A Review of Water Management and Conceptual C^3 Framework for Sustainable System

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***Abstract*: Water is a vital resource for animals and plants to live and sustain. It was assumed as a resource in abundance but proves to be wrong. In the recent past access and affordability of water is becoming far reach. Environmentalists and researchers have cautioned the ignorance of water collection, consumption and conservation. This paper brings forth such research outcomes in the form of causes of water crisis and highlights the scenario at different levels. The causes are represented in the form cause and effect diagram and attached the responsibility. Further authors are proposing a framework for sustainable water management system.**

***Key Words*: C^3 (Collect, Conserve and Consume), R^3 (Reduce, Reuse and Recycle), Ignored consumption, Cause and Effect, Water Resource Management (WRM)**

I. INTRODUCTION

Water is next to air as essentials for all living beings. Historically it was never considered as scared resource. 19th century onwards, rise in population, irrigation, industrialization, urbanization, deforestation and attach on environment have decreased rainfall and increased the demand for water. Today, Asia and Africa are facing acute shortage of water. Other continents may follow the suite soon. India in particular is facing severe water crisis. Last year drinking water to Lathur city in Maharastra was supplied railway wagons. This year it may recur in other parts of the country. In the years to come, water may be costlier than petrol if not addressed properly. The technology alone can't bring solution to the crisis but the behavioural change is essential. Hence, Water Resource Management (WRM) must evolve a sustainable solution with public, private and societal participation.

WRM is the activity of planning, conservation, distributing and managing the optimum use of water resources. It is a sub-set of water cycle management. Water is technically considered a renewable resource because it can be used over and over again and it has a rain cycle. However, it is only in the short-term that water can be thought of as a renewable resource and the sustainability of this renewable resource is questionable.

This paper reviews the literature to understand water crisis better and attempts to put the crisis in right perspective. This will help others to find a systemic solution to the problem. This paper depicts the review based on territory from global to local. Finally proposes the causes of water crisis in the form of fish-bone diagram.

II. WATER RESOURCE SCENARIO

This paper attempted to group the reviews on the basis of territory like Global, India, Karnataka and Local (Hubballi) and given below:

Global:

Water is becoming scared everywhere across the globe. Many researchers have assessed the scenario time and then. Few of them have been quoted here.

J. A. A. JONES (2004) argued that civilized ideas, aspirations and knowledge helped for the development of water science and engineering.The Royal bank of Canada (1950) said that we can live without housing or clothing for months, we can live without food for days, but to live without water is figured in terms of hours and minutes. It is only when crisis occurs we realize our dependence upon water. Andrew Keller R. Sakthivadivel and David Seckler explained scarcity of water in futurebecause of increase in population. The population will be a major problem in future for managing water resource and explained the need for development for additional storage facilities and techniques which will help in some extent to solve the water scarcity in future.

UNICEF investigated that in the worldwide more than two billion people living in the water scarcity regions.

Global water resource: freshwater resources are unevenly distributed, with much of the water located far from human populations. Many of the world's largest river basins run through thinly populated regions. 1. There are an estimated 263 major international river basins in the world, covering 231 059 898 km2 or 45.3% of the Earth's land surface area (excluding Antarctica). 2. Groundwater represents about 90% of the world's readily available freshwater resources, and some 1.5 billion people depend upon groundwater for their drinking water. 3. Agricultural water use accounts for about 75% of total global consumption, mainly through crop irrigation, while industrial use accounts for about 20%, and the remaining 5% is used for domestic purposes. 4. It is estimated that two out of every three people will live in water-stressed areas by the year 2025. In Africa alone, it is estimated

that 25 countries will be experiencing water stress (below 1,700 m3 per capita per year) by 2025. Today, 450 million people in 29 countries suffer from water shortages. 5. Clean water supplies and sanitation remain major problems in many parts of the world, with 20% of the global population lacking access to safe drinking water. Water-borne diseases from faecal pollution of surface waters continue to be a major cause of illness in developing countries. Polluted water is estimated to affect the health of 1.2 billion people, and contributes to the death of 15 million children annually.

KalipadaChatterjee ( )explained that the importance of WRM because of the available fresh water in the globe is only 2.5% where rest of the 97.5% is saline water. So, the multi utilization of water such as drinking, cleaning, agriculture, transportation, industry recreation, and animal husbandry, producing electricity for domestic, industrial and commercial use has be to be managed within 2.5% of fresh water.

William Blomquis (2004) as provided a recommendations for studying water institutions in a comparative context including methodological recommendations concerning approaches to comparative institutional research, and topics for comparative institutional research that appear especially fruitful at this time author has used the conjunctive management to illustrate the importance of institutional factors in water management, drawing to some extent on the authors' recent experience with a comparative study of conjunctive management institutions

India:

UNICEF also explored that by 2050 Indian population will overtake China's population, consecutively that may strain on water resources and investigated that in India in the year 2006 approximately 829 billion cubic meters of water used by different sectors (domestic, agricultural, and industrial). It is estimated that by 2050 supply of water demand will be doubled as compared to 2006. It's report on Indian water said that there will be constant competition for the usage of water for domestic as well as commercial purpose.

The main rivers, the Ganges, Bramhaputra, Mahanadi, Godavari, Krishna, Cauvery, Indus, Narmada, and Tapti, flow into the Bay of Bengal and Arabian Sea. India receives an average of 4,000 billion cubic meters of rainfall every year. Unfortunately, 48% of rainfall ends up in India's rivers. Due to lack of storage and crumbling infrastructure, only 18% can be utilized. India possesses about 432 bcm of groundwater replenished yearly from rain and river drainage, but only 395 bcm are utilizable. Of that 395 bcm, 82% goes to irrigation and agricultural purposes, while only 18% is divided between domestic and industrial. Total static groundwater available is approximately 10,812 bcm.

SusantoSen ( ) said India has an average annual of 1,869 Billion Cubic Metre of water is available and only 1,120 BCM is available for consumption. The large investment should be made to the solutions of addressing the water scarcity for creation of new water assets or for operating and maintaining the existing assets.

India's agricultural sector currently uses about 90% of total water resources. Irrigated agriculture has been fundamental to economic development, but unfortunately caused groundwater depletion.

According to the Ministry of Water Resources, industrial water usage in India stands at about 50 billion cubic meters or nearly 6 per cent of total freshwater abstraction.

India's 1.1 billion people need access to clean drinking water. The demand for drinking water is divided between the urban and rural populations, and comprises about 4-6% of total water demand. Due to the amenities of typical urban life, such as flush toilets and washing machines, people living in cities tend to lead more water intensive lives. The urban population has doubled over the past 30 years, now representing 30% of India's total population and is expected to reach 50% of the total population by 2025. Currently 30% of the rural population lack access to drinking water and of the all the states in India, only 7 have full availability of drinking water for rural inhabitants

Historically, agriculture is the back bone of India. Pratap Singh Solanki , R. S. Thakur explained that economy is also based on the agriculture. Based on the literature reviewed the studies related to use of data mining techniques in the field of water resource sector for water management. Presently, the WRM has become most challenging, interesting and fascinating domain around the word since last many years.

Ashim Das Gupta ( ) explained that Integrated Water Resources Management (IWRM) is a process, which promotes the coordinated development and management of water, land and related resources and IWRM involves collection and management of natural resources information, the understanding of the interactions that occur in the use of these resources, together with the implementation of policies, practices and administration structures, which enable the resources to be used.

Achieving implementation of IWRM paper by The International Union for Conservation of Nature and Natural resources said that IWRM is practical and achievable. The key is a two-track strategy where IWRM planning is complemented by pilot actions demonstrating results that address local to national priorities.

David McKenzie ( ) said that India as a lens through which to view the problems of access to water in urban areas and the various options available for reform and also said that water conservation is also important which should be implemented by checking the leaks, taking shorter showers and practicing sound outdoor watering principles can reduce water bills and conserve this precious natural resource.

S. Sethuram(2014) explained that the water scarcity in Chennai caused due to the climatic change and he explained the water security and adaption strategies.

S. Vigneswaran and M. Sundaravadivel ( ) explained recycle and reuse of domestic wastewater.The reuse of wastewater for domestic and agricultural purposes has been occurring since historical times. However, planned reuse has gained importance only two or three decades ago. The demands for water dramatically increased due to technological advancement, population growth, and urbanization, which put great stress on the natural water cycle.

SandhyaThakkar(2012) explained that WRMas the current rate of population growth, combined with the growing strain on available water resources, India could well have the dubious distinction of having the largest number of water-deprived persons in the world in the next 25 years. 85% of India's urban population has access to drinking water but only 20% of the available drinking water meets health and safety standards. It is estimated that by the year 2050, half of India's population will be living in urban areas and will face acute water problems Hence WRMis essential, not only in India but around the globe.

Council on Energy, Environment and Water (2011) stated that India is fast running out of utilizable water resources. There is considerable room for improving the management and use of the available water supplies in order to close the growing gap between demand and supply.

Karnataka:

K. M. Murugesha (2013)estimated about the access to water resources of Karnataka, could be from canals (36%) tanks (6%) wells (12 %) tube wells(34 %) lift irrigation (4 %) other sources (9%). Karnataka's water resources are fast dwindling due to population explosion and increased utilization of water for the rapidly growing economic activities. Water demand on the one hand for consumptive (drinking, health and sanitation needs) and productive uses (agriculture, industrial production, power generation, mining operations and navigation, and recreational activities) have increased tremendously, and on the other hand, water supply has declined with depletion and degradation of water resources causing water distress or scarcity in the state. Depletion of quantity and degradation of quality of water has restricted the availability of water for consumptive and productive uses and has consequently caused "negative externality" which imposes economic and social cost on society. The declining trend in the economic contribution of water resources has occurred due to physical and economic water scarcity which results in insufficient use, poor management, declining water productivity, and increasing environmental and economic costs. Obviously, the outcome is growing imbalance between water needs and supply augmentation capability of the state.

Historically the dispute over sharing Cauvery, Krishna, Mahadiyi between Karnataka and neighbouring states is still a burning problem. This year the problem aggregated due to worst rain fall and even disturbing the social fabric of the region.

M. G. Chandrakanth (2009) explained that availability of ground water is estimated at 485 TMC. Ground water resources have not been exploited uniformly throughout the state. Exploitation of ground water in the dry Taluks of North and South interior Karnataka is higher as compared to Coastal, Malnad and irrigation command areas. There is deficiency of water for drinking, agricultural and industrial use in dry taluks of North and South interior Karnataka.

Thomas Fuller ( ) revealed that moving on to the utilization of available surface water resources, of the ultimate irrigation potential of 55 lakh hectares,

the state has been able to create a potential of 35.35 lakh hectares (65 percent) from both surface and ground water . About 35 % of the potential area remains to be untapped.

Hubblli-Dharawad

ShaimaaKamelater (2015) tackled the lack of care towards sustainability issues on contemporary Egyptian campuses' design and management and explained that water sustainability for landscape depends mainly on reduction of consumption, collection of water and recycling of water

Government of India ministry of water resources central ground water board (2013) Ground water information booklet Dharwad district, Karnataka state revealed that in view of the Socio-Economic development with subsequent demand for fresh water and changes in the local environment it is necessary to conserve the water resource and adopt unconventional means to artificially recharge the ground water in the water level declining/prone to decline areas and prevent further decline in the water level and deterioration in the quality of water. In the groundwater "SAFE" category areas of the district it is advocated for the development of a water supply model so that the optimum utilization of resource is achieved.

Priya Sangameswaran, Roopa Madhav, Clifton D'Rozario ( ) explained that the HDMC made provision for supply of water from public and private but water supply services were poor and there were heavy losses in the distribution system, which has been attributed to mismanagement by HDMC. There was also an inequity in distribution of water, with local variations in both frequency and duration of water supply.

III. CONCLUSION

The vitality of the water is more or less same at every level i.e. global or local. Water is essential for every living being and plants but becoming more and more scared. This problem must be addressed on priority basis. Goldman Sachs describes it as "the petroleum of the next century". Dr Upmanu Lall (Directir, Columbia Water Center) predicted that as soon as 2025, large parts of the world could experience perennial

water shortage. The causes of shortage of water are given in figure 1. Each of these causes must be controlled by appropriate means to make it sustainable. The causes can be categorised depending on the responsibility – government, community and individual and is shown in table 1.

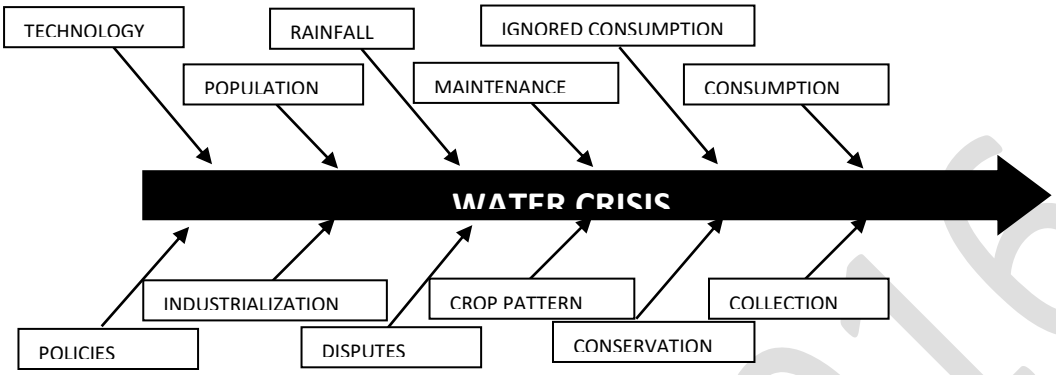

Figure 1: Cause and Effect Diagram for Water Crisis

Table 1: Responsibility-wise Categorization

Government	Community	Individual
Policies	Ignored Consumption	Collection
Technology	Crop pattern	Consumption
Population	Maintenance	Conservation
Industrialization		
Disputes		

The conceptual framework is proposed as one of the remedy for water crisis. The framework has three main components C^3 (conserve, collect and consume) and are self explanatory. The consume component can be effectively managed by R^3 (Reduce, Reuse and Recycle).

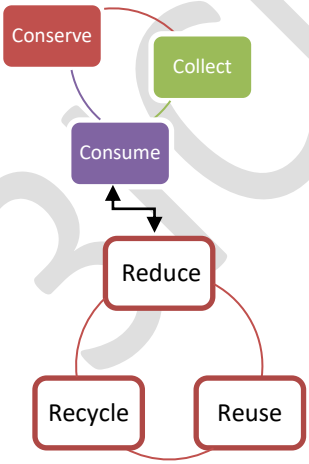

Figure 2: Conceptual C^3 Framework

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