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NATURAL AND AGGREGATE EXTRACTION CONDITIONNED SANDY SHELF SEDIMENTDYNAMICS

Guy DE MOOR*

Changes of seafloor stability by deposition, by erosion or by change in the way of sediment transportation even without residual effects can have their impact on navigation routes, on waste disposal, on fish population and fisheries, etc. ...

Therefore the study of the present day morphodynamics and sedimentdynamics of the shelf sea bottom under extraction conditions but as well under natural conditions is of fundamental importance.

Such research is carried out on the sandbanks of Belgian Continental Platform by the Laboratory for Physical Geography of State University Gent (Prof. Dr. G. DE MOOR). Till 1983 the research area has been restricted to the Flemish Banks and to some of the Coastal Banks. Since 1984 the research covers the whole of the Belgian Continental Platform. Special attention has been paid to the Oost Dyck, the Buiten Ratel and especially to the Kwintebank which was continuously under important sand extraction stress and provided an excellent opportunity to study the sedimentation process reactions to such an extraction.

Morphodynamics form the study of the changes in form, position and volume of the seabottom relief features of different types and sizes due to various factors as well of natural (tidal streams, tides, waves, etc. ...) as of a man made origin.

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* Laboratorium voor Fysische Aardrijkskunde
Geologisch Instituut, Rijksuniversiteit Gent
Krijgslaan 281, B-9000 Gent, Belgium

Sedimentdynamics comprise the study of the volume, the intensity, the nature and the path of the sediment movements involved in these morphological changes, the analysis of the mechanisms by which they affect the stability of the bottom topography,and the definition of zones of ensuing residual erosion or deposition and of origin or destination of the different types of sediments and surficial sedimentary structures involved.

The topographic forms involved in these present day dynamics comprise small features such as transversal-ripple fields, longitudinal dunes and megaripples (unto 2 m relative height), sandwaves (with 5 to 10 m maximal height) and sandbanks extending over tens of kilometers as well as other features such as erosion pits, trough gullies,channels, etc. ... Shape and sizes are the result of the interaction of the characteristics of the sediments and of the hydrodynamics with their specific tidal character. Therefore repartition of these features as well as the granulometric cartography of the bottom surface itself allow already a first approach of the sediment movement and the bottom stability. Asymmetry, size and stretch, especially in the case of smaller and medium surficial structures, open a way to a better analysis of sedimentdynamics. The principal problem however is the detailled and accurate observation of the bottom features involved in the sediment transport, especially the surficial sedimentary structures moving with the bottom transport.

The definition of gains or losses and the monitoring of changes in shape, size and location of larger features can been worked out by volumetric and shape comparisons, based on accurate sequential bathymetric surveys. The study of morphodynamics and morphology of smaller features as a way to approach sedimentdynamics can hardly be carried out on such a way and demands of direct areal observations.

Due to local slackening or intensification of their movement, smaller features construct or destroy larger ones or condition their stability or their move.

These dynamics of features and sediments cover periods of different lengths : certain motion components are short term and directly observable (present day dynamics), others cover medium term periods (secular dynamics), others cover long periods and are only known by the interpretation of the internal sedimentary structures based on their comparison with similar present day active surficial sedimentary structures (geological dynamics).

Present day dynamics themselves consist of variations covering different time spans and occuring with varying speeds. In relation to larger feature stability residual effects over longer time spans are of main interest. In relation to fisheries short term sediment movements, and therefore the dynamics of the smaller features as well as the depth variations of the bottom, are the main concern.

Ecologically important is the fact that the sediment movement and the movement of the various types of moving structures (ripples, megaripples, sandwaves) affect sweepzones of different depth and wherein sediments are renewed within different periods above the sweep base. The faster the sediment and structure movements, the faster and more frequently sediments are renewed.

This is a kind of sediment instability which can easily correspond to a residual shape and volume stability and which is quite different from the direct impacts of sand extraction on sandbanks such as dredging furrouws and their infilling, residual lowering, shape variation or displacement of a sand-bank.

The renewal of such a sweepzone possibly occurs with or without residual volumetric changes of the feature. In the case of residual gains, sweepzone remainders are gradually

superposed in a sediment aggradation, which on slopes can be a progradation. In the case of residual losses the sweep base gradually cuts more and more deeply into the previously existing deposits, but at any cycle the sediment cover is renewed over a certain depth, and, if the sweep is by moving structures, especially outside the troughs of that surficial sedimentary structure.

Because of these different reasons study of the possible repercussions of sand extractions within a fisheries framework, not only has to mind residual changes in volume, shape and situation of larger features, but to mind the movements of surficial sedimentary structures as well - not only as a analysis technique of sediment movements -, and to take an eye on possible changes in depth, in renewal frequency and period and in residual effects of superficial sediment sweeping as well.

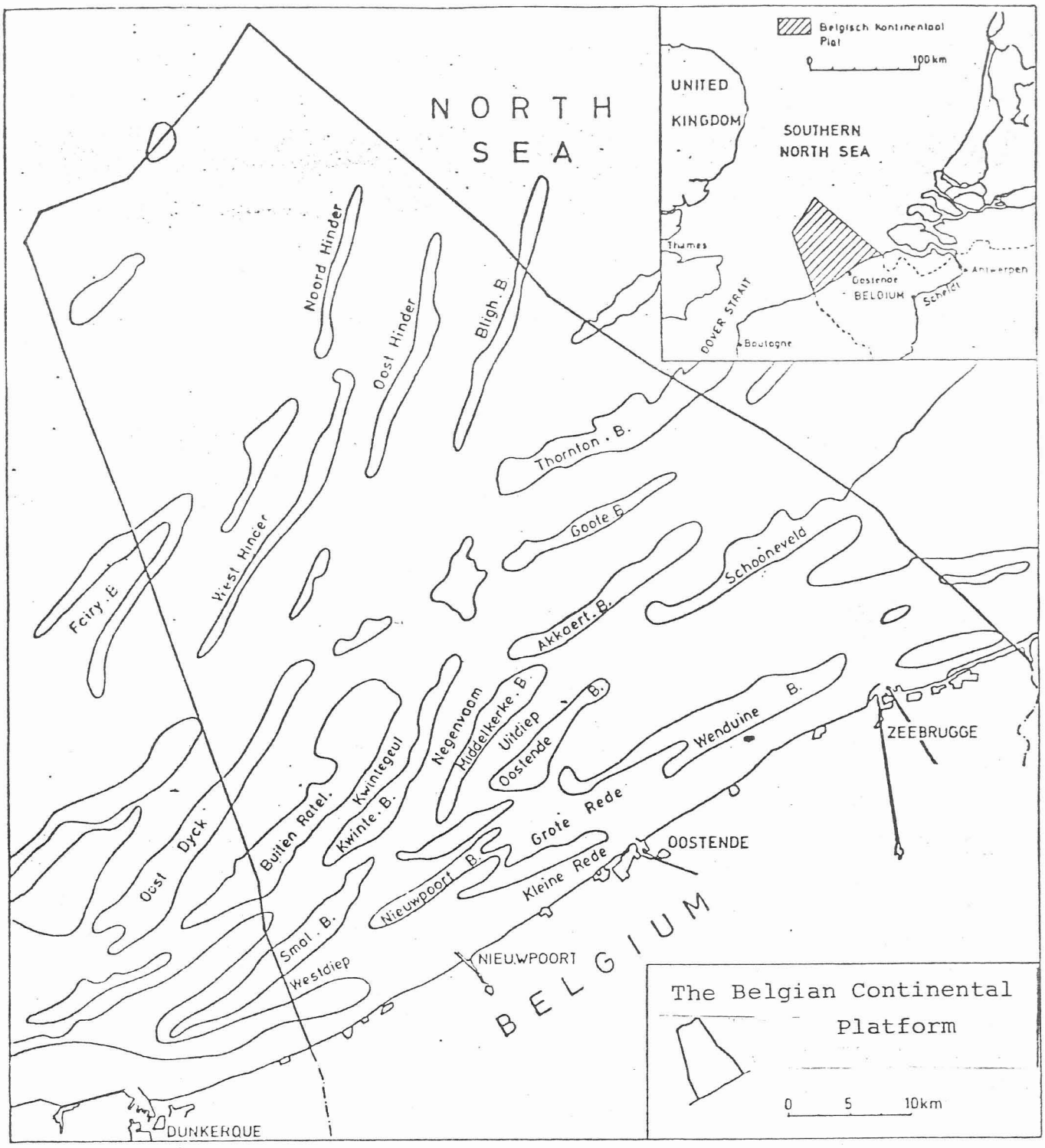
The Laboratory research uses especially accurate sequential reference track surveys with polyfrequential detailed echosounding, with side scan sonar registrations, with Subbottom profiling and sampling of the surficial sediments layers. Beside specific morphological and sedimentological interpretation great attention is paid to the problems of positioning, of navigation and of computerised data acquisition and data elaboration, especially concerning computer cartography and elaboration of comparable sequential bathymetric profiles.

Up to now greatest attention has been given to the repercussion of the sand extraction on the Kwintebank upon the bank stability, and to the global residual sand movements on the Belgian Continental Platform.

As to the Kwintebank the results show that despite a mean sand extraction of at least 500 000 m^3/year since 1978 no residual change affected the Kwintebank over the period 1981-1985. It has been possible to prove the existence of a

maintenance mechanism by which sand is piled up on top of the bank by upslope moving sedimentary structures due to deflection of residually seaward moving megaripples in the flood dominated Kwinte channel and to deflection of residually landward moving structures of finer sands in the eb dominated Negenvaam channel. Moreover due to a longer term mechanism today the steep western side of the bank is a residually erosion slope and not a progradation slope, while today the slighter eastern side presents residual aggradation.

The results of the 1984 and 1985 campaigns however suggest a slight deterioriation on the off shore edge of the Kwintebank, but the role of the high energetic environment and that of extraction is debatable and asks primarily for comparison with similar evolutions and positions. Moreover the daily mean normalised unit width volumetric changes above reference depth along reference tracks on sandbanks over the whole of the Belgian Continental Platform over the period May 1983 - September 1985, covering a span of 700-800 days suggest a very slight volume increase of most of the banks with the exception of a few partial areas, not directly related to extraction, while such residual changes over a shorter period of 390 days between Augustu 1984 and September 1985 distinctly indicate more generalised sand losses and a much higher mobility. Therefore more attention now will be given to the dynamics in the channels, to the natural sediment dynamics over different time spans as well as to the question of the natural and man conditioned sweep characteristics. The problem of a better adaption to factorial conditions needs greater flexibility in the matter of ship facilities.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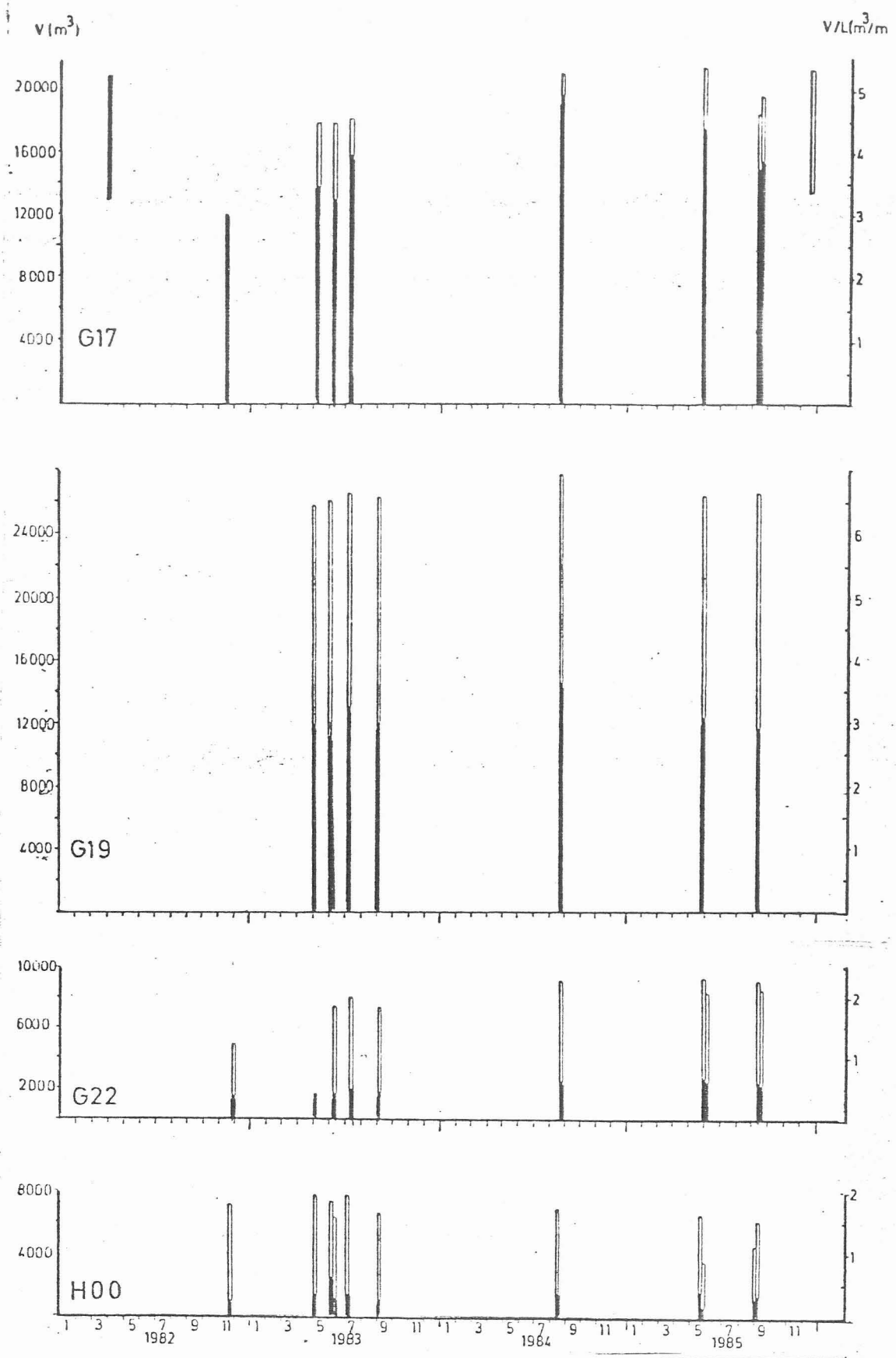

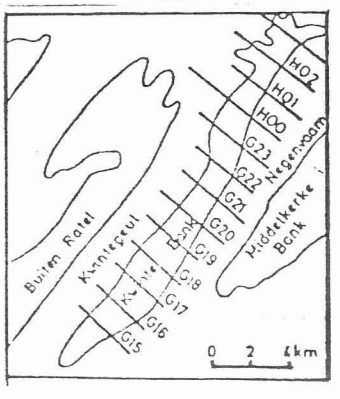

Fig.6 Evolution of the unit width bankvolume of the Kwintebank above level -15 m (MLLSL) along several reference transversals. (G. DE MOOR, 1986)