Impact of sewage sludge disposal on meiofauna community structure

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INTRODUCTION

The submarine wastewater outfalls represent one of the important sources of coastal water pollution. Untreated or inadequately treated sewage effluents may lead to eutrophication, habitat degradation and organic enrichment of marine sediments that can cause severe disturbances in the benthic communities. Due to their small size, high species diversity, short generation time, continuous reproduction throughout the year and direct benthic development, meiobenthic assemblages are often considered a valuable tool in pollution effects studies. The present study aimed to assess the effects of sewage sludge disposal on meiobenthic community structure in the vicinity of municipal sewage outfall of Rovinj. Assessment of marine environmental quality using meiobenthic assemblages as a biological quality element, can be valuable tool for ecological characterization of benthic habitats affected by sewage discharge, as well as for valorization of the wastewater management effectiveness.

MATERIALS AND METHODS

Research area and sampling

The municipal sewage outfall of Rovinj is located in the Cuvi bay (northern Adriatic Sea, Croatia) (**Fig.1**).
Mechanically treated wastewater is discharged 830 m away from the coast at 27 m depth. Samples were collected along 4 profiles, starting from the discharge point in the directions SE, SW, NE, NW from November to December 2009. At each profile sampling was performed at distances of 50, 100 and 150 m from sewage outfall. Samples were taken with Van Veen grab and subsampled with 5 sediment corers (Φ=3,5 cm, area 10 cm^{-2}), inserted 10 cm deep in sediment. Three core samples were used for meiofauna analyses and two for sediment characterization.

Initial split of two main sediment fractions for grain size analysis was performed using a wet sieve method, while the analysis of coarse fraction >63 μm was done by dry sieving method using series of sieves, graded at 1 phi intervals (Buchanan and Kain, 1971). Total organic matter content of sediments was determined by ignition loss method (Parker, 1983).

Meiofauna were extracted from the sediment by centrifugation (3000 rpm, 10 min, 3 times) in Ludox HS 40 gradient of density, and sieved through a 63 μm mesh size. Extracted organisms were sorted, counted and identified to main taxa level using stereomicroscope. Meiofaunal community structure was analysed using descriptive statistics, univariate (ANOVA) and multivariate methods (n-MDS). Statistical analyses were performed using MS Excel 2007 and Primer V 5.

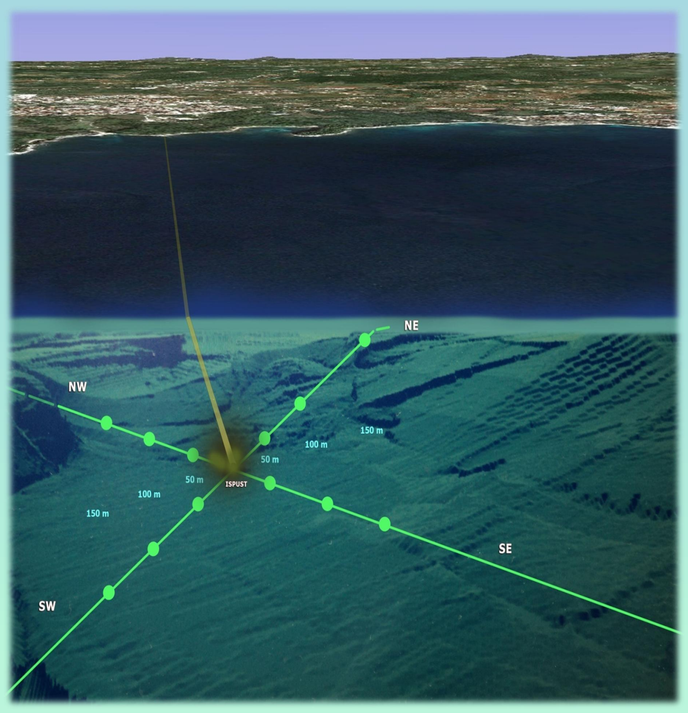
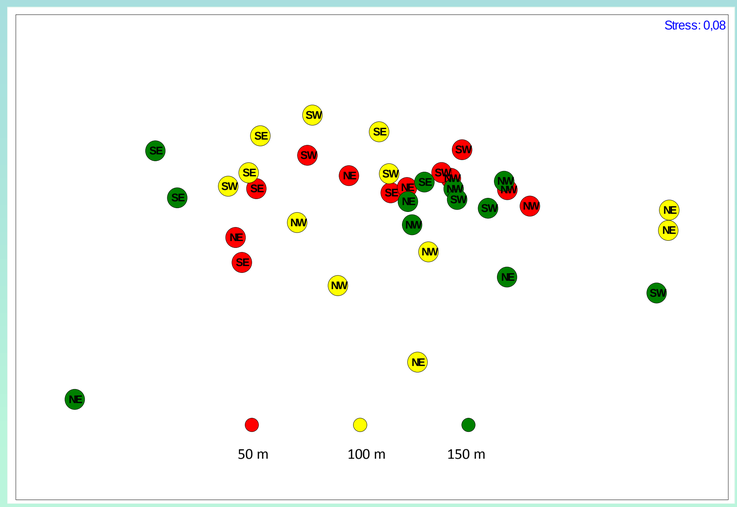


Fig.1. Map of the research area with 12 sampling sites

MDS analyses pointed out very similar community structure at all investigated sites. No statistically significant differences in meiofauna density along the gradient of organic pollution was found, probably due to the high small scale variability (**Fig. 5**).



RESULTS

The results of granulometric analysis of sediment are shown in **Fig 2.** SE, SW and NW profiles characterized with sandy silt and NE profile with silty sand sediment type. The NE profile distinguish by considerably larger amount of sand related to other profiles, as well as with clear gradient of granulometric composition, characterized by increase of sandy fraction with increasing distance from the sewage outfall. Percentage share of sandy fraction at the other northern profile was also higher compared to southern profiles.

A clear gradient of organic matter content was detected at all directions excluding SE profile (**Fig. 3**). At SW, NW and NE profiles percentage share of TOM in sediment have shown decreasing trend with increasing distance from outfall .

Mean meiofaunal densities were rather high and very variable, ranging from 1956±1049 (SE-150) to 5089±2537 (SW-150). In total, 12 meiofaunal taxa were recorded. Nematodes predominated over the other taxonomic groups and represented 91-99 % of total meiofauna abundance. At all but three sites nematode/copepod ratio was > 100 with the extreme value of 479 at the site located 50 m NE from the sewage outfall (**Fig. 4**).

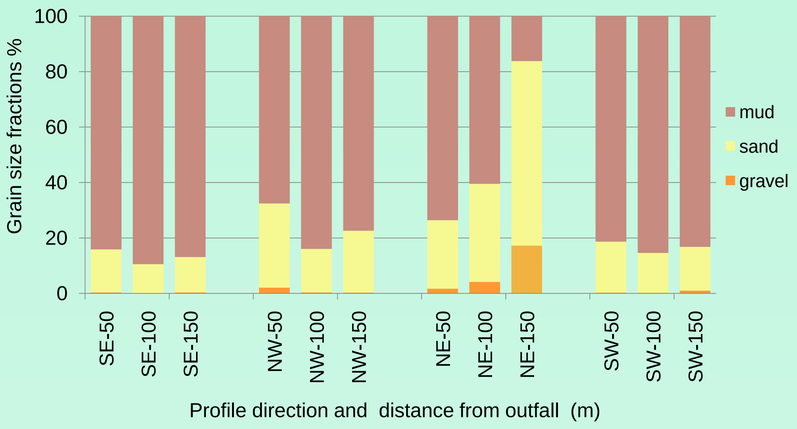


Fig.2. Granulometric charateristics of sediments

Fig.4. Total meiofaunal abundance

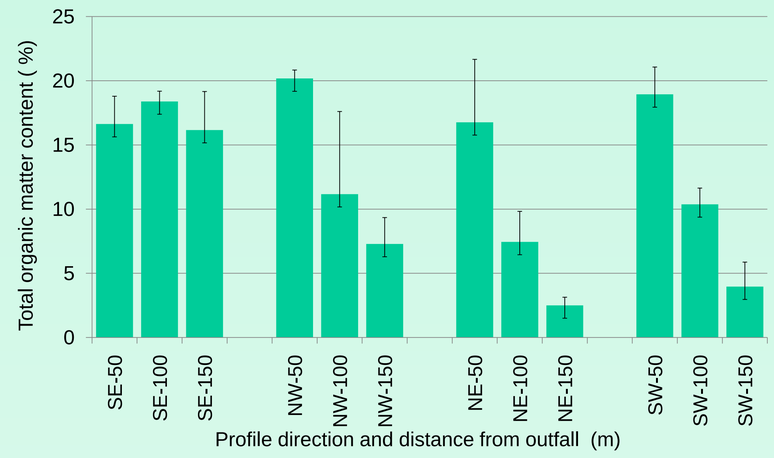


Fig.3. Total organic carbon content

DISCUSSION AND CONCLUSIONS

A small number of meiofaunal taxa, where nematodes accounting for more than 90% of total meiofauna and extremly high nematode/copepod ratio at most sampling sites indicates that the investigated area is under stress in all direction and at all distances from outfall. Reduced taxonomic richness indicates low environmental quality around the waste water outlet. Further analyses at lower taxonomic level could possibly reveal stress response on Nematoda and Copepoda populations. Results of this study suggest that secondary biological wastewater treatment is needed in order to increase the ecological quality of benthos in the investigated area.

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