Impact of Institutions in Managing Rural Water Resources: Identifying Appropriate Institutional Framework in a Semi-Arid Region of Rajasthan

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Abstract

Water acts as an important component in sustaining rural livelihood. In a semi-arid region like Alwar district of Rajasthan water management is inevitable for rural livelihood. Effective water management depends upon appropriate institutional framework viz., tripartite and bipartite institutional framework. Community participation is indispensable for making any project successful. Tripartite institutional framework comprises community, NGO and international funding agency. On the other hand, bipartite institutional framework comprises of government and *panchayat*. The work attempts to identify an appropriate institutional framework, in enhancing rural sustainability. It further attempts to examine the impact of institution i.e., participation and income on rural sustainability. The results of t-statistics showed significant mean difference between the performance of bi-partite and tri-partite institutional framework. In order to examine institutional impact, socio-economic impact assessment approach has been used. Tobit estimates show that participation and income level are having significant and positive impact on different sustainability indexes.

Keywords: Water management, Community participation, Bipartite and tripartite institutional framework, Rural sustainability, NGO, Government, Panchayat.

Introduction

Significance of Institutions in Natural Resource Management

Institutions play a significant role in facilitating governance. New institutional economics (NIE) strongly advocate the importance of institutions in economic development. Economic development in developing countries primarily based on effective utilization and management of natural resources like forest, water and minerals. In India, various institutions promoted by rulers and kings had played an important role in the management of country's vast natural resources. From time immemorial, the state or institutions promoted by the state remained crucial in providing basic needs, particularly water, to their subjects. Thus the institutions were highly centralized and the decision for matters related to public welfare was primarily undertaken by the king/ state. Ophuls (1973, p.228, cited in Ostrom, pp. 8-9), Heilbroner (1974, cited in Ostrom, p.9) and Carruthers and Stones (1981, p.29) propositions favors state or government control over the management of natural resources. Baumol and oats (as cited in Ostrom, 1990s) favored government intervention in the form of fiscal measures and legislation for dealing with the environmental problem. Free market environmentalist assured regarding the verifiability of 'coase theorem' and therefore the environmental degradation can be worked out through negotiations between the agents provided pre-assignment of property rights.

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Ostrom (1990) has observed that neither state nor market is uniformly successful in enabling individuals to sustain long-term productive use of natural resources. Hardin (1978, p.314, as cited in Ostrom, 1990, p.9) acclaimed private enterprise system on one hand and socialism on the other as the only alternate to the common dilemma. Therefore, the present work attempted to identify the alternative form of institutions, which is best suited for managing common pool water resources. The study compares two types of institutional framework viz., bipartite and tripartite institutional framework. Former is supported by government and *panchayat* while latter constitute NGO, International Funding Agency and community. The present work is an attempt to analysis the role of institutions in water resource management. Before examining the significance of institutions in water resource management, certain issues need to be addressed.

Issues and Theoretical Framework

Agriculture is a predominant activity in rural India. Development of rural economy primarily depends on agricultural development. Water acts as an input in agricultural and allied activities therefore its management is the key to overall rural development. Further water cannot be view as an independent component of the ecosystem. Its management depends upon the management of other natural resources. Therefore, the need is to manage the entire watershed encompassing land, water and biomass. Various issues are involved in the management of water resources. Few that need specific concern and attempted to explore in the present study are: (i) How does community manage rural watersheds and how does their activity (i.e., participation) contribute to rural development, (ii) What effects/ impacts, if any, of water harvesting structures (WHS) in a water scarce region on the socio-economic life of the rural population, (iii) Does the community think that their watershed management activities have improved their livelihood. Proponents of institutional economists claim that institutions play a significant role in the developmental practices. Besides, the performance of institutions depends on good interaction, adaptability, compliance and awareness. Performance, in our study, is measured in terms of different sustainability indicators viz., ecological sustainability, economic sustainability, overall sustainability, direct impact and spillover effect indexes which is due to water harvesting structures (WHS) management. Institution works in the form of community participation. In the present work, we have examined institutional impact on rural sustainability through managing water harvesting Structure (WHS) i.e., *Johad.* Before proceeding to our analysis let us have a glimpse over earlier studies based on the impact of water harvesting structures (WHS) management through group participation on the rural livelihood.

Studies based on Impact Assessment of Water Conservation Practices on Rural Livelihood

An extensive literature has been available on impact assessment study pertaining to water harvesting practices. The study includes Tilala & Shiyani (2005) who examined the impacts of Water harvesting Structures (WHS) on the Raj Samadhiyala village of Saurashtra. The study evaluated the impacts of Water harvesting Structures (WHS) on direct beneficiaries and non-beneficiaries. Their findings show a substantial profile impact on the cropping pattern, crop yield and farmer's income. Sikarwar et al. (2005) in their study scrutinized the impact of five small check dams and 5 marginal check dams constructed by Gujarat State Land development Corporations (GSLDC) near river Ambakai between 2002 and 2004. The variables on which the impact was assessed were water table, cropping-pattern, net-revenue, farmer's socio-economic status. A drastic improvement has been found in all the aforementioned variables, which was attributable to the construction of check dams. Gandhi & Sharma (2009) had conducted research on check dam movement. They have taken saurashtra region (Gujarat) in northern India as the area of their study. They have identified a local village level institution (groups) which was engaged in jointly undertaking planning, finance and construction of a system of check dams as well as other rain-water harvesting structures both within and around the villages. Besides they have also identified that since late 90s the number of these institutions have been proliferated and are currently active in hundreds of villages in the region. Traces of a major impact of the initiatives (group participation) on water availability and agricultural incomes have been identified. Results are supporting the New Institutional economics i.e., adaptability,

compliance, good interaction and awareness among the project beneficiaries are key to water sector performance.

Material and Methods

Objectives

The study attempted to accomplish twofold objectives viz. i.) To identify significant difference between means of various pre-identified indices, namely, ecological sustainability, economic sustainability, overall sustainability, direct impact and spillover effects indexes under bipartite (comprising panchayat and government) and tripartite institutional framework (comprising NGO, funding agency and community), ii.) To find the impact of variables viz., participation, income, and socio-economic status on different sustainability indexes.

Indices and Variables

Following sustainability indexes and variables have been identified for accomplishing our study objectives:

1. Ecological sustainability index includes (i) soil fertility restoration of the cultivable land; (ii) fodder availability; (iii) fuelwood availability; (iv) perenniality of water sources and their restoration; (v) raising the water table (groundwater level) of the villages; (vi) soil moisture content in the cultivable land; (vii) soil erosion (sedimentation) due to the run-off caused by rainfall; (viii) forest/ plant cover in the villages and their vicinity; (ix) cropping patterns (particularly, growing water-intensive crops) used on the agricultural land; and (x) biodiversity in the afforested areas/ vicinity of the village, which included herbs, shrubs, plants, creepers, trees, natural groves and wild animals, such as monkeys, deer, hyenas, leopards and birds.
2. Economic sustainability index included (i) the availability of water resources for irrigation purposes (which measured the efficiency of the system to meet the villagers' water demands); (ii) the irrigated area under cultivation; (iii) crop yield (per year or per acre/ *bigha*);[1] which included bajra, maize, wheat, rice and pulses; (iv) multiple cropping (frequency per year); (v) marketing the surplus from agricultural production; (vi) household income from agricultural production, working on others' land and any other sources; (vii) profits from rearing livestock; (viii) milk production for self-consumption and surplus; (ix) asset holdings, which included agricultural equipment, land, living accommodations (number of rooms) and vehicles; (x) land asset value having changed due to the new irrigation practices; (xi) size of land-holdings (in acres); (xii) employment opportunities in the village/ locality, including agricultural and non-agricultural sources; (xiii) energy consumption in the average rural household and the types of fuel, which included fuelwood, charcoal, kerosene and electricity; (xiv) the transformation from *kaccha* (uncemented) houses to *pukka* (cemented) ones; (xv) farmers' indebtedness; (xvi) pattern of household savings and any change in their form; (xvii) occupational diversification; and (xviii) other variables, which comprised equality in the distribution of water resources among the farmers in the villages, the availability of other resources, like fuelwood, fodder, etc., and equity in the distribution of these resources among the villagers.
3. Overall sustainability index comprises of both ecological and economic sustainability indicators.
4. Direct impact index includes (i) stability of crop yield; (ii) plantation/ afforestation; (iii) volume/ coverage area; (iv) annual fisheries growth (dropped afterwards, since it was practiced in only one village); (v) growth of animal husbandry, which included the cow, buffalo, ox (dropped afterwards, since not found much), goat/ sheep, camel, poultry (hens/ others) and others to be specified (dropped afterwards, because of limited traces); (vi) soil conservation through bunding, growth of vegetation and other means (dropped afterwards, since not found, except for a loose soil check-dam with stones which was constructed on the hill slopes near Mandalavas village); (vii) standard of living (excluded in order to avoid redundancy, since it was captured by other variables); and (viii) happiness among women, which was ascertained by the time involved in water, fuelwood and fodder collection, and the availability of employment opportunities for women.
5. Spill-over index includes (i) change in health

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levels; (ii) change in expenditure on healthcare; (iii) dietary changes, due to fruits, wheat, vegetables, maize, rice, pulses and other foods; (iv) out-migration, whether seasonal or permanent, and in-migration due to agricultural laborers from other districts/ regions (dropped afterwards, since no traces were found); (v) schooling, in terms of primary school enrolment and dropout; and (vi) household expenditure, which included annual expenditure on social ceremonies and functions, the healthcare of family members, higher education of children, and alcohol consumption by family members, if any (villagers refused to answer this question, therefore it was excluded, but we found some liquor shops near Kishori village).

Methodology

Socio-economic impact assessment methodology has been adopted for accomplishing the research objectives. Respondents opinion has been quantify on four point Likert type scale. Following statistical tools has been applied for accomplishing our research objectives: i.) T-statistics, and ii.) Principal Component Analysis and iv.) Tobit analysis and Marginal Effects (Post-estimation). T-statistics has been used to identify whether there exist any significant mean differences between the scores of different indexes under bipartite and tripartite institutional frameworks. The statistics is worked out in SPSS 18 software. Principal Component Analysis (PCA) is used to assign technical weights to the components extracted based on their respective variance. The exercise also helps to avoid the problem of multi-collinearity. In PCA the scores of correlation coefficients between variables and components have been taken for working out Tobit estimates. In our study, PCA is accomplished in Lisrel 8 software.

In the linear regression model, slope coefficient can be interpreted as a unit change in the explanatory variable gives ßs (i.e., respective coefficient value) amount of change in the dependent variable. This is because the slope coefficient of the individual explanatory variable tells about the marginal effect of that particular variable, keeping other variables impact on dependent variable as constant. We have collected respondent's opinion on 4-point Likert type scale with 4 as the highest value and 1 as the lowest value. Ecological sustainability index comprises of 17 variables therefore the value cannot fall below 17 and above 68. Similarly for other indexes viz., economic sustainability, overall sustainability, direct impact and spillover affects the value lie within the range i.e., 42-168, 11-44 and 16-64. Our dataset is censored one and the ordinary least square estimates of censored regression models are biased as well as inconsistent since the conditional mean of the error term, u_i, is nonzero and the error is correlated with the regressors. Therefore, we need to work out Tobit and Marginal Effects (ME) estimates. While using PCA correlation coefficient (r) values between variables and respective components we have put lowest r value and highest r value as lower and upper limits. Eviews 5 and Stata 10 softwares have been used for Tobit and Marginal effects estimates.

Models

The models we have constructed for identifying the impact of participation and income on different sustainability indicators are:

$$Y^* = ß_1 + ß_2 \text{Participation} + ß_3 \text{Income} + u_i \quad (1)$$

$$Y^* = ß_1 + ß_2 \text{Participation} + ß_3 \text{Income} + ß_3 \text{Ecological Sustainability} + ß4 \text{Economic Sustainability} + u_i \quad (2)$$

Where $u_i \sim (0, \sigma^2)$

Variables under direct impact and spillover effects indexes changes with the impact of ecological sustainability and economic sustainability indexes. Y* is a latent variable and is not actually observable for all observations. Due to censoring we only observe Y* for those observations with values between the aforementioned ranges (i.e., 17-68, 42-168, 11-44 and 16-64).

$Yi = Y_L^*$ if $Yi^* < Y_L^*$ where Y_L^* is the lower limit of Yi^* and Yi is realized or actual sustainability

$Yi = Yu^*$ if $Y_i^* > Yu^*$ where Yu^* is the upper limit of Yi^*.

$Yi = Yi^*$ if $Yu^* \geq Y_i \geq Y_L^*$.

Some observations on the regressand are censored (because are unobserved), the Tobit model is used which is based on maximum likelihood (ML). The analyses have been accomplished in Eviews and Stata.

Coverage of the Study

Data are primary in nature and have been gathered from Rajasthan. About 76% of the State's population resides in rural areas. Only 1% of India's water resources is available to Rajasthan.

60% of Rajasthan has been categorized as an arid zone, while the remaining 40% comes under the semi-arid zone. Rathore (1993, p.1) pointed that out of 102 years only 9 years were drought free. One may be interested to know about the justification for the selection of a specific area for our study purpose. Worst drought hit these areas in 1985 and 1987. It is to be noteworthy that despite four blocks, namely, Rajgarh, Lachmangarh, Thanagazi and Basu of the Alwar district were declared by the State government of Rajasthan as the dark zone i.e., an area where the groundwater table was receded below the recoupable level, the so called dark zone has turned out to be the brightest spot in the region. This motivates us to opt Rajgarh block of Alwar district as the area of our study. It has been ascertained that through the wholehearted efforts of Tarun Bharat Sangh, an NGO, the water resources of the region has been successfully managed. The specific area comprises of the 14 villages viz., Umri-Deori, Talab, Ladiya, Nandurada, Losal, Ghewar, Murlipura, Palpur, Rajor, Mitravat , Alie, Jirawali, Karoth, under bipartite and tripartite institutional framework in the Alwar district of Rajasthan. Overall, 441 samples have been collected.

Results and Discussion

T-statistics has been worked out to identify that whether there exist significant difference among the means of ecological, economic, direct impact, spillover effects indexes between bipartite and tripartite institutional framework and are found to be highly significant.

Index/ Variables	Mean	N	Standard	Levene's Test	t-statistics	
			Error	Equality of (Variance)		
				F	Equal Variance	Unequal Variance
Ecological	41.4348(BPIF)	115	.41669	7.420***	-19.200 (439)***	-17.743***
	49.7117(TPIF)	326	.20970			
Economic	110.6609(BPIF)	115	1.06364	22.968***	-5.544(439)***	-4.667***
	116.0245(TPIF)	326	.43560			
Direct Impact	17.2087(BPIF)	115	.17092	33.059***	-52.671(439)***	-66.399***
	33.2209(TPIF)	326	.17011			
Spillover Effects	32.5478(BPIF)	115	.14096	62.381***	-40.383(439)***	-57.044***
	46.3558(TPIF)	326	.19678			

***Significant at .01 levels, BPIF: Bipartite Institutional Framework, TIF: Tripartite Institutional Framework

Table 1.Mean Comparison of Indices between Bipartite and Tripartite Institutional Framework

This suggests that there exist significant difference in water sector performance in the villages having different institutional framework. Levene's test is rejecting the null hypothesis i.e. variance of samples are homogenous, in each case and thus we have drawn conclusion based on t-statistics representing the unequal variance. The result shows that tripartite institutional framework is successful in imparting rural sustainability as compared to bipartite institutional framework, which is inefficient in its endeavor.

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Dependent Variables		Independent Variables				
		Participation	Income	Ecological	Economic	Pseudo R-squared
Ecological Sustainability	.471713	.0128562*	-0.132227	----------	----------	0.0344
(Tobit estimates and dy/dx)						
Economic Sustainability	-.462105**	.1484489*	.2899976***	----------	----------	2.7756
(Tobit estimates and dy/dx)						
Overall Sustainability	-.5685179**	.1757365**	.2539848***	----------	----------	3.6081
(Tobit estimates and dy/dx)						
Direct Impact Index	-.0583754	-.0651437	.0673358	-.0704039	.1508081	0.0454
(Tobit estimates and dy/dx)						
Spill Over Index	.1748874	.2237426*	.1359676	.1781523	-.2875602	0.2927
(Tobit estimates and dy/dx)						

*.10 level of Significance, ** .05 level of significance, .01 level of Significance

Table 2.Results of Tobit Analysis based on PCA Scores (work out in Lisrel)

Interpretation of Results (Tobit Estimates)

In practice, our point of concern is the impact of regressors on Y_i, i.e., the actual value observed in the sample but our slope coefficients of explanatory variables give the marginal impact of the regressors on the mean value of Y_i^* i.e., the latent variable.

In such situation, we cannot interpret the ßs coefficient likewise ordinary least square (OLS) estimates. Therefore, we need to work out marginal effects or go for post estimation test. In our case, both Tobit estimates and MEs (Marginal Effects) are similar.

The Tobit and Marginal Effects estimates show positive and significant effects for participation and income and expect the index/ variables to increase the probability that overall sustainability has increased.

Besides Participation is playing important role in affecting spillover effect index in a significant manner. Likewise, income is also playing important role in affecting economic sustainability index in a significant manner.

Conclusion

It has been concluded that there exist a significant difference between tripartite and bipartite institutional framework in creating an impact on different sustainability indexes. Community Participation, an important feature of tripartite institutional framework, is found to be significant and having a positive impact on ecological, and economic and overall sustainability indicators. Besides income, level is also creating a significant impact on economic and overall sustainability indexes in a positive direction. This implies that agricultural production in the concerned villages, where tripartite institutional framework exists, has been increased despite of erratic rainfall. Soil has developed the water retention capability. The problem pertaining to food and fodder availability had been solved to a greater extent.

Migration has been stopped and there exist an increment in the villager's animal wealth. Overall standard of living of the community had been increased drastically. Water in wells was

negligible before the existence of tripartite institutional framework's project of water management through water harvesting structures but afterwards it has increased and the now water is available only at 16-17.5 meters. There is an overall development of the tribal community residing nearby, despite of the fact that most of the governmental community based watershed program is a failure due to its top down approach and its bureaucratic nature. The villages of Alie, Jirawali, karoth and moonpur where panchayati raj institution has been set up for the management of water resources community participation was absent and failed in enhancing rural sustainability through ground water recharge. In nutshell, the work of tripartite institutional framework is highly appreciable in terms of not only imparting rural sustainability but also mobilizing community through their participation.

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