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**BIOGENIC SUBSTANCES IN THE WATERS
OF THE GULF OF GDAŃSK IN THE IIIRD DECADE
OF JULY 1997, AFTER PASSAGE OF FLOOD WAVE**

Abstract

The paper discusses the distribution of salinity and of dissolved non-organic salts of nitrogen and phosphorus (nitrates, nitrites, ammonium, phosphates) in the surface waters of the Gulf of Gdańsk after the flood wave passed in the IIIrd decade of July 1997. It was found, by comparing with data obtained in the past years, that the summer flood wave did not cause large changes in the amounts of the investigated biogenic substances in the waters of the region.

1. Introduction

The July flood wave on the Vistula was caused by very high rainfall on the whole area of Poland between July 3 and 8 1997. The rise of water level started on July 5, and was extremely quick. Along the whole length of the Odra alarm water levels were exceeded, and in the Vistula basin the river started to rise very quickly on 8-th July, peaking in Kraków, Karsy and at Szczucino on July 10 [4].

The area affected by floods was located mainly along the tributaries and Odra and Vistula in the upper parts of these two rivers, and these are one of the most urbanised and industrialised areas of Poland. It is also the most polluted area. The largest in the whole Baltic Sea basin number of sources emitting the most dangerous to environment pollutants is located here. Excessive urbanisation together with high density of industry results in increased volumes of sewage, larger number of sewage treatment plants, numerous industrial and municipal waste dumping sites. In 26 voivodships dumping sites, industrial storage areas, sewage treatment plants and septic tanks etc. of about 1200 towns and villages were flooded. From the flooded sewage treatment

plants about 400,000 m³ per day of sewage flowed freely into the Vistula. With seepage from municipal dumping sites, pathogenic bacteria, large amounts of chlorides, sulphates, magnesium, sodium, potassium, nitrogen, phosphorus and trace metals got into the rivers.

In the period July 20 - August 10, two peaks of the flood wave, reaching the alarm level, were observed along the outlet part of the Vistula (water-level gauge Tczew) [3]. The river carried extremely large, many times higher than the multi-annual average, amounts of mineral suspensions. Water flow was about 5 times larger than in 1996 and resulted in a rather small decrease of oxygenation and a slightly larger dilution of mineral components. The several times higher water flow (Fig. 1) caused a similar or even higher flow of inorganic compounds of nitrogen and phosphorus.

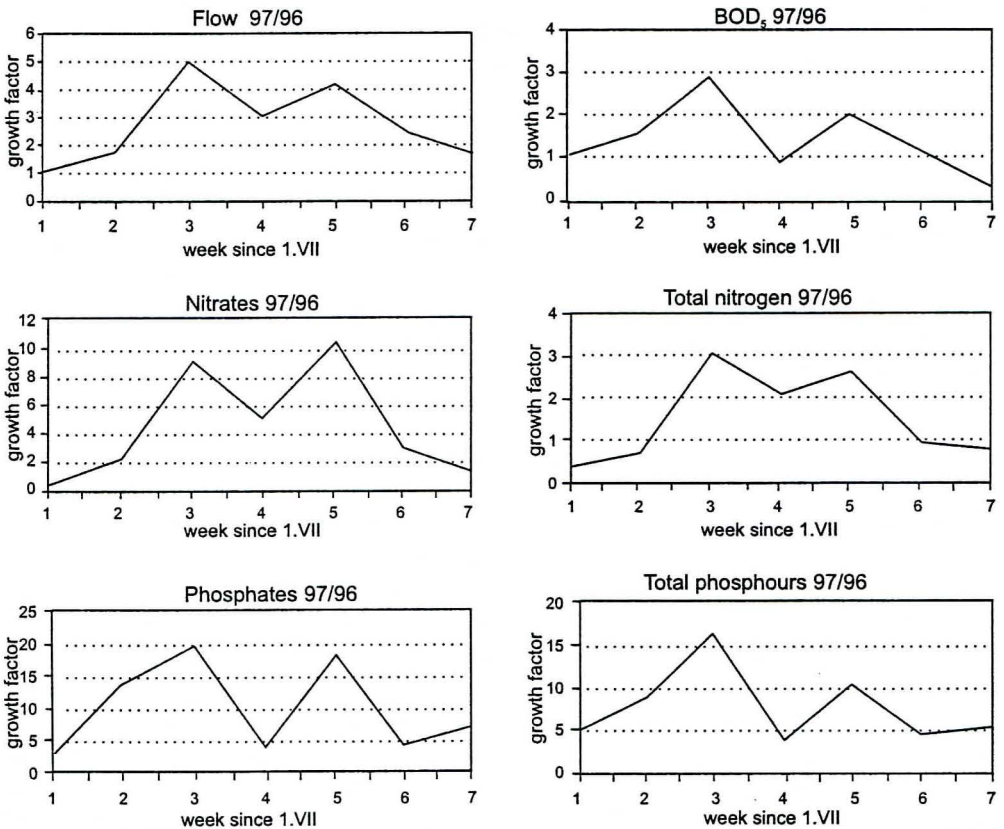


Fig.1. Increase of pollutant discharge from the Vistula during the summer flood wave in 1997 in comparison with 1996 [3]

2. Results of investigations

The inflow of river water into the Gulf of Gdańsk was quite distinct, but on the other hand it was not as extensive as it was expected in the beginning. On July 29, 1997 from the deck of r/v Dr. Lubecki 80 water samples were taken to test the content of biogenic substances, also the temperature and salinity of water were measured. Laboratory tests were carried out at the Department of Environmental Protection of the Maritime Institute.

The surface distributions of temperature (Fig. 2) and salinity (Fig. 3) are similar. At the Vistula outlet close to Świbno salinity was below 1 PSU, and from there gradually increased to the north and north-east. Comparing these data with earlier salinity data no significant change is found. This means that in principle, the flood wave had no influence on the salinity of the Gulf of Gdańsk waters.

According to the data of the Institute of Meteorology and Water Management [4], concentration of nitrates during the first period when the flood wave reached the Gulf reached $140 \mu\text{mol}/\text{dm}^3$. Our data show that by the end of July the Vistula waters became diluted, and nitrate concentration reached only $90 \mu\text{mol}/\text{dm}^3$ (Fig. 4). Significantly increased concentrations of nitrates appeared only along the Vistula Spit. Concentrations of investigated components decreased with distance from coast, finally reaching values similar to the ones obtained in former years, when in about the same period concentration did not exceed several $\mu\text{mol}/\text{dm}^3$ [1, 2]. Investigations of Falkowska et. al. [1] show that in the period 1981-1991 concentration of nitrates in the coastal zone (down to the 20 depth contour), in the warm season, ranged from 0.63 to nearly $97 \mu\text{mol}/\text{dm}^3$. It results that nitrate concentrations after the flood wave reached the Gulf of Gdańsk were similar to the maximum concentrations observed in the 80ties.

With respect to nitrites, during the flood wave flow into the Gulf at the end of July 1997 (July 29th), increased content of this inorganic form of nitrogen was observed only in the Dead Vistula (Fig. 5) and Vistula Cut areas.

In the years 1981-1991 [1], concentration of ammonia in the coastal zone to 20 m depth, in the warm season, ranged from 0.22 to $49.12 \mu\text{mol}/\text{dm}^3$ (at mean concentration $4.16 \mu\text{mol}/\text{dm}^3$), and in the open waters - in the layer 0-40 m - from 0.05 to $11.75 \mu\text{mol}/\text{dm}^3$. Therefore, ammonia concentrations measured in the surface waters of the Gulf of Gdańsk after the passage of the flood wave (Fig. 6) are similar to the earlier values. Maximum ammonia concentration was recorded along the central part of the Vistula Spit ($41.7 \mu\text{mol}/\text{dm}^3$).

In the warm season in earlier years [1], maximum concentrations of phosphates were noted at the outlet of the Vistula. They reached nearly $28 \mu\text{mol}/\text{dm}^3$. In the open waters of the Gulf concentration was significantly lower. After the passage of the flood wave no drastic increase of inorganic phosphorus salts in water was observed (Fig. 7). Surface waters in the zone below 20 m depth contained phosphates in similar amounts as during the multi-annual period.

As the flood wave entered the Gulf, waters of the Vistula were propagated along the coast. During that time much of the material accumulated on the beach, increasing pollution of that zone. Such distribution of biogenic substances in the coastal zone

was caused by the meteorological and dynamic situation prevailing over the Gulf just before and during the time when the flood wave entered the Gulf of Gdańsk. It should be added that the wind situation, which resulted in such as observed distribution of the investigated substances (wind blowing from the western sector), is the most often occurring situation in the discussed region.

3. Summary

It must be stated that the summer flood wave on the Vistula did not result in significant changes in the amount of inorganic compounds of nitrogen and phosphorus dissolved in the Gulf of Gdańsk. Increased concentrations of the investigated chemical substances were observed in the Dead Vistula and Vistula Cut and along the Vistula Spit. Maximum concentration of biogenic substances was about the same as the maximum values obtained in former years in the vegetation period. On the other hand, it is difficult to determine whether these increased amounts of salts have been included into the food chain, and in effect into the whole circulation of the ecosystem of the Gulf of Gdańsk.

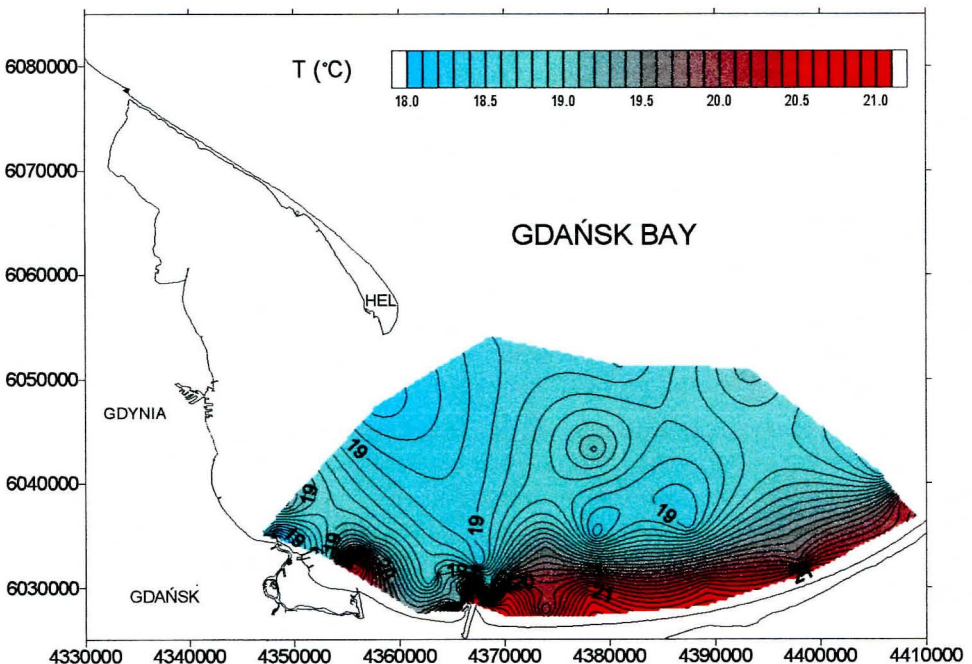


Fig.2. Temperature ($^{\circ}\text{C}$) of surface waters of the Gulf of Gdańsk on July 29th 1997

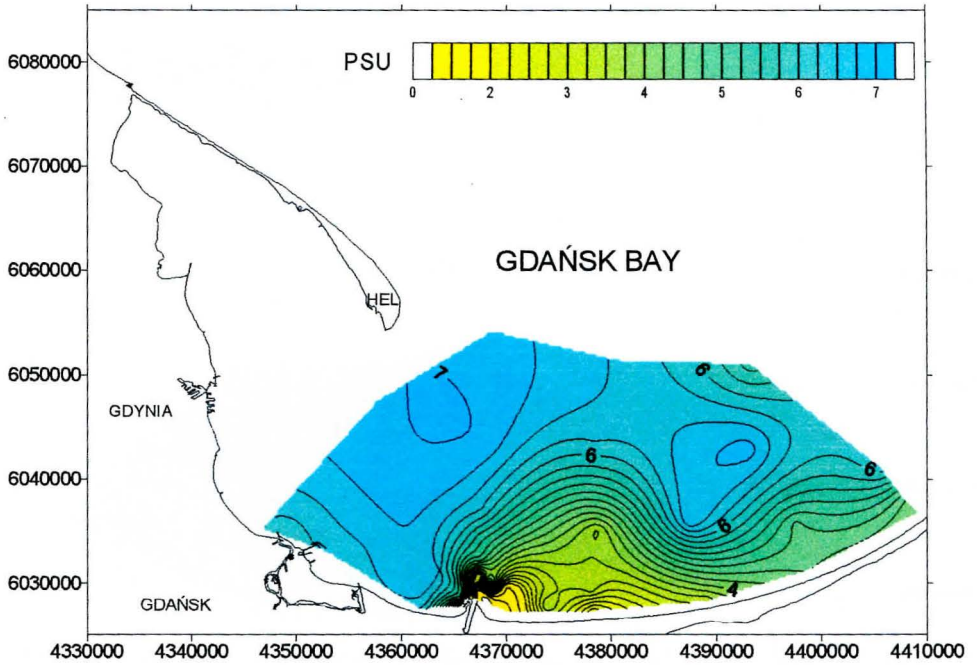


Fig.3. Salinity (PSU) of surface waters of the Gulf of Gdańsk on July 29th 1997

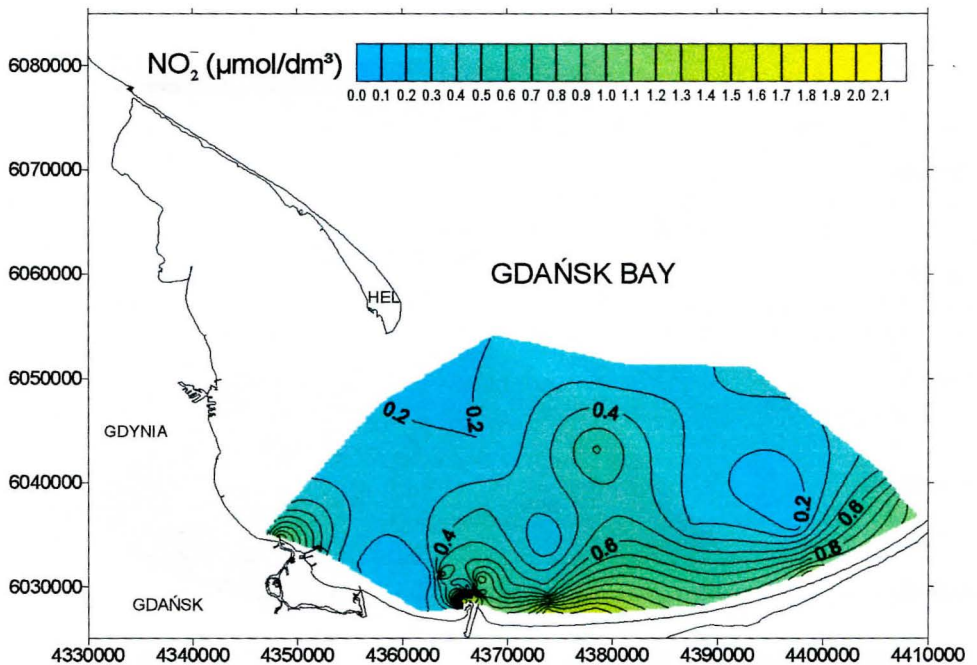


Fig.4. Nitrates ($\mu\text{mol}/\text{dm}^3$) in the surface waters of the Gulf of Gdańsk on July 29th 1997

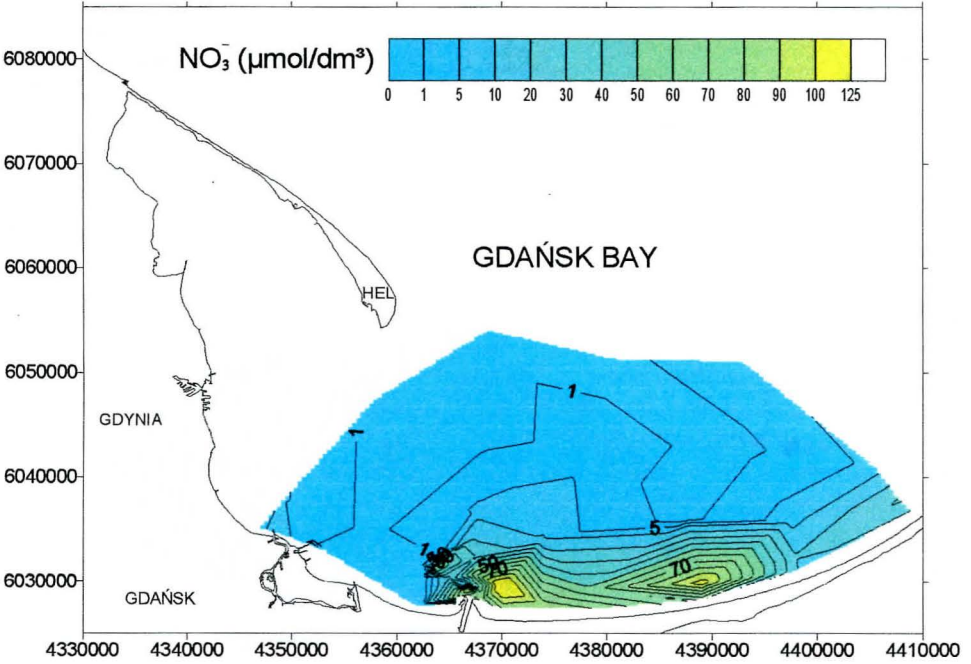


Fig.5. Nitrates ($\mu\text{mol/dm}^3$) in the surface waters of the Gulf of Gdańsk on July 29th 1997

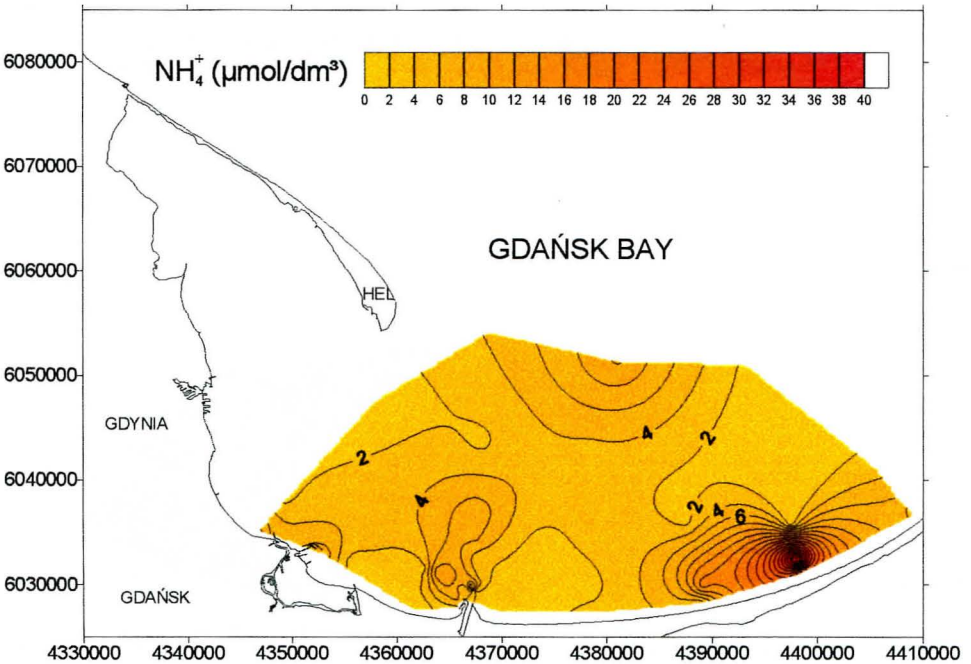


Fig. 6. Ammonia ($\mu\text{mol/dm}^3$) in the surface waters of the Gulf of Gdańsk on July 29th 1997

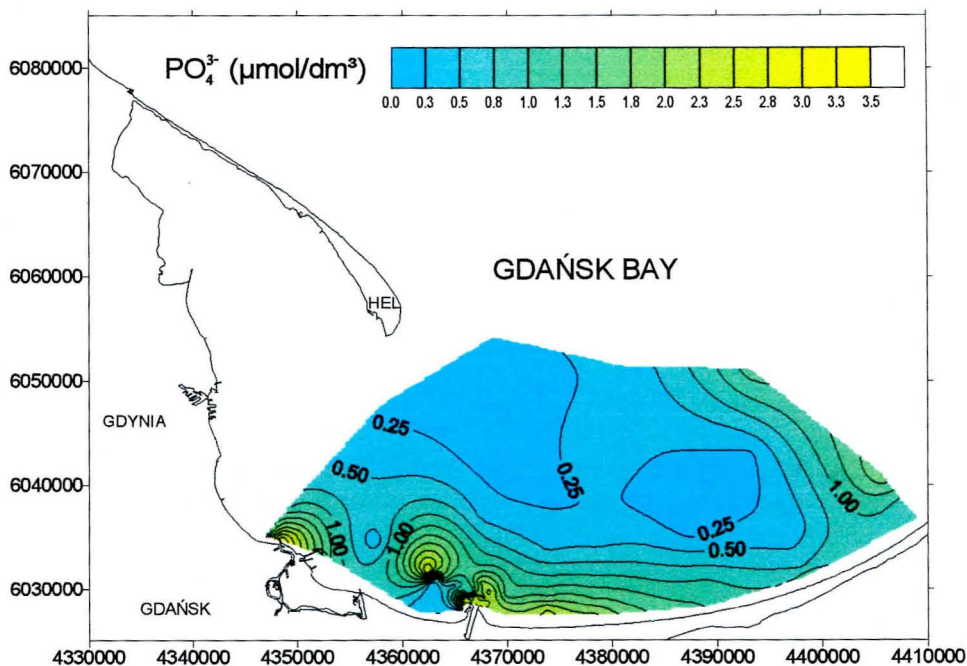


Fig.7. Phosphates ($\mu\text{mol}/\text{dm}^3$) in the surface waters of the Gulf of Gdańsk on July 29th 1997

References

- [1] Falkowska L., Bolałek J., Nowacki J., 1993, *Nutrients and oxygen in the Gulf of Gdańsk*. Stud. i Mater. Oceanolog. 64.
- [2] Łysiak-Pastuszek E., 1995, *Compounds of nitrogen* [in:] *Environmental conditions in the Polish zone of the Southern Baltic*, IMGW, Materiały Oddziału Morskiego, Gdynia. (In Polish).
- [3] Niemirycz E., 1997, *Participation of Poland in the discharge of pollutants into the Baltic Sea* [in:] *Evaluation of pollutant discharge into the Baltic Sea*. Mat. Symp., Gdańsk. (In Polish).
- [4] Swerpel S., 1997, *The flood "E-bomb"*, Wiedza i Życie, Warszawa. (In Polish).