THE STATISTICAL INTERPRETATION OF PHOSPHORUS LEVELS IN A MARINE EUTROPHIC ENVIRONMENT : A CASE EXAMPLE.

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Abstract

A set of $P\text{-}PO_4$ data (120 samples) collected during the period 1977-81 from a sewage outfall area was subjected to a frequency distribution analysis. It was shown that the Normal Distribution analysis can be used to calculate the probability of $P\text{-}PO_4$ concentrations to exceed any given level.

This procedure can be used to clarify interpretations regarding levels of nutrients and to assist authorities with respect to management of waste discharges.

Introduction

Areas which are affected by domestic sewage discharge are normaly surveyed at frequent time intervals for evaluation of the nutrient levels (phosphorus, nitrogen). The recorded data of such regular measurements are usually non-statistically analysed and therefore the only information that can readily provide is the range (maximum and minimum values) and the average of the concentration of the nutrient in question.

In the example used here a set of $P\text{-}PO_4$ data collected during the period 1977-1981 from a sewage outfall area have been analysed statistically (normal distribution analysis) in order to obtain a better understanding of what may be considered as "typical" phosphorus quantity of an area.

Materials and Methods

The $P\text{-}PO_4$ data (120 samples) were collected monthly from the Saronicos Gulf, Aegean Sea, near the sewage outfall area.

A frequency distribution analysis was applied to the above data (MORONEY, 1964; SOKAL and ROHLF, 1969). The values of $P\text{-}PO_4$ (µg/l) concentration were transformed logarithmically (base e) and they were arranged in ascending order with frequency of observation. The logarithmically transformed values remained in this state throught any statistical manipulation and they were taken out of transformation at the end of all calculations.

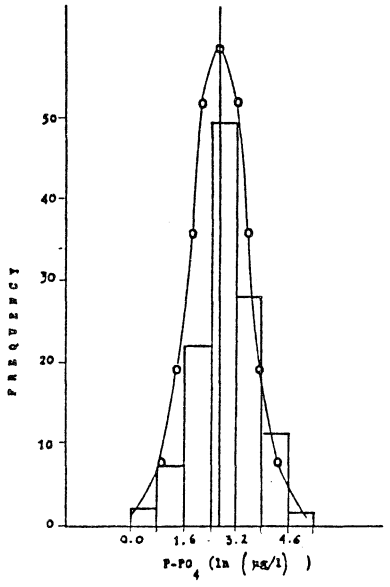
Results and Discussion

A grouped frequency table (Table 1) was costructed from the $P\text{-}PO_4$ data.

Table 1. Grouped frequency distribution of data

Range of $P\text{-}PO_4$ (ln µg/l)	Class boundaries	Class mid-mark	Frequency
0.10 - 0.80	0.05 - 0.85	0.45	2
0.90 - 1.60	0.85 - 1.65	1.25	7
1.70 - 2.40	1.65 - 2.45	2.05	22
2.50 - 3.20	2.45 - 3.25	2.85	49
3.30 - 4.00	3.25 - 4.05	3.65	28
4.10 - 4.80	4.05 - 4.85	4.45	11
4.90 - 5.60	4.85 - 5.65	5.25	1

Fig.1. Histogram of data.



A histogram of the data from Table 1 was drawn (Fig.1). The histogram gives a clear indication of the variation in the $P\text{-}PO_4$ levels in sea water. Such a histogram could have a curve known as a normal curve. The $P\text{-}PO_4$ data had a mean $\bar{x} = 2.79$ equiv. to 16.28 µg/l $P\text{-}PO_4$ and standard deviation $\sigma = 0.80$.

The probability of any given value of $P\text{-}PO_4$ concentration to exceed:

mean+ σ (36.28 µg/l $P\text{-}PO_4$) is 15.90 %
mean+2σ (80.64 µg/l $P\text{-}PO_4$) is 2.75 %
mean+3σ (179.47 µg/l $P\text{-}PO_4$) is 0.13 %

These answers are predictions. In the normal course of events (e.g. constant effluent composition and rate from the sewage outfall) one should expect these predictions to be reasonably close to the truth. The statistically derived "mean" of $P\text{-}PO_4$ may be considered as a "typical" consentration of this nutrient in the area and this "mean" is a more reliable quantity for comparisons of the nutrient levels between areas. Also, the shape of the distribution of the $P\text{-}PO_4$ values around the "mean" may be indicative of the quantitative distribution of the nutrient in an area, and it can be also used for comparing areas with different $P\text{-}PO_4$ load.

It is hoped that this procedure can be used to clarify interpretations regarding levels of nutrients or any other pollutant and to assist authorities with respect to management of waste discharge.

References

1. MORONEY, M.J., 1964. Facts from Figures. Penguin Books Ltd., England.

2. SOKAL, R.R. and F.J. ROHLF, 1969. Biometry. W.H. Freeman and Co., San Francisco.