IMPACT OF THERMAL EFFLUENTS ON SEAWEED BED OF TUTICORIN BAY

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Introduction

The Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) of FAO defines marine pollution as "the introduction by man, directly or indirectly of substances or energy into 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 seawater and reduction of amenities". Thermal (heat) is one of the seven major categories of environmental pollutant. Thermal pollution is "any change in natural water temperature that adversely affects the aquatic environment". Thermal power plant may contribute significantly towards economic growth but they may bring associated ills of environmental pollution. The largest single industrial use of water is for cooling purposes and vast quantities of water heated in this way are discharged into natural bodies of water. The main sources of thermal effluents from thermal power stations are; cooling water, wastewater from water treatment plants and condenser cleaners, wastewater contaminated with petroleum products such as oil and grease, water from hydraulic ash disposal system and water collected inside the territory of the power stations. Thermal pollution due to cooling water, wastewater and fly ash slurry discharges are bound to have detrimental effects on the hydrography of the receiving waters.

Methodology

Tuticorin Bay is situated in the southeast coast of India in the Gulf of Mannar along the Tamilnadu coast. Tuticorin Bay encloses a water area of 56 sq.km. The Hare Island forms the eastern boundary of the Bay and Tuticorin land mass are on its western side. The southern point of Tuticorin Bay extends to a creek with wide mangrove area and a fresh water creek. Tuticorin Thermal Power Station (TTPS) was commissioned in 1978, at an area of about 160 hectares and produces 1050 MW electricity per day. TTPS is located 2 km to the east of Tuticorin Port and the northern boundary of the complex is on the brim of the intertidal area of the Tuticorin Bay. The hot water effluent generated by cooling the condenser is pumped directly into the Bay. In addition there is wastewater

outlets also located 1 km. westwards of the hot water outlet. Marine pollution is also caused by the seepage and overflowing of fly ash slurry from the fly ash pond. The amount of hot effluent water dumped into Tuticorin Bay is approximately 3780 tons/day and the wastewater effluents discharged is 54 tons/day. Before commissioning of TTPS, The Tuticorin Bay and its adjacent areas supported rich flora and fauna such as seaweeds, seagrass beds, mangroves and corals, The pollution from TTPS over the years had created a barren intertidal area almost devoid of seaweeds and seagrass beds and also changed the once blue clear waters of Tuticorin Bay into an area with high turbidity and non-productive bottom muddy area. The study comprises following aspects.

i) The effects of thermal, wastewater and fly ash on the hydrography of Tuticorin Bay.

ii) The changes in net productivity and chlorophyll content of seaweeds.

iii) Variations in biochemical constituents, and

iv) Heavy metal concentrations of seawater, sediment and bioaccumulation by seaweeds.

A total of five stations were fixed to compare the hydrography of polluted (Tuticorin Bay) and control site (Terespuram). Hydrographical parameters such as water temperature, salinity, dissolved oxygen, pH, nutrients and primary productivity were studied.

Impacts on water quality

The average monthly water temperature in the Tuticorin Bay just off the hot water site is 10.3 to 11.5 °C higher than the controle station and forms a thermal plume of an area covering approximately 1.5 sq.km. The maximum phytoplankton production observed at hot water effluent site is only 0.05gC/m^3/day showing a 30-fold decrease in production compared to the controle site. At hot water effluent site, the values of phosphate and nitrate were comparatively lower than the other stations. The hydrological parameters studied show a significant variation between stations.

Pollution by metal arises from various land-based operations such as mining, milling and smelting activities. Some of the metals may enter the sea through the aquatic route while a certain proportion reaches the oceans via atmosphere and is washed out by rain. Smelter emissions and coal burning thermal power plants may transmit substantial quantity of metal into atmosphere.

Another source of pollution from TTPS is the discharge of wastewater. The amount of wastewater discharged is approximately 54 tons/day. This consists mainly of acidic and alkaline chemical solutions used in cleaning power plant equipments, acid water drainage from coal storage and wastewater contaminated with petroleum products such as oil and grease. In addition to pollution by fly ash and wastewater effluents, the discharge of hot water also plays an important role. Water of high temperature in combination with fly ash slurry and wastewater may promote the leaching of heavy metals.

Concentrations of heavy metals in seawater at hot water and wastewater effluent site of TTPS are far higher than those reported for natural and other polluted waters. At Tuticorin Bay, the source of heavy metal in seawater and sediment were fly ash, hot water and wastewater effluents. The concentration of metals in seawater were of the order Cu > Ni > Zn > Pb and in sediment Ni > Cu > Zn > Pb. A marked seasonal variation in concentration of heavy metals in seawater and sediments is observed. Correlation of environmental parameters, metals in seawater and sediments with metals in seaweed indicates that at the wastewater effluent site, all the parameters contribute significantly to metal uptake.

The concentration of heavy metals in wastewater effluent sites of Tuticorin Thermal Power Station is far higher than those reported for natural waters. The concentration of heavy metals in seawater is of order Cu > Ni > Zn > Pb > Fe and in sediments Ni > Cu > Zn > Pb > Fe. A marked seasonal variation in concentration of heavy metals in seawater and sediments is observed. Correlation of environmental parameters, metals in seawater and sediments with metals in seaweed indicates that at the wastewater effluent site all parameters contribute to metal uptake.

Impacts on Seaweed beds

Seaweeds are ideal indicators of pollution because they are sessile, easily accessible and sensitive to environment factors. Since seaweeds do not have root, stem and leaf, the entire body known as thallus absorbs the nutrients from the surrounding water for its survival. Any pollutant or toxic elements present in seawater get accumulated to critical or lethal levels. Seaweeds being primary producers contribute to the sustenance of higher trophic levels.

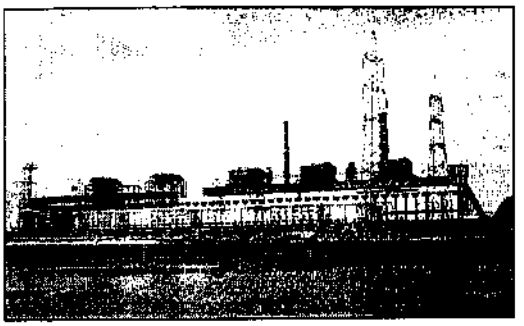
The impact of pollution was measured by monitoring the changes in net productivity and chlorophyll content, and the biochemical constituents examined were protein, carbohydrate and lipid. The three species of seaweeds selected for the study were *Gracilaria verrucosa*, *Enteromorpha compressa* and *Chaetomorpha linum*.

The total absence of seaweed vegetation at the termal effluent out fall site clearly indicates that seaweeds cannot survive at a temperature above 35 °C. Temperature increments of 7-8 °C between thermal effluent site and wastewater site resulted in the survival of hardy local species, resistant to warm water and effective at colonizing disturbed areas.The only macro algal vegetation observed at wastewater site was *Gracilaria verrucosa, Enteromorpha compressa* and *Chaetomorpha linum*. A combination of increased temperature and turbidity leads to reduced net production by seaweeds and chlorophyll content at wastewater effluent site. The protein, carbohydrate and lipid of macro algae from wastewater effluent station were less than the control station.Salinity and pH does not show significant variation between stations

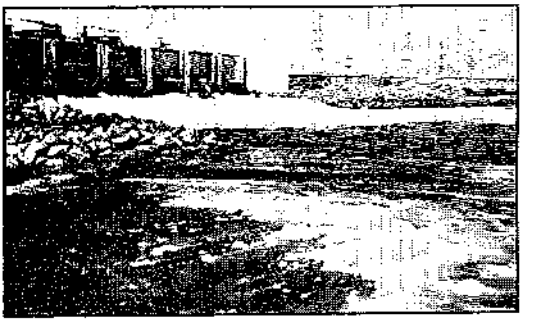
The bioaccumulations of metals by *Gracilaria verrucosa* and *Enteromorpha compressa* show that they tolerate a high level of pollution and hence can be used as

"Indicator species" of heavy metal pollution along Indian Coast. Copper and Zinc concentration of seaweeds are far greater than the permissible limits of human consumption.

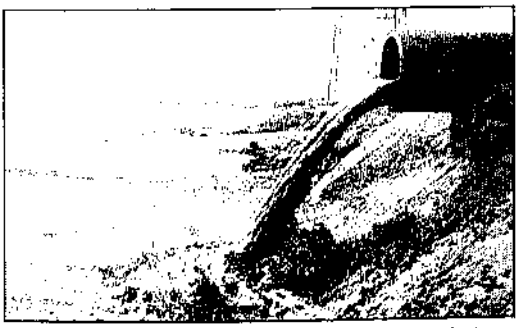
It is believed that these observations would form a base for further studies. Tuticorin Bay, which forms a part of Gulf of Mannar, is declared as a Biosphere Reserve to preserve the genetic diversity of this marine ecosystem. This study reveals that dumping of thermal and wastewater effluents and fly ash into Tuticorin Bay has caused extensive damage to this fragile system.



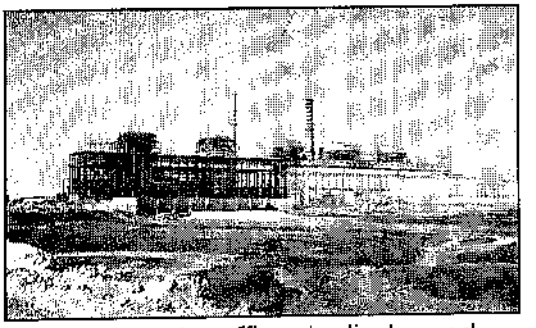
Tuticorin Thermal power Station which produces 1050 MW electric power



Thermal effluents from the power station flowing directly into Tuticorin Bay. (Average water temperature 40°C)



Waste water effluents discharged into intertidal area of the Tuticorin Bay



Waste water effluents discharged into intertidal area mixes with the Tuticorin Bay waters