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NEED FOR STORAGE DAMS FOR WATER SECURITY

VIVEK TRIPATHI
Director, CMDD(E&NE), Central Water Commission

KARAN SINGH SAINI AND MADHUKANT GOYAL
Assistant Director, CMDD(E&NE), Central Water Commission

ABSTRACT

Storing water has long been a cornerstone of socioeconomic development, particularly for societies exposed to large climatic variability. Nature has always supplied the bulk of water storage on earth but we are unable to harness the water by not creating enough storage. Today, numerous countries suffer from water storage gaps and increasingly variable precipitation, threatening sustainable development. There is a growing need to develop more water storage types and better management of existing storages. This paper argues that water storage should be perceived as a service, not just a facility. Ultimately, more important than the amount of water stored behind a dam or in a catchment area is the ability to provide a variety of services with a particular level of security at a particular time and place. The storage system must be designed and managed to provide the service standards of interest. This paper does not present new data or research, but provides an overview of the current knowledge and issues surrounding water storage and benefits of water storage infrastructure. It outlines the new constructive water storage agenda for the coming decades.

INTRODUCTION

Water is one of the most important renewable natural resources for sustaining life. As India's population grows, so does water usage. India's annual rainfall (including snowfall) averages about 4000 BCM, of which 1869 BCM is available as a water resource. Only 1123 BCM of this 1869 BCM can be utilized. Water demand in 2000 was 634 BCM and is expected to reach 1093 BCM by 2025. Due to the country's rapid population growth and growing economy, water demand will continue to grow and run short in the coming decades. One of the most effective solutions to these multifactorial challenges is the creation of reservoirs for irrigation and power supply. In addition, the country's water resources scenario presents a mysterious paradox of the existence of droughts and floods, and large-scale projects can address both situations at the same time, significantly eliminating unpredictable climate behavior.

Present scenario of the world suggests that there are more than 50,000 large dams in use worldwide. And India is placed third with over 5000 dams built across the nation. The fig.1 reveals the current status of three major countries having maximum no. of large dams (as per ICOLD2) along with water availability per capita. The Fig.1 shows that India is way behind in terms of water availability per capita thus pressing the need for more water storage. Fig. 2 shows the water availability situation of India over the years and reveals a harsh truth of India becoming a water scarce country in the coming years.

To address the escalating water crisis in India, the possible solution is to store the water flowing into the oceans and it requires large water storage structures. The creation of reservoirs by dam construction serves objectives such as water supply, irrigation, flood control, hydropower, shipping, industrial use, fish and wildlife conservation, and groundwater cultivation. To achieve these goals, multiple dams have to be constructed to control and regulate the natural flow.

World Bank Report, namely 'The World Bank's Experience with Large Dams: A Preliminary Review of Impacts', states that; "...without the exploitation of rivers, the world would be a much different place, such as a cycle of drought, floods and famines. The rivers support fewer viable human settlements life for many people in the Great River and basins of the world."

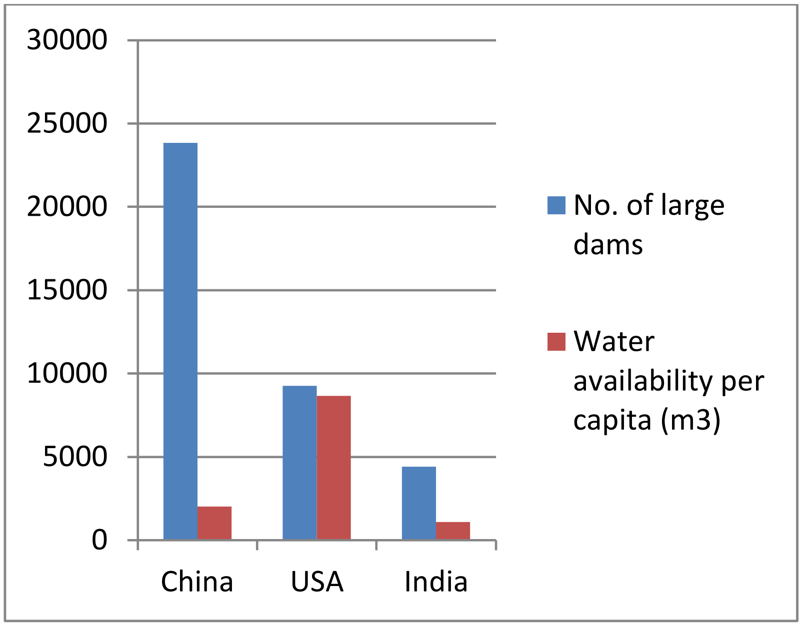

Fig. 1 : Scenario of 3 major countries

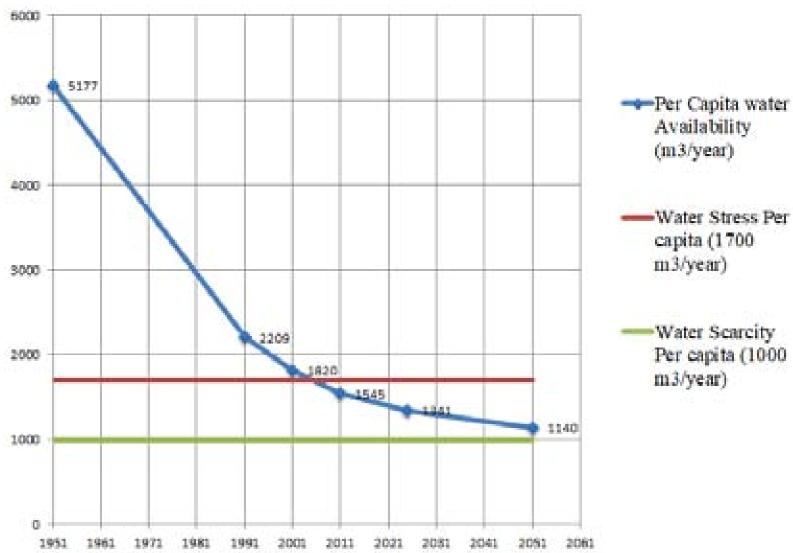

Fig. 2 : Water availability scenario of India

IMPACT OF WATER STORAGE STRUCTURE

Water storages have impact on various sectors of development and have the capability to change the socio economic status of the country. Globally, 50% of large dams were built primarily for irrigation. Dams are estimated to account for 12-16% of world food production. Almost all large dams are built for hydropower. Hydropower currently supplies 19% of the world's total electricity supply and is used in more than 150 countries. About 12% of large dams are designated as domestic water supply dams.

According to a survey by the International Commission on Large Dams (ICOLD2), the living conditions of billions of people have improved today by the construction of dam. In addition to the need for basic drinking water, the main benefits of the dam include the supply of industrial water, food production by irrigation, energy and power generation, flood control, and the provision of recreational facilities.

LARGE DAMS

As per International Commission on Large Dams (ICOLD2) standard, a large dam is one with height of more than 15m from its deepest foundation.

Small projects themselves cannot adequately absorb the large amount of rainfall available for sustainable use. Small dams can be considered worth adding, but they are not a substitute for large dams. Storage behind large dams in each basin provides both extra cushioning and built-in carryover storage. Given the considerable water storage capacity, large dams can have sufficient flood buffers to mitigate serious floods. Flood mitigation can be achieved in large dams with proper regulation of stocking, even without assigned flood reservoirs. Water is also an energy source. Large dams and reservoirs help generate significant hydropower and also help improve the economics of the project. In fact, most existing dams have some advantages. Therefore, if possible, in addition to irrigation and drinking water supply, power generation to utilize the remaining water resources can also be provided, thereby facilitating proper hydro-thermal for improving operational reliability.

Between 1951 and 2000, India's edible grain production quadrupled from 51 million tonnes to about 200 million tonnes. In 2000, it was estimated that the area irrigated by the dam would occupy about 35% of India's irrigated land. Other methods of obtaining water for irrigation, such as groundwater and small systems, are still widespread, but they cannot be trusted to fully meet the needs of India's large and growing population. Moreover, these forms of water harvesting are not cost effective and do not have the added advantages of hydropower generation and flood management.

As per Central Water Commission (CWC)1, India has constructed 5334 no. of large dams and 411 are under construction. The large dam constructed so far have provided nearly 257 BCM of storage and it can be extended upto 690BCM (approx.).

Dam and Irrigation

It is estimated that half of the world's major dams are built alone or primarily for irrigation, with an estimated 30-40% of the world's 217 million hectares of irrigation dependent on dams. Dams account for an estimated 12-16% of world food production. About a billion people depend on food from reservoir irrigation. There is no alternative to producing this food in any other way.

The ultimate irrigation potential of the India has been estimated to be 139.5 Mha and India has acquired an irrigation potential of about 112 Mha only. The estimated 139.5 Mha comprises of 58.5 Mha from major and medium schemes, 15 Mha from minor irrigation schemes and 66 Mha from groundwater exploitation.

Figure 3 explains the Irrigation potential created (IPC) and Irrigation Potential Utilized (IPU) over the years. Graph suggests that the gap between IPC and IPU is increasing. This doesn't mean that irrigation potential created by surface water is underutilized rather it indicates that ground water is exploited more to fulfill the irrigation requirement. Madhya Pradesh is an example where use of tube well has increased in recent time due to government policy and cheap electricity. One need to understand that this is not a sustainable option in long term also the cheap electricity available to farmers is only possible because of hydropower generation. With proper government policy, this gap can be filled and more water storage should be planned fulfilling all the requirements. This will also save ground water table from going down further.

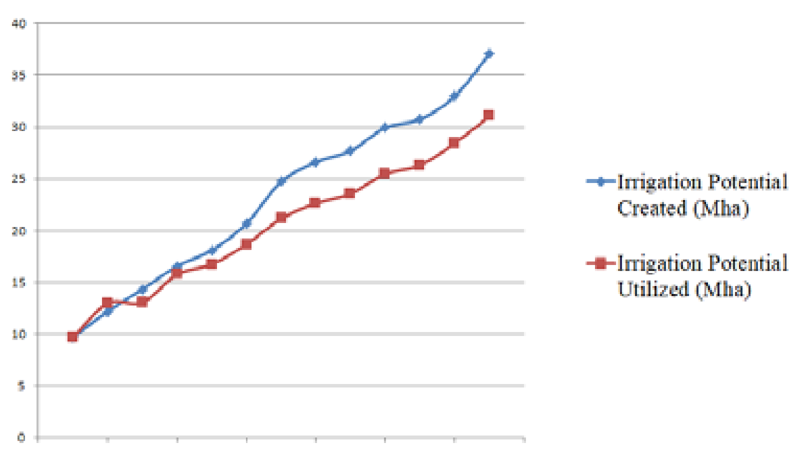

Fig. 3 : IPC & IPU over the years

Most dam projects are not only aiming for economic benefits, but also dealing with social and economic development of people in this area. The most important irrigation projects that depend on the construction of dam are helpful to prevent rural migration to the city simultaneously providing higher lifestyles in their native fields.

Dam and Domestic Supply

Water available for drinking is a rare and valuable resource. While water covers two thirds of the earth's surface, most of it is salty and not suitable for drinking. Only 2.7% of the available water on earth is freshwater and only 1% of the available freshwater can be accessed for use from rivers, lakes and groundwater. Access to water continues to be a challenge in India. The National Sample Survey Office (NSSO)7 data shows that only one in every five households have access to piped water connections in the country. Rural areas continue to lag behind in terms of access to piped water as compared to urban.

Around 58.3% of households still rely on hand pumps, tube wells, public taps, piped water from neighbor, protected or unprotected wells, and private or public taps for their water.

As high as 48.6% rural households and 28% urban households have to survive without access to an improved source (devoid of contamination/safe) of drinking water throughout the year. Also, 11.3% households do not get sufficient drinking water from their primary sources throughout the year.

The recently released National family health Survey (NFHS)6, NFHS-5 (2019-2020) data also shows that while access to drinking water from improved sources has increased in the 22 states surveyed as compared to NFHS (2015-2016) , rural areas still continue to lag behind as compared to urban in terms of access to safe drinking water.

But In the coming near future, the depletion in the ground water will result in dismantling these sources and the only source left would be surface water and that can be achieved from constructing large dams to store water. 0.265MCM of drinking water per day has been provided by Tehri Dam for Delhi and UP fulfilling requirement of 70+lac peoples. Srisailam Dam provides drinking water supply to entire Chennai city whose ground water had depleted long back. Major large dams in India provide a successful source for the drinking water resource benefiting millions of people.

Dam and Energy

The availability of assured power is required to improve the economy of the country. There is a need for a permanent, non-polluting and cost-effective power supply, and hydropower from large projects not only can provide a solution to this need but also assure power to meet the peaking load demand.

All major dams in the world were built for hydropower. The world's first hydroelectric project was used to power a single lamp in the Cragside country house in Northumberland, England, in 1878. Four years later, the first plant to serve a system of private and commercial customers was opened in Wisconsin, USA. By 1900, hundreds of large dams had been commissioned around the world. According to WCD10 report, hydropower presently provides 19% of the total electricity supply and is used in over 150 countries. About a third of the countries in the world currently rely on hydropower for more than half of their electricity need.

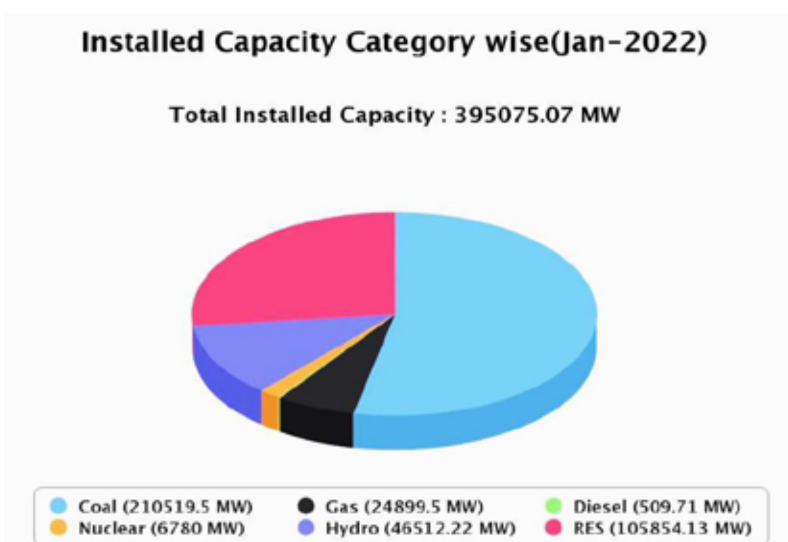

Fig. 4 : Total Installed capacity in India

Hydropower is the most plentiful and most efficient renewable energy resource, contributing considerable % of all renewable electric energy produced all over the world. According to the study realized by the USCOLD in the USA, the efficiency of a modern hydropower plant exceeds 90%, which is more than twice the efficiency of a thermal plant. It is a well-known fact that energy is one of the most important commodities for the satisfaction of physical needs and for providing economic development of modern society. Meanwhile energy needs are continuously growing. The demand for electric power continues to grow rapidly. The world energy market, up to date, has depended upon the non-renewable, but low cost, fossil fuels. But its depletion will mark the question on its supply in the near future. Apart from this, an environmental issue also opposes the use of fossil fuels for energy generation. Fig.4 shows the total installed capacity of 395075 MW in India out of which 46512 MW (11.77%) is generated from hydropower. As the hydropower is a renewable and non-polluting source, it is a viable option to replace use of fossil fuels for power generation.

LARGE DAM PROJECTS IN INDIA

Contribution of the few of the major projects of India in socio-economic development of the region is discussed here stating the benefits to the society and thereby increasing the livelihood of the country.

Tehri Dam & Hydro Power Projec9

THPC is a multipurpose scheme on river Bhagirathi, a tributary of river Ganges. It comprises of a 260.5 m high earth and rockfill dam. It is designed for storing surplus water of river Bhagirathi during monsoon and releasing the stored water to fulfill the irrigation and drinking water needs of the population in the Gangetic plains of Uttarakhand and Uttar Pradesh during non-monsoon period while generating 2400MW of peaking power.

Tehri HPC consists of the following:

1. Tehri Hydro Power Plant (Tehri HPP) - 1000 MW (4x250MW)
2. Koteshwar Hydro Electric Project (Koteshwar HEP) - 400 MW (4x100MW)
3. Tehri Pumped Storage Plant (Tehri PSP) - 1000 MW (4x250MW)

The annual energy provided by the project is estimated to be 5220 MU for the peaking demand and thus providing power to Northern grid. Project also helps to generate 200 MU of additional power by supplying water to downstream projects.

Apart from the Power generation, it will meet drinking water requirement of 40+ lac people of Delhi by supplying 300 cusecs (162 gallons per day) water. In addition, 200 cusec (108 gallons per day) of drinking water for Uttar Pradesh towns and villages is supplied by the project benefiting around 30+ lac people.

After commissioning of Tehri, apart from stabilization of the existing 6.04 lac Ha irrigation, it provides additional irrigation to approx. 2.0 lac Ha area in the command area of Lower Ganga, Parallel Lower Ganga, Madhya Ganga Stage - I and Agra Canal system.

The project completely changes the Garhwal region and provided integrated development to the region. A new hill station town is developed with provision of all civic facilities, improved communication, education, health & tourism, development of horticulture, fisheries, and afforestation of the region.

Sardar Sarovar Project8

163 m High Concrete gravity dam is constructed on Narmada River to harness irrigation and power generation in the basin. The Project provides irrigation facilities to the 18.45 lac Ha of land (of which 75% command area is drought prone), covering 3112 villages of 73 talukas in 15 districts of Gujarat. It also irrigates 2.46 lac Ha of land in the strategic desert districts of Barmer and Jallore in Rajasthan (which is drought prone) and 37,500 Ha in the tribal hilly tract of Maharashtra through lift.

It provides drinking water to 173 urban centers and 9490 villages within and out-side command in Gujarat benefiting population of 40+ million. All the villages and urban centers of arid region of Saurashtra and Kachchh and all "no source" villages and the villages affected by salinity and fluoride in North Gujarat are benefited with the project. Water supply requirement of several industries will also be met from the project giving a boost to all-round production.

This project has installed capacity of 1450 MW of power. This power is shared by three states - Madhya Pradesh - 57%, Maharashtra - 27% and Gujarat 16%. It provides a useful peaking power to western grid of the country which had very limited Hydel power production.

Apart from these benefits, it also provides flood protection to riverine reaches measuring 30,000 Ha covering 210 villages and Bharuch city and a population of 4.0lac in Gujarat.

Bhakra Nangal Project4

The Bhakra dam is a 225.55 m high concrete gravity dam and Nangal Barrage in its downstream diverts the water of Satluj River into the Nangal Hydel Channel (NHC) for power generation and irrigation. It acts as a balancing reservoir with storage about 19.74 MCM to smoothen the variations in releases from the Bhakra power plants supplying regulated flow to Nangal Hydel Channel. There are several hydropower plants under Bhakra System in Indus basin with total installed capacity of 2755.30MW. This project has total irrigation potential of 6.76 lac Ha benefitting people of Punjab, Haryana and Rajasthan.

Indira Gandhi Nahar Pariyojana (IGNP) planned in the d/s of Bhakra Nangal system, helps to transfer surplus waters of Ravi, Beas and Satluj to Rajasthan right up to Jaisalmer and Barmer and has eliminated drought conditions, provided power benefits and transformed desert waste land into an agriculturally productive area by bringing irrigation and vegetation to about 20 lac Ha area. IGNP provides additional irrigation to 9.64 lac Ha. Canal water is also being used to meet domestic needs. It delivers drinking water to 14 million people besides a large cattle population .The project has dramatically changed the living standard and socio-economic conditions of the people in the region. Other than these benefits, it has generated employment for around 5 Lac people on regular basis.

Hirakud Dam3

The multi-purpose Hirakud Dam on the Mahanadi River was built for flood control, irrigation and power generation. The Hirakud Dam is a composite structure of earth, concrete and brick masonry. The main dam has a total length of 4.8 km, considered the longest earth dam in the world, 25.8 km long with dams and dikes joined together. It also has the rare distinction of forming the largest man-made lake in Asia with a reservoir area of 743 km^2 at full lake level.

In the upper Mahanadi basin, centered on the Chhattisgarh plain, periodic droughts contrast with the situation in the lower delta where flooding can damage crops. The dam was built to help alleviate these problems by creating a reservoir and controlling the flow of the river through the drainage system. The dam regulates the flow of the Mahanadi River and generates hydroelectricity through several hydroelectric plants.

The dam helps control floods in the Mahanadi delta and irrigates 1,36,000 Ha in Delta Stage –II and stabilization of irrigation to 1, 67,000 Ha of Delta Stage –I.

The dam supports two different hydroelectric power houses i.e, Power house –I & II with installed capacity of 259.5 MW & 347.5 MW respectively. This energy generates benefits the people of odisha help in meeting their electricity requirement.

Also, Water from Hirakud Dam at a later stage was allocated to various industries, primarily for mineral processing and coal fired thermal power plants in Jharsuguda and Sambalpur districts helping the integrated development to the area. Current industrial demand is 0.499 MAF per annum which is met by HiraKud Dam.

CONCLUSION

With increasing population and growing economy, the gap between the water required and water available is continuously increasing. Another factor responsible for increase in this gap is rapidly changing climate. Where there is a less gap between required and available water, other water source i.e. ground water is used due to the lack of infrastructure of surface water storage. But worrisomely, the over-exploitation of groundwater will eventually deplete its levels, leading to more severe conditions in the future. According to MoWR's8 assessment, the annual groundwater extraction for all fields is 249 BCM, of which 89% is used for irrigation and the remaining 11% is for industrial and domestic use. As there is no restriction on irrigation use of water, it requires proper education to farmers as well as providing adequate surface source to hold back the over exploitation of ground water. As the best possible solution, surface water entering the ocean must be captured and used to its full potential. The four projects discussed have largely contributed to the region's socio-economic development and contributed to the country's GDP. The overall development of the area and the population associated with the projects meets the requirements of the project. Cities like Chennai, Delhi, etc., which are densely populated and cannot get groundwater have to rely on surface water. The added benefit of building large dams is it can generate electricity and with depleting fossil fuels, the constraints posed by environmental factors due to climate change are pushing the country to opt for renewable energy sources. And with the ever-increasing energy demand for the coming future and limitations, it is necessary to develop a hydroelectric project. To conclude, water storage structure should be practiced for the development of the region and thereby developing the nation.

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