Chapter 5
Physical-Chemical Parameters and Assessment of Pollution Through Bioindicators of Narta Lagoon

Petrit Kotori, Luan Hasanaj and Sonila Kane

Abstract Coastal lagoons are the most fragile ecosystems, with an increasing pressure from anthropogenic inputs (urban and agricultural sewages, industrial wastes, etc). These ecosystems are widely distributed along Mediterranean coasts. Narta Lagoon represents an important wetland ecosystem. It is located in the northwestern part of Vlora city separated by the Adriatic Sea through a narrow belt of land and communicates to sea by two channels. The aims of this study were: (a) the determination of some physical-chemical parameters of Narta Lagoon water, (b) identification of recent benthonic foraminifera, (c) observation of different damages of their fragile shells, and (d) the possible correlation of these damages to variations of water physical-chemical parameters.

For this purpose, some water samples (to assess some physical-chemical parameters and nutrients) and surface sediments were taken for benthonic foraminifera at the same time and stations, as mentioned above.

5.1 Introduction

Coastal lagoons are particularly important but especially vulnerable among coastal habitats (Gonenc and Wolflin 2005). They perform a range of ecosystem services of socioeconomic value to coastal communities, including shoreline stabilization, sediment and nutrient retention, high primary and secondary production, fisheries resources, habitat and food resources for terrestrial, aquatic and marine fauna, coastal water quality buffering, biomass and biodiversity reservation, and recreation and tourism amenities (Costanza et al. 1997; Gedan et al. 2011). The water pollution is the result of releasing of fluid toxic substances, urban and industrial remains, or accidental discharges. The water organisms absorb and accumulate these components more than their concentrations in aquatic environment (Nixon et al. 1994).

P. Kotori (✉) · L. Hasanaj · S. Kane
University Ismail Qemali, Vlora, Albania
e-mail: petrit_kotori@yahoo.it

C. Stylios et al. (eds.), *Sustainable Development of Sea-Corridors and Coastal Waters,*
DOI 10.1007/978-3-319-11385-2_5

Benthic foraminifera are increasingly used as environmental bioindicators of pollution in coastal and marginal marine settings. Because of their high sensitivity to environmental conditions, they are increasingly used for ecological and paleoecological studies all over the world (Samir 2000; Samir et al. 2003). Numerous studies have shown that the distribution of benthic foraminiferal assemblages can be related to several environmental and sedimentological conditions. The response of foraminifera to the changed environmental conditions is reflected in the variation in abundance and morphology of the test. The foraminiferal test has high preservation potential, thus, making these microorganisms one of the most useful proxies for the long- as well as short-term temporal variation in the amount and type of toxins in all kinds of marine environments, especially the near-shore coastal areas. Their community structure provides useful information on the general characteristics of the environment quality and more species are sensitive to specific environmental parameters (Alve 1991; Alve 1995; Coccioni 2000; Samir 2000; Debenay et al. 2001; Coccioni et al. 2003; Coccioni et al. 2005). This study discusses the environmental situation of Narta Lagoon one of the largest lagoons in Albania, located in the northwestern part of Vlora city, Adriatic Sea, with geographical coordinates: 40°32′ N latitude, 19°28′ E longitude. For this purpose, one expedition was conducted in September 2013 for sampling water samples and surface sediments for benthonic foraminifera (water and surface sediment samples were collected at same time and stations). Water samples were analyzed for physical-chemical parameters (pH, temperature, total suspended matter (TSS), dissolved oxygen (DO), biological oxygen demand (BOD), etc.) and nutrients (nitrites, nitrates, and phosphates). Surface sediments were observed for possible damages of benthonic foraminifera.

5.2 Materials and Methods

This study was carried out to determine some physical-chemical parameters (pH, T, redox, potential DO, BOD) and nutrients in water samples of Narta Lagoon and to give possible correlation between damaged fragile shells of foraminifera and these physical-chemical parameters. For these purposes, water samples and surface sediments for benthonic foraminifera were collected (at same time and places) according to a network of four sampling points in Narta Lagoon shown in Fig. 5.1.

Sample stations were chosen in order to do a better evaluation of Narta Lagoon possible polluting sources and human impact. Sample collection, transport and conservation was done according to standard methods recommended (American Public Health Association, APHA). Water samples were analysed in the laboratory of "Environmental Centre" of Vlora University. Water samples were collected in 1.5 L polyethylene terephthalate (PET) bottles and were transported during the same day to the laboratory by refrigerated containers under the temperature of 40 °C (Table 5.1).

Physical-chemical parameters of water were determined immediately after the samples were taken to the laboratory. pH and redox potential, were measured with a

Fig. 5.1 Network of sampling points in Narta Lagoon

Table 5.1 Sampling stations

Sample station	Latitude (decimal degrees)	Longitude (decimal degrees)
St. 1	40°30′14.01″ N	190°27′32.60″ E
St. 2	40°30′32.60″ N	190°25′25.07″ E
St. 3	40°31′ 02.78″ N	190°24′14.76″ E
St. 4	40°30′ 58.44″ N	190°23′47.11″ E

pH meter (Model pHS-3BW). Then, the water was filtered (glass filter of 0.42 µm pore size) with the aim to separate all the inert materials that can indicate in the results and stored at −200 °C until nutrient analysis. TSS was determined by pouring 1 L volume of water through a pre-weighed filter of 0.42 µm pore size, then weighing the filter again after drying it at 1050 °C for 2 h to remove all water dissolved oxygen, and BOD were determined using the Winkler method.

Nitrogen (NO_2–N, NO_3–N, and NH_4–N) and phosphates (PO_4–P) in water were measured by using an UV-VIS spectrophotometer (model UV 2400 PC), following the standard methods recommended by APHA/AWWA/WPCF (1995).

To analyze microfauna sediment (benthonic foraminifera), samples (mud, silt) were taken in the uppermost part of lagoon bottom. Each sample (about 100 g sediment), after being washed, dried, and passed through a 63 micron sieve, and after the picking up of foraminifera, was identified under a stereomicroscope.

5.3 Results and Discussion

The results of chemical-physical parameters of Narta Lagoon are shown in diagrams of Fig. 5.2, and the statistical data of physical-chemical parameters obtained through descriptive statistics are shown in Table 5.2.

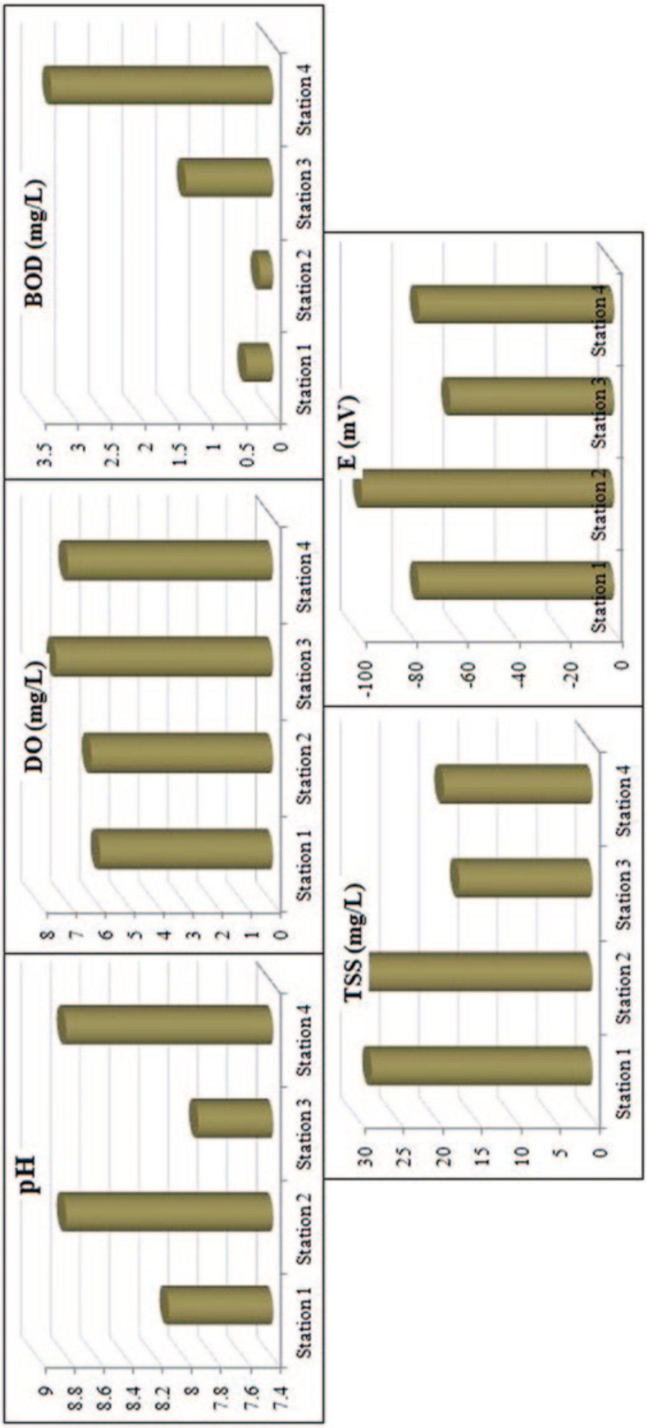

Fig. 5.2 The results of physical-chemical parameters of Narta Lagoon

Table 5.2 Statistical data of physical-chemical parameters

Statistical parameters	pH	E (mV)	TSS (mg/L)	DO (mg/L)	BOD (mg/L)
Mean	8.41	−78.5	23.3	6.625	1.3
Median	8.46	−76	23.6	6.6	0.85
Minimum	7.91	−98.2	17	5.9	0.2
Maximum	8.81	−63.8	29	7.4	3.3

TSS total suspended matter

As it can be seen, pH values resulted within normal levels for natural waters in Narta Lagoon. Higher levels of pH were found in station 2 (near Dampa) and lower level resulted in station 3 (Ura e Manastirit) of Narta Lagoon. Redox potential values fluctuated between a minimum of −98.2 mV at station 2 and a maximum of −63.8 mV at station 3. TSS resulted in high levels especially in stations 1 and 2 due to the small depth (0.3–1.0 m) of the Narta Lagoon.

Dissolved oxygen is one of the main chemical factors necessary for good water quality and can be considered as an indicator of healthy water. Changes in the dissolved oxygen levels in water can be caused by aquatic vegetation and temperature. When aquatic vegetation photosynthesize, dissolved oxygen levels in water increase, while levels can be decreased when the same vegetation respire, which uses up oxygen and produces CO_2.

Cold water can absorb more oxygen, producing higher values, while warm water produces lower values (when measured as mg/L). In samples studied, lower levels of dissolved oxygen were measured in stations 1 and 2 due to urban wastes.

The results of nitrite, nitrate, and phosphate content in water of Narta Lagoon are shown in diagrams of Fig. 5.3 and the descriptive statistical data of nutrients are given in Table 5.3.

Nitrates concentrations vary between 0.023 and 0.0202 mg/L. Higher levels were found in stations 2 and 3. This might be due to discharges of sewage water, agricultural and livestock wastes, or organic loads. Lower levels were found in station 4. As we can see nitrites ($N–NO_2^-$) resulted in higher content in station 1 and in other stations nitrites resulted in very low content (lower than the detection limit of spectrophotometer).

Phosphates resulted in higher level in station 1 of Narta Lagoon. The reasons for having higher values of phosphorus content in this station are urban discharges (sewage, phosphate fertilizers, and detergents).

During last decades benthonic foraminifera are used as environmental bioindicators of lagoons, ports, bays, etc. (Alve 1991; Alve 1995; Buosi et al. 2010). This is because foraminifera possess such features like: (1) short cycle life, (2) abundant in the sea and coastal ecosystems, (3) they have quick response to environmental changes, and (4) some of their species are characteristic for special ecosystems, etc. (25, 26). Foraminifera assemblages consist of four genera and five species: *Ammonia tepida, A. parkinsionana, A. gr. beccarii, Nonion depressulum, N.* sp, *Haynesina*

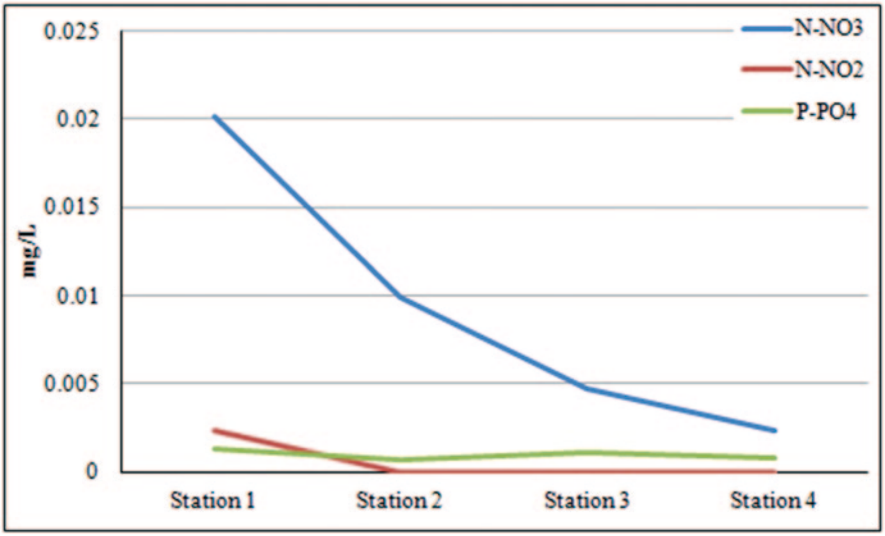

Fig. 5.3 The results of nitrates, nitrites, and phosphates

Table 5.3 Statistical data of nitrates, nitrites, and phosphates

Statistical parameters	$N–NO_3$ (mg/L)	$N–NO_2$ (mg/L)	$P–PO_4$ (mg/L)
Mean	0.009275	0.000579	0.000979
Median	0.0073	0	0.00095
Minimum	0.0023	0	0.0007
Maximum	0.0202	0.002317	0.001315

germanica, Quinqueloculina sp. as well as Ostracods, Microgastropods, and small Bivalvia. Although the study is not statistically encountered, microfauna shows that individuals of *A. tepida* and Ostracods are most abundant.

Up to 200 individuals were picked from sample residues. About 10 % of population (tests) resulted damaged or deformed. Dilution and deformed shells observed, were due to their damage. They were more stressed in the last three chambers, between sutures and apertures. Damages are observed also in some Ostracods and Microgastropods. Stations 1 and 2 represent the most damaged microfauna (Fig. 5.4).

Fig. 5.4 Damaged benthic foraminifera

5.4 Conclusions

pH, TSS, and nutrients determined in water samples collected in Narta Lagoon resulted in higher levels (DO and BOD in lower level) in stations 1 and 2 due to urban and industrial discharges near these stations (station 1 is positioned near Narta channel and station Narta 2 is positioned near the landfill of wasted deposits from industrial activities).

From above data, we can say that there exists a good correlation between variations of physical-chemical parameters and damaged foraminifera in stations 1 and 2. Based on the results of physical-chemical parameters and the study of foraminifera, Narta Lagoon represents a polluted ecosystem especially in its southern part due to artificial human interventions (urban, industrial, agricultural discharges) In the future, we think to extend the study not only in Narta Lagoon but in Karavasta and Patok lagoons as well.

Acknowledgments Thanks to the community and the local government area of Narta Lagoon, who expressed interest and readiness in conducting this study.

References

Alve E (1991) Benthic foraminifera in sediment cores reflecting heavy metal pollution in SORFJORD, western Norway. J Foraminifer Res 32(1):1–19, pl 1–3

Alve E (1995) Benthic foraminiferal responses to eustuarine pollution: a review. J Foraminifer Res 25(3):190–203

APHA/AWWA/WPCF (1995) Standard methods for the examination of water and wastewater, 19th edn. American Public Health Association, Washington, D.C.

Buosi C, Frontalini F, Da Pelo S, Cherchi A, Coccioni R, Bucci C (2010) Foraminiferal proxies for environmental monitoring in the polluted lagoon of Santa Gilla (Cagliary, Italy). Present environment and sustainable development. Nr. 4

Coccioni R (2000) Benthic foraminifera as bioindicators of heavy metal pollution—a case study from the Goro Lagoon (Italy). In: Martin RE (ed) Environmental micropaleontology: the application of microfossils to environmental geology. Kluwer Academic/Plenum, New York, pp 71–103

Coccioni R, Marsili A, Venturati A (2003) Foraminiferi e stress ambientale, In: Coccioni R (ed) Verso la gestione integrata della costa del Monte S. Bartolo: risultati di un progetto pilota. Quaderni del Centro di Geo-biologia Università degli Studi di Urbino, Vol 1. pp 99–118

Coccioni R, Marsili A, Frontalini F, Troiani F (2005) Foraminiferi bentonici e metalli in traccia: implicazioni ambientali, In: Coccioni R (ed) La dinamica evolutiva della fascia costiera tra le foci del fiume Foglia e Metauro: verso la gestione integrata di una costa di elevato pregio ambientale. Quaderni del Centro di Geobiologia Università degli Studi di Urbino, Vol 1. pp 57–92

Costanza R, d'Arge R, de Groot R, Farber S, Grasso M, Hannon V, Limburg K, Naeem S, O'Neill RV, Paruelo J, Raskin RG, Sutton P, van den Belt M (1997) The value of the world's ecosystem services and natural capital. Nature 287:253–260

Debenay JP, Tsakiridis E, Soulard R, Grossel H (2001) Factors determining the distribution of foraminiferal assemblages in Port Joinville Harbor (Ile d'Yeu, France): the influence of pollution. Mar Micropaleontol 43:75–118

Gedan KB, Kirwan ML, Wolanski E, Barbier EB, Silliman BR (2011) The present and future role of coastal wetland vegetation in protecting shorelines: answering recent challenges to the paradigm. Clim Change 106(1):7–29
Gonenc IE, Wolflin JP (2005) Coastal lagoons: ecosystem processes and modeling for sustainable use and development. CRC, Boca Raton
Nixon E, Mclaughlin D, Rowe A, Smyth M (1994) Monitoring of shellfish grown areas. Marine environmental series 1/95 section 1–1
Samir AM (2000) The response of benthic foraminifera and ostracods to various pollution sources: a study from two lagoons in Egypt. J Foraminifer Res 30:83–98
Samir AM, Abdou HF, Zazou SM, El-Menhawey WH (2003) Cluster analysis of recent benthic foraminifera from the northwestern Mediterranean coast of Egypt. Revue de Micro-paleontologie 46:111–130