WATER ALLOCATION POLICIES IN COASTAL KARNATAKA: AN ANALYSIS OF NETHRAVATHY RIVER BASIN

Ramachandra Bhatta*

Abstract

The paper to looks at the water allocation policy follow in coastal Karnataka. The state water policy accords top priority to drinking water followed by irrigation, power generation through hydroelectric projects, agro industries, industries and transport. However, there is a mismatch in the policy and its implementation. The analysis of the information and data shows that there are negative social and ecological impacts on the livelihood of the farmers and fisher folk because of poor implementation of these policies. Karnataka Agricultural Policy - 2006 is focused on doubling the agricultural production in the next decade with the aim of achieving a 4.5% growth rate for the agriculture sector and a subsequent increase in the net income of the farmer. Simultaneously, the Karnataka government is planning to set up a PCPIL (petroleum, chemicals and petrochemical investment region) in Dakshin Kanadda (DK) and set up MSEZ near Mangalore as a precursor to the PCPIL project. The area selected for setting up the petrochemical zone comprise villages which are currently involved in agriculture, horticulture and fisheries. The establishment of PCPIL and MSEZ are likely to increase the pressure on the Nethrawathy and Gurupur river basins and cause serious degradation of the marine ecology of the region adversely affecting fist yields. The proposed project is similar to the Reliance petrochemicals project in Jamnagar, Gujarat, which has had serious implications for the welfare of the villages displaced and the ecology.

The paper tries to analyses and point out ways in which DK and Mangalore region are likely to be affected because of the proposed petrochemical development. The state has pursued and implemented the water policy contrary to the suggestions from expert recommendations. This is likely to lead to negative impacts on the livelihood of the local communities.

1. INTRODUCTION

The state of Karnataka has a geographical area of 1,50,162 km^2 and is divided into three distinct natural divisions based on climatic conditions and soil type. The coastal plain spreads to 16887km^2, comprises the three districts of Dakshina Kannada, Udupi and Uttara Kannada and receives an average rainfall of 4,000 mm/yr. The second zone is Malnad zone, a densely forested land covering an area of 28,000kms^2, comprises the districts of Dharwad, Shimoga, Chikamagalur, Hasan and Kodagu and receives an average rainfall of 2,500–3,000mm/yr. The third zone, Maidan zone has a land area of 105,113 km^2 (70% of the Karnatakas total land area), with an average rainfall of 500 mm. Karnataka has a monsoon tropical climate and a bulk of the rainfall occurs during southwest monsoon period of June-September.

The coastal ecosystem of Karnataka is a mosaic of monsoon wetlands, beaches and mountains stretched along its 300 km long shoreline. The Western Ghats separate the coastal eco-region of the state. A number of rivers flow from the Western Ghats. These rivers before joining the sea form vast estuaries y and support fish production in both coastal waters and estuarine waters. Coastal wetlands are an important source of economic livelihood for local communities generating income in millions of rupees. The coastline has more than 26,600 fishing units. The region harvests prawns and commercial fish species including sardines, mackerels, oil sardines and some crustaceans. In 2004, Karnataka exported 1500 tonnes of marine products worth Rs. 2000 million. The higher fish production of the Karnataka coast could be assessed by the fact that with only one-third of the coastline of Andhra Pradesh, Karnataka produces as much fisht as Andhra Pradesh.

*Professor and Head, Department of Fisheries Economics College of Fisheries, Mangalore. Email: rcbhatta@gmail.com

Mangalore is one of the fastest growing cities in South India. It is located in the southern region of the west coast of India and lies on the confluence of the Nethravathy and Gurupur rivers and spreads over an area of 141.77 km^2. The population of Mangalore city was 4.60 lac as per 2001 census and is projected to reach 6.82 lakh by 2020.

The city hosts major industries such as oil, fertilizers, chemicals and thermal electricity. These developments have increased the stress on the river to provide water for a variety of services such as drinking, commercial and industrial needs. Large scale expansion of industries during 1990s and later such as fertilizers, chemicals, petrochemicals etc have increased the conflicts in water utilization.

The study provides insights into the nature of the conflict that can emerge as a result of pursuing water allocation policies that do not reflect the concerns of the society at large. This is done through an assessment of the social costs of increasing reallocation of water from Netravathy river basin meant for drinking and irrigation for industrial uses. The specific objectives of the paper are as follows:

To study the current status of water utilization of Nethravathy river, to assess the impact of water allocation policies for industrial growth to study the extent of economic losses to crop and fisheries sectors with diversification of water.

2. WATER UTILIZATION IN THE NETHRAVATHY BASIN

The Nethravathy Rriver length is only 120 km and 50% of it is the Ghat section. The estimated flow of the river is approximately 12,000 million cubic meters (MCM) at 50% dependability and 9400 MCM at 95% cent dependability. Further 78% of the flow is during monsoon and another 20% flows during immediate post-monsoon period. This leaves only 2% of the flow available in the 6 summer months. But, the drinking water supply and irrigation needs, which actually increase substantially during summer, are heavily dependent on lean season flows. Nethravathy River river is the main source of drinking water supply to Mangalore city, one of the fastest growing cities of South India. It lies on the confluence of two rivers namely, Nethravathy and Gurupur, and is spread over an area of 141.77 km^2. One of the important impacts of impoundment of water is that , the down stream flow will consequently be reduced, especially during Jan-May.

Table 1: River flow Pattern of Nethravathy (Million cubic meters)

Month	MCM
June	936
July	4104
August	3606
September	1719
October	940
November	505
December	117
January	66
February	40
March	26
April	15
May	66
Total	12080

The large petrochemical complex plans to utilize the Nethravathy river water to meet part of its water requirement. This is based on the premise that 98% of the river flow is still unutilized. However, due to topographical factors and seasonality of the river-flow, it is not possible and feasible to utilize the river water even to the extent of 2-3%. If we have to make use of this 240 MCM (2%) the entire water needs to be stored with the help of small reservoirs. Even if we construct check dams on Nethravathy River river at a distance of 10-12 km over a stretch of 50 km it is possible to store only 150 MCM of water. This is just enough to meet the requirements of cities, towns and rural areas of the catchment. Hence, there will be no surplus water in the storage that could be made to make available for the new industries.

The additional utilization of water from the river will be possible only through diversion systems. Part of the diversion to meet the concurrent water demands for industrial water use will occur during the lean season. This will reduce the lean season discharge of the river. Such reductions in river discharge will change the conditions of mixing and exchange process in the estuary. As the results of a research by George Abe et al (1997) show, the salinity intrusion magnitude and length will increase appreciably if the river discharge reduces to about $25m^3$.

The proposal to provide water supply, through four barrages, to meet a requirement of 15 MGD of water[1] for a petrochemical refinery in the newly established MSEZ Ltd (Mangalore Special Economic Zone Ltd.) would further reduce the lean season river discharge. This would significantly affect the estuarine and marine fisheries.

The reason is that lean season flows are required for the enhancement of dissolved oxygen and nutrient content such as nitrate, phosphate and silicate in coastal waters. For instance, Humborg et. al. (1997) reported that river discharge plays a major role in bringing large quantities of silicate into coastal waters. Kumar (2004) showed the effects of river discharge in reducing BOD, ammonia and concentrations of toxic trace metals in Nethravathy waters. A study on Nethravathy river by Kumar (2004) very clearly established the adverse effects of reduction in river discharge and increase in salinity and water temperature due to diversions on nutrients (NO_3 and SiO_3) and dissolved oxygen supply to coastal waters.

The time series data of lean season flows in Nethravathy River for 1989-2002 clearly shows an already declining trend in the river discharge to the estuary. With the existing anthropogenic activities, the water temperature, salinity, Ph, nitrate, phosphate, ammonia, TDS and TSS is significantly higher in Nethravathy River when compared to Sharavathy River. The studies have shown that with the proposed new impoundments and diversions, out of 80 days of lean period, the river will have no flows for 64 days (Krishna Kumar, 2004). This would affect the downstream fisheries and population of estuarine fishes and shrimps due to decline in primary productivity of the river.

3. IMPACT OF NEW INDUSTRIES ON RIVER POLLUTION

There is a proposal to establish PCPIR (Petroleum, Chemicals, and Petrochemical Investment Region) by notifying 300 km^2 in Dakshina Kannada district[2]. But, such decisions were not based on proper environmental impact assessments. The justification for the establishment of such a region is that there is large area of non-agricultural land available in the district. Contrary to this, the fact is that the agricultural land available around Mangalore and DK is known for the production of paddy, fruits and vegetables, horticultural crops such as cashew, areca-nut and floriculture. Recently, Dakshina Kannada was selected for the development of horticulture under the Horticulture Mission Project of the Government of India. Whereas, Jasmine, widely grown in the district, is known internationally, and many small, marginal and land-less families are able to earn a good

[1] This is out of the total requirement of 48 MGD of water.

[2] The project proposal was prepared by Karnataka Industrial Investment and Development Corporation (KSIIDC) for the approval of the Government of Karnataka which received the state government approval in August 2007 and sent for the approval of the Government of India. The setting up of strategic storages of crude oil in phases to construct 15 million ton of strategic storage of oil at an estimated cost of Rs.11267 crore over a 9-year period will take six years to build the storage and 3 years to actually fill the same. While all this is for securing just 15 days of reserves, presently the oil companies have product-holding capacity for 83 days

livelihood. Still, the cropland is getting converted because of forcible acquisition by the state for industrial development in the private sector.

KSIIDC had been asserting that PCPIR is environment-friendly. But, as per the recent research by Nayar (2003 and 2005), high concentrations of dissolved or dispersed petroleum hydrocarbon (DDPH) and absorbed or adsorbed petroleum hydrocarbon (AAPH) in the estuary may exert adverse effects on biotic components, particularly those sessile organisms that may not leave site in event of a severe oil spill. The final pre-feasibility report on Mangalore PCPIR does not mention about any survey to determine impact of petrochemical waste on the fisheries environment[3].

Many factors such as toxicants, salinity and eutraphication (excess nutrients) are likely to influence aquatic plants, mangroves, phytoplankton and fisheries. It is important to quantify the existing level of effluents released into the sea and the existing biological carrying capacity of the system here. The increase in effluents and nutrient releases into the river with the setting up of the proposed complex would adversely affect marine life and aquatic plants. This impact on marine life through algae-bloom has been substantially researched in similar ecosystems elsewhere (Nayar et al. 2004 & 2005). The direct impacts of hydrocarbons would be increase in toxicity causing mortality of aquatic plants and animals. The indirect impact would be through food webs of basic physiological aspects or due to environmental change. Most of these direct and indirect impacts could be chronic and acute. Any EIA would be incomplete without proper quantification of acute and chronic toxicity with direct and indirect impacts.

The total water demand of PCPIR (Petroleum, Chemicals, Petrochemicals Investment Region) covering an area of 70,000 acres of land in the coastal hilly region of the district was placed at 641 MLD (144 MGD) and it proposes to source water from Gurupur and Mulki rivers. The pre feasibility report also suggests that existing water impounding structure at Thumbe across Netravathy river can be upgraded. Experts in fisheries ecology say that this would lead to an increase in salinity of estuaries of Gurupur and Mulki rivers due to over usage of river water. The estimated water requirements for petrochemical industrial development in different phases are presented in Table 2. The water is to be sources from three rivers, viz., Nethravathy, Gurupur and Shambhavi. Nearly 76 MLD of effluent and 13 MLD of sewage would be generated in first phase of PCPIR.

Table 2: Estimated water requirement for petrochemical industrial development (PCPIR)

Sr. No	Phase	Total Water Requirement(MGD)
1.	Phase I	45
2.	Phase II	44
3.	Phase III	55
	Total	144

The total water demand of Mangalore city including the utilization by the existing industries such as Mangalore Chemicals and Fertilizers, Kudremukh Iron Ore Company Ltd and many other small scale industries alone is 18 MGD. The total water requirement of one single largest industrial unit will be 8 times higher than the present requirement of the city.

With many industries and municipalities releasing sewage without any tertiary treatment, additional sewage and effluents from PCPIR would cause eutraphication of marine water causing an increase in phytoplankton and reduction in dissolved oxygen levels in estuaries and sea. Experts warn that undesirable increase of phytoplankton would be toxic to fishes. Oxygen level in sea water had decreased due to many reasons and further decrease in dissolved oxygen levels may result in mass mortality of aquatic organisms including commercially important fishes.

[3] Report says that potential environmental impacts had been identified and measures required to mitigate impacts had been identified.

The water flow of Gurupur River is 4127 MLD per year which is one of the main sources of water for the proposed PCPIR (which has 3 times less flow compared to Nethravathy River) out of which 90% flow is during June-Sept (monsoon and post monsoon period). In order to create storage dam to meet the water demand of 46 cubic meters, we will have to construct a dam, which would be almost 10 times the existing dam at Thumbe, which has the capacity to store 4.8 cubic meters to supply drinking water to the city. Thus, water storage capacity has to be created for 8 times the existing dam with less than 3 times water flow. Meanwhile, Petroleum, Oil and Lubricant (POL) traffic had also increased considerably in Mangalore. POL traffic through NMPT was 6, 12,000 ton in 1991 and increased to 1, 63, 18,000 in 2005. This has already contributed to increased oil pollution in the project area.

Table 3: Sources of water supply for Phase I of the PCPIR (Million Gallons per Day)

Source	Water supply MGD	Storage requirements	Assumptions
Nethravathy	10	2 barrages	There will be no reduction in the flow of water to the Thumbe
Gurupur	5	2 barrages	
Treated Sewage	18	3 STPs through a SPV	STPs will supply 18 MGDs
MSEZ Reservoir	12	5 MCM	Reservoir will supply 12 MGD
Total	45		

4. GAPS IN WATER ALLOCATION ASSUMPTIONS

Sewage treatment plants (STPs) will be unable to supply 18 MGD until 2026. Reservoirs will be unable to supply 12 MGD due to seepages and evaporation. For drinking water supply, provision of 90 days of storage has been considered while a minimum need is that of 110 days storage. No reservoirs and STPs would be available. River water would be the only source of additional water. 4 barrages are expected to supply 15 MGD water for Phase I. By the same analogy, theoretically, for 99 MGD 27 barrages would be required. That adds up to 9 additional barrages across each of the three rivers. However, the water yield declines as we go up and getting enough supply is impossible. River flows to Thumbe dam, which is the main storage of drinking water to Mangalore City will be affected and hence Mangalore City Corporation will have to constantly haggle with district administration and PCPIR during summer months. Other smaller but growing towns along the Nethravathy will also face water scarcity. Farmers will have to sacrifice cropland (with large area being impounded) and pay higher price for access to water. It may be the beginning of the legal battle for water as a commodity, which was hitherto a free social good.

5. SOCIOECONOMIC IMPACT

The Dakshina Kannada is one of the most developed districts of Karnataka according Karnataka Human Development Index (Karnataka Development Report, 2006). The percapita income of the district is one of the highest in the country (Rs. 22,000/year) with least number of people below the poverty line (only 9%). In order to study the socioeconomic status of the farmers a socioeconomic survey was made in the region.

Table 4 presents a description of the sample villages, which are being acquired by the Karnataka Industrial Areas Development Board for the MSEZ ltd. Most part of the Tenka Yekkar and nearly 40% of the area in Permude villages are acquired for industries and hence the local households, institutions, culture and also local self governments are likely to be wiped out completely with the establishment of the industries.

Table 4: Description of the sampled villages

Particulars	Permude	Kuthetheoor	Yekkar (Tenka and Badaga)		Delantha Bettu	Total
Total number of families	652	650	660	549	295	2806
Total Population	3233	2675	3294	2419	1451	13072
Male	1554	1354	1600	1163	721	6393
Female	1679	1351	1694	1256	730	6711
Total area (acres)	1742	686	1582	2498	770	7278
Area acquired	874	344	447	-	440	2105
Sample size	38	—	92	—	17	147

Table 5: Housing Ownership and Pattern

Type of housing	Tenka Ekkar		Delantabettu		Permude		Total	
	no. of respondents	%	no. of respondents	%	no. of respondents	%	no. of respondents	%
Tiled housing	77.00	83.70	15.00	88.24	32.00	84.21	124.00	84.35
Cement sheets with RCC	6.00	6.52	0.00	0.00	1.00	2.63	7.00	4.76
Others	9.00	9.78	0.00	0.00	3.00	7.89	12.00	10.20
Total	92.00	100.00	17.00	100.00	38.00	100.00	147.00	100.00

Table 6: Education and Employment

Age	SSLC or Below		Degree/Diploma				Total	
	Female	Percentage	Male	Percentage	Percentage	Female	Male	Female
15 to 20	12.00	57.14	6.00	33.33	9.00	42.86	18.00	21.00
20 to 40	108.00	86.40	11.00	9.65	17.00	13.60	114.00	125.00
40 to 60	32.00	100.00	4.00	16.67	0.00	0.00	24.00	32.00
60 and above	18.00	100.00	0.00	0.00	0.00	0.00	8.00	18.00

The age and educational qualifications of the people likely to be displaced very clearly indicate that the proposed resettlement and rehabilitation package under which the company is promising one job for one family does not help majority of the project affected families. Table 6 shows that only 9.65% of the male and 17% of the female have education up to degree or diploma and hence only they could be employed in the company. All other families will have to be satisfied with very low unskilled jobs with low wages under contractual arrangements.

Table 7 presents the average income from different horticulture crops normally grown by most of the families in the area identified for industrial development. The table shows that the average percapita income in the region is 3-4 times higher than the income estimated by the company sponsored socioeconomic report (Lokesh et al.,). The Table 8 presents the economics of crop enterprises integrated with various horticulture crops (Nagaraj et al., 2005).

Table 7: Total revenue from plantation crops (average/family)

Items	Unit	Average Number of plants/family	Yield/tree	Price/unit	Total Revenue
Average family	number	5			
Coconut	number	15	150	6	13500
areca nut	kg	5	6	90	2705
Mango	number	3	150	4	1800
Jackfruit	number	4	20	10	800
cashew nut	kg	2	3	40	240
Teak	Cubic feet	1	$1feet^3$	1000	1000
Jasmine	-	2	2000	4000	8000
Banana	kg	15	10	22	2250
Pepper	kg	2	4	150	1200
Beatle nut	number	10	-	200/week	8000
Overall income/ family					39500
Per capita annual income					7900

Table 8: Economics of key horticultural crops and farming systems in Dakshina Kannada

Areca nut based horticulture farming system	Initial investment/ acre	Yield/acre	Gross income	Total cost	Net income	Ratio of net return to variable cost of cultivation
Arecanut pepper	20300	1200 kg+ 250 Kg	87000	27160	59840	2.20
Arecanut+ Pepper+ Banana	25300	1200 kg+ 250 Kg+5 tonnes	127000	37160	89840	2.41
Areca nut+ pepper + Cocoa	29050	1200 kg+ 250 Kg + 250 Kg	119500	32160	87340	2.71
Coconut	5000	3000 nuts	15000	6000	9000	1.5
Cashew	5500	210 Kg	6930	3700	3230	0.87
Mango	4347	1.5 tonnes	15000	11250	3750	0.33
Sapota	5000	1.8 tonnes	18000	12000	6000	0.5
Rambutan	3000	2000 kg	100000	12300	87700	7.13
Garcinia	3000	10 tonnes	50000	2500	47500	19.2
Jasmine (0.15 acre)	5500	2500 bundles	50000	29450	20550	0.69

Note: The economics of different crops are on per acre basis except jasmine

6. IMPACT ON LIVELIHOOD OF RIVER AND ESTUARINE FISHERS

Table 9 presents the cost and returns of multi-species harvests by the river fishers. The table shows that each fishing unit receives a gross income of Rs. 67096 per year out of which around 90% is shared by the crewmen since the capital investment is very less. The returns to labour are as high as 85% indicating the attraction of fishers in this sector.

Table 9: Cost, returns and profitability of river fishing

		Lady fish	Mullets	Mullets (Mugil sp)	Cat fish	Others	Total/unit
A1	Average harvest quantity/trip	4	9	3	5	3	24
2	Average no of fishing trips/year	70	200	200	200	270	200
3	Total Harvested Quantity (kg/year)	2449.55	4725.15	1919	1998.435	1562.2	12653
4	Price/kg	150	30	100	20	25	70
5	Total revenue (Average harvested quantity*fish price)	31687.42	12175	16464.26	3432	3338	67096
6	Net revenue(after 5% deduction of auction cost)	1584	609	823	172	167	3355
B1	Labour cost @90% of the harvested value	27093	10409	14076.94	2935	2854	57367
2	Boat rentals @10% of total revenue	3010	1157	1564	326	317	6374
3	Depreciation @10% of capital investment for crafts and gears	660	660	660	660	660	3300
	Returns to labour ((B1/Total revenue)*100)	85.50	85.50	85.50	85.52	85.50	85.50

The study by (Bhatta 2007) shows that the Nethravathy estuary alone generates a direct income of Rs. 7 crores/year for 350 fishers from fishing within a radius of 5-10 kms and a direct employment of 148200 days per year in the fishing activity it self. If we add the backward and forward linked processes in fishing and post-harvest the employment generation would be double. Further with the capital investment requirement of only Rs. 35000-40,000/unit the fisherfolk are harvesting 14000-15000 kgs of valuable estuarine fishes per year.

Table10 provides the gross income generated by the estuarine fishery and also labour employment generated per year. The study shows that the river fishing generates around 7 crores of income apart from generating a labour employment of 148200 days per year.

Any harm caused to the river discharge and water quality could lead to loss of livelihood and income to poor farmers, who do not have alternative income generating activities. The loss of fish catch over an 8 km stretch of the river with the establishment of river diversion dams could be enormous. Bhatta et. al. (2003) has clearly established the declining trend in marine fish production since 2000. It was estimated that the pelagic fish production would decline from 69412 tons in 2000 to 39937 tons in 2008 and demersal fish production could decline from 37120 tons in 2000 to 25780 tons in 2008. The overall marine fish production could decline from 140,000 tons in 2000 to 125,000 tons in 2008. It was observed that there is positive correlation between the increasing water pollution and fish productivity.

Table 10: Gross Income of the Estuarine Fishery

1	Average no of fishing trips/year	200
2	Number of crew/trip	2
3	Number of fishing boats	350
4	Average annual catch/year/unit(in kgs)	321
5	Number of labour days/year(No of boats*no of crewmen*no of fishing trips)	148200
6	Total income generated a. Rainy season (weighted average price*no of fishing days in rainy season*no of fishing boats)	2820000
	b. Summer season (weighted average price*no of fishing days in summer*no of fishing boats)	4000000
7	Total income (a+b)	6820000
8	Gross income from primary fishing activity (5+7)	6968200

7. EXPERIENCE FROM RELIANCE PETROCHEMICAL INDUSTRIES IN JAMNAGAR

Janpath, a state level network of voluntary organizations in Gujarat has conducted a tour along the coastline visiting 450 villages of 34 blocks of 13 districts of the state. The tour was organized under the banner of Dariya Kinara Samvad Yatra and was actively participated by large number voluntary organizations and community based groups. The experience of small-scale fisher-folk of the villages close to Reliance Refinery at Jamnagar in which the fishers experienced decline in fish catch was documented. The pipelines of the refinery is allowed to pass through the protected areas (marine national park) and because of this lot of marine life is being disturbed and destroyed. On the other hand, small fishermen are not allowed to fish in marine national park area. Four years back, one of the fishermen had accidentally reached into the areas near to the refinery and was fired by the by security.

It was promised by the company at the time of establishing the oil refinery that 33% of the total employees shall be from these villages, but not even 3% of their labour-force is from local area. The traditional fisher-folk of the villages near the refinery (sikka, sarmat, jodia), have experienced 50-60% reduction in fish catch during the past 10-12 years. They have observed oil spillage quite often in the inshore areas from where pipelines pass. Whenever there is oil spillage fish die in large numbers. Because of low fish catch, fishing community is forced to migrate towards Jakhau and Miyana. Farmers who had sold their land to Reliance Company have become daily wage earners. The monetary compensation they earned was spent within 5-10 years.

Past experience in places with high concentration of chemical industries in India is alarming. Vapi, which has a high concentration of similar chemical industries, was featured in the Blacksmith Institute's list of the ten most polluted environmental hotspots in the world. According to a report by the Indian Medical Association, pollution in Vapi has led to high incidence of respiratory diseases, chemical dermatitis, carcinoma and cancer of the skin, lung and throat. A high incidence of spontaneous abortion, bleeding during pregnancy, abnormal foetuses and infertility is reported among women. In children, there is a high incidence of respiratory and skin diseases and retarded growth. A 1999 study by Greenpeace in four industrial areas of Gujarat - Nandesari, Ankleshwar, Vapi and Sarigam - which use Common Effluent Treatment Plants (CETPs) to varying degrees showed that the CETPs fails to deal with all chemical pollutants. They found that not all heavy metals and persistent organic pollutants (POPs) were removed by the CETPs. At best, the effluent was converted into a highly concentrated sludge to be disposed of in a solid waste disposal facility. A Gujarat pollution control board

(GPCB) report in 1995 said that in Amlakhadi, a rivulet that flows through Vapi industrial area, the chemical oxygen demand (COD) was 11,007 mg/l against its own acceptable limit of 250 mg/l and the biological oxygen demand (BOD) was 442 mg/l against the GPCB acceptable limit of 30 mg/l. Mercury in groundwater near Vapi is 96 times the WHO limit according to the Blacksmiths Institute report. Even in developed countries, most solid waste disposal facilities are known to have polluted groundwater in the neighborhood.

The PCPIR will bring in a similar concentration of chemical industries resulting in similar consequences for the local environment. The proposed project poses very high risks to the surrounding population due to toxic emissions as well as due to the possibility of major accidents. The main anchor for the PCPIR, namely MRPL-ONGC, has a questionable environmental management record. Paddy fields and wells in the surrounding area were found to be contaminated with effluents and fishermen complain of a drop in fish catch since the commissioning of the refinery at MRPL. The MSEZ, which is the precursor for the PCPIR is located very close to Mangalore city. It will handle numerous hazardous chemicals. The Rapid risk analysis report for the expansion of MRPL, the first phase of the MSEZ, does not provide a worst case scenario analysis of the risks faced by the workers and general public. For example, it does not consider the possibility of catastrophic failure of an 8000 tonne storage tank for benzene which is a class A carcinogen. As Mangalore city has a high population density of 1500 persons per $km^{2,}$ there could be heavy loss of human life in the case of failure. Even during normal operation, leakage of small amounts of hazardous chemicals can lead to increased morbidity and mortality in the population. The site selection also violates the sitting guidelines of the KSPCB (Karnataka Pollution Control Board) itself in relation to proximity to major human settlements.

8. CONCLUSIONS

The state water policy accords top priority to drinking water followed by irrigation, power generation through hydroelectric projects, agro industries, industries and transport. Karnataka Agricultural Policy 2006 focuses on doubling the agricultural production during the next decade, achieving a rate of growth of 4.5% per annum for the agriculture sector and increasing the net income of the farmer. A comprehensive district agricultural plan in line with the state agricultural policy has been prepared and is awaiting approval. Improving soil health and conservation of natural resources are crucial to achieving the targeted growth rate. Large scale industrialisation will work against this. The National Horticulture Mission envisages a doubling of horticultural production by 2011-2012. DK has been identified as one of 17 districts in the state for providing thrust in this sector. Opening up of cultivable land to non-agricultural use and the environmental damage caused by polluting industries reduce the chances of achieving these targets. In fact, the PCPIR policy document from the Ministry of Chemicals and Fertilizers itself states that acquisition of agricultural land for setting up industries should be avoided. Where land acquisition is required, the natural choice should be wasteland and or abandoned land.

On the request of the Government of India, the Department of Forest Environment and Ecology, GOK commissioned a Danish Joint Venture consisting of COWI consult, RH&H Consult, Carl Bro International, Water Quality Institute and Management Services Group to carry out an Environmental Master Plan Study (EMPS) and Environmental Management Plan and Action Plans for DK district. The Plan (popularly known as the DANIDA Report), approved in 1995, spells out specific actions to be taken by local and state institutions through 21 interventions to ensure that district (undivided DK & Udupi) development proceeds in a sustainable manner. Consideration of a huge industrial complex with refinery, aromatics and olefins complex, together with general multi-purpose industries, power plant, etc needs to be preceded by the implementation of the recommendations from the EMPS.

According to climate change experts (The UN's Intergovernmental Panel on Climate Change, Fourth Assessment Report, "Climate Change 2007" (AR4)), wet tropics will receive higher rainfall and dry tropics even lower rainfall. This will adversely affect agricultural production in tropical countries such as India. Climate change is likely to undermine food production in the developing countries while industrial countries could gain in production potential according to Jacques Diouf, Director General of the UN Food and Agriculture Organization. It was stated that India could lose 125 million tons of rain-fed cereal production equivalent to 18% of its total product (Finance and Development, Sept 2007). In addition to such crop losses due to natural and human

induced factors the state is pursuing a policy of converting the crop land for industrial purposes which will undermine the food security of the region and the country. In order to ensure long term food security, agricultural activity should be given priority in areas like DK district where land is productive and which receives good rainfall. Diversion of agricultural and horticultural land for industrial purposes in such areas is unwise.

REFERENCES

Bhatta, R; K. Aruna Rao and Suguna M. Nayak (2003), Marine Fish Production in Karnataka: Trends and Composition. *Economic and Political Weekly,* vol. XXXVIII No.44 November 1-7. p. 44685-4693

Bhatta, R; (2007), Socioeconomic assessment of estuarine fisheries of Karnataka: A case study of Nethravathy River, Dakshina Kannada, Karnataka. Unpublished report, Department of Fisheries Economics, College of Fisheries, Mangalore p22.

George Abe; P. Jayakumar and E. J. James (1997), Impact of fresh water diversion on mixing and exchange processes in the Muvattupuzha estuary. Journal of the Institution of Engineers (India) vol 77, p 186-189.

Janapath (2006), Dariya Kinara Samvad Yatra: A report (survey of coastal structures and livelihood of Gujarat State), December Janapath, Ahmedabad p19-23.

Jacques Diouf (2007), Tropical crops feel the heat, *Finance and Development*, Sept 2007, p3.

Krishna Kumar (2004), Impact of dams on river run-off into sea and changes in the nutrient and productivity profile of coastal waters. NATP Project Report, Central Marine Fisheries Research Institute, Cochin. P.52

Nayar, S; B.P.L. Goh and LM Chou (2005), Environmental impacts of diesel fuel on bacteria and phytoplankton in a tropical estuary assessed using in situ Mesocosms. Eco-toxicology, 14, 397–412, 2005.

Nayar, S; B. P.L Goh and LM Chou (2004), The impact of petroleum hydrocarbons (diesel) on periphyton in an impacted tropical estuary based on in situ microcosms. Journal of Experimental Marine Biology and Ecology. 302 (2004) 213– 232.