Water Harvesting (Quality & quantity) with community involvement- A case study

With a theme of **Water Saving Technologies**

Global / India water partnership activities (GWP / IWP)

with

Indian water works association (IWWA)

At

Government Higher primary School,
N.S.palya, Near Ajaneyswamy Temple,
B.T.M Layout, Bangalore

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WATER QUALITY – AN OVERVIEW

1. General

Water, the finite and fragile resource, has become the most abused and grossly mismanaged natural resource in the country. Over the years, the country has been facing recurring problems of plenty in the form of devastating floods in eastern and north eastern parts and also acute scarcity in many parts especially in the hard rock regions with limited water potential and covering two third of the geographical area of the country. Added to this the major problem of degradation of water quality of both surface and ground water.

The world's earliest civilisations began on the banks of rivers. With time, this became an accepted phenomenon as water was essential to sustain human habitat. Unfortunately, water has been over used and abused across the world irrespective of the economic status of the region. The civilisations, namely, Babylonian and Indus valley perished due to their inability to use water efficiently and also due to accompanying problems of soil arising out of poor water management.

The five elements recognised in our texts are – soil, water, fire, sky & air and from among them, water is the most precious element on the earth. Water symbolizes prosperity, our National song 'Oande Matharam' bows to mother-earth with water (sujalam); Ganga is worshiped and its water considered to be holy enough to wash all sins. Mythology records Bhagirath to bring Ganga on the earth for the salvation of his forefathers. As early as 2000 B.C., Rigveda mentions water as the essence of life (Jivan), and Kautilya's Arthasshastra elaborates the irrigation system and the responsibility of the King to construct ponds etc. Thus from time immemorial the importance of water and its use and management has been established covering surface water, geohydrology and even water-laden clouds.

In a developing country like India, the problems of water quality are associated with microbiological contamination due to inadequate sanitation. Water borne diseases caused by the consumption of contaminated water continue to take a heavy toll of human lives every year. Besides, water pollution is increasing due to indiscriminate disposal of untreated effluents from industrial, domestic and agricultural sources. Bulk of the water supply in our country is ground water based (more than 85%), developed through hand pump, installed spot sources and piped water supply schemes based on energised deep tube wells. Generally, ground water being an under ground system is less susceptible to pollution as compared to surface water. However ground water quality is getting increasingly polluted and sustainability of water quality has become a major concern. Water quality monitoring and pollution prevention is normally carried out by public health department only during outbreak of epidemics. There is no national or state legislation for regular water quality surveillance, monitoring and testing.

2. Water Quality Status

It is common knowledge that ground water pollution is generally of two types. (a) Contamination caused by the very nature of the geological formation : excess fluoride, arsenic, total hardness, iron and salinity fall under this category; (b) Ground Water Pollution caused by human intereference (anthropogenic). Some of the examples are (I) excess application of chemical fertilizers having high quantity of Nitrates, used in the agricultural sector; (ii) biological contamination due to discharge of untreated domestic sewage; (iii) discharge of untreated industrial effluents; (iv) excess pumping of ground water in coastal areas leading to brackishness; (v) water logging and soil salinity in canal command areas due to unilateral and isolated development of surface water, causing water table to rise. Apart from the above, excess pumping of ground water from a large number of tube wells in arsenic affected areas in West Bengal is also attributed as one of the reasons for the arsenic problem. It is a matter of serious concern that the quality problems of fluoride and arsenic contamination have come to the forefront, affecting a large segment of population in our country. A variety of diseases have emerged including dental and skeletal fluorosis (caused by excess fluoride), and arsenic dermatosis and skin cancer (due to excess arsenic), besides the less serious stomach problems (due to excess iron and brackishness). The reported population directly affected and at risk in case of fluoride and arsenic problem in rural areas is estimated at 25.1 and 71.3 million respectively.

In all 1,54,491 groundwater samples have been collected and analysed for 14 major parameters covering 33,667 villages / habitations out of the total 56,682 villages / habitations throughout Karnataka State by the Department of Rural Development and Engineering Department (RDED) in 2000-01. As per the available data, 69 taluks spread over 18 districts are affected by chemical contamination of the drinking water sources. In general, the problems are due to Fluoride (17%), Total Dissolved Salts (4%), Total Hardness (3%), Iron (28%) and Nitrate (10%) in excess of permissible levels.

3. Water Quality Problems

Salient features of some of the major quality problems of chemical origin in water supply are highlighted below:

INDIAN STANDARD DRINKING WATER SPECIFICATION (IS 10,500-1991)
(Physico chemical and Bacteriological parameters)

Sl. No.	Substance / Characteristic	Desirable Limit	Permissible Limit	Remarks
1	Colour (Hazen Unit)	5	25	Makes water aesthetically undesirable.
2	Appearance	-	Clear	Consumer acceptance decreases
3	Turbidity (NTU)	5	10	Consumer acceptance decreases
4	Conductivity			Indicates the amount of ions present in it.
5	pH	6.5	8.5	Indicative of acidic or alkaline waters, affects taste and corrode water supply system
6	Total Dissolved Solids (TDS-mg/lit)	500	2000	Palatability decreases and may cause gastrointestinal irritation in human, may have laxative effect particularly upon transits.
7	Total Hardness (mg/lit)	300	600	Affects Water Supply system (scaling), excessive soap consumption, calcification of arteries, may cause primary concretions, diseases of kidney or bladder and stomach disorder.
8	Chlorides (mg/lit)	250	1000	May be injurious to some people suffering from diseases of Heart or Kidney's, taste, indigestion, corrosion and palatability are affected.
9	Sulphate (mg/lit)	200	400	Causes gastrointestinal irritation.
10	Fluoride (mg/lit)	1	1.5	Reduces dental carries, very high concentration may cause crippling, skeletal fluorosis.
11	Alkalinity (mg/lit)	200	600	Imparts distinctly unpleasant taste, may be deleterious to humans in presence of high pH, hardness and TDS.
12	Iron (mg/lit)	0.3	1	Gives bittersweet astringent taste, causes staining of laundry and porcelain. In traces it is essential for nutrition.
13	Nitrate (mg/lit)	50	100	Causes infant methaemoglobinaemia (Blue babies) at very high concentration causes gastric cancer and adversely affects central nervous system and cardiovascular system.
14	Bacteria (MPN/100 ml) • Total Coliform • Fecal Coliform	1	10	Causes water borne diseases like jaundice, typhoid, cholera, etc. produces infections involving skin, mucous membrane of eyes, ears and throat.

4. Hierarchy / Priority Levels of Technical Options for Water Quality

Sl. No.	Parameter	Available Options	Accepted / Recommended Options in order of priority
1	Fluoride	a) Alternate local/distant ground water source (with appropriate ground water recharge arrangements) b) Local/distant surface source c) blending with non-fluoride water wherever feasible d) Dual supply with different service level (drinking, cooking & other purposes) e) Household defluoridation units f) Nalagonda Technique (using Alum), Ion exchange process using activated Alumina.	a) Where isolated small number of habitations are affected b) Where large number of contiguous villages are affected c) Where fluoride concentration is marginally higher (1.5-2 mg/l) and fluoride free water is available d) Where community is aware and able to distinguish the difference (on pilot basis) e) Can be tried on an experimental basis f) Can be tried on an experimental basis
2	Nitrate	a. In areas affected with Nitrate, open well sources shall be avoided b. Alternatively, bore well with at least 10 meters casing is recommended. Flushing is to be done first, before commissioning the supply	a. In areas affected with Nitrate, open well sources shall be avoided b. Alternatively bore well with at least 10 meter casing is recommended. Flushing is to be done first.
3	TDS	a. Alternate distant source/ground water b. Alternate local/distant surface source. c. Blending, if possible.	a. Alternate distant source/ground water b. Alternate local/distant surface source. c. Blending if possible.
4	Iron	a. Treatment for iron removal. b. Regular use of bore wells to avoid accumulation of corrosion products from iron pipes.	a. Creating awareness to avoid long idealing of bore wells. b. Store water longer and strain through cloth. c. Change the GI pipe to PVC pipe casing. d. Use PVC pipe for new bore wells. e. Install iron removal plant.
5	Bacteria (Coliforms)	a. Disinfection	a. Continuous chlorination of water supply to maintain a minimum residual concentration of 0.2 mg/l.

5. Methodology

Water Saving Technologies

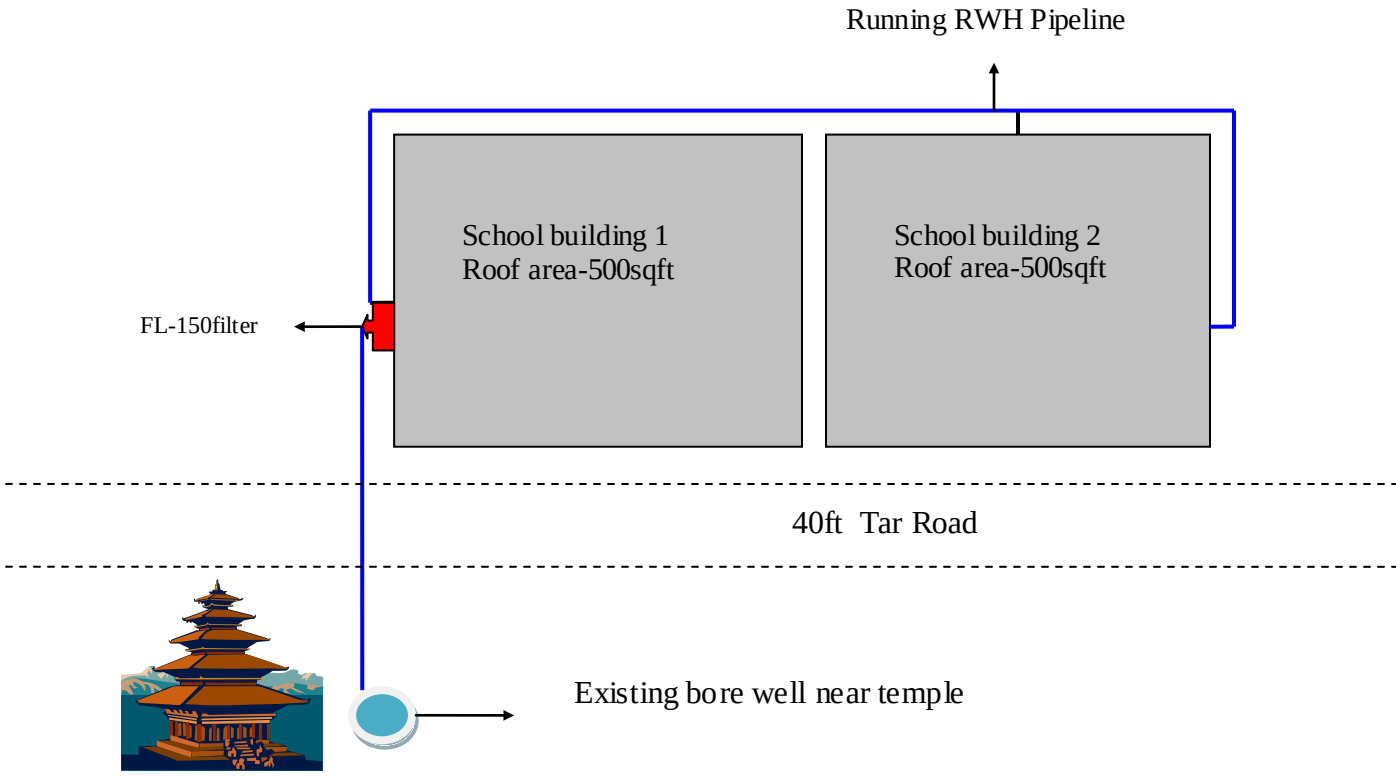
Physical investigations are carried out to choose the area for water quality /quantity management activities.

* We have choosen the Corporation School, roof area available 1000 sq feet (92 sq meters) with a probable water storage capacity of 70,000 litres.

*The supply of water to this school is from a Bore well (is located 30 m away from the school campus) which is located in a Temple grounds.

*A water harvesting structure is provided to this bore well by collecting the water from school campus. Water quality/quantity monitoring is going on from lost 4 months, will be continued till the till March 2010.

Rain water Harvesting System at Govt higher primary school, N.S.Palya, Bangalore



Details:-

Total Roof Area -92m²(1000 sqft)
Assume 1000mm rainfall/year
Expected Yield =90x0.85x0.90x1000=70380(70m³)

Index:

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"Roof Top Rain water Harvesting System" (Water Saving Technologies)

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An example: The total roof top area available for rainwater harvesting at Government Higher Primary school at N.S. Palya, Bangalore Roof area is 1000 SQ FEET (**92** square meters)

A RCC roof an area of **92m^2,** Using a **'Rainy'** RWH Filter in an area with local annual rainfall of **1000 mm** would yield**92 x 0.85 x 0.90x 1000=(70380 LITERS) (70 m^3):**

There is one existing bore well near to the school this well can be recharged with Rain water harvesting system, the quantity of water 70kilo liter can be recharged with the proposed Rain water harvesting system per anum..Since the roof area is around 92 sq mtr we have recommended one number's of Rainy FL-150 RWH Filters

ADVANTAGES:

•Increases Groundwater level by recharging and reduces salinity and fluoride contents in the open wells.
•Provides potable Drinking Water.
• Rejuvenation of declining open Wells
•Due to recharging of open well, the static water level in the well increases, so the pump load reduces, this reduces the power required to pump same quantity of water. Power saving around 20 to 25%

The Water samples were collected (rainfall data & water table data also collected) monthly & analyzed for all drinking water quality parameters

Physico chemical and Bacteriological parameters

Sl. No.	Parametrer (Water table from Ground level) rainfall (mm)	Sep2009 (110 ft) 16	Oct2009 (97 ft) 80	Nov2009 (62 ft) 47	Dec 2009 (47 ft) 04
1	Colour (Hazen Unit)	10	10	10	10
2	Appearance	good	good	Good	good
3	Turbidity (NTU)	9	10	10	10
4	Conductivity	-	-	-	-
5	pH	6.5	7.1	7.1	7.3
6	Total Dissolved Solids (TDS-mg/lit)	2300	1800	1650	1400
7	Total Hardness (mg/lit)	465	430	330	210
8	Chlorides (mg/lit)	512	434	355	312
9	Sulphate (mg/lit)	310	300	280	240
10	Fluoride (mg/lit)	1.0	1.0	0.8	0.6
11	Alkalinity (mg/lit)	310	300	250	230
12	Iron (mg/lit)	0.2	0.2	0.1	0.1
13	Nitrate (mg/lit)	54	45	40	35
14	Bacteria (MPN/100 ml) • Total Coliform • Fecal Coliform	1	0	0	0

6. Water Quality monitoring & surveillance : Community based approach

The monitoring of water quality in urban/ rural habitations is an important component of water supply and sanitation. The main goal of Water Quality Monitoring (WQM) is to ensure that the community water supplies conform to the drinking water standards on a sustained basis. Lack of safe drinking water has been a major cause of endemicity of most water borne diseases like Cholera, Typhoid, Infectious Hepatitis, Enteric diseases, Diarrhea, etc. As a matter of fact epidemic of such diseases has become an annual event in urban, peri-urban and rural areas of our country particularly among the low-income groups of people and the under-served areas. In India, during the last few decades the national policies have shown increasing emphasis on rural water supply and sanitation. In terms of physical progress, the achievements have been remarkable, and most of the problem villages are now covered with an optimum supply of water. Unfortunately however, such progress has not been seen to be translated into health benefits, and water

borne diseases continue to be the dominant cause of morbidity and mortality in many parts of India. The reasons are fairly obvious: **though water is being supplied, its potability** is not being ensured. The lack of Water Quality Surveillance (WQS) in urban/ rural areas is acutely brought into focus during the episodes of water borne epidemics.

Water Quality Monitoring Program and Surveillance

Present Scenario

The District Health and Family Welfare office collects and analysis water samples from rural habitations during periods of epidemic outbreaks of diseases on only when public complaints regarding water quality are received. The analysis of water samples is again restricted to the bacteriological quality only. In the year 2000, a programme of testing water quality for organized water supply schemes for 14 quality parameters has been started by the RDED. This programme, however, does not include traditional sources, which are commonly used in villages and the public taps.

Proposed Strategy

As for the water quality monitoring, there is a need for a 'State of art' laboratory at the RDED at the State level which could function as a referral laboratory for all the district laboratories. The mandatory functions of the state laboratory would include the following.

- analysis of water and waste water for complex / difficult parameters such as pesticides and insecticides, trace metals, etc.
- analytical quality control
- R&D on local field problems such as high fluoride in drinking water, simple cost effective methods of disinfection, appropriate household latrine designs, etc.
- evaluation of new products and processes for their adoption and large scale promotion in the field.
- training of laboratory personnel in water and waste water analysis.

In the light of the large number of habitations affected by high levels of fluoride in drinking water in the project districts, it is necessary to find alternative sources for new water supply schemes. If such sources can not be found within economic distance, simple household / community defluoridation systems have to be identified. The two technologies developed and accepted with fair degree of success are (i) the Nalgonda technique and (ii) the activated alumina process. In this context the field experiences gained in the implementation of DANIDA assisted project in the State should be brought to bear upon the decision making in the choice of technology. Additionally, it is necessary to undertake R&D on commercially offered technologies, defluoridation such as electrodialysis, ion-exchange etc for their efficacy under field conditions. This objective could best be achieved only by establishing at the State level (RDED) an R&D wing backed by a “State of Art” laboratory and multi-disciplinary team of well qualified, experienced environmental engineers / scientists with adequate financial support. The R&D wing would also undertake evaluation of other process / products used in water treatment and field problems that may be identified in the area of rural water supply and sanitation and

training programmes. In the light of estimated investment in the proposed project and the likely technology issues that may arise during its implementation, the establishment of an R&D wing as above will be well justified. This wing should be headed by a well qualified and competent environmental engineers at CE / SE level supported by one EE (Environmental Engineering) and a team of scientists comprising a chemist, a biochemist, an instrumentation scientist (M.Sc. / Ph.D. in Physics) and other supporting staff i.e. lab technicians.

In this backdrop the following strategy is commended in order to strengthen the various institutions at the State / District level.

Human Resource	**Infrastructure**
At State Level (RDED) ● One Environmental Engineer with minimum P.G. qualification in the cadre of CE / SE. ● Two Executive Engineers with P.G. Degree in Environmental Engineering and Sciences. ● One Chief Chemist-cum-Bacteriologist. ● Two Lab. Technicians. ● One Social Scientist-cum-Hygiene Education Specialist with P.G. qualification and Diploma in Health Education. ● Other Supporting Staff.	**At State Level (RDED)** ● State of art laboratory with modern equipment for Water Quality Testing, Analytical Quality Control (AQC) and R&D support. ● Audiovisual equipment with a mobile van.
At District Level ● A Chemist with experience in routine water and waste water analysis. ● One lab. technician.	**At District Level** ● Studies on adverse effect on community and proposal for rectification. ● Existing district labs established under RGNDWM to be made functional and strengthened in terms of instrument / equipment. ● Audiovisual equipment with a mobile van.

To develop water quality monitoring on a sustainable footing, it may be necessary to consider innovative approaches, such as creating awareness about water quality at all levels involving communities in water quality testing and identifying / designating separate agencies for I) water quality monitoring and control and ii) water quality surveillance. In this context the following strategy is recommended / followed in Jal Nirmal project.

3 tier system of Water Quality Monitoring

GP-VWSC

1. Trained Grama Panchayath / Village Water Supplied Sanitation Committees (GP/VWSC) hand pump operators / value man will monitor the water supply distribution system.
2. Simple routine rests everyday for residual chlorine (min.concentration of 0.2 mg/lit using Chloroscope / portable kits will be carried out.
3. Physical / Chemical / Biological analysis to be carried out once in 6 months from the identified laboratories by GP / VWSC.
4. Operation and maintenance cost towards water (sample) collection / Analysis will be met by GP. The water quality analysis data with clear markings (painted with blue colour for potable sources and red colour for non-potable sources) of the source and documentation is done at GP level.
5. Any problems in water quality, GP / VWSC may directly contact the ZPED for clarification and rectification.

ZPED

1. Zilla Panchayath Engineering Department (ZPED) shall impart training to the persons identified by the GP about routine collection (physico-chemical and Bacteriological) of water samples as per standard procedures. For supplies from surface sources (Rivers, open wells, traditional tanks) Ground water, Sources (Overhead tanks, Traditional Tanks), Mini water supply tanks, cisterns), the residual chlorine in the treated water should be tested daily as a parameter to indicate the bacteriological safety of the supply.
2. Training to maintain proper record to test results and contribution for O and M of the scheme at GP level.
3. Training to collect water samples twice a year (pre monsoons and monsoons) as per standard procedures. ZPED will coordinate with GP for the collection, analyses of water samples from the identified laboratories / ZP owned laboratory.
4. During outbreaks, if any abnormal changes in water quality parameter values should be immediately brought to the notice to District Public Health units for necessary follow up action as appropriate.
5. The ZPED checks the portability of any newly established borewell / surface source by conducting all the tests on the water samples collected. If the quality parameters are with in the prescribed limits, the source is developed and allowed to be used by the beneficiaries. If the water does not satisfy the quality requirements, new borewells are drilled after conducting detailed geophysical survey.

RDED

1. Rural Development Engineering Department (RDED) will impart training to the persons identified by ZPED in Water Quality Management.
2. It will undertake R & D on commercially offered technologies, defluoridation such as electro dialysis, ion exchange etc. for their effectiveness under field conditions.

3. Innovative water treatment methodology and technology are tried on pilot and replicated in quality affected areas. The R & D wing would also undertake evaluation of other process / products used in water treatment and field problems that may be identified in the area of rural water supply.
4. RDED will create a districtwise / Gram Panchayatwise water quality data and create database of GIS based quality profile of water sources.
5. On receipt of complaints from ZPED. It will interact for the mitigative measures.

- Awareness Programmes / Public Consultations for implementation of Water Quality Monitoring Programme

7. Preparatory visits to selected Pilot area

In order to prepare the community for their participation during public consultations, it was decided to undertake preparatory visits to selected pilot areas of heterogeneous (Surface / Ground Water Source) Water Supply System. The purpose of these visits was to meet with the elected representatives of the area &s also the target population and officials of the various development departments at the local levels to sensitize them regarding the **Water Quality Monitoring Programme,** as also their role and stakes in the project. During these preparatory meetings, the participants were informed about the public consultations that were to follow. This advance intimation was aimed at providing adequate time and opportunities to the target groups to formulate / firm up their views.

These preparatory meetings were held on September 2009 first at the local level and officials of various development departments such as corporation Health & Family Welfare, Mines & Geology and elected representatives of local corporation . The preparatory visits also enabled collection of available secondary information on the existing status of water quality monitoring in the area through interviews and on-site observations.

Public Consultation Meetings

The schedule of meetings for Public Consultations was drawn up in consultation with the concerned corporators , school teachers , temple trust members. Formal meeting notice(s) cum handout in Kannada were prepared giving details of the Water Quality Monitoring Programme. The rules for participation by the local people, the details of capital cost sharing and the O&M responsibilities by the beneficiary community. Printed copies of notices were distributed widely to the public, the elected representatives and other functionaries. The meeting notices were circulated well in advance (one week) of the date of consultation and displayed in local temple Offices and other important public places such as temples, school and bus stops. Public announcement regarding the meeting was also made in the local area through the traditional public address system (i.e.) 'tom-tom' and through local media, (cable T.V.) and Newspapers. Banners were also displayed at the venue of the Public Consultations. All efforts were made to have full participation of the stakeholders in the meetings.

8. Results & Discussion

The harvesting structure was implemented in the month of October 2009. The water sample analyzed were presented in the table. Ph is varied from 6.5-7.9, Total Hardness is varied from 210-465 mg/lit. Nitrate is observed to be 52 mg /lit in the month of September 2009 . The rainfall varied from 47 mm to 110 mm in these four months & water table is found to be higher in the months of october to december . The results clearly indicates rise in water table (in addition to rainfall) due to recharge & dilution effect, the changes in water quality were also observed**.**

Water Quality management activities during September – December 2009. It is observed from the field visits that , People are more concerned about the quality of drinking water they receive.They are also aware of the ill effects of using contaminated water .This has led to increased interest in deploying better systems for monitoring and control of water quality.Surveillance programme should be enforced and encouraged in all cities /towns for ensuring that consumers have access to safe drinking water free from contaminants. The Water Quality Monitoring training programme for local people /students /school children, Hand Pump Operators, local staff were conducted .

9.Conclusion

The present mindset of majority of the population is that water is government's business. This needs to be replaced by a model in which all major stakeholders participate at all levels. Without this change technology solutions will be of no use. The change could be brought about by public awareness, education, identification and dissemination of best practices and incentives for action, thereby facilitating conservation of this precious resource and equitable distribution among the needy people.

Warning signals are already visible cautioning that the limit of renewable fresh water that the hydrological cycle can yield has already reached and such a situation cannot be continued forever. We should not wait for the crisis or flash point to occur since it is possible to face the problems in conserving and managing the resource though various short and long term measures, supported by action plans. It would then be easier to overwhelm the conflict inducing characteristics of water by developing a sustainable arrangement.

To sum up participatory management has come to stay as the most viable concept for successful option of any system. A number of success stories based on community based pilot projects in rural water supply adds further conviction to this concept. In view of the intimate linkage of water and sanitation with human health and in the context of the continued annual toll of precious lives due to water borne diseases, a community based water quality surveillance may probe to the right strategy for achieving the cherished goal of "Safe Water, Safe Sanitation and Safe Health" for all rural population in the country.