Assessment of the impacts of treated wastewater discharge on assemblages of benthic macrofauna in the N. Aegean Sea

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ΙΝΣΤΙΤΟΥΤΟ ΑΛΙΕΤΙΚΩΝ ΕΡΕΥΝΩΝ

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Introduction

Domestic sewage that is discharged in the environment without or with inadequate prior treatment can cause harm to the aquatic ecosystems by means of organic pollution, eutrophication, anoxia, and other pressure mechanisms (Gray et al., 2002).

Assessments of the impacts of organic pollution on the marine environment are often based, at least partly, on the study of characteristics of the assemblages of benthic macrofauna (Dauer, 1993).

The aim of this study was to assess the impacts of the discharge of treated domestic wastewater of Kavala and Palio on the ecosystems of the marine areas adjacent to the points of effluent discharge in the N. Aegean Sea.

Methodology

The samplings were conducted at the marine areas where the effluents from the sewage treatment plants (STP) of Kavala and Palio are discharged via pipes (Fig. 1).

Samples of bottom sediment were collected at three stations in each study area and one reference station (two replicates per station) with a Van Veen grab sampler (0.025 m^2) (Fig. 2).

The assessment of the ecological quality status was carried out with the "Benthic Quality Index - family level (BQI-family)" biotic index (Dimitriou et al., 2012), an adaptation of the original BQI index that uses species-level benthic macrofauna abundance data (Rosenberg et al., 2004; Leonardsson et al., 2009). The BQI-family index allows rapid but still robust assessments (Karakassis & Hatzigianni, 2000; Dimitriou et al., 2012).

A coefficient of sensitivity to organic pollution must be known for the macrobenthic families present in the samples. This coefficient is used as a parameter of the BQI index equation.

Nemertea, Nematoda and Phoronidae were present in the samples collected in this study but do not have sensitivity coefficient values assigned by Dimitriou et al. (2012) and were consequently excluded from the analysis.

The ecological quality class boundaries for the BQI-family index that were used in this study are those given by Dimitriou et al. (2012) (Table 1).

Classification of families to trophic groups was based on Jumars et al. (2015).

Table 1. Ecological quality class boundaries for the BQI-family index that were used in this study.

Ecological Quality class	BQI-family index ranges
High	≥ 20.8
Good	9.2 to ≤ 20.8
Moderate	5.7 to ≤ 9.2
Poor	1.9 to ≤ 5.7
Bad	0 to ≤ 1.9

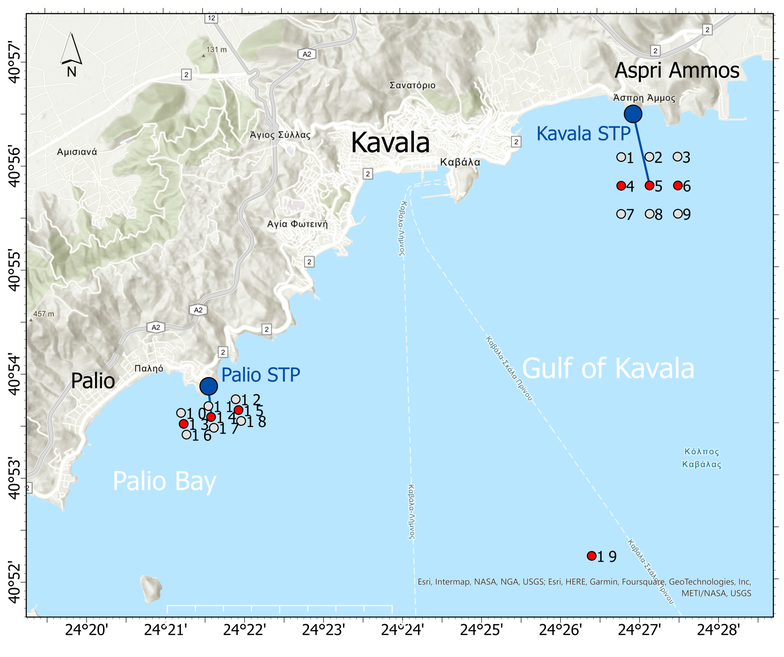

Fig. 1. Map of the study areas, with the benthic macrofauna sampling stations indicated in red. Stations 4 – 6 correspond to the Kavala STP, stations 13 – 15 to the Palio STP, and station 19 is the ref. station. The locations of STPs and their effluent discharge pipes are colored in blue.

Fig. 2. The sediment samples were collected with a Van Veen grab and were sieved on-board with a 0.5 mm mesh-size sieve.

Results

A total of 518 individuals of benthic macrofauna were found in the samples and were classified in 37 taxa: 35 families of Mollusca, Polychaeta, Sipuncula, Phoronida, Crustacea, Tanaidacea and Echinodermata, and also Nematoda and Nemertea.

We found that the dominant taxa belonged to the polychaete families Cirratulidae, Lumbrineridae, Magelonidae and Paraonidae, and also to Nemertea.

Generally, all stations were characterised by the dominance of endobenthic, burrowing families of polychaetes and nemertean worms that are deposit-feeders or predators. The also abundant epibenthic Cirratulidae are either deposit or detritus feeders.

The dominant taxa, with the exception of Cirratulidae, had relatively high sensitivity coefficient values. The ecological quality status was classified at all stations as "Good" (Table 2).

Table 2. Classification of the samples in ecological quality status classes based on the values of the BQI-family index.

Study area	Sampling station	Replicate	BQI-family index	Ecological Quality class
Kavala STP	4	A	11.5	Good
		B	12.4	Good
	5	A	11.6	Good
		B	11.9	Good
	6	A	11.7	Good
		B	11.8	Good
Palio STP	13	A	14.1	Good
		B	13.6	Good
	14	A	9.6	Good
		B	12.0	Good
	15	A	12.3	Good
		B	12.8	Good
Ref. station	19	B	10.3	Good

Discussion

The dominance of deposit feeders could be associated with the high concentrations of organic matter measured in the bottom sediment at all stations (5.3 – 9.8 %).

The dominant families Lumbrineridae, Magelonidae and Paraonidae are considered sensitive or indifferent to organic pollution (Borja et al., 2000; Forde et al., 2013; Dimitriou et al., 2012).

With the exception of Cirratulidae, families that are tolerant to organic pollution (e.g., Lasaeidae, Synaptidae, Nephtyidae, Nereididae, Spionidae) had low abundances in the samples.

Although concentrations of organic matter in the bottom sediment were high, the dominant macrobenthic taxa were found to be mostly sensitive or indifferent to organic pollution and ecological quality status was consequently classified at all stations as "Good". However, the mean values of the index in the two study areas (11.8 and 12.4) were closer to the lower boundary of the "Good" class.

The similarity of the two study areas and the reference stations pertaining to the concentrations of sediment organic matter and the response of the benthic macrofauna could indicate that the causal process underlying the observed patterns was not organic pollution due to STP effluent discharge.

A potential alternative explanation could be that the observed patterns were influenced by the organic matter produced by the extensive plankton bloom that took place in the spring of 2021 in the N. Aegean Sea.

Acknowledgements

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