Global Water Partnership Mediterranean Athens, Greece

Lake Ohrid Watershed Management Plan

Phase 5 – Lake Ohrid Watershed Management Plan

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ABBREVIATIONS AND ACRONYMS

AL	Albania
AWB	Artificial Water Body
BOD	Biological oxygen demand
CPA	Cumulative Precipitation Anomalies
CPE	Communal Public Enterprise
DCG	Drin Core Group
DRB	Drin River Basin
DW	Department of Waters
EPA	Environment Protection Agency
EQR	Ecological Quality Ratio
EQS	Environmental quality standard
ERC	Energy Regulatory Commission
ES	Ecosystem services
EU	European Union
EWG	Expert Working Group
GAP	Good agriculture practices
GEF	Global Environment Facility
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GWP-Med	Global Water Partnership Mediterranean
ha	Hectare
HBI	Hydro-Biological Institute
HMWB	Heavily Modified Water Bodies
IBNET	International Benchmarking Network
IED	Industrial Emission Directive
IPPC	Integrated Pollution Prevention and Control
IRBM	Integrated River Basin Management
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
km	Kilometer
KTM	Key Type Measure
LOW	Lake Ohrid Watershed
LOWMP	Lake Ohrid Watershed Management Plan
LUC	Land use class
MAFWE	Ministry of Agriculture, Forestry and Water Economy (North Macedonia)
masl	Meters above sea level
MARD	Ministry of Agriculture and Rural Development (Albania)
MKD	North Macedonia
MoEPP	Ministry of Environment and Physical Planning
MoU	Memorandum of Understanding
MS	Measuring (gauging) station
O&M	Operation and maintenance
PCU	Project Coordination Unit
PE	Population Equivalents
PoM	Programme of Measures
PP	Polluter pays
RBC	River Basin Councils
RBMC	River Basin Management Council
RBMP	River Basin Management Plan

RBSP	River Basin Specific Pollutants
SFI	Shorezone Functionality Index
SHPP	Small Hydro Power Plant
SWB	Surface Water Bodies
TEV	Total Economic Value
ToR	Terms of Reference
TSI	Trophic State Index
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
UWWTD	Urban Waste Water Treatment Directive
WB	Water Body
WFD	Water Framework Directive
WM	Waste management
WRA	Water Regulatory Authority
WUA	Water User Association
WWM	Wastewater management
WWTP	Wastewater Treatment Plant
W&WW	Water supply and wastewater management

1 INTRODUCTION

Rina Consulting, in association with PointPro Consulting, has been appointed by the Global Water Partnership Mediterranean (GWP-Med) to:

- ✓ carry out the Watershed Management Plan (WMP) for the Ohrid Lake divided between the southwestern part of the Former Yugoslav Republic (FYR) of Macedonia and eastern part of Albania (Task I); and
- ✓ test and establish an approach (in the form of Terms of Reference (ToR) for the extended Drin Basin) for the preparation of transboundary management plans in the rivers and lakes of the Drin basin and to develop the ToR for the development of the Extended Drin Basin Management Plan (Task II).

This document represents the Draft Lake Ohrid Watershed Management Plan and is the sixth Report in a series of 9 Intermediate Reports, respectively to be prepared from 1 to 7 under Project Task I and from 8 to 9 under Project Task II:

- ✓ Intermediate Report 1: Phase 1 - Inception Report;
- ✓ Intermediate Report 2: Phase 2 - Data Collection and Analysis Progress Report;
- ✓ Intermediate Report 3: Phase 3 - Summary of River Basin Characteristics Progress Report;
- ✓ Intermediate Report 4: Phase 4 - Programme of Measures Progress Report;
- ✓ Intermediate Report 5: Phase 4: Long – Term Basin - Scale Monitoring Programme Progress Report;
- ✓ **Intermediate Report 6: Phase 5 - Draft Lake Ohrid Watershed Management Plan;**
- ✓ Intermediate Report 7: Phase 5 - Final Lake Ohrid Watershed Management Plan;
- ✓ Intermediate Report 8: Generic ToR Template for Transboundary Basin Management Plan, and
- ✓ Intermediate Report 9: ToR for the Drin River Basin Management Plan.

1.1 PROJECT BACKGROUND

Coordinated action at the Drin Basin level has been absent until the development of the Shared Vision for the sustainable management of the Drin Basin and the signing of a related Memorandum of Understanding (Tirana, 25 November 2011) by the Ministers of the water and environment management competent ministries of the Drin Riparians i.e. Albania, North Macedonia, Greece, Kosovo and Montenegro. This was the outcome of the Drin Dialogue coordinated by the Global Water Partnership Mediterranean (GWP-Med) and United Nations Economic Commission for Europe (UNECE).

The main objective of the Drin Memorandum of Understanding (MoU) is the attainment of the Shared Vision: “Promote joint action for the coordinated integrated management of the shared water resources in the Drin Basin, as a means to safeguard and restore, to the extent possible, the ecosystems and the services they provide, and to promote sustainable development across the Drin Basin”.

The ultimate goal of the work in the Drin Basin is to reach a point in the future where the scale of management lifts from single water bodies to the hydrological interconnected system of the Drin Basin, eventually leading from the sharing of waters among Riparians and conflicting uses, to the sharing of benefits among stakeholders.

A process called the “Drin CORDA”, Drin Coordinated Action for the implementation of the Drin MoU, was put in place after the signing of the latter. Following the provisions of the MoU an institutional structure was established in 2012. It includes:

- ✓ the Meeting of the Parties;
- ✓ the Drin Core Group (DCG). This body is given the mandate to coordinate actions for the implementation of the MoU; and
- ✓ three Expert Working Groups (EWG) to assist the DCG in its work:
  - Water Framework Directive (WFD) implementation EWG,
  - monitoring and information exchange EWG, and
  - biodiversity and ecosystem EWG.

The DCG Secretariat provides technical and administrative support to the DCG; Global Water Partnership – Mediterranean (GWP-Med) serves by appointment of the Parties through the MoU as the Secretariat.

An Action Plan was prepared to operationalize the Drin CORDA. This has been subject to updates and amendments in accordance with the decisions of the Meeting of the Parties to the Drin MoU and the DCG. The DCG and its Secretariat guides the implementation of the action plan while its implementation is currently being supported by the Global Environment Facility (GEF).

GEF supported Project "Enabling transboundary cooperation and integrated water resources management in the extended Drin River Basin" (GEF Drin Project) is aligned in content, aims and objectives with the Action Plan and the activities under the Drin CORDA.

The objective of the project is to promote joint management of the shared water resources of the transboundary Drin River Basin, including coordination mechanisms among the various sub-basin joint commissions and committees. Albania, North Macedonia and Montenegro are the Project beneficiaries. The GEF Drin project is structured around five components:

- component 1: consolidating a common knowledge base;
- component 2: building the foundation for multi-country cooperation;
- component 3: institutional strengthening for Integrated River Basin Management (IRBM);
- component 4: demonstration of technologies and practices for the Integrated Water Resources Management (IWRM) and ecosystem management, and
- component 5: stakeholder involvement, gender mainstreaming and communication strategies.

The Project is implemented by the United Nations Development Programme (UNDP) and executed by the Global Water Partnership (GWP) through GWP-Mediterranean (GWP-Med) in cooperation with the UNECE. GWP-Med is responsible for the realization of the Project. The DCG is the Steering Committee (SC) of the Project. It is managed by a Project Coordination Unit (PCU), based in Tirana, Albania; staff is stationed also in Podgorica, Ohrid, Pristina, and Athens. The duration of the Project is four years.

1.2 SCOPE OF WORK

The general Scope of Work (SoW) of the present assignment is to:

- carry out the Lake Ohrid Watershed Management Plan (LOWMP) – Task I; and
- test and establish an approach (in the form of ToR for the extended Drin Basin) for the preparation of transboundary management plans in the rivers and lakes of the Drin basin and to develop the ToR for the development of the Extended Drin Basin Management Plan (Task II).

Preparation of the LOWMP is one of the pilot projects adopted in the frame of Component 4. The work is carried out in accordance with the international obligations of the countries, the developmental plans of the national governments, local authorities as well as the management plans of protected areas, forests, fisheries etc. in Ohrid sub-basin as well as in the area that extends beyond the Ohrid sub-basin, downstream in the Black Drin Basin. The work also takes into consideration all water needs, both consumptive and non-consumptive e.g. for the generation of hydroelectricity by the electricity companies as per existing plans; the relevant international agreements between the two countries regarding the management of basins and allocation of water. The development of the LOWMP is based on:

- regional perspectives within the Ohrid basin in each one of the two countries for economic development, and disparities in poverty and well-being across the basin areas and between rural and urban areas;
- inter-sectorial perspectives in terms of economic value of water used in the different sectors;
- the need to analyze gender difference in access to, control of and use of water resources and plan accordingly; and
- the need to coordinate between the two littoral countries as well in each one of the countries, and sequence interventions, among others in the form of investments, to ensure sustainable and economical efficient water resources management in the basin.

Additional input for the preparation of the LOWMP comes from:

- work that has been done in the two littoral countries for the implementation of the legislation that transposes the EU-WFD as well as the European Union (EU) Directives that relate to the management of water resources, basins, aquifers and ecosystems;
- the outcomes of the:
    - Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) supported "Conservation and Sustainable Use of Biodiversity" program on the three lakes Skadar, Ohrid and Prespa,
    - GIZ supported "Climate Change Adaptation Program in Western Balkans" that includes activities also in the Drin Basin.
- the outcomes of the (on-going) Albanian Drin Management Plan preparation project;
- existing studies and information available to the institutions and research institutes in the littoral countries;
- strategic documents (sectoral, of local governments etc.) in the two littoral countries regarding the development of the area in the Lake Ohrid Watershed (LOW), including spatial plans;

- ✓ any investigation undertaken by the authorities of any of the two countries towards the designation of Lake Ohrid as a “Sensitive Area” in line with EU Urban Waste Water Treatment Directive(UWWTD);
- ✓ decision of adjoining countries for the designation of sensitive areas or catchments of sensitive areas, and
- ✓ experiences from the UNDP/GEF projects in the Danube River Basin to prepare EU WFD Characterization Reports and River Basin Management Plans to guide the approach adopted.

The process for the development of the LOWMP is highly participatory in accordance to the related guidance documents of the EU WFD and the best practices in this regard, and in line with the UNECE Water Convention and the ESPOO Convention.

The groups of stakeholders include national and local institutions and authorities in the field of the management of environment, water, natural resources, land, local authorities, developmental ministries, NGOs, private sector, academia etc.

1.3 REPORT ORGANIZATION

This document represents the sixth Progress Report related to the implementation of this assignment. Based on the above, the Report is organized as follows:

- ✓ Section 1 (present section) - Introduction – includes the Project background and the scope of work;
- ✓ Section 2 presents the description of the Lake Ohrid watershed;
- ✓ Section 3 provides an overview of the institutional setup for water resources management in the LOW; a list of stakeholders in the LOW is also provided;
- ✓ Section 4 includes assessment of drivers and pressures on water quality and quantity in the LOW;
- ✓ Section 5 includes the assessed ecological and chemical status of water bodies in the LOW;
- ✓ Section 6 presents the environmental objectives of the LOWMP;
- ✓ Section 7 represents the plan’s Programme of Measures;
- ✓ Section 8 includes economic analysis.

Supporting information is provided in Supplements and Annexes. Graphical presentation of key data is presented in Thematic GIS-based Maps. Technical information is presented in metric units and the costs are in US$ or Euro.

2 DESCRIPTION OF THE LAKE OHRID WATERSHED

2.1 NATURAL CONDITIONS

2.1.1 Topography and Geology

With a maximum depth of 290 meters and average depth of 155 meters, straddled in the mountainous region between the southwest part of North Macedonia and the eastern part of Albania, Lake Ohrid is one of the oldest and deepest lakes in Europe. The lake is located at an altitude of 693 masl and has an area of 358 km^2. The hydrological regime of the lake is dominated by inflow of water from the nearby Lake Prespa via karstic aquifers, while the outflow occurs through the Black Drin river in the town of Struga.

The Lake Ohrid watershed (LOW) is part of the extended transboundary Drin River Basin (DRB), located in the South-Western part of the Balkan Peninsula and shared between Albania, Kosovo, North Macedonia and Montenegro (Fig. 2.1). The DRB comprises seven sub-basins: Lake Prespa, Lake Ohrid, Black Drin River, White Drin River, Drin River, Lake Skadar/Shkodër and Buna/Bojana River.

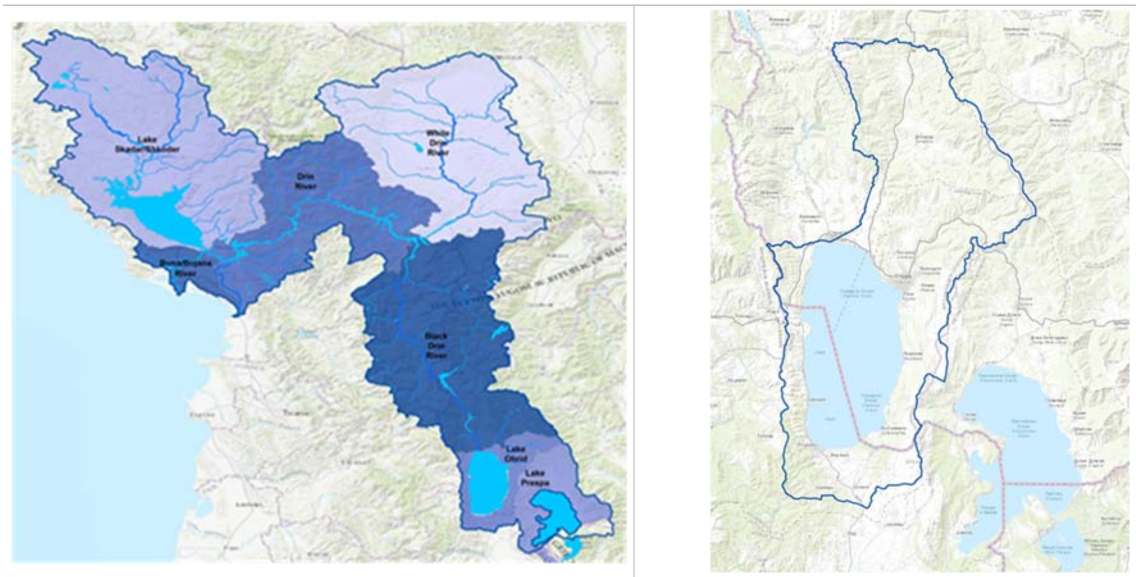

Figure 2.1. The Extended Drin River Basin and Lake Ohrid Watershed

With an estimated age of 2 to 5 million years and maximum water depth of 290m Lake Ohrid is a deep, calcium bicarbonate-dominated, oligotrophic lake that represents a unique aquatic ecosystem. Of the 1,200 registered animal species in the lake, 212 are considered endemic. The importance of the lake is further emphasized with its declaration as a World Heritage Site by UNESCO in 1979. With all its amenities and values the lake also represents the most important tourist center in North Macedonia. Key characteristics of the LOW are presented in Fig 2.2 below.

2.1.2 Climate, Hydrology and Hydrography

In general, the local climate conditions in the LOW are categorized as Mediterranean with continental influences. According to Watzin et al. (2003) the local climate is influenced by the proximity to the Adriatic Sea, by the surrounding mountains, and by the thermal capacity of Lake Ohrid.

The mean annual temperature recorded in the Ohrid region averages at 11.5 °C; average temperatures range from 21ºC during summer to 1.8ºC during winter (Fig 2.3). The temperature of Lake Ohrid's pelagic water (below 150 m depth, year-round) ranges from 6ºC to 24–27ºC at the surface during summer.

The morphology of the catchment also affects the wind regime, with Northerly winds prevailing during winter and southerly and southeasterly winds during spring and summer. Average speed of the wind in the Lake Ohrid region is relatively low at 1.8 m/sec.

Indicator	
Watershed area (km^2)	1,404.9
Lake total area (km^2)	357.9
Watershed/Lake area ratio	3.9
Maximum elevation (masl)	2,271
Average watershed elevation (masl)	1,139
Minimum elevation (Lake Ohrid, masl)	693.1
Lake water level control (Yes/No)	Yes
Average water level change (m)	0.8
Average lake depth (m)	155
Maximum lake depth (m)	293
Lake volume (km^3)	58.6
Dynamic ratio (km/m)	0.6
Retention time (Years)	70- 80
Shoreline length (km)	87.5
Trophic classification	Oligotrophic

Figure 2.2: Key Characteristics of the Lake Ohrid Watershed

Precipitation averages around 750 mm annually and is at a minimum during summer.

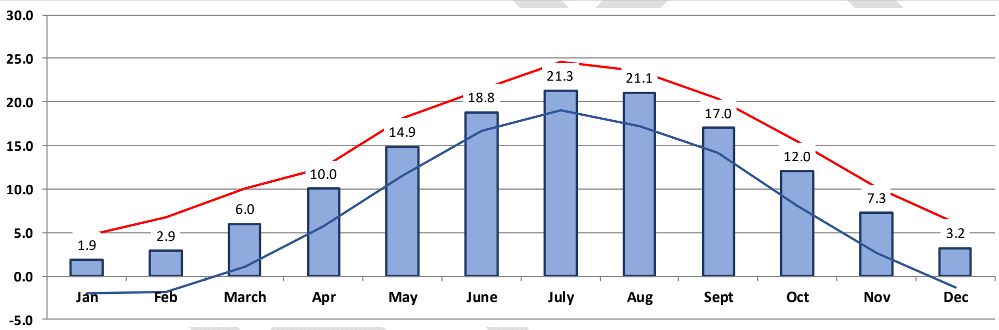

Figure 2.3: LOW: Average (Av. Min and Av. Max) Temperature (MS Ohrid, 1961 – 2016)

On annual basis, precipitation and lake water-level oscillation reach their peak values (maximum and minimum) in different seasons. Maximum precipitation occurs in the form of snowfall in November/ December, when the lake's water levels are at their lowest. The snow remains throughout the winter at high altitudes (above 1,000–1,500 masl.), but begins melting and entering the lake in March/April which then reaches its maximum water level in May/June (Fig. 2.5).

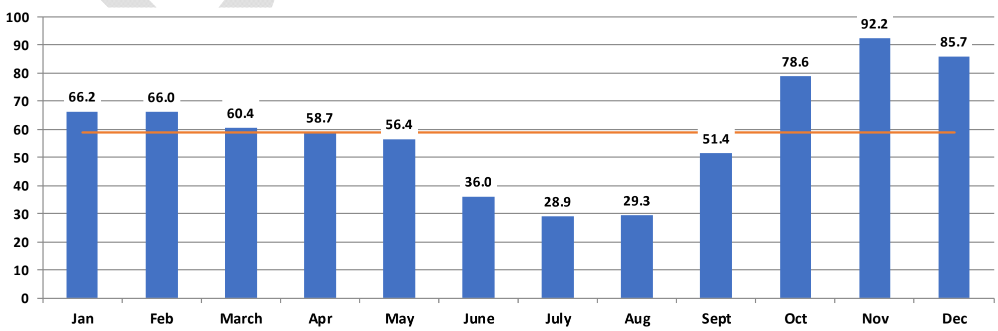

Figure 2.4: LOW: Average Monthly Precipitation (MS Ohrid, 1961 – 2016)

In order to assess the influence of precipitation on fluctuations of the Lake Ohrid water level, the Cumulative Precipitation Anomalies (CPA) have been analyzed. CPA directly measure the shortage of rainfall by calculating the difference between the observation and the long-term climatological record. The CPA values are calculated based on:

- ✓ differences between monthly precipitation average values for the period 1965-2015; and
- ✓ those anomalies are cumulated. The CPA graph determines the positive and negative phases in precipitation variability.

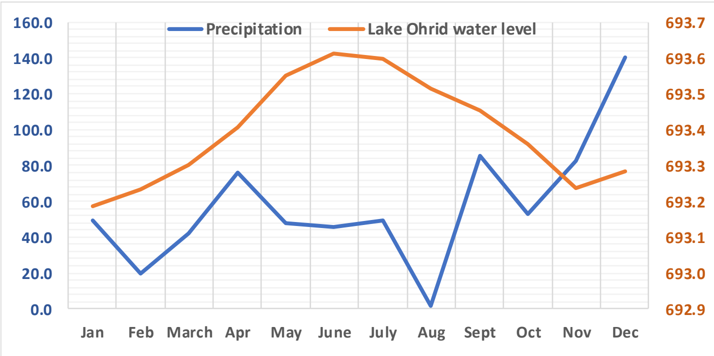

Figure 2.5: Annual Precipitation and Lake Water Level Changes (MS Ohrid, 2014)

The drought event registered for the analyzed period can be seen in the negative slopes of the graph, starting from 1986/7 until 1995/6.

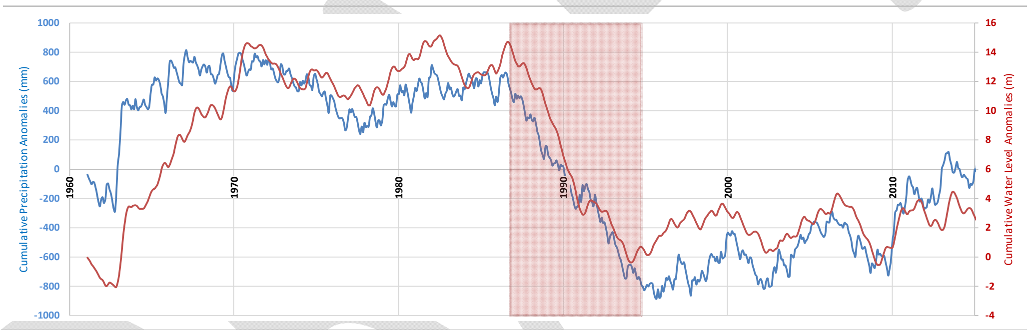

Figure 2.6: LOW: Precipitation and Lake Water Level, Monthly Cumulative Anomalies

The hypothesis that the water from Prespa Lake is seeping into the karst massif of the Galichica and Suva Gora mountains and draining into Ohrid Lake (LOW) was first published by Cvijić (1906). The validity of the hypothesis was proven with isotope-based tests (Anovski et al. 1997, 2001; Eftimi and Zoto 1997). Much of the karstic type of aquifers are found in the triennial limestones of Galichica and Jablanica, which drain through numerous springs into Lake Ohrid. Estimates imply that 49% of the inflow from springs into the lake comes from sublacustrine (under water) springs and 51% from surface springs. The most important are: St. Naum (5-10 m^3/sec), Tushemisht (2.5 m3/sec), Biljanini springs (1-2 m3/sec), Bej Bunar (40-100 l/s), and other unknown number of sublacustrine springs.

Besides the springs, important volume of water drains in Lake Ohrid through a number of tributaries, most of which are small creeks that flow only temporarily during snowmelt and heavy rain periods. The main rivers in the LOW, tributaries to Lake Ohrid (Fig. 2.7; Map 1), include: Sateska, Koselska, Shushica and Grashnica river in North Macedonia, as well as Çeravë and Verdovë rivers in Albania. Details regarding the hydrological parameters of these rivers are given further in the document (Section 2.3: Typology and delineation of water bodies).

Two-thirds of the LOW (Lake Ohrid) water outflow passes into the Black Drin River at the town of Struga, flowing Northwards on the way to the estuary in the Adriatic Sea. The remaining one-third of the lake's water is lost through evaporation (Watzin et al. 2002).[1]

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1 Source: "Shorezone Functionality, Ohrid Lake"; Implementing the EU Water Framework Directive in South-Eastern Europe. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (2017).

Since 1962 the river's outflow has been controlled with a weir, which regulates the water level. According to an agreement between Yugoslavia and Albania in 1962, the maximum water level in Ohrid Lake is not permitted to exceed the value of 693 masl and the minimum water level to fall below 691.65 masl (Watzin et al. 2002)[2]. However, following later developments, i.e. negotiations and agreements between the two countries, since 1979 the minimum water level in Lake Ohrid is set at 693.10 masl (outflow in Black Drin river in Struga) and the maximum 'operational' level at 693.75 masl, resulting in annual fluctuations of the level in the range of 0.65 m. Further, the agreement between the countries stipulates that in the case of extreme events of water inflow into the lake (with probability up to 1%) the set maximum water level of 693.75 can be exceeded, but not surpassing 694.00 masl.

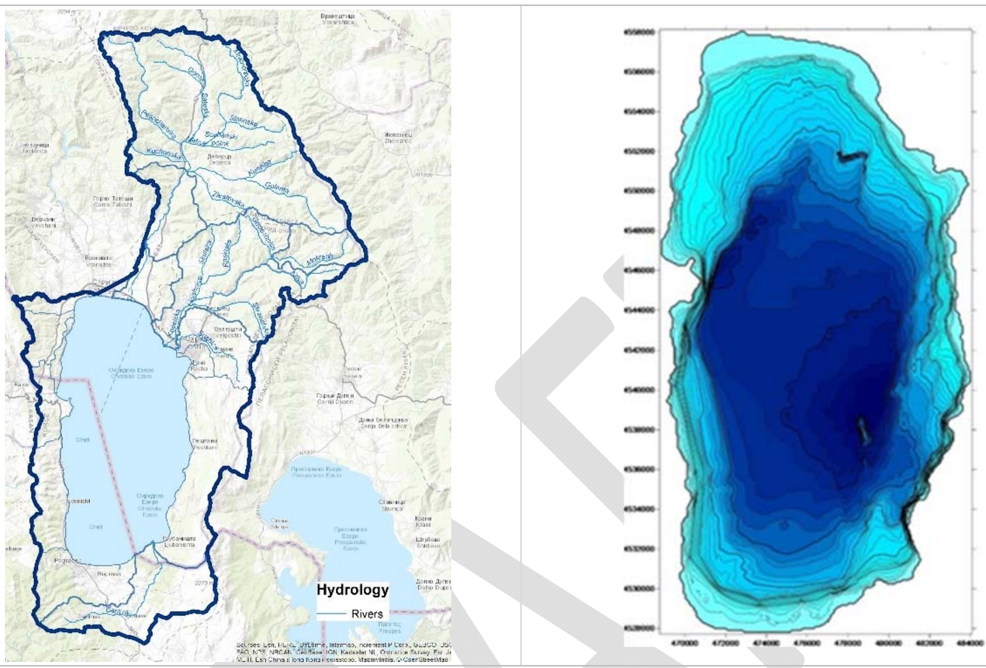

Figure 2.7: LOW: Tributaries and Bathymetric Map of Lake Ohrid

Based on analysis of the recorded water level in Lake Ohrid for the period 1965 – 2016, it is evident that the level of 693.75 masl has been exceeded for a total of 1,970 days, or roughly 10% of the total number of days for the period. Further, the level of 694.00 masl has also been exceeded in 129 days (ratio of 1%). These events, on annual basis, take place during the April – June period. Finally, also the minimum set level of 693.10 masl has not been observed occasionally, that is the actual water level has been lower than the agreed minimum, for a total of 160 days (ratio of 1%) during the drought period 1989 – 1991.

2.1.3 Land Cover

The land cover/land use analysis of the LOW is based on data from the European Environment Agency's CORINE Programme[3] (Fig. 2.8; Map 2; Map 3). A total of 14 land cover classes are analyzed that are included under Programme's Level 2 nomenclature; the area of Lake Ohrid is treated as a separate (one of the 14) land cover category.

The surface area of the LOW is dominated by Forests, Scrub and open spaces, and the surface area of Lake Ohrid, which collectively account for 79% of the total basin area (Fig. 2.8)[4]. Other dominating land cover classes are Arable land and Heterogeneous agricultural areas, which make up 15.6% of the area. Of the remaining 5.3% of land, dominant classes are Urban fabric (2%) and Pastures (1.9%).

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2 Source: "Shorezone Functionality, Ohrid Lake"; Implementing the EU Water Framework Directive in South-Eastern Europe. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (2017).

3 European Environment Agency (EEA), CORINE (Coordination of information on the environment).

4 Data for 2012.

2.1.4 Protected Areas

A total of 9 protected and sensitive areas located in the LOW are identified, that fall into four of the six IUCN[5] categories (Table 2.1; Map 4). The total area of all protected areas equals 661.6 km^2 (47% of the total basin area), of which 268.4 km^2 in Albania and 393.2 km^2 in North Macedonia.

CORINE Land Classes	Area (km2)	% of total
Arable land	43.0	3.06%
Artificial, non-agri. vegetated areas	1.4	0.10%
Forests	457.5	32.58%
Heterogeneous agricultural areas	176.1	12.54%
Industrial, comm. and transport units	2.0	0.14%
Inland waters	2.0	0.14%
Inland wetlands	0.7	0.05%
Mine, dump and construction sites	0.6	0.04%
Open spaces with little or no vegetation	0.4	0.03%
Pastures	26.0	1.85%
Permanent crops	15.1	1.07%
Scrub and/or herbaceous vegetation	294.8	20.99%
Urban fabric	27.6	1.96%
Lake area	357.0	25.43%
Total LOW	**1,404.0**	

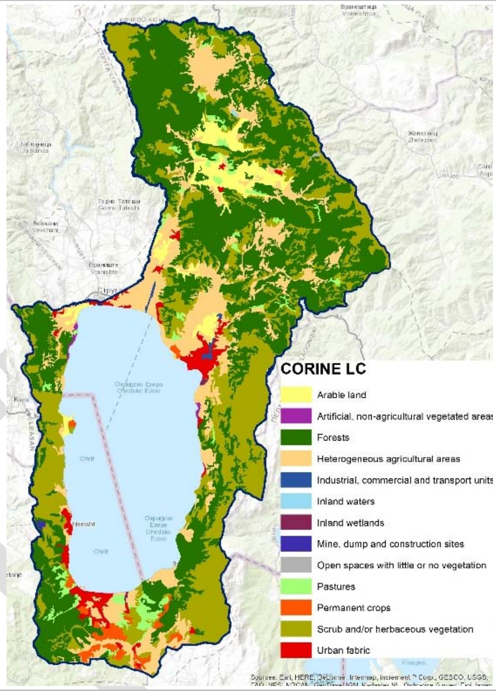

Figure 2.8 LOW: Land cover (CORINE Level 2 LUC)

Annex IV of the WFD specifies five categories of protected areas. Besides the IUCN-areas listed in Table 2.1, to the extent possible also the areas designated for abstraction of water intended for human consumption (captured springs, groundwater/wells and abstractions directly from the lake, Annex A-2-2), the karst springs of Lake Ohrid and fish spawning sites in Lake Ohrid are identified and mapped (Map 4). In addition, although specific bathing areas (Directive 2006/7/EC) are not designated in Albania and North Macedonia, the entire Lake Ohrid is regarded as bathing area. Finally, the remaining two types of protected areas – nutrient sensitive areas and Natura 2000-sites – are not applicable (such areas have not yet been designated) in both Albania and North Macedonia.

Table 2.1: LOW: Protected Areas6

ISO3	Site Name	Year	Designation	IUCN CAT	Area (km^2)
MKD	Galichica	1958	National Park	II	145.9
MKD	Ohridsko Ezero	1977	Designated area not yet reviewed	III	247.4
MKD	Duvalo (Kosel)	1979	Designated area not yet reviewed	III	0.0
MKD	Makedonski dab, s.Trpejca, Ohrid	1967	Designated area not yet reviewed	III	0.0
MKD	Platan s.Kalishte, Struga	1961	Designated area not yet reviewed	III	0.0
MKD	Platan-chinar, Ohrid	1967	Designated area not yet reviewed	III	0.0
ALB	Shebenik-Jabllanice	2008	National Park (category II)	II	0.6
MKD	Platanovi Stebla, Ohrid	1967	Designated area not yet reviewed	III	0.0
ALB	Liqeni I Ulzes	2013	Managed Nature Reserve (category IV IUCN)	IV	267.8
				Total	**661.6**

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[5] IUCN – International Union for Conservation of Nature.

[6] Source: European Environment Agency's (EEA), The European inventory of nationally designated areas holds information about protected areas and the national legislative instruments, which directly or indirectly create protected areas.

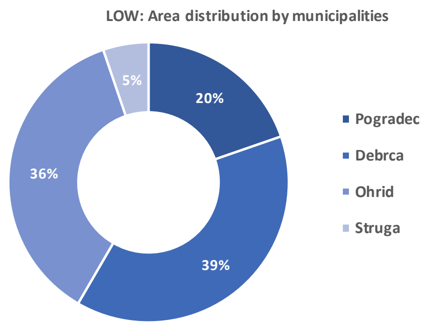
2.2 SOCIO-ECONOMIC CONDITIONS

2.2.1 Administrative Division and Governance

As mentioned before, the transboundary LOW is part of the extended DRB and is shared between Albania (313 km^2 or 22% of the total basin territory) and North Macedonia (1,091 km^2; 78% of the territory).

Administratively, the watershed area falls under four municipalities (local government units), of which Pogradec municipality is in Albania, while Ohrid, Struga and Debrca municipalities are in North Macedonia. The distribution of the LOW territory by the four municipalities is shown on Fig. 2.9. In reference to the administrative division of the basin territory by municipalities, it should be pointed out that only 34% of Pogradec, 98% and 95% of Ohrid and Debrca respectively, and merely 11% of the total area of Struga municipality falls within the LOW.

Following the territorial division of Albania from 2014/15, the Albanian territory of the LOW falls under five Administrative Units: Buçimas, Çeravë, Dardhas, Pogradec and Hudenisht.



Municipality	No of settlements	<500	500 - 1,000	1,000 - 2,000	>2,000
Pogradec	25				
Debrca	30	29	1		
Ohrid	33	23	6	1	3
Struga	6	1	1	2	2
TOTAL in LOW	**94**	**53**	**8**	**3**	**5**

Figure 2.9: LOW: Area and Settlements Distribution by Municipalities

The total number of settlements in the basin equals 94, of which 25 (26.6%) in Albania (Pogradec municipality) and 69 (73.4%) in North Macedonia. 53 of the 94 settlements (or 56%) have population of less than 500, and only 5 have population bigger than 2,000 (Fig. 2.9, Map 5)[7]. 58% of the total population in the LOW lives in the three largest cities (municipal administrative centers): Pogradec, Ohrid and Struga.

2.2.2 Demography and Housing

The total population of the LOW equals 132,059 divided nearly equally between female and male population. Of the total, 39% live in Pogradec municipality, 3% in Debrca, 39% in Ohrid and 19% in Struga (Table 2.2, Fig. 2.10 and Annex 1).

Table 2.2: LOW: Population Statistics

Municipality	Female	Male	Total Municipality	Year	% of LOW population	Area (km^2)	Population density (cap/km^2)	% Urban	% Rural
Pogradec	25,341	26,375	51,716	2011	**39%**	206.2	251	14%	86%
Debrca	2,005	1,989	3,994	2015	**3%**	405.0	10	0%	100%
Ohrid	26,183	25,668	51,850	2015	**39%**	381.0	136	75%	25%
Struga	12,285	12,214	24,498	2015	**19%**	54.8	447	71%	29%
TOTAL in LOW	**65,813**	**66,245**	**132,059**		**100%**	**1,047.0**	**126**	**48%**	**52%**

The overall density of the population for the LOW as a whole is 126 persons per square kilometer. However, there are important differences among population densities per municipalities, ranging from 447 cap/km^2 in Struga, 251 cap/km^2 in Pogradec, 136 cap/km^2 in Ohrid, and only 10 cap/km^2 in Debrca.

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[7] Population data for Albania is at a level of Administrative Units.

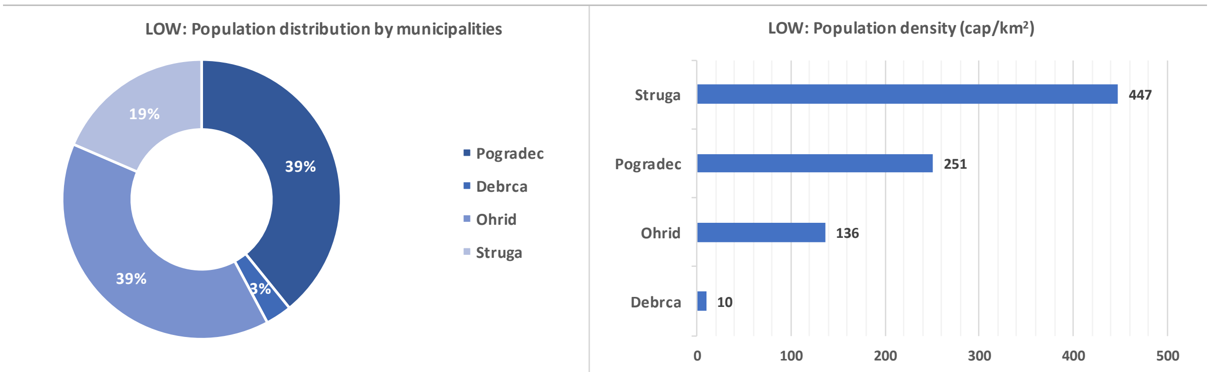

Figure 2.10. LOW: Population Distribution and Density by Municipalities

2.2.3 GDP and Employment

According to national statistics, the GDP per capita in 2018 was $5,239 in Albania and $6,100 in North Macedonia. Statistical data for both countries show relatively steady upward growth in these figures over the last several years.

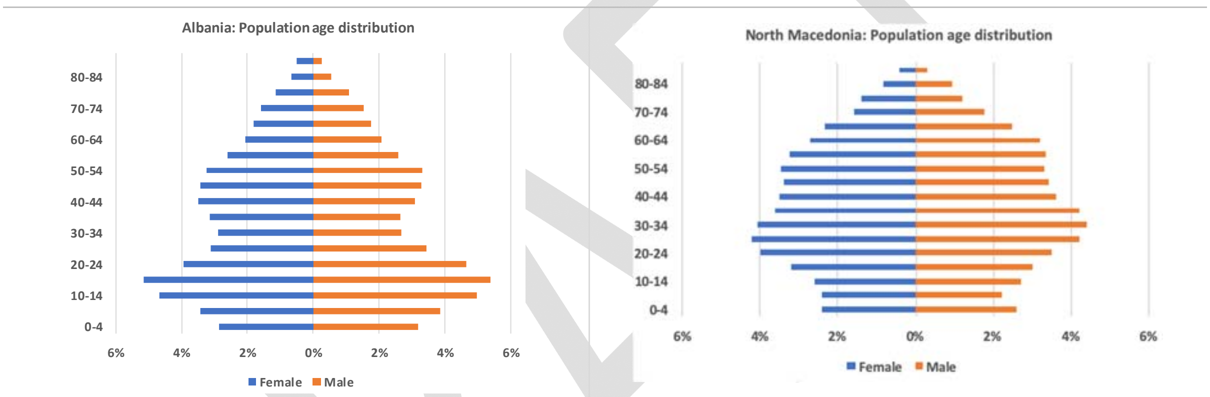

Figure 2.11: LOW: Population Age Structure

As regards employment, statistics are kept differently in each country but it is clear that unemployment and/or underemployment are high in both countries. In Albania, according to data compiled by the Albanian Institute of Statistics, in 2016 the unemployment rate equaled 15.2%; in North Macedonia, according to the State Statistical Office, the same rate equaled 23.7%. The situation is considered even more difficult if market indicators are segregated by gender. Thus, the inactivity rate (proportion of the population that is not in the labor force) in 2015 in Albania equaled 52.7% for female population and 35.7% for male population, whereas in North Macedonia the same rate for the female population equaled 55% and 30.8% for male population.

2.2.4 Tourism and Local Economic Development

Tourism is one of the most important and fastest growing activities/industries worldwide. The tourism industry has a significant direct and indirect impacts on the economies of a number of countries. In 2016 1.23 billion tourists travelled the world, generating income, supporting job creation and boosting development.

As mentioned before, tourism is the key economic activity in both countries around Lake Ohrid. The climate, geography and physical variety of the territory represented by the lake and mountain ranges accompanied by exceptionally rich biodiversity of flora and fauna, as well as by culture monuments and historical sites, make the entire LOW an attractive and highly-valued tourism site. A number of national parks and nature reserves are also located within the basin, offering possibilities for development of various types of tourism and travel experiences. Finally, Lake Ohrid is declared as a World Heritage Site by UNESCO since 1979.

The key types of tourism activities in the LOW are:

- ✓ water/lake-based tourism, which includes various kinds of leisure activities in the form of “beach and sun” tourism;
- ✓ alternative/adventure tourism, which includes all kinds of rural tourism, eco-tourism and nature based activities: paragliding, mountain biking, fishing, trekking, climbing, hiking, study tours, etc., in basin’s natural parks;
- ✓ culture and history based tourism, concentrated around various kinds of archeological and spiritual sites in the region; and
- ✓ business and transit tourism, is the last type of tourism present in the LOW, which is by and large related to business trips and associated activities (e.g. meetings, conferences, exhibitions) taking place primarily in the bigger cities (municipal centers).

Table 2.3 provides an overview of registered visitors within the LOW for the 2011 – 2017 period. The number of visitors in the region has increased from nearly 290,000 in 2011 to over 410,000 in 2017, which is a 142% increase, while the number of registered overnights has increased from 1.28 million to nearly 1.44 million over the same period. Further, both the number of foreign and domestic visitors has been constantly increasing, albeit at different rates.

Table 2.3: LOW: Tourism statistics[8]

Municipality	Administrative Unit	Tourists, domestic and foreign 2011 - 2017							Average
		2011	2012	2013	2014	2015	2016	2017	
Pogradec	Buçimas	51,100	50,000	50,000	50,000	52,500	55,125	57,881	52,372
	Çerravë								
	Dardhas								
	Pogradec								
	Udenisht								
Debrca	N/A								
Ohrid	N/A	178,277	183,335	192,746	197,196	219,944	234,361	275,613	211,639
Struga	N/A	59,079	55,556	59,526	59,171	64,094	74,415	77,238	64,154
TOTAL in LOW		**288,456**	**288,891**	**302,272**	**306,367**	**336,538**	**363,901**	**410,732**	**328,165**
Municipality	**Administrative Unit**	**Overnights, domestic and foreign 2011 - 2017**							**Average**
		2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	
Pogradec	Buçimas	153,300	150,000	150,000	150,000	157,500	165,375	173,644	157,117
	Çerravë								
	Dardhas								
	Pogradec								
	Udenisht								
Debrca	N/A								
Ohrid	N/A	810,795	823,666	796,048	754,048	818,175	830,333	937,041	824,301
Struga	N/A	317,143	295,726	276,920	260,090	300,791	311,624	330,489	298,969
TOTAL in LOW		**1,281,238**	**1,269,392**	**1,222,968**	**1,164,138**	**1,276,466**	**1,307,332**	**1,441,174**	**1,280,387**

The major tourism and recreation facilities in the basin are located around the three municipal centers of Pogradec, Ohrid and Struga, but as well along the eastern shoreline (Ohrid town to the village of Peshtani), south-east part around the villages of Trpejca, Ljubanishta and St. Naum and north-west section from Struga to Kalishta in North Macedonia, and on the stripe from Tushemisht to Pogradec and the Lin peninsula in Albania (Map 6).

Apart from tourism, other dominant local economic activities in the LOW are fishery, agriculture, trade and services, forestry and hunting. Mining, metal fabrication, wood processing, textile fabrication and other light industries are present on the Albanian side of the basin, mainly around the city of Pogradec[9]. On the North Macedonia side the industry sector is centered around construction, textile fabrication, and food processing. The local economy on both sides is dominated by small size enterprises.

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[8] Source: North Macedonia – State Statistical Office; Albania – “Baseline Assessment of the Lake Ohrid region – Albania”, Towards Strengthened Governance of the Shared Transboundary Natural and Cultural Heritage of the Lake Ohrid Region, IUCN-ICOMOS (2016). Data for 2011 and 2013 given in the source;

[9] Source: “Baseline Assessment of the Lake Ohrid region – Albania”, Towards Strengthened Governance of the Shared Transboundary Natural and Cultural Heritage of the Lake Ohrid Region, IUCN-ICOMOS (2016).

2.2.5 Economic infrastructure

Pogradec is located about 139 km from the capital of Tirana and 40 km from Korça. Pogradec is also the last railway station: Tirana - Durrës - Elbasan - Librazhd - Pogradec and located along SH3 road that passes through Devoll and continues to Greece. The road network connecting Pogradec and the other settlements in the municipality is 140 km. A modern road section Qafe Thane-Lin-Pogradec has been recently reconstructed. Most of the villages in the region can be reached by paved roads, especially along the national highway between Tirana and Korce (south eastern Albania). In the south of the lake there is a paved road connecting Pogradec with the North Macedonia border.

On the North Macedonia side, Ohrid and Struga are roughly 180 km from the capital of Skopje. A new high-way Kichevo-Ohrid is under construction, that will significantly further improve the connection between the region and the capital and other larger cities in the country. A paved road along the entire North Macedonia part of the lake has been constructed since the 1960-ties.

There is also an international airport on the North Macedonia part of the basin – the St. Paul Apostle airport near Ohrid, with capacity of 400,000 passengers and registered average annual number of passengers of over 83,000 for the 2010 – 2016 period. The Ohrid airport is also used for cargo transport.

Overview of the main infrastructure in the LOW is given on Map 7.

2.2.6 Cultural Heritage

Apart from the natural heritage of the Lake Ohrid region, which dates back to the Tertiary period, it has homed humanity for thousands of years as well. Remains of Neolithic settlements have been found around the lake, with further inhabitance by Illyrian and Hellenic tribes confirmed by ancient scripts, the still standing Ancient theatre of Ohrid and the Monumental Tombs of Lower Selca.

As the history of the region developed, so did the appearance and life in the settlements around the lake. The remains of Via Egnatia, the ancient Roman road connecting Rome and Istanbul in near vicinity of the lake are proof of the civilization continuum throughout the era before Christ. Various early roman Basilicas and mosaics, such as the ones in Lin, St. Erasmo and Plaoshnik account for the early adoption of Christianity in the region. The 6-th century paleochristian church of Lin's floor mosaics spreading over $120m^2$ are remarkably conserved and have an outstanding artistic value.

As the Slavic tribes began to settle in the region and adopted Christianity, the region became a cradle of Christian theology. Various saints practiced and spread Christianity around the lake, amongst which St. Clement of Ohrid is the most important. Nowadays a newly reconstructed Church sits where St. Clement himself reconstructed an old Church with the purpose of spreading Christianity amongst Slavs. He founded the Ohrid Literacy School, where the Bible was taught in Old Church Slavonic with the use of the Cyrillic script, which he helped develop. His tomb rests in the church to this day.

In the middle ages the region became part of Tsar Samuil's empire, with the city of Ohrid serving as the capital. The fortress built for his needs, with findings of ancient Greek scripts suggesting that it was originally built in the 4-th century B.C., was later used by the Ottoman empire and it sits on the highest point of the city to this day.

On top of a hill in Pogradec there are remains of an Illyrian-Albanian castle in a site that has been populated since the 6-th century B.C. The churches of St. Sophia and Kaneo in the city of Ohrid from the 11th and 13th century respectively, are prime examples of Byzantine architecture that attract plenty of tourists, host cultural events, etc. St John Kaneo's church, sitting on a cliff right above the lake, blends marvelously with the natural setting of the region. The St. Naum monastery from the 16-th century on the other side, too, sits on a plateau right above the lake and has historically welcomed both Christians and Muslims from the region.

Apart from the Byzantine, today's architecture of the area is mostly from the times of the Ottoman Empire. The narrow cobbled streets, numerous mosques and churches, tightly built two to three story buildings throughout the lakeside cities of Ohrid and Pogradec are what gives them such a particular charm.

2.3 TYPOLOGY AND DELINEATION OF WATER BODIES

2.3.1 Surface waters

Lake Ohrid has special physical and biological characteristics compared to other large lakes in Europe. The lake is stratified into two distinct layers, the hydrologically dynamic epilimnion (upper layer) and the more static, voluminous hypolimnion (lower layer).

The WFD System A (Annex II, Section 1.2) was used to for establishing the typology of water bodies in the LOW. Selection of the appropriate methodology A and B depends on the existing data, but some descriptors specifically for system B were considered for refinement of the delineation of Lake Ohrid watershed. For many of the river and lake water bodies in LOW there are no available data according to requirements of System B. Additionally, several other projects performed on Lake Ohrid (GIZ, NIVA) used the same methodology for delineation of the water bodies in the LOW.

Typology of Lake Water Bodies

Lake Ohrid was considered as a single type of water body in previous research projects[9]. Some previous typology and delineations were made on political basis, i.e. using the border line between Albania and North Macedonia. However, such an approach is not appropriate and not applicable since the lake as ecosystem cannot be divided on such criterion that is different (opposite) to WFD recommendations. Such political criteria might be used for delineation of the waterbodies, but not for typology of the lake. During the process of establishing typology and delineation of water bodies, all relevant documents (e.g. the GIZ report and the Draft Drini Management Plan) were consulted.

In general, the WFD does not exclude other elements, such as part of a lake, from being considered as distinct water bodies. For example, if part of a lake is of a different type to the rest of the lake or the pressures categories and intensity differ the lake must be sub-divided into more than one surface water body.

Past and recent investigations of biota from Lake Ohrid show significant difference in species composition between littoral and sublittoral/profundal regions. Also, significant differences in species composition have been observed on different substrates at same depth. For instance, diatoms, macroinvertebrates and macrophytes are different on sandy substrate and hard substrates (stones and rock). According to Cvetkoska et al. substrate and depth have the greatest impact on diatom distribution is the lake. Additionally, at least 182 animal species and more than 200 diatom species are considered as endemic for Lake Ohrid and in many cases have limited distribution, inhabiting particular habitat or locality in the lake. According to Cvetkoska et al. at some localities in the lake such as St. Naum Bay, Trpejca Bay and Kalishta, between 65-80% of the diatom species in the community are endemic for Lake Ohrid. More detailed explanation of Lake Ohrid being a biodiversity hot-spot is given in Supplement IV.

Type-specific biological reference should be established for every type of water body representing the values of the biological quality elements (specified in point 1.1 in WFD Annex V) for that surface water body type at high ecological status as defined in the relevant table in WFD section 1.2 in Annex V. In such case it will be extremely hard to almost impossible to establish type-specific biological reference conditions for Lake Ohrid if it is treated as a single type. In general it is very hard to establish reference conditions for Lake Ohrid because of two reasons:

- ✓ the presence of high percentage of specific (endemic or relict) species; and
- ✓ limited taxonomical, ecological and biogeographical research of biological quality elements (for instance macroinvertebrates).

Some progress on this field has been made in last 10-15 years, suggesting that the number of endemic species is even higher than it was previously known/supposed. However, attempts to find other reference lakes in Montenegro and Albania should be omitted as inappropriate. Lake Ohrid is unique ecosystem in the world and trying to find reference conditions in other lake has no scientific basis. In this moment it is imperative to have detailed taxonomical, distributional and ecological research on biological quality elements made by relevant researchers for all taxonomical groups that will be used as basis for establishing reference conditions.

WFD Guidance Document No. 2 “Identification of Water Bodies” suggests subdivision of lakes on the basis of significant differences in the biological and hydrogeological characteristics.

Based on these criteria and specific geomorphological features of Lake Ohrid, four (4) different types of water bodies have been identified in the lake:

1. the first type is part of the littoral region of 0 to 15 m water depth, characterized by sandy substrate, almost flat bottom and gentle slope where water depth gradually increases;
2. the second type comprises also the littoral region (0 to 15 m water depth), but with rocky bottom and steep slope;
3. the third type is the largest one, comprising the deep part of the lake characterized by clay bottom and more stable physico-chemical conditions (temperature, oxygen, light availability, etc.); and
4. the fourth type includes the spring regions of St. Naum (North Macedonia) and Tushemisht (Albania).

Delineation of Lake Water Bodies

For purposes of the LOWMP a more detailed delineation of the Surface Water Bodies (SWB) is proposed, based on differences in the size (surface area), geology (substrate) altitude, depth and possible risk of failing the environmental quality objectives (Table 2.4). Beside hydromorphological and biological elements, the presence of significant point source pollution from urban, industrial, and other installations and activities, as well as diffuse pollution from agriculturalactivities, is used as criteria for delineation of water bodies. Such approach is based on information from previously identified pressures on Lake Ohrid and monitoring data from Hidrobiological Institute.

Overall, 8 Lake Water Bodies belong to MSSM type, 4 to MSRM and 1 MMCD. According to hydrological data, maps and field trips, previous research and biological data, in total 13 lake water bodies have been identified (Fig. 2.12; Map 8). Beside water depth, slope, form and shape of bed, substratum composition, also available data for relevant biological elements (diatoms, macrophytes, microinvertebrates and fish) are used for delineation and identification of the water bodies in Lake Ohrid watershed.

Table 2.4: LOW: Typology and Delineation of Lake Water Bodies

No.	Water body type	Water body name	Starting point altitude	Altitude	Surface area of water body (km2)	Area of WB sub-catchment (km2)	Size typology	Geology	Geology code	Depth	Code
1	L	L-Radozhda	693.4	M	3.16	6.2	S	Sand	S	M	MSSM
2	L	L-Kalishta	693.4	M	0.8	22.3	S	Sand	S	M	MSSM
3	L	L-Struga-Black Drin	693.4	M	5.25	14.4	S	Sand	S	M	MSSM
4	L	L-Sateska	693.4	M	4.8	32	S	Sand	S	M	MSSM
5	L	L-Koselska	693.4	M	1.8	157	S	Sand	S	M	MSSM
6	L	L- Ohrid bay	693.4	M	1.6	9.85	S	Rock	R	M	MSRM
7	L	L-Velidab	693.4	M	3.1	116	S	Rock	R	M	MSRM
8	L	L-Bay of St. Naum	693.4	M	1.6	91	S	Sand	S	M	MSSM
9	L	L-Tushemisht	693.4	M	0.81		S	Sand	S	M	MSSM
10	L	L-Pogradec	693.4	M	5.8	56.6	S	Sand	S	M	MSSM
11	L	L-Hudenisht	693.4	M	3.4	40.6	S	Rock	R	M	MSRM
12	L	L-Lin	693.4	M	2.24	22.7	S	Rock	R	M	MSRM
13	L	L-Lake Ohrid-Pelagic	693.4	M	322		M	Clay	C	D	MMCD

Typology and Delineation of River Water Bodies

Based on the quantity and quality of the available data, the only possible choice is to use system A for identification and delineation of the river water bodies in the LOW. However, data from GIS digital maps (model) are obtained for the mean water course slope, and these data are used for proper river basin characterization (surface water body delineation and typology).

Based on the WFD requirements, three (3) types of river water bodies have been identified in the LOW (Map 8):

1. HMC – rivers on High altitude with Medium size Catchment area on carbonate background;
2. MSC – rivers on Medium altitude with Small size Catchment area on carbonate background; and
3. MMC – rivers on Medium altitude with Medium size Catchment area on carbonate background.

According to this typology the following subdivision can be made (Table 2.5):

- ✓ one river water body belongs to type 1 HMC (Sateska 1);
- ✓ three river water bodies belong to type 2 MSC (Sateska 2, Koselska 1 and Cerave);
- ✓ two river water bodies belong to type 3 MMC (Koselska 2 and Sushica);
- ✓ one water body is characterized as heavily modified – Sateska 3; and
- ✓ one water body characterized as artificial – Studenchishki kanal.

Table 2.5: LOW: Typology and Delineation of River Water Bodies

No.	Water body Type	Water Body Name	Starting Point Altitude	End Point Altitude	Altitude	Catchment size (km^2)	Size typology	Geology	Combination
1	R	R-Sateska 1	1,273	760	North	345.0	M	C	HMC
2	R	R-Sateska 2	760	709	M	49.0	S	C	MSC
3	HMWB	R-Sateska 3	709	693.4	M	32.0	S	C	MSC
4	R	R-Koselska 1	1,979	877	M	36.0	S	C	MSC
5	R	R-Koselska 2	1,833	693.4	M	157.0	M	C	MMC
6	R	R-Cerave	1,035	695	M	91	S	C	MSC
7	R	R-Sushica	1,220	693.4	M	45	S	C	MMC
8	AWB	Studenchishki kanal	693.5	693.5	M	9.85	S	C	MSC

Typology and Delineation of Heavily Modified and Artificial Water Bodies

According to the WFD, Heavily Modified Water Bodies (HMWB) should be identified and designated where good ecological status is not being achieved because of impacts on the hydromorphological characteristics of a surface water resulting from physical alterations. The identification of HMWB must be based on the designation criteria set out for river water bodies. According to WFD artificial water body represents a body of surface water created by human activity, while HMWB is a body of surface water which as a result of physical alterations by human activity is substantially changed in character. Artificial or heavily modified water bodies are designated if:

- ✓ the changes to the hydromorphological characteristics of that body would have significant adverse effects on the wider environment and water regulation, flood protection, land drainage;
- ✓ the beneficial objectives served by the artificial or modified characteristics of the water body cannot, for reasons of technical feasibility or disproportionate costs, reasonably be achieved by other means, which are a significantly better environmental option; and
- ✓ these conditions are proved in the designation test.

In principle, the boundaries of HMWBs are primarily delineated by the extent of changes to the hydromorphological characteristics that:

- ✓ result from physical alterations by human activity; and
- ✓ prevent the achievement of good ecological status.

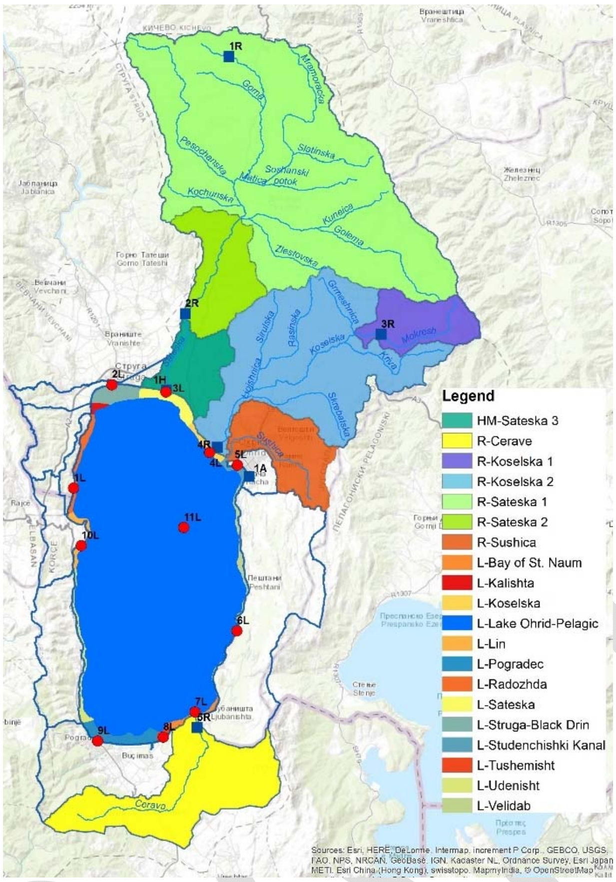

Figure 2.12: LOW: Delineation of Surface Water Bodies

Based on available data one single HMWB has been identified in the LOW – River Sateska 3. This part of the river starts near the village of Volino at altitude of 709 masl. and ends at the inflow into the lake, with total length of 7 km. Regulation (channelization) of the river bed is mainly for prevention of flood of the surrounding agricultural land and settlements.

In the LOW, also one Artificial Water Body (AWB) was identified – channel Studenchista. It is with total length of approximately 700 m located between Ohrid and Racha, and in the past known as Studenchishka River. The Studencishta wetland is located around the channel at an altitude of 694 to 696 masl. (medium height of 695 masl.) between Studencishka Reka (today the Studencishta canal) and the Racha River (North and south) and between the regional road Ohrid-St. Naum and the coast of Ohrid Lake (east and west).

The Studencishta wetland is valorized as a natural phenomenon preserved for millennia and hence it’s particular significance for the Ohrid Lake. The wetland, not long ago, was an integral part of the Ohrid Lake. It stretched North and south of Studenchiska Reka (today the Studencishta channel) and with numerous channels it was connected with Lake Ohrid. Any change in the water level of the lake directly influenced the wetland. It was inhabited by various plant and animal species. Many cyprinid (white) fish (especially carp) were spawned in the wetland, and many water birds also nested. Today, wet habitats occupy an area of over 50 ha, while muddy and swampy fields stretch about 25 ha, in the immediate vicinity of the channel. The wet meadows around occupy larger spaces. The southern and eastern parts of the site are converted into cultivated areas, fields, meadows and orchards.

2.3.2 Groundwater

The groundwater body delineation for North Macedonia has been made based on available raster hydrogeological maps in scale 1:200.000 (source: Geological survey of North Macedonia), and the groundwater aquifer has been divided into 5 different types of typology as follows[10]:

- ✓ Type 1 - Aquifer zones with intergranular porosity having high to middle transmissivity and permeability;
- ✓ Type 2 - Aquifer zones with intergranular porosity having low transmissivity and permeability;
- ✓ Type 3 - Aquifer zones with karst-fracture porosity having high transmissity and permeability;
- ✓ Type 4 - Zones with local aquifers with limited extent close to the surface and waterproof at deeper levels practically impermeable; and
- ✓ Type 5 – zones that are neither an aquifer nor a groundwater body.

Following this delineation, there are four groundwater bodies in the LOW:

Table 2.6: LOW: Typology and Delineation of Groundwater Bodies

Groundwater body name	Aquifer Type	Horizon	Description
GWB001_Horz1	1	1	Porous highly productive
GWB002_Horz1	1	1	Porous highly productive
GWB021_Horz2	2	1	Fissure highly productive
GWB022_Horz2	2	1	Fissure highly productive

In addition, referenced publication also specifies a total of 12 transboundary groundwater aquifers, including those shared between Albania and North Macedonia. Fig. 2.13 below and Map 9 represent the groundwater bodies in the LOW based on the “Type1 - Type5” delineation.

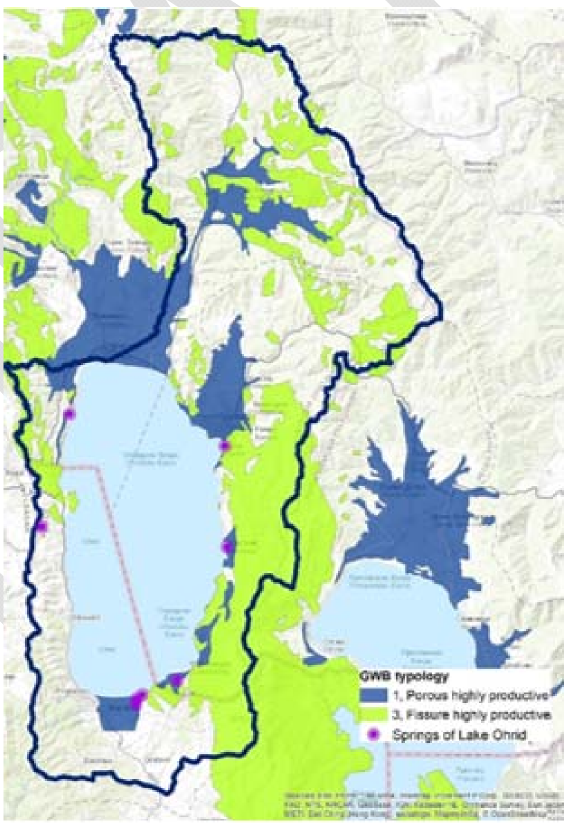

Figure 2.13: LOW: Typology and Delineation of Groundwater Bodies

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[10] Source: “Typologies of Groundwater in Macedonia (FYR)”, Report”; Proj. Ref. EuropeAid/132108/D/SER/MK : Technical Assistance for Strengthening the Institutional Capacities for Approximation and Implementation of Environmental Legislation in the Area of Water Management; Ramboll (2015).

On the other hand, following other authors, groundwater on the territory of North Macedonia is generally prevalent in deposits located in two types of lithological formations: non-bound quartile and neogeneous lithological formations with intergranular porosity (compact type of aquifers – i.e. equivalent to Type 1); and aquifers formed in carbonate rock masses with karst cracks porosity (karst fissure type of aquifers, equivalent to Type 3).

The country is divided into 16 water management areas. The Ohrid-Struga water-management unit covers an area of 1,489 km2 or about 5.8% of the total country area. This area covers the Ohrid-Struga basin, as well as the bordering parts of the mountains Jablanica, Galichica and Karaorman. The compact type of free-level aquifer has been developed in quaternary and Pliocene deposits in valleys with a thickness of 10-40 m, as well as in the alluvium deposits of the Black Drin, Koselska and Sateska River. In the Pliocene sediments in the central part of Struga valley and parts of Ohrid valley a developed type of spring with a pressure level with variable capacity of water bodies is found.

Table 2.7: LOW: Groundwater Reserves represents estimated groundwater reserves in the Ohrid-Struga Water Management District. The total yield of all sources in this water management area is estimated at around 10 m3/sec. The biggest consumers of water in the area are the cities of Ohrid and Struga, which are supplied mainly by purification of the lake water and with underground waters from the karst spring. Ohrid is supplied with purified lake water (250 l/sec), as well as by delimitation of the karst springs Bej Bunar, Biljanini springs, as well as several wells in the karst (spring near locality of Orman - Dolno Lakocherej with a total amount of about 250-300 l/sec groundwater). Struga and the surrounding settlements are supplied by capping of karst springs in Gorna Belica and Shum (280l/sec). There are a number of villages in this area that are not connected to public water supply systems, using mostly own capped karst springs and rarely drilled wells.

Table 2.7: LOW: Groundwater Reserves

Aquifer type	Source of underground water	Estimated groundwater reserves Static (x106m^3) Exploitation (m^3/s)	
Compact	Ohrid-Struga valley (Quaternary)	161	0.5
	Ohrid-Struga valley (Pliocene)	72	
Karstic	Galichica		5.0
	Jablanica		

Much of the karstic type of aquifers are found in the triennial limestones of Galichica and Jablanica, which drain through numerous springs into Lake Ohrid (Map 4). Estimates imply that 49% of the inflow from springs into the lake comes from sublacustrine (under water) springs and 51% from surface springs. The most important are: St. Naum (5-10 m3/sec), Tushemisht (2.5 m3/sec), Biljanini springs (1-2 m3/sec), Bej Bunar (40-100 l/s), and other unknown number of sublacustrine springs.

2.4 LAKE OHRID SHOREZONE FUNCTIONALITY

2.4.1 Overview

Lakes provide a variety of ecosystem services: provisioning (e.g. fresh water, fish), regulating and maintenance (regulation of flows, habitat maintenance, etc.) and cultural (tourism and recreation, aesthetic satisfaction, abiotic characteristics of nature that enable spiritual, symbolic and other interactions). Thus, there are numerous dissimilar interests for the lakes' environment. On the other hand, lakes are affected by a number of pressures coming from the watershed's streams that negatively distresses the trophic-evolutionary processes of their waters.

The riparian zone has an important role in protecting and buffering the degradation of the lake's aquatic ecosystem derived by human activities. Land uses that consist in elimination of riparian vegetation, often cause environmental stresses, increased instances of non-point source pollution, and result in morphologic alterations and habitat destruction[11]. The area around the shores is a transitional zone between the surrounding territory and the lake and guarantees the execution of ecological process needed to protect the lake from the watershed's pollution. Its structure and extension are influenced by the topography, the climate and the soil's geological composition, while its water fluxes, the nutrients and sediment inputs, and the diffusion of animal and plant species are influenced by the lake riparian vegetation.

The shorezone represents the area that includes the littoral (maximum depth of 1 meter) and the riparian zones, which can carry out important ecological functions such as: regulate nutrients inputs, filters runoff and aids sedimentation before the water coming from the watershed enters into the lake, provides habitat for aquatic and terrestrial animals, offering food, shade, shelters, areas for hunting and breeding, protects the shoreline from erosion**,** favoring bank stabilization. "Lake Shorezone Functionality" represents the capacity to accomplish those determinate functions.

The lake Shorezone Functionality Index (SFI) looks at the overall status of the lake environment and assists in the identification of the causes of deterioration, zooming out from the waterbody itself to include all the surrounding territory and watershed topography. The potential of the SFI method lies in the ability of obtaining a synthetic value of lake shorezone functionality. The results obtained provide an immediate general picture of the state of the shores around the lakes. The results can also be used to easily identify the location and the actions needed in potential restoration sites, location of protected areas, location of areas of important economic value and so on. Thematic map can be created for each parameter called in the field and spatial analysis can be carried out to identify the weaker or stronger locations, the areas more in need or more prone to restoration actions[12].

The SFI was developed in Italy in 2004 by a working group of the Italian Agency for Environmental Protection and Technical Services, and has consequently been adopted by several EU countries. The SFI approach has recently been used for assessment of Lake Ohrid's hydromorphology[13]. Results of the analysis have been taken into consideration for delineation of LOW surface WBs; summary information from the analysis is presented further.

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[11] Source: "Lake Shorezone Functionality Index, A Tool for the Definition of Ecological Quality"; Maurizio Siligardi et all, 2010).

[12] Source: https://North.zennarobarbara.com/resource-management.html#

[13] "Shorezone Functionality, Ohrid Lake"; Implementing the EU Water Framework Directive in South-Eastern Europe. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (2017).

2.4.2 Hydromorphological Areas and Main Shorezone Typologies

Seven hydrogeomorphological areas have been identified, characterized by different geological, hydrological and morphological features, which either represent an advantage for or a limitation to the natural growth of a functional shorezone (Fig. 2.14). However, it has also been concluded that at Lake Ohrid the main modifier influencing the structure and functionality of the lake shorezone is anthropogenic pressure.

Hydromorphological area (HGM)	Drainage basin (km^2)	Shore length (km)	Drainage basin/ shore length ratio
I- North Jablanica	40.7	16.1	2.5
II -- Black Drin outlet	18.2	7.2	n/a
III - Northern plains	677.5	13.4	50.6
IV - Karstic Mountains	115.9	23.5	4.9
V - Springs	2.3	8.9	0.3
VI - Southern plains	130.8	8.7	15.0
VII - South Jablanica	62.8	18.8	3.3

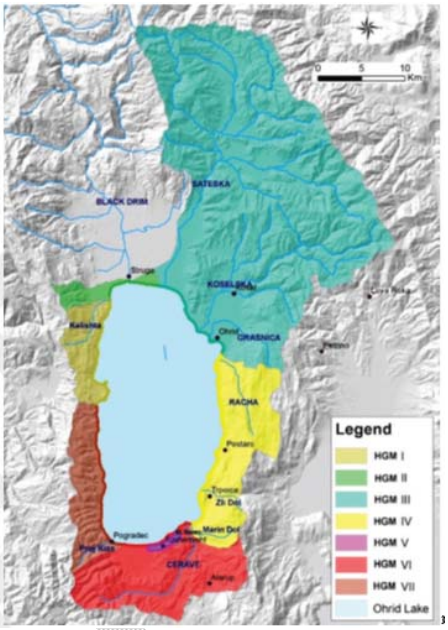

Figure 2.14: LOW: Hydromorphological Areas (in Relation to SFI)[14]

Further, seven shorezone typologies have been identified at Lake Ohrid, which partly correlate with the natural topography of the land surrounding the lake and partly with the degree of human pressure exerted on the lake. In the typologies, the presence or absence of reeds greatly influences the width of the shorezone and therefore its functionality value (Table 2.8).

Table 2.8: LOW: Shorezone Typology (in relation to SFI)[15]

Shorezone Typology	Brief Description
Typology 1 – Wide belt of riparian vegetation (trees and reeds)	Characterized by belt of riparian vegetation, accompanied by reeds in the littoral zone; provides a high value of complexity and functionality; **SFI = 1**
Typology 2 – Narrow belt of riparian vegetation (no reeds)	Narrow belt of riparian vegetation, often due to the natural slope of the terrain; reeds are lacking, which decreases the potential width of the functional shorezone; still provides complexity and good functionality; **SFI = 2**
Typology 3 – Cliffs with limited vegetation	Characterized by cliffs that directly border the lake; shorezone mainly comprises bare rock and scattered shrubs; **SFI = 3**
Typology 4 – Reeds, with little or no terrestrial riparian vegetation	Terrestrial environment of the lakeside plains intensively farmed, natural riparian vegetation removed and replaced with crops. Shallow bathymetry promotes growth of reeds, which perform a number of ecological functions; **SFI = 2/3**
Typology 5 – Thin belt of riparian trees, high artificiality	Belt of riparian trees and/or shrubs, similar to typology 2 but more limited in width; human pressure is the main factor limiting the growth of riparian vegetation; **SFI = 3**
Typology 6 – Artificial shore	Lake's shorezone has been heavily modified to accommodate tourism: artificial beaches; retaining walls; **SFI = 5**
Typology 7 – Impermeable walling with reeds	Impermeable walls interrupt the continuum between the littoral and the terrestrial zone; **SFI = 5**

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14 Source: Ibid.

15 Source: Ibid.

2.4.3 Lake Ohrid Shorezone Functionality Index

Summary information regarding SFI for Lake Ohrid are presented in Fig. 2.15.

Overall, 75% of the whole perimeter of the lake falls into the moderate, poor or bad category, which means that most of the shoreline cannot perform ecological functions such as nutrient removal, shore stabilization or provision of habitats for aquatic and terrestrial species. The lake is assessed to be highly vulnerable to diffuse and point source pollution from urban, industrial, agricultural and other activities.

SFI Value	Number of streches	Total length (km)	%
1 - High	6	6.2	7.1%
2 - Good	15	16.1	18.3%
3 - Moderate	19	13.9	15.8%
4 - Poor	3	2.6	3.0%
5 - Bad	44	49.0	55.8%
Total	87	87.8	100%

Figure 2.15: LOW: Shorezone Functionality Index[16]

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16 Source: Ibid.

3 INSTITUTIONAL SETUP FOR WATER RESOURCE MANAGEMENT IN ALBANIA AND NORTH MACEDONIA

Detailed overview and assessment of the legal, regulatory and institutional setup for water resource and environmental management in Albania and North Macedonia is given as a separate Supplement I. Provided below is a brief outlook of the key stakeholders related to this plan, along with their responsibilities.

3.1 OVERVIEW OF STAKEHOLDERS – ALBANIA

Stakeholder category	Relevant stakeholder	Territorial Jurisdiction	Matter Jurisdiction
LEGISLATIVE AND POLICY DEVELOPMENT COMPETENCES	**Assembly of Albania**	Central level	Legislative and policy development : Laws; ratification of international agreements for RBD management
	Council of Ministers	Central level	Legislative and policy development: approves the composition and regulation of operation of the National Water Council; and the manner of organization and functioning of the Water Resources Management Agency; approves the National Strategy of Water Resources Management; appoints a special commission for cross-border water management; determines the territorial boundaries of each basin waters of the Republic of Albania, as well the center of council composition of each of them; approves the hydrographic boundaries of basins water; approves the river basin management plans; determines areas, distances and width of the shores of water resources
	National Water Council	Central level	Central decision-making body responsible for managing water resources: approves interregional and national plans and projects in the field; takes appropriate measures for the implementation of any international agreement, water management conventions of which the Republic of Albania is a party; issues permits and authorizations for water use and discharges when the activity is performed outside the boundary of a single basin; approves the initiatives of any contracting authority for initiating concession procedure for the use of water resources; approves the regulation of the river basin councils Council, the water basin council and the water basin agency
EXECUTIVE COMPETENCES	**Water Resource Management Agency**	Central level and RBD level	Central governmental body responsible for implementation of the water management regulations and the integrated management of water resources, quantitative and qualitative preservation, and their further consolidation
	Special Commissions for the Management of Transboundary Waters	Central level and RBD level	Special commission tasked with the administration of transboundary waters, managing the relations with the border countries for these waters, based on Albanian legislation and relevant international agreements.
	Ministry of Tourism and Environment	Central level	Drafting and implementing policies, strategies and national plans related to climate change, for the protection of aquatic resources, water

			resources, inland and temporary water surface, marine water and groundwater.
	National Environmental Agency	Central level	Monitor the state of the environment and to monitor the quality and quantity of water resources and to develop new policies for their protection and improvement. National Environmental Agency monitors wastewater discharges
	Regional Environmental Agencies	Regional level	Responsible for permitting and enforcing environmental legislation
	State Inspectorate of Environment, Forests and Water	Central level	Enforcement of legislation on environmental protection, forests, water and fishery
	Ministry of Agriculture and Rural Development	Central level	Responsible for water utilization for irrigation purposes and drainage. This ministry is responsible for water utilization for irrigation, for drainage, for the protection of flood systems and for the preservation of fishery resources
	Directorate of Agriculture and drainage boards	Regional level	Technical, specialized structures, responsible for operation and maintenance of drainage, flood protection systems and main irrigation infrastructure (large dams and main irrigation canals)
	Directorate of Water and Fishery Policies-The Fishery and Aquaculture Sect	Central level	Drafting of policies, strategies for fishery and aquaculture development and the preparing of the Fishery and Aquaculture Administration Plan. This sector is also responsible for directing and coordinating the monitoring and controlling system for scientific research projects that relate to sea fishery resources, the evaluation of internal waters, and fishery information and statistics systems
	Ministry of transport and infrastructure: General Maritime Directorate; General Directorate of Water Supply and Sewerage	Central	Elaboration of the policies related to water supply and sanitation. The authority is in charge of developing policies on water supply and sewerage systems, and for investing in waste management facilities
	Water Regulatory Authority	Central level	Regulatory authority, responsible for regulating the sector of water supply and wastewater disposal and treatment in Albania
	Ministry of Health	Central level	Responsible for setting drinking water standards and monitoring the quality of drinking water, bathing water and curative waters, by protecting water sources and the chlorination of supply entering the distribution systems
	Ministry of Energy and Industry	Central level	Responsible for hydropower production and power produced by renewable energy resources
	Ministry of Interior General Directorate of Civil Emergency	Central level	Monitors, manages and controls states of emergency, including floods and other emergencies, in the entire territory of Albania
	Ministry of Economic Development, Tourism, Trade and Entrepreneurship	Central level	Responsible for the planning and approval of tourism policies, and has the duty to ensure and protect the sustainable use of water resources for tourists
MONITORING COMPETENCES	**Institute for Public Health**	Central level	Monitoring the safety of water supply, including water chemical and biological monitoring
	Administration for Hydro-Meteorological Service	Central level	Operation of the hydrological monitoring network, to inform the public on the state of waters and alarm on the appearance of

			imminent dangerous or harmful hydrological circumstances
	Institute of Geoscience, Energy, Water and Environment	Central level	Monitor surface water quality and quantity; studying and evaluating the country's natural mineral and underground energy and water resources; for groundwater quality and quantity monitoring; for assessing surface water quality for rivers, lakes, underground and marine water; and for monitoring rainfall, temperature and other hydro meteorological parameters
	Albanian Geological Survey	Central level	Groundwater quality and quantity monitoring. It also conducts the watershed hydro-geological studies and recommends measures for the protection of groundwater resources
POLICY AND EXECUTIVE COMPETENCES AT LOCAL LEVEL	**Local self-government Unites (municipalities) And quarks**	Respectively at municipal level	Sewerage and treatment of public waste water, and collection, transport and treatment of municipal solid waste and technological waste
	River Basin Councils	River basin and local level	Integrated management of water resources in the relevant basin at the local level. competent to issue authorizations and permits when the activity is to be carried out within the territory of the Republic of Albania and within the boundaries of a single basin
	Water Basin Management Offices - Agency branches	River basin	Drafts the water resource plan for the respective basin and submits it for approval to the river basin council; inventory of water resources in quantity and quality, Promotes the participation of water users in the management and management of water resources; prepare reports; prepares materials for the meetings of the river basin council; surveillance over implementation of the decisions of the National Water Council and the river basin Council; prepare programs for preventing and avoiding contamination of receiving water resources under their jurisdiction from liquid discharges; compile the program of measures for the water basin; keep a register listing all licenses, authorizations, permits and concessions issued.
WATER USERS	**Water Supply and Sewerage Association of Albania**	Central level	Non-profit association of water supply and sewerage professionals formed by a group of representatives from eight water supply and sewerage enterprises in Albania, to represent the interests of the enterprises operating in the water sector, and to raise the level of professionalism
	Water User Associations (WUAs)	Local level	Private and financially independent entities to manage the irrigation.
	Albanian Union of chamber of Commerce and industry	Central level	Represent and promote the general interests of business chambers for the development of trade and industry at all levels
ORGANIZED INTEREST GROUPS	Environmental NGOs/associations; NGOs dealing with biodiversity conservation	Central and Local level	Public participation in the decision-making process negotiate (lobby) on matters of public interest

	and nature protection; Consumer protection associations		

3.2 OVERVIEW OF STAKEHOLDERS – NORTH MACEDONIA

Stakeholder category	Relevant stakeholder	Territorial Jurisdiction	Matter Jurisdiction
LEGISLATIVE AND POLICY DEVELOPMENT COMPETENCES	**Assembly of Republic of North Macedonia**	Central level	Legislative and policy development : LoW and other lex specialis; Water strategy, Water Master plan; ratification of international agreements for RBD management
	Government of Republic of North Macedonia	Central level	Legislative and policy development : proposals LoW and other lex specialis; Water strategy, Water Master plan; Adoption of RBMP
EXECUTIVE COMPETENCES	**Ministry of environment and physical planning**	Central level	Legislative and policy development : proposals LoW and other *lex specialis;* Water strategy, Water Master plan< proposal, implementation of RBMP
	Environmental Administration (EA) - Department of Waters (DW)	Central level	Executive competences: Water Management Planning and Development; Concession and Inter-Sectorial Cooperation, permitting procedures- water rights/consents,
	Crn Drim River Basin Management Unit	River basin district	River basin management planning and implementation
	Ministry of Foreign Affairs	Central level	Establishment and management of international RBD; conclusion of international agreement/treaty; ratification procedures
	Ministry of Economy	Central level	Proposals for concession for water use, covers ground waters, use of mineral and thermo-mineral resources and electricity generation; including use of water by hydro power and thermal power plants
	Ministry of Transport and Communication	Central level	Responsible for implementation (financing) of infrastructure development programs and projects related to drinking water supply and wastewater collection
	Ministry of Health, Food Directorate, Institute for public health, State sanitary inspectorate	Central and regional level	Water bodies suitable for human consumption and bathing waters, control of the sanitary and protective zones around these bodies, safety of drinking and bathing waters and protection of population from waterborne diseases, hygiene and health ecology, monitoring of drinking water and surface waters, communal hygiene in public facilities, quality control and hygienic-bacteriological status, monitoring of waters
	Energy Regulatory Commission of North Macedonia	Central level	Determine tariffs for water management services and enforcement of tariffs
	Ministry of Agriculture, Forestry and Water Management, Administration for Water management	Central level	Manages water use in agriculture (irrigation, land drainage, fisheries), large infrastructure facilities related to use of water such as dams, reservoirs, irrigation/hydro systems, etc. performs expert supervision over the operations of Water Inc. Good agricultural practices

	Administration for Hydro-Meteorological Service	Central level	Tasked with responsibilities for monitoring the quantity and quality of surface and groundwater, operation of the hydrological monitoring network, to inform the public on the state of waters and alarm on the appearance of imminent dangerous or harmful hydrological circumstances
	National Park Galichica	National Park Area	Managing the national park, the protection of nature, biological, landscape diversity and natural heritage
POLICY AND EXECUTIVE COMPETENCES AT LOCAL LEVEL	**Local self-government Unites (municipalities) Ohrid, Struga, Debrca**	Respectively at municipal level	Protection from, and prevention of, water pollution, drinking water supply, drainage, collection and treatment of wastewater. They carry out activities by the own local infrastructure as well as using infrastructure of the communal (municipal) enterprises, which are practically operating as public utilities. LSG units are also responsible for operation of the local monitoring network for the local water bodies within their respective areas; operation, maintenance, and development of the local monitoring network. LSG environmental inspectors carry out inspection functions enforcement for local level competences; determination of prices of water services
ENFORCEMENT COMPETENCES	**State Environmental Inspectorate**	Central level	Empowered to implement the MoEPP responsibilities in the area of enforcement of environmental legislation and, in particular, water management legislation. It covers the obligations for inspection surveillance on central level in the field of environment and, respectively, in the field of water management.
	State Communal Inspectorate (SCI)	Central level	Possesses jurisdiction in the area of public water supply systems and systems for collection, drainage and wastewaters treatment, implemented through its state communal inspectors. The State Inspectorate for Agriculture (SIA) possesses jurisdiction with regard to control of the nitrate vulnerable zones and irrigation and drainage.
	Authorized municipal inspectors	At LSGUs level	Empowered to implement the LSGs responsibilities in the area of enforcement of environmental legislation and, in particular, water management legislation
OPERATORS – PUBLIC INTEREST SERVICE PROVIDERS	**Joint stock company Water Management of the Republic of North Macedonia in state ownership Branch office "Crn Drim)"**	Territory of Prespa (Municipality of Resen); Municipalities of Ohrid, Struga, Vevchani, Centar Zupa, Debar, Kicevo and Plasnica	The water management service is public utility services, i.e. water supply for irrigation and drainage of land and construction and ongoing maintenance and investment in the systems. Water Inc. will use, maintain and manage the irrigation and drainage as a whole, in order to Supply of irrigation water; supply of the communal enterprises with water intended for human consumption (drinking water and other uses); supply of water for industrial and technological (economic) needs including the production of electricity; Regulation of watercourses/ river beds; drainage of land and drainage of discharged waters; responsible for managing the environment, construct and maintain facilities for the protection and defence from

			floods; - construct and maintain facilities for prevention and protection from erosion; construct and maintain facilities for regulation of the rivers and torrents
	Public Utility/ Communal Enterprise ”PROAKVA” ; PCE “Debrca”	At LSG level relevant for the DRBD	Drinking water supply; and collection, disposal and treatment of sewage and storm water; Plan for tariff adjustment for water services and Business plans for investment
CONSULTATIVE BODIES	**National Water Council**	National level	Provides independent opinion and improvement suggestions regarding development, ratification and implementation of water management regulating laws and bylaws; adoption of the national water strategy, river basin management plans, etc.
	Crn Drim River basin management council	River basin district	Preparation, implementation and surveillance over the river basin management plans, and for proposing measures for improved water management, opinions of the RBMC are taken into consideration in the planning process at all stages, from beginning to end
ORGANIZED INTEREST GROUPS	Environmental NGOs/associations; NGOs dealing with biodiversity conservation and nature protection; Consumer protection associations	Local level	Public participation in the decision-making process
	Chamber of Commerce EVN North Macedonia,	Local level	Industrial capacities operation Dam regulation Public participation in the decision-making process
	Farmers Association Fishing associations/ concessioner	Local lake level	Public participation in the decision-making process, Good agricultural practice fishing

4 DRIVERS AND PRESSURES ON WATER BODIES IN THE LOW

The following section provides an overview of the key pressures, along with the drivers triggering the pressures, on the surface and ground waters in the LOW. The description by and large follows the provisions stated in the WFD Reporting Guidance 2016[17].

4.1 URBAN DEVELOPMENT, TOURISM AND RECREATION

4.1.1 Abstraction for Public Water Supply (Households, Public Sector and Tourism)

From a viewpoint of potential impact on the overall balance of water resources, most water abstractions are currently sustainable in the LOW. Relatively large amounts of water are abstracted daily for domestic use and for use in industry and recreation. Most of this water is treated to a high standard to remove impurities and make it appropriate for consumption.

Table 4.1 below shows the volume of annual water abstractions by municipalities in the LOW for use by households, public/commercial institutions, small-scale industry and tourism/recreation facilities; more detailed data is given in Annex 2. The total population connected to a public water supply systems, i.e. systems that are operated by a municipal communal public enterprise, is estimated at 115,842 (88% of the total population), or 56,372 household connections. In addition, roughly 3,700 residents in the basin use local community-based water supply system, and some 12,500 (9% of the total) have a self-organized water supply. The number of commercial and industry connections to the public water supply system varies by municipalities, with a peak of 2,300 connections in Ohrid, indicating the relatively large number of tourist facilities in the municipality. The total average annual volume of water abstractions for the listed uses is estimated at 14 mill m^3. The overall unit water production (water input into the systems) equals 331 l/cap/daily, whereas the unit water consumption equals 136 l/cap/daily, resulting in large ratio of non-revenue water (59% for the basin as a whole).

Table 4.1: LOW: Water abstraction for Domestic, Public, Industry and Tourism Use by Municipalities[18]

Municipality	Administrative Unit	Population	Population connected to central WS system	Number of HH connections	Number of comm/ind connections	Total water input volume (m3/year)	Total billed consumption (m3/year)	Unit water production (lcd)	Unit water consumption (lcd)	Non-revenue vs. total water input ratio
Pogradec	Buçimas	15,687	45,910	11,772		3,100,059	1,843,278	185	75	59%
	Çerravë	7,009								
	Dardhas	2,182								
	Pogradec	20,848								
	Hudenisht	5,990								
Debrca		3,994	1,876	1,051	22	217,614	188,766	318	276	13.3%
Ohrid		51,850	46,937	29,400	2,301	8,916,955	3,091,128	520	180	65.3%
Struga		24,498	21,119	14,150	562	1,771,346	619,187	230	80	65.0%
TOTAL in LOW		132,059	115,842	56,372		14,005,974	5,742,359	331	136	59.0%

Map 4 shows the abstraction locations in the North Macedonia part of the LOW. Major part of the abstractions are either wells (pumped groundwater) or captured springs with varying capacities. However, four locations were also identified where water from Lake Ohrid is directly pumped, treated and used for water supply.

As a specific problem related to water abstractions, the non-revenue water is very high in all cases (Table 4.1). The extent and impact of the underlaying causes for this situation, such as physical water losses, unaccounted-for water, etc., are beyond the scope of this analysis. However, the high non-revenue water ratios lead to an undisputable conclusion related to presence of significant inefficiencies in utilities' operation, thus overuse of water resources.

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[17] WFD Reporting Guidance 2016, Final Draft 6.0.1, 23 September 2015.

[18] Source: North Macedonia: "Water Supply and Wastewater assessment of existing situation and Gap Analysis", The EU Operational Programme for Regional Development 2007-2013, Eptisa (2015); Albania: International Benchmarking Network for Water and Sanitation Utilities (IBNET, 2015).

4.1.2 Wastewater discharge (Households, Public Sector and Tourism, Point Source)

Alike water supply, organized waste water management (WWM) service in the LOW is provided by municipal communal public enterprises (CPE). The coverage of the population with WWM service varies significantly between the LOW municipalities (Fig. 4.1 and Annex 3). The overall ratio of households connected to public wastewater collection system for the basin equals 72%; the remaining 28% are assumed to use septic tanks for discharge of waste water. However, the ratios of population connected to central WWM system varies from 11% in Debrca municipality, 61% in Pogradec, and roughly 84% for Ohrid and Struga municipalities.

Municipality	Population	Population connected to sewer/ WWTP	Septic tanks
Pogradec	51,716	31,313	20,403
Debrca	3,994	449	3,545
Ohrid	51,850	43,104	8,747
Struga	24,498	20,656	3,842
Total	132,059	95,521	36,537
		72%	*28%*

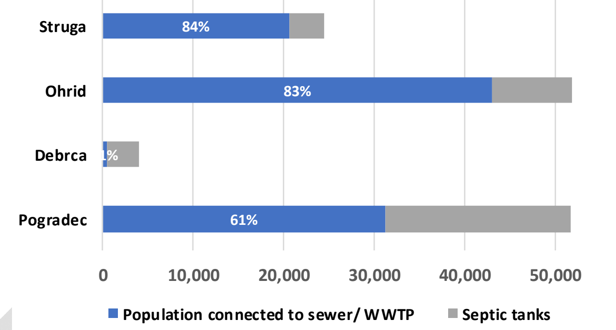

Figure 4.1: LOW: Wastewater Management Service Coverage by Municipalities (2015)[19]

Another important aspect related to WWM in the LOW is the presence of a large number of tourists in the region (section 2.2), and in particular the distribution of visitors and overnights throughout the year, which creates significant imbalances of pollutant load to water bodies (Figure 4.2: LOW: Distribution of Tourists and Overnight Visitors in Ohrid and Struga (2015 - 2017)). Based on available data, roughly 73% of the tourists visit the Lake Ohrid region in North Macedonia during the summer period (May through September), and even over 85% of the overnights take place during the June – October period. It is assumed that a similar pattern of visitors is applicable also on the Albanian part of the basin.

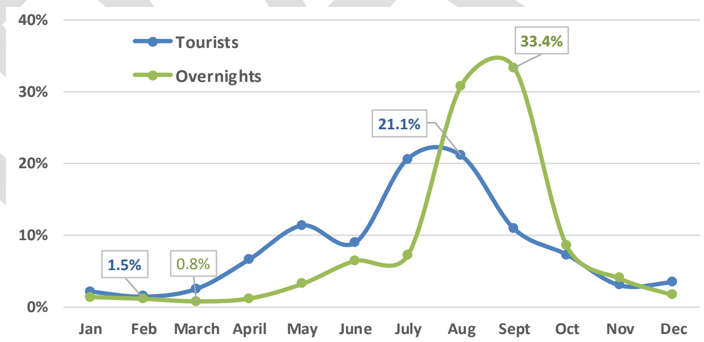

Figure 4.2: LOW: Distribution of Tourists and Overnight Visitors in Ohrid and Struga (2015 - 2017)[20]

At present there are two main/central waste water treatment plants (WWTP) in the LOW – WWTP Vranishta near Struga and WWTP Tushemisht in Albania (Map 10). In addition, there are several decentralized small-scale WWTPs on the North Macedonia part of the basin targeting mainly local tourist facilities (e.g. Campsite in St. Naum, Campsite in Radozda, Biser Hotel in Kalishta, etc.).

WWTP Vranishta is operational since 1988, and has a total installed capacity of 120,000 population equivalents (PE). The current maximum load of the plant equals roughly 80,000 PE, of which 64,000 PE from local population connected to the plant and roughly 15,000 PE (as a daily maximum) from tourists residing in facilities around Ohrid and Struga that are connected to the central WWM system/WWTP. Two primary waste water collecting branches

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19 Source: Ibid.

20 Source: State Statistical Office of North Macedonia

are connected to the WWTP with total length of toughly 40 km, covering a perimeter around the lake from the village of Peshtani south of Ohrid, the city of Ohrid and several major villages to the North-east, the Ohrid-Struga shoreline, the city of Struga, and the Elen Kamen-Struga section along the lake north-west of Struga. There are a total of 13 pump stations for transport of collected waste water in the primary sewer branches[21].

WWTP Vranista employs an oxidation ditch process, wherein two units/reactors are used for the wastewater treatment process in a cycle. The influent is mixed from both volumes of wastewater from the Ohrid and Struga sides. Subsequently, an influent pump station inside the plant lifts the wastewater to a mechanical screen unit and pre-treatment channels. Two spherical reactors are followed by channels and the influent is biologically treated using activated sludge. After the biological process, water is conveyed to the clarifiers to settle activated sludge by gravity, whereupon the treated water is discharged into Black Drin river. Equipped chlorination channels are usually used for final disinfection before discharging.

The WWTP is equipped with two reactors to mature the condition of the activated sludge and a gravity thickener is used to separate the sludge component by settling. After the thickening process a dual-unit belt filter press is used to dewater the thickened sludge using a polymer coagulant for a dewatering aid. Finally, the dewatered sludge is placed onto sludge drying beds under sunlight. Dewatered sludge is given to nearby farmers free of charge, which functions well and eliminates the need to find a final dumping site for the dried sludge.

According to data from the referenced study, the BOD, COD and total suspended solids components taken at the WWTP influent show significant fluctuations throughout the year, but when only data for recent years are compared, influent records showed a relatively constant tendency for the influent contents to be more concentrated during the summer and less in the winter. The BOD in the influent tends to peak in July and August, ranging around 125-131 mg/L during 2008-2011; COD is usually analyzed as CODCr and usually peaks in the summer, ranging around 200-274 mg/L during 2008-2011. Total suspended solids show no clear seasonal tendencies, with recorded values fluctuating significantly.

With regard to the water quality components in the effluent for the 2005-2011 period, BOD remained below the criteria regulating at 25 mg/L or less throughout the year; COD showed below the limit at 125 mg/L throughout the year[22]. Total suspended solids sometimes exceeded the limit of 35 mg/L but averaged between 12 and 31 mg/L. Thus, the average annual BOD reduction ratio for the stated period ranges between 79.8% to 92.8%, COD between 69.5% to 93.5% and the reduction of total suspended solidsa varied between 80.3% and 97.9%.

Identified key problems resulting in inefficient operation of the Lake Ohrid central WWM system in North Macedonia include:

- ✓ infiltration of groundwater and water from the lake into the system;
- ✓ intrusion of stormwater in the system (lack of separate drainage system for stormwater);
- ✓ lack of information on existing system inventories;
- ✓ defective pump stations; and
- ✓ inefficient operation of the WWTP as a result of variation of effluent quality (due to ground and storm water inflow)23.

WWTP Tushemish in Albania is operational since 2009. The plant has an installed capacity of 40,000 PE; the current load is roughly 31,000 PE. The plant is located near the village of Tushemisht, and by and large covers the city of Pogradec and surrounding settlements along the lake in the Buçimas Administrative Unit[24].

The plant is designed to achieve the effluent discharge standards of: 25 mg/L of BOD,125 mg/L COD, and 1000 MPN faecal coliforms/100 ml. The effluent meets thesestandards. It is envisaged that nutrient removal will be progressively introduced to reduce eutrophication load on Lake Ohrid, as follows: 2 mg/L P from 2017 and 15 mg/L N from 2027.

The negative impact (pollution load) from discharge of waste waters per separate water bodies is estimated based on the following assumptions:

- ✓ population (not) connected to central WWM system/WWTP (Fig. 4.3);
- ✓ maximum daily number of tourists (not)connected to central WWM per WB;

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21 Source: “Data Collection Survey for Ohrid Lake Environmental Improvement”, Final Report. Japan International Cooperation Agency (JICA), MoEPP (October 2012).

22 Reference: Council Directive 91/271/EEC of 21 May, 1991 concerning urban wastewater treatment.

23 Source: Ibid.

24 Sources: “Environmental Impact of The Pogradec Wastewater, Estimated Through the Global Pollution Index Method”; The Annals of “Valahia” University of Targoviste (2010); “Wastewater Treatment and Current Sludge Management Practices in Pogradeci Region”; Agricultural University of Tirana (2018).

- unit load of BOD for the population and tourists (60 grams per capita daily) and the industry (assumed 15% of residential load); and
- BOD removal ratios of 90% for the WWM system and 30% for septic tanks25.

Summary of the results from the analysis are given in Annex 3 and Map 10.

In general, critical zones (WBs) in this regard are the ones with discharges not connected to sewerage network, which include:

- the south-east section (WB Velidab – i.e. predominantly tourist locations at Trpejca, Ljubanishta and St. Naum);
- North-west section (WB Kalishta and Radozda) along the lake in North Macedonia;
- the North-west section along the lake in Albania (WB Lin);
- WB Çeravë and WB Pogradec in Albania, mainly as a result of important part of the population and tourists not connected to WWM system; and
- AWB Studenchishki kanal near the city of Ohrid.

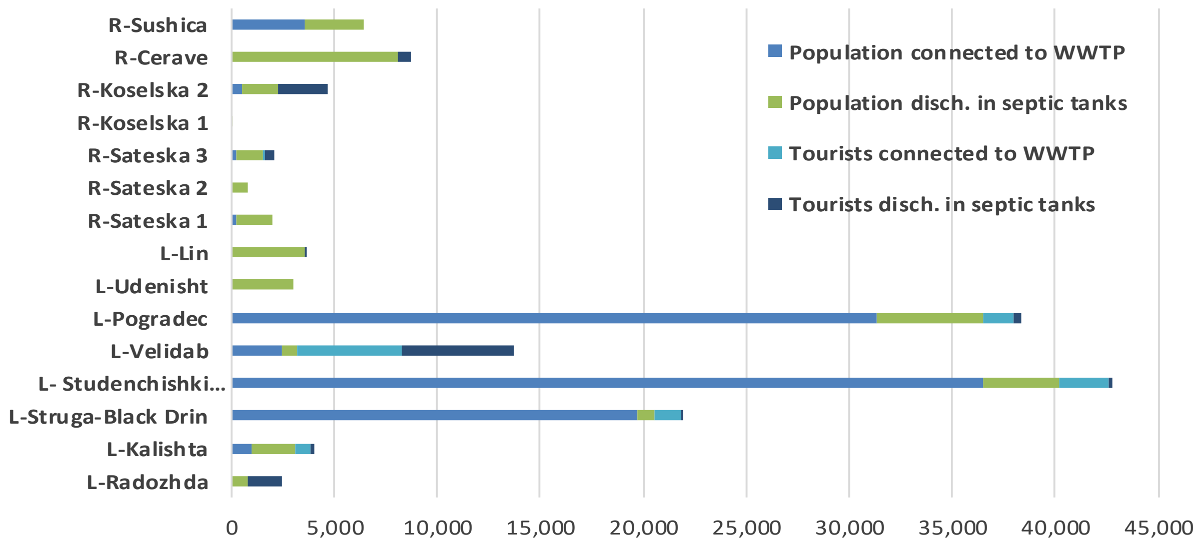

Figure 4.3: LOW: Waste Water Service Coverage by Water Bodies (Population and Tourists – Max Daily Visitors)

4.1.3 Waste Management

Dominant form of organization regarding waste management (WM) in the region is the existence of service companies (utilities) providing collection and disposal of solid wastes generated by the population and the industries on a municipal level. Table 4.2 and Map 11. provide key information regarding management of wastes in the LOW[26].

Overall, as is the case with water supply and WWM, the WM service coverage varies between municipalities in the basin. The unit generation of solid waste in the basin ranges from 0.55 kg per capita daily in Debrca to 1.0 kg/cap/day in Pogradec.

In addition, notable difference is identified between unit waste generation in urban areas, where it goes up to 1 kg/cap/day, and rural areas frequently having 0.4-0.5 kg/cap/day.

For the basin as a whole, the total daily volume of municipal solid waste generated equals 118 tons, or nearly 43,000 tons/year.

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[25] Adopted from: “Data Collection Survey for Ohrid Lake Environmental Improvement”, Final Report. Japan International Cooperation Agency (JICA), MoEPP (October 2012).

[26] Source: “Thematic Report on Socio-Economics of the Extended Drin River Basin; The Global Water Partnership – Mediterranean (GWP – Med), November 2017.

Table 4.2: LOW: Status of Waste Management

Municipality	Administrative Unit	Population	SWM service coverage	Waste generation			Waste disposal	
				kg/cap/day	tons/day	tons/year	Controlled landfills	Illegal dumps
Pogradec	Buçimas	15,687	90%	1.0	51.7	18,876	15,021	3,855
	Çerravë	7,009						
	Dardhas	2,182						
	Pogradec	20,848						
	Hudenisht	5,990						
Debrca	N/A	3,994	53%	0.55	2.2	802	0	802
Ohrid	N/A	51,850	100%	0.9	46.7	17,033	15,670	1,363
Struga	N/A	24,498	80%	0.7	17.1	6,259	5,320	939
TOTAL in LOW		**132,059**	**91%**		**118**	**42,970**	**36,012**	**6,959**

In terms of quality and environmental standards of the discussed WM service, it should be pointed out that it is by and large at a low level. Thus, the service is mostly centered around municipal centers and larger villages, leaving the smaller, rural settlements without any organized service. In addition, even for the bigger urban and rural settlements that do have organized WM service, it is limited to collection and transport of communal waste to a central, designated or ‘controlled (authorized) municipal’ landfill. The rural settlements are thus forced to manage the waste on their own, which in most cases ends up with citizens transporting waste to a village dump.

The management of the special waste types in the LOW largely remains an unanswered aspect. In particular this refers to management of hazardous wastes, such as medical waste. To the extent of consultants’ knowledge and experience from the region, bulk part of the hazardous waste components found in communal solid waste streams (e.g. batteries) end up in municipal landfills.

There are three larger (municipal) landfills in the basin (Map 11)[27]. Regrettably, these landfills are not compliant with the EU standards. Collected wastes are commonly dumped over the edges of the sites, and a bulldozer is used to compact the deposits and place cover material over a portion of the exposed waste. Quite often there does not appear to be an accessible amount of soil material for creating a waterproof soil cover, resulting in significant volumes of disposed wastes continuously opened to the atmosphere. Landfill fires occur frequently. Pollutants, mainly decomposed organic matter, metals and fuel, from the bottom of the landfills seep into the ground and travel through groundwaters, thus making the pressure from improper WM among the key threats to water resource quality in the LOW.

4.2 INDUSTRY

Industrial production facilities in both Albania and North Macedonia are subject to environmental permitting. The permitting process is governed by environmental legislation, and linked to environmental impact assessment procedures.

In Albania the system of environmental permitting is established by the Law on Environmental Impact Assessment, the Law on Environmental Permitting, and the Law on Licenses, Authorizations and Permits in the Republic of Albania. Three types of environmental permits, depending on the thresholds of industrial activity, production and capacity, are issued: Types A, B and C. The State Inspectorate of Environment and Forests is responsible for inspection, compliance checking and the enforcement of environmental permit requirements[28].

In North Macedonia the permitting process is also managed by the Ministry of Environment and Spatial Planning. Depending on the size and capacity of the industrial activity/plant, two types of environmental permits are issued – Type A and B. Type A refers to major production capacities and is managed directly by the Ministry. Type B permits are required for smaller production processes, and are issued by environmental departments within Local Government Units (municipalities).

Major part of the industry in the LOW is located close to the urban centers of Pogradec, Ohrid and Struga. The most common industrial activities on the Albanian part of the basin include mineral (iron-nickel) exploitation and chromium mining, while on North Macedonia part construction industry (concrete production), food processing (poultry farms), wholesale and retail trade, transport.

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27 The municipal landfill near Struga, although formally outside of the LOW, is located practically on the very edge of the basin and is thus taken into consideration.

28 Source: http://North.themisnetwork.eu/tools/standard-operating-procedures/albania/pollution-and-nature/environmental-permits.html.

A total of 26 registered industrial operators eligible for environmental permitting as per the existing national regulations[29]. The type of facilities (IPPC A or B)[30] and their distribution by municipalities and SWB is presented in Map 11 present overview of the locations of registered industrial sites in the basin.

Municipality	Administrative Unit	Industry permits	
		Type A	Type B
Pogradec	Çerravë		1
	Pogradec		1
	Hudenisht		9
Debrca	N/A		3
Ohrid	N/A		6
Struga	N/A	1	5
TOTAL in LOW		1	25

WB Name	Industry permits	
	Type A	Type B
R-Cerave		1
Hudenisht		10
R-Sateska 1		1
R-Sateska 2		2
R-Koselska 2		5
R-Sushica		1
Struga-Drim	1	4
Kalishta		1
Total	1	25

Figure 4.4: LOW: Industry per Municipalities and WBs

4.2.1 Abstraction for industrial water supply and waste water discharge from industry

All these industries use both drinking and technical water in their operation processes. Depending on their needs and possibilities, drinking water is commonly supplied via a public water supply system, and technical water via separate water supply systems from reservoirs or rivers, or from own wells usually located in their vicinity. Besides water supplied from a public system that is regularly measured, there is no precise data on the used amount of technical water from the wells, rivers or reservoirs. There are only isolated cases where the total amount of water used in the production is regularly measured.

Industrial and other similar operations in the basin create important pressure to basin's water bodies caused by the emissions of various pollutants from the technological processes. Industrial waste, wastewater and storm water discharges from industrial facilities are among the contributors to the degradation of the aquatic ecosystems.

4.2.2 Contaminated/Abandoned Industrial/Mining Sites

In addition to eutrophication, Lake Ohrid also is under pressure of metal pollution near the sites of abandoned old chromium, iron, nickel and coal mines outside Pogradec in Albania. Preliminary samples that Albanian scientists have collected at the Guri i Kuq mine show concentrations of metals in the near shore lake water that are importantly high. It is likely that muds and sands in these near shore locations are also contaminated, and this may pose a risk to the invertebrates, fish and birds living in this section of the lake. It is possible that local drinking water sources are at risk of being contaminated.

4.3 AGRICULTURE

Unsustainable practices in agriculture production can cause serious pressures on natural resources, especially soil and water, affecting its ecosystem services. In general, agriculture causes a diffuse (non-point) pollution of surface and ground water bodies with nutrients, pesticides, sterile sediment and organic polluters. Overview of agriculture activities in the LOW and the pressure on water resources created by these activities is provided further; detailed analysis is included in Supplement III.

Agricultural production in the LOW is by and large organized within small households. Out of the whole number of households in the Southwestern region in North Macedonia, more than 72% are smaller than 1 ha, while more than 95% are up to 3 ha, divided into several parcels with average size less than 0.1-0.2 ha. Statistical data for Albania reveals similar situation as well, regarding the farm and parcel size. Most of the production is for self-consumption or for green markets during the touristic season.

Estimation of the land use in the North Macedonia part of the LOW is based on the Land Parcel Identification System (LPIS), which allows identification of land use on a parcel level within several categories. For the Albanian part of the basin statistical data coupled with photo-interpretation of a satellite image from 2018 vegetative season (Sentinel 2) was used for identification of areas under different categories of land use.

Taking into consideration identified land use types and areas under certain land use type, the intensity of agricultural production and location, it can be concluded that there are significant differences in the intensity of

[29] Sources: Albania: "Pogradec Terrestrial/Aquatic Territory Protected Landscape Area Management Plan", Final Report (2013); North Macedonia: Municipal records (Ohrid, Struga, Debrca) of issued IPPC B permits.

[30] IPPC – Integrated Pollution Prevention and Control.

pressure from agriculture within each of the WBs on water resources. To this end, water bodies in the watershed can be categorized in four groups, as follows:

- ✓ water bodies with small agricultural area and dominance of low intensity field crop production and natural vegetation, distant from Lake Ohrid or its tributaries, like: Koselska 1;
- ✓ second group of water bodies are those with significant areas of agricultural land distant from Lake Ohrid but close to one of its tributaries, like: Sateska 1 and 2 in North Macedonia side Çeravë WB in Albania;
- ✓ the third group of water bodies are those with small areas of low intensity agricultural production that are close to Lake Ohrid, like: Velidab, Studenchishki kanal, Kalishta, Radozda, Lin and Undenisht; and
- ✓ the fourth group of water bodies that have heavy influence on water resources due to big areas of intensive agricultural production like: Pogradec, Sateska 3, Koselska 2, Sushica, Struga-Drim and Lin.

The total agricultural land in the LOW equals nearly 25,500 ha including pastures, while arable land is 9,960 ha or 31.9% of the total (Table 4.3).

Within the arable land the category 'field crops' covers the majority of the agricultural land with over 8,225 ha (92.6%). Most of the area under field crops, according to data from performed field visits, consists of cereal crops: wheat and maize, and small areas of forage crops, mining that the majority of this category is under in-extensive, low input systems of agricultural production. There are certain areas with vegetable production within the category of mixed land use mainly within the house yards in the villages, like: potato, cabbage and beans production. There is a more significant production of beans in the Çeravë WB. Orchard and vineyards are more intensive systems of agricultural production with higher inputs of fertilizers and pesticides. Majority of these three land use types with a total of 10.44% of the agricultural land are spread in Koselska 2, HMWB Sateska 3, Çeravë and Pogradec WBs. These categories of land use, having in mind the intensity of production and inputs and its closeness to the lake shore, can be designated as areas with high risk for pollution of water resources.

Table 4.3: LOW: Land Use

Water Body	Land use (ha)						
	Field crops	Orchards	Perennial plantations	Mixed per. plantations	Vineyards	Pastures	Total
Lake Water Bodies							
L-Radozhda	21.5	0.7	0.8	0.0	1.6	23.8	48.4
L-Kalishta	118.4	0.1	0.4	0.3	0.0	80.1	199.4
L-Struga-Black Drin	345.8	23.8	5.6	0.4	0.5	118.8	494.9
L-Sateska							
L-Koselska							
L-Ohrid bay							
L-Velidab	137.9	4.6	39.8	1.2	20.4	4,872.6	5,076.6
L-Bay of St. Naum							
L-Tushemisht							
L-Pogradec	950.1	67.4	11.5	0.0	62.4	516.3	1,607.8
L-Udenisht	256.3	17.9	0.0	0.0	16.6	53.1	343.9
L-Lin	204.9	13.1	0.0	0.0	12.2	34.6	264.7
L-Lake Ohrid-Pelagic							
River Water Bodies							
R-Sateska 1	2,054.4	14.6	9.4	0.0	0.4	4,844.1	6,922.8
R-Sateska 2	429.3	91.4	17.7	0.0	106.6	293.4	938.3
R-Sateska 3	810.4	153.5	18.5	1.1	35.1	247.2	1,265.8
R-Koselska 1	12.6	0.6	0.0	0.0	0.0	779.7	793.0
R-Koselska 2	943.0	315.3	28.1	0.9	70.3	1,533.1	2,890.8
R-Cerave	1,370.5	162.0	16.6	0.8	107.0	494.2	2,151.0
R-Sushica	538.4	184.5	41.5	2.2	24.3	1,578.5	2,369.4
AWB- Studenchishki kanal	32.2	4.1	3.7	0.0	9.3	67.3	116.6
Total	**8,225.8**	**1,053.8**	**193.6**	**6.8**	**466.6**	**15,536.8**	**25,483.3**
	32.3%	***4.1%***	***0.8%***	***0.03%***	***1.8%***	***61.0%***	

The total area of greenhouses in the basin is negligible. Vegetables are estimated on approx. 1,540 ha of the arable land. The dominant crops within the vegetables group are beans and onion. Land use categories like orchards, vineyards and perennial and mixed perennial plantations are more intensive systems of agricultural production with higher inputs of fertilizers and pesticides. Majority of areas within these land use types, which cover 1,721 ha (17.3%) of the arable land of the catchment area, are mainly distributed within Koselska 2, Sateska 2 and 3, Struga-Black Drin, Sushica and Çeravë and Pogradec WBs.

The remaining part of the agricultural land are under pastures, which cover 15,537 ha (61%). Areas within this land use category are mainly covered with meadows, permanent grass or natural pastures. This category of land use have a very limited human attention, due to what cannot be considered as areas with potential risk of diffuse pollution.

4.3.1 Diffuse pollution – fertilizer and pesticide use

Fertilizer and pesticide use in agriculture is a prerequisite for sustainable production in terms of yields and quality of the agricultural products. For these reasons its usage especially in the modern and intensive systems of production is unavoidable practice. Depending on the area of agricultural land threated and its vicinity to water resources, inputs of high quantities of agro-chemicals, especially if used without plans and programs for its use (fertilization and plant protection plans), can cause serious damage to natural resources. If used in an excessive quantities the mineral fertilizers and pesticides on a long run can cause contamination of soil and ground and surface water. In addition, excessive quantities of mineral nutrients can have negative impact on the soil production potential and agro-biodiversity, as well as negative economic impact for the producers.

The total agriculture area treated with fertilizers in the LOW is estimated on 9,960 ha, which is less than 50% of the total agriculture area. The estimated total annual quantities of applied fertilizers equals 3,950 tons, with average input of 400 kg of mineral fertilizers per hectare in one vegetation season. The total nitrogen applied is estimated on 637 tons/year, while the phosphorus and potassium quantities are estimated on 314 and 332 tons/year respectively. It should be noted that in these figures the quantities of nutrients applied with organic fertilizers are not included.

The distribution of fertilizer quantities per water body catchments depends to the total agricultural area and the structure of land use types. Water bodies with highest fertilizers inputs are: Çeravë (647.4 t/year); Koselska 2 (632.1 t/year); Pogradec and Sateska 1 with more than 560 tons/year; Sateska 3 and Sushica with quantities of about 270-280 tons/year; and Sateska 2 with more than 200 t/year (Fig. 4.5; Map 12). These quantities of fertilizers in some cases, due to closeness to the surface or ground water resources, represent serious direct threat to waters of Lake Ohrid (e.g. HMWB Sateska 3, Sateska 2 and Struga-Black Drin), or to its tributaries Koselska river (Koselska 2) or Çeravë. For these reasons particular attention to the optimization of fertilizers application and measures for improvement of the efficiency of nutrients uptake, should be paid in the future.

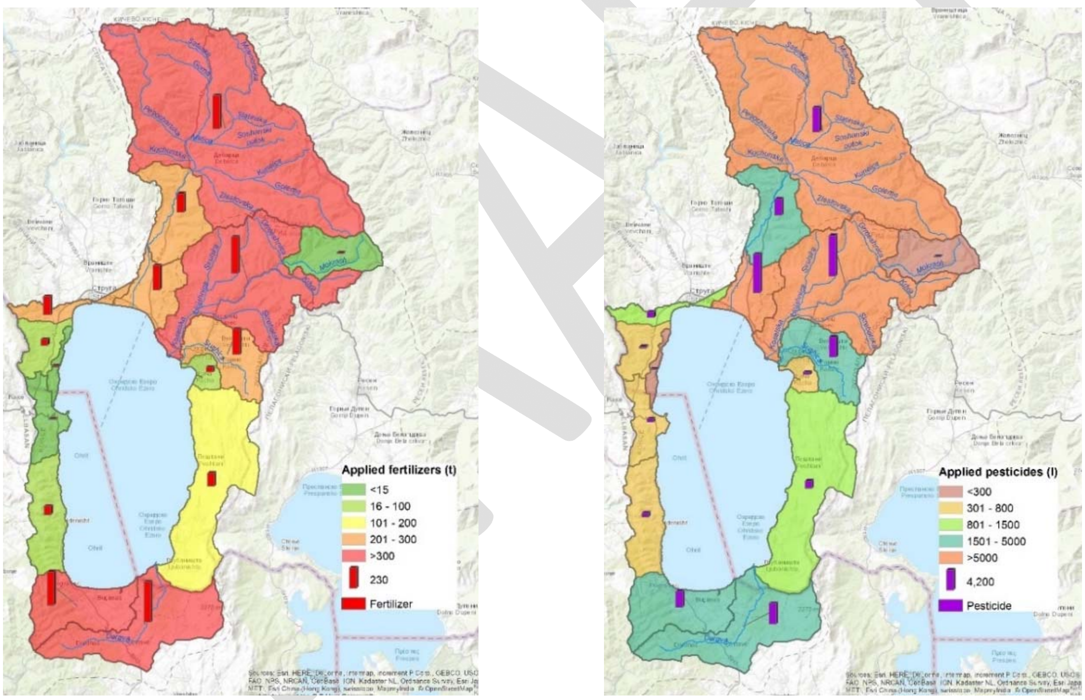

Figure 4.5. LOW: Fertilizer and Pesticide Use in LOW, by Water Bodies catchments

The retention of nutrients in soil and ground water is result of the excessive quantities or biased application of fertilizers. According to the analysis the yearly accumulation of nitrogen in the basin yields 135.96 t and 118.45 t/year of phosphorus, while potassium is in deficit of more than 252 t/year, meaning that this element is amended from the natural soil abundance. The highest quantities of retention are in Sateska 1, Sateska 3 and Koselska 2 in the North Macedonia part of the basin, and Çeravë on the Albanian side. The quantities of accumulated nutrients every year are alarming, and emphasizes the need of sound and concrete action for optimization of fertilizers use, since nutrient pollution might have a serious negative impact on the aquatic environment. Excessive presence of nitrogen and phosphorous in the water causes algae to grow faster than ecosystems can handle. In addition, the excessive use of mineral fertilizers, especially inorganic nitrogen, leads to acidification of soil, also known as agrochemical pollution.

The use of pesticide is estimated on a total area of 7,408 ha, with a total input of 45,400 liters of pesticides, or on the average 6.12 l/ha. The net area of vineyards and orchards on WB level plus an estimated percentage of field crops area are used as basis for calculation of areas treated with pesticides. For estimation of the quantities of pesticides used per hectare agricultural land, data collected during field survey and field historical field survey data were used as well as data from the local authorities regarding the quantities of used pesticides in the region. The average quantities of applied pesticides significantly differ depending to the type of pesticide or the crop type. For instance, in average pesticides in vineyards are applied 2-3 times in quantities of 3-3.5 liters, while in cereals they are used 1-2 times per year in quantities of 2-3 liters, which is in line with the estimation of 6.8 l/ha as an average for all land use types.

Of the total treated area of 7,408 ha over 4,800 ha (64.9 %) are in water bodies catchments in the North Macedonia side of the basin, of which 3,124 (65%) are within three WB river basin (Sateska 1, Sateska 3 and Koselska 2). On the Albanian side the total treated area is 35% out of total 7,408 ha, while more than 70% of the treated area is in Çeravë and Pogradec WB watersheds (Fig. 4.5; Map 13).

Taking in consideration the location of the above-mentioned water bodies it can be concluded that the first two – Koselska 2 and Sateska 3 – can generate serious direct diffuse pollution to Lake Ohrid and the groundwater as well through leaching of nitrogen and residues of pesticides, while the other three water bodies have direct influence on Lake Ohrid tributaries: Sateska, Çeravë and Sushica rivers. Nevertheless, due to the high input of pesticides in these water bodies despite its indirect influence on Lake Ohrid, they can be considered as zones with high risk of diffuse pollution of the lake. On the other hand, the pesticide loads in some water bodies are with negligible quantities, such as: Koselska-1 and Radozhda with 29.7 and 87.6 liters respectively.

4.3.2 Abstraction/hydrological Alteration of Surface and Ground Water for Irrigation

Although the LOW is situated in a region with 662.3 mm/year as total sum of precipitations (period 1970-2000) and thus is considered as more humid than the country averages, still irrigation, especially in the modern and intensive systems of production, is an essential agro-technical measure for achieving of high quality and stabile production. As mentioned before, of the total agricultural land nearly 83% are field crops, of which only cereals, vineyards and some forage crops can be cultivated under rain feed conditions, while all other crops within this category need to be irrigated.

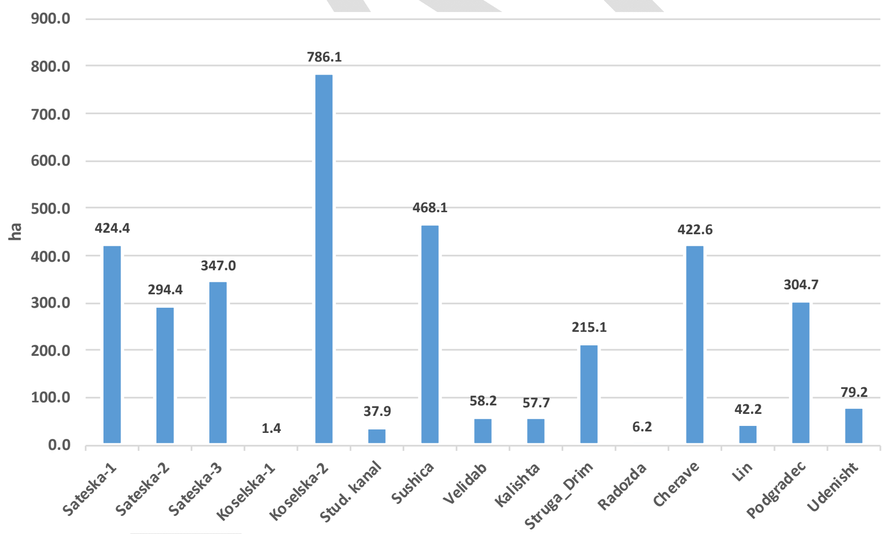

Figure 4.6: LOW: Irrigated Agriculture Area by Water Bodies catchments

Estimation of the irrigated area in the watershed is based on the area occupied with certain categories of land use and field visits and delineated with support of available graphical data sets with GIS technology. The territory of irrigated arable land on both sides of the lake is estimated on 3,545 ha, of which almost 76.1% are in North Macedonia, mostly situated within four WB Sateska 1 and 3, Koselska 2 and Sushica catchments. On the Albanian side, the total irrigated area is around 850 ha, of which more than 85% is situated within Çeravë and Pogradec WB watershed (Fig. 4.6).

In terms of abstractions of surface waters there are 4 small water reservoirs in the basin that are used for irrigation. According to the existing data, there is no functional irrigation schemes in place within the basin, except some cases of a very small areas where small irrigation schemes were functioning in the past. Abstraction of surface water is not a common practice in the basin and is used in some areas near to a big water courses, like Koselska, Sateska or Çeravë river, or areas very near to the lake, like Tushemisht, Studenchista, Hudenisht, etc. Surface abstraction is mainly used for furrow irrigation and mostly applied on spring crops that are traditionally cultivated in rows which enables application of this technique. For these reasons, it is estimated that only a small part of no more than 10-15% of the irrigated area is irrigated with abstraction of surface water.

Based on available data from recent masurement, in other basin, the level of groundwater is decreasing mainly as a result of unsustainable irrigation practices. According the available statistical data and on the basis of applied crop structure, it can be estimated that the biggest part of the groundwater used for irrigation in the LOW is applied through furrow irrigation. Almost 53% of the irrigated area in North Macedonia and 83% in Albania are irrigated with furrows, while a smaller part is irrigated through sprinkler irrigation.

4.3.3 Animal Husbandry – Farming

The total number of animals in the LOW is over 39,300 heads and nearly 94,000 units of poultry, according to data from the MAFWE`s Regional Office in Ohrid and the Regional Office of MARD in Korcha. The total number of cattle is 4,313, almost evenly distributed on the both sides of the lake catchment. In most cases agricultural holdings are breeding dairy cattle in a small heard of less than 5 or in many cases 2-3 heads. The total number of dairy cattle is 48,2% out of the total number of cattle, mainly distributed within several WB catchments which according the previously analyzed land use, can provide a solid base for livestock, like: Sateska 1, Koselska 1, Pogradec and Çeravë.

The total number of sheep in the basin is estimated to 24,462 heads, kept in small herds of less than 500 heads and mainly located at remote location in rural areas. More than 60.1% of the total number of sheep are located within four WB catchments: Sateska 1, Struga-Black Drin, Pogradec and Çeravë. Estimated number of goats is 9,768 distributed similarly like sheep within several WB catchments: Sateska 1, Koselska 2, Pogradec and Çeravë. Almost 71% of the total number of goats are situated within these four water bodies watersheds. Pigs are represented in a very small number of just 760 units, of which nearly 50% are in Sateska 1 WB catchment.

Table 4.4: LOW: Animal Husbandry

Water Body	Animal husbandry in animal units (AU)				
	Cattle	Sheeps	Goats	Pigs	Poultry
L-Radozhda	43,1	27,2	22,4	0,0	33,7
L-Kalishta	92,3	61,3	12,4	0,0	14,5
L-Struga-Black Drin	192,1	220,0	31,8	0,0	26,0
L-Velidab	393,2	97,9	37,1	0,0	89,7
L-Pogradec	485,9	265,6	101,2	20,7	43,5
L-Udenisht	281,3	146,1	50,6	0,0	30,4
L-Lin	255,7	119,5	40,5	0,0	39,1
R-Sateska 1	575,4	482,2	214,8	65,6	99,7
R-Sateska 2	137,8	21,7	34,3	6,8	59,8
R-Sateska 3	202,9	16,8	4,4	0,3	39,9
R-Koselska 1	0,0	181,4	1,0	0,0	22,4
R-Koselska 2	719,4	169,8	69,0	1,5	179,4
R-Sushica	375,6	134,5	49,1	0,1	148,0
Cerave	1078,2	502,1	198,7	22,3	104,3
AWB_Stud Kanal	8,8	0,0	8,7	0,0	9,0
TOTAL	**4841,7**	**2446,1**	**876,0**	**117,1**	**939,6**

Other important aspects related to animal farming are the quantities of manure produced and its management. The quantities of manure produced per year within the LOW for each animal category converted into AU are presented in Fig. 4.7.

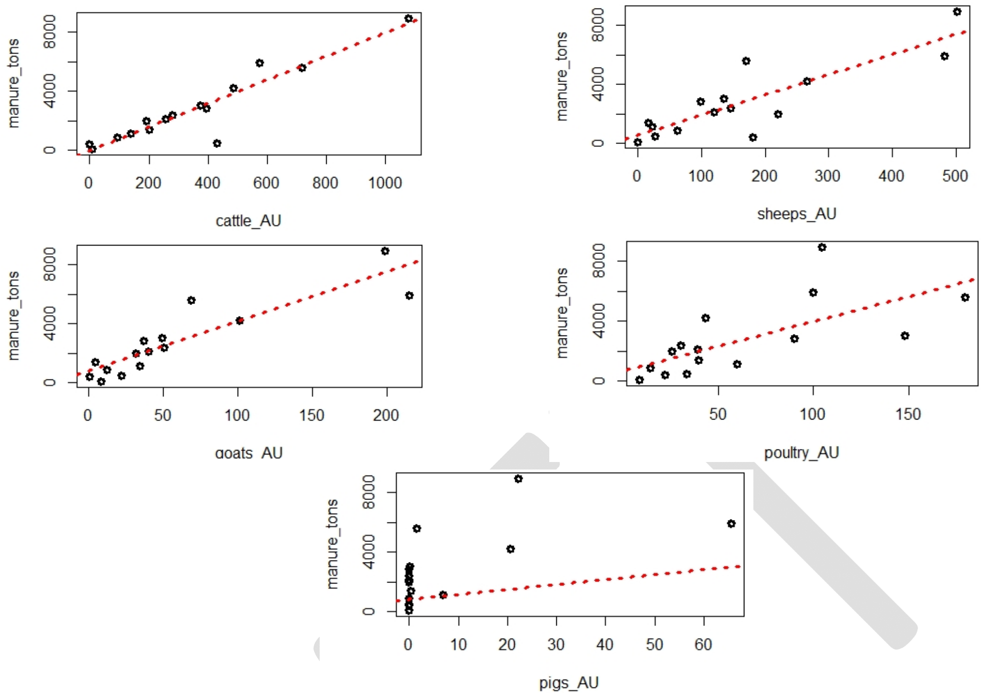

Figure 4.7: Correlation between manure production and AU of each animal category

The highest content of manure production is in WB Sateska 1 (5,909 t/year) and Koselska 2 (5,612 t/year) on the North Macedonia side and Çeravë (8,962 t/year) in Albania, which is result of the high number of cattle and sheep in these WB.

Application of manure on arable land is a fundamental measure for maintenance of the soil organic matter content. However, the quantities of produced manure are limited and insufficient to meet the actual requirement of arable land in the basin area. Another obstacle which affects the efficiency of the already limited quantities of manure is the inappropriate way of management. During the field visits it was observed that farmers in the basin do not practice proper storage of manure and its application. In many cases it is stored on open space uncovered for few months, or left as a small clumps in the field before being scattered and incorporated in the soil with ploughing. Until than the majority of nutrients are lost, and the efficiency of such managed manure is almost zero.

4.4 FISHERY AND AQUACULTURE

Overview of fishery and aquaculture activities/sectors in the LOW, as well as the pressures on water resources and biodiversity created by these activities, is provided further; detailed analysis is included in Supplement V.

4.4.1 Exploitation – commercial and recreational fishing

Although Fishery Master Plan for Lake Ohrid exists on both sides of the lake, adequate fish catch survey, in terms of catch structure (size, weight, age and sex) indicating the main determinants for controlling and proper protection of fishes in the lake, is lacking.

This is mainly a concern for the endemic Salmonid species in the lake – Ohrid Trout and Belvica – that are the main market demanded fish species. Adding poaching (illegal fishing), the pressure to these fishes has increased to a level of possible irreversibility of their populations.

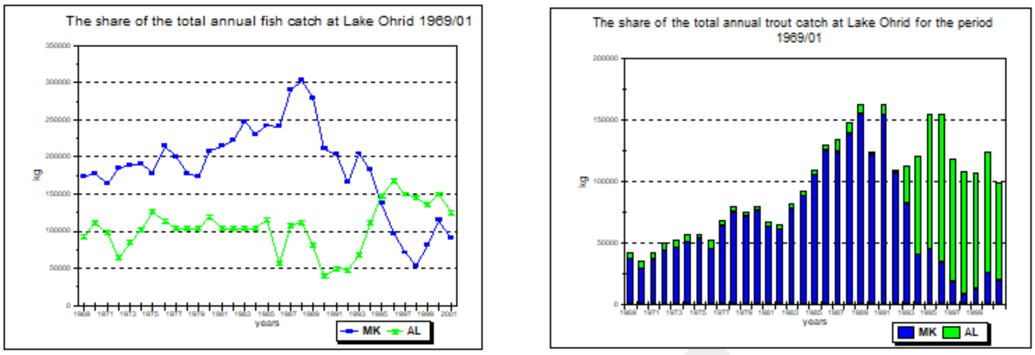

Figure 4.8: hare of Total Annual Fish and Annual Trout Catch at Lake Ohrid, 1969 – 200131

Despite the vast efforts in restocking of the lake with offspring of Ohrid Trout, which takes part every year on both sides with roughly 3,500,000 individuals for the whole lake, inadequate protection and unsustainable fishing practices are pushing towards inevitable further population destruction of these two fish species.

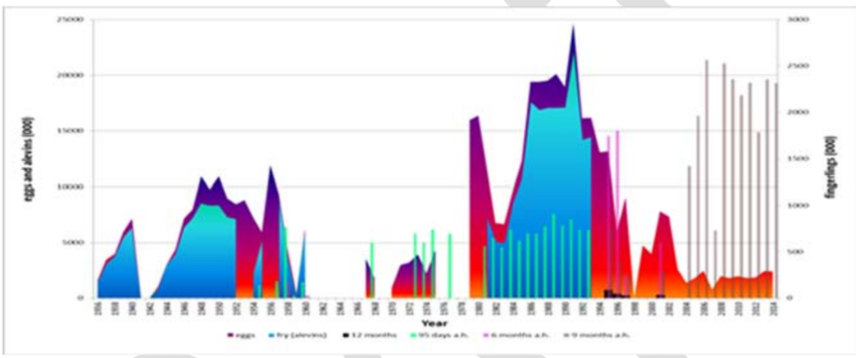

Figure 4.9: Lake Ohrid trout restocking on the North Macedonia side of the lake32

Lake Ohrid has in the past has been described as salmonid water. Yet, recent findings show that the lake is dominated by cyprinid species, both in terms of numbers and biomass. On the other hand, the destruction of salmonid species favors the bleak (small fish with biggest abundance in the lake), which in shortage of trout as a predator spreads all over the lake spatially and temporally, invading new ecological niches in the lake (e.g. pelagic) previously reserved for the trout. Thus, the common nutritive component for these two fish species – the zooplankton – becomes more affordable for the bleak unlike previously for the trout. Further, the misbalanced trout:bleak ratio also contributes to worsening of the water quality, in particular due to increased presence of excretive metabolites from the bleak that differ from the trout ones. Hence, very low exploitation of the bleak is just worsening the ecosystem characteristics.

Table 4.5: LOW: Commercial Fish Catch 2010 - 2016

Lake Ohrid - Fish Species and Catch (t)																
Fish species	Albania					North Macedonia					Total					%;
Common name	2010	2011	2012	2013	2014	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016	(2014)
Lake Ohrid trout	51.0	52.0	50.5	50.0	51.8	0.2	0.9	1.1	0.7	0.3	50.7	50.9	52.9			28.9%
Belvica	12.0	11.0	11.7	12.0	12.5	1.0	8.0	14.7	17.1	17.4	12.7	20.0	27.2			14.9%
Carp	5.0	4.4	4.2	4.0	4.9	3.6	14.3	21.7	11.3	5.2	7.8	18.3	26.6			14.6%
European eel						0.2	1.1	1.1	0.2	0.0	0.2	1.1	1.1			0.6%
Bleak	57.0	55.0	54.9	58.0	56.1	3.6	5.0	5.7	0.0	0.1	58.5	63.0	61.8			33.9%
Roach						0.0	0.6	0.0	0.0	0.0	0.0	0.6	0.0			0.0%
Chub	4.8	5.7	5.0	4.2	6.5	0.5	3.1	3.1	1.1	0.9	5.5	7.3	9.6			5.3%
Rudd						0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0			0.0%
Barbel						0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0			0.0%
Prussian carp	2.7	2.9	3.4	3.0	3.2	1.0	0.4	0.3	0.0	0.0	4.4	3.4	3.5			1.9%
Total (t)	**132.5**	**131.0**	**129.7**	**131.2**	**135.0**	**10.1**	**33.4**	**47.6**	**30.7**	**23.9**	**139.8**	**164.6**	**182.6**	**0.0**	**0.0**	**100%**

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31 Source: Spirkovski at all., 2002.

32 Source: HBI Ohrid Statistics.

4.4.2 Introduced Species and Diseases

There are six introduced (alien) fish species in Lake Ohrid at the moment. During the performance of Lake Ohrid fish and fisheries monitoring program 2013/2015 the following situation was registered. The absence of the other four alien species is a result of used sampling (fishing) method, period of sampling and their very low abundance, yet there are sporadic evidences of their presence. At any rate, the two key alien fish species in the lake (stone moroko and the bitterling; Table 4.6) have already established stable population size and can be stated without significant harm to the native species.

Table 4.6: LOW: Registered Alien Species

Species Latin name	Species common name	Alien species (year of introduction)
Carassius gibelio	Prussian carp	+ (1983)
Gambusia holbrooki	Mosquito fish	+ (1940's)
Lepomis gibbosus	Pumpkinseed	+ (1990's)
Oncorhynchus mykiss	Rainbow trout	+ (1974)
Pseudorasbora parva	Stone moroko	+ (1970's)
Rhodeus amarus	Bitterling	+ (1990's)

4.4.3 Abstraction of surface water and diffuse pollution from aquaculture

At present abstraction of surface water for aquaculture takes place at the two hatcheries (trout restocking fish farms) in Ohrid (HBI) and Lin, as well as at three small fish farms on the Albanian part of the lake. The total extracted water volume equals roughly 2.5 mill m^3/year.

Diffuse pollution from aquaculture, although at a minimal level, is a result of the presence of both restocking fish farms in Ohrid (HBI site) and Lin. The amount of food (nutrient load) used for these fish farms is minimal, at roughly 3,000 kg/year at each site. There are no other fish farms (cages) in the lake at present. On the other hand, diffuse pollution from other activities (e.g. agriculture) expressed in agrochemical load in the lake affects the fish fauna in various manners. Of particular importance in this regard is the presence of pesticides and herbicides, which harm the fish physiology, result in metabolism changes and worst in genetic changes – masculinization or feminization of the opposite genders.

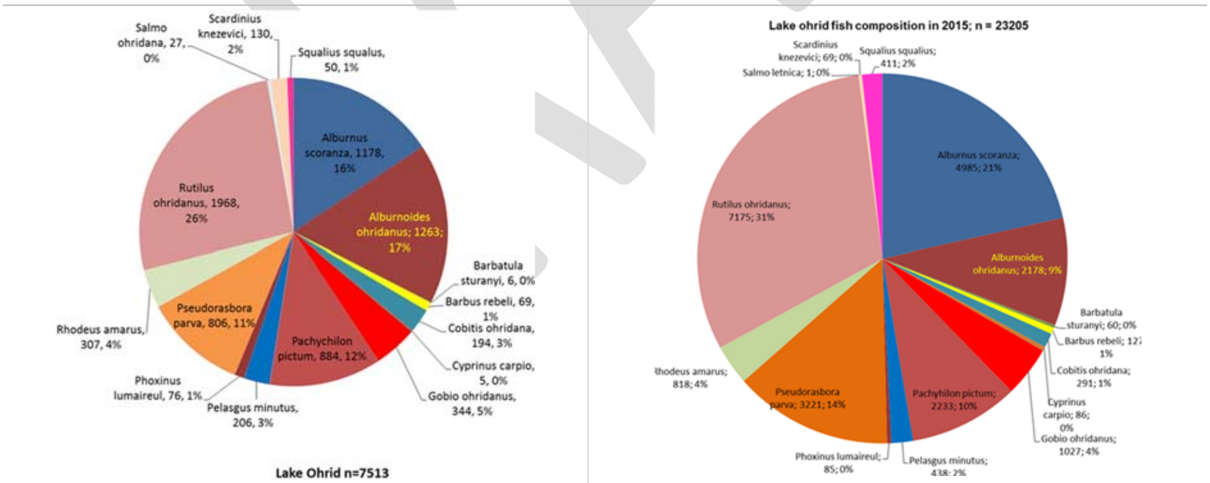

Figure 4.10: LOW: Fish Species Composition in Lake Ohrid, 2013 and 2015 Sampling Campaigns

4.5 COMMERCIAL AND LEISURE BOATING, ANGLING

Cruising and boating are important recreational and tourism activities in Lake Ohrid and commercial boating is an economic activity of importance for the local population. Based on information given by the Port Authority in Ohrid, there are two types of watercrafts used in Lake Ohrid: recreation and/or fishing boats (smaller vessels with length up to 12m, largely for personal use) and larger water taxi (sightseeing/passenger) boats used for public transport. There are a total of 2,268 recreation and fishing boats registered by the Port Authority since 1999, of which 500-600 of these are in regular use at present, and 4 sightseeing boats in use on the North Macedonia part of the lake. Nevertheless, it is also reported that some 40-50 private recreation boats are in use for transport of passengers on commercial basis. Data on the boats in use on the Albanian side of the lake are not available; it is estimated, however, that there are not more than roughly 200 small boats used for recreation and fishing.

Summary information on the commercial boat transport on Lake Ohrid is given in Table 4.7[33].

Table 4.7: Commercial Boat Transport in Lake Ohrid (North Macedonia)

Lake Ohrid boat transport	2014	2015	2016	2017	2018
Number of passenger boats	4	4	4	4	4
Capacity (passengers)	530	530	530	530	530
Total annual number of passengers	36,620	38,685	30,430	44,510	46,590
Total number of passenger kilometers	741,000	875,000	898,000	1,007,000	1,082,000
Average km/passenger	20	23	29	23	23

Cruising and boating can give rise to localized water problems including discharge from onboard toilets, physical disturbance by boat wakes and potential engine-oil spillage. Besides, leisure boating by violating the inland water navigation regulations causes additional stress and disruption of the fish ecology especially in the natural spawning period and the spawning grounds. Also, using boats and speedboats for poaching during the spawning period further worsens the situation.

Nevertheless, the biggest problem related to cruising and boating is the lack of proper infrastructure for docking and servicing used watercrafts. As a matter of fact, on the North Macedonia part of the lake there are only two ports that can be used for docking of passenger boats: a relatively small boat port in the very center of the town of Ohrid, and even a smaller one on the other side of the lake at St. Naum. In addition there are some 15 docking stations along the shoreline that are used by the private recreation and fishing boats. Thus, majority of the boats currently in use are forced to use the AWB Studenchishki kanal as a docking station (Fig. 4.11). However, besides lack of capacity, the ‘kanal’ is also not equipped with even elementary infrastructure and facilities for refueling and servicing of boats. The situation on the Albanian part of the lake, albeit the pressure from cruising and boating is much lower, is similar.

Figure 4.11: Boat Docking at Studenchishki Kanal Near Ohrid

Angling at present is reduced only to shoreline fishing and fishing from boats in the littoral zone, which is a result of the reduced trout population in the lake, contrary to the situation until the late 1990-ties when it was the main way of recreational fishing – spinners hook trawling for the local population as well for tourists. Thus, at present no threats of angling are deemed significant, with exception of poachers dealing with non-allowed fishing gears and methods (electricity, spears, scratch hooks).

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[33] Source: State Statistical Office of North Macedonia (2019).

4.6 FLOOD PROTECTION

4.6.1 Physical/Hydromorphological Alteration of Water Bodies

Floods are among the most challenging and recurring natural hazards in the LOW. River floods occur mainly in spring and autumn. Autumn floods resulting from heavy rainfalls are more sudden and have very high flows. Flash floods are common in mountain areas. Further, Climate change is forecasted to increase both the frequency and intensity of flooding and droughts in the basin. Shifting weather patterns will likely result in warmer and wetter winter seasons that could result in increased flood risks. Although an overall decrease in total precipitation is expected, a higher frequency of extreme weather conditions are expected, causing floods and pollution of waters as a consequence of soil erosion.

The following sources of flooding occur in the LOW:

- ✓ pluvial (surface water) flooding when run-off from the surrounding area exceeds the flow capacity of the rivers, streams or the artificial drainage system (Sateska, Koselska, Çeravë River);
- ✓ torrential foods, which are combination of high water discharge and mass movement moving through the channels of the streams, leading to transport of large volumes of sediment and debris (Sushicka, Vërdova, Gështenjas and Hudënisht and other torrential rivers);
- ✓ coastal flooding, in coastal areas in Ohrid and Struga, during extreme weather and high tides cause a rise in lake levels resulting in coastal flooding;
- ✓ groundwater flood especially in the region of Struga. In conditions of high water level in valleys such as the Ohrid-Struga, the level of underground water rises to the surface of the terrain and the frequent occurrence of flooding of the terrain is characteristic; and
- ✓ drain and sewer flooding in urban areas.

Table 4.8 provides an overview of hydromorphological modifications/alterations of water bodies in the LOW for purposes of lowering flood risk.

4.7 ENERGY - HYDROPOWER

Water resources of the LOW are also used for hydropower generation. A total of five small hydro power plants (SHPP) are identified in the North Macedonia part of the basin (Fig. 4.12; Map 14), with installed capacity ranging from 0.2 to 0.6 MW[34]. The plants create an impact on the water body ecological status/potential (flow regime) on AWB: Studenchishki kanal and WBs Koselska 2, Sushica and Sateska 1.

Table 4.8: LOW: Flood Protection Infrastructure

River/WB	Regulated length (km)	Capacity (m^3/s)	Return period	Probability	Description
L-Struga-Black Drin	0.9	130	Q100	1%	Major and minor river bad with concrete walls
R-Koselska 2	0.4	NA	NA	NA	
R-Sateska 3	6.9	100	Q100	1%	Earth embankments
L-Pogradec	1.0	NA	NA	NA	Concrete

Apart from the SHPPs located within the LOW boundaries, waters draining from the lake into the Drin River feed a series of seven large cascade hydropower plants (HPP) along the flow to the Adriatic Sea: HPP Globochica and HPP Shpilje in North Macedonia; HPP Fierzë, HPP Komanit, HPP Vau I Dejës and HPPs Ashta 1 and Ashta 2 in Albania (Fig. 4.12). The combined installed capacity of the seven HPPs equals 1,520 MW, and the total annual electricity generation by the plants in 2015 equaled 5,230 GWh (4,700 GWh by HPPs in Albania and 540 GWh by HPPs in North Macedonia)[35]. Over 80% of the total power produced in Albania in 2015 was from HPPs in the Drin basin. Waters from the LOW account for roughly 70% of the electricity generated by the two HPPs in North Macedonia, and 7%-8% of the total electricity generated by the HPP cascade on Drin River.

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[34] Source: Energy Agency of North Macedonia (http://North.ea.gov.mk)

[35] Source: "Thematic Report on Socio-Economics of the Extended Drin River Basin; The Global Water Partnership – Mediterranean (GWP – Med), November 2017.

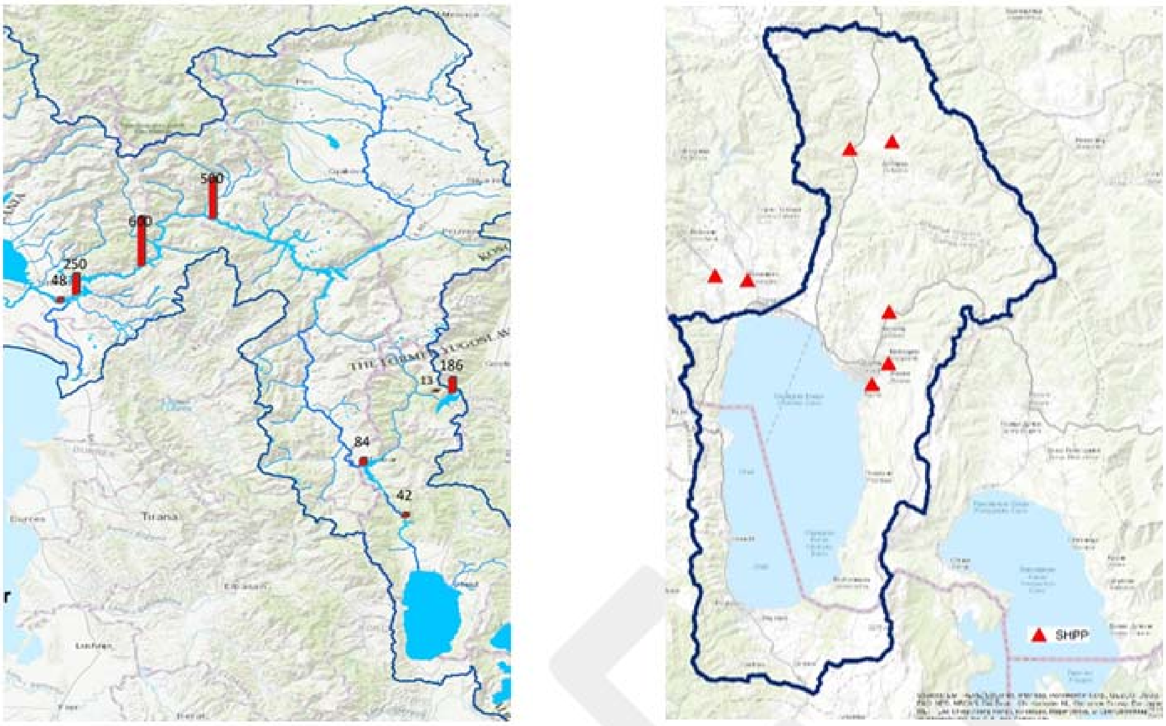

Figure 4.12: Hydropower Plants Fed by Water Resources of LOW – Wider Drin River Basin and LOW

4.7.1 Hydrological/Physical Alteration of River Bed (Sateska River)

A specific aspect related to hydropower generation in the LOW is the diversion (physical alteration) of the flow of Sateska river. Namely, in 1961/62 a 7-km artificial channel had been constructed that enabled the flow of Sateska river, which previously (physically) drained directly into Black Drin (Fig. 4.13), to end up in Lake Ohrid. The key goals of the rerouting was to: protect the regulated flow of Black Drin river from sediments coming from Sateska, use the lake volume for balancing of Sateska water flow (through the controlled outflow in Black Drin River in Struga) for electricity production on the Drin cascades in North Macedonia, and flood protection.

Figure 4.13: Sateska River – Natural and Diverted Flow

The average inflow of waters from Sateska river into Lake Ohrid equal 5.5 m^3/sec, and the rerouting of the river increased the LOW area for 35% to 40%. In addition, various authors in different documents have evaluated the total amount of transported sediment since the diversion, where values range from 108,000 m^3/year to 128,000 m^3/year. However, based on information from the HBI in Ohrid the average daily discharge of sediments from Sateska into the lake equals up to 130 m^3. Thus, according to bathymetric analysis of the lake bottom from 1994, estimated transported sediment volume equals 48,760 m^3/year, which for the past period of 55 years amounts to nearly 3 mill m^3 of deposited sediment in the lake.

This constant, long-term input of suspended matter have created severe changes of the littoral zone of the lake, forming sandy deposits which at a lower water level create visible 'islands' near the influx area (Fig 4.14). Thus, the natural heterogeneity of the bottom is profoundly transformed into uniform sandy habitat, which further results in absence of aquatic vegetation and fauna commonly present in other littoral parts of the lake.

Figure 4.14. The Inflow of (Diverted) Sateska River in Lake Ohrid

Further, the inflow of Sateska river is the main source of phosphorus in the lake, with an estimated amount of 39% of the total phosphorus inflow from tributaries, and the second largest source of nitrogen (29% of the total nitrogen inflow). The inflow of phosphorus and nitrogen represent a huge pressure for eutrophication of the lake waters. In addition, the inflow of Sateska river represents a 'corridor' for input of invasive species in the lake.

4.8 WATER BALANCE

As reported in Section 2.1, Lake Ohrid is hydrogeologically connected to the nearby Lake Prespa, which sits at an elevation of roughly 150 m higher than Lake Ohrid. The two lakes are separated by the Galichica and Suva Gora mountains, which consist of karstified limestone through which water from Lake Prespa is draining into Lake Ohrid (Fig. 4.15). This makes Lake Prespa one of the main sources of inflowing waters into Lake Ohrid.

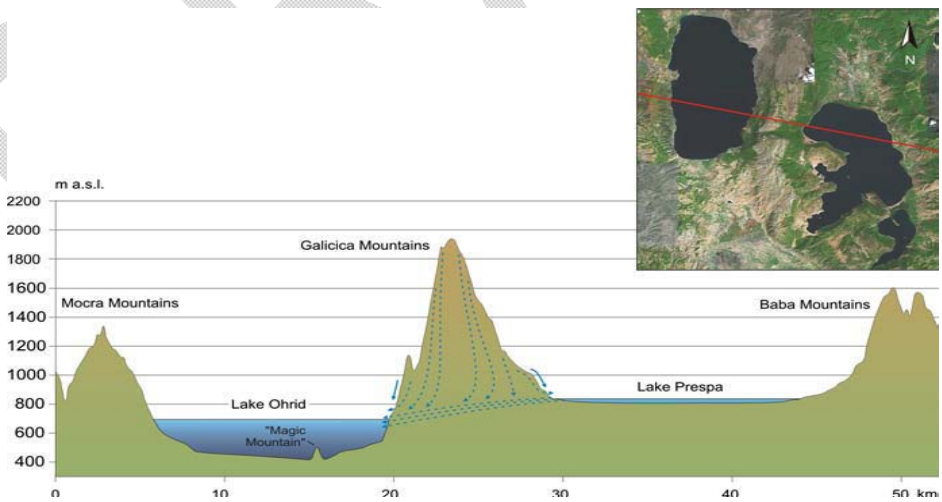

Figure 4.15: The Underground Karstic Connection between Lake Prespa and Lake Ohrid[36]

Apart from the springs, important volume of water drains in Lake Ohrid through a number of tributaries, most of which are small creeks that flow only temporarily during snowmelt and heavy rain periods. The main rivers in the

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[36] Adopted from [38]

LOW, tributaries to Lake Ohrid (Map 1), include: Sateska, Koselska, Shushica and Grashnica river in North Macedonia, as well as Çeravë and Verdovë rivers in Albania.

Water from Lake Ohrid outflows into the Black Drin River at the town of Struga, flowing northwards on the way to the estuary in the Adriatic Sea. Since 1962 the river's outflow has been controlled with a weir, which regulates the water level. Based on agreements between Albania and the former Yugoslavia, since 1979 the minimum water level in Lake Ohrid is set at 693.10 masl and the maximum level at 693.75 masl, resulting in annual fluctuations of the level in the range of 0.65m.

4.8.1 Water Budget

The analysis is based on the following assumptions:

- ✓ 20-year period (1978 – 1998) for which historical input data for all parameters are available that enable compatibility and comparability of the results with other analysis;
- ✓ the analysis is on monthly basis;
- ✓ input of water into the lake based on:
  - measured discharge from rivers (where applicable) and correlated for other streams,
  - precipitation in the watershed,
  - discharge from springs (Lake Prespa);
- ✓ output from the lake:
  - evaporation from the lake surface area,
  - transpiration of water from other parts of the basin (forests),
  - abstractions for water supply,
  - outflow from the lake based on measurements in MS Lozhani;
- ✓ control of results based on measured outflow and water-level fluctuations in the lake.

Based on this, the annual inflow of water of 988 million m^3 is nearly equally reliant on input from rivers, precipitation and discharge from springs/Lake Prespa. On the other hand, two-thirds (66.6%) of the output of water from the watershed is through the outflow in Black Drin river and one third from evapotranspiration (Table 4.9). Further, 54% of the sum of inflow from tributaries is from Sateska, roughly 12% from Koselska, and the remaining 34% from all other rivers. The inflow from precipitation nearly equals the outflow from evapotranspiration in the watershed. The annual volume of water abstractions for water supply is less than 1% of the available inflow[37].

Table 4.9: LOW: Water Budget

Water Budget Component	Inflow			Outflow		
	Average (m3/sec)	Annual (m3*10^6)	%	Average (m3/sec)	Annual (m3*10^6)	%
Sateska river	*5.49*	*173.2*				
Koselska river	*1.19*	*37.7*				
Other rivers	*3.50*	*110.5*				
Sum Rivers	10.19	321.3	32.5%			
Precipitation	10.25	323.1	32.7%			
Prespa/springs Inflow	10.91	344.1	34.8%			
Black Drin				20.89	658.9	66.7%
Transpiration/Evaporation				10.16	320.5	32.4%
Water supply				0.28	8.7	0.9%
Total	**31.35**	**988.5**	**100%**	**31.33**	**988.1**	**100%**

4.8.2 Long-term Water Balance and Lake Ohrid Water-Level Fluctuations

As indicated before the outflow from Lake Ohrid is controlled with a weir, which regulates the water level in the lake within the agreed elevations of 693.10 masl as a minimum and 693.75 masl as a maximum, resulting in annual fluctuations of the level in the range of 0.65m. Therefore, since the outflow is controlled, the annual fluctuations of the water level do not directly reflect the long-term variations of water inflow into the lake. On the other hand, the analysis of the monthly cumulative precipitation anomalies for the watershed (Section 2.1; Fig. 2.6) clearly determine the positive and negative phases in precipitation variability, with an observed major drought event over

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[37] Water withdrawals for irrigation directly from the lake are uncommon; irrigation withdrawals from rivers and groundwater are included in the analysis through the (reduced) inflow from tributaries.

the 1986/7 to 1995/6 period. Further, apart from precipitation variances within the LOW territory, the long-term variations of water inflow from the karstic springs (Lake Prespa) have also not been adequately ascertained.

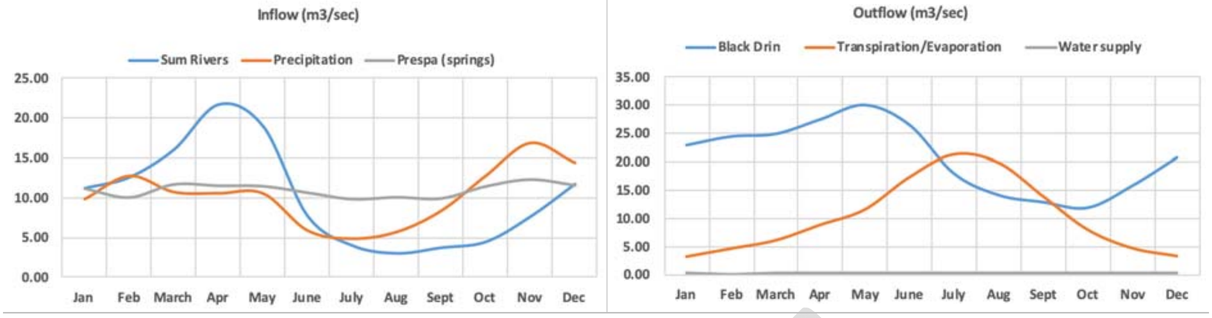

Figure 4.16: Average Monthly Inflow and Outflow of Water from Lake Ohrid (1978-1998)

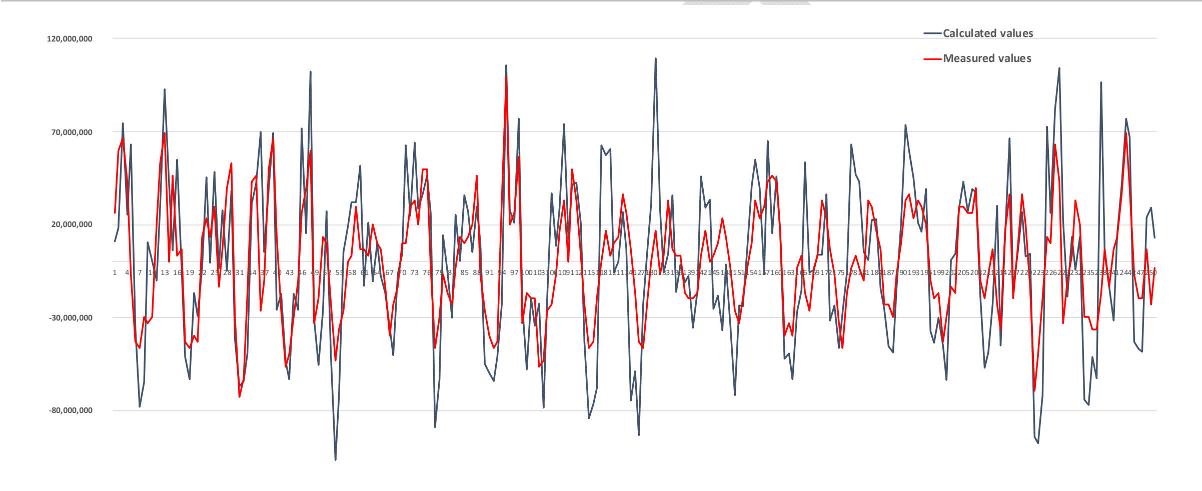

Figure 4.17: LOW: Monthly Water Balance (1978 – 1998)

The long-term monthly water balance of the LOW was modelled through the use of empirical and stochastic methods to simulate the variations in the input parameters (e.g. precipitation, evapotranspiration, irrigation withdrawals within the basin, possible irrigation/groundwater withdrawals from contiguous agriculture areas around Struga which are fed by water from the lake, inflow from Lake Prespa, etc.) and their correlation with available documented data for water outflow and water-level variations. Summary results are presented on Figure 4.17: LOW: Monthly Water Balance (1978 – 1998), Figure 4.18. Discharge from Lake Prespa to Lake Ohrid and Lake Prespa water-level fluctuations (1978 – 1998), Figure 4.19: Monthly Water-Level Fluctuations (1978 – 1998).

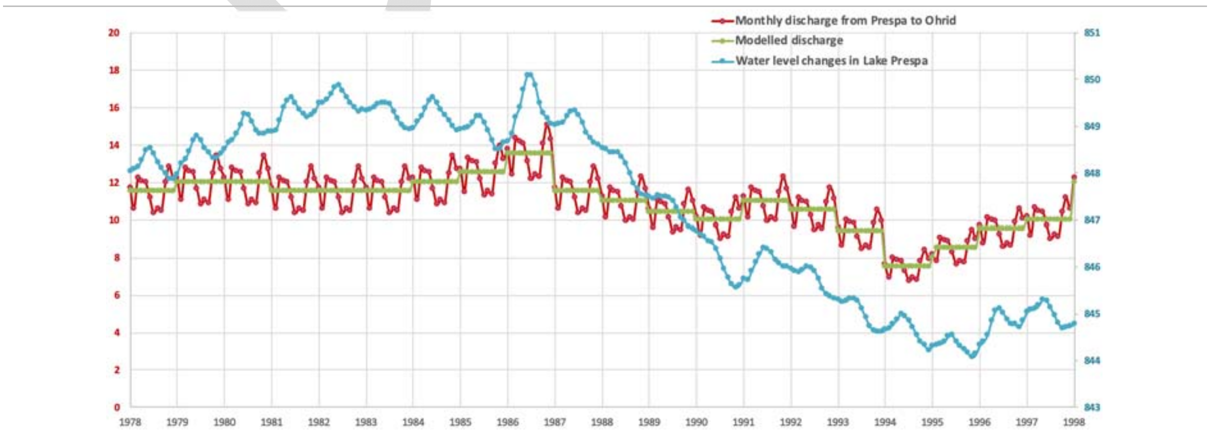

Figure 4.18. Discharge from Lake Prespa to Lake Ohrid and Lake Prespa water-level fluctuations (1978 – 1998)

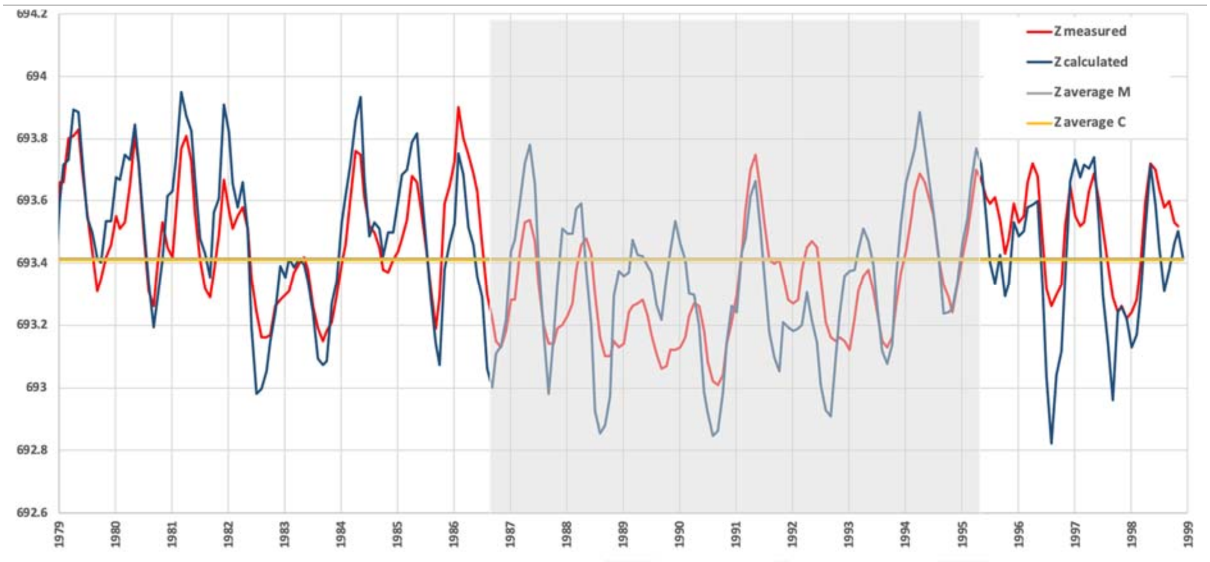

Figure 4.19: Monthly Water-Level Fluctuations (1978 – 1998)

Several observations and conclusions arise from the analysis:

- ✓ as a result of the hydrological system's complexity, the model is highly sensitive to practically all input parameters;
- ✓ in spite of the importance and continuous focus of the broader scientific community for the basin, there is a serious gap in the availability and reliability (consistency) of measured data that would enable precise modeling of the LOW hydrological specifics, thus also for use of the model for projection of potential future outcome variations that may arise as a result of changes in the input parameters, which is an aspect that needs to be addressed instantly;
- ✓ of particular importance in this regard is the need for conducting analysis aimed at precise determination of the 'link' between Lake Prespa and Lake Ohrid. It is evidenced that the climate/hydrology/water-level variations in the Lake Prespa basin result in important oscillations of the inflow of waters from Prespa into Ohrid, however the expected result-accuracy is lacking. This, in particular, is of essence for projection of potential adverse effects of future draught periods in the region on the water balance of Lake Ohrid;
- ✓ the controlled (regulated) outflow from Lake Ohrid, which enables water-level fluctuations within the 0.65m to 0.75m range throughout the year, undoubtedly has highly positive effects on preservation of basin's hallmarks of – biodiversity/endemism hot-spot and tourism attractiveness; and
- ✓ given the availability of water resources, which embraces both the volume of Lake Ohrid (58 km^3) and the annual water inflow volume (988 mill m^3), water abstractions from the basin (including withdrawals for drinking plus industry water supply and irrigation) do not represent a serious threat to its water balance.

4.9 SUMMARY OF PRESSURE TYPES IN LOW

Table 4.10 below provides an overview of the pressure types and drivers according to WFD Reporting Guidance 2016.

Table 4.10: LOW: Summary of Pressures on Water Resources

Pressure	Driver	Indicators	Index	Affected WBs
1.1 - Point – Urban waste water	Urban development	Load of BOD to be reduced (in tonnes/day) to achieve objectives	2.97 (t/day)	[1] [2] [6] [7] [10] [18] [19]
		Load of nitrogen to be reduced (tonnes/day) to achieve objectives	TBD	
		Load of phosphorus to be reduced (tonnes/day) to achieve objectives	TBD	
		Number of water bodies failing EQS for RBSP	12	
1.2 - Point – Storm overflows	Urban development	Number of urban areas with excessive overflows that are causing or contributing to failure of objectives	3 larger cities + 30 other settlements	[1] to [20]
		Number of water bodies failing EQS for PS and/or RBSP	11	
1.3 - Point –Non-IED plants	Industry	Number of permits not compatible with the achievement of objectives	14	
		Number of water bodies failing EQS for RBSP	14	
1.6 - Point – Waste disposal	Urban development	Number of waste disposal sites affecting achievement of objectives	2(+2) official landfills 20 illegal dumps	[1] to [20]
		Number of water bodies failing EQS for PS and/or RBSP	14	
1.8 - Point - Aquaculture	Fisheries and aquaculture	Number of point sources affecting achievement of objectives	2 hatcheries + 3 small fish farms	[6] [19]
2.1 - Diffuse - Urban runoff	Urban development	Length (km)/area (km^2) of water bodies that are not achieving objectives because of diffuse urban run off	320 km^2	[3] [5] [6] [7] [10] [12]
2.2 - Diffuse – Agricultural	Agriculture	Load of nitrogen to be reduced (in tonnes) to achieve objectives	TBD	[3] [4] [6] [7] [10] [11] [12] [14] [15] [18] [19] [20]
		Load of phosphorus to be reduced (in tonnes) to achieve objectives	TBD	
		Number of water bodies failing EQS for pesticides originating from diffuse agricultural sources	12	
		Number of farms not covered by advisory services	TBD	
		Area of agricultural land at risk of soil erosion	TBD	
2.5 - Diffuse – Contaminated or abandoned industrial sites	Industry	Area of land (ha) under pressure that needs to be subject to measures	20 ha	[11]

Pressure	Driver	Indicators	Index	Affected WBs
2.6 - Diffuse – Discharges not connected to sewer network	Urban development	Length (km)/area (km^2) of water bodies not achieving objectives because of this pressure	47.5 km	[1] [7] [11] [12] [19]
2.9 - Diffuse – Aquaculture	Fisheries and Aquaculture	Length (km)/area (km^2) of water bodies not achieving objectives because of this pressure	5 km	[6] [19]
3.1 - Abstraction or flow diversion – Agriculture	Agriculture	Volume of water abstracted/diverted for agriculture (million m^3) to be reduced to achieve objectives	TBD	
3.2 – Abstraction/flow diversion – Water supply	Urban development	Volume of water abstracted for public water supply (million m3) to be reduced to achieve objectives	8.5 mill m^3/year	[1] to [20]
3.3 - Abstraction or flow diversion – Industry	Industry	Volume of water abstracted for industry (million m^3) to be reduced to achieve objectives	TBD	
3.5 – Flow diversion – Hydropower (Sateska river)	Energy – hydropower	Volume of water diverted (million m^3) to be reduced to achieve objectives	187.5 mill m^3/year	[13] [15]
		Volume of sediment to be reduced to achieve objectives	34,150 m^3/year	
3.6 - Abstraction or flow diversion - Fish farms	Fisheries and Aquaculture	Volume of water abstracted for aquaculture (million m^3) to be reduced to achieve objectives	1.75 mill m^3/year	[6] [19]
4.1.1 - Physical alteration of channel – Flood protection	Energy – hydropower Flood protection	Length (km) of water bodies affected by alterations for flood protection not compatible with good ecological status/potential	9.2 km on river WBs 5 km along the Lake	[3] [6] [10]
5.1 - Introduced species and diseases	Fisheries and aquaculture	Number of introduced species preventing the achievement of GES/GEP	6 species	[1] to [12]
5.2 - Exploitation or removal of animals	Fisheries and aquaculture,	Length (km) /area (km^2) of water bodies where the exploitation of animal is preventing the achievement of good ecological status/good ecological potential	356 km^2	
5.3 – Litter or fly tipping	Urban development,	Length (km) of water bodies impacted by litter or fly tipping	All Lake WBs 65 km of RWBs	[1] to [12] [5] [14] [15] [19] [20]
7 – Anthropogenic pressure – Other (boating)	Tourism and recreation	Length (km) /area (km^2) of water bodies where other anthropogenic pressures are causing the non-achievement of objectives	356 km^2	All Lake WBs

[1]	L-Radozhda	[6]	L- Studenchishki kanal	[11]	L-Udenisht	[16]	R-Sateska 3
[2]	L-Kalishta	[7]	L-Velidab	[12]	L-Lin	[17]	R-Koselska 1
[3]	L-Struga-Black Drin	[8]	L-Bay of St. Naum	[13]	L-Lake Ohrid-Pelagic	[18]	R-Koselska 2
[4[	L-Sateska	[9]	L-Tushemisht	[14]	R-Sateska 1	[19]	R-Cerave
[5]	L-Koselska	[10]	L-Pogradec	[15]	R-Sateska 2	[20]	Sushica

5 ECOLOGICAL AND CHEMICAL STATUS/POTENTIAL OF WATER BODIES IN THE LOW

5.1 WFD REQUIREMENTS

The WFD (Annex V) requires classification of surface water bodies through determination of their ecological and chemical status. The ecological status is determined through classification of biological quality element values specified for each surface water category. The estimation should be based on results of direct measurements by an established monitoring system, whereas the system shall utilize particular species or groups of species that are representative of the quality element as a whole. The chemical status for each SWB is determined based on assessed level of compliance with quality standards as defined by Article 16 and Annex IX of the WFD, as well as other EU legislation setting environmental quality standards. The chemical status is also based on results of measurements through the monitoring system. In addition, for heavily modified or artificial water bodies reference to ecological status should be interpreted as ecological potential (Fig. 5.1).

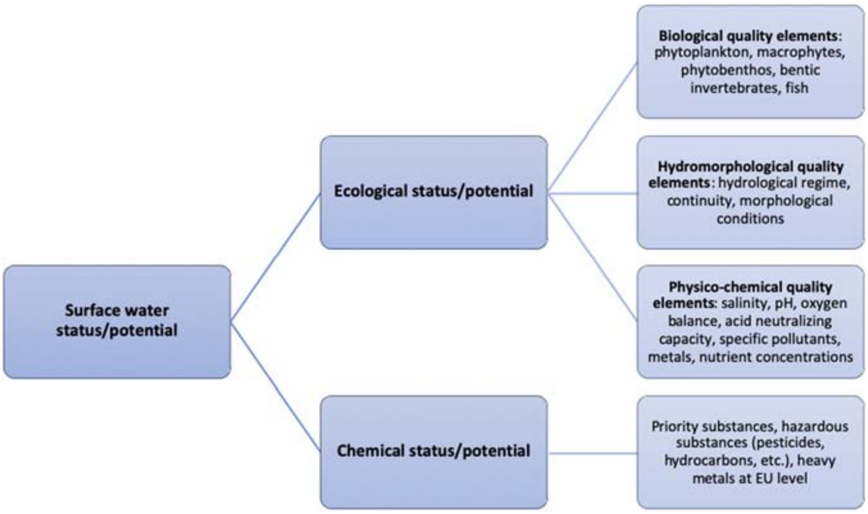

Figure 5.1: Surface Water Status Classification as Defined by the WFD

5.2 EXISTING MONITORING NETWORKS

At present regular monitoring based on the requirements of WFD is not performed in the LOW. In general there are some analyses of water quality performed within the framework of various project. Also two institutions in North Macedonia, more or less regularly analyse few selected parameters. The Institute of public health is responsible for monitoring of drinking water and water for recreation. Based on their program the Institute performes analyses of physico-chemical and bacteriological parameters on 30 sampling site in littoral zone of Lake Ohrid. The frequency of this monitoring is twice per month during summer season and once per month in other seasons. The National Hydrometeorological service is responsible for hydrological network in North Macedonia. In Lake Ohrid watershed two automatic stations for monitoring of water level and temperature are installed and functioning. On the Albanian side regular monitoring is performed on two sampling site.

For ensuring comparability of the classification the results of the monitoring are expressed as Ecological Quality Ratios (EQR), which represents a relationship between the values of observed biological parameter value and the reference condition value of the same parameters for each surface water body.

Ecological Status Classification			Ecological Potential Classification			Chemical Status Classification	
	High (EQR close to 1)						Good
	Good			Good and above			Failing to achieve good
	Moderate			Moderate			
	Poor			Poor			
	Bad (EQR close to 0)			Bad			

Figure 5.2: Ecological and Chemical Status Classes and Colour Codes as defined by the WFD

Finally, the classification based on the EQR is divided in five classes, ranging from High to Bad ecological status. The classification of the chemical status is divided in two classes – Good or Failing to achieve good. The classes of both the ecological and chemical status are also color-coded, as shown on Fig. 5.2.

Evidently the EQR, which is based on comparison of measured biological parameters with reference conditions for the same parameters, is the key factor for determination of the ecological status (classes) of water bodies. Further, type-specific biological reference conditions need to be established for every type of water body representing the values of the biological quality elements for that surface water body type at high ecological status. However, as described also in Section 2.3, Lake Ohrid is a unique ecosystem in the world and trying to find reference conditions in other lakes has no scientific basis. In addition, at present it is practically not possible to establish reference conditions for Lake Ohrid because of two reasons:

- ✓ the presence of high percentage of specific (endemic or relict) species; and
- ✓ limited taxonomical, ecological and biogeographical research of biological quality elements required for proper establishment of reference conditions.

Because of these reasons, the classification of the water bodies of Lake Ohrid is made on the basis of the Carlson's Trophic State Index (TSI), i.e. the US EPA 2000 classification system[38]. The EPA system defines the classification of the trophic status of lake water bodies, thus it differs from the WFD classification. However, the EPA system reflects the primary response (biological activity) of the lake to nutrient overenrichment and therefore represents sound basis for assessing the status of water quality in the lake.

According to the EPA 2000 scheme total phosphorus (TP in µg/l), Chlorophyll-*a* (Chl-*a* in µg/l) concentrations and water transparency (Secchi Disk in m) by using the TSI determine the classification of lakes into six trophic status classes (Table 5.1).

Figure 5.3: LOW: Classification of Lake Water Bodies according to EPA (EPA 2000)

TSI average	SD (m)	TP (µg/l)	Chl-*a* (µg/l)	Trophic status-Attributes
< 30	> 8	< 6	< 0.94	Oligotrophic-Clear water, oxygen throughout the year in the hypolimnion
30 - 40	8 - 4	6 - 12	0.94 – 2.6	Oligotrophic -A lake will still exhibit oligotrophy, but some shallower lakes will become anoxic during the summer
40 - 50	4 - 2	12 - 24	2.6 – 6.4	Mesotrophic-Water moderately clear, but increasing probability of anoxia during the summer
50 - 60	2 - 1	24 - 48	6.4 - 20	Eutrophic-Lower boundary of classical eutrophy: Decreased transparency, warm-water fisheries only
60 - 70	0.5 - 1	48 - 96	20 - 56	Eutrophic-Dominance of blue-green algae, algal scum probable, extensive macrophyte problems
> 70	< 0.25	> 96	> 56	Hypereutrophic, Heavy algal blooms possible throughout the summer, often hypereutrophic

5.3 ECOLOGICAL STATUS/POTENTIAL OF WBs IN THE LOW

For proper determination of the status of water bodies in the LOW a special Surveillance Monitoring Programme was designed and carried out in 2019. The Programme was implemented by a Consortium of specialized research institutions – the Greek Biotope/Wetland Centre (EKBY, part of the Goulandris Natural History Museum, Greece) and the Institute of Marine Biological Resources and Inland Waters (IMBRIW) of Hellenic Centre for Marine Research (HCMR) – and included three monitoring campaigns – February, April and July 2019. The monitoring was carried out at a total of 20 sampling points (Fig. 5.3): 13 lake WBs, 6 river WBs and 1 AWB – Studenchishki kanal. Details from the monitoring are given in a separate consolidated report[39].

Based on results of the Monitoring Programme, but as well on data from previous monitoring and analysis for water bodies that were not included in the Programme (e.g. Sushica river), classification of the ecological status of river

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[38] The use of the EPA classification for Lake Ohrid was also suggested by the Surveillance Monitoring Programme Report; details are given further.

[39] "Final report: Surveillance Monitoring Programme for the Lake Ohrid Watershed" (September 2019).

WBs according to the WFD is shown in Fig. 5.3 and Table 5.2; The classification of lake WBs based on the TSI is presented on Fig. 5.3, Table 5.3 and Map 15.

Overall, 2 river WBs – R-Sateska 1 and R-Koselska 1 – are assessed as having Good ecological status; 3 river WBs – R-Sateska 2, R-Sateska 3 and R-Koselska 2 – as having a Moderate status/potential; 2 rivers/WBs – R-Cerave and R-Sushica – as having Bad status; and the AWB Studenchishki kanal as having Poor status/potential.

Table 5.1: LOW: Ecological Status/Potential of River WBs

Water Body	Ecologocal Status/Potential	WB length (m)	Total river length (m)	WB as % of total river length
R-Sateska 1	GOOD	23,138	40,828	57%
R-Sateska 2	MODERATE	10,727		26%
R-Sateska 3	MODERATE	6,963		17%
R-Koselska 1	GOOD	13,963	33,779	41%
R-Koselska 2	MODERATE	19,816		59%
R-Cerave	BAD	19,940	19,940	100%
R-Sushica	BAD	7,627	7,627	100%
AWB Studenchishki kanal	POOR	625	625	100%

As regards Lake Ohrid, 5 of its WBs are classified as Oligotrophic-Clear water, 6 as Oligotrophic – A, and the remaining 2 lake WBs as Mesotrophic – Water moderately clear status under the EPA system (Fig. 5.3). All water bodies in the basin are assessed as currently having Good chemical status.

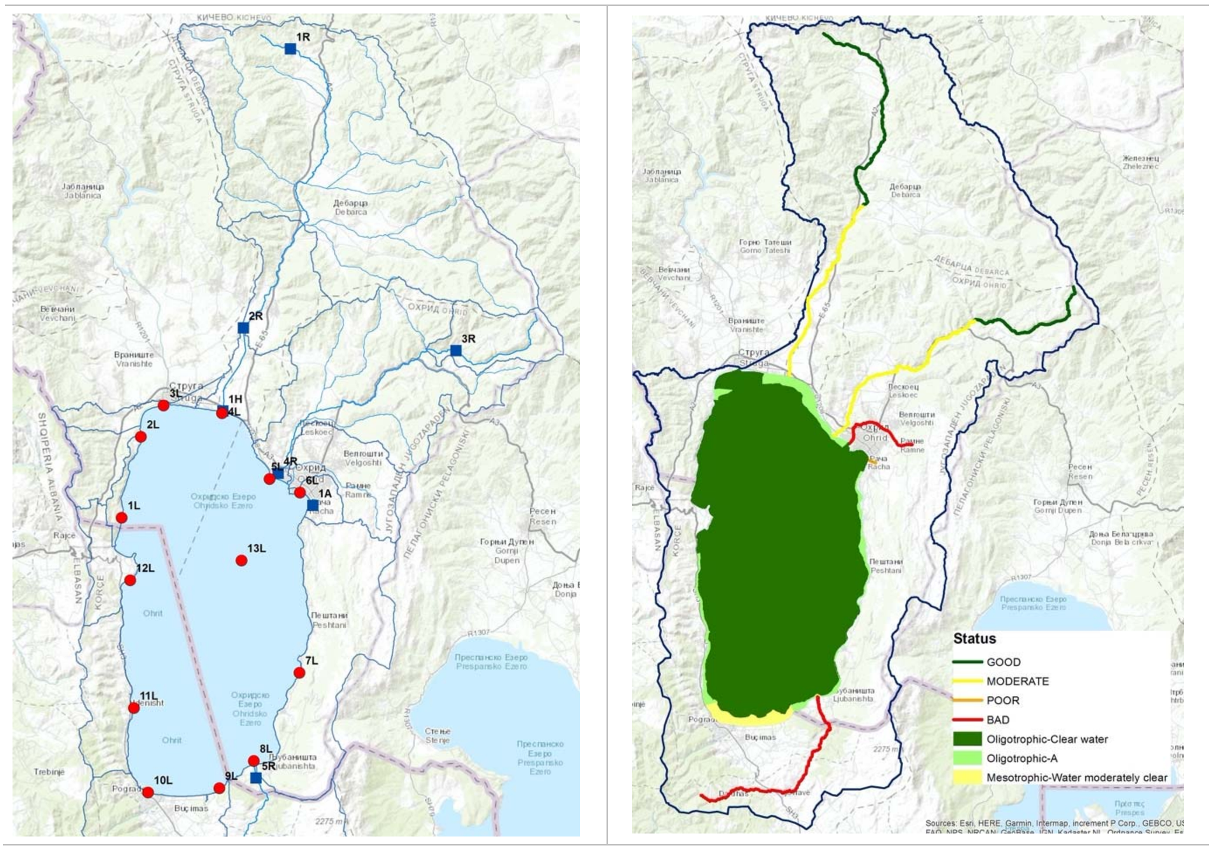

Figure 5.4: LOW: Sampling Sites for the Surveillance Monitoring Programme; Classification of Surface Water Bodies

Table 5.2: LOW: Trophic Status of Lake WBs

No.	Type	WB Name	Trophic Status	Mean TSI
1	L	L-Radozhda	Oligotrophic-Clear water	28.60
2	L	L-Kalishta	Oligotrophic-A	33.43
3	L	L-Struga-Black Drin	Oligotrophic-Clear water	26.42
4	L	L-Sateska	Oligotrophic-A	38.21
5	L	L-Koselska	Oligotrophic-A	33.84
6	L	L- Ohrid bay	Oligotrophic-Clear water	28.91
7	L	L-Velidab	Oligotrophic-A	38.67
8	L	L-Bay of St. Naum	Oligotrophic-A	36.84
9	L	L-Tushemisht	Mesotrophic-Water moderately clear	43.08
10	L	L-Pogradec	Mesotrophic-Water moderately clear	46.78
11	L	L-Udenisht	Oligotrophic-A	30.70
12	L	L-Lin	Oligotrophic-Clear water	29.72
13	L	L-Lake Ohrid-Pelagic	Oligotrophic-Clear water	26.81

Finally, the Final Report of the Surveillance Monitoring Programme also concludes that "…results [of the monitoring] are in complete accordance with other studies, revealing the most water quality degraded waterbodies and that indeed an anthropogenic eutrophication is taking place in Lake Ohrid; …phosphorus concentration has increased four times over the past 100 years because of increased anthropogenic phosphorus loads. The building of a sewerage system and a treatment plant in North Macedonia in the 1980's has definitely had an effect on the P-load. In recent years this decrease seems to be compensated by increasing population. The alternation of decrease and increase in the P-concentration could explain why the increased input of the past decades cannot not be observed in the water quality. The domestic phosphorus input contributes the largest share to the anthropogenic P-load. Thus, it has the largest reduction potential at the moment. Furthermore, morphological alterations in the littoral zone of Lake Ohrid shape biological communities, and it is proposed that they are addressed. Finally, future intensification of agriculture could change the situation dramatically. As a result good agricultural practices should be communicated in following years".

5.4 PLAN FOR FUTURE MONITORING IN THE LOW IN LINE WITH FWD

Annex V indicates that monitoring information from surface waters is required for:

- ✓ the classification of status;
- ✓ supplementing and validating the Annex II risk assessment procedure;
- ✓ the efficient and effective design of future monitoring programmes;
- ✓ the assessment of long-term changes in natural conditions;
- ✓ the assessment of long-term changes resulting from widespread anthropogenic activity;
- ✓ estimating pollutant loads transferred across international boundaries or discharging into seas;
- ✓ assessing changes in status of those bodies identified as being at risk in response to the application of measures for improvement or prevention of deterioration;
- ✓ ascertaining causes of water bodies failing to achieve environmental objectives where the reason for failure has not been identified;
- ✓ ascertaining the magnitude and impacts of accidental pollution;
- ✓ assessing compliance with the standards and objectives of Protected Areas; and,
- ✓ quantifying reference conditions (where they exist) for surface water bodies should.

The results of surveillance monitoring shall be reviewed and used, in combination with the impact assessment procedure described in Annex II, to determine requirements for monitoring programmes in the current and subsequent river basin management plan.

As elaborated before, performed surveillance monitoring in the course of this project was not sufficient for obtaining the most reliable scientific data and applicable data base for determination of the ecological status of surface and ground waters in the LOW.

As stated in the WFD, the basic characteristics of operational monitoring systems are the following.

Operational monitoring has to be undertaken for all water bodies that have been identified, by the review of the environmental impact of human activities (Annex II) and/or from the results of the surveillance monitoring, as being at risk of failing the relevant environmental objectives under Article 4. Monitoring must also be carried out for all bodies into which priority substances are discharged. This implies that monitoring in all such bodies will not necessarily be required as the Directive allows similar water bodies to be grouped and representatively monitored. In addition, monitoring sites for those priority list substances with environmental quality standards should be selected according to the requirements of the legislation establishing the standards.

Based on obtained results, and aiming to resolve the basic causes of the recorded ecological situation in the basin, the following operational monitoring plan is proposed for the next immediate period within the timeframe of development of the management plan:

- ✓ a total of six (6) monitoring points on river water bodies should be selected; and
- ✓ a total of eight (8) monitoring points on lake water bodies should be selected.

Investigative monitoring may also be required in specified cases. These are given as:

- ✓ where the reason for any exceedences is unknown;
- ✓ where surveillance monitoring indicates that the objectives set under Article 4 for a body of water are not likely to be achieved and operational monitoring has not already been established, in order to ascertain the causes of a water body or water bodies failing to achieve the environmental objectives; or
- ✓ to ascertain the magnitude and impacts of accidental pollution.

The results of the monitoring would then be used to inform the establishment of a programme of measures for the achievement of the environmental objectives and specific measures necessary to remedy the effects of accidental pollution. Investigative monitoring will thus be designed to the specific case or problem being investigated.

Investigative monitoring for reference conditions of Ohrid Lake and river water bodies. Therefore, the proposal is to monitor four reference areas for rivers and to try to obtain the cleanest water courses and possibly to detect the natural background conditions. The proposal is to monitor physico-chemical and biological parameters at these 4 points at least 4 times per year, and two analyses of priority substances per year.

Based on the results of surveillance monitoring it is necessary Investigative monitoring for phosphorus in Ohrid Lake to be established. At least two waterbodies are classified as mesotrophic. This is in concordance with the scientific data that phosphorus concentrations are four times increased over the past 100 years due to the anthropogenic phosphorus loads.

6 ENVIRONMENTAL OBJECTIVES OF THE LOWMP

Having assessed the current status of the waters, the next stage is to set environmental objectives for the water resources in the LOW. Objective setting activities during development of the plan considered waters that require protection from deterioration as well as waters that require restoration and the timescales needed for recovery. This section of the plan sets out the objectives that the plan aims to achieve.

6.1 REGULATORY REQUIREMENTS

The WFD establishes demanding environmental objectives for surface waters and ground waters (Article 4). The Directive has four core environmental objectives; it also allows alternative objectives to be set in certain circumstances. The principal objective of the WFD is that Member States are required to achieve Good surface water status and Good groundwater status in 2015[40] at the latest. In. addition, the deterioration of waters whose status is already good or high, has to be prevented. In particular, the pollution of surface waters with priority substances and priority hazardous substances has to be reduced progressively and phased out in case of priority hazardous substances.

The WFD addresses different areas of legislation related to several separate Directives (Annex VI). The WFD also requires that a RBMP objectives and measures have to comply with requirements of these Directives.

6.2 LAKE OHRID WMP OBJECTIVES

The plan establishes four core environmental objectives to be achieved generally by 2031:

1. Restore good status of surface and ground water bodies;
2. Prevent deterioration of water bodies already having good or high status;
3. Reduce chemical pollution;
4. Achieve water related objectives for protected areas.

6.2.1 Restore Good Status of Surface and Ground Water Bodies

The objective set out in the WFD for surface waters and groundwater is to improve waters where necessary with the aim of achieving at least good ecological status. Restoring good status is to be achieved generally in a 15-year period where it is technically feasible, environmentally sustainable and not disproportionately expensive to do so. However, the WFD also recognizes that despite the implementation of measures some waters will take longer than others to reach their target because of the slower natural rates of recovery.

Based on the monitoring results and classification of 5 river water bodies and 1 AWB in the LOW are currently below good status and require restoration to good status/potential.

6.2.2 Prevent Deterioration

The WFD requires implementation of measures necessary to prevent deterioration in status of all surface waters and groundwater.

6.2.3 Reduce Chemical Pollution

The core objective is to progressively reduce surface water and groundwater pollution from priority substances and cease or phase out emissions, discharges and losses of priority hazardous substances. Chemical monitoring programme, as part of the overall water quality monitoring system for the LOW, will be established.

6.2.4 Achieve Water Related Protected Areas Objectives

Some protected areas in the LOW currently do not meet protected areas objectives defined by EU Directives. The objective for the water bodies associated with these protected areas is to restore them so that they meet all applicable standards.

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[40] The dates stated in the WFD, adopted in 2000, are an obligation for the EU Member States.

6.3 TIME FRAME

As mentioned before, the WFD defines an initial 15-year period for accomplishment of objectives set out in watershed management plans. It further instructs (Article 11) that every 6 years thereafter the programme of measures defined with the plans should be reviewed and updated accordingly.

The time period assumed in this Plan for the LOW is the following:

- ✓ Phase I: 2020 – 2025; and
- ✓ Phase II: 2026 – 2031.

6.4 ALTERNATIVE OBJECTIVES

The WFD also allows alternative objectives/exemptions to be set in certain circumstances. In these cases, however, even where alternative objectives are set, measures must still be taken to achieve best possible status within the defined period. Alternative objectives may be necessary due to:

- ✓ technical, economic, environmental or cost recovery constraints. In some cases extended deadlines have been set for waters where necessary (time exemptions); and
- ✓ proposed new physical modifications and sustainable developments. Alternative, less stringent objectives may have to be set to cater for future projects (objective exemptions).

This plan establishes alternative objectives for certain water bodies related mainly to extended deadlines, i.e. deadlines beyond the analyzed 12-year period (2020 – 2031).

6.4.1 Extended Deadlines

Extended deadlines, usually of one additional planning cycle of 6 years, need to be applied to some water bodies due to technical, economic, environmental or cost recovery constraints. Also, in some cases further investigations are required to confirm the extent of impacts or to identify appropriate measures and implement them. The effectiveness of some measures is uncertain and status recovery is expected to take longer than the first planning cycle.

The reasons why timescale extensions may be needed to restore certain waters to good status in the LOW are set out in the matrix below.

Issue	Status level likely to fail	Water bodies likely to be affected	Constraint
NPK losses to surface waters (agriculture)	Phosphorus, nitrogen and potassium levels decreasing ecological status	4, 6, 9, 10, 12, 17, 18, 19, 20	Reductions/recovery from current high soil NPK levels to environmentally sustainable levels may take longer than the analyzed period (up to 12 years), even with full implementation of GAP measures. As a result, nutrient losses to waters may persist.
Dangerous substances/pollution from accumulated landfill leachate	Priority substances	Groundwater	Recovery of pollution accumulated in soil and groundwater from existing incompliant waste landfills will take longer than the analyzed period. Remediation of polluted soil to remove accumulated leachate pollution will increase waste service costs beyond affordability level.

6.5 EXPECTED RESULTS

It is estimated and expected that implementing planned measures (as defined further) will by 2031 achieve an Oligotrophic – Clear water trophic status in 11 of the 13 lake water bodies (i.e. the 6 LWB currently having Oligotrophic – A status will improve to Oligotrophic – Clear water) and the remaining 2 LWB currently having Mesotrophic status (LWB Tushemisht and LWB Pogradec) will, as a minimum, achieve an Oligotrophic – A status. In addition, the 2 river water bodies currently having Moderate status and the AWB Studenchishki kanal with Poor ecological status will achieve Good status, while the 2 RWB currently characterized as having Bad status (RWB Çeravë and RWB Sushica) will achieve, again as a minimum, Moderate status. Further improvements should be expected over the consequent planning cycles. Improvements of groundwater can be defined as data from monitoring activities are available.

7 PROGRAMME OF MEASURES

Section 6 sets out the environmental objectives for the LOWMP. This section describes the measures that need to be implemented to achieve those objectives.

It should be mentioned that significant progress has been made in recent years in putting the necessary legislation in place to support the implementation of river basin plans and programmes of measures in both countries sharing the basin. The core requirements of the WFD are transposed in the respective 'Water Laws'.

The key provisions of the Programme of Measures (PoM) for the LOW are summarized further. Proposed programme, following the WFD requirements is divided in basic and supplementary measures, followed by more precise distribution in selected groups of measures as indicated below. Further, following the provisions of the WFD Reporting Guidance (2016), proposed specific measures are linked to distinct water bodies, as well as with identified drivers, significant pressures and impacts; they are also associated with the predefined Key Types of Measures (KTM, as specified in the Guidance document), and reported along with KTM indicators and assessed expenditures for the two implementation periods. Finally, the PoM is aligned with the recently developed Strategic Action Programme for the entire Drin River Basin[41]. The full PoM is presented in Table 7.1 below.

7.1 POLICY, REGULATORY AND KNOWLEDGE BASE INCREASE MEASURES

Policy and regulatory measures are considered those measures that either come out as requirements of the legislation or this plan (e.g. establishment and implementation of water monitoring system, adopting new water pricing policies, harmonization of boating legislation, etc.), or aim at strengthening the institutional capacity for ensuring monitoring of LOW MP and its measures implementation, on a local level on IED implementation, including monitoring of performance of existing installations and their compliance with the permit conditions. Further, several measures are proposed which are focused on increasing the knowledge base regarding various aspects of the LOW, thus reducing uncertainties for future planning (e.g. conducting research for determination of reference conditions for Lake Ohrid, development of a type specific surface water classification system, groundwater status monitoring and classification, protected areas designation, climate change impact). Also, an analysis should be done on the necessity of designation of LOW as a nutrient sensitive area under the UWWT Directive and nitrate vulnerable area under the Nitrates Directive in order to mitigate the risk of eutrophication. The same can apply on the elaboration and implementation of specific legislation for using phosphates free detergents.

7.2 CONTROL OF URBAN WASTEWATER DISCHARGES

Inappropriate wastewater management. i.e. wastewater discharge, is certainly one of the most important sources of pollution in the LOW. Based on the analysis presented in Section 4.1 currently the ratio of households connected to public wastewater collection system for the basin equals 72%; the remaining 28% are assumed to use septic tanks for discharge of wastewater. Additional important aspect related to WWM in the LOW is the presence of a large number of tourists in the region, and in particular the distribution of visitors and overnights throughout the year, which creates significant imbalances of pollutant load to water bodies. Further, although there are two central WWM systems (WWTP Vranishta in North Macedonia and Tushemisht in Albania) and several small-scale (decentralized) plants for local tourist facilities around the lake, these are currently facing a number of problems and limitations in their daily operation. Finally, apart from previous studies, the surveillance monitoring programme that was carried out in 2019 also confirmed that anthropogenic eutrophication is taking place in Lake Ohrid, with the domestic phosphorus input contributing the largest share in the total anthropogenic phosphorus load.

Thus, it is expected that during the analyzed 12-year period the WFD requirements regarding WWM should be given highest priority and fully met. Proposed measures for control of urban wastewater discharges (Table 7.1) take into consideration reconstruction and upgrade of the two central WWM systems, completion of sewer networks in settlements and connecting these networks to the central systems, construction of small-scale WWM systems in villages that will be equipped with WWTPs, and termination of combined sewer systems (i.e. construction of separate surface runoff systems) in urban areas around the lake. Conducted analysis for determination of the size/capacity and required expenditures for the WWM systems are based on input data from the JICA-study mentioned in Section 4.1[42].

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[41] "Drin Basin: The Strategic Action Programme", Draft Version; GWP-Med (12 September 2019).

[42] "Data Collection Survey for Ohrid Lake Environmental Improvement", Final Report. Japan International Cooperation Agency (JICA), MoEPP (October 2012).

7.3 WASTE MANAGEMENT

The sub-group of measures is focused on activities for mitigation of another major pollution sector – solid waste management. It includes improvements in waste collection activities and establishment of regional waste management centers, which in general is an accepted strategy for waste management in both countries, but as well on measures for closure and remediation of the existing non-compliant municipal landfills and village dump sites, introduction of waste recycling, etc. The analyses for both countries are based on unit input data from a study for establishment of regional waste management plan for the South-east region in North Macedonia[43].

7.4 CONTROL OF AGRICULTURAL SOURCES OF POLLUTION

Proposed measures within this group refer to control of diffuse (non-point) pollution which is result of agriculture activities. Identified measures are divided in the following sub-groups:

- ✓ Control of fertilizer and pesticide use measures, referring mainly to implementation of good agricultural practices (GAP) in crop cultivation and farm management, with the aim of reducing nutrient (fertilizer) and pesticide pollution; and
- ✓ Agriculture waste and hazardous materials management measures, focused on managing of agriculture waste and waste materials: pesticide and fertilizer packaging (hazardous) waste; PE waste; organic (bio-degradable) waste; and mainly liquid waste from cleaning of agriculture machinery.

7.5 CONTROL OF WATER WITHDRAWALS

This group refers to activities for control of water abstraction (withdrawal) from the basin and increase of water use efficiency. The following sub groups of measures are taken into consideration:

- ✓ control of irrigation water withdrawals, Irrigation is the largest water consumer in the basin. On the other hand current irrigation practices are extremely inefficient. Therefore, a specific focus is given to development and implementation of measures directed at increasing the economy of water use for agriculture purposes. Foreseen measures include:
  - upgrading of existing irrigation schemes, to enable use of modern irrigation techniques (e.g. drip irrigation);
  - promotion and application of advanced irrigation and fertigation technologies on individual farms;
  - promotion of cropping pattern/mix change; and irrigation demand automation measures; and
- ✓ control of municipal and industrial water withdrawals, by reducing physical water losses in drinking and industry water supply networks, mainly in urban areas. Foreseen activities include supply side measures (reparation of water leaks and network upgrade), as well as demand side measures (increased water metering, development and promotion of new water supply codes, etc.).

7.6 FISHERY AND BIODIVERSITY MANAGEMENT MEASURES

As pointed out in Section 4.4, even though fishery master plans are in place in both countries and major efforts for restocking are continuously being implemented for several decades, as a result of inadequate protection and unsustainable fishing practices the two endemic Salmonid species of the lake (Ohrid Trout and Belvica) are at threat of possible irreversible loss of their populations. Further, additional pressure is the presence of introduced (alien) fish species in the lake.

Therefore, particular measures are proposed which by and large refer to harmonization of the fishery regulations in both countries and adoption of a joint Fishery Master Plan, as a main prerequisite for further continuous implementation of activities for controlling of listed adverse impacts. In addition, measures such as upgrading the capacity of the restocking hatcheries, as well as for strengthening of fishing inspection units are also planned.

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43 "Preparation of Documents for Establishment of Integrated and Financially Sustainable Systems for Waste Management Centers – Southeast region"; EuropeAid/136347/IH/SER/MK. ENVIROPLAN S.A. and consortium partners: Louis Berger, BiPRO GmbH, EPEM S.A., SLR Consulting Limited (2016).

7.7 OTHER MEASURES

The group of other projected measures includes:

- ✓ protected areas measures, focused mainly on restoration and improved management of protected areas (e.g. drinking water supply sources) within the LOW;
- ✓ remediation of contaminated industrial sites. As mentioned in Section 4.2, in addition to eutrophication Lake Ohrid is also under pressure of pollution resulting from abandoned old chromium, iron and nickel mines outside Pogradec in Albania. Therefore, the plan includes implementation of measures and activities focused on mitigation of this pressure in the form of:
  - detailed site investigations for precise determination of the contamination extent and selection of preferred clean-up technologies, and
  - implementation of remediation works;
- ✓ flow diversion – hydropower, the measure refers to reducing the highly negative impact from Sateska river on Lake Ohrid (see Section 4.7), through implementation of design and civil works for re-routing the main flow of the river in its original riverbed with discharge directly into the Black Drin river and additional erosion-control activities. The concept that is observed here is based on analysis carried out in 1998 by the Directorate for Water Economy in North Macedonia44 and includes four phases:
  - reconstruction of the section of Sateska river from the Volino village to Black Drin (8 km length) to enable a flow-capacity of 100 m3/sec and construction of a special flow-diversion structure with the same capacity,
  - regulation of the upper section of the Sateska riverbed (channel) from Volino to Klimeshtica (20 km length),
  - construction of check dams (sediment settling basins) along the upper section of Sateska, and
  - implementation of reforestation and other erosion-control measures on the upper section. These works will enable full control of up to Q50-year flow in Sateska of 180 m^3/sec, whereas in the case of such an event Q100 m^3/sec will surge directly to Black Drim and the remaining 80 m^3/sec to Lake Ohrid. Thus, the solution will prevent practically all current discharge of sediment and nutrients (phosphorus and nitrogen) in the lake, without affecting the annual hydropower generation on the cascade reservoirs/HPPs along the Drin river; and
- ✓ other anthropogenic pressure management measures, focused on activities for mitigation of the remaining major anthropogenic pressure – boating. Besides harmonization of boating legislation with the EU standards and strengthening the capacity of boating administrations, this sub group also includes construction of modern docking (boat) marinas on both sides of the lake.

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[44] Zavod za Vodostopanstvo, 1998.

Table 7.1: Programme of Measures

Pressure	Driver	Impact Type[1]	WB[2]	KTM[3]	Specific Measure	KTM Indicators 2020-2025	KTM Indicators 2026-2031	Expenditure (EUR) 2020-2025	Expenditure (EUR) 2026-2031
1.1 - Point – Urban waste water	Urban development Tourism and recreation	CHEM/ MICR/ NUTR/ ORGA	**2, 3, 5, 6, 7, 17, 18**	9, 10 (MKD)	• Setting up of advanced WWM tariff policy for households, commercial needs (tourism) and SMEs in Municipalities of Struga and Ohrid based on the national ERC methodology	[*See indicators specified under pressure 3.2 below*]			
		CHEM/ MICR/ NUTR/ ORGA	**2, 3, 5, 6, 7, 17, 18**	1 (MKD)	• Preparation/update of Feasibility Study and engineering design documents • Reconstruction and upgrading of the existing WWM system Vranishta	PE required to be treated by upgrade of WWM 80,000 curr. + 40,000 (120,000 max)		€23,240,000	
		CHEM/ MICR/ NUTR/ ORGA	**9, 10, 11, 12, 19**	9, 10 (AL)	• Setting up of advanced water WWM tariff policy for households, commercial needs (tourism) and SMEs in Municipality of Pogradec	[*See indicators specified under pressure 3.2 below*]			
		CHEM/ MICR/ NUTR/ ORGA	**9, 10**	1	• Preparation of Feasibility Study and engineering design documents • Reconstruction and upgrading of the existing WWM system Tushemisht	PE required to be treated by upgrade of WWM 40,000 (max)		€14,300,000	
		MICR/ NUTR/ ORGA	**1**	1 (MKD)	• Extension of the existing WWM system Vranishta, to connect all settlements and tourist facilities in the WB (L-Radozhda) • Construction of secondary sewers in Radozhda village and tourist facilities in WB	Number of WWT works to be constructed/upgraded 1 PE to be treated by extension/upgrade of WWM 1,700		€1,090,000	
		MICR/ NUTR/ ORGA	**2**	1 (MKD)	• Completion of secondary sewer systems in Kalishta, Frangovo and	Number of WWT works to be constructed/upgraded		€6,080,000	

Pressure	Driver	Impact Type[1]	WB[2]	KTM[3]	Specific Measure	KTM Indicators 2020-2025	KTM Indicators 2026-2031	Expenditure (EUR) 2020-2025	Expenditure (EUR) 2026-2031
					Mali Vlaj villages and tourist facilities in WB • Connecting secondary sewer systems to the central WWM system Vranishta	3			
						PE to be treated by extension/upgrade of WWM			
						3,000			
		MICR/ NUTR/ ORGA	**5, 17, 18, 20**	1 (MKD)	• Completion of secondary sewer systems in settlements and tourist facilities in WBs • Connecting secondary sewer systems to the central WWM system Vranishta, or construction of distributed small-scale WWM systems for individual settlements	PE required to be treated by upgrade/extension of WWM		€2,380,000	
						3,700			
		MICR/ NUTR/ ORGA	**6**	1 (MKD)	• Completion of secondary sewer systems in Ohrid, Istok and Racha settlements and tourist facilities in WB • Connecting secondary sewers to the central WWM system Vranishta	Number of WWT works to be constructed/upgraded		€2,570,000	
						3			
						PE required to be treated by upgrade/extension of WWM			
						4,000			
		MICR/ NUTR/ ORGA	**7**	1 (MKD)	• Completion of secondary sewer systems in settlements (Eleshec, Elshani, Sv. Stefan) and tourist facilities in WB (sewer systems connected to WWM Vranishta)	Number of WWT works to be constructed/upgraded		€2,700,000	
						2			
						PE required to be treated by upgrade/extension of WWM			
						4,200			

Pressure	Driver	Impact Type[1]	WB[2]	KTM[3]	Specific Measure	KTM Indicators 2020-2025	KTM Indicators 2026-2031	Expenditure (EUR) 2020-2025	Expenditure (EUR) 2026-2031
		MICR/ NUTR/ ORGA	**7**	1 (MKD)	• Construction of small-scale WWTM systems for Trpejca, Ljubanishta, Velestovo villages and tourist facilities	PE required to be treated by upgrade of WWM: 4,300 Number of WWT works to be constructed: 3		€4,420,000	
		MICR/ NUTR/ ORGA	**8**	1 (MKD)	• Reconstruction/upgrading of small-scale WWM system in St. Naum	Number of WWT works to be constructed/upgraded: 1		€250,000	
		MICR/ NUTR/ ORGA	**9, 19**	1 (AL)	• Construction/completion of secondary sewer systems in settlements and tourist facilities in WB (Çerravë and Dardhas Admin Units) • Connecting secondary sewer systems to the central WWM system Tushemisht, or construction of distributed small-scale WWM systems for settlements	PE required to be treated by upgrade of WWM: 10,000		€6,420,000	
		MICR/ NUTR/ ORGA	**10**	1 (AL)	• Completion of secondary sewer systems in settlements and tourist facilities in WB Pogradec (Buçimas and Pogradec Admin Units) • Connecting secondary sewer systems to the central WWM system Tushemisht	PE required to be treated by upgrade of WWM: 7,100		€4,600,000	
		MICR/ NUTR/ ORGA	**11**	1 (AL)	• Construction of small-scale WWTM systems for settlements and tourist facilities in WB Hudenisht (Hudenisht and Lin Admin Units)	PE required to be treated by upgrade of WWM: 3,000		€3,000,000	

Pressure	Driver	Impact Type[1]	WB[2]	KTM[3]	Specific Measure	KTM Indicators 2020-2025	KTM Indicators 2026-2031	Expenditure (EUR) 2020-2025	Expenditure (EUR) 2026-2031
		MICR/ NUTR/ ORGA	**12**	1 (AL)	• Construction of small-scale WWTM systems for settlements and tourist facilities in WB Lin (Hudenisht and Lin Admin Units)	PE required to be treated by upgrade of WWM		€3,500,000	
						3,500			
1.2 - Point – Storm overflows	Urban development Tourism and recreation	CHEM/ OTHE	**3**	1, 21 (MKD)	• Termination of combined sewer, by construction (or completion) of separate storm/surface runoff collection system in Struga and disconnecting existing storm runoff connections from the WWM system Vranishta	Number of sustainable drainage systems			€5,000,000
						1 (0%)	(100%)		
		CHEM/ OTHE	**6**	1, 21 (MKD)	• Termination of combined sewer, by construction (or completion) of separate storm/surface runoff collection system in Ohrid and disconnecting existing storm runoff connections from the WWM system Vranishta	Number of sustainable drainage systems			€4,000,000
						1 (0%)	(100%)		
		CHEM/ OTHE	**10**	1, 21 (AL)	• Termination of combined sewer, by construction (or completion) of separate storm/surface runoff collection system in Pogradec and disconnecting existing storm runoff connections from the WWM system Tushemisht	Number of sustainable drainage systems			€2,000,000
						1 (0%)	(100%)		
		CHEM/ OTHE	**2, 5, 6, 7, 17, 18**	1, 21 (MKD)	• Disconnection of existing housing and tourist facilities' storm runoff connections from the WWM system Vranishta (all WB settlements in Struga and Ohrid municipalities with sewers connected to WWM Vranishta)	Number of upgraded storm overflows			€9,000,000
							TBC		
		CHEM/ OTHE	**9, 10**	1, 21 (AL)	• Disconnection of existing housing and tourist facilities' storm runoff connections from the WWM system Tushemisht (all WB	Number of upgraded storm overflows			€2,000,000
							TBC (100%)		

Pressure	Driver	Impact Type[1]	WB[2]	KTM[3]	Specific Measure	KTM Indicators		Expenditure (EUR)	
						2020-2025	2026-2031	2020-2025	2026-2031
					settlements in Buçimas, Çerravë, Dardhas and Pogradec Admin Units with sewers connected to WWM Tushemisht)				
1.3 - Point –-IED plants	Industry	CHEM/ ECOS/ ORGA/ OTHE	**1, 2, 3, 5, 6, 7, 8, 17, 18, 20**	10, 16 (MKD)	• Development and implementation of capacity building program for local government employees in Municipalities of Struga and Ohrid on environmental permitting procedure and enforcement of IED/SEVESO/IPPC legislation for industry (IPPC Type B)	Number of trained municipal employees: 4		€250,000	
					• Revisiting and continuous monitoring of compliance with environmental requirements for existing IED/IPPC Type B permits (industrial units)	Number of revised permits: 14		€750,000	
		CHEM/ ECOS/ ORGA/ OTHE	**9, 10, 11, 12**	10, 16 (AL)	• Development and implementation of capacity building program for local government employees in Municipality of Pogradec on environmental permitting procedure and enforcement of IED/SEVESO/IPPC legislation for industry (IPPC Type B and C)	Number of trained municipal employees: 3		€200,000	
					• Revisiting and continuous monitoring of compliance with environmental requirements for existing IED/IPPC Type B/C permits (industrial units)	Number of revised permits: 11		€600,000	
1.6 - Point – Waste disposal	Urban development	CHEM/ ECOS/ LITT/ MICR/ NUTR	**1, 2, 3, 5, 6, 7, 8, 17, 18, 20**	21 (MKD)	• Site identification and selection; preparation of design documents for development of regional waste management facility for Ohrid and	Population from LOW to be covered by the regional WM facility: 85,000		€8,880,000	€5,920,000

Pressure	Driver	Impact Type[1]	WB[2]	KTM[3]	Specific Measure	KTM Indicators		Expenditure (EUR)	
						2020-2025	2026-2031	2020-2025	2026-2031
					Struga Municipalities (Southwest Region in MKD)	Waste disposal capacity (t/y) at regional WM facility for LOW			
					• Construction of regional waste management facility for Ohrid and Struga Municipalities (Southwest Region in MKD)	32,000 t/y			
			9, 10, 11, 12	21 (AL)	• Site identification and selection; preparation of Feasibility Study and engineering design documents for development of regional waste management facility (landfill) for Pogradec Municipality (Buçimas, Çerravë, Dardhas, Pogradec and Hudenisht Admin Units)	Population from LOW to be covered by the regional WM facility		€5,400,000	€3,600,000
						55,000			
					• Construction of regional waste management facility for Pogradec Municipality	Waste disposal capacity (t/y) at regional WM facility for LOW			
						20,000 t/y			
			1, 2, 3, 5, 6, 7, 8, 17, 18, 20	21 (MKD)	• Closure of existing municipal landfills in Municipalities of Ohrid (Bukovo) and Struga, including remediation of the landfill sites	No. of remediated waste disposal sites		€4,200,000	€260,000
						4			
			9, 10, 11, 12	21 (AL)	• Closure of existing municipal landfill in Municipality of Pogradec (Çerravë Admin Unit) and remediation of the landfill site	Number of remediated waste disposal sites		€2,700,00	€175,000
						1			
			1, 2, 3, 5, 6, 7, 8, 17, 18, 20	21 (MKD)	• Closure of illegal (village) dumps in Municipalities of Ohrid and Struga, including remediation of the landfill sites	Number of remediated illegal dumps		€175,000	
						19			
			9, 10, 11, 12	21 (AL)	• Closure of illegal dumps (villages within the LOW) in Municipality of Pogradec, including remediation of the landfill sites	Number of remediated illegal dumps		€100,000	
						TBD			
1.8 - Point - Aquaculture	Fisheries and aquaculture	CHEM/ ORGA	**13**	18 (AL)	• Closure of the fish farms with rainbow trout, or upgrading to	Number of closed aquaculture facilities		€50,000	
						TBD			

Pressure	Driver	Impact Type[1]	WB[2]	KTM[3]	Specific Measure	KTM Indicators		Expenditure (EUR)	
						2020-2025	2026-2031	2020-2025	2026-2031
					farming of Ohrid trout (required intervention on the outlet water)				
				1 (MKD)	• Construction of small-scale WWM systems for on outlet water at HBI Ohrid	Number of WWT works to be constructed		€100,000	
						1			
2.1 - Diffuse - Urban runoff	Urban development Tourism and recreation	CHEM/ OTHE	**1 to 20**	21	[*See measures, indicators and investments specified under pressure 1.2 above*]				
2.2 - Diffuse – Agricultural	Agriculture	CHEM/ ECOS/ NUTR	**2, 3, 4, 5, 6, 7, 17, 18**	2, 12 (MKD)	• Reduce nutrient pollution from agriculture through optimization of mineral fertilizers use efficiency by laboratory soil testing, fertilization plans on areas with intensive agricultural systems	Area of agricultural land required to be covered		€850,000	€550,000
						4,000 ha (60% of tot)	2,680 ha (40% of tot)		
			9, 10, 11 12, 19	2, 12 (AL)	• Reduce nutrient pollution from agriculture through optimization of mineral fertilizers use efficiency by laboratory soil testing, fertilization plans on areas with intensive agricultural systems	Area of agricultural land required to be covered		€400,000	€250,000
						1,970 ha (60% of tot)	1,300 ha (40% of tot)		
			2, 3, 4, 5, 6, 7, 17, 18	2, 12 (MKD)	• Advisory services for agriculture: Development of facilities and procedures for proper on farm management and storage of organic (manure) fertilizer	Number of farms that need to be covered by advisory services		€1,500,000	€2,000,000
						40%	30%		
			9, 10, 11 12, 19	2, 12 (AL)	• Advisory services for agriculture: Development of facilities and procedures for proper on farm management and storage of organic (manure) fertilizer	Number of farms that need to be covered by advisory services		€700,000	€500,000
						40%	30%		
			2, 3, 4, 5, 6, 7, 17, 18	2, 12 (MKD)	• Advisory services for agriculture: Implementing procedures and enforcing capacities for application	Number of farms that need to be covered by advisory services		€1,800,000	€1,100,000
						30%	20%		

Pressure	Driver	Impact Type[1]	WB[2]	KTM[3]	Specific Measure	KTM Indicators		Expenditure (EUR)	
						2020-2025	2026-2031	2020-2025	2026-2031
					of manure in line with Nitrate directive provisions				
			9, 10, 11 12, 19	2, 12 (AL)	• Advisory services for agriculture: Implementing procedures and enforcing capacities for application of manure in line with Nitrate directive provisions	Number of farms that need to be covered by advisory services		€600,000	€350,000
						30%	20%		
			2, 3, 4, 5, 6, 7, 17, 18	2, 12 (MKD)	• Reduce nutrient pollution from agriculture: Delineation of vulnerable areas in a line with Nitrate directive	Area of buffer zones required to be covered		€1,200,000	€550,000
						70%	30%		
			9, 10, 11 12, 19	2, 12 (AL)	• Reduce nutrient pollution from agriculture: Delineation of vulnerable areas in a line with Nitrate directive	Area of buffer zones required to be covered		€300,000	€100,000
						70%	30%		
			2, 3, 4, 5, 6, 7, 17, 18	2, 12 (MKD)	• Reduce nutrient pollution from agriculture: Introduction of on farm agro-ecological measures for sustainable agricultural production	Area of agricultural land required to be covered		€1,900,000	€1,400,000
						2,670 ha	2,000 ha		
			9, 10, 11 12, 19	2, 12 (AL)	• Reduce nutrient pollution from agriculture: Introduction of on farm agro-ecological measures for sustainable agricultural production	Area of agricultural land required to be covered		€900,000	€700,000
						1,300 ha	980 ha		
			2, 3, 4, 5, 6, 7, 17, 18	3, 12 (MKD)	• Reduce pesticides pollution from agriculture: Implementation of plant protection programs for optimization of pesticide use and effective pest control	Area of agricultural land required to be covered		€900,000	€600,000
						3,000 ha	2,350 ha		
						Number of farms that need to be covered by advisory services			
						45%	35%		
			9, 10, 11 12, 19	3, 12 (AL)	• Reduce pesticides pollution from agriculture: Implementation of plant protection programs for optimization of pesticide use and effective pest control	Area of agricultural land required to be covered		€300,000	€200,000
						1,300 ha	980 ha		
						Number of farms that need to be covered by advisory services			

Pressure	Driver	Impact Type[1]	WB[2]	KTM[3]	Specific Measure	KTM Indicators		Expenditure (EUR)	
						2020-2025	2026-2031	2020-2025	2026-2031
						45%	35%		
			2, 3, 4, 5, 6, 7, 17, 18	3, 12 (MKD)	• Reduce pesticides pollution from agriculture: Development of facilities and procedures for proper on farm management of pesticides and storage	Number of farms that need to be covered by advisory services		€900,000	€600,000
						(45%)	(35%)		
			9, 10, 11 12, 19	3, 12 (AL)	• Reduce pesticides pollution from agriculture: Development of facilities and procedures for proper on farm management of pesticides and storage	Number of farms that need to be covered by advisory services		€300,000	€200,000
						(45%)	(35%)		
			2, 3, 4, 5, 6, 7, 17, 18	15 (MKD)	• Development of facilities for collection and processing of agricultural organic by-products	Number of farms that need to be covered by advisory services		€1,000,000	€800,000
						(30%)	(40%)		
			9, 10, 11 12, 19	15 (AL)	• Development of facilities for collection and processing of agricultural organic by-products	Number of farms that need to be covered by advisory services		€400,000	€250,000
						(30%)	(40%)		
2.5 - Diffuse – Contaminated or abandoned industrial sites	Industry	CHEM/ OTHE	**9, 10, 11, 12**	4 (AL)	• Remedial Investigation /Feasibility Study, for determination of nature and extent of contamination. Assess the treatability of site contamination and evaluates the potential performance and cost of treatment technologies • Implementation of remediation (clean-up) activities	Area of land covered by the measures (ha) required to achieve objectives			
						5	15	€1,500,000	€4,500,000
2.6 - Diffuse – Discharges not connected to sewer network	Urban development Tourism and recreation	MICR/ NUTR/ ORGA	**1 to 20**	21	*[See measures, indicators and investments specified under pressure 1.1 above]*				
2.9 - Diffuse – Aquaculture	Fisheries and Aquaculture		**13**	18, 1	*[See measures, indicators and investments specified under pressure 1.8 above]*				

Pressure	Driver	Impact Type[1]	WB[2]	KTM[3]	Specific Measure	KTM Indicators 2020-2025	KTM Indicators 2026-2031	Expenditure (EUR) 2020-2025	Expenditure (EUR) 2026-2031
3.1 - Abstraction or flow diversion – Agriculture	Agriculture	LOWT	**2, 3, 4, 5, 6, 7, 17, 18**	8 (MKD)	• Restoration of existing irrigation channel scheme	Area of irrigated land required to be covered 400 ha	300 ha	€2,000,000	€1,500,000
			9, 10, 11 12, 19	8 (AL)	• Restoration of existing irrigation channel scheme	Area of irrigated land required to be covered 300 ha	200 ha	€1,500,000	€1,000,000
			2, 3, 4, 5, 6, 7, 17, 18	8 (MKD)	• Introduction/application of modern irrigation systems (drip and sprinkle irrigation)	Area of irrigated land required to be covered 800 ha	400 ha	€1,600,000	€800,000
			9, 10, 11 12, 19	8 (AL)	• Introduction/application of modern irrigation systems (drip and sprinkle irrigation)	400 ha	250 ha	€800,000	€500,000
			2, 3, 4, 5, 6, 7, 17, 18	8 (MKD)	• Introduction of advanced approaches in soil moisture controlling systems and irrigation scheduling	Area of irrigated land required to be covered 800 ha	400 ha	€1,200,000	€600,000
			9, 10, 11 12, 19	8 (AL)	• Introduction of advanced approaches in soil moisture controlling systems and irrigation scheduling	Area of irrigated land required to be covered 400 ha	250 ha	€600,000	€375,000
			2, 3, 4, 5, 6, 7, 17, 18	8 (MKD)	• Introduction of fertigation in high productive agricultural systems	Area of irrigated land required to be covered 800 ha	400 ha	€1,200,000	€600,000
			9, 10, 11 12, 19	8 (AL)	• Introduction of fertigation in high productive agricultural systems	Area of irrigated land required to be covered 400 ha	400 ha	€600,000	€375,000
			2, 3, 4, 5, 6, 7, 17, 18	24 (MKD)	• Mitigation of negative impact of climate change with implementing of adaptive measures for more effective water savings	Number of farms that need to be covered by advisory services 55%	25%	€2,700,000	€2,000,000
			9, 10, 11 12, 19	24 (AL)	• Mitigation of negative impact of climate change with implementing of adaptive measures for more effective water savings	Number of farms that need to be covered by advisory services 45%	30%	€1,200,000	€950,000
			2, 3, 4, 5, 6, 7, 17, 18	11 (MKD)		Agricultural area (ha) where water pricing		€100,000	

Pressure	Driver	Impact Type[1]	WB[2]	KTM[3]	Specific Measure	KTM Indicators 2020-2025	KTM Indicators 2026-2031	Expenditure (EUR) 2020-2025	Expenditure (EUR) 2026-2031
					• Improve water pricing policy and implementation of cost recovery measures for water services from agriculture	policy measures are required 2,000 ha			
			9, 10, 11 12, 19	11 (AL)	• Improve water pricing policy and implementation of cost recovery measures for water services from agriculture	Agricultural area (ha) where water pricing policy measures are required 5,000 ha		€100,000	
3.2 – Abstraction/ flow diversion – Water supply	Urban development Tourism and recreation	LOWT	**1, 2, 3, 6, 7, 8, 17, 18, 20**	9 (MKD)	• Reevaluating existing water supply tariff policy of CPE covering Municipalities of Struga and Ohrid, following cost recovery and PP principles; Setting up of advanced water supply tariff policy for households, commercial needs (tourism) and SMEs based on the national ERC methodology	Population for which water pricing policy measures are required 76,000		€100,000	
			1, 2, 3, 6, 7, 8, 17, 18, 20	8 (MKD)	• Development and implementation of a water supply efficiency increase program, to reduce non-revenue water in Municipalities of Struga and Ohrid (all settlements and tourism sites) to a sustainable level	Reduction (%) in non-revenue water required 35%	35%	€4,200,000	€4,200,000
			1, 2, 3, 6, 7, 8, 17, 18, 20	13 (MKD)	• Reassessment of compliance with EU directives and standards, or establishment of appropriate safeguard (buffer) zones for drinking water abstraction sources (wells, springs) in Municipalities of Struga and Ohrid	Number of drinking water protection zones required TBD		€1,000,000	
		LOWT	**9, 10, 11, 12, 19**	9 (AL)	• Reevaluating existing water supply tariff policy of CPE covering Municipality of Pogradec, following cost recovery and PP principles; Setting up of advanced water	Population for which water pricing policy measures are required 30,000		€100,000	

Pressure	Driver	Impact Type[1]	WB[2]	KTM[3]	Specific Measure	KTM Indicators		Expenditure (EUR)	
						2020-2025	2026-2031	2020-2025	2026-2031
					supply tariff policy for households, commercial needs (tourism) and SMEs				
			9, 10, 11, 12, 19	8 (AL)	• Development and implementation of a water supply efficiency increase program, to reduce non-revenue water in Municipality of Pogradec (all settlements and tourism sites) to a sustainable level	Reduction (%) in non-revenue water required		€1,900,000	€1,900,000
						35%	35%		
			9, 10, 11, 12, 19	13 (AL)	• Reassessment of compliance with EU directives and standards, or establishment of appropriate safeguard (buffer) zones for drinking water abstraction sources (wells, springs) in Municipality of Pogradec	Number of drinking water protection zones required		€500,000	
						TBD			
3.3 - Abstraction or flow diversion – Industry	Industry			*[See measures, indicators and investments specified under pressure 3.2 above]*					
3.5 – Flow diversion – Hydropower (Sateska river)	Energy – hydropower	HHYC/ HMOC/ NUTR/ ORGA	**13, 14, 15, 16**	5, 6, 7, 17 (MKD)	• Preparation of Feasibility Study and engineering design documents • Implementation of construction activities and measures for rediverting of Sateska river in its original flow (riverbed) with discharge into Black Drin river	Length of rivers (km) affected by the measure		€14,220,000	
						8 km			
						Number of water bodies affected by the measures			
						4			
3.6 - Abstraction or flow diversion - Fish farms	Fisheries and Aquaculture	NOSI	**13**	*[See measures, indicators and investments specified under pressure 1.8 above]*					
4.1.1 - Physical alteration of channel – Flood protection	Energy – hydropower Flood protection	NOSI		*[Minor pressure, no measures]*					

Pressure	Driver	Impact Type[1]	WB[2]	KTM[3]	Specific Measure	KTM Indicators		Expenditure (EUR)	
						2020-2025	2026-2031	2020-2025	2026-2031
5.1 - Introduced species and diseases	Fisheries and aquaculture	OTHE	**13**	18	• Implementation of measures to control adverse impacts of invasive alien species: ♦ Permanent fish stock and fisheries monitoring ♦ Establishment of Eel Management Units according to EU eel Regulation ♦ Introduction of measures for eradication of invasive fish species (L. gib.)	Number of species for which codes of practice to reduce spread of invasive alien species are required 6		€1,250,000	
5.2 - Exploitation or removal of animals	Fisheries and aquaculture	OTHE	**13**	20	• Harmonization (coordination) of fishery regulations between AL and MKD, including (1) detailed fish stock assessment and (2) preparation of joint Fishery Management Plan. • Implementation of measures to control adverse impacts of fishing and other removal of animals: ♦ Permanent fish stock and fisheries monitoring (also in 5.1) ♦ Introduction of new fishing techniques for bleak exploitation from the lake ♦ Establishment of a common minimal catchable size (fishing gears) and fishing quotas for both countries ♦ Reassessment of efficiency of fish-management practices (concession) ♦ Upgrading of volume (capacity) and standards of trout	Number of water bodies affected by the measures 1 Area of water bodies (km2) affected by the measure 356 km2		€4,000,000	

Pressure	Driver	Impact Type[1]	WB[2]	KTM[3]	Specific Measure	KTM Indicators		Expenditure (EUR)	
						2020-2025	2026-2031	2020-2025	2026-2031
					hatcheries Ohrid and Shum (MKD), Lin (AL) ♦ Strengthening of fishing inspection (Law Enforcement) units in MKD, AL				
5.3 – Litter or fly tipping	Urban development	CHEM/ LITT/ MICR/ NUTR	**1, 2, 3, 5, 6, 7, 8, 17, 18, 20**	21 (MKD)	• Improved/upgraded waste collection in urban areas (settlements) and tourist facilities • Introduction of waste recycling practices	[*Indicators and investments specified under pressure 1.6*]			
			9, 10, 11, 12	21 (AL)	• Improved/upgraded waste collection in urban areas (settlements) and tourist facilities • Introduction of waste recycling practices	[*Indicators and investments specified under pressure 1.6*]			
7 – Anthropogenic pressure – Other (boating, tourism, recreation)	Tourism and recreation Fisheries and aquaculture Transport/ Navigation	CHEM/ OTHE	**13**	19, 21 (MKD, AL)	• Harmonization of boating legislation and regulations (bylaws) with the pertinent EU Directives and standards	Area of water bodies (km2) affected by the measure 356 km2		€100,000	
				19, 21 (MKD	• Strengthening the capacity of the Port Authority in Ohrid	Area of water bodies (km2) affected by the measure 356 km2		€200,000	
				19, 21 (AL)	• Analysis of requirements and possibilities for establishment of independent port authority in Pogradec	Area of water bodies (km2) affected by the measure 356 km2		€100,000	
				19, 21 (MKD)	• Site identification and selection; preparation of Feasibility Study and engineering design documents for development of joint boat marina for Ohrid and Struga	Area of water bodies (km2) affected by the measure 356 km2		€15,000,000	

Pressure	Driver	Impact Type[1]	WB[2]	KTM[3]	Specific Measure	KTM Indicators 2020-2025	KTM Indicators 2026-2031	Expenditure (EUR) 2020-2025	Expenditure (EUR) 2026-2031
					municipalities. Estimated capacity 1,000 boats. • Construction of a modern boat marina for Ohrid and Struga.				
				19, 21 (AL)	• Site identification and selection; preparation of Feasibility Study and engineering design documents for development of boat marina in Pogradec. Estimated capacity 250 boats. • Construction of a modern boat marina in Pogradec.	Area of water bodies (km2) affected by the measure 356 km2		€3,750,000	
			8	21 (MKD)	• Development and implementation of plan for protection and management of the wider area around the surface springs at St. Naum	Area of water bodies (km2) affected by the measure		€1,000,000	
			9	21 (AL)	• Development and implementation of plan for protection and management of the wider area around the surface springs at Tushemisht	Area of water bodies (km2) affected by the measure		€1,000,000	
Policy measures, research, knowledge base	N/A	N/A	**1 - 20**	14	• Preparation and development of monitoring programme for transboundary water resource management in the LOW, in accordance with WFD: ♦ Preparation of a study to assess: (1) existing monitoring programmes and capacities on national level and (2) required needs and procedures to perform monitoring in the LOW at the transboundary level, in accordance with EU Directives	Assessment study identifying need for monitoring Agreement on transboundary monitoring stations Agreed list of monitoring parameters and protocols		€250,000	

Pressure	Driver	Impact Type[1]	WB[2]	KTM[3]	Specific Measure	KTM Indicators		Expenditure (EUR)	
						2020-2025	2026-2031	2020-2025	2026-2031
					♦ Agreement on LOW transboundary monitoring programme: (1) agreement on transboundary monitoring program locations; (2) agreement on transboundary monitoring program requirements and procedures; (3) preparation of joint monitoring guidelines based on international guidance and standards for implementing monitoring protocols ♦ Designation of appropriate authorities responsible for the implementation of the transboundary monitoring programme				
					• Updating and increasing precision of water balance for the entire Prespa-Ohrid Lakes Watershed, including analysis of potential climate chenge impact on both lakes	Assessment study reporting (detailing) water balance (hydrology) aspects of the Prespa-Ohrid basin		€500,000	
					• Conducting research and establishment of reference conditions for future determination of ecological status of Lake Ohrid water bodies	Study establishing reference conditions for assessment of biological quality status of Lake Ohrid water bodies		€250,000	
					• Conducting analysis for improved water resource management (outflow from Lake Ohrid), to balance the needs of all stakeholders	Study with recom-mendations for improved management of outflow regimes from Lake Ohrid		€100,000	
					• Preparation and development of programme for reed management	Study with recom-mendations for long-		€100,000	

Pressure	Driver	Impact Type[1]	WB[2]	KTM[3]	Specific Measure	KTM Indicators		Expenditure (EUR)	
						2020-2025	2026-2031	2020-2025	2026-2031
						term reed management in the LOW			

1: Impact types

CHEM - Chemical pollution	HMOC - Altered habitats due to morphological changes	NOSI - No significant impact
ECOS - Damage to groundwater-dependent terrestrial ecosystems	LOWT - Abstraction exceeds available groundwater resource	NUTR - Nutrient pollution
HHYC - Altered habitats due to hydrological changes	MICR - Microbiological pollution	ORGA - Organic pollution

2: Water Bodies

[1]	L-Radozhda	[6]	L- Studenchishki kanal	[11]	L-Udenisht	[16]	R-Sateska 3
[2]	L-Kalishta	[7]	L-Velidab	[12]	L-Lin	[17]	R-Koselska 1
[3]	L-Struga-Black Drin	[8]	L-Bay of St. Naum	[13]	L-Lake Ohrid-Pelagic	[18]	R-Koselska 2
[4[	L-Sateska	[9]	L-Tushemisht	[14]	R-Sateska 1	[19]	R-Cerave
[5]	L-Koselska	[10]	L-Pogradec	[15]	R-Sateska 2	[20]	Sushica

3: Key Type Measures: Annex 4.

8 ECONOMIC ANALYSIS

8.1 PURPOSE OF THE ECONOMIC ANALYSIS

The WFD puts a strong emphasis on conducting economic analysis in the preparation of basin management plans. The purpose of the economic analysis is to provide valuable information to aid policy decision making with the aim of achieving defined environmental and resource protection goals.

The specific objectives of the analysis include:

- ✓ understanding the economic issues and tradeoffs at stake in a river/lake basin, as a starting point in assessing the impact of restoring water quality on economic sectors that have significant role and importance in the local, regional and national economy;
- ✓ supporting the development of economic and financial instruments that may be effective in reaching environmental objectives;
- ✓ assessing the least costly way for the economy to achieve defined environmental objectives for water resources;
- ✓ assessing the economic impact of proposed programmes of measures aimed at improving water status; and
- ✓ assessing regions or water bodies where environmental objectives need to be made less stringent to account for economic and social impacts in a search for overall sustainability.

Several types of economic analysis need to be carried out for accomplishing listed objectives, such as:

- ✓ development of baseline socio-economic scenario for the basin, including description of the importance of water and water ecosystem use;
- ✓ cost-recovery analysis;
- ✓ cost-effectiveness analysis, and/or
- ✓ cost-benefit analysis.

This section provides summary of the economic analysis carried for development of the LOWMP.

8.2 OVERVIEW OF APPLIED ECONOMIC INSTRUMENTS FOR WATER MANAGEMENT

Economic instruments are a widely used tool in environmental protection policies in both developed and developing countries throughout the world. The key reason for implementing economic instruments is to send out a signal that the use of a resource imposes costs on others, i.e. some form of external costs which are not covered in the price of services or products. In essence, economic instruments increase the efficiency in resource use by decreasing demand and thus reducing damages, however at the same time generating revenues for further use for environmental resource management.

Albania and North Macedonia have developed economic instruments related to water resource management. Overview of the water-related economic instruments established in Albania and North Macedonia is shown in Table 8.1[45]; details are provided in Annex 5. Applied economic instruments are divided in four categories:

- ✓ water service tariffs (fees);
- ✓ water use charges;
- ✓ emission charges; and
- ✓ product charges.

The fifth category refers to charges/fees as a consequence of water resources use under a concession agreement.

It should be pointed out that important differences exist in the level of the listed economic instruments between the two countries, as well as that at present the effectiveness of these instruments in not known.

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45 Source: "Thematic Report on Socio-Economics of the Extended Drin River Basin; The Global Water Partnership – Mediterranean (GWP – Med), November 2017.

8.3 TARIFFS FOR WATER SUPPLY AND WASTEWATER MANAGEMENT

8.3.1 Tariff Setting and Operating Cost Recovery of Water Services

In both countries sharing the LOW water service tariffs are regulated by special national agencies – the Albanian Regulatory Authority of the Water Supply and Waste Water Disposal and Treatment Sector[46], and the Energy and Water Services Regulatory Commission of the Republic of North Macedonia[47]. Thus, tariffs for drinking water supply and wastewater collection and treatment are defined based on specific tariff-setting methodologies, which are based on legislative and regulatory provisions, and as such are obligatory for all service providers in the countries.

Table 8.1: Overview of Economic Instruments for Water Management in Albania and North Macedonia

Economic Instruments	Economic activities	Albania	North Macedonia
Water service fees/tariffs	Water supply	•	•
	Wastewater collection	•	•
	Wastewater treatment	•	•
	Irrigation	•	•
	Land drainage		•
Water use(r) charges	Water supply for human consumption		•
	Water supply for industry/production	•	•
	Irrigation		•
	Fish breeding/aquaculture	•	•
	Land drainage		•
	Livestock	•	
	Use of geothermal water	•	•
	Water used for cooling systems	•	
Emission charges	Untreated wastewater discharge		•
	Fertilizer and pesticide use		
Product charges	Electricity production	•	•
	Sand, gravel and stone exploitation	•	•
	Water bottling	•	•
	Alcoholic and non-alcoholic drinks	•	
	Phosphorous detergents		
Water use concession	Water tourism activities	•	•
	Lake/water transport		
	Use of ports		

Table 8.2 below provides an outline of average water supply and wastewater service tariffs (prices) in 2018 in LOW municipalities; average water service tariffs for both countries are also provided.

The total water service tariff of €0.67/m^3 (82.22 ALL/m^3) charged by the CPE in Pogradec is 29% lower than the national average, with an average water supply tariff of €0.37/m^3 (45.4 ALL/m^3) being 65% lower than, and wastewater management tariff of €0.30/m^3 (36.8 ALL/m^3) being 36% higher than the national average.

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[46] http://www.erru.al/index.php?lang=2

[47] https://www.erc.org.mk/Default_en.aspx

Table 8.2: Water service tariffs for households and industry in LOW municipalities[48]

Water tariff (Euro/m3)	2018					
	Podradec	Ohrid	Struga	Debrca	AL average	NMK average
Households						
Total water tariff	0.67	0.70	0.97	0.42	0.80	0.61
Water supply	0.37	0.56	0.57	0.36	0.61	0.43
WWM	0.30	0.14	0.40	0.06	0.19	0.18
Industry and public sector						
Total water tariff	0.91	0.70	0.97	0.42		0.61
Water supply	0.61	0.56	0.57	0.36		0.43
WWM	0.30	0.14	0.40	0.06		0.18

The situation is somewhat different on the other side of the lake in North Macedonia, where the CPEs in Ohrid and Struga charge higher total water service tariffs than the national average (e.g. in Struga the total water service tariff of €0.97/m^3 (59.5 MKD/m^3) is nearly 40% higher and the wastewater tariff being even 56% higher than the national averages). On the other hand, Debrca municipality charges significantly lower tariffs that the national averages.

Another important aspect is the marked difference between tariffs charged to households vs. industry and public institutions in Pogradec. Finally, evidently Struga has by far highest water service prices in the region for both households and industry.

Table 8.3: Operational and Financial Indicators of the Water Service Providers in the LOW49

Index	2015		
	Pogradec	Ohrid/Struga	Debrca
Water Coverage (%)	87.0%	91.0%	47.0%
Water Coverage – Household Connections (%)	87.0%	91.0%	47.0%
Sewerage Coverage (%)	72.0%	89.7%	15.1%
Average Revenue W&WW (US$/m3 water sold)	0.65	0.55	0.33
Unit Operational Cost Water and Wastewater (W&WW) (US$/m3 sold)	0.37	0.62	0.36
Staff Water/000 Water pop served (#/000 W pop served)		2.55	0.95
Collection Period (days)		1,077.15	505.08
Collection ratio (%)	100%	100%	100%
Operating Cost Coverage (ratio)	1.78	0.88	0.93
Water Consumption (liters/person/day)	75.0	180/80	276.0
Non Revenue Water (%)	59.0%	65.3%	13.3%
Non Revenue Water (m3/km/day)	28.6	57.1	1.2
Water sold that is metered (%)	96.8%	85.0%	95.5%

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[48] Sources: Albanian Regulatory Authority of the Water Supply and Waste Water Disposal and Treatment Sector (2018); Energy and Water Services Regulatory Commission of the Republic of North Macedonia (2018). International Benchmarking Network for Water and Sanitation Utilities (IBNET), 2015/18.

[49] Source: International Benchmarking Network for Water and Sanitation Utilities (IBNET), 2015.

Selected operational and financial indicators for 2015 of the four CPEs providing W&WW management services in the LOW are presented in Table 8.3 and Fig. 8.1. Most important elements from presented data are the differences in water consumption (both total and residential), non-revenue water (as a percentage of the total water supply), tariff collection period, and above all the operating cost ratio (revenues vs. operating costs).

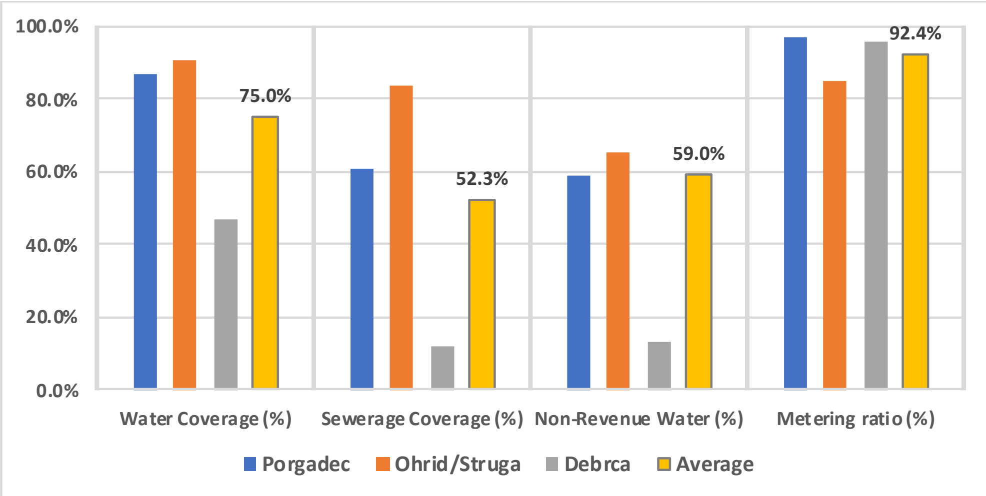

Figure 8.1: Operating Indicators of Water Service Providers in the LOW

Thus, as regards cost-recovery for the W&WW service it is concluded that, except for Pogradec municipality, the tariffs levied to households and industry in the LOW (North Macedonia) enable operation of the service providers at a level of covering only the basic financial/service operating costs – O&M and replacements. That is, by and large a very small reserve is applicable for capital investments in development and extension of the infrastructure. Nevertheless, these are figures from 2015 and, as mentioned before, currently the water service tariffs in both countries are regulated and set based on methodology designed to progressively enable full cost-recovery.

8.3.2 Affordability of Water Service Tariffs

Affordability, or ability to pay, in general, is a function of income related to the cost of living, or expenses that need to be paid for a certain service against the benefits derived from the use of the service. Income is often used to estimate a community's socio-economic status and the related ability of residents to support utility costs. The most prevalent method of assessing household affordability involves determining the monthly/annual amount spent on services as a function of monthly/annual household income. Overview of analysis and results regarding assessment of the affordability of the local population in the LOW to bear the current costs of W&WW management is presented further.

When discussing W&WW affordability a thresholds value expressed as a percentage is applied on household income that determines the point at which the cost of water and wastewater services becomes unaffordable. Table 8.4 represents such threshold values used by various international organizations and the value established in North Macedonia.

Table 8.4: Water Service affordability Threshold Values

Organization	Threshold value*
World bank (2002)	3% – 5%
UK Government	3%
US Government (USEPA)	2.50%
Asian Development Bank (ADB)	5%
UNDP	3%
North Macedonia (regulator)	3%

% of average household income that can be spent on water and wastewater services

Further, for assessment of W&WW services affordability several factors need to be taken into consideration, such as average water consumption, service price, household size and type, average household income, household income by different income groups, etc. The information regarding W&WW affordability presented herein are based on official statistical and other available data.

The share of current water service expenditures in the total household expenditures for several categories of household income is shown in Table 8.5.

Table 8.5: Share of Water Service Expenditures by Categories of Household income in the LOW

HH income categories (Euro/month)	WS+WWM expenses as % of HH monthly income			
	Podradec	Ohrid	Struga	Debrca
250	1.7%	4.0%	3.0%	2.7%
400	1.1%	2.5%	1.9%	1.7%
600	0.7%	1.7%	1.2%	1.1%
800	0.5%	1.3%	0.9%	0.8%
1,000	0.4%	1.0%	0.7%	0.7%

It is concluded that at present the average prices charged by CPEs for W&WW in LOW municipalities are affordable for the local population, except for households of the group with lowest income. Evidently, the recent increase of water service tariffs vs. affordability aspects is reflected in the water consumption patterns (see Tables 4.1 and 8.2).

Finally, projections regarding future household affordability to pay for W&WW services are directly related to projections of possible changes in water consumption, upgrade of the services, household size by types of households, and above all expected changes in household income. The last listed aspect is based on projections of expected GDP growth. In addition, perhaps a key influencing factor is whether required investments for increased/improved wastewater treatment will be included in future service costs. In such a case it can be expected that the consequent increase of the tariffs may lead to a situation where affordability of water services may become an issue for important groups of the local population. Thus, it is concluded that capital subsidies in the form of grants to cover major part of investment costs for modernization of the water services will have to be applied in the future too.

8.4 COST-BENEFIT ANALYSIS

8.4.1 Investment Costs of the Proposed Programme of Measures

Investment costs in the 2020 – 2031 period for implementing the measures specified in the PoM of this plan total € 236.2 million. Nearly 41% or €96.6 million will be spent on measures for control of urban wastewater discharge and storm overflows; 13.3% of the total (€31.4 mill) will be spent on measures for waste management improvement; 10.2% (€24.1 mill) on measures for control of agricultural sources of pollution; 9.4% (€22.3 mill) on control of irrigation withdrawals; 6% (€13.88 mill) on control of municipal water abstractions; 2.3% of the total (€5.4 mill) on fishery improvement measures; 16.7% (€39.4 mill) on other measures, of which €6 mill on remediation of contaminated industrial sites, €14.2 mill on flow diversion (Sateska river) and €19.2 mill on other anthropogenic pressure management measures (i.e. construction of boat docking stations); and 1.4% (€3.2 mill) on policy measures.

Given the importance of the measures for achieving the plan objectives, 74%, or €174.82 mill, are planned to be spent in the first 6-year implementation period and the remaining 26% in the second period (Table 8.6 and Fig. 8.2). 67% of the total costs (nearly €158 mill) are for measures in North Macedonia and 33% (€78.2 mill) for measures on the Albanian side of the watershed.

Table 8.6: Allocation of PoM Costs

Pressure addressed with KTM	Expenditure (€)		Sum (€)	% of Total
	2020-2025	2026-2031	(2020-2031)	
1.1 - Point – Urban waste water + 2.1 - Diffuse - Urban runoff + 2.6 - Diffuse - Discharges not connected to sewer	€ 74,550,000	€ -	€ 74,550,000	31.6%
1.2 - Point – Storm overflows	€ -	€ 22,000,000	€ 22,000,000	9.3%
1.3 - Point – Non-IED plants	€ 2,000,000	€ -	€ 2,000,000	0.8%
1.6 - Point – Waste disposal + 5.3 - Litter or fly tipping	€ 21,455,000	€ 9,950,000	€ 31,405,000	13.3%
1.8 - Point - Aquaculture + 2.9 - Diffuse - Aquaculture	€ 150,000	€ -	€ 150,000	0.1%
2.2 - Diffuse – Agriculture	€ 13,950,000	€ 10,150,000	€ 24,100,000	10.2%
2.5 - Diffuse – Contam. industry sites	€ 1,500,000	€ 4,500,000	€ 6,000,000	2.5%
3.1 - Abstraction – Agriculture	€ 13,600,000	€ 8,700,000	€ 22,300,000	9.4%
3.2 – Abstraction – Water supply + 3.3 -- Abstraction industry	€ 7,790,000	€ 6,090,000	€ 13,880,000	5.9%
3.5 – Flow diversion – Hydropower	€ 14,220,000	€ -	€ 14,220,000	6.0%
5.1 - Introduced species and diseases	€ 1,250,000	€ -	€ 1,250,000	0.5%
5.2 - Exploitation/removal of animals	€ 4,000,000	€ -	€ 4,000,000	1.7%
7 - Other pressures (boating)	€ 19,150,000	€ -	€ 19,150,000	8.1%
Policy measures, research, knowledge	€ 1,200,000	€ -	€ 1,200,000	0.5%
Total	**€ 174,815,000**	**€ 61,390,000**	**€ 236,205,000**	**100%**
% of Total per period	74%	26%		

8.4.2 Expected benefits from Protection of Water Resources in the LOW

As outlined in Section 6 implementation of the LOWMP has four distinct objectives related to

- ✓ restoration of good status/quality of surface and ground waters;
- ✓ preventing deterioration of water resources already having a good status;
- ✓ reduction of chemical pollution of water resources; and
- ✓ achieving objectives related to protected areas. Accomplishment of these objectives, on the other hand, will bring about a number of benefits for the local population in the basin, but as well for the wider community.

Nevertheless, a significant amount of financial resources will need to be devoted for accomplishment of the benefits, which in the end is a question of making a decision for allocating the required funding. Such decisions that have unequal consequences for different stakeholders and affect the well-being of entire communities are better taken in the most informed way, i.e. through cost and benefit accounting. This environmental accounting approach has the precise purpose of ensuring that all the benefits and costs for natural resource protection are taken into account for the purpose of making informed and sustainable decisions.

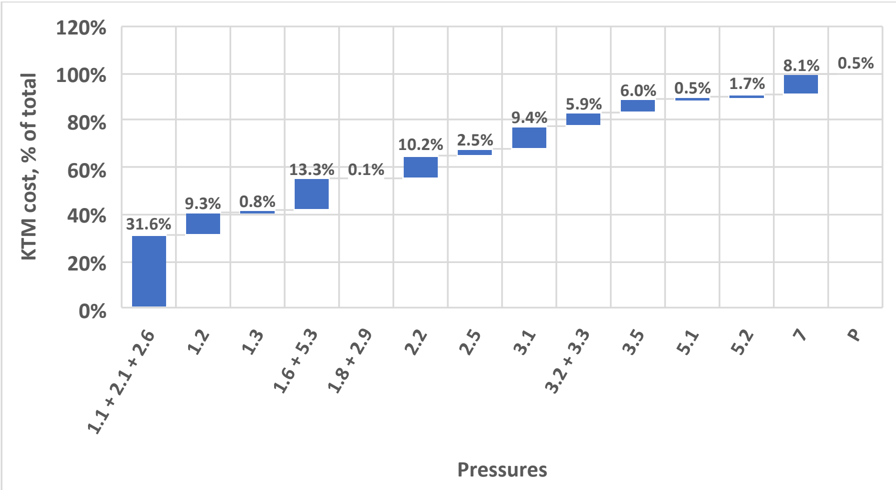

Figure 8.2: Distribution of PoM Costs

Thus, it is of highest importance to recognize the different values that people hold in terms of benefits from nature at the local, regional, national, and global level. These values have to do with how much people depend on the resource being protected, culture, income, and worldviews. The more dependent people are on natural resources for their livelihoods, the more they will care about productive functions stemming from these resources. On the other hand, tourists often value scenic beauty and biodiversity more than the locals, which in the case of the LOW is also of outmost importance to be recognized. Such benefits, or values, typically outweigh the costs of resource protection when assessed in monetary terms.

For these reasons the broad array of benefits expected to be accomplished with implementation of the LOWMP as a whole were assessed through the concept of valuing the ecosystem services provided by the natural and cultural capital of the LOW. Summary results from the valuation are presented in Table 8.7 below; detailed overview is provided in Supplement II.

A total of twelve Ecosystem Services (ES) provided by the Lake Ohrid watershed were valued using various economic techniques such as direct and indirect market price and avoided cost (direct market valuation approach), benefit transfer and travel cost (revealed preference approach), and contingent valuation (stated preference approach) methods. The range of valued ES is divided in ES of Lake Ohrid; ES of forests, protected and agricultural areas; and ES related to the entire watershed.

Table 8.7: Total Economic Value of LOW Ecosystem Services

Watershed part	Ecosystem Services	Service Type	Service value type (TEV approach)	Valuation method	Estimated ES value ($)	Period	% of Total
Lake Ohrid	Drinking water - households, industry	Provisioning	Use value - direct	Market price	$ 5,780,135	2016/17	2.0%
	Hydropower generation	Provisioning	Use value - direct	Market price	$ 55,525,470		18.8%
	Commercial fishery	Provisioning	Use value - direct	Market price	$ 1,016,506		0.3%
	Commercial boating	Provisioning	Use value - direct (NC)	Market price	$ 708,606		0.2%
Forests, Protected and Agriculture Areas	Raw materials -- timber, fuelwood	Provisioning	Use value - direct	Market price	$ 3,735,613	2016-2018	1.3%
	Food - game, fungi	Provisioning	Use value - direct	Market price	$ 5,774,725		2.0%
	Medicinal resources -- herbs	Provisioning	Use value - direct	Market price	$ 5,761,573		2.0%
	Agriculture production (crops)	Provisioning	Use value - direct	Market price	$ 17,480,000		5.9%
	Erosion prevention/soil protection	Regulating	Use value - indirect	Avoided cost	$ 346,531		0.1%
	CO2 sequestration	Regulating	Use value - indirect	Market price	$ 2,423,878		0.8%
Entire Watershed	Tourism and recreation	Cultural	Use value - direct (NC)	Travel cost	$ 191,438,339	2017/18	64.9%
	Existence/bequest/altruist value	Cultural	Non-use value	Contingent valuation	$ 5,114,937		1.7%
NC - non consumptive				Total Value	$ 295,106,314		100%
				Unit Value ($/ha)	$ 2,102		

The Total annual Economic Value (TEV) expressed in monetary units of the ecosystem services of the LOW in 2017[50] is $295.1 million. The unit value per area, taking into consideration the entire area of the watershed, equals $2,102/ha. Within this, the value of services of Lake Ohrid is $63.3 mill, or 21.4% of the total value; the value of services of forests, protected and agriculture areas within the watershed is $35.52 mill. (12% of the TEV); and the value of services that are related to the entire watershed is $196.55 mill, or 66.6% of the total value.

In summary, three of the twelve analyzed ES – Tourism and recreation, Hydropower and Agriculture – account for nearly 90% (89.6%) of the total estimated value. Of the remaining services, Drinking water, Food, Medicinal herbs and Existence/bequest, account for 2% of the total each.

The simplified cost-benefit analysis is based on the following data and assumptions:

- ✓ the time frame for the assessment is set to 15 years;
- ✓ the average expected inflation rate is set to 2.5%, assumed to be valid for both Albania and North Macedonia;
- ✓ the average US$ to Euro conversion rate for 2017/18 equals 0.85;
- ✓ two different discount rates were used: a minimum of 3%, as a case of solely accounting for minimum projected inflation, and a 5% rate;
- ✓ the total sum of PoM costs are included, distributed as equal annual expenditures over the two implementation periods;
- ✓ annual operating costs for the new/improved infrastructure systems that will results from the PoM are assumed to equal 2% of the investments made in the previous years; and
- ✓ the values only of the water quality-related ES are taken into consideration: Drinking water provision, Commercial fishery, Agriculture production, Tourism and recreation and Existence value. The benefits from implementation of the plan are assumed to take 6 years to manifest, i.e. the first implementation period, after which a uniform annual 2% value increase is assumed. The logic behind this rather conservative approach is that implementing the PoM, which is focused on restoration and protection of water resources in the watershed, and assuming that other risks are managed will, as a minimum, result in sustaining the current value of the analyzed water quality-related ecosystem services.

The analysis shows that the benefits that implementation of the plan would bring over the next 15 years are 8.4 to 8.7 times higher than the costs when different discount rates are used (Table 8.8).

Table 8.8: Summary Results of the Cost-Benefit Analysis

Cost or benefits	3% Discount rate	5% Discount rate
PV of costs	€ 268,046,819	€240,794,500
PV of benefits	€2,336,887,820	€2,022,248,415
B/C ratio	8.7	8.4

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[50] Due to data availability the analysis are for the period 2016 – 2018. However, all valued ecosystem services are on an annual basis, thus 2017 is assumed as an 'average year'.

9 PUBLIC PARTICIPATION

[This section will be finalized after all public participation events for the draft LOWMP take place].

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APPENDIX A

Appendix A

Population in the LOW

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