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Contribution of *in situ* production to the budget of dissolved inorganic nutrients (P, N and Si) in the eastern part of the Southern Bight of the North Sea.

by

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1. Introduction

This is a tentative contribution on in situ effects found as a result of nutrient budget studies performed during three cruises in September and October 1973 with R.V. Aurelia.

A group of chemists and biologists in our institute studied the mass balance of five trace elements, phosphorus, nitrogen, silicium, copper and zinc. The study was executed in the framework of the international JO(int) N(orth) S(ea) D(ata) A(cquisition) P(rogramme) Besides salinity, temperature and oxygen, dissolved inorganic and organic nutrients were analyzed; furthermore unfiltered water was analyzed to estimate the suspended fractions. Quantitative torpedo-plankton fishing was performed and a series of biological parameters measured. The combined results will in a later stage be used for a study of wider scope.

Salinity and temperature data are given in another paper to this committee (Visser & Wiggers, 1974). Some trace metal data are presented to the Fisheries Impr. Cttee (Duinker & Nolting, 1974).

2. The advective model

The Southern Bight is an open system with a mean flushing time of a few months determined by the input of English Channel Water through Dover Strait. In the eastern part the salinity regime is furthermore determined by the fresh water from Rhine -Meuse and Scheldt.

Advective Water Transport

The principles of conservation of watervolumes and of freshwater volumes were applied to a simple advective box model.
As boundarieswere chosen: Dover Strait, the axis of maximum salinity, the northernmost survey track and the Dutch-Belgian-French coast (15000 km^2, fig. 1). On the basis of salinity distributions and daily river discharge values, water transport values through the northern boundary(V_N) and the southern boundary(V_S) were computed for each period between successive surveys (Tijssen & Lindeboom, 1975). The results are summarized in the first Table.

Table 1.

Advective water transport in the eastern part of the Southern Bight (northerly transport has + sign)

	V_S ($10^9 m^3$)	V_R ($10^9 m^3$)
September 73	+76	2.33
October 73	− 4	3.02

Diffusive fresh water transport across the boundaries was estimated to be relatively unimportant.

3. Nutrient budget and in situ production.

The same model, again with neglection of diffusive effects across the boundaries was applied to nutrients. Input and output quantities are computed from equations like, $V_S . \bar{c}_S$, and $V_R . \bar{c}_R$ (the index R stand for river).

It became soon evident that for all three nutrient element the same trend appears: the output quantities subtracted from the input quantities were much smaller than the increased quantities found in the area at the end of both periods, which means that in situ production must be assumed. For phosphorus orthophosphate, total dissolved P and suspended P conc. were determined, for nitrogen nitrite, nitrate and ammonia were analyzed and for silicium reactive silicate and at a few stations, the amount of amorphous silica in suspended material. Some results are summed up in Table 2.

Table 2.

In situ production of P, N and Si in the eastern part of the Southern Bight, September and October 1973. (in 10^6 kg in the upper row and in 10^{-3} g.m^{-2} in the lower row).

	PO4-P	tot P	NO2-N	NO3-N	NH3-N	H4SiO4-SiO2
Sept.	+3.4	+4.6	+1.9	+8.7	+0.6	+31
	+220	+310	+130	+580	+ 40	+2100
Oct.	+0.4	+1.4	+0.4	+13.3	−11.3	+19
	+ 30	+ 90	+ 30	+890	−750	+1300

Orthophosphate distributions are given in figure 2a, b and c.
For the sake of comparison the riverinput values are given in Tabel 3

Tabel 3.

Freshwater nutrient input into the Southern Bight (Rotterdam Waterway, Haringvliet and Scheldt) in 10^6 kg.

	PO4-P	tot P	NO2-N	NO3-N	NH3-N	H4SiO4-SiO2
Sept.	1.1	1.5	0.9	6.6	4.7	6.6
Oct.	1.4	1.9	0.4	8.5	6.8	11.5

In Table 4 the atomic ratios are given.

Table 4.

Atomic ratios of produced dissolved inorganic nutrients.

	P :	N :	Si
September	1	7.3	4.7
October	1	13	24

Inspection of the concentration changes shows that production could be found all over the area, certain subareas however are particularly productive e.g. the southeastern part.

4. Conclusions

4.1. High in situ production of dissolved inorganic nutrients (P, N and Si) was proven. The quantities found in September were several times larger than the corresponding riverinputs.

4.2. For phosphate the source is undoubtly the bottom. In view of the quantities involved it seems probable that the same conclusion (partly?) holds for the nitrogen compounds and for reactive silicate. However, a direct proof cannot be given at the moment. The concentrations of total dissolved and particulate nitrogen are not yet available. Existing knowledge of the mineralogical composition of the suspended material and of the dissolution kinetics of the various silica -containing minerals in suspension is not sufficient to exclude a possible contribution from weathering of material in suspension.

4.3. In the period of declining in situ production (October) a considerable net nitrification rate was detected, (7.10^{-8} M. dag^{-1}N) which was absent in September.

5. References

DUINKER, J.C. & R.F. NOLTING. Trace metals in water and suspended matter in the Southern Bight (Copper, Zinc, Manganese and Iron). ICES C.M.1974/E : 26.

TIJSSEN, S.B. & H.J. LINDEBOOM, 1974. Estimates of advective water-transport in the eastern part of the Southern Bight of the North Sea. Neth. J. Sea Res. 8(3) in press.

VISSER, M.P. & E. WIGGERS. "Preliminary results of "JONSDAP 1973" surveys". ICES C.M.1974/C : 22.

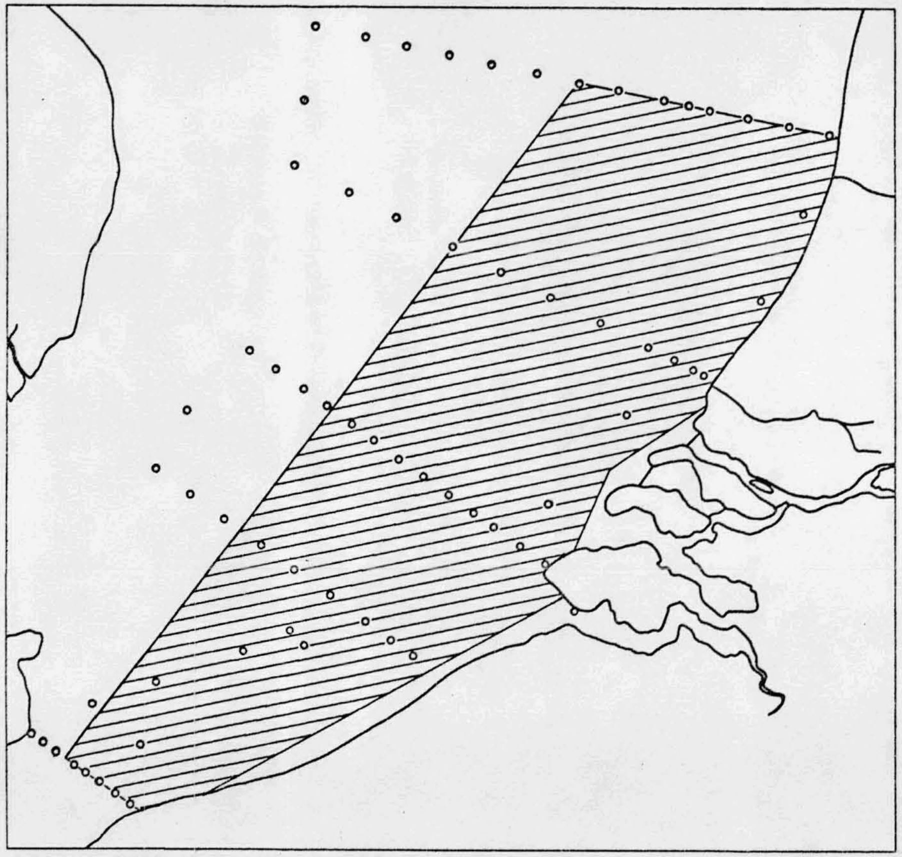

Figure 1.

R.V.Aurelia sampling grid for the JONSDAP-
cruises:1. 3-6 Sept.1973
2. 1-5 Oct. 1973
3. 29 Oct.-1 Nov.1973
Shaded: the area used in computing water- and nutrientbudgets.

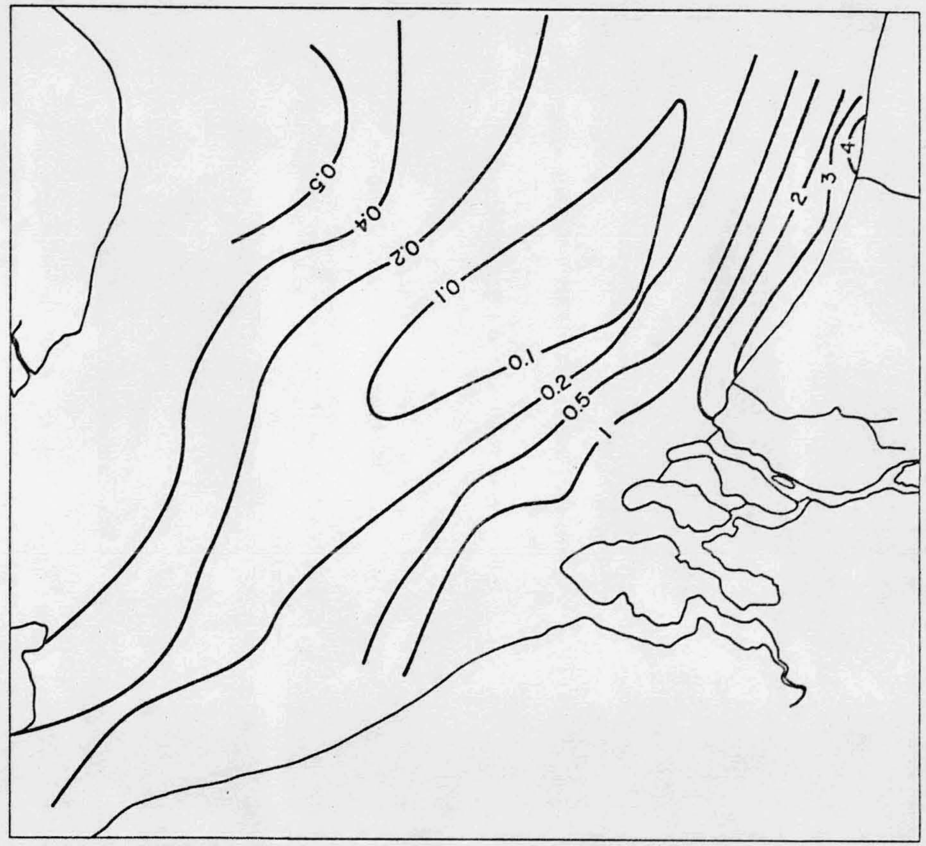

Figure 2a.

Sol. PO4-P, 10^{-6}M
Surface
3-6 Sept.1973

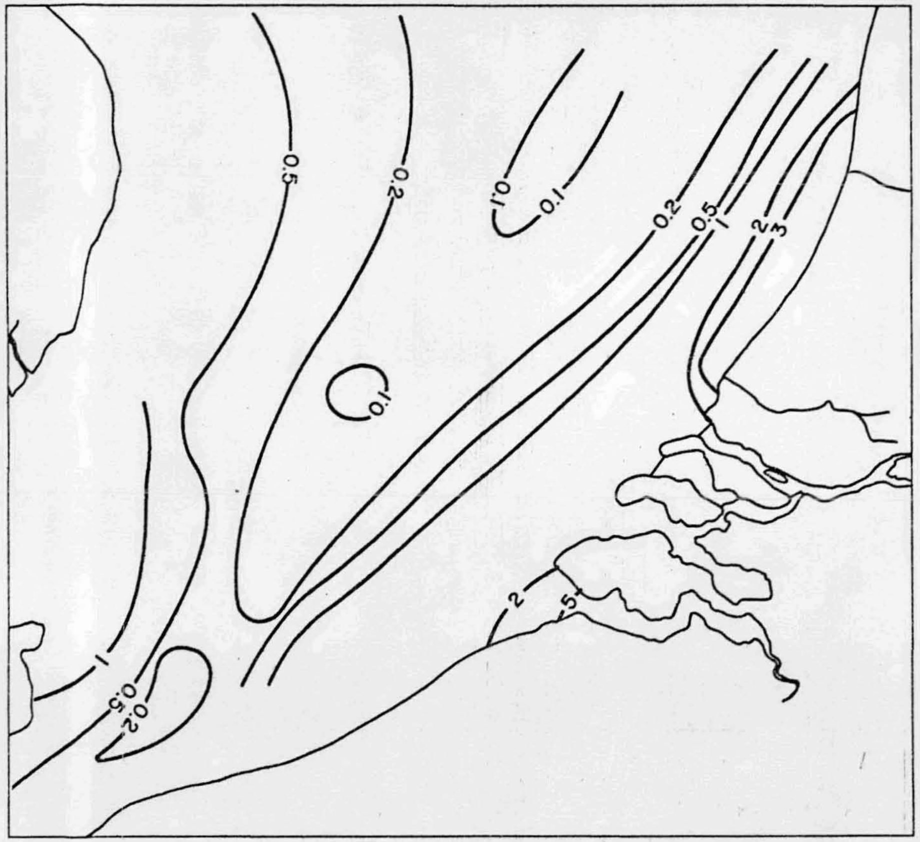

Figure 2b.

Sol. PO4-P, 10^{-6}M
Surface
1-5 Oct. 1973

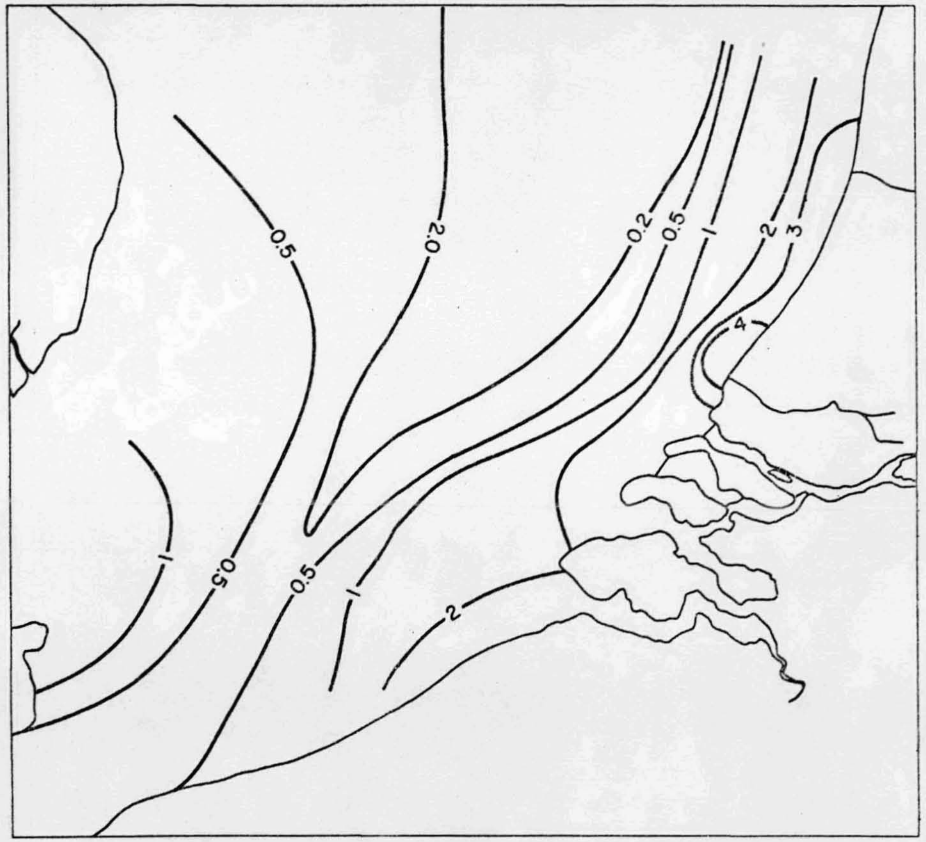

Figure 2c.

Sol. PO4-P, 10^{-6}M
Surface
29 Oct.-1 Nov.1973