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Water transparency in the Polish zone of the Baltic Sea

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Anna Trzosińska
Institute of Meteorology
and Water Management,
Maritime Branch,
Gdynia

Abstract

Statistical analysis of water transparency measurements using the Secchi disc indicated a significant decrease in transparency in 1957–1990. The intensity of this negative trend varied according to region, season and period. The general decrease in water transparency expressed by modals ranged from about 3 m in the Gulf of Gdańsk and open sea water of the southern Baltic to over 3.5 m in the Pomeranian Bay and shallow coastal areas of the central Polish coast.

In the Gdańsk Deep the mean coefficient of the negative trend in water transparency was very high (-0.08 m y^{-1}) and statistically significant in the vegetation seasons of 1957–1990, thus indicating a close relation with the eutrophication of the entire Baltic Sea.

1. Materials and methods

Over 2400 Secchi disc readings taken by the Institute of Meteorology and Water Management in the southern Baltic during 1957–1990 were analysed in order to evaluate spatial and temporal fluctuations of water transparency.

Year round data were taken into account when constructing histograms, in both 1 m wide classes (Figs. 1 and 3) and 2 m wide classes (Figs. 2 and 4). For the calculations of long-term trends, Secchi depths measured in the Gdańsk Deep (station P1 = BMP L1) were divided into two sets :

- data collected during the warm seasons (April – September) of 1957–1990 (n = 224),
- data collected during the cold seasons (October – March) of 1957–1990 (n = 70).

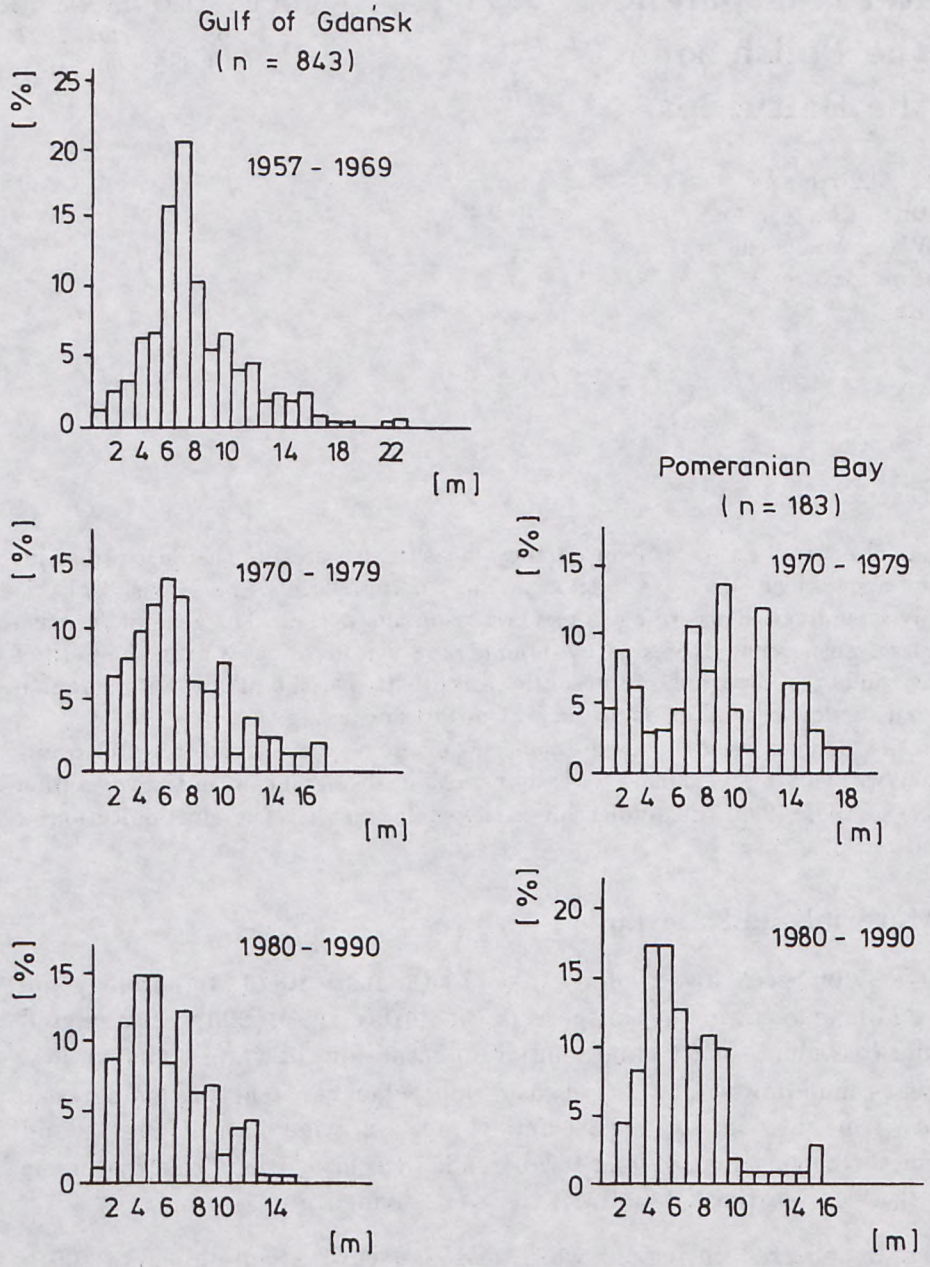

Fig. 1. Frequency distribution of Secchi depths in the Gulf of Gdańsk and the Pomeranian Bay, calculated for different periods of 1957–1990 in 1 m wide classes

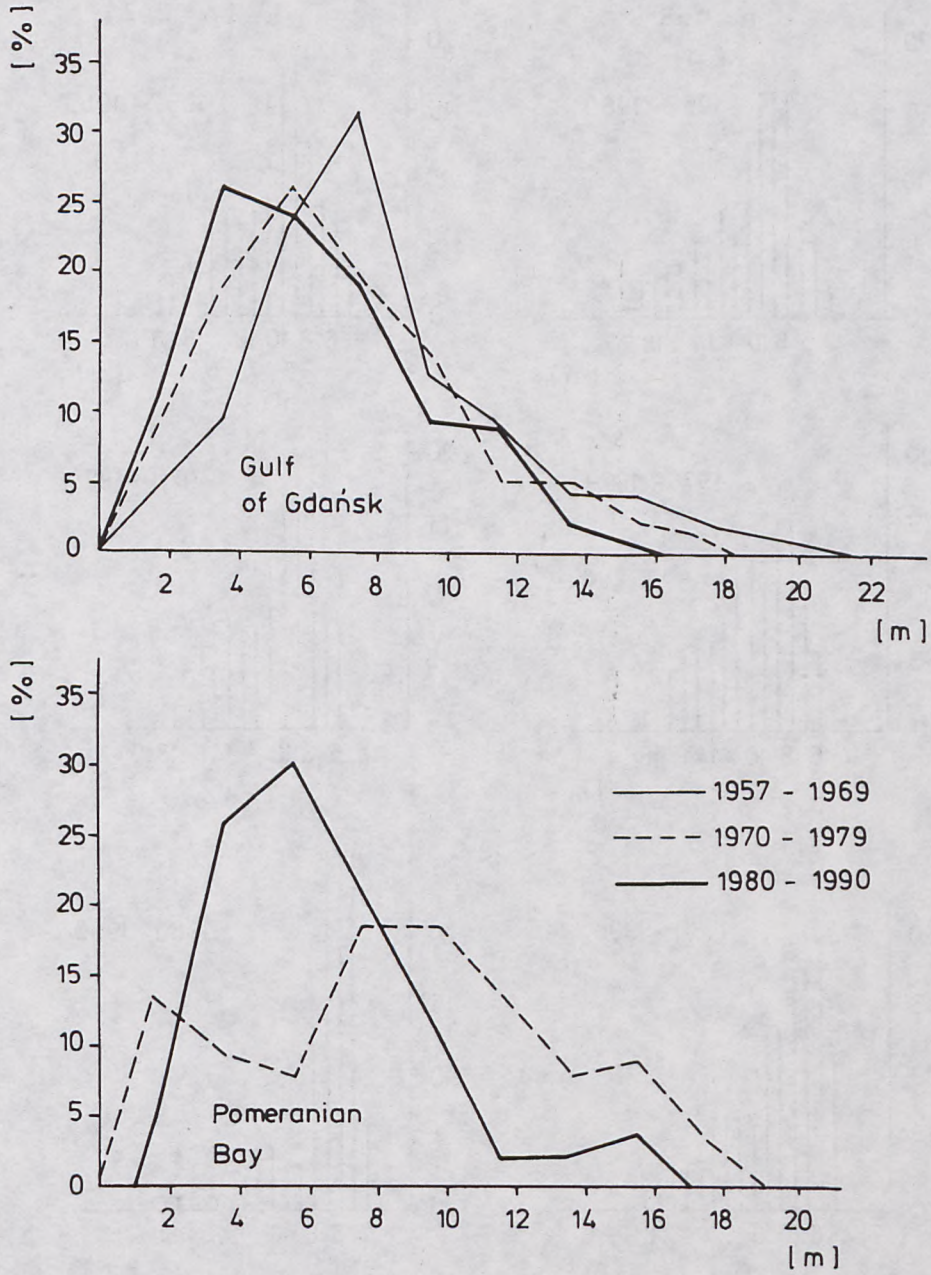

Fig. 2. Frequency distribution of Secchi depths in the Gulf of Gdańsk and the Pomeranian Bay, calculated for different periods of 1957–1990 in 2 m wide classes

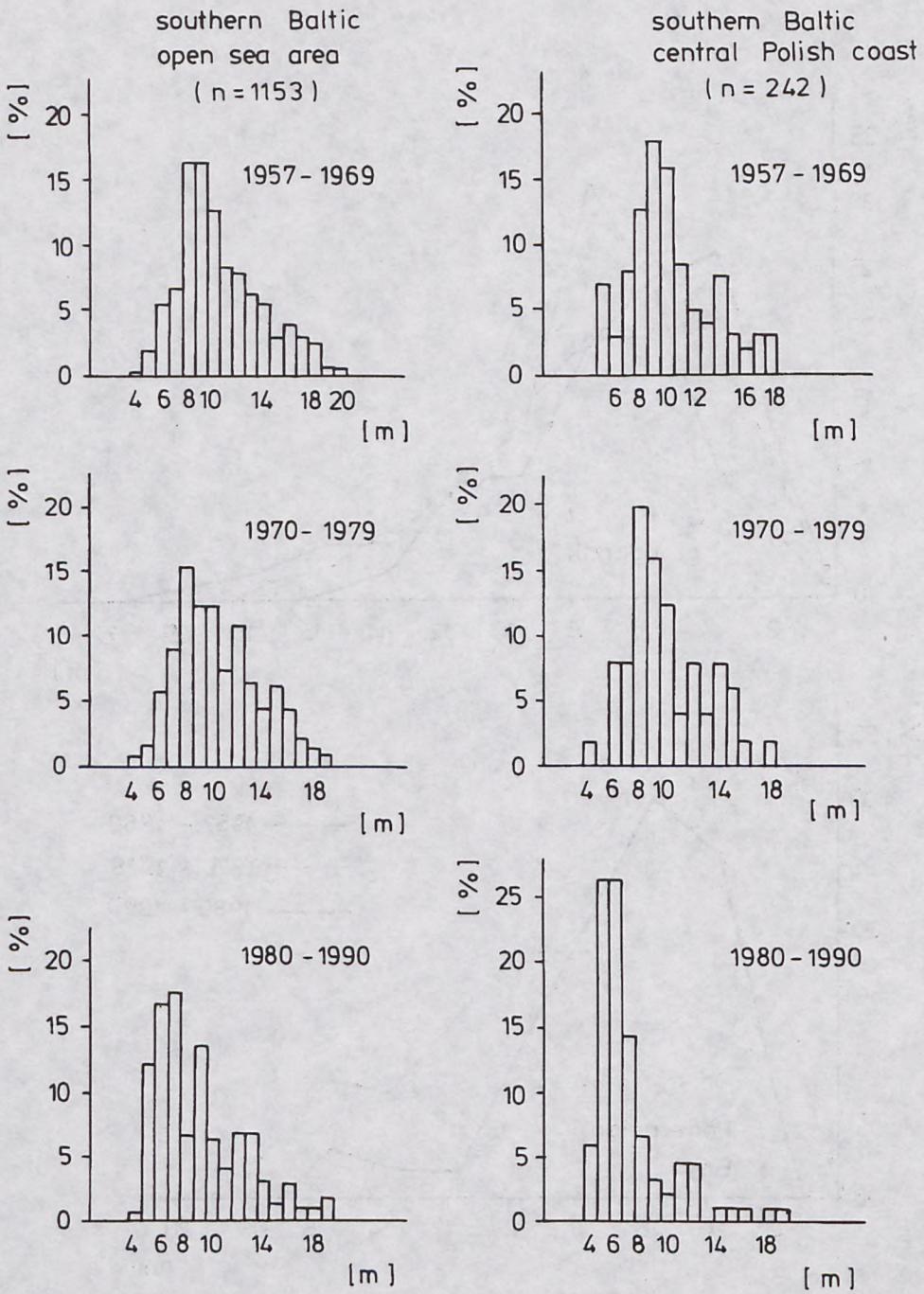

Fig. 3. Frequency distribution of Secchi depths in the southern Baltic, calculated for different periods of 1957–1990 in 1 m wide classes

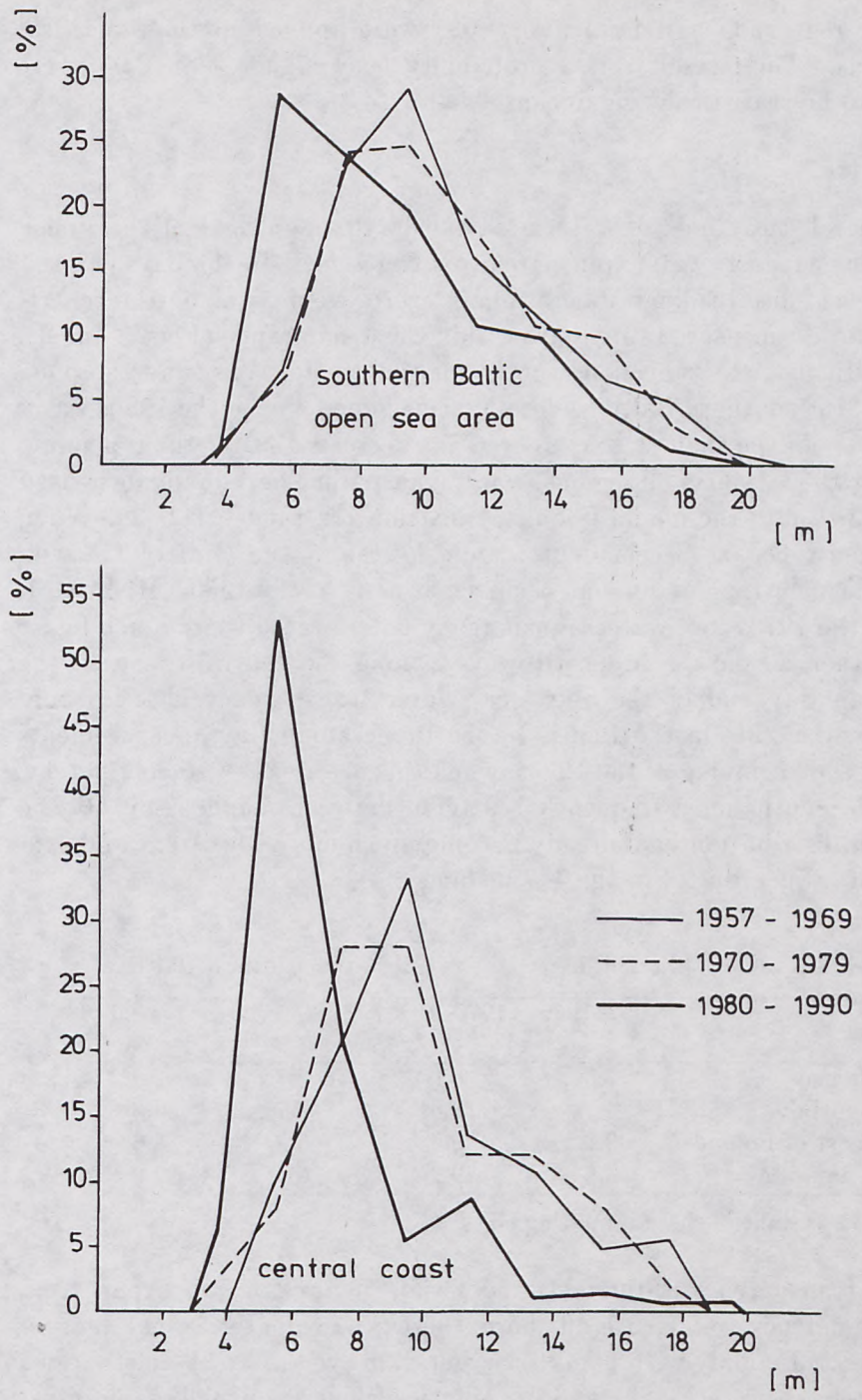

Fig. 4. Frequency distribution of Secchi depths in the southern Baltic, calculated for different periods of 1957–1990 in 2 m wide classes

Linear regression and Student's t–test were applied in the statistical calculations. Their results, at a probability level higher than 0.95, were assumed to be statistically significant.

2. Results

In general, two kinds of water area can be distinguished in the Polish coastal zone as far as water transparency is concerned. In the bays (Figs. 1 and 2), Secchi disc readings start at almost zero, whereas along the central coast the lowest measured values are within the 4–5 m range (Figs. 3 and 4). Until the 1980s histograms constructed for the central coast and the open sea area of the southern Baltic were similarly shaped. Since the 1980s water transparency in the shallow coastal area has decreased faster than offshore.

During 1957–1990 in all regions, water transparency gradually decreased by about 3–4 m in the modal frequency distribution range (Tab. 1). When measurements began, Secchi depths were lowest in the Gulf of Gdańsk, where signs of eutrophication had occurred as early as the 1950s (HELCOM, 1987). In the 1970s too, water transparency deteriorated there much faster than in other regions (Tab. 1). However, along the central coast, in the Pomeranian Bay and in the open sea, water transparency changes only started to accelerate in the 1980s. In the Pomeranian Bay, measurements started at the beginning of the 1970s, when this area was extremely patchy, with Secchi depths most frequently scattered between 7 and 12 m. By the 1980s their distribution had already become much more consistent and over 50% of data was grouped in the 4–7 m range.

Table 1. Modal values of Secchi disc readings [m] in the southern Baltic

Region	1957–1969	1970–1979	1980–1990	Overall decrease
Gulf of Gdańsk	7.6	6.0	4.7	2.9
Pomeranian Bay		(8.5)	5.7	3.3
Central coast of Poland	9.8	9.0	6.2	3.6
Open sea area	9.6	9.2	6.7	2.9

In brackets – variant of the dominating class.

Water transparency is differentiated within each region too. Apart from a general tendency to increase off shore, there are evident seasonal fluctuations connected mainly with plankton vegetation cycles. All the histograms are positively skewed (Figs. 1 and 3). Winter values are usually concentrated at the right hand side of the scale, but this does not apply to the water areas in the vicinity of the river mouths. However, it should be mentioned that the best water transparency has occasionally been recorded in May;

this may well have been a 'scavenger' effect of phytoplankton sinking after its vernal bloom. Maximum Secchi depths also decreased considerably during 1957–1990, down to 15–16 m in the bays and 15 m in the open sea and along the central coast.

Table 2. Long-term trends of water transparency in the Gdańsk Deep (station BMP L1) 1957–1990

Period	Mean trend coefficient [m y^{-1}]	Correlation coefficient	Significant level	Overall trend [m]
1957–1990	- 0.074	-0.31	0.92	2.5
October–March	- 0.033	-0.15	<0.90	1.1
April–September	- 0.082	-0.41	0.98	2.8

In the Gdańsk Deep the negative trends in water transparency were found in all seasons, but only for the warm (productive) months was the trend statistically significant (Tab. 2). The average Secchi depth of about 9 m at the end of the l950s has decreased to less than 6 m at the beginning of the 1990s. The results correspond well with the frequency distribution of water transparency in the Gulf of Gdańsk (Figs. 1 and 2), for which station BMP L1 in the Gdańsk Deep represents its northern part, the most distant from the coast.

3. Conclusions

In the Polish coastal area of the Baltic Sea, water transparency is closely related to its trophic level. In the Gdańsk Deep the negative trend in Secchi disc readings, approximately -0.08 m per year, was statistically significant only for the productive months of 1957–1990.

References

HELCOM, 1987, *First periodic assessment of the state of the marine environment of the Baltic Sea area, 1980–1985,* Background Document. Baltic Sea Environment Proceedings, 17 B, 57–61.