Water Resource Potential, Utilization and Conservation in India

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Received June 11, 2017 Accepted July 12, 2017

ABSTRACT

Water is essential for life on earth. India has 4 per cent of world water resource whereas it constitutes 18 per cent of world population and 15 per cent livestock of world. Water is a vital resource for not only the development of agricultural sector of a country but also for transport, fisheries and urban and industrial supplies of water. Optimum development and utilization of water resources, therefore becomes an important objective of national planning. Water is one the most essential natural resources and a key component of the socio-economic development. Sustainable development of the country requires efficient utilization and conservation of water resources. The objectives of the present paper are – (i) to highlight the major recommendations of the National Water Policy; (ii) to describe potential and utilization of surface water; (iii) to analyse ground water availability, utilization and stage of development; (iv) to assess irrigation potential created and utilized and to identify major constraints in irrigation efficiency; and (v) to mention the main water conservation strategies such as drip irrigation, sprinkle irrigation and rain water harvesting.

Key words: Water, Utilisation, Potential, Sustainable and Conservation.

Water is essential for life on earth. India has 4 per cent of world water resource whereas it constitutes 18 per cent of world population and 15 per cent livestock of world. Water is a vital resource for not only the development of agricultural sector of a country but also for transport, fisheries and urban and industrial supplies of water. Optimum development and utilization of water resources, therefore becomes an important objective of national planning. Water is one the most essential natural resources and a key component of the socio-economic development. Sustainable development of the country requires efficient utilization and conservation of water resources. Policies and programmes for water resource development and regulation of water resources in India are looked after by the Ministry of Water Resources now renamed as the Ministry of Water Resources, River Development and Ganga Rejuvenation. The National Water Policy adopted in September 1987 by the National Water Resource Council recognizes water as a prime natural resource, a basic human need and a precious national asset.

The National Water Policy, 2002 lays emphasis on the integrated water resources development and management for optimal and sustainable utilization of the available surface and groundwater; creation of well-developed information system; water conservation and demand management; quantity and quality aspects as well as environmental considerations; involvement of beneficiaries and stakeholders in the project planning and participatory approach in water resources management; adequate training and research; resettlement and rehabilitation aspects of project affected persons. The policy also encourages private sector participation in placing development and management water resources project for diverse uses, wherever feasible with a view to introducing innovative ideas, generating financial resources and introducing corporate management and improving service efficiency and accountability to users. According to this policy, each state has to formulate its own State Water Policy for achieving the desired goals.

The National Water Policy, 2012 was adopted by the National Water Resources Council. The National Water Policy, 2012 made several recommendations for conservation, development and improved management of water resources in the country. Some of the major recommendations of include – need for a National Water Framework Law; comprehensive legislation for optimum development of inter-state rivers and river-valleys; evolving a system of benchmarks for water uses for different purposes to ensure

efficient use of water; setting up of Water Regulatory Authority by each state; and incentivizing recycle and reuse of water are some of the important recommendations in the Policy. The Policy also lays emphasis on community participation in management of water resources projects and services; incentivizing water saving in irrigation through methods like aligning cropping pattern with natural resource endowments, micro irrigation, automated irrigation operation, evaporation-transpiration reduction etc; undertaking conservation of rivers, river corridors, water bodies and infrastructure in a scientifically planned manner through community participation; and arresting declining ground water levels in over-exploited areas.

Surface Water

India is a rich country in terms of the total water resource potential. From precipitation India receives 4,000 km^3 or BCM (Billion Cubic Metres) water. Out of this, 3,000 km^3 or BCM is received in south-west monsoon season from June to September. A major part of total precipitation is lost through the processes of evaporation and plant transpiration. The average run-off coming into the rivers systems of the country has been assessed at 1869 cubic km by the Ministry of Water Resources. Of this, total utilizable water resource is assessed as 1123 cubic km. About 690 cubic km of this potential is utilizable by conventional storage and diversion. In addition to this, the country has a replenishable ground water potential amounting to 433 cubic km. If used judiciously, this resource can be used in a sustainable manner. However, with the increasing population, the per capita availability of water has been continuously decreasing. It amounted to about 6008 cubic metres in 1947, 5177 cubic metres in 1951, 1820 cubic metres in 2001 and stands at about 1545 cubic metres according to the 2011 population of India. At world level, less than 1700 cubic metres per capita represents condition of water stress. According to an estimate in 2025 per capita water availability of water will be 1340 cubic metres and in 2050 only 1140 cubic metres.

Availability of water varies a great deal from one river basin to the other (table). Ganga-Brahmputra-Barak-Meghna system is most important source of utilizable surface water. In annual surface run-off Brahmputra is the leading basin in the country with a run-off of 585 BCM. But majority of this potential resource is not utilized and rather plays destructive role in the form of floods. In terms of surface flow the Ganga basin ranks second in the country but it has the largest storage and utilizable water. Godavari, Krishna, Mahanadi, Narmada and Kaveri are the other major catchments of India in descending order (Table 1).

Table: 1 Surface Water Resources According to River Basins

River Basin	Average Annual Run-off in BCM (Billion Cubic metres)
Indus (up to border)	73.31
Ganga	525.02
Brahmputra – Barak and other sub-basins	585.6
Godavari	110.54
Krishna	78.12
Kaveri	21.36
Penner	6.32
East flowing rivers between Mahanadi and Penner	22.52
East flowing rivers between Penner and Kanniyakumari	16.46
Mahanadi	66.88
Brahmani and Vaitarni	28.48
Subaranarekha	12.37
Sabarmati	3.81
Mahi	11.02
Rivers flowing West of Kachchh, including Sabarmati and Luni	15.1
Narmada	45.64
Tapi	14.88
West flowing rivers (between Tadri and Tapi)	87.41

West flowing rivers (between Tapi and Kanniyakumari)	113.53
Small river basins (flowing in Myanmar and Bangaldesh)	31.0
Total Surface Run-off of India	1869.37

Groundwater

According to Central Ground Water Board, the total replenishable ground water resources in the country have been reassessed as 433 BCM. Existing gross ground water draft for all uses is about 243 BCM. Therefore the stage of ground water development in India is 61 per cent (table). The development of ground water in different areas of the country has not been uniform. Highly intensive development of ground water in certain areas of the country had resulted in over exploitation leading to decline in the levels of ground water. There is a continuous growth in dark and overexploited areas in the country.

Central Ground Water Board (CGWB), under the Ministry of Water Resources, River Development and Ganga Rejuvenation is a multidisciplinary scientific organisation with a mandate to: "Develop and disseminate the technologies, monitor and implement national policies for the scientific and sustainable development and management of India's ground water resources including their exploration, assessment, conservation, augmentation, protection from pollution and distribution based on principles of economic and ecological efficiency and equity".

The major activities of the Board include management of ground water, exploratory drilling, monitoring of ground water levels and water quality through a network of ground water observation wells, implementation of demonstrative schemes for artificial recharge and rainwater harvesting for recharge, augmentation, periodic assessment of ground water resources of the country. In the XII Plan CGWB has taken up the National Project on Aquifer Management (NAOUIM) to facilitate identification, delineation, characterization and effective management of aquifers to ensure sustainability of ground water resources. The preparation of Aquifer Map and Aquifer Management has been completed for an area 2.28 lakh square km till March 2016.

As per the latest assessment of ground water resources carried out jointly by the Central Ground Water Board (CGWB) and the States, the assessment units are categorized as 'over exploited', 'critical' and 'semi- critical' based on the stage of ground water development and the long term water level declining trend during the past decade. Out of 6,607 assessment units (Blocks/Mandals/Talukas) in the country, 1,071 units in various States have been categorized as 'over exploited', i.e., the annual ground water extraction exceeds the annual replenishable resource. In addition 217 units as 'critical', i.e., the stage of ground water development is more than 90 per cent and within 100 per cent of annual replenishable resource. There are 697 'semi-critical' units, where the stage of ground water development is between 70 per cent and 90 per cent, 92 assessment units as 'saline' and the remaining have been categorized as safe from ground water development point of view. List of these areas is being circulated to the State Pollution Control Boards and Ministry of Environment and Forests which refer the new industries/ projects falling in these areas to the Central Ground Water Authority (CGWA) for obtaining clearance for water withdrawal.

Out of the total of about 433 BCM per year of this resource about one-third lies in the states of Uttar Pradesh (the richest state in this respect), Maharashtra and Madhya Pradesh. Andhra Pradesh, Assam, Bihar, Gujarat, Odisha, Tamil Nadu and West Bengal are other major states with high ground water resource. Out of the total replenishable ground water resource in the country 221.29 BCM/year is available for irrigation and 21.8 BCM/year for domestic and industrial uses. Some of the states have developed a high proportion of their replenishable ground water resources(Table 2).

Table: 2 State-wise Ground Water Resources Availability, Utilization and Stage of Development (2009)

States/UTs	Annual Replenishable Ground Water Resource BCM/year	Natural Discharge during non-monsoon season BCM/year	Net Annual Ground Water Availability BCM/year	Net Annual Use BCM/year	Irrigation BCM/ year	Domestic and Industrial usesBCM/year	Stage of Ground Water Development (%)
Andhra Pradesh	33.83	3.07	30.76	14.15	12.61	1.54	46
Assam	30.35	2.57	27.81	6.026	5.33	0.69	22
Bihar	28.63	2.42	26.21	11.36	9.79	1.56	43
Chhattisgarh	12.22	0.64	11.58	3.60	3.08	0.52	31
Delhi	0.31	0.02	0.29	0.40	0.14	0.26	138
Goa	0.221	0.088	0.133	0.044	0.014	0.030	33
Gujarat	18.43	1.08	17.35	12.99	11.93	1.05	5
Haryana	10.48	0.68	9.80	12.43	11.71	0.72	127
Himachal Pradesh	0.59	0.06	0.53	0.31	0.23	0.08	58
Jammu and Kashmir	3.70	0.37	3.33	0.73	0.15	0.58	22
Jharkhand	5.96	0.55	5.41	1.61	1.17	0.44	30
Karnataka	16.81	2.00	14.81	10.01	9.01	1.00	68
Kerala	6.62	0.59	6.03	2.81	1.30	1.50	47
Madhya Pradesh	33.95	1.70	32.25	17.99	16.66	1.33	56
Maharashtra	35.73	1.93	33.81	16.95	15.91	1.04	50
Odisha	17.78	1.09	16.69	4.36	3.47	0.89	26
Punjab	22.56	2.21	20.35	34.66	33.97	0.69	170
Rajasthan	11.86	1.07	10.79	14.52	12.86	1.65	135
Tamil Nadu	22.94	2.29	20.65	16.56	14.71	1.85	80
Uttar Pradesh	75.25	6.68	68.57	49.48	46.00	3.49	72
Uttarakhand	2.17	0.10	2.07	1.05	1.01	0.03	51
West Bengal	30.50	2.92	2.58	10.91	10.11	0.79	40
India	432.43	33.73	398.70	243.14	221.29	21.83	61

Among the states, Punjab has the highest level (170 per cent) of development of the replenishable ground water resource. Other areas with a high level of development of their replenishable ground water potential are Delhi (138 per cent), Rajasthan (135 per cent), Haryana (127 per cent) and Tamil Nadu (80 per cent). Other areas that have developed more than 61 per cent of their potential include Gujarat (75 per cent), Uttar Pradesh (72 per cent) and Karnataka (68 per cent). The national average level of development of this potential is 61 per cent.

Due to a high level of development of the potential, Punjab, Haryana, Rajasthan and Delhi are experiencing a rapid fall in the water-table and will face more severe shortages of ground water in future. It is generally observed that the states with a limited total potential have developed a higher proportion of their total resource. This is logical because the areas with a relatively lower total potential are the ones receiving a lower amount of annual rainfall and there is a greater need for irrigation and hence need for development of the potential resource in such areas. On the other hand the areas receiving

a larger amount of rainfall have a lower need for developing irrigation. Hence the proportion of the total potential developed in such areas is generally lower.

National Water Mission

National Water Mission is one of the missions under NAPCC (National Action Plan on Climate Change). The main objective of the National Water Mission is "conservation of water, minimizing wastage and ensuring its more equitable distribution both across and within States through integrated water resources development and management". The five identified goals of Mission are: (a) comprehensive water data base in public domain and assessment of impact of climate change on water resource; (b) promotion of citizen and state action for water conservation, augmentation and preservation; (c) focused attention to vulnerable areas including over-exploited areas; (d) increasing water use efficiency by 20 per cent, and (e) promotion of basin level integrated water resource management. Under this Mission, WRIS (Water Resource Information System) a portal for providing information on water resources has been developed by Central Water Commission.

Major Use of Water Resource: Irrigation

In terms of the proportion of the total water used, irrigation occupies the top position among all uses of water in India. With a low and variable rainfall, that is also highly concentrated in a few months of the year, irrigation water becomes one of the most important agricultural inputs in India. Hence provision of irrigation has been one of the most important preoccupations of the people of this sub-continent. The need for irrigation varies from one part of the country to the other. Generally there is an inverse relationship between the amount of rainfall and the need for irrigation. Nearly half of the area of the country receives a rainfall of less than 75 cm. This part of the country is referred to as the area of dry farming. This region not only receives a limited amount of rainfall, rains in this region are also more variable and less reliable. Historically many such regions have been prone to crop failures and famines. Irrigation support is necessary for successful farming in such areas. It is due to expansion of irrigation facilities in the country that today India has become self-sufficient in production of most of the farm products. In fact the country also exports some of the farm products due to increase in production with support of irrigation among other factors. The Green Revolution would not have been possible without extension of irrigation facilities in the areas where this new technology package was introduced.

India has a fairly large Ultimate Irrigation Potential (139.9 million hectares) and the area under irrigated farming in the country is also among the largest in the world. However, we are still far from using the entire irrigation potential of the country. The total potential developed amounts to 118 million hectares (table). It means that the country has developed about 84 per cent of the irrigation potential. Out of the created irrigation potential the utilization efficiency is about 90 per cent. It means 10 per cent of the created potential in not utilized (Table 3).

Table: 3 India: Irrigation Potential Created and Utilized (in million hectares)

Plan	Year	Potential Created	Potential Utilized	Ratio (%)
-	1950-51	22.6	22.6	100.0
I	1951-56	26.6	25.0	95.41
II	1956-61	29.1	27.8	95.53
III	1961-66	33.6	31.8	94.64
IV	1969-74	44.2	42.0	95.00
V	1974-78	52.0	48.5	93.26
VI	1980-85	65.2	58.8	90.18
VII	1985-90	76.5	68.6	89.67

VIII	1992-97	86.2	77.2	89.56
IX	1997-02	94.0	81.0	86.17
X	2002-07	102.1	87.2	85.40
XI	2007-12	118.0	103.2	87.45

Also, the proportion of the total cultivated area that has assured irrigation facilities is rather low and there is scope of raising this proportion. The net irrigated area is 65.26 million hectares and gross irrigated area is 91.53 million hectares (2011-12). Out of the net sown area about 46 per cent is net irrigated. There is a well-recognized need to bring additional area under irrigation. Only an assured irrigation can make multiple cropping possible in many parts of the country. Intensive farming with multiple cropping will play an increasingly important role in meeting the increasing demand for agro-products in the country. The decreasing per capita arable land leaves multiple cropping as the only means to feed the expanding population in future. Irrigation helps not only in increasing the intensity of cropping but also agricultural productivity by making possible the use of modern inputs like high yielding varieties of seeds and chemical fertilizers. Increased production through irrigation can reduce the demand or need for expansion of cultivated area, the only possibilities of which can be through encroachment upon some other type of land uses. Increased productivity with the help of irrigation can also help in releasing land for a number of other important activities like forestry and animal husbandry.

Irrigation being the most important usage of water resources in the country, a large number of irrigation projects and schemes has been undertaken in India. Irrigation projects in the country are classified as major, medium and minor projects on the basis of the culturable command area (CCA). All those irrigation projects that have a CCA exceeding 10,000 hectares are called the *major irrigation projects*. Most of the river valley projects taken up in the early part of planning are major irrigation projects. However, the scope for development of major irrigation projects is limited. In areas where the total potential of developing such projects is limited, medium and minor irrigation projects are formulated to make use of the limited irrigation potential. Those projects having a CCA of 2,000 to 10,000 hectares are categorised as *medium irrigation projects* while the ones having a CCA of less than 2,000 hectares are called the *minor irrigation projects*. Since the scope of developing major irrigation projects is comparatively lesser, more and more emphasis has been laid on the development of medium and minor irrigation projects during the successive Five Year Plans.

Command Area Development and Water Management

The Centrally Sponsored Command Area Development Programme (CADP) was introduced in 1974-75 to enhance water efficiency and to increase production and productivity of crops per unit of land and water for improving the socio-economic condition of farmers. Initially, 60 major and medium irrigation projects were taken up under the programme, covering a Culturable Command Area (CCA) of about 15 million hectares. The programme was restructured and renamed as Command Area Development and Water Management (CAD and WM) Programme from 2004. After inclusion of new projects, deletion of 219 completed projects and clubbing of some projects, there are now 142 projects under implementation. The programme is being implemented under Pradhan Mantri Krishi Sinchai Yojana (PMKSY) – Har Khet Ko Pani – from 2015-16.

The components of the CAD and WM Programme are as follows: a) survey, planning and designing of on-farm developments (OFD) works; b) on farm development (OFD) works comprising construction of field channels, land leveling and micro-irrigation; c) construction of field, intermediate and link drains for letting out surplus water; d) correction of system deficiencies above the outlet up to distributaries of 4.25 cumec (150 cusec) capacity; e) reclamation of waterlogged area; f) one time functional and infrastructure grants to Water Users'

Associations; g) trainings/adaptive trials/demonstrations through Water and Land Management Institutes (WALMIs)/ Irrigation Management and Training Institutes (IMTIs) and other Central /State institutions and monitoring and evaluation of programme with 75 per cent funding from Government of India; h) one time infrastructure grants to WALMIs/IMTIs; and i) establishment cost – 10 per cent of the total Central Assistance on items (b), (c), (d) and (e).

The following broad provisions have been made in the Programme during XII Five Year Plan: (i) to promote water use efficiency in irrigation, financial assistance is to be provided to the states for development of infrastructure for micro-irrigation to facilitate use of sprinkler/drip irrigation as an alternative to construction of field channels. At least 10 per cent CCA of each project is to be covered under micro-irrigation without any restriction on upper limit. The assistance under this item is not admissible for sprinkler and drip irrigation systems (assistance for drip and sprinkler irrigation systems is available under the schemes of Ministry of Agriculture) but limited to construction of stilling tank, pump house and laying conveyance pipes to farmer's fields; (ii) Inclusion of any new project/command is to be governed as per the approved District Irrigation Plan (DIP)/State Irrigation Plan (SIP).

Under the Programme, there is a thrust on Participatory Irrigation Management (PIM) and, therefore, following features have been made mandatory for its implementation: i) Central assistance to states have been linked to enactment of PIM legislation. Till this is done, alternative arrangements have to be in place for formation and empowerment of Water User's Associations (WUAs); ii) WUAs have to be in position before Project Components are taken up so that beneficiaries are involved in the implementation of Programme activities since inception; iii) Central assistance for correction of system deficiencies up to distributaries of 4.25 cumec (150 cusec) capacity has been linked to formation of Distributaries Committees and handing over of the distributaries to such Committee for maintenance in future.

Accelerated Irrigation Benefits Programme

The Accelerated Irrigation Benefits Programme (AIBP) was launched in 1996-97 to provide central assistance to major/medium irrigation projects in the country, with the objective to accelerate implementation of such projects which were beyond resource capability of the states or were in advanced stage of completion. Priority was given to those projects which were started in pre-Fifth and Fifth Plan period and also those which were benefitting tribal and drought prone areas. From the year 1999-2000 onwards assistance under this programme was extended to special category states like North Eastern States, H.P., Uttrakhand, J&K and projects benefitting KBK districts of Odisha. Out of 297 projects, 143 projects have been completed and an irrigation potential of 24.39 lakh hactares has been created through the completed projects.

Pradhan Mantri Krishi Sinchayee Yojana

During 2015-16, Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) was launched to achieve the following objectives – a) achieve convergence of investments in irrigation at the field level (preparation of district level and if required, sub district level water use plans); b) enhance the physical access of water on the farm and expand cultivable area under assured irrigation (Har Khet Ko Pani); c) enhance the adoption of precision-irrigation and other water saving technologies (more crop pre drop); d) enhance recharge of aquifers and introduce sustainable water conservation practices; e) ensure the integrated development of rainfed areas using the watershed approach towards soil and water conservation, regeneration of ground water, arresting runoff, providing livelihood options and other NRM activities; f) promote extension activities relating to water harvesting, water management and crop alignment for farmers and grass root level field functionaries; g) explore the feasibility of reusing treated municipal water for peri-urban agriculture, and h) attract greater private investments in precision irrigation. Ministry of Water Resources, River Development and Ganga Rejuvenation has been

entrusted with two main components of PMKSY e.g. AIBP and PMKSY-HKKP. Major and medium irrigation projects are being funded under PMKSY-AIBP and repair, renovation and restoration (RRR) of water bodies, surface minor irrigation (SMI) projects and command area development and water management (CADWM) projects are being funded under PMKSY-Har Khet Ko Pani (HKKP).

National Water Grid or Interlinking of Rivers

In August 1980, a National Perspective Plan for interlinking of rivers was framed by the Ministry of Water Resources and National Water Development Agency suggested interlinking of 26 major rivers of India by constructing 30 links. Two components of the project are Himalayan Rivers Development Component (14 links) and Peninsular Rivers Development Component (16 links). The Himalayan Rivers links are (i) Koshi-Mechi, (ii) Kosi-Ghaghra, (iii) Gandak-Ganga, (iv) Ghaghra-Yamuna, (v) Sarda-Yamuna, (vi) Yamuna-Rajasthan, (vii) Rajasthan-Sabarmati, (viii) Rajasthan-Sabarmati, (ix) Son-southern tributaries of Ganga, (x) Brahmputra-Ganga (MSTG), (xi) Brahmputra-Ganga, (xii) Farakka-Sunderbans, (xiii) Ganga-Damodar-Subarnarekha, and (xiv) Subarnrekha-Mahanadi.

The Peninsular Rivers Development Component includes following links – (i) Mahanadi-Godavari, (ii) Godavari-Krishna, (iii) Godavari-Krishna (Nagarjuna Sagar), (iv) Godavari (Polavaram)-Krishna, (v) Krishna (Almati)-Pennar, (vi) Krishna (Sriasallam)-Pennar, (vii) & (viii) Pennar-Cauvery, (ix) Cauvery-Vaigai-Gundar, (x) Ken-Betwa, (xi) Parbati-Kalisindh-Chambal, (xii) Narmada-Tapi, (xiii) Daman Ganga-Pinjal, (xiv) Bedti-Varda, (xv) Netravati-Hemavati, and (xvi) Pamba-Achankavil-Vaippar. The links namely (i) Ken-Betwa, (ii) Parbati-Kalisindh-Chambal, (iii) Godavari (Polavaram)-Krishna (Vijaywada), (iv) Tapi-Narmada, and (v) Mahanadi-Godavari-Krishna-Pennar-Vaigai-Gundar have been identified as priority links.

This project will help in overcoming the problems of floods, droughts and other water related problems in different parts of the country. Surplus water from eastern river basins will be transferred to water deficit areas of central, western and southern regions of the country. Flood problem, particularly in eastern Uttar Pradesh, Bihar and Assam will be addressed to a great extent. It will also help in resolving interstate water disputes. It will help to generate 34,000 MW hydroelectricity; 35 million hectare additional irrigation facility and provide base for inland navigation. But this plan has been criticized on grounds of huge cost, construction of dams and canals and associated ecological problems.

Earlier the Ganga-Cauvery link canal was proposed by Dr. K.L.Rao. this link canal was to take off near Patna, pass through the basins of the Son, the Narmada (Jabalpur), the Godavari, the Krishna, the Pennar, and join the Cauvery upstream of the Grand Anicut. This proposed link of 2680 km withdrawing 60,000 cusecs from flood flows of 150 monsoon days would have involved a lifting mechanism because the Peninsular India has higher absolute height (about 449 mts) as compared to the Great Plains. The scheme was given green signal by a team of UNDP but Central Water Commission thoroughly examined and found it impractical mainly because of cost factor.

Likewise, the Garland Canal Project was proposed by Captain Dastur. It included construction of a garland canal over peninsular region linking rivers on the eastern side and western side of the Western Ghats. Another canal was proposed in the Himalayan foothills (height range 335-457 mts) as the Himalayan Canal. These two canals were to be linked by two pipelines. Like the Ganga-Cauvery link project this proposal was also rejected on economic and ecological grounds.

Conservation of Water Resources

Water is vital resource. It is the very basis of life on earth. It is used for drinking, irrigation, industry, transportation, hydro-electricity and for domestic uses. The best way to conserve water is to use it judiciously. The major use of water in India is in irrigation. The practice of flood irrigation i.e. to flood the fields with water) is very inefficient. Majority water is not utilized by plants and gets evaporated. In addition to this over-irrigation and seepage result in to waterlogging and saline and alkaline tracts will emerge as

wastelands. The over-drafts by tube-wells results in to lowering down of ground water tables. To overcome wasteful use of water and to reuse water – drip irrigation, sprinkle irrigation, rainwater harvesting and prevention and control of water pollution is required.

Drip irrigation is a form of irrigation that saves water and fertilizers. It allows water to drip slowly drop by drop to the roots of plants, either on the soil surface or directly on the root zone. It involves a network of valve, pipes, tubing and emitters. Sometimes it is also called trickle irrigation and involves dripping water onto the soil at very slow rates (2-20 litres/hour) from a system of small diameter plastic pipes fitted with outlets called emitters or drippers. Almost no water is lost through surface runoff or evaporation and soil particles have plenty of opportunity to absorb and hold water for plants. With drip irrigation water application are more frequent (usually every 1-3 days) than with other methods. This provides a very favourable high moisture level in the soil in which plants can flourish. Drip irrigation is most suitable for row crops (vegetables, fruits), trees and vine crops. It is adaptive to any farmable slope.

Sprinkle irrigation is a method of applying irrigation water which is similar to natural rainfall. Water is distributed through a system of pipes usually by pumping. It is then sprayed into the air through sprinklers so that it breaks up into small water drops which fall to the ground. This technique of irrigation is suited for most row, field and tree crops and water can be sprayed over or under the crop canopy. Like drip irrigation, sprinkle irrigation is adaptable to any favourable slope.

Rain water harvesting is one of the most effective methods of water conservation and management. It is used to denote the process of collection and storage of rain water for human, animals and plants needs. It involves collection and storage of rain water at surface or in sub-surface aquifer, before it is lost as surface run off. The central and state governments in India have introduced many motivational and compulsory steps in this direction.

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Make failure your teacher, not your undertaker.
~ Zig Ziglar