# Presence of peculiar organisms in the water of Lagoons: Potentially valuables Bio indicators for cultural eutrophication level assessment.

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**Abstract-** *Coastal lagoons are transitional ecosystems located on the border between land and sea characterized by strong environmental fluctuations which affect the physiological and ecological adaptations of the living species.*
*The environmental quality of the lagoon ecosystem depends on the balance between chemical-physical components (water salinity, temperature, water-dissolved oxygen, high productivity, reduced hydrodynamics) and biological processes that define the complexity of the trophic chain. All these factors are strongly influenced by human activities that cause the phenomenon of eutrophication.*
*The coastal lagoon ecosystem is an heterogeneous environment easily affected by changes of different kinds (both natural and artificial) which cause the reduction in size of wetlands areas, increment of coastal erosion and more frequent flooding. Human activities are also important stressors which can lead to significant biological changes.*
*In this context the study of the structure and space-time dynamics of biological communities is an important way to assess the ecosystem's quality, to evaluate its healthiness level and to suggest possible strategies for environmental remediation.*
*The individuation of specific Bioindicators becomes fundamental for a precise assessment of the "health status" of the animal, vegetal and microorganism populations and the quality of their habitat.*
*The continuous monitoring of Bioindicators over time allows to define plan and realize interventions focused on adapting as soon as possible ecosystem to environmental changes improving resilience to the climate changes.*

*Key words: Transition water; Bioindicators; Eutrophication; Trophic state; Biodiversity.*

**State of art**

Nowadays climate change and human interventions are becoming the main threats to the availability of water on our planet. The goal number 6 of the 2030 Agenda provides for actions by 2050 aimed to improve the availability and management of this source important for life. The objective of these actions is the protection of the environmental ecosystem linked to water.

In the Mediterranean Sea, the climate change is carrying different risks for the environment:

- Temperature increase of 2.0-6.5 °C
- Decrease in precipitation
- Increase in the probability of environmental disasters
- Increase in sea level

These factors, associated with human interventions, are becoming huge threats to the coastal lagoon ecosystems and they result more dangerous if they happen in synergy. As an example of such a threat, the increase in sea level can reduce the coastal areas and enhance its erosion leading to the loss of a natural habitat, which is pivotal for all the different animals and vegetable species that inhabit this peculiar environment and therefore might become endangered. It is important to

| Classes | Intervals | Secchi S (m) | Total Phosphorus ($mg.m^{-3}$) | Chlorophyll – a ($\mu g.L^{-1}$) |
|---|---|---|---|---|
| Ultraoligotrophic | TSI ≤ 47 | S ≥ 2.4 | P ≤ 8 | CL ≤ 1.17 |
| Oligotrophic | 47 <TSI ≤ 52 | 2.4 > S ≥ 1.7 | 8 < P ≤ 19 | 1.17< CL ≤ 3.24 |
| Mesotrophic | 52 <TSI≤ 59 | 1.7 > S ≥ 1.1 | 19 < P ≤ 52 | 3.24 < CL ≤ 11.03 |
| Eutrophic | 59 <TSI≤ 63 | 1,1 > S ≥ 0.8 | 52 < P ≤ 120 | 11.03 < CL≤ 30.55 |
| Super-eutrophic | 63 <TSI≤ 67 | 0.8 > S ≥ 0.6 | 120 < P ≤ 233 | 30.55 < CL≤ 69.05 |
| Hypereutrophic | TSI> 67 | S > 0.6 | 233 < P | 69.05 < CL |

*Table 1/ The table describes trophic class by means of trophic state index (TSI) based on three different trophic indicators: physical indicator (water turbidity), chemical indicator (total Phosphorus and/or orthophosphate concentration) and biological indicator (chlorophyll-a concentration) (10)*



take measures to adapt the environment to the territorial changes in order to defend the integrity of the ecosystem and protect it against natural and human-related risks. The actions to adopt must be useful to develop methodologies allowing to evaluate the environmental vulnerability (11).

The transition waters and lagoons are environments which strongly suffer these changes. The mean stress factors influencing coastal lagoons are abiotic and biotic: the abiotic factors have natural origin and concern climate changes (i.e. humidity, rain, temperature variations and wind); they lead to the increment of coastal erosion resulting in flooding and loss of wetland. Biotic factors arise from human activity which happen in the environment, like fishing, mining, farming and building activities and cause significant variations in the biological components of the coastal and lagoon ecosystems (1).

In the lagoon environment changes in trophic states depend on the contribution of different factors such as the circulation and the limited exchange between sea and fresh water, organic and inorganic pollution, erosion phenomena and anthropogenic factors which cause eutrophication.

The lagoons are environments heavily populated by a high variety of plants and animals and it is very important to ensure their survival, in order to preserve the biodiversity of the territory.

A continuous change of the environment forces living beings to adapt for surviving.

For this reason, to understand the dynamics which induce changes on the ecosystem, and therefore on life of living beings, it becomes fundamental to protect the environment. In this frame Bioindicators play an important role to identify early on the environmental conditions (5).

The selection of specific Bioindicators to be used for environmental investigation is critical. A Bioindicator can be an element that readily reflects the state of the environment and represents the impact of change on an habitat, highlighting the ability of the environment to support life (4).

The assessment about "Trophic State" of water is a good indicator to evaluate the eutrophication level of aquatic ecosystem. The high number of algae species can alter the clarity, colour and pH of the water, can promote the formation of foam on the water surface and can reduce the amount of dissolved oxygen and generate unpleasant smell. (3).

Chlorophyll a (algal biomass assessment parameter) and phosphorus and nitrogen total quantity (nutrients responsible for algal growth) are used as indicators to evaluate the "biological productivity" of the aquatic basin representing the its capability to support life. (2).

It is possible to give a "Trophic State" classification to aquatic environment according to algae and nutrient concentration and water condition. The parameters are summarized in Table 1.

Some professionals use the Trophic State Index (TSI) to describe the productivity and trophic state of aquatic environment. TSI is calculated on three different productivity measures: water transparency, chlorophyll

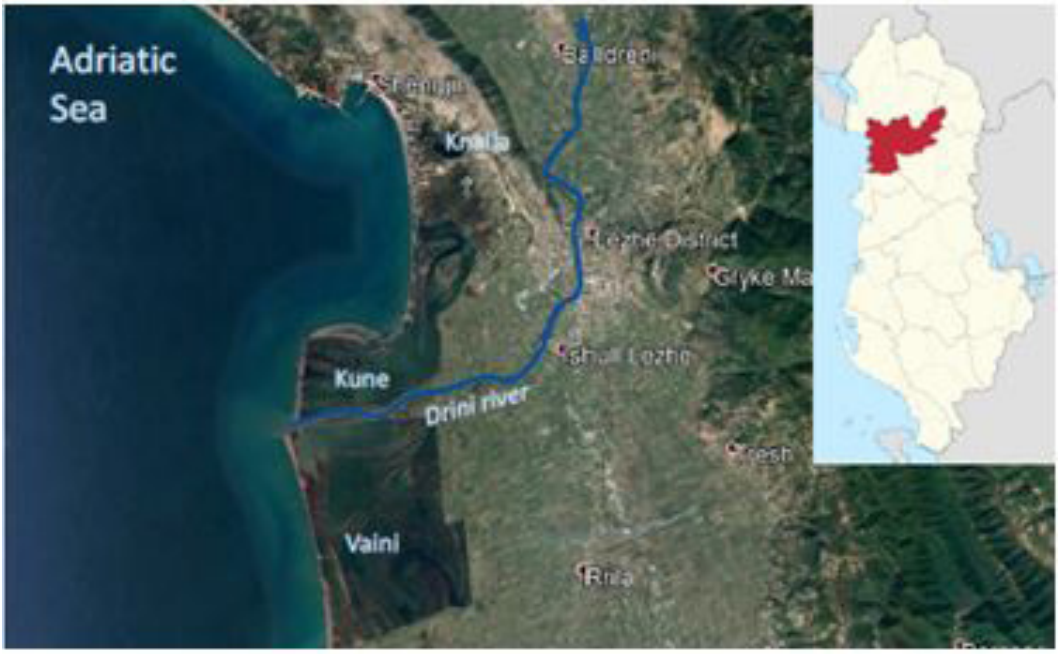


*Fig.1/ Satellite view of the Kune-Vain lagoon (12). Source: Google Earth*



'a' and total phosphorus (8).
Comparison of the TSI evaluated by the chlorophyll-a and phosphorus content, shown the same variation of the two parameters as more phosphorus causes more algae to grow, thus making water less clear (5).
The lagoons of the north-west of Albania represent one of the most important ecosystems of the territory in terms of biodiversity.
Kune-Vein is a natural reserve located in the district of Lezha (Picture 1).

Several years ago, this territory threatened to disappear, which explains the importance of taking swift action to stop its destruction. Over time, human interventions and climate change have led to a sharp increase in the salinization of the waters of the lagoon. As a result, there has been a slow but long degradation of its natural vegetation that has put at risk some animal species which inhabit the lagoon, including Pelecaniformes and Ciconiiformes. In addition, the increase in hunting and fishing activities even in forbidden seasons has put at risk other protected species. Some bird species such as the Cormorants, are persecuted because they are considered active competitors in fishing in the lagoon and along the Drin river. In addition to that, grazing has greatly increased: cows, sheep and goats are free to graze without the definition of specific boundaries thus destroying consistent portions of the natural vegetation. Furthermore the presence of factories in Lezha has further contributed to the degradation of the lagoon ecosystem due to the high phosphate discharges that occur directly in the course of the Drin river worsening water quality and therefore the same happens to the lagoon and the sea (7).

**Objectives and Methodology**

In order to have a clear and precise idea of the characteristics of an aquatic environment, such as a lagoon, it would be a good idea to monitor the water for long periods of time and at regular intervals, by adopting sampling and analysing methodologies. By acting this way, it is possible to understand how the ecosystem evolves according to seasonality and climate change. The sampling methodology must be carried out on a monthly schedule and they must be performed at different sampling representative spots of the lagoon environment. Initially, the sampling activity must be more frequent, providing an exhaustive representation of the lagoon's ecological conditions (2). Then it is possible to diminish the sampling frequency by retaining it as fixed on representative periods and factors, like season change or other impacting events. The biological parameters, in association with physic-chemical parameters, to be kept under constant control are:

- Determination of Chlorophyll-a concentration according to the acetone trichromatic methods (9)
- Phosphor content in water determined spectrophotometrically using the appropriate kit.
- Water turbidity determined by using of Sacchi disc.

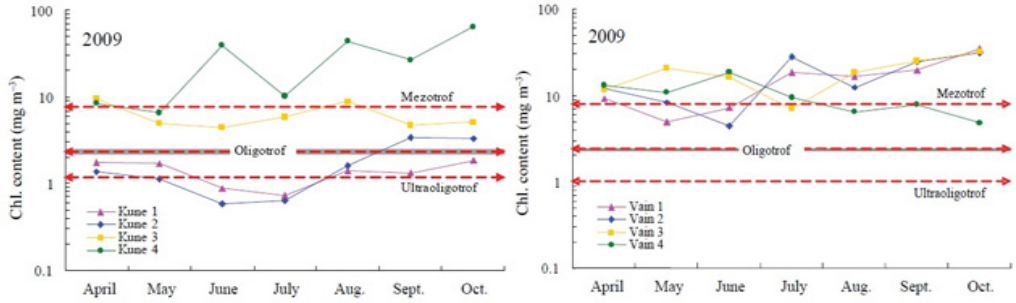


*Fig. 2 / Dynamics of chlorophyll-a content in the Kune and Vein lagoon among the selected stations in 2009. Source: Ariola Bacu*

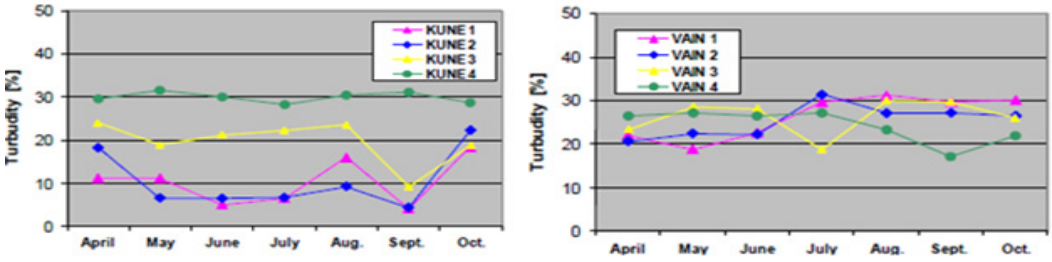


*Fig. 3 / Variation of water turbidity in Kune - Vain lagoon among the selected stations in 2009 from April to October.(5)*

Furthermore, the methodology has to grant the possibility of confrontation between different lagoon's environments and their trophic characteristics. In order to preserve the biodiversity of animals and plant, it would be a good idea to evaluate the survival capacity of the species, for example by carrying out a the census at least once per year.

**Results and discussion**

The assessment of the trophic status offers an overview of the quality of life of the waters of the lagoon on which also depends the terrestrial animal and vegetable life. Studies have shown that in Kune Vein lagoon, exists an oligotrophic (Kune) and eutrophic (Vein) states coexist given by the concentration levels of Chlorophyll-a (Picture 1) and the level of turbidity measured over time (Picture 2).

It is known that every alteration in an ecosystem can affect the biological community state, reducing its richness and determining the selection of more opportunistic species at the expense of more vulnerable ones.

To study the population's biodiversity and biological dynamics of the community in relation to the climate changes and anthropogenic influence becomes an important starting point to identify suitable biological markers -Bioindicators- which can determine the reaction of the resident organisms compared to the alteration of environmental conditions in which they use to live and multiply.

2000/60/EC Directive explains monitoring programs to follow in order to provide a complete framework of the water quality in the water basins and also it underlines the importance to assess early the communities' behaviour in lagoon as answer to the entity of the perturbation factors, searching for the specific environmental Bioindicators which represents useful tools to identify the trophic status of the lagoon waters because they can quantify the "biological productivity" and they can also evaluate the capability of this peculiar environment to support life.

It is not possible to define a standard protocol on the research of Bioindicators because transitional waters in general and coastal lagoons are naturally stressed environments, being subject to frequent changes in the ecosystem and to anthropogenic interventions. For this reason, it becomes important to define the specific hydro morphological context of the lagoon in which to contextualize biological indicators specific to that particular environment (6).

**Conclusions**

A well-defined monitoring program to be applied at short and long periods of time in different comparable spots of the lagoon can be useful to define a standardized protocol capable to identify early any risk condition. In association with TSI, it would be very useful to define parameters related to the climate change and the anthropization of the territory, factors that puts at risk the environmental integrity. All these parameters, if considered in their totality, allow to understand and possibly to predict the risk level of loss of

biodiversity for animal and plant species. The data obtained, when combined with the environmental parameters collected over time, might offer a complete picture of the dynamism of the changes in the ecosystem and the adaptability of the living species which inhabit that environment. It is important early understanding the development of a lagoon ecosystem because it makes the possibility to intervene quickly in case of need in order to prevent living species from becoming endangered.

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