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Changing dimensions and interactions of water crisis and human rights in developing countries

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ABSTRACT

Water resources are essential for sustaining life forms, food production, socio-economic development, and for general well-being. Water is intrinsically linked with several perspectives of human rights like right to life, right to food, right to self-determination, right to adequate standard of living, right to housing, right to education, right to health, right to take part in cultural life, right to suitable working conditions etc. Yet, human rights to water remains imperfectly defined. Global water consumption is doubling every 20 years, more than twice the rate of human population growth. The growth in water consumption is highest in the agricultural and industrial areas, where the resources to buy water are readily available with rich farmers and industrialists. Potential human right issues can arise from lack of safe water. Construction of dams can lead to ecosystem imbalances and degradation of the quality of human life, specially the livelihood of the indigenous and tribal populations. To solve the growing water crisis, one of the possible solutions that has been proposed and has been implemented is water privatization, which majorly considers water as a profitable commodity. Water pricing and privatization will inevitably increase the price of the major crops and vegetables all around the world, which, in turn, can adversely affect food security. Community based water management policies such as rainwater harvesting, check dam construction, sustainable watershed management, integrated river basin management and irrigation efficiency can be sustainable solutions of water crisis, which also can respect the human right issues as well.

***Keywords*:** water, dams, privatization, food security, human rights

1. INTRODUCTION

There are three phases of human civilization, namely, agricultural, industrial and information technology based globalized civilization. In all of these phases, man gradually has become an agent that has modified his immediate environment which gives him physical sustenance and affords him the opportunity for intellectual, moral, social and spiritual growth. Since ancient age, man has developed the capacity to modify the face of the earth. During the course of evolution of the human race, civilization has transformed the environment in countless ways and on an unprecedented scale. Use of fire, domestication of animals and early agricultural practices are the major steps to modify the already existing conditions. During last two centuries, the human society has tremendously used energy, raw materials, marginalized people and transport commodities over huge distances and generated enormous amount of wastes-mostly hazardous, culminating in the destruction of the equilibrium of the environment. Environmental degradation has raised the uncomfortable questions about the concept of development itself. So far as the protection of nature is concerned, there is always a philosophical conflict between the developed and developing nations. Development has increased consumerism in a small section of the society, but as expected, it has degraded and depleted natural resources.

Water is a compound whose material constitution becomes secondary to its symbolic value because of its reflection in our mind as a symbol of life. The access to water is a basic human right, because water is a social and cultural good, not merely an economic commodity. The hydrological cycle of the globe can be referred to as an excellent example of natural water democracy, because it is a system of distributing water for all the living beings. Providing water is absolutely essential for fulfilling the developmental objectives – job creation, food security, GDP growth and social goals including poverty reduction[1]. Despite significant progress of human society, water related problems are continuously affecting the social infrastructures and jeopardizing the productivity of the society. A substantial proportion of ill health in India is because of lack of safe drinking water, poor sanitation and hygiene practices.

In 2002, the World Health Organization estimated that 1.1 billion people (17% of the global population) lacked access to safe water resources, and 2.6 billion people (42% of the global population) lacked access to improved sanitation, which is the primary cause of water contamination and waterborne diseases"[2]. Changed consumption patterns and unsustainable management policies of our society are continuously leading us toward a polluted and water stressed world.

Water is intrinsically linked with several perspectives of human rights like right to life, right to food, right to self-determination, right to adequate standard of living, right to housing, right to education, right to health, right to take part in cultural life, right to suitable working conditions etc.

Yet, human rights to water remain imperfectly defined. The rights to water do not only include the human perspectives, but also includes the needs of the environment with regard to different water bodies, aquifers, oceans and aquatic ecosystems. The consideration of water as only a social resource can constrict the human right approaches; hence the social and natural perspectives together can give more justice to the human rights issues.

2. GLOBAL WATER STRESS, CONSUMPTION PATTERNS AND HUMAN RIGHTS

The amount of global water consumption is doubling every 20 years, more than twice the rate of human population growth. At present more than one billion people on earth lack access to fresh drinking water. By the year 2025 the demand for freshwater is expected to rise to 56% above what currently available water can deliver, if current trends persist[3]. Many of the world's major industries are highly water intensive. In many areas, agriculture is also irrigation intensive. Such irrigations need a huge amount of water. India has the highest volume of annual groundwater extraction in the world, and in most parts of it, groundwater extraction is twice the rate of annual recharge[3]. Interestingly, the annual average rainfall in India is 4000 billion cubic meters, but the annual water requirement of India is only 450 billion cubic meters[4]. Still the country is plagued by environmental issues such as water pollution from raw sewage and runoff of agricultural pesticides, water crisis and unequal distribution problems, which, in turn, is making the whole situation paradoxical[5].

The concept of basic water requirement (BWR) was proposed by the governments of different countries, water agencies and community organizations, which can reflect the human rights issues centered on this important resource. The concept refers to the amount of water that an individual would need daily to fulfill their four basic domestic needs like drinking, sanitation, bathing and cooking. Various levels of BWR have been suggested by the World Bank, WHO, USAID, the UN based on the objectives of betterment for the fundamental health conditions of individuals and assumptions of technology choices made at modest levels of economic development. Estimates of the BWR range from 20 - 50 liters per day, independent of climate, technology and culture[6].

A region where renewable fresh water availability is below 1700 cubic meters/capita/annum is a water stress region and the regions where availability falls below 1000 cubic meters/capita/annum is termed as water scarce region[7]. The annual per capita availability of renewable freshwater in India has reduced from around 5,277 cubic meters in 1955 to 2,464 cubic meters in 1990. Considering the projected increase in population by the year 2025, the per capita availability is likely to drop to below 1,000 cubic meters and India will face severe water scarcity[8].

Potential human right issues can arise from lack of safe water. For example, environmental refugees often can't get proper access to safe water and sanitation. Lack of access to safe water in the vicinity of the home can affect the health and education of women and children[9]. Many children usually carry water from distant sources rather than going to school, which impairs their right to an education. Most of the women and girl children in Rajasthan, India spend a considerable amount of time of their life for collecting water. On an average, a rural woman walks more than 14000 km./year for searching and collecting water[10]. In the remote rural areas of Rajasthan, men generally migrate to urban areas in search of work because the chances of agricultural prosperity are minimum in those water scarce regions. Women spend most of their time in collecting water, and little time is generally left for other productive works[10]. On the other hand, the story is just the reverse for the developed areas of the world. North Americans use 1,280 cubic meters of water/person/year; Europeans use 694; South Americans use 311; whereas in Asia and Africa, the figures are 535 and 186 respectively[1].

Women in particular suffer from the lack of appropriate sanitation facilities in the developing countries. A major reason for parents not sending their daughters to school in many countries is the lack of secure sanitation facilities. Water facilities and services must be culturally appropriate and sensitive to satisfy gender, lifecycle and privacy requirements[11].

Indigenous peoples may face problems accessing safe water. Natural water sources traditionally used by these people may no longer be accessible because of land expropriation and contamination. While water is important to every community, many indigenous groups rely on waterways and water bodies for their traditional livelihoods, including fishing, whaling, and sealing. When access to fresh water is compromised, often indigenous rights to self-determination and occupation are impinged upon, as are their water-reliant traditions[11]. The local population living in the wetland areas is also suffering from the human rights viewpoint. The local population depends on the vegetations of the wetlands for food, some of which are threatened due to environmental and anthropogenic stresses. The disappearance of these plant species will affect the food security of the low income local people in future[12].

Many river ecosystems of the world are highly threatened by over exploitation of freshwater resources and unsustainable developmental policies. More than half of the major river systems are polluted and/or dried up because of overexploitation of resources. The main source of pollution is the disposal of over 2 million tons of human waste materials in these water courses. Contamination and overuse of river basins has created more than 25 million environmental refugees in 1998-1999 [41].

3. WATER ECONOMY AND HUMAN RIGHTS

Civilization is becoming more and more dependent on irrigated land for growing food. Scarcity of fresh water affects the food security issues. In water stressed areas, particularly in the tropics, the FAO estimated that temperature rise because of global warming can increase evapotranspiration which can increase salinity in the soil and water. The reduction of the overall availability of water for irrigation would limit the possibility to extend irrigated areas for agriculture in future. In addition to the water scarcity on arid lands, salinity will also affect soil productivity adversely[13]. The intensity of groundwater use, partly encouraged by subsidized rural electrification, has led to the emergence of many groundwater-dependent economies, which are currently facing serious threats from aquifer depletion and pollution related problems[1].

The concepts of water footprints and virtual water are often used to describe the relations between water management, international trade and policies. Water footprint is defined as the total volume of fresh water used for production of goods and services consumed by the individual or community. On the other hand, virtual water is referred to the amount of water used for the production of goods or services, and is a tool for determining the movement of water through international trade. Water mainly a local issue, although it becomes a regional issue where rivers or lakes cross national boundaries. It is the virtual water that actually makes it a global issue in terms of production and consumption. Countries with water shortages can import water-intensive goods and services, while water-abundant countries can increase the economic strength by using the crisis[1].

The diminishing quality of water supplies, water tax, privatization and strict environmental effluent standards are compelling industries to increase their water efficiency.

Industrial water productivity is a general indicator of efficiency and performance in water use. In emerging market economies industrial demand for water is rising with rapid growth in manufacturing output, so water use efficiency should be increased accordingly to maintain the equilibrium[1].

4. WATER POLLUTION AND HUMAN RIGHTS

An aquifer's accessibility is often disturbed by contamination. Shallow aquifers suffer from synthetic fertilizers and pesticides released from the agricultural sources, and the polluted domestic and industrial waste water. Major water pollutants include microbes (ex. intestinal pathogens and viruses), nutrients (ex. phosphates and nitrates), heavy metals and metalloids (ex. arsenic, lead, mercury), organic chemicals (ex. DDT, lubricants, industrial solvents), oil, sediments and heat. Almost all industrial and goods-producing activities generate pollutants as unwanted by-products. Heavy metals are contaminating the groundwater resources and subsequently can bioaccumulate in the food chains. For example, more than 100 million people are living in the arsenic affected districts of India and Bangladesh. 9 districts out of 19 in West Bengal, 78 blocks and around 3150 villages are affected with arsenic-contaminated groundwater[14]. The use of arsenic contaminated groundwater for irrigation purpose in crop fields subsequently transmits arsenic in the food chains[15-17].

Mercury and lead coming out from industrial effluents, mining and landfill leachates also affect human health. In Japan, mercury pollution caused Minamata disease which killed and impaired several thousand people in the Minamata Bay. Minamata disease is a disease of central nervous system developed among the inhabitants who consumed large quantities of fishes and shellfishes in which methylmercury compound had been absorbed directly through the gills or through the intestinal tracts or been accumulated at high concentrations after discharge from chemical plant to the sea and rivers[18].

Groundwater systems are very vulnerable freshwater resources and prone to contamination. Pollutants can take several years to reach the aquifers, but, once they reach the water source, it is very difficult and costly to remove the pollutants from the groundwater. More than 80% of sewage in developing countries is discharged without proper treatment which can pollute the river systems, lakes and coastal water bodies[1]. These examples can reflect that human rights issues concerning safe water access rights are continuously affected in modern developmental scenario. A small section of the society is violating the rules and the whole civilization is paying the cost.

5. CLIMATE CHANGE, WATER RESOURCES AND HUMAN RIGHTS

In the past few decades scientists have assembled considerable amount of database which speak in favour of the causes and projected impacts of the growing concern of climate change. United Nations Framework Convention on Climate Change (UNFCC) defines climate change as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods[13].

Global average surface temperature of the earth has increased by about 0.74 °C over the last century. The 1980s and 1990s were the warmest decades since accurate records began in the mid of late 1800s[19]. A group of scientists from NASA warned that 2005 is the warmest year on record since the end of last major ice age nearly 12000 years ago[20].

Several noticeable changes can be observed in the earth in recent times, which are the effects of climate change on human society, directly or indirectly affecting the basic human rights. As for example, one of the many warning signals of global warming is the changes in the ice caps due to melting, thinning, shrinking, retreating, freezing and disappearing[20]. Settlements in mountain regions are at enhanced risk of floods caused by melting glaciers[21]. In parts of Central Asia, regional temperature increase will increase mudflows and avalanches that could adversely affect human settlements[22]. In the past century, sea level rise has occurred at a mean rate of 1.8 mm per year[23], but the recent satellite data revealed that the rate has been changed from 1993 onwards (2.8 ±0.4 to 3.1 ±0.7 mm. per year)[24]. Although it is clear that human population can live, survive, and flourish in extreme climates from the Arctic to the Sahara, but if the predictable extremes of the local climate are exceeded, problems will occur. Sea level rise could also displace many coastal populations; it is estimated that a sea level rise of just 200 mm could create 740,000 homeless people in Nigeria[25]. Many small islands have poorly developed infrastructure and limited resources, and often small island populations are dependent on marine resources to meet their protein needs. So, climate change could completely devastate the social and economic conditions of the islands. Sea level rise will also destroy about 40-50% of the world's coastal wetlands by 2080[20]. World Bank has reported that sea level rise in Bangladesh can destroy up to 16% of land, supporting 13% of population and producing 12% of the current GDP[22]. In Bangladesh, three extreme floods have occurred in the last two decades, and in 1998 about 70% of the country's area was inundated[25]. A World Bank report in 1994 concluded that human activities in the deltas can cause the areas to sink much faster than any predicted rise to sea level, thus can increase their vulnerability to storms and floods[22]. Sea level rise in the Nile delta can change the water quality, can affect many freshwater fishes, can increase the salinity of the groundwater and also can inundate the fertile agricultural lands. Rising sea levels will threaten coastal aquifers. Reports are showing that the underdeveloped countries that emit very low carbon are affected most due to the effect of climate change[13].

A warmer climate will accelerate the hydrological cycle; can alter the intensity and timing of rainfall. Warm air can hold more moisture and can increase evaporation of surface moisture, which in turn can intensify rainfall and snowfall events. So, intensity of flood will also increase. If there is deficiency of moisture in the soil, solar radiation will increase the temperature, which could contribute to longer and more severe droughts[25]. In a number of studies, it has been proved that global warming and decline in rainfall may reduce net recharge and can affect groundwater levels. Decrease in winter precipitation would reduce the total seasonal precipitation being received during December–February, and can impose greater water stress. Intense rain for few days will result increased frequency of floods and the monsoon rain would also be lost as direct run-off, thus can decrease the groundwater recharging potential[26]. Increased rainfall amounts and intensities will lead to greater rates of soil erosion. In India, Pakistan, Nepal and Bangladesh, rapid urbanization and industrialization, population growth and inefficient water use are the main causes of water crisis which is further aggravated by changing climate and its adverse impacts on demand, supply and water quality.

Future climate change is expected to have considerable impacts on water resources, which, in turn, can lead to social instability and conflict, often followed by displacement of people and changes in occupancy and migration patterns[27]. The production losses due to climate change may drastically increase the problem of poverty, food insecurity and malnutrition in several developing countries in Asia[28,29].

Sustainable development has become part of all climate change policy discussions at the global level. It is 'the development that meets the needs of the present without compromising the ability of future generations to meet their own needs'[30]. Environmental conservation for sustainability of natural resources is not a luxury but a necessity when considering long-term economic growth and development, particularly in the least developed countries. Linking the concept of sustainable development to climate change provides an opportunity to explore long-term societal responses to global environmental change, which, in turn, can conserve human rights as a whole.

6. DAMS CONSTRUCTION AND HUMAN RIGHTS

The displacement of local inhabitants caused by irrigation projects and dam construction is one of the major environmental concerns in recent times. It is evident that large dams are the single largest cause of displacement in India since independence[31,32]. Large scale deforestation is one of the inevitable consequences of large dam construction which can lead to imbalances in the ecosystems. Following the construction of dams, the aquatic life in the area is generally severely affected. Changes in water velocity, water chemistry, temperature and turbidity disturb the movement and activities of fishes. Weeds often grow in irrigation reservoirs, which in turn can spread diseases in human population and livestock. Constructions of dams on many rivers can decrease the biodiversity and can reduce the water flow[33]. Because of the reduction in flow, the rivers become incapable of withstanding the pollution load. As most of the civilizations depend on the rivers for their social, cultural, biological and economic benefits, it can lead to degradation of the quality of human life. Soil erosion and degradation are the other significant effects caused by large dam construction, mainly because of water logging and increase in salinity. Dams are usually constructed in remote forest and hill areas which are the habitat of the indigenous people. Construction activities can eminently affect the livelihood and economy of the tribal population. The sudden influx of modern technologies, destruction and modification of the natural systems and the process of displacement and resettlement can cause social, cultural and economic collapse in the indigenous communities[33]. Large dam projects can displace people in a number of ways including the construction of canals, downstream impacts, treatment of catchment area, compensatory afforestation programmes, secondary displacement strategies and due to related conservation measures like establishment of sanctuaries and national parks. If all the factors are considered together for evaluation, the figures of displacement would be much larger. Estimates of human displacement sometimes overlook the effect of water level rise because of siltation in the reservoir. The actual area of submergence is generally larger than originally estimated, consequently larger numbers of people are displaced than previous estimations. The people resettled at the edges of the reservoir sometimes forced to move as the water rises to submerge the new settlements. A review by the World Bank published that on an average, 13,000 people is displaced for each new dam construction in modern

scenario[34]. Considering this estimate, more than 39 million people have been displaced so far due to construction of over 3000 large dams. The official reports showed displacement of only 2 million people in India till 1990 because of all dams, which are highly inaccurate[6]. The project authorities often executed much lower displacement figures than might actually be the case in proposal documents for proving a favourable cost benefit ratio to the funding authority for getting the project clearance[32,34].

7. WATER PRIVATIZATION AND HUMAN RIGHTS

In India, changes in the economy have been made with the liberalization, privatization and globalization of almost every aspect. While this process began in 1991 in sectors like power, it has gradually expanded in the water sector in recent times. To solve the growing water crisis, one of the possible solutions that has been proposed and has been implemented is privatization of water, which in effect leads to treatment of water as a commodity[35]. The ideological choice of treating water as an economic good or a 'cashable resource' is based on the assertion that market is the principal mechanism to regulate the flow of goods. Hence, it should be remembered that under fundamental rights in the Constitution of India, Article 21 entitled 'protection of life and personal liberty' states: 'no person shall be deprived of his life or personal liberty except according to procedure established by law'[36]. In view of the scope of this right, environmental and ecological damage of water resources are regarded as amounting to violation of Article 21. Further, 'the entitlement of citizens to receive safe drinking water (potable water) is part of the right to life under Article 21'[37].

The administrations are consciously overlooking the complexities of the water management systems that are deeply integrated in the social, political and economical structures. On the other hand, water has become big business for global corporations. It has limitless markets in the changing scenario of growing water demand and water scarcity. Numerous case studies around the world highlight the other ills of water privatization such as poor quality of water, unsustainable water mining and lack of transparency and accountability[1]. The privatization of water has already happened in several developed countries and is being pushed in many developing countries through structural adjustment policies[3]. Water privatization will invariably increase the price of this common property resource because there are hidden costs involved in water collection, purification and distribution. The corporations will recover their costs by exploiting the consumers. It has been argued that privatization will help to reduce unsustainable water use and will promote water conservation. But the market dynamics will inevitably affect the economically weaker class of the society who cannot afford the increased water tariffs[3].

Another possible threat of water privatization is the unsustainable water extraction by the water corporations for maximizing profits and subsequent destruction of water bodies and aquifers. Corporations in search of profits can compromise on water quality in order to reduce the costs. This is especially relevant in the countries, where the water quality regulatory boards do not have enough efficiency to enforce their standards. There have been numerous examples of outbreak of epidemics because of poor water quality management and regulations[2].

Indiscriminate mining of groundwater by a multinational soft drink giant in Andhra Pradesh, Tamil Nadu and Kerala has resulted severe threats to the local water resources. They

are extracting 1 million liter of groundwater per day which is destroying the balance of the local ecosystems and human societies. Many wells are dried up and also become contaminated (with excessive calcium and magnesium) in the adjoining areas of the soft drink bottling factory in Kerala. The company's usage of agricultural land for non-agricultural purposes is also questionable. A study of World Wildlife Federation in 2001 showed that the bottled water industries use 1.5 million tons of plastic every year, and after disposal, these bottles release toxic chemicals in the environment[3]. In India, the drinking water and soft drink industries have been shown to have high pesticide levels in their products. In 2003, the New Delhi, India based Centre for Science and Environment showed that some of the soft drinks that were being sold in India contained lindane, DDT, malathion and other deadly pesticides which can cause cancer and can affect the immune systems[38]. Privatization can also favour bulk water exports as control over water is transferred from local communities to global corporations, which will have disastrous ecological and environmental consequences. Many crops and vegetables need huge amount of water for their growth and production. For example, in India, production of 1 kg. of Basmati rice requires 4200 liters of water, for long duration coarse rice it is 2500 liters and for wheat the amount is 700 liters[33]. Water pricing and privatization will inevitably increase the price of the major crops and vegetables all around the world, which, in turn, can adversely affect another human right issue of food security. While government management of water resources is partly responsible for the water crisis we face today, privatization will at best compound the problem.

8. CONCLUSIONS

The water footprint of humanity has exceeded sustainable levels at several places and is unequally distributed among people. Good information about water footprints of communities and businesses will help to understand how we can achieve a more sustainable and equitable use of fresh water. Reducing the water footprint is the need of the hour, just like reducing the carbon footprint, to ensure our environmental, economic and social security.

Community based water management policies such as rainwater harvesting, check dam construction, sustainable watershed management, integrated river basin management and irrigation efficiency are far better and sustainable alternatives to water privatization. We should learn and comprehend the ancient knowledge of traditional water management and apply it in our modern society to get rid of the present water stressed condition[39]. These actions also can respect the human rights as well and should be implemented in large scales[40].

The meaningful implementation of sustainable development can now be further advanced to help link social development and human rights aspects of sustainable development with the environment, as well as ensuring economic well being through the benefits that adequate supplies of water can provide. It is absolutely essential for us to secure the right for saving water resources and environment in general. Though a lot of regulations, acts and laws have been enacted here and there, but it is more important to raise the general awareness of the common people about their basic rights. Then only the people will come to understand how their rights are being violated. Knowledge about development and environment is not enough, rather the upsurge of the common people and pushing the principles of human rights are extremely important. The elevation of the issue of safe water to

the human rights sphere needs to be enhanced in the developing nations, as it is a fundamental precondition for working on both poverty and environment.

References

[1] UNESCO. World Water Assessment Programme. The United Nations World Water Development Report 3: Water in a changing world: http://www.unesco.org/water/wwap/wwdr/wwdr3/pdf/WWDR3_Water_in_a_Changing_World.pdf. Accessed on 22 June, 2015 (2009).

[2] World Health Organization. *Water sanitation and hygiene linked to health.* http://www.who.int/water_sanitation_health/publications/facts2004/en/. Accessed on 24 April, 2015 (2004).

[3] Barlow, M. Blue Gold – The Fight to Stop the Corporate Theft of the World's Water. Leftword Books, New Delhi, India (2003).

[4] Rao, K.L. India's Water Wealth. Orient Longman, India (1995).

[5] Sharma, S. Background and perspective: Infochange water resources. http://www.infochangeindia.org/WaterResourceIbp.jsp. Accessed on 22 June, 2015 (2005).

[6] Gleick, P.H. The World's Water: The Biennial Report on Freshwater Resources. Island Press, Washington DC (1999).

[7] Falkenmark, M., Widstrand, C. Population and Water Resources: A Delicate Balance. Population Bulletin 47, Population Reference Bureau (PRB). Washington, DC (1992)

[8] The Energy and Resources Institute. State of India's Environment (A Quantitative Analysis). Report No. 1995EE52 (1996).

[9] World Health Organization. Global Water Supply and Sanitation Assessment 2000 Report. http://www.who.int/water_sanitation_health/monitoring/jmp2000.pdf. Accessed on 22 June, 2015 (2000).

[10] Shiva, V., Jalees, K. Water and women: A Report by Research Foundation for Science, Technology and Ecology for National Commission for Women. Navdanya, India (2005)

[11] World Health Organization. The right to water. Health and human rights publication series; no. 3. http://www.who.int/water_sanitation_health/en/righttowater.pdf. Accessed on 2 June, 2015 (2003).

[12] Bhattacharya, S., Ganguli, A., Bose, S., Mukhopadhyay, A. Biodiversity, traditional practices and sustainability issues of East Kolkata Wetlands: A significance Ramsar site of West Bengal, (India). *Res rev biosci* 6(11), 340-347 (2012).

[13] Parry, M.L., Canziani, O.F., Palutikof, J.P., Hanson, C.E. (eds.) IPCC Forth Assessment Report: Climate Change 2007. Cambridge University Press, New York.

[14] http://www.ipcc.ch/publications_and_data/ar4/wg2/en/contents.html. Accessed on 2 May, 2015 (2007).

[15] Chakraborti, D., Rahman, M.M., Paul, K., Chowdhury, U.K., Sengupta, M.K., Lodh, D., Chanda, C.R., Saha, K.C., Mukherjee, S.C. Arsenic calamity in the Indian subcontinent: what lessons have been learned?. *Talanta* 58(4), 3-22 (2002).

[16] Meharg, A.A., Rahman, M.M. Arsenic contamination in Bangladesh paddy field soils: implication for rice contribution to arsenic consumption. *Environ Sci Technol* 37(2), 229-234 (2003).

[17] Bhattacharya, S, Gupta, K., Debnath, S., Ghosh, U.C., Chattopadhyay, D.J., Mukhopadhyay, A. Arsenic bioaccumulation in edible plants and subsequent transmission through food chain in Bengal basin: with special reference to rice. *Toxicol Environ Chem* 94(3), 429-441 (2012).

[18] Bhattacharya, S., Ghosh, U.C. Environmental, economic and health perspectives of arsenic toxicity in Bengal Delta. *World Scientific News* 4 (2015) 111-139.

[19] Ministry of the Environment, Government of Japan. Annual Report on the Environment in Japan. http://www.env.go.jp/en/wpaper/2006/index.html. Accessed on 23 May, 2015 (2006).

[20] Garvey, J. The Ethics of Climate Change- right or wrong in a warming world. Continuum International Publishing Group, New York (2009).

[21] Nair, P.S.G. Earth in Peril. Publication Division. Ministry of Information and Broadcasting, Govt. of India (2009).

[22] Bhattacharya, S. Environmental, geological and economic effects of climate change on the Indian hydrology: A review. *World Scientific News* 7 (2015) 30-49.

[23] Afiazova, R.K. Climate change impact on mud flow formation in Trans-Ili Alatay mountains. *Hydrometeorol Ecol* 3, 12-23 (1997).

[24] Douglas, B.C. Global Sea Rise: A Redetermination. *Surv Geophys* 18, 279-292 (1997).

[25] Mirza, M.M.Q. Three recent extreme floods in Bangladesh: a hydrometeorological analysis. *Nat Hazards* 28, 35-64 (2003).

[26] Clarke, R., King, J. The Atlas of Water. Earthscan, London (2004).

[27] Mall, R.K., Gupta, A., Singh, R., Singh, R.S., Rathore, L.S. Water resources and climate change: An Indian perspective. *Curr Sci* 90, 1610-1626 (2006).

[28] Barnett, J. Security and climate change. *Global Environ Chang* 13, 7-17 (2003).

[29] Bhattacharya, S., Chattopadhyay, D., Mukhopadhyay, A. Changing dimensions of food security in a globalized world: A review of the perspectives for environment, economy and health. *Int Res J Environ Sci* 2(3), 1-7 (2013).

[30] Wang, X., Chen, F., Dong, Z. The relative role of climatic and human factors in desertification in semiarid China. *Global Environ Chang* 16, 48-57 (2006).

[31] WCED. Our Common Future (Report of the World Commission on Environment and Development). Oxford University Press, New York. http://worldinbalance.net/intagreements/1987-brundtland.php. Accessed on 22 June, 2015 (1987)

[32] Thukral, E.G. Big Dams, Displaced People: Rivers of Sorrow, Rivers of Change. Sage Publications, New Delhi (1992).

[33] McCully, P. Silenced Rivers: The Ecology and Politics of Large Dams. Orient Longman. Hyderabad, India (1997).

[34] Shiva, V., Jalees, K. The Impact of the River Linking Project. Navdanya, New Delhi (2003)

[35] Cernea, M.M. Public Policy Responses to Development Induced Population Displacement. *Econ Polit Weekly* 31(24), 1515-1523 (1996).

[36] Bhattacharya, S., Banerjee, A. Water privatization in developing countries: Principles, implementations and socio-economic consequences. *World Scientific News* 4 (2015) 17-31.

[37] Government of India. Constitution of India. New Delhi: Government of India (1986).

[38] Sinha, S. Environmental Protection: Role of Constitutional Courts. In: Contribution of the Andhra Pradesh High Court in the Development of Constitutional Law, High Court of Andhra Pradesh, Hyderabad (2001).

[39] The rights to water and sanitation. Case against Coca Cola Kerala State: India. http://www.righttowater.info/rights-in-practice/legal-approach-case-studies/case-against-coca-cola-kerala-state-india/, Accessed on 22 May, 2015 (2015).

[40] Bhattacharya, S. Traditional water harvesting structures and sustainable water management in India: A socio-hydrological review. *Int Lett Nat Sci* 37, 30-38 (2015).

[41] Agarwal, A., Narain, S. Dying wisdom. Rise, fall and potential of India's traditional water harvesting systems. Centre for Science & Environment (CSE), New Delhi, India (1997).

[42] IUCN. Water as a human right? IUCN Environmental Policy and Law Paper no. 51. https://portals.iucn.org/library/efiles/edocs/EPLP-051.pdf, Accessed on 22 May, 2015 (2004).

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