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Irrigation, Agriculture, Livelihood and Poverty Linkages in Odisha

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Abstract

An analysis of irrigation, agriculture, livelihood and poverty linkages in the districts of Odisha has been carried out. District-wise scenario of irrigation, agriculture, livelihood and poverty has been revealed with the help of different indexes developed. The values of Groundwater Development Index have been found low to very low for 25 districts. Created irrigation potential out of the total potential ranged from 19 to 93 per cent in *kharif* and 8 to 61 per cent in *rabi* season. Half of the districts have shown medium Agricultural Development Index values. Level of living of majority of districts has been found at medium level. About 60 per cent of the BPL rural families comprise agricultural labourers, marginal and small farmers; ranging from 25 to 94 per cent. Balasore, Bargarh, Bhadrak, Cuttack, Ganjam, Jajpur and Puri districts have shown higher irrigation and agricultural development and Deogarh, Dhenkanal, Kandhamal, Malkangiri, Nawapara, Raygarh and Sundargarh districts have shown lower irrigation and agricultural development. The links and/or missing links between irrigation resources, agriculture development, poverty and level of living have been explored.

Key words: Irrigation, livelihood, poverty, Odisha, groundwater development index, agricultural development index, level of living index

JEL Classification: Q15, O42

Introduction

Over the past four decades, the policy agenda of agricultural development has evolved from an initial focus on increasing food production to concerns for the environment, poverty and diversified livelihood options. It has been recognized that irrigation resources play a major role in poverty alleviation by ensuring agricultural development, expanding livelihood opportunities and employment both on and off the farm. Development of irrigated agriculture has been a major engine for economic growth and poverty reduction. But, the growing scarcity and competition for water are putting the poor in irrigated areas at a risk (Barker *et al.*, 2000). Poverty alleviation has always been an important aim of the governments of developing countries when investing in the development of irrigation infrastructure (van Koppen *et al.*, 2002). Between the mid-1970s and 1990, the number of people below the poverty line in India fell from over 50 per cent to approximately 35 per cent (Datt, 1998); however, the absolute number of poor has increased. An important factor to poverty alleviation was the growth in public sector-funded canal irrigation and private sector-funded tube-well irrigation. Identification of analytical, methodological and policy issues are crucial for understanding and promoting the overall poverty alleviation impacts of irrigation (Saleth *et al.*, 2003). During the 3rd annual partners meet of the International Water Management Institute (IWMI) – Tata Water Policy Research Programme in February 2004 it was mentioned that (a) irrigation development

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promotes non-farm employment, (b) the impact of irrigation was relatively higher in temporal and spatial variations in rural poverty, (c) groundwater irrigation has explained variations in rural poverty even better than canal irrigation, and (d) irrigation availability (measured as irrigated area per worker) has a positive impact on real farm wage rates. If irrigation has the potential to produce such profound impacts on agrarian dynamism, why such impacts are not visible in eastern India, where it is greatly needed and has the water resources to sustain intensive irrigation (Shah, 2004). Delineation of the missing links between growth of irrigation and agriculture sector and poverty scenario holds significance. The state of Odisha is still poverty-stricken (about 47% population is below poverty line) with narrow livelihood options inspite of plentiful water resources. To study this kind of mismatch, an analysis of irrigation, agriculture, livelihood and poverty linkages in the state of Odisha was carried out.

Methodology

Different indexes were constructed for the assessment of district-wise scenario of irrigation, agriculture, livelihood and poverty. These are: Irrigation Potential Development Index (IPDI), Groundwater Development Index (GWDI), Irrigation Potential Utilization Index (IPUI), Irrigation Coverage Index (ICI), Composite Irrigation Index (CII), Agricultural Development Index (ADI), Poverty Ratio Index (PRI), and Level of Living Index (LLI). A brief account of these indexes is given below:

- IPDI considered the created irrigation potential for both *kharif* and *rabi* seasons out of total potential.
- GWDI included gross annual draft (ha-m) out of utilizable groundwater resource (ha-m).
- IPUI considered the utilized irrigation potential for both *kharif* and *rabi* seasons out of the created potential.
- ICI was calculated as annual gross irrigated area out of gross cultivated area.
- CII was calculated by averaging IPDI, GWDI, IPUI, and ICI giving equal weightage to all.
- ADI included eight indicators, viz. percentage of cultivable land to total land area, percentage of net sown area to total cultivable area, percentage of gross irrigated area to gross cropped area, cropping intensity, percentage of area under HYV of major crop, yield of major crop, food grain production and per ha fertilizer consumption.
- PRI was calculated on the basis of percentage rural families under below poverty line (BPL) to total number of rural families
- LLI included 14 indicators viz. percentage of rural families above poverty line, literacy rate, per capita food grain production, yield of major crop, percentage of gross irrigated area to gross cropped area, percentage of village electrification, women work participation rate, percentage of agricultural laborers to total main workers, percentage of cultivators to total main workers, percentage of industrial workers to total main workers, percentage of main workers to total population, percentage of urban population to total population, agricultural productivity per worker, and SC/ST population.

District-wise data on selected variables were taken from the *Economic Survey* (2004-05, 2005-06, 2006-07), *Agricultural Statistics of Odisha* (2004-05, 2005-06, 2006-07), *2001 Census*, *Odisha BPL Survey* 1997 (BPL census was conducted in 2002 but it could not be published due to restriction by the Supreme Court; since BPL census is conducted every five years, a fresh survey should have been conducted in 2007. District-wise values of different indices were calculated. Each index takes value between 0.0 and 1.0. The districts have been classified under each index into five categories viz. very low (0.0 to 0.2), low (>0.2 to 0.4), medium (>0.4 to 0.6), high (>0.6 to 0.8) and very high (>0.8 to 1.0).

Results and Discussion

District-wise values of different indices are mentioned in Table 1 and frequency of districts under the five categories of each index is given in Table 2.

A look at the district-wise irrigation scenario at the end of Tenth Five Year Plan (March 2007) in Odisha reveals that the created irrigation potential out of the total potential varied across 30 districts of Odisha, ranging from 19 per cent (Nawarangpur district) to 93 per cent (Puri district) in *kharif* and 8 per cent (Bolangir district) to 61 per cent (Puri district) in *rabi* season. Irrigation potential development is more than 50 per

Table 1. Values of different developmental indexes in the districts of Odisha

Sl. No.	District	GWDI[1]	IPDI[2]	IPUI[3]	ICI[4]	CII[5]	ADI[6]	LLI[7]	PRI[8]
1	Balasore	1.00	0.39	0.72	0.64	0.69	0.72	0.49	0.33
2	Bhadrak	0.95	0.53	0.81	0.95	0.81	0.76	0.58	0.52
3	Bolangir	0.26	0.03	0.82	0.13	0.31	0.45	0.42	0.67
4	Sonepur	0.13	0.77	0.80	0.85	0.64	0.66	0.57	0.35
5	Cuttack	0.30	0.73	0.59	0.85	0.62	0.67	0.60	0.91
6	Jajpur	0.72	0.85	0.48	1.00	0.76	0.61	0.43	0.69
7	Jagatsingpur	0.21	0.13	0.57	0.27	0.30	0.48	0.53	0.90
8	Kendrapara	0.62	0.62	0.27	0.41	0.48	0.58	0.53	0.70
9	Dhenkanal	0.24	0.14	0.53	0.30	0.30	0.39	0.43	0.63
10	Angul	0.28	0.09	0.70	0.24	0.33	0.41	0.46	0.72
11	Ganjam	0.47	0.45	0.88	0.67	0.62	0.71	0.50	0.84
12	Gajpati	0.29	0.20	0.61	0.18	0.32	0.50	0.40	0.66
13	Kalahandi	0.20	0.48	0.91	0.51	0.52	0.56	0.39	0.63
14	Nawapara	0.24	0.17	0.76	0.16	0.33	0.35	0.27	0.00
15	Keonjhar	0.18	0.21	0.73	0.27	0.35	0.46	0.39	0.24
16	Koraput	0.02	0.31	0.85	0.49	0.41	0.47	0.35	0.05
17	Malkangiri	0.00	0.58	0.19	0.29	0.27	0.39	0.41	0.10
18	Nawarangpur	0.26	0.01	0.58	0.00	0.21	0.41	0.30	0.33
19	Rayagarh	0.16	0.19	0.71	0.29	0.34	0.35	0.30	0.37
20	Mayurbhanj	0.38	0.13	0.74	0.42	0.42	0.43	0.43	0.22
21	Kandhamal	0.11	0.08	0.61	0.08	0.22	0.19	0.31	0.20
22	Boudh	0.26	0.44	0.89	0.57	0.54	0.44	0.45	0.15
23	Puri	0.11	1.00	0.65	0.90	0.67	0.68	0.55	0.45
24	Khurda	0.19	0.44	0.62	0.51	0.44	0.54	0.56	0.72
25	Nayagarh	0.11	0.22	0.66	0.27	0.31	0.41	0.40	0.49
26	Sambalpur	0.10	0.26	0.85	0.48	0.42	0.56	0.61	0.71
27	Bargarh	0.20	0.35	0.91	0.79	0.56	0.77	0.61	0.69
28	Deogarh	0.13	0.16	0.92	0.32	0.38	0.32	0.28	0.19
29	Jharsuguda	0.40	0.02	0.97	0.23	0.41	0.43	0.53	1.00
30	Sundargarh	0.23	0.16	0.73	0.29	0.35	0.31	0.41	0.56
Max. value		1.00	1.00	0.97	1.00	0.81	0.77	0.61	1.00
Min. value		0.00	0.01	0.19	0.00	0.21	0.19	0.27	0.00
Mean value		0.29	0.34	0.70	0.45	0.44	0.50	0.45	0.50
Standard deviation		0.24	0.26	0.18	0.28	0.16	0.15	0.10	0.28

Note: [1]Groundwater Development Index (GWDI), [2]Irrigation Potential Development Index (IPDI), [3]Irrigation Potential Utilization Index (IPUI), [4]Irrigation Coverage Index (ICI), [5]Composite Irrigation Index (CII), [6]Agricultural Development Index (ADI), [7]Level of Living Index (LLI) and [8]Poverty Ratio Index (PRI)

Table 2. Number of districts under each developmental index in Odisha

Categories	Districts (No.)							
	GWDI	IPDI	IPUI	ICI	CII	ADI	LLI	PRI
Very low (0.0-0.20)	13	13	1	5	0	1	0	6
Low (>0.2-0.4)	12	6	1	10	14	6	9	6
Medium (>0.4-0.6)	1	6	5	7	9	15	19	4
High (>0.6-0.8)	2	3	13	3	6	8	2	10
Very high (>0.8-1.0)	2	2	10	5	1	0	0	4

cent in 11 districts out of which 6 districts have 50 per cent of cultivated area irrigated. About 30 per cent of GCA is irrigated in 15 districts. The IPDI values of 12 districts are very low (0-0.2) and of 6 districts are low (>0.2-0.4).

Groundwater development varied from 6 per cent (Malkangiri district) to 47 per cent (Balasore district). Groundwater development is less than 20 per cent in only 23 districts with the state average of about 18 per cent. The GWDI values of 25 districts have been found low to very low; only for 4 districts the value is >0.6 i.e. high to very high.

The irrigation utilization varied from 23 to 96 per cent and 25 to 98 per cent of the created potential in *kharif* and *rabi* seasons, respectively. The IPUI values of 11 and 12 districts were under very high (>0.8 to 1.0) and high (>0.6 to 0.8) category, respectively. Irrigation intensity varied from 14 per cent (Nawarangpur district) to 125 per cent (Puri district) with the state average 52 per cent.

The gross irrigated area ranged from 9 per cent (Nawarangpur district) to 62 per cent (Jajpur district) of gross cultivated area with a state average 33 per cent. ICI values of 15 districts were very low to low, while that of 8 districts was high to very high. CII value varied from 0.21(Nawarangpur district) to 0.81 (Bhadrak district). CII values of 14 districts were low, while 6 districts were under high category.

District-wise agricultural development was assessed on the basis of data on selected indicators for the years 2004-05, 2005-06 and 2006-07 and the data were screened for the year categorized as a normal year without any flood, drought or other natural calamities affecting agricultural performance. ADI values of 30 districts ranged from 0.77 (Bargarh dist.) to 0.19 (Kandhamal dist.). Half of the districts showed medium ADI values (>0.4-0.6); while 6 and 8 districts indicated low (>0.2-0.4) and high (>0.6-0.8) agricultural development, respectively.

Rural poverty was explored through the percentage of rural families under below poverty line (BPL) to total number of rural families. About 60 per cent of BPL rural families comprised agricultural labourers, marginal and small farmers families; it ranged from 25 per cent (Ganjam) to 94 per cent (Nawarangpur). PRI values of 10 districts were in high range (higher the value of index lower is the poverty), while 12 districts showed the very high to high poverty level with PRI values in the range of 0.0 to 0.2 and >0.2 to 0.4, respectively. Rural poverty was highest in the Nawapara district (86 % of rural families are BPL); and is lowest in Jharsuguda where about half of the rural families were BPL (49%). Overall in Odisha, 66 per cent of rural families were living BPL.

The level of living of 19 districts was found as medium (with LLI value >0.4-0.6) and of 9 districts was low (with LLI value >0.2-0.4). Sambalpur and Bargarh were the only two districts with a high LLI value.

The districts with high values of different developmental indexes are explored (Table 3). It is revealed that overall irrigation scenario is best in Bhadrak district followed by Jajpur and Balasore districts with high CII values, which are mainly attributed to better groundwater development in those districts. Irrigation coverage i.e. percentage of gross irrigated area out of gross cultivated area is also found to be high with higher ICI values in Jajpur and Bhadrak districts. It may be concluded that groundwater irrigation is having better impact on overall irrigation scenario. Bhattarai and Narayanmoorthy (2003) and Rijsberman (2003) also reported similar trend. The better irrigation scenario is reflected in better agricultural scenario both in Bhadrak and Balasore districts with higher ADI values. However, Bargarh district is found to best in agricultural development and level of living with highest index values. The level of living of Samabalpur district is also found to be high followed by Cuttack and Bhadrak districts. Better level of living in Cuttack district has reflected in lower poverty scenario. Jharsuguda which is one of the industrially developed districts along with Sambalpur in the state of Odisha with better living scenario has showed relatively lower poverty.

Low values of different developmental indexes of few districts reveal the poor scenario of irrigation, agriculture, living and poverty (Table 3). Nawarangpur, Kandhamal and Malkangiri are found to be poor in overall irrigation as evident from lower values of CII. Groundwater development, irrigation potential development, utilization and percentage of gross irrigated area out of gross cultivated area in those districts are poor. The ADI value of Kandhamal district is found lowest followed by Sundargarh and Deogarh. The poor irrigation scenario in Kandhamal is the main

Table 3. Districts with high and low values of different developmental indices

Sl. No.	Index	1st value	2nd value	3rd value
		High value		
1	Groundwater Development Index (GWDI)	Balasore (1.00)	Bhadrak (0.95)	Jajpur (0.72)
2	Irrigation Potential Development Index (IPDI)	Puri (1.00)	Jajpur (0.85)	Sonepur (0.77)
3	Irrigation Potential Utilization Index (IPUI)	Jharsuguda (0.97)	Deogarh (0.92)	Bargarh (0.91) Kalahandi (0.91)
4	Irrigation Coverage Index (ICI)	Jajpur (1.00)	Bhadrak (0.95)	Sonepur (0.85) Cuttack (0.85)
5	Composite Irrigation Index (CII)	Bhadrak (0.81)	Jajpur (0.76)	Balasore (0.69)
6	Agricultural Development Index (ADI)	Bargarh (0.77)	Bhadrak (0.76)	Balasore (0.72)
7	Level of Living Index (LLI)	Bargah (0.61) Sambalpur (0.61)	Cuttack (0.60)	Bhadrak (0.58)
8	Poverty Ratio Index (PRI)	Jharsuguda (1.00)	Cuttack (0.91)	Jagatsinghpur (0.90)
		Low value		
1	Groundwater Development Index (GWDI)	Malkangiri (0.00)	Koraput (0.02)	Sambalpur (0.10)
2	Irrigation Potential Development Index (IPDI)	Nawarangpur (0.01)	Jharsuguda (0.02)	Bolangir (0.03)
3	Irrigation Potential Utilization Index (IPUI)	Malkangiri (0.19)	Kendrapara (0.27)	Jajpur (0.48)
4	Irrigation Coverage Index (ICI)	Nawarangpur (0.00)	Kandhamal (0.08)	Bolangir (0.13)
5	Composite Irrigation Index (CII)	Nawarangpur (0.21)	Kandhamal (0.22)	Malkangiri (0.27)
6	Agricultural Development Index (ADI)	Kandhamal (0.19)	Sundargarh (0.31)	Deogarh (0.32)
7	Level of Living Index (LLI)	Kalahandi (0.27)	Deogarh (0.28)	Nawarangpur (0.30)
8	Poverty Ratio Index (PRI)	Nawapara (0.00)	Malkangiri (0.10)	Boudh (0.15)

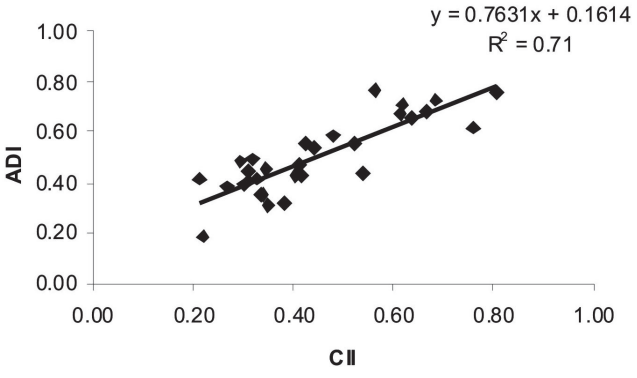
Table 4. Correlation matrix of different indicators

Indicator	GWDI	IPDI	IPUI	ICI	CII	ADI	LLI	PRI
GWDI	1.000							
IPDI	0.207	1.000						
IPUI	-0.044	-0.270	1.000					
ICI	0.399*	0.834**	0.121	1.000				
CII	0.615**	0.762**	0.206	0.947**	1.000			
ADI	0.513**	0.657**	0.116	0.827**	0.843**	1.000		
LLI	0.271	0.478**	0.043	0.641**	0.580**	0.751**	1.000	
PRI	0.238	0.065	0.011	0.191	0.200	0.400*	0.619**	1.000

Note: ** significant at 0.01 per cent level (r > 0.463) and * significant at 0.05 per cent level (r > 0.361)

reason for low agricultural performance. The level of living is worst in Kalahandi district followed by Deogarh and Nawarangpur districts which are also one of the poorest districts with respect to agricultural and irrigation development, respectively. Three most poverty stricken districts in Odisha are found to be Nawapara, Malkangiri and Boudh. It is noted that the districts are found to be common in many cases under higher and lower developmental index values, which indicate the possibility of link between developmental level of one sector with another.

Links between irrigation, agriculture, livelihood and poverty were understood through a correlation matrix (Table 4). The correlation matrix revealed that ADI was significantly related with GWDI, IPDI, ICI and CII, while LLI was significantly related with IPDI, ICI, CII, ADI and PRI. Correlation coefficient value between PRI and ADI was significant. However, the



Regression Summary between ADI and CII		
Multiple R	=	0.843**
R^2	=	0.710
F value	=	68.55**
Reg. coefficient	=	0.763
t - test	=	8.280**

Figure 1. Relationship between ADI and CII

regression analyses revealed that 71 per cent variation in ADI was explained by CII (Figure 1). It is relevant to note that IPDI, ICI and CII values were lowest in Nawarangpur district showing very poor irrigation scenario with highest percentage of agricultural labourers, marginal and small farmers families below poverty line in rural areas to total number of rural families. In contrast, Balasore and Bhadrak districts were agriculturally developed with highest groundwater development. The marginal impact of groundwater irrigation on poverty reduction was larger than that of canal irrigation, which is due to greater control in the application and widespread use of groundwater irrigation than of canal irrigation (Bhattarai and Narayanmoorthy, 2003). In recent years, investments made by the private farmers in groundwater irrigation might have had a larger impact on livelihoods for poor people than the public investments in large-scale surface water irrigation systems (Rijsberman, 2003). In this context, lower groundwater exploitation for irrigation in Odisha has a bearing on the lower impact of irrigation development on the poverty and livelihood scenario in the state.

A linkage matrix has been prepared showing frequency of districts under various combinations of links between irrigation, agriculture, livelihood and poverty (Table 5). The CII, ADI, LLI and PRI values of each district were considered to delineate the districts falling under index: high to very high (value>0.6), index: medium (value 0.4-0.6) and index: low to very low (value<0.4) with various combinations of links between the indexes. Number of districts having values of CII, ADI, LLI and PRI more than 0.6 counted under the index: high to very high within various combinations of links; similarly, the values of said indexes falling under 0.4 for fem districts those were counted under index: low to very low with various combinations of links. The districts with developmental indexes values between 0.4-0.6 for are categorized under the index: medium with various links. Thus, the values of CII and ADI were found more than 0.6 (index:

Table 5. Linkage matrix showing number of districts under various combinations of links between irrigation, agriculture, livelihood and poverty

Types of links	Districts (No.)			
	Index: High to very high	Index: Medium	Index: Low to very low	Total
Irrigation – Agriculture	8	8	7	23
Agriculture – Livelihood	1	9	4	14
Irrigation – Livelihood	1	5	7	13
Livelihood – Poverty	2	3	7	12
Irrigation – Poverty	4	0	7	11
Irrigation – Agriculture – Livelihood	1	4	5	10
Irrigation – Agriculture – Poverty	4	0	5	9
Agriculture – Poverty	4	0	5	9
Irrigation – Livelihood – Poverty	1	0	6	7
Agriculture – Livelihood – Poverty	1	0	4	5
Irrigation – Agriculture – Livelihood - Poverty	1	0	4	5

high to very high) for 8 districts, less than 0.4 (index: low to very low) for 7 districts and between 0.4 to 0.6 (index: medium) for 8 districts; therefore, overall the 'Irrigation – Agriculture' link is found in 23 districts. However, it is narrowed down to 14 and 13 districts in the case of 'Agriculture – Livelihood' and 'Irrigation – Livelihood' links, respectively. The 'Irrigation – Poverty' and 'Agriculture – Poverty' links are visible in 11 and 9 districts, respectively. The 'Irrigation – Agriculture – Livelihood – Poverty' link is seen only in 5 districts.

Conclusions

District-wise scenario of irrigation, agriculture, livelihood and poverty has been revealed with the help of different indexes developed for the study. Significant association has been found between development of irrigation and agriculture. Balasore, Bargarh, Bhadrak, Cuttack, Ganjam, Jajpur and Puri districts have shown higher irrigation and agricultural development; while Deogarh, Dhenkanal, Kandhamal, Malkangiri, Nawapara, Raygarh and Sundargarh districts have shown lower irrigation and agricultural development. Lower groundwater exploitation for irrigation in Odisha has attributed to the lower impact of irrigation development on the poverty and livelihood scenario. The links have been found more in case of poorer condition of different sectors; while betterment in one sector has not linked to betterment of other sectors in many of the districts. Thus, the study has unveiled the links and/or missing links between irrigation resources, agricultural development, poverty and level of living which would help in formulating future policies and planning for the development in districts of Odisha.

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