Annex A.3

Yantra and Kamchia River Basins

THE STUDY ON INTERGRATED WATER MANAGEMENT IN THE REPUBLIC OF BULGARIA

JICA STUDY TEAM CTI Engineering International

Address: *JICA Study Team Office*
14, G.M.Dimitrov Blvd., level 4, Danube River Basin Directorate – Sofia Branch suite
Sofia 1797, Bulgaria
Phone / Fax: ++359 (02) 971-3140
E-mail: jicastudyteam_sofiaoffice@yahoo.com and jicast@abv.bg

THE YANTRA RIVER BASIN

SURVEY REPORT

November 2007

Sofia

CTI Engineering International Co., Ltd.

THE YANTRA RIVER BASIN SURVEY REPORT

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1. Outline

Location : The Yantra River is a right tributary of the Danube River and is located in the central northern part of Bulgaria. It originates in the Central Stara Planina Mountain at an elevation of 1340m above sea level and flows into the Danube River at chainage 533^{+900}km, near the village of Krivina at 18m above sea level. The Yantra River watershed and its tributaries are bounded on the west with the Osam River valley, to the east – with the river valleys of the Rusenski Lom River and the Kamchiya River, to the north – with the Danube River, and to the south – the ridge of Stara Planina mountain.

Characteristics : The drainage basin of the Yantra River is the fifth largest in Bulgaria with an area of 7,862km^2. The Yantra River receives water from 10 tributaries along its 285.5km length. Their names and characteristics are as the followings:

- The Rositsa River is a left tributary with 164.3km length and drains a territory with an area of 2265km^2. It confluences with the main river at chainage 107^{+500}km
- The Stara (Lefedzha) River – a right tributary with 91.8km length and an area of 2424km^2, and flows into the main river at chainage 140^{+000}km; and
- The Eliiska River – a left tributary with 32.0km length and an area of 262.3km^2, and flows into the main river at chainage 81^{+100}km

The Yantra River basin is typically very irregular and about 16% of the area has inclinations of more than 4.2‰. There the streams are characterized by the series of rapids and small waterfalls. Another 35% of the watershed having grades >1.2‰ up to the plain area where the main tributaries leave formed deep gorges. The Yantra River shows its meandering nature, typical for a river crossing level plains, before its flows into the Danube River. The average inclination in this area covered by many smooth plane hills varies between 0.37 and 0.25‰.

Average altitude of the Yantra watershed is calculated on 470m above sea level and the river network density is ranged within specified limits of 0.7km/km^2 for the main river to 1.5km/km^2 for upstream tributaries.

Oak and beech trees cover 2250km^2 of the Yantra River drainage territory and forestation the total area is estimated on 28%.

Average discharge to the Danube River confluence point is evaluated on approximately 50m^3/s. Discharge is variable, with usual yearly mean discharges ranging from 15 to 96m^3/s.

Settlements : The administrative boundaries of 18 nos. of municipalities are coinciding in general with the boundaries of the Yantra river catchment. Total number of settlements located there is 809 with a population of approximately 470,000 (to 2002). It is about 5.5% of the total population of the country (to 2002). Major cities within the Yantra river basin are Veliko Tarnovo, Gabrovo, Gorna Oryahovitsa, Sevlievo, Tryavna, Pavlikeni and Omurtag where about 50% of people live and work.

Industry : Despite the considerable decrease in the volume of production compared to 1990, the traditionally developed branches of industry within the Yantra river basin territory - food and food processing, wine and brewing industry, textile and knitwear production, leather and shoe manufacturing, chemical industry, machine engineering, metalwork and processing industry, automation and spare standard & non-standard parts and equipment manufacturing, woodwork and furniture industry, electric cables and conductors production, metal & plastic products and wooden structures and elements for construction industry – still hold a large share in the region's production.

Agriculture : Farming is a priority branch for the Yantra drainage basin plains where many firms and cooperatives are mostly engaged in agriculture and dealing with the production of grain crops, technical crops, fodder crops and perennial plants. The mill and fodder production are in correspondence with the grain production in the region – farina processing and extrusion of soybeans are well developed as a result of 60 years of experience in the technology for the growing and production of soybeans and maize, these extremely valuable products for the feeding of farm animals. Floriculture has good traditions and develops fast in the plane municipalities of the Yantra River catchment. Mainly roses and evergreen vegetation are grown, and also planting material for the greenbelt setting of parks and gardens.

Stock- breeding : Animal breeding is less development than agriculture. A production of beef and dairy cattle, sheep and goats is drastic down comparing to the past (1990) because of the former governmental policy collapse and increased people migration in search of new employment, higher wages, new lifestyle and educational opportunities for themselves and their children. Some new producers of broilers, laying hens and eggs with international partnership were established in the last few years and work with their full capacity.

Utilization : According to The General Schemes for Water Utilization in the River Basin Management Regions' conclusions defined by the Water Problems Institute of Bulgarian Academy of Sciences, the water use and availability ratio of the Yantra drainage basin is assessed as "good". Unfortunately no available data is applied to prove this consideration neither some written statements. (A stressed watershed is defined by the Organization for Economic Co-operation and Development as a watershed in which greater than 40% of the available renewable water within the watershed is used by humanity for industrial, agricultural, or personal uses).

Up to 1990 many hydraulic facilities and structures have been constructed by the Government to service the needs of water supply and sewerage, hydropower electricity generation, irrigation and flood protection. Most of them are not in good conditions and deteriorated, and their rehabilitation and upgrade is mostly recommended. The most significant water infrastructure in the Yantra River watershed described by water utilities are as the followings:

Water supply and sewerage - The water supply and sewerage (ViK) companies of Gabrovo, Yovkovtsi, Sevlievo, Targovishte, Sliven and Troyan are responsible to serve about 0.5 million people populating in the urban areas of 18 municipalities. In addition to the existing six drinking water purification plants,

the above water utilities maintain and operate more than 5,000km of water lines and 250 water pump plants, and more than 70 million m^3 of potable water taken in at least 550 nos. of water intakes, spring boxes, water wells and other facilities are provided to the consumers yearly. Total length of serviced sewerage network in settlements exceeds 500km and most of the collected urban sewage is treated by WWTP constructed in the towns of Gabrovo, Veliko Tarnovo, Strazhitsa and Gorna Oryahovitsa. Another two wastewater treatment plants proposed to improve water quality in the Rositsa River at Sevlievo and the Karadere River at Antonovo are under construction.

Hydropower electricity – A stream flow capacity of the Yantra River and its tributaries available to be used for electricity generation is estimated on 139.8 MW-h. Since 1912 year 13 nos. of hydropower plants with installed total capacity of 18.21 MW are in operation. 4 nos. of them with installed capacity of 11.12 MW rely on the water stored into "Hristo Smirnenski" reservoir and "Alexander Stamboliiski" reservoir. Remain capacity of a gravity flow in amount of 76.15 MW-h is calculated, but it is utilization will require construction of many new mini hydropower plants.

Irrigation – During the socialism time (up to the end of 1989) most of the existing agricultural land into the Yantra River watershed was equipped with irrigation infrastructure. About 65,600ha agricultural area had been determined as irrigable and designed to be irrigated. Because of that many protective dykes, water intakes, irrigation channels and different scale dam lakes were constructed to serve and maintain agriculture within the region. The biggest irrigation areas were formed and built in the valleys of the Rositsa River, the Stara River and the Golyama River, and low places near their confluence with the main river, as well as of the lowland around the Yantra River downstream where it inflows into the Danube River. They are as the followings: Rositsa irrigation system, Vardin-Karamanovo irrigation system, Strazhitsa irrigation system, Negovanka irrigation system, Krapets irrigation system, Yantra-Borovo irrigation system, and Popovo irrigation system. Most of heavy irrigation of the above farm areas is ensured with water coming from "Alexender Stamboliiski" and "Yastrebino" reservoirs, and few water intakes located on the main streams via the channel network constructed in the period 1960 to 1989. Some of separated small irrigation fields are connected to the independent small dam lakes spread on the territory of the Yantra river basin. Water transfers for irrigation needs between the Yantra River watershed and neighbor basins of the Osam River and the Rusenski Lom River are carried out near Pavlikeni town and near Popovo town. Unfortunately most of the constructed and well-maintained irrigation structures in the past are derogated and/or abandoned because a lack of funding sources for their operation and maintenance.

Reservoirs – 20nos. of dam lakes in the volume capacity > 1,000,000m^3 are constructed within the Yantra River basin. Depending of their main purpose these reservoirs can be outlined as:

Potable water supply - "Yovkovtsi" with the capacity of 92,200,000 m^3 and "Hristo Smirnenski" – 28,300,000 m^3;

Multipurpose (irrigation, electricity generation & flood control) - "Alexander Stamboliiski" with the capacity of 222,000,000m^3; and

Irrigation - "Yastrebino" – 62,800,000 m^3, "Krapets" – 17,800,000m^3, "Karaisen" – 10,250,000m^3, "Kazal Dere" – 8,500,000m^3 and another 13nos. of small reservoirs where the total volume of 21,650,000 m^3 water is ensured.

Floods :

Periodically flood events occur into the Yantra River drainage basin when an area of land, usually low-laying along the main stream and/or its biggest tributaries – the Rositsa River, the Golyama river, the Stara River, and Dzhulyunitsa River. As a rule, the worst floods consistently happen when a river overflows its banks and protective dykes constructed there. In upper (mountain) area of the Yantra river watershed the river floods are as result from heavy rains, mostly combined with snow melting. The low lands in the towns of Gabrovo, Tryavna, Zlataritsa, Draynovo and Apriltsi were covered with water many times because of flash floods. A bad manner of the Yantra mid- and downstream forces many times the low lands of the towns of Veliko Tarnovo and Dolna Oryahovitsa, and of the some villages located in the natural flood plain of the river to suffer. Data of recorded floods in the Yantra River basin is given in the table below.

No.	River	Affected Settlement Location	Drainage Area (km^2)	Observed Water Quantity (m^3/s)	Date
1	Rositsa	Sevlievo	1084	n/a	1894
2	Rositsa	Karamichevtsi village	203	1978	28-Jun-39
3	Vidima	Sevlievo	560	690	28-Jun-39
4	Rositsa	Sevlievo	1084	2755	29-Jun-39
5	Yantra	Cholakovtsi village	1289	1307	14-Jul-44
6	Yantra	Vetrintsi village	476	692	28-Jun-57
7	Rositsa	Vodolei village	1856	1100	28-Jun-57
8	Yantra	Radnevo village	6574	1336	29-Jun-57
9	Yantra	Gabrovo	287	240	04-Jun-66
10	Belishka	Kilifarevo	n/a	n/a	06-Jul-91
11	Dryanovska	Dryanovo	165	n/a	06-Jul-91
12	Yantra	Veliko Tarnovo	1289	n/a	06-Jul-91
13	Yantra	Gabrovo	287	n/a	1995
14	Yantra	Veliko Tarnovo	1289	n/a*	30-May-02
15	Plachkovitsa	Plachkovtsi town	n/a	n/a	25-May-05
16	Rositsa	Sevlievo	1084	n/a	26-May-05
17	Yantra	Gabrovo	287	150	04-Jul-05
18	Yantra	Veliko Tarnovo	1289	572	04-Jul-05
19	Yantra	Villages of Pisarevo & Parvomaytsi		n/a	04-Jul-05
20	Golyama	Strazhitsa	605	~500	05-Jul-05
21	Dzhulyunitsa	Dzhulyunitsa village	882	453	05-Jul-05
22	Yantra	Gabrovo	287	165	14-Jul-05
23	Zlatarishka	Zlataritsa	n/a	n/a	19-Sep-05
24	Yantra	Gabrovo	287	n/a	19-Sep-05

To be continued

Continuation

No.	River	Affected Settlement Location	Drainage Area (km^2)	Observed Water Quantity (m^3/s)	Date
25	Yantra	Veliko Tarnovo	1289	376.5	20-Sep-05
26	Yantra	Dolna Oryahovitsa	n/a	n/a	20-Sep-05
27	Rositsa	Vodolei & Resen villages	1856	n/a	20-Sep-05
28	Yantra	Gabrovo	287	n/a	22-May-07
29	Yantra	Veliko Tarnovo	1289	n/a	22-May-07

Sources:

Floods in Bulgaria, 2005 & 2006, NIMH: http://hydro.meteo.bg/bg/data/REKI_2005.rtf; http://hydro.meteo.bg/bg/data/REKI_2006.rtf; and http://balwois.mpl.ird.fr/balwois/administration/full_paper/ffp-821.pdf

2007, Global Register of Major Flood Events: http://www.dartmouth.edu/~floods/Archives/2005sum.htm

** - Several days of heavy rain classified as "heaviest rainfall in Bulgaria for the last 50 years". 16,000ha of crops were inundated in northeast Bulgaria. Many villages are isolated. More than 100 villages and small towns were affected by floods. Damages were estimated on 15,000,000 leva.*

2. Equipment List

Travel : TOYOTA Land Cruiser 4WD

GPS Navigation : Global Positioning System Receiver GARMIN GPSMAP 60 MONO

GPS Accuracy: **Position:** < 15 meters (49 feet), 95% typical[2]

Velocity: 0.05 meters per second steady state

[2] – Subject to accuracy degradation to 100m 2DRMS under the U.S. Department of Defense imposed Selective Availability (SA) Program.

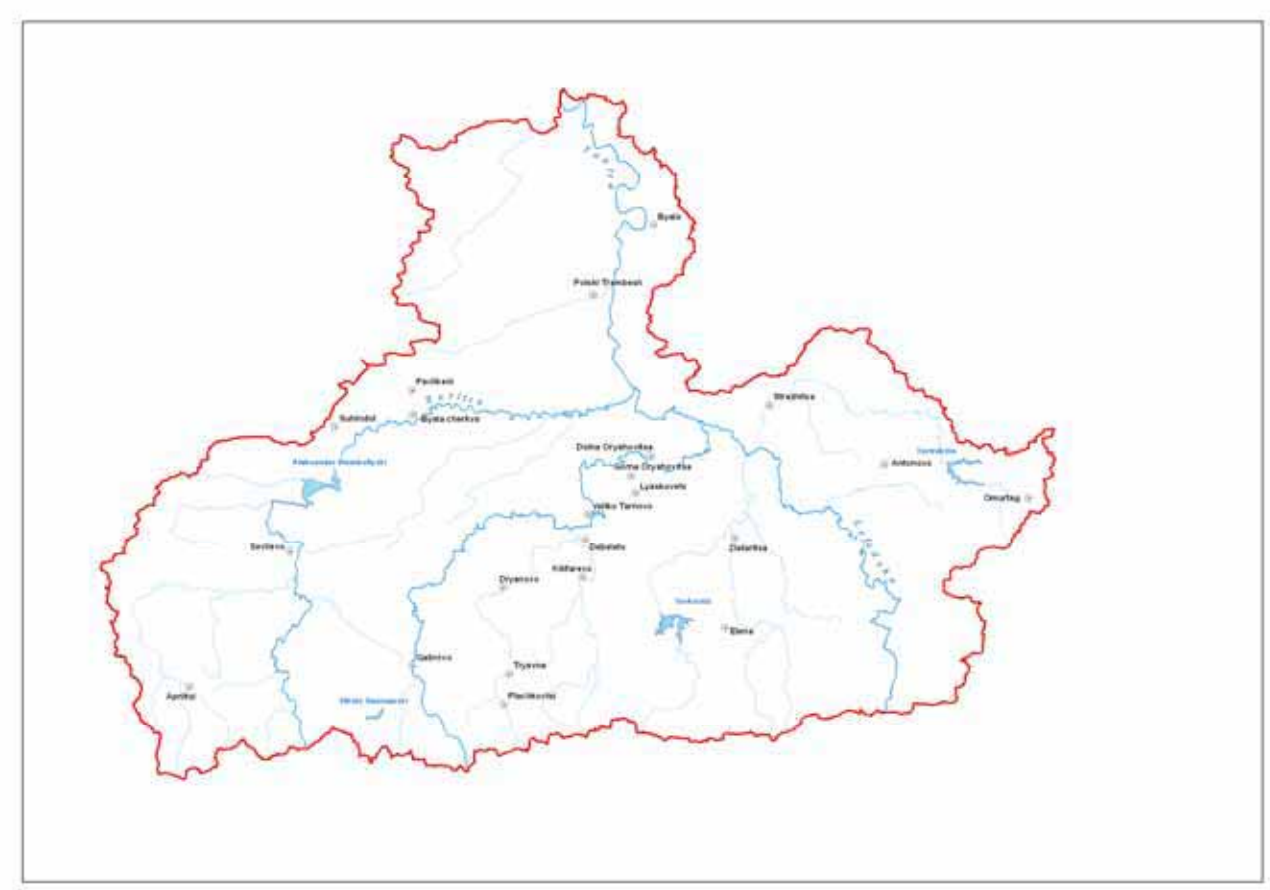
Distance Measurement : Laser Rangefinder/Hypsometer Opti-Logic 600LH

Operational Range:	Model	Passive	Reflective
	600LH:	4-600 yd	Up to 999 yd

Range Resolution: 1 foot / 0.5 yard / 0.1 meter

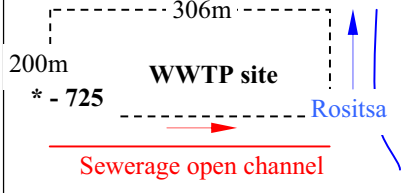
Digital Camera : PRAKTICA luxmedia 6203

3. The Yantra River Drainage Basin Scheme



4. Visited Points List

Schedule : November 12 and 13, 2007

No.	Point ID and Site Location	River Drainage Basin	Datum: WGS 84 Position			Note and/or Description
			Lat (N)	Lon (E)	Alt *(m)*	
Nov 12, 2007 (Mon)						
1	**725 :** Sevlievo WWTP Construction Site	Rositsa	43°01'49.9"	25°05'51.7"	208	1. 5.5m above sewerage outlet 

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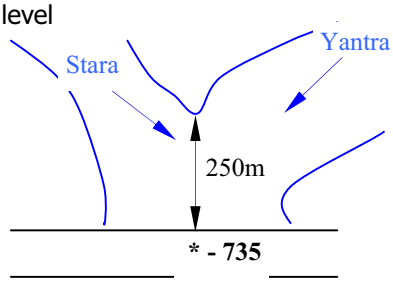
Continuation

No.	Point ID and Site Location	River Drainage Basin	Datum: WGS 84 Position			Note and/or Description
			Lat (N)	Lon (E)	Alt *(m)*	
Nov 12, 2007 (Mon)						
2	**726:** The road bridge at Sevlievo town	Rositsa	43°01'21.4"	25°06'30.4"	201	1.) 8.0m above recent water level 2.) Total width of river – 80m
3	**727:** Sevlievo Landfill (Solid waste dumping site)	Rositsa	43°00'28.6"	25°08'11.5"	266	1.) At the landfill entrance
4	**728:** The road bridge near a confluence of Vidima River with Rositsa River	Vidima	42°59'09.0"	25°06'01.1"	216	1.) 8.0m above recent water level 2.) Total width of river – 37m 3.) 200m distance westward from the rivers confluence
5	**729:** Batoshevo-1 HPP at the village of Batoshevo	Rositsa	42°54'08.9"	25°05'10.8"	276	1.) 150m distance northward from the HPP Bldg 2.) Batoshevo-2 HPP water intake is located on ~200m distance from Batoshevo-1 HPP upstream 3.) Rock masonry sharp crested weir with 2 gates – 38m length
6	**730:** Hristo Smirnenski reservoir at Gabrovo	Yantra	42°49'03.8"	25°15'57.0"	542	1.) 1.50m above non overflow crest elevation
7	**733:** The road bridge near a confluence of Draynovska River with Yantra River near Cholakovtsi, at Veliko Tarnovo	Yantra	43°03'34.8"	25°35'58.3"	282	1.) 12.0m above recent water level 2.) Total width of river – 45m 3.) 67m distance downstream from the rivers confluence
8	**734:** Yovkovtsi reservoir	Veselina	42°56'49.8"	25°45'46.1"	341	1.) 1.50m above non overflow crest elevation
9	**735:** The road bridge near a confluence of Stara River with Yantra River at Gorski Dolen Trambesh village	Yantra	43°12'10.7"	25°49'28.2"	63	1.) 15.0m above recent water level 

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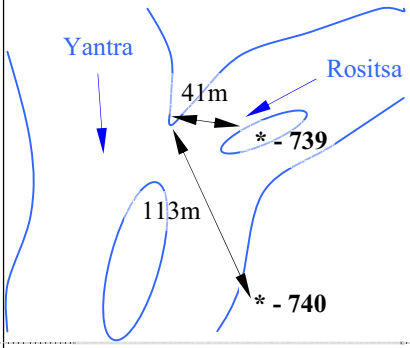
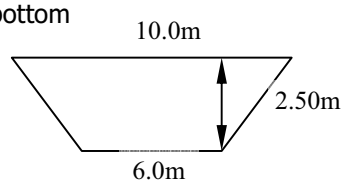
Continuation

No.	Point ID and Site Location	River Drainage Basin	Datum: WGS 84 Position			Note and/or Description
			Lat (N)	Lon (E)	Alt *(m)*	
Nov 13, 2007 (Tue)						
10	**736:** Gorna Oryahovitsa WWTP – inlet	Yantra	43°08'38.3"	25°43'50.1"	92	1.) The coordinates are taken on the inlet concrete coverage surface at the beginning of inlet channel
11	**737:** Gorna Oryahovitsa WWTP – outlet	Yantra	43°08'37.6"	25°43'56.2"	89	1.) The coordinates are taken on the outlet concrete coverage surface at the beginning of discharge channel
12	**738:** The road bridge on the Rositsa River before its confluence with Yantra River	Rositsa	43°12'59.1"	25°38'14.8"	56	1.) 0.50m above recent water level of the Rositsa River 2.) Total width of river – 35m 3.) Fishing of roach, knife and pikeperch fishes
13	**739 & 740:** Confluence point of Rositsa River with Yantra River at Krusheto village	Yantra	43°14'44.6" & 43°14'46.7"	25°42'28.0" & 25°42'23.2"	47 & 51	1.) 739: - at the recent water level of the Rositsa River 2.) 740: - on the top of left river bank dyke ~6.0m above recent water level of the Yantra River 
14	**741:** HMS No.23850 at Karantsi village on the Yantra River	Yantra	43°22'48.7"	25°40'06.2"	38	1.) On the right river bank 3.0m above the recent water level of the Yantra River 2.) Total width of river – 64m 3.) It looks like abandoned!
14	**743:** Nikyup irrigation channel at Lesicheri village on the road bridge	Rositsa	43°13'25.9"	25°25'16.5"	125	1.) On the road bridge fence, 3.0m above the irrigation channel bottom 

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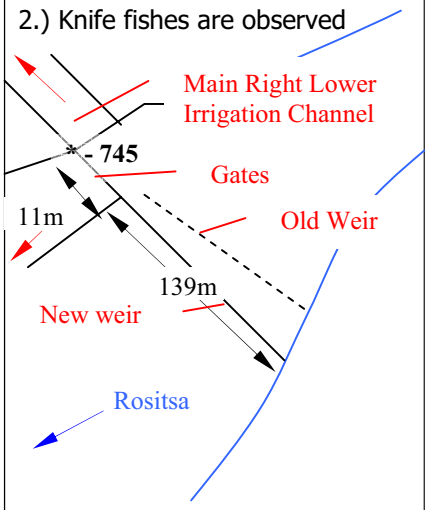
Continuation

No.	Point ID and Site Location	River Drainage Basin	Datum: WGS 84 Position			Note and/or Description
			Lat (N)	Lon (E)	Alt *(m)*	
Nov 13, 2007 (Tue)						
15	**744:** Main Lower irrigation channel serving Pavlikeni irrigation area & Rositsa-3 HPP at Stambolovo village on the road bridge	Rositsa	43°11'50.9"	25°20'59.7"	106	1.) On the road bridge fence, 2.50m above the irrigation channel bottom 2.) Designed to provide – 10m^3/s 3.) Under operation transfers about – 4.0m^3/s 4.) Concrete coverage surface of irrigation channel is very dilapidated
16	**745:** The bridge and weir gates near Byala cherkva town on the Rositsa River	Rositsa	43°11'44.9"	25°17'47.1"	113	1.) Water intake with dam type weir was built in 1960. In 1995 new dam type weir is constructed at new location. The structure is renovated in 1999 to 2000. 2.) Knife fishes are observed 
17	**746:** Alexander Stamboliiski reservoir at Gorsko Kosovo village	Rositsa	43°07'29.9"	25°10'10.4"	193	1.) 1.50m above non overflow crest elevation
18	**747:** Main Transfer irrigation channel serving Rositsa irrigation system & Rositsa-2 HPP at Byala Reka village on the road bridge	Rositsa	43°08'17.6"	25°11'00.7"	159	1.) On the road bridge fence, 2.0m above the recent water level 2.) Under operation

5. Visited Points Photos in the Yantra River Basin on Nov12, 2007

Pic.1 – General view of Sevlievo WWTP construction site

Pic.2 – The Rositsa River at Sevlievo town

Pic.3 – General view of Sevlievo Landfill (Solid waste dumping site)

Pic.4 – The Vidima River near confluence with the Rositsa River at Sevlievo town

Pic.5 – Batoshevo-1 HPP at Batoshevo village on the Rositsa River

Pic.6 – General view of Hristo Smirnenski reservoir, dam and tower intake

Pic.7 – Pollution discharge into the Yantra River near Cholakovtsi uptown at Veliko Tarnovo

Pic.8 – The confluence of the Dryanovska River (red arrow) with the Yantra River (blue arrow) near Cholakovtsi uptown at Veliko Tarnovo

Pic.9 – Tower intake of Yovkovtsi reservoir

Pic.10 – General view of the Stara River (blue arrow) confluence with the Yantra River (red arrow) at Gorski Dolen Trambesh village

6. Visited Points Photos in the Yantra River Basin on Nov 13, 2007

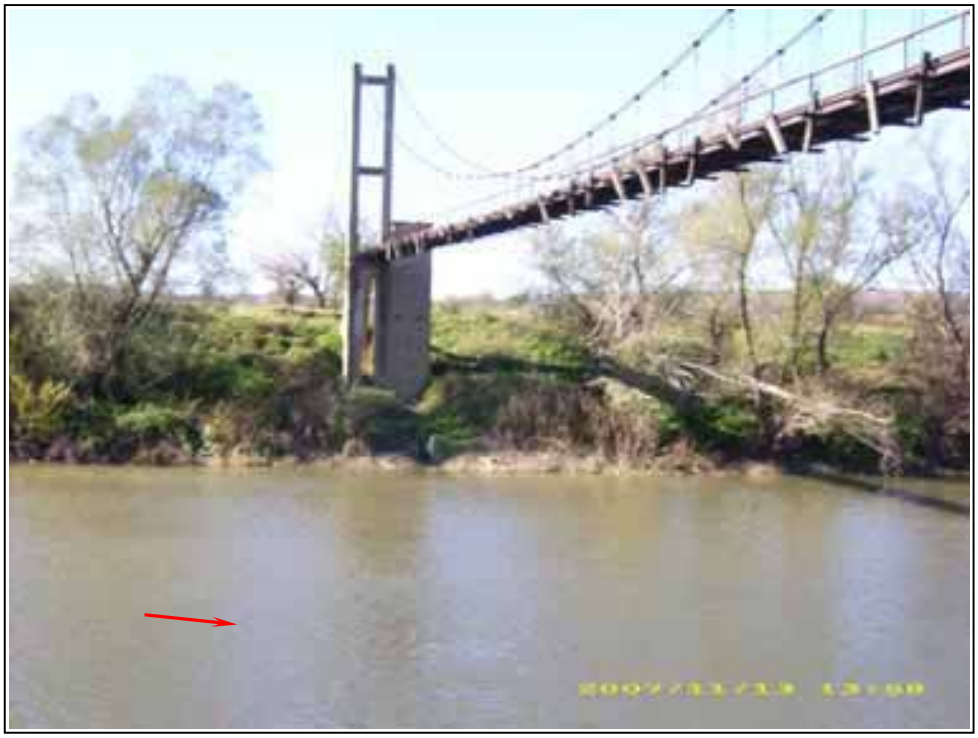
Pic.11 – Gorna Oryahovitsa WWTP: General view of inlet, inlet channel and storm water basin

Pic.12 – Gorna Oryahovitsa WWTP: Aeration tank with nitrification, denitrification and phosphorous removal

Pic.13 – The Rositsa River at the bridge of the road Veliko Tarnovo – Polski Trambesh

Pic.14 – Old meander of the Yantra River near Krusheto village

Pic.15 – General view of the Rositsa River (red arrow) confluence with the Yantra River (blue arrow) at Krusheto village



Pic.16 – Abandoned HMS No.23850 at Karantsi village on the Yantra River

Pic.17 – Nikyup irrigation channel at Lesicheri village on the road bridge

Pic.18 – Main Lower Right irrigation channel serving Pavlikeni irrigation area and Rositsa-3 HPP at Stambolovo village on the road bridge

Pic.19 – General view of the bridge and weir gates near Byala Cherkva town on the Rositsa River

Pic.20 – General view of the intake chamber and the beginning of the Main Lower Right irrigation channel at Byala Cherkva weir

Pic.21 – General view of Alexander Stamboliiski reservoir, dam and tower intake

Pic.22 – Main Transfer irrigation channel serving Rositsa irrigation system and Rositsa-2 HPP at Byala Reka village on the road bridge

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Address: *JICA Study Team Office*
14, G.M.Dimitrov Blvd., level 4, Danube River Basin Directorate – Sofia Branch suite
Sofia 1797, Bulgaria
Phone / Fax: ++359 (02) 971-3140
E-mail: jicastudyteam_sofiaoffice@yahoo.com and jicast@abv.bg

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1. Outline

Location : The Kamchia River is the biggest Bulgarian river flows into the Black sea. It is located mainly in the Eastern Stara Planina Mountain, but some of its left tributaries come from small chain of hills outlining northern boundary of the watershed. The Kamchiya River flows east where finally reaches the Black sea. Its basin is bounded on the west with the Yantra River watershed, to the northwest and north – with the valleys of the Rusenski Lom River tributaries and the Provadiiska River, and to the south – with the Tundzha River catchment area.

Characteristics : The drainage basin of the Kamchia River is the seventh largest in Bulgaria with an area of 5358km^2. The largest two rivers there – the Luda Kamchia and the Golyama Kamchia are braided in one bigger within 46km of the Black sea where the Kamchia River terminates through a confluence. In 1964 after careful consideration the Golyama Kamchia River has been determined as a main watercourse. It originates from a small spring in the Lisa Mountain at an elevation of 710m above sea level. The Kamchia River receives water from 27 tributaries along its 244.5km length. For 24 of them a stream distance between its spring and confluence with the main river is less than 30km. The names and characteristics of the Kamchia River headwaters are as the followings:

- The Luda Kamchia River is a right tributary with 200.9km length and drains a territory with an area of 1612km^2. It confluences with the main river at chainage 46^{+000}km
- The Vrana River – a left tributary with 67.6km length and an area of 937.6km^2, and flows into the main river at chainage 149^{+200}km; and
- The Eleshnitsa River – a right tributary with 43.4km length and an area of 178.8km^2, and flows into the main river at chainage 40^{+300}km

The Kamchia River is a typical mature river where the average stream gradient is 5.3‰. The rapids streams take only 7% of the watershed and the riverbed inclination there is about 22‰. Another 32% of the watercourse grades in descending order from 5.16‰ to 2.19‰. Downstream of the Kamchia River is a predominantly flat with a very low gradient - 0.57‰.

Average altitude of the Kamchia watershed is calculated on 327m above sea level and the river network density is very low - 0.7km/km^2 only.

The forestation is estimated on 49% or 2600km^2 of the total river basin area. A correlation between the high-stemmed vegetation in presence of oak, beech, elm and ash trees, and the low-stemmed woody plants and shrubs covering the Kamchia River drainage territory is evaluated in 50/50.

Average discharge to the Black sea confluence is evaluated on approximately 27m^3/s. Discharge is variable, with usual yearly mean average discharges ranging from 3 to 50m^3/s. During the years the values exceed few times the annual average water quantity were recorded by some hydrometric stations on the rivers in the Kamchia River basin. The quantity of 488m^3/s is observed at Poda site, chainage 8^{+300}km, on the Kamchia River on Apr 18, 1973. Another significant result in the amount of 481m^3/s was registered at Grozdyovo village, chainage 40^{+300}km, on the same river on Mar 04, 1965.

Settlements : The administrative boundaries of 10 nos. of municipalities are coinciding in general with the boundaries of the Kamchia River catchment. Total number of settlements located there is 230 with a population of approximately 340,000 (to 2005). Major cities within the Kamchia River basin are Shumen, Targovishte, and Veliki Presvav where about 42% of people live and work.

Industry : The most important for the economy of the Kamchia river basin territory are automotive, non-ferrous metals, perfumery and cosmetics, electronics, furniture, agriculture products processing, wine production, porcelain and faience, tailoring and textile industries. Some of the big companies in the area produce trucks and spare parts, shaped aluminum metal manufacturing, production and trade of electrical appliances, soaps, and washing agents, and natural aroma products, cosmetics and pharmaceutical products. Also purchase and processing of grape, production and trade of wines and high spirit alcoholic beverages are well developed. Other of the traditionally developed branches of economy as food and food processing, brewery, leather manufacturing, textile and sewing industry, metalwork and processing industry, chemical industry, glass and glass articles production, ceramic industry, wood processing and furniture production, tobacco related processing industry and preserved foods manufacturing are also well situated there.

Agriculture : The main agricultural products in the Kamchia drainage basin are wheat, corn, sunflower, barley butter and green beans, and grapes. Except the grain crops production, the dealing with technical crops and fodder crops is extended in the region too. Also the perennial plants growing and production has good traditions there, but in ranges less than 1990. Mainly apples, peaches, plums and cherries, and vegetation are grown and delivered to the regional market and abroad.

Stock- breeding : Most of landforms spread in the Kamchia River territory are very appropriate for animal breeding there. On the other hand the region has traditions in farming and animal production and people could keep the breeding range of beef and dairy cattle, horses and buffalos, sheep and goats, rabbits and chicken. The view of black pigs grazing free near the settlements or in the meadows is another preserved regional peculiarity, typical for the Kamchia River area.

Utilization : Water utilization has a long history in the Kamchia River watershed. During the years many of the rivers there have been modified since life needs require straightening of streams so that farm lands become more manageable, or roads and bridges can be constructed more easily, or the capacity of watercourse within urban areas to be increased for flooding prevention. Up to 1960 some engineering works concerning riverbank reinforcement aiming at protecting human activities from flood damages and hydropower generation were carried out on selected river sections in the Kamchia catchments. A dyke with a length of 11.2km to protect the farm area within the distance from the river mouth at Black sea to Poda site, chainage 6^{+900}km was constructed. In the period 1960 - 1989 intensive protective and irrigation activities covering big scale areas of agricultural land along the rivers and fish-breeding ponds construction were done, but not fully completed. Except the reservoirs, most of structures built in the past are in bad conditions and too many deteriorated. The most significant water

infrastructure in the Kamchia River watershed described by existing water utilities are as the followings:

Water supply and sewerage - The water supply and sewerage (ViK) companies of Varna, Shumen, Targovishte, Sliven and Burgas are responsible to serve about 1.0 million people populating in the region (approximately 340,000 habitants in the urban areas of 10 municipalities matching the Kamchia River drainage territory). In addition to the existing five drinking water purification plants, the above water utilities maintain and operate more than 5,100km of water lines and 30 water pump plants, and more than 44 million m^3 of potable water taken in at least 323 nos. of water intakes, spring boxes, water wells and other facilities are provided to the consumers yearly. Total length of serviced sewerage network in settlements exceeds 315km and most of the collected urban sewage is treated by WWTP constructed in the towns of Shumen, Dalgopol and DolniChiflik village, and Kamchia resort. Another two wastewater treatment plants proposed to improve water quality in the Golyama Kamchia River at Veliki Preslav and the Vrana River at Targovishte are under construction.

Hydropower electricity – A stream flow capacity of the Kamchia River and its tributaries available to be used for electricity generation is estimated on about 6.0 million kW-h. Since 1951 year only 1 hydropower plant with installed total capacity of 0.4 MW was constructed at Veliki Preslav town on the Golyama Kamchia River, because of the irregular spatial distribution of the waterpower relative potential within the Kamchia watershed.

Irrigation – Highly rate of cultivation on all lands appropriate to be farmed is favored due to morphological structures and conditions in the Kamchia River watershed. Forming of big scale irrigation infrastructure was initiated by the construction of "Ticha" and "Tsonevo" reservoirs in 70s'. According to the big dam lakes location the existing small reservoirs and served by them irrigation areas were joined consecutively. Two big irrigation systems were formed and built in the Kamchia River basin. First one was developed in the Golyama Kamchia River valley between the towns of Veliki Preslav and Smyadovo, and plains around the towns of Targovishte and Shumen. The 2nd of them was covered downstream of the Kamchia River valley from Komunari village to the river mouth at Black sea. In accordance with The General Schemes for Water Utilization in the River Basin Management Regions' conclusions defined by the Water Problems Institute of Bulgarian Academy of Sciences in 2002, about 42,259ha agricultural area within the Kamchia River basin were determined as "in good status" and proposed to be rehabilitated. The existing irrigation systems by locations as a subject of further operation and maintenance are as follows:
Golyama Kamchia region (upper watercourse) has a 37475ha of farming area and includes Dabrositsa irrigation system, Ovcharovo irrigation system, Saedinenie irrigation system, Polyanitsa irrigation system, Krasnoseltsi irrigation system, and Vinitsa irrigation system; and
Kamchia region (lower watercourse) covers 4781ha of agriculture land shared among Tsonevo irrigation system, Eleshnitsa irrigation system and Dolen Chiflik irrigation system. In addition the appropriate infrastructure connection between Tsonevo reservoir and Devnya industrial area was constructed in the 80s' of twenty century. It has to ensure industrial water supply needs there, but after changing of owner in Devnya's industries and the renovation which followed, this

released water volume was transferred to provide a back up of Varna's drinking water supply in the case of emergency.

Reservoirs – 23nos. of dam lakes in the volume capacity > 1,000,000m^3 are constructed within the Kamchia River basin. Depending of their main purpose these reservoirs can be outlined as:

Potable water supply: Ticha" with the capacity of 312,000,000 m^3 and "Kamchia" - 228,800,000 m^3;

Multipurpose (industrial water supply, drinking water supply back up, irrigation & flood control): "Tsonevo" with the capacity of 329,000,000m^3; and

Irrigation: "Saedinenie" – 12,810,000 m^3, "Eleshnitsa" – 10,620,000m^3, "Kayabash-1" – 10,340,000 m^3, "Fisek" – 8,930,000m^3 and another 16 nos. of small reservoirs where the total volume of 33,180,000 m^3 water is ensured.

Floods :

The long-term observations and analysis of the flash flood events in the country investigated by the Bulgarian Academy of Sciences classify the rivers in the Kamchia watershed from moderate torrential (up to 4-6 cases per year) to heavily torrential (at least 8-9 times) depending of the number of catastrophic phenomena recurrence annually. Under the above of typology the Vrana River is indicated as in moderate risk, while the Golyama Kamchia and the Luda Kamchia Rivers are determined as in heavily risk. Data of recorded floods in the Kamchia River basin is given in the table below.

No.	River	Affected Settlement or Area Location	Drainage Area (km^2)	Observed Water Quantity (m^3/s)	Date
1	Bokludzhadere	Shumen	n/a	n/a	1821
2	Kamchia	Grozdyovo village	4857	428	04-May-37
3	Luda Kamchia	Asparuhovo village	1521	536	17-Dec-53
4	Vrana	Kochovo village	880	81.7	06-Mar-54
5	Golyama Kamchia	Veliki Preslav	1010	626	06-Nov-57
6	Kamchia	Grozdyovo village	4857	413	05-Feb-63
7	Kamchia	Poda site	5262	422	05-Feb-63
8	Vrana	Targovishte, Lilyak village	73.30 n/a	n/a	04-Jul-99
9	Ashiridere	Davidovo village	n/a	n/a	04-Jul-99
10	Kalaidzhidere	Osen village, Ruets village	n/a	n/a	04-Jul-99
11	Golyama Kamchia	Veliki Preslav	203	n/a	03-Sep-99
12	Dragoevska	Dragoevo village	n/a	n/a	03-Sep-99
13	Vrana	Targovishte	73.30	n/a	03-Sep-99
14	Bokludzhadere	Shumen	n/a	n/a	04-Sep-99
15	Golyama Kamchia	Ticha village	122	n/a	04-Sep-99

To be continued

Continuation

No.	River	Affected Settlement or Area Location	Drainage Area (km^2)	Observed Water Quantity (m^3/s)	Date
16	Kamchia	Poda site	5262	n/a	04-Sep-99
17	Dragoevska	Dragoevo village	n/a	n/a*	01-Jun-02
18	Bokludzhadere	Shumen	n/a	n/a*	01-Jun-02
19	Kamchia	Poda site	5262	n/a*	01-Jun-02
20	Golyama Kamchia	Salmanovo village	2095	n/a	04-Jul-05
21	Vrana, Siva	Targovishte, Lilyak village	73.3 n/a	n/a	04-Jul-05
22	Ashiridere	Davidovo village	n/a	n/a	04-Jul-05
23	Kalaidzhidere	Osen village, Ruets village	n/a	n/a	04-Jul-05
24	Kralevska	Kralevo village	11.80	n/a	04-Jul-05
25	Luda Kamchia	Beronovo village	590.40	n/a**	04-Jul-05

Sources:

Floods in Bulgaria, 2005 & 2006, NIMH: http://hydro.meteo.bg/bg/data/REKI_2005.rtf; http://hydro.meteo.bg/bg/data/REKI_2006.rtf; and http://balwois.mpl.ird.fr/balwois/administration/full_paper/ffp-821.pdf

2007, Global Register of Major Flood Events: http://www.dartmouth.edu/~floods/Archives/2005sum.htm

** - Several days of heavy rain classified as "heaviest rainfall in Bulgaria for the last 50 years". 16,000ha of crops were inundated in northeast Bulgaria. Many villages are isolated. More than 100 villages and small towns were affected by floods. Damages were estimated on 15,000,000 leva.*

***- Rope bridge and concrete weir were destroyed by the river high water. Observation hut of HMS No.43500 was abandoned after the flood.*

2. Equipment List

Travel : TOYOTA Land Cruiser 4WD

GPS Navigation : Global Positioning System Receiver GARMIN GPSMAP 60 MONO

GPS Accuracy: **Position:** < 15 meters (49 feet), 95% typical[2]

Velocity: 0.05 meters per second steady state

[2] – Subject to accuracy degradation to 100m 2DRMS under the U.S. Department of Defense imposed Selective Availability (SA) Program.

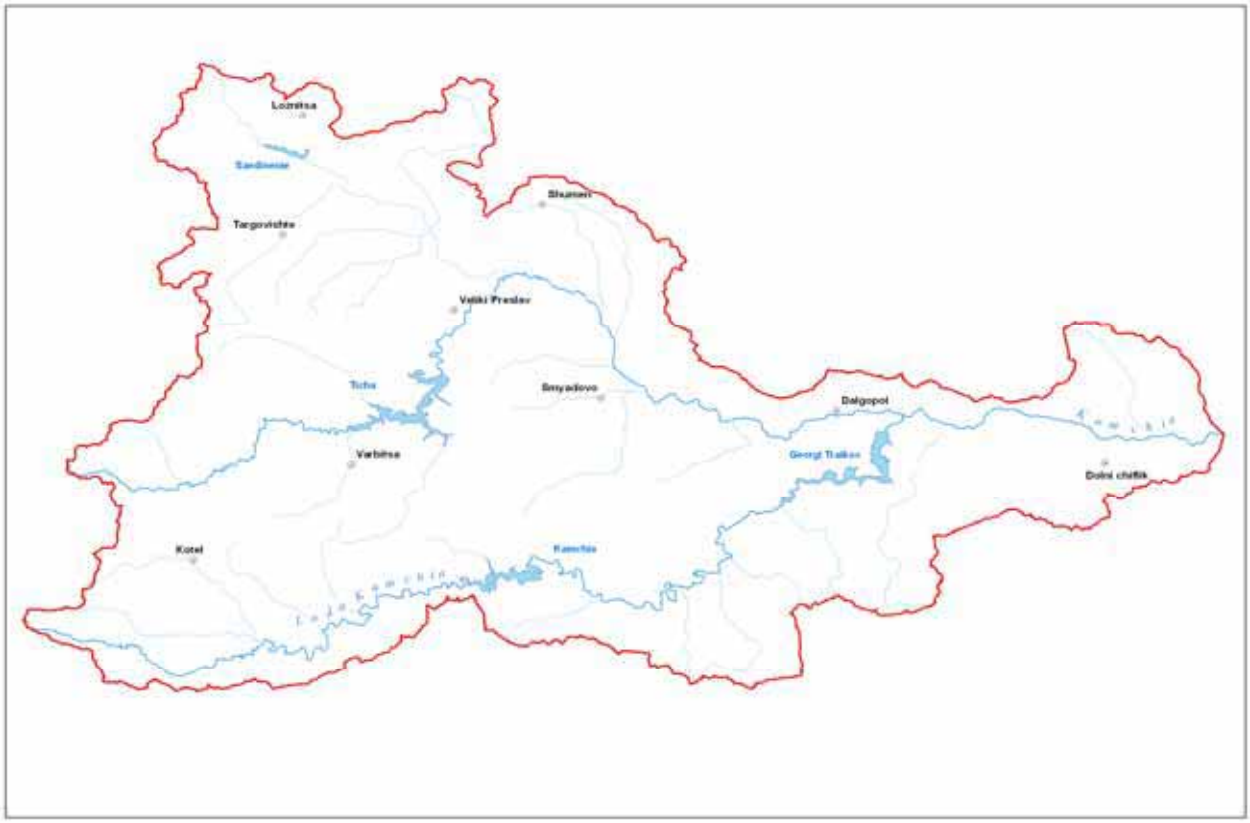
Distance Measurement : Laser Rangefinder/Hypsometer Opti-Logic 600LH

Operational Range:	Model	Passive	Reflective
	600LH:	4-600 yd	Up to 999 yd

Range Resolution: 1 foot / 0.5 yard / 0.1 meter

Digital Camera : PRAKTICA luxmedia 6203

3. The Kamchia Drainage Basin Scheme



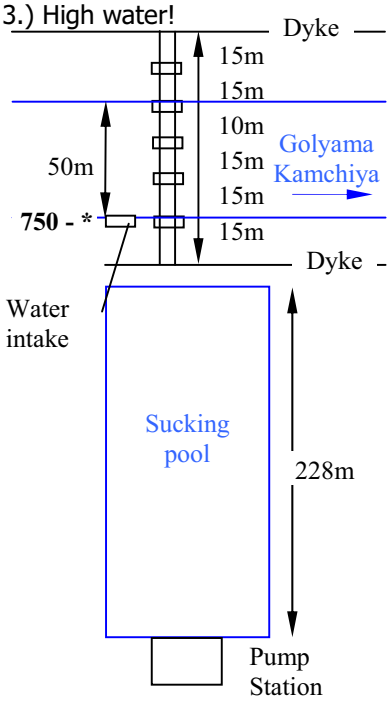
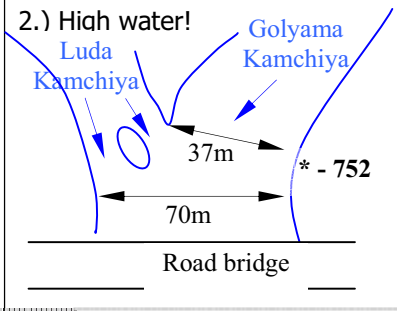
4. Visited Points List

Schedule : November 19 and 20, 2007

No.	Point ID and Site Location	River Drainage Basin	Datum: WGS 84 Position			Note and/or Description
			Lat (N)	Lon (E)	Alt *(m)*	
Nov 19, 2007 (Mon)						
1	**748:** Kamchia reservoir at Kamchia village	Luda Kamchia	42°53'04.9" & 42°52'04"	26°55'28.2" & 26°52'32"	269	* - Within a distance of 300m to the exact location! ** - Reservoir's tile location!

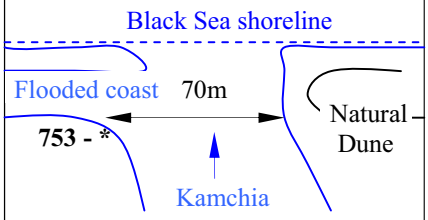
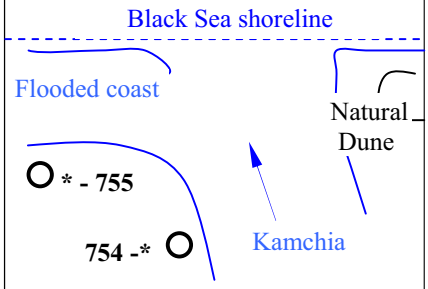
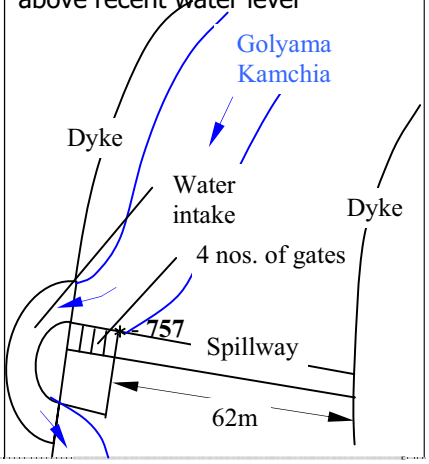
To be continued

Continuation

No.	Point ID and Site Location	River Drainage Basin	Datum: WGS 84 Position			Note and/or Description
			Lat (N)	Lon (E)	Alt *(m)*	
Nov 19, 2007 (Mon)						
2	**749:** The road bridge on the Luda Kamchia River at Daskotna village	Luda Kamchia	42°52'37.9"	27°10'58.9"	88	1.) 8.0m above recent water level 2.) Total width of river – 40m 3.) High water!
3	**750:** The bridge, wear mechanism and irrigation intake at Komunari village on the Golyama Kamchia River	Golyama Kamchia	43°01'09.2"	27°16'45.1"	35	1.) 0.0m above recent water level 2.) Total width of river – 50m 3.) High water! 
4	**751:** Tsonevo reservoir at Tsonevo village	Luda Kamchia	43°01'48.9"	27°24'24.8"	59	1.) 0.0m above non overflow crest elevation 2.) At the dam on the right hill slope
5	**752:** The road bridge at Velichkovo village on the Kamchia Fork	Kamchia	43°02'39.9"	27°26'33.5"	24	1.) At the top of protective dyke 2.0m above recent water level 2.) High water! 

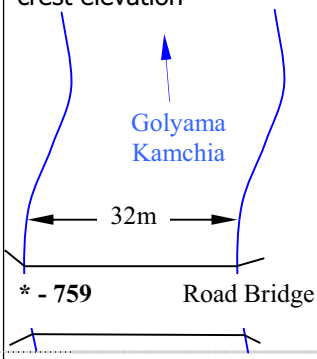
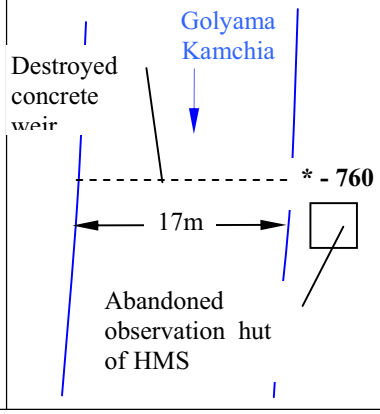
To be continued

Continuation

No.	Point ID and Site Location	River Drainage Basin	Datum: WGS 84 Position			Note and/or Description
			Lat (N)	Lon (E)	Alt *(m)*	
Nov 19, 2007 (Mon)						
6	**753:** The Kamchia River mouth at Black Sea	Kamchia	43°01'22.0"	27°53'17.4"	1	1.) Sand coast was flooded because of high water 2.) At the edge of flooded area 1.0m above recent water level 
7	**754 & 755:** Sewer manholes location of the sanitary conduit serving a tourist resort at the Kamchia River mouth	Kamchia	43°01'21.2" & 43°01'21.9"	27°53'15.4" & 27°53'15.1"	2 & 2	1.) The coordinates are taken on the manhole concrete surface 
Nov 20, 2007 (Tue)						
8	**756:** Shumen WWTP – inlet and inlet channel	Bokludzha Veselina	42°56'49.8"	25°45'46.1"	341	1.) The coordinates are taken on the bridge concrete surface 2.50m above the recent water level
9	**757:** The bridge and weir gates of Ticha HPP near Veliki Preslav town on the Golyama Kamchia River	Golyama Kamchia	43°12'10.7"	25°49'28.2"	63	1.) The coordinates are taken on the bridge concrete surface 4.0m above recent water level 

To be continued

Continuation

No.	Point ID and Site Location	River Drainage Basin	Datum: WGS 84 Position			Note and/or Description
			Lat (N)	Lon (E)	Alt *(m)*	
Nov 13, 2007 (Tue)						
10	**758:** Ticha reservoir	Golyama Kamchia	43°08'38.3"	25°43'50.1"	92	1.) 1.0m above non overflow crest elevation 2.) At the dam on the right hill slope
11	**759:** The Golyama Kamchia River on the road bridge at Mengishevo village	Golyama Kamchia	43°08'37.6"	25°43'56.2"	89	1.) 15.0m above non overflow crest elevation 
12	**760:** HMS No.43500 at Beronovo village on the Luda Kamchia River	Rositsa	43°12'59.1"	25°38'14.8"	56	1.) At the recent high water level of the Luda Kamchia River 2.) Abandoned! 

5. Visited Points Photos in the Kamchia River Basin on Nov19, 2007

Pic.1 – General view of Kamchia reservoir and rockfill dam

Pic.2 – The Luda Kamchia River at Daskotna village

Pic.3 – General view of the bridge, the weir gate and the irrigation intake at Komunari village on the Golyama Kamchia River

Pic.4 – Detailed view of the gate mechanism, flooded irrigation intake and lifting pump station (red circle) behind the water pool

Pic.5 – General view of Tsonevo reservoir, dam and tower intake

Pic.6 – The confluence of the Luda Kamchia River (red arrow) with the Golyama Kamchia River (blue arrow) at Velichkovo village

Pic.7 – Sand coast of the Black Sea flooded by the Kamchia River' high water at Kamchia resort

Pic.8 – This is the mouth of the Kamchia River, where it finally reaches the sea

6. Visited Points Photos in the Kamchia River Basin on Nov 20, 2007

Pic.9 – Shumen WWTP: General view of inlet channel, racks and grit chamber

Pic.10 – Shumen WWTP: Detailed view of aeration tank

Pic.11 – Shumen WWTP: Chemical laboratory of Shumen Water Supply & Sewerage (Water Utility) company is well equipped and accredited

Pic.12 – The bridge and the gate mechanism of Ticha HPP water intake near Veliki Preslav town on the Golyama Kamchia River

Pic.13 – Ticha reservoir and tower intake

Pic.14 – The Golyama Kamchia River at Mengishevo village

Pic.15 – The Luda Kamchia River at Beronovo village

Pic.16 – Abandoned HMS No.43500 and destroyed observation hut at Beronovo village on the Luda Kamchia River

Existing Water Balance

in

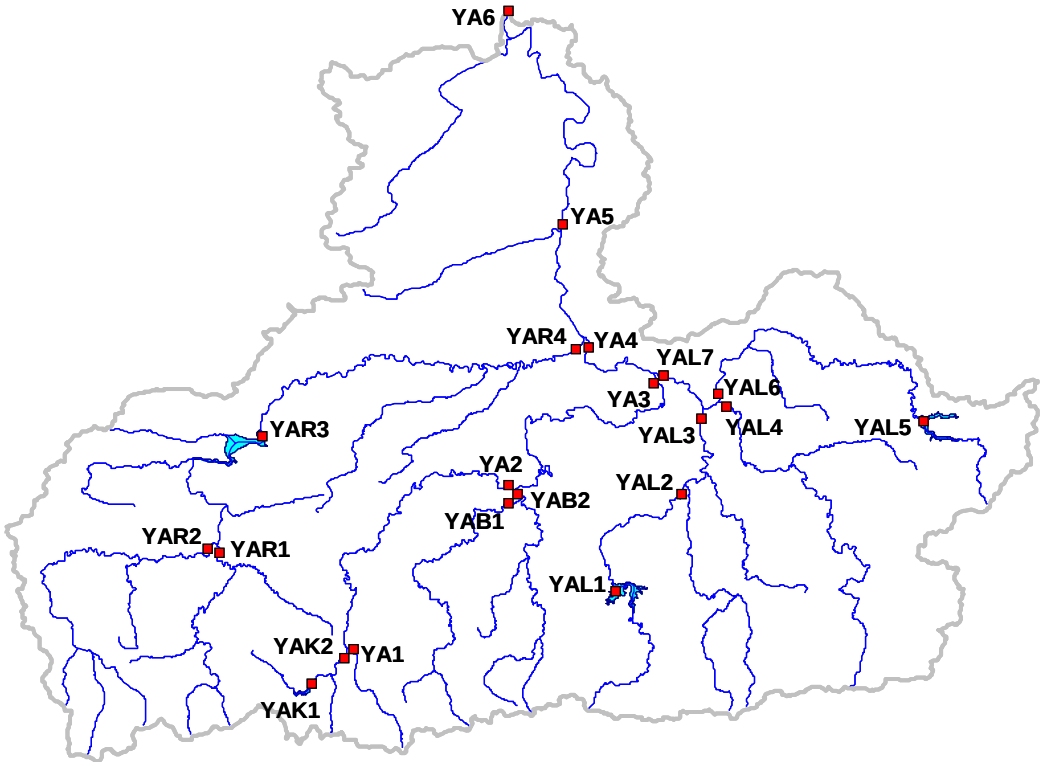
Yantra and Kamchia River Basins

General Note:

The existing water balance in Yantra and Kamchia river basins is estimated by basically same methodology applied to EABD and WABD rivers, which is described in *Supporting Report B and E*. The Simple model_ver_Existing for Yantra and Kamchia river basins have been prepared and used for the study on the existing water balance. However, the followings are different from the methodology applied to EABD and WABD rivers.

- MIKE11-RR (NAM) model was not developed in Yantra and Kamchia river basins, because of limited time frame and insufficient meteorological data.
- To estimate quasi-natural runoff from each catchment, observed water quantity at a representative hydrometric station in the basin and data related to reservoir operation (inflow and outflow) are directly used. Firstly, quasi-natural flow at several representative points is estimated. Secondary, it is distributed to each catchment considering long-term averaged annual precipitation and potential evapo-transpiration based on WORDCLIM database.
- Spatial distribution of abstraction for irrigation water is estimated based on scheme shown by Irrigation Systems Ltd., which is prepared in the Study as one of GIS layers.

Yantra River Basin


YA6
YA5
YAR4
YA4
YAL7
YA3
YAL6
YAR3
YAL3
YAL4
YAL5
YA2
YAL2
YAB2
YAB1
YAR2
YAR1
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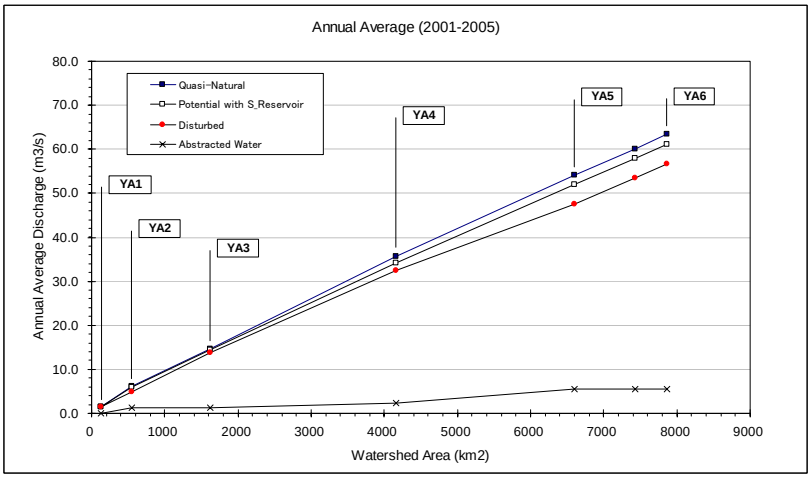
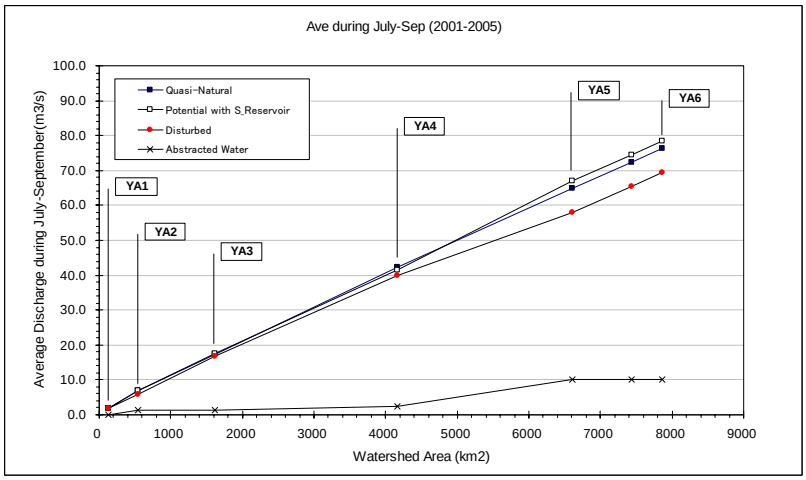
YAK2
YA1
YAK1


Annual Average (2001-2005)
Quasi-Natural
Potential with S_Reservoir
Disturbed
Abstracted Water
YA1
YA2
YA3
YA4
YA5
YA6
Annual Average Discharge (m3/s)
Watershed Area (km2)
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000

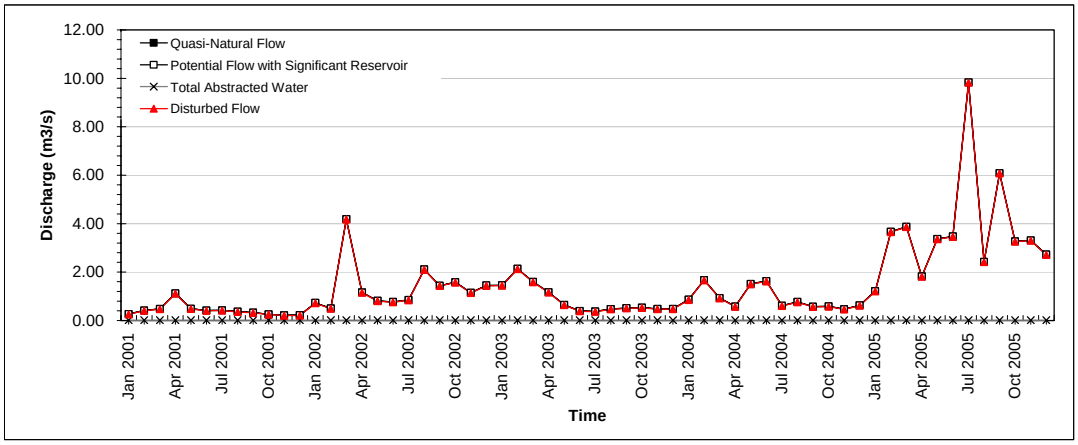

Ave during July-Sep (2001-2005)
Quasi-Natural
Potential with S_Reservoir
Disturbed
Abstracted Water
YA1
YA2
YA3
YA4
YA5
YA6
Average Discharge during July-September(m3/s)
Watershed Area (km2)
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000

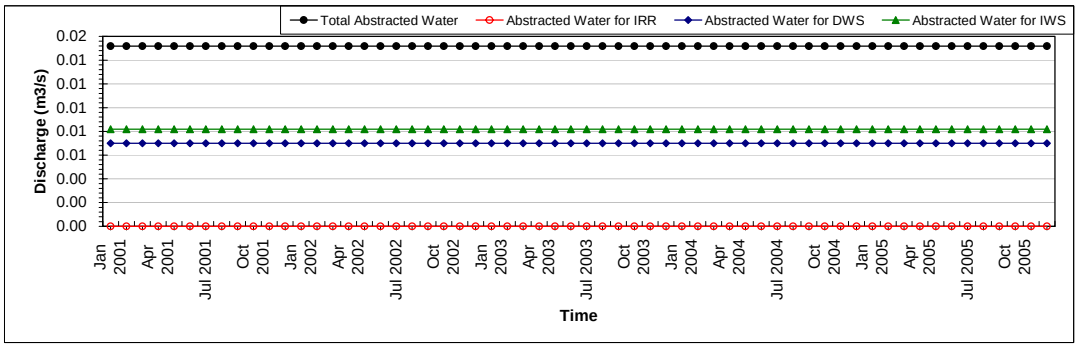
No.	YA1	YA2	YA3	YA4	YA5	YA6	YAR1	YAR2	YAR3	YAR4
NAM Catchment	YA_M6	YA_M5	YA_M4	YA_M3	YA_M2	YA_M1	YA_ROS3	YA_VID	YA_ROS2	YA_ROS1
Catchment JICA_ID	841	747	721	673	957	955	791	782	1147	682
DownStream or UpStream	D	D	D	D	U	D	D	D	D	D
Upsteram Area (km2)	123.44	547.31	1617.07	4161.29	6866.78	7861.91	431.78	562.21	1485.42	2261.07
UpStreamArea excluding out of Territory (km2)	123.44	547.31	1617.07	4161.29	6866.78	7861.91	431.78	562.21	1485.42	2261.07
All Year Ave (2001-2005)										
Quasi-Natural Flow (NF) (m3/s)	1.464	6.048	14.579	35.583	55.606	63.382	4.020	5.380	13.040	17.596
Potential Flow (PF) (m3/s)	1.464	5.886	14.416	34.155	53.336	61.112	4.020	5.380	13.040	16.754
Disturbed Flow (DF) (m3/s)	1.451	4.874	13.721	32.549	48.899	56.761	3.653	5.105	12.470	13.905
(PF-NF)/NF (%)	0.0	-2.7	-1.1	-4.0	-4.1	-3.6	0.0	0.0	0.0	-4.8
(DF-NF)/NF (%)	-0.9	-19.4	-5.9	-8.5	-12.1	-10.4	-9.1	-5.1	-4.4	-21.0
(DF-PF)/PF (%)	-0.9	-17.2	-4.8	-4.7	-8.3	-7.1	-9.1	-5.1	-4.4	-17.0
Accumulated Abstracted Water for Irrigation (IRR) (m3/s)	0.000	0.000	0.000	0.000	2.270	2.276	0.000	0.000	0.000	2.270
Accumulated Abstracted Water for Drinking Water (DWS) (m3/s)	0.007	1.161	1.175	2.225	2.994	2.994	0.385	0.286	0.671	0.768
Accumulated Abstracted Water for Industrial Water (IWS) (m3/s)	0.008	0.045	0.164	0.185	0.259	0.259	0.000	0.026	0.044	0.044
Accumulated Total Water Abstraction (TotalAbst) (m3/s)	0.015	1.206	1.339	2.410	5.523	5.528	0.385	0.312	0.716	3.083
IRR/PF (%)	0.0	0.0	0.0	0.0	4.3	3.7	0.0	0.0	0.0	13.6
DWS/PF (%)	0.5	19.7	8.1	6.5	5.6	4.9	9.6	5.3	5.1	4.6
IWS/PF (%)	0.6	0.8	1.1	0.5	0.5	0.4	0.0	0.5	0.3	0.3
TotalAbst/PF (%)	1.0	20.5	9.3	7.1	10.4	9.0	9.6	5.8	5.5	18.4
HPPmax/PF (%)										
Accumulated Domestic WasteWater Discharge (DWW) (m3/s)	0.002	0.190	0.629	0.788	1.059	1.149	0.018	0.029	0.136	0.224
Accumulated Industrial WasteWater Discharge (IWW) (m3/s)	0.000	0.003	0.014	0.016	0.027	0.028	0.000	0.009	0.010	0.011
Accumulated Total WasteWater Discharge (TotalWW) (m3/s)	0.002	0.193	0.643	0.804	1.085	1.177	0.018	0.038	0.146	0.234
DWW/DF(%)	0.2	3.9	4.6	2.4	2.2	2.0	0.5	0.6	1.1	1.6
IWW/DF (%)	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.2	0.1	0.1
TotalWW/DF (%)	0.2	4.0	4.7	2.5	2.2	2.1	0.5	0.7	1.2	1.7
Ave in July-September (2001-2005)										
Quasi-Natural Flow (NF) (m3/s)	1.811	6.866	17.417	42.271	66.648	76.265	4.856	6.493	15.739	21.375
Potential Flow (PF) (m3/s)	1.811	7.025	17.576	41.568	68.915	78.533	4.856	6.493	15.739	24.345
Disturbed Flow (DF) (m3/s)	1.798	5.945	16.813	39.866	59.792	69.483	4.489	6.219	15.169	16.907
(PF-NF)/NF (%)	0.0	2.3	0.9	-1.7	3.4	3.0	0.0	0.0	0.0	13.9
(DF-NF)/NF (%)	-0.7	-13.4	-3.5	-5.7	-10.3	-8.9	-7.6	-4.2	-3.6	-20.9
(DF-PF)/PF (%)	-0.7	-15.4	-4.3	-4.1	-13.2	-11.5	-7.6	-4.2	-3.6	-30.6
Accumulated Abstracted Water for Irrigation (IRR) (m3/s)	0.000	0.000	0.000	0.000	6.802	6.821	0.000	0.000	0.000	6.802
Accumulated Abstracted Water for Drinking Water (DWS) (m3/s)	0.007	1.228	1.242	2.321	3.147	3.147	0.385	0.286	0.671	0.826
Accumulated Abstracted Water for Industrial Water (IWS) (m3/s)	0.008	0.045	0.164	0.185	0.259	0.259	0.000	0.026	0.044	0.044
Accumulated Total Water Abstraction (TotalAbst) (m3/s)	0.015	1.273	1.406	2.506	10.208	10.227	0.385	0.312	0.716	7.673
IRR/PF (%)	0.0	0.0	0.0	0.0	9.9	8.7	0.0	0.0	0.0	27.9
DWS/PF (%)	0.4	17.5	7.1	5.6	4.6	4.0	7.9	4.4	4.3	3.4
IWS/PF (%)	0.5	0.6	0.9	0.4	0.4	0.3	0.0	0.4	0.3	0.2
TotalAbst/PF (%)	0.8	18.1	8.0	6.0	14.8	13.0	7.9	4.8	4.5	31.5
HPPmax/PF (%)										
Accumulated Domestic WasteWater Discharge (DWW) (m3/s)	0.002	0.190	0.629	0.788	1.059	1.149	0.018	0.029	0.136	0.224
Accumulated Industrial WasteWater Discharge (IWW) (m3/s)	0.000	0.003	0.014	0.016	0.027	0.028	0.000	0.009	0.010	0.011
Accumulated Total WasteWater Discharge (TotalWW) (m3/s)	0.002	0.193	0.643	0.804	1.085	1.177	0.018	0.038	0.146	0.234
DWW/DF(%)	0.1	3.2	3.7	2.0	1.8	1.7	0.4	0.5	0.9	1.3
IWW/DF (%)	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1
TotalWW/DF (%)	0.1	3.3	3.8	2.0	1.8	1.7	0.4	0.6	1.0	1.4

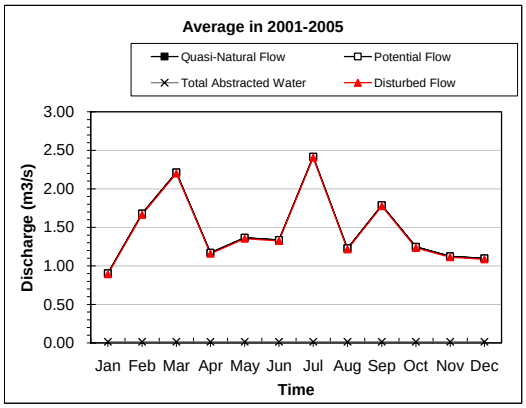
No.	YAK1	YAK2	YAB1	YAB2	YAL1	YAL2	YAL3	YAL4	YAL5	YAL6	YAL7
NAM Catchment	YA_RPA	YA_KOZ	YA_DRY	YA_BEL	YA_VES2	YA_VES1	YA_DZH	YA_LEF2	YA_GOL2	YA_GOL1	YA_LEF1
Catchment JICA_ID	1144	851	769	767	1148	1150	732	720	799	684	709
DownStream or UpStream	D	D	D	D	D	D	D	D	D	D	D
Upsteram Area (km2)	53.46	112.05	337.43	739.57	217.29	381.21	893.55	809.50	225.60	672.28	2426.42
UpStreamArea excluding out of Territory (km2)	53.46	112.05	337.43	739.57	217.29	381.21	893.55	809.50	225.60	672.28	2426.42
All Year Ave (2001-2005)											
Quasi-Natural Flow (NF) (m3/s)	1.444	2.116	3.091	6.650	2.042	3.207	7.815	7.901	0.909	4.368	20.349
Potential Flow (PF) (m3/s)	1.444	1.954	3.091	6.650	2.042	2.895	7.504	7.901	0.909	3.415	19.084
Disturbed Flow (DF) (m3/s)	1.444	0.799	3.127	6.712	2.044	1.851	6.483	7.927	0.954	3.489	18.166
(PF-NF)/NF (%)	0.0	-7.7	0.0	0.0	0.0	-9.7	-4.0	0.0	0.0	-21.8	-6.2
(DF-NF)/NF (%)	0.0	-62.3	1.2	0.9	0.1	-42.3	-17.0	0.3	5.0	-20.1	-10.7
(DF-PF)/PF (%)	0.0	-59.1	1.2	0.9	0.1	-36.1	-13.6	0.3	5.0	2.2	-4.8
Accumulated Abstracted Water for Irrigation (IRR) (m3/s)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Accumulated Abstracted Water for Drinking Water (DWS) (m3/s)	0.000	1.154	0.014	0.014	0.000	1.051	1.051	0.000	0.000	0.000	1.051
Accumulated Abstracted Water for Industrial Water (IWS) (m3/s)	0.000	0.002	0.017	0.017	0.000	0.000	0.020	0.001	0.000	0.000	0.021
Accumulated Total Water Abstraction (TotalAbst) (m3/s)	0.000	1.156	0.031	0.031	0.000	1.051	1.070	0.001	0.000	0.000	1.071
IRR/PF (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DWS/PF (%)	0.0	59.0	0.5	0.2	0.0	36.3	14.0	0.0	0.0	0.0	5.5
IWS/PF (%)	0.0	0.1	0.5	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.1
TotalAbst/PF (%)	0.0	59.1	1.0	0.5	0.0	36.3	14.3	0.0	0.0	0.0	5.6
HPPmax/PF (%)											
Accumulated Domestic WasteWater Discharge (DWW) (m3/s)	0.000	0.000	0.065	0.090	0.001	0.006	0.049	0.026	0.045	0.074	0.151
Accumulated Industrial WasteWater Discharge (IWW) (m3/s)	0.000	0.000	0.002	0.003	0.000	0.000	0.001	0.001	0.000	0.000	0.002
Accumulated Total WasteWater Discharge (TotalWW) (m3/s)	0.000	0.000	0.067	0.093	0.001	0.006	0.050	0.027	0.045	0.075	0.154
DWW/DF(%)	0.0	0.0	2.1	1.3	0.1	0.3	0.7	0.3	4.7	2.1	0.8
IWW/DF (%)	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TotalWW/DF (%)	0.0	0.0	2.2	1.4	0.1	0.3	0.8	0.3	4.7	2.1	0.8
Ave in July-September (2001-2005)											
Quasi-Natural Flow (NF) (m3/s)	1.171	2.002	3.823	8.225	1.320	2.761	8.461	9.773	1.204	5.483	24.044
Potential Flow (PF) (m3/s)	1.171	2.161	3.823	8.225	1.320	3.148	8.848	9.773	1.204	4.234	23.182
Disturbed Flow (DF) (m3/s)	1.171	0.939	3.859	8.287	1.321	2.075	7.799	9.799	1.249	4.309	22.235
(PF-NF)/NF (%)	0.0	7.9	0.0	0.0	0.0	14.0	4.6	0.0	0.0	-22.8	-3.6
(DF-NF)/NF (%)	0.0	-53.1	1.0	0.8	0.1	-24.8	-7.8	0.3	3.8	-21.4	-7.5
(DF-PF)/PF (%)	0.0	-56.6	1.0	0.8	0.1	-34.1	-11.9	0.3	3.8	1.8	-4.1
Accumulated Abstracted Water for Irrigation (IRR) (m3/s)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Accumulated Abstracted Water for Drinking Water (DWS) (m3/s)	0.000	1.221	0.014	0.014	0.000	1.079	1.079	0.000	0.000	0.000	1.079
Accumulated Abstracted Water for Industrial Water (IWS) (m3/s)	0.000	0.002	0.017	0.017	0.000	0.000	0.020	0.001	0.000	0.000	0.021
Accumulated Total Water Abstraction (TotalAbst) (m3/s)	0.000	1.223	0.031	0.031	0.000	1.079	1.099	0.001	0.000	0.000	1.100
IRR/PF (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DWS/PF (%)	0.0	56.5	0.4	0.2	0.0	34.3	12.2	0.0	0.0	0.0	4.7
IWS/PF (%)	0.0	0.1	0.4	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.1
TotalAbst/PF (%)	0.0	56.6	0.8	0.4	0.0	34.3	12.4	0.0	0.0	0.0	4.7
HPPmax/PF (%)											
Accumulated Domestic WasteWater Discharge (DWW) (m3/s)	0.000	0.000	0.065	0.090	0.001	0.006	0.049	0.026	0.045	0.074	0.151
Accumulated Industrial WasteWater Discharge (IWW) (m3/s)	0.000	0.000	0.002	0.003	0.000	0.000	0.001	0.001	0.000	0.000	0.002
Accumulated Total WasteWater Discharge (TotalWW) (m3/s)	0.000	0.000	0.067	0.093	0.001	0.006	0.050	0.027	0.045	0.075	0.154
DWW/DF(%)	0.0	0.0	1.7	1.1	0.1	0.3	0.6	0.3	3.6	1.7	0.7
IWW/DF (%)	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TotalWW/DF (%)	0.0	0.0	1.7	1.1	0.1	0.3	0.6	0.3	3.6	1.7	0.7

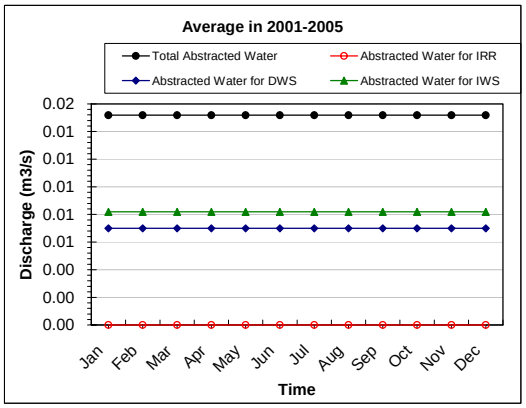
YA1

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	YA1		









YA2

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
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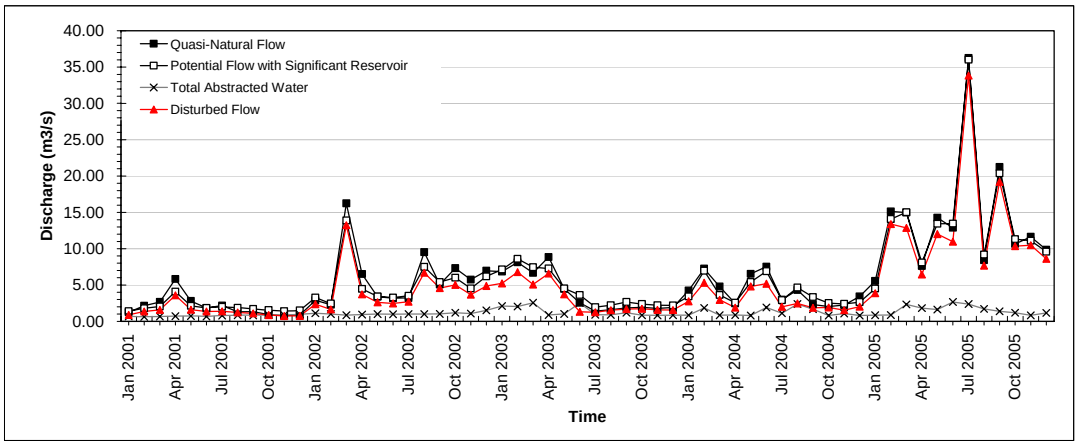

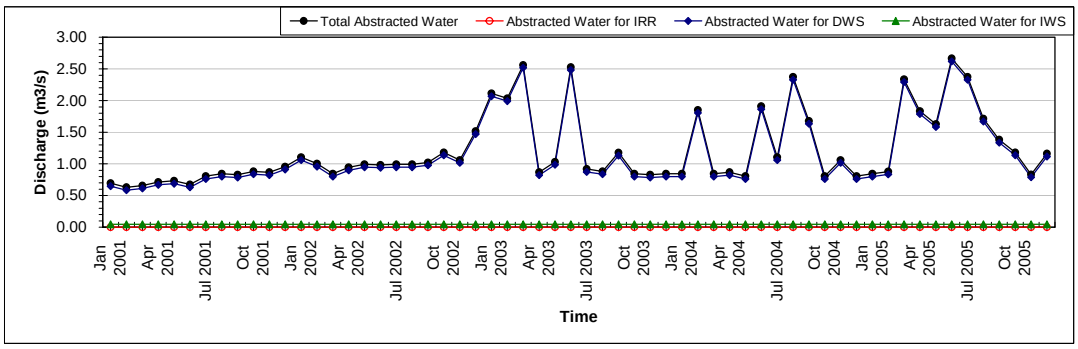

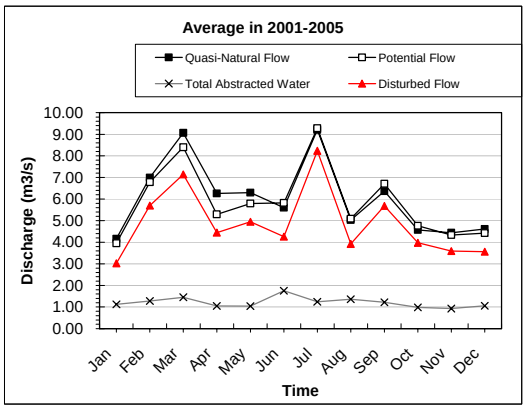

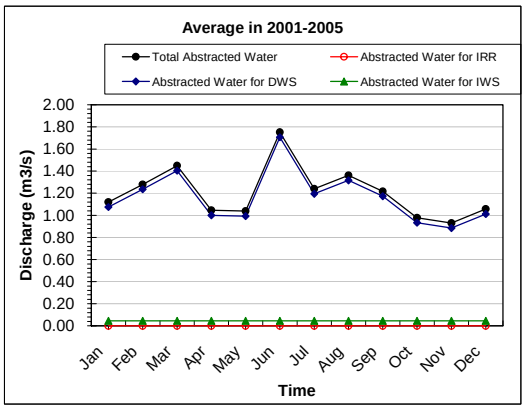

YA3

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
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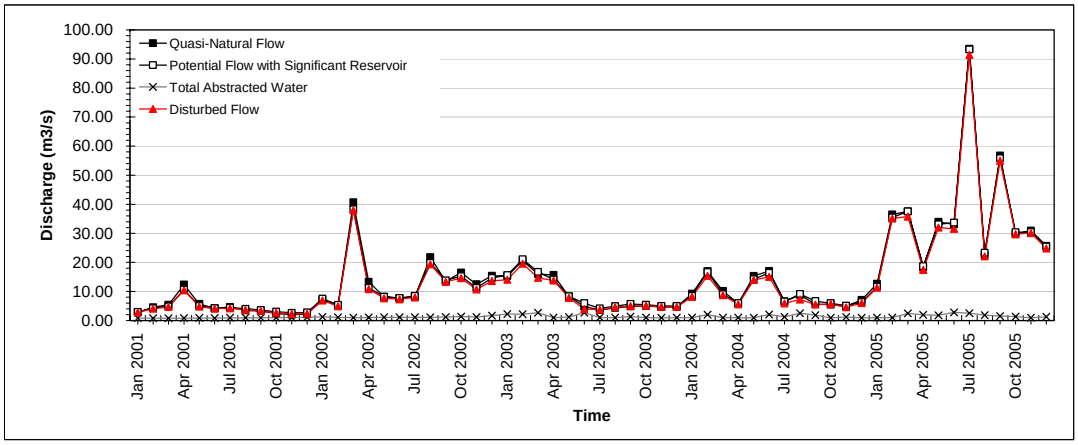
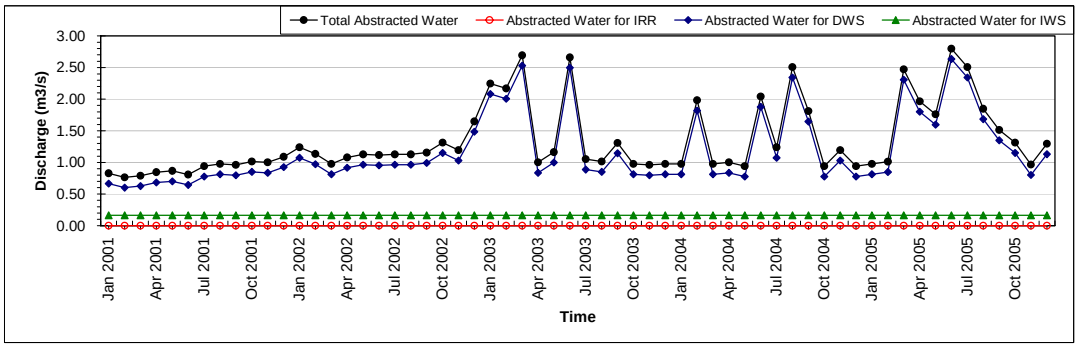
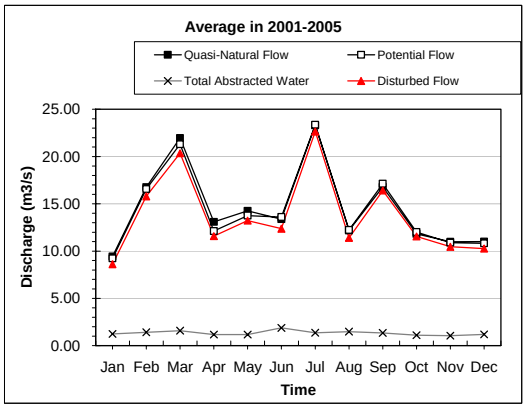
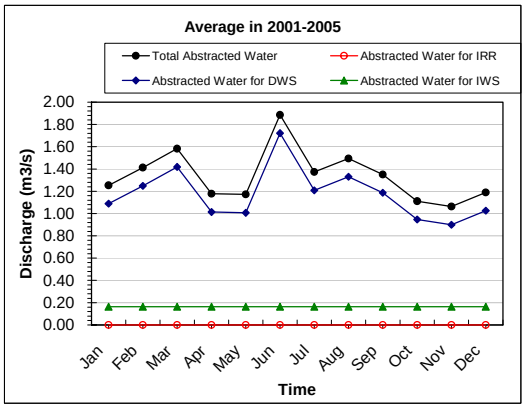


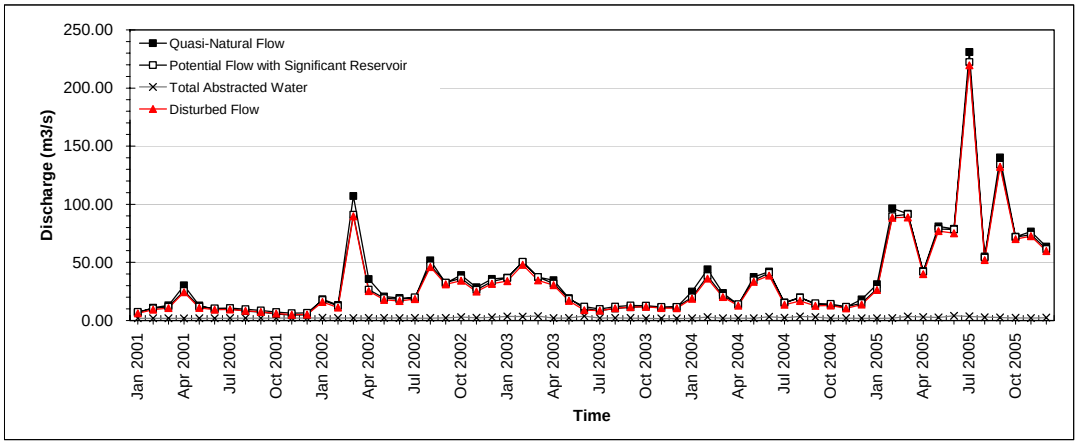


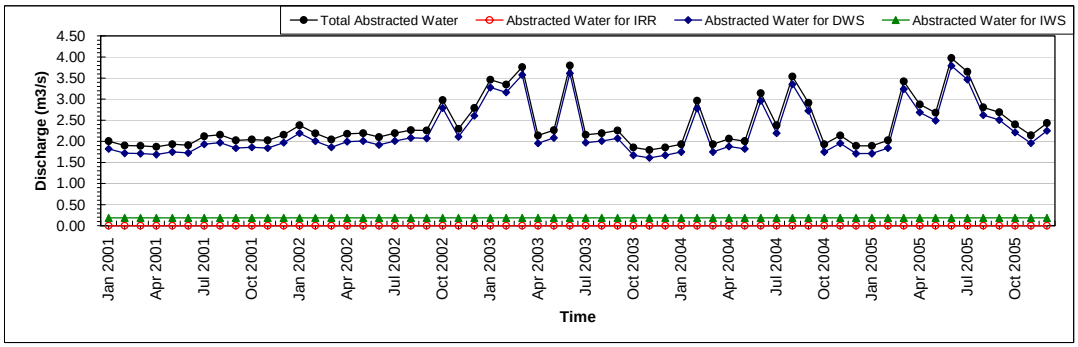


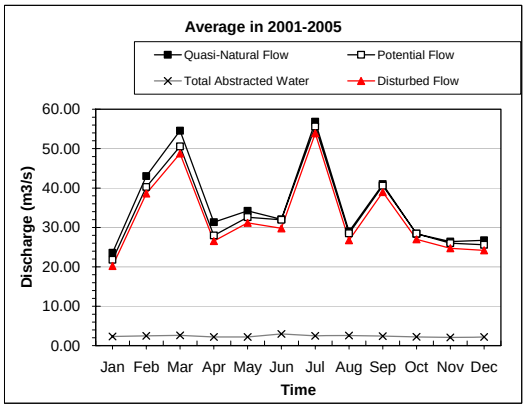


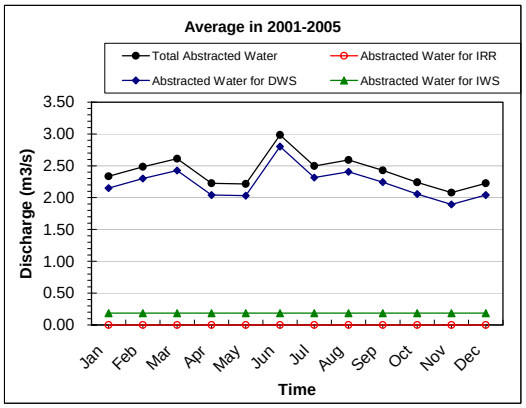
YA4

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	YA4		



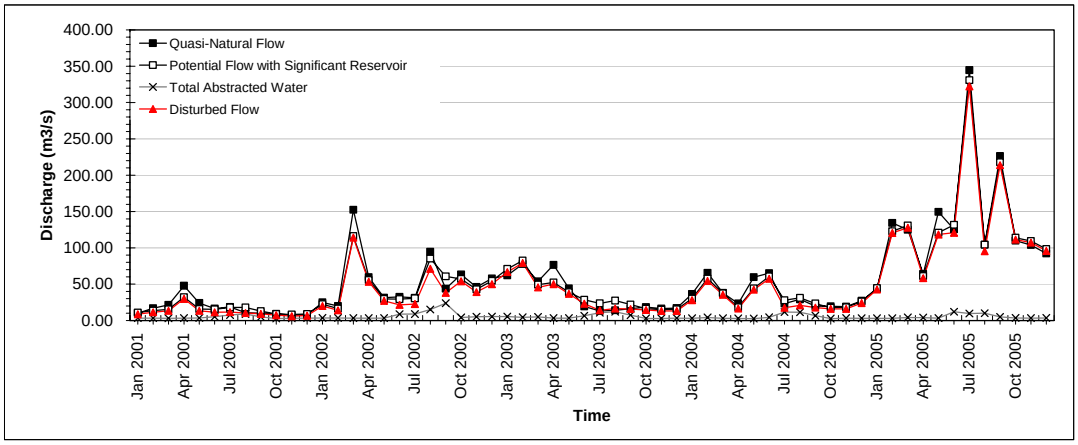


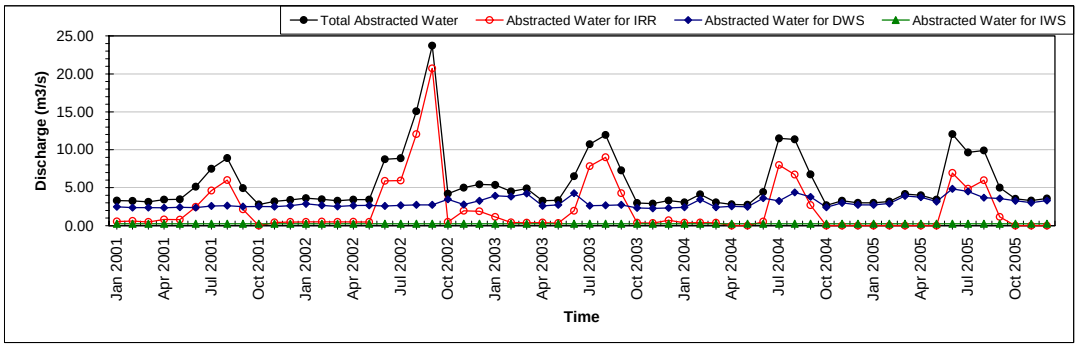


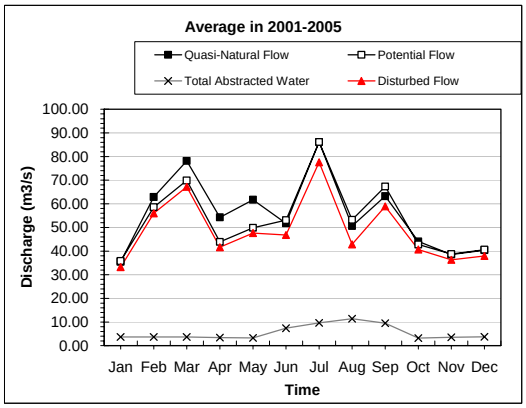


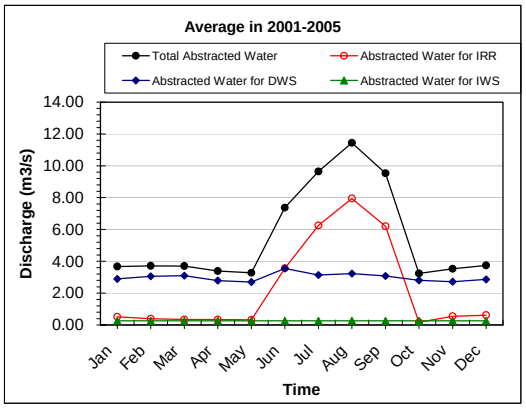
YA5

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	YA5		



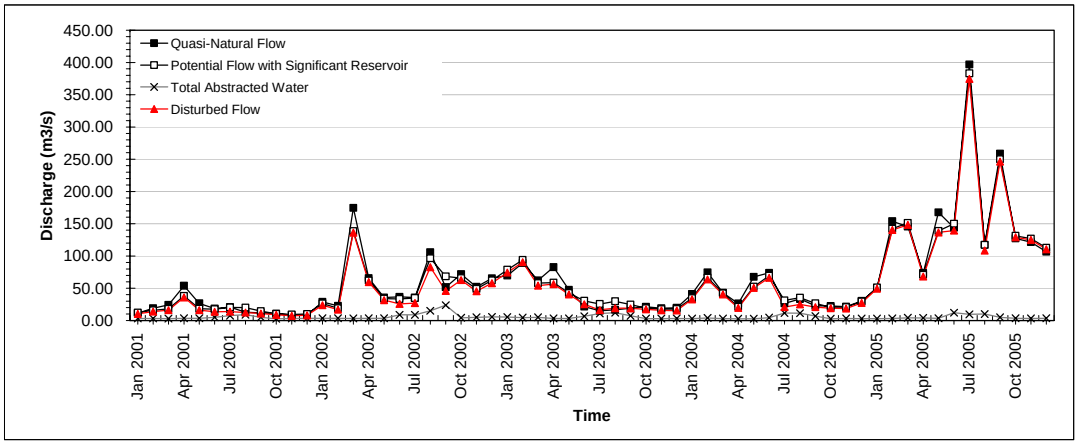


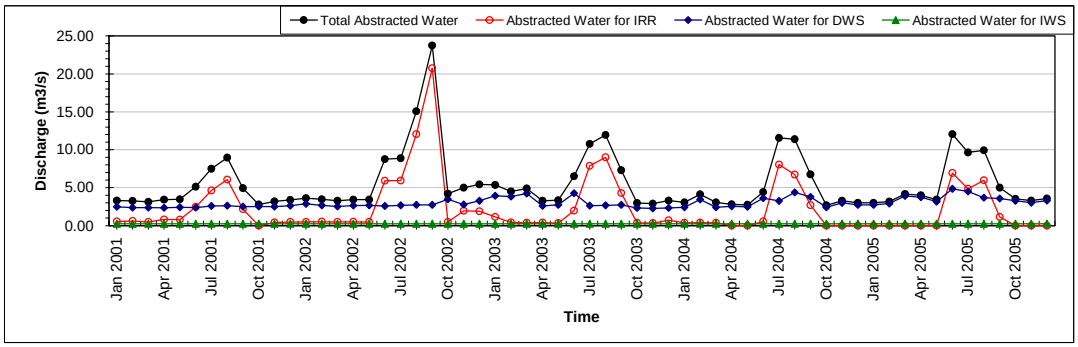


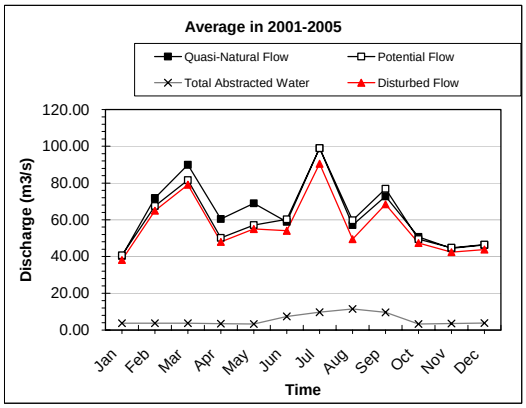


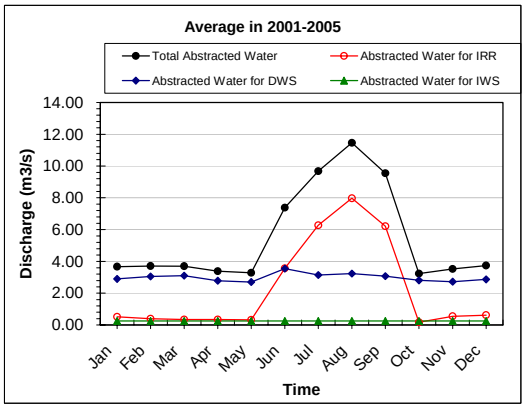
YA6

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	YA6		









YAR1

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
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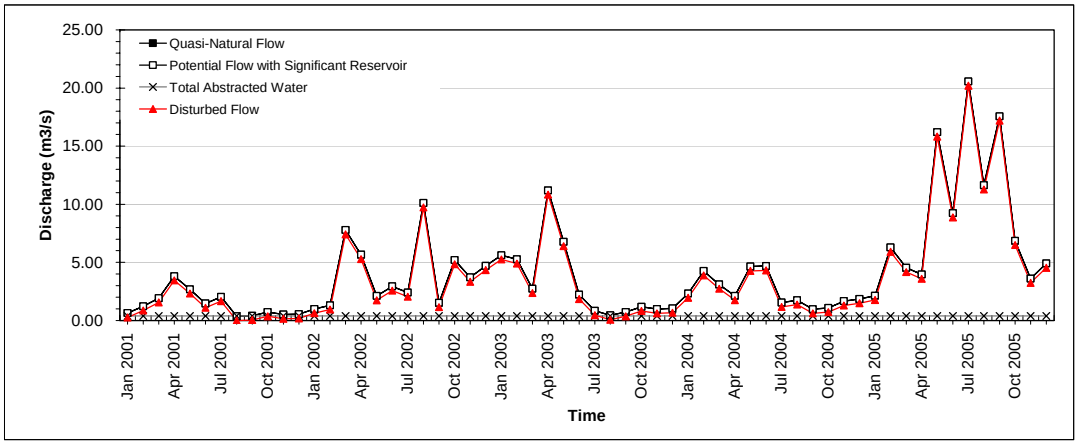
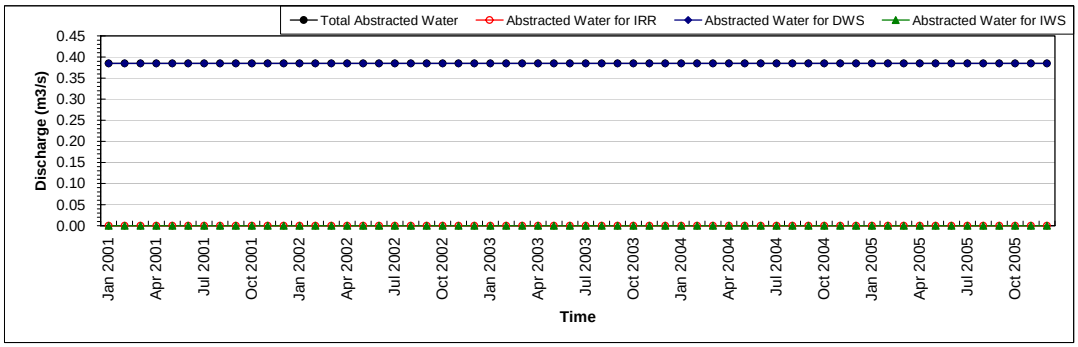
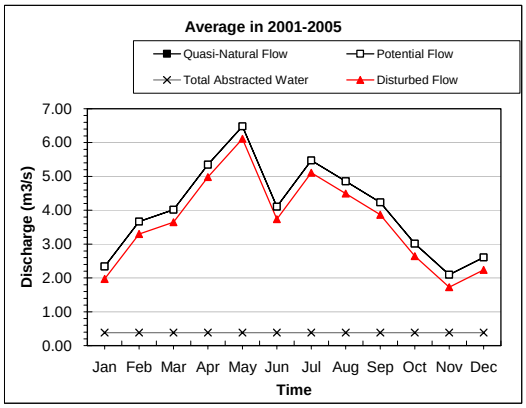
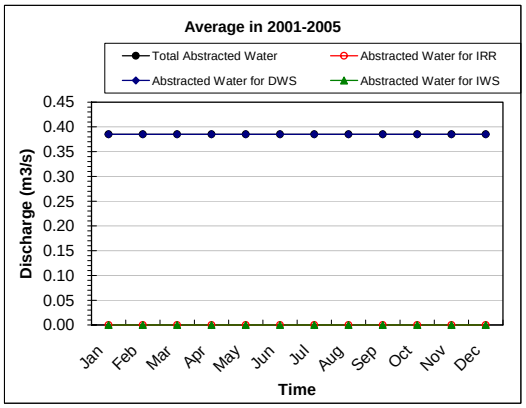


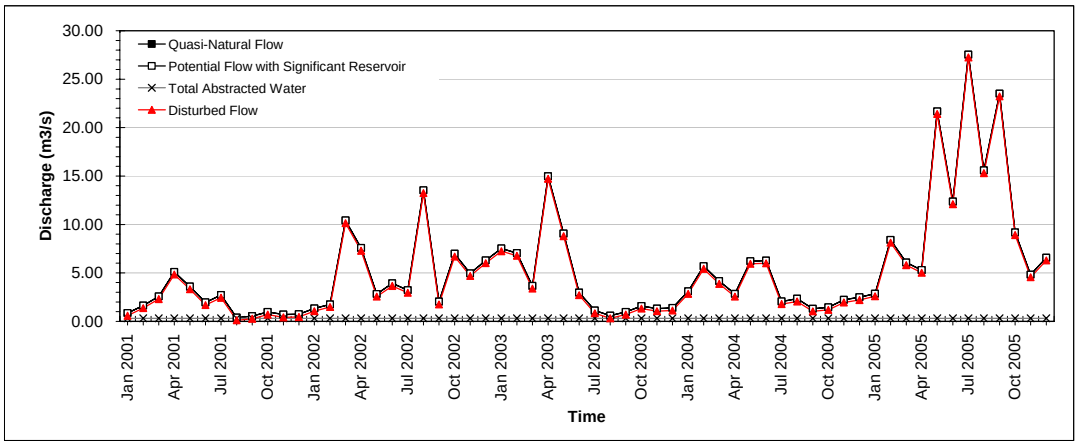


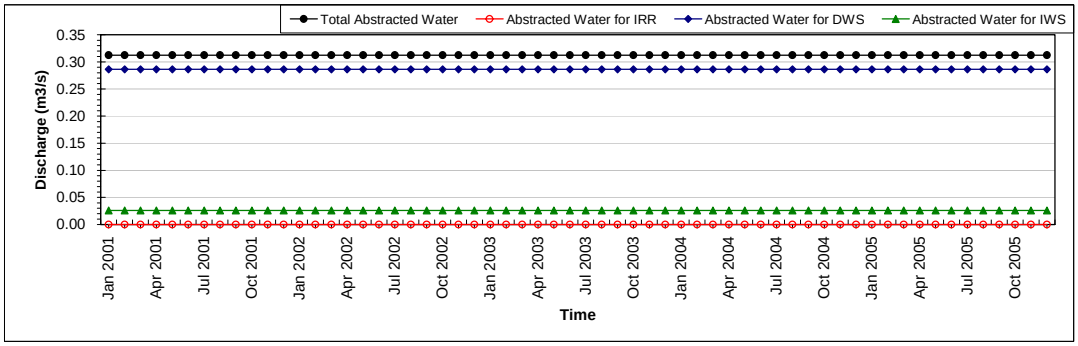


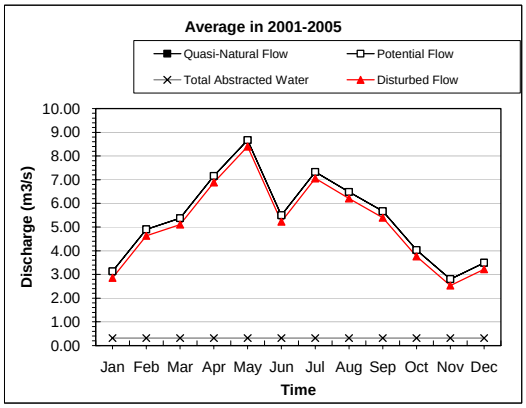


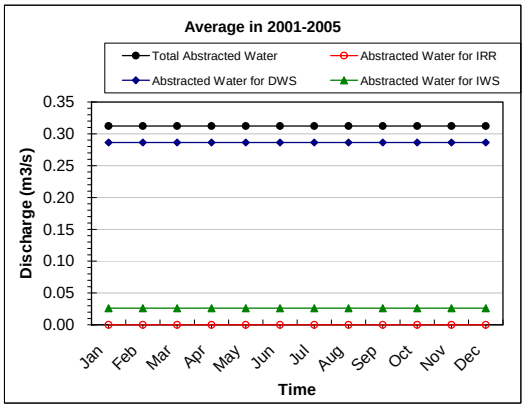
YAR2

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	YAR2		



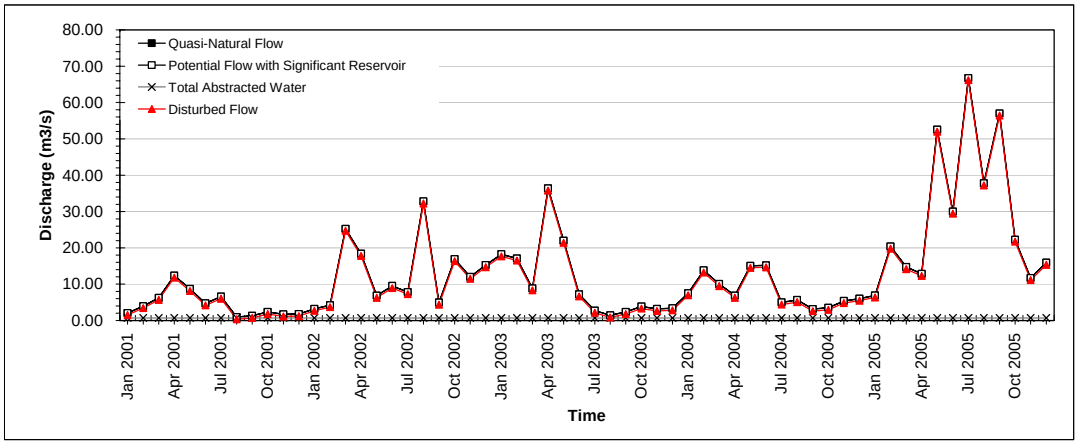


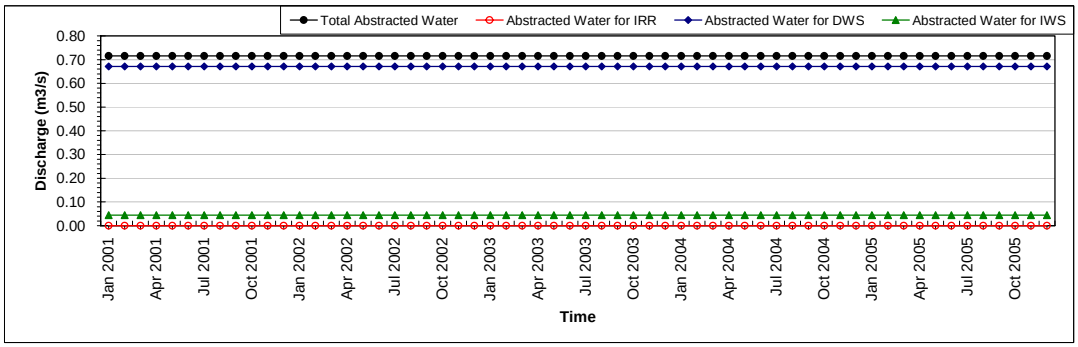


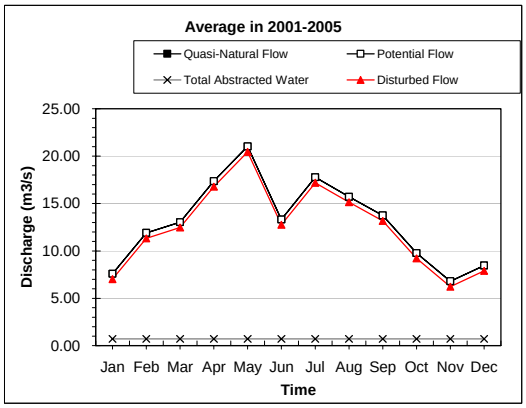


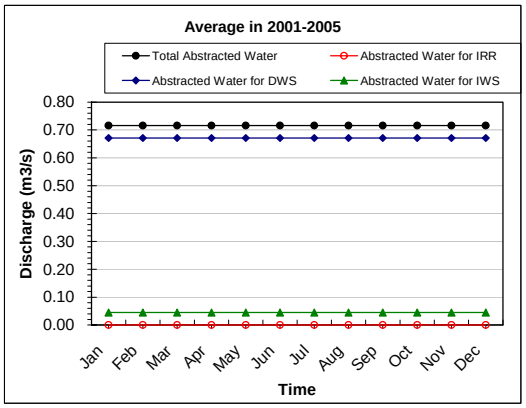
YAR3

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	YAR3		



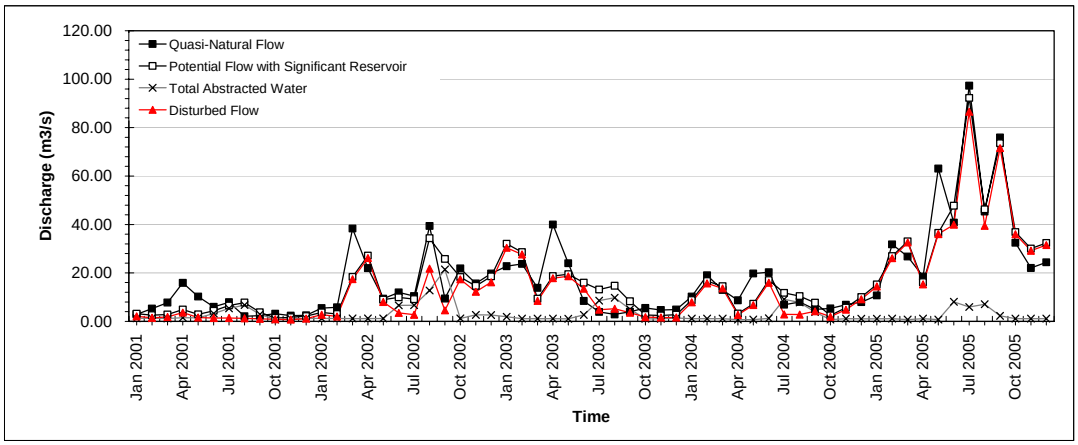


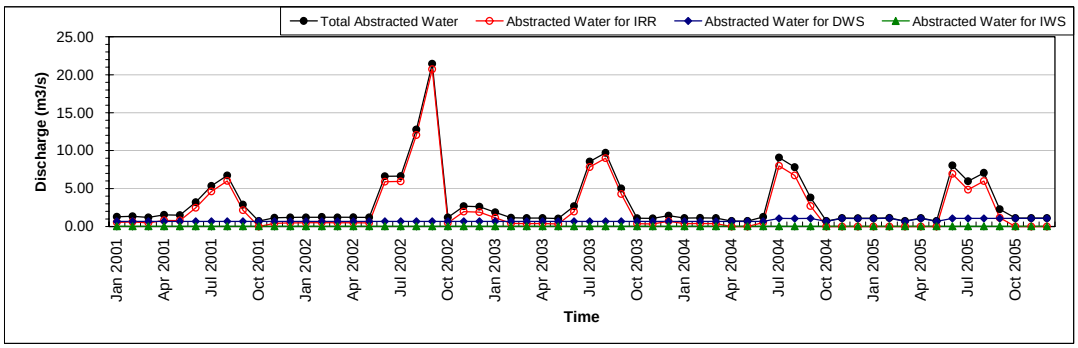


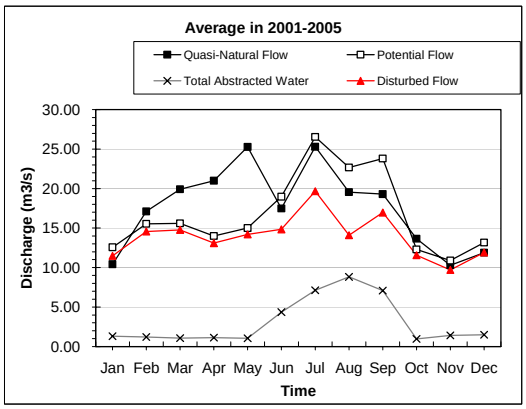


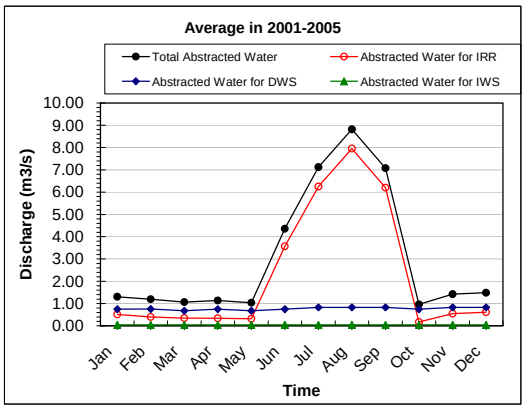
YAR4

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	YAR4		









YAK1

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
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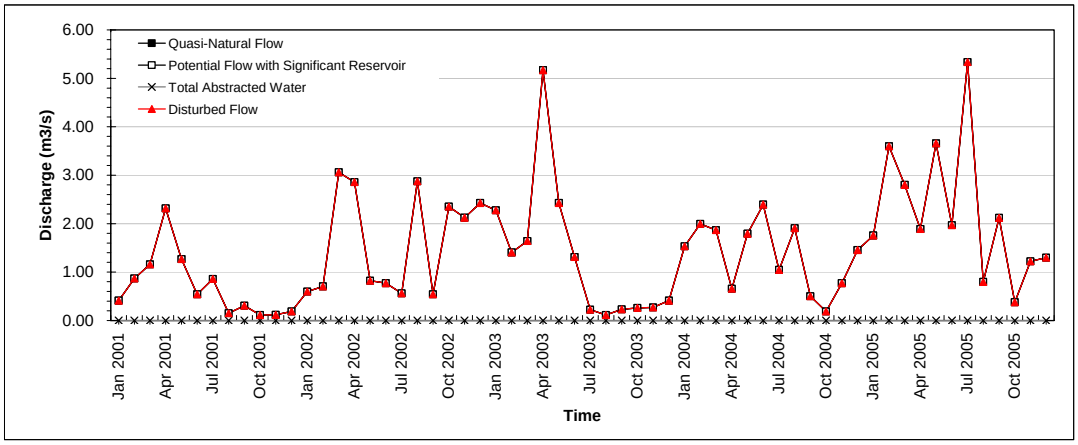

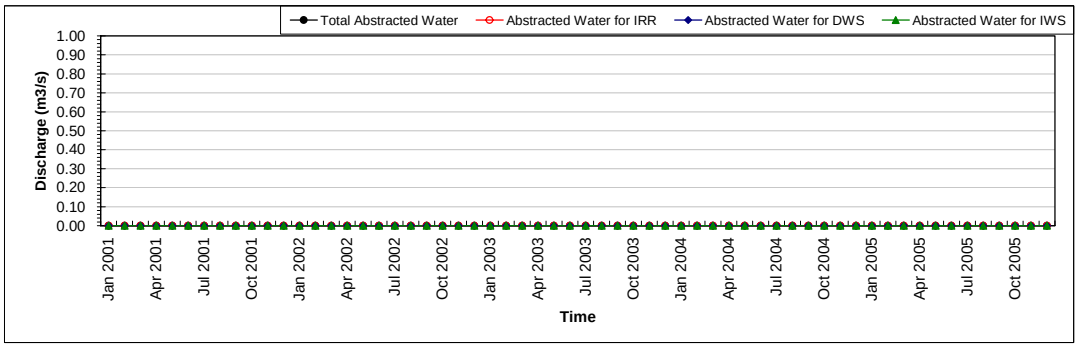

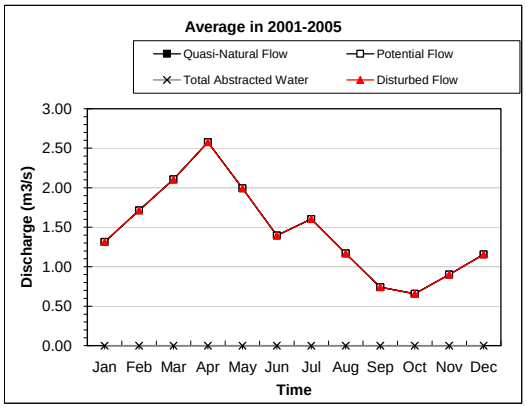

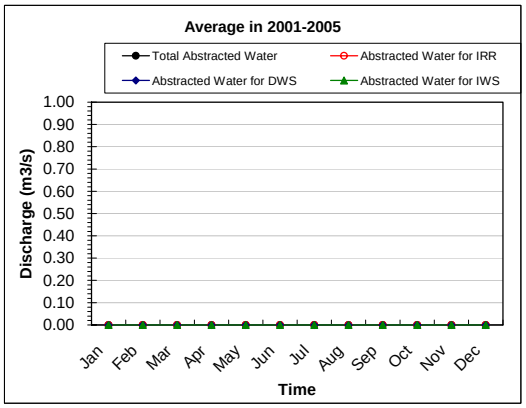

YAK2

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
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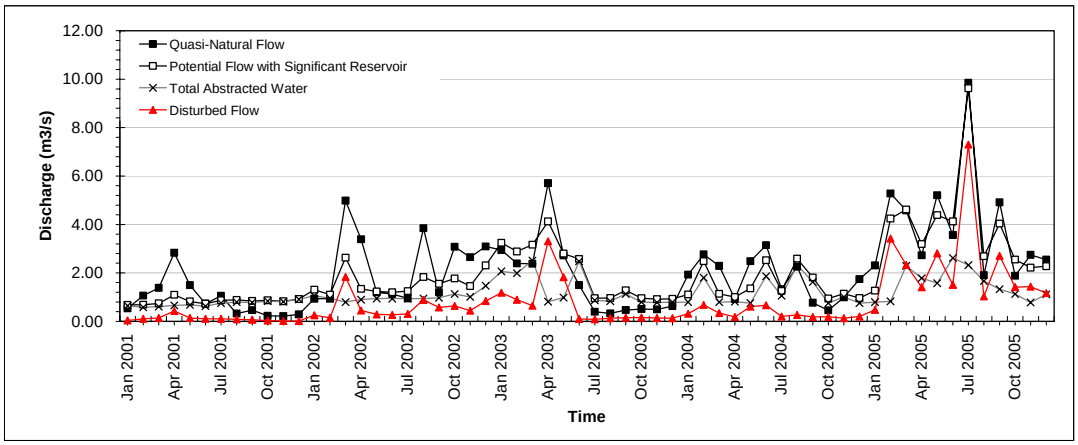

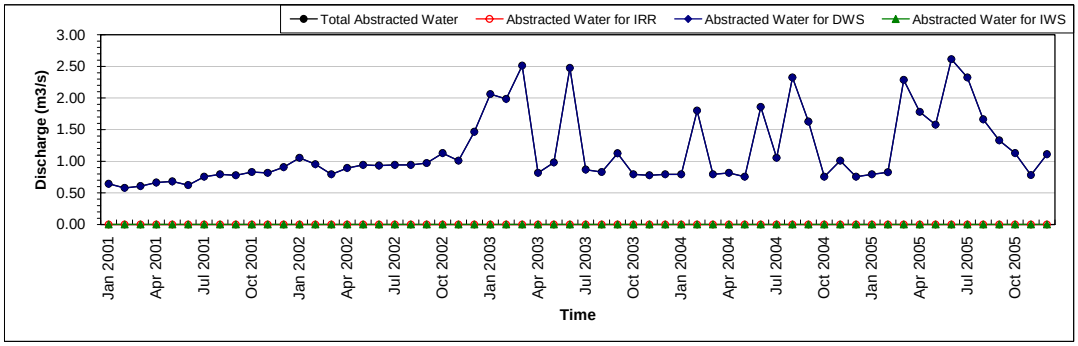

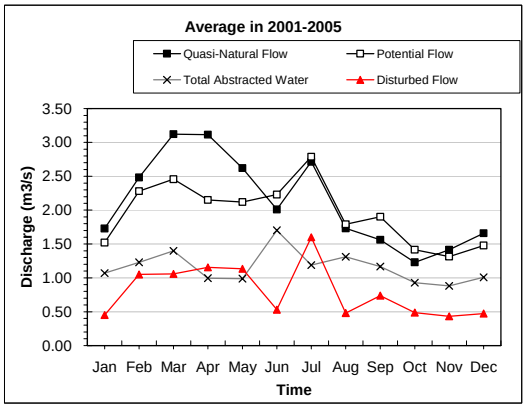

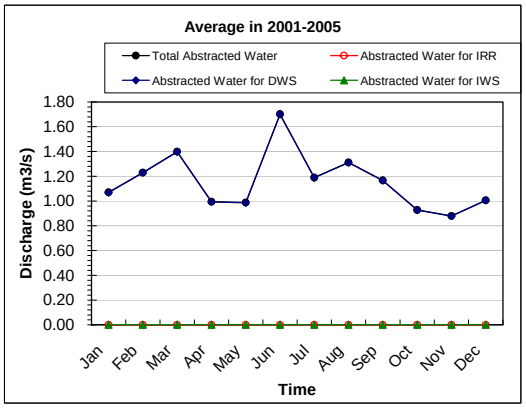

YAB1

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
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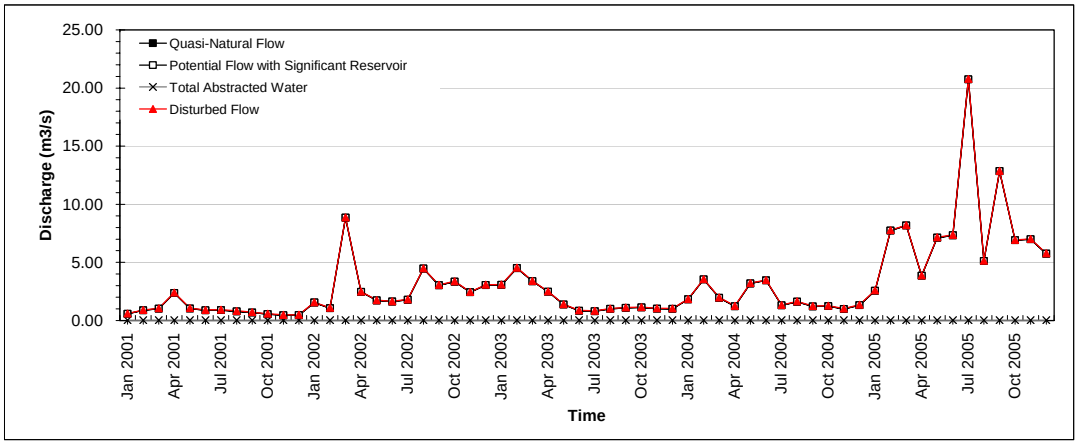

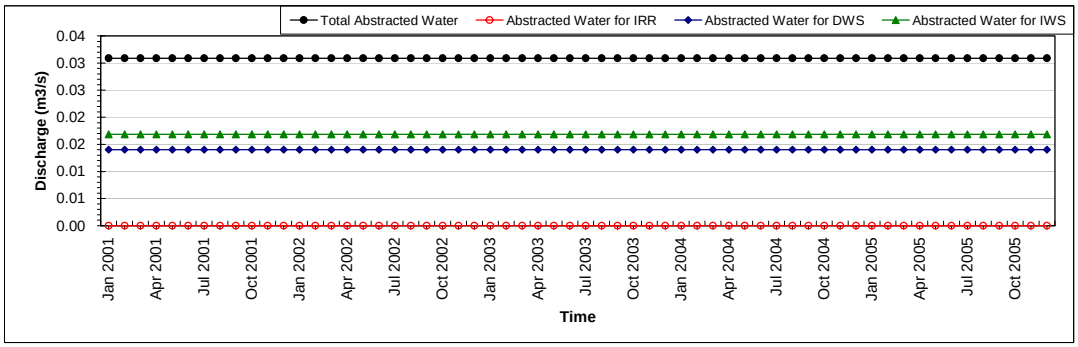

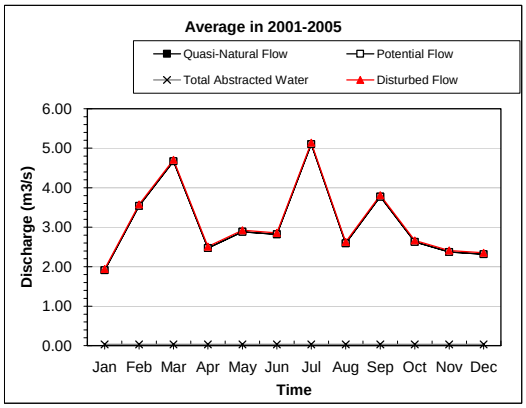

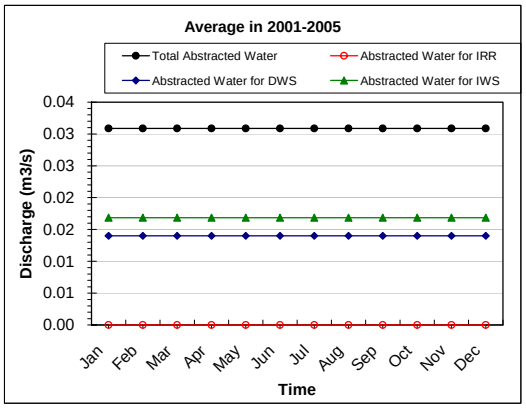

YAB2

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
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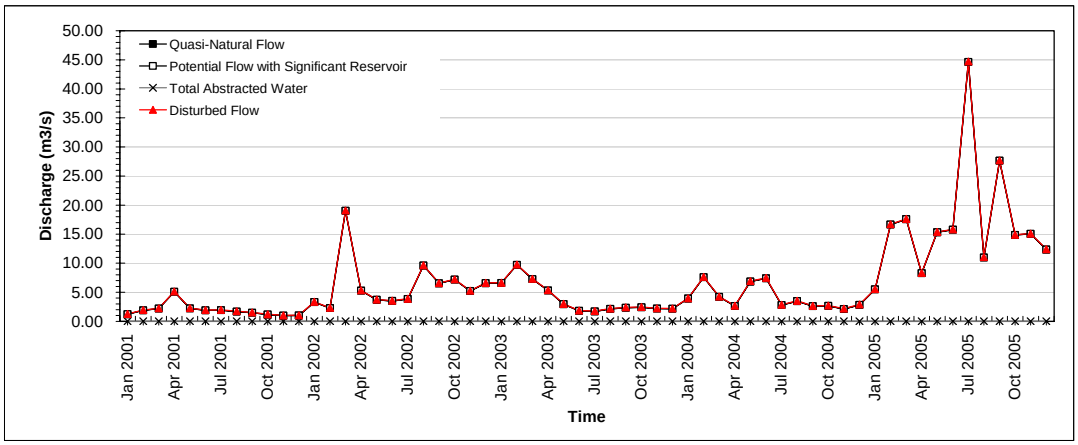
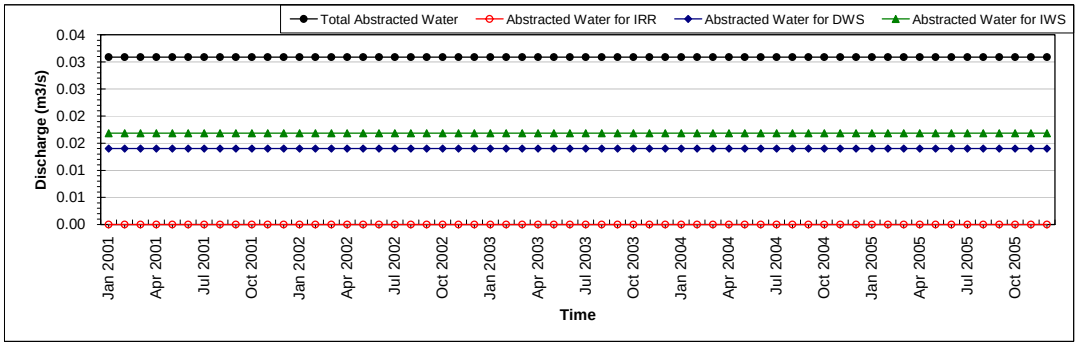
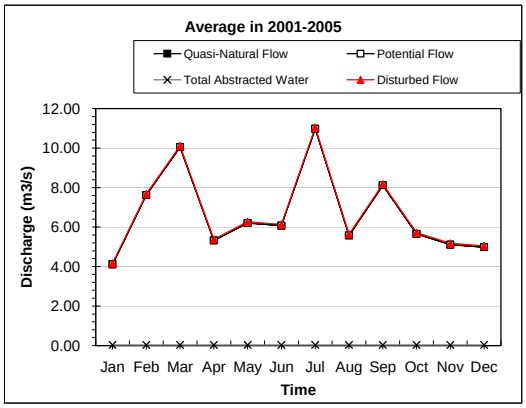
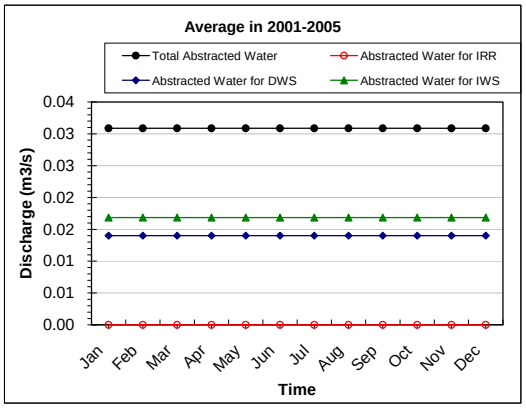


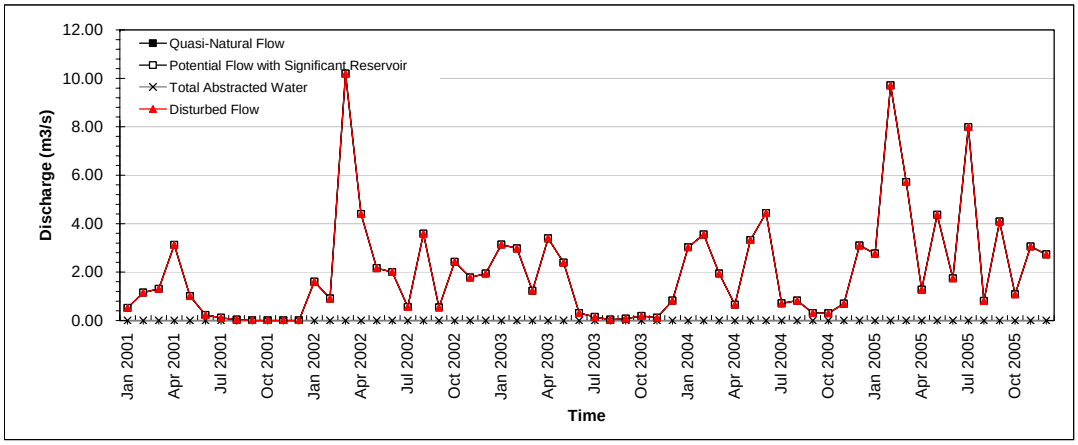


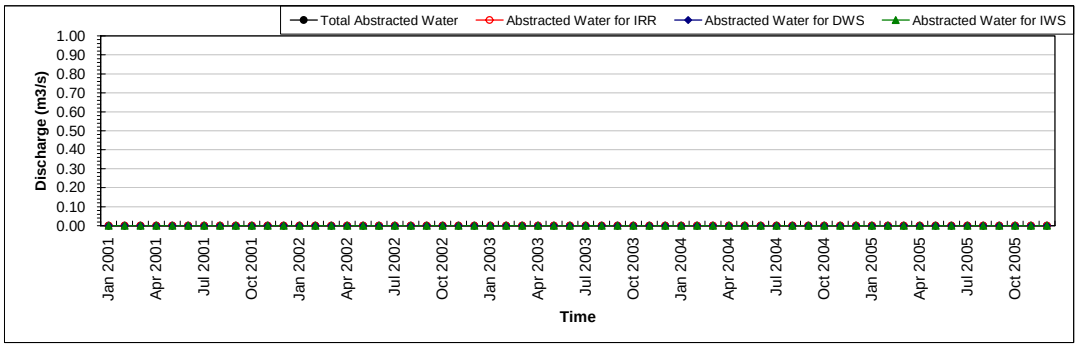


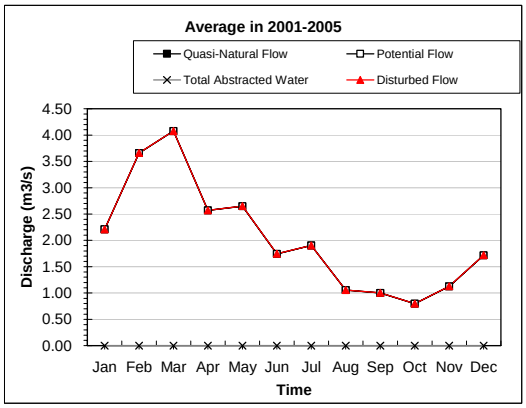


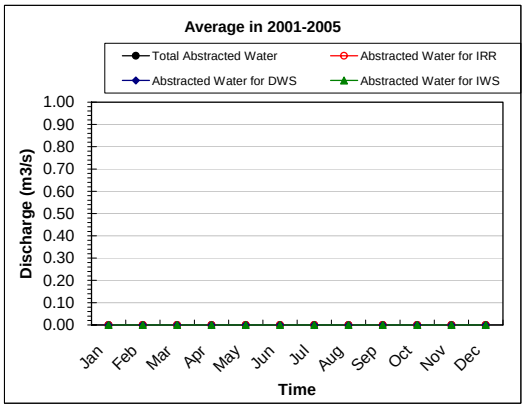
YAL1

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	YAL1		



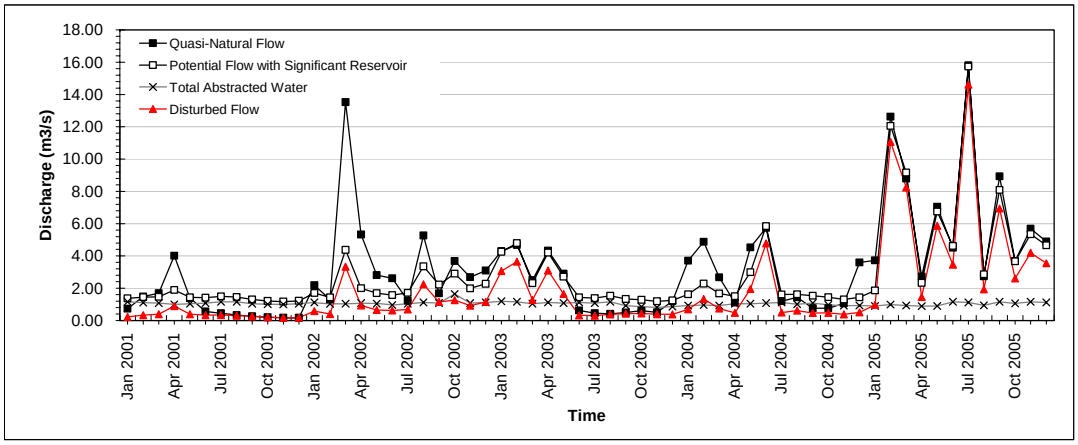


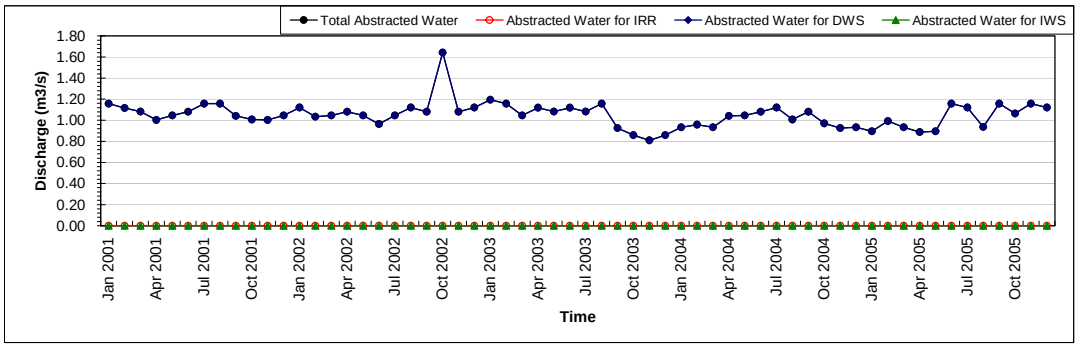


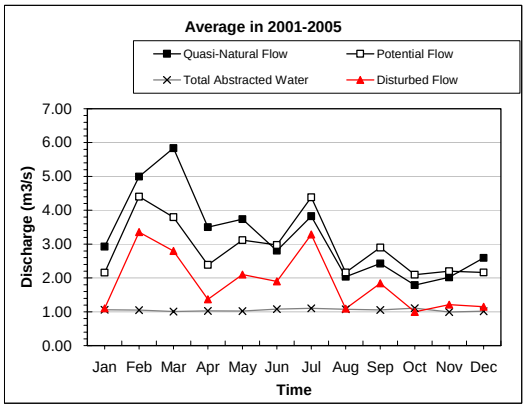


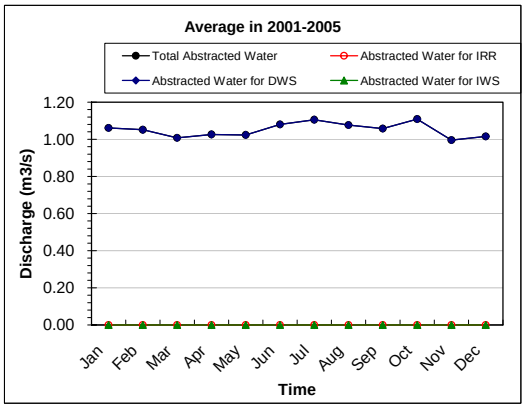
YAL2

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	YAL2		









YAL3

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
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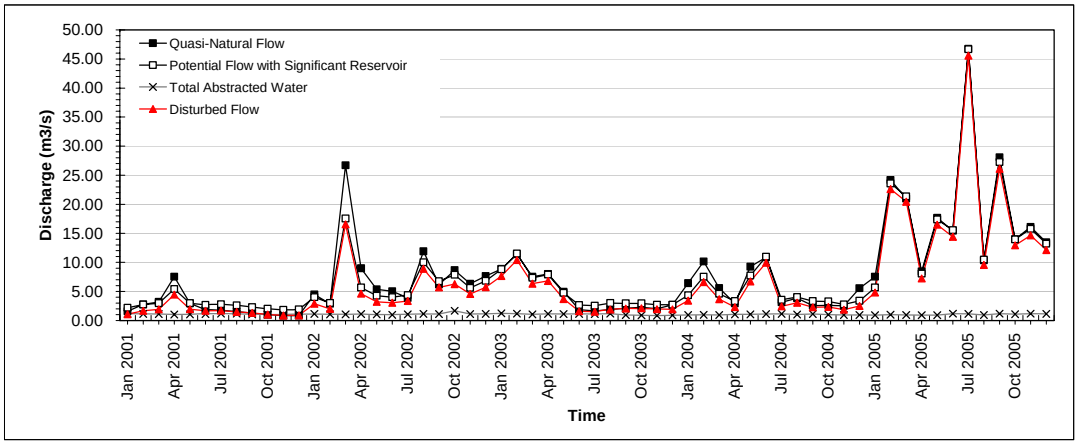
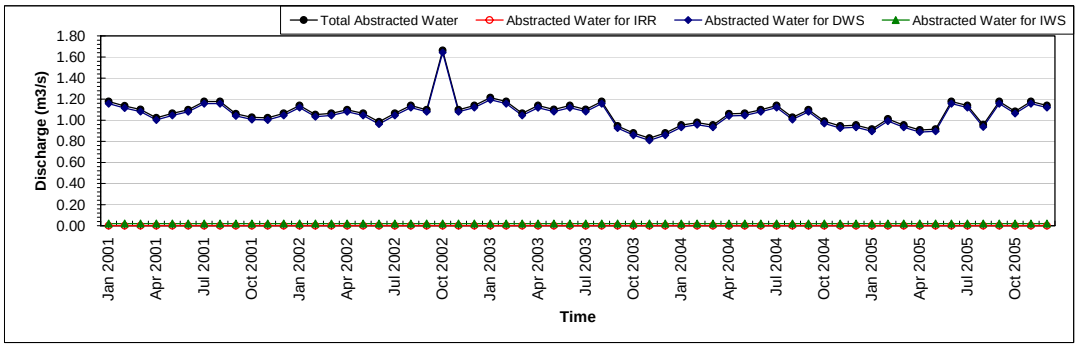
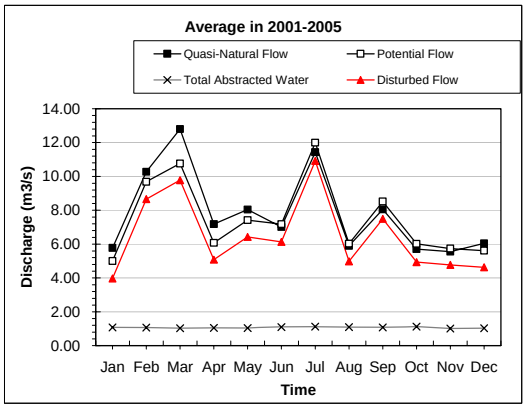
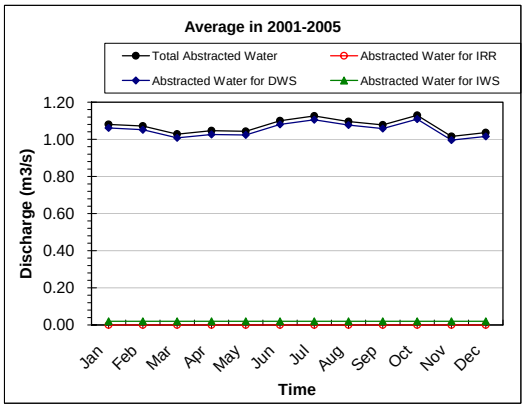


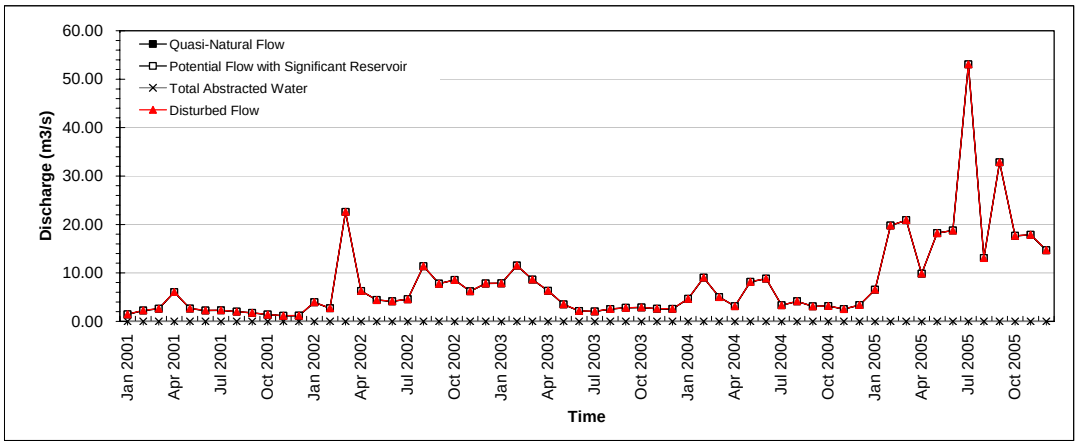


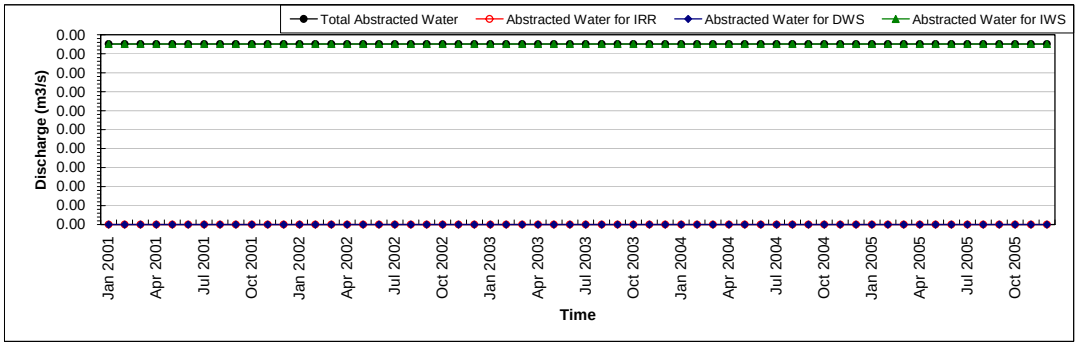


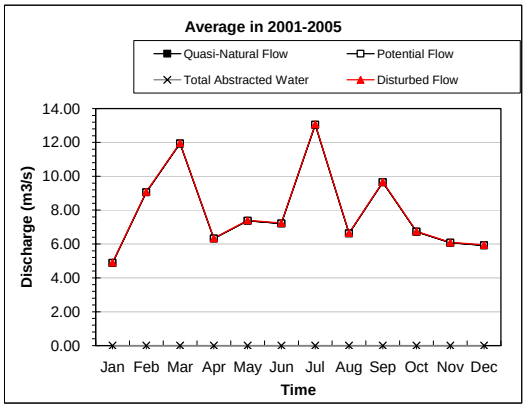


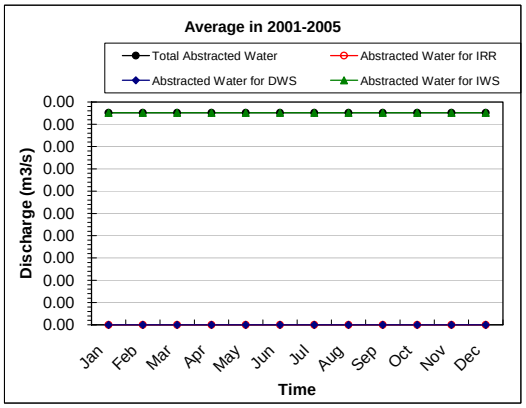
YAL4

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	YAL4		



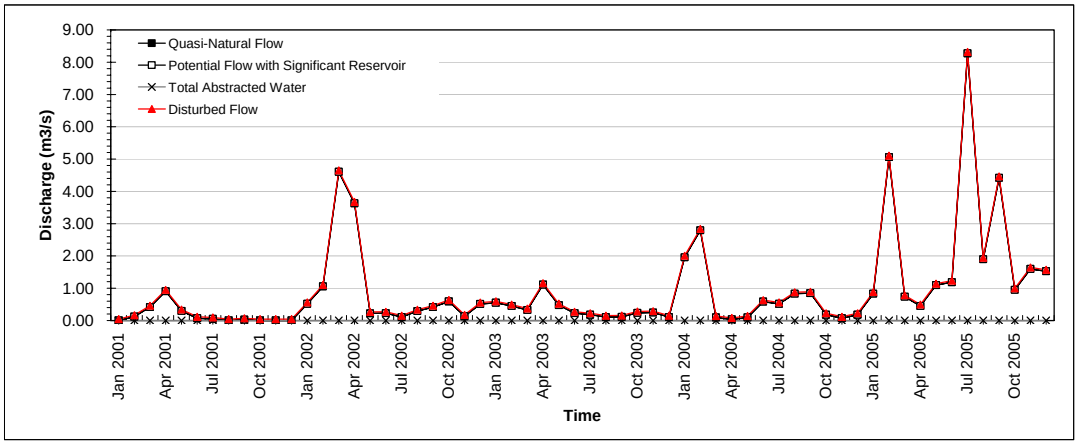


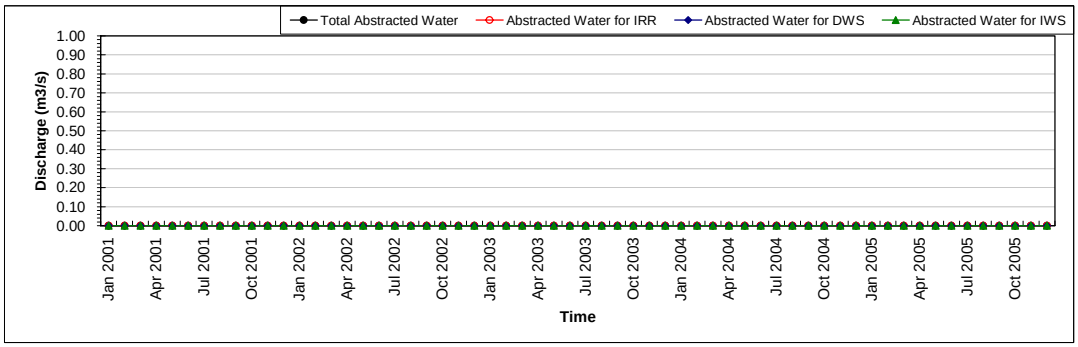


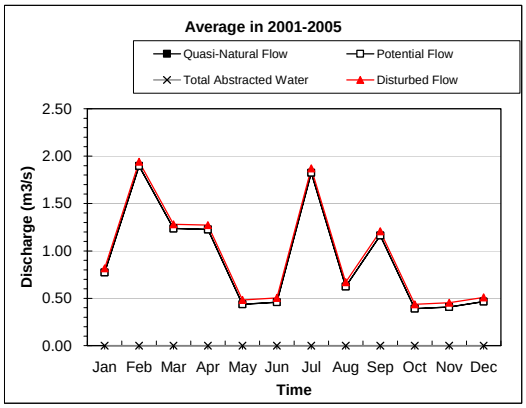


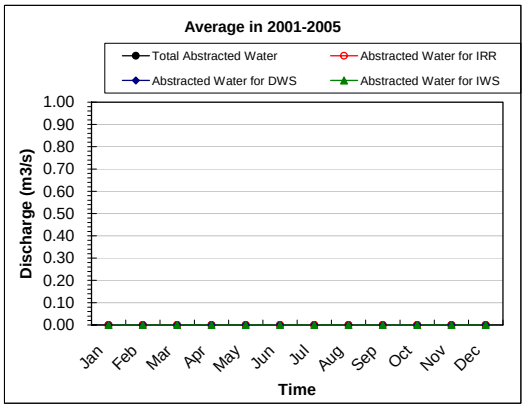
YAL5

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	YAL5		



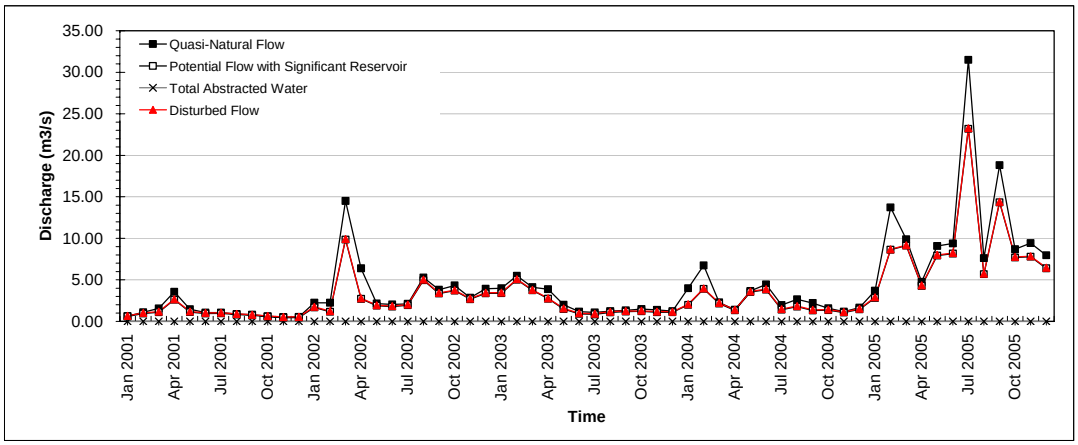


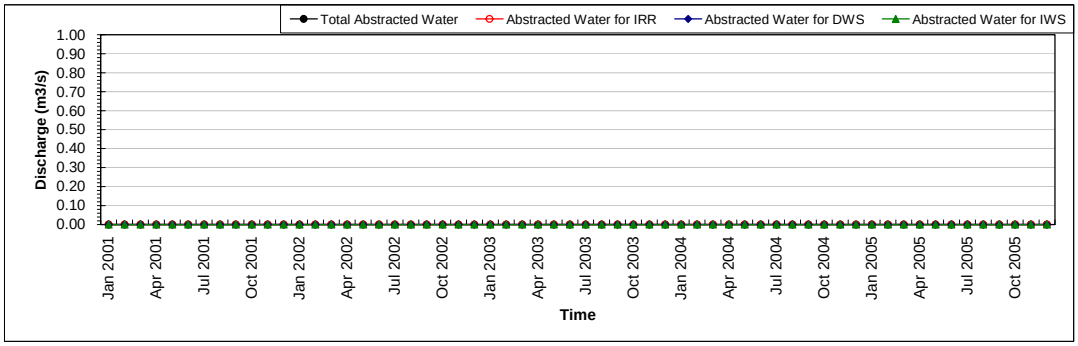


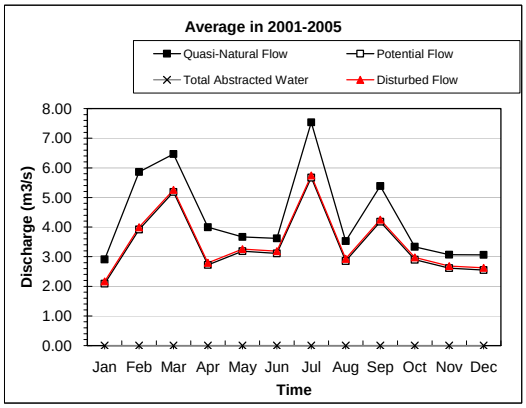


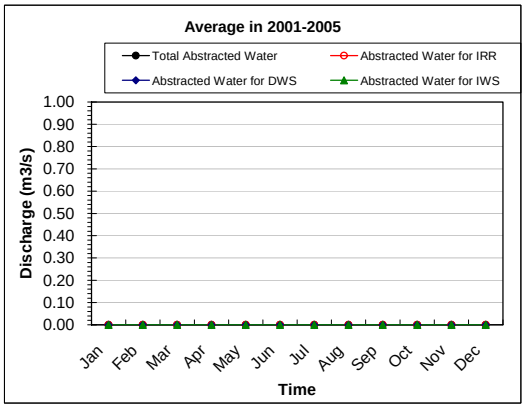
YAL6

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	YAL6		



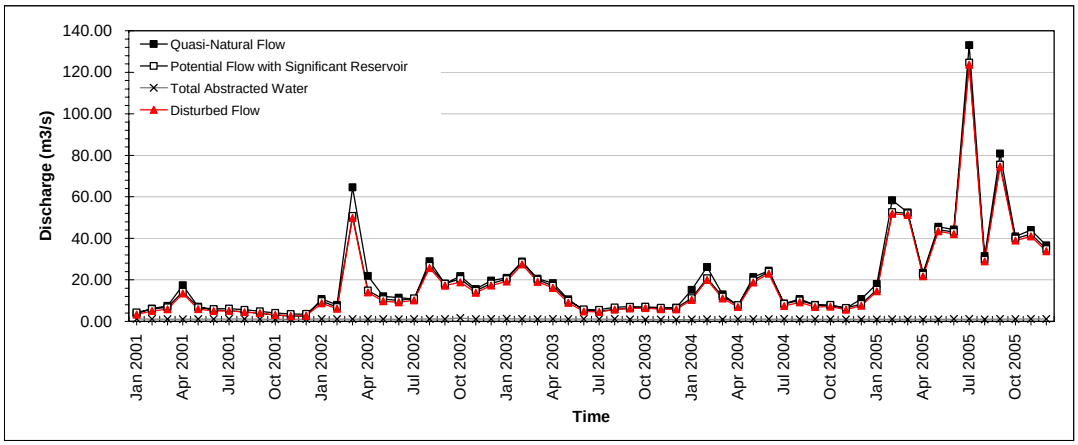


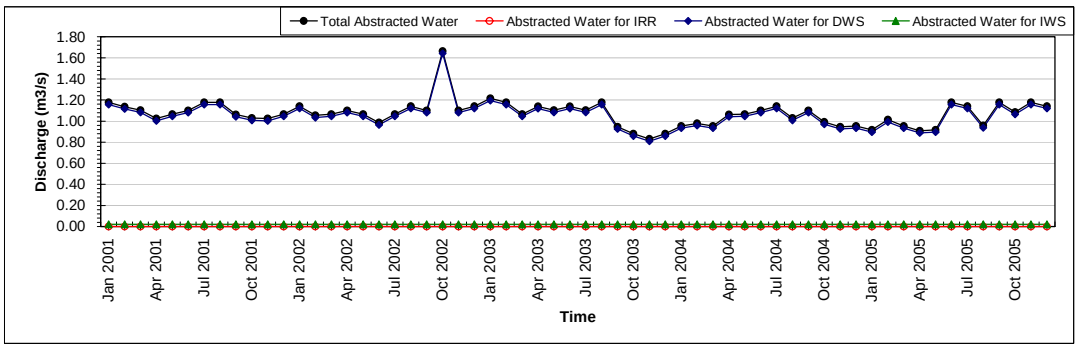


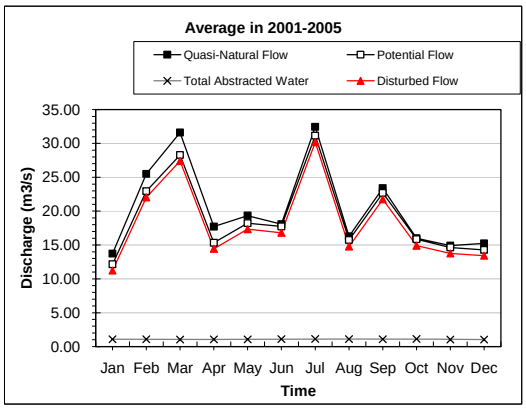


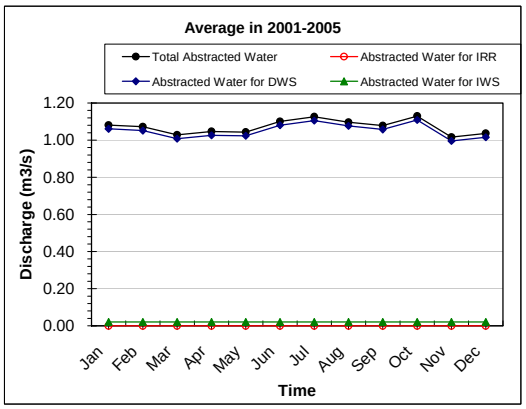
YAL7

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	YAL7		

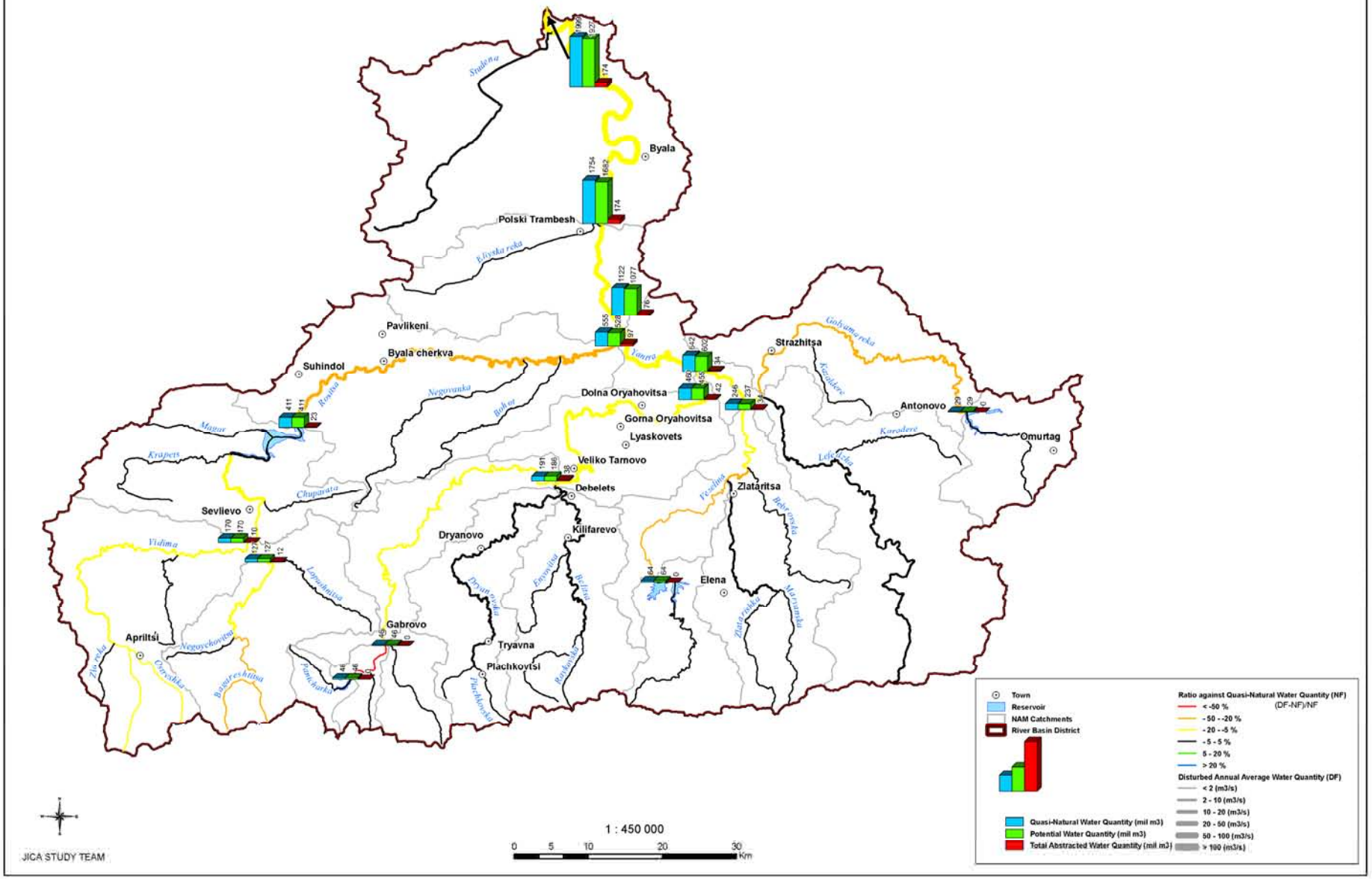




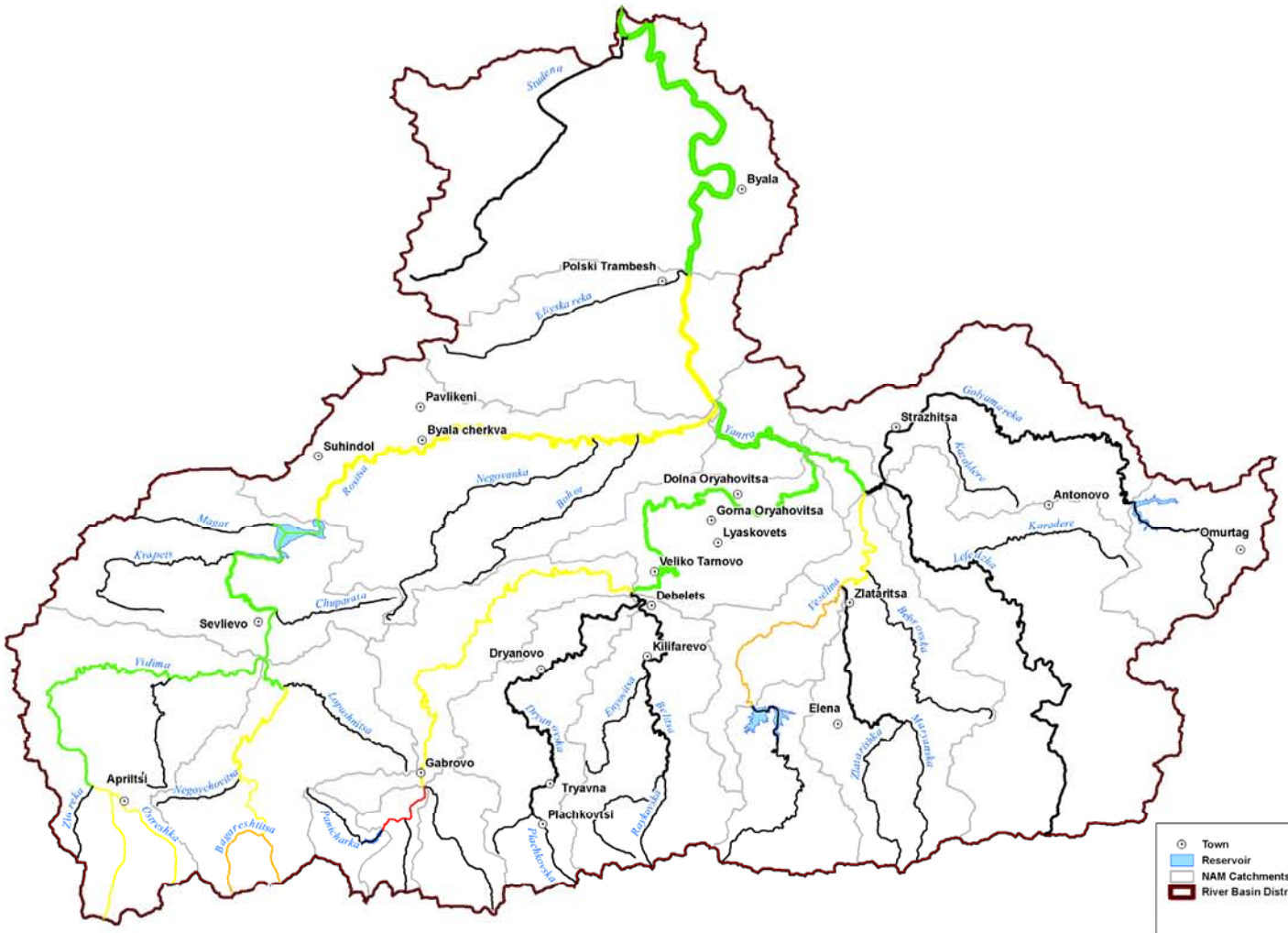




Existing Annual Water Quantity Distribution (2001 - 2005) in Yantra River Basin



Ratio of Abstracted Water Amount against Potential Flow (2001 - 2005) in Yantra River Basin



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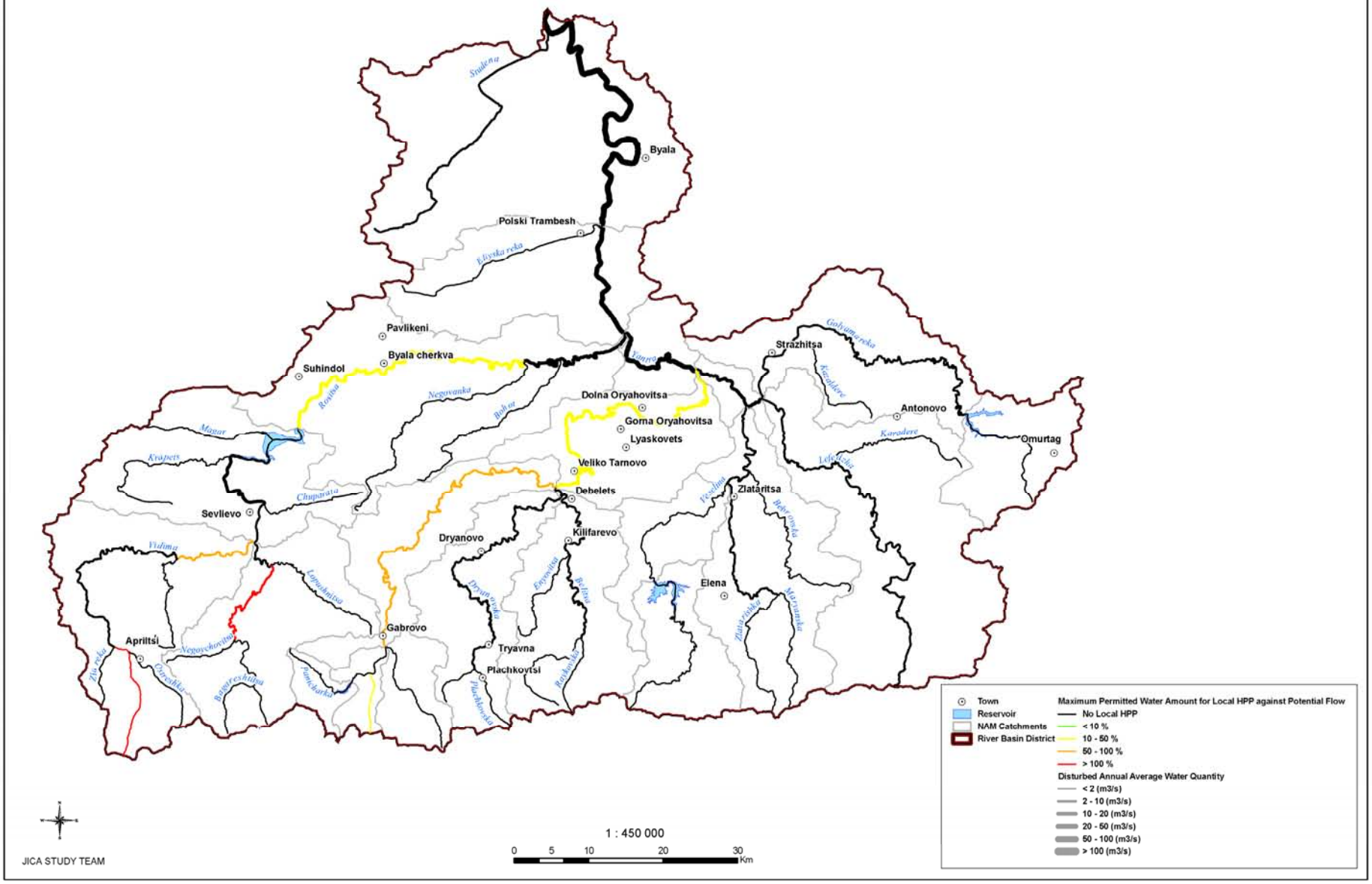
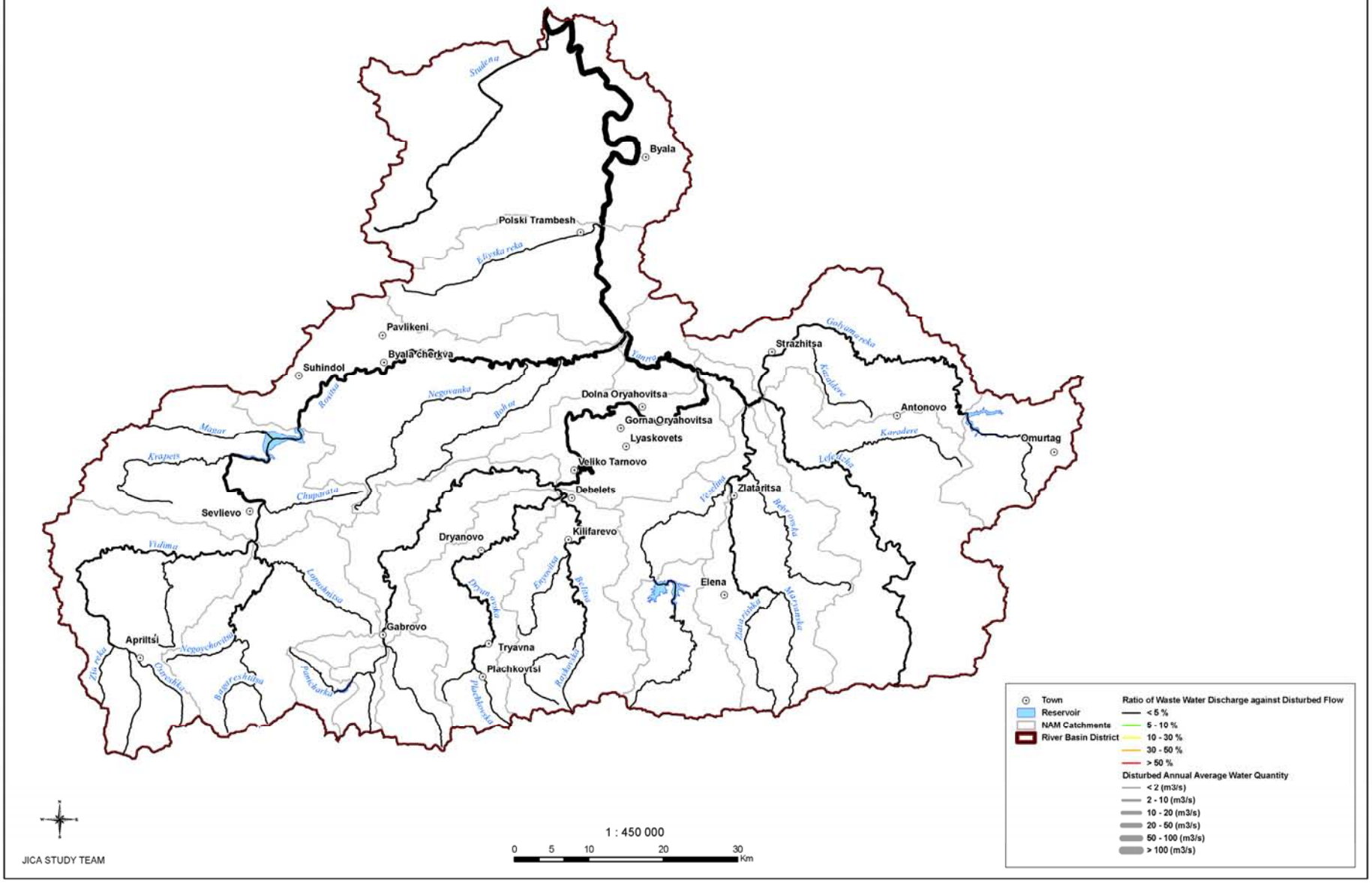
Maximum Permitted Water Amount for Local HPP against Potential Flow (2001 - 2005) in Yantra River Basin

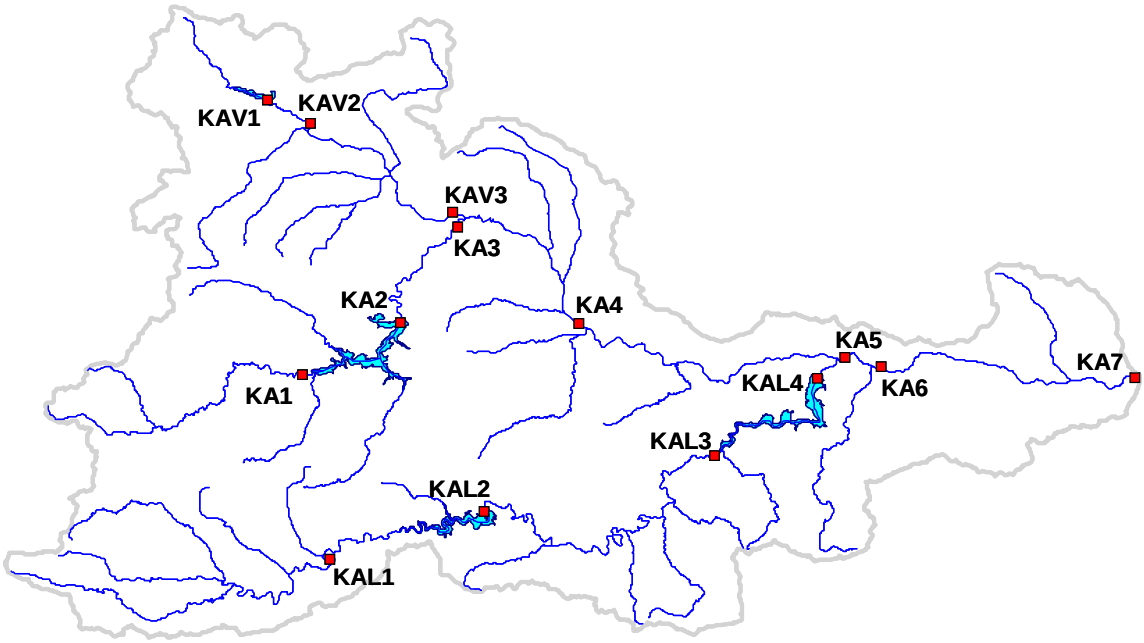


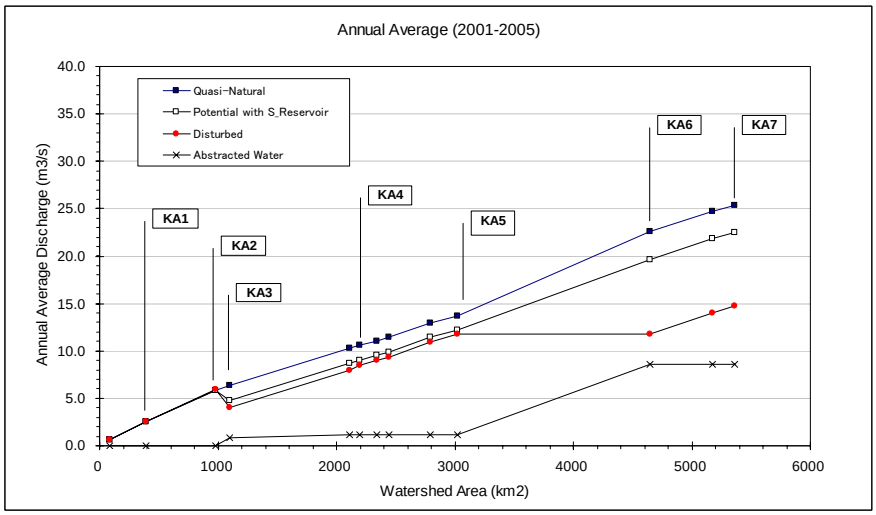
Ratio of Waste Water Discharge against Disturbed Flow (2001 - 2005) in Yantra River Basin

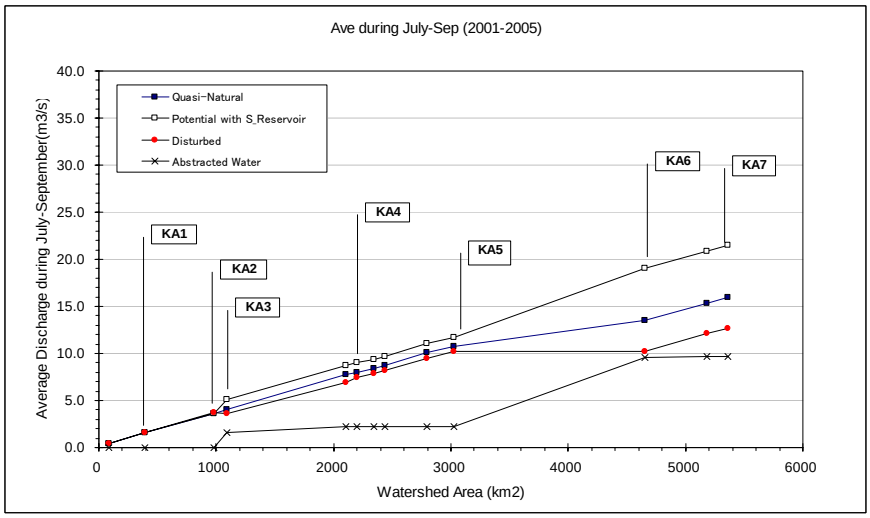


JICA STUDY TEAM

Kamichia River Basin


KAV1
KAV2
KAV3
KA3
KA2
KA4
KA5
KA7
KA6
KAL4
KA1
KAL3
KAL2
KAL1


Annual Average (2001-2005)
Quasi-Natural
Potential with S_Reservoir
Disturbed
Abstracted Water
KA1
KA2
KA3
KA4
KA5
KA6
KA7
Annual Average Discharge (m3/s)
Watershed Area (km2)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
0
1000
2000
3000
4000
5000
6000

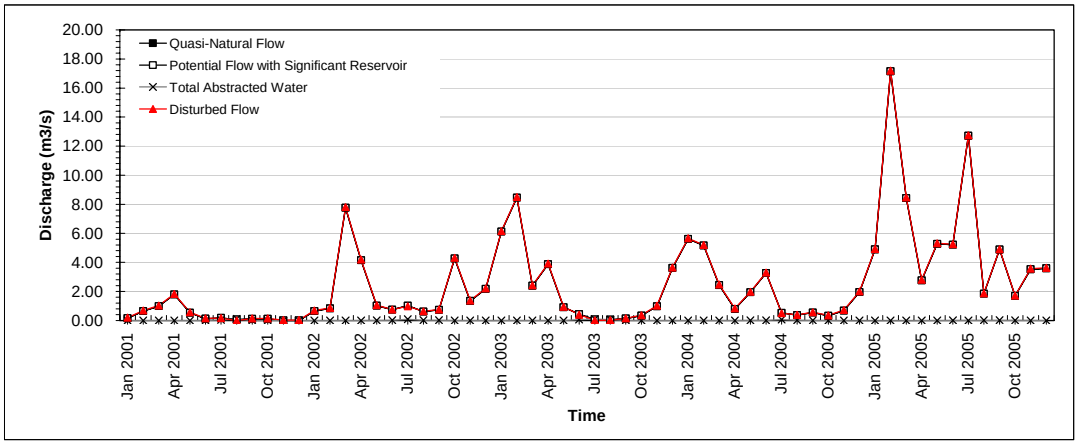

Ave during July-Sep (2001-2005)
Quasi-Natural
Potential with S_Reservoir
Disturbed
Abstracted Water
KA1
KA2
KA3
KA4
KA5
KA6
KA7
Average Discharge during July-September(m3/s)
Watershed Area (km2)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
0
1000
2000
3000
4000
5000
6000

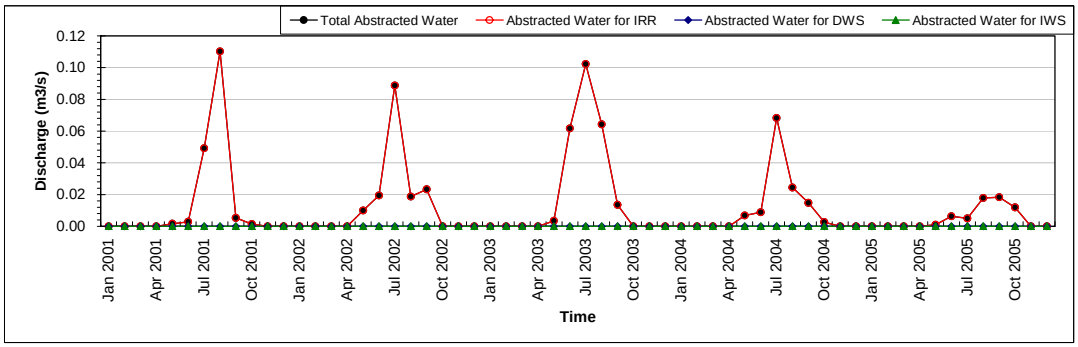
No.	KA1	KA2	KA3	KA4	KA5	KA6	KA7	KAL1	KAL2	KAL3
NAM Catchment	KA_M7	KA_M6	KA_M5	KA_M4	KA_M3	KA_M2	KA_M1	KA_LUD4	KA_LUD3	KA_LUD2
Catchment JICA_ID	744	800	724	751	755	746	740	870	1153	793
DownStream or UpStream	D	D	D	D	U	U	D	D	D	D
Upsteram Area (km2)	388.22	975.88	1094.25	2440.78	4631.23	4836.28	5362.75	517.55	788.61	1418.09
UpStreamArea excluding out of Territory (km2)	388.22	975.88	1094.25	2440.78	4631.23	4836.28	5362.75	517.55	788.61	1418.09
All Year Ave (2001-2005)										
Quasi-Natural Flow (NF) (m3/s)	2.550	5.852	6.369	11.406	22.501	23.246	25.391	4.096	5.939	8.227
Potential Flow (PF) (m3/s)	2.550	5.852	4.817	9.860	19.583	20.329	22.473	4.096	5.939	7.587
Disturbed Flow (DF) (m3/s)	2.576	5.915	4.070	9.361	11.769	12.502	14.712	4.127	5.976	4.646
(PF-NF)/NF (%)	0.0	0.0	-24.4	-13.6	-13.0	-12.5	-11.5	0.0	0.0	-7.8
(DF-NF)/NF (%)	1.0	1.1	-36.1	-17.9	-47.7	-46.2	-42.1	0.8	0.6	-43.5
(DF-PF)/PF (%)	1.0	1.1	-15.5	-5.1	-39.9	-38.5	-34.5	0.8	0.6	-38.8
Accumulated Abstracted Water for Irrigation (IRR) (m3/s)	0.013	0.016	0.868	1.123	2.006	2.023	2.031	0.004	0.004	0.004
Accumulated Abstracted Water for Drinking Water (DWS) (m3/s)	0.000	0.000	0.000	0.000	6.605	6.605	6.605	0.000	0.000	3.026
Accumulated Abstracted Water for Industrial Water (IWS) (m3/s)	0.000	0.000	0.002	0.002	0.004	0.007	0.010	0.000	0.000	0.000
Accumulated Total Water Abstraction (TotalAbst) (m3/s)	0.013	0.016	0.869	1.125	8.614	8.634	8.646	0.004	0.004	3.029
IRR/PF (%)	0.5	0.3	18.0	11.4	10.2	9.9	9.0	0.1	0.1	0.0
DWS/PF (%)	0.0	0.0	0.0	0.0	33.7	32.5	29.4	0.0	0.0	39.9
IWS/PF (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TotalAbst/PF (%)	0.5	0.3	18.0	11.4	44.0	42.5	38.5	0.1	0.1	39.9
HPPmax/PF (%)										
Accumulated Domestic WasteWater Discharge (DWW) (m3/s)	0.038	0.080	0.120	0.591	0.757	0.764	0.828	0.034	0.040	0.088
Accumulated Industrial WasteWater Discharge (IWW) (m3/s)	0.000	0.000	0.002	0.035	0.043	0.043	0.056	0.000	0.000	0.000
Accumulated Total WasteWater Discharge (TotalWW) (m3/s)	0.038	0.080	0.122	0.626	0.800	0.807	0.884	0.034	0.040	0.088
DWW/DF(%)	1.5	1.4	2.9	6.3	6.4	6.1	5.6	0.8	0.7	1.9
IWW/DF (%)	0.0	0.0	0.1	0.4	0.4	0.3	0.4	0.0	0.0	0.0
TotalWW/DF (%)	1.5	1.4	3.0	6.7	6.8	6.5	6.0	0.8	0.7	1.9
Ave in July-September (2001-2005)										
Quasi-Natural Flow (NF) (m3/s)	1.592	3.651	4.093	8.727	13.456	14.092	15.923	1.193	1.730	2.544
Potential Flow (PF) (m3/s)	1.592	3.651	5.088	9.712	19.002	19.639	21.469	1.193	1.730	5.012
Disturbed Flow (DF) (m3/s)	1.588	3.678	3.600	8.142	10.209	10.796	12.673	1.217	1.759	1.374
(PF-NF)/NF (%)	0.0	0.0	24.3	11.3	41.2	39.4	34.8	0.0	0.0	97.0
(DF-NF)/NF (%)	-0.2	0.7	-12.0	-6.7	-24.1	-23.4	-20.4	2.0	1.7	-46.0
(DF-PF)/PF (%)	-0.2	0.7	-29.2	-16.2	-46.3	-45.0	-41.0	2.0	1.7	-72.6
Accumulated Abstracted Water for Irrigation (IRR) (m3/s)	0.042	0.053	1.609	2.194	2.992	3.045	3.073	0.011	0.011	0.011
Accumulated Abstracted Water for Drinking Water (DWS) (m3/s)	0.000	0.000	0.000	0.000	6.598	6.598	6.598	0.000	0.000	3.715
Accumulated Abstracted Water for Industrial Water (IWS) (m3/s)	0.000	0.000	0.002	0.002	0.004	0.007	0.010	0.000	0.000	0.000
Accumulated Total Water Abstraction (TotalAbst) (m3/s)	0.042	0.053	1.610	2.196	9.594	9.650	9.681	0.011	0.011	3.726
IRR/PF (%)	2.6	1.4	31.6	22.6	15.7	15.5	14.3	0.9	0.6	0.2
DWS/PF (%)	0.0	0.0	0.0	0.0	34.7	33.6	30.7	0.0	0.0	74.1
IWS/PF (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TotalAbst/PF (%)	2.6	1.4	31.6	22.6	50.5	49.1	45.1	0.9	0.6	74.3
HPPmax/PF (%)										
Accumulated Domestic WasteWater Discharge (DWW) (m3/s)	0.038	0.080	0.120	0.591	0.757	0.764	0.828	0.034	0.040	0.088
Accumulated Industrial WasteWater Discharge (IWW) (m3/s)	0.000	0.000	0.002	0.035	0.043	0.043	0.056	0.000	0.000	0.000
Accumulated Total WasteWater Discharge (TotalWW) (m3/s)	0.038	0.080	0.122	0.626	0.800	0.807	0.884	0.034	0.040	0.088
DWW/DF(%)	2.4	2.2	3.3	7.3	7.4	7.1	6.5	2.8	2.3	6.4
IWW/DF (%)	0.0	0.0	0.1	0.4	0.4	0.4	0.4	0.0	0.0	0.0
TotalWW/DF (%)	2.4	2.2	3.4	7.7	7.8	7.5	7.0	2.8	2.3	6.4

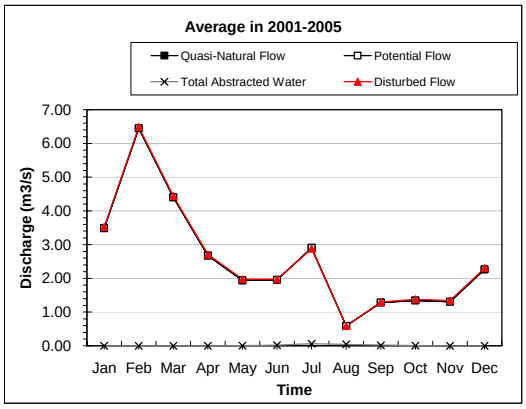
No.	KAL4	KAV1	KAV2	KAV3
NAM Catchment	KA_LUD1	KA_KER2	KA_KER1	KA_VRA
Catchment JICA_ID	1154	801	630	1121
DownStream or UpStream	D	D	D	D
Upsteram Area (km2)	1603.87	186.72	212.83	938.62
UpStreamArea excluding out of Territory (km2)	1603.87	186.72	212.83	938.62
All Year Ave (2001-2005)				
Quasi-Natural Flow (NF) (m3/s)	8.756	0.209	0.321	3.635
Potential Flow (PF) (m3/s)	8.116	0.209	0.327	3.641
Disturbed Flow (DF) (m3/s)	5.189	0.224	0.117	3.615
(PF-NF)/NF (%)	-7.3	0.0	1.9	0.2
(DF-NF)/NF (%)	-40.7	7.3	-63.4	-0.5
(DF-PF)/PF (%)	-36.1	7.3	-64.1	-0.7
Accumulated Abstracted Water for Irrigation (IRR) (m3/s)	0.004	0.006	0.236	0.255
Accumulated Abstracted Water for Drinking Water (DWS) (m3/s)	3.026	0.000	0.000	0.000
Accumulated Abstracted Water for Industrial Water (IWS) (m3/s)	0.000	0.000	0.000	0.000
Accumulated Total Water Abstraction (TotalAbst) (m3/s)	3.029	0.006	0.236	0.255
IRR/PF (%)	0.0	3.1	72.3	7.0
DWS/PF (%)	37.3	0.0	0.0	0.0
IWS/PF (%)	0.0	0.0	0.0	0.0
TotalAbst/PF (%)	37.3	3.1	72.3	7.0
HPPmax/PF (%)				
Accumulated Domestic WasteWater Discharge (DWW)	0.102	0.022	0.027	0.212
Accumulated Industrial WasteWater Discharge (IWW)	0.001	0.000	0.000	0.017
Accumulated Total WasteWater Discharge (TotalWW) (m3/s)	0.102	0.022	0.027	0.230
DWW/DF(%)	2.0	9.7	22.9	5.9
IWW/DF (%)	0.0	0.0	0.0	0.5
TotalWW/DF (%)	2.0	9.7	22.9	6.3
Ave in July-September (2001-2005)				
Quasi-Natural Flow (NF) (m3/s)	2.732	0.513	0.608	3.438
Potential Flow (PF) (m3/s)	5.200	0.513	0.598	3.427
Disturbed Flow (DF) (m3/s)	1.576	0.513	0.101	3.072
(PF-NF)/NF (%)	90.3	0.0	-1.7	-0.3
(DF-NF)/NF (%)	-42.3	0.1	-83.4	-10.6
(DF-PF)/PF (%)	-69.7	0.1	-83.1	-10.4
Accumulated Abstracted Water for Irrigation (IRR) (m3/s)	0.011	0.021	0.524	0.585
Accumulated Abstracted Water for Drinking Water (DWS) (m3/s)	3.715	0.000	0.000	0.000
Accumulated Abstracted Water for Industrial Water (IWS) (m3/s)	0.000	0.000	0.000	0.000
Accumulated Total Water Abstraction (TotalAbst) (m3/s)	3.726	0.021	0.524	0.585
IRR/PF (%)	0.2	4.1	87.6	17.1
DWS/PF (%)	71.4	0.0	0.0	0.0
IWS/PF (%)	0.0	0.0	0.0	0.0
TotalAbst/PF (%)	71.7	4.1	87.6	17.1
HPPmax/PF (%)				
Accumulated Domestic WasteWater Discharge (DWW)	0.102	0.022	0.027	0.212
Accumulated Industrial WasteWater Discharge (IWW)	0.001	0.000	0.000	0.017
Accumulated Total WasteWater Discharge (TotalWW) (m3/s)	0.102	0.022	0.027	0.230
DWW/DF(%)	6.5	4.2	26.6	6.9
IWW/DF (%)	0.0	0.0	0.0	0.6
TotalWW/DF (%)	6.5	4.2	26.6	7.5

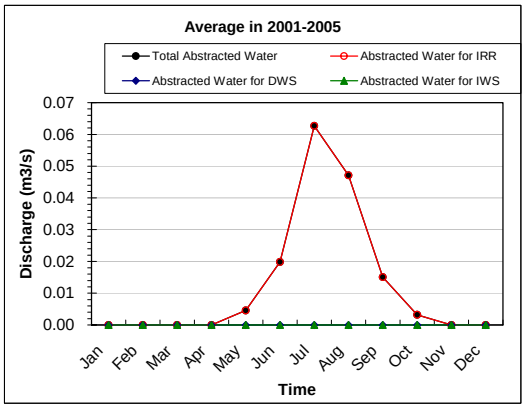
KA1

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	KA1		



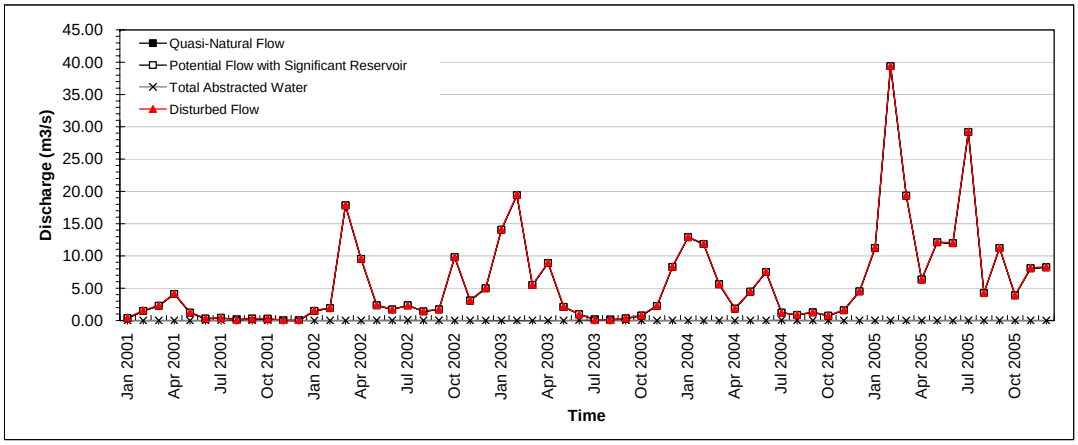


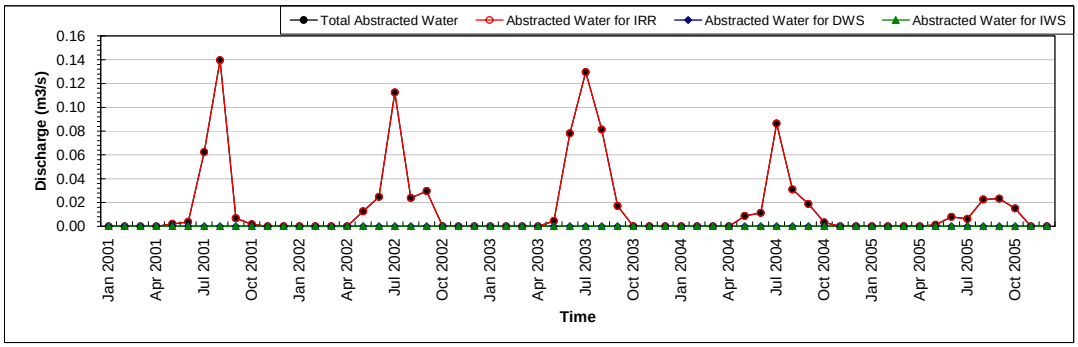


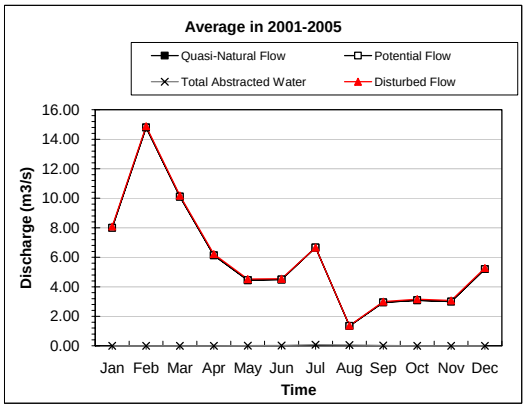


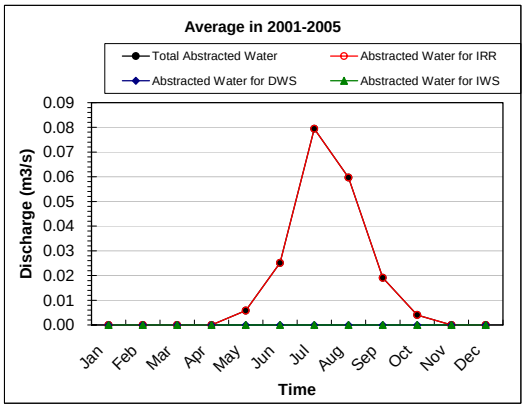
KA2

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	KA2		



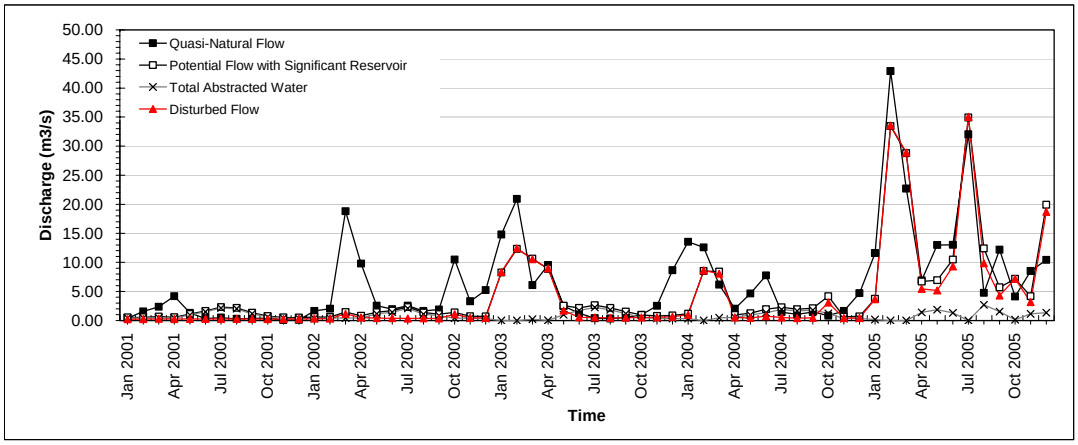


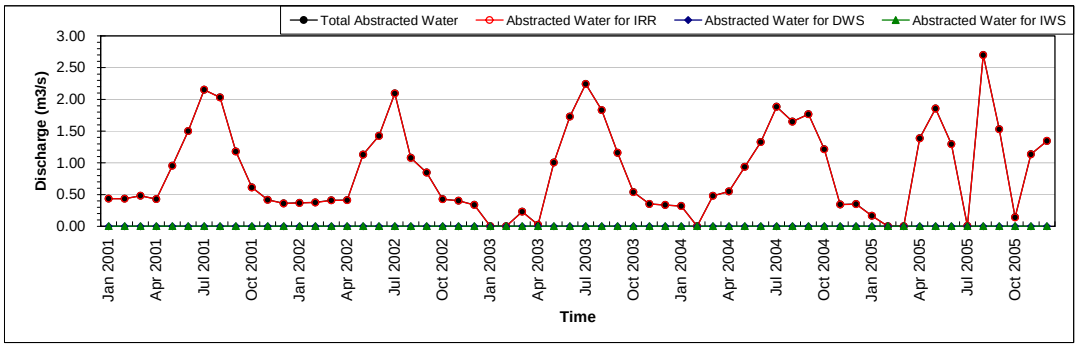


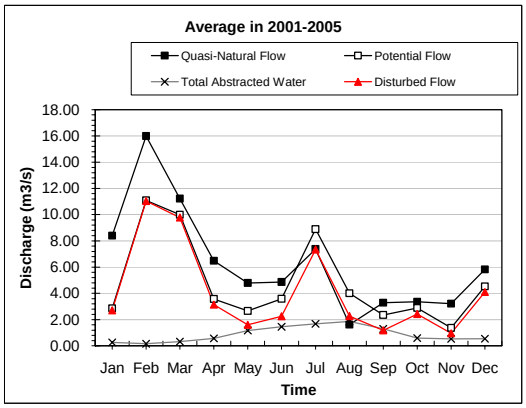


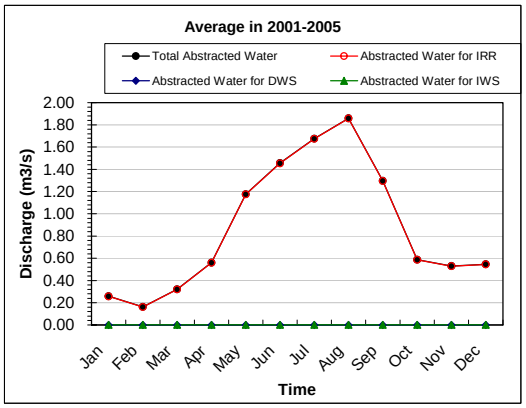
KA3

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	KA3		



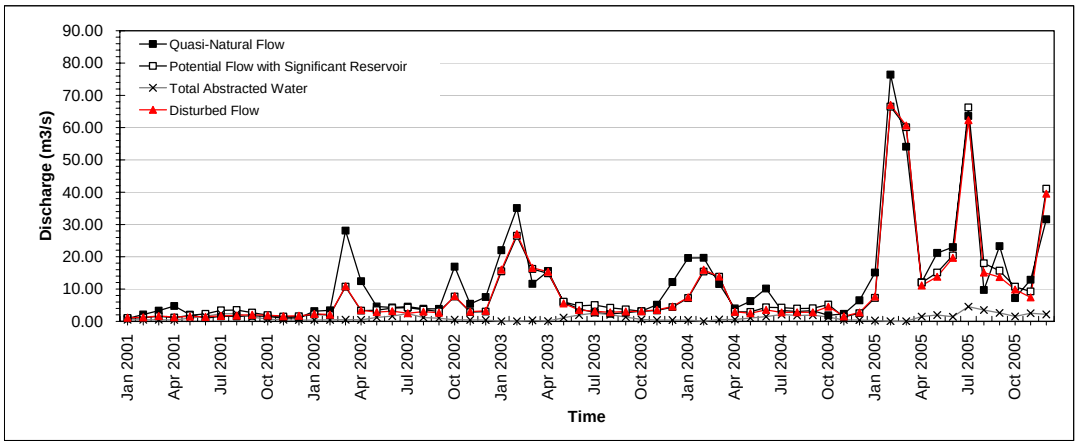


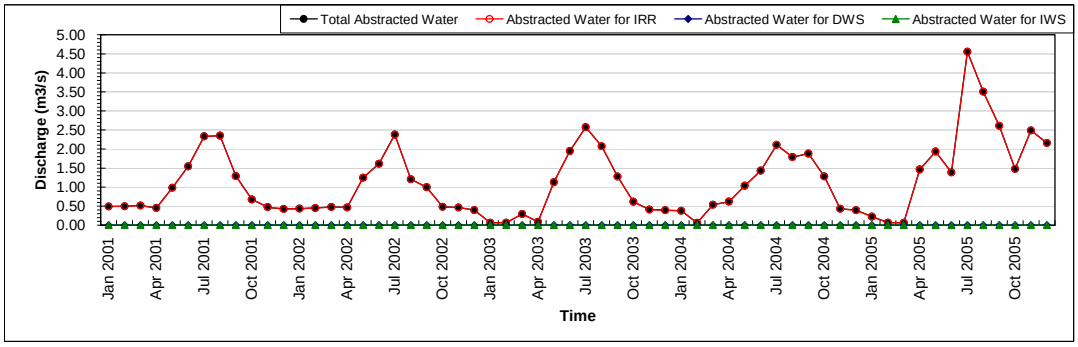


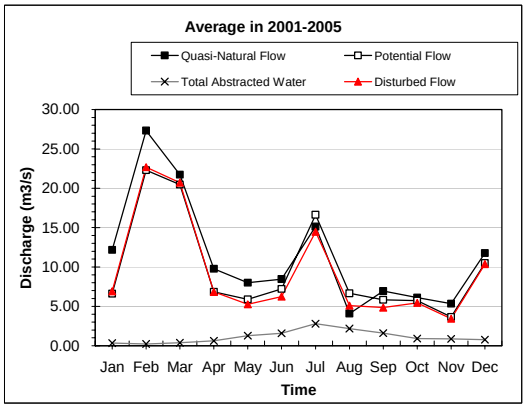


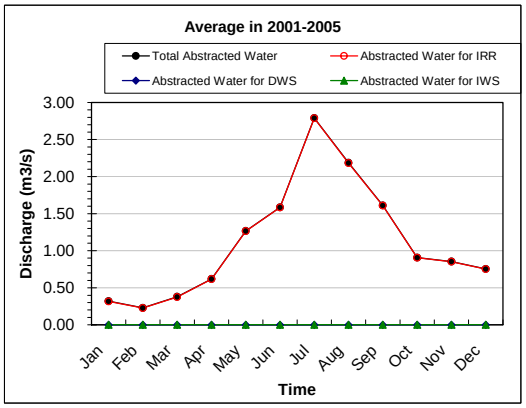
KA4

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	KA4		



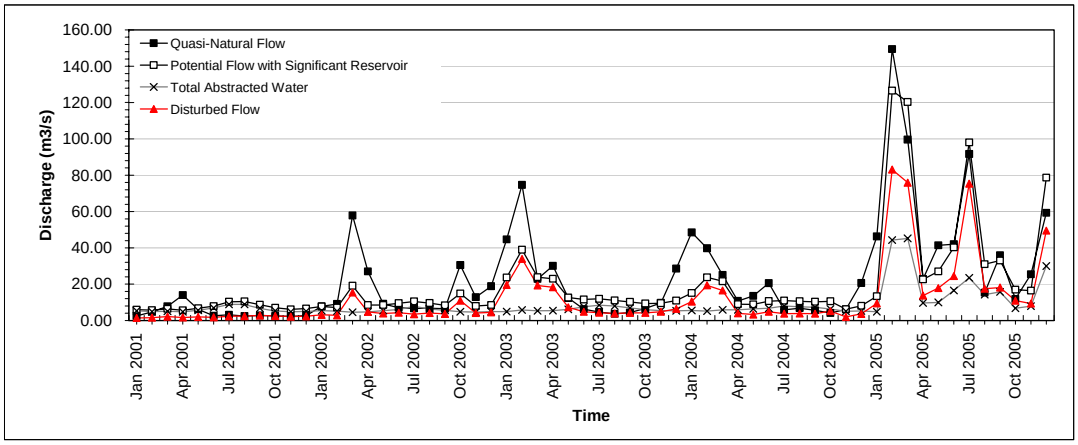


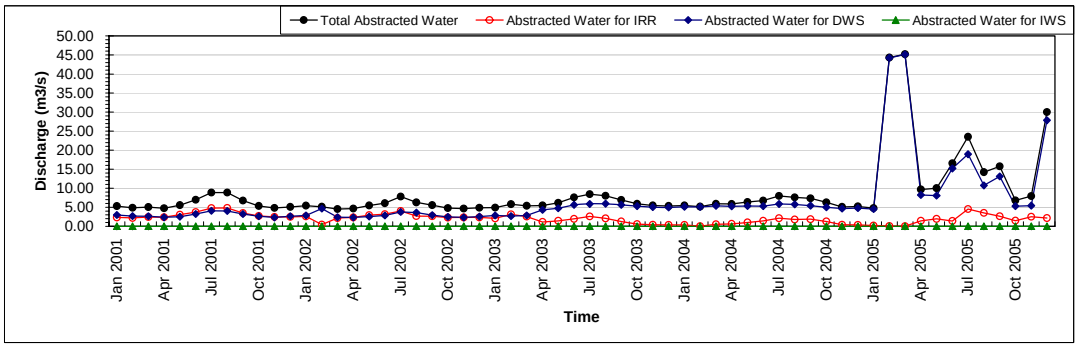


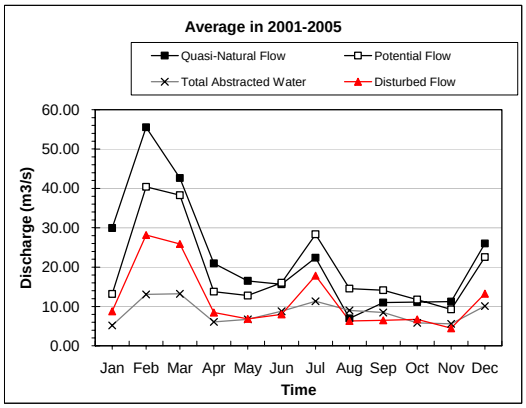


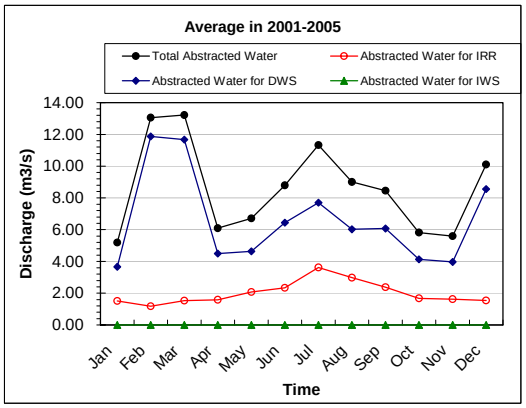
KA5

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	KA5		



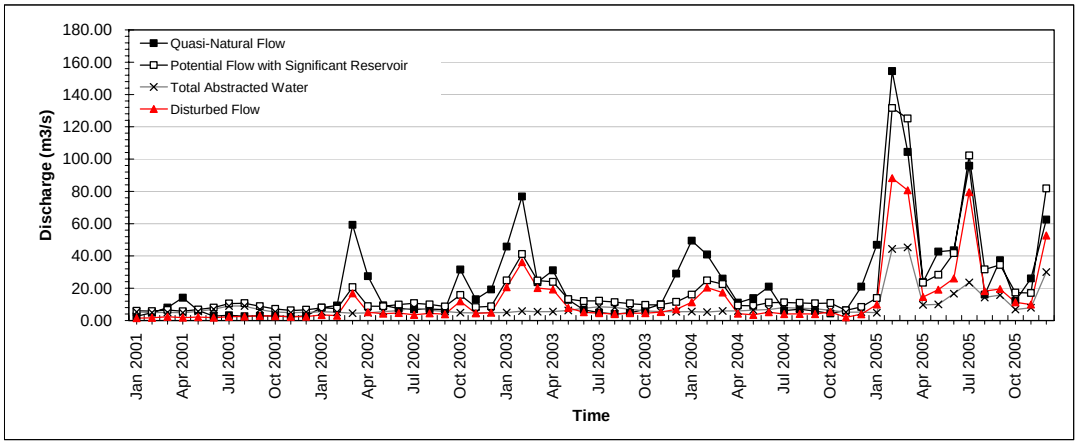


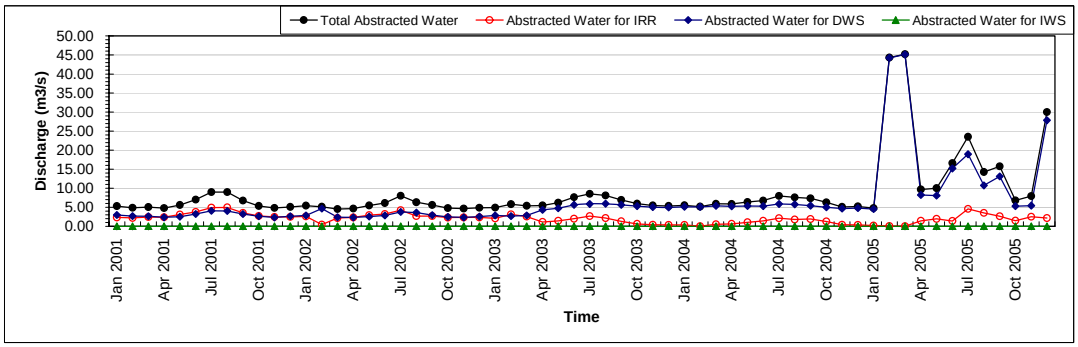


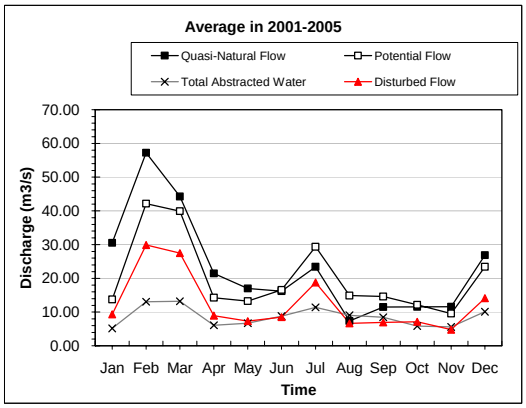


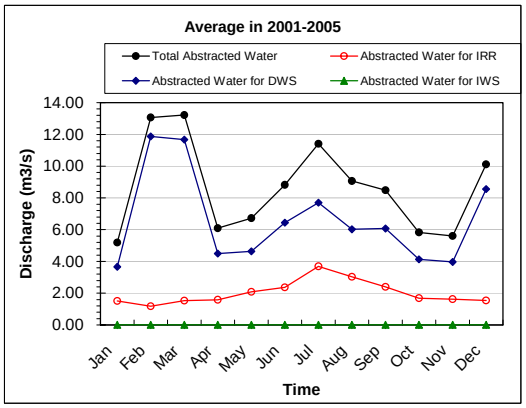
KA6

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	KA6		









KA7

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
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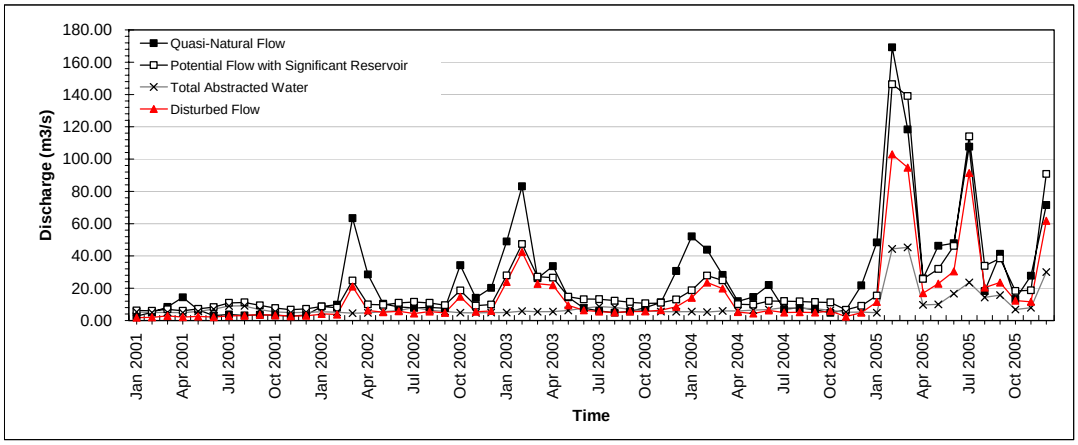

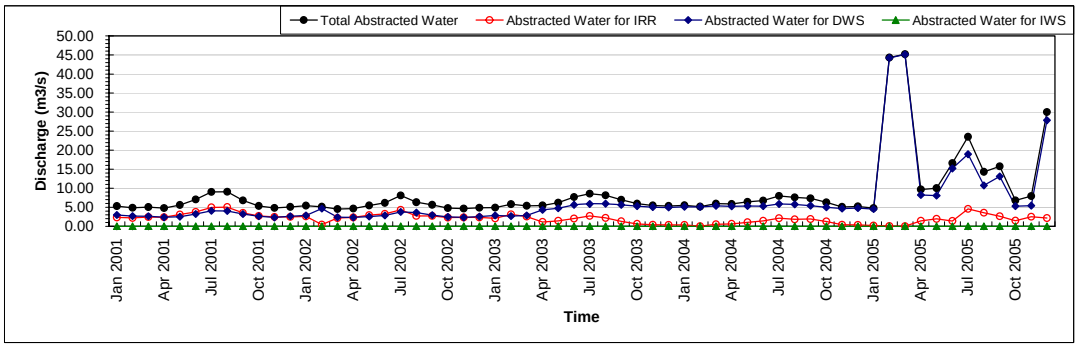

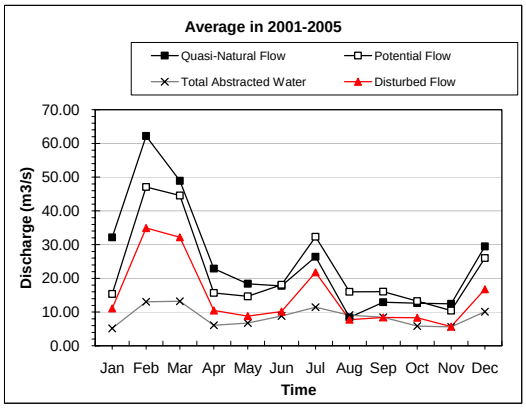

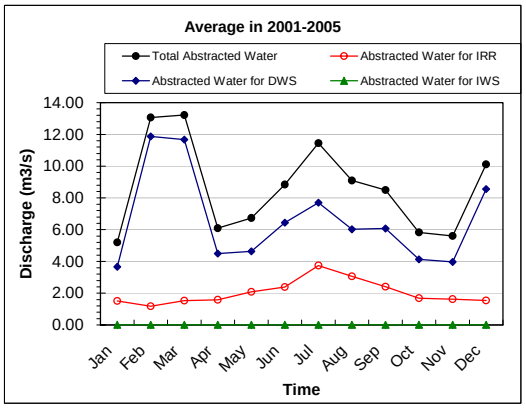

KAL1

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
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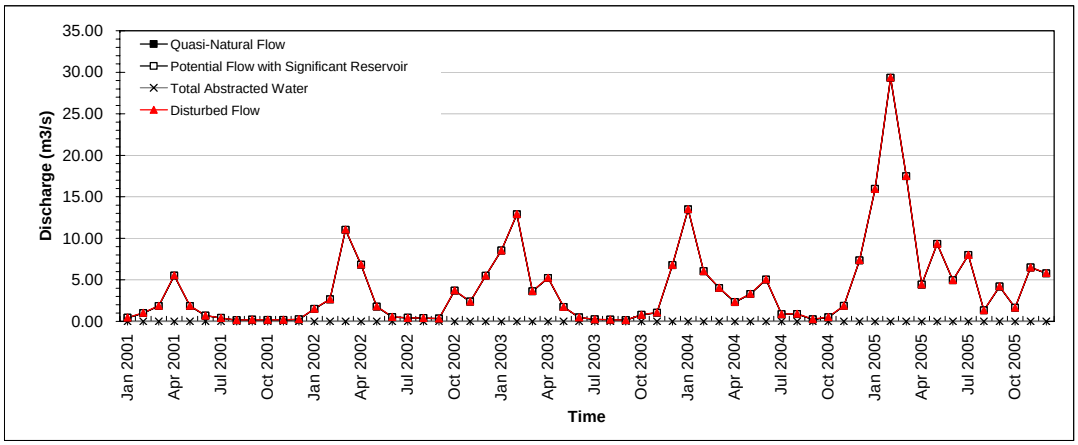

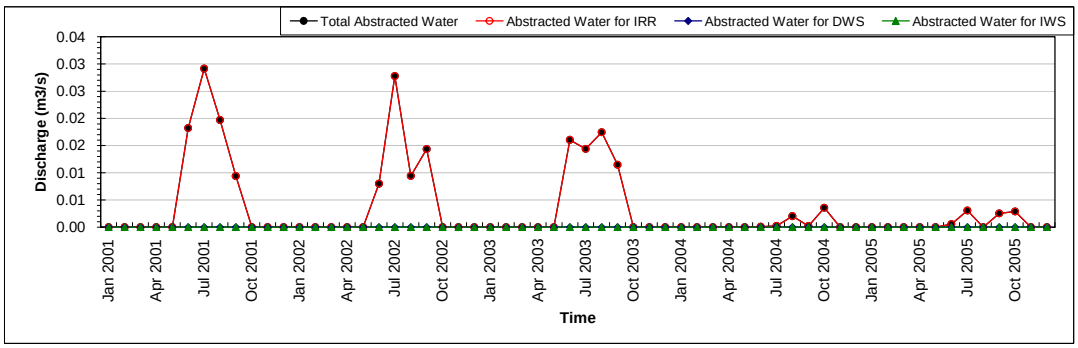

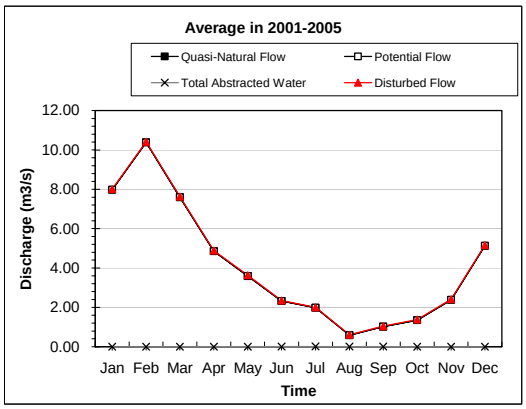

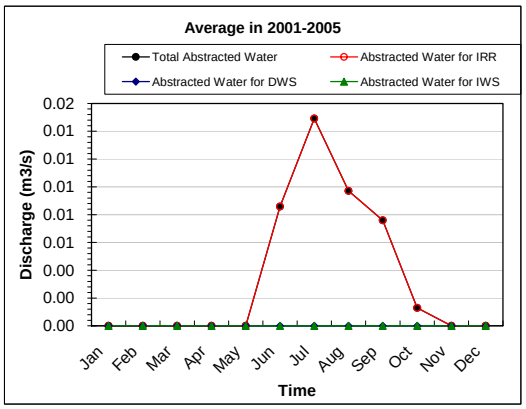

KAL2

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
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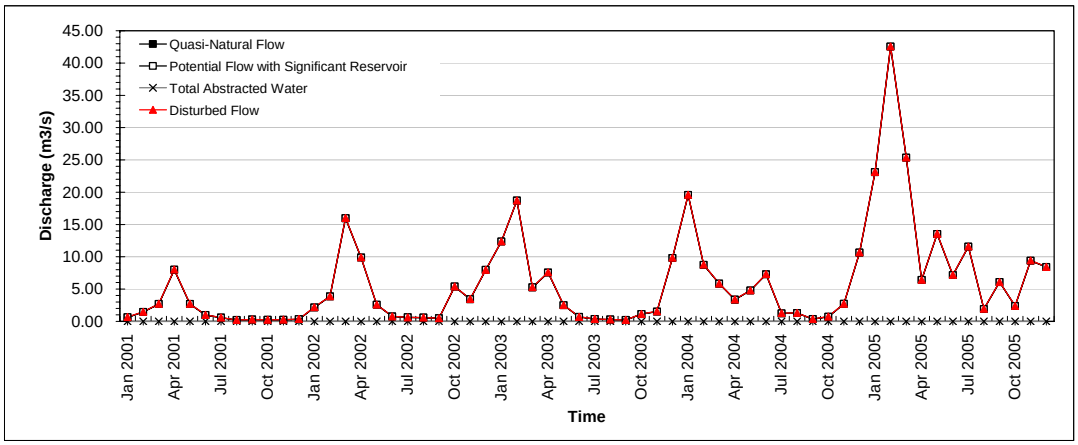

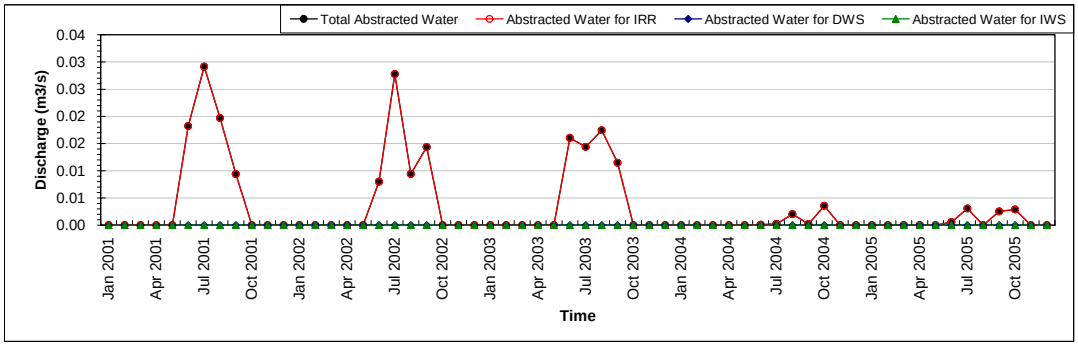

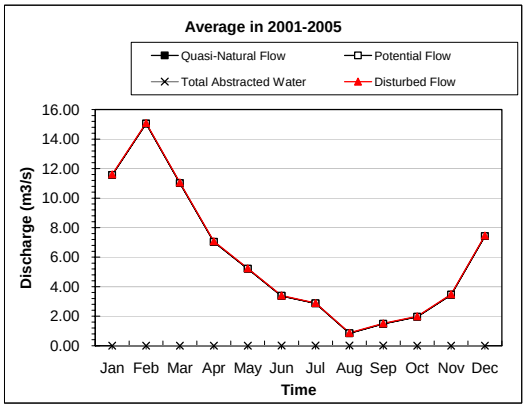

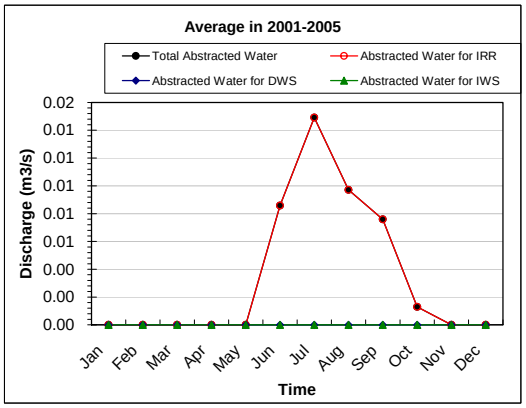

KAL3

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
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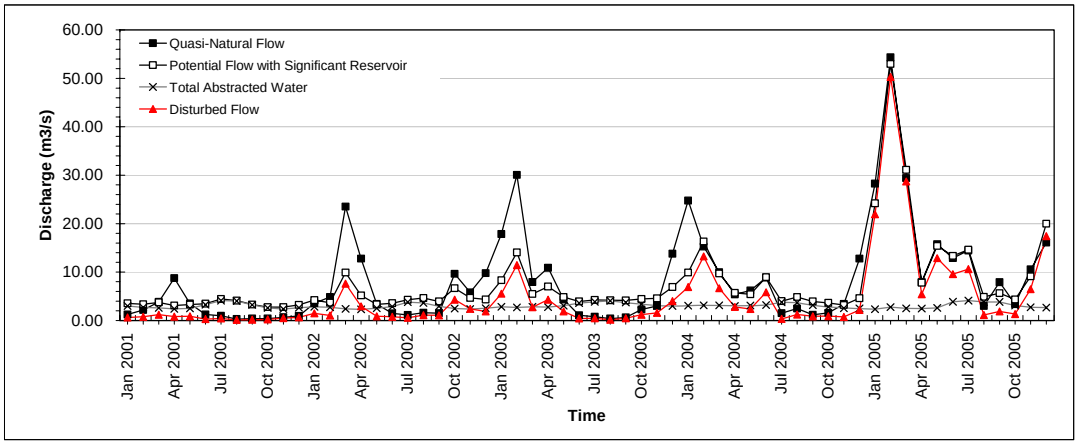

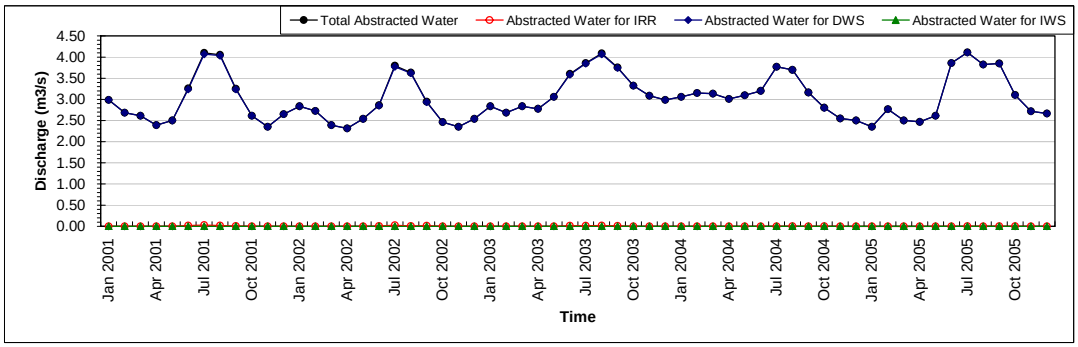

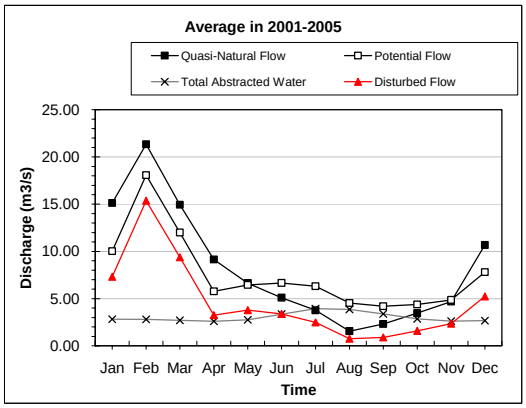

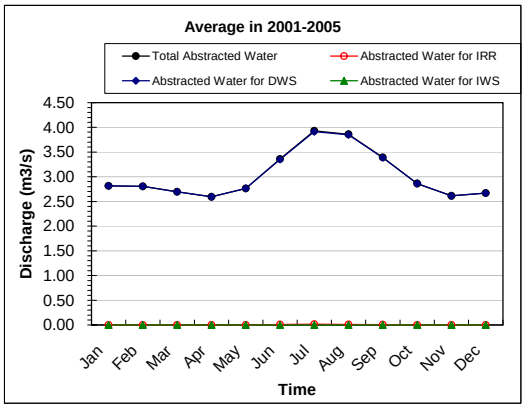

KAL4

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
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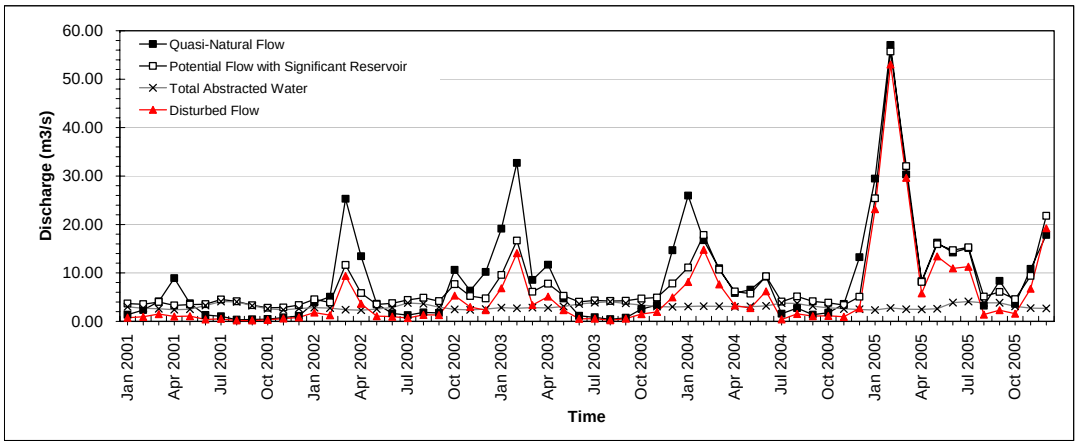

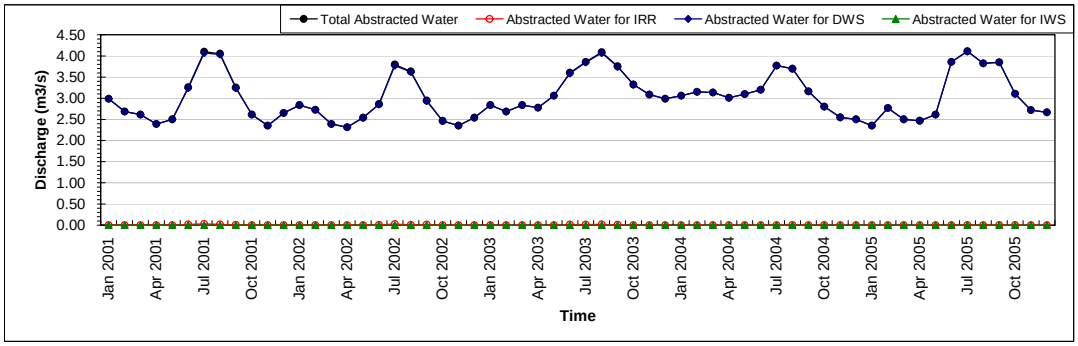

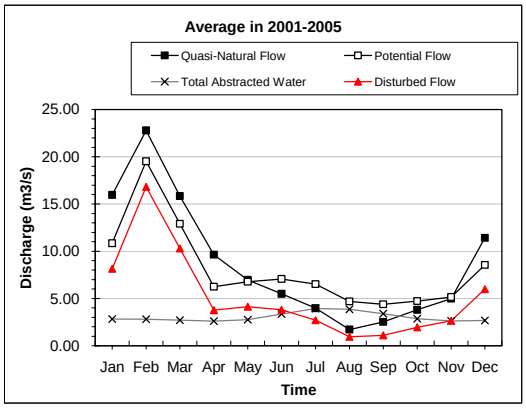

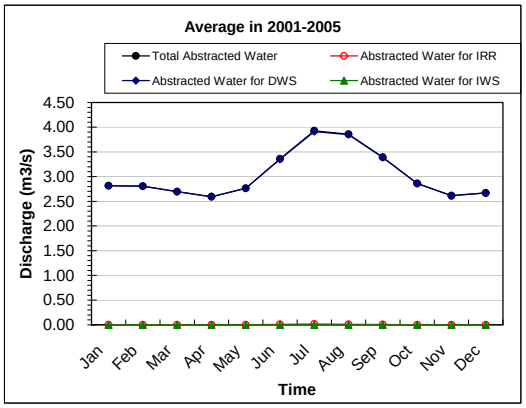

KAV1

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
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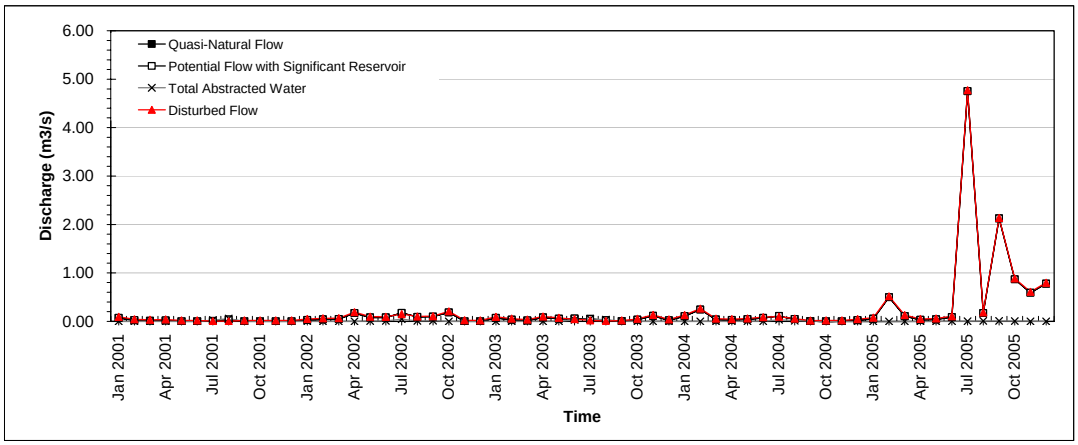

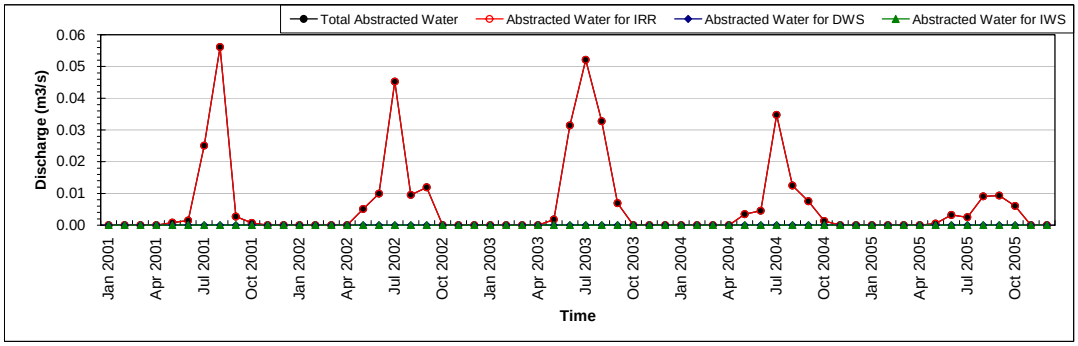

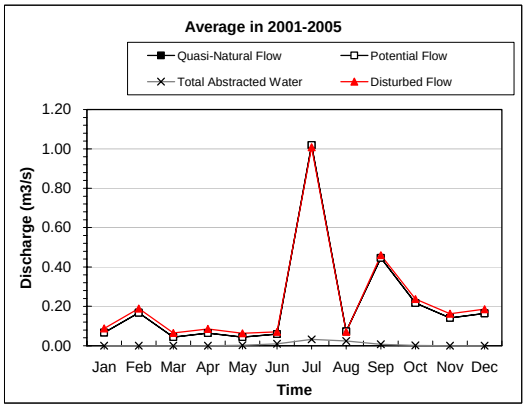

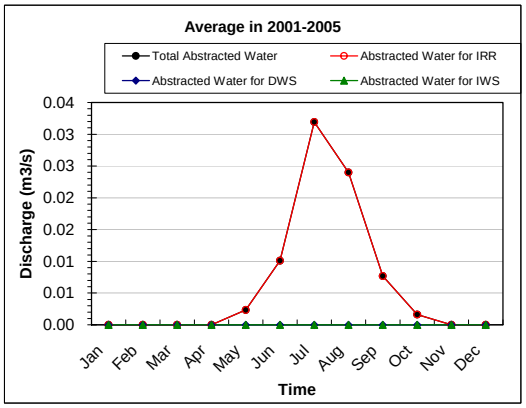

KAV2

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
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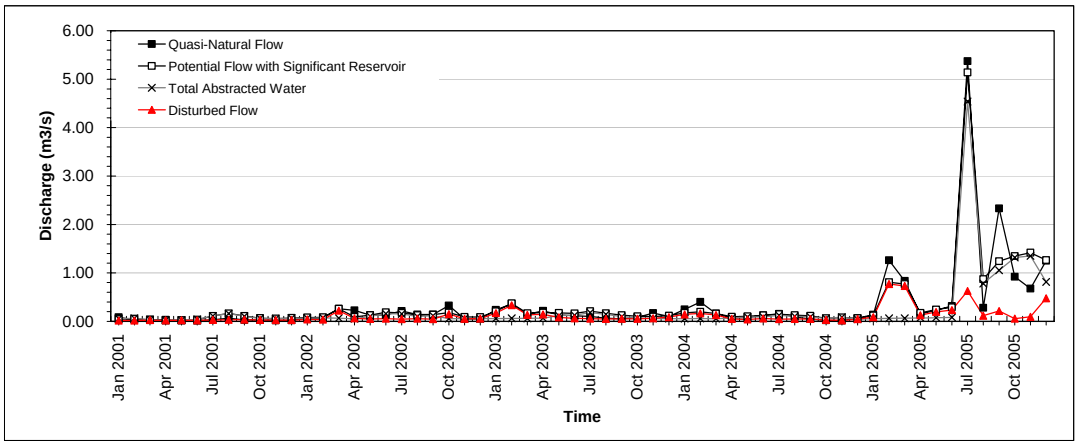
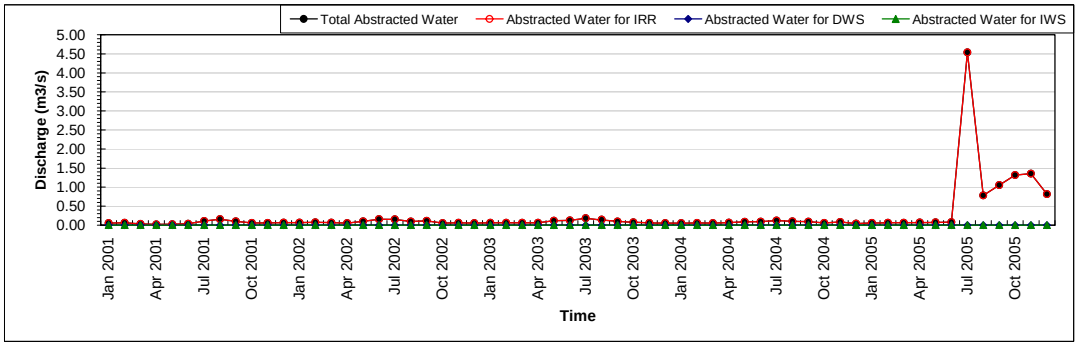
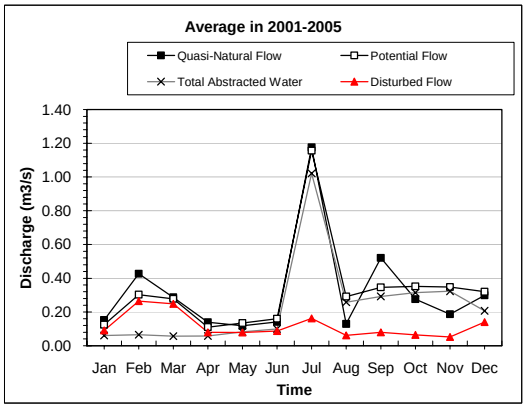
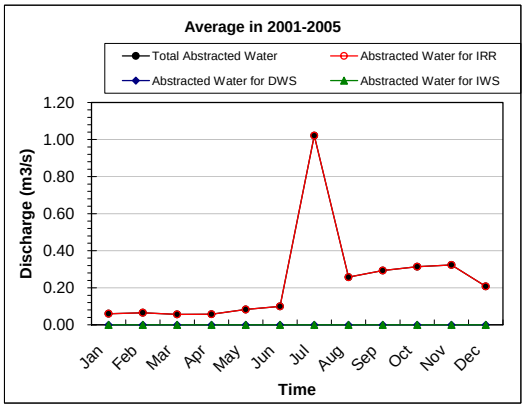


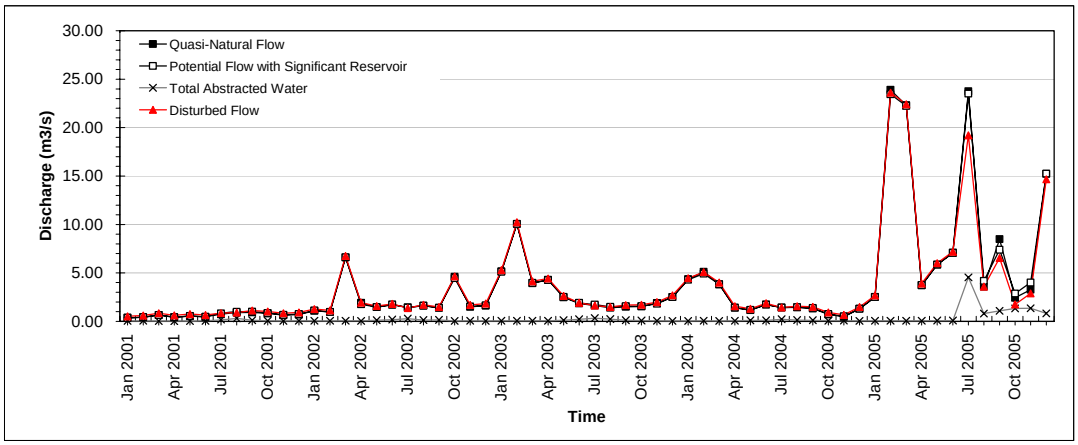


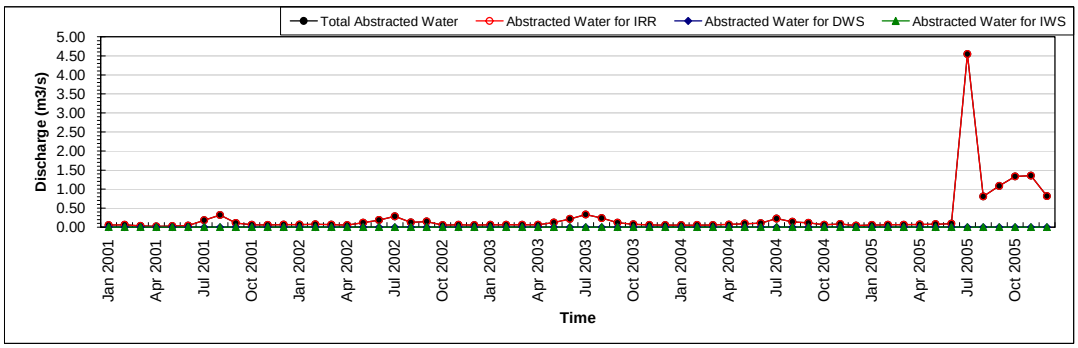


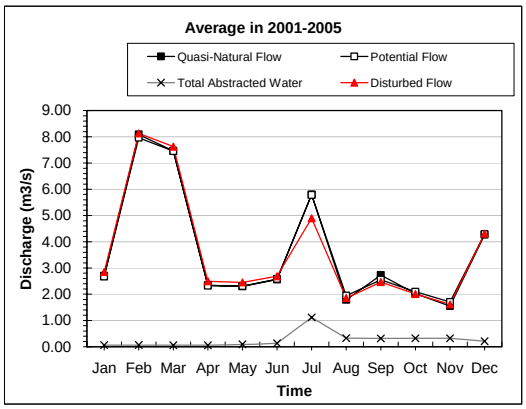


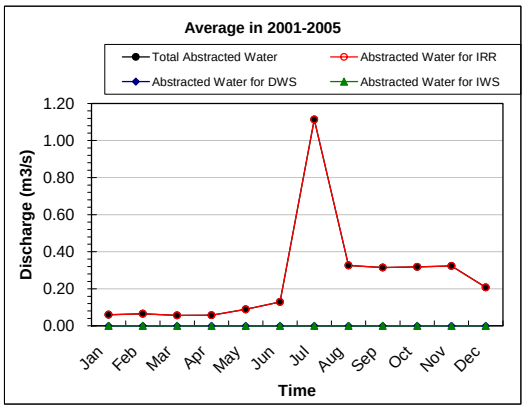
KAV3

Point 1: RefPoint 2: Segment	No. of RefPoint (for 1)	Catchment JICA_ID (For 2)	Re-plot TimeSeries
1	KAV3		

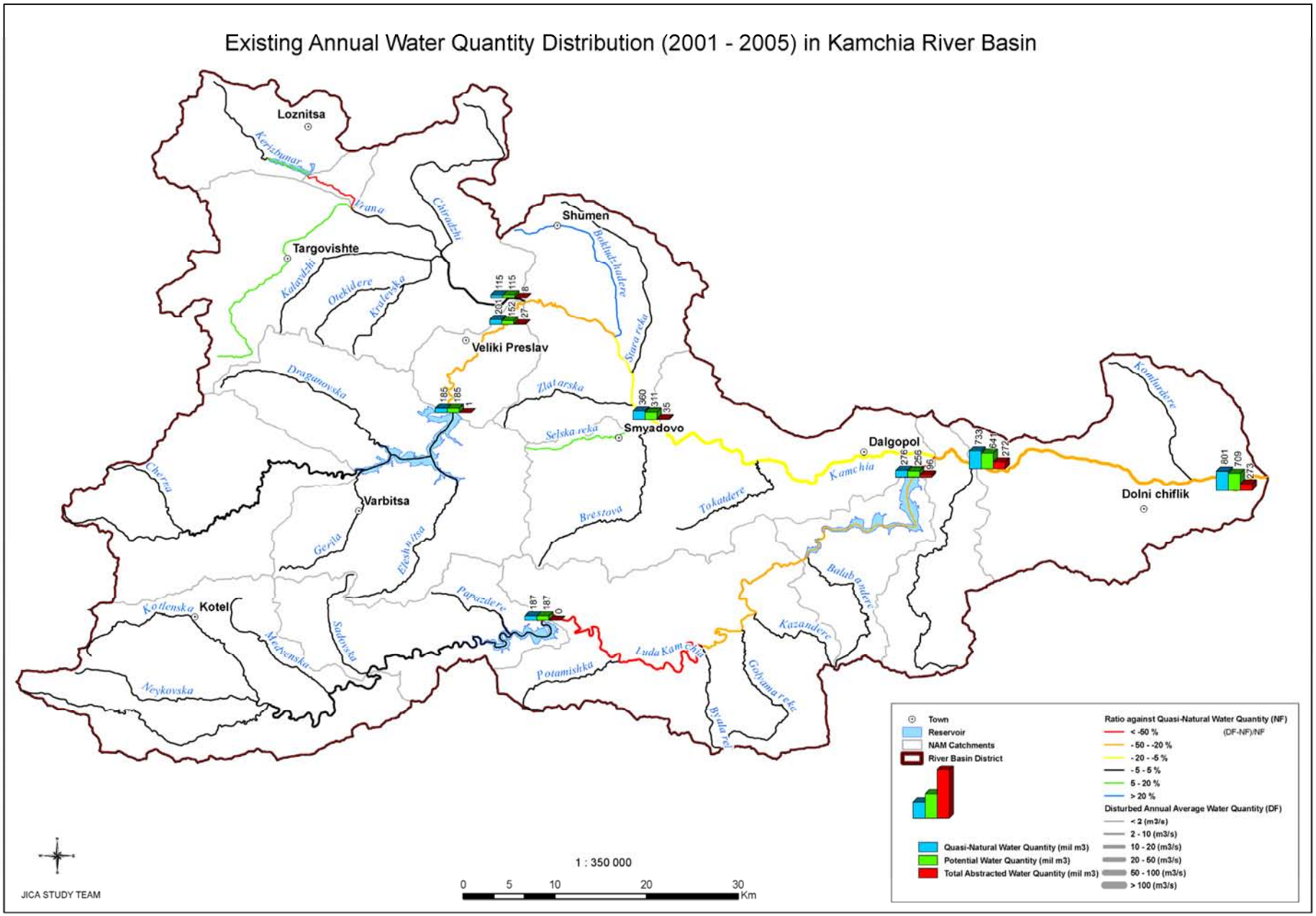




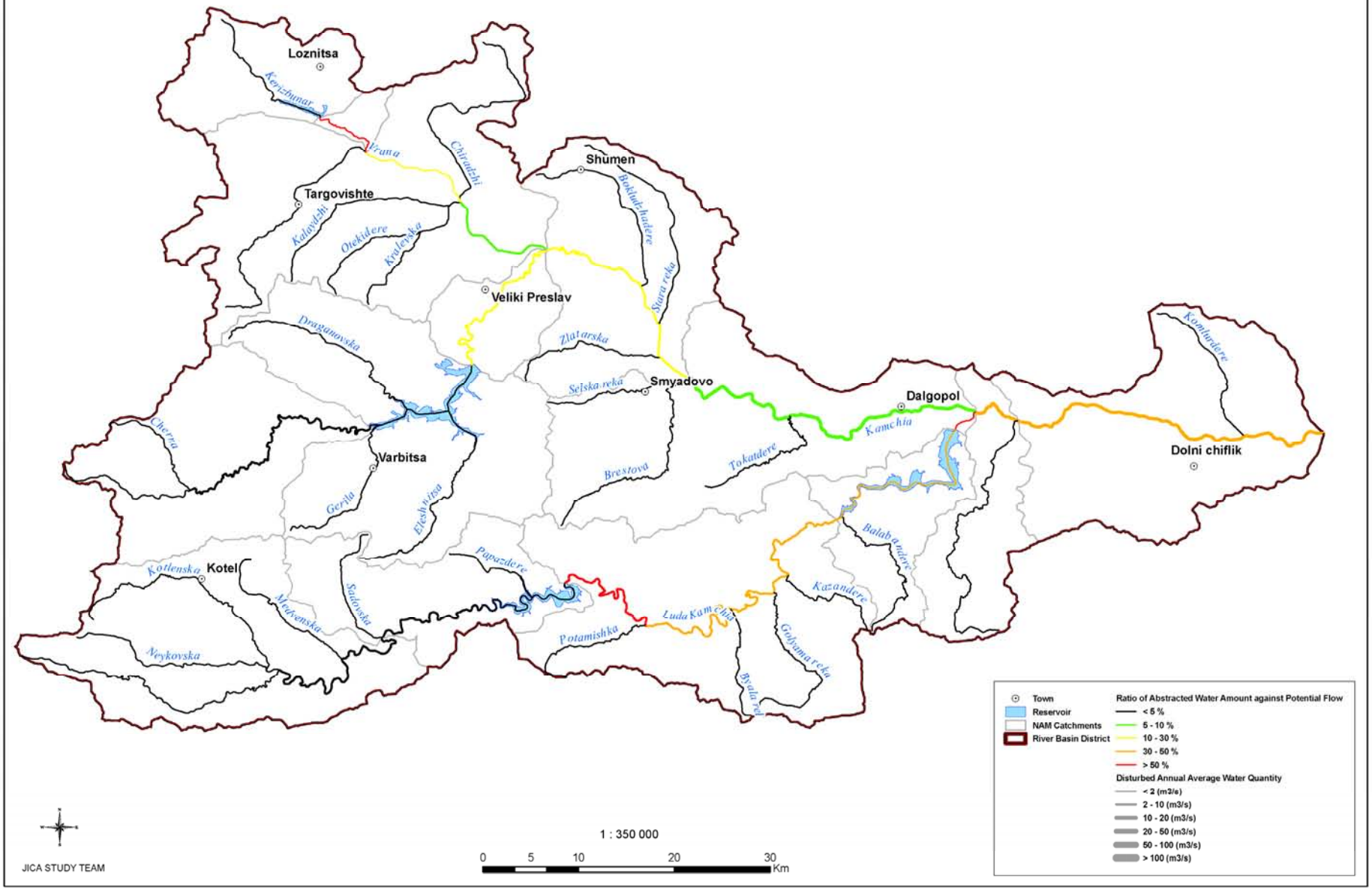




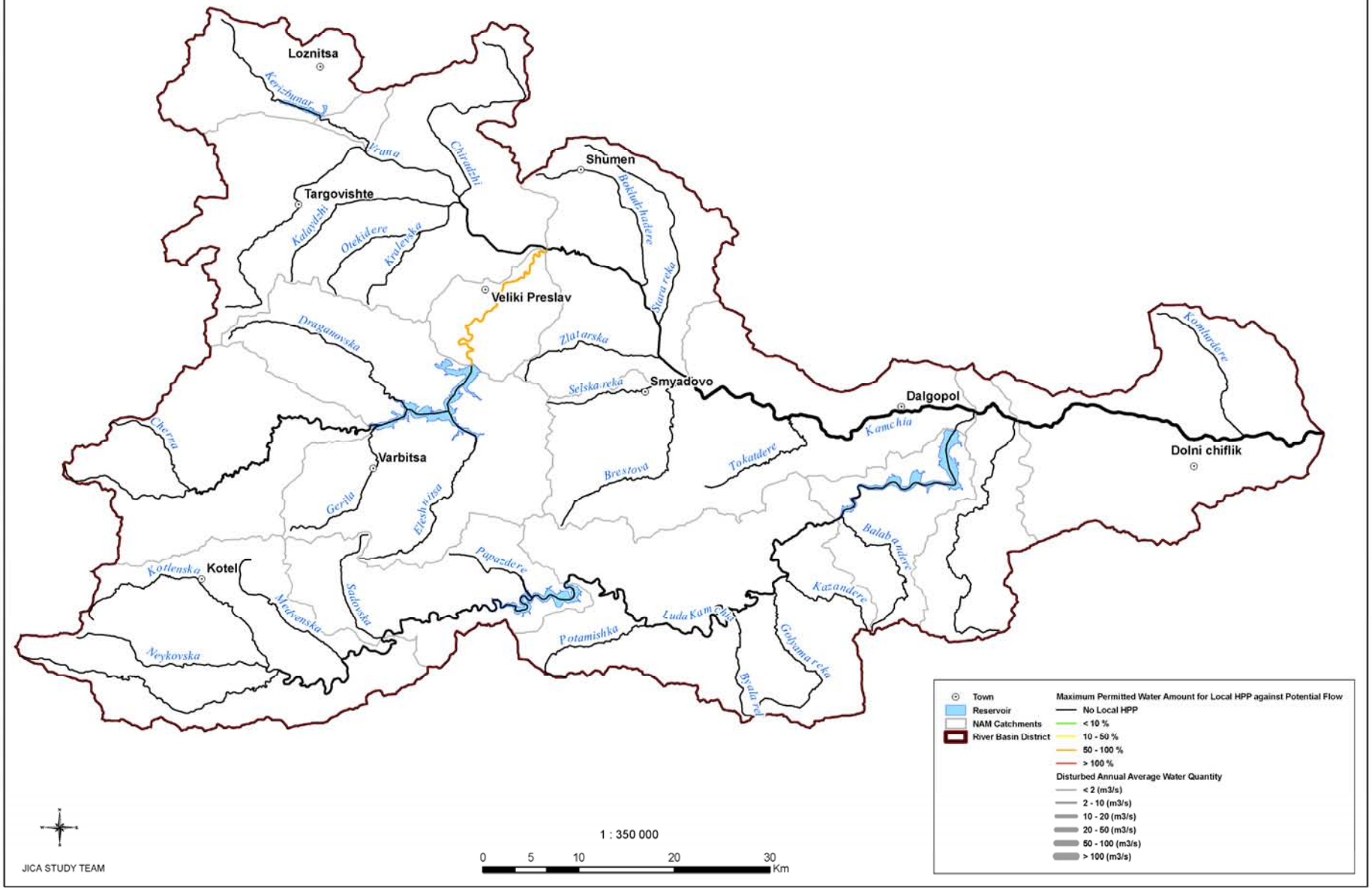
Existing Annual Water Quantity Distribution (2001 - 2005) in Kamchia River Basin



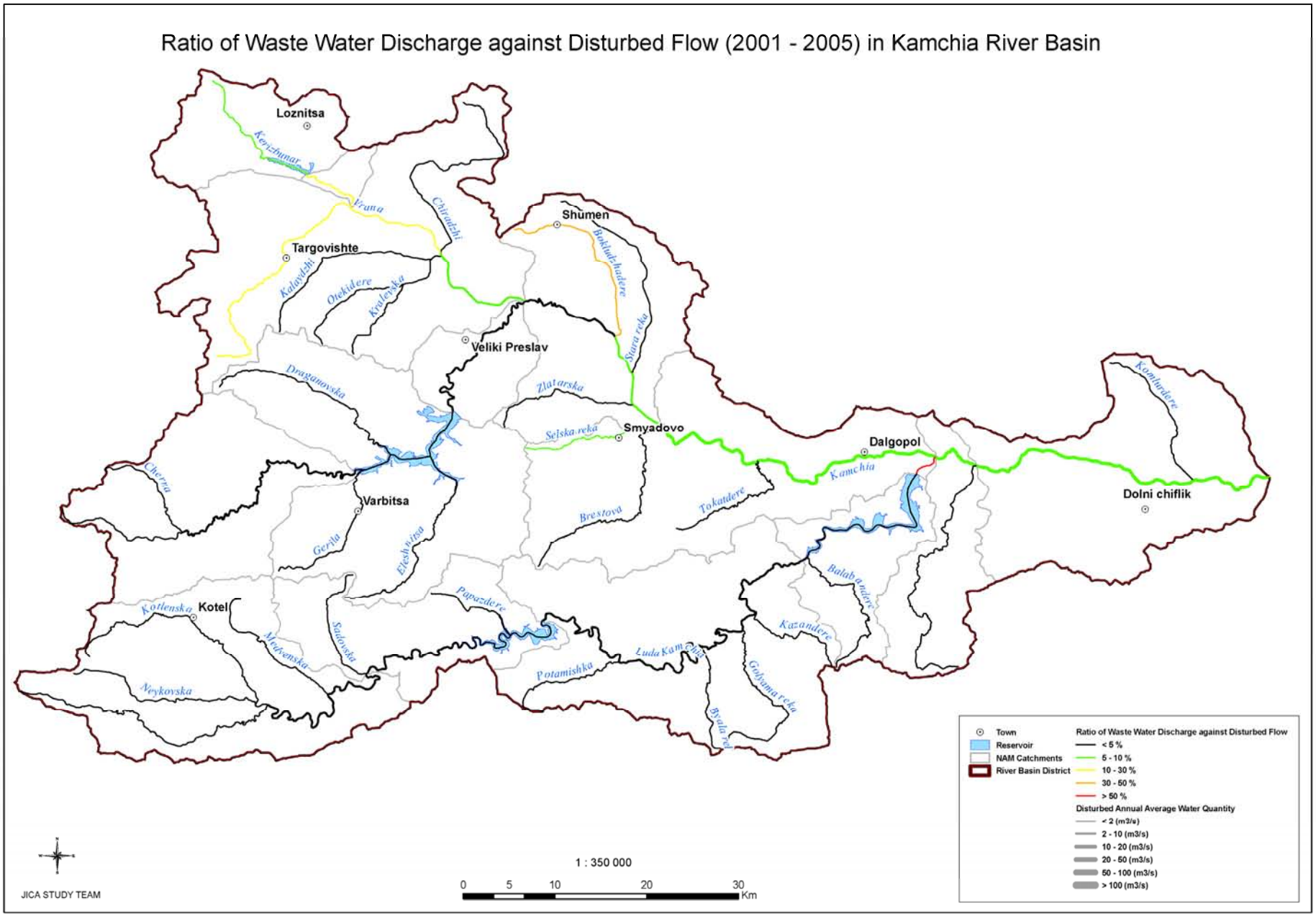
Ratio of Abstracted Water Amount against Potential Flow (2001 - 2005) in Kamchia River Basin



Maximum Permitted Water Amount for Local HPP against Potential Flow (2001 - 2005) in Kamchia River Basin



Ratio of Waste Water Discharge against Disturbed Flow (2001 - 2005) in Kamchia River Basin



Pollution Load Distribution

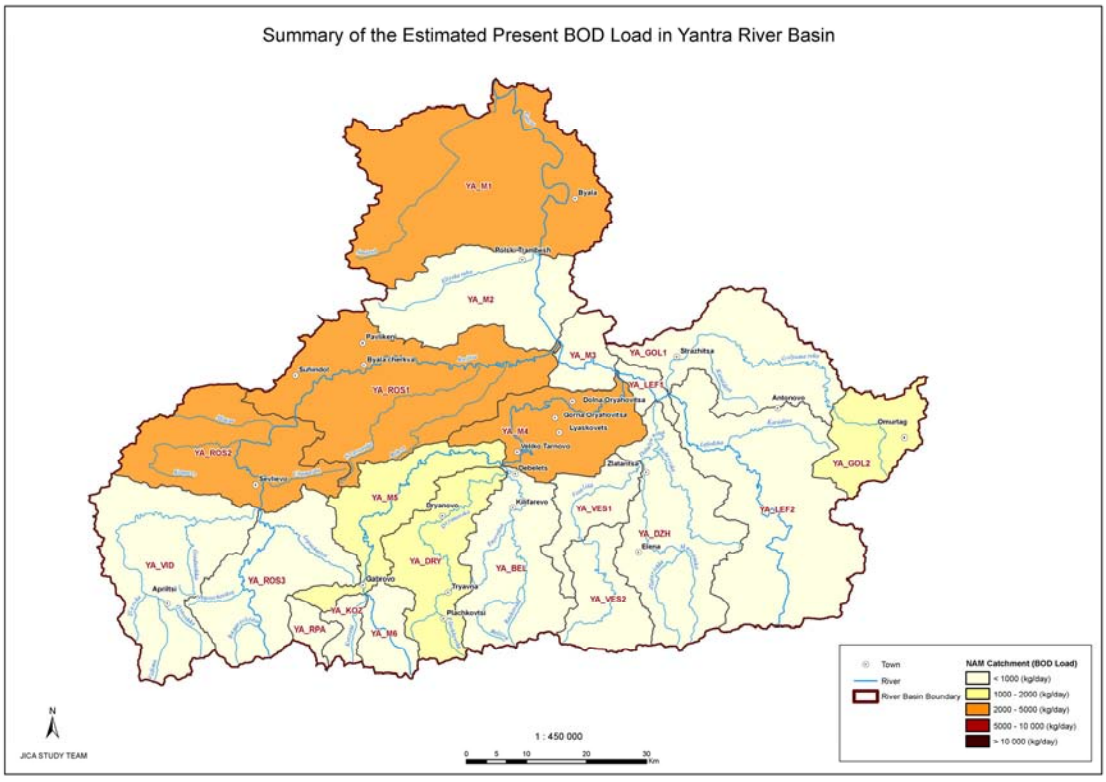
in

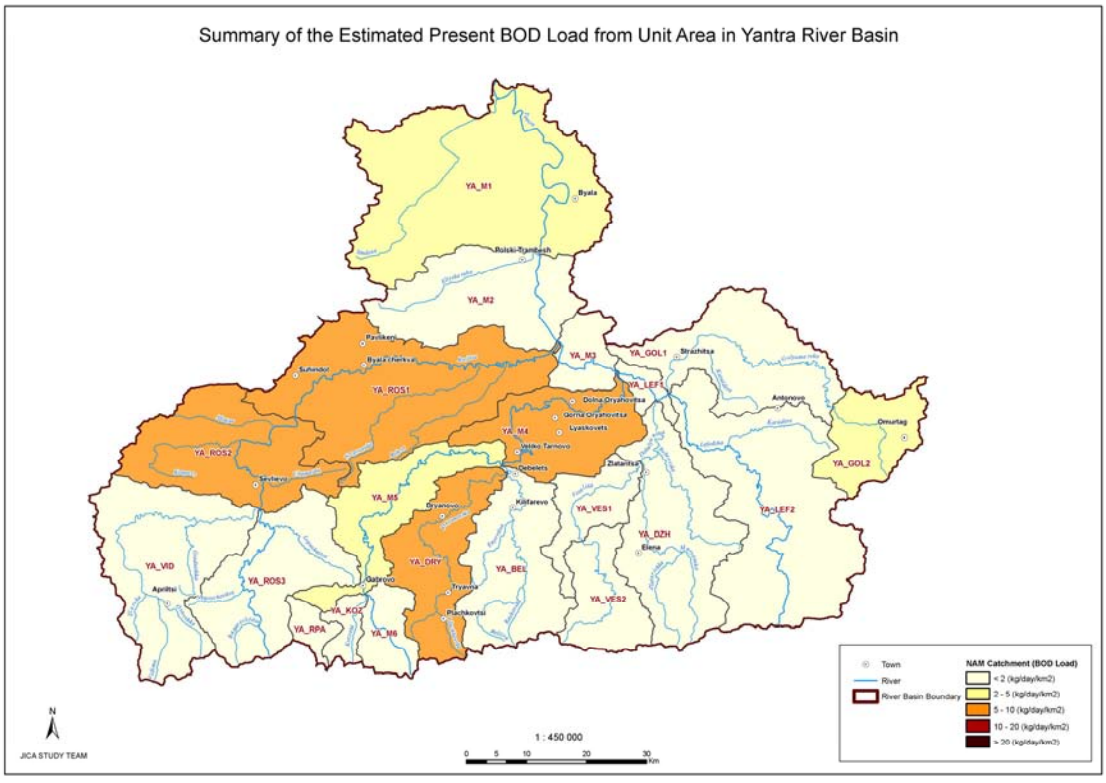
Yantra and Kamchia River Basins

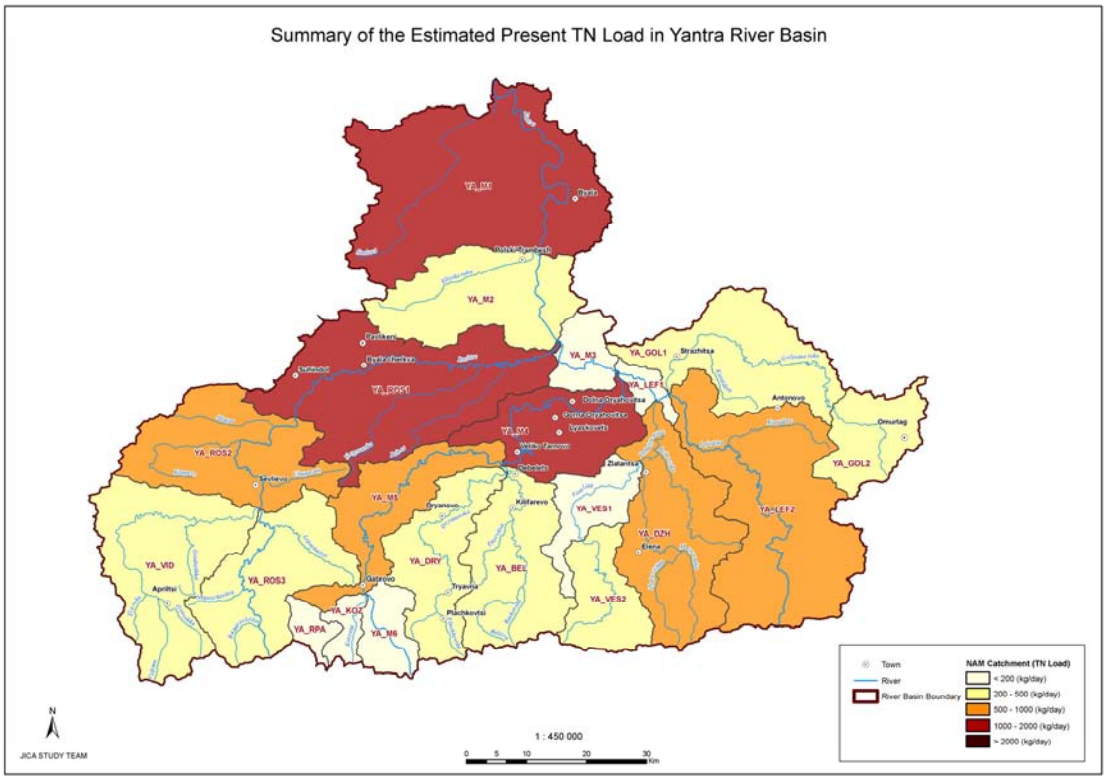
Yantra River Basin

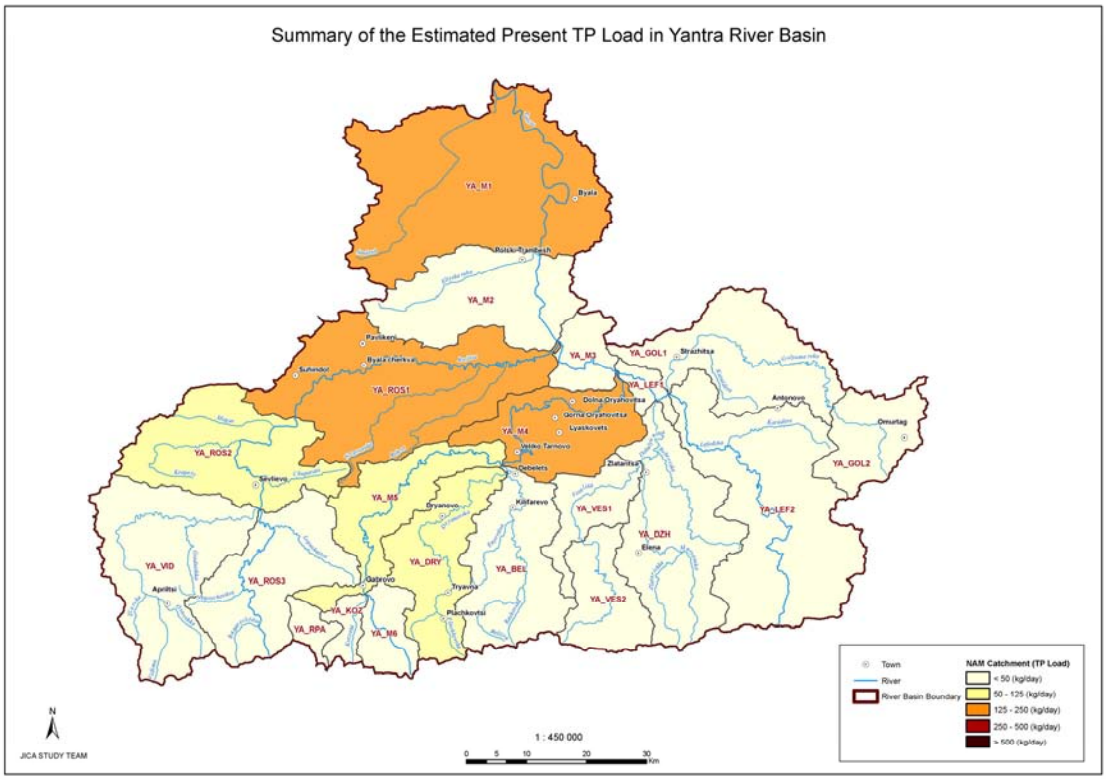
Annex Estimated Pollution Pollution Loads by NAM Catchments for the Yantra River Basin under the Present Condition

			BOD Load							TN Load							TP Load						
NAM Catchment Name	NAM Catch. Area (km2)	PE	Domestic & Industr. loads into SW (kg/day)	Fertilizer Non-point Load (kg/day)	Major Livestock Load (kg/day)	Livestock Non-point Load (kg/day)	Livestock Load Total (kg/day)	Industr. load direct inflow (kg/day)	Total BOD Load (kg/day)	Domestic & Industr. loads into SW (kg/day)	Fertilizer Non-point Load (kg/day)	Major Livestock Load (kg/day)	Livestock Non-point Load (kg/day)	Livestock Load Total (kg/day)	Industr. load direct inflow (kg/day)	Total TN Load (kg/day)	Domestic & Industr. loads into SW (kg/day)	Fertilizer Non-point Load (kg/day)	Major Livestock Load (kg/day)	Livestock Non-point Load (kg/day)	Livestock Load Total (kg/day)	Industr. load direct inflow (kg/day)	Total TP Load (kg/day)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
YA_BEL	402	9,768	128		397	77	474	3	605	39	205	136	30	167	1	412	10	1	2	3	6	0	17
YA_DRY	337	32,134	1,732		158	66	224	22	1,978	320	68	54	24	78	2	468	54	2	1	2	3	0	60
YA_DZH	512	18,119	593		76	105	181	3	777	112	334	26	38	64	1	510	24	0	0	3	3	0	27
YA_GOL1	447	15,618	468			154	154		622	88	247		56	56		391	20	5		4	4		28
YA_GOL2	226	20,133	669		144	186	331	1	1,001	126	104	50	66	115	0	346	27	4	1	4	4	0	35
YA_KOZ	59	107	1			15	15		16	0	10		5	5		16	0	0		0	0		1
YA_LEF1	51	976	22			26	26		48	5	33		10	10		48	1	0		1	1		2
YA_LEF2	810	11,298	323			250	250	2	574	63	361		89	89		513	14	7		6	6	0	27
YA_M1	995	54,602	1,843		967	342	1,310	3	3,156	346	667	437	121	558	0	1,571	73	13	32	10	42	0	128
YA_M2	444	8,211	198		113	176	290		488	41	290	39	67	106		437	10	0	1	6	7		17
YA_M3	118	3,410	34			61	61		95	14	77		23	23		113	3	0		2	2		5
YA_M4	330	206,562	2,041		450	121	571	77	2,688	614	215	240	42	281	4	1,114	198	0	24	3	27	1	225
YA_M5	312	99,307	1,108		115	76	191	1	1,300	394	91	66	27	93	1	579	100	1	20	2	21	0	123
YA_M6	123	913	10			31	31		41	4	22		11	11		37	1	1		1	1		3
YA_ROS1	776	38,885	1,174		2,584	136	2,720		3,894	235	475	1,206	40	1,246		1,955	50	1	158	0	159		209
YA_ROS2	491	60,506	2,623		413	111	524	14	3,161	486	99	170	40	210	1	797	91	3	10	3	13	1	107
YA_ROS3	432	13,108	327		170	103	273		600	74	76	58	38	96		246	16	2	1	3	4		23
YA_RPA	53	0	0			14	14		14	0	9		5	5		15	0	0		0	0		1
YA_VES1	164	2,064	24			46	46		70	8	107		18	18		132	2	0		2	2		4
YA_VES2	217	573	23		189	23	212		235	4	141	65	8	73		219	1	0	1	1	2		3
YA_VID	562	12,594	381		403	121	524	9	915	79	108	139	45	183	1	371	17	4	2	4	6	1	28
Total	**7,862**	**608,887**	**13,721**	**0**	**6,180**	**2,243**	**8,422**	**134**	**22,278**	**3,051**	**3,739**	**2,686**	**802**	**3,488**	**10**	**10,288**	**711**	**44**	**253**	**59**	**312**	**3**	**1,072**
			62%	**0%**	**28%**	**10%**	**38%**	**1%**	**100%**	**30%**	**36%**	**26%**	**8%**	**34%**	**0%**	**100%**	**66%**	**4%**	**24%**	**6%**	**29%**	**0%**	**100%**


Summary of the Estimated Present BOD Load in Yantra River Basin
YA_M1
Byala
Ruski-Tsarnbesh
YA_M2
Pavlikeni
Suhindol
Byala Cherkva
YA_M3
YA_GOL1
Strazhitsa
YA_LEF1
YA_ROS1
Dolna Oryahovitsa
Gorna Oryahovitsa
Antonovo
YA_M4
Lyaskovets
Omurtag
YA_ROS2
Veliko Tarnovo
Zlataritsa
YA_GOL2
Debelets
Sevlievo
YA_M5
Kaliarevo
YA_VES1
YA_LEF2
Dryanovo
YA_DZH
Elena
YA_VID
YA_DRY
YA_BEL
YA_ROS3
Gabrovo
Tryavna
Apriltsi
YA_KOZ
YA_VES2
Plachkovtsi
YA_RPA
YA_M6
Town
River
River Basin Boundary
NAM Catchment (BOD Load)
< 1000 (kg/day)
1000 - 2000 (kg/day)
2000 - 5000 (kg/day)
5000 - 10 000 (kg/day)
> 10 000 (kg/day)
N
JICA STUDY TEAM
1 : 450 000
0 5 10 20 30
Km


Summary of the Estimated Present BOD Load from Unit Area in Yantra River Basin
YA_M1
Byala
Ruski-Tsarnbesh
YA_M2
Pavlikeni
Suhindol
Byala Cherkva
YA_M3
YA_GOL1
Strazhitsa
YA_LEF1
YA_ROS1
Dolna Oryahovitsa
Gorna Oryahovitsa
Antonovo
YA_M4
Lyaskovets
Omurtag
YA_ROS2
Veliko Tarnovo
Zlataritsa
YA_GOL2
Debelets
Sevlievo
YA_M5
Kaliarevo
YA_VES1
YA_LEF2
Dryanovo
YA_DZH
Elena
YA_VID
YA_DRY
YA_BEL
YA_ROS3
Gabrovo
Tryavna
Apriltsi
YA_KOZ
YA_VES2
Plachkovtsi
YA_RPA
YA_M6
Town
River
River Basin Boundary
NAM Catchment (BOD Load)
< 2 (kg/day/km2)
2 - 5 (kg/day/km2)
5 - 10 (kg/day/km2)
10 - 20 (kg/day/km2)
> 20 (kg/day/km2)
N
JICA STUDY TEAM
1 : 450 000
0 5 10 20 30
Km

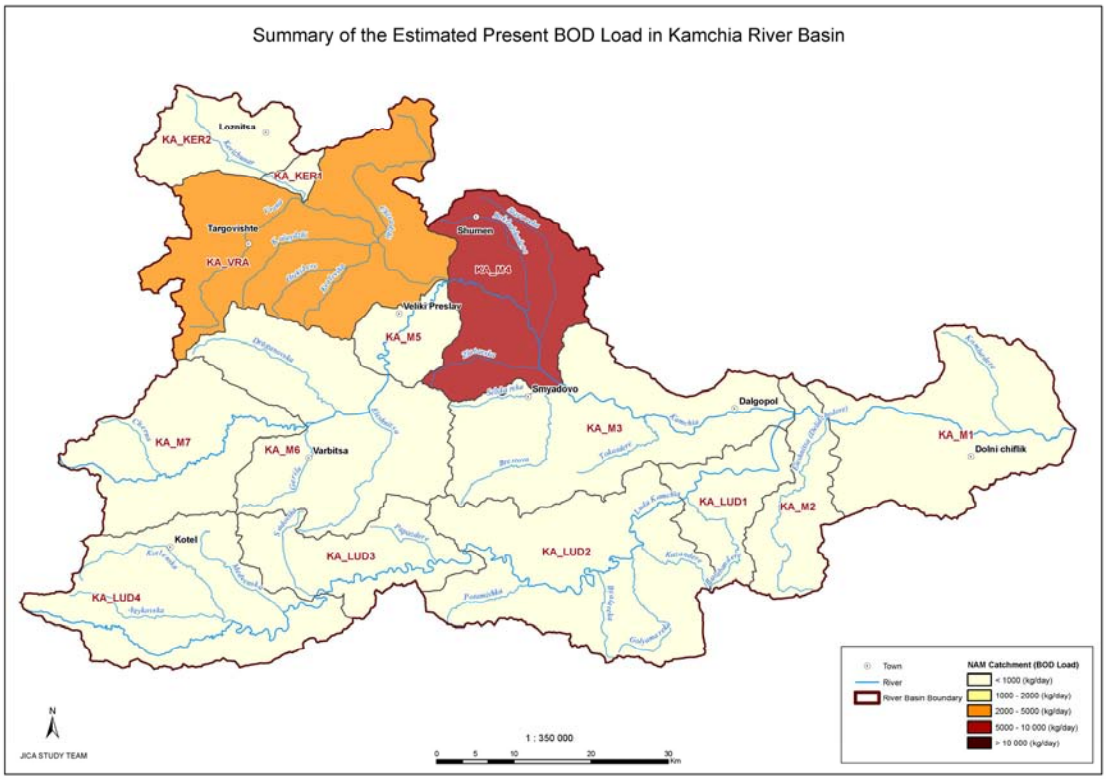

Summary of the Estimated Present TN Load in Yantra River Basin
YA_M1
Byala
Polski Trambesh
YA_M2
Pavlikeni
Byala Cherkva
Suhindol
YA_RPP1
Dryanovo
YA_M3
YA_GOL1
Strazhitsa
YA_LEF1
Dolna Oryahovitsa
Gorna Oryahovitsa
Lyaskovets
YA_M4
Ventsi Tarnovo
Antonovo
Omurtag
YA_ROS2
Sevlievo
Zlataritsa
Gabolevo
YA_GOL2
YA_M5
Kilifarevo
YA_VES1
YA_LEF2
YA_DZH
Elena
YA_VID
YA_DRY
YA_BEL
YA_ROS3
Apriltsi
Gabrovo
Tryavna
YA_VES2
YA_KOZ
Plachkovtsi
YA_RPA
YA_M6
Town
River
River Basin Boundary
NAM Catchment (TN Load)
< 200 (kg/day)
200 - 500 (kg/day)
500 - 1000 (kg/day)
1000 - 2000 (kg/day)
> 2000 (kg/day)
N
JICA STUDY TEAM
1 : 450 000
0 5 10 20 30
Km

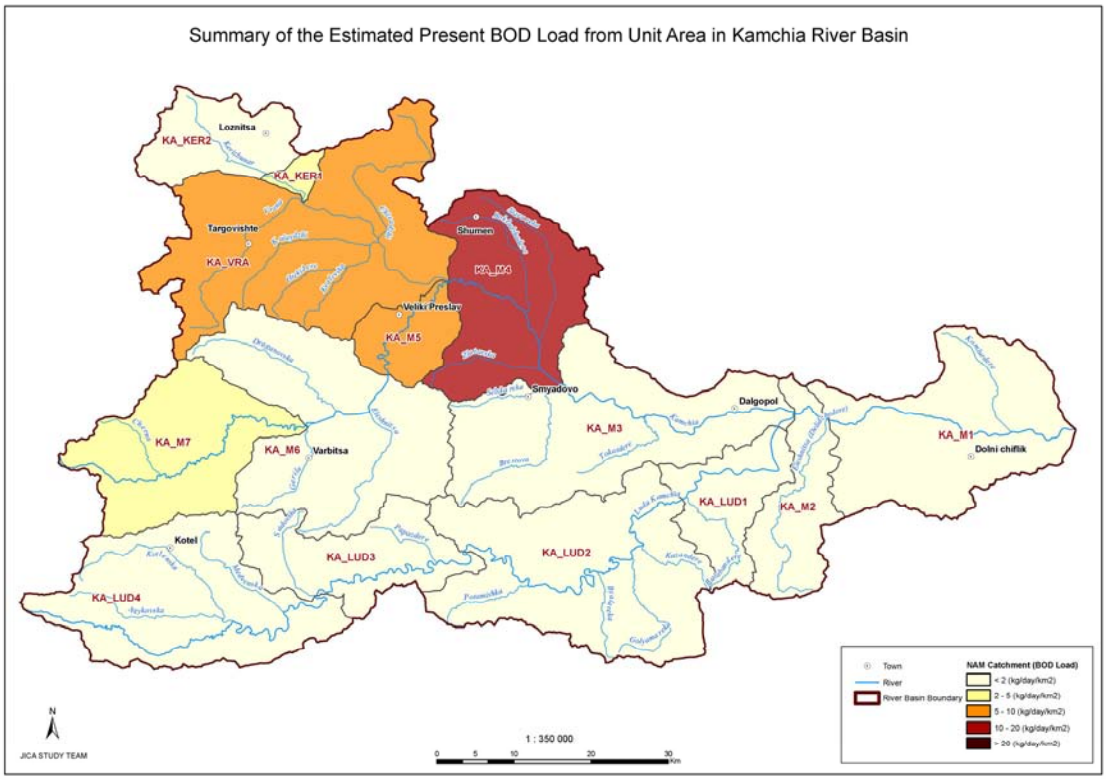

Summary of the Estimated Present TP Load in Yantra River Basin
YA_M1
Byala
Polski Trambesh
YA_M2
Pavlikeni
Byala Cherkva
Suhindol
YA_ROS1
Dryanovo
YA_M3
YA_GOL1
Strazhitsa
YA_LEF1
Dolna Oryahovitsa
Gorna Oryahovitsa
Lyaskovets
YA_M4
Ventsi Tarnovo
Antonovo
Omurtag
YA_ROS2
Sevlievo
Zlataritsa
Gabolevo
YA_GOL2
YA_M5
Kilifarevo
YA_VES1
YA_LEF2
YA_DZH
Elena
YA_VID
YA_DRY
YA_BEL
YA_ROS3
Apriltsi
Gabrovo
Tryavna
YA_VES2
YA_KOZ
Plachkovtsi
YA_RPA
YA_M6
Town
River
River Basin Boundary
NAM Catchment (TP Load)
< 50 (kg/day)
50 - 125 (kg/day)
125 - 250 (kg/day)
250 - 500 (kg/day)
> 500 (kg/day)
N
JICA STUDY TEAM
1 : 450 000
0 5 10 20 30
Km

Kamchia River Basin

Annex Estimated Pollution Pollution Loads by NAM Catchments for the Kamchia River Basin under the Present Condition

			BOD Load							TN Load							TP Load						
NAM Catchment Name	NAM Catch. Area (km2)	PE	Domestic & Industr. loads into SW (kg/day)	Fertilizer Non-point Load (kg/day)	Major Livestock Load (kg/day)	Livestock Non-point Load (kg/day)	Livestock Load Total (kg/day)	Industr. load direct inflow (kg/day)	Total BOD Load (kg/day)	Domestic & Industr. loads into SW (kg/day)	Fertilizer Non-point Load (kg/day)	Major Livestock Load (kg/day)	Livestock Non-point Load (kg/day)	Livestock Load Total (kg/day)	Industr. load direct inflow (kg/day)	Total TN Load (kg/day)	Domestic & Industr. loads into SW (kg/day)	Fertilizer Non-point Load (kg/day)	Major Livestock Load (kg/day)	Livestock Non-point Load (kg/day)	Livestock Load Total (kg/day)	Industr. load direct inflow (kg/day)	Total TP Load (kg/day)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
KA_KER1	26	1,328	58			17	17	0	75	11	13		6	6	0	30	2	1		0	0	0	3
KA_KER2	187	9,336	195			102	102		298	41	117		36	36		195	10	5		2	2		17
KA_LUD1	186	6,064	90			67	67	0	156	18	79		24	24	0	122	6	2		2	2	0	10
KA_LUD2	629	21,607	331			232	232	1	564	66	204		83	83	0	352	22	1		5	5	0	28
KA_LUD3	271	2,511	38			42	42		80	8	87		15	15		109	3	1		1	1		5
KA_LUD4	518	14,775	423			123	123	0	546	80	138		44	44	0	263	18	2		3	3	0	24
KA_M1	526	27,311	758			80	80	35	873	144	280		31	31	3	458	33	11		4	4	2	51
KA_M2	205	2,970	47			57	57		104	10	95		21	21		126	3	3		2	2		8
KA_M3	587	27,882	631		11	99	110	0	741	133	309	7	37	44	0	486	32	12	1	5	5	0	50
KA_M4	408	111,899	3,604		2,132	80	2,212	94	5,910	1,092	215	1,364	6	1,370	14	2,690	188	9	169	1	170	1	367
KA_M5	118	17,237	712		156	32	187	61	960	132	62	53	12	65	1	261	25	3	1	1	2	0	30
KA_M6	588	18,082	420			285	285		705	81	299		101	101		481	21	12		6	6		39
KA_M7	388	16,440	509		212	196	408		918	96	136	73	69	142		375	21	4	1	4	5		31
KA_VRA	726	80,312	3,464			421	421	18	3,903	654	352		154	154	7	1,167	122	14		13	13	1	150
Total	**5,363**	**357,754**	**11,279**	**0**	**2,511**	**1,834**	**4,345**	**210**	**15,834**	**2,566**	**2,385**	**1,498**	**640**	**2,137**	**25**	**7,114**	**506**	**79**	**172**	**51**	**223**	**3**	**812**
			71%	**0%**	**16%**	**12%**	**27%**	**1%**	**100%**	**36%**	**34%**	**21%**	**9%**	**30%**	**0%**	**100%**	**62%**	**10%**	**21%**	**6%**	**27%**	**0%**	**100%**


Summary of the Estimated Present BOD Load in Kamchia River Basin
KA_KER2
KA_KER1
KA_VRA
KA_M4
KA_M5
KA_M7
KA_M6
KA_M3
KA_M1
KA_M2
KA_LUD1
KA_LUD2
KA_LUD3
KA_LUD4
Loznitsa
Targovishte
Shumen
Veliki Preslav
Smyadovo
Dalgopol
Varbitsa
Dolni chiflik
Kotel
Town
River
River Basin Boundary
NAM Catchment (BOD Load)
< 1000 (kg/day)
1000 - 2000 (kg/day)
2000 - 5000 (kg/day)
5000 - 10 000 (kg/day)
> 10 000 (kg/day)
N
JICA STUDY TEAM
1 : 350 000
0 5 10 20 30
Km


Summary of the Estimated Present BOD Load from Unit Area in Kamchia River Basin
KA_KER2
KA_KER1
KA_VRA
KA_M4
KA_M5
KA_M7
KA_M6
KA_M3
KA_M1
KA_M2
KA_LUD1
KA_LUD2
KA_LUD3
KA_LUD4
Loznitsa
Targovishte
Shumen
Veliki Preslav
Smyadovo
Dalgopol
Varbitsa
Dolni chiflik
Kotel
Town
River
River Basin Boundary
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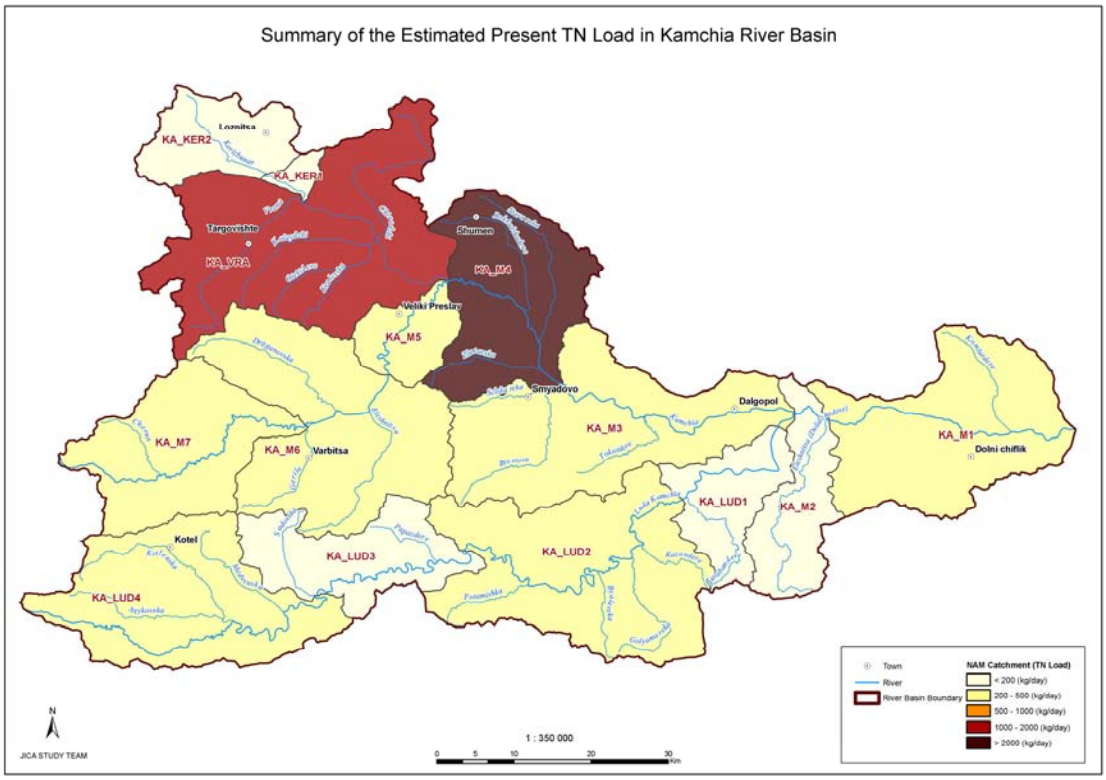
Summary of the Estimated Present TN Load in Kamchia River Basin
KA_KER2
KA_KER1
Loznitsa
Targovishte
KA_VRA
Shumen
KA_M4
Veliki Preslav
KA_M5
Smyadovo
Dalgopol
KA_M3
KA_M1
Dolni chiflik
KA_M7
KA_M6
Varbitsa
KA_LUD1
KA_M2
Kotel
KA_LUD3
KA_LUD2
KA_LUD4
N
JICA STUDY TEAM
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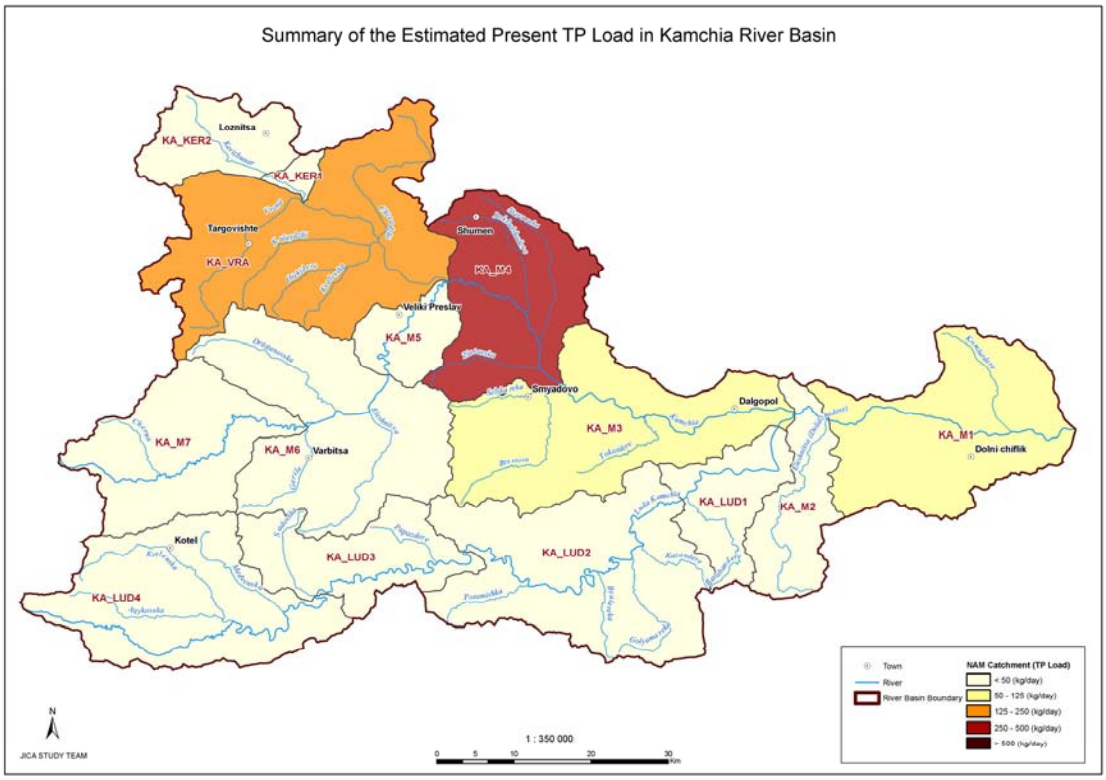
200 - 500 (kg/day)
500 - 1000 (kg/day)
1000 - 2000 (kg/day)
> 2000 (kg/day)


Summary of the Estimated Present TP Load in Kamchia River Basin
KA_KER2
KA_KER1
Loznitsa
Targovishte
KA_VRA
Shumen
KA_M4
Veliki Preslav
KA_M5
Smyadovo
Dalgopol
KA_M3
KA_M1
Dolni chiflik
KA_M7
KA_M6
Varbitsa
KA_LUD1
KA_M2
Kotel
KA_LUD3
KA_LUD2
KA_LUD4
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JICA STUDY TEAM
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50 - 125 (kg/day)
125 - 250 (kg/day)
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> 500 (kg/day)