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Sustainable Water Resource Development in East Champaran in Bihar

Ajit Sharma

ABSTRACT

Natural resource management is expected to play a key role in the development of the nation in the years to come Sustainable development is both a global and local challenge to managing change. It requires integrating social, ecological and economic objectives and system requirements. Bihar faces the great environmental challenges due to climate change. It has wide-ranging effects on the environment, and on socioeconomic sectors, including water resources, agriculture and food security, human health, ecosystems and biodiversity. Climatically, the state of Bihar lies on the crossroads of the wet eastern coastal regions and the relatively dry continental region of the western plains. It caused regional variations in rainfall distribution as well as rainfall variability. It makes state vulnerable to drought and floods both. Present paper purports to review development of water resources in East Champaran district of Bihar in India.

Introduction

Bihar is 12th largest state of India in terms of geographical size and 3rd largest in terms of its population. The state is well known for its abundant natural resources, perennial rivers, fertile lands and a long glorious history. In spite of abundant natural resources the state remained one of the poorest in the country since independence. Bihar is India's most flood-prone State, with 76 percent of the population in the north Bihar living under the recurring threat of flood devastation. According to some historical data, 16.5 percent of the total flood affected area in India is located in Bihar while 22.1 percent of the flood affected population in India lives in Bihar. About 73.06 percent area is flood affected. East Champaran is located in Tirhut division of Bihar which is adjoining to Nepal Border. There are 534 development blocks and 43897 inhabited villages in the state. In the selected district, there are 18 development blocks and 1564 villages. Bihar is blessed with a bund ant surface and ground water resources that are sufficient to cater to demands for various end uses. Ground water development was reported 39 per cent however, there are several quality problems, including arsenic, fluoride, iron and nitrate concentrations in many districts. There are six major sources of irrigation – surface canals (major), surface

Research Scholar , Department of Public Administration , Lucknow University, Lucknow

canals (minor), tanks, tube wells, other wells and other sources. Tanks and other sources are becoming less important over the time, leaving the other four sources for providing irrigation facilities. During 2009-10, canals provided 27.5 per cent, wells provided 61.4 per cent of total irrigation. Tube wells continue4d to be an extremely important sources of irrigation, providing more than 50 per cent of the total irrigation in the state.

Water Resources

The main water resources of India consist of precipitation on the Indian Territory which is estimated to be around 4000 km^3/year and trans-boundary flows which it receives in its rivers and aquifers from the upper riparian countries . Out of total precipitation, including snow fall, the availability from surface water and replenish able groundwater is estimated to be 1869 km^3. The precipitation over a large part of India is concentrated in the monsoon season during June to September/October. Precipitation varies from 100 mm in the western parts of Rajasthan to over 11000 mm at Cherrapunji in Meghalaya. There are occurrences of both floods and droughts in India. Due to access rainwater, floods, about 40 million hectare of land mass is flood prone which constitutes about 12 per cent of the total geographical area of the country. Droughts are also experienced due to deficient rainfall, accounting for 51 million hectare area and 16 per cent of geographical area. India receives an annual rainfall equivalent of about 4000 billion cubic meters. This source of water is unevenly distributed both spatially as well as temporarily. Most of the rainfall is confined to monsoon season, from June to September and levels of precipitation vary from 100 mm a year in western Rajasthan to over 9000 mm a year in north eastern state of Meghalaya. India's rivers carry 90 per cent of water during the period from June-November. Thus, only 10 per cent of the river flow is available during the other six months. The utilizable water resource availability in the country varies from 18417 cubic meters in Brahmaputra valley to as low as 180 cubic meters in the Sabarmati basin. Rajasthan has only one per cent of the country's water resources while Bihar has just five per cent of the water resources. At the Independence India's population was less than 400 million and per capita water availability over 5000 cubic meters per year. Today, the population has grown to over a billion and per capita water availability has fallen to hardly 2000 cubic meters per annum and actual usable quantity is around 1122 cubic meters per annum.

Groundwater is one of the most precious natural resource and has played a significant role in maintenance of India's economy, environment and standard of living. Besides being the primary source of water supply for domestic and many industrial usages, it is the single largest and most productive source of irrigation water. India is a very vast country having diversified geological climatologically and topographic setup, giving rise to

divergent groundwater situation in different parts of the country. The annual replenish able groundwater resource is estimated to be 433.02 BCM while net annual availability of groundwater is about 399.35 BCM. Most of the groundwater is being utilized for irrigation purposes. The state of groundwater development is only 58 per cent. However, in certain areas, it is as low as 0.18 per cent in Meghalaya. National Commission for Integrated Water Resource Development, 1999, had worked the gross water requirement for the future. It has been estimated that 843 BCM water will be required in the year 2025 in a high demand scenario from all the sources. Out of total requirement, 35.3 per cent is estimated to be the contribution from the groundwater source while the rest is estimated to be met from surface water source. Pushpangadan and Murugan (1998) are of the view that the concept of sustainability in economic development has been discussed and debated in the context of inter-generational equity. But its relevance to water resources development, especially for drinking water, is increasingly gathering momentum throughout the world.. Sustainability literally means 'keep going or maintain'.

The Central Groundwater Board has recorded a yearly drop of 2.5-3 mt. in groundwater levels of Ahmadabad urban areas where the rate of exploitation of city's aquifers is 1.23 per cent. The worst affected are the states of Rajasthan, Gujarat, parts of Andhra Pradesh and Western Madhya Pradesh where water was abundantly available 10-15 years ago. The groundwater table in these areas has fallen below 300 mt. now, and drought has become a yearly phenomenon (Pangare, et. al., 2006). As per estimates of 2004, 839 blocks were reported overexploited while 226 blocks were reported to be critical in terms of groundwater development. The proportion of overexploited blocks was reported high in Punjab, Delhi, Rajasthan, Tamil Nadu, Karnataka, Haryana and Andhra Pradesh. There has been gradual increase in the number of dark blocks in India during 1984-85 to 2004. The highest increase has been reported in the states of Andhra Pradesh, Karnataka, Madhya Pradesh, Rajasthan and Tamil Nadu Four Indian states viz. Punjab, Rajasthan, Haryana and Delhi are depleting at least 30 per cent more of their groundwater resources than previously estimated by government. The scientists report that these states have depleted on an average 17.7 BCM of water annually between August, 2002 and October, 2008. This is more than the government's estimates of 13.2 BCM in the same period. The groundwater depletion in the region was equivalent to a net, irreplaceable loss of 109 BCM, nearly 20 per cent of annual water consumption of 634 BCM

Environmental problems including water quality degradation from agro-chemicals, industrial and domestic pollution, ground water depletion, water logging, soil Stalinization, siltation, degradation of wastelands, eco system impacts and various health related problems have caused concern to policy makers and administrators. Thus, management of water resources is imperative

rather than development of the resources. Water borne diseases of a wide spectrum and are caused by direct transmission though water containing a variety of pathogens such as viruses, parasites or bacteria. These diseases are most commonly manifested as acute diarrhea, dysentery, dengue, malaria, hepatitis, typhoid and cholera. Water gets contaminated either at source or while passing through poorly laid and maintained water pipes or in the homes when it is not stored properly. A major contributing factor for the incidence of water borne diseases is lack of hygiene such as the absence of the habit of washing hands with soap after going to the toilet. Water quality can be affected by naturally occurring factors and by externally introduced pollutants. Natural water contains inorganic and organic matter, which may get dissolved in the water or remain as suspended particles. Inorganic matter is derived from the rocks and soils through which water percolate or over which it flows. Organic matter is derived from the breakdown of plant material or from algae and other micro organism that grow in the water or on sediments in the water. Natural pollutants are mainly arsenic, fluoride, iron, etc. while external pollutants include dumping of sewage, domestic waste, industrial effluents, nitrogen, pesticides and other chemicals into the water bodies. The extent of fluoride of contamination in water varies from 1 to 48 mg/l across the country. Delhi, Hyderabad, Chennai and Guwahati are reported to be fluoride affected cities of the country. Ground water in Andhra Pradesh has a maximum concentration of 7.83 mg/l. Almost 50 per cent of Delhi area, mostly the western parts, is affected by fluoride pollution, with levels of fluoride being 3 to 4 times higher than the desirable limits. Fluoride affected areas are concentrated in the states of Andhra Pradesh, Gujarat, Rajasthan, Bihar, Delhi, Haryana, Jharkhand, Karnataka, Orissa, Madhya Pradesh, Maharashtra, Tamil Nadu and Uttar Pradesh. India's Water Policy was introduced in 1987 and was amended in 2002. In future, demands for water would increase considerably both on account of rising population and their rising food and domestic water needs, and also on account of larger industrialization and changing life style. Even without climate change, many areas and basins are likely to become water stress. Thus, changes in water policy and evolving strategies for water management are imperative. Similarly, legal framework for coping with climate change is also to be amended. There is more need on institutional building to enhance capacity of the state governments and stake- holding agencies to cope up with climate change and also to regulate the water use for various purposes. More decentralized mechanism for water development and management will be required.

Water is one of the most abundant compounds found in nature, covering approximately three fourths of the surface of the earth. However, potable water availability is limited. Water is distributed in nature in different forms such as rainwater, river water, spring water and natural water. Rain water is in the purest form of naturally occurring water. However, the human activities

contribute impurities in the form of industrial and domestic wastes, agricultural chemicals and other contaminations. Water pollution may be defined as the presence of impurities in water in such quantity and of such nature as to impair the use of the water for a purpose. Water pollution may be classified mainly into four categories viz., physical pollution, chemical pollution, biological pollution and physiological pollution. The physical pollution of water brings about changes in water with regard to its colour, order, density, taste, turbidity and thermal properties etc. The chemical pollution of water is due to the presence of inorganic and organic chemicals such as acids, alkalis, toxic inorganic compounds, dissolved inorganic compound and dissolved organic compounds..

Water pollution is a phenomenon that is characterized by the deterioration of the quality of land water (rivers, lakes, marches and ground water) or sea water as a result of various human activities. Water pollution is any physical or chemical change in the water that can adversely affect organisms. The major sources of water pollution include (i) sewage and domestic wastes; (ii) industrial effluents; (iii) agricultural discharges; (iv) fertilizers; (v) agro chemicals – pesticides, insecticides, fungicides, etc.; (vi) detergents; (vii) toxic metals; (viii) siltation; (ix) thermal pollutants; (x) radio-active materials. Water pollution can be defined as any unfavourable change in physical, chemical and biological properties of water that makes it harmful to humans and other life forms. Human actions reduce the use of water as a resource. However, the decrease in usefulness is in a relative term. Water borne diseases of a wide spectrum and are caused by direct transmission though water containing a variety of pathogens such as viruses, parasites or bacteria. These diseases are most commonly manifested as acute diarrhoea, dysentery, dengue, malaria, hepatitis, typhoid and cholera. Water gets contaminated either at source or while passing through poorly laid and maintained water pipes or in the homes when it is not stored properly. A major contributing factor for the incidence of water borne diseases is lack of hygiene such as the absence of the habit of washing hands with soap after going to the toilet. In Indian villages, 60 to 65 per cent women have gynaecological disorders from lack of hygiene, lack of water for cleaning and the use of community ponds for bathing (Gram Vikas (2001),

Objectives and Methods

The present paper aims at examining the status of water resources in East Champaran district of Bihar in the context of sustainable management of water resources in rural areas. The paper is based on primary data collected through field survey with the help of structured interview schedule. The filed survey was conducted in 10 development blocks viz Chakia, Turkoliya, Motihari, Kotwa, Kalyanpur, Sangrampur, Harsidhi, Paharpur, Mehasi, and Kesaria . The sample comprises of 189 villages and 545 households. The analysis of data has been ensured through use of SPSS package

Research Findings

More than 3/4th respondents revealed that major heads of water consumption in family is bathing while slightly less than half of the respondents reported cleaning of utensils as major head of water consumption. Similarly, less than 1/4th respondents revealed that cleaning of clothes is the major head of water consumption in family. A large proportion of respondents in Kalyanpur and Chakia also reported that gardening is the major head of water consumption in family. The respondents were asked that whether they have rainwater harvesting system in their house (Table 1) .

Table: 1

Water Consumption Except Agriculture In Family

Block	*Bath*	*Cleaning Of Utensils*	*Cleaning Of Floors*	*Gardening*	*Others*
Chakia	54	42	39	9	9
	100.0%	77.8%	72.2%	16.7%	16.7%
Turkoliya	27	18	15	3	22
	46.6%	31.0%	25.9%	5.2%	37.9%
Motihari	39	21	12	0	12
	68.4%	36.8%	21.1%	0.0%	21.1%
Kotwa	46	6	9	0	28
	100.0%	13.0%	19.6%	0.0%	60.9%
Kalyanpur	18	9	12	9	24
	37.5%	18.8%	25.0%	18.8%	50.0%
Sangrampur	48	3	3	0	48
	94.1%	5.9%	5.9%	0.0%	94.1%
Harsidhi	41	41	3	0	12
	69.5%	69.5%	5.1%	0.0%	20.3%
Paharpur	52	31	28	0	18
	94.5%	56.4%	50.9%	0.0%	32.7%
Mehasi	39	30	9	3	18
	68.4%	52.6%	15.8%	5.3%	31.6%
Kesaria	57	57	0	0	3
	95.0%	95.0%	0.0%	0.0%	5.0%
Total	421	258	130	24	194
	77.2%	47.3%	23.9%	4.4%	35.6%

Source: Field Survey

About 14 per cent respondents revealed that they have rain water harvesting system in their house. It was found more pronouncing in Turkoliya

(32.8 per cent) followed by Kalyanpur (31.2 per cent), Mehasi (26.3 per cent) and Harsidhi (25.4 per cent). Most of the respondents reported that they are taking drinking water from hand pumps. However, a significant proportion of respondents in Motihari, Turkoliya and Mehasi reported that they are taking drinking water from supply network (Table 2) .

Table: 2

Rain Water Harvesting System In House

Block	*Yes*	*No*	*Total*
Chakia	0	54	54
	0.0%	100.0%	100.0%
Turkoliya	19	39	58
	32.8%	67.2%	100.0%
Motihari	12	45	57
	21.1%	78.9%	100.0%
Kotwa	0	46	46
	0.0%	100.0%	100.0%
Kalyanpur	15	33	48
	31.2%	68.8%	100.0%
Sangrampur	0	51	51
	0.0%	100.0%	100.0%
Harsidhi	15	44	59
	25.4%	74.6%	100.0%
Paharpur	0	55	55
	0.0%	100.0%	100.0%
Mehasi	15	42	57
	26.3%	73.7%	100.0%
Kesaria	0	60	60
	0.0%	100.0%	100.0%
Total	**76**	**469**	545
	13.9%	86.1%	100.0%

Source: Field Survey

About 83 per cent respondents reported that testing of water quality by government agency is uncertain. However, a significant proportion of respondents in Turkoliya and Kalyanpur reported that testing of water quality is being done twice a year. Similarly, a significant proportion of respondents in Turkoliya and Kalyanpur further reported that testing of water quality is being conducted thrice a year (Table 3) . .

Table: 3

Frequency of Testing of Water Quality In Region By Government Agency

Block	*Once In A Year*	*Twice A Year*	*Thrice A Year*	*Not Certain*	*Total*
Chakia	0	0	0	54	54
	0.0%	0.0%	0.0%	100.0%	100.0%
Turkoliya	12	18	13	15	58
	20.7%	31.0%	22.4%	25.9%	100.0%
Motihari	3	3	6	45	57
	5.3%	5.3%	10.5%	78.9%	100.0%
Kotwa	0	0	0	46	46
	0.0%	0.0%	0.0%	100.0%	100.0%
Kalyanpur	6	15	9	18	48
	12.5%	31.2%	18.8%	37.5%	100.0%
Sangrampur	0	0	0	51	51
	0.0%	0.0%	0.0%	100.0%	100.0%
Harsidhi	0	0	0	59	59
	0.0%	0.0%	0.0%	100.0%	100.0%
Paharpur	0	0	0	55	55
	0.0%	0.0%	0.0%	100.0%	100.0%
Mehasi	0	3	3	51	57
	0.0%	5.3%	5.3%	89.5%	100.0%
Kesaria	0	0	0	60	60
	0.0%	0.0%	0.0%	100.0%	100.0%
Total	**21**	**39**	**31**	**454**	**545**
	3.9%	**7.2%**	**5.7%**	**83.3%**	**100.0%**

Source: Field Survey.

Disposal of waste water is a major public health problem in rural areas. Stagnant waste water smells bad and also acts as breeding place for mosquitoes resulting in spread of diseases like dengue, malaria, filaria etc. Proper disposal and also reuse of waste waster wherever possible will help in combating diseases as well as meeting water scarcity There are two types of waste water generated. These are: (1) grey water from bathroom, washing of clothes and kitchen. Depending on its use, water can require less treatment than black water and generally contains fewer pathogens. Treated water can be reused for garden watering, fodder raising and kitchen gardening, (2) black water hat has been mixed with waste from the toilet. Black water requires biological or chemical treatment and disinfection before re-use.

About half of the respondents reported that major source of irrigation is tube wells. It was found more pronouncing in Kesaria followed by Chakia and Mehasi. More than 2/5th respondents reported that tanks and other sources of irrigation are prevalent in the area. Canal as a source of irrigation was found significant in Kalyanpur, Paharpur, Turkoliya and Harsidhi. About 2/3rd respondents reported that water resources are sensitive due to climate change. It was found more pronouncing in Kotwa followed by Chakia, Sangrampur, Paharpur and Motihari (Table 4). .

Table: 4

Major Sources of Irrigation

Block	*Tube Wells*	*Canal*	*Pond/Lake*	*Others*	*Total*
Chakia	45	0	0	9	54
	83.3%	0.0%	0.0%	16.7%	100.0%
Turkoliya	21	6	6	25	58
	36.2%	10.3%	10.3%	43.1%	100.0%
Motihari	27	3	3	24	57
	47.4%	5.3%	5.3%	42.1%	100.0%
Kotwa	9	3	0	34	46
	19.6%	6.5%	0.0%	73.9%	100.0%
Kalyanpur	21	9	3	15	48
	43.8%	18.8%	6.2%	31.2%	100.0%
Sangrampur	3	0	0	48	51
	5.9%	0.0%	0.0%	94.1%	100.0%
Harsidhi	33	6	0	20	59
	55.9%	10.2%	0.0%	33.9%	100.0%
Paharpur	22	6	0	27	55
	40.0%	10.9%	0.0%	49.1%	100.0%
Mehasi	36	0	0	21	57
	63.2%	0.0%	0.0%	36.8%	100.0%
Kesaria	60	0	0	0	60
	100.0%	0.0%	0.0%	0.0%	100.0%
Total	**277**	**33**	**12**	**223**	**545**
	50.8%	**6.1%**	**2.2%**	**40.9%**	**100.0%**

Source: Field Survey.

About 18 per cent respondents further reported that water resources are very sensitive due to climate change. It was found more pronouncing in Kesaria (50 per cent) followed by Harsidhi (35.6 per cent), Turkoliya (31 per cent) and Mehasi (21.1 per cent). Thus, about 37 per cent respondents in Kalyanpur, 31 per cent respondents in Kesaria and 36.8 per cent respondents in Mehasi

reported that water resources are either slightly sensitive or not sensitive due to climate change (Table 5).

Table: 5

Level of Sensitivity of Water Resources Due To Climate Change

Block	*Very Sensitive*	*Sensitive*	*Slightly Sensitive*	*Not Sensitive*	*Total*
Chakia	0	54	0	0	54
	0.0%	100.0%	0.0%	0.0%	100.0%
Turkoliya	18	31	0	9	58
	31.0%	53.4%	0.0%	15.5%	100.0%
Motihari	6	45	0	6	57
	10.5%	78.9%	0.0%	10.5%	100.0%
Kotwa	0	46	0	0	46
	0.0%	100.0%	0.0%	0.0%	100.0%
Kalyanpur	9	21	6	12	48
	18.8%	43.8%	12.5%	25.0%	100.0%
Sangrampur	0	48	3	0	51
	0.0%	94.1%	5.9%	0.0%	100.0%
Harsidhi	21	30	2	6	59
	35.6%	50.8%	3.4%	10.2%	100.0%
Paharpur	3	49	0	3	55
	5.5%	89.1%	0.0%	5.5%	100.0%
Mehasi	12	24	15	6	57
	21.1%	42.1%	26.3%	10.5%	100.0%
Kesaria	30	12	12	6	60
	50.0%	20.0%	20.0%	10.0%	100.0%
Total	99	360	38	48	545
	18.2%	66.1%	7.0%	8.8%	100.0%

Source: Field Survey.

Water scarcity has emerged, especially during the past decade, as an important theme in discussions on India's socio-economic future. Water is an essential resource for all life on the planet. As time advances, water is becoming scarcer and having access to clean, safe, drinking water is limited among countries. Water is a key driver of economic and social development while it also has a basic function in maintaining the integrity of the natural environment. However water is only one of a number of vital natural resources and it is imperative that water issues are not considered in isolation. Groundwater resources are showing increasing signs of over-development

in India. There are several factors contributing to the over-development of groundwater resources. They are lack of well-defined property rights, presence of subsidised energy for groundwater extraction, easy access to institutional financing for well development and rural electrification. Scarcity of water puts major constraints on increasing food production for the growing population, economic growth, and protection of social and environmental goals. Added to this, the growing competition and conflicts over sharing of shrinking resource result in water scarcity to emerge as a major source of threat to social security and protection of ecosystems. About 20 per cent respondents accepted that they are using drip irrigation system (Table 6). . It was found more pronouncing in Kalyanpur (50 per cent) followed by Chakia (44.4 per cent) and Turkoliya (43.1 per cent). Slightly more than 1/4th respondents reported that they grow crops which consume less water. It was found more pronouncing in Kalyanpur (75 per cent) followed by Chakia (66.7 percent), Turkoliya (43.1 per cent) and Motihari (31.6 per cent).

Table: 6

Whether You Use Sprinkle / Drip Irrigation System

Block	*Yes*	*No*	*Cannot Say*	*Total*
Chakia	24	24	6	54
	44.4%	44.4%	11.1%	100.0%
Turkoliya	25	33	0	58
	43.1%	56.9%	0.0%	100.0%
Motihari	12	36	9	57
	21.1%	63.2%	15.8%	100.0%
Kotwa	0	46	0	46
	0.0%	100.0%	0.0%	100.0%
Kalyanpur	24	21	3	48
	50.0%	43.8%	6.2%	100.0%
Sangrampur	3	48	0	51
	5.9%	94.1%	0.0%	100.0%
Harsidhi	14	42	3	59
	23.7%	71.2%	5.1%	100.0%
Paharpur	3	46	6	55
	5.5%	83.6%	10.9%	100.0%
Mehasi	6	45	6	57
	10.5%	78.9%	10.5%	100.0%
Kesaria	0	60	0	60
	0.0%	100.0%	0.0%	100.0%
Total	**111**	**401**	**33**	**545**
	20.4%	**73.6%**	**6.1%**	**100.0%**

Source: Field Survey.

Conclusion

It is imperative to establish and strengthen ground water monitoring network through construction of observation wells, sanctuary wells for coastal aquifer management and water quality monitoring. It is imperative to establish and strengthen ground water monitoring network through construction of observation wells, sanctuary wells for coastal aquifer management and water quality monitoring . State specific water policies need to be prepared. Ground water legislation needs to be promulgated in all states to promote sustainable water uses and water development. Emphasis should be given to developing surface water use and taking measures for rainwater harvesting to increase water resource availability It must be made mandatory to install rainwater harvesting systems in both public and private buildings, including industrial and commercial establishments. Buildings having a courtyard should allocate a prescribed proportional area for rainwater harvesting and recharging. The ULBs should make ensure such provisions before approving building plans. It is high time to review the National Water Policy with a view to ensure integrated water resource management in the context of climate change challenges in water sector. It must be made mandatory to install rainwater harvesting systems in both public and private buildings, including industrial and commercial establishments. Buildings having a courtyard should allocate a prescribed proportional area for rainwater harvesting and recharging. The ULBs should make ensure such provisions before approving building plans.

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