Water Resource in India: Considerable Empirical Evidence

C. Parvathi
Assistant Professor (SG), Department of Economics, Avinashilingam Institute for Home Science and Higher education for Women, Coimbatore.

D. Yajanthini
M. Phil., Research Scholar, Department of Economics, Avinashilingam Institute for Home Science and Higher education for Women, Coimbatore.

Abstract: *Water is one of the precious natural resource; each and every living thing needs water to survive. By the mid-twenty first century, surface temperature in India may increase by 3^0 C to 4^0 C, leading to noticeable variability in the monsoon pattern, decreased number of rainy days, and an increase in flooding and intensity of droughts. This will seriously affect the food grain production, environment and life sustaining ecosystems in India. India receives annual precipitation of about 4000Km, including snowfall. Out of this, monsoon rainfall is of the order of 3000Km. In this background, the study is based on secondary data sources. Average consumption around the world is about 53 liters per head per day. In India, we expect to soon have only about 20 liters available per head per day. We have had droughts for a long time, and now with global climate change, things will become even more difficult. The annual potential natural ground water recharge from rainfall in India is about 342.43Km, which is 8.56 percent of total rainfall of the country. The estimates indicate that by the year 2025, the water requirements are irrigation 561Km for low demand scenario and 611Km for high demand scenario. These requirements likely to further increase to 628Km for low demand scenario and 807Km for high demand scenario by 2050.Water resource management is a very important issue with regard to the conservation and the protection of water. This study concludes that government should come up with a new water policy prescribing the role and involvement of individuals, community and government for conservation of water.*

Introduction

Water is one of the precious natural resource; each and every living thing needs water to survive. Water resources of a country constitute one of its vital assets. Water resources are sources of water that are useful or potentially useful. Virtually all of these human uses require fresh water. But 97.5% water on earth is salt water and only 2.5 percent is fresh water. It is in different forms such as 68.7% in the form of glaciers, 30.1 is in the form of ground water and the remaining 8% is in the form of 0.8% is permafrost. Out of the available surface water 67.4% is in lakes, 12.2% in the form of soil moisture, 9,5 percent is under wetlands, 1.6 percent is flowing through rivers and the remaining 0.8 percent is in plants and animals slightly over two thirds is frozen in glaciers and polar ice caps. The remaining unfrozen fresh water is mainly found as groundwater, with only a small fraction present above ground or in the air. Uses of water include agricultural, industrial, household, recreational and environmental activities.

Water is essential for sustaining all forms of life, food, production, economic development and general well-being. Water is a unique substance. It is one of the few materials on the earth that exists naturally as a solid, liquid or gas it is not possible for life on earth to exist without water. Scientists estimate that there are over one billion cubic kilometers of water on this earth which covers nearly three fourth of the earth's surface. Though this seems an inordinately huge amount in actual fact, less than 1 percent is fresh and usable and is found in lakes, ponds, rivers and ground water of the remaining, 97 per cent is found in oceans and 2 per cent is locked up in glaciers and ice-caps. By the mid-twenty-first century, surface temperature in India may increase by 3^0 to 4^0 C, leading to noticeable variability in the monsoon pattern, decreased number of rainy days, and an increase in flooding and intensity of droughts. This will seriously affect the food grain production, environment and life sustaining ecosystem in India.

Background of the study

Agriculture is not only one of the important sources of greenhouse gas emission and climate change, it is also a victim of the climate change[1]. As a major source of greenhouse gas emissions, agriculture has much untapped potential to reduce emissions through reduced deforestation and changes in land use and agricultural practices (Intergovernmental panel on Climate Change-IPCC, 2007). There are grave ill-effects of climate changes apart from higher average temperatures. Changes like more intense droughts, floods, and greater temperature variability may result in productivity losses to crop. Agriculture will be damaged by flooding and increased saline ingress into surface and groundwater water, as sea level rises. Less precipitation will reduce the availability of water for irrigation particularly in semi-arid regions.

Current status of water in India

Water and its availability are major causes of concern among all segments of India's society. Linking of rivers, rain harvesting, artificial recharge and desalinization are actively advanced as solutions to water problems. View against the backdrop of the hydrological cycle all these remedies has potential to alleviate water problems in limited ways. However there are no simple or easy solutions for the challenges that confront water management on a national scale. From a science perspective, the inevitable conclusion is that India's economic future will be in jeopardy without an evidence based water policy. The reality of India's water setting is that water availability to finite, subject or uncertainty in time. Bound by these constraints water has to be shared among all segments of society, with the needs of future generations in mind. To constraints imposed on the resource by nature. Table -1 explains the annual water requirements for different uses.

[1] Agriculture, argues Stern (2007), is responsible for about 14 percent of global greenhouse gases emissions. The major emitters are fertilizers (N_2O), livestock (CH_4), cultivation of field crops (N_2O and CH_4), and manures (CH_4 and N_2O).

It is the primary ingredient to our beverages. India faces a flood-drought syndrome where one third of the country is prone to drought and over one eight is liable to flooding. India receives annual precipitation of about 4000 km, including snowfall. Out of this, monsoon rainfall is of the order of 3000km. Rainfall in India is depending on the south-west and north east monsoons. The Himalayas are the major source of water for south Asian perennial rivers. The Ganga-Bhrahmaputra- Meghana river basins provide 60% of India's river follow occupying 33% of geographical areas.

Table 1: Annual Water Requirements for Different Uses (in km.)

Use	1997-98	Low	2010 High	%	Low	2025 High	%	Low	2050 High	%
Surface water										
Irrigation	318	330	339	48	325	366	43	375	463	39
Domestic	17	23	24	3	30	36	5	48	65	6
Industries	21	26	26	4	47	47	6	57	57	5
Power	7	14	15	2	25	26	3	50	56	5
Inland navigation	7	7	1	10	10	1	15	15	1	-
Environment-ecology	5	5	1	10	10	1	20	20	2	-
Evaporation losses	36	42	42	6	50	50	6	76	76	6
Total	399	447	458	65	497	545	656	641	752	64
Ground water										
Irrigation	206	213	218	31	236	245	29	253	344	29
Domestic	13	19	19	2	25	26	3	42	46	4
Industries	9	11	11	1	20	20	2	24	24	2
Power	2	4	4	1	6	7	1	13	14	1
Total	230	247	252	35	287	298	35	332	428	36
Grand total	629	294	710	100	784	843	100	973	1180	100
Total water use										
Irrigation	524	543	557	78	561	611	72	628	807	68
Domestic	30	42	43	6	55	62	7	90	111	9
Industries	30	37	37	5	67	67	8	81	81	7
Power	9	18	19	3	31	33	4	63	70	6
Inland navigation	0	7	7	1	10	10	1	15	15	1
Environment-ecology	0	5	5	1	10	10	1	20	20	2
Evaporation losses	36	42	42	6	50	50	6	76	76	7
Total	629	694	710	100	784	843	100	973	1180	100

Source: NCIWRD, (2013)

Matters and Materials

In India per-capita surface water availability in the years 1991 and 2001 were 2309 and 1902m and these are projected to reduce to 1401 and 1191m by the years 2025 and 2050 respectively. Hence, there is a need for proper planning development and management of the greatest assets of the country viz., water and land resources for raising the standards of living of the millions of people particularly in rural areas. Hydrological Cycle describes the continuous movement of water on, above and below the surface of earth. It plays an unparalleled role in the geographical as well as biological evolution of the earth. The hydrological cycle may be thought to be made up of four interacting components viz., atmosphere, surface water, soil water and ground water. The hydrological cycle is being modified quantitatively and qualitatively in most of the river basins of our country as a result of the developmental activities such as construction of dams and reservoirs etc. Around 70 per cent of India's irrigation needs and 80 per cent of its domestic water supplies come from ground water. A large part of agriculture is dependent on non-renewable ground water. The annual potential natural ground water recharge from rainfall in India about 342.43 km, which is 85.6 percent of the total rainfall of the country. The annual potential groundwater recharge augmentation from canal irrigation system is about 89.46km. The research study is exploratory in nature. As the topic is a need of the hour, the initiatives taken up by different institutions and their new methods and programmes on water conservation and management were observed and revealed through this research. The necessary data were collected from the available secondary sources such as annual reports, journals and the websites of different governmental portals.

Table 2 explains the Central Ground Water Board (CGWB) estimates such as state wise total replenishable ground water resource provision for domestic, industrial' and irrigation uses and utilizable groundwater resources for future. Now comes the most shocking finding, NASA scientists in the US using satellites to tract ground water loss in India North Western grain basket, have found that there has been an average 33 cubic km a year drop in the water table in this region much higher that the Indian government states.

India’s economy and societal infrastructures, argues Stern (2006), are vulnerable to even small changes in monsoon rainfall. Climate change may increase the intensity of heavy rainfall events-the Mumbai floods of 2005 may be an example – while the number of rainy days may decrease. For example, mean yields for some crops in northern India could be reduced by up to 70 percent by 2100. This is set against a background of a rapidly rising population that will need an additional 5 million tons of food production per year just to keep pace with the predicted increase in population to about 1.5 billion by 2030. The impact of climate change on agriculture could result in problems with food security and may threaten the livelihood activities on which much of the population depends. Climate change can affect crop yields as well as the types of crops that can be grown in certain areas, by impacting agricultural inputs such as water for irrigation, amounts of solar radiation that affect plant growth, as well as the prevalence of pests.

Implications of climate change on Indian agriculture are modeled by individuals (shiva, 2009), government institutions (IARI, 2008) as well as international agencies (World Bank, 2008). The rise in global temperature owing to climate change will affect agriculture in strikingly different ways in the lower and higher latitudes. While in productivity, it will have adverse effects in India and other countries in the tropics. The summer monsoon, which accounts for nearly 75 percent of India’s rainfall, is critical for agriculture. Climate change is likely to intensify the variability of summer monsoon dynamics, leading to a rise in extreme events such as increased precipitation and heightened flood risks in some parts of the country and reduced rainfall and prolonged drought in other areas.

Water Resources in India

India occupies only 3.29 million km geographical area, which forms 2.4 per cent of the world's land area. It supports over 15 per cent of the world population. The population of India is 100.2 corers. Thus, India supports 1/6th of world population, 1/50th of worlds land and 1/25th of world's water resources. India is endowed with a rich and vast diversity of water resources. India has seasonal rainfall with high temporal and spatial variability. 50 per cent of precipitation falls in just 15 days and over 90 per cent of river flows in just four month. In pre 20th century India had community level water resource management practices in place, across regions India's irrigation and water supply services are in poor shape. Urban India heavily depends upon ground water sources to meet 'water requirements.

Table 2: State Wise Availability of Ground Water Resources

S.No	States	Total Replenishable Groundwater Resource BCM/yr	Provision for Domestic, Industrial & Other uses BCM/yr	Available Groundwater Resource for Irrigation BCM/yr	Net Draft BCM/yr	Balance Groundwater Resource for Future use BCM/yr	Level of Ground water Development [%]
1.	Andhra Pradesh	35.29	5.29	30.00	8.57	21.43	28.56
2.	Arunachal Pradesh	1.44	0.22	1.22	-	1.22	Neg
3.	Assam	24.72	3.71	21.01	1.84	19.17	8.75
4.	Bihar	26.99	4.05	22.94	10.63	12.31	46.33
5.	Chattisgarh	16.07	2.41	13.66	0.81	12.85	5.93
6.	Delhi	0.29	0.18	-	0.12	-	-
7.	Goa	0.22	0.33	0.19	0.02	0.17	8.30
8.	Gujarat	20.38	3.06	17.32	9.55	7.77	55.16
9.	Haryana	8.53	1.28	7.25	8.13	0.00	112.18
10.	Himachal Pradesh	0.37	0.77	0.29	0.03	0.26	10.72
11.	Jammu & Kashmir	4.43	0.66	3.76	0.03	3.73	0.81
12.	Jharkhand	6.53	0.98	5.55	1.84	3.71	33.13
13.	Karnataka	16.19	2.43	13.76	4.76	9.00	34.60
14.	Kerala	7.90	1.31	6.59	1.46	5.13	22.17
16.	Maharashtra	37.87	12.40	25.47	9.44	16.04	37.04
17.	Manipur	3.15	0.47	2.68	Neg	2.68	Neg
18.	Meghalaya	0.54	0.88	0.46	0.02	0.44	3.97
19.	Mizoram	Under estimation					
20.	Nagaland	0.72	0.11	0.62	Neg	0.62	Neg
21.	Orissa	20.00	3.00	17.00	3.61	13.39	21.23
22.	Punjab	18.66	1087	16.79	16.40	0.00	97.66
23.	Rajasthan	12.71	1.99	10.71	9.26	1.45	86.42
24.	Sikkim	Under estimation					
25.	Tamil Nadu	26.39	3.96	22.43	14.45	7.98	64.43
26.	Tripura	0.66	0.10	0.56	0.19	0.38	33.43
27.	Uttar Pradesh	81.12	12.17	68.95	32.33	36.62	46.89
28.	Uttaranchal	2.70	0.41	2.29	0.82	1.47	35.78
29.	West Bengal	23.09	3.46	19.63	7.50	12.13	38.19
30.	Total States	431.77	70.92	360.73	149.82	211.53	41.53

Source: Sacratees.S, et.al.,(2014)

Union Territories							
S.No	**Union Territories**	**Total Replenishable Groundwater Resource BCM/yr**	**Provision for Domestic, Industrial & Other uses BCM/yr**	**Available Groundwater Resource for Irrigation BCM/yr**	**Net Draft BCM/yr**	**Balance Groundwater Resource for Future use BCM/yr**	**Level of Ground water Development [%]**
1.	Andaman & Nicobar	Under estimation					
2.	Chandigarh	0.030	-	-	0.025	-	-
3.	Dadar & Nagar Haveli	0.042	0.006	0.04	0.005	0.031	12.81
4.	Daman & Diu	0.013	0.002	0.01	0.008	0.003	70.00
5.	Lakshadweep	0.002	-	-	0.007	-	-
6.	Podicherry	0.029	0.004	0.02	0.116	0.000	-
7.	Total UTs	0.116	0.013	0.071	0.160	0.035	-
8.	Grand Total	431.88	70.93	360.80	149.97	211.56	41.57

India with an area of about 3290 billion square meters, receives about 1200rnim if rainfall annually, that is 4000 billion cubic meters of volume of water. In 1991 the availability of water is measure at 2209cum. By the year 2000, it was around 1865cum. It has been recently estimated that by 2025 India will be 'Water stressed', per capita availability will decline to 1342cum. There is considerable scope for increasing the utilization of water in the Ganga-Brahmaputra basins by construction of storages at sustainable locations in neighboring countries. Table three explains the basin wise average utilizable surface water and flow.

Variations in climatic characteristics both in space and time are responsible for uneven distribution of precipitation in India. This uneven distribution of the precipitation results in highly uneven distribution of available water resources both in space and time, which leads to floods and drought affecting the vast areas of the country.

Climate change has an effect on the monsoons too. India is heavily depending on the monsoons to meet its agricultural and water needs. Indian climate is dominated by the south west monsoons which brings most of the regions precipitation (Dhulasi Birundha.B., 2008). Table 4 explains the distribution of rain fall in India.

Water Consumption in India

Average water consumption around the world is about 53 liters per head per day. In India, we expect to soon have only about 20 liters available per head per day. We have droughts for a long time and now with global climate change; things will become even more difficult. The glaciers are receding from the Himalayan Mountains. They are about one fifth the sizes they were about 60 years ago. The waters from the Himalayan glaciers provide water for about 70 percent of all the people in Asia. In India, we have three major rivers -the Indus, Ganges, and Brahmaputra and it is likely that they will drain to small rivers. In most of northern India, there will be no water according to some leading water experts. Right now there are floods. The flood area has increased from 25 million hectares to 60 million hectares in the last 30 years. That is an indication that the water is draining away, and these will become dry areas, this is expected to happen in less than 30 years. Table 5 explains water resources in India, availability of water and sustainable index.

Table 3: Basin wise average utilizable surface water and flow (in km/year)

S.No	River basin	Average annual flow	Utilizable flow
1.	Indus	73.31	46
2.	Ganga-Brahmaputra-Meghna Basin (a) Ganga	525.02	250
3.	(b) Brahmaputra sub-basin	629.05	24
4.	(c) Meghana (Barak) sub-basin	48.36	-
5.	Subarnarekha	48.36	-
6.	Bhrahmni-Baitarani	13.37	6.81
7.	Mahanadi	28.48	18.3
8.	Godavari	66.88	49.99
9.	Krishna	110.54	76.3
10.	Pennar	69.81	58
11.	Cauvery	6.32	6.86
12.	Tapi	21.36	19
13.	Narmada	14.88	14.5
14.	Mahi	45.64	34.5
15.	Sabarmati	11.02	3.1
16.	West flowing rivers of Kachchh and Saurashtra including Luni	3.81	1.93
17.	West flowing rivers south of Tapi	15.1	14.98
18.	East flowing rivers between Mahanadi and Godavari	200.94	36.21
19.	East flowing rivers between Godavari and Krishna	17.08	-
20.	East flowing rivers between Krishna and Pennar	1.81	13.11
21.	East flowing rivers between Pennar and Cauvery	3.63	-
22.	East flowing rivers south of Cauvery	9.98	16.73
23.	Area of north Ladakh not draining into Indus	6.48	NA
24.	Rivers draining into Bangladesh	8.57	NA
25.	Rivers draining into Myanmar	22.43	NA
26.	Drainage areas of Andaman, Nicobar and Lakshadweep Islands	0	NA
	Total	1953	690

Source: Sacratees.S, et.al.,(2014)

Table 4: Distribution of Rainfall in India

S.No	Seasons	Months	Percentage of distribution
1.	Pre-monsoon	March-May	10.4
2.	South-west monsoon	June-September	73.4
3.	Post-monsoon	October-December	13.3
4.	Winter rains	January-February	2.9

Source: Suryanarayana,B.(2013)

Table 5: Water Resources in India

Description	Unit in (BCM)	Percentage
Total precipitation (snow and rain)	**4000**	**100**
Seasonal rainfall	**3000**	**75**
Total water availability	**1869**	**46.7**
Total annual utilizable water	**1123**	**28.1**
Surface water	**690**	**17.3**
Ground water	**433**	**10.8**

AVAILABLE WATER			
Year	**Population crores**	**Available water**	**Remarks**
1991	**84.6**	**2209**	**No stress**
2000	**100.2**	**1865**	**No stress**
2025	**139.3**	**1342**	**Stress**

Source: GCWB(2014)

SUSTAINABILITY INDEX	
Sustainability Index(Cum/Capital/yr)	**Conditions**
More than 1700	**No stress**
1000 to 1700	**No stress**
500 to l000	**Scarcity**
Less than 500	**Acute scarcity**

Water Resource Management

Water resource management is a very important issue with regard to the conservation and the protection of water. Water demand management is meant to manage the available water resources wisely and to deliver the necessary amount for sustainable development. In these include environment conservation with inter and intro generation equity in mind while any policy of conservation is formulated. Unfortunately, water management remains a completely neglected area in our country.

Water Requirement

Indian economy is an agriculture based economy. Hence development of irrigation facilities in order to increase agriculture production for making the country self-sustained in food grains production, and for poverty alleviation programmes has been of crucial importance for the planners. Long term planning has been account for the growth of population. According to NCIWRD estimates the Indian population is expected to be 1333 million in high growth scenario by 2025. In the same way high rate of population growth is likely to result in about 1581 million by the year 2050. Keeping in view the level of consumption, losses in storage and transport, seed requirement, and buffer stock, the projected food-grain and feed demand for 2025 would be 320 million tons and 308 million tons. The requirements of food grains for the year 2050 would be 494 million tons. Table six explains the per capita per year availability and utilizable surface water in India.

Table 6: Per Capita per Year Availability and Utilizable Surface Water in India

Year	Population (in millions)	Per-capita surface water availability	Per-capita utilizable surface water
1951	361	5410	1911
1955	395	4944	1746
1991	846	2309	816
2001	1027	1902	672
2025	a.1286 (low growth)	1519	495
	b.1333 (high growth)	1465	
2050	a.1346 (low growth)	1451	421
	b.1581 (high growth)	1235	

Source: NCIWRD, (2013).

The current crisis could have been avoided with well-planned and better water management practices instead of treating water as an unlimited free gift of Nature Over the years, there has been a distinct lack of attention to water legislation, water conservation, efficiency in water use, water recycling and infrastructure. Fortunately, India gets fairly good rainfall at about 46 inches per annum But almost 50 per cent of it falls within a span of 15 days and 90 per cent of the rain-water run-off occurs in just four months. Only about 15 per cent of the annual rain water is used for irrigation it this water is properly stored used for sustained surface irrigation, it could help solve the country's future agriculture problems and also reduce excessive pressure on ground water) According to reports, Planning Commission has prepared a draft report for an integrated water management policy aimed at easing scarcity for irrigation, industrial, municipal and drinking purposes It suggests setting up a regulator to allocate and price water for farmers, improve data collection, and mandate the recharge of water through check-dams, ponds, etc.

Table seven explains the detailed information of basin wise average flow and utilizable water of India.

Adaptation actions and investments provide a cost-effective way of addressing future climate risks. India has considerable technical and scientific expertise to understand, analyse and act on climate risks. There are many encouraging initiatives and policy reforms that are moving in the right direction.

Table 7: Basin Wise Average Flow and Utilizable Water (in km/year)

S.No	River basin	Average annual flow	Utilizable flow
1.	Indus	73.31	46
2.	Ganga-Brahmaputra-Meghna Basin		
2.A	Ganga	525.02	250
2.B	Brahmputra	629.05	24
2.C	Meghna-sub-basin	48.36	-
3.	Subarnarekha	12.37	6.81
4.	Brahmni-Baitrani	28.48	18.3
5.	Mahanadi	66.88	49.99
6.	Godavari	110.54	76.3
7.	Krishna	69.81	58
8.	Pennar	6.32	6.86
9.	Cauvery	21.36	19
10.	Tapi	14.88	14.5
11.	Narmada	45.64	34.5
12.	Mahi	11.02	3.1
13.	Sabarmathi	3.81	1.93
14.	West-flowing rivers of kachchh and saurashtra including luni	15.1	14.98
15.	West flowing rivers Tapi	200.94	36.21
16.	East flowing rivers between Mahanadhi and Godavari	17.08	-
17.	East flowing rivers between Godavari and Krishna	1.81	13.11
18.	East flowing rivers between Krishna and Pennar	3.63	-
19.	East flowing rivers between pennar and Cauvery	9.98	16.73
20.	East flowing rivers south of Cauvery	6.48	
21.	Areas of north ladakh not draninmg into Indus	0	NA
22.	Rivers draning into Bangladesh	8.57	NA
23.	Rivers draning into mayanmar	22.43	NA
24.	Dranage areas of Andman,Nicobar and Lakshadweep islands	0	NA
Total (rounded)		1953	690

Source: Suryanarayana,B. (2013)

Future line of work for water conservation

- Need for efficient management practices such as adoption of improved technologies such as drought tolerant varieties, use of drip or sprinkler irrigation systems and mulching techniques in agriculture, preserving water quality, protecting water catchment areas etc.
- Incentives farmers for up taking of conservation practices and discouraging water waste in their fields.
- Encouragement of research and development on global climate change.

Conclusion

Water is one of the most essential natural resources for sustaining life and it is likely to become critically scarce in the coming decades, due to continuous increase in its demands, rapid increase in population and expanding economy of the country. The escalation of a water crisis in the world is due essentially to the unsustainable use and management of water resources and destruction of ecosystem. For maintaining ecological balance and for economic and development activities of all kinds, and considering its increasing scarcity, the planning and management of this resource and its optimal, economical and equitable use has become a matter of the utmost urgency. The awareness programmes may be organized for the users and public for encouraging their effective participation in water management practices and developing ethical concepts for making efficient use of water resources. Water is emerging as a national challenge and its most efficient management has to be given top priority in order to meet the future demands of food grains for a fast growing population. The government should finalize the proposals and implement the same on a war footing. It should also make all out efforts to involve the State Governments, district authorities, village panchayat, non-governmental organizations and local populations to ensure that water harvesting, water conservation and efficient water use are accorded top priority. The research paper concluded that the escalation of a water crisis in the world is due essentially to the unsustainable use and management of water resources and destruction of ecosystems such as wetlands, and soil the capture, filter, store and release water, conflicts over land and water may become disturbingly common if we do not develop the institutional framework and long-term policies to ensure their equitable distribution. This study concludes that government should come up with a new water policy prescribing the role and involvement of individuals, community and government for conservation of water.

References

Aggarwal.P.K, (2007), 'Climate Change: Implications for Indian Agriculture', Jalvigyan Sameeksha, vol.22.

Agricultural Statistics at a Glance, (2010), Directorate of Economics and Statistics, Ministry of Agriculture Government of India, New Delhi.

Asian Development Bank, (2006), Rehabilitation and Management of Tanks in India: A Study of Selected States, Philippines.

Bandaragoda.D.J, (2006), Institutional Adaptation for Integrated Water Resource Management; An Effective Strategy for Managing Asian River Basins, working paper 107, Colombo, srilanka; International Water Management Institute (IWMI), PP- 44.

Bhat, and Sairam, (2009), Water Resource Management in India; Few Reflections

Binswanger.H.P, (1980), 'Attitude toward Risk: Experimental Measurement in Rural India', American journal of agricultural economics, august, vol.(62)

Brundtland.G, (1987), Report of the World Commission on Environment and Development: Our Common Future, Oxford University Press, Oxford.

Groundwater Resources of India, (1995), Central Groundwater Board, New Delhi.
Indian Agriculture, Challenges of Globalization, New Century Publications, New Delhi, pp. 121-133.

Integrated Water Resources Development – A Plan for Action, (1999) Report of the National Commission for Integrated Water Resource Development, Ministry of Water Resources, New Delhi.

National Water Policy, Ministry of Water Resource, New Delhi, (2002).

National Water Policy, (2002), Ministry of Water Resources, New Delhi.

Ramappa,K.B,et.al,(2014), " Water Conservation in India; An Institutional Perspective", Eco. Env& Cons. 20(1).Pp 303-311.

Sacratees.J, et.al, (2014), "Sustainability in Water Resource Management in India", Southern Economist, June 2014.

Sah D.C, et.al, (2010) "Climate Change and Indian Agriculture", Man and Development, vol.32, no.2, June 2010.

Seth, S.M, (2000), 'Integrated Water Resource Management – Role of Research and Development in Hydrology', Proceedings of the International Conference on Integrated Water Resource Management for Sustainable Development, New Delhi, Organized by National Institute of Hydrology, Roorkee.

Suryanarayana.B, (2013), "Water Resources in India: Issues and Challenges", Southern Economist, vol.52, no.9, September 2013.

Theme paper 'Five Decades of Water Resources Development in India', Indian Water Resources Society, Roorkee, (1998).

Theme paper on 'Inter Basin Transfers of Water for National Development – Problems and Prospects', Indian Water Resources Society, Roorkee, (1996), Ministry of Water Resources, Government of India, 2002, National Water Policy, April 1, New Delhi.