Journal of Rural Development, Vol. 33 No. (2) pp. 183-196
NIRD, Hyderabad.

IRRIGATION DEVELOPMENT: THE STORY OF AN UNDEREXPLOITED RESOURCE IN ODISHA

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ABSTRACT

The irrigation development in Odisha since the VII Five Year Plan period shows that this resource is highly underutilised due to wide gaps between the irrigation potential created and utilised, low cost recovery of irrigation projects and slow progress of the Pani Panchayat (PP). More funds should be given for speedy completion of the Major & Medium (M&M) irrigation projects, Lift Irrigation Projects (LIPs) and tanks to enhance their efficiency and productivity in a sustainable manner. Poor performance of the PPs can be changed by incurring more O&M expenditures, reducing user charges, minimising conflicts in water sharing, farmer's active participation in the decision making process, and developing capacity building programmes for wise and effective use of water. But Odisha should not overexploit the water resources for the sake of development. There is an immediate need for adoption of a holistic approach to increase water productivity and efficiency of the existing irrigation sources by making a sustainable balance among different uses to achieve high irrigation-led-agricultural growth in future.

Introduction

Irrigation development is considered engine of sustainable economic development, and cornerstone of food security and poverty reduction in India (Dhawan, 1988; Alagh, 2001). At the micro level it leads to increased yield rate, lower risk of crop failure, and round-the-year employment (Vaidyanathan et al., 1994) while at the macro level it promotes economic growth through area effect, yield effect, and cropping pattern effect (Hagos et al., 2009). But it was claimed that performance of irrigation projects is disappointing and far below the anticipated food demand of the country as a whole and also Odisha which made the irrigation systems financially and economically unattractive (Raju & Pillai, 1999; Mishra, 1999). It is complained that total irrigation potential created by irrigation projects in Odisha in every financial year is declining or stagnating at alarming rate (National Centre for Agricultural Economics and Policy, 2001) due to the serious deterioration of the irrigation infrastructures. The existing irrigation potential of the State is just enough to meet the agricultural production of the kharif season and a little left for the rabi crop. As a result irrigation projects only played a protective role rather than productive (Ghosh & Kumar, 2010). Irrigation development in a sustainable manner is thus felt necessary in the recent years by the policy-makers to maintain the environmental health of the ecosystem for promotion of the agricultural production and economic development which requires an in-depth analysis of the factors responsible for such underdevelopment and to find out the possible areas that require adequate policy interventions. The main aim of this study is to explore the irrigation development of Odisha under various Five Year Plans (FYPs).

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The author is Indebted to Dr. K. Sambi Reddy, Consultant to Centre for Economic and Social Studies, Hyderabad for his comments on the earlier draft of this paper. However usual disclaimers apply.

Database and Methodology

This study is based on the secondary data. Data are mainly collected from various published sources such as: Economic Survey of Odisha, Annual Plan of the Department of Water Resources (DoWR), Web information from the DoWR, and Ministry of Water Resources (MoWR), India, Orissa Human Development Report (HDR), Central Water Commission (CWC), Central Ground Water Board (CGWB), etc. To understand the irrigation development scenario of Odisha since the Seventh FYP period data on the water endowment, water requirements, potential created and utilised for various purposes in various FYP periods were compiled and the existing critical gaps in the irrigation economy are computed.

Water endowment is explained in terms of the average annual rainfall in the State, surface runoff in terms of major rivers and their tributaries, and storage in terms of groundwater. The groundwater reserve and surface runoff constitute the total water resources of the State. Water is demanded for various purposes like domestic use, agriculture, industry, environment, and others (i.e. navigation, generation of electricity, etc.). The DoWR, Odisha has estimated potential use of water for various purposes for the year 2001 and also projected water requirements by the year 2051. Plan-wise average proportion of potentials created under each source and their annual variability are estimated to understand the benefits, allocation of resources, constraints involved, and opportunities for further scope of development of each source. Compound annual growth rates for the potential created by each irrigation system for each FYP and their annual variability are estimated from the time series data published by the DoWR to understand the recent development scenario of the irrigation system in Odisha.

According to Saleth (1996), India's irrigation sector is experienced by five critical gaps: (*i*) Utilisation gap, (*ii*) Irrigation gap, (*iii*) Incentive gap, (*iv*) Financial gap, and (*v*) Policy/ Institutional gap. Utilisation gap is defined as the difference between the irrigation potential created and utilised. Irrigation gap is defined as the gap between the demand for and supply of water for irrigation purposes. Incentive gap is the direct outcome of the deficiencies in the current institutions governing the management of water resources—low water rate structure, bureaucratic nature of water allocation and lack of direct farmers' involvement in water resource management.

Financial gap is estimated as the difference between the total expenditure incurred and gross receipts received in terms of water charges and other levy imposed by the government from all the irrigation projects i.e. Major & Medium and multipurpose projects, Minor irrigation schemes and Command Area Development (CAD). Total expenditure has two parts: Capital expenditure and Working expenditure. Capital expenditure is the amount of money spent to acquire or upgrade physical assets such as construction of dams, reservoirs, canals, spillways, and distributary channels of the irrigation projects. Working expenditure is on the other hand the expenditure incurred during a financial year in terms of the expenditure on direction and administration, Machinery and Equipment, Training, survey and investigation, and research on different economic activities carried out for construction of irrigation projects. In Odisha, expenditure on direction and administration fetches a large proportion of the working expenditure each year. The financial gap is estimated here for the 1990-2012 due to lack of availability of data on the previous time periods. Lastly, institutional gap which is the sum of all the above gaps shows the overall leakages in the policy framework to achieve sustainable irrigation development. Qualitative information about the incentive gap and institution gap are presented here since it is very difficult for a quantitative analysis of the extent of these gaps

because these are the outcome of the other gaps (i.e. irrigation, utilisation, and financial). All these gaps in the case of the State of Odisha are estimated to show the existing constraints in the irrigation economy.

Irrigation Development Scenario in Odisha

Odisha is one of the few States in the country endowed with abundant water resources (Table 1). The long-term average annual rainfall in the State is of the order of 1489 mm (equivalent to 231.85 Billion Cubic Meters (BCM) of water) which varies from about 1200 mm in the southern coastal plain to about 1700 mm in the northern plateau (Government of Odisha, 2011). The average annual availability of surface water resources was about 120.39 BCM in 2001, out of which, the yield from its own boundary is 82.84 BCM and inflow from neighbouring States is 37.55 BCM (Government of Odisha, 2011). The total annual replenishable groundwater resource of the State is 17.78 BCM out of which 60 per cent is safe and usable. But the State is able to utilise only 26 per cent of its total utilisable groundwater resources.

Table 1: Water Resource Endowment in Odisha and India

Description	Unit	Odisha*	India
Annual Precipitation	BCM	231.85	4000
Average Precipitation (Monsoon)	BCM	130.27	3000
Utilisable Surface Water Resources	BCM	120	690
Utilisable Ground Water Resource	BCM	17.78	431
Stage of Ground Water Development	Per cent	26	61
Per Capita Water Availability (2001)	CUM	3850	1820
Utilisable Resources as a % of Precipitation)	Per cent	59	28

Source: Economic Survey, GoO (2010-11).
Note: * It also includes water resources outside from the State.
BCM: Billion Cubic Meter, CUM: Cubic Meter.

According to the Economic Survey of Odisha (2010-11), the estimated water utilisation data for various purposes for the year 2001 and projections for the year 2051 by the DoWR show that about 45 per cent of the surface water and 32 per cent of the groundwater is used for agriculture. The requirement of water for irrigation is derived from the projections of the food requirements of the State, per capita income, and changes in dietary habits. It is clearly visible from Table 2 that the projected demand by 2051 for irrigation of agriculture is about 62 per cent in the case of the surface and about 47 per cent in the case of the groundwater. In the coming years demand for both surface and groundwater for irrigation purpose will increase which draws immediate attention of policymakers for its overall development.

Table 2: Water Requirements for Different Uses in 2001 and 2051 Projections in Odisha

Uses	Year 2001						Year 2051 Projection					
	Surface Water		Groundwater		Total		Surface Water		Groundwater		Total (%)	
	Quantity (BCM)	Per cent	Quantity (BCM)	Per cent	Quantity (BCM)	Per cent	Quantity (BCM)	Per cent	Quantity (BCM)	Per cent	Quantity (BCM)	Per cent
Domestics	0.798	1.97	1.198	8.27	1.996	3.63	1.202	1.87	1.803	9.01	3.005	3.57
Irrigation	18.000	44.44	4.688	32.36	22.688	41.26	40	62.35	9.408	47.02	49.408	58.71
Industry	0.606	1.50	0.100	0.69	0.706	1.28	1.75	2.73	0.2	1.00	1.950	2.32
Environment	21.000	51.85	8.400	57.99	29.400	53.46	21	32.74	8.4	41.98	29.400	34.93
Other	0.100	0.25	0.100	0.69	0.200	0.36	0.2	0.31	0.2	1.00	0.400	0.48
Total	40.504	100	14.486	100	54.990	100	64.15	100	20.01	100	84.160	100

Source: Government of Odisha (2010).

Note: Quantity are expressed in terms of BCM.

Before implementation of the Indian FYPs, only 1.769 lakh hectare under kharif and 3890 hectare under rabi were created through various irrigation projects (Dalua, 1999). Only after introduction of the First FYP (1951) by the Government of India, attempts were made for rapid harnessing of water resources and emphasis was laid for overall irrigation development. In the First FYP mostly M&M irrigation projects were initiated which thus contributed negligibly to the total irrigation potential of the State. Significant contribution to total irrigation potential was achieved only in the Third FYP when about 0.93 lakh hectares under Kharif and 0.93 lakh hectares under Rabi were created (Rath & Sahu, 2004) which was slightly increased to 9.70 lakh hectares during Fifth FYP.

In the Seventh FYP, contribution of the M&M irrigation projects was more, followed by the 'other' irrigation projects. Significant progress is also observed in case of minor flow and lift irrigation projects. There is also a 4 per cent increment in total area under water harvesting projects as 6518 number of water harvesting structures with an ayacut of 1.12 lakh hectare were constructed by investing ₹ 41.77 crore under the Drought Prone Area Programme (DPAP) and Areas Development Approach for Poverty Termination Programme (ADAPTP) (Government of Odisha, 1998). But growth rates revealing that, the area covered by M&M irrigation projects in each financial year during the whole Plan period is not satisfactory. Several factors may attribute to this slow progress such as inadequate release of water, faulty water distribution system, huge conveyance loss and seepage, and traditional management system. This period has also experienced a severe waterlogging problem which accounts about 1.96 lakh hectares of land mainly due to seepage of water from adjoining highlands and canals which reduced agricultural productivity (Government of India, 2010).

Table 3: Compound Annual Growth Rates of Irrigation Potential Created and the Share of Different Irrigation Sources in Odisha during 1985-86 to 2011-12

Plan Period	IPC (Thousand Hectare)	Major & Medium CAG (%)	% Share to Total	Minor (flow) CAG (%)	% Share to Total	Minor (lift) CAG (%)	% Share to Total	Others CAG (%)	Others % Share to Total
Seventh Plan	2568	0.65**	50.17	2.59***	15.41	1.45***	14.75	1.88**	19.67
Annual Plans	2858	0.89	48.26	0.30	15.38	1.63	15.08	1.87	21.28
Eighth Plan	3041	0.96***	47.93	1.01***	15.46	1.26***	15.51	-1.74	21.10
Ninth Plan	3433	1.01***	47.80	0.50	15.21	0.63***	15.35	0.39***	21.64
Tenth Plan	3770	0.29**	47.21	1.22	15.16	1.63***	15.86	2.24	21.76
Eleventh Plan	4388	1.05**	43.79	1.23***	14.43	2.48***	17.74	1.66***	24.04
Total	3397	0.81***	47.45	0.93***	15.15	1.34***	15.79	1.35***	21.62

Note: IPC—Irrigation Potential Created per Annum, CAG—Compound Annual Growth Rate.

*** sig. at 01 per cent level, ** sig. at 05 per cent level.

Source: Department of Water Resources, Government of Odisha (Various Years).

During the Eighth Plan period, area under M&M was increased by 0.96 per cent because more attention was given for either speedy completion or improvement of the quality and efficiency of the existing M&M projects by taking huge assistance internationally from the World Bank, Japan Bank for International Corporation (JBIC) and European Commission (EC).The GoO was claiming about creation of 0.34 lakh hectares of irrigation potential by constructing dug wells, tube wells, and community borewells, for which a subsidy amount of ₹ 441.50 lakh was sanctioned by giving preference to marginal and small farmers, tribes, and farmers from the draught-prone areas (Government of Odisha, 2002). Besides these, an additional amount of 0.25 lakh hectare were created through drip irrigation projects. But the performance of these irrigation sources is not satisfactory as there is a high variability in irrigation potential created and the growth rate is showing a negative trend. There is also a declining trend of minor (flow and lift) irrigation projects due to lower investments.

Ninth FYP experienced a 1.01 per cent increase in total irrigated area under M&M irrigation projects while area under minor (flow & lift) projects showed a declining trend (0.50 per cent and 0.63 per cent, respectively) (Table 3).Water User Associations (WUAs), well-known as Pani Panchayat (PP) were formed during 2001, with assistance from external agencies such as World Bank, JBIC, EC, etc., for efficient utilisation of the existing water resources to boost agricultural productivity.During first phase of its implementation, performance of the PP is very slow as only 16 lakh hectares of M&M, minor and CAD projects from all the districts of Odisha were covered by it (Government of Odisha, 2001), cited by Mohanty et al. (2005).The main constraint identified was lower allocation of O&M expenditure. Farmers also not readily accepted the programme due to their fear of increasing water rate and excess burden of O&M expenditure, and other farmer-specific socio-economic constraints. Another scheme called *Biju Krushak Vikash Yojana* (BKVY) was also implemented during 2001 through the PP to revive derelict projects and to construct new minor and lift irrigation projects through Public Private Partnership (PPP) at a proportion of 90:10 for the KBK-districts and 80:20 basis for the non-KBK-districts.This programme did not succeed enough to increase efficiency of the irrigation projects due to constraint of inadequate fund in the first two years of its implementation. The honourable CM of Odisha in his speech also admitted that despite huge irrigation potential, the percentage of area under irrigation is much lower than the All India average (Planning Commission, 2001). The main reasons highlighted for such a low irrigation utilisation were excess loan burden which has already gone beyond the sustainable limit, limited investment potential for speedy completion of the ongoing irrigation projects, and higher interest rate (12 per cent) on the existing loan amount. As a result, about 17.27 lakh hectare under M&M irrigation projects, 14.71 lakh hectare under minor (flow) irrigation project, and 5.56 lakh hectare under minor (lift) irrigation were created over the whole Plan period.

During the Tenth FYP about 21.91 lakh hectare of net irrigation potential has been created through M&M, and minor irrigation project and another 6.21 lakh hectare has been created through unconventional sources like dug wells, water harvesting structures, check dams, etc. (Government of Odisha, 2008). This period has experienced a declining growth of the area under M & M irrigation projects while minor (flow &lift) and 'other' sources have significant contribution to the total irrigation potential of the State. It is so because, in most of the schemes, emphasis was given to the minor irrigation projects. For example, long after implementation of the AIBP programme since 1996, more funds were allocated to the minor irrigation projects. As a result, there is huge gap between the potential created and Gross Irrigated Area (GIA) under M&M projects and the situation is serious

as the trend is increasing over time (Planning Commission, 2010). With regard to the total area under M&M projects huge gap was found between the targets put and achievements made in most of the irrigation development schemes (e.g. RIDF projects). Minor (flow & lift) and 'other' irrigation projects on the other hand even though showed better performance, several problems have been reported such as incompletion of several minor irrigation projects under RIDF scheme; slow revival rate in case of the derelict projects; slower progress of area under BKVY programme; huge gap between the total area registered and final area transferred to the PP members; declining gross irrigation potential under dug well due to large-scale defunct, poor and irregular maintenance and inadequate power supply; default LIPs, deterioration of the distributaries; and declining surface (flow) schemes due to erratic rainfall (Government of Odisha, 2008). As a result, this period experienced highest variability with regard to increase in irrigation potential under all the sources.

The Eleventh FYP accords a high priority for development of the irrigation sector to increase agricultural productivity. It may be due to implementation of the New Water Policy, 2007, where allocation of water for the irrigation sector has been considered third priority and decisions are undertaken for the cost-effective and sustainable development of the surface water, groundwater and water harvesting structures to achieve water security for all. Priority was given for improvement of all irrigation sources including traditional structures such as *Munda, Kata, Bandha*, tanks and check dams, etc. Two new programmes namely, '*Jalanidhi*' and '*35 Per cent Irrigation Master Plan*' were implemented where priority was given for improvement of irrigation potential in the tribal, hilly, mountainous, and water scarce areas. By end of the period, about 44.72 lakh hectare of irrigation potential has been created through M&M and minor (flow & lift) irrigation projects. Besides that, additional 6.17 lakh hectares has been created through 'other' sources like dug well, water harvesting structures, and check dams (Government of Odisha, 2012). Emphasis on the sustainable development of the irrigation sector by maintaining equity and justice thus proved to be significant to reduce variability and increase productivity of the irrigation projects in Odisha.

Critical Gaps in the Water Economy

Thus, anomalies in various Plan periods created huge gap between the irrigation potential created and utilised. From Table 4 it may be seen that over the 1990-2011 period utilisation gap increased by 2.44 per cent because except the Tenth FYP, other FYPs experienced huge gap. Lower application of technology, in-completion of the M&M irrigation projects and underutilisation of the minor irrigation resources are felt to be the main factors determining such a huge gap (Government of Odisha, 2011). A study sponsored by the MoWR, GoI, had estimated opportunity cost of unutilised irrigation potential by year 2003 in all States of India. According to this study, about 20.46 per cent of total irrigation potential created by surface lift irrigation projects is not in use. As a result about 31.58 per cent (0.96 lakh hectare) of total irrigation potential created has been lost (IIM, n.d.). It further claims about loss of 9.48 per cent (0.65 lakh hectare) of irrigation potential created due to underutilisation of 17.39 per cent of irrigation potential created by surface flow irrigation projects. Similarly, the irrigation potential loss due to underutilisation of potential created by shallow tube wells, tube wells, and deep tube wells respectively, are 20.25, 92.73 and 65.97 per cent. From Table 4 it can be seen that irrigation gap is increasing in all the Plan periods. It may be a result of the declining NSA. But still Odisha is lagging behind in the utilising of the existing irrigation potential and creating of additional potential to meet the growing needs.

Table 4: Critical Gaps in the Irrigation Economy of Odisha

Plan Period	Utilisation Gap as a % of IPC	Financial Gap as a % of WE
Seventh Plan	7.91	-
Annual Plans	7.62	90.16
Eighth Plan	29.11	90.70
Ninth Plan	25.47	90.81
Tenth Plan	27.70	79.02
Eleventh Plan *	29.19	78.25

Source: Indiastat.com, Economic Survey of Odisha (various years), Government of Odisha (2010).
Note: IPC—Irrigation Potential Created, NAS—Net Area Sown, WE—Working Expenditure.
* Up to year 2010-11.

The total water resource potential of the State is 141.408 BCM from all sources out of which 108.147 BCM can be utilisable (Table 1). But the water resource requirement for the year 2001 is estimated about 54.99 BCM which is projected to be increased to 84.463 BCM by year 2051 (Table 2). Among the several users, significant increase in demand is observed in case of irrigation. If one considers present per capita availability of water resource of 5539 cum per year and future (by year 2051) decline of per capita availability of 2218 cum, then it is felt that Odisha will face huge irrigation demand-supply gap in near future.

Apart from low water use efficiency, water prices are subsidised in all sectors which have created a heavy financial loss to the government. Low water charge is another major concern in Odisha. The main reason is due to non-revision of the water rates. The Vaidyanathan Committee on pricing of irrigation water during 1992 observed that water rates fixed for different crops are much lower than the other States and the lowest rate is observed in case of the paddy even though it consumes more water (Government of India, 1992). Water rate is not only low but also the different rate classification is in vogue. As a result, the gross receipt from the water charges per hectare is not more than 3 per cent of the gross productivity per hectare of irrigated area. It further added that during 1984-86 period, the gross receipts collected was 54 lakh while that of working expenditure was ₹ 136 lakh. It hampered development of the irrigation projects and created constraints in the way of adoption of new technology and speedy repairment of the projects. Quoting from the National Water Policy 1987, it had suggested of revising water rates in every five years and fixing rates at a point which should cover the annual M&O changes and a part of the fixed cost to achieve full cost recovery, promote saving, create disincentive for waste, provide reliable and assured services and maintain quality of the services.

Odisha revised water rates accordingly. By 1993, the gross receipts from the irrigation was ₹ 5 crore while that of working expenditure including interest was ₹ 68 crore which remained one of the lowest among the several States of India (Centre for Water for Life, n.d.). The main problems identified for this low recovery were discrepancies in the way of timely and adequate provision of reliable source of water, lower supply to tail-end areas, poor maintenance of irrigation system, absence of

direct link between the charges and actual quantity of water supplied, and conflicts between the government officials and user groups. By the triennium ending 2000-02, the cost recovery is only 25 per cent as the average O&M expenditure was only 30 per cent of the desired level. It is because of the low water rate revised (weighted average ₹ 104/ha) during 1998 (National Centre for Agricultural Economics and Policy, 2001). It is so because there is no incentive to economise water as regardless of whether the farmer conserves water or not they have to make the same payment as determined by their farm size and cropping pattern. It induced farmers to maximise their net income per hectare by maximising water application instead of maximising net income per unit of water as required for economic efficiency. It has also not been revised periodically and does not cover the full provisional cost of water and capital cost of irrigation projects. The O&M expenditure has been just enough to meet the staff salaries with little incentives for works (National Centre for Agricultural Economics and Policy, 2001).

The water charge is not only low but also there are huge discrepancies for timely and due realisation of the water rates which reflected huge gap between revenue assessed and actual revenue realised. Up to 2002 the average revenue realised as a percentage of actual revenue assessed for the State of Odisha is 50.96 per cent (Government of India, 2007). The water rates fixed for minor (flow) irrigation from April 2002 to as on March 2006 ranges ₹/ha 28-930 which is one of the lowest among all major States of India (Government of India, 2007). This scenario did not change further as the water rates revised in 2002 shows a weighted average of ₹ 181/ha (Government of Odisha, 2012) which is one of the lowest in India. Low water charges and poor cost recovery resulted in secular declining of funding for maintaining water infrastructure and promotion of efficient water allocation. The ratio of the financial gap to the working expenditure, which is a good indicator of measuring the financial viability of the irrigation projects, is declining over time due to a four-fold increase in the working expenditure (Government of India, 2010) but slower increments in the revenue receipt. Poor cost recovery followed by low water charges resulted in declining of funding for maintaining water infrastructure and promotion of efficient water allocation and reduction of conflicts in water sharing.

Implementation of the participatory approach to irrigation management has a new welcome measure by the Government of Odisha as ultimate users got sole right over the use and management of existing water resources. But the overall progress of the PPs is not satisfactory. During initial period of its implementation only 4.07 lakh hectare were created by transforming 434 M&M and 329 minor (flow) irrigation projects to PP. Up to April 2006, 13434 PP with 10.54 lakh hectare had been formed which was slowly increased to 16618 PP with an ayacut area of 17.25 lakh hectare in March 2008 and further increased to 18619 PP with an ayacut area of 17.69 lakh hectare in March 2009. Mishra's study shows that effectiveness of PP depends on adequate and timely availability of water from upper reach to tail reach areas (Mishra B. , 2007). It creates positive incentive for better farmers' participation, better utilisation of O&M expenditure, and recovery of water charges. But performance of most of the PPs is not satisfactory. Only 44 per cent of total area covered in each PP is fully irrigated which failed to increase water intensity and efficiency. Water bodies are suffering from siltation, seepage, and huge wastages. Dispute among the upper reach and tail-end farmers and with PP members are common phenomena. As a result, most of the farmers are not willing to pay water charges. High default rate is not due to inability of the farmers but because of the low crop yield characterised by inadequate water supply. Lower utilisation of the O&M expenditure for

removal of siltation; clearing of weeds and trees; maintaining of assets; and repairing of sluice gates, canal banks, and distributaries, etc., are the most critical constraints observed in the way of better performance of the PPs. Emphasis was also laid for the introduction of various regulatory policies based on well-sitting, licensing norms, power tariff, and supply manipulations but with little or no success so far.

Conclusion

From the above it is clear that despite abundant water resource endowment in Odisha, irrigation development is highly disappointing. This is due to slow growth of total irrigation potential created in every FYP by all types of irrigation projects—particularly of M&M projects. However, the main causes identified for underdevelopment are high utilisation gap, poor cost recovery and slow progress of the PP. Lower utilisation of the irrigation potential created is observed due to low technological progress to enhance efficiency of the irrigation projects and reduce huge wastage. The problems in case of large and small dams are : (1) inadequate spillways, (2) crakes in galleries, upstream face of concrete dam, and sluice gates, (3) cavities at the bell mouth entry of under sluices in the spillway, (4) heavy leakages, (5) damages in sluice gate and sit block of the gates, (6) scouring in stilling basin, (7) seepage, (8) slushy patches near toe of the dam, (9) cavities in spillway, worn out of ropes, (10) chocking in toe gates, (11) erosion, (12) formation of rain cuts and gullies, etc. (Government of Odisha, 2007). In case of M&M irrigation projects the problems are incompletion of projects, high gestation period, damages and water wastages. In case of minor irrigation projects problems are : loss of storage capacity due to siltation in the tanks, poor maintenance and management, and damage of various structures etc. Technological obsolesce development is observed in terms of low groundwater development. For example, the stage of groundwater development in 1998 was 15.22 per cent which rose to 18 per cent in 2009-10 and 26 per cent in 2011-12 (Cental Ground Water Board, 2012). According to the stage of groundwater development, Odisha stands in 20th position among all the States of India. It is also mentioned earlier that M&M irrigation projects have low productivity and require more investment in its initial years of instalment. Instead of allocating huge investment from the government treasury, which is not adequate enough to meet every demand simultaneously, it is wise to give more preference to ongoing M&M irrigation projects than the newly installed projects to enhance their efficiency and productivity. Minor irrigation projects basically of tanks, LIPs, and water harvesting structures which need less investment but highly productive, are neglected in every Plan Period. Many small tanks have lower storage capacity due to siltation. The State should give preferences for creation of water harvesting structures and water conservation programmes for the restoration of tanks and recharge of groundwater to increase efficiency of these irrigation structures in a sustainable manner to reduce wastages in time.

Poor cost recovery on the other hand has created several burdens in terms of losing interest and financial strength of the State government to give adequate attention and allocation of investments in specific areas of requirement. The problem of slow technological innovation can be resolved in two ways by allocating investments. Firstly, technological innovation requires huge human and financial resources which are very difficult to achieve in a shorter period of time due to present socio-economic development of the State. In other words, State can achieve these goals by putting some long term targets and making wise investments accordingly. Secondly, financial problems can be met from the extra disbursement of grants from the centre.

Slow progress of the PP is mainly due to its failure to maintain equity and efficiency in distribution of adequate water between the

upper reach and lower reach farmers. Water scarcity has created a vicious cycle of low productivity, low farmer's participation, low cost recovery, low O&M expenditure, and again low water availability. This vicious cycle can be broken by disbursing more O&M expenditure to increase storage capacity of the water bodies, provision of subsidies to reduce user charges, minimising conflicts by distributing power, active farmers' participation in the decision making process, and developing capacity building programme for wise and effective water use. However, development does not mean over-exploitation of the water resources—specifically precarious groundwater. For instance, studies mentioning that over-exploitation of groundwater created several environmental problems such as desertification in the fragile resource regions (Reddy, 2001). Economic development does not compromise with the principles of sustainable development. Water should be used sustainably by making a balance among the different users, between space and time, and among the individuals and society to achieve high irrigation development-led-agricultural growth in future.

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Annexure 1: Five Year Plan-wise Allocation of Investment in Various Irrigation Projects in Odisha and India

Five Year Plans	Major & Medium			Minor (Flow & Lift) & CAD		
	India (₹ Crore)	Odisha (₹ Crore)	Share in India (%)	India (₹ Crore)	Odisha (₹ Crore)	Share in India (%)
I Plan (1951-56)	376.2	55.28	14.69	65.6	NA	-
II Plan (1956-61)	380	20	5.26	161.6	1.65	1.16
III Plan (1961-66)	576	26.22	4.55	443.1	6.22	1.90
Annual Plan (1966-69)	429.8	20.44	4.76	560.9	7.95	2.44
IV Plan (1969-1974)	1242.3	20.89	1.68	1173.4	18.88	3.68
V Plan (1974-78)	1409.6	70.63	2.81	3925.8	31	4.92
Annual Plan (1978-80)	2078.6	67.81	3.28	1344.9	28.3	5.69
VI Plan (1980-85)	7368.8	360	4.29	4159.9	85	4.70
VII Plan (1985-90)	11107.3	623.61	5.4	7626.8	177.15	6.32
Annual Plan (1990-92)	5459.2	404.74	7.41	3649.5	103.06	6.13
VIII Plan (1992-97)	21071.9	2276	4.28	13885.3	323.4	2.08
IX Plan (1997-2002)	49289	2331.2	4.73	13760	435.7	3.17
X Plan (2002-07)	83647	2334.02	2.79	16458.9	427.54	2.60
XI Plan (2007-12)	165350	5107.62	3.09	46350	1514.11	3.27

Source: Rath and Sahu (2004), GoI (2011).