NINA Report 293

A summary of the environmental and socio-economic characteristics of the Crna Reka (Crna River) watershed, Macedonia

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Norwegian Institute for Nature Research

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Crna Reka at the inflow to Tikvesh Reservoir.
Photo: Vasil Kostov

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Abstract

Spirkovski, Z., Talevski, T., Ilik-Boeva, D., Kostoski, G. & Sandlund, O.T. 2007. A summary of the environmental and socio-economic characteristics of the Crna Reka (Crna River) watershed, Macedonia. - NINA Report 293. 37 pp + 12 Annexes.

Crna River (Crna Reka) is the biggest tributary to the Vardar River from the west. Vardar River is the biggest watercourse in the Republic of Macedonia, and drains into the Aegean Sea. The catchment area of Crna River is positioned between 20º 57' – 22º 04' E and 40º 50' – 41º 36' N at altitudes from 2601 m a.s.l. (Pelister) to 130 m a.s.l. at the confluence with Vardar River. Mean elevation of the catchment area is 630 m is above sea level. The catchment area of 5093 km^2 includes twenty municipalities, with a total of 232,272 inhabitants. The water potential from the catchment area is 1001x106 m^3. The climate zones are cold continental (60% of the area), continental-submediterranean (20%), and foothills continental mountaineous (20%).

In the source areas of Crna River and its tributaries, typical representatives of flora and fauna communities associated with river sources are present. These communities include several species which are typical of clean unpolluted freshwaters. The flora and fauna along the major part of the river is, however, determined by the habitat types and the extent of human alteration of the natural conditions. Aquatic species diversity is seriously diminished in the middle and lower section of Crna River (through the Pelagonija plains and Tikvesh Valley) due to significant pollution of the waters by the inflow of communal and industrial sewage, as well as nutrients, sediments and pesticides in agricultural runoff. Major sources of pollution are the areas around the towns of Bitola and Priliep. Through the Skocivir ravine, the waters and biodiversity of Crna River is in a somewhat better condition due to the supply of fresh and clean mountain waters from the tributaries.

The Tikvesh reservoir was created by the construction of a dam on the Crna River near the village of Vozarci, and has an increased species diversity due to the substantial water masses and the inflow of clean tributaries into the reservoir. The elevation of the reservoir is 260 m a.s.l., and the surface area is 1232.8 ha. Average, maximum and minimum flow in Crna River at the confluence with Vardar River is 22.4, 46.2 and 3.5 m^3 / sec, respectively.

Water quality in Macedonian water courses is mainly monitored by the Hydrometeorological Agency (HMA). Water quality classes are defined based on the concentration of a number of chemical and biological parameters (e.g. concentration of heavy metals, organic matter, etc., and bacterial content), according to the Macedonian Water Classification Regulative. The required water quality at various points in the Crna River water course has been established by law, but data from the monitoring programme show that the required quality level in many cases is not achieved. The European Fish Index (EFI) and ecological status for River Crna indicate that the upper part of the river, down to Bucin, at 650 m a.s.l., is characterized by rapid flow and salmonid-dominated fish community with a good ecological status. After the inflow of river Blato the ecological status deteriorates. The remaining downstream parts of the river have a moderate ecological status, except at the profile below the town of Bitola, which according the EFI has a bad ecological status. In the Skocivir canyon, the self-purification ability of the river brings the ecological status back to the moderate level all the way to the confluence with the river Vardar.

The effluents from the towns of Bitola and Prilep have a significant negative influence on the fish fauna in River Crna. In the future, special attention must be dedicated to improve the water quality in the rivers Blato and Dragor, and in Canal 5 (which drains the Hydrosystem Strezevo), by establishing effective treatment of communal and industrial waste waters.

Altogether 28 species of fish have been recorded in the Crna River water course. At the uppermost sampling station (760 m a.s.l.), only one species, brown trout (*Salmo trutta*), has been recorded. Brown trout also occurs down to 650 m a.s.l., togeteher with from one to nine cypri-

nid species. Cyprinids are dominant at all remaining sampling stations downstream. At the sampling site Skocivir (520 m a.s.l), only one species, the introduced Prussian carp (*C. gibelio*), was recorded. This indicates an intensive level of pollution at this sampling site. At the sampling site Vliv (450 m a.s.l.) the fish fauna is again fairly diverse, with 12 species representing four families identified in the samples. Altogether eight of the 28 species recorded in Crna Reka have been introduced to the system.

The fish fauna of Tikvesh Reservoir (260 m a.s.l.) is composed of 17 species from 7 families. The fish fauna in Tikvesh Reservoir seem to be in a process of dramatic change. The populations of some of the introduced non-native fish species are increasing in a significant way. This is the case for the population of the North American catfish species *Ameiurus nebulosus* (brown bullhead), as well as the non-native European species *Gymnocephalus cernuus* (ruffe). On the other hand, the populations of the native species *Cyprinius carpio* (common carp), *Rutilus rutilus* (roach), *Tinca tinca* (tench), and *Vimba melanopsis* (Macedonian vimba) are decreasing. Crna River represents an attractive and famous river for angling. The number of daily sport fishing licences sold annually is between 8000-9000. Beside the sport fishing, and commercial fishing on the Tikvesh Reservoir, there is a cage culture mainly of common carp, with an annual production between 500-600 metric tons.

The aquatic invertebrate fauna has been investigated during the last three decades both on Crna River and the Tikvesh Reservoir. All recorded species are common, and no rare or endangered invertebrate species have been recorded.

The natural reserve Tikvesh covers an area of 10,600 hectares. At the time it was established as a natural reserve, 131 bird species had been observed within its borders. This includes 23 species of birds of prey, of which 17 nest within the reserve area. In total, among the birds of prey present in the Crna River watershed and the Tikvesh reserve, four species are on the World Red List and 14 on the European Red List. In addition, many other bird species also contribute to the Tikvesh reserve being on the IUCN list of important bird habitats in Europe.

In relation to possible further hydropower development in this water course, there are a few aspects which may need particular attention. In terms of biodiversity and nature conservation, the natural reserve (SPR) Tikvesh is of special importance. It is linked with the Canyon of Crna River. The canyon stretches 80 km from the village of Skocivir downstream to the upper end of the Tikvesh Reservoir, and in terms of biodiversity represents a refugial zone. In this zone, several species occurs that are listed as threatened according to IUCN.

The most important measure in terms of protection of the Crna River is to reduce the heavy water pollution, which in particular is due to the effluents from the tributaries Blato and Dragor, and from Canal 5 of the Strezevo hydrosystem. Establishment of a comprehensive biodiversity monitoring programme for the Crna River watershed should be a priority in association with the new and planned human activities in the watershed. The new Fisheries Act of Macedonia, which will be adopted during the autumn of 2007, also calls for the development of management plans for all water bodies of the country.

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Sammendrag

Spirkovski, Z., Talevski, T., Ilik-Boeva, D., Kostoski, G. & Sandlund, O.T. 2007. Et sammendrag av kunnskapene om miljø og sosio-økonomiske forhold langs Crna Reka vassdraget, Makedonia. - NINA Report 293. 37 s + 12 annex.

I forbindelse med at Statkraft Energi AS ønsker å engasjere seg i vannkraftprosjekter i Republikken Makedonia ble NINA, i samarbeid med Hydrobiological Institute, Ohrid, Makedonia, gitt i oppdrag å sammenfatte tilgjengelig kunnskap om miljøet og enkelte sosio-økonomiske forhold i nedbørfeltet til Crna Reka ("Crna-elva").

Crna Reka er en sidelelv til Vardar-elva, som er det største vassdraget i Republikken Makedonia. Vardar drenerer til Egéerhavet. Nedbørfeltet til Crna Reka ligger mellom 20º 57' – 22º 04' Ø og 40º 50' – 41º 36' N. Høyeste punkt er 2601 m o.h. (Pelister), mens sammenløpet med Vardar ligger 130 m o.h. Nedbørfeltets gjennomsnittlige høyde over havet er 630 m. Crna Rekas nedbørfelt oppgis av ulike kilder å være mellom 4526 og 5093 km^2, med en befolkning på noe over 232 000 mennesker.

Crna Reka har sitt utspring nær landsbyen Zeleznec 760 m o.h. Elva er relativt ren og uberørt i de øvre deler, men forurensning fra landbruk, husholdning og industri fører til stor belastning på de lavereliggende strekningene, det vil si over Pelargonija-slettene og gjennom Tikveshdalen. Vannkvaliteten i makedonske vassdrag overvåkes av det Hydrometeorologiske Byrået (HMA). Vannkvaliteten klassifiseres på grunnlag av en rekke kjemiske og biologiske parametre i henhold til statlige forskrifter. Målingene i Crna Reka viser at vannkvaliteten i vassdraget til dels er dårlig. Spesielt gjelder dette nedstrøms for byene Bitola og Prilep. Sideelvene Dragor og Blato, samt Kanal 5, som drenerer irrigasjons- og vannsystemet Strezevo, fører sterkt forurenset vann ut i Crna Reka. Selvrensingevnen til elva, og tilførsel av renere vann fra andre sideelver, fører til en bedre vannkvalitet gjennom Skocivir-ravinen, i Tikvesh-reservoiret og ned til sammenløpet med Vardar. Gjennomsnittlig vannføring ved Crna Rekas sammenløp med Vardar-elva er 22,4 m^3 pr sekund, mens maksimum og minimum er henholdsvis 46,2 og 3,5 m^3 pr sekund.

Tikvesh-reservoiret (260 m o.h.) er bygd i forbindelse med det eneste vannkraftanlegget i Crna Rekas hovedløp. Demningen ligger nær landsbyen Vozarci. Reservoiret har en overflate på ca 1233 ha. I tillegg til at vannet utnyttes til kraftproduksjon og irrigasjon drives det fiskeoppdrett, kommersielt fiske og fritidsfiske i Tikvesh-reservoiret.

Fiskefaunaen i vassdraget består av i alt 28 arter. I de øvre delene, ned til ca 650 m o.h. (ved Bucin), domineres den av ørret (*Salmo trutta*). Her klassifiseres den økologiske statusen som "god". Lenger ned dominerer karpefiskene fiskesamfunnet, og økologisk status klassifiseres som "moderat". På den lokaliteten som er tyngst belastet med forurensing (Skocivir) finnes bare en karussart (*Carassius gibelio*), som er en introdusert art. På denne lokaliteten er økologisk status klassifisert som "dårlig". I tillegg til *C. gibelio* er også sju andre fiskearter introdusert i vassdraget. Fiskefaunaen i Tikvesh-reservoiret består av 17 arter, men er i kraftig endring. Flere av de introduserte artene, som f eks den nordamerikanske arten dvergmalle (*Ameiurus nebulosus)* og den introduserte europeiske arten hork (*Gymnocephalus cernuus*), øker kraftig i antall, mens flere av de naturlig forekommende karpefiskartene, som karpe (*Cyprinius carpio*), mort (*Rutilus rutilus*), suter (*Tinca tinca*), and Makedonsk vimme (*Vimba melanopsis*) går tilbake. Crna Reka er en attraktiv elv for sportsfiskere fra store deler av Makedonia.

Det er gjort to undersøkelser av bunndyrfaunaen i Crna Reka og Tikvesh-reservoiret, og det foregår en viss overvåking. Det er så langt ikke påvist noen sjeldne eller truete arter i disse undersøkelsene.

Omgivelsene til Tikvesh-reservoiret og naturreservatet Tikvesh har en særpreget og verneverdig vegetasjon. I dette området er det også en svært artsrik fuglefauna (totalt 134 arter). Spe-

sielt omfatter de 23 artene av rovfugl mange arter som er oppført både på den globale og europeiske rødlista. Dette området er knyttet til Crna Reka-ravinen, som strekker seg 80 km fra landsbyen Skocivir til Tikvesh-reservoiret, og må vies spesiell oppmerksomhet ved en videreutbygging av kraftpotensialet i Crna Reka.

De viktigste miljøtiltakene i Crna Reka vil være å redusere forurensningen, med spesielt fokus på tilførslene fra sideelvene Dragor og Blato, og Kanal 5 fra Strezevo. Det er også viktig å etablere et program for overvåking av biologisk mangfold i og langsmed vassdraget slik at mulige effekter av ny infrastrukturutbygging og annen menneskelig aktivitet kan registreres. Den nye makedonske fiskerilovgivningen, som trolig blir vedtatt høsten 2007, krever også at det utvikles forvaltningsplaner for vassdraget.

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Contents

Foreword

During spring 2007, Statkraft Energy AS commissioned the Norwegian Institute for Nature Research (NINA) and Hydrobiological Institute (HBI), Ohrid, to compile a summary of available information on environmental and socio-economic conditions along the Crna River (Crna Reka) water course in the Republic of Macedonia. The aim was to obtain background documentation necessary for Statkraft Energy's planned activities in Macedonia.

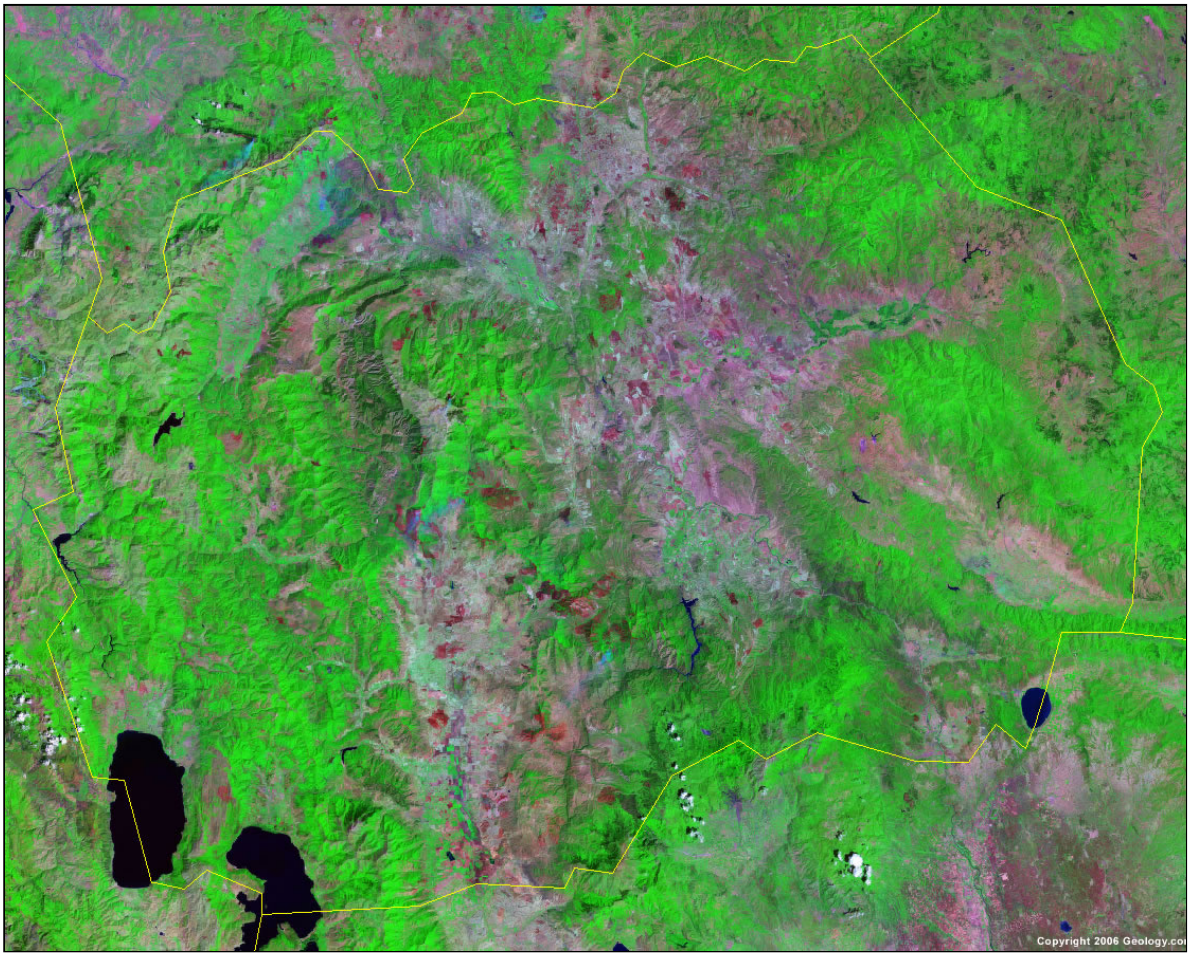
HBI has enlisted a number of Macedonian experts to cover all aspects of this task. The work in Macedonia has been coordinated by Dr. Zoran Spirkovski. Dr. Odd Terje Sandlund has coordinated the work from the Norwegian side, and liaised with the client, Statkraft.

We are grateful for the important contributions from Dr. Vasil Kostov, Institute of Animal Science, and Mr. Stoe Smiljkov, Institute of Biology (Faculty of Natural Sciences and Mathematics), both at the University of St. Cyrilus and Methodius, Skopje. Thanks are also due to Statkraft Energy AS for this interesting commission.

Trondheim/Ohrid, September 2007

Odd Terje Sandlund

Zoran Spirkovski



Satellite image of the Republic of Macedonia.

Map of the Republic of Macedonia.

Top:
Crna River flowing through the village Zeleznec.

Middle:
Crna River nearby the village Graiste.

Bottom:
Crna River flowing through the village Bucin.

All photos: Trajce Talevski

Top:
Crna River between the villages Barakovo and Vardino.

Middle:
Wetland (Blato) at the left tributary of Crna River at the village Borotino.

Bottom:
Crna River at the village Topolcani.

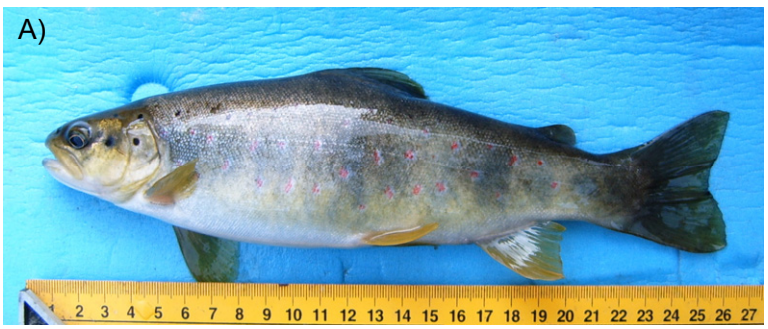
All photos:Trajce Talevski

Top:
The canyon of Crna River near Skocivir.

Middle:
From the Tikvesh reservoir.

Bottom:
Some fish species present in Crna River:
A) Brown trout (Salmo trutta)
B) Vardar loach (Cobitis varda-rensis)
C) Macedonian barbel (Barbus macedonicus)
D) Roach (Rutilus rutilus)

All photos: Vasil Kostov



1 Catchment characteristics

Waters in the Republic of Macedonia affiliate to three watersheds: the Adriatic, the Black Sea and the Aegean watershed (**Figure 1**). The Vardar River, which is the biggest watercourse in the Republic of Macedonia, drains into the Aegean Sea. Its biggest tributary from the west is Crna River (Crna Reka). The catchment area of Crna River is positioned between 20º 57' – 22º 04' E and 40º 50' – 41º 36' N at altitudes from 2601 m a.s.l. (Pelister) to 130 m a.s.l. at the confluence with Vardar River. Mean elevation of the watershed is 630 m above sea level.

Some characteristics of the Crna River catchment area are:

- The catchment area of 5093 km^2 includes twenty municipalities, with 338 settlements (urban: 3, rural: 335), and a total of 232,272 inhabitants. The water potential from the catchment area is $1001x10^6$ m^3 water. The climate zones are cold continental (60% of the area), continental-submediterranean (20%), and foothills continental mountaineous (20%).
- Main rivers in the watercourse are: Crna River, with tributaries Blato River (with Prilepska River), Shemnica River, Elenska River, Skochivirska River, Galishka River, Blashtica River, Pravednichka River, Kamenica River, Dabnishka River, Raec River, Debrishka River, Kamendolska River, Sirkovska River, Krishevichka River.
- There are four swamps: Lokvi, Zabjani, Vozarechko and Manastirsko Blato.
- There are four reservoirs: Strezevo, on the Shemnica River; Prilep, on the Oreovachka River; Suvodol, on the Skochivirska River, and Tikvesh (Lake Tikvesh) on Crna River.
- There arfe three fish ponds: Bel Kamen, Bukri, Ribolom.

There is a large diversity of ecosystem types within the catchment area. The aquatic habitats include streams, rivers, swamps, reservoirs, and fish ponds. The terrestrial habitats include riparian zones, meadows, alluvial plains, gorges, canyon, hilly pastures, shrubs, light forests, and degraded forest complexes.

In the source areas of Crna River and its tributaries, typical aquatic flora and fauna communities associated with clean unpolluted freshwaters are present. The flora and fauna along the major part of the river is, however, determined by the habitat types and the extent of human alteration of the natural conditions.

In the middle section of Crna River (through Pelagonija), and in the lower section (through Tikvesh Valley), the species diversity is seriously diminished as a result of significant pollution of the waters by the inflow of communal and industrial sewage, as well as nutrients, sediments and pesticides in agricultural runoff. Through the Skocivir ravine, the waters and biodiversity of Crna River is in a somewhat better condition due to the supply of fresh and clean mountain waters from the tributaries.

The Tikvesh reservoir also has a significant positive impact on the species diversity due to the substantial water masses and the inflow of clean tributaries into the reservoir. The reservoir was created by the construction of a dam on the Crna River near the village of Vozarci. The location of dam the is 21º 56' 13" E, 41º 18' 40" N (cf. MKVSS0022). The elevation of the reservoir is 260 m a.s.l., and the surface area is 1232.8 ha.

Crna River rises at the spring Crna Dupka near the village of Zeleznec at an elevation of 760 m in Demir Hisar. It flows through several municipalities from the source to its confluence with Vardar River. Crna River is the main recipient of the sewage and industrial waste waters in this densely populated part of the country.

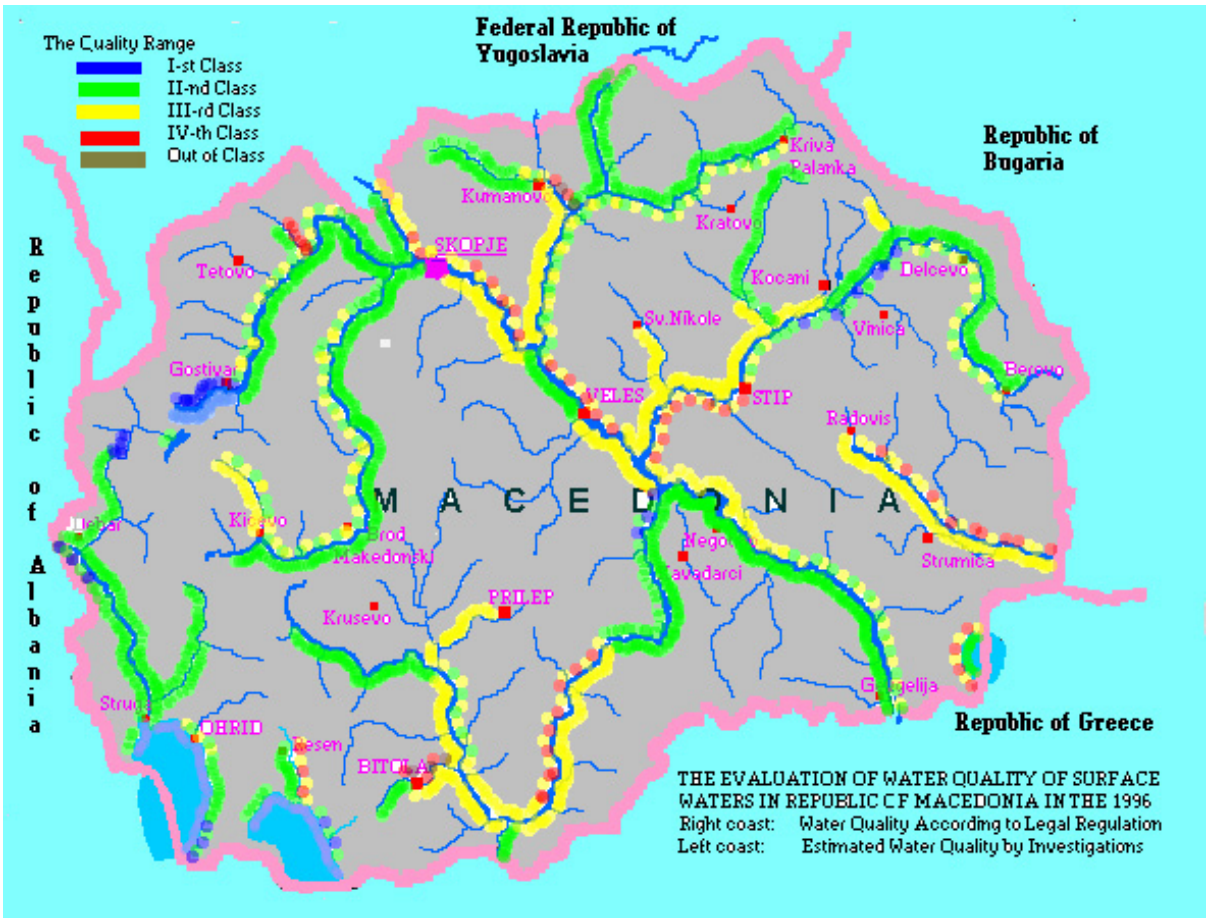


Figure 1. *Hydrographic map of the Republic of Macedonia with classification of water quality in the main rivers (see also* ***Table 6*** *and* ***Annex 10****). Colour code on the right river bank indicate the desired water quality according to legal regulations, colour code on the left river bank water quality according to monitoring data.*

The municipality of Demir Hisar, where Crna River has its source, can be divided into Gorni and Dolni Demir Hisar. Dolni Demir, with the settlement of Demir Hisar, is the municipial centre, whereas the urban centre of Gorni Demir Hisar is the settlement of Sopotnica. Only around 3% of the total population in Gorni Demir Hisar is employed in industrial and mining facilities. Of the three major industrial facilities in this region, the "Demir Hisar" mine for iron ore exploitation is presently out of operation, whereas the Toplica mine for separated limestone, and the "Zeleznik" factory for steel pellets are still active.

Via its minor tributaries, Crna River is the main recipient of sewage and other communal runoff waters in the municipality of Demir Hisar. The most important of these tributaries are the Ilinska River which flows through or past the villages of Golemo Ilino and Malo Ilino; and the Boishka River which flows through or past the villages of Boishta and Virovo. Zaba River, which flows into the Crna River at Goren Demir Hisar, flows through or past the villages Rastoica, Rakitnica, Novo Selo. These three tributaries all join the Crna River from the south. The only northern tributary in this area is Obednichica River, which flows through or past the villages Smilevo, Obednik, and Murgashevo. A watering system managed by the public water company (PWC), which was constructed fifty years ago, is still functioning, although with certain deficiencies. It is situated a few kilometers downstream from the inflow of Boishka River, between the villages of Zvan and Sopotnica.

Crna River may be regarded as a mountain river until the confluence with Boishka River. Starting from the village of Zvan it is a lowland river with a very small gradient and a relatively steady course, mostly due to its wide riverbed and dense riparian vegetation (willows, alders etc.). The current is slow, and the river frequently overflows its banks in some areas, causing flooding of agricultural land. Some hydromorphological modifications were done fifty years ago by clearing the land and straightening the riverbed, but due to lack of maintenance and non-regulated sand and gravel exploitation, floods presently occur on the average every two or three years, especially during February and March.

For 30 km downstream of the confluence with Obednichica River, there are no tributaries to Crna River, except for some dry gorges which infrequently have small amounts of water during periods with heavy precipitation.

According to certain infrastructural plans (dating from 30-40 years ago) a reservoir for irrigation of the Prilepska Pelagonija area should have been built with a 80 meters high dam at the village of Buchin. This reservoir would have reached from the village of Murgashevo all the way to the village of Buchin. A irrigation system owned by PWC was constructed 50 years ago in front of the village Buchin. It is still in function, but in a very bad condition.

After the village of Buchin, Crna River flows through the wide valley of Pelagonija, with the largest wetland in the Republic of Macedonia (**Figure 2**). The tributaries Blato, Shemnica, Dragor and Jelashka join the Crna River throughout Pelagonija. In particular Blato and Dragor bring large amounts of pollution into the Crna River. In addition, Canal 5, which drains the hydrosystem Strezevo, also empties large amounts of polluted water into Crna River. The amount of water in Canal 5 depends on the amount of groundwater in this region.

The Pelagonija Valley includes most of the southwestern part of the country and it spreads in a north-south (meridional) direction (**Figure 2**). The valley is surrounded by mountains in three directions: Dautica Mountains in the north, Nidje and Selecka Mountains in the east, and Baba and Bisheva Mountains in the west. To the south the valley open towards neighbouring Greece. Pelagonija covers an area of over 4,000 km^2, at an average altitude of approximately 600 m above sea level. The climate is mostly moderately continental, but sometimes during the winter months, northerly cold winds may cause very low temperatures, exacerbating the continental character of the climate. Average annual precipitation in this area is about 640 mm. The production of cereals is mostly focused on wheat, barley, and maize; whereas produce for the industry include sunflower, tobacco, sugar beet, etc. One of the most aromatic tobaccos in the world is cultivated in the Prilep region.

The Strezevo reservoir was constructed on the Shemnica River. Its water supply comes from a canal collecting water from the Pelister Mountain. The quantity of water flowing into Crna River at this point depends on the quantity of water which will be released from the hydrosystem Strezevo through Canal 5. This is very low between March and October and is mostly within the range of the legal minimum (the so-called “biological optimum”). The hydrosystem Strezevo is a complex system of water collection from the catchment areas in the Baba mountains, supplying water to irrigation, public water companies and industry. Two hydropower plants (“Filternica” and “Dovledjik”) are also part of this system. A detailed description is given in **Annex 1**.

2 Water flow and water quality in the Crna River

2.1 Water flow

The hydrology of the Crna River has been studied in detail in cooperation with the Republic Hydrometeorological Agency (HMA). The values below were obtained by analysis of all available data from a period of 36 years (1961-1996), and were presented at the Seventh Conference on the Water Management in the Republic of Macedonia, 1-3 June, 2000 (see also http://www.moe.gov.mk/soer/mkd/water/press4.htm).

Average, maximum and minimum flow and duration of flow in Crna River at the confluence with Vardar River is shown in **Table 1** and **2**. The mean discharge value used here (22.4 m^3/s) is based on the 36 year period 1961-96. For the 45 year period 1961-2005, mean discharge is 25.6 m^3/s.

Table 3 gives an example of the development of a flood situation at the hydrological station Novaci, Crna River, from moderate to high flow over a period of 52 hours, demonstrating the dynamic nature of the river in terms of water flow.

The biological minimum water flow is a concept defined in the National Development Strategy, 1997, based on ecological considerations as 10% of the average water flow of the river in question. **Table 4** shows the biological minimum flow in Crna River at the confluence with Vargar River and the corresponding annual water volume.

Table 1. *Maximum, minimum and mean rates of flow at the hydrological station Rasinbegov Most, at the confluence with Vardar River (cf. Figure 2). Source: Seventh conference: Water management in the Republic of Macedonia, 1-3 June, 2000.*

River Watershed	Station	Max. m^3/s	Min. m^3/s	Average m^3/s
Crna River	Rasimbegov Most	46.20	3.51	22.39

Table 2. *Duration of flow and theoretical annual flow at different discharges in the Crna River, with a catchment area of 4 526 km^2. Source: Seventh conference: Water management in the Republic of Macedonia, 1-3 June, 2000.*

Mean discharge	Minimum discharge, exceeded 97% of the year (355 days)	Discharge exceeded 75% of the year (265 days)	Discharge exceeded 50% of the year (175 days)	Discharge exceeded 25% of the year (90 days)
22.4 m^3/s	1.8 m^3/s	5.2 m^3/s	13.3 m^3/s	31.2 m^3/s
Total annual flow, 10^6 m^3	Theoretical annual flow at 1.8 m^3/s	Theoretical annual flow at 5.2 m^3/s	Theoretical annual flow at 13.3 m^3/s	Theoretical annual flow at 31.2 m^3/s
706 x 10^6 m^3	57 x 10^6 m^3	164 x 10^6 m^3	419 x 10^6 m^3	984 x 10^6 m^3

Table 3. *Development of water flow (m^3/s) at the Novaci hydrological station over a period of 52 hrs in February 2005. The hydrological station Novaci is situated just below the confluence with the tributary Dragor River (cf.* ***Figure 2****, station SP63805).*

Date	13.02.05	14.02.05	15.02.05	15.02.05
Time of day	7:30	7:30	7:30	13:30
Novaci - Crna River	10.80	12.20	14.60	49.50

Table 4. *Biological minimum water flow (B, 10% of mean flow) from an ecological viewpoint (as defined in the National development strategy, 1997), in Crna River at the confluence with Vardar River.*

Watershed/measuring station (Watershed area)	Mean flow (m^3/s)	Biological minimum B, (m^3/s)	Annual discharge at mean flow = B (10^6 m^3)
Crna / Rasimbegov Most (4,526 km^2)	22,4	2,2	70

2.2 Water quality

Water quality in Macedonian waters is mainly monitored by the Hydrometeorological Agency (HMA). The sampling stations used for monitoring in the Crna River drainage area are shown in **Figure 2** and **Table 5**. More details on the sampling sites are given in **Annex 2.**

Water quality classes (**Table 6, Figure 3**) are defined based on the concentration of a number of chemical and biological parameters (e.g. concentration of heavy metals, organic matter, etc., and bacterial content), according the Water Classification Regulative ("Official Gazette of R.M." No. 18/99; **Annex 10**). A summary of water quality status is given in **Figure 4.** A selection of more detailed data from the monitoring programme is given in **Annex 3** (nutrients and heavy metals) and **Annex 4** (saprobic index).

The required water quality at various points in the Crna River water course has been defined by law, according to the quality classification system. Data from the monitoring programme, however, show that the required quality level in many cases is not achieved (**Table 6,** see also **Figure 1** and **Annex 11**: Water Categorization Regulative of watercourses, lakes, reservoirs and underground waters "Official Gazette of R.M." No.18/99).

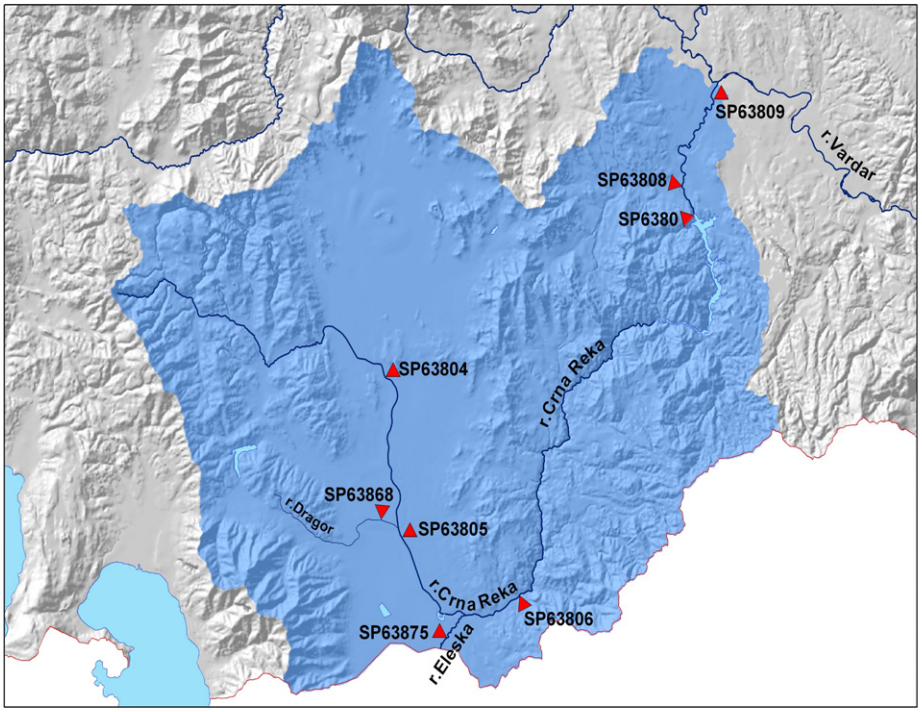


Figure 2. *The Crna River watershed with water sampling stations (see also Table 1). (Source: HMA, 2006).*

***Table 5**. Physical and geographical information about the water quality sampling stations (see also **Figure 2**).*

Water Quality - Sampling Point, Number and Name (cf. Figure 2)		**Position and altitude**		**Mean water depth m**	**River discharge mean flow m^3/s**	**Distance from river source km**	**Catchment area km^2**
Watershed of the Crna River (Crna Reka)		**Latitude / Longitude**	**Altitude m a.s.l.**				
River Crna Reka	SP 63804 v. Topolchani	41° 13' 38'' N 21° 24' 48'' E	580.0	1.10	7.2	40.9	1636.8
	SP 63805 v.Novaci	41° 02' 36'' N 21° 27' 07'' E	572.7	0.80	12.1	63.1	2584.0
	SP 63806 v.Skochivir	40° 58' 08'' N 21° 38' 29'' E	565.58	1.80	20.0	86.9	3979.8
	SP 6380 Tikvesh Reservoir		265.00		Length= 28.0 km Breadth= 0.3-0.7km	163.0	5361.0
	SP 63808 v. Vozarci	41° 25' 30'' N 21° 55' 42'' E	181.42	0.80	27.9 *	164.7	5374.0
	SP 63809 v.Palikura	41° 32' 54'' N 21° 58' 33'' E	130.04	1.20	34.0 *	182.3	5873.0
River Dragor	SP 63868 Bitola	41° 01' 50'' N 21° 20' 23'' E	610.7	0.20	1.0	20.6	117.0
River Eleshka	SP 63875 v. Brod	40° 56' 57'' N 21° 32' 53'' E	581.0 *	0.50	5.1	39.5	866.3

***Table 6**. Water quality at various points in the Crna River and some of its tributaries, 1996, as required by law, and as measured during monitoring. See **Annex 10**. (Data from HMA).*

Locality, Measuring point	**Water quality regulated by law**	**Estimated summary quality by investigation**
Dragor River – Confluence with Crna River	III	IV - w.q.
Eleska River – Confluence with Crna River	II	III – II
Crna River		
v.Topolcani	III	II – III
v.Novaci	III	II – III
v.Skocivir	III	III – IV
Tikvesh Reservoir	II	II

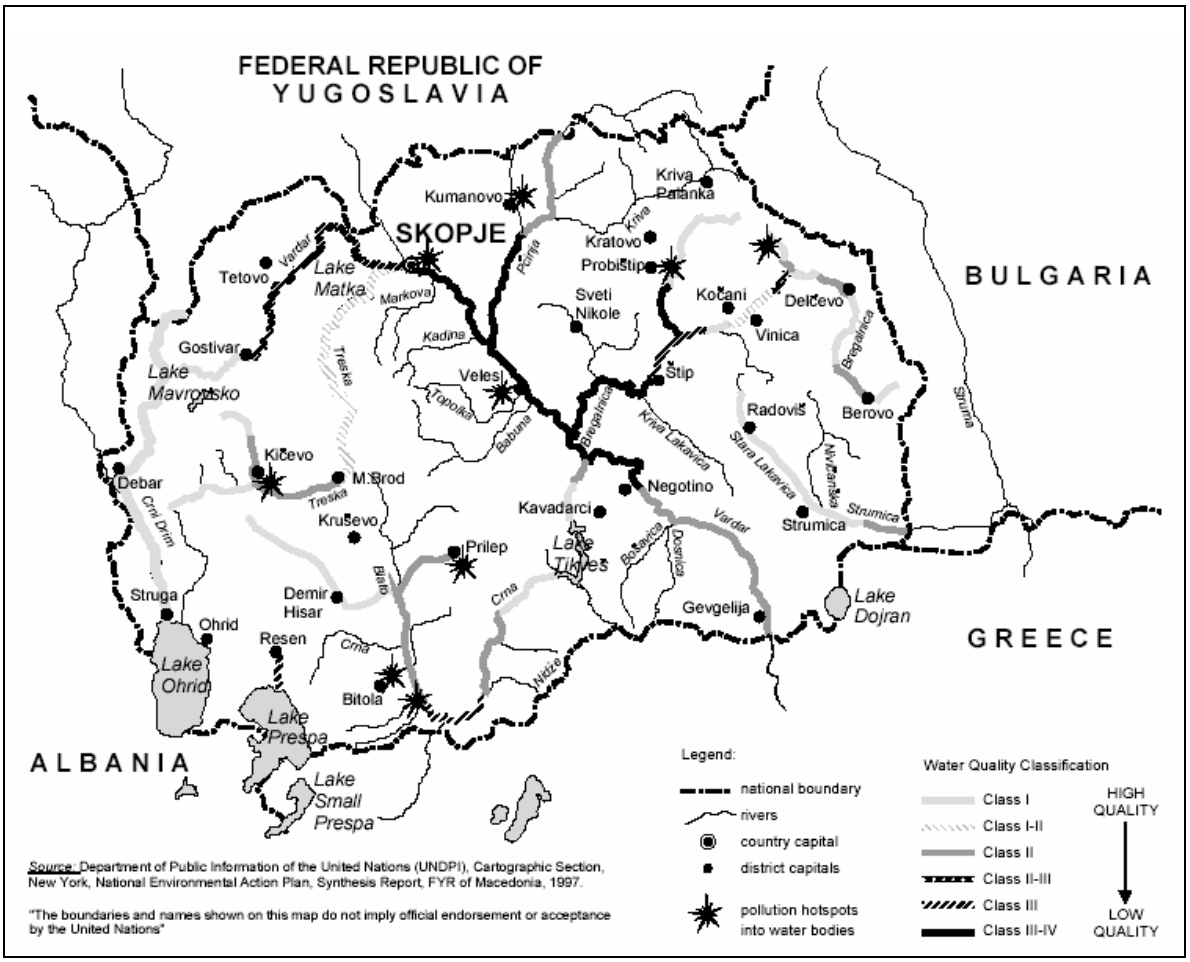


Figure 3. *Water quality classifications (cf.* ***Annex 10****) of Macedonian waters, with pollution hotspots. In the Crna River drainage, note four pollution hotspots: near Kičevo, at the towns of Prilep and Bitola, and downstream from the confluence with Dragor River. (Source: National Environmental Action Plan, 1997).*

Dragor River is a tributary to the Crna River (sampling point SP 63868, **Figure 2**). The poor water quality (IV class) has been present over the last ten years, as a result of discharge of untreated communal and industrial waste waters from the town of Bitola. As it flows into the Crna River, it causes a decline in water quality of this river as well.

Before its confluence with the Crna River, Eleshka River (sampling point SP 63875, **Figure 2**) has a water quality of III class (sometimes of class II). Thus, the legal quality requirement is only partly being met.

The pollution level of Crna River at sampling point SP63806 (**Figure 2**), after it receives untreated communal and industrial waste waters from the town of Bitola, is relatively high. The water quality is usually of class III and occasionally of class IV. Downstream from the Tikvesh reservoir until its confluence with the Vardar River, the pollution level is reduced, and water quality is of class I and sometimes of class II.

According to the report on water quality for rivers and lakes in the Republic of Macedonia in 2002, prepared by the MEIC (Macedonian Environmental Information Center) at the Ministry of Environment and physical planning, concentration of Fe was highest in the Crna River, at the measuring point Skocivir (SP 63806) and in Eleshka River, at measuring point Eleshka (SP

63875). The values of the recorded concentration of Fe classified the water in class IV. For the same measuring point Skocivir in Crna River, dissolved oxygen had the lowest value, so according to this parameter the water was class V.

Regarding COD (chemical oxygen demand, indicating the contents of organic matter), the highest values were recorded in the Crna River, at the village of Skocivir, which put the water in class IV and at the village of Taor on the River Vardar, where value of COD corresponds to the eutrophic character of the water (**Figure 4**). The levels of nitrogen (nitrate, nitrite and ammonium) are shown in **Figure 5**.

The largest cities in the Republic of Macedonia, like Bitola, Prilep, Strumitsa, Tetovo, Gostivar, Veles, and Shtip have no wastewater treatment plants. Some of the rivers are running only as collectors for the wastewater, for example Dragor River in Bitola, Kumanovska River after Kumanovo, Bregalnica River and Crna River. Industries also do not treat the wastewater and especially serious are, beside the organic pollution from food processing industry and slaughterhouses, pollution with heavy metals: chrome (Cr), iron (Fe), cadmium (Cd), lead (Pb), and zink (Zn). The trend of decreasing pollution level shown for Vardar River is positive, but this trend is unfortunately a result of decreasing industrial activity and not due to undertaken measures for protection of the surface water. The quality condition of surface waters is better in areas with low population density and where there is no industry.

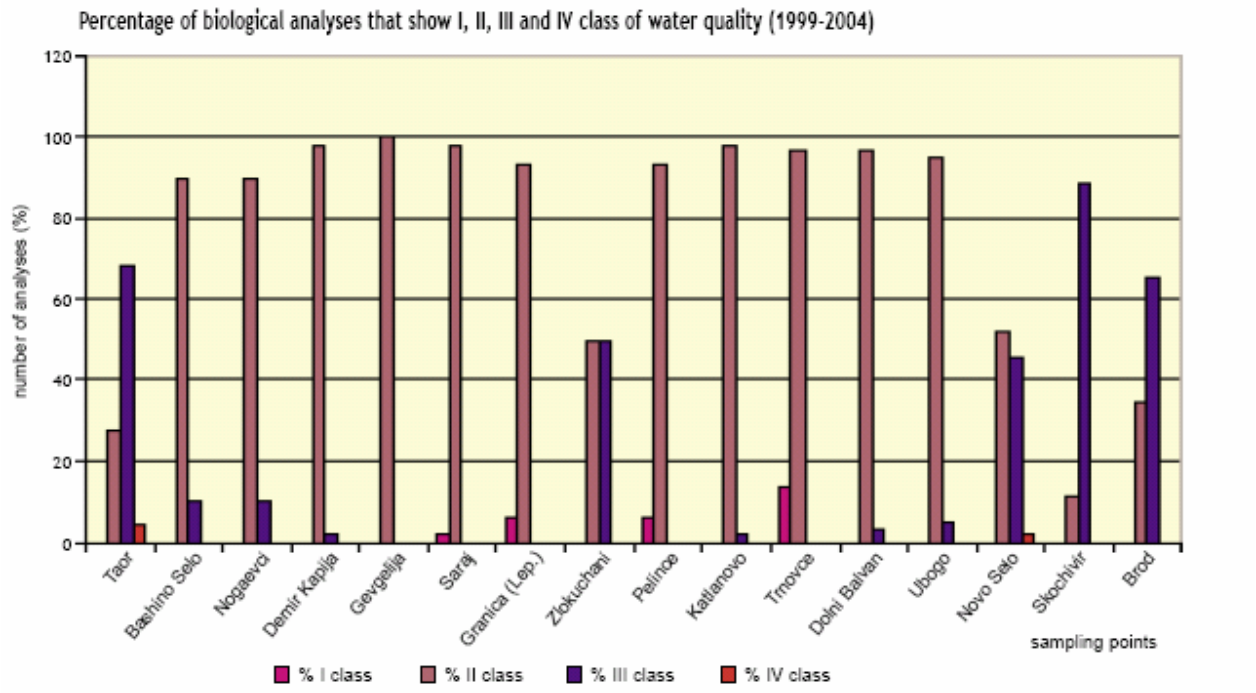


Figure 4. *Percentage of biological analyses showing water quality classes I, II, III and IV at various sampling stations in Macedonian waters during the period 1999-2004. (Source: Hydrometeorological Agency, 2006).*

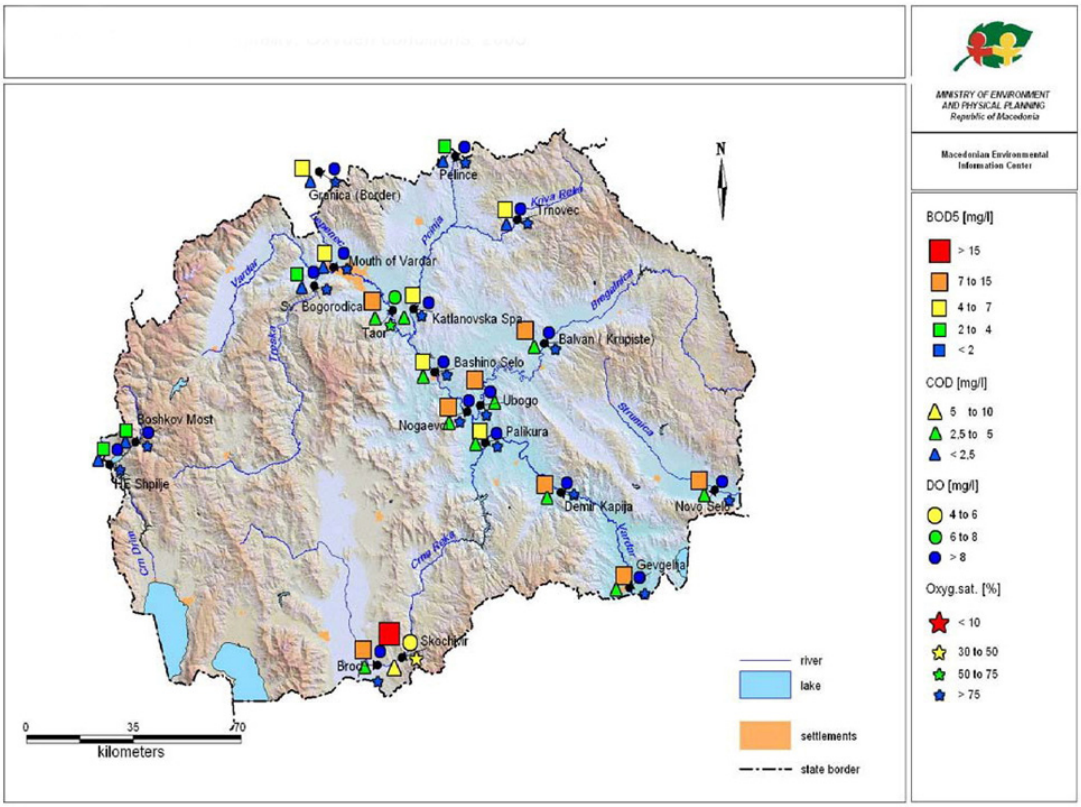


***Figure 5**. Water quality in terms of oxygen conditions in Macedonian rivers, 2005.*

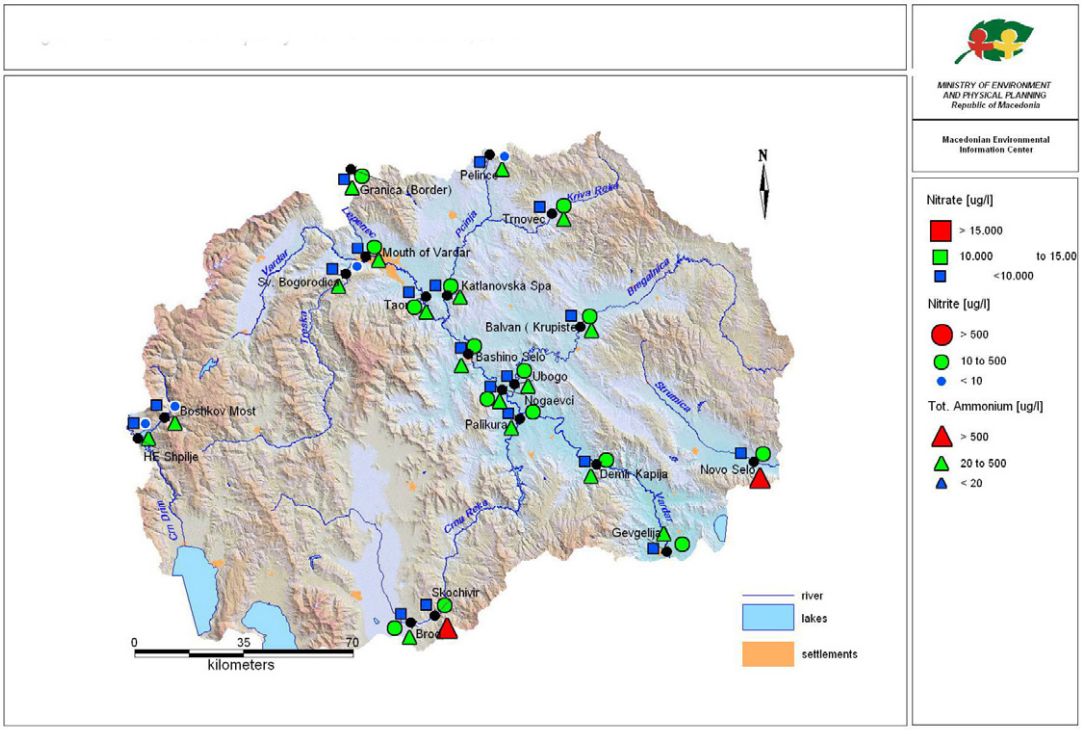


***Figure 6.** Water quality in terms of nitrogen (as nitrate, nitrite and ammonium) in Macedonian rivers, 2005.*

3 Economic activities in the Crna River drainage area

The point sources of pollution in the drainage area of Crna River are mainly associated with industry and mining, which to a large extent is concentrated close to the main urban centres. The main urban centres are the towns of Prilep and Bitola, but also at Demir Hisar, close to the source area of the river, there are several industrial activities. Several economic activities have significant impact on the aquatic ecosystems, such as communal and industrial wastewaters, agricultural runoff, exploitation of water resources (for irrigation, industry, fishery), digging sand, gravel and rocks from riverbeds and riparian areas, production of hydropower, hunting, fishing, and weekend tourism.

3.1 The town and municipality of Prilep

The population of the municipality of Prilep was approximately 77,000 in 2002 (**Annex 5**). Prilep is a town of tobacco and mar ble, and with a rich cultural heritage and history, of national pride and openness to the world, for cultural and historical reasons known as a hero town. The main economical activities are associated with several industrial branches (**Table 7**).

Agriculture and related industries represent one of the most important economic activities in the Prilep municipality. The main agricultural products are tobacco, cereal crops, and garden cultures. The climate is one of the most significant factors for agriculture and tourism development in a certain region. The climate in the Prilep municipality is particularly appropriate for growing tobacco. Prilep is a famous world centre for production of quality tobacco of the type "Prilep" which is especially demanded on the world market. The marble quarries in Prilep produce some of the highest quality marbles in the world.

Table 7. *The economic activity (100%) in Prilep municipality according to the various industries.*

Industry	**%**
Trade	20
Food industry	13
Textile industry	12
Tobacco industry	11
Agriculture	11
Construction	10
Mining	9
Crafts	9
Tourism	3
Metal industry	1
Chemical industry	1
TOTAL:	100

There are numerous mineral deposits in the the Prilep municipality, mostly of nonmetal origin. The following represent the nonmetal ores, which are currently or were previously exploited: feldspar, diatomaceous earth, marbles and dolomites, granite, quartz and perlite. The main mines are situated in the localities Sivec, Kukul, Pletvar, Belovodica, Trojaci, Nebregovo and Sliva. However, the vicinity of Prilep represents an insufficiently investigated area in terms of the available mining resources. Certain abundant natural resources have been detected in some parts which could revolutionize the future development of the region. This concerns mainly the nuclear resources and other mines concentrated in the huge Mariovo Massif. There are also iron ore deposits, but the Prilep region is particularly abundant with marble and granite deposits.

3.2 The town and area of Bitola

Bitola is situated in the western part of Pelagonija, at the foot of Baba Mountain on the riverbanks of Dragor River, which is a major tributary to the Crna River, at an altitude of approximately 650 m. Its urban area encompasses over 24 km^2. The name Bitola has been mentioned since the times of Tzar Samoil. The remains of the ancient Herakle-Linkestis are a proof for the existence of its old town destroyed in the strong earthquake in the year 518. The climate is continental with a mild Mediterranean influence. The average annual temperature is 11 degrees. The population of Bitola is a little more than 95,000 people.

Agricultural production is of major importance for the region of Bitola. The landscape, including the plain and hilly-mountaneous area, greatly determines the character of the agricultural production. The following husbandry productions are important: cattle, sheep, goats and pigs, poultry, and beekeeping. The cultivation farming includes a wide range of products (**Table 8**): cereal crops (wheat, barley, rye, oats and maize), industrial cultures (sunflower, rape seed, tobacco, sugar beet, etc.), forage cultures (maize silage, alfalfa hay, stock peas, sweet peas, cultivated meadows, etc.), field cultures (potato, water/melons, beans, etc.), garden cultures (tomato, pepper, onions, cabbage, etc.), orchard cultures (apple, peach, apricot, sour cherry, etc.), viticulture (wine and table wine sorts), as well as mushrooms, natural meadows and pastures. In summary, agriculture in the Bitola region provides great opportunities for economic growth and job creation, which may contribute to achieving a decent living standard for the population in the rural areas. There is also a large number of factories processing agricultural products in Bitola. Details are given in **Annex 6**.

Table 8. *Types of agricultural production by area in the region of Bitola.*

CULTURES	***Agricultural enterprises (ha)***	***Individual farmers (ha)***	***TOTAL (ha)***
Cereal crops	*10.547*	*15.550*	*26.097*
Industrial cultures	*3.533*	*2.230*	*5.763*
Garden cultures	*105*	*720*	*825*
Field cultures	*-*	*650*	*650*
Forage cultures	*3.019*	*2.120*	*5.139*
Permanent plantations (fruit, etc.)	*790*	*917*	*1.707*
Fish ponds	*216*	*-*	*216*
Meadows	*268*	*4.413*	*4.681*
Noncultivated area	*5.956*	*13.441*	*19.397*
TOTAL AREA	*24.434*	*40.041*	*64.475*

3.3 The municipality of Demir Hisar

In Demir Hisar there are also industrial activities that may impact on the water course. This include:

- Quarry (stone extraction), at the village of Sloeshtica
- Zeleznik, factory for steel pellets production
- A smaller capacity slaughterhouse

Two factories are presently out of work:

- Auto parts factory
- Factory for primary fermentation of tobacco “Jugotutun”- Demir Hisar

4 Biodiversity

4.1 Fish fauna

The occurrence of fish species at 12 sampling stations (**Figure 7**) in the Crna River is shown in **Table 9**. Common (Macedonian and English) and scientific names are given in **Annex 7**.

The investigation was made on 11 sampling sites on River Crna during September and October 2006, and at several sampling sites in the Tikvesh Reservoir during the whole year in 2006 (Kostov, 2007). For the first time in the waters of the Republic of Macedonia the non-native species *Acipenser ruthenus* was recorded. It is not known how this species has been introduced to the Tikvesh Reservoir.

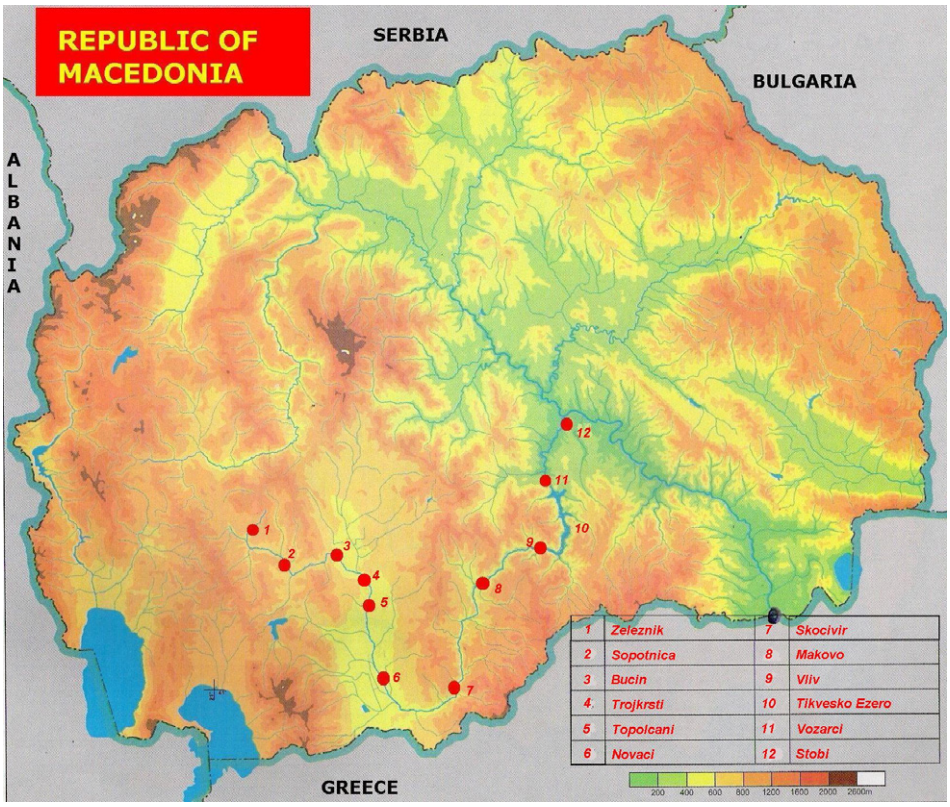


Figure 7. *Sampling localities 1 – 12 in the Crna River, where fish was collected during 2006.*

At the uppermost sampling station (number 1 in **Figure 7**), only one species, brown trout (*Salmo trutta*), was recorded (**Table 9**). At the second sampling site, two species were been recorded, brown trout and the barbel *Barbus peloponnesius*. Brown trout was very abundant, and the dominant species at these two sampling sites. At the third sampling site, near the village of Buchin, brown trout was also found in abundant numbers, but at this site the fauna was dominated by nine recorded species of the Cyprinidae family. Cyprinids were dominant at all remaining sampling stations downstream. At the sampling site Novaci (number 6 in **Figure 7**), the introduced species pike (*Esox lucius*) was recorded for the first time in the waters of Vardar drainage system. The population appears to be abundant and well established. At the sampling site Skocivir (number 7 in **Figure 7**), only one species, the introduced Prussian carp (*C. gibelio*), was recorded. This indicates an intensive level of pollution at this sampling site. At the sampling site Vliv (number 9 in **Figure 7**) the fish fauna was again fairly diverse, with 12 species representing four families identified in the samples.

Table 9. *Occurrence of fish species at twelve sampling localities in the Crna River, 2006. The position of localities is given in* ***Figure 3****. Introduced species (species non-native to this watershed) are in bold letters. Common Macedonian and English names are given in* ***Annex 7****.*

	Map locality	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
	Fish species	**Zeleznec**	**Sopotnica**	**Buchin**	**Trojkrsti**	**Topolcani**	**Novaci**	**Skocivir**	**Makovo**	**Vliv**	**Ezero**	**Vozarci**	**Stobi**	**# sites**
1	*Alburnoides bipunctatus*	-	-	+	+	+	+	-	+	+	+	-	+	*8*
2	*Alburnus alburnus*	-	-	-	+	+	+	-	-	+	+	-	+	*6*
3	*Barbus macedonicus*	-	-	-	-	-	-	-	+	+	-	-	-	*2*
4	*Barbus peloponnesius*	-	+	+	-	+	+	-	+	-	-	+	+	*7*
5	***Carassiun gibelio***	-	-	-	-	-	+	+	+	+	+	-	-	*5*
6	***Carassius carassius***	-	-	+	-	+	-	-	-	-	-	-	+	*3*
7	*Chondrostoma vardarense*	-	-	+	+	+	-	-	-	+	+	-	+	*6*
8	*Cobitis vardarensis*	-	-	-	-	+	+	-	-	-	-	-	+	*3*
9	*Cyprinus carpio*	-	-	-	-	-	+	-	-	-	+	-	-	*2*
10	***Gymnocephalus cernuus***	-	-	-	-	-	-	-	-	-	+	-	-	*1*
11	*Gobio gobio*	-	-	+	-	+	+	-	+	-	-	+	+	*6*
12	*Gobio uranoscopus*	-	-	+	-	-	-	-	-	-	-	-	-	*1*
13	*Leucuscus cephalus*	-	-	+	+	+	+	-	+	+	+	+	+	*9*
14	*Pachychylon macedonicus*	-	-	-	-	-	-	-	+	-	-	-	-	*1*
15	*Perca fluviatilis*	-	-	-	-	-	-	-	-	+	+	-	-	*2*
16	***Pseudorasbora parva***	-	-	-	-	-	+	-	-	-	+	-	+	*3*
17	***Rhodeus amarus***	-	-	+	-	+	+	-	-	+	+	-	+	*6*
18	*Rutilus rutilus*	-	-	-	-	-	-	-	-	+	+	-	-	*2*
19	*Salmo trutta*	+	+	+	-	-	-	-	-	-	-	-	-	*3*
20	*Scardinius erythrophthalmus*	-	-	-	-	-	-	-	-	+	+	+	-	*3*
21	*Silurus glanis*	-	-	-	-	-	-	-	-	+	+	-	-	*2*
22	*Tinca tinca*	-	-	-	-	-	+	-	-	-	+	-	-	*2*
23	*Vimba melanopsis*	-	-	-	-	-	+	-	-	-	+	-	+	*3*
24	***Ameiurus nebulosus***	-	-	-	-	-	-	-	-	-	+	-	-	*1*
25	***Lepomis gibbosus***	-	-	-	-	-	-	-	-	+	+	-	-	*2*
	Total fish species per site	*1*	*2*	*9*	*4*	*9*	*12*	*1*	*7*	*12*	*17*	*3*	*11*	

The fish fauna of Tikvesh Reservoir (sampling site number 10 in **Figure 7**, at 260 m a.s.l.) is composed of 17 species from 7 families. Twelve species belong to the Cyprinidae family. Observations by anglers and others seem to indicate that the fish fauna in Tikvesh Reservoir is in a process of dramatic change. The populations of some of the new introduced fish species are increasing in a significant way. This is the case for the population of the North American catfish species *Ameiurus nebulosus* (brown bullhead), as well as the non-native European species *Gymnocephalus cernuus* (ruffe). On the other hand, the populations of *Cyprinius carpio* (common carp), *Rutilus rutilus* (roach), *Tinca tinca* (tench), and *Vimba melanops* (Macedonian vimba) are decreasing.

Species from the Cyprinidae family are also dominant at the two sampling stations below the Tikvesh dam (number 11 and 12 in **Figure 7**). Particularly abundant is the barbel *B. peloponnesius.*

Table 10 shows the European Fish Index (EFI) (cf. Fame Consortium, 2005) and ecological status calculated for River Crna. The profiles in the upper part of the river ("Zeleznec", "Sopotnica" and "Bucin") are characterized by rapid flow and a salmonid-dominated fish community and have a good ecological status. After the inflow of river Blato, at the profile "Trojkrsti", the ecological status deteriorates. The remaining downstream parts of the river have a moderate ecological status, except at the profile below the town of Bitola, which according the EFI has a bad ecological status. Below the "Skocivir" profile, the river enters the Skocivir canyon, where the self-purification ability of the river is impressive. The water quality improves and the ecology status remains at the moderate level all the way to the confluence with the river Vardar.

The effluents from the towns of Bitola and Prilep have a significant negative influence on the fish fauna in River Crna. This is obvious on the profile "Skocivir" below Bitola and outlet of the "fifth canal" (Canal 5) into the river. In the future, special attention must be dedicated to improve the water quality in the tributaries Dragor and Blato and to establish treatment of the waste waters from Canal 5.

Table 10. *European Fish Index (cf. Fame Consortium 2005) and ecology status of Crna River.*

Site name	latitude	longitude	altitude	EFI	Ecology status
Zeleznec	41º 18' 42"	21º 05' 28"	760.0	0.63	Good
Sopotnica	41º 17' 09"	21º 09' 33"	700.0	0.64	Good
Bucin	41º 15' 29"	21º 12' 10"	650.0	0.60	Good
Trojkrsti	41º 12' 32"	21º 25' 54"	620.0	0.41	Moderate
Topolcani	41º 12' 53"	21º 25' 38"	580.0	0.39	Moderate
Novaci	41º 02' 24"	21º 26' 23"	550.0	0.29	Moderate
Skocivir	40º 58' 17"	21º 38' 20"	520.0	0.09	Bad
Makovo	41º 05' 23"	21º 40' 05"	490.0	0.43	Moderate
Vliv	41º 16' 52"	21º 52' 48"	450.0	0.34	Moderate
Vozarci	41º 25' 02"	21º 53' 47"	105.0	0.31	Moderate
Stobi	41º 33' 02"	21º 58' 43"	95.0	0.44	Moderate

4.2 Fish resources utilisation

Crna River represents is an attractive and famous river for angling. Anglers from all over Macedonia visit this river where in the upper part trout and barbel are most dominant while downstream in the slower running river sections the main target species are various cyprinids, as well as catfish and pike. The number of daily sport fishing licences sold to anglers each year is between 8000-9000. In the Tikvesh Reservoir there is some commercial fishing, and also a cage (net pen) culture, mainly of common carp, with an annual production between 500-600 metric tons.

4.3 Aquatic invertebrates

The aquatic invertebrate fauna has been investigated during the last three decades both on Crna River and the Tikvesh Reservoir. The investigations were performed by the Zoological Department of the Faculty of Natural Sciences and Mathematics in Skopje. All recorded species are characterized as common, and no rare or endangered invertebrate species have been recorded. The occurrence of the invertebrate species is shown in **Table 11**.

Table 11. *Recorded species in the fresh water invertebrate fauna of the River Crna and the Tikvesh Reservoir. Based on Stefanovic, 1979; Bogdanovska, 1984; and 32 qualitative samples from the last 5 years (2001-2006).*

	Crna River	Tikvesh Reservoir
Gastropoda		
Viviparus viviparous L	+	+
Ancylus fluviatilis Muller	+	
Planorbis planorbis L.	+	+
Lymnaea (Radix) peregra Drap.	+	+
Valvata piscinalis Mull.	+	
Lymnaea trunculata Muller	+	+
Oligochaeta		
Nais sp.	+	+
Tubifex tubifex Muller, 1774	+	+
Limnodrilus udekemianus Claparede, 1862	+	
Limnodrilus hoffmeisteri Claparede, 1862		+
Dendrobaena byblica Rosa, 1893		+
Ocstolasium lacteum Oerley,1881		+
Eiseniella tetraedra Savigny,1826		+
Hirudinea		
Dina lineata lineata O.F. Muller,1774	+	+
Crustacea: Isopoda		
Asellus aquaticus L.	+	+
Crustacea: Amphipoda		
Gammarus balcanicus Sch.	+	+

Table 11 continued	**Crna River**	**Tikvesh Reservoir**
Heteroptera		
Nepa cinerea		+
Coleoptera		
Hydroporus sp.	+	
Limnius volckmari	+	+
Plecoptera		
Chloroperla torrentium Pictet	+	
Perlodes microcephala Pictet, 1842	+	
Amphinemura sulcicollis Stephens	+	
Chloroperla tripunctata Skopoli	+	
Perla bipunctata Kieff.	+	
Nemoura sp.	+	+
Nemoura cinerea Retzius, 1783	+	
Protonemura meyeri Pict.	+	
Ephemeroptera		
Epeorus sylvicola Etn.	+	
Baetis sp. Leach	+	
Heptagenia sulphurea Walsh	+	
Rhitrogena semicolorata Curtis	+	
Ecdyonurus venosos Fabricius	+	
Potamanthus luteus L.	+	
Ephemerella notata Walsh.	+	
Paraleptophlebia submarginata Steph.	+	
Trichoptera		
Hydropsyche angustipennis Curtis, 1834	+	
Sericostoma personatum Spenc.	+	
Polycentropus flavomaculatus Pictet, 1834	+	
Potamophylax latipennis Spenc.	+	
Rhyacophila fasciata Hag.	+	
Rhyacophila nubila Zetterstedt, 1840	+	
Limnophilus lunatus Spenc.	+	
Rhyacophila sp. Walsh	+	
Diptera		
Fam. **Blepharoceridae**		
Liponeura sp. Kieff.	+	
Fam. **Tipulidae** (tipula, bicranota, pedicia)	+	
Fam. **Chironomidae**		
1. *Criptochironomus defectus* Kieff., 1921		+
2. *Microtendipes pedellus* De Geer, 1776	+	
3. *Paratendipes albimanus* Meigen, 1818	+	

Table 11 continued	Crna River	Tikvesh Reservoir
4. *Polypedilum bicrenatum* Kieff., 1921	+	
5. *Polypedilum nubeculosum* Meigen, 1818	+	
6. *Paratanitarsus confuses* Palmen, 1960	+	
7. *Tanytarsus longipes* Ashrorov, 1967	+	
8. *Prodiamesa olivacea* Meigen, 1818	+	
9. *Procladius choreus* Meig.	+	
10. *Ablabesmya monilis* L.	+	
11. *Chironomus gr. plumosus* (L.)		+
12. *Cricotopus gr. sylvestris* Fabr.	+	+
13. *Orthocladius saxicola* Kieff.	+	
14. *Pentapedilum exectum* Kieff.	+	
Fam. **Psychodidae**		
Pericoma sp.	+	+
Fam. **Tabanidae**		
Tabanus sp. Kieff.	+	
Odonata		
Calopteryx (Agrion) virgo Meigen,		+
Anax sp. Kieff.		+

4.4 The Tikvesh Reservoir and surroundings

The Tikvesh Reservoir is a prominent feature of the Crna River, and deserves a more detailed description. It has a significant positive impact on the water quality, and a higher number of species than the upstream section of the River Crna due to the substantial water masses and the inflow of clean tributaries into the reservoir.

- Location: longitude: 21º 56’ 13’’ E, latitude 41º 18’ 40’’ N.
- Altitude: 260 m above sea level, with insignificant water level variations
- Reservoir surface area: 1232.8 ha.

At this locality, a freshwater lake ecosystem has been created by the construction of a dam on Crna River near the village of Vozarci. The reservoir is of great ecological importance. It harbours a large number of animal and plant species, and the presence of the reservoir also influences the terrestrial ecosystems and their biodiversity along the reservoir banks.

The riparian vegetation consists mostly of species of a xerophyte and mediterranean character, but species of a continental character are also found, such as: *Ramonda nathaliae, Verbascum macedonicum, Centaurea grbavescensis, Heptaptera macedonica, Ephedra fragilis, Conandra elegans, Crocus cancelatus, Lilium candidum, Periploca graeca*.

The Lake Tikvesh Watershed vegetation is mainly represented by shrubs, but there are also other woody elements. The following have been recorded: *Quercus pubescens, Caprinus orientalis, Acer monspessulanum, Acer intermedium, Colutea arborescens, Grataegus monogyna, Pistacia terebintus, Juniperus oxicedrus, Juniperus exelsa, Fraxinus ornus, Paliurus spina shysti, Phillyrea media, Qurcus fraineto, Quercus trojana macedonium.*

The following eight plant communities are of a special importance:

- Oak and hornbeam forest: Ostrya-Carpineon orientalis Nor-Vat.
- Shrub: Association (Ass.) Paliurus spina shysti.
- Red juniper shrub: Ass. Juniperetum oxicedrus.
- Macedonian oak forest: Ass. Quercetum trojanae macedonicum.
- Black hornbeam forest: Ass. Querco-ostrietum caprinifoliae Tamas.
- Wild juniper forest: Pruno webbii-Juniperetum exelsae.
- Subassociation Phillyreelosum (Phillyreelosum media).
- Plant community of meadows: Trifolion resupinati.

The fungi diversity has not been particularly studied, but what has been analysed so far proves that it is very rich. Both aquatic and terrestrial fungi are registered, but also species occurring as parasites on wooden and other plant species (for instance the wild juniper).

The aquatic fauna diversity is also very abundant:

- Zooplankton species recorded include: *Bosmina longirostris, Leptodora kindti, Daphnia parvula, Daphnia galeata.*
- Notable among the species rich zoobenthos are: *Pieris ergane, Zerynthia polyxena, Lucaena tityrus, Lucaena alciphrons, Hamearis lucina, Luluthea celtis, Melitaea trivia, Hippachia statilinus, Unio* sp., *Astacus a. balcanicus, Hirundo medicinalis.*
- All together 17 species of fish have been recorded, including six species that are not native to the River Crna (see **Table 9**).

The amphibious and terrestrial fauna is also diverse:

- The herpetofauna includes eight species: Amphibious/aquatic: *Rana ridibunda, Bufo viridis, Hyla arborea, Emys orbicularis, Triturus vulgaris*; Terrestrial: *Natrix tesselata, Natrix natrix, Lacerta viridis.*
- The bird fauna includes 131 bird species the most numerous of which are waterbirds and the birds of prey (see **Table 12** and paragraph 4.5 below).

4.5 The bird fauna in the Crna River watershed and the strict natural reserve "Tikvesh"

Coordinated by the Ministry of Environment of Macedonia, the Macedonian Ecological Association, and The Fund for Natural Flora and Fauna, Kavadarci, regular bird surveys are performed throughout the area of the Crna River watershed.

Of particular importance in this watershed is the strict natural reserve Tikvesh, which was established in 1998 by the Government of the Republic of Macedonia (**Annex 8**). The public company "Water Economy in Macedonia" was declared as the manager of the reserve. The establishment of the Tikvesh reserve was based on the importance of this locality for the bird fauna of the country (see Grubac & Associates 1993, Internal report, Republic Institute for Nature Rarities Protection, Skopje).

The strict natural reserve Tikvesh covers an area of 10,600 hectares. At the time it was established as a natural reserve, 131 bird species had been observed within its borders. This region and reserve is particularly important in terms of the fauna of birds of prey. Of the 39 birds of prey living in Europe, 35 species have been recorded in Macedonia, of which 23 species have been recorded in this area (**Table 12**). Seventeen species nest within the reserve area. Among the birds of prey present in the Crna River watershed and the Tikvesh reserve, four species are on the World Red List and 14 on the European Red List. In addition to the birds of prey listed in **Table 12**, 111 other bird species have been recorded in the Tikvesh reserve. Among these, twelve species are on the International Red List of the world's most endangered bird species, mainly representing migratory water birds. Therefore the reserve,

consisting of the canyon of the Crna River and the wider surroundings, is on the IUCN list of important bird habitats in Europe (Grimmet & Jones, 1989).

Apart from these facts that show the importance of this region for the bird fauna of the Republic of Macedonia, as well as Europe and the World, there are inadequate research and monitoring activities to document changes, and to implement appropriate measures to counteract any negative development. Resources are lacking both for monitoring and research and for implementing various measures to improve the situation for the most threatened species.

Table 12. *Birds of prey present in the Strict Natural Reserve Tikvesh, with comments on its population and Red List status.*

Scienific name (latin)	**English / Macedonian (local) name**	**Comment**
PANDIONIDAE		
Pandion haliaetus (L.)	Osprey / Orel ribar	Formerly spending the winter exclusively at Lake Tikvesh, whereas three years ago the most southern nest was observed where the couple brought up two offspring. On the European Red List.
ACCIPITRIDAE		
Pernis apivorus (L.)	Honey Buzzard / Osojad	Present in the reserve and its wider surroundings, nesting. On the European Red List.
Milvus migrans (L.)	Black Kite / Crvena	Present in the reserve and its wider surroundings. On the European Red List.
Accipiter gentilis (L.)	Goshawk / Golem jastreb	Present in the reserve and there nesting at more localities.
Accipiter brevipes (Sev.)	Kratkoprst jastreb	Present in the reserve and its wider surroundings, nesting. On the European Red List.
Accipiter nisus (L.)	Sparrowhawk / Mal jastreb	
Buteo buteo (L.)	Common Buzzard	Present in the reserve and its wider surroundings, nesting.
Buteo rufinus (Cre.)	Long-legged Buzzard / Beloopashest gluvchar	Present in the reserve and its wider surroundings. Formerly nesting, and now it is found in the course of the whole year. A remarkable new feature is the very light forms of the certain samples met at typical steppe terrains. On the European Red List.
Buteo vulpinus	Steppe Buzzard	Present in the reserve and its wider surroundings.
Aquila pomarina (Brehm)	Lesser Spotted Eagle / Mal orel	Previously only migrating, currently present throughout the whole year.
Aquila heliaca (Sav.)	Imperial Eagle / Carski orel	World rarity, present in the reserve, visiting the feeding point at Vitacevo. To great extent nesting on pylon poles due to a shortage of suitable nesting trees. The population has decreased by 30-40% in the last 4-5 years. On the World Red List.
Aquila chrysaetos (L.)	Golden Eagle / Zlaten orel	Regularly present in the reserve. Nesting. Illegally hunted by shepherds and hunters. On the European Red List.

Table 12 continued

Scienific name (latin)	English / Macedonian (local) name	Comment
Hieraaetus pennatus (Gm.)	Booted Eagle / Mal orel	A small eagle. Occur in the territory of the reserve, observations are very rare. On the European Red List.
Hieraaetus fasciatus (Vi.)	Bonelli's Eagle / Petnest orel	Occur in the territory of the reserve, observations are very rare. On the European Red List.
Neophron percnopterus (L.)	Egyptian Vulture / Egipetski mrshojadec	Present in the reserve at three nesting localities. Its population has rapidly decreased in the last 7-10 years. On the European Red List.
Gypaetus barbatus (L.)	Lammergeier / Bradest mrshojadec	The last remaining nesting couple on the Balkans was situated in this reserve site until 1986. Currently only one individual present. On the European Red List.
Aegypius monachus (L.)	Eurasian Black Vulture / Crn mrshojadec	World rarity, currently present only one individual, the last one in Macedonia. A revival of the species is possible only by reintroduction for which there are favorable conditions, but the prerequisite is a strict protection of the biotopes appropriate for nesting (the three parts of the Mariovo region). On the World Red List.
Gyps fulvus (Hab.)	Griffon Vulture / Beloglav mrshojadec	Present only in two nesting colonies in the reserve. The population diminishes due to a great number of factors, such as: a very low natality rate, reduction of natural food, occasional poisonings. Seven ringed individuals from Israel and Greece have been staying at the reserve for three years. On the European Red List.
Circaetus gallicus (Gm.)	Short-toed Eagle / Orel zmijar	Migratory species nesting in the territory of the reserve. On the European Red List.
FALCONIDAE		
Falco peregrinus (Tun.)	Peregrine Falcon / Sokol skitnik	Nesting. On the European Red List.
Falco biarmicus (Sch.)	Lanner Falcon / Dalmatinski sokol	Nesting. On the European Red List.
Falco cherrug (Gr.)	Saker Falcon / Lovechki sokol	Nesting.
Falco subbuteo (L.*)*	Hobby / Sokol orko	Nesting.
Falco tinnunculus	Common Kestrel	Nesting.
Falco naumanni (Fleic.*)*	Lesser Kestrel / Belovratna vetrushka	World rarity and its population is constantly decreasing due to the immense use of pesticides and degradation of its habitat and nestling sites. On the World Red List.

4.6 Protected areas

In accordance with the relevant international criteria, the natural heritage of the Republic of Macedonia has been assessed and evaluated, and protected by means of specific regulations (**Figure 8**). Protected areas are grouped into six classes according to the criteria of IUCN, and the Law on Natural Rarities Protection (adopted in 1973). The total area of protected areas in the Republic of Macedonia is 237,419 hectares (9.23% of the territory). The largest area is classified as National Parks (NP), covering 108,338 ha (45.63% of the total area under protection). These are the NP Mavrovo (73,088 ha), NP Galicica (22,750 ha), and NP Pelister (12,500 ha). The national parks are important in the protection of mountain flora and large mammals. National Park Pelister includes some high altitude areas in the western part of the Crna River drainage area.

The Lake Ohrid natural, cultural and historical area, which covers 38,000 ha, was included in UNESCO's list of World Heritage sites in 1981. Lake Prespa, a Ramsar Site since 1995, with an area of 18,920 ha, has also been nominated to the list of World Natural Heritage Sites. These areas are both outside the drainage area of both Crna and Vardar River.

Areas classified as Strictly Protected Natural Reserves (SPR) cover 12,730 ha (5.36% of the total protected area). The SPR Tikvesh covers 10,650 ha, and lies with the Crna River watershed, in the canyon of Crna River (**Figure 8**). The major function of the Tikvesh reserve is to protect hill and mountain flora, birds of prey, water birds, and large mammals (cf. paragraph 4.5).

Monuments of nature (MN) occupy 57,093 ha (which is 24.05% of the total protected area).

- MN Gol Covek (Naked Man) with 5 ha,
- MN Drenacka Klisura (Gorge) with 5 ha,
- MN Karsi Bavci with 10 ha,
- MN Murite with 10 ha,
- MN Konce with 0,7 ha, and
- MN Morodvis with 0,5 ha.

The Monument of nature Gol Covek ("Naked Man") is established to protect the rare tree species "naked man" (*Arbutus andrachne*). It is situated on the eastern slopes of Kozuf Mountain, 2.5 km west from the village of Gornicet, on the left bank of Konjska River. It covers an area of about 5 ha. In Macedonia, this rare species of tree can also be found in the canyon part of Crna River.

The Monument of nature Majdan is situated on the north-western slopes of Kozuf Mountain upstream the Bosava River, close to the village of Majdan. It is an important floristic locality characterised by the presence of the plant species allcharian violet (*Viola allchariensis*) and arsenic violet (*Viola arsenica*), which both of them are endemic to Macedonia. The site has been enrolled in the list of CORINE biotopes for Macedonia, under the name of Alsar.

In addition three sites in Bitola and its vicinity have been proposed for protection as Monuments of nature. These are PPR Belo Grotlo, Staravina, PPR Reder, Staravina, and SP Gradeshka River Canyon, Staravina. (Information courtesy of Mr. Vasil Atanasovski, at the Ministry of Environment; http://www.culture.org.mk/bitspopr.htm).

There is a great number of important and valuable cultural monuments in Bitola and surroundings. The church "Sv.Nikola" in the village of Manastir-Mariovo (1095 – year of construction) may be mentioned as an example (http://www.orbis.com.mk/spomenici_na_kulturata.htm#DRUGI%20SPOMENICI). A more complete overview of historical sites is given in **Annex 9**.

Figure 8. *The natural heritage of the Republic of Macedonia (http://www.moe.gov.mk/prirodnonasledstvo/homeA.htm).*

5 Discussion

Information on the aquatic and terrestrial biodiversity of the Crna River watercourse and catchment area has not been systematically collected. The existing knowledge is mainly the result of rare and incomplete surveys, perhaps with the exception of the bird surveys in the Tikvesh natural reserve. The development trends in populations and biotic communities are therefore not known. Hydrology and water quality is more systematically monitored.

The Crna River exhibits a great variety of riverine ecosystems, from the salmonid-dominated oligotrophic and unpolluted streams in the upper reaches, to the cyprinid-dominated lowland river systems. In addition, the impact on the riverine ecosystem from human activities varies from nearly pristine streams to heavily polluted river sections. In addition, the Tikvesh Reservoir has changed a substantial stretch of the river into a productive lake.

River water is utilized for industrial and agricultural purposes, and the water course is an important recipient of urban, industrial and agricultural sewage and runoff. At the same time, the river is a popular site for various recreational activities, especially angling. In the Tikvesh Reservoir, there is both commercial fishing and fish production in net pens.

In terms of biodiversity and nature conservation, the natural reserve (SPR) Tikvesh is of special importance. It is linked with the Canyon of Crna River. It stretches 80 km from the village of Skocivir to the upper end of the Tikvesh Reservoir, and in terms of biodiversity represents a refugial zone. The influence of the warm Mediterranean climate creates conditions for developing sub-Mediterranean vegetation. In this zone, several species occurs that are listed as threatened according to IUCN:

- Flora: *Alissum doerfleri, Centaurea grbavacensis, Heptaptera macedonica, Melampyrum heracleoticum, Onobrychis degenii, Silene viscaripsis, Ramonda natalie, Verbascum macedonicum* and *Verbaskum hercogi.*
- Fish fauna: *Cobitis vardarensis, Gobio banarescui, Vimba melanops, Zingel balcanicus*
- Bird fauna: *Aquila heliaca, Phalacrocorax pygmeus, Falco naumani, Aythia nyroca*
- Mammals: *Rhinolophus euriale, Canis lupus, Felis silvestris, Lutra lutra*

According to the regional climate models the following climate changes are expected in this area:

- The average annual temperature within 50 years is expected to increase by 2.3 ºC, while within 100 years it will increase for 4.6 ºC.
- Winter temperatures are expected to increase less (2.1 and 3.9 ºC for 50 and 100 years respectively) than the summer ones (2.9 and 6.1 ºC for 50 and 100 years respectively).
- Annual sums of precipitation are expected to decrease by 5% in 50 years and 13% in 100 years.
- The reduction in precipitation is predicted to be larger in summer than in winter.

In relation to possible further hydropower development in this watercourse, there are a few aspects that may need particular attention. Construction of new reservoirs may cause destruction of some of the existing refugial forest associations. This may, however, be compensated by the development and implementation of a comprehensive plan to restore and regenerate forest vegetation containing the native species. The bird fauna of this area also needs special protection and restoration measures.

The upper reaches of the river, which are in a relatively pristine condition, with brown trout as the dominant (or only) fish species, should be well protected. This also includes strict control on the river fish stocking programmes in order to avoid introduction of new alien fish species.

In terms of future protection of Crna River, and existing and possible new reservoirs, the most important measure is to solve the problem with the heavy water pollution provided by the influx of water from Canal 5, a component of the Strezevo hydrosystem, as well as from the tributaries Blato and Dragor, which are major sources of pollution for the river.

Establishment of a comprehensive biodiversity monitoring programme for the Crna River watershed should be a priority in association with the new and planned human activities in the watershed. According to the new fisheries legislation, which will be adopted in the autumn of 2007, management plans based on scientific knowledge should be developed for all water courses, including Crna River.

6 References

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List of Annexes

Annex 1 Hydrosystem Strezevo

The Strezevo hydrosystem is a versatile water economy system, aiming to exploit, manage and protect the water resources, and to protect surrounding area against harmful effects of waters, i.a. flooding and erosion.

The collective canal of the hydrosystem Strezevo enables collection of waters of the watercourses in the Baba Mountain (the rivers Kishavska, Graeshka, Ostrechka, Zlokukanska, Old River, Kinderka and Dragor), conditionally during the vegetation period and their transport to the area Prevlec, as well as inflowing into the watershed of Shemnica River ("Jagura 1" from Gorno Srbecki Poroj). Apart from the previously described basic function the canal actively participates in the replenishment of unprocessed water for the needs of the Public Water Company "Vodovod" Bitola and the local sugar factory. The waters are also exploited for hydro power production at the hydropower stations "Filternica" and "Dovledjik".

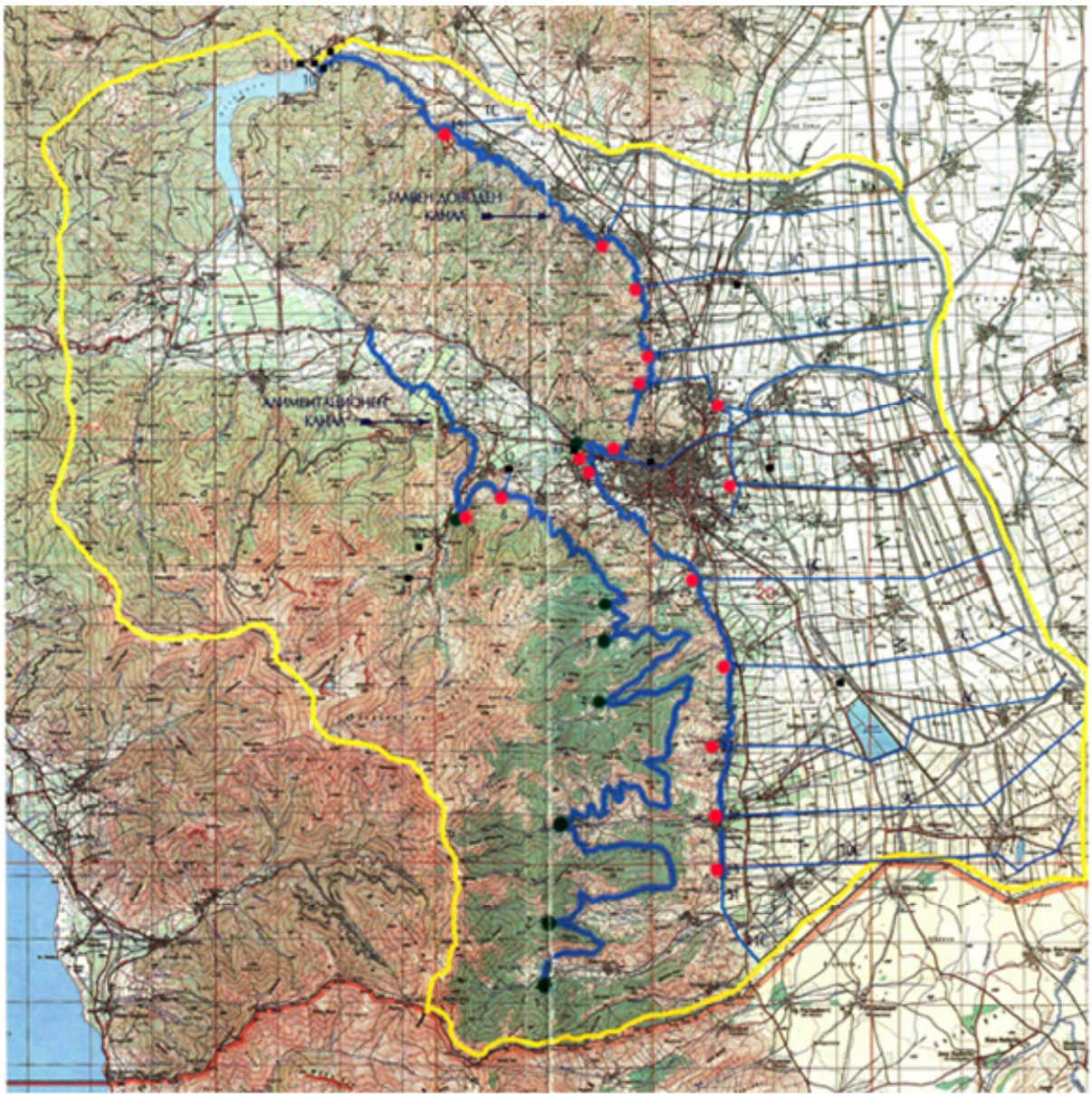


***Figure 1.1**. Map of the hydrosystem Strezevo (Yellow line indicates the watershed boundaries of the Hydrosystem Strezevo; Blue lines are collecting and irrigation canals).*

LEGEND (numbers referring to Figure 1.1:			
1.	Kishavska River eservoir	22.	RO5 Reservoir for ПЦ “Dovledjik”
2.	Graeshka River reservoir	23.	Compensatory pool “Dovledjik”
3.	Ostrechka River reservoir	24.	Sugar factory reservoir
4.	Zlokukanska River reservoir	25.	RO6 Reservoir for 6C (G3)
5.	Stara River reservoir	26.	RO7 Reservoir for 7C (SR11)
6.	Kanderka River reservoir	27.	RO8 Reservoir for 8C(G4)
7.	Dragor River reservoir 940 м s.l.	28.	RO9 Reservoir for 9C(SR12)
8.	PC “Vodovod“ reservoir	29.	Reservoir for 10C (G5)
9.	PC “Vodovod“ reservoir	30.	Compensatory pool “Velusina”
10.	Dam ”Strezevo”	31.	Reservoir for 11C(SR13)
11.	Headquarters	32.	HPP “Filternica”
12.	HPP”Strezevo”	33.	HPP “Dovledjik”
13.	HPP ”Biological minimum”	34.	Management
14.	Fish pond ”Strezevo”	35.	Economy yard
15.	Reservoir за 1C (SR2)	36.	Point “Makpetrol”
16.	RO1 Reservoir for2C (G1)	37.	Point “Zabeni”
17.	RO2 Reservoir for 3C(SR7)	38.	TPP „Bitola“ pipeline
18.	RO3 Reservoir for 4C(SR9)	39.	Sugar factory pipeline
19.	RO4 Reservoir for5C(G2)	40.	Complex “Nizopole”
20.	TPP “Bitola“ reservoir	41.	Complex “Ski lift”
21.	Dragor River reservoir 666 m s.l.		

Annex 2 Water quality sampling stations, parameters and frequency of sampling

Table 2.1. *Characteristics of sampling stations.*

River Lake or Accumulation	Water Quality - Sampling Point Number and Name	Sampling Point : Type based on altitude typology, catchments area and geology	Protection status [International or National Level]	Main Uses [Recreation, Irrigation, Fisheries, Hydropower]	Probable Problems [Pollution]
Watershed of the River Crna Reka					
River Crna Reka	SP 63804 v.Topolchani	Type : Altitude typology : mid-altitude: 200 to 800 m Size typology based on catchments area : large: >1 000 to 10 000 km^2 Geology : siliceous	[National Level- "Regulation for categorization of water courses and lakes "- "Official gazette of Republic of Macedonia" number 18-99/]	[Irrigation]	Point source: Domestic and Industrial Wastewater from Prilep town Diffusion source: Agriculture Activity
	SP 63805 v.Novaci			[Irrigation]	Point source: Domestic and Industrial Wastewater from Bitola town Diffusion source: Agriculture Activity
	SP 63806 v.Skochivir			[Irrigation]	Point source: Domestic and Industrial Wastewater from Bitola town Diffusion source: Agriculture Activity
	SP 6380 Accumulation Tikvesh	Type : Altitude typology : mid-altitude: 200 to 800 m Depth typology based on mean depth: >15 m Size typology based on surface area : 10 to 100 km2 Geology : siliceous	[National Level- "Regulation for categorization of water courses and lakes "- "Official gazette of Republic of Macedonia" number 18-99/]	[Recreation , Irrigation and Hydropower]	-
	SP 63808 v. Vozarci	Type : Altitude typology : mid-altitude: 200 to 800 m Size typology based on catchments area : large: >1 000 to 10 000 km^2 Geology : siliceous	[National Level- "Regulation for categorization of water courses and lakes "- "Official gazette of Republic of Macedonia" number 18-99/]	[Irrigation]	-
	SP 63809 v.Palikura			[Irrigation]	Point source: Domestic and Industrial Wastewater from Bitola town Diffusion source: Agriculture Activity

River Dragor	SP 63868 Bitola	Type : Altitude typology : mid-altitude: 200 to 800 m Size typology based on catchments area : medium: >100 to 1 000 km^2 Geology : siliceous	[National Level- "Regulation for categorization of water courses and lakes "- "Official gazette of Republic of Macedonia" number 18-99/]	[Irrigation]	Point source: Domestic and Industrial Wastewater from Bitola town Diffusion source: Agriculture Activity
River Eleshka	SP 63875 v. Brod	Type : Altitude typology : mid-altitude: 200 to 800 m Size typology based on catchments area : medium: >100 to 1 000 km^2 Geology : siliceous	[National Level- "Regulation for categorization of water courses and lakes "- "Official gazette of Republic of Macedonia" number 18-99/]	[Irrigation]	Point source: Domestic and Industrial Wastewater from Bitola town Diffusion source: Agriculture Activity

Table 2.2. *Indicators [Parameters] included with water quality measurement and analysis in HMA (Source: HMA, 2006).*

a	a1	Hydrological Parameters :	Water Level, Water Discharge – Flow, Mean Velocity and Width cross-section
b	b1	Appearance, Organoleptic and Physical Parameters:	Water and Air Temperature, Odour, Colour, Oil and other flying liquide, pH – value, Redox potential, Specific Electroconductivity, Turbidity
	b2	Mineralization – residues on evaporation	Total Residue / Fixed and Volatile / Filtrable Residue – Dissolved Matters / Fixed – mineral and Volatile – organic / Nonfiltrable residue-Suspended Matters / Fixed – mineral and Volatile – organic /
	b3	Parameters –Oxygen Regime and Nutrients / Eutrophication /	Oxygen regime Parameters: Dissolved oxygen – now, Water oxygen saturation (saturation – supersaturation), Biohemical Oxygen Demand for 5 days, Chemical Oxygen Demand – Permanganate or dichromate; Eutrophication Parameters: Ammonia, Nitrates and Nitrites, Phosphate (as ortopfosphates); Future planning: Total Nitrogen and Total Phosphorus
	b4	Anions and Cations :	Bicarbonate, Carbonate, Hydroxide, (Calculated on Alkalinity – p and m), Chloride, Sulphate, Calcium, Magnesium, Sodium, Potassium, Hardness (total, carbonate and noncarbonate);
c	c1	Harmful Substances – Heavy Metals:	Total Iron, Manganese, Lead, Zinc, Cadmium, Chromium, Copper, Nickel, Cobalt, Aluminium, Future planning: Arsenic, Mercury and other hydride metals, Cyanides, Phenols, Sulfides
d	d1	Harmful Substances - Organic Micropollutants:	Future planning / 2006 Year /: Aldrin, Dieldrin, DDT, DDE, DDD, Endrin, Endosulfan 1, Endosulfan 2, Heptachlor, a-BHC, b-BHC, g-BHC / lindan / , d-BHC, Metoxichlor, Malation, Paration, Methomyl, Atrazine, Alachlor, Folpet and other
e	e1	Saprobiological Parameters:	Saprobity Index of Pantel and Buck, Saprobiological rank of Liebman
f	f1	Microbiological Parameters:	Microbiological Pollution MPN No/100 ml , Thermo-tolerant coliforms, Faecal streptococci

***Table 2.3**. Surface Water Quality-Frequency of Analysis of the rivers Crna Reka, Dragor and Eleshka (Source: HMA, 2006). b-c-f is number of months sampled; numbers in brackets indicate sampling month number (January = 1; December = 12).*

Year	River Crna Reka SP 63809 v.Palikura	River Dragor SP 63868 Bitola	River Eleshka SP 63875 v. Brod
1980	**b-c-f= 6** [1,3,5,7,9,11]	**b-c-f= 6** [1,3,5,7,9,12]	**b-c-f= 6** [1,3,5,7,9,12]
1981	**b-c-f= 5** [1,3,5,7,9]	**b-c-f= 4** [3,5,7,9]	**b-c-f= 4** [3,5,7,9]
1982	**b-c-f= 6** [1,3,5,7,9,12]	**b-c-f= 6** [1,3,5,7,9,12]	**b-c-f= 6** [1,3,5,7,9,12]
1983	**b-c-f= 6** [1,3,5,7,9,11]	**b-c-f= 6** [1,3,5,7,9,11]	**b-c-f= 6** [1,3,5,7,9,11]
1984	**b-c-f= 6** [1,3,5,7,9,11]	**b-c-f= 6** [1,3,5,7,9,11]	**b-c-f= 6** [1,3,5,7,9,11]
1985	**b-c-f= 6** [2,3,5,7,9,11]	**b-c-f= 6** [2,3,5,7,9,11]	**b-c-f= 6** [2,3,5,7,9,11]
1986	**b-c-f= 6** [3,6,8,9,10,11]	**b-c-f= 6** [3,6,8,9,10,11]	**b-c-f= 6** [3,6,8,9,10,11]
1987	**b-c-f= 6** [3,5,6,8,9,11]	**b-c-f= 5** [3,5,6,9,11]	**b-c-f= 5** [3,5,6,9,11]
1988	**b-c-f= 6** [3,5,6,8,9,11]	**b-c-f= 6** [3,5,6,8,9,11]	**b-c-f= 6** [3,5,6,8,9,11]
1989	**b-c-f= 6** [3,5,6,8,9,11]	**b-c-f= 6** [3,5,6,8,9,11]	**b-c-f= 6** [3,5,6,8,9,11]
1990	**b-c-f= 6** [3,5,6,8,9,11]	**b-c-f= 6** [3,5,6,8,9,11]	**b-c-f= 6** [3,5,6,8,9,11]
1991	**b-c-f= 6** [3,5,6,8,9,11]	**b-c-f= 6** [3,5,6,8,9,11]	**b-c-f= 6** [3,5,6,8,9,11]
1992	**b-c-f= 6** [3,5,6,8,10,12]	**b-c-f=** 6 [3,5,6,8,10,12]	**b-c-f= 6** [3,5,6,8,10,12]
1993	**b-c-f= 6** [3,5,6,9,9,11]	**b-c-f= 6** [3,5,6,8,9,11]	**b-c-f= 6** [3,5,6,8,9,11]
1994	**b-c-f= 6** [3,5,6,9,10,11]	**b-c-f= 6** [3,5,6,9,10,11]	**b-c-f= 6** [3,5,6,9,10,11]
1995	**b-c-f= 5** [3,5,6,8,9]	**b-c-f= 5** [3,5,6,8,9]	**b-c-f= 5** [3,5,6,8,9]
1996	**b-c-f= 4** [4,6,9,11]	**b-c-f= 4** [4,6,9,11]	**b-c-f= 4** [4,6,9,11]
1997	-	-	-
1998	-	-	-
1999	**b-c-f= 7** [6,7,7,8,9,10,11]	-	**b-c-f= 7** [6,7,7,8,9,10,11] e= 7 [6,7,7,8,9,10,11]
2000	**b-c-f= 10** [3,4,5,6,7,8, 9,10,11,12]	-	**b-c-f= 10** [3,4,5,6,7,8,9,10,11,12] e= 8 [4,5,6,7,8, 9,10,11]
2001	**b-c-f= 12** [1,2,3,4,5,6,7,8, 9,10,11,12]	-	b-c-f= 12 [1,2,3,4,5,6,7,8, 9,10,11,12] e= 10 [2,3,4,5,6,7,8, 9,10,11]
2002	**b-c-f= 11** [2,3,4,5,6,7,8, 9,10,11,12]	-	**b-c-f= 10** [3,4,5,6,7,8,9,10,11,12] e= 10 [3,4,5,6,7,8,9,10,11,12]
2003	b-c-f= 10 [1,3,5,6,7,8, 9,10,11,12]	-	**b-c-f= 9** [3,5,6,7,8,9,10,11,12] e= 7 [2,3,4,8,9,10,11]
2004	b-c-f= 9 [1,2,3,4,8, 9,10,11,12]	-	**b-c-f= 9** [1,2,3,4,8,9,10,11,12] e= 4 [4,8,9,10]
2005	b-c-f= 10 [2,3,4,5,6,7,8, 9,10,11]	-	**b-c-f= 10** [2,3,4,5,6,7,8,9,10,11] e= 8 [3,4,5,6,7,8, 9,10]

Annex 3 Selected chemical parameters from the water quality monitoring programme, 1 June, 1999 to 2 December 2006 (data from the Hydrometeorological Institute, HMA)

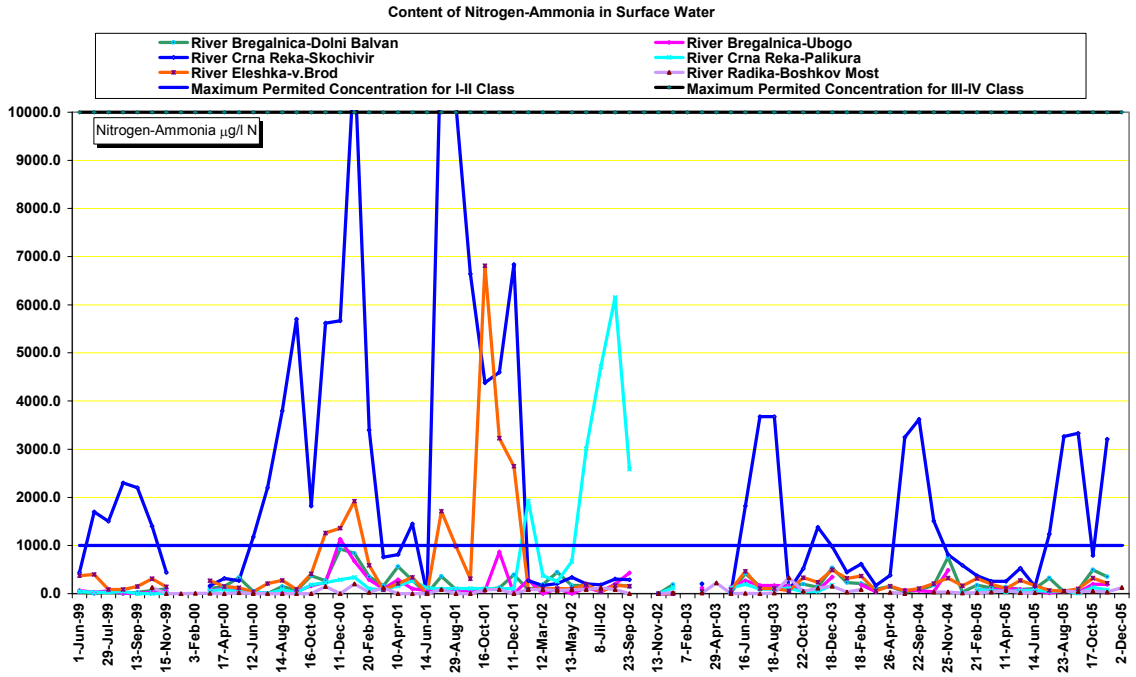


Figure 3.1. *Content of Nitrogen - Ammonia in the River Bregalnica (SP 63306; SP 63309), River Crna Reka (SP 63806; SP 63809) River Eleshka (SP 63875) and River Radika (SP 60909) (Source: HMA, 2006).*

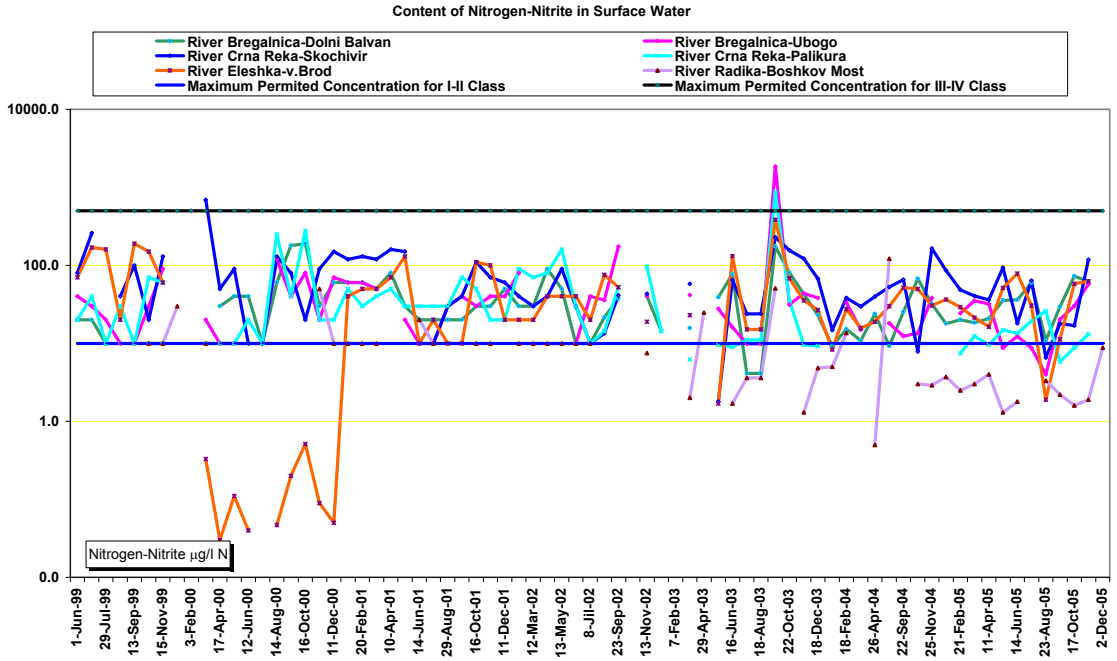


Figure 3.2. *Content of Nitrogen-Nitrite in the River Bregalnica (SP 63306; SP 63309), River Crna Reka (SP 63806; SP 63809), River Eleshka (SP 63875) and River Radika (SP 60909) (Source: HMA, 2006).*

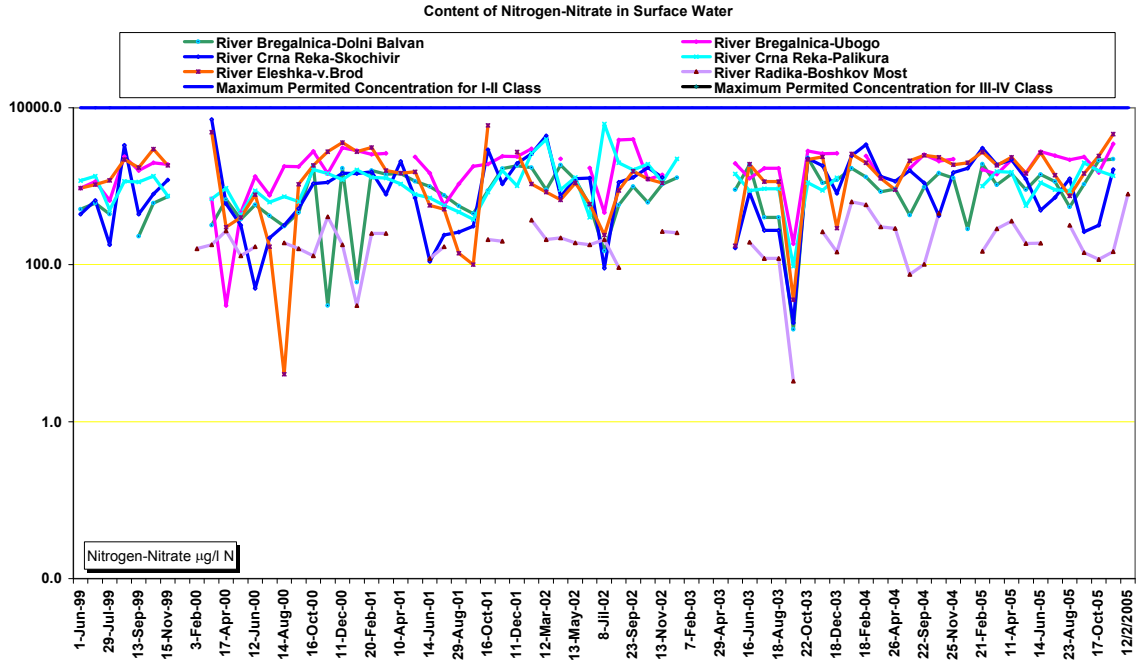


Figure 3.3. *Content of Nitrogen-Nitrate in the River Bregalnica (SP 63306; SP 63309) River Crna Reka (SP 63806; 63809), River Eleshka (SP 63875) and River Radika (SP 60909) (Source: HMA, 2006).*

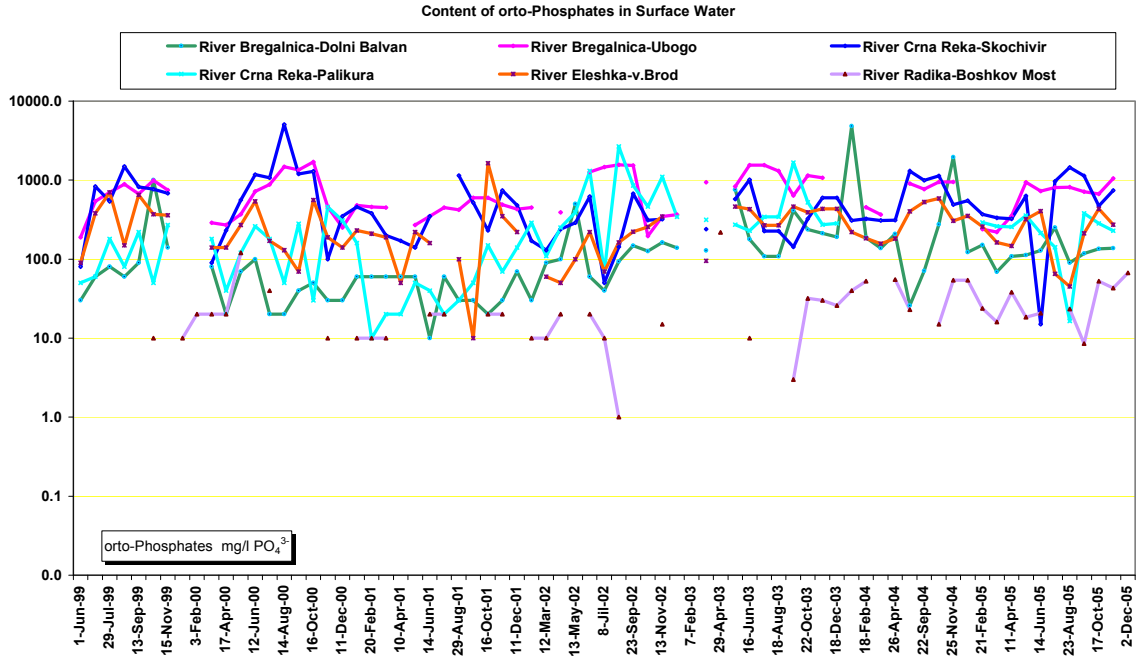


Figure 3.4. *Content of orto-Phosphates in the River Bregalnica (SP 63306; SP 63309), River Crna Reka (SP 63806; SP 63809), River Eleshka (SP 63875) and River Radika (SP 60909) (Source: HMA, 2006).*

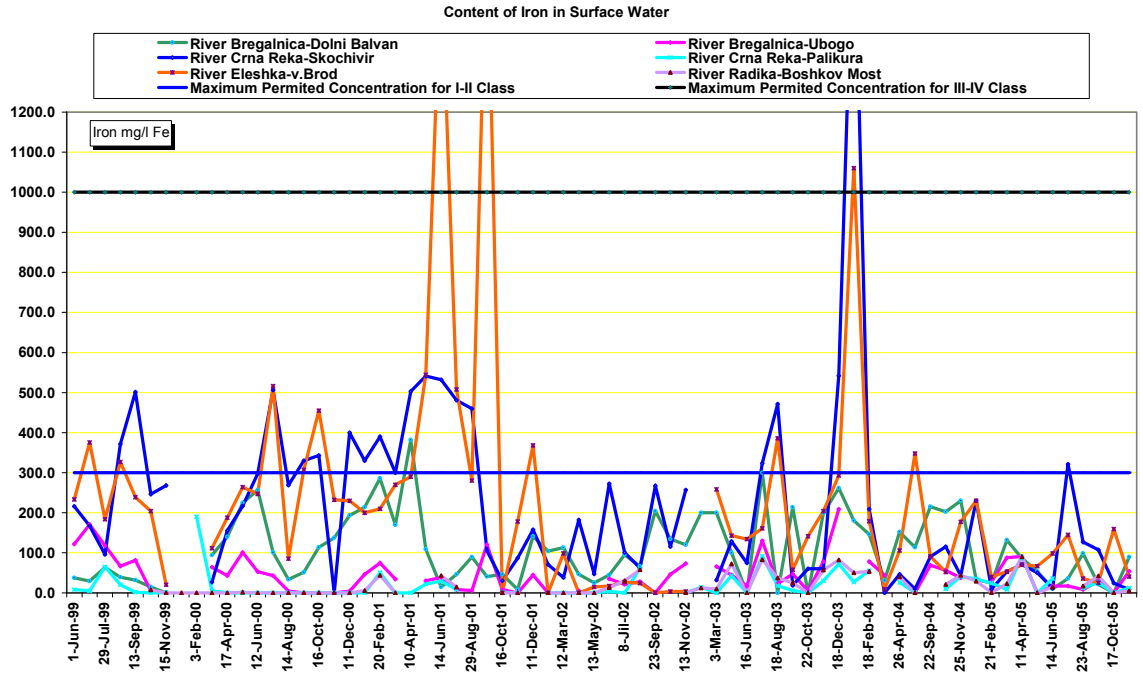


Figure 3.5. *Content of Iron in the River Bregalnica (SP 63306; SP 63309), River Crna Reka (SP 63806; SP 63809), River Eleshka (SP 63875) and River Radika (SP 60909) (Source: HMA, 2006).*

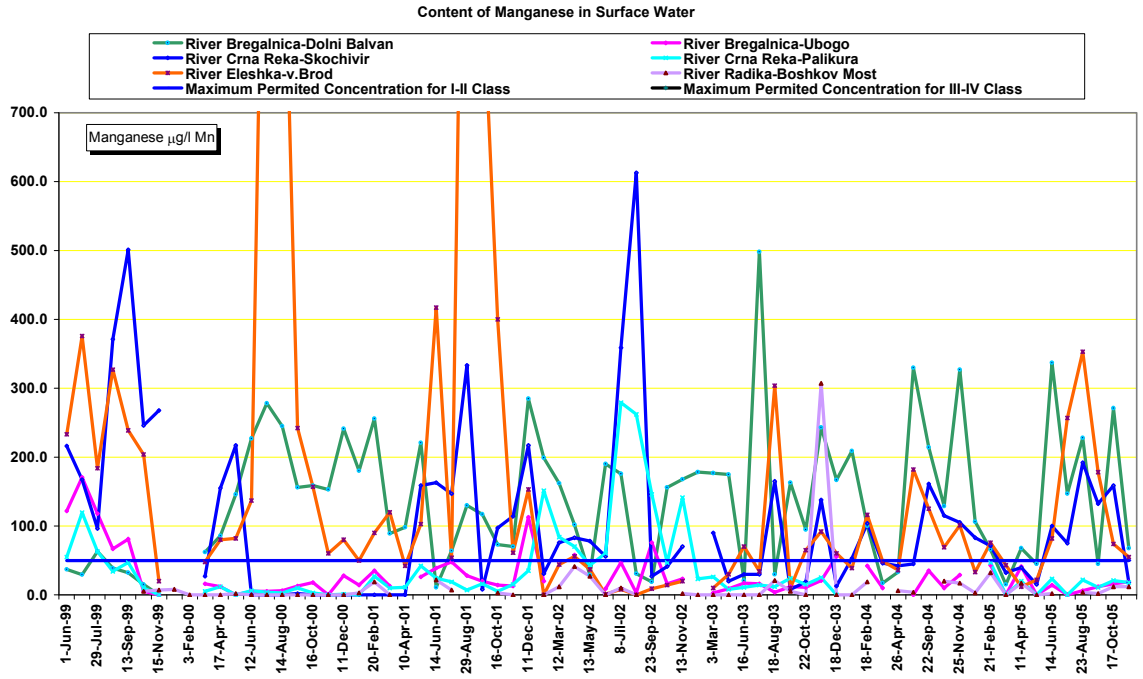


Figure 3.6. *Content of Manganese in the River Bregalnica (SP 63306; SP 63309), River Crna Reka (SP 63806; SP 63809), River Eleshka (SP 63875) and River Radika (SP 60909) (Source: HMA, 2006).*

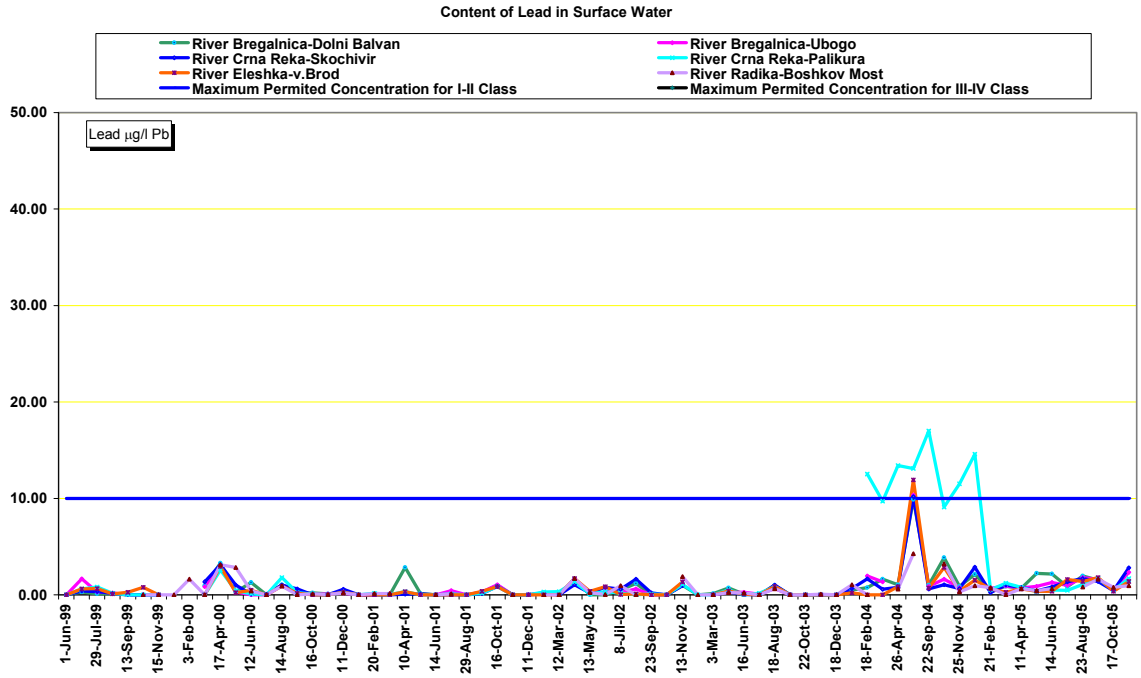


Figure 3.7. *Content of Lead in the River Bregalnica (SP 63306; SP 63309), River Crna Reka (SP 63806; SP 63809), River Eleshka (SP 63875) and River Radika (SP 60909) (Source: HMA, 2006*

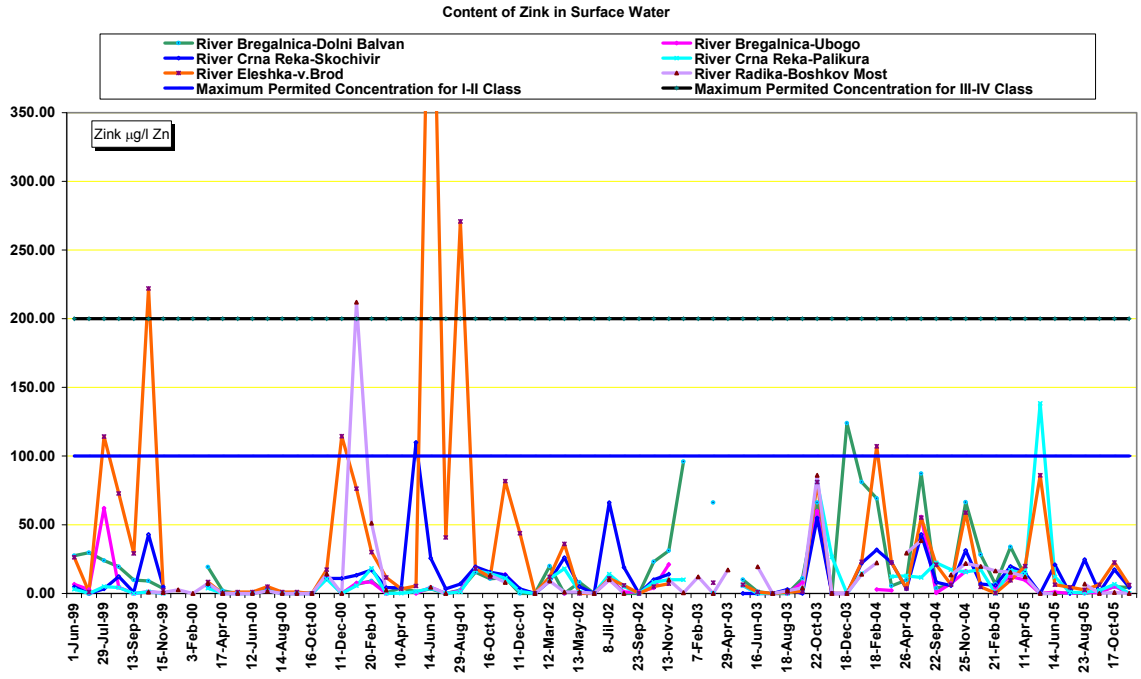


Figure 3.8. *Content of Zink in the River Bregalnica (SP 63306; SP 63309), River Crna Reka (SP 63806; SP 63809), River Eleshka (SP 63875) and River Radika (SP 60909) (Source: HMA, 2006).*

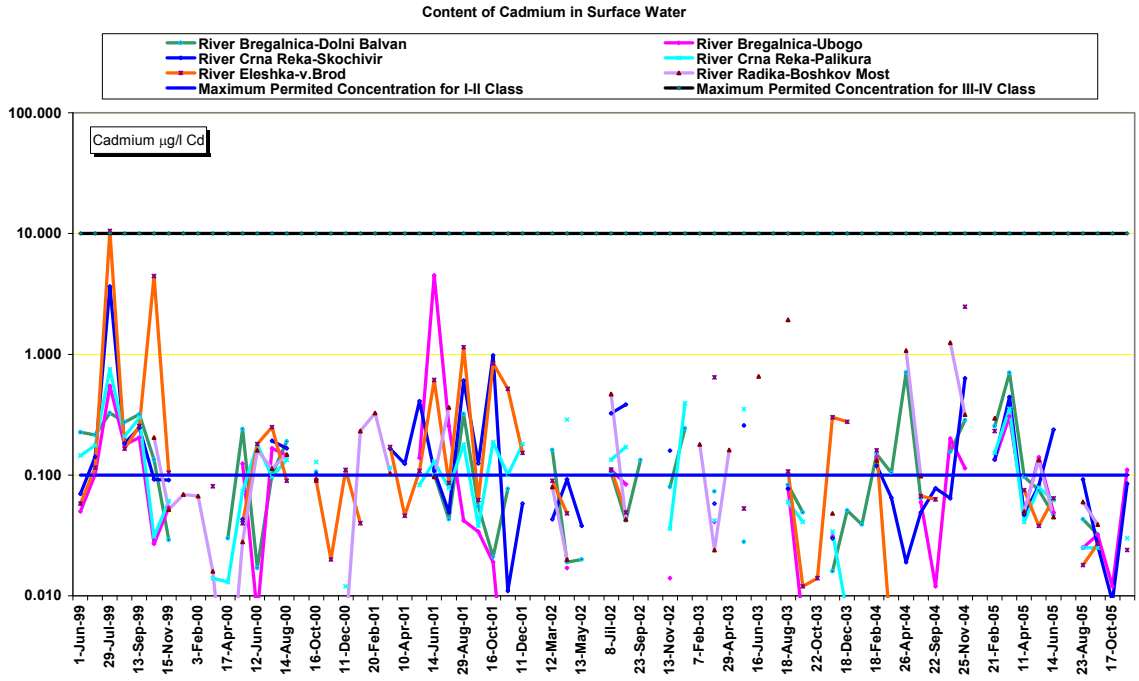


Figure 3.9. *Content of Cadmium in the River Bregalnica (SP 63306; SP 63309), River Crna Reka (SP 63806; SP 63809), River Eleshka (SP 63875) and River Radika (SP 60909) (Source: HMA, 2006).*

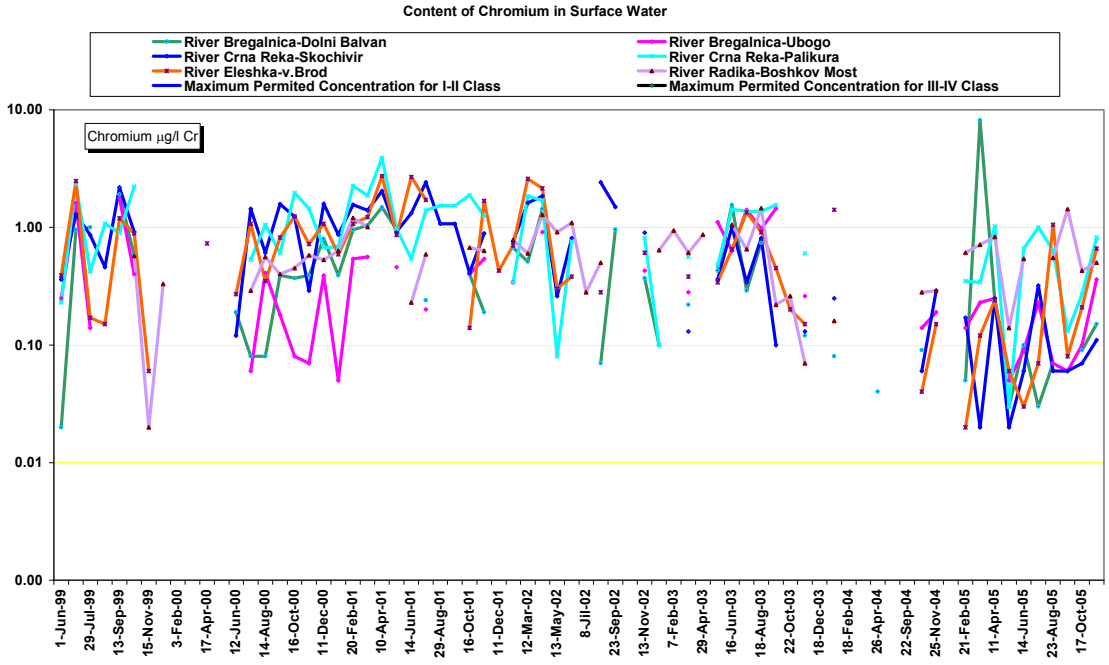


Figure 3.10. *Content of Chromium in the River Bregalnica (SP 63306; SP 63309), River Crna Reka (SP 63806; SP 63809), River Eleshka (SP 63875) and River Radika (SP 60909) (Source: HMA, 2006).*

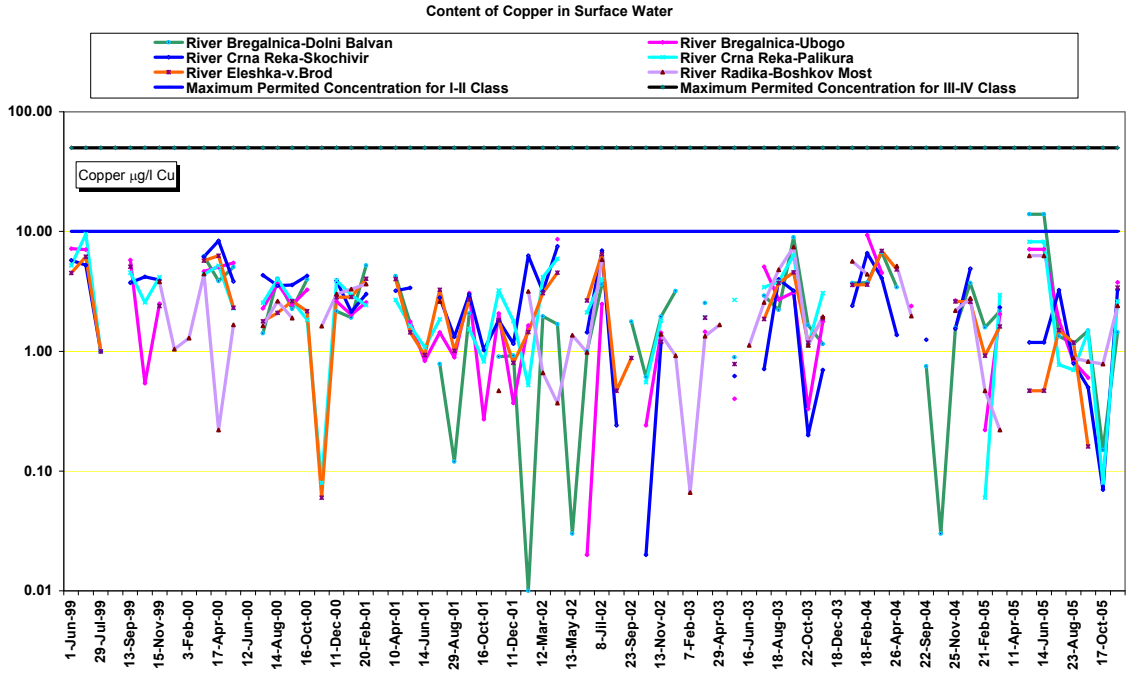


Figure 3.11. *Content of Copper in the River Bregalnica (SP 63306; SP 63309), River Crna Reka (SP 63806; SP 63809), River Eleshka (SP 63875) and River Radika (SP 60909) (Source: HMA, 2006).*

Annex 4 Water Quality (Saprobic Index) of the rivers in the Republic of Macedonia

Data from monitoring the Saprobic Index of the rivers Crna and Eleshka, during the period 1999 - 2004 (**Figures 4.1** and **3.2**). The water quality classes corresponding to the values of the saprobic index are given in **Table 4.1**.

Table 4.1. *Water Quality Classes (cf.* ***Annex 10****) corresponding to the Saprobic Index Value (Source: HMA, 2006).*

SAPROBIC INDEX	CLASS
< 1.50	I
1.50 - 2.50	II
2.51 - 3.50	III
3.51 - 4.50	IV
> 4.50	V

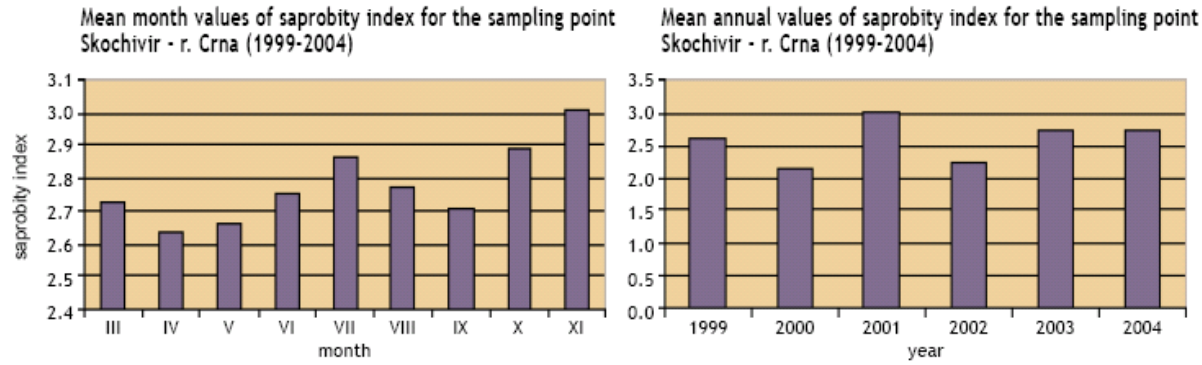


Figure 4.1. *Water Quality Saprobic Index of the Crna River at the village Skochivir (SP 63806) (Source: HMA, 2006).*

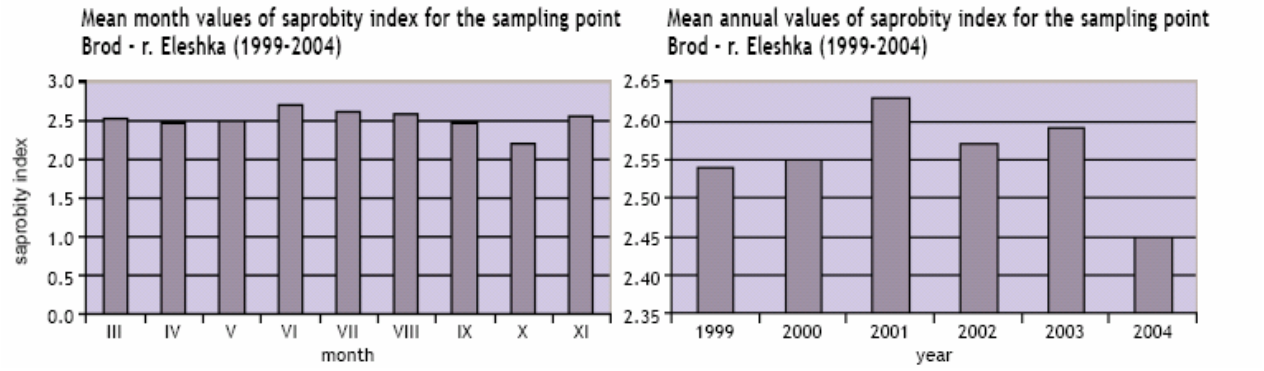


Figure 4.2. *Water Quality Saprobity Index of the River Eleshka (tributary to Crna River) at the village Brod (SP 63875) (Source: HMA, 2006).*

Annex 5 Socio-economic details on the municipality of Prilep

Settlements which represent part of the municipality of Prilep: Alinci, Belovodica, Berovci, Beshishte, Bonche,Veprchani, Veselchani,Vitolishte, Volkovo, Vrpsko, Galichani, Golem Radobil, Golemo Konjari, Gugjakovo, DabnicaDren, Dunje, Erekovci, Zivovo, Zagorani, Kadino Selo, Kalen, Kanatlarci, Klepach, Kokre, Krushevica, Krstec, Lenishta, Lopatica, Mazuchishte, Mal Radobil, Malo Konjari, Malo Ruvci, Manastir, Marul, Nikodin, Novo Lagovo, Oreovec, Peshtani, Pletvar, podmaol, Polchishte, Prilepec, Prisad, Rakle, Selce, Smolani, Staro Lagovo, Toplica, Trojaci, Topolchani, Trojkrsti, Carevik, Chaniste, Chepigovo, Chumovo, Sheleverci and Shtavica.

The population in the municipality of Prilep in 1994 and 2002 is given below.

Table 5.1 *Population figures for the Municipality of Prilep (Prilep, Vitolishte and Topolchani).*

	Total population		Population change		Population growth
	1994	2002	number 1994-2002	% 1994-2002	1994-2002
Municipality Prilep	76,166	76,768	602	0.79%	-240
Prilep	71,899	73,351	1452	2.02%	1412
Vitolishte	882	494	-388	-43.99%	-187
Topolchani	3,385	2,923	-462	-13.65%	-53

Agriculture and the tobacco industry

Agriculture represents one of the most developed industries in the Prilep municipality. The following agricultural cultures are mostly represented: tobacco, cereal crops and garden cultures. Nevertheless, the Prilep municipality is most famous not only in the Republic of Macedonia, but wider by its tobacco production which takes the greatest part of the total agricultural production. Therefore Prilep is called the city of tobacco. In the agricultural production domain, and even more as an industrial culture, tobacco adopts a very significant place not only in the economy of the municipality of Prilep, but also in the Republic of Macedonia. This industrial culture enables benefit on a relatively large low productive surface of the land being cultivated. Such surfaces are very common in this region, and besides that tobacco is imposed as the most important source of income since it enables participation in the production process of that workforce which can not be included in other production capacities of the economy and this gives the tobacco a special place and importance. In addition, a great number of the population deals with tobacco production apart from their main occupation or business to increase its low family budget and ensure its existence. Most of the population dealing with agriculture grows tobacco besides growing other cultures.

It is impossible to determine the exact date when tobacco was brought within the boundaries of Republic of Macedonia. According to certain resources, tobacco was brought more than 400 years ago, but it is a well known fact that the first tobacco storage in Prilep was built in 1873 under the Otoman management of the monopoly.

That day denoted the birth of tobacco industry by us and the creation of the Tobacco Industrial Complex as the biggest giant in the former Yugoslavia. The establishment of this storage enabled fast growth of tobacco and it replaced other agricultural cultures, as well as the region growth into the biggest production centre for oriental tobacco in this part of the Balkans. Tobacco production noted a rapid growth during the Young Turks Revolution (1908-1912) and it represented the main branch of the Prilep agriculture. After the First World War on the territory of Macedonia and Serbia there was a disordered situation in terms of the tobacco categories

because there was a great number of seeds from various categories. Having considered the need for improvement of the quality of tobacco production the Management of state monopolies for tobacco production at that time brought a decision to establish an experimental tobacco station in Prilep. This decision was realized on 24 December 1924 in Prilep, the tobacco town, and the greatest contribution for this belongs to the wellknown expert for tobacco and a scientific worker, the engineer Rudolf Gornik.

The Tobacco Industrial Complex AD Prilep has constantly been a synonym for quality of oriental tobacco and various types of cigarettes since its establishment in 1873.

Table 5.2 *Quantity of grown tobacco in harvest, quantity of planted areas and obtained harvest.*

Harvest	Production of tobacco in kg	ha	kg/ha
1996	3,017,986	2,320	1,301
1997	7,034,464	3,862	1,821
1998	9,909,116	4,876	2,032
1999	9,148,977	5,000	1,634

The major food industry

The Food Industry AD “Vitaminka” Prilep was established in 1956. Today Vitaminka represents a stock company with its Assembly, Supervising Board and Board of Managers.
The production range of “Vitaminka” comprises of: sweet, sour and salty products, everyday products, products for consumers of all ages, appetizer products, additive products, desserts, and products used as salads. The stake of profit of “Vitaminka” are the following products: “Stobi Flips”, chocolates, “Vitacream”, mayonnaise, ketchup, the “Dafinka” seasoning, soups, chocolated products, puddings, whipped cream, the sour program, etc.

The production program of the company is very abundant, and by assortment (range of products) and by types of packaging. It is regarded that the company produces over 170 types of packages, which are basically placed on the market in the Republic of Macedonia and in about 25 countries worldwide. The major part of the products placed abroad by “Vitaminka” are on the markets in Serbia, Montenegro, Australia, Germany, Albania, Bosnia and Herzegovina, Slovenia, Switzerland, Holland, etc. The annual export is within the range of about 3.2 million EUR of the total annual income of about 15 million EUR, with a significant growing tendency.

Mining resources

The vicinity of Prilep represents an insufficiently investigated area in terms of the available mining resources. Certain abundant natural resources have been detected in some parts which could revolutionize the perspective development of the region. Here, it is thought of the nuclear resources and other mines concentrated in the huge Mariovo Massif. There are iron ore deposits, but the Prilep region is abundant with marble and granite deposits. The main mines are situated in the localities Sivec, Kukul, Pletvar, Belovodica, Trojaci, Nebregovo and Sliva. The larger part of the territory of the Prilep municipality region has various mine deposits, mostly of nonmetal origin. The following represent the nonmetal ores which are currently or were previously exploited: feldspar, diatomaceous earth, marbles and dolomites, granite, DISTEN, quartz and perlite.

The marble deposit findings are numerous and varios, both in terms of quantity and quality. An important mine is Sivec, which is situated 10 km away from Prilep. 4,000,000 m^3 of quality marble have been determined at the Sivec mine only. The saccharoid marbles at the Sivec locality have been used in the creation of works of art since ancient times, starting from the first until the fifth and sixth century. There are many sculptures, statues and columns found at the antique localities Stibera, Heraklea, Stobi, etc. The first geological information on marbles as a

comprising part of the Pelagonija Massif originate from Fkosmat (1924), being the first one to distinguish this one as an individual massif. More detailed data regarding the marbles were presented in the period between 1959 and 1961, when the marble series distinguished more marble horizons of different composition. The Prilep marbles have been encompassed in the investigations of magmatic and metamorphic rocks in the wider vicinity of Prilep performed in 1974. After the local investigations in the 50s of the previous century the first surface excavations were commenced on the site Sivec for marble exploitation. In order to necessarily increase the exploitation, manifold geological, geophysical and mine-investigation activities were conducted, but even in 1969 the marble mass in the Sivec mine was systematically and more completely investigated by “Industro Proekt” – Zagreb. Exceptionally detailed structural investigations of the Sivec marbles were performed during the period between 1986 and 1990 by N. Dumurgjanov and Gj. Petrov.

The wider region mostly belongs to the Pelagonian Massif, and a small part to the Vardar zone and the following are presented there: A complex of precambrian rocks, a complex of RIDEJF Cambrian rocks, cretaceous Pliocene-quarternary sediments. The complex of Precambrian rocks represented in the Pelagonian Massif stand as a central part in the shape of horst – ANKIKLINORUM and it represents a relic of the Granville-Proterozoic crust. The complex is lengthened in NNW-SSE direction and is comprised of highly metamorph and granitoid rocks. Generally speaking the highly metamorphic complex of the Pelagonian Massif has a zonal composition and comprises of two different in composition levels, i.e. a lower matamorphic and an upper metamorphic complex.

The lower metamorphic complex displays two distinguished lithostratigraphic levels, i.e. gneiss zone, dominantly formed by muscovite-biothitic gneiss with almandine and rare occurrences of amphibolites shales, and an upper zone where there are vertically arrayed one by one layers of muscovite, muscovite-biothitic, porphyryblastic and other gneiss with traces of mica schists, amphibolites, amphibolitic schists and quartzites. The upper metamorphic complex is composed of a mixed series formed by albitic gneiss, mica schists, cipolins and a marble series formed by more horizons of dolomite, dolomitecalcite and calcite marbles. Apart from the white saccharoid marble – type”Sivec” in the vicinity of Prilep there are also other kinds of marbles, being different not only in the structure but also its coloring.

- Type "Chashka" – a grey white marble, found on Pletvar, by the regional road Prilep – Gradsko.
- Onyx is not a marble rock, although it is similar to marble in terms of chemical composition, but are genetically different because they are created in warm frehwater environment, where microorganisms used $CaCO_3$ in their nutrition and likewise deposited the onyx in layers. There are findings of onyx in the Mariovo region, where it is regularly being exploited at present.
- The Prilep vicinity is also characterised with other kinds of marble, such as the black marble from “Debreshte” and the red marble from “Miokazi”.

The most significant marble site is the mine Sivec which is the largest one and approximately 10 kilometers distance out of Prilep. Other mines for marble exist at the sites Trojaci, Pletvar and Belovodica. There are granite mines in Kukul and Sliva.

The area where the white marble mine “Sivec” is situated belongs to the massif southwest of Baba Mountain. Its location is at the intersection between the mountains Babuna and Kozjak and it stretches into a northwest – southeast direction, at 3 km length and 2 km of width. Most of the marble comes out on the surface in most part of its spanning and it acquires a grey colour due to atmospheric conditions, and this is where the toponym “Sivec” originated from.

Annex 6 Socio-economic details of the region and town of Bitola

Bitola is situated in the south-western part of Republic of Macedonia, in the western part of Pelagonija, at the foot of Baba Mountain on the riverbanks of Dragor River, at 650 meters altitude. Its urban area encompasses over 24 square kilometres. The toponym Bitola has been mentioned since the times of Tzar Samoil. The remains of the ancient Herakle-Linkestis are a proof for the existence of its old town destroyed in the strong earthquake in the year 518. The climate is continental with a mild Mediterranean influence. The average annual temperature is 11 ºC.

Area: **792 km^2**, with **95.385** inhabitants

Number of settlements:

- Towns: **1**
- Villages: **61**
- Number of local offices: **49**

Population: Macedonians 88.71%; Albanians 4.36%; Turks 1.69%; Romas 2.74%; Vlahs 1.33%; Serbs 0.57%; Boshnacs 0.02%; Other 0.58%

Industrial complexes:

- Food industry
- Yeast and spirit factory, the only producer of bread yeast in Macedonia
- Sugar factory “7th November”- Bitola , the only sugar producer in Macedonia, currently not working, but with a potential possibility for restarting production
- Milk and dairy products industry “Ideal Shipka” - Bitola, the biggest privately owned milk industry in the Republic of Macedonia
- Beer industry, one of the three breweries in the Republic of Macedonia
- Confectionery products industry “Krash”- Bitola,
- Slaughterhouse Bitola, one of the bigger slaughterhouses in the Republic of Macedonia
- Zito Bitola, The main caterer of bread in the town of Bitola apart from a large number of privately owned bakeries.There is a mill industry operating within its range
- Leather industry
- Leather processing industry Bitola (out of work),
- Metalprocessing industry
- Refrigerator industry, Bitola (out of work),
- Metalec Bitola,
- Tin containers industry (PLAMBIT)
- Textile industry (there is a great number of textile factories in the process of restarting)
- Bitolateks
- Silk factory
- Idnina,
- Graphic industry
- Fustelarko-Borec

Table 6.1. *Number of business subjects in Bitola.*

Types of business subjects	
Enterprises	4,602
Trade companies	4,776
Individual traders	884
Other	817
Total	11,079

Table 6.2. *Number of business subjects in Bitola.*	
Activity sectors	
Agriculture, hunting and forestry	225
Fishery	1
Mining of ores and stones	11
Processing industry	1,126
Provision with electrical energy, gas and water	7
Construction	286
Retail and wholesale trade, repair of vehicles, motorcycles and goods for personal and household use	6,332
Hotels and restaurants	615
Traffic, storage and links	861
Financial mediation	18
Activities regarding real estate,renting and business activities	480
Public management and defence; obligatory social welfare	95
Education	48
Health and social services	172
Other communal, cultural, common and personal service activities	801
Exterritorial organizations and bodies	1

The crafts and handiwork activities are important for the Bitola economy. According to data from 17 April, 2004, there are 114 craftsmen enrolled in the Craftsmen Register and 49 (old) ones of most various profiles that ought to be re-registered, which totals up to 163 craftsmen of the following trades/crafts:

Table 6.3. *Number of business subjects (craftsmen) in Bitola.*			
	CRAFTSMEN	**No.**	**ACTIVITY**
1	Carpenters	1	Furniture production
2	Hairdressers, Barbers	50	Hairdressing and other beauty treatments
3	Candle makers	3	Other production of goods not mentioned elsewhere
4	Mechanics	9	Maintenance and repair of motor vehicles
5	Tinsmiths	3	Production of other fabricated and metal products not mentioned elsewhere
6	Weavers	1	Weaving of woollen type cloths
7	Knitters	1	Production of knitwear and tights products
8	Goldsmiths	5	Production of jewellery and similar goods not mentioned elsewhere
9	Shoemakers	4	Repair of boots, shoes and other leather goods
10	Hatmakers	2	Production of other goods and clothing accessories not mentioned elsewhere
11	Toymakers	1	Production of games and toys
12	Locksmiths	4	General mechanical works
13	Tailors	4	Production of other upper wear
14	Painters – Glass cutters	2	Painting and glass installation
15	Plastic makers	1	Other construction activities including specific goods
16	Construction workers	1	Other sevice activities not mentioned elsewhere
17	Bell makers	1	Forging, pressing and rolling of metals
18	Electricians	2	Repair of electrical apparatuses
19	Stonecutters	3	Cutting, shaping and processing of stone
20	Bakers	2	Production of bread and white baked goods
21	Entertainment games	2	Fairground and entertainment activities
22	Glass makers	1	Shaping and processing of flat glass
23	Bicycle repairers	1	Repairs not mentioned elsewhere
24	Watchmakers	3	Repair of watches and jewellry

25	Electricians	1	Wiring with electrical installation
26	Photographers	1	Photographic services
27	Photocopying	2	Printing not mentioned elsewhere
28	Catering	1	Catering
29	Ice-cream makers	1	Production of ice-cream and other frozen mixtures
30	Lumberjacks	1	Growing, exploit and protection of forests
Total:		114	

AGRICULTURE

***Table 6.4**. Total area by type of production for agricultural companies and individual farmers (in ha and per cent (%)).*

No.	Sector	Total area	Agricult. area	Cultivated area					Pastures	Forests	Infertile areas
				Total	Fields, gar-dens	Orchards.	Vinery	Meadows			
		179,805	121,970	63,776	55,766	1,222	1,313	5,475	57,884	47,516	10,319
1.	Agricul. Com-pany	72%	64%	44%	48%	27%	46%	5%	87%	95%	58%
		129,647	78,495	27,941	26,748	326	599	268	50,223	45,193	5,995
2.	Ind. farmer	25%	34%	51%	51%	62%	81%	81%	12%	3%	16%
		44,375	41,269	34,462	28,608	761	680	4,413	6,792	1,436	1,688

***Table 6.5.** Land use by cultivation type and product.*

CULTURES	Agricultural enterprises	Individual farmers	TOTAL
Cereal crops	**10,547 ha**	**15,550 ha**	**26,097 ha**
- maize	7,500 ha	7,000 ha	14,500 ha
- barley	2,950 ha	4,300 ha	7,250 ha
- rye	-	400 ha	400 ha
- corn grain	77 ha	3,850 ha	3,927 ha
- corn grain (seed)	20 ha	-	20 ha
Industrial cultures	**3,533 ha**	**2,230 ha**	**5,763 ha**
- rape seed	450 ha	-	450 ha
- sugar beet	234 ha	680 ha	914 ha
- sunflower	2,849 ha	200 ha	3,049 ha
- tobacco	-	1,350 ha	1,350 ha
Garden cultures	**105 ha**	**720 ha**	**825 ha**
- tomatoes	20 ha	420 ha	440 ha
- peppers	10 ha	300 ha	310 ha
- other	75 ha	-	75 ha
Field cultures	**-**	**650 ha**	**650 ha**
- potato	-	350 ha	350 ha
- beans	-	100 ha	100 ha
- water/melons	-	200 ha	200 ha
Forage cultures	**3,019 ha**	**2,120 ha**	**5,139 ha**
- alfalfa	719 ha	300 ha	1,019 ha
- stock peas	360 ha	70 ha	430 ha
- sweet peas	90 ha	-	90 ha
- maize silage	970 ha	1,750 ha	2,720 ha

- SIRAK	860 ha	-	860 ha
- sorghum	20 ha	-	20 ha
Permanent plantations	**790 ha**	**917 ha**	**1,707 ha**
- apple	-	190 ha	190 ha
- pear	-	-	-
- peach	-	10 ha	10 ha
- sour cherry	300 ha	17 ha	317 ha
- apricot	-	-	-
- vinery	490 ha	700 ha	1,190 ha
Fish ponds	216 ha	-	216 ha
Meadows	268 ha	4,413 ha	4,681 ha
Noncultivated area	5,956 ha	13,441 ha	19,397 ha
TOTAL AREA	24,434 ha	40,041 ha	64,475 ha

Table 6.6. *Number of the various farm animals in the Bitola region.*

CATTLE	**Companies**	**Individual stock breeders**	**TOTAL**
Cattle	3,700	15,650	19,350
Cows and heifers	1,850	9,250	11,100
Sheep	3,950	51,756	55,706
Breeding sheep	2,520	37,869	40,389
Goats	-	6,000	6,000
Hogs	5,500	4,888	10,388
Sows and suckling pigs	500	687	1,187
Horses	-	3,100	3,100
Layers	200,000	300,000	500,000
Bee hives	-	2,500	2,500
Fish ponds (biomass)	270 tons	-	270 tons

Processing facilities of agricultural products

The following processing facilities exist in the Bitola region:

- AD-IMB with a daily processing capacity of over 200,000 liters of milk, production range of 48 products
- “Ideal Shipka” - Bitola, with a daily capacity of 40,000 liters, produces five milk products and two mini dairies with capacity of 1,000 liters, producing a four products assortment, two slaughterhouses for slaughtering bigger and smaller castle, one of which is registered for export slaughtering
- AD- FDH – village of Radobor with a daily capacity for production from 150 to 200 tons (with a 28 products range), five mini processing facilities of 15 tons, with a 10 products range.
- AD”Zito Bitola”, with a daily capacity of 140,000 kilograms flour, a range of two types of flour products T-400 and T-500, animal feed flour and 25 types of white baked goods
- Mill „Stojcev” Bitola, with a daily capacity of 50,000 kilograms flour, with a range of two types of flour T-400 and T-500 and 25 types of white baked goods
- AIK “Lozar”, Vinery with a capacity of 4,000,000 kilograms grapes, with a three products range, wine – 2,700,000 liters, grapes destilates (brandy) – 120,000 liters and syrup – 300,000 liters
- Factory for fruit and vegetables processing “Vita Pela” Bitola with a capacity of 10,183,000 kilograms, with a 17 products assortment: tomatoes – 6,000,000 kilograms, green tomatoes – 50,000 kilograms, red peppers for ajvar – 2,000,000 kilograms, yellow peppers – 100,000 kilograms, hot chilly peppers – 60,000 kilograms, cabbage for sarma rolls and salad – 250,000 kilograms, aubergines – 60,000 kilograms, carrots – 150,000 kilograms, gherkins – 500,000 kilograms, cauliflower – 120,000 kilograms, red onions – 20,000 kilograms, parsley – 3,000 kilograms, beetroot – 200,000 kilograms, peas – 120,000 kilograms, industrial apples – 100,000 kilograms, sour cherries –

400,000 kilograms and mushrooms – 50,000 kilograms, which means that the capacity of explou\it of the factory is about 40%

- The sugar factory "4th November" in Bitola with an annual capacity of 150,000 tons sugar beet, with a white sugar production of 13,000 tons and processing of brown sugar in quantities of 35,000 tons.

Table 6.7. *Number of major economies in Bitola municipality important for the environment (Crna River)*	
CONSTRUCTION	44 companies
ENERGETICS	
REK Bitola – Mine Suvodol	
PC Srezevo	
MINING	
REK Bitola – Mine Suvodol	
TEXTILE	Textile production 33 companies
PRINTING	
Paper	22 companies
on plastics	5 companies
on porcelain	1
FOOD INDUSTRY	
Milk production	5
Meat and meat products	2
Beer brewing	1
Mineral water	3
Alcoholic beverages	3
Soft beverages	15
Confectionery products	7
Flour, flour products	7
LEATHER PRODUCTION	3
METAL INDUSTRY	10
TOBACCO PRODUCTION	2
ELECTRICAL MACHINES AND DEVICES, ELECTRONICS	13
Fitting of computer equipment	31
Wood processors	8
PRODUCTION OF NAPKINS AND TOILET PAPER	2
AGRICULTURE, STOCK BREEDING AND POULTRY	
Stock forage – factory, mills	3
AGRICULTURE, STOCK BREEDING 2	2
CHEMICAL INDUSTRY	
Production of chemical products	3
Plastic products 14	14

Annex 7 Scientific name (latin) and common names (in Macedonian and English) of the fish species recorded in the Crna River (introduced species are given in bold letters)

	Scientific name	Macedonian (local) name	English name
1	Alburnoides bipunctatus (Bloc.)	Gomnushka	Minnow (Chub)
2	Alburnus alburnus (L.)	Plashica	Bleak
3	Barbus macedonicus (Kar.)	Makedonska mrena	Macedonian barbel
4	Barbus peloponnesius (Val.)	Mrena	n.a.
5	**Carassius gibelio** (Bloc.)	Srebren karas, babushka	Prussian carp
6	**Carassius carassius** (L.)	Zlaten karas	Crucian carp
7	Chondrostoma vardarense (Kar.)	Vardarski skobust, bojnik	Vardar undermouth
8	Cobitis vardarensis (Kar.)	Vardarska shtipalka	Vardar loach
9	Cyprinus carpio (L.)	Krap	Common carp
10	**Gymnocephalus cernuus** (L.)	n.a.	Ruffe
11	Gobio gobio (L.)	Krkushka	Gudgeon
12	Gobio uranoscopus (Agas.)	Tenkoopashesta krkushka	Danube gudgeon
13	Leuciscus cephalus (L.)	Klen	European chub
14	Pachychylon macedonicus (Ste.)	Moranec	n.a.
15	Perca fluviatilis (L.)	Perkija, kostresh	European perch
16	**Pseudorasbora parva** (Tem.&Sch.)	n.a.	Stone moroko, Rasbora
17	**Rhodeus amarus** (Bloc.)	Platiche	Bitterling
18	Rutilus rutilus (L.)	Grunec	Roach
19	Salmo trutta (L.)	Pastrmka	Brook trout
20	Scardinius erythrophthalmus (L.)	Pisa	Rudd
21	Silurus glanis (L.)	Som	Wels catfish
22	Tinca tinca (L.)	Linish	Tench
23	Vimba melanopsis (Heck.)	Popadika	Macedonian vimba
26	**Ameiurus nebulosus** (Les.)	Americhko somche	Brown bullhead
27	**Lepomis gibbosus** (L.)	Soncharka	Pumkinseed
28	**Esox lucius L.**	Shtuka	Pike

n.a.: no agreed common name available

Annex 8 The Act declaring the Strict Natural Reserve Tikvesh

PROTECTED AREAS IN MARIOVO

ACT FOR PROCLAMATION OF THE ORNITHOLOGICAL LOCALITY "TIKVESH" IN THE CRNA RIVER RAVINE FOR A STRICT NATURAL RESERVE

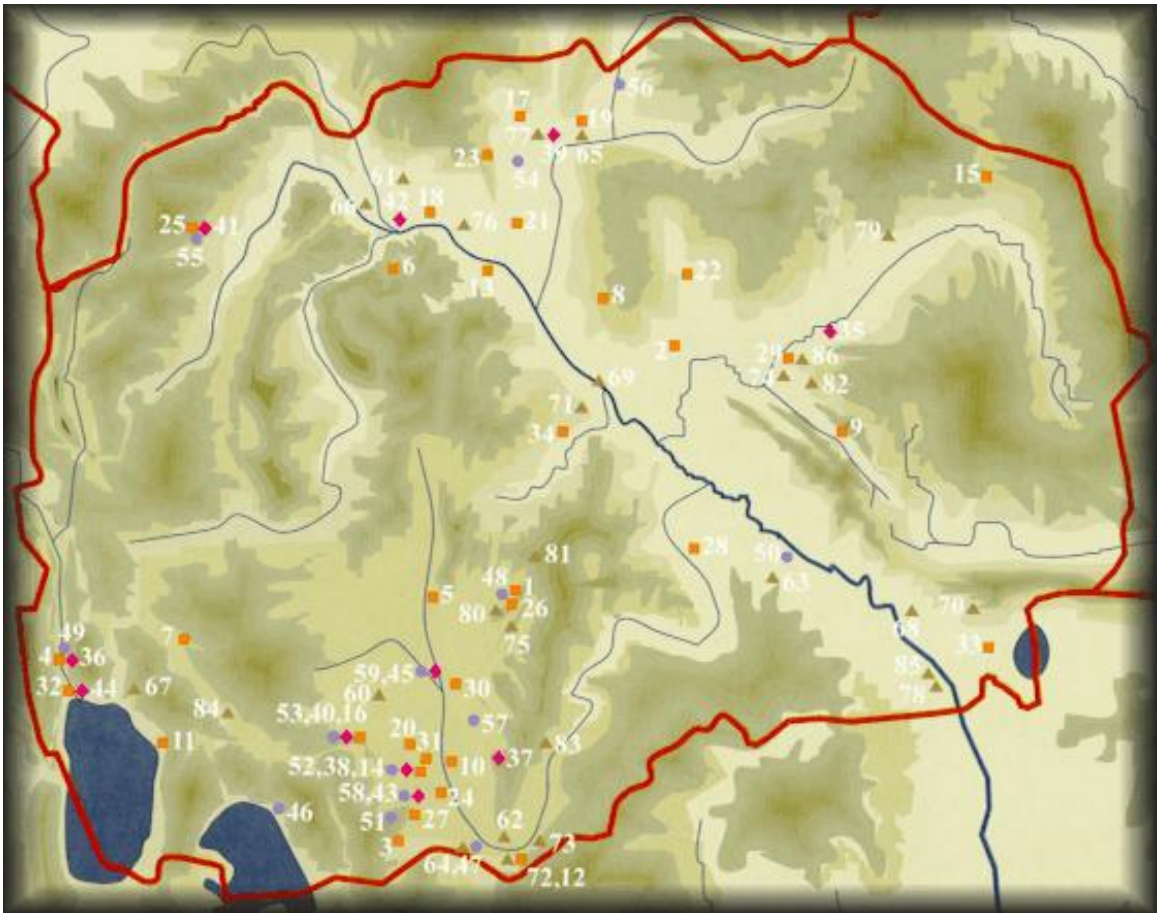
(This Act was declared in the Official Gazette of RM no. 35/97 from 23 July 1997)

Article 2

The boundary of the reserve commences at the western part of Lake Tikvesh under the elevation 396, from where it runs upwards the hill Vrv (775 m) in a west-south-west direction and continues directly to the village of Pravednik from where it declines to above Doljani River Valley. It makes a wide turn there to northwest and intersects the northern parts of the peaks Galchin (1472 m) and Orlite (1480 m), passing through several ridges and valleys. It continues towards the locality Covekot with the elevation 1399 m and from there it declines towards south running upstream of Galishka River, below the village of Galishte. It follows the valley to below the elevation 642 from where it goes down into Gaslishka River through a minor ridge and follows the valley down to the river mouth into the lake, passing it westerly till the elevation 398, then it rises to the northwestern parts of Varelova Tumba and there at a straight angle it swerves to the east and goes to the elevation 609. From this point the border flows in a southwestern direction to the locality Vodena Peshta and the elevation 807 all the way to the elevation 459. From here it rises along the hill Samovilec (772) towards northeast and goes along the ridge to the elevation 694. At this point the border turns a semicircle towards north and passes 500 m westerly from the village of Kumanichevo from where it again takes a northeast direction. It passes easterly from the elevation 1036 where it intersects the road from Kumanichevo to Dragozel and turns to the northwest mildly declining to the elevation 810. From this point the border continues towards north to the locality Plazje and through the elevation 660 after 2 km in the north it turns to the east towards the valley of KamenicaRriver. It intersects the valley and changes its direction in a semicircle to the northeast. It intersects Kasapski Dol, goes to the elevation 432, intersects the road between the village of Begnishte and the lake and it turns mildly through the locality Prpljuj into the west-southwest direction and lands on the Lake Tikvesh coast at the starting point.

The reserve encompasses an area of 10.650 hectares within these boundaries, 9700 hectares of which are land and 950 hectares are water surfaces.

Annex 9 Historical Sites in the Republic of Macedonia



Map of the Historical sites in the Republic of Macedonia

List of Historical sites in the Republic of Macedonia (numbers refer to the map). Localities in bold are within the range of the municipalities Demir Hisar, Prilep, Bitola and Mariovo, i.e. within the drainage area of Crna River.	
Neolithic	Bronze Age
1. Ali cair, Prilep	46. Asamati, Sv. Nedela, Resen
2. Anzabegovo, Barutnica, Shtip	**47. Bukri, Visok rid, Bitola**
3. Velusina, Veluska Tumba, BT.	48. Varos, Prilep
4. Vranista, Crkveni livadi, Struga	49. Vranista, Crkveni livadi, STG.
5. Vrbjani, Vrbjanska cuka, PP.	50. Gradina, Demir Kapija
6. Govrlevo, Cerje, Skopje	**51. Kanino, Tumba, Bitola**
7. Gorno Sredorece, Zlastrana, OH.	**52. Karamani, Tumba, Bitola**
8. Gorubinci, Rug Bair, Sv. Nikole	**53. Kravari, Tumba, Bitola**
9. Damjan, Kanli cair, Radovis	54. Lopate, Pribovce, Kumanovo
10. Dobromiri, Golema tumba, BT.	55. Palciste, Tumba, Tetovo
11. Dolno Trnovo, Ohrid	56. Pelince, Gradiste, Kumanovo
12. Zivojno, Vlaku i Gradiste, BT.	**57. Radobor, Tumba, Bitola**
13. Zelenikovo, Slatina, Skopje	**58. Crnobuki, Tumba, Bitola**
14. Karamani, Tumba, Bitola	**59. Cepigovo, Bakarno gumno, PP.**
15. Kostin dol, Delcevo	Iron Age
16. Kravari, Tumba, Bitola	**60. Beranci, Visoi, Bitola**
17. Lopate, Amam, Kumanovo	61. Brazda, Skopje

18. M. Nagoricino, Na breg, KU.	**62. Brod, Saraj, Bitola**
19. Madzari, Tumba, Skopje	63. Budur, Ciflik, D. Kapija
20. Mogila, Tumba sredselo, BT.	**64. Bukri, Progon, Bitola**
21. Mrsevci, Tumba sredselo, SK.	65. Vojnik, Groblje, Kumanovo
22. Nemanjici, Alin dol, Sv. Nikole	66. Volkovo, Dubice, Skopje
23. Nikustak, Cubuk cesma, KU.	67. Gorenci, Suva cesma, Ohrid
24. Opticari, Trn Tumba, Bitola.	68. Grciste, Glos, Valandovo
25. Palciste, Tumba, Tetovo	69. Dabaci, Veles
26. Pesterica, Prilep	70. Dedeli, Meleznik, Valandovo
27. Porodin, Tumba, Bitola	71. Dolno Orizari, Svilara, Veles
28. Resava, Cakovec, Kavadarci	72. Zivjovo, Bel kamen, Bitola
29. Tarinci, Vrsnik, Stip	**73. Zovic, Marta, Bitola**
30. Topolcani, Cuka, Prilep	74. Karaorman, Orlova cuka, Stip
31. Trn, G. M. Tumba, Bitola	**75. Kaldrma i Kasarni, Prilep**
32. Usta na Drim, Struga	76. Klucka-Hipodrom, Skopje
33. Crnicani, Atici, Gevgelija	77. Kostoperska karpa, Kumanovo
34. Caska, Mramor, Veles	78. Milci, Gevgelija
Eneolithic	79. Orizari, Kunovo cuki, Kocani
35. Burilcevo, Pilavo, Kocani	**80. Popadin dol, Prilep**
36. Vranista, Crkveni livadi, STG.	**81. Prisad, Sivec, Prilep**
37. Dolno Oreovo, Suplevec, BT.	82. Radanje, Krivi dol, Stip
38. Karamani, Tumba, Bitola	**83. Rapes, Slamite, Bitola**
39. Kostoperska karpa, Kumanovo	84. Recica, Lozista, Ohrid
40. Kravari, Tumba, Bitola	85. Suva River, Gevgelija
41. Palciste, Tumba, Tetovo	86. Tarinci, Krst, Stip
42. Skopsko Kale, Skopje	
43. Crnobuki, Tumba, Bitola	
44. Usta na Drim, Struga	
45. Cepigovo, Bakarno gumno, PP.	
Source: www.soros.org.mk/konkurs/090/Pra/pra_fra.htm	

Annex 10 Regulation for Classification of water in the Republic of Macedonia

Based on Article 85 paragraph 4 of the Law on waters ("Official gazette of RM " No 4/98) and Article 46 paragraph 3 from the Law on the Government ("Official gazette of SRM " No 38/90 and "Official gazette of RM" No 63/94 and 63/98) the Government of the Republic of Macedonia on the session held on 23.03.1999 brought:

REGULATION

FOR CLASSIFICATION OF WATER

Article 1

With this Regulation the classification is made of the surface waters / water courses, natural and artificial lakes / and of groundwater.

This Regulation shall not apply to mineral and thermal waters.

Article 2

According to the purpose of usage and the water pureness the Water referred to in Article 1, paragraph 1 of this Regulation are delineated in 5 classes, namely:

1. Class - very clean, oligotrophic water, which in its natural state contains very slight, occasional antropogenic pollution with organic matters / but not with inorganic matters / and which can, with possible disinfecting, can be used for drinking and production and processing of food products. It is constantly saturated with oxygen, with low content of nutrients and bacteria, and is suitable for mating and cultivation of noble types of fish – salmonids. The buffering capacity of the water is very good;
2. Class - slightly polluted, mesotrophic water, which in its natural state has good buffering capacity and can be used for bathing and recreation, water sports, production of other types of fish / ciprinides /, or which can be used – after usual methods of purification / coagulation, filtration, disinfection etc. / – for drinking and production and processing of food products. Oxygen saturation is present throughout the year. The loadings may lead to insignificant increased primary productivity.
3. Class - is moderately euthrophic water, which in its natural state can be used for irrigation, and after usual purification methods (conditioning) for industries which do not need drinking water quality. Buffering capacity of the water is low, but it maintains the / pH value / acidity at a level still suitable for most fish. In hypolimnion occasionally oxygen deficit occurs. The level of primary production is considerable, and some changes in community structure, including fish species can be observed. The load of harmful substances is evident as well as microbial pollution. The concentration of the harmful substances varies from natural levels to levels of chronic toxicity for aquatic life.
4. Class - highly euthrophic, polluted water, which in its natural state can be used for other purposes only after certain processing and which receives organic matter, nutrients and harmful substances. In the epilimnion there is oxygen saturation, and in hypolimnion there is oxygen deficit. Algal blooms are common. Increased decomposition of organic matter at the

same time with the stratification of the water can cause anaerobic conditions and fish kills. Mass occurrences of more tolerant species, fish population and benthic organisms can be affected. The buffering capacity is exceeded, which leads to higher levels of acidity, and which affects the development of the offspring. Microbiologic pollution does not allow the water to be used for recreation. Harmful substances emitted or released from the sediment / deposits /, can affect the quality of the aquatic life. The concentration of harmful substances can very from level of chronic to acute toxicity to aquatic life.

5. Class - very polluted, hiperthrophic water, which in its natural state can not be used for any purpose. The water has no buffer capacity and its acidity / pH value / is harmful for many fish species. Large problems occur with the oxygen regime, namely saturation in hipolimnion absence of oxygen, leading to anaerobic conditions in hipolimnion. Decomposers dominate over producers. Fish and bentosic species are constantly not present. Concentration of harmful substances exceeds acute-toxicity levels for aquatic life.

Article 3

The indicators for the classification of water into classes according to article 2 of this Regulation are:

A. ORGANOLEPTIC INDICATORS:	visible waste, visible color, notable smell, true color, turbidity and tranparency
B. INDICATOR OF ACIDITY:	pH value and alkalinity
C. OXYGEN REGIME INDICATORS:	dissolved oxygen, oxygen saturation, biochemical oxygen demand for 5 days at 20 ^{o}C / BOD_5 /, chemical oxygen demand from potassium permanganate
D. MINERALIZATION INDICATORS :	suspended matters, total dry residue after filtration (total dissolved solids)
E. EUTROFICATION NDICATORS:	total phosphorus, total nitrogen, chlorophyll “a“, saprobic idex, level of biological productivity
F. MICROBIOLOGICAL INDICATORS	most probable number of coliform bacteria, thermotolerant coliforms and Faecal Streptococci
G. RADIOACTIVITY:	total activity of heavy radioactive waste materials which can be released into the surface water - water course during one year, shall be calculated by a separate formula
H. HARMFUL AND DANGEROUS MATTER:	metals and their compounds, other inorganic parameters, hydrocarbon. halo hydrocarbon, nitrated hydrocarbon, pesticides, other inorganic compounds

Article 4

Limit values of indicators from Article 3 of this Regulation are set as follows:

Indicators	**Upper values and concentrations per class**				
	***Class* I**	***Class* II**	***Class* III**	***Class* IV**	***Class* V**
A. ORGANOLEPTIC INDICATORS					
1. visible waste	None	*None*	*None*	*None*	-
2. visible color	None	None	*Little turbid.*	*Turbid*	-
3. notable smell	None	None	*Hardly notable*	*Notable*	-
4. true color mg/l Pt	*<15*	*15-25*	*26-40*	*>40*	*>40*
5. Turbidity NTU	*<0.5*	*0.5-1.0*	*1.1-3.0*	*>3.0*	*>30*
6. Transparency [1]					
B. ACIDITY INDICATORS					
4. pH value	6,5-8,5	6,5-6,3	6,3-6,0	6,0-5,3	< 5,3
5. alkalinity mg/l $CaCO_3$	> 200	200-100	100-20	20-10	< 10
C. OXYGEN REGIME INDICATORS					
6. dissolved oxygen mg/l O_2	> 8,00	7,99 – 6,00	5,99 – 4,00	3,99 – 2,00	< 3,00
7. oxygen saturation					
- epilimnion % O_2 [2]	90 - 105	75 – 90	50 – 75	30 – 50	< 30
		105 - 115	115 - 125	125 – 150	> 150
- hipolimnion % O_2 [2]	75 - 90	50 - 75	30 - 50	30 - 10	< 10
- Total % O_2	75 - 90	50 – 75	50 – 30	30 – 10	< 10
		105 - 115	115 - 125	125 – 150	> 150
8. biochemical oxygen demand for 5 days at 20 ^oC (BOD_5) mg/l O_2	< 2,00	2,01 – 4,00	4,01 – 7,00	7,01 – 15,0	> 15,0
9. chemical oxygen demand –permanganate mg/l O_2					
	<2,50	2,51 – 5,00	5,01 – 10,0	10,0 – 20,0	> 20,0
D. MINERALIZATION INDICATORS					
10. Suspended matter mg/l	< 10	10 - 30	30 - 60	60 - 100	> 100
11. Total dry residue after filtration / total dissolved solids -TDS) mg/l:					
- Surface water	350	500	1000	1500	> 1500
- Groundwater – karstic	350	500	1000	1500	> 1500
- Groundwater – not karstic	800	1000	1500	1500	> 1500
E. EUTROFICATION INDICATORS					
12. total phosphorus P mg/l	<10 / < 15 /	10 – 25 / 15 – 40 /	25 – 50 / 40 – 70 /	50 – 125 / 75 – 190 /	> 125 / > 190 /
13. chlorophyll "a" mg/l	< 2,5 / < 4,0 /	2,5 – 10 / 4,0 – 15 /	10 – 30 / 15 – 45 /	30 – 110 / 45 – 165 /	> 110 / > 165 /
14. , total nitrogen N mg/l	< 300	300 - 750	750 - 1500	1500-2500	> 2500

[1] *given values refers only to lakes and reservoirs*
[2] *given values refers only to lakes and reservoirs*

15. saprobic index-Liebmann	*Oligosaprobic*	*Mesosaprobic*	*Mesosaprobic*	*Mesosaprobic-poli*	*Poli saprobic*
16. level of biological productivity	Oligotrophic	*Mesotrophic*	*Moderate eutrophic*	*Eutrophic*	*Hypertrophic*
F. MICROBIOLOGICAL POLLUTION INDICATORS					
17. most probable number of coli-form bacteria per l-	2000	20000	100000	200000	> 200000
18. thermo-tolerant coliforms - number/100 ml	< 10	10 - 30	30 - 100	100 - 1000	> 1000
19. Faecal Streptococci Number / 100 ml	< 10	10 - 30	30 - 100	100 - 1000	> 1000
G. RADIOACTIVITY					
20.Level of radioactivity	*total activity of heavy radioactive waste materials which can be released into the surface water - water course during one year, shall be calculated by a following formula:* $F/O\ (\Sigma A_i/MDK_i)$ *where:* A_i *- total activity of* i*-th nucleid releised into water course during one year in* Bq. MDK_i *– maximum allowed concentration of i-th radio nucleid in drinking water for ion radiation* Bq/m^3 O *– average yearly discharge of the river in* m^3/s F *– safety factor and reserve, a number depending on radio-ecological and hydrodynamical conditions of the river, of the river water use, the number and position of the inflow of radfioation within the catchment and other information, calculated in a way to provide protection of ionic radiation.*				

H. HARMFUL AND DANGEROUS MATTER

Number	*HARMFUL AND DANGEROUS MATTER - NAME -*	*Unit*	*MAXIMUM ALLOWED CONCENTRATION / mdk /*		
			I-II *CLASS*	III-IV *CLASS*	V *CLASS*
I. METALS AND ITS COMPOUNDS					
01.	*Aluminium*	µg/l Al	1500	1500	> 1500
02.	*Antimony*	µg/l Sb	30	50	> 50
03.	*Arsenic*	µg/l As	30	50	> 50
04.	*Copper*	µg/l Cu	10	50	> 50
05.	*Barium*	µg/l Ba	1000	4000	> 4000
06.	*Beryllium*	µg/l Be	0.2	1	> 1
07.	*Bismuth*	µg/l Bi	50	50	> 50
08.	*Zink*	µg/l Zn	100	200	> 200
09.	*Cadmium*	µg/l Cd	0.1	10	> 10
10.	*Cobalt*	µg/l Co	100	2000	> 2000
11.	*Selenium - inorganic*	µg/l Sn	100	500	> 500
12.	*Chromium – total*	µg/l Cr	50	100	> 100
	Chromium – six-valent	µg/l Cr^{6+}	10	50	> 50
13.	*Manganese*	µg/l Mn	50	1000	> 1000
14.	*Molybdenum*	µg/l Mo	500	500	> 500
15.	*Nickel*	µg/l Ni	50	100	> 100
16.	*Lead*	µg/l Pb	10	30	> 30
17.	*Palladium*	µg/l Pd	2	20	> 20
18.	*Silver*	µg/l Ag	2	20	> 20
19.	*Thallium*	µg/l Ta	3	30	> 30
20.	*Titanium*	µg/l Ti	100	100	> 100

21.	*Vanadium*	µg/l V	100	200	> 200
22.	*Iron*	µg/l Fe	300	1000	> 1000
23.	*Mercury – total*	µg/l Hg	0.2	1	>1
	Total organic-Mercury compounds.	µg/l Hg	0.02	0.1	>0.1
II. OTHER INORGANIC PARAMETERS					
24.	*Ammonia*	µg/l NH_3	20	500	> 500
		µg/l NH_4	1000	10000	>10000
25.	*Asbestos*	µg/l	*May not be present*		
26.	*Boron*	µg/l B	200	750	> 750
27.	*Cyanides*	µg/l CN^-	1	100	> 100
28.	*Fluoride*	µg/l F^-	300	1500	> 1500
29.	*Phosphorus - elementary*	µg/l P	0.01	0.1	> 0.1
30.	*Phosphate*	µg/l P	100 / 25 / [3]	100	> 100
31.	*Chlorine*	µg/l Cl_2	2	10	> 10
32.	*Nitrate*	µg/l N	10000	15000	> 15000
33.	*Nitrite*	µg/l N	10	500	> 500
34.	*Selenium*	µg/l Se	10	10	> 10
35.	*Sulfides –total*	µg/l S^{-2}	2	50	> 50
III. *PHENOLS*					
36.	*Phenol*	µg/l	1	50	> 50
37.	*Cresol* / o-, m-, p- /	µg/l	2	20	> 20
38.	*Nonylphenol*	µg/l	1	10	> 10
39.	2-*chlorophenol*	µg/l	0.1	10	> 10
40.	2, 4-*dichlorophenol*	µg/l	0.3	5	> 5
41.	2, 4, 5-*trichlorophenol*	µg/l	1	10	> 10
42.	*Pentachlorophenol*	µg/l	1	10	> 10
43.	o-*nitrophenol*	µg/l	1	50	> 50
44.	m-*nitrophenol*	µg/l	10	50	> 50
45.	p-*nitrophenol*	µg/l	10	50	> 50
46.	2, 4-*dinitrophenol*	µg/l	30	50	> 50
47.	*Picric acid*	µg/l	10	50	> 50
48.	4, 6-*dinitro*-o-*cresol*	µg/l	10	50	> 50
49.	*Aminophenol* / o-, m-, p- /	µg/l	10	50	> 50
IV. HYDROCARBONS					
50.	*Oil*	µg/l	10	50 / 100 / [4]	> 100
51.	*Benzene*	µg/l	1,5	10 / 50 /	> 50
52.	*Toluene*	µg/l	50	100 / 500 /	> 500
53.	*Xylene* / o-, m-, p- /	µg/l	50	100 / 500 /	> 500
54.	*Ethylbenzene*	µg/l	50	100 / 500 /	> 500
55.	*Styrene*	µg/l	20	100 / 500 /	> 500
56.	*Mesitylene*	µg/l	5	100 / 500 /	> 500
57.	*Diisopropyl benzene*	µg/l	50	100 / 500 /	> 500
58.	*Naphthalene , methyl naphthalene*	µg/l	1	10 / 100 /	> 100
59.	*Fluorene*	µg/l	5	50	> 50
60.	*Phenanthrene*	µg/l	5	50	> 50
61.	*Anthracene*	µg/l	5	50	> 50
62.	*Acenaphthene*	µg/l	5	50	> 50
63.	*Fluoranthene*	µg/l	5	50	> 50
64.	*Polynuclear aromatic hydrocarbons /higher homologous/-cancerogenous*	µg/l	0.01	0.04	> 0.04

[3] *The stated value applies to lakes*
[4] *Values given in brackets refer to water Class IV*

65.	*Ethylene*	µg/l	50	100 / 500 /	> 500
66.	*Propilene*	µg/l	50	100 / 500 /	> 500
67.	*Isobutylene*	µg/l	50	100 / 500 /	> 500
68.	*1-butene*	µg/l	20	100 / 500 /	> 500
69.	*Isoprene*	µg/l	5	100 / 500 /	> 500
70.	*Cyclohexane*	µg/l	20	100 / 500 /	> 500
71.	*Cyclohexene*	µg/l	20	100 / 500 /	> 500
72.	*Biphenyl propane*	µg/l	10	100 / 500 /	> 500
V. *HALOGENATED HYDROCARBONS*					
73.	*Methylchloride*	µg/l	2	20	> 20
74.	*Methylbromide*	µg/l	2	20	> 20
75.	*Dichloromethane*	µg/l	2	20	> 20
76.	*Bromodichlormethane*	µg/l	2	20	> 20
77.	*Bromoform*	µg/l	2	20	> 20
78.	*Chloroform*	µg/l	2	20	> 20
79.	*Tetrachlorcarbon*	µg/l	2	20	> 20
80.	1,2-*dichloroethane*	µg/l	7	100	> 100
81.	1,1.2-*trichloroethane*	µg/l	3	50	> 50
82.	1,1,1-*trichloroethane*	µg/l	25	100	> 100
83.	1,1,2,2-*tetrachloroethane*	µg/l	2	15	> 15
84.	*Hexachloroethane*	µg/l	6	10	> 10
85.	*Vinyl chloride*	µg/l	5	50	> 50
86.	*Dichloroethylene*	µg/l	1,5	25	> 25
87.	*Trichloroethylene*	µg/l	20	75	> 75
88.	*Tetrachloroethylene*	µg/l	2	4	>4
89.	*Monochlorobenzene*	µg/l	20	100	> 100
90.	*Dichlorobenzene*	µg/l	2	20	> 20
91.	*Trichlorobenzene*	µg/l	10	20	> 20
92.	*Pentachlorobenzene*	µg/l	0.5	5	> 5
93.	*Hexachlorobenzene*	µg/l	1	1	> 1
94.	*Trichloronaphthalene*	µg/l	4	4	> 4
95.	*Tetrachloronaphthalene*	µg/l	1,5	1,5	> 1,5
96.	*Pentachloronaphthalene*	µg/l	0,4	0,4	> 0,4
97.	*Hexachloronaphthalene*	µg/l	0,15	0,15	> 0,15
98.	*Dekachloronaphthalene*	µg/l	0,1	0,1	> 0,1
99.	*Dichloropropane*	µg/l	50	200	> 200
100.	*Dichloropropene*	µg/l	1	20	> 20
101.	1.3-*dichlorobutane*	µg/l	20	50	> 50
102.	*Dichlorocyclohexane*	µg/l	20	50	> 50
103.	*Tetrachloropropane*	µg/l	10	50	> 50
104.	*Tetrachloropenthane*	µg/l	5	50	> 50
105.	*Tetrachloroheptanee*	µg/l	3	30	> 30
106.	*Tetrachlorononane*	µg/l	3	30	> 30
107.	*Tetrachlorodekane*	µg/l	7	50	> 50
108.	*Pentachloroheptane*	µg/l	20	100	> 100
109.	*Hexsachlorobutadiene*	µg/l	1	10	> 10
110.	*Heksachlorociklobutadiene*	µg/l	1	10	> 10
111.	*Heksachlorobutane*	µg/l	10	100	> 100
112.	2, 3, 7, 8-*tetrachlorodibenzo*-p-*dioksin* / TKDD /	µg/l	$4{,}5\ 10^{-7}$	$4{,}5\ 10^{-7}$	$4{,}5\ 10^{-7}$
VI. *NITRATED HYDROCARBONS*					
113.	*Nitrobenzene*	µg/l	20	50	> 50
114.	*Dinitrobenzene*	µg/l	10	50	> 50
115.	2, 4-*dinitrochlorobenzene*	µg/l	10	50	> 50
116.	*Nitrotoluen* / o-, m-, p- /	µg/l	10	50	> 50
117.	*Nitrochlorobenzene*	µg/l	20	50	> 50
118.	*Dinitrotoluene*	µg/l	1	10	> 10

119.	2, 4, 6-*trinitrotoluene*	µg/l	20	50	> 50
120.	*Dinitronaphthalene*	µg/l	1	10	> 10
121.	*Nitromethane*	µg/l	5	50	> 50
122.	*Nitropropane*	µg/l	5	50	> 50
123.	*Nitroethane*	µg/l	5	50	> 50
124.	*Nitrobutane*	µg/l	5	50	> 50
125.	*Nitroform*	µg/l	10	50	> 50
126.	*Tetranitrometane*	µg/l	20	50	> 50
127.	*Nitrocyclohexsane*	µg/l	20	50	> 50
128.	N-*nitrosodimethylamine*	µg/l	0.03	0.034	0.03
129.	N-*nitrosodiethylamine*	µg/l	0.01	0.01	0.01
130.	N-*nitrosodibutilamine*	µg/l	0.015	0.015	0.015
131.	N-*nitrosopirolidine*	µg/l	0.1	0.1	0.1
132.	*Benzidine*	µg/l	$2{,}0\ 10^{-3}$	$1\ 10^{-2}$	$1\ 10^{-2}$
133.	*3,3-dihlorbenzidine*	µg/l	$2{,}0\ 10^{-2}$	$2{,}0\ 10^{-2}$	$2{,}0\ 10^{-2}$
VII.	*PESTICIDES*				
134.	*Aldrin*	µg/l	0,003	0,2	> 0,2
135.	*Dieldrin and metabolites*	µg/l	0,003	0,003	0,003
136.	DDT	µg/l	0.001	0.001	0.001
137.	*Endrin*	µg/l	0,004	0.04	> 0.04
138.	*Lindane*	µg/l	0,01	0,1	> 0,1
139.	*Methoxychlor-DDT*	µg/l	0,03	0,3	> 0,3
140.	*Polihlorinated biphenyl PCBs*	µg/l	0.001	0.01	0.01
141.	*Toxsaphene / kamphechlor /*	µg/l	0.005	0.05	0.05
142.	*Heptachlor*	µg/l	0.001	0.001	0.001
143.	*Chlordane*	µg/l	0,01	0,1	0,1
144.	*Common kriterium for other Organic chlornated pesticides*	µg/l	0,01	0,1	0,1
145.	*Karbophos / Malathion /*	µg/l	0,1	1	1
146.	*Merkaptophos / Demeton /*	µg/l	0,1	1	1
147.	*Tiophos / Parathion /*	µg/l	0,04	0,4	0,4
148.	*Common kriterium for other Organic -phosphorus and carbamic pesticides*	µg/l	0,1	1	1
VIII.	*OTHER ORGANIC COMPOUNDS*				
149.	*Acetone*	µg/l	100	2000	2000
150.	*Acetone cyanohydrin*	µg/l	1	1	1
151.	*Acrolein*	µg/l	2	10	10
152.	*Acrylonitril*	µg/l	0,1	200	200
153.	*Anion detergents*	µg/l	100	500	> 500
154.	*Kation detergents*	µg/l	50	100	> 100
155.	*Non-ionic detergents*	µg/l	100	500	> 500
156.	*Surface active materials*	µg/l	1000 / 3000[5] /	5000	> 5000
157.	*Amini* / $C_7 – C_9$ /	µg/l	100	100	> 100
	Amini / $C_{10} – C_{16}$ /	µg/l	40	500	500
	Amini / $C_{17} – C_{20}$ /	µg/l	30	50	50
158.	*Benzoic acid*	µg/l	*BOD_5 not more than allowed concentration . for certain water class*		
159.	*Buten*-1	µg/l	100	10000	10000
160.	*Butanol*	µg/l	1000	5000	5000
161.	*Butyl acrilat*	µg/l	15	1000	1000
162.	*Butyric acid / po BPK_5 /*	mg/l	5	10	10

[5] *the value in the brackets refers to class II*

163.	*Butyl xantate*	µg/l	1	-	-
164.	n-*Butylmercaptan*	µg/l	6	-	-
165.	*Hydrogen sulphide*	µg/l	3	3	3
166.	*Dimethyl sulphide*	µg/l	3	300	300
167.	*Diisopropyl amine*	µg/l	500	50	500
168.	*Cyclohexanol*	µg/l	500	500	500
169.	*Cyclohexanone*	µg/l	20	20	20
170.	*Cyclohexanonoksim*	µg/l	1000	1000	1000
171.	*Diphenylhidrazine*	µg/l	0,4	20	20
172.	*Ethylacrilat*	µg/l	5	50	> 50
173.	*Ethylamine*	µg/l	300	500	500
174.	*Ehylenglicol*	µg/l	1000	1000	1000
175.	*Formaldehyde*	µg/l	300	500	500
176.	*Phtalic ester*	µg/l	3	30	30
177.	*Heptanol*	µg/l	5	5	5
178.	*Isophorone*	µg/l	6	60	60
179.	*Isobutanol*	µg/l	1000	5000	5000
180.	*Ethyl-merkuric chlorid*	µg/l	0,1	0,1	0,1
181.	*Kaprolactam*	µg/l	500	1000	1000
182.	*Potassiumdiethylditio-phosphate*	µg/l	200	2000	2000
183.	*Potassiumisopropyl-ditio-phosphate*	µg/l	20	1000	1000
184.	*Maleic anhydride*	µg/l	1000	1000	1000
185.	*Mercaptoethyldiethyl-amin* -□-	µg/l	100	1000	1000
186.	*Methyldithiocarbamat* Na-*sol*	µg/l	20	500	500
187.	*Methanol*	µg/l	100	500	500
188.	*Methylacrilat*	µg/l	20	200	200
189.	*Methylbenzoat*	µg/l	1	100	100
190.	*Oily acid*	µg/l	500	1000	1000
191.	*Milk acid*	µg/l	500	2000	2000
192.	*Formic acid*	µg/l	1000	4000	> 4000
193.	*Nonil alcohol*	µg/l	10	10	> 10
194.	*Oktil alcohol*	µg/l	50	500	500
195.	*Sintetic masni acid* C_5-C_{20}	µg/l	1000	5000	5000
196.	*Tannin*	µg/l	500	10000	> 10000
197.	*Terpentin*	µg/l	200	5000	> 5000
198.	*Tetraethylselenium*	µg/l	0,2	20	20
199.	*Tetraethyllead*	µg/l	-	0,1	0,1
200.	*Tributilphosphate*	µg/l	10	100	100
201.	*Carbondisulfide*	µg/l	3	3	> 3
202.	*Dimethylformamide*	µg/l	*BOD_5 not more than allowed concentration. for certain water class*		
203.	*Methyllethyl ceton*	µg/l	*BOD_5 not more than allowed concentration. for certain water class*		
204.	*Propilen glicol*	µg/l	*BOD_5 not more than allowed concentration. for certain water class*		
205.	*Triethylen glicol*	µg/l	*BOD_5 not more than allowed concentration. for certain water class*		

Article 5

The values of indicators from Article 4 of this Regulation shall be applied upon:
For water courses without regulated flow: for all discharges equal or larger than the monthly low flow with 95 % probability;
For water courses with regulated flow: for all discharges larger than the guaranteed low flow;
Groundwater: for all discharges and water levels;
Lakes: for unfavorable cases of mixing of waters / during periods of ice and during critical summer months /.

Article 6

As exemptions from Article 4 of this Regulation, certain indicators shall not be used for classification of:
water courses -indicators under number 16 / level of biological productivity /;
groundwater flows in karst - indicators under number 16 / level of biological productivity /, and for other types of groundwater indicators under number 6 / dissolves oxygen /, under number 15 / level of saprobity/ and indicators under number 16 / level of biological productivity /;
natural lakes - indicators under number 6 / dissolves oxygen /, under number 15 / level of saprobity /, and for second class of natural lakes the indicators under number 2 / visible color /.
In the classification of karstic springs, if the turbidity ids from natural cause, the indicators from Article 4 of this Regulation under number 10 / suspended matter/ may be exceeded, but the turbidity should not be present in more than 30 days in one year.

Article 7

In the calculation of the toxicity of larger number of dangerous and harmful matter the allowed concentrations has to comply with the following formula:

$$C_a/L_a + C_b/L_b + ... + C_n/L_n \leq 1$$

Where: Ca, Cb, ….. Cn are the measured concentrations of harmful and dangerous substances in the water, La, Lb, ….. Ln are the maximum allowed concentrations (MAC), for each of those substances individually.

Article 8

Concentrations of harmful and dangerous substances are determined:
for concentrated use of water – at the boundary of the first zone of sanitary protection, or at the place of water intake;
for other concentrated use of water, in the zone of 95 % mixing.

Article 9

With the day of coming into force of this Regulation the use of "Regulation for the maximum allowed concentrations of radio-nucleids and dangerous substances in the international water courses, interrepublican waters and coast sea waters of Yugoslavia" / Official gazette of SFRJ number 8/78 /.

Article 10

This Regulation shall come into force eight days from the day it is published in the "Official Gazette of Republic of Macedonia".

Number
23 of March1999
Skopje

23-1665/1 PRESIDENT
OF THE GOVERNMENT OF
REPUBLIC OF MACEDONIA
Ljubcho Georgievski, s.r.

Annex 11 Regulation for Categorization of water courses and lakes in the Republic of Macedonia

Based on Article 85 paragraph 4 of the Law on waters ("Official gazette of RM " No 4/98) and Article 46 paragraph 3 from the Law on the Government ("Official gazette of SRM " No 38/90 and "Official gazette of RM" No 63/94 and 63/98) the Government of the Republic of Macedonia on the session held on 23.03.1999 brought:

REGULATION

FOR CATEGORIZATION OF
WATER COURSES AND LAKES

Article 1

Natural and man-made water courses, parts of water courses (further in the text: water courses), natural and man-made lakes and groundwater, which, based on the water use and quality, are classified; according to the "**Regulation for classification of water**"/ "Official gazette of Republic of Macedonia" number 18/99, in 5 classes.

In Class I the water courses are classified which have to comply with the conditions for class I, in Class II the conditions for class II, in Class III the conditions for class III, in Class IV the conditions for class IV and in Class V the water courses are classified which have to comply with the conditions for class V.

Article 2

In order to determine the norms for construction of structures and facilities for reduction of pollution or treatment of polluted waters, limitation of discharge, or prohibition of discharge of polluted waters, the water courses in individual watersheds are classified in the following categories:

Watershed of river Vardar	**category**
Direct catchment of river Vardar	
Lakavichka river / Lakajchka river /	
From village Lakavica until the inflow in r. Vardar	II
River Mozdracha	
From v. Negotino until the inflow in r. Vardar	II
Novoselska River	
From v. Novo Selo until the inflow in r. Vardar	II
Palchishka River	
From v. D. Palchishta until the inflow in r. Vardar	II
River Pena	
From Tetovo until the inflow in r. Vardar	II
Dzepchishka River	
From v. Dzepchishte until the inflow in r. Vardar	II
Leshochka River / Leshechka River /	
From v. Leshok until the inflow in r.Vardar	II
River Bistrica	
From v. Tearce until the inflow in r. Vardar	II
Dobroshka River	
From v. Dobroshte untill inflow into r.Vardar	II
River Gabrovica / Gabrojca /	
From v. Nerashte untill the inflow into r.Vardar	II
Belovishka River	

From v. Belovishte untill the inflow into r.Vardar	II
Vratnichka River	
From v. Vratnica untill the inflow into r.Vardar	II
Radushka River	
From “Radusha” mine separation plant until	
the inflow in r. Vardar	III
River Lepenec	
From border with SR Jugoslavija untill	
inflow into r.Vardar	II
River Serava	
From v. Radishani untill inflow into r.Vardar	III
Markova River	
From inflow of r. Sushica untill inflow into r.Vardar	II
Suva River / Bujkovska River /	
From outlet of wastewater frm raffinery "OKTA"	
untill inflow into encircling protection canal	III
Encircling protection canal	
From inflow of Suva River until inflow into r. Vardar	III
Otovichka River	
From lake “Mladost” untill inflow into r.Vardar	II
r. Topolka	
From porcelain f-ry “Boris Kidrich” untill the	
inflow into r. Vardar	III
River Babuna	
From inflow of r. Izvornica untill inflow into r.Vardar	II
River Luda Mara / Vatishka River /	
From Kavadarci untill inflow into r.Vardar	III
Anska River	
From Valandovo untill inflow into r.Vardar	III
River Luda Mara	
From Bogdanci untill inflow into r.Vardar	II
River Vardar	
From inflow of Lakavichka River untill Skopje	
/ outlet of the Skopje municipal sewage canal /	II
From Skopje / outlet of the Skopje municipal sewage	
chanal / untill inflow into r. Pchinja	III
From inflow of r. Pchinja untill Veles / outlet of	
“Zletovo” plant wastewater /	II
From Veles untill inflow into Crna River	III
From inflow of Crna River untill the	
border with Greece	II

B.Treska river watershed

Tajmishka River	
from Tajmishte mine untill inflow into Zajashka River	III
Bachishka River	
From Greshnica untill inflow into Zajashka River	II
River Temnica	
From TEC “ Oslomej ” untill inflow into r.Treska	III
Zajashka River (Kichevska River)	
From inflow of Tajmishka River untill Kichevo	II
From Kichevo untill inflow into r.Treska	III
River Studenchica	
From v. D. Dobrenoec untill inflow into r.Treska	II
Brzjdanska River	
From v. Brzjdani untill inflow into r.Treska	II
Rabetinska River	
From v. Miokazi untill inflow into r.Treska	II
Golema River / Plasnichka River /	

From v. Plasnica untill inflow into r.Treska	II
River Fush	
From v.Grupchin untill inflow into r.Treska	II
River Treska	
From spring untill inflow into r.Vardar	II

C. Watershed of river Pchinja

River Toranica	
From "Toranica" mine untill inflow into Kriva River	III
Kiselichka River	
From "Bentomak" mine untill inflow into Kriva River	III
Kratovska River	
From Kratovo untill inflow into Kriva River	III
Kriva River	
From convergence with r.Toranica untill inflow into r.Pchiwa	II
Kowarska River	
From pig farm at v. Gorno Konjare until conjunction with Lipkovska River	III
Slupchanska River / Slupchanka /	
From v. Slupchane untill inflow into Lipkovska River	II
Mateichka River	
From v. Matejche untill inflow into Lipkovska River	II
Otljanska River	
From v. Otlja untill inflow into Lipkovska River	II
Lipkovska River	
From v. Lipkovo do sostavot so r. Konjarka	II
Kumanovska River / Kumanovska /	III
River Pchinja	
Fromg border with SR Jugoslavija untill inflow into river Vardar	II

D. Watershed of river Bregalnica

Rusinovska River	
From v. Rusinovo untill inflow into Ratevska River	II
Ratevska River	
From inflow of Rusinovska River untill inflow into r. Bregalnica	II
Pehchevska River / from v. Smojmirovo – Smojmirovska River /	
From Pehchevo untill inflow into r. Bregalnica	II
Vladimirska River	
From v. Vladimirovo untill inflow into r. Bregalnica	II
r.Kamenica	
From "Sasa" mine dump site untill inflow into reservoir " Kalimanci"	III
Pekljanska River / Pekljanshtica, Leva River /	
From pig farm at v. Pekljani until inflow into r. Osojnica	III
Vinichka River	
From Vinica untill inflow into r. Osojnica	II
River Osojnica	
From inflow of Pekljanska river untill inflow into r. Bregalnica	II
Gradechka River	
From Vinica untill inflow into r.Bregalnica	II
Zrnovska River	
From v. Zrnovci untill inflow into r.Bregalnica	II
Orizarska River	
from v. Orizari until cellulose f-ry in Kochani	II

from cellulose f-ry untill inflow into r.Bregalnica	III
Kochanska River	
From dam “Gradche“ untill outwlow of city sewerage system	II
From outwlow of city sewerage system untill inflow into r. Bregalnica	III
River Kiselica	
From “Zletovo“ mine dump site untill inflow into Zletovska River	II
Zletovska River / Zletovica /	
From Zletovo untill inflow into r. Kiselica	II
From inflow of r. Kiselica untill inflow into r.Bregalnica	III
River Otinja	
From Shtip untill inflow into r.Bregalnica	III
Topolnichka River and Mademska River	
From “Buchim“ mine dump site untill inflow into into river Kriva Lakavica	III
River Kriva Lakavica	
From inflow of Mademska River untill inflow into r. Bregalnica	III
Draichanal “Azmak“	
From inflow into Stubichka River untill inflw into Svetinikolska River	III
Svetinikolska River	
From Sveti Nikole untill inflow into r.Bregalnica	III
River Bregalnica	
From Berovo untill inflow into Orizarska River	II
From inflow of Orizarska River untill inflow into river Vardar	III

E. Watershed of Crna River

River Obelnichica / Stara River /	
From Demir Hisar untill inflow into Crna River	II
River Sazjlica	
From v. Lazjani untill inflow into r. Blato	II
Kriva River / Selochka River /	
From Prilep untill inflow into Prilepska River	III
Zjitoshka River / Zjitoechka River /	
From Zjitoshe untill inflow into r. Blato	II
r. Ribnik	
From v.Crnilishte untill inflow into r. Blato	II
r. Senokoshica / Senokoshka /	
From farm ZIK “Prilep“untill infow of Stara River	II
Konjarska River	
From v. Malo Konjari untill inflow into Stara River	II
Stara River	
From v. Senokos untill inflow into r. Blato	II
Krushevska River	
From Krushevo untill inflow into r. Blato	III
Prilepska River	
From Prilep untill inflow into r. Blato	III
Stavichka River	
From v. Galichani so vlivot vo r. Blato	II
River Blato	
From ZIK “Prilep“ untill inflow into Prilepska River	II
From inflow of Prilepska River untill inflow into Crna River	III
Chanal “Glaboko“	

From v. Erekovci untill inflow into Crna River	II
II Chanal	
From v. Novoselani untill inflow into Crna River	II
River Shemnica	
From v. Crnoec untill inflow into Crna River	II
Chanal “Dobrushevo”	
From v. Dobrushevo untill inflow into Crna River	III
River Dagor	
From v. Dihovo do Bitola	II
From Bitola untill inflow into Crna River	III
XIII Chanal	
from ZIK “Pelagonija“ in s. Logovardi until inflow into Crna River	II
X Chanal	
From v. Dobromiri untill inflow into Crna River	II
Kristoarska river	
From v. Bukovo untill inflow into V chanal	II
Velushka River	
From v. Velushina untill inflow into V chanal	II
Graeshka River	
From v. Lashec untill inflow into V chanal	II
V Chanal	
From Bitola untill inflow into Crna River	III
Eleshka River	
From border with Greece untill inflow into Crna River	II
River Blashtica / Blashnica /	
From “Feni“ mine untill inflow into Tikvesh Lake	III
Crna River	
From Sopotnica untill inflow into Prilepska River	II
From inflow of Prilepska River untill Tikvesh Lake	III
Fromthe outlet water of HE “Tikvesh“ untill inflow into r. Vardar	II

Watershed of river Crni Drim
Watershed of Prespa Lake

Grncharska River	
From v. Grnchari untill inflow into Prespansko Ezero	II
Golema River	
From v. Jankovec untill inflow into Prespansko Ezero	II
Istochna River	
From v. Carev Dvor untill inflow into Prespansko Ezero	II

B. Catchment of Ohrid Lake

River Sushica	
From v. Ramis untill inflow into Ohridsko Ezero	II
Koselska River / Koselchica /	
From v. Kosel untill inflow into Ohridsko Ezero	II
River Sateska	
From v. Botun untill inflow into Ohridsko Ezero	II

C. Catchment of river Crni Drim

River Shum	
From v. Shum untill inflow into r. Crni Drim	II
Vevchanska River	
From v. Vevchani untill inflow into r. Crni Drim	II
River Sushica / River Vrom /	
From v. Dolno Tateshi untill inflow into r. Crni Drim	II
Labunishka River	
From v. Labunishte untill inflow into r. Crni Drim	II

Podgorechka River	
From v. Podgorci untill inflow into Labunishka River	II
Piskupska River (Jablanichka)	
From v. Jablanica untill inflow into r. Crni Drim	II
Trebishka River	
From border with Albania untill inflow into lake Shpilje	II
Vrbnichka River / Vrmnichka River /	
From border with Albania untill inflow into lake Shpilje	II
River Radika	
From v. Rostushe untill inflow into Debar lake	II
River Crni Drim	
From Struga untill border with Albanija	II
Watershed of river Strumica	
Oraovichka River	
From v. Oraovica untill inflow into Radovishka River	II
Radovishka River	
From Radovish untill inflow into Stara River	III
River Plavija / Podareshka /	
From v. Podaresh untill inflow into Stara River	II
Stara River	
From inflow of Radovishka River untill inflow into Susheva River	III
Kriva River	
From v. Veljusa untill inflow into r. Topolnica	II
Shtuchka River	
From v. Shtuka untill inflow into r. Strumica	II
River Vodenishnica	
From v. Bansko untill inflow into r. Vodochnica	II
River Trkanja	
From Strumica sewer system outflow untill inflow into r. Vodochnica	III
River Vodochnica	
From Strumica untill inflow into r. Trkanja	III
From vlivot na r. Trkanja untill inflow into r. Strumica	III
River Lomnica	
From v. Smolari untill inflow into r. Strumica	II
River Strumica / Strumeshnica, Stara River /	
From inflow of Susheva River untill the border with Bulgaria	III

Article 3

Lake Ohrid and Lake Prespa are classified in Class I. Lake Dojran is classified into Class II.
The other natural lakes are classified into Class I.
Man-made lakes: Mavrovo, Debar, Tikvesh, kalimanci and Lake Mladost are determined as Class II.
Man-made lakes not mentioned in line 4 of this Article are classified in the same class as the water course the lake is constructed on.
Drainage and overflow waters from hydro - dump sites are classified in the same category as the water course they are flowing in.

Article 4

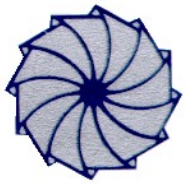
The water courses not mentioned in Article 2 of this Regulation, all natural springs and other groundwater are classified into Class I.
Surface and groundwater drainage canals not mentioned in Article 2 of this Regulation, are determined in Class II.
Irrigation canals for the agricultural land are classified in the same category as the water courses the water is taken from.

Article 5

This Regulation shall come into force eight days from the day it is published in the "Official Gazette of Republic of Macedonia".

Number
23 of March 1999
Skopje

23-1501/1 PRESIDENT
OF THE GOVERNMENT
OF REPUBLIC OF MACEDONIA
Ljubcho Georgievski, s.r.



ELEKTROSTOPANSTVO NA MAKEDONIJA
ELECTRIC POWER COMPANY OF MACEDONIA

HPP "C E B R E N "

Skopje, 2004

The dam site is located at the River Crna Reka, 81 km away from its empty into the River Vardar (*upstream*), near the village Manastir and about 7 km upstream of the Rasimbeg bridge, in the so cold Ravine part of the River Crna Reka.

On this route is already constructed the HPP "Tikveš" with normal elevation of the accumulation 265,00 maSL while for the rest of the ravine part of the River Crna, there have been analyzed more variant solutions for its power usage, whereas in this previous study stage of designing a construction was accepted for two dam-sided power plants with significant accumulation areas as follows: HPP "Galiste" with normal elevation of the lake 392,00 and HPP "Cebren" with the lake elevation of 565,00 maSL.

The partition point "Cebren" is the most narrow part of the river bed of the River Crna, with the most suitable topographic, geological and geotechnical features which gives a possibility for construction of a high dam 192,50 m and forming of an accumulation area of 915 millions m^3 of water.

Out of this volume up to the elevation of 515.00 maSL as min. level will be useful volume of 555 millions m^3 of water, or 60% of the total accumulation, which provides a possibility for multi year regulation of the natural flows of the river Crna.

HPP Cebren is located close to dam - on the river bank with a switchyard close to the power house. Three reversible units are located in the power house with 110.85 MW rated power per unit in turbine mode and 115.78 MW rated power per unit in pumping mode.

Connection with the Electric power system will be through the 400 kV power line and 400/110 kV substation "Mariovo".

The basic design for the river Crna was made in 1963 by HEP - Skopje.

During the period of 1965-1966 a conceptual design for HPP "Cebren" was made, also by HEP - Skopje, the investor of which is "Electric Power Company of Macedonia" - Skopje.

In 1973 - 1974 an "Engineering Study" of the partition point Cebren on the River Crna was completed on the behalf of the Directorate for Coordination of the Integral Development of the River basin of Vardar - AXIOS. This study was made by HEP - Skopje on the basis of the additional researches of the partition point. During the 1974 a conceptual design was made with investment study for partition point Cebren by HEP - Skopje, Civil Engineering Faculty - Skopje and "Yaroslav Cerni" - Belgrade on behalf of the Directorate for Integral Development of the River basin Vardar - AXIOS - Skopje.

During 1984 a technical economical analysis was made by HEP - Skopje and the Civil Engineering Faculty - Skopje, which once again was chosen as the optimal type of the dam Cebren whereas it was accepted for the purpose of the future working out the type of concrete arch dam.

In the middle of 1986 it was concluded a contract for making an investment technical documents (conceptual design and investment study) for HPP "Cebren on River Crna Reka by the four designing companies: HEP - Skopje, EMO - Ohrid, Faculty of Civil Engineering - Skopje and IZIIS - Skopje (HEGI). At the same period a contract was concluded with "Energoproject" - Belgrade as an executor of the technical control revision, simultaneously with the working out the technical documents for HPP Cebren.

In the same year there have been carried out tremendous engineering geological researches of the partition point Cebren, required for the preparing of the conceptual design, which were sufficient for the elaboration of the main design regarding the scope and quality.

The preparation of the conceptual design with the investment study for the HPP "Cebren" was completed and revised at the end of 1990.

The final decision for the optimal utilization of the Crna River cascades was made after preparation of the Feasibility Study Investment Options in the Energy Sector-Optimisation of the River Crna System for Electricity Production, prepared by Exergia S.A. in 2003 and financed by PHARE PROGRAMME.

Additional Tender documents for BOT concession will be prepared in the future.

Hydrological data

The hydrological data are concerning the chronological period 1946-95.
According to the calculations the available flow is 26 m^3/s. The measurements are recorded at monitoring stations located at three locations: Skocivir, Rasimbeg bridge and Tikves.

Environmental aspects

In general, the positive aspects to construct hydro power plant (HPP) Cebren in the Crna River preponderate the negative impacts of construction, impounding and operation. The multiple benefits for the region and the country include the improvement of living conditions, the improvement of the hydrological monitoring and the possible micro and macro economic spin-offs. This solution has smaller draw-downs that cause less negative environmental impacts through reduced flooded shorelines and improved reservoir management.The application of appropriate operation patterns will result in lower visual impacts on the landscape, reduced erosion, improved micro-climate, reduced health risks, better fish spawning areas etc.
Through Cebren HPP the hydrological conditions of the Crna River will then be controlled in order to allow an appropriate ecological minimum discharge as well as water discharges for impounding of the other down stream reservoirs as well as water requirements for irrigation and power generation of Tikves HPP.

Power generation

The Cebren HPP is designed with reversible units and an installed capacity of 332,8 MW – turbine mode and 347,3 MW – pump mode.
A small dam, the Orlov Kamen, is constructed downstream from the Cebren Dam for better operation of the Cebren HPP reversible units.
The Cebren HPP will be used as a peak load power plant, whereas the storage volume of the reservoir makes also possible seasonal shift of the inflow.
According to the analyses performed in the Feasibility Study Cebren HPP will annualy generate 840,3 GWh.

Construction Cost

According to the calculations in the Feasibility Study, estimated cost of the plant construction amounts 338.381.000 EUR, and:

- Preliminary works	14.415.000 EUR
- Preparatory works	48.892.000 EUR
- Main civil works	205.920.000 EUR
- Equipment	69.155.000 EUR

The project construction will be realized on the BOT concession basis.

1. HYDROLOGICAL FEATURES

• HYDROLOGICAL PERIOD	1946 ÷ 1995 year
• TOTAL ANNUAL FLOW - NATURAL	820,00 x 10^6 m^3
• AVERAGE ANNUAL FLOW	26,00 m^3/s

2. HYDROTECHNICAL FEATURES

2.1 WATER STORAGE *(Dam Lake)*

• TOTAL VOLUME	915.00 x 10^6 m^3
• USEFUL VOLUME	555.00 x 10^6 m^3
• NORMAL LEVEL	565.00 maSL
• MAX. LEVEL	565.00 maSL

• MIN. LEVEL	515.00 maSL
2.2 DAM	
• DAM TYPE	concrete arch
• DESIGNED HEIGHT	192.50 m
• SURVEY HEIGHT	180.00 m
• DAM VOLUME	1.214.706 m^3
• WEIR CREST LENGTH	500.00 m
• WEIR CREST WIDTH	7.0 ÷ 9.0 m
2.3 EVACUATION ORGANS	
2.3.1 OVERFLOW	
• TYPE	surface-over the dam
• CAPACITY	1900 m^3/s
2.3.2 FOUNDATION OUTLET	
• TYPE	pipeline through the dam body
• CAPACITY	200 m^3/s
• NUMBER	2
• DIMENSION	2.25 m
2.4 SUPPLY ORGAN	
• TYPE	Tunnel type
• LENGTH	400,00 m
• DIAMETER	5,50 m

3. BASIC ENERGY PARAMETERS	
• NUMBER OF UNITS	3
• INSTALLED CAPACITY	
◦ TURBINE MODE	3 x 110.95 MW
◦ PUMP MODE	3 x 115,78 MW
• TYPE OF UNITS	REVERSIBLE
• ANNUAL GENERATION	840,30 GWh
• ANNUAL CONSUMPTION	785,60 GWh

• VOLTAGE LEVEL	110 kV

4. ELECTROMECHANICAL PARAMETERS

4.1 PUMP-TURBINE

• TYPE	FRANCIS-VERTICAL
• RATED POWER-TURBINE MODE	110,95 MW
• RATED POWER-PUMP MODE	115,78 MW
• NUMBER OF REVOLUTIONS	333,33 r/min.
• RATED FLOW - TURBINE MODE	77,00 m^3/s
• RATED FLOW – PUMP MODE	69,33 m^3/s

4.2 GENERATOR

• TYPE	3 phase-synchron
• RATED POWER	131,80 MVA
• VOLTAGE LEVEL	15,75±5% kV
• NUMBER OF REVOLUTIONS	333,33 r/min.

4.3 TRANSFORMER

• RATED POWER	131,80 MVA
• TRANSITION RATIO	15,75/110 kV

4.4 SWITCHYARD

110 kV SWITCHYARD COMPRISING FOUR 110 kV POWER LINE FIELDS AND ONE 35 kV LONGDISTANCE POWER LINE FIELDS

5. SUBSTATION MARIOVO 400/110 kV

5.1 400 kV

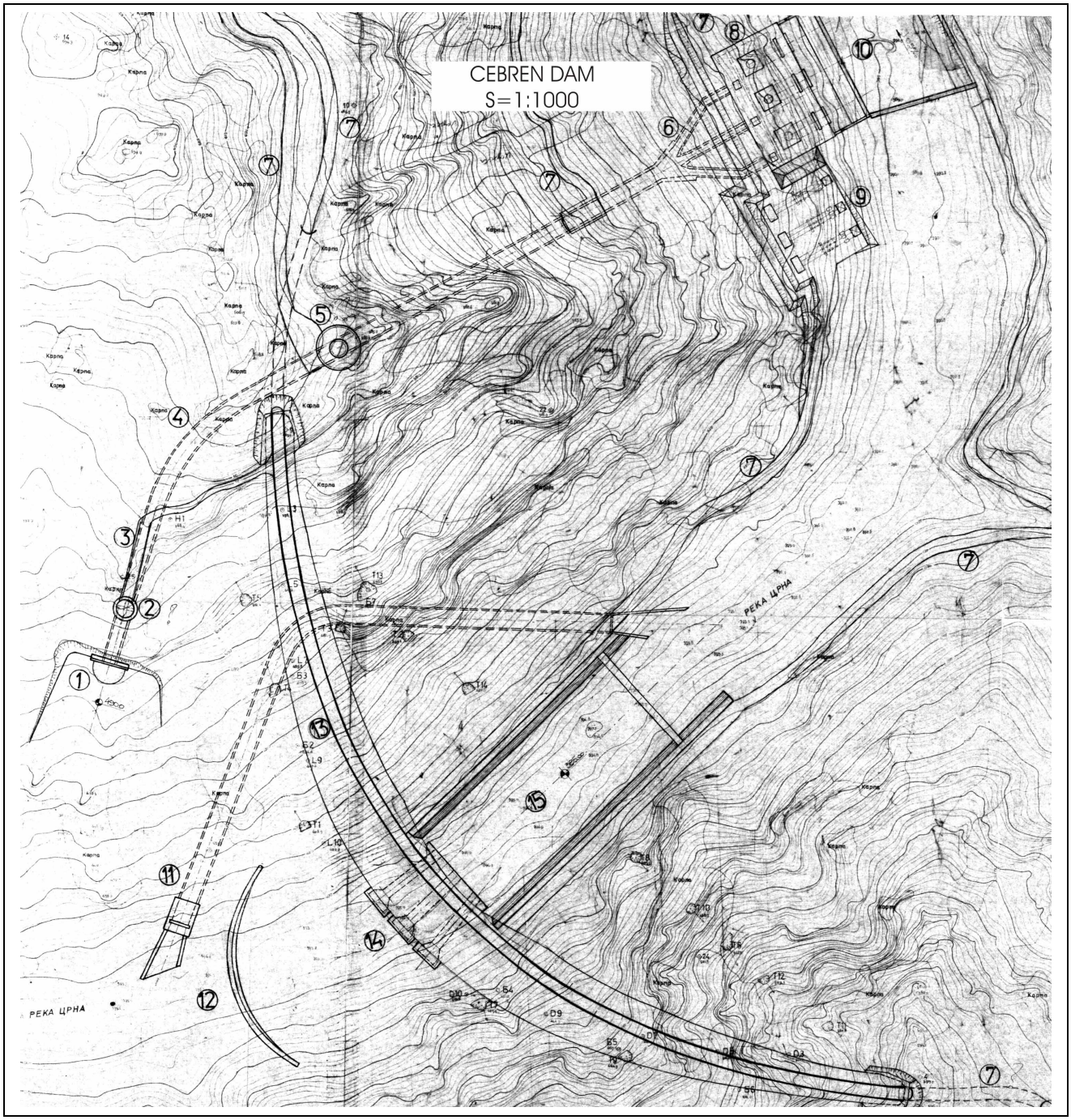
• TRANSMISSION FIELD	2
• TRANSFORMER FIELD	1
• COUPLING & MEASURING FIELD	1
• TRANSFORMER 300 MVA 400/110kV	1

5.2 110 kV

• BLOCK TRANSMISSION LINE CEBREN 2.0 km	3

• TRANSMISSION LINE TO SS PRILEP 30 km	1
• TRANSFORMER FIELD	1
• COUPLING & MEASURING FIELD	1
• TRANSFORMER 20 MVA 110/35 kV	1


FR YUGOSLAVIA
BULGARIA
ALBANIA
GREECE
MACEDONIA
SKOPJE
Kumanovo
K Palanka
Kratovo
Probishtip
Delcevo
Kocani
Tetovo
HPP Kozjak
HPP Raven
HPP Vrben
Gostivar
HPP Vrutok
Veles
Stip
Berovo
Radovis
Debar
HPP Spilje
TPP Oslomej
Kicevo
Kavadarci
TPP Negotino
Strumica
Negotino
HPP Globocica
Prilep
HPP Tikves
HPP Cebren
HPP Gallste
Struga
Gevgelija
Ohrid
Resen
Bitola
TPP Bitola


CEBREN DAM
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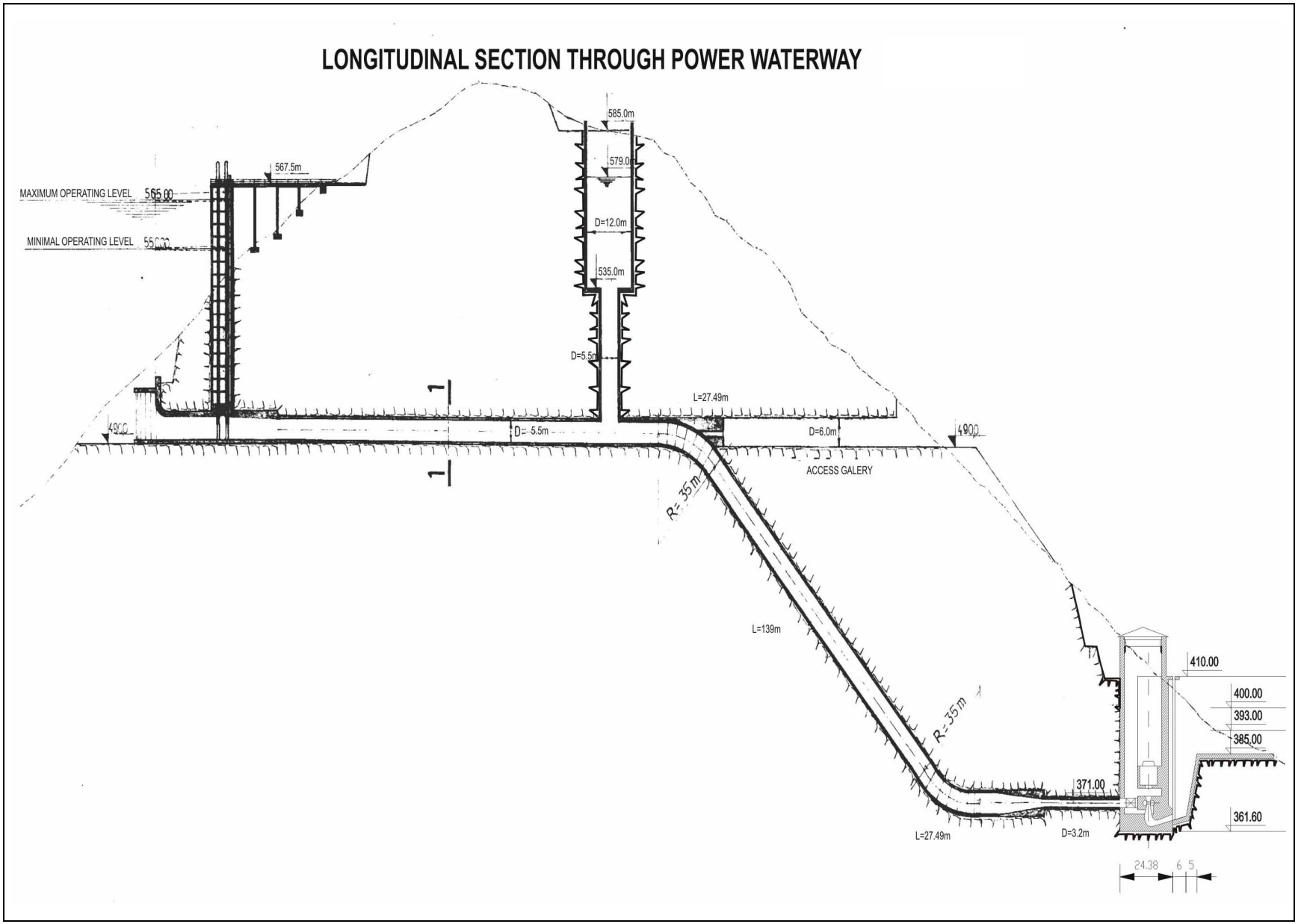
РЕКА ЦРНА
РЕКА ЦРНА

LONGITUDINAL SECTION THROUGH POWER WATERWAY



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