

WISER

Current questions in water management

**Book of abstracts to the WISER final conference
Tallinn, Estonia, 25-26 January 2012**



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Edited by Astrid Schmidt-Kloiber, Anne Hartmann, Jörg Strackbein, Christian K. Feld & Daniel Hering

WISER – Water bodies in Europe

Integrative Systems to assess Ecological status and Recovery

Funded by the European Union under the 7th Framework Programme,
Theme 6 (Environment including Climate Change), contract No. 226273

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Benthic macrophyte changes across an anthropogenic pressures gradient in Mediterranean and Black Sea water systems: structural vs. functional approaches

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Introduction

Biotic metrics of benthic macrophytes represent an effort to describe different and complex aspects of communities or other different biological organizational levels by integrating them in a formula producing a single numerical output (Orfanidis et al., 2011). This approach may distinguish responses of human impact from natural variability when supported by quantitative data enabling to study communities' heterogeneity (see Orfanidis et al., 2008) and to identify correlations and casual relationships between the biotic and abiotic data.

The aim of this paper was to test the relationship among different structural and functional metrics with key abiotic parameters and total pressures in Mediterranean (Lesina Lagoon, Italy) and Black Sea (Varna Lake and Bay, Bulgaria) water systems. A verification of metrics responses to natural or anthropogenic ecological processes at an international scale across different water typologies is intended.

Material & Methods

Sampling and data analysis efforts

Sampling in Lesina Lagoon (Figure 1a) was undertaken between 21st and 23rd September 2009. A 0.0225 m² Ekman grab was used to collect twelve random samples in each site at 0.6 to 1.2 m depth. 84 samples were selected in total. In the laboratory the samples were sorted out and the species were identified to functional group level and as much as possible to species level. In order to estimate % coverage a transparent double bottom square PVC container, filled with sea water and

having at its bottom a square 15x15 cm matrix divided in 100 squares, was used. The surface covered by each sorted taxon in vertical projection floating in sea water was quantified as % of coverage.

Sampling in Varna Lake and Bay (Figure 1b) was undertaken between 8th and 10th September 2009. At each site different number (from 7 to 42) square frame (0.01 m²) samples were collected. Samples were taken from 0-2 m depth with the help of diving technique. 122 samples were selected in total. Visual assessment of

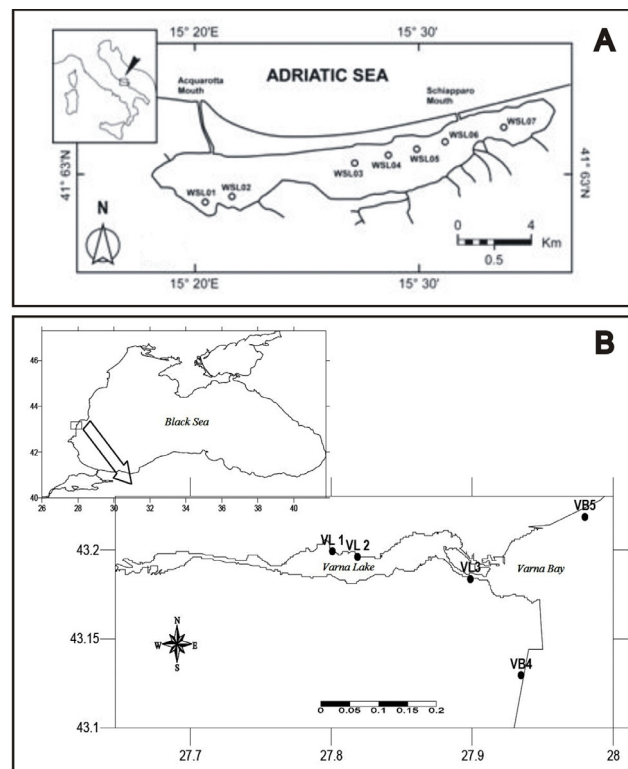


Figure 1: Map of study sites in two locations: (A) Lesina lagoon, (B) Bulgaria-Varna Lake and Bay.

total percent cover of the communities of every depth layer was carried out. In laboratory conditions all benthic macrophyte samples were washed and sieved to remove sediments. Macrophytes were sorted and identified to the lowest possible taxonomic level under microscope when needed. Species were dried for a while on a filter paper and weighted (fresh weight).

Metrics and methods calculation

Nine metrics related to community structure [species number, Shannon-Weaver index (H' , \log_2), Pielou's evenness index (J'), % of total coverage, and dry biomass (g/m^2)] and function (ESG I % coverage, ESG II % coverage, EI and EEI) were estimated. Fresh weight biomass data from Bulgarian coasts were multiplied by factor 0.09 to be transformed to dry biomass. The abundance of the two Ecological State groups (ESG I, ESG II) and the Ecological Evaluation Index (EEI-c) for each site were calculated according to Orfanidis et al. (2011). The calculation of EEI-c in site 7 was modified by introducing a new group (ESG IIC) that includes species of fresh water affinity such as *Potamogeton* sp. This species is valued similarly to opportunistic species (ESG IIB) since its existence in the site 7 is explained by low salinity (close to 10 PSU) that prohibits their growth. A modification of EEI-c index in conformity with Black Sea peculiarities was also developed. Index values are represented as biomass percent ratio of late-successional (sensitive species) divided by biomass of sensitive and opportunistic-tolerant species. Total cover value of macrophyte communities from every site was multiplied by percent biomass values to obtain final EI, presented as continuous numerical values from 0 to 10. For example, for 80% sensitive species biomass EI equals to 8 and for 65% biomass to equals to 6.5. EQR value has been calculated as current obtained EI value

divided by referent value (10). EQR values for different Ecological Status Classes are following: (0-0.2= bad; 0.2-0.4=poor; 0.4-0.6=moderate, 0.6-0.8=good and 0.8-1=high ESC.

Statistical treatment

Only samples with a % coverage >10% were analyzed. The response of metrics and assessment method to the pressure gradient was evaluated using Spearman rank correlation coefficients (ρ) at $p=0.01$ after a $\log(x+1)$ transformation of the data. PCA analyses were performed on $\log(x+1)$ transformed data.

Results & Discussion

PCA components 1 and 2, which explains 86.2 % of the total variability (component 1=65.7%, component 2=20.5%), indicated that the sampled sites belong in a gradient rather than in distinct environments and water types, in terms of depth, salinity, grain size etc (Figure 2).

A strong correlation was found between the total pressures and the functional indices EI and EEI-c (Table 1). A strong non-linear relationship between the total pressures and the EI and EEI-c was also identified (Figure 3). These results indicate a different behavior between the structural and the functional indices as has been earlier documented by Orfanidis et al. (2008). Therefore, the functional indices are better indicating the pressures and thus the ecological status of water systems across different typologies, while the structural indices are better indicating the lagoon confinement.

Using the EEI methodology the studied sites were classified as: VB4 - "bad" ESC; VL1, VL2, VL3, WSL01,

Table 1: Spearman rank correlation coefficient between key abiotic and biotic metrics in Lesina lagoon (a) and Bulgarian coasts (b). Underlined values show significant correlation at $p<0.01$.

	Total coverage (%)	Total dry biomass (g/m^2)	Species No	J'	H'	ESG I%	ESG II%	EI	EEI-c
Depth (m)	-0.18	0.16	0.63	0.41	0.48	0.31	-0.13	0.05	0.13
Temperature ($^{\circ}\text{C}$)	0.10	-0.17	0.06	0.00	-0.04	-0.05	0.24	-0.13	-0.02
Salinity (PSU)	-0.18	-0.50	-0.15	<u>-0.61</u>	-0.59	-0.01	-0.02	0.28	0.36
Oxygen saturation (%)	0.14	0.38	0.04	-0.09	0.05	0.35	0.01	0.07	0.17
Turbidity	-0.12	0.21	<u>0.63</u>	0.42	0.50	0.32	-0.09	0.05	0.12
Organic content (%)	0.40	0.05	<u>-0.75</u>	<u>-0.65</u>	<u>-0.71</u>	0.46	-0.35	<u>0.76</u>	<u>0.73</u>
Gravel (%)	-0.12	-0.03	0.22	0.35	0.34	-0.31	0.47	<u>-0.62</u>	-0.49
Sand (%)	0.14	0.56	0.21	0.15	0.26	<u>0.76</u>	-0.33	0.37	0.56
Mud (%)	-0.12	-0.48	-0.32	<u>-0.72</u>	<u>-0.70</u>	-0.10	-0.22	0.42	0.29
Total pressures	-0.37	-0.35	0.32	0.46	0.40	<u>-0.83</u>	0.40	<u>-0.90</u>	<u>-0.95</u>
Distance to the pressures (km)	0.21	<u>0.67</u>	0.34	0.55	<u>0.61</u>	<u>0.62</u>	-0.33	0.18	0.29

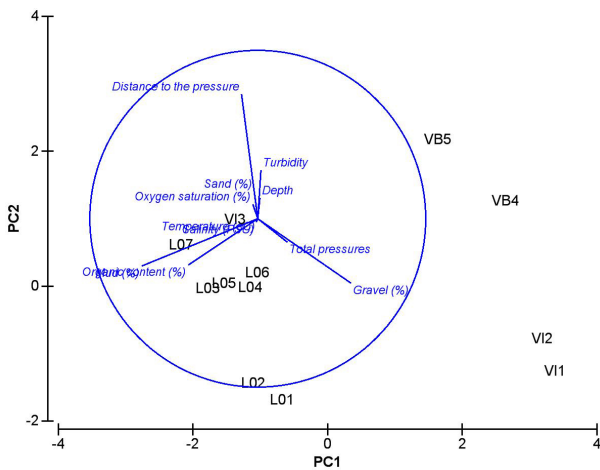


Figure 2: Principal Component Analysis (PCA) using the total pressure and the abiotic data together with the sampling sites of Lesina lagoon and Bulgarian coasts.

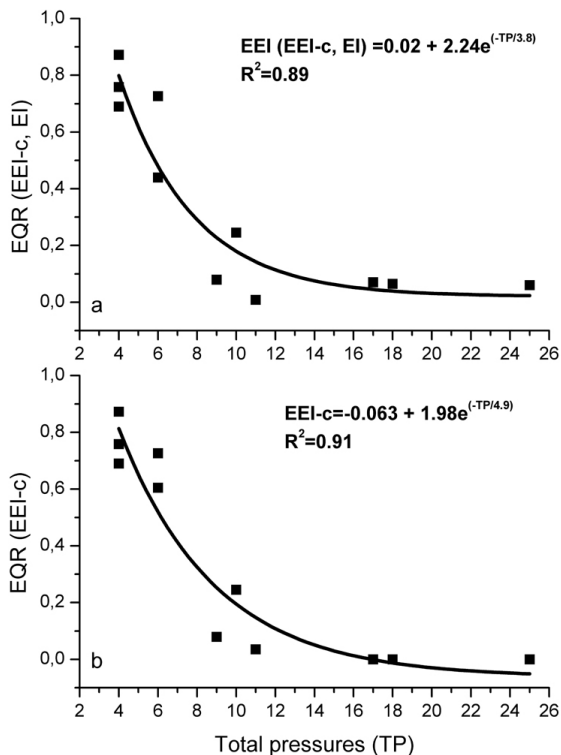


Figure 3: The relationship between a) EEI (EEI-c, EI), and b) EEI-c EQR's with total pressures across the sampling sites of two locations (Lesina lagoon, Varna lake and bay).

WSL02 - "low" ESC; VB5 - "moderate" ESC; WSL03, WSL04, WSL07 - "good" ESC; and WSL5 - "high" ESC. While the mean value of EEI-c index (0.56) classifies the Lesina Lagoon in "good" ESC, the mean value of EI (0.13) classifies the Varna Lake and Bay in "bad" ESC. Indeed the lagoon of Lesina seems to experience a low vulnerability to human activities, especially the central and eastern bases (Vignes et al., 2009). On the

opposite Varna lake is very eutrophicated and polluted ecosystem and both biotic and abiotic parameters advocate for worse conditions (Dencheva, 2010). These contaminated waters enter the bay and the main current in south direction contributes to the deterioration in this part of the bay too.

The structural diversity indices, as in other lagoons (Middelboe et al., 1998), were in general low. A decrease in macrophytes diversity of from the entrance to the inner parts coastal lagoons suggests the existence of physiological stress due to strong salinity gradients or spore, fragment or propagule dispersal restriction (confinement) or interactions between them (Coutino and Seeliger, 1984).

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