E-ISSN: 2708-4523
P-ISSN: 2708-4515
AJMC 2022; 3(2): 07-11

www.allcommercejournal.com
Received: 02-04-2021
Accepted: 09-05-2021

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Sustainable development and a study of water crisis in India

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Abstract
Sustainable development is an economic development in which the needs of future generations for their economic development are also taken care of, so that it may continue for a long time or it can remain sustained. Therefore, it is a wider concept than the economic growth and the economic development also. The sustainable development has mainly two components which are inter-related to each other, that is, economical or which is related to production and consumption of goods and services and ecological in which the use and management of natural resource is taken into consideration. In this research a problem of water shortage in India and its impact on people and some of the suggestions have been advanced to resolve the crisis of water especially in India.

Keywords: Groundwater depletion, economic development, sustainable development, water crisis, renewable water, per capita availability of renewable water

Introduction
Syndromes of water crisis in India are groundwater depletion, ecological destruction, draught driven conflicts, unmet subsistence needs, resource captured by elites and water re-allocation to nature. It is a regionally, locally and seasonally specific problem. Based on per capita renewable water availability, India has enough water to meet its people needs. But despite an estimated 2462 cubic meter per person per year, many of its people suffer from severe water shortages as a result of uneven availability of water. The problem is largely man made. Reduced recharge mechanism, unregulated exploitation of ground water due to highly subsidised electricity supply for pumping water among illegal taping of water by slum-dweller community and waste of water along pipelines are some of the factors responsible for water crisis. The challenge is to develop and apply water saving technology and management methods and through capacity building, enable communities to adopt new approaches for both, rain fed and irrigated agriculture. A major challenge in water sector has been how to effectively implement initiatives founded on a set of general principles i.e. participation, integration and co-ordination in a heterogeneous system made of different cultures, social norms, physical attributes, availability of renewable and non-renewable resources, investment funds, management capacities and institutional arrangements.
It is envisaged that bodies and institutions like Rajiv Gandhi National Drinking Water Mission, National Commission for Integrated Water Resources Development, Central Water Commission, Ministry of Water Resources, and Government of India may be interested with the proposed research results.

Water Crisis in India
In a country like India, that receives copious rain, the water crisis is primarily attributed to human factors. India's population has steadily risen since 1951. Lack of education and absence of comprehensive family planning are responsible for such an increase. Consequently, the demand for water has also increased. While governments have failed to equate the supply with this growing demand of water. As a result of it ½ of the population of India lack access to safe drinking water. More than eighty percent of water needs in India is met by exploiting the ground water resources. This has led to the depletion of water and unprecedented water crisis. Moreover, three fourth of water resources available in India are used for agriculture purposes and irrigation is still carried out in the traditional way. This leads to wastage of water and resulting in water crisis.

According to Verma and Phansalkar (2007) [43], there exists a considerable temporal and spatial variation also within the country with respect to water availability. A land area of thirty three percent is covered by the Ganga-Meghna-Brahamputra basin and it accounts for sixty percent of India's water resources. The rivers flowing in the west cover only three percent of the area and they account for eleven percent of water resources in India. It means that seventy one percent of water resources in India are available only to thirty six percent of the land area while the remaining sixty four percent of the land area has only twenty nine percent of water resources. In such a situation, there is a wider gap between demand and supply of water which is responsible for water crisis. India faces a large gap between current supply and projected demand, amounting to 50% of the demand that is 754 bmc. (Addams *et al*, 2009) [1].

The challenge relating to the equitable distribution of water between different regions, between urban and rural areas and between rich and poor is quite significant. The problem can be solved at macro level by creating new supply but for the solution at micro level is a remote possibility. The rural areas have been deprived of a faire share in water resource development despite heavy investment during five year plans. In the rural sector where surface irrigation facilities are inadequate, excessive ground water usage has depleted the ground water resources, rendering the rural poor at a disadvantage stage.

Technological developments are also called for in the area of irrigation methodology. The implementation of micro-irrigation technologies (MIT) can also increase crop productivity and help to save water up to 50 percent of its present use (Jain 2000) [16]. In the open canal water conductor system, which is currently in use in India, the conveyance efficiency is adversely affected due to excessive seepage, evaporation, leakage, evapotranspiration (through weeds), pilferage, etc. Developments to make water conveyance through pressurised pipes cost effective will encourage its usage, thereby removing most of the water resources associated with an open canal system. Moreover, it may also help implementing the MIT and in reducing the losses of water. There is also need to change the mindset of society. People in India use water in an abundant manner. Water is lost in open taps in homes and public places. Most of the leaks in urban distribution system go unreported resulting in the loss of water (IWRS 1999) [14]. Beside it, a faulty sense of abundance, the common Indian farmer believes that larger application of water yields larger produce. This leads to the over use of water. It also affects soil fertility by washing away its nutrients, water logging and salination. Hence there is a need to change the traditional view.

Definition of the Problem

In traditional hydrology, human induced activities are considered as external drivers in water cycle dynamics (Milly *et al*. 2008) [29]. Although some studies have included human activities into hydrologic studies, most have been predictive models seeking to establish optimal cropping patterns or optimal institutions rather than retrospective efforts trying to better understand the casual drivers of change. Very few hydrological studies link institutions, particularly informal institutions such as social norms and lack of enforcement or monitoring, to water resource availability and human well-being. These linkages are increasingly being recognised and formalised in the emerging fields of socio-hydrology (Sivapalan *et al*. 2012) [39] and social ecological systems (Ostrom, 2009) [34], which aims to characterize and investigate feedbacks between human and natural systems.

An analytical and methodological study has been taken by scientists to solve the problem of complex human environment interactions at regional to global scale. Among the set of complementary methodological approaches, the use of qualitative comparison analysis (QCA) is suggested (Ragin 1987) [37]. This analysis aims to synthesise the causes and outcomes of environmental problems while retaining the complexity and richness of case study research (Scouvart *et al*. 2007) [38]. It also seeks to bridge the gap between traditional qualitative and quantitative approaches by combining some of the advantages of both the strategies.

According to Planning Commission (2008) [35], although the share of agriculture in GDP has declined from one half at the time of independence to one fifth in 2010, it remains predominant sector in terms of employment and livelihood and also consumes more than three fourth of water resources in India. It is widely agreed that irrigation development in the country traverse an unsustainable trajectory with increased dependence on ground water. Free or cheap power as an economic subsidy and political sop has also shown detrimental effect on sustainable ground water extract. According to World Bank Report (2005), irrigation and hydropower are the direct benefits which in turn generate both, inter-industries linkage impacts and consumption induced impacts on the regional and national economies. But excessive use of ground water is a hurdle to ensure the sustainability of this resource. Water demand has both quality and quantity dimensions and it is related to different problems including poor maintenance, low cost recovery and poor economic viability. Water crisis has also affected the performance of several industries among social and economic aspects and it has political, legal and environmental connotations. The ever growing population and the rising per capita consumption of water are primarily responsible for demand side crisis. The absence of national water vision, lack of centralized planning, inadequacy of water usage laws and intolerance of stake holders of water resources development projects towards one another are all non-structural aspects of the water crisis.

International Status

Research on the problem of water crisis has started in the international arena since early 1980s. Different aspects of this problem were examined in different research papers and reports. Some of the works are summarized as below:

Cossi (1993) [5], University of California, USA: Olga Cossi crafted a thought provoking discussion on the problem of clean water, detailing its sources and uses. The study clearly defined the hydrological cycle and described major reasons for water shortages. She analyzed water-quality problems and management programs. However, no technological or methodological approach was adopted in this study.

Waterfall (2004) [44], University of Arizona, USA: in this research thesis, a detailed study of rainwater harvesting is undertaken. In scientific term, water harvesting refers to collection and storage of rain water and also other activities aimed at harvesting surface and ground water, prevention of losses through evaporation and seepage and all other hydrological studies and engineering inventions, aimed at

conservation and efficient utilization of the limited water endowment of physiographic units, such as a water shed. A rainwater harvesting project study, under some assumptions, revealed some results based on the supply and demand numbers from the sample supply and demand worksheet. However, no cost-benefit analysis was undertaken in this study.

Jarvis (2006) [17], Oregon State University, USA: The study considered water to be the most pressing environmental concern of present century, especially under the global populations which continue to grow exponentially. Consequently, demand and supply aspects of the problem of water crisis were considered. However, poor water policy was considered as a major hindrance to achieve the equilibrium between demand and supply. A number of suggestions were also offered in this study to solve the problem. However, no concrete solution was indicated in the study.

Hoffman (2008) [13], US Department of Energy, USA: water security was defined as the ability to access sufficient quantity of rain water to maintain adequate standard of food and goods production, sanitation and health. Hence, the significance of potable water was emphasised especially under the condition when in many parts of developing countries there is a severe water shortages. The conditions of growing population and drinking water supply were explained and various possibilities to improve the conditions were also examined. However, no practical solution was offered in this study to solve the problem of water crisis.

Lopez-gunn *et al*. (2008) [26], Universidad Complutense de Madrid, Spain: in her paper, she offered alternative inter-disciplinary approach to deal with the complexity associated with ground water resources. This study provided a new angle that integrated deep ground water system as defined by hydro-geologists with a paradigm shift in natural resource governance, developed by political scientist. It also questioned the piecemeal approach to the governance of ground water resources, coupled with the lack of acknowledgement regarding the hydraulic connection of deep aquifers, a hidden sea of ground water. This study also suggested to adopt the law of Hidden Sea to solve the ground water depletion problem. However, no practical approaches were adopted.

McCarton, *et al*. (2009) [27], Dublin Institute of Technology, Ireland: In a Pilot Project Report on Rain Water Harvesting, a study was undertaken on the management of water resources. It is no denying that sustaining and recharging the ground water along with judicious use of the limited fresh water resources is a need of the hour. If sufficient measures are not taken up immediately, water crisis will be detrimental to the very survival of mankind. Efficient management of water resources and education about judicious utilization of water resources along with measures of harnessing, recharging and maintaining the quality of water and water bodies has to be taken up on war footing. In this study, quantitative and qualitative results of agricultural harvested rain water results were derived and verified by testing methodology. It observed that this water was not fit for drinking purposes. Cost benefit analysis was also undertaken but this study found it difficult to quantify accurately.

Murray (2013) [30], University of Bristol, UK: A study was undertaken regarding the ground and surface water resources in India. It observed that the current rate of ground water depletion is potentially unsustainable relative to the simulated increase in runoff, and enhanced runoff generation induced by climate change is only enough to moderately extend the longevity of the ground water resource under current rates of extraction. Therefore, it suggested to improve ground water storage fluxes and to develop local water management strategies.

National Status

In India, a number of research studies have been conducted in the last two decades related to the enhancing water productivity (Khan 2010) [19], sustainability of water quality management (Srikanth 2009) [40], rural water management (Biswas 2012), optimization technique in ground water quantity and quality management (Das *et al* 2001) [7], etc., related to the solution of water crisis in India. The following contributions are also traced in the national lavel:

Kumar *et al*. (2001) [23], Indian Journal of Applied Research, Ahmadabad: A study regarding water crisis in this research paper pointed out that water crisis is an alarming problem in India. Harmonious, just and wise use of water was emphasized. The need of a rational water policy was also indicated. It also observed that global water scarcity may become a leading cause of national political conflict. However, no remedial measures were offered to solve this problem.

Kumar *et al* (2005) [24], National Institute of Hydrology, Roorkee: Integrated and co-ordinated development of surface water and ground water resources has been emphasised. There is a need for proper management of ground water resources which presently requires adequate inputs including manpower, financial inputs and technologies. Some measures like rainwater harvesting, ground water recharge, transfer of surface water in lieu of ground water pumping, increasing the economic growth and reduction in dependence on agriculture and formalizing the water sector were also given for the sustainable development of ground water resources.

Garg *et al*. (2007) [29], IIT, Delhi: An attempt has been made to assess the utilizable water resources, based on various studies, in India. This analysis yields that the resources are overestimated in various studies. The analysis also revealed that almost all the basins would become water deficit, and raised a big question about the availability of water through inter-basin transfer. It is also shown that the ground water has already been overexploited. Hence, it calls for an urgent action before it becomes unmanageable.

Srikanth (2009) [40], Water Aid, New Delhi: A model of water quality monitoring and management was built up for water needs in India. It was observed that conditions in India are different than that of western countries. Integration of water quality, sanitation and hygiene with positive outcome of intervention process is vital in bridging the existing gap between demand and supply of water. Outsourcing water quality data management and sample collection and monitoring has been considered as an alternative mechanism to ease the burden on the state and to bring better efficiency and sustainability. The study observed that a more scientific debate on privatization of water quality management is required to solve the problem.

Khan (2010) [19], Indian Council of Agriculture Research, New Delhi: Multiple uses of water are found to be beneficial to enhance overall productivity of water resources. It helps in ensuring the nutritional security to

rural population. Results from different studies revealed that aqua-culture is common in all the systems. However, the intensification of multiple use of water may affect down stream flow. Hence, efforts are needed in evolving a multi-faceted approach.

Iyer (2011) [15], Centre for Policy Research, New Delhi: In this study multiple perspectives on water were taken into consideration and emphasised the need of integrating all of them. It was also observed that non-water policies create difficulties for a good water policy. Hence, there is a need to consider and harmonise policy relationship so that different policies work together and not against one another. However, no methodology or technology has been developed in this study.

Suresh (2011) [42], Centre for Law, Policy and Human Rights Studies, Mysore: In this study, it was observed that India still faced water sector reforms with the issue of unreached communities, iniquitous sharing and financial, resource and ecological sustainability. The strategies to deal with water crisis were suggested as higher technologies, increased investment, organisational restructuring, decentralisation, privatisation and deep research.

Mehta (2012) [28], Centre for Waste Recycling and Remedial Technologies National Law University, Jodhpur: In this research paper on impending water crisis in India, the use of water across fast developing sub-continental economies was undertaken. The need of an imminent action and proper implementation of policy was emphasized. However, no methodological or analytical results were drawn in this study.

Conclusion

Inadequate access to water is a big limitation to the efforts of economic development in India. Water is also a determinant of good health and productivity. The Human Development Report (2011) also observed that clean potable water is a basic necessity to expand higher order capabilities and to enlarge the possibilities of human development. The National Commission on Integrated Water Resources Development (NCIWRD) also observed that despite of the significance of water resources; India is leading a water stressed situation due to alarming increase in population. It means that a water crisis is the problem of disequilibrium between the demand and supply of utilizable water in India. It is an integral component in industrial infrastructure. Moreover, application of water in the form of irrigation to crops and plants is equally important since, irrigation can increase the yields of crops by 100 to 400 percent.

The empirical study in this project is important because there is need to solve the problem of water stress which means the demand for water is much more than the available supply. It also causes deterioration of fresh water and results in draught conditions. Moreover, the study of project is also relevant because it will not only deal with the problem of physical scarcity but also with the problem of economic water scarcity. It is also important to study that the available water is 'wholesome' in nature which means it is fit for human consumption with no risk of short and long term harm and free from disease which are transmitted by drinking contaminated water.

References

1. Addams, Boccaletti L, Kerlie G, Stuchtey M, "Charting Our Water Future: Economic Frameworks to inform Decision-making", World Bank, 2009.
2. Alcamo J, Vorosmarty CJ, Naiman RJ, Lettenmaier D, Pahl-Wostl C. A Grand Challenge for Fresh Water Research: Understanding the Global Water System, 'Environmental Resources. 2008;3:1-6.
3. Arsene CTC, Bargicla A, Al-Dabass D. 'Modelling and Simulation of Water System based on Loop Equation', Nottingham Trent University, UK, 1999.
4. Ballabh V. 'Governance of Water: Issues and Challenges', Sagar Publication, New Delhi, 2008.
5. Cossi O. Water Wars: The Fight to Control and Conserve Nature's Most Precious Resource. New York: Macmillan Publishing Company, 1993.
6. Craig JR. The Future of Analytical Solution Methods for Ground Water Flow and Transport Simulation, University of Waterloo, Canada, 2010.
7. Das A, Bcotta B. 'Application of Optimisation Techniques in Ground Water Quantity and Quality Management', IIT, Kanpur, 2001.
8. Eslinger O. Solving Simulation Based Problems in Hydrology, Amarican Institute of Methodology, Palo Alto, California, USA, 2008.
9. Garg NK, Hassan Q. Alarming Scarcity of Water in India, Current Science. 2007;93(7):932-941.
10. Gleick PH, Palaniappal M. Peak Water Limits to Fresh Water Withdrawal and Use, 'Natural Science', USA. 2010;107:155-162.
11. Hoeastra AY, Chapagain A. 'Globalization of Water: Sharing the Planet Fresh Water Resources', published by Wiley, Hoboken, New Jersey, 2008, pp. 254.
12. Hoeastra AY, Mekonnen MM. Water Footprint of Humanity, 'Natural Science', USA. 2012;109(9):3232-3237.
13. Hoffman, Allan R. Water Security: A Growing Crisis and the Link to Energy, 'AIP Conference Proceedings. 2008;1044:55-63.
14. IWRS. Theme Paper on Water Resources Day: Water Vision 2050, 'Indian Water Resource Society', New Delhi, 1999.
15. Iyer R. National Water Policy: An Alternate Draft for Consideration, EPW. 2011;XLVI(27):201-274.
16. Jain BH. Micro Irrigation Technology- Experiences and Issues Involved in their Promotion in Developing Countries, 'Bhagirath', New Delhi. 2000;47:84-88.
17. Jarvis T. Trans-Boundary Ground Water: Geo-Political Consequences, Common Sense, and the Law of the Hidden Sea, Oragon State University, Ph.D. Dissertation Oregon, State University, USA, 2006.
18. Joy KJ, Paranjape S. Water Conflicts, Contending Water Uses and Agenda for a New Policy, Legal and Institutional Framework, presented at International Conference on water resources policy in South Asia organised by Saci Water at Colombo, Sri Lanka, 2008.
19. Khan MA. Enhancing Water Productivity through Multiple Uses of water in Indo Gangetic basin, Montpellie, France: Innovation and Sustainable Development in Agriculture and Food (ISDA), 2010.
20. Kumar A. Freedom from the Perspective of the Poor, Vidyajyoti. 1999;61(9):617-629.
21. Kumar A. Consequences of the Black Economy, The Black Economy in India, Penguin Books, New Delhi, 2002, pp. 155-192.
22. Kumar A. Growth Scenario: Is the Common Man in the Picture? Alternative Economic Survey, India 2004-05.

Danish Books, New Delhi, 2005.
23. Kumar, Ravi V, Maheshawari GC. The Water Crisis in India: Need for a Balanced Management Approach", published in International Journal of Regulation and Governance. 2001;1(2):159-179.
24. Kumar R, Sharma KD, Singh RD. 'Water Resources of India', Current Science, Special Section: Water. 2005;89(5):794-811.
25. Kurien CT. Appropriate Technology for Rural Industries, 'Overview One', (Edited by V Kanesalingom), Tata McGraw Hill, 1989.
26. Lopez-Gunn, Manuel Ramón Llamas. Re-thinking Water Scarcity: Can Science and Technology Solve the Global Water Crisis?, Natural Resources Forum. 2008;32:228-238.
27. McCarton L, O' Hogain S, Reid A, McIntyra N, Pender J. Rain Water Harvesting Pilot Project Report, National Rural Water Monitoring Committee, Dublin, 2009.
28. Mehta P. Impending Water Crisis in India and Comparing Clean Water Standards among Developing and Developed Nations, published in Archives of Applied Science Research. 2012;4(1):497-507.
29. Milly PCD, Betancourt J, Falkenmark M, Hirsch RM, Kundzewicz ZW, Lettenmaipr DP, *et al*. Climate Change: Stationarity is Dead: Whither Water Management?, 'Science'. 2008;319(5863):573.
30. Murray, Steve. Future Global Water Resources with respect to Climate Change, Ph.D Dissertation, University of Arizona, UK, 2013.
31. Nanwal RK. Dry Land Agriculture Productivity and Sustainability, 'Employment News'. 2001;26:1-2.
32. Narsimhan TN. A Note on India's Water Budget and Evapotranspiration, Journal of Earth System Science. 2008;117(3):237-240.
33. NCIWRD. Report: Integrated Water Resource Development: A Plan for Action, National Commission for Integrated Water Resources Development, New Delhi, 1999, 1.
34. Ostrom E. A General Framework for Analysing Sustainability of Social-Ecological Systems", 'Science'. 2009;325(5939):419-422.
35. Planning Commission, Government of India Eleventh Five Year Plan 2007-2012, New Delhi, 2008.
36. Postal SL, Daily GC, Ehrlich PR Human Appropriation of Renewable Fresh Water, 'Science'. 1996;71:785-788.
37. Ragin C. 'The Comparative Methods: Moving Beyond Qualitative and Quantitative Strategies', University of California Press, Berkeley, 1987, pp. 218.
38. Scouvart M, Adams R, Caldas M, Dale V, Mertens B, Nedelec V, *et al.* Causes of Deforestation in the Brazilian Amazon: A Qualitative Comparative Analysis, 'Journal of Land Science'. 2007;2:257-282.
39. Sivapalan M, Savenije HHG, Bloschl G. Socio-Hydrology: A New Science of People and Water, Hydrological Process'. 2012;26(8):1270-1276.
40. Srikanth R. Challenges of Sustainable Water Quality Management in Rural India, Current Science. 2009;27(3):317-25.
41. Suresh V. 'Democratisation of Waste Water Management-The Paradigm Shift', Centre for Law, Policy and Human Rights Studies, Mysore, 2007.
42. Suresh V. Urban Water Institutions: Myths of Decentralization and Devolution, Arghyan Conference, Mysore, November 18, 2011.
43. Verma S, Phansalkar S. India's Water Future 2050, International Journal of Rural Management. 2007;3(1):149-179.
44. Waterfall, Patrice. Harvesting of Rainwater for Landscape Use, University of Arizona, USA, 2004.
45. Yeomans JS. 'Using Simulation Optimisation Techniques for Water Resource Planning', York University, Toronto, Canada, 2009.