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Changes in nematode communities at the long-term sand extraction site of the Kwintebank (Southern Bight of the North Sea)

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Abstract

We investigated the long-term effects of sand extraction activities on the nematode communities from the Kwintebank. Although changes in nematode community composition cannot be completely uncoupled from natural processes, we suggest that the morphological changes in the sandbank and physical disturbance associated with the dredging activities indeed affected nematode community composition. Nematode diversity did not change since the start of the extraction activities but nematode community composition changed significantly. The SIMPER routine identified predatory nematodes to be important for the within group similarity at the start of the exploitation, while similarity in 1997 and 2001 was determined by the contribution of deposit feeding nematodes. In addition, long nematodes, vulnerable to physical disturbance became less important. These changes are attributed to long term changes in sediment characteristics in combination with additional short-term disturbances by the creation and filling of dredge furrows which are related to the extraction activities.

Keywords: Sand extraction; Nematodes; Meiobenthos; Kwintebank; North Sea

1. Introduction

Due to an increasing demand for suitable sands needed for construction works and other purposes (e.g. beach regeneration), in combination with increasing costs involved with sand extraction on the main land, sand extraction at sea offers a valuable alternative to sustain the growing demand for aggregates.

The effect of sand and aggregate extraction on the marine environment was studied mainly through assessing eventual changes in bottom topography, sediment composition and benthic macrofauna (see reviews by Newell et al., 1998; Boyd et al., 2004). Most of these studies documented a decrease in diversity, density and biomass of the macrobenthic species within the extraction areas (Kenny and Rees, 1994; Desprez, 2000; van Dalfsen et al., 2000; Sardá et al., 2000; van Dalfsen and Essink, 2001; Guerra-Garcia et al., 2003; Newell et al., 2004; Simonini et al., 2005). However, dredging in a sandy gravel deposit in the southern North Sea did not induce such dramatic changes (Robinson et al., 2005) suggesting that impacts of extraction acitivities are site specific and dependent on both local sedimentological/topographical characteristics of the site and the ability of the local macrofauna to cope with the induced disturbance. However, many of these studies were designed to investigate the initial effect of extraction acities, while habitat changes due to long-term sand extraction cause macrofaunal assemblages to change as well (Desprez, 2000).

On the Kwintebank, a sandbank located on the Belgian Continental Shelf (BCS) in the Southern Bight of the North Sea, sand extraction has taken place since 1976. At least 75% of all sand extracted from the BCS originates from the Kwintebank, due to the presence of suitable sands and its close location to the harbour of Oostende (Degrendele et al., in press). Total amounts of sand extracted from the BCS increased from 29,000 $m^3 y^{-1}$ in 1976 to 1,700,000 $m^3 y^{-1}$ in the mid 90s. Maximum exploitation was recorded in 2001 (1,900,000 $m^3 y^{-1}$).

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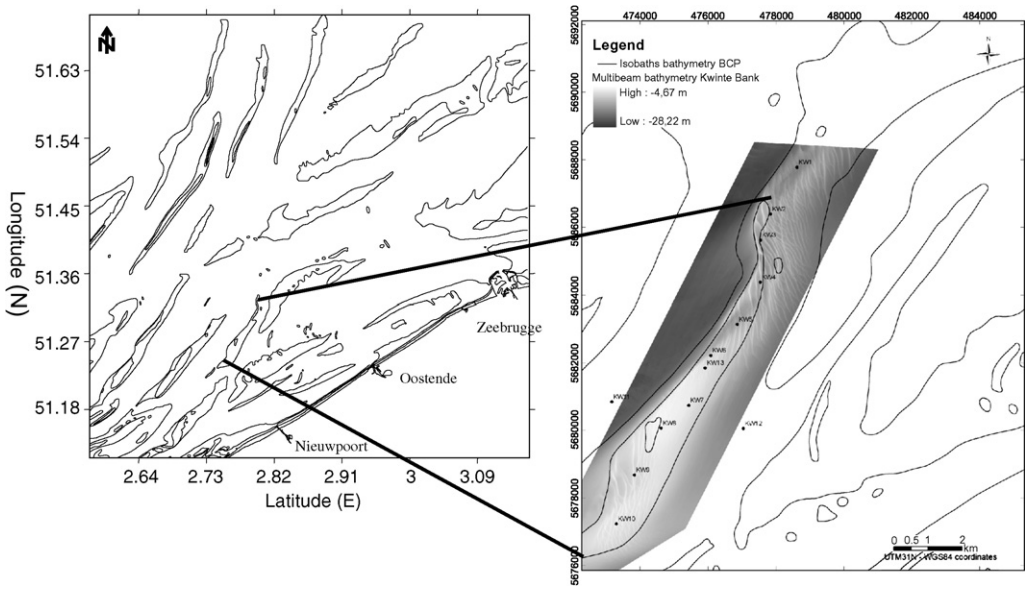

Fig. 1. Map of the Belgian continental shelf and detailed location of the sampling stations on the Kwintebank (Maps redrawn from UGent – RCMG and Federal public service economy, SMEs, Self employed and energy – Fund for sand extraction).

Extraction activities on the Kwintebank were concentrated both in the northern and central part of the Kwintebank (Degrendele et al., in press). Investigating the bathymetric and morphological evolution of the sandbank by single beam profiles, Degrendele et al. (in press) observed the formation of a depression in the central Kwintebank since 1992, which reached a depth of 5 m after 7 years. Later on, in the period 1999–2003, an additional deepening of about 0.5 m occurred.

In this paper, we aim to investigate the effects of long-term extraction activities on the Kwintebank on the nematode communities. Nematodes are accepted to be an ideal biological tool for detecting changes in the benthic environment (Kennedy and Jacoby, 1999).

However, no detailed studies on the response of nematodes in particular and meiobenthos in general to sand extraction are available. Only Bonne (2003), Vanaverbeke et al. (2002) and Vanaverbeke et al. (2003) provided evidence that meiobenthic life was negatively impacted. These studies were limited to a single sampling campaign in 1997 and showed that both harpacticoid communities and nematode communities have changed since the early extraction period in 1978. For both taxa, a decrease in vulnerable large organisms was observed as well. However, repeated sampling campaigns are needed to fully understand the effects of sand extraction on the benthos in order to avoid possible bias due to sampling an exceptional situation.

In this study, we analyse changes in nematode community characteristics (diversity and community composition) from the Kwintebank by analysing the available data on the period 1978–2001, spanning a period where extraction activities were ranging from low to very high. To our knowledge, this is the only study presenting very long-term data (23 years) with respect to the effect of sand extraction on marine benthic life. We investigate the hypotheses of no changes in diversity and community composition between periods with different extraction intensities.

2. Material and methods

2.1. Collection and treatment of samples

The analyses presented in this report are based on historical data from sampling campaigns conducted in June–September 1978 (Vincx, 1986), February 1997 (Vanaverbeke et al., 2002) and December 2001. The samples collected in 1978 are considered as samples from the period before the intense sand extraction activities, while the samples obtained in 1997 and 2001 reflect the situation during intense extraction activities. Detailed information about the location of the Kwintebank is given in Vanaverbeke et al. (2000, 2002).

Collection and treatment of meiobentic samples was identical during all sampling campaigns: 10 stations along the crest of the Kwintebank were sampled using a Reineck box corer (Fig. 1). From each box corer, sub-samples for meiofaunal and sediment analysis were obtained using a perspex core (10 cm^2). Meiobenthic samples were fixed with a hot (70 °C) neutral formaldehyde tap-water solution (final concentration: 4%). Metazoan meiobenthic organisms were extracted from the sediment by centrifugation with Ludox (Heip et al., 1985). Macrofauna was excluded by means of a 1 mm sieve and all animals retained on a 38 μm sieve were stained with Rose Bengal, counted and classified to the taxon level. A fixed amount of nematodes were picked at random, transferred to glycerin and mounted on slides for species identification using the pictorial keys of Platt and Warwick (1983, 1988), Warwick et al.