SUMMARY

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CHAPTER - I

In order to fathom the pollution load incurred by the Mahi estuary at the Gulf of Cambay, due to the continuous discharge of effluents through an effluent channel, an EIA study in terms of physicochemical characteristics and metal content of the channel water, as well as at the estuary, at the point of confluence and also, at upstream and down stream of it was carried out from 1991-1993. Water samples were collected continuously during the three years from the channel and from the estuary at the point of confluence ("J" point) and upstream and down stream of it. Of all the parameters studied at various points, eight parameters showed decline over the years ; they are temperature, pH, dissolved oxygen, alkalinity, ammonical-nitrogen, total Kjeldhal nitrogen and total and fecal coliform-Remaining parameters such as, COD, BOD, oil and grease, solids (TS, TDS, SS), chlorides, sulphate, phenol, cyanide, hardness and, metals (Fe, Ni, Cu, Zn, Cd, Pb, Hg, and Cr) showed an increment ranging between a minimum of 17.6% for total solids at the "J" point and maximum of 3883% for Iron (Fe) at the upstream. Overall, results are discouraging and the various parameters studied have shown continuous increase during the study

period. This is related with effluent output from Industries and also the indiscriminate discharge of effluents directly into the river by by-pass channels.

CHAPTER - II

In order to assess the environmental impact of the effluent channel which not only discharges effluent into the estuary, but water from which is used by the local populace residing along the channel for irrigative purposes, an analysis of metal content was carried out in the estuarine sediment, in the soil and, well waters. The physico-chemical features of the well waters were also evaluated. Sediment from the estuary of river Mahi and soil from all along the channel were collected by the Auger method and, 175 cm column of the sediment/soil was divided into top, middle and bottom layers and analyzed separately. Water from 23 wells located at different villages at a distance of 50 mts from the channel was collected and analysed. The distribution of metals in soil and sediment showed tripartite deposits with the maximum being at the bottom most layer. The minimum and maximum metal content in soil ranged between 100 mg/kg for varied metals and 2000 mg/kg for Zn. In the sediment, it fluctuated between a minimum of 100 mg/kg and 200 mg/kg for Cd and Cu respectively to a maximum of 3000 mg/kg for Zn,

higher contents were registered for Zn, Fe, Pb, Cr, Ni, Cu, and Cd in that order. The values of various physico-chemical parameters as well as metals also showed significant high levels in well waters, of which nitrate was much beyond the permissible levels in some of the wells, highest being 700 mg/l. Of the various metals analysed in water, Cu showed 2 to 9 times and Cd 14 to 30 times greater content more than in the non polluted well waters. In conclusion, it can be said that the channel effluent has not only polluted the estuarine water but also has raised levels of pollutants to alarmingly higher levels in the sediment of the estuary and, soil and well waters of the villages along the channel.

CHAPTER - III

The 56 Km long Baroda effluent channel passes through 24 villages and empties its content into the Mahi estuary at the Gulf of Cambay. Since the populace in the village along the channel pilfer the channel water continuously during the summer months for irrigative purpose, an analysis of metal content in some of the vegetables, cereal grains, pulses, tobacco leaves and grass grown / growing along the channel was carried out to assess the impact of the usage of channel water. The analysis showed minimum level of Cr (1.6 ppm) in potato and maximum level of Pb (91.3 ppm) in tomato. The

content of various other metals ranged in between these values in different vegetables - chilli, drumstick, cauliflower,brinjal, potato, tomato,cabbage and bitter gourd. The values obtained for metals in vegetables were higher by a minimum of 3.6% to a maximum of 6422.5 % as compared to vegetables grown in fields not irrigated by the channel water. Of the cereal grains and pulses, bajara and tuver showed minimum increment of 49.77% for Cu and maximum increment of 4820 % for Ni respectively as compared to the metal content in control samples. All other metals registered levels ranging in between. Tobacco and grass leaves in the region showed values for various metals in the range between a minimum of 2.46 ppm for Ni and 2.06 ppm for Cr to a maximum of 65.43 ppm for Cd and 108.62 ppm for Zn, respectively. The values obtained for various metals in tobacco and grass, showed increment from a minimum 81.9 % for Cd to a maximum of 6107.14% for Zn in grass and 13.48 % for Cu to 2517.2% for Cd in tobacco, as compared with control samples, from non channel irrigated regions. The findings of the present study have clearly indicated the accumulation of metals in vegetables, cereals, grains, pulses, tobacco and grass of the area.

CHAPTER - IV

Since the Baroda effluent channel has been in operation

for the last 12 years, discharging effluent into the Mahi estuary at the Gulf of Cambay, an analysis of metal content in the tissues of the mudskipper, *B.dussumieri*, the only surviving species in the area was carried out. In the present study, Cd, Cr, Cu, Fe, Ni, Pb, and Zn were analysed in liver, intestine, gill, gonad, muscle and brain. Of the various metals studied Cr showed the least content in muscle (2.36 ppm) and Cu the maximum in intestine - (126.9 ppm.) All other metals ranged in between. In the tissues studied, the minimum and maximum metal content registered were, liver - (Cd, 3.21 and Cu, 109.9 ppm) muscle - (Cr, 2.36 and Zn, 9.35 ppm,) intestine -(Fe 12.8 and Cu, 126.9 ppm,) brain -(Cr 39.12 and Zn - 100 ppm), gill- (Cd, 12.6 and Fe, 49.66 ppm) and Ovary - (Cu, 3.2 and Pb, 6.2 ppm). The study showed that there is an increasing bioaccumulation of metals in the fish of the estuary, *B.dussumieri* due to continuous discharge of channel effluent which may have serious consequences on the flora & fauna.

CHAPTER - V

The Baroda effluent channel carrying industrial waste from the major Nandesari complex and discharging it into the Mahi estuary at the Gulf of Cambay has been in operation for the last 12 years. During this period, all fish species

except the mudskipper, *B. dussumieri* have disappeared from a stretch of 56 kms of the estuary, extending about 10km downstream to 46 km upstream from the point of discharge. In this context, the histopathological alterations in muscle, gill, liver, intestine and ovary of *B.dussumieri* have been studied and compared with the histo-architecture of tissues/organs of *B.dussumieri* obtained from other estuaries (Tapi and Narmada) with no effluent channel discharge. The study revealed complete fatty degeneration of liver with erythropoietic activity, distended lamellae of the gills with infiltration of leucocytes and mucous cell degeneration, hypertrophied muscle fibers, decreased folding of the intestinal mucosa with hypertrophy of cells and mucoid cell degeneration and hypertrophy of oocytes with reduced yolk deposition and degeneration of interstitial cells and primary oocytes in the ovary of *B. dussumieri* from the Mahi estuary as compared to the structure of these tissues/organs of *B. dussumieri* obtained from the other estuaries. These gross histopathological lesions suggest the presence of deleterious pollutants including metals in the effluent discharge into the estuary.

CHAPTER - VI

In order to assess the metal load in the human body in relation to proximity to industrial areas and also in

relation to dietary affluence, the metal content of hair in low income group (LIG) individuals residing in industrialized and non-industrialized areas as well as middle income group (MIG) from non-industrialized areas has been analysed. The study has revealed significantly higher content of all metals in the hair samples from industrialized areas as compared to those in the hair samples from non- industrialized areas. It was also revealed that MIG individuals from non industrialized areas had higher metal content than in the LIG individuals from in the same area. It can be concluded from these that, both proximity to industries as well as dietary affluence contribute to increasing metal load in the human body.