CHAPTER I

CHAPTER I

INTRODUCTION

1.1 Introduction:

Life begins in and it is sustained by water. No wonder life revolves round water.. Hence water is one of the prime necessities of life. Though about 70 percent of the earth is water, most part of it is ocean. Practically, only 3 percent of the total water available on earth is freshwater, out of the 3 percent, only one percent is accessible surface freshwater where as rest 2 percent is locked away in the form of ice caps and glaciers in the polar regions.(Rao and Pattnaik, 2003)

Water is essential for survival of life and this essence can be the source of economic wealth, the creator of beautiful environment. Today water resources have been the most exploited natural system since man strode the earth. Pollution of water bodies is increasing steadily due to rapid population growth, industrial proliferation, and urbanisation, improving living standards and wide spheres of human activities

In India major source of drinking water are rivers, springs, tanks, ponds, wells and tube wells. Rivers and other such surface water bodies constitute major drinking water source for people residing in rural areas where as in urban centres people mainly depend upon municipal tap water supply. Central treatment of water and its distribution through pipelines has been the major mode of water reaching houses in cities. Tube wells operated by hand pumps have been emerging as source of drinking water in villages. Ground water is used for domestic supply, industries, and agriculture in most part of the world today as it is a replenishable resource and has inherent advantages over surface water.

Greater human activity tends to deplete locally available water supplies. The continued growth of world population and acceleration in water use to meet increasing human demands, as a result of changing life styles, has already begun to strain the available water resources of some areas, even in the humid regions. This strain has been made more acute by deterioration in water quality brought about by agricultural and industrial use and by waste disposal. Water borne diseases has become a great concern, especially in tropical developing countries.

India receives an annual precipitation (snow fall and rain) of around 4 000 billion cubic meter (bcm) of this, the run-off; accessible water is 1,869 bcm, of which barely 690 bcm is used. Nearly 1,179 bcm of water drains into the sea. Much of it in the rainy days that defines India's wet season. Adding 432 bcm of ground water with 690 bcm run-off accessible water, the total real availability of water in India is 1,122 bcm for the billion-plus population of the country (India Today, June 9, 2003).

Ground water is one of the earth's renewable resources, which occurs as a part of hydrological cycle. About one third of the water that falls on land percolates down through the soil and rocks to become part of the ground water which is primarily stored in aquifers. These are geological formations of permeable structural zones of rocks sand and gravel's Two third of all ground water lies at depths greater than 750 meters and therefore is accessible only by deep wells, entailing expensive pumping costs. (Mehata and Trivedi, 1990).

Gravity and artesian springs, deep and shallow wells and infiltration galleries under sandy riverbeds with a good depth of sand, are common sources of ground water. This water is generally pure when drown from greater depth except that it may be hard. Ground water from fine sandy materials is often very clean because the sand has an enormous surface area upon which impurities are absorbed. This kind of filtration removes biological impurities too, but chemicals such as industrial wastes are not removed from ground water by such filtration.

Surface water and ground water of any region is often closely related. Ground water is recharged by leakage from river channels in certain geological situations. Linkage between wetlands and groundwater may go in either direction. The size of the linkage between ground water and surface water varies with local geology and season (UN, 1975).

Though traditionally over emphasis is given on surface water use, use of ground water is becoming increasingly important today, mainly due to the easy contamination of surface waters. Ground water is highly valued because of certain properties not generally possessed by surface water.

- It does not suffer evaporative loss while stored.
- It is free from mud and sediments.
- It is biologically clean (if uncontaminated by human actions).
- It remains cool in summer and warm in winter, relative to conditions at the land surface.
- It is generally accessible to land overlying an aquifer at no cost of conveyance from its source.

Hence the public water supplies from ground water source are economical as well as less Complicated. In United States, four distinct values have been recognised as legitimate purpose of water resource development viz. economic efficiency, equity, environmental quality and regional economic development.

1.2 Threat to Groundwater Resource

Some 95 percent of the worlds unfrozen fresh water exist as ground water. But there are two main problems to using this supply, first it must usually be pumped to the surface which is expensive, especially after recent rises in energy prices. Second the water cycle may take hundreds of year to replace or replenish ground water. This means that ground water pollution is essentially irreversible and the supply can be depleted.

The soil profile shows a considerable ability to remove or detoxify several of the compounds found in the wastewater, but some may nonetheless affect ground water quality. The soil may also effectively eliminate the pathogenic bacteria through filtration and soil microbiological processes, but survival of viruses is still an open question.

With improved assessment and advances in well drilling and pumping techniques, the demands made upon ground water in the recent yeas is increased considerably. Water is being mined and pumps are being dug 3 to 6 meter deeper every year. Though there is regulation of depth to which the bore wells are allowed to be dug i.e. 60 meters, and also number of wells to be dug in a village/town, no body seems to be bothered about implementing these rules. This is resulting into uncontrolled number of deeper wells in the close proximity further degrading the ground water condition in many parts of the country.

There is also a nexus between the owners of the bore well rigs and the officers of the concerned departments, local representatives and politicians who negatively influence the prevailing rules and regulations and dig wells randomly without any consideration to proper use or equitable use of the scarce resource or its long term conservation.

As a result the ground water levels have plugged in 206 districts in our country. In some areas there was environmental damage as a result of over pumping, subsidence due to compaction following pumping, intrusion of saline water into wells. Some of these changes are irreversible or can be corrected only over very long period of time.

There was evidence that ground water in some arid and semi-arid areas was decreasing as a result of expansion of pump irrigation. Permanent depletion of aquifers proceeded at a rapid rate in number of countries. Regulation of withdrawal was encouraged in western Australia and in some counties of the Economic Commission for Europe (ECE) where rigid licensing requirements were adopted. Subsidence due to pumping was halted in Venice, Osaka and Tokyo metropolitan areas as well as many other cities elsewhere. The ground water situation varied greatly, a wide range of administrative devices were employed to deal with it (UNWC, 1978) .The pursuit of more refined and economical methods of survey exploitation gained urgency. Significant advances were made in methods to predict ground water quality and occurrence (Kovacs, 1977).

Thus ground water over exploitation, misuse and pollution is becoming more serious. Ground water contamination though is difficult to prevent and expansive and in many cases, it is still more difficult and far more expensive to cleanup. While some developed countries are seriously moving to reduce non-point and ground water pollution, many such are India are not. There is growing national and international support for the state; technical and financial aid to spur nation-wide action.

1.3 Groundwater Pollution

Ground water pollution has been defined as an impairment of water quality by chemicals, heat or bacteria to a degree that does not necessarily create an actual public health hazard but thus adversely affect such water for drinking, domestic, farm, municipal or industrial use.

An excessive study of urban water supply system in developing countries revealed that at least 60 percent of the population is still dependent on underground source of drinking water especially in outer city areas and distinct villages. This very important source of water is now getting seriously polluted. Ground water contamination commonly results from human activities where pollutants, which are susceptible to percolate are stored and spread on land surface. Typical pollutant sources are industrial wastewater impoundments, sanitary landfills, storage pits, household septic tanks, improperly constructed wastewater disposal wells and application of chemicals on agricultural land.

The amount of water available to infiltration either from precipitation or the wastewater itself, is primary factor in carrying pollutants down through a soil profile. Water from the surface passes downward through the unsaturated zone and dispose in aquifer in a manner depending upon the sit and condition that is physically by soil porosity and hydrologically by the rate of water movement.

Factors affecting ground water pollution are –

1) Rainfall pattern.

2) Depth of water table.
3) Distance from the source of contamination.
4) Soil properties such as texture, structure and filtration rate etc.

1.3.1 Natural contamination of ground water

The principle natural chemicals found in ground water are dissolved salts, iron and manganese, fluoride, arsenic, radionuclides and trace metals. Both geological and climatic factors influence mineral composition. In humid climates, weathering of sedimentary rock releases calcium and magnesium creating excessive hardness and often-dissolved iron and manganese. Fluoride is a constituent of mineral fluoride found in sedimentary, igneous and metamorphic rocks. Arsenic can be a significant problem in aquifers of volcanic deposits where concentration is very high. Excess Fluoride and Arsenic in ground water has created serious health problems in certain part of the country

1.3.2 Agriculture as a source of groundwater pollution

Of all the activities of man that influence the quality of ground water, agriculture is probably the most important as a diffuse source of pollution from fertilisers, pesticides and animal wastes. Nitrogen in the form of nitrate fertiliser is the most common cause of degradation of groundwater near agricultural land (UNEP, 1981). Because of evaporation the percolation of minerals from irrigation water in two to three times more than applied water.

The most troublesome health related contamination from agriculture is the nitrate ion, which is readily carried by water percolate down through unsaturated zone to saturated zone. Nitrate in ground water, in excess of maximum contaminant level, is a serious problem when small towns are dependent on groundwater as a drinking water source and where former cultivated areas are urbanised and wells installed for public supplies.

1.3.3 Domestic source of groundwater pollution

Septic tanks and cesspools contribute filtered sewage effluent directly to the groundwater, and are the most frequently reported sources of ground water pollution, especially in rural, recreational and sub-urban areas. In many areas, the solid sewage sludge or liquid sewage water spread on agricultural land, which lead to contamination of ground water.

If the soil is permeable, shallow water wells are potential sources of mobile pollutants like detergents, chlorides and nitrate ions. Treated wastewater if discharged to a dry streambed can increase infiltration of dissolved solution. Burial of solid wastes can result in degradation of sub surface water through the generation of leachate caused by the water percolation through the refuse fill. Leachate in highly mineralised water containing such constituents such as sodium chloride, trace metals and variety of organic compounds.

1.3.4 Industrial and Commercial Sources of Pollution

Industrial wastes include a wide spectrum of materials from all types of industry and contain many organic and inorganic chemicals. Industrial waste reach groundwater from impoundment or lagoons, spills, pipeline breaks and land disposal sites.

The stored wastewater tends to be carried to ground water either by accidents. On design to reduce the liquid in storage solid waste and sludge also be buried with other refuse in a sanitary landfill. Injection into deep wells was earlier environmentally acceptable and often an economical method for disposal of hazardous waste water. For toxic chemicals the bore usually penetrate saline aquifers over thousand feet below the surface. Ideally in addition to adequate porosity to receive the flow the stratum should be overlain by impervious layer to prevent upward migration into fresh water zones.

All forms of mining create wastes and changes in hydrological conditions that contribute to degradation of ground water. The principle impurities from mining waste are acidity, dissolved solids, metals and radioactive materials. With both surface and underground mining refuse piles and slurry lagoons are potential source of contamination.

Accidental spills of toxic fluids, particularly gasoline and oil, can migrate through the unsaturated soil zone to groundwater. Hydrocarbons are by far the most prevalent contaminants reported in spills and ruptured buried pipelines and storage tanks. They can persist underground decoder creating foul taste at trace levels in ground water pumped from aquifer.

1.4 The Water Quality and Quantity Problem

All human management of water has some effects upon its quality or quantity or both. To appreciate the quality/quantity relationship it is essential to understand that pollution is not an absolute concept. Nearly all water is contaminated in some way. The problem gets further complicated because the very use to which water is put i.e. washing, irrigation, flushing away waste, cooling, making paper etc. has been adding something to the water. Thus contamination is only a concern when it reaches concentrations that pose a threat to human health or to the uses of water.

The relationship between quality and quantity is being increasingly recognised as ground water supplies also become more intensively exploited. If an aquifer becomes contaminated, increased withdrawals speed the spread of water pollution. Similarly when water is pumped from an aquifer faster than it is recharged, saline water can be sucked in from nearby aquifers or in coastal regions from the ocean. Either form of contamination can render the aquifer useless as a continued source of supply.

Ground water forms a major source of drinking water supply for both urban and rural people of India. Since quality of public health depends to the great extent on the quality of drinking water, it is imperative that in depth information about the quality of drinking water be systematically collected and monitored (.Biswas and Saha, 1982).

Geological Survey of India and Central Groundwater Board have carried out extensive studies of quantitative and qualitative assessment of ground water of the country. The quality of ground water has been determined mainly from the standpoint of their suitability for irrigation purposes. Detailed studies for determination of pollution level posing problem of health hazards have not yet been attempted. However, some detailed studies have been made by Geological Survey of India and other Central and State government agencies to find out the causes of flurosis in certain parts of Andhra Pradesh, Tamilnadu, Rajasthan and Gujarat.

The large-scale mining activities in many of the coal fields of West Bengal and Bihar are known to have polluted the ground water in those regions, but no quantitative data are available (Biswas and Saha, 1982). Bauxite mining is very common in the areas around Kolhapur in the catchment of rivers. No detail investigation seems to have been done on the impact of its pollution on surface and ground drinking water in the region. Similarly there are a large number of old and new stone quarries all around the city. Its impact on the ground water level, availability and quality is yet to be ascertained.

1.5 Evaluation of Groundwater Resource

The last few decades saw major developments in ground water assessment and enhancement techniques. New information was acquired on the dynamics of ground water aquifers and interrelations between ground water and surface water. Also there is improvement in the knowledge of water movement by the use of chemical tracers and environmental isotope analysis and advances in drilling techniques (UNWC, 1978).

The collection of larger masses of data about water, data storage and retrieval and their use in models that permit analysis and forecast become more important. Computer for processing and storing hydrological data came into more general use. These were coupled with mathematical and modelling techniques for analysis, planning and forecasting-modelling for surface water quality was reservoir system (Biswas, 1976). Similarly, the models for ground water movement were more reliable than those for diffusion and transport of contaminants under ground (NRC, 1981). However, for this analysis extensive ground data, on spatial and time scale, is required at local/ regional level. Unfortunately there is no such reliable data in this region making it difficult to design and apply models for quantification and forecasting of ground water use.

The analysis of regional ground water systems is an important aspect of water resource planning. Aquifers are important not only because they are vehicles for providing water supplies but also from the water quality standpoint. As in case of surface water, if ground water sources are so contaminated that their use for any purpose is impaired or precluded, that then regardless of the quality of water available, the source may have to be abandoned or untapped. The method of regional ground water system analysis deal with both the quality and quantity aspects of ground waters and thus applicable to wide variety of water management problems.

Assessment of ground water resources was carried out in most United Nations projects. Groundwater maps covering areas ranging from 5,000 km^2 to more than 10,000 km^2 were proposed in more than twenty-five countries. Some 150 fellowships for training abroad were granted to technical and professional personnel associated with United Nations Ground Water Project (Taylar, 1979).

During recent years, Food and Agriculture Organisation of the United Nations (FAO) and the World Bank (WB) funded large–scale groundwater development projects for irrigation or livestock water supply, for example in Pakistan, India and the Middle East. World Health Organisation (WHO) was concerned with the protection of rural and urban water supplies against disease vectors. United Nation's Educational, Social and Cultural Organisation (UNESCO) was concerned with the scientific and educational exchange on ground water geology and hydrology and undertook studies of large regional aquifer systems such as then Nubian sandstone formation and Chad Basin. This indicates the importance given at the global level for the conservation and sustainable use of the scarce resource, the ground water.

1.6 Towards Blue Revolution

Unlike the green revolution of the 1970s in agriculture, now the world needs another revolution that is a 'Blue Revolution' for conservation and proper maintenance of freshwater. Achieving this revolution will require co-ordinated policies and responses to problems at international level, national and local levels. At the international level, the first United Nations Conference was organised in 1977 at Mar del Plata, Argentina, Similarly the global consultation on safe water and sanitation was held in 1990 in New Delhi; the International Conference on Water and Environment in 1992 at Dublin; UN commission on Sustainable Development (5^{th} session) for Assessment of Global Freshwater Resources in 1997 etc. The assessment concluded that water storage and pollution are causing wide spread public health problems, limiting economic and agricultural development and affecting a wide range of ecosystems. These problems, in the near future, may threaten global food supplies and economic stagnation in many areas of the world. The result could be a series of local and regional water crisis with serious global implications.

A water-short world is an inherently unstable world. This has already become evident from the large number of local, regional and inters state conflicts for drinking and irrigation water in the country. With the serious draught conditions prevailing for the past three years in most part of south India, people have apparently realised value of water, including ground-water. Avoiding international conflicts on water management strategy is also an important factor. Drafting and implementing a national water strategy is essential to sustainable development. The strategy in India is expected to include the four elements such as:

- Adopting a watershed or river basin management perspective, especially for water-short regions.
- Instituting a workable water infrastructure so that national, regional and local water needs can be meet within the context of national water policy.
- Enacting and enforcing water legislation and regulations that value water.

- Connecting water management to the needs of agriculture, industry and municipalities and meeting public health requirements for proper sanitation and disease prevention.(Population Report, 1998).

The National Water policy was adopted in 1987 and the revised policy was adopted in 2002 by the National Water Resource Council with the objective that each state has to formulate its own state water policy. The Union government has launched two important water-related rural development schemes such as "Swajaldhara Yojana" and "Yojana Hariyali". Both the schemes are being implemented by the Panchayatraj institutions with co-operation of community organisations , which play a crucial role in maintenance of village level water conservation projects. Locally led initiatives , though limited are showing that water can be used much more efficiently even in water short areas, both in urban and rural India. There are growing efforts to make people aware and water literate. Recently UN and India Proclaimed Year 2003 as the International Year of Freshwater.

1.7 Water Crisis

Water is the biggest crisis facing the world today. In the populous India the crisis in terms of spread and sensitivity affects one in every three people. As population grows rapidly and use of water per season rises, as a result of changing life styles due to 'Development', the demand for fresh water goes up. Besides, the supply of fresh water is threatened by pollution in most areas.

As per one estimation in 1989, there were 9000 cubic meters of fresh water available for human use per person. By 2000,this amount reduce to 7800 cubic meters per person due to rise of global population, by 2025 the global population will reach 8 billion and the per capita water use will come down to 5100 cubic meters. Even this amount of freshwater per capita would be enough to meet human needs, if it were properly distributed. But equitable distribution is not possible due to mainly two reasons. The first is, two third of the global population lives in areas receiving only one fourth of global annual rainfall and second there is no systematic rainfall through out the season or from year to year. It does mean that systematic, equitable and judicious use of available freshwater is essential even today in the high rainfall areas such as Kolhapur in the Western Ghats.

1.7.1 Water Crisis in India

It is observed that access to safe drinking water is quite inadequate and also unevenly distributed in the rural areas. . In the report of USAID on Environmental and natural resource Management in developing countries, it is stated that " One of the most serious environmental problems in Asia is water supply. The majority of the population lives in rural area and the statistics compiled by WHO suggest that only 10 percent of these rural residents have access to water supplies which meet minimal health standards."

Table 1. Long term changes in ground water levels in various states of India

		Fall (m)		Rise (m)	
Sr. No.	**State**	**Min.**	**Max.**	**Min.**	**Max.**
1	**Andhra Pradesh**	0.01	8.87	0.01	6.85
2	**Arunachal Pradesh**	0.16	0.45	0.01	1.02
3	**Assam**	0.01	6.25	0.10	3.68
4	**Bihar**	0.02	2.97	0.01	5.30
5	**Gujarat**	0.05	17.97	0.17	8.83
6	**Harayana**	0.03	11.53	0.10	11.50
7	**Himachal Pradesh**	0.04	1.78	0.08	11.20
8	**Jammu and Kashmir**	0.02	1.64	0.01	5.41
9	**Karnataka**	0.01	13.99	0.01	15.38
10	**Madhya Pradesh**	0.01	1042	0.02	8.45
11	**Maharashatra**	0.01	14.65	0.01	6.43
12	**Manipur**	0.55	0.55	0.09	1.37
13	**Meghalaya**	0.07	12.01	0.03	7.99
14	**Nagaland**	1.70	3.41	0.89	1.30
15	**Orissa**	0.00	4.39	0.01	4.89
16	**Punjab**	0.01	10.95	0.01	14.81
17	**Rajasthan**	0.02	23.76	0.01	23.26
18	**Tamil Nadu**	0.02	18.91	0.06	18.33
19	**Tripura**	0.24	0.76	0.07	5.90
20	**Utter Pradesh**	0.01	7.47	0.01	9.26
21	**West Bengal**	0.00	8.99	0.01	8.49
22	**India (Average)**	0.00	23.76	0.01	23.26

Source – GOI (1999)

Table 2. Water demand in next 50 years (km^3)

Sector	Years		
	2000	**2025**	**2050**
Domestic	42	73	102
Irrigation	541	910	1072
Industry	8	22	63
Energy	2	15	130
Other	41	72	80
Total	634	1092	1447

Source: CWC (1999)

In India rural population constitutes more than 75 percent of the total population, but the drinking water supply in urban areas receives priority over its rural counterparts. It is observed that the drinking water supply in urban areas has improved over its rural counterparts and also received more than two-third of the total supply.

Water is clearly the single largest problem facing India today though the country was once upon a time categorised as water rich society. Rainfall is uneven and not uniform through out the year. About 90 % of its annual rainfall occur during summer monsoon, which lasts from July to September where as rest of the months the country gets barley a drop of water. In India every summer on an average, 91 districts are drought affected.

India receives an annual precipitation of around 4000 billion cubic meters (bcm). Of this the run-off accessible water is 1869 bcm, of which barley 690 bcm is used. Nearly 1179 bcm of water drains into the sea. Adding 432 bcm of ground water.

Years of rapid population growth and increasing water consumption for agriculture, industries, urbanisation and other areas have strained Indian fresh water resources. Nearly 90 % of the water required for irrigation is meant from ground water resource. The rest 7% and 3 %, the country spends for industrial and domestic purposes, respectively.

In many parts of our country chronic water shortage, loss of arable land, destruction of natural habitats, degradation of the environment and wide spread pollution undermines public heath and threaten economic and social progress. The recent satellite images have revealed that despite increasing number of irrigation projects, larger part of the county is heading for desertification as a consequence of deforestation, changed land use practices and negligence of water resources.

1.8 Water Pollution and Health

On the global scale, total water abundance is not the problem, the problem is waters availability in the right place at right time, in right form. Disease is often due to an imbalance resulting from a poor adjustment between the individual and the environment. Incidence of disease depends on several factors including physical environment, biological environment and life style.

Several waterborne infectious diseases are directly related to polluted water. It attributes in the rise of Cholera, Hepatitis, Dysentery and other waterborne diseases, due to pollution of ground water especially in the zones where the water table is high. The most common complaint is susceptibility to worm infections. The more primitive and weaker societies that live directly off the local environment are often suffered by different environmental health problems. Industrial societies have nearly eliminated environmental diseases such as Cholera, dysentery and typhoid; however, they are more likely to suffer from chronic and acute diseases such as respiratory problems and cancer.

Well water contaminated by nitrates from fertiliser run-off poses a hazard to health, particularly for infants, for a long time, some scientists suspected that much of the drinking water contained organic chemicals other than those of biological origin. Frequent contaminants included two suspected carcinogens, chloroform and carbon tetrachloride and several other organic chemicals of largely unknown physiological and health effects.

Considering the persistent shortage of water in the last few years, for drinking and irrigation purpose and that too its poor quality, in the once water surplus area of Kolhapur, the present study was undertaken to evaluate the ground water conditions in the four representative villages in the immediate vicinity around Kolhapur city. These traditional villages are coming under increasing influence of the urban environment including water over exploitation and its mismanagement. It is expected that in the near future around 48 similar villages around Kolhapur will be included in the city area limits. Therefore this study on quality and availability of ground water has considerable applied significance in terms of its applicability.
