BALANCE AND SYNOPTIC METHODS USED TO DETERMINE CRITICAL POLLUTION OF MARINE WATER AREAS

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The main problem of ecology is the determination of critical anthropogenic load on the environment, while the word "critical" can be replaced by "maximum permissible". Anthropogenic load on the environment is expressed by pollution or withdrawal (reversible or non-reversible) of nature part. In this paper, we'll focus on critical pollution.

The problem of determination of critical environmental pollution has two aspects, the first of which is directly related to substantiation of quality standards or maximum permissible concentration (MPC) of pollutant substances (PS) in the environment. The second aspect is connected with the development of methods for determination of maximal rate of pollutants flow through a unit of the environment, where pollutants concentration should not exceed the MPC.

As we know, this rate (we'll denote it as $\mathbf{A_i}$) represents critical pollution. The pollutants flow through a unit of the environment is composed of the processes of pollutants inflow and outflow. Outflow processes (or self-purification) can be of physical, chemical, biological or complex nature.

We'll further focus on the methods used for determination of critical pollution, which can be classified into empirical and mathematical ones. Empirical method is in fact a trial and error method. Mathematical method consists in transforming mass units (MPC) into flow units ($\mathbf{A_i}$).

These methods are united by the fact that they are "indifferent" to the MPC, which is a reference condition for both. This is an important aspect, which means that ecological efficiency of critical pollution as a standard of anthropogenic load is determined not only by calculation, but also by ecological substantiation of MPC.

Methods used to determine critical pollution can be divided into two groups. The first group is focused on determination of rate of self-purification processes (separately and generally), and the second group considers these processes as a "black box", measuring the rate of pollutants flow in the input and output points.

The second group includes the suggested balance and synoptic methods used to determine critical pollution of marine water areas. To describe these methods we'll further replace the term "critical pollution" with a similar term "assimilation capacity".

Balance method for determining assimilation capacity is based on fundamental ideas on the functioning of marine ecosystems and the data of marine pollution monitoring. Assimilation capacity (A_i) is calculated by the following formula:

$$A_i = (L_l / L_{max}) \times P ,$$

where L_l is permissible load, L_{max} is maximal load and P is the self-purification capacity. The load is expressed in the ratio of units of mass to units of area (e.g. g/m^2), and self-purification capacity is expressed in the ratio of units of mass to unit of area and unit of time (e.g. g/m^2.day). Self-purification capacity is measured in the same units as assimilation capacity.

Maximal load on the selected water area and self-purification potential are determined by the data of long-term monitoring. Besides, the observations should be regular and frequent. Self-purification potential is determined as a maximal rate of reducing of pollutants mass per unit of water area for the whole observation period. Permissible load is determined on the basis of maximal permissible concentration of a pollutant in water, specified for the selected sector of the water area.

Our experience shows that the balance method used to determine assimilation capacity reflects the self-purification capacity of marine ecosystems in case their integrity is preserved. However it is currently difficult to find the source data which could meet the requirements of this method in duration, regularity and frequency of observations.

To overcome these difficulties we have developed a new "synoptic" method for assessing assimilation capacity. It doesn't require long-term or repeated observations. The data obtained during one oceanographic survey are enough.

The method is based on the assumption that uneven distribution of pollutants detected by the survey in homogeneous in physical parameters water body is the consequence of self-purification processes. The reference point of these processes is the time of the last storm in the water area (that is why the method is called "synoptic").

This method determines the rate of pollutants flow passing through a unit of water volume as a ratio $(C_{макс} – C_{мин})/T$, where T is the number of days which passed since the last storm. To calculate the rate of pollutants flow which doesn't damage the ecosystem (this value is the assimilation capacity), this ratio should be multiplied by $C_{пдк}/C_{мак}c$, where $C_{пдк}$ is the maximal permissible concentration of pollutants in water. So, the assimilation capacity is calculated by the formula:

$$A_i = [(C_{макс} – C_{мин})/T] \times C_{пдк}/C_{макс}$$

The method is complicated by the difficulty selecting a hydrologically homogeneous water body. Tests of this method in the North Caspian, which water area mainly refers to the mixing zone of marine and riverine water, have shown overrated results in comparison to balance method.

Currently the "synoptic" method is being tested in halistatic areas of the Caspian Sea and we believe it will well supplement the classical balance method.