Ministry of Environment and Physical Planning, Macedonia
State Secretariat for Economic Affairs, Switzerland

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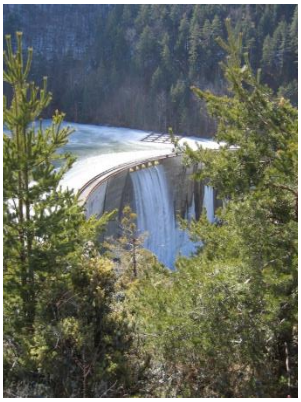
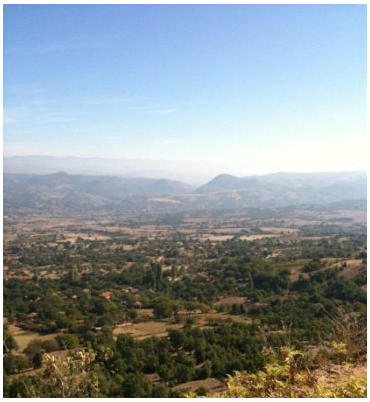
Bregalnica River Basin Management Project

River Basin Management Plan
Final Version of August 26, 2016







AMBISAT

Ernst Basler + Partner

Project team

Ernst Basler + Partner AG, Switzerland (Lead):
Andreas Zysset
Christina Dübendorfer
Reto Bühler
Martin Rauber
Richard Meyer
Rudolf Krockauer
Lukas Egloff
Manijè Alexander-David
Felix Ribi
Matthias Gerth
Tim Kempter
Risch Tratschin
Ivo Foelmli
Martina Nöthiger

Ambisat Ingeniería Ambiental S.L., Spain:
José Carlos Tomico del Río
Alberto Sánchez Gómez
María Díaz Redondo
María Ángeles Martinez Vidal

Local Consultants:
Vladimir Stavric
Nikola Vangelov
Julijana Lapevska
Dusko Mukaetov

National Officers:
Darko Levkov
Marija Dojcinova
Kostadin Runcev

Ernst Basler + Partner AG
Zollikerstrasse 65
8702 Zollikon
Switzerland
Telephone +41 44 395 11 11
info@ebp.ch
www.ebp.ch

Print: 30 April 2015
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Document History

Version	Author	Date	Reviewed by	Remarks
Draft 1	Project Management Team	11.10.13	Steering Committee	
Draft 2	Project Management Team	12.06.14	Steering Committee	Update includes: - New surface water monitoring data (campaigns of August 2013, October 2013 and February 2014) with according updates of section 4.2, section 5.1, Annex A8, and Annex A11 - Elaborated concept for groundwater monitoring with according update of section 4.3 and a new Annex A9 on groundwater monitoring - Elaborated information on public involvement with according update of chapter 10 and Annex A15 - Minor corrections according to comments of Steering Committee to Draft 1
Draft 3	Project Management Team	07.11.14	Steering Committee	Update includes: - Completion of surface water monitoring with campaign of May 2014 and according changes of section 4.2.4, section 5.1, Annex A8 and Annex A11 - Extension of water allocation modeling with scenario calculations and according changes of sections 7.1 to 7.4, Annexes A5 to A7 - Description of foreseen water quality modeling in section 7.5 - Update on public involvement with according changes in chapter 10 and Annex A14
Final Draft	Project Management Team	12.06.15	Steering Committee	Update includes: - Evaluation of groundwater monitoring data, elaboration of section 4.3 and Annex A13 - Exemplary water quality modeling for phosphorus, elaboration of section 7.5 and introduction of Annex A8 - Elaboration of program of measures, including monitoring concept, extension of chapter 9 and introduction of annex A15 - Update on public involvement with according changes in chapter 10 and Annex A16

Version	Author	Date	Reviewed by	Remarks
Final	Project Management Team	26.08.16	Steering Committee and Advisor Committee	Update includes: - Introduction of hydrogeological map, expansion of section 2.3 - Introduction of map on protected drinking water supply zones, expansion of section 2.4 - Introduction of information and map on mines, expansion of section 3.2 - Introduction on information and maps regarding presence and use of geothermal water, expansion of section 3.4 - Introduction of updated map on other pressures and additional tables with coordinates of abstraction permits and hydropower plants, expansion of section 3.4 and Annex 5 - Evaluation of additional regular groundwater monitoring data, adaption of section 4.3 and Annex A10 - Evaluation of investigative groundwater monitoring data, adaption of section 4.3 and Annex A10 - Update of financial data on utilities and need for economic analysis, adaption of chapter 8 - Additional details on program of measures, expansion of section 9.4 and annex A15 - Additional details on proposed monitoring, expansion of section 9.5 - Update on public involvement with according changes in chapter 10 and Annex A16

Glossary

AWB	Artificial Water Body
BRBMU	Bregalnica River Basin Management Unit
CIS	Common Implementation Strategy
DTIDW	Detrended Inverse Distance Weighting
EDR	Elevation Dependent Regression
EPR	East Planning Region
HMWB	Heavily Modified Water Body
HYDMET	National Hydrometeorological Service
IBMWP	Iberian Monitoring Working Party
IDW	Inverse Distance Weighting
IHF	Fluvial Habitat Index
IPH	Institute for Public Health
IPPC	Integrated Pollution Prevention and Control
IPS	Index for specific sensibility to pollution
LAI	Leaf Area Index
MAFWE	Ministry of Agriculture, Forestry and Water Economy
MOEPP	Ministry of Environmental and Physical Planning
PAH	Poly Aromatic Hydrocarbons
PCB	Polychlorinated biphenyl
QBR	Index of riparian quality
RBM	River Basin Management
SDR	Sediment Delivery Ratio
SECO	Swiss State Secretariat for Economic Affairs
SWI	Small Water Infrastructure
UHMR	National Meteorological Service
WFD	Water Framework Directive

Abstract

Sufficient water of good quality is essential for public health, the industry and agriculture. Hence, protecting water resources from undue pressure by human activities serves a sustainable economic development. It is also a prerequisite for preserving ecosystems which all depend on water.

To achieve this aim, integrated water resources management at the river basin scale is the core approach of the Macedonian Water Law and the EU Water Framework Directive. In 2012, the Macedonian Ministry of Environment and Physical Planning together with the Ministry of Agriculture, Forestry and Water Economy started a collaboration supported by the Swiss State Secretariat for Economic Affairs to implement such a river basin management approach on a pilot basis for the Bregalnica region.

The present report documents in eleven chapters the outcome of this collaboration. It provides the final River Basin Management Plan for the Bregalnica catchment, and proposes administrative structures and a public participation approach to implement it.

The Bregalnica basin elongates in the South-East and covers 17% of the Macedonian territory *(chapter 2)*. Its climate is relatively arid, and land use includes mainly agriculture, range land and forests. Abundant plant and a great variety of animal species inhabit this region which is also rich in mineral resources. As surface water resources, the region features the Bregalnica river and its 12 tributaries, six reservoirs and two main irrigation canals. Further the basin includes five groundwater bodies, typically in the form of unconfined aquifers in unconsolidated sediments. Protected areas have not been legally proclaimed so far. 15 municipalities have a significant share in the basin, including all of the East Planning Region. The main economic activities in the region are mining and industry, followed by agriculture, trade and services. The GDP in the region is slightly below national average.

The main pressures on the quality of the Bregalnica water resources are due to domestic, industrial and agricultural activities, stemming from both diffuse and point sources *(chapter 3)*:

- Only 4% of the total domestic wastewater is treated, although 78% of the population is connected to a sewage system. Most of the wastewater is directly discharged into surface water bodies. Phosphorous is the main pollutant from this source.
- Agriculture contributes to diffuse pollution through inappropriate fertilizing and irrigation practices, and careless handling of fertilizers and pesticides. Mounting soil erosion through inadequate tilling techniques and climate change is reason for additional concern.
- Most significant industrial polluters are mines, food production (pig farms), and the textile industry. Main diffuse and point source pollutants are heavy metals (mines), phosphorous

and nitrogen (livestock farms), and phthalates, which are used as plasticizers in a variety of chemical products. The textile industry can cause high pH in wastewater.

The report documents the results from the surveillance monitoring for both surface water and groundwater *(chapter 4)*. Corresponding to the pressures, high phosphorous levels and high level of nitrites were found widely spread in the surface waters of the basin which cause euthrophicated reservoirs, resulting in a bad ecological status. Further, relatively low heavy metal concentrations were measured with exceptions of zinc, copper, lead and manganese in several surface water bodies. In addition, high concentrations of phthalates were found in surface waters of the entire Bregalnica river basin, including the heavily modified water bodies. In groundwater, high phosphorus concentrations were detected, in conjunction with low levels of dissolved oxygen and high levels of nitrates. Nitrogen pesticides and polycyclic aromatic hydrocarbons were also found to be widespread in the Bregalnica groundwater bodies.

Although some of the water bodies show a good chemical status, the water status of all surface water bodies (rivers; reservoirs; irrigation canals) fail to achieve a good status *(chapter 5)*. In groundwater, the Delcevo groundwater body is the only one achieving a good chemical status. The other four groundwater bodies are rated to have a poor chemical status. The quantitative status of all five groundwater bodies is rated to be good.

The environmental objectives are firstly to avoid the further deterioration of the status of the water bodies in the Bregalnica catchment, and secondly to achieve a good status or a good environmental potential for all water bodies *(chapter 6)*, while acknowledging that for some water bodies less stringent objectives or exemptions from the interdiction of further deterioration might have to be made. A good status and environmental potential shall be achieved gradually and in line with the goals set forth by the Macedonian Water Law.

In terms of quantity, a rainfall/run-off model and a water allocation model show that at present all water demands within the basin can be met *(chapter 7)*. With the potentially irrigable areas being used in the future, a shortage might occur. This is confirmed by socio-economic and climate change scenario calculations which show that the concurrent decrease of supply and the increase of demand may result in unmet water demands in the Bregalnica river basin within the next 30 years. In this development, the impact of climate change is an order of magnitude smaller than the one from the potential extension of irrigated areas. The biggest supply shortages are linked to the reservoirs of Knezevo and Mantovo. The catchment area of these reservoirs is rather small in relation to the potential irrigated area in the future. A water quality modeling of diffuse phosphorus pollution due to soil erosion shows that soil loss maybe most pronounced in areas with steep slopes or landcovers prone to erosion such as vineyards or orchards, while phosphorus fluxes to surface waters maybe highest in areas with excessive fertilizer applications or high livestock numbers compared to the available agricultural land.

The economic analysis aims at assessing the economic use of water resources and the financial sustainability of water infrastructure *(chapter 8)*. Operational cost coverage levels of water supply and sanitation utilities are typically between 100% and 150% which indicates that current revenues manage to cover operating expenses in most cases but are insufficient for the renewal or replacement of existing infrastructure. The economic analysis is so far limited due to data availability. The present data gaps on full costs prevent an evidenced based introduction of the full cost recovery principle and an according design of financing models. The current focus will have to be laid on achieving a user fee based recovery of running costs, an approximation of capital costs requirements for priority investments and devicing according financing schemes.

The proposed program of measures emphasizes on water quality related measures at the household, agricultural and industrial level *(chapter 9)*. Measures include solid waste and wastewater treatment, control of hazardous substances, improved tilling techniques and soil erosion control, pesticides and fertilizer control, and industrial sludge control. The project finances small water infrastructure to tackle some of the identified hot spots. In terms of water quantity, water use regulation and efficiency as well as flood control were identified as measures. All drafted measures are specified with responsible institutions and institutions taking action on the ground. Reporting on the measures' implementation will be facilitated by specified indicators. In the coming months, the Bregalnica Advisory Council should approve the Bregalnica RBM Plan as a pre-condition for its adoption by the Government of Macedonia.

The public involvement and communication was assured so far through four public surveys (March 2013, April 2014, April 2015, April 2016), four public project presentations (October 2012, November 2013, December 2014, November 2015), five rounds of sub-regional workshops (May 2013, October 2013, May 2014, February 2015, July 2015), three professional surveys (October 2013, December 2014, May 2016), four meetings of the Advisory Council (November 2013, August 2014, September 2015, February 2016), and five meetings with the National Policy Dialogue partners (March 2014, December 2014, June 2015, February 2016, June 2016). The website, media relations and informational products are continuously updated *(chapter 10)*.

These concrete actions shall be accompanied with improving the regulatory framework and institutional capacities, defining clear roles and responsibilities in the organizational structure of the competent authorities *(chapter 11)*, and better implementing the already existing regulations. All of these measures shall contribute to the overall goals stated by the Water Law.

Резиме

За јавното здравје, идустријата и земјоделството, неопходно е да има доволна количина на вода со добар квалитет. Оттаму, заштитата на водните ресурси од прекумерни притисоци од човековите активности придонесува кон одржлив економски развој. Исто така, тое е и предуслов за заштита на екосистемите кои зависат од водата.

За да се постигне таа цел, суштински пристап на македонскиот Закон за води и на Рамковната директива за води на ЕУ е интегрирано управување со водните ресурси на ниво на речен слив. Македонското Министерство за животна средина и просторно планирање, заедно со Министерството за земјоделство, шумарство и водостопанство, подржани од Швајцарскиот секретаријат за економски прашања во 2012 година започнаа соработка за спроведување на пилот проект за примена на пристапот на управување со речен слив во регионот на Брегалница.

Овој извештај, во единаесет поглавја ги прикажува резултатите на оваа соработка. Извештајот е конечен План за управување со сливот на р. Брегалница, и предлага административна структура и пристап со учество на јавноста за негово спроведување.

Сливот на Брегалница се протега југо-источно и покрива 17% од територијата на Македонија (Поглавје 2). Климата е релативно аридна, а земјиштето е под земјоделство, пасишта и шуми. Бројни растителни и многу разновидни животински видови го населуваат овој регион, кој е исто така богат и со минерални ресурси. Од водните ресурси, во регионот се наоѓа реката Брегалница со своите 12 притоки, шест акумулации и два канала за наводнување. Понатаму, регионот содржи пет подземни водоносни тела, типично како збиен тип на аквифери во неконсолидирани седименти. Заштитени зони сеуште официјално не се прогласени. Петнаесет општини имаат значаен дел во сливот, вклучително и целиот Источен плански регион. Главни економски активности во регионот се рударството и индустријата, потоа земјоделството, трговијата и услугите. Бруто националниот продукт во регионот е малку под националниот просек.

Главните притисоци на квалитетот на водните ресурси во Брегалничкиот слив се од точкести и дифузни извори на загадување, како резултат на активностите во домаќинствата, индустријата и земјоделството (Поглавје 3):

- Само 4% од отпадната вода од домаќинствата се пречистува, иако 78% од домаќинствата се приклучени на канализациони системи. Поголемиот дел од отпадната вода директно се испушта во површинските водотеци. Главен загадувач од овој извор е фосфорот.
- Земјоделството придонасува кон дифузно загадување преку несоодветни практики на ѓубрење и наводнување, како и со несоодветно ракување со ѓубривата и пестицидите. Зголемената ерозија на земјиштето поради несоодветни практики на орање и климатските промени се исто така причини за додатна загриженост.

- Најзначајни индустриски загадувачи се рудниците, производство на храна (свињарски фарми) и текстилната индустрија. Главни загадувачи од дифузни и точкести извори се тешките метали (рудници), фосфорот и азотот (сточарски фарми), и фталатите, кои се користат како пластификатори во разни хемиски производи. Текстилната индустрија може да предизвика високо pH во отпадните води.

Овој извештај ги документира резултатите од едногодишниот истражувачки мониторинг на површинските и подземните води (Поглавје 4). Соодветно на притисоците, во површинските водни тела е пронајдено распространето високо ниво на фосфор и високо ниво на нитрити кои предизвикуваат еутрофикација на акумулациите и резултираат со лош еколошки статус. Понатаму, регистрирани се релативно ниски концентрации на тешки метали, со исклучок на појавата на цинк, бакар, олово и манган во неколку површински водни тела. Измерени се високи концентрации на фталати во површинските води во целиот слив на Брегалница, вклучително и во многу изменетите водни тела (акумулации). Во подземните води забележани се високи концентрации на фосфор во комбинација со ниско ниво на растворен кислород и високи концентрации на нитрати. Откриено е и дека азотни пестициди и полициклични ароматски јаглеводородни соединенија се распространети во подземните водни тела во Брегалничкиот слив.

И покрај тоа што кај некои водни тела хемискиот статус е добар, вкупниот статус на сите површински водни тела од сите три типа (реки, акумулации, канали за наводнување) не го достигнуваат статусот ‘добар’ (Поглавје 5). Од подземните води, единствено Делчевскиот аквифер постигнува добар хемиски статус. Останатите четири подземни водни тела имаат слаб хемиски статус. Квантитативниот статус на сите пет аквифера е оценет како добар.

Целите на животната средина, првенствено се да се избегне понатамошно влошување на статусот на водните тела во сливот на Брегалница, и второ, да се постигне добар еколошки статус или еколошки потенцијал на сите водни тела (Поглавје 6), притоа прифаќајки дека за некои водни тела ќе треба да се постават помалку строги цели и можеби ќе треба да се побараат исклучоци/дерогации за спречување на понатамошното загадување. Добар статус и еколошки потенцијал ќе се постигне постепено и во согласност со целите поставени во македонскиот Закон за води.

Во однос на квантитетот, хидролошкиот модел и моделот за распределба на водните ресурси покажуваат дека во овој момент можат да бидат задоволени сите потреби во сливот (Поглавје 7). Со развој на потенцијалните, нови површини под наводнување, во иднина може да дојде до недостатоци на вода. Пресметките на социо-економските и сценаријата за климатски промени го потврдуваат тоа, покажувајќи дека намалувањето на дотекувањата и истовремено зголемување на побарувачката може да резултира со недостаток на вода во сливот на Брегалница во наредните 30 години. При ваков развој, влијанието на климатските промени е за ред на величина помал од потенцијалното зголемување на површините под наводнување. Најголемите недостатоци во снабдувањето се поврзани со акумулациите Кнежево и Мантово.

Сливните површини на овие акумулации се прилично мали во споредба со потенцијалните површини под наводнување во иднина.Моделирањето на квалитетот на водата, со моделирање на дифузното загадување со фосфор како резултат на ерозијата на земјата, покажува дека загубата на почва може да биде поизразена во областите со поголем наклон на теренот или покриени со вегетација подложна на ерозија, како лозја и овоштарници. Истекувањата на фосфор во површинските води се најголеми во областите со прекумерна апликација на ѓубрива или со поголем број на стока во споредба со постојното земјоделско земјиште.

Економската анализа ги оценува економското користење на водните ресурси и финансиската одржливост на инфраструктурата (Поглавје 8). Нивото на покриеност на оперативните трошоци на јавните комунални претпријатија е помеѓу 100% и 150%, што покажува дека постојните приходи успеваат да ги покријат оперативните трошоци во повеќето случаи, но се недоволни за обновување или замена на постојната инфраструктура. Економската анализа во овој документ е ограничена поради недостаток на податоци. Постојниот недостаок на податоци за вкупните трошоци оневозможува воведување на принципот на целосен поврат на трошоците базиран на докази и дизајн на соодветни финансиски модели. Фокусот сега треба да биде насочен кон постигнување на поврат на тековните трошоци за работа од наплата на сметките на корисниците, проценка на потребите од капитал/средства за приоритетните инвестиции и поставување на соодветен систем на финансирање.

Предложениот програм на мерки ги акцентира мерките во домаќинствата, индустријата и земјоделството, поврзани со квалитетот на водите (Поглавје 9). Мерките опфаќаат третман на отпадните води и цврстиот отпад, контрола на опасните загадувачки материи, подобрување на техниките на обработка на земјиштето и контрола на ерозијата, пестицидите и ѓубривата, и индустриските јаловишта. Проектот финансира мали инфраструктурни проекти за справување со некои од идентификуваните жешки точки. Во однос на квантитетот, идентификувани се мерки за подобрување на управувањето и ефикасноста на користење на водите, како и мерки за заштита од поплави. За сите идентификувани мерки наведени се и одговорните институции, како и оние кои мерките треба да ги спроведат на терен. Следењето на спроведување на мерките е овозможено со дадените индикатори. Во следните месеци, Советот за управување со сливот на р. Брегалница треба да го одобри Планот за управување со сливот на р. Брегалница, како предуслов за негово усвојување од страна на Владата на Република Македонија.

Учеството и комуникацијата со јавноста беше обезбедена преку три јавни анкети (март 2013, април 2014, април 2015 и април 2016), четири јавни презентации на проектот (октомври 2012, ноември 2013, декември 2014 и ноември 2015), пет круга на суб-регионалните работилници (мај и октомври 2013, во мај 2014, февруари и јули 2015), три професионални анкети (октомври 2013, декември 2014 и мај 2016), четири состанока на Советот за управување со сливот (ноември 2013, август 2014, септември 2015 и во февруари 2016), и пет состанока на проектните партнери во Националниот дијалог за политиките (март и декември 2014, јуни 2015 и февруари и јуни 2016).. Интернет страницата на проектот, соработка со медиумите и информативните материјали постојано се ажурираат (Поглавје 10).

Конкретните активности треба да бидат придружени со подобрување на регулаторната рамка и институционалните капацитети, со јасно дефинирање на улогите и одговорностите во организационата структура на релевантните институции (Поглавје 11), и подобрено спроведување на постојните прописи. Сите овие мерки ќе придонесат за остварување на целите на Законот за води.

Contents

Appendices

1 Introduction

1.1 Background

Clean water is fundamental for a good public health, for a performing industry, for high-value crops and for healthy livestock holdings. Only with clean water it is possible to have a strong economy.

The rivers, lakes and groundwater aquifers in the Bregalnica catchment provide the drinking and the irrigation water necessary to the fifteen municipalities present in the catchment. But these water resources are under high pressures, caused by the human activities. The use of chemicals in agriculture and industry as well as the discharge of untreated wastewater have been polluting the water resources in the Bregalnica catchment over the last few decades.

Through the Bregalnica River Basin Management (RBM) Plan the current and future situation of the water resources in the Bregalnica catchment will be appraised and a plan of measures to improve the water quality in this region will be elaborated.

In 2004, Macedonia submitted an application to become EU member. To prepare EU membership, Macedonia has to implement EU compatible legislations. An important step towards this target was done in 2008 with the approval of the new Macedonian Water Law, which introduces the River Basin Management (RBM) approach in line with the EU Water Framework Directive (WFD).

To bring forward the implementation of the new Macedonian Water Law and the RBM approach, the Ministry of Environment and Physical Planning (MOEPP) and the Ministry of Agriculture, Forestry and Water Economy (MAFWE) started in 2012 a collaboration with the Swiss State Secretariat for Economic Affairs (SECO).

MOEPP, MAFWE and SECO selected the Bregalnica river basin as pilot region to apply the RBM approach. The Project started in July 2012 and is co-financed by SECO, MOEPP, MAFWE, and the municipalities of the Bregalnica region. The project is carried out by a team of national and international experts, forming the nucleus of a Bregalnica RBM Unit, supported by a Steering Committee, a Bregalnica RBM Advisory Council, and a Bregalnica Basin Planning Group. The latter comes in the form of several rounds of sub-regional workshops, each time carried out in three sub-regions (i.e. Upper Bregalnica, Middle Bregalnica and Lower Bregalnica). Figure 1 gives an overview of the project stakeholders.

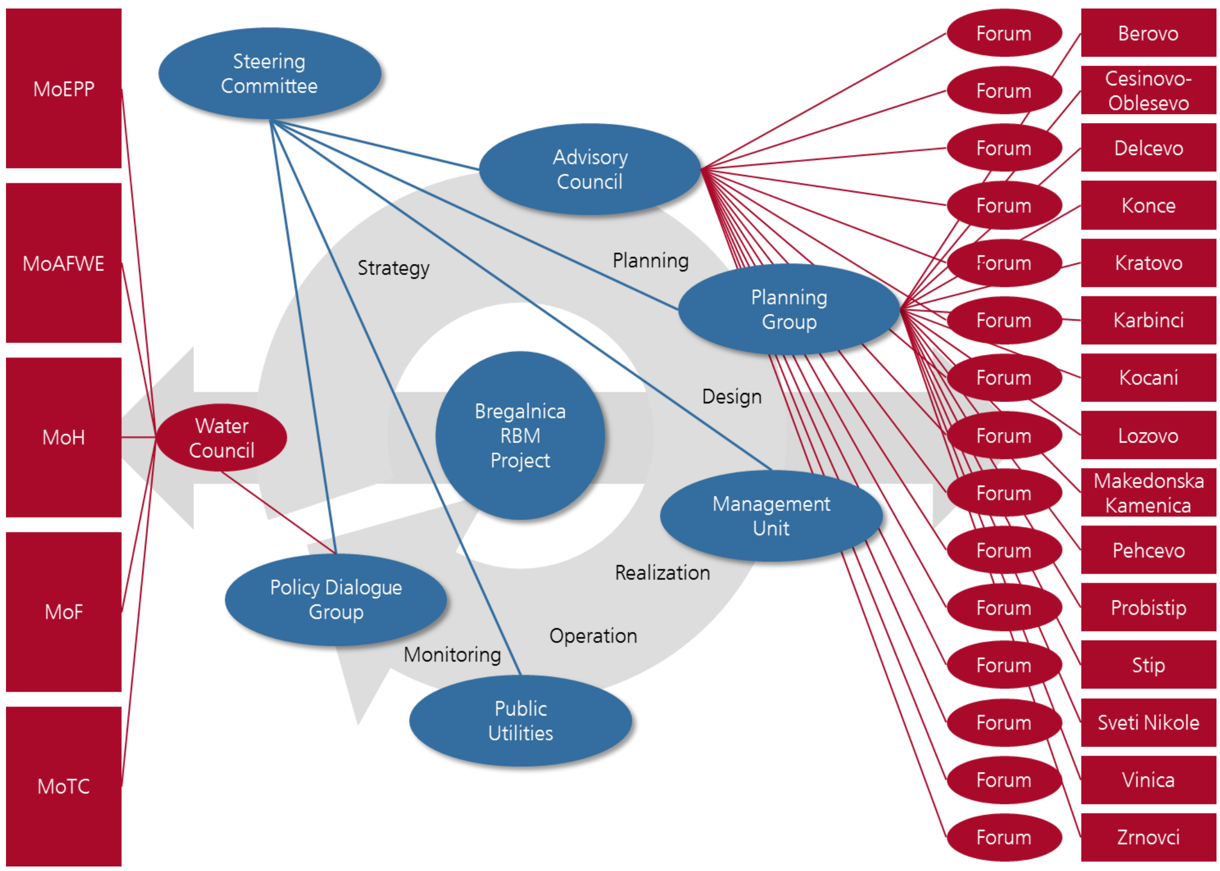

Figure 1: Overview of the project stakeholders

The main objective of the project is the sustainable management of the water resources in the Bregalnica river basin, by this promoting the economic development of the region, stimulating industry, agriculture and tourism. The enforcement of the Macedonian water law through the project should bring about the improvement of the water and sanitation services in the Bregalnica River Basin.

The project is divided into the following **two components**:

- The **Bregalnica River Basin Management** (RBM) Plan, comprising the analysis of the actual and future situation of the water resources and demand in the Bregalnica region, the identification of possible conflicts and the identification of improvement measurements. Additionally it comprehends the definition and putting into operation of the necessary organizational structures.
- The **Small Water Infrastructure** (SWI) Projects, comprising the establishment and operation of an investment fund to provide financing for small water infrastructure projects, including support to the municipalities of the Bregalnica river basin in the planning, tender design, contracting and implementation of the projects.

This document reports all works done until June 2015 regarding the component Bregalnica RBM Plan.

1.2 Purpose of the Bregalnica RBM Plan

Main goals of the Bregalnica RBM Plan are:

- The definition of a general action plan in the Bregalnica river basin to achieve a sustainable management of the water resources;
- The creation of adequate administrative structures for water resources management;
- The public participation and awareness of the population in the Bregalnica region on water issues.

The Bregalnica RBM Plan will be used as the main basis for selecting the SWI projects.

1.3 Report Structure

The tasks and the main results to achieve the above-mentioned goals are presented in this report as follows:

- Chapter 1, Introduction: Background and goals of the Bregalnica RBM Plan
- Chapter 2, Description of the Basin: Characteristics and properties of the Bregalnica River Basin and of its water resources in terms of quality and quantity
- Chapter 3, Pressures: Sector related description, actual situation and development of the pressures present in the Bregalnica region
- Chapter 4, Monitoring: Existing and newly implemented monitoring network for surface water, groundwater and protected areas
- Chapter 5, Status: Overview of the water bodies status
- Chapter 6, Environmental Objectives: Definition of environmental objectives for the Bregalnica region
- Chapter 7, Water Allocation Model: Balance between water resources and water uses, today and in the future
- Chapter 8, Economic Analysis: Financial analysis of water supply and wastewater services, identified gaps for economic analysis
- Chapter 9, Program of Measures: Definition and description of priority improvement measures to achieve the environmental objectives
- Chapter 10, Public Involvement: Description of the public participation and awareness measures in elaborating the Bregalnica RBM Plan
- Chapter 11, Competent Authorities: Names, function and responsibilities of official Bregalnica RBM stakeholders

2 Description of the Basin

2.1 General Description of the Bregalnica Basin

2.1.1 Geography

Bregalnica River is one of the major tributaries to Vardar River. The Vardar watershed drains in the Aegean Sea – Mediterranean Sea. The Bregalnica watershed as shown in Figure 2 comprises a territory of 4’307 km^2, which is approximately 21% of the Vardar watershed in Macedonia and about 17% of the overall territory of the country.

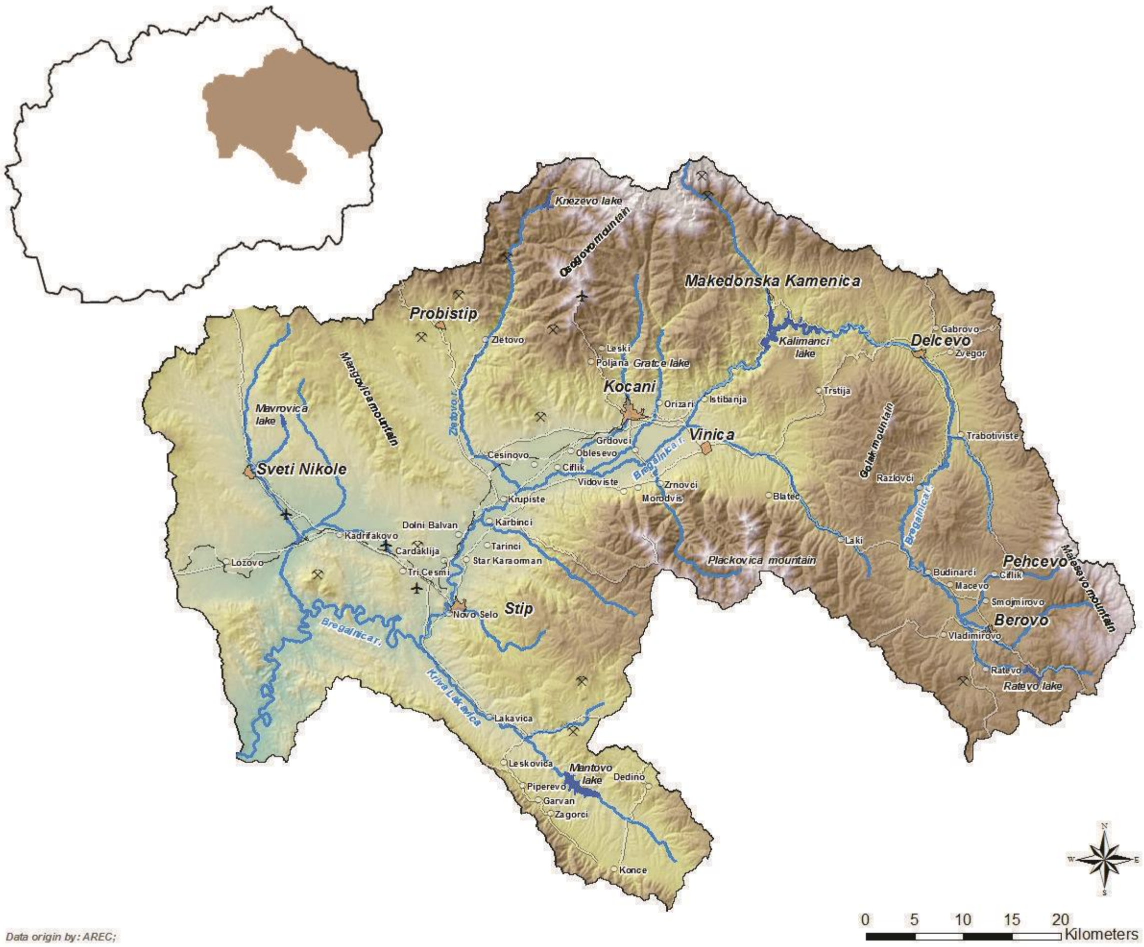

Figure 2: *Top corner left: Map of Macedonia with border of the Bregalnica river basin. Main figure: Map of Bregalnica with: land use and general geography, major cities, major rivers and lakes*

The Bregalnica watershed borders with Bulgaria in the east, Strumica River catchment in the south, Pcunja River in the north, and Vardar River in the west. The average altitude of the Bregalnica watershed is 722 m a.s.l.

In terms of **geology**, the eastern part of Macedonia including the Bregalnica basin belongs to the Rodopic system (Serbian-Macedonian massif) containing mostly crystalized shales and granites. The formation of these mountains occurred in the Paleozoic, with faults introduced later in the Tertiary.

Nowadays, the watershed is characterized by a very varied relief structure, which includes plains, such as parts of Ovche Pole, Ezhovo Pole; valleys along the Bregalnica river, such as Pijanec valley, Meleshevo valley, Vinica-Kochani valley, and Berovo-Pehchevo Pole; hilly areas, consisting of torrential deposits, cones, covered with diluvial soil, which cover large areas and present the dominant agricultural land; and mountainous areas, such as the mountains Osogovo, Plackovica, Serta, Konechka, Maleshevo, Ograzhden, Vlaina, Obozna and Golak.

The larger aquifers appearing in the region are typically unconfined aquifers in unconsolidated sediments, usually of Neogene – Quaternary origin. They are present in river valleys and terraces, as well as in alluvial fans. They range from aquifers with a good hydraulic conductivity ($K_f > 10^{-2}$ cm/s), to medium conductivity ($K_f=10^{-2}$ - 10^{-3} cm/s) and down to low conductivity ($K_f < 10^{-3}$ cm/s). There are also some karstic fractured aquifers, occurring in the Plackovica mountains, with highly variable yield, and some other fractured type aquifers, occurring in various rocks, with relatively low conductivity and yield.

The **climate** in the Bregalnica catchment is relatively arid, falling predominantly into the modified-continental climate type. This is the result of being in the contact zone between the influences of the Mediterranean Sea and Continental Eastern Europe. The characteristics for the modified-continental climate type are long and dry summers, often with temperatures as high as +41°C, together with mild and wet winters. Rarely, temperatures can get as low as -22 °C in winter. This happens especially in the most eastern and mountainous part of the Bregalnica watershed, the Maleshevo region, where the climate tends towards the continental type.

The average annual precipitation in the region varies between 506 mm in Kochansko Pole and 672 mm in Maleshevo. Precipitation is distributed unevenly over the year. Rainfall is maximal in the months of April and May, and minimal in the summer months of July and August. The average mean annual temperature in the plains is 12.9 °C, and in higher parts, such as Maleshevo around 8.7 °C. Snow falls from December until March. Fog is rare in this region, except in Maleshevo, where there is an average of 3 to 5 foggy days per year.

Vegetation: The diversity of biotopes in the region results in an abundance of plant species. The presence of several endemic species is also evident. Specific climatic conditions, as well as geological diversity in the region, create conditions for a heterogeneous natural vegetation and differentiation of altitude belts. High-rise plants are predominant, whereas lower plants, such as algae, moss and fungi have not been researched comprehensively. The region is home to multiple plant communities. Furthermore, there is a wealth of numerous medicinal and aromatic plants, forest fruits, seeds and mushrooms. The abundance of forests in the region is linked to 25 different tree species, with multiple subspecies.

Regarding the forest ecosystems, mostly located in the mountains of the region, the deciduous forests are more common, with various species of oak and beech, while coniferous forests are more rare, and consist of pine, silver fir and spruce. Mixed forests are present on smaller areas. The forests have an important in function in increasing water storage and reducing soil erosion as well as in maintaining biological diversity. Total forested area in the catchment is 1’157 km^2 or around 27% of the territory of the region.

Parts of the region also feature dry meadows, mainly spread over gentle slopes.

Fauna: There exists a great variety of animal species in the region, comprising amphibians, reptiles, insects, birds and mammals. The group of birds and mammals form numerous associations with a large number of individual animals that can be found from the lowest to the highest altitudes. In the forests, the fauna is particularly rich.

Regarding the aquatic ecosystems, the balance in the fish stock has been severely impaired over the past decades, due to disturbances in the water regime and the quality of water caused by human activities.

Mineral resources: The region is rich in mineral resources, including important lead-zinc mines in Zletovo, Dobrevo and Makedonska Kamenica. The presence of copper and iron-titanium minerals has been established in the Osogovo massif. On the territory of Delcevo, gold deposits as well as alluvial gold in river deposits from the Bregalnica river have been found. Finally, there is a major copper mine near Radovis, called Bucim.

Regarding non-metallic minerals, the most common ones in the Bregalnica region are asbestos, kaolin clays, naturally baked clay, granite, limestone, basalt, feldspar, opal breccias, opalised tuff and bituminous schists. The micro region Maleshevia contains lignite. In the Delcevo-Pehcevo basin there are major deposits of coal. There are also some smaller coal deposits on the territories of the municipalities of Probistip and Makedonska Kamenica.

Natural, Cultural and Historical Heritage: The Bregalnica region has an exceptionally rich natural heritage. There is also a rich cultural and historical heritage in the region, including the archaeological sites of Vinichko Kale and Bargala.

Land Use

The sharing among different uses in the Bregalnica region is shown in Table 1.

Unproductive land	29.9	2’990	0.7%
Field crops	806.5	80’650	18.7%
Intensive agriculture and plantations	72.3	7’230	1.7%
Traditional agriculture	771.0	77’100	17.9%
Range land	751.7	75’170	17.4%
Pastures	431.2	43’120	10.0%
Grasslands and meadows	288.5	28’850	6.7%
Forest	1157.6	115’760	26.8%
Water bodies	7.8	780	0.2%
Total	**4316.5**	**431’650**	**100.0%**

Table 1: Land use in the Bregalnica region

Source: Regions of the Republic of Macedonia, 2012, State Statistical Office

Demography: The Bregalnica river catchment encompasses the territory of the whole East Planning Region (11 municipalities, see Table 1), but also practically the complete territories of Lozovo and Sveti Nikole municipalities (Vardar Region) and Konce (South-Easter Region). A significant portion of the territory of the Kratovo municipality (25%) including some major water sources are in the Bregalnica catchment, and are, therefore, included in the current Bregalnica RBM Project.

Even though the Bregalnica catchment boundary mainly coincides with the municipal boundaries, minor parts of the territory of Radovis, Negotino, Gradsko, Veles, Kumanovo and Kriva Palanka fall into it also. However, due to negligibly low percentage of these areas as compared to the municipal area, and the fact they are sparsely inhabited remote mountainous areas – these municipalities were not included in the Project and the RBM Plan.

Planning Region	Municipality	Municipal Center	Population	Rural Population	Total	In Bregalnica catchment
East	Berovo	Berovo	6’983	6’920	13’903	
	Cesinovo	Cesinovo - Oblesevo	2’123	5’346	7’470	
	Delcevo	Delcevo	11’469	5’989	17’458	
	Karbinci	Karbinci	671	3’330	4’001	
	Kocani	Kocani	28’254	9’759	38’012	
	M. Kamenica	M. Kamenica	5’133	2’955	8’088	
	Pehcevo	Pehcevo	3’228	2’274	5’502	
	Probistip	Probistip	8’023	7’912	15’935	
	Stip	Stip	43’534	4’089	47’623	
	Vinica	Vinica	10’834	9’051	19’884	
	Zrnovci	Zrnovci	2’215	778	2’993	**180’870**
Vardar/Central	Sveti Nikole	Sveti Nikole	13’709	4’626	18’335	
	Lozovo	Lozovo	894	1’957	2’850	**21’186**
South-East	Konce	Konce	969	2’574	3’543	**3’543**
North-East	Kratovo	Kratovo	6’924	2’574	10’441	**20**
	Total		**144,963**	**70’133**	**216’039**	**205’618**

Table 2: Municipalities and population in the Bregalnica catchment

In the country context, the region is relatively sparsely populated with around 50.6 inhabitants per km², compared to 82.7 in Macedonia. The average age is 40 years, which is higher than the national average. Also lower are the fertility rate (1.3) and the natural increase of the population (-0.1 %/year). The education level is average as for the country. The unemployment rate is lower than the national average (18.5%), slightly higher with man in the urban parts. The net average salary in 2012 is the lowest in the country (MKD 14’957 per month), at 71.6 % of the national average. Over the last two decades, a lack of higher education employment opportunities in most rural settlements resulted in a population migration to the towns and abroad.

The main economic activities in the region are mining and industry, followed by services, trade and agriculture. The relation of GDP of the East Planning Region (11 municipalities) to the National can be seen in the following Table 3.

	Macedonia		East Planning Region		East Planning Region as percentage of national average
Population	**2'058'539**		**179'387**		
	Total (million MKD)	**per capita (MKD)**	**Total (million MKD)**	**per capita (MKD)**	**per capita (%)**
Gross value added	**402'392**	**195'475**	**32'462**	**180'961**	**93%**
Agriculture, forestry, fishing	43'895	21'323	4'427	24'678	116%
Mining; manufacturing; electricity, gas, steam and air conditioning, supply; water supply; sewerage, waste management and remediation activities	87'048	42'286	11'514	64'185	152%
Construction	29'924	14'537	3'092	17'236	119%
Wholesale and retail trade, repair of motor vehicles and motorcycles, transportation and storage; accommodation and food service activities	83'316	40'473	4'171	23'251	57%
Information and communication	18'990	9'225	282	1'572	17%
Financial and insurance activities	11'401	5'538	154	858	16%
Real estate activities, plus imputed rents	31'209	15'161	2'758	15'375	101%
Professional, scientific and technical activities; administrative and support service activities	15'098	7'334	529	2'949	40%
Public administration and defence; compulsory social security; education; human health and social work activities	67'656	32'866	4'714	26'278	80%
Arts, entertainment and recreation; other service activities	13'856	6'731	821	4'577	68%

Table 3: GDP for Macedonia and its East Planning Region

Source: State Statistical Office, year 2011

2.2 Surface Water Bodies

As the following figure shows, the Bregalnica catchment features quite a few rivers, irrigation channels (artificial water bodies) and lakes (reservoirs, also called heavily modified water bodies).

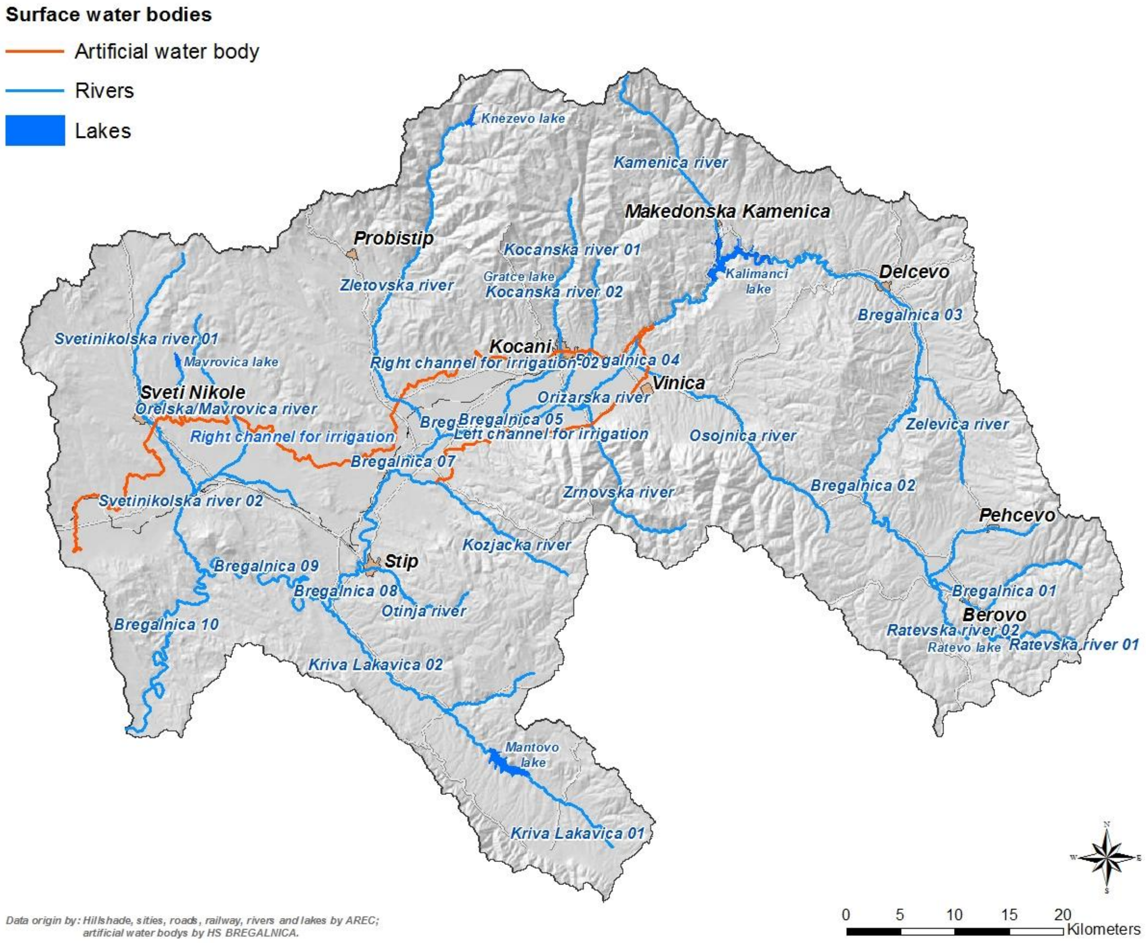

Figure 3: Map of Bregalnica River Basin with the selected surface water bodies

In Bregalnica catchment the following categories of surface water bodies exist:

- Rivers:
  - Bregalnica river, split into 10 stretches (i.e. separate water bodies)
  - 12 major tributaries of Bregalnica river:
    - Left tributaries (6): Ratevska, Osojnica, Zrnovska, Kozjacka, Otinja, and Lakavica
    - Right tributaries (6): Zelevica, Kamenicka, Orizarska, Kocanska, Zletovica and Svetini-kolska
- 6 Reservoirs (i.e. heavily modified water bodies):
  - Lake Berovsko/Ratevsko; Kalimanci; Gradce; Zletovsko Ezero/Knezevo; Mantovo and Mavrovica
- 2 main irrigation canals (i.e. artificial water bodies)

The surface water bodies were typified according to the systematization of the WFD (system A). More details on this method are given in Annex A2.

For the rivers, 27 water bodies were identified and classified into 7 types of water bodies (see Table 4).

			Altitude		Catchment size		Geology	System A Type	
Code	**Name of the Water Body**	**Type**	**Start**	**End**	**km²**	**Size**	**Geology**		**Type**
SR-01	Bregalnica 1	H	1'367	811	103.1	S	S	HSS	1
SR-02	Bregalnica 2	M	811	647	528.9	M	S	MMS	2
SR-03	Bregalnica 3	M	647	435	907.1	M	S	MMS	2
SR-04	Bregalnica 4	M	435	308	1'697.8	L	S	MLS	3
SR-05	Bregalnica 5	M	308	299	1'844.3	L	S	MLS	3
SR-06	Bregalnica 6	M	299	292	2'119.6	L	S	MLS	3
SR-07	Bregalnica 7	M	292	268	2'895.4	L	S	MLS	3
SR-08	Bregalnica 8	M	268	252	2'974.9	L	S	MLS	3
SR-09	Bregalnica 9	M	252	204	3'500.8	L	C	MLC	4
SR-10	Bregalnica 10	L	204	140	4'316.3	L	C	LLC	5
SR-11	Ratevska 1	H	1'263	984	31.3	S	S	HSS	1
Sr-12	Ratevska 2	H	937	800	139.4	M	S	HMS	7
SR-13	Zelevica	M	809	645	116.1	M	S	MMS	2
SR-14	Kamenica	M	1'320	517	95.9	S	S	MSS	6
SR-15	Osojnica	M	1'126	353	322.6	S	S	MSS	6
SR-16	Zrnovska	M	1'198	323	76.2	S	S	MSS	6
SR-17	Orizarska	M	1'490	304	146.2	M	S	MMS	2
SR-18	Kocanska 1	M	800	465	64.6	S	S	MSS	6
SR-19	Kocanska 2	M	420	299	145.8	S	S	MSS	6
SR-21	Kozjacka	M	970	282	491.3	S	S	MSS	6
SR-20	Zletovska	M	1'400	292	56.7	M	S	MMS	2
SR-22	Otinja	M	795	267	52.0	S	S	MSS	6
SR-23	Lakavica 1	M	602		114.5	M	S	MMS	2
SR-24	Lakavica 2	M		254	421.1	M	S	MMS	2
SR-25	Svetinikolska 1	M	550	238	283.9	M	S	MMS	2
SR-26	Nemanjica	M	360	237	213.0	M	S	MMS	2
SR-27	Svetinikolska 2	M	238	207	652.6	M	S	MMS	2

Table 4: River surface water bodies and types in the Bregalnica catchment; water body type as explained in Annex A2

The geographical repartition of the different river types is shown in Figure 4.

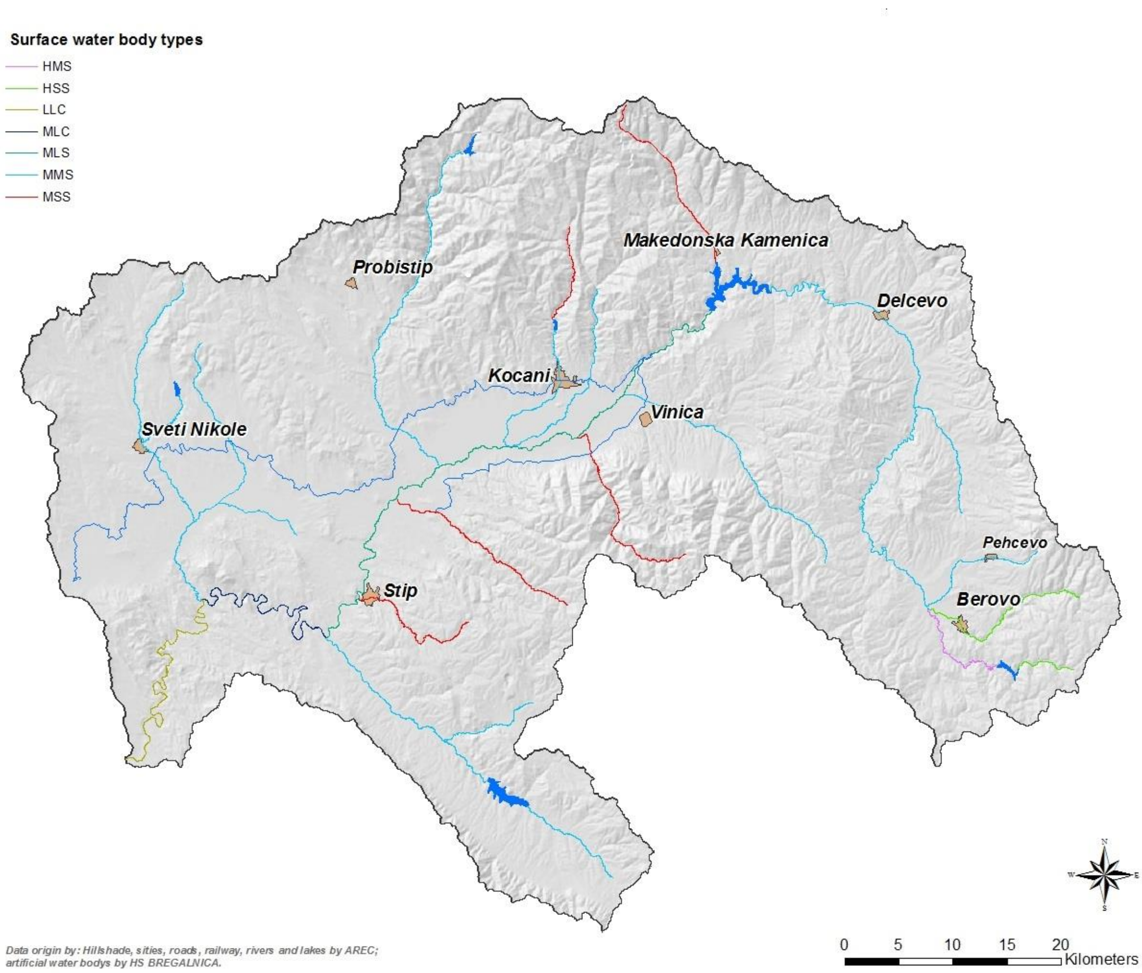

Figure 4: Distribution of river water body types in the Bregalnica catchment

Six reservoirs exist in the catchment of Bregalnica. Their types according to WFD (system A) are shown in Table 5.

Code	**Name**	**Altitude**			**Area Size**			**Geol-ogy**	**Depth**		**Type**	
		Type	HWL (m)	LWL (m)	Catch-ment (km²)	surface (km²)	Type	Type		Type		
AL-1	Berovsko/Ratevo	H	984	937	53.6	0.57	S	S	>15 m	D	Type 1	HSSD
AL-2	Kalimanci	M	517	435	1,100.0	4.23	M	S	>15 m	D	Type 2	MMSD
AL-3	Gradce	M	465	438	87.5	0.19	xS	S	>15 m	D	Type 3	MSSD
AL-4	Zletovo	H	1061	990			xS	S	>15 m	D	Type 1	HSSD
AL-5	Mantovo	M	402.5	369	180.0	4.94	M	S	>15 m	D	Type 2	MMSD
AL-6	Mavrovica	M	371		44.0	0.25	xS	S	3-15m	M	Type 4	MSSM

Table 5: Reservoirs (heavily modified water bodies) and types in the Bregalnica catchment; water body types as explained in Annex A2

The irrigation channels of the Bregalnica Irrigation Scheme (also called Bregalnica Hydro-System) are significant conduits of water, interacting with natural streams and rivers in the catchment. They strongly influence the overall hydrology and water balance in the catchment, especially in the irrigation season (April to September).

Given their hydrological significance, they were included as separate artificial water bodies as shown in Table 6.

Code	Name	Length (m)	Capacity (l/s)	Type
AC-01	Left Main Irrigation Channel	35’600	6’000 – 1’600	AWB
AC-02	Right Main Irrigation Channel, Upper Part	50’000	12’000 – 6’000	AWB
AC-03	Right Main Irrigation Channel, Lower Part	48’720	6’000 – 3’500	AWB

Table 6: Main irrigation channels (artificial water bodies) in the Bregalnica catchment, with length, capacity (in flow direction) and type (AWB: artificial water body)

2.3 Groundwater Bodies

In the Bregalnica catchment, 5 groundwater bodies have been identified. These are distinct aquifers also identified in some previous national strategic and planning documents.

In general, it may be said that the aquifers in the Bregalnica catchment are of alluvial and deluvial origin, unconsolidated and relatively shallow. Deeper parts of aquifers are in the deluvial foothill sediments and are used as water supply resource of some towns, including Kocani.

Systematic geologic and hydrogeologic studies on these aquifers were made in the 1960s and 70s which led to the nowadays existing maps. After this period, only a few sporadic investigations have been undertaken (available information consolidated in Figure 5).

Groundwater monitoring, introduced in the 1960s, has been deteriorating in quantity and quality since the late 1980s, leading to a data gap for the last three decades. The previously existing borehole/piezometer network has now been obsolete for some time. A new groundwater monitoring network will be required as a basis for a sustainable groundwater use and protection in the future.

The existing data from previous monitoring are predominantly on quantity (water level, yield exploration data and similar). Information on groundwater quality is merely incidental from sporadic projects or investigations.

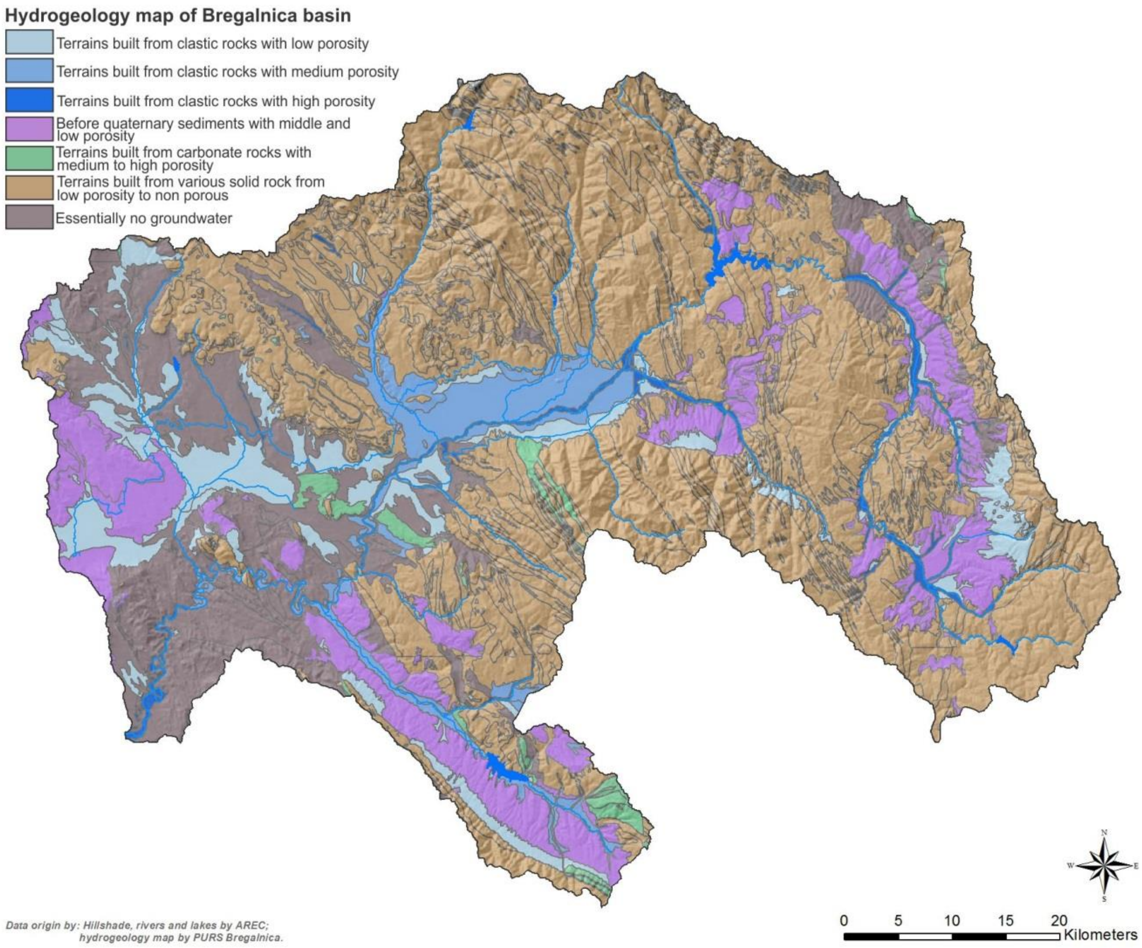

Figure 5: Hydrogeological map of the Bregalnica catchment

The static groundwater reserves were estimated[1] as follows:

- Berovo - Pehcevo valley: 360 million m^3
- Ovce Pole: 256 million m^3

For two of the aquifers, previous studies estimated the abstraction capacity or the safe yield as follows:

- Berovo - Delcevo: 120 l/s
- Kocani - Stip: 350 l/s

The identified six groundwater bodies are shown in Figure 6 and characterized as described in the following sections.

[1] Expert Study on Water Resources, for the Spatial Plan of the Republic of Macedonia

GWB_01: Berovo - Pehcevo

This is an unconsolidated phreatic aquifer, composed mainly of coarse gravels, and sands containing cobbles and smaller rocks from Quaternary. It has good hydraulic conductivity with a coefficient of $K_f \geq 1 \times 10^{-2}$ cm/s. Recharge of this groundwater body is from precipitation and the Bregalnica river. Based on existing wells, the average depth is estimated at around 10 m. The surface area of it is 6 km^2.

GWB_02: Delcevo

This is an unconsolidated phreatic aquifer, composed mainly of alluvial sediments of the Bregalnica river with coarse gravels, sands containing cobbles and smaller rocks from Quaternary. It has a good hydraulic conductivity with a coefficient of $K_f \geq 1 \times 10^{-2}$ cm/s. Recharge of this groundwater body is from precipitation and the Bregalnica river. Based on existing wells, the average depth is estimated at around 15 m. Its surface area is 14 km^2.

GWB_03: Stip - Kocani

This is an unconsolidated phreatic aquifer, encompassing higher and lower alluvial river terraces of different age. The aquifer is composed mainly of alluvial sediments of the Bregalnica river with coarse gravels, sands and clays from Quaternary. It has a good hydraulic conductivity with a coefficient of $K_f \geq 1 \times 10^{-2}$ cm/s.

In a test on one of the main abstraction points (wells of the Public Utility Fortuna - Stip, used for supply of potable water), the following hydrogeological parameters were obtained: $K_f = 8.2 \times 10^{-2}$ cm/s and transmissivity $T = 7.4 \times 10^{-3}$ m^2/s. The capacity of the wells is between 25 – 30 l/s. In another important abstraction point (Grdovski Orman, water supply for Kocani), a hydraulic conductivity of $K_f = 6.0 \times 10^{-2}$ cm/s and a well capacity of 15 – 40 l/s were observed. There are indications that this groundwater bodies may locally have several water-bearing horizons.

Recharge of this groundwater body is from precipitation and the Bregalnica river. Its depth is varying around 10 m, and its total surface area is 124 km^2.

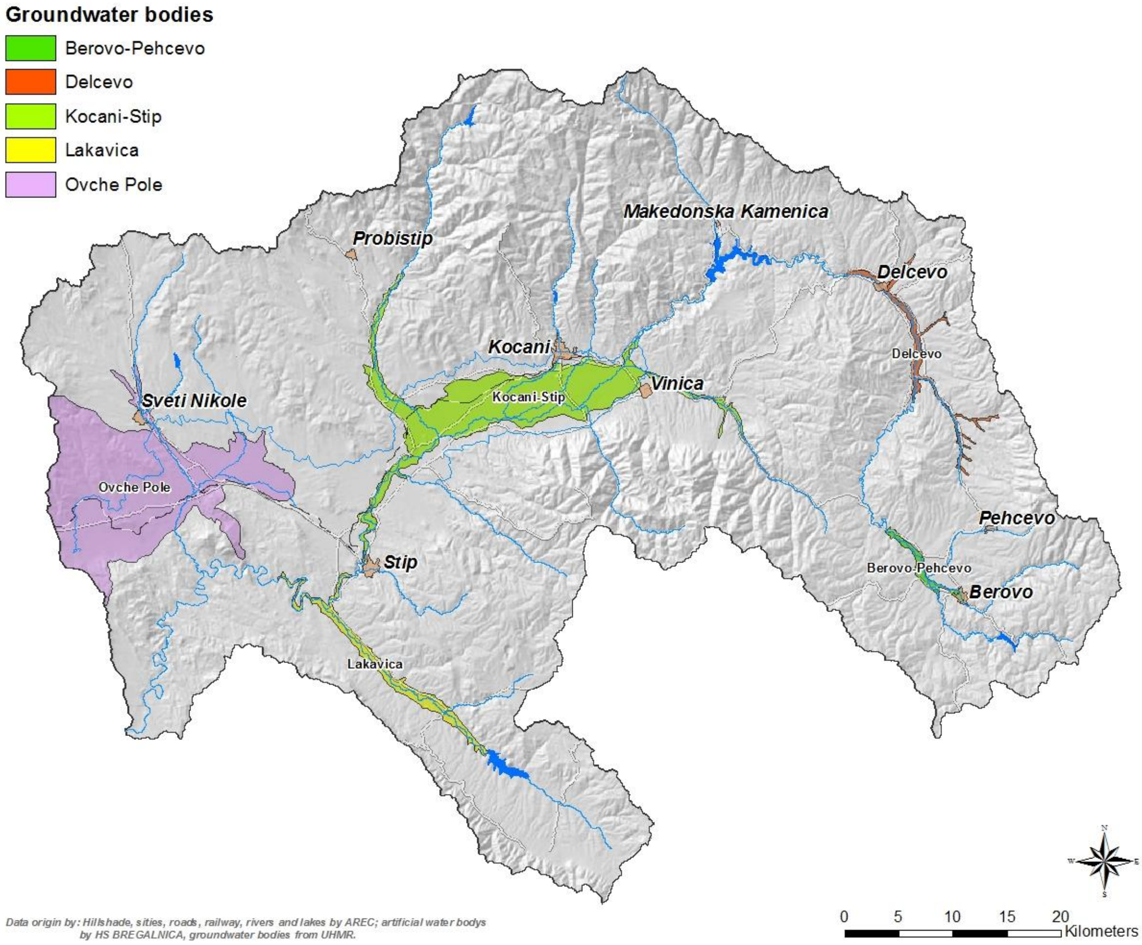

Figure 6: Map of groundwater aquifers in the Bregalnica catchment

GWB_04: Lakavica

This is an unconsolidated phreatic aquifer, composed mainly of alluvial sediments from the Kriva Lakavica River with coarse gravels, sands and clays from Quaternary. It has a good hydraulic conductivity with a coefficient of $K_f \geq 1 \times 10^{-2}$ cm/s. Recharge of this groundwater body is from precipitation and the river. The average depth is around 10 m. The surface area of it is 22 km^2.

GWB_05: Ovce Pole

This is an unconsolidated phreatic aquifer composed mainly of alluvial and lacustrine sediments with Quaternary sandy clays, clays and sands as well as Neocene gravels, sands and sandy clays. It has a poor hydraulic conductivity with a coefficient of $K_f \leq 1 \times 10^{-3}$ cm/s. The usual well capacity is around 1 l/s. Ovce Pole aquifer also has probably several water-bearing horizons with varying depth. Its surface area is 214 km^2.

2.4 Protected Areas

The basis for establishing and managing protected areas in Macedonia is the Law on Environment (53/05) and the Law on Nature Protection (67/04) as well as the pertinent subsequent amendments and by-laws.

The Water Law (87/08) transposes the EU WFD requirements on establishing areas for the protection and improvement of water resources. These requirements encompass the following protection zones:

- Water intended for human consumption
- Water designated as recreational waters, including areas designated as bathing waters
- Nutrient-sensitive areas, including areas designated as vulnerable zones under Directive 91/676/EEC and areas designated as sensitive areas under Directive 91/271/EEC
- Water bodies sensitive to urban wastewater discharge
- Areas designated as natural heritage, or for the conservation of habitats and species directly depending on water, although this is only required when there is a risk of non-compliance with the environmental objectives under article 4 of the WFD (ANNEX V)
- Areas for the protection of economically significant aquatic species

Presently, there are two protected areas for drinking water sources in the Bregalnica catchment (Figure 7). There is a protected area on the artificial Lake Ratevo which is used for drinking water supply to Berovo and another one on the artificial Lake Knezevo and along the Zletovska river up to the village of Zletovo. The water from Lake Knezovo and the Zletovska river are presently being used for water supply to Kratovo, Probishtip and Sveti Nikole.

According to the existing regulations, each location features three types of protective zones:

- First narrow protection zone or zone of strict sanitary supervision
- Second larger protected area or zone of sanitary restriction
- Third wider protection zone or area of hygiene - epidemiological monitoring and observation

In addition to these protected areas for drinking water purposes, a number of initiatives exist to proclaim some of the areas as protected areas of various protection categories, according to the Macedonian legislation. The MOEEP is involved in the whole process and their plan for future designations of protected area is depicted on the following Figure 8.

The areas requiring protection, based on Art. 96 of the Water Law (and WFD) will be established following a full cycle of one-year surveillance monitoring of surface and groundwater in Bregalnica catchment, and in coordination with the Bregalnica Nature Conservation Programme. Special attention, as in the Water Law, will be paid to proposal of the protection zones of water bodies intended for human consumption.

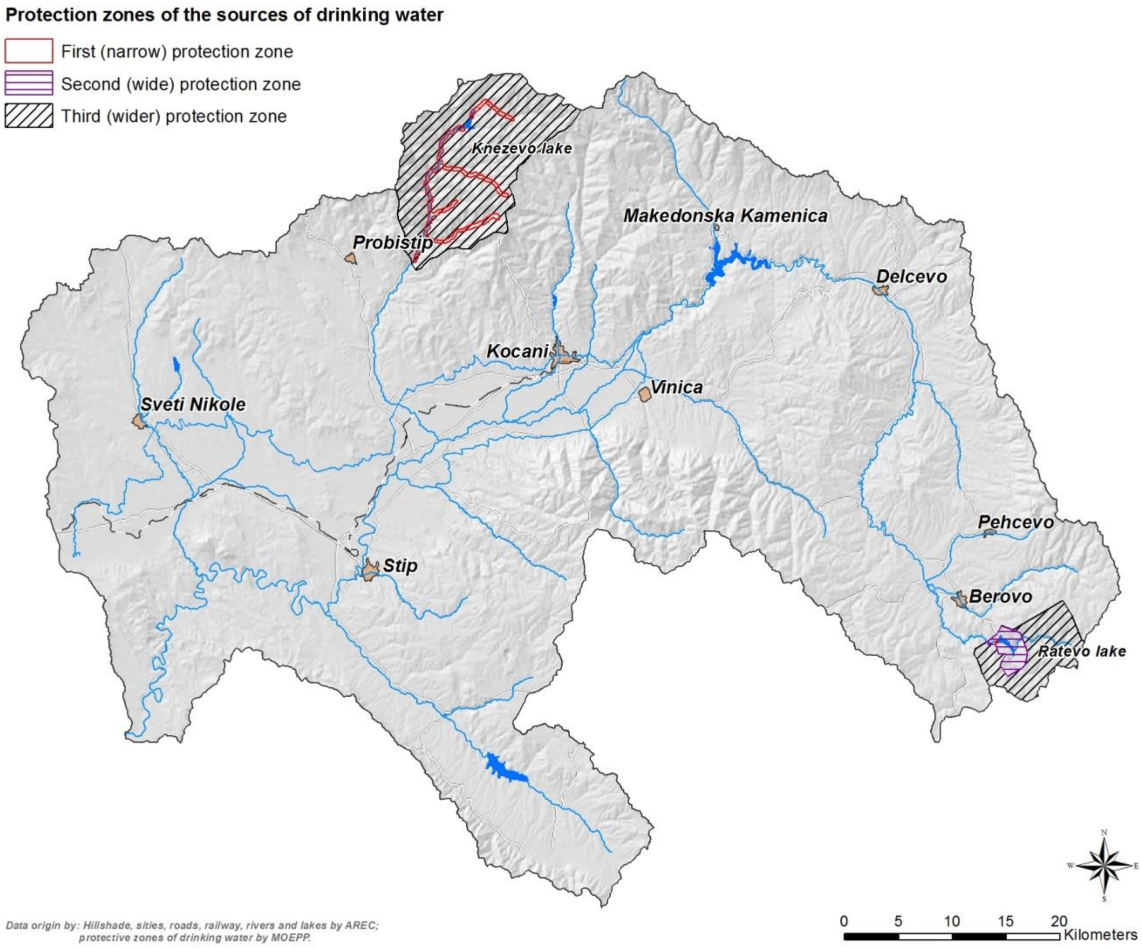

Figure 7: Protected drinking water zones in the Bregalnica catchment

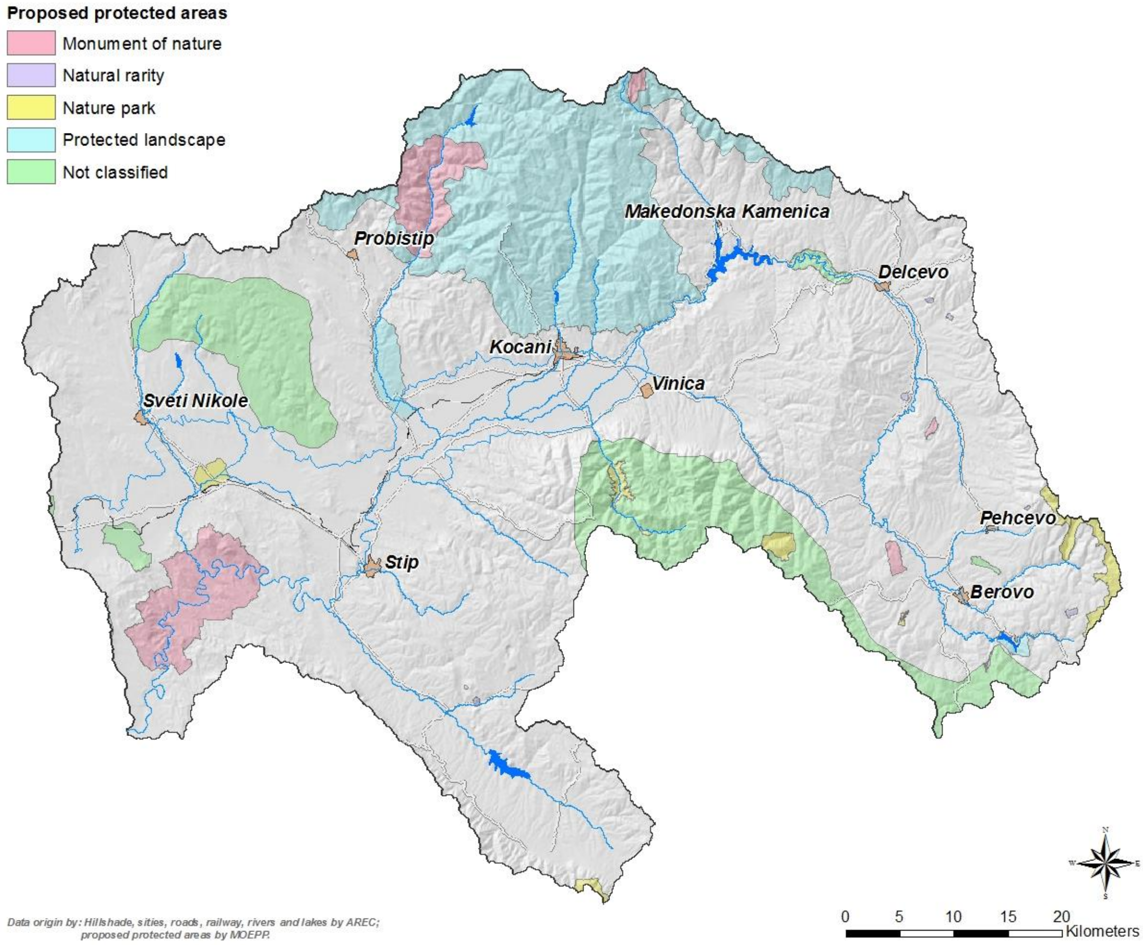

Figure 8: *Map of Bregalnica catchment with proposed nature protected areas*

Source: MOEPP

3 Pressures

The following chapter gives an overview of the pressures on water quality and quantity in the Bregalnica catchment. More detailed information regarding pressures is given in Annex A1.

3.1 Households

3.1.1 Description

The population density in the Bregalnica region is around the world's average with 50 persons per km^2. A total of 216'000 persons live in the Bregalnica river basin, which depend entirely on the water resources of the river basin (including water supply, irrigation and wastewater disposal). The only exception is the municipality of Kratovo which - due to its specific location - disposes of its wastewater into a different river basin. Towns in the upper part of the catchment are smaller than the ones further downstream. The population increases when moving downstream: 45'000 persons live in the upper part, approximately 84'000 persons in the middle part, and about 87'000 persons in the lower part of the catchment. The population density in the upper part of the basin is 38 persons per km^2 and in the middle and lower part around 53 persons per km^2.

In every municipality, a public enterprise is partially or completely in charge of the maintenance of the water supply and the wastewater infrastructure.

Regarding water supply, the settlements located at higher altitudes use surface water, i.e. water from springs, rivers or lakes. As there is not much industry present in this part of the basin, this water is of relatively good quality. In the middle and the lower part of the basin, the sources for water supply are mainly wells. As most of the municipalities own water treatment plants, almost all settlements - with the exception of a few villages - are connected to a drinking water utility. However, on a local scale lack of raw water during dry periods affects the supply reliability. Furthermore, due to the deterioration of the distribution network the water losses in the water supply systems are from 50% to 70% of the total amount of produced water.

The average annual water demand per person is 92.5 m^3/cap/a, which includes: the billed water used by the households; the non-billed water (for public use, illegal consumption); the losses caused by the deterioration of the water supply system; the water used for maintenance of the water supply system (washing of pipes, reservoirs and filters); and the losses caused by malfunction e.g. of the customer's water meters.

Regarding the collection and treatment of wastewater, the problems are acute. All the urban wastewater except from Berovo is directly discharged to the receiving water body. All the towns and the bigger villages have sewerage networks for collection and disposal of wastewater, but only 4% of the total domestic wastewater is treated. The only functional wastewater treatment plant is in Berovo (currently approximately 9'000 PE capacity) In the past, another six wastewater treatment plants existed, namely in Cesinovo (1'000 PE), Lozovo (5'000 PE), Tarinci (1'000 PE), Sveti Nikole (14’400 PE), Zletovo (2’800 PE) and Argulica (1'000 PE). However, all of these are currently out of operation. Figure 9 gives an overview on the wastewater treatment plants in the catchment.

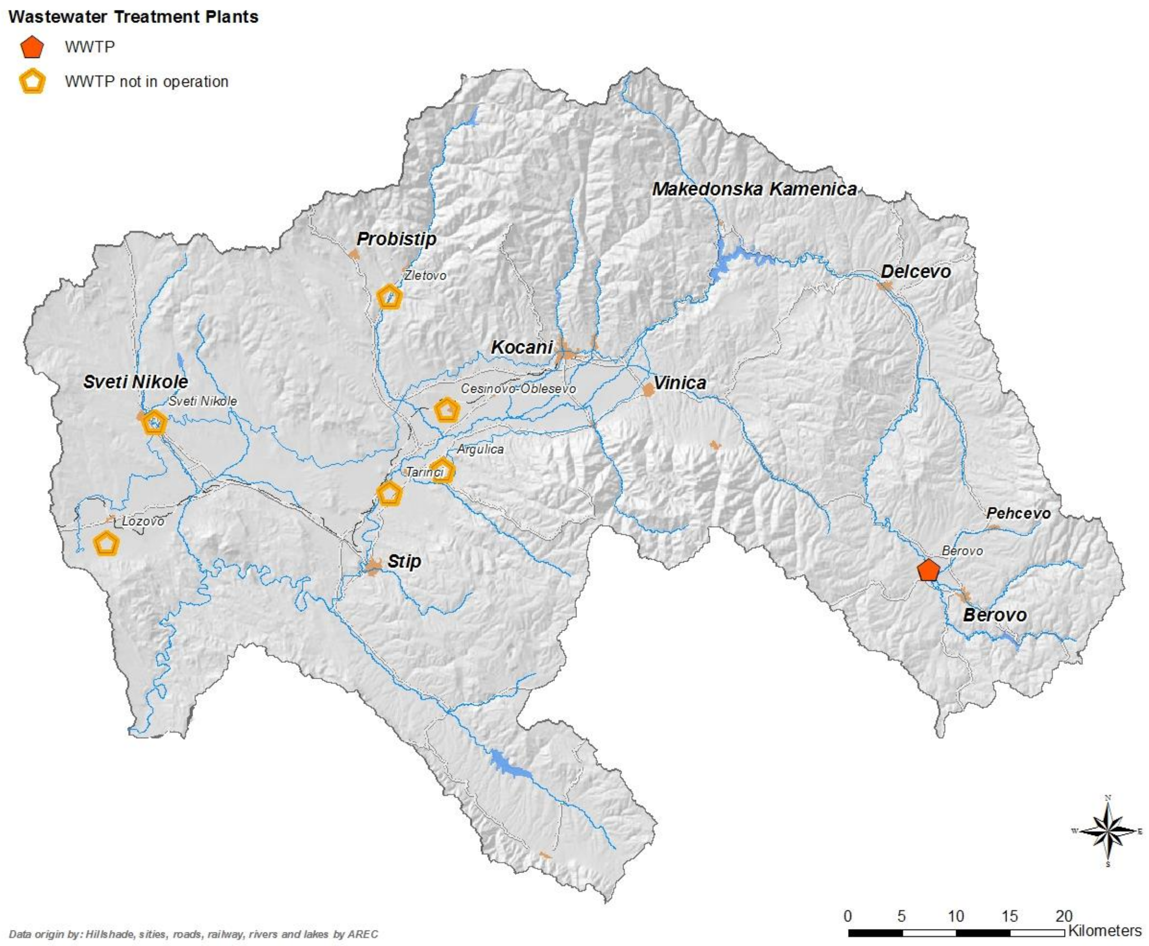

Figure 9: Overview on wastewater treatment plants in the catchment area

Most of the urban sewerage systems are mixed systems, combining urban wastewater and stormwater in the same collection systems. The exceptions are some streets in bigger settlements which have separate stormwater collection systems. During rain periods, the collection, disposal and treatment of wastewater prove to be especially problematic due to the increased inflow rainwater into the combined systems. Displacement of manhole covers and local flooding of streets may occur in such situations.

3.1.2 Development

The last Macedonian census in 2002 counted 216'500 people living in the Bregalnica river basin. Taking into account the growth rate of the population in the Bregalnica region between 2002 and 2013 of - 0.09% (estimated by the State Statistical Office) the estimate for 2013 is around 216'000. Generally, the number of people living in the Bregalnica river basin is not expected to change drastically until 2050.

The water demand per capita is expected to increase until 2030 as tendencies observed in the past few years are likely to aggravate, namely too low water tariffs, the bad economic situation of public enterprises and the lack of sufficient means for ongoing maintenance and reconstruction of the deteriorated water supply systems. A turnaround seems not possible in the next few years and more realistic for the period after 2030. In this case a stabilization of the demand may be expected after 2030 due to increasing water tariffs, increasing necessary investments in the water supply systems and due to improved awareness regarding water saving.

Regarding wastewater collection and treatment, the situation is likely to improve in the future: in a first phase wastewater treatment plants for the bigger towns will be constructed which later would be joined by the surrounding villages. For the more distant settlements separate wastewater treatment plants would need to be constructed.

3.1.3 Water Demand

Figure 10 shows the present municipal water demand in the Bregalnica river basin per water body. The present total municipal water demand amounts to 20 million m^3 (Mm^3). Roughly half of these municipal withdrawals are taken from the groundwater body Kocani-Stip (GW_03), which is the primary source of drinking water for the cities of Stip and Kocani.

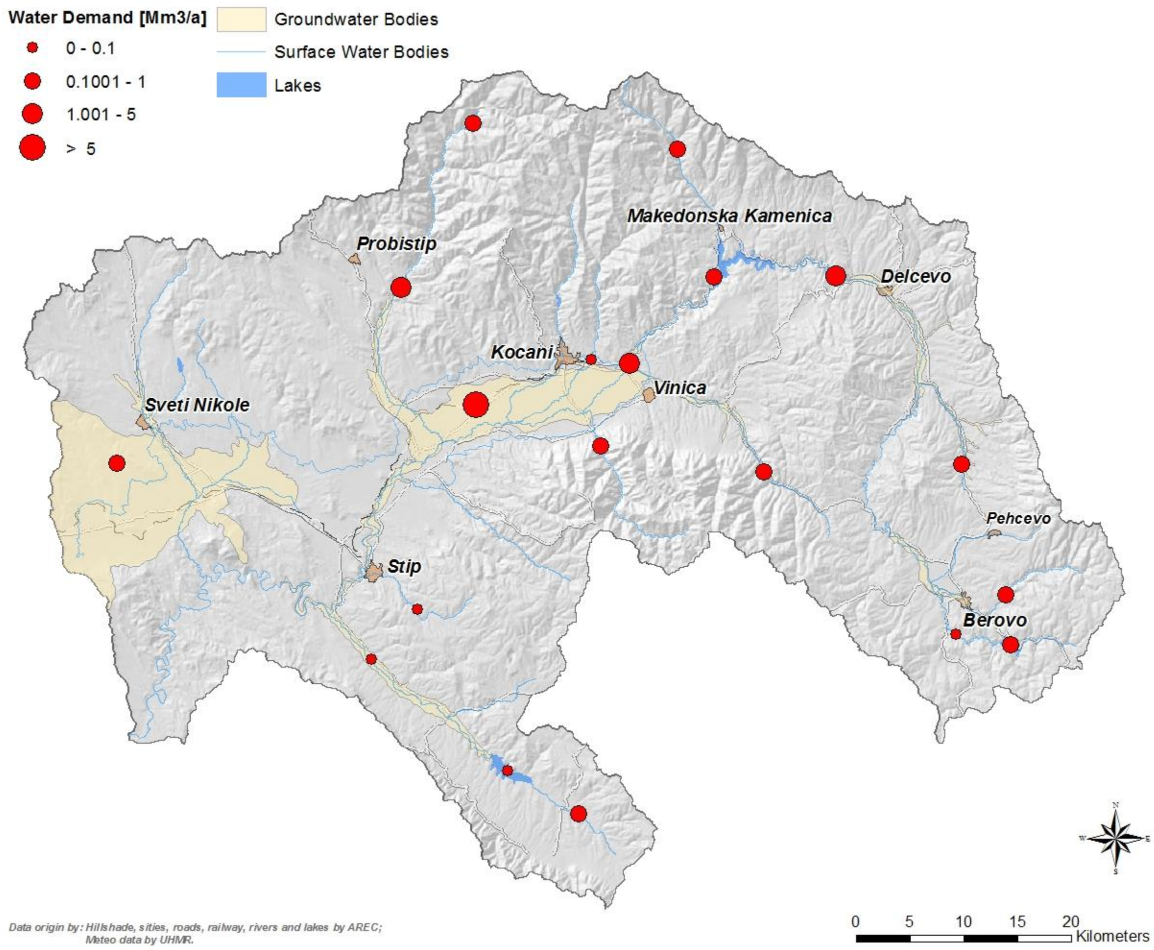

Figure 10: Overview on present annual municipal water demand in the Bregalnica catchment per water body source (i.e. the water demand of all cities and villages with the same water body source were summed up). The water demand points southwest of the cities of Kocani and Sveti Nikole are drawing their water from groundwater bodies

3.1.4 Pollution

The main pollution from the households stems from the wastewater and the livestock and poultry, which are kept around the houses. It can be diffusive or of point source type. 78% of the population are connected to a sewage system operated either by public utilities or private entities. Only 4% of the communal wastewater are treated in treatment plants.

Phosphorus is the main pollutant of concern when considering the domestic wastewater. It mainly gets into the wastewater through human excretion. Additionally, increased biological and chemical oxygen demand can be noticed in the vicinity of wastewater discharge points.

3.2 Industry

3.2.1 Description

Most of the industry in the Bregalnica catchment is located in the middle and the lower part of the river basin. There is textile industry, food production, wood production, production of construction materials, metal industry, and agricultural production (green houses); gravel abstraction; quarries for basalt, tuff and gabbro; and mines for coal, zinc, lead and iron. Figure 11 gives an overview on the types of industrial sites in the catchment.

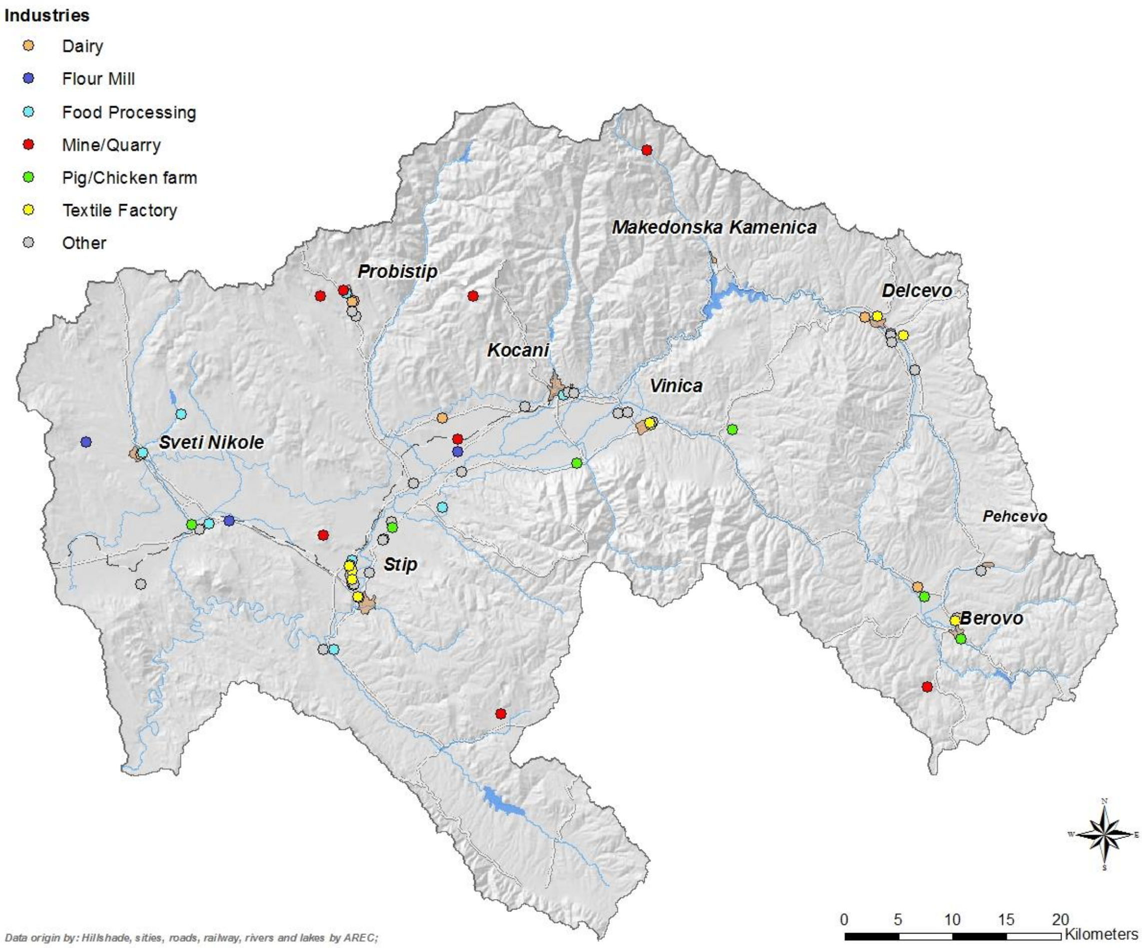

Figure 11: Overview on types of industrial sites in the Bregalnica catchment

All these industrial sectors use both drinking and technical water in their operation processes. Depending on their needs and possibilities, they get drinking water via the public enterprises or technical water via separate water supply systems from dams or rivers, or from own wells usually located in their vicinity. Besides the water received from the public enterprises (which is regularly measured) there is no precise data on the used amount of technical water from the wells, rivers or dams. There are only a few cases, where the total amount of water used in the production is regularly measured.

The greatest potential polluters in the Bregalnica river basin are mines, food production (pig farms), and textile industry. The industrial wastewater in most cases is disposed directly in the rivers and the lakes through channels or sewage pipes. Only 15% of all industrial wastewater is connected to urban wastewater systems. According to the Law on Urban Water, the industries should - depending on the production process - install pre-treatment of wastewater before discharging it to the urban wastewater systems. However, if industrial wastewater is directly released into a recipient, the water must be treated in an industrial wastewater treatment plant. Only the wastewater from the Berovo industry is treated in a wastewater treatment plant.

3.2.2 Development

The industrial growth is expected to keep up with the projected growth of the GDP of 2% per year. Consequently the water demand up to 2030 is also expected to grow. Based on the assumption that the price of water will increase drastically after 2030 the companies are then expected to apply more water saving measures.

In the future, four mines are planned to open in the Bregalnica catchment (Figure 12), two being related to the exploitation of coal and the other two being related to the exploitation of metal deposits.

The planned coal mines are:

- Coal mine Dzvegor-Stamer (Delcevo), where according to the latest data from the detailed geological research significant reserves of coal were discovered. The planned area corresponds to 4.0 km^2.
- Coal mine Pancarevo-Star Istevnik (Pehcevo), where at the moment detailed geological research are being carried out. It covers an area of around 6.0 km^2.

The metallic deposits planned for mining are:

- Deposits of copper, gold and silver around "Plavica and Black Peak" in the Municipality of Probistip. The area of the concession is 17.41 km^2.
- Deposits of copper, gold and silver around "Kadiica" in the Municipality of Pehcevo. The area of the concession is 17.41 km^2.

For all four mines, detailed geological research is being carried out at this moment. The opening of these mines will put high pressure on the environment and water resources in the Bregalnica region. Special attention should be paid to the coal mine Dzvegor-Stamer in Delcevo which touches on the Bregalnica river, hence directly affecting its water quality and its bed.

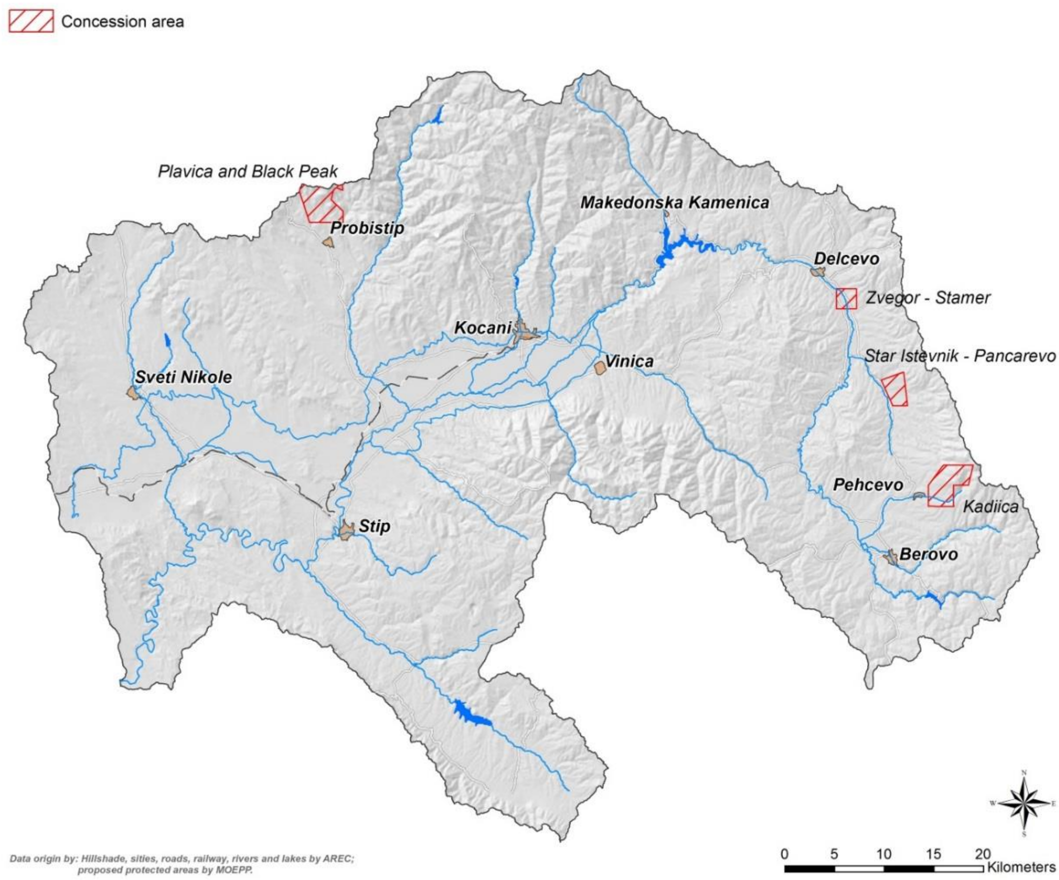

Figure 12: Location of concession areas of planned mines in the Bregalnica catchment

According to the Law on Environment from 2005, the existing industries as well as the new ones that are to be built, should apply for permits related to Integrated Pollution Prevention and Control (IPPC), be it an IPPC A permit (issued by MOEPP) or an IPPC B permit (issued by Municipality). For those that do not meet the standards for acquiring IPPC, the MOEPP has passed a decision for compliance with the operational plan according to which all industries need an IPPC A or IPPC B by 2014. As a result it is expected that after 2014 pollution from industry will be drastically reduced and that all future industrial sites will meet the laws on the disposal of wastewater.

3.2.3 Water Demand

Figure 13 shows the present industrial water demand in the Bregalnica catchment per industrial site. According to the data from the MOEPP, the total average annual water use of the industry in Bregalnica river basin is approximately 9.6 Mm^3/a. 10 of the 76 considered industrial sites make up for over 96% of the total industrial water demand in the catchment.

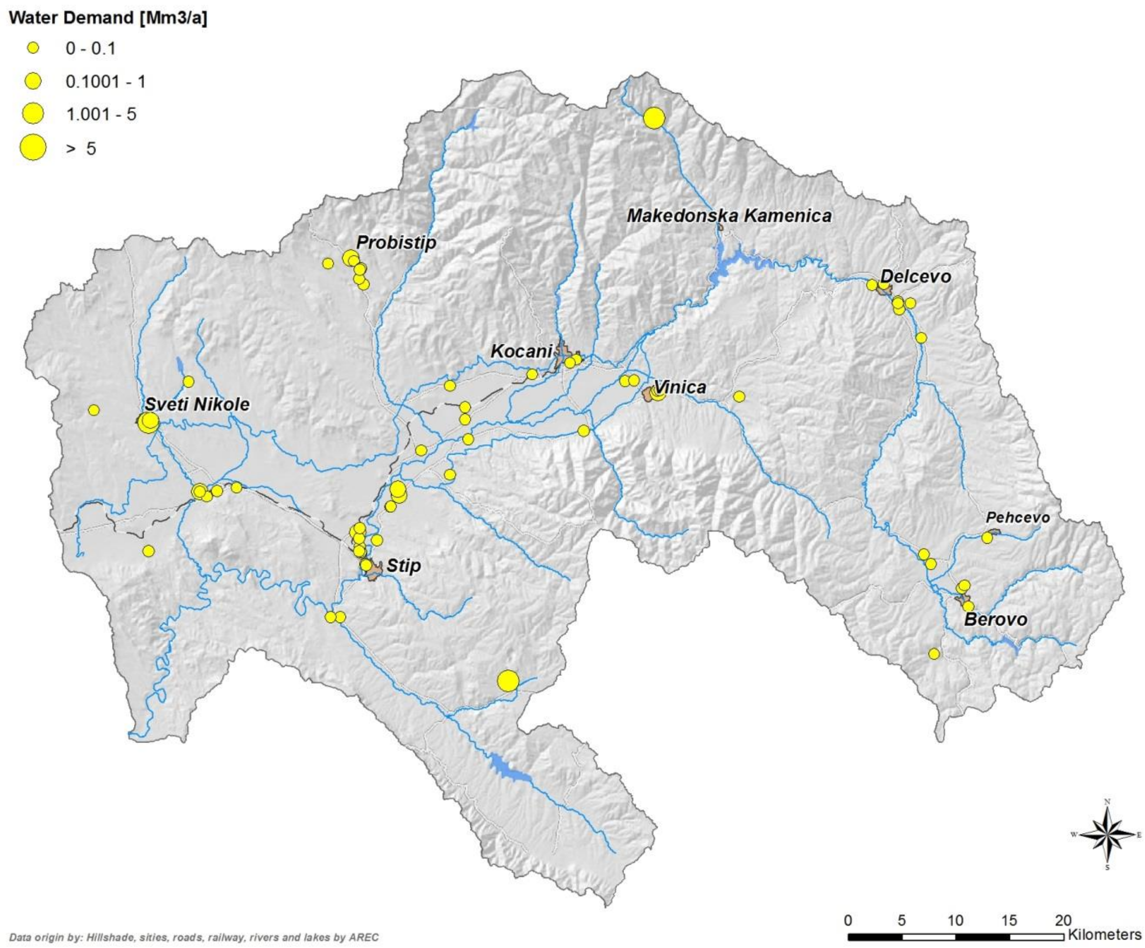

Figure 13: Overview on present annual industrial water demand in the Bregalnica catchment per industrial site

3.2.4 Pollution

The industry is an important potential polluter of the surface water and groundwater in the Bregalnica river basin. The most important potential polluters in this region are the mines, the food production (pig farms) and the textile industry. In the Bregalnica river basin there are three bigger operational mines: the Sasa mine near Makedonska Kamenica, the Zletovo mine near Probistip and the Bucimmine near Radovis. The greatest challenge in operating these mines is the management of the hydro tailings in view of water reuse. The water which is coming from the process contains suspended solids which sediment in the settling ponds from where it is reused in the mining process. These settling ponds are relatively unstable. When there is excessive inflow of process water or stormwater, suspended solids or sludge, which contain high concentration of heavy metals, may overflow and run off in an uncontrolled way. In addition, the water of the ponds infiltrates into the subsoil and subsequently into the groundwater.

The potential pollution from the textile industries is related to the fabric treatment process, i.e. the bleaching and dyeing. The wastewater from the process can have a high pH and, depending on the colors used, it might also contain heavy metals.

Finally, the pig farms have to be mentioned as potential polluters. There are five bigger ones in the Bregalnica basin, being located near Berovo, Vinica, Sveti Nikole, Stip and Karbinci. Usually, the manure is collected in big lagoons, where it sediments and dehydrates. After a certain time the manure is collected and distributed to the agricultural fields. During heavy or after long-lasting rain periods wastewater overflow from the lagoons is possible. As the wastewater contains high concentrations of phosphorus and nitrogen compounds, the groundwater and surface water can be impaired by these lagoons.

3.3 Agriculture

3.3.1 Description

The following assessment of the rainfed and irrigated arable land areas is based on the Statistical agricultural report for 2012, the LPis-MAFWE data set, information from the HMS Bregalnica office, MAFWE `s Water economy sector as well as expert judgment.

Out of the total Bregalnica catchment area of 4’300 km^2 (430’000 hectares), about 1’000 km^2 (100’000 hectares) are arable land. Approximately half of this area is presently under cultivation, with the remaining area most probably being abandoned or temporally uncultivated (fallow). Figure 14 shows the distribution of the arable land in the Bregalnica catchment.

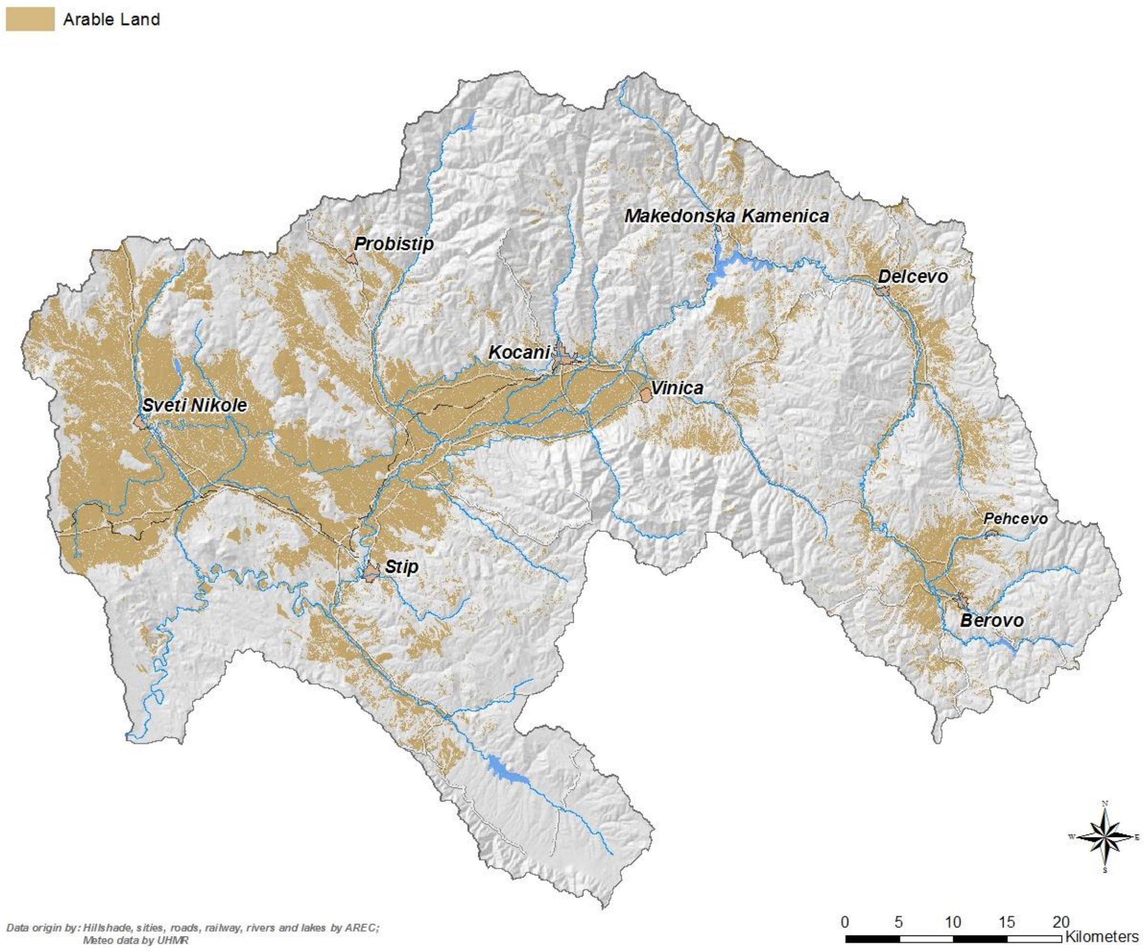

Figure 14: Distribution of arable land in the Bregalnica catchment

The present irrigation infrastructure enables the irrigation of roughly 200 km^2 (20'000 hectares). Presently about 90 - 100 km^2 (9'000 – 10'000 hectares) or half of the potentially irrigable area is actually irrigated. Today's potentially irrigable areas as well as the planned irrigated areas are depicted in Figure 15.

The catchment can be subdivided into the following 3 major agricultural areas.

Upper part of Bregalnica catchment

The upper part of the Bregalnica catchment (Berovo, Pehcevo, Delcevo and major part of M. Kamenica Plain) covers a total arable area of approximately 200 km^2 (20'000 hectares), half of which is currently under cultivation. A net area of 38 - 45 km^2 (3'800 – 4'500 hectares) can be potentially irrigated with the five existing irrigation systems Malesevsko Pole-Berovo, Crn Dol_Pehcevo, Sandanski, Milkovo Brdo and Jugotutun. At present only about 6 km^2 (600 hectares) are actually irrigated. Main crops cultivated in this part of the Bregalnica catchment are cereals and potatoes (18%).

In this part traditional, not market oriented, low intensity agricultural practice is widespread with little use of fertilizers and pesticides. While general irrigation practice is still extensive, modern pressurized irrigation systems are being used more frequently in the last few years especially for orchards. Recently, subsidies from MAFWE helped with starting to establish more modern and intensive plantations, although awareness regarding irrigation efficiency is still generally low. Fertilizers are applied schematically without permanent control of soil fertility.

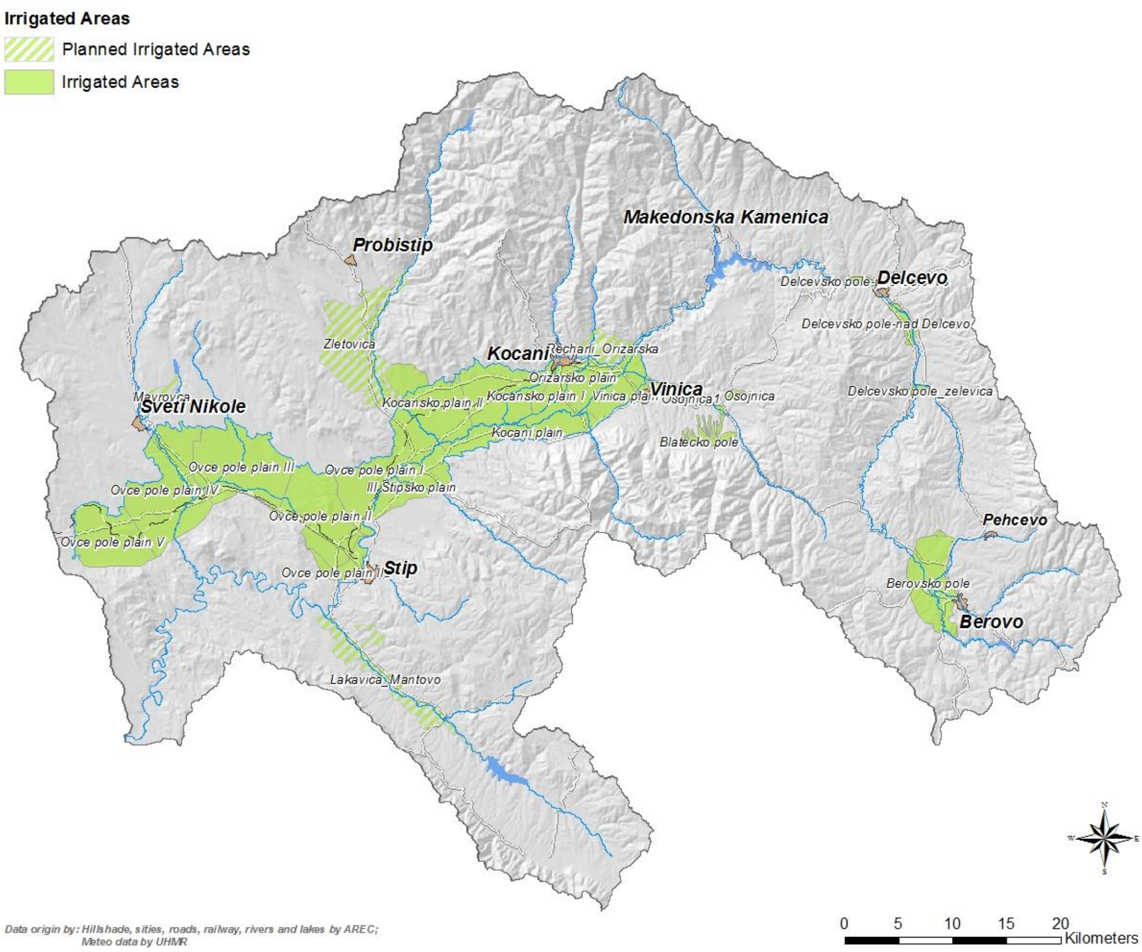

Figure 15: Present and planned irrigation planes in the Bregalnica catchment

Middle part of Bregalnica catchment

The middle part of the catchment (Vinica, Kocani, Zrnovci, Karbinci, Cesinovo-Obleshevo and Probistip) encompasses a total arable area of about 350 km^2 (35'000 hectares) with about 200 km^2 (20'000 hectares) presently under cultivation. The major part is covered with the HMS Bregalnica (Orizarsko Plain, Vinica Plain, Kocansko Plain and Kocansko Plain I and II, Stipsko and Ovce Pole Plain I), HMS Osojnica and HMS Blatecko pole. The total net potential irrigated area of these 3 irrigation systems amounts to 130 km^2 (13'000 hectares), out of which 50 - 60 km^2 (5'000 – 6'000 hectares) are actually irrigated at present. Almost all rice fields of the Bregalnica catchment are situated in this subpart and make up most of the irrigated areas (45 km^2, equivalent to 4’500 hectares). Besides rice fields, cereals (wheat and barley) cover a major part (40%) of the arable land in this sub-region.

The rice fields are flooded during the vegetation period except for short periods, when the water level is kept low or the fields are dried for carrying out agro technical operations. Agricultural production in this area is much more intensive with high inputs of fertilizers and pesticides, especially on the rice fields, in green houses and newly established orchards and vineyards.

Lower part of Bregalnica catchment

The lower part of the catchment (Stip, St. Nikole, Konce and Lozovo) covers about 450 km^2 (45’000 hectares) of arable land, with about 200 km^2 (20’000 hectares) presently under cultivation. The net irrigation area covered by HMS Bregalnica (Ovce Pole Plain II-V) and HMS Mavrovica amounts to 115 km^2 (11’500 hectares). At the moment only 20 - 30 km^2 (2’000 – 3’000 hectares) are actually irrigated. The dominant crops covering about half of the currently cultivated area are cereals.

3.3.2 Development

In general the areas under intensive agriculture will increase in the future together with investments and inputs in the agricultural sector (more fertilizers and pesticides). More specifically, the following trends may have a significant impact on the future development of the agricultural sector:

- Significant financial support for farmers on state level in the form of subsidies or through the IPA program. These subsidies may alter farming practices e.g. increased establishment of orchards and vineyard plantations or implementation of new techniques of production.
- An increased interest of the farmers for modern irrigation and fertilization systems. This presently increasing interest is due to economic reasons (augmented price of fertilizers) as well as a general need to simplify the traditionally very time consuming irrigation process. Possible developments may include the implementation of control systems facilitating optimized irrigation scheduling as well as the preparation of fertilizing programs for a more efficient use of fertilizers.
- MAFWE’s policy for permanent control of soil fertility: To get subsidies for the establishment of perennial plantations, farmers are obliged to perform a soil analysis to establish the present soil condition and identify measures to improve soil fertility. If the so acquired data is centrally collected and stored by the Ministry, it may provide an improved overview of the current agricultural soil condition and facilitate the identification of efficient and cost-effective measures in the future.
- In the past few years MAFWE started with the development of several important data bases which may form a good base for the inventarisation of the agricultural sector and an effi-

cient implementation of future policies e.g. with LPis as a part of IACS (Integrated Administration and Controlling System) and FADN (Farm Accountancy Data Network), or the establishment of a paying agency for the distribution and control of subsidies in the agricultural sector.

3.3.3 Water Demand

Figure 16 shows the present irrigation water demand in the Bregalnica catchment per irrigation plane. The present total irrigation water demand amounts to 126 Mm^3 per year. Unsurprisingly, HMS Bregalnica, being by far the biggest irrigation system in the catchment, makes up for over 80% of the total irrigation water demand.

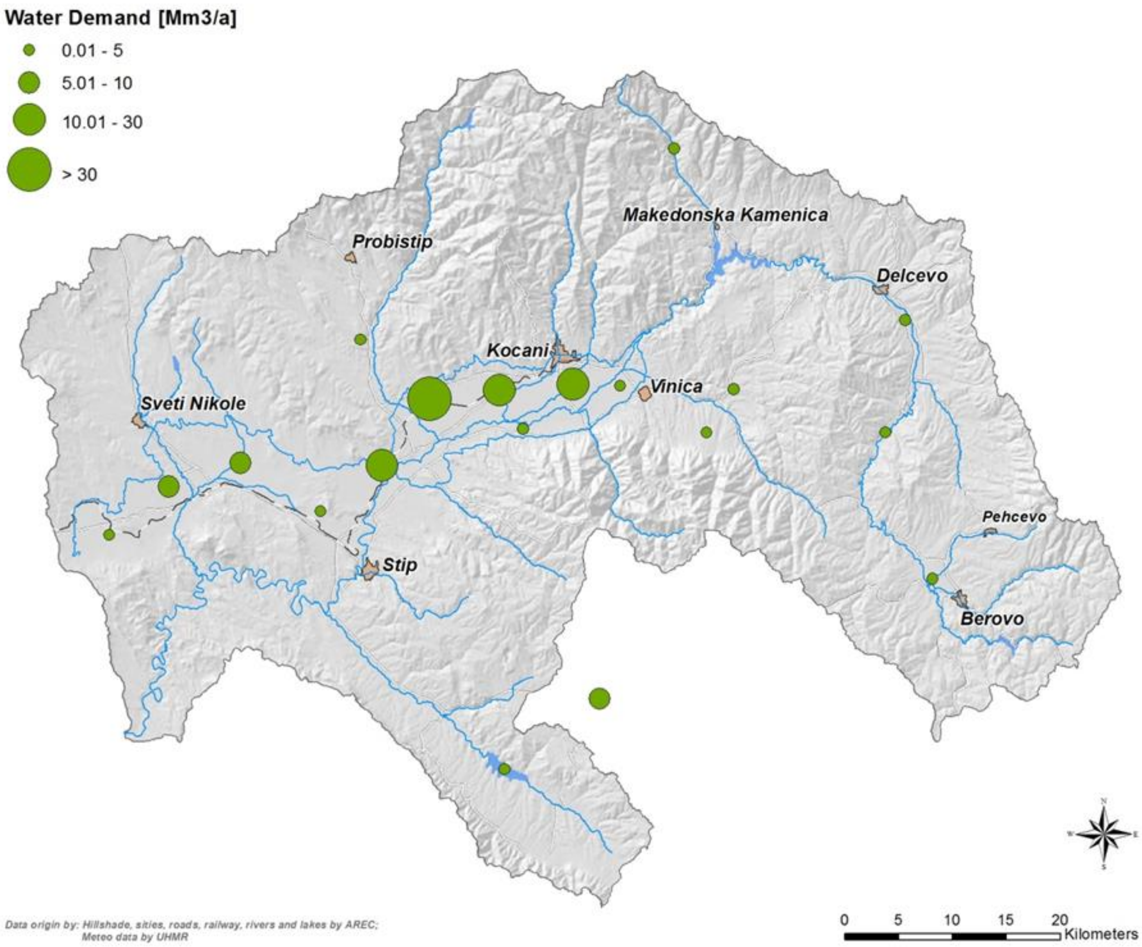

Figure 16: Overview on present annual irrigation water demand in the Bregalnica catchment per irrigation plane

3.3.4 Pollution

The agricultural sector is an important source of diffuse pollution in the Bregalnica catchment. Considering the present land use it can be concluded that the areas with rice fields, greenhouses or permanent cultivations are the main sources for the diffuse pollution of the water.

This situation is mainly due to inappropriate fertilizing and irrigation practices: excessive use of fertilizers, inappropriate forms of fertilizers in different growing stages and schematic fertilization, i.e. without soil testing and thus without taking into account the site-specific condition of the soil. A similar situation can be found especially on the rice fields with the application of pesticides and herbicides. In order to secure their production, farmers quite often apply much higher quantities of pesticides or herbicides than actually needed. Thus, apart from the water contamination the effectiveness of the pesticides is much reduced due to evolving resistances.

Another diffuse pollution source is the careless handling of bags, containers and other types of packing for fertilizers, pesticides and herbicides. In addition, various agricultural activities such as washing of machines used for applying fertilizers, pesticides and herbicides in the field (injection vehicles, sprayers) as well as fruit and vegetable processing produce contaminated washing water or wastewater which drains into the soil and groundwater or directly reaches the surface water bodies.

The lower parts of the Bregalnica catchment (Ovce Pole and Lozovo) fall within the most arid regions of the country with a total precipitation below 350 mm per year. With a changing climate (higher average temperatures, heat waves, disturbed rainfall regime, wind blows etc.), soil erosion becomes a severe problem in the region.

Soil erosion is also accelerated by poor agricultural practices, leading to the destruction of the soil structure and the depletion of soil organic matter. There are no exact measurements or a quantification of the intensity of soil erosion (wind or water induced) under different cropping systems and soil management practices. Initial research results in the Skopje and the Negotino region showed significant differences on the intensity of soil erosion under various management practices.

The agricultural areas most prone to soil erosion are those on sloping terrains (more than 5%) under intensive agricultural production, such as irrigated areas, vineyards and orchards with a down slope cultivation technique, as well as areas with degraded forest and natural vegetation.

The most relevant point source pollutions in agriculture are livestock farms. The potential impact of livestock farms on the water bodies is on the one hand dependent of the vicinity of the source to the next water body and on the other hand the way how the waste management is done, i.e. to which extent state-of-the-art technology and methods are followed. Therefore, it is important to know the location of the farms, the quantities of produced waste, and how the waste management is done, in order to assess the possible risk of farms on the water quality.

Table 38 and Table 39 in Annex A1 give an overview on the situation in the Bregalnica catchment showing a detailed inventory of the livestock and the according estimated manure output as well as the potential space for accommodating livestock and for storing liquid and solid manure.

3.4 Other Pressures

3.4.1 Description

Figure 17 gives an overview on other potential pressures in the river basin besides the municipal, industrial and agricultural sector. These pressures include 4 built and 2 planned large hydropower plants, 4 airports (sports flying and for agricultural needs), 9 fish farms and 36 gas stations.

Given the relatively low road traffic with no highways in the region and the limited railway infrastructure with only a short railway line from Veles to Kocani, mainly used for cargo transport in the region, the water pollution caused by traffic emissions is minor and negligible.

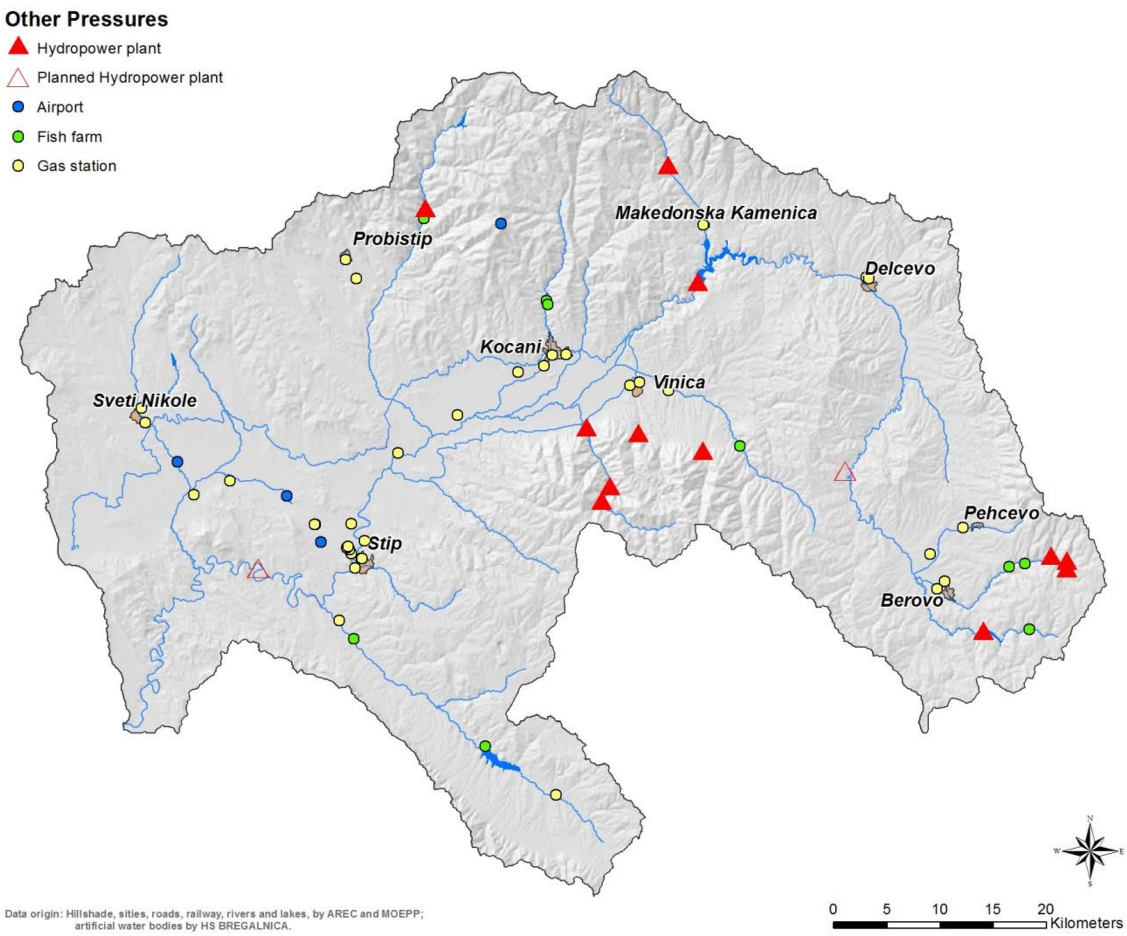

Figure 17: Overview on other pressures in the Bregalnica catchment

With the present economic situation and the non-existence of heavy industry in the towns in and around the river basin, the pollution by the washout from the air is also minor.

3.4.2 Flow Regulation and Morphological Alteration

The natural stream flow in the Bregalnica river system is heavily altered by the six big reservoirs: Ratevska (AL_01), Kalimanci (AL_02), Gradche (AL_03), Knezevo (AL_04), Mantovo (AL_05) and Mavrovica (AL_06). Four additional big reservoirs are planned. Furthermore there are several smaller dams (height > 10 m) and weirs (height < 10 m) in the river basin. Figure 18 gives an overview on the reservoirs, dams and weirs.

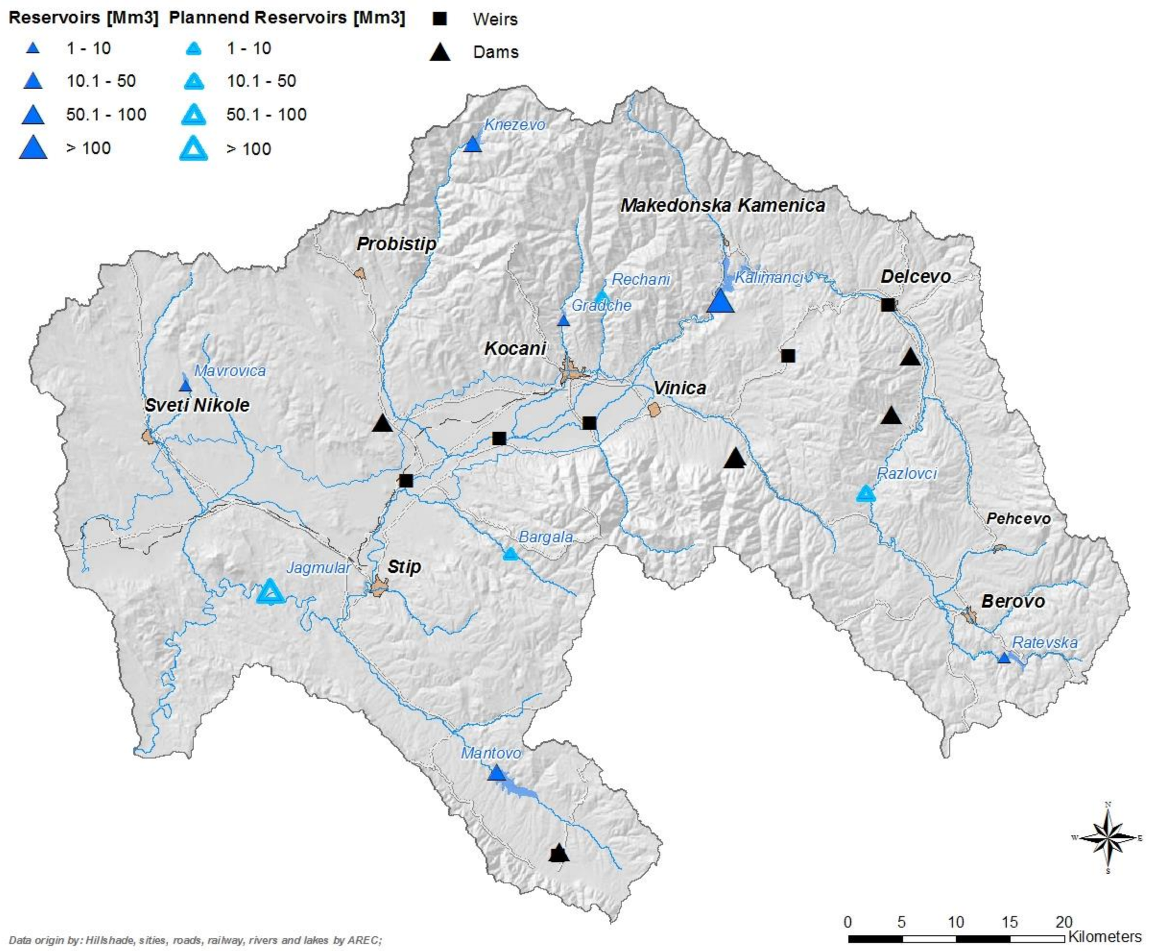

Figure 18: Overview on the 6 built and 4 planned large reservoirs as well as additional smaller dams (height > 10 m) and weirs (height < 10 m)

Most of the reservoirs, dams and weirs are built and operated for irrigation purposes. The most prominent example is Kalimanci reservoir, which regulates the upstream water flow for HMS Bregalnica, the largest irrigation system in the catchment.

Minimal biological flow regulations are issued for all big reservoirs and water intakes and usually amount to 10% of the mean annual runoff. For the big reservoirs and large water intakes these regulations are usually followed. For small water intakes or small hydropower plants biological flow requirements are not enforced as strictly.

Further morphological alterations are mainly found in urban areas, where several rivers feature channelized sections.

3.4.3 Presence and Use of Geothermal Water

In the Bregalnica basin, there are two localities where geothermal fields occur and geothermal energy is used for different proposes. These two areas are: Kocani valley and the granite massif around Stip (Figure 19).

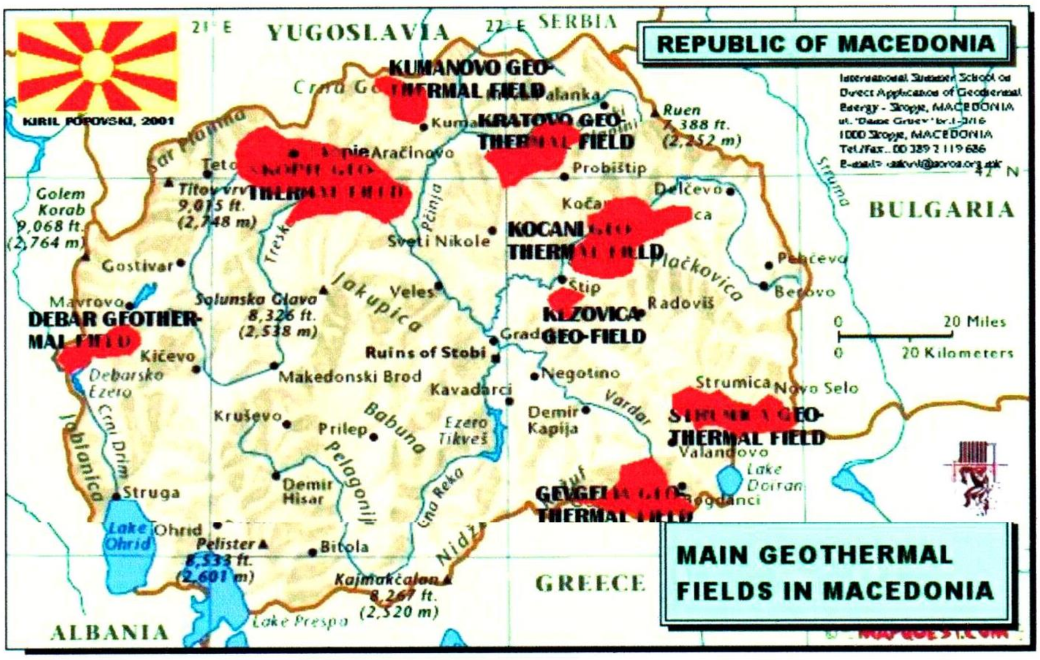

Figure 19: Main geothermal fields in Macedonia

Source: Popovski K., Micevski E., Popovska-Vasilevska S., 2005. Macedonia – Country Update 2004, Proceedings, World Geothermal Congress, Antalya, Turkey

Hydro geothermal system Kocani valley

The main characteristics of the Kocani valley geothermal system are the presence of two geothermal fields, Podlog-Banja and Istibanja, without hydraulic connection between them. The primary reservoir consists of Precambrian gneiss and Paleozoic carbonated schists, in which by drilling, the highest measured geothermal temperature of Macedonia (79°C) was found. The Kocani geothermal system is the best explored system in Macedonia. There are more than 25 boreholes and wells with depths between 100 and 1’170 m.

The geothermal sub-system of Podlog-Banja (Figure 20) is the most important deposit of geothermal water in Macedonia, with reserves of 157x106 m^3, good chemical characteristics, and a mean temperature of 75°C. The Podlog-Banja region is situated west of Kocani. The deposit in its regional sense belongs to the zone of higher thermal flow that stretches from Turkey, across northern Greece, eastern Macedonia all the way to the Panonian basin. In a tectonic sense, the region is a complicated orogene area that belongs to two tectonic units: the Serbian-Macedonian basin and the Vardar zone, comprising the Kratovo-Zletovo volcanic area.

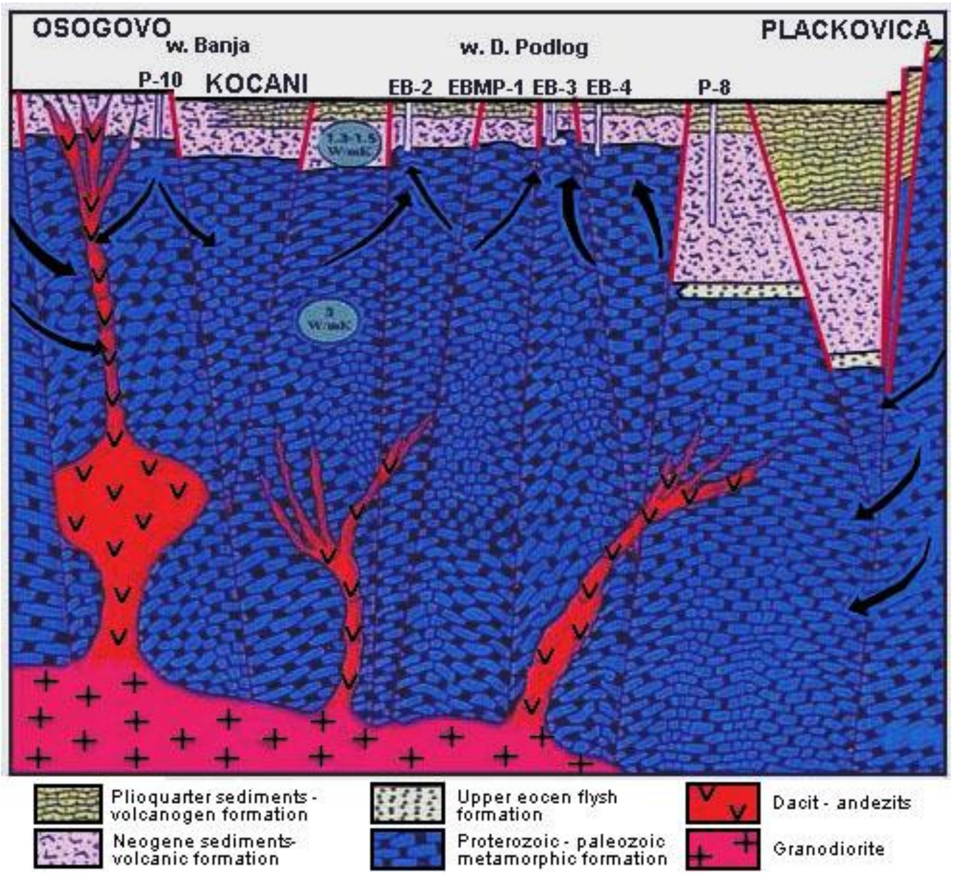

Figure 20: Geological model of the geothermal sub-system of Podlog-Banja, Kocani valley

Source: Naunov, J., 2003. Geothermal system Geoterma. Second conference for geothermal energy in Macedonia, Proceedings, Bansko

The thermal water in Banja is used for balneology purposes and is known under the name of Kocanska Banja (Bath). The thermal water in Banja was utilized in the past via an ordinary dug well. Today, there is a modern bath with accommodation rooms.

A geothermal system called "Geoterma" with an installed capacity 300 l/s exploits and distributes geothermal water to the following types of end users:

- Heating greenhouses
- Low-temperature procedures

- Central heating of public and administrative buildings
- Recreation centers and balneology

In Table 1 below, basic data is given on the exploiting wells that are being used by „Geoterma".

Exploiting well	Depth (m)	Capacity (l/s)	Temperature
EWMP-1	328	12	78
EW-2	464	100	73
EW-3	349	150	78
EW-4	502	75	80
D-1	600	50	74

Table 7: Basic data of the exploiting wells that are used by „Geoterma"

There is also a well for reinjection with a depth of 434 m and a capacity of of 50 l/s.

The geothermal sub-system of Istibanja-Vinica (Figure 21), with its thermo-mineral springs is set in the surroundings of the village Istibanja (Vinica), along the river Bregalnica. From a geological point of view, the sub-system Istibanja-Vinica lies in the contact zone between two tectonic units (the Serbian-Macedonian massif on the East and the Vardar zone on the West) at the eastern periphery of the Kocani valley, very close to Istibanja and Vinica. The micro location of the exploitation wells I-3, I-4 and I-5 is between the regional motorway Kocani-Istibanja-Delchevo and the river Bregalnica, drilled in the river terrace along the river bed. The geothermal water from these wells is used for the heating of greenhouses.

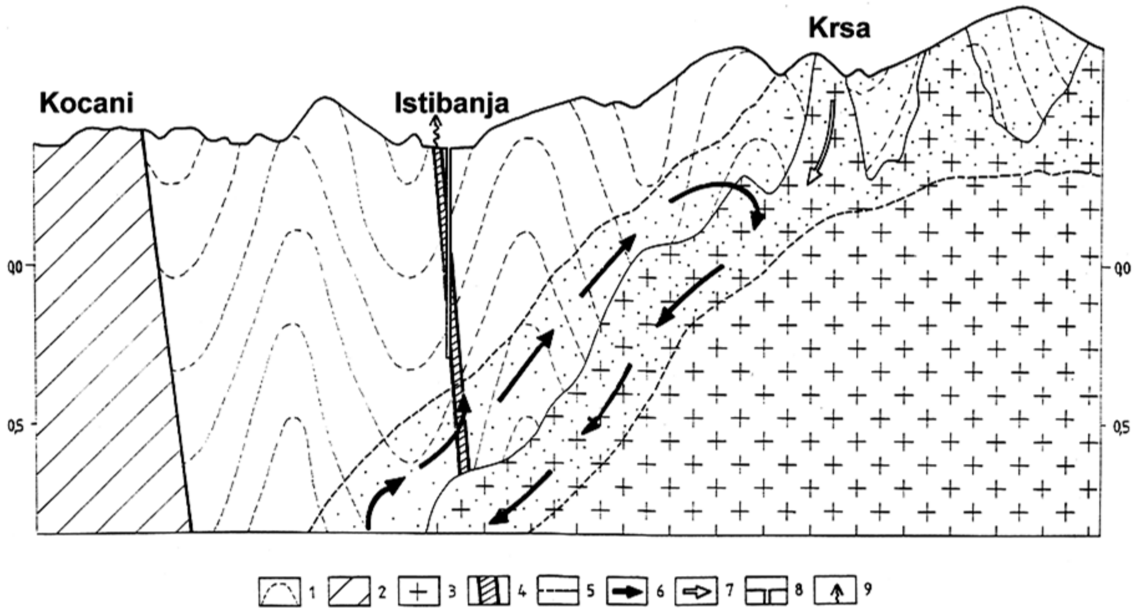

Figure 21: Model of the geo-thermal field Istibanja – Vinica

Source: Micevski Eftim (2006), Geothermal potential in southeast Macedonia a creating conditions for exploitation of geothermal resources in Bregalnica-Strumica-Gevgelia region

Hydro geothermal system Kezhovica-Ldzhi - Stip

The hydro geothermal system Kezhovica-Ldzhi - Stip is located 2 km to the southwest from the center of Stip, on the exit towards Novo Selo. The system Kezhovica - Ldzhi is near to the Kezhovica spa in Novo Selo / Stip. All these sources of thermal mineral water are located within a distance of 300 m and they lie on the same fissure (fault zone). The reservoir of this hydro-geothermal system Kezhovica - Ldzhi is set in Jurassic granites where big parts of these granites are covered with tertiary sediments of Ovchepole and Lakavica basin (Figure 22).

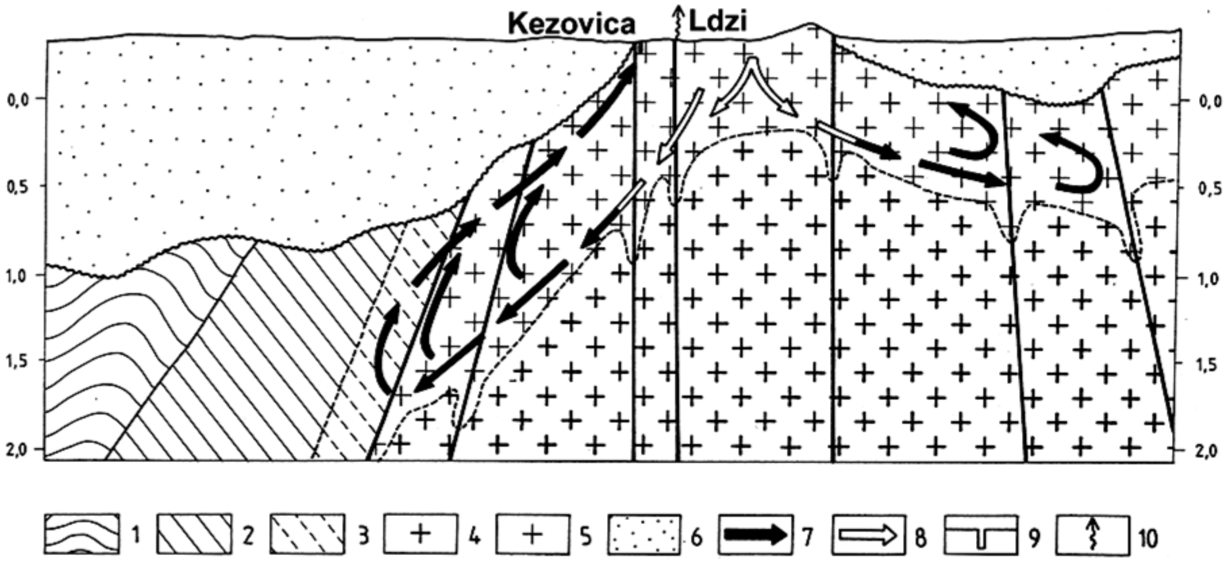

Figure 22: Model of the Kezhovica - Ldzi geothermal system

Source: Micevski Eftim (2006), Geothermal potential in southeast Macedonia a creating conditions for exploitation of geothermal resources in Bregalnica-Strumica-Gevgelia region

In Ldzhi, there are other thermo-mineral waters in the form of springs. Their maximum capacity is around 0.03 to 1.0 l/s. All these springs are of the same origin and are hydraulically connected, their temperature varying from 28 to 59°C. The capacity and the temperature of the springs in Ldzhi depend on the water level in the river Bregalnica. With raising water levels in the river Bregalnica, the capacity and the temperature of the springs are also rising, due to infiltration from the river into the underground.

In Kezhovica, there is a modern spa center (Kezhovica spa) which uses water from shallow wells with a capacity of 4.5 l/s and a water temperature of 57 to 63°C. Kezhovica as a spa is known since the Ottoman's Empire in Macedonia, when it was renowned for its healing thermal water. According to its radioactivity, it ranks among the most radioactive thermal waters in Macedonia and the Balkans (Figure 23).

There are also 5 drilled wells with a maximum capacity of 20.7 l/s in the hydro geothermal system Kezhovica-Ldzhi – Stip.

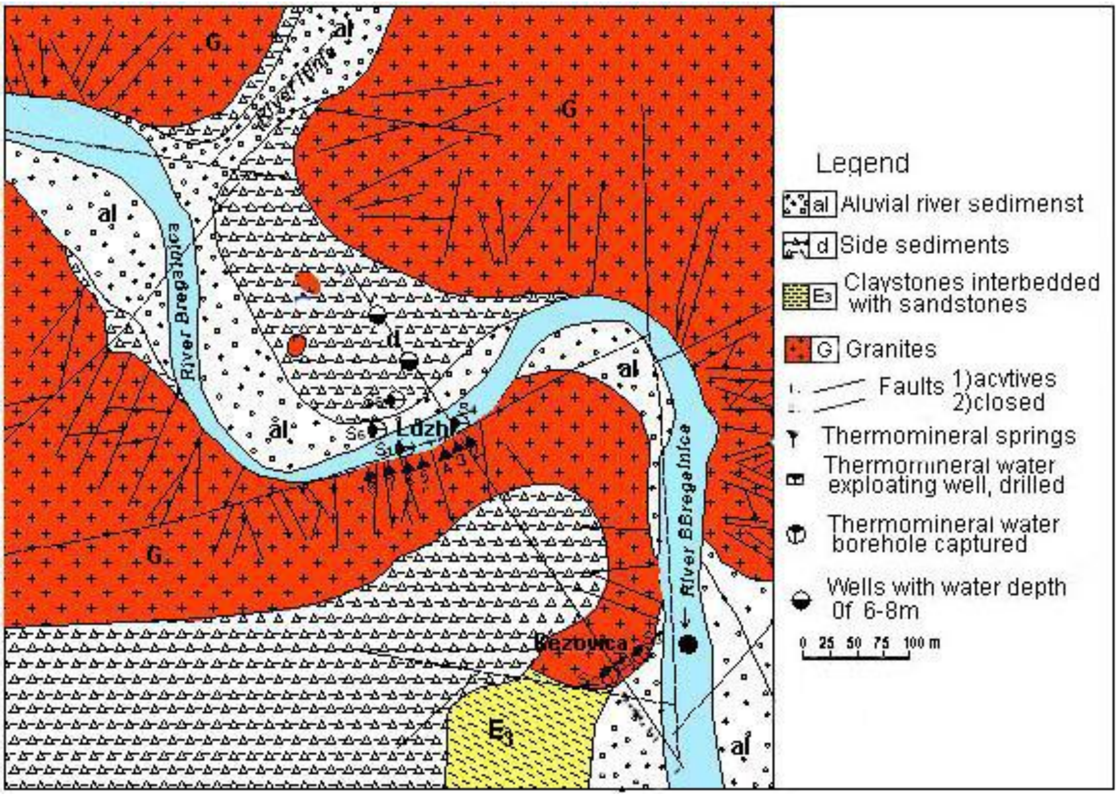

Figure 23: Geological map of the hydro geothermal system of Kezovica Spa

Source: Micevski Eftim (2006), Geothermal potential in southeast Macedonia a creating conditions for exploitation of geothermal resources in Bregalnica-Strumica-Gevgelia region

3.5 Overview on Pollution

3.5.1 Point Sources of Pollution

The main point sources of pollution in the Bregalnica river basin come from wastewater discharges, both from industries and households. Some of the industries have wastewater treatment plants. However, most of the urban wastewaters are released untreated.

Even though there are seven urban wastewater treatment plants in the whole river basin, only one of them is operational. Therefore, the majority of the population in the river basin is not connected to any wastewater treatment.

The pressure from this kind of point-source pollution is identifiable in the wastewater content, namely organic matter, nitrogen and phosphorus, hazardous substances, bacteria and viruses. Most of the urban wastewater discharges occur into small streams with low flow and consequently, low capacity for self-cleansing.

There are several mid-size industrial enterprises performing different activities: pig and poultry farming, food processing, metal processing and finishing, production and finishing of textiles, construction and wood industries, production of ceramics and production of chemicals. A minor point-source pressure is fish farming.

From these industrial activities, metal processing and leather and textile industries are major sources of pollutants. The wastewater from these sources is typically alkaline and contains heavy metals (chromium, cadmium, zinc, etc.), halogenated organics, pesticides, aromatic poly-hydrocarbons and phenols. Processes generating these pollutants in the wastewater typically involve bleaching, washing, laminating and scouring.

In addition, it is worth mentioning that several mines exist with direct wastewater discharges to water courses. These wastewaters tend to contain heavy metals such as lead, aluminum, manganese, cadmium, nickel, copper, chromium and iron.

3.5.2 Diffuse Pollution

The pressures associated with diffuse pollution are important throughout the basin due to the high density of both agricultural lands and livestock farming occurring in certain areas in the basin. Livestock farming includes pig farms and poultry, with the dung spread directly to the land. The contribution of elements in the dung in the form of nitrogen and phosphorous, together with surplus agricultural fertilization, define a significant diffuse pressure on Bregalnica river basin waters. Proof of this are 25 surface water bodies (rivers) identified as affected by the contribution of phosphorous pollution from livestock and agricultural sources.

The risk of eutrophication in reservoirs is due to high concentrations of phosphorus, stemming from both point sources of pollution (discharges of untreated urban wastewater) and diffuse sources (fertilizers).

Another main issue concerning diffuse pollution is the existence of several mines throughout the basin. Although some of them have direct discharges in water courses, the metals contained in the soils extracted can also reach surface waters through runoff.

Finally, the disposal of solid wastes and wastes from agricultural activity in the river banks is another pressure that significantly contributes to the organic pollution of waters.

4 Monitoring

The following chapter gives an overview on the existing and newly implemented monitoring network for surface water, groundwater and protected areas. For more detailed information regarding monitoring please refer to Annexes A8 to A11.

4.1 Introduction

The WFD foresees three types of monitoring for different periods during RBM planning:

- **Surveillance monitoring** is implemented in the first year of RBM planning and aims at the definition of the status of the water bodies.
- **Operational monitoring** is a long-term monitoring and is used to assess any changes in the status of water bodies, which were identified as being at risk of failing to meet the environmental objectives.
- **Investigative monitoring** is employed in specific and/or exceptional cases (e.g. accidents) and aims at assessing the magnitude and the impact of accidental pollution.

In the first year of the Bregalnica RBM planning, surveillance monitoring is being applied. Surveillance monitoring was defined for all water bodies and implemented in a first step from summer 2013 to spring 2014 for the surface water bodies. For groundwater bodies, the surveillance monitoring was performed in spring/summer 2014. The later start of the groundwater monitoring was forced by the lack of data on groundwater bodies, which was considerable and required a stepwise approach to be overcome.

The operational groundwater monitoring started in June 2014. Due to lack of human resources and finances no operational surface water monitoring has been implemented so far.

Based on the results from the surveillance monitoring, two investigative groundwater monitoring campaigns were conducted in spring 2016 to asses potential sources of specific pollutants. Scope, approach and results of the investigative monitoring are presented in chapter 4.3.5.

4.2 Surface Water

The defined surveillance monitoring for surface water bodies foresees following measurement campaigns: June/July 2013 (late spring), August 2013 (summer), October 2013 (autumn) February 2014 (winter) and May 2014 (spring). The definition of the surveillance monitoring was based on the gaps between the requirements in the WFD (Annexes II and V) and the existing monitoring network. The following subchapters present in more detail the existing monitoring, its extension, the indicators measured and the time scheduling. Annex A8 shows the monitoring results of all campaigns.

4.2.1 Monitoring Network at the beginning of 2013

The following figure presents the existing monitoring network at the beginning of 2013 for surface water bodies in the Bregalnica region.

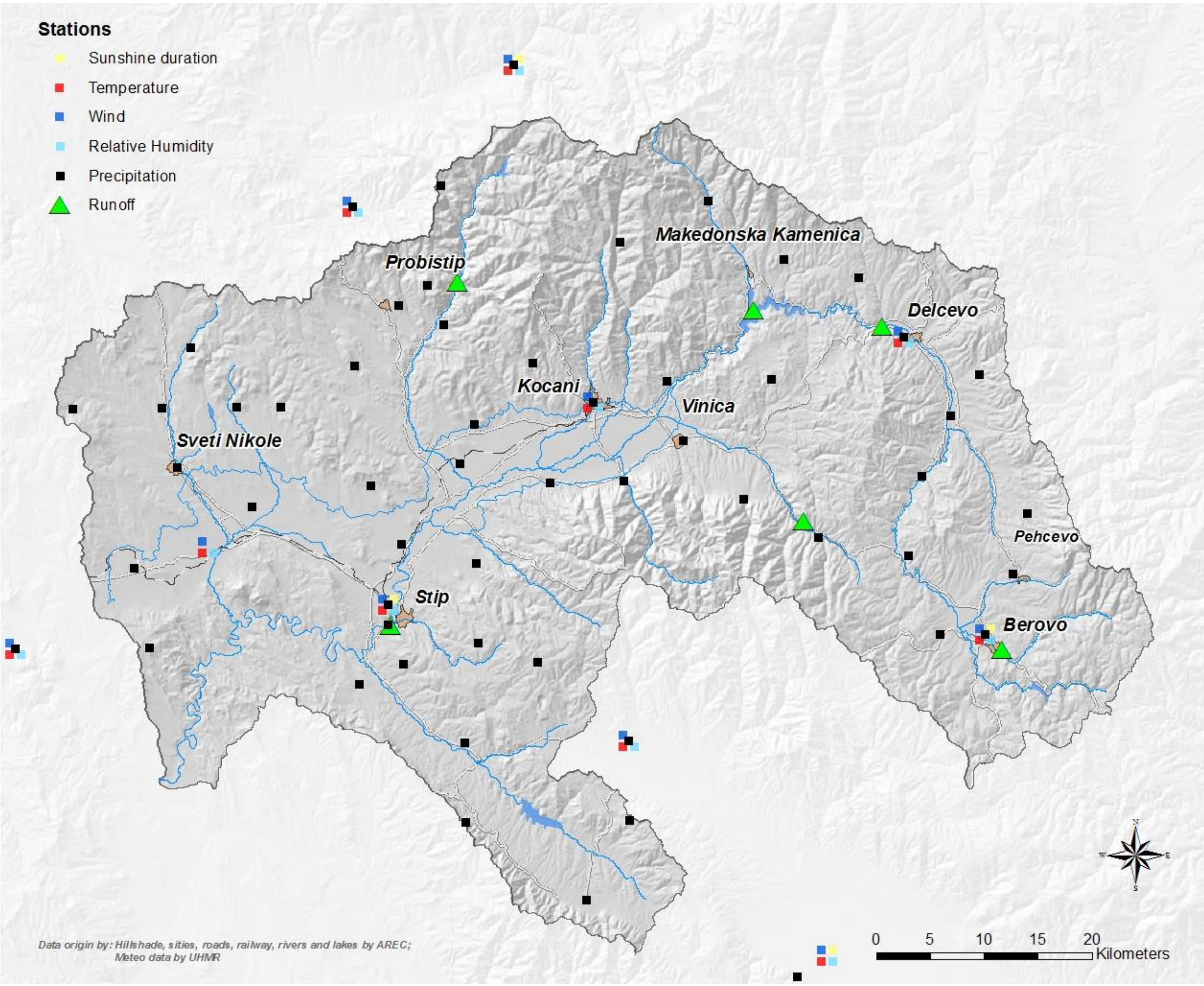

Figure 24: Map of Bregalnica river basin with surface water bodies and monitoring network at the beginning of 2013

The monitoring network at the beginning of 2013 of the Bregalnica region consisted on:

- Five meteorological stations, situated in Berovo, Delcevo, Kocani, Stip, and Lozovo. In these stations at least air temperature as well as wind speed and direction are measured, and in some of them additionally sunshine duration and relative humidity.
- Almost 50 monitoring stations for precipitation measurement
- Six runoff measurement stations in Berovo, Delcevo, Makedonska Kamenica, Laki, Probistip and Stip

These data are used for the water allocation model.

4.2.2 Extension for the Purposes of the Bregalnica RBM Plan

The following figure shows the measurement points selected for the extension of the monitoring network for surface water bodies in the Bregalnica region.

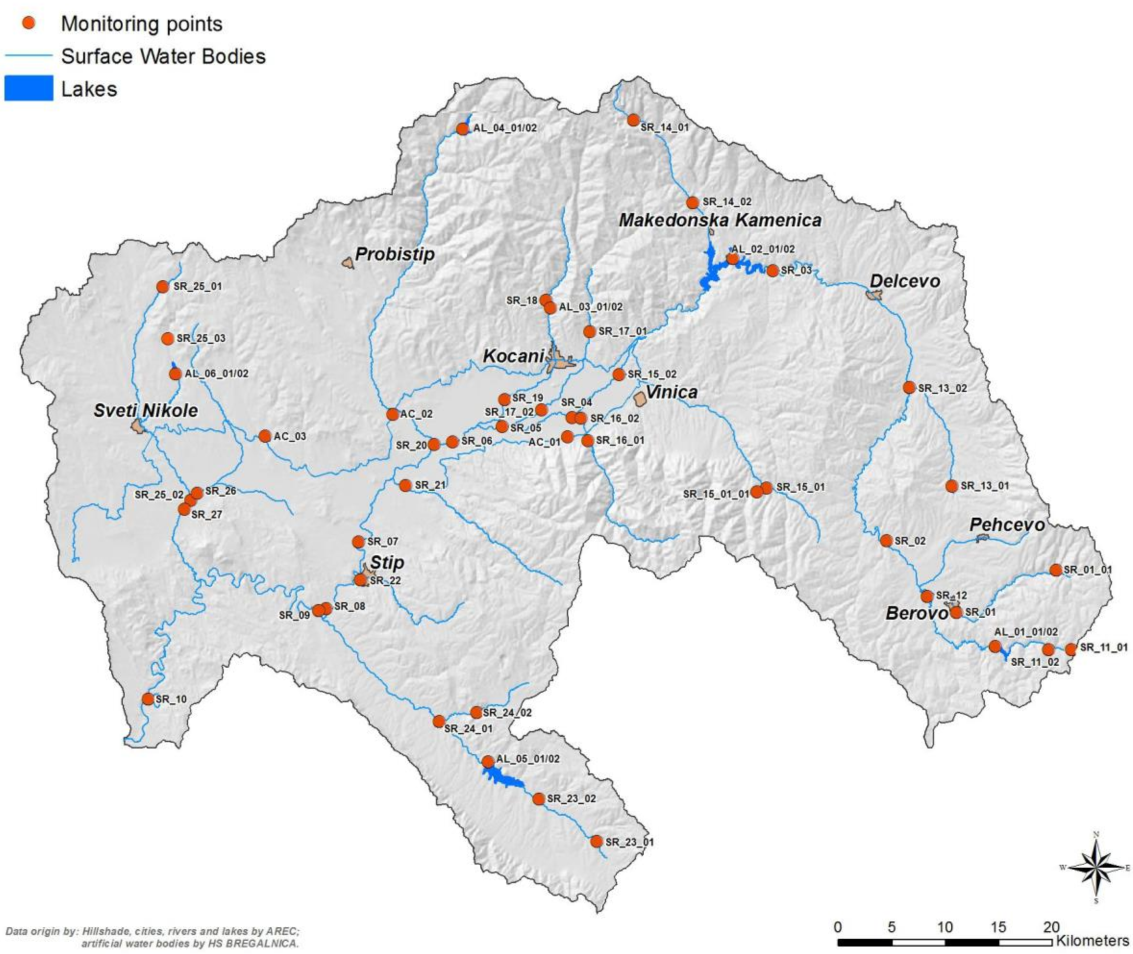

Figure 25: Map of Bregalnica river basin with the surface water bodies and the monitoring points for the extension of the monitoring network

To meet the requirements of the WFD, Art. 8 and Annex V, the monitoring network of the year 2013 was extended to collect data on priority substances, biology and chemical-physical conditions. Each water body is covered by at least one monitoring point to allow the definition of its respective status. Figure 25 shows all monitoring points used during the five campaigns; some points have been monitored once, others during all five campaigns. The selection and the position of each monitoring point were discussed and reviewed before each campaign. Further information is available in Annex A8.

For each heavily modified water body, two measurement points were selected; of which one close to the water surface and one at a specific depth (for details, see Annex A8). The two water samples were mixed and analyzed.

For each artificial water body one measurement point was selected.

Regarding river monitoring points, the following selection was implemented:

- To be able to define the reference conditions of the catchment, at least two measurement points per water body were selected by following water bodies: Bregalnica river (SR_01), Ratevska river (SR_11), Zelevica river (SR_13), Osojnica river (SR_15), Zrnovska river (SR_16), Orizarska river (SR_17), Kriva Lakavica (SR_23) and Svetinikolska river (SR_25). .
- For the water bodies Kamenica river (SR_14) and Kriva Lakavica (SR_24) two measurement points were selected: one directly after the mine and one close to the inflow in the Bregalnica.
- For all other measured rivers, one point was selected.

The following table summarizes the above written information.

Surface water body		Total measurement points
Type	**Number**	**Number**
River	27	39*
Artificial	3	3
Heavily modified	6	12
Total	36	54

*Table 8: Total number of surface water bodies and monitoring points. * Some points have been monitored once, others during all five campaigns (for details see Annex A8).*

4.2.3 Indicators and Monitoring Schedule

The surveillance monitoring for surface water bodies comprehends four groups of indicators: biological, hydro-morphological, physical-chemical and priority substances. The next table shows the measured parameters, the amount of indicators per parameter and the measurement time during the year.

Group	Parameter	Amount of indicators	Rivers				Artificial WB				HMWB			
			I	II	III	IV	I	II	III	IV	I	II	III	IV
Biological	Phytobenthos	1	x		x						x		x	
	Zoobenthos	2	x		x						x		x	

Group	Parameter	Amount of indicators	Rivers				Artificial WB				HMWB			
			I	II	III	IV	I	II	III	IV	I	II	III	IV
	Fish	1	x		x						x		x	
	Phytoplankton	4									x		x	
Hydromor-phologi-cal	Riparian vegetation	1	x		x									
	River habitat	1	x		x									
Physical-Chemical	Turbidity	1	x	x	x	x	x		x		x		x	
	Thermal condition	1	x	x	x	x	x		x		x		x	
	Salinity	1	x	x	x	x	x		x		x		x	
	Acidification	1	x	x	x	x	x		x		x		x	
	Oxygenation	3	x	x	x	x	x		x		x		x	
	Nutrient / Nitrogen	6	x	x	x	x	x		x		x		x	
Priority sub-stances	Metals, metalloids	14	x		x	x	x		x		x		x	
	Pesticides	3	x		x		x		x		x		x	
	Persistent hydro-carbons	2	x		x		x		x		x		x	
	Polyphenols	2	x		x		x		x		x		x	

Table 9: *Overview of the surveillance monitoring: group, elements, number of indicators and scheduling. Legend: WB = Water body, x = Measurement, I = Campaign of June/July 2013, II = Campaign of August 2013, III = Campaign of October 2013, IV = Campaign of February 2014. The campaign of May 2014 has a special plan, which cannot be shown in this table, for more information refer to Annex A8.*

4.2.4 Results

The monitoring results presented in this report are based on five monitoring campaigns (June/July, August, October 2013, February 2014 and May 2014). According to the monitoring campaigns from June 2013 to May 2014 the following observations can be made:

- In the whole catchment phosphorous (P_{tot} and PO_4) is present in high concentrations. The high concentration is most likely the result of human activities (household and industrial wastewater, erosion and run-off from crop production, livestock breeding), but could also be partially natural (erosion and run-off from pastures and forests).
- Nitrite ($N\text{-}NO_2$) is present in high concentrations in several rivers: almost the whole Bregalnica river (SR_02 until SR_10), Kamenica river (SR_14), Osijnica river (SR_15), Kocanska river (SR_19)and Svetinikolska river (SR_27). The high nitrite concentrations could stem from similar sources as phosphorus, i.e. human activities (household and industrial wastewater, erosion and run-off from crop production, livestock breeding), but could also be partially natural (erosion and run-off from pastures and forests). Additionally nitrites are indicators for

current fecal pollution, especially in the downstream part of the rivers, because of missing waste water treatment.

- The Fluvial Habitat Index (IHF) is almost for all rivers moderate or lower. The indicator assesses the capacity of the physical habitat to shelter different populations of fauna. For most measurement points, the IHF indicator is correlated to the IBWMP indicator, which assesses the abundance of macroinvertebrate families, which are more tolerant with respect to pollution. By evaluating the IHF and IBWMP indicators together one can conclude that the low diversity of habitats and the pollution in most water bodies have an adverse effect on the diversity of the marcoinvertebrates and the fauna. That indicates a high human impact (e.g. by the use of chemicals). Additionally, a bacteriological pollution was measured in some rivers, indicating a eutrophic or hyper-eutrophic stage, which is due to continued pressures over a long period of time.
- The index of riparian quality (QBR) shows the quality of the riparian vegetation. The index is based on four components of the riparian habitats: overall cover of the riparian vegetation, structure and quality of the cover, and possible changes of the channel's structure. It also considers the differences in the river's geomorphology. Interesting for this index is that the first and the last monitoring point of Bregalnica river (SR_01 and SR_10) present a good status, but it changes from good to bad from the two extremity points of the river to the middle (SR_06). These changes are caused by agriculture activities and human population that are concentrated in the middle part of the Bregalnica catchment area. All the heavily modified water bodies (i.e. the reservoirs) have a bad biological condition, which is due to an advanced eutrophication of the water bodies and is indicated by the presence of macroinvertebrate families which are tolerant to pollution.
- The algae in the heavily modified water bodies (i.e. the reservoirs) show a bad biological condition in six reservoirs of the Bregalnica River catchment. This confirms the previous findings that almost all analyzed ecosystems are under severe human pressure; the only reservoir which is found in an initial stage of eutrophication only is Knezevo. Ratevska Reka, Kalimanci, Gradce and Mantovo were found to oscillate between eutrophy and hyper-trophy depending on time of sampling, season and the total capacity of the specific ecosystem. The reasons for this pollution can be the use of chemicals in industry and in agriculture, the soil erosion and/or the inflow of untreated wastewater.
- Low concentrations of the priority substances were noticed, with five exceptions:
  - High concentrations of zinc (Zn) were detected in two heavily modified water bodies (the reservoirs, AL_01 and AL_04), in Kamenica river (SR_14) and Kriva Lakavica river (SR_24). The high concentration of zinc in rivers could be related to the mines and industries upstream of the measurement point, which also influence the concentration in Kalimanci Lake (AL_2).

- High concentrations of manganese (Mn) were measured in Kamenica river (SR_14) and Osojnica river (SR_15).
- A high concentration of copper (Cu) was detected in Kriva Lakavica river (SR_24), which is most likely caused by the nearby mine for copper.
- High concentrations of lead (Pb) were measured in several Bregalnica river stretches (SR_04 and SR_08 until SR_10), Zelevica river (SR_13), and Kocanska river (SR_18 and SR_19). This high concentration of lead in several Bregalnica river stretches and Kocanska river could be related to pollution by the industry. However, in the case of Zelevica river it is known that lead is naturally present in the subsurface of this area in high concentrations.
- High concentrations of phthalates were measured in all heavily modified water bodies, and in almost the entire Bregalnica river basin. Only the upstream part of Bregalnica and its tributaries are not impacted by phthalates, which are used as plasticizers in various plastic materials. It is most likely that these high concentrations of phthalates are the result of human activities and the disposal of plastic waste into the rivers respectively.

4.3 Groundwater

Few data regarding the groundwater in the Bregalnica region are available. Sources of those data are the National Hydrometeorological Service (HYDMET) and the public water utilities of several municipalities. The available data allows the delineation and characterization of the groundwater bodies, but no interpretations about the groundwater quality can be done.

4.3.1 Existing Monitoring Network

Figure 26 shows the monitoring network of the groundwater in the Bregalnica region.

Starting from approximately 1950 until about 1990, the Bregalnica region featured a comprehensive and operational monitoring network for groundwater. Almost 80 wells and piezometers were monitored and delivered data about groundwater quantity and thickness, but no data on water quality. In the last 20 years, the groundwater monitoring network gradually deteriorated. Today, it is obsolete and out of operation. From the previous 80 operational monitoring points only approximately 25 still exist but are either unusable or need maintenance to become operational again; no new monitoring points were installed. Consequently, no measurements on groundwater are available presently.

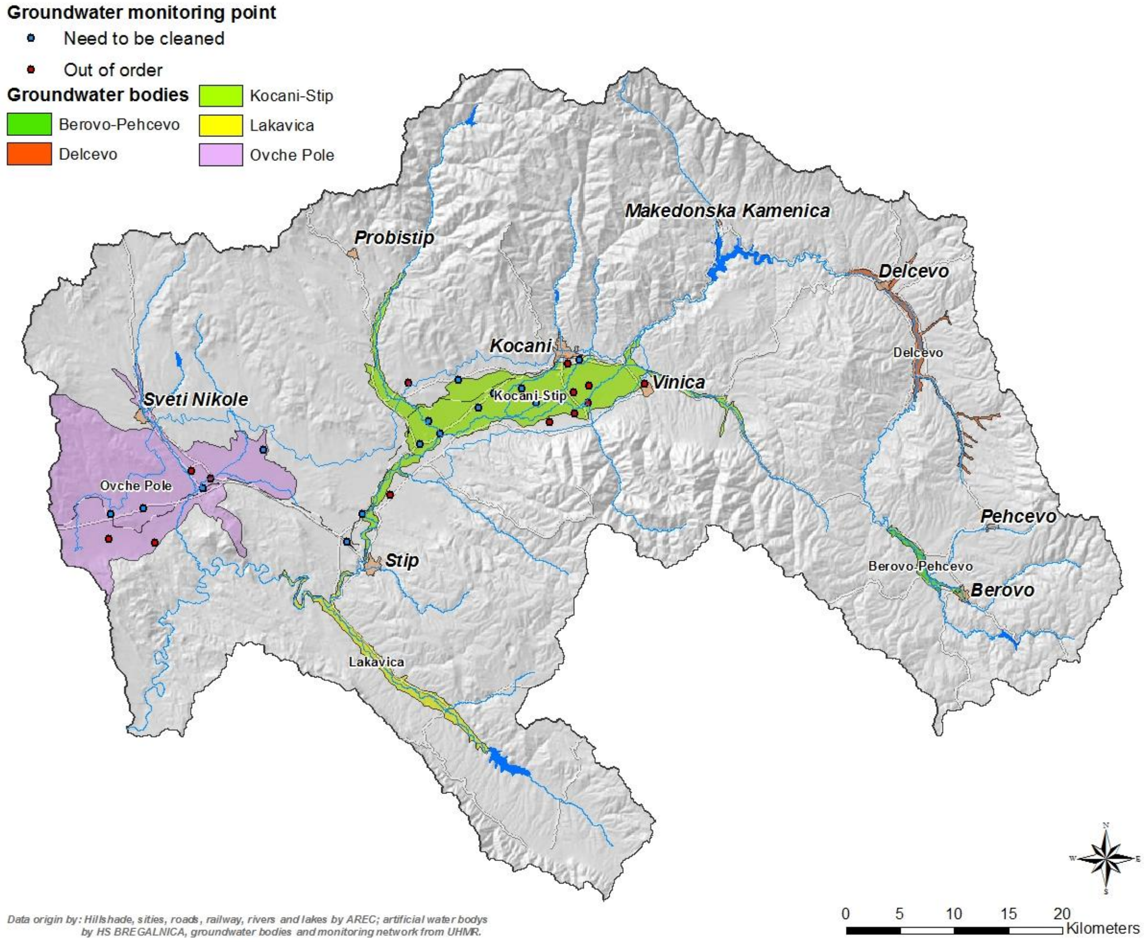

Figure 26: Map of the Bregalnica river basin with the groundwater bodies and their monitoring network

4.3.2 Extension for the Purposes of the Bregalnica RBM Plan

Based on the results from the four first monitoring campaigns on surface water bodies and on the available information about the groundwater bodies, the groundwater monitoring scheme was designed in early 2014.

To allow for a representative and time and cost efficient monitoring of the groundwater bodies in the Bregalnica river basin the following amount of monitoring points for the surveillance and operational monitoring were specified:

GWB	Name	Amount of Monitoring Points	
		Surveillance Monitoring	Operational Monitoring*
01	Berovo Pehcevo	3	4
02	Delcevo	3	6
03	Stip Kocani	5	9
04	Ovce Pole	4	7
05	Lakavica	3	7
	Total:	**18**	**33****

*Table 10: Overview on the amount of monitoring points for the surveillance and operational monitoring for each groundwater body. *The operational monitoring comprehends all monitoring points of the surveillance monitoring. **By May 2016, only 31 monitoring points are in operation (AMP_13 and DMP_17 are not in operation anymore)*

Figure 27 shows the location of the monitoring points for the surveillance monitoring of the groundwater bodies (for details, see annex A10).

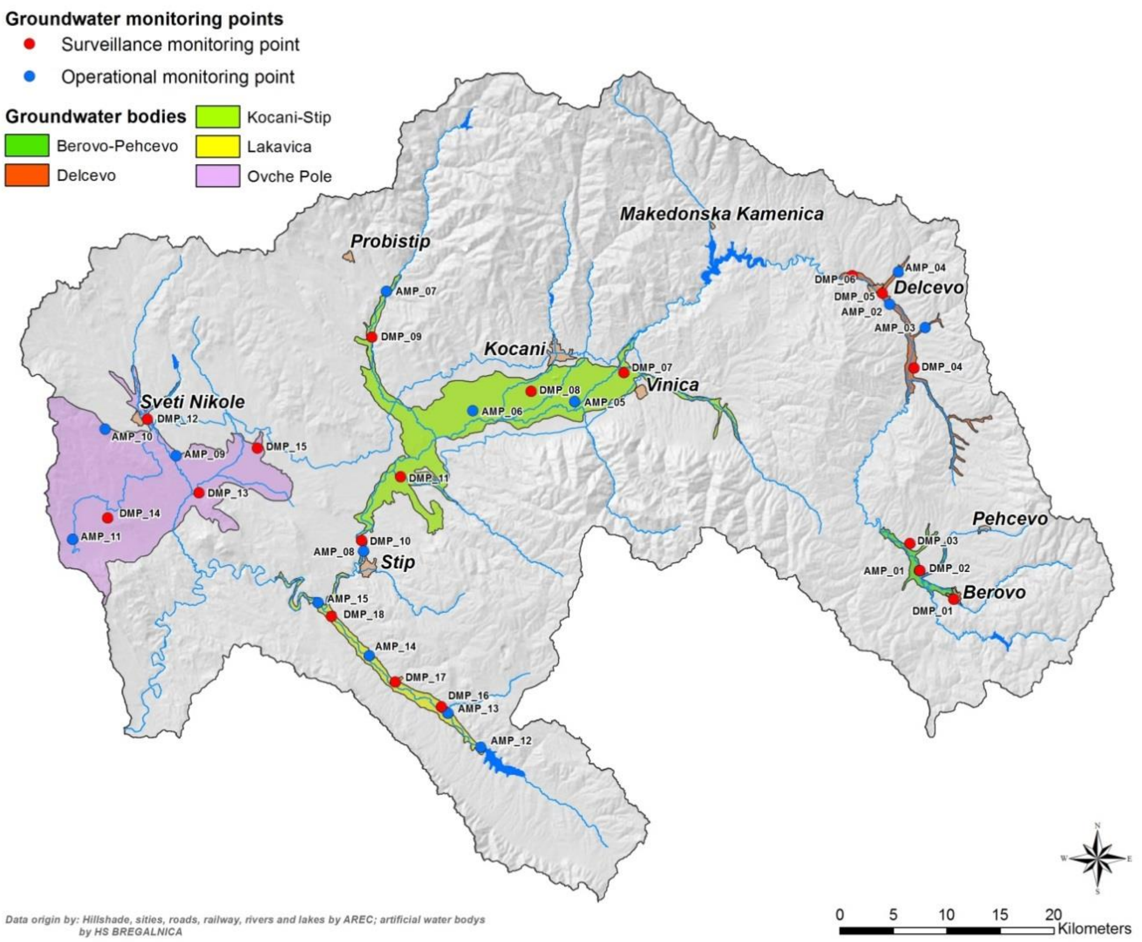

Figure 27: Map of Bregalnica river basin with the groundwater bodies and the monitoring points for the extension of the groundwater monitoring network

4.3.3 Indicators and Monitoring Schedule

In case of a surveillance monitoring on groundwater, three groups of indicators should be measured: quantity, physical-chemical and priority substances. Table 11 shows the measured parameters, the indicators per parameter and the suggested measurement time during the year.

The groundwater monitoring is divided into a surveillance monitoring, which is implemented half-yearly for about thirty indicators and an operational monitoring, which is implemented monthly for about five indicators.

The surveillance monitoring was implemented with two campaigns within one year (spring and autumn 2014).

The operational monitoring is conducted monthly by the National Officers.

The measured indicators of the surveillance and the operational monitoring are shown in Table 11.

Group	**Element / *Indicators***	**Amount of Indicators**	**Surveillance Monitoring**		**Operational Monitoring**
			I	**II**	**I-XII**
Water Quantity	Groundwater level	1	x	x	x
Physical-Chemical	Thermal condition: *temperature*	1	x	x	x
	Salinity: *conductivity*	1	x	x	x
	Acidification: *pH*	1	x	x	x
	Oxygenation: *dissolved oxygen, dissolved CO2, redox potential*	3	x	x	x
	Nutrient / Nitrogen: $N\text{-}NO_3$, $N\text{-}NO_2$, $N\text{-}NH_4$, P_{tot}, PO_4^-	5	x	x	-
	Majority cations: *Ca, Mg, Na, K*	4	x	x	-
	Majority anions: *Cl*, SO_4, CO_3	3	x	x	-
Priority Substances	Metals, metalloids: *Ag, Al, As, Ba, Cd, Co, Cr, Pb, Hg, Ni, Zn, Cu, Mn, Fe, V*	15	-	x	-
	Pesticides: *Malathion, Lindan (gama HCH), HCH (alfa+beta+delta), Aldrin, Dieldrin, HCB, 2,4' DDE, 4,4' DDE, 2,4' DDD, 4,4' DDD, 2,4' DDT, 4,4' DDT, Endosulfan sulfate, Endrin, Endrin ketone, alfa Endosulfan, beta Endosulfan*	17	-	x	-
	Polyaromatic hydrocarbons (PAH): *Acenaph-thene, Acenaphthylene, Anthracene, Benz[a]anthracene, Benzo[b]fluoranthene, Benzo (k) fluoranthene, Benzo [ghi] perylene, Indeno(1,2,3-cd)pyrene, Ben-zo[a]pyrene, Chrysene, Dibenz[a,h]anthracene, Fluoranthene, Fluo-rene, Naphthalene, Phenanthrene, Pyrene*	16	-	x	-
	Phtalates: *Benzylbutylphthalate (BBzP), Di-ethyl phthalate (DEP), Dimethyl phthalate,*	5	-	x	-

Group	Element / *Indicators*	Amount of Indicators	Surveillance Monitoring		Operational Monitoring
			I	II	I-XII
	Bis (2-ethylhexyl) phthalate, Di(n-octyl) phthalate				
	Polychlorinated biphenyls (PCB): *PCB 28, PCB 52, PCB 101, PCB 105, PCB 118, PCB 138, PCB 153, PCB 156, PCB 180,PCB 209*	10	-	x	-

Table 11: Overview of the surveillance and operational monitoring: group, elements, indicators and scheduling. Legend: x = Measurement, I = Campaign of June 2014, II = Campaign of September 2015, I-XII= once a month

4.3.4 Results

The monitoring results presented in this report are based on the surveillance monitoring which included two campaigns (June 2014 and September 2014) as well as on the operational monitoring campaign which is continuous and includes monthly measurements from June 2014 to April 2016. The main findings are summarized below:

- Similar to the results of the surface water monitoring, high concentrations of phosphorus (P_{tot}) were detected in almost all ground water bodies. Even though the background concentrations are not known, the presence of phosphorus indicates the strong human pressure stemming mainly from the application of fertilizers in the agriculture and the wastewater being discharged to the surface waters without treatment and infiltrating into the groundwater.
- Low level of dissolved oxygen is detected in several monitoring points (e.g. DMP_03; DMP_08; DMP_13; DMP_15; DMP_18). The low concentration of oxygen found in the groundwater is related to the infiltration of surface water into the groundwater, to microbiological degradation of organic substances and to the oxidation of metals such as manganese which was found in DMP_08 for example.
- A high nitrate concentration was detected in DMP_01, DMP_03, DMP_14 and DMP_15. Most likely it stems from agricultural activities and fertilizers respectively as it is the case in DMP_01, where in addition increased concentrations of K ions and PO_4^{3-} were found.
- High concentrations of NH_4 were detected in the Lakavica groundwater body (DMP_16; DMP_17; DMP_18), which may be related to the blasting activities at the mining sites. Ammonium nitrate fuel oil (ANFO) is a widely used explosive and is readily soluble in water.
- Magnesium was detected in high concentrations in the groundwater bodies Ovce Pole and Lakavica (DMP_12; DMP_13; DMP_15; DMP_16; DMP_18). In prehistoric times this region was a seascape, which may cause an increased background concentration of magnesium. However, in the case of the Lakavica groundwater body it may be related to blasting activities again, as magnesium sulphate is a commonly used explosive. This assumption is sup-

ported by the high sulphate (SO_4^{2-}) concentrations found in the Lakavica groundwater body (DMP_16 and DMP_18). The high concentrations of magnesium and sulphate in the Ovce Pole groundwater body are more likely of natural origin, as there is no mining area nearby.

- Manganese (Mn) is detected in several monitoring points (DMP_02; DMP_03; DMP_08; DMP_10; DMP_18). The reason for this is unkown. Both natural sources and pollution due to human activities are possible. Low oxygen conditions or acid mine drainage favor the dissolution of manganese. In the case of DMP_08 and DMP_10 it is assumed that the manganese is of geogenic origin. However, manganese does not pose a threat to human health, but impairs the taste when used as drinking water.
- Nitrogen pesticides are detected in half of the monitoring points. They are widely spread in the whole river basin and in all groundwater bodies respectively. Their presence is related to agricultural activities.
- Polycyclic aromatic hydrocarbons (PAHs) are organic compounds that contain only carbon and hydrogen. They are composed of multiple aromatic rings. Naturally they are part of fossil fuels (oil and coal). In the environment PAH can be generated by burning fossil fuels with sufficient oxygen. However, this does not explain the indications that PAHs are present in the Bregalnica groundwater bodies. The source of PAH is only known for DMP_12, which is located close to a bitumen factory.
- As expected, groundwater levels of most of the monitoring points show a seasonal fluctuation having a lower level during summer months than during winter time. The upper part of Lakavica GWB (DMP_16 / DMP_17 / DMP 18) is very responsive to rainfall events as the monitoring points show quite highly fluctuating water levels. Some monitoring points were even flooded in winter months. Compared to the other monitoring points, DMP_13 shows a different seasonal pattern which might be heavily influenced by its operational schedule for cooling processes of the bitumen factory. From the 2-year operational monitoring, there is no indication of a longterm decreasing of the groundwater quantity.

4.3.5 Investigative Monitoring

Two investigative monitoring campaigns were implemented in February and April 2016, to further investigate the presence of PAH in the groundwater bodies in the Bregalnica catchment. As leachate of landfills might contribute substantially to the PAH flux into groundwater bodies, 16 out of 33 operational monitoring points close to landfills were selected. Focusing on the influence of waste disposal, the monitoring program was extended by ammonium (first campaign) and pesticides (second campaign).

GWB	Name	Investigative Monitoring Points
01	Berovo Pehcevo	2
02	Delcevo	4
03	Stip Kocani	6
04	Ovce Pole	1
05	Lakavica	3
	Total:	**16**

Table 12: Overview on monitoring points for the investigative monitoring for each groundwater body

Figure 28 shows the location of the monitoring points for the investigative monitoring of the groundwater bodies.

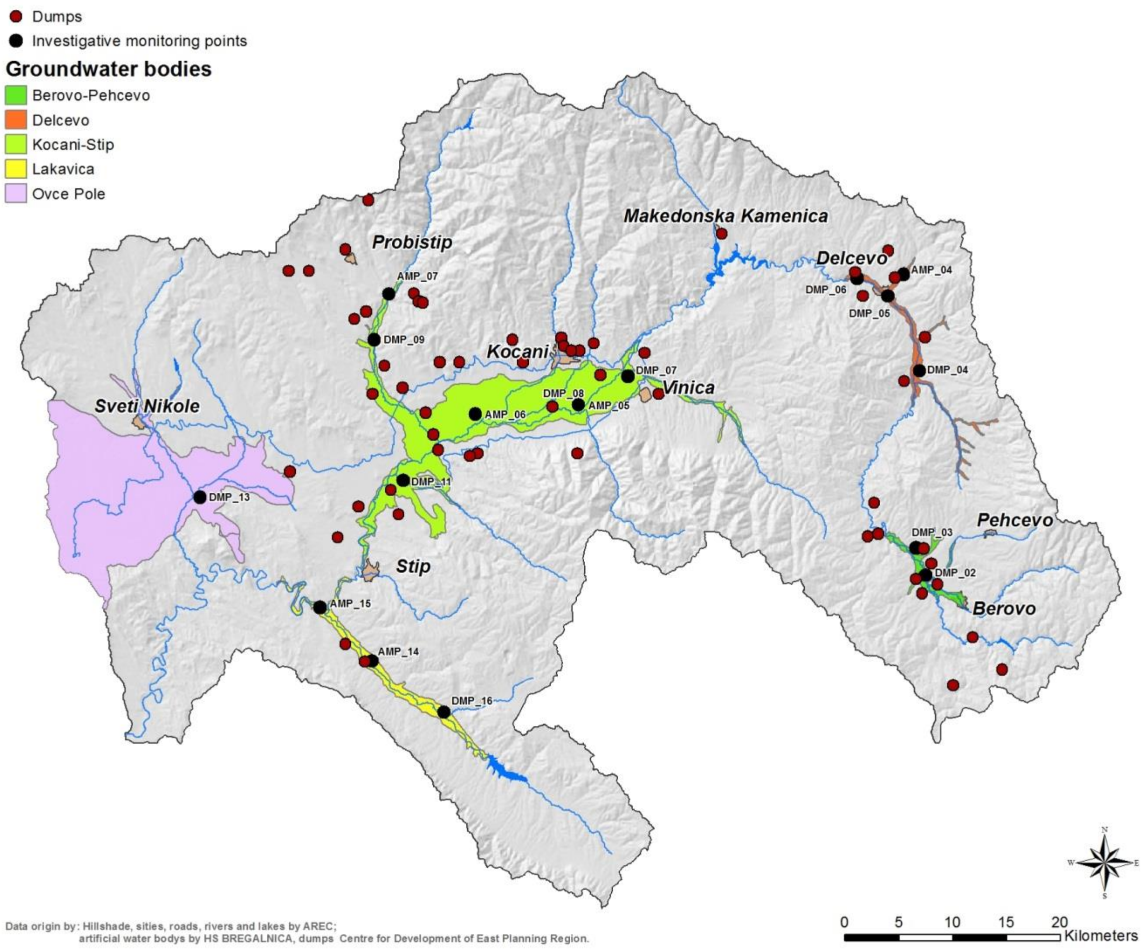

Figure 28: Map of Bregalnica river basin with the groundwater bodies, the monitoring points for the investigative monitoring and the dumps according to the "Regional Waste Management Plan for East and North-East regions"

Both campaigns were conducted by specialized institutes and coordinated by the National Officers.

The main findings are summarized below:

- The threshold limits for PAH in groundwater require a high technical standard regarding the analytical equipment. The required detection limits should ideally be one order of magnitude lower than the legal limits and could thus not be met for all substances during the first campaign. Moreover, analyses in the concentration range below 0.1 µg /l are accompagnied with a rather high uncertainty.
- In the first monitoring campaign, at least four out of 15 monitoring points showed elevated concentrations of PAH. The analysis of 16 monitoring points in the second campaign revealed only one exceedance of the legal limits. This indicates that PAH is not widely spread in the catchment but rather elevated only in certain areas due to local inputs.
- Analysis of groundwater from one monitoring point (DMP-02) resulted in a poor status regarding ammonia. Sources might be leaking waste water or pig farms nearby.

4.4 Protected Areas

At the moment there are no legally proclaimed nature protected areas in the Bregalnica catchment. Consequently no specific monitoring was established.

5 Status

5.1 Surface Water Bodies

According to the results from the monitoring campaigns from June 2013 to May 2014, all surface water bodies in the Bregalnica river basin present an ecological status or ecological potential below the category “good”. For rivers, this status is mostly due to very high values for phosphates. For reservoirs, the ecological potential is conditioned by the bad results of the biological analyses.

Therefore, although some of the water bodies present a good chemical status, the final water status of all of them falls into the category “failing to achieve good”. These results are shown in the following map and table.

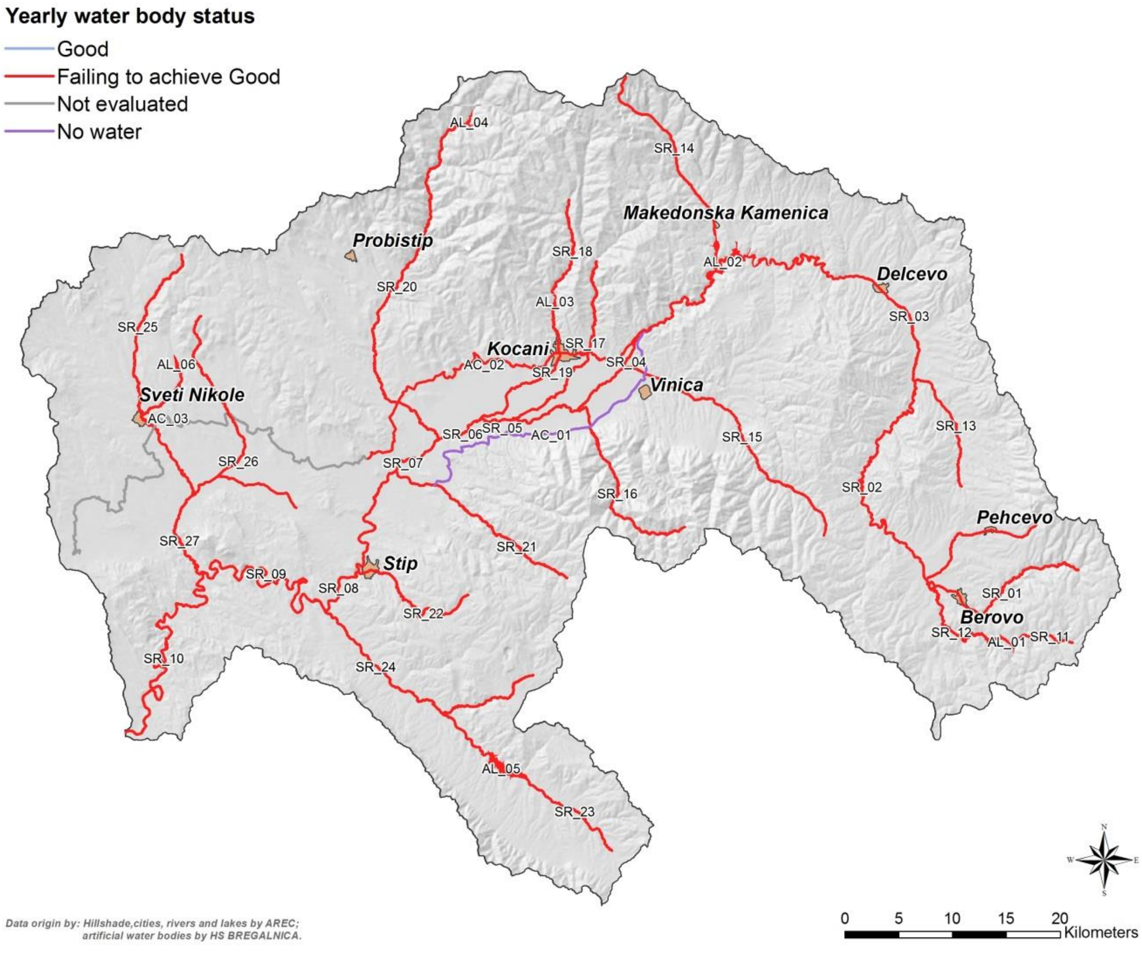

Figure 29: Bregalnica river basin with the surface water status, aggregated value from the monitoring campaigns from June 2013 to May 2014

Category	Status	Number	%	km or km²	%
Rivers	Good and above	0	0	0	0
	Failing to achieve good	27	100	606	100
	Not evaluated	0	0	0	0
	Total	27	100	606	100
Heavily modified water bodies	Good and above	0	0	0	0
	Failing to achieve good	6	100	9	100
	Not evaluated	0	0	0	0
	Total	6	100	9	100
Artificial water bodies	Good and above	0	0	0	0
	Failing to achieve good	2	67	75	57
	Not evaluated	1	33	57	43
	Total	3	100	132	100

Table 13: Summary of surface water bodies status, aggregated value from the monitoring campaigns from June 2013 to May 2014. Length is expressed in km for rivers and artificial water bodies and in km² for lakes

Annex A12 shows the detailed results of the monitoring campaigns and the methodology employed for the assessment of the water bodies status.

5.2 Groundwater Bodies

The existing groundwater monitoring network in the Bregalnica region is in a very poor condition. Available information only includes quantitative data, but no information on groundwater quality. Therefore, an extension of the groundwater monitoring was implemented. The results of the extended monitoring allow the definition of the status of groundwater bodies in the basin.

From the results of the groundwater monitoring it can be seen that just one groundwater body has a good chemical status, namely the Delcevo groundwater body. The other four groundwater bodies have a poor chemical status. The main reasons for this assessment are the presence of pesticides and phosphorus. All five groundwater bodies have good quantitative status.

On the following maps the chemical and quantitative statuses are presented for every groundwater body.

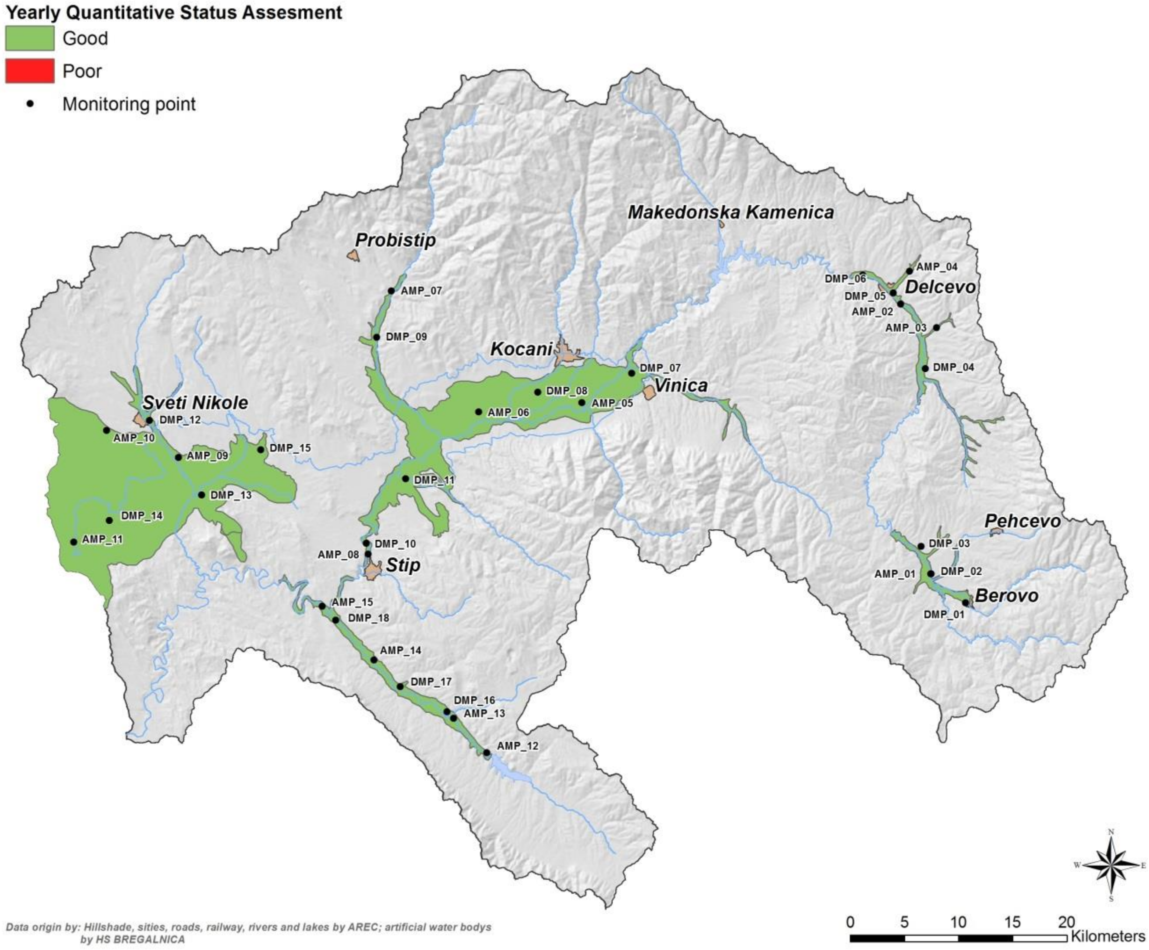

Figure 30: Bregalnica river basin with the quantitative groundwater body status, aggregated value from the monitoring campaigns from spring and autumn 2014

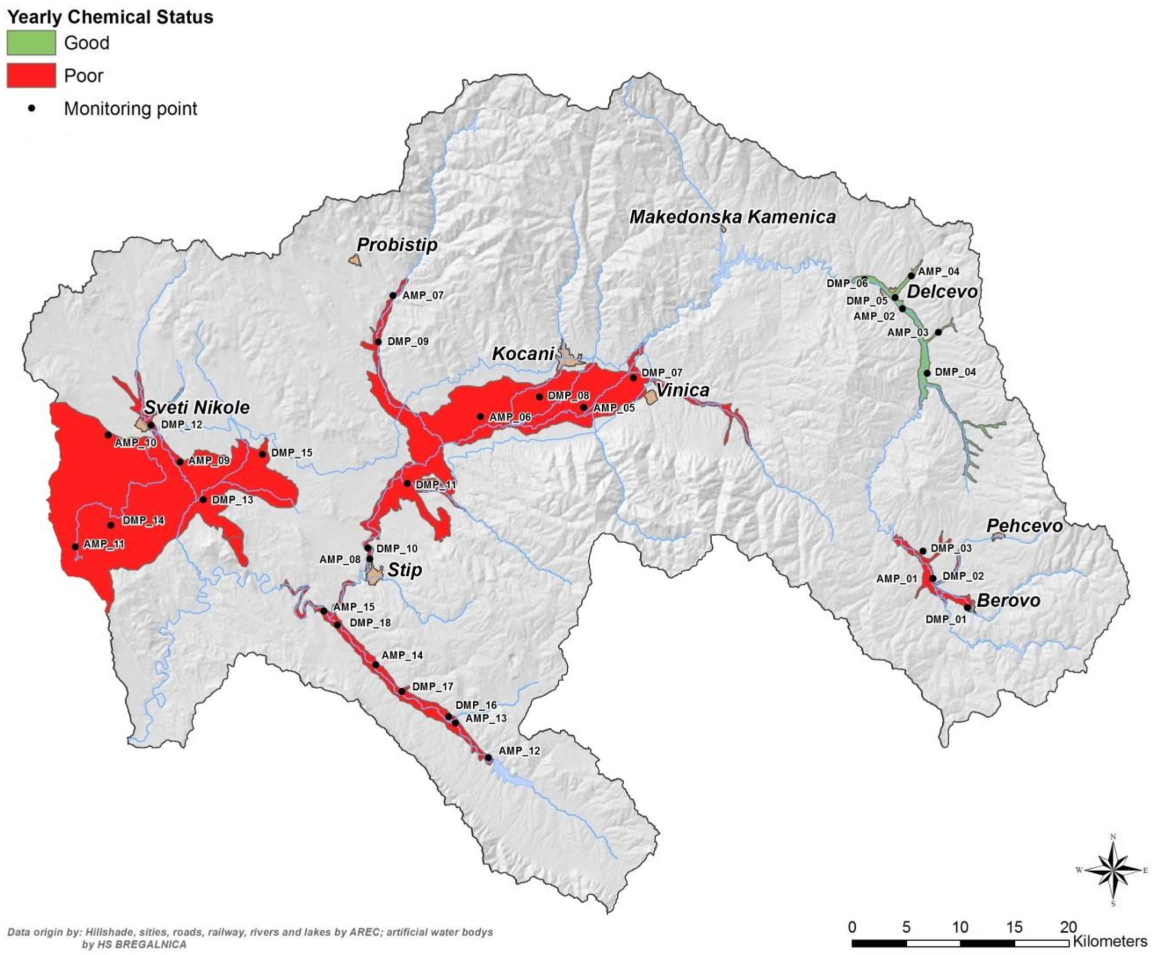

Figure 31: Bregalnica river basin with the chemical groundwater body status, aggregated value from the monitoring campaigns from spring and autumn 2014

Thus, only the groundwater body Delcevo has an overall good status.

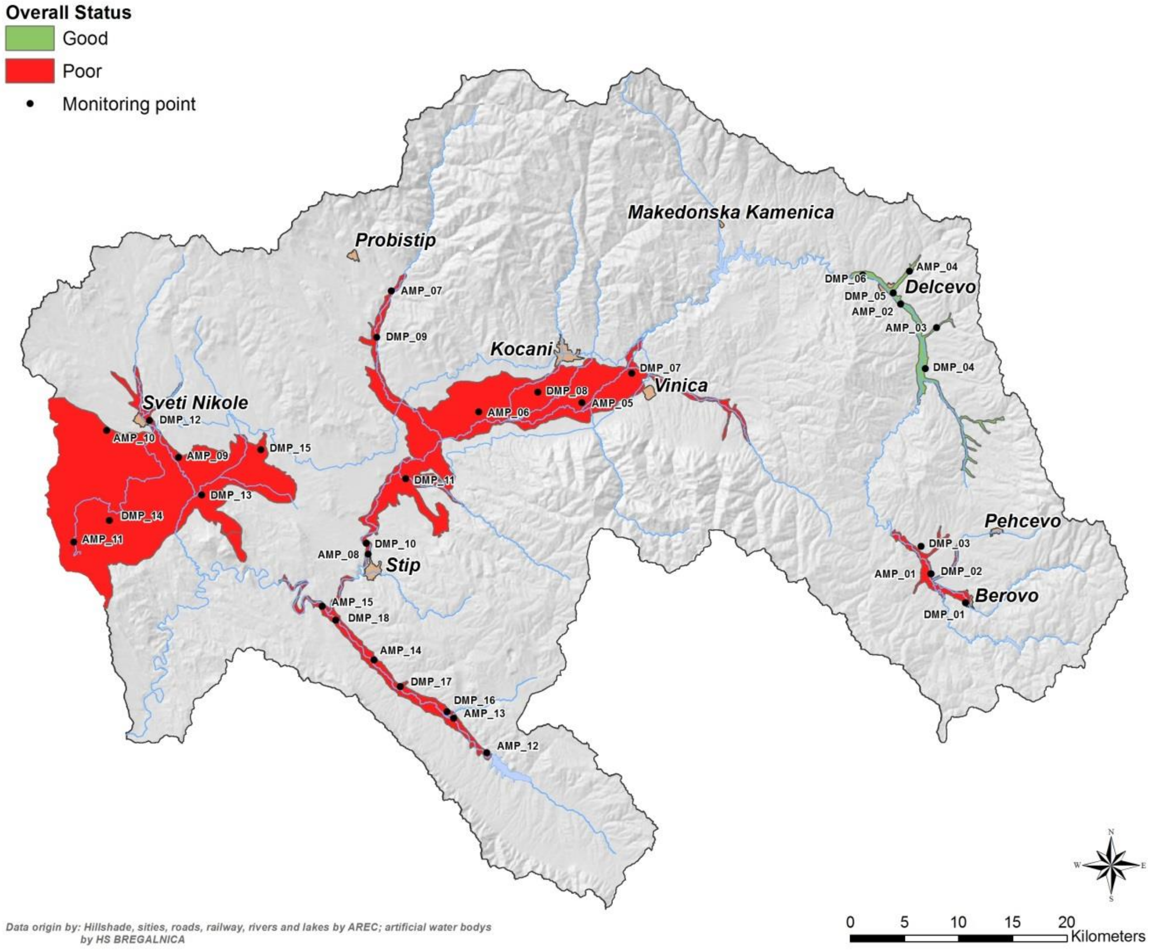

Figure 32: Bregalnica river basin with overall groundwater body status, aggregated value from the monitoring campaigns from spring and autumn 2014

6 Environmental Objectives

6.1 Legal Basis

The Macedonian Water Law (Art. 90) proscribes that the surface waters shall be managed in such a way to:

1. avoid deterioration of the water status, and avoid impacts which give rise to a deterioration of the aquatic ecosystems and the chemical status of water;
2. achieve a good status of the water bodies and of the aquatic ecosystems, as well as of the water dependant terrestrial ecosystems
3. achieve a good chemical status and good ecological potential in case of artificial and heavily modified bodies of water

According to the same law (Art. 92), groundwater shall be managed in such a way to:

1. avoid an impairment of its quantitative and chemical status
2. reverse any significant and sustained upward trend in the concentration of any pollutant resulting from human activity
3. ensure a balance between abstraction and recharge of groundwater
4. achieve a good quantitative and chemical groundwater status

These objectives of the Macedonian Water Law are well in line with the purpose of the EU WFD (Art. 1).

Based on the Macedonian Water Law (Art. 72), the Bregalnica RBM Plan shall specify a program of measures for achieving these environmental objectives in the Bregalnica catchment.

Thus, the environmental objectives for the Bregalnica catchment are to avoid the deterioration of the status of its water bodies and to achieve a good status or a good environmental potential for all its water bodies. In doing so, the following definitions of the EU WFD (Art. 2) shall be used, in line with the EU WFD (Art. 4.1):

- good surface water status: status achieved by a surface water body when both its ecological status and its chemical status are at least good
- good groundwater status: status achieved by a groundwater body when both its quantitative status and its chemical status are at least good
- good environmental potential: status of a heavily modified or an artificial body of water which is as good as possible, given the conditions which result from the artificial or heavily modified characteristics of the water body

In line with the EU WFD (Art. 4.4), a phased achievement of environmental objectives for different water bodies in the Bregalnica catchment is targeted, with the following deadlines: end of year 2015; end of year 2021; and end of year 2027. The phasing will be made based on the technical feasibility of measures, their costs and the natural conditions regarding timely improvement of status in the different water bodies.

In line with the EU WFD (Art. 4.5), less stringent environmental objectives for specific water bodies in the Bregalnica catchment are aimed at when they are so affected by human activity or their natural condition is such that the achievement of these objectives would be infeasible or disproportionately expensive. An economic analysis will be needed in such cases to show that the environmental and socioeconomic needs served by such human activity cannot be achieved by other means.

In line with the EU WFD (Art. 4.7), there may exemptions from the requirement to prevent further deterioration for certain water bodies in the Bregalnica catchment if unforeseen or exceptional circumstances occur, in particular floods and droughts, or if the physical characteristics of a certain water body are modified for reasons of overriding public interest, provided that all practicable steps are taken to mitigate the adverse impact on the status of the water body.

6.2 Surface Water

6.2.1 Deadlines for Achieving Good Status or Potential

Figure 33 to Figure 35 show which surface water bodies shall achieve a good status or ecological potential by end of the years 2015, 2021 and 2027, respectively. Table 14 to Table 16 give the according numbers.

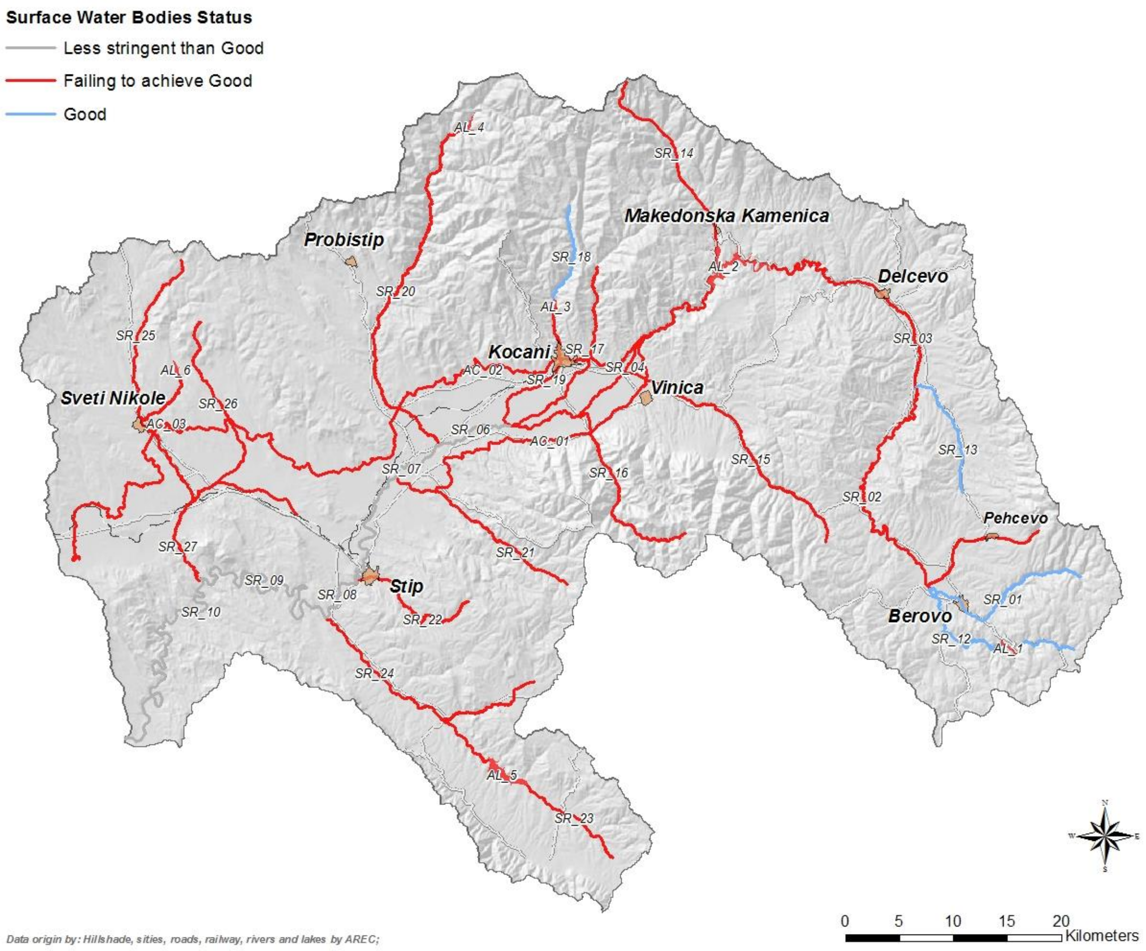

Figure 33: Bregalnica river basin with targeted surface water status for end of 2015

Category	Status 2015	Number	%	km or km²	%
Rivers	Good and above	5	19%	66.8	11%
	Failing to achieve good	22	63%	433.6	72%
	Less stringent than good	5	18%	105.6	17%
	Total	27	100%	606.0	100%
Heavily modified water bodies	Good and above	0	0%	0	0%
	Failing to achieve good	6	100%	9.00	100%
	Total	6	100%	9.00	100%
Artificial water bodies	Good and above	0	0%	0	0%
	Failing to achieve good	3	100%	131.7	100%
	Total	3	100%	131.7	100%

Table 14: Summary of surface water bodies status for end of the year 2015. Length is expressed in km for rivers and artificial water bodies and in km² for lakes

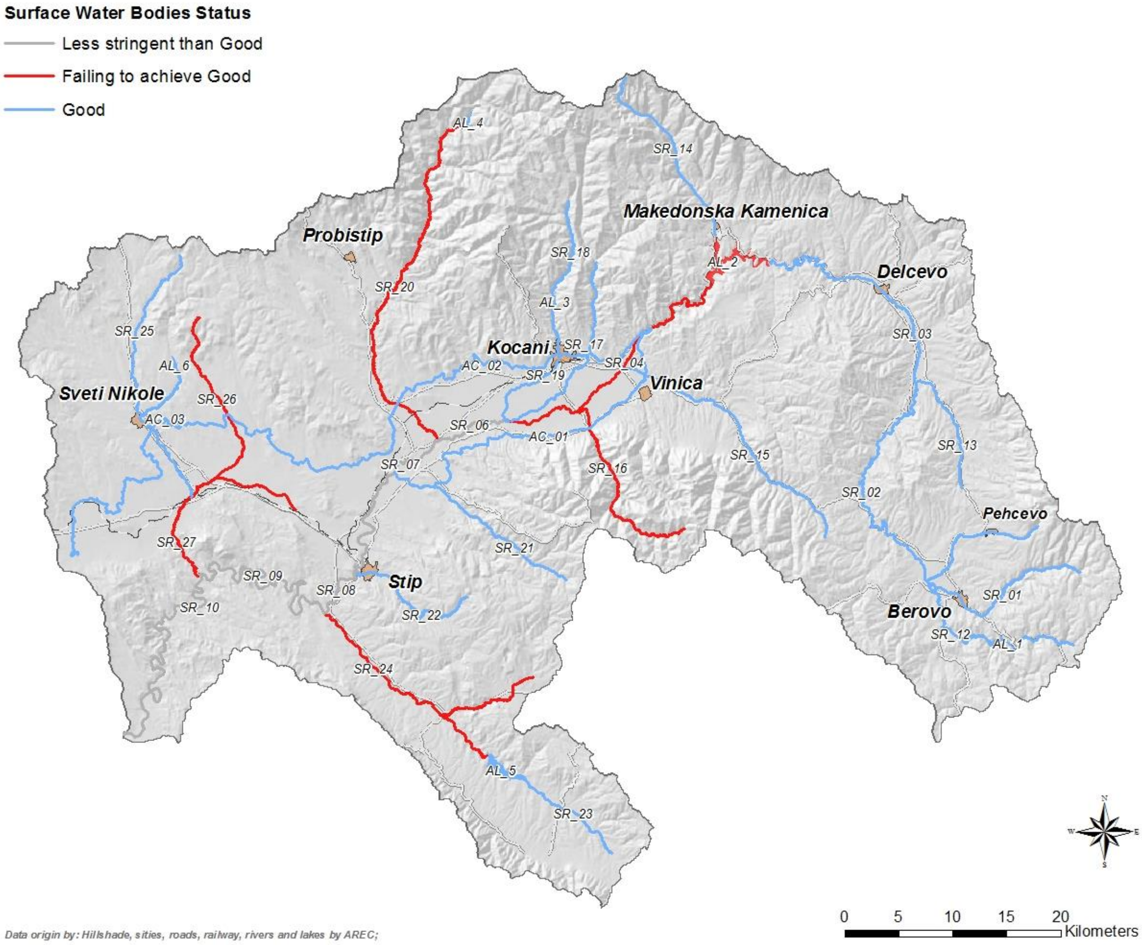

Figure 34: *Bregalnica river basin with targeted surface water status for end of 2021*

Category	Status 2021	Number	%	km or km²	%
Rivers	Good and above	5	19%	323.4	56%
	Failing to achieve good	22	63%	177.0	29%
	Less stringent than good	5	18%	105.6	17%
	Total	27	100%	606.0	100%
Heavily modified water bodies	Good and above	5	83%	4.5	50%
	Failing to achieve good	1	17%	4.5	50%
	Total	6	100%	9.0	100%
Artificial water bodies	Good and above	3	100%	131.7	100%
	Failing to achieve good	0	0%	0.00	0%
	Total	3	100%	131.7	100%

Table 15: *Summary of surface water bodies status for end of the year 2021. Length is expressed in km for rivers and artificial water bodies and in km² for lakes*

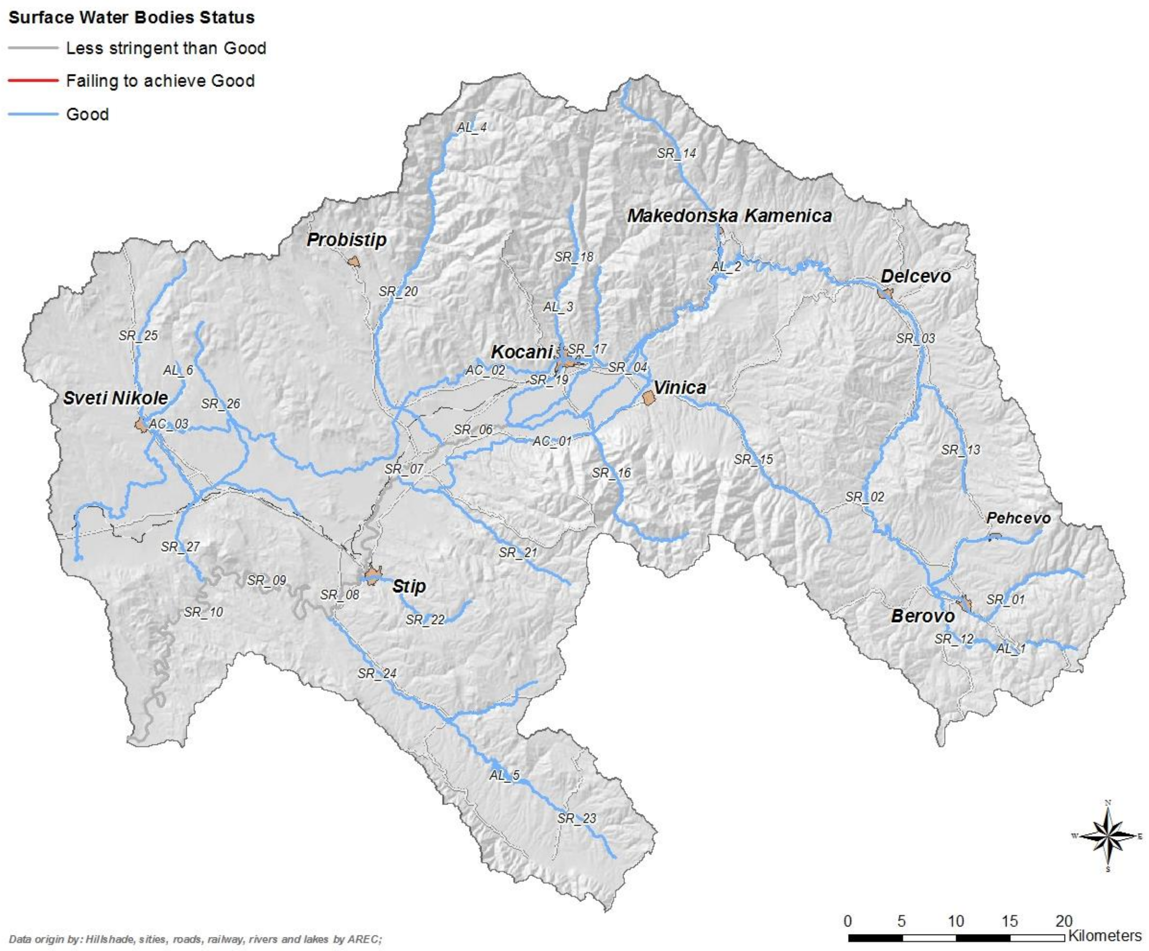

Figure 35: Bregalnica river basin with targeted surface water status for end of 2027

Category	Status 2027	Number	%	km or km²	%
Rivers	Good and above	22	81%	500.3	83%
	Failing to achieve good	5	0%	0.0	0%
	Less stringent than good	0	19%	105.6	17%
	Total	27	100%	606.0	100%
Heavily modified water bodies	Good and above	6	100%	9. 0	100%
	Failing to achieve good	0	0%	0.0	0%
	Total	6	100%	9. 0	100%
Artificial water bodies	Good and above	3	100%	131.7	100%
	Failing to achieve good	0	0%	0.0	0%
	Total	3	100%	131.7	100%

Table 16: Summary of surface water bodies status for end of the year 2027. Length is expressed in km for rivers and artificial water bodies and in km² for lakes

6.2.2 Water Bodies with Less Stringent Objectives

For the lower parts of the Bregalnica river it is anticipated that achieving a good status, even by 2027, is not feasible. These stretches carry the combined pollution load from agriculture and wastewater from the main settlements and the areas in the Middle Bregalnica region with an intensive agricultural use.

6.2.3 Water Bodies with Permitted Deterioration

There are no exemptions for any surface water bodies foreseen so far which would allow a deterioration of their present water status.

6.3 Groundwater

6.3.1 Deadlines for Achieving a Good Status

It is not feasible that besides the Delcevo groundwater body which already has a good status one of the groundwater bodies Berovo-Pehcevo, Kocani-Stip, Ovce Pole and Lakavica will reach good status by the end of 2015 or 2021. However, the groundwater body Berovo-Pehcevo shall achieve good quantitative and chemical status by the end of 2027.

6.3.2 Water Bodies with Less Stringent Objectives

There is no rationale for any water bodies to allow less stringent objectives.

6.3.3 Water Bodies with Permitted Deterioration

There are no exemptions for any groundwater bodies foreseen so far which would allow a deterioration of their present water status.

6.4 Protected Areas

6.4.1 Deadlines for Achieving Compliance

As there are no legally proclaimed nature protected areas in the Bregalnica catchment at this moment, no deadlines for achieving any nature protection standards or objectives exist.

6.4.2 Protected Areas with Less Stringent Compliance

As there are no legally proclaimed nature protected areas in the Bregalnica catchment at this moment, there is no rationale for any nature protected area to allow less stringent protection standards or objectives.

6.4.3 Protected Areas with Permitted Deterioration

As there are no legally proclaimed nature protected areas in the Bregalnica catchment at this moment, there is no rationale for any nature protected area to allow a deterioration of its present status.

7 Water Allocation Model

The following chapter gives an overview on the main results of the applied rainfall-runoff model and the water allocation model. The applied methodology and approach are described in more detail in Annex A6 (Rainfall-Runoff Model) and Annex A7 (Water Allocation Model).

7.1 Climate Change and Socio-Economic Scenarios

In the following, a short overview on the applied scenarios is provided. For a more in-depth discussion of the climate change and land use change scenarios please refer to Annex A7 (Water Allocation Model).

7.1.1 Climate Change Scenarios

Based on downscaled General Circulation Model (GCM) data from IPCC's fourth assessment report on climate change[2)], three climate change impact scenarios were selected for the Bregalnica river basin. For scenario selection the change in the Climate Moisture Index (CMI), which is in essence a measure for the aridity of a region, was analysed for all available scenarios. Based on the CMI change the following three scenarios were selected[3)]:

- A high impact scenario or "dry" scenario with maximum potential impact on water supply and demand
- A low impact scenario or "wet" scenario with minimal potential impact on water supply and demand
- A medium scenario which lies between the low and high impact scenario and is closest to the multi model mean CMI of all considered scenarios

Each selected impact scenario is associated with a GCM model run of a distinct greenhouse gas emission scenario. The impact scenarios project temperature and precipitation changes for two future time frames (2046 – 2065 and 2081 – 2100). Based on the difference between the future projections of precipitation and temperature and the historical baseline run (1961 - 1990)

2) Source: World Bank Knowledge Portal on Climate Change
3) Scenario selection was carried out in analogy to Sutton, William R., Srivastava, J. P., Neumann, J. E., Strzepek, K. M., & Boehlert, B. B. (2013). Reducing the Vulnerability of the Former Yugoslav Republic of Macedonia's Agricultural Systems to Climate Change: Impact Assessment and Adaptation Options. *World Bank Publications*.

of each GCM, monthly changes in climate were computed and introduced in the water allocation model.

The effect of climate change on the seasonal distribution of temperature and precipitation in the Bregalnica river basin for the period 2046 - 2065 is illustrated in Figure 36.The highest temperature increases are predicted for the summer season. At the same time, forecasted precipitation reductions are most pronounced in the period from May to October.

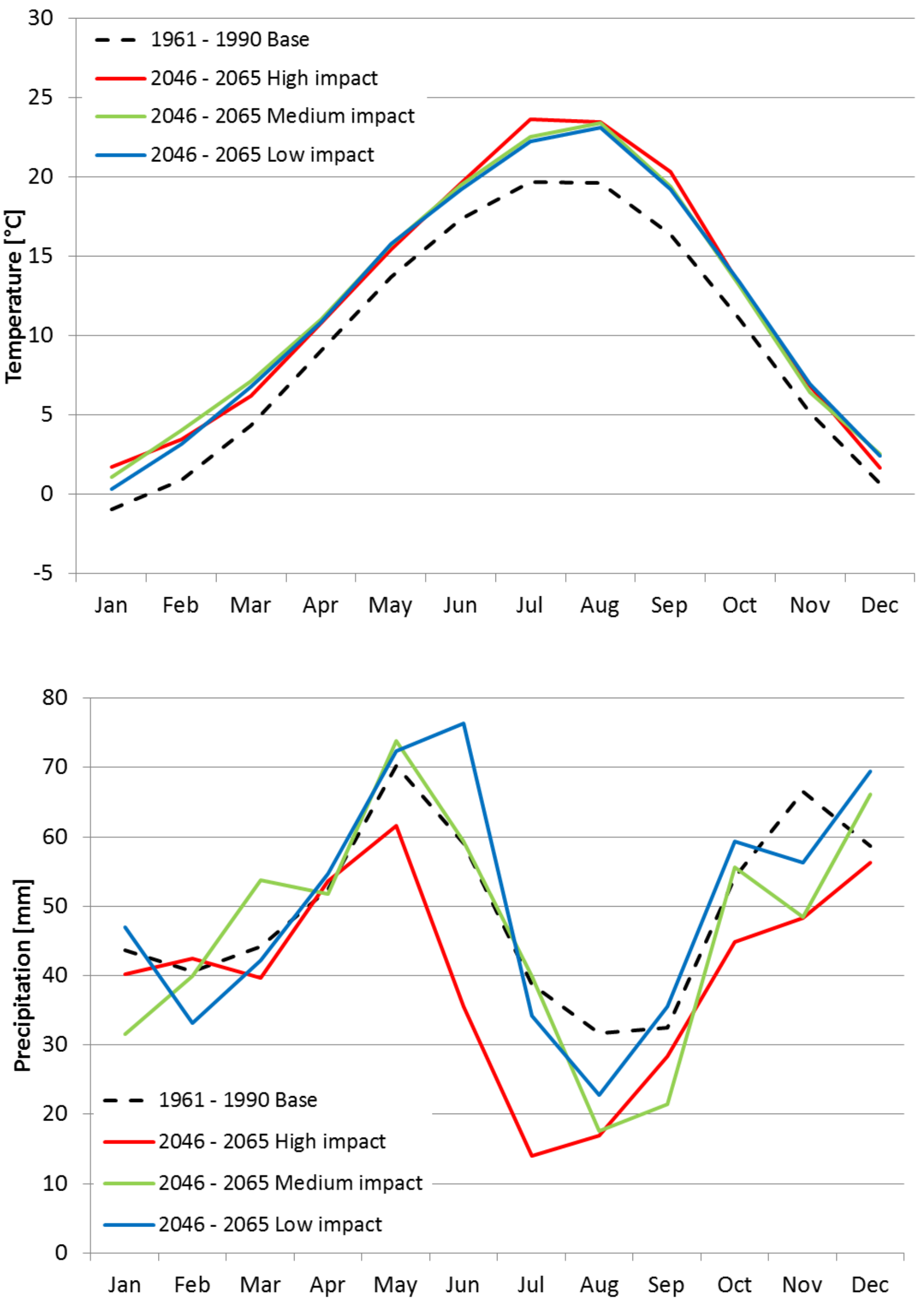

Figure 36: Effect of climate change on average monthly temperature (top) and precipitation (bottom) for the mid-century in the Bregalnica river basin for the selected climate impact scenarios

Changes in temperature and precipitation are expected to mainly influence the natural flow regime and agricultural water demand. Impacts of climate change on industrial and municipal water demand are not reflected within this modelling exercise.

7.1.2 Land Use Change Scenario

The land use developments with the biggest anticipated impact on water resources in the Bregalnica catchment are changes in irrigated agricultural areas. Consequently the considered land use change scenario focuses on the potential future expansion of irrigated area in the major hydro-meliorative systems (HMS).

Taking into account anticipated trends in the agricultural sector (see chapter 3.3.2), the potentially irrigable areas as well as the feasibility of reconstruction and rehabilitation of old irrigation systems, projections of future irrigated area and cultivated crop types in the major HMS were developed in close collaboration with the Ministry of Agriculture, Forestry and Water Economy.

- The present irrigated area in these HMS amounts to about 100 km^2 or 10’000 ha, of which ~8’800 ha are located in the Bregalnica basin and ~1000 ha in the municipality of Radovish. The latter agricultural area is irrigated with water out of Mantovo reservoir.
- Projected future irrigated agricultural area extends over 280 km^2 or 28’000 ha, which consists of ~22’800 ha in Bregalnica basin, ~4’150 ha in the municipality of Radovish and ~1000 ha in the municipality of Kratovo (irrigated with water out of Knezevo reservoir).

The land use scenario does not feature temporal variability, i.e. only one predicted future state of irrigated agricultural area is considered.

7.1.3 Development of Municipal Water Demand

According to the anticipated future development (chapter 3.1.2) the water demand per capita is expected to increase until 2030 as tendencies observed in the past few years are likely to aggravate, namely too low water tariffs, the bad economic situation of public enterprises and the lack of sufficient means for ongoing maintenance and reconstruction of the deteriorated water supply systems. A turnaround seems not possible in the next few years and more realistic for the period after 2030. In this case a stabilization of the demand may be expected after 2030 due to increasing water tariffs, increasing necessary investments in the water supply systems and due to improved awareness regarding water saving.

Accordingly, municipal water demand is expected to increase in line with the projected growth of the GDP of 2% until 2030 and is expected to stabilize after 2030.

7.1.4 Development of Industrial Water Demand

According to the anticipated future development (chapter 3.2.2) the industrial growth is expected to keep up with the projected growth of the GDP of 2%. Consequently the water demand up to 2030 is also expected to grow. Based on the assumption that the price of water will increase substantially after 2030 the companies are then expected to apply more water saving measures.

Accordingly, industrial water demand is expected to increase in line with the projected growth of the GDP of 2% until 2030 and is expected to stabilize after 2030.

7.1.5 Planned Major Reservoirs

Figure 18 in chapter 3.4.2 gives an overview on the 4 planned major reservoirs (Jagmular, Bargala, Rechani and Razlovci) in the Bregalnica basin. It is assumed that all reservoirs except Jagmular will be built within the next 20 years. Jagmular seems unlikely to be built in the foreseeable future, as Kalimanci reservoir - which already assumes a similar role in the basin - is not used to its full capacity in the present state. Table 44 in Annex A5 indicates the storage volumes of the planned reservoirs.

7.2 Water Resources

7.2.1 Current Status

The average natural discharge for every surface water body was determined by means of a rainfall-runoff model for the period of 1966 to 1990. The resulting average annual runoff is depicted in Figure 37.

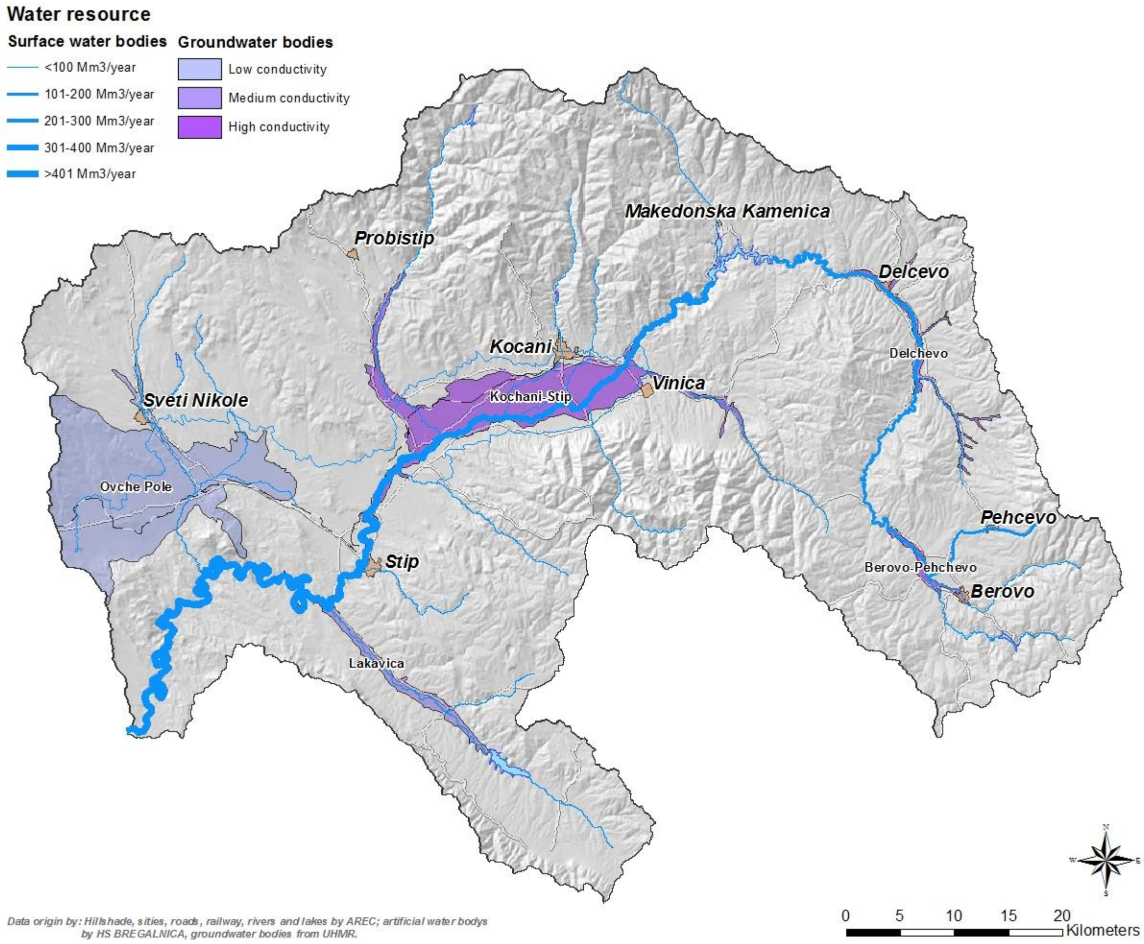

Figure 37: Modeled natural average annual discharge in the Bregalnica river system for the period of 1966-1990 and qualitative assessment of conductivity of the different ground water bodies

7.2.2 Development

Figure 38 compares natural average monthly flows for the period of 1966 - 1990 with the projected flow distribution in 2046 – 2065 at the river basin outlet. Generally, the combination of reduced precipitation and year-round increase of temperature leads to reductions in snowpack, earlier snow melt and declining spring runoff. Due to reduced precipitation and elevated evapotranspiration rates the medium and high impact scenario also feature significantly reduced natural runoff in (late) summer; a period usually associated with high irrigational water demands and minimum reservoir levels (see chapter 7.4). By mid-century, average natural runoff at the basin outlet is expected to decrease by 4% (low impact scenario), 15% (medium impact) and 29% (high impact) respectively.

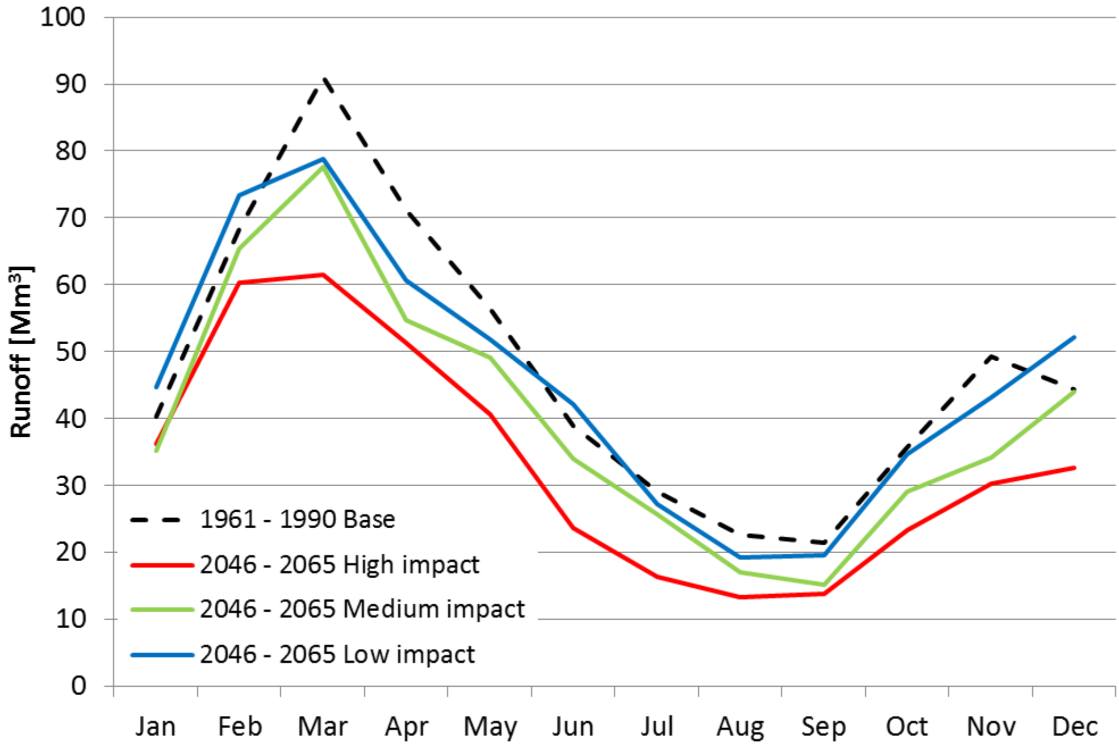

Figure 38: Effect of climate change on average monthly natural runoff of the river Bregalnica at the confluence with Vardar for the mid-century

7.3 Total Water Demand

7.3.1 Current Status

Figure 39 and Figure 40 give an overview on the distribution of the consumptive and non-consumptive water demand among the different sectors as well as the biological flow requirements in the Bregalnica river basin. The demands for the municipal, industrial and agricultural sector are identical to the ones initially introduced in Chapter 3.

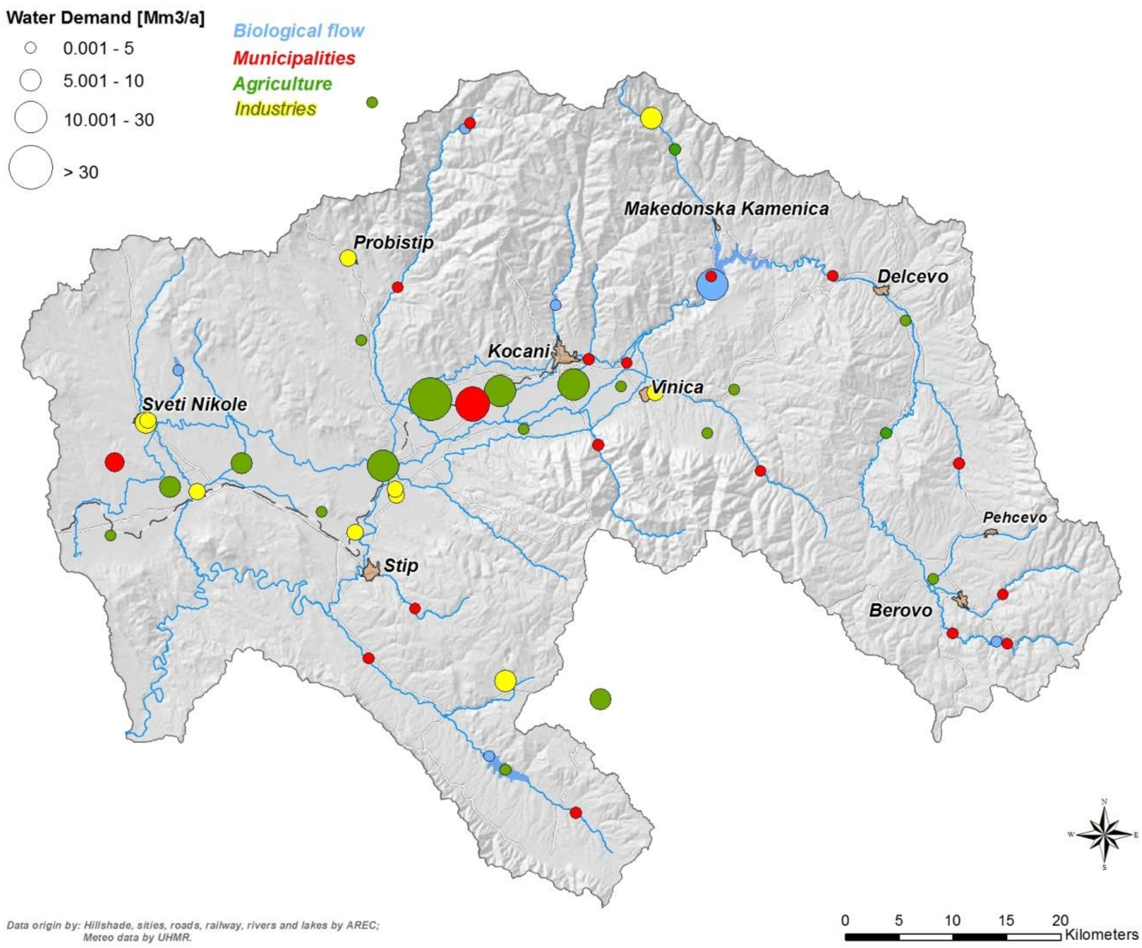

Figure 39: Overview of the major total water demands in the Bregalnica river basin

The consumptive and non-consumptive agricultural water demand exceeds the water demand of the other sectors by far. Rice cultures, while making up less than one third of the currently irrigated area, account for over 70% of the total agricultural water demand, making them the single most important water demand in the river basin. Furthermore the modeled agricultural water demand can be regarded as a rather conservative estimate, as it is based on cultivated areas drawn from official records, which are likely to neglect most of the areas irrigated by private wells or private water intakes.

Water demands arising from biological minimal flow requirements and hydropower production are non-consumptive, i.e. the water is not lost for the river basin. Biological flow requirements impose the main constraints on the operational course of action of the major reservoirs by forcing them to release water during periods (winter time), when other demands are on low levels. Hydropower production in the Bregalnica river basin is of secondary importance in comparison to the water demands of the other sectors.

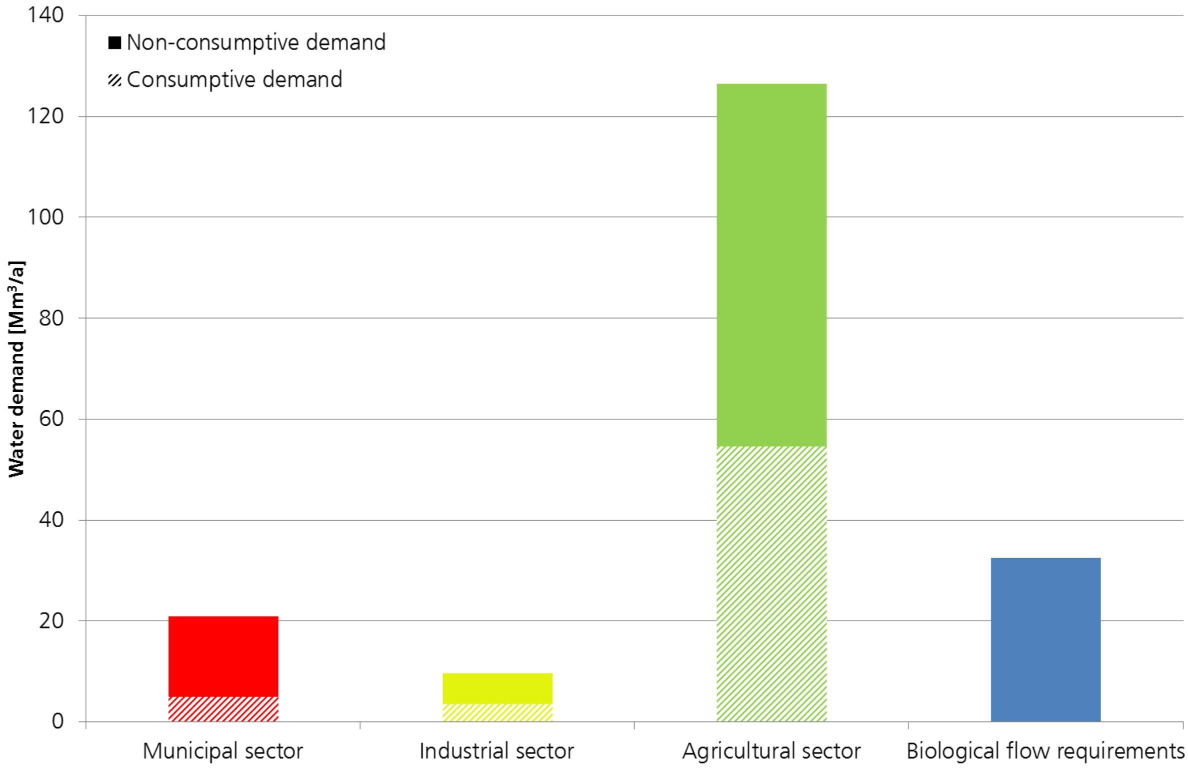

Figure 40: Consumptive and non-consumptive water demand by sector. Biological flow requirements account for the flow requirements downstream of the six major reservoirs

The main reservoirs are multi-purpose and are dynamically operated over the year to meet the above mentioned seasonal demands. Again, agricultural demand is by far the most important factor defining the dimensioning of the reservoirs to allow for seasonal storage of required summer irrigation demand.

7.3.2 Development

Future total water demands under climate and land use change (increased irrigated area) are depicted in Figure 41. Even without an increase in irrigated areas, changes in future water demands are likely to be most pronounced in the agricultural sector. Increased irrigational demands due to climate change are dwarfed by comparison to the additional water demand arising from a potential extension of irrigated crop land.

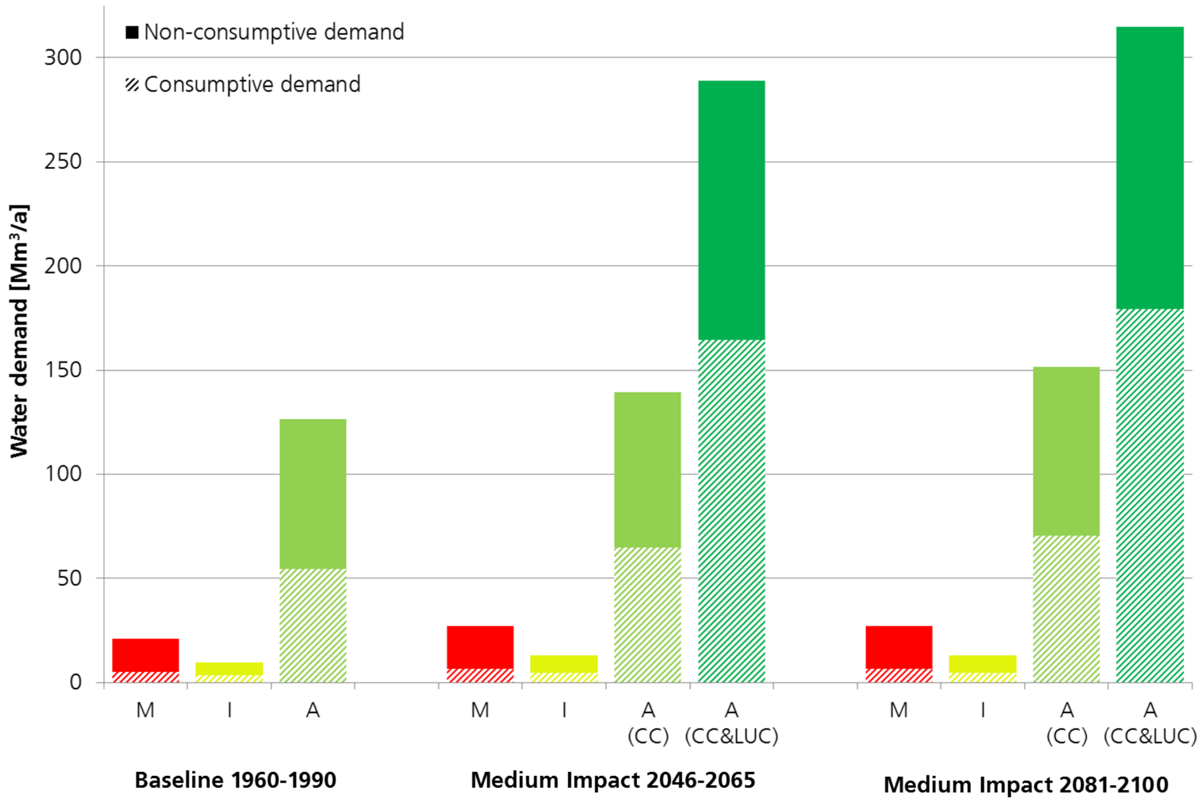

Figure 41: Consumptive and non-consumptive water demand for municipal (M), industrial (I) and agricultural (A) sector for the historical baseline, the mid-century and the end of century for the medium impact scenario. The displayed future agricultural water demands account for the effect of climate change and unchanged irrigated areas (CC, shaded in lime green) and the combined effect of climate and land use change (CC & LUC, shaded in dark green)

While the seasonal water demand patterns of the municipal and industrial sector may be expected to growth more or less uniformly, the increase in irrigational water demands will be focused on the spring and summer season. Figure 42 compares the total monthly irrigation demand for the historical baseline and the three climate change impact scenarios for the mid of the century.

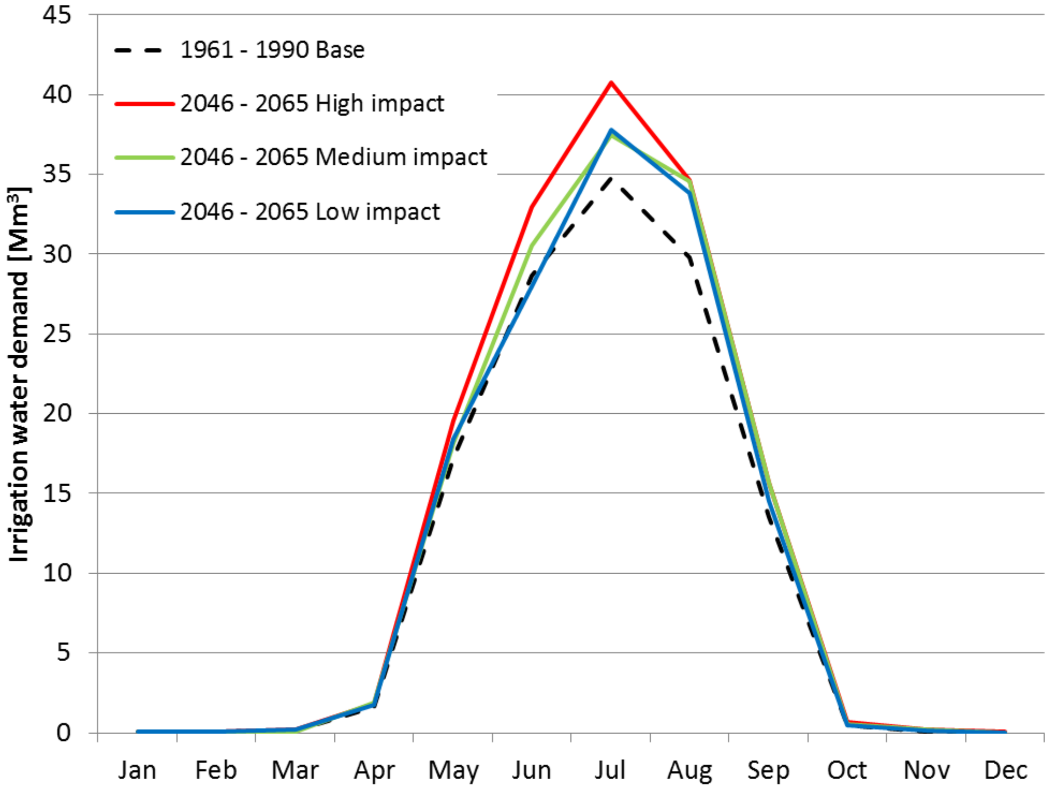

Figure 42: Mean monthly irrigation water demand for the whole Bregalnica basin for the historical baseline and three climate change impact scenarios for the mid-century

7.4 Balance: Water Demand vs. Water Resources

The results of the Water Allocation Model exercise suggest that all present demands can be met if looked at on a regional scale, i.e. on the level of individual sub-catchments. The model further suggests that demands can even be met under extreme conditions during the low-flow summer months after several dry years. From a more local vantage point water shortages may occur during dry periods in certain river stretches or below individual water intakes, especially in smaller streams.

The present flow regulation infrastructure in general and Kalimanci reservoir and the main irrigation channels of HMS Bregalnica in particular were dimensioned for the irrigation of areas which amount to 2-3 times the presently irrigated areas. Hence there are large inherited reserves in the present flow regulation system. This is may be best illustrated by the stage records of Kalimanci reservoir (Figure 43), which indicate that the reservoir capacity has never been fully exhausted in the past decade.

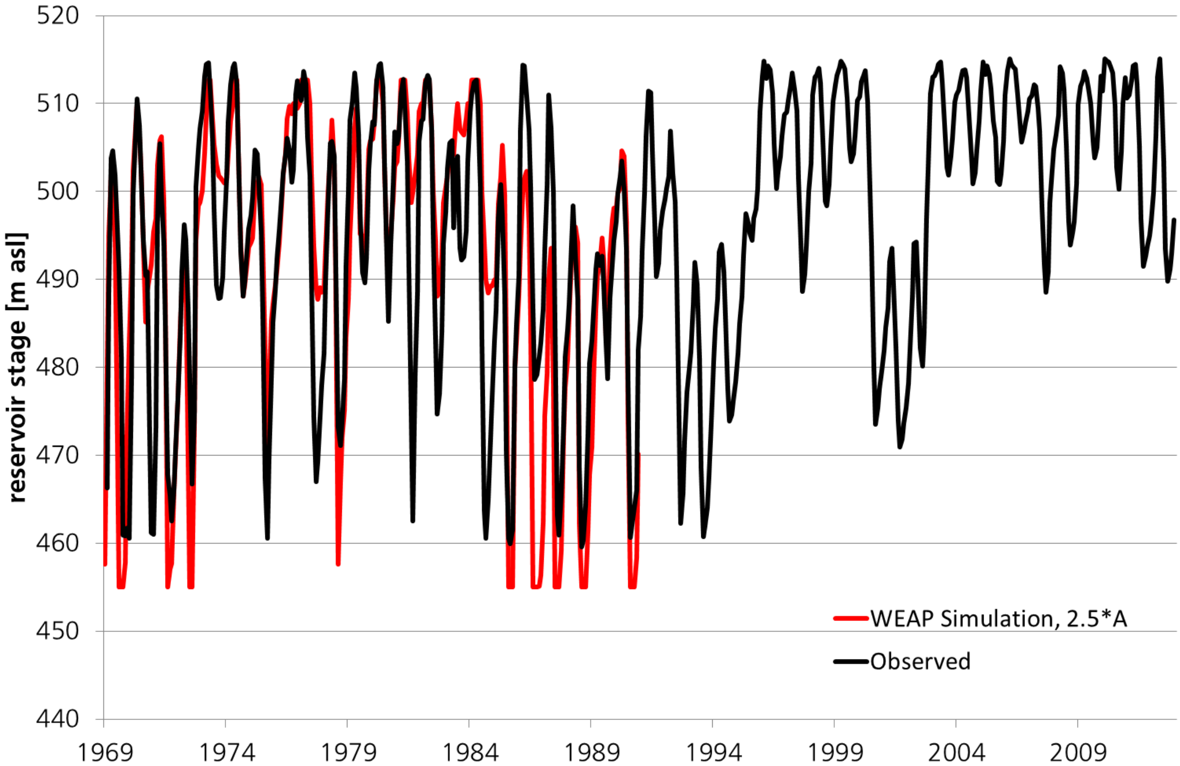

Figure 43: Observed and modeled reservoir stage in Kalimanci reservoir. The WEAP model run accounts for 2.5 times the presently irrigated area in HMS Bregalnica

7.4.1 Development

Unsurprisingly, the concurrent decrease of supply (chapter 7.2.2) and increase of demand (chapter 7.3.2) result in projected unmet water demands in the future. Figure 44 illustrates unmet average water demands for the whole basin. In the accordance with the above findings, the impact of climate change is an order of magnitude smaller than the one from the potential extension of irrigated areas.

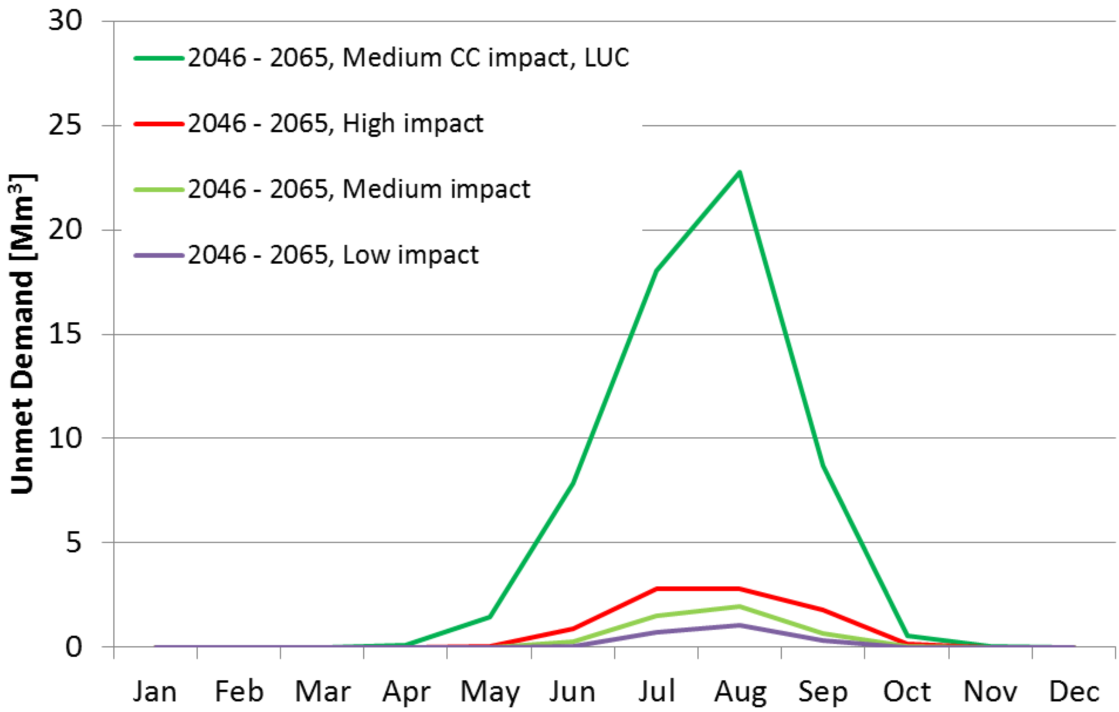

Figure 44: Average unmet water demands over the whole basin for three climate change impact scenarios and one land use change scenario (LUC) for mid-century

Figure 45 gives an overview on the average covered demands under the climate change impact scenario while accounting for the potential increase in irrigated agricultural area. In this case, major demand reliability issues are limited to agricultural demand sites (municipal and industrial nodes are attributed with a higher demand priority). The biggest supply shortages (agricultural nodes in Radovish, Kratovo, Probistib and Konce) are linked to the reservoirs of Knezevo and Mantovo. The catchment area of these reservoirs is rather small in relation to the potential irrigated area in the future.

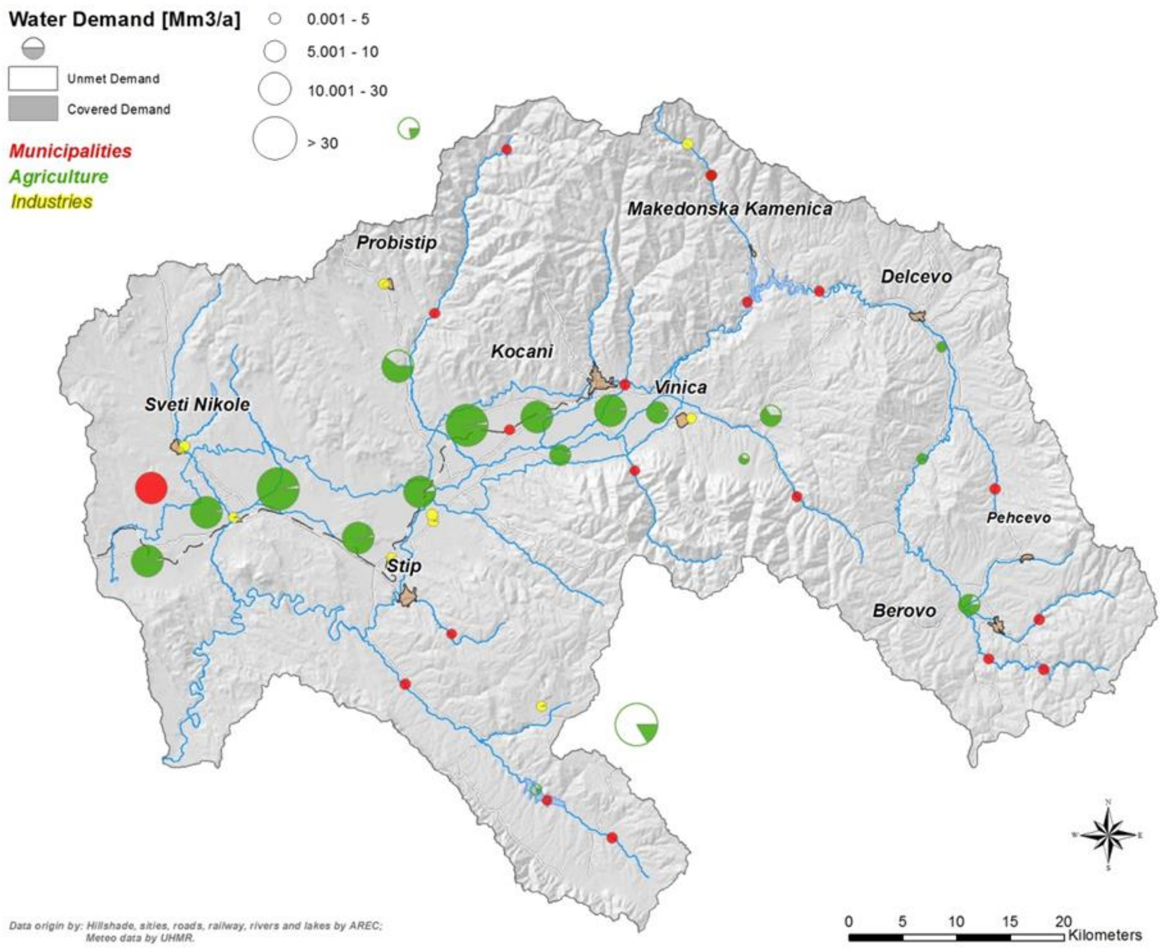

Figure 45: *Average covered annual water demand under the medium climate change impact scenario and including the projected extension of irrigated area for the mid-century (2046 – 2065).*

7.5 Water Quality Modeling

7.5.1 General Remarks

Based on the monitoring campaigns from June 2013 to September 2014, phosphorus in the dissolved form of ortho-phosphate is the main pollutant of concern in the Bregalnica river basin. Agricultural practices and the lack of wastewater treatment are the main source for this diffuse and point-source pollution, which is not limited to certain areas and affects both up- and downstream water bodies including reservoirs.

The sources which contribute phosphorus to the aquatic environment differ with respect to mode and timing of delivery (continuous or unsteady discharge) and their composition (concentration, speciation and bioavailability). For example, dissolved phosphorus primarily consists of ortho-phosphate which is immediately available for uptake by algae while particulate phosphorus is much less bioavailable as it has to undergo transformation or desorption processes first. Thus, the impacts on water quality differ widely.

Point sources such as domestic and industrial wastewater are highly concentrated in soluble phosphorus (mostly ortho-phosphate) and discharge continuously. Thus, streams receiving wastewater effluent typically show a characteristic pattern of high total phosphate concentrations during summer low flows and lower concentrations during winter storm events.

Figure 46 and Figure 47 show the monitoring results for phosphates in surface water samples in August 2013 and February 2014. The highest phosphate concentrations for most monitoring points along Bregalnica were measured during summer months. However, single concentration values always have to be interpreted with caution due to the high discharge-dependency. It can be noted that in very sparsely populated areas non-point sources become more important.

Diffuse phosphorus emissions into surface water have a much greater proportion of phosphorus in the particulate form, as phosphorus is easily adsorbed to soil particles. Diffuse sources include different pathways such as inputs into surface waters by erosion, via surface and subsurface runoff and via tile drainage. Hence, phosphorus is delivered to the surface water bodies during rainfall events.

As a huge area of the Bregalnica catchment is characterized by strong erosion potential erosion is considered as a relevant process for unsteady phosphorus transport from non-point sources. Most of the sediment bound phosphorus is transported relatively unaltered as it is in a stable mineral form, i.e. held within mineral lattices. However, some of the particulate phosphorus is adsorbed onto soil surfaces or incorporated into particulate organic matter. Phosphorus in these more unstable forms is much more likely to contribute to elevated phosphate concentrations in surface water bodies.

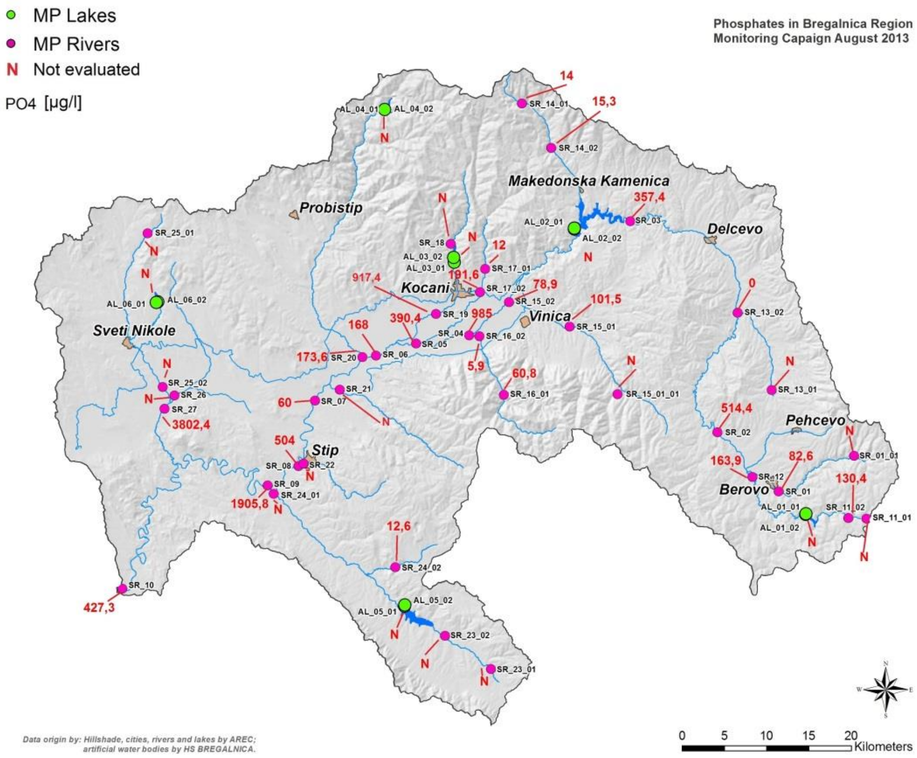

Figure 46: Concentration of ortho-phosphates [µg/l] in surface water samples taken during monitoring campaign in August 2013

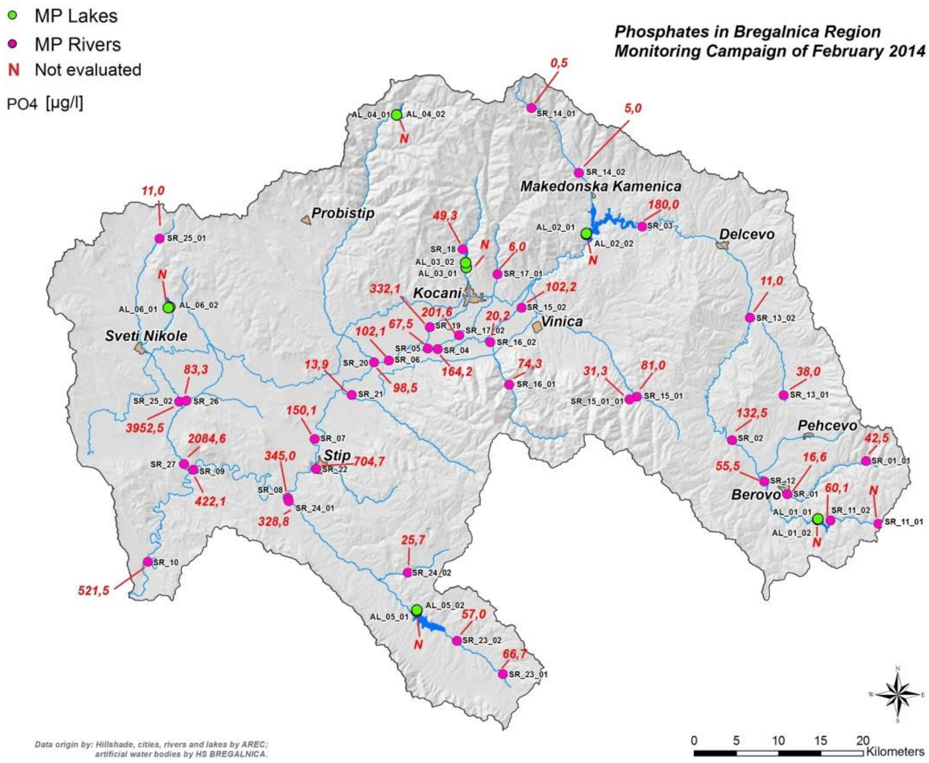

Figure 47: Concentration of ortho-phosphates [µg/l] in surface water samples taken during monitoring campaign in February 2014

7.5.2 Phosphorus Flux Model

Erosion and sediment yield model

With the help of a soil erosion model and sediment delivery ratios, the phosphorous flux into surface water bodies can be estimated. Here, the Revised Universal Soil Loss Equation (RUSLE) was employed which is a detachment capacity limited model for erosion. Developed by the U.S. Department of Agriculture, it has been widely used to predict the average annual soil loss caused by rainfall. However, only a certain amount of the detached particles reaches the river which is described as sediment yield. To estimate the yearly sediment yield, sediment delivery ratios (SDR) were calculated. The applied methodology and approach as well as the limitations and constraints of the model are described in more detail in Annex A8 (Phosphorus flux model).

Phosphorus input due to erosion

In a next step, the sediment yield results from the RUSLE model were coupled with two spatially distributed phosphorus datasets to calculate the sediment bound phosphorus input:

- Annual phosphorus surplus on agricultural area: yearly phosphorus addition of fertilizer and livestock manure reduced by the amount removed with the crop at harvest
- Phosphorus content in topsoil: Natural phosphorus content and long term phosphorus accumulation together introduced as "background phosphorus"

As the phosphorus in fertilizer and manure is much more readily bioavailable in an aquatic environment than "background phosphorus", this distinction was made. Thus, surplus phosphorus is of main concern when evaluating sources for the water quality parameter "ortho-phosphate" in surface water. Losses of "background phosphorus" are of interest for the parameter "total phosphorus".

To estimate the average annual phosphorus surplus, a survey on fertilizer practices among farmers in the Bregalnica basin was conducted. Moreover, livestock numbers were assigned to the agricultural area and phosphorus input due to application of manure was calculated. Values for phosphorus content in topsoil were taken from the "Geochemical Atlas of the region of the Bregalnica river basin"[4]. For this study, samples from topsoils (at depth 0 – 5 cm) were taken at 179 monitoring points in 2012 resulting in a sampling density of 5 x 5 km.

7.5.3 Potential Annual Soil Loss and Sediment Yield

The potential annual soil loss predicted by RUSLE for the whole Bregalnica river basin is equal to about 7'000'000 tonnes with an average area-specific soil loss rate of 15 tons per hectare and

4) Stafilov, T., Balabanova, B., Sajn, R. (2014). Geochemical Atlas of the region of the Bregalnica River Basin. Faculty of Natrual Sciences and Mathematics – Skopje.

year. The predicted spatial pattern of soil erosion is subdivided into seven classes (Figure 48). By using a bulk density value of 1.3 g/cm^3 on average, 1.1 mm soil is lost yearly due to erosion. However, the model predicts soil loss of up to more than 60 tons per hectare and year (equals more than 4.6 mm soil loss per year) in areas prone to high erosion. These areas are characterizde by either steep slopes or a landcover which is prone to erosion such as vineyards and orchards or by a combination of these factors. More detailed results for each surface water body can be found in Annex A8.

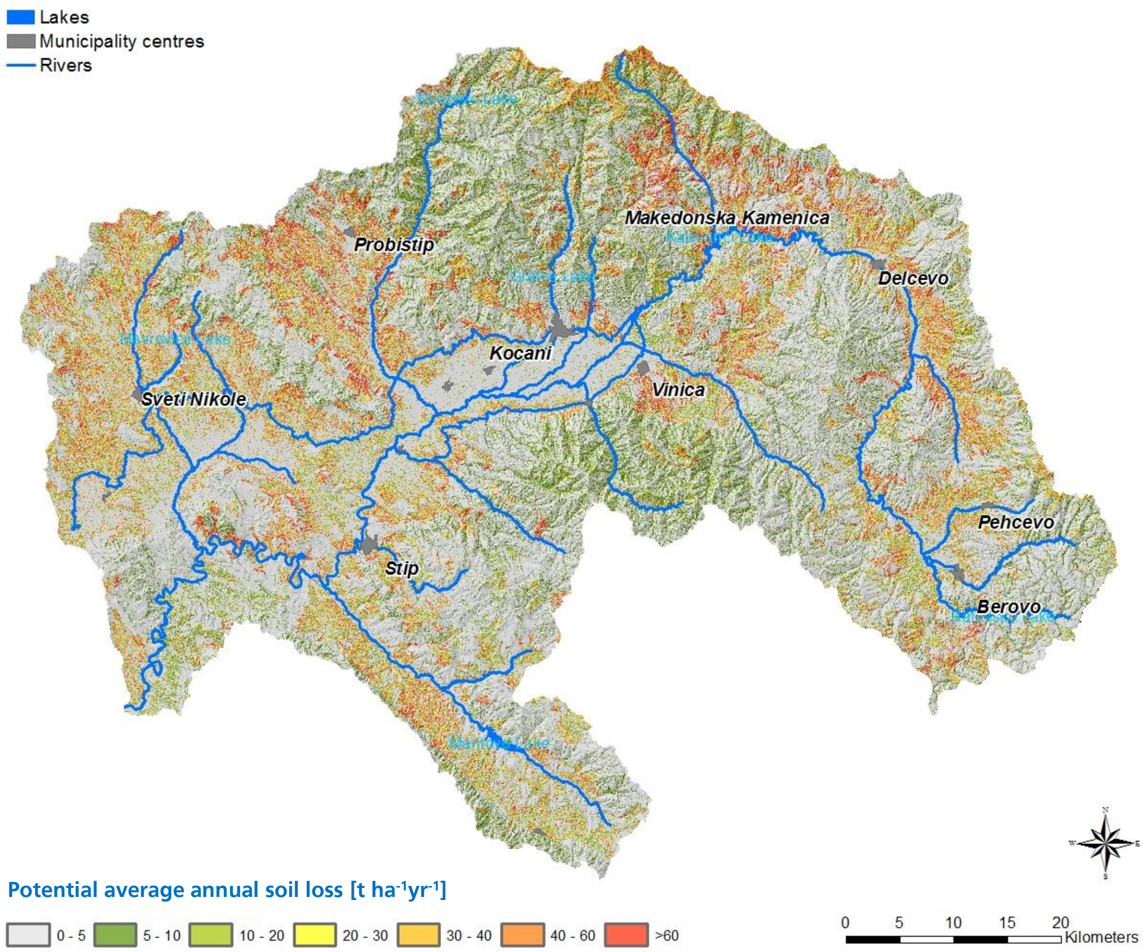

Figure 48: Potential average annual soil loss in tons per hectare and year (RUSLE model)

Two sediment delivery ratios (SDRs) were calculated based on two different approaches. Using these SDRs of 0.26 and 0.51 on average, the annual sediment yield result was 4 and 8 tons per hectare and year, respectively.

7.5.4 Phosphorus Fluxes into Surface Water Bodies

The phosphorus flux into surface water body due to erosion was further divided based on the origin of the phosphorus, and thereby based on the subsequent fate in the aquatic environment.

Combining the sediment yield raster dataset with the dataset of the annual phosphorus surplus on agricultural area, phosphorus losses from agricultural sources were computed. The average annual phosphorus flux is equal to 6 tons per year for the whole Bregalnica catchment.

Figure 49 shows the spatial distribution of the surplus phosphorus deriving from the fertilizer input-plant uptake balance and from livestock year, which is transported to water bodies due to erosive forces.

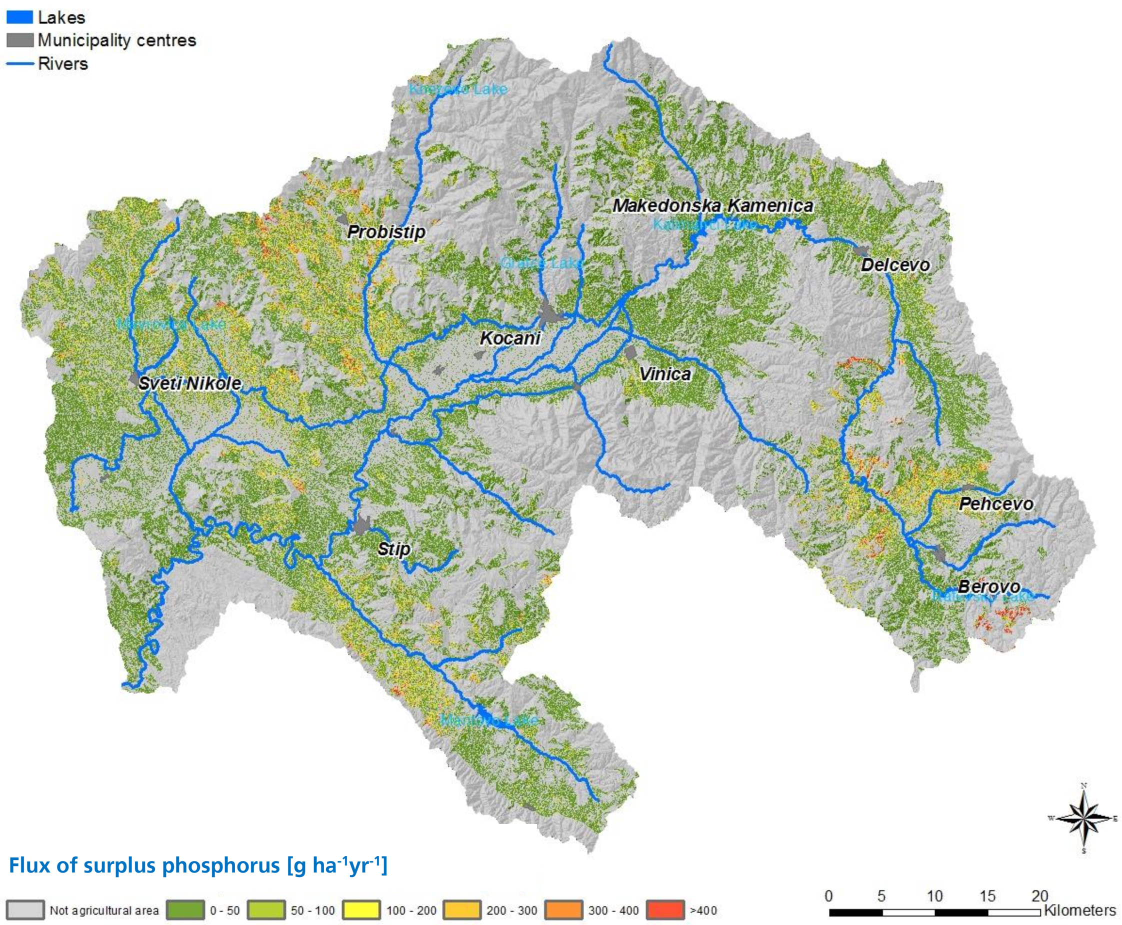

Figure 49: Computed flux of surplus phosphorus [g per ha and yr] to surface water bodies due to erosion

With an area-specific loss rate of 200 grams phosphorus per hectare and year, the Ratevsko Lake subcatchment south of Berovo has the highest rates when averaged on the subcatchement level. The highest amount of phosphorus input (1.1 ton per year) was estimated for the subcatchment Bregalnica02. More detailed results for each surface water body can be found in

Annex A8. The high loss rates in the area around Berovo is on one hand due to moderate up to high potential soil loss rates, but more importantly are excessive fertilizer applications and high lifestock numbers compared to the agricultural land.

Looking at background phosphorus, 1’900 tons are delivered to the aquatic environment yearly based on the model calculations. However, as mentioned above, the vast majority is transported unaltered during heavy rain events and high water conditions. The spatial distribution of the emission rates corresponds to the phosphorus content in the topsoil.

7.5.5 Comparison of Phosphorus Sources and Fluxes

Rough estimates of the potential annual amount of phosphorus from sources such as communal waste water and animal manure production can be calculated and compared with fluxes into surface waters. Having a total number of inhabitants of about 160’000 and accounting for waste water from industries by adding another 10 % (16’000) as well as a population equivalent of 1.6 g phosphorus per day, the resulting annual amount would be around 100 tons total phosphorus per year. The main question regarding the flux into Bregalnica is the amount of wastewater actually reaching the river. There is not enough data to accurately answer this question.

On the other hand, having the number of animals in the Bregalnica catchment, the annual manure production and the P-content of the manure, the potential of lifestock’s phosphorus input can be calculated, leading to a result of about 1’400 tons total phosphorus per year. The phosphorus will be taken up partly by plants, accumulated in soils or transported to the watercourses by different ways. The used model accounts for the erosion flux and predicts that the yearly flux from fertilizer and livestock to surface water bodies is about 6 tons. Compared with the above mentioned potential, this value seems quite small and indicates that this source may not be an important pressure on a catchment-scale with proper manure application. Nevertheless, especially in sparsely populated areas with high phosphorus emissions (e.g. area south of Berovo, compare Figure 49), diffuse agricultural sources have a much higher potential to impair the water quality of the tributaries. This will especially be the case where: (i) manure heaps are not properly sealed; (ii) liquid manure enters watercourses; or (iii) solid manure is disposed of in excessive amounts close to watercourses. However, as no data on the spatial distribution of P-inputs from lifestock was available, the inputs were not treated as hotspots but assigned to the whole agricultural area. This lack of spatial data may lead to a significant underestimation of the flux.

7.5.6 Model Improvement and Extension

The phosphorus flux model covering phosphorus inputs in water bodies due to erosive processes could be further improved regarding data and processes included. Further data on phosphorus input in soils (manure application, fertilizer – plant uptake balances) should be collected with focus on amount as well as on spatial and temporal distribution.

Moreover, further research should be done regarding the amount and fate of "long term accumulation phosphorus" in soils, e.g. comparing the content of soil samples taken every fifth year at exact the same location. This would also allow making firm statements regarding the natural level of phosphorus in soils.

Furthermore, sediment deposition and hydrological connectivity with water bodies should also be considered.

8 Economic Analysis

8.1 Introduction

According to articles 66 and 71 of the Macedonian Law on Water, and in line with articles 5 and 9 of the EU WFD, the Bregalnica RBM Plan should comprehend an economic analysis of the water use. The economic analysis gives an overview of the actual and future cost recovery for water services incl. environment and resources costs. In addition, it should be ensured "that water-pricing policies provide adequate incentives for users to use water resources efficiently, and thereby contribute to the environmental objectives" (Art. 9, WFD). Therefore the prices for the different water uses e.g. industry, households, and agriculture should be set at a level that they contribute in an adequate way to the recovery of the costs for water services. In this way it should be possible to implement the user pays principle.

The contents and the degree of accurateness of the economic analysis are described in Annex III of the WFD. According to this WFD Annex, the degree of detail of the information should depend on the costs associated with the data collection; and current and future investments in the water services should be estimated.

Considering the above background, three main domains are the basis for the economic analysis:

- **Economic use of water resources**: Which costs and benefits are connected to the water resource uses? Which are the economically relevant sectors depending on water resources today and in the future?
- **Financial sustainability of water infrastructure**: Which are the current financing models for water infrastructure? Are they sustainable? Which investments have to be expected for the future? How should the financing models look like?
- **Economic side effects of water uses**: Which positive and negative side effects are connected to water uses? Can those side effects be monetized?

8.2 Approach and Data Collection

Presently, data availability is still too limited to fully appraise the financial sustainability of different water uses in the Bregalnica river basin. In all water use domains, the data scarcity for assessing the costs and benefits of water resource uses or estimating the economic side effects of water uses is pronounced. For industrial and agricultural water uses, sufficient data for reliably assessing costs and benefits of according infrastructure are presently not available.

Therefore, the current analysis focuses on water supply and wastewater services and specifically on two topics, the financial sustainability and commercial efficiency of water supply and sanitation services.

Economic and financial indicators to be applied nation-wide for water supply and wastewater services are currently proposed as part of the draft tariff setting methodology which is a by-law to the Law on Setting of Water Service Prices.[5)]

The following indicators are taken from the draft version of the tariff setting methodology. They concern financial sustainability and commercial efficiency of the public utilities in charge of water and wastewater services. They are used for the subsequent financial analysis.

- Total operational costs for water and wastewater services, in MKD[6)]
- Total collected operating revenues for water and wastewater services, in MKD[7)]
- Cost coverage (collected) i.e. total collected operating revenues / total operational costs, in %
- Total accounts receivable and total accounts payable, in MKD[8)]
- Days receivable and days payable, in days[9)]
- Average water supply and wastewater tariffs for domestic customers (MKD/m^3) and corporate customers (MKD/m^3). Corporate customers include industrial, commercial and institutional customers if not indicated otherwise.

The data used for this analysis was collected from all 15 municipal utilities in the Bregalnica river basin in March/April 2016 through a questionnaire and subsequently validated by the project team. Data was sought disaggregated by customer group and by the two services water supply and wastewater.

Data collection proved to be very difficult. Utilities provide other municipal services e.g. solid waste management, funeral services, street cleaning etc. In consequence, costs and revenues in many utilities are not available disaggregated by service. Personnel costs are not assigned in a standardized way to the different services / costs centres. The data has the following limitations:

- Cost and revenue data for water and wastewater services is available only from 10 of 15 utilities. The other 5 utilities provided data of utilities' overall costs and revenues.
- The accounts receivable and payable are taken from the utilities balance sheets which include figures which are aggregated across different services. Therefore data on accounts receivable and payable refer to the utility as a whole.

5) The Law on Setting Water Service Prices was approved by the Macedonian Parliament on 15th January 2016. It includes the methodology and procedure for setting the tariffs for water / wastewater service provision and the establishment of a regulatory commission. See: Tariff setting methodology, draft version March 2016.

6) Total operational costs including personnel costs, debt servicing and maintenance costs, excluding costs of support services and excluding depreciation (source: income statement)

7) Total collected revenues excluding connection fees, reconnection fees, other operational revenues, subsidies, and all taxes (source: income statement)

8) Total of all accounts *receivable* at year end including water billings, and all other outstanding invoices; Total of all accounts *payable* to suppliers, taxes and employee benefits. (source: balance sheet)

9) Accounts receivable / (total collected revenues/360) (source: balance sheet and income statement)

- Population density is calculated with estimated current population (2015) based on data from the 2002 census and sub-regional growth rates published by the State Statistic Institute.

8.3 Water Supply and Wastewater Services

Figure 50 shows the volumetric tariffs for domestic customers for water supply (WS) and wastewater (WW) services and the changes between 2012 and 2015. These numbers are excluding lump-sum amounts for wastewater services (concerns Cesinovo-Oblesevo and Konce) and the tariffs of the largest settlement within the 15 municipalities are used.[10] The following changes occurred over this period:

- Six out of 15 utilities increased their WS tariffs in the last three years; five of those six also increased their WW tariff.
- When analysing those utilities which increased their WS tariff: those which had relatively high WS tariffs already in 2012 increased their tariffs less in absolute terms compared to utilities which had a relatively low WS tariff in 2012.
- Comparing the increases of WS and WW tariffs in the five utilities concerned, the figure shows that in absolute terms the WW tariffs experienced a higher increase compared to WS tariffs in Kocani and Lozovo, while in Zrnovci, Pehcevo and Vinica the WS tariff experienced a higher increase compared to their WW tariffs.

The average WS tariff for domestic customers increased from 22.9 in 2012 to 25.3 MKD/m^3 in 2015, the WW tariff from 6.4 to 8.1 MKD/m^3 (excluding lump-sum amounts), the aggregated tariff thus from 29.3 to 33.4 MKD/m^3 which corresponds to 14.0%.

Figure 51 shows the tariffs for corporate customers for WS and WW services and changes between 2012 and 2015. The following changes occurred over this period:

- Six out of 15 utilities increased their WS tariff for corporate customers in the last three years, four of those six utilities also increased their WW tariff. One small-sized utility (Zrnovci) increased only the WW tariff while one medium-sized utility (Sveti Nikole) reduced the WW tariff for corporate customers.
- When looking at those utilities which increased their WS tariff, the cases where WS tariffs were at a relatively high level already in 2012 the increases in absolute terms were smaller compared to utilities which had a relatively low WS tariff in 2012.
- Comparing the increases of WS and WW tariffs in the four utilities concerned, the figure shows that in absolute terms the WW tariffs experienced a higher increase compared to WS tariffs in Kocani and Lozovo, while in Pehcevo and Vinica the WS tariff experienced a higher increase compared to their WW tariffs.

10) Three municipalities apply non-uniform tariffs i.e. smaller settlements within the municipalities have either lower (Sveti Nikole, Probistip for domestic users) or higher (Konce, Probistip for corporate users) tariffs.

The average WS tariff for corporate customers increased from 41.3 in 2012 to 45.3 MKD/m³ in 2015, the WW tariff from 10.4 to 13.4 MKD/m³ (excluding lump-sum amounts), the aggregated tariff thus from 51.7 to 58.7 MKD/m³ which corresponds to 13.5%.

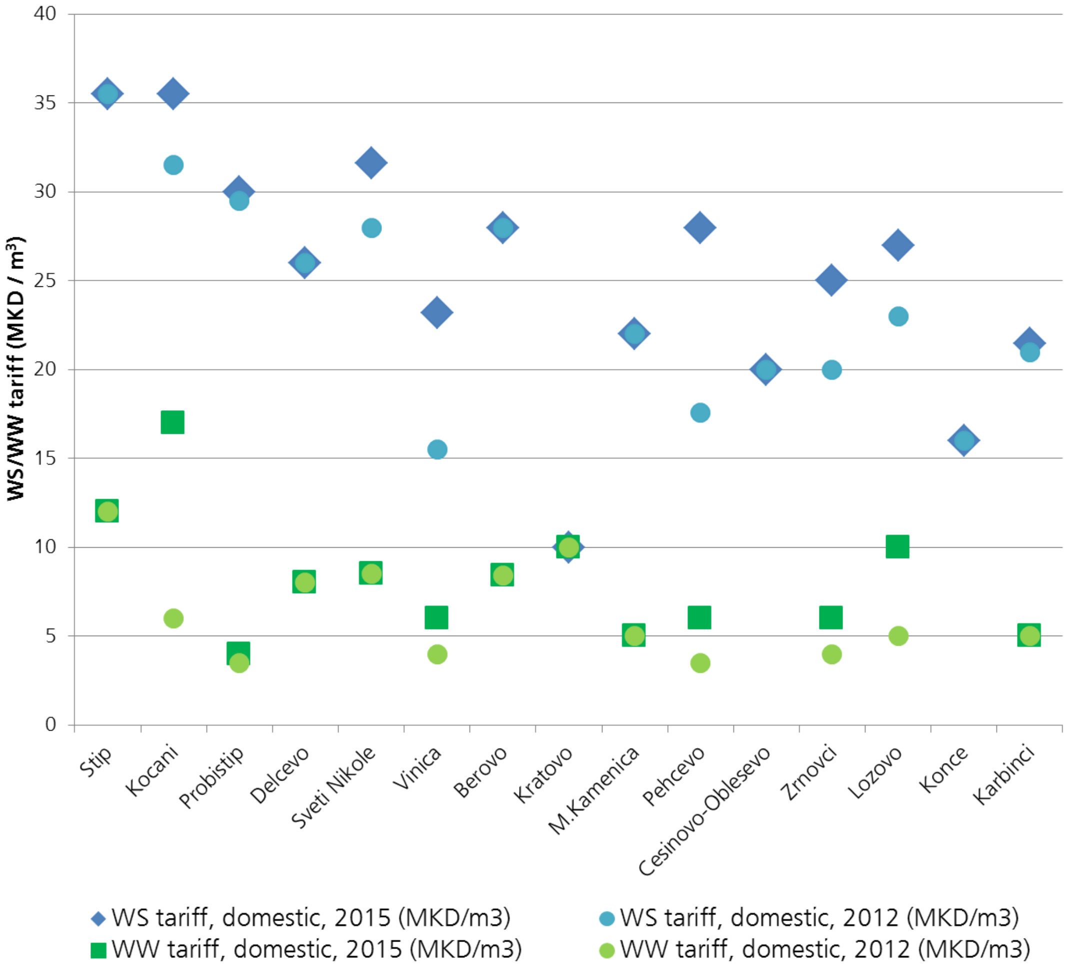

Figure 50: Tariffs for water supply and wastewater services for domestic customers and changes between 2012 and 2015

Notes: The municipalities are ordered according to decreasing WS tariff in 2012 from left to right. Cesinovo-Oblesevo charges lump-sum amounts for WW services for domestic customers (MKD 50/customer/month). Konce charges lump-sum amounts for WW services for all customers (MKD 50/customer/month). Kratovo charges one tariff for WS and WW services for domestic customers (20 MKD/m³).

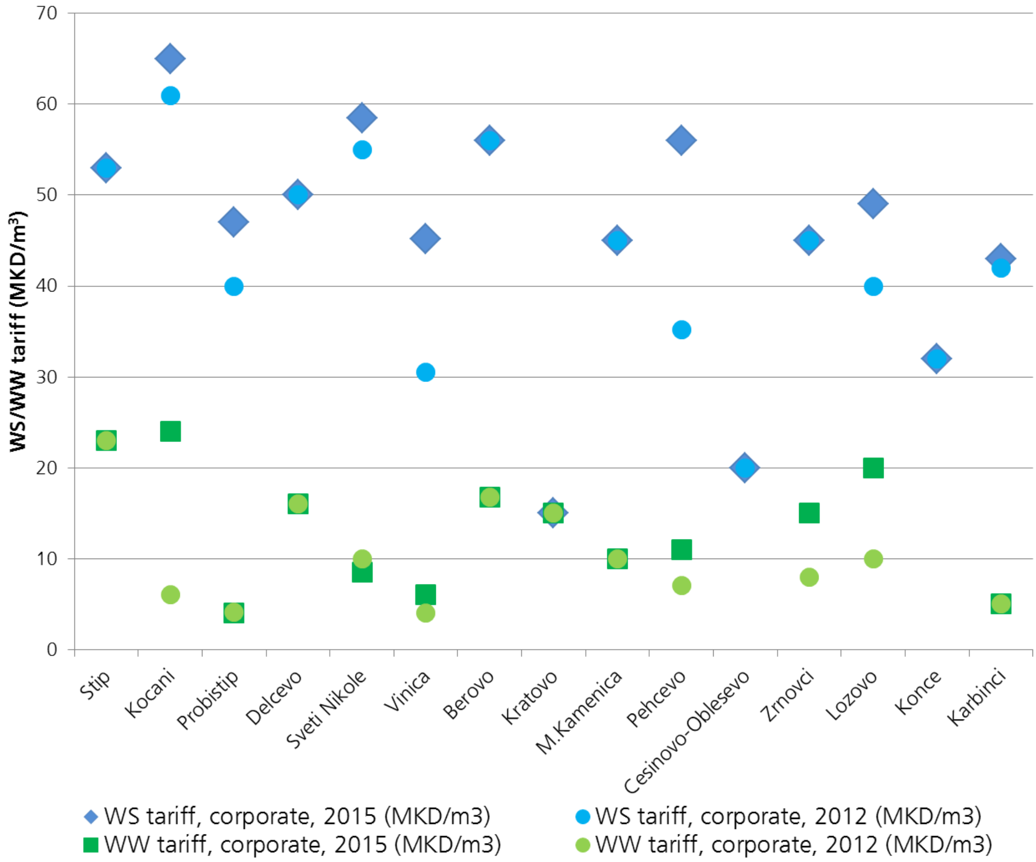

Figure 51: Tariffs for water supply and wastewater services for ***corporate customers*** *including institutional customers, changes between 2012 and 2015*

Notes: The municipalities are structured in the same order as in Figure 50. Cesinovo-Oblesevo charges lump-sum amounts for WW services for corporate customers (MKD 100/customer/month). Konce charges lump-sum amounts for WW services for all customers (MKD 50/customer/month). Kratovo charges one tariff for WS and WW services for corporate customers (30 MKD/m³).

The figures with tariff changes show further that water supply tariffs are generally higher than wastewater tariffs for both customer groups. Further, corporate customers pay higher wastewater tariffs i.e. 14 MKD/m³ compared to domestic users who pay 8.3 MKD/m³.

Among the municipalities which have increased their WW tariffs are Kocani and Lozovo: these two municipalities are currently improving their wastewater collection and treatment infrastructure.

Generally it can be concluded that a development towards increasing tariff is noticeable and that – given the current financial difficulties all utilities in the Bregalnica region – these increases represent an improvement because it increases the cost covering ratios.

Figure 52 shows the total operational costs per inhabitant served with at least water supply service. For some municipalities the operational costs are available for the WS and WW services, for others only for the whole utility. The municipalities are sorted by decreasing population served from left to right.

The figure shows a very limited correlation between decreasing numbers of inhabitants served and operational per capita costs of WS and WW services (red). However it remains unclear whether the figure for Berovo includes salary costs (as they are typically accounted for as utility overhead) and whether Lozovo and Karbinci refer to the overall utility services. The data related to the overall utility costs (blue) show no correlation with the number of population served.

The correlation should further be interpreted with caution because the service level i.e. whether there is wastewater treatment or not as well as the current status of infrastructure influences operational costs independent of their number of customers. Further also topography and actual clustering of settlements influences per capita operational costs e.g. pumping / electricity cost.

The figure also shows that municipalities with the largest settlements like Stip and Kocani had similar per capita operational costs in 2015.

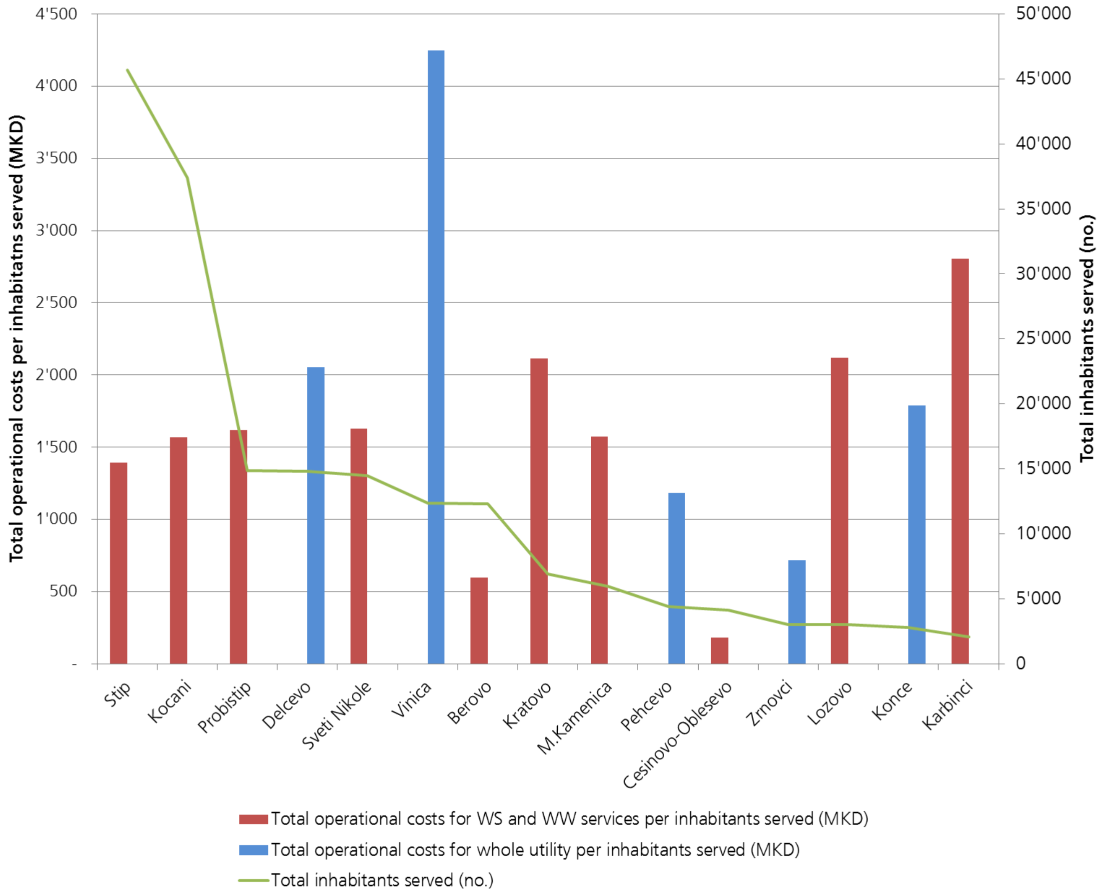

Figure 52: Total operational costs per inhabitant served (MKD, for year 2015) and total inhabitants served (number, for year 2013)
Note: The municipalities are ordered according to inhabitants served, decreasing from left to right.

Figure 53 shows a comparison of the population served with the cost coverage ratio i.e. operational costs versus collected revenues. Data aggregates all customer groups. The cost coverage figure refers to operational costs for WS and WW services except for Delcevo, Vinica and Konce which refer to operational costs of all utility services.

The cost coverage ratio indicates the utility's financial sustainability. As operational costs exclude capital costs (depreciation), a financially sustainable and therefore recommendable cost coverage ratio would be around 150% to 200%. The results may be summarized as follows:

- 10 of 15 utilities have cost coverage ratios between 100 and 150% which indicates that insufficient financial means related to asset renewal and extension are being accumulated.
- Three utilities have cost coverage ratios below 100% which is insufficient also for day-to-day operation: revenues do not even cover operational costs.
- Two municipalities (Stip, Berovo) have cost ratios above 200% and hence do have a revenue stream which allows infrastructure renewal with own financial capacity. However it could well be that bills invoiced before 2015 were collected in 2015 which would have increased the revenue stream in 2015.

In summary, current revenues manage in most cases to cover operating expenses but not allow the renewal or replacement of infrastructure with own means.

The figure further illustrates that there is no correlation between the size of the municipalities and their cost coverage.

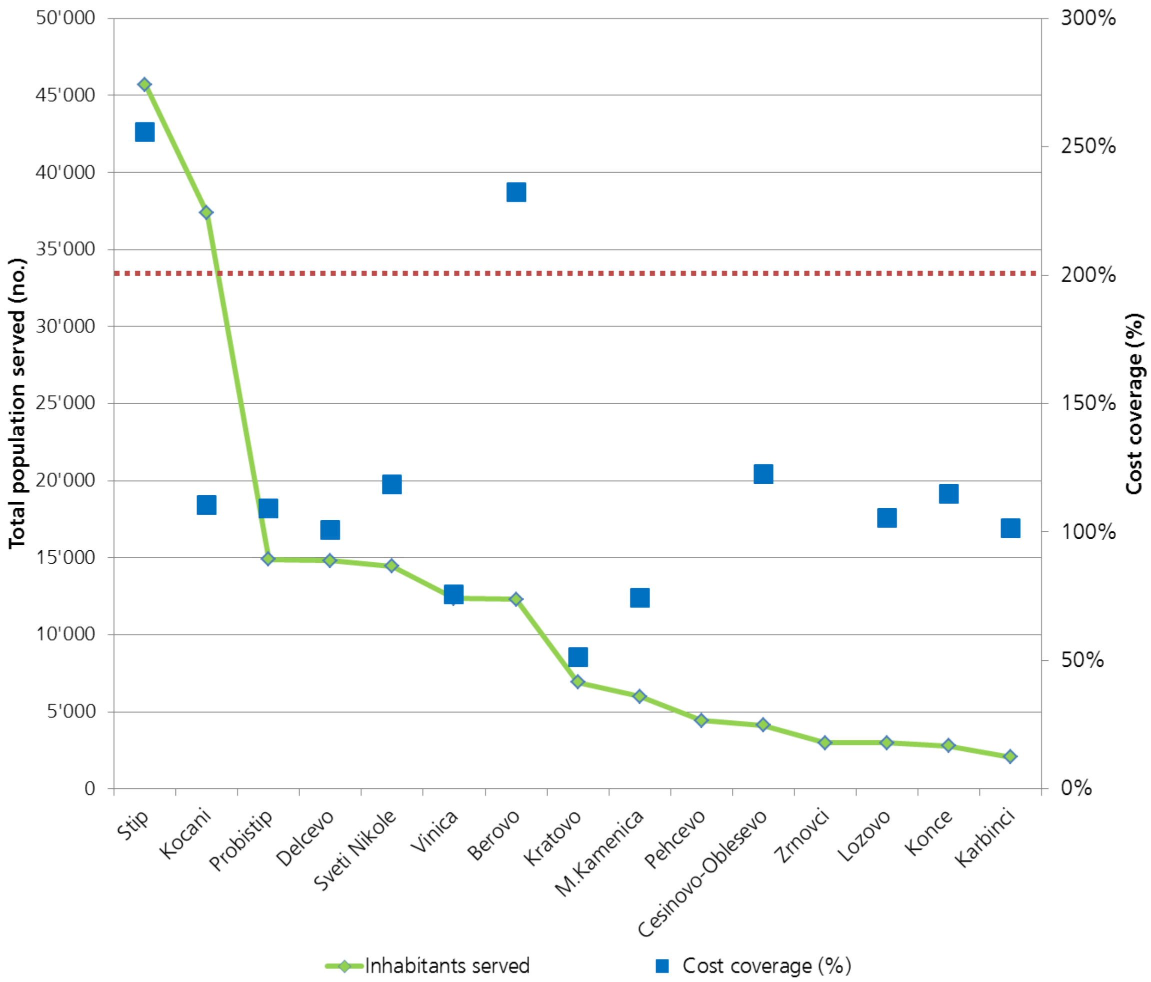

Figure 53: Inhabitants served and cost coverage for water supply and wastewater services (except Delcevo, Vinica and Konce data refer to the overall utility's cost coverage) for the year 2015.

Notes: The municipalities are ordered according to inhabitants served, decreasing from left to right. Data for Pehcevo and Zrnovci is not available.

Figure 54 shows accounts receivable and payable of the utilities. These figures are taken from the balance sheet of the utilities and thus include not only water and wastewater services but all services provided by that particular utility. The number of inhabitants served is the number of people served by at least water supply service.

The figure shows that:

- Utilities with large customer numbers - such as Stip and Kocani – also have large accounts receivable. Berovo for example shows a relatively good situation compared to the number of customers.
- Accounts receivable are typically higher than accounts payable (with two exceptions, Berovo and Pehcevo). This indicates that invoices are not sufficiently collected i.e. a low collection efficiency with a potential for improving commercial efficiency.
- Salaries and supplier invoices are paid faster than invoices issued to customers. More generally, the accounts payable are at a relatively low level except in Kocani. Low accounts payable make utilities reliable employers and partners for suppliers.

Overall this analysis shows that the accumulated debts – also referred to as "bad debts" – should be addressed on the national, regulatory level e.g. in the process of enforcing the new law on tariff setting and the establishment of a national water service regulator.

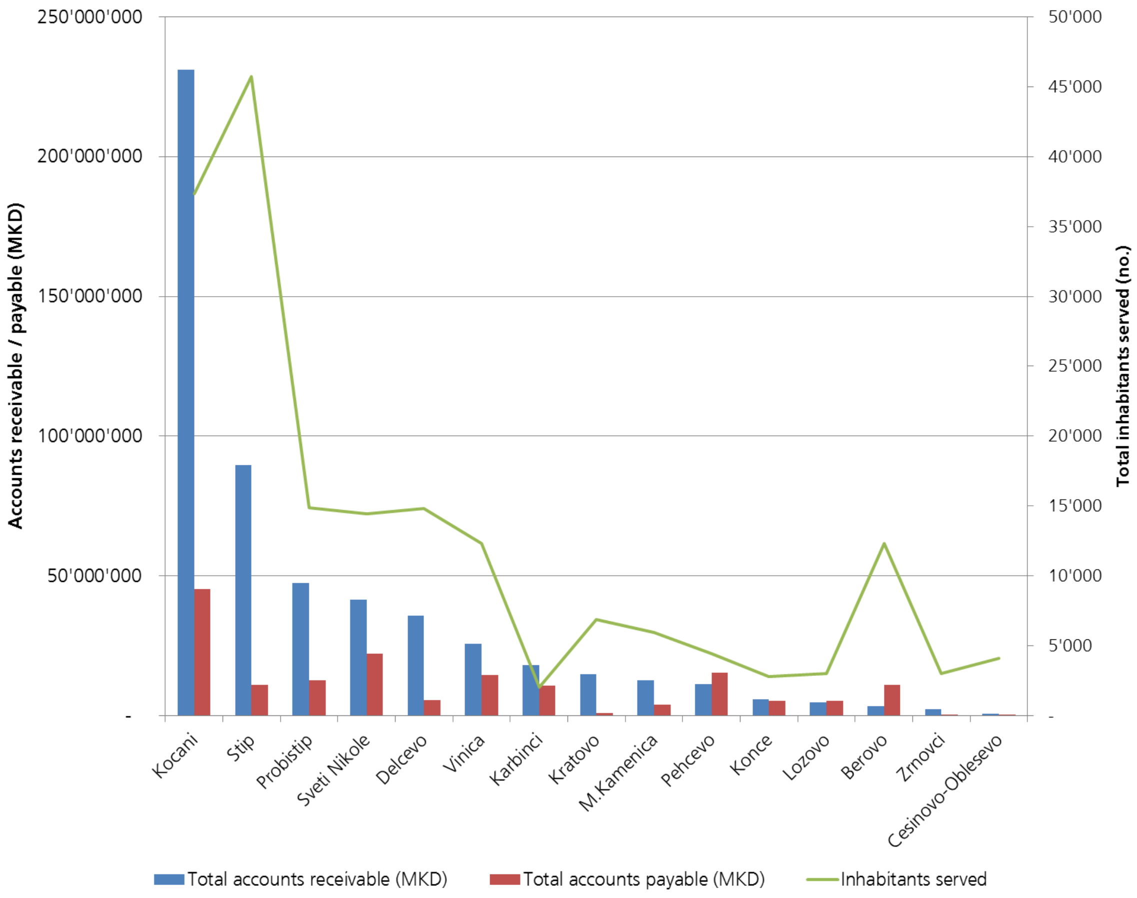

Figure 54: Accounts receivable and payable by end of 2015 (in MKD) compared to the total inhabitants served (number, figure for 2013).

Note: The municipalities are ordered according to total accounts receivable, decreasing from left to right.

8.4 Conclusions

The above financial analysis shows that water supply and waste water tariffs have increased between 2012 and 2015 in some of the municipalities. Tariffs are generally higher in municipalities with urban centres. Differences of tariffs continue to exist which seem to correlate to some extent with the service level especially regarding wastewater treatment. With investments to renew or improve infrastructure further tariff adjustments will be necessary.

Operational cost coverage levels are typically between 100% and 150% which indicates that current revenues manage to cover operating expenses in most cases but are insufficient for the renewal or replacement of existing infrastructure. As counter measures the tariff setting process should more thoroughly reflect capital costs and renewal of infrastructure. The generally low, patchy and irregular investment volumes in water infrastructure indicate that financial sustainability of capital costs is not assured yet. However, more in-depth analysis will be required to quantify the necessary re-investments.

The accounts receivable vary widely between the 15 different utilities but correlate with the inhabitants served. This points at a poor commercial efficiency i.e. the ability to effectively collect invoiced water bills. Also the problem of bad debts should be solved in order to get realistic annual depreciation costs.

In terms of data quality the analysis proved that data consistency and thus comparability is limited and that cost centre accounting – which is being promoted by the new law on water services - is not yet established in these utilities. For instance the assignment of personnel costs to different municipal services is not done systematically – if at all. Thus, present data gaps on full costs prevent an evidenced based introduction of the full cost recovery principle and an according design of financing models.

For the three domains of the economic analysis (economic use of water resources, financial sustainability of water infrastructure, economic side effects of water uses) the following gaps related to data availability exist and are recommended to be addressed for the next update of this RBMP:

- More detailed data to analyse and economically valuate the current/future benefits deriving from water uses as well as the current/future costs i.e. investments and recurrent expenses for water resource management.[11)]
    - Benefits of water uses, economic valuation of: access levels to water and sanitation services; level of continuous water availability for different water use sectors; water quality data, residual flow and other ecological indicators
    - Costs of water uses, economic valuation of: financial, environmental and resource costs related to water uses i.e. investments and recurrent costs of infrastructure, costs related to environmental degradation and opportunity costs of water resource use
- More detailed financial analysis to analyse the current cost-recovery levels of water services i.e. compare taxes, tariffs or fees paid for water services with total costs of water service provision including environmental and resource costs. Tariff changes over time should be compared with data about the service quality. The focus will have to be laid on:
    - Establishing consistent data gathering processes and respective capacity building at utility level,
    - Establishing sound tariff setting processes, and
    - Designing sustainable and practical business plans including financial plans.

11) The role of economic valuation in the WFD is described in chapter 2 of the "Scoping Study on the Economic (or Non-Market) Valuation Issues and the Implementation of the WFD", http://ec.europa.eu/environment/water/water-framework/economics/pdf/Scoping%20Study.pdf [accessed 03.60.2016]

The objectives should be to achieve a user fee based recovery of operational costs including capital costs for priority investments, and the establishment of commercial activities which actually generate the necessary revenue streams. This process shall be established under the new Law on Setting of Water Service Prices.

- Economic side effects may best be analysed based on concrete measures (i.e. for the Program of Measures), for instance its impact on public health (reduction of water-borne diseases), regional increase of employment and technological innovations through investments in water resources, improvement of social equity through improved access to water and sanitation.

9 Program of Measures

9.1 Introduction

The following chapter gives a detailed overview of the planned measures for managing water and land uses responsible for the pressures on water quality, water flows and levels and stabilization of bed and banks in the Bregalnica river catchment. The top ten priority domains for managing these pressures from households, industry, agriculture and other sectors to achieve the environmental objectives were identified. Within those priority domains and within the legislative framework of the Program of Measures, the necessesary actions to avoid the deterioration of the status of its water bodies and to achieve a good status or a good environmental potential for all its water bodies were compiled also consulting existing plans and programs.

9.2 Legislative Framwork

According to the Water Law (Art. 73), the Program of Measures shall foresee measures appropriate to:

- reduce discharges and emissions of pollutants
- progressively reduce discharges, emissions and losses of individual pollutants or groups of pollutants presenting a significant risk to the aquatic environment, including drinking water (priority material and substances)
- introduce cessation and phasing out of discharges of priority hazardous substances
- remedy or mitigate the effects of any pollution of the waters, riparian land and wetlands
- restore the natural status of any body of water in case this is feasible and would not entail disproportionate cost, or if this would not have significant adverse effects on the environment, the navigation and recreation, storage of water for drinking supply, irrigation and power generation, water flow regulation and flood protection, as well as other important activities of human development
- improve the characteristics of artificial and heavily modified bodies of surface water bodies

The control of discharges in surface waters shall be based upon a combined approach for both point and diffuse sources of pollution, focusing upon the following criteria as set throughout this law:

- emission controls based on best available techniques and
- introduction of relevant emission limit values
- in case of diffuse impacts, as appropriate, best environmental practices

Such measures and criteria are well in line with the EU WFD requirements (Art. 11) for a Program of Measures.

9.3 Priority Domains for Measures

An overview on priority domains for measures, the expected effects and priority for the Bregalnica RBM Plan, based on the present water body status and pressures, is shown in Table 17.

	Water Quality	Water Flows and Levels	Fish Migration, Beds and Banks
Households	Land use control		
Households		Water use regulation	
Households		Water use efficiency	
Households	Solid waste management		
Households	Wastewater treatment		
Households			Flood control
Industry	Land use control		
Industry		Water use efficiency	
Industry	Control of hazardous substances		
Industry	Wastewater treatment		
Industry	Solid waste management		
Industry			Flood control
Agriculture	Land use control		
Agriculture	Tilling techniques and soil erosion control		
Agriculture		Water use regulation	
Agriculture		Water use efficiency	
Agriculture		Crop selection	
Agriculture	Pesticides and fertilizers control		
Agriculture	Drainage control		
Other Pressures	Land use control in forestry and on pastures		
Other Pressures		Water abstraction control in hydropower generation	
Other Pressures	Soil erosion control in forestry and on pastures		
Other Pressures			Extraction control in mines and quarries
Other Pressures	Sludge control in mines and quarries		

Table 17: Priority domains for measures in the different pressure categories; medium and light shading show main and side effects, respectively; top ten priority domains for the Bregalnica RBM Plan are framed in red

9.4 Specific Measures

9.4.1 General Remarks

The Progam of Measures aiming at the achievement of the environmental objectives contains a list of necessary actions. As a preliminary step, gaps between the baseline scenarios (present state) and the expected scenarios (state with environmental objectives achieved) were identified. If improvements are required in one of the priority domains, measures were defined, also by consulting existing plans and programs of authorities (e.g. Regional Plan for Solid Waste Management, Municipal Investment Plans).

Besides the technical and environmental aspects regarding the management of pressures on the water environment, the following factors were also taken into account:

- the as yet insufficiently developed and inconsistent legal and regulatory framework
- the lack of fully clarified roles and responsibilities in the organisational structure
- the need to improve institutional capacity

A large part of pressures identified, both regarding water quality and quantity, are the result of poor implementation or non-implementation of adopted laws and regulations. Accordingly, some of the defined measures aim at a better implementation of already existing regulations.

A number of identified gaps will be overcome by a full implementation of the provisions of the new Law on Water. This applies to water rights and permissions for water use, registration and record-keeping of all water abstraction and use, discharges into water bodies, sustainable financing of the water sector.

Some amendments to the Water Law are needed to enable the enactment and enforcement of the principles of polluter/user pays and full service cost recovery in the water sector and thus to ensure the successful and sustainable implementation of the RBM Plan.

The identified measures were scrutinized and assigned to a RBM time cycle of 6 years according to the environmental objectives, which demand a completion of the measures either by 2015, 2021 or 2027. Within the RBM cycle, the measures were prioritized according to the following categories:

1	• Full implementation of the provisions of the existing Law on Water: e.g. water rights and permissions for water use, registration and record-keeping of all water abstraction and use, discharges into water bodies, sustainable financing of the water sector • Enactment and enforcement of the principles of polluter/user pays and full service cost recovery in the water sector • Actions tackling high input of pollutants from point sources
2	• Actions tackling medium input of pollutants from point sources or input from diffuse sources
3	• Actions with minor / local (positive) effects

Table 18: Priorization of measures within the 6-year RBM cycle

The Program of Measures shall be updated at least every 6 years. If a measure cannot be completed within the specified time cycle, it might be revised and included in the updated program. However, the priority of these measures will not automatically increase.

Listed below are the key measures grouped according to the priority domains. If more than one RBM cycle is selected for completion, the associated submeasures aim at different completion dates. For a more detailed list containing all identified sub-measures including cost estimates, refer to Appendix A15.

9.4.2 Measures on Water Quality

Wastewater treatment

Improvements regarding the following issues are required:

- High input of nutrients and hazardous substances from housholds and industries
- Insufficient connection to sewage networks, insufficient collection of wastewater from housholds and industries as well as separation of stormwater collection systems
- Lack of regulation of discharges

Nr.	Measure	2015	2021	2027	Responsible	Action on the ground	Indicators
1.1	Small Infrastructure projects • First call • Second call	1			BRBMU	Municipality	# of completed projects
1.2	Construction of WWTP – Municipalities with more than 15'000 PE *Completed by 2021:* • WWTP Kocani • WWTP Vinica *Completed by 2027:* • WWTP Delcevo • WWTP Probistip • WWTP Stip		1	1	MOEPP	Municipality	% of treated communal waste water # of designed WWTP
1.3	Construction of WWTP – Municipalities with 2'000 to 15'000 PE		2		MOEPP	Municipality	% of treated communal waste water # of designed WWTP
1.4	Construction of WWTP – Municipalities from 0 to 2'000 PE		2		MOEPP	Municipality	% of treated communal waste water # of designed WWTP
1.5	Extension of existing waste water networks and collectors • Rehabilitation, reconstruction, completion of seawage networks • Collection of wastewater	2	2		MOEPP	Municipality	% of population covered
1.6	Separation of rainwater and sewage networks		3		MOEPP	Municipality	% of separated network
1.7	Rehabilitation/reconstruction of existing WWTPs		2		MOEPP	Municipality	# completed rehabilitation projects
1.8	Development of ordinances to regulate discharges		2		MOEPP	MOEPP	% of completion
1.9	Implementation of ordinances for discharges		2		MOEPP	MOEPP	% of completion

Table 19: Key measures for tackling point source pollution from wastewater. PE=Population Equivalent

Solid waste management

Improvements regarding the following issues are required:

- Improved solid waste management to avoid illegal disposal
- Reduction of pollution of soil and water courses due to communal, industrial and agricultural waste
- Significant reduction of leaking landfills and dumps

Nr.	Measure	2015	2021	2027	Responsible	Action on the ground	Indicators
2.1	Establishment of efficient systems for agricultural solid waste management • Collection of solid waste (e.g. fertilizer bags) • Washing location for equipment • Bio residue managment		1		MOEPP	Municipality	% of treated solid waste generated from agricultural activities
2.2	Integrated Solid Waste Management - Municipalities East Planning Region • Rehabilitation of landfills with (very) high risk • Public awareness campaigns • Replacement of equipment • Construction of landfills		1		EPR	Municipality	% of plan implemented

Table 20: Key measures for tackling point source pollution from solid waste

The MOEPP Project "Preparation of regional waste management plans and strategic environmental assessments for east and north-east regions", prepared in 2014 with EuropeAid support, defined four waste management scenarios (including sub-scenarios). The scenarios were based on specific objectives and the recent national legislation for waste management. They take into account the regional waste production and composition as well as the existing waste system infrastructure.

In the following table, the investment and operating cost of each scenario as calculated in the project are given:

Scenario	**Investment Cost** (EUR/year)	**Investment Cost** (MKD/year)
Scenario 1a/East Region	15’127’902	930’860’640
Scenario1b/East & North East Regions	94’888’459	5’838’743’103
Scenario 2/East Region	13’609’541	837’431’817
Scenario 3a/East Region	13’915’905	856’283’209
Scenario 3b/East Region	17’046’046	1’048’889’236
Scenario 3c/East & North East Regions	91’116’926	5’606’670’478
Scenario 4/East Region	13’315’934	819’365’369

The project also investigated three models of landfill remediation. A summary of the costs for implementing the remediation activities as calculated in the project is given in the table below:

	Model “A” (in EUR)	**Model “B”** (in EUR)	**Model “C”** (in EUR)	**Total** (in EUR)
East Region	131’785	1’529’177	2’810’560	4’471’522

Control of hazardous substances / Sludge control in mines and quarries

Improvements regarding the following issues are required:

- Lack of implementation on IPPC A and B environmental permits
- Lack of implementation of emission limits of urban wastewater according to permits
- Lack of knowledge and management regarding contaminated soils

Nr.	Measure	2015	2021	2027	Responsible	Action on the ground	Indicators
3.1	Ensuring enforcement of the IPPC environmental permits regime		1		MOEPP	Industries, Inspectors	# of IPPC A permits
3.2	Enforcement of the IPPC A environmental permits regime		1		MOEPP	Industries, Inspectors	# of IPPC A permits
3.3	Enforcement of the IPPC B environmental permits regime		1		Municipalities	Industries, Inspectors	# of IPPC B permits
3.4	Enforcement of the emmision controls of urban waste water		1		MOEPP Municipality	MOEPP, Municipality	# of municipalities in full compliance with the regulations
3.5	Management of contaminated soils / areas • Inventory of contaminated soils • Plan for treatment of contaminated soils • Replacement of equipment • Remediation of hotspots		1	1	MOEPP	MOEPP	% of management plan completed % of remediated / rehabilitated hotspots according to plan

Table 21: Key measures for tackling point source pollution of hazardous substances from industries (incl. mines and quarries)

IPPC implementation is expected to be simultaneous with the implementation of the Bregalnica RBM Plan. The IPPC operational permits will regulate discharges into the environment and water bodies, thus significantly decreasing the input of pollutants in the region.

At regional and municipal level, installations subject to IPPC B have been identified and the harmonization of their operational permits is an on-going process. It must be emphasized that the implementation of IPPC A and B permits will not be the responsibility of national and local institutions, except for an improved monitoring of this implementation. The implementation costs will be fully borne by the installations' operators subject to these regulations.

Tilling techniques and soil erosion control

Improvements regarding the following issues are required:

- Land management not according to best practice
- High soil loss rates and sediment yields due to bare soils and improper tilling techniques
- Insufficient knowledge of soil protection measures

Nr.	Measure	2015	2021	2027	Responsible	Action on the ground	Indicators
4.1	Improved land management systems • Reduced or no-tillage system • Contour farming system		2		MAFWE	NEA (National Extension Service, Farmer associations)	# of ha cultivated with reduced or no tillage # of ha cultivated with contour farming system
4.2	Depletion of surface run-off quantities and sediment loss • Non-tilling buffer zones alongside water courses • Cover crops and mulching in vineyards and orchards		2		MAFWE	NEA (National Extension Service, Farmer associations), Municipalities	# of ha of vineyards and orchards with cover crops # of km of buffer zones established
4.3	Education on practices related to soil erosion control • Maintenance of organic matter, soil stability and infiltration rate	2	2		MAFWE	NEA Scientific community	# of trained extension officers # of trained farmers

Table 22: Key measures for tackling diffuse pollution and high sediment input in water courses due to land management

Pesticides and fertilizers control

Improvements regarding the following issues are required:

- Leaching of pesticides in waterbodies, both surface and ground water
- Inputs of organic waste into the water environment
- Poor land management practices in agricultural production
- Risk of accidental contamination of water courses

Nr.	Measure	2015	2021	2027	Responsible	Action on the ground	Indicators
5.1	Install buffer zone alongside water-courses		2		MAFWE	Farmers	# area of buffer zones # of educated farmers
5.2	Educate farmers for proper use of pesticides and waste disposal		2		MAFWE	Farmers	# of educated farmers - reduced concentration of pesticides in groundwater
5.3	Management of livestock and waste stores - controll access of livestock to surface waters - manage waste stores to mini-mise losses to water environment		2		MAFWE	Farmers	# of farmers working according to best practice
5.4	Training for improvement of fertilizer and pesticide use efficiency		2		MAFWE	NEA, Scientific community	# of soil analysis # of farmers performing soil analysis % of arable land cov-ered a permanent control system # of prepared plans for fertilisation # of farmers implement-ing recommenda-tions of fertilisation plans
5.5	Integrated rice production for opti-misation of: pest control and wa-ter and fertilizer use efficiency			2	MAFWE	NEA, Scientific community	% of rice fields imple-menting integrated rice production # of farmers adopting integrated rice pro-duction
5.6	Integrated production in protected environment (greenhouses and plastic houses)			2	MAFWE	NEA, Scientific community	% of rice fields imple-menting integrated rice production # of farmers adopting integrated rice pro-duction
5.7	Integrated vine and orchard produc-tion for optimisation of: pest control and water and fertilizer use efficiency			2	MAFWE	NEA, Scientific community	% of rice fields imple-menting integrated rice production # of farmers adopting

Nr.	Measure	2015	2021	2027	Responsible	Action on the ground	Indicators
							integrated rice production
5.8	Training for implementing of GAP standards and AE measures in practice			2	MAFWE	NEA, Scientific community	# of trained extension officers # of trained farmers

Table 23: Key measures for tackling diffuse pollution from pesticide and fertilizer applications

Soil erosion control in forestry and on pastures

Improvements regarding the following issues are required:

- Soil erosion and land degradation
- Poor nutrient supply

Nr.	Measure	2015	2021	2027	Responsible	Action on the ground	Indicators
6.1	Afforestation of deforested and degraded forest areas			1	MAFWE	Municipality, PE Macedonian forests	# of ha of afforested land
6.2	Terracing and afforestation of deforested sloped terrains			1	MAFWE	Municipality PE Macedonian forests	# of ha of newly terraced agricultural area
6.3	Enforcement of sustainable land management • Maintenance and cleaning of pastures and range lands • Implementation of agro-forestry • Construction and maintence on gullies, gaps and streams		2		MAFWE	Municiplaity, MAFWE	# of ha of maintaned natural grassland and rangeland # of regulated streams and gullies # of ha of land coverd with agro-forest system of cultivation
6.4	Training on implementing of good management practices for protection of forest and forest ecosystem services		2		MAFWE	NEA, Scientific community	# of trained extension officers # of trained farmers # of trained inspectors

Table 24: Key measures for tackling diffuse pollution and high sediment input in water courses from forestry and pastures

9.4.3 Measures on Water Flows and Levels

Water use regulation

Improvements regarding the following issues are required:

- Poor irrigation practices, inefficient water use and water supply systems
- Insufficient implementation of cost recovery principle
- Insufficient control of water abstractions

Nr.	Measure	2015	2021	2027	Responsible	Action on the ground	Indicators
7.1	Preparation of groundwater cadaster		1		MOEPP	MOEPP	% of cadaster completed
7.2	Water abstraction control		1		MOEPP	MOEPP	# of water rights renewed/issued % of boreholes covered
7.3	Implementation of running cost recovery principle		1		MOEPP	Municipality	% of water services costs recovered
7.4	Improved inspection of water use/water rights on surface and groundwater, concessions, discharges		1		MOEPP, MAFWE	MOEPP, AFWE, Municipality	# of inspections
7.5	Construction of the dam Recani on the Orizarska River - Kocani		1		Government	Municipality	# population covered annual savings [Mm³ or MKD or kWh]
7.6	Rehabilitation of the dam Pisica in Probistip		1		Government	Municipality	# population covered annual savings [Mm³ or MKD or kWh]
7.7	Modernization of irrigation systems			1	MAFWE	Municipality	% of revitalised irrigation schemes, # of newly irrigated area
7.8	Replacement of gravity irrigation (surface and furrow) irrigation with pressurized irrigation systems (drip irrigation and microsprinklers) irrigation		2	2	MAFWE	Farmers	% of irrigated plantations with upgraded irrigation systems
7.9	Training on implementation of advanced irrigation technologies and practices		2		MAFWE	NEA, Scientific community	# of trained extension officers # of trained farmers
7.10	Extension of irrigation systems		2		GoM, MAFWE	HMS Bregalnica	Irrigated area [ha]
7.11	Improvement of water supply systems • Extension and rehabilitation of existing systems • Construction of new systems		2		GoM	Municipality	# population covered

Table 25: Key measures to reduce pressure from water abstraction

9.4.4 Measures on River Bed and Bank Stability

Flood control

Improvements regarding the following issues are required:

- Flood protection
- Erosion protection
- Maintenance of drainage network

Nr.	Measure	2015	2021	2027	Responsible	Action on the ground	Indicators
8.1	Elaboration of a management plan / reservoir operation rules for reservoirs: Ratevo, Kalimaci, Gratche and Mavrovica		1		MOEPP	HS Bregalnica	# of reservoirs with management plans
8.2	Elaboration of a technical documentation for protection and stabilization of Bregalnica River watercourse		1		MOEPP, MAFWE	HS Bregalnica	# of Bregalnica River sections with technical documentation
8.3	Regular maintenance of drainage canals in Kocani Valley and in Ovce Pole		1		MAFWE	HS Bregalnica	Improved carrying capacity of canals (m^3/s)
8.4	Elaboration of Bregalnica catchment flood protection plan		1		MOEPP, Municipality	MOEPP Municipality	Plan elaborated
8.5	Update of urban planning measures for flood protection			1	MOEPP, APP[12)]	Municipality	# of Urban Plans updated
8.6	Sediment and erosion control for Bregalnica River		2		MOEPP	MOEPP	% of study on sediment transport completed # of permits/water rights issued based on study
8.7	Promoting insurance from flooding for population and goods, including agricultural insurance			3	GoM MAFWE	Municipality, Farmers Associations	# of farms insured # of insurance policies

Table 26: Key measures for flood control

12) Agency for Physical Planning (under MOEPP)

9.4.5 Miscellaneous Measures

The following measures are not domain specific.

Management of protection zones

Improvements regarding the following issues are required:

- Protection of groundwater and surface water for drinking water use
- Protection of nature

Nr.	Measure	2015	2021	2027	Responsible	Action on the ground	Indicators
Management of Protection zones							
10.1	Establishment / proclamation of water protected zones / areas	1			MOEPP	Municipality	# of protected zones established
10.2	Re-evaluation and proclamation of nature protection areas		2		MOEPP	Municipality	# of protected zones established
Monitoring							
11.1	Establishment of monitoring of waters – operational / regular annual monitoring	1	1	1	MOEPP	BRBMU, AHMW[13)], HS Bregalnica, HS Zletovica	# of monitoring samples and analyses
11.2	Investigative monitoring	1	1		MOEPP		# of monitoring samples and analyses
11.3	Monitoring of nature protection areas		2	2	MOEPP	Nature Conservation Department	# of campaigns completed
Economic analysis							
12.1	Economic analysis of water use		1		MOEPP		# of analysis completed

Table 27: Key measures for Management of Protection zones, Monitoring and Economic analysis

13) Administration for Hydro-Meteorological Works (under auspices of MoAFWE)

9.5 Proposed Monitoring

To be able to further assess the quantitative and qualitative situation of the water bodies in the Bregalnica river basin, a continuation of surveillance, operational and investigative monitoring will be needed for surface water as well as for groundwater.

The surveillance monitoring will support the indentification of long term trends in natural conditions as well as caused by anthropogenic activity and will confirm the good status of the bodies not being at risk.

The operational monitoring will allow the assessment of the bodies at risk and of the effectiveness of the programme of measures.

The investigative monitoring will be implemented in specific and/or exceptional cases, e.g. in the case of accidents or when the source of pollution is unknown.

The different kinds of monitoring will expand the data base and help to further improveme the characterization and understanding of the basin.

9.5.1 Surface Water

Most surface water bodies have a poor or bad water body status. The most critical parameters are: algae, macroinvertebrates, fish, total phosphorus, phosphates, and phthalates.

Surveillance monitoring

The surveillance monitoring shall be done once per cycle, i.e. once in a six years period. All monitoring points that were already measured in the first cycle of the RBM Plan for the surveillance monitoring shall be included as shown in Figure 55. The scope of the monitoring program and the parameters respectively shall correspond to those of the first cycle.

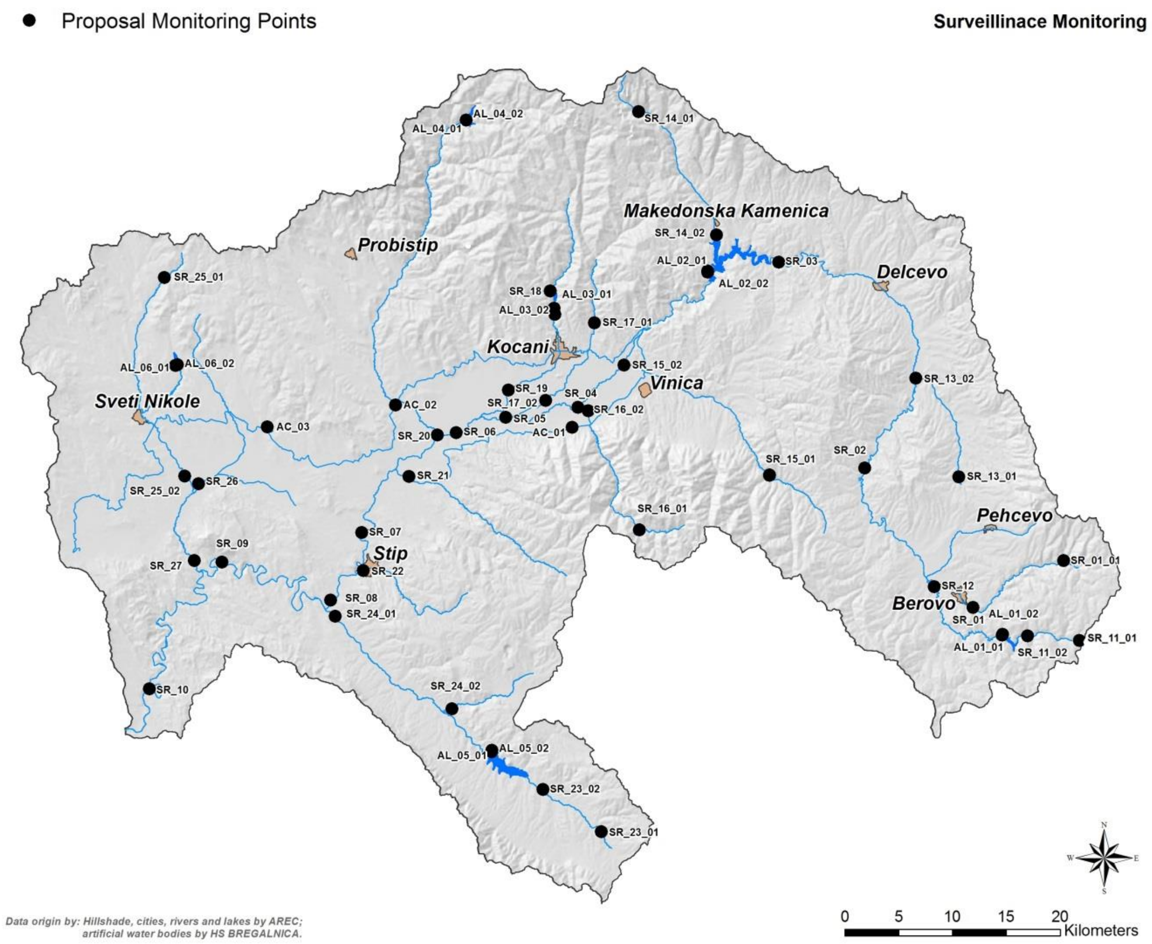

Figure 55: Monitoring points for surveillance monitoring

Operational monitoring

The operational monitoring is designed differently for each surface water body type:

- Rivers:

  The operational monitoring shall be implemented at the discharge points of the surface water bodies. The following 14 monitoring points of rivers shall be included in the monitoring program: SR_01; SR_02; SR_03; SR_04; SR_05, SR_06; SR_07; SR_08; SR_09; SR_10; SR_14_02; SR_24_01; SR_24_02; SR_27. The following indicators shall be analyzed at these points:

  - biological indicators: IPS, IBMWP or comparable indicator
  - physical-chemical indicators: nutrient indicators (total phosphorus, PO_4, NO_2), oxygen indicators (DO, BOD and/or COD), sulphate
  - priority substances: heavy metals (Mn, Cu, Zn and Pb), phthalates

  In line with the WFD, the biological indicators are deemed most relevant for classifying surface water. They shall be analyzed for all monitoring points.

The physical-chemical indicators are mainly determining the ecological status. In addition, they support the assessment of long-term trends in natural conditions and in pollutant concentrations resulting from human activities. Sulphates should be included in monitoring mainly in the middle and downstream area of the Bregalnica river basin.

Heavy metals and priority substances are used for determining the chemical status. Their presence is not detected in every surface water body except phthalates. Also not all heavy metals are present in every water sample. But the need of monitoring heavy metals and priority substances remains. Thus, Mn, Cu, Zn, Pb and phthalates shall be analyzed at all monitoring points.

The frequencies of the monitoring are as follows:

Indicator Type	Monitoring Frequency
Biological indicators	4 times per year
Physical-chemical indicators	12 times per year
Heavy metals and priority substances	once per year

Table 28: Frequencies of monitoring for rivers

- Heavily modified water bodies (HMWB):

For this type of surface water body the ecological potential and not the ecological status is evaluated. Besides the physical-chemical indicators the biological indicators play an important role for determining the ecological potential.

The following indicators shall be analyzed at the monitoring points:

- biological indicators: fish, Shannon-Wiener indicator, cyanobacteria, phytoplankton
- physical-chemical indicators: nutrient indicators (total phosphorus, PO_4, NO_2 and NO_3), oxygen indicators (BOD and/or COD), sulphate
- priority substances: heavy metals (Mn, Cu, Zn and Pb) and phthalates

These indicators shall be analyzed at all monitoring points for HMWB.

The frequencies of the monitoring are as follows:

Indicator Type	Monitoring Frequency
Biological indicators	4 times per year
Physical-chemical indicators	12 times per year
Heavy metals and priority substances	once per year

Table 29: Frequencies of monitoring for heavily modified water bodies (HMWB)

- Artificial water bodies (AWB):

The following indicators shall be analyzed twice a year at all monitoring points for AWB:

- physical-chemical indicators: nutrient indicators (total phosphorus, PO_4, NO_2 and NO_3), oxygen indicators (BOD and/or COD)
- priority substances: heavy metals (Mn, Cu, Zn and Pb), phthalates

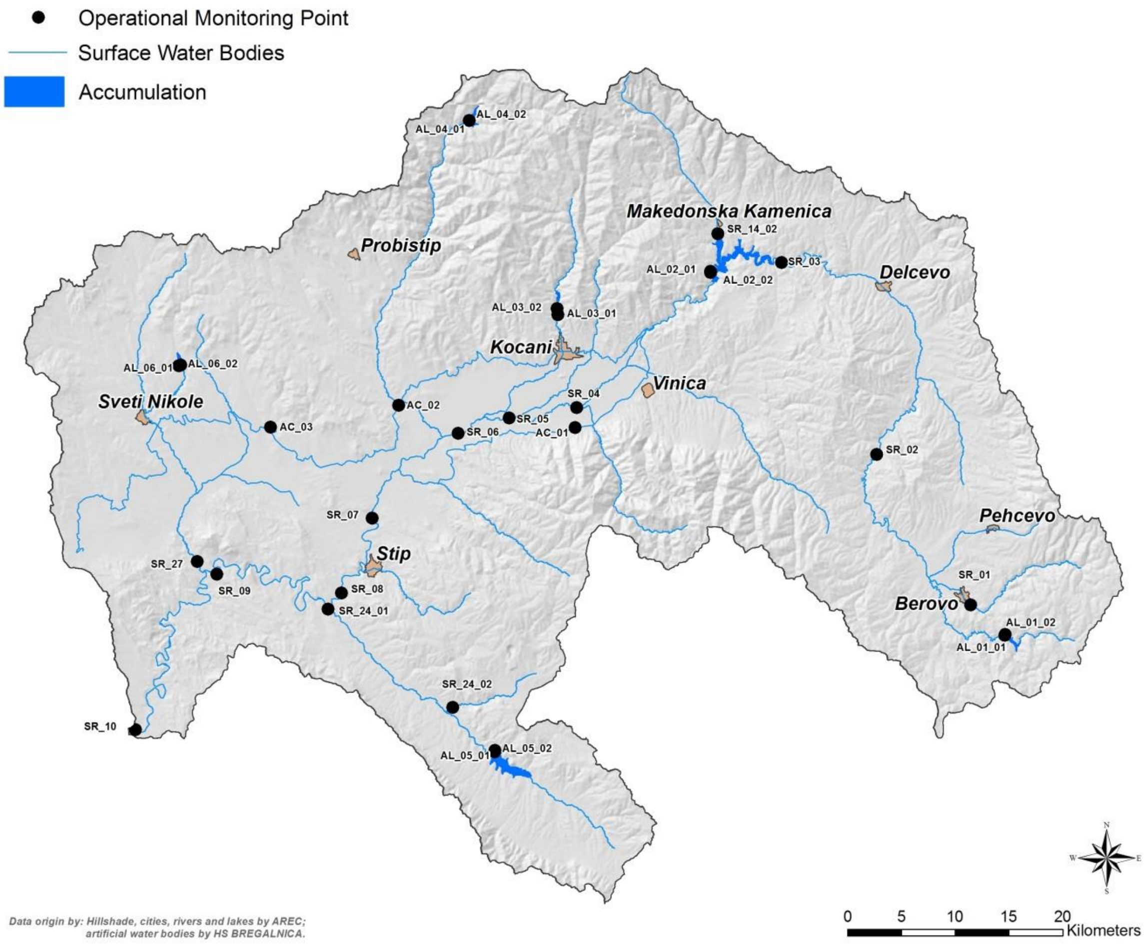

Figure 56: Monitoring points for operational monitoring

Investigative monitoring

An investigative monitoring is suggested to identify the source of phthalates which can be found in the entire Bregalnica river basin. It is not clear at this time, why phthalates even occur at places where there are almost no human acitivities. It also has to be excluded and confirmed that the measured concentrations are not due to unsuitable sampling and laboratory analysis methods, as the measurement of phthalates is very sensitive with respect to the materials used for sampling and laboratory analysis, especially any kind of plastic materials.

Moreover, an investigative monitoring to appraise phosphorus immissions into water resources from different sources (communal wastewater from major settlements, minor settlements, fertilizer and soil erosion) is suggested to be carried out. Identifing major sources combined with a rough quantification will allow assessing cost-effectiveness of different measures to reduce phosphorus input such as centralized wastewater treatment, decentralized wastewater treatment or improved agricultural practices.

9.5.2 Groundwater

Surveillance monitoring

All monitoring points already analyzed in the first cycle of the RBM Plan for surveillance monitoring, shall be included in the surveillance monitoring of the next cycle. Moreover, all paramaters which were determined in the first cycle shall be measured at all mointoing points.

Operational monitoring

The operational monitoring shall continue with the same parameters as in the first cycle and shall be extended with the following parameters: total phosphorus (P_{tot}), nitrates (NO_3), sulphates (SO_4) and phosphates (PO_4). To keep down the cost the purchase of a photometer is proposed, which complements the testing equipment already being at the BRBMU's disposal for measuring all parameters foreseen in the operational monitoring.

In total the following nine parameters will be determined by the BRBMU: groundwater level, temperature, conductivity, pH, DO, Ptot, $NO_{3,}$ SO_4, PO_4. However, the number of monitoring points will be reduced from 33 to 20-25 depending on the results which will be received from one year more of operational monitoring data collection and from the surveillance monitoring.

Investigative monitoring

Investigative monitoring is foreseen for the following indicators:

- The two investigative monitoring campaigns revealed certain uncertainties regarding the comparability of analytical results from different laboratories. While the analysis of the majority of indicators is well established, few indicators such as polycyclic aromatic hydrocarbons (PAH) and pesticides need an elaborated analytical device and a sophisticated method to reach the required detection limits. With regard to the next surveillance monitoring, a need for an intercalibration of laboratories has been identified. Thus, it is recommended to perform another investigative monitoring campaign as a case study for a comparison of measurements. This would allow assessing more detailed the different outcomes of the surveillance monitoring and the two conducted investigative monitoring campaign. It is assumed that they are a consequence of uncertainties in the analytical methods. However, it can not be excluded by now that the differences in the obtained results are due to high fluctuations in pollutant loads.
- In addition to the operational monitoring a microbiological monitoring shall be performed in the first year of the next cycle to support the interpretation of oxygen concentrations and to assess the potential organic pollution.

It is important that the analysis of the PAH and pesticides are performed by a laboratory which has the suitable equipment for detecting substances below the threshold limits for groundwater.

9.6 Implementing Agencies and Ensuring Action

RBM Plan is governing issuance of permits and concessions

According to the Macedonian Law on Waters (Art. 66.2), the Government shall adopt the RBM Plan, upon a proposal made the Minister of Environment and Physical Planning. The RBM Plan governs how the water regime, including both quantitative and qualitative status, shall be maintained and improved (Law on Waters, Art. 12.3). This includes issuance of permits (Law on Waters, Art. 28.3) and granting of concessions (Law on Waters, Art. 54.2).

RBM Plan is binding for all institutions

All governmental institutions in the water sector are bound by the RBM Plan (Law on Waters, Art. 66.8). The RBM Plan is also to be observed for all investment projects with facilities related to water resources (Law on Waters, Art. 168). The Ministry of Environment and Physical Planning (MOEPP) is the responsible governmental body for water management (Law on Waters, Art. 8.2) unless otherwise stated in the Law on Waters. The management shall occur on the level of river basin districts (Law on Waters, Art. 7). To this end, the MOEPP shall contain river basin management units (Law on Waters, Art. 8.3).

The responsible institutions for implementing the Program of Measures are named in Chapter 9.4. They may be joined by other institutions on the ground for taking action, also named in Chapter 9.4.

Reporting to Government and public is part of implementation

The MOEPP shall report yearly to the Government on the implementation of the Program of Measures (Law on Waters, Art. 75.1). The MOEPP shall also periodically inform the public about the implementation of the Program of Measures (Law on Waters, Art. 162.1).

The indicators defined in Program of Measures (Chapter 9.4) shall serve this purpose.

10 Public Involvement

In order to steer and plan the public involvement, a Communication Concept was developed early on in February 2013, identifying the main goals and target groups of all public involvement activities. The following aims have been identified as main focus for communication activities:

- Raise awareness all over the Bregalnica region
- Inform regularly, transparently and comprehensibly
- Make the project visible for everyone
- Motivate for participation
- Advocate for acceptance and manage expectations

The following sub-sections give an overview of public involvement activities that have been implemented and the respective framework. Detailed information on the activities is given in Annex A14.

Public Project Presentations

In the first Public Project Presentation in October 2012, around 100 representatives of the Macedonian government, the municipalities of the Bregalnica region, utilities, NGOs and business organizations gathered at the Faculty of Law in Kocani. The presentation focused on explaining the project and its purpose. The presentation was well received by attendees and the media.

The second Public Project Presentation was carried out in November 2013 in Stip, centering on the first monitoring results and the first draft of the RBM Plan. Again, almost 80 representatives of the Macedonian government, the municipalities of the Bregalnica region, utilities, NGOs and business organizations gathered at the Economic Faculty in Stip.

The third Public Project Presentation was held in Kocani in December 2014 with around 120 participants. This presentation mainly focused on Small Infrastructure projects (both calls 1 and 2) in connection with news from the last update of the RBM Plan.

The fourth and last Public Project Presentation was held in November 2015 in Kocani with more than 100 participants. The draft final RBM was presented, with its environmental objectives and priority measures to achieve them. The improvements already achieved through the first call Small Infrastructure projects were also shown.

Sub-Regional Workshops

In May 2013, a first round of three public sub-regional workshops took place in Stip, Kocani and Delcevo. The workshops focused on the needs and expectations of the people in the region. A mix of presentation and group work style has been successfully used. The workshops were very well received and a total of around 80 persons joined the discussions. In closing of the workshops, the participants were asked to propose one or two possible ideas for Small Infrastructure Projects. The idea of constructing waste water treatment plants was most frequent. The participants prefer to have small waste water treatment plants in all municipalities, and not one for several municipalities. The other ideas were: rehabilitation and extension of drinking water systems; building of sewerage systems; correction and arranging of river beds in towns and villages; regulation of steep terrains; rehabilitation of irrigational channels; campaigns and other methods for rising eco-awareness; aforestation on erosive terrains; equipment for testing of drinking water quality specially for villages, etc.

A second round of sub-regional workshops was carried out in Kocani, Delcevo and Probistip in October / November 2013 with a total of again around 80 participants from municipalities, public utilities and water users served to discuss the first draft of the RBM Plan. Group works were carried out to develop measures to be included in the RBM Plan and to prioritize these measures. The three top priorities emerging from these discussions were: wastewater pre-treatment for all industrial facilities; ecological awareness raising among the population; and construction of sewerage and wastewater treatment. Almost 80% from the participants of the first round of workshops were present at the second round of workshops.

A third round of sub-regional workshops was implemented in May 2014 in Kocani, Makedonska-Kamenica and Sveti Nikole. This time, the workshops focused on the Small Infrastructure Projects, especially the second, competitive call for projects. The well-received setting of the previous rounds was used again: group-work and presentation. And again around 70 to 80 participants attended the workshops and were eager to learn more about the details of the second call for Small Infrastructure Projects. Apart from this, preliminary results from the third public survey were presented and the current monitoring results were explained. In groups, the participants collected some ideas for public awareness activities that could be implemented on a local level, within the municipality and with the support of the municipal staff. Here some ideas were the following: Educational videos; different kinds of competitions (for drawings, photos, literary texts, etc.); information on local TV and websites; open discussions with different target groups; training for usage of pesticides for people from agriculture; public announcement of a list on the major pollutants in the region; games or applications with quiz for kids; informational flyer for economical use of drinking water with each water bill.

A fourth round of sub-regional workshops was carried out in January and February 2015 in Vinica, Berovo and Stip. The Program of Measures was the main topic in this round. At all three workshops, 20 to 35 people from all target groups participated: municipal administration, communal utilities, environmental NGOs, people from agriculture and forestry, professors from local schools, national environmental and agricultural inspectors responsible for the region, mayors from some municipalities etc. Almost 80% of the participants have been participating in previous workshops. Thus, these workshops are still established as an effective and efficient platform for public participation within the Bregalnica RBM. Municipalities were invited to submit their existing measures lists before the workshops. Main domains for measures identified during the workshops were: erection and rehabilitation of wastewater treatment plants; erection of village sewerage systems; modernization of solid waste management, including landfills; river regulation and maintenance; emission control of industries; training and support on best practices in agriculture, solid waste management, wastewater management; and modernization of irrigation systems.

A fifth round of sub-regional workshops was held in June and July 2015 in Kocani, Pehcevo and Probistip. At all three workshops, 20 to 35 people from all target groups participated: municipal administration, communal utilities, environmental NGOs, people from agriculture and forestry, professors from local schools, national environmental and agricultural inspectors responsible for the region, mayors from some municipalities etc. The main topic was to refine the Program of Measures, as included in the draft final RBM Plan. Almost 80% of the participants have been participating in previous workshops, allowing for a consistent work on the Program of Measures.

Advisory Council

The Advisory Council with 23 representatives from authorities, private economy and civil society had a first meeting in November 2013 to get information on the Project. The second meeting of the Advisory Council was held in August 2014 in Kocani, with a focus on the second draft of the RBM Plan. These first two meetings mainly served as information events for the Council's members on the progress in elaborating the draft RBM Plan.

A third meeting in September 2015 and a fourth meeting in February 2016 discussed the draft final RBM Plan in two readings. Both meetings provided valuable inputs.

The legal approval of the present final RBM Plan by the Advisory Council in accordance with Section XI of the Macedonian Law on Waters is lacking yet. This will be a pre-condition for the Government to adopt the RBM Plan.

National Policy Dialogue

A first National Policy Dialogue on invitation by MOEPP was carried out in March 2014 with participants from ministries, academia and NGOs. The discussions focused on institutional effectiveness and efficiency, as well as on financial sustainability in the water sector.

The participants highlighted the widely shared regulatory responsibilities in the Macedonian water sector which makes accountability difficult. Despite these shared responsibilities, resources dedicated to the water sector within the state administration – both in terms of human and financial resources – are minimal and important strategic planning decisions as foreseen in the Macedonian Law on Waters (i.e. National Strategy for Waters, Water Master Plan, River Basin Management Plans, Section III of the Law) are still lacking. The National Water Council – the central advisory and coordination body foreseen in the Law on Waters, Section XI – is not fully functional. Missing by-laws and directives as well as lacking law enforcement prevent yet the Law on Waters to become fully effective.

The financial sustainability of the water sector is not ensured yet. The lacking planning documents impair the coherence of investments decisions. Financing for proper water resources management (i.e. monitoring, emissions control, establishment of protection zones) is minimal. Revenues from the water sector (e.g. charges, permit and concession fees) count as general tax income and are not sufficiently compensated by budget allocations for water resources management.

A second National Policy Dialogue took place in December 2014 with a similar participation as in the first Dialogue. The second Dialogue discussed the needs for capacity building in the water sector.

The discussion among participants confirmed that central authorities are in need for skill development in water resources management. The new tasks in water bodies assessment and planning as well as in monitoring, including indicators on biological parameters and morphology, have yet to be trained more widely. Institutional specialization for separate tasks (such as policy development, technical regulation, permitting, emissions control) should be further developed.

Stakeholders should focus on skills development in tasks in which they have a leading role. For the implementation of RBM Plans, regional units could play a bigger role as they are close to user and beneficiaries as well as to issues and solutions. Flood prevention and protection capactities should also be further strengthened at the municipal level.

In planning, stakeholders' skills vary a lot. The biggest shortfalls exist at the central level, with the above-mentioned gaps regarding the National Strategy for Waters, Water Master Plan, and the River Basin Management Plans.

A third National Policy Dialogue in June 2015 discussed the relation between River Basin Management Plans and the Water Master Plan, with a focus on financing and implementation options. Input presentations with principles and characteristics of Swiss water sector financing and of Croatian water management helped launching the discussion. The roles of the key stakeholders along the water resources management cycle were appraised. A fund concept for financing the implementation of River Basin Management Plans was reviewed.

The discussion among participants revealed that the continuous financing of water resources management in Macedonia is not solved yet. The state budget allocated to the water sector program is volatile, changing from year to year. The establishment of a Water Fund on a national level should be further investigated.

Regarding the main planning documents (i.e. Water Strategy, Water Master Plan, River Basin Management Plans), their relationship has to be further clarified. Continuous monitoring of water quality and quantity is a prerequisite for informed management decisions. Establishing a national Water Agency or strengthening one of the ministries are possible options for further institutional development.

The fourth National Policy Dialogue of February 2016 discussed the question whether the latest changes in the Water law and the new methodology for tariff setting wil be a further step towards financial sustainability. An input paper on the implications of the draft tariff setting methodology helped launching the discussion.

The discussion among participants treated the main challenges of the new methodology, namely data quality of indicators, strategic planning of service providers and the tariff setting process in general. Among the significant changes in the Law is the establishment of a 'regulatory body' for the implementation of the new system for tariff setting. A new methodology has to be produced in 2016 and fully implemented by 2018. The methodology will cover three services in the water sector: water supply, wastewater collection and wastewater treatment. This approach and the schedule are fully supported by the professional public.

In the process of implementing and enforcing the new methodology attention will have to be paid to include all necessary components in order to calculate the costs properly. This will be necessary to achieve full cost recovery for services in the water sector.

Investments in the water infrastructure from various sources should be assessed separately and administrative provisions for accounting will have to be set properly in order to achieve cost recovery and long-term sustainability.

The results of the preceding four National Policy Dialogue meetings were consolidated and are to be presented in a fifth and last meeting in September 2016, for its further use by the Government of Macedonia.

Municipality Forums

To develop project proposals for Small Infrastructure Projects in a participatory way, two rounds of forums in all 15 eligible municipalities were carried out in September and October 2013. These forums were organized by the municipalities, with the support of external moderators.

To apply in the second call for Small Infrastructure Projects which was announced in June 2014, municipalities were again asked to organize Municipal Forums. As in the first call all 15 municipalities organized two forums sessions and one workshop in between the sessions lead by certified moderators. Forums for the second call took place in June and July 2014.

Public Events

On the occasion of the World Water Day and the International Biodiversity Day, two public events were organized in 2014 in Kocani (World Water Day) and in Delcevo (International Day of Biodiversity) to raise public awareness on water issues in the region. The events included free water testing as well as games and competitions for children. Both events received considerable attention by the broad public as well as by the local and national media and politicians.

In 2015, a big regional event was carried out on June 2 and 3. On June 2, the main goal was to involve the municipalities of the Bregalnica in a "clean-up-day" competition. 12 out of 15 municipalities region participated. At the same time, a photo and drawings competition was promoted in the whole region. A total of around 90 drawings were received. In the photo-competition, around 75 pictures were sent in. On June 3, all municipalities were invited to come to Vinica to participate in an educational event with their schools. For the local people in Vinica, a water testing was offered at the same time. The kids and teenagers were involved in creative educational activitiers such a game explaining the water cycle or a water cleaning experiment.

Website

One of the first means of communication that was published in October 2012 and has continuously been in use since then is the website www.bregalnica.mk. The site serves primarily as a hub of information on the Project and as a public library of important documents. It also offers online participation tools like comment function and a forum. The publication of tender documents and forms for Small Infrastructure Projects increased the number of daily visits considerably. In general, statistics show that the use of the website is increasing significantly and steadily.

In summer 2014, additional information about the Bregalnica region and the Project were posted on Wikipedia within the existing "Bregalnica" keyword. This helped the Project to be even more visible on the internet. It will also help anyone interested to find current and accurate data and information on the Bregalnica river basin and the Project. The entries were posted in Macedonian and English as well as a shorter version in German.

In 2013, the average number of daily visits to the website stood at around 4 with an average time of 3 minutes spent on the website. In 2014, the average number of daily visits had increased to almost 6, with an average time of 2.5 minutes per visit. In both years, around 90% of visitors were from Macedonia.

In 2015, the website continued to serve as a platform for the Small Water Infrastructure Projects and the Bregalnica RBM Project in general. Daily visits were usually around 2 to 10, with an average at 4. However, in May and June 2015 the daily visits increased significantly. The peaks were on May 22 (57 visits) and June 2 (56 visits). These were also absolute peaks since the project started in 2013. The average time a visitor spent in 2015 was 2 minutes. Around 85% of the visitors were from Macedonia and 5% from Switzerland.

In 2016, with the Project approaching its end, daily visits were still around 4 on average, with some peaks in May 2016 of over 20 visits per day. The average time a visitor spent in 2016 was a bit above 1 minute. Around 65% of the visitors were from Macedonia, 5% from the United States of America, and the rest from various countries, not exceeding 3% per country.

Media Relations

The relations to media and journalists are very important. This includes private media as well as media channels managed by the municipalities themselves. Journalists were invited to all public events and activities, including workshops and public presentations.

Corporate Identity

A corporate identity has been developed, defining fonts, colors, icons, image policy as well as the project's own logo and its use. The identity is very important to support recognition.

Products

The following communication products have been developed:

- Photos and videos, with a selection of documentary and promotional photos and videos being published online in the channels of Flickr and Youtube; including a well received promotional video
- Flyers, with a first flyer produced in December 2012 explaining the Project, and a second flyer of April 2014, presenting key messages from the first draft RBM Plan and an overview of the Small Infrastructure Projects in the framework of the first call
- Postcards produced in October 2013 in order to promote the website
- Folders, produced in April 2013, to contain give away documents about the Project
- Rollups for public events and presentations, produced in May 2013, presenting basic information on the Project
- Baseball-caps produced for the event in Delcevo in May 2014 in the framework of the UN International Day of Biodiversity
- Stickers, gym-bags, new postcards, water-cycle-puzzles as well as informational leaflets and roll-ups were produced for the regional event in June 2015
- A lay summary prepared in both Macedonian and English, in September 2015
- Fact sheets in Macedonian on First Call Small Infrastructure Projects, in January 2016
- Fact sheets in Macedonian on Second Call Small Infrastructure Projects, in September 2016

In order to implement as many activities as possible and to show important linkages, the Project closely collaborated with two other projects on similar topics (Nature Conservation Project, and Environmental Education Project; both with Swiss support) on the coordination of joint events.

Public Survey

To measure the success of public involvement and communication activities, a baseline public survey was carried out in March 2013 with 231 interviews. The survey clearly showed that water quality and quantity are top issues for the people living in the Bregalnica region. The satisfaction with the existing water and sanitation services is mixed. People see scope for improvement but at the same time they do not think the services are completely bad.

At the moment of the first survey, the project was not very well known yet. Also, people did not know any background information about actors behind the project or the detailed purpose of the project.

The public survey was repeated in April 2014 with 343 interviews. The 2014 results mainly confirm the results from the first survey. The questionnaire that was used in a similar fashion proofed to be a strong instrument to measure the changes in the public perception. Whereas the general perception of the water issues is still the same, the Project itself is now very well known. Up to 85% of the respondents said that they have already heard about the Project. However, future work will have to make sure that people understand the background and the benefits of the Project.

In April 2015, another public survey was implemented with 377 interviews. The results proved to be relatively stable compared to 2014. Over the last three years, the issue of cleaner water for everyone lost a little bit of importance in the public perception while still being the most important one, whereas the issue of reasonable tariffs for water supply and sanitation gained some more importance. A very high 90% of the interviewed persons are aware of the Project, throughout all municipalities. Still, some facts on the Project are not clear to everyone. For example, a majority of the survey participants think that the Project is being implemented by the European Union and the Swiss Cooperation together. Also, the involvement of the muncipalities is not clear to many interviewees. Only around 7% knew that that the municipalities play a role in the Project.

The last public survey of April 2016 comprised 417 interviews. Again, the results showed to be relatively stable compared to the previous years. In public perception, a stronger regulation of water protection is seen as the most important issue, followed by concerns about water contamination from industry and about more frequent droughts due to climate change. Public satisfaction with water supply and sanitation slightly increased in comparison to survey results from 2014 and 2015, possibly due the implementation of the Small Infrastructure Projects. The Project continues to be known by more 85% of the survey participants. The Swiss Cooperation and the Ministry of Environment and Physical Planning are known to be the project sponsors by more than half of the survey participants.

For this last public survey, two new questions were added, namely whether there is a need for similar new project and if yes, what the focus of this new project should be. All survey participants affirmed the need for a new project and named the water quality improvement for the Bregalnica River as its preferred focus.

Professional Survey

A first professional survey was concluded in October 2013 with 20 water specialists from authorities, utilities and academia. It served to learn about the perception of sector experts and selected professionals on important water issues in the country.

The general view expressed in this survey is that the Macedonian water legislation is relatively updated and harmonized with the EU, but the implementation is regarded as poor The instruments available for the protection of water resources are considered useful, but due to poor implementation (such as lack of planning documents, standards and water quality objectives, lack of funds and capacity at all levels), the overall protection of water resources is poor.

The protection of the population from adverse effects of water such as from floods was assessed mostly as sufficient to bad. Similar answers were recorded regarding the protection of property and infrastructures. The reasons indicated are that the programs of protection have not been made and are not implemented.

The survey also showed that the Project is known and recognized in the professional environment in Macedonia.

A second professional survey in December 2014 showed a similar picture. Experts and professionals felt that the general situation in the water sector in Macedonia was not improving in this year. The Bregalnica RBM Project however is known and recognized in the professional environment in Macedonia.

A third and last professional survey was conducted in April and May 2016. It showed that the water sector in Macedonia is not improving and the reforms are not happening yet. The changes in all facets are negligible and insufficient to significantly improve the stagnant situation. Besides some new initiatives (recent changes in the Water law, introduction of new tariff-setting methodology planned for 2018), enforcement of existing regulations remains poor, as well as the implementation of national plans and programs. Partly, this is a result of unsufficient financing in the sector, due to budgetary restrictions and regular cuts in - and in some years, even lack of - a Water Programme of the MOEPP, but also as a result of insufficient institutional and personal capacity.

The expert community clearly expressed the need for a more substantial reform of the sector, including legal, organizational, institutional and financial changes.

11 Competent Authorities

The new Water Law was adopted in August 2008. The first phase of implementation, on the organizational and institutional set-up, transferred responsibility for water resources management from the Ministry of Agriculture to the Ministry of Environment and Physical Planning, as from January 2011. The National Water Strategy, adopted in 2012, paves the way for the preparation of the Water Master Plan and River Basin Management Plans.

Four River Basin Management Districts have been identified and these districts will be administered by three River Basin Management Bodies: Vardar (including Lebnica), Strumica and Crni Drim. The River Basin Management Bodies will take over some management responsibilities from the existing Water Managements (formerly Water Management Organizations) which are currently undergoing a fundamental transformation.

As shown in Figure 57, the Bregalnica catchment is differentiated into two Water Management Divisions:

- **Upper Bregalnica**: This region encompasses the upper part of river Bregalnica, from spring to the Kalimanci reservoir. Major urban centres are Delcevo, Berovo and Pehcevo.
- **Middle and Lower Bregalnica**: This region stretches from the middle part of the Bregalnica river (including the Kalimanci reservoir) to its confluence with the Vardar river.

The River Basin Management Bodies are supposed to be established within four years of the adoption of the Water Law and each River Basin Management Body is supposed to prepare a River Basin Management Plan which must be finalized within six years of the adoption of the Water Law. It will also be possible, where appropriate, to prepare sub-basin management plans, including one for the Bregalnica basin.

The Water Law facilitates the full transposition of the EU WFD and the approximation with seven further EU environmental and water-related directives, including the Nitrates Directive, the Bathing Waters Directive, the Drinking Water Directive, and others.

Spatial plans have already been adopted for most of the territory of Macedonia, including the four River Basin Management Districts. Each spatial plan contains specific provisions for the protection of the natural and cultural heritage, requiring that these values be taken into consideration in the preparation and adoption of River Basin Management Plans.

Water quality protection is already included in a number of national strategic documents, plans and legislation, as well as some local initiatives. Further efforts shall be made at the national level to establish a workable organizational, financial and capacity basis for the integrated and comprehensive water management and protection.

The existing institutional structures for the protection of water quality, operating under the Ministry of Environment and Physical Planning are being restructured and re-established within the

Office of Environment and Water. The responsible authority is the Department of Water, within which the new water management structure is being currently established.

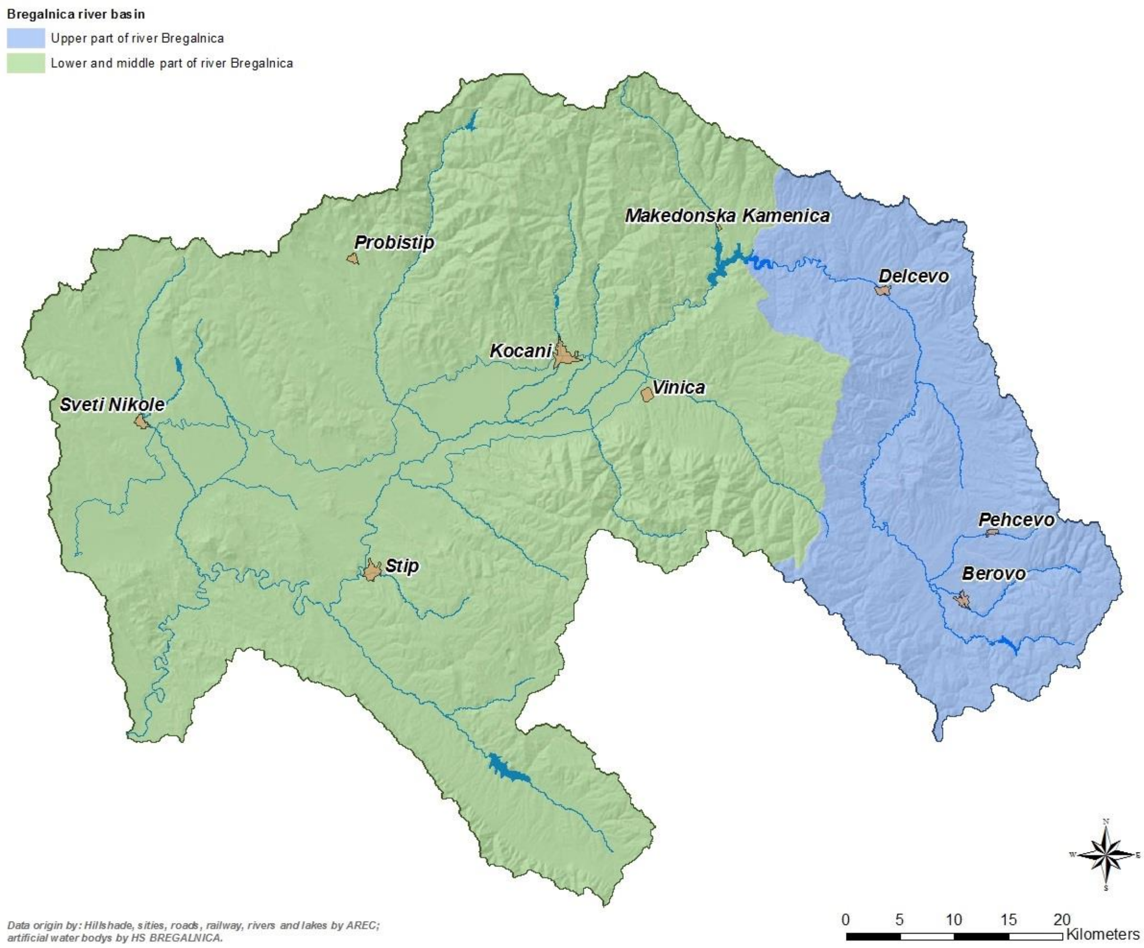

Figure 57: Management divisions in Bregalnica river basin

Currently, discussions on the setup of the water sector in Macedonia are carried out by various stakeholders. Institutional, legal, organizational, financial and economic aspects will be subject to a national policy dialogue, and possibly leading to some changes in the near future.

The water quality monitoring system has been established for many years and monitors a range of parameters, including physical, chemical and bacterial pollutants and metals. However, there is a need for this monitoring system to be improved and coordinated with the development of the planning documents at all levels.

In respect of water monitoring and analysis, funding is not ensured yet by the new Water Law. Apart from funding the procurement of monitoring or analysis equipment, significant funding will be required for the maintenance and recalibration of such equipment and the training of operational personnel. Although the new Water Law assigns responsibility for particular activities to certain institutions, no funding for such institutions is prescribed under the legislation.

Irrigation schemes and organizations have suffered greatly during the transition and restructuring process over the past two decades. Following a complete disarray, they are now in a process of re-establishment and re-organization. The newly established Water Management Organizations lack funding, capacity and sufficient mandate to rehabilitate the obsolete and deteriorated irrigation infrastructure. By law, the Water Management Organizations now have an increased mandate; however, they lack the means of managing the water resources that fall within their responsibility. In the Bregalnica catchment there are two Water Management Organizations – Berovo and Bregalnica (Kocani), the latter managing the big Bregalnica irrigation scheme.

Irrigation Water Communities (Irrigation Associations) aim at organizing the agricultural water users. Around 25 Irrigation Water Communities exist in Bregalnica irrigation scheme.

As regards transboundary cooperation, the new Water Law commits Macedonia to cooperating with co-basin states in respect of transboundary waters. Although Macedonia has not yet ratified the 1992 UNECE Helsinki Convention, the Government of Macedonia is committed to transboundary cooperation in respect of shared waters.

A1 Categories of Surface Water Bodies

The definition of the category of surface water bodies in the Bregalnica catchment has been made according to the Macedonian Water Law of 2008 (57/2008) and with guidance documents of the WFD (2000/60/EC).

"The "water body" should be a coherent sub-unit in the river basin (district) to which the environmental objectives of the directive must apply. Hence, the main purpose of identifying "water bodies" is to enable the status to be accurately described and compared to environmental objectives" (Common Implementation Strategy for the WFD (2000/60/EC), Guidance document n.° 2, Identification of Water Bodies, page 2).

The identification of the water bodies is an iterative process. As first step for the Bregalnica RBM Plan it was decided to use as basis the sub-division of the watercourses already defined in the Macedonian strategic planning and legislation. Since the prepared identification of the water bodies must provide a sufficiently accurate description of the Bregalnica catchment, further verification and refinement steps of the water body identification are foreseen in the update of the Bregalnica RBM Plan.

The following table shows the categories of the surface water bodies identified in the Bregalnica catchment.

Category	**Subdivision**	**Name**
Rivers	Main river	Bregalnica, split into 10 water bodies
	Left tributaries	Kozjacka, Lakavica, Osojnica, Otinja, Ratevska, Zrnovska
	Right tributatries	Kamenicka, Kocanska, Orelska/Mavrovica, Orizarska, Svetinikolska, Zelevica, Zletovica,
Heavily modified water bodies	Lakes	Berovsko/Ratevsko, Ezero/Knezevo, Gradce, Kalimanci, Mantovo, Mavrovica
Artificial water bodies	Irrigation channels	Right irrigation channel and left irrigation channel

Table 30: Overview of surface water bodies according to their category

A2 Surface Water Bodies Type

The type of the surface water bodies was defined according to the WFD, Annex II, system A.

For the rivers the definition of the type is based on the four criteria ecoregion, altitude, catchment size, and geology. Seven types of surface water bodies were defined.

In the Bregalnica catchment there are no natural lakes. The existing ones are reservoirs created by damming the rivers for water storage for various, usually multiple purposes. Consequently these water bodies are categorized as heavily modified water bodies. The WFD suggests to use, for the definition of the water body type, the criteria of the most similar water body; in this case the lake. Therefore the type of the heavily modified water bodies was defined through the lakes criteria given in the WFD, Annex II, System A: lake size, mean depth, altitude, geology. Four types of heavily modified water bodied were defined.

In the next pages, the following results are shown:

- Ecoregion
- Rivers:
  - Overview of the limits per each criteria
  - Altitude
  - Catchment size
  - Geology
  - Summary of the results and water body types in table and figure form
- Heavily modified water bodies:
  - Overview of the limits per each criteria
  - Summary of the results in table form
- Artificial water bodies

Ecoregion

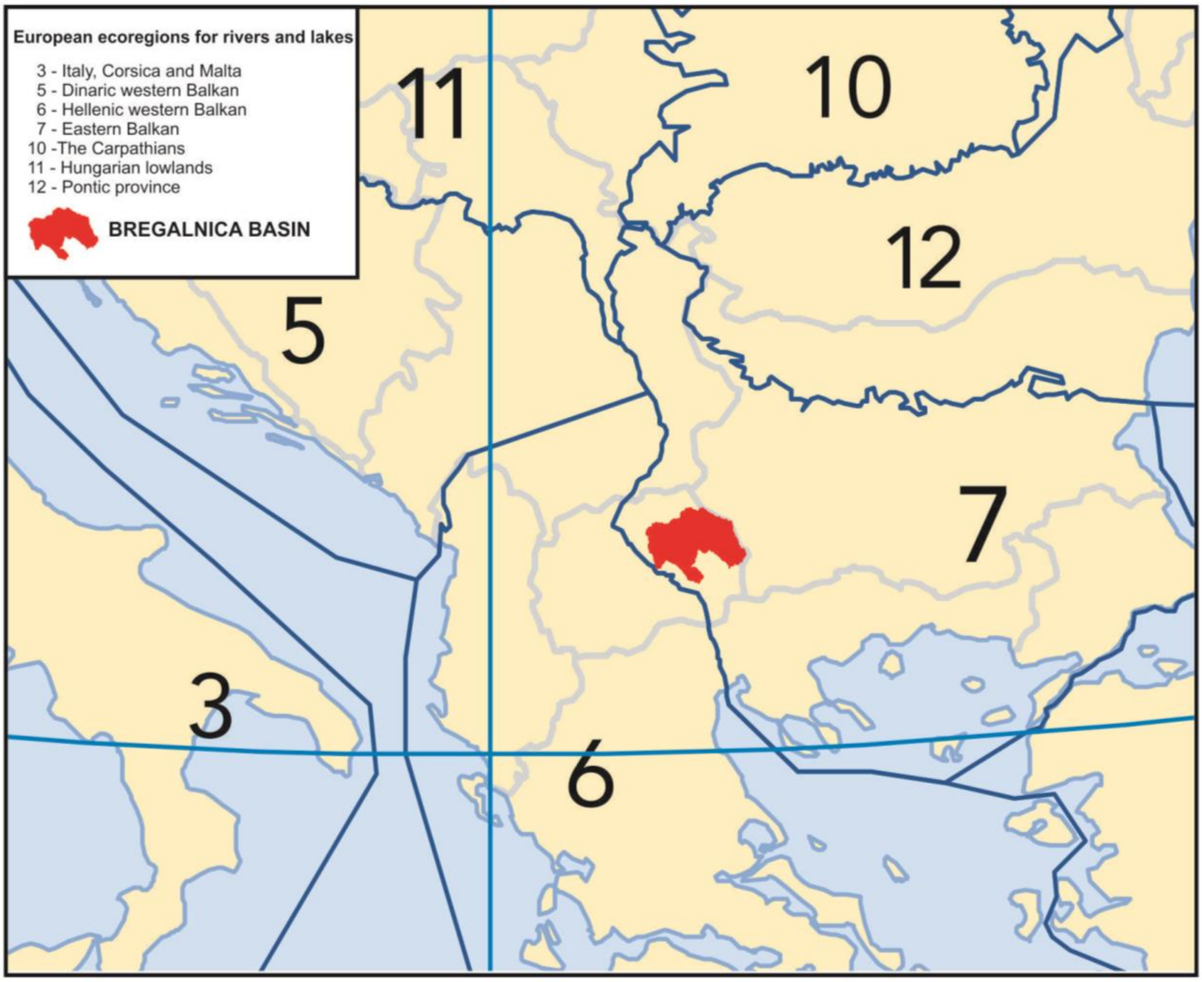

Figure 58: Map of the European ecoregions for rivers and lakes (according to the WFD, Annex XI) with the Bregalnica river basin highlighted in red

Figure 58 shows that the Bregalnica catchment is included in one ecoregion, namely the Eastern Balkan ecoregion.

Overview of the limits for each criterion

Following table shows the limits, which were used for the definition of the rivers types.

Altitude in m		Catchment size in km²		Geology	
H	high: > 800	S	small: 10 to 100	C	calcareous
M	mid-altitude: 200 to 800	M	medium: > 100 to 1'000	S	siliceous
L	lowland: < 200	L	large: > 1'000 to 10'000	O	organic
		xL	very large: > 10'000		

Table 1: Overview of the criteria for the definition of the river type, according to the system A described in the Annex II of the WFD

Altitude

The following figure shows the different altitude type for each river.

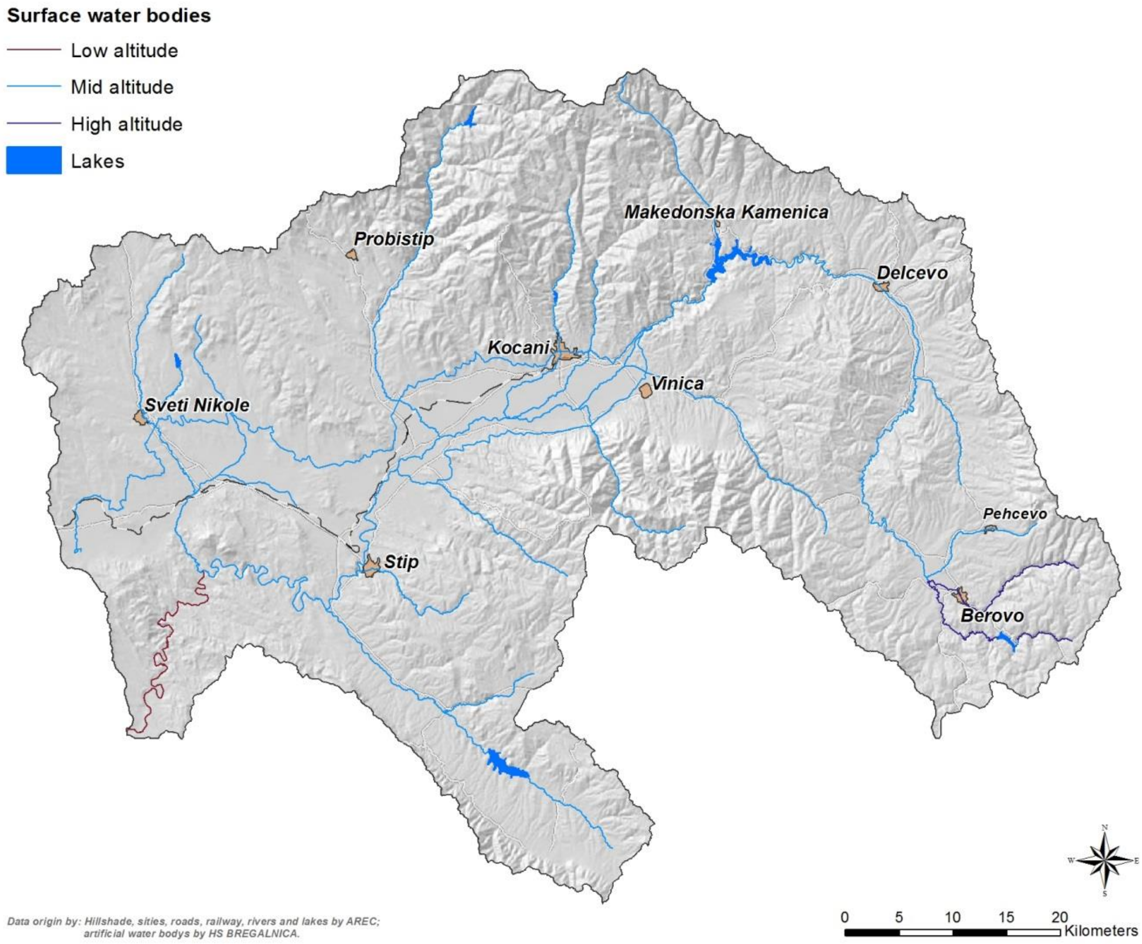

Figure 59: Map of the Bregalnica river basin with the altitude type: high, mid-altitude, and lowland (according to WFD, Annex II, system A)

Almost all rivers have a mid-altitude with the exceptions of the most upstream water body of the Bregalnica river (high altitude), the most downstream water body of the Bregalnica river (lowland) and the Ratevska river (high altitude).

Catchment area

The following figure shows the catchment area per each water body.

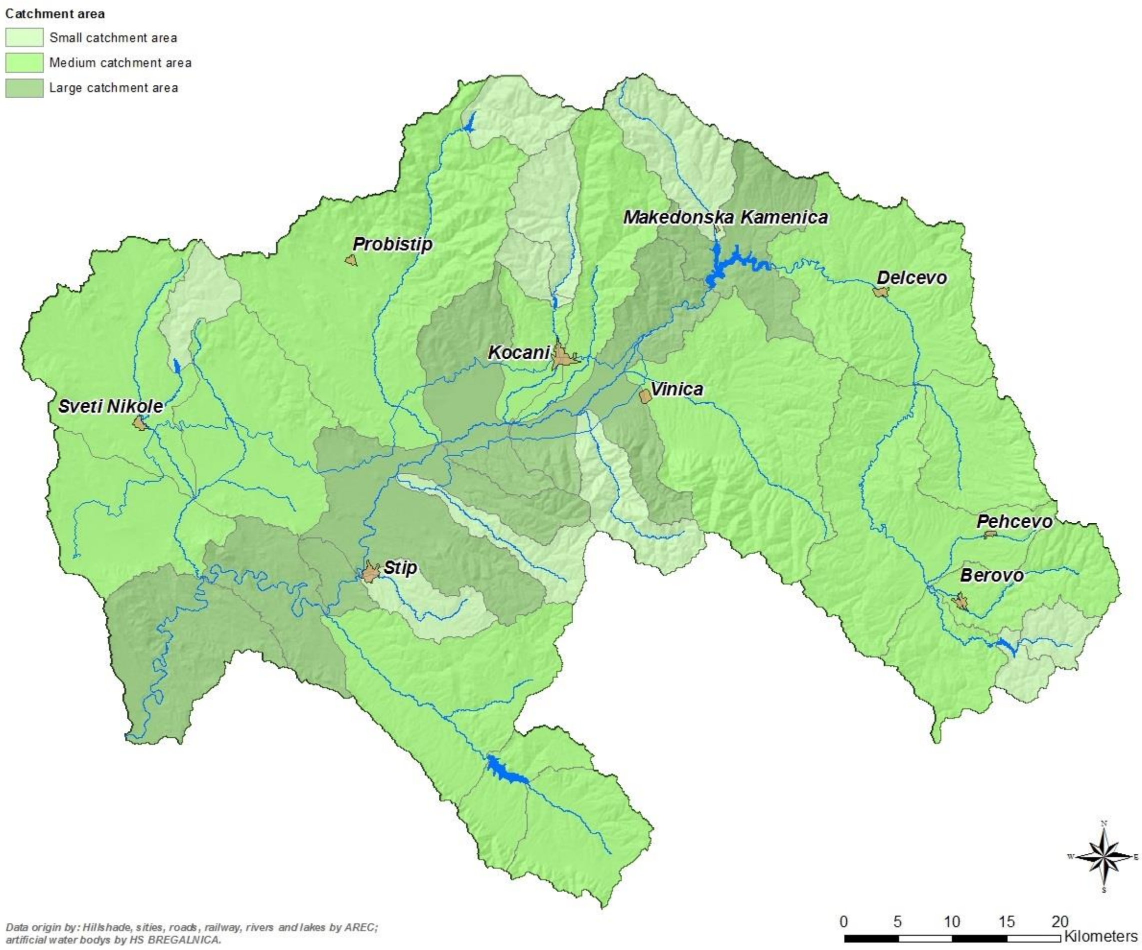

Figure 60: Map of Bregalnica river basin with the catchment areas: small, medium, large, and very large (according to WFD, Annex II, system A)

Eleven water bodies have medium, nine small and seven large catchment areas. No water body has a very large catchment area.

Geology

The following figure shows the geology of the Bregalnica catchment.

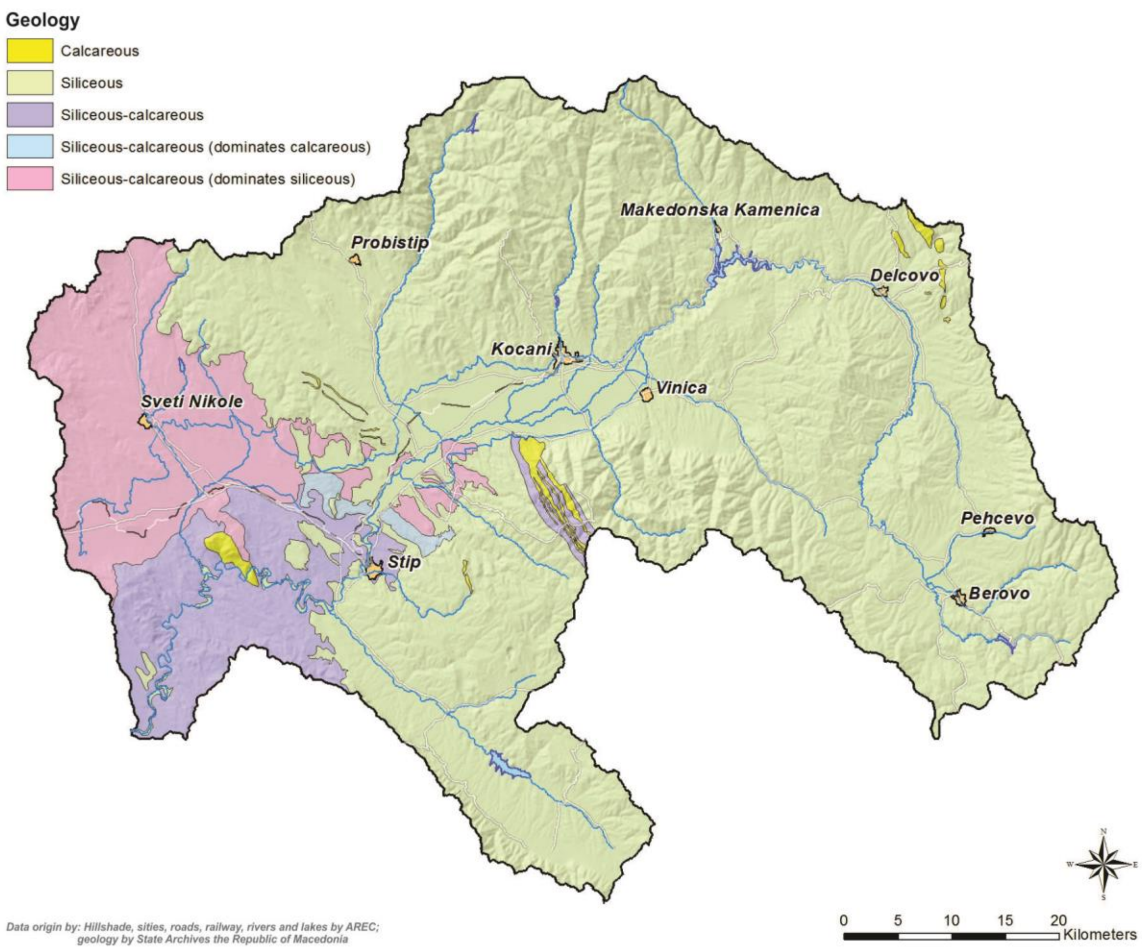

Figure 61: Geology map of the Bregalnica catchment (according to WFD, Annex II, System A)

The main part of the Bregalnica catchment has a siliceous geology, particularly in the upper and middle part of the catchment. The lower part of the catchment has a siliceous-calcareous geology, dominated by limes on the north-west side and by silicates in the south part.

Surface water body types

The following figure shows the rivers types identified in the Bregalnica catchment.

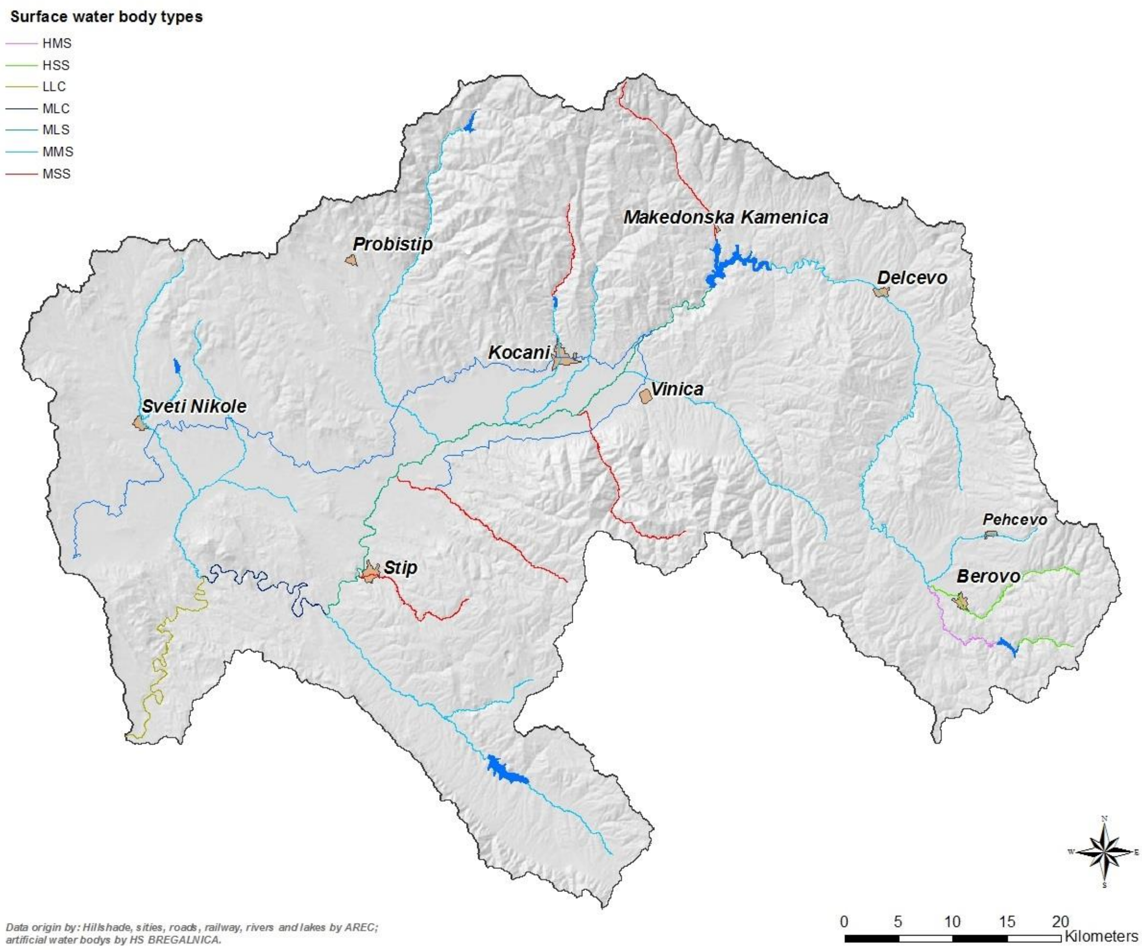

Figure 62: Map of the Bregalnica river basin with the river types (according to WFD, Annex II, System A)

The following table shows the detail of the seven types of rivers, which have been identified in the catchment.

No.	Code	Name of water body	Altitude			Size		Geology	Type	
			Spring	Inflow	Type	km²	Type	Type	Code	No.
1	SR-01	Bregalnica 1	1367	811	H	103	S	S	HSS	1
2	SR-02	Bregalnica 2	811	647	M	529	M	S	MMS	2
3	SR-03	Bregalnica 3	647	435	M	907	M	S	MMS	2
4	SR-04	Bregalnica 4	435	308	M	1’698	L	S	MLS	3
5	SR-05	Bregalnica 5	308	299	M	1’844	L	S	MLS	3
6	SR-06	Bregalnica 6	299	292	M	2’119	L	S	MLS	3
7	SR-07	Bregalnica 7	292	268	M	2’895	L	S	MLS	3
8	SR-08	Bregalnica 8	268	252	M	2’975	L	S	MLS	3
9	SR-09	Bregalnica 9	252	204	M	3’501	L	C	MLC	4
10	SR-10	Bregalnica 10	204	140	L	4’316	L	C	LLC	5
11	SR-11	Ratevska 1	1263	984	H	31	S	S	HSS	1
12	Sr-12	Ratevska 2	937	800	H	139	M	S	HMS	7
13	SR-13	Zelevica	809	645	M	116	M	S	MMS	2
14	SR-14	Kamenica	1320	517	M	96	S	S	MSS	6
15	SR-15	Osojnica	1126	353	M	323	S	S	MSS	6
16	SR-16	Zrnovska	1198	323	M	76	S	S	MSS	6
17	SR-17	Orizarska	1490	304	M	146	M	S	MMS	2
18	SR-18	Kocanska 1	800	465	M	65	S	S	MSS	6
19	SR-19	Kocanska 2	420	299	M	146	S	S	MSS	6
20	SR-21	Kozjacka	970	282	M	491	S	S	MSS	6
21	SR-20	Zletovska	1400	292	M	57	M	S	MMS	2
22	SR-22	Otinja	795	267	M	52	S	S	MSS	6
23	SR-23	Lakavica 1	602		M	115	M	S	MMS	2
24	SR-24	Lakavica 2		254	M	421	M	S	MMS	2
25	SR-25	Svetinikolska 1	550	238	M	284	M	S	MMS	2
26	SR-26	Orelska/Mavrovica	360	237	M	213	M	S	MMS	2
27	SR-27	Svetinikolska 1	238	207	M	653	M	S	MMS	2

Table 31: Overview of the identified rivers in the Bregalnica catchment

Heavily modified water bodies – Overview of the limits for the criteria

The following table shows the limits of the criteria for the definition of the heavily modified water body type.

Lakes size in km²		Mean depth in m		Altitude typology in m		Geology	
S	0,5 to 1	S	< 3	H	high: > 800	C	calcareous
M	1 to 10	M	3 to 15	M	mid-altitude: 200 to 800	S	siliceous
L	10 to 100	D	> 15	L	lowland: < 200	O	organic
xL	>100						

Table 2: Overview of the limits of the criteria for the definition of the heavily modified water body type. According to the WFD, Annex II, system A, lake

Heavily modified water bodies – Summary of the result

The following table shows the details and the type of the heavily modified water bodies.

Code	Name	Altitude [m]			Lake size		Geology	Depth		Type	
		HWL	LWL	Type	km²	Type	Type	m	Type	Code	No.
AL-1	Berov-sko / Ratevo	984	937	H	0.57	S	S	>15	D	HSSD	1
AL-2	Kali-manci	517	435	M	4.23	M	S	>15	D	MMSD	2
AL-3	Gradce	465	438	M	0.19	xS	S	>15	D	MSSD	3
AL-4	Zletovo	1061	990	H		xS	S	>15	D	HSSD	1
AL-5	Manto-to-vo	403	369	M	4.94	M	S	>15	D	MMSD	2
AL-6	Mavrovica	371		M	0.25	xS	S	3-15	M	MSSM	4

Table 3: Overview of the heavily modified water bodies in the Bregalnica catchment with the type criteria and results

Artificial water bodies

The irrigation channels of the Bregalnica irrigation scheme, managed by the Water Management Bregalnica are significant conduits of irrigation water. They strongly influence the overall hydrological regime and water balance in the catchment, especially in the irrigation season (April to September). For their significance, they were included as separate artificial water bodies.

Code	Name	Length [m]	Capacity [l/s]
AC-01	Left main irrigation channel	35’600	6’000 – 1’600
AC-02	Right main irrigation channel	50’000	12’000 – 6’000
AC-03	Right main irrigation channel	48’720	6’000 – 3’500

Table 4: Artificial water bodies in the Bregalnica catchment with length and capacity variation (in flow direction)

A3 Groundwater Bodies

Groundwater bodies, according to Article 2.12 of the WFD, are defined as "a distinct volume of groundwater within an aquifer or aquifers". According to EU CIS guidance on risk (EC, 2010), they are units for the management of groundwater resources that are either exploited by man or support surface ecosystems.

Information on the extent and the characteristics of the groundwater bodies in the Bregalnica catchment have been collected from various sources: Macedonian Agency for Real Estate Cadastre, Hydro-Geological Map of Macedonia, Geologic Map of Macedonia (courtesy of National Archive of Macedonia and MOEPP), and other national and regional institutions. Additionally some information on the status and on the monitoring was obtained through the Macedonian Hydro-Meteorological Service.

Systematic geologic and hydrogeologic studies have been made in the 1960s and the 1970s, when maps were produced. After this period only few sporadic investigations have been undertaken.

The monitoring of groundwater, established in the 1960s has also been deteriorating in quantity and quality, entailing a data gap in the last few decades. The previously existing borehole/piezometer network which was operated by Hydro-Meteorological Service is completely obsolete.

According to the collected information, five groundwater bodies have been identified in the Bregalnica catchment. These aquifers were also identified in some previous national strategic and planning documents.

The aquifers in the Bregalnica catchment are of alluvial and deluvial origin, unconsolidated and relatively shallow. The deeper parts of the aquifers are in the deluvial foothill sediments and are used as water supply resource of some towns (e.g. in Kocani).

Following table shows the identified groundwater bodies and their characteristics.

Name	ID	Conductivity K_f [cm/s]	Depth [m]	Surface [km²]	Geology	Static reserve [million m³]	Acstraction capacity [l/s]
Berovo-Pehcevo	GWB_01	$\geq 1 \times 10^{-2}$	10	6	Quartenary	360	120
Delcevo	GWB_02	$\geq 1 \times 10^{-2}$	15	14	Quartenary	n.a.	120
Kocani-Stip	GWB_03	$\geq 1 \times 10^{-2}$ ($K_f = 8{,}2 \times 10^{-2}$ $T = 7{,}4 \times 10^{-3}$ m²/s)	Variable	124	Quartenary	n.a.	350
Lakavica	GWB_04	$\geq 1 \times 10^{-2}$	10	22	Quartenary	n.a.	n.a.
Ovce Pole	GWB_05	$\leq 1 \times 10^{-3}$	Variable	214	Quartenary	256	n.a.

Table 32: Overview of the groundwater bodies and, were available, their characteristics. n.a. = not available. The static reserve was estimated in the Expert Study on Water Resources, for the Spatial Plan of Macedonia

The following figure shows the groundwater bodies in the Bregalnica catchment.

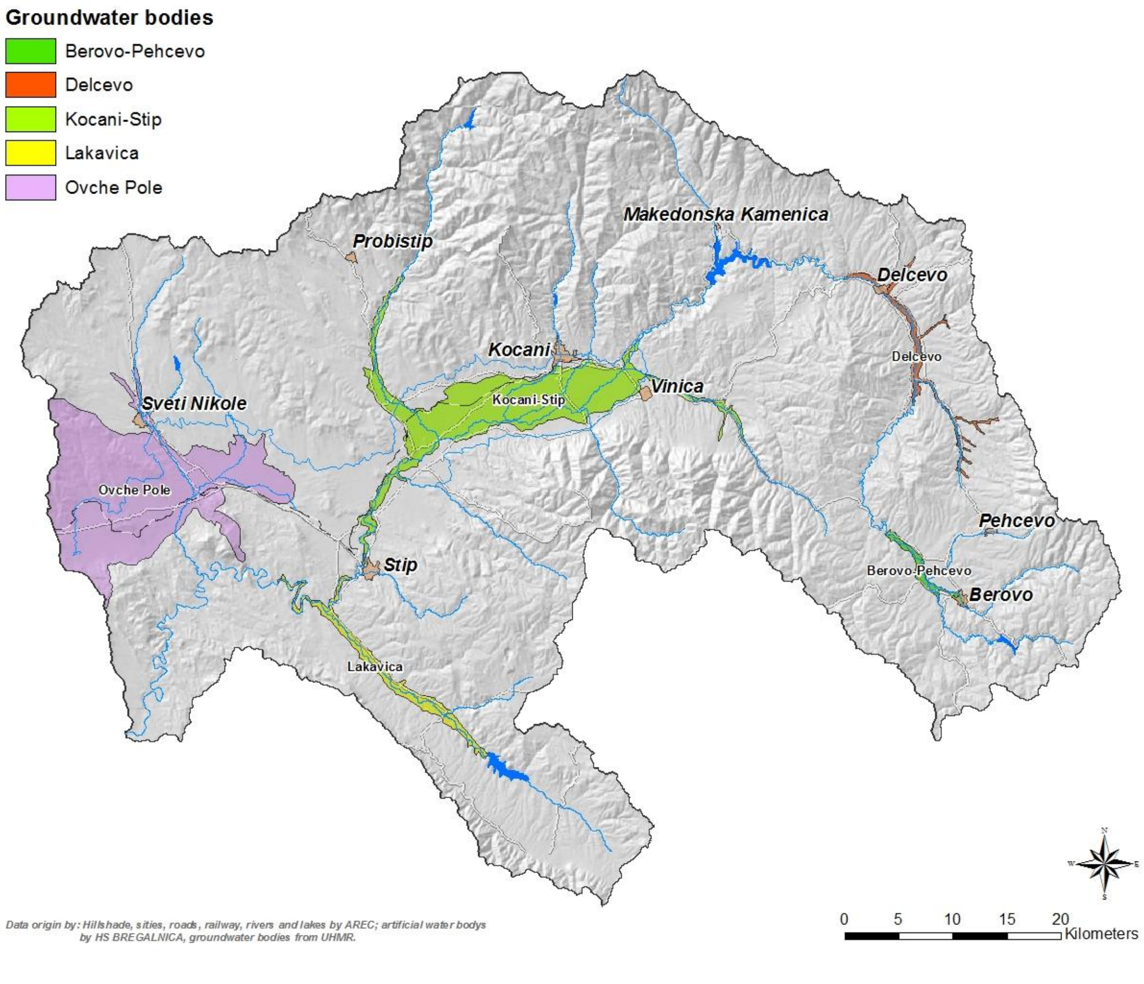

Figure 63: Map of the Bregalnica river basin with the identified groundwater bodies

A4 Description of Protected Areas

At the moment there are no legally proclaimed nature protected areas in the Bregalnica catchment.

A5 Pressures: Water Demand and Pollution

Municipal water demand

Water source	Water demand [million m³/a]
Ratevska Reservoir (AL_01)	1.00
Kalimanci Reservoir (AL_02)	0.15
Knezevo Reservoir (AL_04)	0.95
Mantovo Reservoir (AL_05)	0.00
Bregalnica River (SR_01)	0.34
Bregalnica River (SR_03)	1.31
Bregalnica River (SR_04)	1.16
Ratevska River (SR_12)	0.07
Zelevica River (SR_13)	0.11
Kamenica River (SR_14)	0.72
Osojnica River (SR_15)	0.38
Zrnovska River (SR_16)	0.30
Orizarska River (SR_17)	0.04
Zletovica River (SR_20)	2.01
Otinja River (SR_22)	0.01
Kriva Lakavica River (SR_23)	0.44
Kriva Lakavica River (SR_24)	0.01
Groundwater Kocani-Stip (GW_03)	10.28
Groundwater Ovche Pole (GW_05)	0.61
Total	**19.89**

Table 33: Aggregated municipal water demand per water body source

Municipality	Total annual water demand [million m^3/a]	Water demand per capita [$m^3/(a*cap)$]
Berovo	1.06	80.7
Cesinovo-Oblesevo	0.71	94.9
Delcevo	1.34	76.7
Karbinci	0.26	65.7
Kocani	3.15	82.9
Konce	0.44	125.3
Kratovo	0.93	89.8
Lozovo	0.19	65.7
Makedonska Kamenica	0.89	109.5
Pehcevo	0.46	84.0
Probistip	1.14	71.5
Stip	6.05	127.0
Sveti Nikole	1.31	71.2
Vinica	1.66	83.6
Zrnovci	0.29	98.6
Total	**19.9**	**92.4**

Table 34: Annual municipal water demand per municipality

Industrial water demand

Type of activity	Municipality	Water Demand [million m³/a]	Consump-tion rate	Water Source	Outlet
Copper mine	Radovis	8.040	50%	Kriva Lakavica (SR_24)	Kriva Lakavica (SR_24)
Lead and zinc mine	M. Kamenica	4.560	50%	Kamenica (SR_14)	Kamenica (SR_14)
Dairy	Sveti Nikole	3.650	0%	Groundwater Ovche Pole (GW_05)	Svetinikolska (GW_05)
Lead and zinc mines	Probistip	0.636	50%	Zletovica (SR_20) and Groundwater Kocani-Stip (GW_03)	Zletovica (SR_20)
Pig farm	Karbinci	0.290	31%	Groundwater Kocani-Stip (GW_03)	Bregalnica (GW_03)
Production of textiles and textile products	Vinica	0.251	5%	Bregalnica (SR_04) and Groundwater Kocani-Stip (GW_03)	Bregalnica (SR_04)
Chicken breeding farm	Stip	0.230	85%	Groundwater Ovche Pole (GW_05)	Orelska/Mavrovica (GW_05)
Pig farm	Sveti Nikole	0.230	85%	Groundwater Ovche Pole (GW_05)	Orelska/Mavrovica (GW_05)
Agricultural production	Sveti Nikole	0.191	100%	Groundwater Ovche Pole (GW_05)	Svetinikolska (GW_05)
Grin house	Karbinci	0.151	95%	Groundwater Kocani-Stip (GW_03)	Bregalnica (GW_03)
Paper industry	Kocani	0.150	20%	Gradche Reservoir (AL_03) and Groundwater Kocani-Stip (GW_03)	Osojnica (AL_03)
Production of cooking oil	Stip	0.108	30%	Groundwater Kocani-Stip (GW_03)	Bregalnica (GW_03)
Battery factory	Probistip	0.066	30%	Knezevo Reservoir (AL_04)	Zletovica (AL_04)
Refractory	Pehcevo	0.048	80%	Bregalnica (SR_01)	Bregalnica (SR_01)
Production of bitumen and hydroinsulation materials	Sveti Nikole	0.043	3%	Groundwater Ovche Pole (GW_05)	Orelska/Mavrovica (GW_05)
Pig farm (in village Peklani)	Vinica	0.040	3%	Groundwater Kocani-Stip (GW_03)	Osojnica (GW_03)
Production of meat products	Sveti Nikole	0.038	20%	Groundwater Ovche Pole (GW_05)	Svetinikolska (GW_05)
Finishing of textiles	Stip	0.031	0%	Groundwater Kocani-Stip (GW_03)	Bregalnica (GW_03)
Pig farm	Berovo	0.022	80%	Ratevska Reservoir (AL_01)	Bregalnica (AL_01)
Production of ceramic products	Lozovo	0.019	85%	Groundwater Ovche Pole (GW_05)	Svetinikolska (GW_05)
Production of textiles and textile products	Vinica	0.019	3%	Bregalnica (SR_04)	Bregalnica (SR_04)

Type of activity	Municipality	Water Demand [million m³/a]	Consump-tion rate	Water Source	Outlet
Metal industry	Kocani	0.012	45%	Groundwater Kocani-Stip (GW_03) and Gradche Reservoir (AL_03)	Osojnica (GW_03)
Special construction works	Stip	0.012	99%	Groundwater Kocani-Stip (GW_03)	Bregalnica (GW_03)
Processing of fruits, vegetables and tobacco	Sveti Nikole	0.008	4%	Groundwater Ovche Pole (GW_05)	Svetinikolska (GW_05)
Pig farm	Stip	0.008	62%	Groundwater Kocani-Stip (GW_03)	Bregalnica (GW_03)
Bakery and flour mill	Sveti Nikole	0.008	0%	Groundwater Ovche Pole (GW_05)	Svetinikolska (GW_05)
Food industry	Kocani	0.008	55%	Groundwater Kocani-Stip (GW_03)	Osojnica (GW_03)
Production of roof tiles	Vinica	0.008	0%	Bregalnica (SR_04) and Groundwater Kocani-Stip (GW_03)	Bregalnica (SR_04)
Textile industry	Berovo	0.007	20%	Ratevska Reservoir (AL_01)	Bregalnica (AL_01)
Dairy	Cesinivo-Oblesevo	0.006	20%	Groundwater Kocani-Stip (GW_03)	Zletovica (GW_03)
Dairy	Pehcevo	0.006	10%	Bregalnica (SR_01)	Bregalnica (SR_01)
Mebel production	Vinica	0.005	45%	Bregalnica (SR_04) and Groundwater Kocani-Stip (GW_03)	Bregalnica (SR_04)
Gravel separation	Delcevo	0.005	0%	Bregalnica (SR_03)	Bregalnica (SR_03)
Bakery	Probistip	0.005	30%	Knezevo Reservoir (AL_04)	Zletovica (AL_04)
Flour mill	Cesinovo-Oblesevo	0.004	15%	Groundwater Kocani-Stip (GW_03)	Bregalnica (GW_03)
Vinery	Stip	0.004	0%	Groundwater Kocani-Stip (GW_03)	Bregalnica (GW_03)
Construction materials	Cesinovo-Oblesevo	0.004	90%	Groundwater Kocani-Stip (GW_03)	Bregalnica (GW_03)
Dairy	Konce	0.004	10%	Not known	Not known
Chicken and egg farm	Berovo	0.004	90%	Ratevska Reservoir (AL_01)	Not known
Construction company	Delcevo	0.004	20%	Bregalnica (SR_03)	Bregalnica (SR_03)
Gravel separation	Delcevo	0.004	0%	Bregalnica (SR_03)	Bregalnica (SR_03)
Textile factory	Delcevo	0.003	20%	Bregalnica (SR_03)	Bregalnica (SR_03)
Gravel separation	Delcevo	0.003	65%	Bregalnica (SR_03)	Bregalnica (SR_03)
Rubber processing for oil	Karbinci	0.003	20%	Groundwater Kocani-Stip (GW_03)	Bregalnica (GW_03)
Self-adhesive tapes	Berovo	0.002	20%	Ratevska Reservoir (AL_01)	Bregalnica (AL_01)
Excavation, crushing and sieving of nonmetal materials	Cesinovo-Oblesevo	0.002	50%	Groundwater Kocani-Stip (GW_03)	Bregalnica (GW_03)
Mebel production	Vinica	0.001	5%	Bregalnica (SR_04)	Bregalnica (SR_04)
Eggs production	Zrnovci	0.001	30%	Zrnovska (SR_16)	Zrnovska (SR_16)

Type of activity	Municipality	Water Demand [million m³/a]	Consump-tion rate	Water Source	Outlet
dairy and fruit pro-cessing	Delcevo	0.001	10%	Bregalnica (SR_03)	Bregalnica (SR_03)
Flour mill	Karbinci	0.001	20%	Groundwater Kocani-Stip (GW_03)	Bregalnica (GW_03)
Vegetable processing	Karbinci	0.001	20%	Groundwater Kocani-Stip (GW_03)	Bregalnica (GW_03)
Bottles production	Karbinci	0.001	20%	Groundwater Kocani-Stip (GW_03)	Bregalnica (GW_03)
Dairy	Probistip	0.001	20%	Knezevo Reservoir (AL_04)	Zletovica (AL_04)
Coal Mine	Berovo	0.001	20%	Ratevska (SR_12)	Ratevska (SR_12)
Recycling	Stip	0.001	62%	Groundwater Kocani-Stip (GW_03)	Bregalnica (GW_03)
Pig farm	Sveti Nikole	0.001	3%	Groundwater Ovche Pole (GW_05)	Svetinikolska (GW_05)
Production of inorgan-ic chemicals	Probistip	0.001	0%	Knezevo Reservoir (AL_04)	Zletovica (AL_04)
Dairy	Probistip	0.000	20%	Knezevo Reservoir (AL_04)	Zletovica (AL_04)
Finishing of textiles	Stip	0.000	3%	Groundwater Kocani-Stip (GW_03)	Bregalnica (GW_03)
Nonmetal mine	Probistip	0.000	0%	Knezevo Reservoir (AL_04)	Zletovica (AL_04)
Flour mill	Sveti Nikole	0.000	0%	Groundwater Ovche Pole (GW_05)	Orelska/Mavrovica (GW_05)
Printing	Kocani	0.000	34%	Groundwater Kocani-Stip (GW_03)	Kochanska (GW_03)
	Stip	0.000	20%	Groundwater Kocani-Stip (GW_03)	Bregalnica (GW_03)
Bakery	Stip	0.000	20%	Not known	Not known
Nonmetal mine	Cesinovo-Oblesevo	0.000	20%	Bregalnica (SR_06)	Bregalnica (SR_06)
Textile factory	Delcevo	0.000	20%	Bregalnica (SR_03)	Bregalnica (SR_03)
Dairy	Stip	0.000	0%	-	-
Fruit processing	Karbinci	0.000	0%	-	-
Vinery	Stip	0.000	0%	-	-
Vinery	Stip	0.000	0%	-	-
Production of oil for cars	Stip	0.000	0%	-	-
Textile industry	Stip	0.000	0%	-	-
Textile industry	Stip	0.000	0%	-	-
Gabbro quarries	Kocani	0.000	0%	-	-
Basalt quarries	Stip	0.000	0%	-	-
Total		18.966			

Table 35: Industrial sites in the Bregalnica river basin, sorted by water demand

Presently irrigated areas in the hydro-meliorative systems

Hydro meliorative systems (HMS)	HMS Malesevsko Plain	HMS Delcevo Plain	HMS Osojnica (Vinitca)	HMS Blatecko Plain	HMS Bregalnica	HMA Mavrovica
Gross irrigation area covered with HMS (in km^2)	30.0	9.5	4.5	6.2	321.0	3.8
Net irrigation area covered with HMS (in km^2)	28.6	8.5	4.2	4.0	235.0	2.5
Present irrigation area (in km^2)	2.8	4.9	1.9	2.0	74.5	2.0

Crops area (in km^2)	**HMS Malesevsko Plain**	**HMS Delcevo Plain**	**HMS Osojnica (Vinitca)**	**HMS Blatecko Plain**	**HMS Bregalnica**	**HMA Mavrovica**
Alphalpha				0.10	15.95	0.20
Cereals					0.03	
Millet					0.15	
Maize	0.10	2.49		0.15	5.59	
Forage maize					0.47	
Sunflower					1.04	
Soyabeens					0.63	
Rice	0.11			0.30	42.44	
Tobacco				0.20	0.90	
Pepper	0.15	0.61		0.10	0.02	
Tomatoes	0.22	0.35	0.20	0.10	0.10	0.20
Potato				0.30	0.00	
Onion	0.21	0.31	0.10	0.07	0.08	
Cabbage	0.28	0.38	0.10	0.05	0.03	0.10
Beans				0.31	0.02	
Melons				0.05	0.60	0.10
Other vegetables	0.14	0.00			1.12	0.20
Apple	0.30	0.22	0.50	0.05	0.16	0.20
Plumbs	1.17	0.36	0.20	0.20	0.10	
Sweet cherry	0.01	0.01	0.30		0.15	0.15
Sour cherry	0.07	0.10	0.50	0.06	0.20	0.15
Vineyards	0.01	0.08			4.58	0.70
Other crops					0.13	
Total area (in km^2)	**2.8**	**4.9**	**1.9**	**2.0**	**74.5**	**2.0**
Grand Total crops area (in km^2)						**88.1**

Table 36: Presently irrigated areas in the hydro meliorative systems

Agricultural area per municipality

Region	Irrigated Area (km²)										Rainfed Area (km²)								Grand Total
	Corn	Rice	Industrial crops (Tobacco)	Vegetables (Tomato)	Fourage crops (alfalfa)	Orchards	Vineyards	Meadows	Other	**Total irrigated**	Cereals	Industrial crops	Vegetables	Fourage crops	Orchards	Vineyards	Other	**Total Rainfed**	
Berovo	0.1	0.1	0.0	2.1	0.0	0.3	0.0	1.0	0.0	3.8	10.1	0.4	6.8	0.6	3.1	0.0	12.4	33.5	37.3
Cesinovo-Oblesevo	0.1	14.5	0.3	0.9	0.5	0.1	0.1	0.1	1.2	17.6	20.2	0.0	0.8	2.3	0.1	1.0	1.5	25.9	43.5
Delcevo	2.5	0.0	0.5	1.1	0.1	0.8	0.0	0.2	0.0	5.1	14.4	0.1	0.8	1.9	3.7	0.1	9.3	30.1	35.2
Karbinci	1.0	2.3	0.2	0.7	0.3	0.1	0.1	0.0	0.3	4.9	19.5	1.0	0.3	1.0	0.3	0.7	3.3	26.1	31.1
Kocani	3.5	7.8	0.6	2.4	0.5	0.4	0.3	0.1	0.1	15.7	19.5	0.0	2.2	1.2	0.7	0.8	4.6	29.0	44.8
Konce	0.2	0.0	0.1	1.0	0.1	0.3	0.0	0.1	0.0	1.8	10.5	9.2	0.2	1.9	0.7	0.8	4.7	28.0	29.8
Lozovo	0.4	0.0	0.5	0.7	0.5	0.1	0.9	0.1	0.2	3.4	8.6	0.8	1.2	0.4	0.0	0.4	0.8	12.2	15.6
Makedonska Kamenica	0.6	0.0	0.1	1.2	0.0	0.2	0.0	0.2	0.0	2.3	2.4	0.0	0.2	0.1	0.6	0.0	2.9	6.3	8.6
Pehcevo	0.1	0.2	0.0	0.5	0.0	0.8	0.0	0.8	0.0	2.4	7.7	0.1	0.9	1.1	2.0	0.0	2.7	14.5	16.9
Probistip	0.8	0.1	0.1	0.5	0.1	0.1	0.1	0.0	0.0	1.7	17.9	2.0	0.3	1.3	0.6	1.4	5.4	28.9	30.6
Stip	3.3	0.4	0.3	0.9	1.4	0.6	0.9	0.1	0.2	8.1	29.7	0.2	0.9	1.7	1.5	2.5	8.8	45.4	53.5
Sveti Nikole	6.5	0.0	1.2	1.1	5.0	0.2	0.9	0.1	0.2	15.2	52.9	0.9	0.6	1.9	0.0	3.8	18.9	79.1	94.3
Vinitsa	5.6	1.0	0.3	1.6	0.2	0.3	0.2	1.3	0.1	10.7	11.7	1.0	1.0	0.4	0.7	1.9	6.0	22.6	33.3
Zrnovci	2.5	0.1	0.3	1.1	0.2	0.1	0.1	0.0	0.1	4.4	3.4	0.0	0.3	0.8	0.1	0.2	0.2	5.0	9.4
Grand Total	27.2	26.4	4.5	15.7	8.8	4.2	3.5	4.1	2.4	**97.0**	228.4	15.8	16.6	16.8	14.0	13.7	81.5	**386.8**	**483.9**

Table 37: Agricultural area per municipality

Source: Macedonia Green Growth and Climate Change, World Bank 2013

Number of animals and manure

Municipalities	Horse No.	Horse Manure kg/day	Cattle Total No.	Cattle Total Manure kg/day	Heifer No.	Heifer Manure kg/day	Calve No.	Calve Manure kg/day	Milk Cow No.	Milk Cow Manure kg/day	Sheep No.	Sheep Manure kg/day	Goat No.	Goat Manure kg/day	Pig No.	Pig Manure kg/day	Poultry No.	Poultry Manure kg/day
Berovo	617	13'636	1'257	42'714	106	2'862	88	1'584	1'063	38'268	26'226	472'068	3'379	8'887	3'623	15'325	12'422	1'183
Vinica	702	15'514	999	33'426	138	3'726	72	1'296	789	28'404	9'255	166'590	6'494	17'079	4'409	18'650	19'693	1'876
Delcevo	322	7'116	2'063	69'768	216	5'832	142	2'556	1'705	61'380	8'558	154'044	6'684	17'579	4'763	20'147	19'752	1'882
Zrnovci	356	7'868	379	12'753	63	1'701	18	324	298	10'728	1'385	24'930	826	2'172	1'254	5'304	7'262	692
Karbinci	144	3'182	1'419	47'025	133	3'591	159	2'862	1'127	40'572	13'506	243'108	2'688	7'069	2'193	9'276	13'003	1'239
Konce	297	6'564	1'262	41'913	89	2'403	151	2'718	1'022	36'792	5'603	100'854	1'454	3'824	651	2'754	5'194	495
Kocani	420	9'282	1'203	40'149	131	3'537	110	1'980	962	34'632	6'664	119'952	4'426	11'640	7'513	31'780	20'666	1'969
Lozovo	22	486	557	18'828	102	2'754	17	306	438	15'768	7'756	139'608	724	1'904	803	3'397	7'203	686
Makedonska Kamenica	96	2'122	914	31'653	95	2'565	22	396	797	28'692	4'067	73'206	3'208	8'437	2'688	11'370	9'586	913
Pehcevo	162	3'580	957	32'283	87	2'349	77	1'386	793	28'548	10'647	191'646	926	2'435	1'112	4'704	6'105	582
Probistip	338	7'470	1'044	35'451	113	3'051	62	1'116	869	31'284	15'180	273'240	2'653	6'977	2'954	12'495	17'015	1'621
Sveti Nikole	118	2'608	1'377	45'801	139	3'753	140	2'520	1'098	39'528	32'015	576'270	1'912	5'029	5'584	23'620	27'521	2'622
Cesinovo-Oblesevo	251	5'547	1'348	44'487	131	3'537	159	2'862	1'058	38'088	10'385	186'930	1'237	3'253	7'638	32'309	26'745	2'548
Stip	124	2'740	1'209	40'437	161	4'347	91	1'638	957	34'452	31'283	563'094	2'441	6'420	3'886	16'438	17'601	1'677
Total:	**3'969**	**87'715**	**15'988**	**536'688**	**1'704**	**46'008**	**1'308**	**23'544**	**12'976**	**467'136**	**182'530**	**3'285'540**	**39'052**	**102'707**	**49'071**	**207'570**	**209'768**	**19'983**

Table 38: Total number of livestock and manure production

	Space for Livestock and Manure					
	Livestock	**Poultry**	**Solid Manure**		**Liquid Manure**	
Municipalities	Area in m^2	Area in m^2	Area in m^2	Volume m^3	Area in m^2	Volume m^3
Berovo	68'356	1'365	22	34	-	-
Vinica	57'774	2'525	1'147	2'954	42	66
Delcevo	54'164	1'580	551	1'324	51	101
Zrnovci	14'594	893	179	333	-	-
Karbinci	24'763	1'368	1'275	2'783	70	160
Konce	26'509	414	74	144	-	-
Kocani	51'310	4'646	2'215	3'944	114	273
Lozovo	12'692	467	35	80	-	-
Makedonska Kamenica	22'437	674	40	86	-	-
Pehcevo	42'905	409	78	126	-	-
Probistip	40'599	2'382	137	293	60	160
Sveti Nikole	67'363	3'738	182	308	455	1'105
Cesinovo-Oblesevo	56'807	2'479	2'084	4'137	-	-
Stip	54'373	2'938	400	895	36	78
Total	**594'646**	**25'878**	**8'419**	**17'441**	**828**	**1'943**

Table 39: Space for livestock and manure

Other pressures

Type	Name	Use	Municipality
Airport	Sports airport Susevo	Sport flying	Stip
Airport	Airport Krivi Dol	Agricultural needs	Stip
Airport	Airport Peshirevo	Agricultural needs	Sv.Nikole
Airport	Sports airport Ponikva	Sport flying / Agricultural needs	Kocani

Table 40: Airports in the Bregalnica river basin

Type	Name	Municipality	Waterbody
Fishfarm	Fisfarm Idila - Ravna reka	Pehcevo	Bregalnica (SR_01)
Fishfarm	Fisfarm Sliv DOOEL	Vinica	Osojnica river (SR_15)
Fishfarm	Fisfarm - Ravna reka	Pehcevo	Bregalnica (SR_01)
Fishfarm	Fisfarm Zletovica	Probistip	Zletovica (SR_20)
Fishfarm	Fisfarm Rajska gradina	Stip	Kriva Lakavica (SR_24)
Fishfarm	Fisfarm Klepalo	Berovo	Ratevska (SR_11)
Fishfarm	Fisfarm Gratce	Kocani	Gradche Reservoir (AL_03)
Fishfarm	Fisfarm Lencka	Kocani	Kochanska (SR_19)
Fishfarm	Fisfarm Mantovo	Konce	Mantovo Reservoir (AL_05)
Fishfarm	Fisfarm Zletovo	Probistip	Zletovica (SR_20)

Table 41: Fishfarms in the Bregalnica river basin

Type	Name	Municipality
Gas station	Berovo-033	Berovo
Gas station	Slivka company	Berovo
Gas station	Diva company	Berovo
Gas station	Euro petrol	Cesinovo-Oblesevo
Gas station	Delcevo 1-032	Delcevo
Gas station	Delcevo 2-138	Delcevo
Gas station	Vago petrol	Karbinci
Gas station	Kocani 2-030	Kocani
Gas station	Ekooil	Kocani
Gas station	Kocani 1-028	Kocani
Gas station	Filopov	Kocani
Gas station	Orizari-029	Kocani
Gas station	Konce-126	Konce
Gas station	M.Kamenica-092	M.Kamenica
Gas station	Pehcevo-119	Pehcevo
Gas station	Probistip-049	Probistip
Gas station	Cresovo Topce	Probistip
Gas station	8 mile-133	Stip
Gas station	Stip2-145	Stip
Gas station	Stip1-073	Stip
Gas station	Novo Selo-074	Stip
Gas station	Niko Petrol	Stip
Gas station	Tri Cesmi-045	Stip
Gas station	Okta-Vago petrol	Stip
Gas station	Tri Cesmi-112	Stip
Gas station	Lukoil	Stip
Gas station	Petrol	Stip
Gas station	Lukoil	Stip
Gas station	Makpetrol	Stip
Gas station	Okta-Miki petrol	Sv.Nikole
Gas station		Sv.Nikole
Gas station	Sv.Nikole-055	Sv.Nikole
Gas station	Kadrifakovo?	Sv.Nikole
Gas station	Vinica-031	Vinica
Gas station	Elgo	Vinica
Gas station	Dadi kompani	Vinica

Table 42: Gas stations in the Bregalnica river basin

Name	Status	Max. Turbine Flow [m3/s]	Tailwater Elevation [m]	Water Source	Outlet
MHE Ratevo	operational	1	47	Ratevska Reservoir (AL_01)	Main water supply pipe to Berovo WTP and to the irrigation system
HEC Kalimanci	operational	20	80	Kalimanci Reservoir (AL_02)	Bregalnica river (SR_04)
HEC Zrnovci	operational	1	220	Zrnovska (SR_16)	Zrnovska (SR_16)
HEC Kamenicka river	operational	3	147	Kamenica (SR_14)	Kamenica (SR_14)
Jagmular	planned	-	-	Bregalnica (SR_09)	Bregalnica (SR_09)
Razlovci	planned	-	-	Bregalnica (SR_02)	Bregalnica (SR_02)

Table 43: Operational and planned hydropower plants in the Bregalnica river basin

Name	Status	Active Storage Volume [Mm3]	Waterbody	Purpose*
Ratevska	operational	9	Ratevska Reservoir (AL_01)	I, M&I
Kalimanci	operational	120	Kalimanci Reservoir (AL_02)	I, sP
Gradche	operational	2	Gradche Reservoir (AL_03)	I, M&I
Knezevo	operational	23	Knezevo Reservoir (AL_04)	I, M&I, sP
Mantovo	operational	39	Mantovo Reservoir (AL_05)	I
Mavrovica	operational	2.5	Mavrovica Reservoir (AL_06)	I, M&I
Jagmular	planned	145	Bregalnica (SR_09)	M&I, TPC, I, sP
Bargala	planned	3.5	Kozjacka (SR_21)	I, M&I
Rechani	planned	20	Orizarska (SR_17)	I, M&I
Razlovci	planned	46	Bregalnica (SR_02)	I, P, M&I

* P = Power generation, sP = Small hydro Power, I = Irrigation, FC = Flood Control,
M&I = Municipal and Industrial water supply

Table 44: Operational and planned major reservoirs in the Bregalnica river basin

PLANT Name	RIVER Name	LON X Gauss-Krüger	LAT Y Gauss-Krüger	OPERATOR Name	First Year of Operation	Mean Annual Flow (m³/s)	Ecological Min Flow (m³/s)	Σ Installed Power (MW)
HPP Kalimanci	Bregalnica	631'230	4'648'654	EVN	1969	n/a	1.100	12.8
HPP Ratevska	Ratevska	658'086	4'615'803	Water Economy „Berovo" - Berovo	1970	n/a	0.060	0.4
SHP Kriva reka 1	Kriva Reka	620'735	4'672'050	EMK DOOEL	2013	n/a	0.040	0.5
SHP Zelen grad	Zelengradska	605'590	4'655'580	Hidro eko	2013	n/a	0.007	0.1
SHP Blatesnica	Blateshnica	631'726	4'632'765	Energi luks	2015	28.4	0.023	0.6
SHP Ljutacka 326 (1A	Ljutacka	665'935	4'622'410	EMK DOOEL	2012	n/a	0.017	0.2
SHP Ljutacka 326(2A	Ztacka	665'935	4'622'410	EMK DOOEL	2012	n/a	0.014	n/a
SHP Bregalnica 325	Kriva reka	664'475	4'622'905	EMK DOOEL	2012	21.1	0.046	0.7
SHP Kriva reka 327(1A	Strednjacka	665'930	4'621'710	EMK DOOEL	2012	14.1	n/a	0.1
SHP Kriva reka 327(2A	Mlecanska	665'930	4'621'710	EMK DOOEL	2012	n/a	n/a	n/a
SHP Gradecka	Gradecka	625'645	4'634'458	PCC Hidro dooel	2011	31.1	0.026	0.9
SHP Zrnovska 353	Lomija	622'221	4'628'084	Italian Macedonian Power Generation	2015	41.0	0.055	0.8
SHP Zrnovska 351	Zrnovska	622'979	4'629'438	Italian Macedonian Power Generation	2015	42.0	0.068	1.8

Table 45: MOEPP Register of hydropower plants in the Bregalnica river basin
(n/a: information not available or not applicable)

PERMIT ID Abstraction	PERMIT ID Discharge	OPERATOR Name	WATER USE Type	WATER BODY Name	X LON Gauss-Krüger	Y LAT Gauss-Krüger
11-3877/A	11-3877/Б	Hidro eco inzinering	Hydropower	Zelengradska	n/a	n/a
11-2935/1A	11-2935/1Б	EMK DOOEL	Hydropower	Srednjacka	665'540	4'620'735
11-2935/2A	11-2935/2Б	EMK DOOEL	Hydropower	Mlecanska	666'300	4'620'920
11-2512/1A	11-2512/2Б	HS Berovo	Accumulation	Klepalska	615'586	4'660'107
11-2512/2A	11-2512/2Б	HS Berovo	Accumulation	Zamanicka	614'573	4'659'750
11-2512/3A		HS Berovo	Irrigation	Ratevo	n/a	n/a
11- УП1 бр.137/A	11- УП1 бр.137/Б	Enegeri Luks	Hydropower	Blatecka	632'205	4'630'892
11-5850/A	11-5850/B	PCC HIDRO DOOEL	Hydropower	Gradecka	625'235	4'631'789
11-4192/1A		Agrofila DOOEL	Irrigation	Blagova	624'997	4'603'924
11-4192/2A		Agrofila DOOEL	Irrigation	Blagova	624'093	4'604'763
11 УП1 бр.95/A		Silkom DOOEL Kratovo	Water supply	Zletovska	610'846	4'665'849
11 УП1 бр.92/A	11 УП1 бр.92/Б	JKP Bregalnica Delcevo	Accumulation with water supply	Loshana	638'300	4'647'500
11-4825/1A		SASA Mine Doo	Mine	Saska	n/a	n/a
11-4825/2A		SASA Mine Doo	Mine	Petrova	n/a	n/a
11-894/1A		SASA Mine Doo	Mine	Kozja	625'730	4'667'539
11-894/2A		SASA Mine Doo	Mine	Zanofito	626'018	4'666'762
11-894/3A		SASA Mine Doo	Mine	Zanofito	625'999	4'666'726
11-894/4A		SASA Mine Doo	Mine	Zanofito	625'987	4'666'699
11-2934/1A	11-2934/1Б	EMK DOOEL	Hydropower	Ztacka	664'410	4'623'320
11-2934/2A	11-2934/2Б	EMK DOOEL	Hydropower	Ljutacka	666'685	4'622'695
11-5250/A		Municipality M Kamenica	Water supply	Gorestica	660'675	4'627'740
11-2145/A		Municipality Berovo	Water supply	Elenska	659'903	4'603'874
11-2933/1A	11-2933/1Б	EMK DOOEL	Hydropower	Kriva river	621'604	4'665'948
11-2933/2A	11-2933/2Б	EMK DOOEL	Hydropower	Ljutacka	621'699	4'665'928
11-5850/A	11-5850/Б	PCC HIDRO DOOEL	Hydropower	Gradecka	625'235	4'631'789
УП1 бр. 11-284/1A	УП1 бр. 11-284/1Б	MA BEL Union	Fishfarms	Zelevica	639'036	4'652'260

Table 46: MOEPP Register of surface water abstraction permits in the Bregalnica river basin
(n/a: not available)

PERMIT ID Abstraction	OPERATOR Name	WATER USE Type	X LON Gauss-Krüger	Y LAT Gauss-Krüger
UP1 br. 11-274	Buchim	Water Supply	613'326	4'610'554
11-UP br. 109	Kozuvchanka	Water bottling	586'996	4'559'610
11-UP 1 br.234	Zipe Toni	Food Processing	566'366	4'621'181
11-UP1 br.146	Toplana BEG	Multi Purpose	538'029	4'650'102
11-UP 1 br.70	Veze Shari	Food Processing	503'069	4'651'473
11-UP1 br.143	Sivec	Water Supply	550'439	4'585'164
11-UP1 br.171	IN MAK Beton	Manufacturing	641'349	4'588'685
UP1 br. 11-147	HAJ TECH KORPORACIJA	Manufacturing	550'844	4'639'189
11-UP1 br.143	Pivara Skopje	Irrigation	539'115	4'650'516
11-UP1 br.200	AGRIA agroind.grupacija	Food Processing	567'548	4'616'078
11-560/1	AKVA KOKINO	Water bottling	570'929	4'675'430
11-277/2	Vardar Pesok	Manufacturing	600'222	4'591'360
11-2021/2	AGRIA agroind.grupacija	pig farming	576'109	4'602'829
11-UP1 br.59	Opstina Veles	Water Supply	569'576	4'616'021
11-UP1 br.106	Sinohidro Korporejshn	technical purpose	578'187	4'637'873
11-UP1 br.62	ZITOPOLOG	chicken farm	498'385	4'637'160
11-2654/2	KODING	Manufacturing	590'564	4'567'494
11-UP1 br.124	Opstina Zelino	Water Supply	504'927	4'649'259
11-UP1 br.1	VETEKS Veles	Manufacturing	620'771	4'564'722
11-UP1 br.86	DAVINA VODA	Water bottling	536'957	4'641'229
11-12203/1	MAK MINERAL	Water bottling	539'802	4'531'273
11-UP1 br.123	Maja Kompani	chicken farming	549'326	4'648'433
11-UP1 br.55	MEDI DOOEL	pig farming	532'468	4'658'668
11-UP1 br.14	Rade Koncar	Manufacturing	538'006	4'648'673
11-10776/3	Oranzerii Dobra	warming, Irrigation	615'556	4'639'987
11-8836	STOBI	Irrigation	577'809	4'605'062
11-10543	Oranzerii Hamzali	Manufacturing	500'668	4'548'890
11-4475	Otljanac Zvonko	separation of sand	565'241	4'660'508
11-5646	JKP Vodovod	Irrigation	546'153	4'646'813
11-6312	Mali Loshinj	Water bottling	474'414	4'595'427
11-6414	Makpetrol Skopje	Water Supply	571'785	4'542'198
11-11667	VIZAR DOO	Water bottling	534'345	4'544'650
11-3906	Alkaloid Skopje	Manufacturing	539'137	4'650'727
11-3627	Opstina Tearce	Water Supply	507'561	4'661'128
11-6070	Uprava pri min. za pravda	Water Supply	654'140	4'578'342
11-12328	Alkaloid ad Berovo	Manufacturing	654'507	4'620'715
11-6394	VLAMAR Kicevo	Water bottling	484'851	4'592'790
11-4803	Opstina Prilep	Water Supply	547'977	4'561'941
11-UP1 br.80	SKOVIN Skopje	Food Processing	540'259	4'650'851
11-UP1 br.107	TONDAH Makedonija	Manufacturing	623'003	4'640'221
11-UP1 br.132	BRAKO	Manufacturing	463'815	4'619'389
11-UP1 br.201	BHZ Projekt Development	Water bottling	533'420	4'543'753
11-2817	Oranzerii Dobra	warming	615'288	4'640'093
11-708	JKP Vodovod Kocani	Water bottling and warming	613'061	4'649'072
11-UP1 br.40	KANET AGRO	warming,irrigation	626'064	4'562'557
11-1771	Tehnicki gasovi Skopje	Manufacturing	538'825	4'652'850
11-1277	ProKredit Reg.Akadem	Irrigation	562'655	4'625'510
11-8817	Makedonija turist	hitting/cooling	536'612	4'650'171
11-12277	Rudine MM	Irrigation	649'050	4'646'667
11-5413	BOBO Komerc	Water Supply	599'143	4'625'464
11-576	KOM TRANS	sand separation	547'736	4'644'230
11-3178	Gradba promet	sand separation	580'382	4'597'912
11-6935	Vardar Gradba	sand separation	649'463	4'542'893
11-2671	GOIVA	Manufacturing	541'859	4'644'283
11-1533	Gamatroniks	Manufacturing	528'888	4'659'523
11-418	GRANIT	Water Supply	508'108	4'571'140
11-4407	BETON AD	Manufacturing	540'018	4'649'840
11-UP1 br.104	SOPOT DOO	Manufacturing	561'269	4'679'328
11-448	GRANIT AD	Manufacturing	532'468	4'658'668
11-277	Vardar Pesok	sand separation	600'222	4'591'360
UP br.17	Berovik Beton	sand separation	551'567	4'643'095
11-6134	STENTON	sand separation	544'686	4'535'005
11-7132	GRANIT AD	sand separation	600'179	4'590'259
11-867	JP Komunalec Kriva Planka	Water Supply	604'464	4'671'137
11-11328	Euro-Mim	sand separation	546'535	4'641'781
11-1085	AD Grozd	Water bottling	637'431	4'590'690
11-4076	Opstina Demir Hisar	Water Supply	516'814	4'559'725
11-4541	KANET AGRO	warming,irrigation	625'848	4'561'610
11-5202	PELALEK DOOEL	Water bottling	530'337	4'544'410
11-1700	Oranzerii Dobra	warming,irrigation	615'556	4'639'987
11-7683	Mali Losin	Water bottling	474'580	4'595'703
11-5537	MAGRONI DOO	Water bottling	590'117	4'659'037
11-5441	Filip Vtori	hitting,cooling	533'877	4'651'152
11-391	KODING	Water bottling	592'335	4'564'830
11-3241	KOZUVCANKA	Water bottling	583'612	4'560'640

Table 47: MOEPP Register of groundwater abstraction permits in the Bregalnica river basin

A6 Hydrology

To derive runoff estimates for all 33 selected surface water bodies, a rainfall-runoff model was employed. The conducted analysis focuses on the years from 1966 to 1990, i.e. the period featuring (i) reliable records for the runoff measurement stations which cover significant catchment areas, namely Stip and Ochi Pale, and (ii) observations from a dense meteorological measurement network operated by UHMR (see Figure 64).

Historical runoff records

For the hydrological analysis historical flow records from 6 runoff stations in the Bregalnica river basin were considered (see Table 48 and Figure 64).

Station Name	River	Catchment area [km^2]	Data availability		
Berovo	Bregalnica	88	1961	-	1990
Ochi Pale	Bregalnica	846	1976	-	1996
Shtip	Bregalnica	2940	1963	-	1996
Makedonska Kamenica	Kamenica	105	1976	-	1996
Laki	Osojnica	73	1961	-	1996
Zletovo	Zletovska	172	1961	-	1990

Table 48: Available historical flow records in the Bregalnica catchment

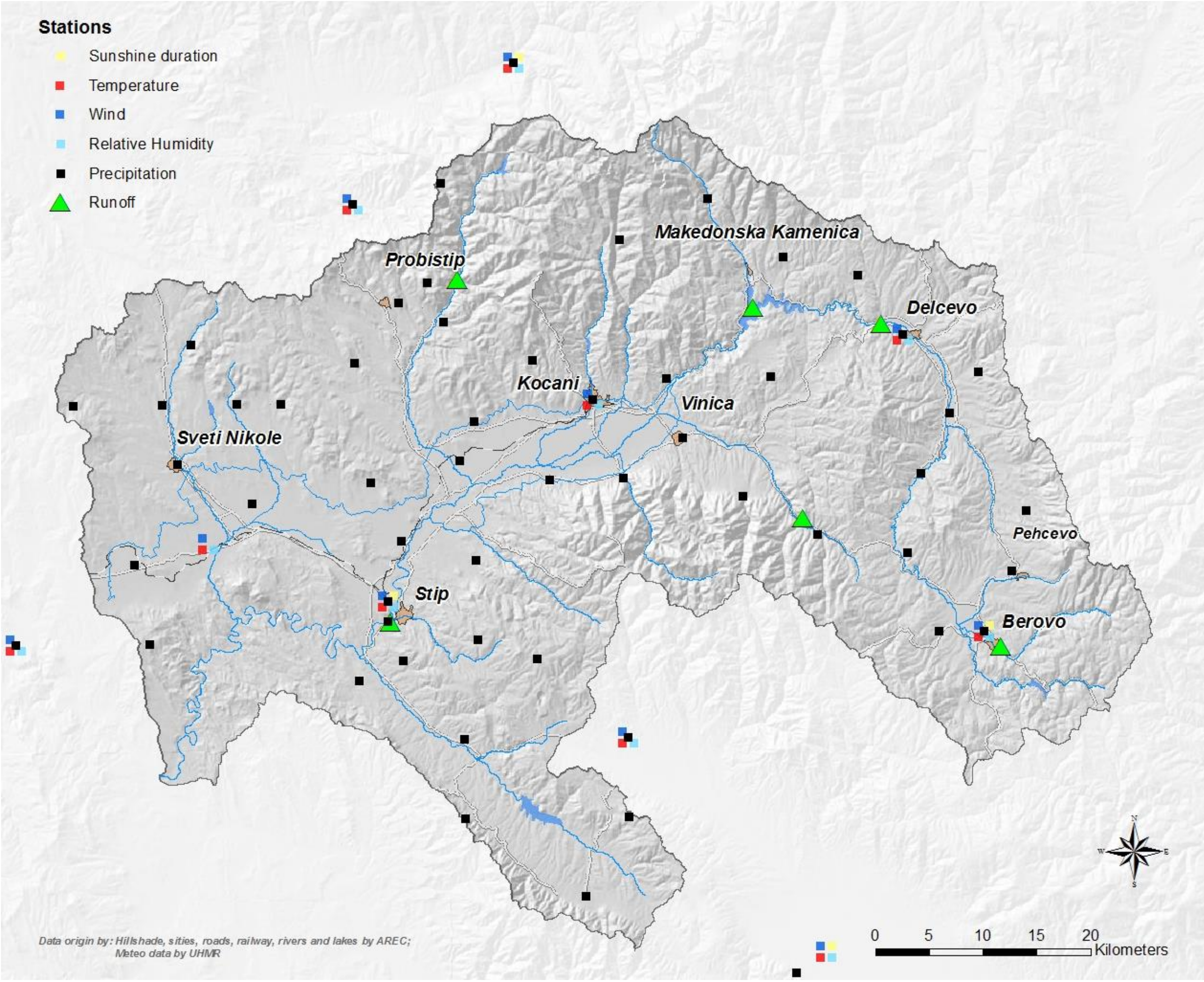

Figure 64: UHMR measurement network for the period 1966 to 1990 in the Bregalnica river basin

Development of monthly climate time-series (climate baseline)

Table 49 shows the climatological observations, which served as a basis for the development of monthly climate time-series for the period 1966 to 1990 for the catchments area of every selected surface water body, henceforth referred to as climate baseline.

Climatic parameter	Unit	Number of considered stations	Period of analysis	Technique for geo-statistical analysis
Precipitation; monthly sum	mm	57	1966-1990	Detrended Inverse Distance Weighting (DTIDW)
Temperature; monthly average of daily maximum	°C	14	1966-1990	Detrended Inverse Distance Weighting (DTIDW)
Temperature; monthly average of daily minimum	°C	14	1966-1990	Detrended Inverse Distance Weighting (DTIDW)
Relative humidity; monthly average	%	14	1966-1990	IDW
Wind speed; monthly average	m/s	14	1966-1990	IDW
Sunshine duration; monthly average	[0-1]	4	1966-1990	Mapping based on proximity & topography

Table 49: Overview on climatological observations used the rainfall-runoff model and the water allocation model

To arrive at a climate-baseline for the catchment area of every selected surface water body the historical discrete point measurements were spatially interpolated to obtain monthly continuous fields over the whole river basin for every climate parameter (a sample of a continuous precipitation field for the whole analyzed period 1966-1990 is given in Figure 65).

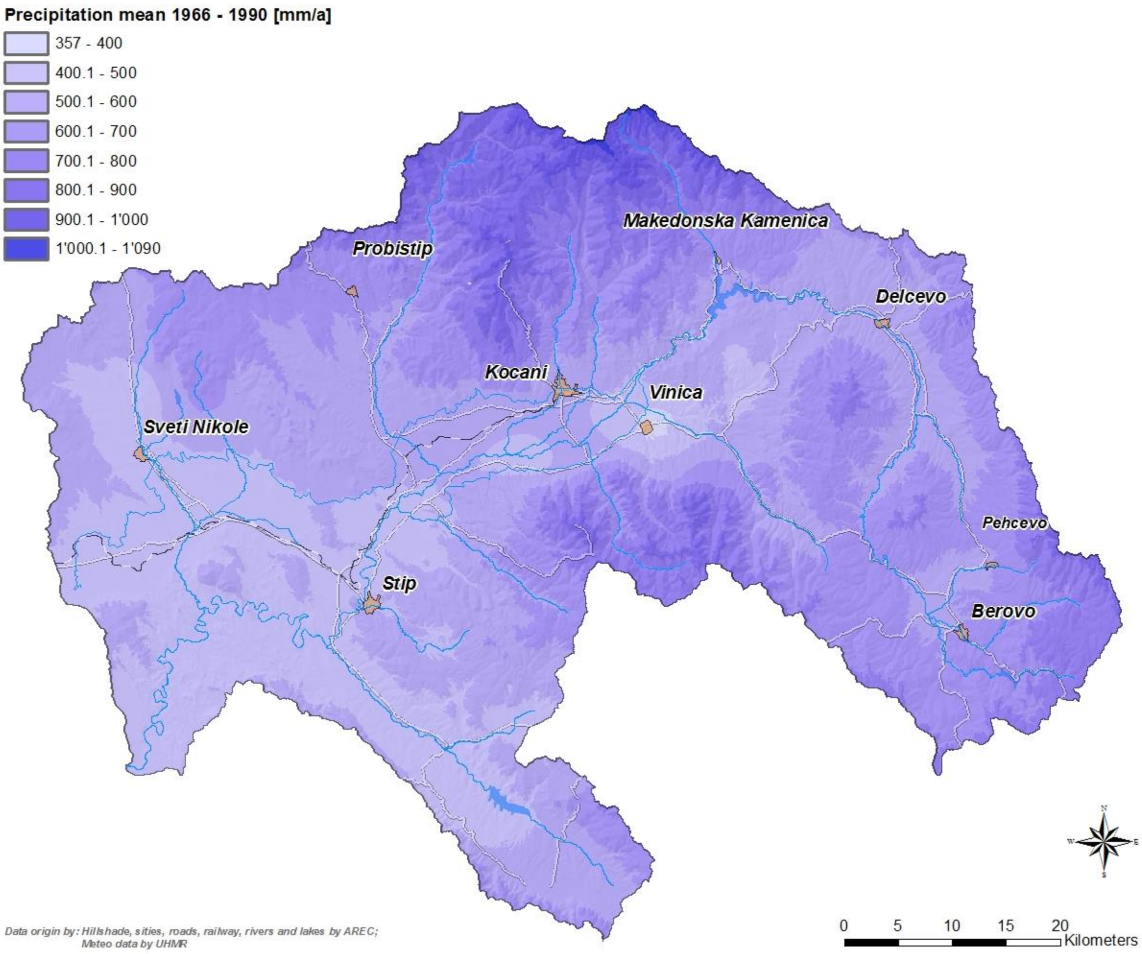

Figure 65: Climatological mean of yearly precipitation for the period 1966-1990. Spatial interpolation of the observations from 57 measurement stations was carried out by means of detrended inverse distance weighting

For parameters with no clear elevation-dependency the spatial interpolation of the observed values was carried out by means of Inverse Distance Weighting (IDW). For parameters with a significant elevation-dependency - namely precipitation and temperature - Detrended Inverse Distance Weighting (DTIDW) was employed. DTIDW essentially divides the spatial variability in a vertical and a horizontal component by combining IDW with elevation dependent regression (EDR), resulting in a detrended interpolation. To this end, the residuals (difference between interpolated value and observed value) of the EDR method are spatially interpolated with IDW. By adding this interpolated residual map to the map interpolated with EDR, interpolation biases at the station locations are adjusted spatially (see e.g. Garen and Marks (2001) for a more in depth discussion of DTIDW).

To finally arrive at monthly estimates of every climatic parameter for all catchments, the continuous climate fields were intersected with the catchment areas of the selected surface water bodies and areal averages for all catchment areas were computed.

The following paragraphs describe the treatment of the different climatological time-series parameters in more detail.

Precipitation

There were several periods with missing values in the time series of the 57 measurement stations. Systematic data gaps were filled with reanalysis data from the NCEP/NCAR Reanalysis Project (e.g. http://www.cpc.ncep.noaa.gov/products/wesley/reanalysis.html). The monthly precipitation data of the 57 stations show a distinct elevation dependency. As the elevation trend showed significance variance from month to month (see Figure 66 as a sample for the month of June), the precipitation data was detrended with a month-specific elevation-dependent trend. To this end monthly trends with elevation were estimated with a linear regression model. Stations where no precipitation was observed (0 mm) were not considered while deriving the elevation dependent trends. For months with negative trends, it was assumed that there was no elevation dependency and regular IDW was employed.

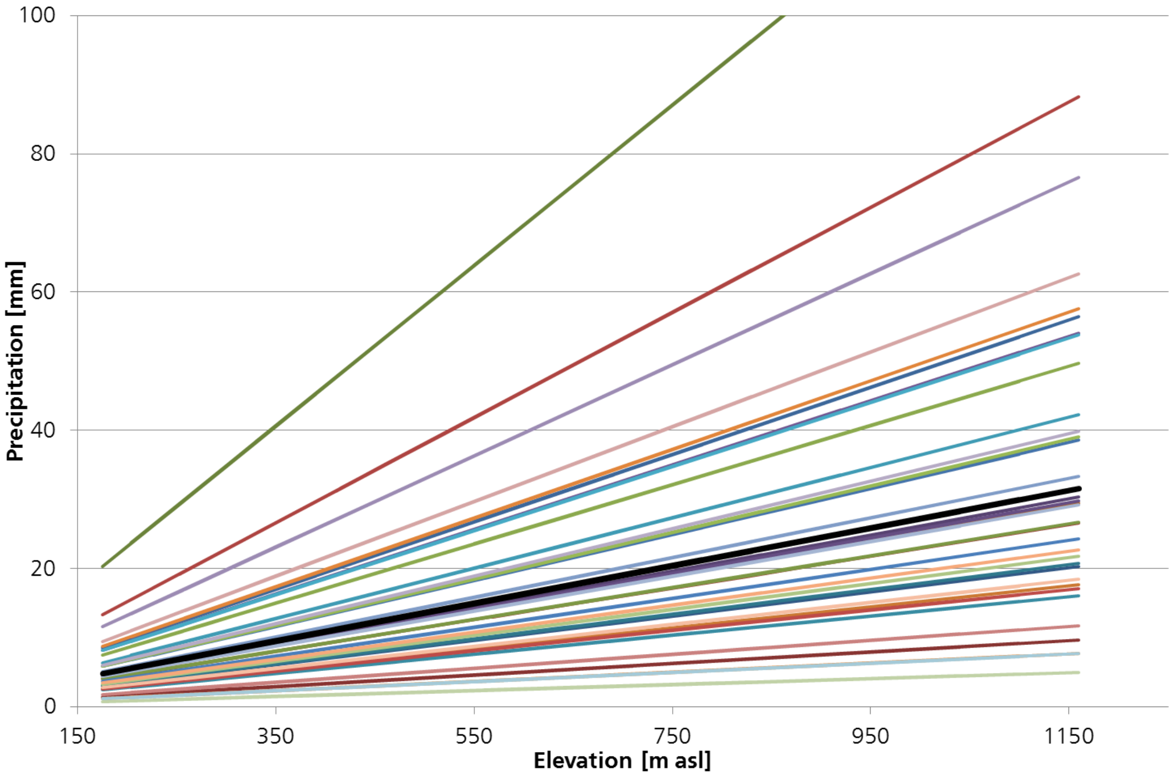

Figure 66: Employed linear trends of monthly precipitation with elevation in DTIDW for the month of June for the period 1966 – 1990. The black line shows the climatological mean trend for June 1966-1990

Temperature

The monthly averages of the daily maximum and minimum temperature of the 14 meteorological stations showed a strong and consistent elevation-dependency. As the elevation dependency featured little temporal variation from year to year 12 monthly linear regression trends were estimated for maximum and minimum temperature respectively. These 12 monthly trends were then employed in DTIDW for the whole period 1966-1990.

Relative humidity

The monthly average values of relative humidity from the 14 meteorological stations did not show a clear elevation dependency. Therefore straightforward IDW was applied to arrive at the spatially interpolated fields of relative humidity.

Wind speed

The monthly average values of wind speed from the 14 meteorological stations did not show a clear elevation dependency. Therefore straightforward IDW was applied to arrive at the spatially interpolated fields of wind speed.

Sunshine duration and cloud fraction

To derive monthly cloud fractions (input parameter of the rainfall-runoff model) the measured monthly sum of sunshine duration was divided by the maximum potential sunshine duration at the locations of the 4 measurement stations (maximal potential sunshine duration was obtained from www.solartopo.com). The so derived monthly cloud fractions at the 4 measurement stations were then attributed to the catchment areas based on proximity and topography.

Rainfall-runoff model

The employed rainfall-runoff model is the soil moisture method in WEAP, which is a conceptual, semi-distributed, two-bucket rainfall-runoff model which represents each catchment with two soil layers (see Figure 67):

- Upper soil layer: the model simulates evapotranspiration for irrigated and rainfed agricultural and non-agricultural land, runoff, shallow interflow and changes in soil moisture. The method accounts for different land use and/or soil types.
- Lower soil layer: the model simulates baseflow routing and soil moisture changes.

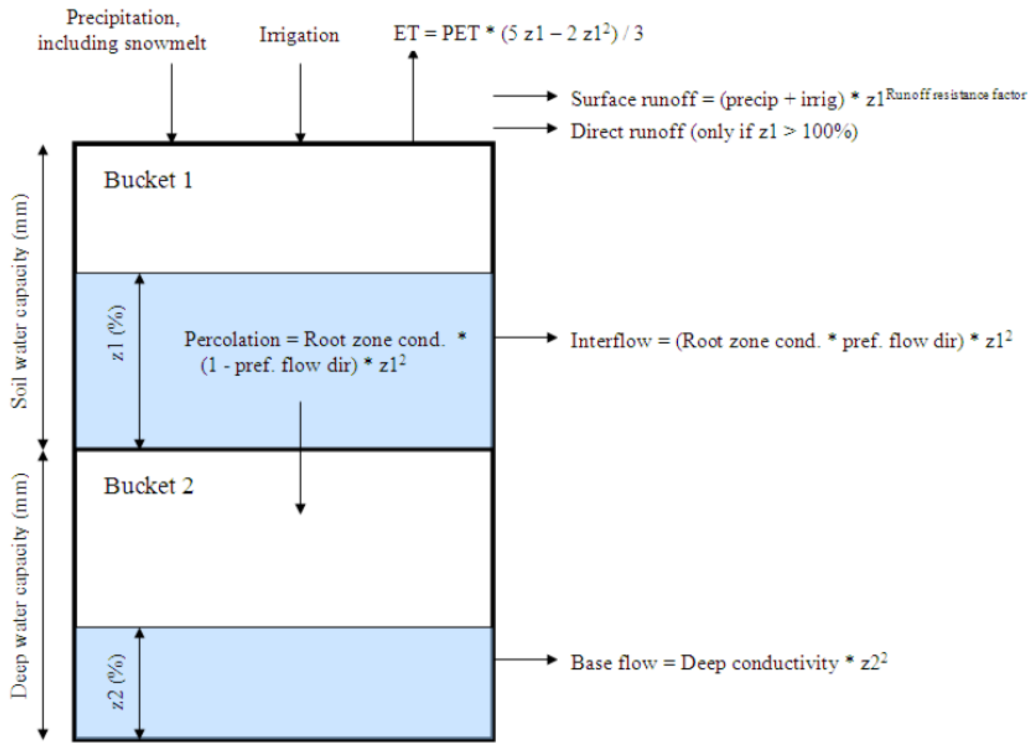

Figure 67: Schematic of the two-bucket model incorporated in WEAP showing the different hydrologic inputs and outputs for a given land cover or crop

More information on WEAP in general and the soil-moisture method in particular can be found in Yates (2005) or in the WEAP-Manual available under http://www.weap21.org/.

Calibration

In line with the objective of the water allocation modelling exercise – evaluating water resources availability over the mid- and long-term – calibration of the rainfall-runoff and the water allocation model were guided with the aim to reproduce the characteristics of the water resources system in a statistical sense. Thus this approach does not strive primarily for the replication of single historic events as accurately as possible (as done in e.g. flood modelling) but tries to capture the magnitude and seasonality of the observed historic flows over several years, i.e. when analysed at a decadal scale the modelled low and high flows should lie in a similar range as the observations.

Model calibration was approached in a step-wise manner. Before calibration, some of the models parameters were prescribed as follows:

- The derived monthly climate-baselines for precipitation, temperature, relative humidity, wind speed and cloud fraction for every sub-catchment served as input data.
- Based on the Corine Land Cover 2006 data set (http://sia.eionet.europa.eu/CLC2006) the fractional areas of the following land-cover types were computed for every sub-catchment in the Bregalnica river basin: Urban area, Arable Land, Grassland, Deciduous Forest, Evergreen

and Shrubs. Initial soil water capacities for the different land-covers were estimated based on Yates (2009) and Ingol-Blanco (2009) and were adjusted subsequently during calibration.

- Evapotranspiration rates in WEAP are computed via the Penman-Monteith equation, the modelled soil-moisture content of the upper soil layer and crop coefficient values for the different vegetation covers. Seasonal crop coefficient values were estimated based on FAO paper No. 56 and adjusted according to local expert judgment (see Table 50).

Land cover class	**Crop coefficient [-]**											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Arable land (rainfed)	0.3	0.3	0.6	0.9	1.2	1.2	1.2	1.2	1.0	0.8	0.3	0.3
Grassland	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Deciduous forest	0.4	0.4	0.6	0.9	1.2	1.2	1.2	1.2	1.0	0.6	0.4	0.4
Evergreen	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Shrubs	0.4	0.4	0.6	0.8	1.0	1.0	1.0	1.0	0.7	0.5	0.4	0.4
Urban area	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Various	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 50: Employed monthly crop coefficient values for rainfall-runoff model. Values are based on FAO paper No. 56 and local expert judgment

- The WEAP-parameter called Runoff Resistance factor, governs the speed of runoffs response to precipitation, and is connected to the Leaf Area Index (LAI) of the vegetation cover and the catchments slope. LAI values were derived from Asner (2003). These LAI values were then scaled by a slope-factor, which is was estimated during the calibration process. To this end the mean slope of every sub-catchment was computed and the catchments were classified into mountainous catchments with high mean slopes (slope-factor applies) and relatively flat catchments (slope-factor does not apply).

Actual calibration was carried out by combination of manual calibration and automatic calibration via PEST (http://www.pesthomepage.org/) and was approached as follows:

- First, the mountainous catchments were calibrated with the historical runoff records of the stations of Ochi Pale (1977-1986), Makedonska Kamenica (calibration period: 1977-1986) and Berovo (1966-1980) with the underlying assumption that all mountainous catchments feature similar hydrologic characteristics. Based on this assumption the calibrated parameter set was then transferred to all other mountainous catchments. The calibration of the mountainous catchments is mainly based on the runoff records at Ochi Pale as these are representative for a larger catchment size than Berovo and M. Kamenica (Table 48). The remaining years up to 1990 were used for validation.
- In a second step, the relatively flat catchments were calibrated with historical runoff records of Stip (1966-1968), for periods where hydrologic regime could still be considered near-natural, i.e. before Kalimanci reservoir became operational in the beginning of 1969. Again, the calibrated parameter set was then transferred to all other flat catchments.
- Third, as the calibration period of 3 years for Stip is considered rather short, the initial calibrated parameter set for the flat catchments was adjusted iteratively based on the (no longer natural) flow records in Stip 1969-1985, going back and forth between the water allocation model and the rainfall-runoff model.

Table 51, Figure 68 and Figure 69 illustrate the model performance of the rainfall-runoff model in relation to measured runoff records at Ochi Pale for the period 1977 - 1986. The model performance is judged as satisfactory as the simulated flows reproduce the seasonality and magnitude of the observed flows adequately in the majority of the analysed years. During some years (1980; 1982; 1983; 1986) the model substantially underestimates the observed runoff, which results in a fairly high root mean square error (Table 51). In contrast, the mean monthly flows as well as the annual water balance are captured rather well (Table 51, Figure 69).

Note that the observations at Ochi Pale do not depict perfectly natural runoff conditions, as upstream Ratevska reservoir was operated from 1974. The reservoirs storage capacity of 9 Mm^3 corresponds to ~3.5 m^3/s of flow during one month, which may induce some of the deviations between measured and modelled values. Moreover, the rainfall-runoff model does not account for irrigational demands, which may partly explain the overestimated summer runoff. Other possible sources for deviations are discussed in Annex A7 (calibration of water allocation model with flow records at Stip).

Efficiency criteria	Min & Max Value	Oci Pale 1977-1986
Logarithmic Nash-Sutcliffe efficiency[14)] of monthly runoff times series (ln E)	[-∞ , 1]	0.74
Root Mean Square Error of monthly runoff times series	no bounds	4.18 m^3/s
Coefficient of determination of mean monthly flows (r^2)	[0; 1]	0.82
Relative error of mean annual water balance	no bounds	-0.4%

Table 51: Efficiency criteria of the calibrated rainfall-runoff model in relation to the historical observations for the river Bregalnica at Ochi Pale

14) Nash-Sutcliffe efficiency as proposed by Nash and Sutcliffe (1970) is defined as one minus the sum of the absolute squared differences between the predicted (P) and observed values (O) normalized by the variance of the observed values during the period under investigation:

$$E = 1 - \frac{\sum_{i=1}^{n} (O_i - P_i)^2}{\sum_{i=1}^{n} (O_i - \bar{O})^2}$$

To reduce the sensitivity to extreme values of the original Nash-Sutcliffe efficiency it is calculated here with logarithmic values of O and P. Through the logarithmic transformation of the runoff values, the peaks are flattened and the low flows are kept more or less at the same level. As a result the influence of the low flow values is increased in comparison to the flood peaks resulting in an increase in sensitivity of ln E to systematic model over- or underprediction (Krause et al. 2005).

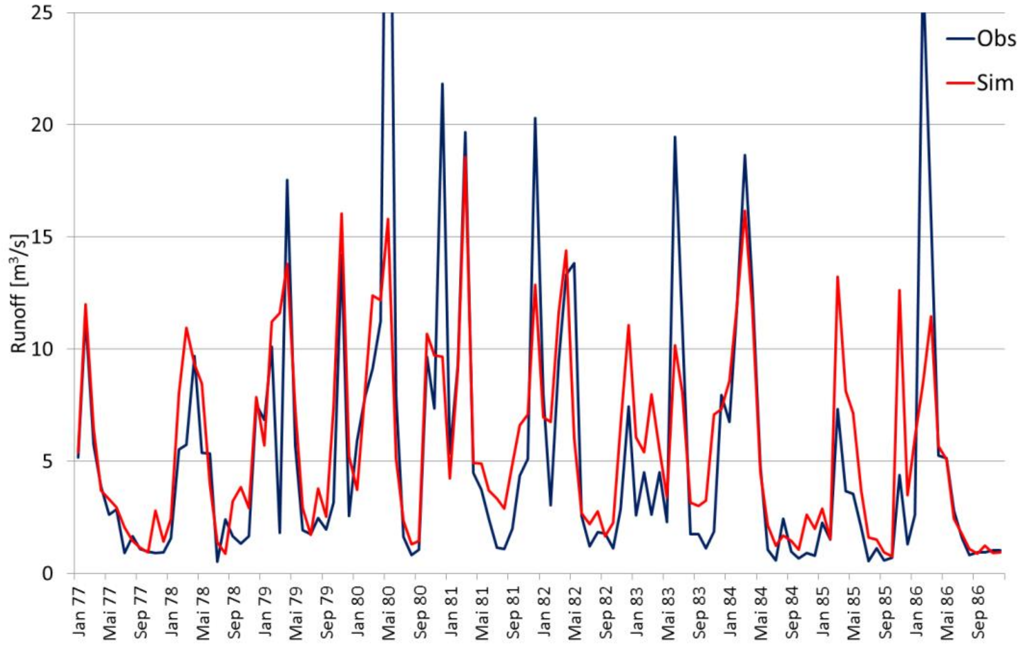

Figure 68: Natural runoff simulated by the rainfall-runoff model and observed runoff for the river Bregalnica at Ochi Pale

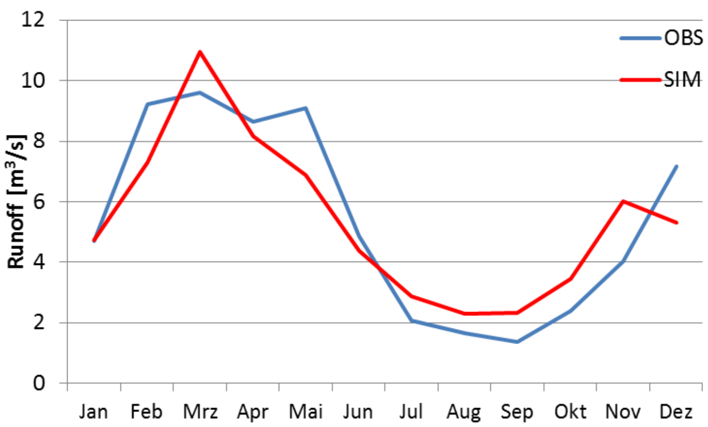

Figure 69: Mean monthly simulated and observed runoff for the river Bregalnica at Ochi Pale for the period 1977 – 1986

Overall, calibration and validation of the rainfall-runoff lead to satisfactory results which were able to capture the magnitude and seasonality of the observed flow records adequately.

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A7 Water Allocation Model: Methodology, Assumptions, Scenarios

The water allocation modelling exercise was carried out with the software WEAP. More information about the WEAP software can be found in Yates (2005) or in the WEAP-Manual available under http://www.weap21.org/.

Groundwater

The Groundwater bodies Kocani-Stip (GW_03) and Ovche Pole (GW_05) were included in the model as they are significant water sources for industrial and municipal water demands. As there is little known quantitative information on the ground water bodies, the storage capacities and natural recharge rates were estimated based on expert judgment.

Water demands

With the calibrated Rainfall-Runoff model and the ground water bodies representing the supply side, the water demands of the different sectors were added in WEAP as follows:

- Municipal demand: The collected data on produced water for all the settlements was aggregated for every water body, i.e. the water demand of all cities and villages with the same water body source and the same water body outlet were summed up resulting in a total of 33 municipal demand points. A general consumption rate of 20% was assumed for municipal water demand.
- Industrial demand: Water demand and water consumption rate were collected for all industrial entities requiring IPPC A or IPPC B. In WEAP only the 10 biggest industrial water consumers in the river basin were included. These account for over 97% of the total industrial water demand.
- Agricultural demand: The present irrigated agricultural areas and applied irrigation technologies were estimated based on the Statistical agricultural report for 2012, information from the HMS Bregalnica office as well as expert judgment. 17 irrigational demand points were distinguished in WEAP, 11 of them belonging to the HMS Bregalnica. The total presently irrigated area was assumed to amount to 92 km^2 (9’200 hectares). The modelled agricultural water demand can be regarded as a rather conservative estimate, as it is mostly based on cultivated areas drawn from official records, which are likely to neglect most of the areas irrigated by private wells or private water intakes. Irrigation efficiencies were assessed based on the information on applied irrigation technologies and expert judgment. Effective rainfall was estimated based on FAO Training manual No. 3. In WEAP Evapotranspiration rates for agricultural areas are computed via the Penman-Monteith equation and crop coefficient val-

ues for the different vegetation covers. Seasonal crop coefficient values were estimated based on FAO paper No. 56 and adjusted according to local expert judgment (see Table 52).

Crop type	Crop coefficient [-]											
	Jan	**Feb**	**Mar**	**Apr**	**Mai**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Vegetables (Tomatoes)	0.05	0.05	0.05	0.6	0.85	1.1	1.1	0.9	0.05	0.05	0.05	0.05
Fodder Crops	0.05	0.05	0.05	0.4	0.75	0.95	0.95	0.9	0.9	0.05	0.05	0.05
Industrial Crops (Tobacco)	0.05	0.05	0.05	0.3	0.5	0.7	0.95	0.9	0.75	0.05	0.05	0.05
Maize	0.05	0.05	0.05	0.3	0.7	1.15	1.15	1.05	0.05	0.05	0.05	0.05
Vineyards	0.05	0.05	0.05	0.3	0.5	0.7	0.7	0.7	0.7	0.65	0.55	0.05
Orchards	0.05	0.05	0.05	0.5	0.7	0.9	1.05	1.05	1.05	0.9	0.05	0.05
Rice	0.05	0.05	0.05	0.05	1.05	1.15	1.2	1.2	0.95	0.05	0.05	0.05

Table 52: Employed monthly crop coefficient values for irrigated agricultural areas. Values are based on FAO paper No. 56 and local expert judgment

For verification purposes, total irrigation water demand in the Bregalnica catchment was also estimated with the help of crop irrigation norms (m^3/ha) for optimal crop water demand and 100% efficiency of the irrigations system. The so derived total water demand (113 Mm^3/a) for the Bregalnica catchment was in a similar order of magnitude as the modeled demand (126 Mm^3/a) where irrigation efficiencies, water re-use rates etc. were considered.

Hydraulic structures

In addition, the following main hydraulic structures were included in the model:

- The 6 main reservoirs Ratevska (AL_01), Kalimanci (AL_02), Gradche (AL_03), Knezevo (AL_04), Mantovo (AL_05) and Mavrovica (AL_06) which included information on storage-elevation relationships, active storage volumes and losses to groundwater and due to evaporation.
- The two main irrigation channels of HMS Bregalnica, which are located downstream of Kalimanci reservoir.

Flow network

The final WEAP flow schematic is displayed in Figure 70.

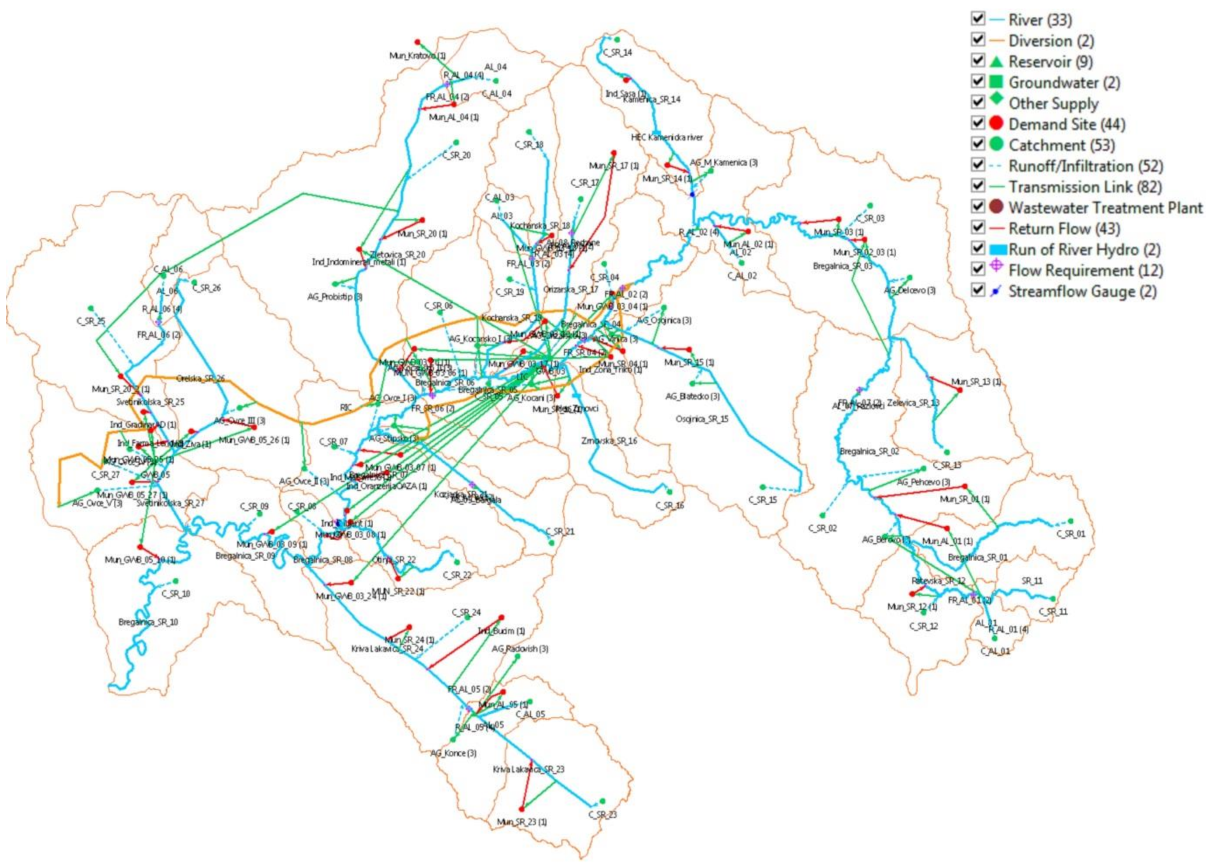

Figure 70: WEAP flow schematic of the Bregalnica river basin

Model performance

In line with the objective of the water allocation modelling exercise – evaluating water resources availability over the mid- and long-term – calibration of the rainfall-runoff and the water allocation model were guided with the aim to reproduce the characteristics of the water resources system in a statistical sense. Thus this approach does not strive primarily for the replication of single historic events as accurately as possible (as done in e.g. flood modelling) but tries to capture the magnitude and seasonality of the observed historic flows over several years, i.e. when analysed at a decadal scale the modelled low and high flows should lie in a similar range as the observations.

Table 53, Figure 71 and Figure 72 illustrate the model performance of the combined rainfall-runoff and water allocation model in relation to the observed runoff values at Stip. The model performance is judged as satisfactory as the simulated flows reproduce the seasonality and magnitude of the observed flows adequately in the majority of the analysed years. During a few years (1973; 1974; 1976/1977) the model substantially underestimates the observed runoff, which results in a fairly high root mean square error (Table 53). In contrast, the mean monthly flows as well as the annual water balance are captured rather well (Table 53, Figure 72). Besides imperfectly calibrated model parameters, the deviations between observations and simulations may originate from the following sources:

- Agricultural water demand: while the cultivated crop types and the extent of irrigated agricultural areas are fixed in the model over the whole analysed period, historically both may have undergone substantial temporal and spatial variations. As the consumptive and non-consumptive agricultural water demand exceeds the water demand of the other sectors by far, this may result in substantial deviations between modelled and observed values.
- Demand priorities: reservoir operation in the water allocation model is guided and constrained by the prescribed priorities of the different water demands (demand priorities in decreasing order: Municipal, Industry, Agriculture, Hydropower). In reality, extraordinary circumstances may result in departures from reservoir operation according to these fixed priorities (e.g. construction works; pre-emptive release of water for flood protection).
- Input data: erroneous model input data, especially regarding precipitation and temperature, may lead to substantial deviations in flow time series. Errors in the input fields may stem from faulty historical observations records and the applied spatial interpolation methods. While anomalies in precipitation fields affect flow dynamic and magnitude in a straightforward manner, temperature may impact runoff over the division of precipitation into rain and snow, the timing of snow melt as well as over potential evapotranspiration rates.
- Temporal / spatial resolution: limitations in temporal (monthly time step) and spatial resolutions (catchment sizes of 20 – 440 km^2) may lead to an inadequate treatment of sub-scale processes (e.g. floods due to heavy precipitation or rapid snow melt events).

Overall calibration and validation of the rainfall-runoff and the water allocation model lead to satisfactory results which were able to capture the magnitude and seasonality of the observed flow records adequately.

Efficiency criteria	**Min & Max Value**	**Stip 1969-1985**
Logarithmic Nash-Sutcliffe efficiency of monthly runoff times series (ln E)	[-∞ , 1]	0.81
Root Mean Square Error of monthly runoff times series	no bounds	7.56 m^3/s
Coefficient of determination of mean monthly flows (r^2)	[0; 1]	0.79
Relative error of mean annual water balance	no bounds	+1.3%

Table 53: Efficiency criteria of the water allocantion model in relation to the historical observarions for the river Bregalnica at Stip

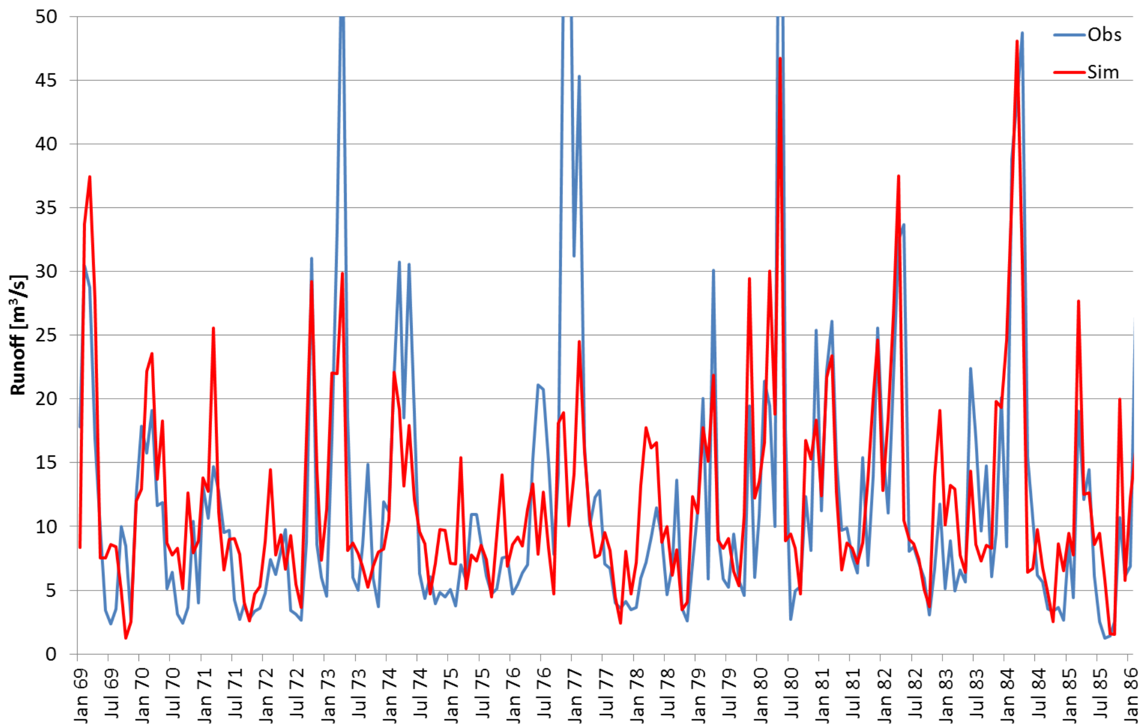

Figure 71: Monthly simulated and observed runoff for the river Bregalnica at Stip for the period 1969 – 1985

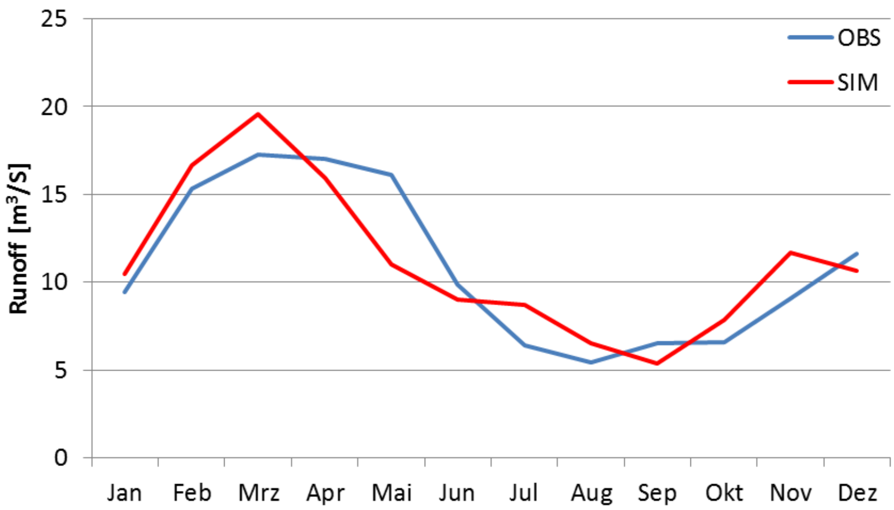

Figure 72: Mean monthly simulated and observed runoff for the river Bregalnica at Stip for the period 1969 – 1985

Scenarios

The following scenarios regarding future developments in the Bregalnica river basin were considered.

Climate Change

The Climate Change Knowledge Portal of the World Bank[15)] offers downscaled climate data of 9 general circulation models (GCM) and 3 emission scenarios (B1, A1B, A2) from the Intergovernmental Panel on Climate Change's (IPCC) 4th Assessment report (IPCC, 2007). Downscaled data is available for a historical period (1961 – 1990) as well as for the mid and the end of this century (2046 – 2065 and 2081 – 2100).

As there is still substantial uncertainty regarding the future development of the earth's climate, three different climate change forecasts were considered in this study: a high, medium and low impact scenario respectively. Scenario selection was carried out in analogy to Sutton et al. (2013). That is, different climate change scenarios were evaluated based on their degree of impact on the agriculture sector, which accounts for the lion's share of total water demand in the Bregalnica basin. As agricultural water demand is influenced by both precipitation and temperature, scenarios were selected on the basis of the Climate Moisture Index (CMI). CMI accounts for the combined effect of temperature and precipitation and is assumed to be well correlated with agricultural water demand due to its linkage to soil moisture.

The climate change scenario with the smallest change in CMI compared to the historic baseline is considered the low impact or "wet" scenario, i.e. a scenario with a minimal potential impact on water resources. On the other hand, the "dry" scenario (highest CMI change) is considered to be the high impact scenario. The medium scenario is selected as the one, featuring the smallest deviation to the model mean CMI of all 27 considered scenarios (9 GCMs, each with 3 emission scenarios).

As described in Sutton et al. (2013) the employed approach allows accounting for a full range of scenarios for future climate change in a manageable way. Moreover the considered climate scenarios are based on distinct and consistent GCM results. The selected scenarios are shown in Table 54.

Scenario name	GCM forming the basis for scenario	Relevant IPCC SRES scenario
High impact	Geophysical Fluid Dynamics Laboratory, Climate Model 2.1 (US)	A2
Medium impact	Canadian Center for Climate Modelling and Analysis, Model CGCM3 (T47)	A1B
Low impact	Meteorological Institute, University of Bonn, Model ECHO-G (Germany)	B1

Table 54: Selected climate change scenarios for the Bregalnica river basin.

The evolution of annual average temperature and precipitation until 2100 in the Bregalnica basin for the selected climate impact scenarios is depicted in Figure 73. While the selected impact

15) http://sdwebx.worldbank.org/climateportal/index.cfm
http://climateknowledgeportal.climatewizard.org

scenarios consistently predict substantial temperature rise they also indicate considerable uncertainty in the direction and magnitude of future changes in precipitation. The latter observation is in line with current climate science which indicates that precipitation trends show significant variance between different GCMs and even within one climate scenario, with some scenarios showing positive precipitation trends in the short term and negative trends in the long term (IPCC, 2013).

The effect of climate change on the seasonal distribution of temperature and precipitation in the Bregalnica river basin for the end of the century is illustrated in Figure 74. The highest temperature increases are predicted for the summer season. At the same time, forecasted precipitation reductions are most pronounced in the period from May to October.

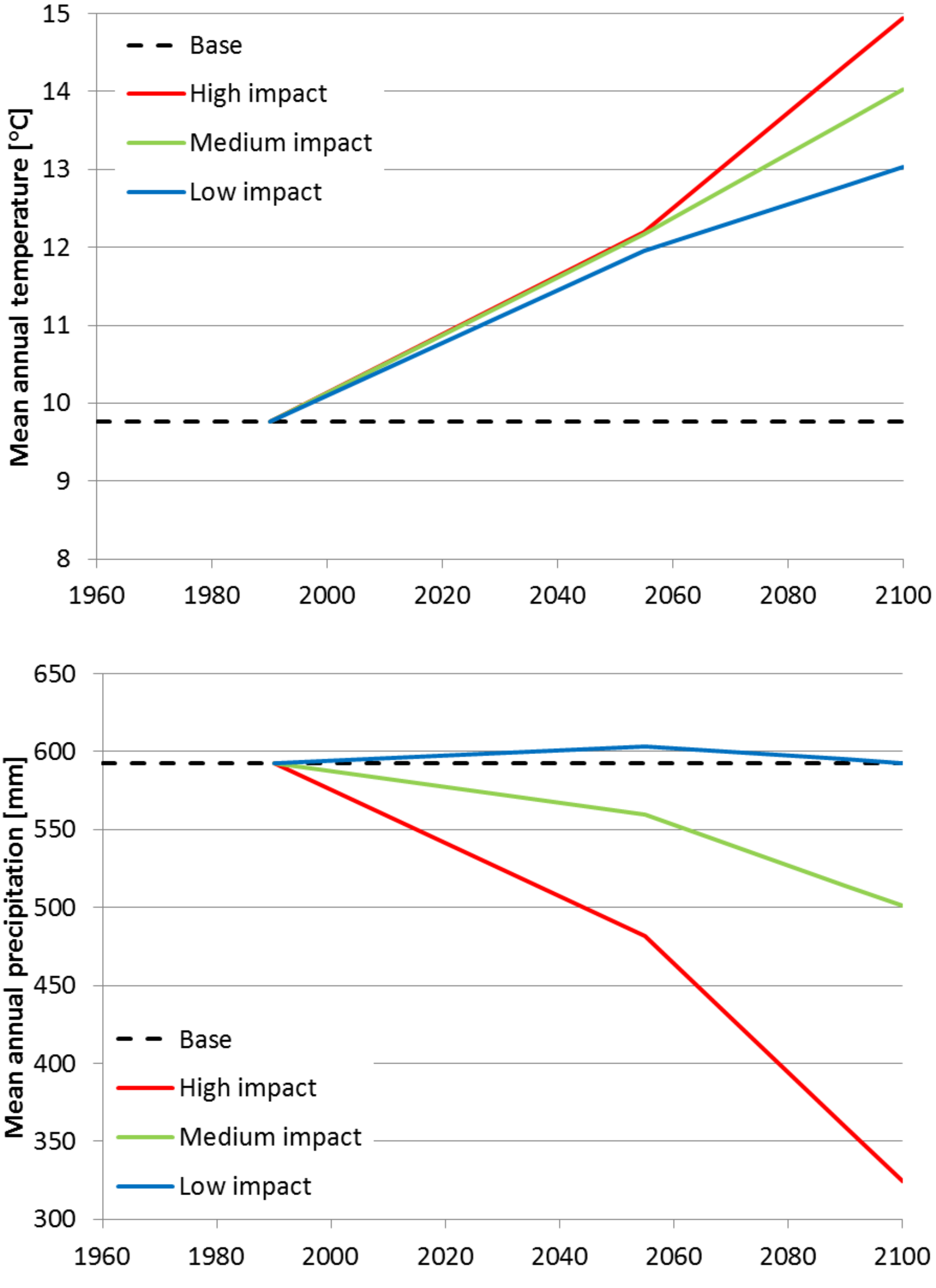

Figure 73: Effect of climate change on average annual temperature (top) and average annual precipitation (bottom) in the Bregalnica river basin for the selected climate impact scenarios

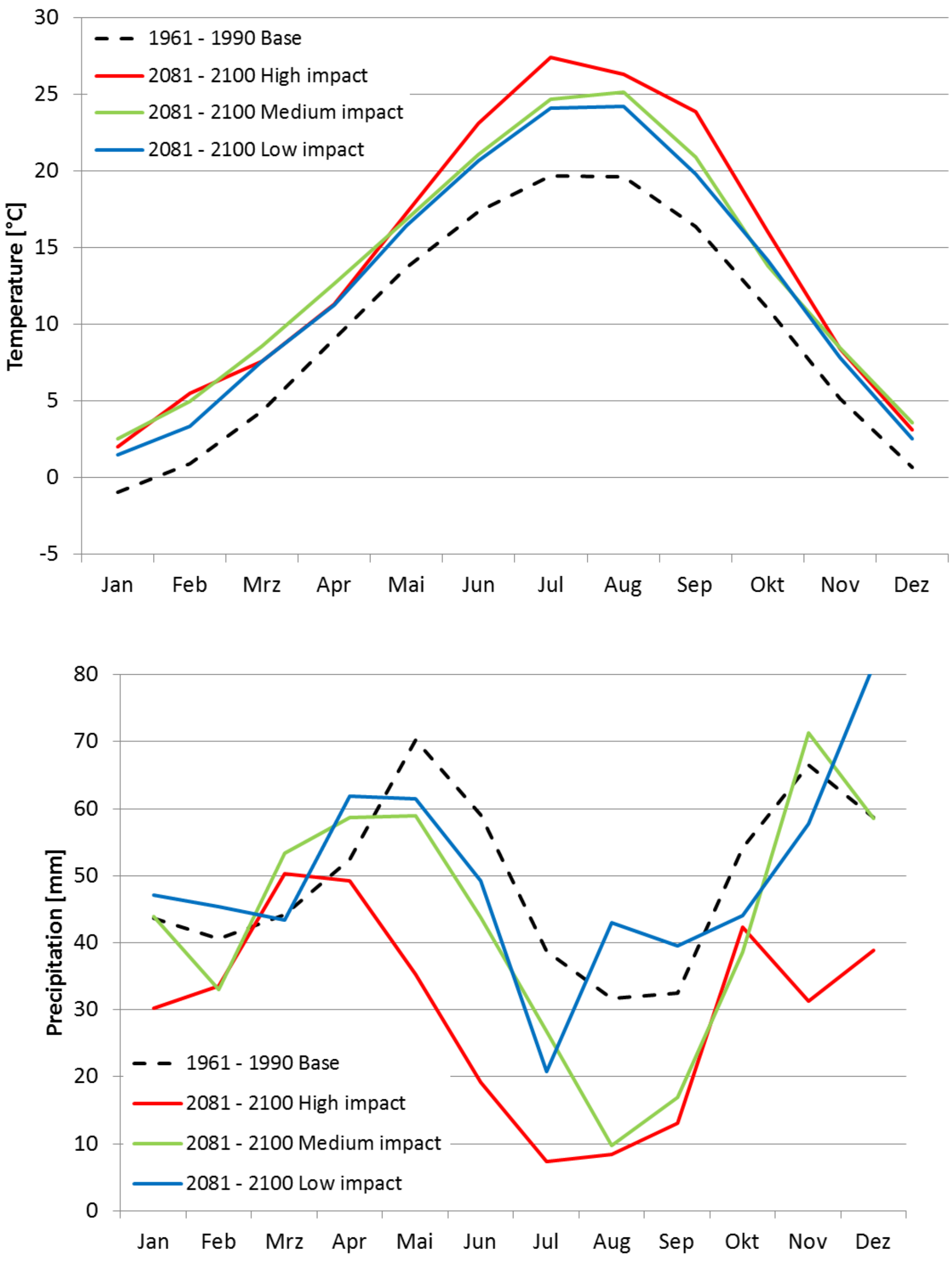

Figure 74: Effect of climate change on average monthly temperature (top) and precipitation (bottom) for the end of century (bottom) in the Bregalnica river basin for the selected climate impact scenarios

Table 55 compares natural average monthly flows for the period of 1966 - 1990 with the projected flow distribution in 2046 – 2065 and 2081 - 2100 at the river basin outlet.

		Runoff [Mm³]													
Time Period	**Impact Scenario**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual Average**	**Anomaly rel. to base**
1961 - 1990	Baseline	40	68	91	71	56	39	29	23	21	36	49	44	47	0%
2046 - 2065	Low impact	45	73	79	61	52	42	27	19	20	35	43	52	46	-4%
	Medium impact	35	66	78	55	49	34	26	17	15	29	34	44	40	-15%
	High impact	36	60	62	51	41	24	16	13	14	23	30	33	34	-29%
2081 - 2100	Low impact	51	82	85	68	48	31	20	20	20	29	41	57	46	-3%
	Medium impact	40	59	71	54	40	26	19	13	12	20	39	40	36	-24%
	High impact	22	41	49	38	24	14	11	9	9	17	19	21	23	-52%

Table 55: Effect of climate change on average natural runoff of the river Bregalnica at the confluence with Vardar for the mid-century

Land Use Change

The land use developments with the biggest anticipated impact on water resources in the Bregalnica catchment are changes in irrigated agricultural areas. Consequently the considered land use change scenario focus on the potential future expansion of irrigated area in the major hydro-meliorative systems (HMS) in the Bregalnica basin.

Table 56 shows the present irrigated area (~8’800 ha in Bregalnica basin and ~1000 ha in the municipality of Radovish) and projected future irrigated agricultural area (~22’800 ha in Bregalnica basin, ~1000 ha in the municipality of Kratovo and ~4’150 ha in the municipality of Radovish) for the major HMS. The projections were developed in close collaboration with Blagoja Stoilov (Ministry of Agriculture, Forestry and Water Economy) and take into account anticipated trends in the agricultural sector (see chapter 3.3.2), the potentially irrigable areas as well as the feasibility of reconstruction and rehabilitation of old irrigation systems. The land use scenario does not feature temporal variability, i.e. only one predicted future state of irrigated agricultural area is considered.

Presently irrigated area [ha]								
Crop types	HMS Bregalnica	HMS Malesevsko plain	HMS Delcevsko plain	HMS Osojnica (Vinica)	HMS Blatecko plain	HMS Zletovica (Probistib)	HMS Zletovica (Kratovo)	HMS Lakavica (Radovish)
Fourage Crops	1'589	1	9	0	10	6	0	54
Industrial Crops	194	5	47	0	20	8	0	471
Maize	631	10	249	0	15	78	0	140
Orchard	61	33	78	0	0	8	0	117
Rice	4'244	11	1	0	30	8	0	0
Vegetables	272	214	106	190	129	50	0	127
Vine Yard	458	1	1	0	0	6	0	61
Total area	7'450	276	491	190	204	164	0	970

Future irrigated area [ha]								
Crop types	HMS Bregalnica	HMS Malesevsko plain	HMS Delcevsko plain	HMS Osojnica (Vinica)	HMS Blatecko plain	HMS Zletovica (Probistib)	HMS Zletovica (Kratovo)	HMS Lakavica (Radovish)
Fourage Crops	2'500	197	110	0	10	540	150	232
Industrial Crops	1'300	33	50	40	20	620	170	2'012
Maize	1'700	550	90	0	15	1'400	450	596
Orchard	400	50	0	0	0	220	150	502
Rice	4'200	0	0	170	30	0	0	0
Vegetable	4'400	620	442	216	129	430	100	545
Vine Yard	2'000	0	8	0	0	320	50	258
Total area	16'500	1'450	700	426	204	3'530	1'070	4'145

Table 56: Present and estimated future irrigated areas for the major Hydro-Meliorative Systems (HMS) in the Bregalnica basin

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A8 Phosphorus Flux Model

General remarks

The main objective of the modeling exercise was to model the particulate phosphorus flux into surface water bodies by coupling an erosion model (RUSLE) and a generated sediment yield with the phosphorus content in soil and phosphorus surpluses due to fertilizer and manure application.

Potential average annual soil loss - RUSLE model

RUSLE, a functional model derived from the analysis of intensive soil erosion data, has seen a wide application in long-term water erosion prediction (Renard et al., 1997). The RUSLE model enables the prediction of an average annual rate of soil erosion for a site of interest. The calculations were done with a GIS using raster datasets (Fernandez et al., 2003).

Several determining factors, such as the soil erodibility factor, rainfall factor, length-slope factor, cover management factor and support practice factor are required for the computation of the expected average annual soil loss. RUSLE uses the following equation (Renard et al., 1997):

$$A = R * K * LS * C * P$$

Equation 1: Calculation of potential average annual soil loss

The annual soil loss was computed by overlaying four raster grid layers of the Bregalnica river catchment: the grid surfaces representing the R-factor values, K- factor values, C-factor values and LS-factor values. The factors are described more in detail below.

Factor	Description	Necessary Dataset	Source
A	Potential average annual soil loss	-	-
R	Rainfall erosivity factor	Meteorological data	UHMR (see also Appendix A6)
K	Soil erodibility factor	Soil map and soil profile data	Raw Data from Institute of Agriculture Skopje, Department of soil science and agrochemistry
LS	Slope length and steepness factor	Digital Elevation Model (DEM)	-
C	Cover management factor	CORINE land cover	European Environment Agency
P	Support practice factor	Not included in model	-

Table 57: Overview of factors used by the RUSLE method and necessary data sets

<u>Rainfall erosivity (R-factor)</u>

The rainfall erosivity describes the kinetic energy of rainfall and corresponds to the potential erosion risk. It increases with increasing intensity of rainfall and flatter terrain. The rainfall erosivity grid was derived by using a regression model based on measured annual precipitation and information for elevation of the meteorological station from the DEM. Rainfall data from four meteorological stations located in the study area for the period from year 2001 to year 2010 were used. Yearly rainfall sums ranged from 352 to 1200 mm.

Soil erodibility (K-factor)

The soil erodibility factor can be described as the soils tendency to erode. It is dependent on the local soil properties and can be determined from soil profile data.

In total, 39 soil types or complexes were identified in the Bregalnica river catchment. The soil erodibility factor was derived by using the texture of the topsoil horizon (content of coarse sand, fine sand, silt and clay). For the area of interest, the data from 552 soil profile were extracted, with topsoil depth for different soil types and complexes ranging from 0 to 43 cm.

According to the soil texture triangle of the U.S. Department of Agriculture (USDA), six soil texture classes were identified. The following values for K factor for different soil texture types were assigned (Stone and Hilborn, undated):

Soil texture	K-factor [US units][16]
Paved / Artificial Surfaces	0.0001
Sandy Clay Loam	0.2
Sandy loam	0.13
Loam	0.3
Clay Loam	0.3
Loamy Fine Sand	0.11
Clay	0.22

Table 58: List of used K-factors related to soil texture

Slope length and slope steepness factor (LS factor)

The effect of topography on soil erosion is accounted for by the LS factor in RUSLE, which combines the effects of a slope length factor L and a slope steepness factor S. In general, as slope length (L) increases, total soil erosion and soil erosion per unit area increase due to the progres-

16) The values were converted from the US units [t ac h $(100ac)^{-1}ft^{-1}tf^{-1}in^{-1}$] to the SI metric units [t ha h ha^{-1} $MJ^{-1}mm^{-1}$] (multiplied by 0.1317)

sive accumulation of runoff in the downslope direction. As the slope steepness (S) increases, the velocity and erosivity of runoff increase. The LS factor was calculated using the DEM (5 m spatial resolution) according to the following formula (Pelton et al., undated):

$$LS = (\frac{Area}{22.13})^m * \left(\frac{\sin\beta}{0.0896}\right)^n * (m+1)$$

Equation 2: Calculation of LS-factor

The RUSLE incorporates the drained area by using the flow accumulation function of ArcGIS and the slope angle β. The "m" and "n" being empirically derived coefficients account for the kind of erosion considered (rill or sheet erosion). According to the literature, m=0.4 and n=1.4 were used.

Land cover (C factor)

The land cover factor represents the influence of land cover, cropping and management practices on soil erosion by water. A vegetative cover changes the impact and intensity of rainfall as well as the resistance to water flow or the sediment transport. For this study, CORINE land cover data was used in order to derive the C-factor. The values were assigned according to the following table (Rulli et al., 2013).

CORINE land cover class code	C-factor
14x, 231, 31x, 32x, 41x	0.001-0.01
241, 243, 244	0.1
211, 212, 242	0.165–0.0335
11x, 12x, 13x, 331, 332, 51x	0.35-0.55

Table 59: List of used C-factors

Sediment Delivery Ratio

The RUSLE model cannot be directly used to estimate the amount of sediment reaching downstream areas, because some portion of the eroded soil may be deposited and does not reach the waterbody.

There exist several approaches in the literature on how to account for these processes. In this study, the Sediment Delivery Ratio (SDR) was used. It describes the sediment delivery from the hillslopes to the water body which is affected by many highly variable physical characteristics of the watershed. It varies with the drainage area, slope, relief-length ratio, runoff-rainfall factors, land use/land cover and sediment particle size, etc. In the past, several empirical equations relating SDR with one or more factors were developed. In this study, two different SDR were used which are described below (Fernandez et al., 2003).

SDR using SCS Runoff Curve Number method

SDR can be calculated using Soil Conservation Services Curve Number method (SCS-CN) which is a widely used technique for estimating surface runoff for a given amount of rainfall in catchments. The SCS method considers the relationship of land cover type and hydrologic soil group (e.g. differences in soil infiltration capability) which together make up the curve number (Gangodagamage, 2001).

The non-dimensional curve number (CN) is an index that expresses the catchment's runoff response to a rainfall event and therefore indicates the proportion of rainwater that contributes to surface runoff (Melenti et al., 2011). CN has high values in impervious areas and low values in pervious areas with a good ground cover.

The sediment delivery ratio can be calculated based on the above described model with the following formula (Ouyang and Bartholic, undated).

$$SDR = \left(\frac{Q}{R}\right) * 0.56$$

Equation 3: SDR calculation using SCS Runoff Curve Number method

Where Q is the runoff (calculated according to SCS Curve Number method) and R is rainfall. The actual runoff is estimated with the following formula:

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S}$$

Equation 4: Runoff equation

Where the actual runoff Q, the potential maximum runoff (rainfall) P and the potential of maximum retention of soil S are included, the runoff curve number, CN, is related to S with the following formula (AGNPS User's Guide, undated):

$$S = \frac{25400}{CN} - 254$$

Equation 5: Relationship of curve number CN and the potential of maximum retention of soil S

The CN is related to soil type, soil infiltration capability, land use, and the depth of the seasonal high water table. To account for different soils' ability to infiltrate, soils are divided into four hydrologic soil groups (HSGs). For this study, the table below shows how soil types where assigned to the specific hydrologic soil group.

Hydrologic Soil Group (HSG)	Soil texture
A	Sandy, loamy sand or sandy loam
B	Silt loam or loam
C	Sandy Clay Loam
D	Clay loam, Silty clay loam, sandy clay, silty clay or clay

Table 60: List of Hydrologic Soil Group (HSG) and related soil texture

The table below presents the curve numbers (CN) for the hydrological soil group related to the CORINE land cover class code.

CORINE land cover class code	Curve numbers for hydrologic soil group			
	A	B	C	D
100-199 (urban)	98	98	98	98
221,222,242 Agriculture without conservation	62	71	78	81
232, 321, 331 pastures	39	61	74	80
311, 312, 313, 324 forest	33	57	71	78

Table 61: Curve numbers (Schröder D., undated)

SDR estimation based on drainage area

It is suggested in the literature that sediment production rates decline with increasing catchment area (Ndomba, 2011). This theory is supported by the fact that the probability of entrapment of a particle being transported downstream increases as the drainage area increases and chance of soil particles reaching the water channel system is low. Watersheds with large drainage area and fields with a long distance to the streams have a low sediment delivery ratio. The relationship between SDR and drainage area A was calculated according to a model proposed by Vanoni in 1975 (Ouyang and Bartholic, undated).

$$SDR = 0.42\,A^{-0.125}$$

Equation 6: SDR estimation based on drainage area

Sediment yield

The sediment yield can be defined as the amount of sediment reaching or passing a point of interest in a given period of time. Within the GIS raster cell environment, a distributed model for SDR was obtained where the sediment delivery rate of each raster cell is estimated. Accordingly, the sediment yield (SY) at each raster was calculated from the potential soil loss estimates obtained by the RUSLE method and the estimated SDR at each cell:

$$SY = E * SDR$$

Equation 7: Calculation of sediment yield

Where SY=sediment yield, SDR = the sediment delivery ratio, and E = the gross erosion per unit area above a measuring point obtained by RUSLE model (Ouyang and Bartholic, undated).

Phosphorus fluxes into water bodies

The flux of phosphorus (P) into surface water body due to erosion was further divided based on the origin of the P, and with it based on the subsequent fate in the aquatic environment, resulting in two different P flux datasets. To obtain these fluxes, the sediment yield raster dataset was combined with the following two P datasets:

- Annual P surplus on agricultural area: Yearly P-addition of fertilizer and livestock manure reduced by the amount removed with the crop at harvest
- P-content in topsoil: Natural P content and long term P accumulation = "background phosphorus"

To obtain these two P-datasets, the following data sources were used:

- Background P content derived with spline interpolation using grid of sampling points on 5 km distance. The soil samples were taken from the topsoil at depth 0-5 cm. At each location were 5 sub-samples taken and homogenized in the laboratory. Only the fine material (<2 mm) was analyzed with ICP-OES. (source: Geochemical atlas, Institute of Chemistry - Skopje).
- Agricultural area covered derived from land parcel identification system data (LPIS) (source: Ministry of Agriculture Forestry and Water Economy - MAFWE)
- Number of livestock available on municipal level (source: State statistical office, Republic of Macedonia).

Furthermore, several field trips were organized and questionnaires were filled by farmers in the area in order to obtain information about use of fertilizers. This data were later used in correlation with the crops identified from LPIS. Moreover, livestock number and data about the P-output per animal was used to produce a P-distribution layer per surface water body (SWB) according to relative area that each SWB occupy in the municipality. The P-output of the animals was only assigned to the agricultural area, according to the CORINE 2006 land cover.

The annual P surplus on agricultural area was then calculated as follows:

$$P - surplus\ in\ topsoil = P - Input\ of\ fertilizers + P - input\ from\ livestock\ manure - P - uptake\ of\ crops$$

It was then assumed that the resulting amount of phosphorus corresponds to the surplus content in the topsoil with a layer thickness of 5 cm.

Results and discussion

Potential annual soil loss – RUSLE model

Table 62 shows the potential annual soil loss calculated with RUSLE per SWB.

Over the whole Bregalnica basin, a soil loss due to erosion of 14.5 t ha^{-1} yr^{-1} on average is estimated. However, the values differ between 4.0 and 30 t ha^{-1} yr^{-1} showing soil degradation categories between low and high (according to Boardman J. and Poesen J., 2006).

These results can be compared with a study conducted for upper part of Bregalnica watershed. A watershed oriented soil erosion map based on methodology of Gavrilovic, prepared by Djordjevic et al. (1993), shows an average annual soil erosion potential of the upper Bregalnica watershed of 960 m^3 km^{-2} yr^{-1} (Milevski et al, undated). In the present study, the obtained result for the upper Bregalnica area was 925 m^3 km^{-2} yr. Hence, the resulting soil loss estimates are quite close.

A study done by Barret R. (2015) using the Universal soil loss equation (USLE) resulted in an average soil loss of 6.5 – 8.1 t ha^{-1} yr^{-1} in the Bregalnica watershed, which is roughly half of the amount obtained in the present study. The difference between these studies lies in the used spatial resolution of the DEM. The coarser resolution of 100 m leads to smaller values compared to the 5 m resolution used in this study.

As no field data are available, the results cannot be validated. However, as the RUSLE and USLE models do not account for deposition, soil loss in flatter area might be overestimated to a certain amount. The empirical nature of the model should also be kept in mind.

Name Surface Water Body	Area [ha]	Total [t yr^{-1}]	Area-specific average [t ha^{-1} yr^{-1}]	mm soil loss
		Potential average annual soil loss		
Bregalnica01	10'304	64'424	6.3	0.5
Bregalnica02	28'632	406'133	14.2	1.1
Bregalnica03	26'168	474'918	18.1	1.4
Bregalnica04	17'285	238'105	13.8	1.1
Bregalnica05	2'377	23'672	10.0	0.8
Bregalnica06	10'291	156'832	15.2	1.2
Bregalnica07	22'783	370'098	16.2	1.2
Bregalnica08	2'754	60'822	22.1	1.7
Bregalnica09	10'489	198'495	18.9	1.5
Bregalnica10	16'349	151'908	9.3	0.7
Gratce Lake	2'380	18'915	7.9	0.6
Kalimanci Lake	11'826	313'061	26.5	2.0
Kamenicka river	9'571	287'234	30.0	2.3
Knezevo Lake	5'179	59'945	11.6	0.9
Kocanska river01	6'456	68'235	10.6	0.8
Kocanska river02	6'042	71'655	11.9	0.9
Kozjacka river	5'668	55'492	9.8	0.8
Kriva Lakavica01	11'444	118'760	10.4	0.8
Kriva Lakavica02	23'117	352'919	15.3	1.2
Mantovo Lake	7'219	80'968	11.2	0.9
Mavrovica Lake	4'313	72'945	16.9	1.3
Orelska/Mavrovica river	21'299	336'454	15.8	1.2
Orizarska river	14'616	237'898	16.3	1.3
Osojnica river	32'258	442'177	13.7	1.1
Otinja river	5'198	63'922	12.3	0.9
Ratevska river01	3'118	12'321	4.0	0.3
Ratevska river02	8'488	141'503	16.7	1.3
Ratevsko Lake	2'256	15'272	6.8	0.5
Svetinikolska river01	24'045	539'455	22.4	1.7
Svetinikolska river02	15'570	236'130	15.2	1.2
Zelevica river	11'597	237'217	20.5	1.6
Zletovska river	43'881	1'037'992	23.7	1.8
Zrnovska river	7'617	45'767	6.0	0.5
Sum	**430'590**	**6'991'648**	**-**	**-**
Average	**-**	**-**	**14.5**	**1.1**

Table 62: Potential average annual soil loss (RUSLE model) for each SWB in Bregalnica catchment

Sediment Yield

Soil erosion and sediment yield predictions in ungauged drainage basin are challenging, because of spatial heterogeneity and complex arrangements of the components of the drainage basin. The attained results with two different approaches for calculation of the sediment delivery ratio (SDR) are the following: SDR using SCS Curve numbers ranged from 0.28 to 0.56 for the study area, and results from SDR estimation according to the drainage area based method ranged from 0.22 to 0.32. These numbers indicate the portion of detached soil particles which actually reach the water bodies.

A comparison of these results for all surface water bodies is shown in Figure 75. It can be clearly seen that the estimated sediment yield calculated with the drainage area based SDR is much smaller (almost half) than the results calculated with the SCS Curve numbers based SDR. This difference is also shown in the annual sediment yield averaged on the whole Bregalnica basin, which resulted in 4 and 8 tons per hectare and year, respectively. In total, 1’700’000 tons and 3’600’000 tons of sediments, respectively, were estimated to reach the water bodies in the basin.

The results can be compared with a study from Blinkov and Trendafilov (2004) done for Kamenicka river where it is stated that the total quantity of deposed sediment in the Kalimanci reservoir in the period 1969-1991 was more than 9’000’000 m^3. The average annual yield rate was about 450’000 m^3 per year and the contribution of Kamenicka Reka was estimated by 25%, resulting in about 150’000 tons of sediment transported by Kamenicka River which equals the calculated sediment yield using the SDR CN approach.

Therefore, especially for the upper part, the values obtained with SDR CN approach appear to be reasonable. However, for the lower parts of Bregalnica, the sediment delivery might be overestimated as the method is less feasible for flatter sub-catchments.

The sediment yield results can also be compared with the study of Barrett (2015). For that study, a pathway based topographic index analysis was undertaken to identify areas which are hydrologically connected to the river network instead of using SDR’s. Those results ranged from 900’000 to 1’900’000 tons sediment for the whole basin which is comparable with the results of the present study when using the drainage area based SDR.

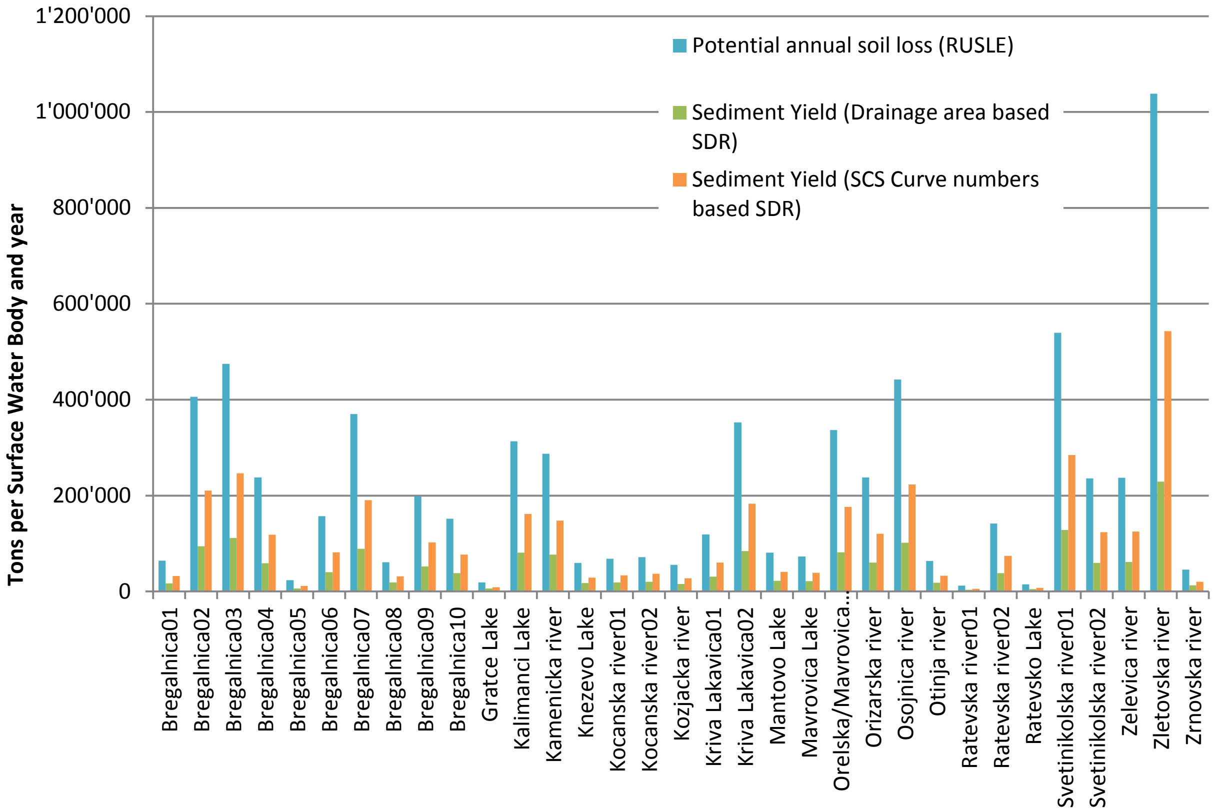

Figure 75: Comparison of potential annual soil loss (RUSLE model) with sediment yields using two SDR approaches for each surface water body

Phosphorus fluxes into water bodies

In the table below, the input into water bodies from the annual P surplus (including fertilizer and manure) and "background phosphorus" input is shown per SWB.

		Phosphorus surplus (fertilizer, manure)		**Background phosphorus**	
Name Surface Water Body	**Area [ha]**	**Total [t yr^{-1}]**	**Area-specific average [g ha^{-1} yr^{-1}]**	**Total [t yr^{-1}]**	**Area-specific average [g ha^{-1} yr^{-1}]**
Bregalnica01	10'304	0.01	0.9	13	1'248
Bregalnica02	28'632	1.10	38.3	106	3'689
Bregalnica03	26'168	0.27	10.2	170	6'517
Bregalnica04	17'285	0.09	5.4	59	3'425
Bregalnica05	2'377	<0.01	1.4	0	6'923
Bregalnica06	10'291	0.05	4.6	94	7'243
Bregalnica07	22'783	0.12	5.2	95	4'167
Bregalnica08	2'754	0.01	2.6	12	4'514
Bregalnica09	10'489	0.22	21.0	41	3'874
Bregalnica10	16'349	0.04	2.7	27	1'676
Gratce Lake	2'380	<0.01	0.2	4	1'889
Kalimanci Lake	11'826	0.04	3.8	58	4'875
Kamenicka river	9'571	0.04	4.2	162	16'972
Knezevo Lake	5'179	<0.01	0.0	12	2'382
Kocanska river01	6'456	0.01	1.9	14	2'172
Kocanska river02	6'042	0.02	4.1	21	3'705
Kozjacka river	5'668	0.01	1.1	18	3'197
Kriva Lakavica01	11'444	0.08	7.3	17	1'445
Kriva Lakavica02	23'117	0.68	29.5	67	2'881
Mantovo Lake	7'219	0.01	1.6	18	2'453
Mavrovica Lake	4'313	0.04	8.9	17	3'928
Orelska/Mavrovica river	21'299	0.67	31.5	96	4'504
Orizarska river	14'616	0.09	6.2	74	5'095
Osojnica river	32'258	0.11	3.5	63	1'950
Otinja river	5'198	0.01	1.1	13	2'530
Ratevska river01	3'118	<0.01	0.0	2	700
Ratevska river02	8'488	0.02	2.8	38	4'509
Ratevsko Lake	2'256	0.44	196.1	4	1'821
Svetinikolska river01	24'045	0.63	26.3	125	5'186
Svetinikolska river02	15'570	0.08	4.8	50	3'198
Zelevica river	11'597	0.03	2.7	58	5'008
Zletovska river	43'881	1.44	32.8	388	8'832
Zrnovska river	7'617	<0.01	0.1	11	1'509
Sum	**430'590**	**6.4**	**-**	**1'948**	**-**
Average	**-**	**-**	**20**	**-**	**430'000**

Table 63: Phosphorus fluxes into surface water bodies per SWB

Model Limitations

RUSLE model

Regarding the RUSLE method, several limitations can be identified such as:

- As no field data is available for soil loss and sediment yield, one should keep in mind that no calibration or validation of the model can be made. RUSLE does also not account for areas with a potential for deposition. Therefore, the predicted soil loss is very likely to be overestimated for the lower part of Bregalnica. However, the obtained results for the upper part of Bregalnica are comparable with results based on the Gavrilovic method.
- Rainfall erosivity factor is usually calculated as product of the total kinetic energy of the storm (E) times its maximum 30-minute intensity (I) for all rainfall storms during the year: These data were unfortunately not available in this case.
- Uncertainties associated with the DEM derived topographical parameters used for soil erosion modeling can tend to reduce the reliability of the predicted erosion estimates (Datta and Schack-Kirchner, 2010). Spatial resolution of elevation data as a whole have a tremendous effect on the response of erosion models (i.e. RUSLE, USLE etc.) which use slope as an important component. As consideration for further development and improvement for the RUSLE approach modelling, the influence of the spatial resolution should be assessed.

SDR and sediment yield estimation

- The SDR estimation in order to assess the correlation of sediment yields to erosion in ungauged basin by itself poses uncertainties to the model.
- SDR's have several limitations and their use, especially for flatter areas, is questionable. It can be concluded that for the upper part of the catchment the results obtained with SDR CN method are reasonable, but for the lower part of the catchment the results may be overestimated. As future possibility for improvement, the study area can be divided and elaborated in two parts, as SWB in hilly area and SWB in lower part of the catchment.

Phosphorus fluxes

- Agricultural phosphorus hotspots close to water bodies such as leaking or overflowing liquid manure ponds, farmyard areas or manure heaps were not taken into account as no data was available. However, the contribution to the P-flux can be substantial.
- As the model has no temporal scale, peaks of phosphorus inputs in water bodies such as application of fertilizer or manure followed by a rain period cannot be shown.
- It is assumed that the background phosphorus is transported mainly unaltered by the water bodies and does mainly not contribute to the amount of dissolved phosphorus. Further investigation should be done to support this assumption.

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A9 Monitoring Results – Surface Water Bodies

Monitoring points for surface water bodies

Water body (WB)	ID WB	ID monitor-ing point	Monitoring campaign					
			I	II	III	IV	V	Comment
Bregalnica	SR_01	SR_01	X	X	X	X		-
		SR_01_01			X	X	X	RC
Bregalnica	SR_02	SR_02	X	X	X	X		-
Bregalnica	SR_03	SR_03	X	X	X	X		-
Bregalnica	SR_04	SR_04	X	X	X	X		-
Bregalnica	SR_05	SR_05	X	X	X	X		-
Bregalnica	SR_06	SR_06	X	X	X	X		-
Bregalnica	SR_07	SR_07	X	X	X	X	X	-
Bregalnica	SR_08	SR_08	X	X	X	X		-
Bregalnica	SR_09	SR_09	X	X	X	X		-
Bregalnica	SR_10	SR_10	X	X	X	X		-
Ratevksa river	SR_11	SR_11_01						RC
		SR_11_02	X	X	X	X		-
Ratevska river	SR_12	SR_12	X	X	X	X		-
Zelevica river	SR_13	SR_13_01				X	X	RC.
		SR_13_02	X	X	X	X	X	-
Kamenica river	SR_14	SR_14_01	X	X	X	X		RC
		SR_14_02	X	X	X	X		-
Osojnica river	SR_15	SR_15_01	X	X	X	X	X	RC
		SR_15_01_01			X	X		RC
		SR_15_02	X	X	X	X		-
Zrnovska river	SR_16	SR_16_01	X	X	X	X	X	RC
		SR_16_02	X	X	X	X		-
Orizarska river	SR_17	SR_17_01	X	X	X	X		RC
		SR_17_02	X	X	X	X		-
Kocanska river	SR_18	SR_18			X	X	X	-
Kocanska river	SR_19	SR_19	X	X	X	X		-
Zletovska river	SR_20	SR_20	X	X	X	X		-
Kozjacka river	SR_21	SR_21	X	X	X	X	X	-
Otinja river	SR_22	SR_22	X	X	X	X	X	-
Kriva Lakavica	SR_23	SR_23_01				X		RC
		SR_23_02			X	X	X	-
Kriva Lakavica	SR_24	SR_24_01	X	X	X	X		-
		SR_24_02	X	X	X	X		RC

Water body (WB)	ID WB	ID monitoring point	Monitoring campaign					
			I	II	III	IV	V	Comment
Svetinikolska river	SR_25	SR_25_01				X		RC
		SR_25_02				X	X	-
Nemanjica river	SR_26	SR_26	X	X	X	X	X	-
Svetinikolska river	SR_27	SR_27	X	X	X	X		-
Ratevo Lake	AL_01	AL_01_01	X		X			L
		AL_01_02	X					P
Kalimanci Lake	AL_02	AL_02_01	X		X			L
		AL_02_02	X		X			P
Gradce Lake	AL_03	AL_03_01	X		X			L
		AL_03_02			X			P
Zletovo Lake	AL_04	AL_04_01	X		X			L
		AL_04_02	X		X			P
Mantovo Lake	AL_05	AL_05_01	X		X			L
		AL_05_02	X		X			P
Mavrovica Lake	AL_06	AL_06_01	X		X			L
		AL_06_02	X		X			P
Left channel for irrigation	AC_01	AC_01	X		X			-
Right channel for irrigation02	AC_02	AC_02	X		X			-
Right channel for irrigation03	AC_03	AC_03	X		X			-

Table 64: Overview of the monitoring points for surface water body and campaign. I = June/July 2013, II = August 2013, III = October 2013, IV = February 2014, V = May 2014, X = Measurement, RC = Monitoring point for the definition of the reference condition, L = Littoral, P = Profundal.

The following table shows the depths of the measurement points for the heavily modified water bodies.

Heavily modified water bodies	ID	Depth for biological indicators in m	Depth for physic-chemical indicators in m
Ratevo Lake	38L	surface	surface
Ratevo Lake	38P	18	10
Kalimanci Lake	39L	2	littoral and 5
Kalimanci Lake	39P	19	10 and 19
Gradce Lake	40	surface	surface
Zletovo Lake	41L	surface	surface and 5
Zletovo Lake	41P	16	10 and 29
Mantovo Lake	42L	10	surface and 5
Mantovo Lake	42P	28	10 and 28

Heavily modified water bodies	ID	Depth for biological indicators in m	Depth for physic-chemical indicators in m
Mavrovica Lake	43L	2	surface and 3

Table 65: Depths of the measurement points for the heavily modified water bodies

Indicators for surface water bodies

The following table shows the indicators of the surface water bodies monitoring. In the right columns, it is indicated for which type of water body the indicator is measured (R = river, A = artificial water body, H = heavily modified water body).

Group	Element	Indicators	Water body		
			R	A	H
Biological	Phytobenthos: Diatoms	Index for specific sensibility to pollution (IPS)	x		x
	Zoobenthos: Macroinvertebrates	Iberian Monitoring Working Party (IBMWP)	x		
		Shannon-Wiener diversity index			x
	Fish	Qualitative analysis	x		x
	Phytoplankton	Species composition, total biovolume, % of cyanobacteria, chlorophyll "a"			x
Hydro-morphological	Riparian vegetation	Index of riparian quality (QBR)	x		
	River habitat	Fluvial habitat Index (IHF)	x		
Physical-Chemical	Turbidity	Nephelometric turbidity units	x	x	x
	Thermal condition	Temperature	x	x	x
	Salinity	Conductivity	x	x	x
	Acidification	pH	x	x	x
	Oxygenation	DO, BOD, COD	x	x	x
	Nutrient / Nitrogen	Ptot, PO_4, SO_4, N-NO_3, N-NO_2, N-NH_4	x	x	x
Priority substances	Metals and Metalloids	Ag, Al, As, Ba, Cd, Co, Cr, Pb, Hg, Ni, Zn, Cu, Mn, Fe, V	x	x	x
	Pesticides	Nitrogen and phosphorous pesticides, organochlorine pesticides	x	x	x
	Persistent hydrocarbons	Poly Aromatic Hydrocarbons (PAH) Phtalates	x	x	x
	Polyphenols	Polychlorinated biphenyl (PCB) Organchloring components	x	x	x

Table 66: Overview of the surveillance monitoring: group, elements, and indicators. Abbreviations: R = Rivers, A = Artificial water bodies, H = Heavily modified water body

Reference conditions and limits of the indicators

Table 69 to Table 74report the reference conditions (RC) and the limits (L) for each measured indicator. These RC and L values are the base for the definition of statuses.

The reference conditions are specific for each surface water body type and indicator. They represent the undisturbed or very minor disturbed condition of the water body, meaning that the water body is under no or very minor influences of pressures. The reference conditions are used to define the limits of the indicators, as shown in the following figure.

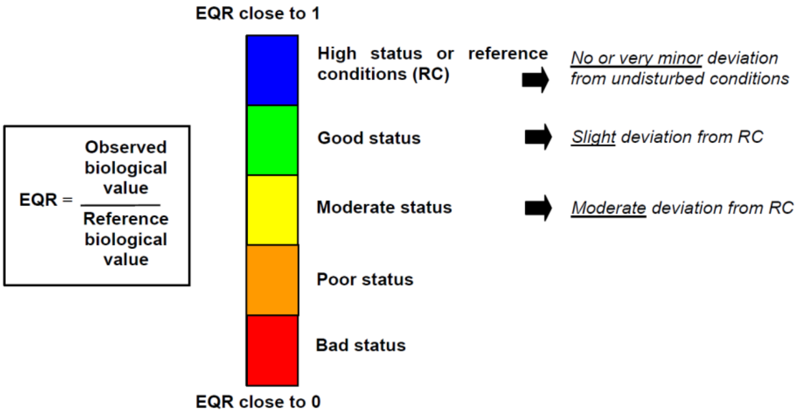


Figure 76: Link between reference condition and limit definition. Source: Common Implementation Strategy for the Water Framework Directive (2000/60/EC), Guidance document Nr. 10, River and lakes – Typology, reference conditions and classification systems, page 21

According to the WFD, Annex V, for each indicator the following limits were defined:

Ecological status	
H	High
G	Good
M	Moderate
P	Poor
B	Bad

Ecological potential	
G	Good and above
M	Moderate
P	Poor
B	Bad

Chemical status	
G	Good
F	Failing to achieve good

Table 67: Overview of the limits for the ecological status, ecological potential, and chemical status

The details regarding the reference condition and the limits are listed in the next tables. The numeric values for the limits were proposed by GTI, the company responsible for the sampling, laboratory analysis and assessment. The limits were mainly derived from the Macedonian Regulation for Classification of Water and the Water Framework Directive 2008/105/EC or were based on expert judgment. The limits will be rechecked and further compared with limits used in other river basin management plans, especially with respect to the most critical substances: P_{tot}, PO_4, SO_4, $N\text{-}NO_2$, Pb, Zn, Cu, Mn and phthalates.

RIVERS		Source of limit definition
Biologycal	IPS	OMNIDIA software - *Lecointe, C., Coste, M., Prygiel, J. & Ector, L. (1999): Le logiciel OMNIDIA version 2*
	IBMWP	IBMWP – Armitage, P.D., Moss, D., Wright, J., Furse, M. (1983)
	Fish Quan. Score	expert judgment
Hydro-morphological	QBR	expert judgment, QBR index
	IHF	expert judgment, IHF index
Phycical - Chemical	Turbidity	expert judgement
	Temperature*	expert judgement
	Conductivity	Directive 78/659/EEC
	pH	expert judgment
	DO	The Official Gazette of Republic of Macedonia, No.18/99
	BOD	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	COD	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	Ammonia	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	Nitrates	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	Nitrites	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	Tot.Phosphorus	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	Phosphates	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	Sulphates	expert judgment
Priority Substances	Argentum	expert judgment
	Aluminium	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99,
	Arsenic	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99,
	Barium	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99,
	Cadmium	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99,
	Cobalt	Macedonian Regulation for Classification of Water"The Official Gazzette of Republic of Macedonia" No,18/99,
	Chrome	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99,
	Lead	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99,
	Mercury	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99,
	Nickel	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99,
	Zink	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99,
	Cooper	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99,
	Manganese	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99,
	Iron	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99,
	Vanadium	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99,
	PAH	Macedonian Regulation for Classification of Water, DIRECTIVE 2008/105/EC, Expert judgement
	Phthalates	Macedonian Regulation for Classification of Water, DIRECTIVE 2008/105/EC
	NP pesticides	Macedonian Regulation for Classification of Water, DIRECTIVE 2008/105/EC
	PCB	Macedonian Regulation for Classification of Water, DIRECTIVE 2008/105/EC
	OC pesticides	Macedonian Regulation for Classification of Water, DIRECTIVE 2008/105/EC
	OC components	Macedonian Regulation for Classification of Water, DIRECTIVE 2008/105/EC

Table 68: Source or method for defining reference conditions and limits of the indicators for the water body types HSS, MMS, MLS, MLC, LLC, MSS and HMS (rivers)

RIVERS		UNIT	1 (HSS) RC	L_B/P	L_P/M	L_M/G	L_G/H	2 (MMS) RC	L_B/P	L_P/M	L_M/G	L_G/H	3 (MLS) RC	L_B/P	L_P/M	L_M/G	L_G/H
Biologycal	IPS	-	14	4	6	8	10	13	4	6	8	10	12	4	6	8	10
	IBMWP	-	100	20	40	60	80	90	20	40	60	80	80	20	40	60	80
	Fish Quan. Score	-	1	0,15	0,35	0,55	0,75	0,9	0,15	0,35	0,55	0,75	0,8	0,15	0,35	0,55	0,75
Hydro-morphological	QBR	-	95	25	50	70	90	90	24	50	70	90	90	25	50	70	90
	IHF	-	90	30	50	70	90	90	30	50	70	90	90	30	50	70	90
Phycical - Chemical	Turbidity	NTU	10	100	60	30	10	10	100	60	30	10	10	100	60	30	10
	Temperature*	°C	natu.temp. var.	4,5	3,5	2,5	1,5	natu.temp. var.	4,5	3,5	2,5	1,5	natu.temp. var.	4,5	3,5	2,5	1,5
	Conductivity	mS/cm	200	1.000	750	500	250	200	1.000	750	500	250	200	1.000	750	500	250
	pH	pH	6,50	5,29	5,99	6,29	6,49	6,50	5,29	5,99	6,29	6,49	6,50	5,29	5,99	6,29	6,49
	DO	mg/L	8,00	1,99	3,99	5,99	7,99	8,00	1,99	3,99	5,99	7,99	8,00	1,99	3,99	5,99	7,99
	BOD	mg/L	2	15	7	4	2	2	15	7	4	2	2	15	7	4	2
	COD	mg/L	2,5	20,0	10,0	5,0	2,5	2,5	20,0	10,0	5,0	2,5	2,5	20,0	10,0	5,0	2,5
	Ammonia	mg/L NH_4	1	15	10	5	1	1	15	10	5	1	1	15	10	5	1
	Nitrates	mg/L NO_3	10	45	30	15	10	11	45	30	15	11	12	45	30	15	12
	Nitrites	mg/L NO_2	0,005	0,510	0,251	0,011	0,005	0,005	0,510	0,251	0,011	0,005	0,005	0,510	0,251	0,011	0,005
	Tot.Phosphorus	mg/L P	4	50	25	15	10	4	50	25	15	10	4	50	25	15	10
	Phosphates	mg/L PO_4	12	150	75	45	12	12	150	75	45	12	12	150	75	45	12
	Sulphates	mg/L SO_4	10	100	75	45	10	10	100	75	45	10	10	100	75	45	10
Priority Substances	Argentum	mg/L Ag	2	20	15	10	2	2	20	15	10	2	2	20	15	10	2
	Aluminium	mg/L Al	1.100	1.500	1.300	1.200	1.100	1.100	1.500	1.300	1.200	1.100	1.100	1.500	1.300	1.200	1.100
	Arsenic	mg/L As	10,00	50	30	20,0	10,0	10,00	50	30	20,0	10,0	10,00	50	30	20,0	10,0
	Barium	mg/L Ba	500	4.000	2.000	1.000	500	500	4.000	2.000	1.000	500	500	4.000	2.000	1.000	500
	Cadmium	mg/L Cd	0,1	11,0	10,0	5,0	0,1	0,1	11,0	10,0	5,0	0,1	0,1	11,0	10,0	5,0	0,1
	Cobalt	mg/L Co	50	2.000	1.000	100	50	50	2.000	1.000	100	50	50	2.000	1.000	100	50
	Chrome	mg/L Cr	20	110	100	50	20	20	110	100	50	20	20	110	100	50	20
	Lead	mg/L Pb	5	30	20	10	5	5	30	20	10	5	5	30	20	10	5
	Mercury	mg/L Hg	0,1	1,0	0,8	0,2	0,1	0,1	1,0	0,8	0,2	0,1	0,1	1,0	0,8	0,2	0,1
	Nickel	mg/L Ni	20	100	80	60	50	20	100	80	60	50	20	100	80	60	50
	Zink	mg/L Zn	50	200	150	100	50	50	200	150	100	50	50	200	150	100	50
	Cooper	mg/L Cu	10	50	30	20	10	10	50	30	20	10	10	50	30	20	10
	Manganese	mg/L Mn	50	1.000	750	500	50	50	1.000	750	500	50	50	1.000	750	500	50
	Iron	mg/L Fe	300	1000	750	500	300	300	1000	750	500	300	300	1000	750	500	300
	Vanadium	mg/L V	100	200	180	150	100	100	200	180	150	100	100	200	180	150	100
				L_B/G					L_B/G					L_B/G			
	PAH	µg/L		5,01					5,01					5,01			
	Phthalates	µg/L		1,30					1,30					1,30			
	NP pesticides	µg/L		1,30					1,30					1,30			
	PCB	µg/L		0,10					0,10					0,10			
	OC pesticides	µg/L		0,10					0,10					0,10			
	OC components	µg/L		0,10					0,10					0,10			

Table 69: Reference conditions and limits of the indicators for the water body types HSS, MMS, MLS (rivers); RC: reference condition; L_B/P, L_P/M, L_M/G, L_G/H: upper limits of bad, moderate, good and high condition

RIVERS		UNIT	4 (MLC) RC	L_B/P	L_P/M	L_M/G	5 (LLC) RC	L_B/P	L_P/M	L_M/G	L_G/H	6 (MSS) RC	L_B/P	L_P/M	L_M/G	L_G/H
Biologycal	IPS	-	12	4	6	8	12	4	6	8	10	12	4	6	8	10
	IBMWP	-	80	20	40	60	80	20	40	60	80	80	20	40	60	80
	Fish Quan. Score	-	0,8	0,15	0,35	0,55	0,8	0,15	0,35	0,55	0,75	0,8	0,15	0,35	0,55	0,75
Hydro-morphological	QBR	-	90	25	50	70	90	25	50	70	90	90	25	50	70	90
	IHF	-	90	30	50	70	90	30	50	70	90	90	30	50	70	90
Phycical - Chemical	Turbidity	NTU	10	100	60	30	10	100	60	30	10	10	100	60	30	10
	Temperature*	°C	natu.temp. var.	4,5	3,5	2,5	natu.temp. var.	4,5	3,5	2,5	1,5	natu.temp. var.	4,5	3,5	2,5	1,5
	Conductivity	mS/cm	200	1.000	750	500	200	1.000	750	500	250	200	1.000	750	500	250
	pH	pH	6,50	5,29	5,99	6,29	6,50	5,29	5,99	6,29	6,49	6,50	5,29	5,99	6,29	6,49
	DO	mg/L	8,00	1,99	3,99	5,99	8,00	1,99	3,99	5,99	7,99	8,00	1,99	3,99	5,99	7,99
	BOD	mg/L	2	15	7	4	2	15	7	4	2	2	15	7	4	2
	COD	mg/L	2,5	20,0	10,0	5,0	2,5	20,0	10,0	5,0	2,5	2,5	20,0	10,0	5,0	2,5
	Ammonia	mg/L NH_4	1	15	10	5	1	15	10	5	1	1	15	10	5	1
	Nitrates	mg/L NO_3	12	45	30	15	12	45	30	15	10	12	45	30	15	10
	Nitrites	mg/L NO_2	0,005	0,510	0,251	0,011	0,005	0,510	0,251	0,011	0,005	0,005	0,510	0,251	0,011	0,005
	Tot.Phosphorus	mg/L P	4	50	25	15	4	50	25	15	10	4	50	25	15	10
	Phosphates	mg/L PO_4	12	150	75	45	12	150	75	45	12	12	150	75	45	12
	Sulphates	mg/L SO_4	10	100	75	45	10	100	75	45	10	10	100	75	45	10
Priority Substances	Argentum	mg/L Ag	2	20	15	10	2	20	15	10	2	2	20	15	10	2
	Aluminium	mg/L Al	1.100	1.500	1.300	1.200	1.100	1.500	1.300	1.200	1.100	1.100	1.500	1.300	1.200	1.100
	Arsenic	mg/L As	10,00	50	30	20,0	10,00	50	30	20,0	10,0	10,00	50	30	20,0	10,0
	Barium	mg/L Ba	500	4.000	2.000	1.000	500	4.000	2.000	1.000	500	500	4.000	2.000	1.000	500
	Cadmium	mg/L Cd	0,1	11,0	10,0	5,0	0,1	11,0	10,0	5,0	0,1	0,1	11,0	10,0	5,0	0,1
	Cobalt	mg/L Co	50	2.000	1.000	100	50	2.000	1.000	100	50	50	2.000	1.000	100	50
	Chrome	mg/L Cr	20	110	100	50	20	110	100	50	20	20	110	100	50	20
	Lead	mg/L Pb	5	30	20	10	5	30	20	10	5	5	30	20	10	5
	Mercury	mg/L Hg	0,1	1,0	0,8	0,2	0,1	1,0	0,8	0,2	0,1	0,1	1,0	0,8	0,2	0,1
	Nickel	mg/L Ni	20	100	80	60	20	100	80	60	50	20	100	80	60	50
	Zink	mg/L Zn	50	200	150	100	50	200	150	100	50	50	200	150	100	50
	Cooper	mg/L Cu	10	50	30	20	10	50	30	20	10	10	50	30	20	10
	Manganese	mg/L Mn	50	1.000	750	500	50	1.000	750	500	50	50	1.000	750	500	50
	Iron	mg/L Fe	300	1000	750	500	300	1000	750	500	300	300	1000	750	500	300
	Vanadium	mg/L V	100	200	180	150	100	200	180	150	100	100	200	180	150	100
				L_B/G				L_B/G					L_B/G			
	PAH	μg/L		5,01				5,01					5,01			
	Phthalates	μg/L		1,30				1,30					1,30			
	NP pesticides	μg/L		1,30				1,30					1,30			
	PCB	μg/L		0,10				0,10					0,10			
	OC pesticides	μg/L		0,10				0,10					0,10			
	OC components	μg/L		0,10				0,10					0,10			

Table 70: Reference conditions and limits of the indicators for the water body types MLC, LLC, MSS (rivers); RC: reference condition; L_B/P, L_P/M, L_M/G, L_G/H: upper limits of bad, moderate, good and high condition

RIVERS		UNIT	7 (HMS)				
			RC	L_B/P	L_P/M	L_M/G	L_G/H
Biologycal	IPS	-	14	4	6	8	10
	IBMWP	-	100	20	40	60	80
	Fish Quan. Score	-	1	0,15	0,35	0,55	0,75
Hydro-morphological	QBR	-	95	25	50	70	90
	IHF	-	90	30	50	70	90
Phycical - Chemical	Turbidity	NTU	10	100	60	30	10
	Temperature*	°C	natu.temp. var.	4,5	3,5	2,5	1,5
	Conductivity	mS/cm	200	1.000	750	500	250
	pH	pH	6,50	5,29	5,99	6,29	6,49
	DO	mg/L	8,00	1,99	3,99	5,99	7,99
	BOD	mg/L	2	15	7	4	2
	COD	mg/L	2,5	20,0	10,0	5,0	2,5
	Ammonia	mg/L NH_4	1	15	10	5	1
	Nitrates	mg/L NO_3	10	45	1.000	750	500
	Nitrites	mg/L NO_2	0,005	0,510	0,251	0,011	0,005
	Tot.Phosphorus	mg/L P	10	50,01	30,01	20,01	10,01
	Phosphates	mg/L PO_4	12	150	75	45	12
	Sulphates	mg/L SO_4	10	100	75	45	10
Priority Substances	Argentum	mg/L Ag	2	20	15	10	2
	Aluminium	mg/L Al	1.100	1.500	1.300	1.200	1.100
	Arsenic	mg/L As	10,00	50	30	20,0	10,0
	Barium	mg/L Ba	500	4.000	2.000	1.000	500
	Cadmium	mg/L Cd	0,1	11,0	10,0	5,0	0,1
	Cobalt	mg/L Co	50	2.000	1.000	100	50
	Chrome	mg/L Cr	20	110	100	50	20
	Lead	mg/L Pb	5	30	20	10	5
	Mercury	mg/L Hg	0,1	1,0	0,8	0,2	0,1
	Nickel	mg/L Ni	20	100	80	60	50
	Zink	mg/L Zn	50	200	150	100	50
	Cooper	mg/L Cu	10	50	30	20	10
	Manganese	mg/L Mn	50	1.000	750	500	50
	Iron	mg/L Fe	300	1000	750	500	300
	Vanadium	mg/L V	100	200	180	150	100
				L_B/G			
	PAH	µg/L		5,01			
	Phthalates	µg/L		1,30			
	NP pesticides	µg/L		1,30			
	PCB	µg/L		0,10			
	OC pesticides	µg/L		0,10			
	OC components	µg/L		0,10			

Table 71: Reference conditions and limits of the indicators for the water body type HMS (rivers); RC: reference condition; L_B/P, L_P/M, L_M/G, L_G/H: upper limits of bad, moderate, good and high condition

LAKES		Source of limit definition
Biologycal	IPS - phytobenthos	expert judgement
	IBMWP	IBMWP – Armitage, P.D., Moss, D., Wright, J., Furse, M. (1983)
	Fish quan. Score	expert judgement
	Shannon-Wiener	expert judgement
	Tot_biovolume	expert judgement
	Cyanobacteria	expert judgement
	Chlorophil_a	expert judgement
Physical - Chemical	Turbidity	expert judgement
	Secchi depth	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	Temperature	Directive 78/659/EEC
	Conductivity	expert judgement
	pH	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	Alkality	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	DO	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	BOD	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	COD	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	Ptot	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	PO4	expert judgement
	SO4	expert judgement
	N-NO3	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	N-NO2	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	N-NH4	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
Piority substances	Ag	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	Al	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	As	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	Ba	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	Cd	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99,
	Co	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	Pb	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99,
	Hg	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99,
	Ni	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99,
	Zn	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	Cu	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	Mn	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	Fe	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	Cr	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99
	V	Macedonian Regulation for Classification of Water "The Official Gazzette of Republic of Macedonia" No,18/99,
	PAH	Macedonian Regulation for Classification of Water, DIRECTIVE 2008/105/EC, Expert judgement
	Phthalates	Macedonian Regulation for Classification of Water, DIRECTIVE 2008/105/EC
	NP pesticides	Macedonian Regulation for Classification of Water, DIRECTIVE 2008/105/EC
	PCB	Macedonian Regulation for Classification of Water, DIRECTIVE 2008/105/EC
	OC pesticides	Macedonian Regulation for Classification of Water, DIRECTIVE 2008/105/EC
	OC components	Macedonian Regulation for Classification of Water, DIRECTIVE 2008/105/EC

Table 72: Source or method for defining reference conditions and limits of the indicators for the water body types HSSD, MMSD, MSSD and MSSM (lakes)

LAKES		UNIT	1 (HSSD) RC	L_B/P	L_P/M	L_M/G	L_G/H	2 (MMSD) RC	L_B/P	L_P/M	L_M/G	L_G/H	3 (MSSD) RC	L_B/P	L_P/M	L_M/G	L_G/H
Biologycal	IPS - phytobenthos	-	12	2	4	6	8	10	2	4	6	8	10	2	4	6	8
	IBMWP	-	80	30	40	50	70	70	30	40	50	70	70	30	40	50	70
	Fish quan. Score	-	1	0,15	0,35	0,55	0,75	0,8	0,15	0,35	0,55	0,75	0,8	0,15	0,35	0,55	0,75
	Shannon-Wiener	-	2,5	0,5	1	1,5	2	2	0,5	1	1,5	2	2	0,5	1	1,5	2
	Tot_biovolume	mm^3/L	3	20	15	10	5	5	20	15	10	5	5	20	15	10	5
	Cyanobacteria	%	2	30	20	10	5	5	30	20	10	5	5	30	20	10	5
	Chlorophil_a	mg/L	2	10	7,5	3,8	2	4	10	7,5	3,8	4	4	10	7,5	3,8	4
Physical - Chemical	Turbidity	NTU	10	100	60	30	10	10	100	60	30	10	10	100	60	30	10
	Secchi depth	m	7	1	2	4	6	6	1	2	4	6	6	1	2	4	6
	Temperature	°C	natu.temp. var.	4,5	3,5	2,5	1,5	natu.temp. var.	4,5	3,5	2,5	1,5	natu.temp. var.	4,5	3,5	2,5	1,5
	Conductivity	mS/cm	250	1000	750	500	250	250	1000	750	500	250	250	1000	750	500	250
	pH	-	8,5	5,3	6,0	6,3	8,5	8,5	5,3	6,0	6,3	8,5	8,5	5,3	6,0	6,3	8,5
	Alkality	-	150	10	50	100	150	150	10	50	100	150	150	10	50	100	150
	DO	mg/L	7	3	4	6	7	7	3	4	6	7	7	3	4	6	7
	BOD	mg/L	2	15	7	4	2	2	15	7	4	2	2	15	7	4	2
	COD	mg/L	2,5	20	10	5	2,5	2,5	20	10	5	2,5	2,5	20	10	5	2,5
	Ptot	mg/L	15	190	75	40	15	15	190	75	40	15	15	190	75	40	15
	PO4	mg/L PO4	21	225	60	33	21	21	225	60	33	21	21	225	60	33	21
	SO4	mg/L SO4	10	100	75	45	10	10	100	75	45	10	10	100	75	45	10
	N-NO3	mg/L N	10	45	30	15	10	10	45	30	15	10	10	45	30	15	10
	N-NO2	mg/L N	0,005	0,6	0,5	0,01	0,005	0,005	0,6	0,5	0,01	0,005	0,005	0,6	0,5	0,01	0,005
	N-NH4	mg/L N	1	15	10	5	1	1	15	10	5	1	1	15	10	5	1
Piority substances	Ag	µg/L	6	20	15	10	6	6	20	15	10	6	6	20	15	10	6
	Al	µg/L	1100	1500	1300	1200	1100	1100	1500	1300	1200	1100	1100	1500	1300	1200	1100
	As	µg/L	20	50	40	30	25	20	50	40	30	25	20	50	40	30	25
	Ba	µg/L	1500	4000	3000	2000	1500	1500	4000	3000	2000	1500	1500	4000	3000	2000	1500
	Cd	µg/L	0,1	11	10	5	0,1	0,1	11	10	5	0,1	0,1	11	10	5	0,1
	Co	µg/L	500	2000	1500	1000	500	500	2000	1500	1000	500	500	2000	1500	1000	500
	Pb	µg/L	10	30	20	15	10	10	30	20	15	10	10	30	20	15	10
	Hg	µg/L	0,2	1	0,6	0,4	0,2	0,2	1	0,6	0,4	0,2	0,2	1	0,6	0,4	0,2
	Ni	µg/L	50	100	70	60	50	50	100	70	60	50	50	100	70	60	50
	Zn	µg/L	100	200	170	150	120	100	200	170	150	120	100	200	170	150	120
	Cu	µg/L	10,0	50	30	20	10	10,0	50	30	20	10	10,0	50	30	20	10
	Mn	µg/L	50,0	1000	750	500	50	50,0	1000	750	500	50	50,0	1000	750	500	50
	Fe	µg/L	300,0	1000	750	500	300	300,0	1000	750	500	300	300,0	1000	750	500	300
	Cr	µg/L	20,0	110	100	50	20	20,0	110	100	50	20	20,0	110	100	50	20
	V	µg/L	100	200	180	150	100	100	200	180	150	100	100	200	180	150	100
				L_B/G					L_B/G					L_B/G			
	PAH	µg/L		5,01					5,01					5,01			
	Phthalates	µg/L		1,30					1,30					1,30			
	NP pesticides	µg/L		1,30					1,30					1,30			
	PCB	µg/L		0,10					0,10					0,10			
	OC pesticides	µg/L		0,10					0,10					0,10			
	OC components	µg/L		0,10					0,10					0,10			

Table 73: Reference conditions and limits of the indicators for the water body types HSSD, MMSD, MSSD (lakes); RC: reference condition; L_B/P, L_P/M, L_M/G, L_G/H: upper limits of bad, moderate, good and high condition

LAKES		UNIT	4 (MSSM)				
			RC	L_B/P	L_P/M	L_M/G	L_G/H
Biologycal	IPS - phytobenthos	-	10	2	4	6	8
	IBMWP	-	70	30	40	50	70
	Fish quan. Score	-	0,8	0,15	0,35	0,55	0,75
	Shannon-Wiener	-	2	0,5	1	1,5	2
	Tot_biovolume	mm^3/L	5	20	15	10	5
	Cyanobacteria	%	5	30	20	10	5
	Chlorophil_a	mg/L	4	10	7,5	3,8	4
Physical - Chemical	Turbidity	NTU	10	100	60	30	10
	Secchi depth	m	6	1	2	4	6
	Temperature	°C	natu.temp. var.	4,5	3,5	2,5	1,5
	Conductivity	mS/cm	250	1000	750	500	250
	pH	-	8,5	5,3	6,0	6,3	8,5
	Alkality	-	150	10	50	100	150
	DO	mg/L	7	3	4	6	7
	BOD	mg/L	2	15	7	4	2
	COD	mg/L	2,5	20	10	5	2,5
	Ptot	mg/L	15	190	75	40	15
	PO4	mg/L PO4	21	225	60	33	21
	SO4	mg/L SO4	10	100	75	45	10
	N-NO3	mg/L N	10	45	30	15	10
	N-NO2	mg/L N	0,005	0,6	0,5	0,01	0,005
	N-NH4	mg/L N	1	15	10	5	1
Piority substances	Ag	µg/L	6	20	15	10	6
	Al	µg/L	1100	1500	1300	1200	1100
	As	µg/L	20	50	40	30	25
	Ba	µg/L	1500	4000	3000	2000	1500
	Cd	µg/L	0,1	11	10	5	0,1
	Co	µg/L	500	2000	1500	1000	500
	Pb	µg/L	10	30	20	15	10
	Hg	µg/L	0,2	1	0,6	0,4	0,2
	Ni	µg/L	50	100	70	60	50
	Zn	µg/L	100	200	170	150	120
	Cu	µg/L	10,0	50	30	20	10
	Mn	µg/L	50,0	1000	750	500	50
	Fe	µg/L	300,0	1000	750	500	300
	Cr	µg/L	20,0	110	100	50	20
	V	µg/L	100	200	180	150	100
				L_B/G			
	PAH	µg/L		5,01			
	Phthalates	µg/L		1,30			
	NP pesticides	µg/L		1,30			
	PCB	µg/L		0,10			
	OC pesticides	µg/L		0,10			
	OC components	µg/L		0,10			

Table 74: Reference conditions and limits of the indicators for the water body type MSSM (lakes); RC: reference condition; L_B/P, L_P/M, L_M/G, L_G/H: upper limits of bad, moderate, good and high condition

Overview of the monitoring results

The next tables and maps summarize the monitoring results of the campaigns, which took place from June/July 2013 to May 2014. The tables and the maps do not present the measured values but already the interpretation of it using the predefined limits. The measured values are available in separated reports of the company GTI, which implemented the monitoring.

In addition to the monitoring results, also the ecological status, the ecological potential, the chemical status and the water body status per each monitoring point is given (where data are available).

The results are presented in the following order and in the following tables and figures:

- Campaign of June/July 2013
- Campaign of August 2013
- Campaign of October 2013
- Campaign of February 2014
- Campaign of May 2014

Results	**Campaign**				
	June/July 2013	**August 2013**	**October 2013**	**February 2014**	**May 2014**
Overview table	Table 76	Table 77	Table 78	Table 79	Table 80
Physical-chemical evaluation	-	Figure 80	-	-	-
Ecological status/potential	Figure 77	-	Figure 81	-	Figure 85
Chemical status	Figure 78	-	Figure 82	Figure 84	Figure 86
Water body status	Figure 79	-	Figure 83	-	Figure 87

Table 75: Overview of the tables and figures of the monitoring results

Campaign of June/July 2013

Monitoring campaign of June/July 2013

Water body	Monitorin point ID	Biological								Hyd-mor		Physical-Chemical												
		IPS	IBMWP	Fish	Shannon-Wiener	Tot_biovolume	Cyanobacteria	Chlorophil_a	Phytoplankton	QBR	IHF	Turbidity	Temperature	Conductivity	pH	DO	BOD	COD	Ptot	PO4	SO4	N-NO3	N-NO2	N-NH4
Rivers																								
Bregalnica01	SR_01	B	G	B	-	-	-	-	-	G	M	G	H	H	H	H	H	G	M	P	N	H	H	H
Bregalnica01	SR_01_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica02	SR_02	B	G	G	-	-	-	-	-	G	M	H	H	H	H	H	G	G	M	P	N	H	M	H
Bregalnica03	SR_03	P	G	G	-	-	-	-	-	G	M	H	G	G	H	G	G	G	P	B	N	H	M	H
Bregalnica04	SR_04	P	P	G	-	-	-	-	-	P	P	H	G	G	H	G	H	H	M	P	N	H	M	H
Bregalnica05	SR_05	P	P	G	-	-	-	-	-	G	M	H	G	G	H	G	G	H	H	P	N	H	M	H
Bregalnica06	SR_06	P	P	G	-	-	-	-	-	B	M	H	G	G	H	G	G	G	H	G	N	H	M	H
Bregalnica07	SR_07	P	M	G	-	-	-	-	-	P	P	H	G	G	H	H	H	G	M	M	N	H	M	H
Bregalnica08	SR_08	P	M	G	-	-	-	-	-	P	M	H	G	G	H	H	H	G	M	P	N	H	M	H
Bregalnica09	SR_09	P	P	G	-	-	-	-	-	P	M	H	G	G	H	M	M	G	G	B	N	H	M	H
Bregalnica10	SR_10	B	M	G	-	-	-	-	-	G	M	H	G	G	H	G	G	M	B	B	N	H	G	H
Ratevska river01	SR_11_01	N	N	N	-	-	-	-	-	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Ratevska river01	SR_11_02	P	H	B	-	-	-	-	-	G	M	G	H	H	H	H	H	M	H	P	N	H	H	H
Ratevska river02	SR_12	P	M	G	-	-	-	-	-	G	G	H	H	H	H	H	H	M	G	M	N	H	H	H
Zelevica river	SR_13_01	N	N	N	-	-	-	-	-	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Zelevica river	SR_13_02	P	M	G	-	-	-	-	-	P	M	H	G	G	H	G	H	H	G	M	N	H	G	H
Kamenica river	SR_14_01	B	M	B	-	-	-	-	-	G	G	H	H	H	H	H	H	H	H	H	N	H	H	H
Kamenica river	SR_14_02	P	P	G	-	-	-	-	-	M	M	H	G	G	H	H	G	H	H	H	N	H	M	H
Osijnica river	SR_15_01	B	H	G	-	-	-	-	-	M	M	H	H	H	H	H	H	G	M	P	N	H	G	H
Osijnica river	SR_15_01_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Osijnica river	SR_15_02	P	P	G	-	-	-	-	-	B	B	H	G	H	H	H	G	H	H	P	N	H	M	H
Zrnovska river	SR_16_01	G	H	H	-	-	-	-	-	P	M	H	G	H	H	H	H	G	H	M	N	H	H	H
Zrnovska river	SR_16_02	B	M	B	-	-	-	-	-	B	M	H	H	H	H	H	G	G	H	P	N	H	H	H
Orizarska river	SR_17_01	B	H	G	-	-	-	-	-	G	G	G	H	H	H	H	H	G	H	M	N	H	H	H
Orizarska river	SR_17_02	P	M	G	-	-	-	-	-	P	M	H	H	H	H	H	H	G	H	P	N	H	H	H
Kocanska river01	SR_18	N	N	N	-	-	-	-	-	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Kocanska river02	SR_19	P	B	M	-	-	-	-	-	P	P	H	G	G	H	G	M	M	B	B	N	H	M	M
Zletovska river	SR_20	P	P	G	-	-	-	-	-	P	M	G	G	G	H	H	H	H	P	B	N	H	G	H
Kozjacka river	SR_21	Nw	Nw	Nw	-	-	-	-	-	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
Otinja	SR_22	Nw	Nw	Nw	-	-	-	-	-	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
Kriva Lakavica01	SR_23_01	N	N	N	-	-	-	-	-	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Kriva Lakavica01	SR_23_02	N	N	N	-	-	-	-	-	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Kriva Lakavica02	SR_24-01	B	B	B	-	-	-	-	-	P	M	H	G	B	H	M	H	H	M	P	N	H	H	H
Kriva Lakavica02	SR_24-02	P	B	B	-	-	-	-	-	M	M	H	G	B	H	G	H	G	H	M	N	H	M	H
Svetinikolska river01	SR_25_01	N	N	N	-	-	-	-	-	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Svetinikolska river01	SR_25_02	N	N	N	-	-	-	-	-	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Nemanjica river	SR_26	N	N	N	-	-	-	-	-	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Svetinikolska river02	SR_27	B	B	B	-	-	-	-	-	P	M	G	G	B	H	P	G	M	B	B	N	H	B	G
Heavily modified water bodies																								
Ratevo Lake_L	AL_01_01	M	-	-	B	M	Ga	M	P	-	-	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	N	B	Ga	Ga
Ratevo Lake_P	AL_01_02	M	-	-	B	M	Ga	M	P	-	-	Ga	Ga	Ga	Ga	Ga	Ga	Ga	P	Ga	N	Ga	Ga	Ga
Kalimanci Lake_L	AL_02_01	P	-	B	P	Ga	Ga	Ga	Ga	-	-	Ga	Ga	Ga	Ga	Ga	Ga	Ga	B	B	N	Ga	Ga	Ga
Kalimanci Lake_P	AL_02_02	P	-	B	P	Ga	Ga	Ga	Ga	-	-	Ga	Ga	Ga	Ga	M	Ga	Ga	P	Ga	N	Ga	Ga	Ga
Gradce Lake_L	AL_03_01	P	-	-	M	P	Ga	M	P	-	-	Ga	Ga	Ga	Ga	Ga	P	M	Ga	Ga	N	Ga	Ga	Ga
Gradce Lake_P	AL_03_02	N	N	N	N	N	N	N	N	-	-	N	N	N	N	N	N	N	N	N	N	N	N	N
Knezevo Lake_L	AL_04_01	B	-	P	B	Ga	Ga	Ga	B	-	-	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	N	Ga	Ga	Ga
Knezevo Lake_P	AL_04_02	B	-	P	B	Ga	Ga	Ga	B	-	-	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	N	Ga	Ga	Ga
Mantovo Lake_L	AL_05_01	B	-	-	P	P	Ga	M	Ga	-	-	Ga	M	Ga	Ga	Ga	Ga	M	Ga	Ga	N	Ga	Ga	Ga
Mantovo Lake_P	AL_05_02	B	-	-	P	P	Ga	M	Ga	-	-	Ga	Ga	Ga	Ga	Ga	M	M	Ga	Ga	N	Ga	Ga	Ga
Mavrovica Lake_L	AL_06_01	B	-	-	P	Ga	Ga	M	Ga	-	-	Ga	M	Ga	Ga	Ga	Ga	M	Ga	Ga	N	Ga	Ga	Ga
Mavrovica Lake_P	AL_06_02	B	-	-	P	Ga	Ga	M	Ga	-	-	Ga	Ga	Ga	Ga	Ga	Ga	M	Ga	Ga	N	Ga	M	Ga
Artificial water bodies																								
Left irigation chanal	AC_01	-	-	-	-	-	-	-	-	-	-	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
Right irigation chanal 1	AC_02	-	-	-	-	-	-	-	-	-	-	Ga	Ga	Ga	Ga	Ga	M	Ga	Ga	P	N	Ga	Ga	Ga
Right irigation chanal 2	AC_03	-	-	-	-	-	-	-	-	-	-	N	N	N	N	N	N	N	N	N	N	N	N	N

Water body	Monitorin point ID	Priority substances																					Eco-logical status / potential	Che-mical status	Water body status
		Ag	Al	As	Ba	Cd	Co	Cr	Pb	Hg	Ni	Zn	Cu	Mn	Fe	V	PAH	Phtalates	NP pesticides	PCB	Organochlorine pesticides	Organchloring components			
Rivers																									
Bregalnica01	SR_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Bregalnica01	SR_01_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
Bregalnica02	SR_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	F	Gc	Gc	Gc	Gc	B	F	F
Bregalnica03	SR_03	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	F	Gc	Gc	Gc	Gc	P	F	F
Bregalnica04	SR_04	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc	F
Bregalnica05	SR_05	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc	F
Bregalnica06	SR_06	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc	F
Bregalnica07	SR_07	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc	F
Bregalnica08	SR_08	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc	F
Bregalnica09	SR_09	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc	F
Bregalnica10	SR_10	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Ratevska river01	SR_11_01	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Ratevska river01	SR_11_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Ratevska river02	SR_12	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc	F
Zelevica river	SR_13_01	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Zelevica river	SR_13_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc	F
Kamenica river	SR_14_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Kamenica river	SR_14_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	F	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	F	F
Osijnica river	SR_15_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Osijnica river	SR_15_01_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
Osijnica river	SR_15_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	F	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	F	F
Zrnovska river	SR_16_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	M	Gc	F
Zrnovska river	SR_16_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	F	Gc	Gc	Gc	Gc	B	F	F
Orizarska river	SR_17_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Orizarska river	SR_17_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc	F
Kocanska river01	SR_18	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Kocanska river02	SR_19	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Zletovska river	SR_20	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc	F
Kozjacka river	SR_21	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
Otinja	SR_22	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
Kriva Lakavica01	SR_23_01	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Kriva Lakavica01	SR_23_02	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Kriva Lakavica02	SR_24-01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Kriva Lakavica02	SR_24-02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Svetinikolska river01	SR_25_01	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Svetinikolska river01	SR_25_02	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Nemanjica river	SR_26	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Svetinikolska river02	SR_27	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Heavily modified water bodies																									
Ratevo Lake_L	AL_01_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Ratevo Lake_P	AL_01_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Kalimanci Lake_L	AL_02_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Kalimanci Lake_P	AL_02_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Gradce Lake_L	AL_03_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc	F
Gradce Lake_P	AL_03_02	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Knezevo Lake_L	AL_04_01	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	B	N	F
Knezevo Lake_P	AL_04_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Mantovo Lake_L	AL_05_01	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	N	F
Mantovo Lake_P	AL_05_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc	F
Mavrovica Lake_L	AL_06_01	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	N	F
Mavrovica Lake_P	AL_06_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc	F
Artificial water bodies																									
Left irigation chanal	AC_01	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
Right irigation chanal 1	AC_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc	F
Right irigation chanal 2	AC_03	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Legend
- N Not evaluated
- Nw No water
- \- No measure foreseen
- L Littoral
- P Profundal

Ecological status
- H High
- G Good
- M Moderate
- P Poor
- B Bad
- N Not evaluated

Ecological potential
- Ga Good and above
- M Moderate
- P Poor
- B Bad
- N Not evaluated

Chemical status
- Gc Good
- F Failing to achieve Good
- N Not evaluated

Water body status
- G Good
- F Failing to achieve Good
- N Not evaluated

Table 76: Overview of the monitoring result and of the status of each monitoring point for the campaign of June/July 2013

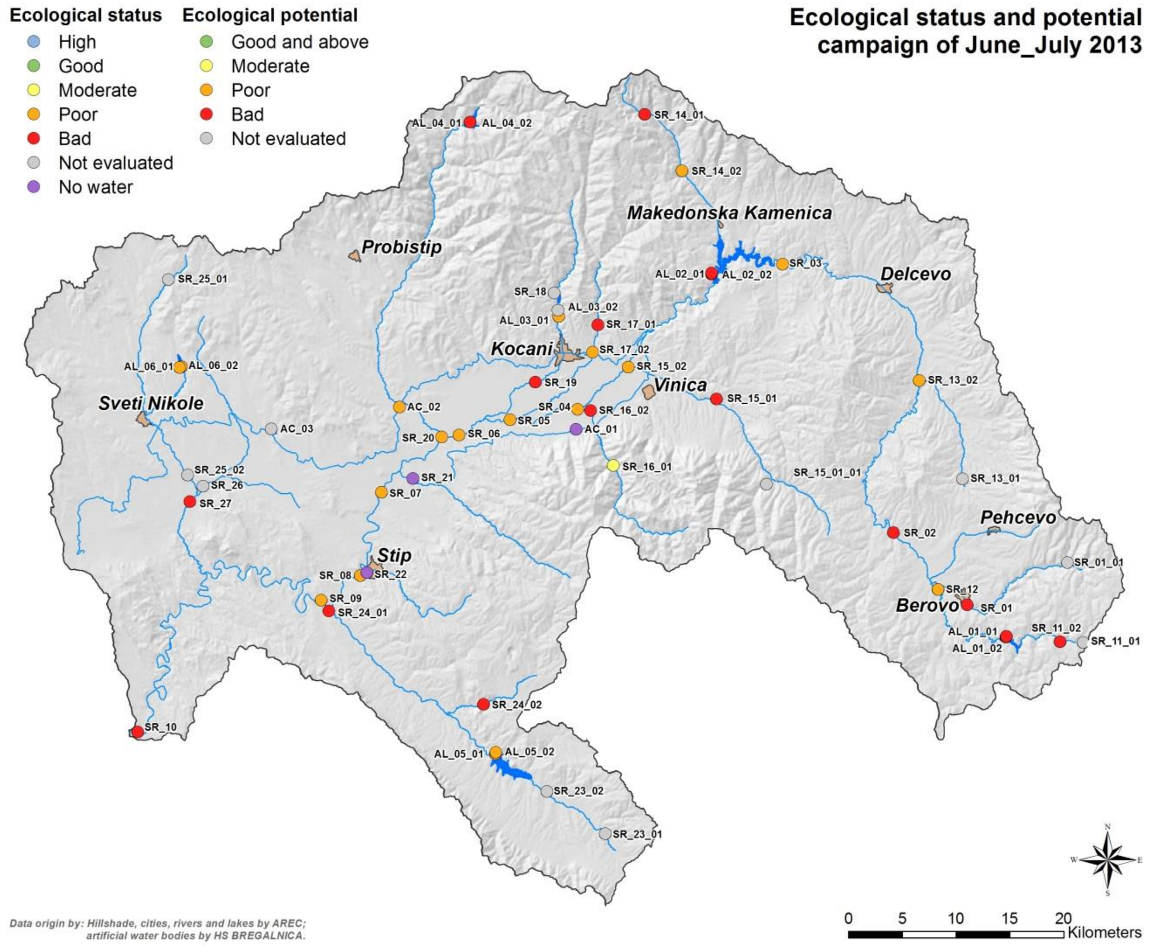


Figure 77: Ecological status/potential, monitoring campaign of June/July 2013

The ecological status and/or potential of the monitoring points in the Bregalnica region are for the major part poor. One measurement point has a moderate status (SR_16_01) and the other measured points have a bad status. None of the measurement points show a high or good ecological status. This is because of the influence of the indicators IPS, Fish, IHF, Ptot and PO_4. In three water bodies no water was present during the measurement campaign; those monitoring points are marked in purple color in Figure 77 and concern the irrigation channel AC_01, Kozjacka river (SR_21) and Otinja river (SR_22). An equal number of the heavily modified water bodies (reservoirs) has poor and bad ecological potential. Mainly the influence of the IPS, Shannon-Wiener and Phytoplankton indicators is responsible for the bad and poor ecological potential in heavily modified water bodies. The ecological status does not always present deterioration along a river as it is the case in the Zrnovska river, where the status decreases from moderate upstream (SR_16_01), to bad in the downstream part (SR_16_02). Sometimes, an amelioration is recognizable, as for example in the Kamenica river, where upstream the ecological status is bad (SR_14_01) and downstream poor (SR_14_02).

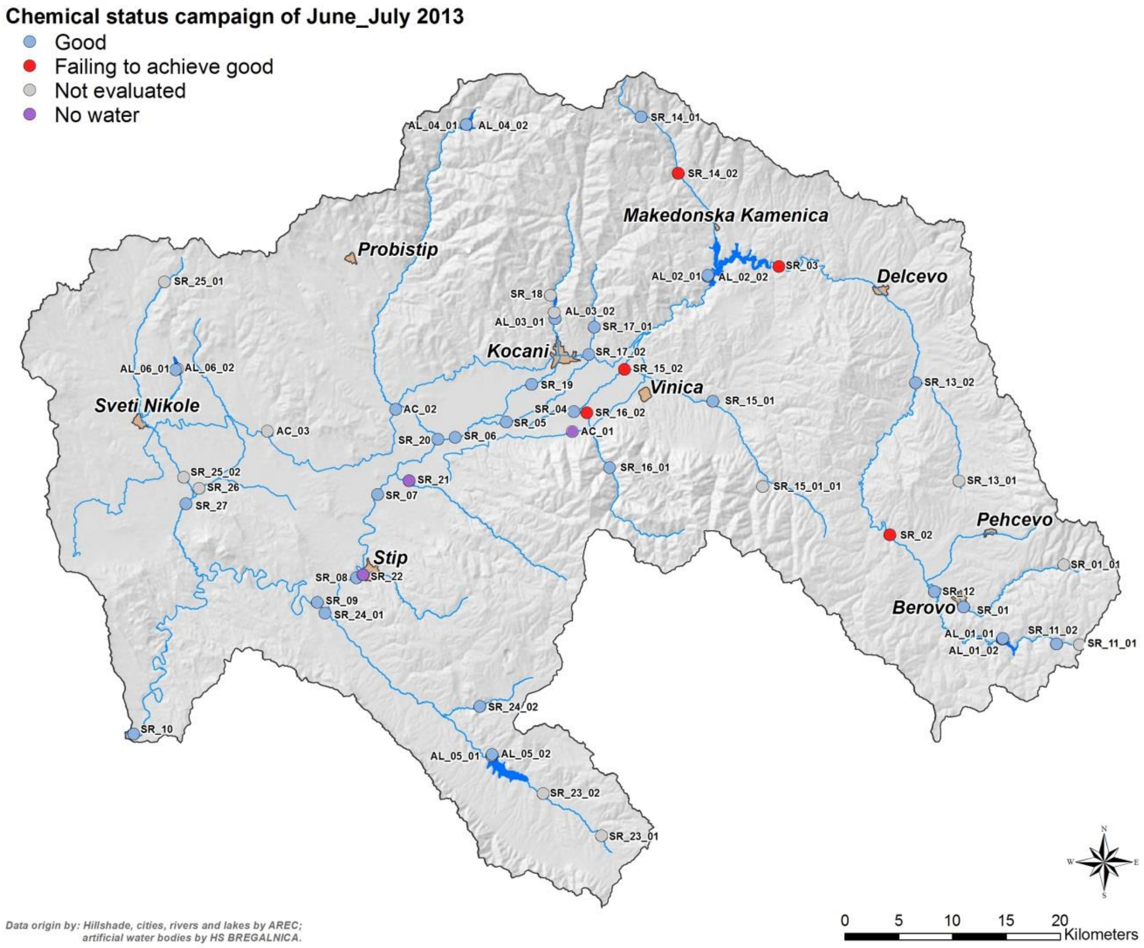


Figure 78: Chemical status, monitoring campaign of June/July 2013

The chemical status of the heavily modified water bodies (reservoirs) is equal to "Good and above", the same status is registered at the measurement points in most Bregalnica river stretches (SR_01, from SR_04 to SR_10), Ratevska river (SR_11_02 and SR_12), Zelevica river (SR_13_02), Osojnica river (SR_15-01), Zrnovska river (SR_16-01), Orizarska river (SR_17_01/02), Kocanska river (SR_19), Zletovska river (SR_20), Kriva Lakavica river (SR_24-01/02), Svetinikolska river (SR_27) and the right irrigation channel (AC_02). A bad status was registered in the upper part of the Bregalnica river (SR_02 and SR_03) and in the downstream part of Osojnica river (SR_15_02) and Zrnovska river (SR_16_02).). No evaluation is available for Ratevska river (SR_11_01), Zelevica river (SR_13_01), Kocanska river (SR_18), Kriva Lakavica river01 (SR_23_01/02), Svetinikolska river01 (SR_25_01/02), Nemanjica river (SR_26) and the right irrigation channel (AC_03). The remaining water bodies were without water.

Out of the 16 priority substances, which determine the chemical status, only phthalates and manganese were crucial for the status definition, because they were the only substances showing high concentrations.

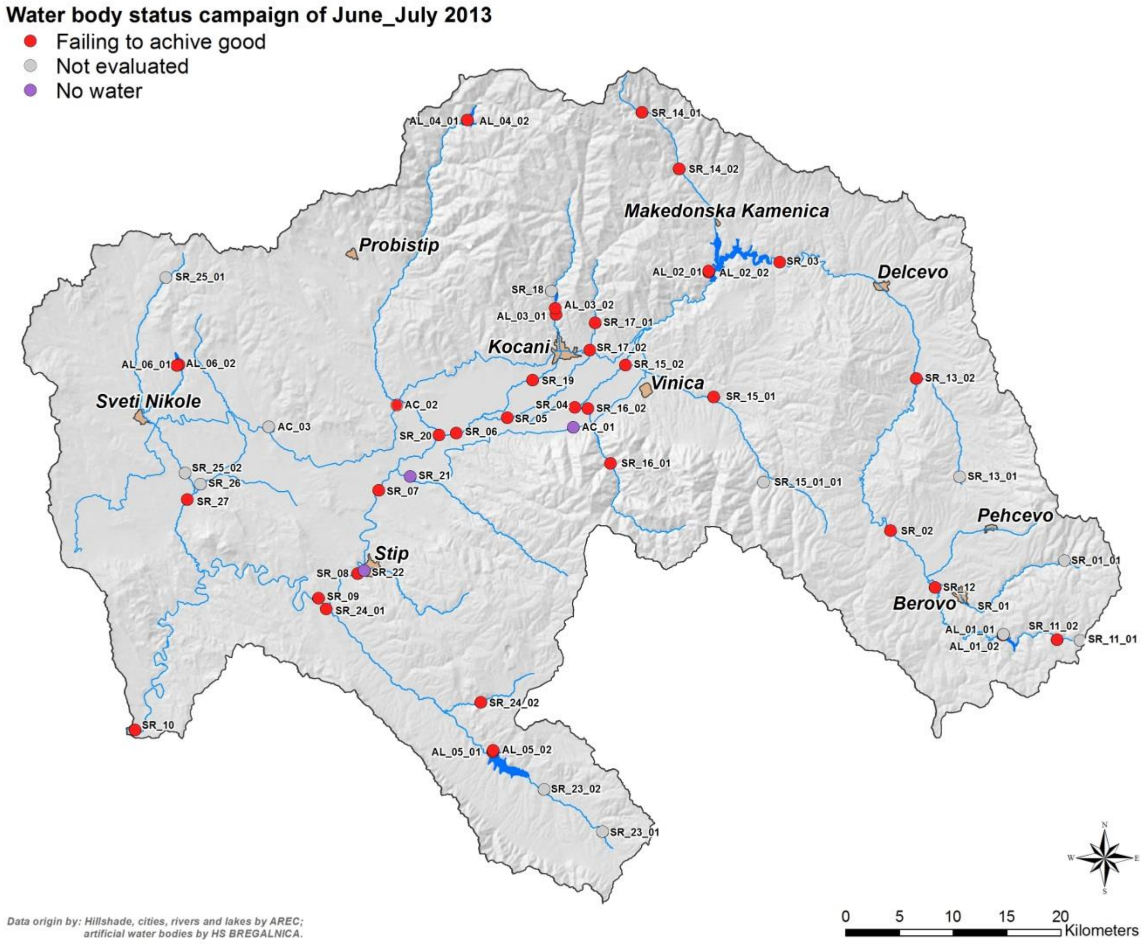


Figure 79: Water body status, monitoring campaign of June/July 2013

All evaluated monitoring points show the status “failing to achieve good”. The reason for this is the use of the ecological status/potential and chemical status for the determination of the water body status.

Campaign of August 2013

Monitoring campaign of August 2013

Water body	ID	Biological: IPS	IBMWP	Fish	Shannon-Wiener	Tot_biovolume	Cyanobacteria	Chlorophil_a	Phytoplankton	Hyd-mor: QBR	IHF
Rivers											
Bregalnica01	SR_01	-	-	-	-	-	-	-	-	-	-
Bregalnica01	SR_01_01	-	-	-	-	-	-	-	-	-	-
Bregalnica02	SR_02	-	-	-	-	-	-	-	-	-	-
Bregalnica03	SR_03	-	-	-	-	-	-	-	-	-	-
Bregalnica04	SR_04	-	-	-	-	-	-	-	-	-	-
Bregalnica05	SR_05	-	-	-	-	-	-	-	-	-	-
Bregalnica06	SR_06	-	-	-	-	-	-	-	-	-	-
Bregalnica07	SR_07	-	-	-	-	-	-	-	-	-	-
Bregalnica08	SR_08	-	-	-	-	-	-	-	-	-	-
Bregalnica09	SR_09	-	-	-	-	-	-	-	-	-	-
Bregalnica10	SR_10	-	-	-	-	-	-	-	-	-	-
Ratevska river01	SR_11_01	-	-	-	-	-	-	-	-	-	-
Ratevska river01	SR_11_02	-	-	-	-	-	-	-	-	-	-
Ratevska river02	SR_12	-	-	-	-	-	-	-	-	-	-
Zelevica river	SR_13_01	-	-	-	-	-	-	-	-	-	-
Zelevica river	SR_13_02	-	-	-	-	-	-	-	-	-	-
Kamenica river	SR_14_01	-	-	-	-	-	-	-	-	-	-
Kamenica river	SR_14_02	-	-	-	-	-	-	-	-	-	-
Osijnica river	SR_15_01	-	-	-	-	-	-	-	-	-	-
Osijnica river	SR_15_01_01	-	-	-	-	-	-	-	-	-	-
Osijnica river	SR_15_02	-	-	-	-	-	-	-	-	-	-
Zrnovska river	SR_16_01	-	-	-	-	-	-	-	-	-	-
Zrnovska river	SR_16_02	-	-	-	-	-	-	-	-	-	-
Orizarska river	SR_17_01	-	-	-	-	-	-	-	-	-	-
Orizarska river	SR_17_02	-	-	-	-	-	-	-	-	-	-
Kocanska river01	SR_18	-	-	-	-	-	-	-	-	-	-
Kocanska river02	SR_19	-	-	-	-	-	-	-	-	-	-
Zletovska river	SR_20	-	-	-	-	-	-	-	-	-	-
Kozjacka river	SR_21	-	-	-	-	-	-	-	-	-	-
Otinja	SR_22	-	-	-	-	-	-	-	-	-	-
Kriva Lakavica01	SR_23_01	-	-	-	-	-	-	-	-	-	-
Kriva Lakavica01	SR_23_02	-	-	-	-	-	-	-	-	-	-
Kriva Lakavica02	SR_24_01	-	-	-	-	-	-	-	-	-	-
Kriva Lakavica02	SR_24_02	-	-	-	-	-	-	-	-	-	-
Svetinikolska river01	SR_25_01	-	-	-	-	-	-	-	-	-	-
Svetinikolska river01	SR_25_02	-	-	-	-	-	-	-	-	-	-
Nemanjica river	SR_26	-	-	-	-	-	-	-	-	-	-
Svetinikolska river02	SR_27	-	-	-	-	-	-	-	-	-	-
Heavily modified water bodies											
Ratevo Lake_L	AL_01_01	-	-	-	-	-	-	-	-	-	-
Ratevo Lake_P	AL_01_02	-	-	-	-	-	-	-	-	-	-
Kalimanci Lake_L	AL_02_01	-	-	-	-	-	-	-	-	-	-
Kalimanci Lake_P	AL_02_02	-	-	-	-	-	-	-	-	-	-
Gradce Lake_L	AL_03_01	-	-	-	-	-	-	-	-	-	-
Gradce Lake_P	AL_03_02	-	-	-	-	-	-	-	-	-	-
Knezevo Lake_L	AL_04_01	-	-	-	-	-	-	-	-	-	-
Knezevo Lake_P	AL_04_02	-	-	-	-	-	-	-	-	-	-
Mantovo Lake_L	AL_05_01	-	-	-	-	-	-	-	-	-	-
Mantovo Lake_P	AL_05_02	-	-	-	-	-	-	-	-	-	-
Mavrovica Lake_L	AL_06_01	-	-	-	-	-	-	-	-	-	-
Mavrovica Lake_P	AL_06_02	-	-	-	-	-	-	-	-	-	-
Artificial water bodies											
Left irigation chanal	AC_01	-	-	-	-	-	-	-	-	-	-
Right irigation chanal 1	AC_02	-	-	-	-	-	-	-	-	-	-
Right irigation chanal 2	AC_03	-	-	-	-	-	-	-	-	-	-

Water body	ID	Physical-Chemical: Turbidity	Temperature	Conductivity	pH	DO	BOD	COD	Ptot	PO4	SO4	N-NO3	N-NO2	N-NH4	Physical-chemical evaluation
Rivers															
Bregalnica01	SR_01	H	H	H	H	H	H	H	H	P	-	H	H	H	P
Bregalnica01	SR_01_01	-	-	-	-	-	-	-	-	-	-	-	-	-	N
Bregalnica02	SR_02	H	H	H	H	G	H	G	B	B	-	H	M	H	B
Bregalnica03	SR_03	H	H	G	H	H	M	G	B	B	-	H	M	H	B
Bregalnica04	SR_04	H	H	G	H	H	H	G	H	B	-	H	G	H	B
Bregalnica05	SR_05	H	H	G	H	H	H	H	H	B	-	H	M	H	B
Bregalnica06	SR_06	H	H	G	H	G	G	H	H	B	-	H	M	H	B
Bregalnica07	SR_07	H	H	G	H	H	H	G	M	M	-	H	G	H	M
Bregalnica08	SR_08	H	H	G	H	H	G	G	P	B	-	H	G	H	B
Bregalnica09	SR_09	H	H	M	H	M	M	G	B	B	-	H	P	H	B
Bregalnica10	SR_10	H	H	M	H	G	H	G	P	B	-	H	H	H	B
Ratevska river01	SR_11_01	N	N	N	N	N	N	N	N	N	-	N	N	N	N
Ratevska river01	SR_11_02	G	H	H	H	G	G	M	H	P	-	H	M	H	P
Ratevska river02	SR_12	H	H	H	H	G	H	M	M	B	-	H	H	H	B
Zelevica river	SR_13_01	N	N	N	N	N	N	N	N	N	-	N	N	N	N
Zelevica river	SR_13_02	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	-	Nw	Nw	Nw	Nw
Kamenica river	SR_14_01	H	H	H	H	H	H	H	H	G	-	H	G	H	G
Kamenica river	SR_14_02	H	H	M	H	H	G	H	H	G	-	H	G	H	M
Osijnica river	SR_15_01	H	H	H	H	H	H	G	H	P	-	H	G	H	P
Osijnica river	SR_15_01_01	-	-	-	-	-	-	-	-	-	-	-	-	-	N
Osijnica river	SR_15_02	H	H	G	H	H	G	H	H	P	-	H	M	H	P
Zrnovska river	SR_16_01	H	H	H	H	H	H	H	H	M	-	H	H	H	M
Zrnovska river	SR_16_02	H	H	G	H	M	H	H	H	H	-	H	G	H	M
Orizarska river	SR_17_01	H	H	H	H	H	H	H	H	H	-	H	H	H	H
Orizarska river	SR_17_02	H	H	G	H	G	M	G	H	B	-	H	M	H	B
Kocanska river01	SR_18	N	N	N	N	N	N	N	N	N	-	N	N	N	N
Kocanska river02	SR_19	H	H	G	H	P	H	G	B	B	-	H	M	G	B
Zletovska river	SR_20	H	H	G	H	G	H	H	G	B	-	H	H	H	B
Kozjacka river	SR_21	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	-	Nw	Nw	Nw	Nw
Otinja	SR_22	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	-	Nw	Nw	Nw	Nw
Kriva Lakavica01	SR_23_01	N	N	N	N	N	N	N	N	N	-	N	N	N	N
Kriva Lakavica01	SR_23_02	N	N	N	N	N	N	N	N	N	-	N	N	N	N
Kriva Lakavica02	SR_24_01	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	-	Nw	Nw	Nw	Nw
Kriva Lakavica02	SR_24_02	H	H	M	H	G	H	H	B	G	-	H	H	H	B
Svetinikolska river01	SR_25_01	N	N	N	N	N	N	N	N	N	-	N	N	N	N
Svetinikolska river01	SR_25_02	N	N	N	N	N	N	N	N	N	-	N	N	N	N
Nemanjica river	SR_26	N	N	N	N	N	N	N	N	N	-	N	N	N	N
Svetinikolska river02	SR_27	H	H	P	H	M	M	M	B	B	-	G	B	G	B
Heavily modified water bodies															
Ratevo Lake_L	AL_01_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratevo Lake_P	AL_01_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalimanci Lake_L	AL_02_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalimanci Lake_P	AL_02_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gradce Lake_L	AL_03_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gradce Lake_P	AL_03_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Knezevo Lake_L	AL_04_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Knezevo Lake_P	AL_04_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mantovo Lake_L	AL_05_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mantovo Lake_P	AL_05_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mavrovica Lake_L	AL_06_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mavrovica Lake_P	AL_06_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Artificial water bodies															
Left irigation chanal	AC_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Right irigation chanal 1	AC_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Right irigation chanal 2	AC_03	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Water body	ID	Priority substances: Ag	Al	As	Ba	Cd	Co	Cr	Pb	Hg	Ni	Zn	Cu	Mn	Fe	V	PAH	Phtalates	NP pesticides	PCB	Organochlorine pesticides	Organchloring components
Rivers																						
Bregalnica01	SR_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica01	SR_01_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica02	SR_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica03	SR_03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica04	SR_04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica05	SR_05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica06	SR_06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica07	SR_07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica08	SR_08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica09	SR_09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica10	SR_10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratevska river01	SR_11_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratevska river01	SR_11_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratevska river02	SR_12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zelevica river	SR_13_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zelevica river	SR_13_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kamenica river	SR_14_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kamenica river	SR_14_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Osijnica river	SR_15_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Osijnica river	SR_15_01_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Osijnica river	SR_15_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zrnovska river	SR_16_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zrnovska river	SR_16_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orizarska river	SR_17_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orizarska river	SR_17_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kocanska river01	SR_18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kocanska river02	SR_19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zletovska river	SR_20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kozjacka river	SR_21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Otinja	SR_22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kriva Lakavica01	SR_23_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kriva Lakavica01	SR_23_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kriva Lakavica02	SR_24_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kriva Lakavica02	SR_24_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Svetinikolska river01	SR_25_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Svetinikolska river01	SR_25_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nemanjica river	SR_26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Svetinikolska river02	SR_27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heavily modified water bodies																						
Ratevo Lake_L	AL_01_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratevo Lake_P	AL_01_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalimanci Lake_L	AL_02_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalimanci Lake_P	AL_02_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gradce Lake_L	AL_03_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gradce Lake_P	AL_03_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Knezevo Lake_L	AL_04_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Knezevo Lake_P	AL_04_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mantovo Lake_L	AL_05_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mantovo Lake_P	AL_05_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mavrovica Lake_L	AL_06_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mavrovica Lake_P	AL_06_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Artificial water bodies																						
Left irigation chanal	AC_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Right irigation chanal 1	AC_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Right irigation chanal 2	AC_03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Legend

- N Not evaluated
- Nw No water
- \- No measure foreseen
- L Littoral
- P Profundal

Physical-chemical evaluation

- H High
- G Good
- M Moderate
- P Poor
- B Bad
- N Not evaluated

Table 77: Overview of the monitoring result and of the status of each monitoring point for the campaign of August 2013

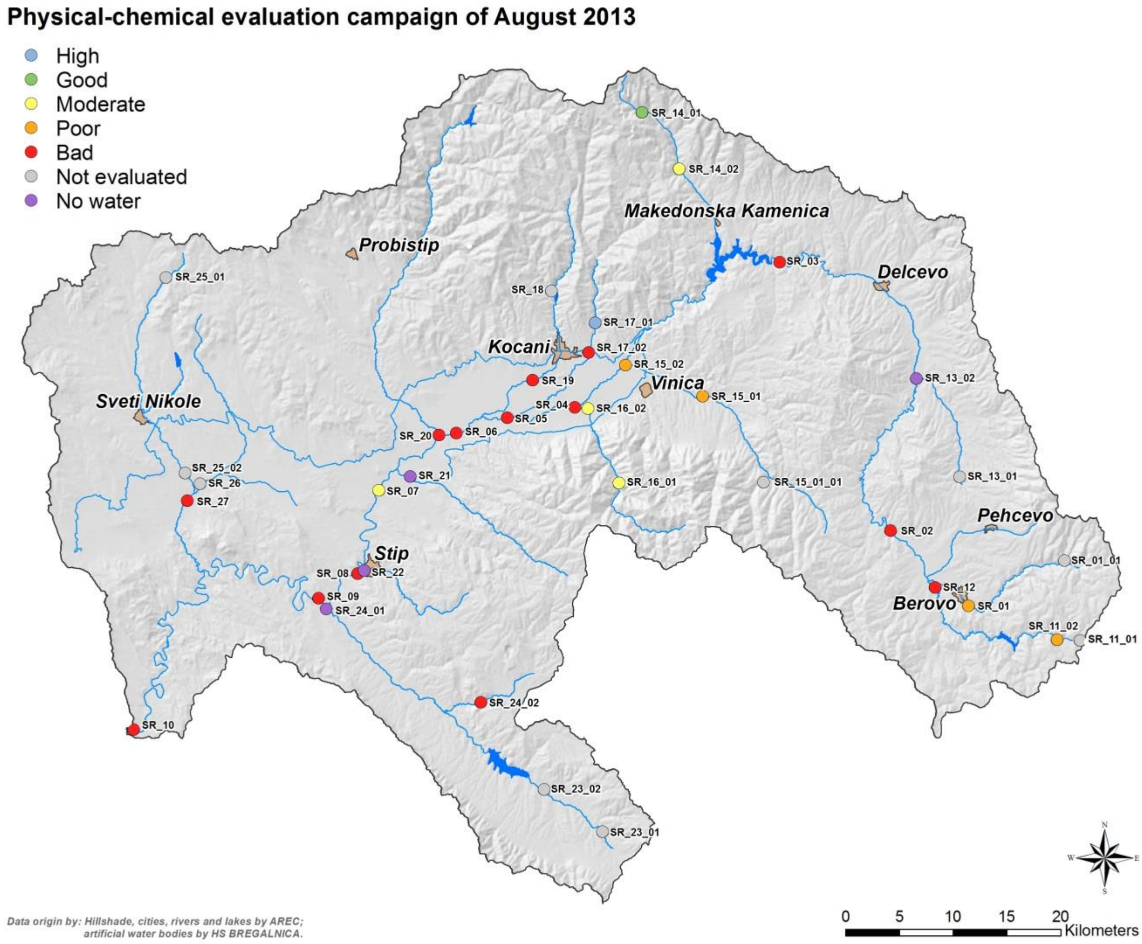


Figure 80: Physical-chemical evaluation, monitoring campaign of August 2013

Perceptibly increased concentrations of Ptot, PO_4 and NO_2 are the reason why the majority of the monitoring points have a bad physical-chemical evaluation status. A high physical-chemical evaluation status is shown only for one monitoring point in Orizarska river (SR_17_01). Kamenicka river (SR_14_01) achieved a good physical-chemical evaluation status. Equal numbers of points have a poor and moderate physical-chemical evaluation status. Zelevica river (SR_13_02), Kozjacka river (SR_21), Otinja river (SR_22) and Kriva Lakavica river (SR_24_01) are marked with purple color in Figure 80 which means that there was no water during the August 2013 monitoring campaign. The rest of the monitoring points (grey) were not evaluated.

Campaign of October 2013

Monitoring campaign of October 2013		Biological								Hyd-mor		Physical-Chemical														Priority substances																					Eco-logical status / potential	Che-mical status
Water body	ID	IPS	IBMWP	Fish	Shannon-Wiener	Tot_biovolume	Cyanobacteria	Chlorophil_a	Phytoplankton	QBR	IHF	Turbidity	Temperature	Conductivity	pH	DO	BOD	COD	Ptot	PO4	Alkality	SO4	N-NO3	N-NO2	N-NH4	Ag	Al	As	Ba	Cd	Co	Cr	Pb	Hg	Ni	Zn	Cu	Mn	Fe	V	PAH	Phtalates	NP pesticides	PCB	Organochlorine pesticides	Organochloring components		
Rivers																																																
Bregalnica01	SR_01	M	G	H	-	-	-	-	-	G	M	H	H	H	H	H	H	G	H	G	-	G	H	H	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	M	Gc
Bregalnica01	SR_01_01	G	H	B	-	-	-	-	-	H	G	H	H	H	H	H	G	G	H	M	-	G	H	H	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc
Bregalnica02	SR_02	P	P	H	-	-	-	-	-	M	M	H	H	H	H	H	G	G	H	G	-	G	H	H	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc
Bregalnica03	SR_03	P	M	H	-	-	-	-	-	M	M	H	H	H	H	H	G	G	H	B	-	G	H	M	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc
Bregalnica04	SR_04	P	P	H	-	-	-	-	-	P	M	H	H	G	H	G	G	G	H	P	-	G	H	M	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	P	F
Bregalnica05	SR_05	P	P	H	-	-	-	-	-	M	M	G	H	G	H	G	G	G	H	M	-	G	H	M	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	P	F
Bregalnica06	SR_06	P	P	H	-	-	-	-	-	P	M	G	H	G	H	G	M	G	H	P	-	G	H	M	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	P	F
Bregalnica07	SR_07	P	P	H	-	-	-	-	-	P	M	H	H	G	H	H	H	H	H	G	-	M	H	M	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc
Bregalnica08	SR_08	P	M	H	-	-	-	-	-	M	M	G	H	M	H	H	H	M	H	B	-	M	H	M	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	B	F
Bregalnica09	SR_09	P	P	H	-	-	-	-	-	M	M	G	H	M	H	G	M	G	H	B	-	P	H	M	G	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	B	F
Bregalnica10	SR_10	P	M	H	-	-	-	-	-	G	M	H	H	M	H	G	G	G	H	B	-	M	H	G	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	B	F
Ratevska river01	SR_11_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratevska river01	SR_11_02	P	H	H	-	-	-	-	-	G	M	H	H	H	H	H	H	G	H	P	-	G	H	H	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc
Ratevska river	SR_12	G	M	H	-	-	-	-	-	M	M	H	H	H	H	H	H	G	H	B	-	G	H	H	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc
Zelevica river	SR_13_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zelevica river	SR_13_02	Nw	Nw	Nw	-	-	-	-	-	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	-	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
Kamenica river01	SR_14_01	M	P	B	-	-	-	-	-	M	G	H	H	H	P	H	H	H	H	H	-	G	H	H	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gk
Kamenica river02	SR_14_02	P	M	B	-	-	-	-	-	M	M	H	H	M	H	H	G	H	H	H	-	B	H	M	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc	P	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	B	F
Osijnica river01	SR_15_01	M	H	H	-	-	-	-	-	M	G	H	H	H	H	H	G	G	H	G	-	G	H	H	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	G	Gc
Brbusnica river	SR_15_01_01	G	H	-	-	-	-	-	-	H	G	H	H	G	H	H	H	H	H	G	-	G	H	H	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	G	Gc
Osijnica river02	SR_15_02	P	P	H	-	-	-	-	-	B	P	H	H	G	H	H	H	H	H	M	-	G	H	M	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	P	F
Zrnovska river01	SR_16_01	G	G	H	-	-	-	-	-	G	G	H	H	H	H	H	H	G	H	G	-	G	H	H	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	G	F
Zrnovska river02	SR_16_02	P	B	B	-	-	-	-	-	P	P	H	H	H	H	G	M	M	H	B	-	G	H	M	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	B	F
Orizarska river01	SR_17_01	G	H	H	-	-	-	-	-	G	M	G	H	H	H	H	G	M	H	H	-	G	H	H	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	M	Gc
Orizarska river01	SR_17_02	P	P	H	-	-	-	-	-	P	P	G	H	H	H	P	M	M	H	B	-	G	H	M	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	P	F
Kocanska river	SR_18	P	H	H	-	-	-	-	-	G	M	H	H	H	H	H	G	H	H	P	-	G	H	H	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc
Kocanska river	SR_19	P	B	H	-	-	-	-	-	P	P	G	H	M	H	M	M	M	B	B	-	G	H	M	G	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	B	F
Zletovska river	SR_20	P	M	H	-	-	-	-	-	M	M	G	H	G	H	H	G	G	H	P	-	M	H	G	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	Gc
Kozjacka river	SR_21	Nw	Nw	Nw	-	-	-	-	-	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	-	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
Otinja	SR_22	Nw	Nw	Nw	-	-	-	-	-	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	-	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
Kriva Lakavica01	SR_23_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kriva Lakavica01	SR_23_02	P	M	B	-	-	-	-	-	G	M	H	H	G	H	G	G	G	H	H	-	G	H	H	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	B	F
Kriva Lakavica02	SR_24-01	B	B	B	-	-	-	-	-	P	P	H	H	B	H	H	G	H	H	G	-	B	H	G	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	M	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	B	F
Kriva Lakavica02	SR_24-02	B	B	B	-	-	-	-	-	G	M	H	H	B	H	H	M	G	H	H	-	B	H	H	H	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	B	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	F
Svetinikolska river01	SR_25_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Svetinikolska river01	SR_25_02	B	-	-	-	-	-	-	-	P	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	B	N
Nemanjica river	SR_26	B	Nw	Nw	-	-	-	-	-	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	-	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
Svetinikolska river02	SR_27	B	B	B	-	-	-	-	-	G	M	H	H	B	H	P	M	M	B	B	-	B	H	M	P	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	B	F
Heavily modified water bodies																																																
Ratevo Lake_L	AL_01-01	P	-	P	M	Ga	-	Ga	M	-	-	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	M	-	Ga	Ga	Ga	Ga	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	M	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	P	F
Ratevo Lake_P	AL_01-02	P	-	P	M	Ga	-	Ga	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	N
Kalimanci Lake_L	AL_02-01	B	-	B	P	B	B	P	P	-	-	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	-	M	Ga	Ga	Ga	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	B	F
Kalimanci Lake_P	AL_02-02	B	-	B	P	B	B	P	P	-	-	Ga	Ga	Ga	Ga	Ga	M	Ga	Ga	Ga	-	M	Ga	Ga	Ga	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	B	F
Gradce Lake_L	AL_03-01	B	-	B	B	Ga	Ga	Ga	P	-	-	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	-	Ga	Ga	Ga	Ga	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc
Gradce Lake_P	AL_03-02	B	-	B	B	Ga	Ga	Ga	P	-	-	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	-	Ga	Ga	Ga	Ga	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	B	F
Zletovo Lake_L	AL_04-01	M	-	P	P	Ga	-	Ga	M	-	-	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	-	Ga	Ga	Ga	Ga	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	P	F
Zletovo Lake_P	AL_04-02	M	-	P	P	Ga	-	Ga	M	-	-	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	-	Ga	Ga	Ga	Ga	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	P	F
Mantovo Lake_L	AL_05-01	P	-	B	Ga	P	P	M	B	-	-	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	-	Ga	Ga	Ga	Ga	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	B	F
Mantovo Lake_P	AL_05-02	P	-	B	Ga	P	P	M	B	-	-	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	Ga	-	Ga	Ga	Ga	Ga	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	B	F
Mavrovica Lake_L	AL_06-01	B	-	P	Ga	Ga	Ga	Ga	B	-	-	Ga	Ga	Ga	Ga	Ga	Ga	M	Ga	Ga	-	B	Ga	Ga	Ga	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	B	F
Mavrovica Lake_P	AL_06-02	B	-	P	Ga	Ga	Ga	Ga	B	-	-	Ga	Ga	Ga	Ga	Ga	M	M	Ga	M	-	B	Ga	Ga	Ga	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	Gc	Gc	Gc	B	F
Artificial water bodies																																																
Leftirigation chanal	AC_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Right irigation chanal 1	AC_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Right irigation chanal 2	AC_03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Legend

Nw No water
- No measure foreseen
L Littoral
P Profundal

Ecological status

H High
G Good
M Moderate
P Poor
B Bad
N Not evaluated

Ecological potential

G Good and above
M Moderate
P Poor
B Bad
N Not evaluated

Chemical status

Gc Good
F Failing to achieve Good
N Not evaluated

Table 78: Overview of the monitoring result and of the status of each monitoring point for the campaign of October 2013

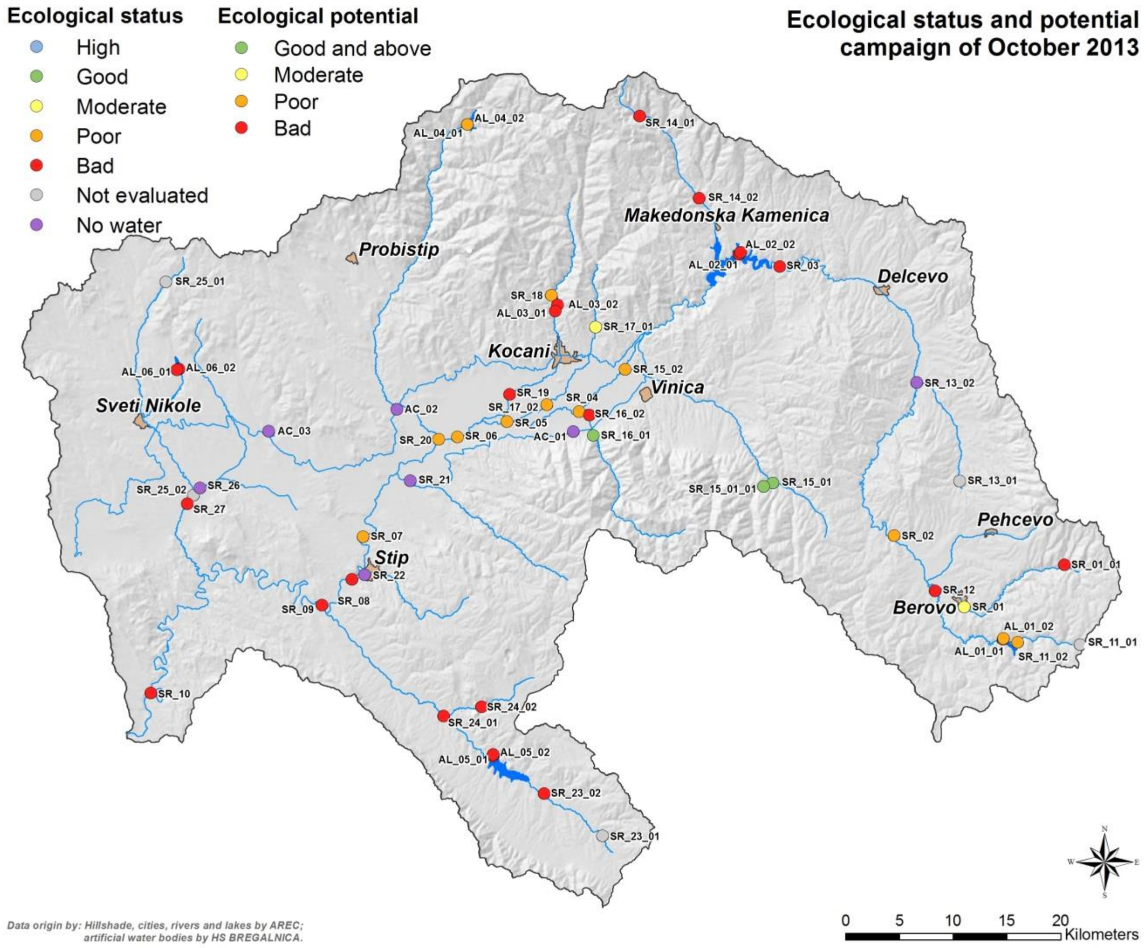


Figure 81: Ecological status/potential, monitoring campaign of October 2013

Most of the monitoring points that are on rivers have a bad ecological status (15). 10 have a poor, 2 have a moderate and 3 good ecological status. The indicators IPS, IBMWP, Fish, Hydro-morphological, Ptot, PO_4 and SO_4 are the main reason for the bad situation. The upper part of Osojnica river (SR_15_01 and SR_15_01_01) and Zrnovska river (SR_16_01) has good ecological status. All irrigation channels (AC_01, AC_02, and AC_03; → end of irrigation season), Zelevica river (SR_13_02), Kozjacka river (SR_21) and Otinja river (SR_22) and Nemanjica river (SR-26) were without water. The rest of the monitoring points were not evaluated. Heavily modified water bodies mainly have a bad ecological potential. Only two of them have at least a poor ecological potential (Ratevo lake and Knezevo lake). A low level of fish and other species indicate eutrophication. These, together with the phthalates are the main reasons for that situation. The ecological status does not always present a deterioration along a river as it is the case in the Zrnovska river, where the status decreases from "good" upstream (SR_16_01) to "bad" in the downstream part (SR_16_02).

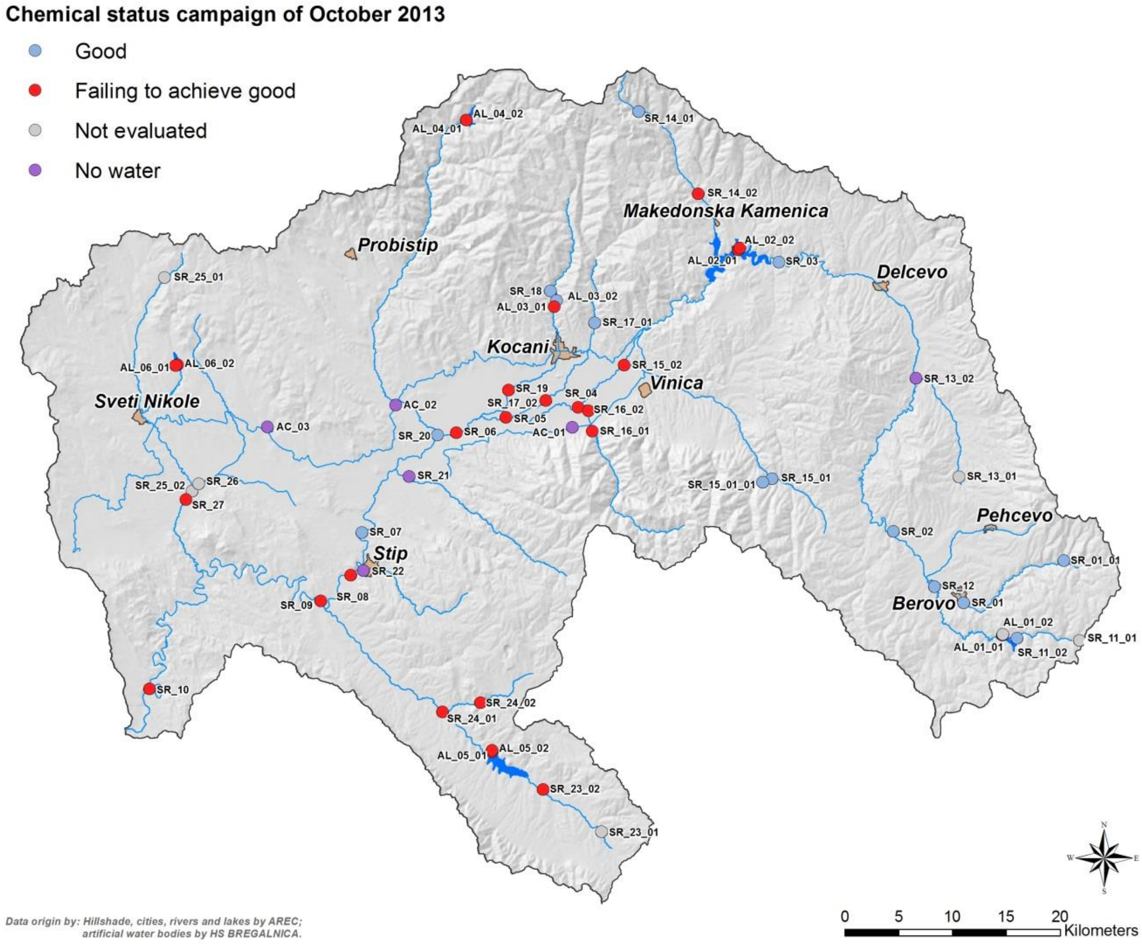


Figure 82: Chemical status, monitoring campaign of October 2013

The chemical status of "failing to achieve good" is the predominant status in the October 2013 monitoring campaign. The indicators Zn, Cu, Mn, Fe, and Phthalates are the main reason for that situation. Especially Phthalates are present in high concentrations in almost every water body. A similar situation is found in the heavily modified water bodies. Only Gradce lake_L (AL_03_01) has a "good and above" chemical status. Several monitoring points are without water: all irrigation channels (AC_01, AC_02, AC_03), Zelevica river (SR_13_02), Kozjacka river (SR_21) and Otinja river (SR_22). The other monitoring points were not evaluated.

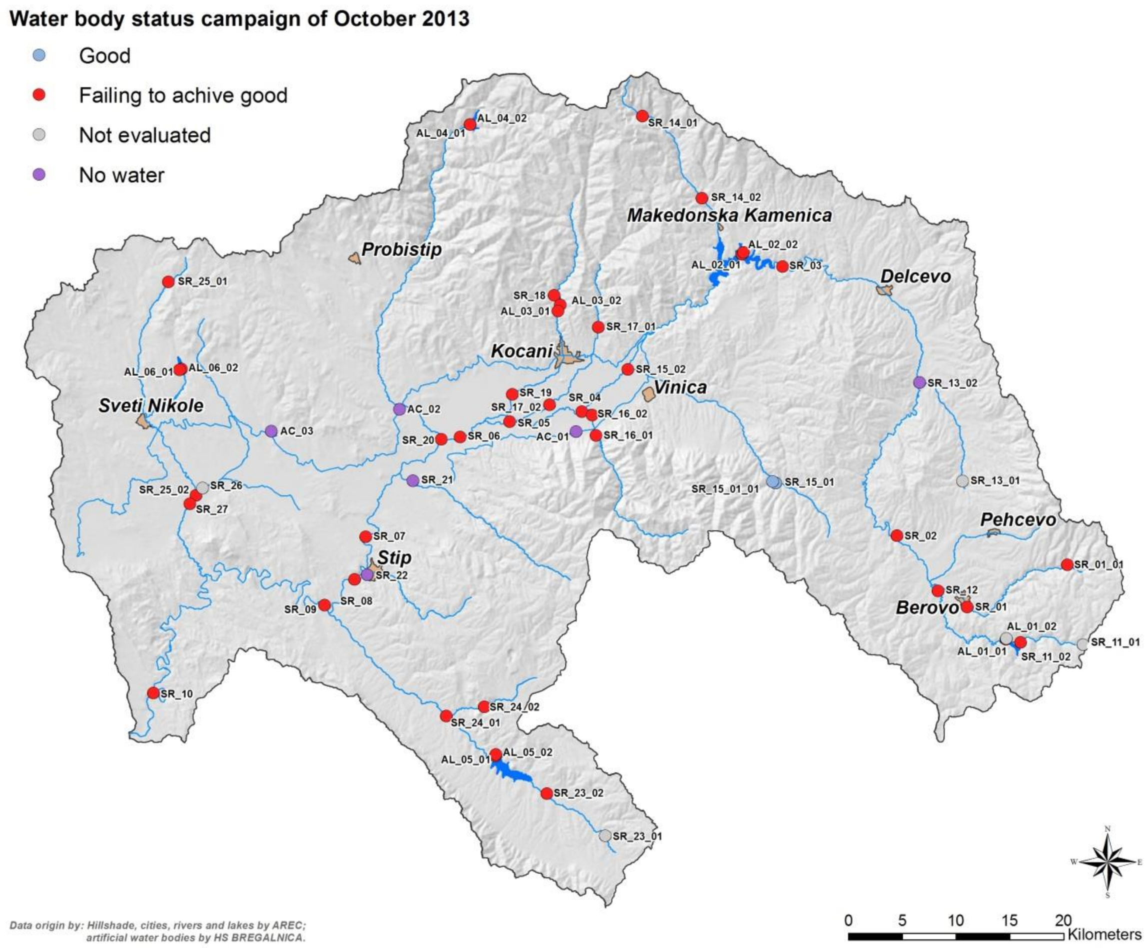


Figure 83: Water body status, monitoring campaign of October 2013

Osojnica river (SR_15_01 and SR_15_01_01) only showed a good water body status. All irrigation channels (AC_01, AC_02, and AC_03), Zelevica river (SR_13_02), Kozjacka river (SR_21) and Otinja river (SR_22) were without water. Zelevica river (13_01), Kriva Lakavica river01 (SR_23_01) and Nemanjica (SR_26) were not evaluated. All other monitoring points showed a water body status of "failing to achieve good".

Campaign of February 2014

Monitoring campaign of February 2014

Water body	Monitorin point ID	Biological: IPS	IBMWP	Fish	Shannon-Wiener	Tot_biovolume	Cyanobacteria	Chlorophil_a	Phytoplankton	Hyd-mor: QBR	IHF
Rivers											
Bregalnica01	SR_01	-	-	-	-	-	-	-	-	-	-
Bregalnica01	SR_01_01	-	-	-	-	-	-	-	-	-	-
Bregalnica02	SR_02	-	-	-	-	-	-	-	-	-	-
Bregalnica03	SR_03	-	-	-	-	-	-	-	-	-	-
Bregalnica04	SR_04	-	-	-	-	-	-	-	-	-	-
Bregalnica05	SR_05	-	-	-	-	-	-	-	-	-	-
Bregalnica06	SR_06	-	-	-	-	-	-	-	-	-	-
Bregalnica07	SR_07	-	-	-	-	-	-	-	-	-	-
Bregalnica08	SR_08	-	-	-	-	-	-	-	-	-	-
Bregalnica09	SR_09	-	-	-	-	-	-	-	-	-	-
Bregalnica10	SR_10	-	-	-	-	-	-	-	-	-	-
Ratevska river01	SR_11_01	-	-	-	-	-	-	-	-	-	-
Ratevska river01	SR_11_02	-	-	-	-	-	-	-	-	-	-
Ratevska river02	SR_12	-	-	-	-	-	-	-	-	-	-
Zelevica river	SR_13_01	-	-	-	-	-	-	-	-	-	-
Zelevica river	SR_13_02	-	-	-	-	-	-	-	-	-	-
Kamenica river	SR_14_01	-	-	-	-	-	-	-	-	-	-
Kamenica river	SR_14_02	-	-	-	-	-	-	-	-	-	-
Osijnica river	SR_15_01	-	-	-	-	-	-	-	-	-	-
Osijnica river	SR_15_01_01	-	-	-	-	-	-	-	-	-	-
Osijnica river	SR_15_02	-	-	-	-	-	-	-	-	-	-
Zrnovska river	SR_16_01	-	-	-	-	-	-	-	-	-	-
Zrnovska river	SR_16_02	-	-	-	-	-	-	-	-	-	-
Orizarska river	SR_17_01	-	-	-	-	-	-	-	-	-	-
Orizarska river	SR_17_02	-	-	-	-	-	-	-	-	-	-
Kocanska river01	SR_18	-	-	-	-	-	-	-	-	-	-
Kocanska river02	SR_19	-	-	-	-	-	-	-	-	-	-
Zletovska river	SR_20	-	-	-	-	-	-	-	-	-	-
Kozjacka river	SR_21	-	-	-	-	-	-	-	-	-	-
Otinja	SR_22	-	-	-	-	-	-	-	-	-	-
Kriva Lakavica01	SR_23_01	-	-	-	-	-	-	-	-	-	-
Kriva Lakavica01	SR_23_02	-	-	-	-	-	-	-	-	-	-
Kriva Lakavica02	SR_24_01	-	-	-	-	-	-	-	-	-	-
Kriva Lakavica02	SR_24_02	-	-	-	-	-	-	-	-	-	-
Svetinikolska river01	SR_25_01	-	-	-	-	-	-	-	-	-	-
Svetinikolska river01	SR_25_02	-	-	-	-	-	-	-	-	-	-
Nemanjica river	SR_26	-	-	-	-	-	-	-	-	-	-
Svetinikolska river02	SR_27	-	-	-	-	-	-	-	-	-	-
Heavily modified water bodies											
Ratevo Lake_L	AL_01_01	-	-	-	-	-	-	-	-	-	-
Ratevo Lake_P	AL_01_02	-	-	-	-	-	-	-	-	-	-
Kalimanci Lake_L	AL_02_01	-	-	-	-	-	-	-	-	-	-
Kalimanci Lake_P	AL_02_02	-	-	-	-	-	-	-	-	-	-
Gradce Lake_L	AL_03_01	-	-	-	-	-	-	-	-	-	-
Gradce Lake_P	AL_03_02	-	-	-	-	-	-	-	-	-	-
Knezevo Lake_L	AL_04_01	-	-	-	-	-	-	-	-	-	-
Knezevo Lake_P	AL_04_02	-	-	-	-	-	-	-	-	-	-
Mantovo Lake_L	AL_05_01	-	-	-	-	-	-	-	-	-	-
Mantovo Lake_P	AL_05_02	-	-	-	-	-	-	-	-	-	-
Mavrovica Lake_L	AL_06_01	-	-	-	-	-	-	-	-	-	-
Mavrovica Lake_P	AL_06_02	-	-	-	-	-	-	-	-	-	-
Artificial water bodies											
Left irigation chanal	AC_01	-	-	-	-	-	-	-	-	-	-
Right irigation chanal 1	AC_02	-	-	-	-	-	-	-	-	-	-
Right irigation chanal 2	AC_03	-	-	-	-	-	-	-	-	-	-

Water body	Monitorin point ID	Physical-Chemical: Turbidity	Temperature	Conductivity	pH	DO	BOD	COD	Ptot	PO4	SO4	N-NO3	N-NO2	N-NH4
Rivers														
Bregalnica01	SR_01	H	H	H	H	H	H	H	H	G	G	H	H	H
Bregalnica01	SR_01_01	H	H	H	H	H	G	H	H	G	G	H	H	H
Bregalnica02	SR_02	H	H	H	H	H	G	G	H	P	G	H	M	H
Bregalnica03	SR_03	H	H	G	H	H	G	H	B	B	G	H	M	H
Bregalnica04	SR_04	H	H	G	H	H	G	H	H	B	G	H	M	H
Bregalnica05	SR_05	H	H	G	H	H	H	H	P	M	G	H	M	H
Bregalnica06	SR_06	H	H	G	H	H	M	H	H	P	G	H	M	H
Bregalnica07	SR_07	H	H	G	H	H	H	H	H	B	M	H	M	H
Bregalnica08	SR_08	G	H	G	H	H	P	G	B	B	M	H	M	H
Bregalnica09	SR_09	G	H	G	H	H	P	G	B	B	M	H	M	H
Bregalnica10	SR_10	H	H	M	H	H	H	G	B	B	P	H	M	H
Ratevska river01	SR_11_01	N	N	N	N	N	N	N	N	N	N	N	N	N
Ratevska river01	SR_11_02	H	H	H	H	H	G	H	H	M	G	H	G	H
Ratevska river02	SR_12	H	H	H	H	H	G	G	H	M	M	H	G	H
Zelevica river	SR_13_01	H	H	G	H	H	H	H	H	G	G	H	H	H
Zelevica river	SR_13_02	H	H	G	H	H	H	H	H	H	G	H	H	H
Kamenica river	SR_14_01	H	H	H	G	H	G	H	H	H	G	H	H	H
Kamenica river	SR_14_02	H	H	M	H	H	G	H	P	H	B	H	H	H
Osijnica river	SR_15_01	H	H	H	H	H	G	G	H	P	G	H	H	H
Osijnica river	SR_15_01_01	H	H	G	H	H	H	H	H	G	G	H	H	H
Osijnica river	SR_15_02	H	H	H	H	H	H	H	P	P	G	H	H	H
Zrnovska river	SR_16_01	H	H	H	H	H	G	H	H	M	G	H	H	H
Zrnovska river	SR_16_02	H	H	H	H	H	G	H	H	G	G	H	H	H
Orizarska river	SR_17_01	H	H	H	H	H	G	H	H	H	G	H	H	H
Orizarska river	SR_17_02	H	H	H	H	H	M	G	B	B	G	H	H	H
Kocanska river01	SR_18	H	H	H	H	H	G	H	H	M	G	H	H	H
Kocanska river02	SR_19	G	H	G	H	G	P	G	B	B	G	H	H	G
Zletovska river	SR_20	G	H	G	H	H	G	H	H	P	P	H	H	H
Kozjacka river	SR_21	H	H	G	H	H	G	H	P	G	G	H	H	H
Otinja	SR_22	H	H	P	H	H	G	H	B	B	B	H	H	H
Kriva Lakavica01	SR_23_01	H	H	H	H	H	G	H	H	M	G	H	H	H
Kriva Lakavica01	SR_23_02	H	H	G	H	H	H	H	H	M	G	H	H	H
Kriva Lakavica02	SR_24_01	H	H	H	H	H	M	G	B	B	B	H	H	H
Kriva Lakavica02	SR_24_02	H	H	M	H	H	G	H	H	G	B	H	H	H
Svetinikolska river01	SR_25_01	H	H	M	H	H	G	H	H	H	B	H	H	H
Svetinikolska river01	SR_25_02	P	H	M	H	H	B	B	B	B	B	H	H	M
Nemanjica river	SR_26	N	N	N	N	N	N	N	N	N	N	N	N	N
Svetinikolska river02	SR_27	G	H	P	H	G	M	M	B	B	B	H	G	G
Heavily modified water bodies														
Ratevo Lake_L	AL_01_01	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratevo Lake_P	AL_01_02	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalimanci Lake_L	AL_02_01	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalimanci Lake_P	AL_02_02	-	-	-	-	-	-	-	-	-	-	-	-	-
Gradce Lake_L	AL_03_01	-	-	-	-	-	-	-	-	-	-	-	-	-
Gradce Lake_P	AL_03_02	-	-	-	-	-	-	-	-	-	-	-	-	-
Knezevo Lake_L	AL_04_01	-	-	-	-	-	-	-	-	-	-	-	-	-
Knezevo Lake_P	AL_04_02	-	-	-	-	-	-	-	-	-	-	-	-	-
Mantovo Lake_L	AL_05_01	-	-	-	-	-	-	-	-	-	-	-	-	-
Mantovo Lake_P	AL_05_02	-	-	-	-	-	-	-	-	-	-	-	-	-
Mavrovica Lake_L	AL_06_01	-	-	-	-	-	-	-	-	-	-	-	-	-
Mavrovica Lake_P	AL_06_02	-	-	-	-	-	-	-	-	-	-	-	-	-
Artificial water bodies														
Left irigation chanal	AC_01	-	-	-	-	-	-	-	-	-	-	-	-	-
Right irigation chanal 1	AC_02	-	-	-	-	-	-	-	-	-	-	-	-	-
Right irigation chanal 2	AC_03	-	-	-	-	-	-	-	-	-	-	-	-	-

Water body	Monitorin point ID	Priority substances: Ag	Al	As	Ba	Cd	Co	Cr	Pb	Hg	Ni	Zn	Cu	Mn	Fe	V
Rivers																
Bregalnica01	SR_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Bregalnica01	SR_01_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Bregalnica02	SR_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Bregalnica03	SR_03	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Bregalnica04	SR_04	Gc	Gc	Gc	Gc	Gc	Gc	Gc	F	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Bregalnica05	SR_05	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Bregalnica06	SR_06	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Bregalnica07	SR_07	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Bregalnica08	SR_08	Gc	Gc	Gc	Gc	Gc	Gc	Gc	F	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Bregalnica09	SR_09	Gc	Gc	Gc	Gc	Gc	Gc	Gc	F	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Bregalnica10	SR_10	Gc	Gc	Gc	Gc	Gc	Gc	Gc	F	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Ratevska river01	SR_11_01	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Ratevska river01	SR_11_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Ratevska river02	SR_12	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Zelevica river	SR_13_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Zelevica river	SR_13_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	F	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Kamenica river	SR_14_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Kamenica river	SR_14_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	F	Gc	F	Gc	Gc
Osijnica river	SR_15_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Osijnica river	SR_15_01_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Osijnica river	SR_15_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Zrnovska river	SR_16_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Zrnovska river	SR_16_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Orizarska river	SR_17_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Orizarska river	SR_17_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Kocanska river01	SR_18	Gc	Gc	Gc	Gc	Gc	Gc	Gc	F	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Kocanska river02	SR_19	Gc	Gc	Gc	Gc	Gc	Gc	Gc	F	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Zletovska river	SR_20	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Kozjacka river	SR_21	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Otinja	SR_22	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Kriva Lakavica01	SR_23_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Kriva Lakavica01	SR_23_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Kriva Lakavica02	SR_24_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Kriva Lakavica02	SR_24_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	F	Gc	Gc	Gc
Svetinikolska river01	SR_25_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Svetinikolska river01	SR_25_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Nemanjica river	SR_26	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Svetinikolska river02	SR_27	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc
Heavily modified water bodies																
Ratevo Lake_L	AL_01_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratevo Lake_P	AL_01_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalimanci Lake_L	AL_02_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalimanci Lake_P	AL_02_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gradce Lake_L	AL_03_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gradce Lake_P	AL_03_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Knezevo Lake_L	AL_04_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Knezevo Lake_P	AL_04_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mantovo Lake_L	AL_05_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mantovo Lake_P	AL_05_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mavrovica Lake_L	AL_06_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mavrovica Lake_P	AL_06_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Artificial water bodies																
Left irigation chanal	AC_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Right irigation chanal 1	AC_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Right irigation chanal 2	AC_03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Water body	Monitorin point ID	Priority substances: PAH	Phtalates	NP pesticides	PCB	Organochlorine pesticides	Organchloring components	Eco-logical status / potential	Che-mical status	Water body status
Rivers										
Bregalnica01	SR_01	-	-	-	-	-	-	-	Gc	-
Bregalnica01	SR_01_01	-	-	-	-	-	-	-	Gc	-
Bregalnica02	SR_02	-	-	-	-	-	-	-	Gc	-
Bregalnica03	SR_03	-	-	-	-	-	-	-	Gc	-
Bregalnica04	SR_04	-	-	-	-	-	-	-	F	F
Bregalnica05	SR_05	-	-	-	-	-	-	-	Gc	-
Bregalnica06	SR_06	-	-	-	-	-	-	-	Gc	-
Bregalnica07	SR_07	-	-	-	-	-	-	-	Gc	-
Bregalnica08	SR_08	-	-	-	-	-	-	-	F	F
Bregalnica09	SR_09	-	-	-	-	-	-	-	F	F
Bregalnica10	SR_10	-	-	-	-	-	-	-	F	F
Ratevska river01	SR_11_01	-	-	-	-	-	-	-	N	N
Ratevska river01	SR_11_02	-	-	-	-	-	-	-	Gc	-
Ratevska river02	SR_12	-	-	-	-	-	-	-	Gc	-
Zelevica river	SR_13_01	-	-	-	-	-	-	-	Gc	-
Zelevica river	SR_13_02	-	-	-	-	-	-	-	F	F
Kamenica river	SR_14_01	-	-	-	-	-	-	-	Gc	-
Kamenica river	SR_14_02	-	-	-	-	-	-	-	F	F
Osijnica river	SR_15_01	-	-	-	-	-	-	-	Gc	-
Osijnica river	SR_15_01_01	-	-	-	-	-	-	-	Gc	-
Osijnica river	SR_15_02	-	-	-	-	-	-	-	Gc	-
Zrnovska river	SR_16_01	-	-	-	-	-	-	-	Gc	-
Zrnovska river	SR_16_02	-	-	-	-	-	-	-	Gc	-
Orizarska river	SR_17_01	-	-	-	-	-	-	-	Gc	-
Orizarska river	SR_17_02	-	-	-	-	-	-	-	Gc	-
Kocanska river01	SR_18	-	-	-	-	-	-	-	F	F
Kocanska river02	SR_19	-	-	-	-	-	-	-	F	F
Zletovska river	SR_20	-	-	-	-	-	-	-	Gc	-
Kozjacka river	SR_21	-	-	-	-	-	-	-	Gc	-
Otinja	SR_22	-	-	-	-	-	-	-	Gc	-
Kriva Lakavica01	SR_23_01	-	-	-	-	-	-	-	Gc	-
Kriva Lakavica01	SR_23_02	-	-	-	-	-	-	-	Gc	-
Kriva Lakavica02	SR_24_01	-	-	-	-	-	-	-	Gc	-
Kriva Lakavica02	SR_24_02	-	-	-	-	-	-	-	F	F
Svetinikolska river01	SR_25_01	-	-	-	-	-	-	-	Gc	-
Svetinikolska river01	SR_25_02	-	-	-	-	-	-	-	Gc	-
Nemanjica river	SR_26	-	-	-	-	-	-	-	N	N
Svetinikolska river02	SR_27	-	-	-	-	-	-	-	Gc	-
Heavily modified water bodies										
Ratevo Lake_L	AL_01_01	-	-	-	-	-	-	-	-	-
Ratevo Lake_P	AL_01_02	-	-	-	-	-	-	-	-	-
Kalimanci Lake_L	AL_02_01	-	-	-	-	-	-	-	-	-
Kalimanci Lake_P	AL_02_02	-	-	-	-	-	-	-	-	-
Gradce Lake_L	AL_03_01	-	-	-	-	-	-	-	-	-
Gradce Lake_P	AL_03_02	-	-	-	-	-	-	-	-	-
Knezevo Lake_L	AL_04_01	-	-	-	-	-	-	-	-	-
Knezevo Lake_P	AL_04_02	-	-	-	-	-	-	-	-	-
Mantovo Lake_L	AL_05_01	-	-	-	-	-	-	-	-	-
Mantovo Lake_P	AL_05_02	-	-	-	-	-	-	-	-	-
Mavrovica Lake_L	AL_06_01	-	-	-	-	-	-	-	-	-
Mavrovica Lake_P	AL_06_02	-	-	-	-	-	-	-	-	-
Artificial water bodies										
Left irigation chanal	AC_01	-	-	-	-	-	-	-	-	-
Right irigation chanal 1	AC_02	-	-	-	-	-	-	-	-	-
Right irigation chanal 2	AC_03	-	-	-	-	-	-	-	-	-

Legend

N Not evaluated
Nw No water
- No measure foreseen

Ecological status: H High; G Good; M Moderate; P Poor; B Bad; N Not evaluated

Ecological potential: Ga Good and above; M Moderate; P Poor; B Bad; N Not evaluated

Chemical status: Gc Good; F Failing to achieve Good; N Not evaluated

Water body status: G Good; F Failing to achieve Good; N Not evaluated

Table 79: Overview of the monitoring result and of the status of each monitoring point for the campaign of February 2014

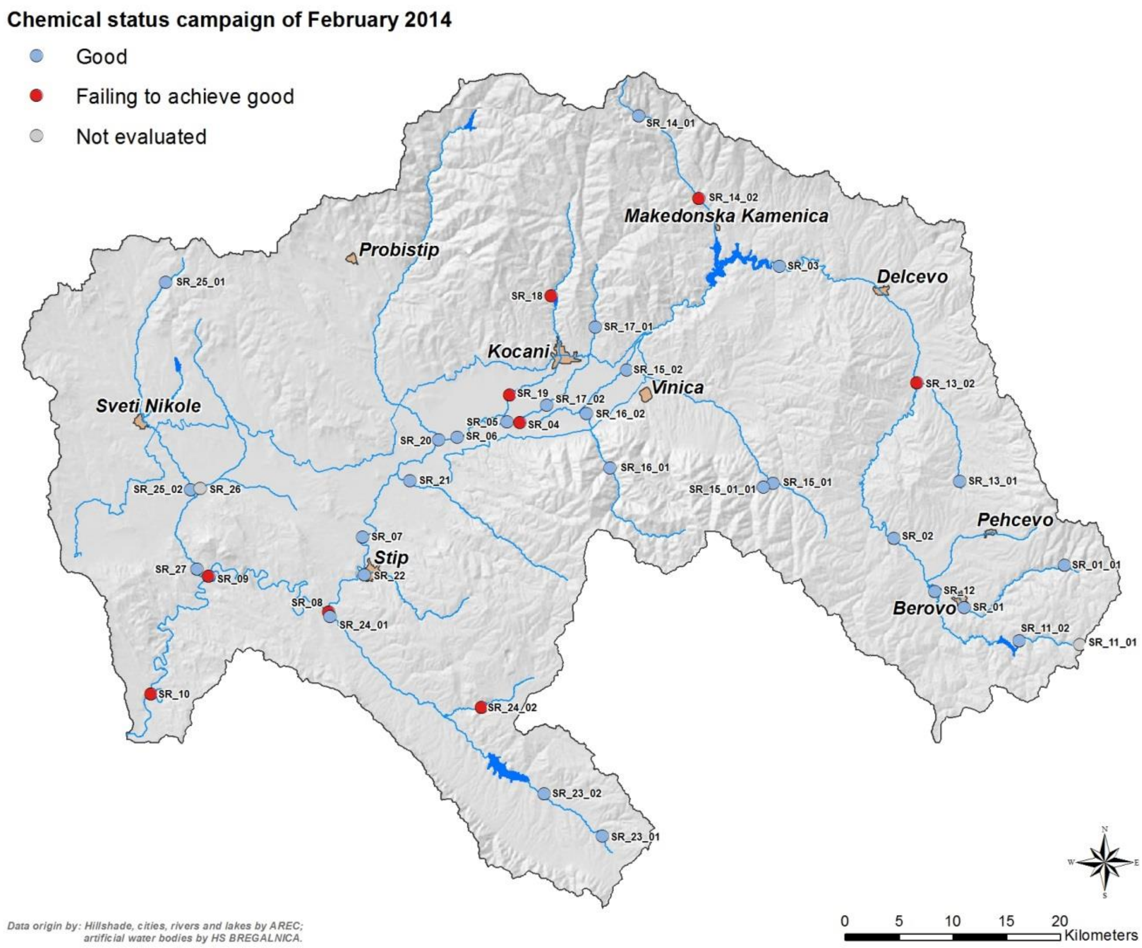


Figure 84: Chemical status, monitoring campaign of February 2014

Most monitoring points have a good chemical status. Several Bregalnica stretches (SR_04, SR_08, SR_09, SR_10), Zelevica river (SR_13_02), Kamenicka river (SR_14_02), Kocanska river (SR_18/19), Kriva Lakavica02 (SR_24_02) show a chemical status of "Failing to achieve good". The main reason for the chemical status of "failing to achieve good" is the presence of Pb, Zn, Cu and Mn. The chemical status does not always present a deterioration along a river as it is the case in the Zelevica river, where the status decreases from "good" upstream (SR_13_01) to "failing to achieve good" in the downstream part (SR_13_02). In some cases an amelioration is observable, as for example in the Kriva Lakavica river, where upstream the chemical status is failing to achieve good (SR_24_02) and downstream the status is good (SR_24_01).

Campaign of May 2014

Monitoring campaign of May 2014

		Biological								Hyd-mor		Physical -Chemical													
Water body	ID	IPS	IBMWP	Fish	Shannon-Wiener	Tot_biovolume	Cyanobacteria	Chlorophil_a	Phytoplankton	QBR	IHF	Turbidity	Temperature	Conductivity	pH	DO	BOD	COD	Ptot	PO4	Alkality	SO4	N-NO3	N-NO2	N-NH4
Rivers																									
Bregalnica01	SR_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica01	SR_01_01	N/A	M	B	-	-	-	-	-	H	H	H	H	H	H	H	G	G	H	G	-	G	H	G	H
Bregalnica02	SR_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica03	SR_03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica04	SR_04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica05	SR_05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica06	SR_06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica07	SR_07	N/A	M	B	-	-	-	-	-	P	M	M	H	G	H	H	G	G	H	P	-	M	H	M	H
Bregalnica08	SR_08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica09	SR_09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica10	SR_10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratevska river01	SR_11_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratevska river01	SR_11_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratevska river	SR_12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zelevica river	SR_13_01	N/A	M	B	-	-	-	-	-	P	G	G	H	H	H	H	G	G	H	P	-	G	H	H	H
Zelevica river	SR_13_02	P	P	B	-	-	-	-	-	P	M	H	H	G	H	H	G	G	H	M	-	G	H	G	H
Kamenica river01	SR_14_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kamenica river02	SR_14_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Osijnica river01	SR_15_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brbusnica river	SR_15_01_01	N/A	H	B	-	-	-	-	-	H	G	H	H	G	H	H	G	H	H	M	-	G	H	H	H
Osijnica river02	SR_15_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zrnovska river01	SR_16_01	M	H	B	-	-	-	-	-	G	G	H	H	H	H	H	G	G	H	G	-	G	H	H	H
Zrnovska river02	SR_16_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orizarska river01	SR_17_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orizarska river01	SR_17_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kocanska river	SR_18	N/A	H	B	-	-	-	-	-	H	M	H	H	H	H	H	H	G	H	P	-	G	H	H	H
Kocanska river	SR_19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zletovska river	SR_20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kozjacka river	SR_21	N/A	B	B	-	-	-	-	-	P	P	H	H	G	H	H	G	H	H	G	-	G	H	H	H
Otinja	SR_22	P	P	B	-	-	-	-	-	B	M	H	H	M	H	H	H	G	B	B	-	M	H	G	H
Kriva Lakavica01	SR_23_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kriva Lakavica01	SR_23_02	P	M	M	-	-	-	-	-	G	M	G	H	G	H	H	G	H	H	B	-	G	H	M	H
Kriva Lakavica02	SR_24-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kriva Lakavica02	SR_24-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Svetinikolska river01	SR_25_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Svetinikolska river01	SR_25_02	B	B	B	-	-	-	-	-	P	M	G	H	B	H	P	M	M	B	B	-	B	H	P	H
Nemanjica river	SR_26	P	P	B	-	-	-	-	-	P	M	H	H	P	H	H	H	G	M	M	-	B	H	M	H
Svetinikolska river02	SR_27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heavily modified water bodies																									
Ratevo Lake_L	AL_01-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratevo Lake_P	AL_01-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalimanci Lake_L	AL_02-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalimanci Lake_P	AL_02-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gradce Lake_L	AL_03-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gradce Lake_P	AL_03-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zletovo Lake_L	AL_04-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zletovo Lake_P	AL_04-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mantovo Lake_L	AL_05-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mantovo Lake_P	AL_05-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mavrovica Lake_L	AL_06-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mavrovica Lake_P	AL_06-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Artificial water bodies																									
Left irigation chanal	AC_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Right irigation chanal 1	AC_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Right irigation chanal 2	AC_03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

		Priority substances																							
Water body	ID	Ag	Al	As	Ba	Cd	Co	Cr	Pb	Hg	Ni	Zn	Cu	Mn	Fe	V	PAH	Phtalates	NP pesticides	PCB	Organochlorine pesticides	Organchloring components	Eco-logical status / potential	Che-mical status	Water body status
Rivers																									
Bregalnica01	SR_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica01	SR_01_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Bregalnica02	SR_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica03	SR_03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica04	SR_04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica05	SR_05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica06	SR_06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica07	SR_07	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Bregalnica08	SR_08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica09	SR_09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bregalnica10	SR_10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratevska river01	SR_11_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratevska river01	SR_11_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratevska river	SR_12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zelevica river	SR_13_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Zelevica river	SR_13_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Kamenica river01	SR_14_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kamenica river02	SR_14_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Osijnica river01	SR_15_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brbusnica river	SR_15_01_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Osijnica river02	SR_15_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zrnovska river01	SR_16_01	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Zrnovska river02	SR_16_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orizarska river01	SR_17_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orizarska river01	SR_17_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kocanska river	SR_18	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Kocanska river	SR_19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zletovska river	SR_20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kozjacka river	SR_21	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Otinja	SR_22	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	F	Gc	Gc	Gc	Gc	B	F	F
Kriva Lakavica01	SR_23_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kriva Lakavica01	SR_23_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Kriva Lakavica02	SR_24-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kriva Lakavica02	SR_24-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Svetinikolska river01	SR_25_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Svetinikolska river01	SR_25_02	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Nemanjica river	SR_26	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	Gc	B	Gc	F
Svetinikolska river02	SR_27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heavily modified water bodies																									
Ratevo Lake_L	AL_01-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ratevo Lake_P	AL_01-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalimanci Lake_L	AL_02-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalimanci Lake_P	AL_02-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gradce Lake_L	AL_03-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gradce Lake_P	AL_03-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zletovo Lake_L	AL_04-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zletovo Lake_P	AL_04-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mantovo Lake_L	AL_05-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mantovo Lake_P	AL_05-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mavrovica Lake_L	AL_06-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mavrovica Lake_P	AL_06-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Artificial water bodies																									
Left irigation chanal	AC_01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Right irigation chanal 1	AC_02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Right irigation chanal 2	AC_03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Legend

Nw No water
\- No measure foreseen
N/A Result couldn't be set

Ecological status
H High
G Good
M Moderate
P Poor
B Bad
N Not evaluated

Ecological potential
G Good and above
M Moderate
P Poor
B Bad
N Not evaluated

Chemical status
Gc Good
F Failing to achieve Good
N Not evaluated

Water body status
Gc Good
F Failing to achieve Good
N Not evaluated

Table 80: Overview of the monitoring result and of the status of each monitoring point for the campaign of May 2014

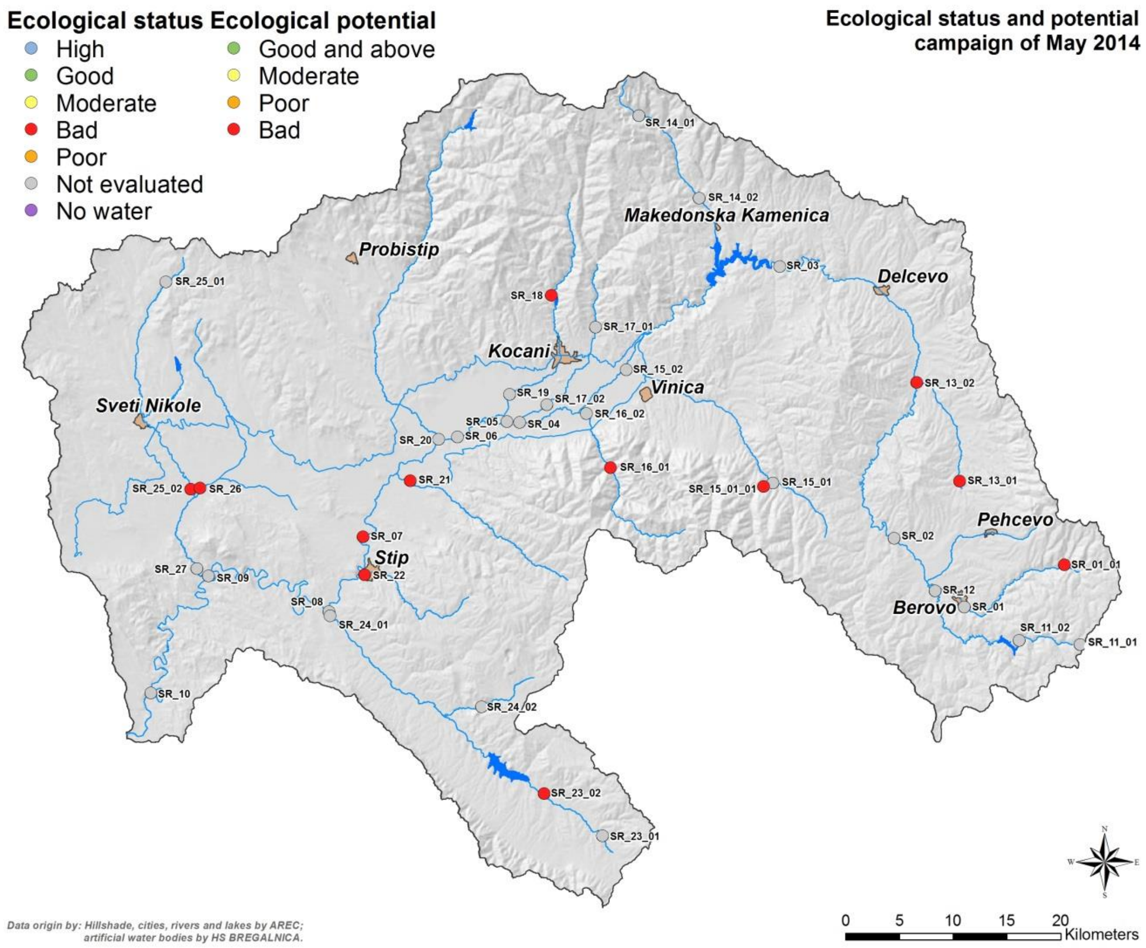


Figure 85: Ecological status, monitoring campaign of May 2014

All evaluated monitoring points show a bad ecological status. The main reasons are several biological indicators as for example IPS, Fish, and the hydro-morphological indicator-QBR. The results confirm and complete the findings of the previous monitoring campaigns.

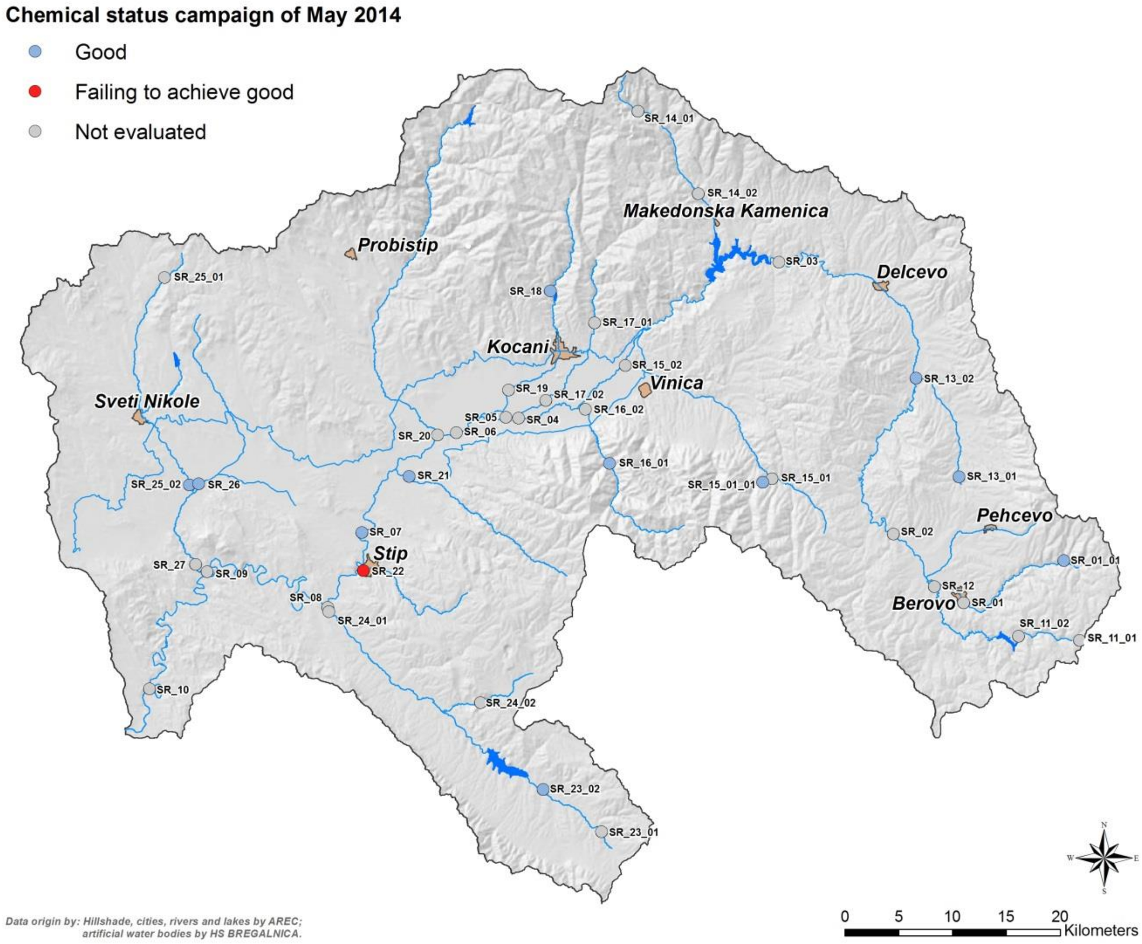


Figure 86: Chemical status, monitoring campaign of May 2014

In almost all monitoring points a good chemical status was detected. Only the monitoring point at the Otinja river (SR_22) registered the status "Falling to achieve good", because of the high concentration of phthalates.

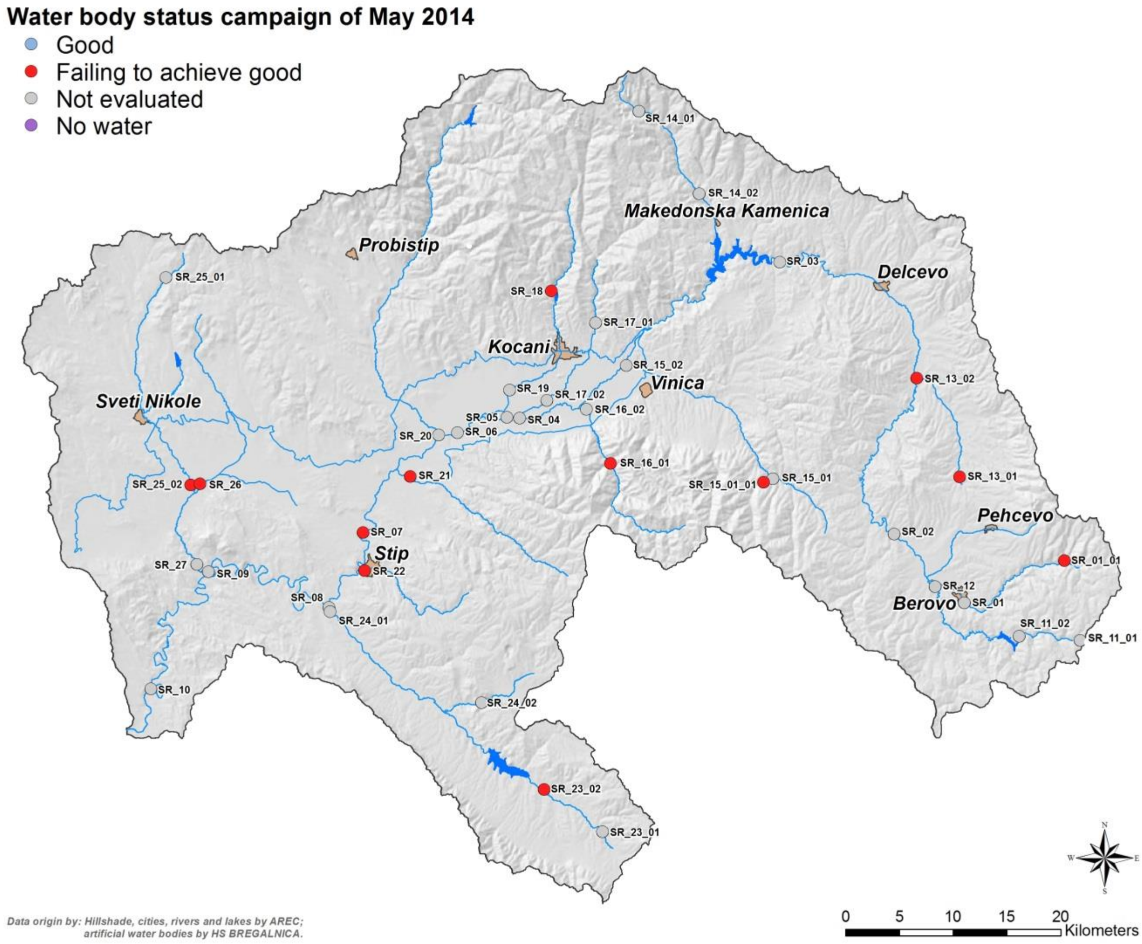


Figure 87: Water body status, monitoring campaign of May 2014

None of the monitoring points reached the water body status good. This is due to the ecological statuses, which reach the status bad only.

A10 Monitoring Results – Groundwater Bodies

Monitoring points for groundwater bodies

Figure 88 to Figure 92 show the location of the selected monitoring points for each GWB. For each GWB at least three monitoring points were selected. For the selection of the points the following criteria had to be fulfilled:

- Distribution over the whole GWB: up-, middle and downstream position,
- Technical documents from hydrological, geological and/or geo-mechanical investigations are available,
- The well/piezometer is: in good condition, the owner allows the use of it, the location is accessible with a vehicle, and the filtered section is in the GWB.

The selection of the monitoring points was done between December 2013 and January 2014 by the National Officers and the local consultants with the support of the international consultants. Each possible monitoring point in the five GWB was evaluated and the most appropriate monitoring points were selected according to the previous criteria and to an inspection on field.

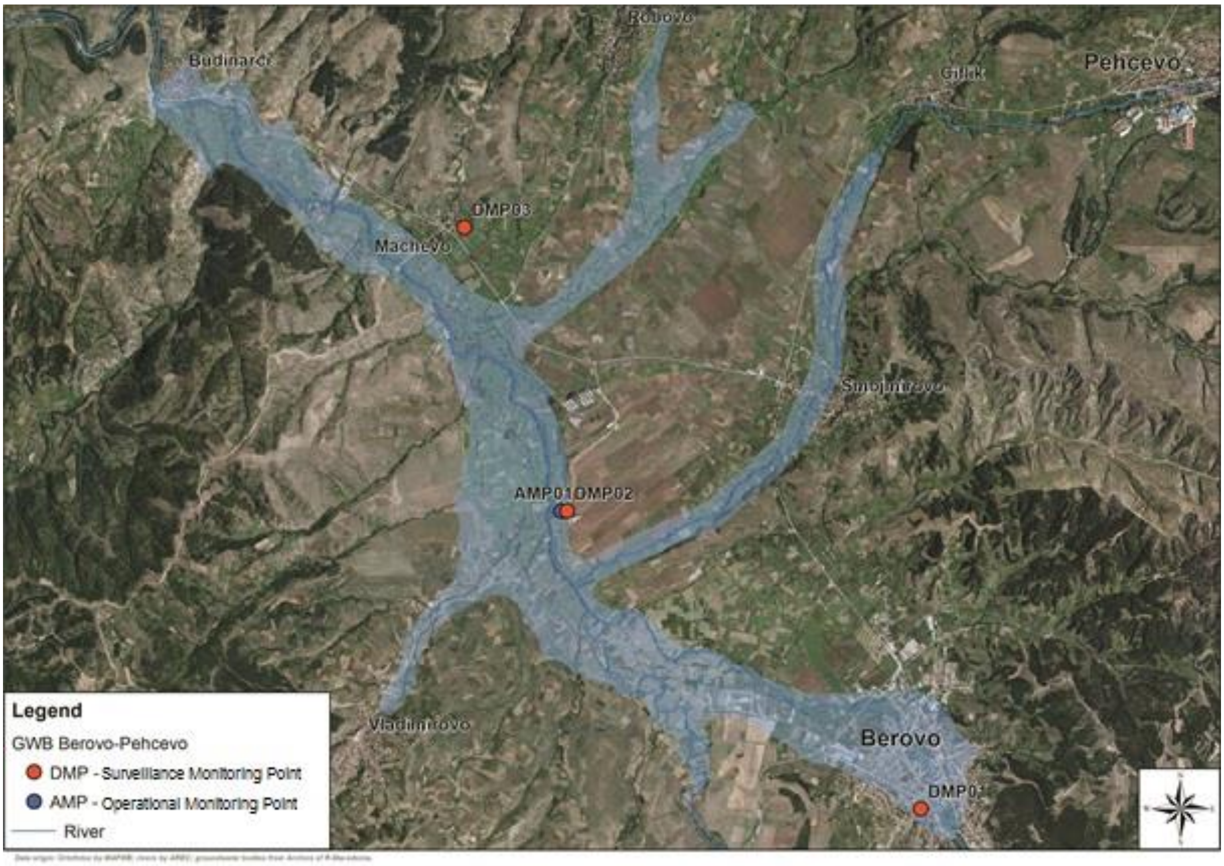


Figure 88: Overview of the location of the monitoring points for the GWB Berovo-Pehcevo

To be able to monitor the downstream part of the GWB Berovo-Pehcevo, the monitoring point DMP 03 was selected. According to Figure 88, DMP 03 seems to be located outside the GWB, but most likely the boundary of the GBW is more extended and reaches Machevo. Therefore, DMP 03 was included into the first monitoring campaign. This is a drilled well and has a depth of approximately 60 m. The analysis of the results of the first campaign will show whether DMP 03 is located within the GWB Berovo-Pehcevo and should be also integrated in the second detailed campaign, or it rather is a hillside groundwater.

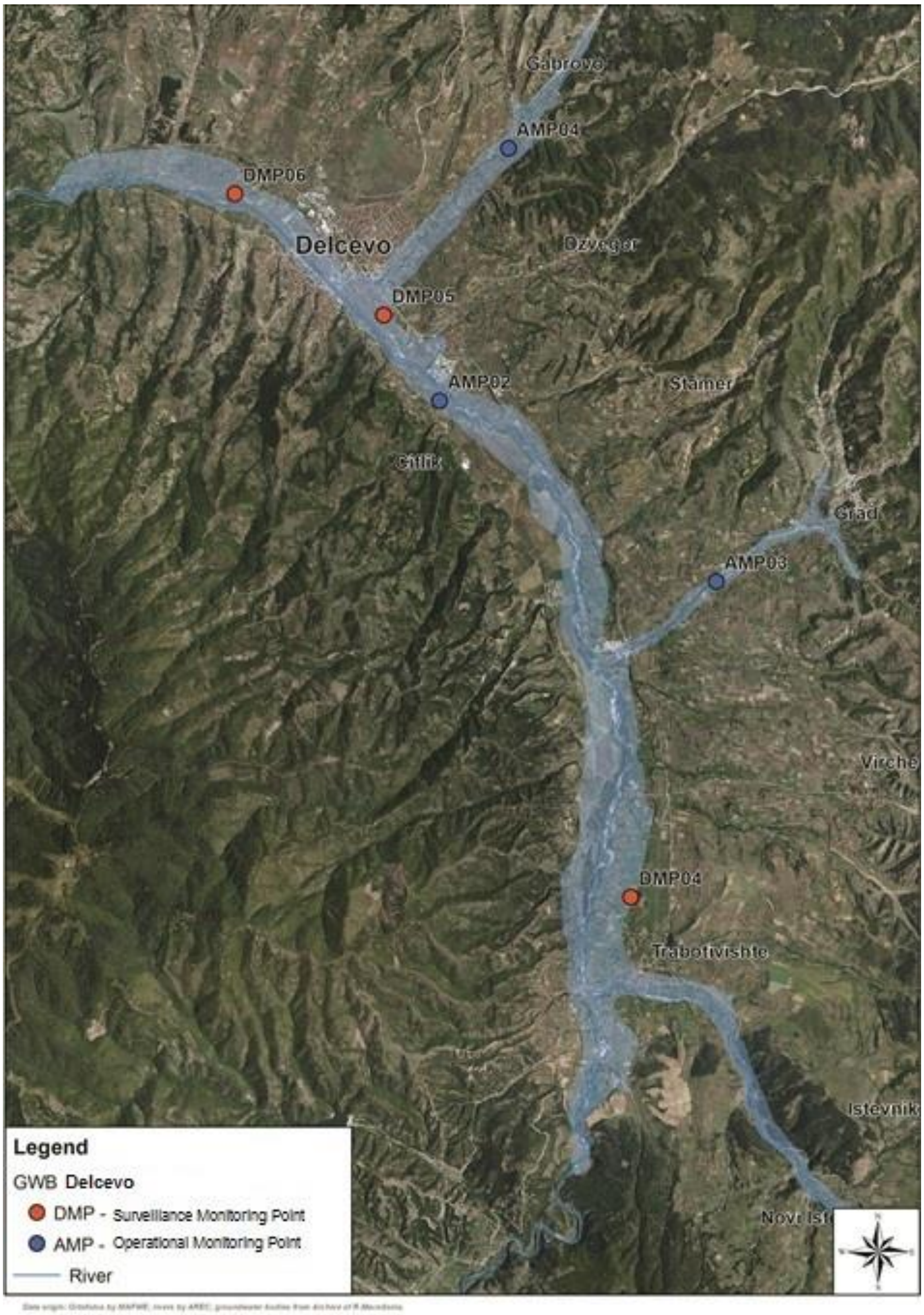


Figure 89: Overview of the location of the monitoring points for the GWB Berovo-Pehcevo

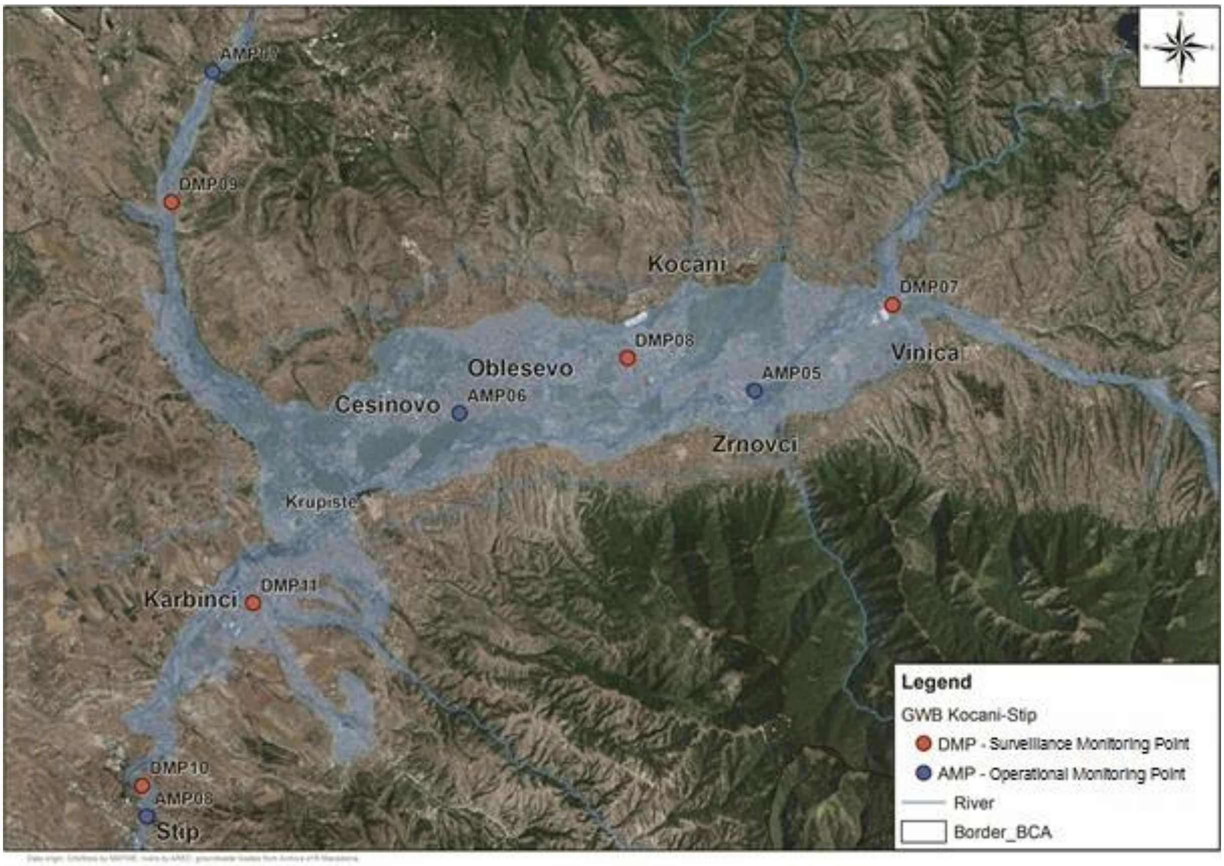


Figure 90: Overview of the location of the monitoring points for the GWB Kocani-Stip

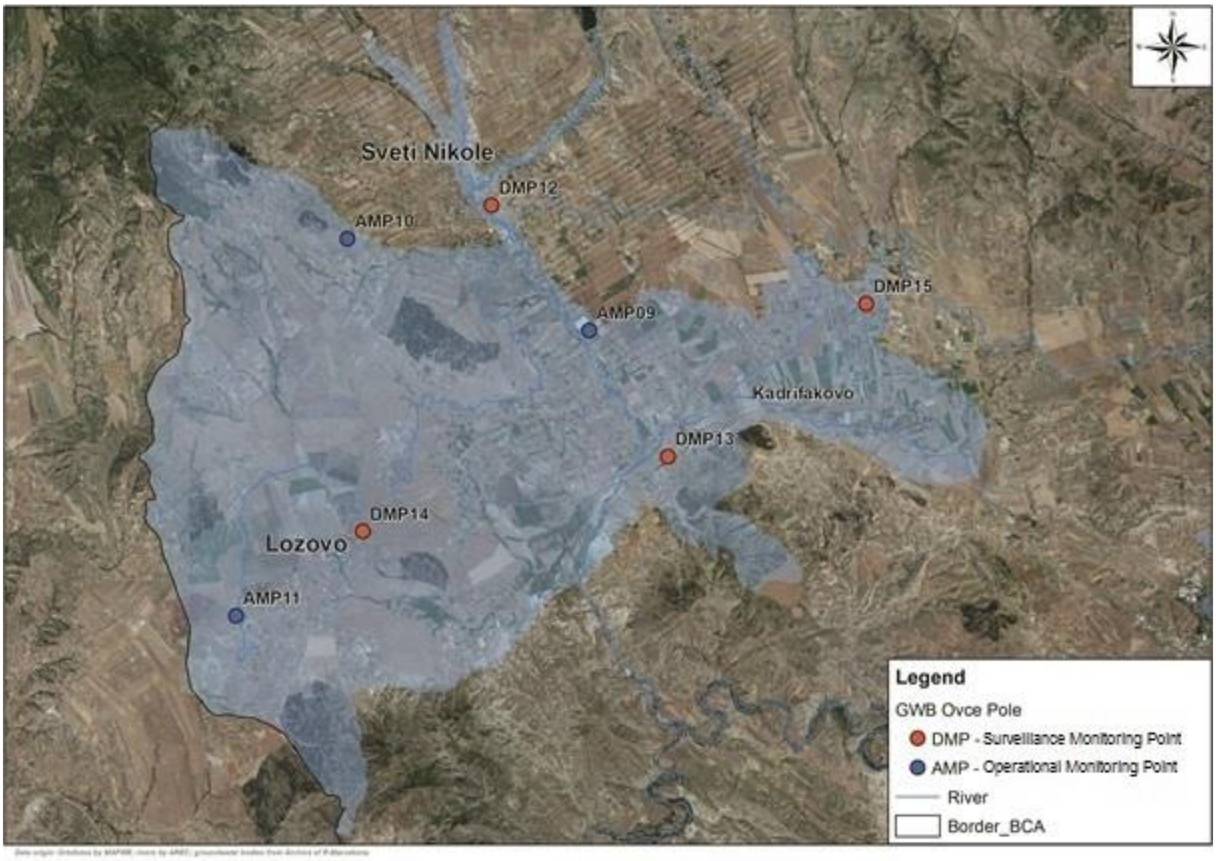


Figure 91: Overview of the location of the monitoring points for the GWB Ovce Pole

Figure 92: Overview of the location of the monitoring points for the GWB Lakavica

More details on the selection of the monitoring points and the monitoring points themselves can be found in the separate "Report on the groundwater monitoring points" dated 19 February 2014.

Indicators for groundwater bodies

Parameter	Indicator(s) to be measured	Spring 2014	Autumn 2014
Water quantity	Groundwater level	X	X
Thermal condition	Temperature	X	X
Salinity	Conductivity	X	X
Acidification	pH	X	X
Oxygenation	Dissolved Oxygen, dissolved CO_2, Redox potential	X	X
Nutrient condition	N-NO_3, N-NO_2, N-NH_4, Ptot, PO_4^{3-}	X	X
Majority cations	Ca, Mg, Na, K	X	X
Majority anions	Cl, SO_4, CO_3	X	X
Priority substances	Metals & Metaloids (Ag, Al, As, Ba, Cd, Co, Cr, Pb, Hg, Ni, Zn, Cu, Mn, Fe, V), Poly Aromatic Hydrocarbons (PAH), Phtalates, Nitrogen and Phosphorous pesticides, Polychlorinated biphenyl (PCB), Organochlorine pesticides, Organochlorine components		X

Table 81: Overview of the indicators and measures per year of the detailed monitoring. X = Measurement

The operational monitoring was conducted monthly by the National Officers according to Table 82 since June 2014.

Parameter	Indicator to be measured	Measures per year
Water quantity	Groundwater level	12
Thermal condition	Temperature	12
Salinity	Conductivity	12
Acidification	pH	12
Oxygenation	Dissolved Oxygen	12

Table 82: Overview of the indicators and measures per year of the additional monitoring

Reference conditions and limits of the indicators

In the tables below the source and the value of the reference condition and limit are shown for each indicator. The numeric values for the limits were initially proposed by GEING, i.e. the company responsible for the sampling, laboratory analysis and assessment. The limits were mainly derived from the Macedonian Regulation for Classification of Water, the Regulation of Safety of Water, the EPA - Secondary MCL and the Water Framework Directive 2008/105/EC or were based on expert judgment. These proposed limits were further checked and compared with limits used in other river basin management plans or proposed by other institutions such as

Swiss regulations, WH and FAO, especially with respect to the most critical substances: P_{tot}, DO, SO_4, N-NO_3, N-NH_4, Mn, nitrogen pesticides and polycyclic aromatic hydrocarbons (PAH).

Indicators		**Source of limit definition**
Quantita-tive	Water level	n.a.
Chemical	Temperature	not available
	Conductivity	Official Gazette of the Republic of Macedonia No.57/04
	pH	Official Gazette of the Republic of Macedonia No.18/1999
	DO	Official Gazette of the Republic of Macedonia No.18/1999; expert judg-ment
	Dissolved CO_2	not available
	Redox potential	Swedish Environmental Protection Agency, 2002
	N-NO_3	Official Gazette of the Republic of Macedonia No.18/1999
	N-NO_2	Official Gazette of the Republic of Macedonia No.18/1999
	N-NH_4	Official Gazette of the Republic of Macedonia No.18/1999
	P_{tot}	Official Gazette of the Republic of Macedonia No.18/1999; expert judg-ment
	PO_4	Official Gazette of the Republic of Macedonia No.46/08
	Ca	Official Gazette of the Republic of Serbia 42/98; expert judgment
	Mg	Official Gazette of the Republic of Serbia 42/98
	Na	Official Gazette of the Republic of Macedonia No.46/08
	K	Official Gazette of the Republic of Macedonia No.46/08
	Cl	Indicator Values in Switzerland for Groundwater; EPA - Secondary MCL
	SO_4	Official Gazette of the Republic of Macedonia No.46/08
	CO_3	Official Gazette of the Republic of Macedonia No.18/1999
	Argentum	Official Gazette of the Republic of Macedonia No.18/1999
	Aluminum	Official Gazette of the Republic of Macedonia No.18/1999
	Arsenic	Indicator Values in Switzerland for Groundwater; Council Directive 98/83/EC
	Barium	Official Gazette of the Republic of Macedonia No.18/1999
	Cadmium	Official Gazette of the Republic of Macedonia No.18/1999; Indicator Values in Switzerland for Groundwater
	Cobalt	FAO Degree of Restriction on Use for irrigation water; Official Gazette of the Republic of Macedonia No.18/1999
	Chrome	Official Gazette of the Republic of Macedonia No.18/1999; Indicator Values in Switzerland for Groundwater
	Lead	Official Gazette of the Republic of Macedonia No.18/1999; Indicator Values in Switzerland for Groundwater
	Mercury	Official Gazette of the Republic of Macedonia No.18/1999; Indicator Values in Switzerland for Groundwater
	Nickel	Official Gazette of the Republic of Macedonia No.18/1999; Indicator Values in Switzerland for Groundwater
	Zink	Indicator Values in Switzerland for Groundwater
	Cooper	Official Gazette of the Republic of Macedonia No.18/1999
	Manganese	Official Gazette of the Republic of Macedonia No.18/1999
	Iron	Official Gazette of the Republic of Macedonia No.18/1999; SVGW Values for Drinking Water
	Vanadium	Official Gazette of the Republic of Macedonia No.18/1999
	PAH	Official Gazette of the Republic of Macedonia No. 18/1999
	Phthalate	Macedonian Regulation for Classification of Water, DIRECTIVE

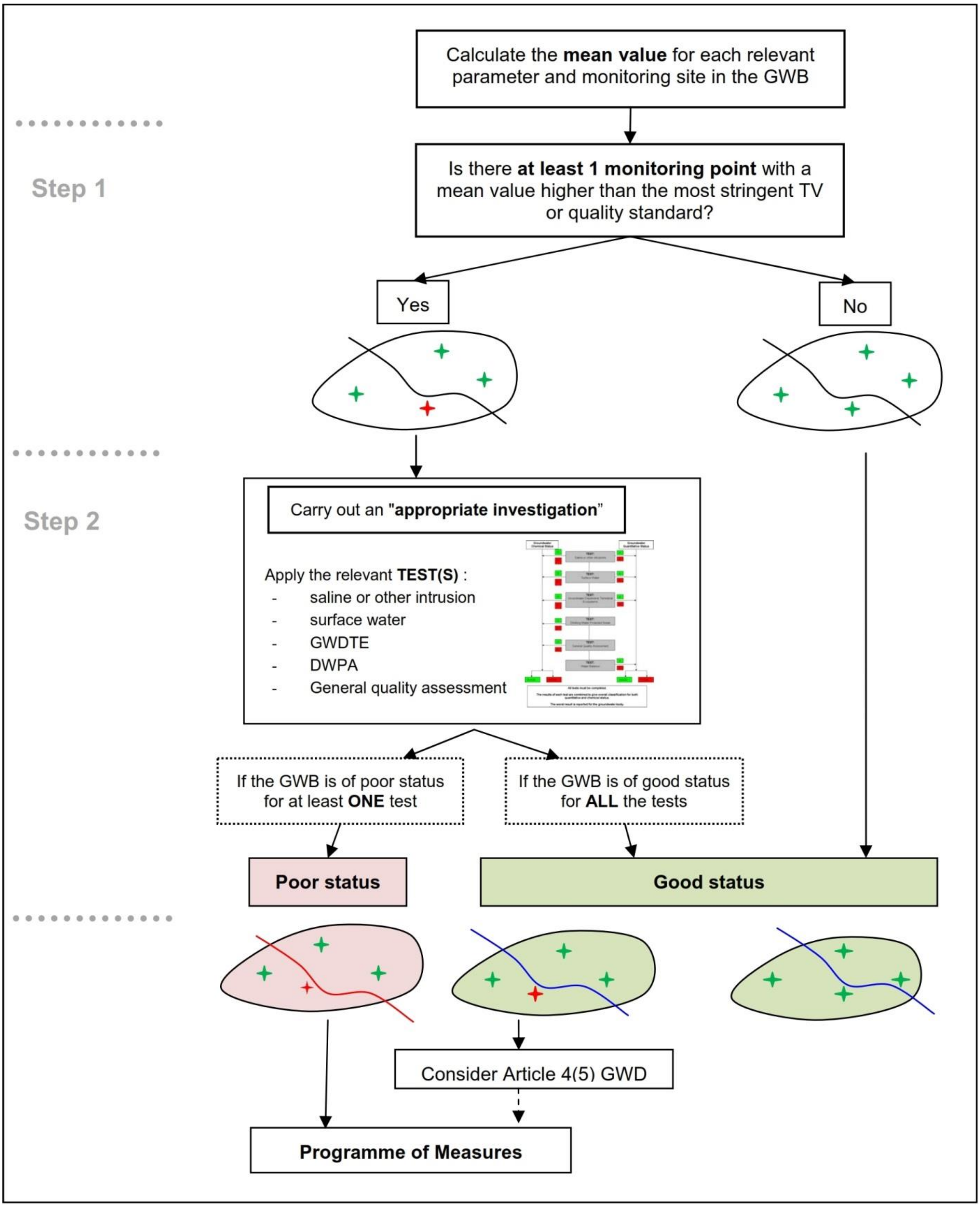
Indicators		Source of limit definition
		2008/105/EC
	Nitrogen pesticides	Official Gazette of the Republic of Macedonia No.46/08
	Phosphorous pesticides	Official Gazette of the Republic of Macedonia No.46/08
	PCB	Official Gazette of the Republic of Macedonia No. 18/1999
	Organochlorine pesticides	Official Gazette of the Republic of Macedonia No.46/08
	Organochlorine components	Official Gazette of the Republic of Macedonia No. 18/1999

Table 83: Source or method for defining the reference conditions and limits of the indicators for groundwater bodies

Indicators		Unit	RC	Poor/Good
Quantitative	water level			
Chemical	Temperature	°C		
	Conductivity	µS/cm	500	500
	pH	-	6.5 – 8.5	6.5 – 8.5
	DO	mg/L	8.00	4.00
	Dissolved CO_2	mg/L	10	10.01
	Redox potential	mV	from -400 to +800	500.01
	$N\text{-}NO_3$	mg/L	10-15	15.01
	$N\text{-}NO_2$	mg/L	0.01-0.50	0.501
	$N\text{-}NH_4$	mg/L	1.00	1.01
	Ptot	µg/L	< 4.00	50.01
	PO_4	µg/L	< 300.00	300.01
	Ca	mg/L	80.00	200.01
	Mg	mg/L	50.00	50.01
	Na	mg/L	200.00	200.01
	K	mg/L	10.00	12.01
	Cl	mg/L	40.00	250.01
	SO_4	mg/L	250.00	250.01
	CO_3	mg/L	> 200.00	200.00
	Argentum	µg/L	2.00	2.01
	Aluminum	µg/L	1’500.00	1’500.01
	Arsenic	µg/L	5.00	10.01
	Barium	µg/L	1’000.00	1’000.01
	Cadmium	µg/L	0.10	5.01
	Cobalt	µg/L	50.00	100.01
	Chrome	µg/L	< 2	50.01
	Lead	µg/L	1.00	10.01
	Mercury	µg/L	0.10	0.20
	Nickel	µg/L	5.00	50.00
	Zink	µg/L	5.00	100.01
	Cooper	µg/L	10.00	10.01
	Manganese	µg/L	50.00	50.01
	Iron	µg/L	50.00	300.01
	Vanadium	µg/L	100.00	100.00
	PAH	µg/L	0.00	0.01
	Phthalate	µg/L	0.00	1.30
	Nitrogen pesticides	µg/L	0.00	0.50
	Phosphorous pesticides	µg/L	0.00	0.50
	PCB	µg/L	0.00	0.001
	Organochlorine pesticides	µg/L	0.00	0.01
	Organochlorine components	µg/L	0.00	0.10

Table 84: Reference conditions and limits of the groundwater body indicators for the definition of good and poor chemical status

In the following scheme the steps for setting the chemical status of the entire GWB are shown (source: WFD Guidance Document No. 18).


Step 1
Step 2
Calculate the mean value for each relevant parameter and monitoring site in the GWB
Is there at least 1 monitoring point with a mean value higher than the most stringent TV or quality standard?
Yes
No
Carry out an "appropriate investigation"
Apply the relevant TEST(S) :
- saline or other intrusion
- surface water
- GWDTE
- DWPA
- General quality assessment
If the GWB is of poor status for at least ONE test
If the GWB is of good status for ALL the tests
Poor status
Good status
Consider Article 4(5) GWD
Programme of Measures

Overview on the monitoring results

The monitoring of the groundwater bodies started in June 2014. There were two types of ground water monitoring programs: a detailed one namely the surveillance monitoring done by the specialized company GEING which comprised two campaigns in June and September 2014, and an operational monitoring program implemented by the PURS-Bregalnica team which comprised monthly measurement of a reduced set of parameters. The latter one also started in June 2014.

At least 3 monitoring points per ground water body or in total 18 monitoring points were subject to surveillance monitoring. These points are used for setting the chemical status. The additional 15 monitoring points are used for observing the qualitative and quantitative situation and development of the groundwater bodies. The operational monitoring includes the 18 monitoring points of the surveillance monitoring and the additional 15 monitoring points. However, two monitoring points (AMP_13 and DMP_17) became out of order in 2014.

Surveillance monitoring

According to WFD Guidance No.18 on Groundwater Status and Trend Assessment, the chemical status is determinated first for the GWB as a whole. If there is at least one monitoring point in the GWB not meeting the required quality standard, an appropriate investigation has to be performed with respect to

- saline or other intrusion,
- diminution of ecological or chemical quality of associated surface water body,
- damage of terrestrial ecosystems directly dependent on groundwater, and
- deterioration in quality of waters for human consumption.

If the GWB is of good status for all tests, the GWB is considered of good chemical status. At the table below the results of the general assessment are shown:

GWB	Nu	ID	Does the mean value at any monitoring point in the GWB exceed a GW-QS or TV?	If necessary, split the group of GWBs, improve delineation for component bodies concerned and treat as GWB.	What is the (weighted) extent of exceedance of a GW-QS or TV in a GWB?	Further assessments verify GWB is of good status	Groundwater Body Status
Berovo-Pehcevo	1	DMP01	Yes	/	>20%	No	P
	3	DMP02					
	4	DMP03					
Delchevo	5	DMP04	Yes	/	>20%	Yes	G
	7	DMP05					
	9	DMP06					
Kochani-Shtip	11	DMP07	Yes	/	>20%	No	P
	14	DMP08					
	16	DMP09					
	17	DMP10					
	19	DMP11					
Ovche Pole	20	DMP12	Yes	/	>20%	No	P
	22	DMP13					
	24	DMP14					
	26	DMP15					
Lakavica	29	DMP16	Yes	/	>20%	No	P
	31	DMP17					
	33	DMP18					

Table 85: Results obtained from the tests of the general assessment of the chemical status of the GBW as a whole

The quantitative status is based on the results from the surveillance and the operational monitoring. All five GWBs reached good quantitative status. Similar to the tests done for the qualitative assessment the following tests are applied to assess the quantitative status:

- water balance
- surface water flow
- groundwater dependent terrestrial ecosystems
- saline or other intrusion

The respective results are presented in the table below:

GWB	Nu	ID	Water balance (GWB scale)	Surface Water Flow	Groundwater Dependent Terrestrial Ecosystems (GWDTE)	Saline (or other) Intrusion	Groundwater Body Status
Berovo-Pehcevo	1	DMP01	*	G	G	G	G
	3	DMP02	*	G	G	G	
	4	DMP03	*	G	G	G	
Delchevo	5	DMP04	*	G	G	G	G
	7	DMP05	*	G	G	G	
	9	DMP06	*	G	G	G	
Kochani-Shtip	11	DMP07	*	G	G	G	G
	14	DMP08	*	G	G	G	
	16	DMP09	*	G	G	G	
	17	DMP10	*	G	G	G	
	19	DMP11	*	G	G	G	
Ovche Pole	20	DMP12	*	G	G	G	G
	22	DMP13	*	G	G	G	
	24	DMP14	*	G	G	G	
	26	DMP15	*	G	G	G	
Lakavica	29	DMP16	*	G	G	G	G
	31	DMP17	*	G	G	G	
	33	DMP18	*	G	G	G	

Legend:
G Good status
* Status could not be set because of lack of data

Table 86: Overview of the groundwater monitoring result and of the quantitative status done according WFD Guidance Document No. 18 on Groundwater Status and Trend Assessment

In Table 87 the qualitative or chemical status is determined with respect to each indicator and monitoring point respectively, and it is indicated where an indicator exceeds the limit by more than 20%. As it can be seen from the table, the qualitative status is poor at the majority of the ground monitoring points in the Bregalnica region. The most common parameters that cause poor status are dissolved oxygen (DO), conductivity, N-NO_3 P_{tot}, Mg, sulphates (SO_4), nitrogen pesticides and manganese (Mn). Polycyclic aromatic hydrocarbons (PAH) are detected in all monitoring points. N-NH_4 was detected at the monitoring points in Lakavica groundwater body.

GWB		Berovo-Pehcevo			Delchevo			Kochani-Shtip					Ovche Pole				Lakavica		
ID		DMP01	DMP02	DMP03	DMP04	DMP05	DMP06	DMP07	DMP08	DMP09	DMP10	DMP11	DMP12	DMP13	DMP14	DMP15	DMP16	DMP17	DMP18
Qualitative	Status DO (mg/L)	G	P	P	G	G	G	P	P	P	G	G	P	P	G	P	P	G	P
	deviation bigger than 20%	OK	N	N	OK	OK	OK	OK	N	N	OK	OK	N	N	OK	N	OK	OK	N
	Status pH	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status REDOX (mV)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Conductivity (µS/cm)	P	G	P	P	P	P	G	P	G	G	P	P	P	P	P	P	P	P
	deviation bigger than 20%	OK	OK	N	OK	N	N	OK	N	OK	OK	OK	N	N	N	N	N	N	N
	Status T (°C)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Dissolved CO_2 (mg/L)	P	G	G	G	G	G	P	G	P	G	G	G	G	G	G	G	P	G
	deviation bigger than 20%	N	OK	OK	OK	OK	OK	N	OK	N	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status N-NO_3 (mg/L)	P	G	P	G	P	G	P	G	G	G	G	G	G	P	P	G	G	G
	deviation bigger than 20%	N	OK	N	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	N	N	OK	OK	OK
	Status N-NO_2 (mg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status N-NH_4 (mg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	P	P	P
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	N	N	N
	Status Ptot (µg/L)	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
	deviation bigger than 20%	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	Status PO_4 (µg/L)	P	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	N	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Ca (mg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	P	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Mg (mg/L)	G	G	G	G	G	G	G	G	G	G	G	P	P	G	P	P	G	P
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	N	N	OK	N	N	OK	N
	Status Na (mg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status K (mg/L)	P	G	G	G	P	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	N	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Cl (mg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status SO_4 (mg/L)	G	G	G	G	G	G	G	G	G	G	G	P	P	G	G	P	G	P
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	N	OK	OK	N	OK	N
	Status CO_3 (mg/L)	G	G	G	G	G	G	G	G	P	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	N	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Ag (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Al (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status As (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Ba (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Cd (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Co (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Cr (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Pb (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Hg (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Ni (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Zn (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Cu (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Mn (µg/L)	G	P	P	G	G	G	G	P	G	P	G	G	G	G	G	G	G	P
	deviation bigger than 20%	OK	N	N	OK	OK	OK	OK	N	OK	N	OK	OK	OK	OK	OK	OK	OK	N
	Status Fe (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status V (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status PAH (µg/L)	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
	deviation bigger than 20%	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	Status Phthalates (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Nitrogen pesticides (µg/L)	G	P	G	G	P	G	P	G	P	G	P	P	G	G	P	P	P	G
	deviation bigger than 20%	OK	N	OK	OK	N	OK	N	OK	N	OK	N	N	OK	OK	N	N	N	OK
	Status Phosphorous pesticides (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status PCB (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Organochlorine pesticides (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Status Organochlorine components (µg/L)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
	deviation bigger than 20%	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK

Table 87: Overview of the qualitative status at each monitoring point and indication where exceedance from limits is more than 20%

In Table 88 the qualitative status is set for the groundwater bodies based on the appropriate investigations or tests proposed by the WFD, GD No. 18 for those monitoring points and indicators exceeding the limit more than 20%. For more details on the tests see Annex 1, Table 6.

GWB	Nu	ID	Municipality	Saline or other intrusions	Significant diminution of associated surface water chemistry and ecology due to transfer of pollutants from the groundwater body	Significant damage to groundwater dependent terrestrial ecosystems (GWDTE) due to transfer of pollutants from the groundwater body	Meet the requirements of WFD Article 7(3) - Drinking Water Protected Areas	Groundwater Body Status
Berovo-Pehcevo	1	DMP01	Berovo	P	G	*According Guidenc No.18: The test should be performed for all groundwater bodies which are connected to GWDTE that are significantly damaged (or at risk of damage) considering the conceptual model of each groundwater body during each stage of the assessment.* In our situation we are not familiar with existence any GWBTE.	G	P
	3	DMP02	Berovo-PSOV	P	G		G	
	4	DMP03	Berovo (Machevo)	P	G		G	
Delchevo	5	DMP04	Delchevo (Trabotiviste)	G	G		G	G
	7	DMP05	Delchevo (Plastenik)	G	G		G	
	9	DMP06	Delchevo (Mlekara Golak)	G	G		G	
Kochani-Shtip	11	DMP07	Vinica	P	G		G	P
	14	DMP08	Kochani (G.Podlog-Danivo)	P	G		G	
	16	DMP09	Probishtip (v.Tripatanci)	P	G		G	
	17	DMP10	Shtip	P	G		G	
	19	DMP11	Karbinci	P	G		G	
Ovche Pole	20	DMP12	Sv.Nikole(Agrofer)	P	G		G	P
	22	DMP13	Sv.Nikole(BIM)	P	G		G	
	24	DMP14	Lozovo(Prodavnica)	P	G		G	
	26	DMP15	Sv.Nikole(Mustafino_02)	P	G		G	
Lakavica	29	DMP16	Shtip(20km)	P	G		G	P
	31	DMP17	Shtip(v.Lakavica)	P	G		G	
	33	DMP18	Shtip(KPU-Shtip)	P	G		G	

Table 88: Overview on the qualitative status of the groundwater bodies which are set based on the tests proposed by the WFD, GD No. 18

Operational monitoring

The operational monitoring of the groundwater bodies started in June 2014 and was conducted for almost two years resulting in a good overview of the behaviour of the measured indicators over time. The figures below show the results of the indicators water level, dissolved oxygen and conductivity for three selected groundwater bodies over time.

Some findings are:

- GWB Berovo-Pehcevo: The values for water level and conductivity are rather stable, but dissolved oxygen fluctuates more and decreases generally in flow direction, possibly due to microbiological degradation of infiltrating wastewater or fertilizers.
- GWB Ovce Pole: The seasonal pattern of the water level results for most monitoring points can be pointed out. The highly fluctuating results for DMP_13 might be strongly influenced by the operational schedule a bitumen factory which uses groundwater for cooling processes.
- GWB Lakavica: The upper part of the groundwater body is more responsive to the seasonality of meterological events than the lower part. There is a trend of decreasing oxygen levels in flow direction, possibly due to microbiological degradation of infiltrating wastewater or fertilizers.

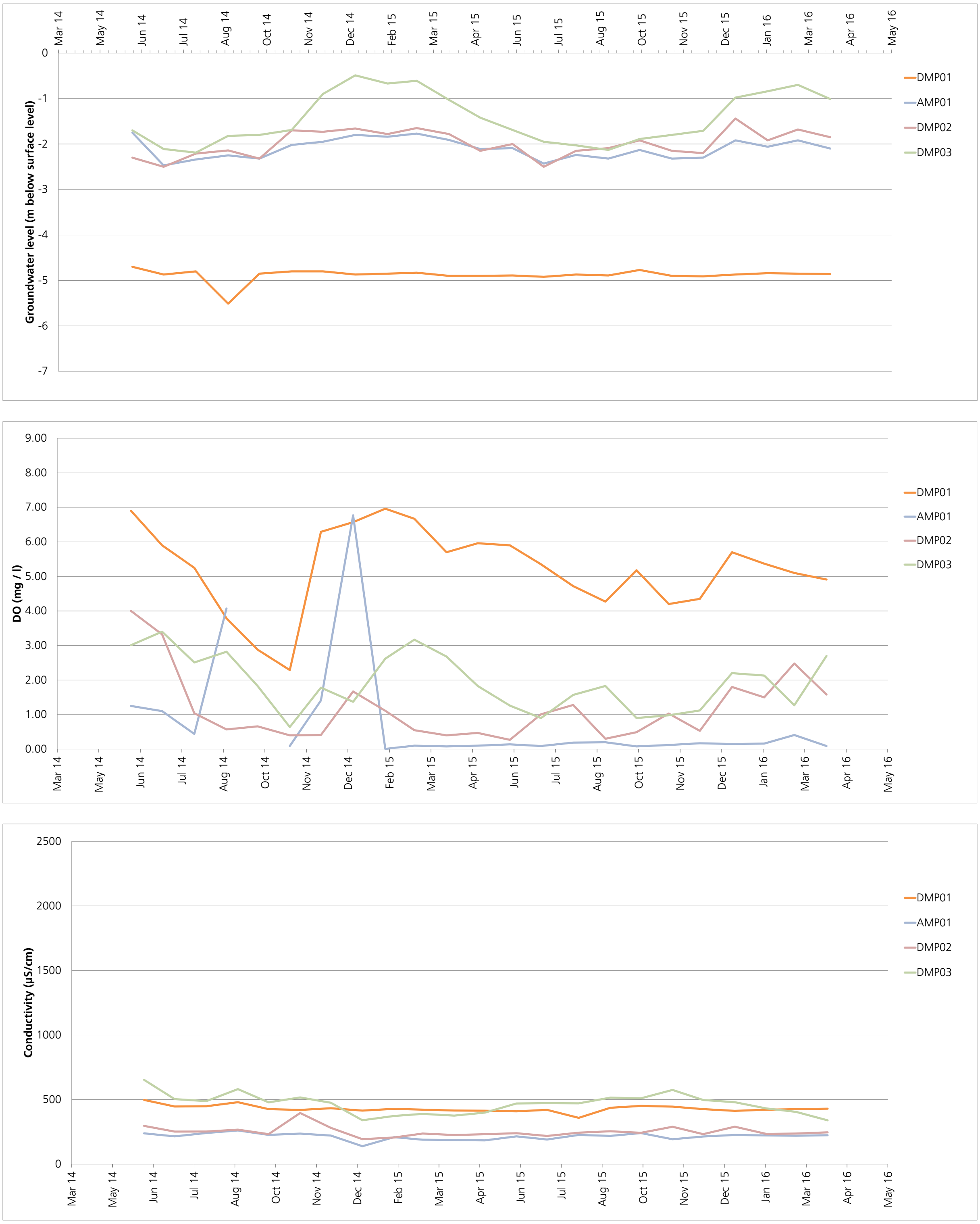
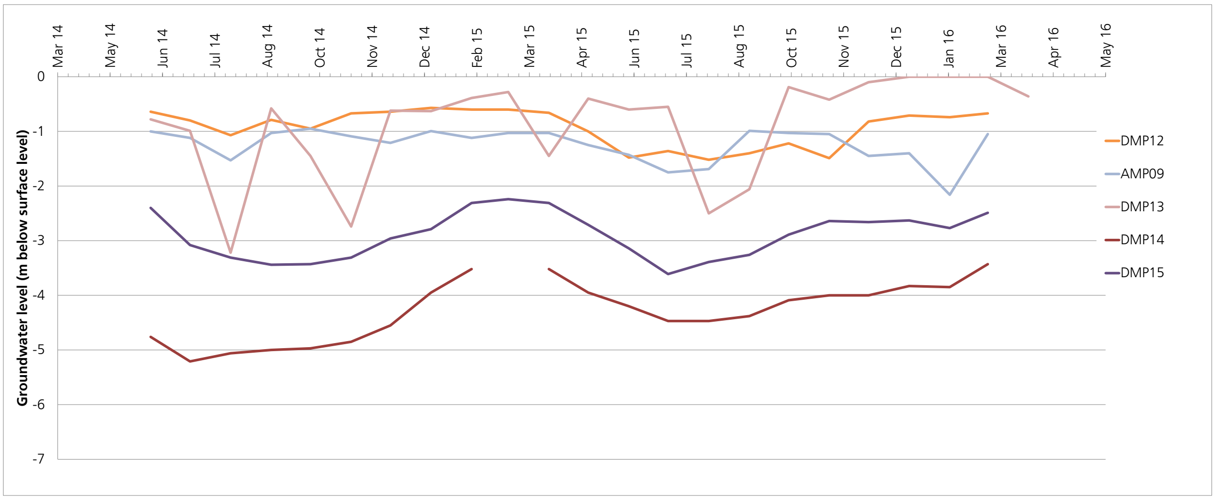
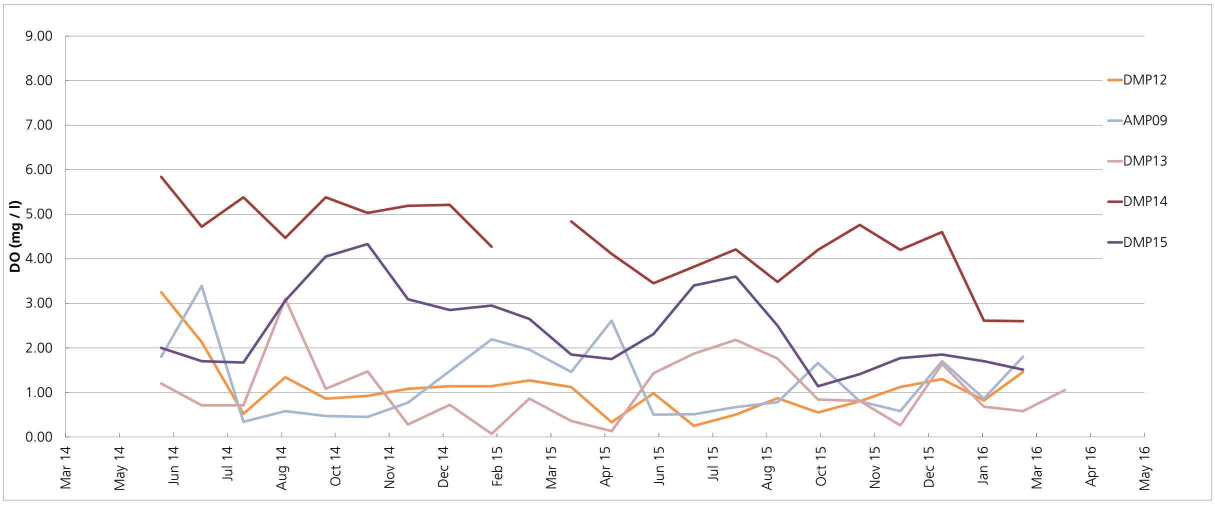


Figure 93: Overview of the operational monitoring results (water level, dissolved oxygen, conductivity) for selected monitoring points for the GWB Berovo-Pehcevo from June 2014 until April 2016





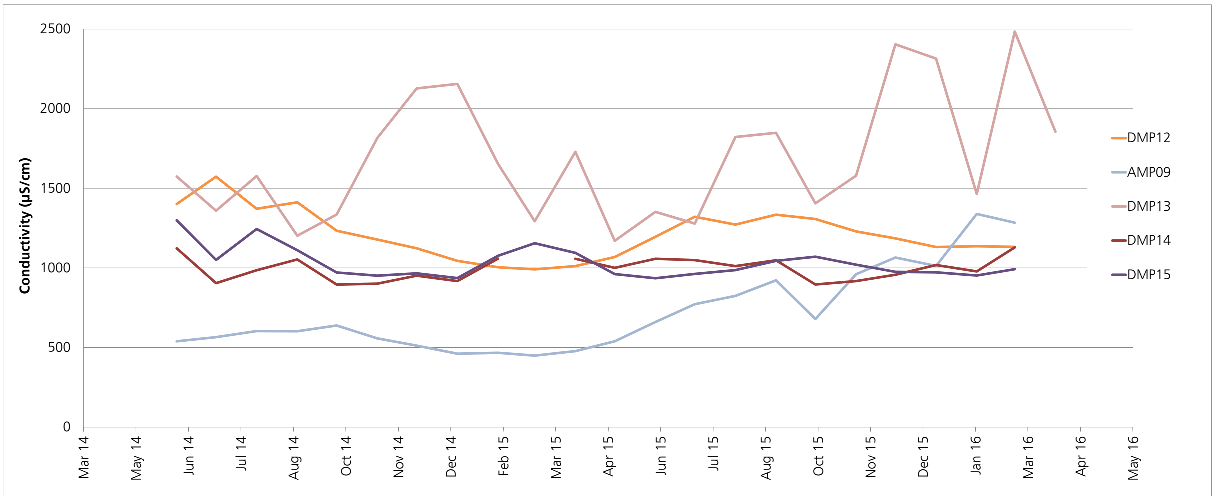


Figure 94: Overview of the operational monitoring results (water level, dissolved oxygen, conductivity) for selected monitoring points of GWB Ovce Pole from June 2014 until April 2016

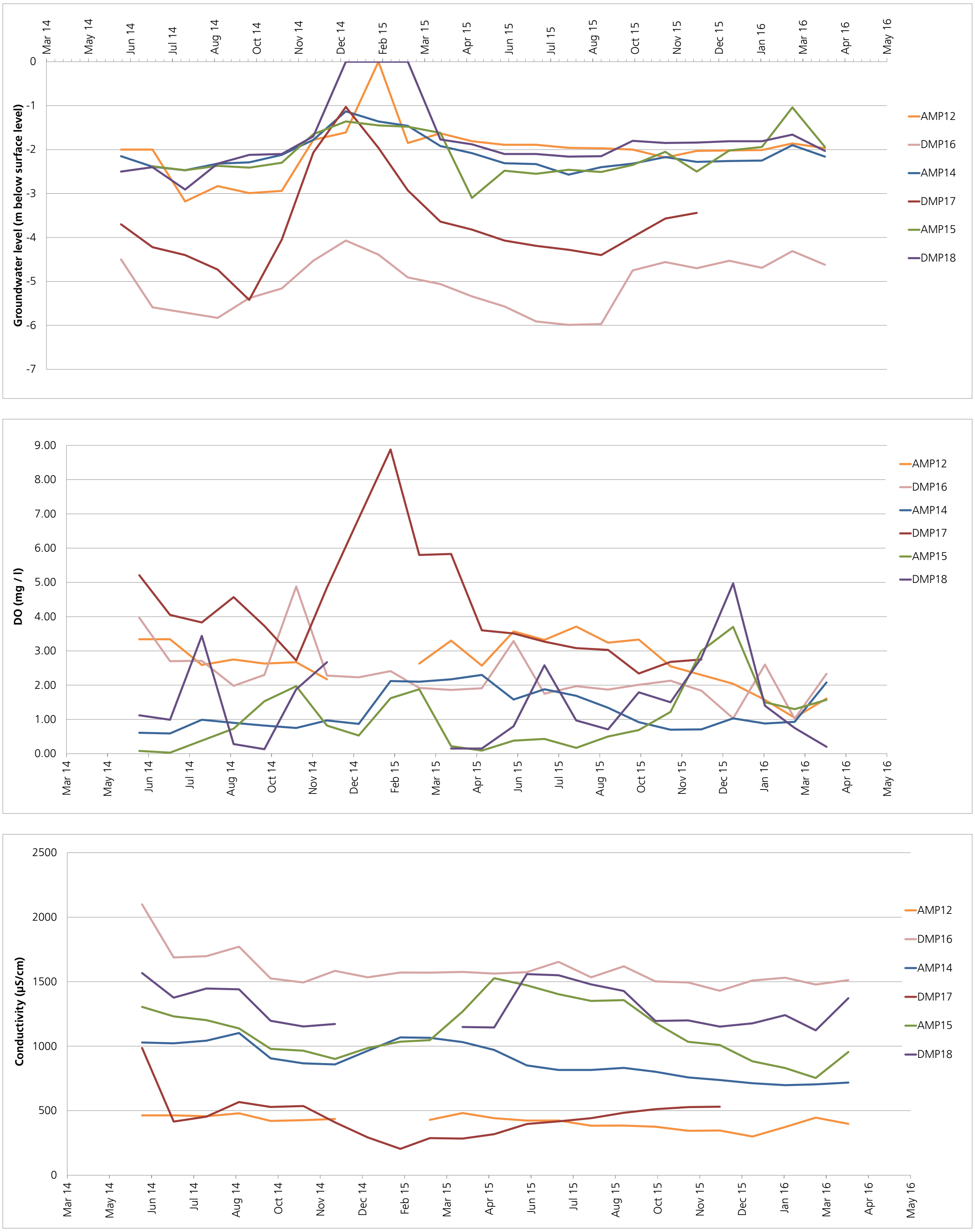


Figure 95: Overview of the operational monitoring results (water level, dissolved oxygen, conductivity) for selected monitoring points for the GWB Lakavica from June 2014 until April 2016

Investigative monitoring

The next tables summarize the monitoring results of the two investigative campaigns, which took place in February 2016 and April 2016. The tables present the measured values for ammonium and PAH and the interpretation by using the predefined limits. The measured values for ammonium, PAH and pesticides are also available in separate reports from the laboratories, which implemented the monitoring.

Due to analytical constraints regarding the detection of substances below the threshold limits for groundwater, the interpretation of the PAH results from the first campaign is limited. Four monitoring points (AMP-05, AMP-06, AMP-15, DMP-07) have certainly elevated results for PAH. No statement can be made for the other monitoring points for sure.

In the second campaign, the detection limits of all single PAH substances were below the required concentration. Except for DMP_03, groundwater samples from all other monitoring points have met the requirements for a good status with regard to PAH.

With regard to ammonium, only DMP_02 exceeds the limits for the definition of good and poor chemical status. This monitoring point is situated close to the WWTP and a pig farm which both might be a source for the elevated concentration.

The analysis of pesticides revealed no presence in the groundwater bodies of Bregalnica catchment.

The two investigative monitoring campaigns point out that rather highly sensitive analytical devices and sophisticated methods have to be used by the laboratories to meet the detection requirements for PAH to compare the results with the limits. The presented results indicate that PAH might occure in elevated concentrations only in certain areas and not in most parts of the catchment.

Sample ID	I			Campaign I Polycyclic aromatic hydrocarbons																	
	NH_4^+	Limit G/P	Status	naphthalene	acenaphthylene	acenaphthene	flourene	phenanthrene	anthracene	fluoranthene	pyrene	benzo(a) anthracene	crysene	benzo(b)fluorant hene	benzo(k)fluorant hene	benzo(a)pyrene	dibenzo(a,h) anthracene	benzo(g,h,i) perylene	indeno(1,2,3-cd) pyrene	Limit G/P	Status
AMP-04	0.15	1.01	G	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	n-a
AMP-05	0.15	1.01	G	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	n-a
AMP-06	<DL	1.01	G	<DL	<DL	<DL	<DL	<DL	<DL	0.037	0.035	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	P
AMP-07	<DL	1.01	G	<DL	<DL	<DL	<DL	<DL	0.031	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	P
AMP-15	<DL	1.01	G	<DL	<DL	<DL	<DL	<DL	0.025	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	P
DMP-02	1.07	1.01	P	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	n-a
DMP-03	<DL	1.01	G	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	n-a
DMP-04	0.07	1.01	G	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	n-a
DMP-05	0.30	1.01	G	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	n-a
DMP-06	0.01	1.01	G	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	n-a
DMP-07	<DL	1.01	G	<DL	<DL	<DL	<DL	<DL	0.14	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	P
DMP-09	<DL	1.01	G	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	n-a
DMP-11	<DL	1.01	G	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	n-a
DMP-13	0.20	1.01	G	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	n-a
DMP-16	0.13	1.01	G	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	n-a
Detection Limit	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.004	<0.004	<0.032	<0.032	<0.064	<0.064	<0.125	<0.500	<0.500	<0.500	-	-

Legend:

<DL	Concentration is below the Detection Limit
G	Good
P	Poor
I	February 2016
II	April 2016
n-a	Not applicable, as detection limits exceed Limit G/P

Table 89: Overview of the groundwater investigative monitoring result for ammonium and PAH from campaign I; and the resulting status according to the limits of the groundwater body indicators for the definition of good and poor chemical status

Sample ID	Campaign II Polycyclic aromatic hydrocarbons																		
	naphthalene	acenaphthylene	acenaphthene	flourene	phenanthrene	anthracene	fluoranthene	pyrene	benzo(a) anthracene	crysene	benzo(b)fluorant hene	benzo(k)fluorant hene	benzo(a)pyrene	dibenzo(a,h) anthracene	benzo(g,h,i) perylene	indeno(1,2,3-cd) pyrene	Sum	Limit G/P	Status
AMP-04	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	G
AMP-05	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	G
AMP-06	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	G
AMP-07	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	G
AMP-14	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	G
AMP-15	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	G
DMP-02	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	G
DMP-03	<DL	<DL	<DL	<DL	*0.006*	<DL	*0.0034*	*0.0024*	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	*0.0118*	0.01	P
DMP-04	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	G
DMP-05	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	G
DMP-06	<DL	<DL	<DL	*0.0034*	*0.0014*	*0.0009*	<DL	*0.0014*	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	*0.0071*	0.01	G
DMP-07	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	G
DMP-09	<DL	<DL	<DL	*0.0012*	*0.002*	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	G
DMP-11	<DL	<DL	<DL	*0.0016*	*0.0026*	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	*0.0042*	0.01	G
DMP-13	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	G
DMP-16	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	0.01	G

Legend:

<DL	Concentration is below the Detection Limit (For PAH: 0.0002 µg/L)
G	Good
P	Poor
I	February 2016
II	April 2016

Table 90: Overview of the groundwater investigative monitoring result for PAH from campaign II; and the resulting status according to the limits of the groundwater body indicators for the definition of good and poor chemical status

A11 Monitoring of Protected Areas

At the moment there are no legally proclaimed nature protection areas in the Bregalnica catchment.

A12 Status – Surface Water Bodies

Classification Method

The purpose of this Annex is to describe the method used on the assessment of the ecological status and potential, leading to the overall ecological classification of water bodies for the purposes of the Water Framework Directive (WFD).

For that reason, the classification of status/potential contained in this document is based on the guidelines outlined in *WFD CIS Guidance Document No. 13 Overall Approach to the Classification of Ecological Status and Ecological Potential*, which in turn summarizes the overall ecological classification rules provided by WFD CIS Guidance Document Nos. 10 (reference conditions), 5 (coastal waters), 4 (heavily modified water bodies) and 7 (monitoring).

Ecological status/potential

The WFD requires surface water classification through the assessment of ecological status or ecological potential, and surface water chemical status. On the one hand, for surface waters, the main objective of the WFD is for Member States to achieve "good ecological status" and "good surface water chemical status". On the other hand, for those water bodies designated as artificial water bodies (AWB) and heavily modified water bodies (HMWB) according with Article 4, instead of "good ecological status", the principal environmental objective is "good ecological potential" and "good surface water chemical status".

'Ecological status' is an expression of the quality of the structure and functioning of aquatic ecosystems associated with surface waters, classified in accordance with Annex V. Article 2(21).

'Good ecological potential' is the status of a heavily modified or an artificial body of water, classified in accordance with the relevant provisions of Annex V. Article 2(23).

A general definition of ecological status in each of five status classes (high, good, moderate, poor and bad) is given in Table 1.2 WFD Annex V and, for HMWBs and AWBs, definitions for maximum, good and moderate ecological potential are provided in Table 1.2.5.

To sum up, the ecological status and the ecological potential are classified into 5 and 4 categories, respectively, as stated in the following table:

Rivers and Lakes Ecological status	Color code	HMWB, AWB Ecological potential	Color code
High			
Good		Good and above	
Moderate		Moderate	
Poor		Poor	
Bad		Bad	

Table 91: Classification of Ecological Status and Ecological Potential

The **quality elements** that must be used for the assessment of the ecological status/potential are those defined in the WFD Annex V, Table 1.1, which have been taken into account for the design of the monitoring network (see Annex 8). Basically, they fall into 3 groups of elements: biological elements and, supporting the biological elements, hydro-morphological and chemical and physico-chemical elements.

As part of the monitoring exercise, for each of the water body categories, the **limits** for the classification of water bodies into the different ecological status/potential categories have been established on the basis of both the existing national legislation (Regulation for Classification of the Water, Official Gazette of the Republic of Macedonia No.18-99) and the expert criteria (see Annex 8).

As a first step, the status/potential category assigned to each of the above-mentioned three groups is determined by the worst value of the parameters included in each group.

Afterwards, as the WFD Guidance Documents recommend, the assignment of water bodies to the good, moderate, poor or bad ecological status/potential classes has been made on the basis of the monitoring results following the relationships described in Figure 96.

As a first step, the values of each of the biological quality elements are taken into account, then the physico-chemical elements and finally the hydro-morphological elements. Therefore, the assignment of water bodies to the good, moderate, poor or bad ecological status/ecological potential classes are made on the basis of the monitoring results for the biological elements; then the values of the physico-chemical quality elements must be taken into account when assigning water bodies to the high and good ecological status classes and to the maximum and good ecological potential classes; and finally, the values of the hydro-morphological quality elements are taken into account when assigning water bodies to the high ecological status class and the maximum ecological potential class (i.e. when downgrading from high ecological status or maximum ecological potential to good ecological status/potential). For the other status/potential classes, the hydro-morphological elements are required to have "conditions consistent with the achievement of the values specified for the biological quality elements" (Tables 1.2.1 - 1.2.5 WFD Annex V).

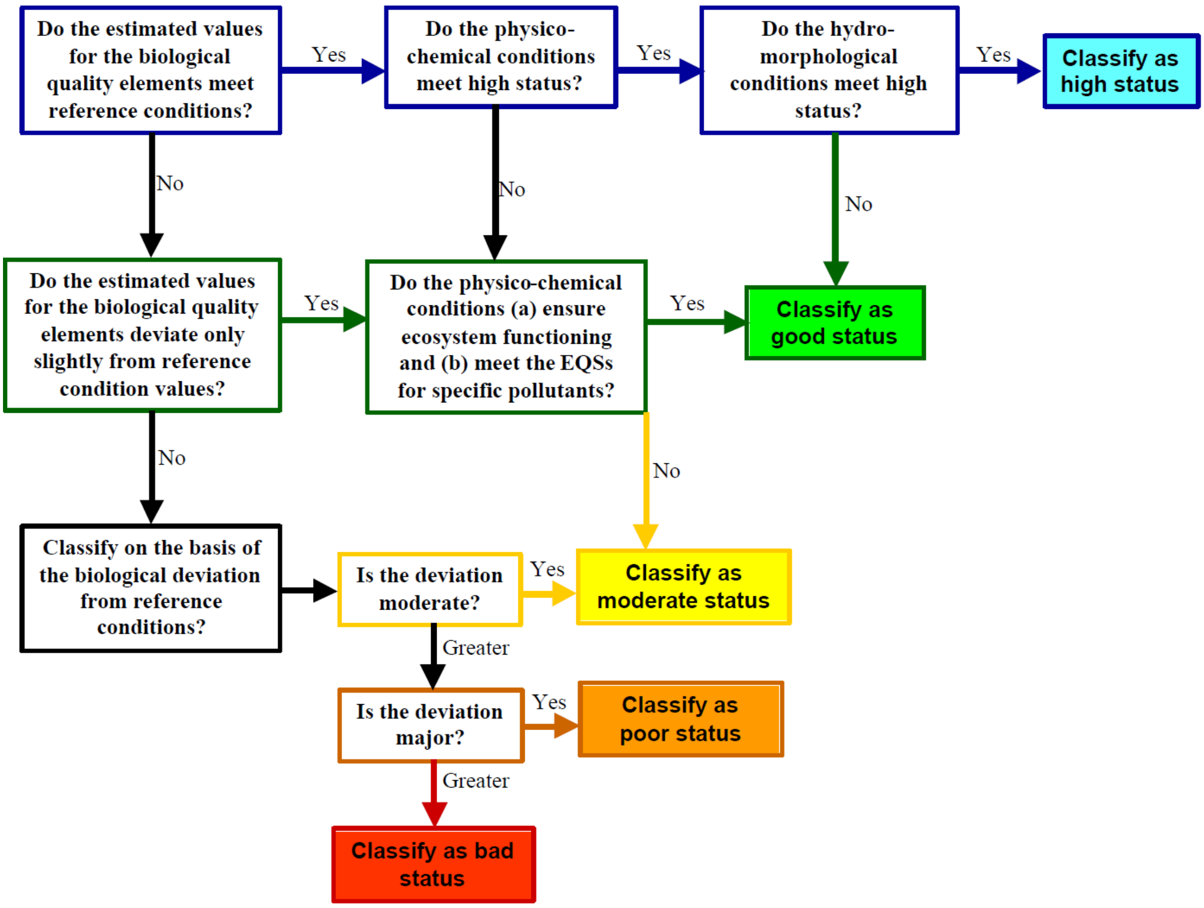


Figure 96: Illustration of the relative roles of biological, hydro-morphological and physico-chemical quality elements in ecological status classification (Guidance Document no. 13)

As regards to ecological potential for HMWB and AWB, given the hydro-morphological characteristics and associated physico-chemical conditions that cannot be changed without significant adverse effects on the specified use or the wider environment, the biological conditions have been associated with the closest comparable natural water body type.

Chemical status

'Good surface water chemical status' means the chemical status required to meet the environmental objectives for surface waters established in Article 4(1)(a), that is the chemical status achieved by a body of surface water in which concentrations of pollutants do not exceed the environmental quality standards established in Annex IX and under Article 16(7), and under other relevant Community legislation setting environmental quality standards at Community level, as defined in Article 2(24).

In other words, where a body of water achieves compliance with all the environmental quality standards established in Annex IX, Article 16 and under other relevant Community legislation setting environmental quality standards it shall be recorded as achieving good chemical status. If not, the body shall be recorded as failing to achieve good chemical status. Annex V 1.4.3.

To sum up, the chemical status is classified into 2 categories, as stated in the following table:

Chemical status (colour)	
Good	
Failing to achieve good	

Table 92: Classification of Chemical Status

As the Guidance Document No. 13 states, it has been agreed under the Common Implementation Strategy (CIS) that once environmental quality standards have been adopted at Community-level for the priority substances (WFD Art. 16, Annex X), the concentrations of these substances in water bodies should only be taken into account in the classification of surface water chemical status and not in the classification of ecological status/potential. This does not affect the overall classification of a water body because for good surface water status, both ecological and chemical status must be good.

Also, as the Macedonian legislation (Regulation for Classification of the Water, Official Gazette of the Republic of Macedonia No.18-99) incorporates the priority substances, these ones have been taken into account for the assessment of water chemical status. For each of those substances, a limit is established that cannot be exceeded in order to protect human health and the environment.

Water status

'Surface water status' is the general expression of the status of a body of surface water, determined by the poorer of its ecological status and its chemical status as defined in Article 2(17).

The status of a surface water body has been determined by the worst value of its ecological status/potential or its chemical status:

Water status (colour)	
Good	
Failing to achieve good	

Table 93: Classification of Water Status

Results

Ecological status/potential

Figure 97, Figure 98, Figure 99 and Table 94 show the results on ecological status/potential from all implemented monitoring campaigns, which allow an evaluation.

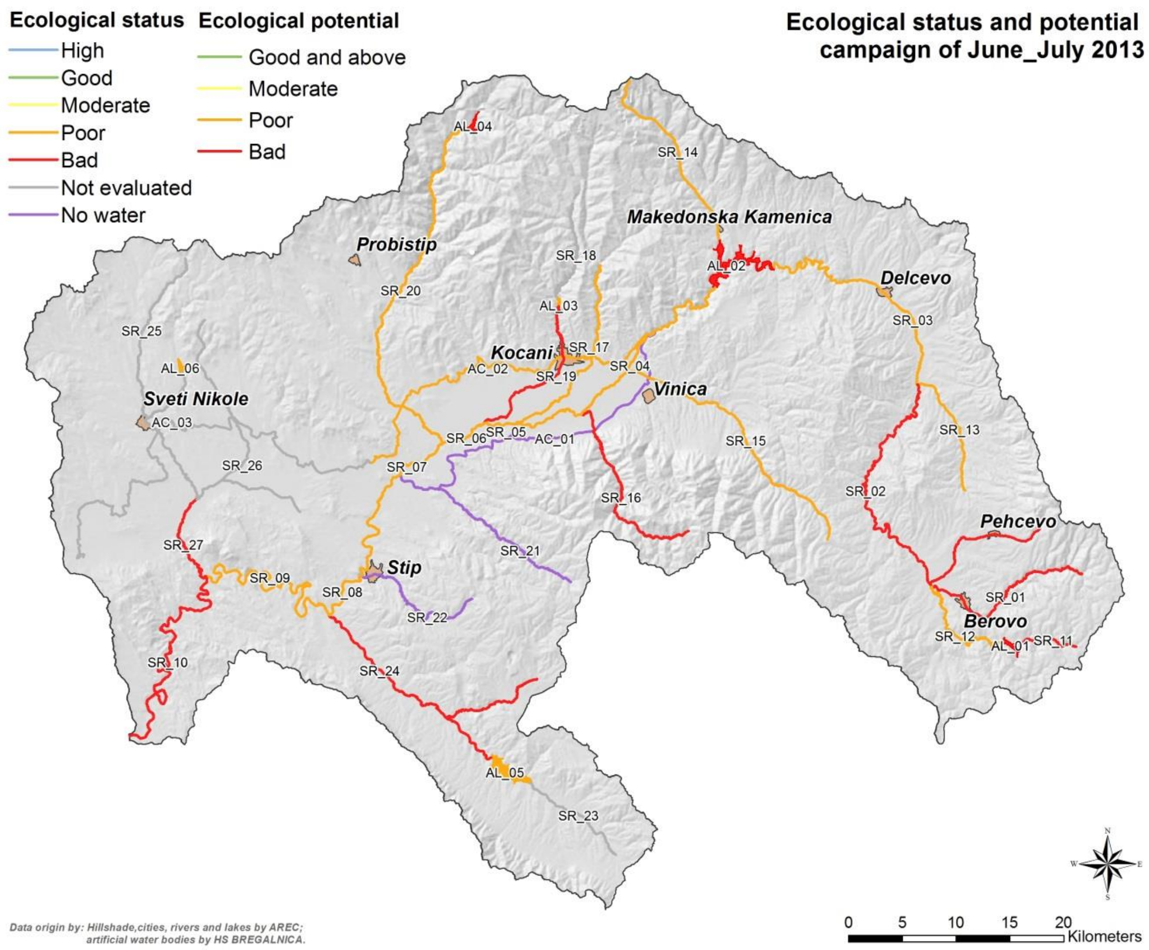


Figure 97: Bregalnica river basin with the ecological status of rivers and with the ecological potential of artificial and heavily modified water bodies. Results from the monitoring campaign of June/July 2013

In the entire Bregalnica river basin the ecological status/potential is not higher than poor. Even in the upper parts of the region a bad ecological status/potential is found: Bregalnica01 (SR_01) and Ratevska river01 (SR_11). A reason for this is the bad status with respect to IPS, fish and to high concentrations of PO_4. A high concentration of PO_4 and Ptot was detected in the entire region. These concentrations are related to human and agricultural activities. Several water bodies were not evaluated: Kocanska river (SR_18), Kriva Lakavica river (SR_23), Svetinikolska river (SR_25), Nemanjica river (SR_26) and a section of the right irrigation channel (AC_03).

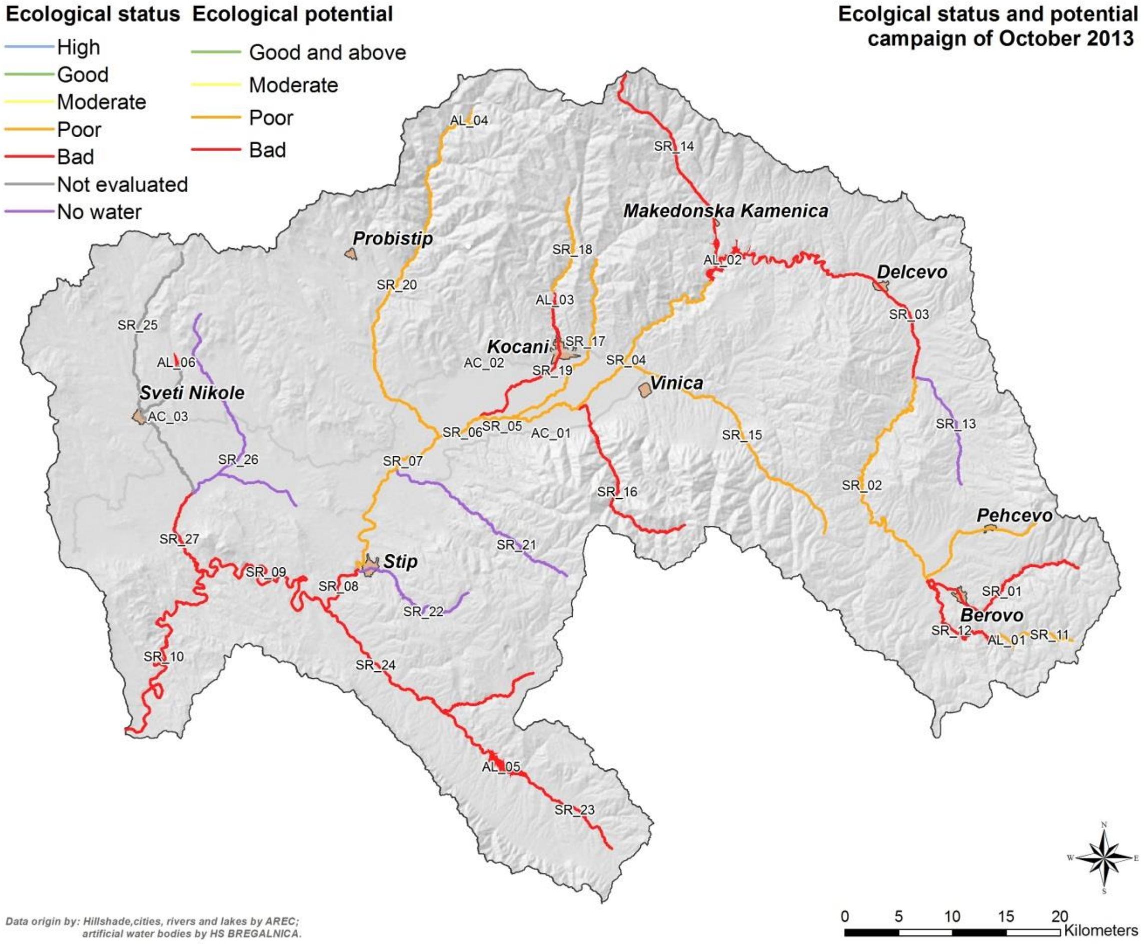


Figure 98: *Bregalnica river basin with the ecological status of rivers and with the ecological potential of artificial and heavily modified water bodies. Results from the monitoring campaign of October 2013*

The results from the third monitoring campaign show that the ecological status of all water bodies is below the moderate status. Domination of the bad and poor ecological status by rivers and ecological potential by heavily modified water bodies is related to the indicators IPS, IBMWP, Fish, Shannon-Wiener, Ptot and PO_4. In the river water bodies also the hydro-morphological parameters are not in a good condition. The artificial water bodies (AC_01,AC_02, AC_03) were not subject of monitoring in this campaigns. Zelevica river (SR_13), Kozjacka river (SR_21),Otinja river (SR_13) and Nemanjica (SR_26) were without water.

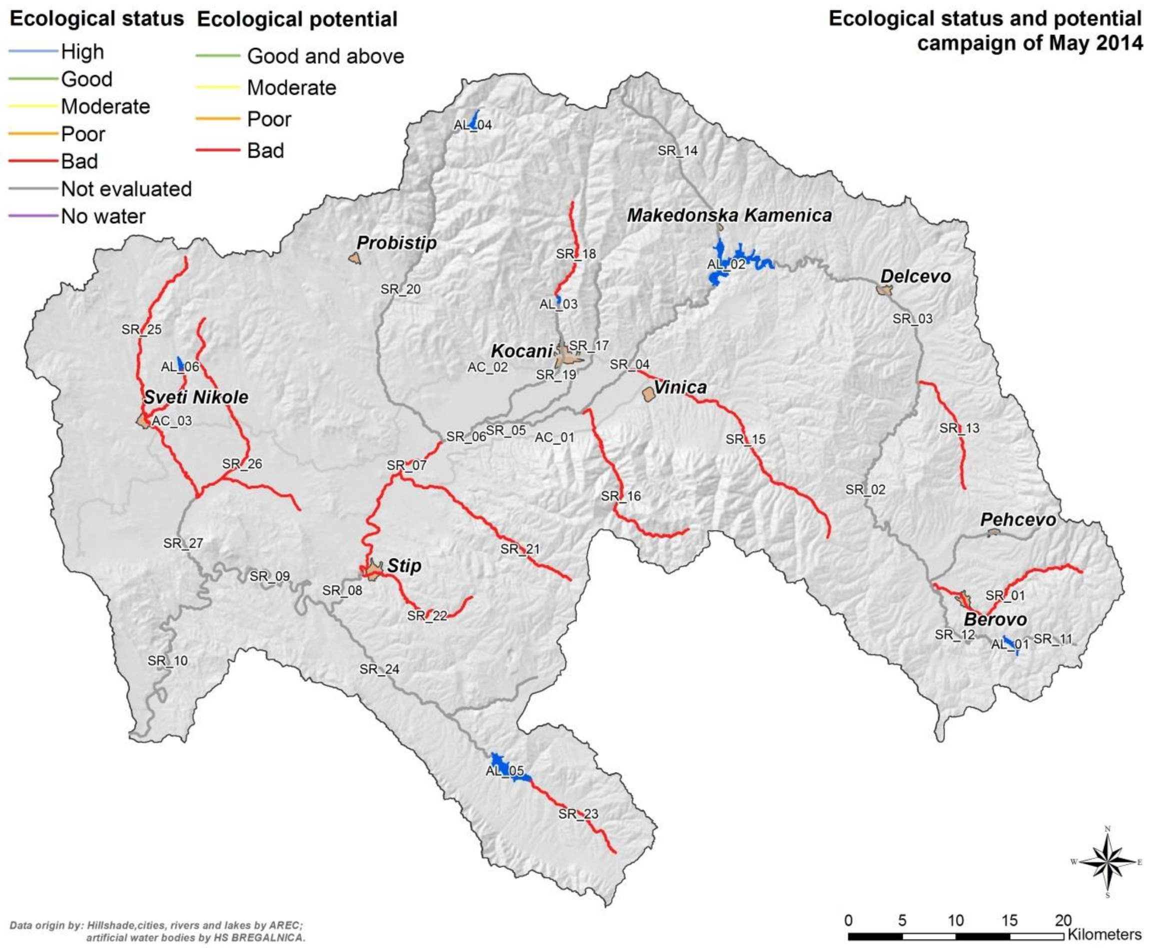


Figure 99: Bregalnica river basin with the ecological status of rivers. Results from the monitoring campaign of May 2014

The water bodies that were subject of monitoring in the May campaign show a bad ecological status. This is mainly because of the biological indicators (IPS, IMBWP and Fish) and several physical-chemical parameters (Ptot, PO_4 and SO_4).

Comparing the October 2013 with the June/July 2013 and May 2014 monitoring campaign, it can be seen that the situation in the region is worst in October and in May. A reason for this could be the low water level during the October 2013 monitoring campaign and inconsistent water level in the rivers in the May 2014 monitoring campaign.

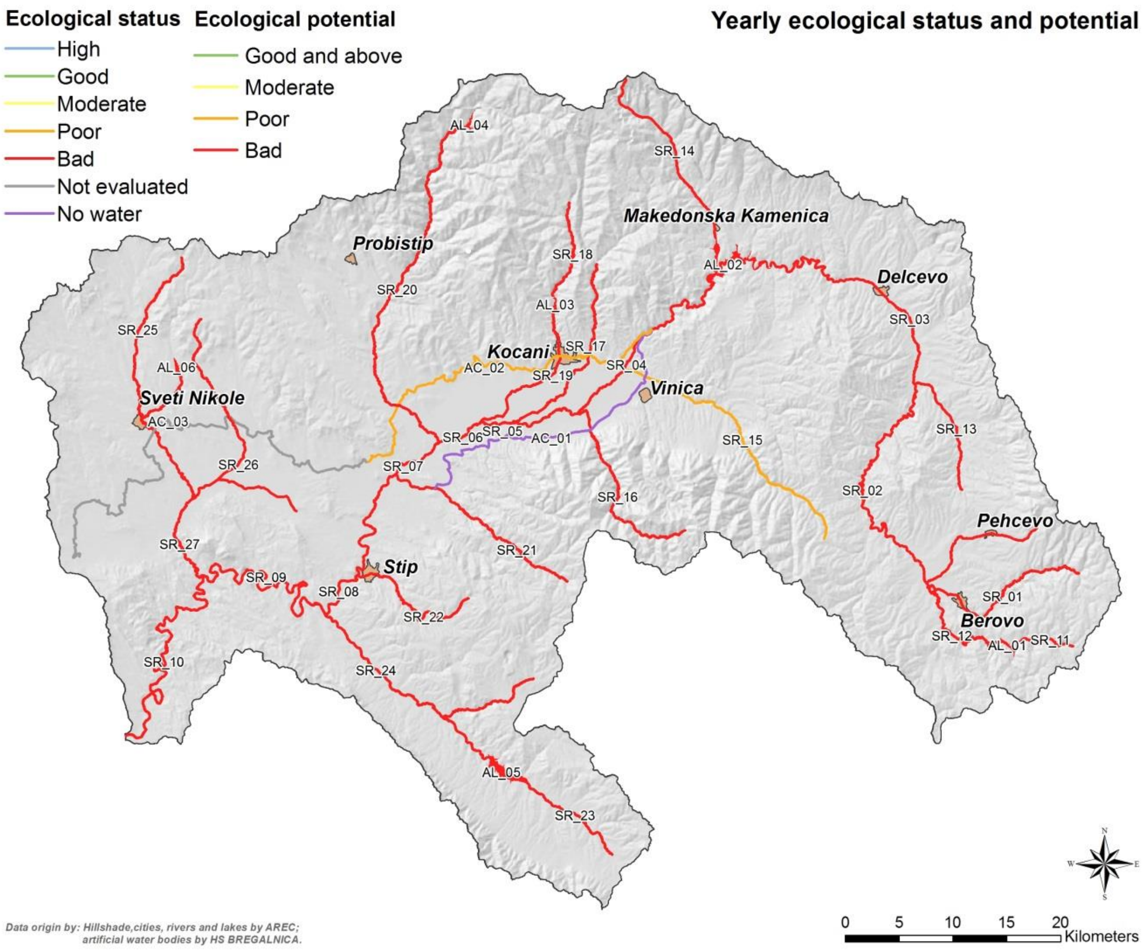


Figure 100: Bregalnica river basin with the ecological status of rivers and with the ecological potential of artificial and heavily modified water bodies. Aggregated result from all implemented monitoring campaigns (June 2013 – May 2014)

If the yearly values are shown as aggregated values, it can be seen that the bad and poor ecological status/potential is predominant. The statuses are mainly influenced by the presence (or non-presence) of the different types of macroinvertebrates and algae, which are indicators for the eutrophication of the rivers and the heavily modificated water bodies, as well as by the indicator fish and by high concentrations of PO_4, NO_2 and Ptot.

Cat.	Eco. St. Eco. Pot.	June/July 2013				October 2013				Mai 2014				Aggregate Value			
		#	%	km km^2	%	#	%	km km^2	%	#	%	km km^2	%	#	%	km km^2	%
Rivers	High	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Good	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Moderate	0	0	0	0	1	4	20	3	0	0	0	0	0	0	0	0
	Poor	12	44	227	37	9	33	197	33	0	0	0	0	4	15	68	11
	Bad	11	41	283	47	17	63	388	64	8	30	172	28	23	85	538	89
	Not ev.	4	15	96	16	0	0	0	0	19	70	434	72	0	0	0	0
	Total	27	100	606	100	27	100	606	100	27	100	606	100	27	100	606	100
Heavily Modified Water Bodies	Good and above	0	0	0	0	0	0	0	0	-	-	-	-	0	0	0	0
	Moderate	0	0	0	0	0	0	0	0	-	-	-	-	0	0	0	0
	Poor	3	50	3	39	2	33	1	11	-	-	-	-	0	0	0	0
	Bad	3	50	6	61	4	67	8	89	-	-	-	-	6	100	9	100
	Not ev.	0	0	0	0	0	0	0	0	-	-	-	-	0	0	0	0
	Total	6	100	9	100	6	100	9	100	-	-	-	-	6	100	9	100
Artificial Water Bodies	Good and above	0	0	0	0	0	0	0	0	-	-	-	-	0	0	0	0
	Moderate	0	0	0	0	0	0	0	0	-	-	-	-	0	0	0	0
	Poor	1	33	42	32	0	0	0	0	-	-	-	-	1	33	42	32
	Bad	1	33	33	25	3	100	132	100	-	-	-	-	1	33	33	25
	Not ev.	1	33	57	43	0	0	0	0	-	-	-	-	1	33	57	43
	Total	3	100	132	100	3	100	132	100	-	-	-	-	3	100	132	100

Table 94: Summary of ecological status of water bodies. Length is expressed in km for rivers and artificial water bodies and in km² for lakes. Note: the water bodies with "No water" are counted under the status "Bad". Cat. = Category, Eco. St. = Ecological Status, Eco. Pot. = Ecological Potential, # = Number, Not ev. = Not evaluated

Table 94 gives an overview on the statuses of the water bodies in the entire river basin for each campaign and the aggregated value of the three campaigns. The status is expressed as totoal number of water bodies (#), percentage (%) of total number of water bodies, length (km) for rivers and artificial water bodies or area (km²) for lakes. In every campaign bad ecological status/potential is dominated

Chemical status

Figure 101 to Figure 105 and Table 95 show the results of the chemical status for all monitoring campaigns.

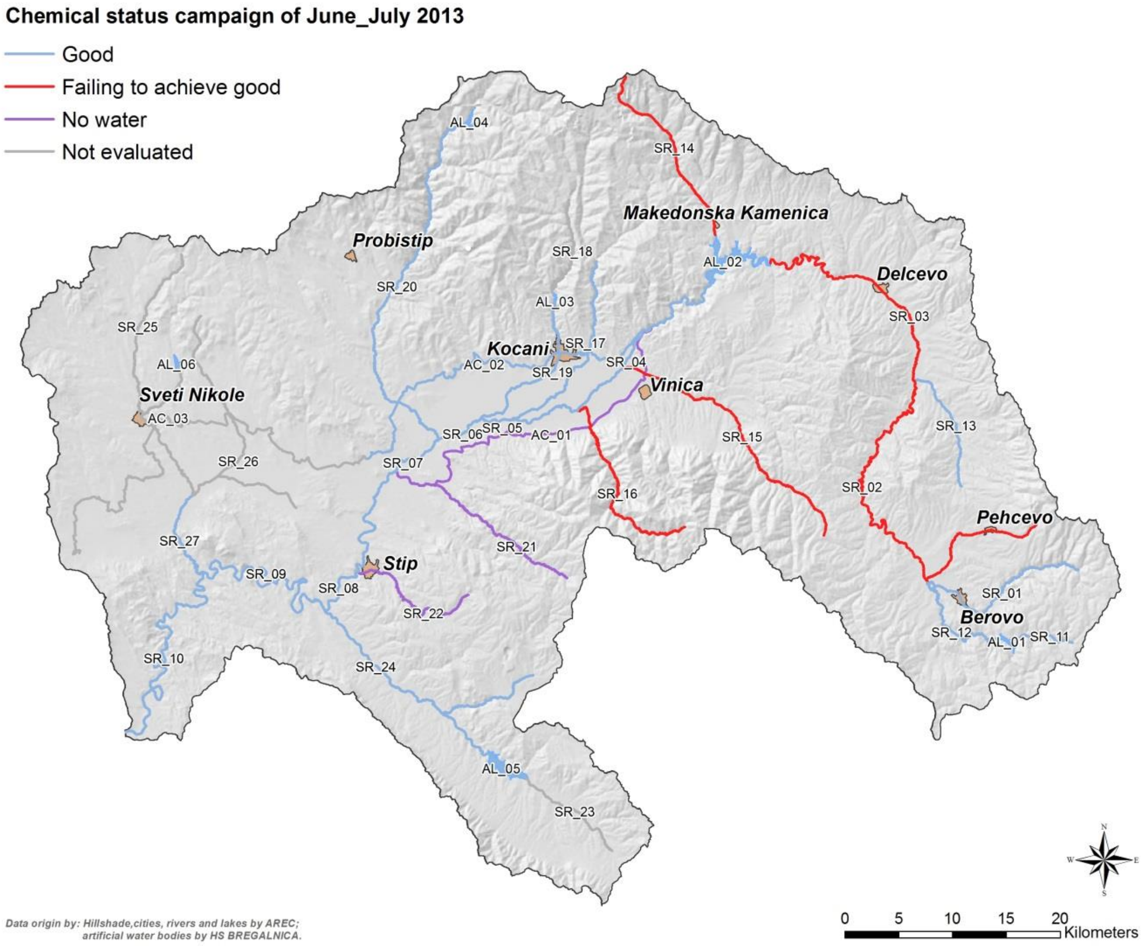


Figure 101: Bregalnica river basin with the chemical status of rivers and artificial and heavily modified water bodies. Results from the monitoring campaign of June/July 2013

Except for five water bodies with bad ecological status, i.e. two Bregalnica stretches (SR_02 and SR_03), Kamenicka river (SR_14), Osojnica river (SR_15) and Zrnovska river (SR_16), and for the Left irrigation channel (AC_01), Kozjacka river (SR_21) and Otinja river (SR_22), which were without water; the water bodies showed a good chemical status (including heavily modified water bodies). Four water bodies were not evaluated: Kriva Lakavica01 (SR_23), Svetinikolska river (SR_25), Nemanjica river (SR_26) and Right irrigation channel 2 (AC_03).

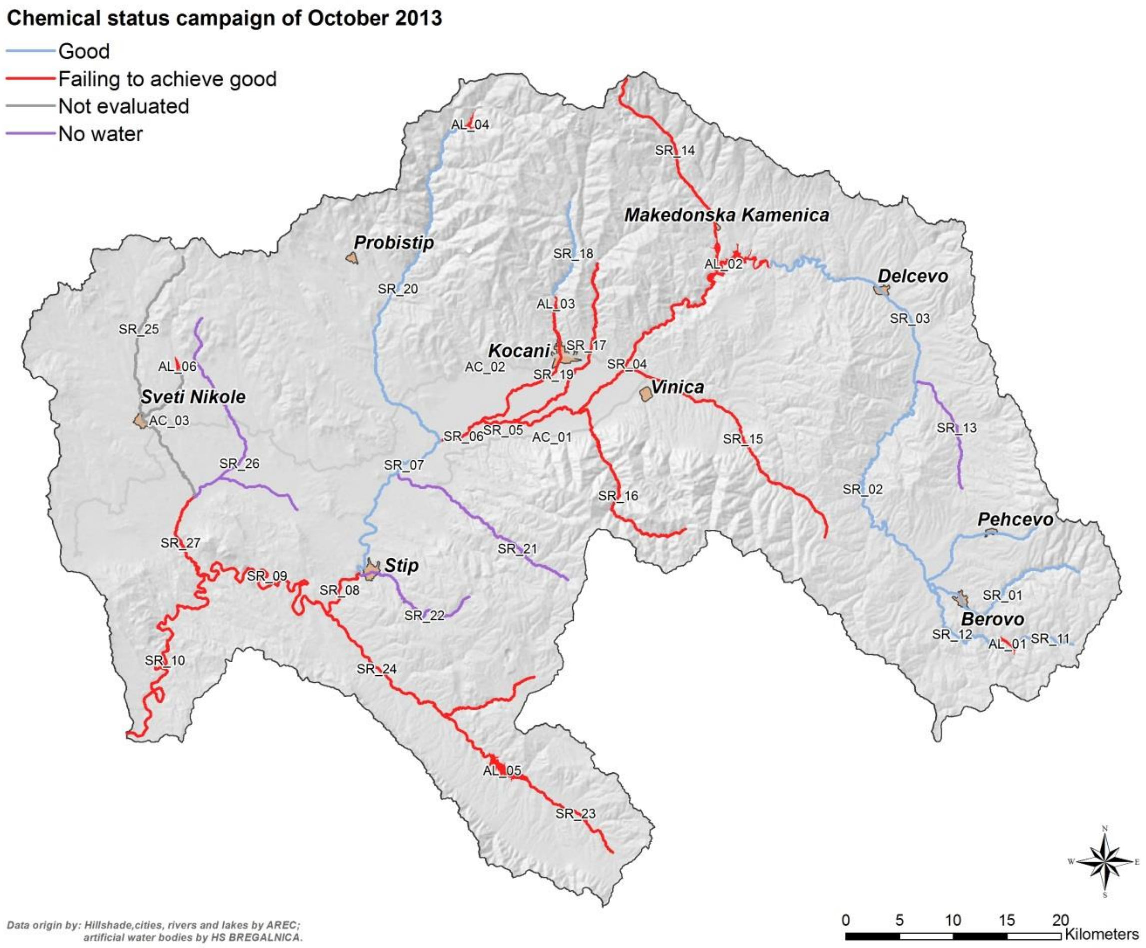


Figure 102: Bregalnica river basin with the chemical status of rivers and artificial and heavily modified water bodies. Results from the monitoring campaign of October 2013

All heavily modified water bodies and most of river water bodies have a chemical status of "failing to achieve good", which is mainly due to often increased concentrations of Phthalates as well as of Zn, Cu, Mn and Fe. One water body was not evaluated Svetinikolska river01 (SR_25)). Several water bodies were without water: all irrigation channels (AC_01, AC_01 and AC_03), Zelevica river (SR_13), Kozjacka river (SR_21), Otinja river (SR_22) and Nemanjica (SR_26). The other water bodies have a good chemical status.

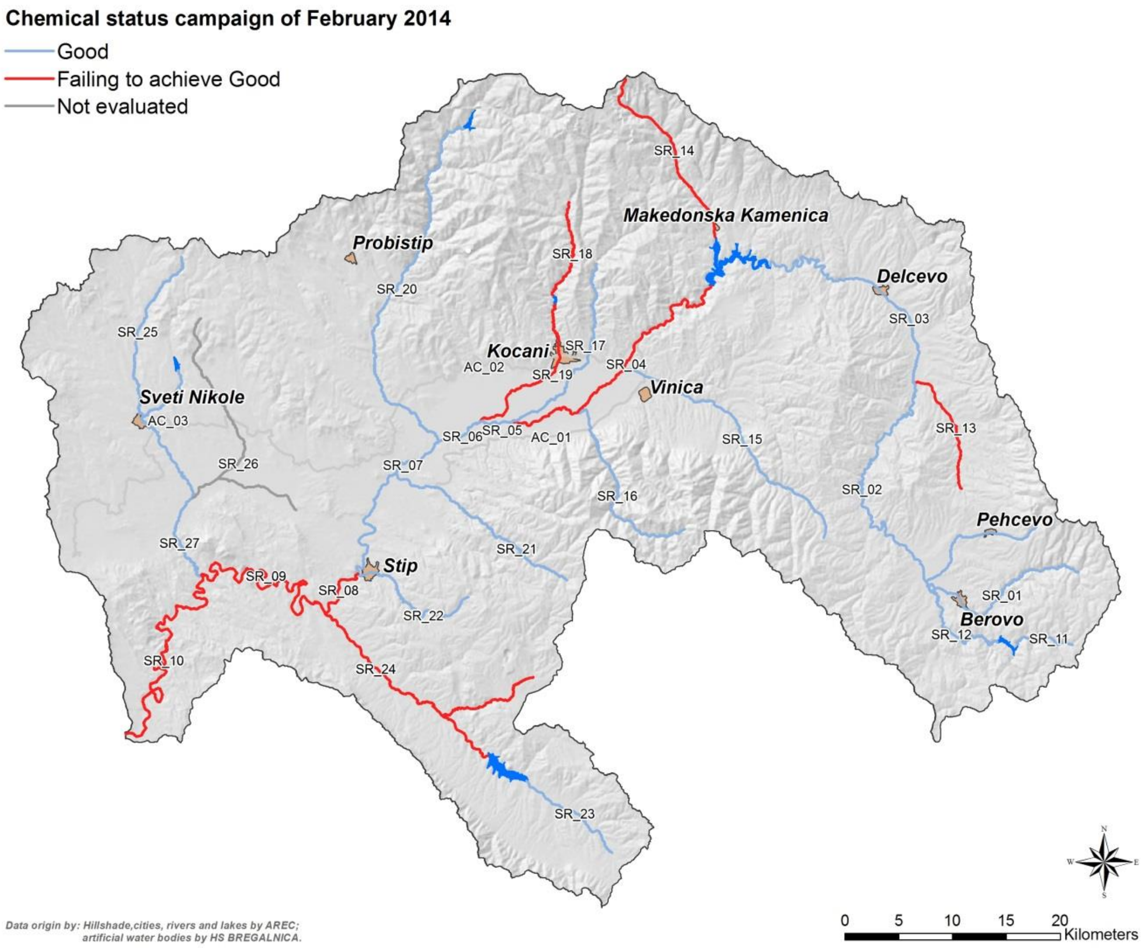


Figure 103: Bregalnica river basin with the chemical status of rivers and artificial and heavily modified water bodies. Results from the monitoring campaign of February 2014

With respect to the chemical status the situation is similar for most rivers as almost all of them achieve a good chemical status. For Bregalnica04 (SR_04) it is interesting to observe that before its inflow into Kalimanci lake (AL_02) it has a chemical status of "good", but the water in Bregalnica04 (SR_04) downstream of Kalimanci lake shows a "falling to achieve good" status. That indicates that inflow of Kamenicka river affects the quality of the water.

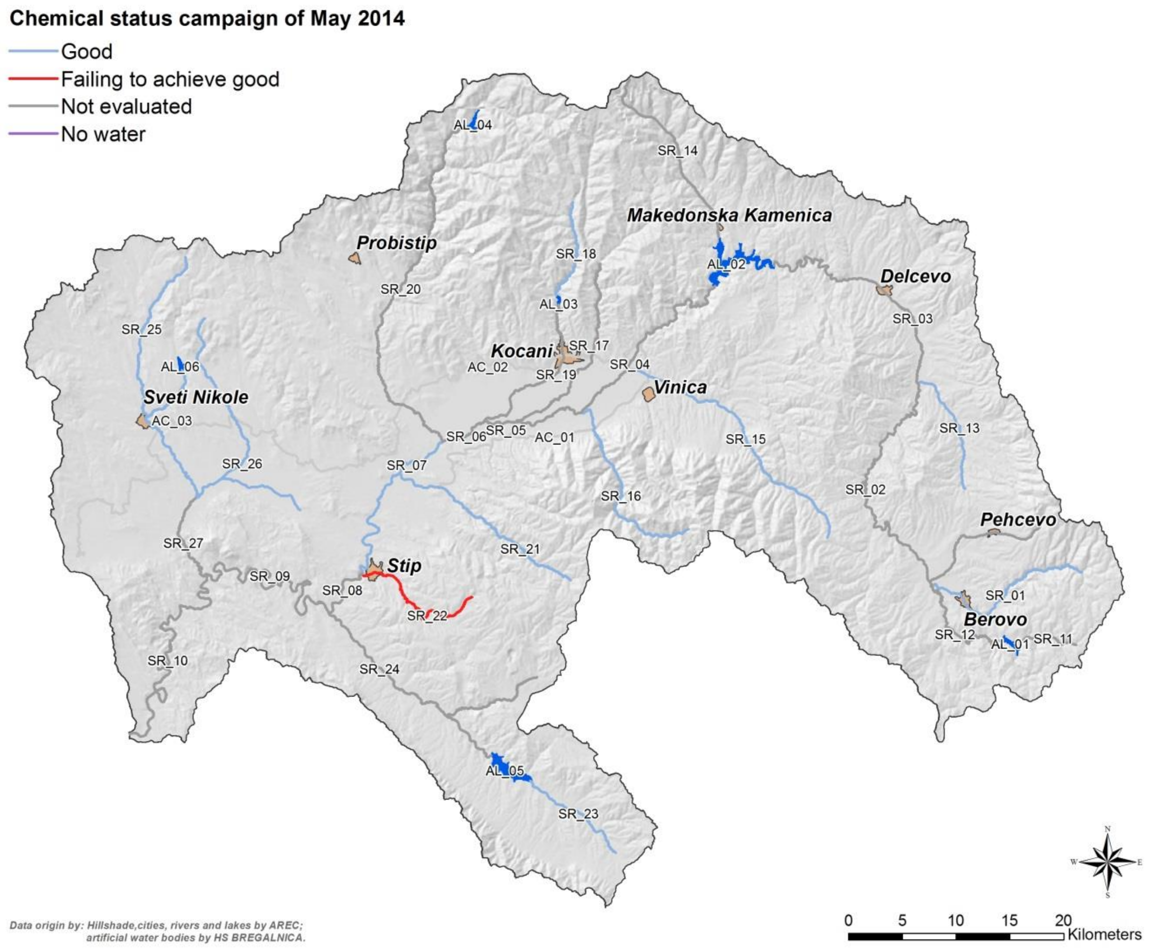


Figure 104: Bregalnica river basin with the chemical status of rivers. Results from the monitoring campaign of May 2014

The reason for the chemical status of "failing to achieve good" in few water bodies is the increased concentration of Pb, Zn, Cu, Mn.

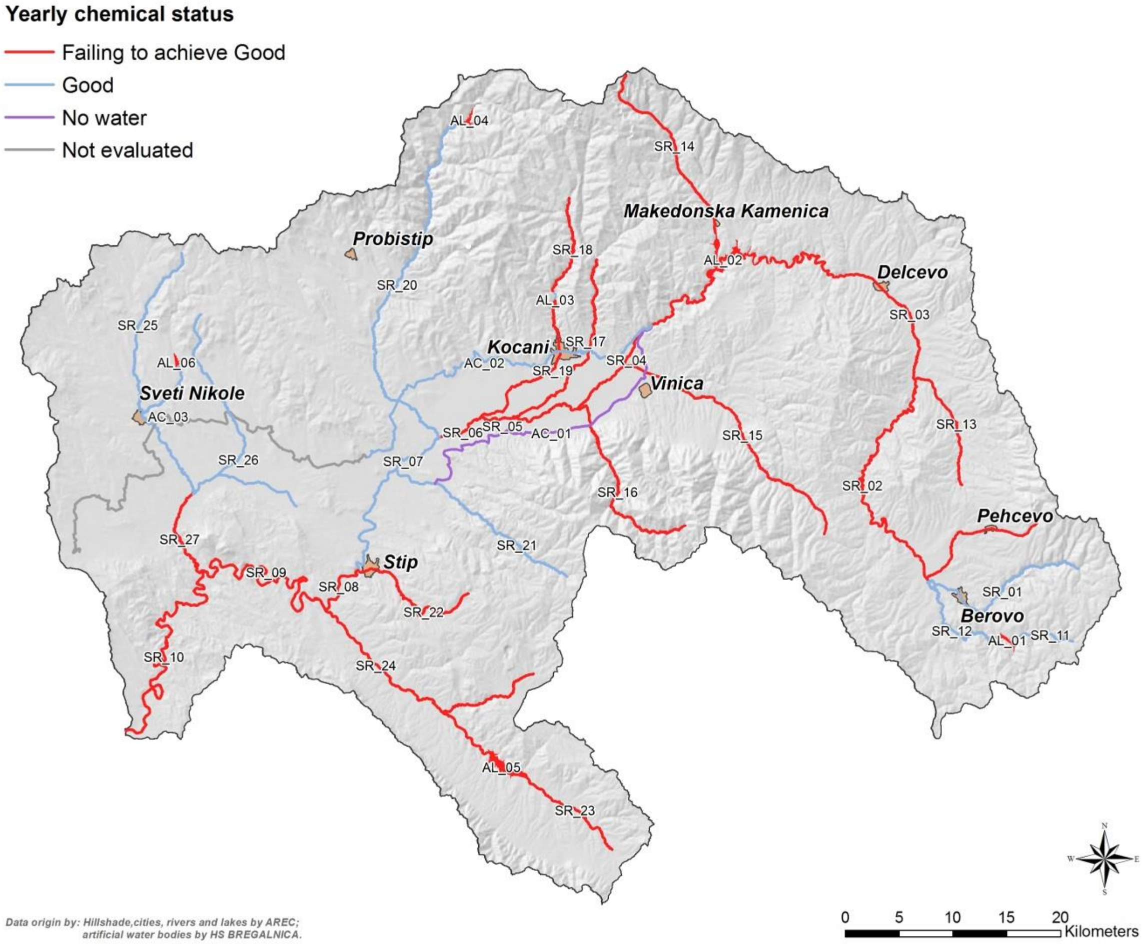


Figure 105: Bregalnica river basin with the chemical status of rivers and artificial and heavily modified water bodies. Aggregated result from all implemented monitoring campaigns (June 2013 to May 2014)

Taking into account the aggregated result from all implemented monitoring campaigns most water bodies have a chemical status of "Failing to achieve good" as shown in Figure 105. This is mainly due to high and continuous concentrations of phthalates (from human impact) and zinc in the rivers and in heavily modified water bodies. In addition, high concentrations of lead, manganese and copper were detected in some of the rivers and are related to mining activities nearby.

Cat.	Chemical status																			
	June/July 2013				October 2013				February 2014				Mai 2014				Aggregated value			
	#	%	km km²	%	#	%	km km²	%	#	%	km km²	%	#	%	km km²	%	#	%	km km²	%
Rivers																				
G	16	59	321	53	8	30	194	32	17	63	370	61	7	26	155	26	8	30	203	33
F	7	26	189	31	17	63	340	56	9	33	204	34	1	4	17	3	19	70	403	67
N	4	15	96	16	2	7	73	12	1	4	32	5	19	70	434	72	0	0	0	0
T	27	100	606	100	27	100	606	100	27	100	606	100	27	100	606	100	27	100	606	100
Heavily modified water bodies																				
G	3	50	5	58	1	17	0,2	2	-	-	-	-	-	-	-	-	1	17	0,2	2
F	0	0	0	0	5	83	8,8	98	-	-	-	-	-	-	-	-	5	83	8,8	98
N	3	50	4	42	0	0	0	0	-	-	-	-	-	-	-	-	0	0	0	0
T	6	100	9	100	6	100	9	100	-	-	-	-	-	-	-	-	6	100	9	100
Artificial water bodies																				
G	1	33	42	32	0	0	0	0	-	-	-	-	-	-	-	-	1	33	42	32
F	1	33	33	25	3	100	132	100	-	-	-	-	-	-	-	-	1	33	33	25
N	1	33	57	43	0	0	0	0	-	-	-	-	-	-	-	-	1	33	57	43
T	3	100	132	100	3	100	132	100	-	-	-	-	-	-	-	-	3	100	132	100

Table 95: Summary of chemical status of surface water bodies. Length is expressed in km for rivers and artificial water bodies and in km² for lakes. Note: the water bodies with "No water" are counted under the status "Bad". Cat. = Category, # = Number of bodies, G = Good, F = Failing to achieve good, N = Not evaluated, T = Total

From Table 95 it can be seen that the chemical status is changing from period to period. In June/July the chemical status is predominantly good, but in the October campaign the situation in the basin is drastically changing and most water bodies have a chemical status of "failing to achieve good". In the February campaign the situation in the basin is getting better again. A good chemical status is the predominated one. The same situation occurs in the May campaign. This is the situation for all types of water bodies.

Water status

Figure 106 to Figure 109 and Table 96 show the results with respect to the water body status for all monitoring campaigns.

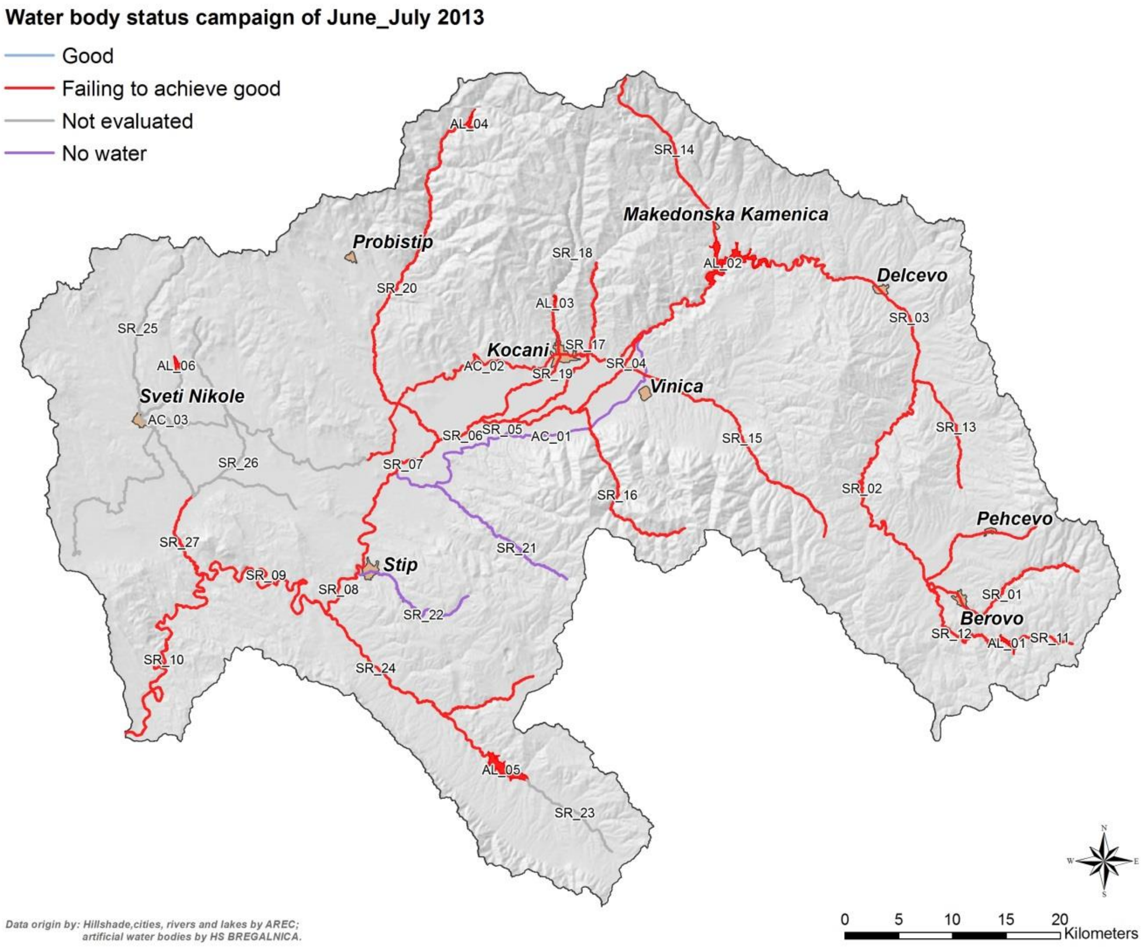


Figure 106: Bregalnica river basin with the water body status of rivers and artificial and heavily modified water bodies. Results from the monitoring campaign of June/July 2013

In the June/July campaign all water bearing water bodies had the status of "Failing to achieve good". Some of the water bodies were without water such as the left irrigation channel (AC_01), Kozjacka river (SR_21) and Otinja river (SR_22). All other water bodies were not evaluated.

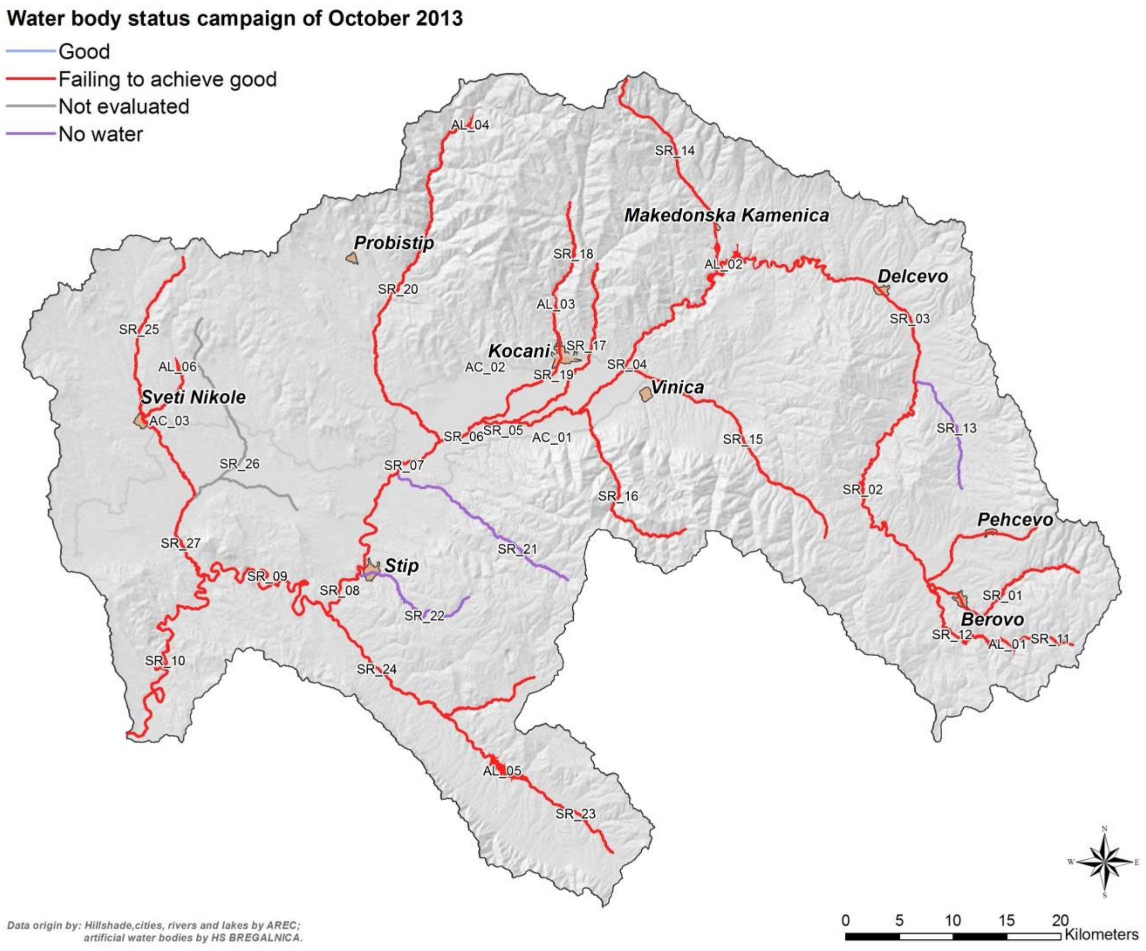


Figure 107: Bregalnica river basin with the water body status of rivers and artificial and heavily modified water bodies. Results from the monitoring campaign of October 2013

In the October campaign the situation is similar to the situation in the June /July campaign: most water bodies reach a water body status of "Failing to achieve good". The following water bodies were without water: Zelevica river (SR_13), Kozjacka river (SR_21) and Otinja river (SR_22) and all irrigation channels (AC_01, AC_02 and AC_03).

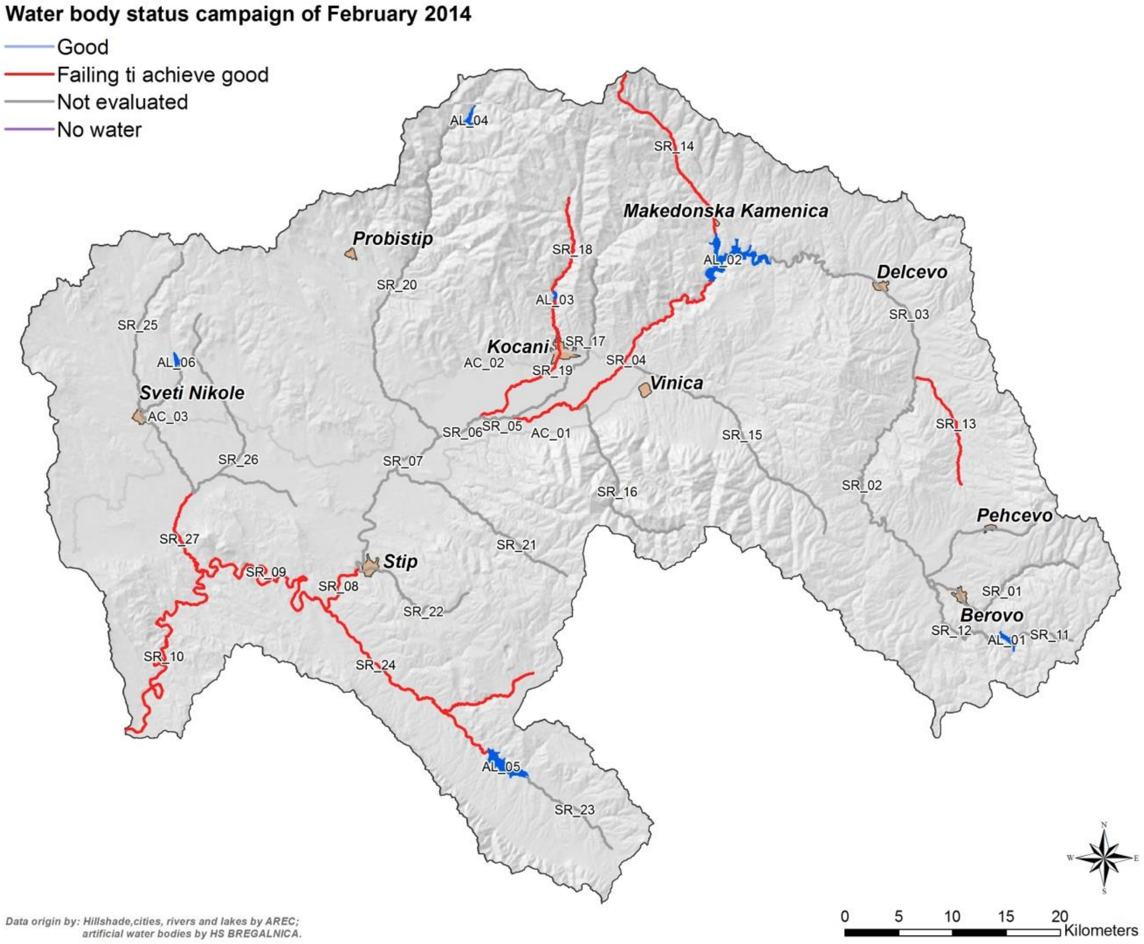


Figure 108: Bregalnica river basin with the water body status of rivers. Results from the monitoring campaign of February 2014

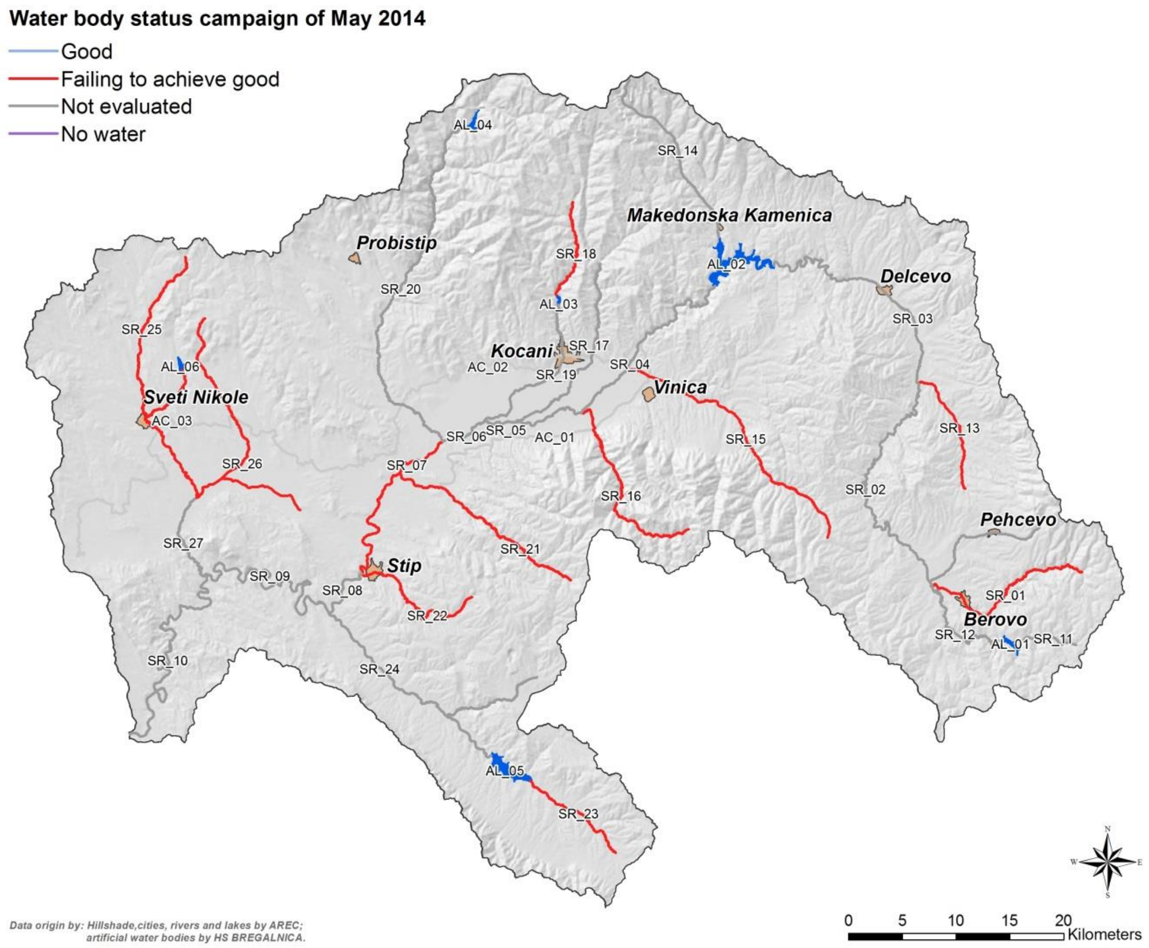


Figure 109: Bregalnica river basin with the water body status of rivers. Results from the monitoring campaign of May 2014

Cate-gory	Water body status	June/July 2013 #	%	km; km²	%	October 2013 #	%	km; km²	%	February 2014 #	%	km; km²	%	Mai 2014 #	%	km; km²	%
Rivers	Good	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Failing to achieve good	23	85	510	84	26	96	574	95	10	37	215	35	8	30	172	28
	Not evaluated	4	15	96	16	1	4	32	5	17	63	391	65	19	70	434	72
	Total	27	100	606	100	27	100	606	100	27	100	606	100	27	100	606	100
Heavily modified water bodies	Good	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-
	Failing to achieve good	6	100	9	100	6	100	9	100	-	-	-	-	-	-	-	-
	Not evaluated	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-
	Total	6	100	9	100	6	100	9	100	-	-	-	-	-	-	-	-
Artificial water bodies	Good	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-
	Failing to achieve good	2	67	75	57	3	100	132	100	-	-	-	-	-	-	-	-
	Not evaluated	1	33	57	43	0	0	0	0	-	-	-	-	-	-	-	-
	Total	3	100	132	100	3	100	132	100	-	-	-	-	-	-	-	-

Table 96: Summary of water body status of surface water bodies. Length is expressed in km for rivers and artificial water bodies and in km² for lakes. Note: the water bodies with "No water" are counted under the status "Failing to achieve good"

The table below includes the following results for each monitoring point (where available):

- the biological evaluation
- the hydro-morphological evaluation
- the physical-chemical evaluation
- the ecological status or ecological potential
- the chemical status, and
- the resulting surface water status.

Water body	Monitoring point ID	Biological evaluation						Hydro-morphological evaluation						Physical-chemical evaluation					
		J/J	Aug	Oct	Feb	May	Av[1]	J/J	Aug	Oct	Feb	May	Av[1]	J/J	Aug	Oct	Feb	May	Av[1]
Rivers																			
Bregalnica01	SR_01	B	-	M	-	-	B	M	-	M	-	-	M	P	P	G	G	-	P
Bregalnica01	SR_01_01	-	-	B	-	B	B	-	-	G	-	H	G	-	-	M	G	G	M
Bregalnica02	SR_02	B	-	P	-	-	B	M	-	M	-	-	M	P	B	G	P	-	B
Bregalnica03	SR_03	P	-	P	-	-	P	M	-	M	-	-	M	B	B	B	B	-	B
Bregalnica04	SR_04	P	-	P	-	-	P	P	-	P	-	-	P	P	B	P	B	-	B
Bregalnica05	SR_05	P	-	P	-	-	P	M	-	M	-	-	M	P	B	M	P	-	B
Bregalnica06	SR_06	P	-	P	-	-	P	B	-	P	-	-	B	M	B	P	P	-	B
Bregalnica07	SR_07	P	-	P	-	B	B	P	-	P	-	P	P	M	M	M	B	P	B
Bregalnica08	SR_08	P	-	P	-	-	P	P	-	M	-	-	P	P	B	B	B	-	B
Bregalnica09	SR_09	P	-	P	-	-	P	P	-	M	-	-	P	B	B	B	B	-	B
Bregalnica10	SR_10	B	-	P	-	-	B	M	-	M	-	-	M	B	B	B	B	-	B
Ratevska river01	SR_11_01	N	-	N	-	-	N	N	-	N	-	-	N	N	N	N	-	-	N
Ratevska river01	SR_11_02	B	-	P	-	-	B	M	-	M	-	-	M	P	P	P	M	-	P
Ratevska river02	SR_12	P	-	M	-	-	P	G	-	M	-	-	M	M	B	B	M	-	B
Zelevica river	SR_13_01	N	-	N	-	B	B	N	-	N	-	P	P	N	N	N	G	P	P
Zelevica river	SR_13_02	P	-	Nw	-	B	P	P	-	Nw	-	P	P	M	Nw	Nw	G	M	M
Kamenica river	SR_14_01	B	-	B	-	-	B	G	-	M	-	-	M	H	G	P	G	-	P
Kamenica river	SR_14_02	P	-	B	-	-	B	M	-	M	-	-	M	M	M	B	B	-	B
Osijnica river	SR_15_01	B	-	M	-	-	B	M	-	M	-	-	M	P	P	G	P	-	P
Osijnica river	SR_15_01_01	N	-	G	-	B	B	N	-	G	-	G	G	N	-	G	G	M	M
Osijnica river	SR_15_02	P	-	P	-	-	P	B	-	B	-	-	B	P	P	M	P	-	P
Zrnovska river	SR_16_01	G	-	G	-	B	B	P	-	G	-	G	P	M	M	G	M	G	M
Zrnovska river	SR_16_02	B	-	B	-	-	B	B	-	P	-	-	B	P	M	B	G	-	B
Orizarska river	SR_17_01	B	-	G	-	-	B	G	-	M	-	-	M	M	H	M	G	-	M
Orizarska river	SR_17_02	P	-	P	-	-	P	P	-	P	-	-	P	P	B	B	B	-	B
Kocanska river01	SR_18	N	-	P	-	B	B	N	-	M	-	M	M	N	N	P	M	P	P
Kocanska river02	SR_19	B	-	B	-	-	B	P	-	P	-	-	P	B	B	B	B	-	B
Zletovska river	SR_20	P	-	M	-	-	P	P	-	M	-	-	P	B	B	P	P	-	B
Kozjacka river	SR_21	Nw	-	Nw	-	B	B	Nw	-	Nw	-	P	P	Nw	Nw	Nw	P	G	P
Otinja	SR_22	Nw	-	Nw	-	B	B	Nw	-	Nw	-	B	B	Nw	Nw	Nw	B	B	B
Kriva Lakavica01	SR_23_01	N	-	-	-	-	N	N	-	-	-	-	N	N	N	N	M	-	M
Kriva Lakavica01	SR_23_02	N	-	B	-	P	B	N	-	M	-	M	M	N	N	G	M	B	B
Kriva Lakavica02	SR_24_01	B	-	B	-	-	B	P	-	P	-	-	P	B	Nw	B	B	-	B
Kriva Lakavica02	SR_24_02	B	-	B	-	-	B	M	-	M	-	-	M	B	B	B	B	-	B
Svetinikolska river01	SR_25_01	N	-	N	-	-	N	N	-	N	-	-	N	N	N	N	B	-	B
Svetinikolska river01	SR_25_02	N	-	B	-	B	B	N	-	P	-	P	P	N	N	N	B	B	B
Svetinikolska river01	SR_25_03	Nw	-	Nw	-	-	N	Nw	-	Nw	-	-	N	Nw	Nw	Nw	B	-	B
Nemanjica river	SR_26	N	-	Nw	-	B	B	N	-	Nw	-	P	P	N	N	Nw	N	B	B
Svetinikolska river02	SR_27	B	-	B	-	-	B	P	-	M	-	-	P	B	B	B	B	-	B

Water body	Monitoring point ID	Ecological status/potential						Chemical status						Water body status					
		J/J	Aug	Oct	Feb	May	Av[1]	J/J	Aug	Oct	Feb	May	Av[1]	J/J	Aug	Oct	Feb	May	Av[1]
Rivers																			
Bregalnica01	SR_01	B	-	M	-	-	B	Gc	-	Gc	Gc	-	Gc	F	-	F	-	-	F
Bregalnica01	SR_01_01	-	-	B	-	B	B	-	-	Gc	Gc	Gc	Gc	-	-	F	-	F	F
Bregalnica02	SR_02	B	-	P	-	-	B	F	-	Gc	Gc	-	F	F	-	F	-	-	F
Bregalnica03	SR_03	P	-	B	-	-	B	F	-	Gc	Gc	-	F	F	-	F	-	-	F
Bregalnica04	SR_04	P	-	P	-	-	P	Gc	-	F	F	-	F	F	-	F	F	-	F
Bregalnica05	SR_05	P	-	P	-	-	P	Gc	-	F	Gc	-	F	F	-	F	-	-	F
Bregalnica06	SR_06	P	-	P	-	-	P	Gc	-	F	Gc	-	F	F	-	F	-	-	F
Bregalnica07	SR_07	P	-	P	-	B	B	Gc	-	Gc	Gc	Gc	Gc	F	-	F	-	F	F
Bregalnica08	SR_08	P	-	B	-	-	B	Gc	-	F	F	-	F	F	-	F	F	-	F
Bregalnica09	SR_09	P	-	B	-	-	B	Gc	-	F	F	-	F	F	-	F	F	-	F
Bregalnica10	SR_10	B	-	B	-	-	B	Gc	-	F	F	-	F	F	-	F	F	-	F
Ratevska river01	SR_11_01	N	-	N	-	-	N	N	-	N	-	-	N	N	-	N	-	-	N
Ratevska river01	SR_11_02	B	-	P	-	-	B	Gc	-	Gc	Gc	-	Gc	F	-	F	-	-	F
Ratevska river02	SR_12	P	-	B	-	-	B	Gc	-	Gc	Gc	-	Gc	F	-	F	-	-	F
Zelevica river	SR_13_01	N	-	-	-	B	B	N	-	N	Gc	Gc	Gc	N	-	N	-	F	F
Zelevica river	SR_13_02	P	-	Nw	-	B	B	Gc	-	Nw	F	Gc	F	F	-	Nw	F	F	F
Kamenica river	SR_14_01	B	-	B	-	-	B	Gc	-	Gc	Gc	-	Gc	F	-	F	-	-	F
Kamenica river	SR_14_02	P	-	B	-	-	B	F	-	F	F	-	F	F	-	F	F	-	F
Osijnica river	SR_15_01	B	-	G	-	-	B	Gc	-	Gc	Gc	-	Gc	F	-	G	-	-	F
Osijnica river	SR_15_01_01	N	-	G	-	B	B	N	-	Gc	Gc	Gc	Gc	N	-	G	-	F	F
Osijnica river	SR_15_02	P	-	P	-	-	P	F	-	F	Gc	-	F	F	-	F	-	-	F
Zrnovska river	SR_16_01	P	-	G	-	B	B	Gc	-	F	Gc	Gc	F	F	-	F	-	F	F
Zrnovska river	SR_16_02	B	-	B	-	-	B	F	-	F	Gc	-	F	F	-	F	-	-	F
Orizarska river	SR_17_01	B	-	M	-	-	B	Gc	-	Gc	Gc	-	Gc	F	-	F	-	-	F
Orizarska river	SR_17_02	P	-	B	-	-	B	Gc	-	F	Gc	-	F	F	-	F	-	-	F
Kocanska river01	SR_18	N	-	P	-	B	B	N	-	Gc	F	Gc	F	N	-	F	F	F	F
Kocanska river02	SR_19	B	-	B	-	-	B	Gc	-	F	F	-	F	F	-	F	F	-	F
Zletovska river	SR_20	B	-	P	-	-	B	Gc	-	Gc	Gc	-	Gc	F	-	F	-	-	F
Kozjacka river	SR_21	Nw	-	Nw	-	B	B	Nw	-	Nw	Gc	Gc	Gc	Nw	-	Nw	-	F	F
Otinja	SR_22	Nw	-	Nw	-	B	B	Nw	-	Nw	Gc	F	F	Nw	-	Nw	-	F	F
Kriva Lakavica01	SR_23_01	N	-	-	-	-	B	N	-	N	Gc	-	Gc	N	-	N	-	-	F
Kriva Lakavica01	SR_23_02	N	-	B	-	B	B	N	-	F	Gc	Gc	F	N	-	F	-	F	F
Kriva Lakavica02	SR_24_01	B	-	B	-	-	B	Gc	-	F	Gc	-	F	F	-	F	-	-	F
Kriva Lakavica02	SR_24_02	B	-	B	-	-	B	Gc	-	F	F	-	F	F	-	F	F	-	F
Svetinikolska river01	SR_25_01	N	-	N	-	-	N	N	-	N	Gc	-	Gc	N	-	N	-	-	F
Svetinikolska river01	SR_25_02	N	-	B	-	B	B	N	-	N	Gc	Gc	Gc	N	-	F	-	F	F
Svetinikolska river01	SR_25_03	Nw	-	Nw	-	-	N	Nw	-	Nw	Gc	-	Gc	Nw	-	Nw	-	-	N
Nemanjica river	SR_26	N	N	Nw	-	B	B	N	-	Nw	N	F	F	N	-	N	-	F	F
Svetinikolska river02	SR_27	B	-	B	-	-	B	F	-	F	F	-	F	F	-	F	F	-	F

Table 97: Overview of all statuses and evaluations for rivers. See Table 98 for the legend

Water body	Monitoring point ID	Biological evaluation						Hydro-morphological evaluation						Physical-chemical evaluation						Ecological status/potential						Chemical status						Water body status					
		J/J	Aug	Oct	Feb	May	Av[1]	J/J	Aug	Oct	Feb	May	Av[1]	J/J	Aug	Oct	Feb	May	Av[1]	J/J	Aug	Oct	Feb	May	Av[1]	J/J	Aug	Oct	Feb	May	Av[1]	J/J	Aug	Oct	Feb	May	Av[1]
Heavily modified water bodies																																					
Ratevo Lake_L	AL_01_01	B	-	P	-	-	B	-	-	-	-	-	-	B	-	Ga	-	-	B	B	-	P	-	-	B	Gc	-	F	-	-	F	F	-	F	-	-	F
Ratevo Lake_P	AL_01_02	B	-	P	-	-	B	-	-	-	-	-	-	Ga	-	N	-	-	Ga	B	-	P	-	-	B	Gc	-	N	-	-	Gc	F	-	F	-	-	F
Kalimanci Lake_L	AL_02_01	B	-	B	-	-	B	-	-	-	-	-	-	B	-	M	-	-	B	B	-	B	-	-	B	Gc	-	F	-	-	F	F	-	F	-	-	F
Kalimanci Lake_P	AL_02_02	B	-	B	-	-	B	-	-	-	-	-	-	M	-	M	-	-	M	B	-	B	-	-	B	Gc	-	F	-	-	F	F	-	F	-	-	F
Gradce Lake_L	AL_03_01	P	-	B	-	-	B	-	-	-	-	-	-	P	-	Ga	-	-	P	P	-	B	-	-	B	Gc	-	Gc	-	-	Gc	F	-	F	-	-	F
Gradce Lake_P	AL_03_02	N	-	B	-	-	B	-	-	-	-	-	-	N	-	Ga	-	-	Ga	N	-	B	-	-	B	N	-	F	-	-	F	N	-	F	-	-	F
Knezevo Lake_L	AL_04_01	B	-	P	-	-	B	-	-	-	-	-	-	Ga	-	Ga	-	-	Ga	B	-	P	-	-	B	N	-	F	-	-	F	F	-	F	-	-	F
Knezevo Lake_P	AL_04_02	B	-	P	-	-	B	-	-	-	-	-	-	Ga	-	Ga	-	-	Ga	B	-	P	-	-	B	Gc	-	F	-	-	F	F	-	F	-	-	F
Mantovo Lake_L	AL_05_01	B	-	B	-	-	B	-	-	-	-	-	-	M	-	Ga	-	-	M	P	-	B	-	-	B	N	-	F	-	-	F	F	-	F	-	-	F
Mantovo Lake_P	AL_05_02	B	-	B	-	-	B	-	-	-	-	-	-	M	-	Ga	-	-	M	P	-	B	-	-	B	Gc	-	F	-	-	F	F	-	F	-	-	F
Mavrovica Lake_L	AL_06_01	B	-	P	-	-	P	-	-	-	-	-	-	M	-	B	-	-	B	P	-	B	-	-	B	N	-	F	-	-	F	F	-	F	-	-	F
Mavrovica Lake_P	AL_06_02	B	-	P	-	-	P	-	-	-	-	-	-	M	-	B	-	-	B	P	-	B	-	-	B	Gc	-	F	-		F	F	-	F	-	-	F
Artificial water bodies																																					
Left irigation chanal	AC_01	-	-	-	-	-	-	-	-	-	-	-	-	Nw	-	-	-	-	Nw	Nw	-	Nw	-	-	Nw	Nw	-	Nw	-	-	Nw	Nw	-	Nw	-	-	Nw
Right irigation chanal 1	AC_02	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	P	P	-	Nw	-	-	P	Gc	-	Nw	-	-	Gc	F	-	Nw	-	-	F
Right irigation chanal 2	AC_03	-	-	-	-	-	-	-	-	-	-	-	-	N	-	-	-	-	N	N	-	Nw	-	-	N	N	-	Nw	-	-	N	N	-	Nw	-	-	N

Legend:

J/J	Results from the June/July 2013 campaign
Aug	Results from the August 2013 campaign
Oct	Results from the October 2013 campaign
Feb	Results from the February 2014 campaign
May	Results from the April 2014 campaign
Av[1]	Aggregated value; the status is defined as "bad", if at least once no water was observed
Nw	No water
-	No measurement required

Biological, Hydro-morphological and Physical-chemical-evaluation: H High; G Good; M Moderate; P Poor; B Bad; N Not evaluated

Ecological status: H High; G Good; M Moderate; P Poor; B Bad; N Not evaluated

Ecological potential: Ga Good and above; M Moderate; P Poor; B Bad; N Not evaluated

Chemical status: Gc Good; F Failing to achieve Good; N Not evaluated

Water body status: G Good; F Failing to achieve Good; N Not evaluated

Table 98: Overview of all statuses and evaluations for HMWB and artificial water bodies

Table 97 and Table 98 show the biological, hydro-morphological, physical-chemical evaluation, ecological status and potential, chemical status and water body status per each monitoring point and monitoring campaign. It is interesting to observe that the physical-chemical evaluation for Kamenicka river (SR_14), Zrnovksa river (SR_16), Orizarska river (SR_17) and Kriva Lakavica01 (SR_23) is significantly changing seasonally. The reason for this behavior could not be determined so far.

A13 Status – Groundwater Bodies

In the following sections the methodology to set the qualitative and quantitative status of the groundwater bodies according WFD is outlined. The relevant documents are the

- Groundwater Directive 2006/118/EC on the protection of groundwater against pollution and deterioration
- COUNCIL DIRECTIVE 98/83/EC on the quality of water intended for human consumption
- WFD Guidance Document No. 18 "Guidance on Groundwater Status and Trend Assessment"
- WFD Guidance Document No. 15 "Guidance on Groundwater Monitoring"
- Several laws, regulations, standards such as
  - Official Gazette of the Republic of Macedonia No.46/08
  - Official Gazette of the Republic of Macedonia No.18/1999
  - Gazette of the Republic of Serbia 42/98
  - Indicator values for groundwater in Switzerland
  - US Environmental Protection Agency (EPA): national primary and secondary drinking water regulations (maximum contaminant level MCL)
  - Food and Agriculture Organization FAO of the United Nations: Degree of Restriction on Use for irrigation water
  - World Health Organization: Guidelines for Drinking Water Quality, 4th edition
  - Swiss Association of Gas and Water: values for the definition of drinking water quality

1) Methodology for assessing the quantitative status and results

The WFD requires classification of groundwater bodies by assessing the quantitative and qualitative (chemical) status. A good quantitative status is achieved in accordance with WFD Guidance Document No.18, Article 5 when: "The level of groundwater in the groundwater body is such that the available groundwater resource is not exceeded by the long term annual average rate of abstraction."

The quantitative status assessment includes several tests:

- water balance
- surface water flow
- groundwater dependent terrestrial ecosystems
- saline or other intrusion

Test 1: Water Balance (GWB scale)

As it is written in the WFD Guidance Document No.18, Article 5.3.1 this test considers the cumulative effects across the body and is a body-wide test. For the water balance the annual average abstraction against the available groundwater resource in the groundwater body has to be assessed. The available resource is an approximate value, based on the recharge and the low flow requirements to support the ecology in surface water bodies and terrestrial ecosystems that are dependent of the groundwater body. Thus, in some hydrogeological situations the groundwater body may have a poor status, even though the available resource is larger than the abstraction.

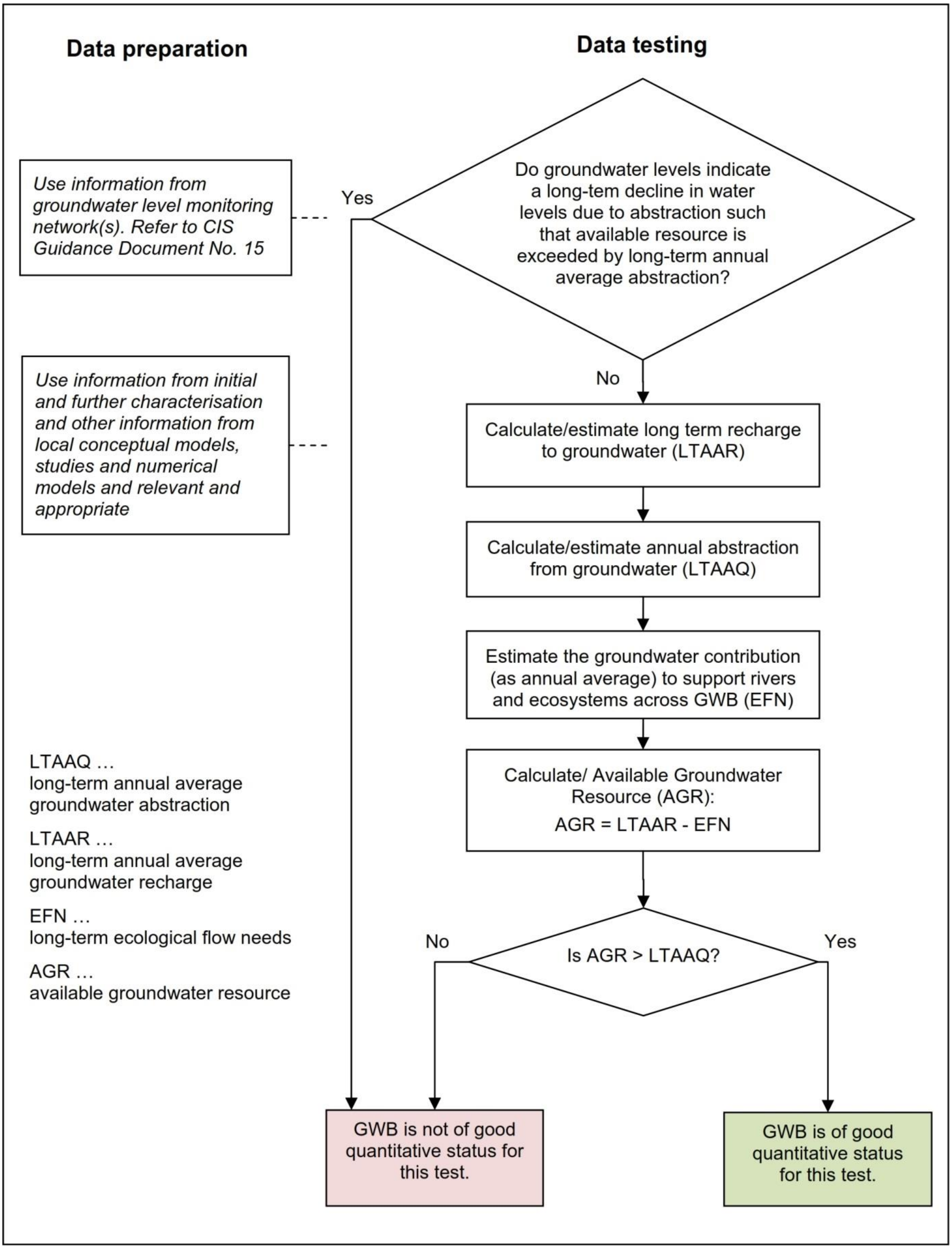


Figure 110: Outline of procedure and data requirements for water balance test according WFD Guidance Document No. 18

The results of the water balance test are summarized in the following table:

GWB	Nu	ID	Do groundwater levels indicate a long-tem decline in water levels due to abstraction such that available resource is exceeded by long-term annual average abstraction?	Calculate/estimate long term recharge to groundwater (LTAAR)	Calculate/estimate annual abstraction from groundwater (LTAAQ)	Estimate the groundwater contribution (as annual average) to support rivers and ecosystems across GWB (EFN)	Calculate/ Available Groundwater Resource (AGR): AGR = LTAAR - EFN	Is AGR > LTAAQ?	Status	Ground Water Body status
Berovo-Pehcevo	1	DMP01	No	*	*	*	-	-	G	G
	3	DMP02	No	*	*	*	-	-	G	
	4	DMP03	No	*	*	*	-	-	G	
Delchevo	5	DMP04	No	*	*	*	-	-	G	G
	7	DMP05	No	*	*	*	-	-	G	
	9	DMP06	No	*	*	*	-	-	G	
Kochani-Shtip	11	DMP07	No	*	*	*	-	-	G	G
	14	DMP08	No	*	*	*	-	-	G	
	16	DMP09	No	*	*	*	-	-	G	
	17	DMP10	No	*	*	*	-	-	G	
	19	DMP11	No	*	*	*	-	-	G	
Ovche Pole	20	DMP12	No	*	*	*	-	-	G	G
	22	DMP13	No	*	*	*	-	-	G	
	24	DMP14	No	*	*	*	-	-	G	
	26	DMP15	No	*	*	*	-	-	G	
Lakavica	29	DMP16	No	*	*	*	-	-	G	G
	31	DMP17	No	*	*	*	-	-	G	
	33	DMP18	No	*	*	*	-	-	G	

Legend:
LTAAQ ... long-term annual average groundwater abstraction
LTAAR ... long-term annual average groundwater recharge
EFN ... long-term ecological flow needs
AGR ... available groundwater resource

* not enough information for these requirements
G good status

Table 99: Results of test 1: water balance test

Based on the observations of the groundwater level during almost one year as shown in the following figure and based on expert judgement, no unnatural level fluctuation could be noticed and thus there is no indication of any problems with respect to groundwater quantity at present. Those monitoring points showing a larger variation of the water level were influenced by flooding, when the measurements were done.

The data base is too limited to make any assessment of the future trend.

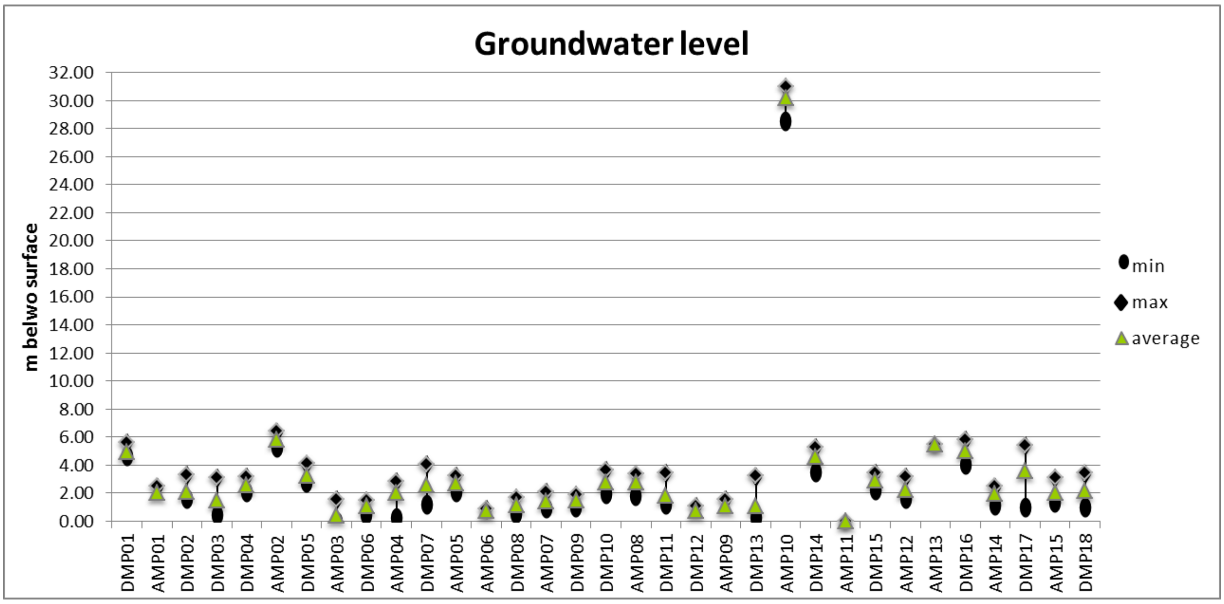


Figure 111: Groundwater level measured in m below terrain surface with indication of average, minimum and maximum value

Test 2: Surface Water Flow

One groundwater body can be connected with more than one surface water body. The purpose of this test is to estimate the pressure, if it exists at all, that the GWB may have on the surface water body or bodies by uncontrolled abstractions of groundwater which could lead to failure of achieving good status of the surface water body or bodies.

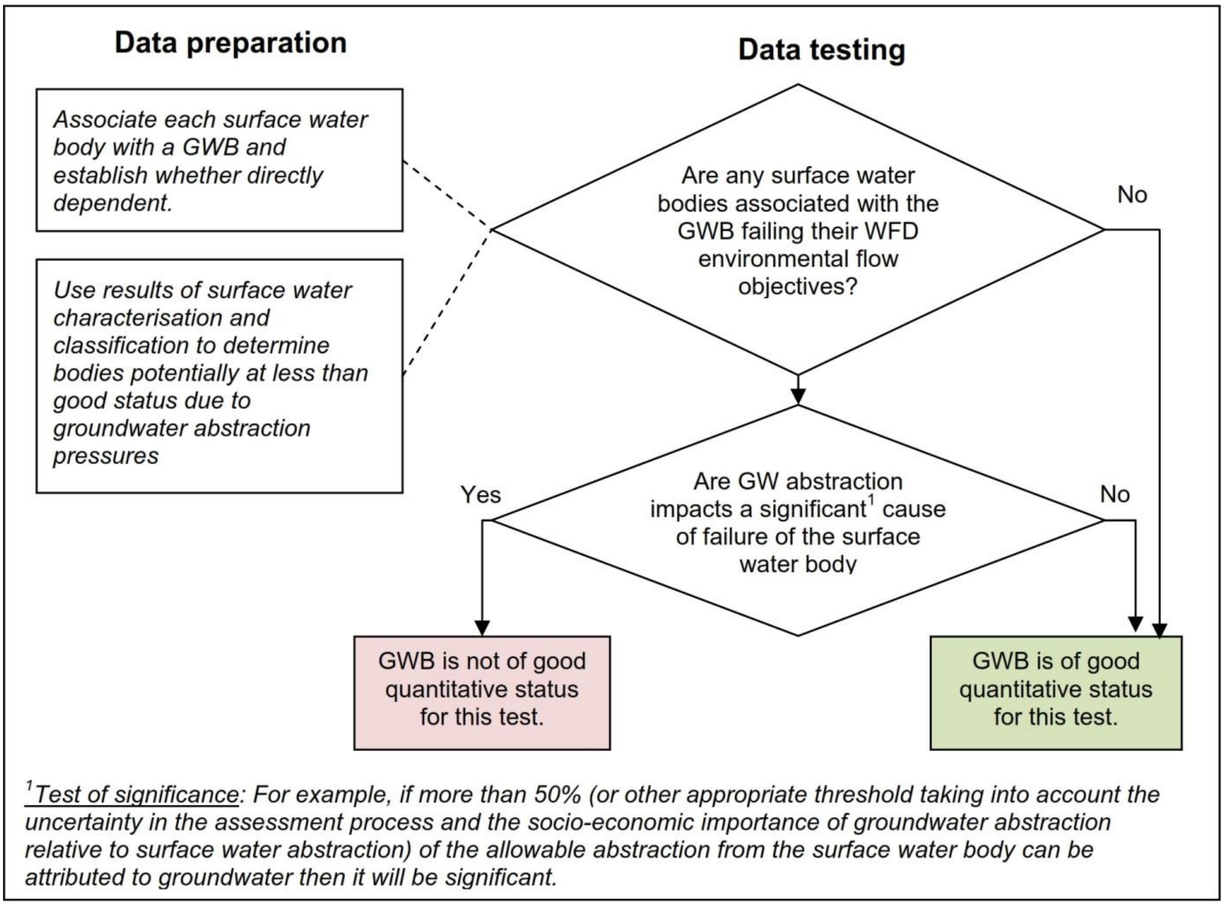


Figure 112: Outline of procedure for the surface water flow test according WFD Guidance Document No. 18

The results of the surface water flow test are summarized in the following table:

GWB	Nu	ID	Are any surface water bodies associated with the GWB failing their WFD environmental flow objectives?	Are GW abstraction impacts a significant[1] cause of failure of the surface water body	Status	Groundwater body status
Berovo-Pehcevo	1	DMP01	No	No	G	G
	3	DMP02	No	No	G	
	4	DMP03	No	No	G	
Delchevo	5	DMP04	No	No	G	G
	7	DMP05	No	No	G	
	9	DMP06	No	No	G	
Kochani-Shtip	11	DMP07	No	No	G	G
	14	DMP08	No	No	G	
	16	DMP09	No	No	G	
	17	DMP10	No	No	G	
	19	DMP11	No	No	G	
Ovche Pole	20	DMP12	No	No	G	G
	22	DMP13	No	No	G	
	24	DMP14	No	No	G	
	26	DMP15	No	No	G	
Lakavica	29	DMP16	No	No	G	G
	31	DMP17	No	No	G	
	33	DMP18	No	No	G	

1 Test of significance: For example, if more than 50% (or other appropriate threshold taking into account the uncertainty in the assessment process and the socio-economic importance of groundwater abstraction relative to surface water abstraction) of the allowable abstraction from the surface water body can be attributed to groundwater then it will be significant.

G Good status

Table 100 Results of test 2: surface water flow test

Each monitoring point reached good status. Thus, all GWB have a good status for this test.

Test 3: Groundwater Dependent Terrestrial Ecosystem (GWDTE)

With this test it is examined, whether there is no significant damage to a terrestrial ecosystem which depends on groundwater. There is a close link between both the chemical status and quantitative assessment test.

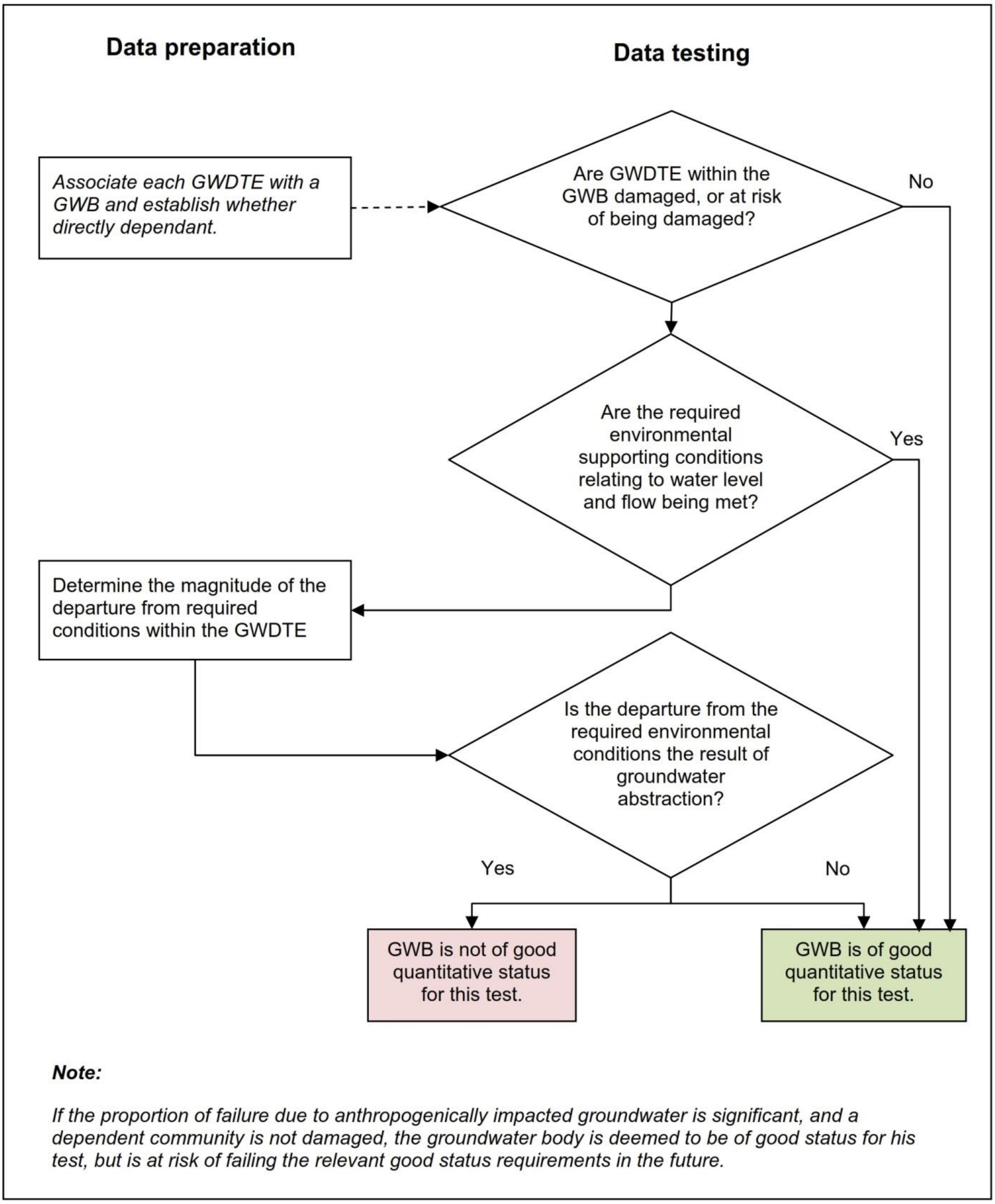


Figure 113: Outline of procedure for the GWDTE test according WFD Guidance Document No. 18

The results of the groundwater dependent terrestrial ecosystem test are summarized in the following table:

GWB	Nu	ID	Ground Water Dependet Terrestrial Ecosystem	Status	Groundwater body Status
Berovo-Pehcevo	1	DMP01	According Guidance No.18: *For many sites, it will not be possible to quantify supporting conditions required within the GWDTE be available for all sites. Under these circumstances the groundwater body will be of good status for this test decide if sites are considered 'at risk'. These 'at risk' sites should be prioritised for further investigation.and the results of initial risk screening and any other available evidence should be used to.*	G	G
	3	DMP02		G	
	4	DMP03		G	
Delchevo	5	DMP04		G	G
	7	DMP05		G	
	9	DMP06		G	
Kochani-Shtip	11	DMP07		G	G
	14	DMP08		G	
	16	DMP09		G	
	17	DMP10		G	
	19	DMP11		G	
Ovche Pole	20	DMP12		G	G
	22	DMP13		G	
	24	DMP14		G	
	26	DMP15		G	
Lakavica	29	DMP16		G	G
	31	DMP17		G	
	33	DMP18		G	

Table 101: Results of test 3: groundwater dependent terrestrial ecosystem test

In the Bregalnica river catchment no GWDTE have been classified as such so far. This is most likely due to not performing according investigations or due to lack of site-specific information. Thus, according to WFD Guidance No.18 all groundwater bodies have a good status for this test.

Test 4: Saline (or other) intrusion

To achieve good status there should be no long-term saline intrusion or other intrusion of poor quality water due to anthropogenically induced acitivities (e.g. water level change due to abstraction). This test is very closely connected with the test for saline and other intrusion for the chemical status assessment.

The results of the saline (or other) intrusion test are summarized in the following table:

GWB	Nu	ID	Is there evidence of pressure based on a quantitative assessment?	Does the mean value at any relevant monitoring point exceed a GW-QS or TV?	Is there a statistically significant upward trend in one or more relevant monitoring points?	Is there an existing significant impact on a point of abstraction?	Status	Groundwater Body Status
Berovo-Pencevo	1	DMP01	No	/	/	/	G	G
	3	DMP02	No	/	/	/	G	
	4	DMP03	No	/	/	/	G	
Delchevo	5	DMP04	No	/	/	/	G	G
	7	DMP05	No	/	/	/	G	
	9	DMP06	No	/	/	/	G	
Kochani-Shtip	11	DMP07	No	/	/	/	G	G
	14	DMP08	No	/	/	/	G	
	16	DMP09	No	/	/	/	G	
	17	DMP10	No	/	/	/	G	
	19	DMP11	No	/	/	/	G	
Ovche Pole	20	DMP12	No	/	/	/	G	G
	22	DMP13	No	/	/	/	G	
	24	DMP14	No	/	/	/	G	
	26	DMP15	No	/	/	/	G	
Lakavica	29	DMP16	No	/	/	/	G	G
	31	DMP17	No	/	/	/	G	
	33	DMP18	No	/	/	/	G	

/ if first answer is "no", then directly status is "good"

G Good status

Table 102: Results of test 4: saline (or other) intrusion test

All GWB have a good status for this test.

The overall quantitative status of the GWBs is summarized in the following table:

GWB	Nu	ID	Water balance (GWB scale)	Surface Water Flow	Groundwater Dependent Terrestrial Ecosystems (GWDTE)	Saline (or other) Intrusion	Groundwater Body Status
Berovo-Pencevo	1	DMP01	*	G	G	G	G
	3	DMP02	*	G	G	G	
	4	DMP03	*	G	G	G	
Delchevo	5	DMP04	*	G	G	G	G
	7	DMP05	*	G	G	G	
	9	DMP06	*	G	G	G	
Kochani-Shtip	11	DMP07	*	G	G	G	G
	14	DMP08	*	G	G	G	
	16	DMP09	*	G	G	G	
	17	DMP10	*	G	G	G	
	19	DMP11	*	G	G	G	
Ovche Pole	20	DMP12	*	G	G	G	G
	22	DMP13	*	G	G	G	
	24	DMP14	*	G	G	G	
	26	DMP15	*	G	G	G	
Lakavica	29	DMP16	*	G	G	G	G
	31	DMP17	*	G	G	G	
	33	DMP18	*	G	G	G	

G Good status

* Status could not be set because of lack of information

Table 103: Overall quantitive status of GWB

Based on the assessment through the four above mentioned tests the quantitative status of all groundwater bodies is good.

2) Methodology for assessing the chemical status and results

Test 1: Saline or other intrusion

In the test for saline and other intrusion it is assessed, whether there is any kind of intrusion present into the GWB, such as

- marine saline intrusion (not possible in Bregalnica river basin);
- leakage and intrusion of poor water quality river water;
- upward leakage from salty layers;
- up-coning of connate water; and
- intrusion from adjacent poor quality aquifer.

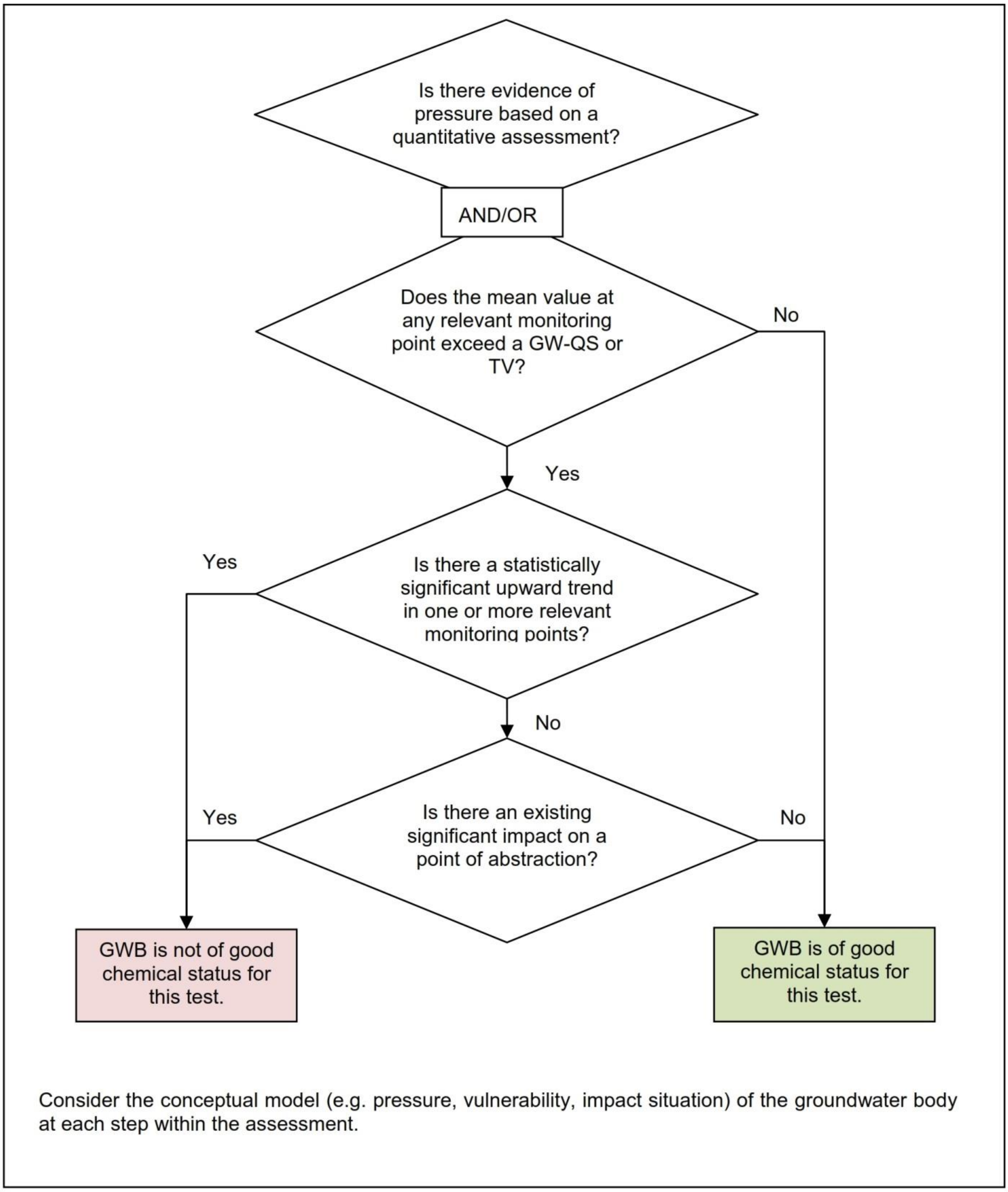


Figure 114: Outline of procedure for the test of saline and other intrusion according WFD Guidance Document No. 18

The results of the saline or other intrusion test are summarized in the following table:

GWB	Nu	ID	Does the mean value at any relevant monitoring point exceed a GW-QS or TV?	Is there a statistically significant upward trend in one or more relevant monitoring points?	Is there an existing significant impact on a point of abstraction?	Groundwater Body Status
Berovo-Pehcevo	1	DMP01	Yes	there aren't enough informations;	No	P
	3	DMP02	Yes	there aren't enough informations;	No	
	4	DMP03	Yes	there aren't enough informations;	No	
Delchevo	5	DMP04	Yes	there aren't enough informations	No	G*
	7	DMP05	Yes	there aren't enough informations	No	
	9	DMP06	Yes	there aren't enough informations	No	
Kochani-Shtip	11	DMP07	Yes	there aren't enough informations	No	P
	14	DMP08	Yes	there aren't enough informations;	No	
	16	DMP09	Yes	there aren't enough informations;	No	
	17	DMP10	Yes	there aren't enough informations;	No	
	19	DMP11	Yes	there aren't enough informations;	No	
Ovche Pole	20	DMP12	Yes	there aren't enough informations;	No	P
	22	DMP13	Yes	there aren't enough informations;	No	
	24	DMP14	Yes	there aren't enough informations;	No	
	26	DMP15	Yes	there aren't enough informations;	No	
Lakavica	29	DMP16	Yes	there aren't enough informations;	No	P
	31	DMP17	Yes	there aren't enough informations;	No	
	33	DMP18	Yes	there aren't enough informations;	No	

Legend:

G	Good
P	Poor
*	Explanation is given in the text below

Table 104: Results of test 1: saline or other intrusion test

As it is mentioned above, the tests of saline and other intrusion for quantity and quality are very closely connected. In the entire Bregalnica river catchment only one ground water body reached good status. All other four are failing to achieve good status and thus have a poor status. Main reasons for the predominant poor status are the occurrence of N-NO_3, P_{tot}, SO_4 and pesticides.

As it can be seen in Table 104, answers on the questions for the test on saline and/or other intrusions are the same for every monitoring point, but only the Delcevo groundwater body reached a good status and the others are with a poor status. There are several reasons for this result.

Statuses are based only on one year monitoring (survelliance and operational), causing a lack of information. From Table 87, it can be seen that the Delcevo groundwater body possesses more qualities than the other groundwater bodies in the Bregalnica catchment, such as for dissolved oxygen, PO_4, SO_4 and Mn. The only lesser performing parameters are conductivity, nitrogen, pesticides (on one monitoring point) and PAH. For PAH, an investigative monitoring was conducted to ascertain their presence in the groundwater. Nitrogen pesticides are detected only in one monitoring point, during the only run of surveillance monitoring. Conductivity is a less relevant indicator for the quality of ground water, as it is mentioned in the Guidance Document No.18. Based on these assessments, the Delcevo groundwater body reaches a good qualitative status.

Below the observations of the conductivity measurements are shown. Those monitoring points showing a high maximum conductivity value such as AMP06, DMP13 or DMP16 were measured after flooding periods. In several monitoring points such as AMP10, DMP13, DMP16 and DMP17 high average values of conductivity were found, which are most likely of geogenic origin.

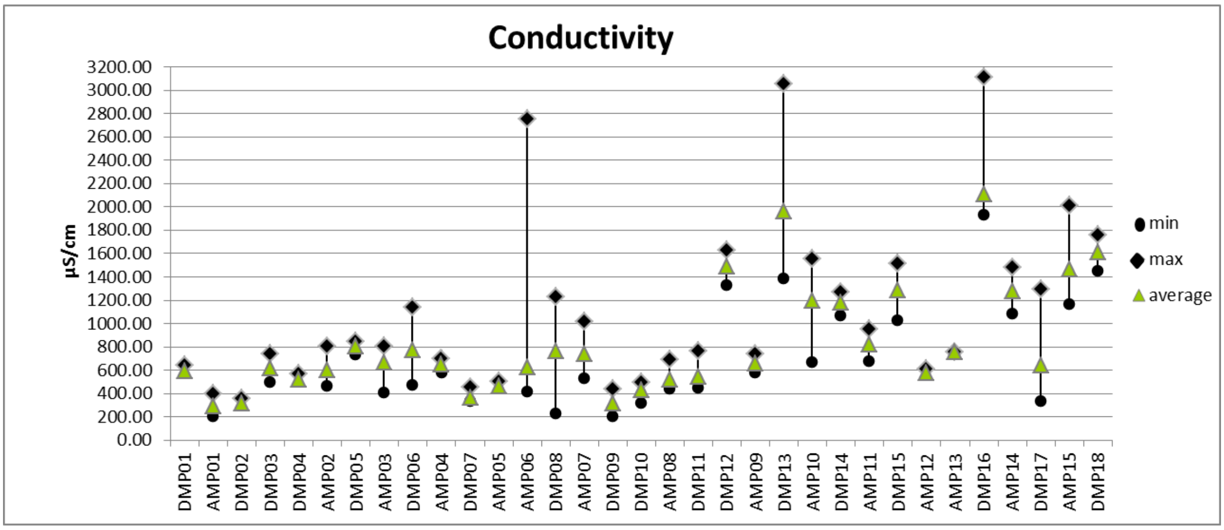


Figure 115: Conductivity in µS/cm with indication of average, minimum and maximum value

Test 2: Significant diminution of associated surface water chemistry and ecology due to transfer of pollutants from the groundwater body (surface water test)

To achieve a good status with respect to this test no significant diminution of the surface water ecology or surface water chemistry shall occur due to the transfer of pollutants from the GWB. The test is based on a combination of surface water classification results and an assessment of chemical inputs from groundwater bodies in the surface water bodies.

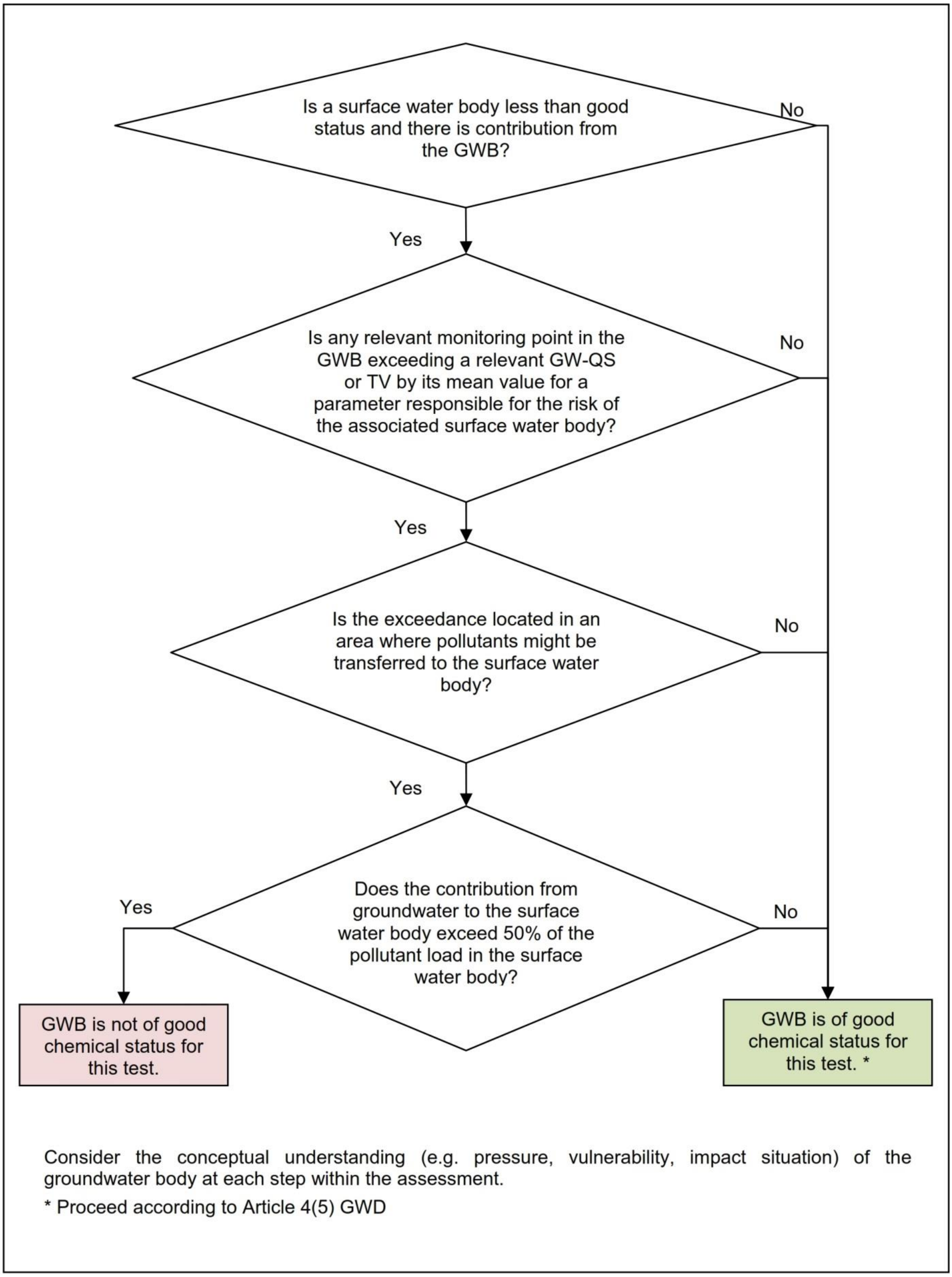


Figure 116: Outline of procedure for test of significant diminution of the ecological or chemical quality of an associated surface water body according WFD Guidance Document No. 18

The results of the surface water test are summarized in the following table:

GWB	Nu	ID	Is a surface water body less than good status and there is contribution from the GWB?	Is any relevant monitoring point in the GWB exceeding a relevant GW-QS or TV by its mean value for a parameter responsible for the risk of the associated surface water body?	Is the exceedance located in an area where pollutants might be transferred to the surface water body?	Does the contribution from groundwater to the surface water body exceed 50% of the pollutant load in the surface water body?	Status	Groundwater Body Status
Berovo-Pehcevo	1	DMP01	Yes	Yes	No	*	G	G
	3	DMP02	Yes	Yes	No	*	G	
	4	DMP03	Yes	Yes	No	*	G	
Delchevo	5	DMP04	Yes	Yes	No	*	G	G
	7	DMP05	Yes	Yes	No	*	G	
	9	DMP06	Yes	Yes	No	*	G	
Kochani-Shtip	11	DMP07	Yes	Yes	No	*	G	G
	14	DMP08	Yes	Yes	No	*	G	
	16	DMP09	Yes	Yes	No	*	G	
	17	DMP10	Yes	Yes	No	*	G	
	19	DMP11	Yes	Yes	No	*	G	
Ovche Pole	20	DMP12	Yes	Yes	No	*	G	G
	22	DMP13	Yes	Yes	No	*	G	
	24	DMP14	Yes	Yes	No	*	G	
	26	DMP15	Yes	Yes	No	*	G	
Lakavica	29	DMP16	Yes	Yes	No	*	G	G
	31	DMP17	Yes	Yes	No	*	G	
	33	DMP18	Yes	Yes	No	*	G	

G Good status

* If answer is "No", then status directly is "Good"

Table 105: Results of test 2: surface water test

In the surface water bodies high concentrations of P_{tot}, N-NO_2, Mn and Cu were found. However, these values could not be related to the measured according values in the groundwater. As there is no indication of significant transfer of pollutants from the groundwater to the surface water, the GBW reached good status for this test.

Test 3: Significant damage to groundwater dependent terrestrial ecosystem (GWDTE) due to transfer of pollutants from the groundwater body

With this test it is determined, whether pollutant concentrations in the GWB may impact a GWDTE or other relevant protected areas.

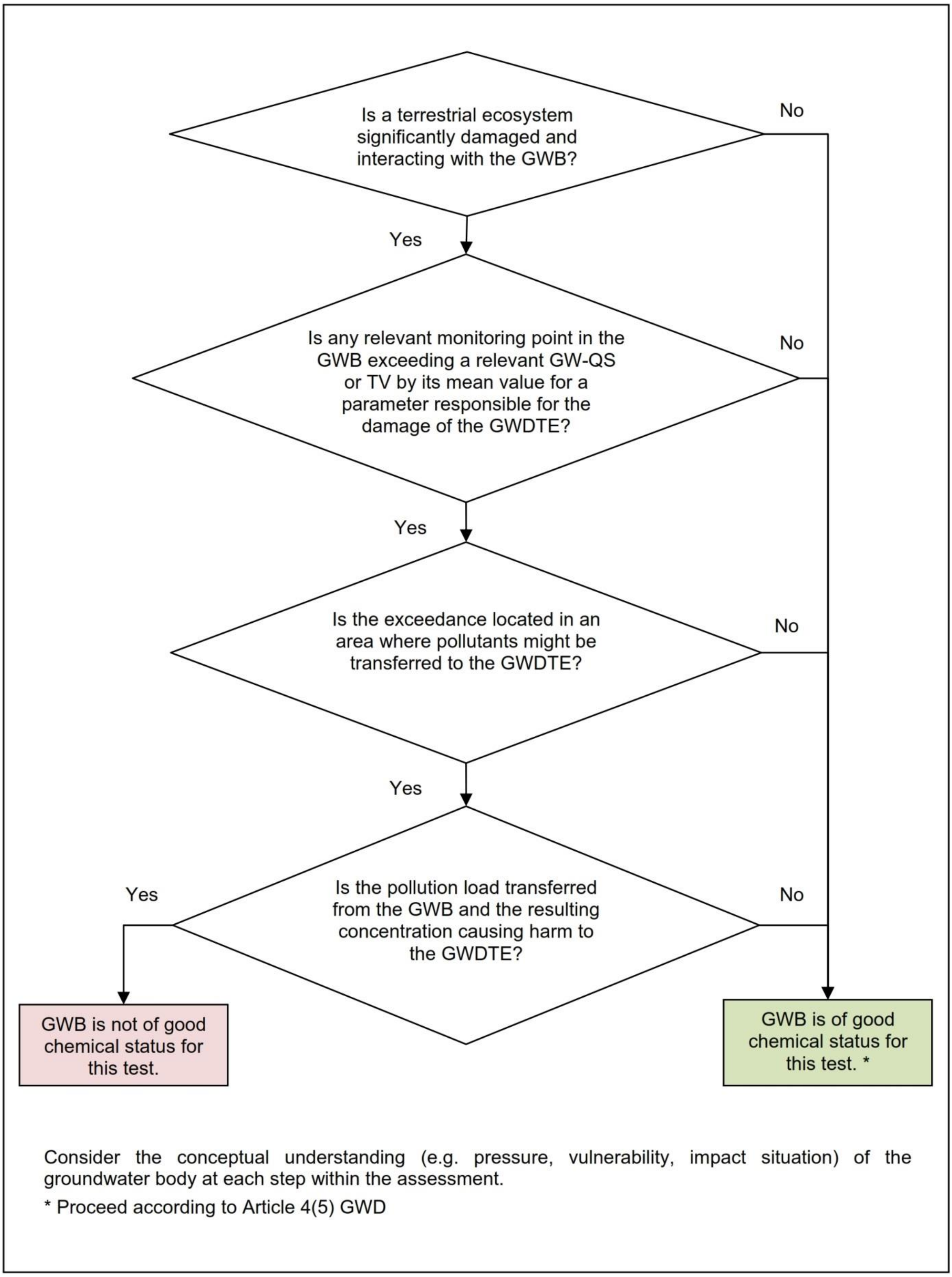


Figure 117: Outline of procedure for test of significant damage of terrestrial ecosystems directly dependent on the GWB according WFD Guidance Document No. 18

The results of the GWDTE test are summarized in the following table:

GWB	Nu	ID	Is a terrestrial ecosystem significantly damaged and interacting with the GWB?	Is any relevant monitoring point in the GWB exceeding a relevant GW-QS or TV by its mean value for a parameter responsible for the damage of the GWDTE?	Is the exceedance located in an area where pollutants might be transferred to the GWDTE?	Is the pollution load transferred from the GWB and the resulting concentration causing harm to the GWDTE?	Status	Ground Water Body Status
Berovo-Pehcevo	1	DMP01	No	*	*	*	G	G
	3	DMP02	No	*	*	*	G	
	4	DMP03	No	*	*	*	G	
Delchevo	5	DMP04	No	*	*	*	G	G
	7	DMP05	No	*	*	*	G	
	9	DMP06	No	*	*	*	G	
Kochani-Shtip	11	DMP07	No	*	*	*	G	G
	14	DMP08	No	*	*	*	G	
	16	DMP09	No	*	*	*	G	
	17	DMP10	No	*	*	*	G	
	19	DMP11	No	*	*	*	G	
Ovche Pole	20	DMP12	No	*	*	*	G	G
	22	DMP13	No	*	*	*	G	
	24	DMP14	No	*	*	*	G	
	26	DMP15	No	*	*	*	G	
Lakavica	29	DMP16	No	*	*	*	G	G
	31	DMP17	No	*	*	*	G	
	33	DMP18	No	*	*	*	G	

G Good status

* If answer is "No", then status directly is "Good"

Table 106: Results of test 3: GWDTE test

In the Bregalnica river catchment no GWDTE have been classified as such so far. This is most likely due to not performing according investigations or due to lack of site-specific information. Thus, according to WFD Guidance No.18 all groundwater bodies have a good status for this test.

Test 4: Meet the requirements of WFD Article 7(3) – Drinking Water Protected Areas (DWPA test)

Drinking water protected areas (DWPA) are assessed in this test with respect to significant and sustained changes or trends in the untreated water quality due to anthropogenic influences. If a change is noticed, the impact on the level of treatment shall be assessed.

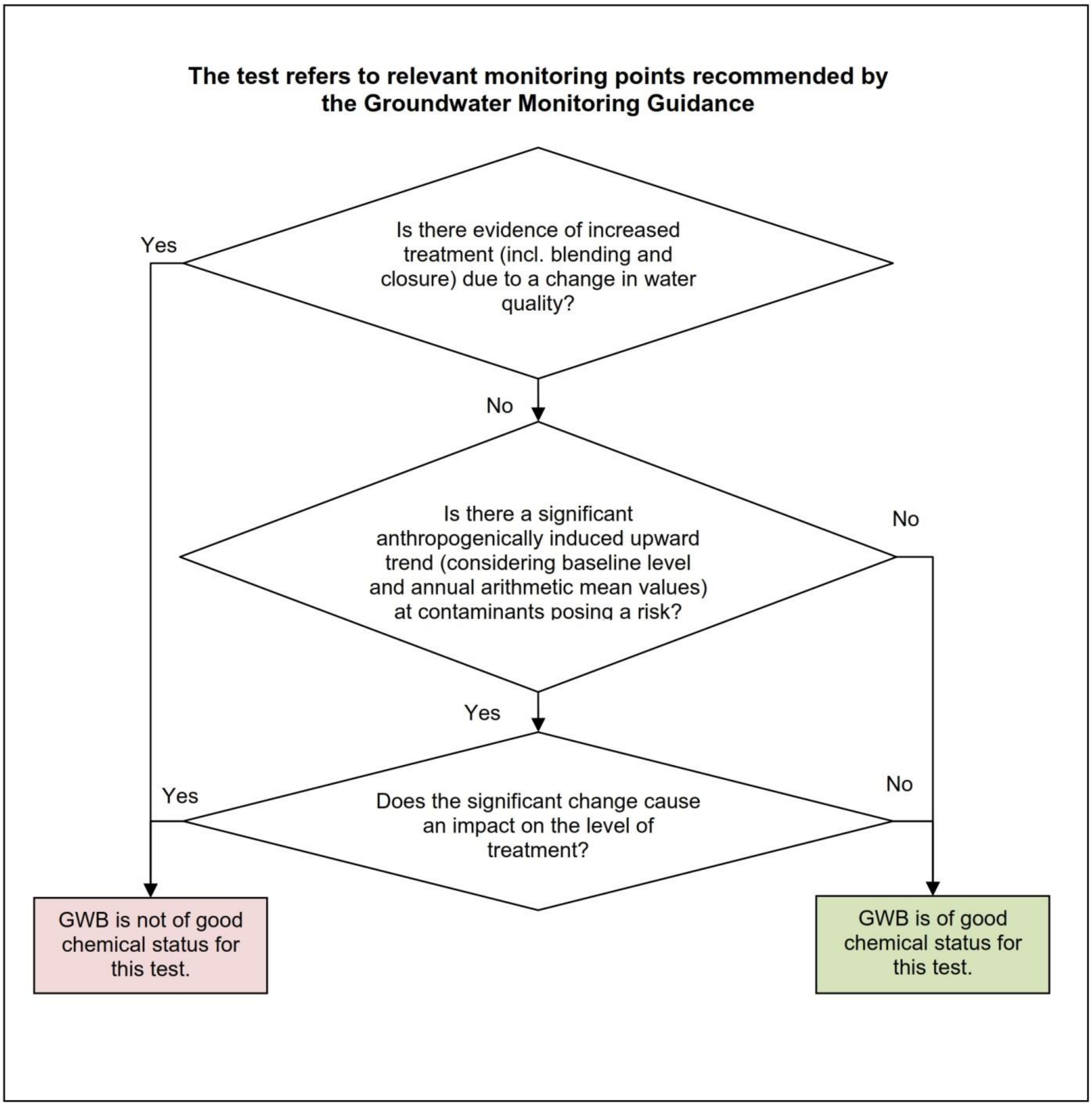


Figure 118: Proposed procedure for meeting the requirements of WFD Article 7(3) – DWPAs according WFD Guidance Document No. 18

The results of the DWPA test are summarized in the following table:

GWB	Nu	ID	Is there evidence of increased treatment (incl. blending and closure) due to a change in water quality?	Is there a significant anthropogenically induced upward trend (considering baseline level and annual arithmetic mean values) at contaminants posing a risk?	Does the significant change cause an impact on the level of treatment?	Status	Groundwater Body Status
Berovo-Pehcevo	1	DMP01	No	Yes	No	G	G
	3	DMP02	No	Yes	No	G	
	4	DMP03	No	Yes	No	G	
Delchevo	5	DMP04	No	Yes	No	G	G
	7	DMP05	No	Yes	No	G	
	9	DMP06	No	Yes	No	G	
Kochani-Shtip	11	DMP07	No	Yes	No	G	G
	14	DMP08	No	Yes	No	G	
	16	DMP09	No	Yes	No	G	
	17	DMP10	No	Yes	No	G	
	19	DMP11	No	Yes	No	G	
Ovche Pole	20	DMP12	No	Yes	No	G	G
	22	DMP13	No	Yes	No	G	
	24	DMP14	No	Yes	No	G	
	26	DMP15	No	Yes	No	G	
Lakavica	29	DMP16	No	Yes	No	G	G
	31	DMP17	No	Yes	No	G	
	33	DMP18	No	Yes	No	G	

G Good status

Table 107: Results of test 3: DWPA test

Although increased concentrations of several parameters were found in groundwater such as conductivity, dissolved CO_2, $N\text{-}NO_3$, $N\text{-}NH_4$, P_{tot}, Mg, SO_4, CO_3, Mn, PAH, pesticides and low concenrtations of DO (dissolved oxygen), all GWB still have a good status, because these parameters do not threaten human health. The samples that were taken are from raw and untreated water, which after treatment is suitable for human consumption.

The overall chemical status of the GWBs is summarized in the following table:

GWB	Nu	ID	Municipality	Saline or other intrusions	Significant diminution of associated surface water chemistry and ecology due to transfer of pollutants from the groundwater body	Significant damage to groundwater dependent terrestrial ecosystems (GWDTE) due to transfer of pollutants from the groundwater body	Meet the requirements of WFD Article 7(3) - Drinking Water Protected Areas	Groundwater Body Status
Berovo-Pehcevo	1	DMP01	Berovo	P	G	*According Guidenc No.18: The test should be performed for all groundwater bodies which are connected to GWDTE that are significantly damaged (or at risk of damage) considering the conceptual model of each groundwater body during each stage of the assessment.* In our situation we are not familiar with existence any GWBTE.	G	P
	3	DMP02	Berovo-PSOV	P	G		G	
	4	DMP03	Berovo (Machevo)	P	G		G	
Delchevo	5	DMP04	Delchevo (Trabotiviste)	G	G		G	G
	7	DMP05	Delchevo (Plastenik)	G	G		G	
	9	DMP06	Delchevo (Mlekara Golak)	G	G		G	
Kochani-Shtip	11	DMP07	Vinica	P	G		G	P
	14	DMP08	Kochani (G.Podlog-Danivo)	P	G		G	
	16	DMP09	Probishtip (v.Tripatanci)	P	G		G	
	17	DMP10	Shtip	P	G		G	
	19	DMP11	Karbinci	P	G		G	
Ovche Pole	20	DMP12	Sv.Nikole(Agrofer)	P	G		G	P
	22	DMP13	Sv.Nikole(BIM)	P	G		G	
	24	DMP14	Lozovo(Prodavnica)	P	G		G	
	26	DMP15	Sv.Nikole(Mustafino_02)	P	G		G	
Lakavica	29	DMP16	Shtip(20km)	P	G		G	P
	31	DMP17	Shtip(v.Lakavica)	P	G		G	
	33	DMP18	Shtip(KPU-Shtip)	P	G		G	

Based on the assessment through the four above mentioned tests the chemical status of all groundwater bodies is poor except the Delchevo groundwater body which has a good status.

A14 Environmental Objectives

In Table 108, the deadlines for achieving a good status for each surface water body are given.

Category	ID	Name	Categorized in quality class*	Deadline for Good Status
Rivers	SR_01	Bregalnica 1	II	2015
	SR_02	Bregalnica 2	II	2021
	SR_03	Bregalnica 3	II	2021
	SR_04	Bregalnica 4	II	2027
	SR_05	Bregalnica 5	III	2027
	SR_06	Bregalnica 6	III	Less stringent
	SR_07	Bregalnica 7	III	Less stringent
	SR_08	Bregalnica 8	III	Less stringent
	SR_09	Bregalnica 9	III	Less stringent
	SR_10	Bregalnica 10	III	Less stringent
	SR_11	Ratevska 1		2015
	SR_12	Ratevska 2	II	2015
	SR_13	Zelevica		2015
	SR_14	Kamenica	II	2021
	SR_15	Osojnica	II (III)	2021
	SR_16	Zrnovska	II	2027
	SR_17	Orizarska	II & III	2021
	SR_18	Kocanska 1		2015
	SR_19	Kocanska 2	II & III	2021
	SR_20	Kozjacka		2027
	SR_21	Zletovska	II & III	2021
	SR_22	Otinja	III	2021
	SR_23	Lakavica 1		2021
	SR_24	Lakavica 2	III	2027
	SR_25	Svetinikolska 1		2021
	SR_26	Orelska/Mavrovica		2027
	SR_27	Svetinikolska 1	III	2027
Heavily modified water bodies	AL_01	Berovsko/Ratevo	II	2021
	AL_02	Kalimanci	II	2027
	AL_03	Gradce	II	2021
	AL_04	Zletovo	II	2021
	AL_05	Mantovo	II	2021
	AL_06	Mavrovica	II	2021

Category	ID	Name	Categorized in quality class*	Deadline for Good Status
Artificial water bodies	AC_01	Left Main Irrigation Channel	n/a	2021
	AC_02	Right Main Irrigation Channel, Upper Part	n/a	2021
	AC_03	Right Main Irrigation Channel, Lower Part	n/a (III)	2021

*Table 108: Definition of deadline for achieving good status for each surface water body; n/a: not applicable; *: quality target in categories, according to the decree on the classification of waters (Official Gazette of the Republic of Macedonia No. 18/99 of 31.09.1999), and the decree on the categorization of watercourses, lakes, reservoirs and groundwater (Official Gazette of the Republic of Macedonia No. 18/99 of 31.09.1999)*

Reasons for less stringent objectives for certain water bodies

For the lower parts of the Bregalnica river (i.e. water bodies SR_6 to SR_10) it is anticipated that achieving a good status, even by 2027, is not feasible. These stretches carry the combined pollution load from agriculture and wastewater from the main settlements and the areas with intensive agricultural use. At the same time, flow is rather low during the irrigation season in these stretches of the Bregalnica due to upstream irrigation intakes. This adds additional pressure (e.g. high water temperatures and reduced water depths) on the aquatic environment in these stretches.

Exemptions with permitted deterioration for certain water bodies

There are no exemptions foreseen so far.

A15 Detailed Program of Measures

Addressed gaps and pressures, estimated costs

	MEASURES	Improvement required regarding = "Gap analysis"	Will reduce pressures				Completed by			Priority	Responsible for ensuring action	Who will take action on the ground?	Indicators	Total Costs [MKD]
			Households	Industry	Agriculture	Other pressures	2015	2021	2027					
1	**Wastewater collection and treatment**													
1.1	**Small infrastructure projects**	Input of nutrients and hazardous substances (amongst others)	x				x			1	RBM Project	Municipality	#of completed projects	**120'000'000**
1.2	**Construction of WWTP - municipalities with more than 15'000 population equivalent**	Input of nutrients and hazardous substances	x					x	x	1	MoePP	Municipality	% of treated communal waste water # of designed WWTP	
1.2.1	Construction of WWTP Kochani	Input of nutrients and hazardous substances	x					x		1	GoM	Municipality	% of treated communal waste water	1'353'000'000
1.2.2	Construction of WWTP for Delchevo	Input of nutrients and hazardous substances	x						x	1	MoePP	Municipality	% of treated communal waste water	701'100'000
1.2.3	Construction of WWTP for Vinica	Input of nutrients and hazardous substances	x					x		1	MoePP	Municipality	% of treated communal waste water	719'550'000
1.2.4	Construction of WWTP for Probishtip	Input of nutrients and hazardous substances	x						x	1	MoePP	Municipality	% of treated communal waste water	510'450'000
1.2.5	Construction of WWTP for Stip	Input of nutrients and hazardous substances	x						x	1	MoePP	Municipality	% of treated communal waste water	1'918'800'000
1.3	**Construction of WWTP - municipalities from 2'000 to 15'000 population equivalent**	Input of nutrients and hazardous substances	x					x		2	MoePP	Municipality	% of treated communal waste water # of designed WWTP	
1.3.1	Construction of WWTP for Pehchevo	Input of nutrients and hazardous substances	x						x	2	MoePP	Municipality	% of treated communal waste water	
1.3.2	Construction of WWTP for M. Kamenica	Input of nutrients and hazardous substances	x						x	2	GoM	Municipality	% of treated communal waste water	50'000'000
1.3.3	Construction of WWTP for Zrnovci	Input of nutrients and hazardous substances	x						x	2	MoePP	Municipality	% of treated communal waste water	26'752'500
1.3.4	Construction of WWTP for Ceshinovo-Obleshevo	Input of nutrients and hazardous substances	x					x		2	MoePP	Municipality	% of treated communal waste water	26'752'500
1.3.5	Construction of WWTP for Karbinci	Input of nutrients and hazardous substances	x				x			2	MoePP	Municipality	% of treated communal waste water	26'752'500
1.4	**Construction of WWTP - 0 to 2'000 population equivalent**	Input of nutrients and hazardous substances	x					x		2	MoePP	Municipality	% of treated communal waste water # of designed WWTP	
1.4.1	Construction of WWTP for Kucicino	Input of nutrients and hazardous substances	x				x			3	MoePP	Municipality	% of treated communal waste water	12'300'000
1.4.2	Construction of WWTP for Gabrevci	Input of nutrients and hazardous substances	x				x			2	MoePP	Municipality	% of treated communal waste water	9'840'000
1.4.3	Construction of WWTP for municipality of Berovo: v.Rusinovo, Dvoriste, Ratevo, Vladimirovo, Smojmirovo, Macevo, Budinarci, Mitrasinci	Input of nutrients and hazardous substances	x					x		2	MoePP	Municipality	% of treated communal waste water	

	MEASURES	Improvement required regarding = "Gap analysis"	Will reduce pressures				Completed by			Priority	Responsible for ensuring action	Who will take action on the ground?	Indicators	Total Costs [MKD]
			Households	Industry	Agriculture	Other pressures	2015	2021	2027					
1	**Wastewater collection and treatment**													
1.5	**Extension of existing sewerage networks and sewage collectors**	Collection and disposal of wastewater	x	x			x	x		1-3	MOEPP / GoM	Municipality	% of population covered	
1.5.1	Sewerage network in Gabrevci - Konce	For connection to WWTP Gabrevci - BRBMP SIP 2 Proeject	x	x			x			1	GoM	Municipality	% of population covered	8'397'792
1.5.2	Sewerage network in Vidovise - Zrnovci	Wastewater disposal	x	x				x		1	GoM	Municipality	% of population covered	5'938'619
1.5.3	Sewerage network in Kucicino - Cesinovo Oblesevo	For connection to WWTP Kucicino - BRBMP SIP 2 Proeject	x	x				x		1	GoM	Municipality	% of population covered	16'911'276
1.5.4	Sewerage network in Gorodinci - S Nikole	Wastewater disposal	x	x				x		1	GoM	Municipality	% of population covered	5'706'641
1.5.5	Completion of sewerage network for municipality of Berovo. v. Rusinovo, Dvoriste, Ratevo, Vladimirovo, Smojmirovo, Macevo, Budinarci, Mitrasinci	Wastewater disposal	x					x		1	MOEPP	Municipality	% of population covered	
1.5.6	Completion of sewerage network for municipality of Berovo: Delchevo, v. Bigla, Vetren, Virce, Vratislavci	Wastewater disposal	x						x	3	MOEPP	Municipality	% of population covered	
1.5.7	Completion of sewerage network for municipality of Pehchevo: Robovo, Ciflik, Negrevo, Crnik, Pancarevo	Wastewater disposal	x					x		2	MOEPP	Municipality	% of population covered	
1.5.8	Completion of sewerage network for municipality of Makedonska Kamenica: v.Dulica, Kosevica, Kostin Dol, Lukovica, Moshtica, Sasa, Todorovci, Cera	Wastewater disposal	x					x		2	MOEPP	Municipality	% of population covered	
1.5.9	Completion of sewerage network for Vinica, v.Jakimovo, Pekljani (municipality of Vinica)	Wastewater disposal	x						x	3	MOEPP	Municipality	% of population covered	
1.5.10	Completion of sewerage network for municipality of Zrnovci: Zrnovci, Vidoviste	Wastewater disposal	x					x		2	MOEPP	Municipality	% of population covered	
1.5.11	Completion of sewerage network for Kocani, Orizari town (since 2005 part of municipality of Kocani), v.Pribacevo (main village of Orizari), Beli, Gorni Podlog, Dolni Podlog, Grdovci, Mojanci, Trkanje, Leshki, Nivicani, pantelej, Rajcani,Gorno Gradec, Jastrebnik, Polaki (municipality of Kochani)	Wastewater disposal	x					x		2	MOEPP	Municipality	% of population covered	
1.5.12	Completion of sewerage network for municipality of Chesinovo-Obleshevo: Obleshevo, Chesinovo, Chiflik	Wastewater disposal	x					x		2	MOEPP	Municipality	% of population covered	
1.5.13	Completion of sewerage network for Probistip and v.Kalniste, Buciste, Gajranci, Gorni Stubol, Gorno Barbarevo, Griizilevci, Gujnovci, Dobrevo, Dolni Stubol, Drenok, Kundino, Lezovo, Marcino, Nekoazi, Plesenci, Puzderci, Strisovci, Strmos, Troolo, Bunes, Dolno Barbarevo, Dreveno, Zarapinci, Zelengrad, Zletovo, Jamiste, Kukovo, Lesnovo, Pestrisino, Petrisino, Pisica, Ratavica, Tripatanci, Turski Rudari, Stalkavica; m. Probishtip	Wastewater disposal	x						x	3	MOEPP	Municipality	% of population covered	
1.5.14	Completion of sewerage network for Blizanci, Vakuf, Gorno, Kratovo, Dimance, Emirica, Zeleznica, Zivalevo, Kavrak, Ketenovo, Knezevo, Kojkovo, Krilatica, Konjuk, Kuklica, Kunovo, Lukovo, Muskovo, Nezilovo, Pendak, Prikovci, Sekulica, Stracin, Talashmance, Tatomir, Topolnik, Trnovac, Turalevo, Filipovci, Shlegovo, Shopsko Rudare (municipality of Kratovo)	Wastewater disposal	x						x	3	MOEPP	Municipality	% of population covered	
1.5.15	Completion of sewerage network for Karbinci, Argulica, Dolni Balvan, Krupiste, Radanje, Tarinci (municipality of Karbinci)	Wastewater disposal	x					x		2	MOEPP	Municipality	% of population covered	
1.5.16	Completion of sewerage network for Stip and v.Baltalija, Brest, Vrsakovo, Goracino, Dobrosani, Dolani, Dragoevo, Krivi dol, Lakavica, Leskovica, Ljuboten, Piperevo, Pochivalo, Puhce, Sarievo, Selce, Sofilari, Star Karaorman, Stepanci, Suvo Grlo, Sudic, Sushevo, Sasavarlija (municipality of Shtip)	Wastewater disposal	x						x	3	MOEPP	Municipality	% of population covered	
1.5.17	Completion of sewerage network for Amzabegovo, Gorobinci, Gorno Crniliste, Dolno Djudjance, Dolno Crniliste, Erdzelija, Kadrifakovo, Knezje, Krusica, Mustafino, Nemanjica, Orel, Pavlesenci, Pesirovo, Preod, Rancinci, Sopot, Stanjevci, Trstenik (municipality of Sveti Nikole)	Wastewater disposal	x					x		2	MOEPP	Municipality	% of population covered	
1.5.18	Completion of sewerage network for Adjibegovo, Bekirlija, Durfulija, Gjuzemelci, Karatmanovo, Kisino, Milino, Saramzalino, Kjoselari, Adjimatovo (municipality of Lozovo)	Wastewater disposal	x					x		2	MOEPP	Municipality	% of population covered	
1.5.19	Completion of sewerage network for municipality of Konche: Konche, Dolni Lipovik, Dedino, Rakitec	Wastewater disposal	x						x	3	MOEPP	Municipality	% of population covered	

	MEASURES	Improvement required regarding = "Gap analysis"	Will reduce pressures: Households	Will reduce pressures: Industry	Will reduce pressures: Agriculture	Will reduce pressures: Other pressures	Completed by: 2015	Completed by: 2021	Completed by: 2027	Priority	Responsible for ensuring action	Who will take action on the ground?	Indicators	Total Costs [MKD]
1	**Wastewater collection and treatment**													
1.5	**Extension of existing sewerage networks and sewage collectors**	Collection and disposal of wastewater	x	x			x	x		1-3	MoePP / GoM	Municipality	% of population covered	
1.5.1	Sewerage network in Gabrevci - Konce	For connection to WWTP Gabrevci - BRBMP SIP 2 Proeject	x	x			x			1	GoM	Municipality	% of population covered	8'397'792
1.5.2	Sewerage network in Vidovise - Zrnovci	Wastewater disposal	x	x				x		1	GoM	Municipality	% of population covered	5'938'619
1.5.3	Sewerage network in Kucicino - Cesinovo Oblesevo	For connection to WWTP Kucicino - BRBMP SIP 2 Proeject	x	x				x		1	GoM	Municipality	% of population covered	16'911'276
1.5.4	Sewerage network in Gorodinci - S Nikole	Wastewater disposal	x	x				x		1	GoM	Municipality	% of population covered	5'706'641
1.5.5	Completion of sewerage network for municipality of Berovo. v. Rusinovo, Dvoriste, Ratevo, Vladimirovo, Smojmirovo, Macevo, Budinarci, Mitrasinci	Wastewater disposal	x					x		1	MoePP	Municipality	% of population covered	
1.5.6	Completion of sewerage network for municipality of Berovo: Delchevo, v. Bigla, Vetren, Virce, Vratislavci	Wastewater disposal	x						x	3	MoePP	Municipality	% of population covered	
1.5.7	Completion of sewerage network for municipality of Pehchevo: Robovo, Ciflik, Negrevo, Crnik, Pancarevo	Wastewater disposal	x					x		2	MoePP	Municipality	% of population covered	
1.5.8	Completion of sewerage network for municipality of Makedonska Kamenica: v.Dulica, Kosevica, Kostin Dol, Lukovica, Moshtica, Sasa, Todorovci, Cera	Wastewater disposal	x					x		2	MoePP	Municipality	% of population covered	
1.5.9	Completion of sewerage network for Vinica, v.Jakimovo, Pekljani (municipality of Vinica)	Wastewater disposal	x						x	3	MoePP	Municipality	% of population covered	
1.5.10	Completion of sewerage network for municipality of Zrnovci: Zrnovci, Vidoviste	Wastewater disposal	x					x		2	MoePP	Municipality	% of population covered	
1.5.11	Completion of sewerage network for Kocani, Orizari town (since 2005 part of municipality of Kocani), v.Pribacevo (main village of Orizari), Beli, Gorni Podlog, Dolni Podlog, Grdovci, Mojanci, Trkanje, Leshki, Nivicani, pantelej, Rajcani,Gorno Gradec, Jastrebnik, Polaki (municipality of Kochani)	Wastewater disposal	x					x		2	MoePP	Municipality	% of population covered	
1.5.12	Completion of sewerage network for municipality of Chesinovo-Obleshevo: Obleshevo, Chesinovo, Chiflik	Wastewater disposal	x					x		2	MoePP	Municipality	% of population covered	
1.5.13	Completion of sewerage network for Probistip and v.Kalniste, Buciste, Gajranci, Gorni Stubol, Gorno Barbarevo, Griizilevci, Gujnovci, Dobrevo, Dolni Stubol, Drenok, Kundino, Lezovo, Marcino, Nekoazi, Plesenci, Puzderci, Strisovci, Strmos, Troolo, Bunes, Dolno Barbarevo, Dreveno, Zarapinci, Zelengrad, Zletovo, Jamiste, Kukovo, Lesnovo, Pestrisino, Petrisino, Pisica, Ratavica, Tripatanci, Turski Rudari, Stalkavica; m. Probishtip	Wastewater disposal	x						x	3	MoePP	Municipality	% of population covered	
1.5.14	Completion of sewerage network for Blizanci, Vakuf, Gorno, Kratovo, Dimance, Emirica, Zeleznica, Zivalevo, Kavrak, Ketenovo, Knezevo, Kojkovo, Krilatica, Konjuk, Kuklica, Kunovo, Lukovo, Muskovo, Nezilovo, Pendak, Prikovci, Sekulica, Stracin, Talashmance, Tatomir, Topolnik, Trnovac, Turalevo, Filipovci, Shlegovo, Shopsko Rudare (municipality of Kratovo)	Wastewater disposal	x						x	3	MoePP	Municipality	% of population covered	
1.5.15	Completion of sewerage network for Karbinci, Argulica, Dolni Balvan, Krupiste, Radanje, Tarinci (municipality of Karbinci)	Wastewater disposal	x					x		2	MoePP	Municipality	% of population covered	
1.5.16	Completion of sewerage network for Stip and v.Baltalija, Brest, Vrsakovo, Goracino, Dobrosani, Dolani, Dragoevo, Krivi dol, Lakavica, Leskovica, Ljuboten, Piperevo, Pochivalo, Puhce, Sarievo, Selce, Sofilari, Star Karaorman, Stepanci, Suvo Grlo, Sudic, Sushevo, Sasavarlija (municipality of Shtip)	Wastewater disposal	x						x	3	MoePP	Municipality	% of population covered	
1.5.17	Completion of sewerage network for Amzabegovo, Gorobinci, Gorno Crniliste, Dolno Djudjance, Dolno Crniliste, Erdzelija, Kadrifakovo, Knezje, Krusica, Mustafino, Nemanjica, Orel, Pavlesenci, Pesirovo, Preod, Rancinci, Sopot, Stanjevci, Trstenik (municipality of Sveti Nikole)	Wastewater disposal	x					x		2	MoePP	Municipality	% of population covered	
1.5.18	Completion of sewerage network for Adjibegovo, Bekirlija, Durfulija, Gjuzemelci, Karatmanovo, Kisino, Milino, Saramzalino, Kjoselari, Adjimatovo (municipality of Lozovo)	Wastewater disposal	x					x		2	MoePP	Municipality	% of population covered	
1.5.19	Completion of sewerage network for municipality of Konche: Konche, Dolni Lipovik, Dedino, Rakitec	Wastewater disposal	x						x	3	MoePP	Municipality	% of population covered	

	MEASURES	Improvement required regarding = "Gap analysis"	Will reduce pressures: Households	Industry	Agriculture	Other pressures	Completed by: 2015	2021	2027	Priority	Responsible for ensuring action	Who will take action on the ground?	Indicators	Total Costs [MKD]
1	**Wastewater collection and treatment**													
1.5	**Extension of existing sewerage networks and sewage collectors**	Collection and disposal of wastewater	x	x			x	x		1-3	MOEPP / GoM	Municipality	% of population covered	
1.5.20	Wastewater collector for municipality of Berovo: v. Rusinovo,Dvoriste, Ratevo, Vladimirovo, Smojmirovo, Macevo, Budinarci, Mitrasinci	Collection of wastewater	x					x		2	MOEPP	Municipality	% of population covered	
1.5.21	Wastewater collector for m. Delchevo	Collection of wastewater	x					x		2	MOEPP	Municipality	% of population covered	
1.5.22	Wastewater collector for m. Pehchevo	Collection of wastewater	x					x		2	MOEPP	Municipality	% of population covered	
1.5.23	Wastewater collector for m. Makedonska Kamenica	Collection of wastewater	x					x		2	MOEPP	Municipality	% of population covered	
1.5.24	Wastewater collector for m. Vinica	Collection of wastewater	x					x		1	MOEPP	Municipality	% of population covered	
1.5.25	Wastewater collector for m. Kochani	Collection of wastewater	x					x		1	MOEPP	Municipality	% of population covered	
1.5.26	Wastewater collector for m. Ceshesinovo-Obleshevo	Collection of wastewater	x					x		2	MOEPP	Municipality	% of population covered	
1.5.27	Wastewater collector for m. Proboshtip	Collection of wastewater	x						x	3	MOEPP	Municipality	% of population covered	
1.5.28	Wastewater collector for m. Kratovo	Collection of wastewater	x						x	3	MOEPP	Municipality	% of population covered	
1.5.29	Wastewater collector for m. Sveti Nikole	Collection of wastewater	x						x	2	MOEPP	Municipality	% of population covered	
1.5.30	Wastewater collector for v. Hadzimatovo, Kjoselari; m. Lozovo	Collection of wastewater	x						x	2	MOEPP	Municipality	% of population covered	
1.5.31	Wastewater collector for m. Karbinci	Collection of wastewater	x					x		2	MOEPP	Municipality	% of population covered	
1.5.32	Wastewater collector for m.Konche	Collection of wastewater	x						x	2	MOEPP	Municipality	% of population covered	
1.5.33	Rehabilitations of the wastewater collector for m. Shtip	Collection of wastewater	x						x	2	MOEPP	Municipality	% of population covered	
1.5.34	Rehabilitation, reconstruction and extension of sewage network for v.Bigla, Vetren, Virce, Vratislavci; m.Delchevo	Wastewater disposal	x						x	3	MOEPP	Municipality	% of population covered	
1.5.35	Rehabilitation, Reconstruction, Extension of sewage for v.Robovo; m.Pehchevo	Wastewater disposal	x				x			1	MOEPP	Municipality	% of population covered	
1.5.36	Rehabilitation, reconstruction and extension of sewage network for v. Vinicka Krsla, Gradec, Grljani, Dragobrasti, Istibanja, , Krusevo, Laki, Leski, Trsino, Lipec, Blatec, Kalimanci, Crn Kamen; m.Vinica	Wastewater disposal	x						x	2	MOEPP	Municipality	% of population covered	
1.5.37	Rehabilitation, Reconstruction, Extension of sewage for v. Morodvis; m.Zrnovci	Wastewater disposal	x						x	3	MOEPP	Municipality	% of population covered	
1.5.38	Rehabilitation, reconstruction and extension of sewage network for v. Banja, Burilcevo, Vrbica, Ziganci, Kucicino, Lepopelci, Novoselja, Sokolarci, Spancevo, Teranci, Ularci, Ciflik; m.Chesinovo-Obleshevo	Wastewater disposal	x						x	2	MOEPP	Municipality	% of population covered	
1.5.39	Rehabilitation, reconstruction and extension of sewage network for v. Gabrevci, Zagorci, Garvan, Gorni Lipovik, Lubnica, Skorusa; m.Konche	Wastewater disposal	x						x	3	MOEPP	Municipality	% of population covered	
1.5.40	Rehabilitation, reconstruction and extension of sewage network for v. Batanje, Vrteska, Golem Gaber, Gorni Balvan, Gorno Trogerci, Dolno Trogerci, Ebeplija, Junuzlija, Kepekcelija, Kalauzlija, Kozjak, Kurfalija, Kucica, Nov Karaorman, Odjalija, Prnalija, Pripecani, Ruljak, Crvulevo; m.Karbinci	Wastewater disposal	x						x	3	MOEPP	Municipality	% of population covered	
1.6	**Separation of rainwater and sewage networks**	WWTP efficiency	x					x	x	2		Municipality	% of networks separated	
1.6.1	Separating sewage from rainwater and construction of a new sewerage in Kocani	Input of nutrients and hazardous substances	x					x		2	GoM	Municipality	% of networks separated	68'016'294
1.6.2	Completion of atmospheric network for v. Rusinovo,Dvoriste, Ratevo, Vladimirovo, Smojmirovo, Macevo, Budinarci, Mitrasinci ; m. Berovo	WWTP efficiency	x						x	3	MOEPP	Municipality	% of networks separated	
1.6.3	Separation atmospheric from sewage for m. Delchevo	WWTP efficiency	x						x	3	MOEPP	Municipality	% of networks separated	
1.6.4	Separation atmospheric from sewage for m.Pehchevo	WWTP efficiency	x						x	2	MOEPP	Municipality	% of networks separated	
1.6.5	Separation atmospheric from sewage for m.Makedonska Kamenica	WWTP efficiency	x						x	2	MOEPP	Municipality	% of networks separated	
1.6.6	Separation atmospheric from sewage for m.Vinica	WWTP efficiency	x						x	2	MOEPP	Municipality	% of networks separated	
1.6.7	Separation atmospheric from sewage for m.Kochani	WWTP efficiency	x					x		1	MOEPP	Municipality	% of networks separated	
1.6.8	Separation atmospheric from sewage for m.Cheshinovo-Obleshevo	WWTP efficiency	x						x	2	MOEPP	Municipality	% of networks separated	
1.6.9	Separation atmospheric from sewage for m.Probishtip	WWTP efficiency	x						x	3	MOEPP	Municipality	% of networks separated	
1.6.10	Separation atmospheric from sewage for m.Kratovo	WWTP efficiency	x						x	3	MOEPP	Municipality	% of networks separated	
1.6.11	Separation atmospheric from sewage for m.karbinci	WWTP efficiency	x						x	3	MOEPP	Municipality	% of networks separated	
1.6.12	Separation atmospheric from sewage for m.Shtip	WWTP efficiency	x						x	2	MOEPP	Municipality	% of networks separated	
1.6.13	Separation atmospheric from sewage for m.Sveti Nikole	WWTP efficiency	x						x	2	MOEPP	Municipality	% of networks separated	
1.6.14	Separation atmospheric from sewage for m. Lozovo	WWTP efficiency	x						x	3	MOEPP	Municipality	% of networks separated	
1.6.15	Separation atmospheric from sewage for m.Konche	WWTP efficiency	x						x	3	MOEPP	Municipality	% of networks separated	
1.7	**Rehabilitation/reconstruction of existing WWTP**	Input of nutrients and hazardous substances	x					x		2	MOEPP	Municipality	Completed rehabilitation project	
1.7.1	Rehabilitation and reconstruction WWTP Sveti Nikole	Input of nutrients and hazardous substances	x					x		2	MOEPP	Municipality	Completed rehabilitation project	
1.8	**Development of ordinances to regulate discharges**	Legislativ framework for point sources	x					x		2	MOEPP	MOEPP	% of completion	
1.9	**Implementation of ordinances for discharges**	Legislativ framework for point sources	x					x		2	MOEPP	MOEPP	% of completion	

	MEASURES	Improvement required regarding = "Gap analysis"	Will reduce pressures: Households	Will reduce pressures: Industry	Will reduce pressures: Agriculture	Will reduce pressures: Other pressures	Completed by: 2015	Completed by: 2021	Completed by: 2027	Priority	Responsible for ensuring action	Who will take action on the ground?	Indicators	Total Costs [MKD]
2	**Solid waste treatment**													
2.1	**Establishment of efficient systems for agricultural solid waste management**				x			x		1	MOEPP	Municipality	% of treated solid waste generated frm agricultural activities	**15'670'000**
2.1.1	Facilities for organized collection of solid waste from agriculture (plastic bags and packages of fertilizers and pesticides)	Contamination of soil and water courses with inorganic and organic waste			x			x		1	MOEPP	Municipality	% of treated solid waste generated frm agricultural activities	4'300'000
2.1.2	Special locations for washing of sprayers and dump of excessive hazardous liquids	Contamination of surface and ground water with pesticide recidues and nutrients			x			x		1	MOEPP	Municiplaity	# of farmers using the serviceso f the faciltites #of colected hazardous liquids	5'530'000
2.1.3	Efficient solutions for bio residues management in rice production, orchards and vineyards	Lose of renewable source energy and organic matter and contamination of water courses with bio solids			x			x		2	MAFWE	Municipality, Farmer associations	% of treated biorezidues from rice, orchards and vineyard production, # of produced biofuels or bioproducts	5'840'000
2.2	**Integrated Solid Waste Management - Municipalities East Planning Region**	Poor Solid Waste Management / Illegal waste dumps	x	x				x		1	EPR	Municipalites	% of plan implemented	**835'430'022**
2.2.1	Technical assistance and supervision in solid waste management	Poor Solid Waste Management	x	x				x		1	EPR	Municipalites	% of plan implemented	92'250'000
2.2.2	Revision of Regional Waste Management Plan	Plan obsolete and ambitious	x	x				x		1	EPR	Municipalites	Plan revised and adopted	
2.2.3	Creating priority projects - studies, analysis	Prioritization - Solid Waste Mng.	x	x				x		1	EPR	Public Utility	Prioritization made and adopted	79'950'000
2.2.4	Recycling of waste materials, waste collection places in the region, Equipment and supplies for waste collecting	Amount of solid waste	x	x				x		1	EPR	Municipalites	% solid waste collected % of solid waste recycled	127'853'580
2.2.5	Rehabilitation of permanent landfills and dumps with very high risk	Leaching of hazardous substances	x	x				x		1	EPR	Municipalites	# dumps rehabilitated	172'849'440
2.2.6	Rehabilitation of permanent landfills and dumps with high risk	Leaching of hazardous substances	x	x				x		2	EPR	Municipalites	# dumps rehabilitated	16'651'740
2.2.7	Campaigns to raise public awareness of waste management	Low awareness	x	x				x		1	EPR	Municipalites	# of campaigns % of population outreached	10'455'000
2.2.8	Package of measures for the implementation and campaigns for public awarness	Low awareness	x	x				x		1	EPR	Municipalites	# of reached people by campaign	0
2.2.9	Replacement of equipment for collection of waste and transfer station	Infastructure & and equipment outdated	x	x				x		1	EPR	Municipalites	% of equipment replaced & operational #transfer station completed & operational	130'770'648
2.2.10	Replacement of treatment equipment (plant and machinery)	Infastructure & and equipment outdated	x	x				x		2	EPR	Municipalites	% of equipment replaced & operational	254'845'422
2.2.11	Reinvestment project replacement equipment	Infastructure & and equipment outdated	x	x				x		2	EPR	Municipalites	% of equipment replaced & operational	130'770'648
2.2.12	Selection, recycling and collection packaging waste	Packaging Waste not selected and recycled	x	x				x		1	GoM	Municipalites	% of solid waste recycled	1'000'000
2.2.13	Construction of landfill cell	Landfills not according to Best Practice	x	x				x		1	EPR	Municipalites	# of cells constructed	
2.2.14	Construction of landfill cell type B (for remains)	Landfills not according to Best Practice	x	x				x		1	EPR	Municipalites	# of cells constructed	

	MEASURES	Improvement required regarding = "Gap analysis"	Will reduce pressures: Households	Will reduce pressures: Industry	Will reduce pressures: Agriculture	Will reduce pressures: Other pressures	Completed by: 2015	Completed by: 2021	Completed by: 2027	Priority	Responsible for ensuring action	Who will take action on the ground?	Indicators	Total Costs [MKD]
3	**Control of hazardous substances / Sludge control in mines and quarries**													
3.1	**Ensuring enforcement of the IPPC environmental permits regime**	Lack of implementation of IPPC environmental permits		x				x		1	MOEPP	Industries	# of IPPC permits	
3.2	**Enforcement of the IPPC A environmental permits regime**	Delays of implementation of IPPC A environmental permits		x				x		1	MOEPP	Industries	# of IPPC A permits	
3.3	**Enforcement of the IPPC B environmental permits regime**	Lack of implementation of IPPC B environmental permits		x				x		1	Municip., MOEPP	Industries	# of IPPC B permits	
3.4	**Enforcement of the emission controls of urban wastewater**	Lack of implementation of emission limits according to permits	x	x				x		1	MOEPP, Municip.	MOEPP, Municip.	# of municipalities in full compliance with the regulations	
3.4.1	Technical support for establishment and implementation of a new water services tarif system	Lack of implementation of emission limits according to permits	x					x		1	MOEPP, Municip.	Municip., Utilities	# of municipalities under new tarif system	30'750'000
3.4.2	Improvement of the emission controls of urban wastewater - strengthening of the inspection surveillance-national level	Lack of implementation of emission limits according to permits	x					x		1	MOEPP, Municip.	MOEPP, Municip.	# of water inspectors # of water inspections	3'075'000
3.4.3	Improvement of the emission controls of urban wastewater - strengthening of the inspection surveillance - local level	Lack of implementation of emission limits according to permits	x					x		1	MOEPP, Municip.	Municip.	# of water inspectors # of water inspections	3'075'000
3.5	**Management of contaminated soils / areas**	Lack of knowledge and management regarding contaminated soils		x				x	x	1	MOEPP	MOEPP	% of management plan completed % of remediated / rehabilitated hotspots according to plan	
3.5.1	Inventory of contaminated soils	Investigation/research project		x				x		1	MOEPP	MOEPP	% of investigation area	9'225'000
3.5.2	Elaboration of a plan for treatment of contaminated soils / hot spots	No plan available		x				x		1	MOEPP	MOEPP	% of plan completed	9'225'000
3.5.3	Remediation/rehabilitation of contamination hot-spots (soil) in the Bregalnica catchment	Historical pollution (mining accidents)		x					x	1	MOEPP	MOEPP	% of remediated / rehabilitated hotspots according to plan	153'750'000

	MEASURES	Improvement required regarding = "Gap analysis"	Will reduce pressures: Households	Will reduce pressures: Industry	Will reduce pressures: Agriculture	Will reduce pressures: Other pressures	Completed by: 2015	Completed by: 2021	Completed by: 2027	Priority	Responsible for ensuring action	Who will take action on the ground?	Indicators	Total Costs [MKD]
4	**Tilling techniques and soil erosion control**													
4.1	**Improved land management systems**	Land management not according to best practice			x			x		2	MAFWE	NEA (National Extension Service, Farmer associations	# of ha cultivated with no-tilage or reduced tillage # of ha cultivated with contour farming system	**24'600'000**
4.1.1	Interuction in practice of reduced or no-tillage systems	Soil distrubance and destroying of soil structure			x			x		2	MAFWE	NEA (National Extension Service, Farmer associations	# of ha cultivated with no-tilage or reduced tillage	12'300'000
4.1.2	Introduction in practice of contour farming systems	Production of soil sediment from the arable land on inclinated terains affecting surface water bodies			x			x		2	MAFWE	NEA (National Extension Service, Farmer associations	# of ha cultivated with contour farming system	12'300'000
4.2	**Depletion of surface run-off quantities and sediment loss**	• High soil loss rates and sediment yields (due to bare soils)			x		x	x		2	MAFWE	NEA (National Extension Service, Farmer associations), Municipalities	# of ha of vineyards and orchards with cover crops # of km of buffer zones established	**11'992'000**
4.2.1	Cover crops and mulching in vineyards and orchards for protection of soil surface from rain drops impact and surface run-off	Detoration of soil surface by rain drops and irrigation water			x		x			2	MAFWE	NEA (National Extension Service, Farmer associations	# of ha of vineyards and orchards with cover crops	7'380'000
4.2.2	Establishment of non-tilling buffer zones alongside water courses	Inflow and accumulation of eroded sediment near and into water cources						x		2	MAFWE, MOEPP	Municipalities	# of km of buffer zones established	4'612'000
4.3	**Education on practices related to soil erosion control**	Insufficient knowledge of erosion protection methods			x		x			2	MAFWE	NEA, Scientific community	# of trained extension officers, # of trained farmers	**4'300'000**
4.3.1	Training on management practices for maintenance of Soil Organic Matter content, soil stability and infiltration rate	Low awarenes of the importance of on-farm management practices related to soil erosion and soil fertility			x		x			2	MAFWE	NEA, Scientific community	# of trained extension officers, # of trained farmers	4'300'000

	MEASURES	Improvement required regarding = "Gap analysis"	Will reduce pressures: Households	Will reduce pressures: Industry	Will reduce pressures: Agriculture	Will reduce pressures: Other pressures	Completed by: 2015	Completed by: 2021	Completed by: 2027	Priority	Responsible for ensuring action	Who will take action on the ground?	Indicators	Total Costs [MKD]
5	**Pesticides and fertilizers control**													
5.1	**Install buffer zone alongside watercourses**	Leaching of pesticides in waterbodies (surface and groundwater bodies)			x			x		2	MAFWE	Farmers	# area of buffer zones # of educated farmers	**9'200'000**
5.2	**Educate farmers for proper use of pesticides and waste disposal**	Leaching of pesticides in waterbodies (surface and groundwater bodies)			x			x		2	MAFWE	Farmers	# of educated farmers - reduced concentration of pesticides in groundwater	**3'700'000**
5.3	**Management of livestock and waste stores - controll access of livestock to surface waters - manage waste stores to minimise losses to water environment**	Inputs of organic waste to the water environment			x			x		2	MAFWE	Farmers	# of farmers working according to best prac-tice	**4'300'000**
5.4	**Training for improvement of fertilizer and pesticide use efficiency**	Insuffcient knowledge and awareness for the importance of soil fertility maintenance Degradation of surface and ground water bodies with nutrients originated from diffuse source of polution			x			x		2	MAFWE	NEA, Scientific community	# of soil analysis, # of farmers performing soil analysis % of arable land covered a permanent control system # of prepared plans for fertilisation # of farmers implementing recommendations of fertilisation plans	**4'700'000**
5.4.1	Establishing of system for permanent control of soil fertility	Insuffcient knowledge and awareness for the importance of soil fertility maintenance			x			x		2	MAFWE	NEA, Scientific community	# of soil analysis, # of farmers performing soil analysis % of arable land covered with the permanent control system	3'200'000
5.4.2	Fertilization plans for better efficiency of applied fertilizers and maintenance of soil fertility	Degradation of surface and ground water bodies with nutrients originated from diffuse source of polution			x			x		2	MAFWE	NEA, Scientific community	# of prepared plans for fertilisation # of farmers implementing recommendations of the fertilisation plans	1'500'000
5.5	**Integrated rice production for optimisation of: pest control and water and fertilizer use efficiency**	Insufficient management practices in rice production			x				x	2	MAFWE	NEA, Scientific community	% of rice fileds implementing integrated rice production, # of farmers adopting integrated rice production	**1'500'000**
5.6	**Integrated production in protected environment (greenhouses and plastic houses)**	Insufficient agro-technical practices in vegetable production			x				x	2	MAFWE	NEA, Scientific community	% of rice fileds implementing integrated rice production, # of farmers adopting integrated rice production	**1'500'000**
5.7	**Integrated vine and orchard production for optimisation of: pest control and water and fertilizer use efficiency**	Low management practices in vine and fruit production			x				x	2	MAFWE	NEA, Scientific community	% of rice fileds implementing integrated rice production, # of farmers adopting integrated rice production	**1'500'000**
5.8	**Training for implementing of GAP standards and AE measures in practice**	High risk of contamination of water courses, water supply facilities and human health Contamination of soil and water courses with nutrients and biosolids	x		x				x	2	MAFWE	NEA, Scientific community	# of trained extension officers, # of trained farmers	**6'000'000**
5.8.1	Timely application of adequate quantities of manure	Contamination of soil and water courses with nutrients and biosolids			x			x		2	MAFWE	NEA, Scientific community	# of trained extension officers, # of trained farmers	1'500'000
5.8.2	Adoption of adequate aplication techniques for better fertilizer use efficiency	Contamination of soil and water courses with nutrients and biosolids			x			x		2	MAFWE	NEA, Scientific community	# of trained extension officers, # of trained farmers	1'500'000
5.8.3	Safe manure management during storage and transportation	High risk of contamiantion of water courses, water supply facilities and human health	x		x			x		2	MAFWE	NEA, Scientific community	# of trained extension officers, # of trained farmers	1'500'000
5.8.4	Aplication of measures for safe mineral fertilizer storage and transport	High risk of contamiantion of water courses, water supply facilities and human health	x		x			x		2	MAFWE	NEA, Scientific community	# of trained extension officers, # of trained farmers	1'500'000

	MEASURES	Improvement required regarding = "Gap analysis"	Will reduce pressures: Households	Industry	Agriculture	Other pressures	Completed by: 2015	2021	2027	Priority	Responsible for ensuring action	Who will take action on the ground?	Indicators	Total Costs [MKD]
6	**Soil erosion control in forestry and on pastures**													
6.1	**Afforestation of deforested and degraded forest**	Intense processes of soil erosion and landdegradation				x			x	1	MAFWE	Municipality, PE Macedonian forests	# of ha of aforested land	**184'500'000**
6.2	**Terracing and afforestation of deforested sloppy terrains**	Top soil detoration and loss of fertile layer, Poor supply with nutrients and fast run-off of rain water			x				x	1	MAFWE	Municipality, PE Macedonian forests	# of ha of terraced sloppy agricultural area	**123'000'000**
6.3	**Enforcement of sustainable land management**	Management of sediment deposition			x			x		2	MAFWE	Municiplaity, MAFWE	# of ha of maintaned natural grassland and rangeland # of regulated streams and gullies # of ha of land coverd with agro-forest system of cultivation	**293'970'000**
6.3.1	Maintenance and cleaning of pastures and range lands	Degradation of pastures with low shrubs and wooden species, stones and low nutritive species			x			x		2	MAFWE	Found of pastures	# of ha of maintaned natural grassland and rangeland	92'250'000
6.3.2	Maintenance and construction works on gullies, gaps and streams for collecting of eroded sediment	Deposition of high amount of eroded soil sediment on low lands and surface water bodies			x				x	1	MAFWE	Municiplaity, MAFWE	# of regulated streams and gullies	17'220'000
6.3.3	Implementation of agroforestry	Big areas of sloppy foothils and inclinatd relief forms are deforested and abandoned generating significant ammount of soil sediment			x			x		2	MAFWE	Municipality	# of ha of land coverd with agro-forest system of cultivation	184'500'000
6.4	**Training on implelementing of good management practices for protection of forest and forest ecosystem services**	Bad practices			x			x		2	MAFWE	NEA, Scientific community	# of trained extension officers, # of trained farmers # of trained inspectors	**12'325'000**
6.4.1	Implementation of systainable forest management practices	Lack of extensive application of sustainable forest management, e.g. planning of forest explotation, development of digital data base on forest associations and records of activities			x			x		2	MAFWE	NEA, Scientific community	# of trained extension officers, # of trained farmers	3'075'000
6.4.2	Control of illegal cut and forest fires	Lack in application of prevention measures in forest management, Insufficient awareness on procedures for protection and recovery of degraded forests Training on risk assessment and sanation of damaged forests			x			x		1	MAFWE	NEA, Scientific community	# of trained extension officers, # of trained farmers # of trained inspectors	2'450'000
6.4.3	Control of overgrazing and degradation of pastures and bare lands	Uncontrolled and intensive explotation of natural grass land, Low awareness of the importance of sustainable management and protection of natural grass land			x			x		2	MAFWE	NEA, Scientific community	# of trained extension officers, # of trained farmers # of trained inspectors	3'600'000
6.4.4	Pest conrol in forests	Inexsitance of integrated system for prevention and control of pests in forests			x			x		1	MAFWE	NEA, Scientific community	# of trained extension officers, # of trained farmers # of trained inspectors	3'200'000

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7		**Water use regulation**													
7.1		**Preparation of Groundwater cadaster**	Insufficient control of water abstraction	x	x	x			x		1	MOEPP	MOEPP	% of cadaster completed	**21'525'000**
7.2		**Water Abstraction Controls**	Insufficient control of water abstraction	x	x	x			x		1	MOEPP	MOEPP	# of water rights renewed/issued % of boreholes covered	
	7.2.1	Implementation of the water Law - re-issuance of water rights for surface water utilization	Insufficient control of water abstraction	x	x	x			x		1	MOEPP	MOEPP, Water Sector - Env.Dir	# of water rights renewed/issued	
	7.2.2	Implementation of the water Law - re-issuance of water rights for groundwater utilization	Insufficient control of water abstraction	x	x	x			x		1	MOEPP	MOEPP, Water Sector - Env.Dir	# of water rights renewed/issued % of boreholes covered	
	7.2.3	Setting standards for extractions and water rights in groundwater bodies	Insufficient control of water abstraction	x	x	x			x		1		MOEPP, Water Sector - Env.Dir, SciComm.	# of GW bodies covered % of boreholes covered	**30'750'000**
7.3		**Implement Running Cost Recovery Principle**	Insufficient control of water abstraction	x	x	x			x		1	MOEPP	Municip	% of water services costs recovered	
	7.3.1	Drinking water/water supply		x	x				x		1	MOEPP	Municip	# of municipalities implement	0
	7.3.2	Wastewater collection & treatment	Insufficient control of water abstraction	x	x				x		1	MOEPP	Municip	# of municipalities implement	
	7.3.3	Irrigation water	Insufficient control of water abstraction			x			x		1	MoAFWE	WMs	% irrigation area	
	7.3.4	System of subsidies for improvement of water-use efficiency in irrigation	Insufficient control of water abstraction			x			x		1	MoAFWE	WMs	% water savings # subsidies	
	7.3.5	Installation of water meters in irrigation				x				x	1	MoAFWE	WMs	# water meters % of delivered water	0
	7.3.6	Efficiency incentive water pricing	Insufficient control of water abstraction	x	x	x			x		1	MoAFWE	WMs	# of institutions/oragnisations included	
7.4		**Improved inspection of water use/watr rights surface and groundwater, concessions, discharges**	Insufficient control of water abstraction	x	x	x			x		1	MOEPP, MoAFWE	MOEPP, MoAFWE, Municip.	# of inspections	
	7.4.1	Increased staff		x	x	x			x		1	MOEPP, MoAFWE	MOEPP, MoAFWE, Municip.	# new staff	0
	7.4.2	Increased mandate and financing		x	x	x			x		1	MOEPP, MoAFWE	MOEPP, MoAFWE, Municip.	% increse of financing	0
7.5		**Construction of the dam Rechani on the Orizarska River - Kocani**	Safe and reliable potable water supply	x	x	x			x		1	Government	Municipality	# population covered annual savings [Mm^3 or MKD or kWh]	**2'265'000'000**
7.6		**Rehabilitation of the dam Pisica Probistip**	Safe and reliable potable water supply	x	x	x			x		1	Government	Municipality	# population covered annual savings [Mm^3 or MKD or kWh]	**82'000'000**
7.7		**Modernization of HM systems**	Insuficient network of the irrigation scheme and high percentage of losses in the system			x	x			x	1	MAFWE	Municipality	% of revitalised irrigation sheme, # of newly irrigated area	**349'320'000**
	7.7.1	Complete reconstruction of existing open channels	High losses of irrigation water in damaged and ruined primary and secondary network			x				x	1	MAFWE	MAFWE, Municipality	# of km of completelly reonstructed irrigation channels	66'420'000
	7.7.2	Rehabiltation and maintenance of existing open channels (permanent)	High losses of irrigation water in damaged and ruined primary and secondary network			x			x		1	MAFWE	MAFWE, Municipality	# of km of rehabilitated channel network	221'400'000
	7.7.3	Establishing of new secondary and terciary pipe network	Insuficient density of the secondary and terciary channels network			x				x	1	MAFWE	MAFWE, Municipality	# of km of newly established channel network	61'500'000

	MEASURES	Improvement required regarding = "Gap analysis"	Will reduce pressures				Completed by			Priority	Responsible for ensuring action	Who will take action on the ground?	Indicators	Total Costs [MKD]
			Households	Industry	Agriculture	Other pressures	2015	2021	2027					
7.8	**Replacement of gravity irrigation (surface and furrow) irrigation with pressurized irrigation systems (drip irrigation and microsprinklers) irrigation**	Bad irrigation practices and insufficient water efficiency			x			x	x	2	MAFWE	Farmers	% of irrigated plantations with upgraded irrigation systems	**65'039'940**
7.8.1	Implementing of drip irigation on 18 ha of vienyards and orchards in Argulica	Bad irrigation practices and insufficient water efficiency			x			x		2	MAFWE	Farmers	70% of total area under vienayrds and orchards with improved irrigation systems	929'880
7.8.2	Implementing of drip irigation on 150 ha of vienyards and orchards in Berovo	Bad irrigation practices and insufficient water efficiency			x				x	2	MAFWE	Farmers	70% of total area under vienayrds and orchards with improved irrigation systems	7'749'000
7.8.3	Implementing of drip irigation on 105 ha of vienyards and orchards in Burilcevo	Bad irrigation practices and insufficient water efficiency			x				x	2	MAFWE	Farmers	70% of total area under vienayrds and orchards with improved irrigation systems	5'424'300
7.8.4	Implementing of drip irigation on 81 ha of vienyards and orchards in Burilovci	Bad irrigation practices and insufficient water efficiency			x				x	2	MAFWE	Farmers	70% of total area under vienayrds and orchards with improved irrigation systems	4'184'460
7.8.5	Implementing of drip irigation on 69 ha of vienyards and orchards in Balvan_Batanja	Bad irrigation practices and insufficient water efficiency			x				x	2	MAFWE	Farmers	70% of total area under vienayrds and orchards with improved irrigation systems	3'564'540
7.8.6	Implementing of drip irigation on 100 ha of vienyards and orchards in Lepopelci	Bad irrigation practices and insufficient water efficiency			x				x	2	MAFWE	Farmers	70% of total area under vienayrds and orchards with improved irrigation systems	5'166'000
7.8.7	Implementing of drip irigation on 300 ha of vienyards and orchards in Milino_Durfulija_Lozovo	Bad irrigation practices and insufficient water efficiency			x				x	2	MAFWE	Farmers	70% of total area under vienayrds and orchards with improved irrigation systems	15'498'000
7.8.8	Implementing of drip irigation on 20 ha of vienyards and orchards in Mustafino	Bad irrigation practices and insufficient water efficiency			x			x		2	MAFWE	Farmers	70% of total area under vienayrds and orchards with improved irrigation systems	1'033'200
7.8.9	Implementing of drip irigation on 200 ha of vienyards and orchards in Crniliste_Adzimatovo_Saramzalino	Bad irrigation practices and insufficient water efficiency			x				x	2	MAFWE	Farmers	70% of total area under vienayrds and orchards with improved irrigation systems	10'332'000
7.8.10	Implementing of drip irigation on 71 ha of vienyards and orchards in Teranci_Morodvis	Bad irrigation practices and insufficient water efficiency			x			x		2	MAFWE	Farmers	70% of total area under vienayrds and orchards with improved irrigation systems	3'667'860
7.8.11	Implementing of drip irigation on 30 ha of vienyards and orchards in Trkanja_Banja_Spanchevo	Bad irrigation practices and insufficient water efficiency			x			x		2	MAFWE	Farmers	70% of total area under vienayrds and orchards with improved irrigation systems	1'549'800
7.8.12	Implementing of drip irigation on 115 ha of vienyards and orchards in Vinica	Bad irrigation practices and insufficient water efficiency			x				x	2	MAFWE	Farmers	70% of total area under vienayrds and orchards with improved irrigation systems	5'940'900
7.9	**Training on implementaton of advanced irrigation technologies and practices**	Lack of knowhow in advanced irrigation methods and practices			x			x		2	MAFWE	NEA, Scientific community	# of trained extension officers, # of trained farmers	**6'600'000**
7.9.1	Installation of advanced system for control and decision making in irrigation scheduling in agriculture	Lack of know how in advanced irrigation methods and practices			x			x		2	MAFWE	NEA, Scientific community	# of trained extension officers, # of trained farmers	**3'600'000**
7.9.2	Introducing of feritigation in common agriculture for increasing of water and fertilizer use efficiency	Lack of know how in advanced irrigation methods and practices			x			x		2	MAFWE	NEA, Scientific community	# of trained extension officers, # of trained farmers	**3'600'000**

	MEASURES	Improvement required regarding = "Gap analysis"	Will reduce pressures: Households	Industry	Agriculture	Other pressures	Completed by: 2015	2021	2027	Priority	Responsible for ensuring action	Who will take action on the ground?	Indicators	Total Costs [MKD]
7.10	**Extension of Irrigation Hydrosystems**	Improved irrigation water supply	x	x	x			x		2	GoM, MoAFWE	HMS Bregalnica	Irrigated area [ha]	
7.10.1	Hydro Expansion of HS Bregalnica in Municipality S Nikole	Improved irrigation water supply	x	x	x				x	3	GoM, MoAFWE	HMS Bregalnica	Irrigated area [ha]	200'000'000
7.10.2	Construction of Hydro-system Zletovica 1 (Probistip area)	Improved irrigation water supply	x		x			x		2	GoM, MoAFWE	HS Zletovica	Irrigated area [ha]	
7.10.3	Construction of Hydro-system Zletovica 2 (Kratovo)	Improved irrigation water supply - decrease of resources Bregalnica basin (inter-basin transfer)	x		x			x		2	GoM, MoAFWE	HS Zletovica	Irrigated area [ha] Ongoing investment	
7.10.4	Rehabilitation of a rubber dam in the village Karbinci	Improved irrigation water supply - pressure to river bed	x	x	x			x		2	GoM, MoAFWE	HMS Bregalnica	Irrigated area [ha]	12'000'000
7.10.5	Rehabilitation of existing rubber dams in Chiflik I Grdovci	Improved irrigation water supply - pressure to river bed	x	x	x			x		2	GoM, MoAFWE	HMS Bregalnica	Irrigated area [ha]	9'225'000
7.10.6	Construction of a rubber dam on Bregalnica near the inflow of river Zletovska	Improved irrigation water supply - pressure to river bed	x	x	x			x		2	GoM, MoAFWE	HMS Bregalnica	Irrigated area [ha]	12'000'000
7.11	**Improvement of water supply systems**	Safe and reliable potable water supply	x					x		2	GoM	Municipality	# population covered	
7.11.1	Reconstruction of water supply in Makedonska Kamenica	Safe and reliable potable water supply	x					x		2	GoM	Municipality	# population covered annual savings [Mm³ or MKD or kWh]	19'189'046
7.11.2	Completion of a major pipeline in Grdovski Orman Kocani with previously realized replacing and II Part of the expansion of the zone measuring points for SCADA system in Kocani	Safe and reliable potable water supply	x					x		2	Government	Municipality	# population covered annual savings [Mm³ or MKD or kWh]	42'000'000
7.11.3	Construction of a WS intake the river Kratovska in Kratovo	Safe and reliable potable water supply	x							2	Government	Municipality		54'719'810
7.11.4	Construction and renovation of water supply system HS Zletovica	Safe and reliable potable water supply	x	x	x			x		2	Government	Municipality	# population covered	350'000
7.11.5	Water supply in the village Bunjesh	Safe and reliable potable water supply	x					x		2	Government	Municipality	# population covered	23'174'145
7.11.6	New system for v. Dvorishte, m.Berovo	Safe and reliable potable water supply	x						x	2	MOEPP	Municipality	# population covered	
7.11.7	New system for v. Morodvis, m.Zrnovci	Safe and reliable potable water supply	x						x	2	MOEPP	Municipality	# population covered	
7.11.8	New system for v. Leshki, Nivicani, Pantelej, Rajcani, Gorno Gradec, Jastrebnik, Polaki; m.Kochani	Safe and reliable potable water supply	x						x	2	MOEPP	Municipality	# population covered	
7.11.9	New system for v.Cesinovo, Oblesevo, Vrbica, Ziganci, Lepopelci, Ularci, Ciflic; m.Cheshinovo-Obleshevo	Safe and reliable potable water supply	x						x	2	MOEPP	Municipality	# population covered	
7.11.10	New system for v.Gajranci, Gorno Barbarevo, Gujnovci, Griizilevci, Drenok, Puzderci, Zarapinci, Zelengrad, Jamiste, Kukovo, Pestrisino; m. Probishtip	Safe and reliable potable water supply	x						x	2	MOEPP	Municipality	# population covered	
7.11.11	New system for v.Blizanci, Gorno Kratovo, Dimance, Emirica, Kavrak, Knezevo, Kojkovo, Konjuk, Kuklica, Kunovo, Lukovo, Muskovo, Nezilovo, Pendak, Tatomir; m. Kratovo	Safe and reliable potable water supply	x						x	3	MOEPP	Municipality	# population covered	
7.11.12	New system for v.Batanje, Vrteska, Gorno Trogerci, Dolno Trogerci, Junuzlija, Kepekcelija, Kurfalija, Pripecani, Ruljak; m. Karbinci	Safe and reliable potable water supply	x						x	2	MOEPP	Municipality	# population covered	
7.11.13	New system for v.Baltalija, Brest, Vrsakovo, Goracino, Dobrosan, Krivi Dol, Leskovica, Ljuboten, Pipeevo, pocivalo, Puhce, Sarcievo, Selce, Stepance, Suvo Grlo, Sushevo, Cardaklija, Sasavarlija; m. Shtip	Safe and reliable potable water supply	x						x	2	MOEPP	Municipality	# population covered	
7.11.14	New system Adjibegovo, Bekirlija, Kisino, Karatmanovo; m. Lozovo	Safe and reliable potable water supply	x						x	2	MOEPP	Municipality	# population covered	
7.11.15	New system Garvan; m. Konche	Safe and reliable potable water supply	x						x	2	MOEPP	Municipality	# population covered	
7.11.16	Rehabilitation, Reconstruction, Extension for v. Ratevo, Rusinovo; m. **Berovo**	Safe and reliable potable water supply	x						x	2	MOEPP	Municipality	# population covered	
7.11.17	Rehabilitation, Reconstruction, Extension for v. Bigla, Zvegor, Vetren, Poleto, Iliovo; m. **Delchevo**	Safe and reliable potable water supply	x						x	2	MOEPP	Municipality	# population covered	
7.11.18	Rehabilitation, Reconstruction, Extension for m.Vinica, v. Vinicka Krsla, Gradec, Grljani, Dragobrasti, Istibanja, Jakimovo, Krusevo, Laki, Leski. Pekljani, Trsino, Lipec, Blatec; m. **Vinica**	Safe and reliable potable water supply	x						x	2	MOEPP	Municipality	# population covered	
7.11.19	Rehabilitation, Reconstruction, Extension for m.Kocani, v.Orizari town (since 2005 part of Mun. Kocani), Pribacevo (main village of Orizari), Beli, Gorni Podlog, Dolni Podlog, Grdovci, Mojanci, Trkanje; m. **Kochani**	Safe and reliable potable water supply	x						x	2	MOEPP	Municipality	# population covered	
7.11.20	Rehabilitation, Reconstruction, Extension for v. Bunes; m. **Probishtip**	Safe and reliable potable water supply	x						x	2	MOEPP	Municipality	# population covered	
7.11.21	Rehabilitation, Reconstruction, Extension for v. Vakuf, Zeleznica, Krilatica, Sekulica, Talashmance, Topolnik, Trnovac, Filopovci, Shopsko Rudare; m. **Kratovo**	Safe and reliable potable water supply	x						x	2	MOEPP	Municipality	# population covered	
7.11.22	Rehabilitation, Reconstruction, Extension for v. Karbinci, Nov Karaorman; m. **Karbinci**	Safe and reliable potable water supply	x						x	2	MOEPP	Municipality	# population covered	
7.11.23	Rehabilitation, Reconstruction, Extension for v. Durfulija; m. **Lozovo**	Safe and reliable potable water supply	x						x	2	MOEPP	Municipality	# population covered	

		MEASURES	Improvement required regarding = "Gap analysis"	Will reduce pressures: Households	Industry	Agriculture	Other pressures	Completed by: 2015	2021	2027	Priority	Responsible for ensuring action	Who will take action on the ground?	Indicators	Total Costs [MKD]
8		**Flood control**													
8.1		**Elaboration of a management plan /reservoir operation rules for reservoirs: Ratevo, Kalimaci, Gratche and Mavrovica**	Insufficient flood protection	x	x	x			x		1	MOEPP	HS Bregalnica	# of reservoirs with management plans	**3'100'000**
8.2		**Elaboration of technical documentation for protection/stabilization of Bregalnica River watercourse:**	Insufficient flood protection	x	x	x			x		1	MOEPP, MoAFWE	HS Bregalnica,	# of Bregalnica River sections with tech-nical documentation	**4'920'000**
	8.2.1	Restoration and cleaning of Bregalnica riverbed and banks between Stip and Vinica	Remediation of degraded riverbed and banks (total 45 km)				x		x		2	MOEPP	DRS,HS Bregalnica, HS Zletovica	Length of restored riverbed (km)	350'000
	8.2.2	Stabilization and riverbed proetection at inflow points (tributaries mouths)	Remediation of degraded part so the riverbed and banks				x		x		2	MOEPP	HS Bregalnica,	Length of restored riverbed (km)	350'000
	8.2.3	Restoration and stabilization of riverbed and banks in the areas of temporary water intakes and/or construction of permanent intake structures	Rational water use + flood protection						x		1	MoAFWE	HS Bregalnica,	Length of restored riverbed (km)	12'300'000
	8.2.4	Regular maintenance of regulated parts of rivers Kocanska, Orizarska and Zletovska and lateral canal Banja-Zletovska reka in Kocani field	Maintanance 6 years - 2015-2021				x		x		1	MoAFWE	HS Bregalnica,		6'150'000
	8.2.5	Restoration works for Osojnica river - parts of riverbed and banks and cleaning of the riverbed between the inflow upstream to Krshlanski most (around 6km)	Restoratin of the riverbed				x		x		1	MOEPP, MoAFWE	HS Bregalnica,	Length of restored riverbed (km)	3'690'000
	8.2.6	Restoration measures: demolition of obsolete barriers that obstruct the longitudinal connectivity	Restoratin of the riverbed				x		x		1	MOEPP	HS Bregalnica,	Improved carrying capacity riverbed (m^3/s)	6'150'000
	8.2.7	Measures to improve the flow of sediments in the river environment (by-pass, cleaning, studies ...)	Restoratin of the riverbed				x		x		1	MOEPP	HS Bregalnica,	Improved carrying capacity riverbed (m^3/s)	12'300'000
8.3		**Regular maintenance of drainage canals in Kocani Valley and in Ovce Pole**	Insufficient Drainage maintenance			x			x		1	MoAFWE	HS Bregalnica,	Improved carrying capacity canals (m^3/s)	**1'230'000**
8.4		**Elaboration of Bregalnica Catchment Flood Protection Plan**	Flood protection				x		x		1	MOEPP, Municip	MOEPP, Municip.	% of plan completed	**18'450'000**
	8.4.1	Preliminary Flood Risk Assessment for Bregalnica River Basin	Flood protection				x		x		1	MOEPP, Municip	MOEPP, Municip.	Plan elaborated	6'150'000
	8.4.2	Elaboration of Flood Hazard Maps and Flood Risk Maps	Flood protection				x		x		1	MOEPP, Municip	MOEPP, Municip.	Maps elaborated	6'150'000
	8.4.3	Flood Risk Management Plan	Flood protection				x		x		1	MOEPP, Municip	MOEPP, Municip.	Plan elaborated	6'150'000
8.5		**Urban Planning Measures for Flood protection**	Flood protection	x		x	x			x	1	MOEPP, APP	Municipality	# of Urban Plans updated	
	8.5.1	Revision of Urban Plans, zoning, construction permits	Flood protection	x	x	x	x		x		1	MOEPP, APP	Municipality	# of Urban Plans updated	
8.6		**Sediment/Erosion control Bregalnica River**	Flood & erosion protection				x		x		2	MOEPP	MOEPP	% of study on sediment transport completed # of permits/water rights issued based on study	
	8.6.1	Study on erosion, sedimentation and sediment transport in Bregalnica river	Flood & erosion protection				x		x		2	MOEPP, MAFWE	MOEPP, Sci.Comm	% of study completed	**12'300'000**
	8.6.2	Preparation and approval of regulations governing extraction of sand and gravel from riverbeds	Flood & erosion protection				x		x		2	MOEPP	MOEPP	# of permits/water rights issued based on study	
8.7		**Promoting insurance from flooding for population and goods, including agricultural insurance**	(Flood protection) Damage coverage/reimbursement				x			x	3	GoM, MoAFWE	Municipality, FAs	# of farms insured # of insurance policies	

	MEASURES	Improvement required regarding = "Gap analysis"	Will reduce pressures				Completed by			Priority	Responsible for ensuring action	Who will take action on the ground?	Indicators	Total Costs [MKD]
			Households	Industry	Agriculture	Other pressures	2015	2021	2027					
10	**Management of Protection zones**													
10.1	**Establishment/proclamation of water protected zones/areas**	Insufficient Protection of water sources					x			1	MOEPP	Minicipality	# of protected zones established	
10.1.1	Sources of drinking water	Protection of drinking water sources (WFD An.VI.A.iii)	x				x			1	MOEPP	Minicipality, IPH	# of protected zones established # of municipalities	7'380'000
10.1.2	Bathing waters/recrteational areas					x	x			1	MOEPP	Minicipality, IPH	# of protected zones established	1'230'000
10.1.3	Nitrate sensitive areas	WFD art. 10.c.3	x	x	x		x			1	MOEPP	Minicipality	# of protected zones established	1'230'000
10.1.4	Areas vulnerable to wastewater discharges	WFD art. 10.c.3	x	x			x			1	MOEPP	Minicipality	# of protected zones established	1'230'000
10.1.5	Economically significant aquatic species	WFD art. 10.c.3				x	x			1	MOEPP	Minicipality	# of protected zones established	615'000
10.2	**Nature Protection Areas - re-evaluation and proclamation**	Insufficient Protection of nature				x		x		2	MOEPP	Minicipality	# of protected zones established	**18'450'000**
11	**Monitoring**													
11.1	**Establishment of monitoring of waters - operational/regular annual monitoring**	Monitoring - physico-chemical, heavy metals, priority substances, biological and morphological surface waters	x	x	x	x	x	x	x	1	MOEPP	BRBMB, AHMW, HS Bregalnica, HS Zletovica	# of monitoring samples and analyses	**3'075'000**
11.1.1	Surface waters - 20 moinitoring points	All parameters	x	x	x	x	x	x		1	MOEPP	BRBMB, AHMW, HS Bregalnica, HS Zletovica		9'225'000
11.1.2	Groundwater	Physical-Chem + Priority Subst.	x	x	x		x	x		1	MOEPP	BRBMB, AHMW, HS Bregalnica, HS Zletovica		3'075'000
11.2	**Investigative monitoring**	Specialized investigations					x	x		1	MOEPP		# of monitoring samples and analyses	
11.2.1	Bregalnica headwaters + tributaries - Phosphoris origin	Origin of high Phosphorus concentrations in surface water		x	x	x		x		1	MOEPP	BRBMP	Investigation conducted and	12'300'000
11.2.2	Investigation of contaminated soils and hot-spots near mines and regular follow-up	Historical poliution and hot-spots		x		x		x		1	MOEPP	BRBMP		3'075'000
11.3	**Monitoring of nature protected areas**	Nature protection				x		x	x	2	MOEPP	Nature conservation Dept	# of campaigns completed	**3'075'000**
12	**Economic analysis**													
	Economic analysis of water use	Required by the Macedonian law						x		1	MOEPP		% of analysis completed	

A	**PLANNED INVESTMENTS IN THE CATCHMENT**													
A1	**Energy system**													
A1.1	Geothermal Energy Utilisation in the country	Existing development and investment plans	x	x							Government			1'230'000'000
A2	**Mining**													
A2.1	Research copper gold and silver at the site Plavica in Probistip and Kratovo										Government	Municipality		>200'000'000 EUR
A2.2	Granting of concessions Northwest part of Mine Sasa M Kamenica		x	x	x						Government	Municipality		18'000'000 EUR

Addressed water bodies, reference in EU / WFD system

	MEASURES	Measure is directly influencing the following water bodies	Measure is indirectly influencing the following water bodies	Reference in EU / WFD system			
				Measure nature	WFD article	Description	Directive
1	**Wastewater collection and treatment**						
1.1	**Small infrastructure projects**						
1.2	**Construction of WWTP - municipalities with more than 15'000 population equivalent**						
1.2.1	Construction of WWTP Kocani	SR 17	SR 18, SR 19	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.2.2	Construction of WWTP for Delchevo	SR 02	SR 03, SR 13	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.2.3	Construction of WWTP for Vinica	SR 04	SR 15	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.2.4	Construction of WWTP for Probistip	SR 20		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.2.5	Construction of WWTP for Stip	SR 06	SR 07, SR 22, SR 24	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.3	**Construction of WWTP - municipalities from 2'000 to 15'000 population equivalent**						
1.3.1	Construction of WWTP for Pehchevo	SR 01	SR 02, SR 13	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.3.2	Construction of WWTP for M. Kamenica	SR 04	Sr 14	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.3.3	Construction of WWTP for Zrnovci	SR 16		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.3.4	Construction of WWTP for Ceshinovo-Obleshevo	SR 06	SR 19, SR 20	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.3.5	Construction of WWTP for Karbinci	SR 21	SR 07	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC

	MEASURES	Measure is directly influencing the following water bodies	Measure is indirectly influencing the following water bodies	Reference in EU / WFD system: Measure nature	WFD article	Description	Directive
1.4	**Construction of WWTP - 0 to 2'000 population equivalent**						
1.4.1	Construction of WWTP for Kucicino	SR 06		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.4.2	Construction of WWTP for Gabrevci	SR 23		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.4.3	Construction of WWTP for municipality of Berovo: v.Rusinovo, Dvoriste, Ratevo, Vladimirovo, Smojmirovo, Macevo, Budinarci, Mitrasinci	SR 02	SR 12	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5	**Extension of existing sewerage networks and sewage collectors**						
1.5.1	Sewerage network in Gabrevci - Konce	SR 23		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.2	Sewerage network in Vidovise - Zrnovci	SR 16		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.3	Sewerage network in Kucicino - Cesinovo Oblesevo	SR 06		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.4	Sewerage network in Gorodinci - S Nikole	SR 25		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.5	Completion of sewerage network for municipality of Berovo. v. Rusinovo, Dvoriste, Ratevo, Vladimirovo, Smojmirovo, Macevo, Budinarci, Mitrasinci	SR 02	SR 12	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.6	Completion of sewerage network for municipality of Berovo: Delchevo, v. Bigla, Vetren, Virce, Vratislavci	SR 03		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.7	Completion of sewerage network for municipality of Pehchevo: Robovo, Ciflik, Negrevo, Crnik, Pancarevo	SR 02	SR 13	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.8	Completion of sewerage network for municipality of Makedonska Kamenica: v.Dulica, Kosevica, Kostin Dol, Lukovica, Moshtica, Sasa, Todorovci, Cera	SR 14	SR 04	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.9	Completion of sewerage network for Vinica, v.Jakimovo, Pekljani (municipality of Vinica)	SR 15		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.10	Completion of sewerage network for municipality of Zrnovci: Zrnovci, Vidoviste	SR 16	SR 04	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.11	Completion of sewerage network for Kocani, Orizari town (since 2005 part of municipality of Kocani), v.Pribacevo (main village of Orizari), Beli, Gorni Podlog, Dolni Podlog, Grdovci, Mojanci, Trkanje, Leshki, Nivicani, pantelej, Rajcani,Gorno Gradec, Jastrebnik, Polaki (municipality of Kocani)	SR 19	SR 17, SR 18	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.12	Completion of sewerage network for municipality of Chesinovo-Obleshevo: Obleshevo, Chesinovo, Chiflik	SR 06	SR 19, SR 20	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.13	Completion of sewerage network for Probistip and v.Kalniste, Buciste, Gajranci, Gorni Stubol, Gorno Barbarevo, Griizilevci, Gujnovci, Dobrevo, Dolni Stubol, Drenok, Kundino, Lezovo, Marcino, Nekoazi, Plesenci, Puzderci, Strisovci, Strmos, Troolo, Bunes, Dolno Barbarevo, Dreveno, Zarapinci, Zelengrad, Zletovo, Jamiste, Kukovo, Lesnovo, Pestrisino, Petrisino, Pisica, Ratavica, Tripatanci, Turski Rudari, Stalkavica; m. Probistip	SR 20		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC

	MEASURES	Measure is directly influencing the following water bodies	Measure is indirectly influencing the following water bodies	Reference in EU / WFD system: Measure nature	WFD article	Description	Directive
1.5.14	Completion of sewerage network for Blizanci, Vakuf, Gorno, Kratovo, Dimance, Emirica, Zeleznica, Zivalevo, Kavrak, Ketenovo, Knezevo, Kojkovo, Krilatica, Konjuk, Kuklica, Kunovo, Lukovo, Muskovo, Nezilovo, Pendak, Prikovci, Sekulica, Stracin, Talashmance, Tatomir, Topolnik, Trnovac, Turalevo, Filipovci, Shlegovo, Shopsko Rudare (municipality of Kratovo)	SR 20		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.15	Completion of sewerage network for Karbinci, Argulica, Dolni Balvan, Krupiste, Radanje, Tarinci (municipality of Karbinci)	SR 21	SR 07	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.16	Completion of sewerage network for Stip and v.Baltalija, Brest, Vrsakovo, Goracino, Dobrosani, Dolani, Dragoevo, Krivi dol, Lakavica, Leskovica, Ljuboten, Piperevo, Pochivalo, Puhce, Sarievo, Selce, Sofilari, Star Karaorman, Stepanci, Suvo Grlo, Sudic, Sushevo, Sasavarlija (municipality of Shtip)	SR 09	SR 07, SR 22	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.17	Completion of sewerage network for Amzabegovo, Gorobinci, Gorno Crniliste, Dolno Djudjance, Dolno Crniliste, Erdzelija, Kadrifakovo, Knezje, Krusica, Mustafino, Nemanjica, Orel, Pavlesenci, Pesirovo, Preod, Rancinci, Sopot, Stanjevci, Trstenik (municipality of Sveti Nikole)	SR 25	SR 26	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.18	Completion of sewerage network for Adjibegovo, Bekirlija, Durfulija, Gjuzemelci, Karatmanovo, Kisino, Milino, Saramzalino, Kjoselari, Adjimatovo (municipality of Lozovo)	SR 27		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.19	Completion of sewerage network for municipality of Konche: Konche, Dolni Lipovik, Dedino, Rakitec	SR 23	SR 24	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.20	Wastewater collector for municipality of Berovo: v. Rusinovo,Dvoriste, Ratevo, Vladimirovo, Smojmirovo, Macevo, Budinarci, Mitrasinci	SR 02	SR 12	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.21	Wastewater collector for m. Delchevo	SR 06	SR 07, SR 22, SR 24	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.22	Wastewater collector for m. Pehchevo	SR 02	SR 13	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.23	Wastewater collector for m. Makedonska Kamenica	SR 14	SR 04	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.24	Wastewater collector for m. Vinica	SR 15		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.25	Wastewater collector for m. Kocani	SR 19	SR 17, SR 18	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.26	Wastewater collector for m. Ceshesinovo-Obleshevo	SR 06	SR 19, SR 20	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.27	Wastewater collector for m. Proboshtip	SR 20		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.28	Wastewater collector for m. Kratovo	SR 20		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.29	Wastewater collector for m. Sveti Nikole	SR 25	SR 26, SR 27	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.30	Wastewater collector for v. Hadzimatovo, Kjoselari; m. Lozovo	SR 27		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.31	Wastewater collector for m. Karbinci	SR 21	SR 07	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.32	Wastewater collector for m.Konche	SR 23		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.33	Rehabilitations of the wastewater collector for m. Shtip	SR 06	SR 07, SR 22, SR 24	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.34	Rehabilitation, reconstruction and extension of sewage network for v.Bigla, Vetren, Virce, Vratislavci; m.Delchevo	SR 03		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.35	Rehabilitation, Reconstruction, Extension of sewage for v.Robovo; m.Pehchevo	SR 02		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.36	Rehabilitation, reconstruction and extension of sewage network for v. Vinicka Krsla, Gradec, Grljani, Dragobrasti, Istibanja, , Krusevo, Laki, Leski, Trsino, Lipec, Blatec, Kalimanci, Crn Kamen; m.Vinica	SR 15		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC

	MEASURES	Measure is directly influencing the following water bodies	Measure is indirectly influencing the following water bodies	Reference in EU / WFD system: Measure nature	WFD article	Description	Directive
1.5.37	Rehabilitation, Reconstruction, Extension of sewage for v. Morodvis; m.Zrnovci	SR 16	SR 04	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.38	Rehabilitation, reconstruction and extension of sewage network for v. Banja, Burilcevo, Vrbica, Ziganci, Kucicino, Lepopelci, Novoselja, Sokolarci, Spancevo, Teranci, Ularci, Ciflik; m.Chesinovo-Obleshevo	SR 06	SR 19, SR 20	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.39	Rehabilitation, reconstruction and extension of sewage network for v. Gabrevci, Zagorci, Garvan, Gorni Lipovik, Lubnica, Skorusa; m.Konche	SR 23		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.5.40	Rehabilitation, reconstruction and extension of sewage network for v. Batanje, Vrteska, Golem Gaber, Gorni Balvan, Gorno Trogerci, Dolno Trogerci, Ebeplija, Junuzlija, Kepekcelija, Kalauzlija, Kozjak, Kurfalija, Kucica, Nov Karaorman, Odjalija, Prnalija, Pripecani, Ruljak, Crvulevo; m.Karbinci	SR 21	SR 07	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.6	**Separation of rainwater and sewage networks**						
1.6.1	Separating sewage from rainwater and construction of a new sewerage in Kocani	SR 19	SR 17, SR 18	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.6.2	Completion of atmospheric network for v. Rusinovo,Dvoriste, Ratevo, Vladimirovo, Smojmirovo, Macevo, Budinarci, Mitrasinci ; m. Berovo	SR 02	SR 12	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.6.3	Separation atmospheric from sewage for m. Delchevo	SR 03		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.6.4	Separation atmospheric from sewage for m.Pehchevo	SR 02	SR 13	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.6.5	Separation atmospheric from sewage for m.Makedonska Kamenica	SR 14	SR 04	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.6.6	Separation atmospheric from sewage for m.Vinica	SR 15		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.6.7	Separation atmospheric from sewage for m.Kocani	SR 19	SR 17, SR 18	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.6.8	Separation atmospheric from sewage for m.Cheshinovo-Obleshevo	SR 06	SR 19, SR 20	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.6.9	Separation atmospheric from sewage for m.Probistip	SR 20		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.6.10	Separation atmospheric from sewage for m.Kratovo	SR 20		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.6.11	Separation atmospheric from sewage for m.karbinci	SR 21	SR 07	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.6.12	Separation atmospheric from sewage for m.Shtip	SR 25	SR 26, SR 27	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.6.13	Separation atmospheric from sewage for m.Sveti Nikole	SR 25	SR 26, SR 27	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.6.14	Separation atmospheric from sewage for m. Lozovo	SR 27		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.6.15	Separation atmospheric from sewage for m.Konche	SR 23		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.7	**Rehabilitation/reconstruction of existing WWTP**						
1.7.1	Rehabilitation and reconstruction WWTP Sveti Nikole	SR 25	SR 26, SR 27	Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.8	**Development of ordinances to regulate discharges**	All region		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC
1.9	**Implementation of ordinances for discharges**	All region		Basic	art.10.2.c.2	Urban waste-water treatment	91/271/EEC

	MEASURES	Measure is directly influencing the following water bodies	Measure is indirectly influencing the following water bodies	Reference in EU / WFD system			
				Measure nature	WFD article	Description	Directive
2	**Solid waste treatment**						
2.1	**Establishment of efficient systems for agricultural solid waste management**						
2.1.1	Facilities for organized collection of solid waste from agriculture (plastic bags and packages of fertilizers and pesticides)	All region		Basic	art.10.2.c.4 / art. 16	Environmental Quality Standards s regards priority or priority hazardous substances - Modified by 2013/39/UE	2008/105/EC
2.1.2	Special locations for washing of sprayers and dump of excessive hazardous liquids	All region		Basic	art.10.2.c.4 / art. 16	Environmental Quality Standards s regards priority or priority hazardous substances - Modified by 2013/39/UE	2008/105/EC
2.1.3	Efficient solutions for bio residues management in rice production, orchards and vineyards	SR 17	SR01, SR 03, SR 06, SR 07, SR 19, SR 24, SR 25	Basic	art. 10.c.3	Protection of waters against pollution caused by nitrates from agricultural sources	91/676/EEC
2.2	**Integrated Solid Waste Management - Municipalities East Planning Region**						
2.2.1	Technical assistance and supervision in solid waste management	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
2.2.2	Revision of Regional Waste Management Plan	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
2.2.3	Creating priority projects - studies, analysis	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
2.2.4	Recycling of waste materials, waste collection places in the region, Equipment and supplies for waste collecting	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
2.2.5	Rehabilitation of permanent landfills and dumps with very high risk	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
2.2.6	Rehabilitation of permanent landfills and dumps with high risk	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
2.2.7	Campaigns to raise public awareness of waste management	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
2.2.8	Package of measures for the implementation and campaigns for public awarness	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
2.2.9	Replacement of equipment for collection of waste and transfer station	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
2.2.10	Replacement of treatment equipment (plant and machinery)	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
2.2.11	Reinvestment project replacement equipment	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
2.2.12	Selection, recycling and collection packaging waste	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
2.2.13	Construction of landfill cell	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
2.2.14	Construction of landfill cell type B (for remains)	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC

	MEASURES	Measure is directly influencing the following water bodies	Measure is indirectly influencing the following water bodies	Reference in EU / WFD system			
				Measure nature	WFD article	Description	Directive
3	**Control of hazardous substances / Sludge control in mines and quarries**						
3.1	**Ensuring enforcement of the IPPC environmental permits regime**	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
3.2	**Enforcement of the IPPC A environmental permits regime**	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
3.3	**Enforcement of the IPPC B environmental permits regime**	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
3.4	**Enforcement of the emission controls of urban wastewater**	All region					
3.4.1	Technical support for establishment and implementation of a new water services tarif system	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
3.4.2	Improvement of the emission controls of urban wastewater - strengthening of the inspection surveillance-national level	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
3.4.3	Improvement of the emission controls of urban wastewater - strengthening of the inspection surveillance - local level	All region		Basic	art.10.2.c.1	Integrated pollution prevention and control	96/61/EC
3.5	**Management of contaminated soils / areas**	All region					
3.5.1	Inventory of contaminated soils	All region		Basic	art.10.2.c.4 / art. 16	Environmental Quality Standards s regards priority or priority hazardous substances - Modified by 2013/39/UE	2008/105/EC
3.5.2	Elaboration of a plan for treatment of contaminated soils / hot spots	All region		Basic	art.10.2.c.4 / art. 16	Environmental Quality Standards s regards priority or priority hazardous substances - Modified by 2013/39/UE	2008/105/EC
3.5.3	Remediation/rehabilitation of contamination hot-spots (soil) in the Bregalnica catchment	All region		Basic	art.10.2.c.4 / art. 16	Environmental Quality Standards s regards priority or priority hazardous substances - Modified by 2013/39/UE	2008/105/EC
4	**Tilling techniques and soil erosion control**						
4.1	**Improved land management systems**	All region					
4.1.1	Intoruction in practice of reduced or no-tillage systems	All region		Basic	art. 10.c.3	Protection of waters against pollution caused by nitrates from agricultural sources	91/676/EEC
4.1.2	Introduction in practice of contour farming systems	All region		Basic	art. 10.c.3	Protection of waters against pollution caused by nitrates from agricultural sources	91/676/EEC

	MEASURES	Measure is directly influencing the following water bodies	Measure is indirectly influencing the following water bodies	Reference in EU / WFD system			
				Measure nature	WFD article	Description	Directive
4.2	**Depletion of surface run-off quantities and sediment loss**	All region					
4.2.1	Cover crops and mulching in vineyards and orchards for protection of soil surface from rain drops impact and surface run-off	All region		Basic	art. 10.c.3	Protection of waters against pollution caused by nitrates from agricultural sources	91/676/EEC
4.2.2	Establishment of non-tilling buffer zones alongside water courses	All region		Basic	art. 10.c.3	Protection of waters against pollution caused by nitrates from agricultural sources	91/676/EEC
4.3	**Education on practices related to soil erosion control**	All region					
4.3.1	Training on management practices for maintenance of Soil Organic Matter content, soil stability and infiltration rate	All region		Basic	art. 10.c.3	Protection of waters against pollution caused by nitrates from agricultural sources	91/676/EEC
5	**Pesticides and fertilizers control**						
5.1	**Install buffer zone alongside watercourses**	All region		Basic	--	Pollution caused by certain dangerous substances discharged into the aquatic environment of the Community	2006/11/EC
5.2	**Educate farmers for proper use of pesticides and waste disposal**	All region		Basic	--	Pollution caused by certain dangerous substances discharged into the aquatic environment of the Community	2006/11/EC
5.3	**Management of livestock and waste stores** **- controll access of livestock to surface waters** **- manage waste stores to minimise losses to water environment**	All region		Basic	--	Pollution caused by certain dangerous substances discharged into the aquatic environment of the Community	2006/11/EC
5.4	**Training for improvement of fertilizer and pesticide use efficiency**	All region					
5.4.1	Establishing of system for permanent control of soil fertility	All region		Basic	--	Pollution caused by certain dangerous substances discharged into the aquatic environment of the Community	2006/11/EC
5.4.2	Fertilization plans for better efficiency of applied fertilizers and maintenance of soil fertility	All region		Basic	--	Pollution caused by certain dangerous substances discharged into the aquatic environment of the Community	2006/11/EC

	MEASURES	Measure is directly influencing the following water bodies	Measure is indirectly influencing the following water bodies	Reference in EU / WFD system			
				Measure nature	WFD article	Description	Directive
5.5	**Integrated rice production for optimisation of: pest control and water and fertilizer use efficiency**	All region		Basic	--	Pollution caused by certain dangerous substances discharged into the aquatic environment of the Community	2006/11/EC
5.6	**Integrated production in protected environment (greenhouses and plastic houses)**	All region		Basic	--	Pollution caused by certain dangerous substances discharged into the aquatic environment of the Community	2006/11/EC
5.7	**Integrated vine and orchard production for optimisation of: pest control and water and fertilizer use efficiency**	**SR 03**	**SR 06, SR 07, SR 20, SR 24, SR 25**	Basic	--	Pollution caused by certain dangerous substances discharged into the aquatic environment of the Community	2006/11/EC
5.8	**Training for implementing of GAP standards and AE measures in practice**		**SR 07, SR 08, SR 19, SR 25**				
5.8.1		All region		Basic	--	Pollution caused by certain dangerous substances discharged into the aquatic environment of the Community	2006/11/EC
5.8.2		All region		Basic	--	Pollution caused by certain dangerous substances discharged into the aquatic environment of the Community	2006/11/EC
5.8.3		All region		Basic	--	Pollution caused by certain dangerous substances discharged into the aquatic environment of the Community	2006/11/EC
5.8.4		All region		Basic	--	Pollution caused by certain dangerous substances discharged into the aquatic environment of the Community	2006/11/EC
6	**Soil erosion control in forestry and on pastures**						
6.1	**Afforestation of deforested and degraded forest**	At this moment can not be connected to water body	All water bodies downstream from the location of the implemented measures	Supplementary	art. 11.4 An. VI B	vi) codes of good practices	
6.2	**Terracing and afforestation of deforested sloppy terrains**	At this moment can not be connected to water body	All water bodies downstream from the location of the implemented measures	Supplementary	art. 11.4 An. VI B	vi) codes of good practices	

	MEASURES	Measure is directly influencing the following water bodies	Measure is indirectly influencing the following water bodies	Reference in EU / WFD system			
				Measure nature	WFD article	Description	Directive
6.3	**Enforcement of sustainable land management**	Not applicable					
6.3.1	Maintenance and cleaning of pastures and range lands	At this moment can not be connected to water body	All water bodies downstream from the location of the implemented measures	Supplementary	art. 11.4 An. VI B	vi) codes of good practices	
6.3.2	Maintenance and construction works on gullies, gaps and streams for collecting of eroded sediment	At this moment can not be connected to water body	All water bodies downstream from the location of the implemented measures	Supplementary	art. 11.4 An. VI B	vi) codes of good practices	
6.3.3	Implementation of agroforestry	At this moment can not be connected to water body	All water bodies downstream from the location of the implemented measures	Supplementary	art. 11.4 An. VI B	vi) codes of good practices	
6.4	**Training on implelementing of good management practices for protection of forest and forest ecosystem services**						
6.4.1	Implementation of systainable forest management practices	Not applicable		Supplementary	art. 11.4 An. VI B	vi) codes of good practices	
6.4.2	Control of illegal cut and forest fires	Not applicable		Supplementary	art. 11.4 An. VI B	vi) codes of good practices	
6.4.3	Control of overgrazing and degradation of pastures and bare lands	Not applicable		Supplementary	art. 11.4 An. VI B	vi) codes of good practices	
6.4.4	Pest conrol in forests	Not applicable		Supplementary	art. 11.4 An. VI B	vi) codes of good practices	

	MEASURES	Measure is directly influencing the following water bodies	Measure is indirectly influencing the following water bodies	Reference in EU / WFD system			
				Measure nature	WFD article	Description	Directive
7	**Water use regulation**						
7.1	**Preparation of Groundwater cadaster**			Supplementary	art. 11.4 An. VI B	viii) water abstraction controls	
7.2	**Water Abstraction Controls**	Not applicable					
7.2.1	Implementation of the water Law - re-issuance of water rights for surface water utilization	All surface water bodies	All surface water bodies	Supplementary	art. 11.4 An. VI B	viii) water abstraction controls	
7.2.2	Implementation of the water Law - re-issuance of water rights for groundwater utilization	All groundwater bodies	All groundwater bodies	Supplementary	art. 11.4 An. VI B	viii) water abstraction controls	
7.2.3	Setting standards for extractions and water rights in groundwater bodies	All groundwater bodies	All groundwater bodies	Supplementary	art. 11.4 An. VI B	viii) water abstraction controls	
7.3	**Implement Running Cost Recovery Principle**						
7.3.1	Drinking water/water supply	Not applicable to water bodies		Supplementary	art. 11.4 An. VI B	viii) water abstraction controls	
7.3.2	Wastewater collection & treatment	Not applicable to water bodies		Supplementary	art. 11.4 An. VI B	viii) water abstraction controls	
7.3.3	Irrigation water	Not applicable to water bodies		Supplementary	art. 11.4 An. VI B	viii) water abstraction controls	
7.3.4	System of subsidies for improvement of water-use efficiency in irrigation	Not applicable to water bodies		Supplementary	art. 11.4 An. VI B	viii) water abstraction controls	
7.3.5	Installation of water meters in irrigation	Not applicable to water bodies		Supplementary	art. 11.4 An. VI B	viii) water abstraction controls	
7.3.6	Efficiency incentive water pricing	Not applicable to water bodies		Supplementary	art. 11.4 An. VI B	viii) water abstraction controls	
7.4	**Improved inspection of water use/water rights surface and groundwater, concessions, discharges**			Supplementary	art. 11.4 An. VI B	viii) water abstraction controls	
7.4.1	Increased staff	Not applicable	Not applicable	Supplementary	art. 11.4 An. VI B	viii) water abstraction controls	
7.4.2	Increased mandate and financing	Not applicable	Not applicable	Supplementary	art. 11.4 An. VI B	viii) water abstraction controls	
7.5	**Construction of the dam Rechani on the Orizarska River - Kocani**	SR_17	SR_05, SR_06, SR_07, SR_08, SR_09, SR_10	Supplementary	art. 11.4 An. VI B	xi) construction projects	
7.6	**Rehabilitation of the dam Pisica Probistip**	SR_20	SR_07, SR_08, SR_09, SR_10	Supplementary	art. 11.4 An. VI B	xi) construction projects	

	MEASURES	Measure is directly influencing the following water bodies	Measure is indirectly influencing the following water bodies	Reference in EU / WFD system: Measure nature	WFD article	Description	Directive
7.7	**Modernization of HM systems**						
7.7.1	Complete reconstruction of existing open channels	AC_01, AC_02, AC_03		Supplementary	art. 11.4 An. VI B	xi) construction projects	
7.7.2	Rehabiltation and maintenance of existing open channels (permanent)	AC_01, AC_02, AC_03		Supplementary	art. 11.4 An. VI B	xi) construction projects	
7.7.3	Establishing of new secondary and tertiary pipe network	Not applicable to water bodies	Not applicable to water bodies	Supplementary	art. 11.4 An. VI B	xi) construction projects	
7.8	**Replacement of gravity irrigation (surface and furrow) irrigation with pressurized irrigation systems (drip irrigation and microsprinklers) irrigation**						
7.8.1	Implementing of drip irrigation on 18 ha of vineyards and orchards in Argulica	SR_07	SR_08, SR_09, SR_10	Supplementary	art. 11.4 An. VI B	x) efficiency and re-use measures (promotion of water efficient technologies in industry and water saving irrigation techniques)	
7.8.2	Implementing of drip irrigation on 150 ha of vineyards and orchards in Berovo	SR_02	SR_03, SR_04, SR_05, SR_06, SR_07, SR_08, SR_09, SR_10	Supplementary	art. 11.4 An. VI B	x) efficiency and re-use measures (promotion of water efficient technologies in industry and water saving irrigation techniques)	
7.8.3	Implementing of drip irrigation on 105 ha of vineyards and orchards in Burilcevo	SR_06	SR_07, SR_08, SR_09, SR_10	Supplementary	art. 11.4 An. VI B	x) efficiency and re-use measures (promotion of water efficient technologies in industry and water saving irrigation techniques)	
7.8.4	Implementing of drip irrigation on 81 ha of vineyards and orchards in Burilovci	SR_26	SR_27, SR_10	Supplementary	art. 11.4 An. VI B	x) efficiency and re-use measures (promotion of water efficient technologies in industry and water saving irrigation techniques)	
7.8.5	Implementing of drip irrigation on 69 ha of vineyards and orchards in Balvan_Batanja	SR_07	SR_08, SR_09, SR_10	Supplementary	art. 11.4 An. VI B	x) efficiency and re-use measures (promotion of water efficient technologies in industry and water saving irrigation techniques)	
7.8.6	Implementing of drip irrigation on 100 ha of vineyards and orchards in Lepopelci	SR_20	SR_07, SR_08, SR_09, SR_10	Supplementary	art. 11.4 An. VI B	x) efficiency and re-use measures (promotion of water efficient technologies in industry and water saving irrigation techniques)	
7.8.7	Implementing of drip irrigation on 300 ha of vineyards and orchards in Milino_Durfulija_Lozovo	SR_27	SR_10	Supplementary	art. 11.4 An. VI B	x) efficiency and re-use measures (promotion of water efficient technologies in industry and water saving irrigation techniques)	
7.8.8	Implementing of drip irrigation on 20 ha of vineyards and orchards in Mustafino	SR_26	SR_27, SR_10	Supplementary	art. 11.4 An. VI B	x) efficiency and re-use measures (promotion of water efficient technologies in industry and water saving irrigation techniques)	

	MEASURES	Measure is directly influencing the following water bodies	Measure is indirectly influencing the following water bodies	Reference in EU / WFD system: Measure nature	WFD article	Description	Directive
7.8.9	Implementing of drip irrigation on 200 ha of vineyards and orchards in Crniliste_Adzimatovo_Saramzalino	SR_27	SR_10	Supplementary	art. 11.4 An. VI B	x) efficiency and re-use measures (promotion of water efficient technologies in industry and water saving irrigation techniques)	
7.8.10	Implementing of drip irrigation on 71 ha of vineyards and orchards in Teranci_Morodvis	SR_04	SR_05, SR_06, SR_07, SR_08, SR_09, SR_10	Supplementary	art. 11.4 An. VI B	x) efficiency and re-use measures (promotion of water efficient technologies in industry and water saving irrigation techniques)	
7.8.11	Implementing of drip irrigation on 30 ha of vineyards and orchards in Trkanja_Banja_Spanchevo	SR_19, SR_06	SR_07, SR_08, SR_09, SR_10	Supplementary	art. 11.4 An. VI B	x) efficiency and re-use measures (promotion of water efficient technologies in industry and water saving irrigation techniques)	
7.8.12	Implementing of drip irrigation on 115 ha of vineyards and orchards in Vinica	SR_15	SR_04, SR_05, SR_06, SR_07, SR_08, SR_09, SR_10	Supplementary	art. 11.4 An. VI B	x) efficiency and re-use measures (promotion of water efficient technologies in industry and water saving irrigation techniques)	
7.9	**Training on implementation of advanced irrigation technologies and practices**						
7.9.1	Installation of advanced system for control and decision making in irrigation scheduling in agriculture			Supplementary	art. 11.4 An. VI B	xv) educational projects	
7.9.2	Introducing of feritigation in common agriculture for increasing of water and fertilizer use efficiency	All water bodies	All water bodies	Supplementary	art. 11.4 An. VI B	xv) educational projects	
7.10	**Extension of Irrigation Hydrosystems**						
7.10.1	Hydro Expansion of HS Bregalnica in Municipality S Nikole	SR_25, SR_26, SR_27	SR_10	Supplementary	art. 11.4 An. VI B	xi) construction projects	
7.10.2	Construction of Hydro-system Zletovica 1 (Probistip area)	SR_20	SR_07, SR_08, SR_09, SR_10	Supplementary	art. 11.4 An. VI B	xi) construction projects	
7.10.3	Construction of Hydro-system Zletovica 2 (Kratovo)	Not in our catchment area (SR_20 ?)		Supplementary	art. 11.4 An. VI B	xi) construction projects	
7.10.4	Rehabilitation of a rubber dam in the village Karbinci	SR_07	SR_08, SR_09, SR_10	Supplementary	art. 11.4 An. VI B	xi) construction projects	
7.10.5	Rehabilitation of existing rubber dams in Chiflik I Grdovci	SR_04, SR_05	SR_06, SR_07, SR_08, SR_09, SR_10	Supplementary	art. 11.4 An. VI B	xi) construction projects	
7.10.6	Construction of a rubber dam on Bregalnica near the inflow of river Zletovska	SR_07	SR_08, SR_09, SR_10	Supplementary	art. 11.4 An. VI B	xi) construction projects	
7.11	**Improvement of water supply systems**						
7.11.1	Reconstruction of water supply in Makedonska Kamenica	SR_14	AL_02, SR_04, SR_05, SR_06, SR_07, SR_08, SR_09, SR_10	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.2	Completion of a major pipeline in Grdovski Orman Kocani with previously realized replacing and II Part of the expansion of the zone measuring points for SCADA system in Kocani	SR_04	SR_05, SR_06, SR_07, SR_08, SR_09, SR_10	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC

	MEASURES	Measure is directly influencing the following water bodies	Measure is indirectly influencing the following water bodies	Reference in EU / WFD system			
				Measure nature	WFD article	Description	Directive
7.11.3	Construction of a WS intake the river Kratovska in Kratovo	Not in our catchment area		Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.4	Construction and renovation of water supply system HS Zletovica	SR_20	SR_07, SR_08, SR_09, SR_10	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.5	Water supply in the village Bunjesh	SR_20	SR_07, SR_08, SR_09, SR_10	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.6	New system for v. Dvorishte, m.Berovo	Not in our catchment area		Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.7	New system for v. Morodvis, m.Zrnovci	SR_04	SR_05, SR_06, SR_07, SR_08, SR_09, SR_10	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.8	New system for v. Leshki, Nivicani, Pantelej, Rajcani, Gorno Gradec, Jastrebnik, Polaki; m.Kocani	SR_18, AL_03, SR_06	SR_19, SR_07, SR_08, SR_09, SR_10	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.9	New system for v.Cesinovo, Oblesevo, Vrbica, Ziganci, Lepopelci, Ularci, Ciflic; m.Cheshinovo-Obleshevo	SR_20	SR_07, SR_08, SR_09, SR_10	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.10	New system for v.Gajranci, Gorno Barbarevo, Gujnovci, Griizilevci, Drenok, Puzderci, Zarapinci, Zelengrad, Jamiste, Kukovo, Pestrisino; m. Probistip	SR_20	SR_07, SR_08, SR_09, SR_10	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.11	New system for v.Blizanci, Gorno Kratovo, Dimance, Emirica, Kavrak, Knezevo, Kojkovo, Konjuk, Kuklica, Kunovo, Lukovo, Muskovo, Nezilovo, Pendak, Tatomir; m. Kratovo	SR_20	SR_07, SR_08, SR_09, SR_10	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.12	New system for v.Batanje, Vrteska, Gorno Trogerci, Dolno Trogerci, Junuzlija, Kepekcelija, Kurfalija, Pripecani, Ruljak; m. Karbinci	SR_21, SR_05, SR_07	SR_08, SR_09, SR_10	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.13	New system for v.Baltalija, Brest, Vrsakovo, Goracino, Dobrosan, Krivi Dol, Leskovica, Ljuboten, Pipeevo, pocivalo, Puhce, Sarcievo, Selce, Stepance, Suvo Grlo, Sushevo, Cardaklija, Sasavarlija; m. Shtip	SR_22, SR_24, SR_26, SR_07, SR_08, SR_09	SR_10	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.14	New system Adjibegovo, Bekirlija, Kisino, Karatmanovo; m. Lozovo	SR_27	SR_10	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.15	New system Garvan; m. Konche	SR_23	SR_24, SR_09, SR_10	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.16	Rehabilitation, Reconstruction, Extension for v. Ratevo, Rusinovo; m. Berovo	SR_12	SR_02, SR_03, SR_04, SR_05, SR_06, SR_07, SR_08, SR_09, SR_10, AL_02	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.17	Rehabilitation, Reconstruction, Extension for v. Bigla, Zvegor, Vetren, Poleto, Iliovo; m. Delchevo	SR_03	SR_04, SR_05, SR_06, SR_07, SR_08, SR_09, SR_10, AL_02	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.18	Rehabilitation, Reconstruction, Extension for m.Vinica, v. Vinicka Krsla, Gradec, Grljani, Dragobrasti, Istibanja, Jakimovo, Krusevo, Laki, Leski. Pekljani, Trsino, Lipec, Blatec; m. Vinica	SR_04, SR_15	SR_05, SR_06, SR_07, SR_08, SR_09, SR_10	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.19	Rehabilitation, Reconstruction, Extension for m.Kocani, v.Orizari town (since 2005 part of Mun. Kocani), Pribacevo (main village of Orizari), Beli, Gorni Podlog, Dolni Podlog, Grdovci, Mojanci, Trkanje; m. Kocani	SR_04, SR_17, SR_19	SR_05, SR_06, SR_07, SR_08, SR_09, SR_10	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC

	MEASURES	Measure is directly influencing the following water bodies	Measure is indirectly influencing the following water bodies	Reference in EU / WFD system: Measure nature	WFD article	Description	Directive
7.11.20	Rehabilitation, Reconstruction, Extension for v. Bunes; m. Probistip	SR_20	SR_07, SR_08, SR_09, SR_10	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.21	Rehabilitation, Reconstruction, Extension for v. Vakuf, Zeleznica, Krilatica, Sekulica, Talashmance, Topolnik, Trnovac, Filopovci, Shopsko Rudare; m. Kratovo	Not in Bregalnica catchment area	Not in Bregalnica catchment area	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.22	Rehabilitation, Reconstruction, Extension for v. Karbinci, Nov Karaorman; m. Karbinci	SR_21, SR_07	SR_08, SR_09, SR_10	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
7.11.23	Rehabilitation, Reconstruction, Extension for v. Durfulija; m. Lozovo	SR_27	SR_10	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
8	**Flood control**						
8.1	**Elaboration of a management plan /reservoir operation rules for reservoirs: Ratevo, Kalimaci, Gratche and Mavrovica**	AL_01, AL_02, AL_03, AL_04	SR_02, SR_03, SR_04, SR_05, SR_06, SR_07, SR_08, SR_09, SR_10, SR_19, SR_25, SR_27, SR_20,	Basic	--	Assessment and management of flood risks	2007/60/EC
8.2	**Elaboration of technical documentation for protection/stabilization of Bregalnica River watercourse:**	SR_01, SR_02, SR_03, SR_04, SR_05, SR_06,SR_07, SR_08, SR_09,SR_10					
8.2.1	Restoration and cleaning of Bregalnica riverbed and banks between Stip and Vinica	SR_04, SR_05, SR_06, SR_07, SR_08	SR_09, SR_10	Basic	--	Assessment and management of flood risks	2007/60/EC
8.2.2	Stabilization and riverbed proetection at inflow points (tributaries mouths)	All water bodies	All water bodies	Basic	--	Assessment and management of flood risks	2007/60/EC
8.2.3	Restoration and stabilization of riverbed and banks in the areas of temporary water intakes and/or construction of permanent intake structures	Of the water bodies where we have temporaly water intakes	All water bodies downstream from the location of the implemented measures	Basic	--	Assessment and management of flood risks	2007/60/EC
8.2.4	Regular maintenance of regulated parts of rivers Kocanska, Orizarska and Zletovska and lateral canal Banja-Zletovska reka in Kocani field	SR_19, SR_17, SR_20	SR_04, SR_05, SR_06, SR_07, SR_08, SR_09, SR_10	Basic	--	Assessment and management of flood risks	2007/60/EC
8.2.5	Restoration works for Osojnica river - parts of riverbed and banks and cleaning of the riverbed between the inflow upstream to Krshlanski most (around 6km)	SR_15	SR_04, SR_05, SR_06, SR_07, SR_08, SR_09, SR_10	Basic	--	Assessment and management of flood risks	2007/60/EC
8.2.6	Restoration measures: demolition of obsolete barriers that obstruct the longitudinal connectivity	On the water body where will be implemented this measures	All water bodies downstream from the location of the implemented measures	Basic	--	Assessment and management of flood risks	2007/60/EC
8.2.7	Measures to improve the flow of sediments in the river environment (by-pass, cleaning, studies ...)	On the water body where will be implemented this measures	All water bodies downstream from the location of the implemented measures	Basic	--	Assessment and management of flood risks	2007/60/EC

	MEASURES	Measure is directly influencing the following water bodies	Measure is indirectly influencing the following water bodies	Reference in EU / WFD system: Measure nature	WFD article	Description	Directive
8.3	**Regular maintenance of drainage canals in Kocani Valley and in Ovce Pole**		All water bodies downstream from the location of the implemented measures	Basic	--	Assessment and management of flood risks	2007/60/EC
8.4	**Elaboration of Bregalnica Catchment Flood Protection Plan**						
8.4.1	Preliminary Flood Risk Assessment for Bregalnica River Basin	Not applicable	Not applicable	Basic	--	Assessment and management of flood risks	2007/60/EC
8.4.2	Elaboration of Flood Hazard Maps and Flood Risk Maps	All water bodies	All water bodies	Basic	--	Assessment and management of flood risks	2007/60/EC
8.4.3	Flood Risk Management Plan	All water bodies	All water bodies	Basic	--	Assessment and management of flood risks	2007/60/EC
8.5	**Urban Planning Measures for Flood protection**						
8.5.1	Revision of Urban Plans, zoning, construction permits	Not applicable	Not applicable	Basic	--	Assessment and management of flood risks	2007/60/EC
8.6	**Sediment/Erosion control Bregalnica River**						
8.6.1	Study on erosion, sedimentation and sediment transport in Bregalnica river	Not applicable to water bodies	Not applicable to water bodies	Basic	--	Assessment and management of flood risks	2007/60/EC
8.6.2	Preparation and approval of regulations governing extraction of sand and gravel from riverbeds	Not applicable to water bodies	Not applicable to water bodies	Basic	--	Assessment and management of flood risks	2007/60/EC
8.7	**Promoting insurance from flooding for population and goods, including agricultural insurance**	Not applicable to water bodies	Not applicable to water bodies	Basic	--	Assessment and management of flood risks	2007/60/EC
10	**Management of Protection zones**						
10.1	**Establishment/proclamation of water protected zones/areas**						
10.1.1	Sources of drinking water	All water bodies	All water bodies	Basic	An.VI.A.iii	Quality of water for human consumption	98/83/EC
10.1.2	Bathing waters/recreational areas	Still not established protected zones	All water bodies downstream from the location of the implemented measures	Basic	An.VI.A.i	Management of bathing water quality	2006/7/EC
10.1.3	Nitrate sensitive areas	All water bodies	All water bodies	Basic	art. 10.c.3	Protection of waters against pollution caused by nitrates from agricultural sources	91/676/EEC
10.1.4	Areas vulnerable to wastewater discharges	All water bodies	All water bodies	Basic	art. 10.c.3	Protection of waters against pollution caused by nitrates from agricultural sources	91/676/EEC
10.1.5	Economically significant aquatic species			Basic	art. 10.c.3	Protection of waters against pollution caused by nitrates from agricultural sources	91/676/EEC
10.2	**Nature Protection Areas - re-evaluation and proclamation**			Basic	An.VI.A.x	Conservation of wild fauna, flora and habitats	92/43/EEC

	MEASURES	Measure is directly influencing the following water bodies	Measure is indirectly influencing the following water bodies	Reference in EU / WFD system			
				Measure nature	WFD article	Description	Directive
11	**Monitoring**						
11.1	**Establishment of monitoring of waters - operational/regular annual monitoring**						
11.1.1	Surface waters - 20 moinitoring points	SR_01-SR-27, AL_01-AL_06	All water bodies	Basic	--	Technical specifications for chemical analysis and monitoring of water status	2009/90/EC
11.1.2	Groundwater	GWB_01, GWB_02, GWB_03, GWB_04, GWB_05	All groundwater bodies	Basic	--	Technical specifications for chemical analysis and monitoring of water status	2009/90/EC
11.2	**Investigative monitoring**						
11.2.1	Bregalnica headwaters + tributaries - Phosphoris origin	All water bodies	All water bodies	Basic	--	Technical specifications for chemical analysis and monitoring of water status	2009/90/EC
11.2.2	Investigation of contaminated soils and hot-spots near mines and regular follow-up	All water bodies	All water bodies	Basic	--	Technical specifications for chemical analysis and monitoring of water status	2009/90/EC
11.3	**Monitoring of nature protected areas**			Basic	An.VI.A.x	Conservation of wild fauna, flora and habitats	92/43/EEC
12	**Economic analysis**						
	Economic analysis of water use	Not applicable to water bodies	Not applicable to water bodies	Supplementary	art. 11.4 An. VI B	iii) economic or fiscal instruments	

A16 Public Information and Participation

An overview on public activities held so far is shown in the following table (chronological order).

Activity	Date	Place
First Public Presentation	19.10.2012	Faculty of Law, Kocani
Tour with journalists	30.10.2012	Presentation of project in Berovo
Data collection for public survey	From 04.03.2013 to 15.03.2013	All municipalities
Subregional Workshops (1st round)	10.05.2013	Kocani
	20.05.2013	Stip
	22.05.2013	Delcevo
Municipal forums (call 1)	12.09.2013	Probishtip
	16.09.2013	Berovo
	17.09.2013	Cesinovo-Obleshevo
	17.09.2013	Karbinci
	18.09.2013	Kocani
	18.09.2013	Zrnovci
	19.09.2013	Delčevo
	19.09.2013	Makedonska Kamenica
	19.09.2013	Pehcevo
	20.09.2013	Vinica
	20.09.2013	Lozovo
	23.09.2013	Stip
	23.09.2013	Kratovo
	24.09.2013	Konce
	25.09.2013	Sveti Nikole
Subregional Workshops (2nd round)	29.10.2013	Kocani
	31.10.2013	Delcevo
	05.11.2013	Probistip
Second Public Presentation	22.11.2013	Stip
Media training for National Officers and Local Team	25.11.2013	Kocani
International Day of Water: Water Testing in Kocani	22.03.2014	Kocani
Data collection for public survey	From 14.04.2014 to 07.05.2014	All 15 municipalities
International Day of Biodiversity: Participation at the event of the NCP-project	22.05.2014	Delcevo
Subregional Workshops (3rd round)	23.05.2014	Kocani
	27.05.2014	Sveti Nikole
	30.05.2014	Makedonska Kamenica

Municipal forums (call 2)	03.07.2014 and 10.07.2014	Probistip
	17.07.2014 and 22,07.2014	Berovo
	08.07.2014 and 15.07.2014	Cesinovo-Oblesevo
	02.07.2014 and 09.07.2014	Karbinci
	03.07.2014 and 17.07.2014	Kocani
	07.07.2014 and 14.07.2014	Zrnovci
	08.07.2014 and 15.07.2014	Delcevo
	04.07.2014 and 11.07.2014	Makedonska Kamenica
	07.07.2014 and 15.07.2014	Pehcevo
	02.07.2014 and 08.07.2014	Vinica
	30.06.2014 and 14.07.2014	Lozovo
	03.07.2014 and 09.07.2014	Stip
	09.07.2014 and 16.07.2014	Kratovo
	05.07.2014 and 16.07.2014	Konce
	08.07.2014 and 18.07.2014	Sveti Nikole
Third Public Presentation	04.12.2014	Kocani
Subregional Workshops (4th round)	23.01.2015	Vinica
	30.01.2015	Berovo
	03.02.2015	Stip
Data collection for public survey	01.03.2015 – 30.04.2015	All municipalities
River cleaning day	02.06.2015	12 municipalities
Regional market event	03.06.2015	Vinica
Subregional Workshops (5th round)	30.06.2015	Vinica
	03.07.2015	Pehcevo
	07.07.2015	Probistip
Fourth Public Presentation	26.11.2015	Kocani
Data collection for public survey	01.04.2016 – 31.05.2016	All municipalities

A17 List and Information on Competent Authorities

The following table shows the two authorities responsible, at national level, for the Bregalnica river basin.

Authority	Contact
Ministry of Environment and Physical Planning, Office for Environment and Water, Water Department	Bul. "Goce Delcev" no.18 MRTV building (10,11,12 floor) 1000 Skopje Republic of Macedonia Phone:+389 3 251-400 Fax:+389 3 220-165 e-mail: info@moepp.gov.mk
Ministry of Agriculture, Forestry and Water Economy, Water Economy Directorate	Aminta Third St. No. 2 1000 Skopje Republic of Macedonia Phone: (02) 3134 477 Fax: (02) 3230 429 e-mail: info@mzsv.gov.mk

Table 109: Responsible authorities at national level for the Bregalnica river basin