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SOCIO-ECONOMIC ASPECTS OF WATER

By

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PROF. V. RAMAN ENDOWMENT LECTURE

LATE SHRI V. RAMAN

The endowment lectrure is regularly organised by IWWA to commemorate the found memory of Prof.V. Raman, who died prematurely on 1st Jan. 1985.

Born on 19th May, 1932, Late Mr. V. Raman took his B.Sc. degree from Travancore and B. Tech from IIT Madras in Civil Engineering in 1956, and M.Sc. (Public Health Engineering) from University of Madras in 1957. Later, while in service, he took Post-Graduate Diploma in Industrial Hygiene and Air Pollution from the University of Zagrev in 1964.

After a brilliant academic carreer, Mr. Raman joined All India Institute of Hygiene and Public Health, Calcutta as Assistant Professor of Sanitary Engineering in July, 1958. He was associated with this institution till July, 1970.

His next appointment was with NEERI. He was appointed Assistant Director incharge of the Zonal Laboratory at Bombay where he carried out field studies in Air Pollution survey of Bombay, Master Plan of Water Supply and Sewerage of the City of Bombay and other assignments connected with industrial waste, air emission survey, pilot field studies on leakage detection and control, organising training programmes, etc.

In December, 1975, he was promoted as Senior Assistant Director, NEERI and was incharge of the Environmental Engineering Consultancy Division, Sewage Treatment Division and Rural Sanitation Cell. He planned and executed research and field studies in water Distribution Systems, Low Costs Waste Treatment and Rural Sanitation. Among important assignments carried out by him were, Pilot Plant Studies on water supply of Ahmedabad City and Project on land utilisation of Bombay, sponsored by EEC/ Metcalf & EDDY and Bombay Municipal Corporation (World Bank Project).

Mr. Raman had 115 papers to his credit, 20 of which had appeared in International Journals. He was connected with several professional institutions. He was Fellow of Institution of Engineers (India), Member - Indian Water Works Association, Member - International Water Supply Association, Member - International Association for Water Pollution Research, Secretary - Indian Association for Water Pollution Control (and also its Editor) and Chairman - IWWA (Nagpur Centre). He was guide/examiner for students preparing for Master's and Doctor's degree in Public Health Engineering at the University of Nagpur and South Gujrat.

His International assignments include: WHO Consultant of Govt. of Iran, UNIDO/UNSEP/ ESCAPE Expert of Govt. of Sri Lanka. WHO Consultant of Govt. of Bangladesh (one month in 1981 - 82). Asian Development Bank , and WAPCOS, INDIA (Govt. of India).

In his death in Jaunary, 1985, the Public Health Engineers of India lost a Scholar, a Professor of International reputation, an eminent Research Worker, and a lovable friend, philosopher and guide.

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SOCIO-ECONOMIC ASPECTS OF WATER

Prof. P.B.Sharma
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I consider it a matter of high honour to be invited to deliver the Raman Memorial lecture at the National Convention of Indian Water Works Association. I feel equally delighted that the convention is being held at Bhopal in the State of Madhya Pradesh where under the dynamic leadership of Shri. Digvijay Singh, Hon'ble Chief Minister of M.P. several concrete steps have been initiated towards augmenting the water resources in this State. The theme chosen for the present convention is highly relevant as the effective Management of Water Resources in 21 st Century will in fact ensure a sustained improvement in the quality of life of our people and will help advance our country on the path of rapid track economic growth. Let me therefore extend my heartiest greetings to all the delegates who have come from various parts of the country to pool their matured wisdom together to deliberate on various issues relating to the management of water resources.

I am conscious of the importance which is required to be attached to the preservation and maintenance of water resources in our country. We in India, compared to many other countries of the world have to place a much higher priority to the enrichment and preservation of water resources as we belong to a civilization that is predominantly dependent on water for its life current, for its socio-cultural traditions and for the sustenance of life style so deeply integrated with the natural resources such as water. The Rajiv Gandhi Proudyogiki Vishwavidyalaya (University of Technology of Madhya Pradesh) of which I have the privilege to serve as the founder Vice-Chancellor shares the responsibility to supplement the efforts being made by our Government in respect of creating a mind set tuned to preservation and maintenance of water resources. In this endeavor we have to go beyond the knowledge base in our quest to generate human resources, provide a strong support to out State's and Nation's economy while at the same time ensure that the quality of life of our people is significantly improved.

Ladies and Gentlemen, I need not remind you that we in India belong to a of civilization which right from the very dawns of civilization has shown a high respect to the nature, to the environment and to its intimate relationship with human-kind. The harmony with nature has been considered as the most vital component of assuring happiness in this part of the world. In the words of one of the greatest philosopher seers of the modern time, namely Shri Aurbindo "a true happiness in this world is the right terrestrial aim of man, and true happiness lies in the finding and maintenance of a natural harmony of spirit, mind and body." and such a harmony cannot be established unless we learn to live in harmony with nature. Our forefathers understood this aspect so well that they have been able to evolve and sustain a happy and healthy abode for our people during the last five thousand years or more and it is in this respect India counts tallest among the worlds ancient civilizations.

क्षिति जल पावक गगन समीरा,
पंच रचित अति अधम सरीरा।

Often quoted lines from Saint Tulsidas' s Ramayan very aptly describe the importance of the five vital elements of which undoubtedly water is the most important as in it we have fire (Hydrogen) and air (Oxygen) as well as the capability to harmonize the sky with earth. In the famous Tatriya Upnished, the Vedic seers have propounded that: अग्निः पूर्वरूपम्। आदित्य उत्तररूपम्। आपः संधिः। वैद्युत सन्धानम्। i.e the water is the element that units fire with the ever luminescent the sun, the eternal source of energy and that the electricity is the means to achieve this integration.

For all living beings 80% of earth's surface is covered by water. Almost all human activity is dependent on water. Water is the primary requirement for any settlement or society. One can not think of life without water .

HISTORICAL ASPECTS

It is well recognized that prehistoric human settlements were located by the side of rivers. Indian civilization from its early days of settlements has emerged as a river valley civilization and has continued to date to depend on the flowing streams of rivers and on the water bodies for its continued march·on the path of progress and prosperity. The mighty rivers of India have provided the life-line of human settlement we as a civilization have shown the highest respect to mother earth, its vegetation, its water bodies, flowing streams and rivers as these have provided a valid means to connect the human mind with the divine bliss. Harmony with nature was the basis of all developmental programme is the pre-industrial society, particularly in India. Indians learnt to treat nature with respect and adjusted with it while westerns thought of conquering nature treating it as hostile. This is the basic difference in the philosophy of development. Perhaps the wrath of nature is more severe when we try to conquer it, compared to the situation when we try to harmonize with it. During the pre-medieval period, in our country we have attached a high significance to the concept of controlled consumption of resources. " Apirgraha" was indeed the very basis of our development and growth. It is because of this emphasis on controlled consumption that Indians have been able to live through the millennium of human existence on this large peninsula without causing any serious concern for our survival. This developmental model effectively limits wastes, conserves the energy and material resources but then it also prohibits the man to manifest his full potentialities both mental and physical to explore the nature and its surroundings.

Post industrial revolution models of development provide an interesting insight into the shift of our concern for the environment. In our quest to develop fast we have not only disturb the harmony with nature but have caused a serious destruction of nature in turn creating misery for human beings and other living beings on earth. The monumental problem of air, water and soil pollution has already brought India under the list of the most polluted countries of the world. The quality of water flowing in the rivers has degraded beyond redemption. Ground water has also been polluted in the urban areas. We have the irony "Water - Water every where but not a drop to drink". In fact because of uncontrolled and unabated discharge of effluents from the industries and untreated discharge of waste water the holy rivers of India have already turned into the rivers of poison. Who else other then our modern society is responsible for this rather man made catastrophe, I ask you ladies and gentlemen? India must awaken and our government, our science and technology professionals, our Industries and our people at large have to join together to clean the menace which we have created for ourselves.

GLOBAL WATER RESOURCES

In order to take stock of global water resources, it is important to understand the solar driven hydrological water cycle. This cycle traces the successive changes of water as it moves from the ocean, through precipitation, transpiration, percolation, infiltration, evaporation, and then back to ocean. This cycle plays an important role in the world's water supply system. (fig.1 & fig.2) It would be clear from these figures that oceans and sun play a crucial role in supply of fresh water in this planet.

As the water is transferred through the water cycle, its quality changes. The ocean waters are highly saline containing about 35 g/L of dissolved solids with approximately 70% being made up of Sodium Chloride (NaCl) Solar evaporation desalinizes the sea water with cloud formation and then precipitation. Most of this evaporated water falls back into the oceans 91% as precipitation in the forms of rain, snow and ice. Despite the fact that almost two third of the earth's surface is covered with water, there is very little fresh water available for human use. As such the importance of preservation of fresh water resources such as flowing streams of rivers and water bodies cannot be over emphasized.

The UNESCO estimated in 1974, that the earth's total water reserves were 1.386 x 10^9 km^3 while the total fresh water reserves on earth can be considered to be around 35.03 x 10^6 km^3. It is interesting to note that oceans contain estimated 96.5% of all the water on earth, the remaining 3.5% being tied up in glaciers, ground ice permafrost and ground water (1.7%) with the remaining in atmosphere and lakes, rivers, swamps and biological systems. Out of this 3.5% of the water is found in the land areas, approximately 1% is either too saline or too inaccessible to be included in the global fresh water reserves. This leaves an estimated 2.5% of the total global water reserves classified as available fresh water.

Of the 35 x 10^6 km^3 of global fresh water described earlier, 69.55% is in the from of frozen fresh water and 0.26% is in lakes and streams. On a global basis, it is estimated that 30% (10.5 x 10^6 km^3) of available fresh water on earth is found in ground water aquifers. An over draft of ground water can cause the land to subside as well as permit sea water to intrude into aquifers adjacent to the sea. An outstanding example of land subsidence is Mexico city, where an astounding subsidence of 3.2 m has taken place since the beginning of the century .

ESTIMATED GLOBAL WATER USE AND CONSUMPTION

The annual renewable fresh water resources of the world in 1987 were estimated at 40,673 km^3 per year with total annual fresh water withdrawals estimated at 3.240 km^3. Therefore on a global basis, the fresh water withdrawals account for only 8% of the total renewable fresh water. It was also estimated that the per capita fresh water withdrawals on a global basis in 1987 were 660 m^3/person/ year i.e.1808 liters per capita per day. 8% i.e. 145 liters per capita per day for domestic use, 23% i.e. 416 liters per capita per day for industrial purposes and 1247 liters per capita per day for agricultural purposes. Though the estimated global usage were higher in 1990 but the percentages of usage were essentially the same.

RECLAIMATION OF WASTE WATER

It is estimated on a global scale that humans are now using over half (54%) of the worlds accessible supplies of renewable fresh water and that by the year 2025, three quarters of the world's renewable fresh water supply will be committed. Of this 54% of the global fresh water now being used, about 61% goes for direct withdrawals (agricultural, industrial and municipal) and 35% for preserving in stream flows.

With the increasing demand for fresh water supplies, the use of treated waste water is a feasible way to supplement the global water resources (Fig.3). It can be economical and a feasible preposition. Waste water reclamation and reuse can be divided into two board categories. The first category being for the treatment of waste water for disposal purpose in order too protect the surface waters from pollution and the second category being for the treatment of waste water for some beneficial or controlled use that would not otherwise occur .

It is estimated that only 70-80% of the fresh water used for domestic purpose could reach waste water treatment facilities. Industry on the other hand could recycle much of their waste water and only about 30% of their discharges go to public or municipal waste water facilities. On the basis of these estimates only about 518 km^3 year of the waste water on a global basis is available for reclamation and reuse. It is estimated that less than 1% of this waste water is currently reclaimed for a beneficial use. There are many benefits along with obstacles associated with waste water reclamation and reuse. The technological advances are not catching on like other technological innovations. In India we have to pay a much greater attention to the treatment of waste water, its reclamation and reuse as this will go a long way to protect our ground water reserves while at the same time relieving our rivers from the burden of water pollution caused by the discharge of untreated water.

There are many applications of reclaimed water. These applications depend on the standards set for the reclaimed water quality .(Table-2). gives the basic parameters in waste water characterization. These standards are legally enforceable by Governmental agencies and include rules and regulations for sampling, testing and reporting procedures. WHO has issued guidelines for agricultural irrigation in tropical and subtropical countries. In the formulation of standards, community involvement must be sought sources is also getting polluted particularly in urban areas.

WASTE MINIMIZATION APPROACHES AND TECHNIQUES

We, as a Nation, have to pay a much greater attention to waste minimization so as to conserve our precious natural resources. Table 1 gives the possible approaches and techniques that can be adopted to achieve the desired results. In this mission we must pay a greater attention to inventory management and use improved material handling operations. we should focus on technology up gradations to install equipment's that produce minimal or no waste, develop zero waste and zero defect engineering production processes and improve efficiency of the equipment's and efficacy of the processes the whole world is currently focusing its attention to improving the work processes and production systems so that the tomorrow's world community is revealed of the enormous concern for pollution and depletion of natural resources. We, in India have to arise to this challenge and engage ourselves through well planned missions and strategies . There is also dearth of ground water recharging resulting in depletion of ground water resources. National Drinking Water Mission is highly dependent on ground water resources. This has to be properly managed by water harvesting and ground water recharging missions. Of course the State Government as well as Govt. of India are doing their utmost in these areas but unless there is community involvement and public awareness the Governmental efforts alone would not bring the desired results. Maharastra experiment is quite well known and often quoted. I wish there are many Anna Hazares in our country to galvanize the community to conserve the scares water resources.

GROUND WATER REGULATORY AUTHORITY NEEDED

In view of the acute water shortage and depleting ground water table in the state of Madhya Pradesh, it is proposed that immediate steps be taken at the Government level to formulate a water policy for the state, which besides preventing the wasteful utilization of water, must regulate the use of ground water resources. The water policy should emphasize on Water Conservation, Wastewater Recycling and should outline a programmed drive for Water Harvesting and ground water recharge. All major industrial and agriculture projects should be audited for effective utilization of water and must have an in-built component of water conservation and ground water recharge. All the metro cities and district headquarters should ensure that water harvesting is implemented in a manner so that, by the year 2005 the pressure on ground water utilization is totally relieved for civic usage.

The water policy should also pave the way for the establishment of a Ground Water Regulatory Authority, which right from the block level should regulate the ground water utilization and conservation of water resources. In this exercise a greater appreciation of the role of professionally competent hydro-geologist should be incorporated, so that, their expert services could provide a valid support to the technoeconomical success of the water regulatory authorities.

Strict adherence to the water quality audit for drinking water is essential for the maintenance of public health and this requires, besides legislation, a well planned strategy to make fresh water available for drinking water. The current dependence on river water utilization for drinking water should be effectively supplemented by fresh water harvesting. The rivers themselves are to be de-silted so as to enhance their reservior capacity and a major exercise of abetting river water pollution is to be carried out. However, all these efforts will succeed only if the mindset of people is prepared to understand the importance of water conservation and preserving the water resources. A mass movement aimed at generating such a public awareness is the need of the hour.

CONCLUSION

It is obvious that water is an important element in sustenance of life in this planet. Water thus plays an important role in the behavioral aspects of human race. By implication socioeconomic aspects of water are thus intricately interrelated with every human activity. One may like to observe the impact of water in the desert-culture to appreciate this. For modern society food, health, environment, industry and power are all related to water. In earlier times its availability was assured free of cost but with increasing pressure of population and consumerism, supply and demand mechanism has started playing a significant role in water pricing. There is water-rush these days akin to "Gold-Rush" of historical times. Times may come when people may like to exchange gold for fresh drinking water if we continue to neglect the precious water resources. Water-pricing should adequately cater to developing proper economic value for water so as to discourage wastage and encourage optimal use.

The need to conserve water cannot be over emphasized. Water recycle and reuse has to be encouraged. Water shed management and ground water recharging have to be resorted to. Prevention of pollution of ground water from surface water pollution has also to be taken care. All these issues need our attention as much as population control and literacy missions for if there is not enough safe fresh water the human race could hardly survive on mother planet earth.

Famous Hindi poet "Rahim wrote centuries ago"

रहिमन पानी राखिये, बिन पानी सब सून,

पानी गये न उबरे मोती, मानष, चून।

meaning that one should care for water because without water pearl, man and lime cannot be sustained. Though Rahim referred to water for human beings in the context of self esteem, but it also reflects the need to preserve water for survival, in as much as survival only can guarantee self esteem.

Let us therefore pledge to preserve and maintain the water resources and develop a mindset and attitude akin to minimization of waste and preservation of harmony with nature as this is the surest way to sustain a happy and healthy living on earth.

Thank you ladies and gentlemen for your perseverance and patience hearing .

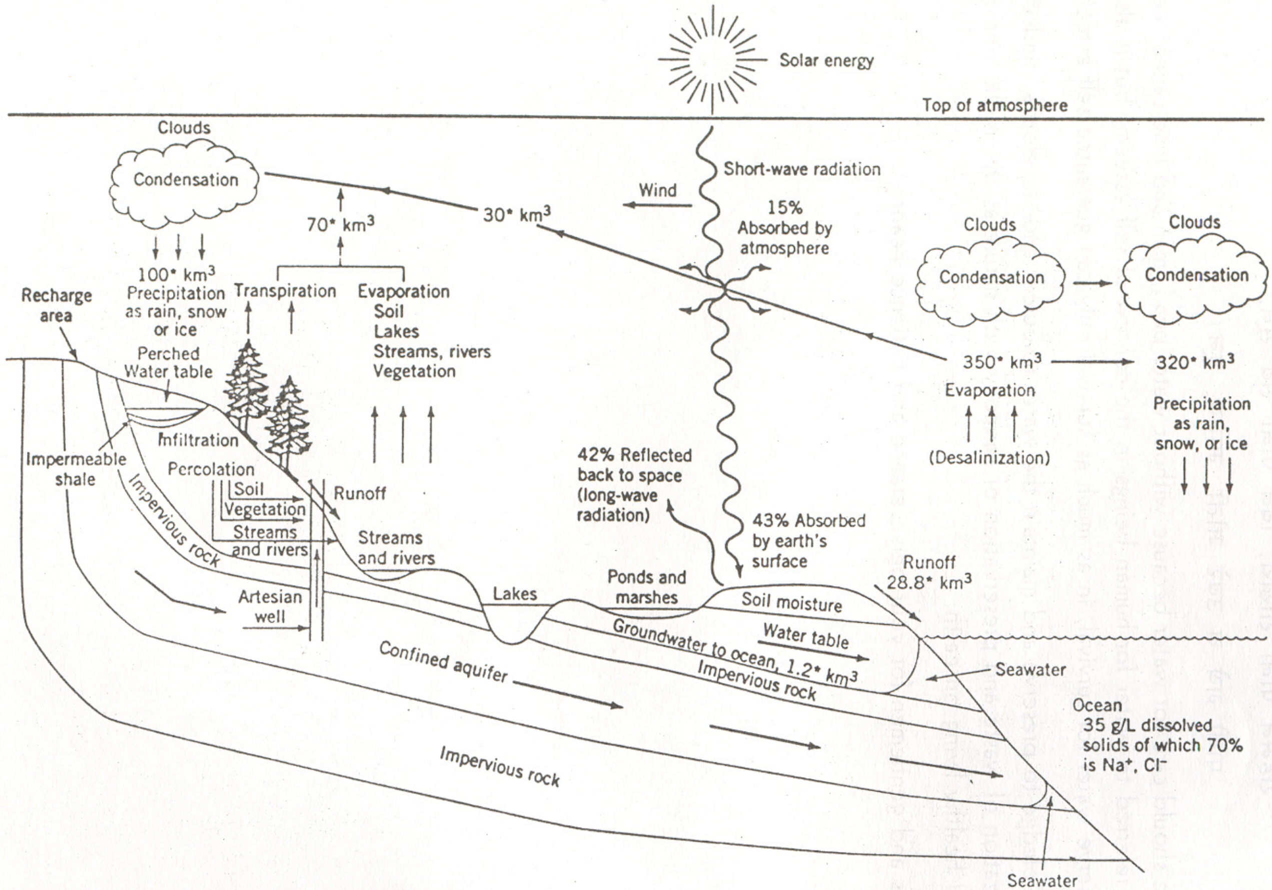


Figure 1. Solar-driven hydrologic water cycle (4,5). An * = $km^3 \times 1000$.

[Ref : Wiley Environmental Analysis & Remediation Vol.8, 1998 pp-5182]

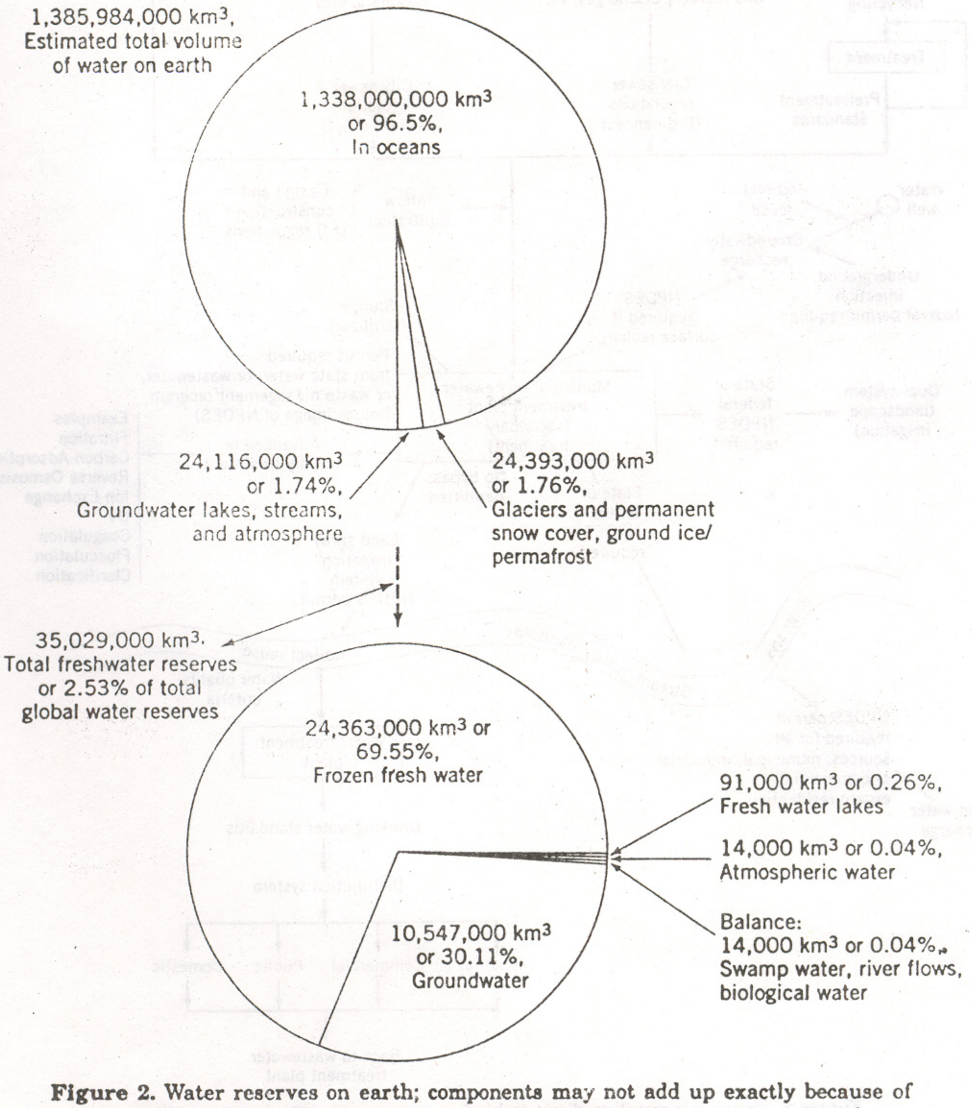


Figure 2. Water reserves on earth; components may not add up exactly because of rounding of figures (6–8).

[Ref : Wiley Environmental Analysis & Remediation Vol.8, 1998]

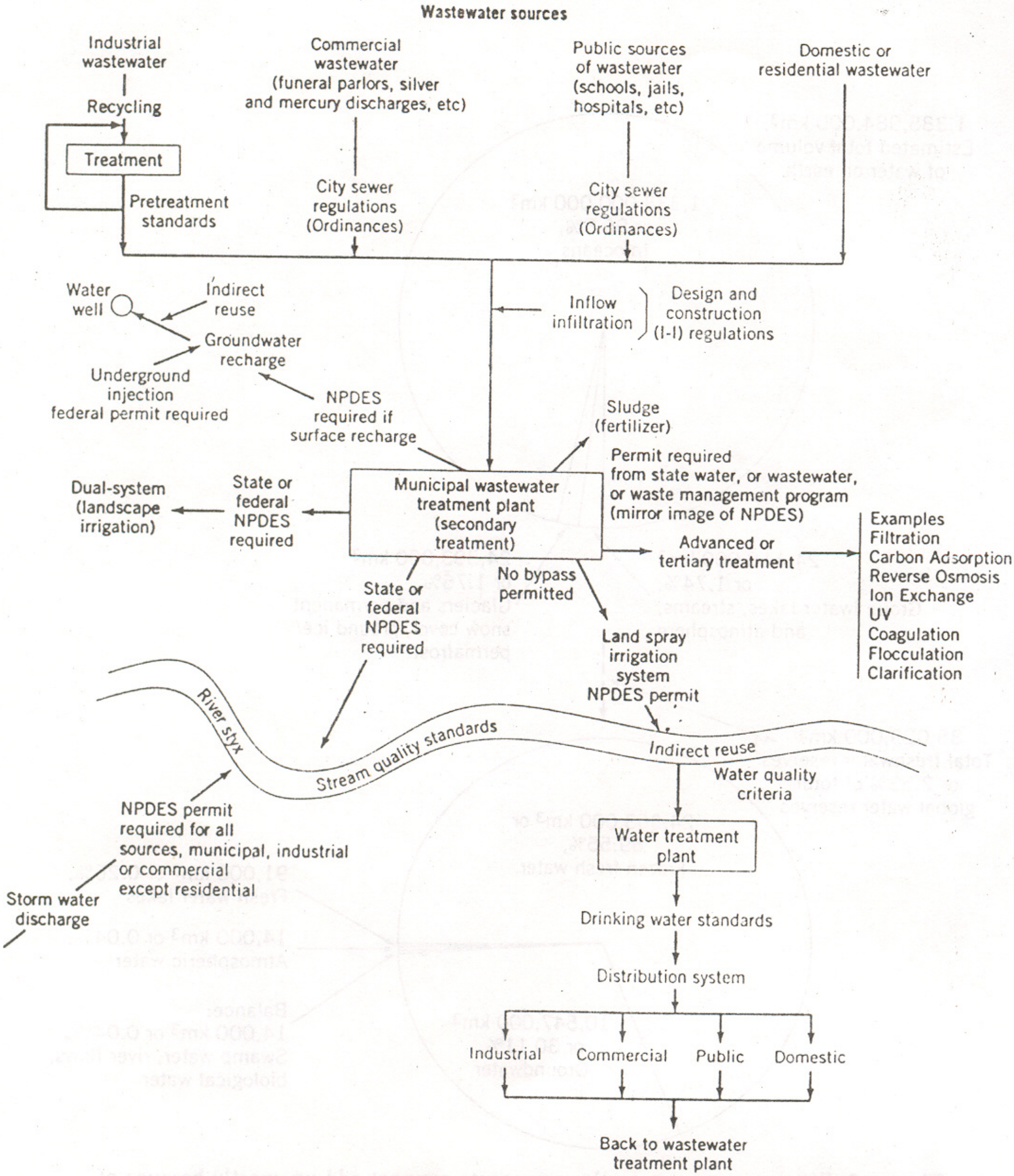


Figure 3. Wastewater recycling, direct and indirect reuse, and various water quality standards and permits required; after a combination of advanced or tertiary treatment, direct reuse of water may be possible (30,37). NPDES = national pollutant discharge elimination system.

[Ref : Wiley Environmental Analysis & Remediation Vol.8, 1998]

Table I. Waste Minimization Approaches and Techniques

Inventory Management and Improved Operations .

* Inventory and trace all raw materials .
* Purchase fewer toxic and more nontoxic production materials .
* Implement employee training and management feedback .
* Improve material receiving, storage, and handling practices

Modification of Equipment .

* Install equipment that produces minimal or no waste .
* Modify equipment to enhance recoveryor recycling options .
* Redesign equipment or production lines to produce less waste .
* Improve operating efficiency of equipment .
* Maintain a strict preventive maintenance program
* Production Process Changes .
* Substitute nonhazardous for hazardous raw materials .
* Segregate wastes by type for recovery .
* Eliminate sources of leaks and spills .
* Separate hazardous from nonhazardous wastes .
* Redesign or reformulate end products to be less hazardous.
* Optimize reactions and raw material use

Recycling and Reuse .

* Install closed -loop systems .
* Recycle on-site for reuse .
* Recycle off -site for reuse . .
* Exchange wastes .

[Ref: Wiley Environmental Analysis & Remediation Vol. 8, 1998]

Table 2. Basic Parameters in Wastewater Characterization.

1. Source information for the individual points of origin Waste constituents (specific compounds or general composition) Discharge rate (average and peak) Batch discharges Frequency of emergeqcy discharges or spills

2. Chemical composition Organic and Inorganic constituents Gross organics-chemical oxygen demand (COD) Total organic carbon (TOC) Biochemical oxygen demand (BOD) Extractables Toxics, hazardous compounds, priority pollutants Gross inorganics-total dissolved solids Specific inorganic ions (As, Ba, Cd, CN, Hg, Pb, Se, Ni, Sg, nitrates) pH, acidity, alkalinity Nitrogen and phosphorus Oil and grease Oxidizing and reducing agents (eg, sulfides) Surfactants Chlorine demand

3. Physical properties Temperature range and distribution Particulates-colloidal, settleable and floatable solids Color Odor Foamability Corrosiveness Radioactivity

4. Biological factors Biochemical oxygen demand Toxicity (aquatic life, bacteria, animals, plants) Pathogenic bacteria

5. Flow characteristics Average daily flow rate Duration and magnitude of peak flow rate Maximum rate of change of flow rate .

Storm water flow rate (average and peak) Causes of Variability in Waste Characterization Changes in production rate Variations in plant product mix Batch operations Variations in efficiencies of production units Changes in raw materials Upsets in production processes Maintenance (equipment shutdown and cleanout) Miscellaneous leaks and spills Contaminated drainage and runoff from rainstorms

PROFFESSOR P.B.SHARMA

A Brief Biographical Sketch

Born in April 1948 at Vidisha in Madhya Pradsh, Professor Pritam B. Sharma graduated in Mechanical Engineering from Samrat Ashok Technological Institute with a GOLD MEDAL in 1969. He obtained his Post Graduate Degree in Thermal Engineering from University of Birmingham (UK) in 1974 and received the Post Graduate Prize for being the topper of the Engineering Faculty. He later received his Doctorate Degree in Mechanical Engineering from the University of Birmingham (UK) in 1978.

Professor Sharma has over 28 years of experience of teaching and research, which includes 12 years at IIT, Delhi, where he was a Professor of Mechanical Engineering before taking over as Principal of Delhi College of Engineering in 1990. Besides teaching at UG and PG levels, Professor Sharma has made a significant contribution to R&D in the area of Power Generation and Aeroengine technology. He has guided Ph.D. scholars and has undertaken a number of major R&D Projects sponsored by the Government and Private Agencies. His work on contra-rotation for future generation aircraft engines is highly valued internationally.

Professor Sharma has widely traveled abroad and has interacted with Universities and industries, in the developed as well as in the developing countries. He is a Fellow of Institution of Engineers and also a Fellow of the Aeronautical Society of India.

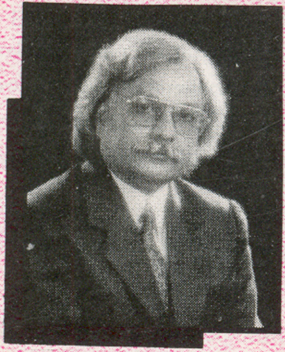
Professor Sharma is heading the prestigious Delhi College of Engineering, the mother institution of a number of National Institutes including I.I.T., Delhi & School of Planning and Architecture.

In the year of 1992, Professor Sharma has been awarded the NAFEN National Excellence Award for Best Technical Educator of the year. Professor Sharma has also been awarded "Order of Merit in Management" by the Indian council of Management Executives. He has also received the coveted Sir C. V. Raman Memorial Award for 1997 for his outstanding contributions to Engineering Education and Research.

During his tenure as Principal DCE, Professor Sharma has made a distinct contribution to the Management of Technical Education. He has authored a number of research papers on Quality and Productivity in Technical Education and made a profound contribution to the policy issues in technical education administration.

Professor Sharma brings with him a combine of a first rate academician and an active technologist having a strong interface with the industry . Recently Professor Sharma has been awarded Fellowship of World Academy of Productivity Science.

Professor Sharma has been appointed the first Vice-Chancellor of Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal, Madhya Pradesh. He has joined his new assignment w.e.f. August 23, 1999.



Prof. P.B.Sharma

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