MONITORING THE EFFECTS OF DOMESTIC AND INDUSTRIAL WASTES IN MARINE ENVIRONMENT

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INTRODUCTION

Water pollution is defined as "anything which brings about a reduction in the diversity of aquatic life and eventually destroys the balance of life (Vesilind. 1975).

In connection with sea, the pollution has been defined as: the introduction by man directly or indirectly of substances or energy into the marine environment (including estuaries) which results in such deleterious effects as harm to living resources, hazards to human health, hindrance to marine activities including fishing. impairment of quality for use of sea water and reduction of amenities (IMCO/FAO/Unesco/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP).

The seas appear limitless, covering about two-thirds of the surface of the earth, about 140 million square miles.

For many years we have assumed that our lakes, streams and marine resources were unlimited and that they would accept whatever liquid waste we could pump into them. We have assumed also that, we could handle our waste problems forever by dumping it into the vast resources of our unpolluted marine areas. But now, the problems of pollution arizing from wastes has become one of national interest. All these activities have had clear biological implications. The impact of such activities, particularly waste disposal, is most pronounced on the coastal ecosystems adjacent to major centers of population.

In order to prevent, reduce or at least contain pollution by domestic and industrial effluents, the authorities of many countries have had to prepare monitoring and research programmes, so that water quality criteria can be defined and the maximum levels of pollutants established.

NATURE AND CHARACTERISTIC OF DOMESTIC AND INDUSTRIAL EFFLUENTS:

Domestic effluents may consist of "domestic sewage" (house-hold wastewater from residential areas) which have a reasonably uniform and well documented composition. More commonly, domestic effluents consist of "industrial sewage" which is derived from mixed residential and industrial areas. Its composition is less predictable, depending to a large extent, on that of the industrial components.

Industrial effluent is the wastewater from industrial plant and often contains a small admixture of sewage. Its composition will vary according to the manufacturing processes involved, thus it may be highly toxic.

CHARACTERISTICS OF THE WASTES

GESAMP (1982) reported the physical, chemical and biological characteristics of wastes:

Physical Characteristics

The dispersal of liquid wastes miscible in sea water is influenced by their density, but this applies mostly in the initial period. Thus,into an aquatic environment liquid wastes discharged often disperse following rapid dilution in contrast to domestic wastes released from a submarine outfall which usually comes up to the surface on the account of its significantly lower density even after initial mixing.

Miscible and immiscible low density wastes which float on the surface often pose particularly difficult disposal problem. They are confined to a two-dimensional medium and disperse much less effectively. Furthermore, surface convergences concentrate floating waste and may cause their reaccumulation rather than dispersal.

Wastes of particulate forme disperse according to their settling velocity. The median settling velocity of particulate material in sewage is very slow (10^{-3} cm s^{-1}), since their density is close to that of sea water.

Deposition of particulate waste on the sea floor is affected by the density of the waste cloud and by the properties of the bottom surface. Under the turbulent conditions prevailing in tidal waters, or over some continental shelves, the probability of permenant deposition for waste particles becomes very small, in other words, the probability of their resuspension becomes very high.

An important aspect of the behaviour of particulate waste is that individual particles are not necessarily permanent. They may aggregate and be enriched by flocculation or reduced by scavenging.

Finally, it is necessary to know whether the waste is liquid, solid, or a solid in suspension, to know the density of the waste as a whole and of any solids it may contain, since these properties will influence initial dilution as well as subsequent dispersion and settlement.

Chemical Characteristics

An appreciation of the chemical composition of a waste is necessary to assess its potential effects on water quality and on biota. Knowledge of the raw materials and production processes used will often provide a key to the probable composition of the waste.

Wastes can modify the chemistry of the marine environment in a number of ways. Also, under calm conditions, as lagoon or fjords, wastes with high chemical oxygen demand (COD) and/or biochemical oxygen demand (BOD) can lead to deoxygenation of the water or the sediment.

Changes in the pH of sea water can be detrimental in the longer term through effects on the partial pressure of carbon dioxide. The acid wastes contain many organic chemicals and alkaline wastes usually contain organic or mineral constituents.

Heat treatment wastes contain barium and unspent cyanide and have been disposed of as solid in deep water areas. The cyanide is hydrolysed to formic acid and the barium precipitates as barium sulphate. Chlorine is readily reduced to chloride and many of the highly toxic organophosphorus compounds are hydrolysed in sea water. Not all chemicals discharged to the sea are readily rendered harmless by dilution or degradation. Certain groups, e.g. some of the halogenated organic chemicals, are relatively resistant to biochemical degredation and can persist in the environment for many years.

The importance of the chemical state of a substance should also be noted; in insoluble form, and sometimes in complex form , the acute toxicity of lead, zinc and copper is much reduced. In anoxic areas of the sea (as on many sediments below the top few centimetres, where hydrogen sulphide occurs) heavy metals can be virtually eliminated from the water by formation of very insoluble metal sulphides. It should also be noted that under anoxic conditions mercury sulphide is more soluble in sea water than would be expected from its solubility product (IEAE, 1971, quoted in GESAMP, 1982).

Biological Characteristics

Wastes can have a biological impact in two ways. They may add biological material, especially micro-organisms, or they may modify the physical and chemical environments, thus affecting existing flora and fauna.

Sewage sludges, polluted dredge spoils and certain industrial wastes introduce organisms into the sea that are largely foreign to the marine environment. Micro-organisms attached to particles can exist as aggregates and the sedimentary environment could have a stabilizing effect on their viability. It is also of concern that parasitic worms, pathogenic bacteria and viruses, protozoans, yeasts and fungi may be present in the waste in concentrations well above the minimum ineffective dose for humans. The number and kinds of pathogenic organisms present in sludges are very variable, depending primarily on the health of the community from which the sludge is generated. There are usually sufficient pathogenic organisms present in raw sludge. Despite much study, the exact health risk of viral pathogents has not yet been quantified.

SOME EFFECTS OF DOMESTIC AND INDUSTRIAL WASTES

The effects of wastes entering the coastal system will depend upon many factors, notably the composition of the waste itself and the physical, chemical and biological characteristics of the receiving area. Some possible effects are summarized below (Newton et al., 1979):

1- Effluent exerting a high BOD may utilize dissolved oxygen (DO) in receiving waters to the extent that DO tensions fall too low to support a normal biota. In extreme circumstances, all the DO may be consumed and anaerobic conditions established; H_2O and CH_4 gases are then evolved which may give rise to small nuisance, and widespread mortalities occur among aquatic organisms.

2- Elevated concentrations of nutrients may promote prolific growths of planktonic and attached algae, which will, in due course, exert a BOD.

3- Heated effluent, such as cooling water, may subject the biota to thermal shock, perhaps with lethal effect, or reduce the oxygen-carrying capacity of water.

4- Heavy metals, PCBs, pesticides and other conservative substances may exert direct toxic effects if present in sufficient concentration or they are accumulated by some organisms in minute quantities and by concentration via the food web, high order carnivores can incur significant and even lethal body burdens.

5- Domestic effluent may seriously contaminate beaches and nearshore waters, rendering them unattractive and the levels of faecal bacteria present may make them unfit for bathing or growing shellfish.

6- Radioactive wastes, which may enter the coastal environment from military installations, hospitals, power stations, etc. and petroleum wastes may also have serious effects.

It is therefore inevitable to monitor the effects of waste waters and their contents either on human beings or on aquatic organisms.

MONITORING THE EFFECTS OF DOMESTIC AND INDUSTRIAL WASTES

Monitoring is defined in different ways by different authors.

According to Lee et al., (1972) monitoring is considered to be a systematic observation of properties related to specific problems concerned with the marine environment, the observations being carried out in such a way as to show these properties vary with time at a number of fixed locations or geographical areas.

Portmann (1976) defined the monitoring as; the measurement of a pollutant or its effects with a view to the assessment or control of exposure to that pollutant of either man or specified elements of the biosphere.

Purposes of Monitoring Waste Waters

The effects of wastes and the requirement of monitoring of these effects were mentioned above.

According to Basu (1978), the purposes of monitoring waste waters are:

- To maintain sufficient control of (in-plant) operations to prevent violations of discharge standards, where standard exist,
- To build up necessary data for use in the design and operation of waste treatment plants.
- To enable detailed budgets of material to be drawn up for each plant and so optimize process efficiencies.

The monitoring of waste streams from "point" sources are less complicated, precise and quickly adoptive. However, "Non-point" sources may give rise to numerous other problems during sampling and analyses and these are of concern from control point of view.

The point sources are essentially discharges of sewage or industrial effluents, and they represent identifiable and controllable sources of pollution. Non-point sources are more difficult to identify either because of their uncontrollable diffuse character or because thev arise at least in part from natural phenomena, e.g. soil erosion, as in the case of Golden Horn.

MONITORING OF THE EFFECTS OF WASTE WATERS IN GOLDEN HORN

Golden Horn is an estuary situated in the heart of Istanbul which is the most populated and industrialized city of our country. This estuary subjects to heavy pollution by sewage and industrial inputs (Baykut, 1977; Samsunlu, 1977).

Institute of Marine Sciences of Middle East Technical University (IMS-METU) has begun such a monitoring program under the sponsorship of the DEPARTMENT OF WATER AND SEWERAGE ADMINISTRATION, MUNICIPALITY OF ISTANBUL (ISKI), in 1985.

In this connection, we studied the effects of pollution, which is of sewage and industrial origine, on the distribution of benthic fauna, particularly on Polychaetous Annelids from December 1985 to July 1986 at 7 permanent stations in Golden Horn (Fig. 1).

The results showed that pollution increases from the mouth to the inner parts of the estuary. On the other hand the number of Polychaete species was highest at St.H2, and it started to decrease towards the inner parts which best indicates the existence of pollution. Dominant Polychaete species showed spatial and temporal variations; at St.H2 Nereis falsa, Polydora ciliata and Nereis caudata have been found to be dominant during different times of year while Capitella capitata and Scolelepis fuliginosa were observed to be dominant species at other sampling stations. During the sampling period, C. capitata, S. fuliginosa and P.ciliata were always dominant in number and in biomass. Among these species, C.capitata was most abundant with 52% in number and 65.5% in biomass of all species found throughout the sampling period. This species was shown by several authors to be indicator of the areas where heavy organic pollution occurs (Bellan, 1967, 1968; Cognetti, 1972; Pearson and Rosenberg, 1976, 1978; Gray, 1981). This implies that, Golden Horn is an area polluted by wastes (domestic and industrial) and that the degree of pollution increases from the mouth to the inner parts of the estuary although seasonal fluctuations were observed. These results were also supported by "species diversity index" calculated by Shannon-Wiener function (Rosenberg, 1976).

$$H' = -\sum_{i=1}^{s} pi \log_2 pi$$

where pi is the proportion of the abundance of individuals belonging to the i^{th} species.

Our studies are still continuing in order to monitor the effects of wastes and to follow the efficiencies of precautions that have been taken since two years and to be taken in the future by the authorities of City.

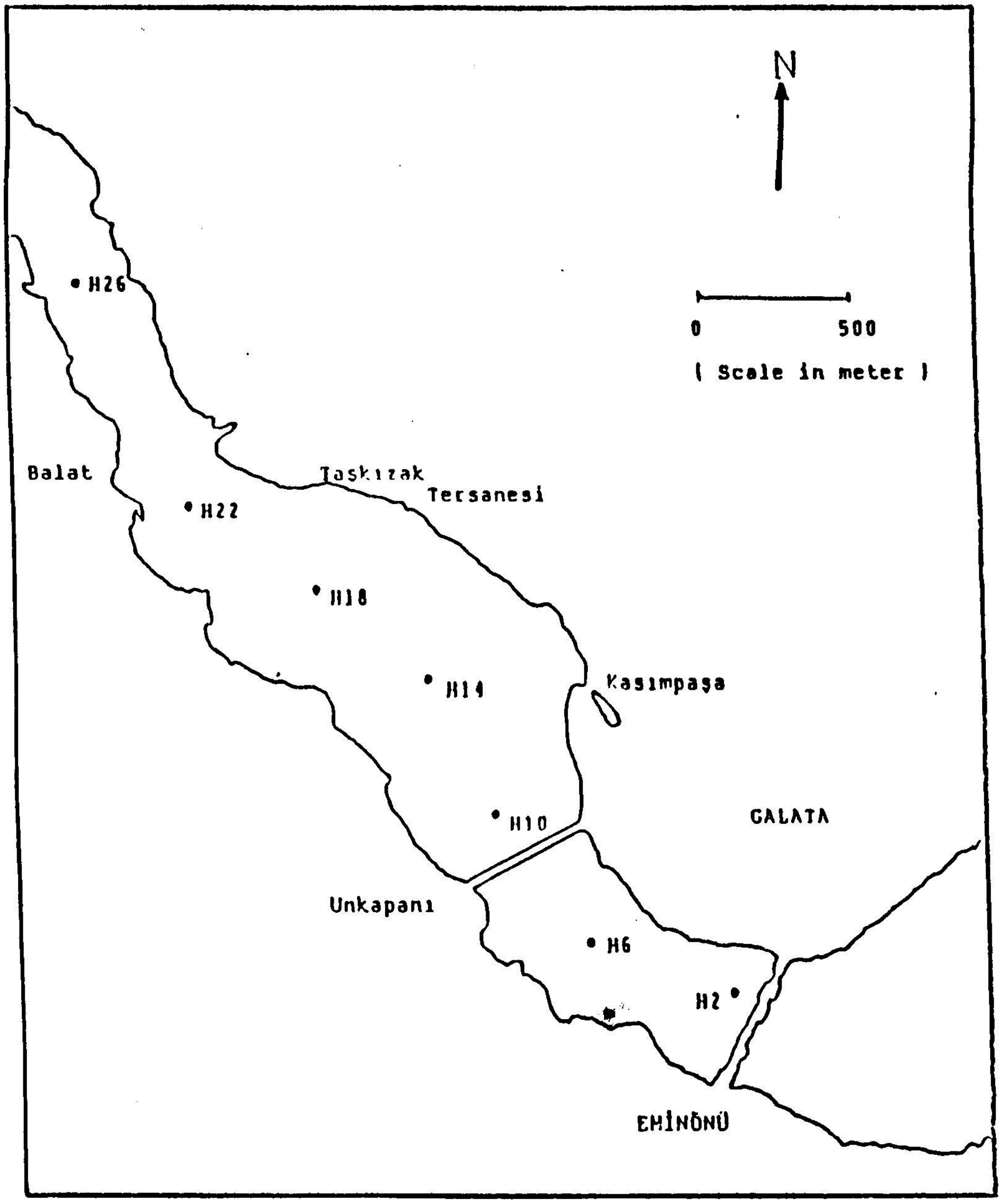

Fig. 1. Sample stations in Golden Horn.

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