Wat. Sci. Tech. Vol.17, Amsterdam, pp.1421-1424.
Printed in Great Britain.

0273-1223/85 $0.00 + .50

THE LAGOON OF SANTA GILLA (SARDINIA): PRESENT CONDITIONS AND POSSIBILITIES OF RESTORATION

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INTRODUCTION

The lagoon of Santa Gilla, of about 1500 hectares, corresponds to the terminal western part of the Campidano plain and is placed between the reliefs of granite and schist of the Sulcis to the west and the arenaceous marl-limestone hills of Cagliari to the east. Its environmental situation has changed profoundly during the last thirty years. In the 50's a very modest bacterial pollution was verified (Cioglia 1958). In the same years the lagoon was abounding in high quality fish. Because of the domestic sewage of the town of Cagliari and the industrial wastes from the petro-chemical factories, the industrial laundries and a treatment plant of minerals of fluorine and barium, wich flow into the lagoon, pollution has increased so much since the early 60's that the fishing had to be prohibited in 1974. The aim of the present paper is to verify the present situation in the light of the recent reclamation works and to evaluate the possibility of restoring the lagoon to its natural conditions.

MORPHOLOGICAL ASPECTS

During the Quaternary the coastal plain of the Campidano has been subjected to successive transgressions and regressions depending on climatic variations. The lagoon still provides testimony of these morphological events along the banks, in the outcroppings and in the stratigraphy of the bottom sediments. The waters of the rivers Cixerri and Mannu flow mainly on limestone-marl sediments transporting considerable quantities of fine materials. Proceeding north to south, three areas with different characteristics can be located in the lagoon:(fig. 1):

- in the A area between the mouth of the river Cixerri and Mannu and the town of Elmas the marshly banks are gaining ground because of intensive animal and vegetal biological activity; the movement and recycle of the water is not very extended and the bottom sediments do not undergo erosion. The mean depth is 0.70 meters.
- in the B area the fluvial waters are let in; during hign tide they determine important bottom streams which move the accumulated sediments. This phenomenon is heightened by the recent canalization of the mouths of the above rivers. The mean depth is 1.20 meters.
- the C area is located between Punta Coterusi and Sa Illetta. It finds its natural development in the wide channel that flows to Sa Scafa and then into the Gulf

of Cagliari. Sa Illetta is the witness of the coastal cord which separated the paleolagoon from the sea during the Tyrrhenian. The channel that flows between Campo S. Gilla and Sa Illetta is the place where the principal reflux and influx movements of the waters into the lagoon occur. In the whole C area evidence of the erosion forms and accumulated fine sediments caused by bottom streams can be seen on the bottom; even on observing the aerial photos taken at different times and altitudes. Particularly remarkable are the formations of anastomised furrows by linear erosion which assumes a regressive character from the sea towards the interior. We must observe that a navigable canal, dredged at a depth about 3 meters between Sa Scafa and Porto S. Pietro has further complicated the dynamics of the movements of the water and of the distribution of the sediments. In general after long periods of winds from southern quadrants, together with high tides and a high flow from the effluents, the waters of the lagoon are drained more rapidly, consequently increasing the erosion of the bottom. On these occasions, which may happen several times a year, a turbid stream can be seen in the sea a few miles from the mouth of the lagoon.

MICROBIOLOGICAL ASPECTS

The systematical microbiological tests made in 1977 and repeated in 1982 allowed some observations on the hygienic conditions of the lagoon. Thus it was possible to observe that in stations where basic pollution predominates, positive variations were verified as far as regards microbial pollution. In the 1977 research all the lagoon presented very serious pollution, especially in the vicinity of the outfall of the main sewers (max. values of total coliforms 10^7/100 ml; fecal streptococci 10^6/100 ml). In 1982, on account of the construction of a partially perimetral canal that collects the wastes from some main sewers of Cagliari, a very remarkable improvement in bacteriological pollution has been verified. In fact the indexes of microbial pollution have never reached the values found previously, and even though basic pollution persists due to the discharge into the lagoon of domestic wastes (total coliforms 10^5/100ml; fecal coliforms 10^3/100 ml; fecal streptococci 10^4/100 ml), the situation is definitely improving.

TROPHIC ASPECTS

The total concentrations of P in September-October 1978 are about 250 mg P/m^3 on the whole lagoon with maximum value 500 mg P/m^3 in the zones around the urban discharges (Sechi et al., 1983). In 1981 in the same period there is a mean concentration of 140 mg P/m^3 with maximum value 300 mg P/m^3 near the undeviated waste outfalls (A area). The difference in total P is therefore quite significant; its availability in 1981 was still so high that the lagoon was considered politrophic. The $N\text{-}NH_3$ and $N\text{-}NO_2^-$ concentrations during September-October 1978 averaged respectively 70 mg N/m^3 and 12 mg N/m^3. The concentrations of these two compounds have definitively decreased reaching acceptable levels, even though maximum values are indeed significant. Other parameters analysed in 1981 and not in 1977 give a rather significant picture of the trophic conditions of the lagoon. $N\text{-}NO_3^-$ has a mean annual content of about 300 mg N/m^3 with maximum value 1100 mg N/m^3 in the C area. From an estimate of the phytoplanctonic biomass the chlorophill *a* has a mean annual content of about 20 mg/m^3 in the A area and maximum value 100 mg/m^3. In the C area chlorophyll *a* has a mean annual content of about 8 mg/m^3 and maximum values 30-50 mg/m^3. The density of the phytoplankton analysed in the central part of the lagoon has oscillating values from 0.1×10^6 cells/liter to 170×10^6 cells/liter with maximum values between February and May.

The variety of species presents very reduced values ranging between 0.03 and 0.5. So it is clear that the trophic condition of the lagoon is still very high.

CHEMICAL ASPECTS

High levels of Pb, Hg and Cr were found in the sediments of the lagoon both in the superficial layer and at 40 cm of the examined cores. A first research carried out in 1978 on a grid of 90 stations showed mean concentrations of 27.9 ppm of Hg in the superficial sediments taken near the outfall wastes of a chloro-alkali plant. Pb and Cr reached mean concentrations of 768 and 114 ppm respectively, adjacent to the mouth of the rivers (B area). Even at a lower depth of the cores the pollution appeared high. In 1981 fewer samples showed some improvement, even though they confirmed that contamination was still present (mean values: Hg 7.6 ppm; Pb 440 ppm; Cr 73 ppm).

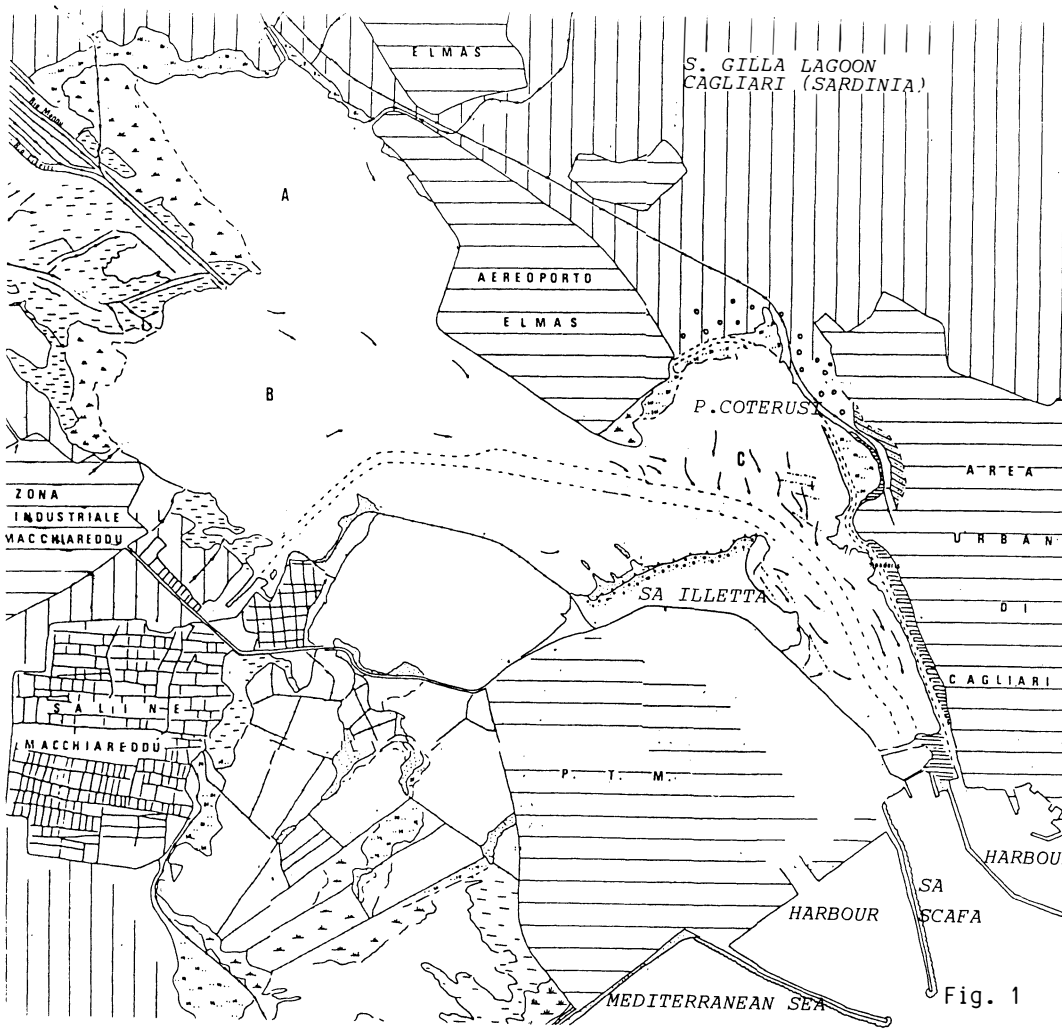

Fig. 1

The product of the percent organic nitrogen and organic carbon in the sediments (Organic Sediment Index) (Ballinger and McKee, 1971) allowed a classification in four types, on the basis of the nature of their organic substrate, and an evaluation of their capacity to retain heavy metals (Contu et al., 1983a), also by the grain size distribution. In the most polluted zones the sediments formed by very sandy pelites and with a very high content of nitrogenous substances actively decomposing, proved to be of type III, showing a high capacity of retaining metals. Sediments of type I, typical of stabilized organic depots or inorganic, made up of pelitic sands, were found in zones nearest to the sea and showed a lower content of heavy metals.

CONCLUSIONS

Although some restoration works considerably improve the situation of the lagoon, especially from the bacteriological point of view, the level of Pb, Hg and Cr in the sediments are still so high as to discredit some of the methods proposed to recover the lagoon for fishing. In any case, it is imperative to stop the input of all pollutants. The vertical profile of sediments shows in fact very high concentration of heavy metals at a depth of 40 cm. Dredging operations, therefore involve both enormous expenses and unforseen consequences on the ecosystem and may reduce only partly the level of heavy metals in the sediments. The possibility of favouring the natural removal of superficial sediments by bottom streams with an appropriate running of the waters through the mouths of the lagoon could also taken into account. A gradual transport of the pollutants from the lagoon to the Gulf of Cagliari has been pointed out in a previous work (Contu et al.,1983b), and is corroborated by a slight decrease in the levels of heavy metals recorded since 1977 in connection with a lower input of wastes. To speed up this self-purification process may have an adverse effect on the marine ecosystem and may extend the problem to the Gulf of Cagliari.

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