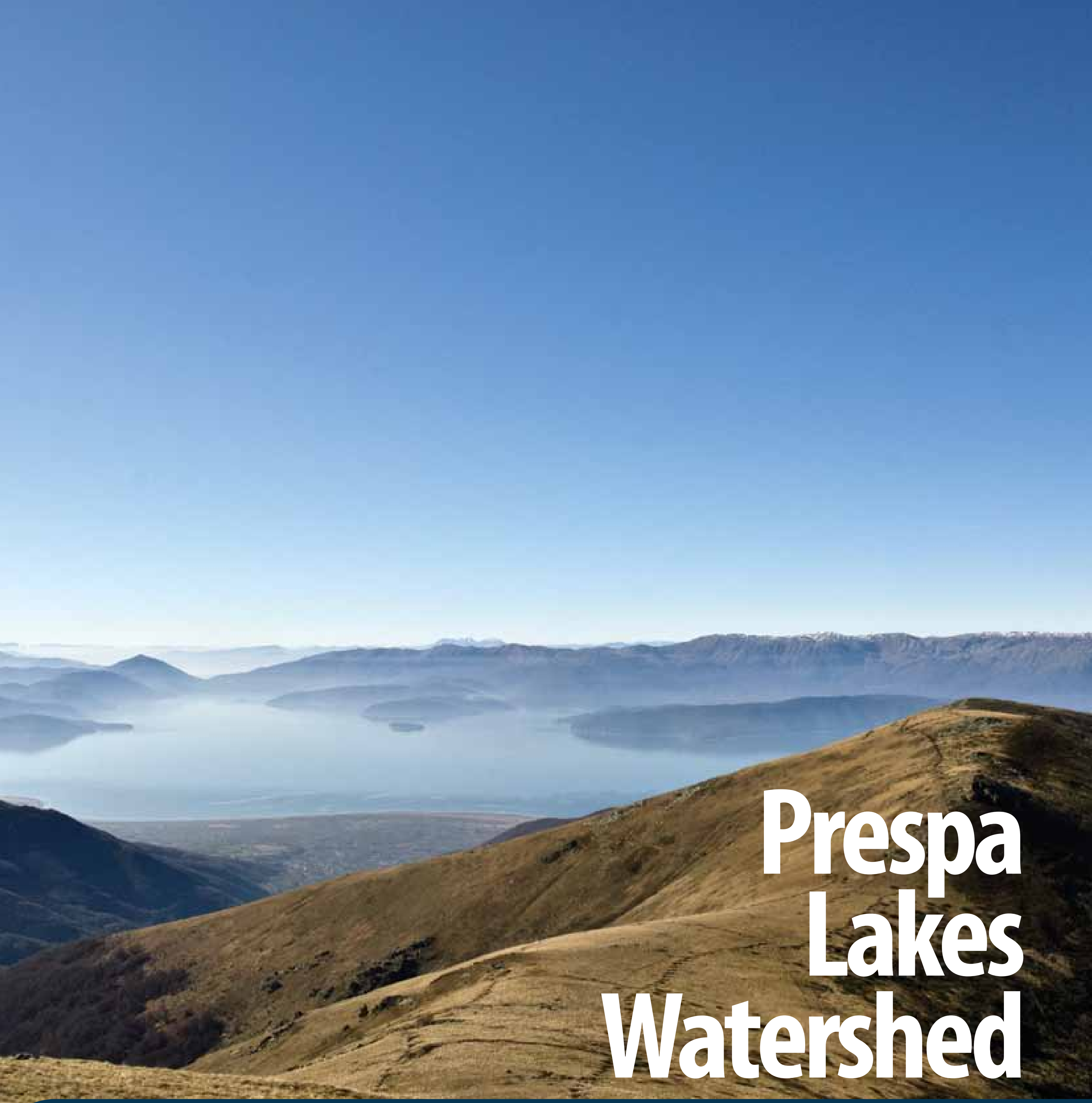

Prespa Lakes Watershed

management plan

Republic of Macedonia
Ministry of Environment
and Physical Planning

The preparation of the Prespa Lake Watershed Management Plan was produced with the technical and financial support of the United Nations Development Programme (UNDP), in the framework of the Integrated Ecosystem Management in the Prespa Lakes Basin project.

The Integrated Ecosystem Management in the Prespa Lakes Basin project is implemented by UNDP with financial support from the Global Environment Facility (GEF). Its overall objective of is to help the region's people with long term economic and social development,conserve the rich biodiversity and protect the waters of the Prespa Lakes Basin.

ABOUT THE GEF:

The Global Environment Facility unites 182 member governments - in partnership with international institutions, nongovernmental organizations, and the private sector - to address global environmental issues. As an independent financial organization, the GEF provides grants to developing countries and countries with economies in transition for projects related to biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants. These projects benefit the global environment, linking local, national, and global environmental challenges and promoting sustainable livelihoods.

ABOUT UNDP:

UNDP partners with people at all levels of society to help build nations that can withstand crisis, and drive and sustain the kind of growth that improves the quality of life for everyone. On the ground in 177 countries and territories, we offer global perspective and local insight to help empower lives and build resilient nations.

Prespa Lake Watershed Management Plan

Project:	Integrated Ecosystem Management in the Prespa Lake Basin
Executing Agency:	Ministry of Environment and Physical Planning
Implementing Agency:	United Nations Development Programe
A Project is funded by	The Global Environmental Facility
A Project developed by	GTI - GEOTEHNICKI INZENERING doo, Skopje

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During the preparation of various topics, other persons were consulted or participated in fieldwork or laboratory analysis.

Contents

Introduction

Foreword

The present pilot project for watershed management planning in the Prespa Lake Watershed represents an initial stage in Macedonia's efforts to further EU approximation by applying the principles of the Water Frame¬work Directive in the water management sector.

Work on the Prespa Watershed Management Plan started in 2009 as part of the GEF/UNDP National Prespa Park Project, following several years of preparation. It is an effort to initiate the implementa¬tion of the Directive and the new Water Law of 2008.

The Water Framework Directive was adopted by the EU in December 2000. The Directive lays down the framework for future management of the aquatic environ¬ment in EU Member States. The objec¬tive of the Water Framework Directive is to ensure that, by 2015 at the latest, all parts of the aquatic environment, i.e. water¬courses, wetlands, lakes and coastal waters, achieve 'good surface water status' and that groundwater achieves 'good groundwater status'. This is to be achieved through riv¬er basin management plans in which each river basin is treated as a coherent entity. The Water Framework Directive integrates a number of previously adopted directives aimed at specific sources of pollution (e.g. the Wastewater Directive and the Nitrates Directive) or the protection of specific waters (e.g. the Bathing Water Directive and the Shellfish Waters Directive) and combines the measures in these directives in an in¬tegrated approach. To facilitate this integrated and ambi¬tious reorganization of EU water policy, the EU Water Directors have agreed upon a coordinated strategy for implementation of the Water Framework Directive – the Common Implementation Strategy (CIS).

The reason for designating Prespa Lake Watershed as a pilot basin is that the ba¬sin includes a wide range of aquatic and terrestrial habitats that are subject to major sources of environmental pressure, such as intensive agricultural production and the presence of the urban centre of Resen. The wider region is also of high environmental importance, as has been recognized by the establishment of national parks, a nature reserve and the designation of Prespa Lake itself as a Ramsar site. The Lake and its watershed are shared among three countries and this project is thus an important example of international cooperation for sustainable development.

The aim of carrying out the present pilot project has been to demonstrate and apply the methodology of the Water Framework Directive from the characterization of surface water and groundwater to the establish¬ment of environmental objectives based on reference conditions and the preparation of programmes of measures optimized on the basis of economic analyses and cost-effectiveness. The watershed manage¬ment plan is a technical plan that estab¬lishes the most cost-effective programme of measures for the whole of the aquatic environment within the river basin. No political judgment has been made as to whether the total cost of the programme of measures might be considered dispropor¬tionate for the society. Moreover, the watershed management plan does not deal with how the programme of measures is to be fi¬nanced, including whether the programme is to be paid for by water users/consumers, by businesses, or in some other way. Funding is to be clarified in the approval process.

The watershed management plan contains in-depth analysis as to whether or not the necessary legislation is in place to ensure that the programme of measures can be realized. The institutional/organizational setup in the sector, as well as the available capacity, has also been analyzed. The analysis determined that it is necessary to draw up statu¬tory orders and establish a necessary legislative basis for the forthcoming implementation of the river basin management plan¬ in Macedonia. As this was not fully in place when the present pilot project started, the present analyses and proposals must be considered provi¬sional.

The watershed management plan has been completed in the context of a serious deficiency of environmental monitoring data, as well as time constraints, meaning that it has at times only been possible to determine the magnitude of the necessary measures on the basis of expert judgment/experi¬ence. It is expected that the present example of the basin manage¬ment plan will serve as a source of inspi¬ration for river basin district authorities in Macedonia in coming years when they have to undertake com¬prehensive aquatic environment planning.

The project team would like to take this opportunity to thank all who participated and contributed to the elaboration of this Watershed Management Plan: the expert team and associates, the UNDP Office in Skopje, the UNDP Prespa Project team, the Ministry of Environment and Physical Planning, the Prespa Watershed Management Council and the Municipality of Resen. Gratitude is also extended to the Ministry of Agriculture, Forestry and Water Economy (Water Economy Administration) and the Netherlands Commission for Environmental Assessment (NCEA) for their interest in the project and their cooperation throughout the project period.

Background

The Prespa region is situated in the Balkan Peninsula and is shared among the three neighbouring countries of Albania, Macedonia and Greece. It is considered to be an ecosystem of global significance and has been identified as one of Europe's major trans-boundary 'ecological bricks'. The Prespa Region hosts unique habitats which are important from both a European and global conservation perspective. The health of the ecosystem of the Prespa Basin is under stress, however, from unsustainable practices in agriculture, fisheries, water and forest management. There is limited knowledge of environmental protection and conservation issues among the relevant decision-makers and the general population and a lack of streamlined information available for interested parties.

The aim of the ongoing GEF/UNDP Prespa Transboundary Project is to mainstream ecosystem management objectives and priorities into productive sector practices and policies. The project is designed to strengthen capacity for restoring the health of the ecosystem and conserving biodiversity at local, national and trans-boundary levels in the three neighbouring states in the Prespa region by piloting ecosystem-oriented approaches to main productive sector practices within the basin, including land-use/spatial planning, water management, agriculture, forest and fishery management, conservation and protected area management. Since one of the key outcomes of the GEF project is to establish an integrated land and water management basis for maintaining and restoring the health of the ecosystem in Prespa, it has been recognized that the development of an 'ecosystem-oriented' watershed management plan for the lake basin provides an excellent opportunity for doing so. Three of the Prespa Basin's four perennial streams are located in the Macedonian territory of the Prespa region. Three quarters of the population of the Prespa Basin live in this region and more than 75% of the Prespa Basin's agricultural land is located in the Macedonian territory of Prespa. Effective ecosystem-friendly water management in Macedonia is thus central to maintaining the health of the ecosystem of the entire transboundary Prespa Basin. The Ministry of Environment and Physical Planning (MoEPP), supported by the UNDP/GEF Prespa project, is therefore striving to develop a watershed management plan for the Macedonian part of the basin that will also consider water and land-use management aspects in the other two co-basin states.

The new Law on Waters prescribes the main provisions for the management of waters at country level. The first phase of the implementation of the Law, which commenced with the entry into force of Chapter III on planning and Chapter XI on organizational / institutional set-up, transferred responsibility for the management of water resources from the Ministry of Agriculture, Forestry and Water Economy to the Ministry of Environment and Physical Planning, with full responsibility transferred by January 2011. Following this phase, the National Water Council needs to be established and will have responsibility for adopting the National Water Strategy. The adoption of the National Water Strategy will pave the way for subsequent preparation of the Water Master Plan, which is due to be adopted within four years of the Law's entering into force. In addition, four River Basin Management Districts (RBMDs) have been identified which will be administered by three River Basin Management Bodies (RBMBs). RBMBs must be established within four years of the adoption of the Water Law and each RBMB will prepare a River Basin Management Plan that must be finalized within six years of the adoption of the Law on Waters. The law also provides possibilities, where appropriate and deemed necessary, to prepare sub-basin management plans. The Prespa Lakes Basin belongs as a sub-basin to the larger Crni Drim River basin and the Law stipulates that watershed management plans prepared for all sub-basins (including the Lake Ohrid Basin) are to be included within the major watershed management plan for the river to which these sub-basins belong. Being the first watershed management plan under the new Law on Water, the watershed management plan for the Prespa Lake sub-basin will be included in the Crni Drim watershed management plan and has the potential to serve as a model plan that will establish basic principles and guidelines for the preparation of other watershed management plans in accordance with the IRBM across the country. Therefore, the watershed management plan for the MK Prespa Lakes watershed must be in line with the principles of Integrated River Basin Management (IRBM). As regards transboundary cooperation, the new Water Law commits the country to cooperating with co-basin states in respect of transboundary waters. The watershed management plan accordingly considers the transboundary aspects of water management.

The implementation of the plan should be conducted in parallel with efforts to develop watershed management capacity by establishing and operationalizing the key organizations/institutions for water management at national level and especially at local/regional level.

Current Legal & Institutional Status in Macedonia

The new Water Law was adopted in August 2008. The first phase of implementation, which commenced with the entry into force of Chapter III on planning and Chapter XI on organizational / institutional set-up, is supposed to transfer responsibility for water resources management from the Ministry of Agriculture to the Ministry of Environment and Physical Planning (MEPP), with full responsibility transferred by January 2011.
The National Water Council has been established and will have responsibility for adopting the National Water Strategy. Adoption of the National Water Strategy will pave the way for subsequent preparation of the Water Master Plan which is due to be adopted within four years of the Law's entry into force. Although the National Water Strategy is currently under preparation, it is not clear when the Strategy and associated strategic documents will be completed.

Four River Basin Management Districts (RBMDs) have been identified and these districts will be administered by three River Basin Management Bodies (RBMBs). The RBMBs will take over some management responsibilities from existing Water Managements which are heavily indebted and currently undergoing a fundamental transformation. RBMBs must be established within four years of the adoption of the Water Law and each RBMB will 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 Prespa / Ohrid basin.

The Water Law facilitates the full transposition of the E.C. Water Framework Directive and approximation with seven further E.C. 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 the Republic of Macedonia, including the four RBMDs. 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 RBMPs. Currently, the Regional Spatial Plan (RSP) for the Prespa / Ohrid Region has been completed. The Plan makes express reference to the need to gather further data on water resources in the region and to develop further methodologies for the collection of such data. Conveniently, it would appear that the area of the Prespa / Ohrid basin within the territory of Macedonia corresponds almost exactly with the boundaries of one of the provisionally proposed RBMDs.

Although water quality protection is included within the focus of a number of national strategic documents, plans and legislation, as well as some local initiatives, further efforts will need to be made at national level to establish a workable organizational, financial and capacity basis for integrated and comprehensive water management and protection.

Existing institutional structures for the protection of water quality operating under the Ministry of Environment and Physical Planning are currently being restructured. 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 upgraded and coordinated with the development of the National Water Strategy and the Water Master Plan. In respect of water monitoring and analysis, funding is a constant constraint. This significant aspect of ensuring a sustainable and operational water sector has also been neglected in the new Water Law. Even if monitoring or analysis equipment were to be donated, significant funding would be required for the maintenance and recalibration of such equipment and the training of operatives. Although the new Water Law assigns responsibility for particular activities to certain institutions, no funding for such institutions is prescribed under the legislation.

Irrigation and irrigation organizations have suffered greatly during the transition/restructuring process over the past two decades and are now in complete disarray. The newly established Water Management organizations (WMs) lack funding, capacity and sufficient mandate to rehabilitate the obsolete and deteriorated irrigation infrastructure. By law, the WMs now have an increased mandate; however, they lack any realistic means of managing the resources that fall within their responsibility. Water Communities (Irrigation Associations) represent a desperate effort to organize a chaotic situation in the irrigation sector. This situation has fostered the development of a number of individual wells/drip-irrigation systems in a region highly dependent on agriculture (predominantly apple cultivation, which verges on a monoculture).

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 appears to be committed to transboundary cooperation in respect of shared waters.

The 2011 EC Report on Macedonia's progress in transposing the EU acquis on water states the following:

"Little progress can be reported in the area of water quality. Administrative reorganization of this sector is underway. The process of transposition of the acquis in this field is not very advanced. Some implementing legislation was adopted to further align with the Urban Waste Water directive and the Water Framework Directive. Administrative capacity is still insufficient at all levels. The lack of sufficient coordination between the competent authorities in the water sector is hampering the implementation of the legislation. There is very little progress in addressing the gaps in the water monitoring system. Planning and preparation of infrastructure investments are lagging behind and the funding is far too low in relation to needs. No progress has been made in applying the polluter-pays principle. This creates problems for the sustainability of investments in this sector. Preparations are lagging behind in this area."

Summary

The results of the pilot project presented in this Report can be sum¬marized as follows:

- According to the typology suggested by the WFD, 16 watercourses have been identified as waterbodies: 13 waterbodies as rivers; 1 heavily modified waterbody; and 2 artificial waterbodies. Prespa Lake is delineated as a single transboundary waterbody. Six groundwater bodies have been identified in the Prespa region.

- Initial 12-month comprehensive surveillance monitoring of the water quality and ecological status has been conducted for all the identified/delineated waterbodies and reference conditions have been established.

- The pressures on waterbodies from both natural and anthropogenic origins have been extensively identified and analyzed. These pressures include the input of pollutants (e.g. nutrients and hazardous sub¬stances) and physical pressures on the wa¬terbodies (e.g. agriculture in the river corridor, drainage, watercourse maintenance and ab¬straction). The input of pollutants takes place via both water and air from diffuse sources (e.g. nutrient leaching from farmland) and point sources (e.g. wastewater discharges from house¬holds and industry, emissions from industry and agriculture and leaching from disused landfills). The harmful impacts of water (floods, erosion) and the morphological pressures on rivers and on the lake, as well as the state of protected areas, have all been scrutinized. The results of these analyses are presented in Chapter 3.

- Existing monitoring activities have been analysed and assessed for their compliance with the requirements of the new Law on Water and relevant national regulations (taking into account the WFD and other Directives), and other relevant environmental laws & regulations. The absence of monitoring and data, the existing monitoring capacity and the organizational and financial aspects of required monitoring have also been analysed in depth. Besides establishing the initial network for surveillance monitoring of environmental data, a comprehensive monitoring programme in accordance with the WFD and the Law on Water has been proposed as part of the Programme of Measures.
- As a result of monitoring, the status (including biological, hydromorphological and physico-chemical quality elements) of all the waterbodies in Prespa region has been determined (Chapter 4).

- The environmental objectives and respective indicators, both for the general environment and for the individual waterbodies in terms of their progress towards 'achieving good water status for all waterbodies', are presented in Chapter 5.

- The economic use of water has been analyzed and a summary is presented in Chapter

6. This analysis has revealed significant problems regarding institutional setup and capacity, overall management deficiencies, deterioration of infrastructure, low or no cost recovery and, finally, dire prospects for investment in the water sector.

- Based on Problem Analysis (identifying the main problems and root causes) and Gap Analysis (including: Legal and Policy Framework, Organizational Setup and Institutional Capacity, Water and Wastewater Management Systems and Procedures), a comprehensive Programme of Measures for achieving the set objectives has been developed. This consists of 45 measures aimed primarily at resolving technical and environmental issues and problems in the region. These measures have been scrutinized and subjected to multi-criteria prioritization and ranking.

- Three implementation strategies have been determined: A Business as Usual Strategy - Alternative 0; A Water Framework Directive Implementation Strategy - Alternative 2; and A Realistic Implementation Strategy -Alternative 1. Specifically:

  - **Business as Usual Strategy**, whereby none of the 45 measures needed are implemented and the Prespa Lake Watershed area deteriorates further in terms of economic growth, environmental management and ecological status.

  - **Water Framework Directive Implementation Strategy**, whereby all the needed 45 measures are implemented in full accordance with the WFD, thus assuring the achievement of the environmental objectives at a total cost estimated as being in the area of 52 million EUR.

  - **Realistic Implementation Strategy**, whereby some of the above 45 measures are implemented based on the availability of economic resources, including manpower and skills resources, at a total cost estimated as being in the area of 14.5 million EUR.

- Based on previous assessments—and especially given the insufficiently developed and inconsistent legal and regulatory framework, insufficiently clarified roles and responsibilities in the organisational structure, and the need for improvement of institutional capacity—it is recommended that the WMP processes be initiated with measures at local level as the priority for the first six-year period. Successful implementation of actions and investments at local level may serve as a motivation for action at national level.

- The Prespa Lake Watershed Management Plan will be implemented in accordance with a two-tier strategy:

  - The first priority will be to implement measures which address the enabling environment, the institutional roles and management instruments, thus establishing the foundation and preparatory measures for the more technical measures.

  - In parallel with this, and while the legal and regulatory frameworks are put into place and the organisational structures and institutional capacity are developed, the more technical measures will be implemented in a structured 'learning-by-doing' process.

- An economic analysis has been made of the proposed Programme of Measures. Based on the previous analyses, an Implementation Schedule for the Prespa Watershed Management Plan has been proposed.

2 Description of the Watershed

2.1 General Description of the Watershed

Prespa watershed is a high-altitude basin at approximately 850 meters above sea level. It includes two inter-linked lakes: Micro Prespa (47.4 km2) and Macro Prespa (259.4 km2). The watershed is shared between Macedonia, Albania and Greece. The lakes, along with the surrounding forested mountain slopes of Pelister, Galichica, Mali i Thate, Varnountas and Triklario, cover a total area of 1,386 km2. The area which forms the subject of this study is the Macedonian part of the watershed of Macro Prespa Lake.

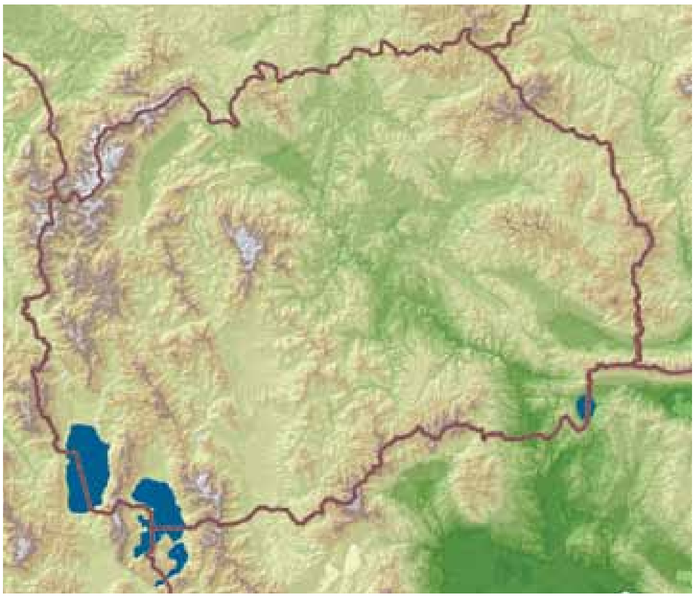


Figure 1. *Location of the Prespa Lake watershed*

Most of the Macedonian part of the basin is classified as hilly and hilly-mountainous. It can be divided into Prespa valley and the surrounding mountains of Baba, Ilinska and Galicica. The hilly and hilly-mountain part of the area is classified as being of a high rank of steepness (i.e. higher than 32%).

Topography of the working area

Slope of the working area

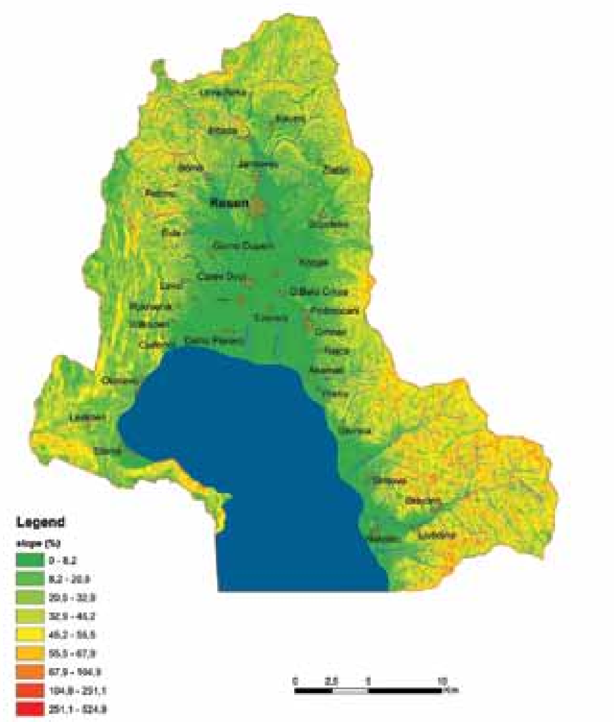
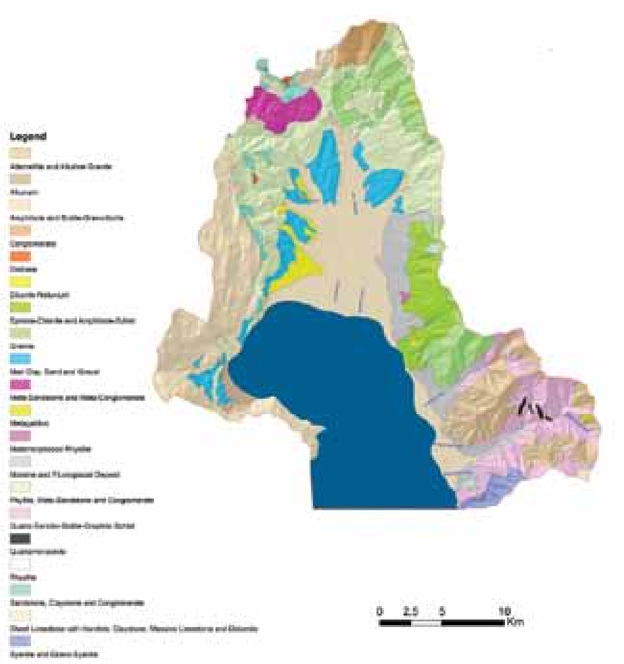


Figure 2. *Topography and slope of Prespa Lake watershed*

The Prespa region is characterized by a fairly complex geological-tectonic structure, with rocks ranging in age from the oldest Paleozoic formations to the youngest Neogene and Quaternary sediment rocks. The mountains and the valley are mainly composed of rocks varying in age and composition.

Geology map



Soil map

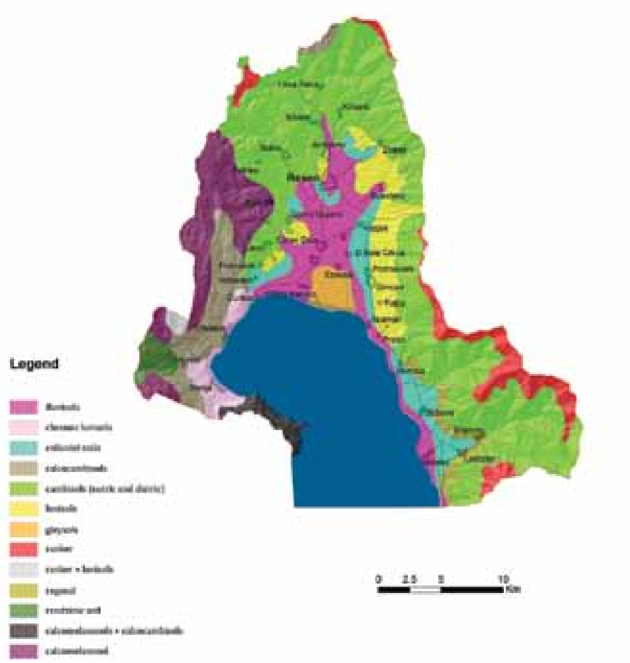


Figure 3. *Geology Map and Soil Map*

The specific orographic conditions that have an impact on the dynamic factors of the climate, together with the impact of geographical and local factors, create three different types of climate throughout the watershed: a warm and cold sub-Mediterranean climatic area; a sub-mountainous and mountainous sub-Mediterranean climatic area; and a sub-alpine and alpine climatic area. The annual average temperature is relatively low; however, it is very suitable for orchards—and for apple trees in particular. The specific local warm continental climate is created by the relief, the altitude, the fluctuation of the water body of the Prespa Lake and the weak influence of the Mediterranean climate.

Prespa Valley is surrounded by the mountains of Petrinska Planina, Galicica, Suva Planina, Ivan Planina and Suva Gora. Both the mountains and the valley are composed mainly of rocks varying in age, mineralogical composition and origin. The calcareous rocks are dominant overall, and also, in lesser extent distributed between magmatic rocks and Grano-Diorites. Syenites are present in the higher elevation areas, but Triassic carbonate rock masses are present in many areas as well. Different types of Quaternary sediments, such as alluvial, fluvio-glacial, proluvial, organogenic-marsh and deluvial sediments, are dominant in the valley, especially on the riverbeds.

Prespa valley, as part of the western Macedonian hydrogeological province, is characterized by the presence of rocks with different hydrogeological characteristics and types of porosity (fractured, confined, karst and karst-fractured types of aquifer), as well as the occurrence of mineral and thermo-mineral groundwater.

The dominant soils in the Prespa valley are alluvial soils located in the lowest region. A significant part of the valley area and the hills on the western side are mainly used for agriculture. Cabisoils are dominant in the mountain region and are covered with forest vegetation. The subalpine and alpine areas only contain grass vegetation. The Macedonian part has small deposits of marble, dolomite, limestone and peat. The major mineral resource is limestone and dolomite in the western part. Sand and gravel is exploited around the mouth of the Golema River into the Prespa Lake.

Vegetation varies from submerged aquatic formations and reed-beds to shrublands of junipers and oaks, to forests of oak, beech, from mixed broadleaves to alpine grassland. From a phytocoenological perspective, the presence of the endemic plant community Lemneto-Spirodeletum polyrrhize aldrovandetosum is the most important. In total, there are 1,326 plant species in Prespa; 23 freshwater fish species; 11 amphibian species; 21 reptile species; more than 42 mammal species, among which are the brown bear, the wolf, the otter and the chamois; and over 260 species of bird. As well as providing a shelter for over 90 species of migratory birds, the Prespa lakes are also home to tens of species that have been officially registered as critically endangered or vulnerable. Among these is the Dalmatian Pelican, one of the largest flying birds in the world, which seeks secluded wetlands to build nests and to hatch chicks in what is its largest breeding colony worldwide. The most important fauna are the fish fauna, 80% of which are endemic species. The population of the Macedonian part of the watershed belong to a single municipality, the Municipality of Resen, comprising a total area of 739 km2, of which 177 km2 is lake area. There are 44 settlements, 43 rural and 1 urban (the town of Resen). Only 39 of these are settlements are currently populated. The total number of inhabitants is 16, 825, living in 4, 848 households. Over the last 10 to 15 years there has been a decline in demography mostly due to local migration from the area. More than 5 percent of the total population of the Municipality of Resen is illiterate, while the figure for the City of Resen is 3.9 percent. Of the total population aged over 15 in the rural areas of Resen, two thirds have completed at least primary schooling, while 8.9 % have a university degree.

With regard to land use, around 32% of the Macedonian part of the catchment area is covered by forest according to the EU CORINE Project (2000), while agriculture comprises 27% of the area, of which 16% is cultivated. The remaining 41% consists of settlements, roads, and unused land. Agriculture plays a significant role in terms of employment and economic sustainability. Currently, over 60% of the total population of the Municipality of Resen depend on agriculture, primarily on apple production. Industries—including food, textiles, metal, paper, chemical and construction, and represented mostly by medium-sized enterprises—are the biggest contributor to the local GDP. There is presently no significant tourism industry. Land-use figures from the Prespa-Ohrid Spatial Plan correspond with the CORINE data (Tables 1 and 2).

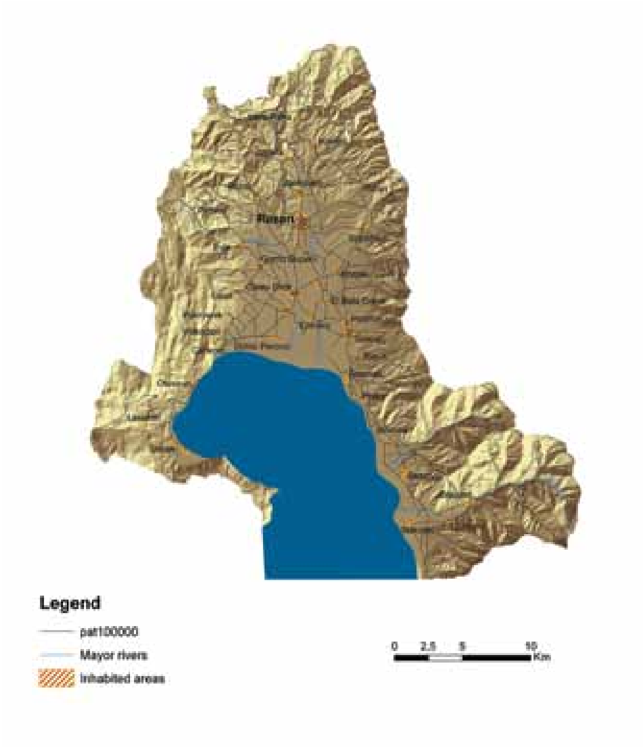
Code	CORINE – Class	ha	%
112	Discontinuous urban fabric	361.34	0.47
121	Industrial or commercial units	23.09	0.03
131	Mineral extraction sites	22.88	0.03
142	Sport and leisure facilities	23.83	0.03
211	Non-irrigated arable land	910.61	1.20
221	Vineyards	35.81	0.05
222	Complex cultivation patterns	9653.27	12.68
222	Fruit trees and berry plantations	251.44	0.33
231	Pastures	1693.68	2.22
243	Land principally occupied by agriculture, with significant areas of natural vegetation	2027.16	2.66
311	Broad-leaved forest	24828.8	32.61
312	Coniferous forest	619.19	0.81
313	Mixed forest	1716.77	2.25
321	Natural grasslands	5033.95	6.61
324	Transitional woodland-shrub	8102.53	10.64
331	Beaches, dunes, sands	85.82	0.11
411	Inland marshes	2485.83	3.27
512	Waterbodies	18258.3	23.98

Table 1. *Land-use classes (year 2000) according to the CORINE delineation (see also Figure 4.)*

Municipality	Total Area	Forests		Pastures		Cultivated land		Non-productive land	
	ha	ha	%	ha	%	ha	%	ha	%
1	2	3	4	5	6	7	8	9	10
Resen	73884	23625	32	8195	11	11932	16	30123	41

Table 2. *Land use pattern in the municipality of Resen (Spatial plan for Ohrid-Prespa region 2005-2020)*

Settlements and road network



Household connections to the water supply and to wastewater collection are mainly the responsibility of the ‘Proleter’ Public Utility Enterprise. All houses are equipped with water-meters, though bulk metering is common. Metering and billing is performed on a monthly basis. Illegal connections are not a problem in the area. Almost all communities within the Golema Reka watershed (10 out of 13) are part of the regional Krusje – Resen – Sirhan water supply system. Only Leva Reka, Podmocani and Grncari are not connected to the central system, being managed and operated by the Proleter Public Utility Company. The system is quite old but it does provide safe drinking water to users. During the summer period, some higher zones in the system lack regular water supply due to the reduced capacity of wells.

Corine land cover/use (2000)

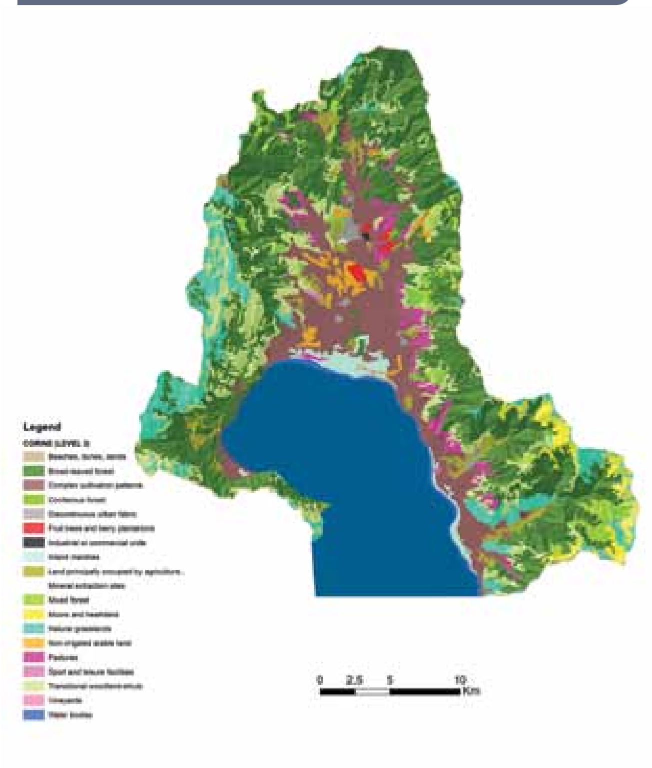


Figure 4. *Socio-economic maps of the Prespa region: Settlements and road network; Land Use*

2.2 Location, Typology and Delineation of Waterbodies

This section of the report summarizes the location, typology and delineation of the water bodies. The aim of this typology is to as¬sign the water bodies to groups sharing rela¬tively uniform natural reference conditions. The characterization of waterbodies used is in accordance with System A (WFD, Annex II).

2.2.1 Surface Waters

Prespa watershed includes two interlinked lakes, Micro Prespa and Macro Prespa, which together constitute an inner-mountainous basin that has no natural surface outflow. Drainage happens only through underground links from which the water of the Macro Prespa Lake (approx. 845 m a.s.l) drains westwards to Ohrid Lake, approximately 150 m lower. On its northern shore, the Ohrid Lake has a natural outlet into the Crni Drim River in the town of Struga. The Micro Prespa Lake is shared between Greece and Albania, while the Macro Prespa Lake is shared between Albania, Macedonia and Greece. Ohrid Lake belongs partly to Macedonia and partly to Albania. Micro and Macro Prespa Lakes are connected by a small natural channel, here referred to as the Isthmus of Koula. The dominant streams in the Macedonian part of the region are Istočka Reka, Golema Reka, Brajčinska Reka, Kranska Reka, and Kurbinska Reka.

The watercourses in the Prespa watershed are subdivided according to the typology suggested by the WFD. In total, 16 watercourses have been identified as waterbodies, of which 13 waterbodies are rivers, 1 is a heavily modified waterbody and 2 are artificial waterbodies. The large number of delineated waterbodies in a relatively small watershed is due to the fact that Prespa Lake watershed has not been studied sufficiently in the past. Aiming to analyze the state of the ecosystem more accurately, the Project Team addressed a larger number of waterbodies. This trade-off between quality assessment and reporting difficulties in later stages of implementation may be subject to further revision in the next WM plans.

Hydrological network

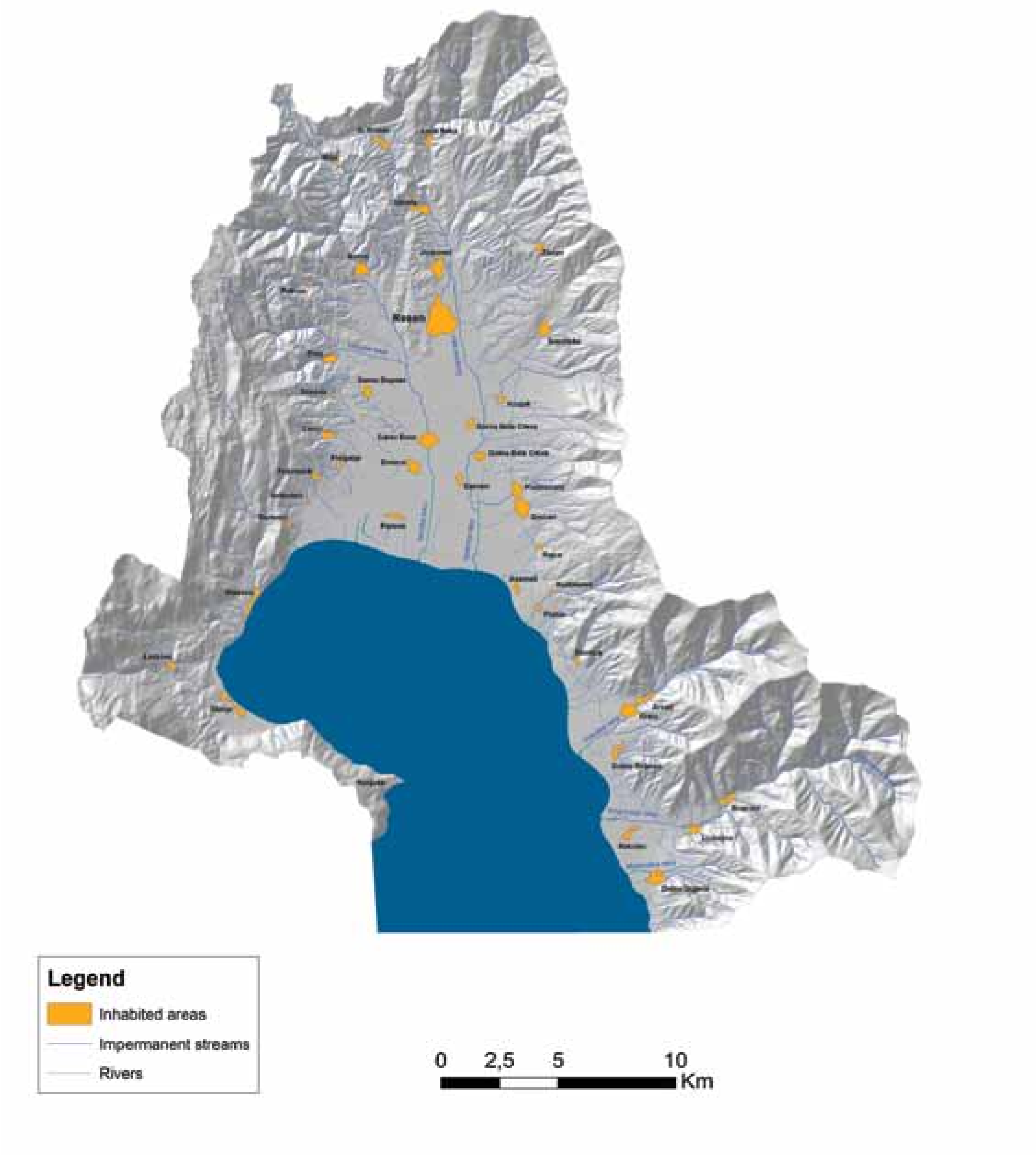


Figure 5. *Hydrological network in the watershed*

Istočka Reka was delineated in 3 waterbodies, all of which are classified as rivers.

- Istočka 1 is delineated as the river segment from the source to the village of Carev Dvor.
- Istočka 2 encompasses the section from the village of Carev Dvor up to the border of the protected area of "Ezerani".
- Istočka 3 is separated as a waterbody because it belongs to the Ezerani protected area.

Golema Reka has been divided into eight waterbodies (GR 1-8). Five of these belong to the category of rivers (GR1-GR5); one in the category of a heavily modified waterbody (GR6), and two in the category of artificial waterbodies (GR7-GR8).

- Golema Reka 1 represents Leva Reka (left spring area of the Golema Reka watershed).
- Golema Reka 2 represents Krušje (right spring area of the Golema Reka watershed).
- Golema Reka 3 represents the part from the mouth of Krušje to Leva Reka up to the mouth of Češinska Reka.
- Golema Reka 4 represents the left tributary Češinska Reka.
- Golema Reka 5 represents the section be-

tween the mouths of Češinska Reka up to the beginning of the town of Resen.
- Golema Reka 6 is a heavily modified waterbody. It represents a section where the river is trained and canalized by a concrete canal and other hydraulic structures.
- Golema Reka 7 and Golema Reka 8 are delineated as artificial waterbodies.
- Golema Reka 8 is a part of the river that belongs to the Ezerani protected area.
Kurbinska Reka is delineated as a single waterbody.
Kranska Reka has been divided into two waterbodies belonging to the category of rivers.
- Kranska 1 represents the upper section up to the village of Asamati.
- Kranska 2 represents the downstream part of the river, i.e. from Asamati up to the mouth to the Prespa Lake.
Brajčinska Reka has been divided into two (2) waterbodies, both rivers.
- Brajčinska 1 represents part of a river that belongs to the protected area of the National Park of Pelister.
- Brajčinska 2 represents the downstream section up to the mouth in the lake.

Macro Prespa Lake is delineated as a single waterbody. It is also a trans-boundary waterbody. Micro Prespa is a separate waterbody.

Water bodies: Rivers, HMWB, AWB

Hydrological network (water bodies)

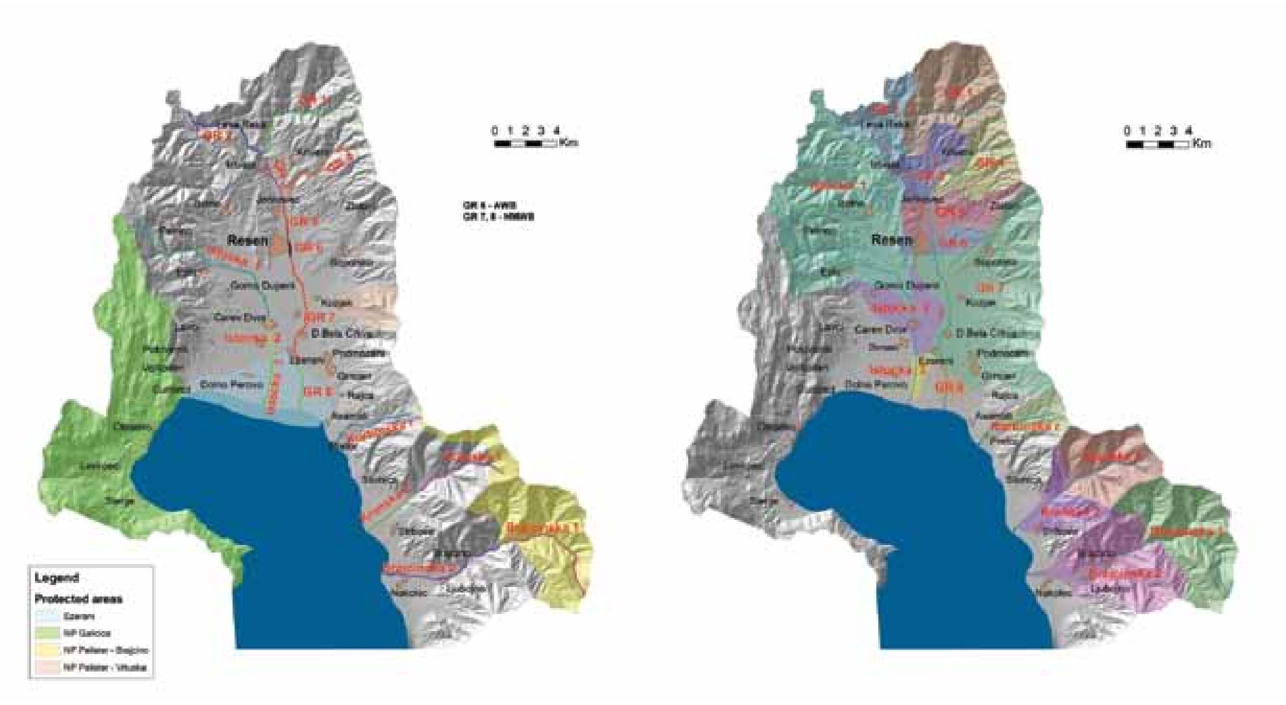


Figure 6. *Delineated surface waterbodies in the watershed*

The whole region of the Prespa Lake watershed belongs to the Hellenic Western Balkan Eco-region 6. All waterbodies are located above 800 m.a.s.l., i.e. in the mountain region (M). The watershed area of all the waterbodies is lower than 100 km2 and they are characterized as small (S). According to the petrographic structure of the watersheds of each waterbody separately, 11 out of 13 waterbodies consist of silicate rocks. Only in two waterbody watersheds (Istočka 1 and Golema 2) is there a slight presence of carbonates in a predominantly silicate petrographic structure. Taking into consideration the abovementioned characteristics, all the waterbodies (rivers) are categorized as one type (type 1). A heavily modified waterbody is characterized as type 1h, while artificial waterbodies belong to type 1a. Surface waterbody types in Prespa watershed are presented in Tables 3 and 4.

Name	Eco-region	Altitude	Size	Geology		Type
Surface waterbodies – rivers						
Istočka Reka 1	6	M	S	S	*	1
Istočka Reka 2	6	M	S	S		1
Istočka Reka 3	6	M	S	S		1
Golema Reka 1	6	M	S	S		1
Golema Reka 2	6	M	S	S	*	1
Golema Reka 3	6	M	S	S		1
Golema Reka 4	6	M	S	S		1
Golema Reka 5	6	M	S	S		1
Kurbinska Reka 1	6	M	S	S		1
Kranska Reka 1	6	M	S	S		1
Kranska Reka 2	6	M	S	S		1
Brajčinska Reka 1	6	M	S	S		1
Brajčinska Reka 2	6	M	S	S		1
Surface waterbodies – heavily modified WB						
Golema Reka 6	6	M	S	S		1h
Surface waterbodies – artificial WB						
Golema Reka 7	6	M	M	S		1a
Golema Reka 8	6	M	M	S		1a

Table 3. *Typology of surface waterbodies - watercourses* *presence of carbonates in the geological structure

According to the typology suggested by the WFD System A, Lake Prespa is delineated as a single waterbody.

Name		Lake Prespa
Eco-region	Hellenic Western Balkan	6
Altitude	844.3 – 853.4	M
Size	259.4 [>100 km²]	L
Geology	Silicate / Carbonate	S/C
Depth	55 m [>15 m]	
Type		**1L**

Table 4. *Typology of surface waterbodies – Lakes - system A*

NO.	GWB	SURFACE (km²)	STRATIGRAPHIC ELEMENT	GEOLOGIC LAYER	TYPE OF AQUIFER	CLASS OF WATER PERMEABILITY
1	GWB01201	68.08	Q [al + pr + j]	Youngest Quaternary sediments	Porous	poor & moderate
2	GWB01202	15.45	Q [al]		Porous	moderate
3	GWB01301	13.20	Q [al]		Porous	high
4	GWB02201	118.03	Pl_3	Upper Pliocene sediments	Porous	moderate
5	GWB03201	11.80	$T_2^{1,2}$	Middle and Upper Triassic carbonate rocks	Karstic	moderate
6	GWB03301	96.73	$T_2^{1,2}$		Karstic	high

Table 5. *Delineated groundwater resources in the Prespa Lake Watershed*

2.2.2 Groundwater

Delineation of the groundwater basins was developed using a conceptual model based on geological and hydrogeological conditions. Delineated groundwater bodies in the Prespa area are situated in three layers. Observation and numbering was performed by adopting the stratigraphic principle. Additional delineation of groundwater bodies was made according to permeability, i.e. yield. Six groundwater bodies were identified in the Prespa region:

Hydrogeology map

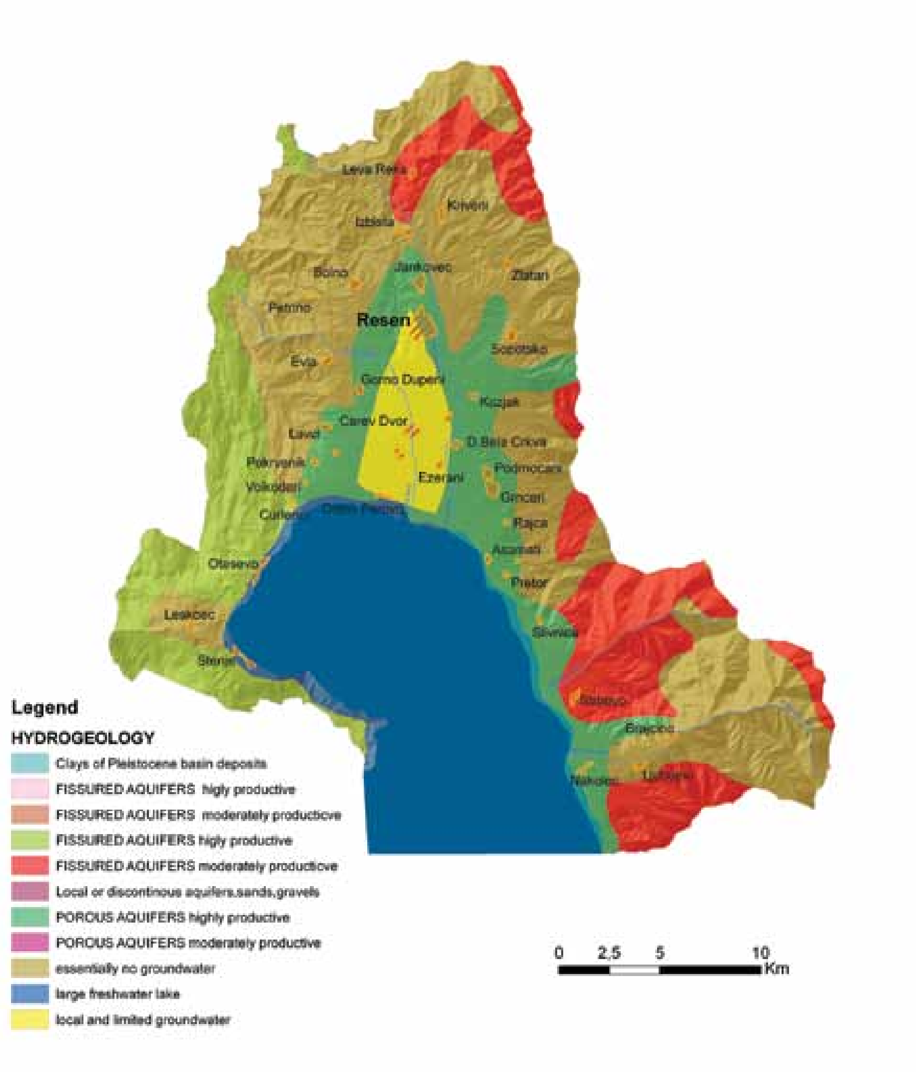


Figure 7. *Hydrogeological map of the delineated groundwater bodies in the Prespa Lake Watershed*

- Youngest Quaternary sediments are delineated in 3 (three) classes of water permeability (POOR, MODERATE and HIGH); Three GWBs (identified by internal notation GWB01201, GWB01202 and GWB01301) were delineated from the Youngest Quaternary sediments.
- One GWB (GWB02201) was delineated from Upper Pliocene sediments.
- Two GWBs (GWB03201and GWB03301) were delineated from Middle and Upper Triassic carbonate rocks.

2.3 Reference Conditions for Waterbodies in the Prespa Region

During the project period, an initial 12-month comprehensive surveillance monitoring of water quality and ecological status was conducted for all the identified/delineated waterbodies and reference conditions were established.

2.3.1 Surface Waters

Watercourses

Although past data about the rivers in the Lake Prespa watershed is very scarce, the reference conditions were quite easy to determine given the following factors: a) all rivers belong to the same river type; b) they have very short and rapid flows prior to their inflow into Prespa Lake; c) their source waters belong to two different National Parks where they are well protected from any significant human activities; d) even with a limited number of samplings, water chemistry and biology were easily distinguished from the rest of the river watercourses where human impact was much more severe.

Reference conditions for the rivers in the Lake Prespa watershed	
Parameter (units)	Value
Dissolved oxygen (mg.L^{-1})	>9
Conductivity (mS.cm^{-1})	<50
pH	6-7
NH_x-N (mg.L^{-1})	<0.05
NO_x-N (mg.L^{-1})	<0.6
Total N (mg.L^{-})	<1.0
PO_4-P (mg.L^{-1})	<0.020
Total P (mg.L^{-1})	<0.030
Toxic heavy metals and priority substances (mg.L^{-1})	<0.001
Dominant algae – diatoms	Diatoms: *Meridion circulare, Meridion circulare var. constricta, Diatoma hyemalis, Diatoma mesodon, Eunotia spp., Staurosirella pinnata, Hannea arcus, Psammothidium daonense, Amphipleura pellucida, Decussata hexagona, Luticola nivalis, Diadesmis perpusila, Krsticiella ohridana, Pinnularia sudetica.* Red algae: *Lemanea fluviatilis.*
Dominant benthic invertebrates	Heptagenia sulphurea, *Baetis rhodani, Baetis alpinus, Baetis fuscatus, Baetis vernus, Potamophylax latipennis, Capnia vidua, Brachyptera risi, Nemoura cinerea, Austropotamobius torrentium, Astacus astacus*
DSFI index – invertebrates	^{3}7

Table 6. *Reference conditions for rivers*

The reference conditions for the rivers in the Lake Prespa watershed are thus very close to conditions found in Kranska Reka 1 and Brajčinska Reka 1. These are natural rivers with good hydraulic contact with their surroundings, rich riparian vegetation, clear water with very low conductivity (<100), slightly acidic, low in nutrients which are easily biodegradable, and with diverse natural flora and fauna in and around the watercourse.

Lake Prespa

Establishing the reference conditions for Lake Prespa (or any other lake) is much more difficult. If one applies the only reasonable and justified principle of regarding every water ecosystem as a separate entity (the state-changed approach as opposed to spatial state classification, Moss et al., 1997), then Prespa Lake cannot be compared for its reference parameters to any other lake (even with Lake Ohrid, for which Lake Prespa is the major water source.

This is even more important if the turbulent and variable past of Prespa Lake is taken into account. The lake was formed by three rivers whose underwater flows are still detectable in the lake and which were constrained by lime masses blocking their way to Lake Ohrid. On this basis, the ecosystem started to develop with a very variable surface area and volume in the past. In addition, numerous human constructions (buildings, roads, etc.) have been recorded at the bottom of the lake. All of these characteristics describe Prespa Lake as a very large waterbody, intensively mixed by numerous sub-lacustrine sources of water and with a very unstable water mass basically depending on climate, hydrologic regime and human activities. It is also a system in which there is a constant mixing of the water column, either by wind or powerful underwater currents and sources, which also means a constant supply of nutrients in the water column.

For a water body such as this which suffers from a lack of continual monitoring data (especially regarding biology), establishing reference conditions has proven to be an extremely demanding task. However, as part of this Project, core samples dated from 10 ka before the present (BP) were obtained from the University of Cologne Project B2 – The Climatic and Environmental History of the Balkans During the Last Glacial Cycle (Wagner & Schäbitz, 2009). The basic chemicals (major cations, heavy metals, total N and P content) and biological (diatom assemblages) parameters in the core layers dating from 0.5, 1, 2, 5 and 10 ka BP respectively, have been analysed within the Prespa WMP assignment and for the first time the historical development of major parameters has been used to establish the reference conditions in the Lake.

Regarding the concentrations of major cations and heavy metals obtained from the analyses of Prespa Lake core samples, Prespa Lake is dominated by aluminium and iron throughout the analysed ten thousand year period. On the other hand, calcium concentration varies with increases of up to 300 % in the same period. In the last 500 years, sodium concentration has tripled, while potassium has increased by 30%. These are clear signs of human alterations to the natural conditions.

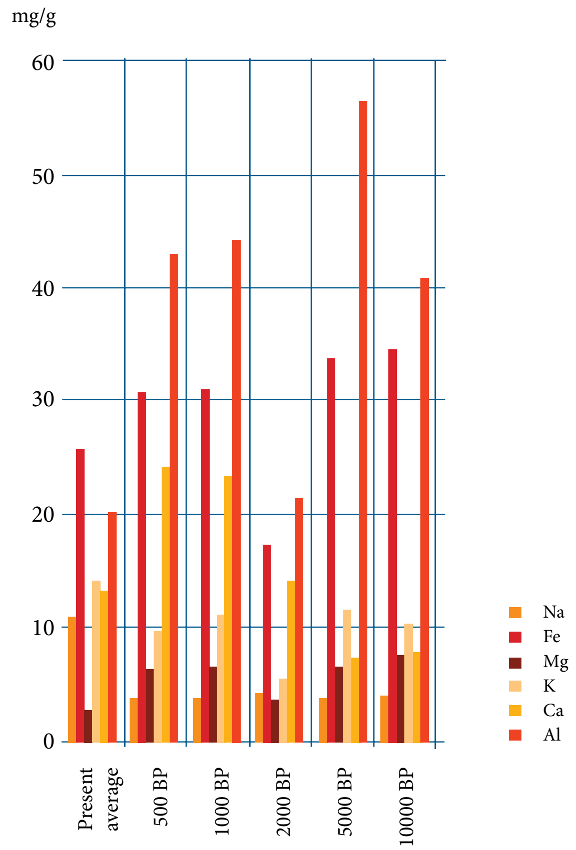


Figure 7. *Major cations and heavy metals in core samples from Lake Prespa*

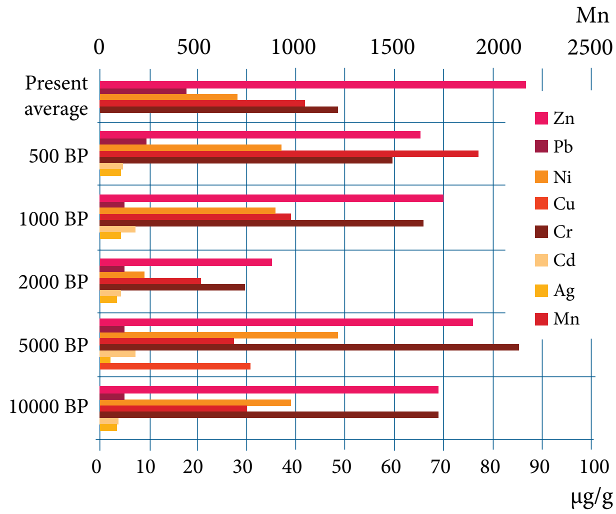


Figure 9. *Heavy and toxic metals in core samples from Lake Prespa*

Regarding heavy and toxic metals, the greatest increase is recorded in concentrations of zinc and manganese, but lead has also shown a steady increase over time and a recent sudden surge. These results clearly indicate intensified human impact due to waste input in the sediments of the lake over the past 500 years. The results obtained for the total P content in the present-day sediments of Lake Prespa are quite interesting. It can be concluded that the phosphorus in Lake Prespa plays a crucial role in the overall eco-physiology of the system. It is not deposited at a regular pace and it is not used in a predictable manner. A significant increase of phosphorous input has also been recorded during summer months.

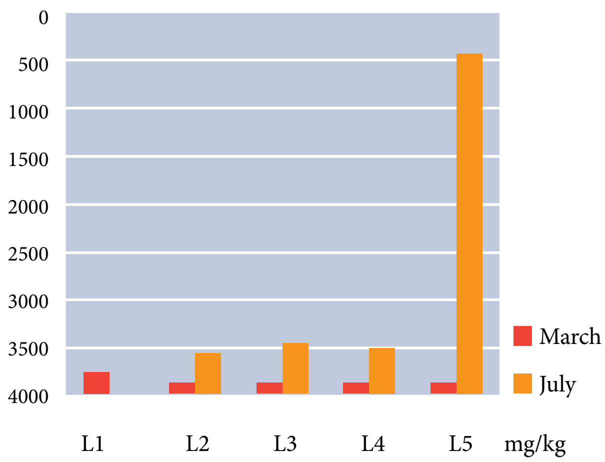


Figure 10. *Total P content measured in recent sediments at the sampling sites of Prespa Lake.*

Note: L1-Stenje, L2-Pretor, L3-Krani, L4-Nakolec, L5-Dolno Dupeni

Compared to the results obtained from analyses of the core samples, the phosphorus in Lake Prespa reveals further important features. Firstly, it has been deposited in recent sediments in significantly higher quantities (almost 3 times higher) than recorded in the core samples. Secondly, its predominance over nitrogen has taken place over the last 500 years. Thirdly, Lake Prespa has never been a nitrogen-limiting lake, since the values for total nitrogen are almost constant throughout the analysed period. Therefore, the principal nutrient that is driving the observed changes in the lake's plankton communities (cyanobacterial 'water blooms') is phosphorus. The observed occurrence of cyanobacterial 'water blooms' at the L5 sampling site (by the village of Dolno Dupeni) and the results for the phosphorus deposition in the same area of the lake is more than a mere coincidence and deserves much more attention in the future.

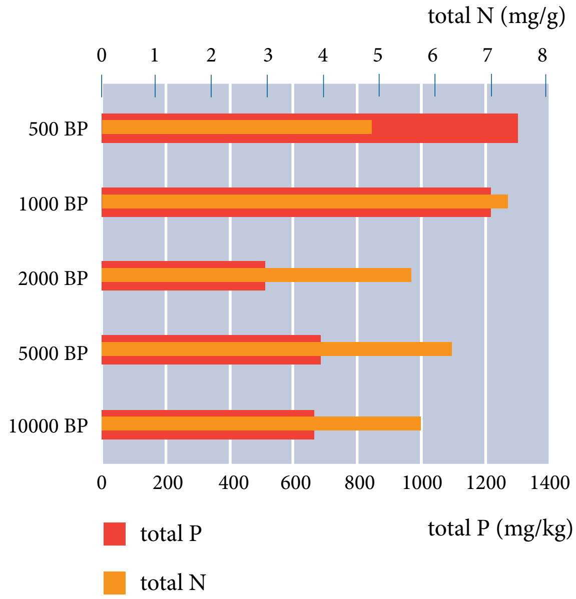


Figure 11. *Total P and total N in Prespa Lake core sediments.*

There are very few well preserved organisms or remains of organisms in the lacustrine sediments that can be easily retrieved for observation. Having siliceous cell walls, diatoms are probably the optimum choice (Krstic et al., 2007) for monitoring recent and paleo environments since they rapidly and constantly change their assemblages according to environmental conditions and their specific autecological preferences (Stoermer and Smoll, 1999).

By analysing the diatom assemblages in different core layers of Lake Prespa to reveal possible changes in dominant planktonic or benthic taxa and thus deduce the corresponding changes of environmental conditions forced by human activities, the following observations can be formulated:

- Diatom assemblages along the 10 ka core of Lake Prespa are surprisingly uniform. Only very slight changes in the dominance of specific taxa can be observed; typically dominant throughout the core are Cyclotella ocellata, Stephanodiscus rotula, Diploneis mauleri and Camplylodiscus noricus.
- The diatom flora of Lake Prespa is very rich in taxa, as previously recorded (Levkov et al., 2006). But the overall composition of taxa in the communities indicates an ecosystem which is naturally rich in nutrients and enables the development of diverse microflora, reflecting the basic mesotrophic state (according to our present state of knowledge regarding diatom nutrient preferences and autecology) of the environment at least up to 10,000 years BP.

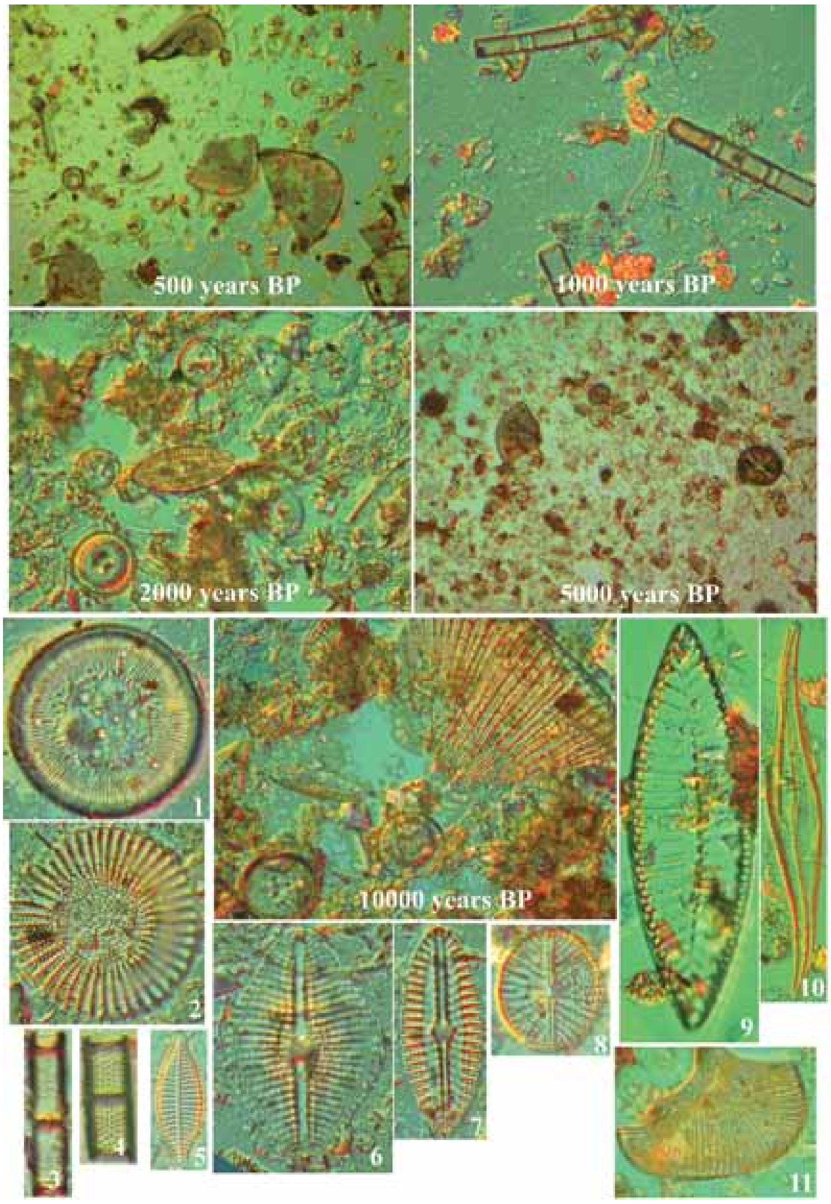


Figure 12. *Comparative presentation of diatom assemblages retrieved from 0.5-10 ka BP core samples from Prespa Lake and some of the most dominant and characteristic taxa in the investigated core samples: 1. Cyclotella ocellata, 2. Stephanodiscus rotula, 3. Aulacoseira granulata, 4. Aulacoseira ambigua, 5. Karayevia clevei var.balcanica f.rostrata, 6. Diploneis ostracodarum, 7. Diploneis mauleri, 8. Cavinula scutelloides, 9. Surirella bifrons, 10. Gyrosigma macedonicum, 11. Camplylodiscus noricus.*

The only important occurrence observed of a diatom form that may offer conclusive proof of a significant increase in nutrients in the ecosystem is the appearance of Aulacoseira spp. (especially Aulacoseira granulata) in the sediments approximately 1000 BP and persisting in the communities to the present day. This unique but very subtle change in diatom taxa dominance can be connected to the high increase of phosphorus concentration recorded in the Lake Prespa sediments presented in Fig.12. For comparison, the Aulacoseira taxa determined in Lake Prespa can be found in co-dominance with various cyanobacterial taxa (which are usually regarded as potentially toxic) in the plankton of highly eutrophic lakes like Lake Dojran in Macedonia (Fig.13. Krstic et al., in prep).

Figure 13. *Plankton sample from Lake Dojran (August 2010), dominated by Aulacoseira granulata and at least 3 Microcystis taxa; circular filaments belong to Lynbya contorta.*

Since we cannot see the cells of other algae (or their remains) in the core layers, by deduction from our present knowledge we can conclude that Lake Prespa has become eutrophic, at least during the most productive periods, due to an increase of phosphorus and possibly other nutrients not yet analyzed in the core samples. The presented timeframe supports the strong possibility that human activities have played a crucial role in increasing the eutrophic status of Prespa Lake.

The final support for the overall conclusion that Lake Prespa has completed the turnover to a highly eutrophic system comes from analyses of plankton communities during summer months. Only two cyanobacteria forms have produced a typical 'water bloom' from May to September, Anabaena affinis and Anabaena contorta, which have fully replaced the usual plankton dominance of diatoms belonging to the genus Cyclotella. Consequently, ELISA tests for cyanotoxins (microcystins) in the lake's waters have revealed a significant presence of these toxins in summer months (see Fig. 15): the maximum detected value was 53 mg^*L^{-1} at L1 (v.Stenje) in August 2010. The allowed/recommended maximum concentration is 10 mg^*L^{-1} for bathing waters (BWD, 2006/7/EC) and only 1 mg^*L^{-1} for drinking water (WHO, 2011).

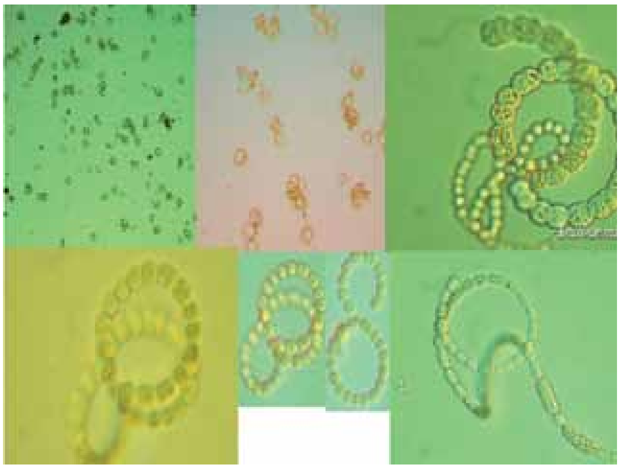


Figure 14. *'Water bloom' caused by Anabaena affinis and Anabaena contorta in Prespa Lake waters.*

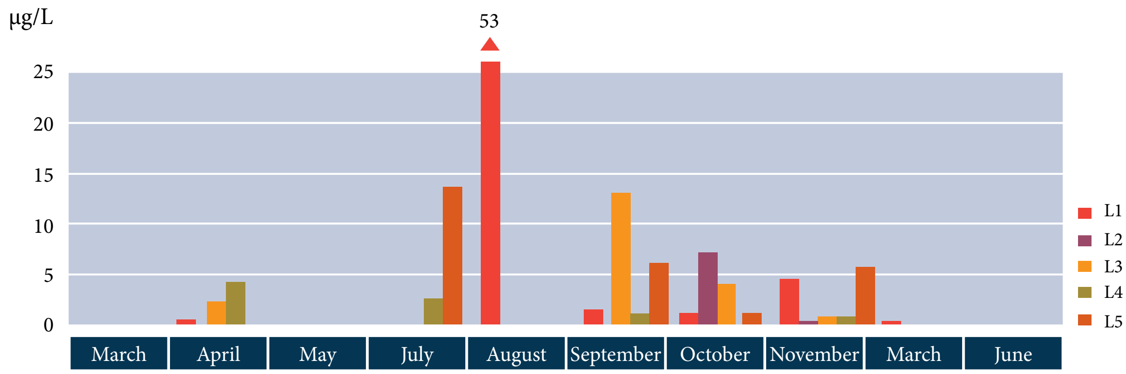


Figure 15. *Cyanotoxins-microcystins in Prespa Lake waters during the 12-month investigation period*

Clear signs of human alterations to the natural conditions of Prespa Lake have thus been confirmed.
The reference conditions of Macro Prespa Lake are presented in Table 7:

Reference conditions for Lake Prespa	
Parameter (units)	Value
Dissolved oxygen (mg.L^{-1})	6-7 (surface); >4 (bottom)
Conductivity (mS.cm^{-1})	200-300
pH	7-8
NH_x-N (mg.L^{-1})	<0.05
NO_x-N (mg.L^{-1})	<1.0
Total N (mg.L^{-})	<3.0
PO_4-P (mg.L^{-1})	<0.005
Total P (mg.L^{-1})	0.015-0.025
Chlorophyll a (mg.L^{-1})	<3.8
Secchi depth (m)	>5
Dominant algae	Diatoms, Chrysophytes, green coccoid algae, Xanthophytes, Charophytes. No cyanobacteria or 'water blooms' by any algal group.
Dominant benthic invertebrates	Snails, clams, dragonflies, mayflies, caddis flies, leeches, sponges, amphipods, Ddcapods. No Chironomids or Tubificids indicators for eutrophic conditions
BQI index Diversity index H	>3 2.33-3.00

Table 7. *Reference conditions for Lake Prespa*

The reference conditions for the Macro Prespa Lake ecosystem as a single waterbody are presented in Table 9, based on all other analyses and elaborations. The values for the most important parameters are targeted on the boundary between good and moderate water quality status for Lake Prespa. These values were exceeded at least a century ago. Given the very high pressure of a variety of pollutants and human influences elaborated in this report, the target reference conditions may seem beyond reach. If current conditions continue, however, a total turnover of Lake Prespa towards a hyper-eutrophic ecosystem should be expected in the very near future. In this case, the overall status of the Prespa-Ohrid-Crni Drim River system will be jeopardized and much more difficult to control, let alone brought to the status of good water quality.

2.3.2 Groundwater Bodies

Due to the geological and hydrogeological preconditions, especially the interconnection of reservoirs and the contamination of resources, it is difficult to establish a reference condition for the groundwater resources.
However, there is a possibility of identifying GWB03301 (highly-permeable Triassic carbonate rocks or "Galičica" karst) as a reference condition due to:

The quality status of the 'Sirhan' karst spring as a potential reference condition for the upstream part of Galičica karst (given the absence of fruit orchards).

The quality status of the occasional 'Leskoec' karst spring as a potential reference condition for the upstream part of Galičica karst (given the absence of fruit orchards).
The water quality of the Upper Pliocene sediments of GWB02201 could be identified as a reference condition pending further investigation. For the remaining groundwater bodies (Quartenary sediments GWB01201, GWB01202, and GWB01301, as well as the moderately-permeable Triassic carbonate rocks of GWB03201), the establishment of reference conditions will need further elaboration.

3 Anthropogenic Impacts on the Status of Surface and Groundwater

Bodies in the Basin

The pressures on the waterbodies are both natural and anthropogenic in origin. These pressures include the input of pollutants, including nutrients and hazardous substances, and physical pressures on the waterbodies, for example agriculture in the river corridor, drainage, watercourse maintenance and abstraction. The input of pollutants takes place via both water and soil from diffuse sources (e.g. nutrient leaching from farmland) and point sources (e.g. wastewater discharges from households and industry, emissions from industry and agriculture, and leaching from disused landfills).

3.1 Summary of Surveillance Monitoring Results

In the course of project implementation, comprehensive surveillance monitoring was conducted for water quality and ecological status. The results are summarised below:

- Of the 16 delineated river waterbodies, 13 are delineated as type 1 rivers. Of these, the majority (six, or 46.2%) have moderate ecological status and three have either poor (two, or 15.4%) or bad status (one, or 7.7%). On the other hand, there are two waterbodies with good and high ecological status (four in total, or 30.8%). The remaining three, namely the one heavily modified waterbody and the two artificial waterbodies, have bad ecological potential and chemical status. (See Table 14 for further details.)
- All the rivers examined contain significantly increased nutrient concentrations in their lower reaches: phosphates, sulphates, total N and ammonia, typically high above the levels for natural conditions.
- Manganese, iron and aluminium were found to be dominant heavy metal pollutants in the rivers, usually indicating III-IV water quality class. The most severely affected rivers were Golema and Istočka, which are also characterized by a significant presence of mercury, lead and arsenic.
- Macro Prespa Lake receives more than 27 tonnes of iron and almost 26 tonnes of aluminium per year from its major tributaries. It is also loaded with 4.6 tonnes of manganese, 3.5 tonnes of zinc and more than 1.5 tonnes of copper per year. Toxic metals are less abundant (563, 504, 132 and 118 kg per year for arsenic, lead, chromium and mercury respectively) but they do represent a significant load and a dangerous hazard to humans and water biota through processes of bioaccumulation.
- A total of 18 priority substances were detected in the rivers. Bis (2-Ethylhexyl) phthalate was present in almost all samples, the highest amounts being recorded in the Golema and Brajčinska rivers. Dibutilphthalate was also found in all rivers except Kurbinska River, but in slightly lower concentrations. Organchlorine pesticides were recorded in different concentrations and levels of dominance. Gama-HCH (Lindane), Alpha HCH, and Alpha Endosulfan were the most common, but there were very high values for Heptachlor in Golema Reka 6 and especially in Kranska Reka.
- The numerous different priority substances detected, some of them with very high concentrations (III-IV or V water quality class), represent an increased risk for the environment, water biota and humans. Toxic and already forbidden chemicals like DDD or DDE are still present in the rivers, which proves they are still in use.
- Benthic organisms, algae and macrozoobenthos were used as primary ecological quality elements for evaluating the ecological status of the river waterbodies. A clear distinction of algal assemblages between good-moderate-bad status gradient has been established, with the final mass development of epiphytic and benthic cyanobacteria (Pseudoanabaena limnetica and Phormidium limosum respectively) as indicators of poor or bad ecological conditions. Reference conditions were represented in the headwaters of Kranska and Brajčinska rivers as having acidophilic and oligosaprobic dominant diatom flora and high EPT and DSFI zoobenthos indexes. Due to excessive pollution, the HMWB (Golema Reka 6) did not host any macrozoobenthos taxa, while the full stretch of the benthos was covered by the mass development of filamentous cyanobacteria.

- Macro Prespa Lake is a naturally nutrient-rich environment. Detected values for total N and P content in the sediments from the past 10 ka and the corresponding diatom assemblages point to the boundary between good and moderate ecological conditions.
- Nevertheless, a shift from an N dominated environment to P dominance has been recorded over the past 1,000 years, being more intensive in the last 500 years. This evidently human influence has shifted the dominance from diatoms and chrysophytes in plankton towards intensive development ('water blooms') of potentially toxic cyanobacteria like Anabaena flos-aquae during summer-autumn periods. A change in diatom plankton species dominance by the continual presence of Aulacoseira granulata in the last 1000-500 years has also been recorded.
- Nutrient levels in Lake Prespa fully reflect the overall conditions already identified in the watershed. The lake is dominated by sulphates, as are the rivers, but there is also a marked presence of total N basically due to higher concentrations of nitrates and ammonia. Regarding ammonia, the whole investigated area was found to be in the III-IV category class described in domestic legislation; while the total presence of nitrates in Lake Prespa means it must be declared a Nitrate Vulnerable Zone as described in EU legislation.
- The phosphorus content places the lake at a hyper-eutrophic level in accordance with both domestic and EU legislation.
- Copper, iron and zinc are the dominant metals. For copper, the detected values were almost entirely within the III-IV category. The increased presence of the other two metals confirms their prolonged input.
- Mercury and arsenic have also been detected and increased concentrations were found in July 2010. Mercury has been found at the L2 sampling site with concentrations high above the V water quality class. Arsenic is also present in all the sampled waters of Lake Prespa, but in much lower concentrations than mercury. It rose to III-IV water quality range only in L4 (Nakolec village – the waters of the mouth of the River Brajčinska) in July 2010. However, its accumulation and persistence in the waters of Lake Prespa is evident.
- Lake Prespa was found to contain 20 priority substances out of more than 70 substances analysed in March and July 2010. As is the case for the rivers, Bis (2-Ethylhexyl) phthalate and Dibutilphthalate dominated in the water samples from Lake Prespa. There is also a marked presence of Benzo (a) pyrene, Benzo (a) anthracene and Naphthalene. Gamma-HCH (Lindane) was present in all the analyzed samples of sediments.
- Macrozoobenthos communities indicate different biological water quality in the littoral and profundal part of the Lake. At different sampling sites, littoral benthic fauna is composed of species and diversity indicating good-moderate ecological status, while the profundal is almost totally inhabited by fauna indicative of poor-bad ecological status.
- The macrophyte vegetation shows a relatively high level of species diversity in different parts of the littoral region. Recorded differences in the number of macrophyte species are most probably the result of different ecological conditions present in the localities investigated, especially in the case of nutrients. A higher number of species implies a very intensive anthropogenic influence in areas of the littoral region with an increased presence of organic and inorganic material.
- The results obtained for macrophyte composition and abundance point to moderate ecological conditions for Lake Prespa, with a marked tendency for bad ecological status if no measures are taken.
- Prespa bleak and roach were the most abundant species caught in Prespa Lake during the period of the project's investigations. By contrast, sensitive species like eel, barb and Prespa salmon have not been detected at any of the examined localities in the lake. Carp has been present in the catches but in very low numbers.
- In summary, according to the results obtained in this surveillance investigation in relation to allochthonous and autochthonous representatives of fish fauna, their age structure and species composition in community, the bad status of Prespa Lake has been confirmed.

3.2 Point Sources of Pollution

3.2.1 Wastewater from Households and Industry

Wastewater pressure on the waterbodies comes from the Ezerani wastewater treatment plant, storm-water outfalls from separate and com¬bined sewerage systems, and from sparsely built-up areas and industry. The pressure on the waterbodies is primarily attribut¬able to the wastewater content of organic matter (BOD5), nitrogen, phosphorus, hazardous substances, heavy metals and pathogenic bacteria and viruses. In addition, there are other point-source pressures such as fish farming.

According to the most recent census (2002), the Municipality of Resen includes 16,825 inhabitants living in 44 locations. In addition, the following tourist centres exert additional pressure on the sewage network and waterbodies, especially in the summer period:

- Hotel Pretor, Pretor (seasonal average of 254 guests)
- Hotel Kitka, Resen (seasonal average of 40 guests)
- Auto-Camp Krani, Krani (seasonal average of 3298 guests)
- Private accommodation in villages (seasonal average of 375 guests): Brajčino, D.Dupeni, Pretor, Slivnica, Ljubojno and Stenje.

According to these calculations, the current load from household sewage (without wastewater treatment) plays a significant role in the pollution of waterbodies.

On the Macedonian side of Lake Prespa, there are several mid-size industrial enterprises performing eight different industrial activities: food processing, poultry farming, textiles, metal processing, wood processing, civil construction, ceramics, and chemicals. The companies involved are as follows:

- Food and Juices (DOO Swisslion Agroplod & CD Fruit – Carev Dvor, Vita Fruit Ltd.)- Textiles (DOO Hatex, DOO Krznoteks, DOO Tekstilprom)
- Chemical Industry (Ohis Prespa Plast AD & Delatask)
- Metal Processing (AD Algreta), civil constructions (AD IGM Sloga)
- Poultry Farming (Swisslion Agrar)
- Ceramics Production (Hamzali)
- Wood Processing (DOO Interbrauk).

A wastewater collection system exists in Resen covering 95% of the population/households and some of the surrounding villages (Jankovec 40%, Ezerani 95%, Carev Dvor 95%). The wastewater system in Resen is planned to be separate. However, only 25% of the stormwater network has been completed. The sewage network is burdened with high quantities of rainwater during rainfall. A number of SMEs in the urban areas are also connected to the system. The Ezerani Wastewater Treatment Plant has been constructed near the village of Ezerani, 7 km south of Resen, for the treatment of wastewater sewage. The process at the plant in Ezera-

Parameter	Unit	Value
Inhabitant	person	20 792
Q_{water} per capita	l/d*People Equivalent	150
BOD5	g/PE*d	60
COD	g/PE*d	110
TSS	g/PE*d	70
N (as TKN)	g/PE*d	8.8
P	g/PE*d	1.8
Calculation for Wastewater Quantity and Quality:		
Flow (Q)=(People*Qper capita)/1000	m³/d	3,118.8
	m³/year	1,138,362
BOD5	kg/d	1,247.5
	kg/year	455,344.8
	mg/l	400
COD	kg/d	2,287.1
	kg/year	834,798.8
	mg/l	733.3
TSS	kg/d	1,455.4
	kg/year	531,235.6
	mg/l	466 .7
N	kg/d	183
	kg/year	66,783.9
	mg/l	58 .7
P	kg/d	37.4
	kg/year	13,660.3
	mg/l	12

Table 8. *Calculations for 20,792 people (including tourists), based on average load per person*

ni comprises of activated sludge and subsequent aerobic sludge treatment.
While the treated effluent is being directed into two maturation ponds in series, the stabilized sludge is diverted directly into the sludge-drying beds. The design capacity of the plan is 12000 PE. The inflow of large quantities of rainwater in wet periods hampers the operation of the plant.

Apart from the existing WWTP in Resen, a number of treatment facilities have been constructed in the Prespa watershed area. However, few of the existing facilities are operational and the facilities functioned only for a short time after construction. An exception is the WWTP in the tourist area of Otesevo. There exists a small WWTP in the village of Nakolec (not covering the upstream villages of Brajcino and Ljubojno).

Industrial installations in Macedonia are subject to Integrated Pollution Prevention and Control (the IPPC system harmonized with EU Directives) adopted with the Law on the Environment (Official Gazette of R.M no. 53/05, 81/05 and 24/07) and specifically described in chapters XII and XIV and the Decree for determining the activities of the installations for which integrated environmental permissions have been issued. The adjustment permit with the operative plan and time schedule for submitting the application for the adjustment permit with the operative plan (Official Gazette of RM no. 89/05) are described in detail in the regulations. The Macedonian IPPC system is characterised by a two-level approach. UNDP has provided support to the municipal authorities, industrial installations and other interested stakeholders in the Municipality of Resen to introduce and ensure compliance with the integrated pollution prevention and control requirements through the delivery of hands-on training and the preparation of training materials. Major installations require an IPPC A Permit issued by the MoEPP. In the Prespa watershed there are three such installations which require an A Permit for adjustment with the operating plan:

1. A.D Algreta - aluminium and zinc foundry (capacity 10t/day)
2. CD Fruit Ltd., Carev Dvor village, Resen – production of juices and juice concentrates (capacity 70 t/day)
3. Swisslion Agroplod Ltd. in Resen – food industry (production 40.48 t/day)

Within the jurisdiction of the Municipality of Resen there are some installations which require an IPPC B Permit. These include, among others, Swisslion Agrar, a poultry farm with over 40,000 egg-laying hens, and Hamzali in Resen, which produces some 69 t/day of ceramics.
Small-scale installations are required to prepare an elaborate for environmental protection.
The Municipality of Resen has identified all installations within its jurisdiction and has already issued three B Permits. The implementation of IPPC and EIA progresses at local level with generous support from UNDP and other donor organizations/projects. This is expected to result in investments in phased pollution reduction. The plan for the forthcoming period is to complete the issuance of IPPC B Permits in the municipality and then to focus on monitoring compliance.

Based on all available data and documentation, as well as the measurements conducted as part of this project, Table 9 presents overall estimates of point source pollution from major industrial plants, with significant pollution values indicated in red:

Indicator:	SwissLion (Agroplod) doo (5.11.2008) 3rd point (biscuits-napolitana)	SwissLion (Agroplod) doo (5.11.2008) 2nd point (resana cakes)	SwissLion (Agroplod) doo (5.11.2008) 1st point (coffee & peanuts)	Algreta AD Resen (14.10.2009) Recipient Golema River	CD Frut, Carev Dvor (28.11.2008) Recipient Bolsnica river	MDK (II class waters)*	Total:
pH value	6.5	6.5	8.7	6.54	6.2	6.5- 6.3	
Total suspended solids TSS (mg/L)	25	30	25	29	53	10 – 30	162
BOD_5 (mg/L)	4.5	6.6	7.3	7.7	5.3	2 – 4	31.4
COD (mg/L)	341	372	341	18.4	9	2.5 – 5	1,081
NitratesNO_3(mg/L)	3	50	3	0.4	1.3	15	57.7
Nitrites NO_2(mg/L)	0	0	0	0	0.3	0.5	0.3
NH_4 (mg/L)	0.4	0.150	0	0.19	0.1	0.02	0.84
Fe (mg/L)	/	/	/	>1	0.25	0.3	1.25
Mn (mg/L)	/	/	/	0.315	0.3	0L05	0.615
Al (mg/L)	/	/	/	0.009	/	1-1.5	0.009
Cd (mg/L)	/	/	/	/	0.0005	0.0001	0.0005
Cl_2 (mg/L)	14.9	17.7	82.2	/	0.0025	0.002	114.8
Cr_{total} (mg/L)	/	/	/	/	0.038	0.05	0.038
Cu (mg/L)	/	/	/	/	0.012	0.01	0.012
Ni (mg/L)	/	/	/	/	0.035	0.05	0.035
Zn (mg/L)	/	/	/	/	0.075	0.1	0.075
Turbidity (NTU)	20	10	20	393	/	0.5-1	443
Total N (mg/L)	/	/	/	/	/	0.2 -0.32	
TDS (mg/L) in: surface waters, ground waters	385	290	580	/	146	500	1.401
Total P (mg/L)	/	/	/	/	/	10 – 25	
Eutrophication Indicators – Most probable number of thermo-tolerant coli form bacteria No/100 ml	240,000	240,000	240,000	/	/	5 – 50	240,000

Table 9. *Calculation of various pollutants per source of pollution*

* Note: Maximum Allowed Concentration in Waterbodies, according to the Regulation for Classification of Water (Official Gazette of RM, No. 18-99)

In order to estimate overall loads, estimations of loads for poultry farming, ceramics, textile and wood industries have been taken into consideration in addition to the values above. In the absence of measurements, the discharge emissions/loads of these other industries have been estimated from available literature and guidelines.

Typical emissions into wastewater from poultry farms include ammonia, uric acid, magnesium, sulphates, total nitrogen (N) and total phosphorus (P), as well as small concentrations of heavy metals (Cu, Cr, Fe, Mn, Ni, Zn, Cd, Hg and Pb). Using these emission factors, total releases of NH3 from manure in the SwissLion Agrar poultry farm areas are estimated to be 13,600 kg/year. Some 720 mg/L of total nitrogen and total phosphorus concentrations of 100 mg/L are released on average per year. BOD levels are reported to be 1,000 – 5,000 mg/l.

Process wastewater is a major source of pollutants from textile industries. It is typically alkaline and has high BOD, from 700 to 2,000 milligrams per litre, and high chemical oxygen demand (COD) at approximately 2 to 5 times the BOD level. The wastewater also contains chromium, solids, oil, and possibly toxic organics, including phenols from dyeing and finishing and halogenated organics from processes such as bleaching. Dye wastewaters are frequently high in colour and may contain heavy metals such as copper and chromium. Wool processing may release bacteria and other pathogens as well. Pesticides are sometimes used for the preservation of natural fibres and these are transferred to wastewaters during washing and scouring operations. Pesticides are used for mothproofing, brominated flame retardants are used for synthetic fabrics, and isocyanides are used for lamination.

3.2.2 Summary of Wastewater Loads

FROM DOMESTIC WASTEWATER (HOUSEHOLD SEWAGE)
Total load estimation based on pressure from 20,792 inhabitants (without WWT):

- BOD5: c.455 tonnes per year
- COD: c. 835 tonnes per year
- Total suspended solids: c. 531 t per year
- Nitrogen: c.67 tonnes per year
- Phosphorous: c.14 tonnes per year

Only 55% of the villages and settlements are connected to a proper domestic wastewater disposal system.

INDUSTRIAL POLLUTION
On the Macedonian side of Lake Prespa there are several Small and Medium-Scale Enterprises (SMEs). Their impacts include ammonium, nitrates, phosphorus, aluminium, very high concentrations of Cl2, high BOD5 and COD concentrations, an increased number of thermo-tolerant coli form bacteria, an increase in heavy metal pollution-Fe, Zn, Cr, Cd, very high turbidity, phenols, benzene, halogenated organics, illegal pesticides in high quantities, brominated flame retardants, and isocyanides used for lamination, oils and grease. Both SwissLion Agroplod and CD Fruit Carev Dvor are planning to make their small WWTP operational in the near future, but currently they are discharging effluents directly into the waterbodies with no pre-treatment. Industrial wastewater from the town of Resen is estimated at 69,350 m3/year. The total annual amount of wastewater from CD Fruit is around 9,000 m3. There is also pressure from agricultural activities and from sparsely built-up areas and stormwater outflows that do not have their own infrastructure.

3.2.3 Identification of Priority Substances

Of the proposed priority substances for surveillance and operational monitoring purposes (Directive 2008/105/EC), the comprehensive analyses performed so far in Lake Prespa watershed cover the following substances:

- Chlorinated aromatic hydrocarbons
- Poly-aromatic hydrocarbons (PAHs)
- Poly-chlorinated biphenyls (PCBs)
- Organophosphate pesticides
- Phenols
- Phthalates
- Organ chlorine pesticides

A total of 18 priority substances have been detected in rivers in the area:

- Bis (2-Ethylhexyl) phthalate was present in almost all samples. The highest values were recorded in the Golema and Brajčinska rivers.
- Dibutilphthalate was also found in all river waterbodies except Kurbinska River, but in slightly lower concentrations.
- Organ chlorine pesticides were recorded in different concentrations and rates of prevalence.
- Gama-HCH (Lindale), Alpha HCH, and Alpha Endosulfan were the most common, but with very high values for Heptachlor in Golema Reka 6 and especially in Kranska Reka.

In summary, the Lake Prespa watershed has suffered significant pollution pressure for a considerable period of time due to the uncontrolled use of various pesticides and components of industrial production. Even the uphill mountain rivers that should be used as reference conditions and which in principle should not be impacted are under obvious pressure. These results highlight the fact that the surface waterbodies in the Lake Prespa watershed have been and continue to be subjected to intensive pressure from agriculture and irregular waste disposal. By comparing the obtained results on priority substances for the river waterbodies and sampling sites of Lake Prespa, some interesting correlations can be formulated. Substances detected in high concentrations in the rivers, such as Bis (2-Ethylhexyl) phthalate or gamma-HCH (Lindane), remain high in the lake's waters. Others that were not recorded in very high concentrations in rivers, such as Dibutilphthalate or Heptachlor, show much higher concentrations in the lake, while PCBs tend to disappear from the lake's waters. These findings highlight the very complicated and unpredictable pathways followed by the priority substances detected in the Lake Prespa ecosystem and indicate the fundamental necessity of monitoring and revealing their final destination and assessing the impact they pose to the ecosystem, to biota and to human health.

The major sources of pollution identified in the watershed are presented in Figure 16.

Sources of pollution

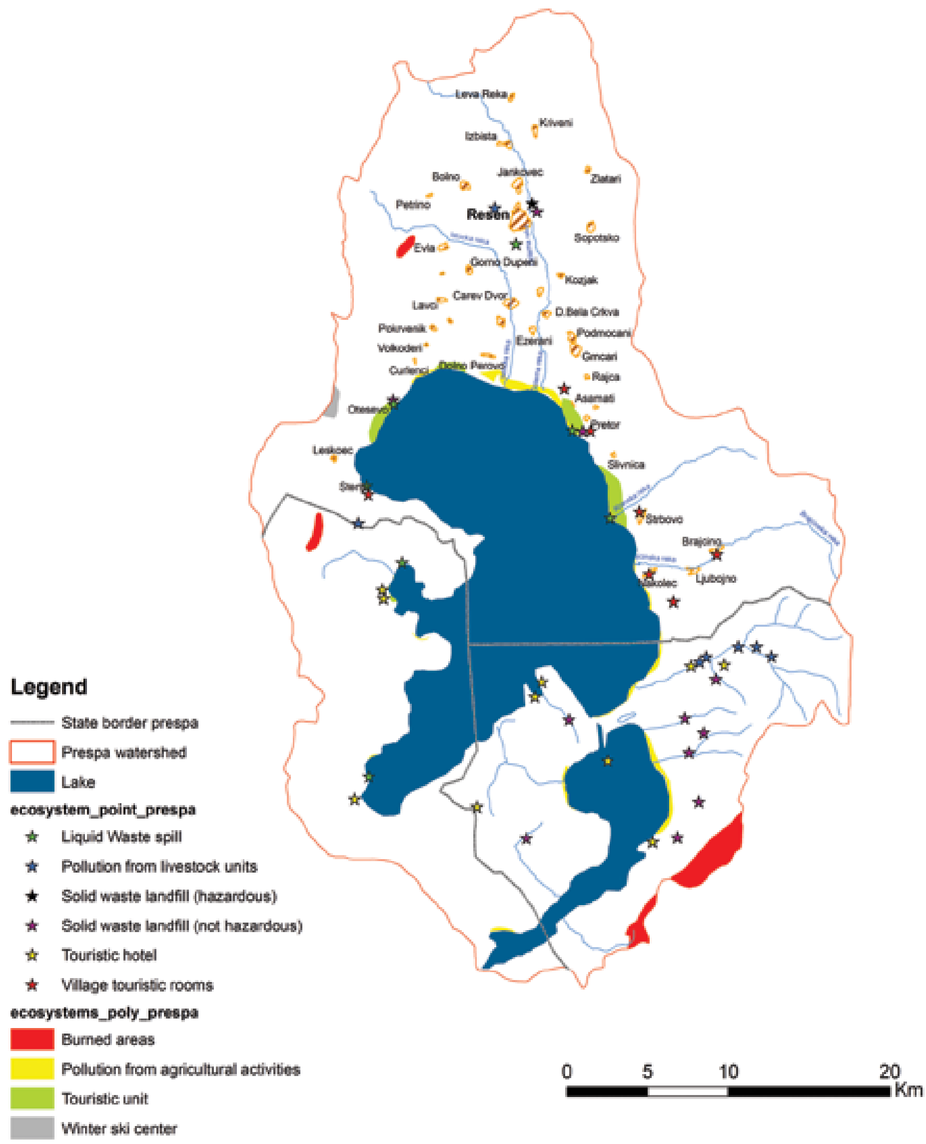


Figure 16. *Sources of pollution in the Lake Prespa watershed*

3.3 Estimation of Diffuse Source Pollution

3.3.1 Agriculture

Agricultural production affects terrestrial natural habitats and the aquatic environ¬ment in a number of different ways. Crop cultivation re¬sults in a loss of nitrogen and phosphorus, etc. The use and handling of fertilizers and pesticides can cause environmental problems, as can pharmaceutical residues. Agricultural activities increase physical pressure on water¬courses and wetlands, resulting in higher nutrient loading of the Prespa lakes. The types and quantities of fertilizers are noted here on the basis of information from the Union of Agricultural Associations and the local AES office. In general, the fertilization of apples/ fruits is performed in 3 phases:

- Phase I: Autumn Basic Fertilization with complex NPK (4:7:28) fertilizer in the amount of 500 to 700 kg per hectare.
- Phase II: Early Spring Fertilizing with complex NPK (15:15:15) in the amount 400 to 600 kg per hectare.
- Phase III: Late Spring Fertilization with usage of nitrate fertilizer such as ammonium nitrate in the amount of 300 to 400 kg per hectare.

Some farmers apply fertilizers only twice a year. The use of organic fertilizers is very rare. Based on these data, the total annual quantity of fertilizers used for apple production in the Golema Reka river basin (for 1,200 ha) equals roughly 1,900 tons. There is no information on fertilizers used for other crop types. However, other crop types are insignificant as compared to apple growing and this is expected to remain the case.

System of Fertilization and Period	Fertilizer Type	Quantity (kg/ha)	Active substances (kg/ha)		
			N	P_2O_5	K_2O
Basic autumn fertilization	NPK 4:7:28	700	28	49	196
Early spring fertilization	NPK 15:15:15	500	75	75	75
Late spring fertilization	NH_4NO_3 34 %	400	136	0.0	0.0
Total		1600	239	124	271

Table 10. *Practice of fertilization in private orchards in the Prespa region*

The spatial distribution of the load of fertilizers and pesticides varies in the catchment, depending on the agricultural land (orchards) available. Table 11 presents the load per identified waterbody (watercourse stretch) and river, as well as the overall load for Lake Prespa.

Water body or Sub-catchment	Apple area	Input of N	Input of P_2O_5	Input of K_2O [kg]	Total input of fertilizers	Input of fungicides	Input of herbicides	Input of insecticides and acaricides	Total input of pesticides
	[ha]	[kg]	[kg]	[kg]	[kg]	[kg]	[kg]	[kg]	[kg]
Istočka Reka 1	309.5	73970.1	38377.8	83874	196221.9	3095	257.2	1808.8	5161
Istočka Reka 2	402.5	96197.7	49910.1	109077.7	255185.5	4025	334.5	2352.3	6711.8
Istočka Reka 3	45.1	10773.3	5589.5	12215.7	28578.5	450.8	37.5	263.4	751.7
Golema Reka 1	22	5267.3	2732.8	5972.5	13972.6	220.4	18.3	128.8	367.5
Golema Reka 2	14.1	3360.1	1743.3	3810	8913.4	140.6	11.7	82.2	234.4
Golema Reka 3	135.1	32288.9	16752.4	36612.1	85653.4	1351	112.3	789.5	2252.8
Golema Reka 4	45.6	10909.9	5660.4	12370.7	28941	456.5	37.9	266.8	761.2
Golema Reka 5	260.4	62244	32294	70577.9	165115.9	2604.4	216.5	1522	4342.8
Golema Reka 6	116.8	27911	14481	31648.1	74040.1	1167.8	97.1	682.5	1947.4
Golema Reka 7	935.6	223597.1	116008.5	253534.8	593140.4	9355.5	777.6	5467.5	15600.6
Golema Reka 8	49.9	11936.9	6193.2	13535.1	31665.2	499.5	41.5	291.9	832.9
Kurbinska Reka	16.8	4007.1	2079	4543.6	10629.7	167.7	13.9	98	279.6
Kranska Reka 1	4	952.8	494.3	1080.3	2527.4	39.9	3.3	23.3	66.5
Kranska Reka 2	110.5	26412.8	13703.7	29949.3	70065.8	1105.1	91.9	645.9	1842.9
Brajčinska Reka 1	0	0	0	0	0	0	0	0	0
Brajčinska Reka 2	83.2	19883.5	10316.1	22545.8	52745.4	831.9	69.1	486.2	1387.3
Galičica with Prespa Lake	757.6	181067.9	93943.2	205311.3	480322.4	7576.1	629.7	4427.6	12633.3
Istočka Reka- Golema Reka	9.3	2233.2	1158.7	2532.3	5924.2	93.4	7.8	54.6	155.8
Golema - Kurbinska	194.5	46488.5	24119.5	52712.9	123320.9	1945.1	161.7	1136.8	3243.6
Kurbinska - Kranska	166.7	39837.9	20669	45171.9	105678.8	1666.9	138.5	974.1	2779.5
Kranska - Brajčinska	72.5	17330.5	8991.6	19651	45973.1	725.1	60.3	423.8	1209.2
Brajčinska – Markova noga	98.2	23479.5	12181.8	26623.2	62284.5	982.4	81.7	574.1	1638.2
Total	3850	920150	477400	1043350	2440900	38500	3200	22500	64200

Table 11. *Use of fertilizers and Pesticides per waterbody and per sub-catchments [in kg]*

In total, around 920 tonnes of nitrogen is applied each season. It is practically impossible to determine to what extent farmers in the region overuse fertilizers.
According to relevant publications, the texture of the dominant soil types is sandy with a high percentage of coarse fractions, making them permeable for water and dissolved mineral matters. Water from precipitation and irrigation can therefore have a strong impact on the dilution of nitrogen forms from fertilizers and other materials that can finally reach the river basin by underground leaching or surface runoff. Nitrogen is an especially big problem for water pollution because it is in water-soluble form and readily moves with water. Leaching of nitrogen from soil is a consequence of (a) the presence of nitrogen dissolved in the soil water and (b) the downward movement of soil water after excessive precipitation.

In total, around 477 tons of phosphorous are used. A large quantity of P-fertilizers are used as a result of a widely held perception that the soil has low fertility. Examples have been reported of farmers who have had soil samples analyzed in various soil-testing laboratories in the country and have been advised not to apply certain nutrients – in particular P and K – for a period of 3 to 4 years in order to achieve the required balance. However, this cannot be taken as a general rule for the entire region since there are farmers who do not use high quantities of fertilizers due to limited finances. Nevertheless, there is significant evidence of the overuse of phosphorous and it should be assumed to be one of the major risks of pollution and eutrophication of water from agricultural sources.
More than 1.000 tons of potassium oxide is applied.

There is no exact data available regarding the amount of pesticides used. As is the case with fertilizers, individual producers either purchase pesticides from private agriculture stores or import them from the neighbouring countries of Albania, Greece and Bulgaria. The branch office of MAFWE, which is the institution responsible for the control of agricultural stores, does not have information on the quantities of pesticides sold by stores. The table below represents rough data on the use of pesticides calculated on the basis of average quantities of pesticides used per hectare of apple orchards and wheat production fields.

Pesticide type	Quantity (tons)	% of total
Fungicides	38.5	60 %
Herbicides	3.2	5 %
Insecticides	22.5	35 %
Total	64.2	100 %

Table 12. *Use of pesticides in the Prespa region*

In total, it is estimated that around 64 tonnes of pesticides are used each year. It is obvious that a much lower amount of pesticides is used in comparison with fertilizer use.

Due to the inappropriate solid waste management system currently in use in the Municipality of Resen, including Golema Reka, together with a low level of public awareness, significant quantities of mainly organic waste (waste apples and yard waste) and partly hazardous solid waste generated by agricultural activity (pesticide packaging) are being disposed of in the river channel and the riparian corridor. This inappropriately disposed waste has a significant negative impact on the surface waterbodies and the groundwaters and soil, and especially on the Golema Reka water eco-system, hence influencing the Prespa Lake ecosystem.

3.4 Estimation of Pressures on the Quantitative Status of Water, Including Abstraction

Analysis of the water balance shows that Lake Prespa has experienced a significant drop in water levels over the past sixty years.

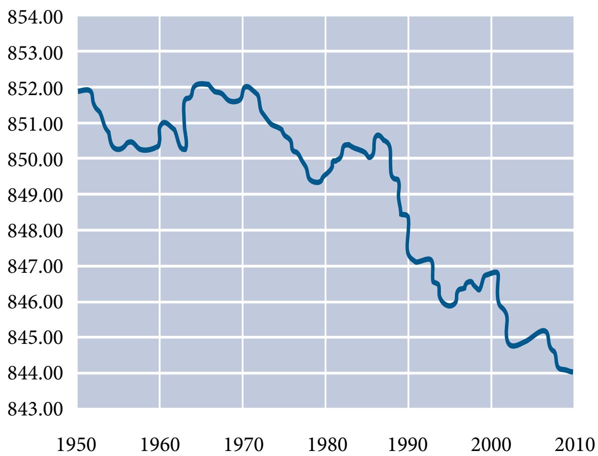


Figure 17. *Water level decrease of Prespa Lake over the period 1951-2008*

Water balance simulations (see Annex 2 TR2) show that wet years led to a rapid increase in water levels, while a series of dry years had the opposite effect. These facts should be taken into account when determining the activities to be restricted in shoreline zones where water level fluctuations will have the greatest effect. These are mainly the shallow zones.

Lake Prespa has been used as a source of water for both irrigation and municipal water supply since the late 1950s. Two pumping stations, one in Asamati and the other in Sirhan, have been used to supply irrigation systems on the eastern and western shores of Lake Prespa in Macedonian territory. According to Sherdenkovski (2000), the average amount of water extraction planned in original projects for Lake Prespa is calculated as 3,200 ha x 4,300 m^3/ha, or 13.76 million m^3 per year. Adding the requirement of 0.35 million m^3 for water supply (possibly a low assumption), the total extraction amounts to around 14 million m^3 per year.

Due to unfavourable local economic conditions since the beginning of the 1990s, the irrigated agricultural surface in Macedonian Prespa had decreased to approximately 700 ha by 2004. Nevertheless, annual irrigation water demand remains high (about 7 to 10 million m^3). In addition, there are an increasing number of water wells being drilled, especially in the catchments of Golema and Istočka Reka. The quantity of water they abstract cannot be estimated accurately due to lack of data. Currently, newly constructed wells/irrigation systems are primarily being used by individuals for drip-irrigation (especially in apple orchards). In the Micro Prespa watershed, irrigation systems are used on approximately 1,100 ha of the agricultural surface around Agios Germanos. The quantities pumped amount to approximately 7 million m^3 per year. In addition, prior to 2001, Albania also extracted water from Micro Prespa. Presumably, these abstractions were balanced by comparable inflows from the Devoli River. According to Sherdenkovski (2000), up to 35 million m^3 per year were withdrawn from Micro Prespa during the operation of the pumping system. Over the years, the capacity of the system steadily decreased due to sedimentation and other technical problems. Ultimately, only 4 million m^3 could have been extracted in 2000, the last year the system was operational. Continuous readings of the amount of water abstracted from the lakes are not available. An examination of available data concerning the quantity extracted compared to the total annual water balance shows that water losses during the critical years were two to six times higher than suggested by the conservative abstraction values presented above.

Map of water objects

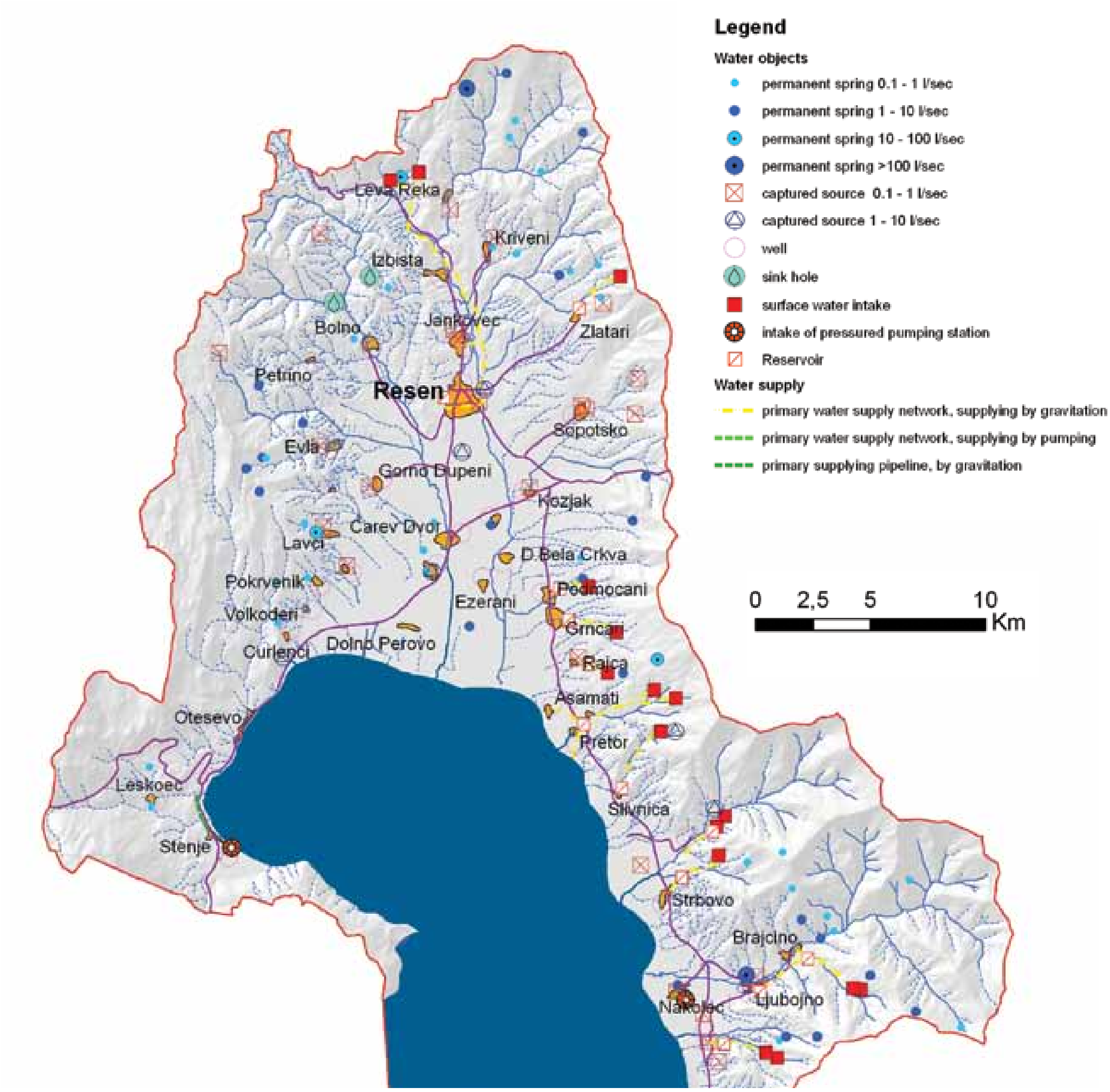


Figure 18. *Water objects in the Prespa Lake Watershed*

Within the Macedonian part of Lake Prespa, the Prespansko Pole Irrigation System was constructed in the late 1950s. At the present time, Lake Prespa and its tributaries, as well as the groundwater reserves, are all used as water resources for irrigation purposes. Although the area of relatively intensive agriculture accounts for only about 4.5% of the total catchment area, it should be noted that many fields are located next to the lakeshore or in areas with a high groundwater table and this exacerbates the seepage of nutrients into both the lake and the groundwater. The Prespansko Irrigation System is divided into three sub-systems. All three sub-systems urgently need rehabilitation / reconstruction in order to reduce conveyance losses and increase overall irrigation efficiency (PROWA 2002).

The irrigation system in Macedonian Prespa, which operated seasonally (from June 15 to September 15) with a design capacity of 1.8 m3/s or 15,552,000 m3 per year, now has significantly decreased capacity due to severe deterioration. The irrigation systems in Greece and Albania use water from the catchment of Micro Prespa Lake. Together, the water quantity used for irrigation by all three countries was estimated in the late 1990s as accounting for some 88.98% of total water use. Of this amount, estimates indicated the following breakdown: lake water (83.22%), groundwater (10.9%), river water (4.98%), and spring water (1.71%).

Currently, wells combined with drip-irrigation systems have become the predominant method of irrigation in the region due to the unreliability of channel irrigation systems. Some 8,000 to 10,000 wells have been drilled, covering an area estimated to be at least 3,000 ha. Hence the share of groundwater used in the region has significantly increased over the last few decades.

Besides wells, a number of irrigation water intakes exist in rivers in the watershed. Some of these use the remnants of the old irrigation system but a significant number are completely new, unregulated and beyond the control of water authorities, with low efficiency and high water losses.

These new developments in irrigation seriously jeopardize lake and groundwater quality. This is because of the use of water in the dry summer period of low recharge of both surface and groundwater and low water level in the lake. Depletion of the lake water in the critical summer period, in conjunction with high temperatures, promotes algal and cyanobacterial growth.

The town of Resen and some of the villages on the northern shore of Lake Prespa are connected to a central drinking water supply system. Their combined populations amount to about 13,600 of the approximately 16,800 total inhabitants within the entire Macedonian part of the catchment area (2004 census). The water distribution network is gravity-fed via water from springs located near the village of Krusje. Additionally, groundwater from two wells near Carev Dvor can be used to supplement the capacity of the distribution network depending on drinking water demand and the availability of sufficient spring water. A second existing water supply system is the local Kurbinovo - Pretor - Asamati system, supplying three villages with 500 inhabitants. The remaining 16 villages, inhabited by about 4,000 residents, have their own separate supply systems. The water supply system covering the town and the abovementioned villages is managed by the Proleter communal enterprise. The villages of Leva Reka, Podmočani and Grnčari are not connected to the central system but are supplied by their own systems, also managed and operated by Proleter. Concurrent investigations estimate an industrial demand of 700 m^3 per day and domestic consumption of 110 l/day/capita. Experience with unfavourable hydrological conditions over the last few summers shows a deficiency of about 30 l/sec.

The main pipeline is 11 km long and the secondary lines are 15 km long. Although built at the beginning of the 1980s, they are still in good condition. While the inner-city water supply network is old and in disrepair, it does provide safe drinking water to users. It was built in the 1960s when the town was much smaller. All houses are equipped with water-meters, but bulk metering is common. Metering and billing is performed on a monthly basis. Illegal connections are not a problem in the area, but wanton damage to water-meters causes difficulties. About 10% of the water-meters do not function. Applying these estimated figures, the total net consumption was 0.9 million m3 in 2009. Thus it appears that 53% of gross production was lost due to deficiencies within the distribution system and so must be considered as uncounted consumption.

3.5 Analysis of Other Impacts of Human Activity on the Water Status

Due to its vicinity to Lake Prespa, one of the three great natural lakes in Macedonia protected by law, the Municipality of Resen has a basic infrastructure for wastewater collection and treatment. However, the wastewater system does not fully cover all wastewater generated along the Golema Reka basin. Only 80 % of households are connected to sewers. Only the upper part of Jankovec (40 to 50 %) is connected to the gravity sewer, while the lower part closer to the river remains to be connected in the future.

Many communities in the vicinity of the main sewer (e.g. Gorna and Dolna Bela Crkva, Kozjak, Podmočani and Grnčari) are not connected to the system because of the lack of funds and incentives. In the late 1980s, the municipality of Resen launched a program to improve the wastewater situation in the town. This program consisted of a wastewater collection network and the construction of a wastewater treatment plant (WWTP) in Ezerani.

A feasibility study conducted in 1988 first introduced the idea of extending the collection network in a western and eastern direction, providing a central treatment plant in Ezerani to which the wastewater is presently being transported. This plant has undergone several rehabilitations intended to replace obsolete technical units and improve treatment efficiency, thus reducing operational costs and positively influencing the effluent quality.

The process at the WWTP in Ezerani consists of activated sludge with subsequent aerobic sludge treatment. While the treated effluent is being directed into two maturation ponds in series, the stabilized sludge is diverted directly into the sludge-drying beds.

Apart from the existing Ezerani WWTP in Resen, a number of treatment facilities have been constructed in the Prespa watershed area, reflecting a concern to address the requirements of the sensitive environment in the region. However, few of the existing facilities are operational and the facilities were only operational for a short time after construction.

An exception is the WWTP near the Institute for the Prevention, Treatment and Rehabilitation of Non-Specific, Chronic, Respiratory and Allergic Diseases in the tourist area of Otesevo.

A small WWTP exists in the village of Nakolec (not covering the upstream villages of Brajcino and Ljubojno). However, this WWTP has still not been put into operation.

Like the public WSS, Proleter Public Utility Enterprise is responsible for the operation and maintenance of sewage collection and treatment. It invoices annually around 300,000 m3 for wastewater collection and treatment, or three times less than the actually treated annual quantity. The analysis of JKP Proleter shows that the price should be increased threefold in order to break even with included depreciation costs.

3.6 Harmful Impact of Water

FLOODS

Several types of floods have been recorded in the area.

- The most frequent type of flood results from **snow melting in combination with high river water levels** that occur in the lower parts of the major watercourses. They are recorded during snow-melt from Baba and Plakenska mountains. The most seriously affected areas are the Brajčinska and Golema Rivers in Macedonia. High groundwater levels are customary for the spring period, particularly for Resen valley when the interaction of surface and underground water creates ponds and pools on the surface of the terrain. Flows of the Brajčinska and Golema Rivers bigger than 15 m3/s contribute to this condition.
- **Floods of bigger rivers** appear when river flows are larger than 40 m3/s. Three floods of this type have been recorded over the past century, in 1942, 1962 and 1979. The watershed of the Golema Reka River produced the largest flooded area, downstream of Resen, all the way to its mouth into the lake. The Brajcinska River has greater destructive power, rolling massive boulders from Baba Mountain, unlike the Golema River, which brings more suspended sediments. The maximum water flows of the Brajcinska River (Qmax = 45.7 m3/s), and the Golema River (36.7 m3/s) were recorded in the flood of November 1962.
- **Lake floods** occur in cases of high lake surface water level. Such floods took place in 1942/43 and 1963, flooding the villages of Nakolec, Asamati, Ezerani, Perovo and large areas of agricultural land. The lake level reached its highest value of 851.93 m a.s.l. (Macedonian levels). The most important recorded floods happened in November 1962, November 1963, and November 1979.
- **Flash floods** caused by torrents were prevalent in past periods when there were more barren hills. The high-intensity short-term rainfalls create dry ravines very fast, bringing huge quantities of eroded material and debris into the villages and agricultural land. The best-known torrent watercourses are situated on the eastern coast (Dolno Dupenska River, Podmočanska/Avatska River, etc.).

EROSION

Documentation related to erosion and torrents shows that torrent and erosion damage occurred even before the 1960s, prompting the authorities in the late 1950s and early 60s to prepare necessary technical documentation (final designs and studies), and subsequently carry out construction work for torrent prevention and protection.

The average annual erosion coefficient of the Lake Prespa watershed is Z = 0.33. Figure 10 presents the erosion risk distribution per categories (where I is the highest risk and V is the lowest risk category).

A large part of the watershed (69%) is classified as low erosion risk (III, IV and V), but almost 13% of the watershed belongs to the highest I and II risk categories and actions to control erosion control need to be prioritised in these parts of the watershed. The most erosive catchments include Ajdra Bair, Kopac, Kutliste, Metok, Istočka Reka, Brajčinska Reka, and Zlatarska Reka.

Torrent and erosion control structures (barrages, cascades, retention ditches, contour trenches, forestation, etc) are multifunctional. In addition to their main role of controlling erosion, they control the direction and rate of flow and contribute to reducing the peak of discharge and flash flood hazards. Erosion and torrent control measures and structures have been implemented in the following catchments: Brajčinska Reka, Suica, Slivnička Reka, Metok, Kopac, Podmočanska Reka, Gorica, Zadgorica, Strasen Dol, Dlaboko Doliste, Dunica, Kozjak, Golema Reka, Bolnska Reka, Istočka Reka and Evlanska Reka.

Soil erosion risk map

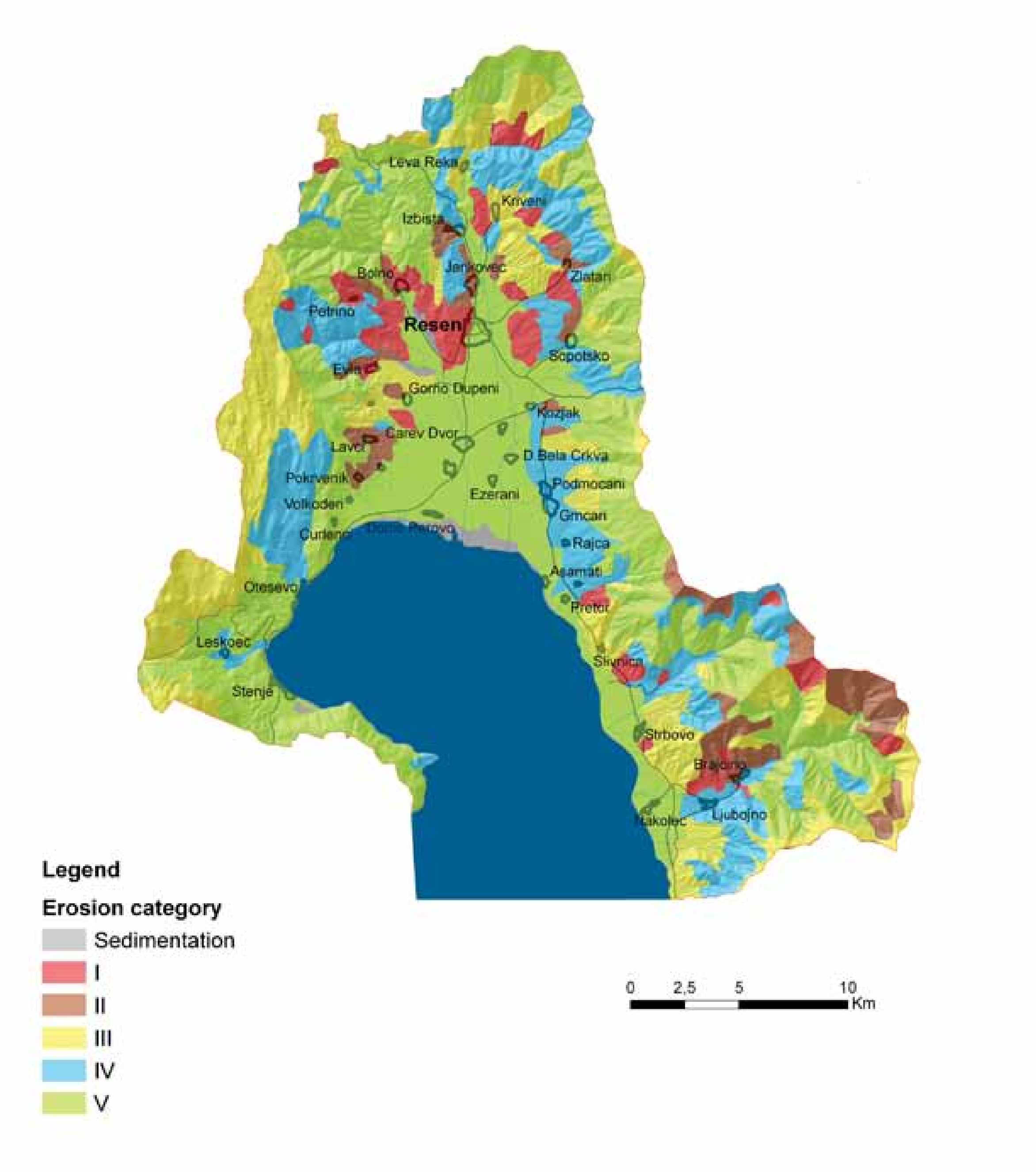


Figure 19. *Soil erosion risk map of Prespa Lake Watershed*

3.7 Other Impacts

Sand and gravel are excavated/exploited around the mouth of the Golema River into the Prespa Lake. This is an illegal activity as it takes place within the protected Ezerani Natural Reserve (ENR). Sand and gravel are exploited in other parts of the catchment. Controlling these activities appears to be problematic. Agricultural activities in the vicinity of all watercourses in the region take place within the natural river corridor, preventing the establishment of a necessary buffer zone as prescribed by the existing regulations.

3.8 The Designation of Protected Areas and Management

The entire Prespa region hosts unique habitats that are important from both a European and global conservation perspective. It is considered to be an ecosystem of global significance and has been identified as one of Europe's major trans-boundary 'ecological bricks'. Currently, the following areas in MK Prespa region are protected in accordance with the Law on Nature Protection:

- National Parks (IUCN II)
  - he Pelister National Park
  - The Galicica National Park
- Strictly Protected Nature Reserve (IUCN I)
  - The Erezani Wetland (Note: the protection category might be changed to IUCN IV In the current process of re-evaluation & designation.)

Pelister National Park covers an area of around 15,000 hectares on the Baba massif at altitudes between 900 and 2,601 m. A part of this area (5,000 ha) is located in the Lake Prespa watershed.

The National Park "Galičica" is situated on Mount Galicica, which is part of the mountain range of Sara-Pind. The Park covers an area of around 23 km2 between the Ohrid and Prespa lakes, stretching in a meridian direction. Almost half of this area belongs to the Lake Prespa Watershed. A new management plan for Galicica National Park has been prepared.

There are three significant wetlands in the Golema Reka catchment: Krusje spring, a karst source for Golema Reka, three former fish ponds, and Ezerani, a natural lacustrine fringe wetland already designated as a 'Strictly

Protected Natural Reserve' according to national legislation (now proposed as IUCN IV). The location of these wetlands, as well as their significance in terms of biodiversity and their conservation and economic status, differ greatly.
In 2002, Lake Prespa became the first designated Ramsar Site in the country. (In 2008, Lake Dojran also gained this designation.)

Protected areas within the working area

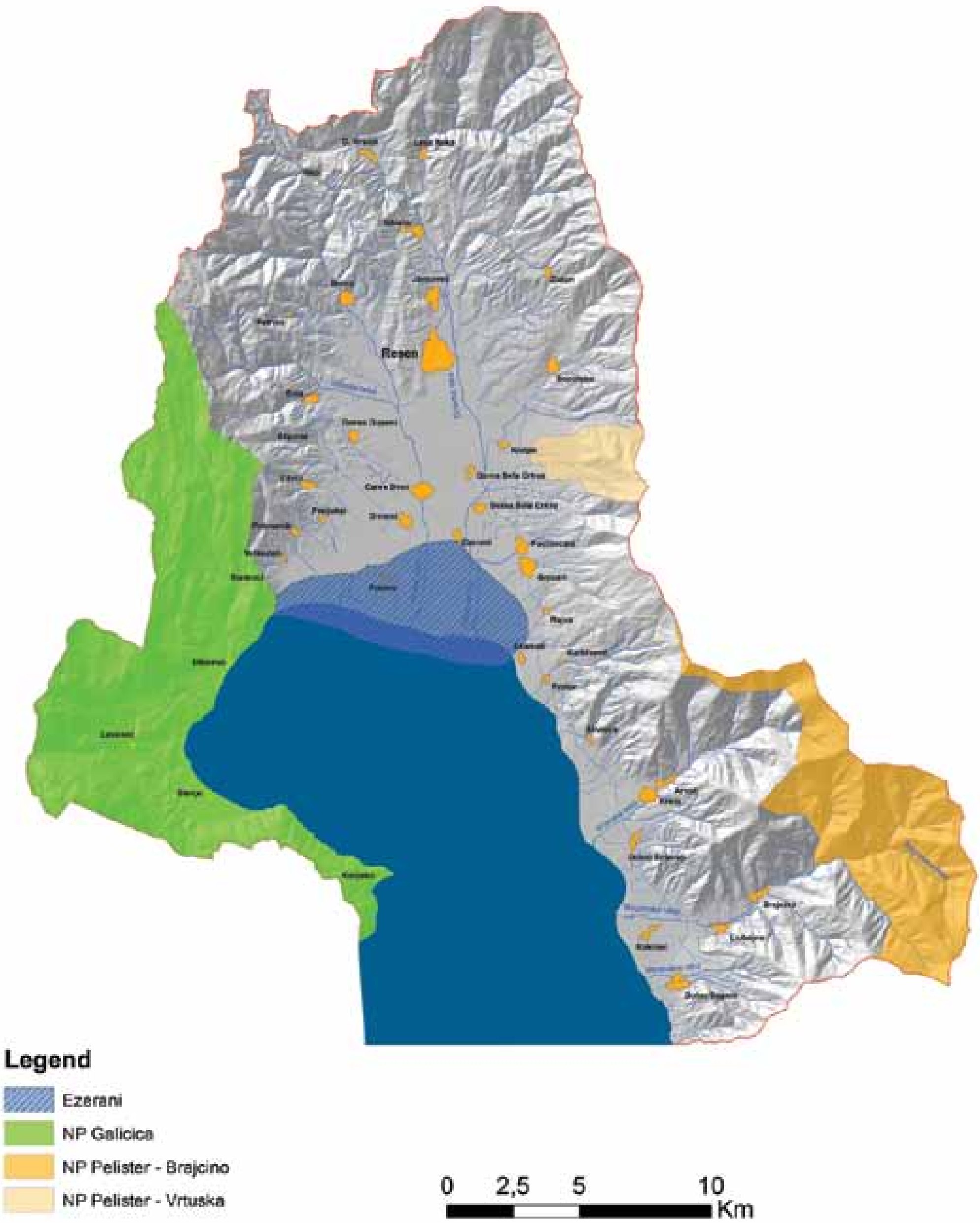


Figure 20. *Nature reserves (protected areas according to the Law on Nature Protection)*

At present, no protection areas have been designated to regulate:

- The abstraction of water intended for human consumption. (e.g. the karstic Spring Krusje, but also local waster supply systems, like Kurbinovo-Pretor Asamati and other intakes for villages in the region.
- The protection of economically significant aquatic species.
- The use of water for recreation, including areas designated as bathing waters. A number of tourist facilities and recreational areas exist in the Prespa region, especially around the Lake. The designation of bathing water areas and their appropriate management and monitoring would support the redevelopment of tourism in the region.
- Nitrate-sensitive areas. Analyses show that Lake Prespa is suffering from increasing eutrophication, which puts it in a category sensitive to nitrates as defined in the new Law on Water. The concentrations of nitrates in the watercourses seem to be within the given guidelines, in spite of increased input in agriculture (more than 210 kg/ha) However, the Lake is eutrophic and must be protected. Sources of nitrogen include agricultural activities, poultry farming, illegal dumping of organic matter and, seemingly, discharged effluents from wastewater treatment plant in Ezerani which doesn't have any tertiary de-nitrification treatment. The Preliminary Expert Assessment (Technical Report 5) suggests that the entire Prespa region should be proclaimed a nitrate-sensitive area.

Wetlands

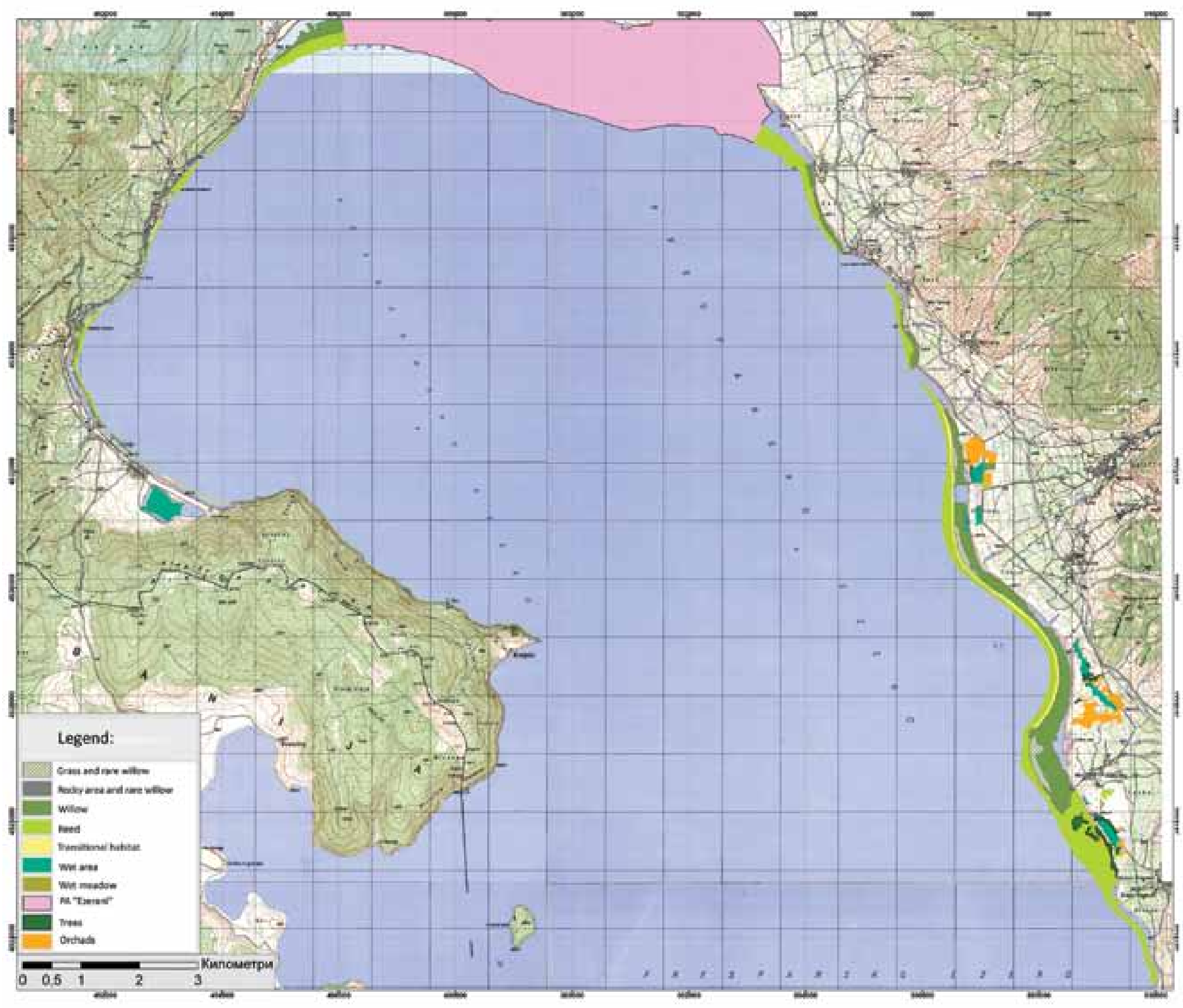


Figure 21. *Map of wetlands around the Prespa Lake*

Existing and newly proposed protection zones

Figure 22. *Existing and newly proposed protection zones*

- Waterbodies sensitive to urban wastewaters. According to the present Law on Water and preliminary monitoring results, there are eight waterbodies sensitive to the discharge of urban wastewater: Lake Prespa, Istocka 2 and 3, Golema Reka 6, 7 and 8, Brajcinaska Reka 2 and Kranska Reka 2 (in the tourist season). These waterbodies (except for Kranska) show deteriorated conditions (see Ch. 4) and require action.
- Areas of protected natural heritage. Besides Lake Prespa, which is already under protection due to important rare, relict and endemic species and habitats, and 'Ezerani' protected area, several smaller wetlands and habitats have been identified near Stenje, Ezerani, Krani and Nakolec.
- Riparian zones. In the Law on Water of 2008, as well as in previous water laws, the riparian protection zones for watercourses and lakes are clearly defined. However, these have never been implemented properly, leading to deterioration and misuse of protection buffer zones.

As part of this project, a proposal for the designation of additional protection zones has been elaborated (see Technical Report 5 for further details). The proposed (and existing) protection zones are presented in Figure 22.

4 Mapping Existing Monitoring Networks and Results from Monitoring Activities

Besides the comprehensive surveillance conducted to monitor water quality and ecological status, existing monitoring has been analysed and assessed for compliance with the requirements of the new Law on Water and relevant national regulations (taking into account the WFD and other Directives), relevant environmental laws and regulations. The absence of monitoring and data, existing monitoring capacity and the organizational and financial aspects of required monitoring have also been analysed in depth.

4.1 Surface Waters

4.1.1 Existing Monitoring

Hydrological and meteorological surveillance monitoring has been conducted in accordance with the Law on Hydro-meteorological Affairs, the Law on Waters, and the Programme for the Protection of Ohrid, Prespa and Dojran Lakes. The monitoring system comprises of:

- Lake stations to measure water levels and water temperature were established in 1935, 1948 and 1954.
- River stations are located on the Golema and Brajcinska rivers.
- The Resen Climatologic station was established in 1947 as a rainfall-measuring station and was in operation between 1980 and 1993.
- The Pretor Meteorological station was established in 1980 as a polygon for preventing hail, employing professionals to monitor meteorological parameters.
- Seven rainfall measuring stations are situated in the coastal parts of Prespa Lake: Stenje, Carev Dvor, Perovo, Izbista, Asamati, Nakolec, and Brajcino. These rainfall-measuring stations register the condition of the pluviograph regime on the coastal part of Prespa Lake watershed and on the lake surface itself. No information is available for the higher parts of the watershed.

As a result of identified insufficiencies in data content and coverage by existing monitoring programmes to accurately determine the watershed water balance, further development and improvement of the regional monitoring programme for Lake Prespa has been discussed amongst the riparian countries. Data from stations In Albania and Greece are useful for meteorological or hydrological calculations, in spite of the different systems and methodologies used. In addition, data from outflow stations and data from stations in the vicinity of Lake Ohrid and Crni Drim are important due to the interconnection of these waterbodies.

Although monitoring is a legal obligation, there is no systematic continuous monitoring of the water quality in the Macedonian part of the Lake Prespa watershed. Gaps in the hydrological data and the lack of accurate data hamper efforts to provide reliable picture of the water balance in the region.

Existing monitoring has been analysed and assessed for compliance with the requirements of the new Law on Waters and relevant national regulations (taking into account the WFD and other Directives), environmental laws & regulations. Absence of monitoring and data, existing monitoring capacity and organizational and financial aspects of required monitoring have also been analysed in depth. Besides setting up an initial network for surveillance monitoring of environmental data, a comprehensive monitoring programme in accordance with the WFD and the LoW has been proposed as part of the Programme of Measures.

4.1.2 Monitoring for the Purposes of the Prespa Watershed Management Plan

An initial 12-month comprehensive surveillance monitoring of the water quality and ecological status has been conducted on all waterbodies identified/delineated and reference conditions have been established. Pressures on the waterbodies from natural and anthropogenic sources have been extensively identified and analyzed. These pressures include the input of pollutants, nutrients and hazardous sub¬stances, physical pressures on the waer bodies—for example, agriculture in the river corridor, drainage, watercourse maintenance and abstraction. The input of pollutants takes place via both water and the soil from diffuse sources (e.g. nutrient leaching from farmland) and point sources (e.g. wastewater discharges from households and industry, emissions from industry and agriculture and leaching from disused landfills). The harmful impacts of water and the pressures and state of protection areas have been scrutinized. A summary of these analyses is presented in Chapter 3.

Monitoring sites

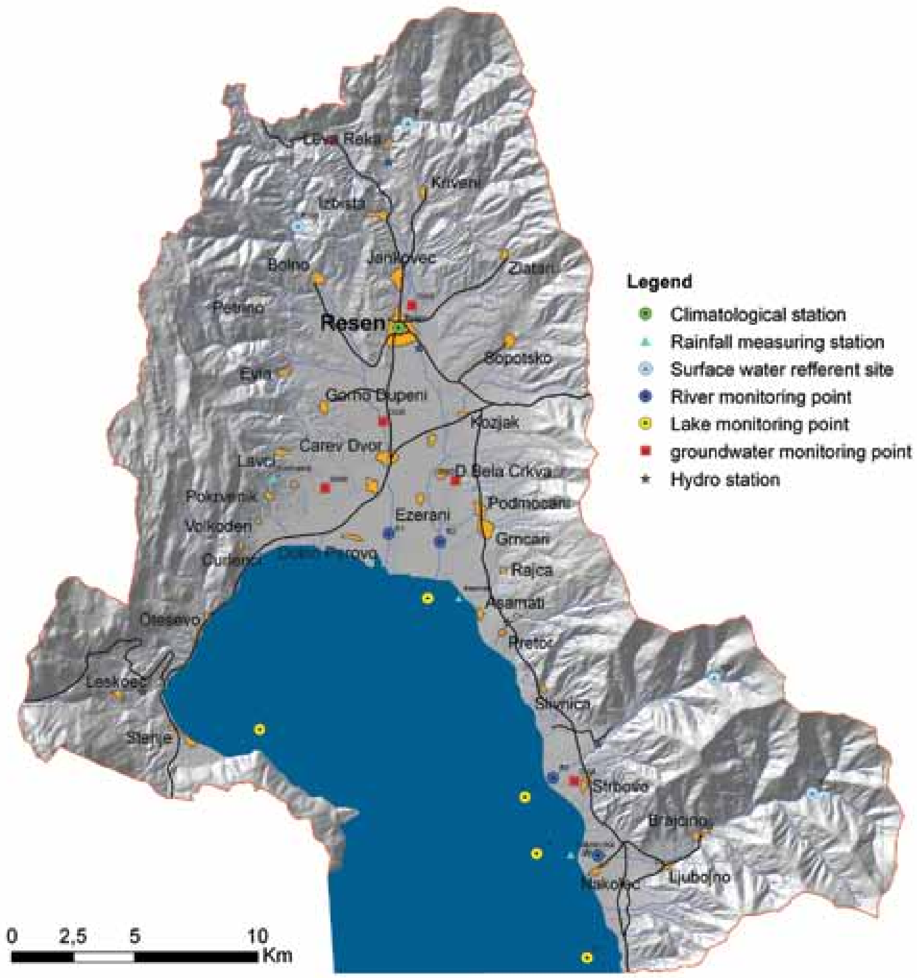


Figure 23. *Monitoring sites in the delineated waterbodies in the Lake Prespa watershed that were continuously monitored during the course of this project*

As a result of the monitoring, the status of all the waterbodies in Prespa region has been determined, including their biological, hydromorphological and physico-chemical quality elements. (See Table 13. and Figure 24.).
In conclusion, Prespa Lake is under intensive pressure from human activities. This pressure is exerted through various physical impacts, such as alterations of watercourses and water abstraction, chemical pollution originating from untreated wastewaters and agriculture, and the deterioration of natural biodiversity through the introduction of alien species and overfishing. The intensity and duration of the negative human impacts on Lake Prespa have resulted in severe and comprehensive deterioration of the water quality, except for the elevated stretches of the rivers a long distance from human activities. In order to prevent further deterioration of the water quality in the watershed, substantial measures need to be introduced and implemented. However, even if these measures are implemented and become fully operational, the timeframe for the full recovery of the ecosystems may be prolonged, since the accumulated quantities of harmful substances are at high levels. If none of the recommended measures are initiated and implemented in the area, the overall environmental quality of the Lake Prespa watershed will become much more degraded in the near future. This is especially important for Lake Prespa itself, which has already started to show clear signs of becoming eutrophic throughout the year with even more frequent and possibly toxic cyanobacterial 'blooms'. If the turnover towards a fully eutrophic system is completed, activities to restore and improve its water quality will become much more difficult and perhaps impossible, thus rendering Prespa Lake unsafe and unusable for future generations.

Waterbody name	WB type	Status					Action needed under	
		High	Good	Moderate	Poor	Bad	UWWTD or ND	WFD
Surface waterbodies (rivers)								
Istočka Reka 1	1		Good				no	No
Istočka Reka 2	1					Bad	yes	
Istočka Reka 3	1				Poor		yes	
Golema Reka 1	1		Good				no	
Golema Reka 2	1			Moderate			yes	
Golema Reka 3	1			Moderate			yes	
Golema Reka 4	1			Moderate			yes	
Golema Reka 5	1			Moderate			yes	
Kurbinska Reka 1	1			Moderate			yes	
Kranska Reka 1	1	High						No
Kranska Reka 2	1			Moderate			yes	
Brajčinska Reka 1	1	High						No
Brajčinska Reka 2	1				Poor		yes	
Surface waterbodies – heavily modified waterbodies								
Golema Reka 6	1h					Bad	yes	
Surface water bodies – artificial waterbodies								
Golema Reka 7	1a					Bad	yes	
Golema Reka 8	1a				Poor		yes	
Surface water bodies (lake)								
Prespa Lake	1L			Moderate			yes	

Table 13. *Classification of the ecological status of identified surface waterbodies*

Classification of the ecological status of the water bodies

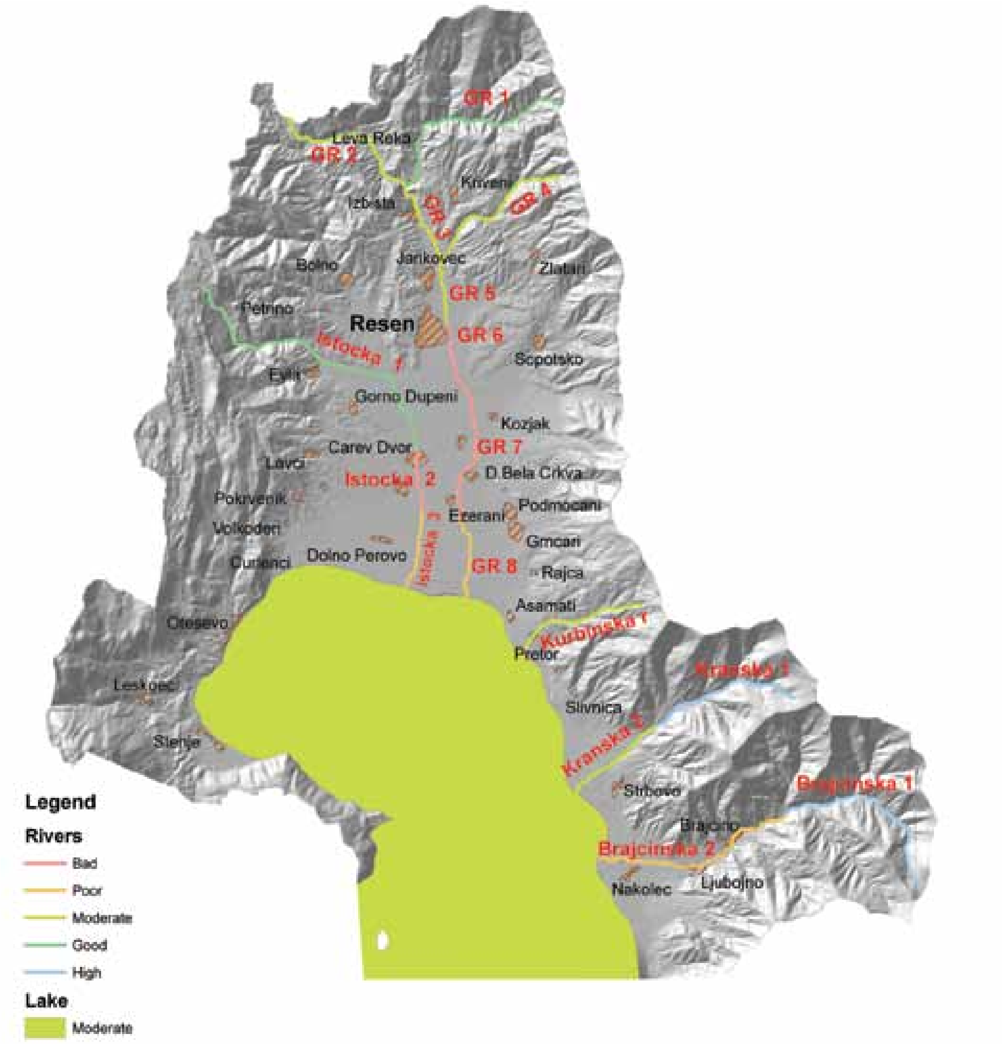


Figure 24. *Map of the classification of the ecological status of the waterbodies in the Lake Prespa Watershed*

4.2 Groundwater

4.2.1 Existing Monitoring

Existing geological maps were used as a first step in defining the boundaries of the groundwater resources. (These included the Basic Geological Maps for Ohrid, Podgradec, Bitola and Lerin in 1: 100.000 scale)

For groundwater resources, a conceptual model of groundwater flow was developed on the basis of geological and hydro-geological conditions and covering large groundwater reservoirs. Its main purpose was to determine which resources can be sustainably used for water supply and to identify vulnerable groundwater resources that cannot easily be used in a sustainable way for water supply and/or are susceptible to pollution and should thus be protected.

In spite of numerous wells in the region, especially in the Istocka and Golema catchments, and the importance of groundwater resources for the region, no monitoring data is available from the last few decades on water levels and especially on water quality and trends. The only data available is historical data from the monitoring of a limited set of parameters. Due to intense developments in groundwater use, this data was deemed insufficient as a basis for relevant conclusions.

4.2.2 Groundwater Monitoring: The Purposes Of The Prespa Watershed Management Plan

A monitoring network of seven groundwater sites has been established for the purposes of the Prespa WMP, covering all delineated groundwater bodies (see Figure 25).
The following parameters have been monitored:

- Groundwater level and seasonal fluctuations
- Physico-chemical parameters
- Biological characteristics
- Pesticides
- Sodium Absorption Ratio

Hidrology map, groundwater bodies and monitoring sites

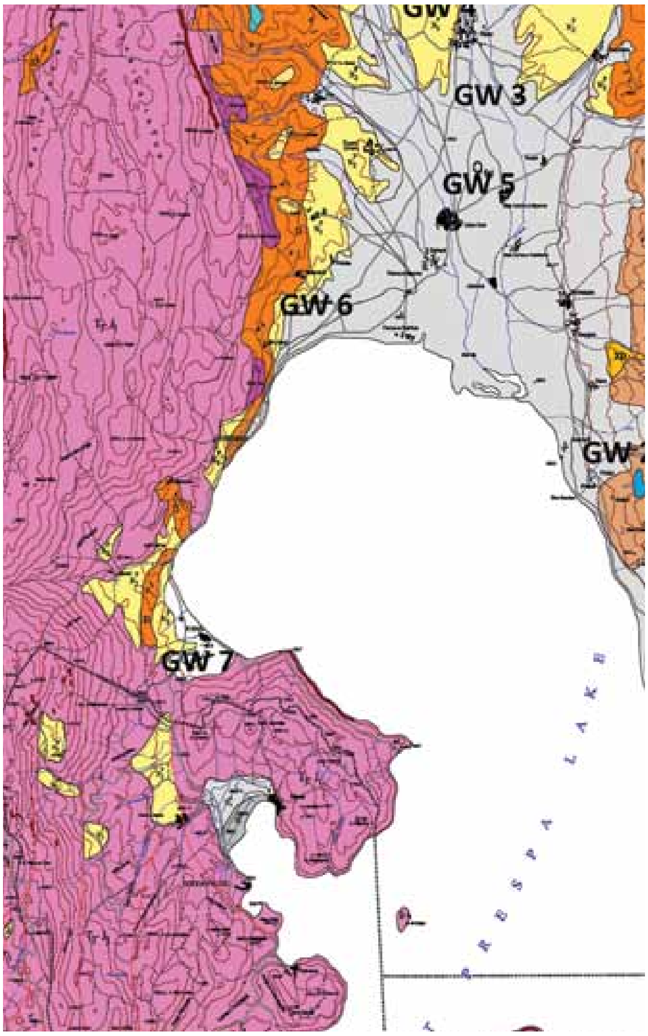


Figure 25. *Map of the delineated groundwater bodies and monitoring sites*

Some of the monitoring results are presented in Table 14 and Figures 26 and 27 below.

No.	GW monitoring points	Ca mg/l	Mg mg/L	K mg/L	Na mg/L	Fe mg/L	Mn mg/L	As µg/L	Al µg/L	Cd µg/L	Cr µg/L	Cu µg/L	Hg µg/L	Ni µg/L	Pb µg/L	Zn µg/L
1	GW1 (Krani)	14.75	3.19	1.96	4.30	0.48	0.041	<1	329.2	<0.1	2.11	<1	<0.1	1.44	7.0	<5
2	GW2 (Asamati)	33.07	7.06	1.05	8.03	0.22	0.007	<1	96.0	<0.1	<1	<1	<0.1	1.54	<1	<5
3	GW3 (f-ry Swisslion)	48.95	12.16	1.76	11.91	14.78	0.23	1.02	<20	<0.1	<1	<1	<0.1	14.7	<1	<5
4	GW4 (Krusje spring)	73.22	12.39	0.83	3.75	0.042	0.002	<1	<20	0.13	<1	<1	<0.1	1.54	<1	<5
5	GW5 (Carev Dvor)	53.94	7.86	1.17	3.76	0.44	0.015	<1	<20	<0.1	<1	<1	<0.1	<1	<1	<5
6	GW6 (Preljublje)	13.22	8.03	0.85	8.71	2.18	0.30	<1	<20	<0.1	<1	<1	<0.1	<1	<1	<5
7	GW7 (Stenje)	112.37	5.47	0.26	1.18	0.074	0.002	1.14	<20	<0.1	1.73	1.1	<0.1	1.70	2.6	<5

Table 14. *Physico-chemical results (measurement of May, 2010)*

The results of the groundwater surveillance monitoring conducted as part of this project can be summarised as follows:

- HIGH to MODERATE groundwater quality for irrigation purposes
- The presence of pesticides has been detected in the majority of the monitored wells
- Bacteriological contamination has been detected in all monitored wells
- Serious seasonal drawdown of groundwater level has been detected in a number of wells (to be confirmed by the establishment of a comprehensive monitoring network)
- Unregulated drilling creates hydraulic connections between different aquifers of various depth, increasing the possibility of the spread of pollution (bacteriological and pesticides)

Figure 26. *BIS (2-Ethylhexyl)phthalate MPL<6 ng/l*

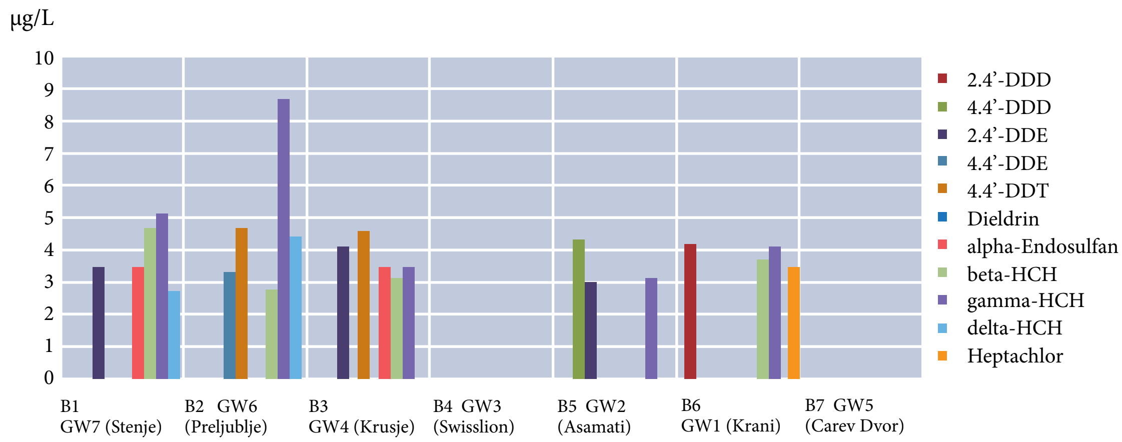


Figure 27. *MPL level for organoclorine pesticide*

5 Environmental Objectives

The Macedonian Law on Water of 2008, as well as the WFD, requires that all surface waterbodies be classi¬fied on the basis of their ecological status (i.e. their biological, hydromorphological and physico-chemical quality elements). Ground¬water bodies are to be classified according to two status classes, quantitative status and chemical status. The status classes are to be established on the basis of reference conditions for the waterbodies, defined as "no, or only very minor anthropogenic alterations" compared with "undisturbed conditions".

The GEF Transboundary Diagnostic Analysis (TDA, 2010) undertaken in the Prespa Watershed is a scientific / technical fact-finding analysis to scale the relative importance of sources, causes and impacts of pressures in the basin. The TDA presented the facts associated with the problems facing the basin and the pressures and stresses on the ecosystem. Following the TDA, a GEF Strategic Action Programme (SAP) is a negotiated policy document that identifies the policy, legal and institutional reforms and investments needed to mitigate the stresses on the ecosystem.

Given the transboundary character and the consensus achieved, environmental objectives identified with the TDA have been taken into account in the course of elaborating the Prespa Watershed Management Plan. In this way, the Macedonian side takes an important first step in compliance with mutually agreed trans-boundary priorities.

TDA identified five priority trans-boundary environmental problems: Poor Water Quality (nutrient, organic and hazardous substances pollution); Inappropriate Land Management; Non-Sustainable Fisheries Management; Declining Lake Level; and Large Sediment Transportation.

The TDA Report has identified Environmental Objectives, divided into long term (+10 years), mid-term (5-10 years) and short-term (1-5 years) objectives. The following objectives were taken into account for the Prespa Watershed Management Plan.

For surface waterbodies:

- Environmental Objective 1: Improvement of environmental conditions ensuring good water and soil quality for human health and for the ecosystem by 2025 (long-term)
- Environmental Objective 2: To control water levels (prevent losses) and promote sustain-

able use (short-term & continuous)

- Environmental Objective 3: To ensure sustainable fisheries (mid-term)
- Environmental Objective 4: To reduce pesticide/fertilizer loadings, waste from packaging, and pressure from agriculture (short-term & continuous)
- Environmental Objective 5: To reduce physical pressures (short-term & continuous)

For groundwater bodies:
These include the abovementioned Environmental Objectives 1, 2, 4 and 5, as well as the following objectives:

- Environmental objective 6: To base the drinking water supply on pure groundwater without the need for more than simple treatment (long-term). To ensure that the water supplied to the population only contains nitrate in natural concentrations (short-term & continuous).
- Environmental objective 7: To safeguard the groundwater resource against overexploitation (mid-term).
- Environmental objective 8: To protect the groundwater against contamination (short-term & continuous). To ensure there are no pesticides or other hazardous substances in groundwater used for the supply of drinking water (short-term & continuous).

For protected areas:

- Environmental Objective 9: To establish an Inventory and evaluate the existing institutional and regulatory systems for lake management at national and transboundary level. To develop a unified methodology for monitoring. To evaluate the enforcement of environmental laws in all three countries (short-term).
- Environmental Objective 10: To improve land management and planning (mid-term)
- Environmental Objective 11: To conserve Prespa's biodiversity and habitats (short-term & continuous)
- Environmental Objective 12: To ensure sustainable forestry (short-term & continuous)

Environmental objectives 1 and 2, being the most important, have been adopted as benchmarks for further elaboration of the Prespa WMP and as a basis for the development of the Programme of Measures and the 6-year implementation plan.

5.1 Objectives for the Waterbodies in the Prespa Region

The following objectives have been adopted for the Prespa watershed and the specific waterbodies in the catchment:

For all waterbodies: to achieve GOOD water status
For artificial waterbodies and heavily modified waterbodies: to achieve good environmental potential

Name	Current status	Action needed?	Objectives	
			Rivers	HMWB & AWB
Istocka 1	Good			
Istocka 2	Bad	Y	Good	
Istocka 3	Poor	Y	Good	
Golema 1	Good			
Golema 2	Moderate	Y	Good	
Golema 3	Moderate	Y	Good	
Golema 4	Moderate	Y	Good	
Golema 5	Moderate	Y	Good	
Golema 6	Bad	Y		Good potential
Golema 7	Bad	Y		Good potential
Golema 8	Poor	Y		Good potential
Kurbinska	Moderate	Y	Good	
Kranska 1	High			
Kranska 2	Moderate	Y	Good	
Brajcinska 1	High			
Brajcinska 2	Poor	Y	Good	

Table 15. *Objectives for delineated waterbodies in the Prespa Region*

According to WFD, the implementation of measures is planned to be carried out in order to progressively reduce pollution and gradually achieve the objectives. The Prespa Watershed Management Plan will include two alternative approaches for achieving the environmental quality objectives, including elaboration of the defined waterbody-specific objectives as well as the programme of measures for their achievement.
The Programme of Measures has been developed to achieve the defined environmental objectives. The Watershed Management Plan refers to measures in the 6-year planning period. Because some of the presented objectives are seen as long-term, the Plan identifies 'start-up' actions or 'road-to-completion' indicators to monitor progress in achieving those objectives (see Chapter 6 for more details).

5.2 Indicators

To each of the Environmental Quality Objectives there is attached an indicator to enable the monitoring of progress made in meeting the objective for surface water and groundwaters.
The WFD requires states to implement measures to progressively reduce pollution and to ensure the phase-out of priority hazardous substances by 2025.
Some of the objectives for the Lake Prespa watershed identified by the TDA as being most relevant for waters are listed in the following tables, including specific sub-objectives and a number of indicators:

Overall Objective 1	Improvement of environmental conditions to ensure good water and soil quality for human health and the ecosystem by 2025
Indicator	Measurable decline in levels of the main pollutant groups and pressures in water, sediment and biota
1a:	Good surface water quality: - Reduce / prevent further eutrophication/organic pollution - Reduce / prevent further hydromorphological changes - Reduce / prevent further habitat fragmentation - Maintain biological water quality (phytoplankton, macrophytes, invertebrates and fish) - Reduce / prevent hazardous substances pollution
1b:	Good groundwater quality: - Control water abstraction - Reduce / prevent water pollution from point and non-point sources - Maintain good physical and chemical characteristics
1c:	Good ecological potential for HMWB and AWB: - Reduce / prevent further eutrophication/organic pollution - Reduce / prevent further hydromorphological changes - Reduce / prevent further habitat fragmentation - Improve biological water quality (phytoplankton, macrophytes, invertebrates and fish) - Reduce / prevent hazardous substances pollution
Overall Objective 2	Sustainable and efficient water utilization for maintenance/control of the Lake Prespa water level and groundwater table
Indicator	Measurable and sustained water utilization
2a:	Introduce water conservation and demand management: - Irrigation abstraction - Drinking water abstraction - Abstraction of water for industry
2b:	Increase and update knowledge on the hydrological and limnological regime of Prespa Lakes and their catchment area, also integrating climate change impact and disaster management: - Lake water levels - Irrigated area - Precipitation - Air temperature - Lake evaporation
2c:	Increase and update knowledge on the hydrological and limnological regime of Prespa Lakes and their catchment area: - Karstic spring flow to Ohrid - Groundwater level

Table 16. *Key environmental objectives and indicators*

The Program of Measures within the Prespa Watershed Management Plan will primarily use the above-listed indicators to assess the effectiveness of the measures and the progress made towards achieving the objectives.

6 Overview of the Economic Analysis of Water Use

6.1 General Overview of Water Use in the Regional Economy

Water is a significant resource and input in the overall economy of Prespa. Besides the supply of water to the population and to industries, water is used in agriculture. Water management is also important for fisheries and for the safeguarding of protected areas and tourism. Industry and agriculture make the greatest contribution to the municipal GDP, followed by trade, traffic, construction, and a small contribution from the catering industry and from tourism. There are 4,705 employees. The average employment rate is around 43.5%, with a significant unemployment rate of 30.1%. .
Almost two-thirds of the local GDP is generated by industry, predominantly food processing, followed by textiles, chemical, metal, building materials, wood and tobacco industries. Industry is the second largest user of water in the region.
Agriculture in the region is a very significant economic activity and is by far the major user of water for irrigation, mostly for growing apples, which are the main agricultural product in the region. Almost all the agricultural land is privately owned (91%). The use of fertilizers is intensive. In this municipality there are 3,500 ha of orchards. By applying modern agro-technical measures, Prespa produces at least 60-70 million kilograms of high quality apples per year. More than 80% are produced for export to other countries in the region.
JKP Proleter is the municipal enterprise in charge of the water supply, sewage collection, treatment, and other public services. It was established and is owned by the Municipality of Resen.
A description of the water supply systems with their technical capacities has been elaborated in Technical Reports 1-3 and Chapter 2 of this Report; only the financial-economic aspects are summarized here.

6.2 Water Supply –Population and Industry

JKP Proleter supplies water to approximately 13,600 people and 300 legal entities/companies. Some 900,000 m^3 are invoiced annually, priced 27.73 MKD for households and 37.73 MKD for legal entities. The water is measured with water meters. In addition, the price for wastewater collection and treatment are added on the monthly bill.
The quantity of water invoiced has decreased from 900,000 m^3 in 1994 to 680,000 m^3 in 2008, with the greatest fluctuations occurring in the demand and supply of water to industries.
The collection rate is 65-70% from the issued invoices.

	Covered Area	Number	Water Consumption m^3	Price MKD/ha	Cost MKD
Population connected to the public WS system	Resen	13,600	720,000	22. .3	16,056,000
Population with self-supply	16 villages	4,000	200,000	22. .3	4,460,000
WS – industry & companies	Resen	300	180,000	37. .73	6,791,400

Table 17. *Municipal and industrial water supply, consumption and revenue*

No	Description	Annual Quantity	Monthly Quantity	In %
1	Citizens in m^3	525,179 m^3	43,765	79.45
2	Companies in m^3	135,794 m^3	11,317	20.55
	Total:	660,973 m^3	55,082	100.00

Table 18. *Quantity of potable water delivered*

According to the previous data, the average price is:
1,403,055 MKD/monthly: 55.082 m^3/monthly = 25.47 MKD/m^3
Accordingly, the monthly revenues are as follows:

Description	Monthly Quantities In m^3	Current Price	Monthly Revenues	In %
Citizens	43,765 m^3	16.25 MKD/m^3	711,181 MKD/мес	69.56%
Companies	11,317 m^3	27.50 MKD/m^3	311,217 MKD/мес	30.44%
Total:	55,082 m^3		1,022,398 MKD/мес	100.00%

Table 19. *Revenues from water delivered to users*

Only 72.87 % of monthly expenses are covered by this revenue. In order to cover expenses fully, the price of water would need to be as follows:

Description	Monthly Expenses	In %	Revenues	Monthly Water Quantity	New Price In MKD/m^3	Increase In %
Citizens	1,403,055	69.56	975,965	43,765 m^3	22.30 MKD/m^3	37.23
Companies	1,403,055	30.44	427,090	11,317 m^3	37.73 MKD/m^3	37.23
Total:		100.00	1,403,055	55,082 m^3		

Table 20. *Price of water for full cost coverage*

6.3 Wastewater Collection and Treatment

The Ezerani wastewater treatment plant was built 60% by the Government and 40% by the Municipality and has been given to JKP Proleter for maintenance. JKP Proleter issues water bills with separate lines for water supply, wastewater collection and wastewater treatment. At the treatment station there is a water gauge which measures the water in the station and shows a higher quantity than the supply water delivered, measured and invoiced by the water gauges because of the inflow of stormwaters into the sewage system. According to the manager of JKP Proleter, it is invoiced for 300.000 m^3 and purified three times more. The purified water is transferred 2-3 km by pipeline to a marsh and then into the lake.
The annually invoiced wastewater quantity varies slightly from 313,000 m^3 (1997) to 397,000 m^3 (2005), of which around 80% are communal waters from households and 20% from legal entities/ companies.

The prices for wastewater collection and treatment are set as follows:

Sewerage collection
- Citizens 4.62 MKD./m^3
- Companies 6.23 MKD./m^3

Wastewater
- Citizens 11.23 MKD/m^3
- Companies 15.84 MKD/m^3

	Covered Area	Number	Water Consumption m3	Price MKD/ha	Cost MKD
Population connected to sewerage system	Resen	8,000	720,000	4.62	3,326,400
Sewerage companies	Resen	300	180,000	6.23	1,121,400
Population connected to a wastewater treatment plant	Resen	-	300,000	11.23	3,369,000
Wastewater treatment companies	Resen	-	60,000	15.84	950,400

Table 21. *Wastewater disposal systems and revenues*

The analysis of JKP Proleter shows that the price should be increased threefold in order to break even with included depreciation costs.

6.4 Irrigation Water

The construction of the system for the irrigation of Prespa started in 1954 and was fully completed in 1962. It is one of the oldest in the country.

The irrigation infrastructure consists of a network 263.26 kilometres in length, of which the main channels extend 58.13 km while the secondary and detailed network extends 205.03 km. The concrete channels are open and cover 2,500 ha of apple orchard area. The water is taken from Lake Prespa by pumping stations. Three (2+1) pumps with a capacity of 500 l/s are situated on the east coast of the lake in Pretor. Two pumps of 500 l / sec. and four of 150l/s are located in Sirhan on the western shore. A number of other pumping stations have been constructed for additional pumping of water into the system (Kurbinska and Kranska river areas, as well as Dolno Dupeni and Slivnica).

Although the abovementioned network covers 2,500 ha of fertile area, only 533.18 ha were irrigated in 2005. This is due to the following factors: the deteriorated physical state and capacity of the system; huge losses of water; poor services; low revenue collection rates; decreasing demand from farmers; the low institutional capacity of the Prespansko Pole Water Management Organization, which had financial problems resulting in liquidation; and bad overall management in the water sector, including an increase in the number of individual irrigation wells, of which there are now estimated to be over 10,000 in the region. The decreasing trend has continued in recent years with the transformation of the WMO Prespansko Pole and the initial establishment of Water User Associations in the region. Only 300 ha were reported to have been irrigated in 2009.

However, irrigation in the apple orchards continues, with individual wells and predominantly individual drip-irrigation installations completely beyond the control of the water authorities. The reason for this is the wide availability of groundwater, especially in the Resen Plain. It is conservatively estimated that at least 1,000 ha are irrigated in this way.

The costs for the construction of wells/system are borne solely by farmers. According to reports, costs include drilling (25 €/m depth) and the purchase of pumps (and other installations, generators, etc.), as well as the installation of drip-irrigation pipelines (c. 1,000 €/ha). Individual farmers also incur costs of electricity/fuel for pumping and for regular and investment maintenance of the system.

Three Water User Associations have recently been established in the region. These charge 28,000 -35,000 MKD/ha (440 – 580 €/ha) for annual irrigation. The collection rate varies from 65-70% to 100%. In spite of some promising results, the extent of WUAs is local and does not cover the needs of the wider region. Such associations thus cannot be a comprehensive solution to the problems.

Irrigation water consumption over the last few years is presented in the following table:

	Irrigated area [ha]	Water users	Water Consumption m³	Price MKD/ha	Cost MKD
Irrigation scheme Prespansko Pole					
Water User Communities A1	50	102	-	26,600	1,330,000
Water User Communities A2	90	-	-	28,000	2,520,000
Water User Communities B2	7	21	-	35,000	245,000
Irrigation from ground water	3,000	10,000 wells / pumps	-	20,000	60,000,000
Irrigation from rivers	500	-	-	20,000	10,000,000

Table 22. *Water Consumption for Irrigation and Revenues*

In conclusion, irrigation in the region is in complete disarray for all the reasons mentioned above. Besides poor services and low area coverage, there is no recovery of costs and no organized and coherent water management structure for the proper management of resources.

6.5 Cost Recovery

The costs of services from JP Proleter are collected on a monthly basis. These costs are unsatisfactory and do not cover the real costs of operations. The problems can be summarized as follows:

- The tariffs do not reflect the real costs
- Some water is unaccounted for, e.g. from collapsed industries, social welfare receivers, illegal connections, technical water losses, etc.
- The rate of collection of invoiced bills is insufficient

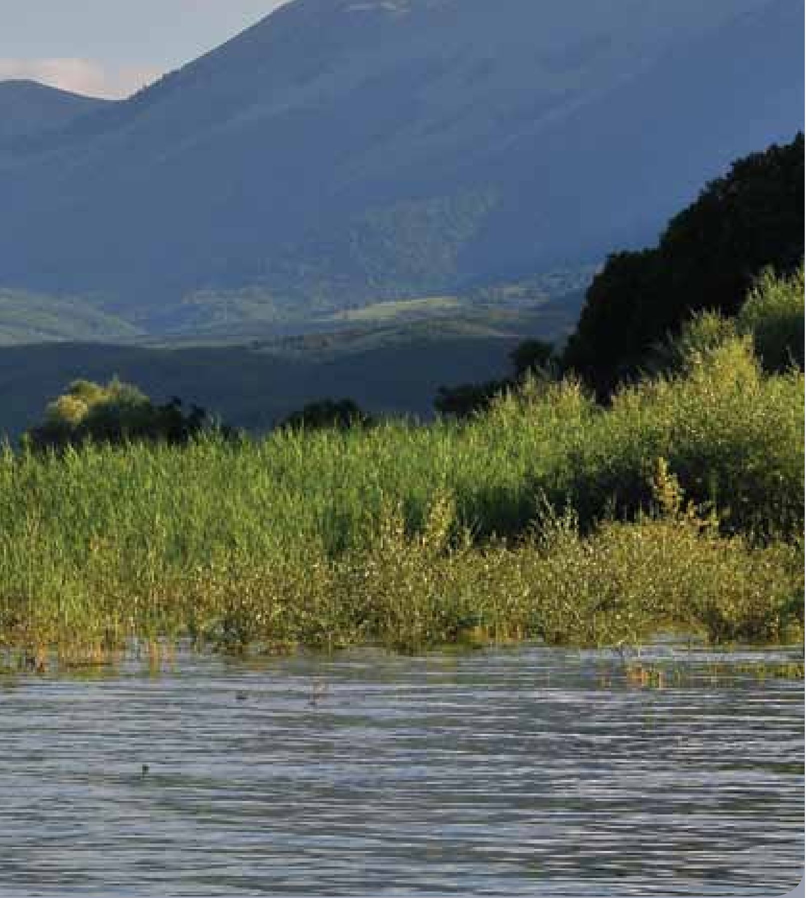
The methodology for cost calculation in JKP Proleter seems financially and economically sound. It also includes various prices (tariffs) for various users, as well as for various services (WS, WW, treatment). The prices of services, however, are kept low for various reasons. The last water supply price increment was 37.23% in 2008. With this increased price, JKP Proleter is close to breaking even.

Given the general situation in the region, each investment referring to the fulfilment of the eco-criteria would probably cause a rise in the price of wastewater services in the bills which JKP Proleter delivers to citizens and business entities.

The water supply expenses for private individuals that are not included in the drinking water system are in the amount of 4,460,000 MKD. The price per m3 is the same as the price in the calculation of JKP Proleter, even though this price may be lower since private individuals do not have the same expenses as JKP Proleter.

As far as irrigation is concerned, the greatest problem is that farmers irrigate their land outside of the system. The majority of private individuals irrigate by pumps from wells, while a minority irrigate directly from the rivers. According to the latest assessments, there are around 10,000 pumps in the region. According to the estimated use of water of 24,000,000 m3, this creates an expense of around 60,000,000 MKD.

The expenses incurred and revenues collected by the three water communities through the irrigation system are insignificant. Fixed expenses, which account for depreciation of the system in order to secure assets for investment and improvement of the irrigation system, are not taken into consideration because the irrigation system is old and the quantity of water loss is high.



7 Programme of Measures for Achieving Environmental Objectives

The Programme of Measures is the outcome of in-depth expert investigation and research into all technical, environmental, economic, social and other aspects of possible measures to overcome deficiencies in the water management sector and to achieve the objectives. All identified measures have been scrutinized and checked for environmental effectiveness, extent, contribution to specific objectives, cost (economic and financial) and social effects.

Analysis of legislation, organizational setup and institutional capacity and sustainability in the sector has highlighted some systemic deficiencies related to the implementation of the Programme of Measures. Some of the actions necessary to create an enabling and sustainable environment for the implementation of the Programme of Measures are given in Chapter 9. For more detailed information about the selection and ranking process, as well as the results of this process, see Technical Report Part III: Programme of Measures.

7.1 Problem Analysis

The main problems and the main sources of the problems described in previous chapters and detailed in Technical Report Parts I and II are summarized in Table 23:

Cat.	Main problems		Main causes
Surface Water	SW quality: Prespa Lake and most other waterbodies (rivers) do not meet the WFD-criteria	▪ High nutrient concentrations (N, PO4, SO4) ▪ Heavy metals in rivers (Mn, Fe, Al) and in Prespa Lake (Zn, Cu and toxic metals like Hg) ▪ Priority substances (pesticides) ▪ Ecological status partly moderate/ poor/bad	**Point sources:** ▪ domestic wastewater ▪ industrial pollution (poultry farming, metal processing, food processing, ceramics production, etc.) - IPPC not implemented ▪ Illegal solid-waste landfills ▪ Inappropriate WW systems in rural areas, stormwater outfall in urban areas **Diffuse sources:** ▪ fertilizers (inefficient techniques) ▪ pesticides (preparation, application, washing, waste dumping) ▪ organic waste (apples, pesticide packaging)
	SW quantity	▪ The level of Lake Prespa has dropped significantly in the last 25 years ▪ Lack of water for irrigation and water supply in periods of high consumption	▪ Irrigation network obsolete ▪ Unregulated & uncontrolled abstractions in the catchment (river intakes & groundwater wells) for irrigation and water supply ▪ Insufficient institutional & organizational setup and capacity for sustainable water management
	Protection from harmful impacts of water	▪ Erosion ▪ Flood	▪ Lack of erosion & flood protection plans & programmes ▪ Insufficient institutional & organizational setup and capacity

Groundwater	GW quality	▪ Contamination with pesticides and bacteria
		▪ Negative groundwater quality trend
			▪ Leaching from illegal solid-waste landfills & organic waste
			▪ Current agricultural/irrigation practices
			  ▪ fertilizers (inefficient techniques)
			  ▪ pesticides (preparation, application, washing, waste dumping)
			▪ Large number of extraction wells

	GW quantity	▪ Drawdown of groundwater level ▪ Deepening of exploitation wells	▪ Unregulated & uncontrolled abstractions in the catchment (river intakes & groundwater wells) for irrigation and water supply ▪ Institutional & organizational setup and capacity for sustainable water management

Table 23. *Problem Analysis for the Prespa Lake Watershed*

The criteria and indicators for addressing the above problems and their root causes are given. In the following table:

Theme	Criteria	Indicator
Water quality	▪ Nutrient concentrations	▪ % reduction of inflow from ▪ wastewater ▪ farming ▪ use of fertilizers ▪ organic waste ▪ polluted sediment
	▪ Heavy metals	▪ % reduction of inflow from ▪ industry ▪ polluted sediment
	▪ Priority substances	▪ % reduction of inflow from ▪ pesticide use (preparing, applying, washing) ▪ waste dump
	▪ Ecological status	▪ change of status of water bodies and/or parameters
Water quantity	▪ Water extraction from Prespa Lake catchment ▪ Groundwater extraction	▪ % reduction of water extraction for ▪ irrigation ▪ water supply
Nature	▪ (Conditions for) conservation and development of protected habitats	▪ improvement of water quality (expert judgment) ▪ maintenance of desired water level ▪ changes in breeding and foraging area for fish ▪ changes in feeding and resting areas for birds, etc.
Public health	▪ Drinking water	▪ quality of drinking water (expert judgment)
Functions	▪ Fisheries ▪ Agriculture ▪ Tourism ▪ Housing	▪ conditions for sustainable fisheries (water quality, water levels), etc.

Table 24. *Criteria and indicators for addressing the water management problems of the Lake Prespa watershed*

7.2 Gap Analysis

Based on previous chapters, and with reference to the detailed description, information and analysis in Technical Report Parts I and II, a Gap Analysis has been conducted with the detailed results given in the Technical Report Part III. This Gap Analysis was structured in accordance with the following main water management components:

- Legal and Policy Framework
- Organizational Setting and Institutional Capacity
- Water and Wastewater Management Systems and Procedures

Detailed results of the Gap Analysis are given in Technical Report Part III. A summarized version is given in Table 25 below.

Problem:	Possible solution:
Legal, institutional and organizational	
Legal	
The new Water Law does not provide for: a. Clear division of responsibilities in the water sector b. Sustainable financing of activities in the water sector (programme of measures) c. Institutional accountability	Toprepare amendments to the Law on Water To implement the provisions of the Law on Water ('user pays, polluter pays') for gathering all contributions and compensations for services, for usage and for protection from the harmful impacts of water. To conduct institutional capacity-building programmes & Technical Assistance Projects
Secondary legislation in the water sector (by-laws, regulations, decrees) not available	To prepare and adopt secondary legislation
Protected areas (around springs, bathing areas, etc.) have not yet been designated in accordance with the Law on Water	To designate protected areas according to the Law on Water To adopt secondary legislation in accordance with the Law on Water
The forestry sector needs to transform its management approach from the traditional practice to ecosystem-oriented forestry, including securing the necessary finances	To introduce instrument "payment for ecosystem services" of forests
Lack of secondary legislation related to the geospatial database	To adopt secondary legislation for the geospatial database: a rulebook for the coding system; a rulebook for data type and format, etc.)
Policy	
Policy and strategic documents have not been elaborated	To elaborate strategic documents a. Water Strategy b. Water Master Plan (national level) c. River Basin (Watershed) Management Plan for Crni Drim
Organizational/institutional	
A Water Management Authority has not been established	To establish Water Management Authorities a. At national level b. Watershed Management Authority – Crni Drim
Prespa Park Coordination Committee: the Project does not have the mandate for IWRM; respective Working Groups under the TB UNDP/GEF Project are not yet operational and self sustainable	To strengthen the role and mandate of working groups and and the Prespa Park Coordination Committee
Ezerani PA – management organization/ structure not yet appointed	To appoint management organization/institution
MoEPP – Water management sector within the Office of Environment: a. Insufficient level of capacity at national level for water management b. Lack of regional structures/ institutions for integrated water management	To strengthen the Water Sector within the MoEPP: - Technical assistance projects & capacity building - Support in the establishment of RBA

Problem:	Possible solution:

Water Economy – Prespansko Pole only recently established and not yet fully operational
▪ Limited capacity
▪ Weak financial base, inadequate for sustainable rehabilitation, reconstruction, operation and maintenance of organized irrigation & drainage
▪ Insufficient mandate for integrated water management in the sub-catchment (water quality, watercourse management, flood protection, erosion, etc.)
▪ No capacity for investment in major infrastructural projects
▪ Normal operation might be hampered by existing developments in the water sector in the region (individual wells for irrigation)
	To strengthen capacity
	To enable a sustainable financial basis for rehabilitation and O&M funds
	To involve WE in the development & implementation of a River Basin Plan (Programme of Measures)
	To plan for centralized, sustainable & efficient irrigation in the region:
	-rehabilitation, reconstruction and modernization of irrigation schemes
	▪ change of irrigation practices
	▪ development of new sources of irrigation water
	  ▪ protection from the harmful impacts of water
	  ▪ protection of the quantity of water resources (efficient water use, decrease of water use per unit area, demand management)
	▪ maintenance and of streams and erosion control

Limited capacity & mandate of Irrigation WCs in the Region	To strengthen capacity
Water use & management	
Shortage of water for irrigation and water supply in high consumption season	To improve overall water supply in the region by the construction of impounding/reservoir structures in the catchment - Dam and reservoir construction to be located on Chesinska Reka (total storage of app. $20x10^6$ m^3) To improve the distribution and control of drinking water
Unlicensed river intakes for irrigation	To regulate river intakes
Unlicensed irrigation wells	To regulate irrigation wells To implement the Water Law (2008)
Existing irrigation network is obsolete	To introduce by-gravity drip irrigation of some 4,000 ha to replace the existing practice of pumping from the lake for irrigation during the dry season.
Lack of data on irrigation water sources: - groundwater - rivers - lake water - irrigation scheme	To create a database of the irrigation water sources for each field/plot -Relate direct payment scheme (subsidies scheme) with a certificate (permit) for using water for irrigation -Relate LPIS with source of irrigation water
Harmful impacts of water	
Various flood types detected: - groundwater - rivers - torrents	- To prepare preliminary flood risk assessment - To prepare flood hazard maps - To prepare flood risk maps - To prepare a flood risk management plan
Lack of flood control structures - groundwater - rivers - torrents	- To prepare technical documentation - To adopt other plans (urban, forest, agriculture, etc.) on flood control risk - To prepare contingency plans - To implement flood control measures

Problem:	Possible solution:
Erosion intensity is significant and causes on-site damage and off-site damage (sedimentation, transport of P_2 to the streams and lake)	- To develop a study on Erosion Risk Areas (according to the Law on Water) - To designate erosive risk areas (in accordance with the Law on Water) - To provide education in Good Agricultural Practices related to erosion
Insufficient erosion control structures and measures - bare lands - afforestation of 5,800 ha bare land Problems with fluvial erosion	- To prepare a long-term plan for the afforestation of bare land - Afforestation of 5,800 ha - Preparation of designs - Implementation of erosion control measures
Surface Water Quality	
Point sources of pollution	
Incomplete IPPC permits (adjustment permits with adjustment plans) and Environmental elaborates for municipality industries	To enforce the IPPC environmental permit regime and Environmental Elaborates. (To conduct regular measurements of environmental parameters through monitoring programmes for Industries).
Strengthening the capacities of the municipality's environmental unit.	To employ and train additional staff in the environmental unit within the Municipality. To impose a stricter Inspection regime.
Major direct loadings are causing pressure to waterbodies (mainly to Istocka and Golema Reka)	To put an industrial wastewater treatment plant into operation, designing adequate pre-treatment, sanitation in order to prevent direct discharges of wastewater from industry (to ensure compliance with legal limits prior to discharge).
Insufficient treatment of wastewater from domestic households in the municipality	To rehabilitate the Ezerani wastewater treatment plant in order to achieve the recommended limit values, adding an additional secondary treatment clarifier To introduce tertiary treatment (nitrogen and phosphorous removal) by using the abandoned fish ponds as artificial wetlands (eco-remediation) To construct WWTPs for agglomerations of 2000 PE (population equivalent) and less in the region
Inadequate existing sewage network; villages unconnected to the network	To improve the existing sewage network in Resen and Jankovec and to improve connections in other villages. To construct/expand the wastewater network in rural areas
Pressures from sparsely built-up areas are not assessed.	To model calculations of discharges and reduce possible pollution by half (SIMCAT model or similar). To rehabilitate/reconstruct cess pits or septic tanks for isolated and sparsely built dwellings (several households).
Inappropriate stormwater outfall systems	To separate stormwater from wastewater, designing appropriate stormwater outfall systems (reducing inflow quantities) To develop options for the re-use of this water.

Problem:	Possible solution:
Overfishing and a decline in endemic fish populations	To assess fish resources, fish stock and fishery capacity. To ensure accurate and permanent monitoring of fish stock and fish catch. To phase out Illegal fishing. To implement fishery laws and sustainable fishing methods. TO establish a hatchery for endemic fish species.
Diffuse sources of pollution	
Agricultural practices in the region are not appropriate, causing pressure on waterbodies from leaching.	To improve the irrigation scheme by the introduction of the latest agricultural practices & technologies. To introduce CAP to farmers, common operational plan for organic farming. To measure nutrient leaching from fields.
No designated appropriate waste disposal site in the municipality. Illegal waste dump sites.	To close and sanitize illegal dump sites. To build a licensed municipality waste disposal site for 44 inhabited places and to introduce organized collection.
Severe impact from illegal overuse of pesticides / fertilizers.	To implement a pilot programme for demonstration projects on the rational use of pesticides and fertilizers (N: P: K ratio). To promote alternatives and safe disposal of packaging. To establish a 10m buffer zone alongside watercourses in lake catchments.
Large amounts of waste apples in the water bodies.	To provide training for farmers; to enforce the law more effectively. To impose penalties for dumping waste apples in waterbodies. To conduct a project for composting waste apples and yard waste
The severity of the impact from atmospheric deposition on the watershed is unknown.	To implement regular monitoring of aero emissions ad depositions in urban and rural areas. To model atmospheric deposition.
Transport of agrochemicals into the waterbodies through erosion	To conduct a project on the possibilities of applying soil conservation practices on sloped areas (plant grass in the orchards)
Leaching of pesticides in the waterbodies (both surface and groundwater bodies)	To upgrade the capacities of the system for the recommendation of plant protection activities. To create buffer zones next to the surface waterbodies free of pesticides. To upgrade the capacities of the system for the collection of hazardous waste. To conduct a project to educate farmers in the proper use of pesticides
Lake Prespa eutrophication	
Accelerated eutrophication of Prespa Lake	To implement a WFD monitoring system on Prespa Lake
Increased occurrence of nuisance and possible toxic algal ‘water blooms’	- To introduce regular monitoring of algal ‘blooms’ based on WFD principles. - To designate and monitor recreational areas of the lake.
Negative impacts of Lake Prespa eutrophication on the environment and water use	- To conduct a feasibility study on different aspects of the management of eutrophication. - To select and implement effective strategies for the management of eutrophication.

Problem:	Possible solution:
Inadequate fertilization practices that influence the eutrophication of the lake	To conduct project/training for optimum fertilization according to crop requirement To conduct project/training for spreading fertigation as a common fertilization practice To strengthen the capacities of the Laboratory for Soil Analysis for recommendations on fertilization To apply the GAP to all apple orchards To pronounce the entire Prespa area a nitrate-sensitive zone and conduct a project to determine nitrate-sensitive zones
Groundwater quantity and quality	
Lack of data related to groundwater bodies in terms of their distribution, depth, number of aquifers, filtration characteristics, reference conditions and characteristics of nourishment, migration and drainage of groundwater.	To undertake regional hydro-geological explorations, with a projected volume and type of research that will cover the entire Prespa region: ▪ Hydrogeological mapping of the terrain ▪ Geophysical explorations ▪ Hydrogeological exploration drilling of the chosen locations ▪ Groundwater tracer tests ▪ Field and laboratory tests of the filtration parameters ▪ Installation of the groundwater monitoring network
Lack of data on the delineated groundwater body (GWB01301) in terms of its distribution, depth, filtration characteristics, with the aim of establishing the protective zones of the exploitation wells at Carev Dvor.	To undertake local detailed hydrogeological explorations with a projected volume and type of research that will cover the entire groundwater body: ▪ Geophysical explorations ▪ Hydrogeological exploration drilling of the chosen locations ▪ Field and laboratory tests of the filtration parameters ▪ Installation of the groundwater monitoring network ▪ Determination of the direction and velocity of the groundwater
No cadastre listing the existing individual exploitation wells for irrigating apple orchards.	To make records of all existing individual exploitation wells.

Table 25. *Identified problems & possible solutions (summarized)*

7.3 Programme of Measures

The Programme of Measures for achieving the Prespa Watershed Management Plan Objective of ensuring good water quality for all water resources in the watershed contains a list of measures to be implemented. The mainly technical and environmental measures follow below. The necessary preparatory measures, dealing with legal, policy, regulatory and organizational measures to establish the enabling environment are presented in Chapter 9.
The measures are grouped as follows:

- Measures to be adopted to meet the requirements of water used for abstraction of drinking water (to improve the reliability and quality of drinking water)
- Measures for controlling the abstraction and impoundment of water (to ensure that all abstraction is licensed and based on the cost-recovery principle)
- Measures and controls to be adopted for point source discharges and other activities which have an impact on the status of water (to ensure that all point source discharges are licensed and based on the cost-recovery principle)
- Measures and controls to be adopted to prevent or reduce the impact of accidental pollution incidents (to prevent and/or reduce the impact of accidental pollution incidents)
- Measures and controls to be adopted to reduce priority substances (to eliminate the discharge of priority substances)
- Measures to be adopted for waterbodies unlikely to achieve good quality status (to improve heavily modified waterbodies)
- Measures to be adopted for agricultural production to minimize the use of irrigation water and minimize pollution by agrochemicals (to establish environmentally, economically and socially sustainable agricultural and irrigation management and practices)
- Details of the supplementary measures identified as necessary in order to meet water quality environmental objectives (the eutrophication of Lake Prespa)
- Register of further detailed plans and programmes for the Lake Prespa basin dealing with particular water issues

Programme of Measures	Priority	Respon-sible institu-tion	Implemented by:	Indicators	Costs [EURO]
1.2. Measures to be adopted to meet requirements of water used for abstraction of driniking water					
1.2.1. Specific works necessary to improve reliability and quality of drinking water					
Measure 22a - Elaboration of a feasibility study for the improvement of drinking and irrigation water in the Mk Prespa watershed	1	MoAFWE, MoEPP, USG Resen	MoAFWE, PCEP,	- Feasibility Study elaborated	
Measure 22b - Dam and reservoir construction to be located on Chesinska Reka (total storage of app. 20x106 m3) - improvement of distribution and control of drinking water - Improvement of irrigation security	3	MoAFWE, MoEPP	MoAFWE, PCEP, WEPP, WCs	- Dam built - improved distribution of drinking water - improved security & distribution of irrigation water	30,000,000
1.3. Measures to be adopted on the controls of abstraction and impoundment of water					
1.3.1. Specific regulatory measures necessary to ensure that all abstraction and impoundments are licensed - cost recovery					
Measure 22 - Regulate/issue water rights for river intakes for irrigation;	1	MoEPP,	MoEPP, WEPP , WCs,	- # of permissions - database set up	
Measure 23 - Regulate/issue water rights for irrigation wells	1	MoEPP,	MoEPP, WEPP, WCs	- # of permissions - database set up	
1.4. Measures and controls to be adopted for point source discharges and other activities which have an impact on status of water					
1.4.1. Specific regulatory measures necessary to ensure that all discharges are licensed and, where appropriate, contribute to cost recovery					
Measure 411 - Enforcement of the IPPC environmental permits regime and Environmental Elaborates.	1	MoEPP USG Resen	Installations (IPPC A & B) Inspectorate ,	- # of IPPC permits	0
Measure 411 - Employment and training of additional staff in the environmental unit within the Municipality. Stricter Inspection regime	2	MoEPP USG Resen	USG Resen Inspectorate ,	- 2 employed and trained inspectors (6-year)	86,400
1.5. Measures and controls to be adopted for point source discharges and other activities which have an impact on status of water					
Measure 413 - Putting industrial WWTP into operation, designing adequate pre-treatment and sanitation in order to prevent direct loads of wastewater from industry and to ensure they comply with legal limits prior to discharge	2	MoEPP, USG Resen	Industries	- # of designed WWTP - Decreased input of pollutants	0
Measure 414a - Improvement of WWTP “Ezerani” , including primary and secondary treatment (in order to achieve legally set effluent values)	3	USG Resen	PCEP	- WWTP rehabilitated & improved treatment	500,000
Measure 414b - Introduction of tertiary treatment (N & P) in WWTP Ezerani	3	USG Resen	PCEP	- Pond area (ha) - N removed (kg) - P removed (kg)	300,000 +expropriation costs

Waterbodies and terrestrial natural habitats affected by the measure						Expected Effects							
Rivers	Lake	HMWB, Atrificial	Wetlands	Groundwater	Terrestrial natural Habitats	Nitrogen	Phosphorus	Physical Pressure	Natural Habitats	Priority substances	Water supply security	Harmful impacts of water	Other
						Reduction of input	Reduction of input	Reduction	Re-establishment and improvement of quality	Reduction of input	Safe & timely supply	Reduction	
+	+ +	+	+	+++	-	+	+	+	-	o	++	+	
+++	+	+	+	+	o			+			+		
+	o	o	o	o	o				+				
+	+	+	+	+	+	+	+	+	+	+	+	+	+
+	+	+	+	+	+	+	+	+	+	+	+	+	+
+++	+++	+++	+++	+++		+++	+++		+++	+			
+++	+++	+++	+++	+++		+++	+++		+++	+			
+++	+++	+++	+++	+++		+++	+++		+++	+			

Programme of Measures	Priority	Respon-sible institu-tion	Implemented by:	Indicators	Costs [EURO]
Measure 414c- Construction of WWTP for smaller agglomerations (<2000 PE) in the region	3	USG Resen	PCEP	- WWTP rehabilitated & improved treatment	2,500,000
Measure 415a - Improvement of the existing sewage network in Resen and Jankovec; improved connections in other villages.	2	PCEP	PCEP	- constructed/ reconstructed sewage network in Resen and Jankovec in [m]	1,000,000
Measure 415b - Improvement of existing sewage network in smaller agglomerations in the region.	2	PCEP	PCEP	- constructed/ reconstructed sewage network in agglomerations	1,000,000
Measure 416 - Model calculations of discharges and reduce possible pollution by half (SIMCAT model or similar). Sanitation project design for cesspits or septic tanks for several households.	1	MoEPP, HMA, USG Resen		- model set up and calculations done	500,000
Measure 417 - Separation of stormwater from wastewater, designing appropriate stormwater outfall systems (reducing Q by more than 1,17l/sec), options for re-use of this water.	1	USG Resen		- Q reduced	250,000

1.6 Measures and controls to be adopted to prevent or reduce the impact of accidental pollution incidents

1.6.1. Description of necessary measures such as buffer reservoirs to prevent accidental pollution of waterbodies

Measure 62 - Rehabilitation of the former fish ponds and construction of a gate/ barrage on Golema Reka -increase of wetland area -eco-remediation treatment of wastewater outflow from the Ezerani WWTP -protection of rare alder forest within the reserve -decrease of input of primary nutrients and sediments into Lake Prespa	3	WEPP, USG Resen		- Area fish ponds (ha) - Alder forest state - Alder forest (ha) - Nutrient reduction (P,N in kg)	250,000

1.7. Measures and controls to be adopted to reduce the priority substances

1.7.1. Description of measures necessary to eliminate the discharge of priority substances

NOTE: All measures that are set up for reducing point and diffuse source of pollution are relevant and connected with this measure.

Measure 54 - Improvement of the management of priority substances in the region. Conduct project for Investigation of the sources. Conduct feasibility study for elimination of causes of the presence of priority substances in the surface water	2	MOEPP, MAFWE, FA		- Project completed - Feasibility Study completed - Monitoring plan developed and implemented	60,000

Waterbodies and terrestrial natural habitats affected by the measure						Expected Effects							
Rivers	Lake	HMWB, Atrificial	Wetlands	Groundwater	Terrestrial natural Habitats	Nitrogen	Phosphorus	Physical Pressure	Natural Habitats	Priority substances	Water supply security	Harmful impacts of water	Other
						Reduction of input	Reduction of input	Reduction	Re-establishment and improvement of quality	Reduction of input	Safe & timely supply	Reduction	
+++	+++	+++	+++	+++		+++	+++		+++	+			
+++	+++	+++	+++	+++		+++	+++		+++	+			
+++	+++	+++	+++	+++		+++	+++		+++	+			
o	o	o	o	o		+	+		+				
+	+	+	+	+		+	+		+				
	++		+++	+		+	+	+	+	+			

Programme of Measures	Priority	Respon-sible institu-tion	Implemented by:	Indicators	Costs [EURO]
Measure 55 - Conduct project for Investigation of the sources. Conduct feasibility study for the elimination of the causes of the presence of priority substances in the groundwater.	2	MOEPP, PCEP		- Feasibility Study completed - Database of priority substances established - Monitoring plan developed and implemented	30,000

1.8. Measures to be adopted for waterbodies unlikely to achieve good quality status

1.8.1. Description of measures to be taken to improve heavily modified waterbodies

1.9. Measures to be adopted for agricultural production to minimize use of irrigation water and minimize pollution by agrochemicals

1.9.1. Description of measures to be taken to establish sustainable agricultural and irrigation practices

Measure 24 - Introduction of gravity drip- irrigation of some 4,000 ha to replace existing practices of irrigation by pumping -from the lake during the dry season	1	WEPP, WCs		- Area drip-irrigation (ha)	4,000,000
Measure 25 - Creation of a database for irrigation water sources by field/plot -Relate direct payment scheme (subvention scheme) with certificate (permit) for using of water for irrigation - Relate LPIS with source of irrigation water	1	MAFWE, SCR , WEPP, WCs	MAFWE, SCR , WEPP, WCs	- created database # of subsidies, Amount of subsidies (Mill. MKD)	100,000
Measure 421 - Improvement of the irrigation scheme through the introduction of the latest agricultural practices & technologies. Implementation of GAP to farmers, common operational plan for organic farming. Measuring nutrient leaching from fields.	3	MAFWE	MAFWE	- # of farmers using GAP	300,000
Measure 422 - Closure and sanitation of illegal dump sites. Building of a licensed municipality waste disposal site for 44 inhabited places & organized collection - prioritization according to the following criteria: - location: 1 Protected areas and 2. Areas close to waterbodies (primarily Lake Prespa) - Implementation according to the existing Plan for solid waste management in Prespa region	3	MoEPP, USG Resen, Inspectorate	MoEPP, USG Resen	- # of illegal dumpsites cleaned - # of settlements with organized waste collection - population coverage (%)	250,000
Measure 423 - Implementation of pilot/ Programme for demonstration projects on: Rational use of pesticides and fertilizers (N: P: K ratio); Alternatives and safe disposition of packaging; 10m buffer zone alongside watercourses in lake catchments.	3	MAFWE, MoEPP, USG Resen, Inspectorate, SCR	MAFWE, USG Resen	- # of implemented pilot programmes - # of farmers using GAP , - % of area designated as buffer zones	100,000

Waterbodies and terrestrial natural habitats affected by the measure						Expected Effects							
Rivers	Lake	HMWB, Atrificial	Wetlands	Groundwater	Terrestrial natural Habitats	Nitrogen	Phosphorus	Physical Pressure	Natural Habitats	Priority substances	Water supply security	Harmful impacts of water	Other
						Reduction of input	Reduction of input	Reduction	Re-establishment and improvement of quality	Reduction of input	Safe & timely supply	Reduction	
+++	+++		+	+++		+++	+++		+	++	+++	+	+
++	++		++	++	++	+++	+++	+	++	+++	++		
++	++		+++	+++	++	+++	+++		+++	+++			

Programme of Measures	Priority	Respon-sible institu-tion	Implemented by:	Indicators	Costs [EURO]
Measure 424 - Training for farmers, enforcement of law. Penalties for dumping of waste apples in waterbodies. Conduct project for composting waste apple and yard waste	3	MAFWE, MoEPP, USG Resen, SCR, FA	MAFWE, USG Resen	- # of trained farmers, - # of penalties, - # projects	100,000
Measure 425- Implementation of regular monitoring of aero emissions and depositions in urban and rural areas. Modelling atmospheric deposition (CalPuff or other software).	3	MoEPP, HMA	HMA	- # of monitoring stations - database setup & operartional	50,000
Measure 426- Implementation of agro-environmental measures (green cover in orchards)	3	MAFWE	USG Resen, SCR, FA	- # area covered in ha - # of farmers carrying out new conservation practices	300,000
Measure 427- Upgrading capacities of: - System for recommendation of plant protection activities - System for collection of hazardous waste - Farmers for proper use of pesticides	3	MAFWE, MoEPP, USG Resen, SCR, FA	USG Resen, SCR, FA	- % of farmers using SRPP - % of farmers using SCHW - % of farmers using PUP	50,000
Measure 56 - Conduct project/training for optimization of irrigation according to crop water requirements. Develop information system for irrigation scheduling based on measured evapotranspiration and soil moisture	2	MAFWE, SCR, USG RESEN, FA	MAFWE	- # of trainings - # of trainees	30,000
Measure 434- Conduct project/training for optimization of fertilization according to crop requirement Conduct project/training for spreading fertigation as a common fertilization practice. Strengthening the capacities of the Laboratory for Soil Analysis. Implementation of nutrient management plans.	2	MAFWE, USG Resen, SCR, FA	MAFWE	- # of projects conducted - # of farmers carrying out new practices	60,000

1.10. Details of the supplementary measures identified as necessary in order to meet water quality environmental objectives

1.10.1 Eutrophication of Prespa Lake

Measure 431- Implementation of WFD monitoring system on Prespa Lake	3	MoEPP, HMA, SC	HMA, SC	- WFD Monitoring system implemented	20000/y
Measure 432a - Regular monitoring of algal 'blooms' based on WFD principles.	3	MoEPP, HMA, SC	SC	- WFD Monitoring system implemented	40000/y
Measure 432b - Designation and monitoring of recreational areas of the lake.	3	MoEPP, HMA, SC, USG Resen	SC	- Recreational areas designated	40000/y

Waterbodies and terrestrial natural habitats affected by the measure						Expected Effects							
Rivers	Lake	HMWB, Atrificial	Wetlands	Groundwater	Terrestrial natural Habitats	Nitrogen	Phosphorus	Physical Pressure	Natural Habitats	Priority substances	Water supply security	Harmful impacts of water	Other
						Reduction of input	Reduction of input	Reduction	Re-establishment and improvement of quality	Reduction of input	Safe & timely supply	Reduction	
++	++		++	++	++	+++	++	+	+	++		++	
+	+		+	+	+					+++			
+	+		+	+	+	++	++		+				

Programme of Measures	Priority	Respon-sible institu-tion	Implemented by:	Indicators	Costs [EURO]
Measure 433a - Conduct feasibility study on different aspects of the management of eutrophication.	3	MoEPP, HMA, USG RESEN	SC	- Feasibility Study conducted	1,500,000
Measure 433b - Selection and implementation of effective strategies for the management of eutrophication.	3	MoEPP, HMA, USG RESEN	SC	- Strategies selected & implemented	

1.11. Register of further detailed plans and programmes for the Prespa Lake basin dealing with particular water issues

1.11.1. Description of other necessary work

Programme of Measures	Priority	Respon-sible institu-tion	Implemented by:	Indicators	Costs [EURO]
Measure 51- Regional hydrogeological explorations with projected volume & type of research to cover the entire Prespa region; hydrogeological mapping of the area; geophysical explorations	3	MoE, MoEPP, HMA	GPE	- # of maps/layers completed	800,000
Measure 52 - Local detailed hydrogeological explorations with projected volume and type of research covering the entire groundwater body: Geophysical explorations; Hydrogeological exploration drilling of the chosen locations; Field and laboratory tests of the filtration parameters; Installation of the groundwater monitoring network; Determination of the direction and velocity of the groundwater	3	MoE, MoEPP, HMA	GPE	- GW bodies adequately investigated - monitoring network set - Monitoring database established	100,000
Measure 53 - Inventory of all existing individual exploitation wells.	3	MoE, M0EPP, WEPP		- cadastre of individual exploitation wells set up and operational	200,000
Measure 61 - Implementation of management plans for the protected areas Ezerani, Galicica and Pelister.	3	MoEPP, PAMB , Inspectorate	PAMB	- inspector control reports	0
Measure 63 - Harmonization of methodology for the collection of environmental data	3	MoEPP, HMA. HBI., SCR	MoEPP, SC	- approved rulebook for data collection	25,000
Measure 64 - Implementation of transboundary monitoring programme (50.000 EUR/y)	3	MoEPP, HMA. HBI., SCR	MoEPP, SC	- implemented monitoring programme - reports	300,000
Measure 65 - Conduct project for utilization of biomass as energy source (briquetting, pelleting, syngas)	3	MoEPP, HMA. SCR USG Resen, FA	MoEPP, SC	- # of farmers that utilize biomass as energy - Energy produced (J)	70,000
Measure 418 - Assessment of fish resources, fish stock and fishery capacity. Accurate and permanent monitoring of fish stock and fish catch. Phasing out of Illegal fishing. Implementing fishery laws and sustainable fishing methods. Establishing a hatchery for endemic fish species.	3	MAFWE, MoEPP, USG Resen, PA authority	HBI, UKIM, MAFWE	- concession issued - improved fish stock (in %) - # of introduced hatcheries	150,000

Waterbodies and terrestrial natural habitats affected by the measure						Expected Effects							
Rivers	Lake	HMWB, Atrificial	Wetlands	Groundwater	Terrestrial natural Habitats	Nitrogen	Phosphorus	Physical Pressure	Natural Habitats	Priority substances	Water supply security	Harmful impacts of water	Other
						Reduction of input	Reduction of input	Reduction	Re-establishment and improvement of quality	Reduction of input	Safe & timely supply	Reduction	
	+++		+						+++				
+	+		+	+	+++	+	+	+	+++		+	+	
+	+		+	+					+++				

Programme of Measures	Priority	Respon-sible institu-tion	Implemented by:	Indicators	Costs [EURO]
Measure 31 - Preparation of flood hazard/risk-related plans Preparation of flood hazard maps Preparation of flood risk maps Preparation of flood risk management plan Adoption of other plans (urban, forest, agriculture etc.) on flood risk Preparation of contingency plans; Technical documentation preparation	2	MoEPP, USG Resen, SCR, WEPP	MoEPP, USG Resen	- # of prepared assessments, maps plans, technical documentation	250,000
Measure 32 - Flood control measures and activities Implementation of flood control measures and structures	1	MoEPP, USG Resen, SCR, WEPP	MoEPP, USG Resen, SCR, WEPP	- # of prepared technical documentation - adopted plans - Prepared risk/ contingency plans - constructed flood control constructions	5,000,000
Measure 33 - Erosion control plans (Development of study for erosion risk areas (according to the Law on Water) Designation of erosive risk areas (according to the Law on Water), Education in good agricultural practices related to erosion	2	MAFWE, SCR, USG RESEN, MOEPP, PE MF, FA	MAFWE, SCR, USG RESEN, MOEPP, PE MF, FA	- # of prepared studies, - # of designated areas, - # of trained farmers - # of constructions	50,000
Measure 34 - Erosion control structures and measures (Preparation long-term, plan for afforestation of bare land; afforestation of 5800 ha; Preparation of 15 torrent control final designs; Implementation of erosion control measure	2	MAFWE, SCR, USG RESEN, MOEPP, PE MF,	MAFWE, SCR, USG RESEN, MOEPP, PE MF,	- - # of prepared plans for afforestation, - # final designs, - Area afforested (ha), - # of torrents regulated	7,500,000

Table 26. *Programme of Measures for the achievement of good water status in the Prespa watershed*

GAP - Good Agricultural Practice (EU)
FA - Farmer Associations
HBI - Hydro-Biological Institute
HMA - Hydro-meteorological Administration
MAFWE - Ministry of Agriculture, Forestry and Water Economy
MoEPP - Ministry of Environment and Physical Planning
PAMB - Protected Area Management Body
PCEP - Public Communal Enterprise Proleter
PPP - Prespa Park Project
SCR - Steering Committee Resen
USG Resen - Unit of Self Government Resen
WEPP - Water Economy Prespansko Pole

Waterbodies and terrestrial natural habitats affected by the measure						Expected Effects							
Rivers	Lake	HMWB, Atrificial	Wetlands	Groundwater	Terrestrial natural Habitats	Nitrogen	Phosphorus	Physical Pressure	Natural Habitats	Priority substances	Water supply security	Harmful impacts of water	Other
						Reduction of input	Reduction of input	Reduction	Re-establishment and improvement of quality	Reduction of input	Safe & timely supply	Reduction	
												+++	

7.4 Possible Implementation Strategies

There are basically three alternative implementation strategies:

- A Business as Usual Strategy in which none of the 45 necessary measures listed above are implemented and the Prespa Lake Watershed further deteriorates in terms of economic growth, environmental management and ecological status. — Alternative 0
- A Water Framework Directive Implementation Strategy in which all 45 measures are implemented in full accordance with the WFD, ensuring the achievement of the environmental objectives. — Alternative 2
- A Realistic Implementation Strategy in which some of the above 45 measures are implemented based on the availability of economic resources, manpower and skills. — Alternative 1

The selection of a combination of the 45 measures to be implemented should be based on an agreed selection process in accordance with agreed selection criteria, scoring and ranking. These selection criteria should cover hard selection criteria such as available funding, available manpower and necessary skills, as well as softer selection criteria reflecting national, regional and local political priorities. The most simple selection model would be to identify available funds and then 'shop' from the top of the list until the funds are used (see Chapter 9 for more details).
As a first step in the prioritization/selection process, the 45 measures have been ranked and prioritized in accordance with the following factors:

- Environmental effectiveness (contribution to achieving the targets set for the waterbodies)
- Legal requirement – to be enforced in accordance with present legislation & regulations
- Multi-criteria analysis score (highest score) according to the following criteria:
  - Legal requirement 0-20 points
  - Environmental extent 0-10 points
  - Environmental effect 0-10 points
  - Security & resources preservation 0-20 points
  - Prevention of harmful impacts 0-5 points
  - Economic benefits 0-10 points
  - Financial costs 0-10 points
  - Social benefits 0-15 points

Total 0-100 points

The results of this technical ranking are given in Table 27.

Rank	Score	ID	Programme of Measures	Legal requirements	Cost		Implementation Period /Duration [y]	Proposed Alternatives		
					Total [10³ €]	Annual [10³ €]		0 Business as usual	1 Realistic	2 WFD Implementation
1	68,3	23	Regulate irrigation wells	Yes	200		3			
2	66,2	22	Regulate irrigation intake from rivers	Yes	0		3			
3	65,3	426	Develop green cover in orchards	-	300		6			
4	63,3	34	Erosion control	-	7,500		18			
5	63,0	421	Upgrade irrigation schemes	-	300		5			
6	62,3	422	Closure of illegal dumping sites and establishment of a controlled sanitary landfill	-	250		2			
7	62,2	413	Upgrade industrial wastewater treatment	Yes			12			

Rank	Score	ID	Programme of Measures	Legal requirements	Cost		Implementation Period /Duration [y]	Proposed Alternatives		
					Total [10³ €]	Annual [10³ €]		0 Business as usual	1 Realistic	2 WFD Implementation
8	62,0	414a	Upgrade Ezerani wastewater treatment plant	-	500		2			
9	61,7	62	Rehabilitate fish ponds and construct gate/barrier on Golema River	-	250		2			
10	61,5	33	Erosion control plans based on erosion risk assessment and training	-	500		6			
11	61,5	61	Implementation of management plans for the protected areas: Ezerani, Galicica and Pelister	-	0		3/cont*			
12	61,3	431	Implementation of WFD monitoring for Lake Prespa	Yes		20	3/cont			
13	60,3	411	Enforcement of IPPC	Yes	0		3/cont			
14	59,8	424	Educating farmers in good agricultural and environmental practices, including the composting of orchard waste	-	100		2			
15	59,7	31	Preparation of flood risk and mitigation plans	-+	250		3			
16	57,8	423	Pilot project for environmentally safe use of fertilizers and pesticides	-	100		2			
17	57,7	24	Introduce drip-irrigation systems on 4,000 ha	-	4.000		4			
18	55,4	22b	Construct a dam on Chesinska Reka	-	30,000		6			
19	55,2	432b	Designate and monitor recreational areas	-+		40	2/cont			
20	53,8	418	Upgrade fisheries management based on source and catch assessment	-+	150		3/cont			
21	53,7	25	Develop a database on irrigation	-	100		2			
22	53,0	32	Implement flood control measures	-+	5,000		12			
23	53,0	414c	Construction of WWTP for smaller agglomerations (<2000 PE)		2,500		12			
24	52,5	53	Establish inventory of private wells	Yes	200		2/cont			
25	52,2	427	Upgrade farmers' capacity for proper disposal of hazardous waste and use of pesticides	-	50		2			
26	51,8	56	Train farmers in proper irrigation management	-	30		1			
27	50,8	54	Improve management of priority substances	-+	60		2			
28	50,5	415a	Improve sewage network in Resen and Jankovec	-+	1,000		6			
29	50,0	432a	Introduce regular monitoring of algae blooms	-		40	2/cont			
30	49,0	434	Improve fertilizer management, including capacity for laboratory analysis	-	60		2/cont			
31	48,8	433b	Introduce effective eutrophication strategies	-	1,500		4			
32	48,0	414b	Establish tertiary wastewater treatment in former fish ponds	-	300		2			
33	47,8	64	Establish transboundary monitoring programme	-+	300	*50	2/cont			
34	46,3	63	Ensure harmonization of environmental data management	-+	25		1			
35	46,0	415b	Improve existing sewage network and construct new sewage networks in smaller agglomerations in the region	-+	2,500		12			
36	45,5	65	Pilot project for use of biomass as energy resource	-	70		2			

Rank	Score	ID	Programme of Measures	Legal requirements	Cost		Implementation Period /Duration [y]	Proposed Alternatives		
					Total [10³ €]	Annual [10³ €]		0 Business as usual	1 Realistic	2 WFD Implementation
37	45,3	52	Conduct detailed local hydrogeological investigations	-	100		1			
38	44,3	51	Conduct regional hydrogeological investigations	-	800		4			
39	44,0	433a	Conduct a feasibility study on alternative eutrophication mitigation strategies	-	-		1			
40	38,3	55	Conduct source investigations of priority substances in groundwater	-+	30		1			
41	37,8	416	Conduct modelling of the effect of different discharge reduction strategies	-	500		2			
42	37,3	417	Implement project for the separation of stormwater and construction of proper outfalls	-+	250		6			
43	37,2	22a	Conduct a comprehensive feasibility study for improving the management of water for drinking purposes and for irrigation covering the whole catchment area	-	200		2			
44	36,8	425	Establish air pollution model	-	50		1			
45	24,8	411	Upgrade capacity in terms of both manpower and skills in the Municipal Inspectorates	-	86.4		2/cont			

1-17, 22, 43	Alternative 1- Realistic Implementation Strategy	Total A1:	14,450
1-45	Alternative 2 – Full WFD Implementation	Total A2:	59,95.,4

Table 27. *Technical ranking / prioritization of the 45 Measures*

The three alternative implementation strategies are listed in Table 27:

A Business as Usual Strategy.	Alternative 0
A Water Framework Directive Implementation Strategy (52 million EUR.)	Alternative 2
A Realistic Implementation Strategy, (14.5 million EUR)	Alternative 1

7.5 Sensitivity Analysis

Technical ranking employing the above criteria was used to rank and select 20 measures for the Realistic Implementation Strategy (Alternative 1).
The prioritization was subjected to sensitivity analysis. The ranking of measures was checked with a different set of weights and with focus on various aspects. Specifically, the prioritization of measures was made for the following objectives and sets of criteria:

1. Environmental (impact, extent, resource security & preservation, prevention of harmful impacts)
   Using ranking purely based on environmental criteria, 16 measures selected in Alternative 1 are in the first 20 measures ranked according to this criteria.
2. Socio-economic (economic benefits, financial costs, social benefits)
   By applying purely socio-economic criteria, the ranking of measures changes. However, 10 out of 20 selected measures in Alternative 1 make the first 20 ranking. With socio-economic factors as the dominant criteria, some of the long-term heavy investment measures (dam for water supply, irrigation improvements, erosion and flood protection measures) score higher in the rankings. This is because, in spite of higher costs, these measures have long-term economic benefits and contribute to greater progress due to increased productivity and revenues, as well as employment.

Based on the sensitivity analysis, it can be concluded that the proposed set of measures in Alternative 1 is robust and well balanced with the set of criteria & weights agreed with the stakeholders.

8 Public Consultation Process

8.1 Description of Public Consultation and Information Measures

This Chapter describes the public consultation process and information measures, in particular the information provided to the public and stakeholders and the changes made to the plan as a result of feedback.

The Water Framework Directive requires that the river basin management plans include a summary of public information and consultation regarding the planning process.

This section describes the experience gained from public participation in the Prespa Lake watershed project and draws parallels with the public participation process required by the Environmental Objectives Act. The provisions of the Water Framework Directive are transposed into the Macedonian Law on Water. The latter describes the work and planning process that must be carried out to facilitate the achievement of the Water Framework Directive's objective of 'good status' in all surface waters and groundwater.

To ensure the successful implementa¬tion of a river basin management plan, it is necessary to gain general acceptance of the plan, the proposed environmental objectives, and the measures needed to achieve the environmental objectives in the Lake Prespa Watershed. This necessitates the early identification of all stakeholders and their participation in the planning process—a requirement which the watershed authority fulfilled from the start of the present project.

8.2 Stakeholders

The sectors with the greatest impacts on the Prespa watershed have been identified as follows: the water and waste management sector, agriculture, forestry, land use, fisheries, biodiversity and protected areas, industry and tourism. Stakeholder analysis highlights those sectors in order to assess the capacity to implement various measures aimed at preventing and mitigating these impacts.

The Terms of Reference emphasize the following stakeholders as being most relevant: the MoEPP; the Municipality of Resen; the Forest Enterprise; the Ministry of Agriculture, the Forestry and Water Economy; the Farmers Association for Resen; the NGO representative; the Protected Area Manager(s); the Fishermen's Association for MK-Prespa; the Public Water Management Authority for Resen; the Ministry of Transport and Communications; and the Ministry of Foreign Affairs. Details of the sector stakeholders directly involved in the watershed management planning process are given below.

Water and Wastewater management:
- Ministry of Environment and Physical Planning:
- Ministry of Agriculture, Forestry and Water Economy
- Ministry of Transport and Communications
- Ministry of Economy
- Local Government/Public Utility JKP "Proleter" – Resen
- Public Enterprise "Prespansko Pole" (Water Management Organization)
- Water User Communities

Agriculture, Forestry, Fishing:
- Ministry of Agriculture, Forestry and Water Economy (MAFWE)
- National Agency for Agriculture Promotion and Development (NEA) – Agriculture Extension Service (AES
- Union of Agricultural Associations, Resen (NGO).
- PE Macedonian Forests, branch office "Prespa Drvo" - Resen

Industry
- AD Agroplod – Resen

- AD CD Fruit - Carev Dvor
- Hateks DOO - Resen
- AD Resena – Resen
- Stenje Teks DOO – Stenje
- AD Krznoteks – Resen
- AD Prespaplast – Resen
- Chemical Industry AD Hemiski Vlakna
- Wood industry MIntaerrcnoan, iD
- Construction Industry AD Sloga – Resen
- Metal processing Algreta – Resen

Nature protection
- PI National Park "Pelister" – Bitola
- PI National Park "Galicica" – Ohrid

Scientific Institution:
- Hydrobiological Institute – Ohrid
- University of Ss. Cyril and Methodius – Skopje

Municipality Administration, Medical Institutions, Local NGOs etc.

8.3 Consultations

Three official stakeholder meetings were held in which representatives of all stakeholders participated.
The First Stakeholder Meeting was held in Resen soon after the launch of the project. The aim of this meeting was to introduce the identified stakeholders to the Project.
The aim of the second stakeholder meeting, held in Bitola, was to present the current situation of water-related issues in the Prespa Lake watershed.
At the third meeting, also held in Bitola, the Programme of Measures was presented and proposed.
Beside these meetings, members of the team organized individual meetings with representatives of various institutions in their field of interest during site visits.
Very useful information was collected from farmers at informal meetings in the villages.
Note: For more information, see Technical Report 1.

8.4 Contact Points and Procedures for Obtaining Background Documentation and Information

Part of the team worked on previous projects in various fields related to Prespa Lake Watershed, such as biology and ecology, hydrology, erosion and torrents, agriculture, forestry, nature protection, civil engineering, spatial planning, etc. Data from these projects was used to provide a basis to be upgraded later.
A list of documentation used—projects, reports, etc.—is presented in Annex 2.
Some data was obtained from the UNDP office (from various projects within the Prespa Park project), while other data was obtained from PCE "Proleter", from water-user communities, and from the Farmers' Association.
Much of the data related to agricultural and irrigation activities was obtained from farmers through informal communications.
With regard to GIS data, the work had to begin from scratch as the data available was not good or useful due to an incompatible coordinate system and projection. In the course of the project implementation, a great deal of data was collected and input into GIS databases, with new layers created as required. These databases are an inherent part of the Prespa Watershed Management Plan.
Note: For more information, see Technical Report 1

9 Overall Implementation Strategy in the Macedonian Context

9.1 Prioritisation of Identified Measures

The 45 measures identified in the previous chapters have been ranked, scored and prioritised on the basis of multi-criteria analyses, resulting in the following list of prioritisation in which the estimated costs are also given (in thousands of EUR):

1.	Regulate irrigation wells.	200
2.	Regulate irrigation intake from rivers.	0
3.	Green cover in orchards.	300
4.	Erosion control.	7,500
5.	Upgrade irrigation schemes.	300
6.	Closure of illegal dump sites and establishment of a controlled sanitary landfill.	250
7.	Upgrade industrial wastewater treatment.	-
8.	Upgrade Ezerani wastewater treatment plant.	500
9.	Rehabilitate fish ponds and construct gate/barrier on Golema River.	250
10.	Erosion control plans based on erosion risk assessment and training.	500
11.	Implementation of management plans for the protected areas:	0
12.	Implementation of WFD monitoring for Lake Prespa.	20
13.	Enforcement of IPPC.	0
14.	Educating farmers in good agricultural and environmental practices.	100
15.	Preparation of flood risk and mitigation plans.	250
16.	Pilot project for environmentally safe use of fertilizers and pesticides.	100
17.	Introduce drip irrigation systems on 4,000 ha.	4,000
18.	Construct a dam on Chesinska Reka.	30,000
19.	Designate and monitor recreational areas.	40
20.	Upgrade fisheries management based on source and catch assessment.	150
21.	Develop a database on irrigation.	100
22.	Implement flood control measures.	5,000
23.	Pilot projects, training and implementation of WWTP for individual households.	50
24.	Establish inventory of private wells.	200
25.	Upgrade farmers' capacity for proper disposal of hazardous waste and use of pesticides.	50
26.	Train farmers in proper irrigation management.	30
27.	Improve management of priority substances.	60
28.	Improve sewage network in Resen and Jankovec.	1,000
29.	Introduce regular monitoring of algae blooms.	40
30.	Improve fertilizer management, including capacity for laboratory analysis.	60
31.	Introduce effective eutrophication strategies.	1,500
32.	Establish tertiary wastewater treatment in former fish ponds.	300
33.	Establish a trans-boundary monitoring programme.	300
34.	Ensure harmonization of environmental data management.	25
35.	Pilot project for use of biomass as energy resource.	70
36.	Conduct detailed local hydrogeological investigations.	100
37.	Conduct regional hydrogeological investigations.	800
38.	Conduct a feasibility study on alternative eutrophication mitigation strategies.	-
39.	Conduct source investigations of priority substances in groundwater.	30
40.	Conduct modelling of the effect of different discharge reduction strategies.	500

41. Implement project for the separation of storm-water and the construction of proper outfas.	250
42. Conduct a comprehensive feasibility study for improving the management of water for drinking purposes and for irrigation covering the whole catchment area.	200
43. Installation of regional air quality monitoring station and development of air pollution model.	50
44. Upgrade capacity in manpower and skills in the municipal inspectorates.	87

9.2 Necessary Preparatory Measures

The Prespa Lake Watershed Management Plan will be implemented on the basis of a two-tier strategy. This approach is based on the assessments described above and takes into account the following factors: the as yet insufficiently developed and inconsistent legal and regulatory framework; the lack of fully clarified roles and responsibilities in the organisational structure; and the need to improve institutional capacity.

- The first priority will be to implement measures that address the enabling environment—the institutional roles and management instruments that will be the foundation for the implementation of the technical measures

- While the legal and regulatory framework is being put into place and as the organisational structures and institutional capacities are developed, more technical measures will be implemented in a structured 'learning-by-doing' process.

Based on the two-tier strategy above, the preparatory measures are addressed below in relation to the Macedonian context:

- The Enabling Environment
  - Policies
  - Legislative Framework
  - Financing and Incentive Structure

- Institutional Roles
  - Creating an Organisational Structure
  - Building Institutional Capacity

- Management Instruments
  - Social Change Instruments
  - Regulatory Instruments
  - Economic Instruments

9.3 Legal Requirements

Many of the gaps identified are the result of poor implementation (or non-implementation) of previously adopted laws and regulations. In the formulation of the Programme of Measures, these implementation needs were thus identified as 'measures' and included in the overall list. The rationale for doing so is that the effective implementation of these regulations would itself produce significant results in the achievement of some of the goals of the Prespa Watershed Plan—i.e. the improvement of the environmental status of some of the waterbodies—and would contribute significantly to the overall objective. Some of the regulations which have been adopted and put in place have been partially implemented. For some of the regulations, the timeframe of implementation has been set in the near future (IPPC) and implementation is expected to be simultaneous with the implementation of the plan.

A number of identified gaps will be overcome by 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 waterbodies, sustainable financing of the water sector and amendments to enable the enactment/enforcement of the principles of 'polluter/user pays' and 'full service cost recovery' in the water sector and thus ensure the successful and sustainable implementation of the plan.

A number of other key environmental laws also need to be implemented in the country and in the Prespa region. One of the most significant of these is the Law on Environment and the specific IPPC regulations which this law contains. The IPPC operational permits will regulate discharges into the environment/water and significantly decrease the input of pollutants in the region. At regional/municipal level, installations subject to IPPC B have been identified and the harmonization of their operational permits is an ongoing process. It must be emphasized that the implementation of IPPC A and B permits is not considered a cost for the Watershed Management Plan since no significant costs are incurred by full implementation of the IPPC in the regular work of the relevant national and local institutions, except for improved monitoring of implementation. These costs will be fully borne by the installations subject to these regulations. Hence, legal requirements have been formulated as 'measures' and included in the Plan. The rationale for this approach is that these actions do not have an alternative or substitute, apart from the implementation of the law itself.

The full set of measures identified to provide the legal, policy and institutional preconditions necessary to create an enabling environment for the implementation of the Prespa Watershed Water Management Plan are listed in Table 28.

Problem / Measures	Priority	Responsible institution	Done by:	Level	Indicators	Costs [EURO]
1.1 Legal						
1.1.1 New Water Law (85/2008):						
1.1.1.a Clear division of responsibilities in the water sector						
Measure 111a - Amendments to the Law on Water to provide a clear division of responsibilities in the water sector	1	MoEPP	MOEPP, Parliament, TA	N	▪ # of amendments prepared & adopted	-
1.1.1.b Sustainable financing of activities in the water sector (Programme of Measures)						
Measure 111b - Implementation of the provisions of the Law on Water ('user pays, polluter pays') for gathering all contributions and compensations for services, for usage, and for protection from the harmful impacts of water.	1	MoEPP	MOEPP, Parliament, MAFWE, MTC, LSGU, MoE	N	▪ Amount of funds collected at local/ regional level ▪ Amount of funds returned for IWRM in the region	-

Problem / Measures	Priority	Responsible institution	Done by:	Level	Indicators	Costs [EURO]
1.1.1.c Institutional accountability						
Measure 111c - Institutional capacity- building programmes & technical assistance projects	1	MLSG, MoE, MTC, WEPP and WCs	MoEPP, Bilateral and Multilateral Donor Agencies	N	▪# capacity-building programmes conducted ▪# trained staff – key institutions	40,000
1.1.2 Secondary legislation in the water sector (by-laws, regulations, decrees) not available						
Measure 112 – Adoption of secondary legislation	1	MoEPP	MoEPP, Parliament	N	▪# by-laws prepared & adopted	-
1.1.3 Protected areas according to the Law on Water (around springs, bathing areas etc.) not designated yet						
Measure 113 – Designation of protected areas in accordance with the Law on Water – potable water sources, bathing areas, sensitive areas, etc.)	3	MoEPP, LSGU	MoEPP, LSGU	N L	▪# protected area designated ▪Area covered (ha)	60,000
1.1.4 Forestry sector management approach not focused on ecosystem oriented forest management including defining financing of this activity						
Measure 114 – Introduction of the instrument “Payment for Ecosystem Services” (PES)	2	MoEPP, MoAFWE, PEMF, LSGU	MoEPP, MoAFWE LSGU	N, L	▪Funds collected for ecosystem services ▪Rulebook on PES ▪# TA & CB projects implemented	40,000
1.1.5 Lack of secondary legislation related to the geospatial data & databases						
Measure 1.1.5 Adoption of secondary legislation for geospatial database (rulebook for coding system; rulebook for data type and format, etc.)	3	MoEPP, MoAFWE, PEMF, LSGU	MoEPP, MoAFWE, PEMF, LSGU	N, L	▪# of by-laws & regulations adopted ▪Rulebook prepared ▪Geospatial database set & functional	20,000
1.2 Policy						
1.2.1 Policy & strategic documents have not been elaborated						
Measure 121 – National Water Strategy	2	MoEPP	MoEPP	N	Strategy adopted	50,000
Measure 122 - Water Master Plan (national level)	2	MoEPP, MoAFWE	MoEPP, MoAFWE	N	WMP adopted	200,000
Measure 123 - River Basin (Watershed) Management Plan for Crni Drim	2	MoEPP,	MoEPP	N, L	RBMP adopted	200,000
1.3 Organizational/Institutional						
1.3.1 Water Management Authority not established						
Measure 131a - Establishment of Water Management Authority at national level	1	MOEPP, MAFWE, FA	MoEPP	N	Water Authority established & operational	-
Measure 131b - Establishment of Watershed Management Authority – Crni Drim	1	MOEPP, MAFWE, FA	MoEPP	N	Water Authority established & operational	-
1.3.2 Prespa Park Coordination Committee (PPCC) – *The Project does not have the mandate for IWRM and Working Groups (WG) under the TB UNDP/GEF Project are not yet operational and self sustainable*						
Measure 132 - Strengthening the role and mandate of WG and PPCC	3	MoEPP	PPP, LSGU Resen, TB UNDP GEF Project, MoEPP	N, L		
1.3.3 Ezerani PA – management organization/structure not yet appointed						
Measure 133 – Appointment of a management organization/institution for PA Ezerani	3	MoEPP, LSGU	MoEPP, LSGU	N, L	Management entity appointed & operational	30,000

Problem / Measures	Priority	Responsible institution	Done by:	Level	Indicators	Costs [EURO]
1.3.4 MoEPP – Water management sector within the Office of Environment capacity and structures						
Measure 134a – Strengthening the capacity at national level for the IWRM - Water Sector within the MoEPP	1	MoEPP	MoEPP, Donor Agencies	N	▪ # of Technical assistance projects & capacity building implemented	-
Measure 134b - Lack of regional structures/ institutions for IWRM Support for the establishment of RBA	1	MoEPP, LSGU Resen,	MoEPP, LSGU Resen	N,L	RBA established & sustainable	-
1.3.5 Water Economy –"Prespansko Pole" has recently been established and is not yet fully operational. It has a weak financial base inadequate for sustainable rehabilitation, reconstruction, and the operation and maintenance of organized irrigation & drainage, investment etc. Insufficient mandate for IWRM						
Measure 135 – Strengthening of the capacity of WE Prespansko Pole ▪ To enable a sustainable financial basis for rehabilitation and O&M funds. To involve the WE in the development & implementation of a River Basin Plan (programme of measures) ▪ Plan for centralized, sustainable & efficient irrigation in the region: development of new sources of irrigation water ▪ protection of the quantity of water resources ▪ protection against the harmful impact of water; maintenance of streams and erosion control	1	MoAFWE, LSGU	MoAFWE	N, L	▪ WE Prespansko Pole established & operational ▪ Sustainable financing secured ▪ Irrigation plan elaborated and implemented	160,000
1.3.6 Limited capacity & mandate of Irrigation WCs in the Region						
Measure 136 – Strengthening of the capacity of WCs	3	MoAFWE	MoAFWE	N, L	▪ # of WCs established ▪ Agricultural area covered (ha) ▪ # of farmers	10,000

Table 28. *Measures to provide an enabling environment*

Note: A number of measures listed in Table 18 exceed the mandate and scope of the Prespa Watershed Management Plan. Those which need to be implemented at national level and those which are to be tackled by local authorities at local/regional level are noted with 'N' and 'L' respectively.

9.4 Analysis of Alternative Implementation Strategies

9.4.1 Cost Effectiveness of Proposed Alternatives

In order to better explain the environmental and economic effects of the measures in the two defined alternatives, a full dynamic implementation plan has been developed (see Annex). This gives a clear picture of the implementation period or duration (1-6 years or continuous) of each prescribed measure in the alternative and its associated costs. Most of the measures are not costly, while some are quite demanding and need to be financed/implemented by the operators/farmers/land owners .

METHODOLOGIES FOR ESTIMATING VALUES

Cost-based valuation method - based on the assumption that the cost of maintaining an environmental benefit is a reasonable estimate of its value.

Necessity of Assessing Disproportionate Costs - an approach for determining whether the total costs of the programme of measures are disproportionately costly is relevant for justifying derogation. This approach is relevant for:

- Designating heavily modified water bodies (HMWB) when the beneficial objectives served by the artificial or modified characteristics of the waterbody cannot, for reasons including disproportionate costs, reasonably be achieved by other means that represent a significantly better environmental option;
- Time derogation when completing the improvements in the status of waterbodies within the timescale would be disproportionately expensive;
- Less stringent environmental objectives when the achievement of these objectives would be infeasible or disproportionately expensive and the environmental and socio-economic needs served by such human activity cannot be achieved by other means that are a significantly better environmental option not entailing disproportionate costs; and
- Failure to achieve good status or failure to prevent deterioration as a result of new modifications to the waterbody when the beneficial objectives served by those modifications or alterations of the waterbody cannot for reasons including disproportionate costs be achieved by other means that are a significantly better environmental option.

In a cost-effectiveness analysis, the costs of a particular environmental measure are expressed in monetary units, while the environmental effect of the measure is expressed in physical units such as the reduction in the number of tonnes of nitrogen or phosphorus loaded in the aquatic environment.
The following assumptions were taken into account:

A. The suggested measures are expected to be realized in the next 24 years, even though the period according to the ToR is 6 years. The period of realization is longer than the period in the ToR because there are a number of preconditions that need to be achieved in order for the measures to be realized.

B. The expense of each measure has been estimated/calculated by the expert team. Each expense is increased for running costs.
Direct costs (made up of mainly financial and administrative costs) are included in all components of the economic assessment.
Financial costs are the costs of providing and administering water services.
Operating costs are all the costs incurred to keep an environmental facility running (e.g. material and staffing costs). The operating costs should take into account additional costs to ensure new capital investments.
Maintenance costs are the costs of maintaining existing (or new) assets in good functioning order until the end of their useful life. As many water and wastewater assets are long-lasting and buried underground, it is difficult to estimate

the appropriate level of maintenance needed for exploiting the assets without leading to their deterioration.
Capital costs include new investments, the cost of new investment expenditures and associated costs (e.g. site preparation costs, start-up costs, legal fees). Associated costs are also substantial. For projections, the costs of new capital investments are spread over a number of years.
The Annual Equivalent Cost (AEC) method allows for converting the Net Present Value (NPV) of a new capital expenditure into an annuity (or rental) which has the same value. This is done as follows:

1. By listing all capital expenditures as they are incurred;
2. By calculating the net present value of expenditures, using the chosen discount rate;
3. By converting this net present value into an annual equivalent cost (AEC)

Depreciation - The depreciation allowance represents an annualized cost for replacing existing assets in future. Estimating depreciation requires defining the value of existing assets and a depreciation methodology.
Administrative costs are the administrative costs related to water resource management.

C. The discount rate used for the calculation of expenses is 6%. The factors taken into consideration in determining the discount rate include the following: the reference rate of the Central Bank of the Republic of Macedonia (4% at the moment of the determination of the discount rate); the annual rate of EURIBOR (2.14% at the moment of determining the discount rate); and the macroeconomic policy of the Republic of Macedonia, according to which the rate of inflation is expected to be between 3% and 5%

D. The measures are divided into two groups. The first group of measures refers to water used for irrigation. The second group of measures refers to the treatment of wastewater. The reason for this classification is to enable the distribution of the costs for the measures per unit.
- The first group of users consists of farmers who will use the water for irrigation. In this group, one hectare of agriculture area is considered as the cost unit. The total irrigation area is 4,000 hectares.
- The second group of users consists of the legal entities that will be included in the treatment of wastewater, in which group households and legal entities are considered as cost units. There are 4,000 households and legal entities (companies and institutions) in the area.

E. Two periods have been taken into consideration in determining the payback period: 40 years and 20 years. In the first case, the expenses for the implementation of the measures are expected to be recovered over a longer period, i.e. 40 years, which represents the average useful life of the dam. In the second case, if the measures are implemented by issuing concessions for operation of the dam or the establishment of PPP, the private investor is interested in recovering the investment in a shorter period and therefore the payback period is calculated as 20 years.

Net present value (NPV) calculated for the two groups of measures is presented in the following preview:

Measures for treatment of water for irrigation	NPV ('000 €)	Repayment period 40 years		Repayment period 20 years	
		Annual equivalent cost ('000 €)	Annual cost per ha (4,000 ha) in €	Annual equivalent cost ('000 €)	Annual cost per ha (4,000 ha) in €
Alternative 1 - Full WFD Implementation	42,838	1,071	268	2,142	535
Alternative 2 -Realistic Implementation Strategy	11,035	276	69	552	138

Table 29. *NPV - group of measures for water supply & irrigation*

Measures for treatment of water for irrigation	NPV ('000 €)	Repayment period 40 years		Repayment period 20 years	
		Annual equivalent cost ('000 €)	Annual cost per ha (4,000 ha) in €	Annual equivalent cost ('000 €)	Annual cost per ha (4,000 ha) in €
Alternative 1 - Full WFD Implementation	8,843	221	4.5	442	9
Alternative 2 -Realistic Implementation Strategy	472	12	0.2	24	0.5

Table 30. *NPV – group of measures for treatment of wastewater*

Conclusions:

- If full WFD Implementation is applied for the treatment of irrigation water for a Payback Period of 40 years, the annual cost unit per hectare will be 268 €; while for a Payback Period of 20 years the annual cost unit per hectare will be 535 €.
- If the Realistic Scenario is applied for the same measures, the annual cost unit per hectare will be 69 € for a Payback Period of 40 years, or 138 € for a Payback Period of 20 years.
- According to the analyses, the current unit cost per hectare for irrigation is 325 €.
- If full WFD Implementation is applied for the treatment of wastewater, the monthly cost per entity (households and legal entities) will be 4.5 € for a Payback Period of 40 years, or 9 € for a Payback Period of 20 years.
- If the Realistic Scenario is applied, the monthly cost per entity (households and legal entities) will be 0.2 € for a Payback Period of 40 years, or 0.5 € for Payback Period of 20 years.

9.5 Implementation Schedule

Taking all considerations into account, the proposed implementation schedule for the Prespa Watershed Management Plan is presented in Table 31 overleaf.
Regardless of the alternative selected, the implementation of the Programme of Measures should follow the proposed Implementation Schedule in order to tackle the issues in the water sector and improve the status of waterbodies in Prespa Watershed in a timely and systematic manner.
The Economic Analysis, including the investment requirements of both alternatives, is presented in the previous sub-chapter (see Technical Report 4 for details).
In conjunction with the physical measures/actions, it is of paramount importance to address the Enabling Environment measures listed in Table 27. This presupposes actions at both national and local level by the institutions responsible in the sector. Only in this way can the Prespa Watershed Management Plan serve as a pioneering first step towards a new water management paradigm as foreseen by the new LoW and the WFD.

Rank	Score	ID	Programme of Measures	Cost		Impl.Period / Duration [y]	Proposed Alternatives		
			Measures	Total [10^3 €]	Ann. [10^3 €]		0	1	2
							BaU	R	WFD
1	68.3	23	Regulate irrigation wells	200		3			
2	66.2	22	Regulate river intakes	0		3			
3	65.3	426	Green cover in orchards	300		6			
4	63.3	34	Erosion structures	7,500		18			
5	63	421	Upgrade irrigation schemes	300		5			
6	62.3	422	Closure of illegal dumps	250		6			
7	62.2	413	Upgrade industrial WWT			12			
8	62	414a	Upgrade Ezerani WWTP	500		2			
9	61.7	62	Rehabilitate fish ponds	250		3			
10	61.5	33	Erosion control plans	500		6			
11	61.5	61	Management plans Pas	0		3/cont			
12	61.3	431	WFD monitoring for Lake Prespa		20	3/cont			
13	60.3	411	Enforcement of IPPC	0		3/cont			
14	59.8	424	Educate farmers in good agricultural and environmental practices, including composting of orchard waste	100		2			
15	59.7	31	Preparation of flood risk and mitigation plans	250		3			
16	57.8	423	Pilot project for environmentally safe use of fertilizers and pesticides	100		2			
17	57.7	24	Introduce drip irrigation systems on 4,000 ha *	4,000		4 + 4			
18	55.4	22b	Construct a dam on Chesinska Reka	30,000		6			
19	55.2	432b	Designate and monitor recreational areas		40	2/cont			
20	53.8	418	Upgrade fisheries management based on source and catch assessment	150		3/cont			
21	53.7	25	Develop a database on irrigation	100		2			
22	53	32	Implement flood control measures	5,000		12			
23	53	414c	Construct WWTP for smaller agglomerations (<2000 PE)	2,500		13			
24	52.5	53	Establish inventory of private wells	200		2/cont			
25	52.2	427	Upgrade farmers' capacity for proper disposal of hazardous waste and use of pesticides	50		2			
26	51.8	56	Train farmers in proper irrigation management	30		1			
27	50.8	54	Improve management of priority substances	60		2			
28	50.5	415a	Improve sewage network in Resen and Jankovec	1,000		6			
29	50	432a	Introduce regular monitoring of algae blooms		40	2/cont			
30	49	434	Improve fertilizer management including capacity for laboratory analysis	60		2/cont			
31	48.8	433b	Introduce effective eutrophication strategies	1,500		4			
32	48	414b	Establish tertiary wastewater treatment in former fish ponds	300		2			
33	47.8	64	Establish trans-boundary monitoring programme	300	*50	2/cont			
34	46.3	63	Ensure harmonization of environmental data management	25		1			
35	46	415b	Improve the existing sewage network and construct new sewage networks in smaller agglomerations in the region	2,500		14			
36	45.5	65	Pilot project for use of biomass as energy resource	70		2			
37	45.3	52	Conduct detailed local hydrogeological investigations	100		1			
38	44.3	51	Conduct regional hydrogeological investigations	800		4			
39	44	433a	Conduct a feasibility study on alternative eutrophication mitigation strategies	-		1			
40	38.3	55	Conduct source investigations of priority substances in ground water	30		1			
41	37.8	416	Conduct modelling of the effect of different discharge reduction strategies	500		2			
42	37.3	417	Implement project for separation of storm-water and construction of proper outfalls	250		6			
43	37.2	22a	Conduct a comprehensive feasibility study for improving the management of water for drinking purposes and for irrigation covering the whole catchment area	200		2			
44	36.8	425	Establish air pollution model	50		1			
45	24.8	411	Upgrade capacity in manpower and skills of the Municipal Inspectorates	86.4		2/cont			

Table 31. *Implementation Schedule – Programme of Measures*

Initial 6-year WMP implementation	Second 6-year WMP implementation period	Third 6-year WMP implementation period			Predecessor
Year 1-6	Year 7-12	Years 13-18	19	20	
					53
					33
					EE
					EE
					EE
					22b
					22a
					EE/Inst
					31
					415b
					62
					EE
					EE

9.6 Environmental Effects

The implementation of the Prespa Watershed Management Plan in accordance with the proposed Implementation schedule will contribute significantly to the achievement of the Environmental Objectives set in the WFD and the new Water Law. The primary objective of achieving good status for all waterbodies is possible if the proposed measures are properly implemented. It is recommended that the implementation of the WMP be conducted in a comprehensive but staggered approach, with prudent evaluation/ review of implementation processes, results and environmental effects in the prescribed 6-year periods. Simultaneously, it is of utmost importance to give equal priority to measures providing an 'enabling environment' for the implementation of the Plan (legal, institutional & capacity issues).
It is important to initiate the process of implementation with selected measures that are achievable at local level with existing capacities, which will be enhanced in the course of implementation.
The expected effects of WMP implementation on individual surface waterbodies in the Prespa watershed are presented in Table 32. and 33. below:

Name	Current status	Action needed?	Objectives			Alternatives		
			Rivers	HMWB & AWB		"0" No action	1 Realistic	2 Full WFD
Istocka 1	Good					Good	Good	Good
Istocka 2	Bad	Y	Good			Bad	Moderate	Good
Istocka 3	Poor	Y	Good			Poor	Moderate	Good
Golema 1	Good					Good	Good	Good
Golema 2	Moderate	Y	Good			Moderate	Good	Good
Golema 3	Moderate	Y	Good			Moderate	Good	Good
Golema 4	Moderate	Y	Good			Moderate	Good	Good
Golema 5	Moderate	Y	Good			Moderate	Good	Good
Golema 6	Bad	Y		Good potential		Bad	Moderate	Good
Golema 7	Bad	Y		Good potential		Bad	Moderate	Good
Golema 8	Poor	Y		Good potential		Poor	Moderate	Good
Kurbinska	Moderate	Y	Good			Moderate	Good	Good
Kranska 1	High					High	High	High
Kranska 2	Moderate	Y	Good			Moderate	Good	Good
Brajcinska 1	High					High	High	High
Brajcinska 2	Poor	Y	Good			Poor	Moderate	Good
Lake Prespa	Moderate		Good			Poor	Good	Good

Table 32. *Expected effects on individual surface waterbodies*

In accordance with the Environmental Objectives set by the TDA and adopted by the Prespa WMP, the implementation of the Plan is expected to achieve the following effects:

Objectives	Sub-objective	Indicators	Alternatives		
			"0" No action	1 Realistic	2 Full WFD
Overall Objective 1: Improvement of environmental conditions ensuring good water and soil quality for human health and ecosystem by 2025 Indicator: Measurable decline in levels of the main pollutant groups and pressures on water, sediment and biota	1a: Good surface water quality:	Reduce/prevent further eutrophication/organic pollution			
		Reduce/prevent further hydromorphological changes			
		Reduce/prevent further habitat fragmentation			
		Maintain biological water quality (phytoplankton, macrophytes, invertebrates and fish)			
		Reduce/prevent hazardous substances pollution			
	1b: Good groundwater quality:	Control water abstraction			
		Reduce/prevent water pollution from point and non-point sources			
		Maintain good physical and chemical characteristics			
	1c: Good ecological potential for HMWB and AWB:	Reduce/prevent further eutrophication/organic pollution			
		Reduce/prevent further hydromorphological changes			
		Reduce/prevent further habitat fragmentation			
		Improve biological water quality (phytoplankton, macrophytes, invertebrates and fish)			
		Reduce/prevent hazardous substances pollution			
Overall Objective 2: Sustainable and efficient water utilization for maintenance/ control of Lake Prespa water level and groundwater table Indicator: Measurable and sustained water utilization	2a: Introduce water conservation and demand management:	Irrigation abstraction			
		Drinking water abstraction			
		Abstraction of water for industry			
	2b, 2c: Increase knowledge - hydrological & limnological regime; CC impacts & disaster management:	Lake water level			
		Irrigated area			
		Precipitation Air temperature Lake evaporation			
		Karstic spring flow to Ohrid			
		Groundwater level			

Table 33. *Environmental Effects on adopted TDA objectives & criteria*

ANNEX 1 List of Tables

ANNEX 2 List of Figures

ANNEX 3 Abbreviations

AL Albania
AWB Artificial water bodies
CIS Common Implementation Strategy for WFD
DSS Decision Support System
DPSIR Driver, Pressure, State, Impact, Response
EC European Commission
EU European Union
GIS Geographical Information System
GR Greece
GTI GTI - Geotehnicki Inzenering, Skopje (the Consultant)
FA Farmer Associations
HBI Hydro-Biological Institute
HMA Hydro-meteorological Administration
HMWB Heavily Modified Water Bodies
ICPDR International Commission for the Protection of the Danube River
IRBM Integrated River Basin Management
IT Information Technologies
IPPC Integrated pollution prevention & control
ISO International Standardisation Organisation
IWM Integrated Water Management
JTWG Joint Technical Working Group (MK-AL-GR)
LFM Logical Framework Matrix
LSGU Local self-government unit
MK Macedonia
MoAFWE Ministry of Agriculture, Forestry and Water Economy
MoTC Ministry of Transport and Communications
MoE Ministry of Economy
MoFA Ministry of Foreign Affairs
MoEPP Ministry of Environment and Physical Planning
M&O Methodology & Organization
MR Municipality of Resen
NGO Non-Governmental Organisation
NMM Non-stationary Meteorological Model
PE Public enterprise
PP Plans and programmes
PIU Project Implementation Unit
PoM Programmes of Measures
PAM Protected areas management
PWMP Prespa Watershed Management Plan
PWMC Prespa Watershed Management Council
PWMWG Prespa Water Management Working Group
SoE State of the Environment
ToR Terms of Reference
WMA Water Management Administration (of Macedonia)
WMP Watershed Management Plan
WBR Water Bodies at Risk
WFD Water Framework Directive
WMC Water Management Council
WQM Water Quality Management
SEA Strategic environmental assessment

ANNEX 4 Literature

Projects and project documentation

1	**CARDS 2003, Improvement of Management of Transboundary Water Resources**			
	Report on Vardar River Basin GIS Design, Project No: 03/MAC01/10/002	August, 2007	Euroconsult Mott MacDonald	EAR/MoEPP
	Work Package 1 - Legal & Institutional Framework, Options for Improved Management of the Vardar River, Project No: 03/MAC01/10/104	August, 2007	Euroconsult Mott MacDonald	EAR/MoEPP
	Work Package 2 - Water Quality, Preliminary Assessment of the Effects of Pollution and Management on Water Quality in the Vardar River, Project No: 03/MAC01/10/002	August, 2007	Euroconsult Mott MacDonald	EAR/MoEPP
	Work Package 3 - Industrial Pollution Assesment; A Report on the Most Serious Industrial Pollution Sources in the Vardar Basin …", Project No: 03/MAC01/10/104	August, 2007	Euroconsult Mott MacDonald	EAR/MoEPP
	Work Package 4 - Fisheries; Overview of the Fisheries of the Vardar Basin and Influence of River Management and Polution on Fisheries, Project No: 03/MAC01/10/104	August, 2007	Euroconsult Mott MacDonald	EAR/MoEPP
	Work Package 5a - Dojran Lake Study; Report of Water Balance of Lake Dojran; Project No: 03/MAC01/10/002	August, 2007	Euroconsult Mott MacDonald	EAR/MoEPP
	Work Package 5b - Dojran Lake Study; Report of Water Balance of Lake Dojran - GROUND WATER; Project No: 03/MAC01/10/002	August, 2007	Euroconsult Mott MacDonald	EAR/MoEPP
	Work Package 6 - Water resources; Assessment of the Water Resources of Vardar/Axios River Basin; Project No: 03/MAC01/10/104	August, 2007	Euroconsult Mott MacDonald	EAR/MoEPP
	Work Package 7 - River Basin Management Planning; Project Summary and Recommendations; Project No: 03/MAC01/10/104	August, 2007	Euroconsult Mott MacDonald	EAR/MoEPP
2	**Fishing Basis for the Fishing Area of Prespa Lake for the Period of 2009-2014**	**November, 2008**	**PSI Hydrobiological Institute, Ohrid**	**MoAFWM**
	Proposal for a Process to Establish Transboundary Fisheries Management Cooperation, Consultancy Report	September, 2009	Wolf D. Hartmann, Transboundary Fish and FM Specialist	Prespa Park, UNDP/GEF
	Situational Analysis of the Fisheries in the Prespa Basin (Draft) Consultant Report	September, 2009	Wolf D. Hartmann, Transboundary Fish and FM Specialist	Prespa Park, UNDP/GEF
3	**Project: 000511409 "Support for integration of Ecosystem Oriented Forest Management in the Prespa region**			

	Assessment of the current forest ecosystem in the Forest Management Unit "Leva reka/Bigla", Phase I Report	July, 2008	Dr. Vlatko Andonovski	UNDP/GEF
	In-depth assessment of the currently used forest management practices in the Forest Management Unit "Leva reka/Bigla" and their impact on forest ecosystem, Phase II Report	August, 2008	Dr. Vlatko Andonovski	UNDP/GEF
	Sustainable Ecosystem Oriented Forest Management Guidelines	September, 2008	Dr. Vlatko Andonovski	UNDP/GEF
	Action Plan for Sustainable Forest Management (ecosystem-oriented forest management) practices that will be implemented in two selected pilot areas within the Forest Management Unit "Leva reka/Bigla	October, 2008	Dr. Vlatko Andonovski	UNDP/GEF
4	**Restoration of Golema Reka**			
	Hydrology	December, 2006	Geing Krebs und Kiefer	Swiss Agency for Development and Cooperation/ UNDP
	Mitigation of Problems Related to Solid Waste Management and Wastewater Pollution	October, 2006	PointPro Consulting	SDC/UNDP
	Wetlands in Golema Reka Catchment	October, 2006	Geing Krebs und Kiefer	SDC/UNDP
	Improvement of the forest cover and protection against erosion in the river basin of Golema Reka	October, 2006	Geing Krebs und Kiefer	SDC/UNDP
	Mitigation of Problems Related to Current Land Use	July, 2006	Geing Krebs und Kiefer	SDC/UNDP
	Improvement of the river monitoring	October, 2006	Geing Krebs und Kiefer	SDC/UNDP
5	**GIS Report**			
	A preliminary assessment of map requirements, current use of GIS and urgent GIS needs of the productive sector.	December, 2008		UNDP/Prespa Park
6	**Integrated ecosystem management in the Prespa Lakes basin of Albania, Macedonia and Greece**			
	IPPC Permits System	December, 2008	Dekons-Ema	UNDP
7	**Project Preparation & Development of the Transboundary Prespa Park Project, Feasibility Study**			
	Part I: Context and Project Brief	August, 2005	GFA Consulting Group GmbH	KfW Bank, Frankfurt/M.
	Part II: Republic of Macedonia Project Concept for Galicica National Park	August, 2005	GFA Consulting Group GmbH	KfW Bank, Frankfurt/M.
	Part III: Republic of Albania Project Concept Prespa National Park	August, 2005	GFA Consulting Group GmbH	KfW Bank, Frankfurt/M.

	Part IV: Report 1, Conservation Management Galicica and Prespa	August, 2005	GFA Consulting Group GmbH	KfW Bank, Frankfurt/M.
	Part IV: Report 2a, Institutional and Legal Framework for Conservation Management Republic of Macedonia	August, 2005	GFA Consulting Group GmbH	KfW Bank, Frankfurt/M.
	Part IV: Report 2b, Institutional and Legal Framework for Conservation Management Albania	August, 2005	GFA Consulting Group GmbH	KfW Bank, Frankfurt/M.
	Part IV: Report 3a, Republic of Macedonia, Galicica National Park Stakeholder Analysis Financial Sustainability Socio-Economic Impact	August, 2005	GFA Consulting Group GmbH	KfW Bank, Frankfurt/M.
	Part IV: Report 3b, Main stakeholders in the NP Prespa Albania – Socio-economic analysis	August, 2005	GFA Consulting Group GmbH	KfW Bank, Frankfurt/M.
	Part IV: Report 4, Albania Forestry Management Prespa Park Project Feasibility Study	August, 2005	GFA Consulting Group GmbH	KfW Bank, Frankfurt/M.
8	**Стратегија за развој на Општина РЕсен, SWOT 1, SWOT 2 (Macedonian version ONLY)**	**June, 2009**		**Municipality of Resen**
	Акционен план развој на Општина Ресен за периодото 2006-2011	(last modified) March, 2008		Municipality of Resen
	Project: Стандарди за локален квалитет на Преспа,, No. 05MAC02/01/01/003; Студија за проценка на постоечката состојба и капацитетите за развој на агротуризмот во Општина Ресен (Macedonian version ONLY)	September, 2008	Urban Rural Consulting - URC, Skopje	EU-EAR / Municipality of Resen
9	**UNDP Project "Integrated Ecosystem Management in the Prespa Lake Basin"**			
	Guidelines for handling of pesticide packaging, Draft version	December, 2008	Foundation Agro-Centre for Education, Skopje MK, Rege-Fox, Brno CH	UNDP
	Rulebook on the manner of pesticide and pesticide packaging collection disposal and destruction (DRAFT)	December, 2008	Foundation Agro-Centre for Education, Skopje MK, Rege-Fox, Brno CH	UNDP
10	**Просторен план на Република Македонија (Spatial Plan of Macedonia)**			
	Просторен план на Охридско – Преспанскиот регион 2005-2020, Nacrt (Spatial Plan of Ohrid-Prespa region, 2005 – 2020)	2007	Agency of Spatial Planning	MoESP
11	**Integration of the Ecosystem Health Maintenance Objectives into the Spatial Plan for the Prespa Region**			
	Working Paper 1: NATIONAL SPATIAL PLANNING REVEW	October, 2008	Mike Sharrocks Consultancy Pte Ltd	UNDP/GEF/ Stakeholders
	Working Paper 2: EUROPEAN PLANNING MODELS	October, 2008	Mike Sharrocks Consultancy Pte Ltd	UNDP/GEF/ Stakeholders
	Working Paper 3: TERMS OF REFERENCE FOR MUNICIPALITY OF RESEN SPATIAL PLAN	December, 2008	Mike Sharrocks Consultancy Pte Ltd	UNDP/GEF/ Stakeholders

12	**Consulting Services of training on Conservation and Action Planning for Priority Transboundary Habitats and Species in the Prespa Lakes basin-Preparatory Phase**			
	Draft Assessment Report, Ref.RFP 26/2009	September, 2009	Dekons-EMA	UNDP/Prespa Park
13	**Lake Prespa, Transboundary Diagnostic Analysis**			
	Integral Report (Draft)	July, 2009	Regional Environmental Center (REC)	UNDP/GEF/ Prespa Park
	Technical Task Team (TTT) for the collection, assessment and evaluation of national information in support of the Transboundary Diagnostic Analysis (TDA) and development of a Strategic Action Programme (SAP) in the Prespa Lakes Basin National Report (Draft), MACEDONIA	July, 2009	Regional Environmental Center (REC)	UNDP/GEF/ Prespa Park
14	**Preparation of a Tri-lateral Tourism Strategy and Action Plan for the Prespa Region**			
	A situational analysis and proposal, Consultant Report	December, 2008	Gottfried Hilz-Ward	UNDP/GEF/ Prespa Park
15	**TRABOREMA (Project No. INCO-CT-2004-509177**			
	Concepts for integrated trans boundary water managemeny and sustainable socio-economic development in the cross border region Albania, FYR Macedonia and Greece, TRABOREMA results and conclusions	May, 2007	Oekosys, ESCi	EC/EAR/FP6
16	**Integrated Ecosystem Management in the Prespa Lakes Basin**			
	1-st Technical Report, Water resources monitoring -	May, 2009		Prespa Park, UNDP/GEF
	2-nd Report, Birds and other biodiversity 1 (species)	May, 2009		Prespa Park, UNDP/GEF
	2-nd Report, Land Use	May, 2009		Prespa Park, UNDP/GEF
	2-nd Report, Socio-Economy	May, 2009		Prespa Park, UNDP/GEF
	2-nd Report, Water resources monitoring -	May, 2009		Prespa Park, UNDP/GEF
	2-nd Report, Aquatic Vegetation	May, 2009		Prespa Park, UNDP/GEF
	Conclusions_15May2009; Thematic Group on Fish and Fisheries; Wetland Habitats and aquatic vegetation; Forests & other terrestrial habitats	May, 2009		Prespa Park, UNDP/GEF
	Conclusions_29May2009; Thematic Group on: Birds and other Biodiversity; Water; Socio-economy and Land-use	May, 2009		Prespa Park, UNDP/GEF
	Fish and Fisheries – Subfinal	May, 2009		Prespa Park, UNDP/GEF

	Forest & Terrestrial Habitats – Subfinal	May, 2009		Prespa Park, UNDP/GEF
	Land_use_2ndPhase_final	May, 2009		Prespa Park, UNDP/GEF
17	Integrated Ecosystem Management in the Prespa Lakes Basin of Albania, FYR of Macedonia and Greece Ref. No. MCD/07/HR/03			
	Technical Assessment Report, PRESPA PARK COORDINATION COMMITTEE IN TRANSBOUNDARY ECOSYSTEM MANAGEMENT	December, 2007	Dr. Slavko Bogdanovic International Consultant	Prespa Park, UNDP/GEF
	Consultant Report, ENHANCING TRANSBOUNDARY COOPERATION IN WATER MANAGEMENT IN THE PRESPA LAKES BASIN	June, 2009	Dr. Owen McIntyre University College Cork Ireland	Prespa Park, UNDP/GEF
18	Watershed Management Council			
	НАЦРТ - ИЗВЕШТАЈ За условите за формирање и работа на Совет за управување со сливот на Преспанско Езеро (Macedonian version ONLY)	October, 2009	Д-р Билјана Пулеска	Prespa Park, UNDP/GEF

Eu directives and manuals/guidance documents

Water Framework Directive, 2000/60/EC, amended by Decision on establishing the list of priority substances 2455/2001/EC
Bathing Water, 76/160/EEC
Potable Water 98/83/EC
Urban Waste Water Treatment, 91/271/EC
Nitrates Directive, 91/676/EEC, but also the Law takes into consideration:
Sewage Sludge Directive, 86/278/EEC
Plant Protection Products, 91/41/EEC
Biocides Directive, 98/8/EC
Groundwater Directive 2006/118/EC
Flood Directive 2007/60/EC
WFD CIS Guidance Documents

- No. 1. Economics and the Environment - The Implementation Challenge of the Water Framework Directive
- No. 2. Identification of Water Bodies
- No. 3. Analysis of Pressures and Impacts
- No. 4. Identification and Designation of Heavily Modified and Artificial Water Bodies
- No. 5. Transitional and Coastal Waters - Typology, Reference Conditions and Classification Systems
- No. 6. Towards a Guidance on Establishment of the Intercalibration Network and the Process on the Intercalibration Exercise
- No. 7. Monitoring under the Water Framework Directive
- No. 8. Public Participation in Relation to the Water Framework Directive
- No. 9. Implementing the Geographical Information System Elements (GIS) of the Water Framework Directive
- No. 10. Rivers and Lakes - Typology, Reference Conditions and Classification Systems
- No. 11. Planning Processes
- No. 12. The Role of Wetlands in the Water Framework Directive
- No. 13. Overall Approach to the Classification of Ecological Status and Ecological Potential
- No. 14. Guidance on the Intercalibration Process (2004-2006)
- N° 15. Groundwater Monitoring (WG C)
- N° 16. Groundwater in Drinking Water Protected Areas
- N° 17. Direct and indirect inputs in the light of the 2006/118/EC Directive
- N° 18. Groundwater Status and Trend Assessment

N° 19. Surface water chemical monitoring.pdf
N° 20. Exemptions to the environmental objectives
N° 21. Guidance for reprting under the WFD
N° 22. Updated WISE GIS guidance (nov 2008)
N° 23 – Eutrophication Assessment in the Context of European Water Policies
N° 24. River Basin Management in a changing climate
N° 25. Chemical Monitoring of Sediment and Biota
N° 26. Risk Assessment and the Use of Conceptual Models for Groundwater

Other literature

A. Sommer (2005). Strategic environmental assessment: From scoping to monitoring - Content requirements and proposals for practical work.

Andersen, J. H.; Conley, D.J. & Heda, S. (2004). Implementation of the European water framework directive from the Basque country (northern Spain): a methodological approach. Marine Pollution Bulletin, 49: 283-290.

Belgian Tokai (2004). Wastewater reduction techniques

Birk, S. & Hering, D. (2006). Direct comparison of assessment methods using benthic macroinvertebrates: a contribution to the EU Water Framework Directive intercalibration exercise. Hydrobiologia, 566: 401-415.

Bode, R. W.; Novak, M.A. & Abele L.A. (1997). Biological stream testing. NYS Department of Environmental Protection; Division of Water; Bureau of Monitoring and Assessment; Stream monitoring unit; Albany., USA.

Boon, J.P. (1992). Essential elements in the case for river conservation. In: River Conservation and Management, Boon. P.J. Calow, P. and Petts, G.E. (Eds.), John Wiley and Sons Ltd., Chichester, pp. 11 - 33.

Braun-Blanquet, J. (1964). Pflanzensoziologie: Grundzüge der vegetationskunde, 3 ed. — Springer-Verlag, Wien. 865 pp.

BREF Documents, 2003. Reference Document on Best Available Techniques for Intensive Rearing of Poultry and Pigs

CEN (2003). EN 13946 – Guidance standard for the routine sampling and pre-treatment of benthic diatoms.

Danish Ministry of the Environment . Odense Pilot River Basin. Pilot project for river basin management planning. Water Framework Directive Article 13.Danish Ministry of the Environment ,Environment Centre Odense . ISBN: 87-92197-03-5

Dinsmore, W. P.; Scrimgeour, G. J. & Prepas, E.E. (1999). Empirical relationships between profundal macroinvertebrate biomass and environmental variables in boreal lakes of Alberta, Canada. Freshwater Biology, 41: 91-100.

Downes, B.J.; Lake, P.S. & Schreiber, E.S.G. (1993). Spatial variation in the distribution of stream invertebrates: implications of patchiness for models of community organization. Freshwater Biology, 30: 119 - 132.

EC (2003) Guidance for the analysis of Pressures and Impacts in accordance with the Water Framework Directive

EPA (2007). Strategic Environmental Assessment for Water Framework Directive River Basin Management Plans and Programmes of Measures.

EPA (2009). Strategic Environmental Assessment statement for the river basin management plan for the Solway Tweed river basin district.

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Germany (2004). German Ordinance on Requirements for the Discharge of Waste Water into Waters- ATV131A methodology

GEF (2010). Strategic action programme for Prespa Lake.

Grupce, Lj. (1997). Autochthonous and allochthonous quantities of phosphorus in Prespa Lake waters. Symposium Proceedings, 24-26.10.1997 Korcha, Albania, 68-78.

Hering, D.; Moog, O.; Sandin, L. & Verdonschot, P. (2004). Overview and application of the AQEM assessment system.
Hydrobiologia, 516, 1-20.

ICPDR 2009 ICPDR / International Commission for the Protection of the Danube River / Danube River Basin Management Plan

ISO (2003). 7828 – Methods of biological sampling guidance for macroinvertebrates.

Jansson, A.M., M. Hammer, C. Folke, and R. Costanza (eds.) (1994). Investing in natural capital: The ecological economics approach to sustainability. Washington, DC: Island Press.

Krstic, S. (2007). Saprobiological and trophic models for Lake Prespa (saprographs) for use in similar regions and its application for evaluation of Ecological Quality Ratios (indicators). EC-FP6 project "TRABOREMAINCO-CT-2004-509177, Deliverable 3.3., 98 pp.

Krstić, S. (2011). Estimation of the eutrophication level, consequences and remediation methods of some freshwater ecosystems in Republic of China – research on Lake Honghu and the east part of Lake Hubei. Final Project Report, Ministry of Education and Science, Bilateral project R.China-R.Macedonia, Project number 03-1735/1, 2010-2011, 50 pp.

Krstic, S.; Svircev, Z.; Levkov, Z. & Nakov T. (2007). Selecting appropriate bioindicator regarding the WFD guidelines for freshwaters - a Macedonian experience. International Journal on Algae, 9(1), 41-63.

Levkov, Z.; Krstic, S.; Metzeltin, D. & Nakov, T. (2006). Diatoms of Lakes Prespa and Ohrid (Macedonia). Iconographia Diatomologica 16: 603 pp.

MER (2010). Draft guidance document on SEA and watershed management planning in Macedonia

Micevski, E. (2000). Geological and hydro-geological characteristics of the Ohrid - Prespa region. Proceedings of the International Symposium "Sustainable Development of Prespa Region", Oteshevo 23-25.06.2000, Republic of Macedonia, 10-17.

Moss, B.; Johnes, P. & Phyllips, G. (1997). New approaches to monitoring and classifying standing waters. In: Freshwater quality: Defining the indefinable? Boon, P.J, Howell, D.L.(eds), Scottish natural heritage, Edinburgh, 118-133.

Naumovski, T.; Novevska V.; Lokoska L. & Mitic V. (1997). Trophic state of Prespa Lake. Symposium Proceedings, 24-26.10.1997 Korcha, Albania, 132-137.

OECD (1982). Eutrophication of Waters, monitoring assessment and control. Paris, Organisation for Economic Cooperation and Development.

P. Scott & P. Marsden (2003). Development of Strategic Environmental Assessment (SEA) Methodologies for Plans and Programmes in Ireland.

Rockström, J., W. Steffen, K. Noone, Persson, S.F. Chapin III, E.F. Lambin, T.M. Lenton, M. Scheffer (2009). A safe operating space for humanity. Nature 461: 472–475.

Rosenberg, D.M. & Resh, V.H. (1993). Freshwater biomonitoring and benthic macroinvertebrates. Chapman and Hall, New York, 488 pp.

Rosling, H. 2010. Gapminder, for a fact-based worldview. http://www.gapminder.org/.

Sandin, L. & Johnson, R. K. (2000). The statistical power of selected indicator metrics using macroinvertebrates for assessing acidification and eutrophication of running waters. Hydrobiologia, 422/423, 233-243.

Skriver, J.; Friberg, N. & Kirkegaard, J. (2000). Biological assessment of running waters in Denmark: Introduction of the Danish stream fauna index (DSFI). Verh. Int. Ver. Limnology, 27:1822–183.

Steffen, W., Persson, L. Deutsch, J. Zalasiewicz, M. Williams, K. Richardson, C. Crumley, P. Crutzen (2011). The Anthropocene: From global change to planetary stewardship. Ambio. doi:10.1007/s13280-011-0185-x.

Steneck, R.S., T.P. Hughes, J.E. Cinner, W.N. Adger, S.N. Arnold, S. Boudreau, K. Brown, Berkes, F. (2011). The gilded trap of Maine's lobster fishery: A cautionary tale. Conservation Biology. doi:10.1111/j.1523-1739.2011.01717x.

Stoermer, E.F. & Smol J.P. (eds.) (1999): The Diatoms: Applications for the Environmental and Earth Sciences, Cambridge University Press, Cambridge, 484 pp.

Stumm, W. & Morgan, J. (1981). Aquatic chemistry. New York: Wiley.

Svirčev Z, Marković S, Krstić S, Krstić K, Obreht I (2010) Ecoremediation (ERM) and Saprobiology – is there a link? Geophysical Research Abstracts Vol. 12, EGU2010-2052, 2010.

UNDP-GEF project 00058373 - PIMS 3728, "Strengthening the Ecological, Institutional and Financial Sustainability of Macedonia's National Protected Areas System", Project activity. Ref. RFP 79/2009, "Development of Representative National System of Protected Areas

Van Dam, H. et al. (2005). ECOSURV Project Report – BQE for Hungarian water bodies: Phytobenthos, 54 pp.

Wagner B. & Schäbitz F., 2009. Project B2 - Climatic and Environmental History of the Balkans during the Last Glacial Cycle. University of Cologne, core Co1215 (15.75 m ~ 40 ka BP). http://www.sfb806.de.

WFD (2008). Directive 2008/105/EC – Priority substances. Official Journal of EU, 24 December 2008.

WHO (1993). Assessment of Sources of Air, Water, and Land Pollution. A Guide to Rapid Source Inventory Techniques and their Use in Formulating Environmental Control St

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GLOBAL ENVIRONMENT FACILITY
INVESTING IN OUR PLANET

This first ever watershed management plan for the Prespa region has been prepared with the technical and financial support of the United Nations Development Programme and the Global Environment Facility.
Fully in line with the EU Water Framework Directive, the plan offers guidance for directing future investments in the Prespa water sector and recommendations to improve water resource management issues in the basin, such as irrigation, water supply and wastewater treatment.
This plan is expected to become an important driver for achieving sustainable management of the Prespa waters for many years to come.