THE IMPACT OF SEWAGE OUTFLOW ON THE SEAWATER CHARACTERISTICS IN PALEOCHORA, CRETE.

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ABSTRACT

The dispersion of the Paleochora municipal sewage pipe outlet was studied by monitoring the chemical and microbiological seawater characteristics in the coastal area from three sampling stations located at 0m, 150m and 300m SW from the outflow. Water samples were collected from 0m and 10m depth in a water column at each station. During the research period, the values of NO_3^-, NH_4^+, PO_{43}^- and the colonies of *total coliforms, E. coli and F Streprtococcus* and f*ecal coliforms* were measured employing standard methods of analysis. The highly reduced values of all quality parameters measured at a distance of 150m SW from the outlet, showed the high dispersion rate of the sewage.

1. INTRODUCTION

Nutrient enrichment of coastal waters has become a continually growing world-wide problem, leading to the undesirable algal growth in the water column and the development of anoxic conditions in the underlying sediments. Such problem mostly originates from the release of nitrogen and phosphorus compounds from point nutrient sources such as wastewater treatment facilities, industrial effluents and agricultural non-point inputs [1]. The southern Aegean Sea (Cretan Sea) is one to the most oligotrophic sub-basins of the Mediterranean Sea [2] but minimum information has been published for the Libyan Sea, the south sea border of Creece [3].

This paper presents the dispersion rate of the Paleochora municipal sewage outlet by monitoring the chemical and microbiological seawater characteristics in the outflow area from three sampling stations located at 0m, 150m and 300m SW from the pipe outlet.

2. MATERIALS AND METHODS

Paleochora is the capital town of the municipality of Pelekanos, in the province of Selino and its population was 2213 in the 2001 census. It is built on the ruins of the ancient city of Kalamydi. Paleochora is located 77 km south of Chania, at the southwest coastline of Crete. It's built on a small peninsula of 400m width and 700m length which divides the coastal zone bordering the Libyan Sea into two parts, the eastern and the western part. Agriculture and tourism are the main human activities in the area.

On the edge of the peninsula towards the Libyan Sea, close to the entrance of the marina, the municipal sewage pipe is submerged on the sea bottom and the untreated sewage is discharged to the sea. In order to evaluate the effect of the dispersion of the municipal sewage outlet on the sea water quality, samples were collected during six cruises from March to August 2008, at 3 sampling positions along the coastal line at a depth of 10m (Fig 1). The sampling stations were positioned above the outflow, 150m SW and 300m SW from the pipe outflow, in a manner aiming at detecting the nutrient and microbiological

loadings of the municipal sewage outlet and to record its temporal and spatial variability. The SW position was selected since the marina is located SW from the outflow and the underwater currents often have a SW movement. A local fishing boat was hired for the sampling cruises.

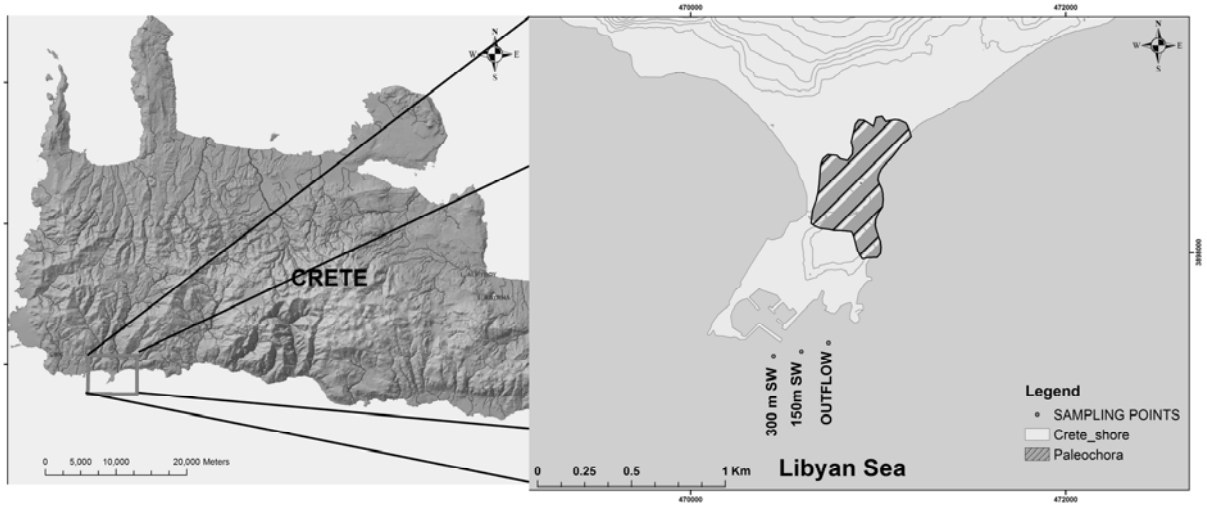

Figure 1. Geographical location of Palaiochora and the three sampling points.

Water samples were collected from the sea surface and 10m depth along the contour 10m on 16/3, 17/5, 6/7, 20/7, 10/8 and 25/08/2008. Time intervals were depended on the weather conditions and the intensive human activities around. Each of the samples was collected in double, placed in 1lt plastic polyethylene and glass bottles, and transferred in a portable cooler to the laboratory, where samples were analysed within 6 hours of collection.

For the analysis of the qualitative parameters NO_3^-, NH_4^+, PO_4^{3-} as well as for the bacterial detection, official methods [4] and test kits were employed [5]. The determination of nitrate NO_3^-, ammonia NH_4^+, phosphate PO_4^{3-} was carried our using test kits (MERCK 14942, 14752, 14848 respectively) and photometetric detection (MERCK Spectroquant NOVA 60) [5]. For the determination of total coliforms, *E.coli*, and *S. faecalis*, water samples of 100ml were filtered through sterile 0.45μm pore size cellulose filters and placed in dishes with the respective substrate, Membrane Lauryl Sulphate Broth ((LAB M 82) or Slanetz & Bartley Medium (LAB M 166), for incubation. Results were expressed as colony forming units cfu/100ml.

3. RESULTS AND DISCUSSION

The concentration of NO_3^- from the surface and the 10m depth water samples was measured below 2mg/l at all the sampling positions during the research period except of the May sampling. According to the records, a few days before the May sampling, a damage on the infrastructure released the pipe which was found floating below the sea surface. As a result, a high NO_3^- value was recorded in the surface water sampled above the outflow (18.6 mg/l) and reduced to the half (9.3mg/l) 300m apart from the pipeline. As soon as the damage was fixed, all the next samples demonstrated the high dispersion rate of the nutrient in the sea water (Fig 2).

The concentration of NH_4^+ at the 10m deep water samples was measured constantly below 0.1mg/l at all the sampling positions during the research period. Different behavior was recorded for the NH_4^+ concentration in surface water samples above the pipe outflow. A gradually increase from 0.3 to 2.18 mg/l was measured the period from May to July, which did not affect any other sampling points in both depths during the studied period. This is possible based on the high rate of the nutrient dispersion in the

aquatic environment. The temporal variability of the concentration of PO_4^{3-} in the surface water samples above the pipe outflow was similar to that of NH_4^+ and similar maximum values were recorded. In addition, the slow dispersion rate of PO_4^{3-} resulted in measurable PO_4^{3-} concentrations even at 300m away from the pipeline.

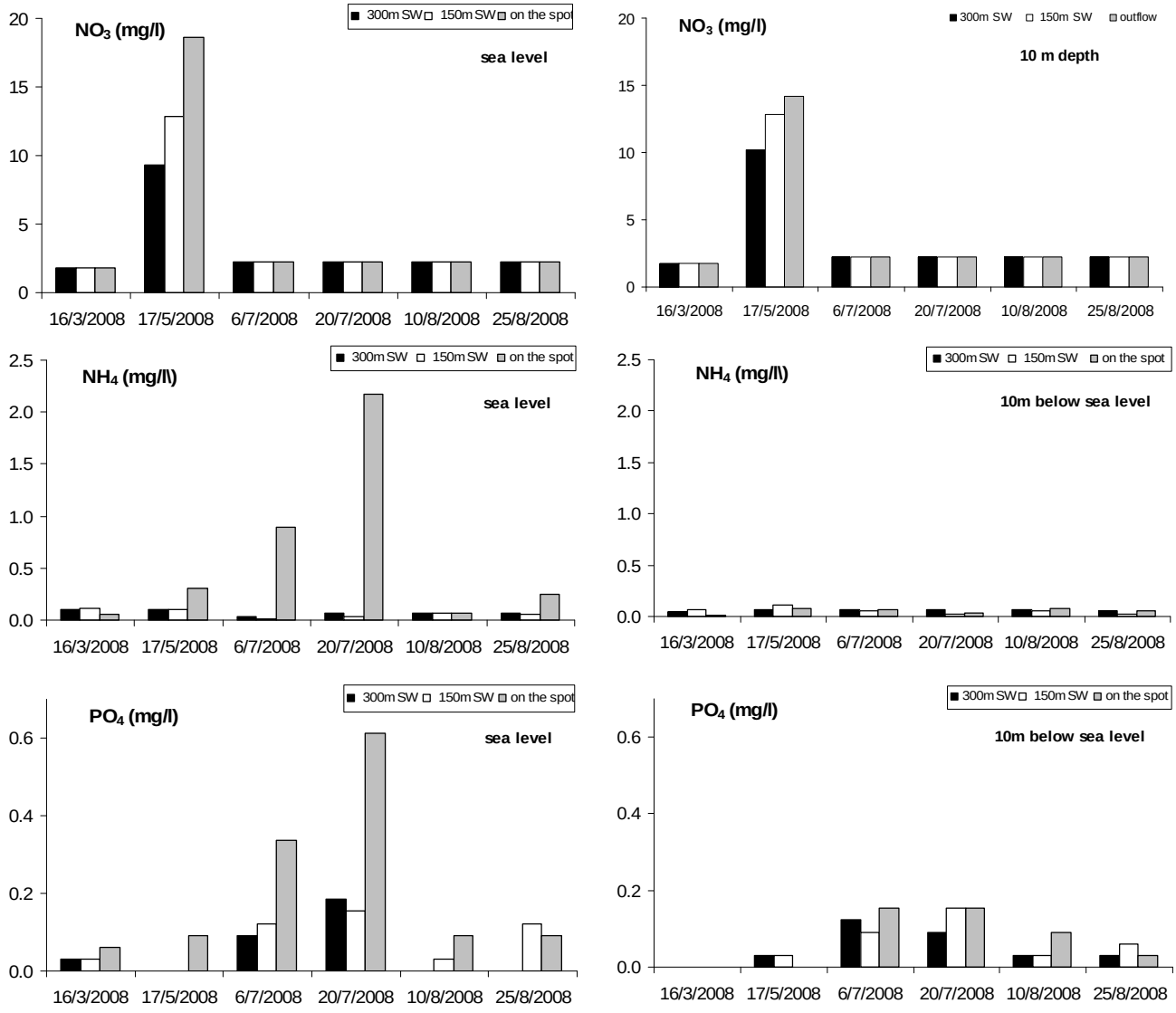

Figure 2. Spatial and temporal variability of NO_3^-, NH_4^+ and PO_4^{3-} in the water samples collected from sea surface and 10m depth

The microbiological load in the research area showed high spatial and temporal variability after discharged in the sea water [3]. The microbiological indices total coliforms, *E. coli* and *S faecalis* were continuously measurable in the sea water above the pipeline and 150m SW from the outflow. In the winter period, total coliforms, *E. coli* and *S. faecalis* in the surface water samples above the outflow were below the limits of legislation for bathing waters, whereas during the summer period the respective maximum values of 28,000cfu/100ml, 12,600cfu/100ml, 9,180cfu/100ml, exceeded 2-10 times the legislation limits. Zero values of total coliforms and *E. coli* where measured in the period from March to July, in the surface and 10m deep seawater, 300m apart the outflow, whereas *S. faecalis* was measurable in the May sampling. However, the higher values of all the microbiological indices measured were marginally within the legislation limits.

The remarkable dispersion rate within 300m SW from the pipeline reduced the microbiological load 30-80 times compared with the pipe outflow, probably is due to underwater currents.

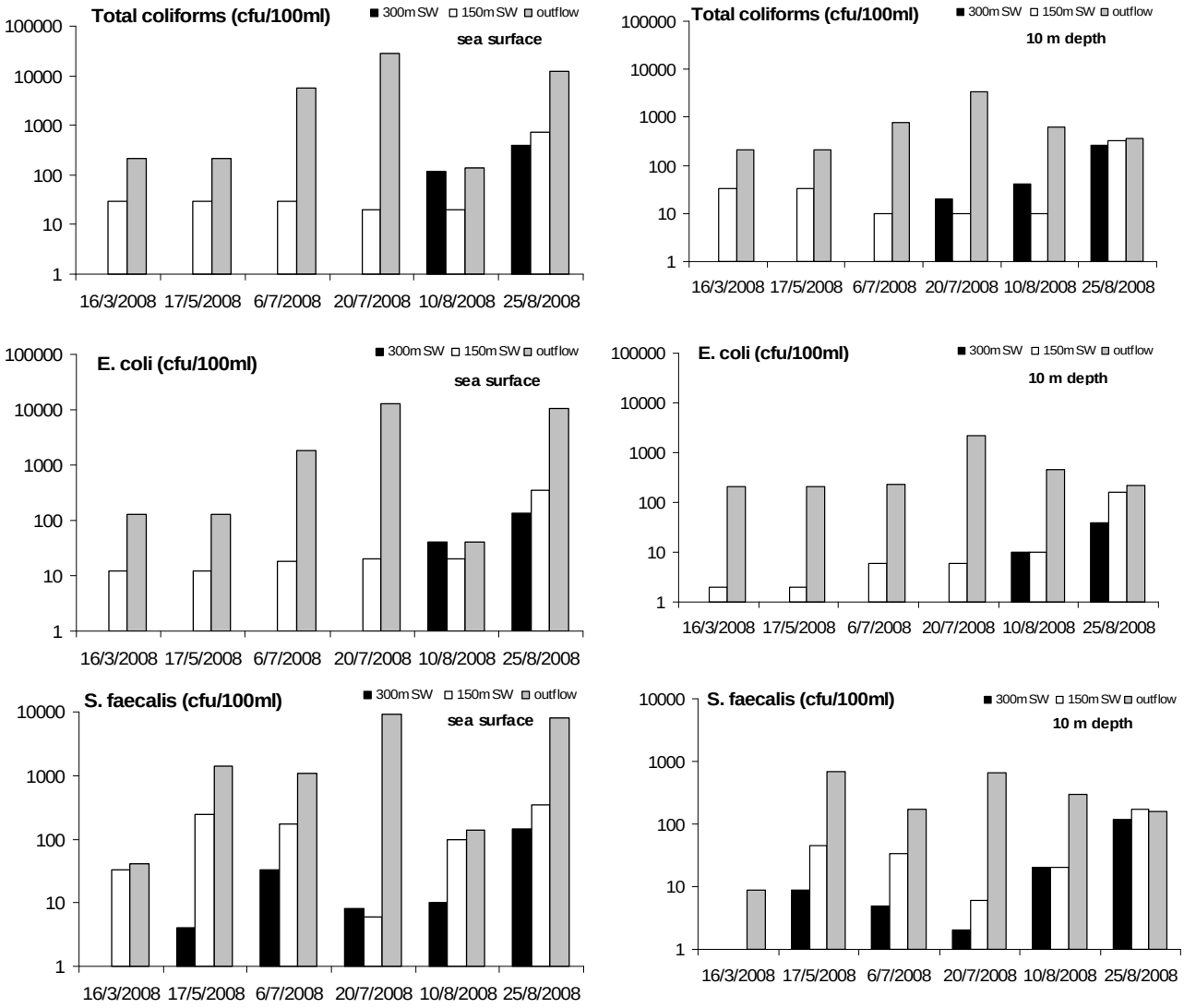

Figure 3. Spatial and temporal variability of Total coliforms, *E coli* and *S. faecalis* in the water samples collected from sea surface and 10m depth

4. CONCLUSIONS

Point source of nutrients from municipal wastewater pipe outflow appears responsible for the local increase in the concentration of dissolved nitrogen and phosphorus constituents in the studied area. The highly reduced values of all quality parameters measured even at a 150m SW from the outlet showed the high dispersion rate of the sewage. Although the selected sampling points are not near in one of the beaches, are of great importance because of their proximity to the marina entrance where fishing and pleasure boats are docked. The odor is a weak point for the area and do not support the sustainable development of Palaiochora which is surrounded by dreamy coasts sandy or not. It is important to clarify that the presented results are part of a larger research project which covered all the coastal area of the Palaiochora sea, beaches included, and demonstrated no effect on the contour 10m or the beach at Pachia Ammos and Halikia located 1.5 km west and east of the outflow.

Although the risk for the bathing water quality at the local beaches is insignificant, the construction of a wastewater treatment plant supporting all the south coast of the Prefecture of Chania is assumed of great importance and should be a priority for the decision makers.

5. REFERENCES

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