POSTSCRIPT

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MAN & HIS ENVIRONMENT

"Industrial exploitation and environmental protection are the keys to the future of man-kind" but, "like trapeze artists, they come together only to swing away". In the above quote, if the former is the necessary evil, the latter is the necessary righteous. However, what we witness in the present day times is increasing industrial exploitation with increasing environmental degradation. Modern man in his quest for increasing day to day needs has opted for short sighted industrial self-sufficiency with utter disregard for environmental conservation, a matter of long sightedness, so vital for human existence and perpetuation. If industrialization is a necessary evil, so is environmental degradation an unnecessary devil. Every life form on this earth is a creation of the environment, and no life form can exist without an environment. Our life sustaining environment from ancient times consists of air, land and water. Man being a terrestrial form, is not only depended on the resources of the land but also on the life saving principles of air and also on the life sustaining gifts of water. Ironically, the present generation of man with his

short sighted aim of achieving the needs of self, has abrogated the sanctity of his aerial and aquatic environments. Industrialization no doubt generates chemical waste but, its safe disposal becomes an urgent need of priority and responsibility.

The industrial effluents not only contaminate our environment but also create serious health problems. Initially the maiden industries must have dumped their waste as a matter of convenience in their immediate vicinity. When they started posing problems to themselves, they started dumping the waste a little away in any available open land or into the nearby available water bodies. Adjacent water bodies have proved to be the boon for industries as, water is an ideal medium to discharge the waste. Mushrooming of industries around rivers and rivulets all over the world bear testimony to this. Discharge of small quantities of waste into rivers is tolerable as it is within the carrying capacity of the river. However, with mammoth industrialization, and ever increasing population, the water bodies are being loaded with waste beyond their carrying capacity and are getting choked with enormous waste of variety and quality. With increasing population size and increasing urban and city limits, the distance between human habitation and industrial sites has shrunken at an alarming

pace, with the result, very often, the industrial units are very much in the midst of human dwellings. This has proved hazardous and is posing serious threat to human health and quality of life. When the rivers started getting choked and polluted, proving to be too good to his comfort, man started looking to the estuaries and open seas, a vast mass of water for discharge of pollutants, harping on its huge diluting effects. With his new found receptacle, man embarked on a path of colossal industrialization, dumping the gargantuan pollutant effluents and wastes into it with renewed vigor and zeal. Though the seas and oceans have greater carrying capacity and diluting effect, man with his perpetual myopic outlook forgets that like any other natural resources, the water of the seas and oceans is also limited and his assault on it is bound to exceed the carrying capacity and, choke them too, beyond redemption. Man is so selfish and ultra myopic, that with his wanton acts, is only so to say, purchasing time with utter disregard and callous indifference to his future generations. It is an irony that we never think about the legacy that we leave behind and, instead of leaving a safer and decent environment for our future generations to dwell, we are hell bend in leaving a thoroughly ravaged and ravished life choking environment, totally unhealthy and unfit for life. Earth's atmosphere has been changing and evolving, guided by the natural forces

continuously, right from the time of origin of life. However, man with his acts of omissions and commissions are creating an alien and in hospitable environment, even much faster than the changes being brought about by the natural forces. Man with his highly evolved nervous system and superior intellect, equipped with high potential for reasoning and logic, had never indulged in a long term futuristic application of mind. In this respect, he appears to be no better than his inferior creatures not gifted with these powers.

A BIRD'S EYE-VIEW OF NANDESARI INDUSTRIAL BELT

Baroda being a major centre of industrial activity in the state of Gujarat, the threat of environmental pollution looms large over the horizon. In recent years, Baroda has become a mega Industrial city with the advent of large complexes like GSFC, IPCL, Refinary, Petrofils, GSFC, Polymers, ONGC, Heavy water plant, Gujarat Dyestuff Industries, Indian Dyestuff Industries, and ABS Plastics, besides many medium and small scale industries catering to the production of H-acid, Dyes, Intermediates, Thionylchloride, Vinylsulphone, various chemicals, Fertilizers and Pharmaceuticals. All the mega complexes, except ONGC, along with the biggest industrial estate, the Nandesari complex, being clustered around the northern limits of Baroda city in the vicinity of river Mahi, has

made this area a hot bed of industrial pollution totally offsetting the lucrative employment opportunities and economic returns that they offer.

Initially the industries used to discharge their effluents into the river Mahi and a tributary rivulet, the Mini. The disposal of industrial waste through Mini into Mahi started at about 1962 and later increased to very high proportions. Sporadic incidents of death of fish and cattles after drinking water from the confluence point of rivers Mahi and Mini, occurred in late 1960's and early 1970's. The increased discharge of industrial effluents into these rivers and the incessant complaints from the populace residing along the banks, led to the appointment of a technical committee in 1969 to investigate the problem of pollution of Mahi. The committee after careful consideration of the problem and much deliberations came out with a solution, and recommended conveying and discharging of effluents into the Mahi estuary at the Gulf of Cambay. Following ecological studies by the National Environmental Engineering Research Institute (NEERI) and Hydrographic survey by National Institute of oceanography (NIO) and, planning by the Gujarat State Public Health Department (GSPHD), it was decided round about in 1979, to collect the effluents into a common channel and discharge it into the estuary at the Gulf of Cambay. This decision was

implemented by making in 1983, a 56 km long effluent channel passing through 24 villages of Baroda and Bharuch districts and ultimately terminating into the estuary near the village Sarod. The *modus operandi* of the entire programme as envisaged, included treatment of effluents by the industries in the primary treatment plants at their own premises, followed by collection and collective treatment at a common treatment plant and ultimate disposal into the effluent channel for conveyance and discharge into the Mahi estuary. The channel has been in operation since 1983 and volumes and volumes of effluents have been discharged into the Mahi estuary for the last 12 years. Having commissioned the channel, no authority of any kind has ever bothered to make an environmental assessment study, which is a must, in order to periodically review, assess and device remedial measures. It is not only that there had never been any assessment study, but the villagers along the channel are continuously pilfering the channel effluent for irrigating their land and growing vegetables and cereal plants. Since, the industrial effluents are likely to contain toxic chemicals and other pollutants, inspite and despite of treatment, a close monitoring and check of use of such water for irrigational purposes are warranted. Continuous process of irrigation, year in and year out, is likely to pollute the soil, the vegetation and even the underground water bodies. Besides,

continuous discharge of the effluents into the estuary is likely to affect the ecology of the estuarine system and cause irreparable damage. It is the lack of any environmental impact assessment since the commissioning of the channel, that prompted the present investigation on this line. Exhaustive studies are carried out on the characteristics of the effluent water, the quality of the estuarine water at the point of confluence, down stream of it and also upstream of it, together with analysis of metal content in the estuarine sediment, the soil and vegetation along the channel and, also in the tissues of an estuarine fish. Our studies have revealed provocative and alarming trends. It is clear that the acidity of the estuarine water is increasing and DO is decreasing, while there is tremendous increase in TDS, SS, TS, Cl, So_4, BOD, COD, oil and grease, phenol, cyanide, hardness and metals. Similarly, there is precipitous qualitative change in the water of some of the wells. This is well reflected in the increased metal content of the soil and vegetables of the area. There is depletion in the fauna and flora of the estuary and, even those fishes surviving in that area show pathological alterations in their organs.

CASE REVIEW :GENERAL AND, IN SPECIFIC REFERENCE TO THE BARODA EFFLUENT CHANNEL

In the ecosystem terminology, most of the tropical

marine ecosystems are characterised by being highly productive and highly diverse. Throughout the tropics of the world, specific cases are recorded of damage by oil spills, sewage, dredging operations and filling. Though the tropical marine ecosystems are very productive, in most cases not enough is known about the biological mechanisms to ascertain the causes or the levels at which pollutants affect (stress) the ecosystem to the point of triggering collapse or radical transformation. Because of variability in environmental factors, some of these ecosystems are high diversity indices and, some have low indices. Estuaries are good examples of low diversity, presumably because of short term, severe abiotic fluctuations. Available evidence suggests that these ecosystems are unstable, hence violent changes in pollution balance can occur. Man tends to congregate around estuaries, especially industries, to discharge the effluents and in this context a large amount of evidence of pollution damage is accumulating. Continuous dumping of effluents and wastes into the estuaries and deep Oceans are putting these ecosystems to extreme stress and causing ecological damage. Of the various pollutants of the disposed effluents/wastes, highly toxic but short lived pollutants are less important than those that persist for long periods of time and likely to cause considerable damage to organisms.

Industrial pollutants consisting of heavy metals and other inorganics, petroleum, petrochemicals and other orgnaics, and a vast spectrum of pesticides and detergents are entering the marine environment on a massive scale. Most of these substances have varying degrees of toxicity to both marine organisms and man. Most have great public health importance and constitute a serious threat to the future utilization of fishery and other marine resources. These poisonous substances pose special problems in environmental toxicology because of their extreme persistence and bio-accumulation. Many of these materials are highly lipophilic and are not adversely affected by water. Some become protein bound within the body of marine organisms and thus enter the food-web at all tropic levels including that of man. Evidence of toxicity of these industrial pollutants is being increasingly observed in the marine environment by the steady increase in cancerous growth, leukemia, skin ulceration, tail deformities, genetic changes and other disease condition in fish and shell-fish taken from heavily polluted areas, like southern California, Washington, New York, the Baltic sea, etc. A vast plethora of highly toxic and carcinogenic substances now persist in the marine environment. Some of the most serious aspects of the overall marine and estuarine toxicological problems are those of low level, long term effects. At present, acute toxicity, particularly lethality,

is used as the prime indicator of toxicity and pollution. However, accute toxicity is an unreliable standard and a poor indicator of what may actually be taking place within the environment : therefore, attention must be directed towards the detection of early or relatively low levels of injury. Consideration should also be given to the extrapolation of data on the toxic effects of marine and estuarine animals and their application to man. Generally, permissible levels of environmental toxicants in the marine and esturaine bodies are fixed by various agencies all over the world, but much of the data are of questionable significance and validity in the light of the long-term persistence and bio-accumulation of toxicants in these environments. There is an almost complete lack of data on the synergistic effects of these toxicants on both marine and esturaine environments and man. Research is also urgently needed to throw light on the acute and low level chronic effects of pollutants on a wider range of vertebrates. An eco-toxicological approach is required which will elucidate the synergistic effects on pollutants, and the resulting interactions, and their effects on fishery resources. Studies on the role of pollutants in the biogenesis of marine bio-toxins and their effects on fishery resources particularly in tropical latitudes are needed. There is a requirement for a multi- disciplinary approach involving basic biology, fisheries, chemical, toxicological

and health sciences, if these problems are to be effectively handled.

Coming to the present specific case, of the effluent channel at Baroda and discharge of effluent straight into the Mahi estuary (Figs- 1a, 1b), all the above mentioned facts, possibilities and predications hold good. It is indeed comically somber that in the midst of much trumpeting and high profile canvassing and propaganda about environmental protection, conservation and bio-diversity in recent times, creation of various governmental agencies towards these ends and, the sprouting and mushrooming of so-called environmental conscious NGO's and associations, the impact of the effluent channel discharge into the Mahi estuary on its ecosystem, including afflictions of the local populace, had never been thought worth assessing, though the channel had been in operation for the last 12 years. In this context, the picture that is getting projected from the environmental impact assessment (EIA) studies presently carried out is distressful, and poses a looming threat *incognito* with wider implications. Some of the unique features of the mosaic picture are -

1) A nearly 60 km stretch of denuded and barren estuary, extending from Sindhroad, 58 km upstream of the J-point

Figure 1a: The terminus of channel at the "J" Point and the effluent gushing out.

Figure 1b: The effluent flowing out into the estuary at the Gulf of Cambay.

Figure 1c: Stretch of barren and denuded estuary at the "J"- point.

1a

1b

1c

at Nahar to Shiv temple, about 3 Km down stream of the J-point (Fig- 1c).

2) Progressively deteriorating quality of the effluent with unwarranted physico-chemical features, many of them on the wrong side of the fixed norms, and increase in metal content.

3) The reflection of the above in the form of corresponding deteriorating quality of esturaine water, getting more pronounced in the upstream.

4) Tremendously increasing metal content in the estuarine water and sediment.

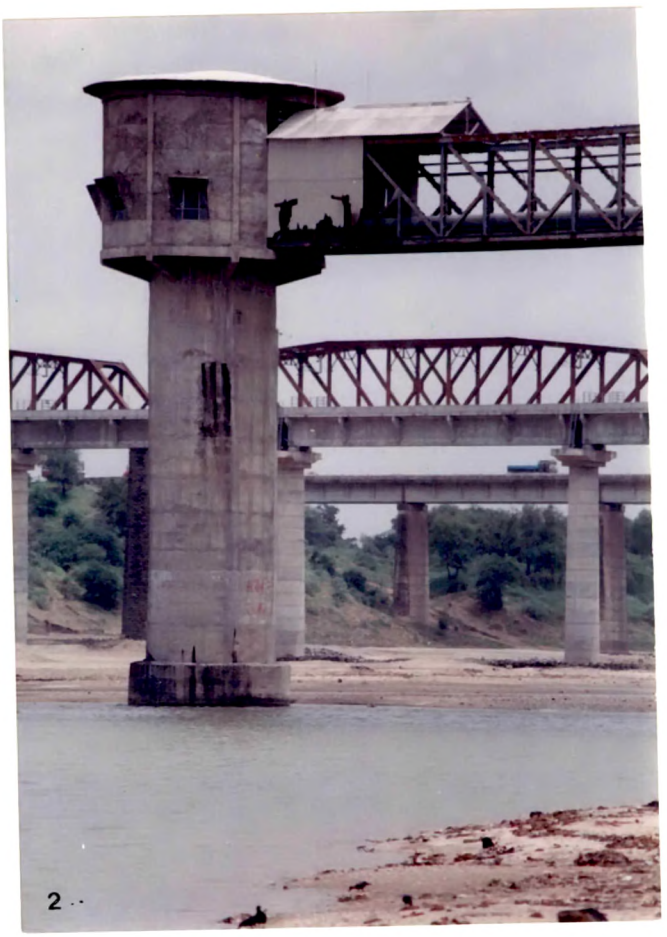
5) Significant accumulation of the various metals in the tissues of the fish, *B.dussumieri*, a lone skeletally surviving fish in the stretch of estuary with histo-pathological alterations in their gills, liver, intestine and ovary.

The increasingly deteriorating quality of the upstream water is, due to the poor dilution effect of the Mahi estuary due to its structural peculiarity, as well as continuous discharge of untreated and highly polluted effluents through the rivulet Mini. The poor dilution effect of the Mahi estuary and the ecological ramifications of the discharge of

effluents into the Mahi estuary had been recognised by NEERI and NIO as early as 1975 (NEERI, 1975). The above report had also talked about the sharp decline in the species diversity of the aquatic flora and fauna due to the cumulative effects of the pollutants in the river. Exasperatingly, 20 years thereafter and about 12 years after the commissioning of the affluent channel, there has been no survey or evaluation of any kind to assess the impact of the channel in terms of degree of damage to the esturaine ecosystem. A great cause of worry in this context is the known capacity of the tidal ingress of the Mahi estuary to push up the river water upto Vasad bridge, a distance of nearly 60 km. With the upstream region of the estuary being highly polluted, due to the reasons cited above, the tidal ingress can carry these pollutants upto Vasad bridge where the French wells are dug for supply of potable water to the western parts of Baroda city (Fig- 2). This can create serious health problems in the years to come, or even cases occurring due to this cause may be going undetected.

This bleak scenario is further confounded by the practice of the populace living along the channel in the form of unhindered pilferation of the channel effluent for irrigating the land along the channel for purposes of growing vegetables and cereal crops and even tobacco (Figs-

Figure 2: The French well in the river Mahi near vasad bridge for supplying of drinking water to western parts of Baroda city.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3a, 3b). It is indeed baffling that such usage of the channel water has gone unchecked for all these years, when the quality of the effluent water is not what it is supposed to be, and is apparently unfit for irrigative purpose. Shocking as it is to the uninitiated mind on the ways of Governmental agencies, there has never been any attempt at assessment of the impact of such practice on soil and underground water qualities or, on the vegetables produced or on man. The present assessment in this respect carried out with the restricted aim of gauging the metal load of the vegetables, cereal grains, grass and tobacco from the area and also the metal load and physico-chemical features of the well waters in the area, have provided the following picture.

1. There is increasing soil metal content on yearly basis.
2. The vegetables, cereal grains, the grass and the tobacco of the area have very high levels of metal content. Some of the wells have got tainted with abnormal physico-chemical features and also increased metal content.

If this practice is continued, the prognosis is somber, and fraught with dire consequences. To the chagrin of those concerned, what defies logic and sane thinking, is the utter neglect and disregard and the zombic indifference of the authorities. The entire stretch of land is likely to

Figure 3a: The villagers fixing/checking and operating a large water pump for pumping effluent water from the channel.

Figure 3b: The huge pipe from the pump being taken up and connected with the common distribution tank in which well water is stored. The mixed water is then distributed into fields.

3a

3b

become barren and unsuited for human habitation as, it is bordered on the north by the much polluted river Mini (Figs-4a-4d) and by the channel on the south. With Mini being a perpetual receptacle of various types of untreated effluents emanating from the various mushroomed industries in the Nandaseri complex, and often discharged by devious means through the so-called by-pass channels and, on the other hand continuing pilferation of channel effluent for irrigation (Figs- 5a,5b) together, pose an unforseen and unfathomable danger of underground seepage and spread, leading to pollution and adulteration of all underground aquifers. This would make the well waters of the area non-potable and the soil unfit for human subsistence. The situation is akin to that of slow poisoning.

A very serious aspect which escapes much needed attention is increased content of metals in the vegetables, cereal grains and other vegetation grown/growing along the channel which could ultimately affect man. There are two related aspects worthy of consideration which portend potential implications to man -

1) With the continuously increasing metal content of the effluent water and the unhindered usage of the effluent water for irrigation, the soil metal content is bound to register temporal increase. This in turn can result

Figure 4a: The river Mini at Angadh from the weir (arrow). Note the completly polluted water.

Figure 4b: The water from river Mini opening to the other side of the road at Angadh through under road drain.


4a


4b

Figure 4c: An enlarged closeup view of the under road drain opening.

Figure 4d: The river mini flowing along ravine towards Jaspur.


4C


4d

Figure 5a: Channel water being pumped into natural drain, for purpose of gross irrigation of fields. Note an onlooker watching the nallah.

Figure 5b: The natural drainage nallah with channel effluent flowing away to fields on the yonder.

5a

5b

in increased uptake and concentration in vegetables, cereal plants and other types of vegetation.

2) The metal content of vegetables and cereal grains grown along the channel is already relatively high but, could be passed off as within the permissible levels or below dangerous levels as stipulated by the highly inflated levels prescribed by the authorities. However, irrespective of whether the level is potentially hazardous or not, the populace of Baroda who consume these vegetables and grains continuously over the years is bio-accumulating these metals in their body, which in due course of time can build upto potentially dangerous levels resulting in various afflictions and ailments. What the authorities fix as a safe level of metal content is, in one pack of food or in a particular vegetable/cereal. But what escapes a rationale and logic aspect is that, man does not consume only one pack of food or eat a particular vegetable or cereal grain, only once. He consumes vegetables and other food items many times a day, every day, every week, every month and every year. In this process, the purported safe levels add up to most unsafe levels over a period of time. Another source of entry of higher levels of metals is by smoking

cigarettes and beedies made from tobacco leaves grown along the channel. It is also seen that the grass of the area also have relatively higher metal content which can directly affect the cattle, goat and other domestic animals in the area. Consumption of milk from these animals and usage of these animals for meat purpose could also serve as an indirect source of entry of metals into the human body. A strong corroborative evidence of bio-magnification and accumulation in the human body is provided by the presently reported higher hair metal content in the Baroda populace.

The various aspects reviewed in the background of the Baroda effluent channel and the aftermath of it in terms of environmental quality and its relation to human life, seems to be like a long term programmed human engineered slow ticking environmental time bomb. If not taken seriously, or not assessed judiciously and rationally, it could be not only a total estuarine and terrestrial degradation of the area, but also cause of untold human misery and loss.

MALADY AND REMEDY

Looked at the present impasse with hind sight, it is apparent that Mahi and its estuary at Cambay are not well suited for heavy effluent discharge. This is related with the

structural peculiarity and the less diluent capacity of the estuary as has been well recognised by the agencies which undertook a survey of the Mahi river and its estuary before recommending the construction of an effluent channel for disposal of effluents from the huge industrial complex in the Nandesri belt (NEERI, 1975). The plan envisaged the commissioning of a common effluent treatment plant at the head (start) of the channel, with the idea of extensive treatment of the effluents received from various industries before the release of the treated combined effluent into the channel. The member industries were required to subject their effluents to an in-house primary treatment prior to conduction into the common treatment plant. Though these well intended measures were envisaged and emphasized, they remained on a theoretical basis on paper and, today, as late as 12 years after the commissioning of the channel, it is disconcerting to note that the common effluent treatment plant (CETP) has never come into operation, least to say not even commissioned. It is a matter of consternation, that the CETP though built, has not been put into use and, one fails to understand the reasons or the intricacies behind this unsavoury situation. The very disagreeable physico-chemical features and the high metal content of the channel effluent, bear mute testimony to the above. If this impasse continues, not only the complete Mahi estuary and a vast

stretch of the upstream area of the river itself would be completely wrecked, but even, the villages and the populace along the channel would be seriously affected. So, it's time that the concerned authorities, agencies and industries sat together and hammered out a solution in all earnestness to mitigate the situation and to prevent any further environmental degardation. Another matter of cause and worry is that, the member industries do not even carry out proper in house primary treatment due to one reason or the other. These facts have totally off set the purpose and intend of an effluent channel.

Environmetal conservation requires not only an acute awareness but also committed practical willingness to take/implement suitable measures or else it remains simply a catchy jargon. It is possible only if there is sincere participation by planners, thinkers, scientists, politicians, agencies, industries, individuals and society, and also co-hoerent and purposeful interaction between them. Looking to the present problem of the channel and discharge of its effluents and its damaging impact on environmental viabiliy, some remedial measures have to be identified and implemented. They are -

1) Every industry must become conscious of its responsibility and, even at the cost of some cut in

their profit margin, should construct and operate in-house treatement plants meticulously and continuously.

2) The common - ETP should be commissioned at the earliest and operated at its best and to this end, the concerned authorities, agencies and industries should become self conscious or else be goaded by public pressure to iron out a solution.

3) There must be constant monitoring of the levels of pollutants in the estuary and the river and the organisms in them, and also setup an efficient institutional frame work for the anti-pollution fight.

4) The usage of channel effluent by villagers along the channel for irrigative purpose should be striclty prevented till such time that the channel water becomes fit for irrigation.

5) In any case there should be constant monitoring for the content of metals and other pollutants in the vegetables, food grains and other vegetation grown along the channel.

6) There should be sporadic monitoring of well water and underground aquifers in the area for detection of contamination.

7) There should be medical screeening of the populace residing along the bank of the rivers as well as those residing along the channel for identifying any potential link between endemic pollutants and some common ailments/diseases.

8) Discharge of untreated deleterious effluents surreptitiously through concealed by-pass channels into the Mini, should be completely prevented. Also, direct discharge of such effluents into the estuary through tankers should be stopped. To meet these eventualities, tight vigilance should be maintained and strict punitive action should be taken against erring industries/parties and, if need be, even lock up or cancellation of license should be resorted to.

9) Issue of license to any new industry in the area should be strictly withheld unless and until they comply fully with the expected safe-guard and necessary control measures including an effective and efficient treatment plant and its operation.

10) Since the effluents from the area have high metallic contamination as well as dissolved inorganic solids and other complex organic solids, the authorities, and industries should think of, and plan and device methods

of tertiary treatment which may include processes like chemical precipitation, ion exchange, reverse osmosis, electrodialysis etc.

11) Researches aimed at screening, identification and isolation of appropriate plasmid bearing microorganisms capable of metal utilization and degradation should be promoted and funded adequately, Efficiency of such organisms when isolated can be potentiated and broadened by genetic manipulation.

12) Till such time, alternative measures like growing metal concentrating plants on a large scale should be explored.

13) Last but not least, is the need for proper inculcation and awareness among industrialists, politicians, scientists and concerned authorities for environmental protection and a genuine concern for the society at large.

In a nutshell, the EIA study along the channel and the Mahi estuary has helped in bringing out certain aspects of environmental impact of the much publicized Asia's the only and India's largest effluent channel. The salient points emerging from the assessment are -

1) The so called treated effluent flowing through the

channel is still rich in pollutant load capable of causing considerable harm to living systems.

2) The illegal and willfully unchecked pilferation of the channel water for growing seasonal crops and vegetables along the channel by the populace has created a situation of ever increasing soil metallic content with an immediate consequence of bio-accumulation in the vegetables and crops and possible long term consequence of seepage and contamination of underground fresh water aquifers leading to pollution of the sources of potable water.

3) The continued consumption of the vegetables and corps grown in that area by the local populace or by others in the district of Baroda, where they are usually marketed, is likely to create health hazards over the years.

4) The dumping of the effluent waste with increasing pollution load, into the Mahi estuary at the Gulf of Cambay, has altered the estuarine aquatic environment perceptibly with dire consequences to the estuarine eco-system, partly already manifested and partly potentially iminent.

5) The above points are well justified by the observed accumulation of toxic metals in the tissues of an endemic species of fish, together with accompanying histopathological alterations and the perceptibly declining population of this species over the years.

6) The metallic load of the effluent channel can be well correlated with the observed higher content of metals in the hair of individuals residing in the Nandaseri industrial belt, and also the residents of Baroda in general.

Over all, the findings of the present study portend potential hidden environmental and health hazards which in all probability are likely to remain hidden and unknown due to the expected and publicized nature of the project and, apathy of the authorities as well as the acts of the unsuspecting and gullible populace along the channel (Fig-6). It is in this behest, that the earlier mentioned remedial/protective measures are proposed.

Figure 6: The unsuspecting local populace standing atop the channel with their crop growth behind. Note the openable sites of the channel (Arrow)


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