

Water Crisis and the Role of 'Hydrological Information'

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Abstract: *Water is the basic human need and a prime natural resource. From the human consumption point of view water is to be viewed as scarce, which is an objective physical reality. And the increasing population and urbanization is furthering the problem of water scarcity to a state of water risk, which is a deleterious water crisis event. Therefore management of water resources is an urgent need of the hour and it is the responsibility of everybody, be it community or country; through every means conventional or innovative; by whatever approach feasible local or global; through partnership or participation. This study tries to capture all the present approaches and actions which are diverse but all aimed at reading and recording information (data) on hydrological cycle which is the basis for managing water resources and present them in their proper perspective i.e., local, regional and global perspective; followed by a few prospective 'crisis - mitigation - preparedness - activities ', undertaken by the Government of India, through its 'National Water Policy' ('NWP'), that are relevant to the development of 'Hydrological Information System' ('HIS') ; helpful partnerships and approaches; for bettering the management of water globally. And in conclusion the immediate action area has been identified as the ongoing Hydrology Project phase III work (HP-III) covering the entire nation of India, so that all the above said aspects of water management may be considered for inclusion as further 'Hydrological information needs' ('HIN') in HP-III, right at this beginning stage itself, to make it more effective, inclusive and futuristic.*

Introduction

The water crisis we have today is not about having too little water to satisfy our needs but it is about managing water so badly, that billions of people and the environment, suffer badly. The chief problem with fresh water is that of availability and accessibility. The quantity of fresh surface water compared to all the earth's water would be a very small fraction of it. All of Earth's water (liquid, ice, fresh & saline) comes to about **1385 million cubic kilometers** and the directly usable fresh surface water found in Rivers & lakes amounts to

only **0.0931 million cubic kilometers**, which is a mere 0.007 percent of all the water on earth. Having stated the facts about the total water and the readily usable fresh water, it should also be said that quantitatively speaking, fresh water is abundant and the volume of fresh water renewed by the hydrological cycle between the oceans, the atmosphere, the Sun and the land is more than enough to meet the needs of five to ten times the existing world population. From this global perspective, there is apparent abundance of water which is deceptive but often taken for granted. In reality, quality of water available for drinking is posing a serious threat to the existence of life as a consequence of human activities, land use practices and economic development. Coupled with it is the problem of increasing tendency to abuse and overuse fresh water. While the availability of fresh water is limited, the demand for it is increasing rapidly due to growing population, rapid urbanization, rapid industrialization and economic development. In addition, there are inequities in distribution and lack of a unified perspective in planning, management and use of water resources.

It is note-worthy that 'Bad Management', occupies a very prominent place among the main reasons for water scarcity, finding place next only to population increase. Hence there is an immediate need for wisely managing water resources, for economic and social progress, particularly in the developing countries. A necessary pre-requisite to overcome this impediment is an accurate, comprehensive and timely 'hydrological data'.

1. Situation in India: Like any developing country, India is also facing problems in management of hydrological information. India is being projected as one of the countries in which millions of people will be sentenced to hard-to handle 'hydrological poverty'. By 2050 India will add another 519 million people (50% increase) to its side. Requirement of food grain is slated for a rise because, increasing portion of Indian population will become affluent and consumes more nutrition. Population in India is the main cause for imposing limitations to the availability of water resources. More than 17 percent of the world's population live in India which occupies only 2.6% of world's land

area and has only 4% of world's renewable water resources. As per present estimate, India receives on average annual precipitation of about 4000 Billion Cubic Meters (BCM), which is its basic water resource. Out of this 2131 BCM is lost due to the natural evaporation-transpiration, leaving about 1869 Billion Cubic Meters (BCM) as the average annual natural flow through rivers and aquifers. Further reduction of 747 BCM is also caused due to space-temporal variations (physiographic factors), leaving an estimated 690 BCM of surface water only, as utilizable, to which is to be added 432 BCM of replenishable groundwater, and that comes to only 1123 BCM (690 + 432) and only this much is the utilizable water flows in India, through the present strategies (not considering large inter-basin transfers, as they are still not fully implemented [1]). From the foregoing statistics, it becomes very evident that climatic factors, over which we have negligible or no control, plays a more dominant role in altering the availability of water resources, than physiographic factors whose role is comparatively less, in addition to the fact that they are very much alterable by under-taking projects like inter-linking of major rivers in the country, there-by providing-for 'inter-basin water transfer'.

The solution to this problem is 'Sustainable Development'. Sustainable development is - "development that meets the needs of the present without compromising the ability of the future generations to meet their own needs". Sustainable development aims at maintaining equilibrium between human needs and economic development, while conserving the environment through efficient use of natural resources. It emphasizes the need of protection of environment and is considered to be the most reasonable way of combining the current growth with planning of future projects. Information; access to information; knowledge; development policy and decision-making; are the imminent topics in discussion on sustainable development. Therefore, a study on 'the role of Hydrological Information System' (HIS) in the management of Water Resources provides the essential basis for making decisions for sustainable development in water sector, which is the need of the hour. First of all, the present 'Hydrological Information Needs' ('HIN'), have to be placed in their proper perspective.

We know that hydrological cycle is a global phenomenon and it operates with-in the global climate. Data required to fully describe the climate and global hydrology, therefore, needs to be developed over a long period say for about 30 years, to be counted as a dependable source. Strange it may sound, but in respect of water it is true that the data needs of the days to come, find their solution in the present day observations of the hydro-climatic parameters. The parameters observed today,

therefore needs to be highly futuristic and anticipatory in nature.

Through this paper an attempt is made, to put the present 'hydrological data needs' in their proper perspective, so that they will be useful in finding future solutions prospectively. That means, the present perspective of data observations should be so comprehensive and inclusive that they would be able to meet 'future prospective demands' in finding solutions to impending water crisis facing the world at large. This is the immediate action that is needed to be undertaken on priority, as follows. Main Title

2. Proper Perspective of the Present 'Hydrological Information Needs' ('HIN'):

Any water problem has to be studied, both from the availability and the distribution points of view. From the availability point of view, the problem is of global dimension, since water operates within a global Hydrological Cycle. That is why, it is necessary to size down the problem from global scale to a more manageable local (national) scale. World Metrological Organization (WMO), has been observing the hydrological cycle through WHYCOS Mission (World Hydrological Cycle Observing System [2]) and for handling purposes, it is broken down to regional components, called HYCOS (Hydrological Cycle Observing System), by clubbing together a few adjacent nations. Again within each Regional HYCOS, each nation has its own NHS (National Hydrological Services) executed through various projects, and national organizations that take primary care of their own National water priorities. These national, regional and global initiatives should be so aligned in their activities as to be able to achieve desired out-comes, such as creating hydrological data records as well as providing flood warnings and forecasts. This is the availability side of the problem.

From distribution side of water across the globe, it is important to note that water related problems can occur in diverse ways, by virtue of the special and unique characteristics of water. Quantitative problems of water can lead to 'water scarcity', qualitative problems can lead to 'water stress' and the problem of water changing its form, can lead to 'water risk'.

2.1. Water Scarcity: Besides being a natural resource fundamental to life, livelihood, food security and sustainable development; water is also a scarce resource. 'Water scarcity' refers to the volumetric abundance or lack, of water supply, which is calculated as a ratio of human water consumption to available water supply, in a given area. Water scarcity is a physical objective reality

that can be measured. Water scarcity is a description about a **quantifiable 'existing phenomenon'**.

2.2. Water stress: Although fresh water is a renewable resource, yet the world's supply of clean, fresh water is steadily decreasing. As a consequence some areas which although are 'not Water scarce', could be having egregious water pollution, there-by rendering it unusable. Such a situation results in demand exceeding supply in many parts of the world, and as world population continues to rise at an unprecedented rate, many more areas are expected to experience this imbalance which is called 'water stress'. Water stress includes an '**imposed phenomenon**', unlike water scarcity which is an existing phenomenon and therefore it depends on human activity, which is **non-quantifiable**.

2.3. Water Risk: Added to this problem of water stress, is the threat from climate change effect, which looms large on the water resources, threatening to change both in terms of physical quantity as well as quality of water, which could lead to what is called as 'water risk'. Water risk refers to the possibility of experiencing a **deleterious water-related 'crisis event'**. About such eventualities, we should be really concerned-about.

The above 3 types of problems demand completely different approaches for their accurate assessment and mitigation. Further these problems do not occur in isolation. All the 3 can be found occurring together, which makes it really hard to read and manage them. Therefore a comprehensive understanding and mapping of the planet's water system is an absolute necessity and as such recorded data on all the parameters of water collected on a continuous basis, over a long period of time is essential. Systematically collected and maintained data providers are called '**Hydrological Information Systems**' ('HIS'), which are being developed by most of the nations. And in view of the growing concern about the water futures in the light of the much talked about climate change effects on water, a global 'Hydrological Information System' is also being developed under the name '**WHYCOS**' (**World Hydrological Cycle Observing System**). WHYCOS is a global program, developed in response to the scarcity or absence of accurate data and information accessible in real or near real time, on freshwater resources in many parts of the world, particularly in the developing countries, caused by the deterioration of many observing networks and insufficient data management capabilities. WHYCOS's ultimate objective is to promote and facilitate the collection, analysis, exchange, dissemination and use of water-related information, using modern information technologies. WHYCOS is being developed in the form of regional components, **HYCOSs (Hydrological Cycle**

Observing System), independently implemented, which meet the priorities expressed by the participating countries. The HYCOS components collectively form the building blocks to constitute the WHYCOS program, where hydrological and meteorological variables are captured and transmitted to national and regional databases to support, in all parts of the world, the establishment and enhancement of 'information systems', which can supply reliable water-related data and information to planners, decision makers, scientists and the general public. India comes under '**HYCOS-HKH (Hindu Kush Himalayan) Region**' [3], which is a vast region composed of high mountains, valleys, and plateaus shared by Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan. India is one of the 6 nations that constitute HKH-HYCOS component of WHYCOS.

In India National Hydrological & Metrological Service support is being created chiefly through **Hydrology Project**, which was taken up with world bank assistance and has now grown to a national level. It is developing 'Hydrological Information System (HIS)', by creating facilities and standardized procedures for data collection, data compilation, processing, data storage and data utilization. Initially, Hydrology Project Phase-I was implemented during 1995 to 2003; followed by, Hydrology Project Phase-II (HP-II) and this was implemented in 13 States from 2006 to 2014 [4]. The objectives of Hydrology Project-II (HP-II) are., to extend and promote the sustained and effective use of HIS by all implementing agencies concerned with water resources planning and management both in public and private, thereby contributing to improve productivity and cost effectiveness of water related investments in 13 participating States and 8 Central agencies. Strengthening the capabilities of implementing agencies at state/central level in using HIS for efficient water resource planning and management. At present Hydrology Project Phase-III is under finalization for implementation [5]. Although some major achievements are made through the HP, there remains a need for closer study to verify whether there is that alignment to fit into the regional and global initiatives already in place and working to observe the Hydrological cycle.

In view of the prevalence of 'water scarcity, water stress and water risk', there is an imperative need to plan, develop and manage water resources. And the good news is that, **water is one of the 'most manageable' natural resources, as it is capable of diversion, transport, and storage and recycling**. But for managing water resources, full information on water and factors affecting its availability is needed. The data on the hydrologic and climatic parameters of water and its processes are collected and recorded and made available through a system

called as, 'Hydrological Information System' (H.I.S). Across the globe, Hydrological Information Systems are developed and maintained by different organizations and nations. H.I.S is a systematic collection & compilation of water Data that enables: i) Data monitoring, ii) processing, iii) storage, iv) retrieval and v) dissemination, which forms the basis for developing models to understand the dynamics of water on our planet. However since Hydrology is a global phenomenon, the H.I.S also should be globally uniform in coverage, content and development. But in practice this is not what is happening, as a result of which uniformly reliable & scientific data is found wanting. In addition to this inherent problem, climatic changes that are taking place and adversely affecting the Hydrological cycle, is another problem which is external to the HIS being developed. Further there are tangible measures like 'Virtual Water Trade', for reducing water scarcity, but its implementation requires 'Water Foot Printing' data. Therefore the existing 'HIS' needs to be widened to cover data regarding additional parameters of water. Increased need for water information is also because of the new policy directives issued by the National Water Policy 2012 and because of the ambitious initiative undertaken by the Govt. of India in collaboration with the Govt. of Israel to adopt innovative water technologies successfully implemented in Israel (MoU dt. 3-12-2015 [6]). The need for expanding the 'HIS' has been evidenced in the objectives framed for Phase-III of HP, which need to be verified for its adequacy to accommodate the objectives of all the important water initiatives like WHYCOS, NWP-2012, Virtual Water Trade and Indo-Israeli MoU 2015. Therefore, the role of 'HIS' now being developed under Hydrology Project Phase-III (HP-III) requires to be studied in detail to verify whether it fits into the global and national initiatives.

3. Prospective Preparedness in Mitigating Future Water Challenges:

National Water Policy 2012 has been evolved after widespread consultations with all stakeholders, including consultations with the Honorable Members of Parliament in the Parliamentary Standing Committee and the Parliamentary Consultative Committee. NWP 2012, is an effort to focus attention on the looming crisis in the water sector and to lay a roadmap for the future, based on the fundamental principles of equity, sustainability and good governance, as well as an appreciation of the fact that we are approaching a critical juncture for the future of water management in India. **Most objective data available today point unerringly to the conclusion that water, or the lack of it, could well become the limiting factor to our social and economic growth in the future. With around 18% of the world's**

population but only 4% of its usable fresh water, India already faces a **scarcity of water**, which is a vital and stressed natural resource. Climate change could further aggravate the distortions in water availability in our country. Receding glaciers would negatively impact flows in major rivers and pose a major new threat to the welfare of millions of people. The 12th Plan, which was adopted by the National Development Council on 27-12-2012, has dwelt on these and other issues confronting the water sector and called for path-breaking reform.

3.1. Policy Directions in NWP (2012) that are Relevant to the 'HIS':

3.1.1. Database & Information system (Item 14 of NWP 2012):

All hydrological data, other than those classified on national security consideration, should be in public domain. However, a periodic review for further declassification of data may be carried out. A National Water Informatics Center should be established to collect, collate and process hydrologic data regularly from all over the country, conduct the preliminary processing, and maintain in open and transparent manner on a GIS platform. In view of the likely climate change, much more data about snow and glaciers, evaporation, tidal hydrology and hydraulics, river geometry changes, erosion, sedimentation, etc. needs to be collected. A programme of such data collection needs to be developed and implemented.

All water related data, like rainfall, snowfall, geomorphological, climatic, geological, surface water, ground water, water quality, ecological, water extraction and use, irrigated area, glaciers, etc., should be integrated with well-defined procedures and formats to ensure online updating and transfer of data to facilitate development of database for informed decision making in the management of water.

3.1.2. Enhancing Water Available for Use (Item. 5.1. of NWP 2012) :

The availability of water resources and its use by various sectors in various basin and States in the country need to be assessed scientifically and reviewed at periodic intervals, say, every five years. The trends in water availability due to various factors including climate change must be assessed and accounted for during water resources planning.

The availability of water is limited but the demand of water is increasing rapidly due to growing population, rapid urbanization, rapid industrialization and economic development. Therefore, availability of water for utilization needs to be augmented to meet increasing demands of water. Direct use of rainfall and avoidance of inadvertent evapo-

transpiration are the new additional strategies for augmenting utilizable water resources.

3.1.3. Water Literacy Campaign like, Water Management Courses, Applied Research and Training (Item.15.5 of NWP 2012):

To meet the need of the skilled manpower in the water sector, regular training and academic courses in water management should be promoted. These training and academic institutions should be regularly updated by developing infrastructure and promoting applied research, which would help to improve the current procedures of analysis and informed decision making in the line departments and by the community. A national campaign for water literacy needs to be started for capacity building of different stakeholders in the water sector.

Having identified three (3) policy directions that are related to the 'HIS', the next step is to verify whether the current 'HIS' being developed in India is able to accommodate those policy directions and satisfy the objectives of National water policy. This brings before us the subject of ongoing activities in regard to development of HIS in India.

3.2. Water Futures Partnership :

Global information being used for local application is called as **Glocalization**, which is the other way round to what happens in globalization. Glocalizing water information is both inevitable and critical to resolving water problems almost anywhere in the world, simply because water operates with-in the water cycle, which is a global phenomenon.

But the impacts of water scarcity are often felt locally and gradually, therefore response of governments is often fragmented and weak. This means that the responsibility to address unsustainable management of water increasingly falls on the local stakeholders. The risks facing the local community, businesses and ecosystems are often unique and require local knowledge and insight to tackle them. As a consequence, local problems are usually best solved by local stakeholders working together to deliver meaningful change on the ground.

Although water is a global problem, the factors that contribute to the issue, such as local climate and geography, are often unique to a specific region or country. To tackle this issue therefore requires an approach that can harness the scale and expertise of global organizations, whilst enabling specific local water issues to be identified and for local stakeholders to be drawn together to address them. The local water challenges are usually best solved in partnership with NGOs, local governments, communities and other local businesses.

Water Futures aims to prove the business case for private sector engagement in promoting the sustainable management of water resources. The partnership seeks to share the lessons learnt throughout the business's global operations with other stakeholders to promote better water stewardship. The fundamental concept underpinning the partnership is that a lack of water security presents risks that are shared by the business, other water users, ecosystems and governments. **The partnership follows an innovative and participatory approach to sustainably manage water resources.** One typical extreme event, which deserves 'glocalization i.e., application of global information and co-operation for tackling a local problem'; one that is a consequence of global climatic change, is the unprecedented and disastrous floods caused by **cumulonimbus clouds** for the first time in the region of Kurnool of Andhra Pradesh, in India, in the year 2009 [7].

3.3. Dangers of Country-Centric Approach :

National policy makers are not usually interested in global or regional water savings but rather in the status of national water resources. The danger of adopting purely country-centric focus is that it takes no direct account of the costs of production on the exporting country. A study by the Council for Scientific and Industrial Research (CSIR) published virtual-water content values for crops that were significantly lower than internationally published values. The impact on water resources in the exporting country may not be a primary concern of the importing country. Virtual-water trading can truly hope to lead to global water savings [8]. However, it is evident from this analysis that importers could potentially benefit at the expense of less sophisticated exporters. In respect of cotton that with the general lack of proper water-pricing mechanisms or other ways of transmitting production information, cotton consumers have little incentive to take responsibility for the impact on remote water systems. In this way, virtual-water trading can truly hope to lead to global water savings. Importers could potentially benefit at the expense of less sophisticated exporters. Cotton consumers have little incentive to take responsibility for the impact on remote water systems. Through water Footprint Manual the 'blue, green and grey' water footprints have been developed for all countries worldwide. The validity of these values, however, needs to be verified through country-specific studies. Common, harmonized procedures of estimating virtual-water content and virtual-water accounting should be developed and disseminated, enabling accurate and unbiased estimates of virtual-water flows between countries.

4. Conclusion and Action Areas :

Globally acclaimed Innovative solutions are a result of the 'out of the box' researches, and the solutions are usually found hidden in the data of the problem event itself, like flash floods caused by thunder storms taking place in the same direction that the lightning flashes during the thunder-storm. This is as though, nature is giving a warning in the form of visual display, a signal or a 'hint to the havoc' that the coming sudden downpour is about to cause. And the availability of comprehensive 'event-data' it-self, is the key to innovatively solve problems of this sort. Since almost all the water related problems fall under such category, what is critically important is to examine whether the existing 'Hydrological data observation net-works and Systems', are able to generate data that is reliable and capable of supporting such needed innovations. If not, action must be taken to put them in place.

With this intension, the Hydrology Project (HP) which is now under Phase-III of development in India is developing 'Hydrological Information System' ('HIS'), from the stand point of innovative water technology initiatives set-out in the Indo-Israeli MoU 2015 and the policy directives of India's National Water Policy (NWP) - 2012, all of which focus on development of a comprehensive and reliable 'HIS' that would serve the purpose in the areas of water use efficiency, water reuse, water conservation and rejuvenation of rivers.

Systematically collected data sets are an essential necessity to know on record what is happening within the Life-sustaining Hydrological Cycle, as well as to innovatively search for possible 'hidden in the havoc' solutions to the catastrophic and devastating water extreme events and find natural solutions to all water-related problems of availability and distribution of readily usable fresh water. To realize this goal, the presently on-going Phase-III project work of Hydrology Project (HP), should be so reinforced as to make it objectively fit into the globally unified 'WHYCOS MISSION', through its regional component called as 'HKH-HYCOS', as discussed above; while making the HP-III accommodate for the innovative technology requirements of the Indo-Israeli MoU as well as the national priority for the development of 'Integrated Water Resources Management' (IWRM) set-out in the latest National Water Policy (NWP-2012). Such a 'diverse and inclusive' task as this would certainly call for a well-oiled monitoring and review mechanism for successful completion of the project and for achieving desired results, in tackling future water challenges.

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