SOCIETY FOR THE PROTECTION OF PRESPA

DESIGN AND ORGANIZATION OF A TRANSBOUNDARY MONITORING SYSTEM (TMS) FOR THE PRESPA PARK

Expert proposal for the transboundary water monitoring system of the Prespa Park

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Society for the Protection of Prespa
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Study Team

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1. Introduction

1.1. Project for the development of a Transboundary Monitoring System

The present Expert Proposal was prepared following an initiative of the Society for the Protection of Prespa (SPP). SPP has been implementing since 2007 a project for the design of a Transboundary Monitoring System (TMS) for the Prespa Park area, with funding from WWF-Greece and in collaboration with the GEF/ UNDP Prespa Regional Project.

In November 2009 the TMS project produced an Expert Study describing in detail a future TMS for the Prespa Park[1]. The Expert Study was developed by the Technical Consultant of the TMS project (Tour du Valat, France) together with international and national experts from the three countries. The TMS is structured in seven monitoring themes[2], including water monitoring. The future TMS described by the Expert Study is expected to be implemented by the competent national monitoring institutions of the three countries.

1.2. Basis of transboundary water monitoring in the Prespa Park

Out of the seven monitoring themes proposed by the TMS Project and the Expert Study, water monitoring is by far the most complex, from technical, environmental and governance points of view.

The crucial decision on the water monitoring indicators to be piloted and implemented in Prespa should be based on solid science, on the national and international legal obligations of the three littoral countries and on the most up-to-date technical and legal instruments, such as the EU Water Framework Directive 2000/60/EC and its daughter directives.

[1] The full text of the Expert Study is available at: http://www.spp.gr/monitoring_en/

[2] The seven monitoring themes in the Expert Study are: Water; Aquatic Vegetation; Forests and Terrestrial Habitats; Fish and Fisheries; Birds and other Biodiversity; Socio-economy; Land-use

There is need, apart from the national monitoring systems under design by the three littoral countries, for a *transboundary* water monitoring system for the Prespa Park which will additionally take into consideration the technical and legal provisions for shared waters, and the peculiarities of the Prespa Park basin.

Finally, the deployment of a transboundary water monitoring system in the Prespa Park will depend on the agreement and commitment of the national monitoring authorities of the three littoral countries, and on the availability of funding.

1.3. Expert Proposal for an operational transboundary water monitoring in the Prespa Park

The TMS project has already made a first draft proposal in 2009 for a transboundary water monitoring system for the Prespa Park, which is included in the TMS Expert Study.

However, owing to the inherent complexity of water monitoring, the SPP and the TMS project propose that consultations take place between the legally appointed national monitoring authorities, in a workshop for the agreement on the monitoring indicators that could/ should be transboundary tested and shared by the three littoral countries.

The present Expert Proposal is building upon the first draft proposal of the TMS Expert Study, and is intended to be submitted to the competent national authorities, as a working document to support a workshop on transboundary water monitoring in Prespa.

1.4. Study team

The SPP and the TMS project invited three national experts on water monitoring and supported their work for the development of the present Expert Document:

Prof. Molnar Kolaneci (Institute of Energy, Water and Environment, Polytechnic University of Tirana), Prof. Svetislav Krstic (Faculty of Natural Sciences and Mathematics, University of S.S. Cyril and Methodius, Skopje) and Vaso Tsiaoussi, MSc (Greek Biotope Wetland Centre /EKBY, Thessaloniki).

The three national experts have experience and involvement in the design of the national water monitoring systems of their respective countries. Their work is intended to enhance the first draft proposal by the TMS project, and to provide direct links to the national water monitoring systems designed by the three littoral countries.

The joint work of the three national experts also included a working meeting, which took place in Lemos, Prespa, on 20-21 June 2011, and was facilitated by the hydrologist Dr. Giorgos Parisopoulos, Chairman of the Management Authority of the Prespa National Park (Greece).

1.5. Way of working

The three national experts have taken into consideration and rapidly reviewed the first draft proposal for a transboundary water monitoring system developed in the Expert Study of the Prespa TMS.

They have taken into consideration the national water monitoring plans (under implementation or planned) and the existing situation of water monitoring in their respective countries.

They have taken into account WFD 2000/60 and national water legislation, as pertain to the Prespa basin.

They have jointly identified the parameters (water quality, quantity) that are adequate for the characterization of the status of the lakes' waters, and are appropriate and feasible to be measured by the national competent authorities or other national organizations with the authorization to do so.

For the parameters selected, the sampling methodologies have been harmonized, to the extent possible, in order to enable the exchange and comparison of data between the three littoral countries.

The selection of the parameters has been made under the assumption that monitoring and analysis can be made in each country independently, in order to respect national sovereignty.

The national experts' proposal has followed the spirit of the WFD, thus providing information on the ecological status of waters and not merely measuring physico-chemical parameters.

The ultimate aim of the present Expert Proposal is to come up with a scientifically and technically solid proposal for an operational transboundary water monitoring system for the Prespa lakes. This proposal could be adopted by the national water authorities of the three countries and implemented reliably and with low cost. It should be ideally part of, or incorporated in, the national monitoring programs of the three countries in order to ensure cost-effectiveness and sustainability in the long term.

2. Expert proposal

Table A: Parameters, sampling sites, schedule and methods of the Transboundary Monitoring System for the Prespa Park

QUANTITY						
Hydrology/ hydrometrics						
Parameters	**Sampling Sites**	**Coordinates**	**Sampling Frequency**	**Sampling Method**	**Lab Analytical Method**	**Important Notes**
Lake water level	**Macro Prespa** Albania: WL1: Liqenas Greece: WL2: Koula FYR-Macedonia: WL3: Stenje **Micro Prespa** Albania: WL4: Near Tren Cave Greece: WL5: Koula	Exact coordinates depending on suitability of site.	a. Daily (staff gauge); b. Continuous (automated water level sensor)	a. Staff gauge, calibrated; b. Automated water level sensor with data logger	-	1. There is a need for an agreement on a common altitude reference for water level 2. The option of using automated sensors with data loggers depends on funding, and on availability of secure site.
Inflow catchment Macro Prespa	**Macro Prespa** Mouth waters of: R1. Golema River; R2. Brajcinska River R3. Agios Germanos River	R1. 40°59'32.75" N; 21°01'49.93" E; R2. 40°53'59.41" N; 21°05'30.17" E; R3. 40°50'12" N; 21° 8'22.33" E	12 times/ year	Water level gauge	Computed. Need to establish rating curve (stage-discharge relationship)	According to TMS Expert Study, Istocka river mouth may be considered**.**
Koula Micro to Macro Prespa flow	Koula sluice	40°48'40''N; 21°04'15''E	12 times/ year	Computed	Computed from water level and sluice position at Koula using adequate hydraulic formula	
Pumping from Micro Prespa	Pumping station in Greece	40°46'43''N; 21°07'26''E	12 times/ year (or during irrigation season)	Computed	Computed from daily/ monthly pumping duration and pumping stations characteristics	
Karstic spring flow to Ohrid	Tushemisht, Drilon, Sv.Naum		Continuous or at	Water level gauge	Discharge data from	

			least daily		continuous (or at least daily) water level measurements	
Groundwater level			See TMS Expert Study	Piezometric level in a selection of wells	-	
Meteorology						
Precipitation Catchment	Existing meteo stations; additional stations as per recommendations of TMS Expert Study	To be defined.	Daily (averages, highs, lows); or continuous. See TMS Expert Study.	See TMS Expert Study.	-	According to TMS Expert Study, precipitation/ snow should also be taken at a selection of sites between 1300 and 2000 m asl
Precipitation lake	Same as above	Same as above	Same as above	Same as above	Spatial average of precipitations measurements; see TMS Expert Study.	
Air temperature Lake	Same as above	Same as above	Same as above	Same as above	See TMS Expert Study.	
Lake evaporation	Same as above	Same as above	Same as above	Same as above	Calculated by the Penman method, compared to pan evaporation (data of Koula); see TMS Expert Study.	

QUALITY-LAKES						
Biological Quality Elements						
Parameters – Lakes Micro and Macro Prespa	**Sampling Sites**	**Coordinates**	**Sampling Frequency**	**Sampling Method**	**Lab Analytical Method**	**Important Notes**
Phytoplankton						
1. Species composition; 2. Chl *a* (biomass); 3. Blue-green dominance; 4. Toxic 'blooms'	**Macro Prespa** FYR-Macedonia L1. Stenje L2. Asamati; L3. Dolno Dupeni Albania L4. WQPC-L1 Greece	L1. 40°56'46.39'' N; 20°57'38.94'' E; L2. 40°58'39.54'' N; 21°02'05.61'' E; L3. 40°51'57.77'' N; 21°05'56.34'' E; L4. 40°52'6.12'' N, 20°58'18.76'' E	4 times/ year in the period Apr-Oct 1. Apr-May 2. Jun-Jul 3. Aug-Sep 4. Oct	Collection of depth integrated samples at the euphotic layer (2.5*Secchi Disk depth), with a water sampler. Plankton net/ mesh size 5 μm.	Utermöhl, microscopy, BBE field Chl-a probe, ELISA test, HPLC, MS Spectro. Alive and preserved samples will be used for the determination of phytoplankton biomass and composition, using	1. Sufficient length of net sample dragging. 2. In FYR-Macedonia BBE sampler will be used. In Greece either BBE or a comparable Chl-*a* method will be used.

	L5. Macro Prespa A L6. Macro Prespa B **Micro Prespa** Greece L7. Micro Prespa A L8. Micro Prespa B Albania L9. Micro Prespa Tren Cave	L5. 40.850569N; 20.988752E L6. 40.840191N; 21.085274E L7. 40.770305N; 21.101276E L8. 40.715568N; 21.063736E L9: Depending on suitability of site; the same as WL4 where water level measurements are taken. See Map 1			Utermöhl method with Inverted Microscope (1958). Assessment of total biovolume, % of Cyanobacteria, Catalan Index (2003) and Assemblage Index (Padisak *et al* 2006). For Chlorophyll α, extraction with acetone 90%, Fiber glass filter. Spectrophotometric evaluation by Lorenzen (1967) and Jeffrey & Humphrey (1975) method. No ISO/CEN Standards.	
Macrophytes						
Not included in the proposal.						An exchange of data every 5-6 years is suggested in order to enhance the water quality picture.
Fish						
1. Composition 2. Abundance 3. Sensitive species 4. Age structure 5. Fish endemic to Prespa lakes trend	Same as above	Same as above	1-2 times/ year	EN 14011:2003	Fishing with Nordic nets for fish trend and quantitative results for the assessment; electro fishing (deep-water or coastal) to complement species list.	Alternatively, plain nets could be used for fish trend, if budget for Nordic nets is not made available.
Physico-chemical Supporting Elements						
General physico-chemical parameters 1. Transparency (Secchi depth, turbidity, colour, TSS) 2. Thermal conditions (temperature) 3. Oxygenation conditions (DO, TOC, BOD, COD, DOC) 4. Salinity (conductivity) 5. Acidification status (pH) 6. Nutrient conditions (total P,	Same as above	Same as above	5 times / year (4 times in active months + 1 in winter) - profiling	EN 25814:1992; EN ISO 10304-1:1995; EN 12260:2003	Field probes, meters, spectrophotometry, various analytical tests. - Transparency: Secchi Disk. - Thermal conditions, Salinity, pH: autographic instruments. - Nutrient concentrations: A.P.H.A. - Oxygenation	Profile samples for pH.

SRP, total N, N-NO3, N-NO2, N-NH, Sulphates)					conditions: Samples from the field and laboratory analysis.	
Chemical Quality Elements (Priority Substances, Non-priority specific pollutants, Other pollutants)						
Metals Pb Fe Zn As Cu Hg Mn			4 times / year as above (3 times in active months + 1 winter)	Various standards Refer to Table B below	AAS	Refer to Table B below
PAHs (poly-aromatic hydrocarbons) Organochlorine Pesticides Halogenated/ Chlorinated hydrocarbons Other pesticides Phenols Others Please refer to Table B below for substances to be measured in GR- and AL-Prespa	Same as above	Same as above	4 times / year	EN ISO 15680:2003 EN ISO 6468:1996 EN 1485:1996 EN ISO 11369:1997 EN ISO 17495:2003 ISO 18856:2000	Gas chromatography	IN GR-Prespa and AL-Prespa, during 1st year surveillance monitoring will be implemented. It will include all substances (Table B), 12 times/ year. During years 2-5, operational monitoring will be conducted 4times/year. It will include only selected substances found in excess during surveillance.
Hydromorphological Quality Elements						
Hydrological regime lakes						
GROUP	**Sampling Sites**	**Coordinates**	**Sampling Frequency**	**Sampling Method; Lab Analytical Method**		**Important Notes**
PARAMETERS 1. Quantity and dynamics of water flow [inflow and outflow rates, water level, spillway and bottom outlets discharges (reservoirs), mixing and circulation pattern)] 2. Residence time (volume, depth, inflow and outflow)	Refer to quantity (hydrology/ hydrometrics) parameters, and their sampling sites.	Refer to quantity (hydrology/ hydrometrics) parameters, and the coordinates of their sampling sites.	Every month. (Daily for water level)	Quantity: Construction of Water level - volume relation using lake bed topography. Dynamics: a) Water level gauge, b) inflow discharges using flowmeter.		1. Refer to quantity (hydrology/ hydrometrics) parameters. 2. These parameters strictly speaking are not monitoring parameters but research analysis and data processing;

3. Connection to groundwater bodies (lake surface, lake volume) and groundwater level						they are included here for the sake of completeness.
Morphological conditions						
PARAMETERS 1. Lake depth variation - water level variation - bathymetry (lake surface, lake volume, lake depth)	Same as above	Same as above	Every 6 years	Same as above		These parameters strictly speaking are not monitoring parameters but research analysis and data processing; they are included here for the sake of completeness.
QUALITY-RIVERS						
Biological Quality Elements						
Major rivers in watershed	**Sampling Sites**	**Coordinates**	**Sampling Frequency**	**Sampling Method**	**Lab Analytical Method**	**Important Notes**
Phytobenthos						
1. Species composition; 2. Chl *a* (biomass); 3. Blue-green dominance; 4. Diatoms	Mouth waters of: R1. Golema River; R2. Brajcinska River R3. Agios Germanos River	R1. 40°59'32.75" N; 21°01'49.93" E; R2. 40°53'59.41" N; 21°05'30.17" E; R3. 40°50'12" N; 21° 8'22.33" E Note: The sampling site had better remain at the village, especially for microinvertebrates as riffles are found there and not at the mouth of the river.	4 times / year, seasonal	EN 13946:2003	Indices	This parameter group is not included in Greek national monitoring schedule.
Zoobenthos / Macroinvertebrates						
1. Species composition; 2. Abundance; 3. Diversity; 4. Indexes	Same as above	Same as above	4 times / year, seasonal	EN ISO 8689-1:2000	Biotic Indices (e.g. HES, Artemiadou και Lazaridou 2005)	

Riparian Vegetation						
Riparian vegetation (not included in first monitoring cycle of 6 years)	Same as above	Same as above	Once every year	EN 14184:2003	Vegetation cover continuity	Riparian vegetation monitoring not included in the first monitoring cycle (first 6 years). Indicators to be applied to be defined.
Fish						
Endemic Trout population trend	Along the rivers at suitable habitats (eg three locations per river)	Not defined yet.	Once per year	EN 14011:2003	Electro fishing	Sampling will also include upper stretches of rivers; see TMS Expert Study.
Physico-chemical Supporting Elements						
1. Transparency (Secchi depth, turbidity, colour, TSS) 2. Thermal conditions (temperature) 3. Oxygenation conditions (DO, TOC, BOD, COD, DOC) 4. Salinity (conductivity) 5. Acidification status (pH) 6. Nutrient conditions (total P, total N, $N\text{-}NO_3$, $N\text{-}NO_2$, $N\text{-}NH_4$, Sulphates)	R1, R2, R3 sampling sites.	See above for R1, R2, R3 coordinates.	5 times / year, together with biological quality elements.	EN 25814:1992 EN ISO 10304-1:1995 EN 12260:2003	Field probes, meters, spectrophotometry, various analytical tests	SRP measured in lakes but not in rivers.
Chemical Quality Elements (Priority Substances, Non-priority specific pollutants, Other pollutants)						
Metals Pb Fe Zn As Cu Hg Mn Refer to Table B below	Same as above	Same as above	4 times / year as above (3 times in active months + 1 winter)	various standards Refer to Table B below	AAS	Refer to Table B below
PAHs (poly-aromatic hydrocarbons)	Same as above	Same as above	Same as above	EN ISO 15680:2003 EN ISO 6468:1996	Gas chromatography	IN GR rivers, during 1st year surveillance monitoring will be

Organochlorine Pesticides Halogenated/ Chlorinated hydrocarbons Other pesticides Phenols Others Please refer to Table B below for substances to be measured in GR- and AL-Prespa				EN 1485:1996 EN ISO 11369:1997 EN ISO 17495:2003 ISO 18856:2000		implemented. It will include all substances (see Table B below)., 12 times/ year. During years 2-5, operational monitoring will be conducted 4times/year. It will include only selected substances found in excess during surveillance.
Current velocity						
Current velocity		Measured at the site of samples where benthos is measured.	4 times / year, seasonal			

Table B: Monitoring of Chemical Quality Elements in Lakes Micro and Macro Prespa and rivers in the catchment

	Substances
Priority Substances (Annex 10)	Alachlor
	Atrazine
	Brominated diphenylether
	Cadmium
	Chloroalkanes, C10-13
	Chlorfenvinphos
	Chlorpyrifos (Chlorpyrifos-eth12l)
	Cyclodiene pesticides
	DDT total
	para-para-DDT
	Phthalic acid 2-ethylhexyl-ester (DEHP)
	Diuron
	Endosulfan
	Hexachlorobenzene
	Hexachlorobutadiene
	Hexachlorocyclohexane
	Isoproturon
	Lead
	Mercury
	Nickel
	4-nonylphenol
	Octylphenol
	Pentachlorobenzene
	Pentachlorophenol
	PAH
	Simazine
	Tetrachloroethylene
	Tributyltin compounds
	Trichlorobenzenes (all isomers)
	Trichloromethane
	Trifluralin
Non-Priority specific pollutants (Annex 8 & 9)	4-chlorotoluene
	1,1,2-trichloroethane
	Heptaclor
	Linuron
	Cobalt
	Molybdenum
	Selenium
	Copper
	Dimethoate
	2,4,5-trichlorophenoxyacetic acid
	Demeton-S-Methyl
Other pollutants	2,4-dichlorophenoxyacetic acid
	2-chlorotoluene
	3,4-dichloroaniline

	4-chloroaniline
	Azinphosenthyl
	Azinphosmethyl
	Bentazone
	Coumaphos
	Demeton (O+S)
	Dichlorprop
	Disulfoton
	Fenitrothion
	Fenthion
	Heptaclor hepoxide
	Malathion
	MCPA
	Mecoprop
	Methamidofhos
	Mevinphos
	Monolinuron
	Omethoate
	Oxydemeton-methyl
	Parathion
	Parathion methyl
	Propanil
	Pyrazon
	Triazophos
	Trichlorfon
	Surfactants - linear alkylbenzene sulfonates (LAS)
	Cyanide
	Total phenols
	Polychlorinated biphenyls (PCBs)
	Phenol
	Chlorobenzene
	Chrome VI

Table C: Indicative prices for sample analysis

Parameter	Indicative price-range per sample (in €)
QUANTITY	
Hydrology/ hydrometrics	
Lake water level	50 euros/month
Inflow catchment Macro Prespa	
Koula Micro to Macro Prespa flow	
Pumping from Micro Prespa	
Karstic spring flow to Ohrid	
Groundwater level	100
Precipitation Catchment	20
Precipitation lake	20
Air temperature Lake	5
Lake evaporation	20
QUALITY-LAKES	
Phytoplankton	
1. Species composition;	30
2. Chl a (biomass);	20
3. Blue-green dominance;	30
4. Toxic 'blooms'	100
Fish	
Composition	50
Abundance	50
Sensitive species	20
Age structure	70
Fish endemic to Prespa lakes trend	30
Physico-chemical Supporting Elements	
DO	5-17
pH	5-11
Conductivity	5-17
Temperature	5
Turbidity ,	5-17
transparency (Secchi))	5
Total N	10-20
Total P	10-35
N-compounds	10-20
Sulphates	10-20
BOD, COD	10-29
TSS	10-17

Pb	5-20
Fe	5-20
Zn	5-20
As	5-20
Cu	5-20
Hg	5-20
Mn	5-20
PAHs and hydrocarbons	300-450
Organochlorines	Incl. above
Halogenated/ Chlorinated hydrocarbons	Incl. above
Other pesticides	Incl. above
Phenols	Incl. above
Others	
Hydrological regime lakes	
1. Quantity and dynamics of water flow [inflow and outflow rates, water level, spillway and bottom outlets discharges (reservoirs), mixing and circulation pattern)]	500
2. Residence time (volume, depth, inflow and outflow)	500
3. Connection to groundwater bodies (lake surface, lake volume) and groundwater level	200
Morphological conditions	
1. Lake depth variation - water level variation - bathymetry (lake surface, lake volume, lake depth)	100
QUALITY-RIVERS	
Phytobenthos	
1. Species composition	30
2. Chl a (biomass);	20
3. Blue-green dominance;	30
4. Diatoms	100
Zoobenthos / Macroinvertebrates	
1. Species composition	40
2. Abundance	40
3. Diversity	40
4. Indexes	20
Riparian Vegetation	50
Fish	

Endemic Trout population trend	100
Physico-chemical Supporting Elements	
DO	5-17
pH	5-11
Conductivity	5-17
Temperature	5
Turbidity , transparency (Secchi)	5-17
TDS	5-17
TSS	5-17
$P\text{-}PO_4$,	5-20
$N\text{-}NH_4$	5-20
O_2	5
$N\text{-}NO_2$	5
BODs	10
Total N	10-20
Total P	10-35
N-compounds	10
Sulphates	10-20
BOD, COD	10-29
TSS	10-17
Pb	5-20
Fe	5-20
Zn	5-20
As	5-20
Cu	5-20
Hg	5-20
Mn	5-20
Current velocity	5
Priority Substances	
PAHs and hydrocarbons	300-450
Organochlorines	Incl. above
Halogenated/ Chlorinated hydrocarbons	Incl. above
Other pesticides	Incl. above
Phenols	Incl. above
Others	Incl. above
Approximate Total Cost: (for 8-9 lake sampling points and 3 river sampling points, and for the sampling frequencies specified under Table A)	72,000-91,000€/ year