Chapter -1

INTRODUCTION

Water plays extremely important role on the earth’s surface. It is so familiar with our daily lives that we often forget its importance. Presence of water on earth’s surface makes its character dynamic, changing both physical and chemical properties with time. Without water the earth would have been looked like a moon. It is a universal solvent in the biosphere and essential component of all biochemical reactions. It is a major constituent of all living beings. Living cells are made of aquatic solutions, suspensions and emulsions with water present in the range of 25 to 85 per cent. The young tissues contain more water than the old ones (Anonymous 2010b).

In general plants take water and mineral salts from soils. Plants contain 50 to 75 percent water, while in human beings the water varies from 60 to 65 percent in males and 50 to 60 percent in females. It is intimately involved in the functional systems, and it takes part in the synthesis and decomposition of number of organic compounds. The natural water contains minerals and organic impurities and dissolved gases such as air and carbon dioxide.

1.1 CHEMISTRY OF WATER

Water is composed of one atom of oxygen and two atoms of hydrogen. Each hydrogen atom is covalently bonded to the oxygen via a shared pair of electrons, thus there are four pairs of electrons surrounding the oxygen atoms, two pairs involved in covalent bonds with hydrogen, and two unshared pairs are on the opposite side. Compared to hydrogen oxygen is an “electronegative” or electron “loving” atom. Water is a “polar” molecule, meaning that there is an uneven distribution of electron density. Thus water has a partial negative charge near the oxygen atoms due to the unshared electrons, and partial positive charge near the hydrogen atoms. An electrostatic attraction between the partial negative charge near the oxygen results in the formation of a hydrogen bond. The ability of ions and other molecules to dissolve in
water is due to polarity. The unique property of ice to float in water is due to hydrogen bonds. Hydrogen bonds holds further apart in a solid than liquid, where there is one less hydrogen bond per molecule. The other physical properties such as high heat of vaporization, strong surface tension, high specific heat and nearly universal solvent properties of water are also due to hydrogen bonding. The hydrophobic effect or the exclusion of compounds containing carbon and hydrogen (non polar compounds) is another unique/exclusive property of water squeezes non-polar molecules together. The pH of water is neutral, because water ionizes to $\text{H}^+$ and $\text{OH}^-$ (Anonymous 2010a).

There are six valence electrons on the oxygen, and one each from the hydrogen atoms in the water molecule. The eight electron form two H-O bonds, and remaining two lone pairs. The lone pairs and bonds stay away from each other and they extend towards the corners of a tetrahedron. Such an ideal structure should give H-O-H bond angle of $109-5^0$, but the lone pairs repel each other more than they repel the O-H bonds. Thus, the O-H bonds are pushed closer, making the H-O-H angle less than $109^0$.

Both elements have natural stable radioactive isotopes, viz. H, D$^2$, T$^3$ and O$^{14}$, O$^{15}$, O$^{16}$, O$^{17}$, O$^{18}$. The prominent water molecules H$_2$O$^{16}$ which constitutes 99.78 percent water has a mass of 18 amu, but molecules with a mass of 19 and 20 known as heavy water also occur significantly up to 0.03 percent and 0.20 percent respectively (Anonymous 2010a).

Ice occurs in many places including the Antarctic. If all the ice melts, the water level of the oceans will rise about 70 m. the density of ice is smaller than water, due to regular arrangement of water molecules via hydrogen bonds. In ice, each oxygen atom is surrounded by four hydrogen bonds and every hydrogen atom is involved in hydrogen bond.

### 1.2 WATER AND HUMAN HEALTH

Good quality water supply and sanitation are vital for protecting the environment, improving health and alleviating poverty. Safe water is also crucial to many traditional and cultural activities. An estimated 80 per cent of all diseases and
over 1/3 of deaths in developing countries are caused by the consumption of contaminated water, and on an average as much as 1/10 of each person’s productive time is sacrificed to water related diseases. Concerted efforts during the 80’s brought water and sanitation services to the 100’s of millions of the world’s poorest people. The most outstanding of these efforts was launching of “International drinking water supply and sanitation decade” in 1981. The target of the decade was to provide safe drinking water and sanitation to underserved urban and rural areas by 1990, but still one in three people in the developing world lacks these two basic requirements for health and cleanliness.

Fresh water is essential for human health. The human body contains 50 to 70 percent water. Organ wise human body contains about 25 percent water in bones, 70 percent water in muscles, 80 percent in blood and 85 percent in brain.

Globally, more than 50 percent of modern medicines and more than 90 percent of traditional medicines come from wild plants and animals. More than 70,000 plant species are used as medicine, making up “one of the most significant ways in human beings to use biodiversity. Many of the leads for treatment of cancer of life threatening diseases, HIV, AIDS, Diabetes, Alzheimers and many other are coming from the marine ecosystem in coral reefs.

Increase in human diseases has been related to the interception of ecosystem services by deforestation, agricultural development, disturbed water flows, urbanization and climate change. The studies show that increase in deforestation and forest fragmentation lead to an increase in disease vectors such as mosquitoes. It is further reported that many of the infectious diseases are linked to increased human wild life contact.

Water itself acts as a healing agent in our body. Around 70 percent of our body weight is due to water. The quantity is high in organs such as lungs and brain and fluids such as blood, lymph, saliva and secretions by the organs of the digestive system. Water serves as a medium for various enzymatic and chemical reactions that take place within each cell of a living organism which provide energy for vital processes and for synthesizing new organic material. Energy thus obtained from the metabolic nutrients is utilized for maintenance and growth processes. Through water, nutrients, hormones, antibodies and oxygen moves in the blood stream and lymphatic
system. The proteins and enzymes in our body functions more efficiently in solutions of low viscosity. Water is the solvent of the body and it regulates all functions, including the activity of everything it dissolves and circulates. Water also helps to regulate our body temperature, prevent dehydration and helps to maintain proper metabolism in our body.

1.2.1 Water as Carrier of Chemical Energy

As such a water molecule is neutral in reaction as it dissociates it into $\text{H}^+$ and $\text{OH}^-$ ions, thus resulting into equal ions of hydrogen and hydroxyl. The concentration of each ion equivalent to $10^{-7}$ moles per litre result’s into a pH of 7.

The shortage of water in our house leads to economy and prioritize its use. The shortage of water in our body triggers a system of water regulation through histamine (amino acid present in the cells), Histamine directs some neutron transmitters to operate sub-systems to regulate water intake. The ratio of water content inside and outside the cells of various organs is very important. As the age advances water content in the cells decreases. Inadequate water in the body leads to lac of some vital functions in the body. Waste metabolic products and surplus salts moves out of the body through urine. The human kidneys usually produce 1.0-1.5 litres of urine per day containing 50-70 g salts. The salts excreted are mostly urea, uric acid and some inorganic salts (Anonymous 2010c).

1.3 SOCIO-ECONOMIC CONTEXT

Water plays complex multiple environmental, social and economic roles, some of which have long term implications. The differences in the spatial availability of water both in terms of quantity and quality further complicates the matter. Thus it is important to understand and manage such complexity to maintain and protect the multiple roles of water (Burmil et al. 1999 and Lemily et al. 2000). Water is essential to maintain the health and productivity of the ecological and socio-economic subsystems. Thus sustainable development of water is an essential component of water management. The four pillars of sustainable development are social, economic,
environmental and cultural dimensions. Keeping all this in view, an integrated approach for water management and cultural dimensions needs to be taken up under which each possible innovative approach and their possible implications need to be considered.

1.4 WATER REQUIREMENT

The quantity of water required varies with climate, culture, food habits, work and working conditions, life of development and above all the availability of water. The Bureau of Indian Standards IS: 1172-1993 mentions minimum water supply of 200 liter per capita per day (lpcd) for domestic consumption in cities with full flushing systems. The Bureau also mentions that supply may be reduced to 135 lpcd for LIG and the economical weaker sections (EWS) of the society and in small towns. Besides domestic, there is a demand for commercial, industrial and civic use of water. Thus the Bureau gives total requirement of 280 lpcd in towns with full flushing systems. The ninth plan (1997-2002) had advocated the requirement of 125 lpcd in cities with the planned sewerage system; 40 lpcd for those collecting water from public stand posts. In the 10th five years plan, the cities with planned sewerage system were classified into two groups based on population, i.e. metropolitan or megacities and non-metropolitan cities. In the former, the recommended minimum water supply level was 150 lpcd and in the latter 135 lpcd. The national commission on urbanization in 1988 recommended that a per capita water supply of 90-100 liters per day is needed to lead a hygiene existence and emphasized that this level of water supply must be ensured to all citizens, the World Health Organization (WHO) has categorized the supply of 100 to 200 lpcd as optimal.

Even though the rate of urbanization in India is among the lowest in the world, the nation has more than 250 million city-dwellers. Experts predict that this number will rise even further, and by 2020 about 50 per cent of India’s population will be living in cities. In Punjab too it is estimated that urban population will exceed rural population by 2030 (Ahmed 2011). This is going to put further pressure on the already strained centralized water supply systems of urban areas.
The urban water supply and sanitation sector in the country is suffering from inadequate levels of service, an increasing demand-supply gap, poor sanitary conditions and deteriorating financial and technical performance.

Supply of water is highly erratic and unreliable. Transmission and distribution networks are old and poorly maintained, and generally of a poor quality. Consequently physical losses are typically high, ranging from 25 to over 50 per cent. Low pressures and intermittent supplies allow back siphoning, which results in contamination of water in the distribution network. At some places within cities and towns water is typically available only for a few minutes, sometimes not at all.

1.5 WATER AVAILABILITY

While fresh water supplies are adequate to meet demand for the foreseeable future, the world’s freshwater is poorly distributed across and within countries and between seasons. Hence, practical distribution problems covered with location, space and affordability lead to a widening gap between demand and supply in many parts of the world. The water scarcity situation is compounded by the major impacts of climate change on the water resources, namely shorter duration of the precipitation seasons and increase in hydrological extremes. The water scarcity situation will get worse in the world’s urban areas where it is projected that over 50 per cent of the world’s population will live by 2015 (United Nations, 2004). Between 2000-2030, it is projected that there will be an increase of urban population to 2.12 billion, with over 95 per cent of this increase expected to be low income combination (UN-HABITANT, 2004). It has been estimated in Punjab urban population will exceed rural population by 2030.

The fresh water resources in the world are estimated to the tune of 43750 km³/year. This water is distributed throughout the world according to the patch work of climate and physiographic structure. At the continental level, America has the largest share of the world’s total fresh water resources with 45 per cent, followed by Asia with 28 per cent, Europe with 15.5 per cent and Africa with 9 per cent. In terms of resources per in-habitant in each continent, America has 24000 m³/year, Europe 9300 m³/year, Africa 5000 m³/year and Asia 3400 m³/year. These figures are for the
year 2000 and does not include the exploitable resources and non–renewable resources. In India the annual renewable resources as estimated in year 1999 were 1907.8 km$^3$.

The rates of exploitable water resources to total renewable resources is close to 100 per cent in areas of the Mediterranean, where the main source of water is groundwater (Israel, Gaza strip and Libyan Arab Jamahiriya) but it is generally less than 70 per cent in countries where surface water resources are important (Turkey, Morocco, Greece etc) and even lower where there are major technical constraints (Malta) or political restrictions (Portugal).

At country level there is an extreme variability in TRWR (Total Renewable Water Resources) from a minimum of 10 m$^3$/inhabitant in Kuwait to more than 100000 m$^3$/inhabitant in Canada, Iceland, Gabon and Surinam. For 19 countries or territories, TRWR per inhabitant are less than 500 m$^3$ and number of countries or territories with less than 1000 m$^3$/inhabitant are 29. The ten poorest countries in terms of water resources per inhabitant are Bahrain, Jordan, Kuwait, Libya Arab, Jamahiriya, Maldives, Malta, Qatar, Saudi Arabia, UAE and Yemen. In the large countries the water resources are unevenly distributed in relation to the population.

In addition to spatial variability, there is high variability in time within the year or among different years.

1.5.1 Indian Subcontinent

The Indian subcontinent sub-region extends over an area of 3961680 km$^2$, about 18 per cent of the region’s total area. It comprises Bangladesh, Bhutan, India, Nepal, Maldives, Pakistan and Sri Lanka. The geomorphology of these countries consists of a large portion of flood plains along the Indus and Ganges river basins, some terraces and hilly areas, and the mountainous terrain of the Himalayas, with the world’s highest peak (Mount Everest) 8848 masl (metre above sea level).

India experiences a tropical monsoon climate, with significant seasonal variations in rainfall and temperature. A nearly 80 per cent of the total rainfall occurs from June to September. The rainfall during winter months (November-March) is by the North-east winds which are relatively light. These winds are also known as
western disturbances. The annual precipitation in the region varies from 150 mm in North-west desert of Rajasthan to 1000cm in the khasi hills in the northeast India. The geological survey of India claims that Himalayan Glaciers occupy about 17 per cent of the total mountainous range, while an additional 30 to 40 per cent area has seasonal snow cover. In the whole Himalayan range there are 18,065 small and big glaciers with a total area of 34,659.6 km\(^2\) and a total ice volume of 3,734.4796 km\(^3\). The major cluster of glaciers are around the 10 Himalayan peaks and massifs, Nanga Parbet (Gilgit), the Nanda Devi group in Garhwal, the Dhaulagiri massif. The Everest Makalu group, The Kanchan Junga, The Kula Kangri area, and Namche Bazar. The principal glaciers are: Siachen 72 km; Gangotri 26 km; Zemu 26 km; Milam 19 km; and Kedarnath 14.5 km, the Gangotri glacier has retreated by about 850 m.

The Indian Himalayan glaciers are broadly divided into three river basins of the Indus, Ganga, and Brahmaputra. The Indus basin has the largest number of glaciers (3,538), followed by Ganga basin (1,020) and the Barahmaputra (662).

One may believe it or not but the climate change is real and happening now and it is causing a serious impact on fragile ecosystems like glaciers. Seventy per cent of the world’s freshwater is frozen in glaciers. Glacier melt buffer other ecosystems against climate variability. Very often, it provides the only source of water for humans and biodiversity during dry seasons.

India’s Parliamentary Affairs Minister, Pawan Bansal told Parliament last week that the average annual water availability for the country had been assessed as 1,869 billion cubic meters (BCM) with estimated utilizable water of about 1,123 BCM.

Increase in population had resulted in decreased per capita water availability. In the year 1951, per capita water availability was about 5,177 cubic metre a year, it worked out to about 1,820 cubic metre a year on the basis of 2001 Census.

In view of topographical constraints and hydrological features, utilizable water has been assessed to about 1,123 BCM. The country’s total water requirement, including agriculture, industrial and domestic uses has been assessed to about 813 BCM, 1,093 BCM and 1,447 BCM by 2010, 2025 and 2050, respectively. However, the requirement can be brought down to 710 BCM, 843 BCM and 1,180 BCM for 2010, 2025 and 2050, respectively, with efficiency in utilization (Sharma 2010).
**1.5.2 Punjab**

The state derives its name from five rivers, but at present three rivers namely, Ravi, Beas and Sutlej flows through the state.

The report on “State of environment on Punjab (Tiwana et al. 2007)” has predicted a very grim water scenario in the state. The report has predicted that in about 66 per cent area of the central districts in Punjab the depth of water table would recede to 50 meters by 2030. The report says that Punjab is taking water shortfall to the tune of 1.25 m ha m every year.

Overall, the total demand of water for agricultural purposes based on cropping pattern and practices of 2000-01 is 4.38 m ha m against the total supply of 3.13 m ha m. Out of this, surface canals provide 1.68 m ha m of water and the deficit is met through over exploitation of underground water reserves through tube wells.

Due to extensive usage of tube wells, on an average the water table has receded at an annual rate of 66 cm across the state between 1993-2003. While in the central districts like Amritsar, Jalandhar, Kapurthala and Patiala have recorded a significant fall of 75 cm during the same period, the report said. Districts like Moga, Sangrur and Patiala are the worst hit with areas where water table depletion is beyond 10 meters, increasing from 3 per cent in 1973 to 95 per cent in 2005. Overall, out of 142 blocks in the state, 103 are over-exploited, five are critical, four are semi-critical and only 25 are in safe category as far as groundwater situation is concerned, the report added. The blocks which are in safe category have brackish sub-soil water.

The situation is likely to deteriorate as it has been estimated that by 2010, a whopping Rs 40 billion would be spent by farmers on replacing centrifugal pumps with submersible pumps if the groundwater table does not improve, said the report. This will increase the demand for electricity. The rural population is already feeling the pinch due to long cuts in electricity supply sometimes ranging from 10 to 12 hours daily. The inter-governmental panel on climate change has concluded that effect of global warming on water availability in the future will be a bigger challenge than energy security. Thus availability of good quality water both for domestic use and food production will be a critical factor for food security and development of the state.
1.6 WATER CRISIS

An important and widely shared perception in India is that of an imminent water crisis. The crucial element here is the demand projection, and that needs to be looked at carefully. In every kind of water use, major economies are desirable and possible, though difficult. If these are achieved, the demand picture will not remain the same. Turning to the supply side, large-dam projects are not the only answer; there are other possibilities. Local rainwater harvesting (catching the raindrop as it falls) and watershed development are also part of the supply-side answers to the demand. Through a combination of these two approaches namely, on the demand side, the practice of the utmost economy and efficiency in water-use and of resource-conservation, and on the supply side, efforts to augment the availability of ‘usable’ water through extensive resource harness to local water-harvesting and watershed development. These efforts will help avert a crisis, though the situation will undoubtedly be difficult and will call for careful management.

The National Water Policy (Anonymous 2002) states that efficiency of water utilization should be optimized and measures for improved management are underway. Further increasing water efficiency use by 20 percent has been identified as one of the important goals under the national action plan on climate change.

The ADB report says aggregate 2030 demand and supply would be 1498 billion cubic metres (BCM) and 744 BCM, respectively. Thus there will be a shortage of 50 percent in the demand and supply mainly due to rapid growth in agricultural, industrial and domestic sector demand. The government hopes to bridge the gap by increasing level of efficiencies in water utilization and conservation as reported in the Asian Development Bank (ADB) draft report.

1.6.1 The groundwater crisis

Counting reckless exploitation of groundwater, leading to the rapid depletion of aquifers in many places, portends disasters. The situation, which has been described as ‘colossal anarchy’ (Shah 2004), needs to be quickly brought under
control, but there are enormous legal, political and practical difficulties here. There may be need for changes in the law relating to ownership rights over groundwater, establishment of regulatory bodies, rationalization of power tariffs, and so on. However, with regard to the very large number of private tube-wells in the country (estimated at 21 million) and the fact that most of these are cases of ‘self-supply’, i.e. outside the purview of public supply systems. There is some scepticism about the feasibility of ‘regulation’ and the efficacy of changes in policy or law as remedies for the depletion and contamination of water, the debate needs to be pursued further.

1.7 THE NEED FOR ACTION

What can we do to avert such situations? How can we improve the availability of the fresh water to prevent the likelihood of water related violence? The root cause of the conflicts is the shortage of water and the solution lies in improving its availability - through storage and conservation by reducing wastage, by recycling and reuse.

Wherever the available water resources are not fully harnessed, as in the developing countries like India, there is need for major, medium and minor storages to be created on priority to tap the billions of cubic meters of the unutilized monsoon flows, which are being discharged into the sea every year. Agriculture is not only the world’s largest water user in terms of volume claiming more than two-thirds of the water withdrawn from the earth’s rivers, lakes and aquifers, it is also a relatively low volume, low efficient and highly subsidized water user at present. In many places, as much as 60 per cent of water diverted for irrigation does not reach the crop since losses are tremendous. Cities divert precious water for distributing through leaky systems to under-paying or non-paying customers. Industries, cities and agriculture are key components in polluting water and large quantities are lost to unrecoverable contamination.

We should not allow such wastage to occur when there are means to improve the situation. Latest management practices in the irrigation system to result in better efficiency have to be adopted to save water. These would include modernization and rehabilitation of inefficient systems and substitution of traditional systems stemming
from a past era of plenty, with systems based on modern technology. Measures like
demand oriented water management, adoption of improved irrigation methods and
innovative water management technologies through appropriate technology transfer
will help in reducing losses and thereby improving the fresh water availability.
Recycling and reuse of drainage water would add to the availability of water.
Transferring water from water surplus basins to water scarce regions can also enhance
the availability of water.

The present mindset of a 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 through various short and long term measures, supported by action plans. It
would be then easier to overwhelm the conflict, including characteristics of water by
developing a sustainable arrangement.

1.8 WATER AS COMMODITY

The delegation attending at the stockholders Water Symposium in August
2000 agreed that human race has taken water for granted and grossly misjudged the
capacity of earth’s water system to sustain the demands on it. Our supply of fresh
water is less than half percent of total water stock. The group recognized the terrible
reality that by the year 2025, as much as two-third of the world’s population will be
living with water shortages or absolute water scarcity. Under such a situation, instead
of taking great care of limited resources we are polluting and depleting it at an
alarming rate.
In the new economy, everything is for sale, even those areas of life once considered sacred, like seeds and genes, culture and heritage, food, air and water. The vital commons of knowledge and our natural heritage has been hijacked by the forces of private greed. The land, water, air and sea have been functionally transformed from life supporting system into repositories for waste. Under the current system of market-driven economic globalization, there are no limits placed on where capital can go to harvest nature.

The arrangement echoed even among some environmentalists, is that we have taken water for granted, and have overused it. Pricing will cause us to understand its real value and force us to start conserving it from economic necessity. This argument is flawed in several ways, e.g. water pricing exacerbates the existing global inequality of access to water. The countries that are now suffering severe water shortages are home to the poorest people on earth. It has been estimated that in third world only 12 percent population have access to sufficient clean water (Ramachandraiah 2001). The privatization of this scarce resource will lead to a two-tiered world, those who can afford and those who cannot. Plans for international “water futures” trading are understood to be at an embryonic stage and it could be only a few years before water joins crude oil, pork bellies, orange futures and other commodities traded on global markets.

1.9 MANAGING WATER SUPPLY

Issues related to water consumption are the focus of public debate particularly at times of scarcity. Entering of private companies into drinking water business and depleting water resources and increasing demand has further accentuated the debate. Thus considering the social and political reality water is an issue of storing public reactions and people have their own beliefs, values, knowledge, attitude and behaviour. This approach allows us to categorize people’s orientation into four following categories:

- Affective dimension: This includes people’s perception about future water availability, belief about sustainable water supply system and views about efficient use of available water.
- Cognitive dimension: People’s knowledge about hydrological cycle, fresh water available and the players who are involved in the supply and use of water.
- Co-native dimension: people’s appreciation of various water management and distribution policies, guidelines and regulates in incoming water supply and reducing demand.
- Active dimension: Behaviours of population with regard to water consumption.

The studies have been conducted to determine the relationships between the above four dimensions so that suitable public policies can be designed for creating awareness on efficient use of water and its preservation. The citizen’s opinions and beliefs with respect to water are situation specific. However, these issues can be clubbed under following three heads:

- Water rights and management schemes
- Criteria for water supply to different users/groups of users
- Cost of water

The study of water culture is thus aimed at, to determine how water debate is formulated among the population sentiments, beliefs and values (affective dimension); around preferences regarding policies to regulate water consumption (co-native dimension); around citizens behaviour regarding water use (active dimension), or if it is a combination of all three dimensions, and attributing the impact of knowledge on above three.

The opinion of the people depend upon social factors such as type of user, type of activity, type of business family income and type of household; demographic factors, viz. age and sex; cultural factors, viz. education level and value system and contextual level, i.e. level of water supply (low, medium etc.). Thus the positions of various stake holders in water debate will depend upon the above variables. The position taken by consumers is mainly dependent upon the type of consumers. The consumers can be broadly categorized into two categories:

- Productive consumers: The consumers which use water for production. Both agriculture production and industrial production comes in this category. The rationale for this consumption depends upon the type of production i.e. to
produce 1 kg of rice one needs 3500 litres of water and to produce 1 kg of wheat one needs 1500 litres of water. Similarly the use of water in industrial production will depend upon the economics of production of a particular commodity.

- Domestic consumers: For domestic consumers, the consumption of water is dependent upon the cultural patterns and availability rather than the industrial rationale.

Within the above two groups there will be number of subgroups depending upon the type of production for productive consumers and socio-cultural factors and demographic features of the domestic consumers. Though the people are same their biological needs are same yet the water consumption varies with the availability of water. The rural/tribal population, who do not have access to piped water or have to fetch it from 3 to 5 km make both ends meet with just 20 lpcd as compared to elite urban population having access to piped water use as much as 200-300 lpcd.

1.10 CONCEPT OF WATER USE

The concept of available resources will depend upon the environmental changes, i.e. changes in rainfall pattern due to global warming etc, which further is a result of burning of fossil fuels, cropping patterns and deforestation etc. In addition, the impact of internal laws as well as development, viz. the development in China will influence the flow of water in rivers that is used for irrigation in China, If China is constructing dams to regulate and divert the flow of Sutlej; it will adversely effect storage in Parchu lake etc. Similarly the interstate laws such as riparian laws also needs to be taken care off for estimation of available water resources because each state want to construct dams to harness electricity and regulate supply. The recent concept also acknowledges that water resources available for socio-economic uses have to be computed after taking into consideration the environmental water needs, such as environmental flows in rivers have been quantified and discounted from the available water resources. This means a considerable change from the old policy that all available water needs to be harnessed for consumptive use.
Apart from different type of consumers the variation within various uses of water in urban areas is important. The basic water requirement for drinking and other domestic needs should be considered as right. The other uses such as water for lawns, swimming pools, washing of cars, houses, public parks, private resorts etc. needs to be given second priority. But both types of users get same water and same priority in the urban areas. This is unfair from the point of view of social needs and economic rationality because tourist activities in urban areas receive preferential treatment simply because of their urban status.

- The domestic water use for drinking, cooking, bathing and washing etc. must get top priority as basic human right. For sustainable biosphere, water needs to be reserved for essential environmental functions.
- The second priority should go to general hygiene of the surroundings where population lives.
- The third priority should go to economic activities such as food production, industry and tourisms etc.

Water for private use needs to be managed by the public authorities and applying principles of economic rationality in order to optimize economic efficiency.

1.10.1 Public awareness

The public needs to be constantly educated about the existing water resources, demand for water, quality and quantity of water supplied.

The population and economic growth needs more and more water. In addition to resource management improvement, water demand management also needs greater attention. The food production sector will remain the major consumer of water and thus efficient management of water in this sector will pay more dividends. Thus productivity of food per unit of water needs to be enhanced.

1.10.2 Perception of scarcity

The old generations faced water scarcity because the access to water was limited and painful. As a result they were more sensible in water usage. Now a days
the population in cities have access to water at all times and places which sent a wrong signal that the water is available in plenty. Thus public awareness programs need to be holistic and multi-disciplinary. The programmes should not focus solely on schools and universities only but extend to education system as a whole and cover all sections of the population – young and old, rich and poor, farmers, industrialists and ethical organizations.

Recycling of waste water is another important aspect which needs to be considered as use of this water can significantly add to the total water availability.

1.11 PUBLIC PARTICIPATORY APPROACHES IN BUDGETING AND EXPENDITURE MANAGEMENT

User perceptions on the quality, efficiency and adequacy of the various services can be aggregated to create a ‘report card’ that rated the performance of all major service providers in the cities and rural areas. The findings will bring out a quantitative measure of satisfaction and perceived levels of corruption, which can be followed by coverage in the media. This will not only mobilize citizens and government support for reforms, but also prompt the rated agencies themselves to respond positively to civic calls for improvement in services. This exercise can be tried in selected regions on pilot basis and can be extended if found useful as in the case with water users associations in a small dam areas. By systematically gathering and disseminating public feedback, report cards may serve as a “surrogate for competition” for monopolies- usually government owned- that lack the incentive to be as responsive as the private enterprises to their client’s needs. They are a useful medium through which citizens can credibly and collectively ‘signal’ to agencies about their performance and pressure for change.

1.12 RECYCLING OF WATER

Increased water demand and climate change have promoted increased use of alternative water sources including recycled water from sewerage effluents as a substitute for potable water for non-potable water uses. Community acceptance of
water recycling is critical to the implementation of water recycling schemes. There is relatively little research regarding the attitudes and likely behaviour of water consumers and the community regarding acceptance of water recycling in both urban and rural settings. This is particularly so for drinking water recycling usually expressed as indirect drinking water recycling (indirect potable reuse). To increase consumer acceptance of recycled water there are at least three main areas of the public’s perception.

- Risk perception in relation to different delivery systems of recycled water.
- Trust in the authorities to ensure quality control, and
- The frequent emotional response of ‘disgust’ in regard to potable reuse.

All water that interacts with humans and their settlements need to be treated in similar way. It picks up and conveys pollutants, must be transported away, and requires some human interventions to treat and to release it back into the environment. The parallels extend into treatment for both kinds of water, we use mechanism to settle out transported solids, as well as to conduct chemical or biological treatments.

Local governments can play critical role in this human water interaction cycle, and they have the best opportunity to integrate water management. The local government control the overwhelming share of land use and water management decisions that determine how and where the human water interaction will occur and very importantly who will pay for how much money for water treatment. Local governments can also decide whether and when to purchase sewers as a waste water management strategy and directly address the political and financial fallout of our ongoing sewer wars.

The fact that local governments have started embracing storm water management but clinging to reactionary, expensive and politically drainage sewer or waste water management represents a failure of imagination on the part of regulators, municipal leaders and water resource managers. A realistic waste water management that focuses on the long term health and functioning of onsite systems is essential.
1.13 OBJECTIVES

Though there are sufficient fresh water resources in the world as well as country. It is a conditionally renewable resource, which means its supply cannot be sustainable if its use is not kept in tune with the supply as is the case with Punjab. The fresh water is being depleted by excessive use in agriculture as well as industry and domestic purposes. Those who are rich and have access to water they waste it by washing vehicles and houses, filling pools and over irrigating lawns (by flooding). Those who are poor and living in slums, waste water by removing taps/or leaving public taps open. The State Government is conscious of depleting water resources and make efforts to augment and manage it but the consumers are not cooperating to the desired level. Why the consumers are not responding to government’s requests with facts and figures? Even in the urban areas where almost whole of the population is literate, the consumers are not responding properly, particularly in saving fresh water/avoiding wastage. Potable water which is fit for drinking is being used for flushing toilets and irrigating lawns, where the treated recycled water can serve the purpose. It is high time that consumers awareness and perception about water availability and behaviour is studied in relation to proper use of water. The main objectives of the study are to:

i. Examine existing water supply system in urban Punjab.
ii. Examine present use of water in relation to economic status.
iii. Examine consumer’s perception about the future water supply.
iv. Study methods of conservative water use and economize on the use of domestic supply.
v. Explore the possibilities of use of recycled water for toilet flushing and irrigating lawns.
vi. Explore the possibility of rain water harvesting.

In addition to achieving the above objectives, following hypotheses were framed and tested for the study:

\[ H_1 \] The per capita water consumption varies with city and size of the household.

\[ H_2 \] Consumer satisfaction is influenced by the demographic features.
Awareness level of respondents regarding water usage is influenced by the demographic features.

Increase in price of water have negative impact on its consumption.

Awareness level of consumers regarding water usage influenced their satisfaction level.

Willingness to pay water charges varies with demographic features of the respondents.

The study will be relevant in terms of determining various sources of water being used by domestic consumers which indirectly gives the coverage of consumers through public distribution system. Awareness level of consumers will be studied to determine the educational needs, consumer perception about the quality of water being used and their demand both in terms of quality and quantity of water being supplied. The study will also bring out the cost of water which the consumers are willing to pay and the ways and means to economize water and minimum requirement of water. The consumer’s perception and willingness to use the recycled water for non-drinking purposes will enable the policy makers to efficiently utilize this source of water to augment the urban water supply. The consumer’s perception about compulsory installation of rain water harvesting structures in newly constructed areas will help the local bodies to implement the decision. In a democratic set up all these issues are very sensitive and for successful implementation of such projects the involvement of consumers in planning and implementation is desirable which is possible only after assessing the mood of the citizens.

1.14 REFERENCES

