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Institutionalisation of Water Resources in India

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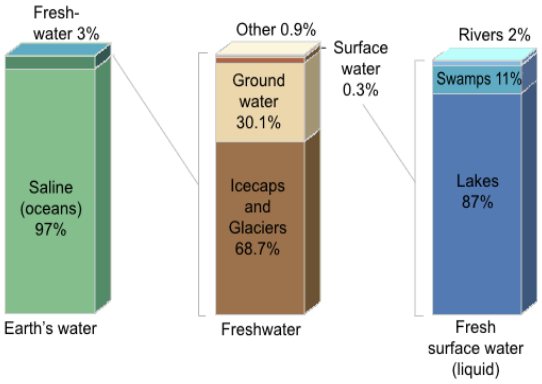
***Abstract* - India shares nearly 17.5% of the global population, but accounts for only 4% of the total freshwater resources. Around 80% of rainfall occurs in the four moths of monsoon from June to September. Within these four months, most of the rainfall comes in a few spells of intense rain which is not being brought to productive use due to limited storage capacity. The projected 'Water Gap' for India by the 2030 has been estimated to 50%. So, in order to meet the growing demand and cover the alarming water gap, there is a need to manage our available water resources more efficiently in order to improve the current performance and achieve sustainability. In this paper an attempt has been made to explore the role of institutionalisation in water resource management to meet the growing challenge for future.**

Key words: Water Resource Management, Water Pricing, Institutional Strengthening

I. WORLD WATER RESOURCES

"Around 97% of the water on the Earth is saline water in oceans and only 3% of the Earth's water is fresh water. Most of it is in icecaps and glaciers (69%) and groundwater (30%), while all lakes, rivers and swamps combined only account for a small fraction (0.3%) of the Earth's total freshwater reserves." (Earth's Water Distribution, US Geological Survey) (Fig.1) Water is most important as it is needed for life to exist. Water is required in each and every area like agricultural sector, industrial, household, recreational sectors as well as necessary for environmental activities. Virtually all these areas require the fresh water which comes from the only 0.3% of the earth's fresh water reserves. This makes the water resources potentially useful to humans and all living beings and needs to be preserved and managed in proper manner.



(Source: http://ga.water.usgs.gov/edu/waterdistribution.html)
Fig.1: Distribution of Earth's Water

Fresh water is termed as naturally occurring water on Earth's surface in ice caps, glaciers, icebergs, ponds, lakes, rivers and streams, and underground as groundwater in aquifers and underground streams.

II. WATER RESOURCES SCENARIO OF INDIA

"Water is life". It is a unique natural resource among all sources available on earth. Without water no life can be sustained on the planet. So, water is probably the single largest natural resource under severe stress in major part of the globe particularly in India. As per India's Second National Communication to the United Nations Framework Convention on Climate Change (2012), India identifies water as the most critical component of life support system. With an increasing population and a fast growing economy the demand for water is increasing. India shares nearly 17.5% of the global population but accounts for only 4% of global water resources. Beside this, around 80% of rainfall occurs in the four months of monsoon from June to September. Within these four months, most of the rainfall comes in a few spells of intense rain limited to a few weeks, which is not being brought to productive use due to limited storage capacity. Present scenario of available water resources and their distribution in India are as under.

A. Water Bodies

Inland Water resources of the country are classified as: rivers and canals, reservoirs, tanks, lakes & ponds. The area of water bodies at all-India level has been given in Table-1. Total water bodies other than rivers and canals cover an area of about 7.36 Mha. Among these water bodies, "reservoirs" have maximum area (2.91 Mha) followed by "tanks, lakes and ponds" (2.41 Mha).

Table-1: Inland Water Resources of India

Rivers & Canals (length in km)	195210
Other Water Bodies (area in Mha)	
Reservoirs	2.91
Tanks & Ponds	2.41
Flood Plain Lakes & Derelict Water bodies	0.80
Brackish Water	1.24
Total	7.36

(Source: Water and Related Statistics,CWC, 2013)

India is blessed with many rivers. A huge canal network drawing waters form these rivers have also been constructed. Presently the total length of rivers and canals in the country is approximately 2 lakh km. According to the total length of rivers and canals the States and UTs have been classified in

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Table 2. It shows Uttar Pradesh and Jammu & Kashmir are having the highest total length of rivers and canals.

Table-2: States by total length of rivers and canals

Length (km)	Name of States/UT
25000 & above	Jammu & Kashmir, Uttar Pradesh
20000-24999	-
15000-19999	Madhya Pradesh, Maharashtra, Punjab,
10000-14999	Andhra Pradesh
5000-9999	Haryana, Karnataka, Meghalaya, Rajasthan, Tamil Nadu,
2000-4999	Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Himachal Pradesh, Jharkhand, Kerala, Manipur, Orissa, Uttarakhand, West Bengal
1000-1999	Mizoram, Nagaland, Tripura
500-999	Sikkim
Less than 500	Andaman & Nicobar Is, Chandigarh, Dadra & Nagar Haveli, Daman & Diu, Delhi, Goa, Lakshadweep, Puducherry

(Source: Water and Related Statistics, CWC, 2013)

B. Rainfall

The main source of water in country is annual precipitation. It includes rainfall and snowfall both. In our country estimated annual rainfall including snowfall is of the order of 4000 BCM. A detail of annual precipitation for last decade has been given in Table 3.

Table 3: Volume of Rainfall in the country

Year	Total Rainfall (mm)	Total Volume of Rainfall (BCM)
2001	1110	3648
2002	930	3200
2003	1234	4057
2004	1086	3570
2005	1215	3996
2006	1161	3819
2007	1181	3882
2008	1117	3674
2009	954	3136
2010	1213	3989
2011	1116	3669

III. WATER RESOURCES POTENTIAL IN INDIA

The water resources potential of the country which occurs as natural run off in the rivers is about 1869 BCM as per the estimates of Central Water Commission (CWC), considering both surface and ground water into account. River basin-wise catchment area, average water resources potential and utilisable water resources potential are given in Table 4.

Table-4: Major River Basins

Sl. No	River Basin	Catchment Area (MHa)	Average Water Resources Potential (BCM)	Utilisable Surface Water Resources (BCM)
1	Indus Basin (In India)	32.1289	73.31	46.00
2	Ganga- Brahmaputra-Meghna Basin			
	Ganga Basin	86.1452	525.02	250.00
	Brahmaputra Basin	19.4413	537.24	24.00
	Barak & Oth. Basin	4.1723	48.36	-
3	Godavari Basin	31.2812	110.54	76.30
4	Krishna Basin	25.8948	78.12	58.00
5	Cauvery Basin	8.1155	21.36	19.00
6	Subernarekha Basin	2.9196	12.37	6.800
7	Brahamani & Baitarni Basin	5.1822	28.48	18.30
8	Mahanadi Basin	14.1589	66.88	50.00
9	Pennar Basin	5.5213	6.32	6.90
10	Mahi Basin	3.4842	11.02	3.10
11	Sabarmati Basin	2.1674	3.81	1.90
12	Narmada Basin	9.8796	45.64	34.50
13	Tapi Basin	6.5145	14.88	14.50
14	Basin of West Flowing Rivers From Tapi to Tadri	5.5940	87.41	11.90
15	Basin of West Flowing Rivers From Tadri to Kanyakumari	5.6177	113.53	24.30
16	Basin of East Flowing Rivers between Mahanadi & Pennar	8.6643	22.52	13.10
17	Basin of East Flowing Rivers between Pennar and Kanyakumari	10.0139	16.46	16.50
18	Basin of West Flowing Rivers Of Kutch and Saurashtra including Luni	32.1851	15.10	15.00
19	Basin of Minor River Draining into Myanmar & Bangladesh	3.6302	31.00	-
Total			**1869.37**	**690.10**

(Source: Water and Related Statistics, CWC, 2013)

So for large basins the proportion of utilisable surface water is significantly lower with respect to available water resources potential. Whereas, for smaller basins the proportion of the utilisable surface water is very high. For some basins like Pennar Basin the total utilization surface water resources exceeds annual availability of natural flows. This is mainly because of the utilisation can approach or even exceed the average annual availability of natural flow as the total withdrawal (and not the consumptive use) is considered as utilisation.

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A. Surface Storage

Due to major & medium completed irrigation projects a total storage capacity of 253.4 BCM has been created in India. Further the ongoing projects will additionally contribute for 51 BCM. So after completion of ongoing projects the total storage will increase to 304.3 BCM against the total available water potential of 1869 BCM in the different river basins of the country. Among the all river basins the maximum storage lies in the Ganga Basin followed by Krishna, Godavari and Narmada.

B. Ground water

In India, total annual replenishable ground water resources potential has been calculated to 431 BCM. State wise detailed break-up are shown in table 5.

Table-5: Annual Replenishable Ground Water Resources

State	Annual Replenishable Ground Water Resources	
	(BCM / Year)	%
Uttar Pradesh	75.25	17.46
Maharashtra	35.73	8.29
Madhya Pradesh	33.95	7.88
Andhra Pradesh	33.83	7.85
West Bengal	30.5	7.08
Assam	30.35	7.04
Bihar	28.63	6.64
Tamil Nadu	22.94	5.32
Punjab	22.56	5.23
Gujarat	18.43	4.28
Orissa	17.78	4.13
Karnataka	16.81	3.90
Chhattisgarh	12.22	2.83
Rajasthan	11.86	2.75
Others	40.19	9.32
Total	431.02	100.00

(Source: Water and Related Statistics, CWC, 2013)

IV. WATER STRESS CONDITION IN INDIA

More than 50 percent of country's total area is facing extremely high to high water stress condition. Approximately 600 million people are at higher risk of surface-water supply disruptions. Particularly, the North-west region of the country falls under extremely high stress zone. This part includes Punjab and Haryana state which is well known for fulfilling the food security requirements of the country. These two states alone produce the half of India's rice supply and more than 80% of wheat stocks making this region as bread basket of the country. These two crops are extremely water intensive. Rainfall is not sufficient in the region to meet the water requirement of the crop, hence more dependency on the ground water for irrigation. Various studies show that the level of ground water across the country is declining. India Water Tool (IWT) has given the statistically significant trend in this regard. Out of 4,000 wells observed, in last 7 years around 54% wells have shown declining trend. Figure 2 shows the base line water stress map of the country.

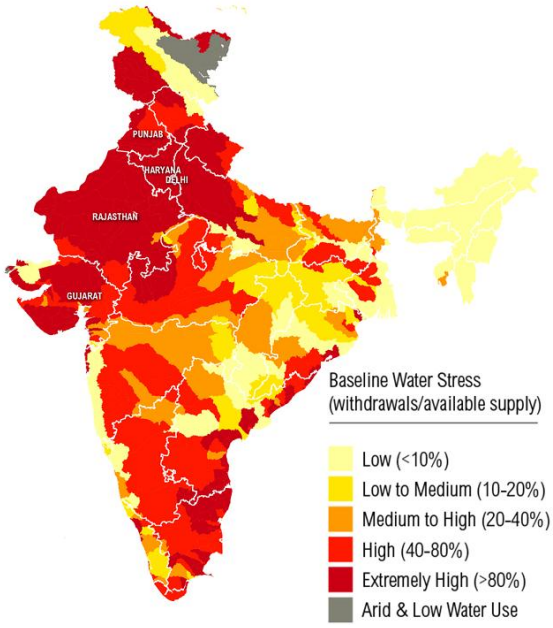

Figure 2: Baseline Water Stress Map of India

(Source: IWT2.0)

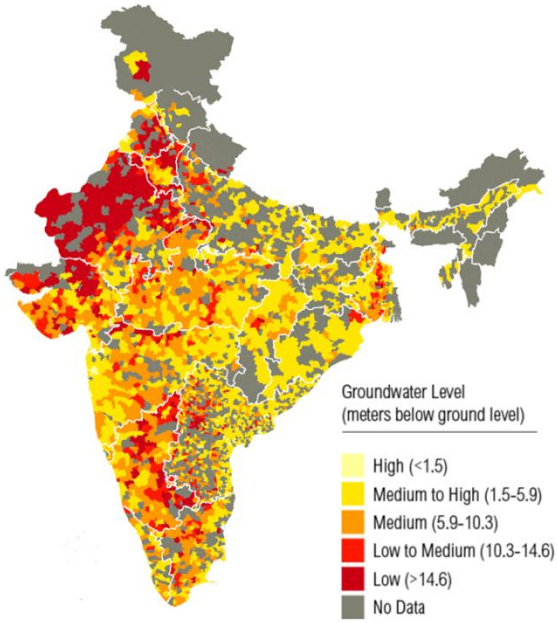

Figure 3: Ground Water Level Map of India

(Source: IWT2.0)

The more alarming fact is approximately 16% is declining at a rate of more than 3.2 feet (1 meter) per year. Figure 3 shows the depth of ground water level below the ground level. Farmers in arid region having irregular rainfall are more dependable on groundwater for irrigation purposes.

Government also provides the subsidy to farmers on electric or diesel pumps and presently no limits is being imposed on groundwater extraction. North western region is the most vulnerable state. Particularly in this region a total of 550 wells have been studied and 58% of these wells shows declining ground water level.

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IWT also measures water quality parameters and compares with permissible limits of Bureau of Indian Standards (BIS). Report shows that in many areas both surface water and ground water are below par. If any pollutant concentration exceeds the permissible safe limit then the water is considered unsafe for drinking. On this pattern out of IWT's 632 groundwater quality districts, only 59 districts have been found safe with respect to water quality. Approximately 130 millions peoples live in such districts where at least one pollutant exceeded national safety standards in 2011. Eight districts having population more than 20 million having at least three pollutants exceeded safe limits. Bagalkot, Karnataka, is the most polluted, with five of six groundwater quality indicators at unsafe levels. Figure 4 shows the areas with number of quality standards breached across the country.

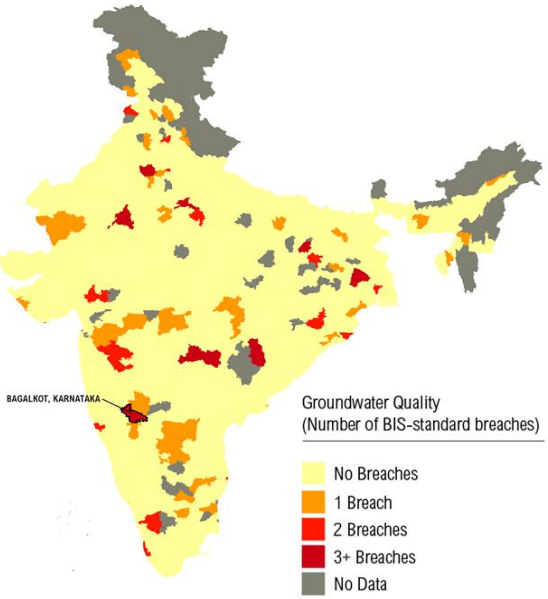

Figure 4: Ground Water Quality Map of India

(Source: IWT2.0)

Beside these issues climate change is also a global problem now a days. India is also facing the threat of climate change. Climate change predominantly affects the glacial melt and intensity and pattern of rainfall. It results to alteration in river flow and groundwater recharge which finally leads to the availability pattern of water resources. This will result in severe droughts and more intense floods in different part of country. This will also cause the saline water intrusion in the coastal aquifers due to lowering down the groundwater level and will raise the water quality issues. Water is the most vital resource for equitable growth of society and development of nation. It is also required for food security, life and livelihood. So access to safe water is quite essential for productivity and health. The implication of unsafe water on public health is unacceptable.

A study done by 2030 Water Resource Group (2030WRG) shows that the estimated water supply and demand gap for the year 2030 will be at alarming level of 50%. Figure 5 shows the estimated water supply and demand gap for various river basins in India in the year 2030. Figure 6 shows the sector wise projected demand and estimated water gap in India for 2030.

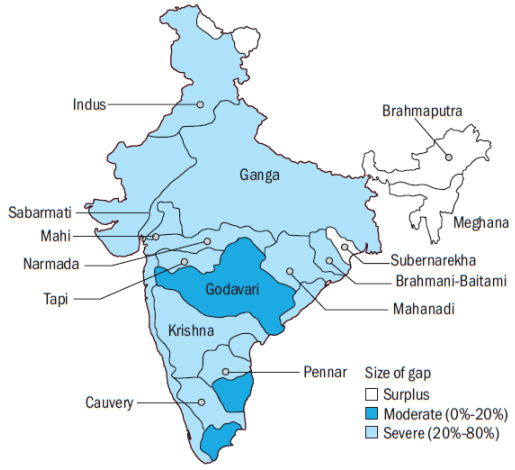

Figure 5: Water supply and demand gap in India in various river basins

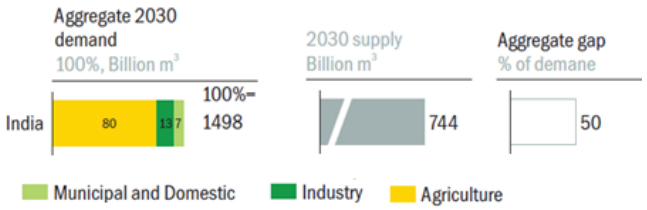

Figure 6: Sector wise projected demand and estimated Water Gap for India

V. NEED FOR WATER RESOURCES MANAGEMENT

With the available water resource potential for growing population the availability of water per capita is continuously decreasing. On the other hand due to growth in various sectors like agriculture and industry, the water requirement for various purposes is increasing day by day. Requirement of water is not only varying with time, rather also varies with place. For urban areas and industrial sectors water is required throughout the year in comparatively uniform manner but in agricultural areas water requirement is significantly high but for a short spell of specified time. National Water Policy states that, "the requirement of drinking water for both human beings and animals should be first charged on any available water." As the time passes the water is going to be scare, makes us more concern to manage our water resources for its sustainability. There is a need of time to lawful allocation of water in various sectors for different purposes to maintain the basic requirements of living being without sacrificing the industrial and agricultural developments.

So, in view of the vital importance of water for all living beings i.e. human and animal life, for maintaining flora and fauna i.e. ecological balance in nature and for economic and developmental activities of all kinds like agricultural, industrial, etc., and considering its increasing scarcity, the planning and management of water resource and its optimal, economical and equitable use has become a matter of the utmost urgency. Management of water resources in India is of paramount importance to sustain the huge population. At the same time it is also necessary to focus on maintaining the quality of freshwater. With the growing uncertainties of global climate change and the long term impacts of management actions, the decision-making will be even more difficult. So, there is a need to protect and conserve water resources with specific emphasis on improving water quality

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towards closing the supply-demand gap within an ecosystem approach. So first on the way to water resources management, it is necessary to determine the current availability of water resources and its productivity in different segments. Then challenge is to close the gap between current supply with projected future demand to meet the developmental activities. Three core ways can be adopted to attain the objective to close the water supply and demand gap. (i) by expanding supply, (ii) by increasing the productivity of existing water use, and (iii) by reducing demand by shifting the economy towards less water-intensive activities.

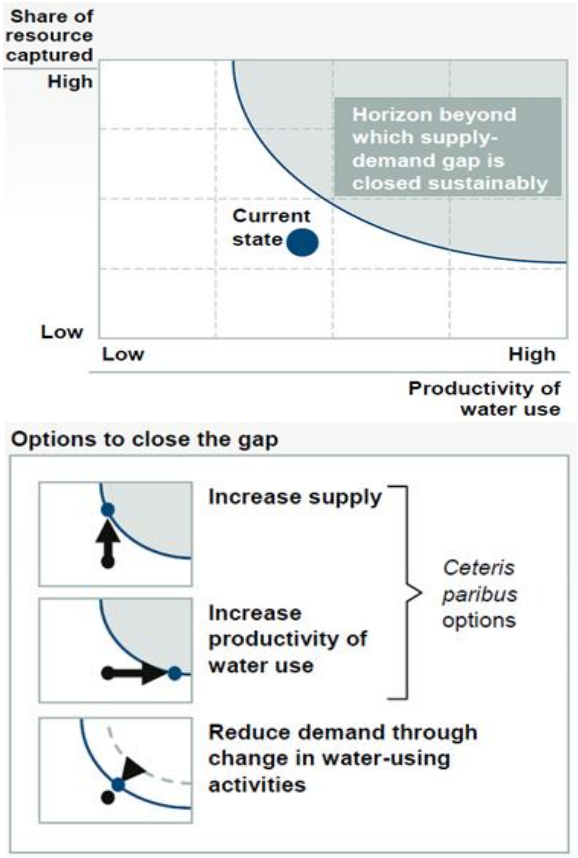

Figure 7: Three options for closing the supply-demand gap

- First option simply refers to increasing the water supply for various uses. But this concept is valid in the region of surplus water only and not applicable in water scares areas. As the major part of India is facing the water stress condition, so this option is not much feasible.
- Second option refers to filling the water supply and water demand gap by increasing the productivity of water available. This can be achieved by proper management and by adopting the advanced technologies. In agricultural sector a lot of work is being carried out with the slogan "more crop per drop" which is the best example of filling the gap between water supply and demand by increasing the productivity of water for that sector.
- Third option is to reduce demand through change in water using activities. It refers to encouraging the activities requiring the less water. It can be achieved by avoiding less productive industries requiring more water. In agricultural sector canal networks can be replaced by piped networks to considerably reduce the water demand in the sector as the losses will be almost eliminated.

VI. ROLE OF INSTITUTIONALISATION

Water management is so vast area that cannot be guaranteed by the state government or central government on their own. It is necessary to aware the every people on the way to manage our water resources and ensure their participation. Governments should provide the proper training, financial resources, and management support to individuals and communities and with their cooperation only a productive water management can be achieved. Development of community institutions is required for effective and efficient water management practices to propagate good practices at local level and apply social pressure to ensure proper regulations for minimizing the wastage and improve the efficiency. Panchayati Raj Institutions (PRIs) and Urban Local Bodies (ULBs), which are already positioned to be entrusted with this function in the Eleventh and Twelfth Schedule of the Constitution of India, can play the key role to sustainable management of water resources for the nation and hence their capacity-building seems to be a matter of prime concern.

A. Integrated Planning and Utilization of Surface Water and Ground Water

As far as planning and management aspect is concerned, both surface water and ground water should be treated equally important as a common resource. Rejuvenation of water bodies in and around the populated areas should be kept at priority level. Schemes for repair, renovation and restoration (RRR) should be taken up and preferably in coordination with Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) particularly in rural areas. Already in so many states such initiatives have been started by using MNREGA funds for earth work, excavation, and desilting of existing ponds and small water bodies. In case of ground water, it is declining continuously due to over exploitation. To take care of ground water, initiative should be taken to encourage community based management. Peoples should be encouraged to provide recharge wells in their fields and in their residential premises to recharge the aquifers. Incentives can be awarded to promote the farmers to harvest rainwater using farm ponds and other soil and water conservation measures. Additionally, large artificial recharge projects can be taken up at government levels. Ultimately there is a need to sensitize the local communities and public representatives of overexploited areas on severity of the problem. An integrated watershed development activity requires to be taken up to increase soil moisture and reduce sediment yield to finally increase overall land and water productivity. There is a need to systematically mapping of aquifers in order to assess the quantum and quality of ground water resources, so that planning for its sustainable management can be done by involving local communities.

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B. Sustainable Management of Surface Water Bodies

Surface water includes rivers and canal networks, surface water bodies and storage structures. These are the major contributor in water supply hence conservation in this segment is extremely important for sustainable management. To achieve the renovations of existing water bodies, preventing it from encroachments and controlling pollution of water bodies by strict and punitive regulations. Central government has taken up a large initiative to distribute the unevenness of available surface water resources by river interlinking project. The formulation of this project may improve the utilisable proportion of available water resources. Encroachments and diversions of drainage channels and water bodies should not be allowed under any circumstances and concerned departments should take strict actions against the peoples violating it. In unavoidable circumstances competent authority can decide on such diversions by taking proper care of its feasibility. Law should be made strict and administrative setup should be strengthened with vested powers at lower level to take immediate actions against trespassers. Polluting the water bodies should not be permitted and strict action must be taken against the persons doing so. Water bodies must be inspected at regular intervals to check the quantity and quality and immediate steps should be taken if any absurd trend is observed. Joint reviews should be done for the large water bodies and inter-state rivers to identify the issues if any and resolve them. Systematic water-area based rejuvenation mission needs to be launched to restore these river stretches/ water bodies to maintain its ecological flow and quality.

C. Demand Management and Water Use Efficiency

According to the National Commission for Integrated Water Resources Development (NCIWRD), about 83% of water is being used in agricultural sector while the remaining 17% serves industries, domestic, recreational and other purposes. Although, the requirement of water in agricultural sector is going to be increased over the time. Because of shifting towards irrigated agriculture from rain fed agriculture on the way of food security. But at the same time due to increasing population the domestic need will also increase, which will be fulfilled on priority basis as per national water policy. So conclusively in spite of increased demand, by the year 2030 allocation of water for agriculture will reduce to 80% which will further reduce to 69% by the year 2050. So it emphasise on the efficient use of water as a part of demand management strategies. It can be achieved by adopting technological and regulatory measures. Likewise, in irrigation sector micro-irrigation such as drip irrigation, sprinkler irrigation system should be used to reduce evaporation losses. Community should be encouraged to adopt local level structures like small bunds and field ponds to eliminate the huge conveyance losses. Conjunctive use of surface water along with groundwater should be encouraged. Incentives to be awarded for using groundwater, may be in terms of reduced energy pricing for agriculture. Regional water audits for water uses in agriculture sector on sample basis needs to be institutionalized in order to locate policy and management gaps for remedial action. Water audit needs to be made mandatory for specified types of industries and/or identified areas in order to efficiently manage water resources in the industrial sector.

D. Water Pricing

Water pricing is also very useful to ensure more efficient utilization of water as it will make users aware not to waste it. For different types of users and in various sector, differential pricing policies may be adopted. Like in industries and in urban areas it may be charged higher and for irrigation and in rural areas it may cost less. Water allocation and pricing policies should be adopted based on economic principles. To regulate such things establishment of bodies like water regulatory authority (WRA) is required to regulate the water tariff system for not only irrigation, but for all users. Tariffs may be levied on a consumption basis or a combination of consumption and minimum basis. The concerned authorities may impose additional charges on account of development, management, and operation & maintenance charges while fixing tariffs.

VII. INSTITUTIONAL STRENGTHENING

For sustainable management of water resources institutional capacity building is of maximum significance. It requires the building up of planning, regulatory, R&D, management of data, and community-level institutions, each of which desired to execute a particular set of function so that water is treated as a finite but renewable resource. So that it should be judiciously used and carefully managed to ensure its sustainability.

A. Regulatory and planning authorities

For economical and efficient use of water, it is very important to create its regulatory action through valuation. The State Water regulatory agency may be statutorily empowered to mend acceptable tariffs, enforce recycling measures, pollution management, make sure the preservation and management of water resources, promote R&D, and capacity-building. The Central Government of India must develop a Model Law, in order that States can enact legislation conforming to a broadly uniform framework. Similar Boards at State level would wish to discharge the State Level planning functions, appropriately providing for planning role for Municipal and panchayet bodies at the lowest level.

Under Ministry of Water Resources, Government of India, Central ground water Board (CGWB)works. It is the National Apex Agency which has been confided with the responsibilities to provide scientific inputs for management and monitoring. It is also responsible for exploration, augmentation, regulation and assessment related to nationwide ground water resource. Aiming for regulation and management of ground water and development in terms of the Environmental Protection Act (EPA) CGWA has been established. In crucial and overexploited areas, it regulates withdrawal of ground water. It also forestalls construction of ground water structures or drilling of tube wells in areas crucial or overexploited. However, regulatory authority should also take care for proper management of the resource. Particular legislation is needed for the better management of

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not only for ground water but also for surface water and ground water as a conjoint resource.

In the field of water resources, Central Water Commission (CWC) is a premier technical organization of India. It works under the Ministry of Water Resources, GoI. General responsibilities of CWC are initiating, coordinating, and furthering in consultation. It is done by involving State Government, schemes for management, conservation, and utilization of water resources within the nation. The main purpose of all these activities are flood control, irrigation, navigation, drinkable supply, and water power development.

B. Training and R&D

Each State must install a training organization to provide training and develop abilities for Municipal, Panchayets, and outsourced carrier providers. Central Government need to install an R&D group with Regional Centres for studies on all elements associated with aid use efficiency in the area. There is a necessity to perceive adequate number of National and State scaled Key Resource Centres to build the ability of the group of workers and officers on efficient control of water assets. The education and potential-constructing activities should be accomplished in a sustained manner, with appropriate monitoring mechanism in vicinity so as to correctly disseminate the learning and putting it into effect on-ground.

C. Database and Management Information System (MIS)

The database, records and information desires to be made sturdy that allows to correctly display the development inside the sector. A National Water Informatics Centre need to be created to collate, and process hydrologic facts frequently from all around the nation and maintain it in an open and accessible manner on a Geographic Information System (GIS) platform. All hydrological records should be accessible in public domain subjected to national security consideration.

D. State Water Policies

Water being a State subject, the State has jurisdiction extending to water elements, storage and hydro energy, drainage and embankments, irrigation and canals. States and local governance establishments in the long run must control the right use of hydro sources and local groups. Local governance institutions like Panchayets and Municipalities should work in co-ordination within and also with other departments involved in the state. State governments should bring out clear and far reaching regulations according to the national policy which must set out State priorities formulated on State level conditions, rules, and potentialities of industrialization, urbanization.

VIII. CONCLUSION

Major part of country is facing high to extremely high water stress. Groundwater levels are also declining significantly. Quality of both surface water and ground water is not confirming within the permissible limit of BIS. Water resources group 2030 (WRG2030) has estimated 50% water gap for India by 2030. Due to climate change water resources are also being affected significantly. There is a need to protect and conserve water resources with specific emphasis on improving water quality towards closing the supply-demand gap within an ecosystem approach. In order to fulfil the water demand in different sectors various approaches like integrated planning and utilization of both surface and ground water, demand management and water use efficiency, and water pricing are suggested. To overcome the growing future challenges clear and comprehensive science-based Water Resource Policy at Central and State levels for water resource management focusing on both supply- and demand-side dimensions of water use is necessary. Also there is a need of effective legislation at State level (based on the Central Model Law) for regulation of ground water and surface water providing an explicit and increasing role for Municipal and Panchayati Raj Bodies in planning, management, and regulation. Restructuring, strengthening, and empowerment of the existing institutions (Central, State, and local) involved in different aspects of service delivery so as to improve efficiency in management and sustainability of the resource is desirable.

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