LONG TERM CHANGES OF TRANSPARENCY IN THE CENTRAL ADRIATIC

Mira MOROVIĆ
Institute of Oceanography and Fisheries, Split

ABSTRACT

Long term variations of transparency are compared with phytoplankton and rainfall in the heavily polluted coastal region as well as in an offshore region in the Central Adriatic. Long term changes are similar at both stations and both show a trend of decreasing of Secchi disc depths. Transparency in the coastal region is more dependent on phytoplankton than in the offshore region.

RESUME

On a pris en considération les fluctuation à long-terme de transparence et celles du phytoplancton et des précipitations dans les eaux côtières ainsi qu'en haute mer (Adriatique Centrale). Sur tout les deux stations on a pui observer des fluctuations analogues de ces paramèters ainsi qu'une tendence générale en sens de diminution de la transparence. On a constaté un rapport plus régulier entre la densité du phytoplancton et la transparence dans les eaux côtières qu'en plèine mer.

Secchi disc measurements allow some conclusions about transparency dependence on biological and/or climatological data. Transparency in Kaštela Bay and Stončica (Fig.1) show similar long term variations (Fig.2) having common planetary ground (biological or climatological).

Trends in transparency from 1961 to 81 are expressed by these regression lines:

(1) $H = 10.87 - 0.14 \cdot X$ ..... Kaštela Bay
(2) $H = 25.86 - 0.17 \cdot X$ ..... Stončica
(H is Secchi disc depth, X is year, 1971 is denoted as zero year)

The greater decrease in transparency at the offshore station cannot be explained by pollution. The situation is different if the increase in extinction coefficients is examined.

Denoting $\alpha+k=c$ and assuming $\ln Co/C_H=\text{const}$ in relation $H=(1/\alpha+k).\ln Co/C_H$ we have that $H=\text{const}/c$. For small changes of Secchi depths Δc represents the change in extinction coefficinet:

(3) $\Delta c = \text{const.}\ \Delta(\frac{1}{H})$

The trend, beginning with 1961, shows an increase in extinction coefficient of $0.002 \cdot \text{const}$ for Kaštela Bay, while for Stončica it is $0.0005 \cdot \text{const}$. The comparison of increase in extinction coefficients rather than regression lines is more descriptive of the decreased transparency in the coastal zone than in offshore waters.

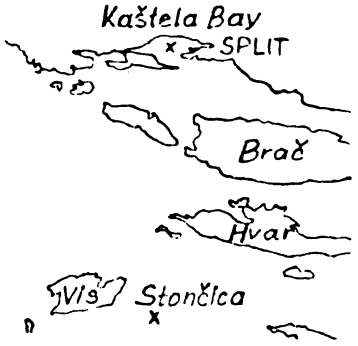

Fig.1. Station map

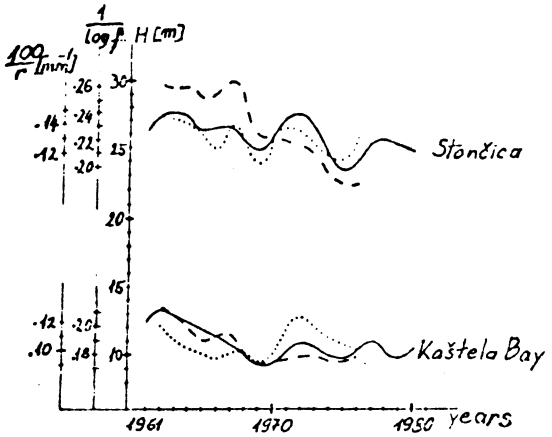

Fig.2. Long term changes of transparency, phytoplankton and rainfall
H - annual average Secchi depth (————)
f - annual average phytoplankton (-------)
r - annual total rainfall (.....)

In Kaštela Bay Secchi depths are better correlated with phytoplankton r=-0.80 than at Stončica r=-0.46 as at Stončica phytoplankton is much less abundant. Annual averages of transparency are correlated with annual total rainfall, the correlation coefficient is r=-0.47, while for Stončica it is r=-0.53. Although a greater influence of rainfall on transparency in the shallower might be expected the failure to consider other fresh water sources, results in a lower correlation. On the other hand annual total rainfall and annual average phytoplankton are not correlated well. Multiple correlation from 1961 to 77 between Secchi disc depths with phytoplankton and rainfall is expressed with regressions and muitiple correlation coefficients:

(4) $H = 15.31 - 0.04 \cdot f - 0.29 \cdot r$ $\quad R_{H \cdot fr} = 0.84$ Kaštela Bay
(5) $H = 32.20 - 0.12 \cdot f - 0.72 \cdot r$ $\quad R_{H.fr} = 0.73$ Stončica

(H is annual average Secchi depth in meters, f is number of phytoplankton per liter times 10^{-4}, r is annual total rainfall in milimeters times 10^{-2}).

Relationship (4) show that an increase in phytoplankton of about 250 000 causes a decrease of transparency of one meter at the Bay while for Stončica (5) shows that same decrease of transparency is caused by 83 000 phytoplankton, while rainfall is constant. If phytoplankton is constant transparency is decreased by one meter if rainfall is increased by 340 mm in the Bay, while at Stončica only 140 mm of rainfall is necessary. Transparency in the coastal sea is more sensitive to changes in phytoplankton density than the offshore sea but the opposite is true for rainfall as it follows from β coefficients ($\beta_{hf \cdot r}=0.72$, $\beta_{Hr \cdot f}=0.27$ for the Bay; $\beta_{Hf.r}=0.49$, $\beta_{Hr.f}=0.56$ for Stončica).

Multiple correlation coefficients show smaller dispersion around regression line for the coastal region. Reason for greater dispersion in offshore region is that this station is under the influence of the open Adriatic and sometimes under the influence of coastal sea. Also inflow of Mediteranean waters, richer in nutrient salts, can increase production and reduce transparency. There are indications that transparency decreased in ingressional years (1968, 1969, 1975, 1976).