

Excessive presence of Nitrogen and Phosphorus in the Drini River and their impact on the Kune-Vain lagoon ecosystem: how anthropization can affect biodiversity

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Abstract- *In the western part of Albania there are various examples of lagoons and wetlands ecosystems; the object of this manuscript is addressing the environmental conditions of The Kune-Vain Lagoon, located in proximity of the city of Lezhë and south of the Drini River and its delta and providing suggestions about its preservation: it has been calculated that about 10 million m³ of polluted water are released, in many ways, every year into the Drini River. Because of its biodiversity this land has both national and international protection status. However, the flux of contaminants and pollutants derived from anthropic activities is strongly affecting this transitional body of water which is located at the interface of the river and the Adriatic Sea. Due to human activities, mobile aqueous species of nitrogen (N) and phosphorous (P) have become an actual environmental issue because high levels of such chemical elements are linked to the eutrophication of the lagoon's waters, causing the proliferation of invasive species (mostly microorganisms, plants and crustaceans). As mentioned above a very high quantity of N and P from anthropogenic sources can infiltrate the ecosystem in many ways, like from mining activity, liquid and solid wastes from the urban area of Lezhë, from farms and livestock, from fires and more. But the main cause of this problem is associated with the use that people make with soils and lands: the increment of fallow uncultivated areas from abandoned agricultural sites contribute indeed to the surface runoff, erosion and subsequent transport of N and P chemical species to the actually cultivated territory in which cultivation and managements practices for forage and cereals are present; this leads to ulterior release of soil particles that are rich in N and P chemicals compounds into the aqueous phase of the land. A very big portion of those aforementioned particles have been and still are depositing in the main area of the Kune-Vain Lagoon. The Lagoon is part of the coastal area, thus it is very important for economy, industry and tourism and it also act as a 'buffer zone' between the sea and the agricultural areas because of its biological function as natural filter for nutrients overload through its characteristic vegetation. Nevertheless, the Kune-Vain lagoon waters show a clear tendency toward degradation and something must be done to prevent heavy ecological issues. It would be useful to constantly monitor the chemical composition and the state of the waters. Also, the employment of meanings of phytoremediation would represent a practical, cheap and environmental-friendly way to help the process of recovery toward better environmental conditions of the Kune-Vain Lagoon.*

Keywords: Anthropization; Eutrophication; Biodiversity; Lagoon; Ecosystem

The abundance and richness of freshwater resources is a natural characteristic of Albania, however, over time, and especially roughly during the last 30 years, a gradual deterioration in terms of its quality and

pollutant quantity has been more and more evident. Many factors characterized by a social, economic and anthropogenic nature, played a pivotal role to the determination of the actual environmental



Fig. 1/ Kune-Vain Lagoon, Lezhë

water conditions, as listed below [Sulçe, Rroco, Malltezi, Shallari, Libohova, Sinaj and Qafoku, 2018: 279-280]:

- Social/economics factors: as the change from a one-party system to a democratic system that was preceded by an important downturn in terms of internal economy.
- Anthropogenic factors: such as modification to the topographical and hydrological characteristics of the territory due to human interventions in order to exploit natural resources for agriculture, mining, factories, urbanization and other activities which led to a deep environmental impact.
- Ecological factors: most of them are consequential to the aforementioned land exploitation. They include the pollution and consequent eutrophication of water resources and the draining of freshwater resources for agricultural and industrial purposes.

All these factors described above are useful to pinpoint the main scope of this manuscript: addressing the deteriorating conditions of a specific location: The Kune-Vain Lagoon, a transitional body of water which is located at the interface of the river and the Adriatic Sea located in proximity of the city of Lezhë and south of the Drini River and his delta (Fig1, www.intoalbania.com, photo by Gjergj Figuri).

This environment has both national and international protection status due to the fact it is a natural habitat for many species of wild animals, such as the golden jackal (*Canis aureus*), the pink flamingo (*Phoenicopterus roseus*), the kingfisher (*Accedo attis*) and the curly

pelican (*Pelicanus crispus*). The Kune-Vain lagoon is an ecosystem with a delicate equilibrium which is menaced because of the flux, due to human activities, of pollutants from mobile aqueous species of nitrogen (N) and phosphorous (P) that causes the dangerous phenomenon of water eutrophication [Yin, Wang and Zhao, 2018: 231]. This is linked to an overabundance of many invasive species of microalgae and bacteria whose excessive presence essentially cause a deficiency in oxygen levels in the water of the lagoon [Awal, 2019:1312]. This lack of oxygen and subsequent proliferation of those microorganisms paves the way for the arrival and spread of other invasive species like the Atlantic blue crab (*Callinectes sapidus*), an aggressive and very fecund crustacean native to the western coasts of the Atlantic Ocean which inhabits lagoons and coastal areas [Mancinelli, Chainho, Cilenti, Falco, Kapiris, Katselis and Ribeiro, 2017:01] and it is now menacing the ecosystem of the Kune-Vain lagoon by disrupting the natural food chain and therefore causing a significative loss in terms biodiversity which characterizes this location (Fig2, www.theguardian.com, photo by Jean Claude Cartin/Biosphoto).

The urban area of the city of Lezhë (Fig3, www.konica.al) with a population of 113.535 [lezha.gov.al, 2019:01], is located in proximity of the Kune-Vain Lagoon, becoming an important source for chemical pollutants that infiltrates the ecosystem in many ways.

Most of them are associated with human activities that can be distinguished



Fig. 2/ A male blue crab hunting down a prey

as “point” and “non-point” sources [Carpenter, Caraco, Correll, Howarth, Sharpley and Smith, 1998: 560], as listed below:

POINT SOURCES:

- Wastewater effluent (both from municipal and industrial sites)
- Runoff and leachate from waste disposal sites
- Runoff and infiltration from animal feedlots
- Runoff from mines, oil fields, unsewered industrial sites
- Storm sewer outfalls from cities with a population > 100.000
- Overflows of combined storm and sanitary sewers
- Runoff from construction sites

NON-POINT SOURCES

- Runoff from agriculture (including return flow from irrigated agriculture)
- Runoff from pasture and range
- Urban runoff from unsewered areas and sewered areas with a population >100.000
- Septic tank leachate and runoff from failed septic systems
- Runoff from construction sites
- Runoff from abandoned mines
- Atmospheric deposition over a water surface
- Activities on land that generate contaminants, such as logging, wetland conversion, construction and development of land or waterways

All the aforementioned factors are still today contributing to change the ecological conditions of the Kune-Vain Lagoon, but some of them play a greater

role than the others in releasing N and P chemical species into its waters. It has been calculated that about 10 million m³ of polluted water are released, in many ways, every year into the Drini River [Cullaj, Hasko, Miho, Schanz, Brandl, Bachofen, 2005:139]. Nevertheless, it has to be pointed out that evaluating the water quality condition and its eutrophic status without established thresholds for nutrient concentrations can be very challenging [Clune, Crawford, Boyer, 2020:02]. One of the main causes is associated with the use of land and soil for agricultural purposes and the abandonment of those sites after their exploitation or because they become unsuitable for cultivation: the increasing rate of uncultivated fallow areas of abandoned agricultural sites significantly contribute to the instauration of phenomena like erosion which causes the subsequent runoff of N and P chemical species to streams [Sulçe, Rroco, Malltezi, Shallari, Libohova, Sinaj and Qafoku, 2018:284] and waters that are used for irrigation of other cultivated areas in which fertilization, cultivation and management practices for forage and cereals are present. This leads to an ulterior release of soil particles that are rich in N and P chemical compounds into the aqueous phase of the land. The same process of chemical discharging originates from other main sources such as industrial and mining sites (either still in use or abandoned), making the water surrounding the urban area of Lezhë and its wild habitats (such as the coasts and the Kune-Vain Lagoon) polluted by chemical-organic meanings (Fig4, Environmental International, issue



Fig. 3/ Aerial view of the urban area of Lezhë and its interface with the lagoon and the Adriatic Sea

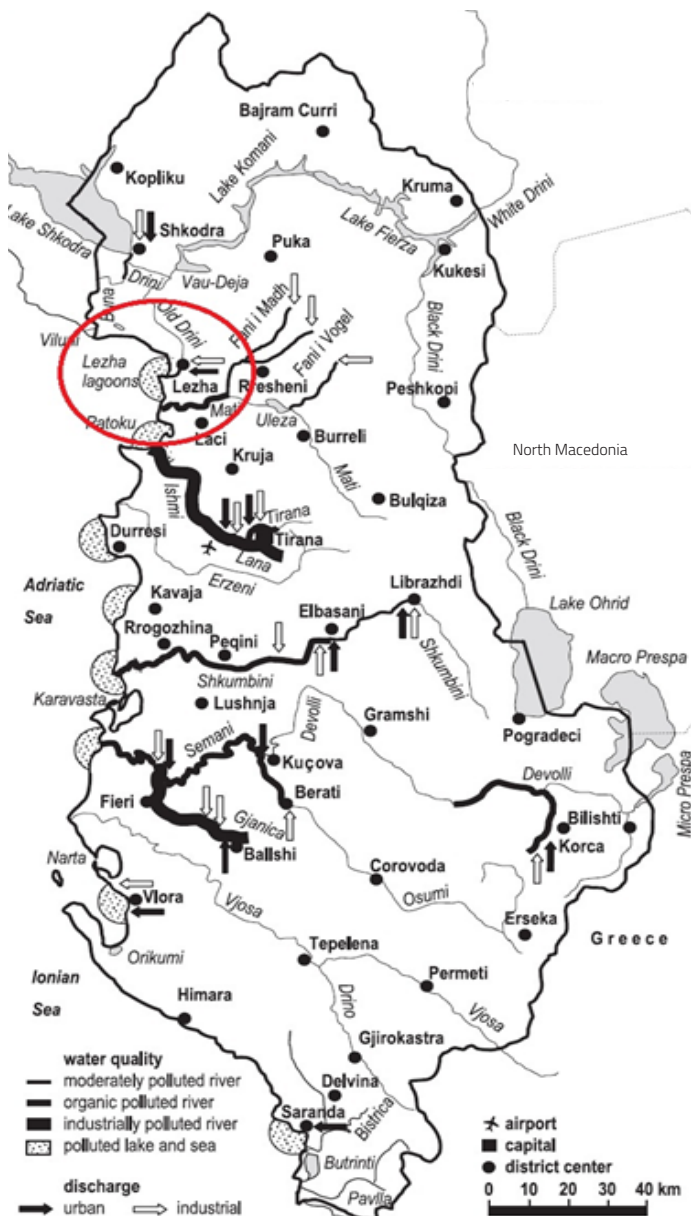


Fig. 4 / Hydrogeological map of the main polluting sites of Albania, highlighting the area of Lezhë. Source: Reinhard Bachofen

n°31:2005; drawn modified from UNEP, 2000).

This overuse and abuse of environmental resources is aimed to a rapid economic development which is often uncontrolled and unsustainable and does not protect from its threats the special areas, like the Kune-Vain Lagoon, that are symbols of the Albanian natural environment: as already stated the pollution problems of this aquatic ecosystem are linked to urban development, industrial waste management and land erosion among other factors [Cullaj, Hasko, Miho, Schanz, Brandl and Bachofen, 2005:139]. A proper way to assess the water conditions about its relative quantity of pollutants might be found in the USEPA guidelines "Nutrient Criteria Technical Guidance Manual: Rivers and Streams" which proposes and describes in details several steps to keep them monitored [Buck, Denton, Dodds, Fisher, Flemer, Hart, Parker, Porter, Rector, Steinman, Stevenson, Stoner, Tillman, Wang, Watson, Welch, 2000: XIII]:

- Identify water quality needs and goals with regard to managing nutrient enrichment problems.
- Classify rivers and streams first by type, and then by trophic status.
- Select variables for monitoring nutrients, algae, macrophytes, and their impacts.
- Design sampling program for monitoring nutrients and algal biomass in rivers and streams.
- Collect data and build database.
- Analyze data.
- Develop criteria based on reference condition and data analyses.
- Implement nutrient control strategies.
- Monitor effectiveness of nutrient control strategies and reassess the validity of nutrient criteria.

Furthermore, the employment of meanings of phytoremediation would represent a practical, cheap and environmental-friendly way to help the process of recovery toward better environmental conditions of the Kune-Vain Lagoon: by artificially increasing the number of the already existent species of macrophytes like wild reeds of the family of *Phragmites* spp as they are very efficient in adsorbing and therefore eliminating the excessive nutrients chemical species which are present in the water of the Kune-Vain Lagoon [Wilkins, Fallowfield and Baring, 2022:02].

In conclusion: the main scope of this manuscript is to address the environmental conditions of The Kune-Vain Lagoon, to provide suggestions about its preservation and to give consciousness

about the relevance of this environment which is pivotal both in terms of ecological and economic value. Since the Kune-Vain Lagoon represents a consistent part of the coastal area it must be considered as very important for economy, industry and tourism. But its role does not ends there: it also act as a 'buffer zone' between the sea and the agricultural, urban and industrial areas because of its biological function as acting as natural filter for nutrients chemical species overload by N and P sources, a function that is also carried out by means of phytoremediation through is characteristic vegetation which is composed, among other species, of macrophytes like reeds (*Phragmites* spp.) which are efficient in adsorbing nutrients and contaminants into their roots. Nevertheless, the Kune-Vain lagoon waters show a clear tendency toward degradation and something must be done to at least monitor their conditions.

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