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# Identification, typology and environmental assessment of water bodies at Mygdonia basin

A.M. Giantsi<sup>1\*</sup>, G. Zalidis<sup>1,2</sup>, I. Zaharias<sup>3</sup>, E. Pana<sup>1</sup>, and V. Takavakoglou<sup>1</sup>

<sup>1</sup>Balkan Environment Center (BEC), Loutron 18, GR-57200 Lagadas, Greece

<sup>2</sup>Laboratory of Remote Sensing and GIS, School of Agriculture, Aristotle University of Thessaloniki, GR-54124, Thessaloniki, Greece

<sup>3</sup>Department of Environmental and Natural Resources Management, University of Western Greece, GR-30100, Agrinio, Greece

\*Corresponding author: E-mail: [amgiantsi@agro.auth.gr](mailto:amgiantsi@agro.auth.gr), Tel/Fax: +30 23940 23485

## Abstract

The aim of this work is the identification and typology of water bodies at Mygdonia basin and the assessment of their environmental status. In Mygdonia water basin, 7 heavily modified, 35 natural water bodies and one hydrogeomorphologic water element were identified. The implementation of typology revealed 39 river and 3 lake water bodies. Environmental status assessment was implemented using methodology described in Guidance documents of ecological status, ecological potential, biological status and functional performance. The selection of the appropriate methodology was based on the water ecosystem characterization (type of water body or hydrogeomorphic water element) and the data availability. The environmental status assessment for all water bodies in Mygdonia water basin ranges from "Bad to Good".

**Keywords:** 2000/60/EC, environmental assessment, functional performance.

## 1. INTRODUCTION

The "2000/60/EC Directive of the European Commission and the 23<sup>rd</sup> October 2000 Council for the establishment of the framework for community action in the field of water policy" [1] is the main pillar of the institutional framework. It establishes a legal framework for the protection and restoration of the surface, groundwater, transitional and coastal water across Europe and ensures its long-term and sustainable use, with the main goal of achieving a good ecological status of the water by 2015. The Directive suggests three types of monitoring: surveillance, operational and investigative monitoring, and the assessment of the environmental status are accomplished by monitoring biological, physicochemical and hydromorphological parameters. Monitoring of the study area was based on the surveillance horizontal guidelines of surface water bodies of Mygdonia basin. The 3199/2003 legislation for "Water protection and management" is harmonizing the national legislation with the provisions of the Directive, while the 51/2007 Presidential Decree defines measures and procedures for integrated protection and management and they constitute the national institutional framework of the Directive. Implementation of the Directive in the Member States in cases of wetland ecosystems, although clearly provides supplemental measures for protection, restoration, and minimum ecological water flow, encounters difficulties, since it gives no specific definition for wetlands, neither defines management measures for wetland resources to achieve the Directives' environmental objectives [2].

The existing revised operational and strategic planning of the degraded ecosystem of Koronia wetland was originally made before the incorporation of the Framework Directive into the national law and disregarded the situation (ecological status/ecological potential) of water bodies throughout

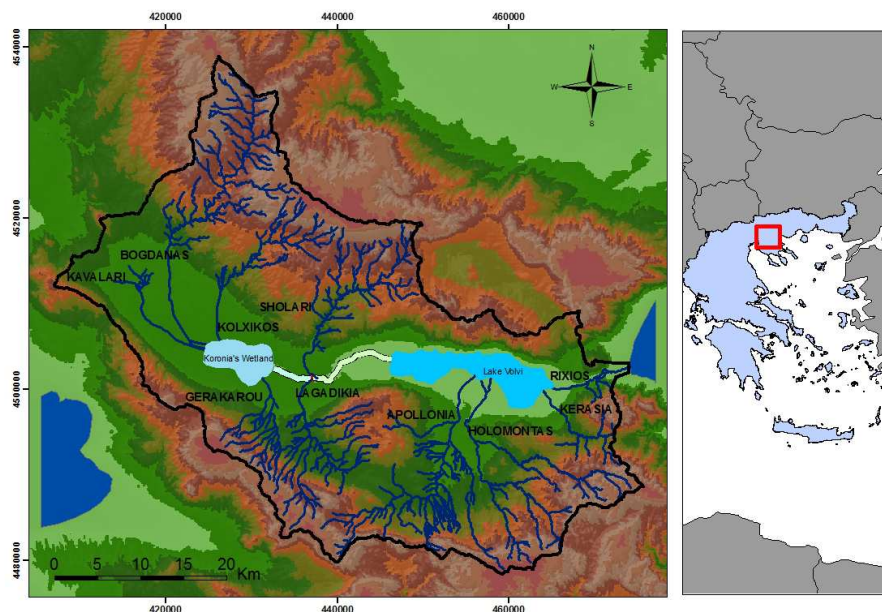
the Mygdonia basin, but based on the performance evaluation of the functions in Koronia. This work bridges the functional assessment with the ecological status and the ecological potential the Directive proposes.

Within this framework, the aim of this work was the identification and typology of water bodies at Mygdonia basin and the assessment of their environmental status. For this purpose, geographical, geomorphological, biological, chemical and physicochemical elements were collected for the classification of the water bodies and hydrogeomorphologic water elements at Mygdonia's basin.

## 2. MATERIALS AND METHODS

### 2.1 Study area

The study area consists of the Mygdonia basin, in which Koronia wetland and Lake Volvi are located, and a set of non-continuous flow streams (Bogdanas, Kavalari, Kolhikos, Gerakarou, Sholari, Lagadikia, Apollonia, Holomontas, Kerasia) that flow into them, and also the Rixios River, which is the natural outlet to the sea area of Strymonikos gulf (Figure 1). Restoration works [3] at the Koronia basin have modified some water bodies. The regulatory and institutional framework governing the protected area is designated as a Ramsar site, the area is also designated as a Special Protection Area under the 79/409/EEC Directive, and under national legislation as a National park, and finally it is part of the NATURA 2000 network, with four sites of community importance.



**Figure 1.** Mygdonia's water basin

### 2.2 Data collection and processing

The spatial data collected for this work included: geological [4], topographic maps [5], digital elevation model (DEM), and Landsat 5 TM satellite image for the year 2010 [6]. With the use of Geographical Information Systems (ArcGis 9.3) and the ERDAS IMAGINE (9.1) software, a series of tasks was achieved (digitization of surface water bodies, geological formations, sub basins, and recognition and classification, as well as export of the elevation from DEM, contour and lake isobaths extraction, classification of altitude, elevation gradients, depth, lake extend, and at the final level export of the water bodies' types). Finally, thematic maps were created for the presentation of the results. At a second level, physicochemical, hydromorphological and biological data for the year 2010 were collected [7]. This data was used for the environmental evaluation of water bodies

(Volvi, Bogdanas, Sholari, Lagadikia), and the hydrogeomorphologic water element of Koronia, where the data was sufficient.

### **2.3 Identification of water bodies**

According to the Directive and its Guidance documents, the surface water bodies were classified into natural (NWB) and heavily modified (HMWB) [8;9]. The hydromorphological characteristics of the Koronia ecosystem (depth parameter) did not allow its identification as a natural or modified water body [10], but it was identified as a hydrogeomorphologic water element [11], because of human modification in its structural characteristics based on WFD Guidance Document No 12 [12].

### **2.4 Typology**

The WFD suggests two systems for the typology [13] of the surface water bodies (A or B). The System B was selected for the river water bodies, as it is considered more flexible and incorporates additional optional descriptors [14]. As additional descriptor, in case of Mygdonia basin, the slope was selected. A four digit code [15] was assigned in each water body that states in order, the altitude, the basin area, the geology and the slope of the river systems. The System A was selected for the typology of lakes' water bodies, as in System B there are no classified optional descriptors. In this case, a four digit code was assigned in each water body that states in order the altitude, the mean depth, the size based on surface area and the geology of the lake.

### **2.5 Environmental Status Assessment**

Environmental status assessment was implemented using the methodologies described in Guidance documents of ecological status, ecological potential, biological status and functional performance. The selection of the appropriate methodology was based on the water ecosystem characterization (type of water body or hydrogeomorphic water element) and data availability.

According to the Guidance Document No. 13 [16] of the Directive 2000/60/EC, for the assessment of the ecological status of the natural water bodies, initially, the measured values of the biological parameters were taken into account and subsequently the physicochemical parameters. In assessing ecological potential, hydromorphological parameters were the primary source of data to be evaluated in order to assess the likelihood that the water body has reached its structural potential and when this condition was met, evaluation of biological parameters took place. In cases where the values of the biological parameters were close to the maximum ecological potential, the physicochemical parameters were examined. The ecological status of the surface waters are presented on a five-point scale and the ecological potential on a four-point scale. For the biological evaluation of the benthic macroinvertebrates for streams, the HES index (Hellenic Evaluation System) [17] was applied.

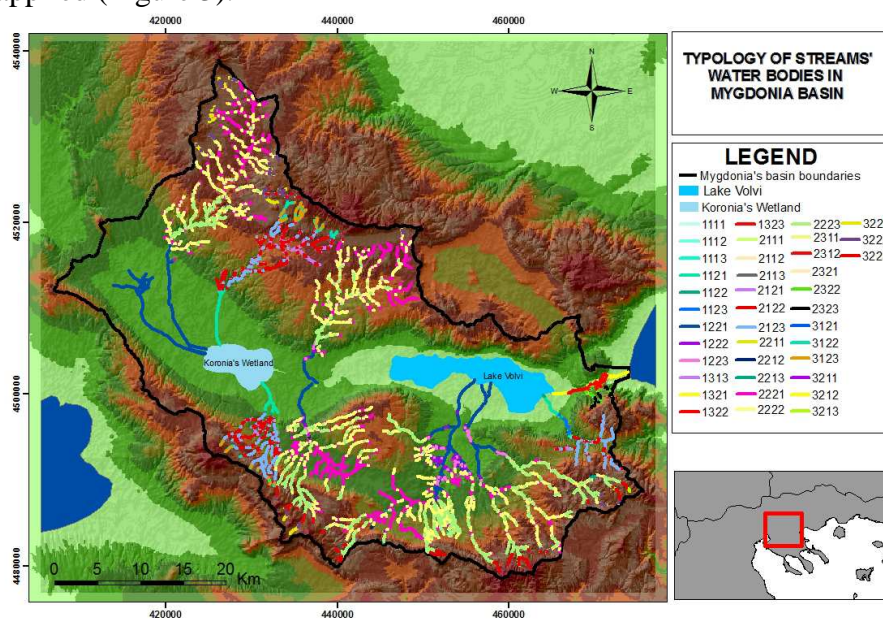
Assessing functional performance is the most appropriate evaluation technique for environmental status of wetlands and can easily assess alternative restoration scenarios. These scenarios in combination with pressure analysis in the wetland's basin will lead to the selection of the best restoration scenario, while the chosen one constitutes the base line for future monitoring for evaluating of the wetland's changes of ecological character. The functional assessment in the study area took into account the characteristics of the entire river basin and not only of the wetland ecosystem [18]. By using proper hydromorphological, physicochemical and biological indicators, the level of functional performance was assessed. In the wetland system of Koronia the assessed functions were the following: a) groundwater recharge, b) flood water attenuation, c) dynamic water storage, d) sediment and toxicant trapping, e) nutrients transformation and removal, and f) food web support.



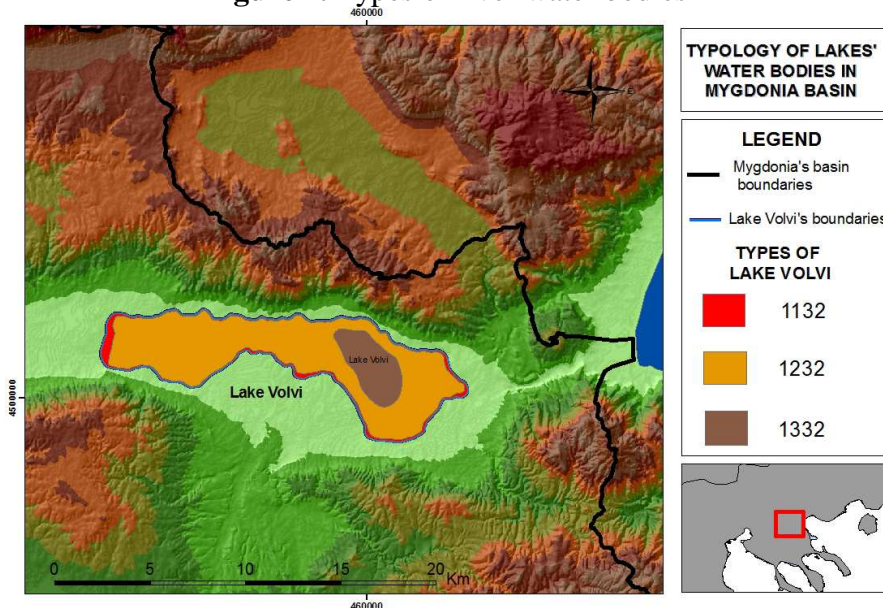
### 3. RESULTS AND DISCUSSION

In the area under study, 43 river and lake water bodies were identified, 7 of them are heavily modified, one has been characterized as a hydrogeomorphic water element and the rest 35 are characterized as natural water bodies. As natural water bodies were identified the streams of Apollonia, Kavalari, Gerakarou, Holomondas, Kerasia, Kolhikos, two out of three stream bodies of Bogdana's stream (Xylopoli and Assiros) and the three water bodies of lake Volvi. As heavily modified were identified the streams of Lagadikia and Sholari, the water bodies modified during restoration works and one water body of Bogdana's stream (Nikopoli). The water body of Koronia was identified as hydrogeomorphic water element.

At the study area, 39 different types of river water bodies (Figure 2) were identified, using the System B typology, while 3 types of lake water bodies were identified at lake Volvi when typology System A was applied (Figure 3).





**Figure 2.** Types of river water bodies

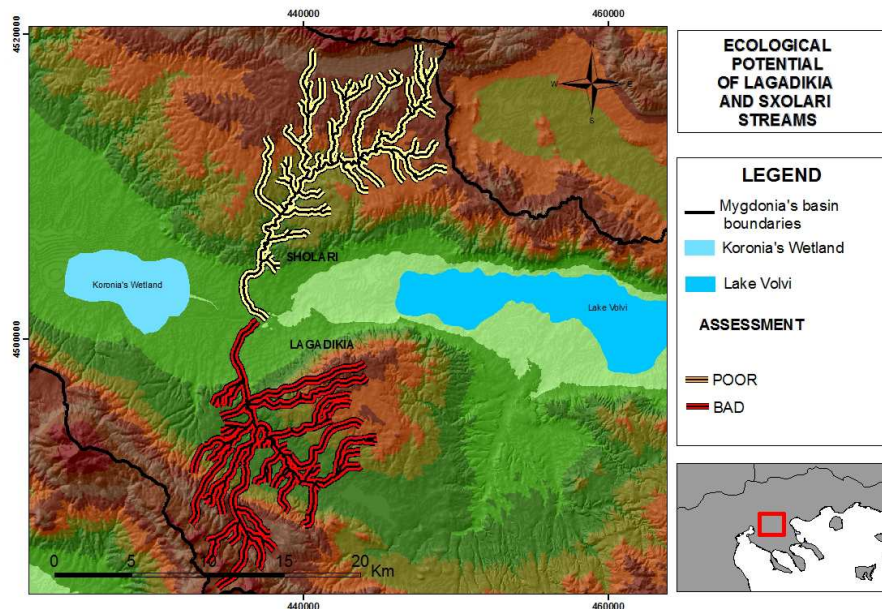


**Figure 3.** Types of water bodies at Lake Volvi

The type of the aquatic ecosystem determines the methodology for assessing the environmental status. Thus, the assessment of the environmental status was performed based on the ecological status or ecological potential or functional performance. The ecological potential of the heavily modified river water bodies of Lagadikia and Sholari was characterized as "Bad" and "Poor" respectively (Table 1, Figure 4). The ecological potential of the heavily modified river water body of Bogdanas was characterized as "Poor" (Table 2, Figure 5). The two natural water bodies of river Bogdanas, were characterized for their ecological status as "Moderate" (Table 2, Figure 5).

**Table 1.** Ecological potential of Lagadikia and Sholari water bodies

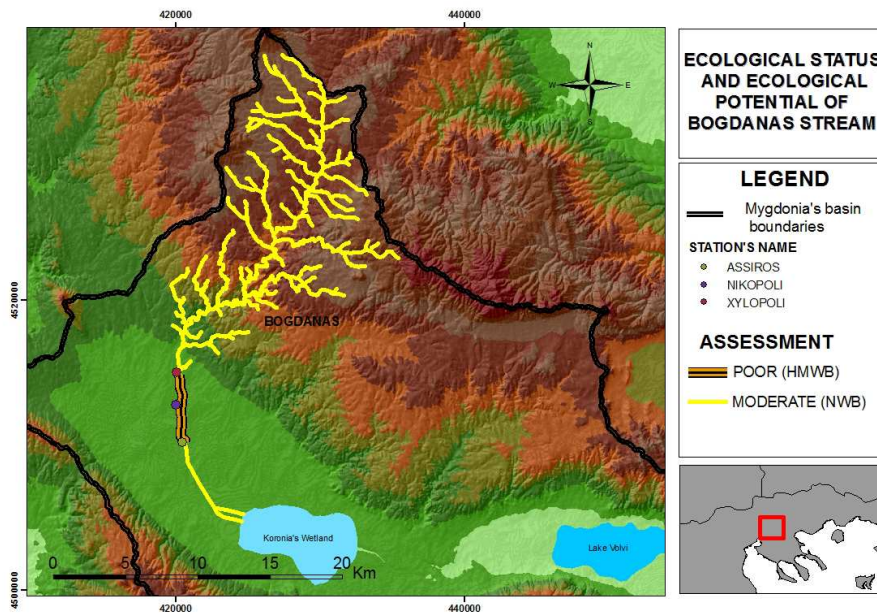
Streams	Color Code	Ecological Potential Assessment
Lagadikia		Bad
Sholari		Poor



**Figure 4.** Ecological potential assessment of Lagadikia and Sholari water bodies

**Table 2.** Ecological status and ecological potential assessment of Bogdanas stream

Bogdana's Stations	Color Code	Ecological Status (ES) – Ecological Potential (EP) Classification
Assiros	Yellow	Moderate (ES)
Nikopoli	Orange and Grey	Poor (EP)
Xylopoli	Yellow	Moderate (ES)

**Figure 5.** Ecological status and ecological potential assessment of Bogdanas stream

The ecological status of the three natural water bodies of Lake Volvi was not assessed due to lack of intercalibrated indicators applied to the Mediterranean lake water systems. Instead, the available biological assessments were used (non intercalibrated indicators) and the natural water bodies were characterized from "Moderate to Bad" (Table 3).

**Table 3.** Biological assessments of Lake Volvi

Biological Parameters	Color Code	Biological Status
Fish Fauna	Red	Bad
Phytoplanton	Yellow	Moderate

The Koronia wetland (hydrogeomorphologic water element) is an ecosystem under restoration and presents a tremendous spatial and temporal variability of the common physicochemical and biological environmental indicators. Therefore, the monitoring indicators of this system are not the same as the monitoring indicators of a lake. Thus, the environmental status assessment was based on the functional evaluation of the system. The evaluation revealed that the functional performance of the system varies from "Good to Bad" (Table 4).



**Table 4.** Functional performance assessment of Koronia wetland

<b>Functions</b>	<b>Functional Performance Assessment</b>
Groundwater recharge	Moderate
Flood water attenuation	Moderate
Dynamic water storage	Good
Sediment and toxicant trapping	Moderate
Nutrients transformation and removal	Moderate
Food web support	Bad

#### **4. CONCLUSIONS AND FUTURE PROPOSALS**

Environmental status assessment was implemented using methodology described in Guidance documents of ecological status, ecological potential, biological status and functional performance. The selection of the appropriate methodology was based on the water ecosystem characterization (type of water body or hydrogeomorphic water element) and the data availability.

For the most efficient application of environmental status assessment, the establishment of a classification scheme using optional descriptors of the System B for the typology of the lake water bodies is proposed, to derive a more substantiated result for typology. Similarly, for better classification, more optional descriptors of the System B for the typology of river water bodies are proposed. Regarding the assessment of the ecological status and the ecological potential of lake water bodies, it is necessary the establishment of intercalibrated biological indicators, acknowledged by the Mediterranean Intercalibration Group, according to the requirements of the Water Framework Directive. For wetland ecosystems, the identification and characterization of these water ecosystems in Greece is recommended, based on wetland characteristics and in accordance with the Guidance Document No 12 of the Directive. In addition, an operational set of environmental indicators for wetlands should be selected that will reflect the functional performance and will be in accordance with the Ramsar Convention for wetlands of international importance, in order to support their sustainable management.



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