Linear referencing as a tool for analyses of organic material deposition along a sandy beach of Gdansk – Sopot - Gdynia (Polish coast of Baltic Sea)

Monika Kędra[1] and Jacek Urbański[2]

[1]Institute of Oceanology PAS, Sopot 81 – 712, Powstańców Warszawy 55, Poland
E-mail: kedra@iopan.gda.pl

[2]Institute of Oceanography, University of Gdańsk, Gdynia 81-378, Al. Marszałka Piłsudskiego 45, Poland

Abstract

Linear referencing is a technique provided by GIS. It supplies tools that help in dealing with data associated with any kind of linear features. In recent years dense algal mats covering the shoreline and algal blooms in the Baltic region became a serious problem and create much concern. The linear referencing technique was used to analyse the dynamic process of organic material deposition along the shoreline. Sampling was done nine times along the sandy beach of Gdańsk – Sopot – Gdynia. The total amount of algal debris washed ashore varied a lot each time and on average was 252.64 tons ±220.97 tons. The linear referencing technique proved to serve well in dealing with processes occurring along any feature that may/can be treated as linear.

Keywords: Linear referencing; organic material deposition; Baltic Sea.

Introduction

Linear referencing is technique provided by GIS. Previously linear referencing was mainly used in GIS - transport sciences for management and for querying spatially and temporally referenced transportation data. In case of transportation linear referencing is a core method due to the fact that transportation features are linear in nature (Sutton and Wyman, 2000).

Linear referencing supplies tools that help in dealing with data associated with any kind of linear features. It reduces the effort of maintaining, organising, analysing and controlling any data describing processes that occur along existing linear features. It allows associating any multiple a set of objects with linear features. Then, it enables querying, editing or analysing attributive data sets without affecting the linear feature (Brennan, 2002).

Recently some effort was made to introduce linear referencing to environmental sciences. The technique was used to investigate coastal erosion and river systems classification.

In our case deposition of organic material along the sandy shoreline was analysed with the linear referencing technique. Dense algal mats covering the shoreline and algal blooms in the Baltic region became/are becoming a serious problem and created/creates much concern (Kotwicki *et al.*, 2002). Sandy beaches are very important due to their economical and social values. They also play an important role in the ecosystem as active biological filters. High organic material deposition along the shoreline strongly affects their socio-economical values and may influence the biota associated with interstitial system that plays a great role in processing organic material and returning nutrients back to the sea. The presence of green algal mats in shallow soft bottom areas could cause large changes in the local ecology (Isaksson and Pihl, 1992).

It is essential to assess the amount and volume of organic material and then to analyse biological processes connected with algae debris along the shoreline and linear referencing may serve this aim well.

Material and methods

The material was collected along the sandy beach of Gdańsk – Sopot – Gdynia (Polish coast of Baltic Sea) (fig. 1). There were 9 sampling campaigns from June to August 2004, carried out every week. Geographic position of each piece of organic material washed ashore was measured by using a GPS and portable GIS system. At the same time the volume of organic debris was measured. Small amounts were assessed as 1 dm^3. In case of larger amounts, length, width and depth of each assembly were measured and then the volume was calculated. Also the average volume of organic material deposited on every meter of the beach was calculated.

In Sopot additional sampling was made. 1dm^3 of swash wash water was taken in June and the density of drifting algae was assessed. Comparing these findings with the amount found on the beach, the percentage of the algae found in the water and that wash ashore was determined.

On average 1 dm^3 of algal debris deposited on the beach weighted 0.88kg (±0.10). These results were used to estimate the total amount of organic material found on the beach in comparison to the total volume counted from the sampling carried out along the Gdańsk – Sopot – Gdynia shoreline.

By employing the linear referencing method, geographic data may be stored by using a relative position along an already existing linear feature (route). A route is a geographic feature that is represented by a line, with a unique identifier and is stored with/in the geometry measurement system. In this case a shoreline from Gdansk to Gdynia is treated as one route. Any geographic feature occurring along the route should be treated as a route event. Every volume of organic debris is treated as a line event located along the route (shoreline). Linear referencing allows analysing dynamically changing objects with relative position on linear features. The objects are sampled in two dimensions, using x, y coordinates.

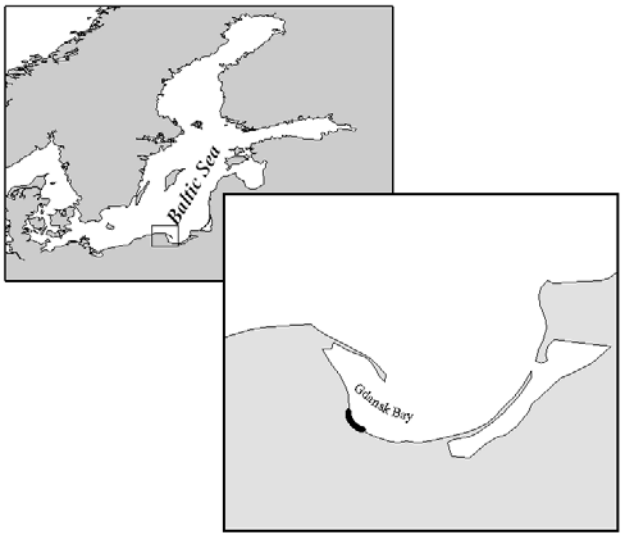

Fig. 1. Sampling area – Gdańsk – Sopot – Gdynia; Polish coast of Baltic Sea.

Results and conclusions

The volume and the amount of algae debris found along the coast varied the most in July. The highest amount was observed on 14.07.2004 while the lowest on 29.07.2004 (fig. 2).

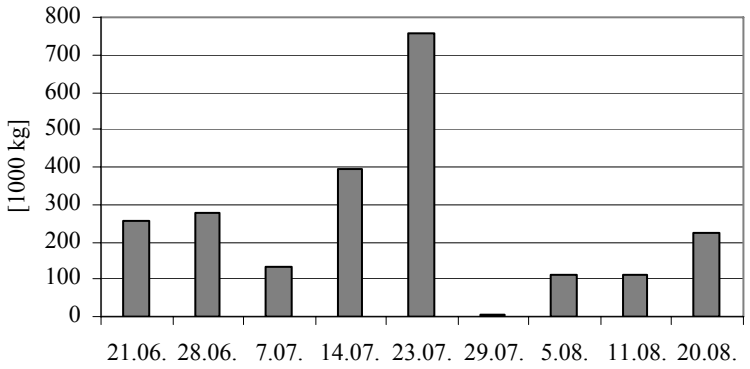

Fig. 2. Total amount of algae debris found along the coast in summer 2004.

The mean volume of algae debris per meter beach varied the most in July (fig. 3). All the 9 samplings carried out through the summer season proved that the manner in which the debris was deposited on the beach might not be treated as casual.

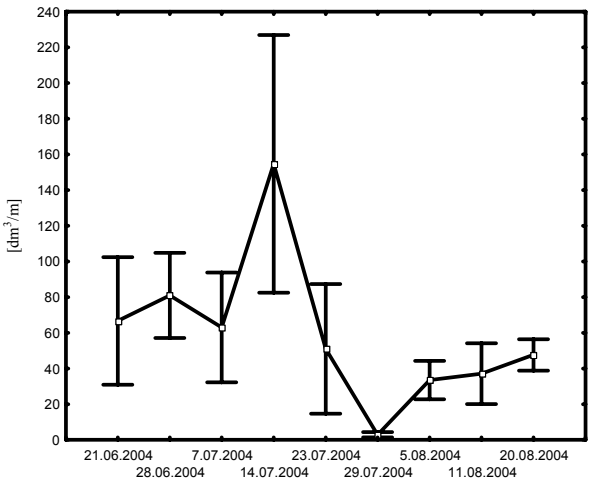

Fig. 3. Mean volume on every meter of the beach of algae debris found along the coast in summer 2004.

In June the mean density of algae in swash water was assessed as 13.5kg for each $1m^3$. 64% of algae from the swash water were deposited on the beach.

Different natural phenomena occurring along the coastline have a linear and patchy character. For analysing such processes and for estimating parameters describing its temporal and spatial changes a precise knowledge regarding its occurrence is needed. That requires very dense and detailed point sampling or some linear framework might be an alternative. The example of organic material deposition along a sandy beach of Gdansk – Sopot – Gdynia showed that linear referencing technique may play such role. The linear referencing technique proved to serve good as a tool for storing, analysing and visualising environmental data connected with the shoreline.

Acknowledgements

We would like to thank Lech Kotwicki and Jan Marcin Węsławski for providing unpublished material.

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