Links between Irrigation, Agriculture and Level of Living

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ABSTRACT

*Present study analyse irrigation, agriculture and level of living in the districts of Orissa. District wise scenario of irrigation, agriculture and living standard were revealed with the help of different indexes developed for the study, which are groundwater development index, irrigation coverage index, composite irrigation index, agricultural development index,*Level of living index and poverty ration index*. Balasore, Bargarh, Bhadrak, Cuttack, Ganjam, Jajpur and Puri districts show higher irrigation and agriculture development. While Deogarh, Dhenkanal, Kandhamal, Malkangiri, Nawapara, Raygarh and Sundargarh districts show lower irrigation and agriculture development. Groundwater development index values of 25 districts are found low to very low. Half of the districts show medium agricultural development index values; while level of living is found at medium level in majority of the districts. About 60% of rural families below poverty line comprise of agricultural labourers, marginal and small farmers. The study delineated the links and/or missing links between irrigation resources, agriculture development, poverty and level of living in the districts of Orissa, which is understood through a correlation matrix. Agricultural development index is significantly related with composite irrigation index, while level of living is significantly related with irrigation, agriculture and poverty indices. The regression analyses revealed that 71% variation in agricultural development index is explained by composite irrigation index.*

Keywords: *Ground water development; Cropped area; Irrigated area; Standard of living; Poverty;*

Irrigation resources have played a major role historically in poverty alleviation by ensuring agricultural development, expanding livelihood opportunities and employment both on and off the farm. But the growing scarcity and competition for water are putting the poor in irrigated areas at great risk (*Barker et. al., 2000*). Improving the performance of irrigation systems by enhancing land and water productivity, diversifying cropping patterns and improving water distribution across locations would help reduce poverty (*Hussain et. al., 2006*) Poverty alleviation has always been an important aim when investing in the construction of irrigation infrastructure (*Van Koppen, 2002*). An important factor to poverty alleviation was the growth in public sector funded canal irrigation and in largely private sector-funded tube well irrigation. Policy issues are crucial for promoting the overall poverty alleviation impacts of irrigation (*Saleth et. al., 2003*). It was mentioned that the impact of irrigation was relatively higher in temporal and spatial variations in rural poverty and groundwater irrigation explained variations in rural poverty even better than canal irrigation. If irrigation has the impacts on agrarian dynamism, why are such impacts not being reflected in eastern India (*Shah, 2004*)? The missing links between irrigation and agriculture sector and living scenario holds significance. Among the eastern Indian states, Orissa is still poverty stricken (about 47% population below poverty line) with narrow livelihood options inspite of plentiful water resources. In this backdrop, analyses of irrigation, agriculture, and living scenario in the districts of Orissa were carried out.

METHODOLOGY

Different indexes were constructed for assessment of district wise scenario of irrigation, agriculture, living and poverty. Groundwater Development Index (GWDI) includes gross annual draft (ha-m) out of utilisable groundwater resource (ha-m). Irrigation Coverage Index (ICI) is calculated as annual gross irrigated area out of gross cultivated area. Composite Irrigation Index (CII) is determined by averaging GWDI and ICI. Agricultural Development Index (ADI) includes eight indicators *viz.* % of cultivable land to total land area, % of net sown area to total cultivable area, % of gross irrigated area to gross cropped area, cropping intensity, % of area under HYV of major crop, yield of major crop, food grain production and per ha fertilizer consumption. Poverty Ration Index (PRI) is calculated on the basis of % rural families under below poverty line (BPL) to total number of rural families. Level of Living Index (LLI) includes 14 indicators *viz.* % of rural families above poverty line, literacy rate, per capita food grain production, yield of major crop, % of gross irrigated area to gross cropped area, % of village electrification, women work participation rate, % of agricultural laborers to total main workers,% of cultivators to total main workers, % of industrial workers to total main workers, % 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 are taken from Economic Survey (2004-05, 2005-06, 2006-07), Agricultural Statistics of Orissa (2004-05, 2005-06, 2006-07), 2001 Census, Orissa BPL Survey and other published sources. District wise values of different indices were calculated. Each index ranges from 0.0 to 1.0. The districts are 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

Groundwater development varies from 6% (Malkangiri dist.) to 47 % (Balasore dist.). Groundwater development is less than 20% in 23 districts with state average of about 18% (Table 1). The GWDI values of 25 districts are found low to very low; only Balasore, Bhadrak, Jajpur and Kendrapara districts' GWDI values are >0.6. The gross irrigated area (GIA) is ranged from 9% (Nawarangpur dist.) to 62% (Jajpur dist.) of gross cultivated area (GCA) with a state average 33%. ICI values of 15 districts are very low to low, while that of eight districts is high to very high. 30% of gross cultivated area is irrigated in 15 districts. CII value varies from 0.21(Nawarangpur dist.) to 0.81 (Bhadrak dist.).CII of 14 districts is low, while six districts fall under high category (Table 2).

District wise agricultural development is assessed on the basis of data on selected indicators. ADI values of 30 districts have ranged from 0.77 (Bargarh dist.) to 0.19 (Kandhamal dist.). Half of the districts show medium ADI values (>0.4-0.6); while six and eight districts indicate low (>0.2-0.4) and high (>0.6-0.8) agricultural development, respectively.

Table 1. Irrigation scenario in the districts of Orissa

Particular	Frequency of districts (n=30)					
	Ground water development	Irrigation potential development		Irrigation potential utilization		GIA out of GCA
		Kharif	Rabi	Kharif	Rabi	
> 80 %	—	3	—	9	23	—
> 70 to 80 %	—	3	—	4	1	—
> 60 to 70 %	—	3	1	5	4	1
> 50 to 60 %	—	2	—	10	1	5
> 40 to 50 %	2	5	3	—	—	2
> 30 to 40 %	2	7	3	1	1	7
> 20 to 30 %	3	6	6	1	1	10
> 10 to 20 %	21	1	14	—	—	4
< 10 %	2	—	3	—	—	1
State (%)	18.31	47.36	22.23	69.71	80.53	33.21

Maximum (%) 47.46 93.02 60.80 96.11 98.63 61.59
Minimum (%)6.02 19.20 8.60 22.64 25.48 9.27

Level of living of 19 and 9 districts is found as medium (with LLI value >0.4-0.6) and low (with LLI value >0.2-0.4), respectively (Table 2). Sambalpur and Bargarh are only two districts with high LLI value. About 60% of BPL rural families comprise of the agricultural labourers, marginal and small farmers families; it ranges from 25% (Ganjam) to 94% (Nawarangpur). PRI values of 10 districts are in high range showing relatively lower poverty level, while 12 districts show 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 is highest in Nawapara district having 86 % of rural families BPL; even it is lowest in Jharsuguda district with about 49% of the rural families are BPL.

Table 2. Different indexes indicating irrigation, agriculture and living situations in different districts of Orissa

S.No.	District	CII	ADI	LLI	PRI	Overall
1.	Balasore	0.69	0.72	0.49	0.33	0.56
2.	Bhadrak	0.81	0.76	0.58	0.52	0.67
3.	Bolangir	0.31	0.45	0.42	0.67	0.46
4.	Sonepur	0.64	0.66	0.57	0.35	0.56
5.	Cuttack	0.62	0.67	0.60	0.91	0.70
6.	Jajpur	0.76	0.61	0.43	0.69	0.62
7.	Jagatsingpur	0.30	0.48	0.53	0.90	0.55
8.	Kendrapara	0.48	0.58	0.53	0.70	0.57
9.	Dhenkanal	0.30	0.39	0.43	0.63	0.44
10.	Angul	0.33	0.41	0.46	0.72	0.48
11.	Ganjam	0.62	0.71	0.50	0.84	0.67
12.	Gajpati	0.32	0.50	0.40	0.66	0.47
13.	Kalahandi	0.52	0.56	0.39	0.63	0.53
14.	Nawapara	0.33	0.35	0.27	0.00	0.24
15.	Keonjhar	0.35	0.46	0.39	0.24	0.36
16.	Koraput	0.41	0.47	0.35	0.05	0.32
17.	Malkangiri	0.27	0.39	0.41	0.10	0.29
18.	Nawarangpur	0.21	0.41	0.30	0.33	0.31
19.	Rayagarh	0.34	0.35	0.30	0.37	0.34
20.	Mayurbhanj	0.42	0.43	0.43	0.22	0.38
21.	Kandhamal	0.22	0.19	0.31	0.20	0.23
22.	Boudh	0.54	0.44	0.45	0.15	0.40
23.	Puri	0.67	0.68	0.55	0.45	0.59
24.	Khurda	0.44	0.54	0.56	0.72	0.57
25.	Nayagarh	0.31	0.41	0.40	0.49	0.40
26.	Sambalpur	0.42	0.56	0.61	0.71	0.58
27.	Bargarh	0.56	0.77	0.61	0.69	0.66
28.	Deogarh	0.38	0.32	0.28	0.19	0.29
29.	Jharsuguda	0.41	0.43	0.53	1.00	0.59
30.	Sundargarh	0.35	0.31	0.41	0.56	0.41
Max. Value		0.81	0.77	0.61	1.00	0.70
Min. Value		0.21	0.19	0.27	0.00	0.23
Mean		0.44	0.50	0.45	0.50	0.47
Standard deviation		0.16	0.15	0.10	0.28	0.14

Links between irrigation, agriculture, level of living and poverty is understood through a correlation matrix (Table 3). Correlation matrix reveals that ADI is significantly related with CII, while LLI is significantly related with CII, ADI and PRI. Correlation coefficient value between PRI and ADI is significant. However, the regression analyses revealed that 71% variation in ADI is explained by CII (Fig. 1). It is relevant to note that CII value is lowest in Nawarangpur district showing very poor irrigation scenario with highest % of agril. labourers, marginal and small farmers families below poverty line (BPL) in rural areas to total number of rural families. In contrast, Balasore and Bhadrak districts are agriculturally developed with highest groundwater development. The marginal impact of groundwater irrigation on poverty reduction is larger than that of canal irrigation, which is due to greater control in the application and wide spread use of groundwater irrigation than of canal irrigation (*Bhattarai and Narayanmoorthy, 2003; Hussain et. al., 2006*). In recent years investments made by the private farmers in groundwater irrigation may 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 Orissa has bearing on the lower impact of irrigation development on the poverty and living scenario in the state.

Table 2. Correlation matrix of different indicators

	CII	ADI	LLI	PRI
CII	1.000			
ADI	0.843**	1.000		
LLI	0.580**	0.751**	1.000	
PRI	0.200	0.400*	0.619**	1.000

*** significant at 0.01 level (r > 0.463)*

** significant at 0.05 level (r > 0.361)*

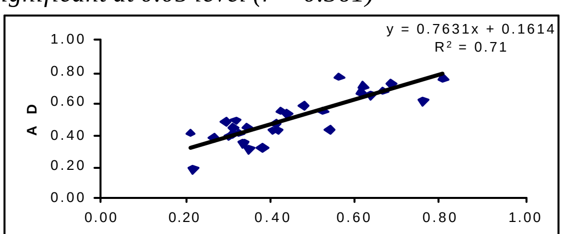

Fig. 1 Relationship between ADI and CII

In agricultural dependent settings, irrigation contributes significantly to improving livelihoods and reducing poverty (*Hussain and Hanjra, 2004*). Multi-country studies provide further evidence that there are strong linkages between irrigation and poverty alleviation, and that the anti-poverty impacts of irrigation vary widely across settings (*Saleth et. al., 2003; Sivamohan, et. al., 2004*). The results from detailed empirical studies on irrigation and poverty in seven Asian countries (*Hussain, 2004*) suggest that irrigation has strong poverty reducing potential through its direct and indirect growth promoting linkages and positive impacts at the local, regional and national levels; poverty is much more and deeper in marginal and non-irrigated areas compared to that in irrigated areas; the impacts of irrigation on poverty vary across settings and the magnitude of the anti-poverty impacts of irrigation depend on a number of factors, which include: structure of land distribution- (in) equity in land distribution- and land quality; condition of the irrigation infrastructure and its management, irrigation water management, allocation and distribution procedures and practices, irrigation and production technologies/methods, cropping patterns and crop diversification, support measures, e.g., information, input and output marketing.

It is evident from the above analyses of irrigation, agriculture, poverty and level of living of the districts of Orissa that the districts are heterogeneous with respect to resource endowment and their exploitation. Thus, it is not possible to give similar technological options treating the whole zone or a particular state as one entity. In view of it, the districts are divided into three categories viz. high potential - high productivity districts, medium potential - medium productivity and low potential - low productivity districts on the basis of overall irrigation, agriculture and living scenario (Table 2). Based on the respective characteristics of three groups of districts, the technological alternatives have been identified.

High potential - high productivity districts: This group comprises of the districts, whose irrigation, agriculture and living scenario are found to be better having pooled index values more than mean + standard deviation i.e. 0.61. The districts under this category are Bargarh, Ganjam, Cuttack, Jajpur and Bhadrak having higher irrigated area, cropping intensity, rice productivity and food grain productivity, etc. However, this might have put a strain on natural resources. Thus, any strategy for future planning should take care of sustainability issues of natural resources i.e. land and water. With this in view, few technological options are screened out for their future application on large scale to improve the overall food availability, production, cropping intensity and quality of life.

The technological options are expansion of available area under high yielding varieties and hybrids of rice and other promising crops, increasing the irrigated area through groundwater exploitation and rainwater conservation/harvesting, crop diversification from rice to high value crops, enhancing bio-fertilizer application under Integrated Nutrient Management and Integrated Pest Management for commercial crops, adoption of Integrated Farming System under favourable agro ecosystem, reclamation and management of waterlogged areas, conversion of marginal lands to horticultural and floriculture enterprises, etc. The first three technological options mentioned above will directly contribute towards enhancing the food grain production and the remaining technologies will help in increasing the production of non food crops, enhancing the net returns and sustaining the agricultural production system.

Medium potential - medium productivity districts: This group comprises of most number of districts (19 districts) whose irrigation, agriculture and living scenario are found to be at medium level having pooled index values between mean – standard deviation to mean + standard deviation i.e. 0.33 to 0.61. More than half of the districts are found in this category. In lieu of its resource base and constraints few technologies have been suggested for increasing food production sustainable natural resource management and income generation by alternate use of land resources. The technologies suggested are rainwater harvesting and management, increase in irrigated area by ground water development, substitution of traditional rice cultivars by HYV/hybrid rice cultivars, Integrated farming system, management of waterlogged areas, etc.

Low potential - low productivity districts: This group comprises of the districts, whose irrigation, agriculture and level of living are found to be at lower level having pooled index values less than mean – standard deviation i.e. 0.33. Nawarangpur, Koraput, Malkangiri, Nawarangpur, Kandhamal and Deogarh are the districts under this group having undulating topography, subsistence agriculture, with poor groundwater availability and limited irrigated area. This group of districts has substantial culturable wasteland, unculturable wasteland and pasture. The culturable wasteland can be put up under different fruit crops with suitable rainwater harvesting measures. Similarly unculturable wasteland can be brought under bio-fuel plantation viz. Jatropha and the like, which have immense potential. The rejuvenation of pasture with strong linkage with livestock will make a significant impact on income of the people. Keeping in view the resource potential and constraints, technological options identified are expansion of irrigation facilities through rainwater harvesting and flow based minor irrigation, substitution of traditional varieties by HYVs, pressurized irrigation system, rejuvenation of pastures alongwith rainwater management, conversion of culturable wastelands to horticulture along with rainwater management, conversion of unculturable wastelands to biofuel plantation, conversion of culturable wastelands to horticulture along with rainwater management, soil amendment for acidic soils reclamation, etc.

CONCLUSION

Balasore, Bargarh, Bhadrak, Cuttack, Ganjam, Jajpur and Puri districts show relatively higher irrigation and agriculture development. While Deogarh, Dhenkanal, Kandhamal, Malkangiri, Nawapara, Raygarh and Sundargarh districts show lower irrigation and agriculture development. The links are more in case of poorer condition of different sectors; while betterment in one sector has not linked to other sectors in many of the districts. Thus, the study has unveiled the links and/ or missing links between irrigation resources, agriculture development, poverty and level of living. The future productivity and livelihood options are dependent upon technological alternatives suiting to the overall potentials of the district, which can bring substantial changes without endangering the natural resource base. With this in view the technological options have been identified for each of the three categories *viz*. high potential - high productivity, medium potential - medium productivity and low potential - low productivity districts.

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