WP7.2 – Kokra River

Pilot Case Study Monograph

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Summary

SHORT DESCRIPTION
This document describes Kokra pilot region test basin with a micro-location that will form a testing ground for MCA in Slovenia.

Document Control

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Summary

Aim of this document is to describe Kokra sub-basin from environmental and water management point of view. Kokra basin is also selected as pilot area in Slovenian Alpine where unexploited hydropotential is recognized and which will provide a testing area for different activites and analyses which will be implemented under the SHARE, especially MCA modeling and hydropower potential estimation and determination.

Introduction

As a typical Slovenian Alpine river where also unexploited hydropotential is recognized Kokra river was selected to be analysed and tested during the SHARE project. Also a lot of data and different analyses on Kokra sub-basin were performed in the past especially in the field of water management which were the basis for Water Framework Directive adoption and harmonization with Slovenian strategies and regulations.

In the report in more detail different subjects are presented which has to be considered for efficient hydropower implementation are closely connected also to other objectives in the field of reaching a good water status and nature preservation.

1. Description of Kokra River pilot region

1.1 Basin characteristics of Kokra River

Kokra is typical Alpine river with a catchment area of 224 km^2. It rises at 1400 m altitude on the Virnikova Mountain. The water catchment area (basin) consists of two bio-geographical regions, mountainous Alps and lowland Carniola. The Alps region extends from Storžič Mountain (2132 m) to the north and east to the Austrian border and through Jezersko Mountain (1218 m) reaches the ridge of Kalec with Krvavec. Lowland area lies beneath the southern part of the part Križ and Storžič Mountain, past the Tupaliče, Hotemaže, Visoko, Britof and largest city of Kranj. Western boundary follows the river route from Senično (600 m) over the Udin Boršt and Kokrica to Kranj plain (nearly 400 m). Kokra flows into the river Sava in Kranj. Upper Sava basin catchment area with Kokra consist 1453 km^2 (Globevnik et al. 1998).

In Preddvor the Kokra basin covers 128 km^2, at 24 kilometer mark reaches the average gradient of 1.8%. Kokra in this part flows through the gorge and has a strong torrential character, with number of boulders, gravel and pools. On the length of 12 kilometers, as it winds through the terrace deposits of lowland between Preddvor and Kranj, the water drops from 440 m above sea level to 343 m (with average gradient of 1.2%), full of picturesque canyons and flood arches maintaining special riparian habitats. In vicinity of Kranj, at village Rupa two smaller tributaries Rupovščica and Kokrica join Kokra. Those drain the foothills Križ, Poljane and Storžič Mountains. Overall length of Kokrica tributary is 13 km, with an average drop of 0.9% (Globevnik et al. 1998).

Figure 1: Photography of Kokra river in middle section

1.2 Geolithological and land cover characterization

The geological structure of the Kokra basin between lower Jezersko and Preddvor is dominated by carbonate rocks. These are limestone and dolomite of Triassic age and alternative keratofirs, tuffs and porphyrs. Slopes are for the most part covered with lateral gravel, composed of smaller rounded rocks. In upper part Kokra shows a shallow alluvial character with shallow sandy gravel. The middle and lower part Kokra deposited thick (30 m and more) sand gravel banks/terraces. The plain over Kranj, which stretches between the Sava River and Kokra River, contains older and younger sandy gravel dams, agglutinated in conglomerated dam. In most cases is conglomerate covered with a thick layer of brown clay sand and gravel. Alluvial river dam of Želinjski Stream, Mlinščica, Ranger, Milka, Belica and Bela have the character of shallow clayed and sandy gravel dams (Globevnik et al. 1998).

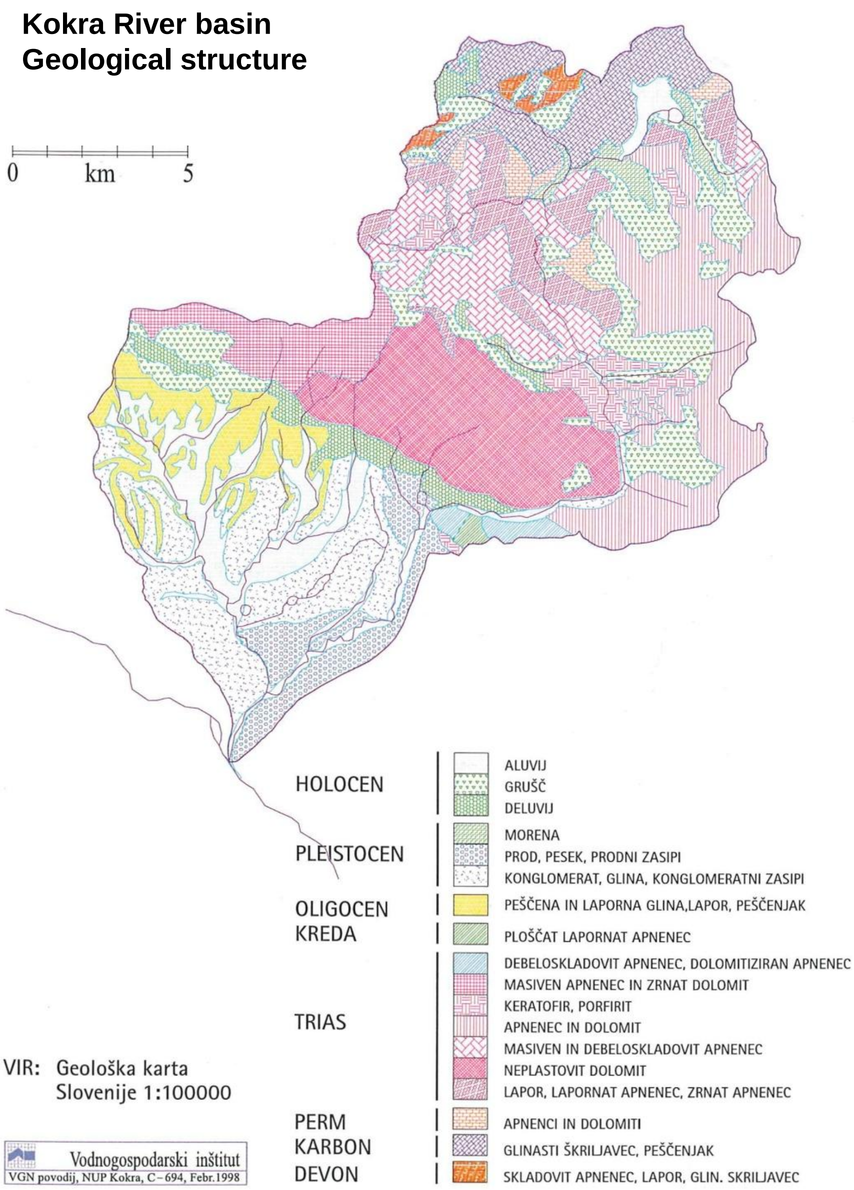

Figure 2: Geological structure of Kokra River basin, showing the location of planned SHP Kokra (Globevnik et al. 1998, 29).

1.2.1 Soil characteristics of the area provided for SHP Kokra

The Alpine part of the river basin is two typical soil composition, soil brown dystric silicate rocks and rendzinas on limestone and dolomite. In higher altitudes, there are also rendzinas on limestone and dolomite. At the foot of the slopes, soil is eroded brown polycarbonat. Soil of oligocene clay and clay soil, sand and conglomerate terraces are 'eutric' (Globevnik et al. 1998).

1.2.2 CORINE land cover

Corine Land Cover (CLC) is a map of the European environmental landscape based on interpretation of satellite images. It provides comparable digital maps of land cover of each country for much of Europe. Despite its inprecision in Slovenia is useful for environmental analysis and for policy makers. The maps in Figures 3 and 4 are taken from CLC 2006 project.

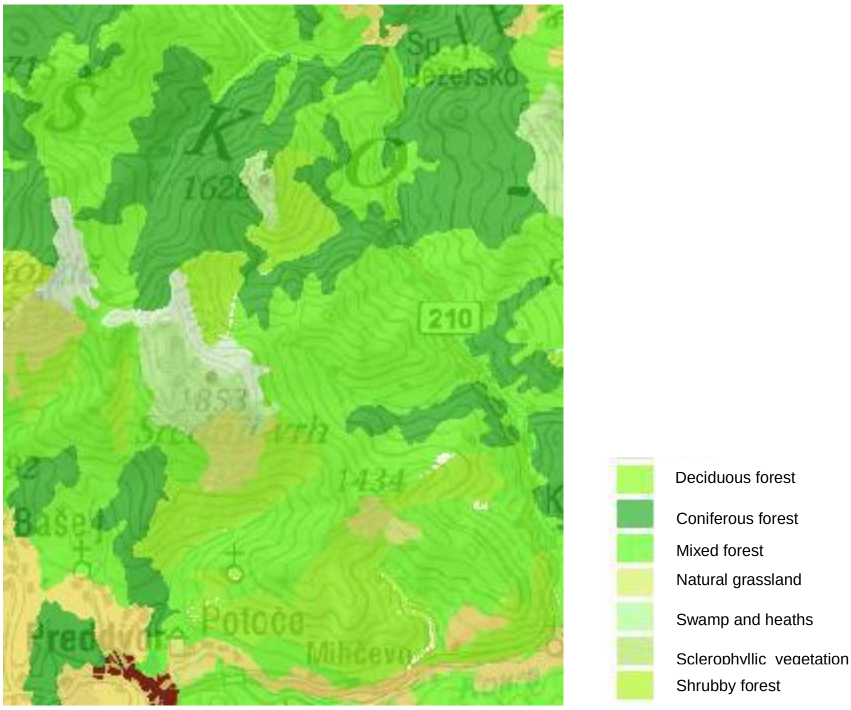

Figure 3: Corine land cover 2006 – the upper Kokra River basin (http://gis.arso.gov.si/atlasokolja/ profile.aspx?id= Atlas_ Okolja_AXL@Arso).

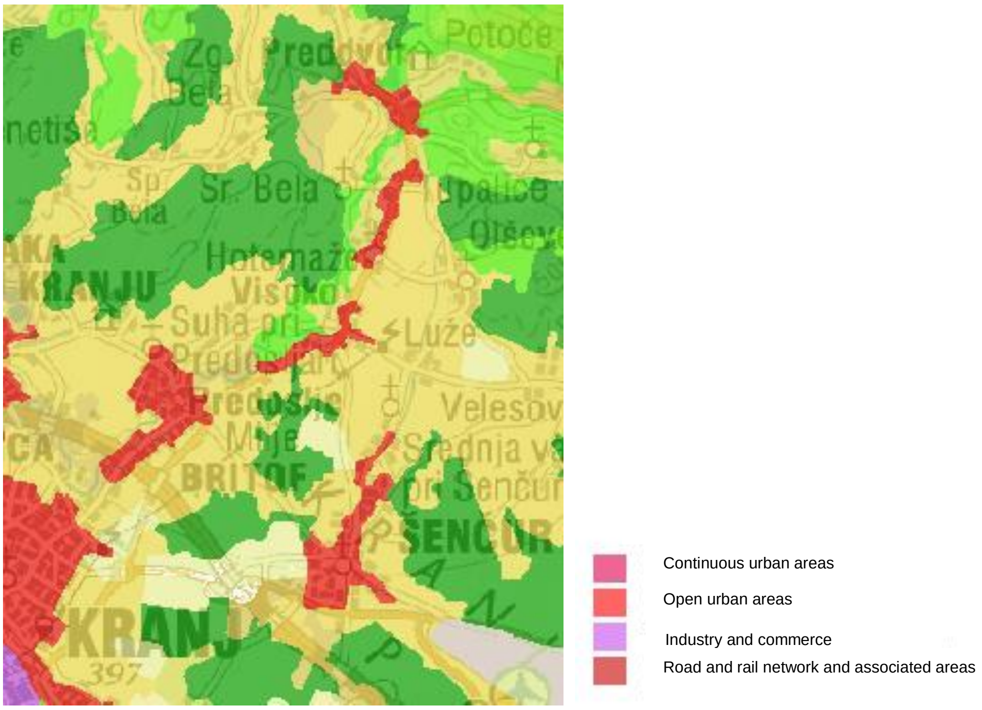

Figure 4: Corine land cover 2006 – the lower Kokra River basin (http://gis.arso.gov.si/atlasokolja/ profile.aspx?id= Atlas_ Okolja_AXL@Arso).

The bulk of mountainous Kokra River catchment area is overgrown by forests (deciduous, coniferous and mixed forests). The lower basin is covered with natural grasslands and urban areas.

From the foothills to the forest frontier is represented by following communities: various beech communities with shrubs, black beech, spruces with moss and dwarf pines. Non forested areas are up to 1800 m mainly grasslands. In the lower hay meadows is dominated by sites with *Arrhenatheretum s. lat*. or golden oatgrass (*Trisetetum flavescentis*), located mainly in meadows, spread over 800 m above sea level. On steep slopes are pastures or grassland, classified in the thermophilic link Bromion erecti. Arable land appears only in the vicinity of settlements up to 1000 m altitude. Above the tree line is typical upland vegetation with classes *Thlaspletea rotundifolii*, communities of *Asplenietea trichomanis*, grasslands and mountain communities *Seslerietea albicantis* (Globevnik et al. 1998).

In the area of proposed SHP Kokra are running water habitats, grassland habitats and riparian forests, arable land, and subalpine and alpine habitats.

1.3 Hydrological characterization

1.3.1 Natural flows regimes of Kokra River basin

Kokra River shows alpine snow-rain regime with the primary spring maximum. This is due to snow melting in the mountains and spring rains. Secondary maximum in autumn is a result of combination of reservation in areas in higher hights above sea level and rains in range in mountains of medium heights. Minimims in winter and summer are very uniform. Again, the period 1991-2000 shows a pronounced primary maximum in autumn and secondary maximum from spring to summer. Primary minimum is in winter and secondary minimum is in the summer. In recent years there has been a shift and increase in the primary peak in the autumn, reducing spring flows and reducing both minimums (Frantar 2010).

Datas shown in Table 1 are taken from the monitoring carried out by Environmental Agency of the Republic of Slovenia. Results are shown as average and annual flow on two gauging stations (GS) on Kokra River. GS Kokra (Kokra I) lies in upper stream of Kokra River while GS Kranj (Kokra II) lies in lower stream, close by outfall of Kokra River in Sava River as shown in Figure 5.

Figure 5: Location of gauging stations Kokra I and Kokra II.

Measured mean annual discharges at the gauging station (GS) Kokra is 4,47 m^3/s and GS Kranj is 5,87 m^3/s. The Sava River before Kokra poured into in Kranj, has mean annual flow of 58 m^3/s. The mean of the low points in GS Kokra is 1,33 m^3/s and in GS Kranj 1,12 m^3/s. Extreme Low Water average for GS Kokra is calculated at 0,8 m^3/s and for GS Kranj 0 m^3/s. Month with lowest water levels is August. High water peaks are occurring in November, December and April (Globevnik, L. 2006).

Table 1: Overview of average monthly and annual flow – Qs (m^3/s) of Kokra River, GS Kokra (Kokra I) (Environmental Agency of the Republic of Slovenia, 2010).

Year/month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	annual
1926	2,61	3,65	2,71	5,12	2,58	4,49	5,19	5,39	3,16	19,4	12,7	5,88	6,09
1927	5,48	4,49	11,8	14,7	8,52	7,38	5,17	4,98	10,5	6,49	21,3	8,03	9,06
1928	1,83	1,65	3,63	2,49	3,4	6,75	8,65	6,6	5,9	8,3	13,8	4,89	5,66
1929	2,57	1,32	2,37	3,66	7,06	7,9	7,93	6,06	3,38	5,73	8,27	5,55	5,17
1930	3,5	2,51	7,82	6,45	6,56	4,31	5,07	8,62	4,6	14,1	7,49	3,71	6,27
1931	4,53	3,37	10,8	6,27	9,53	5,39	3,12	4,61	11,3	8,17	12,2	4,89	7,02
1932	4,17	1,89	2,49	9,26	7,99	6,14	4,08	2,25	1,96	7,89	5,77	4,66	4,89
1933	2,1	1,89	4,16	3,75	7,24	7,42	4,21	2,51	6,84	12,2	9,7	3,94	5,51
1934	3,38	4,12	18,6	9,82	7,28	7,14	4,61	4,53	6,27	11,9	16,7	9,67	8,69
1935	2,57	4,51	3,89	5,34	8,12	5,28	2,27	2,23	2,04	7,47	7,58	7,49	4,9
1936	12,3	7,61	5,44	7,73	7,52	7,38	4,19	2,75	2,18	2,92	4,78	2,35	5,59
1937	1,62	2,62	11,4	8,57	7,88	8,43	3,89	3,9	8,25	8,44	5,51	9,01	6,65
1938	2,69	2,15	3,08	2,69	8,5	5,12	4,33	3,49	2,82	2,48	6,71	3,99	4,02
1939	4,57	2,7	1,34	2,34	8,2	9,53	3,25	2,1	3,2	4	6,19	5,31	4,4
1940	1,16	1,27	2,63	3,28	3,87	2,5	3,89	3,73	7,05	6,78	13,6	1,57	4,27
1941	1,57	2,63	3,25	4,09	4,36	4,99	2,6	2,28	2,06	1,47	3,2	1,74	2,85
1942	1,26	1,36	2,8	4,3	6,35	1,87	4,69	2,49	2,18	1,44	3,52	3,12	2,96
1943	1,28	2,36	1,19	1,29	3,8	7,33	6,42	2,33	2,68	3,97	3,46	6,34	3,55
1944	1,38	1,33	2,88	3	7,34	9,06	4,78	1,75	2,71	9,4	9,17	13,1	5,51
1945	1,83	1,2	1,56	2,37	2,52	1,98	1,33	2,77	2,87	2,68	1,92	5,91	2,42
1946	2,18	1,52	3,2	2,64	2,03	3,41	4,27	2,31	1,64	1,5	4,37	2,45	2,63
1947	1,26	2,93	9,18	7,62	3,56	2,84	3,13	1,82	1,25	1,02	7,93	9,61	4,35
1948	8,59	3,49	2,29	4,56	4,05	13,2	9,03	4,1	2,95	5,1	4,33	1,67	5,28
1949	9,53	1,51	1,06	1,01	2,26	2,64	1,92	2,81	2,01	1,28	7,91	5,84	3,33
1950	1,86	5,21	3,56	6,17	4,86	2,23	1,93	2,18	1,35	1,61	14,2	8,16	4,42
1951	4,73	10,5	9,08	7,27	10,2	6,43	4,5	3,31	2,5	2,18	7,22	4,65	6,01
1952	2,3	1,77	3,5	7,12	3,72	2,57	2,42	4,04	8,44	11,8	6,54	5,2	4,96
1953	4,05	2,23	2,53	4,65	4,55	5,13	4,17	6,91	5,56	5,32	5,34	2,45	4,42
1954	1,65	1,56	5,01	4,03	10,3	6,98	6,66	3,07	2,78	3,82	4,38	5,91	4,71
1955	3,35	5,03	4,99	3,68	7	4	3,09	1,76	1,74	3,76	3,95	2,67	3,75
1956	2,85	1,28	1,54	5,08	5,16	8,62	3,92	3,11	1,96	2,75	4,14	1,93	3,52
1957	1,66	3,57	2,14	5,74	3,56	3,38	7,74	3,58	2,57	2,09	2,76	3,94	3,56
1958	2,38	6,79	3,41	7,68	5,54	5,19	4,49	3,2	2,77	5,01	6,02	10	5,19
1959	3,56	1,86	2,96	7,5	4,9	4,96	3,5	2,97	2,29	4,68	7,38	9,91	4,72
1960	4,25	4,83	5,47	5,65	3,69	2,77	7,42	4,6	9,26	11,2	10,3	13,7	6,94
1961	4,76	2,56	3,05	4,56	4,74	5,47	4,12	3,28	3,69	9,94	10,2	5,95	5,2
1962	8,69	1,49	6,26	7,37	8,63	5,96	4,1	2,25	4,68	2	6,1	3,13	5,07
1963	4,71	1,81	4,14	8,76	6,47	5,44	2,85	4,92	5,19	3,45	11,1	4,41	5,27
1964	1,85	1,56	2,74	4,45	2,69	2,73	3,61	2,1	2,05	13,4	6,24	5,92	4,13
1965	3,54	3,51	5,03	6,93	8,97	10,1	5,25	3,93	12,8	4,17	7,36	6,85	6,53
1966	2,83	3,81	2,47	4,54	4,15	2,74	2,96	2,73	2,69	3,5	7,08	6,85	3,86
1967	2,29	2	4,79	7,37	9,57	5,56	2,54	2,22	3,98	5,47	10,8	3,08	4,98
1968	2,02	8,71	4,47	4,57	3,6	7,84	3,89	4,36	5,11	3,37	6,53	3,55	4,8
1969	3,84	3,65	4,32	5,94	6,79	5,99	3,64	6,37	4,6	2,63	8,52	3,38	4,97
1970	8	3,18	4,3	10,1	8,62	4,07	6,98	3,27	2,57	3	7,4	4,16	5,48
1971	5,81	2,87	4,69	7,66	5,67	3,27	2,32	1,75	1,82	2,11	2,74	2,92	3,64
1972	1,68	3,37	5,11	8,39	10,3	7,03	6,52	4,81	3,02	1,61	5,33	5,4	5,21
1973	1,63	1,73	1,46	5,44	4,97	6,26	4,66	2,81	7,13	8,29	4,79	3,6	4,4
1974	2,63	3,04	3,13	2,52	3,43	5,42	5,58	3,01	4,79	8,36	3,79	2,26	4
1975	1,47	1,41	4,45	13,6	5,87	7,52	8,63	2,56	2,08	2,08	2,48	4,86	4,76
1976	1,96	1,69	1,87	3,48	4,92	3,19	2,46	2,57	5,26	4,57	7,04	9,28	4,03

1977	4,04	8,63	5,01	6,46	4,11	2,64	3,38	6,47	2,84	1,3	2,04	1,9	4,04
1978	2,95	3,78	6,34	7,34	8,02	8,07	7,1	2,49	2,22	7,69	1,42	2,26	4,98
1979	9,88	4,62	4,38	7,84	8,57	5,76	3,63	2,49	2,74	3,64	7,54	4,04	5,43
1980	2,72	4,05	2,52	3,15	5,11	4,7	6,67	2,85	2,96	9,2	5,61	3,53	4,43
1981	1,93	1,6	3,29	2,96	4,42	5,7	3,45	2,55	2,59	4,39	2,76	2,81	3,21
1982	4,77	1,61	1,58	2,3	6,12	4,9	2,71	2,45	2,25	6,89	9,56	10,6	4,67
1983	3,2	1,89	3,84	3,66	3,9	2,91	2	1,71	2,27	4,03	2,02	6,37	3,16
1984	2,88	1,77	3,07	7,58	10,1	6,18	4,53	2,74	5,13	7,94	2,82	2,8	4,81
1985	4,14	2,37	2,52	5,79	7,41	6,36	2,92	2,1	1,64	1,02	3,53	5,91	3,82
1986	4,04	2,41	3,24	8	5,2	6,66	3,14	4,47	3,92	2,94	4,26	2,89	4,27
1987	1,75	3,17	3,01	6,85	8,02	6,06	3,06	4,61	2,95	5,69	8,68	4,63	4,87
1988	4,2	4,27	2,61	4,94	5,14	4,79	2,42	2,73	5,36	3,76	2,03	2,16	3,69
1989	1,07	1,67	3,44	6,54	4,13	2,74	5,62	6,22	4,51	2,04	4,33	2,81	3,77
1990	3,13	2,35	1,52	4,14	2,11	4,72	3,95	1,72	2,18	4,45	10,7	4,59	3,79
1991	2,58	2,03	3,47	2,93	8,13	6,05	4,97	3,11	1,68	3,31	11,4	2,75	4,37
1992	1,45	1,31	3,5	5,85	3,87	2,79	1,94	1,28	1,43	7,66	9,81	10,7	4,31
1993	2,15	1,4	1,18	1,42	1,09	1,09	1,11	1,1	2,76	12,4	4,87	4,54	2,94
1994	6,47	1,91	2,41	5,91	4,4	4,63	2,89	1,82	3,53	3,81	4,38	2,12	3,69
1995	2,7	2,87	4,47	4,75	4,09	4,56	2,21	2,83	7,37	2,3	1,94	4,37	3,7
1996	4,79	2,3	2,17	4,81	7,02	5,52	8,05	4,81	2,99	7,8	7,79	4,1	5,19
1997	2,82	2,46	2,13	1,67	3,08	3,68	2,95	2,28	2,16	1,52	7,46	6,43	3,22
1998	3,07	1,7	1,51	4,75	3,22	2,52	7,74	2,51	4,57	9,04	6,53	2,14	4,12
1999	1,8	1,41	3,73	7,64	5,01	3,89	2,9	2,69	1,95	5,15	3,12	3,16	3,55
2000	1,71	1,56	2,49	4,41	2,75	2,55	2,81	1,72	1,59	5,39	26,9	5,89	4,96
2001	7,36	4,53	10,3	6,14	4,01	3,81	2,68	1,77	5,05	4,32	2,98	2,29	4,6
2002	1,12	1,47	2,4	3,17	2,67	2,82	2,96	4,4	2,79	4,55	6,58	4,96	3,33
2003	3,41	2,1	1,99	2,41	1,93	1,66	1,44	1,11	1,47	3,25	8,18	4,13	2,75
2004	3,18	3,48	4,34	6,84	6,3	6,36	5,24	2,76	3,45	5,31	4,39	3,01	4,55
2005	1,83	1,24	1,7	5,2	3,66	2,12	3,58	4,59	4,55	6,33	2,9	4,13	3,5
2006	1,38	1,77	4,46	6,84	4,97	3,91	1,92	2,34	2,07	2,02	2,15	2,69	3,05
2007	2,12	2,95	4,31	3,49	2,1	1,91	2,96	2,63	5,64	3,8	2,31	2,03	3,02
2008	3,08	1,71	1,90	6,37	3,94	3,06	3,02	2,60	1,61	2,21	3,52	9,80	3,57

Table 2: Overview of average monthly and annual flow – Qs (m³/s) of Kokra River, GS Kranj (Kokra II) (Environmental Agency of the Republic of Slovenia, 2010).

Year/month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	annual
1957	1,8	4,6	2,35	7,52	4,09	3,87	11,2	4,28	2,94	2,29	3,21	5,19	4,44
1958	3,12	9,52	4,71	9,95	4,37	5,48	4,1	3,75	2,22	5,99	6,93	14,4	6,19
1959	3,57	1,29	3,33	11,3	5,31	5,98	3,57	3,59	1,69	4,74	16	18,7	6,61
1960	5,3	6,18	7,17	7,2	4,29	3,13	10,6	5,61	13,7	16,8	15,3	21,8	9,78
1961	8,24	3,18	2,62	5,98	9,42	8,01	7,36	3,05	3,95	14,4	11,6	7,72	7,16
1962	13	1,61	9,23	10,2	12,6	7,78	4,86	2,48	6,26	2,19	8,05	3,64	6,85
1963	12,9	2,8	9,46	10,7	7,77	6,43	3,98	7,98	8,22	5,65	16	3,1	7,92
1964	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
1965	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
1966	3,22	5,13	2,74	5,83	5,21	3,1	3,46	3,12	3,02	4,38	10,3	9,88	4,94
1967	2,53	2,2	6,05	10,1	14,3	7,03	2,84	2,45	4,9	7,46	16,6	3,54	6,67
1968	1,22	12,7	1,32	2,31	3,49	9,97	5,15	3,84	7,28	1,72	10,2	1,12	4,95
1969	5,98	4,1	4,75	11,1	7,04	8,99	7,32	8,46	9,29	1,9	13	4,39	7,18
1970	12,6	3,88	4,03	12,3	9,09	4,57	9,7	4,36	2,56	4,4	8,03	3,66	6,62

1971	5,94	4,09	7,78	10,9	5,18	4,59	2,29	1,26	2,02	2,83	2,93	2,01	4,31
1972	1,76	5,24	6,41	10,9	13,2	8,51	10,1	6,05	4,8	2,56	7,93	6,89	7,02
1973	1,31	1,96	0,836	11,2	2,07	6,25	3,82	2,08	12,2	18,5	6,38	4,06	5,88
1974	2,7	3,46	2,9	2,45	4,31	7,98	10,4	4,52	6,42	8,23	3,18	2,75	4,96
1975	1,87	1,52	4,68	22,3	7,89	6,58	28,6	3,57	2,88	3,09	3,82	3,25	7,54
1976	2,48	2,31	2,41	6,63	8,02	2,62	1,87	1,84	2,86	3,27	3,47	28,7	5,58
1977	5,01	17,1	2,94	17,1	3,62	5,9	15,5	14,4	12	2,21	2,59	2,11	8,29
1978	6,63	3,6	5,96	6,61	18,7	9,78	9,03	4,81	3,22	12,5	2	2,19	7,13
1979	10,4	5,59	3,01	9,23	6,57	6,89	5,63	3,97	4,89	3,65	12,8	3,45	6,32
1980	2,86	3,29	3,54	3,33	4,18	5,71	5,21	3,4	3,43	16	3,97	4,06	4,93
1981	1,87	1,62	5,25	3,61	5,49	5,35	3,48	3,22	13,2	5,14	2,71	2,44	4,45
1982	3,53	2,21	2,24	2,26	7,72	9,2	3,91	7,36	5,57	8,67	8,81	7,74	5,79
1983	3,85	3,09	9,29	7,55	6,67	3,13	2,18	2,29	2,74	6,11	3,09	15,3	5,47
1984	4,92	4,54	6,31	9,32	12,9	8,58	7,29	4,12	9,38	13	4,11	4,11	7,39
1985	12,8	4,18	5,5	6,01	8,97	8,35	2,9	3,07	2,08	1,64	6,22	5,54	5,62
1986	no data	no data	no data	no data	no data	8,97	2,88	4,29	4,2	3,22	4,2	1,4	no data
1987	1,13	2,7	4,49	14,9	16,2	12	6,42	11,6	7,34	15,1	15,5	6,38	9,5
1988	4,62	6,12	2,72	6,31	5,84	5,26	2,53	2,67	5,98	3,8	1,87	2,4	4,16
1989	0,966	1,78	3,89	8,72	4,91	3,23	6,12	6,83	4,84	1,93	6,54	4,59	4,54
1990	4,34	2,77	1,83	5,49	2,13	6,89	4,51	1,45	2,67	7,62	19,1	6,59	5,43
1991	3,75	2,91	5,16	4,54	11,3	8,16	5,18	3,11	1,28	3,66	16,8	3,88	5,82
1992	1,45	2,01	4,93	8,2	4,6	2,44	1,69	0,208	1,3	5,97	12,4	10,5	4,63
1993	1,37	1,05	0,743	1,36	1,13	0,799	0,974	0,652	3	16,2	7,51	5,55	3,39
1994	6,62	1,94	2,06	6,95	5,11	6,23	3,93	1,68	4,97	5,65	5,87	2,36	4,45
1995	4,25	5,52	6,77	4,67	3,77	6,68	2,56	3,44	9,38	2,77	1,89	5,58	4,76
1996	6,43	3,23	3,34	6	7,92	5,47	11	6,97	3,23	11,9	13,5	6,12	7,12
1997	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
1998	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
1999	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
2000	2,24	1,86	3,5	5,07	3,37	2,99	3,42	1,37	1,6	6,37	33,5	9,87	6,24
2001	11,7	5,77	14,6	8,86	5,6	5,75	3,76	1,77	6,75	5,81	3,76	1,97	6,35
2002	1,69	2,65	2,98	4,34	2,85	2,98	3,93	5,62	2,56	5,51	8,99	5,59	4,15
2003	4,22	1,98	1,77	2,44	1,25	0,736	0,63	0,507	0,725	3,63	8,79	4,74	2,62
2004	3,87	3,52	6,46	8,61	7,19	8,01	7,53	2,63	5	11,6	7,83	6,35	6,56
2005	2,47	1,48	2,24	8,34	5,63	2,12	5,63	7,29	5,55	7,56	2,97	7,98	4,97
2006	2,73	3,1	10,4	9,54	8	5,3	2,23	3,33	2,8	2,34	2,16	3,44	4,62
2007	2,72	4,64	5,46	3,77	2,17	2,17	3,33	3,04	9,24	6,97	3,48	3,44	4,19
2008	5,02	2,77	3,58	9,41	5,56	4,38	5,32	4,21	1,80	2,72	5,71	15,8	5,52

For gauging station Kokra I, there are available data for the period 1926 – 2008 and for gauging station Kokra II, for the period 1957 – 2008. The data on gauging station Kokra I were exposed and shown in the following Figures because this gauging station is closer to the MCA test area. The characteristic discharges and discharge duration curves, for dry and wet year, are represented in the next figure (Figure 6).

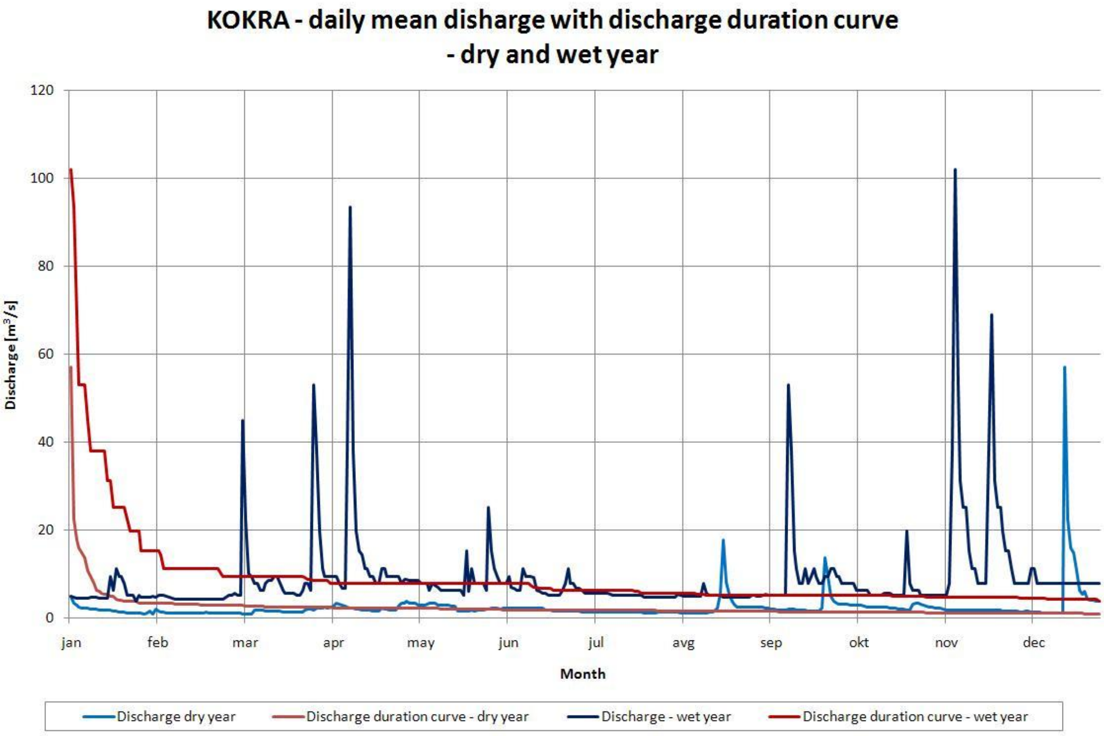

Figure 6: Daily mean discharge with discharge duration curve (dry and wet year) for Kokra river at GS Kokra I.

From available data for Kokra River (gauging station Kokra I), we constructed a graph of average monthly (Figure 7) and annual flows (Figure 8). On Figure 7 can be seen alpine snow-rain river flow regime with primary peak in autumn as a result of reservation of precipitations in higher rainfall areas and rain in low mountain range. Secondary peak in spring is result of melting snow in the mountains and spring rains. Minimums are in winter and summer.

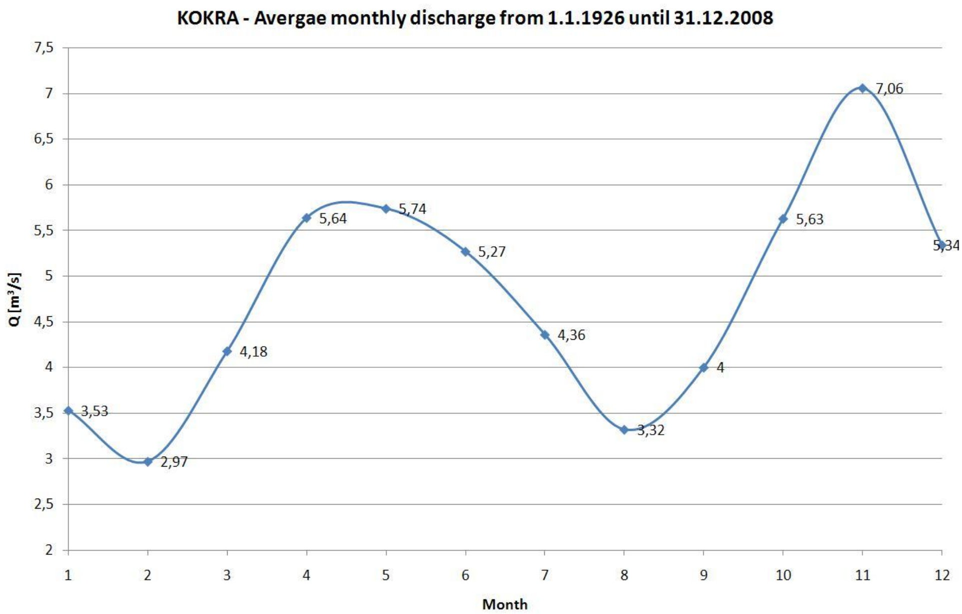

Figure 7: Average monthly discharge from 1.1.1926 until 31.12.2008 for Kokra river at HS Kokra I.

Changing of average annual flows in the period between 1.1.1926 and 31.12.2008 is shown in Figure 8. There is an obvious trend of declining values of the average annual flow. The reason for this is not yet completely evident.

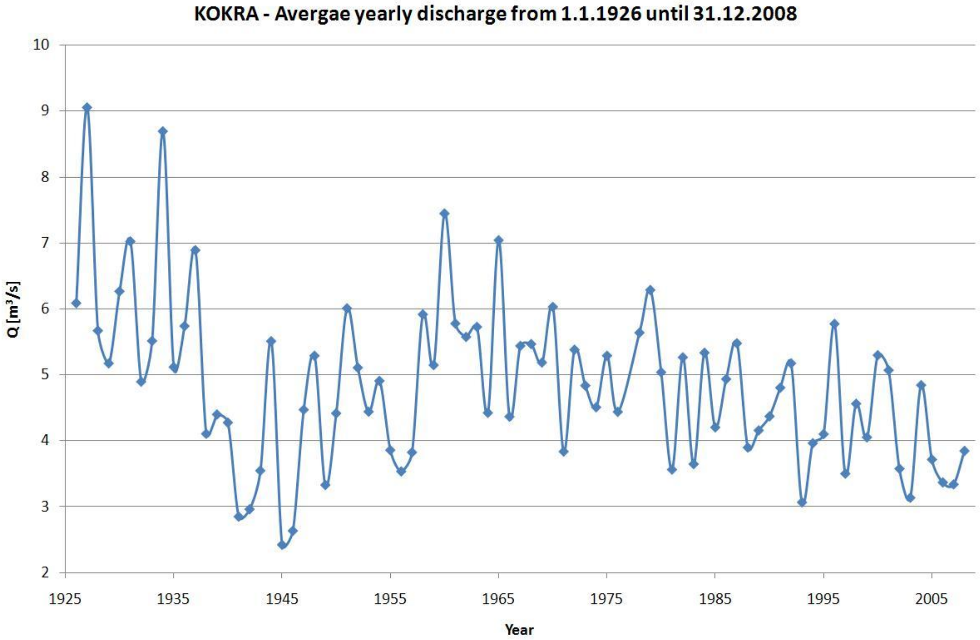

Figure 8: Average yearly discharge from 1.1.1926 until 31.12.2008 for Kokra river at GS Kokra I.

On the othe hand, river drainages of Kokra River downstream from Preddvor (lower Kokra River basin) are modified by water losses in the gravel deposits (Trobec, 2007).

The comparison of two similar types of streams, the Kokra River and Tržiška Bistrica River, shows surprisingly low flows in Kokra River. This shows an undersurface outflows, which is specifically expressive at low water levels (Trobec, 2007).

It is perceived a trend of increasing of low waters, which is probably due to lower total containment capacity of river basin. Many areas where water is letting (marshy, wet areas) are rapidly drained (farmland improvement, hydroreclamation), or even dried, populated or functionally cut off from basic hydrographic network. For the same reasons, the increasing peaks of flood wave appears. Water quantity at large and protracted rains due to lower retention times/space in the hinterland move faster, which again are unable to drain through banks. Therefore water runs faster through the water channel in increase flows like in completely natural state at the same level of hydrological and rainfall conditions (Globevnik et al. 1998).

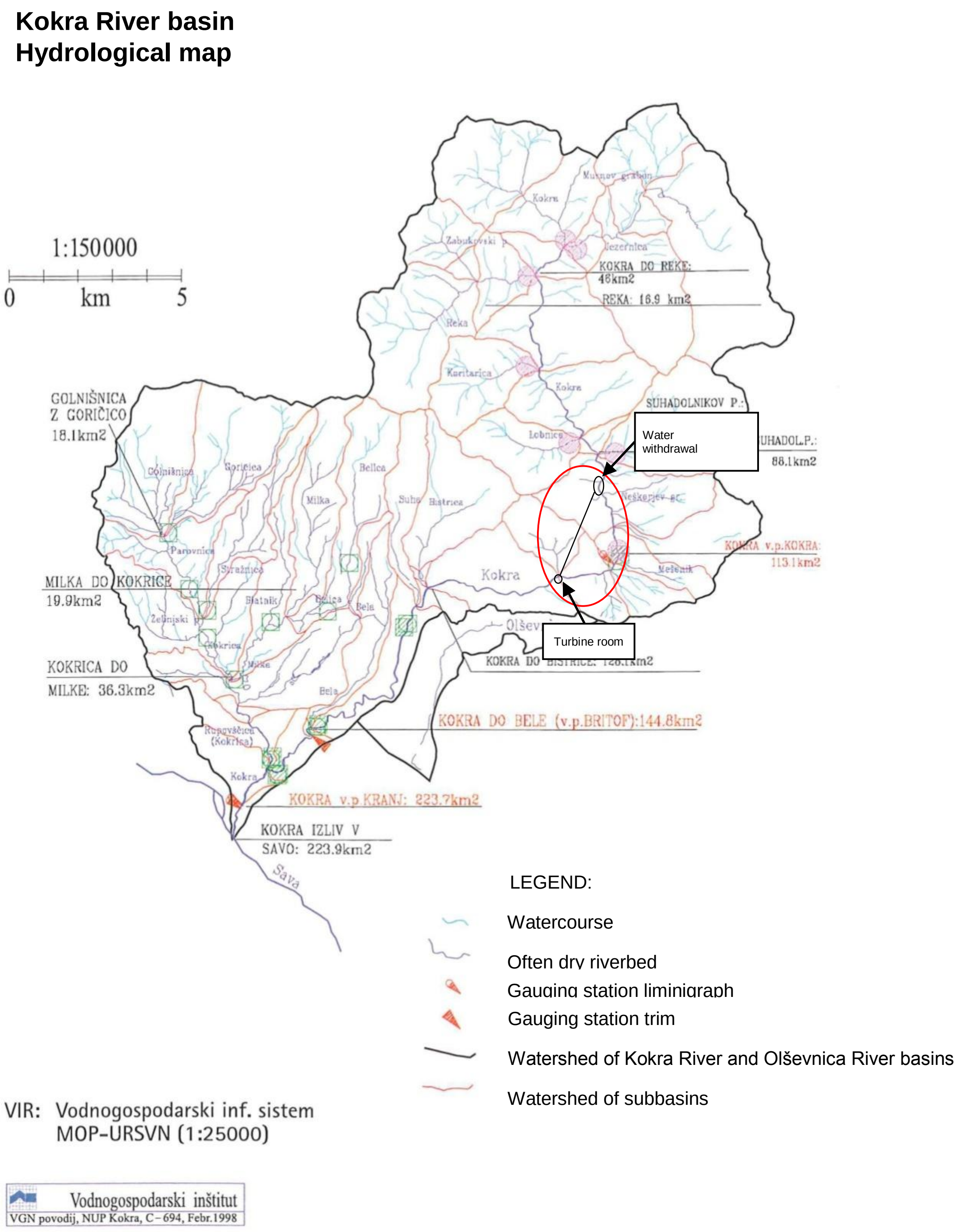

Figure 9: Hydrological map of Kokra River basin, showing the location of planned SHP Kokra (Globevnik et al. 1998, 30).

1.3.2 Meteorological data for the Kokra River basin

River basin of Kokra River falls in an area with a moderate form of the alpine climate with longer periods of low temperatures in winters and fresh summers (Gozdnogospodarski načrt, 2001).

Mean rainfall levels for area between Preddvor and Golnik are 1400 mm and 2000 mm in region around Jezersko. Evaporation varies between 600-700 mm per year in the lowland part and 400-600 mm in the mountainous part. Average annual temperatures of lowland region are 8°C, and Alpine part only 2°C. Most precipitation in the upper part of basin falls in October and November (Jezersko 200 mm/month), in the lowlands in July and November (160 mm/month). At least rain falls in February and March. Maximum daily rainfall is ranging between 114 mm (Krvavec and Golnik) and 214 mm (Jezersko). One hour and two-hour rain with a return period of 10 years are 30 and 40 mm on Jezersko and 34 and 41 mm at Brnik (Globevnik et al. 1998).

Summer rains and storms are frequent, which increases the risk of mountain streams. Snow may also remain lying up to 3.5 months (mostly in higher areas). Vegetation period lasts from 110 to 160 days per year (Forest management plan, 2001).

1.3.3 Hydro morphological characteristics of Kokra River basin

The following picture (Figure 10) shows hydro morphological characteristics of the area, where the construction of the Kokra SHP is planned. Left picture shows the hydrodynamic state. In section where water withdrawal is planned are downstream flood plains (areas) and in the lower part where turbine is planned retentions areas. In the section where they provide ecologically acceptable flows, the flow of Trdovec (tributary) occurs in torrential erosion area (torrential fan). Right picture shows the hydrodynamic conditions in the stream. Visible are torrent active erosion sinks (red dashed line). In the section where they provide ecological acceptable flow, is river bed relatively stable, with no noticeable trend of deepening and deposition. In area of water withdrawal and before the affluent of Čemšenik (tributary), stagnating sections and gravel accumulation occur (Globevnik et al. 1998).

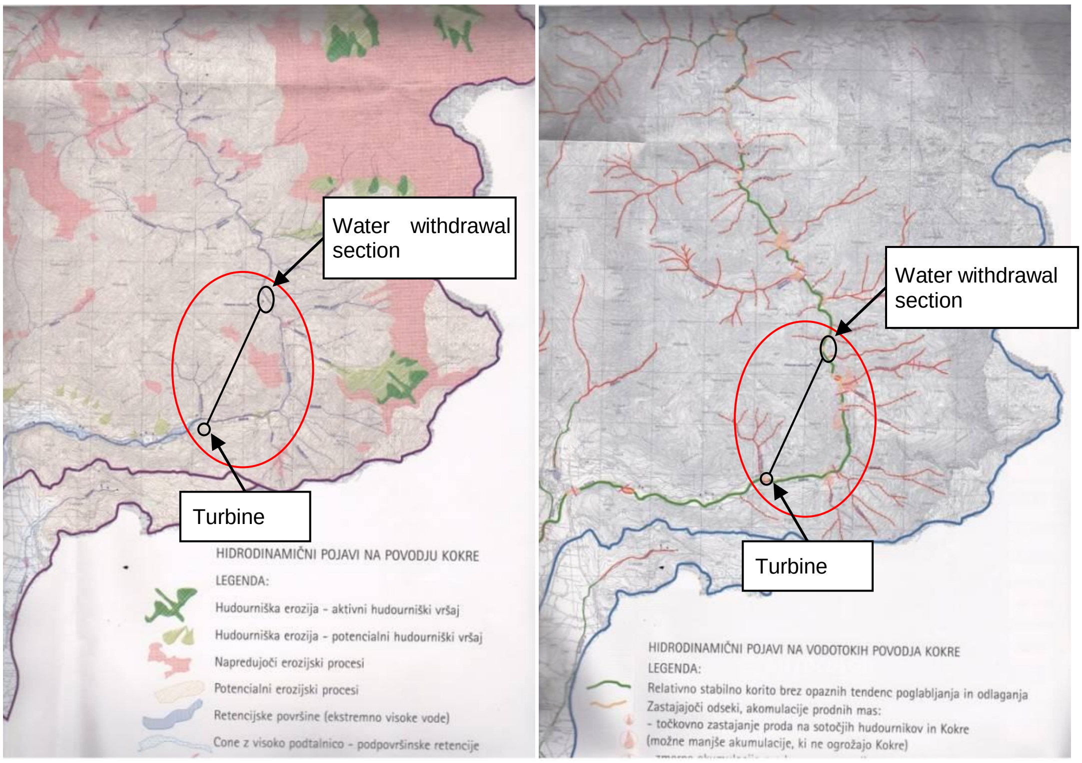

Figure 10: Hydromorphological provided characterization of the SHP Kokra (Globevnik et al. 1998).

1.3.4 Erosion Processes in the range of the estimated SHP Kokra

In the flood plains areas of Kokra are present all forms of erosion, typical for alpine and subalpine conditions. Above the tree line dominated by various forms of water/snow surface erosion. The torrents are typical mountainous, with steep, unstable riverbed, strong fluctuations in water levels and abundant transport capacity. Locally are present all forms and strengths of erosion and sediment release (erosion hot spots) and the deposition of sediment (Globevnik et al. 1998).

1.3.5 River bed-load discharge of Kokra River

Sources of sediment bed-load discharge for the dynamic processes developed on the river Kokra are all lateral areas with torrential ravines and areas with ongoing lateral and vertical erosion. The bed-load discharge of Kokra is not affected by slope rubble and gravel of Ravenska Kočna, while all other areas (slopes) strongly or conditionally impact bed-load discharge. Stronger processes of erosion are mainly caused by Kokra's right tributaries (Neškarjev graben, Suhadolnikov graben). Here derives the shock flow of sediment over longer periods. Intense sediment transport is present in all tributaries Jezernica and Kokra till Preddvor. In the section to Fužine (middle stretch), the river shows strong transport capacity. Till Preddvor the river shows changing character alternating balanced sections and sections with minimal erosion and shorter segments. Excess gravel is deposited in masses by Preddvor, so this area is also called the transition area (Globevnik et al. 1998).

Intense sediment transport is present in all Jezernica River and Kokra River to Preddvor. In the section to Fužine has a strong transporting capacity. Until Preddvor there are balanced segments, segments with minimal erosion and less stagnating segments. The heights of gravel are deposited in Preddvor, so this area is called the transition area. On the plain below Preddvor to Britof section of the dynamic processes are moderately expressed. Through the canyon then again occurs erosion processes.

Sediment release area:
This area predominantly covers the western area of Kamniško-Savinjske Alps. The main sources of sediments is an erosional area upstream Kokra and especially in tributaries, which descend steeply into the canyon of Kokra River. The maximum quantity of gravel, rocks and sand are located at the screes, on the northern edge of the ridge between the Brana, Grintavec and Kočna and on the western slopes of Kočna and Kalški greben. However, most of this material is not directly affected by developments in Kokra River because these sources are removed from the Kokra River and with no direct contact (Makekova Kočna, Ravenska Kočna).

The principal amount of sediment in Kokra brings torrential tributaries, but given the strength of these phenomena can be divided into less active, moderately active and very active. Among the latter is classified Neškarjev graben, which is erosion and gravel carrying the most active tributary of Kokra River. Large quantities of gravel are also found in the upstream of Suhadolnikov graben under Kokrško sedlo, but the ledge of Suhadolnik prevents movements of gravel against Kokra River.

Inflows of sediments to the other tributaries are moderate. At the extreme situations on separate parts of river basin, an increased flow of sediments can be expected. These inflows represent critical points and the points where both divertions and barrages of the Kokra River channel are expected and where is also and increased sediment transport downstream.

Separate sections of Kokra River can also be divided as the release of sediment zone with lateral and depth erosion, but these sections are at work flow, where sediment is predominantly moved.

Sediment transport area:
Kokra River bed is relatively stable. In the upper and middle stream (Kokra to Lower Kokra) the base of river bed is formed by larger boulders, which are filled with rubble and coarse gravel. Stable natural sink is rinsed. Slope is covered with aquatic vegetation. On sections where Kokra River flows in the canyon, bottom is mainly rocky and stable. Deposition segments occur only where the man guided the fall of the river (to protect against harmful effects of water, energy use). Higher rates (up to 6 m high) are located in the upper stream between Zgornja and Spodnja Fužina and in Leskovec. All the bridges over Kokra are protected with the low dams. Above all structures are located short stagnating sections with gravel mass partially occupied. The emergence of lateral erosion was recorded on the left bank below the confluence with the Reka River and in Podlebelica over the outflow of Neškarjev graben (on the left and right bank). According to the frequency of the expressiveness is this site the most threatened in upper stream of Kokra River.

Just before Preddvor is artificially created gravel pocket with remaining of gravel peaks. At this point is also removed from Kokra River. Section to the dam in Preddvor is stagnating, but stable. Heights of gravel is further kept below the dam in Preddvor.

Below the dam in Preddvor to Visoko is the next transect, where Kokra River flows on aluvial ground. The bank is fully regulated. Considered to gravel inflow from upper transect is this transect stable with no visible larger gravel pocket. The areas of erosion are restricted only on separate points, such as Breg (erosion of unbounded aluvium) and above Visoko, where Kokra River indents in conglomerate wall. Because of the alluvial cover layer and fixed level line some water is lost into gravel grounding. Gravel capacity of the river in this section is less than upstream of Preddvor. Withholding and withdrawing of gravel is approximately controlled by the transport capacity of the section.

At Visoko has Kokra River slightly broader, but relatively deep canyon. This stays until Britof. Kokra River here has a natural stream and it meanders between the left and right margin Erosion and deposition segments are alternating. The characteristic of this segment is to assure enough capacity of gravel materials, which is also reflected in the downstream section by Oljarica.

1.4 River quality

1.4.1 Biological elements of the Kokra River basin

Chemical and ecological status has been determined pursuant to the Provisions of the state of surface waters (Ur. l. RS 14/09). The data are taken from the monitoring Environmental Agency of the Republic of Slovenia, which is taking place under the Water Act (Ur. l. RS 67/2002) and the Environmental Protection Act (Ur. l. RS 41/2004). Framework for the functioning is proposed by the European Council Directive 2000/60/EC (Water Directive). Ecological and chemical status are determined for surface water.

Chemical status of surface waters is classified into two classes (good or bad). Ecological status is classified into five classes (very good, good, moderate, bad and very bad). The assessment of chemical status contains confidence level, which according to a comprehensive understanding of the problem defines the probability that the rating actually be as indicated by monitoring data. The high level of confidence means that the assessment of chemical status is very reliable (Cvitanič et al. 2010).

1.4.1.1 Composition and abundance of aquatic flora

Kokra River is an alpine river with rapid flow with a lot of movement of substrate and therefore unsuitable habitat for rooting of macrophytes (Mazej and Epšek 2005), and therefore can not be found on Kokra River. Phytoplankton in the river monitorings programs was not included, although the Directive provides for water because Slovenian rivers liquid quickly so phytoplankton is not relevant biological element (Cvitanič et al. 2010).

Phytobenthos researches were conducted in two sampling sites on Kokra River. The first sample location was in the village Jablanca in the upper stream and the second sample site was just before outflow of Kokra River in Kranj.

Ecological status of surface water was examined on the basis of the biological quality elements, supporting general physico-chemical parameters and specific pollutants. Surface water bodies are classified into one of five classes of ecological status: very good, good, moderate, bad and very bad ecological situation with regard to the worst case evaluation of the results based on the biological quality elements, the general physico-chemical parameters and specific pollutants. At each assessment is also given a level of confidence. The assessment was made with reference to the situation, which has been established on the basis of the stream type (Cvitanič et al. 2010).

Table 3: Phytobentos in the upper stream of Kokra River.

Kokra River, Jablanca, 8.8.2008

	Species	No./500 counted
Diatomeae	*Achnanthes minutissima*	374
	Achnanthes sp.	78
	Caloneis sp.	0,01
	Cocconeis pediculus	10
	Cocconeis placentula	30
	Cymbella affinis	2
	Cymbella cistula	0,01
	Cymbella microcephala	0,01
	Cymbella sinnuata	0,01
	Denticula tenuis	0,01
	Diatoma vulgaris	2
	Didymosphenia geminata	0,01
	Epithemia goeppertiana	0,01
	Gomphonema angustum	4
	Gyrosigma acuminatum	0,01
	Navicula tripunctata	0,01
	Fragilaria ulna	0,01
	Species	Abundance (1-singles, 2-rarely, 3-often, 4-mass, 5-dominant)
Other algae	*Gleocapsa* sp.	2
	Homoeothrix varians	2
	Heteroleibleinia sp.	1
	Phormidium sp.	1
	Cladophora glomerata	1
	Audouinella chalybea	2

Table 4: Phytobentos in the lower stream of Kokra River.

Kokra River, Kranj, 8.8.2008

	Species	No./500 counted
Diatomeae	*Achnanthes minutissima*	240
	Achnanthes sp.	34
	Amphora ovalis	0,01
	Amphora lybica	0,01
	Amphora pediculus	14
	Cocconeis pediculus	20
	Cocconeis placentula	72
	Cyclotella meneghiniana	0,01
	Cymatopleura solea	0,01

	Cymbella silesiaca	4
	Cymbella sinnuata	8
	Denticula tenuis	0,01
	Diatoma moniliformes	0,01
	Diatoma vulgaris	8
	Didymosphenia geminata	0,01
	Fragilaria capucina	0,01
	Fragilaria ulna	2
	Fragilaria ulna v. *acus*	0,01
	Gomphonema angustatum	4
	Gomphonema angustum	6
	Gomphonema augur	0,01
	Gomphonema olivaceum	2
	Gyrosigma acuminatum	0,01
	Melosira varians	0,01
	Navicula cryptocephala	0,01
	Navicula capitatoradiata	14
	Navicula gregaria	2
	Navicula lanceolata	2
	Navicula cryptotenella	22
	Navicula sp.	0,01
	Navicula tripunctata	8
	Navicula viridula	2
	Nitzschia constricta	0,01
	Nitzschia dissipata	6
	Nitzschia fonticola	4
	Nitzschia palea	6
	Nitzschia recta	0,01
	Nitzschia sigmoidea	0,01
	Rhoicosphaenia abbreviata	12
	Surirella angusta	0,01
	Surirella minuta	8

	Species	Abundance (1-singles, 2-rarely, 3-often, 4-mass, 5-dominant)
Other algae	*Chamaesiphon confervicolus*	1
	Gleocapsa sp.	2
	Homoeothrix varians	3
	Heteroleibleinia sp.	2
	Phormidium sp.	1
	Cladophora glomerata	2
	Audouinella chalybea	1

Research of phytobenthos on the Kokra River demonstrated a very good ecological status at both sampling sites with the median level of confidence according to both criteria (saprobity and trophicity) (Cvitanič et al. 2010).

1.4.1.2 Composition and abundance of bentic invertebrate fauna of Kokra River

Table 5: Bentic invertebrates in the upper stream of Kokra River.

Kokra River, Jablanca, 22.8.2008

Family	Taxon	Abundance/0,625 m2
Enchytraeidae	Enchytraeidae	1
Lumbricidae	*Eiseniella tetraedra*	4
Lumbriculidae	*Lumbriculus variegatus*	1
Lumbriculidae	*Stylodrilus heringianus*	4
Lumbriculidae	*Stylodrillus* sp.	32
Naididae	*Nais* sp.	1
Naididae	*Stylaria lacustris*	1
Ancylidae	*Ancylus fluviatilis*	4
Hydrobiidae	*Bythinella schmidti*	2
Hydrachnidia	Hydrachnidia (Hydracarina)	14
Gammaridae	*Gammarus fossarum*	3
Baetidae	*Baetis lutheri*	431
Baetidae	*Baetis rhodani*	463
Ephemerellidae	*Ephemerella ignita*	2
Heptagenidae	*Ecdyonurus* sp.	53
Heptagenidae	*Epeorus* sp.	30
Heptagenidae	*Rhithrogena* sp.	37
Leptophlebidae	*Habroleptoides confusa*	1
Leuctridae	*Leuctra* sp.	301
Nemouridae	*Protonemura* sp.	65
Perlidae	*Dinocras megacephala*	8
Perlodidae	*Dictyogenus/Isoperla*-juv.	1
Perlodidae	*Perlodes* sp.	9
Taeniopterygidae	*Taeniopteryx hubaulti*	1
Elmidae	*Elmis* sp.	24
Elmidae	*Elmis* sp.-larve	23
Elmidae	*Esolus* sp.	19
Elmidae	*Esolus* sp.-larve	6
Elmidae	*Limnius* sp.	4
Elmidae	*Limnius* sp. - larve	12
Elmidae	*Riolus* sp.	4
Elmidae	*Riolus* sp.-larve	5
Hydraenidae	*Hydraena* sp.	6
Brachycentridae	*Brachycentrus montanus*	16
Brachycentridae	*Micrasema minimum*	13
Glossosomatidae	*Agapetus ochripes*	1

Goeridae	*Silo pallipes*	30
Hydropsychidae	*Hydropsyche dinarica*	10
Hydropsychidae	*Hydropsyche incognita*	6
Limnephilidae	Drusinae	106
Odontoceridae	*Odontocerum albicorne*	1
Psychomyiidae	*Tinodes* sp.	3
Rhyacophilidae	*Rhyacophila* sensu stricto	41
Rhyacophilidae	*Rhyacophila tristis*	8
Sericostomatidae	*Sericostoma* sp.	20
Athericidae	*Atherix ibis*	1
Athericidae	*Ibisia(Atherix) marginata*	16
Blephariceridae	*Liponeura* sp.	3
Ceratopogonidae	Ceratopogoninae	1
Chironomidae	Chironomini	5
Chironomidae	Corynoneurinae	1
Chironomidae	Diamesinae	1
Chironomidae	Orthocladiinae	105
Chironomidae	Tanypodinae	8
Chironomidae	Tanytarsini	53
Empididae	Clinocerinae	4
Empididae	Hemerodromiinae	1
Limoniidae	*Antocha* sp.	12
Limoniidae	Limnophilinae	2
Pediciidae	*Dicranota* sp.	8
Simuliidae	*Simulium* sp.	16

Benthic invertebrate researches in upper stream of the Kokra River showed a very good ecological status regarding to saprobity with a median level of confidence and a very good ecological status regarding to hydromorphological alteration with a low level of confidence (Cvitanič et al. 2010).

Table 6: Benthic invertebrates in the lower stream of Kokra River.

Kokra River, Kranj, 22.8.2008

Family	Taxon	Abundance/0,625 m2
Dugesiidae	*Dugesia lugubris/polychroa*	2
Nematoda	Nematoda	1
Enchytraeidae	Enchytraeidae	6
Lumbricidae	*Eiseniella tetraedra*	106
Lumbriculidae	*Rhynchelmis* sp.	2
Lumbriculidae	*Stylodrilus heringianus*	3
Lumbriculidae	*Stylodrillus* sp.	80
Naididae	*Nais* sp.	13
Tubificidae	Tubificidae-z lasastimi ščet.	1

Erpobdellidae	*Trocheta Bykowskii*	3
Ancylidae	*Ancylus fluviatilis*	150
Hydrobiidae	*Bythinella schmidti*	12
Hydrobiidae	*Sadleriana fluminensis*	4
Hydrachnidia	Hydrachnidia(Hydracarina)	34
Gammaridae	*Gammarus fossarum*	5052
Baetidae	*Baetis fuscatus*	10
Baetidae	*Baetis rhodani*	1250
Baetidae	*Baetis scambus*	157
Baetidae	*Baetis vardarensis*	197
Baetidae	*Baetis vernus*	26
Ephemerellidae	*Ephemerella ignita*	5
Heptagenidae	*Ecdyonurus* sp.	4
Heptagenidae	*Epeorus* sp.	32
Leuctridae	*Leuctra* sp.	29
Perlodidae	*Perlodes* sp.	2
Elmidae	*Elmis* sp.	63
Elmidae	*Elmis* sp.-larve	39
Elmidae	*Esolus* sp.	194
Elmidae	*Esolus* sp.-larve	83
Elmidae	*Limnius* sp.	3
Elmidae	*Limnius* sp. –larve	46
Elmidae	*Oulimnius* sp.	1
Elmidae	*Riolus* sp.	10
Hydraenidae	*Hydraena* sp.	9
Glossosomatidae	*Agapetus ochripes*	1
Goeridae	*Silo nigricornis*	3
Goeridae	*Silo pallipes*	43
Hydropsychidae	*Hydropsyche dinarica*	1
Hydropsychidae	*Hydropsyche* sp.-juv.	49
Hydroptilidae	*Hydroptila* sp.	57
Limnephilidae	*Potamophylax cingulatus*	7
Polycentropodidae	*Polycentropus flavomaculatus*	6
Psychomyiidae	*Psychomyia klapaleki*	54
Psychomyiidae	*Psychomyia pusilla*	12
Rhyacophilidae	*Rhyacophila* sensu stricto	122
Rhyacophilidae	*Rhyacophila tristis*	5
Sericostomatidae	*Sericostoma* sp.	3
Athericidae	*Ibisia(Atherix) marginata*	1
Ceratopogonidae	Ceratopogoninae	1
Chironomidae	Chironomini	50
Chironomidae	Corynoneurinae	5
Chironomidae	Diamesinae	43
Chironomidae	Orthocladiinae	302

Chironomidae	*Potthastia* sk. longimana	3
Chironomidae	Tanypodinae	4
Chironomidae	Tanytarsini	14
Empididae	Hemerodromiinae	10
Limoniidae	*Antocha* sp.	170
Pediciidae	*Dicranota* sp.	29
Simuliidae	*Simulium* sp.	24

Benthic invertebrates research in lower stream of Kokra River showed a very good ecological status of saprobity with the low confivdence level. According to hydromorphological alteration of the river currents belongs the lower stream of Kokra River to the middle ecological class (with low confidence) (Cvitanič et al. 2010).

1.4.1.3 Composition, abundance and age structure of fish fauna in Kokra River

Kokra River inhabit following fish species: brown trout (*Salmo trutta* m. *fario*), rainbow trout (*Oncorhynchus mykiss*), grayling (*Thymallus thymallus*) (Globevnik et al. 1998), interested for recreational fishing.

Brown trout habitat are faster running, clear, cold rivers and streams (up 15 to 17°C), well saturated with oxygen and the pebble bed. Pebble bed is obligatory for spawning, which runs from October to February. Water depth at the hatcheries is ranging from 30 to 90 cm. The size of gravel particles on hatcheries, on average, 2 to 6 cm, current velocity and a 10 cm/s. Juvenile inhabit shallower and calmer areas, adult specimens are kept in deep water. Therefore, the settlement in a stream depends on the percent of hiding. They feed on small invertebrates found in streams and insects that come too close to the water surface.

Grayling inhabits lower altitude rivers, with faster water flow and gravel bottom with different-sized pebbles. It is found in the sandy-bottomed streams and rich aquatic vegetation. Stays are mainly in areas with faster flows and moderate water depths. Temperatures should not exceed 18 to 20°C. It thrives mingles in flocks and are not concealing at banks or at bottom. They feed on small invertebrates that thrive on the bottom looking for food but also on the surface. Grayling is a fish species that is very sensitive to water quality (Globevnik et al. 1998).

Rainbow is a non-autochthonous fish species (introduced from North America in the 19th century), very flexible, which inhabits fast flowing water and lakes. They are found in waters with high oxygen content, where the temperature does not exceed 21°C. Like all trout species feed on animals, mainly on invertebrates, as well as larger fish specimens (Globevnik et al. 1998).

Table 7: Insertion of fish in breeding waters of Kokra River basin in years 1991-1995 (Globevnik et al., 1998).

Year	Water body	Species	Investing of fish (kg)
1991	Belica	brown trout (*Salmo trutta* m. *fario*)	172000
	Belica	brown trout (*Salmo trutta* m. *fario*)	60000
	Belica	grayling (*Thymallus thymallus*)	70000
1992	Belica	brown trout (*Salmo trutta* m. *fario*)	70000
	Stražnica	brown trout (*Salmo trutta* m. *fario*)	80000
	Želinjski potok	brown trout (*Salmo trutta* m. *fario*)	20000
	Blatnik	brown trout (*Salmo trutta* m. *fario*)	20000
	Farški potok	brown trout (*Salmo trutta* m. *fario*)	14000
	Zg.Rupovščica	brown trout (*Salmo trutta* m. *fario*)	26000
	Žabeljski potok	brown trout (*Salmo trutta* m. *fario*)	50000
1993	Goričica	brown trout (*Salmo trutta* m. *fario*)	180000
	Kamnjek	brown trout (*Salmo trutta* m. *fario*)	20000
	Zelenec	brown trout (*Salmo trutta* m. *fario*)	30000
1994	Belica	brown trout (*Salmo trutta* m. *fario*)	75000
	Blatnik	brown trout (*Salmo trutta* m. *fario*)	30000
	Stražnica	brown trout (*Salmo trutta* m. *fario*)	80000
	Žabeljski potok	brown trout (*Salmo trutta* m. *fario*)	65500
	Farski potok	brown trout (*Salmo trutta* m. *fario*)	30000
1995	Zg. Rupovščica	brown trout (*Salmo trutta* m. *fario*)	11000
	Vever	brown trout (*Salmo trutta* m. *fario*)	65000
	Goričica	brown trout (*Salmo trutta* m. *fario*)	70000
	Kamnjek	brown trout (*Salmo trutta* m. *fario*)	40000
	Zelenec	brown trout (*Salmo trutta* m. *fario*)	40000
	Želinjski potok	brown trout (*Salmo trutta* m. *fario*)	40000

1.4.2 Hydro morphological elements supporting the biological elements of Kokra River

1.4.2.1 Hydrological regime

Comparisson of the runoff coefficients of the remaining years with the runoff coeficient of wet years on sample site Kokra are runoff coefficints ranging between 0.70 and 0.80 and in years of little rainfall between 0.60 and 0.70. Extremely large differences between dry and wet effluents on samle site Kokra was not determined, because the very aqueous river basin. Individual hydrological characteristics depend on the time dynamics of events. Average annual runoff on sample site Kokra is 0.71. Measured discharges at sample site Britof shows that in dry years, we assume the coefficient of runoff 0.54 and in wet years 0.72. Average annual flows away 0.68 precipitation. At the sample site in Kranj, we assume the coefficient of runoff for the dry year, 0.45 and 12.52 and wet. The average annual runoff coefficient is 0.49.

Analysis of the balance of flows made of premeasured flows and precipitation is not sufficient to understand the balance sheet indicators of Kokra River. After the construction of ponds in Brdo in 1974, has been transformed distribution of outflows in different parts of the river basin. Ponds have linked system Belca (basin Kokrica River) and Bela (basin of Kokra River. Balance situation changes dramatically further withdrawal of water from the river near Preddvor Kokra. The construction of the dyke and the pipeline forecasts from 50 l/s to 320 l/s water to take off the Kokra River to assure enough water for ponds in Brdo. Water balance downstream from Preddvor has changed after year 1974 when water for Protocolar building in Brdo and Lake Črnava started to take away from Kokra River. Towards the end of the seventies, when the regulation of Kokra River was finalized between Tupaliče and Hotemaže, in addition to the hydrological dynamics of the partially changed water balance during low water. As on this section, water disappear undeground, causing water loss of critical ecological conditions in the river especially in dry periods (Globevnik et al. 1998).

Table 8: Water balance of Kokra River in upper stream (Globevnik et al. 1998).

	Catchment area F (km^2)	Mean annula flow Qsr (m^3/s)	Mean annual maximum peak SrQmax (m^3/s)	Mean annual minimum peak SrOtnin (m^3/s)
Kokra do Jezernice	13,0	0,49	21	0,16
Kokra v.p. Kokra	113,1	4,47	93	1,333
Kokra Tupaliče	135,5	4,40	98	1,160
Kokra Britof	144,8	4,20	106	1,000
Kokra pred Kokrico	153,0	4,00	110	0,790
Kokra v.p. Kranj	223.7	5,807	127	1,115
Jezernica	30,7	1,28	35	0,34
Reka do Kokre	16,9	0,76	26	0,23
Koritarica	5,67	0,22	10	0,07
Lobnica	5,16	0,20	9	0,07
Suhadoinikov graben	9,5	0,41	16	0,11

Grey – river portion interested by MCA test

Water balance in Table 8 was evaluated by analysis of time series of hydrological data and using simultaneous measurements. For the analysis of balance is an authentic the river portion downstream from Preddvor, when we exclude redistribution of water in the dam. because of up mentioned Kokra Mon Tupaliče particular section, node. Kokra River on the section between Tupaliče and Britof losses of 0.220 m3/s of water. In balance, we considered the fact that the section between Milje and Britof get extra water 0.05 m3/s from the springs in the canyon. Between Britof and Kranj (to the inflow Kokrica) Kokra River losses from 0.20 m3/s to 0.25 m3/s of water. Water balance is valid with low flows. In the overall balance of low water, when we consider the inflow of Suha and eventual springs on contact with the impermeable layers at the edge of the river channel (depending on the hydrological situation and hydrological conditions), considering that the low river flow in Kranj is averagely less than the flow in Tupaliče for 0.370 m3/s (Globevnik et al. 1998).

In the mid to low flow on sampling site Kokra (1333 m3/s) and assuming the continued withdrawal for Brdo (0.320 m3/s), the average low flow at Tupaliče is estimated on 1160 m3/s. Approximate calculation would be as follows: 1.333 m3/s + 0.150 m3/s (tributaries in between) – 0.320 m3/s gives 1.163 m3/s. Average low flow of Kokra River before inflow of Kokrica River, the current state is estimated at 0.790 m3/s. Average low flow of Kokrica River by Kranj is estimated at 0.310 m3/s (Globevnik et al. 1998). Water balance is given in Table 8.

Almost entire area of Kokra sub-basin is also determined by groundwater aquifers (Figure 11). Their vulnerability is defined by level of connection to surfacewaters or level of change in water regime (see 21). Litological units wrer determined on the basis of their hydrogeological properties with the recommendations of IAH classification. IAH classification classifies aquifers and other hydrogeological units depending on the type of porosity (intergranular and fractured or karst), extensive (extensive, local, smaller) and the rate of flow (low, medium, high yields, variable, local and limited).

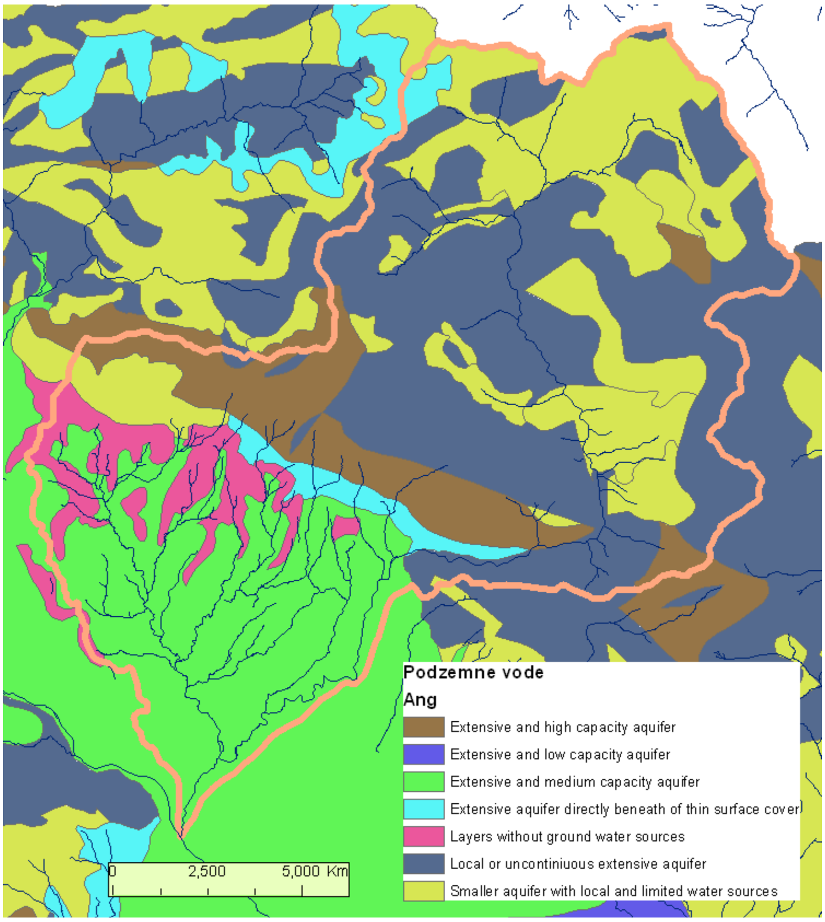

Figure 11: Hydrogeologic areas according to the IAH (International Association of Hydrogeologists) classification (Ground waters)

According to the Water Framework Directive and harmonized national regulations also determination of Ground Water Bodies was processed. Groundwater bodies constituted representative units to define the quantitative and chemical status of groundwater bodies for risk assessment and for achieve the environmental objectives laid down by WFD. Groundwater bodies in Kokra sub-basin are shown in Figure 12 and are described in Table 9.

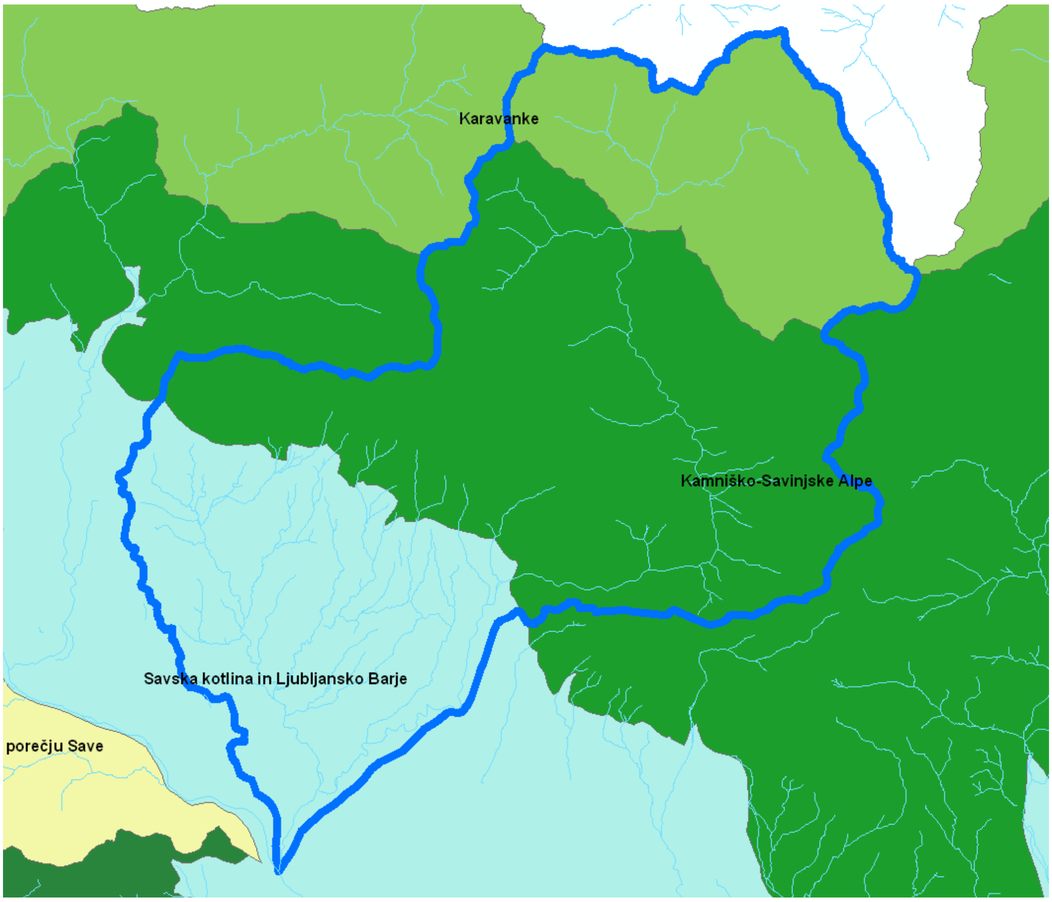

Figure 12: Ground Water Bodies determination according to the Water Framework Directive

Table 9: Ground Water Bodies in Kokra sub-basin

Water body	Mean thickness [m]	Max thickness [m]	Type and capacity	Geological type
Savska kotlina in Ljubljansko Barje	>60	>150	Intergrain, alluvial - extensive and local medium to high capacity (in spots low capacity) acquifiers	Sand/gravel alluvials of Sava river and tributaries
Karavanke	>200	>400	Karst/fissures - extensive and localy with low to high capacity acquifiers	Limestone and dolomite acquifiers - karts formations well developed
Kamniško-Savinjske Alpe	>200	>400	Karst/fissures - extensive and localy with low to high capacity acquifiers	Limestone and dolomite acquifiers - karts formations well developed

According to the process of Water Directive implementation and elaboration of River Basin Management Plan and Programme of measures it is predicted the environmental objectives by year 2015 will be reached for water bodies of Karavanke (ang. Karavanke mountains) and Kamniško Savinjske Alpe (ang. Kamniško Savinjske Alps) and for "Savska kotlina and Ljubljansko barje" (ang. Sava Basin and Ljubljana Marsh") environmental objectives will be probably reached.

1.4.2.2 River continuity

At the confluence of Jezernica River and Kokra River is placed dam, which has a very important role in maintaining soil nivelete of both streams and the entire flow downstream. It is estimated that the height of the dam is too high. Often leads to flooding upstream part of the valley.

Hydraulics of the stream to Preddvor is maintained by numerous dams, but due to some injuries there is a potential destabilization of the hydraulic conditions. In the section of the river basin to Preddvor, Kokra River keeps regular high waters, with the peaks flowing into a narrow valley. There is no major flood areas. Because of the main road, passing through the valley until Jezersko next to the bed of the river Kokra, may occur local floodings of this road and or bridges. The local hydraulic conditions may change drastically, if there is a narrowing of the profiles.

Hydraulics of the bed of the Kokra River in Preddvor is set by a dam. There is also built an intake point channel to a small hydroelectric power plant and water capture facility for protocol centre Brdo. Due to the water standstills accumulates larger geavel masses over the dam. These need to be controlled properly to prevent dam damages.

Below the dam in Jelovica, the Kokra River enters in lowland part of the catchment. River channel is expanding and soon enters into a wider canyon section, where remains largely up to the inflow into the Sava River. High waters flow regular into the submerged meadows along the banks, with the exception of a section between Tupaliče and Visoko. This section was deepened and levelled at the end of the seventies. The slope on the left bank, which was previously constantly under water, now mainly remains dry. Flow rate at which the water in this section is not spilling over the banks (permeability), as estimated by flow-return period of 20 to 25 years.

In the section downstream of Visoko to Britof respectively to Kranj and to the inflow into the Sava River, Kokra River flows through a deep conglomerate terrace channel with steep banks. Due to construction works on the edge of the canyon, descents rainwater and sewage water, which raises slips of larger blocks, and due to the dumping of rubbish and other material on river banks, there is a restriction of the channel. This has a large hydraulic effects on the up and low stream. High water stays in the canyon or in coombs, so this space is also an important reservoir of water. Any change in this part of the channel also means a change of hydraulic conditions on the long section. Interventions in this area are therefore always critical.

Longitudinal profile of Kokra River is shown in Table 10.

Table 10: Longitudinal profile of Kokra River (Globevnik et al. 1998).

PROFILE	Stationary (m)	Kota dna (m)	Kota desnega brega (m)	Kota levega brega (m)	Kota desnega roba kanjona (m)	Kota levega roba kanjona (m)	Kota objekta (m)
Outflow to Sava River	0	346.0	350.9	350.0			
Concrete bridge na Savski cesti	170	346.9	351.9	354.6			353.37
Dam HP Standard	270	349.5	355.6	354.8	384	384.3	
Dam HP Standard	270	355	355.6	354.8	384	384.3	355
Hanging bridge	515	355.4	357.5	357.2	- 384	384.3	
Concrete bridge on Poštni ulici	600	355.8	357.2	357.6	384.1	384.3	383.54
Wooden footbridge	640	356.0	358.5	358.7	384.2	384.3	384.2
Wooden bridge, local way	1120	357.4	359.8	359.5	386.8	384.5	363.8
Concrete bridge -Cesta St. Žagarja	1715	362.7	370.3	370.3	391.6	386.5	392.6
Dam for HP Kokra	1780	363.8	371.5	371.5	392.4/	390.2	
Dam for HP Kokra	1780	371.5			392.4	390.2	
	2530	373.0			386	383.5	
Wooden bridge Rupa - Primskovo	2580	373.5	377.8	376.0			
Rupovščica – right bank	2605	373.6	376.5	377.0			
	3125	377.1	378.7	380.4			
	3395	379.5	381.5	382.2	389	395.5	
	4500	390.2	392.1	391.6	406.2	404.9	
Neškarjev graben – left bank	20550	554.1	560.9	561.1			
Wooden bridge Grobovšek	20875	563.4	566.3	566.5			567
Leskovčev bridge	21070	567.6	571.0	571.0			571.7
Slaparjev studenec – right bank	21185	568.8	573.3	573.0			
Threshold and dam – Hajnriharjev dam	21365	570.7	576.8	576.0			
Threshold and dam– Hajnriharjev dam	21365	574.4	576.8	576.0			
Celarjev bridge	21700	577.4	581.1	581.0			581.67
Vršnikov stream – left bank	21960	580.3	583.7	583.6			
Local wooden bridge - sawmill	22510	586.4	589.0	589.0			589.2
Suhadolnikov stream – left bank	22590	587.5	590.2	590.2			
Concreted bridge local Zg. Kokra	23300	597.1	600.6	600.6			601
Lobnica (Vobenca) – right bank	23360	597.9	601.6	601.6			
Wooden bridge at monument	23830	604.6	609.0	609.0			609.5
Belca – right bank	5140	392.2	397.7	398.6	405.6	405	
dam Oljarica and thresholds	5245	393.7	405.5	405.1	405.6	405.6	
dam Oljarica and thresholds	5245	398.8	405.5	405.1	405.5	405.1	
Concreted bridge Orehovlje - Britof	5485	398.5	405.9	405.5	408.5	407.74	408.62
	6620	404.2	407.8	407.2	422.5	420.1	
	7580	411.1	412.8	413.5	429	425	
	8300	414.3	417.5	418.1	429	429.5	
Wooden bridge Suha - Visoko	9050	422.7	426.3	425.1	430.5	437.5	427.7
	10120	431.5	433.6	433.1	442.5	433.1	
Woodwn bridge local way	10590	435.2	438.8	437.4	445		438.85
	11335	442.7	445.1	445.2	445.13		445.8

Mlinski stream-left bank	11660	447.1	447.9	447.4		
Suha – right bank	12100	449.0	451.5	450.7		
Canal of Bistrica (Jelovica)	12465	451.6	452.7	454.5		
Wooden b. Preddvor- Tupaliče	12795	454.5	459.6	459.8		445.8
dam Jelovica	12910	455.8	458.6	460.7		
dam Jelovica	12910	458.3	458.6	460.7		
Potoče –right bank	13630	465.2	474.5	474.7		
Conc. bridge C 11-319	13725	466.1	476.6	476.6		468
Wooden bridge local way	14860	474.3	478.2	477.5		478.3
Wooden bridge local way	15915	488.7	491.6	491.2		492.08
Čemšeniški stream- right bank	17140	501.7	505.2	505.6		
Concreted bridge local Tkavc	17180	502.4	505.6	506.1		509.3
Wooden bridge locali Prešeren	17840	510.8	513.6	513.6		513.7
Woodwn bridge local Hariš	18310	513.9	516.6	516.6		517
Hribnica – left bank	18335	514.1	517.2	517.2		
Tisovec – left bank	18490	515.5	520.6	521.3		
Tomažkov stream	18750	524.6	528.0	528.0		
Wooden bridge local - Globočnik	18790	526.0	529.0	529.0		529.1
Wooden bridge st schooli	19015	529.4	531.6	531.3		531.8
Mešenik – left bank	19.135	175.6	183.6	174.6		
Wooden bridge C II - 319	19670	541.6	543.6	543.6		544.3
Mlinščica - levi breg	20115	546.4	552.7	552.8		
Wooden bridge locai Podlebelca	20380	549.3	558.2	558.4		558.52
Neškarjev graben – left bank	20550	554.1	560.9	561.1		
Wooden bridge Grobovšek	20875	563.4	566.3	566.5		567
Leskovčev bridge	21070	567.6	571.0	571.0		571.7
Slaparjev studenec – right bank	21185	568.8	573.3	573.0		
Threshold and dam – Hajnriharjev dam	21365	570.7	576.8	576.0		
Threshold and dam – Hajnriharjev dam	21365	574.4	576.8	576.0		
Celarjev bridge	21700	577.4	581.1	581.0		581.67
Vršnikov stream – left bank	21960	580.3	583.7	583.6		
Woodwn bridge local - sawmill	22510	586.4	589.0	589.0		589.2
Suhadolnikov stream – left bank	22590	587.5	590.2	590.2		
Concrete bridge local Zg. Kokra	23300	597.1	600.6	600.6		601
Lobnica (Vobenca) – right bank	23360	597.9	601.6	601.6		
Wooden bridge at monumentum	23830	604.6	609.0	609.0		609.5

Grey – river portion interested by MCA test

1.4.2.3 Morphological conditions

Table 11 shows hydraulic properties of Kokra River and its tributaries from Jezersko to Preddvor at low water. This area is in upper stream of Kokra River. The measurements were taken in January 1996, when low water level occurs.

Table 11: Hydraulic properties of Kokra River and its tributaries from Jezersko to Preddvor at low water level (at winter, 23.1.1996) (Globevnik et al. 1998).

Profile name (size of the catchment area)	Waterline beam	Average and maximum profile depth	Average speed in profile	Discharge
	B (m)	H aver (m), H max (m)	V aver (m/s)	Q (m^3/s)
Kokra to Jezernica (13.0 km^2)	3.65	0.15, 0.21	0.32	0.175
Jezernica to Kokra (30.7 km^2)	2.75	0.19, 0.24	0.53	0.268
Reka (16.9 km^2)	4.75	0.17, 0.23	0.25	0.200
Koritnica (5.7 km^2)	2.23	0.16, 0.23	0.21	0.074
Lobnica (5.2 km^2)	1.90	0.17,0.25	0.18	0.059
Suhadolnikov stream (9.5 km^2)	1.75	0.16, 0.22	0.37	0.101
Kokra v.p. Kokra (113.0 km^2)	9.93	0.41,0.58	0.49	2.011

Grey – river portion interested by MCA test

Table 11 shows hydraulic properties of Kokra River to confluence with Rupovščica at middle and low water level. This portion of river represents lower stream of Kokra River.

Table 12: Hydraulic properties of Kokra River to confluence with Rupovščica at middle and low water level (Globevnik et al. 1998).

Profile name (size of the catchment area)	Hydrological situation	Waterline beam	Average and maximum profile depth	Average speed in profile	Discharge
	0.7.1997, 3.10.1997, 16.1.1998	B (m)	H aver (m), H max (m)	V aver (m/s)	Q(m^3/s)
Kokra v.p. Kokra (113.0 km^2)	Srednje v. - poletje	-	-	-	-
	Srednje v. - zima				
	Nizke v. - jesen	10.03	0.34, 0.51	0.35	1.181
Kokra Tupaliče (135.5 km^2)	Srednje v. - poletje	9.60	0.55, 0.80	0.46	2.449
	Srednje v. - zima	10.12	0.57, 0.85	0.43	2.479
	Nizke v. - jesen	10.05	0.33, 0.53	0.31	1.048
Kokra Britof (144.8 km^2)	Srednje v. - poletje	-	-	-	-
	Srednje v. - zima	13.5	0.40, 0.48	0.43	2.303

	Nizke v. - jesen	6.85	0.28, 0.43	0.47	0.902
Kokra to Rupovščica (153.5 km^2)	Srednje v. - poletje	13.41	0.34, 0.53	0.50	2.309
	Srednje v. - zima	14.92	0.34, 0.56	0.46	2.336
	Nizke v. - jesen	9.30	0.26, 0.51	0.29	0.699
Rupovščica (Kokrica) to Kokra (67.2 km^2)	Srednje v. - poletje	5.75	0.20, 0.29	0.38	0.431
	Srednje v. - zima				
	Nizke v. - jesen	3.10	0.17, 0.24	0.31	0.161

Table 13 represents depth and substrat variations of Kokra River in upper stream (sampling site Jablanca), and in lower stream (sampling site Kranj). The river in Jablanca has variable speed of river current meawhile the depth is lower.

Table 13: Kokra River depth and substrat variations (Izvajanje monitoringa za..., 2010)

Date: 22.8.2008		VM Jablanca	VM Kranj
Length of segment	m	50	50
Average width of river channel	m	25	25
Average moistening of river channel	m	25	10
River channel		Natural	Natural
Depth (%)	1-10 cm	10	0
	10-30 cm	40	10
	30-60 cm	45	80
	nad 60 cm	5	10
Velocity (%)	0-10 cm/s	5	0
	11-30 cm/s	25	50
	31-60 cm/s	30	50
	61 and more cm/s	40	0
Turbidity		Not turbid, clean	Not turbid, clean
Water level		Low	Low
River bottom visible		Yes	Yes
Sediments	% rubble	10	0
	% gravel	80	90
	% sand	10	10
Shadows of the river channel (%)		10	30
Cowering the botoom with algae	(scale 1-6)	2	3

1.4.3 Physical and chemical elements supporting the biological elements

Table 14: General physical and chemical conditions of upper and lower stream of Kokra River (Izvajanje monitoringa za..., 2010).

Date: 22.8.2008		VM Jablanca	VM Kranj
pH		7,86	8,27
T	°C	10,5	15,6
Conductivity	µS/cm	322	330
Concentration of O_2	mg/l	8,4	8,84
Saturation of O_2	%	78,6	93
BPK_5	Estimation*	ZD	D
	Confidence level**	Middle	Middle
Nitrate	Estimation*	D	ZD
	Confidence level**	Low	Low

*-five classes: ZD (very good), D (good), Z (moderate), S (bad), ZS (very bad)
**-three classes: high, middle, low

Kokra River is an alpine stream with low contribution of organic masses, which is a result of relatively poor and dispersed colonization in upper part of stream. The results in Table 14 show a relatively good momentary situation in nutritions (BPK_5 and nitrate). The stream is well saturated with air. The increased pH on sample site Kranj is probably due to prevailing of carbonate grounds.

Tables 15 and 16 show physical and chemical factors and microelements of upper and lower stream of Kokra River during year 2008. The first sample site in upper stream was sampled four times a year, and the second sample site was sampled twelve times a year.

Table 15: Physical and chemical factors and microelements in upper stream of Kokra River (sample site Jablanca) during year 2008 (Environmental Agency of the Republic of Slovenia, 2010).

Jablanca, 2008		Feb.	May	Aug.	Nov.
Water level	cm	/	/	/	/
Air temperature	°C	5	14	16	10
Water temperature	°C	3,8	7,7	11,8	7,9
pH		8,6	8	8,4	8,3
Conductivity	µS/cm	319	310	318	316
Oxygen	mg/l	12,9	10,2	10,1	11,4
Saturation of oxygen	%	98	85	94	96
Suspended solids after drying	mg/l	<2	<2	<2	<2
m-alkalinity	m-eqv/l	3	2,9	3	3
Total hardness	°NT	9,8	9,8	9,9	9,3
Carbonate hardness	°NT	8,3	8,2	8,5	8,4
Nitrites	mg NO2/l	<0,008	<0,008	0,021	<0,008
Nitrates	mg NO3/l	3,18	3,19	2,93	3,21

Amonium	mg NH4/l	/	/	/	/
Total nitrogen TN	mg N/l	0,99	0,96	0,81	0,64
Orthophosphates	mg PO4/l	<0,015	<0,015	<0,015	<0,015
Total phosphorus-unfiltered	mg PO4/l	<0,04	<0,04	<0,04	<0,04
chlorides	mg/l	1,81	1,83	1,5	1,42
fluorides	mg/l	/	/	/	/
sulphates	mg/l	19,7	18,6	19,2	17,8
magnesium	mg/l	13	13	13	12
calcium	mg/l	49	49	49	47
Sodium	mg/l	1,9	1,7	1,6	1,5
potassium	mg/l	0,37	0,33	0,39	0,37
anioactives detergents	mg MBAS/l	/	/	/	/
mineral oils	mg/l	/	/	/	/
KPK s K2Cr2O7	mg O2/l	<5	<5	<5	<5
BPK_5	mg O2/l	<1,4	<1,5	<1,6	<1,7
TOC	mgC/l	0,53	0,57	0,62	0,68
Microelements					
Cooper-filt.	µg/l	0,13	0,52	0,15	<0,056
Zinc-filt.	µg/l	0,88	0,68	0,78	0,4
Cadmium-filt.	µg/l	<0,006	0,03	0,03	<0,006
Chromium-filt.	µg/l	0,13	0,3	0,24	0,11
Nickel-filt.	µg/l	0,83	<0,013	0,35	0,05
Lead-filt.	µg/l	0,13	0,11	<0,012	<0,013
Mercury-filt.	µg/l	0,0002	0,00033	0,00015	0,0004
Arsenic-filt.	µg/l	0,12	0,16	0,16	<0,012
Antimony-filt.	µg/l	0,16	0,16	0,16	<0,009
Boron-filt.	µg/l	/	/	/	/
Cobalt-filt.	µg/l	0,07	0,08	0,12	<0,005
Molybdenum-filt.	µg/l	0,94	0,46	0,55	0,29
Selenium-filt.	µg/l	<0,072	0,08	0,15	<0,072

General physical nad ecological conditions in Kokra River shows a good ecological status with low confidence level (Cvitanič et al. 2010).

Tabela 16: Physical and chemical factors and microelements in lower stream of Kokra River (sample site Kranj) during year 2008 (Environmental Agency of the Republic of Slovenia, 2010).

Kranj		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Water level	cm	87	74	/	80	78	84	/	72	72	72	82	100
Air temperature	°C	/	6	/	/	16	/	/	18	/	/	10	/
Water temperature	°C	/	3,3	/	/	10,5	/	/	14,9	/	/	8,3	/
pH		/	8,5	/	/	7,8	/	/	8,2	/	/	8,1	/
Conductivity	µS/cm	/	353	/	/	328	/	/	345	/	/	348	/
Oxygen	mg/l	/	13,3	/	/	10,8	/	/	9,9	/	/	11,5	/
Saturation of oxygen	%	/	99	/	/	97	/	/	98	/	/	98	/
Suspended solids after drying	mg/l	/	<0,2	/	/	<2	/	/	<2,0	/	/	<2	/
m-alkalinity	m-eqv/l	/	3,4	/	/	3,2	/	/	3,3	/	/	3,4	/
Total hardness	°NT	/	11,2	/	/	10	/	/	10,9	/	/	10,3	/
Carbonate hardness	°NT	/	9,4	/	/	8,9	/	/	9,4	/	/	9,5	/
Nitrites	mg NO2/l	/	0,015	/	/	0,015	/	/	0,072	/	/	0,015	/
Nitrates	mg NO3/l	/	4,24	/	/	3,95	/	/	4,68	/	/	4	/
Amonium	mg NH4/l	/	0,022	/	/	0,024	/	/	0,048	/	/	<0,02	/
Total nitrogen TN	mg N/l	/	1	/	/	0,8	/	/	1,8	/	/	0,83	/
Orthophosphates	mg PO4/l	/	0,017	/	/	<0,015	/	/	0,051	/	/	<0,015	/
Total phosphorus-unfiltered	mg PO4/l	/	0,04	/	/	0,049	/	/	0,1	/	/	0,052	/
chlorides	mg/l	/	3,06	/	/	2,3	/	/	2,83	/	/	2,27	/
fluorides	mg/l	/	/	/	/	/	/	/	/	/	/	/	/
sulphates	mg/l	/	15	/	/	15,2	/	/	15,4	/	/	14,6	/
magnesium	mg/l	/	14	/	/	13	/	/	14	/	/	13	/
calcium	mg/l	/	57	/	/	50	/	/	55	/	/	52	/
sodium	mg/l	/	2,8	/	/	2,1	/	/	2,3	/	/	2	/
potassium	mg/l	/	0,6	/	/	0,51	/	/	0,72	/	/	0,6	/
anioactives detergents	mg MBAS/l	/	<0,05	/	/	<0,05	/	/	<0,05	/	/	<0,05	/
mineral oils	mg/l	/	<0,005	/	/	<0,005	/	/	<0,005	/	/	<0,005	/
KPK s K2Cr2O7	mg O2/l	/	<5	/	/	<5	/	/	<5	/	/	<5	/
BPK_5	mg O2/l	/	<1,4	/	/	<1,4	/	/	<1,4	/	/	<1,4	/
TOC	mgC/l	/	0,83	/	/	0,84	/	/	1	/	/	1,07	/
Microelements													
Cooper-filt.	µg/l	1,35	0,4	0,52	1,4	0,66	<0,056	0,3	0,32	0,32	0,27	0,09	<0,056
Zinc-filt.	µg/l	0,38	0,82	0,52	1,25	0,31	0,64	<0,117	0,72	0,29	<0,117	0,4	0,26
Cadmium-filt.	µg/l	<0,006	<0,006	<0,006	<0,006	<0,006	0,09	<0,006	0,01	<0,006	<0,006	<0,006	0,01
Chromium-filt.	µg/l	0,14	0,13	0,37	0,18	0,33	0,23	0,38	0,29	0,38	0,32	0,06	0,28
Nickel-filt.	µg/l	0,61	1,01	0,57	0,25	<0,013	0,28	0,25	0,45	0,38	0,24	0,14	0,48
Lead-filt.	µg/l	<0,012	0,16	<0,012	0,1	0,12	0,06	<0,012	<0,012	0,03	<0,012	<0,012	0,02
Mercury-filt.	µg/l	0,0004	0,0003	0,0008	0,0006	0,0002	0,0003	0,0008	0,0002	0,0004	0,0003	0,0004	0,0006

Arsenic-filt.	µg/l	0,18	0,13	0,13	0,27	0,2	0,24	0,11	0,29	0,28	0,24	0,03	0,24
Antimony-filt.	µg/l	0,07	0,12	0,08	0,15	0,15	0,11	0,03	0,14	0,18	0,19	<0,009	0,12
Boron-filt.	µg/l	/	/	/	/	/	/	/	/	/	/	/	/
Cobalt-filt.	µg/l	0,05	0,09	0,03	0,04	0,09	0,19	0,01	0,15	0,12	0,11	<0,005	0,1
Molybdenum-filt.	µg/l	0,3	0,73	0,33	0,41	0,41	0,37	0,25	0,43	0,58	0,69	0,17	0,28
Selenium-filt.	µg/l	<0,072	<0,073	<0,074	<0,075	0,08	<0,072	<0,072	0,12	<0,072	<0,072	<0,072	0,08
Pollutants													
Cyanides (total)	mg CN/l	/	<0,02	/	/	<0,02	/	/	<0,02	/	<0,02	/	/

Lower stream of Kokra River belongs to moderate ecological status with low confidence level.

Contents of specific pollutants in the Kokra River are shown in Table 17. Specific pollutants are taken from the monitoring carried out by Environmental Agency of the Republic of Slovenia. In 2009 there were only one sample site in lower stream of Kokra River included in monitoring.

The list of specific pollutants, which have been considered for measurement is taken from the national list of relevant material which has been prepared under the target research project for the development of environmental standards for chemical substances in the aquatic environment. Included are only those pollutants which are discharged into water bodies in significant quantities.

In Table 17 we can see that all the measured pollutants are below the detection limit.

Table 17: Specific pollutants (pesticides and metabolits) in lower stream of Kokra River (sample site Kranj) (Environmental Agency of the Republic of Slovenia, 2009).

		7.4.2009	11.5.2009	10.6.2009	6.7.2009	10.8.2009
Alaklor	µg/l	<0,042	<0,007	<0,007	<0,007	<0,007
Metolaklor	µg/l	<0,029	<0,011	<0,011	<0,011	<0,011
Paration-etil	µg/l	<0,008	<0,008	<0,008	<0,008	<0,008
Paration-metil	µg/l	<0,001	<0,001	<0,001	<0,001	<0,001
Atrazin	µg/l	<0,009	<0,009	<0,009	<0,009	<0,009
Desetil-atrazin	µg/l	<0,004	<0,004	<0,004	<0,004	<0,004
Desizopropil-atrazin	µg/l	<0,04	<0,04	<0,04	<0,04	<0,04
Simazin	µg/l	<0,02	<0,009	<0,009	<0,009	<0,009
Propazin	µg/l	<0,037	<0,009	<0,009	<0,009	<0,009
Prometrin	µg/l	<0,05	<0,01	<0,01	<0,01	<0,01
Cianazin	µg/l	<0,049	<0,009	<0,009	<0,009	<0,009
Terbutilazin	µg/l	<0,025	<0,015	<0,015	<0,015	<0,015
Terbutrin	µg/l	<0,05	<0,013	<0,013	<0,013	<0,013
Sekbumeton	µg/l	<0,024	<0,008	<0,008	<0,008	<0,008
Heksazinon	µg/l	<0,016	<0,013	<0,013	<0,013	<0,013
Triadimefon	µg/l	<0,003	<0,003	<0,003	<0,003	<0,003
Propikonazol	µg/l	<0,002	<0,002	<0,002	<0,002	<0,002
Diklobenil	µg/l	<0,05	<0,05	<0,05	<0,05	<0,05
2,6-diklorobenzamid	µg/l	<0,006	<0,006	<0,006	<0,006	<0,006
Pendimetalin	µg/l	<0,001	<0,001	<0,001	<0,001	<0,001
Trifluralin	µg/l	<0,05	<0,05	<0,05	<0,05	<0,05
Metazaklor	µg/l	<0,051	<0,008	<0,008	<0,008	<0,008
Acetoklor	µg/l	<0,032	<0,007	<0,007	<0,007	<0,007
Dimetenamid	µg/l	<0,001	<0,001	<0,001	<0,001	<0,001
Napropamid	µg/l	<0,017	<0,01	<0,01	<0,01	<0,01
Prosimidon	µg/l	<0,007	<0,007	<0,007	<0,007	<0,007
Vinklozolin	µg/l	<0,05	<0,05	<0,05	<0,05	<0,05
Folpet	µg/l	<0,05	<0,05	<0,05	<0,05	<0,05
Diazinon	µg/l	<0,002	<0,002	0,002	<0,002	<0,002
Kaptan	µg/l	<0,05	<0,05	<0,05	<0,05	<0,05
Diklofluanid	µg/l	<0,02	<0,02	<0,02	<0,02	<0,02
Klorbenzilat	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01
Brompropilat	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01
Azoksistrobin	µg/l	<0,002	<0,002	<0,002	<0,002	<0,002
Tetradifon	µg/l	<0,05	<0,05	<0,05	<0,05	<0,05
Pirimikarb	µg/l	<0,009	<0,009	<0,009	<0,009	<0,009
Malation	µg/l	<0,006	<0,006	<0,006	<0,006	<0,006
Fenitrotion	µg/l	<0,002	<0,002	<0,002	<0,002	<0,002
Fention	µg/l	<0,002	<0,002	<0,002	<0,002	<0,002
Klorfenvinfos	µg/l	<0,002	<0,002	<0,002	<0,002	<0,002
Klorpirifos etil	µg/l	<0,002	<0,002	<0,002	<0,002	<0,002
Klorpirifos metil	µg/l	<0,003	<0,003	<0,003	<0,003	<0,003
Mevinfos	µg/l	<0,002	<0,002	<0,002	<0,002	<0,002
Diklorfos	µg/l	<0,003	<0,003	<0,003	<0,003	<0,003
Ometoat	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1
Dimetoat	µg/l	<0,001	0,001	<0,001	<0,001	<0,001

1.5 Water framework directive typology

A HER typology defines a system of ecological regionalization with use of borders of ecoregions accordint to Illies with application of the mandatory factors for surface water: altitude, catchment size surface and geology. A system is easy to apply, but to a given limited range factors allow only limited accuracy of the observed variables in the reference conditions.

For definition of types of water bodies in Slovenia System B was applied. Table 18 shows the used descriptors and classes for Danube basin water region of Slovenia, where hydroecoregions are presented on Figure 13.

Table 18: Descriptors and their classes for descripton of types of water bodies (Ministry of the Environment and Spatial Planing, 2005).

Hydroecoregion	3 - River Po lowland (Italy by Illies)
	4 - Alps
	5 – Dinarids (Dinaric West Balkan by Illies)
	11 – Panonian lowland (Hungarian lowland by Illies)
Catchment size	M – up to 10 km2
	SM – 10 to 100 km2
	S – 100 – 1000 km2
	SV – 1000 – 10000 km2
	V – more then 10000 km2
Major geology of catchment	A – limestone (carbonates)
	S - silicates
	F – flysch

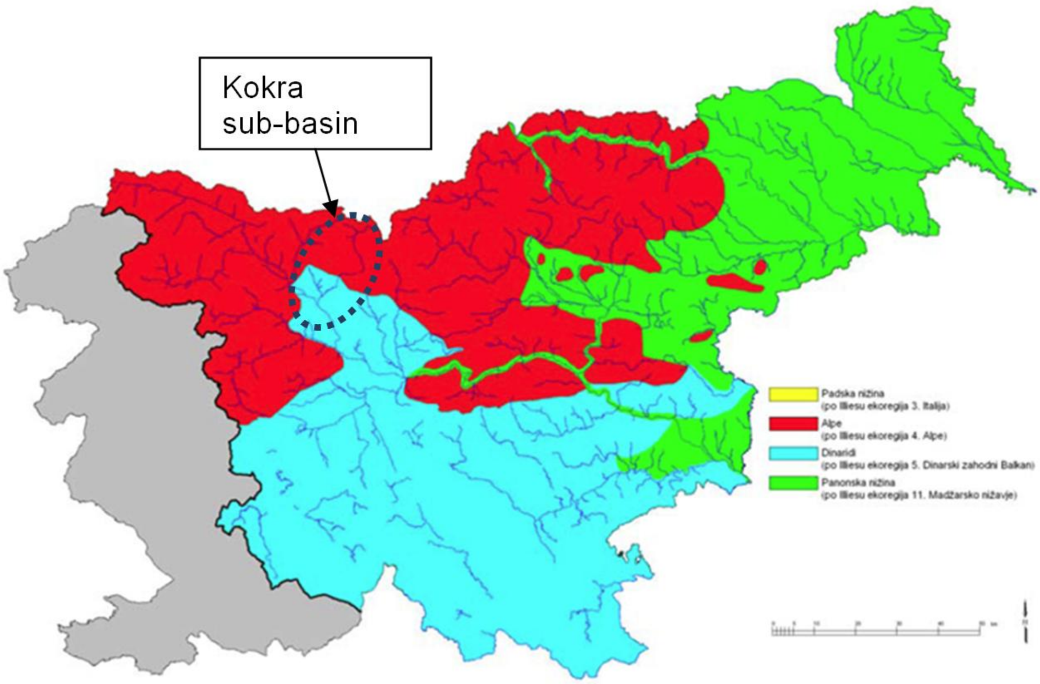

Figure 13: Inland water ecoregions in Slovenia – Danube basin – hydroecoregions in Slovenia

In Slovenian region of Danube basin there were 17 types of water bodies of rivers defined. Kokra sub-basin is divided into two types:

- **4SA**: Alps, 100 – 1000 km2, limestone (carbonates) and
- **5SA**: Dinarids, 100 – 1000 km2, limestone (carbonates)

For further definition of water bodies according to the WFD implementation next criteria were applied:

- Integration of catchments smaller then 10 km2 in size
- At first stage rivers with catchment size more then 100 km2 were defined as independent water bodies. This rivers were defined as main rivers of water region of Danube basin.
- Rivers or their parts, which are not defined as main rivers, are integrated with independent water bodies (as their tributaries), if their condition not significantly differs of that independent water body
- Borders between independent water bodies on main rivers are defined on the basis:
  - Of type based on System B
  - Of natural hydromorphological phenomena (natural drainage, changes of river bottom, slope etc.)
  - Antropoghenic physical changes
  - Significant change of water status (defined on the basis of chemical status, monitoring of biological parameters and on the basis of load data)

Next figure shows final definition of 110 water bodies on Danube basin water region in Slovenia, where in Kokra sub-basin two water bodies are defined:

- **SI116VT5 Kokra VT Kokra Jezersko – Preddvor**
- **SI116VT7 Kokra VT Kokra Preddvor – Kranj.**

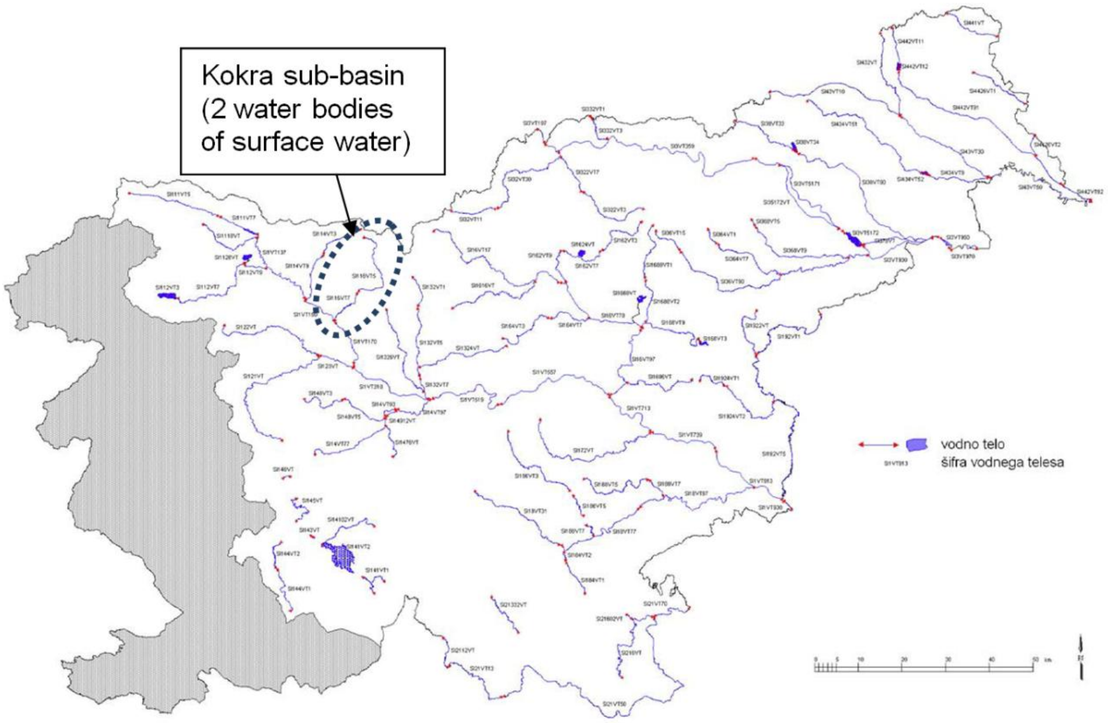

Figure 14: Water bodies of surface water in Danube basin water region

2 Plans and management programs

2.1 Regional energy plans

In the years 2007 to 2013 under the Regional Energy Projects runs projects for district heating with biomass on Jezersko and upgrade of the district heating system in the municipality Preddvor. They will contribute to the sustainable management of forests and the integration of renewable energy sources. Elektro Gorenjska, in the efficient use of electricity runs a project for co-generation of heat and electricity in Kranj for their own needs.

Local energy concept of municipality Kranj has been adopted in 03.17.2008 and it provides mainly analysis of the existent situation. After 2009 they started in accordance with the energy policy of the municipality to implement co-financing the energy efficiency and renewable energy sources that were undertaken by private individuals. In addition, they are carrieng out energy renovation of public facilities, which includes also the capital of the private sector (Local Energy concept ..., 2008).

At an airport Brnik is projected a construction of a trade business zone, resulting in electricity consumption will increase significantly. Due to this fact at an airport Brnik will be built a new 110/20 kV RTP Brnik. SN network will therefore be adjusted according to this new supply point and the need for new electricity supply to new needs for electricity because this new feeder area will comprise the entire municipality of Cerklje na Gorenjskem, Jezersko, Šenčur and a part of Preddvor. Number of changes on the network SN, will be related to the construction of municipal infrastructure, which is mainly to replace overhead line connections with cable conduit. High consumption of electricity is recorded in the ski area Krvavec, which plans are still growing in the future depending on their development (thanks to new lifts, extension of snowing up etc.). This also means an increase in electricity demand. For the purposes of 110/20 kV RTP Brnik will be built and new 110 kV connection. Part of this relationship from RTP 110/20 kV Primskovo to Visoko is already built. A link from here to Kamnik a link still need so be built in the future. Into this will be incorporated the new 110/20 kV RTP Brnik, which will have through RTP 110/20 kV Primskovo and RTP 110/20 kV Kamnik bilaterally loading (Energy concept of the municipality Cerklje..., 2008).

2.2 Forest management plan (Management Unit Kokra 2001-2010)

Forest management plan of the Management Unit (MU) Kokra was made in 2000 for the period 2001-2010. In 2011 is expected a new plan of management. Due to the high slopes, high proportion of forest in the upper forest border, and major threats of steep mountain streams prevails the protective function of the forest. The first step of this function is present in 41% of the total MU Kokra area. The area of Čemšenik represent hydrological function, where are the main water catchment for the city of Kranj. The lack of density in the MU Kokra means quite well preserved nature in biological sense, since it contains the occurrence of rare species (capercaillie, grouse). Due to the research and biotope function are in MU Kokra eliminated the two forest reserves. Viševski Hrib Reserve is excluded due to the preserved forest on the upper forest limit and reserve Hude stene is interesting especially after black pine. Recently, however, the force acquire tourist, recreational and hunting-economical function.

2.3 Protected areas managing plans of Kokra River basin

Kokra River basin falls in Karavanško-Kamniško-Savinjski Regional park. Kokra River with tributaires and waterfalls are protected as nature worth, black alder grove in Tenetiše (PUP Dobrave, 1991), stream Milka (PUP Dobrave, 1991) and areas of natural heritage in the village Žablje (PUP Dobrava, 1991). Nature reservs and natural monuments are shown in Figure 15.

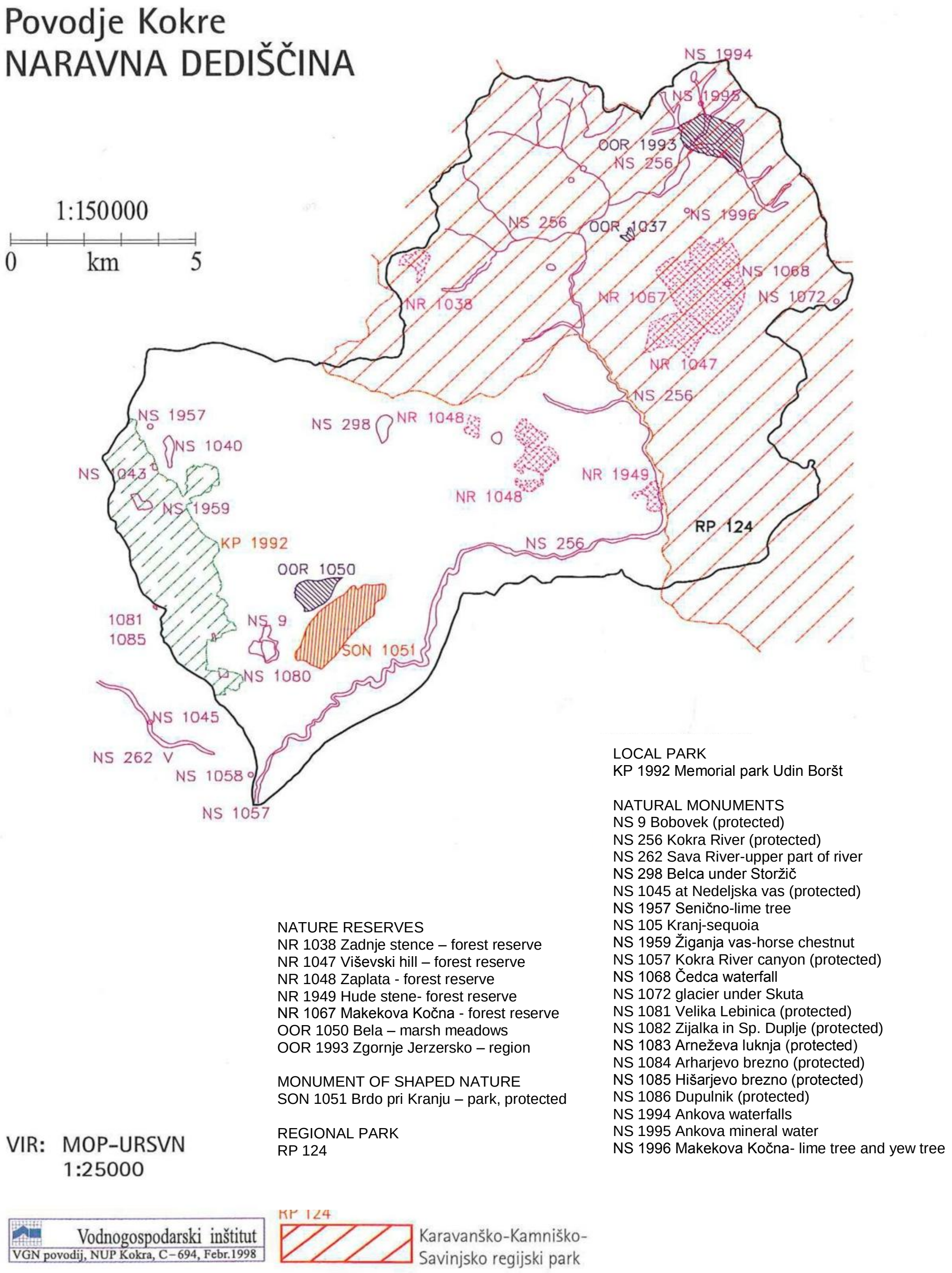

Figure 15: Nature reserves and natural monuments of Kokra River basin (Globevnik et al. 1998)

The Kokra River basin contains more natural heritage sites, some of which are secured by decrees. As the botanical, zoological and palaeontological heritage are protected clay-digging Bobovek Lakes (Uradni vestnik Gorenjske, 9/81). Kokra Canyon in the lower part (of the bridge, which crosses the Oldhamska Street to the outflow) is protected under the old town of Kranj (Uradni vestnik Gorenjske, 19/83). The broad area of Udin Boršt is also protected (Uradni vestnik Gorenjske 20/85). As a forest reserve are protected also the following areas: Zadnje stence, Viševski hrib, Zaplata, Hude stene in Makekova Kočna. The long-term plan of the city of Kranj 1996 - 2000 defined also a forest buffer area (Čemšenik, Zg. Jezersko, over Preddvor, near Golnik, Brdo, lowland forests surrounding the city of Kranj), which have a protected status (Globevnik et al. 1998)

Area of Bobovek

Clay-digging lakes of Bobovek were in 1981 announced as natura momentum. They contained over 140 bird and mammal species. The ecosystem iss threatened by fishing, bathing, touristic arrangements, burnings and reed and bushes removing. Input of numerous hounting species for sport fishing increases the eutrophication of water. Input of alohtones fish species specially grass carp and sun perch destroyed much of the aquatic vegetation.

The canyon of Kokra River

The Canyon of Kokra River in the lower part (of the bridge, which crosses the river Oldhamska street, to the outflow) is protected under the old town of Kranj (Uradni vestnik Gorenjske 19/83), other part of canyon is proposed for protection. Settlement to the edge, draining storm waters (local concentration), wastes of cesspit water, the dynamic load (during the construction, traffic...) and too fast withdrawals and drops in accumulation water levels threaten the stability of canyon. This threatens many lives and property. Slips of material changes the hydrodynamic conditions in the longer segment and thus indirectly causing new erosion processes.

Kokra River

Kokra River from springs to outflow in Sava River is defined a the natural worth (Ur. l. RS 111/2004) as the complex structure of the natural heritage (canyons with boulders in the middle stream, gravel pits, pools, a deep canyon in conglomerates at urban areas). Effects of activities are indirect and direct. Direct effect can be unappropriate infrastructure in riparian zone, changing the bed-load discharge (withdrawals and stopping gravel weight), intense tourist activity, waste disposal, inadequate logging in riparian vegetation and water deprivations. Indirectly, it is threatened by wetland drainage, reinforcement areas (settlements, roads, industrial sites), the unregulated drainage and inadequate municipal water management in agricultural and forested area.

Waterfalls, glaciers, streams with wetlands

Physical interventions in the area of the waterfalls are not acceptable, it is also difficult to acceptable construction of buildings in the impact area of waterfalls and the introduction of monocultures. Intensification of land use for agriculture and settlement requires regulation, consolidation of slopes and drainage of wetlands, thereby destroying the river habitat, primarily bank erosion, gravel and flood meadows, all extremely important nature conservation habitats.

Udin boršt

Udin Boršt area (Protected Natural Heritage, Uradni vestnik Gorenjske, 20/85) is an important water catchment area for Parovnica - Kokrica River with many springs, water caves and water wells. Karst phenomena destruction, deforestation, cultivation of spruce monocultures, waste disposal, the spread of forest roads, fish farming and other non-regulated activities have a negative impact on the hydrological regime of water and water quality.

Forest Reserves

The forest policy has provided a buffer and protection regime in the management of forest reserves. Interventions are carefully planned. Threat by inappropriate interventions in the hinterland of the reserves. The reserves in Kokra River basin are shown in figure 15. An area that is particularly interesting for the MCA test, we find a forest reserve Hude stene. This steep slope is protected and interesting mainly because of thermophilic pine habitat.

Endangered species of mosses, ferns and seedlings of red list of Slovenia, which are found in the Kokra River basin are shown in Table 19.

Table 19: Threatened species of mosses and phanerograms in Kokra River basin (Globevnik et al. 1998).

	Latin name	Threat level	Type of biotopes	Location
	Blindia acuta	R	Rocks	Kokra River valley
	Coscinodon cribrosus	R	Non-carbonate soils	Kokra River valley
	Mielichoferria milichhofer	E	Cracks in silicate rocks	Kokra River valley
	Scopelophyla ligulata	E	Silicate rocks	Kokra River valley
	Rhabdoweisia crispata	R	Silicate screes	Kokra River valley-Leskovec
	Bryum elegans	R	Screes	Grintovec
Bryophyta	*Andraea rupestreis*	R	Silicate rocks	Javorniško sedlo behind Storžič
	Tortella densa	R	dry soil in carbonate bedrock	Kočna
	Physcomitrium pyriforme	V	Humid nutritional soils	Možjanca
	Myurella tenerrima	R	Rocks	Suha at Preddvoru
	Dicranum tauricum	R	Forests	at Kranju
	Dicranella palustris	V	Humid soils	at Olševek near Kranj
	Amblystegium humile	V	Alder forests	Stagne pri Olševku
	Saxifraga mutata	R	rocky cracks in the mountain and subalpine belt	Kokra River valley
	Pedicularis palustris	V	Transitional swamps	Kranj, Zg. Jezersko
	Nigritella lithopolitanica	R, E	Subalpine and alpine grasses	Krvavec
	Diphasium issleri	R	Coniferous forests	Suha/Kranj
	Drosera rotundifolia	V	Peat bogs	Udin boršt
Spermatophyta	*Crepis bocconi*	R	Subalpine rocky grasses	Zaplata
	Gentiana froelichii	Nt, e	Subalpine grasses, rocky cracks	Baba, Dolga njiva, Kalški graben, Kočna, Veliki Zvoh, Zaplata, Zaplata-Sr.vrh, Škarje-Baba
	Allium kermesinum	Nt, e	Subalpine grasses	Bašeljski vrh, Kalški greben, Veliki Zvoh
	Festuca laxa	Nt, e	Subalpine grasses	Baba, Kalški graben

Legend: R-rare, E-threatened, V-vulnerable, Nt-unendangered, E-endemic

Kokra River basin falls within the Natura 2000. The prevalence of this area is shown in the figure 16. SCI area means an area which is confirmed by the European Commission. SPA area means Special Protected Area which is a particularly important area for birds live, which are subject to special protection regimes. Often, the SCI and SPA areas overlap. Those areas adjactent to Kokra River are presented in Table 20.

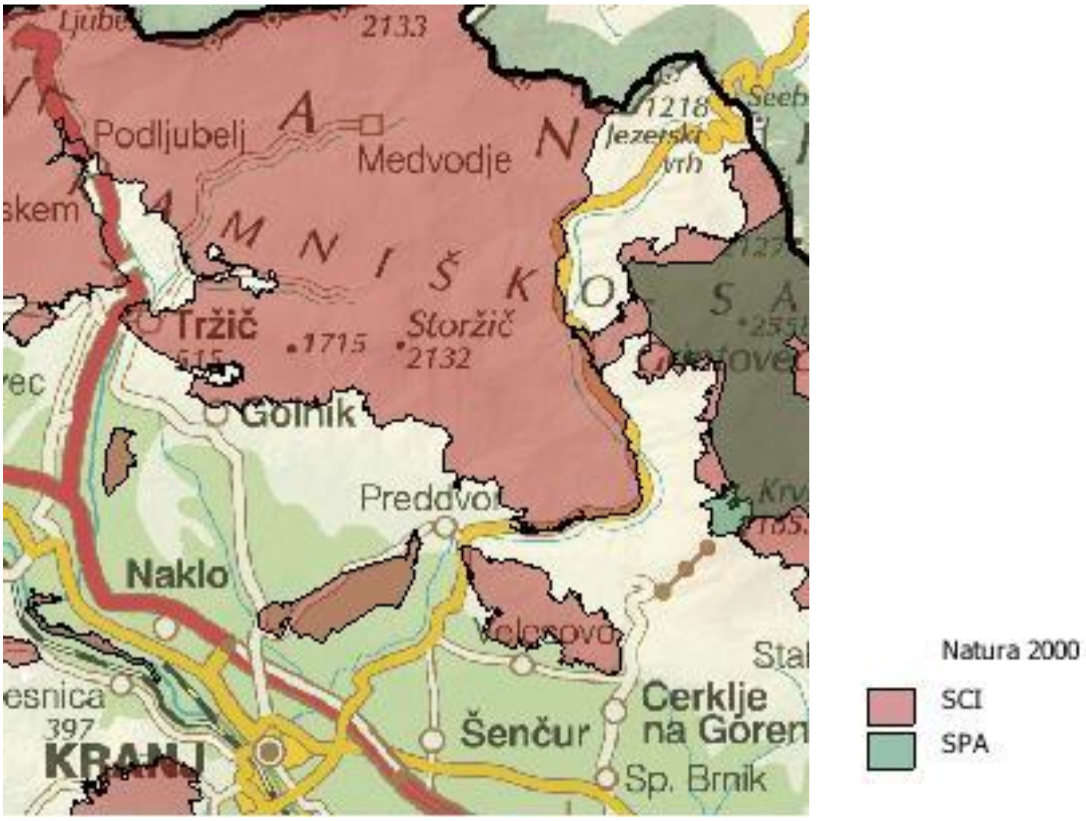

Figure 16: Area of Natura 2000 of Kokra River basin (http://gis.arso.gov.si/ atlasokolja/profile.aspx?id=Atlas_Okolja_AXL@Arso).

Table 20: Regions of Natura 2000 on Kokra River basin with the most important plant and animal species (Ur. l. RS 49/2004).

	Species	Type of habitate
SI3000219 Brdo castle-Preddvor	*Rhinolophus hipposideros* *Lycaena dispar* *Vertigo angustior*	
SI3000101 Forest Olševek-Adergas	*Cordulegaster heros*	
SI3000264* Kamniško-Savinjske Alps	*Gladiolus palustris* *Campanula zoysii* *Cypripedium calceolus* *Aquilegia bertolonii* *Mannia triandra* *Elaphe quatuorlineata*	(9410) Acidophilic spruce forests from montane to alpine zone (*Vaccinio-Piceetea*) (91R0) Dinaric forests of red pine on dolomite (*Genisto januensis-Pinetum*) (91K0) Iliric beech forests (*Fagus sylvatica* (*Aremonio-Fagion*)) (91E0*) Riparian willow, alder and ash (soft-wooded meadow); (*Alnus glutinosa* in *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)) (8310) Caves which are not public opened (8210) Calcareous rocky slopes with vegetation on rock crevices (8160*) Central European calcareous scree in submontane and montane zone(8120) (*Thlaspietea*

	rotundifolii) (6520) Mountain extensive meadows (6170) Alpine and subalpine calcareous grasslands (4070 *) Bushes with *Pinus mugo* and *Rhododendron hirsutum* (*Mugo-Rhododendretum hirsuta*) (4060) Alpine and boreal heaths (3240) Alpine rivers and their ligneous vegetation with black willow (*Salix eleagnos*) along their banks (3220) Alpine rivers and the herbaceous vegetation along their banks

*-priority type of habitate or priority area

It is important to stress that Kokra sub-basin is "burden" with many nature protection regimes which harmonization with RES objectives will be a difficult and time consuming task (Figure 17).

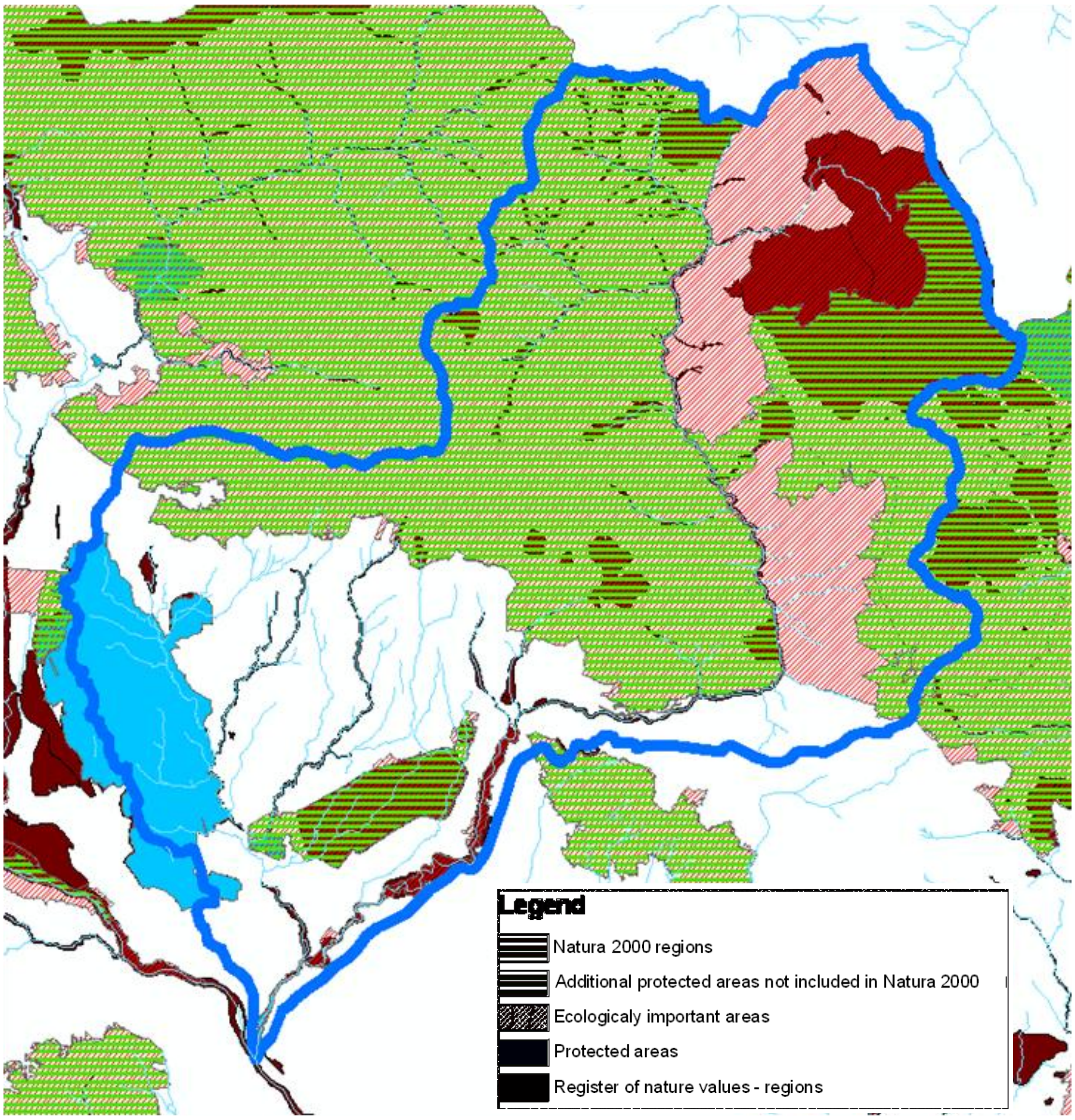

Figure 17: Kokra River sub-basin (blue line) covered by nature protection regimes.

2.4 Hydrogeological risk management plans of Kokra River basin

Aquatic and riparian zones depends largely on the method of managing the water regime in the past and land use throughout the hinterland. Measures of protection against the harmful effects of water, regulating off regime due to urbanization, construction of infrastructure and intensification of agricultural activities are those elements which can help a rough estimate of the aquatic and riparian zones in relation to other river basins. On the Kokra river was conducted relatively few measures of protection against adverse effects of high water, compared with its neighbour Kamniška Bistrica River, which fully regulated in flat areas. Similar considerations apply to Tržiška Bistrica River. This, despite the shorter stream Kokra River, has more artificial protections. This fact is actually a superiority of Kokra River in a extremely active erosion landscape. The reason for the relative humble performance is the morphology of the shoreline, which do not leaves a large disposals of the channel and its distance from the fertile landscape, where settlements are located. Kokra River reflected in the still largely natural character of the channel. The exception is the regulation between Tupaliče and Visoko and regulation of some gravel areas. Hydrobiological continuum is interrupted in the area of small hydropower and large dams. Aquatic and riparian zones are by comparison to other river basin in neighbourhood more natural (Globevnik et al. 1998).

2.5 Kokra river regulation plan

Environmental sensibility study arose as a result of regulation of the Law on Nature Protection (Ur. l. RS 32/93). Potential impacts on operations are simulated on the level of sensitivity over the river and surrounding areas to interventions that alter the water regime and ground water vulnerability (Globevnik et al. 1998).

2.5.1 Estimation of water sensibility

The design procedures of water management have so far implemented only the activities related to mapping vulnerability (fragility) of groundwater. The natural characteristics of the rock/aquifer map gived threats (vulnerability) of water in the aquifers from contamination. For each category of risk are then made recommendations of activities, performance and security standards. Water management plan in the Kokra River supposed that aquatic environment means water as the most important environmental factor comprising nonliving and living component (biotopes and bicenoze). It is a broader term than the aquatic ecosystem, since it includes many aquatic ecosystems (rivers, lakes, groundwater) as well as smaller units (spring, wetland, ponds,...). Before any major interventions should be made more accurate assessment of changes in the wider or narrower or bypass water space (Globevnik et al. 1998).

2.5.2 Sensibility of ground water

Vulnerability of aquifers (Table 21) is made in accordance with the Regulations on the protection of underground water and groundwater and the Methodology for determination of protected areas and in accordance with the guidelines and general practice in the protection of groundwater EC (European Commission) and Directive 80/68/EEC.

The basis of the vulnerability concept is to reduce the risk of groundwater contamination due to certain activities in a location due to the given hydrogeological, hydrological and soil conditions. The concept of risk and vulnerability of groundwater based on the assumption that no rock is not completely waterproof, and no dangerous substance is not fully inmobile. Danger or threat from potential contamination depends on the types of activities and the exposure below the adjacent ground to hazardous substances.

Groundwater is in aquifers as intergranular, karst, kart-craks, cracks porosity. Aquifers may be open or closed. Opened aquifers have free water level of groundwater, which oscillates freely. In open aquifers, the upper limit of the groundwater flows free, its adaptation to changes in air pressure is present. Closed aquifer from the upper and lower side is limited by the impermeable layer, the change of pressure in the aquifer layer has no influence on the water level so water level never falls below the upper limit of the aquifer.

The basic criteria for making vulnerability maps are:
- Classification of aquifers
- Restrictions on aquifers
- Determination of thickness, physical-chemical and hydrodynamic parameters of the unsaturated zone
- Determination of the thickness, physical-chemical and biological properties of sand, clay and shell covers.

Considering the stoneware, which appear in the aquifer, type of porosity and specific hydrological base (level sources) to each aquifer was based on the available data set to assess the level of surface or groundwater. Thickness of unsaturated zones were defined on the basis of groundwater levels and topography. Groundwater vulnerability maps are shown with levels of risk aquifers, which are given in Table 21.

Table 21: Aquifers risk levels (Globevnik et al. 1998).

Risk level	Protective effect	Description	Recommended activity
1st	0 %	Highly vulnerable aquifers or parts of the aquifer (L=0). Open karsts aquifers and cracked aquifers –high speeds of flow (v>10m/day), where the groundwater flow is turbulent or karsts with runoff time <12 hours. Riparian zone of aquifer in contact with the streams at a distance of 5 days in water flow and in the zone of variable supply regime.	Interventions in the soil are not allowed, and only exceptionally and. Construction of new housing settlements is not recommended. Construction industry and trade is not recommended. Construction of municipal landfills is not allowed. These areas are not suitable for the development of intensive agriculture. Organic agriculture is recommended.
2nd	<50 %	Vulnerable aquifers or parts of the aquifer (0.5>L>0 for between grains and 0.25>L>0 for cracked aquifers). Open karsts aquifers and cracked aquifers –high speeds of flow (v>10m/day), where the groundwater flow is turbulent or karsts with runoff time >12 hours.	Interventions in the soil (>2m and wells) are allowed only exceptional. Construction of new housing settlements is recommended under very strict safeguards (impermeable capture and discharge of rainwater).

		Riparian zone of aquifer in contact with the streams at a distance of 5 to 25 days in water flow and in the zone of variable supply regime.	Construction industry and trade is not recommended. Construction of municipal landfills is not allowed. These areas are not suitable for the development of intensive agriculture. Organic agriculture is recommended.
3rd	>50 %	Medium vulnerable aquifers or parts of the aquifer (0.8>L>0.5 for between grains and 0.4>L>0.25 for cracked aquifers). Riparian zone of aquifer in contact with the streams at a distance of 25 to 40 days in water flow and in the zone of variable supply regime.	Construction of new housing settlements is recommended only under protectional hydro technical measures (impermeable canalization and discharge of rainwater). Only clean industry and trade is recommended. The limited use of plant protection products and fertilizers in agriculture.
4th	>80 %	Less vulnerable aquifers or parts of the aquifer (0.95>L>0.8 for between grains and 0.45>L>0.4 for cracked aquifers). Riparian zone of aquifer in contact with the streams at a distance of 40 to 47 days in water flow and in the zone of variable supply regime.	Regarding to the hydro safeguards these areas are suitable for the construction of housing settlements, industry and crafts. Construction of municipal landfills permitted only regarding to stringent safeguards. Areas suitable for agriculture.
5th	>95 %	Very little vulnerable aquifers or parts of the aquifer (1>L>0.95 for between grains and 0.5>L>0.45 for cracked aquifers). Riparian zone of aquifer in contact with the streams at a distance of 47 to 50 days in water flow and in the zone of variable supply regime.	Regarding to the hydro safeguards these areas are suitable for the construction of housing settlements, industry and crafts. Construction of municipal landfills permitted only regarding to stringent safeguards. Areas suitable for agriculture.
6th	100 %	Invulnerable aquifers or parts of the aquifer (L>1 for between grains and L>0.5 for cracked aquifers). Riparian zone of aquifer in contact with the streams at a distance of 47 to 50 days in water flow and in the zone of variable supply regime	Regarding to the hydro safeguards these areas are suitable for urban areas (settlements, industry and crafts, municipal landfills). Areas suitable for agriculture.
7th		Areas without aquifers	Regarding to the hydro safeguards these areas are suitable for urban areas (settlements, industry and crafts, municipal landfills). Areas suitable for agriculture.

L – protective function of the unprotected zone and the thickness and quality of the overlying strata (L = d1*l1+d2*l2+d3*l3 ; d = layer thickness, l = index of soil and rock)

2.5.3 Sensitivity of surface water

The sensitivity of surface waters is the ability of the aquatic environment to transmit / receive negative circumstances, where self-recover plays an important role, the ability to maintain or quick recovery to its original state. Vulnerability of surface water is defined as the sensitivity of the aquatic environment on interventions.

In definition is assumed that the aquatic environment contains:

a) a quantity of water (examination of the sensitivity of the hydrological characteristics of river basin)
b) a quality of water (examination of the sensitivity to physical and chemical properties of water)
c) aquatic and riparian area (examination of the sensitivity of the functioning of ecological components of aquatic and riparian areas, which is primarily sensitive to the change of hydrodynamic flow components).

Sensitivity analysis of the aquatic environment on interventions are carried out through ecosystem breakdown of the area. In this case is used the articulation of space on aquatic and riparian biotopes and those areas that are participating in the hydrodynamic phenomena (retention areas). Scope of the analysis are aquatic and riparian area and retention areas.

Sensitivity analysis of interventions is divided into:

a) study of the sensitivity of hydrodynamic (hydrological/hydromorphological components) characteristics of aquatic and riparian zones (hydrodynamics viability) on interventions
b) study of the sensitivity of water quality
c) study of the sensitivity of the aquatic ecosystem components and the surrounding areas to interventions (viability of ecosystems), particularly in terms of sensitivity to change in hydrodynamic components in the river basin.

The sensitivity analysis considers already achieved loads (woundattion) of the segment, the existing hydrodynamics (hydrology-, gravel-carry-, and erosion processes) and the actual ecological value of aquatic and riparian habitats. The general goal is the protection (conservation) of rich (complex, diverse in composition of species and communities) and exceptional (rare and very sensitive to changes in hydrodynamic processes) aquatic ecosystems, which play an important function in water use. Maintaining the water potential of the environment means the natural flow regime. If the aquatic ecosystem, which includes also riparian zone (protective zone, water purification function, denitrification, dephosphorization, degradation and binding of other chemical compounds), the function of settling tanks and reservoir of sediments, high water retention function and prevention of erosion, than is the ecosystem an important link in protecting the water regime. If the existence of a highly valued ecosystem largely depends on the hydrodynamic phenomena, then their vulnerability to interventions that alter the hydrodynamics is very high. Intense hydrodynamics zones and highly valued ecosystems are very vulnerable (sensitive) to any intervention, such as on-site and major interventions in the basin (reduced dynamics, the quantities of water depletion, pollution ...).

Regenerative capacity such an ecosystem could be significant when appropriate hydrodynamic conditions appears, but usually this does not happen. Poor hydrodynamic zones (artificial, reduced) are still highly valued ecosystems (with features to protect the aquatic environment) and are more sensitive.

Hydrodynamic and ecological evaluation of the surface water system based on group visits to the field, examining the processes and system stability. System is estimated through sections, which means functional integrity (or subsystem). Determining the use and implementation of activities should take into account both water and riparian sensitivity, while ensuring protection of human life and property (protection against flooding and urban infrastructure facilities, protection against erosion, ..).

Table 22 shows an estimation of hydrodynamic and ecological conditions of individual sections of the Kokra River. From this table Sensitivity of Kokra River on type A, B and C interventions, which is given in Table 23. In Table 24 are given warnings for interventions in water and riparian area of Kokra River.

Table 22: Estimation of hydrodynamic and ecological conditions of individual sections of the Kokra River (Globevnik et al. 1998).

Section	Criteria for determining the hydrodynamic characteristics				Criteria for determining ecologic characteristics		
	Gravel carry	relationship banks and buffer role of riparian vegetation	Erosion of banks and connection to retention area along riverbed	-Hydrological regime dynamics --water quality	Importance of water biotopes – riverbed agitation (gravels, pools, shoals, erosion crevices, rocks, overhangs,...)	Riparian vegetation development and the importance of aquatic biotopes and surrounding areas	Relationship between the hydrological and ecological processes
Outflow – SHP Standard	No	No correlation	No correlation	-minor -bad	Minor (inagitate)	Minor importance	Weak
SHP Standard – inflow of Kokrica	Material deposition	River in canyon, banks settled to margin, great dynamics	Erosion of banks due to mountain stream waters and interventions	-partially lowered -bad	Great	Great, different biotopes, characteristic vegetation, rare species	Strong
Confluence with Kokrica-SHP Oljarica Britof	Great- material deposition	Stays, important	Erosion of banks large, moderate retention	-partially lowered downstream from SHP, than bigger -lowered, downstrean from Oljarica bad	Great	Large value of vegetation and diverse habitats	Strong
SHP oljarica Britof – dam Oljarica	Great	Right bank overgrown, agitated, lethargy; right site of canyon degraded; left site in connected with hinterland (vegetation)- great importance	Left bank stabilized, right bank overgrown, agitated, lethargy – important retential area, filled up with material, erosion of banks	-very poorer (hydrobiological continuum disconnected) -lowered	Great	Moderate amount of vegetation and biotopes	Strong
Dam Oljarica – Predoslje	Great	steep hills, buildings in the upper edge of the bank; no larger buffer zones	Erosion in steep hills, retention in riverbed	-moderate -lowered	Moderate	Moderate to great importance of vegetation and biotopes	Moderate
Predoslje – bridge Visoko	Great	Partially canyon, large connection to banks, large buffer influence of vegetation	Erosion of banks, retention in meanders and canyon; connection good	-great -satisfying	Exceptional	Great –biotopes, vegetation	Very strong
Bridge Visoko – start of regulation	Great	Partially canyon, large connection to banks, large buffer influence of vegetation	Moderate erosion, retention in meanders in canyon	-great -satisfying	Exceptional	Great –biotopes, vegetation	Very strong
Start of regulation – bridge Hotemaže	Moderate, pointed, local gravels	Regulation, lower vegetation buffer role in banks (secondary riparian vegetation), significant residual of meadows	Regulated riverbed, erosion controlled, lowered retention role, reduced hyporeic zone	- moderate -satisfying	-moderate to great	Moderate, potential great at retention areas	Strong
Bridge Hotemaže – bridge Tupaliče	Moderate, pointed, local gravels	Regulation, significant residual of meadows	Controlled erosion , lowered retention role	- moderate -satisfying	-moderate to great	Moderate, potential great at former retention areas	Strong
Bridge Tupaliče – inflow of Suha	Moderate, pointed, local gravels	Regulation, significant residual of meadows	Erosion of right bank, lowered retention role	- moderate -lowered	-moderate to great	Moderate to great	Moderate
Inflow of Suha – release from channel Jelovica	Lowered	Regulated riverbed, high-water dyke, weak, but very important connection with riparian vegetation	Moderate erosion, lowered retention role	- moderate -lowered	-moderate to great	Moderate to great	Moderate
Release from channel Jelovica – dam in Preddvor	Lowered	Narrow band of riparian vegetation, important for bank security	Stabilized banks, important retention in riverbed	-lowered -lowered	-great	Moderate	Moderate
Dam Jelovica Preddvor – Potoče	Great- gravel pocket (depositing of large amounts)	Partially regulated –road, moderate influence of vegetation	Moderate erosion	-moderate to high -satisfying	-moderate	Moderate	Moderate
Potoče – Arnež	Great- alternation of transport and deposition	Steep hills, moderate influence of vegetation	Moderate erosion of of steep hills, large retention area at	-moderate to high -satisfying	-great	Great	Strong

	transects		Jablanca				
Arnež – cofluence of Kokra River and Jezernica	Great-alternating of stabile, transporting and forming sections	Direct connection to banks, important riparian vegetation	Lateral erosion, material removal, controlled dynamics with objects	-great -satisfying	-great	Great	Strong
Jezernica – quarry of tufa	Moderate	Moderate, lowered due to road	Lowered erosion	-moderate -satisfying	-moderate	Moderate to great	Strong
Quarry of tufa - Komatevra	Moderate	Direct connection	Strong erosion, clearing trees are dangerous	-great -satisfying	-moderate to great	Moderate	Strong

Grey-river portion specially interested by MCA test

Table 23: Sensitivity of Kokra River on type A, B in C interventions (Globevnik et al. 1998).

Sensitivity to interventions that affect the change of hydrodynamic conditions	Large changes the hydrodynamic conditions in long term (A type)	Partially changes hydrodynamic conditions of river stream (B type)	Minimal changes hydrodynamic conditions (C type)
Outflow –SHP Standard	Minor	Minor	Minor
SHP Standard –inflow of Kokrica	Very much	Much	Moderate
Confluence with Kokrica- SHP Oljarica Britof	Very much	Much	Moderate
SHP oljarica Britof – dam Oljarica	Very much	Very much	Very much
Dam Oljarica – Predoslje	Very much	Moderate	Moderate
Predoslje – bridge Visoko	Very much	Very much	Very much
Bridge Visoko – start of regulation	Very much	Very much	Very much
Start of regulation – bridge Hotemaže	Very much	Much	Moderate
Bridge Hotemaže – bridge Tupaliče	Very much	Much	Moderate
Bridge Tupaliče – inflow of Suha	Very much	Much	Moderate
Inflow of Suha – release from channel Jelovica	Very much	Much	Moderate
Release from channel Jelovica – dam in Preddvor	Much	Moderate	Moderate
Dam Jelovica Preddvor – Potoče	Much	Moderate	Minor
Potoče – Arnež	Much	Moderate	Minor
Arnež – cofluence of Kokra River and Jezernica	Much	Moderate	Minor
Jezernica – quarry of tufa	Much	Moderate	Minor
Quarry of tufa - Komatevra	Much	Much	Minor

Grey-river portion specially interested by MCA test

Type A interventions are those that means large, long-term changes in hydrodynamic conditions. It happens in the construction of reservoirs, major water withdrawals, total inflow sediment interruption, disconnection of hydrobiological continuum, the construction of major drainage systems in retention areas. Schematically be disclosed as:

Type A interventions:
- Increased agro reclamation of land by drainage or irrigation works on the bed or in the hinterland,
- Urbanization on the river bed,
- Urbanization of hinterland,
- Building reservoirs and reservoirs,
- Greater protection against gravel in the hinterland,
- Major water removals on the springs,
- Increased water withdrawals from the river,
- Construction of major hydraulic facilities
- Drying and interruppion of the constant link between the river chanel and retention areas, regulation of riverbeds (deepening, broadening, typing, regulation).

Type B interventions are those that partially alter the hydrodynamic conditions in the river bed:

- Physical interventions in discussing segment of the aquatic and riparian zones (scattered building, infrastructural facilities ...), fields cultivation up to the channel (surface erosion, bank erosion, pollution), minor water outages, minor changes in gravel discharge,...

- Restriction of water flow areas with large or several smaller buildings (bridges, the consolidations of banks, gravel deprivationscircuits of streams,...). In this category falls the construction of those longitudinal and transverse facilities, which both locational and functional does not correspond to hydrodynamic conditions (irregular shaped and dimensioned).

Type C interventions are those that do not means essential changes in hydrodynamics. This are sustainable implemented smaller interventions in discussing segment of the aquatic and riparian zones.

Table 24: Warnings for interventions in water and riparian area of Kokra River (Globevnik et al. 1998).

Sensitivity to interventions that affect the change of hydrodynamic conditions	Sensitivity to type B interventions	Warnings
Outflow –SHP Standard	Minor	Establish ecologically acceptable flow. Regular maintenance of facilities.
SHP Standard –inflow of Kokrica	Much	Extremely sensitive and conflict zone: a specific protection regime is necessary to establish, regarding to nature conditions.
Confluence with Kokrica- SHP Oljarica Britof	Much	Very popular recreational and attractive section Infrastructure charging. A significant part of the left embankment at risk of objects (the problem of stability, slope waters after discharge or leakage from cesspools ...). A complex scheme zonation is proposed. Recreational character remains.
SHP Oljarica Britof – dam Oljarica	Very much	Environmentally significant potential for flood meadows. Right bank is threatened by the disposal of garbage and filling the channel with materials. Necessary to define ecologically acceptable flow and rehabilitate industrial discharge water - water treatment plant!
Dam Oljarica – Predoslje	Moderate	River through town, important to maintain vegetation strip along the riverbed.
Predoslje – bridge Visoko	Very much	Extremely well-preserved section with meadows and channel morphology. In this section, the dynamic processes of Kokra River are balanced. Failure would change balance in the whole downstream segment. Without legal authorization sports facility located in the bed (left bank). New buildings in the water and riparian area are unacceptable!
Bridge Visoko – start of regulation in Visoko	Very much	The transitional section between the control and lower natural segments, as an important buffer section (transition segment).
Start of regulation in Visoko – release from channel Jelovica	Much	Degraded section. Recreation and tourism developed, expanding the flood sacred building various facilities. Department of interest to development. Suggest a complex regulation, land use and zonation renaturacijo adapted land use. Important processes include flooding and downstream impact on the hydrodynamics
Release from channel Jelovica – dam Jelovica	Moderate	Section in the industrial and transport zone. Ecological minimum problem (too little water in the river). Important to

		preserve and protect vegetation and segment from pollution. It is believed that the taking of water for ponds Brdo (below the dam Jelovica) is to high and thus hydrological poors downstream section of Kokra River.
Dam Jelovica Preddvor – Potoče	Moderate	The transitional section between alpine and lowland Kokra River. The place of gravel taking off, which is necessary to maintain the existing hydraulics, and stability downstream. Regime of gravel taking off must be controlled. Because of its transience character and fegime controll thi section should be protected it and set up a special regime of space use.
Potoče – cofluence of Kokra River and Jezernica	Moderate	Sustainable section, hydrodynamic processes are developed, but relatively controlled. Suggested is regular maintenance of facilities and care by road bridging (hydraulics, erosion).
Jezernica – quarry of tufa	Moderate	Section under the influence of water in the dam. Water quality is threatened by activities in the quarry.
Quarry of tufa - Komatevra	Much	Comprehensive and permanent control of erosion processes.

Grey-river portion specially interested by MCA test

2.6 Monitoring programs

2.6.1 Monitoring of water quality

Monitoring of water quality is carried out from the Ministry of the Environment and Spatial Planning, Envitonmental Agency of the Republic of Slovenia. Monitoring of ecological and chemical status of rivers is part of the state (emission) monitoring of the quality of surface water and shall be implemented through Law on waters (Zakon o vodah, Ur. l. RS 67/2002) and the Law on Environmental Protection (Zakon o varstvu okolja, Ur. l. RS 41/2004). Program of rivers monitoring for the years 2007 and 2008 are prepared on the basis of the criteria of the Water Framework Directive with regard to Decision No. 2455/2001/EC and adopt guidelines and instructions within the Water Framework Directive.

For surface water in Slovenia is implementing a program of surface water quality monitoring in accordance with the requirements of the Water Framework Directive from 2007 onwards, but in some parts of the program fit the requirements of the Water Framework Directive before that. The introduction of the Water Framework Directive have also changed the criteria and method for assessing the quality of surface water, so the current estimates are not comparable to estimates prior to 2006. For surface water provides ecological and chemical status. Chemical status of surface water is classified into two (good or bad), ecological status in five categories of quality (very good, good, moderate, poor and very poor).

Due to the comprehensive assessment of the general river conditions in the first river basin management plans in the years 2007, 2008, was made an operational monitoring of chemical parameters and control and operational monitoring of the biological elements. This means that the monitoring of all water bodies is not conducted every year on all water bodies (Cvitanič et al. 2010). Kokra River is listed in the monitoring program in 2008 and 2010.

2.6.2 Monitoring of water level

Monitoring of water level is carried out from Ministry of the Environment and Spatial Planning, Envitonmental Agency of the Republic of Slovenia. The river flows are measured on two gauging stations: Kokra and Kranj. Determining are the following parameters: minimum monthly and annual values-peaks (Qnk), monthly and annual minimum daily values (Qnp) mean monthly and annual values (Qs) – this datas are shown in the tables 1 and 2, monthly and annual maximum daily values (Qvp) and maximum monthly and annual values-peaks (Qvk).

Gauging station Kokra lies in the upper stream of Kokra River and river flows are measured from year 1926 onwards. Gauging station Kranj is located in the lower stream of Kokra River, at the outflow. At this station flows are measured from 1957 onwards. Missing data from the years 1964, 1965, 1986 (Jan. to May) and 1997 to 1999. Data are shown in tables 1 and 2.

2.6.3 Monitoring of birds

Monitoring of birds is carried out from Society for the observation and study of birds of Slovenia. In years 1994 and 1995 were published Atlas of the winter birds in Slovenia (A. Sovinc) and Ornithological Atlas of Slovenia (I Geister). Information of nester are given in Table 25. Inventories for a new ornithological atlas are in execution.

Table 25: Representatives of the endangered species of nesting birds in the Red List, which live in the Kokra River catchment (synthesis of current list of endangered birds nesting in Slovenia) (Globevnik et al. 1998).

	Threating category	Type of biotopes
Significantly threatened species:		
Ixobrychus minutus	RE.LK.TR	Standing waters
Rallus aquaticus	ME, RE. OS	Standing waters
Actitis hypoleucos	RE, TR, OS	Running waters, gravel
Alcedo atthis	RE, ST, TR, OS	Running waters
Upupa epops	ST, KM, TK, OS	Grasslands, meadows
Caprimulgus europaeus	ST, TK, OS	Tree-shrub zone - meadows
Saxicola rubetra	ME,ST, KM,TK	Flooded geasslands
Acrocephalus arundinaceus	ME, RE, ST	Standing waters
Threatened species:		
Cindus cinclus	RE, ST	Running waters
Accipiter nisus	ST, LK, OS	Tree-shrub zone - meadows
Accipiter gentilis	ST, G M, LK	Tree-shrub zone - meadows
Falco tinnunculus	ST, KM, LK,TK	Grasslands, fields
Falco subbuteo	ST. LK	Grasslands, fields
Charadrius dubius	RE, TR, OS	Running waters, gravel
Jynx torquilla	ST, KM, TK	Tree-shrub zone - meadows
Picus canus	ST, GM	Tree-shrub zone - meadows
Picus viridis	ST, KM, TK	Tree-shrub zone - meadows
Streptopelia turtur	ST, LK	Tree-shrub zone - meadows
Galerida eristata	ST, KM, OS	Grasslands, fields
Potentially threatened species:		
Aythya fuligula	LK, TR, OS	Standing waters
Dryocopus martius	ST, GM	Tree-shrub zone - meadows
Dendrocopos minor	ST, KM, TK	Tree-shrub zone - meadows
Alauda arvensis	ST, KM, TK	Grasslands, fields
Sylvia communis	ME, ST, KM	Tree-shrub zone - meadows
Tanius collurio	ME,ST, KM, OS	Tree-shrub zone - meadows

Legend: ME-reclamation, RE-regulation, changes in water regime, ST-toxins, pollution, KM-agricultural monoculture, intensive agriculture, GM-forestry monoculture, intensive logging, TK-abandonment of traditional farming, LK-illegal hunting, destruction, confinement, TR-tourism, recreation

The Kokra River has a great diversity of aquatic and riparian biotopes that are important for ornitofauna. Among them are some particularly valuable for nature conservation. Fast rushing water, which is paving the way for the deferred boulders, is a characteristic of upper tributaries of the Kokra River. In central part of streams when the water calms, where the roots covered bans appears occasionally as a result of erosion of last high water nests also a kingfisher (*Alcedo atthis*). By regulating Parovnica and Milka this bird losses its habitat.

In the zone of sediment displacement, depositing and pouring, have also been developed alluvial forests, meadows and gravel pits on Kokra River. Although these biotopes are significantly smaller than eg. on Sava River or Drava River diversity of living world is not substantially lower. Gravels, renewed by water and without pioneer vegetation and willow, also nest little ringed plover (*Charadrius dubius*). Little plover is a species of European concern. Sit is a summer species in freshwaters in the interior, particularly along rivers and artificial gravel pits. It is strongly threatened by interventions and controls of the rivers, mainly because it nests on river gravel. It nests in the gravel, the sand or in sand, which is gently bedded with the remains of woody plants. Eggs have highly protective paint and alloyed with surroundings. However, little ringed plovers in Europe, despite its ingenuity to find alternative habitats are considered as endangered species whose populations are declining (DOPPS, 2010). In Slovenia is a relatively rare nester.

Along the Kokra River is seen also dipper (*Cinclus cinclus*). This is a dark brown bird with white throat and breast. Short wings, stocky body and strong legs serve him perfectly in keeping under water. By swinging the wing dives and swims under water, with claws sticks to stones preventing the water stream to take it away from the food to the surface. A major food represents aquatic insects and their larvae. He has a typical flight just above the waterline, often squat on the rocks protruding from the water and constantly defend the territory. It lives along the fast running streams, especially in the low mountain range. Spherical nest of moss it bundles under the roots of riparian trees, bridges or behind waterfalls. Considered is as constants, because only in severe winters subjects in the mountains move to lower areas. In Slovenia it is widespread in northwestern Slovenia, the northeast boundary represents Pohorje. In Slovenia belongs to the endangered species (DOPPS 2010).

In gravel part passing in aquatic meadows, lives common sandpiper (*Actitis hypoleucos*). It is in category of the most endangered species on the national red list bird species threatened with extinction. During the "extinct" in the Kokra River basin can be classified also wet marsh meadows that were once primarily large at Rupovščica River.

2.6.4 Monitoring of bathing waters

Monitoring of bathing water carries Health institute in Kranj. Sampling is carried out by Kosorep. This is a part of Kokra River, which has long been known as a wild watering place.

Based on research conducted by the Helth institute in Kranj, a sample taken from the water at Kosorepu not comply with the Rules on the minimum health and other requirements for bathing water (Ur. l. RS 73/2003 and 96/2006). The reason is too many total coliform bacteria (9200/100 ml), too large number of coliform bacterial faecal origin (9200/100 ml) and too many enterococci (330/100 ml) (ZZV Kranj..., 2010). A similar situation was during the bathing season 2009 (ZZV, Kranj, 2009). Bacteriological picture is permanently bad (Globevnik et al. 1998).

3 Water uses

3.1 Water uses

Through history designed hydraulic characteristics of river streams (the depth, width, meandering) as a result of settlements, construction of roads, trails, settlements and infrastructure changed later. The water flow is directed and controlled by dams, thresholds, riverine buildings and channels, which is directly linked to the bridge structures and their flow holes. Table 26 provides a list and description of transverse objects on Kokra River. The objects are necessary in order to direct and control water flow and thus protect against damage of infrastructure (bridges, roads, houses). The objects are under continuous operation of the forces of water erosion, and they must be continuously maintained (Globevnik et al. 1998).

Table 26: Transverse objects on Kokra River (Globevnik et al. 1998, p. 17).

Object	The closest place	Use	Stationary (km)	Type	Material	Height (m)	Width (m)	State
THRESHOLD BEFORE OUTFLOW IN SAVA RIVER	KRANJ	general	0.100	threshold	concrete	1.0	20	injury
STANDARD	KRANJ	special	0.270	dam	concrete	5.0	20	good
ELEKTRO KRANJ	KRANJ	special	1.780	dam	concrete	8.0	20	good
VOČANOV DAM	KRANJ	general	2.700	dam	wood			Almost completely filled
DAM AT OLJARICA	BRITOF	special	5.250	dam	concrete	2.0	20	good
THRESHOLD 5 m UNDER BRIDGE VISOKO	VISOKO	general	8.600	threshold	wood, iron pile	1.0	20	injury
CHUTE ATI HOTEMAŽE	HOTEMAŽE	general	9.550	chute	rock	1.0	20	good
DAM 1 AT HOTEMAŽE	HOTEMAŽE	general	9.600	dam	concrete	2.0	20	good
DAM2 AT HOTEMAŽE	HOTEMAŽE	general	9.700	dam	concrete	2.0	20	good
DAM UNDER BRIDGE HOTEMAŽE	HOTEMAŽE	general	9.900	dam	concrete	1.5-2.0	20.0	good
THRESHOLD UNDER DAM-BREG	BREG	waterworks	10.700	threshold	concrete	0.5	20.0	
DAM UNDER BRIDGE-BREG	BREG	general	10.700	dam	concrete	1.5 -2.0	20.0	
CHUTE UNDER THRESHOLD 1 OVER BRIDGE BREG	BREG	general	11.000	chute	rock, wood	0.5 -1.0	15.0	
THRESHOLD 1 OVER BRIDGE BREG	BREG	general	11.050	threshold	wood	1.0	18.0	good
THRESHOLD 2 OVER BRIDGE BREG	BREG	general	11.200	threshold	wood	1.0	15.0	injury
THRESHOLD 3 OVER BRIDGE BREG	BREG	general	11.300	threshold	wood	1.0	15.0	good
THRESHOLD 4 OVER BRIDGE BREG	BREG	general	11.350	threshold	wood	1.0	15.0	good
DOLENČEV – FUKSOV DAM	PREDDVOR	special /general	12.910	dam	concrete	2.5	12.0	good
THRESHOLDUNDER BRIDGE KORENINŠEK	KORENINŠEK	general	15.200	threshold	wood	0.5	15.0	good
DAM UNDER BRIDGE KAVČ	KAVČ-KOKRA	general	16.500	dam	concrete	2.0	20.0	good
DAM 50 m UNDER BRIDGE MEŽNAR	MEŽNAR-KOKRA	general	18.050	dam	concrete	1.5	15.0	good
DAM IN LUKNJA	KOKRA	general	19.400	dam	concrete	2.5	15.0	good
THRESHOLD UNDER BRIDGE PODLEBELCA	KOKRA	general	19.700	threshold	concrete	1.0	18.0	good
DAM LESKOVEC	KOKRA	special	20.700	dam	concrete	2.0	15.0	good
DAM UNDER CELARJEVBRIDGE	KOKRA	general	21.000	dam	concrete	1.0	20.0	good
DAM UNDER POVŠNARJEV BRIDGE	POVŠNARKOKRA	general	22.600	threshold	concrete	0.5	20.0	good
POVŠNARJEVDAM	POVŠNAR-KOKRA	special	22.800	dam	concrete, wood	1.5	20.0	good
DAM UNDER BRIDGE REKAR	REKAR - KOKRA	general	23.100	threshold	wood	0.5	20.0	dobro
DAM SP.FUŽINE (ŠTULARJEV DAM)	SP.FUŽINA	special	25.200	dam	concrete	4.5	20.0	dobro

DAM ATI ZG. ŽAGA	SP.FUŽINA	general	25.800	dam	concrete	3*0.5	12.0	dobro
DAM AT LAND BORDER	SP.FUŽINA	general	26.050	dam	wood	2.0	15.0	slabo
THRESHOLD UNDER BRIDGE FUŽINE	SP.FUŽINA	general	26.200	threshold	wood	2*0.40	20.0	dobro
DAM ABOVE SV. HUBERT	MACESNOVEC	general	27.800	dam	concrete	1.5	16.0	dobro
THRESHOLD SP. JEZERSKO	SP.JEZERSKO	general	29.700	threshold	wood	0.3	8.0	dobro
DAM SP. JEZERSKO	SP.JEZERSKO	general	29.900	dam	wood	2.0	12.0	dobro

Grey-river portion specially interested in MCA

3.1.1 Hydropower exploitation

Water for the production of electricity is already being used in ten small hydro power plants (SHP) on Kokra River and one in location at Kokrica River. The analysis of water balance segments was made, wherein the length of the river section parallel to the tube during the capture and release was measured. Length of the river with water withdrawal is ranging between 300 and 1000 meters. No fish tracks have been constructed in the past and what is even more problematic - hydro-biological continuum is not guaranteed during the whole year. In the following table the characteristics of existing SHP's are listed and presented in Table 27 and Figure 18.

Table 27: Operating characteristics of small hydropower plants on Kokra River (IBE, 1997).

Name	Watercourse	Legal status	Qi	N (m3/s)	Hz (kW)	Hiz (m)	L (m)
Standard	Kokra/Kranj	EO, LP, WRC, BP	5.0	155	356	348	300 m
Kokra	Kokra/Kranj	EO, LP,WRC, BP	3.7	228	371.7	363.9	370
Britof	Kokra/Britof	WRC, BP	5.0	290	388.6	380.6	900
LIP	Kokra/Preddvor	/	1.12	65	458.4	454.2	750
Virnik-Hajniherjev jez	Kokra/Kokra	NOW	0.8	25	574.8	570.5	350
Povšnar	Kokra/Kokra	BP, WRC	0.73	22	600.8	597.2	250
Ribič- Fužina, Štularjev j.	Kokra/Koritarica	EO, NOW	1.5	60	639.3	634.1	250
Olip	Murnov graben	EO, NOW	0.05	100	825.0	777.0	450
Povšnar	Suhadolnikov graben	NOW	0.08	10	923.0	900.0	200
Zabukovec	Zabukovški graben	LP, WRC, BP	0.230	105	880.0	775.0	960

Legend:

EO	Water management - expert opinion
LP	Location permit
WRC	Water management consensus
NOW	Notification of works
BP	Building permit
Qi	Installed power
N	Installed flow
Hz	Altitude of water withdrawal
Hiz	Altitude of water discharge
L	Length of water withdrawal to discharge

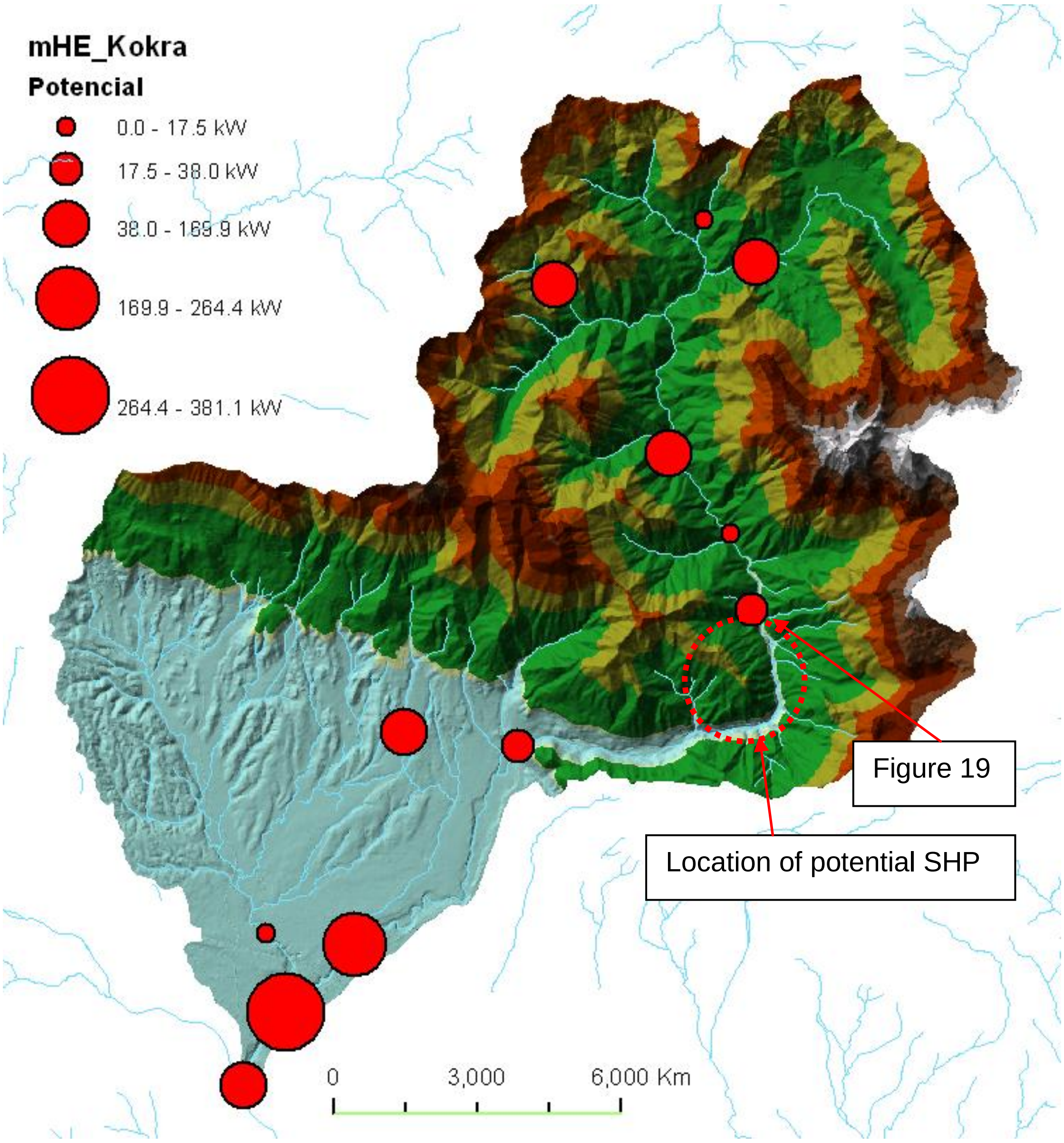

Figure 18: Digital elevation model of Kokra catchment with existing SHPs with their installed capacity, with location of planned one and hydrographic netw

Figure 19: Weir for river bed stabilization and for water intake for SHP (location is shown in previous Figure)

3.1.2 Ecologically acceptable flow determination

Ecologically Acceptable Flow (Minimum Instram Flow or Environmental Flow – MIF) determination in Slovenia is exactly defined and beside depending on mean low water flow (**sQnp**) also depends on:

- type of water withdrawal/ abstraction (reversible or irreversible),
- length of reversible water withdrawal (point, short or long),
- size of catchment area (__<10 – 100 – 1000 – 2500 km2 < __),
- group of ecological type of rivers (1 to 4),
- ratio between mean water flow (**sQs**) and sQnp (sQs/sQnp <> 20),
- amount of withdrawal compare to mean water flow (sQs <> 50 m3/s when catch. area > 1000 m3)

Upper mentioned criteria are the basis for factor ***f*** determination which is a multiplier of sQnp

$$MIF = f \cdot sQnp\ .$$

To support water users to define MIF for certain water use, Ministry of the Environment and Spatial Planning prepared data layer with ecological types of rivers and the size of catchment area, what is presented in next Figure.

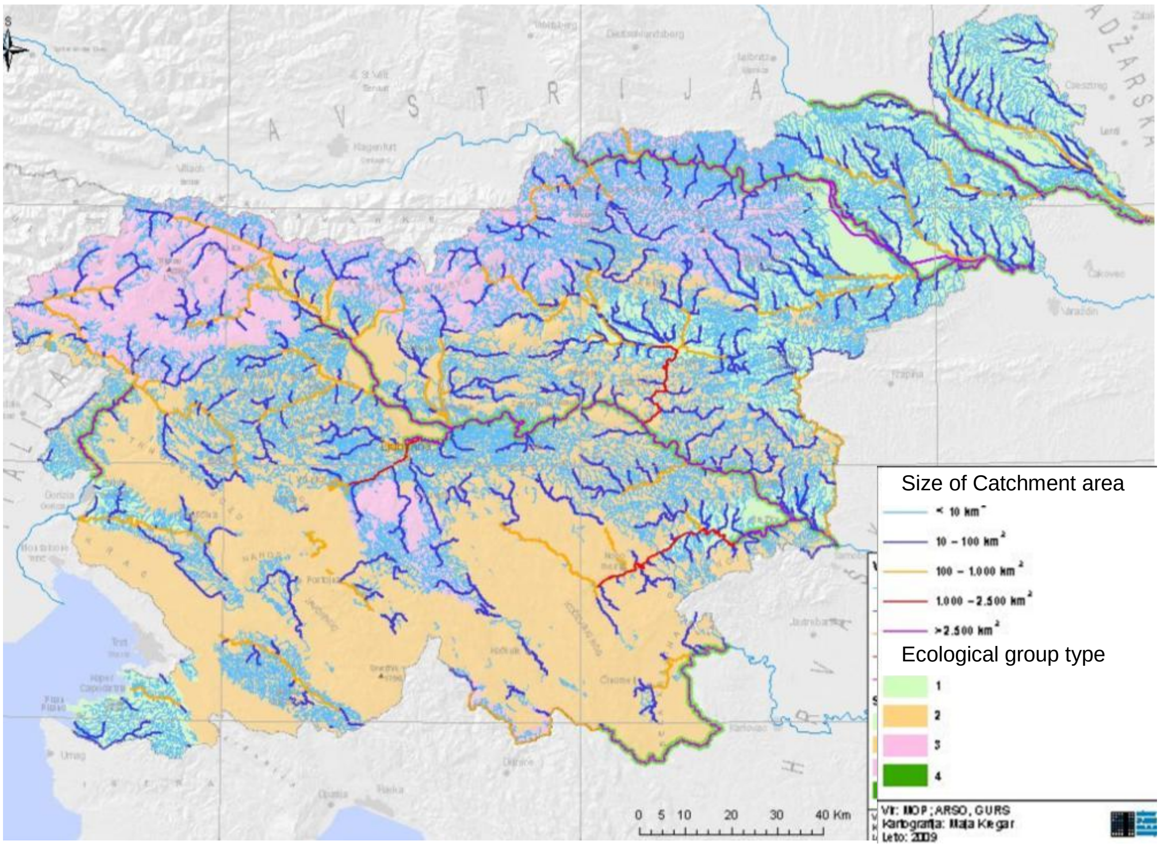

Figure 20: Map of ecological types of rivers with size of catchment area
(http://www.mop.gov.si/fileadmin/mop.gov.si/pageuploads/zakonodaja/okolje/voda/skupine_ekoloskih_tipov_vodotokov.jpg)

Kokra tributary is divided into two types of water bodies (see Paragraph 1.5):

- upstream **4SA**: Alps, 100 – 1000 km2, limestone (carbonates) and
- downstream **5SA**: Dinarids, 100 – 1000 km2, limestone (carbonates).

First is put into ecological group type 3 and second into group type 2. Downstream section 5SA is in size of 100 – 1000 km2, upstream section is in size of 100 – 1000 km2 in dovnstream part and in size of 10 – 100 km2.

Next table, where relative factors f which should be considered in Kokra sub-basin are coloured in green, shows the values multiplication factor f for calculation of MIF in the case of reversible withdrawal (case for hydropower water withdrawals), where first step is to read size of the catchment area and ecological group type from previous Figure.

Table 28: Factor *f* determination for reversible water withdrawals

	Size of catchment area				
Ecological group type	<10 km^2	10 - 100 km^2	100 - 1000 km^2	1000 - 2500 km^2 and sQs < 50 m^3/s	> 2500 km^2 or sQs > 50 m^3/s
Point abstraction					
1 (1)	0.7	0.7	0.5	0.4	
2 (1)	0.7	0.5	0.4	0.4	
3	0.5	0.4	0.3		
4					0.3
Short abstraction all year or long withdrawal in dry period					
1 (1)	1.2	1.2	1.0	0.8	
2 (1)	1.2	1.0	0.8	0.8	
3	1.0	0.8	0.7		
4					0.7
Long abstraction in wet period					
1 (1)	1.9	1.9	1.6	1.3	
2 (1)	1.9	1.6	1.3	1.3	
3	1.6	1.3	1.1		
4					1.1

(1) Factor ***f*** is multiplied by 1.6, if ratio between sQs and sQnp at the withdrawal location is more then 20

For structural lengths (river distance from water intake and water release) > 100 m for catchment size <= 100 km2 and > 500 m for catchment size > 100 km2 **wet and dry period are defined.** Next table presents dry and wet periods according to Slovenian methodology

Table 29: Wet and dry periods definition depending on ecological group type

Ecological group type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	DRY	DRY	WET	WET	WET	DRY	DRY	DRY	DRY	WET	WET	DRY
2,3,4	WET	WET	WET	WET	WET	DRY	DRY	DRY	DRY	WET	WET	WET

It is important to stress that MIF determination can differs in cases

- when MIF was determined before the mentioned determination was adopted by ***Decree on criteria for determination and on the mode of monitoring and reporting of ecologically acceptable flow*** *(Published in OG of RS , no. 97/09; Decree is an act which is adopted by the Government)* **MIF can sustain the same** or
- when a additional study for MIF determination is carried out. Study must be carried according to the Annex 3 of mentioned Decree where minimum requirements for this study are stated.

At the location of potential SHP (Figure 18) MIF was determined according to the mentioned Decree for MIF determination.

Next hydrological parameters were defined o the basis of flow measurement in period between 1928 – 2008:

- mean water flow **sQs = 4,84 m^3/s**
- mean low water flow **sQnp = 0,90 m^3/s**

Next step is factor f determination. Since water use for SHP is a reversible water withdrawal Table 28 was concidered. Also a SHP with long withdrawal is predicted (more then 100 of diversion length). Ecological group type is 3, and catchment size 224 km2 at this Kokra section, so it is classified in class 100 – 1000 km2.

Ration between sQs and sQnp at the withdrawal location is less then 20. So two factors f are determined:

- for dry period **f = 0.7,**
- for wet period **f = 1.1.**

So resulted MIF for location of predicted SHP is:

- for dry period **MIF_{DRY} =** 0.7 * 0,90 m3/s **= 0,63 m3/s**
- for wet period **MIF_{WET} =** 1.1 * 0,90 m3/s **= 0,99 m3/s**.

3.2 Farming

The following maps are depicting land use and the categorization of streams in Kokra River basin.

In the alpine part of the Kokra River basin (cadastral municipality Jezersko and Kokra) is 78% of the land covered with forests, while agricultural land covers only 6% (Kmetijski inštitut Slovenije, 1996). It predominates forestry, extensive stockbreeding (grazing), and turistical activity. The forest in lowland of the catchment area contains 58% and agriculture 35%. Grassland (pastures and meadows) in the lowland part stretching up to 25% of the area. Fields take about 600 ha and 1600 ha grassland. In this area is important grazing (milk cattlebreeding).

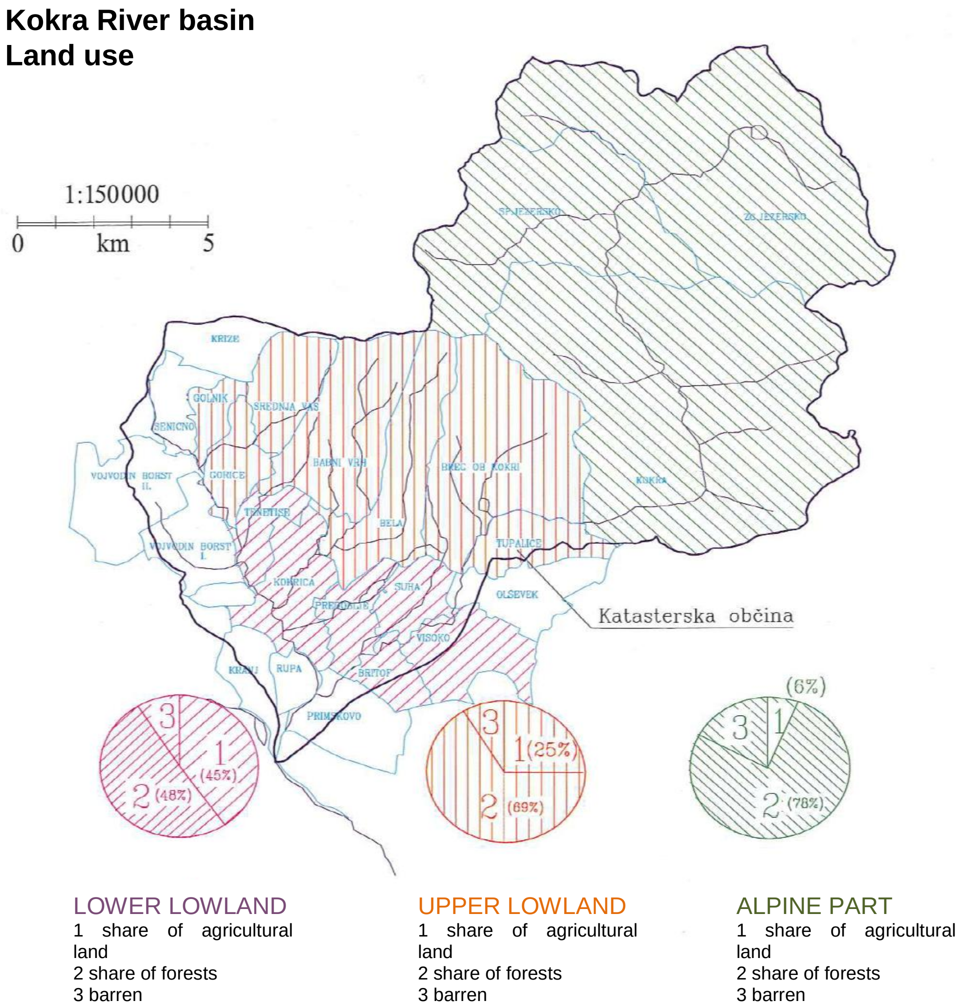

Figure 21: Land use in Kokra River basin (Globevnik et al. 1998, 42).

Kokra River basin
Categorization of streams

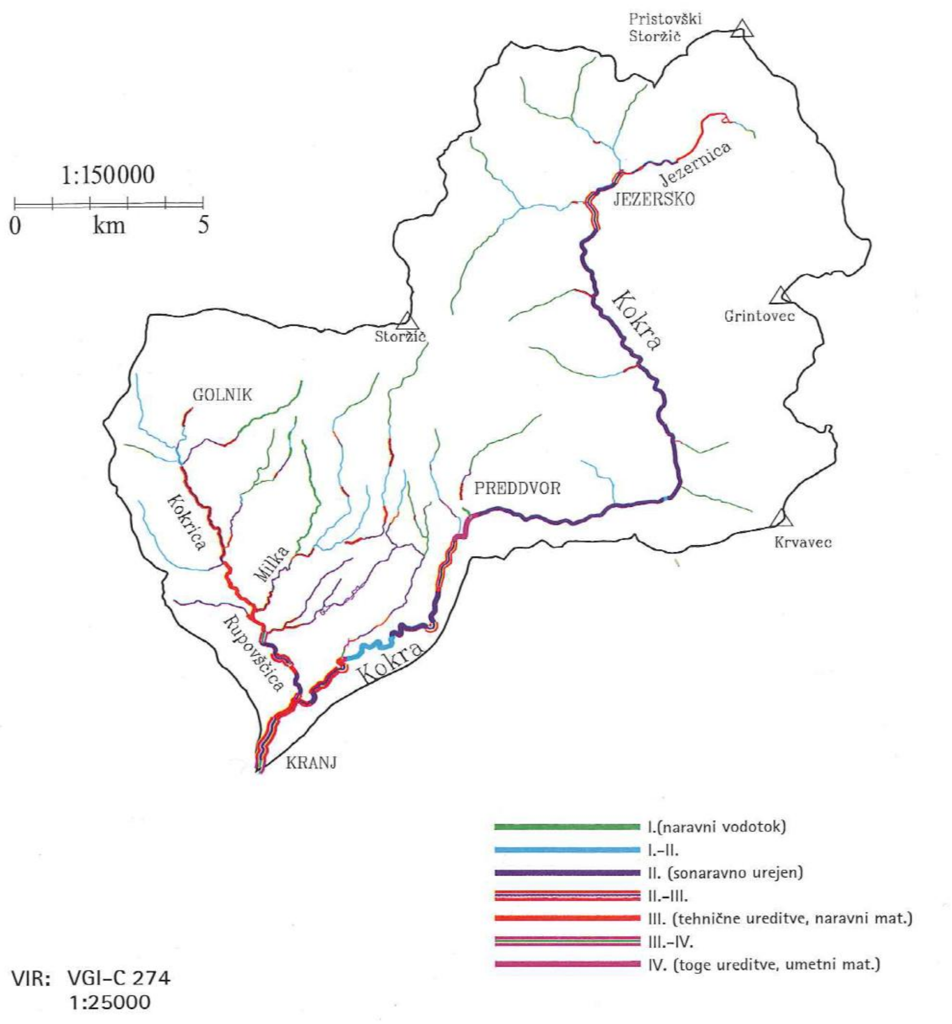

Figure 22: Categorization of streams (by type of river-bed) in the Kokra River basin (Globevnik et al. 1998, 46).

Lower, at area Tenetiše, Mlake, Kokrica, Tupaliče, Visoko and Britof are well-developed agricultural farming activities, such as the cultivation of potatoes, maize, cereals and clover. The largest complex of perennial plantations is in Preddvor (20 ha apples and pears). Other permanent plantations, scattered about the farm, not to exceed the area of 2 ha (Ministry of Agriculture, Forestry and Food, 1997). Figure 21 shows the land use in cadastral municipalities for alpine, upper lowland and lower lowland (Agricultural Institute of Slovenia, 1996).

The total estimate of the burden of livestock is 1.1 to 1.8 livestock units (LSU: cattle, pigs, horses, sheeps, Agricultural Institute of Slovenia, 1996). The average in Kokra River basin is 1.2 LSU. The indicators are under the proposed threshold stress proposed by European Union (the critical limit is 2.5 LSU). Agricultural activities are lead by an Agricultural advisory service in the Agricultural Administrative Institute Unit Kranj.

Irrigation systems within the Kokra River are not present in Kokra River basin although residents in the dry summer months often use water from riverbeds for watering the fields and gardens (Globevnik et al. 1998).

Loading by agriculture

Farming may produce two of two major groups of substances which are undesirable for the environment. The first are pesticides, which in particular unscrupulous use represents a major problem for the environment. Secondly, the nutrients released from fertilizers. The major problem with this are mineral fertilizers, where the nutrients are more concentrated, but also of inappropriate use may represent a risk of pollution to the environment.

However, potential contamination of the environment by over-fertilization does not occur only in the use of mineral fertilizers, but also in the use of organic fertilizers. The most classic of organic fertilizers derives from livestock. These are mainly the liquid manure and manure.

3.3 Industry

In Preddvor is developed wood processing industry, in Kranj, processing, textile, footwear and electronic industry. In the urban area are different mechanical and building installations. Lowland catchment area of Kokra River labels facilities of special interest, hospital Golnik and protocol complex Brdo. The whole area has are intensively developed, service, tourism and recreational activities.

All production activities do not collect and purifies wastewater treatment and thus causes pollution of water. In Kokra River catchment area these activities are concentrated in the vicinity of Kranj as shown in Figure 23.

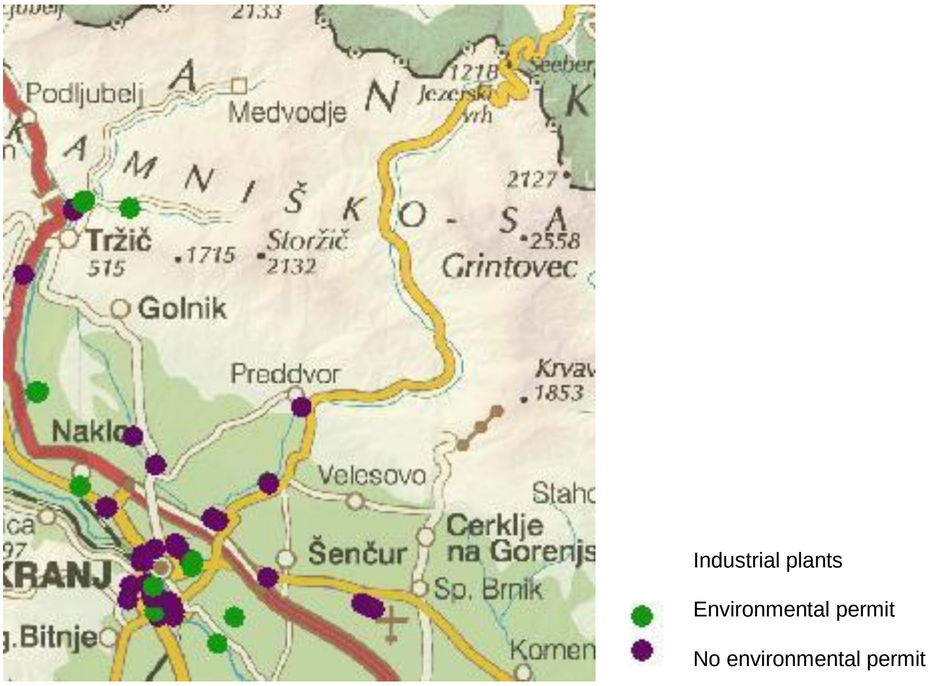

Figure 23: Industrial plants in Kokra River cathment area.

List of a so-called obligationers to acquire IPPC permits within the river Kokra is shown in Table 30. These are companies, which may cause environmental pollution in a large scale, especially air, therefore are obliged to obtain environmental permit under the IPPC regulation. However, administrative procedures are still in progress (http://okolje.arso.gov.si/ ippc/pages.php?op=print&id=IPPC_UVOD).

Table 30: List of a so-called obligationers to acquire IPPC permits (http://okolje.arso.gov.si/ippc/register.php).

Manager	Manager's addres	Activity	Address of IPCC device
ISKRA ISD - Galvanika d.o.o.	Savska Loka 4, 4000 Kranj	Surface treatment of metals using electrolytic and chemical processes	Savska Loka 4, 4000 Kranj
MARJAN GRAŠIČ s.p.	Moše 15A, 1261 Smlednik	Surface treatment of metals using electrolytic and chemical processes	Ljubljanska cesta 24a, Kranj
SAVATECH d.o.o.	Škofjeloška cesta 6, 4000 Kranj	Surface treatment of substances, objects or products using organic solvents	Škofjeloška cesta 6, 4000 Kranj

3.4 Waste discharges

Water is polluted also by the effluent of industrial and municipal wastewater. Waste water is often drawn off in many places directly into a watercourse (Oljarica, settlements along the streams, individual houses ...), or via the local sewer system without a (pre)treatment. The majority of settlements enters their waste water into the subsoil through cesspools. It is assumed that the existing septic tanks do not have adequate filters to purify the waste water properly. The waters are also polluted due to uncontrolled disposal of garbage, bulky and building material by embankments, rivers and hinterland (Globevnik et al. 1998).

In the Kokra River catchment operates wastewater treatment plants (WTP) as shown in Table 31.

Tabela 31: Wastewater treatment plants (WTP) in the Kokra River catchment.

Location of WTP	Size	Owner	Owners address
Brdo	350 PE (prim and sec cleaning)	JGZ Brdo Javne protokolarne storitve RS	PREDOSLJE 39, 4000 Kranj
Preddvor	300 PE	Dom starejših občanov Preddvor	Potoče 2, 4205 Preddvor

PE-population unit

In Preddvor is planned to build another wastewater treatment plant (2.500 PE).

A part of a settlement Kokrica municipal sewage is flow into the wastewater treatment plant along the highway. All other villages have communal networks, few have the outdated local sewage system.

Administrative Unit Kranj had the area of landfill trash in Tenetiše, near Udin Boršt, at the outflow of Želinjski stream in Kokrica River. The landfill, which covered an area of 4.7 ha and partly regulated containment ponds for leachate. Annual capacity of the landfill was 120000 m^3. On trash removal system was connected to 68,600 inhabitants, or 93.1% of all inhabitans of Kranj.

Tenetiše waste landfill site where the Komunala Kranj disposed waste from the municipality of Kranj, Šenčur, Naklo, Jezersko, Cerklje and Preddvor has ceased to operate in 15. july 2009. Since then, most non-hazardous waste is transported in Mala Mežakla (municipality Kranjska gora). Municipality Kranj wasted common 35,000 tonnes per year, 2916 tonnes per month and 135 tonnes per day. It is provided in the future the removal of municipal and industrial waste in the landfill Kovor, the Centre for Waste Management in Celje and export to foreign countries (http://obcina.kranjska-gora.si/ Obcinski_20svet/4_25/4_25_7 _20odlaganje_20odpadkov.pdf).

On the river basin is also a large illegal landfill waste (Kokra Tupaliče - right bank, at the Gorge Kokra growers in the village Britof Kranj, in meadow of Kokra River in Tupaliče, Visoko - the right bank, old meanders of Kokrica River in Tenetiše, river channel of Parovnica stream over Letenice) (Globevnik et al. 1998).

3.5 Drinking water

Kokra River basin is important water catchment for the water supply of a large part of Gorenjska. Regional water supply network in Kranj has at catchment area of Kokra River main drinking water capturers in Povlje, Bašlje, Nova vas, Čemšenik, Tupaliče and Koreninšek. The water from here supply Kranj administrative units (municipality Preddvor, Jezersko, Naklo, Šenčur and the city Kranj) and the municipality Medvode. In the Kokra River basin are located also water captures for the local waterworks (Golnik, Goriče, Trstenik, Preddvor, Jezersko). The situation and the main water supply reservoirs is shown in Figure 24. There is 35 of all reservoirs in the Kokra River basin. List of them is shown in Table 32.

Table 32: List of water reservoirs in Kokra River basin (Globevnik et al. 1998).

Municipallity	Name	Gauss Kruger coordinates of location X	Y	Altitude of location Z!	Angle of water capture Zz	Minimum flow Qmin	Average flow Qsre	Maximum flow Qmax	User	Decree on protection
		(brez 5 milj.)	(brez 5 milj.)	(m)	(m)					
Preddvor	Mojzesova skala	458190	127890	675	260	1	0	3	Vod. Možjanca	N
Preddvor	Rovovka-Mače	455450	130440	620	250	1	0	1	Vod. Mače	N
Preddvor	Zg. Fužine	459160	136470	760	30	0	0	0	Vod. Zg. Fužina	N
Preddvor	Možjanca	458770	127730	730	250	1	0	3	Vod. Možjanca	N
Preddvor	Čemšenik	459600	130100	708	315	0	24	50	Vod. Kranj	D
Preddvor	Nova vas	456800	130700	650	315	0	20	45	Vod. Kranj	D
Preddvor	Belca-Bašelj	454100	131800	700	270	0	20	45	Vod. Kranj	D
Preddvor	Drenaža Koreninšek	458850	128500	480	180	45	60	100	Vod. Kranj	D
Preddvor	Tupaliče TV-1	456250	128025	453		0	5	15	Vod. Kranj	N
Preddvor	Tupaliče TV-2	456200	128000	453		0	5	25	Vod. Kranj	N
Preddvor	Čemšenik V-3	459850	129725	645		0	0	6	Vod. Kranj	D
Preddvor	Vrtine I jI,III,IV	452250	132100	732		2	10	16	Lokalni vod.	D
Preddvor	Čemšenik V-1	459950	129725	625		6	6	6	Vod. Kranj	D
Preddvor	Čemšenik V-2	460000	129650	605		0	0	15	Vod. Kranj	D
Kranj	Trstenik	452300	132200	699	315	0	3	0	Vod. Trstenik	D
Kranj	Goriče	450400	132410	690	272	0	3	0	Lokalni vod.	N
Kranj	Brdja	450280	132140	630	315	0	3	0	Lokalni vod.	N
Kranj	Pod Bregom	450320	132460	700	315	0	3	0	Lokalni vod.	N
Kranj	Zajetje bolnica	449160	132050	528	270	0	7	0	Vod. Golnik	N
Kranj	Goriče	450760	132360	700	270	0	3	0	Lokalni vod.	N
Kranj	Nad Bukovnikom	449280	132200	620	260	0	6	0	Vod. Golnik	N
Kranj	Golnik	448520	132420	575	250	0	6	0	Vod. Golnik	N
Jezersko	Pri Kanonirju	459500	137830	735	350	0	1	0	Vod. Jezersko	N
Jezersko	Ažmanov st.	460050	139200	790	50	0	1	0	Vod. Jezersko	N
Jezersko	Anclovo	463920	139460	920	110	0	1	0	Lokalni vod.	D
Jezersko	Ravenski v.	463590	140800	955	225	0	0	0	Vod. Ravne	N
Jezersko	Anzelnov v.	462220	139740	940	320	0	0	0	Lokalni vod.	N
Jezersko	Izvir Mlinščice	462100	138600	900	110	0	5	0	Vod. Jezrsko	N
Preddvor	Skubrov s.	462140	139690	925	320	0	1	0	Lokalni vod.	N
Tržič	7 manjših virov					0	1	0	Lokalni vod.	N

Legenda: N-no degree; D-degree accepted

With water resources are embranced from 193 l/s (medium volume) to 330 l/s (maximum amount) of drinking water. At four locations, the groundwater is pumped by wells. These are over Trstenik (4 wells), over Bašelj (2 wells) in the ravine of Čemšeniški stream (3 wells) and by Tupaliče (2 wells). In the valley of Kokra River upstream from Preddvor groundwater is took away with drainage others are natural springs. Most drinking water is took away here, up 100 l/s, reservoir Čemšenik with the quantity up to 50 l/s, and then Nova vas and Belca-Bašelj up to 45 l/s. Ten reservoirs have adopted ordinances to protect. Water protection zones and reservoirs areas are shown in Figures 24 and 25.

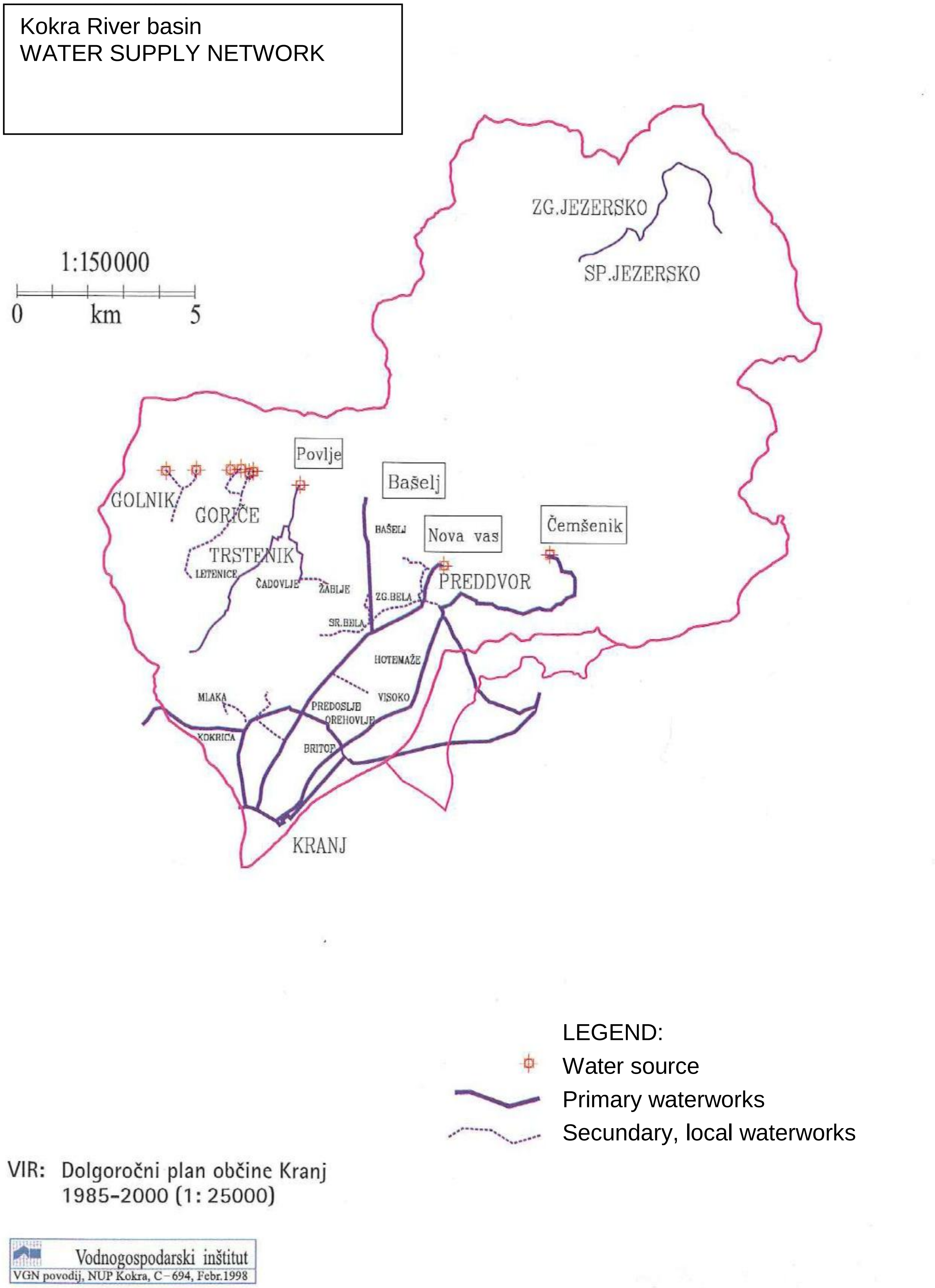

Figure 24: Water supply transport network in Kokra River basin (Globevnik et al. 1998, p. 45).

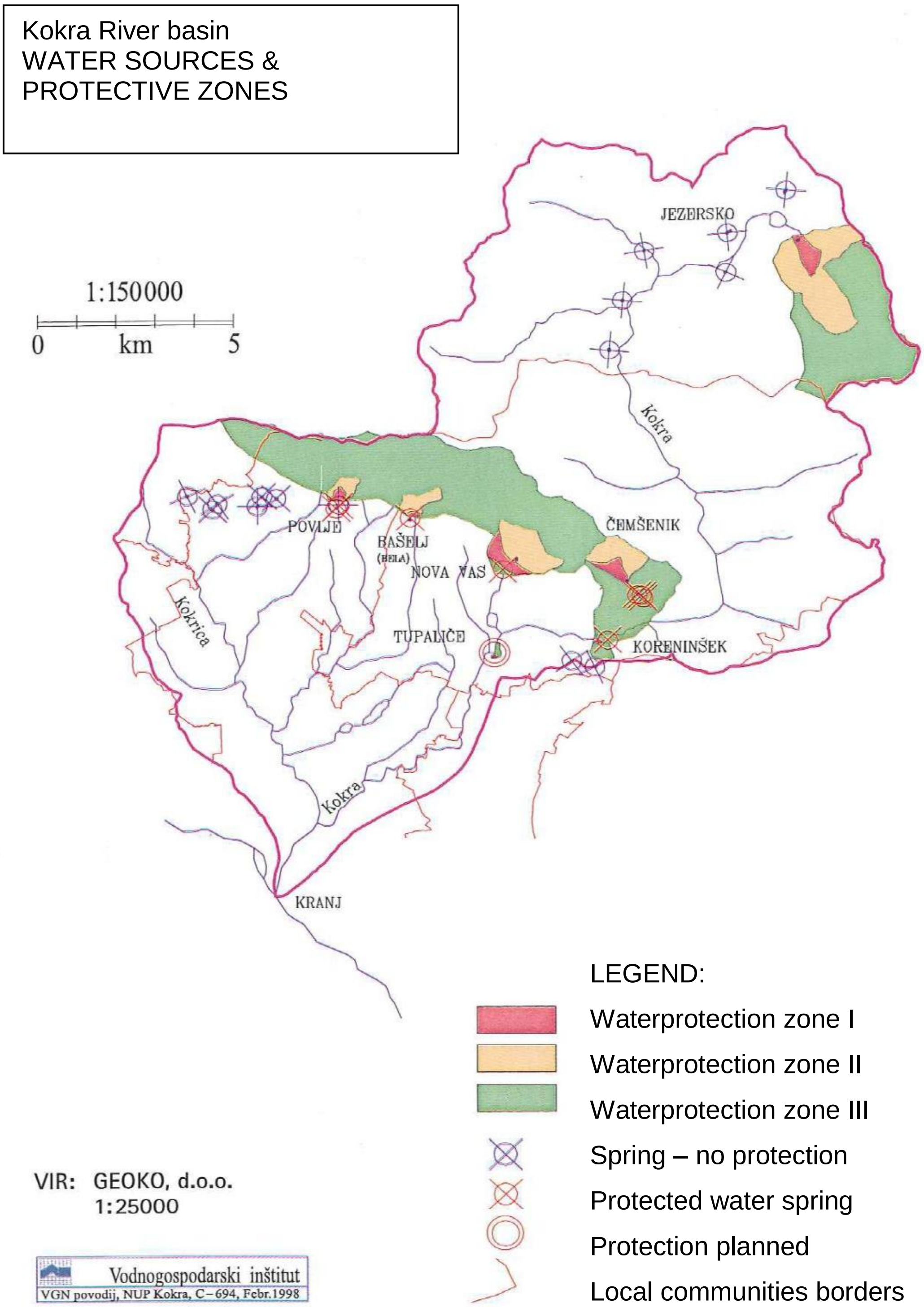

Figure 25: Water captures and protective zones in Kokra River basin (Globevnik et al. 1998, p. 46).

3.6 Touristic fruition

Particularly interesting for tourism is the whole alpine area (Storžič, Kriška gora, Grintovec, Kamniško-Savinjske Alps).

Jezernica stream between Zgornje and Spodnje Jezersko has been regulated and wetland dried in order to arrange Planšarsko lake. Tourism and recreation in this area are well developed.

The area between Tupaliče and Visoko are intensively developed various recreational sporting activities. Built have been several facilities (open field, catering facilities, hypodrome), organizing the picnics and rafting. These activities greatly affect the riparian area of Kokra River, the objects placed have no legally regulated status. Desire of the municipality that contains the mentioned area, is that there a tourist and recreational activities continue. In this area is also developing organic farming.

A sport hall without the permission of the administrative organ is settled also in canyon of Kokra River by Milje. In this part is also placed a dam for flood prevention.

On the left side of the Kokra River, (before Kokrica River inflows) is settled a playground with facility. The mentioned playground, meadows along Kokra River by Vočan, riverbed and riverbanks of Kokra River and Kokrica River upstream from Kranj are an important walking, recreational and sports area of the city of Kranj. Canyon of Kokra River through Kranj is important and famous attraction. A part of canyon in the city is protected.

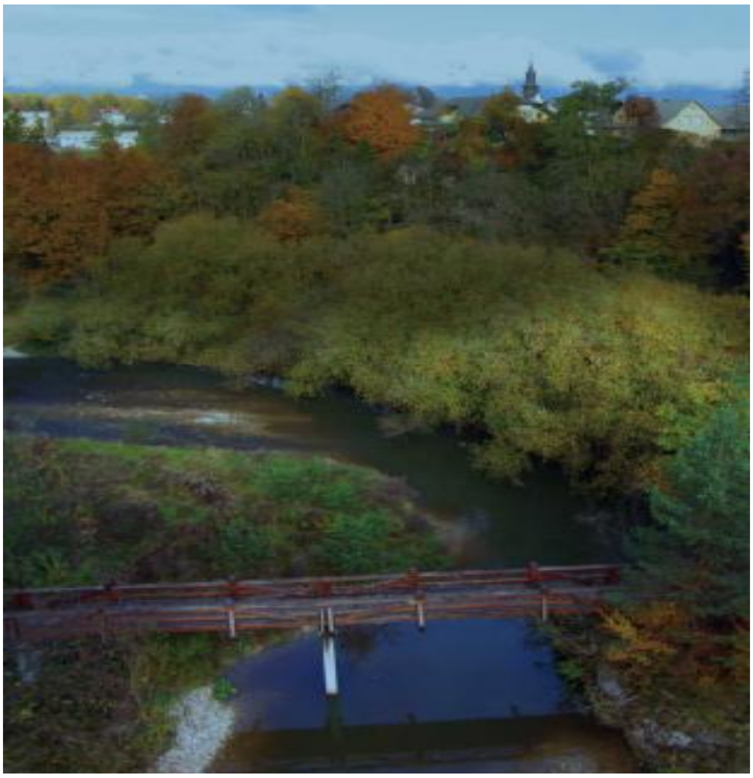

Figure 26: A part of the canyon of Kokra River in Kranj is ordered as a naturalistic teaching route (Naravoslovna šola Kanjon reke Kokre, Kranj, 2010).

In the tributaries in the upper Kokra River basin is recreational and touristical developed area of Lake Črnava. The dam was reconstructed in 1997, lake was regulated. A managment plan of lake is also ready.

The area Krvavec is touristical and recreational regulated and mostly falls within the catchment area of Kokra River. In 1995 was issued the regulation on concession for commercial exploitation of water from the river Kokra for additional snowing on Krvavec (Ur. l. RS 44/95).

At the moment there is no withdrawal of water for snowmaking on Krvavec, withdrawals with regard to general water flows for waterworks are low. A problem represents a particular abstraction of water for ponds in Brdo. In view of the pond capacity Centre it is believed that the quantity of water, regulated in decree, too high. By reducing the amount of pumping water for Brdo would considerably enrich the low-water in Kokra River under Tupaliče. (Globevnik et al. 1998).

Protocolar Centre Brdo is a facility of special social significance, which has a closed touristic activity. Only a part of this facility is opened to the public. After the construction of ponds in Brdo in 1974, changed the distribution of outflows from different parts of the catchment. The situation balance is changed dramatically further due to withdrawal of water from the Kokra River near Preddvor. Towards the end of the seventies, when the regulation of Kokra River between Tupaliče and Visoko was finalized changes water balance, which is critical especially during low flows and also outflow of high waters.

Table 33: Touristic capacities in Kokra River basin (http://www.slovenia.info/si/...).

Touristic capacity	Location
Hotels	
Hotel Kokra****	BRDO PRI KRANJU
Hotel Bellevue***	KRANJ
Hotel Creina***	KRANJ
Hotel Planinka***	ZGORNJE JEZERSKO
Penzion Valerija	ZGORNJE JEZERSKO
Apartments	
Apartmaji Boltez****	KRANJ
Apartma Megamik***	PREDDVOR
Prenočišča pri Liparju	PREDDVOR
Apartmaji in sobe Ušlakar	BREG OB KOKRI
Apartmaji Gubanec	GRAD
Hiša Kocka	ZGORNJE JEZERSKO
Private rooms	
Arvaj Ivana***	KRANJ
Prenočišča pri Liparju	PREDDVOR
Prenočišča Dežman***	KOKRICA
Turistične sobe Sreš Darinka ***	MLAKA PRI KRANJU
Penzion Zaplata	TUPALIČE
Sobe Hrastnik	ZGORNJE JEZERSKO
Sobe Tonejec	ZGORNJE JEZERSKO
Youth hostels	
Dijaški in študentski dom Kranj**	KRANJ
Kmetija Pri Šuštarju	VISOKO
Touristic farms	
Bio kmetija Makek	ZGORNJE JEZERSKO
Turistična kmetija Ancel - Muri	ZGORNJE JEZERSKO
Olipje	ZGORNJE JEZERSKO
Pensions	
Penzion Kanonir	SPODNJE JEZERSKO
Penzion Zaplata	TUPALIČE
Accomodations for the night	
Prenočišča pri Liparju	PREDDVOR
Prenočišča Dežman***	KOKRICA

Penzion Zaplata	TUPALIČE
Restaurants	
Penzion Kanonir	SPODNJE JEZERSKO
Gostišče ob Jezeru**	ZGORNJE JEZERSKO
Mountain cottages or houses	
Češka koča na Spodnjih Ravneh	JEZERSKO
Kranjska koča na Ledinah	JEZERSKO
Planinska koča Iskra na Jakobu	PREDDVOR
Planinski dom na Kališču	PREDDVOR

4 Pressures and impacts related to water uses

The regulation on concession for commercial exploitation of water from the river Kokra for additional snowmaking of ski resorts Krvavec is given a priority list of exploitation of water from Kokra River (Ur. l. RS 44/1995). The first priority is to assure the minimum flow. The provisional estimate is that the minimum flow quantity of Kokra River will not exceed 1.0 m^3/s on the section from Jezersko to Preddvor and 1.3 m^3/s on the section from Preddvor to the confluence with Kokrica (Rupovščica). The second priority is the abstraction of water in the area upstream from Preddvoor for water supply system in Kranj. In the present situation is powered only from reservoirs in Čemšenik in quantities about 0.025 m^3/s but in the future will gradually increased at an estimated 0.300 m^3/s. The third priority is to convey water for water accumulations - ponds to Protocolar Centre Brdo in the quantity of 0.300 m^3/s. The fourth priority is the economic exploitation of water for electricity generation in each of MHE, and the withdrawal of water for additional snowmaking of ski resorts Krvavec. Use and exploitation of Kokra River water must be in the following order:

- flow to the biological minimum: the abstraction of water is not allowed
- flow to the biological minimum + 0.300 m^3/s: a possible withdrawal for the water supply system in Kranj
- flow to the biological minimum + 0.600 m^3/s: a possible withdrawal for accumulations in Brdo
- flow to the biological minimum + 0.600 m^3/s + Qt min: possible start of operation of individual mHE and withdrawal for additional snowmaking in Krvavec (Ur. l. RS 44/1995).

Transversal structures on the part of the Kokra River, what is particular interested by MCA, are listed in Table 26. The area has two small hydroelectric power plants in operation: Virnik-Havniherjev dam and Povšnar (Table 27).

In this area the industry is not present, but a separate small villages with no settled canalization and with no sewage treatment plants.

The area, specially interested by MCA test belongs to the alpine part, dominated by forest and less than 6% of agricultural land, so this is a relatively well-preserved natural environment. Wider area of Čemšenik in which is supposed to be the pipeline for new power plant, is an important drinking water pumping station for municipality Kranj. It belongs to the water protection zone III. This is a broad area in which the milder regime valids and covers the whole area of pumping. Water protection regime in this area should provide an acceptable risk for contamination with radioactive materials and substances that are persistent or decompose very slowly (Regulations concerning the criteria for determining the water protection zone, Ur. l. RS 67/02 and 5/06).

For the constructions in the water protection zones it is necessary to follow the Code for construction in the water protection zones, which can be made only on the water agreement and the documentation required to obtain the approval of water(Ur. l. RS, št. 67/02).

5 Restoration and mitigation actions

Restoration and mitigation actions are presented in Kokra River Regulation Plan (Globevnik et al. 1998) and contains:

1. Protection against high water and lateral erosion:

    - Reactivation of old meanders of Kokrica River in Tenetiše (link to the parent flow).
    - To ability the retention potential of areas between Tenetiše and Kokrica River: minor frequently high water decantation on meadow areas along Kokrica River and Milka stream and link to clay-digging lake Bobovek and eventual construction of the dry reservoirs.
    - Protection of existing wetlands, floodplains and flooded grasslands and prevent drains and regulation of their dreinagers (especially wetlands in Golnik, flooded meadows below Gorice, along Stražnica and Milka streams).
    - Hydraulic suitable road passages and bridge openings settlement (road Golnik - Gorice - Trstenik - Bašelj - Mače – Preddvor; area of Olševnica).

2. Steep mountain stream preventive action and restraint of gravel at critical locations:

    - Sections of the main channel of Kokra River to the confluence with Jezernica (tufa quarry area),
    - Steep mountain streams and erosion zones of Makekova Kočna (Peski),
    - Hinterland of steep mountain stream Škodovnjak,
    - Tributaries of Kokra River beneath Kalški ridge and Kočna (Nežkar and Roblek stream),
    - Segments of steep mountain stream Bistrica upstream from Preddvor.
    - Arrangements of sinking field along the stream Olševnica and construction of the dry reservoir.
    - Sanitation of rockfalls in Primskovo with pre-made complex hydrogeological and geotechnical study of the canyon.

3. Water quality protection:

    - Protection of water resources over Golnikom and Trstenik and water protection areas restoration of the proposed new water sources.
    - Construction of a canalization system with water treatment plants in municipalities Preddvor and Šenčur regarding to outline scheme.
    - An outline scheme of canalization system of the municipality Kranj. Development of the system.
    - Collection and treatment of industrial waste waters.
    - Rehabilitation of prohibited waste dumps in Kokra River bankments in Predoslje, Visoko, Hotemaže, Tupaliče, Tenetiše Kokrica River meanders and prevent access to them.
    - Rehabilitation and arrangements cesspits and liquid manure tanks (in the whole river basin), possibly in combination with constructed wetlands.
    - Establishment 5-10 m wide (relief) zone of vegetation along the streams.

4. Protection of aquatic ecosystems:

   - Protection of Kokra River segment between Predoslje (Britof) and Visoko: it is recommended no use of space, which would in any way alter the natural state of water.
   - Sustainable Kokra River regulation between Visoko and Tupaliče, perform the connection with the left-riverchannel retention areas and at the same time to plan management in the aquatic and riparian area (recommended are only type C activities).
   - Renaturation of the Kokrica River channel on a section Letenice - Tenetiše - Kokrica, establishing of riparian zone, particularly important is renaturation of old meanders of Kokrica River by Tenetiše (link to the parent riverbed, sustainable regulation).
   - Kokra River Regulatory Plan (recreation, tourism, walking trails, teaching routes) in the section from Kranj to Britof.
   - Protection of Kokra River and its main tributaries over Preddvor.
   - Protection of wetland Golnik, alder in Goriščica, Milka River section under Tatinec and wet meadows in the area Brdo-Tatinec and Blato.
   - Establishment of 5-10 m vegetation belts of native bushy trees vegetation along water streams.
   - Restoring of the threshold before outflow in Sava River and the threshold under bridge Breg.
   - Rehabilitation of the dam by Deželna meja.
   - The setting and introduction of ecologically acceptable flow at sites where hydrobiological continuum is disconnected: dam Oljarica Britof, provided SHP Hotemaže, dam Jelovica Preddvor, SHP Povšnar, Reka, Zabukovec, Kokra, Jezersko.
   - Rehabilitation of injuries in the Kokra River canyon through Kranj to take account of the nature protection guidelines. Arrange an access to selected sites in the Kokra River canyon in Kranj regarding the principles of natural heritage protection (Globevnik et al. 1998).

Some items in this plan has already been executed to this day.

5. Necessary retain gravel locations:

Steep mountain tributaries of Kokra River: erosion areas should be stabilized, river beds of steep mountain streams should be consolidated. The most critical locations are:

- Neškarjev graben and both Kočna.
- Kokra over Preddvor: This point is crucial for the stability of the lower Kokra River stream thus raterdations and deprivation os sediment material should be controlled (balanced with the natural inflow of material). Transport capacity in the gravel pocket area shall be equalized with a capacity of downstream sections, as if too much gravel masses would be retained the downstream regulation will begin to deepen. This means that the sediment pockets should be arranged so that actual surpluses will retained and that if necessary they will follow the Kokra River downstream.
- In all tributaries of Kokrica and Kokra River should be provided stabilization systems. With this measure are critical points where surplus material is expected to disposal are displaced to less threatened areas.

- In the steep mountain stream, which flows through Golnik, there should be forecasted new system of drainage and stabilization of rubbles over settlement (consolidation of dry river basin, directing of steep mountain waters).

For all of these locations is necessary to prepare comprehensive documentation. For this purpose, the transport capacity analysis of Kokra River (estimated quantities) is proposed to be made worked out by authorized services. Above the dam Jelovica gravel can be deprivated in order to control transfer of sediment. Exceptionally, the gravel can be deprivated even before the confluence of Kokrica and Kokra River well at Visoko, if a settlement threaten. For each deprivation of gravel should be in accordance with the competent nature protection service and prepare a full documentation. The works are taken by authorized public services.

6. Method of maintenance of watercourses

Guidelines for conducting maintenance works on watercourses (without steep mountain streams) in the Kokra River basin vary depending on the type of stream but all the same rules apply for taking gravel. In principle, the withdrawal of gravel from the river basins is prohibited. Should be permitted only in areas where depositing of gravel threatens the stability of banks or facilities.

7. Abstractions of gravel at appropriate places

Conditions of detention are as follows: deprivations only in the period between September to February, allowed is only abstraction of surface coatings, but not to interfere in depth, the gravel should be removed regularly throughout the profile, it is necessary to preserve parts of the islands in order to allow continued formation of gravel pits, after stopping the exploitation of gravel is not permitted to plant with vegetation.

Natural or nature-like sections of the river channel

Maintenance works should be carried out only in the context of sanitations of injuries.
Interference in the configuration of the river channel or riparian zone and the vegetation is not permitted (Globevnik et al. 1998).

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