Working Paper No. 193

Water Governance:
A Historical Understanding of Mahanadi River Basin, Orissa

by

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June 2005

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Abstract

Many studies on irrigation in colonial India are on the Gangetic valley, northwestern and western India. A comprehensive analysis of the interface between irrigation and agrarian change in eastern India has not been discussed adequately so far. This is particularly in the case of Orissa state. The present work makes a modest effort to fill up this gap. Several socio-economic, technological and political transformations that took place in Orissa over a period of time have altered her socio, political institution. Against these changes, the present study aims to document the development of various irrigation systems in Orissa in conjunction with other technological development during pre- and post- independence period. The subject of governance is so serious that without addressing it in adequate measure in the State, integrated development and management of the water resources for realising sustainable water will only be a reflective exercise. Though the present work predominantly focuses on Hirakud Command Area under Mahanadi river basin, instances from other districts of Orissa were used as illustrations.

Key words: *Water, Governance, Water Management, River Basin*

Approach

It is apparent that, irrigation has a very long history in India. The research on irrigation history is a difficult assignment since the idea of technological development and expansion came from more or less all segments of society from colonial rulers to local chieftains/ ordinary villagers, from the Mauryans to Mughals and the rest. The Grand Anicut[1] is certainly the most famous irrigation work of the post-Mauryans period. The canals and the hydraulic control structures built by Hindu monarchs and Mohammedan rulers are still in existence. During the first quarter of the 19th Century, the East India Irrigation and Canal Company carried out restoration of earlier irrigation works. But the Orissa division was ignored till the onset of the famine of 1866[2].The system of canal irrigation- including operation, design, and management developed largely during British times differs greatly from what we see at present[3].

John Bright mentions that, "British Government spent less money on irrigation in India than U.K., [4] where there was recurring droughts and famines". He also supported A. Cotton to construct canals for irrigation and navigation works, because it was felt that, irrigation not only lead to more production but also provides a cheap means of transport for the movement of food grains to those parts in which food was required most.[5] The English canals were designed for navigation, while the Indian canals were mainly designed for irrigation than for navigation, but Orissa was abandoned till 1866. Thus it is comprehensible from the past history of 'Orissa canals' that, the significance of irrigation and its growth was realised only in the early part of the 20th Century.

Studies on irrigation in colonial India by the engineers, administrators and other interested scholars threw up enormous information on diverse features of its impact on the regional economy[6]. Contributions from economists and historians have also generated more

* Financial support from Malcolm Elizabeth Adiseshiah Ph.D Merit fellowship is gratefully acknowledged. This paper is part of the researcher's ongoing Ph.D research on Water Management. I am indebted to Prof. S. Janakarajan and Prof. Padmini Swaminathan for their constant and continuous advice at various stages of this paper. Responsibility for its shortcomings, however, lies with me. Email: sushantamids@hotmail.com

analytical discussions and consequent impacts[7]. Conversely, as most of these studies discuss Gangetic valley, north-western and western India, a comprehensive analysis of the interface between irrigation and agrarian change in eastern India was never anticipated. This is particularly in the case of Orissa state. The present work makes a modest effort to fill up this gap.

It has been pointed out by Sir Charles Trevelyan (1835) that "Irrigation is everything in India, water is more valuable than lands, because where water is applied to land it increases its productivity at least six fold and generally a great deal more and it makes land productive which otherwise would produce nothing." [8] To make water supply regular, the Royal Commission on Agriculture of 1928 and the Indian Irrigation Commission of 1945 emphasized the need for well irrigation in India. But the Government in Orissa never thought of well irrigation and these were left to the discretions of private individuals.[9]

In his comparative study on "Irrigation policy in India and Philippines", Nirmal Sengupta (1991) pointed out that there were enormous works on the canals in the north and the huge weir in the south i.e. the Grand Anicut. The colonial Government in India did not control its ownership land unoccupied during the invasion. In principle the British Government assumed ownership of all land and settled these with different agencies against a recurrent revenue payment while remained indifferent to the manner of its use and transaction. Afterwards, Irrigation Acts were disseminated though they were of little importance: irrigation matters were mainly arbitrated through land revenue settlements. To make matter more multifarious, varying patterns of settlement were adopted in different periods in different parts of the country, all of which had divergent consequences with respect to irrigation. The freezing of revenue demands under the permanent settlement was being criticised in other parts of India. With the extension of canals it was found that such a settlement did not let the Government share the benefits of improvement. Ultimately in 1867, the Secretary of State decreed that permanent settlement should be withheld in areas like canal irrigation, fully or partly, in the near future (Stone: 1984, p.166)[10].

Water has been principally examined as a problematic of colonial irrigation policies by Colonial India. Elizabeth Whitcombe (1972) in her significant study on the canal systems of the United Provinces provided the first substantial critique of colonial irrigation policies. It was claimed that the canals brought about environmental destruction in the Doab, compounded further by the pulls of the market planned by the railways. Whitcombe (1972) emphasizes that the canals far from becoming works of general improvement served only to depress the peasantry[11]. By contrast, Ian Stone (1984) in his analysis on the canal systems in the United Provinces claimed the opposite. In his enquiry it was articulated that the impact of canals was supplementary to the larger designs of escalating productivity, and peasantry at last from its improvements. The canal in consequence became the foremost cause of dynamism in the Doab. It rescued the peasant's labour, at the same time creating new labour scarcities, and paved way for constant improvement. In other words the canals in the Doab of the United Provinces proved to be advantageous[12].

Imran Ali's (1988) enquiry into the canal colonies of Punjab, examined a special ground of colonial irrigation history. He deals with the social, engineering and political aims that were crucial to the organization of the canal colonies. He recognized both the processes of economic growth and under-development in the colonies. Growth as a result of prolonged production linked to the demands of an export market, and under-development in the continued consolidation of feudal elements that were inextricably part of the political aims of

the colonial regime. The criticism was that a capacity developed by the colonial state for initiating dynamic capitalism was defeated because of the implantation of archaic social institutions. Overall, the imperatives of colonial rule prevented the canal system from realizing its full potential in developing the Canal Zone[13].

Ian Stone (1984) portrays that "For at least four decades following the opening of the Eastern Jamuna Canal in 1830, the entire UP canal system was- even by the standards of the early 1900s- strikingly unsophisticated in terms of design and management. Military engineers with little practical experience to guide them experimented with designs and modes of operation within the tight and fluctuating bounds of 'ordinary expenditures' charged against the revenues of each year. Scarce engineering skills were naturally taken up by the main construction tasks; little time and few resources existed for the details of distribution, and gradually did the attention of the engineers move beyond the prestigious main works to the more mundane activity of establishing an effective distributary system. The construction, operation and management of the actual water distribution systems were, by default, placed in the hands of the irrigation community"[14].

J.W.Ottley (1874) pointed out that the utility of irrigation was very little known to the people in general and Government in particular. Rainfall was not low and it was rather extensive in Orissa. Wells and canals were non-existent then. Irrigation by tanks and by lifts from holes in the marshes was practiced till 1866. Irrigation works started in the latter part of the 19th Century encouraged agriculture. Prior to 1850 Public Works Department under repair works of old canals and new schemes were started, they were barely completed till 1858. Irrigation works to save peasantry from poverty and to increase their tax paying capacities started late, which in a sense diverted the attention of agriculturists from resistant group.[15] These largely have been the principal interest in the study of water for the colonial phase.

Organisation of the paper

Several socio-economic, technological and political transformations that took place in Orissa over a period of time have altered her socio, political institution. The State governed by different rulers at different period of times, has changed the water regime. Against these changes, the present study aims to document the development of irrigation system in Orissa in conjunction with other technological development. The subject of governance is so serious that without addressing it in adequate measure in the State, integrated development and management of the water resources for realising sustainable water will only be in pen and paper. The need for better water governance in the State is critical. Main motivation of this paper is to understand the different irrigation development during pre and post-independence periods. The time period of the study is 1860 to 2001. The paper is organized in the following manner. Section one discusses the study area and the State. Section two briefly examines the development of canal irrigation system in Orissa during pre-independence period. Primarily it covers different canal systems of Orissa, canal conflicts, origin of collapse of Orissa Canals, privatisation of irrigation proposal, income and expenditure of canals, and the areas irrigated by the Orissa Canals from 1870 to 1899. Section three emphasizes on the development of different irrigation practices in Hirakud Command Area in Mahanadi river basin and its implication for local economy and society during pre-independence period. Finally section four deals with development of different irrigation system in Orissa during post-independence period. This part also examines the development of ground water irrigation in Orissa. Finally section five examines the linkages between water governance and water management in the Hirakud Command Area.

Section-I

Backdrop of the Study Region

This section portrays a few points about the backdrop of the State, Mahanadi river basin, Hirakud dam and its command area. In the 19th century Orissa as a State never existed. The Orissa State was a part of the former Bengal Presidency; a few other districts were under the Madras Presidency; several other districts were forming Central Provinces and many Princely States. Perhaps this kind of a fragmentation of the then Orisssa State was one of the main reasons for the backwardness of its economy. Therefore history of the present State itself is very recent. The management of the region by the Mughals and Marathas before its conquest by the East India Company was also disorganized.

The state of Orissa is situated along the south-eastern coast of India with a coastline of 482 km. on the Bay of Bengal (For detailed description of the political boundary of Orissa, see Map-I). The State is endowed with rich resources such as fertile land, labour, abundant water, forest, coastal area, mineral deposits etc. However the Orissa State is known for its backwardness in social and economic sectors and the picture has not changed even after fifty eight years of independence. Orissa is one of the poorest states in the country. The State was more frequently subjected to natural calamities of flood, cyclones and drought due to ecological imbalances caused by large-scale devastation of forests. Historical records show that Orissa had suffered from terrible droughts and famine in the 15th and 16th centuries during the reign of Kapilendradev and Prataprudradev.[16] Severe famine conditions have also been recorded in 1770, 1774-75, 1792-93 and 1865-66[17]. As a result, there was very small capital formation, persistent poverty and regular famines in which, there were mass starvation deaths of the common people. People were badly impoverished and the village structure, which was mostly self-sufficient, was broken down.

The primitive available records show that the undivided district of Sambalpur, which at present forms the main Hirakud Command Area, was one of the regions of the state held by the Chouhan rulers. In 1797 the district was conquered and annexed by the Marathas but due to British intervention the Raja was restored in 1817 and held under the control of Bengal Government till 1862 and then transferred to the central province. Again it was transferred to the Orissa division of Bengal. In 1912 the district was tagged to the province of Bihar and Orissa. In 1936 when the new Orissa state was created the district formed a part of Orissa state.

The British annexed the area along the Sambalpur district in 1849 in pursuance of the Doctrine of Lapse. After colonial take over, the British had introduced a series of survey and settlements with the twin objective of collecting increased land revenue and strengthening state power. For the purpose of land revenue administration the district of undivided Sambalpur was having two tracts namely, the *Khalsa* and the *Zamindaries*. In the *Khalsa* area there were 119 *malguzar*; 870 *Gountia* and 16 *Rayatwari* villages. In the *Zamindaries* area there were 16 *Zamindaries* with 1942 villages. Apart from the *Gountias* and the *Zamindars* there were village servants enjoying revenue-free land like the *Jhankars, Gaudas, Negi, Kumbhar, Lohar, Bhandari, Dhoba* etc. The periodical survey and settlement increased the revenue demand from time to time and it was demanded in cash. Hence the tenants were forced to sell their produce in the market to pay for the land revenue cess on education and *Choukidari* and so on.

MAP-I

Source: www.mapsofindia.com

Agricultural seasons

There are three well-marked agricultural seasons in the State. They are summer, rainy season and winter. The summer continues from March till June when the temperature rises very high. There are occasional showers during this season. The rainy season continues from July till October and there is a heavy rainfall in the month of August. This is the season when there are high floods in the Brahmani, Baitarani and Subarnarekha rivers. Table-1 depicts the district wise, month-wise normal rainy days of Orissa during the period 1901 to 1950[18]. The winter starts in November and continues till February. This is a very pleasant season as winter is not very severe except in some areas of Phulabani and Koraput districts. There are thundershowers in the southern and western parts of the State during the winter.

Table-1: District/Month-wise Normal Rainy Days of Orissa (1901-1950*)

Districts	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Balasore	1.1	1.8	2.1	3.2	5.8	10.4	14.2	14.3	11.8	6.6	1.5	0.4	73.2
Bhadrak	1.1	1.8	2.1	3.2	5.8	10.4	14.2	14.3	11.8	6.6	1.5	0.4	73.2
Balangir	0.8	1.4	1.2	1.6	2.3	10.1	16.9	16.6	11	3.7	1.1	0.3	67
Sonepur	0.8	1.4	1.2	1.6	2.3	10.1	16.9	16.6	11	3.7	1.1	0.3	67
Cuttack	0.8	1.6	1.4	2.2	4.9	10.4	15.1	14.8	12	6.6	1.6	0.3	71.7
Jagatsinghpur	0.8	1.6	1.4	2.2	4.9	10.4	15.1	14.8	12	6.6	1.6	0.3	71.7
Jajpur	0.8	1.6	1.4	2.2	4.9	10.4	15.1	14.8	12	6.6	1.6	0.3	71.7
Kendrapara	0.8	1.6	1.4	2.2	4.9	10.4	15.1	14.8	12	6.6	1.6	0.3	71.7
Dhenkanal	1.1	1.8	1.6	2.1	4.1	10.4	16.7	15.8	12	5.5	1.3	0.4	72.8
Angul	1.1	1.8	1.6	2.1	4.1	10.4	16.7	15.8	12	5.5	1.3	0.4	72.8
Ganjam	0.7	1.4	1.5	3	4.6	8.7	11.7	12.5	11.3	7.1	2.3	0.6	65.4
Gajapati	0.7	1.4	1.5	3	4.6	8.7	11.7	12.5	11.3	7.1	2.3	0.6	65.4
Kalahandi	0.8	1.2	1.2	1.9	2.5	9.8	16.1	16.1	10.5	4.1	1	0.2	65.4
Nawapara	0.8	1.2	1.2	1.9	2.5	9.8	16.1	16.1	10.5	4.1	1	0.2	65.4
Keonjhar	1.4	2.3	1.8	3.1	5.8	10.8	17.2	16.1	12.6	5.9	1.4	0.4	78.8
Koraput	0.6	1	1.3	8.9	5.2	10.9	17.9	18.5	13.7	6.1	2.1	0.5	86.7
Malkangiri	0.6	1	1.3	8.9	5.2	10.9	17.9	18.5	13.7	6.1	2.1	0.4	86.6
Nawarangpur	0.6	1	1.3	8.9	5.2	10.9	17.9	18.5	13.7	6.1	2.1	0.2	86.4
Rayagada	0.6	1	1.3	8.9	5.2	10.9	17.9	18.5	13.7	6.1	2.1	0.5	86.7
Mayurbhanj	1.5	2.4	2.3	3.2	6	12.1	17.8	17.5	12.2	6.2	1.4	0.5	83.1
Phulbani	1	1.8	1.5	2.6	4.4	10.4	17.1	16.8	13	6.2	1.8	0.5	77.1
Boudh	1	1.8	1.5	2.6	4.4	10.4	17.1	16.8	13	6.2	1.8	0.5	77.1
Puri	0.9	1.5	1.3	1.9	3.8	9.6	14.2	14.3	12.6	7.2	1.9	0.5	69.7
Khurda	0.9	1.5	1.3	1.9	3.8	9.6	14.2	14.3	12.6	7.2	1.9	0.5	69.7
Nayagarh	0.9	1.5	1.3	1.9	3.8	9.6	14.2	14.3	12.6	7.2	1.9	0.5	69.7
Sambalpur	0.9	1.9	1.4	1.5	2.3	9.9	18.6	17.5	11.3	3.7	1	0.3	70.3
Bargarh	0.9	1.9	1.4	1.5	2.3	9.9	18.6	17.5	11.3	3.7	1	0.3	70.3
Deogarh	0.9	1.9	1.4	1.5	2.3	9.9	8.6	17.5	11.3	3.7	1	0.3	60.3
Jharsuguda	0.9	1.9	1.4	1.5	2.3	9.9	18.6	17.5	11.3	3.7	1	0.3	70.3
Sundargarh	1.3	2.2	1.7	1.7	3.3	11.3	19.6	18.9	12.3	4.3	1.1	0.5	78.2
Orissa	1	1.7	1.6	2.8	4.2	10.4	16.4	16.1	12	5.6	1.5	0.4	73.4

Note: *: Revised on 12th May, 1961.

Source: Orissa Agricultural Statistics 1999-2000, Directorate of Agriculture & Food Production, Govt. of Orissa

Major rivers of Orissa

The important rivers of Orissa are Mahanadi, Brahmani, Baitarani, Budhabalanga, Subarnarekha, Salandi, Rushikulya, Banshadhara, Bada, Bahuda and Indravati. General characteristics of different rivers of Orissa are provided in the Table 2. The Mahanadi and its tributaries are an inter-State river system, flowing through the States of Madhya Pradesh, Maharashtra, Bihar and Orissa. Three great rivers (Mahanadi, Brahmani and Baitarani) collect the drainage of 57,000 Sq miles of central India and gradually converging towards the coast, dash down their accumulated waters within thirty miles of each other upon the Cuttack District. Mahanadi is the southernmost of the three, originates from the Maikal Mountains popularly known as the Amarkantak plateau of Chhatisgarh (Madhya Pradesh). From here it journeys collecting the waters of several tributaries, gathering currents and force as it contracts in wide to less than half a mile between the Siddheshwar and Debikote hills. At a gorge at Satkosia it bursts forth debouching onto the coastal plains just above Naraj some seven miles from Cuttack. Thence begins its course throwing branches, shooting arms and bifurcations before it finally empties itself into the Bay of Bengal at False Poling (See the Map-II).

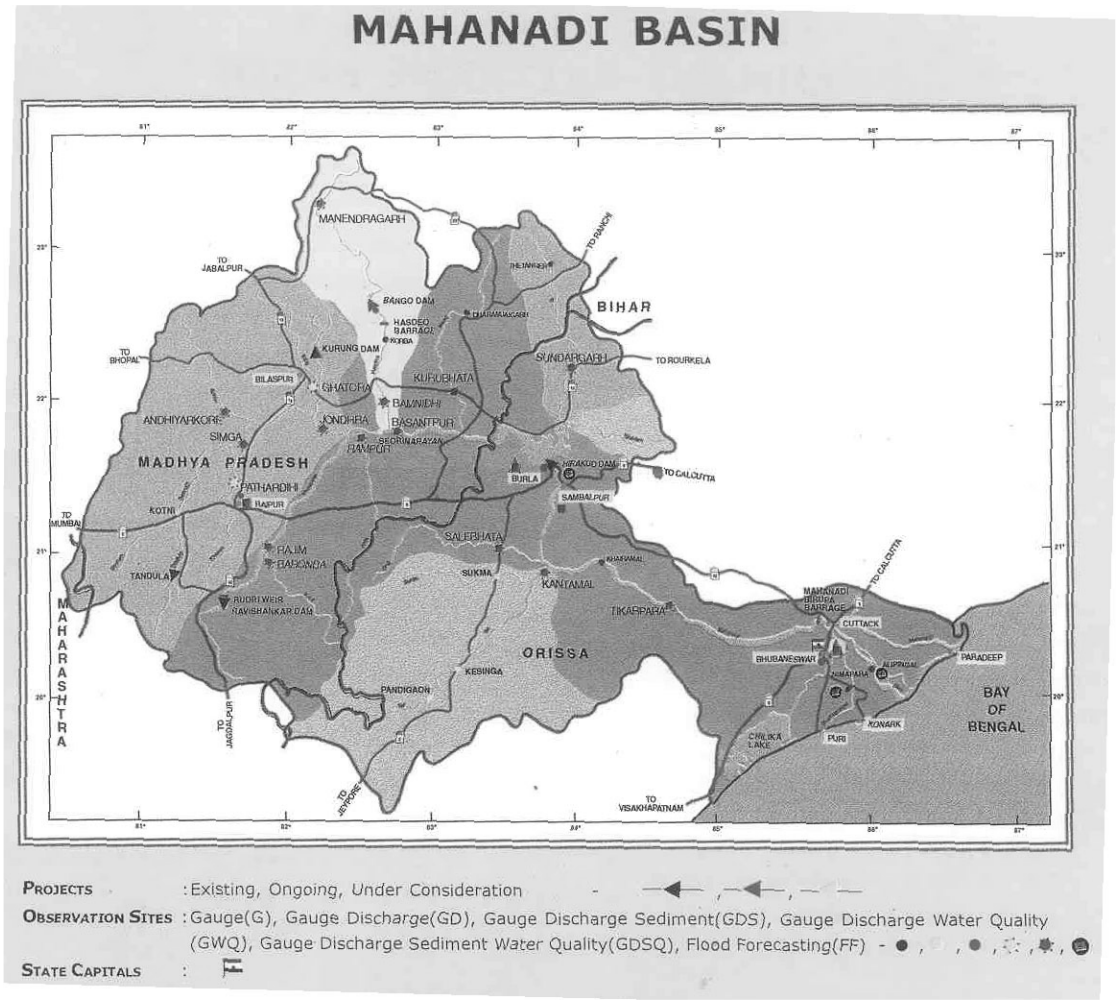
Table-3 depicts the State-wise distribution of the drainage of the Mahanadi river basin. The basin covers large areas in the States of Madhya Pradesh and Orissa, and only small areas in Bihar and Maharashtra. The Mahanadi is by far the biggest river with a catchment area of about 1, 20,500 sq.km. The Hirakud Dam is constructed on it. The Mahanadi basin extends over an area of 141 thousand sq.km and lies between east longitudes 80° 30′ and 84° 50′ and north latitudes 19° 20′ and 23°35′Lying in the north-east of the Deccan plateau. The Mahanadi basin is bounded on the north by the Central India hills, on the south and east by the Eastern Ghats and on the west by the Maikala range. The upper basin is a saucer-shaped depression known as the Chhatisgarh. The basin is circular in shape with a diameter of about 400 km. and an exit passage of about 160 km. length and 60 km breadth. Table-4 shows the state wise catchment area and distance of major tributaries of the Mahanadi river basin. The total length of the river from the head to its outfall into the sea is 851 km. of which 357 km are in Madhya Pradesh and the balance of 494 km. are in Orissa. The basin covers in full the district of Bolangir in Patna and partly the districts of Raipur, Shahdol, Bastar, Bilaspur, Durg, Raigarh and Sarguja in Madhya Pradesh, Cuttack, Dhenkanal, Kalahandi, Koraput, Phulbani, Puri, Sambalpur and Sundargarh in Orissa. The Mahanadi is one of the major rivers of the country flowing east and draining into the Bay of Bengal. Among the peninsular rivers in water potential and flood producing capacity, it ranks second next to the Godavari.

Table-2: General Characteristics of Major Rivers of Orissa

Name of Rivers	Biggest/Holy/ Within State/Inter-state	Length In Kms	Tributaries	Distributaries	Falls at	Use-Irrigation/ Navigation/ Fishing/ Flood Control	Origin	Dam Construction/ speciality
Mahanadi	Biggest Interstate	851	Banga, Tml,Sapua,Salunki	Kathajuri, Chitrotpala, Kuakhai, Birupa, Pakia, etc	Bay of Bengal near false point	All	Mountains of Raipur, Bastor in M.P.	Hirakud (Diamonds)
Brahamani	Within State	700	Kharsuan, Kimiria, Lingari, Patiya	--	Bay of Bengal at Dhamra	-do-	Combined Stream of two smaller rivers South-keel & Sankha in Gangapur, Sundergarh Rises from Bonasika in Keonjhar	Bengali
Baitarani	Holy river, within state	335	It joins with Orahmani as Dhamra River In Orissa 48 Kms.	At Dhamra river	Bay of Bengal at Dhamra	-do-	Originates from Ranchi in Bihar	--
Subarnarekha	Interstate Bihar, West Bengal, Orissa Small river within State	312	--	--	-do-	-do-	Rises from Similipal Hill in Mayurbhanj	Gold cost is found
Budhabalanga	Holy river within State	164	Bada, Ghodahad, Jarau	--	At Chandipur	-do-	Rises from Rushinal Hill near Sana Khimindi	--
Rushikulya	Interstate	200	Joining with Mahendratanaya	--	--	--	Rises from Jeypore Hills of Koraput	--
Bansadhara	Too small rivulates	156	--	At Lalingapatnam in Andhra	--	--	Originates from Hills of Koraput	--
Indrabati Kolab	Within State Boundary between A.P./Orissa	--	--	Flow into Godavari as her Tributary	--	-do-	Flows in Balasore After Koraput it is named as Sileru and falls to Saberi river of A.P.	Dams
Salandi		160	--	--	--	-do-		--
Machkund		--		--	Bay of Bengal			Dam

Source: Compiled from Various sources, i.e. *Agricultural Census of Orissa*, 1970-71, pp.12-13, 67-69, B.N.Sinha (ed), *Geography of Orissa*, Delhi 1981, relevant portions, W.W.Hunter, *Statistical Account of Bengal*, Vol. XVIII, New Delhi, 1976, pp. 22-25, 250-252

MAP-II



Sources: River Basin Maps of India, Ministry of Water Resources, Government of India

Table-3: The State-wise distribution of the drainage of the Mahanadi river basin

State	Drainage area (Sq.km)
Bihar	635
Madhya Pradesh	75,136
Orissa	65,580
Maharashtra	238
Total	141,589

Source: Government of India, Indian Irrigation Commission, (1972): *Report of the Irrigation Commission,* Vol. I, Ministry of Irrigation and Power, New Delhi

Table-4: Tributaries of Mahanadi

Major Tributaries Of the Mahanadi	State	Catchments area (Sq.km)	Distance (km)
Seonath	Madhya Pradesh	30,761	353
Jonk	Orissa	3,637	196
Hasdo	Madhya Pradesh	9,803	333
Mand	Madhya Pradesh	5,237	241.5
Ib	Madhya Pradesh	12,447	251
Ong	Orissa	5,128	204
Tel	Orissa	22,818	296
Mahanadi	Orissa	141,000	851

Source: Same as in Table-3

Physical feature of the Mahanadi river basin

There are four well-defined physical regions in the basin, namely, (i) the Northern Plateau, (ii) the Eastern Ghats, (iii) the Coastal Plain and (iv) the Erosional plains of the Central Table Land. The Northern Plateau and the Eastern Ghats are well-forested hilly regions. The Coastal Plain stretching over the districts of Cuttack and Puri covers the large delta formed by the Mahanadi and is a fertile area well suited for intensive cultivation. The erosion Plains of the Central Table Land are traversed by the Mahanadi and its tributaries.

Land use pattern and agricultural practices

State-wise land use details in the basin, as per the 1967-68 statistics, are given in Table 5. Except in the Chhatisgarh and coastal plains, the basin has an extensive area under forests. This is mainly due to the hilly nature of the terrain and the lack of transport facilities. The Chhatisgarh and coastal plains, with high incidence of rainfall are predominantly rice-growing areas. The land use details indicate that the resources in the basin have not been put to intensive use.

Table-5: Land Use Details in Mahanadi Basin (Thousand hectares)

Item	Name of the State				
	Bihar	Madhya Pradesh	Maharashtra	Orissa*	Total
Gross area	63	7,514	24	6,558	14,159
Reporting area	63	7,474	24	6,410	13,971
Area under forest	15	2,817	15	1,653	4,500
Area not available for cultivation	6	579	2	880	1,477
Culturable area	42	4,078	7	3,867	7,994
Uncultivated culturable area	17	1,005	-	1,348	2,370
Net area sown	25	3,073	7	2,519	5,624
Area sown more than once	2	663	--	739	1,404
Total cropped area	27	3,736	7	3,258	7,028
Net area irrigated	0.5	380.1	1.1	662.3	1,044.0
Gross area irrigated	0.7	382.4	1.1	898.2	1,282.4
Percentage of net area irrigated to cultivable area	1.19	9,32	15.7	17.13	13.06
Percentage of net area sown to culturable area	59.52	75.36	100.0	65.14	70.35
Percentage of net area irrigated to net area sown	2.00	12.37	15.71	26.29	18.56

* Relates to the year 1964-65.
Source: Same as in Table-3

Mahanadi Delta Irrigation system

Mahanadi delta irrigation is one of the oldest systems with two weirs constructed during pre-independence era (1864) to draw water from the river branches of Mahanadi and Birupa near Cuttack to provide irrigation in the delta area. However, with the consturction of Hirakud reservoir in 1958 assured regular releases of 280 cubic metre per second (cumecs) available after power generation the delta irrigation was completed in two stages I and II through the constuction of a new weir across Mahanadi at Mundali upstream of Naraj and the new Mahanadi and Birupa Barrages replacing the old weirs. A total CCA of 3, 03,000 ha out of GCA of 5, 20,000 ha. was brought under assured irrigation. As against the proposed cropping pattern of 148% (kharif 100% + rabi 48%), it is seen that the present cropping pattern is 158.9% (kharif 100% + rabi 58.9%). Like in the Hirakud reservoir command the paddy is the most predominant crop amounting to 139.6% (kharif 95.7% +rabi 43.9%) while jute 3.2% and other rabi crops (16.1%) including pulses oilseeds vegetables etc are grown in very small areas.

The average yield rates of Mahanadi delta irrigation system are shown in Table 6. Here the yield rate is lower compared to Hirakud irrigation system. The delta irrigation system is seen to suffer very seriously from lack of proper drainage aggravated due to very flat terrain, with numerous river branches, with flood embankments on each side coupled with heavy rainfall in the coastal districts of Orissa. Out of the total CCA of 3, 03,000 ha as much as 1, 14,000 ha suffer from this malady to varying degree. 80% of these problem areas were improved by provision of proper economical drainage system.

Table 6 Average Yield of Different crops under Mahanadi Delta Irrigation system

Name of the crops	Average yield rate in (quintals/ha)	
	Kharif	Rabi
HYV paddy	12	15.2
Normal paddy	10.8	8.6
Vegetables	50.8	69.2
Jute	12.6	-
Groundnut	-	-

Source: Same as in Table-3

In 1955, the Mahanadi Delta Irrigation project (Mundali Weir) was taken up for construction. The project comprises a weir across the river Mahanadi at Mundali, 4.8 km. upstream of Naraj in the Cuttack district and a canal system. The weir has 1, 353 m and the main canal has 386.34 km. long. A number of minor schemes consisting of tanks, dug wells and tube wells have also brought a sizeable area under irrigation. In many villages, there are more than one tank which irrigate adjoining agricultural lands. State-wise details of the area irrigated from various sources, in Mahanadi basin for the year 1967-68 are given in Table 7. By the end of 1968-69, the area under minor schemes increased by about 21,660 hectares. Most of the important information relating to water resources development in the basin is either non-existent or has not been compiled and analyzed. Working statistics of canals and reservoirs have neither been compiled nor published. As per the data of Madhya Pradesh and Orissa, the average annual diversion on full development of major and medium projects in operation and under construction as in 1968-69 is likely to be of the order of 13,926 m.cu.m.

Table-7: Source-wise Irrigation – Mahanadi Basin (Thousand hectares)

Source of Irrigation	Area Irrigated				Total
	Bihar	Madhya Pradesh	Maharashtra	Orissa*	
1	2	3	4	5	6
Canals	0.2	308.5	0.2	316.2	625.1
Tanks	Neg	44.5	0.9	131.6	177.3
Wells	0.2	9.5	---	14.9	24.6
Other sources	0.1	17.3	Neg.	199.6	217.0
Total	0.5	380.1	1.1	662.3	1,044.0

* Relates to the year 1964-65
Source: Same as in Table-3

The history of the Hirakud Project dates from 1858 when Sir Arthur Cotton was asked to report on how the waters of the Orissa Rivers could be harnessed and the flood problem tackled. Sir Arthur Cotton suggested the construction of weirs across the Mahanadi, Brahamni and Baitarani rivers. He further suggested the construction of irrigation canals, drainage channels and embankments. This scheme, however, was not considered productive. Hence the recommendations were not adopted. Subsequent suggestions synchronized with the occurrence of floods in Orissa. After Sir Arthur Cotton's recommendations the Flood Enquiry Committee of 1927 was asked to enquire into the flood problem of Orissa and give its recommendations. Sir, M. Visveswaraya's report of 1937, the report of the Flood Enquiry Committee of 1938 and the Flood Enquiry Committee of 1940 followed this. The recommendations of these committees could not be accepted because of shortage of funds.

It was not until 1945 that attention was again directed to the flood problem of the Mahanadi delta. That year in the month of May, Mr. A.N. Khosla, the Chairman of the C.W.I.N.C. visited Orissa and after discussions with the authorities, thought reservoir dams on the Mahanadi to be the best solution to the problem. In November 1945, accordingly, in a conference of the representatives of the Central Government, Orissa, Madhya Pradesh and the Feudatory States, a decision was taken for the "immediate investigation of the Mahanadi for multi-purpose development" and in March 1946 the foundation stone of the Hirakud Dam was laid.[19] However the final design of the Hirakud dam was approved in June 1951, and the earth-cum-concrete and masonry dam was completed in 1957. After its inauguration on 13th January 1957, the reservoir was filled to capacity in the monsoons of 1958.[20]

Ajudhya Nath Khosala, the then internationally reputed Engineer as the Governor of Orissa gave a helping hand to the Chief Minister Biju Pattnaik in formulating the integrated development of the river basins of Orissa. The first official document with regard to the Hirakud project is the report entitled "The Mahanadi Valley Development, Hirakud project, June 1947" (Known as the Khosla Report), contained the original schemes and estimates relating to the project. The Hirakud Dam was conceived as only the first stage, in the unified basin-wise plan for the Mahanadi Valley. This is one of the oldest hydel projects of India, being the first post-independence major multi purpose river valley project in the country. The dam is built across river Mahanadi at about 15 km upstream of Sambalpur town, located at a distance of 6 km from national high way no.6 in the state of Orissa. The nearest railhead is Hirakud Railway Station, which is at a distance of 8 km from the dam site. It was to have a height of R.L. 625.0 feet at which the reservoir has submerged an area of 135,000 acres of which nearly 70,000 acres were cultivated land.

Section-II

Development of Canal Irrigation System in Pre-Independence Orissa

This section briefly examines the development of pre- and post-colonial canal irrigation system in Orissa. Soon after the British had succeeded in acquiring large territories through their military action and various other means of gaining supremacy, they started consolidating their holdings and turned attention on administrative measures to aid civilian rule. Even before India went under the colonial rule of the British, while the East India Company continued to administer the territories in their command, they realized that the restoration and improvements to the existing irrigation works should get the first priority in the civilian rule to keep the farming community in good humour and assist in maintaining food production, incidentally improving their revenue

The beginning of organized irrigation in Orissa is traceable to the second part of the nineteenth century with the inauguration of work on Orissa Canal Project. Preceding to the great famine of 1866, there was practically no irrigation project in the Orissa Province. In general people were cultivating land with the water taken from the streams and tanks. Irrigation from tanks flourishes in certain parts of the State where topography was appropriate for tank construction, but then these tanks got silted up to a great extent over time. Where the water was only a few feet it was scooped up in a *sena.* Among the other local means, *janta* was used to lift water with the help of *tenda* into a reservoir and from that into the water channel by a *sena* or a *janta*. Water used to be taken from *nallas* or *jores* in the low-lying tracts near the coast by means of *tenda* or bamboo-water lift[21]. The attention for irrigation in Orissa was undertaken after terrible famine in 1866, or else well known as *Nanka Durbhikya.* Preceding to this, the suggestion to exploit the water of the rivers for irrigation and navigation was prepared in the year 1858 by Sir Arthur Cotton, who was asked to counsel in the issue of management of floods of the Mahanadi River. He suggested the construction of a complete system of irrigation and navigation canals, abide by the principles then being carried out in the deltas of the Godavari and Krishna. The East India Irrigation and Canal Company carried out the construction of Orissa Canal in 1863.

Sir Arthur Cotton during his visit to the Mahanadi delta in 1858 first proposed the control of the floodwaters through a system of irrigation and navigation canals. He estimated that an area of 2.25 million acres might be irrigated and navigation opened up between Orissa, Midnapore and Calcutta at a cost of 130 lakhs of rupees[22]. The Madras Irrigation and Canal Company addressed the Board of Directors of the East India Company in July 1858 and the Secretary of State in November 1858 to undertake the works of construction as recommended by Sir Arthur. But the Secretary of State declined to sanction such an arrangement. Thereupon, a new company, the East India Irrigation and Canal Company was formed in August 1860 for the purpose of carrying out irrigation works in Orissa. After successful negotiations with the Government, an Act of Parliament incorporated it in 1861[23]. Its Capital was fixed at £2,000,000. The arrangements made between the Government and the Company were that the Government was to give all land free of charge, that the Company was to construct the works and when they were ready for irrigation to distribute the water, at the same time as Government was to collect the water rates and, after deducting the cost of collection to pay the remainder over to the Company[24].

Flood was a persistent problem in the State. Hunter (1872) experimented that, “It is the devastating rivers and not foreign invasion or domestic tumult which the Oriyas have

chiefly to fear for their survival"[25]. Cockburn the then Commissioner of Orissa division reporting in 1859 investigated that, "the finest lands are devasted by finest rivers and streams and cause havoc to the people who are next to starvation"[26].

Arthur Cotton submitted his report in May 1858 says that, "control of the Mahanadi is not a question of protection of town of Cuttack of 35,000 population, it is the protection of province, particularly Cuttack and Puri of population about 1.25 million. Problem of control of waters of Orissa is similar to Godavari and Krishna delta. Thus, his proposal was for irrigation and navigation in Orissa delta and a main canal to connect the deltas of Calcutta with a cost of £1,300,000 could irrigate 2,250,000 acres. He also mentioned that if Government can't do itself, then English Company may be permitted to carry these schemes".[27] Orissa Canal System has a colonial history. It would be adequate to say that the progress of modern irrigation system in Orissa is abundantly obliged to British Rule. Deltaic plain of Orissa, being the largest part productive and wealthy caught the imagination of colonial power for developing irrigation network method. Two well-known irrigation systems i.e Orissa canal and Rushikulya canal systems were developed during the period 1860 to 1910. While the latter is restricted to Rushikulya basin only, the former is extended over the deltaic plain. Both the systems are almost contemporary, integrated in nature and exclusive of each other. However, the Orissa Canal System is much broader in dimension, interlinks three major river systems, has a multi-dimensional objectives, and shaped the history and tradition of Orissa over the years.

Thus, The Orissa canals were commenced by the East India Irrigation Company, on the failure of which works were taken over by the Government at a valuation. During the period 1893-95, the Province of Orissa has been endowed with the following works, which are for the most part located in the Cuttack district i.e. seven weirs across river channels with an aggregate length of 3.5 miles, and constituting, with the canal head sluices and entrance locks, the most expensive system of headwork's of any canal system in India. There are 204.75 miles of canals, which are navigable in addition to carrying water for irrigation; there are also 75 miles canals for irrigation only. Besides this, there are 109.75 miles of distributaries and village channels. The maximum discharge of the canals in 1895-96 was 6,058 cubic feet per second and the area shown as commanded is 56, 20,000 acres[28].

At first, the area irrigated from the canals was very little. Progressively it rose to 200 thousand acres around 1900, and improved further subsequently. Conversely, the irrigated area accounted for only a small portion of the gross cropped area, between 13% and 17% in Cuttack district during 1900-30. In Balasore district it was much less, around 3%.[29] Orissa project embraced four different but interrelated schemes and one out-lire specifically, The Mahanadi series of canals, The Brahmani and the Baitarani series, The Subarnarekha series and The Cossy (Midnapore) series. Each series was specified after the river or rivers from where it derives its supply and all were planned to be connected by a high level canal. Running from river to river with little or no fall, the high level canal was planned to irrigate the very highest land which the water could reach and the same time form a great navigational highway connecting the Chilika lake, Cuttack, Balasore and Midnapore with Calcutta. The outlying scheme was the Hijilee tidal canal connecting the lower part of Hoogly with the Haldi and Raslpur rivers and furnishing an outlet to the large grain trades of Hijilee and Southern Midnapore.

The original and most important were three weirs constructed to control the Mahanadi such as the Naraz, Mahanadi and the Birupa. The other four weirs were built on the

Brahamani and Baitarani. The main canal system consisted of the *Taldanda* and *Machgaon.* for the irrigation of the lands between the Mahanadi and Kathajuri rivers; the *Kendrapara* and the *Pattamundai* for the irrigation of the lands between the Chitratola and the Birupa and three ranges of the High Level Canal for the irrigation of the strip of land lying at the foot of the hills from Cuttack to Bhadrak (Balasore District)[30]. Problems continued to plague the canals even in 1870-71 when the area under the canal shot up dramatically to 130,000 acres. Out of a revenue demand of Rs.1, 24,130 only Rs.10, 346 (roughly 8.57% of the demand) could be realised. In real practice the continuity of Orissa project expanding upto Calcutta was broken due to the non-implementation of the Subarnarekha series. It was partially due to the persistent unwillingness of the cultivators to avail themselves of the irrigation afforded by the Midnapore canal. Subarnarekha series of canal system was similar to those of Midnapore series from agricultural point of view. Apprehending the same reluctant attitude of the cultivators in Subarnarekha series of the British administration suspended the works of Subarnarekha series. Also the Midnapore scheme and Hijila tidal canal were alienated and became isolated project during 1870. Thus the canals led up from Mahanadi, Brahmani and Baitarani formed another project on a distinct and separate basis and named as Orissa Canal System (Baladev Lenka, 2003).

Table-8: Canals of India

Name	Year of starting
The Ganges Canal	1840
The upper Bari Doab Canal	1849
The Godavari Canal	1846
The Krishna Delta Project	1852
Orissa and Midnapur Canal	1863

Source: Compiled from various sources and also from Harris, *Irrigation in India* and Bernard Daley-*Problems of modern India*, Vol.I, etc., cited in Mishra, H.K. (1991)

Table-8 depicts the list of new irrigation schemes in India. It has been found that Orissa Scheme was persistently unsuccessful[31]. The canals turned into a mechanism of oppression for the cultivators of the deltaic region and in its many layered impacts articulated the colonial interest of supremacy and convention. Orissa's rivers were the rivers of unhappiness and commonly flooded the region and brought famines and pestilences practically every three-four years. There were no resourceful flood control measures[32]. Captain Harris carried out initially methodical study of flood control in Mahanadi basin during 1854 that suggested for a building of a spur across river Kathajodi to main Mahanadi. Afterwards, the renowned engineer, Sir Arthur Cotton of Madras presidency was assigned the task of planning and he sketched the blue print of integrated irrigation system in the entire delta. The canal systems were started during 1860 and completed by beginning of 20th century i.e. 1910.

Privatisation of Irrigation proposal: A prior elucidation

The private management of irrigation and canal system was tried way back in the mid nineteenth century in British India. In fact before Sepoy Mutiny (1857) a proposal was submitted by Col. Cotton to form "the Madras Irrigation and Canal Company Limited" which was opposed by the Governor General Dalhousie and some leading authorities, "on grounds that the cultivators welfare was Government's responsibility, especially in times of distress, and that private sale of water would introduce an unnecessary and wholly undesirable complication into the vexed question of property rights". But after the transfer of the responsibility for British Rule in India to the British Crown, the irrigation was perceived as a

profitable public work and therefore "best avenue for Government's investment". "But the cost in terms of the initial capital outlay needed to achieve satisfactory returns was beyond the means of the Government which was barely able in its current financial predicament to meet the maintenance charges on existing works". In 1859, Madras Irrigation and Canal Company, a private company under some conditionality got the Government approval. This irrigation company entered into the canal system for irrigation, and inland navigation in Medinapur district of Orissa. But by 1864, it began to be felt that "the execution of irrigation works by private capital which would entail the wholly unprecedented and undesirable creation of rights to private property in water was roundly declared to be incompatible with the satisfaction of the community's requirements as to welfare and the Government's as to its revenue". In 1864, the Secretary of State, Sir Charles Wood wrote, "the State should undertake all irrigation works it can practically manage in preference to entrusting them to private companies and that, when the surplus revenue and available balances prove insufficient to supply the requirements of this country, funds by means of loans should be raised, resort should not be had to private companies until Government agent shall have been fairly tried and shall have been found wanting". [33]

With reference to the functioning of the East India Irrigation and Canal Company finds the following observation "Anicuts were constructed over the main river of the Cuttack district to regulate the quantity of water pushing down the main stream with a view to flood control and to draw supply for the canals. After a great deal of discussion, the Government agreed to a charge of Rs. 5 per acre for an annual lease. Immediately there were oppositions from *Ryots*. At the end of October 1867, the Company was prepared to supply water for 1, 53,000 acres, while the area actually under irrigation amounted to 9836 acres. The returns were not encouraging and the shares of the Company fell in market. When the resources of the Company were exhausted the Government of India advanced a large loan. In July 1867, the Government of India wrote to the Secretary of State that there was no possibility of the Company being able to carry out the work and that the Orissa Canal Projects be taken over by the Government. The Orissa projects became the property of the Government on payment of 119, 0050 Pounds and cancellation of the loans of 152,000 Pounds".[34] This private Irrigation Company was surrendered to the Government in 1869.

Canal conflicts

This part is mainly based on the issues of canal conflicts that were made to Canal Commission of 1884. The Commission was to explore the conflict that happened in the Canal Zone in the early half of the 1880s. Their report made two references to anti-canal protests, the first occurring in 1881, when *ryots* of 61 *mouzahas* in *pargunnah sungara* resigned their leases and made petitions to the Collector[35]. The second, of a more serious nature, when in April 1884, they met in large bodies at different places resolved never again to apply for water under any circumstances… the cultivators have struck to the determination notwithstanding the occurrence of a drought during the past summer[36].

Origin of collapse of Orissa canals

The causes of failure of Orissa canals were attributed to improper estimate of what they might cost and the vaguest knowledge of what the earnings might be in return. Due to unsystematic planning, canals became unremunerative during the period 1872-99. Nevertheless, scarcity of own resources and lack of ability to increase adequate funds in the London Money Market led to the collapse of the Company to complete the project and as such, the canal was not of much use in the Orissa Famine of 1866. Owing to the incapability of the Company to carry the project on higher capital outlay basis with less than expected

return, in addition the pressure of great famine, the Government took over the project from the Company in 1867. Along with this take-over, it was determined that hereafter all such irrigation works would be carry out by Government only. In agreement with this policy resolution, irrigation development under direct Government scheme initiated in 1868, with the recommencement of the construction of the balance works of Orissa canal and its distributaries, schemes with a total investment of Rs.26.4 million were completed in 1895.

Table-9: Income and expenditure of Canals

Year	Income (Rs.)	Expenditure (Rs.)	Deficit (Rs.)
1872-73	36,623	2,38,009	2,01,386
1881-82	2,23,149	11,03,834	8,80,685
1882-83	3,19,625	3,54,896	35,271
1887-88	1,79,211	5,01,932	1,22,721
1892-93	4,97,375	5,05,507	8,132
1893-94	3,75,365	5,35,467	1,60,162
1898-99	4,65,492	4,95,213	29,721

Source: Annual Administration Report of Bengal Presidency (Orissa division) of the concerned years, also see P.Mukherjee, pp.18, 19

Table-9 explains the income and expenditure of Canal construction during 1872-1899. The financial facet of canal irrigation exposed that the losses were more and hence became unremunerative. The Table depicts that the expenses of canal expansion were more than the income received. The foremost cause for the unwillingness of the State to resolve the irrigation difficulty was that it includes public investment without any assurance of sufficient return from it. Thus, just before the close of the 19th Century, the total costs of the projects amounted to Rs. 2, 63,682 and Orissa was endowed with the following works such as:

1. Kendrapara canal of 59 miles length to irrigate 1, 60,159 acres and for navigation.
2. High level canals from Cuttack to Calcutta
3. Godavari canal of 22 miles length for navigation only.
4. Jaipur canal of 6 miles to irrigate 70,000 acres.
5. Dudhai canal of Cuttack.
6. The Taldanda canal of 53 miles length for irrigation and navigation.
7. Machagoan canal of 32 miles for irrigation only
8. Seven weirs of 3.5 miles length.
9. 205 miles of both irrigable and navigable canals.
10. Pattamundai canal of 48 miles length for irrigation only.

In spite of all the pros and cons, canals make available security both for flood and droughts. Table-10 elucidates the area irrigated in India, which expose an insufficiency of irrigation works in Orissa. On an average 19.5% of lands in India were irrigated in 1902-03 [37] but Orissa was neglected in contrast to other province.

Table-10 Area Irrigated in India up to 1901

Province	Canals	Area Irrigated in acres
Bengal	**Orissa canal**	**2,01,498**
	Midnapur canals	82,134
Agra and Oudh	Jamuna and Ganges canals	27,41,400
Punjab	Canals	49,00,000
Bombay	Canals	1,39,040
Madras	Kaveri, Krishna and Godavari alone	25,00,000

Source: R.Dutt, pp.403-406

Table-11 gives a picture of the areas irrigated by the Orissa Canals from 1870 to 1899 (in acres). There was a distinct negative relationship between rainfall and demand for canal water. While the low rainfall in 1887-88 provides a support to the demand for canal water, abundant rainfall during 1892-95 resulted in a sturdy decline in its demand. Therefore, it seems that irrigation was mostly used for protection against drought in the absence of complementary inputs such as HYVs and fertilizers. The major advantage from canal water in the kharif season was the primitive method of production. On the other hand, in the years of adequate and well-distributed rainfall, there was no significant difference between yields in irrigated and unirrigated fields[38]. Orissa passed under the control of colonial rule during 1803 with Cuttack as the seat of power. Three coastal districts of Cuttack, Puri and Balasore were formed as the major administrative units of a British Orissa. The coastal Orissa was subjected to the vagaries of nature very often, flood and drought being the most familiar. The recurrent natural calamities of the time coupled with economic consideration led to the thinking of British Engineers for irrigation development in Orissa. Economic concern was the large remission of revenue on account of flood and drought.

Table-11: The Areas Irrigated by the Orissa Canals from 1870 to 1899 (In acres)

	ORISSA PROJECT						
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
1869-70	..	1564	165	..	..	..	1729
1870-71	999	8976	12162	..	..	..	22137
1871-72	292	3860	7501	..	..	..	11653
1872-73	198	4318	237	..	..	..	4753
1873-74	1733	7825	3013	..	..	..	12571
1874-75	4095	11105	7259	..	..	..	22459
1875-76	1271	11577	5561	..	..	..	18409
1876-76	5157	17206	8019	..	..	..	30382
1877-78	32604	53769	12122	..	..	..	98495
1878-79	36097	61083	14070	..	..	..	111250
1879-80	37279	57641	13715	189	214	..	109038
1880-81	39400	61871	14023	182	51745	..	167221
1881-82	43941	70627	15588	283	1839	..	132278
1882-83	44131	72468	13955	289	1585	..	132428
1883-84	10300	23685	11937	323	2515	..	48760
1884-85	10546	33022	12270	..	3104	.	58942
1885-86	15489	36375	13404	265	6806	..	72339
1886-87	18685	39714	12412	407	6491	..	77709
1887-88	31277	54404	15312	994	7569	.	109556
1888-89	40391	72796	18092	2385	25628	..	159292
1889-90	40246	77874	26599	2563	39345	..	186627
1890-91	41806	74970	21984	2503	39036	..	180299
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: Maddox, S.L. (1920), *Final Report on the Survey and Settlement of the Province of Orissa (Temporarily settled areas), 1890 to 1900 A.D.,* Vol.I, Part II, Ch.V

First Irrigation Commission, 1901

A significant event is the constitution of a special commission by the Governor General in Council on 18th September 1901 to report on the irrigation of India as a protection against famine. This is referred to as the First Irrigation Commission of India. The commission submitted its report after an elaborate exercise in respect of their Terms of Reference with 91 sittings, visits to the Provinces and examination of as many as , 425 witnesses. The Commission even met the Maharajas of the Native States who expressed a wish to meet, to enquire and compare the conditions of irrigation practices in those States with those of adjacent British territory. The Commission presented its report on the 11th April 1903. For the first time a scientific assessment was made for the entire Indian sub-continent with its large variations, as a whole, of the rainfall and its variability, the soil, climate, the classes of the crop suited to the soil and other local conditions and a record in the form of a report was made available.

The extent of irrigation as on that time in the Indian Empire was estimated about 53 million acres of which 19 million acres were from canals, 16 million acres from wells, 10 million acres from tanks and 8 million acres from other. The Commission realized that a lot of water flows down the rives to the sea and the same time has carefully analysed and detailed the main physical conditions which impose a limit to the use which can be made of the surplus drainage of the country. They felt that at best there can be planning for a further addition of 6.5 million acres. Several administrative and organizational changes that would be required to effect this improvement in irrigation have also been well thought out and detailed. In the mean time, the British Policy in dealing with land and water led to several changes in the erstwhile village structure and in the agrarian economy as well.

Different canals of the Cuttack and Balasore district

The works approved in the Cuttack district incorporated the Taldanda and Machgaon canals for the lands between the Mahanadi and Kathajuri rivers, the Kendrapada and Patamundai Canals for the irrigation of the area between the Chitratola and the Birupa, and three 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. Different canals built in the Balasore district are Churamon or Ricketts' Canal, Coastal Canal and Irrigation from the High Level Canal. During this reign, the canals were mainly constructed in the Cuttack and Balasore districts of the Orissa Province. Detail features of some of the important canal system of the above two districts are provided in appendix-I.

Each year canals were blocked during summer season for repair. Normal closing period was from April to the first week of July. Closing period is changeable from canal to canal. Usual closing days for different canals during 1925 are; Gobri (41), Pattamundai (41), Kendrapada Canal (41), High-level canal (34), Taldanda (47) and Jaipur Canal (47). Kendrapada Canal and Taldanda Canal were alternatively closed for maintaining uninterrupted traffic to Calcutta. In addition to the Mahanadi Canal System in Cuttack and Balasore, the Rushikulya system in Ganjam district was completed in 1901 with a capital expenditure of Rs. 5.0 million by creating an irrigation potential of 40.5 thousand acres. With the exception of this project, the Government till 1943 implemented no other major irrigation scheme in Orissa. But in 1944, some minor irrigation works including restoration of derelict tanks, *bunds*, and wells were undertaken under the 'Grow More Food Campaign' launched after the Bengal Famine of 1943[39].

Over the years, an increase in the area under irrigation was adequately noticed until 1890-91 and it formed some 54% of the area provided with distributaries. But, after the turn of the century there was a relatively steadier increase. This has to be related to the fact that the difference in the value of gross output between irrigated and unirrigated over a period of time, consisting of both good and bad years, could be significant compared to the low water rate that had to be paid[40].

Thus, there was a decline in total irrigated area during this period. In the coastal plains (Cuttack, Puri, Ganjam and Balasore) the total irrigated area decreased by 53.4 thousand acres due to demolition of canals and weirs by recurring floods[41]. On the other hand, in the inland regions (comprising of other 9 undivided districts) traditional system of irrigation i.e. tanks, *bunds,* katas, diversion of hill streams, *Nullas* and wells remained as the major sources of irrigation. The irrigation system in these areas was being controlled, managed and operated by local people.

An analysis of the progress of Irrigation in the pre- independence period

By examining the development of irrigation till 1950, there is evidence of a reduction of total irrigated area in Orissa during the period from 1920 to 1950. In the coastal plains consisting of four districts, the total area under irrigation decreased by 53.4 thousand hectares (Census of India Report, 1951, p.257). This decline was due to the neglect of the two canals and destruction of one weir, at Jenapur, on account of recurring floods. Furthermore, this decline in canal irrigated area was not offset by any increase in minor irrigation during the period, particularly through tanks and wells. In the inland regions of the State, comprising of nine districts, except for two medium projects at Baladia and Haladia in Mayurbhanj district, only tanks, bunds, 'katas', diversion of hill streams and open wells constituted the sources of irrigation. Most of them did not provide irrigation worth the name. The reliability of this argument has been adequately confirmed by the observations of Ramsey (1950, p.73), Bell (1945, p.107) and Ramdhyani (1941, p.17). Apart from the poor standard of these existing irrigation facilities, there was also no increase in the irrigated area during 1921 to 1950 in this in-land division of the State (Misra, S., 1954. pp. 201-202).

Obviously, therefore, in the coastal as well as inland regions of Orissa as a whole, along with the growth of population, the average per capita area under irrigation also declined between 1921 and 1951. This is revealed in the Census Report of 1951, which estimated that in Orissa the per capita irrigated area decreased from 14.1 cents 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. Thus if the extent of irrigation is considered an index of economic security in the rural sector, the people of Orissa were not more protected in 1951 than they were 50 years before. The Famine Enquiry Commission (1945) found out a similar trend, that is, during 1921-22 to 1941-42, the area under irrigation in Orissa decreased 15,000 hectares. [42] In comparison to the Orissa situation, during 1910 to 1950, the net area irrigated in India as a whole increased.

Table-12: Net Irrigated Area as Percentage of Net Area Sown (1951)

	Canals (%)	Well (%)	Tanks and Misc. sources (%)	Total (all sources) (%)
Orissa	3.17	0.45	7.73	13.80
India	7.01	4.51	2.49	16.52

Source: Singh, Jasbir (1978) p.XVI and Census of India Report (1951), Vol. XI, p.226

Table 12 presents the 'net area irrigated' as a percentage of 'net area sown' in Orissa and India as a whole in the pre- plan period. The Table also depicts that the net area irrigated as percentage of net area sown in Orissa was less than that of all-India average just before the commencement of the plan period in 1951. The net canal irrigated area from public sources as a percentage of net area sown was low i.e. 3.17 % which was only 45.24 % of the corresponding all-India figure. Well irrigation was almost absent in Orissa. The high percentage of tanks and miscellaneous sources in Orissa does not indicate a satisfactory state of affairs, because most of them were too slender, deserted and poorly in need of renovation and repair to provide the required irrigation, consequently the state of irrigation development in Orissa in the pre-plan period was far from being satisfactory and successful.

There are many reasons that hinder the development of irrigation in the pre independence period.

(a) In Orissa neither the Government implemented any irrigation scheme of its own, at least in the areas persistently vulnerable to drought, nor did it persuade the farmers to undertake well and tank irrigation as were done in some other States.

(b) The Government rule to implement irrigation programme on its own, and the constraints of resources for investment placed heavy dependence on public debt as a method of financing irrigation expansion. As a result of which, it involved repayment of high debt with interest. Examined on the basis of '1879 financial productivity criterion', [43] it is seen that in Orissa, the Government irrigation works such as Orissa Canals and Rushikulya Systems, were un-productive. This discouraged further public investments on new irrigation projects.

(c) The suggestion of Famine Commissions of 1898, 1901, Irrigation Commission (1903) and the support of Lord Lytton, Lord Northbrook and some liberal friends of India in England advocating the concept of protective irrigation for prevention of famines, led to the creation of "Famine Relief Fund", from which a part was meant to finance protective irrigation works [44] in India. But while States like Punjab and Maharashtra, etc. availed of this financing facility to expand irrigation, especially minor irrigation in Orissa, except Rushikulya, no other scheme, and not even minor works was undertaken with support from this fund.

(d) Apart from this economic barrier, political constraints also significantly hinder the progress of irrigation in Orissa. The separate province of Orissa was formed as late as in 1936, through merger of Oriya-speaking tracts from the neighboring States. Only certain areas had received erratic irrigation facilities created at different times, under different State Governments like Bengal, Bihar, Orissa and Madras Presidency and Central Provinces. And when irrigation which was a subject under Federal or Union List became a provincial or State subject on 1st April 1937, the newly created State of Orissa could not formulate and implement a progressive irrigation plan on account of poor infrastructural facilities and acute paucity of financial resources.

The agrarian scenario in the State has been far from satisfactory at the beginning of the 18th century. The irrigation assets created in the medieval times had deteriorated due to long neglect under the later rules that were more intent on safeguarding their throne from the onslaughts of their enemies than plan for the development and welfare of their subjects. People were left to the mercies of the rain God and the food production was low and

precarious. There were frequent occurrence of droughts and famines. Thus during the pre independence period, the achievements on the irrigation front in Orissa on the whole remained considerably poor. This period was noticeable by the absence of a consistent and integrated water resource development policy, until the Government of India decided to undertake Hirakud Multipurpose River Dam Project in Orissa in 1948. During the pre independence period, the irrigation development was restricted by financial constraint, rather than being molded by the claims of agriculture.

Section-III

Development of Different Irrigation Practices in Hirakud Command Area During Pre-Independence period

This section emphasizes on different irrigation practices in the study region. Basically it covers different form of Irrigation, major source of irrigation such as tanks, wells, canals & other means of irrigation and various techniques of paddy cultivation in the study area. The state of irrigation works, which accumulate, store and control the water distribution, and the organizational arrangements, which look at the maintenance of these works and the distribution of water to the fields, resolve the effective utilization of irrigation as a productive force in any region. Irrigation as the basics of productive forces in the Hirakud Command area endure radical transforms during the colonial period. The central objective of this section is to enquire about these problems during the colonial period of the study area.

Form of Irrigation in the study area

In the earlier period, by and large tanks were the sources of irrigation in the H.C.A. Like in most of the semi-arid but paddy growing acres of the world, the farmers of the command area had constructed a large number of tanks from very early periods. It was mentioned, "In 1903-04 the irrigated area was only 31 square miles, but in the preceding year it had been over 196, being the maximum recorded. With the exception of 12 square miles under sugarcane and garden produce, the only crop irrigated is rice. At the turn of the present century, there was 9,500 irrigation tanks, or on an average between three and four to every village in the undivided district of Sambalpur which presently formed as HCA. In this respect one can raise the question like, if the farmers stock the rainwater in tanks rather than depend on direct rainfall alone would it be probable to cultivate paddy in the region. This type of argument is well illustrated by Narayana *et al* (1982: A-189), by taking into account the water requirement of the paddy crop and the possible evaporation and other losses of moisture from the tank. Their study accomplished that " in a region where the rainfall is about 50 inches, to grow paddy in 100 acres it is necessary to have a tank with a catchments about 80 acres. If the lands are plain and if the tanks are interspersed with fields, catchments can be taken as the surface area of tank". [45]

Specifying the fact that in the H.C.A. the rainfall was less than 50 inches and the topography was flat, where paddy was grown, paddy cultivation depending on rain fed tanks would have meant a far-reaching decline in the area accessible for paddy farming. Leading channels from the ends of the embankment normally affects irrigation, but in years of short rainfall the centre of the tank is sometimes cut through. The *Jambor* and *Sarsuitia Nullahs* near *Machida* are perennial streams, and the water is diverted from them by temporary dams and carried into the fields. In certain regions near the Mahanadi where water is very close to the surface, temporary wells are also sometimes constructed for the irrigation of rice. Irrigation from permanent wells is of no consequence"[46].

The number of tanks increased to 12,282 during 1931 with an area of about 221,347 acres (89,646 hectares) under irrigation from tanks as well as wells. The increase in the irrigated area was most noteworthy in Bargarh *ex-Zamindari* areas where 47,784 acres (19,353 hectares) of rice land could get irrigation compared with 28,205 acres (11,423 hectares) twenty years back. Prior to the completion of the Hirakud Dam Project, the major source of irrigation was tank. The tanks were of three categories i.e. *Kata, Munda* and *Bandh* (Orissa District Gazetteers, Sambalpur, 1971). The detailed descriptions of the three categories of tanks are provided in the appendix- II.

Wells, Canals and Other means of irrigation

Apart from tanks, the region has special irrigational advantages in the wells, canals and other means of irrigation such as *nullahs, tenda & sena*. At places, irrigation by *nullahs* is taken recourse to, by means of which the water is diverted and carried into the fields. For raising water from a lower to a higher level the common lever lift called *tenda* is used. This consists of a long pole poised between two uprights and weighted at its lower end, and is used invariably, whether water is required from a well or from a tank. If there is only a small difference of level, baskets *(Sena)* worked by two men are often used. Sengupta (1993) pointed out that, statistics available for Orissa are quite strange for they show that a substantial hectareage is served by tanks but nothing by other sources. Further, he also added that, no distinction has been made in Orissa between the gravity irrigation tanks *(kata)* and dug out tanks called *bandha*, which necessitates lifting for water appropriation, or impounding of streams called *munda.* Another practice, which was more widespread, is that of submergence tanks or *bundhies*[47].

The construction of the Hirakud Dam makes a great landmark in the system of irrigation in the region. The second objective of the Hirakud project was irrigation. The Khosla Report put the gross commanded area in the districts of Sambalpur and Bolangir (then Patna and Sonepur States) at 13, 13,000 acres. The cultivable commanded area (the irrigable area) was estimated at 8, 75,210 acres. The kharif intensity of cropping was assumed to be 100 per cent and rabi intensity 25 per cent, giving the gross irrigable area of 1,094,953 acres or 1.1 million acres roughly (Mahapatra, S.K., 2002). The original proposal as contemplated in the project report of 1947 was to provide irrigation to an area of 3.54 198 ha of CCA. Subsequently during 1954 after detailed investigation the actual GCA and CCA of Hirakud Command were firmed up as 2, 60,280 ha and 2.19.318 ha respectively. The area was proposed to be irrigated by both gravity and lift canal as given in Table 13

Table- 13: Area irrigated during 1954

Canal	GCA (Ha)	CCA (Ha)	Discharge (Cumecs)	Intensity		
				Kharif (%)	Rabi (%)	Total (%)
1.Right Side flow Canal	1,84,924	1,53,785	115	100	48	148
2.Left side flow canal	33,668	28,785	21	100	48	148
3.Right side lift canal	43,708	36,768	27	100	35	135
Total	2,60,280	2,19,338				

Source: Office of the Executive Engineer, Sambalpur Irrigation Division Burla, Hirakud Research Station

Though the dam and head works were completed during 1957 the distribution system was completed only by 1960.However the above proposed lift canal was not taken up. The irrigated area has substantially increased. The canals of this Dam, which irrigated Sambalpur

district as well as the district of Balangir, consist of three main canals, namely, the Bargarh Canal, the Sasan Canal and the Sambalpur. The water reaches the field through a network of watercourses of about 2,898 Kms in length. Water from the Hirakud reservoir flowed into the Bargarh Canal and Sasan Canal in July 1956 and water was available for irrigation in September 1956. These canals provide irrigation in July, that is, at a time when rainfall is usually irregular and water is much needed in the fields. Hitherto, the people could not practice double cropping. Table-14 explains the details of existing distribution system of Hirakud Command Area. The overall irrigation efficiency in the upland areas near the head reach of the canal is worked out to 35.4% as per the study indicating that 65% of water is lost in different ways such as surface evaporation (5%) flooding outflows (25%) and percolation losses (35%) and the remaining 35% only is the actual consumption crops.

Table-14: Details of existing distribution system of Hirakud Command Area

Name of Canal	Designed CCA (ha)	Discharge (Cumecs)	Total length including minor-sub minor (km)	Total no of outlets
1. Bargarh main canal (Right on Mahanadi)	1,32,170	107.57	3631	2637
2.Sasan Main canal (Left on Mahanadi)	22,663	17.836	487	402
3.Sambalpur distrtibutary (left on Mahanadi)	5,597	3.397	98	128
Total	1,60,430		4216	3,167

Note: As per the certified Ayacut account, the total CCA is shown as 1,55,439 ha.
Source: Hirakud Research Station

Kharipani

The most valuable land in H.C.A. and particular to Sambalpur district is *Kharipani.* As it receives the drainage of the village both by surface flow and by seepage, crops never fail. The water, which flows through the village, carries with it all the manure that is deposited in the village by men and cattle. In 1952, Nilamani Senapati who was the then Food Commissioner made an investigation of village Sarasara in Bargarh subdivision and published a pamphlet with photographs showing that a 2-acre plot of Kharipani produced 50 Maunds (1,899 Kgs.) of paddy per acre with ordinary seeds and no chemical fertilizer. The word *Kharipani* does not occur in coastal districts of Orissa where the land is not undulating. The corresponding description of the land that received the drainage of houses is known as *Bari* and is ordinarily used as kitchen garden whereas *Kharipani* in Sambalpur district is almost always paddy growing.

Techniques of Paddy cultivation

The major crops of the H.C.A are paddy, pulses (*Mung, Biri, Kultha*), oil-seeds (Groundnut, Til, Mustard, Castor), sugar cane, millets and wheat. The total cropped area is about 1,485,000 acres (601,425 hectares). Transplantation is more noticeable in the Bargarh plain. As in other parts of India, there are three common ways, that is, dry sowing just before the rains break (*Khardi*), sowing after the rains have broken and the ground is Wet (*batri*), and sowing late with seeds previously germinated by soaking in water (*achhara*). Regarding the description of the techniques of cultivation Dewar's Settlement Report, 1906 says us: The

quantity of ploughing done before sowing time depends largely on the method of cultivation which is to be adopted, but it is usual to plough up all fields at least once before the rains break in June. Harvesting finishes by the end of November. Sometimes in the case of low-lying *bahal* lands, it is not concluded till December. And as soon as threshing is over, the cultivator ploughs up his *bahal* Fields to turn in the stubble. But the *mal* terraces reaped early in October dry up and harden very quickly, and cannot be touched, unless, as is often the case, heavy showers fall in January or February. The bulk of the work is left for the hot summer months, when heavy storms of thunder and rain usually break once a fortnight, and give the farmer his opportunity to plough.

Khardi technique of sowing requires much first round ploughing, and is applied chiefly to bottom lands, which retain moisture long enough after harvest to admit of effective pulverization. About one-third of the total paddy area is covered by this system of farming. *Batri* Method is appropriate to the *mal* fields, which constitute the bulk of the rice land. These *Mal* fields bake after harvest to a brick-like hardness, and can be but lightly scratched until the monsoon has set in. The *muka* method may be relevant to any embanked field, but most suitable to the lower plots of a *berna* dell. These have been lightly ploughed beforehand, when the rain comes in earnest they are flooded deeply, the plough is put through water and mud, and the seed is sown on the thin slush thus worked up. After two days the water is gently drained off. The *Achhara* method is an expansion of *muka*, which can be useful to all fields with good embankments in a low and level position. On the first full fall of rain the fields are flooded, and the plough is put twice through the water and mud. Four or five days later, the water is drained or scooped off, care being taken to leave no pools. The *Bihura* is necessary early in August, when the plants are about a foot high. It consists simply in running a light plough up and down the field, thus uprooting a large preparation of the plants and leaving the rest sticking loosely in the mud in all directions.

Of the pulses grown in the H.C.A by far the important are *Biri* (*Phaseolus-radiatus*) and *Mung* (phaseolus Mungo). Khesari, Bengalgram, Horsegram *(Kultha)* and Field pea are also grown. After the availability of canal irrigation, Rabi crop occupies a large portion in the canal-irrigated areas. The important oil-seeds of the H.C.A include groundnut, sessamum (til) and castor. Of these, groundnut occupies the largest area of cultivation. It is grown in a large scale in Bargarh and Sambalpur subdivisions. The Sambalpur District Gazetteer of 1932 states: “Next to rice, sugarcane is perhaps the most important crop grown in the H.C.A. Though the area it covers is small, it is tending to increase and the value of its produce is very considerable. In the course of the 20 years preceding the last settlement, the area under this crop had grown from 3,694 acres to 6,287 acres, an increase of 70 per cent. Twenty years ago, the only varieties of cane commonly grown in the H.C.A were *bangla* and *tandi*, but at present many other varieties have been introduced. The variety known as *Khari* has become very popular, and the Agricultural Department is endeavoring to introduce the CO 213 cane from Coimbatore, which needs little irrigation, is not attacked by jackals and yields abundant juice producing very fine sugar”.

Regarding the history of sugarcane cultivation in the region F. Dewar Settlement Report (1906) tells us: “Sugarcane is the most valuable crop grown in the district, and at last settlement it ranked second in general importance to rice. But its area has fallen from 6,473 acres (2,622 hectares) to 3,693 acres (1,496 hectares). From 1890 it steadily declined till 1897-98, but since that year it has again increased, and at present is rapidly extending. The causes of this change are curious and illustrate the general changes that have been taking place in the district. “Before the railway came, the cultivation of cane ranked second only to

that of rice, which it supplemented by providing work for farm labourers throughout the spring and hot weather. There was then little export of grain, but *gur*, being a less bulky commodity, was one of the principal articles of trade. Each village grew all its cane in common land provided by the headman in the proximity of the principal tank. In the Zamindari villages, though these are exposed to damage by pig and bear, fencing material is abundant, and the decline of the area under good cane has been less marked. After 1890-1900, the first rush for rice profits was over, and the price in 1895, became steadier".

Crop Rotation

The cultivators of the region were raising single crop till the Hirakud canals carried water to their fields. When irrigation was assured and with organized extension work, they began to shift to multiple cropping. Introduction of improved agricultural practices and of short duration high yielding varieties has provided opportunities for multiple cropping. Cultivators have begun growing even three crops in irrigated areas.

Section-IV

Development of Irrigation System in Post-Independence Orissa

With the dawn of the independence the first Prime Minister of India, Shri Jawaharlal Nehru, initiated and launched Five-Year Plans for overall development of the country. Agriculture, the predominant occupation of the people had to be developed and all efforts had to be made to grow enough food for the people so that the dependence on imports for food could be reduced, if not totally avoided. Development of irrigation and power was thus upper most in his agenda and he gave these two areas the primary priority in the planning process.

The Government of India had formed the Central Water Irrigation and Navigation Commission (CWINC) on 5th April 1945, with A.N.Khosala as its initial chairman. CWINC's extremely centralized approach is specified in a communication in late 1951 sent by Hare Krushna Mahatab, the then Minister of Industry and Supply in Nehru's Cabinet, to Nabakrushna Chaudhuri, the then Chief Minister of Orissa. In his in-depth studies Rohan D'Souza (2003) depicted that, the Central Government has approved a loan to the Orissa Government for the building the Hirakud project. The Orissa Government handed over to the CWINC the work of implementation, which means both the engineering and the administration. The CWINC is a component of the Government of India and, hence, the Finance Ministry approves anything the CWINC recommended. The sanction of Orissa Government with respect to any suggestion of the CWINC has not been sought or prepared. D'Souza also described that, even the creation of a supplementary post of Superintendent Engineer in which Palit was fixed up, the Finance Ministry has sanctioned it. But as far as the implementation of the project is concerned the complete responsibility is CWINC's[48].

By personally investigating the Mahanadi basin in May 1945 A.N.Khosala concluded that "the only treatment for the numerous difficulty of Orissa, specifically floods, droughts, poverty and disease lay in the control, preservation and utilisation of the massive water wealth of its rivers by way of storage dams".[49] The Government of India's assertion on the project being theoretically sound was not, however, followed with any energetic passion, in spite of the Finance Department's frequent announcements and explanation that trustworthy estimations were not offered to them by CWINC. A large amount of the project continued to be conceded in the near deficiency of accurate survey (Rangaiya, R.M.G.1947). Rangaiya, the then retired Chief Engineer and Secretary of the Mysore P.W.D. made a far-reaching appraisal of the Hirakud dam. His report stated that the Hirakud dam project was proceeding

on a very lean number of analysis and technical research paper.[50] Rohan D'Souza (2003) contended that the resolution to dam the Mahanadi River resulted from the broader calculus of post-colonial rule, and was not merely a seduction by the knowledge of Multi-Purpose River Valley Development (MPRVD).[51]

Orissa is gifted with extensive areas of relatively fertile alluvial soil. It has a climate with temperature appropriate for year-round cropping. With extensive network of surface water resources and vast ground reserves, the irrigation potential of Orissa at full development is estimated to be as much as 5.05 million hectares in kharif (June- December) and 2.35 million in rabi (January- May) seasons. Despite the phenomenal demands that agriculture makes on irrigation, the water resources of the State for the most part, that is 75% have remained unexploited and undeveloped. The meagerness of irrigation facilities available in Orissa, is evident from the fact that, the total command area from all sources of irrigation can not cover 38.4 % of the net cropped area of the State. Most of this irrigation facility is limited to the rainy season. In view of such lack of irrigation facilities, strong appeal have been made for accelerated rate of irrigation growth and as such there has been consistent demand for massive investments in irrigation in Orissa. But in view of the constraints of resources in this less developed State, sizeable steeping up of irrigation investment would represent a diversion of resources from some other sectors, which might be of no less strategic significance to the economy. The question of development of irrigation during post-independence can be observed from a variety of aspects such as investment on irrigation, expansion of area under irrigation, review of plan wise physical achievements in irrigation, strategy on irrigation growth, etc.

Investment on irrigation in Orissa

The public sector investment on irrigation in Orissa is principally channelised by the Government of Orissa, since irrigation is on the State List under Indian Federation. The Central Government also executed the Hirakud Dam Project during the first and second plan period, (1951-52 to 1961-62) as a central sector project in view of Orissa's scarcity of financial resources and lack of managerial power and technical man-power to undertake such a work. Further, the Government of India also provides assistance for certain other tribal sub-plan major and medium scheme, like Upper Kolab, Indravati, Kalo and Pilasalki etc. roughly amounting to 29% of their total outlay. [52] In addition to these, the Union Government has made available financial assistance to the State Government for minor irrigation development in Orissa under different schemes like Community Development Programme, and Emergency Agricultural Production Programme.

Irrigation Potential in Orissa (Lakh hect.) during plan period

Principal significance has been accorded to irrigation development in different plan periods. This can be seen from the outlays made for different irrigation projects in different plan periods in Orissa. Table-15 depicts the plan wise financial expenditure on irrigation in Orissa. It is obviously perceived that in the First Five Year Plan, the entire allocation of 55.28 crore rupees for irrigation development in Orissa was entirely spent on major and medium irrigation projects. Minor irrigation was not at all given any significance to the minor projects. This explains that in Orissa greater prominence has been attached to major and medium irrigation projects in the various plan periods.

Table-15: Plan Wise Financial Expenditure on Irrigation in Orissa *(Rs. in crores)*

Plans Period	M & M	Expenditure on M&M as % of Total Irrg. Expen.	MINOR IRRIGATION			Expenditure on Minor as % of Total Irrg. Expen.
			State Expenditure	Institutional	Total	
I plan (1951-56)	55.3		N.A.	N.A.		
II Plan (1956-61)	20	91.74	1.7	0.1	1.8	8.26
III Plan (1961-66)	26.2	79.64	6.2	0.5	6.7	20.36
Annual Plans (1966-69)	20.4	66.67	8	2.2	10.2	33.33
IV Plan (1969-74)	20.9	37.32	18.9	16.2	35.1	62.68
V Plan (1974-78)	70.6	48.19	31	44.9	75.9	51.81
VI Plan (19780-85)	67.8	52.11	28.3	34	62.3	47.89
VII Plan (1985-90)	322.9	69.31	95.6	47.4	143	30.69
Annual Plan (1990-91)	591.5	73.05	183	35.2	218.2	26.95
Annual Plan (1991-92)	155.5	75.08	44.2	7.4	51.6	24.92
Annual Plan (1992-93)	179.3	75.27	53.3	5.6	58.9	24.73
Annual Plan (1993-94)	189.1	75.88	53.4	6.7	60.1	24.12
Annual Plan (1994-95)	157.4	70.36	56.7	9.6	66.3	29.64
Annual Plan (1995-96)	152.2	66	62	16.4	78.4	34
A. Pn. (Anted) (1995-96)	213.1	67.18	89	15.1	104.1	32.82
Annual Plan (1996-97)	338	73.07	100.6	24	124.6	26.93
Total	2580.2	70.16	831.9	265.3	1097.2	29.84

Sources: Water and Related Statistics, Central Water Commission, 2000 and Ninth Five Year Plan, GOI, Planning Commission, New Delhi.

Table-16 provides the plan wise achievements of irrigation potential created/utilized of major & medium and minor irrigation in Orissa. Analysing the data on potential created and utilized over the different plan periods, it is observed that irrigation potential has increased from 2296 thousand hectares in Sixth Plan (1980-85) to 4033.1 thousand hectares by the end of Ninth Plan (1997-02) which is anticipated. Out of this 2473 thousand hectares is from major and medium projects and 1560.1 thousand hectares from minor schemes using surface and ground water. The percentage of potential created till 1995-96 to ultimate potential was 33% and percentage of potential utilized to corresponding potential created was 89%.

The irrigation potential created in the State by the end of 2000-01 was only 4.09 % of the total irrigation potential created in India. This is a very negligible share in comparison to the corresponding share of major States in India. Further, out of the total potential created in the State till 2000-01, potentials created by the canals, tanks and wells constitutes 46.7%, 14.9% and 38.3% respectively. This is in contrast to their share at all India level. While wells in all India had share of 52% of potential, canal had only 36%. The irrigation potential created upto 2000-01 in Orissa was 46 % of the ultimate irrigation potential, where the contribution of major & medium and minor irrigation projects were 40.11% and 55 % respectively. Compared to the major States and all India level the percentage of irrigation potential created to the ultimate irrigation potential in Orissa was the lowest. This depicted the poor performance of Orissa with respect to the extent of exploitation of available irrigation potential in the State. State wise comparison shows that, the utilization of created irrigation potential in Orissa is lower than the corresponding figures of Major States except Madhya Pradesh and West Bengal (Table-17).

Table-16: Plan wise Achievements of Irrigation Potential Created/Utilized- Major & Medium and Minor Irrigation in Orissa (Thousand Hectares)

		Major & Medium (Cumulative)	Minor Irrigation			Major & Medium and Minor (Cumulative)
			Surface	Ground (Cumulative)	Surface + Ground (Cumulative)	
Ultimate Potential		3600	1000	4203	5203	8803
Sixth Plan (1980-85)	P	1236	553.0	507.0	1060	2296
	U	1178	517.0	463.0	980	2158
VII Plan (1985-90)	P	1356	586.3	569.9	1156.2	2512.2
	U	1254	542.3	517.2	1059.5	2313.5
Annual Plan (1990-92)	P	1409	635.8	609.6	1245.4	2654.4
	U	1326	572.3	553.9	1126.2	2452.2
Target for VIII Plan	P	1743	735.8	659.6	1395.4	3138.4
	U	1666	686.3	593.9	1280.2	2946.2
Annual Plan (1992-93)	P	1427	649.1	627.4	1276.5	2703.5
	U	1348	575.6	554.0	1129.6	2477.6
Annual Plan (1993-94)	P	1439	663.7	645.5	1309.2	2748.2
	U	1366	585.0	561.9	1146.9	2512.9
Annual Plan (1994-95)	P	1457	684.3	665.1	1349.4	2806.4
	U	1378	595.4	561.9	1157.3	2535.3
Annual Plan	P	1504	733.3	699.2	1432.5	2936.5
1995-96 (Anticipated)	U	1396	610.7	596.1	1206.8	2602.8
Annual Plan	P	1558	753.3	712.2	1470.5	3028.5
1996-97 (Anticipated)	U	1443	621.0	600.7	1221.9	2664.9
Target (1997-98)	P	1679	--	--	1536.6	3215.6
	U	1593	--	--	1251.3	2844.3
IX Plan (1997-2002)	P	2473	--	--	1560.1	4033.1
	U	2262	--	--	1323	3585
PC		42	73	17	28	33
PU		93	83	85	84	89

Source: Water and Related Statistics, Central Water Commission, 2000 and Ninth Five Year Plan, GOI, Planning Commission, New Delhi.

Note: P- Potential Created, U- Potential Utilized, PC- Percentage of Potential Created till 1995-96 to Ultimate Potential and PU- Percentage of Potential Utilized till 1995-96 to Corresponding Potential Created.

Table-17: State-wise Ultimate Irrigation Potential from Major, Medium & Minor Irrigation (2000-01) (' 000 Hectares)

State/Uts	Major & Medium Irrigation	Minor Irrigation			Total	UIP (in Ha.) Per Thousand Persons (⊰)
Andhra Pradesh	5000	2300	3960	6260	11260	169
Arunachal Pradesh	0	150	18	168	168	194
Assam	970	1000	900	1900	2870	128
Bihar*	6500	1900	4947	6847	13347	155
Goa	62	25	29	54	116	99
Gujarat	3000	347	2756	3103	6103	148
Haryana	3000	50	1462	1512	4512	274
Himachal Pradesh	50	235	68	303	353	68
Jammu & Kashmir	250	400	708	1108	1358	176
Karnataka	2500	900	2574	3474	5974	133
Kerala	1000	800	879	1679	2679	92
Madhya Pradesh*	6000	2200	9732	11932	17932	271
Maharashtra	4100	1200	3652	4852	8952	113
Manipur	135	100	369	469	604	329
Meghalaya	20	85	63	148	168	95
Mizoram	0	70	0	70	70	101
Nagaland	10	75	0	75	85	70
Orissa	**3600**	**1000**	**4203**	**5203**	**8803**	**278**
Punjab	3000	50	2917	2967	5967	294
Rajasthan	2750	600	1778	2378	5128	117
Sikkim	20	50	0	50	70	172
Tamil Nadu	**1500**	**1200**	**2832**	**4032**	**5532**	**99**
Tripura	100	100	81	181	281	102
Uttar Pradesh*	12500	1200	16799	17999	30499	219
West Bengal	2300	1300	3318	4618	6918	102
Uts	98	41	5	46	144	-
India	**58465**	**17378**	**64050**	**81428**	**139893**	**165**
%	56	71	71	71	65	-

Note: *: Figures include the Ultimate Irrigation Potential (UIP) for Jharkhand, Chhatisgarh, Uttaranchal in the UIP of Bihar, Madhya Pradesh and Uttar Pradesh Respectively.
%: Percentage of Potential created upto the end of 1996-97 to ultimate potential.
(⊰): Derived with 1991 census Population.
Source: Central Water Commission & Lok Sabha Unstarred Question No. 144, dated 19.11.2001., Annual Report 2001-02, Ministry of Water Resources.

Table 18 indicates the distribution of large dams in the State as compared to country. It shows that, only 3.47 % of the country's dam is constructed in the State. 48 % of the dam is constructed during the period 1980-90s. On the other hand 2.58 % of the country's big dam is under construction in the State as on Nov, 2001 (Table 19). Table 20 depicts the different live storage capacities available in Orissa as compared with India. It shows that, 4.6 % of the country's water storage is available in Orissa State. Table 21 gives a picture of the availability of water storage, number of and capacity of major & medium dams in Orissa.

Table-18: Distribution of Large Dams - Abstract in Orissa

State	Number of Dams Completed During the Period									
	Upto 1900	1901-50	1951-60	1961-70	1971-80	1981-89	1990 & Above	Year of Construction not Available	Under Construction	Total
Orissa	0	2	3	5	48	72	0	1	18	149
India	42	251	234	461	1190	1066	116	236	695	4291

Source: Central Water Commission.

Table-19: Big Dams under Construction in Orissa (As on Nov., 2001)

State	No. of Dams Under Construction
Orissa	18
India	695

Source: Rajya Sabha Unstarred Question No. 1048, dated 27.11.2001.

Table-20: Water Storage in Orissa (Billion Cubic Metre)

State	Live Storage Capacities				Percentage of Storage Capacity*
	Completed Projects	Projects Under Construction	Consideration	Total	
Orissa	14.29	3.3	-	17.6	81.2
India	173.73	75.42	132.32	381.48	45.5

*: Completed Projects/Total x 100.

Source: Rajya Sabha Starred Question No. 220, dated 04.12.2001.

Note: 1) Totals may not tally due to rounding off.

2) Projects having a live Storage Capacity of 10 M.Cum. and above only are included. An Additional Live Storage Capacity of 3 B.C.M. (Approx.) has been created through medium projects each having a capacity of less than 10 M.Cum, thus making a total live storage capacity of 177 B.C.M in completed projects.

Table-21: Water Storage in Orissa, Number and Capacity of Major& Medium Dams in Orissa

State	Completed Projects		Projects under Construction	
	Live Storage (MCM)	Number	Live Storage (MCM)	Number
Orissa	14286.8	42	3304.63	14
India	173729	811	75422.5	303

Abbr: MCM: Million Cubic Meters.

Source: Lok Sabha Unstarred Question No. 2758, dated 9.8.2000.

Note: Projects having a live storage capacity of 10 MCM and above only are included. An additional live storage capacity of 3 cubic Km. (approx) is estimated to be created through medium projects each having a capacity of less than 10 MCM

Table-22: Benefits from Major and Medium Irrigation Schemes in Orissa (' 000 Hectares Gross)

State	Ultimate Irrigation Potential	Utilisation At the end of VII Plan 1985-90	Target for VIII Plan 1992-97	Anticipated Achievements 1994-95	
			Utilisation	Potential	Utilisation
Orissa	3600	1254	340	18.5	12.72
India	58465	25467	4252.31	671.76	557.82

Source: Agricultural Research Data Book, 1999.

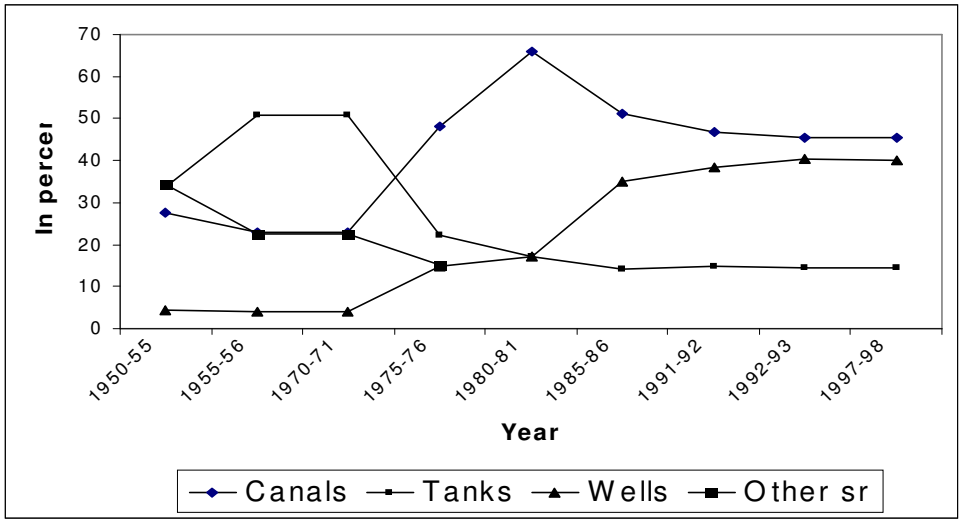
Table 22 depicts the benefits received from major and medium irrigation schemes in Orissa. It shows that utilization at the end of the Seventh Plan was 1254 thousand hectares in the State. Again anticipated potential achievements during 1994-95 was18.5 and utilization were 12.72 thousand hectares.

Table-23: Net Area Irrigated by Different sources of Irrigation for selected years in Orissa (in '000 hectares)

Year	Total canals	(In %)	Tanks	(In %)	Total Wells	(In %)	Other Sources	(In %)	Total Net Irrigated Area	(In %)
1950-55	553	27.59	676	33.73	87	4.34	688	34.33	2004	100.00
1955-56	225	23.03	495	50.67	38	3.89	219	22.42	977	100.00
1970-71	263	22.89	583	50.74	45	3.92	258	22.45	1149	100.00
1975-76	551	48.08	254	22.16	168	14.66	173	15.10	1146	100.00
1980-81	801	65.93	207	17.04	207	17.04	…	…	1215	100.00
1985-86	853	50.99	234	13.99	586	35.03	…	…	1673	100.00
1991-92	904	46.74	289	14.94	741	38.31	…	…	1934	100.00
1992-93	938	45.31	298	14.40	834	40.29	…	…	2070	100.00
1997-98	949	45.41	305	14.59	836	40.00	…	…	2090	100.00

Source: Ministry of Agriculture and Irrigation (2000), Government of India.

Fig. I Net Area Irrigated by Different sources of Irrigation For selected years in Orissa (in %)



Source: Ministry of Agriculture and Irrigation (2000), Government of India.

Table 23 depicts the Net Area Irrigated by different sources of irrigation in Orissa in '000 hectares during the period 1950-55 to 1997-98. The main sources of irrigation in the State are canals, tanks, and wells/ tube well. Their shares in the irrigated acreage have undergone changes over the plan periods, The Table depicts that, during the First Plan 1950-55, percentage of irrigated area under other sources was maximum (34.33%) followed by tanks (33.73%) and canals (27.59%) for the State as a whole. But during 1955-56, percentage of irrigated area under tanks was maximum (50.67%) followed by canals (23.03%) and other sources (22.42%) for the State as a whole. However, from 1975-76, the position of the area under canals and tanks has reversed. During 1980-81, area under canals had remained highest (65.93 %) followed by both tanks (17.04 %) and wells (17.04 %) as same. From Sixth Five Year Plan (1980-85), minor irrigation has assumed greater importance. The area under well

became higher (35.03 %) than that of tanks (13.99 %), but remain lower than canals (50.99 %). In the first three years of Seventh Plan (1985-90), area under canals occupied 50.99 %, whereas area under wells was 35.03 % and area under tanks was only 13.99 %. Thus the Table 23 and fig I shows the increasing importance of canals and wells and declining importance of tanks over the plan periods in Orissa. Again, between the canals and wells, while well irrigation has got a greater boost, importance of canal irrigation seems to have declined since the Sixth Plan (1980-85).

Table-24: Rainfall Pattern in Orissa

Year	Normal rainfall	Actual rainfall	Deviations from normal rainfall in m.m.	Deviations from normal rainfall In %	Natural Calamities
1961	1505.2	1262.8	-242.4	-16.10%	
1962	1505.2	1169.9	-335.3	-22.28%	
1963	1505.2	1467	-38.2	-2.54%	
1964	1505.2	1414.1	-91.1	-6.05%	
1965	1505.2	997.1	-508.1	-33.76%	Severe drought
1966	1505.2	1134.9	-370.3	-24.60%	Drought
1967	1505.2	1326.7	-178.5	-11.86%	Cyclone, Flood
1968	1505.2	1296.1	-209.1	-13.89%	Cyclone, Flood
1969	1505.2	1802.1	296.9	19.72%	Flood
1970	1505.2	1660.2	155	10.30%	Flood
1971	1505.2	1791.5	286.3	19.02%	Severe Cyclone, Flood
1972	1505.2	1177.1	-328.1	-21.80%	Flood, Drought
1973	1505.2	1360.1	-145.1	-9.64%	Flood
1974	1505.2	951.2	-554	-36.81%	Severe Drought, Flood
1975	1505.2	1325.6	-179.6	-11.93%	Flood
1976	1505.2	1012.5	-492.7	-32.73%	Severe Drought
1977	1505.2	1326.9	-178.3	-11.85%	Flood
1978	1505.2	1261.3	-243.9	-16.20%	Hailstorm, Whirlwind, Tornado
1979	1505.2	950.7	-554.5	-36.84%	Severe Drought
1980	1505.2	1321.7	-183.5	-12.19%	Flood, Drought
1981	1505.2	1187.7	-317.5	-21.09%	Whirlwind, Tornado, Flood,Drought
1982	1505.2	1179.9	-325.3	-21.61%	Severe Flood, Drought & Cyclone
1983	1505.2	1374.1	-131.1	-8.71%	
1984	1505.2	1302.8	-202.4	-13.45%	Drought
1985	1505.2	1606.8	101.6	6.75%	Flood
1986	1505.2	1566.1	60.9	4.05%	
1987	1505.2	1040.8	-464.4	-30.85%	Severe Drought
1988	1505.2	1270.5	-234.7	-15.59%	
1989	1505.2	1283.9	-221.3	-14.70%	
1990	1505.2	1865.8	360.6	23.96%	Flood
1991	1505.2	1465.7	-39.5	-2.62%	
1992	1505.2	1344.1	-161.1	-10.70%	Flood & Drought
1993	1505.2	1421.6	-83.6	-5.55%	
1994	1505.2	1700.2	195	12.96%	
1995	1505.2	1588	82.8	5.50%	
1996	1505.2	988.4	-516.8	-34.33%	Severe Drought
1997	1505.2	1499.8	-5.4	-0.36%	
1998	1505.2	1350.6	-154.6	-10.27%	
1999	1505.2	1334.4	-170.8	-11.35%	SUPER CYCLONE
2000	1505.2	1103.8	-401.4	-26.67%	SEVERE DROUGHT
2001	1505.2	920	-585.2	-38.88%	SEVERE FLOOD

Source: Board of Revenue, Orissa, Cuttack and Directorate of Agriculture and Food Production, Orissa.

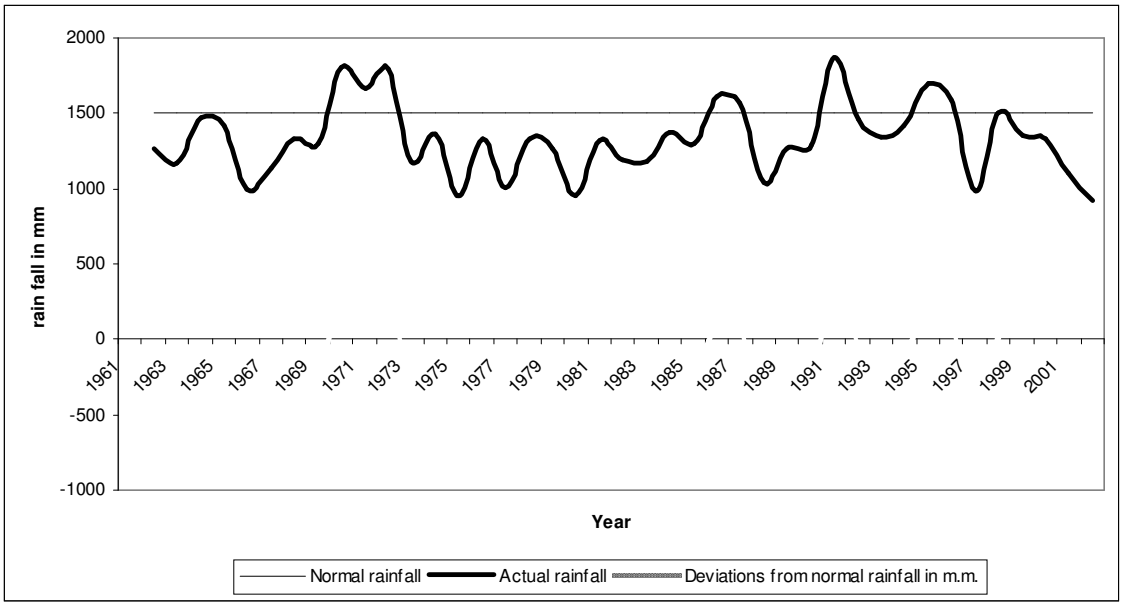
Table-25: Distribution of Rainfall between Monsoon (Jun-Sept) and Non-Monsoon Periods in Orissa

Year	Monsoon Period		Non-monsoon Period		All	
	Total	(%)	Total	(%)	Total	(%)
1965	767.6	76.98	229.5	23.02	997.1	100.0
1966	876.9	77.27	258.0	22.73	1134.9	100.0
1967	1082.8	81.62	243.9	18.38	1326.7	100.0
1968	936.6	72.26	359.5	27.74	1296.1	100.0
1969	1095.8	84.16	206.3	15.84	1302.1	100.0
1970	1417.9	85.41	242.3	14.59	1660.2	100.0
1971	1364.4	76.16	427.2	23.84	1791.6	100.0
1972	1063.7	90.37	113.4	9.63	1177.1	100.0
1973	1032.8	75.94	327.3	24.06	1360.1	100.0
1974	754.1	79.28	197.1	20.72	951.2	100.0
1975	1128.9	85.16	196.7	14.84	1325.6	100.0
1976	867.7	85.66	145.2	14.34	1012.9	100.0
1977	1055.3	79.53	271.6	20.47	1326.9	100.0
1978	1075.6	85.28	185.7	14.72	1261.3	100.0
1979	831.8	87.49	118.9	12.51	950.7	100.0
1980	1131.0	85.57	190.7	14.43	1321.7	100.0
1981	978.6	82.42	208.8	17.58	1187.4	100.0
1982	948.4	80.38	231.5	19.62	1179.9	100.0
1983	1058.0	77.02	316.1	22.98	1374.1	100.0
1984	1174.3	90.14	128.5	9.86	1302.8	100.0
1985	1295.9	80.64	311.1	19.36	1607.0	100.0
1986	1120.7	72.30	429.3	27.70	1550.0	100.0
1987	769.8	73.15	282.6	26.85	1052.4	100.0
1988	1027.2	80.85	243.3	19.15	1270.5	100.0
1989	1138.7	89.51	133.5	10.49	1272.2	100.0
1990	1143.4	61.28	722.4	38.72	1865.8	100.0
1991	1215.4	83.12	246.8	16.88	1462.2	100.0
1992	1148.3	75.43	195.8	24.57	1344.1	100.0

Source: Board of Revenue, Orissa, Cuttack.

Table 24 depicts the rainfall pattern in Orissa during the period 1961 to 2001.The State receives on an average an annual normal rainfall of 1505.0 mm. But there have been much deviations of actual rainfall from the normal rainfall in the State over time (See Table 24 and fig II). This variation of rainfall creates both drought and flood situation in the State. Orissa receives rain from southwest monsoon. Table 25 shows the distribution of rainfall pattern between monsoon (Jun-Sept) and non-monsoon periods in Orissa. The monsoon period alone receives around 80% of the total rainfall. This heavy rainfall sometimes leads to flood situation in the State. Further, excess water also destroys the crops. On the other hand, insufficient rain in non-monsoon period sometimes causes destruction of crops and reduces thereby the number of crops that can be grown. In general, therefore, artificial irrigation is a necessity in much of Orissa and India because of the pattern of rainfall.

Fig. II Rainfall Pattern in Orissa



Source: Board of Revenue, Orissa, Cuttack and Directorate of Agriculture and Food Production, Orissa.

Development of Groundwater Potential in Orissa

This part examines the development of ground water irrigation in Orissa by way of the secondary data collected from Government and institutional publications. In Orissa, out of total cultivable land of 65.59 lakh hectare, irrigation facility has been provided to only 25.2 lakh hectares. This accounts for around 38.4 % of the total cultivable land and 61.6 % remains as being badly affected by the vagaries of monsoon. [53] Despite the fact that the normal rainfall in Orissa is 1482.2 mm, the variability in rainfall is an important aspect, which has to be kept in mind while formulating planning for utilization of groundwater resource. Latest estimation of groundwater potential in Orissa clarifies that it is richly available in the State. Volumetrically, replenishable groundwater of Orissa can be placed at about 20 lakh hectare meter (HaM) out of which nearly 17 lakh HaM of groundwater resource is available for irrigation (CGB, 1997: 33). But the annual net draft is only 1.4 lakh HaM. Therefore hardly 8.4 % of the groundwater potential is utilised for the purpose of irrigation till 1992 (Central Groundwater Board, 1997, p.33) even if, the groundwater statistics of the Ministry of Water Resources 1998 figures claim it to be 15.22 %. Bulk of groundwater potential available for exploitation is estimated to be 15.6 lakh HaM (91.8 %). [54]

According to a more current CGB estimate, the total groundwater resources assessed in Orissa is 21 lakh HaM of which the net annual draft is only 3.1 lakh HaM for all uses. Accordingly, 14.79 % of the groundwater resources have been harnessed till 2001. Therefore, under utilization of irrigation potential in Orissa is a persistent problem, which has been well accepted by the Government and also in various research studies. The World Bank's India Irrigation Sector Review (IISR 1991) noted that groundwater irrigated area in fact is only 12.5 % of total irrigated area in Orissa, the lowest among twelve low agricultural producing States. Even in the neighboring States like Bihar (3808 %) and Madhya Pradesh (40.2 %) area irrigated by groundwater are much higher than area irrigated by groundwater in Orissa. Again, a major weakness of the institutional structuring of irrigation is reflected in the persistent and large gaps between irrigation potential and utilization.

Table-26: Ground Water Irrigation Potential in Orissa

Sources	CCA (Hect.)	Irrigation Potential Created (Hect)				Irrigation Potential Utilised (Hect)				% of IPU to IPC
		Kharif	Rabi	Perennial and other crops	Total (Gross)	Kharif	Rabi	Perennial and other crops	Total (Gross)	
Dug well	137694	107411	81286	17579	206276	45867	36854	9068	91789	44.5
Shallow Tubewell	71026	52763	69215	9270	131248	17017	30767	6447	54231	41.3
Deep Tubewell	51699	40285	37031	4829	82145	1980	12024	143	14139	17.2
Total	260419	--	--	--	419669	--	--	--	160159	38.2

Source: Brief Report on Census of Minor Irrigation Works in Orissa (1993-94), Directorate of Economics and Statistics, Bhubaneswar.

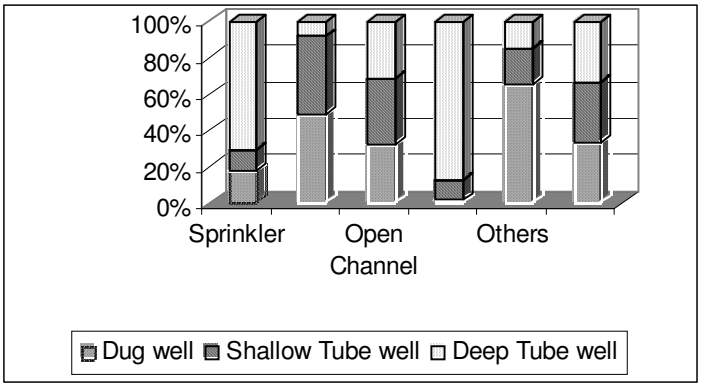
The utilization pattern of groundwater for irrigation purpose demonstrated that, while at the one hand, the development of ground water sources in the State is far behind the actual potential, further, under utilization of created potential also is an issue of large matter. The Table 26 shows that, the proportion of irrigation potential utilized (IPU) in the case of dug well to the irrigation potential created (IPC) is only 44.5%. In case of deep tube well the situation is still inferior i.e. 17.2%. Nevertheless, in the case of shallow tube wells the proportion of IPU to IPC is 41.3%.

Table-27: Ground water Distribution System in Orissa

Sources	Sprinkler	Drip	Open Channel	Under ground	Others	Total
Dug well	0.57	0.18	79.59	0.34	19.32	100.00
Shallow Tube well	0.38	0.16	91.67	1.96	5.83	100.00
Deep Tube well	2.27	0.03	77.19	16.08	4.43	100.00

Source: Brief Report on Census of Minor Irrigation Works in Orissa (1993-94), Directorate of Economics and Statistics, Bhubaneswar.

Fig. III Ground water Distribution System in Orissa



Source: Census of Minor Irrigation Works in Orissa (1993-94), Directorate of Economics and Statistics, Bhubaneswar.

Table 27 and fig III depicts the ground water distribution system in Orissa. Most of the ground water sources for irrigation in Orissa have open channels and this is the most common practice for water distribution. Only in case of deep tube wells, however a considerable proportion (16 %) of distribution is made through under ground conveyances.

Since a large proportion of the water distribution is made through open channels. The most advanced form of ground water distribution in agriculture (the deep and the sprinkler irrigation) is very negligible in Orissa. Only 0.57 % and 0.18 % of the dug wells are used for sprinkler and drip irrigation respectively. Similarly, for the deep tube wells, the figures are 2.27 % and 0.03 % respectively.

Table-28: Sources wise Groundwater Irrigation Potential created and Utilised between 1986-87 and 1993-94 in Orissa

Sources	Up to 1986-87		Up to 1993-94	
	Gross IPC (Hect)	Gross IPU (Hect)	Gross IPC (Hect)	Gross IPU (Hect)
Dug well	106563	63080	206276	91789
Shallow Tube well	58098	25284	131248	54231
Deep Tube well	68696	23711	82145	14139

Source: Brief Report on Census of Minor Irrigation Works in Orissa (1993-94), Directorate of Economics and Statistics, Bhubaneswar, p-42.

Table-29: Culturable Command Area (CCA) and Gross Irrigation Potential (GIP) Created by the Groundwater sources

Sources	1986-87		1993-94		Increment over the period of seven years	
	CCA in Hect	GIP in Hect	CCA in Hect	GIP in Hect	CCA in Hect	GIP in Hect
Dug well	84754	106563	137694	206276	52940	99713
Shallow Tube well	38127	58898	71026	131248	32899	72350
Deep Tube well	42382	68696	51699	82145	9317	13449
From all groundwater sources	165263	234157	260419	419669	95156	185512

Source: Brief Report on Census of Minor Irrigation Works in Orissa (1986-87, 1993-94), Directorate of Economics and Statistics, Bhubaneswar.

Table 29 depicts that, the highest increment in the Culturable Command Area (CCA) and the Gross Irrigation Potential Created (GIP) by the different groundwater sources in Orissa is caused by the dug wells followed by shadow tube wells. Both Tables 28 and 29 represent that the difference between the gross irrigation potential created and utilized in the two irrigation censuses show an increased utilization in absolute terms. Apart from deep tube wells, in all other sources there has been an absolute increase in the gross irrigation potential created and utilized. Consequently it shows that the farmers in the State have gone for ground water irrigation in more numbers in 1993-94 compared to 1986-87.

Table-30: Ownership of Groundwater Sources (In %)

Sources	Government	Co-operative/Panchayat	Individuals	Others	Total
Dug well	0.36	0.08	99.55	0.01	100.00
Shallow Tube well	8.75	0.15	91.02	0.08	100.00
Deep Tube well	96.29	0.10	0.14	3.2	100.00

Source: Brief Report on Census of Minor Irrigation Works in Orissa (1993-94), Directorate of Economics and Statistics, Bhubaneswar.

Table 30 represents the inequality in ground water ownership. It shows that, more or less 99.5% of the dug wells and 91 % of shallow tube wells are owned by private individuals.

The Government owns only 0.36 % of dug wells and 8.75% of the shallow tube wells. With the exception of these two types of ownership, there are also other types (which are very marginal, around 0.08% dug wells and 0.15% shallow tube wells) which are owned by co-operatives or Panchayat. On the other hand, 96.29 % of the total deep tube wells are owned by the Government. The rest around 0.10 %, 0.14 % and 3.20 % of the deep tube wells are owned by co-operatives, individuals and others respectively. This undoubtedly specifies that except for deep tube wells, a key part of the ground water development sources in Orissa is controlled/ managed by private individuals.

Table-31: Ownership of Groundwater Sources by Social Groups (In %)

Sl. No	Class/Caste wise farmers	Dug wells		Shallow Medium Tube wells	
		Up to 1986-87	Up to 1993-94	Up to 1986-87	Up to 1993-94
I	Social Group				
	SC	6.6	12.59	18.20	19.06
	ST	27.2	31.55	0.6	1.72
	Others	66.2	55.86	81.2	79.22
	Total	100.0	100.0	100.0	100.0
II	Class wise Farmers Groups				
	Marginal Farmers	27.1	33.17	15.11	26.87
	Small Farmers	30.5	39.50	24.24	39.59
	Large Farmers	42.4	27.33	60.65	33.54
	Total	100.0	100.0	100.0	100.00

Source: Computed from Reports on MF Census, Directorate of Economics and Statistics, Bhubaneswar (1986-87), and Brief Report on Census of Minor Irrigation Works in Orissa (1993-94).

Table 31 explains the ownership of groundwater sources by different social groups and farmers groups. Despite the fact that bulk of ground water source is owned by the private individuals, by and large, these are largely owned by the higher caste people (55.86 % dug wells and 79.22 % shallow tube wells). Only 12.59 % of the dug wells and 19.06 % of the shallow tube wells are owned by the Scheduled Castes. Correspondingly about 31.55 % of the dug wells and 1.72 % of the shallow tube wells are owned by the Scheduled Tribes. In consequence SC and ST communities together own 44.14 % more dug wells in 1993-94 compared to 1986-87. Thus from the above table it is a clear evidence of the social inequality and deprivation of a productive asset, which must have differentiated them from others in terms of economic well being. Similarly, according to the size of land holdings, the small farmers have a major share in the dug wells, and shallow tube wells in Orissa. The marginal farmers own 33.17 % of the dug wells and 26.87 % of the shallow tube wells. Shallow tube wells are, however, the most favourite sources of ground water of the medium category of farmers. It shows that, the small and marginal farmers together own 72.67 % of the total dug wells during 1993-94 compared to 57.6 % during the preceding census. Thus, the above table infers that, land size has a direct bearing on the types of ground water extracting mechanisms used by the cultivators in Orissa. It can be concluded that, both the disadvantaged groups of population and small holders possess more traditional dug wells. But, whether such traditional groundwater extracting mechanism is really a sustainable source of irrigation or not, is an important point.

Table-32: Financing of Groundwater Sources (In %)

Sources	Own Savings	Own Savings+ Bank loan	Bank loan +Subsidy	Subsidy	Govt. Fund	Others	Total
Dug well	40.82	10.40	24.15	22.39	--	2.24	100.0
Shallow Tubewell	34.27	23.82	24.42	9.28	8.17	0.04	100.0
Deep Tubewell	25.00	23.15	23.15	--	21.30	7.40	100.0

Source: Brief Report on Census of Minor Irrigation Works in Orissa (1993-94), Directorate of Economics and Statistics, Bhubaneswar.

Table 32 represents the different sources of financing of ground water sources. As regards the financing of all these privately owned ground water sources, almost 41 % of dug wells, 34 % of shallow tube wells and 25 % of deep tube wells are installed by self financing from farmers own savings. More or less 10 % of the dug wells, 24 % of the shallow tube wells and 23 % deep tube wells are financed partly through bank loan, and partly by own savings. About 22 % dug wells and 9 % shallow tube wells are financed by subsidy. Around 8.17 % of shallow tube wells and 21.30 % of deep tube wells are financed through Government funding. Other sources account for 2.24 % of dug wells, 0.04 % of shallow tube wells and 7.4 % of the deep tube wells.

Table-33: Banking Plan (NABARD)

Year	Physical Programme (No)			Financial Programme (Rs. Crores)		Area to be Irrigated in Ha.
	DW/DCW	BW/TW	P.S.	BL	RA	
1998-99	5910	2070	13290	41.45	28.67	13002
1999-00	6970	2425	15400	52.91	37.37	15192
2000-01	8140	2780	17820	67.65	47.70	17572
2001-02	9600	3230	20620	86.65	60.29	20468
Total	30620	10505	67130	248.68	174.03	66234

Source: NABARD Minor Irrigation Banking Plan: 8
Note: DW/DCW- Dug well/Dug cum Bore well, BW/TW- Bore well, P.S. - Agricultural Pump sets, BL- Bank Loan, RA- Refinance Assistance,

NABARD banking plan proposed that, by the end of 2001-02, an additional 66234 ha would have been irrigated through ground water with sources consisting of 30620 dug wells/dug-cum-bore wells, 10505 tube wells/bore wells and 67130 agricultural pump sets (Table 33). For this objective to be accomplished, around Rs. 248.68 crores were to be provided through bank loan and around Rs. 174.03 crores to be provided through the refinance assistance (NABARD, Minor Irrigation Banking Plan).

Table-34: Source wise Water Extraction Mechanism (In %)

Sources	Pump sets Electric/Diesel	Wind Power/Solar	Man/ Animal	Others	Total
Dug well	9.31	0.15	88.89	1.65	100.00
Shallow Tube well	95.05	0.24	4.49	0.22	100.00
Deep Tube well	100.00	--	--		100.00

Source: Brief Report on Census of Minor Irrigation Works in Orissa (1993-94), Directorate of Economics and Statistics, Bhubaneswar.

Usually in Orissa, there are two main types of sources to extract and utilize ground water for irrigation such as dug wells and tube wells. For details about the different characteristics of dug wells and tube wells, see the footnote.[55] The Table 34 illustrates the different water extraction mechanism or the lifting device used for extracting groundwater. It shows that the extraction mechanisms in case of dug wells are mostly traditional, and operated by men through *tenda* and treadle pumps or animals through other methods. More or less 9 % of the dug wells are operated by electric or diesel pump sets, and a very small proportion of dug wells are operated by wind mills/ solar pumps and other methods. However, for shallow tube wells the diesel and kerosene pump sets of different capacity specifications account for around 95% of extraction mechanism. More or less 4.5% of the shallow tube wells are manually operated. At this time, solar energy, wind mill and others operated an insignificant share. In case of deep tube wells all are energised

Table-35: Contribution of different sources of irrigation to the Net Irrigated area in some selected States during 1997-98 (In %)

States	Canal Irrigation	Tank Irrigation	Groundwater Irrigation	Others
Orissa	**45.41**	**14.59**	**40.00**	**--**
Bihar	29.58	3.23	49.5	17.69
Haryana	50.02	0.04	48.8	1.15
Madhya Pradesh	28.28	3.47	55.57	12.67
Maharashtra	20.96	14.37	61.20	3.47
Andhra Pradesh	38.99	14.27	42.48	4.26
Punjab	35.25	--	61.27	3.48
Rajasthan	28.13	3.36	67.27	3.48
Tamil Nadu	28.46	22.92	47.98	0.65
Uttar Pradesh	25.47	0.70	71.45	2.38
West Bengal	37.52	13.76	37.26	11.46
India	**31.33**	**5.68**	**56.60**	**6.40**

Source: CMIE, 2001, November: 37

Groundwater irrigation as a proportion of the net irrigated area is as important as the canal irrigation in Orissa. According to CMIE (2001), in 1997-98, groundwater irrigation contributed around 40 % of the net irrigated area in Orissa (Table 35). In most parts of eastern India in general, and Orissa in particular, abundant water table aquifers are regularly recharged by rainfall, perennial river flow, and canal seepage. Hence, under such conditions, groundwater irrigation can play a very important role in enhancing agricultural production in Orissa. Thus there has been a change in the irrigation system from traditional irrigation in the Pre-Independence period to modern irrigation in the post- independence period. In the pre-Independence period there was dominance of tank and streams, but in the plan periods there has been a move towards the dominance of canal irrigation. This became possible as significance has been accorded to irrigation development through increasing expenditure in different plan periods

Section- V

Linkages between Water Governance and Water Management in the Hirakud Command Area

Context:

In India water management has been the main concern of Government for several centuries, with different rulers, from the Mughals to the British and the smaller Princely States paying enormous interest to irrigation and water supplies. In fifty-eight years of independence, the Government developed the country's water resources further and at the moment the possibility for expanding surface and ground water sources is relatively narrow. The range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society is called as water governance. The idea of governance for water contains the ability to design public policies and institutional frameworks that are socially accepted and mobilise social resources in support of them. Water policy and the process for its formulation must have its goal of the sustainable development of water resources, and to make its implementation effective, the key actors/stakeholders must be involved in the process (Rogers, P. et. al, 2003).

The UNDP World Water Development Report has a whole chapter given over to 'Governing Water Wisely for Sustainable Development' (Chapter 15, Water for People, Water for Life, 2004). Water crises can be directly linked to issues of governance. Consequently, resolving the challenges in this area must be a key priority if we are to achieve sustainable water resources development and management (UNDP). Thus, there are several alternative conceptualizations of governance, which recognizes the plurality of actors involved. The significance of governance for sustainable development has been recognized for some time but within the water community there was for a long time little recognition of its centrality. The Global Water Partnership (GWP) Framework for Action, prepared for the Second World Water Forum, stated that the water crisis is often a crisis of governance (GWP 2000) and the Hague Ministerial Declaration identified governing water wisely as one of the seven challenges for achieving the World Water Vision. Basin management offers a promising new form of water governance. The relations between river basin organizations and national bodies and local water management moreover need to be defined. The call for water management at the basin level also extends to the management of basins shared between sovereign states. In transboundary water management building political awareness and commitment is important (Hall, Allan and et.al 2003).

Moving towards more effective water governance is about changing institutions and redefining the roles of different players in society. It is important to link up with other fields, such as land management, export policy, pricing strategy and international diplomacy in order to govern water resources more wisely (Hall, Allan and et.al 2003). Since water is in contested domain, a fuller understanding of governance of water sector could only be gained through analysis of process and mechanisms, different actors mobilize, use resources and interact in different ways to shape and reshape water policies. How these contestations, negotiations and compromises take place is generally ignored in the debate on the overall reform process of water sector. Understanding these processes and resistance for change may bring out new insights for the overall governance of water sector (Mollinga and Bolding, 2004). The relationship between water governance and water management could be

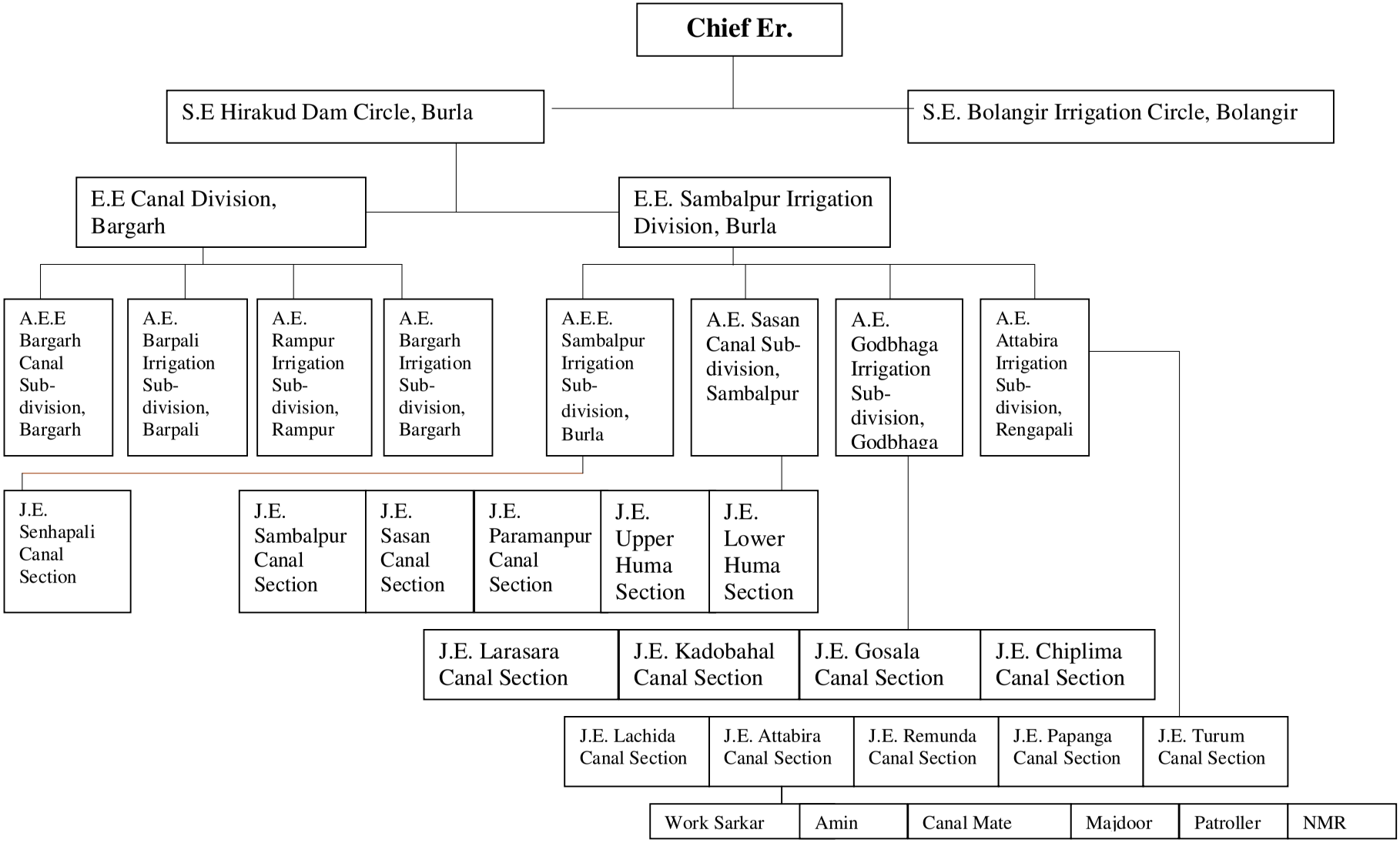
understood as the relationship between the theoretical concepts and their practical application through the tools and approaches of integrated water resources management (IWRM). The 2004 UNDP Water Report is not alone in seeming to equate water governance at the resource level with IWRM, but there is indeed a good deal more depth and detail to the concept, and one might see IWRM as simply one of a number of tools or approaches that should be utilized in pursuit of sensible water governance (Tom Franks 2004).

Issues for Discussions

The Hirakud Command Area (H.C.A.) is spreads over 11 blocks of Sambalpur district (undivided) & 3 blocks of Bolangir district (undivided) i.e. Sambalpur, Jujummra, Attabira, Bargarh, Barpali, Bheden, Bhatli, Bijepur, Rengali, Jamankira & Binka, Dungripali, Agalpur. Its total command area is about 1,59,016.55 ha. The agent is served by Bargarh main canal on the right and Sason main canal on the left. In addition to this, the Sambalpur distributors emerging out of the left and the Senhapali distributors, Chiplima (stage II) power channel also provides irrigation facilities. The actual area irrigated fluctuates from year to year and season to season due to quantum of rainfall, demand for irrigation, accumulation of sand in the river bed, poor maintenance of canals etc. There are barely any tanks in this canal command but conjunctive use of ground water alongside canal is somewhat extensive. The rainfall in the command area is again noticeable by a bimodal distribution with South-west monsoon being the main rainy season. The management of water allocation in Hirakud dam project is exclusively with the Government, right down to the outlet.

Presently the Hirakud dam site and its command area are facing acute problems in different aspects. There were some early problems of regulation by the farmers to canal irrigation. Insufficient and late supply of water, water logging & salinity, lack of maintenance, improper distribution system, under utilization of water supply, destruction of the sluices before an alternative system was created etc. posed as the teething difficulty. Under these difficulties, it is vital to study the water distribution performances of the projects both at main system as well as tertiary levels essentially to classify the operating constraints. This will not only facilitate for improving the existing projects, but also improving the planning for new projects. Given the problems of higher construction costs and less favourable sites for new projects the objectives of increasing the irrigated area and agricultural production could be achieved only through improving the existing systems. Equity and productivity in the irrigation systems are two major function of water distribution. Hence, determinants of water distribution are the primary concern of those interested in projects performance. However, many projects have not been improved in this manner, due to want of adequate research basis to identify appropriately such performance constraints.

Fig. IV Administrative set up of Hirakud Dam Project Management under the Chief Engineer, Upper Mahanadi Basin, Burla



Managerial Structure

In the State of Orissa the irrigation projects belong to the bureaucratically managed system in which all management activities are in the hands of irrigation agency of the State Government. The Government makes water available to the farms, but the Government is neither the end user of the produce, nor is it obliged to see that the produce is properly and economically used. The administrative set up of Hirakud dam project management under the Chief Engineer of upper Mahanadi basin is given in the Fig IV. The responsibility for managing the Hirakud Dam Project, which function covers system maintenance and regulation of water allocation vests with the Department of Water Resources, Government of Orissa. Whole charge is with the Engineer–in-Chief (EIC) located in Bhubaneswar. The officer directly involved in managing the system is a Chief Engineer (CE) (general) posted in Burla. He is assisted by two Superintending Engineer (SE), one is posted at Hirakud dam circle office Burla and other one posted at Bolangir. Under a SE, there are five divisional offices {each headed by an Executive Engineer (EE), each of which in turn controls five subdivisions (headed by an Assistant Executive Engineer (AEE)}[56]. Further the work is divided into different sections under the charge of Junior/ Assistant Engineers (JE/AE). Each section has at least 2-work sarkar (inspectors), an Amin, one canal mate (irrigator), one majdoor, patroller and NMR (Nominal Mustor Roll). The work inspectors are presume to examine uncompleted construction works (together with maintenance work) of the canal and its control structure (sluices, sluice shutters, etc) carried out by private contractors selected through agreed tendering measures and make certain that they are up to obligation. During the spell period (water releasing period from the dam), they also help the section office in regulating the distribution of canal water and keeping a watch against any unlawful tapping of water.

On the other hand Amin were maintaining the ayacut area. Canal mate (irrigator) are the lowest level functionaries and it is they who keep a watch on water flow in each distributary as well as between pipe points fed by each sluice so that all blocks within a distributary can get a fair amount of water. They are usually to document the water reading at the head and tail of each distributary every day. Whenever the water flow at the tail is insufficient, they are expected to adjust the flows in the intermediate sluices (after informing the JE/AE), so that all section get ample water. During the non-spell periods, the canal mates are exploited for maintenance work i.e. de-weeding and de-silting canals/distributaries, and clearing the jeep tracks. The control of a canal mate averages around 4000 acres, and engages in travel over extensive distances.

The purpose of institutions is to settle on the desirable pattern of water use such as in terms of area to be covered, crops to be grown, amounts of water to be delivered in different segments of the command, and to devise operational rules and procedures for enforcing this pattern on a continuing basis. The institutions in water resource management have been concerned with the allocation and management of water delivery services. Normally, the existing institutions do not take care of sustainability of water resources. The institutions and governance structure should be designed in such a way that rights and responsibilities among and within the public agencies and water users are distributed in a manner that prevents ‘free riding’ tendencies and does not allow water resources to become an open access resources. Large canal systems, which are normally planned and constructed by State agencies, have essentially to rely on almost formal organizations, rules and procedures put into operation by a professional bureaucracy and backed by state power. There is opportunity for collective action on the part of users for exerting pressure on the system managers and the State to modify the rules, procedures and even design of the system as a whole and, to a greater

extent, of specific sectors of it. Further in a large purely canal based system, the scheduling of water being a centralized decision, there is very little that ayacutdars of a specific distributary or outlet can do except to convince, or compel the managers to modify the program or try to change the quantum/timing of water flowing to other segment (Vaidyanathan, A. and S.Janakarajan, pp.5-7, 1989).

The State is having large water resources, large number of institutions for operation and maintenance. The Government is spending more on the operation and maintenance of the different offices i.e. from the top Ministry of Water Resources to the bottom pipe point level. Therefore, we can safely say that the country does not lack in institutions. But what we really lack is effective coordination, policy implementation and monitoring mechanisms. Lack of all these are reflected in problems such as dispute between head and the tail reaches, inequity between water sharing across different segments of command areas, crop pattern deviations, soil type, drainage problem, access to water, productivity difference, according to caste, economic assets etc. Apart from this, there are also inappropriate policies, lack of transparency, consistency, democracy and partnership in irrigation management, lack of water measurements, poor irrigation infrastructure, and lack of coordination among irrigation agencies. This rethinking of water governance provides us a micro or grass root view of the patterns of access to water in different segments of the system and for different sections of farmers and across years, as well as the associated differences in the way land and water are used and the level of productivity per unit of land. It helps to examine whether there is any systematic pattern of variation in terms of location and farm size. Attention should also be given to understand the intricacies of institutional (operational rules) and non-institutional arrangement for managing water resources in H.C.A. and to evaluate their (i.e. W.U.A or Pani Panchayat) functioning & characteristics in the context of local water management. There is vital significance of institutional arrangements for managing water resources. What issues necessitate to be tackled through integrated approaches? For instance, Coastal part of Orissa is affected by heavy flood whereas western part is affected by severe drought. In that case problem can be tackled in integrating process that ensures the interests of all stakeholders.

Summing Up

The State is endowed with rich resources such as fertile land, labour, abundant water, forest, long coastal stretch, mineral deposits etc. Overall, it can be concluded that in spite of huge water availability in the State, poverty and livelihoods is a major concern for a majority of the population. One part of the State is affected by the vagaries of natural calamities like super cyclone and flood, and on the other, there is severe drought. The State is known for its backwardness in social and economic sectors and the picture has not changed even after fifty-eight years of independence. Past political events and several historical blunders have contributed quite heavily to the backwardness of the State.

The East India Irrigation Company, on the failure of which works were taken over by the Government, commenced the Orissa canals. It has been found that Orissa Irrigation Scheme was persistently unsuccessful during the colonial reign. The canals turned into a mechanism of oppression for the cultivators of the deltaic region and in its many layered impacts articulated the colonial interest of supremacy and convention. The financial facet of canal irrigation during 1872-1899 exposed that the expenses of canal expansion were more than that of income received. Orissa was neglected in contrast to other province in terms of area irrigated in India up to 1901.

Fragmented territories of the present Orissa State during different periods perhaps is one of the main reasons for the current backwardness of its economy. It accomplished that the main reasons that hinder the development of irrigation in the pre independence period was economic barrier such as lack of Government implemented irrigation scheme, constraints of resources for public investments on new irrigation projects, poor infrastructural facilities and acute paucity of financial resources; and political constraints such as formation of separate province of Orissa State. Thus during the pre independence period, the achievements on the irrigation front in Orissa on the whole remained considerably poor. Government of India decided to undertake Hirakud Multipurpose River Dam Project in 1948 in Orissa, which helped the State's agriculture considerably. Until such time the State suffered enormously and met with several setbacks. After the Hirakud dam project there was hardly major irrigation scheme initiated by the Government of India. Even the Hirakud project, which is currently about five and a half decades old, is heavily silted-up. It requires more Government expenditure on revamping all the old and traditional irrigation institutions in the state.

One of the observations from the analyses of the development of different irrigation system in Orissa during post-independence period was that, minor irrigation scheme was not at all given any significance. Greater prominence has been attached to major and medium irrigation projects in the various plan periods in the State. The share of irrigation potential created in the State is very negligible when compared to the total irrigation potential created in India. State wise comparison shows that, the utilization of created irrigation potential in Orissa is lower than the corresponding figures of major States. Again it shows that there is increasing importance of canals and wells and declining importance of tanks over the plan periods in Orissa. Thus there has been a change in the irrigation system from traditional irrigation in the Pre-Independence period to modern irrigation in the post-independence period. In the pre- Independence period there was dominance of tank and streams, but in the plan periods there has been a move towards the dominance of canal irrigation. This became possible, as significance has been accorded to irrigation development through increasing expenditure in different plan periods

It is clear evidence from the analyses of the ownership of ground water sources by different social groups that, there is social inequality and deprivation of the productive asset, which differentiated them from others in terms of economic well being. Land size has a direct bearing on the types of ground water extracting mechanisms used by the cultivators in Orissa. It can be concluded that, both the disadvantaged groups of population and small holders possess more traditional dug wells. Even if Orissa is gifted with plentiful groundwater resources, their exploitation for the purpose of irrigation has been extremely little. As such, no systematic study has been carried out to investigate the reasons for the under exploitation of ground water resources or to suggest measures for adequate utilization of this untapped groundwater resource for agricultural development in Orissa. Profound thought needs to be given on the crisis like, how to utilize the massive groundwater endowment of Orissa for ensuring better agricultural growth of the State with which the livelihood of three-fourth of rural farm households is strongly related.

It can be concluded that the development of modern irrigation was made only in a small part of the state i.e. coastal plains of the Mahanadi delta neglecting inland regions. The state of irrigation works in Hirakud Command Area (H.C.A.) was not preserved in good quality condition due to the deficient attempt on the part of the authority. The repairs of the irrigation channels and the tanks, anicuts in the region was largely taken care of by the Central Provinces**.** The situation in which these irrigation works were preserved by the

authority during the colonial period was miserable. The crucial result of this state of interaction was the irrigation complexity for H.C.A. peasants. The authority was completely indifferent about the provision of the irrigation works in the region. The endeavor of the state for operation and maintenance of canal was not enough. The situation of insufficient concentration to the irrigation works was not a characteristic restricted to H.C.A. alone, but true of the whole of other provinces.

It is a contradiction that in spite of plenty of natural resources and favourable environment, the agricultural economy of Orissa has continued to be in a state of virtual stagnation. The State has been a land of proverbial poverty in the midst of plenty of natural resources. This paradoxical phenomenon in Orissa reaffirms the historical experience that the availability of natural resources is not a sufficient condition for eradication of poverty. An essential sector, where the pace and pattern of resource exploitation have been less than optimal in Orissa is irrigation. The consequences of absence of extensive and effective irrigation system in Orissa have been distressing.

Various reforms are required in water governance and institutions. Good governance means sound development management. Good governance and capacity building are like two sides of the same coin. Water governance is a challenge in each State, and there is no one approach that fits all requirements. The subject of governance is so serious that without addressing it in adequate measure in the State, integrated development and management of the water resources for realising sustainable water will only be in pen and paper. The need for better water governance in the State is critical. There is need for good governance, transparency and accountability, and participation of all part of the society in the activities. State Water Policies are yet to become effectual in providing a direction to water resources development and management in an integrated framework. The State will have to limit itself to regulatory and facilitating occupation.

Water resources administration is the task of the several sub-sectoral departments and organization. They are of course concerned about development of the infrastructure, facilities and services to meet the needs of the sub-sector. The broader water resources management functions have been to some extent, neglected as a result. Harmonization mechanisms to resolve problems of water allocation and sharing among different sub-sectors are lacking or ineffective. Improvement of suitable and effective institutional frameworks should be a high priority item on the schedule of reforms. Existing appropriate institutions require to be reinforced or new ones developed if needed. The approach should change from top-down compartmentalised departmental structures to decentralised, integrated structures on the basis of river basins. The water resource management at a river basin level is a government's task. River basins are the most suitable unit for managing water resources. But in many States the administrative jurisdictions do not take account of topographic or hydrological boundaries. Institutional strengthening activities might consider the possibility of redefining some boundaries or hydrological lines and working out practical procedures with local governments. Better investments in water resources proposal and better management of water resources not only lead to sustainable increases in the productivity of water but also provide better livelihoods for poor people in rural areas.

Glossary

Achhara	The light and worthless refuse of grain/ sowing late with seeds previously germinated by soaking in water
Amin	A revenue officer who measures land
Anicut	A permanent masonry structure to store and /or divert river flows for irrigation
Att land	High lying land (ridges)
Ayacut	Area Commanded by an irrigation work
Bahal land	A low lying land
Bandh	A four-sided tank excavated below the *Kata*
Barchha	Fertile land suitable for vegetable cultivation
Bari	Homestead land
Batri	Sowing after the rains have broken and the ground is Wet
Berna land	Land occurring towards bottom of a depression (dales)
Bethi Beggari	Unpaid labour
Dalua paddy	A variety of paddy grown in summer
Dewan	The chief executive officer in an ex-feudatory State
Gountia	A village headman
Jagir	Service land
Jami	Land
Jhankar	A village officer whose duty is worship village deity
Kata	An ordinary irrigation tank
Khalsa	A land or village held directly from Government
Khardi	Dry sowing just before the rains break
Khariff	A crop season (summer- autumn)
Kharipani	The most valuable land in H.C.A
Khond	A tribal people in Orissa
Kulthi	A pulse - (Declichus biflorous)
Kumbhar	Village potter
Mahajan	Money lender
Mal land	Up land (slopes)
Malguzar	Revenue payer
Malguzari	Wage labour
Malikana	Allowances paid to a proprietor on his becoming recusant
Maufi	Free hold
Maufidar	Holder of Maufi
Mauza	Village (revenue unit)
Moghulbandi	The areas lying between hill tracts of sea
Munda	An embankment of smaller size across a drainage channel
Nanka Durbhikya	A great famine that befell Orissa in 1866, It is so named for it occurred in the ninth regnal year of the then Raja of Puri
Nazarana	A levy made by one (over lord generally) as a courtesy tribute
Nullah (Nalla)	Small stream or channel
Patta	A lease given to a raiyat showing his land and his rent and the period for which it was fixed
Patwari	A village revenue officer who collects land revenue and maintains village records
Rabi	A crop season (autumn-spring)
Ryot (Raiyat)	A tenant
Sena	Baskets used to lift water for irrigation
Tahasil	A unit of land revenue administration
Tenda	A water lift (For raising water from a lower to a higher level tenda is used
Zamindar	A land-lord (Revenue payer to Govt.)
Zamindari	The type of settlement

Acronyms

AE	Assistant Engineer
AEE	Assistant Executive Engineer
BCM	Billion Cubic Meter
BL	Bank Loan
BW	Bore well
CCA	Culturable Command Area
CE	Chief Engineer
CGB	Central Groundwater Board
CMIE	Centre for Monitoring Indian Economy
CUMECS	Cubic Meter Per Second
CUP	Cambridge University Press
CWC	Central Water Commission
CWINC	Central Water Irrigation and Navigation Commission
DCW	Dug cum Bore well
DW	Dug well
EE	Executive Engineer
EIC	Engineer–in-Chief
GCA	Gross Cropped Area
GIP	Gross Irrigation Potential
GOI	Government of India
GWP	Global Water Partnership
Ha	Hectare
HaM	Hectare Meter
HCA	Hirakud Command Area
HYVs	High Yielding Varieties
IISR	India Irrigation Sector Review
IPC	Irrigation Potential Created
IPU	Irrigation Potential Utilized
IWRM	Integrated Water Resources Management
JE	Junior Engineer
Kg	Kilogram
Km	Kilometer
M & M	Major and Medium
MCum	Million Cubic Meter
Mm	Mili Metre
MPRVD	Multi-Purpose River Valley Development
NABARD	National Bank for Agriculture and Rural Development
NAS	Net Area Sown
NCAER	National Council of Applied Economic Research
NIA	Net Irrigated Area
NMR	Nominal Mustor Roll
OUP	Oxford University Press
PC	Potential Created
PS	Pump sets
PU	Potential Utilized
PWD	Public Works Department
RA	Refinance Assistance
SC	Schedule Caste
SE	Superintending Engineer
ST	Schedule Tribe
TW	Tube Well
UIP	Ultimate Irrigation Potential
UK	United Kingdom
UNDP	United Nations Development Programme
UP	Uttar Pradesh
UTs	Union Territories
WUAs	Water User Associations
WWF	World Water Forum

End Notes

[1] The most important irrigation structure that was built across river Cauvery 16 km east of the Tiruchirapalli town in Tamil Nadu, some time in the second century AD by the King Karikala Chola

[2] Sir William Willcocks, Ancient system of irrigation in Bengal, Quoted in Bhattacharya

[3] W.Eric Gustafson and Richard B. Reidinger ("Delivery of canal water in north India and West Pakistan", *Economic and Political Weekly*, December, 25, 1971, pp. A151-62) examines the historical basis of modern irrigation in India and West Pakistan.

[4] See R.Dutta, p.261

[5] *Report of the Indian Famine Commission* (1880): Part II, Chapter V, Section I, vide R.Dutt, p.263, *Irrigation Commission Report*, 1901-3, para-114.

[6] In this context, see for instance A.K. Connell, *the economic revolution of India and the Public Works Policy* (London, 1883) ; R.B.Buckley, *Irrigation works of India and their financial results, 2nd edition* (London, 1905); P.T.Cautely, *Report on the Ganges canal works, 3 Vol.* (London, 1960); A. Cotton and P.T.Cautely, *A discussion, regarding the projection and present state of the Ganges canal, and the measures required to make it reliably useful and profitable* (London, 1864); J. Dacosta, *Fact and fallacies regarding irrigation as a prevention of famine in India* (London, 1878).

[7] See for instance, B.N.Ganguli, Trends of agriculture and population in the Ganges valley (London, 1938); D.R.Gadgil, *Economic effects of irrigation: Report of a survey of the Direct and Indirect effects of the Godavari and Pranava canals* (Poona, 1948); B.D.Kanetkar, 'Pricing of Irrigation Services in India (1854-1859)', *Artha Vijnana,* No.2, 1960, pp. 158-68; E. Whitcombe, *Agrarian Conditions in Northern India, Vol.1, The United Provicences Under British Rule, 1860-1900* (London, 1972); A.K.Bagchi, 'Foreign capital and Economic Development in India: A Schematic view', in K.Gough and H.P.Sharma eds., *Imperialism and Revolution in South Africa* (New York, 1973) pp.43-76; Gustafson, W. and R.Reidinger (1971); Reidinger, R.,(1974); Wade, R., (1980); Ian Stone, *Canal Irrigation in British India: Perspectives on Technological Change in a Peasant Economy,* (Cambridge, 1984); Donald W. Attwood, *'Irrigation and Imperialism: The causes and Consequences of a shift from Subsistence to Cash Cropping'* The Journal of Development Studies, 1987, pp. 341-66; Pandian, M.S.S. (1987, 1990), Rao, G.N. (1988); Sengupta, Nirmal (1991, 1993, 2001), D' Souza, Rohan (2003).

[8] Vide P.Mukherjee (1967): *Irrigation, inland navigation and flood problems in North Orissa during the British Rule,* Bhubaneswar, pp.1.2

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[10] Cited in Sengupta, Nirmal (1991): pp.55-57

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[15] Note by Lt. J.W.Ottley, 10th December 1874, in papers relating to the Orissa Canals, 1869-1877 and 1881-1883, Calcutta, 1884

[16] Gazetteer of India (1992), Orissa State, Vol. III, P.142

[17] The Indian Famine Commission, 1878, p.39. In 1865-66, occurred a famine of the most intense character commonly known as *'Na Anka Durbhikhya'*, which was the greatest calamity in Orissa of the 19th century. Mortality in the three districts of Cuttack, Puri and Baleshwar was roughly estimated at 10 lakhs out of a total population of 37 lakhs.

[18] For the rainfall data in Orissa after 1950, see section IV, Table 24 Rainfall in Orissa and Table 25 distribution of rainfall between monsoon (Jun-Sept) and non-monsoon periods.

[19] Mahanadi Valley Development, Hirakud Dam Project, June 1947 Government of India, C.W.I.N.C, 1947 p.10

[20] See in this context, Report on the Benefits of Hirakud irrigation (1968): A Socio-Economic study, Bhubaneswar, pp.10-11.

[21] Maddox, S.L(1920)., *Final Report on the Survey and Settlement of the Province of Orissa (Temporarily settled areas), 1890 to 1900 A.D.,* Vol.I, Part II, Part II, Ch.VI pp.99-100

[22] Malley' O, L.S.S. (1933): Cuttack Gazetteer, Patna, p.104

[23] Samal, J.K. (1977): *Orissa under the British Crown 1858-1905*, New Delhi, p.198

[24] Note by Lt. J.W.Ottley, 10th December 1874, in papers relating to the Orissa Canals, 1869-1877 and 1881-1883, Calcutta, 1884, p.82

[25] W.W.Hunter (1872): *History of Orissa*, Vol.II, p.175.

[26] Vide J.M. Tagore to Government of Bengal, 23 November 1866, BRP, and January 1867.

[27] Note by Lt. J.W.Ottley, 10th December 1874, G.C.Marcconchy, *Report on the protective irrigation works in Bengal,* p.256.

[28] Maddox, S.L(1920)., *Final Report on the Survey and Settlement of the Province of Orissa (Temporarily settled areas), 1890 to 1900 A.D.,* Vol.I, Part II, Ch.V

[29] Maddox, S.L (1920), pp.22, 31, 32, 81

[30] Note by Lt. J.W.Ottley, 10th December 1874, in papers relating to the Orissa Canals, 1869-1877 and 1881-1883, Calcutta, 1884, p.82

[31] Note by Lt. J.W.Ottley, 10 December 1874,, op.cit., p.85

[32] Binayak Mishra, Famines in Orissa, Cuttack,1925,1803,1806,1808,1809,1813,1817,1818,1828, 1837,1842,1851,1853,1855,1856,1857,1862,1865,1866,1868,1874,1877,1879,1880,1881,1885,1892,1 894,1895,1896 and 1900

[33] E. Whitcombe (1982): 'Irrigation', in Dharma Kumar (ed.)*, the Cambridge Economic History of India,* Vol. II, Orient Longman, Hyderabad.

[34] History of Orissa Vol.6, by Pravat Mukherjee,pp 400-402

[35] Questions put to and answers given by Baboo Gouree Shankar Roy, Honorary Secretary, Orissa Administration, Appendix C, *Report of the Commissioners appointed to enquire into certain matters in connection with Orissa Canals, 1885, p.49*

[36] *Ibid.,* p. 129

[37] See in this context R.Dutt, pp.403-406.

[38] Maddox, S.L (1920), pp.80-81, 84

[39] Hiranandini. M.G. (1953): *Report on the investigation for extension for irrigation in the Mahanadi delta,* Ministry of Irrigation and Power, Government of India, October.

[40] Padhi, Shakti (1986): Land relations and Agrarian Development- A Comparative Historical Study of two districts in Orissa, Unpublished Ph.D Thesis, CDS, Trivendrum.

[41] Census of India, (1951), pp. 254-55

[42] see in this context *Report of the Famine Enquiry Commission*, 1945, Government of India, p.130

[43] According to the test of the 'financial productivity criterion', an irrigation project in order to be selected should be able to earn a certain percentage of return (4 % up to 31st March 1919, 5 % during 1st April 1919 to 31st July 1921, 6 % during 1st August 1921 to 31st March 1949, 3.75 % after 1st April 1949) on 'sum-at-charge' (i.e., capital cost plus arrears of interest up to that year) in the tenth year after its completion (NCAER, p.10, 1959).

[44] Protective irrigation works were not expected to yield profit as such, but they were justified by savings on the cost of famine relief.

[45] Cited in Pandian (1985)

[46] See in this context The Imperial Gazetteer (1908), quoted in Gazetteer of Sambalpur 1971, p. 142.

[47] See in this context Sengupta, Nirmal (1993), p.46

[48] See in this context Nehru Memorial Museum and Library, New Delhi. Hare Krushna Mahatab's papers, (1st Instalment), Subject file No. 36 (Economics), Letter to Nabakrushna Chaudhuri, 19 June 1951, p.5 , Quoted in Rohan D' Souza (2003): *Damming the Mahanadi river: The emergence of multi-purpose river valley development in India (1943-46)*, The Indian Economic and Social History Review, 40,1.

[49] A.N.Khosala ed. (1947): *Mahanadi Valley Development Hirakud Dam Project*, CWINC, Simla, June, p.10.

[50] See in this context Rangaiya, R.M.G. (1947): *Mahanadi Valley Development: Hirakud Dam Project,* Bangalore, August.

[51] Rohan D' Souza (2003): *Damming the Mahanadi River: The emergence of multi-purpose river valley development in India (1943-46)*, The Indian Economic and Social History Review, 40, 1.

[52] Sixth Five year Plan, Planning and Coordination Department, Government of Orissa, 1980, p.181

[53] Economic Survey, Government of Orissa, 2001-02.

[54] Economic Survey, Government of Orissa, 2001-02.

[55] Different types of dug wells are *kuchha, pucca* and dug-cum- bore well. A *kuchha* dug well is a pit dug of different sizes to utilize ground water and the size of the pit/well depends on the level of water table. Such dug wells have no lining at all, and the nature of the soil regulates their longevity. These are adequately found in Bolangir, Keonjhar, Koraput, Phulbani, Sambalpur, Sundargarh and Angul districts. On the other hand the *pucca* dug wells are same as *kuchha,* but are permanent in nature, because of the lining made of brick or stone. Such types of wells are found every where in Orissa, and the depth/size of these wells are dependent on the level of water table in their respective locations. The most developed type of dug wells are dug cum bore wells generally found in Koraput and Cuttack district. Here, the earth is dug first and an ordinary well is constructed and than boring is done further to obtain the suitable aquifer.

Likewise, different types of tube wells are shallow tube well, bore wells, filter point tube wells, medium tube wells and deep tube wells. But mostly there are two types. Firstly, shallow tube wells, which consist of a bore hole built into ground with the purpose of tapping ground water. Such tube wells generally with a depth up to 70 meters in sedimentary formations discharge 100 to 300 cubic meters per day (with 7 to 8 hours of running per day) during the cropping season and in the cultivable command area not less than a hectare or so (Directorate of Economics and Statistics, 1993-94:1) Secondly, deep tube wells with a depth of 70 meters could discharge 100to 200 cubic meters of water per hour. Such high depth tube wells are constructed through drilling by rotary percussion or rotary cum percussion rigs. The annual extraction of deep tube wells is approximately 15 times that of an average shallow tube well (Directorate of Economics and Statistics, 1993-94:2).

[56] But in the flow chart (fig IV), we mention about only two EE, as we are more interested only in those who are dealing with Hirakud command area. Apart from these two EE offices, the other three EE offices are such as EE Main dam division Burla, EE Sambalpur irrigation division and EE Rourkela irrigation division.

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Appendix-I

Different Canal System of the Cuttack and Balasore District

(A) Different canals of the Cuttack district

The works approved in the Cuttack district incorporated the Taldanda and Machgaon canals for the lands between the Mahanadi and Kathajuri rivers, the Kendrapada and Patamundai Canals for the irrigation of the area between the Chitratola and the Birupa, and three 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.

(a) *Machgaon Canal:* It starts from the south of the Cuttack district, leaving the Taldanda Canal at Fakirapara, seven miles of south Cuttack, runs along the north bank of the Kathajuri River and of its branch Alanka, for a distance of 32 miles. The canal has a discharge of 776 cubic feet per second and commands about 97,000 acres, for 82,000 of which distributaries had been completed in 1897. It irrigates the portions of parganas Kodinda, Hariharpur and Karania south of the Hansua drainage channel; and distributaries have been recently made to command the portion of pargana Kate east of the Deb River and part of pargana Banahar.

(b) *Taldanda Canal:* It takes off from the right bank of the Mahanadi at Jobra, immediately above the anicut, and runs in a south-eastern direction to Fakirpara where it gives off the Machagaon branch. Thence it skirts the southern bank of the Sukhpaika River to Jaipur and from Jaipur to Taldanda it follows to course of the Mahanadi River, forming also a protective embankment. At a total length of 52 miles, it has a discharge of 1342 cubic feet per second, of which about half is taken off by the Machagaon canal and commands 75,000 acres lying in the north of parganas Kodinda, Hariharpur, Jhankar, Tiran and Kandhi.

(c) *Kendrapada Canal:* It is the oldest and most important of the Orissa canals which taking off the Birupa River at Jagatpur just above the anicut, skirts the northern bank of the Mahanadi and its tributary the Nuna River for a distance of 39 miles. It irrigates the country between the Mahanadi and Gobri drainage channel, its right bank forming at once to protective embankment and a thorough-fare for the people. The discharge is 1067 cubic feet per second. The area commanded is 108,000 acres and the 23 distributaries are capable of supplying water to 97,000 acres. Nearly all lands requiring irrigation from this canal are already under lease. It is provided throughout with locks, and is navigable to Marshaghai.

(d) *Gobri Canal:* It is a branch of the Kendrapada Canal. Taking off from the 32nd mile it runs 15 miles in an easterly direction to the Gundakia River. It is navigable and forms part of the main route from Cuttack to Chandabali. The area irrigated lies chiefly in parganas Tikan, Derabisi, and Chedra, a part of the country requiring much systematic drainage before the canal water can be extensively used. Its discharge is 373 cubic feet per second and the area commanded is 21,000 acres, but the distributaries completed can only irrigate 9,200 acres.

(e) *Gobri Extension:* This canal is only six miles long and forms the connecting link between the terminus of the Gobri Canal on the Gandakia River and the Bramhani at Albha. It derives its water supply partly from the Patamundai Canal and partly from rivers, and irrigates the pargana of Utikan. The discharge is 648 cubic feet per second and the area commanded 32,000 acres, but distributaries have been constructed for only 7,600 acres, and this canal is more used for navigation than for irrigation.

(f) *Patamundai Canal:* This canal leaves the Kendrapada Canal just below the head works at Jagatpur and skirts the southern bank of the Birupa River down to Indipur, where it begins to turn southward, and falls into the Gobri Extension near Albha after a circuitous course of 47 miles. It is provided only with weirs and is not therefore available for navigation, but it irrigates some of the richest rice –lands of the province in Sungra, Matkatnagat, and

Chaudakulat, and its left bank protects a large tract from the floods of the Birupa and Brahmani rivers. The discharge is 885 cubic feet per second and the area commanded is 51,000 acres; the distributaries are capable of irrigating nearly 44,000 acres.

(g) *High Level Canal:* This canal forms part of the original scheme for connecting Puri with Calcutta by canal. There ranges only have been completed. Range I, from the Birupa to the Brahmani river, a distances of 33 miles; Range II, from the Brahmani to the Baitarani river, a distance of 12.5 miles; and Range III, from the Baitarani to Bhadrak in the Balasore district, a distance of 39 miles. It is the most picturesque of all the canals of Orissa, skirting the very base of the wooded hills of Darpan and Balarampur. The first range commands 49,000 acres, the whole being irrigable by the existing channels. Only a portion of this is, however, under lease, and in some parts the natural irrigation from hill streams is difficult to replace. The second range commands about 10,000 acres, but only a very small area is irrigated and its most likely use is for *dalua* irrigation through spill channels. By the Balasore range 57,500 acres are said to be commanded but the distributaries are only capable of irrigating 44000 acres.

(h) *Jajpur Canal:* This canal is the youngest member of the Orissa System, starting from the Fork of the Baitarani and Bura rivers, run 6.5 miles in an easterly direction to Jajpur town, up to which it is navigable. It has a discharge of 700 cubic feet per second, and commands 70,000 acres. The area for which water could actually be given in 1896-97 was 37,000 acres.

(B) Different canals of the Balasore district

(a) *Churamon Canal:* The first canal built in the district was that known as the Churamon or Ricketts' Canal. It was apparently completed in 1826, the year before Mr. Ricketts' came to the district. The canal connected Churamon with the Matai River and was intended for the transport of salt from the Arangs in the south to the port of Churamon, thence sloops to Calcutta shipped it. The route lay through the *jheel* land of pargana Ankura, which the canal served in some measure to drain. It was, however, never entirely completed and soon fell into disrepair.

(b) *Coastal Canal:* It connects the Hugli at Geankhali with the river Matai at Charbatia, has a length of 71 miles in the district, and runs along the sea face at a distance varying between 2 and 16 miles from the coast. It contains eight locks and is divided into four ranges, the first of which is fed from the Subarnarekha, the second from the Sartha, the third from the Panchpara, and the fourth or lowest from the Kansabans. The last three ranges have inlets and escapes to allow the admission and exist of floodwater, which thus passes across the canal to the sea. The canal was partially opened on the 15th July, 1885 and entirely in September, 1887, the work having commenced in the year 1880.

(c) *Irrigation from the High Level Canal:* This is the only irrigation system in the district. The area theoretically commanded by the canal and its seven distributaries is 57509 acres, of which 44,000 acres are actually provided with means for irrigation. The distributaries have a total length of 50 miles; 20,350 acres were under irrigation in 1895-96, 25,556 acres in 1896-97 and 29,537 in 1898-99.

Appendix-II

Different Categories of Tanks

Kata

An ordinary irrigation tank, which is known as a *Kata,* is constructed by throwing a strong earthen embankment, slightly curved at either end, across a drainage line, so as to hold up an irregularly-shaped sheet of water. The undulations of the country usually determine its shape as that of a long isosceles triangle of which the dam is the base. It commands a valley, the bottom of which is the *Bahal* land and the sides of which are the *Mal* terraces. As a rule, there is a cutting high up the slope near one end of the embankment. From this the water is led either by a small channel or *Tal* or from field to field along the terraces, down which it finds its way to the lower land. In ordinary years, irrigation may be entirely unnecessary and in that case the superfluous water is passed along until it falls into the *nullah* in which the small valley ends. In years of short rainfall the centre of the tank is sometimes cut through, when the bottom lands need irrigation, but in ordinary years such an expedient would be dangerous, for the water is deepest at the centre and no sluices are used. Such tanks supply water to at least 5 acres (2.025 hectares) and usually to an area of 30 to 300 acres (12 to 121 hectares).

Munda

It is an embankment of smaller size across a drainage channel. Embankments of sort are very common, as they can easily be constructed by the *raiyats* themselves for the benefit of their own holdings. These men have perhaps a few fields commanded by the main village tank, but have built *Mundas* to protect their outlying fields, more recently acquired from others or reclaimed from the waste. For its purpose the *Munda* is useful, for if a failure of rain is not very serious, it may provide water enough in the later months of growth to save the crop. But it is necessarily shallow and cannot give more than a certain supply.

Bandh

The *Bandh* is a four-sided tank excavated below the *Kata*, from which it derives its water by percolation. They are almost invariably used for drinking purposes only, are properly regarded as suitable monuments of piety or charity, and are invariably consecrate or married to a god. Apart from their obvious sanitary advantages, they add to the irrigated area by spreading percolation and by rendering it possible in years of drought to empty the irrigation tank completely.