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Imperative for Paradigm Shift in Water Policy: A Case of Drinking Water Provision in Kanyakumari

J Cyril Kanmony*

Abstract

Freshwater is the fulcrum on which our lives revolve. Without it, there is no life. Its utility cannot be substituted easily by any other material. But, its availability is only limited and the demand for it is ever increasing. Freshwater is becoming scarce both in quantitative and qualitative terms. But, instead of using it prudently as an economic good, it is taken for granted and abused. The reason for this state of affairs is that the approach that we are following is the same old supply-oriented approach that we had followed in the era of plenty. Hence, a paradigm shift in approach to water policy is needed. This paper not only portrays the real scenario of the drinking water supply but also analyses the ways and means to find a solution for the water crisis existing in India particularly in Kanyakumari district. This paper consists of three parts. The first part brings out the quantity and quality aspects of the freshwater available and the demand for it. The second part explains the drinking water scenario. Details regarding the changes in approach and policies are presented in the third section.

Keywords: Water Policy, Freshwater, Drinking Water

Quantity and Quality of Freshwater

The availability of freshwater both in its quantitative and qualitative terms is a matter of very serious concern as both are very important in deciding the per capita availability of safe drinking water. While decline in freshwater quantity or increase in population brings down the per capita availability, poor quality of it reduces its usage.

Quantity of Freshwater: The total accessible freshwater potential of the world is only 90,000 cubic kilo metres (km^3) per year (Shiklomanov 1993 in Saleth and Ariel 2004). Of this quantity of freshwater, nearly two-third is green water[iv]. Hence, the remaining (around 40,000 km^3 per year) is the estimated blue water[v] (FAO 1993 in Saleth and Ariel 2004). But due to the existing economical, technological and environmental constraints freshwater between 12,500 km^3 and 14,000 km^3 is considered to be accessible for human use (Hinrichsen et al. 1999).

In India the total utilisable quantity of freshwater is estimated at 1086 billion cubic metres (bm^3), 690 bm^3 of surface water and 396 bm^3 of groundwater (Kandaswamy 2003). Its estimation also ranges between 1100 and 1140 bm^3 (Meinzen et al 1996; UN 1997).

* Associate Professor, Scott Christian College, Nagercoil, India
E-mail: cyrilkanmony@ymail.com

It is said that this amount is enough to meet human needs if it is evenly distributed among countries, regions, and individuals. But, the freshwater available and the rainfall are unevenly distributed. Nations like the USA, Canada, Brazil and Iceland have a lion share while Arabian and African countries have only a limited share. For example, the share of the USA is 45 % of the total freshwater available and the per capita availability is estimated at 24,000 cubic metres (m^3) per year, against only 10 m^3 in Kuwait (Sivakumar 2004). India and China with more than one third of the world's population have only one tenth of the total freshwater (Shiklomanov 1993 in Saleth and Ariel 2004). The freshwater availability among regions within a country is also unequally distributed. There is also wide variation in rainfall among regions and seasons. While parts of India are flooded after receiving too much of rain, other places are experiencing only scanty rain or drought (Raj 2003, 2008). It is found that 50 % of the total rain falls in about 15 days and in less than 100 hours in a year. The number of days in which rain falls ranges from 5 days in states like Gujarat and Rajasthan to 150 days in the North Eastern states (Narain 2003). Even within a district, there is very wide variation in rainfall. The varying rainfall tells upon the availability of freshwater in different regions (Kumar K. 2008).

- **Per Capita Availability of Freshwater**

The per capita availability of freshwater is continuously decreasing in all countries due to population explosion. The number of countries affected by water stress[vi] and water scarcity[vii] is on the increase year after year. The per capita availability is expected to drop to 5,100 m^3 per person per year in 2025 from 9,000 m^3 in 1987. In some countries, it is a serious problem in the near future while to some others after a few years. The per capita availability of freshwater in different countries, where there may be very serious water problem in the coming days is given in the following table.

In 1995, 31 countries were confronted with the problem of acute water scarcity. In 2025 the problem of water stress will exist in 48 countries. It is expected that by 2050 the problem of water stress or scarcity would have spread to 54 nations covering about 40 % of the projected global population. In India the per capita availability of freshwater decreased from 5000 m^3 in 1947 to 1800 m^3 in 2005 (Swami 2008). But, it is expected to decline to 780 m^3 in 2025 and 666 m^3 in 2050 (Navalwala 1999).

Quality of Freshwater: Water pollution deteriorates water quality. Water pollution is a very serious matter even in countries like the USA, France, Germany and Japan (Seneca and Michael 1984). Human activities are more responsible for water pollution than natural forces. Agricultural, industrial and domestic activities are the major causes for water pollution (Chatturvedi and Peter 1985; Furon 1967; Harison 1993; Joseph 2005; Mitzger and Marcus 1994; Shukla and Srivastava 1992).

Table 1 Problem Countries and Their Per Capita Availability of Freshwater in 1995 and 2025 (Cubic Metres)

Country	1995	2025
Algeria	527	313
Bahrain	161	104
Barbados	192	169
Burundi	594	292
Cape Verde	777	442
Comoros	1667	760
Cyprus	1208	947
Egypt	936	607
Ethiopia	1950	807
Haiti	1544	879
Iran	1719	916
Israel	389	270
Jordan	318	144
Kenya	1112	602
Kuwait	95	55
Libya	111	47
Malawi	1933	917
Morocco	1131	751
Oman	874	295
Qatar	91	64
Rwanda	1215	485
Saudi Arabia	249	107
Singapore	180	142
Somalia	1422	570
South Africa	1206	698
Tunisia	434	288
United Arab Emirates	902	604
Yemen	346	131
Afghanistan	2543	1105
Belgium	1234	1217
Burkina Faso	2672	1194
Eritrea	2775	1353
Ghana	3068	1464
India	2244	1567
Lebanon	1854	1261
Lesotho	2565	1290
Mauritius	1970	1485
Niger	3552	1452
Nigeria	2506	1175
Peru	1700	1126
Poland	1458	1406
South Korea	1472	1258
Tanzania	2964	1425
Togo	2938	1370
Uganda	3352	1467
United Kingdom	1222	1193
Zimbabwe	1787	1037

SOURCE: Population Reports, p.9.

In India, agriculture tops the list of factors polluting the water resources. In India, the use of pesticides has doubled in three decades. That is the reason why the average amount of pesticide residue found in soft drinks was 11.85 part per billion (ppb) or 24 times more than the standards prescribed by the Bureau of Indian Standards, which is 0.5 ppb. Soft drinks contained residues of extremely toxic pesticides and insecticides like Lindane, DDT, Malathian and chloropyrifos (Narain 2006). The excessive application of nitrogenous fertilizers has resulted in both surface and groundwater pollution with nitrate. The use of fertilizers in India per hectare was 60 % higher than in the U.S.A. India uses over 11 million tonnes of nitrogenous fertilizers annually (Raj 2003).

In developing countries including India nearly 90 % of all domestic wastewater and 75 % of industrial effluents still go untreated into rivers and streams. (Carty 1991). All rivers like the Ganga, the Cauvery, the Yamuna, the Sabarmathi, the Damodar, the Bhavani, the Cooum, the Adayar, the Noyyal, the Palar, the Vaigai and the Periyar are polluted (Agarwal 2000; Doraiswamy 2006; Kumar R.V 2006; Mallikarjun 2003; Padmanabhan 2004; Ramakrishnan 2006; Rao and Mamatha 2004; Suchitra 2004). In India, the wastewater generated in class I and II towns alone accounts for 26,054 million litres a day (mld) (Planning Commission 2008). The quantum of hazardous wastes generated by 13,011 industrial units spreading over 373 districts of the country was estimated at 4.4 million tonnes and the three states namely Maharashtra, Gujarat and Tamil Nadu account for over 63 % of the total hazardous wastes generated in the country (Raj 2003). Nowadays, rich countries are using poor countries as a sink for pollution and waste. More than 100,800 tonnes of hazardous wastes have entered India illegally from countries like the U.S.A., Germany, U.K., Australia, Denmark, the Netherlands, Belgium, Norway and other OECD nations until September 2000 (Kaarthikeyan 2005). Solid waste generated in India itself has increased from 6 million tonnes in 1947 to 60 million tonnes in 2002 (Dhar 2003). Hospital wastes, which contain germs of all types of possible diseases, range from 1.5 to 2.5 kg per day per bed (Singh R 2005). A significant part of all these wastes are dumped into water bodies which polluting water resources. Thus, most of surface water sources in India contain only poisoned water. Hence, all the surface water in India is unfit for direct consumption (Dwivedi 2006).

Groundwater is also not free from pollutants. Water is a universal solvent, but it gets contaminated by the material with which it comes into physical contact. Hence, water in aquifers gets contaminated due to chemicals and other soluble materials available in and around the aquifers and also due to the seepage of toxic wastes into them. Some areas have been affected by the presence of excess chemicals. Contamination of groundwater, due to the presence of excessive iron, nitrate, arsenic and fluoride is wide spread. Arsenic contamination is a very serious problem in the entire Gangetic belt and Bangladesh and fluoride affects groundwater in more than 20 states in India (Acharya 2008; Raj 2003; Singh A.K. 2007).

Apart from these, the coastal villages are affected by seawater intrusion, which increases the salt content in groundwater. In some parts of coastal districts, including Chennai, seawater has intruded to more than 15 km (Agarwal 2000; Singh K.M. 2007; Sivanappan 2003). Seawater intrusion is mainly due to over exploitation of groundwater. The use of diesel and electric pump sets has increased from 87,000 in 1950 to 1,500,000 in 2000 (Moench 1997; Sivanappan 2003). The free power scheme existing in states like Tamil Nadu further encourages over exploitation groundwater. It is further said that the groundwater is once polluted; it is very difficult to de-pollute it

(Kumar et al. 2005) because some aquifers contain rainwater absorbed 30 million years ago. On an average groundwater remains in an aquifer for 1,400 years against just 16 days for river water and so aquifers accumulates pollutants more than rivers. So pollutants stay in the aquifers for a long period. For example, DDT is still found in groundwater in the USA even though it was banned in the 1980s. But in India, a number of toxic chemicals have not been banned (Raj 2003). Water pollution considerably reduces the availability of water for direct consumption.

The freshwater available in Kanyakumari, which is one of the industrially backward and wettest districts in India, is also highly polluted. Water samples from two surface sources in Kanyakumari District were taken and tested. The quality details are illustrated in the table given below.

Table 2 Quality of Surface Water Available in Kanyakumari District

Parameters	Pond Water	River Water	
		Station I	Station II
E. Coli cell/ 100 ml	300	200	2452
Turbidity (NTU)	3.83	2.75	19.42
Conductivity (μmhos/cm)	110.35	102.5	159.5
Total Dissolved Solids (TDS)	85	90	249
pH	6.9	6.7	7.1
Co_2 (ppm)	3.6	3.2	4.8
O_2 (ml/L)	4.13	4.75	3.34
Total hardness (mg/L as $CaCo_3$)	3.19	2.89	4.5
BOD (mg/L)	0.028	0.02	0.04

NOTE: BOD = Bio-chemical Oxygen Demand, E.coli = Escherichia coli.

SOURCE: Test Reports.

As it could be seen from the above table 100 ml of pond water in Kanyakumari district generally contains 300 E.coli cells and some other chemicals. It also contains Klbesiella species. It means that the pond water carries a heavy load of bacteria and this is due to the use of ponds as garbage dumps. The laboratory test, to which river water was subjected, has made it clear that it contains certain physical-chemical and microbial characteristics as well. Further, water in the first station of rivers or places close to their origin is not too turbid or polluted. However, it becomes quite dirty as it courses its way to its destination. The organic load is due to domestic and agricultural wastes. Concentration of Chloride, Calcium and Potassium ions increases in Station II, perhaps due to the addition of ash from nearby crematoria. Such polluted water from the pond and the river is used by the local people for bathing and washing purposes and even for drinking.

In Kanyakumari district, the ground water is in general within the permissible limit. The following table gives the important parameters used to measure the quality of ground water in Kanyakumari district.

Table 3 Quality of Ground Water in Kanyakumari District

Quality indicators / Location	Total hardness							
	pH	**ECM mm hrs/cm at 25°c**	**$CaCo_3$**	**CA ppm**	**Mg ppm**	**NA ppm**	**HC_3 ppm**	**CL ppm**
Kanyakumari	8.20	1449	245	52.1	28.0	220.8	329.5	248.22
Kundal	7.80	1331	200	44.1	21.9	213.9	323.30	237.58
Nagercoil	7.00	300	65	16.0	6.1	33.60	62.01	49.64
Thuckalay	7.60	1113	275	61.2	29.2	103.5	49.61	269.50

Source: Ground Water News, September, 1995, p.18.

The ground water quality in Kanyakumari district shows very wide variations. The quality of water in Nagercoil is found to be better compared to other areas. The pH of water is high in Kanyakumari with an increase in electrical conductivity and ionic concentration. Prominent changes in water quality parameters observed in Kanyakumari and Kundal are mainly due to the contiguity of these locations to the sea. There is, probably, leaching of salt from seawater, leading to an increase in the concentration of ions. Water from Thuckalay area seems to be very hard. This is a rocky terrain, where different types of salts are found mixed with water. The ground water resources from Nagercoil area could be properly exploited for domestic use, since it is comparatively of a more potable quality.

Demand for Freshwater

Humanity needs freshwater for hundreds of reasons and there can be no progress without enough freshwater particularly potable water (Iyer V.R. 2004; Kumar et al. 2005; Lincklaen et al. 1996; Mitzgar and Marcus 1994; UN 1976). Demand for water is ever increasing due to the fast growing global population and ever expanding global economic activities. Economic, scientific and technological development also contributes much to the increase in demand for water. Every increase in economic growth results in an increase in demand for freshwater (Krupanidhi 1987; Ramachandraiah 1997). The easy accessibility of water due to technological advances also leads to over exploitation and misuse. Modern technology enables us to dig bore wells as deeper and deeper but without teaching the simple technique of recharging ground water (Narain 2003)

Thus, due to increase in population and human activities, scientific, technological and economic development, the demand for freshwater increases continuously, The withdrawal of freshwater was expected to increase to 4,000 km^3 in 2,000 from 500 km^3 in 1990 (Gleick 1993). In percentage term it will increase to 70 in 2025, from 54 in 1995 (Postel et al. 1996 in Saleth and Ariel 2004). The annual global withdrawal has increased at the rate of 2.5 to 3 % per year since 1940 against the population growth of only 1.5 to 2 % (UN 1997). The total withdrawal of groundwater in India is only 607 bm^3 in 1995, but it is expected to increase to 916 bm^3 in 2020 (Dasgupta 2003), 1095 km^3 in 2025 and 1447 bm^3 in 2050 (Parsai 2004). In terms of percentage, between 1987 and 2002 it was 51.2 in India (World Bank 2006). As freshwater availability is shrinking and the demand for it is ever increasing, water shortage will be a serious problem to countries like India.

Drinking Water Scenario

Right to life is the basic human right. To live a dignified life one has to get adequate potable water. Drinking water is the basic necessity after food and air. It is necessary for the very existence human life. Everyone has to be supplied with a minimum quantity of safe drinking water. But, the minimum quantity of drinking water available per person depends on the total supply of drinking water and the number of persons who demanded it and the level of satisfaction of individuals depends on the quantity of drinking water supplied per person and the quantity of water demanded per person. The supply of drinking water is determined by 1) the development of basic sources, 2) transmission and treatment facilities, distribution, pumping stations and major feeder mains to meet demands and 3) local distribution mains, connections and local storage facilities (UN 1981). The per capita availability of protected drinking water depends on the availability of safe water sources, the amount of investment made on drinking water schemes and the size of population in a country. Though freshwater is limited in supply, no stone is left unturned in both developed and under developed countries in innovating and discovering new sources of drinking water supply and each government is spending huge amount of money on water schemes.

The drinking water problem caught the attention of the United Nations and its subsidiary bodies only in the last fifties of the twentieth century (Rao 1984). The World Health Organisation conducted the first global survey on urban water supply problems in 1962. In 1972, the U.N. Conference on environmental issues was held at Stockholm. It created awareness among people all over the world about the problems related to water scarcity. Then in 1975, a second global survey was conducted to find out the conditions of water supply and sanitation. In 1976, the U.N. Conference on Human Settlements was held in Vancouver, Canada. It put emphasis on the provision of safe drinking water and sanitation. On the basis of the emphasis and recommendations made by the Conference, the U.N. Conference held at Mar-del-Plata, Argentina in March 1977 declared 1981-90 as the International Drinking Water Supply and Sanitation Decade. (Bishnoi 1982 in Rao and Thimmaiah 1989) The aim of the programme was to supply adequate protected drinking water to everybody before 1990.

As it is the duty of the government to provide drinking water to its every citizen, in India also a number of drinking water programmes were introduced. In 1870 the first urban water supply scheme was started to provide drinking water to Madras, Bombay, and Calcutta. In 1947, when India attained independence, only 12.7 million people living in 253 towns had safe water supply. But, those who lived in rural areas depended on sources like wells, tanks, rivers and streams which are, now, considered as unprotected sources. An Environmental Hygiene Committee was set up in 1948-49 for a correct assessment of the problem of water scarcity in the country. With the advent of the era of planning, rural water supply and sanitation programmes were incorporated as a part of the Health Plan (Jacob 1997). In 1954 drinking water supply programme at the national level was launched (Anand 1996). Another landmark was the establishment of the National Water Development Agency in July 1982. It was intended chiefly for considering the water resource development programme in the national perspective (Basu 1985). In 1985 the subjects of rural water supply and rural sanitation were transferred from the Ministry of Urban Development to the Department of Rural Development in the Ministry of Agriculture. This shift was carried out with the aim of evolving better methods of water supply and having them integrated with the rural development schemes (Pant 1996). Rural water supply was an important constituent of the Minimum Needs Programme (MNP) in the 7th Plan. The government also accorded high priority to the provision of drinking water for its villages through Accelerated Rural Water Supply Programmes (ARWSP). In the beginning of the International Drinking Water Supply and Sanitation Decade much stress was laid on the improvement of traditional sources and the development of new technology and their application. In 1986, the National Drinking Water Mission popularly known as Mini Mission was launched to expedite the work related to the provision of drinking water (Adhikari 1998). The National Water Policy of September 1987 laid sufficient emphasis on the need for utmost efficiency in water utilization and public awareness of the importance of its conservation (Khan 1998).

The UNDP and the government of India organized a global conference on "Safe Water – 2000" in Delhi in September 1990 and the New Delhi declaration was later adopted by the U.N General Assembly in November 1990. Steps are, now, being taken under Bharat Nirman Scheme to cover the uncovered habitations (Planning Commission 2008). The government of India allotted a sizable amount of money in each plan for drinking water schemes. In India, the five year plan's outlay on drinking water and sanitation has increased from Rs. 49 crore in the first plan to Rs. 175000 crore in the XI Plan (Banerjee and Jeevan 2002; Planning Commission 2008). The rise in expenditure is very huge after the declaration of International Drinking Water Supply and Sanitation Decade. The following table shows the plan outlay from the I Five Year Plan to the XI Five Year Plan. The importance given by the government to drinking water supply could better be understood from the magnitude of expenditures of various plans.

It is very clear from the table that the percentage of plan outlay for water supply and sanitation increased from 1.46% in the first Plan to 15.88% in the 11th Plan. The same is true of both rural and urban sector. It is very important to observe here that there was a sudden rise in expenditure immediately after the declaration of International Drinking Water Supply and Sanitation Decade

Table 4 Plan-wise Outlay on Water Supply and Sanitation at Current Prices

(Rs. in crore)

Plan Periods	Plan Outlay on Water Supply and Sanitation				Total	
	Rural		Urban			
	Amount	%	Amount	%	Amount	%
I Plan	6.00	0.18	43.00	1.28	49	1.46
II Plan	28.00	0.41	44.00	0.65	72	1.07
III Plan	16.33	0.19	89.37	1.04	105.70	1.23
3 Annual Plans	N.A	N.A	N.A	N.A	106.42	1.60
IV Plan	155.00	0.97	282.00	1.77	437.00	2.75
V Plan	481.24	1.22	549.44	1.40	1030.68	2.62
Annual Plans	232.29	1.85	197.93	1.58	430.22	3.43
VI Plan	2280.32	2.34	1766.68	1.81	4047	4.15
VII Plan	3556.72	1.98	2965.75	1.65	6522.47	3.62
2 Annual Plans	2705.92	1.97	1721.37	1.26	4427.29	3.23
VIII Plan	10728.79	2.47	5982.28	1.38	16711.03	3.85
IX Plan	20914.00	2.43	18624.00	2.16	39538.00	4.46
X Plan	26463.00	3.09	51,397.00	5.58	79,860.00	8.67
XI Plan	100000.00	9.07	75,000.00	6.80	175,000.00	15.88

Source: Shelter, Vol.5, No.1, January, 2002, p.6. & Planning Commission (2008)

Because of the efforts taken by the Central and State governments, there is a significant improvement in the drinking water supply. In 2004, there were 0.55 lakh habitations (in1994-95 the government gave up the conventional village approach and went in for a new approach called ‘the habitation approach) without programmes of safe water supply for domestic purposes. It means that the 10th plan target of providing safe drinking water to all villages was not achieved. Hence, it is proposed to cover the so far uncovered 55,067 habitations in four years (2005 -2009) under Bharat Nirman Scheme. In 2005, 94% of rural households and 91% of households in urban areas had access to safe drinking water. As on 1st April 2007, as per the data supplied by the Department Of Drinking Water Supply, out of 1,507,349 rural habitations, 1.12 million habitations(74.30%) have been fully covered, and 0.22 million (14.60%) are partially covered (Planning Commission 2008). Really, it is an achievement, because there is a substantial improvement over the data given in 1991 census. But, the government reports on achievements do not take into account the inequitable distribution, quality aspect, the distribution system and other demand side factors. The World Bank’s 2006 report notes that the quantity of piped water supplied had wide variations, the period of supply was only for a very short period and the drinking water problem is very serious in many countries including India.

It is observed that drinking water problem is very serious as the existing sources have already been optimally utilised (Bhattacharya and Rajeev 2000; Winpenny 1994). It is a very serious problem in countries like Israel though they have taken a lot of efforts to augment the supply of drinking water (Lenergen and David 1994). Globally, 1.1 billion people have been affected by lack of safe drinking water (Malkin 2006). In South Asia alone, 500 million people are reported to be affected by lack of availability of drinking water (Pauchauri in Krishnan 2007). In India drinking water problem is very serious (Bandopadhyay 1987; Pant 1996; Ryan 1994). Collection of water is a painful task and takes a lot of time. People especially women and children have to walk long distances apart from waiting in queue for hours. In Africa women and children spend 40 billion person hours in fetching drinking water in a year. In India, people have to walk a distance of not less than 10 km every day for a pot of drinking water in states like Gujarat and Rajasthan (Watkin 2006).

As far as the quantity of drinking water supplied is concerned, there is wide disparity between regions and households. In certain areas, drinking water supplied is much less in comparison with some other areas and the actual requirement. Gandhinagar and Miltanagar in Gujarat are examples for the wide disparity in drinking water supply. The per capita water supply ranges between as low as 12 lpcd (litres per capita per day) and as high as 460 lpcd. There are regions where the per capita per day water supply is as low as 7 litres (Rathore and Ratna 1996; Ramachandraiah 1997). Due to the failure of the south-west monsoon in 2009, in Tamil Nadu alone more than 3000 rural habitations will face a serious drinking water problem and the state government is trying to supply every individual 10 litres. Ten litres per capita per day is much less than the actual requirement. Further, a substantial segment of the slum population in many cities is without public water supply. It is pointed out that the subsidized water supplied by the government is not enjoyed much by the poor (Kundu 1991, 1999). Even in the selection of sites for the installation of public taps, the affluent classes have a say. Consequently, they are found concentrated around the places where they live (Abraham 1999; Ogra 1987; Mitzgar and Marcus 1994).

In Kanyakumari district also the TWAD Board and local bodies spent a huge amount on drinking water schemes. The local bodies have launched a number of projects for supplying drinking water under various schemes. In the rural areas the water supply projects usually come under schemes such as Anna Marumalarchi Schemes, Continuing Schemes, New Schemes, Self Financing Schemes and Samathuvapuram Schemes.

In addition to the projects launched under the above schemes, there are certain projects of the TWAD Board as well. The following table and diagram show the trend of finance earmarked for this purpose.

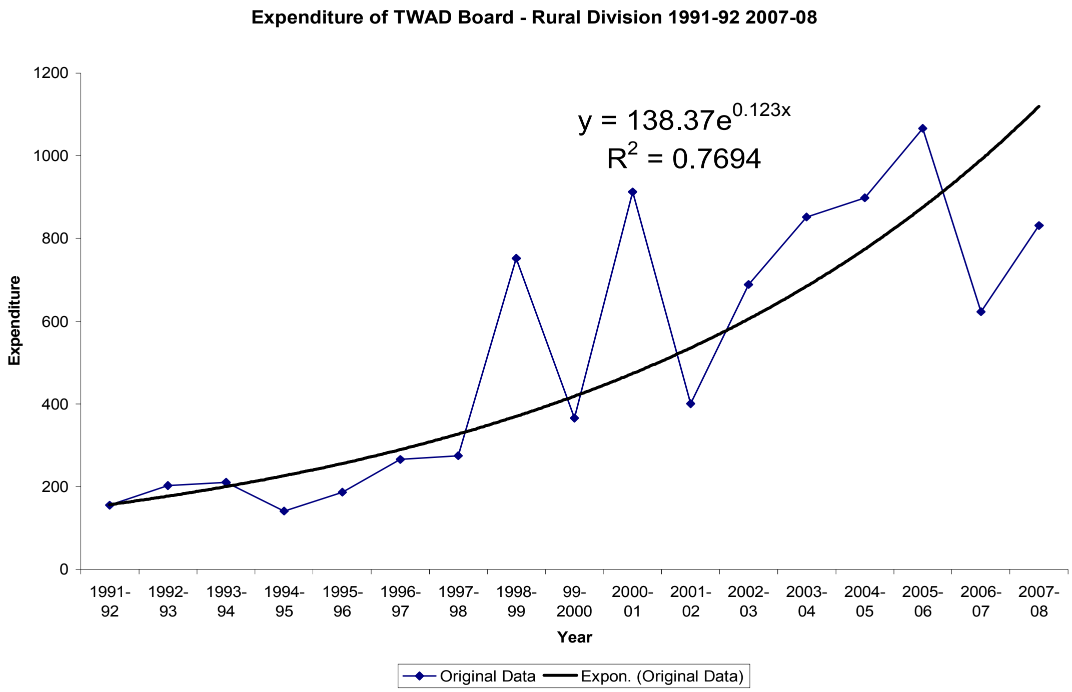
Table 5 Expenditure of TWAD Board, Rural Division during 1991-'92 to 2007-'08

Year	Benefited Habitations	Benefited Population	Expenditure (Rs. in Lakh)	Exponential Growth Rate
1991-92	106	9,704	155.21	
1992-93	72	1,43,600	202.34	
1993-94	62	39,355	210.40	
1994-95	35	25,683	140.98	
1995-96	87	92,905	186.20	0.123
1996-97	67	10,00,646	265.80	
1997-98	54	41,193	275.00	
1998-99	124	1,40,000	752.39	R^2 =0.77*
1999-00	112	1,18,278	366.00	
2000-01	166	91,374-	913.00	
2001-02	138	1,53,870	400.32	
2002-03	118	73,689	688.86	
2003-04	111	1,30,859	852.09	
2004-05	113	91,242	898.68	
2005-06	126	65,936	1066.01	
2006-07	101	54,495	622.54	
2007-08	95	30,390	831.70	

* Significant at 1 % level

Source: TWAD Board, Rural Division, Nagercoil

Figure 1 Expenditure of TWAD Board- Rural Division



It is very clear from the table no 5 and graph that the amount spent on water schemes was on the rise from 1991-92 to 2007-2008. During these years the TWAD board spent a total of Rs.8827.52 lakh. The amount of money allotted for the year 1996-97 for covering 67 habitations was found to be Rs.10,00,646 lakh, highest among the years given. It is followed by the year 2001-'02. The exponential growth rate of expenditure is 0.123, which is significant at 1 % level of probability.

Apart from the money spent by the rural division of TWAD board, the maintenance division of TWAD Board has spent a large amount of money to maintain the combined water schemes from 1996, the year of its inception. The following table shows the money spent by the maintenance division from 1996-97 to 2007-08.

It is evident from the table 6 and figure 2 that the expenditure on maintenance of Combined Water Supply Schemes (CWSS) increased from Rs 61.89 lakh in 1996-97 to Rs 298.22 lakh in 2007-'08. The exponential growth rate of the expenditure on maintenance is 15.76%, which is significant at 1% level of probability.

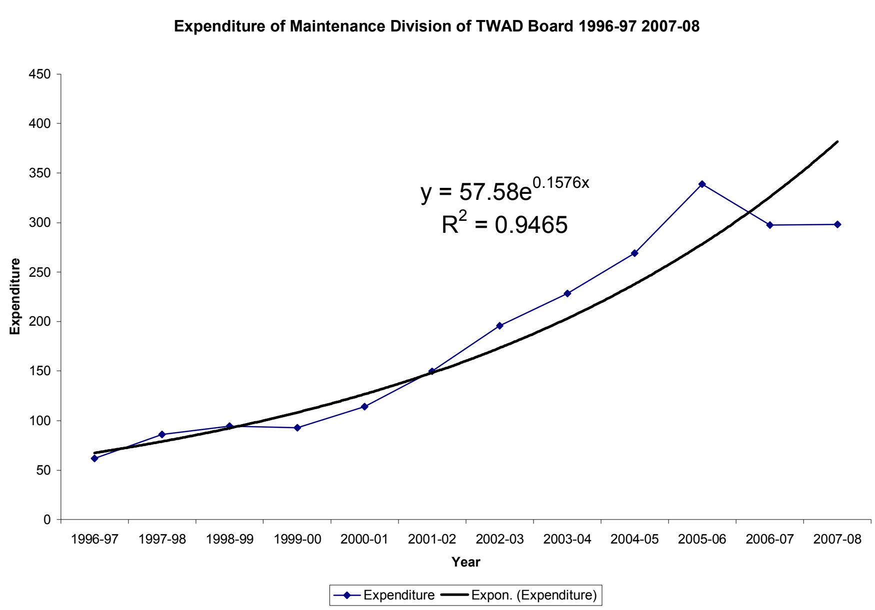
Though such a huge amount was spent on drinking water schemes, the supply of drinking water is not satisfactory. In Kanyakumari district there are four municipalities. Among them, only the Kuzhithurai municipality has been able to supply every individual above 90 litres per day. The Nagercoil, Colachel and Padmanabhapuram municipalities have been able to supply every individual a maximum of only 50 lpcd of water. Hence, people in these municipalities have been put to very great difficulties in their every day life. Besides municipalities, there are 6 urban town panchayats and 61 rural town panchayats. What is sordid about these urban town panchayats is that none of them has been able to supply the people living therein even 70 lpcd of water, which according to the government is what an ordinary individual would require in urban town panchayat for a problem free existence. Among the 61 rural town panchayats, water supply seems to have been introduced only in 54 panchayats. Even in these 54 panchayats water supply has been reasonable only in 13 panchayats. This is a very unfortunate state of affairs as far as Kanyakumari district is concerned because the district is much better off than many other districts with regard to its water resources.

Table 6 Expenditure of Maintenance Division during 1996-97 to 1999-2000

Year	Amount of Expenditure (Rs. in lakhs)	Exponential Growth Rate
1996-97	61.89	
1997-98	86.11	
1998-99	94.50	
1999-00	92.84	
2000-01	114.10	0.1576
2001-02	149.88	
2002-03	195.84	
2003-04	228.39	R =0.95*
2004-05	269.02	
2005-06	338.92	
2006-07	297.74	
2007-08	298.22	

* Significant at 1 % level.Source: TWAD Board, Maintenance Division, Nagercoil.

Figure 2. Expenditure of Maintenance Division of TWAD Board



The local bodies undertake a number of schemes to supply of drinking water for household purposes in both rural and urban areas. But, there is wide disparity in the quantity of water supplied to different households. The way it is supplied could be understood from the following table.

Table 7 Quantity of Water Supplied to Surveyed Households

Quantity (in litres) \ Area	Number of Families											
	Rural						Urban					
	Coastal		Midland		Hilly		Coastal		Midland		Hilly	
	HC	NHC	HC	NHC	HC	NHC	HC	NHC	HC	NHC	HC	NHC
15 – 150	14	16	2	3	-	2	-	11	3	9	7	23
150 – 300	-	-	7	7	1	-	6	6	8	2	4	7
300 – 450	-	-	6	2	-	-	12	-	13	1	6	-
450 – 600	-	-	-	-	-	-	15	-	4	-	2	-
600 – 750	-	-	-	-	-	-	-	-	2	-	1	-
750 – 900	-	-	-	-	-	-	-	-	1	-	-	-
Total	14	16	15	12	1	2	33	17	31	12	20	30

HC = Houses having tap connection. NHC = Houses having no tap connection.
Source: Survey Figures

It could be seen from table 7 that the quantity of water available to those who have their own tap connections is more than to those who depend on public taps. In coastal rural regions water is supplied mostly through public taps. But the quantity of water received through these public pipe connections ranges from 15 litres to 150 litres per family. It ranges between 15 litres and 900 litres in the midland urban area. It is disheartening to note that even within the same region all the households having the same water source, pipe connection do not get equal quantity of water. This is a major problem for which no solution has been found so far. The problem could be rightly attributed to the negligence on the part of the people who handle the water distribution system.

The average quantity of drinking water supplied to each individual in different areas is calculated and given in the following table.

Table 8 Average Quantity of Water Daily Supplied to Individuals (lpcd)

Category \ Area	Rural			Urban		
	Coastal	**Midland**	**Hilly**	**Coastal**	**Midland**	**Hilly**
Having house connection	10.47	58.67	37.50	58.03	71.96	64.93
Depending on Public tap	7.50	40.23	22.50	36.64	14.81	27.66
Overall	9.08	50.78	4.01	51.00	50.97	42.02
σ	5.93	12.35	7.35	17.92	43.97	29.67

Source: Survey Figures.

It is clear from the above survey figures that the average quantum of water supplied in the midland urban areas is 50.97 lpcd. But, the dispersion in water distribution is the highest. The rural coastal area is receiving only 9.08 litres per person per day. Further, those who have water connections of their own and have access to other sources of water like bore wells and open wells (generally rich) get every day more water than their counterparts who depend on public taps.

Even that limited quantity is not supplied regularly (once in a day at a fixed time for a fixed period). In some areas it is supplied daily, whereas it is supplied once in a week and in some other areas it is supplied once in ten days. The following table gives a clear picture of the frequency of water supply in different regions in Kanyakumari District.

Table 9 Frequency of Water Supply in Different Regions of Kanyakumari District

Area / Period	Rural			Urban		
	Coastal	**Midland**	**Hilly**	**Coastal**	**Midland**	**Hilly**
Once in a day	-	27	-	50	4	50
Partially*	30	-	3	-	10	-
Once in a week	-	-	-	-	15	-
Once in 10 days	-	-	-	-	14	-
Total	30	27	3	50	43	50

∗ Instead of supplying water everyday without fail, if water supply is resorted to irregularly on alternate days or once in a week the situation could be described as partial water supply.

SOURCE: Primary Data

It is very clear from above table that out of 203 households only in 131 households, drinking water is supplied daily. All other households are getting it irregularly and so people in that area by and large are disgusted with the existing system of water supply.

To estimate the demand for drinking water, Reddy (1996) has developed two models (approaches). They are; 1) Requirement Approach and 2) Demand Curve approach.

- **Requirement Approach**

Here the demand for water in a particular locality is estimated on the basis of the per capita requirement of the population therein. This approach is used for estimating not only the present demand but also future demand. In the model he has included the use of water both by human population and cattle population.

$DDWit = \Sigma(TP_{ita} \times WRPC_{ita}) + \Sigma(NSL_{itc} \times WRHL_{itc})$

DDWit = Total drinking water demand in i^{th} region

TP_{ita} = Total population in the ‘i^{th}’ region of segment ‘a’.

$WRPC_{ita}$ = Per capita water requirement of the human population in the i^{th} region of segment ‘a’

NSL_{itc} = Number of livestock in the i^{th} region belonging to category ‘c’ when c ranges from 1 to n representing various types of livestock

$WRHL_{itc}$ = Per head water requirements of livestock belonging to category c.

This model is not applicable to all areas. In the rural area, the drinking water demand for cattle population is met mostly from surface sources. Hence, this model has no applicability for estimating the drinking water demand for rural areas. Further the estimation of per capita demand for drinking water is more important, which is not discussed here.

- **Demand Curve Approach**

In this approach the various factors, which influence both the demand for and supply of water, are taken into consideration. They are price, income, subsidy, size of household, rainfall and population.

$$QP_{di} = \alpha_0 + \beta_1 AVPRI_i + \beta_2 AVEXP_i + \beta_3 TSUB_i + \beta_4 TUTL_i + \beta_5 TPOP_i + \beta_6 HSIZE_i + \beta_7 INC_i + \beta_8 ARF_i + \beta_9 POPCOV_i + U_I$$

QP_{di} = Quantity of per capita water used in litres. (i = ith district or town)

AVPRI = Average price paid for water, (in Rs./1000 litres).

AVPEXP = Average working expenditure on water, (in Rs./1000 litres).

TUSB = Total subsidy on water received.

TUTL = Percentage of capacity utilisation.

TPOP = Total population.   HSIZE = Average size of the household.

INC = Average per capital income.   ARF = Average rainfall.

POPCOV = Percentage of population covered by the house connection

Average rainfalls, expenditure on water and capacity utilisation are supply side variables. Price is treated as a co-determinant of supply and demand. The rest of the variables represent the demand side. However, in this model also the estimation of per capita demand is not discussed. Further, the demand for water is inelastic in nature to price. The following are the most important reasons for it:

1. There is no close substitute for water in most of its uses.
2. The amount of money spent on water is generally a relatively small share of any typical household budget and
3. Water is frequently demanded jointly with some other complementary goods (Renwick and Sandra 1998).

As it is very difficult to include every factor, a simple model is developed to estimate the per capita demand for drinking water without taking into account supply side factors and factors like price and water demand for cattle.

$$Q_d = (D+C+B+T+W)$$

D = Quantity for Drinking   C = Quantity for Cooking

B = Quantity for Bathing   T = Quantity for Toilet

W = Quantity for Washing.

With the help of this simple model the overall demand for water for a family can easily be calculated by multiplying the per capita demand by the number of members in a family. If X is taken as total members in a family then the family demand for water is equal to

$$Q_d = (D+C+B+T+W)\ X$$

The total demand for drinking water in a particular region can easily estimated by multiplying the average demand for a family by average family size and total number of households in the region

The demand for potable water for a family in rural and urban areas in two seasons, hot and normal, is estimated and given in the form of equations.

Q_{RN} = (1.27+3.87+20.00+15.03+11.72) X

Q_{RH} = (1.93+3.87+26.75+15.03+11.72) X

Q_{UN} = (1.37+3.39+20.99+17.12+13.09) X

Q_{UH} = (1.96+3.39+28.44+17.12+13.09) X

Q_{RN} = Demand for water in rural family in normal seasons.

Q_{RH} = Quantity of water demanded by a rural family in hot seasons.

Q_{UN} = Quantity of water demanded by an urban family in normal seasons.

Q_{UH} = Quantity of water demanded by an urban family in hot seasons.

The variables influencing the per capita demand for drinking water are identified. Required data were collected and a linear multiple regression equation was fitted separately for regular seasons and summer seasons with water consumed as the dependent variable (Y) and family size (X_1), total income (X_2), plinth area of the house (X_3), availability of water sources in one's own premises (X_4) and the level of dependence on surface sources (X_5) for the coastal, midland and hilly urban areas and for coastal, midland and hilly rural areas.

In the case of the coastal urban area the two regression equations fitted are

$Y_1 = 7.865 – 0.5622^{*} X_1 + 0.0671^{**} X_2 + 0.1275^{NS} X_3 + 0.1152^{**} X_4 – 0.0117^{**} X_5$

$R^2 = 0.65^{**}$ (Regular Season)

$Y_2 = 9.5214 – 0.4785^{*} X_1 + 0.0562^{**} X_2 + 0.1352^{NS} X_3 + 0.1387^{**} X_4 – 0.0216^{*} X_5$

$R^2 = 0.68^{**}$ (Summer Season)

In the case of midland urban area the two regression equations fitted are

$Y_1 = 1.0075 – 0.2361^{**} X_1 + 0.0016^{**} X_2 + 0.1563^{NS} X_3 + 0.1672^{*} X_4$

$R^2 = 0.71^{**}$ (Regular Seasons)

$Y_2 = 1.6572 – 0.1178^{**} X_1 + 0.0058^{**} X_2 + 0.1857^{NS} X_3 + 0.0856^{*} X_4$

$R^2 = 0.68^{**}$ (Summer Season)

The regression equations fitted for hilly urban areas are

$Y_1 = 9.5214 – 0.4785^{*} X_1 + 0.0087^{**} X_2 + 0.1352^{NS} X_3 + 0.1387^{*} X_4 – 0.0216^{*} X_5$

$R^2 = 0.72^{**}$ (Regular Seasons)

$Y_2 = 11.6528 – 0.3856^{*} X_1 + 0.0051^{**} X_2 + 0.1441^{NS} X_3 + 0.1571^{*} X_4 – 0.0584^{**} X_5$

$R^2 = 0.77^{**}$ (Summer Seasons)

For rural areas of coastal region, the fitted regression equations are

$Y_1=10.6176-0.4156^{**}X_1+0.0568^{*}X2+0.0851^{NS}X_3+0.1468^{*}X_4-0.06682^{*}X_5$

$R_2 = 0.53^{**}$ (Regular Seasons)

$Y_2=11.8960-0.5861^{**}X_1+0.01987^{*}X_2+0.0769^{NS}X_3+0.1836X_4-0.05591^{*}X_5$

$R^2 = 0.58^{**}$ (Summer Seasons)

In the case of midland rural areas the two regression equations fitted are

$Y_1=9.8716-0.8693^{**}X1+0.6152^{*}X2+0.1165^{NS}X_3+0.0886^{*}X_4-0.05913^{*}X_5$

$R_2 = 0.58^{**}$ (Regular Seasons)

$Y_2=11.5915-0.9982^{**}X_1+0.5586^{*}X_2+0.1357^{NS}X_3+0.0910*X_4-0.0751^{*}X_5$

$R^2 = 0.53^{**}$ (Summer Seasons)

The regression equation fitted for rural hilly regions are

Y_1=12.7512-0.6512$^{**}X_1$+0.2816$^{*}X_2$+0.2716X_3+0.06691$^{*}X_4$-0.06162$^{*}X_5$

R_2 = 0.51** (Regular Seasons)

Y_2 = 13.6289 – 0.5875$^{**}X_1$ + 0.3118$^{*}X_2$ + 0.3081$^{NS}X_3$ + 0.0852$^{*}X_4$ – 0.5589$^{*}X_5$

R^2 = 0.53** (Summer Seasons)

NS = Not Significant
* = Significant at 5 % level of probability
** = Significant at 1 % level of probability

The R^2 values of different multiple regression equations show the extent to which the consumption of drinking water is explained by the five independent variables identified in the study. All R^2 values are significant at 1% level of probability. The factors, which increase the consumption of water, are income and availability of water sources within premises, which are indicated by positive coefficients in all the equations given above. The significant factors, which influence inversely the demand for drinking water, are family size and the level of dependents on other surface sources for personal uses like bathing and washing. Households in the higher income brackets also have water sources such as pipe connections as well as bore-well fitted with jet pumps.

Further, the availability of water sources within premise often makes people use more water than required. But households, which depend on distant sources, try to use water without any wastage. The reason for the negative effect of a family size is that the local authorities supply a fixed quantity of water. So the family members are forced to share the limited quantity of water supplied. Hence, the per capita availability of water decreases as family size increases. The four factors, X_1, X_2 X_4 and X_5, are significant in influencing the per capita demand for drinking water. The only factor, which is not significant, is the third factor (X_3), plinth area of the informant's house.

The water supplied by the local bodies may or may not be enough to meet the requirements of people. In Kanyakumari district, of the 20 local bodies taken for the study except one village panchayat all the 19 sample local bodies are supplying less than what is actually required. The following table shows the average quantities of water actually required and actually supplied in the study area.

Table 10 Average Requirement and Actual Supply of Drinking Water in Different Local Bodies in Kanyakumari District (in lpcd),

Category \ Area	Municipalities (2)		Town Panchayats (6)		Village Panchayats (12)	
Quantity Required	85		65		41.67	
Quantity Supplied	53.50	(62.94)	38.83	(59.74)	21.25	(51.00)

NOTE: Figures in bracket are percentages of supply to requirement.
Source: Primary Data.

It is obvious from the above table that the village panchayats are able to provide 51%, the town panchayats 59.74% and municipalities 62.94% of the total drinking water needs of the people. However, the per capita requirement is somewhat less than the government's prescribed quantity. It is very clear that the schemes of water supply launched by the local bodies in the district have not been able to cover the entire needs of the people in the district.

The per capita demand for drinking water in two different seasons, normal and hot, for different areas is estimated with help of the simple demand function developed and discussed earlier. The actual quantity of drinking water supplied per person is presented in table 8. The difference between demand and supply in two different seasons in different regions is given in the following table.

Table 11 Additional Water Requirement Per Person Per Day (lpcd)

Area	Coastal		Midland		Hilly	
	Normal	Hot	Normal	Hot	Normal	Hot
Rural	36.10	42.40	2.65	10.73	Nil	Nil
Urban	Nil	5.86	14.79	27.30	9.14	15.06

Source: Primary Data

The quantity of water additionally required is more in rural coastal areas and midland urban areas than in other regions. Closely allied to this is the problem of inordinate waiting involved in collecting water for domestic purposes from public taps. The people, who depend on street pipes, wait for their turn in queues 10 to 30 minutes for every pot of water.

Because of all these reasons, the people in Kanyakumari district are generally not satisfied with the existing drinking water supply system. The attitude of different families is measured with the help of a 3 point scale, 1 = fully satisfied, 2 = partially satisfied and 3 = fully dissatisfied as is given in the following table.

Table 12 Attitude of Families towards Existing System of Water Supply

Area / Attitude	Rural			Urban			Total
	Coastal	Midland	Hilly	Coastal	Midland	Hilly	
1	0	11	1	43	4	Nil	59 (29.06)
2	11	11	2	7	13	12	56 (27.58)
3	19	5	-	Nil	26	38	88 (43.35)
Total	30	27*	3*	50	43*	50	203* (100)

*The remaining sample households depend on their own source.

SOURCE: Primary Data

From the above table, it easily understandable that more than 43 % of the surveyed households are fully dissatisfied and nearly 28% families are partially satisfied. Only 29% is fully satisfied. From table 8, among the urban areas, the quantity of drinking water supplied is the minimum in the urban hilly area. Individuals get almost equal quantity of drinking water both in Nagercoil (50.97 lpcd) and Colachel (51.0 lpcd) municipalities. However, people in the Nagercoil municipality area are highly dissatisfied in comparison with the people in the Colachel municipality. The reasons for this state of affairs are

1. No exact supply time: The survey conducted by the researcher and the reports of local newspapers have substantiated this point. It is observed that in most of the days of water supply, the supply starts at 24.00 hours and closes at 5 am denying water to many households, which fail to wake up or have storage tanks.
2. Inequitable distribution of drinking water: The quantity ranges between 7.5 lpcd to 150 lpcd. The standard deviation calculated for the Nagercoil municipality area is 43.97 against only 17.92 in Colachel municipality area.
3. Pattern of drinking water supplying system: In the Nagercoil municipality area on the day of water supply the duration of supply ranges between 30 minutes in areas of high altitude and 30 hours in low lying areas and this is in sharp contrast to uniform one hour supply in the Colachel municipality.

Thus, there is wide variation in quantity of drinking water received by different families and there is much dissatisfaction among people who depend upon the local authorities for their drinking water requirement. Households having only a limited quantity of safe water are forced to make use of polluted or/and distant water sources.

Poor people in most of the remote villages make use of polluted surface sources like rivers, streams, channels and ponds because of non-availability of treated piped water in adequate quantity (Mitzgar and Marcus 1994). The piped water supplied by local authorities is also not free from pollutants. On the basis of quality, India ranks 120th out of 122 countries from which, potable water has been analysed. The poor quality has been confirmed from the country wide survey conducted by the Central Pollution Control Board (CPCB). It is reported that 66 % of sample water had unacceptable organic values and of which 44% had E.coli (Acharya 2008). The following table shows that quality of drinking water available across the country.

Table 13 Drinking Water Quality in India

Characteristics	Acceptable	Observed (Cause for Rejection)
Turbidity	2.5	10
Colour	5.0	25
Chlorides (mg/l)	200	1000
Fluorides (mg/l)	1.0	1.5
Calcium (mg/l)	75	200
Iron (mg/l)	0.1	1.0
Manganese (mg/l)	0.05	0.5
TDS (mg/l)	500	1500
Zinc(mg/l)	5.0	150
Mineral Oils (mg/l)	0.01	0.3
Pathogenic Agents	0.00	1-3

Source: UN (1990) Water Quality Monitoring in the Asian and Pacific Regions, and UN (1993) Urban Water Resources Management

It is evident from the table that drinking water supplied in India has a large number of unwanted and harmful elements. For example, in drinking water there should not be any pathogenic agents, but in India in the samples tested there are 1-3 pathogenic agents. Samples of water tested by the investigator have confirmed this. All the samples of drinking water tested across rural areas of Kanyakumari district have a minimum of 50 E.coli per 100 ml of drinking water. The details are given in the following table.

Table 14 Quality of Drinking Water Supplied in Kanyakumari District

Area	No. of E. Coli Cells/ 100ml (minimum)
Rural	50
Urban	0

Source: Test Reports (Rural Primary, Urban Secondary)

The sample water tested clearly indicates that the potable water supplied in the rural area is not good in quality, as the E-coli count is beyond the acceptable level. If this water is continuously used for drinking purposes, the chances of contracting contagious diseases are very high. The presence of E-coli indicates that the water was affected by faecal contamination. Presence of E-coli suggested the occurrence of other pathogenic organisms of faecal origin in the water samples.

The most probable reason for the contamination is the unavoidable seepage of pond water into wells sunk for drinking water (most of these wells used for pumping drinking water are constructed at the brim or within ponds). This kind of seepage takes place through under water tunnelling caused by masonry breakdown along the lower rim of the well. The poor quality of drinking water supplied by local bodies has been brought to light by reports in leading newspapers. It is also reported that households in 9 villages situated between Boothapandi and Puthery, receive drinking water without any treatment directly from the Ananthanaru channel which carries untreated freshwater from the Mukudal dam to Nagercoil, Suchindram and Kanyakumari. In other local bodies also the water is not properly treated. The expenditure incurred on water treatment is only meagre in village panchayats. The expenditure incurred by various surveyed local bodies in treating (chlorinating) the drinking water could be seen from the following table.

Table 15 Average Annual Expenditure Involved in Chlorination

	Area		
	Municipality	Town Panchayat	Village Panchayat
Average expenditure (in Rs.)	40,500	11340.33	822.92

Source: Primary Data.

The expenditure, as given in the above table, involved in chlorination is the maximum in urban areas. That is the reason for the absence of any vermin in the drinking water. The average annual expenditure on chlorination in village panchayat has been estimated at Rs.822.92. It is also reported that in most of the village panchayats, chlorination of drinking water is done only during the rainy seasons. It means that the water supplied in the rural area is not treated regularly.

Scarcity of drinking water and the consequent consumption of polluted water is the major cause for water-related diseases. Diseases caused by polluted water are broadly classified into four groups, viz: water-borne diseases, water-based diseases, water-related vector diseases and water-scarce diseases. Diseases spread when people drink dirty water or take bath in the contaminated water or through the insects which thrive in or around

water or when the water is not enough to meet the personal demand. Diseases like cholera, typhoid, polio and hepatitis A and E are some of the water-borne diseases. Diseases caused by aquatic organisms like guinea worms, round worms and tape worms are called parasitic diseases or water-based diseases. Water-related vector diseases are caused by insects such as mosquitoes and these vectors spread diseases like malaria, yellow fever, dengue fever, chikungunya, sleeping sickness and filariasis. Water-scarce diseases or filth-borne diseases are caused by water scarcity and diseases like trachoma, leprosy, conjunctivitis, tuberculosis, dysentery, scabies and skin sepsis are of this type (Hinrichsen et al. 1999).

In India, water-borne diseases are amongst the most major causes of sickness and ill health (Sainath 2006). It is estimated that water-borne diseases alone are responsible for 41.5% of deaths below the age of six. Nearly 50 lakh deaths occur a year as a result of diseases caused by polluted drinking water. According to James Winpenny (1996) each year nearly 30 lakh children under the age of five die due to diarrhoea, about 20 crore are affected with diarrhoeal diseases, nearly 30 crore people with round worm infections, about 15 crore with schistosomiasis and about 30 crore with trachoma which makes nearly 50 lakh people blind. More than 2 lakh people have arsenical skin manifestation (Chakraborthi 1996). Malaria continues to strike over 26 lakh people every year with over 20,000 people dying from it in India (Sharma 2003). Diarrhoea alone kills 6,000 children every day and dirty water poses a greater threat to human life than war or terrorism (Lenton 2005). It is said that every 20 seconds, a child dies from diseases related to lack of clean water. That adds up to the death of 15 lakh children each year. Nearly 50 lakh deaths every year are caused by polluted water (Moon 2008). The following table shows the intensity of four important water-borne diseases in India in 2006.

Table 16 Cases and Deaths due to Water-Borne Diseases in India in 2006

Diseases	**Cases**	**Deaths**
Diarrhoea	10079263	3124
Typhoid	726484	651
Malaria	18116342	963
Hepatitis	146433	673

SOURCE: Eleventh Five Year Plan, Vol. II

The four important water-related diseases, which cause great hardship to the people of Kanyakumari district, are contained in table 17.

Table 17 Number of Rural People Affected by Six Important Water-Related Diseases in Kanyakumari District during 2002-2008

Year	Diseases			
	Typhoid	Diarrhoea	Scabies	Malaria
2002	0	1532	15645	630
2003	0	4263	12779	711
2004	51	3687	10411	920
2005	68	3931	8785	1462
2006	111	5597	9027	1500
2007	18	4618	9163	490
2008	26	2394	5623	97
Growth Rate*	-0.268	0.068	-0.139	-0.210
R^2	0.33	0.11	0.86	0.24

* Calculated figures
Source: Office of Deputy Director of Health Services, Nagercoil.

It is very clear from the above table that except diarrhoea, the other three diseases show a significant negative exponential growth. All values of growth are significant at 1% level. But, in absolute term scabies constitutes large number in all the years taken for analysis. Apart from the above mentioned diseases, arsenic in drinking water causes liver, lungs and kidney/bladder cancer besides skin cancer (Prasad R 2008; Singh K.M 2007). High fluorisis content in drinking water is the cause for fluorial and non skeletal fluorisis. It is reported that nearly 10 million people are vulnerable to cancer due to the presence of excessive arsenic in drinking water and another 6.6 crore face the risk of fluorisis. High fluoride in drinking water causes the birth of deformed children in rural areas of Madhya Pradesh, Jharkhand, Assam and Uttar Pradesh (Acharya 2008). There are about 2.17 lakh quality-affected habitations in the country; with excess iron: 118088, fluoride: 31306, salinity: 23495, nitrate: 13958, and arsenic: 5029 in that order.

Water-related diseases become the cause for many diseases and compel the affected persons to get away from productive work and to get medical treatment. The economic loss of the bad drinking water in India alone is very enormous, i.e. 7.3 crore working days and an income loss of Rs.240 crore. The expenditure made on medicine for curing the water-related diseases by the vulnerable group especially the poor is estimated at Rs.67 lakh (Prasad S 2004). In Uttar Pradesh alone, the polluted Ganga contributes 9 to 12% of the total disease burden. The monetary loss suffered has been put at Rs.960 crore a year (Mallikarjun 2003). India had lost over 180 crore man hours or over 20 crore man days annually (Pant 1996). But, according to D'Souza (1995), in India, the cost in terms of medical treatment and decline in production because of polluted water is around Rs.450 crore annually.

It is very clear from the foregoing analysis that there is a steady decline in the per capita availability and also the quality of freshwater. Subsequently, the gap between supply and demand for drinking water has widened. The other related issues are the inequality in the quantity of drinking water supplied by local bodies to individual households, rise in the expenditure made on drinking water schemes, and the burden of water-related diseases.

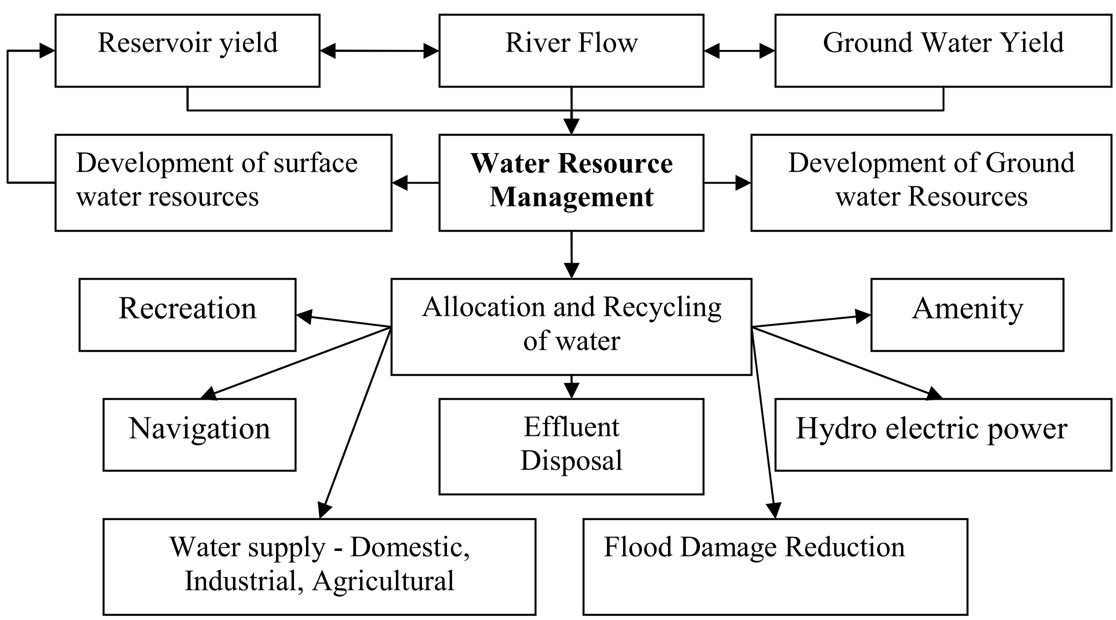
Changes in Water Management Approach and Policies

How can the wide gap between supply and demand be bridged? This is a big question that is everyone has to ponder over. Simply, the answer is to change the approach and policies we have followed so far. In many countries, including India, policies followed are very old, which were framed in the area of plenty (Annan 2004; Ogra 1987; Saleth and Ariel 2004). Hence, the need of the hour is to have a paradigm shift in approach and polices of water management. Whether it is either supply oriented or demand oriented, the efficient water resource management is the only available solution for the present situation for three reasons.

1. Water is available in limited quantities, yet demand for water continues to rise.
2. Water is most readily available in locations distant from the main centres of demand; hence it is necessary to balance supply and demand in both space and time.
3. Water is required for a variety of purposes, only some of which are compatible with one another, so that allocation of available resources between competing claimants becomes essential.

There are three broad aims to water resource management, (i) The development of new reserves of water, (ii) allocation of existing resources and (iii) recycling of water (Porter, 1978). The following chart will make these points very clear.

Chart No. 1. Water Resource Management



It is very clear from the above chart that the efficient management of water resources can be done either by development of new sources of freshwater or by increasing investment on water schemes and or by recycling of water. As it is discussed earlier there is very limited chance for enhancing the availability of freshwater. The next feasible solution is increasing the expenditure on water schemes. It is observed that India has already spent

Rs 1,10,500 crore on various drinking water programmes including Rs 72,600 crore on rural water supply sector (Planning Commission 2008). India has to spend another Rs 92,500 crore for the 11th and 12th plans and the recurrent expenditure of similar amount for urban drinking water schemes. For rural drinking water schemes, it has to spend Rs 70,000 crore for the 11th and 12th plans and the recurrent expenditure of the same amount (Acharya 2008).

There is a proposal for interlinking of rivers as there is wide variation among regions in the availability of freshwater. But, in terms of cost, both monetary and environmental, it is a great burden to governments (Rajamani 2005). It requires a planned expenditure of Rs 56,000 crore per year for 10 long years. It is the proposed amount and it has to be enhanced if the work is not completed within the stipulated period of 10 years (Bhatia 2005). Construction of more dams and bore wells also requires huge budget allocation but becomes the cause for environmental damage and ecological degradation. Our institutions are inefficient and incapable of providing incentives to promote the optimum utilisation and conservation of water resources (Chatturvedi 1976; Cloke and Park 1986).

It is firm that in the present system of distribution, the social cost of expanding drinking water supply is more than the social benefits in view of pervasive water loss, lower water rates, poor cost recovery and other environmental and ecological damages (Saleth and Ariel 2004).

The other solution is desalinization and recycling of wastewater, which can be carried out as they are followed in certain countries. But, in comparison with the cost, these bring only insignificant increase in the supply and the recycled water itself is not preferred by the general public.

The following table shows the attitude of the people in the study area to brown water.

Table 18 Preference of People to Use Brown Water for Domestic Purposes in Kanyakumari District

Category \ Area	Rural			Urban			Total
	Coastal	Midland	Hilly	Coastal	Midland	Hilly	
Ready to use	0	3	0	0	12	2	7 (7.08)
Not ready to use	30	27	30	50	38	48	223 (92.92)

Source: Primary Data.

It is clear from the above table that, in spite of the tremendous growth witnessed in science and technology, the fact remains that the public is not ready to use the recycled water for domestic purposes.

All these indicate that the freshwater sources are already exhausted and a huge amount is spent every year for both new schemes and maintenance of old schemes. It means that the supply-oriented policies framed during the era plenty has no relevance today. Efficient and effective demand side management is a prerequisite for the proper functioning of a water supply system. The demand side approach does not require any huge investment;

but it requires only efficiency and economy in utilization. This can be done by wastage reduction, enhancement of productivity in agricultural and industrial sectors, economizing the use of water in domestic sector, fitting of meter in all house connections, regular and proper assessment of meter reading and so on.

Economical Use of Available Freshwater

In India in every sector, agricultural, industrial or domestic, water is uneconomically used, the distributional wastage is very high and the productivity of the water utilising sector is very poor.

More water is used in agriculture than what is actually required. It is reported that Indians use nearly 4 times more water than what is used in some developed countries for cultivating paddy (Kareem 1995). The water use efficiency in agriculture is very low in India. It is reported that a 10% increase in water use efficiency can add 14 million hectares in India and the adoption of modern irrigation technologies can improve water use efficiency up to 95% and could lead to water saving of more than 50% (Postel 1993, 1999 in Saleth and Ariel 2004). The Madagascar method of irrigation uses only one-third of water what we use in India (Srinivasan 2003). The productivity in agriculture in Kothapally (Andhra Pradesh) has increased substantially due to the water saving systems followed there (Prabu M J 2008). If water is efficiently used we can bring more area under irrigation and thereby increase agricultural production or a significant portion of water used in agriculture can be diverted to other sectors without affecting production as nearly 83% of the total freshwater is used for agricultural purposes (Parsai 2009). Hence, our motto must be more crops from every drop.

In industrial sector also we use more water than that is actually required. In India, the paper industry uses over150 tonnes of water for producing a tonne of paper against the world standard of less than 20 tonnes of water (Narain 2003). In India, 750 litres of water is used to produce 1 kg of steel against 230 to 500 litres in China and only 60 litres in the USA, Japan and Germany (Pisharoty 1995). Application of modern water saving technologies in industry can have positive impact and the water saved can be diverted to other sectors particularly domestic sector. In general the water productivity[viii] in India is very low when compared with certain other countries. The details are given in the following table.

Table 19 Water productivity in a few Countries

Country	Per capita water cu. M (2004)	Water Productivity (1987 -2004)		
		Total	Agriculture	Industry
Group - A				
Kuwait	0	84	0.8	2070
UAE	35	34.5	1.5	197.8
S. Arabia	100	11	0.6	482
Yemen	202	1.5	0.2	116
Oman	389	16	0.3	388.6
India	**1167**	**0.8**	**0.2**	**3.5**
Group B				
Lebanon	1356	12.9	1.1	368.3
U.K	2422	157.0	49.0	49.2
USA	9535	20.9	0.5	9.6
Indonesia	13043	2.2	0.4	145
Uruguay	17154	5.6	0.4	115.2
Sweden	19017	83.4	16.7	39.4
Venezuela	27652	13.2	1.2	83.8
New Zealand	80522	26.7	5.2	66
Norway	83205	79.2	14.5	43.6

Source: World Bank Report – 2006

In the above table there are two groups of countries, Group – A, where the per capita availability of water is less than that of India and Group – B, where the per capita availability is more than that of India. However, it is very clear from the table that in all countries the water productivity in agriculture, industry and in general is more than that of India. The water productivity in industry is the maximum in water scarce Arabian countries: the highest in Kuwait, 2070. It is very clear from the table that the freshwater in India is not efficiently used. Therefore, efforts should be taken to improve the water productivity.

If water saving technique is adapted in household sector, much water can be saved. Water can be saved to a significant level by replacing traditional residential water appliances with dual flush toilets, sensor operated taps, waterless urinals and good and well maintained pumping systems. For instance in California the retrofitting of toilets alone resulted in 25% saving in indoor water use (Gleick 1998 in Saleth and Ariel 2004). For brushing of teeth, it is estimated that the average quantity used is 5 litres if the tap is fully opened, less than 2 litres if the tap is half opened and less than a litre if water is used by taking it in a vessel. During washing also a large quantity of water can be saved. In London, the percentage of water required for washing is estimated at 13% whereas it is estimated at 21.47 in the study area, Kanyakumari district. If it is economically used, then some quantity can be saved. Nano technology can be developed to clean clothes without any water. If waterless technology is used, it will require only less than 2% of water and energy of a conventional washing machine (Xeros 2008). It is true for every domestic use; car washing, cleaning floor and watering plants. The

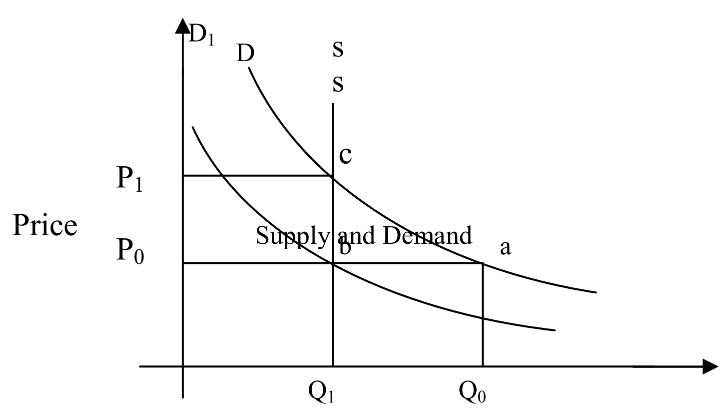
unnecessarily used excess water and unharnessed rainwater flow into roads or streets and causes not only environmental degradation but also damages to roads and streets.

For optimum use of water, water must be properly priced (James and Robert 1971; Saleth and Ariel 2004). But, what we are doing is contrary to this. The human tendency is to either show disrespect or waste those things which are available free of cost or at a very low price. The water that is supplied freely or at a subsidized price is also wasted. One of the reasons for using more water than required in Indian agriculture is very low water charge. It is reported that the poor recovery in agriculture and inadequate operational and maintenance cost in irrigation is attributed to low water rates (Parsai 2004). In Kanyakumari district there is no pricing of water that is used for agriculture except occasional collection of some money from farmers for maintaining ponds and tanks. The price charged in the domestic sector is also not optimum. In the domestic sector, the lower water charges and poor cost recovery jeopardizes the efficient use of water, efficient maintenance of water infrastructure and the resources for future investment (Reddy 1996; Saleth and Ariel 2004).

The objective of any economic policy is to achieve maximum welfare. To attain efficiency and maximum benefits, pricing must be according to marginal cost. If price is greater than the marginal cost, full economic utilization of water will not be feasible. If price is lower than the marginal cost, then the supply will have to be increased. Strict marginal cost pricing applied to short run requires that price should equal marginal cost up to the point of full capacity utilization of existing sources and that price should be high enough to cover both short run marginal cost and the annual equivalent of marginal capacity cost when additional capacity is provided (Jacob 1997).

If water supply is constant and demand is constantly increasing and so a question arises, how to manage the excess demand? There are two methods, one to raise price and the other to enforce rationing (Renwick and Sandro 1998).

Figure 3 Demand Side Management



The initial equilibrium is ‘a’ and now suppose there is a fall in supply and the quantity decreases from Q_0 to Q_1, and it is indicated by short-run inelastic supply curve Q_1S. To reduce excess demand the price has to be increased to P_1 or the demand has to be reduced from D to D_1 by using rationing. Rationing is not accepted by people as water is a basic necessity and so only option is price rise.

The water pricing policy must be such that all sections of the society receive adequate quantity of water. For residential uses also there must be adequate quantity of drinking water to achieve the welfare objective. In the domestic sector, if a uniform price is charged in a country where the income is not equally distributed it would amount to flouting the norm of distributive justice. According Rawl’s theory of justice, equity refers to a situation where the least advantaged persons are allowed to enjoy more benefit. Hence, proper importance must be given to protect the interest of the poor. It can be done by providing subsidized water through public taps. The public tap must be within an accessible distance. Also, the time of supply of drinking water must be exact and convenient. Further the time duration of water supply must be equal to all areas.

The water rates in the domestic sector are abysmally low. For example, in Mumbai city people pay only Rs 3.50 per 1000 litres (Menon 2005) and the people in Delhi pay 4% less than the water pumping and distribution cost (Narain 2003). But, the subsidized water available to rich people is much more than that of the poor. Rich people have their own bore well fitted with motor and the subsidised pipe connection within their premises. They spend drinking water wastefully particularly the subsidized water. Hence, water charge must be increased considerably to the rich people. But, the poor people paid more for their water than the rich. It is substantiated by the study conducted by the researcher. The details are given in the table below.

Table 20 Average Price Charged for 1000 Litres in 2001

Rate (in Rs)	Village Panchayats (12)			Town panchayats (8)			Municipalities (2)			Total	Overall Average (Rs.)
	Coastal	Midland	Hilly	Coastal	Midland	Hilly	Coastal	Midland	Hilly		
1.20	-	-	-	-	-	1	-	-	-	1	
2.00	-	-	-	-	-	-	-	1	-	1	
2.50	-	-	-	-	1	-	-	-	-	1	2.87
3.00	4	3	4	1	1	1	-	-	-	14	
4.00	-	-	-	-	-	-	1	-	-	1	
Total	4	3	4	1	2	2	1	1	-	18	

Source: Survey Figures.

It is very clear from table 20 that in all the village panchayats selected for study the rate at which water supply has been undertaken for drinking purposes has remained constant – Rs 3.00 for every 1000 litres. In town panchayats the data differs from place to place. To put it in simple terms, the price paid by the rural poor for drinking water was much higher than their relatively affluent counterparts in the midland urban areas. It is against the principle of natural justice. However, the recent survey conducted shows a slightly different picture. The urban households and households in town Panchayat areas pay Rs 5.20 and households in village Panchayat areas pay only Rs 3.00 for every 1000 litres of drinking water. But, the price charged is very much lower than the marginal cost, which ranges between Rs 5 and Rs 10 for every 1000 litres.

For proper working of pricing system it is necessary to have an efficient metering system. Metering system is one of the best ways by which wastage of water could be minimised. But, in India the metering system is very poor. The study conducted by the investigator reveals that there is no proper metering system in Kanyakumari district. In the coastal urban areas meters are not properly working. In places, where meters are in very good working condition, readings are not regularly recorded and reported for assessment purposes. It could be understood from the following table.

Table 21 Metering System Prevailing in the District

Area / Category	Rural				Urban			
	Coastal	Midland	Hilly	Total	Coastal	Midland	Hilly	Total
Metered	Nil	15	Nil	15	33	30	20	83
Not Metered	14	Nil	1	15	Nil	1	Nil	1
Total	14	15	1	30	33	31	20	84

Source: Primary Data.

From the table given above it is very clear that 85.96% house connections are systematically metered. While it is 100% in the midland rural areas, zero% in other rural areas. Out of a total 104 house connections only 98 connections are fitted with meters. Further, it is observed that in the coastal urban areas the meters are not properly working. Interestingly enough in places, where the meters are in very good working condition, the readings are not regularly recorded and reported for assessment purposes. This problem could be better understood from the following table.

Table 22 Details about the Meter Reading

Area / Category	Rural			Urban			Total
	Coastal	Midland	Hilly	Coastal	Midland	Hilly	
Reported	-	15	-	33	29	20	97
Not Reported	-	-	-	-	1	-	1
Reading assessed	-	15	-	3	14	-	32
No Reading	-	-	-	30	16	20	66

Source: Primary Data.

It is highlighted in the above table that even though 97 households having pipe connections are reported regularly out of 98 connections with meters, proper assessment is carried out only in 32 connections. Hence, steps should be taken to have proper metering systems and some concessions may be given if less water is used and progressive rates can be introduced to avoid excess use. For example in western countries higher rates are charged for the water used for gardening than the water used for domestic purposes as having a garden is considered a luxury (Badawe 2006). Proper pricing is also necessary to solve the financial problem faced by the local authorities due to low recovery rate and high distribution cost. They are unable even to treat the drinking water that they are supplying, to maintain the different water projects and above all to invest on new water projects. In Kanyakumari district, for example out of 20 panchayats surveyed 18 panchayats are financially very weak and the main reason is poor recovery from households having house connection. Sound finance is the basic necessity for conservation, good maintenance and management. Hence, suitable pricing policy should be adopted.

People in some areas depend on the private water vendors. Private vendors, who sell water, charge up to 10 times more than what the households that have pipe connection provided by the local authority pay (Mulford 2006). People in certain coastal villages in Kanyakumari district pay to private vendors 8 times more (Rs 400 per month) than what the local authority charge (Rs 50/-) for a month per pipe connection. It means that even the poor costal area people are ready to pay more than the price charged by local authorities. And so, the price can be increased particularly to the rich people without creating any dissatisfaction among the people if enough quantity of drinking water is supplied to every household.

Apart from these demand side management systems, there are certain other measures, which can enhance the availability of freshwater for different uses or the availability of utilisable freshwater. Foremost of all, the distributional wastage can be reduced, which is very substantial. The distributional wastage in Indian agriculture is estimated at 35 to 40% (Koshoo and Sharma 1992; Zevedo et al 1999; Winpenny 1994). In the domestic sector also there is high distributional wastage. It is estimated that due to leaky pipes alone the distributional wastage is between 40 and 50% of the total drinking water supplied in the Mexico City (Vidal 2006). In India, it is due to leaky pipes and illegal connections, nearly 50% of drinking water is wasted (Mulford 2005; Suresh 1998 in Hinrichsen 1999). The main reason for high wastage is leakages of drinking water distribution pipes. But, many countries including India have no comprehensive plan to reduce leakages. Stopping the leakages alone has a positive impact on the availability of drinking water. If repair works such as tightening the joints in the water pipes and attending to leaky distribution pipes and household connections are undertaken, it would save more than one third of the water that is currently wasted. In Jakarta, Indonesia, for instance, 20 % water loss is avoided by merely fixing leak free distribution pipes. The water, thus, saved has been estimated at 12 billion gallons of water a year. It can meet the needs of an additional 80,000 users (Postel 1993 in Hinrichsen et al. 1999). The same grim picture is painted in Kanyakumari district also particularly in hilly regions. An area-wise analysis of the problem is made in the following table.

Table 23 Water Supplied and Water Received in the District (in lpcd)

Category \ Area	Rural			Urban		
	Coastal	**Midland**	**Hilly**	**Coastal**	**Midland**	**Hilly**
Supplied	10	55	8	52	55	55
Actual Received	9.08 (90.8)	49.78 (86.87)	4.01 (50.13)	51.00 (98.08)	50.97 (92.67)	42.02 (76.4)
$t_{0.05}$	0.85	1.94	2.91*	0.39	0.65	3.09*

NOTE : Figures in the bracket indicates the percentage to the quantity supplied.

* Significant at 5 % level.

Source: Primary Data.

Table 23 clearly indicates that the absolute wastage is of the order of 12.98 lpcd in the hilly urban areas followed by the midland rural areas, 5.22 lpcd and 4.03 lpcd in the midland urban areas. But, the percentages calculated show a different picture. The $t_{0.05}$ value shows that the distributional wastage is significant at 5% level only in the hilly areas; where the percentages of wastage are 49.87 in the rural areas and 24.6 in the urban areas.

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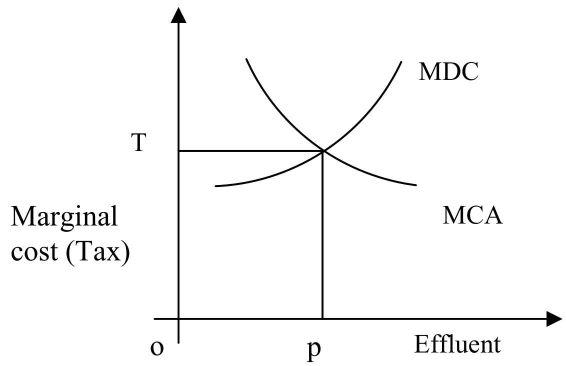
Secondly, the quantity of freshwater available for direct use can be increased when pollution is controlled. It can be done by strictly implementing the Water Pollution and Prevention and Control Act 1969, which was amended in 1974 and 1986. The 'Polluter pay principle' may also be implemented. The three measures suggested by Pigou to counter the problems of environmental pollution may also be applied. They are 1) the pure tax system, (2) the marketable permits scheme and (3) the system of hybrid instruments such as the taxes and standards approach.

(i) **The Pure Pigovian Tax Approach**

The effluents gathered cause pollution and negative externalities. So Pigou advised a tax on effluents. The tax ultimately achieves a socially optimal level of pollution. The tax equalizes the marginal social cost of pollution to the marginal benefits achieved from the production. The managerial costs of effluent control or abatement cost for which the tax is used neutralises the marginal cost of damage by the effluent to the environment. The Marginal Damage Cost Schedule (MDC) and the Marginal Cost of Abatement (MCA) determine both the optimal level of pollution and the optimal tax rate required to achieve it. In the diagram given below P is the optimum effluent, which a society can generate at the existing tax rate, T.

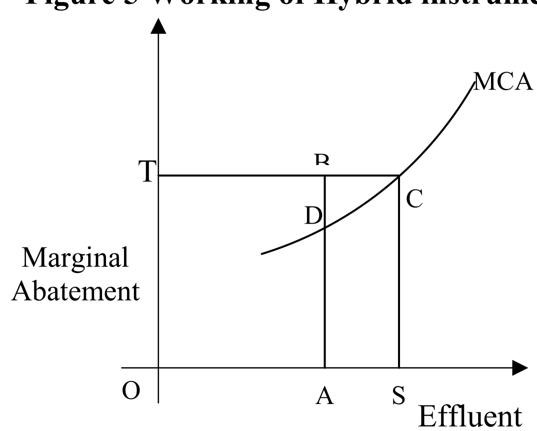
Figure 4 Tax on Effluent



(ii) **The Marketable Permits Scheme**
The alternative to the tax approach is to specify the optimum level of pollution and accordingly a standard for environment. This approach seeks to bring about a given standard at the lowest cost to society. This approach divides the optimal level of total pollution among the various generating units within a certain area.

(iii) **The system of hybrid instruments**
This approach combines the tax approach with the environment quality standard approach. Here a standard for water quality is fixed. As per Pigovian approach, the effluent generator either pays a tax or spends money on effluent disposal. It decides the extent of clean up it will undertake after equating the tax rate to the cost of effluent abatement. But in the taxes and standards approach, a standard has been specified, then the tax rate is fixed at that level which, given the marginal abatement cost, will realize the given standards. Then the marginal abatement cost function can be formulated at either the level of individual firm or the industry as a whole and then the tax rate can be calculated to realize the given standard.

Figure 5 Working of Hybrid instrument



In the above diagram the marginal abatement cost function is given by the curve MCA and the specified standard is given by OS. The tax rate to realize the standard is OT and if a firm abates only OA, then it will have to give a tax equal to AS x OT = ABCS.

A central agency to do quality monitoring in vast countries like India is no doubt quite expensive. So we can have agents at different localities and elite people and students can be trained in monitoring the quality of water. It ensures an optimum utilisation of all available water resources so that every drop of water available can be used properly. Gone are those days when water from all surface sources including ponds and tanks and even water courses running among paddy fields and coconut groves was drunk without any hesitation. If all possible sources of pollution are controlled, then the dependency of people on the local bodies for their daily requirement can be reduced considerably. It certainly reduces investment to be made on drinking water schemes and health expenditure of both individuals and governments and economic loss due to loss of production. It will lead to tension free situation both for the authorities and people as there is only limited quantity is enough to meet very important needs such as water for drinking and cooking. For other demands surface sources may be used without any hesitation.

Thirdly, the unharnessed rainwater can be utilised to enhance the availability of surface sources and to recharge groundwater. Most states in India allow a large quantum of rainwater to wastefully flow into sea as there is not enough storage facility. Though India is blessed with better rainfall than many other countries, over 95% of water received from rainfall is lost through run-off (Lakshmanan 2009). It is said that the total storage capacity of all the world's reservoirs is estimated at about 6,000 km^3 (cubic kilometre). But, the actual storage in these reservoirs is much lower because of siltation, catchment area deterioration and encroachment (FAO 1996; Saleth and Ariel 2004). But, it is proved that desilting improves tank's storage and recharges groundwater (Vydhianathan 2004). In India dams and reservoirs, tanks and ponds can store only 8 to 16% of rainwater obtained from our catchment areas. In Kerala, only 4 to 5% of the natural flow of 7,200 million cubic meters of water is being harnessed by means of reservoirs (Bhattathiripad 1996). In Tamil Nadu also the storing facilities are not enough to store the rainwater which is estimated at 129.66 bm^3. In Chennai city alone, nearly 15 thousand million cubic feet of water has been let into the sea from various reservoirs from 23 November to 13 December 2005. The unharnessed rainwater is equivalent to about 15 month's water supply to the city (Ramakrishnan 2005). In Kanyakumari district itself, 10,000 million cubic feet of water flows into the sea every year. But, it is disheartening to say that no genuine effort is made to conserve this rainwater. Rainwater harvesting techniques is highly beneficial in states like Tamil Nadu, where the natural recharging capacity or the porosity of the soil is very low.

In India, due to the conversion of agricultural lands into housing plots, industrial zones, coconut groves and rubber estates, many ponds have been abandoned or converted into shopping complexes, stadiums, auditoriums and other buildings meant for non-agricultural purposes. It certainly affects the groundwater recharging capacity. These abandoned or unused ponds must be reclaimed. Further, conversion of agricultural lands into lands of other non-agricultural purposes must be stopped as agricultural lands are very helpful for recharging ground water. There are also a number of abandoned wells in every state and these wells can also be used for recharging groundwater. In Tamil Nadu alone there are 1.59 lakh abandoned wells due to various reasons (Ramaswamy C 2003). The reclaimed ponds and abandoned wells can be used for storing rainwater. It not only recharges groundwater but also serves as a barrier to seawater intrusion (Archibald 2007). Steps should also be taken to harvest rainwater in every building.

As water is used recklessly, groundwater, which is a major source of supply not only to agriculture but also to domestic sector, is withdrawn excessively in most of the states in India. It will result in severe water crisis in the future. To avoid excess withdrawal of groundwater, water use rights on quantitative basis may be allowed and progressive pricing must also be introduced. If a pipe connection with adequate quantity with progressive pricing system is given, then that household should not be permitted to extract groundwater and if bore well is there, then pipe connection should not be permitted. It certainly avoids the uneconomical use of fresh water.

Scientific management of water sources with the involvement of community is another step in this direction. Community is the best assessor of the supply and demand for freshwater. Community involvement in rooftop rainwater harvesting, construction of check dams, digging of soak pits, reuse of wastewater and repairing and maintenance has resulted in more equitable distribution as well as more groundwater recharge (Kandaswamy 2003; Malkin 2006; Sharma 2003). Greater participation by local women is needed for the effective implementation, operation and maintenance of water projects (Ali 1984; Kalbermalten et al. 1980; Pant 1996). Involvement of Water User's Associations, NGOs, environmentalists and water institutions and the role of women in every programme have positive impact in the functioning of water distribution systems (Narasimhan 2005; Sharma 2003).

Hence, steps should be taken not only to protect every freshwater source but also to reduce the wastage of available freshwater and run-off rain water. Like conservation of oil and energy, water has to be conserved. Steps should be taken to provide equal quantity of drinking water to each individual as adequate quantity of safe water is of vital importance for dignified life. United and participatory efforts can alone solve this perennial problem. Awareness creation, education on water conservation and economical use of freshwater can help to solve the water problem to a considerable extent. Every citizen, student, NSS volunteer and NCC cadet should be educated on the importance of water conservation and economical use of water. To make people particularly the poor and marginalized free from the brunt of drinking water problem, the above suggested measures will certainly help. In short, the change in approach from supply-oriented to demand-oriented policy is need of the hour.

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