CHAPTER-1

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Water is the elixir of life; without it life is not possible and thus it is one of the essential commodity to the mankind. Although many environmental factors determine the density and distribution of vegetation, one of the most important is the amount of precipitation. Agriculture may flourish in some deserts but only with water, which may be pumped from the ground or imported from other areas. The largest available source of fresh water which lies underground is known as groundwater. Civilizations have flourished with the development of reliable water supplies and then collapsed when the water supply failed. Increased demands for water have compelled for the judicious consumption and development of underground water.

Water is clearly the single largest problem facing India today. Though the country was once upon a time categorized as a water rich society. In India the crisis in term of un-equitable distribution and severity affects one in three people. Since the population growing with rapid pace the use of water per person also raises with the result the demand for fresh water goes up.

Years of rapid population growth and increasing water consumption for agriculture, industry, municipalities, and other areas have strained India fresh water resources. Nearly 90% of the water required for irrigation is met from ground water resources. The rest 7 percent and 3 percent of country’s water resources are spent on industrial and domestic uses respectively.
Until quite recently, rural populations depended on surface water from lakes, ponds, wells and rivers, which exposed them to a variety of water related diseases. As United Nations Council for Education and Development (UNCED) estimates that 80% of all diseases and more than one third of deaths in developing countries are water associated 6000 children die every week from water related diseases. Almost all these diseases result from pollution of water by human and animal wastes. Clean water and basic sanitation are closely interlinked yet 2.4-2.9 billions have no sanitation facilities. Recognizing that the surface water is exposed to microbial contamination, government sought to explore groundwater resources that could be accessed with hand pumps and tube wells. Reports till date indicate, in India more than 97% of villages receive water from ground water resources.

The shift from surface to groundwater has undoubtedly reduced the risk of microbial contamination despite the fact that most water remains untreated. However, this shift has given rise to another set of problems. In some parts of the region, groundwater is contaminated with chemicals that are harmful to health. The increasing water scarcity, combined with its deteriorating quality, will have far reaching global impacts on human health, socio-economic development potential of affected countries, fresh water and marine resources and biodiversity. Symptoms of arsenic poisoning were reported first in 1987 in West Bengal. It has been reported that the population at risk from arsenic contamination in India is 5.3 million.
In dry zones in India, and Sri Lanka, the number of people exposed to and endangered by exposure to fluoride exceeds 65 millions. Nitrate is another widespread health hazard that in near future may be a cause for a major health problem in the society.

In many developed countries disposal of industrial and municipal waste containing hydrocarbons, pesticides, radionuclides, organic solvents and metals has resulted in the contamination of ground water. Agricultural practices have also resulted in degradation of ground and surface water, due to excessive use of fertilizers and insecticides.

While there is great cause for concern over the amount of groundwater contamination, it has been pointed out that perhaps only one or two percent of the available ground-water resource has been contaminated. Yet, the areas where contamination has occurred are frequently the areas of more concentrated population, where the water requirement is optimum. This brings us to the areas where hydro geologists can make the most significant impact and greatest contribution to society in the industrialized nations: proper siting, design and construction of land disposal facilities so as to avoid future ground-water contamination and restoration of water quality in aquifers that have been contaminated.

Even apart from drinking, water is required for basic hygiene and for this reason clean drinking water programme must maintain one strike be combined with sanitation programme also. It must be free from contamination at acceptable level and should be available continuously at an affordable price to meet normal needs.
This will be possible only if water quality is monitored to insure that water resources are managed fairly, that contaminants are detected and controlled before causing harm, environmental deterioration is identified and prevented to reverse the growing crisis. To meet the entire world's need for clean water and sanitation would cost an estimated additional $9 billion per year.

In the present study related to Water status, quality development and augmentation of water resources in urban limits of Jaipur, Rajasthan every aspect of groundwater hydrology has been measured with intense care. The study involves groundwater level measurement through piezometers located in the study area and measuring the water level fluctuation, occurrence of ground water, movement of ground water, ground water quality by measuring different chemical constituents dissolved in it, estimation of recharge and discharge and overall management option in regards to problems of over-exploitation and quality degradation.

Jaipur, the capital city of Rajasthan, is growing rapidly and hence it is of great importance to study various hydrological parameters in the area, which is done by studying the geology and hydrogeology of the area. All the water resource in the area were analysed and collection of samples was done from the entire area in different monsoons, and measuring the water levels. The results thus obtained are described in the forthcoming chapters.
Water plays a decisive and crucial role in the growth and location of settlements. The demand for water has been rising in the urban centre not only due to the accelerated growth in the economic activities and social needs. In the long run this rapacious exploration is bound to end up in an ecological crisis if the required pre - equipitive measures are not taken.

This study was conducted to evaluate options for sustainable management of land and water resources on the one hand and adoption of sustainable and safe abstraction of groundwater resources on the other hand.

**Study Area:**

Jaipur, the capital city of Rajasthan state, popularly known, as "Pink City" is one of the fastest growing cities in the country. This famous city has earned universal renown as the "Pink City" from beautiful pink palaces, havellis and forts.

Jaipur is a tourist paradise with exquisite gold and enameled jewellery with polished precious stones, the internationally famous blue pottery in a tempting array of sizes and shapes, the carving of wood, ivory and marble statue. The city is a centre of unique and sophisticated culture, a culture that speaks volumes of Jaipur citizens, aesthetic sense and wealth. Jaipur vibrates with life and colour; the streets are thronged with people during two very colorful festivals Gangaur and Teej.
Fig. 1 Location Map
The main places of interest for tourists are City Palace where rulers have lived and is presently museum, Hawa Mahal, which is constructed without any foundation with lots of airy windows, Jantar Mantar which was constructed for astronomical calculations, Central Museum, Amber Palace and Nahagarh Fort. There are a few additions to this list like Birla Mandir, Birla Planetarium, Galtaji, Ram Niwas Bagh, Ishar Lat, Gaitor and Ganesh Mandir.

Locations and Aerial Extent:
Jaipur city lies between north latitudes 26°46'30'': 27°02' and between longitude 75°35' and 75°55' in the east - central part of Rajasthan state (Fig-1). The area is covered by survey of India Toposheet No. 45M and 45N, 54B. It is 160 metres above mean sea level. It covers a geographical area of 646 sq. kms. Covering 12% area of Amer Block, 45.5% of Jhotwara Block and 42.5% of Sanganer Block.

The modern city has grown quite rapidly outside its walls with new buildings, shopping centres, stadiums, parks and gardens etc.

Communications:
Jaipur is east – centrally located in the Rajasthan state and conveyance here is easily approachable. It is 262 km. by road from Delhi the national capital. It is connected to Agra, Delhi and Ajmer by national highways and with all other cities by Road. It has a large network of railways also (Fig.2).

Jaipur is 283 Kms. away from Aligarh by road, through Mathura, Bharatpur and Dausa.
Fig. 2 Communication Map
Historical Prospects:

The plains of Rajasthan of which Jaipur is the capital once thundered and echoed with clash of swords and the drums of wars. Sawai Jai Singh – II the prince founded Jaipur in 1727. Jaipur was the first planned city of its time (the earlier planned city in northern India having been built near Taxila sometimes in the 2nd century. B.C.)

Vidhyadhar Bhattacharya a young Bengali architect according to the principles laid down in “Shilpa Shashtra” the epochal Hindu treatise on architecture, tempering it with the sublimity of Moughal and Jain influences of times, planned Jaipur.

The entire city conforms to the traditional walled city concept with its encircling crenullated wall and splendid nine entry gates and is divided into nine rectangular blocks known as chowkaris. The grid system with wide straight avenues, embellished with fairy work of domes, corbel lined with carved lattice places, roads, streets, lanes and uniform rows of shops on either side of the main bazaars and mansions washed in bright pink offer a delightful spectacle, the city itself is an attractive creation worthy of universal admiration.

Population:

The population of area is rapidly increasing. According to 2001 census data the total population of urban area is 2,4,86,942 while it was 14,58,482 in 1991. The population of urban area has grown 10,28,460 in 10 years aving density of 3850 persons per sq. km.
Population of the area in year 2005 was 3,01,165. Total literacy rate here is 78.23% with 82.36% in males and 76.42% in females. Total population of the area localitywise is given in table (Table-I).

Table-I: Population Of The Area

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>296067</td>
<td>273321</td>
<td>569388</td>
</tr>
<tr>
<td>Urban</td>
<td>1292892</td>
<td>1138885</td>
<td>2431777</td>
</tr>
<tr>
<td>Total</td>
<td>1321559</td>
<td>1412206</td>
<td>3001165</td>
</tr>
</tbody>
</table>

Source – Statistics Department Jaipur

Table – II: Household Animal Population

<table>
<thead>
<tr>
<th>Animals</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cows and oxes</td>
<td>44149</td>
</tr>
<tr>
<td>Buffaloes</td>
<td>767065</td>
</tr>
<tr>
<td>Sheeps</td>
<td>361759</td>
</tr>
<tr>
<td>Goats</td>
<td>693741</td>
</tr>
<tr>
<td>Horses</td>
<td>3090</td>
</tr>
<tr>
<td>Donkeys</td>
<td>8324</td>
</tr>
<tr>
<td>Camels</td>
<td>43594</td>
</tr>
<tr>
<td>Rabbits</td>
<td>1132</td>
</tr>
<tr>
<td>Pigs</td>
<td>34082</td>
</tr>
<tr>
<td>Ducks</td>
<td>327</td>
</tr>
<tr>
<td>Hens / Cocks</td>
<td>126182</td>
</tr>
</tbody>
</table>

Source – Statistics Department Jaipur.

Except this there are 83 fisheries in total in the area, which produce fishes like major carp, catfish, minor carp (Table –III).
Table-III: Fish Types In The Area

<table>
<thead>
<tr>
<th>Fish type</th>
<th>Production (kgs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major carp</td>
<td>121830.5</td>
</tr>
<tr>
<td>Cat fish</td>
<td>22150</td>
</tr>
<tr>
<td>Minor carp</td>
<td>39696.8</td>
</tr>
</tbody>
</table>

Source - Statistics Department Jaipur

Previous Work:

The G.S.I. and the Central Ground Water Board have completed systematic hydro geological survey of the entire Jaipur district during 2001 – 2002.


For long term monitoring of water levels, G.S.I. initially established hydrograph stations the water levels on these stations were monitored by G.S.I. during 1969 and 1972, and since 1973 water levels on these stations are being monitored by C.G.W.B. At a later stage number of hydrograph stations have been increased in a phased manner.

Hydrometeorology:

Hydrometeorological data are required to determine the water balance of a basin for developing and managing its water resources. The most useful hydrometeorological elements are precipitation, evaporation, evapotranspiration, solar radiations, temperature and humidity, soil moisture, water levels (surface and underground), stream discharge, water quality etc.
Rainfall can be measured by a network of non-recording and recording rain gauge, which gives the amount of precipitation in the area during certain period of rain.

In the area rainy season usually sets between June and September. The normal annual rainfall of the area is 656.63mm for the period of 1975-2004. The mean annual rainfall recorded at Sanganer, Amer and Jaipur rain gauge stations was 584, 676.50 and 639.50mm respectively between periods of 1970-2003. (Table-XXXIII)

Climate:

Climate is an important factor, which influences to a great extent the microclimate of an urban area. Higher temperatures are observed in urban settlements than rural settlements due to alteration of space, which atleds the heat balance of an urban settlement, leading to higher thermal discomfort. Industrial land use should not be sited in the windward side to the existing or proposed settlements. The classification is based on the distance from windward side from the sources of pollution. The ranking criterion is based on incidence of development from maximum to minimum.

The climate of any place plays a vital role in creating comfort conditions and for the dispersal of pollution provided the activity pattern are managed in a harmonious manner, on the other side, it may cause number of environmental problems if activities like industries are located on the predominant wind direction and close to residential, commercial and environmentally sensitive areas.
Problems like bronchitis, asthma, eye burning and skin diseases can be observed. Decay of the vegetation cover and degradation of aesthetic value of ancient monuments can be experienced.

The five parameters of the climate are temperature, rainfall, humidity, cloudiness and wind of the four seasons, as follows:

**Temperature:**

Temperature of Jaipur is extreme with hot humid summers and chilly winters. Maximum temperature during the summer (from March / April-June) reaches as high as 45°C. On the other hand winters have sunny pleasant days and bitterly cold nights and temperature can touch as low as 5°C, whereas the mean daily minimum temperature is highest (27.3°C) in June. The mean daily minimum temperature is lowest in January (8.3°C).

**Relative Humidity:**

The air is generally dry during the major part of the year. However, during southwest monsoon period (July - September.), the relative humidity is generally over 60% and during summer months, it is as low as 20%.

**Evapo-transpiration:**

As characteristic of semiarid climate, the rate of potential evapo-transpiration is high in the city area. It is highest in the month of May (Average 250 mm) and lowest (60mm) in the month of December.
Winds:

The city by and large experiences light to moderate winds during major part of the year. However, winds become relatively stronger in summer as well as during the monsoon period. It is highest (17.8 km / hour) in June and lowest (7.6 km / hour) in November.

Physiography:

Physiography plays a vital role in determining the environmental quality of any region. The Aravalli ranges which provide Jaipur a distinct physiographic character that makes it an ecologically sensitive area from environmental point of view.

The Jaipur area comprises almost flat plain land with clusters of sand dunes in the south-western part and a long rocky ridge extending roughly from north – north east to south – south west. The plains on either side of this ridge slope away from it.

One of the highest spur supports is the Amer Fort (3618 mams). The ridge runs in south-western direction with its surface gradually rising from Nahargarh fort to the Jhalana Bani.

Surface Water and Drainage:

River is a major environmental resource and an amenity. At the moment when the river becomes inaccessible to the population and does not serve as a recreational amenity, a separate master plan considering the ecological and landscape value of the river needs to be prepared.
Fig. 3 Drainage Pattern
The Jaipur urban area comprises no major river or canal within its agglomerate (Fig. 3). It is mainly drained by a Nalla named Amanishah Nalla from north to south, which meets to the Mendha River in the south at Sanganer block outside the urban area. The Mendha River is also ephemeral in nature and flows only in monsoon period. There are some surface water bodies in the area like Jal Mahal Tal Katora, which are insignificant from the drinking water point of view.

**Land Utilization Data:**

The Jaipur urban area comprises 646 sq. kms. of geographical area which covers 12% of Amber Block 42.5% of Sanganer Block and 45.5% of Jhotwara Block. Increasing industrialization has reduced the land area for agriculture and the area is mainly being used for construction of industries, avenues, halls, flats, Bungalow, residential houses, multistoreyed buidings, offices etc.

**Soil Characteristics:**

The soil in Jaipur is alluvium sand, silt, clay with some kankars of fluvial and fluvio – aeolian nature. It has good porosity and permeability. Total infiltration rate in soils is 17-18cm/hour. The soil used for agricultural activities gives good crop results in bajra, kapas, jwar, and genhu combined with the hydrogeological conditions.
Fig. 4 (A) Location of Sampling Stations post-Monsoon 2003
Fig. 4 (B) Location of Sampling Stations post-Monsoon 2004
Fig. 4 (C) Location of Sampling Stations pre-Monsoon 2004