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ECONOMIC HISTORY OF IRRIGATION DEVELOPMENT IN ODISHA

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Abstract: Water as a natural resource has a multi-dimensional approach. It is not limited to the hydrological cycle, but it can be extended to other aspects like qualitative, environmental, and socio-economic dimensions. One of the most important dimensions is the socio-economics dimension which both influence and influenced by the irrigation sector of a nation. Irrigation is the most important aspect of water resources as it derives human settlement in the world. Irrigation has a significant impact on agricultural output in India and agriculture plays a main role in India's Economy as the share of agriculture and allied sector to GDP is 18% out of which 11.8% is from crop production. With this background, the objective of this paper is to draw eyes to e economic history of irrigation development in Odisha. This paper found from the different studies that in the pre-independence period there was little development in irrigation in Odisha started during the British period. Gradually irrigation development starts after independence with the foundation of the Hirakud Dam. But surprisingly the rate of groundwater irrigation is rising very high. Recently the net irrigated area has fallen then earlier. The demands for irrigation water in the state are in alarming stage for the coming years. At the same time expenditure on irrigation, and development has increased, but the share in the total budget has fallen through the planning period. For this cause, this paper suggests more development of watershed management programs and decentralization of different programs for successful achievements.

Keywords: Irrigation, Development, Ground water, Dam, BAW

I. INTRODUCTION

Water as a natural resource has multi-dimensional approach. It is not limited within the hydrological cycle, but it can be extended to other aspect like qualitative, environmental, and socio-economic dimensions. One of the most important dimensions is socio economics dimension which both influence and influenced by irrigation sector of a nation. Irrigation is the most important aspect of water resources as it derives human settlement in the world. Economic and social development of a nation depends upon creation of surplus agro-product and this ultimately depends upon the irrigation supply of a nation. Irrigation plays an important role in the continuous process of agricultural development. If we look into the past, we will find most settlements were grown near water bodies only. the examples are Mesopotamia civilization (3500 to 2000 BC) along the Tigris and Euphrates rivers, The Egypt civilization(5500 BC) along Nile valley, Huang-He River Civilization (1700 BC) along Yellow river which is present China and Mohenjo-Daro and Harappa Civilization also called Indus valley civilization (2500 B.C.E) along Indus river is the present India and China[1].In India cities like Varanasi, Hardwar, Allahabad and Patna grown at the bank of Ganges, Delhi and Agra near Yamuna. Similarly, cities like Cuttack, Bhubaneswar, Sambalpur and Rourkela grown near the bank of river different river in Odisha. Since Odisha is one of the few states in the country, which is endowed with abundant water. It is blessed with excessive network of rivers and streams. Mahanadi, Brahmani, Baitarani, Rusikulya, Vamsaadhra, Budhabalanga and Subarnarekha are major rivers in the state. River facilitates irrigation and drinking water which is a central need for human settlement. Irrigation has a significant impact on agricultural output in India and agriculture plays a main role in India Economy as share of agriculture

[1] Access from http://www.rivervalleycivilizations.com/ on 27.07.2015 at 10.29 am

and allied sector to GDP is 18% out of which 11.8% is from crop production (Economics Survey, 2014-15). Hence irrigation plays an important role in Indian agriculture.

Irrigation opens the possibilities of three main benefits in an economy. First it raises the yield levels, second appreciate land value and the third one is it increases labour opportunity and real wages. The former twos are the primary benefits from the irrigation whereas the later one is the spillover effect (Shah, 1993). According to Dhawan (1985) the key to understand proper interpretation of irrigation is a two-fold system. One is season-wise composition of an irrigation system on a particular parameter of the input-output structure of a farm. The other makes distinction between contribution of irrigation and impact of irrigation. If we look into the different aspect of irrigation in the context of economic result it important to study a brief history of irrigation in the context of Odisha, because efficient utilization of water resources likes irrigation is a central need to mankind always (Jha, 1984). Since the state contributes 11% of the country's total surface water resources is the highest in the country (Ghosh and Kumar, 2010). Therefore, main objective of this paper is to study the irrigation status from pre and post independent history to the contemporary issues with future challenges especially in the state of Odisha.

1.2 Water Resource in Odisha:

Number of rivers following in Odisha; however, it creates benefits and at the same time it gives loses to human and social life through its over following nature. Odisha largely depends upon the Southwest monsoon for water resources. About 78% of total annual rainfall occurs during the period from June to September and the balance 22% in the remaining period. In addition to seasonal availability, the rainfall in the state also shows spatial variation i.e. from about 1200 mm in southern coastal plain to about 1700 mm in northern plateau. This has resulted in causing droughts in some parts of the state and floods in some others. The long-term average annual rainfall in the state is of the order of 1452 mm, which corresponds to an annual precipitation of about 230.76 billion cubic meters (BCM) of water. The following table No. 1 represents the source and utilizable capacity of water resources in India and Odisha.

Table No.1

Water Resources: India & Orissa (Unit in BCM)

Description	India	Odisha (Including Out of State)
Annual Precipitation	4000	230.76
Average Annual Water Resources	1869	141.408
Utilizable Water Resources (Surface & Ground)	1122	108.147
Utilizable Resources (% of precipitation)	28%	47%

Source: Dept. of Water Resource, Govt. of India

In Odisha eleven major rivers are following with their tributaries and distributaries. Therefore, according to geological classification there are eleven river basins in the state consists of total catchment area 155707 sq. Km within the state. Among these the catchment area of Mahanadi River basin only contains 42% of total geographical area of the state with an average annual flow of 30 BCM (Table No. 2). Following figure No. 1 shows the basin classification of the state.

Figure 1

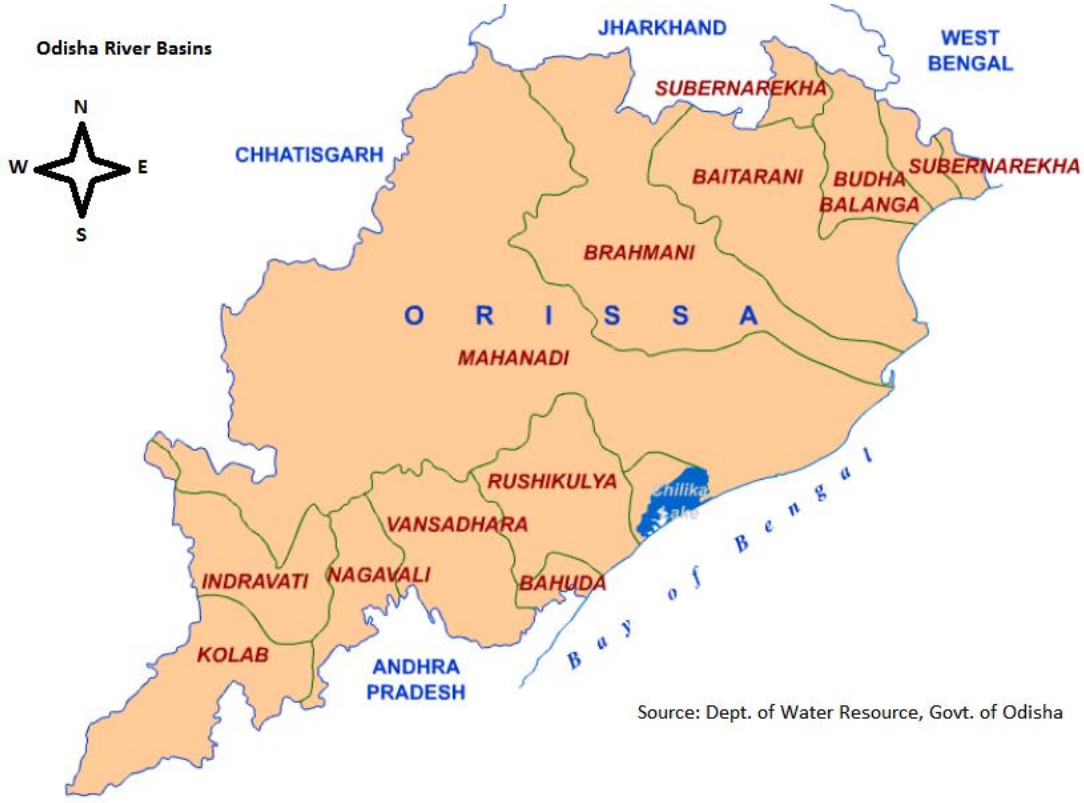
Odisha River Basins
N
W
E
S
JHARKHAND
WEST BENGAL
SUBERNAREKHA
CHHATISGARH
BAITARANI
BUDHA BALANGA
SUBERNAREKHA
BRAHMANI
O R I S S A
MAHANADI
RUSHIKULYA
Chilika Lake
VANSADHARA
INDRAVATI
NAGAVALI
BAHUDA
KOLAB
ANDHRA PRADESH
Bay of Bengal
Source: Dept. of Water Resource, Govt. of Odisha

Table No. 2

River System of Odisha

Sl. No	Name of River Basin	Catchment Area (Sq. Km)			Average Annual Flow (in BCM)			75% dependable flow (in BCM)		
		Total Area	Within Odisha	% to Geo Area of the State	Own State	Outside State	Total	Own State	Outside State	Total
1	Mahanadi	14113	65628	42.15	29.90	29.255	59.155	25.508	23.225	48.732
2	Brahmani	39116	22516	14.46	11.391	7.186	18.577	8.849	5.521	14.011
3	Baitarani	14218	13482	8.66	7.568		7.568	5.434		5.434
4	Kolab	20427	10300	6.61	11.089		11.089	8.885		8.885
5	Rushikulya	8963	8963	5.76	3.949		3.949	2.782		2.782
6	Vansadhara	11377	8960	5.75	5.083		5.083	3.881		3.881
7	Indravati	41700	7400	4.75	6.265		6.265	4.451		4.451
8	Budhabalanga	6691	6354	4.08	3.111		3.111	2.521		2.521
9	Nagavali	9275	4500	2.89	2.853		2.853	2.322		2.322
10	Subarnarekha	19277	2983	1.92	1.193	1.115	2.308	1.193	1.115	2.308
11	Bahuda	1118	890	0.57	0.438		0.438	0.213		0.213
12	Draining to Sea		3731	2.40						
13	Total				82.841	37.556	120.397	65.679	29.861	95.540

Source: Dept. of Water Resource, Govt. Of Odisha

Note: BCM is Billion Cubic Meter

1.3 Development of Irrigation in India and Odisha:

India is a basically denoted as agriculture-based nation with gamble of monsoon. Since the largest use of water in the world is irrigating lands, India cannot remain out of it. In 1990 demand for irrigation was 437 BCM which increased to 688 BCM in 2010 (MOSPI) which is approximately 84% of total water use in the country. In Odisha the total requirement of water was 24 BCM which will increased to 22.5 BCM and 33.6 BCM in 2025 and 2050 respectively whereas the present (as on 14.5.2012) storage capacity of Odisha is 23.934 BCM against 253.39 BCM in India[2]. The subsequent section will explore the idea on irrigation development in India and Odisha in different arena.

1.3.1 Pre independence Irrigation development in India:

India reflects her history from Indus valley civilization as mentioned earlier the reason of creation of this civilization is for source of irrigation. In subsequent period Nandas and Maurya built canal and carried out irrigation projects. The Arthashastra discusses the water use efficiency through water tax and pricing with primitive models for optimum rainfall for most crops developed by Chanakya. It was specified that all water belonging to the king and that users were to pay taxes to withdraw water for irrigation from system installed by king (Thapar, 1990; Krishan, 2011). In ancient Odisha (then Kalinga) also farmer has to pay tax called Bali to the monarch (Parida, 1997). Kharavela considered as great king of Odisha. He executed numerous public works, repaired certain old irrigation tanks and constructed a canal in the 4th century BC (Gait, 1928). But Thapar, (1990) stated that Kharavela refers to irrigation canals built by him to take pride which was actually built by the Nandas. In 10th century the grand Anicut (weir) was constructed by Chola king (Jha, 1984) in South India's Cauvery delta area.

In the medieval period during Mughal rule the main acclaim goes to first ruler for digging canals to foster agriculture was 'Qarauna' sultan, Ghiyasuddin Tughluq in 1220-25 AD (Raychaudhuri, 1991). Firoz Shah Tughlaq built western *Yamuna* canal the biggest network until the nineteenth century in 1335 AD to carry *Yamuna* water in Higation in Hissar. Later it was renovated by Akbar and followed by Shahjahan further improved it and taken one branch to Delhi for supplying water to the fountains and gardens in the red fort (Rao, 1979; Jha, 1984). During the period of Mohammad shah, the eastern *Yamuna* Canal[3]was constructed. Shahjahan built a canal from the Ravi River through *Shalimar* gardens at Lahore[4] is about 180 KM in length and a branch of its carried water to the golden temple. During the British period, the canal was replaced the upper Bari Doab canal system (Rao, 1979).

The early British period did not remark for any notable work related to irrigation. The nineteenth century was evidence of drought and famines, total 31 famines occurred in this century of which 1943[5], 1869, 1877, and 1899 are the worst reflects mortality is about 32.4 million (Rao, 1979; Jha, 1984). This drew eyes of Britishers for the development of railway and irrigation in India. The famine inquire commission 1945 greatly emphasized on the works for the supply and conservation of water (Jha, 1984). The nexus of feminine Commission 1880 and irrigation commission 1901-03 also outlines details impact of these famines (Rao, 1979).

In the nineteenth century two notable people Sir Proby Thomas Cautley and General Sir Arthur Thomas Cotton plays a crucial role in the development of irrigation system in India. Cautley under East India Company took rejuvenation of two important irrigation canal Western Yamuna canal (reopened in 1920) in the Punjab and Eastern Yamuna canal (Re opened in 1930) in united province. He also began upper *Ganga* Canal in 1836 and completed by 1854. On the other side Arthur Cotton starts construction of Cauvery Delta system Grand Anicut[6] (originally built by Cholo king) in 1934 and completed in 1938 with the cost of Rs. 83,401(Kumar and Desai,1983) in Madras presidency. The Godavri anicut was also built in his period in 1846. In Krishna Delta he suggested anicut across the river which started by Captain Orr in 1852 end in 1853 and later it was replaced by a barrage (Stone; 1984; Rao, 1979).

The real development of irrigation started in the second half of the nineteenth century remarked for Upper Bari Doab and Srihind Canal in northern India in 1873 which started irrigating in 1882, The lower Sohang Canal, Para canal (1872-77) and lower Chenab canal (in Punjab now in Pakistan), The Agra Canal, The Betwa canal in UP open in 1893, The Periyar system canal in TN, Khadakwasla Storage Dam constructed from where Mutha Canal draws water, Rishikulya Project (1884), Nira Canals 1881, Gokak Canal 1882. Also, Kurnool Cuddappah Canal was

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[2] This data has taken from IndiaStats.com

[3] originally known as Doab canal during Mughal period

[4] Presently in Pakistan

[5] 1943 feminine is known as Bengal feminine.

[6] With the construction of the Upper Anicut in 1836 flows in the Coleroon diminished as flows required for Cauvery Delta were drawn through the Cauvery arm. To ensure adequate supply to the areas depending on Coleroon, the Lower Anicut across Coleroon was constructed during the same year by Arthur Cotton. The Coleroon river is also known as Kollidam

constructed by a private Dutch company called Madras Irrigation & canal, Co limited during 1863-70 (Jha, 1984; Stone; 1984; Rao, 1979).

The beginning of the 20th century marked a very important even in the history of irrigation in India as the first irrigation Commission established in 1901 under the president ship of colonel sir colin scott Moncrieff. The chief function was to report on the desirability of the extension of irrigation as a means of protection against famines. This creates a land mark history in the modern irrigation system in India. In early part of the twentieth century Tribeni Canal Projects in Bihar, Pravara Canals, Godavari Canals, Nira Right Bank canals in Maharastra, Sarada Canal project in UP, Weinganga and Mahanadi Canals in MP was constructed. During the period of 1921 to 1935 the Krishnasagar Project in Karnataka, Nizam Sagar Project in AP, Mettur Project in TN. The Ganga Canal (also known as Bikanear Canal) takes from sutlej at Ferozpur barrage and irrigates which started 1922 and opened in 1927s. In this arena Dr M. Vishvesarrayya plays an important role in by putting his outstanding engineering ideas (Jha, 1984; Stone; 1984; Rao, 1979). By 1892 nearly 43,800 miles of main canals and distributaries had been constructed by Britishers in India, irrigating 13.4 million acres with a total capital cost of Rs. 382.6 million, and returning net revenue annually at a rate of 4 to 5 per cent on the investment. Fifty years later, when the imperial account books were closed, just over half of British India's total irrigation, some 58.8 million acres, was provided by public works, 74,656 miles of main canals and distributaries which served approximately 32.8 million acres, approximately one-quarter of India's total cropped area (Kumar and Desai,1983).

1.3.2 Pre independence Irrigation development in Odisha

Irrigation in Odisha started in early sixties of nineteenth century through construction of canals. Before that irrigation in Odisha were taken from the streams and tanks. Some irrigation was also carried out through water lift system (known as *tenda*) in case of *dalua* [7]crops. The first canal known as Churaman canal[8] constructed in Baleswar district in 1925 a cut connecting Matai and Gamai Rivers, but after a year this appears to have been closed. Later proposals to initiate irrigation in Odisha came from two reason one, the visit of General Sir Arthur Cotton in 1958 with the object of giving advice to control of flood water of the Mahanadi. He recommended a complete system of irrigation system of irrigation and navigation like deltas of Godavari and Krishna. The other one is, the absence of timely rainfall leads to terrible famine of 1966[9].

Orissa canal and Rushikulya canal systems were two well-known irrigation systems developed during the period 1860 to 1910. The former extended over the deltaic plain, whereas the latter restricted to Rushikulya basin only. The East India Irrigation and Canal Company formed in August 1960 for the purpose of irrigation in the eastern province. The Orissa canals were recommended by the East India Irrigation and Canal Company and carried out construction of most ambitious scheme for a system of canals for navigation and irrigation extended from Calcutta to Puri in 1963. Later on, the failure of the company, the works were taken over by Government at a valuation (Samal,1990; Moharpatra, 2005).

West Bengal happened to be a pioneer in the field of irrigation in India. The earliest one namely Midnapore Canal was taken up in 1866 and irrigation commenced in 1871. The canal originally was part of Orissa Canal Scheme. It was intended to have a high canal providing a navigational route between Cuttack and Calcutta. But the Midnapore canal at an early stage was separated and treated as a distinct project. The water supply is derived from the river Kangsabati at Mohanpur where there is a regulating weir with head works and the canal extends to Uluberia on the river Hooghly crossing the Rupnarayan and Damodar rivers en route. The total command area of the scheme is 49,879 ha.[10]

The famine commission conducted an enquiry into the Orissa Famine of 1866, imposes stressed the need for irrigation works to mitigate such calamities in future. The Government started Orissa Irrigation with very great modifications as fast as possible. From the 1860s a relatively elaborate network of irrigation canals was constructed by the government in the Mahanadi delta. In 1866 there were about 510 miles of Government embankments and 248 miles of Zamindari embankments in Cuttack district. From the beginning irrigation in Orissa made a very slow progress. the works, however, proceeded and in 1873 it was decided to provide for an irrigable area 1,140,000 acres in Orissa at an estimated cost of Rs. 441 lakhs. This area was including 500,000 acres in the balsore and puri sections. The works begains in1668 with sanctioned included the Taladanda and Machgaon Canals for the irrigation of lands between the Mahanadi and Katjuri rivers, the Kendrapara and Patamundai canals for irrigation of the area

[7] Dalua crops are paddy cultivation during Rabi season

[8] Also known as Ricketts Canal after the name of Mr. Ricketts Collector who has designed this

[9] 1966 Famine is well known as Nanka durbhikya in the history of Odisha.

[10] http://www.wbiwd.gov.in/irrigation_sector/major/canals.htm access on 5th August 2015 at 10.45 am

between the Chitratola and the Birupa, and the ranges of the High-Level Canal for the irrigation of the strip of country lying at the foot of the hills from Cuttack to Bhadrak (Samal, 1990; Imp. Gazzeteers of Cuttack,1933).

The total expenditure up to the end of the year 1897-98, was Rs. 2,63,02,141. There were 205 miles of canals for irrigation only, besides nearly; 1100 miles of distributaries and village channels, there were seven weirs across river channels with an aggregate length of 3½ miles, which constituted, with canal head sluices and entrance locks, the most extensive head works of any canal system in India. The maximum discharge of the canals in 1895-96, was 6058 cubic per second and the area commanded was 5,71,000 acres. The area then actually irrigable was about 401, 000 acres and the area leased for irrigation was 2,00,000 acres. By 1900 there were 205 miles of main channels, for irrigation as well as navigation, 75 miles of canals only for irrigation and 1,100 miles of distributaries. Of these only19 miles of main channels and 50 miles of distributaries were in Balasore and the rest were in Cuttack. Initially the area irrigated from the canals was very small. However, the irrigated area accounted for only a small proportion of the gross cropped area, between13 percent and 17 percent in Cuttack district during1900-3 During the period , 48 sluices had been made and 8 were in process of construction, in order to irrigate the land beyond the embankment, and give it silt. A doubt object was gained by this, as the fertility of soil was increased and its level was gradually raised. The area irrigated by these sluices had been 30000 acres in 1910-11 and 34,000 acfres in 1911-12. Escapes had been provided in the embankments on the rivers, Daya, Kushabhadra, Bhargavi, Brahmani, Kharsua and Ganguti, to allow of irrigation by means of flood water. (Samal, 1990; Chudhury, 1991).

Table No- 3

The Areas Irrigated by the Orissa Canals from 1891 to 1898 (In acres)

Year	Taladanda canal and Its branches	Kendrapada canal and its branches	High level Canal-Range I.	High level Canal-Range II.	High level Canal-Range III.	Jajpur canal	Total
1891-92	41906	74180	22423	2513	36211	452	177685
1892-93	36591	67728	21225	2329	32201	878	160952
1893-94	12054	61259	10491	2052	15802	1868	103526
1894-95	24606	65482	13771	2581	14432	1689	122561
1895-96	25672	63936	3859	892	10105	4996	109460
1896-97	52048	81300	23042	3330	31215	16080	207015
1897-98	50304	75811	22052	3243	29193	14999	195602

Source: Mohapatra, 2010, Originally from Maddox Report 1920.

The Kendrapada Canal and High-level canal range-I, was together irrigating 1729 acres during 1869-70. There area under irrigation increased to 177685 acres in 1091-92 by all canals in deltaic region, this falls in subsequent year up to 1895-96. In 1996-97 it rose to 207015 acres and again fall to 195602 acres in 1997-98 (Table No. 3). The total length of canal and distributaries at the end of 1911 were 32 ½ miles and 1246 ½ respectively with capital outlay Rs. 267.93 lakhs and the interest charges were and additionally Rs.354.79 lakhs (Samal,1990). The Census Report of 1951 estimated that in Orissa the per capita irrigated area decreased from 14.1% in 1921 to 13.3 cents in 1951 a decrease of 0.8 cents or 5.6 % per capita during a period of 30 years (Maharpatra, 2005).

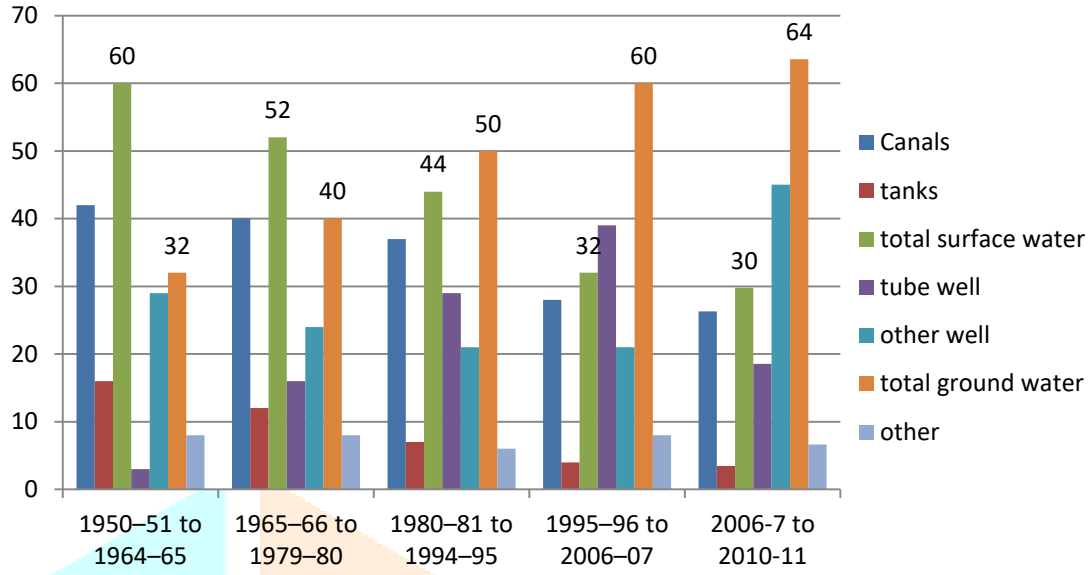
1.4 Development of Irrigation in India and Odisha from Post-Independence Period

Sound agriculture based on optimum utilization of water supplies is the best insurance against famines in India. The states which facilitate better irrigation facilities are always walk a step ahead in agricultural production. Though the irrigation development started in the colonial period in India, the rapidness injected after post-independence period. The Nehruvian socialist mixed economy idea started with the establishment of the planning commission and the first five-year plan was dedicated to the agriculture sector in India. During this period India started giving emphasis on the development of permanent irrigation system through major and medium projects. Nehru stated that dams and power are necessary for growth of nation which he denoted as temples of 'Modern India' (The *Hindu*[11], 2003; Oza, 2007). It is estimated that about 15% of irrigated area in the country served by small tanks. Diversion barrages and storage provide water for 60% of the area and the balance are fed by wells and tube wells (Rao, 1979). But this data has been changed with the span of time, if we look into present condition, it is the ground water which is providing more irrigation than the surface water irrigation. Gradually share of canal and tank irrigation has been declined whereas the share of tube well and other well has increased. According to

[11] http://www.thehindu.com/thehindu/mp/2003/07/07/stories/2003070700880200.htm access on 26.8.2015 at 5.30 pm

estimation of agricultural census by 2010-11 the share of total surface water was 30% and ground water was 64% of total irrigation (Figure No. 2).

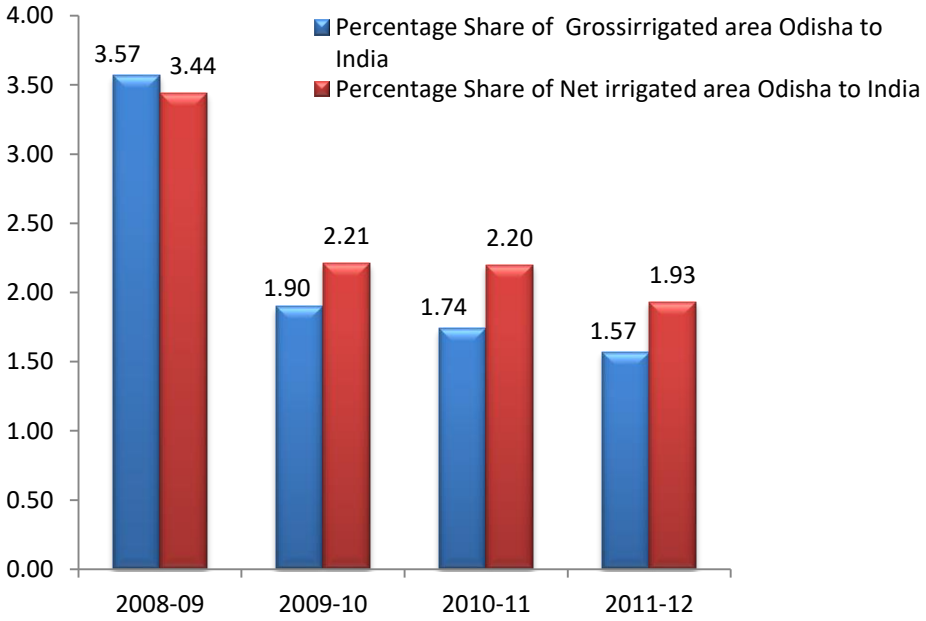
Figure No.2



Source: Compiled from 11th five-year plan and Agriculture statistics 2014 Data.

The agricultural production in India cheering up due to the expansion of persistent irrigation from 1971 to 1978; the area of wheat extended by 35 % at the same time , the share of total rice cultivation raises from 37 to 42 % through permanent irrigation. By 1990, wheat accounted for 78 % of the total area under wheat, whereas irrigated rice occupied only 45 % of the total area under rice (Rothermund,1993) This structure has been changed from time to time with crop diversification in the country. The estimation of Directorate of Economics & Statistics, Ministry of Agriculture shows that, the gross irrigated area falls to 31% for rice and 30% for wheat in 2001-02. Similarly, it falls to 28% for rice, whereas it has increased to 31% for wheat in 2011-12. But both the gross irrigated area (from 88896 to 91530 thousand hectors) and net irrigated area (from 63638 to 65263 thousand hectors) have been raised from in India during 2008-09 to 2011-12, while both fall in the context of Odisha. Again, if we look into the share of gross and net irrigated area of Odisha to India, this has fallen during same period as depicted in the figure No. 3.

Figure No.3

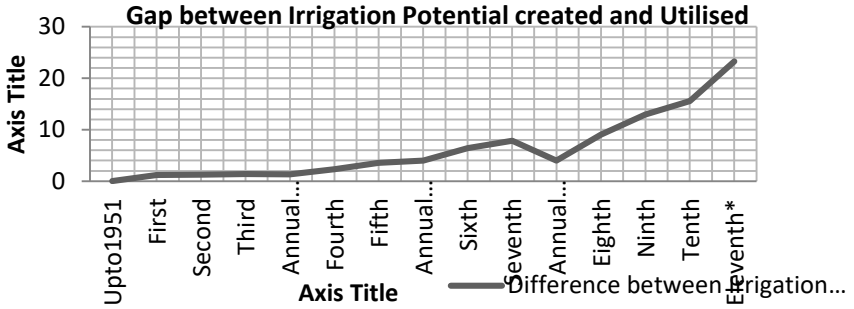


Source: Compiled by author from Directorate of Economics & Statistics, Ministry of Agriculture

During last six decades five year plan plays a vital role in the development of infrastructure in India. The plan outlay for irrigation and flood control has increased in each planning period but expenditure on irrigation to the total

expenditure has fallen. The expenditure on major and medium irrigation during ninth five year plan was 2.78% Odisha to India which increased to 17.61% during eleventh five year plan (Compiled by author from CWC Data, 2015). Rise in expenditure in irrigation in India reflects as increase in the potential creation and utilisation of irrigation in the agriculture sector of the nation. But the main issue is the rising gap between irrigation resource created and utilised. This gap has been rising substantially during the planning period except in between seventh and eighth five year plan. The gap was 1.22 M.Ha during 1st five year plan and slowly rises up to fifth five year plan by 3.97 M.Ha. After this it catches stiffness by eleventh five year plan at 23.3 M.ha (Figure No. 4).

Figure No.4



Source: Compiled from 12th five year plan document data, planning commission

Table No. 4

Status of irrigation Potential created and utilised in Odisha (in 000'Ha)

Year	Irrigation Potential Created			Irrigation Potential Utilised			% Utilisation
	Kharif	Rabi	Total	Kharif	Rabi	Total	
2000-01	2533.83	1071.99	3605.82	1589.88	535.84	2125.72	58.95
2001-02	2554.26	1117.63	3671.89	1752.27	793.64	2545.91	69.34
2002-03	2608.59	1123.75	3732.34	1246.81	465.21	1712.02	45.87
2003-04	2674.12	1161.21	3835.33	1737.49	780.87	2518.36	65.66
2004-05	2707.27	1266.22	3973.49	1845.79	844.87	2690.66	67.72
2005-06	2731.50	1294.92	4026.42	1922.70	1042.79	2965.49	73.65
2006-07	2720.46	1318.52	4038.98	2001.98	1147.47	3149.45	77.98
2007-08	2765.73	1342.06	4107.79	2027.00	1281.46	3308.46	80.54
2008-09	2867.01	1407.18	4274.19	2081.13	1096.03	3177.16	74.33
2009-10	2962.21	1476.81	4439.02	2058.85	979.67	3038.52	68.45
2010-11	3035.85	1477.97	4513.82	2085.21	1020.70	3105.91	68.81
2011-12	3089.34	1501.43	4590.77	2087.90	1009.18	3088.08	67.27
2012-13	3102.84	1543.99	4646.83	2186.86	1178.73	3365.59	71.55

Source: Dept. of water resource Govt. of Odisha.

The Table No. 4 shows that percentage utilisation in irrigation in Odisha has decline during 2000-01 to 2002-03 though it has a stiff rising trend in potential created. After this time period it has increased at a decreasing rate and from 2007-08 it starts again falling. However, in 2012-13 it has increased to 71.55% from 67.27% in 2011-12.

1.4.1 Recent Development of Major and Minor Irrigation in Odisha

Canal water for irrigation is good when available, but unreliable. The supply is unavailable in time due to poor maintenance and operation. Therefore, the farmer is dependent on the irrigation bureaucracy which is a control structure which is not any training service-oriented. When the equity issue arises in the context of irrigation tell end farmers are getting very little amount (Iyer, 2007). The purpose of Canal linings are to improve the capacity of existing channels, first to reduce seepage losses and extend irrigation to the waters so saved or prevent water logging, second to enable flatter slopes to be adopted the canals thus increasing the command, third to reduce the cross sections, lined canal have higher velocities and a smaller rugosity; land acquisition and cost of canal structures can also be reduced to some extent, fourth to provide additional stability to channel sides and finally to ensure continuous operation of canal without annul closure for silt clearance, weed clearance etc. and reduce the maintenance cost. Since line canals are expensive and costs are 3 to 4 times more than the unlined ones of equal capacity. Hence the essential requirements of a satisfactory lining are: low costs, impartibility, hydraulic efficiency, durability and structural stability (Rao, 1979). This is possible through building and proper management of major & minor projects. The national register for large dams' revels that there are eleven states having more than one

hundred large dams and Odisha is one of them. The highest number of dams exists in Maharashtra (1693 completed and 152 under construction) followed by Madhya Pradesh and so on. By 2001 and beyond there are 207 dam height ranges from 10m to 20m and six are under construction in Odisha.

Table No.5

Construction of Large Dams from 1900 in Odisha

Dams Height(m)		UPTO 1900	1901-50	1951-60	1961-70	1971-80	1981-90	1991-00	2001 Beyond	Year not available	completed dams	Under Construction	TOTAL
10-15	Odisha			1	2	19	18	11	6	2	59	1	60
	India	27	170	75	196	553	474	178	81	140	1894	99	1993
> 15	Odisha	2	2	3	6	36	59	22	7	2	139	5	144
	India	40	134	160	300	740	788	450	292	58	2962	215	3177
> 50	Odisha			2		2	2	3			9		9
	India	1	6	9	24	30	34	20	28	5	154	26	183
Total	Odisha	2	2	6	8	57	79	36	13	4	**207**	**6**	213
	India	68	310	244	520	1323	1296	648	401	203	5010	340	5350

Source: National registrar for Large Dam, CWC Govt. of India.

Odisha remarked for a good network of canal system in both western and costal Odisha. About 1411Ha area covered under Canal irrigation in 2009-10 in Odisha. The government of Odisha is very keen for the development of surface irrigation infrastructure in the state. Many projects that have been undertaken after independence are completed and few are under constructions. Construction of Major and Minor projects and BAW (barrage, Anicut and Weir) are the main source to provide surface irrigation in the state. In the seven-basin division about 83 major and minor projects, 179 dams (also includes few major and minor projects) and 40 BAW has undertaken. Among these Mahanadi River basin has highest construction in Odisha followed by Brahmani and Baitarani (Table No.6).

Table No.6

Water Source for Irrigation in Odisha

Sl. No	Basin	Major Medium Irrigation Projects	Dams*	Barrage, Weir and Anicut (BWA)
1	Brahmani and Baitarani	20	42	7
2	East Following Rivers between Mahanadi and Pennar	15	24	18
3	Godavari	5	15	3
4	Mahanadi	34	84	12
5	Subarnarekha	9	14	0
7	Total	83	179	40

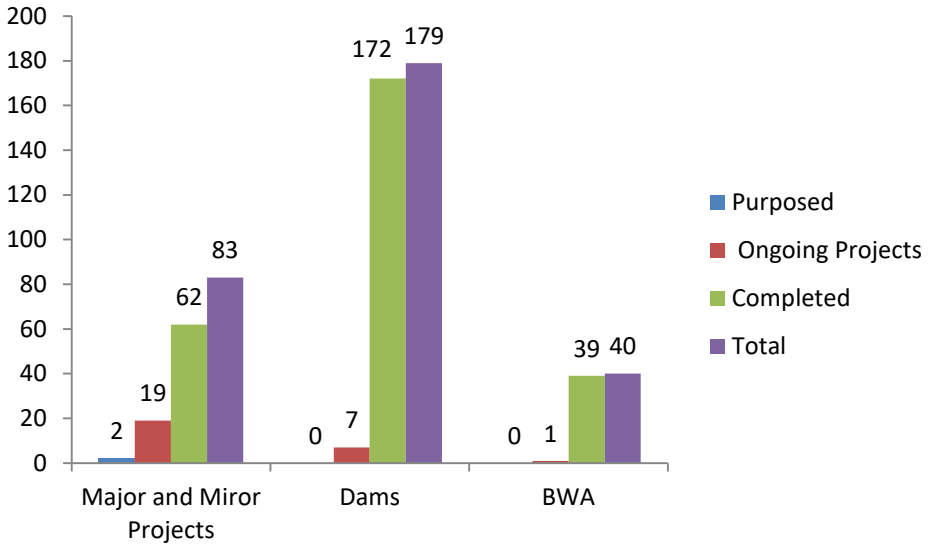
Source: Compiled by Author from India-Wris Wiki

*Few Dams are also included in Major Medium Irrigation Projects.

Out of total major and minor projects in the state 62 projects has been completed, 19 are under construction and 2 new projects are purposed. Similarly in the case dams 7 are under construction and 172 are already completed. In case of BAW 39 out of 40 are completed (Figure No-).

Figure No.5

Projects, Dams and BAW Status in Odisha



Source: Compiled from India-Wris Wiki

It has been assessed that 3130.00 thousand hectares cultivable land can be brought under irrigation through major & medium irrigation projects. By end of March 2014, net irrigation potential of 1382.68 thousand hectares has been created. Similarly 970.00 thousand hectares of cultivable land can be provided irrigation facilities through minor (flow) projects. At the end of March 2014, 604.50 thousand hectares of net irrigation potential has been created and 890.00 thousand hectares of cultivable land can be provided irrigation facilities through Lift irrigation projects. By end of March 2014, net irrigation potential of 708.14 thousand hectares has been created which includes irrigation potential created (IPC) under deep Bore well scheme since inception.

The development of irrigation in odisha grown up under different scheme initiated by the Govt of Odisha and with the help of Govt. of India. These different programmes are Accelerated Irrigation Benefit Programme (AIBP), Rural Infrastructure Development Fund (RIDF), Biju Krushak Vikash Yojana (BKVY), Japan International Co-operation Agency (JICA), Odisha Integrated Irrigated Agriculture and Water Management Investment Programme (OIIAWMIP), Odisha Community Tank Management Project (OCTMP), Dam Rehabilitation and Improvement Project (DRIP), Check Dam construction programme, Deep Bore-well irrigation programme, Repair, Renovation, Restoration of water bodies (RR&R), Mega-lift Construction Programme, Canal Lining & System Rehabilitation Programme (CLSRP).

Under the above programmes through AIBP is 220.061, RIDF is 166.97, JICA is 88.54 and OCTMP is 7254.53 thousands Hectares has been potentially created for irrigation till 2014. The OIIAWMIP has initiated by Dept. of water resource govt. of Odisha with the help of Asian development bank has classifieds into four tranches. These tranches have undertaken some sub projects includes major, medium and minor lift with the target to cover 235208 Ha areas under irrigation. However, CAD of 13865 Ha of Taladanda subproject has been completed in Tranche-I by 2014. Under Tranche-1, out of 650 nos. of Minor Lift Irrigation Sub-Projects only 201 has been completed in the same time period.

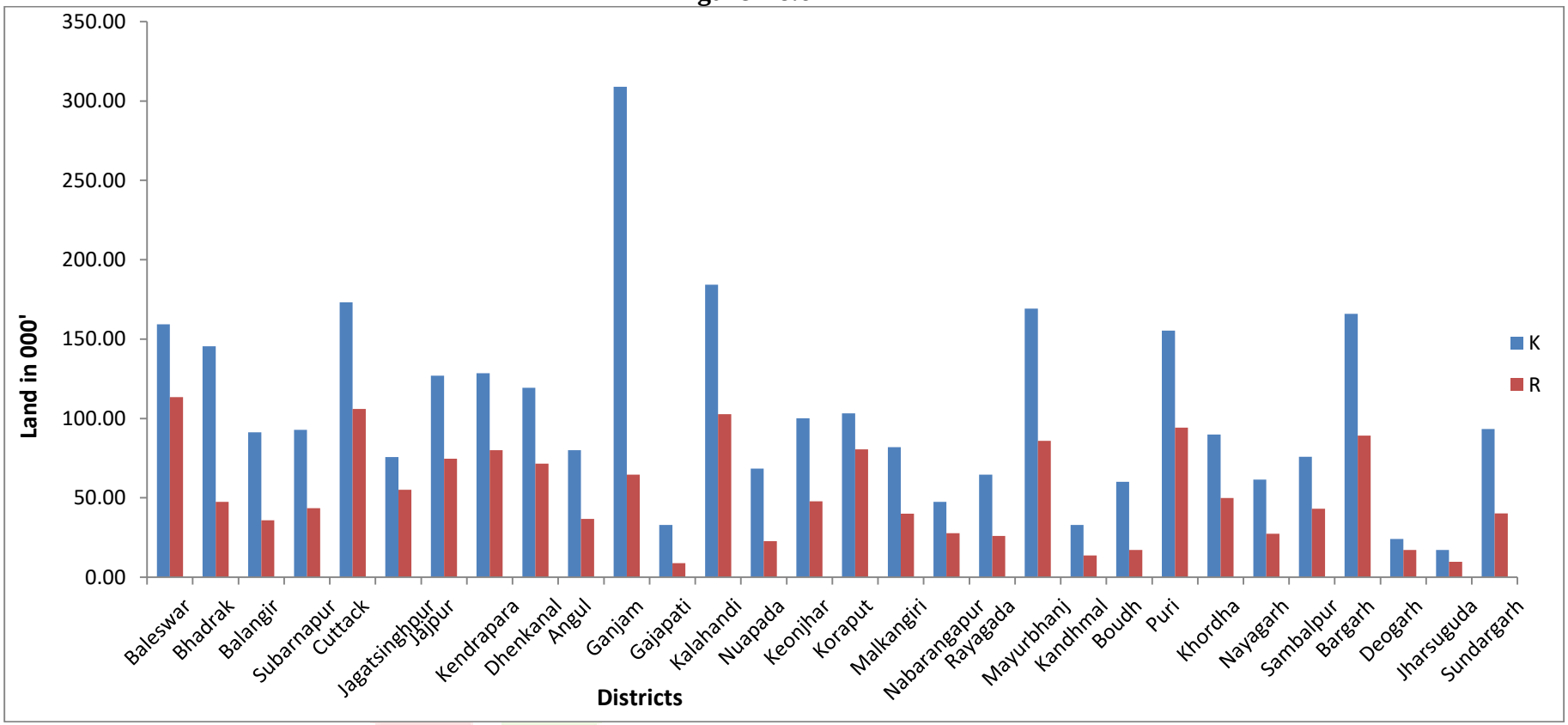
Table No.7
Potential Created (Minor lift irrigation) in Odisha (in 000'Ha)

Year	Kharif	Rabi	Total
2006-07	421.19	234.28	655.47
2007-08	442.31	246.57	688.88
2008-09	473.66	269.62	743.28
2009-10	492.94	276.96	769.90
2010-11	507.55	285.72	793.26
2011-12	533.93	302.06	835.99
2012-13	549.34	311.44	860.78
2013-14*	708.14	350.99	1059.13
2014-15*	794.23	389.61	1183.84

Source: Dept. of Water Resource Govt. of Odisha (* Include both surface lift and tube well lift)

Presently lift irrigation in Odisha providing a great source of irrigation. For this Odisha Agro Industry Corporation and Odisha lift Irrigation Corporation plays a vital role. Table no-))) explains the development of mirror lift irrigation in the state. Under Biju Krushak Vikash Yojana, 9063 Lift Irrigation projects and 84 Minor Irrigation Projects have been taken up, out of which 8128 L.I.Ps and 84 MIPs have been completed daring 2014 and additional irrigation to 164.94 thousand hectares have been created. We can also have a look on the district wise irrigation potential created and utilised including major & medium, minor flow & lift and including other sources reflected in Figure No. 6

Figure No.6



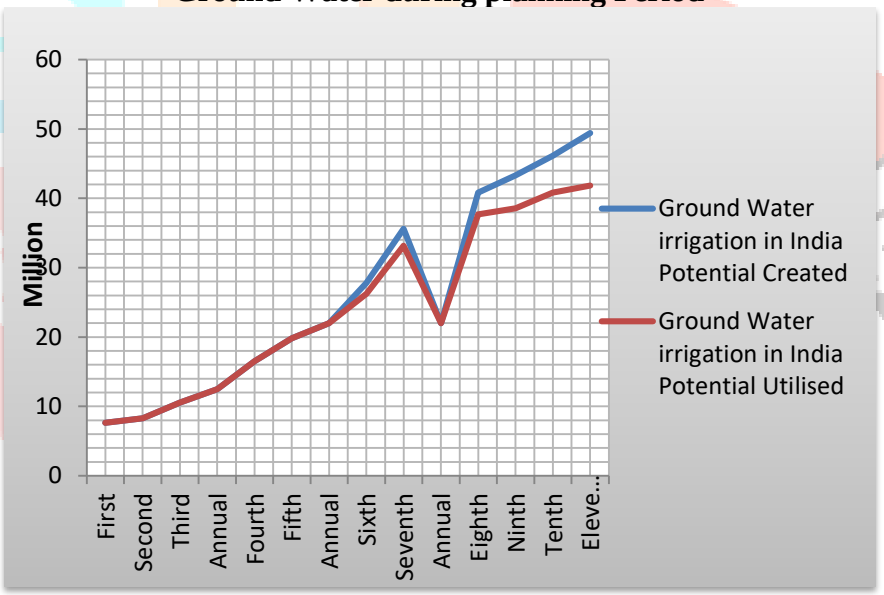
Source: Odisha Agriculture Statistics, 2012-13.

1.4.2 Groundwater Irrigation and its Development in Odisha

In the previous section in this paper Figure No.3 showing that there is a stiff increase in the ground water irrigation from 1950-51 to 2010-11. In the present agriculture scenario groundwater plays an important resource for irrigation. Oza (2011) also mentioned that after 1970 contribution of groundwater is higher than the surface water. The reason is that surface irrigation may not cover all the area; therefore, groundwater plays a crucial role. Ground Water may be cheap with its indivisible nature than the canal irrigation. In India the absence of or presence of vague property right (Zetland, 2013) and open access regime (Kumar et. al., 2004) the exploitation of ground water is raising in the irrigation context. Again, any attempt to solve the problem related to water allocation in the country reintroduces same problem for the exploitation of same aquifer creating a situation of Hydro-schizophrenia (Shah, 2013). This may be due to existence of nexus between subsidiesed power and irrigation. The planning commission revels that 30% sales of state electricity board goes to agriculture sector generating only 3% revenue. World Bank estimates that that farm subsidies amount to 10 per cent of the total supply cost in a year. This is 2.5 times of annual expenditure of Canal irrigation (Oza, 2011).

In India total annual replenishable ground water potential has been estimated as 433 BCM. The break-up of annual replenishable ground water resources by State with share 2.5% or more have been presented in Table T7. It shows 14 States comprise more than 90% of ground water potential. Among the States, Uttar Pradesh ranks first (17.84%) in terms of share of replenishable ground water resources followed by Andhra Pradesh (8.29%), Madhya Pradesh (8.10%), Maharashtra (7.85%), Bihar (6.78%), West Bengal (6.76%) and Assam (6.59 %) . the case of Odisha is 17.78 BCM per year which is 4.11% of the country (CGWB, Ministry of Water Resource). Whereas in Odisha the ultimate irrigation potential (UIP) through ground water is 42 BCM which is 6.5 percent of national level total GW irrigation UIP (MOSPI, 2011).

Figure No.7
Ground Water during planning Period



Source: Planning Commission, Planning Document 11th Five year Plan

The above Figure No.7 shows that both the irrigation potential created and utilised by groundwater during the five-year plan. In the initial period of planning up to sixth five-year plan we can see that both the potential created and utilised are approximately same. This implies that whatever has been created are utilised. But after sixth five year plan the gap started, but during annual plan it disappears with fall in GW irrigation. After annual plan there is a stiff rising of potential created and utilisation of ground water. At the same time the gap also rising. This may imply the waster of groundwater resources.

In Odisha the ground water resource assessment has been done as per norm prescribed by Ground Water Estimation Committee (GEC) of Govt. of India. As per the assessment (as of 2008- 09), the net dynamic ground water resource of the State is 16.68 BCM. The annual draft as of March 2011 for irrigation use is 3.8 BCM, for domestic use is 0.76 BCM, & for industrial use is 0.16 BCM. The gross annual utilisation of ground water (irrigation, domestic & industrial) is estimated to be 4.73 BCM which is 28.33% of the total ground water resources of the State.

The Table No.8 is shows basin wise availability of ground water resources, sectoral annual utilisation and stage of ground water development. On an average 80% of total ground water is used in irrigation in all the basins. Ground water use is highest 85% in Baitarani and Budhabalanga river basin. The Stage of GW Development in Odisha was 28%, in Baitarani basin highest 39% and 9% lowest in Kolab Basin.

Table No. 8

Ground Water Resource and Sectoral Utilisation

Sl No	Basin	GW Resource in HM	Annual Utilisation in HM as on 2011				Stage of GW Development (%)
	River Basin		Irrigation	Domestic	Industrial	Total	
1	Bahuda	11023	2816	558	52	3426	31.08
2	Baitarani	167215	56397	5523	3091	65011	38.88
3	Bansadhara	72402	11218	2167	553	13938	19.25
4	Brahmani	198033	48896	8813	2602	60311	30.46
5	Budhabalanga	83957	26420	3176	1371	30967	36.88
6	Indrabati	55912	4944	3050	404	8398	15.02
7	Jambhira	38634	16015	1339	238	17592	45.54
8	Kolab	75343	4423	1514	877	6814	9.04
9	Mahanadi	685477	138714	36237	4310	179261	26.15
10	Nagavali	26167	2112	1300	530	3942	15.06
11	Rushikulya	117910	25539	6103	935	32577	27.63
12	Subarnarekha	59855	17839	2066	442	20347	33.99
	Area Drain Directly to Sea						
13	Chilika	27372	3918	1221	76	5215	19.05
14	Kansabansa	49614	22000	1525	549	24074	48.52
		1668914	381251	74592	16030	471873	28.27

Source: Dept of Water resource, Govt. of Odisha.
GW: Ground Water, HM: Hectare Metre

The study of Gandhi and Bhamoriya (2011) from the estimation of CGWB 2004 shows that the gross replenishable GW in Odisha was 23 BCM whereas the net availability of GW was 3 BCM per year. The total GW used for irrigation in the same period was 21 BCM and the level of GW development was 14.33%. As per CGWB 2009 estimates shows that the net GW availability was 16.69 BCM and used in irrigation sector was 3.47 BCM is almost 79.5% of total sectoral use of GW. The level of groundwater development was 265 in the same year (GW year Book, 2013-14). According to the estimation of 2011 data which revels that the gross replenishable GW for Odisha was 17.77 BCM. The loss of GW and the net GW available was 1.08 BCM and 16.68 BCM respectively. The sectoral allocation for irrigation was 3.8 BCM is 80.6% of total sectoral allocation. The level of GW development was 28 % in the same year. The disaggregate level shows that this development was highest in Bhadrak district (58%) and lowest in Malkangiri district (9.49%). Now this two-period data (2009 to 2011) shows that fall in the net availability of GW resource and rise in the sectoral allocation of water in irrigation. The level of GW development has increased to 2% (Annual report 2014 Dept of Water Resource, GOO).

Government of Odisha launched a new programme “Deep Bore well Secha Karyakrama” during 2010- 11 to exploit ground water resources in hard rock areas of the state. The main objective is to provide irrigation facilities to small and marginal farmers through installation of deep bore wells covering cultivated area of minimum two hectares. Priority would be given to Blocks having less than 35% irrigation coverage. The scheme would be implemented in 256 blocks of 26 districts (18 non-KBK districts, 8 KBK districts) of the state. By end of March, 2014, 13881 bore wells have energised and handed over to beneficiaries. District wise status is given in the following table. During 2014-15, it has been proposed to take-up 25000 bore wells under this programme.

Finally last but not the list, the development of irrigation in Odisha reflected from the net area covered under irrigation. This can be seen from **figure no.8.** The data reveled that there is a fall in the net irrigated are despite the development of major and minor projects and exploitation. But there were fluctuations in the growth in middle period. From 1995-96 to 2002-03 the growth rate has fallen by 40%. After this period there was a

increase in the net irrigated area by 75% from 2003-03 to 2009-10. After this period still the rates are falling. In 2012-13 the net irrigated area in Odisha was 1248 thousand Ha.

Table No. 9

Groundwater Infrastructure in Odisha

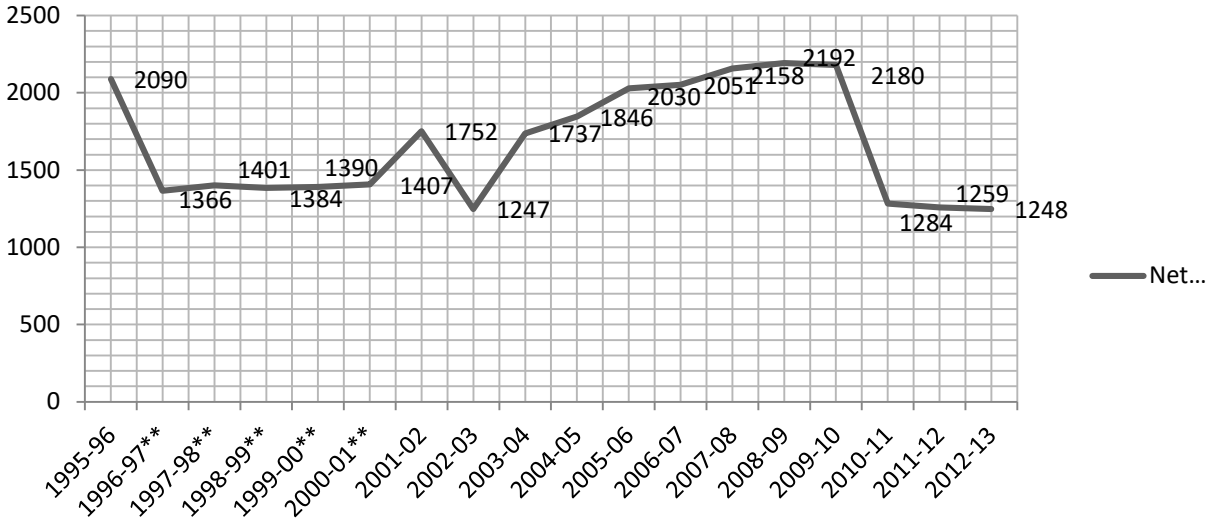
Sl.No.	District	Dug well	Shallow well	Deep well	Total	Bore wells through DBSK as on 2014*	Irrigated area in Ha
1	Angul	31647	299	128	32074	309	618
2	Baleswar	2642	17316	1725	21683	419	838
3	Bargarh	23610	2550	339	26499	1526	3052
4	Bhadrak	254	5211	648	6113	NI	NI
5	Bolangir	59272	115	28	59415	1091	2182
6	Boudh	12875	2	0	12877	742	1484
7	Cuttack	15591	6404	354	22349	173	346
8	Deogarh	7489	12	202	7703	295	590
9	Dhenkanal	12368	98	42	12508	121	242
10	Gajapati	4397	158	3	4558	-	-
11	Ganjam	32596	2016	126	34738	270	540
12	Jagatsinghpur	956	6130	300	7386	NI	NI
13	Jajpur	3218	5063	828	9109	255	510
14	Jharsuguda	6806	16	134	6956	262	524
15	Kalahandi	21563	23	8	21594	1221	2442
16	Kandhmal	9384	5	1	9390	224	448
17	Kendrapara	369	1698	90	2157	NI	NI
18	Keonjhar	23699	1506	141	25346	211	422
19	Khordha	14910	1163	65	16138	541	1082
20	Koraput	5376	64	12	5452	214	428
21	Malkangiri	2196	7	25	2228	483	966
22	Mayurbhanj	13440	2871	454	16765	806	1612
23	Nabarangapur	11570	98	49	11717	671	1342
24	Nayagarh	16467	322	11	16800	544	1088
25	Nuapada	14539	40	19	14598	624	1248
26	Puri	654	6957	103	7714	NI	NI
27	Rayagada	2352	534	27	2913	316	632
28	Sambalpur	17901	40	50	17991	788	1576
29	Subarnapur	13393	33	5	13431	776	1552
30	Sundargarh	24035	88	118	24241	999	1998

Source:fourth Minor Irrigation Census (2006-07) and annual report dept of water resource govt. of odisha

* DBSK: Deep Bore well Secha Karyakrama is a scheme which would be implemented in 256 blocks of 26 districts (18 Non-KBK districts, 8 KBK districts) of the state.

NI: Not implemented districts

Figure No. 8
Net Area Irrigated by Source in Odisha: 1995-1996 to 2012-2013 (In 000' ha)



Source: Ministry of Agriculture, Govt. of India. (From www.Indiastats.com)
Note: ** Irrigated area : The figures related to irrigated area are either estimated based on the data for the latest available year received from the State/UTs or are estimated/taken from agriculture census.

1.5 Contemporary issues and future challenges of Irrigation:

The gradual and more recent debate issue is global scarcity of water resources. It has been estimated that the global accessible use of water will climbs to 70% by the year 2025 and requirement is an additional 500 km3 of irrigation water, a volume roughly equivalent to the annual flow of 6 Nile Rivers or 28 Colorado Rivers (Postel, 2000). Water use for irrigation is almost 80% of total sectoral water requirement. Hence water crisis in near future addressed by researchers and academician which is a great threat to irrigation sector. This perception of water crisis ha a multidimensional perspective. Neo-liberal economist addresses this as a failure of institution like property rights to address water as an economic good (Iyer, 2007). Mainstream Economists consider this as mismatch between demand and supply (Fisher and Peterson, 1976). Whereas socio political thought address this as a socially and politically constructed scarcity (Mehta, 2006). Similarly, few other address this as community failure (Iyer, 2007).

In India the water issues in irrigations mainly concentrates on three things water conflicts, over exploitation of water and water pollution. Water conflicts in India are serious issue at all level starting from trans-boundary to local level. There are 15 states which are in conflicting for water almost all southern states. Odisha also not remain out of it. The state is facing interstate dispute with Andhra Pradesh on Polaveram, whereas farmer level conflicts exist at different dam command area like Hirakud. The issue on ground irrigation related to over exploitation also reflects from the state. Over exploitation of GW affects the quality of water. This leads to soil salinity in coastal area, more fluoridation, excessive nitrates and deep aquifers yields arsenic also. Another important issue in recent year is water pollution. Due to river pollution the water quality is ultimately affects the agricultural production. As all conflicts here are zero sum game in nature (Briscoe and Malik, 2006), therefore attempt towards solving conflicts at different level and raising water quality is a big challenge in this 21st century growing world irrigation demand.

The other aspect of issues in irrigation is role of institution like community, water market and property rights. Not a one institution plays a better role to solve issue related to irrigation in India. It is the combination of all which plays an important role. Since the county's landscape and cultural hegemony is very much diversified in nature. When we look back water management case in India, Briscoe and Malik (2006) highlights four era of water management in India. This illustrates evolving role of citizen and the state in water management. Before 1850 some state works, but most citizens survived along rivers, by local rainwater harvesting and from rainfed agriculture. The era of massive state irrigation works, with a decline in traditional water management by citizens during 1850 and 1970. Between 1970 and 2005 there is declining public funding, and evolved of massive individual investments in tube wells. The present era i.e. 2005 to 2025 is an era in which the state needs to play a major role in surface water provision and in the regulation of groundwater. Though the levels of development in ground water level increased to 28% in Odisha and 60% in India, still restriction on GW exploitation is needed.

Table No.10

Assessment by the National Commission on Integrated Water Resources Development (NCIWRD)

Sl.No.	Total Water Use (BCM)							
	Uses	Year 1997-98	Year 2010		Year 2025		Year 2050	
			Low	High	Low	High	Low	High
1.	Irrigation	524	543	557	561	611	628	807
2.	Domestic	30	42	43	55	62	90	111
3.	Industries	30	37	37	67	67	81	81
4.	Power	9	18	19	31	33	63	70
5.	Inland Navigation	0	7	7	10	10	15	15
6.	Flood Control	0	0	0	0	0	0	0
7.	Environment(1) Afforestation	0	0	0	0	0	0	0
8.	Env.(2)Ecology	0	5	6	10	10	20	20
9.	Evaporation losses	36	42	42	50	50	76	76
	Total	629	694	710	784	843	973	1180

Source: central Water commission, Govt. of India

The above table No: shows the projection of future water demand in different sector. In the context of agriculture, NCIWRD estimated that the efficiency of surface irrigation systems would increase to 60 per cent from the present level of 35–40 per cent. The estimates also indicate that 9 out of the 20 river basins do not have sufficient water for uses (Gandhi and Bhamoriya, 2011). Since Low irrigation yields low recoveries and leads to revenue deficit leads to poor Operation & Maintenance, poor performance, farmer dissatisfaction, low fee payment and low-cost recovery and continues as a vicious circle of irrigation (Gulati, 2005). Due to more convergence of institutional interaction this immerge an issue of political economic analysis of irrigation-system problems (Gulati,2005; Gandhi and Bhamoriya, 2011). This to be happened due to lack of irrigation reforms such as participatory irrigation management or irrigation management transfer which has very limited success (Iyer, 2007). Therefore, breaking this vicious circle of irrigation is a great challenge. This can be possible the means for demand relative to water available when and where it is needed have included (1) technical innovation, (2) social transformation, (3) normative and ethical formulations (Krishan, 2011).

1.6 Conclusion

This study about the irrigation in India elucidated its development in the context of Odisha as well as India. All the situation can be related to future threat of irrigation. Since it was always mentioned that India is agriculture-based country, it is very much important to emphasis on the development of irrigation. Only expenditure on development of irrigation may not proper success. Along with this better technology also needed to enhance water use efficiency in the agriculture sector. As the Indian agriculture more diversified according to land size and agro climatic zone, need of irrigation also differs according to this. Making big projects many times hamper the ecosystem of a particular area and habitats of people with improper rehabilitation process. More watershed management practices should be included for development f irrigation. It is important to understand behaviour of water along with the behaviour people. Steps should be taken to make running water into waling water through different watershed programme.

Presently Govt. lunched Pradhan Mantri Krishi Sinchai Yojana (PMKSY) in centralised manner which will replace and converge all the existing scheme of investment in irrigation (Jharsa, 2015: *The Businessline*). But the decentralisation may be good as the different diversification is exists in irrigation also. The need of development of irrigation in different place depend upon existing soil water nexus. We also have seen that after post-independence period the role of the ground water is rising despite development of major and medium projects. This results as exploitation of ground water and reduction in water quality. The expenditure in irrigation to total expenditure is falling throughout the planning period and this should be address properly for further development of irrigation.

There is no doubt Odisha has improved a lot in the irrigation sector from post-independence and planning era. But the net irrigated area has fallen in recent year. Both the irrigation potential created and utilised increases in the last decade, but the percentage utilisation has fallen in few recent years. In other words, the gap between irrigation potential created and utilised has increased like the national level. This implies that there is development of irrigation in the state but utilisation is not proper, either the irrigation is going on dead or waste. Therefore, steps should be taken to match between both the gaps in case of Odisha as well in India. The coastal length of Odisha is about 23% (560 KM) of total eastern coast having an area 155.7 KM^2. The ground water exploration is growing in coastal area which is threatening soil salinity in coastal area. This ultimately affects the agricultural production. Hence the GW use in those areas of the state should be in sustainable manner.

REFERENCES

[1] Briscoe, J. and Malik, R.P.S. India's Water Economy: Bracing for a turbulent Future, The World Bank, *Oxford University Press*, New York, 2006; 1-78.

[2] Chaudhury, Pradipta. (1991): "Peasants and British Rule in Orissa", *Social Scientist*, Vol. 19(8/9):Pp. 28-56.

[3] Dhawan, B. D. (1985): "Irrigation Impact on Farm Economy", *Economic Political and Weekly*, Vol 37(39): Pp. 124-128.

[4] Fisher, Anthony C. and Peterson, Frederick M. (1976): "The Environment in Economics: A Survey", *Journal of Economic Literature*, Vol. 14(1): Pp. 1-33.

[5] Gait, Edward A. (1928): "Ancient Bihar and Orissa", *Journal of the Royal Society of Arts*, Vol. 76(3932): Pp. 510-529.

[6] Gandhi, Vasant P., and Bhamoriya, V. (2011): "Groundwater Irrigation in India: Growth, Challenges", In India Infrastructure Report 2011: Water: Policy and Performance for Sustainable Development, *Oxford University Press*, First edition, Published by Infrastructure Development Finance Company.

[7] Ghosh, S. and Kumar A. (2010): "Performance of Irrigation and Agricultural Sector in Orissa: An Analysis of Missing Links", *Indian Research Journal of Extension Education*, Vol.10 (2): Pp.48-54.

[8] Govt. of India (2010): "Irrigation Infrastructure", In Infrastructure Statistics: 2010, Central Statistics Office, *Ministry of Statistics and Programme implementation*, New Delhi. http://mospi.nic.in/Mospi_New/upload/Infra_stat_2010/11.ch_irrigation.pdf.

[9] _____ (2014): "National register for Large Dams", *Central Water commission*, New Delhi. http://www.cwc.nic.in/main/downloads/new%20nrld.pdf

[10] _____(2014): "Ground Water Year Book India: 2013-14", *Central Ground Water Board*, Ministry of Water Resources, Faridabad, Haryana. http://www.cgwb.gov.in/Documents/Ground%20Water%20Year%20Book%202013-14.pdf

[11] _____(2015): "Water Related Statistics 2015", *Central Ground Water Board*, Water Resources Information System Directorate, *Central Water Commission*, New Delhi. http://www.cwc.gov.in/main/downloads/Water%20&%20Related%20Statistics%202015.pdf

[12] _____(2015): "Economics Survey of India: 2014-15", *Ministry of Finance Department of Economic Affairs*, Economic Division, New Delhi.

[13] Govt. of Odisha, (2014): "Annual report", *Department of Water Resource*, Orissa State Secretariat Bhubaneswar. http://www.dowrorissa.gov.in/AnnualReport/WR_AR13-14.pdf

[14] _____,(2015): "Economics Survey of Odisha: 2014-15", *Department of Planning & Co-ordination*, Orissa State Secretariat, Bhubaneswar.

[15] _____,(2015): "Odisha Agricultural Statistics: 2012-13*", Directorate of Agriculture & Food Production,* Odisha, Bhubaneswar

[16] Gulati, Ashok. et.al. (2005): "Institutional Reforms in Indian Irrigation", International Food Policy Research Institute, *Publications India Pvt. Ltd.* First Edition, New Delhi. Pp. 15-23.

[17] Harsa, J., (2015): "Latest Irrigation scheme, a non -Starter", *The Business line Editorial*, Hyderabad Edition, Published on 1st September 2015 Tuesday.

[18] Iyer, Ramaswamy R. (2003): "Water, Perspectives, Issues, Concerns", *Sage Publications India Pvt. Ltd*, First Edition, New Delhi.

[19] Jha, U.M., (1984): "Irrigation and Agricultural development", *Deep and Deep Publication*, First Edition, New Delhi.

[20] Krishan, S. (2011): "A brief History of Water Resources in India", Publication Division, *Ministry and Broadcasting*, Govt. of India, New Delhi.

[21] Kumar, D. and Desai, M. (1983): "The Cambridge Economic History of India Volume-2:1957- 1970", *Cambridge University Press*, First publication, University Press, Cambridge, New York.

[22] Mahapatra, S.K. (2005): "Water Governance: A Historical Understanding Of Mahanadi River Basin, Orissa", *Madras Institute of Development Studies Working paper*, No.193.

[23] Mehta, L. (2007): "Whose scarcity? Whose Property? The case of Water in western India", *Land use policy*, No 24: Pp.654-663

[24] O'Malley, L.S.S. and Cousins, E.R.J.R. (1933) "Bihar and Orissa District Gazetteers: Cuttack", *Superintendent Government Printing*, Second edition, Bihar and Orissa, Patna

[25] Oza, Apoorva (2007): "Irrigation: achievements and Challenges", India Infrastructure Report, *Oxford University Press*, New Delhi

[26] Parida, A.K. (1997): "Economic Life in ancient Orissa", in "Economic History of Orissa", Ed. Patnaik, N. R., *Indus Publishing Company*, New Delhi. Pp. 21-31.

[27] Postel, Sandra L. (2000): "Entering an Era of Water Scarcity: The Challenges Ahead", Ecological Applications, Vol. 10(4):Pp.941-948

[28] Rao, K.L., (1979): "India's Water Wealth: its assessment, uses and Projections", *Orient Longman*, First Edition, Hyderabad.

[29] Rothermund, Dietmar. (1993): "An Economic History of India: From Pre-Colonial times to 19991", *Routledge Publication*, Second edition, New Delhi. Pp. 140-141.

[30] Samal, J.K (1990): "Economic History of Orissa, 1866-1912", *Mittal Publication*, First Edition, New Delhi.

[31] Shah, Mihir (2013): "Water: Towards a Paradigm Shift in twelfth plan", *Economic and Political Weekly*, Vol.47 (3):Pp.40-52.

[32] Shah, T. (1993): "Ground water markets and irrigation development: Political economy and practical policy", *Oxford University Press*, First Edition, Bombay.

[33] Stone, Ian. (1984): "Canal irrigation in British India: Perspective on technological Changes in a peasant economy", *Cambridge University Press*, First Edition, London, Great Britain.

[34] Thapar, R. (1990): "A History of India: Volume one", *Penguin Books India (P) Ltd*. Second Edition, New Delhi.

[35] The Hindu, (2003): "The Hindu: Jawaharlal Nehru (1889 1964): Architect of India's modern temples", *The Hindu Newspaper Publication*. Online edition of India's National Newspaper Monday, Jul 07, 2003

[36] The River Valley Civilization Guide, *rivervalleycivilizations.com*. access on 27.07.2015 at 10.29 am.

[37] Zetland, Devid. (2013): "All-in-Auctions for water", *Journal of Environmental Management*, No.115: Pp.78-86.