Science of the Total Environment 643 (2018) 868–883

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

# Biogeochemistry and sedimentology of Lago di Lesina (Italy)

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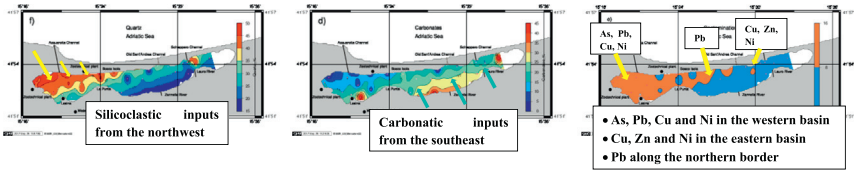
## HIGHLIGHTS

- We investigated the sedimentological processes and pollution of the *Lago di Lesina*.
- We analyzed sediment, mineralogical and biogeochemical properties of lake sediments.
- Silicoclastic, carbonatic and organic sediments supply the *Lago di Lesina sediments*.
- Silicic and carbonatic sediments prevail in different area due to different inputs.
- Weak pollution of As, Pb, Cu, Zn and Ni is present in the lake surface sediments.

## GRAPHICAL ABSTRACT




## ARTICLE INFO

*Article history:*
Received 29 January 2018
Received in revised form 12 June 2018
Accepted 13 June 2018
Available online xxxx

*Keywords:*
Biogeochemical facies
Depositional processes
Hydrodynamic
Pollution
Wetland
Lago di Lesina

## ABSTRACT

The Lago di Lesina (Lesina Lake, southeastern Italy) is a coastal pond located on an alluvial plain to the north of Gargano Promontory. The aim of this work was to study the depositional and hydrological processes, the benthic environment and the heavy metal sediments pollution of Lesina Lake. The study was carried out by Redox potential, water content, grain-size, mineralogical and biogeochemical analyses in surface sediments collected from 100 sampling stations in the coastal pond bottom. The results showed a predominance of three types of bottom pelitic sediments of different origins and compositions: siliciclastic, carbonatic, and organic. Siliciclastic sediments, which were found especially in the western basin and in the northwestern sector of the central basin, are due to inputs from Acquarotta Canal, some intermittent western streams, and deflation by northerly winds of the sandy barrier that separates the lake from the sea. Carbonate sediments are carried by streams and canals draining the carbonate rocks of the Gargano Mountains and entering the lake from its eastern and southeastern border, these sediments are predominant in the eastern basin and in the southeastern sector of the central basin. Organic matter is abundant throughout the whole lake; it is due to the high productivity of the *Lago di Lesina* waters that are rich of nutrients for inputs of waters draining the surrounding intensively cultivated agricultural areas. The finer bottom sediments of the lake tend to be removed from the shallower bottoms between the central and eastern sub-basins and near the borders to be deposited in the central portion of the central and western sub-basins. Heavy metal sediment pollution due to anthropic inputs is limited and consists of As, Pb, Cu, and Ni in the western basin, Cu, Zn, and Ni in the eastern basin, and Pb along the northern border.



## 1. Introduction

Land-sea transition zones encompass environments that are highly sensitive to external forcing. In these environments, interactions between marine and terrestrial processes can sharply induce profound

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https://doi.org/10.1016/j.scitotenv.2018.06.165
0048-9697/

modifications in chemical, physical, sedimentological, and biological parameters (Crossland et al., 2005; Pernetta and Milliman, 1995).

Instability is highest in transitional environments characterized by restricted water circulation (Tett et al., 2003). In such ecosystems, natural events, such as sea level oscillations, abnormal river floods, marine storms, climate variations, sediment inputs from continental and marine sources, and anthropic activities like coastline modifications and high nutrient and pollutant inputs, can induce environmental stress and changes; these, in turn, can result in marked modifications of a number of key parameters, especially salinity, oxygen, nutrients, presence and distribution of biota (Cognetti and Maltagliati, 2000; Moore, 2010; Nixon, 1995), and morphological and sedimentological features (Kjerfve, 1994; Viaroli et al., 2007). At the same time, high levels of continental and marine nutrient inputs make transitional environments highly productive aquatic ecosystems (Nixon, 1988).

The benthic environment is a primary component of transitional basins due to their shallow waters. Their bottom sediments are the final sink for a number of anthropogenic contaminants and where the accumulation of large amounts of organic matter (OM) can deplete oxygen content at the sediment–water interface (Frontalini et al., 2010).

A thorough understanding of the processes occurring in such water bodies is essential to ensure their functionality (Basset et al., 2006; Gonenc and Wolflin, 2004).

The Lago di Lesina (Lesina Lake, southeastern Italy) is a typical transitional basin and an ecosystem of international importance due to its role as a stopover area for several migratory bird species (Fig. 1). For this reason, it is an International Council for Bird Preservation protected site and is part of Gargano National Park (Specchiulli et al., 2010). It also hosts fishing activities and two aquaculture farms (Breber et al., 2008; D'Adamo et al., 2005; Roselli et al., 2009; Specchiulli et al., 2009).

The above considerations indicate that a thorough knowledge of the sedimentological, geochemical, and biological processes taking place in the lake is essential for appropriate management of this ecologically and economically important ecosystem.

The main objectives of this work were to explore the sedimentological processes affecting Lesina Lake and to identify the areas of origin of the bottom sediments, with a view to establishing the provenance and depositional mechanisms of sediments and assessing lake hydrodynamics in terms of waves and currents. To do so, bottom sediments were investigated for conservative mineralogical, biogeochemical, and sedimentological properties and for non-conservative redox potential (Eh) and porosity properties. The areal distribution of the conservative and non-conservative properties of sediments can provide indications on the general as well as more recent processes acting on a basin (Spagnoli et al., 2014).

The approach inferring current sedimentological processes through investigation of the mineralogical, biogeochemical, and sedimentological properties of bottom sediments was originally conceived and applied in the Adriatic Sea (Spagnoli et al., 2008; Spagnoli et al., 2010; Spagnoli et al., 2014). The present study is the first to apply this approach in a small and shallow basin and also the first investigation to undertake the general mineralogical, biogeochemical, and sedimentological characterization of bottom sediments of the Lesina Lake.

A further aim of the study was to analyze sediments for heavy metal pollution due to the farming and animal breeding activities carried out around the Lesina Lake.

The information provided by this study has the potential to be used to formulate management actions to preserve the good environmental status and biological productivity of the Lesina Lake ecosystem.

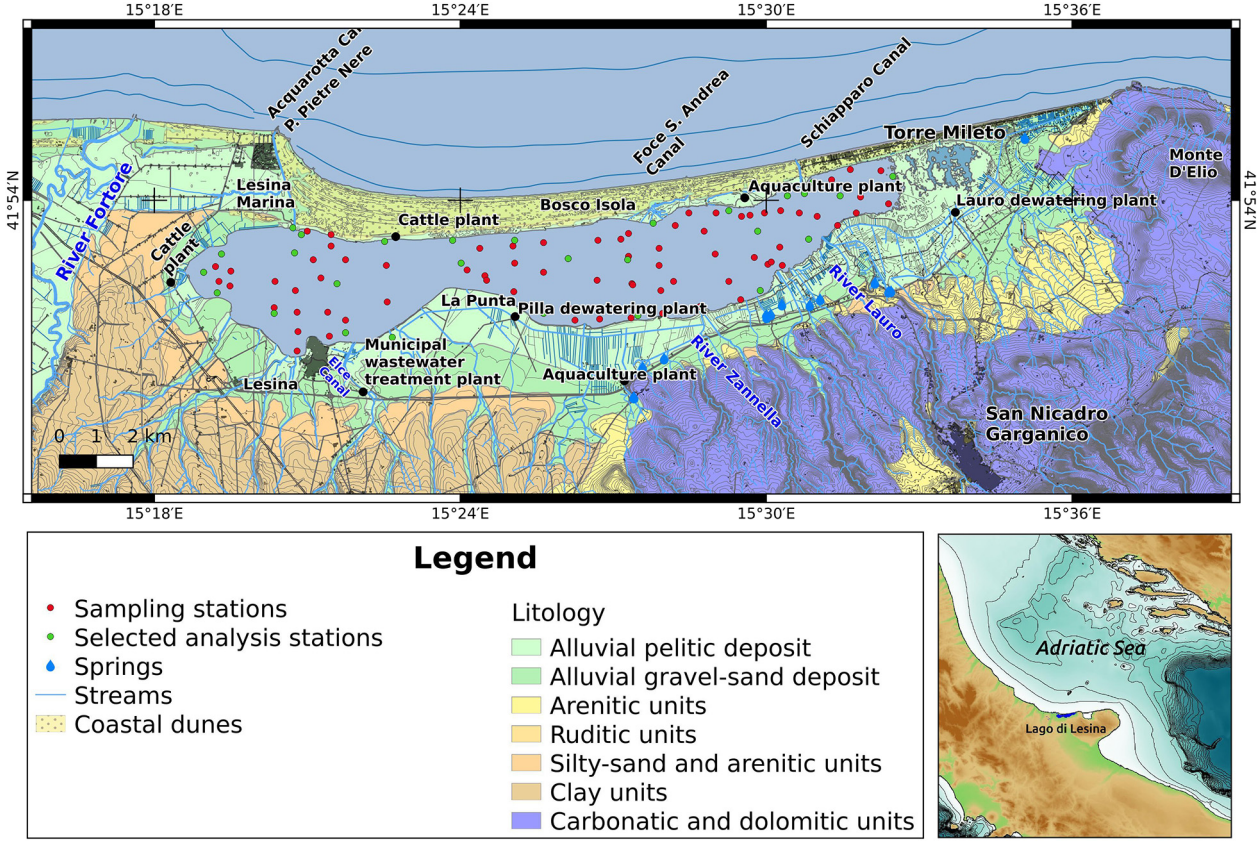


**Fig. 1.** The Lesina Lake with main fresh water tributaries and the two channels communicating with the sea (Acquarotta Canal and Schiapparo Canal). Red and green dots: sediment sampling stations. Green dots: stations selected for biogeochemical and mineralogical analyses. Original data from http://www.sit.puglia.it/ (2017). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)