CHAPTER - 3

PREVENTION AND MITIGATION

Availability of water on earth dependent on hydrological cycle predominantly controlled by nature and seems to be following almost constant cycles. As long as the water taken out from various sources specially the underground sources is with in the natural rate of replenishment which varies from one geographical location to other depending on various factors affecting recharge like rainfall ,nature of strata ,run off speeds etc however excess withdrawal on regular basis results in lowering of water table and chronic scarcity, such situation can be mitigated by following affecting factors.

Demands

As already brought out in chapter 2 if total demand of water is brought with in its local availability without disturbing its natural cycle, there is likely to be no problem but rising concentrated demands lead to water problems. Main demands for water are made up of requirements for drinking and to meet with other domestic needs.

Requirements for drinking and other domestic needs can be limited directly by controlling the overall population of world which has got attention of all countries but though in general all countries including India are following policy for small family of 2 + 2 which should lead to stabilization of population with possibility of marginal reduction in future but same is not made forced mandation in most of countries . However in Europe and more developed countries population has almost become constant. This aspect has almost negligible potential of decreasing demands of water in future.

The localized demand in any geographical area due to fast urbanization can be reduced and shortage problem mitigated in near future to small extent by having well planned urbanization by selecting and allowing optimal population density so that water supply and sanitation needs can be met without creating imbalance in nature. For this basic facilities and infrastructure is to be created and suitably connected so that entire country has almost similar facilities of health, governance, roads and transport, education, recreation and employment which will reduce need for large scale migration of population to small areas of big cities.

It will be better if dwelling centers about 10 KM diameter or so, with required standard amenities and facilities are created at about 100 KM inter distances and are properly connected with super ways, telecom facilities. This normally should provide for use of even cycles only for commuting with in city and entire required work force may not be required to dwell in such centers, as some of them can commute from near by rural areas daily. This can reduce the population pressure per unit area in such city and open area of about 50 KMs around should facilitate natural under ground water recharge.

One more area which can go long way in reducing the water requirement at source is by controlling the wastage of potable water. At present it is seen that this aspect is not getting serious attention for its overall consequences, as the small leakages in any system are very large, but individual is either un concerned or feels that small leakages are not worth diverting his/her attention and money required to get them attended, as these do not immediately cause appreciable damages. However it is correctly said that many a drops can make an ocean . A small leakage of one drop every few second can leak about 1cc of water every minute or about

1.5 liters per day. With about 10 leakage points like taps, stop cocks, valves, joints, cistern etc in a home (noticed or unnoticed)can lead to wastage of about 15 liters of treated water per day ,In addition there are large leakages/wastages in supply system and through public taps. A check in this area can result in reduction of water requirements.

Water requirements can also be brought down further by using improved designs and material for water closets which can achieve same results of flushing with less water. Small reduction can also be brought about in cooking and washing by using suitable technologies like pressure cooking etc.

Following Water Efficiency and Conservation Measures are being developed and adopted in respect of domestic water supply system :

1. Distribution system leak detection and repair. Some of water providers are doing a good job tracking down and repairing leaks. Besides checking the distribution system itself, tracking down leaks often also requires a long-term commitment to replacing aging meters in order to reduce meter slippage and allow better accounting of how much water is used where, and how much is lost along the way. Metering any remaining unmetered users is also required. Ten percent "unaccounted-for" water (the difference between water produced and water sold) is a common "guideline" in the industry.

2. Distribution system pressure reductions. Too high water pressure results in wastefully high flow rates at faucets, showerheads and some other water fixtures. Pressure-reducing valves may be installed in new buildings where water pressures are high, other areas may have high pressure to meet their demands.

3. Automated customer leak detection Advanced meters and associated devices can detect constant low-level flows that indicate leaks.

4. Extreme low-flush toilets. Toilets using as little as 0.5 GPF(2.273L) as against normal cistern capacity of about 10 liters are available. Some use special bowl coatings and vacuum withdrawal to ensure effective flushing

5 New waterless toilet designs are being developed in Europe that use a 2-part bowl to separate urine and feces. Keeping these forms of human waste apart greatly facilitates their subsequent management. These "separating toilets" are widely used in experimental application in urban areas .

6. Some plumbing add-ons provide for instant hot water at the tap, saving the water that is wasted when users let water flow while waiting a few seconds, sometimes longer in larger buildings, for cold water in the lines to be cleared. Point-of-use water heaters achieve the same result.

7. Waterless urinal are now well-proven .

8. Electronic faucet uses electronic sensors that automatically turn

water on and off when hands are present in the sink Such faucets save water over standard faucets and metering (e.g., spring-dosed) faucets.

9. Grass lawns typically account for most of water demand for home yards and other landscapes. Simply reducing turf areas, to where they are most needed, can produce significant water savings. Other, less water intensive plantings and treatments are available for ground covers where turf is not essential.

10. Native plants tend to use much less water and tolerate drought better than non-native species, and their use should be encouraged. Also Xeriscaping is a suite of techniques for producing pleasing landscapes that require no or very little irrigation to supplement natural precipitation thus reducing the water demand.

Irrigation

1. Irrigation demand can also be reduced by using seeds and manures requiring less water. Further new irrigation techniques like sprinkler and drip irrigation can reduce the overall requirement of irrigation water per tonne of agriculture produces .Israel has already taken big lead in such areas.

2. Optimal exploitation and conjunctive use of available surface and groundwater should be pursued. Also reuse of marginal sources should be considered including reuse of drainage and sewage water, brackish water and rain harvesting.

3. Overall storage capacity can be increased by the recharge of sub-surface groundwater reservoirs in suitable geological zones. Also techniques for efficient rainfall harvesting (concentrating the water in the root zone) are well known and have been used in some regions.

4. Surface irrigation is currently by far the most common technique used by small farmers. However, irrigation water at field level is still used with low efficiency in many countries. Improvement of irrigation efficiency at field level is technically possible, including: sprinkler irrigation, drip irrigation and modernized surface irrigation Modern surface irrigation techniques should be considered as crucial including improved leveling techniques and even distribution at field level.

5. Substituting use of fresh water for irrigation with brackish water and wastewater.This results in saving large volume of fresh water for direct domestic consumption.

6. Computers are used to allow real-time operation of the irrigation systems. Soil and plant moisture sensors are also used to provide information on moisture, allowing automatic operation of the system when needed. Further irrigation efficiency is being attempted by regulating water application to each individual plant, using individual moisture sensing emitters. The root volume can also be controlled, leading to a shortening of the crop growing cycle.

7. Surface and subsurface drip irrigation, micro-spray systems, bubblers and soaker hoses are typically more efficient than sprinkler systems, especially conventionally installed sprinklers. The type, spacing and aiming of sprinkler heads greatly affect the application uniformity and therefore the potential efficiency of sprinkler systems. With all irrigation systems, proper zoning to match

the different water needs of different portions of a landscape is important. Irrigation

experts typically find substantial water savings are possible from changing the type,

spacing and zoning of irrigation equipment in both residential and larger landscapes. Use of on-farm advanced micro-irrigation systems also improves efficiency by almost 50%.

8. Evapotranspiration-based irrigation scheduling

Evapotranspiration (ET) refers to the water requirements of plants and associated soil. Water application in excess of ET requirements is wasteful. Many people water all of their landscape the same amount, throughout the irrigation season. ET requirements of representative local landscapes on the basis of typical changes in plant from the beginning to the end of the irrigation season, or actual changes based on recent weather, can be calculated by experts. Also, programmable irrigation timers provide a crude approach to ET-based irrigation by allowing irrigation schedules to be automatically adjusted for typical ET requirements through the irrigation season.

9. Rain sensors connected with irrigation controllers, and Soil moisture sensor can automatically turn off irrigation systems when rain occurs,or when soil moisture is adequate, saving partial or entire irrigation cycles and water requirements.

Indusrial and Commercial Demands :

efficiency can be increased for food service and dishwashing equipment and procedures, cooling tower water recycling and adjustment of blow-down cycles, car wash recycling, cleaning and sanitation equipment (e.g., steam sterilizers, autoclaves, floor washing, etc.), recycling of process water, boiler and steam generator water recycling and optimization, icemaking equipment etc.Thus water requirements can be brought down.

Pollution

Controlling pollution of surface and underground water will help in increasing the availability of useable water. It basically requires to keep our used water from spoiling our water resources, for which we have to ensure removal of the pollutants before the water gets back into the environment. In urban areas in most developed countries, the wastewater from homes, businesses and factories is collected by a system of underground pipes i.e. sewers which carry it to one or more central treatment facilities. Most of these are located near bodies of water into which the treated wastewater is discharged.

Limits are laid on the amounts of various pollutants which may be discharged in water bodies so as not to have any harmful effects on surface and underground water. Industries located in areas where they are not connected to a sewer and can discharge directly into a waterway , should have their own treatment plants. Even industries which are connected to sewers may have to pre treat their wastewaters before discharging them into the sewers, because they may contain materials which will harm the sewers or the treatment plants-- or may be a danger to the people who work in maintaining the sewer system.

Homes in non-urban areas that are not connected to a sewer are usually required to have on-site treatment systems. Most common for single homes are septic systems, which consist of a buried tank connected to a set of perforated pipes, embedded in gravel, which distribute the water into the soil.

It is better practice that in addition to sewer pipes which carry wastewater to a treatment plant, cities and towns also need pipes to collect storm water. The runoff of pollutants from streets and yards into these storm sewers contain oil and other automotive wastes, which may contain toxic metals and organic compounds as well as pesticides and nutrient-containing fertilizers from lawns and gardens, and pathogenic microorganisms from animal wastes.. During rainy periods, combined sewers cause two problems: overloading of the treatment plant with extra water and contaminating waterways with untreated sewage from overflows.

Solid & waste water treatment and recycling methods :

1. Landfill Engineering & Management:
Landfill remains the dominant waste disposal method for successful implementation and desired results ,it is prerequisite to know the chemistry of landfill degradation processes and the geotechnical aspects of landfill design required to limit potential environmental impacts.

2. BioSolidsManagement:

Bio solids are a by-product of waste water treatment Solids that remain at the end of the treatment process are called bio solids these are removed from the waste water stream and broken down using mechanical processes and bacterial action. Both processes significantly reduce the volume of solids in the waste water stream, and allow for discharge of clear water.

3. Hazardous Waste Management

Hazardous Wastes, Bio Medical Waste and E-Waste require special waste management techniques like Incineration Systems ,Autoclave Systems ,Microwave Systems and Recovery Systems for their treatment. Other techniques involved are Waste to Energy Plants ,Biogas Plants ,Composting and Bio Methanation.

Waste Water treatment & Recycling Systems

Waste water treatment and recycling helps industrial sectors to reduce down time and at the same time abide by state laws by following methods :

Effluent Treatment Plant ,Sewage Treatment Plants ,Membrane Filter System Ultra filtration Membranes ,Wastewater Evaporators Wastewater Recycling Equipment ,MBR systems ,Aeration Systems, Clarification Systems, Filtration Systems ,Sludge Handling Systems,Oil and Grease Removal Systems ,RO Systems, Desalination Systems ,Evaporation Systems, Softeners ,De fluoridation ,De-mineralization , Ozonator ,UV Water Purifiers .

Augmenting Availability :

The Most important and vital aspect to tackle this gigantic problem ,created specially in densely urbanized areas as a result of characteristic feature of such areas as already discussed earlier which adversely affect the ground water recharge accordingly following main thrust areas of ground water recharge are discussed in details :

A. Ground water recharge

Ground water recharge is influenced by such things as the season of the year, intensity and duration of precipitation, topography, vegetative cover, soils, land use, evapotransporation, availability of storage, etc.

The rates and amounts of recharge may be improved by:

(1) Increasing opportunity time by regulating the flow of water over

the intake area.

(2) Desilting and removing materials or debris which might seal the

intake area.

(3) Planting or improving the growth of deep rooted vegetation.

(4) Diversions from l e s s t o more suitable intake areas

The following factors are to be considered in selecting the proper location of

sites for artificial recharge:

(1) Water (availability, source, turbidity, quality, etc .)

(2) surface soils

(3) depth to aquifer

(4) geologic structure and capacity of the ground-water reservoir

(5) movement of ground water

(6) location of withdrawal area.

Rain Water Harvesting:

Rain Water Harvesting is the widely practiced and popular effective Ground water recharge technique world over in India this is a focus area for tackling water problems specially in urban areas where it has almost been made mandatory.

Rain Water harvesting is the technique of collection and storage of rain water at surface or in sub-surface aquifer, before it is lost as surface run-off. The augmented resource can be harvested when needed. Thus it covers wide range of means of collecting and storing water but popularly this item is becoming synonymous to artificial recharging of ground water aquifer.

Following are three basic types:-

(a) Roof top rain water harvesting and storage in tanks.

(b) Roof top rain water harvesting and recharging subsurface aquifer.

(c) Surface run-off harvesting and recharging subsurface aquifer.

In addition to promoting adequacy of underground water it has following advantages

Mitigates the effect of drought.

Reduces soil erosion as surface run-off is reduced.

Decreases load on storm water disposal system.

Reduces flood hazards.

Improves ground quality/decreases salinity (by dilution).

Prevents ingress of sea water in subsurface aquifers in coastal areas.

Affects rise in ground water table. Thus saving energy (to lift water).

The cost of recharging subsurface aquifer is lower than surface reservoirs.

The subsurface aquifer also serves as storage and distribution system.

No land is wasted for storage purpose and no population displacement is involved.

Storing water underground is environment friendly.

MODES AND TECHNIQUES

Roof top water/storm runoff is harvested is harvested by following techniques :

Through recharge pit

Recharge through abandoned hand pump

Recharge through abandoned dug well/open well

Through recharge trench

Recharge through shafts

Recharge trench with bore

B. Other non - Conventional Water Resources and Conservation areas

1. Reclaimed Wastewater Effluents. The use of reclaimed and treated municipal wastewater is becoming an increasingly important source of water for agricultural and industrial purposes. before or after artificial recharge into a confined aquifer.

2. Intercepted runoff and artificial recharge

The schemes divert storm flow into surface reservoirs or to spreading grounds where it percolate through sand layers into the underlying aquifer.

3. Cloud Seeding.

Cloud seeding with silver iodide crystals has been practiced for last 30 years in different parts of world. In Israel controlled seeding experiments conducted between 1960 and 1975 provided the scientific justification for the routine seeding. It is assumed that a significant increase of 10 - 15% in rainfall is achieved. Ground incinerators are being replaced by special air-crafts using brine as the seeding material.

4. Desalination: Many small and medium desalination plants are in operation for the desalination of brackish and sea water, for domestic water supply. In Israel facilities near Eilat produce 44,000cum/day of water from brackish groundwater and sea water.

C. Scientific development of ground water

In view of the reducing availability of fresh water resources and increasing demands, it is essential that stress is laid on development of ground water in areas with prolific aquifers and low stage of development; conservation of fresh ground water resources through development of ground water in water logged areas and promoting use of saline/ brackish ground water. There are many areas in different parts of the country, where potential for development of ground water still exists. It is proposed to develop ground water resources in safe (low stress) areas throughout the country except in the States of Haryana, Punjab and Rajasthan and Union Territories of Chandigarh, Delhi, Lakshadweep, Pondicherry and Daman & Diu, where there are problems of either continuously declining ground water levels or that of quality deterioration. Shallow tubewells are proposed to be constructed in alluvial areas and in areas underlain by hard rocks, borewells and boring in dugwells are proposed.

D. Development of deeper aquifers

As per the National Water Policy, the development of ground water is to be restricted to the replenishable resource. The in-storage ground water resources of the country have been assessed as 10812 BCM, which can be retained for future use/ harnessed in periods of crisis. CGWB has till now explored potential aquifers upto the depth of 400 metres in alluvial areas and 200 metres in hard rocks. However, to increase the availability of water to meet the increasing demands and to retain the same for future use, newer potential sources of ground water would need to be explored. Exploration of deeper aquifers to ensure sustainable water supply for various uses would need to be carried out, so that potential aquifers can be exploited for use.

In coastal areas, sufficient scope exists to tap deeper ground water aquifers. It is, therefore, essential that deeper ground water exploration be carried out in coastal areas to ascertain the safe yield of these aquifers for sustainable development.

E. Development of ground water in flood plain areas

The flood plains in the vicinity of the rivers act as repositories for ground water. To meet the additional demands, ground water from the flood plains can be withdrawn during non-monsoon period. The dewatered aquifer zones would be recharged during the subsequent monsoon period through flood water. Recharge to ground water can be enhanced by adopting appropriate artificial recharge practices including construction of additional barrages.

F. Integrated use of surface and ground water - conjunctive use.

The Studies have established that the isolated use of surface water ignoring optimal ground water use in irrigation command has resulted into various environmental problems. Further, there is a need to adopt Ground Water Hydraulic Management Models (Management models) which incorporates a ground water simulation model as constraint in the Management model which can be efficiently used in planning the conjunctive use of water.

G. Development of ground water in water logged areas

Large areas particularly in the command areas of major and medium irrigation projects suffer from water logging due to rejected recharge. The water logging conditions have been created due to high intensity of irrigation without adequate drainage, which results in upward movement of water table Provision of horizontal drainage in such areas is one of solutions. The water table from such areas can also be depressed by constructing wells/ tubewells. Pumping of ground water besides alleviating the conditions of water logging will also contribute to increase in irrigation intensity.

Following articles bring out the need and possibility of water recharge techniques world over :

Take measures to improve underground water table[26]

Rejuvenation of ponds and lakes should be given top priority in order to improve the underground water table. New ponds and tanks should be constructed

---

[26] Deccan herald Wednesday, July 30, 2008

where ever rainwater can easily sink into the ground, suggested education expert M Shriramareddy

Speaking to media persons here on Monday, he said, Gujarat government was the right example, in this regard. The new ponds and tanks constructed in that State and also, the projects meant for ensuring the sinking of rainwater into the ground, were all fruitful.

If effective measures are not taken to increase the groundwater levels in the State, the day will not be far when, even water will also be rationed, Mr Shriramareddy warned.

Large quantities of rainwater flows, without being put to proper use. There was a lack of serious concern to utilise the rainwater systematically. The agricultural community should pay their attention in this regard. If the rainwater that flows in the fields are stopped, it can be put to proper use for cultivating crops and also for increasing the ground water levels. There was a need to enlighten the farmers in this regard, he explained. Right now, desiltation of the ponds and tanks were being undertaken just for namesake. The desiltation process is being implemented only in the peripheral regions of the ponds and tanks.

This does not help in the rejuvenation of the water bodies. Since, all the ponds and tanks in Kolar district are organically inter-connected with one another, the desiltation process should be implemented systematically. If it is implemented haphazardly, these water bodies will be filled with silt again, he added.

The system of utilising the dried-up lakes and basin areas for the construction of residences and other developmental activities should be given up. Our elders used to construct villages, where ever water was available.

Unfortunately, these days, our political leaders sanction construction of new residential layouts on dried-up lake beds, thus reducing the water resources, Mr Shriramareddy added.

One of the noble project for recharging ground water is exploring possibility of reviving ancient rivers which presently have almost become extinct due to geological changes and human neglect. One of such scheme being conceived in India is for river Saraswati is given below :

Revival Of River To Recharge Ground Water In Haryana [27]

The Haryana government has acquired almost 20 acres of land and work is under way on a 50 km-long channel in Kurukshetra, through which the river will flow again. "The revival of the Sarasvati will benefit countless people in the region as it will augment ground water resources," says Darshan Lal Jain of the Sarasvati Nadi Shodh Sansthan, which is working with the government on this project. The plan is not to line with the river's course with bricks so that water can permeate the ground. With ground water levels dipping to as low as 150 feet, the river's revival may be a boon for parched Haryana.

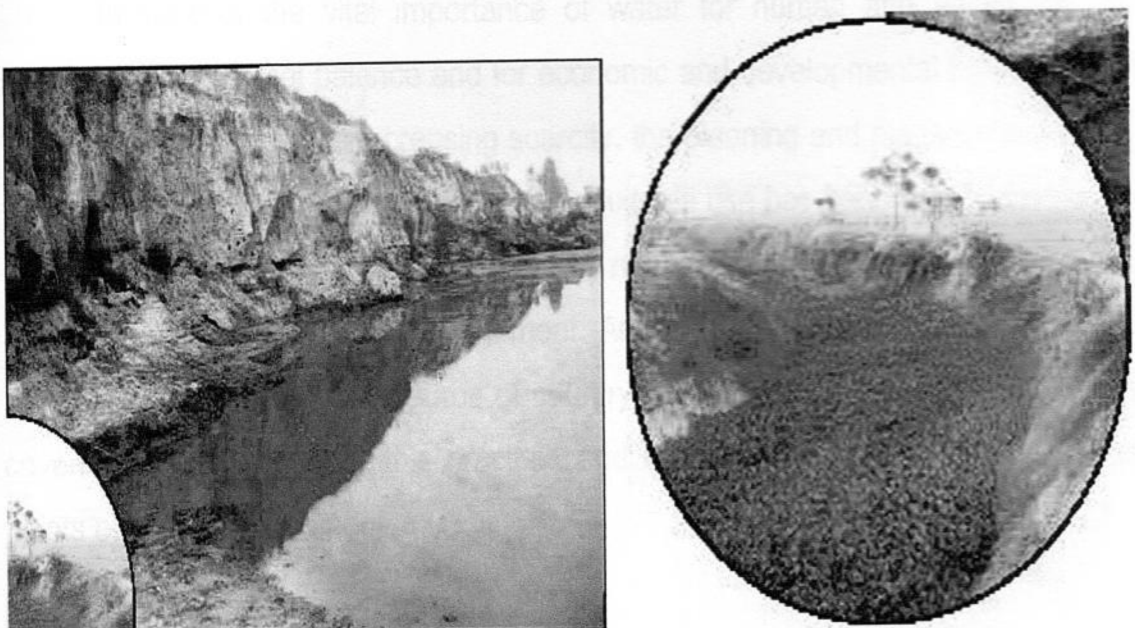

Fig 3.1 The river bed that was discovered near Bhoresaidan in Haryana and (right) the channel that is being cleared for the Sarasvati

[27] *Atul Sethi | TNN*