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Externality Effects of Common Property Resource Degradation

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Natural resources comprising land, water, forests and fisheries constitute the basic support systems of life on earth. Quite a significant proportion of the total endowment of these resources is used in common by people and is known as Common Property Resources (CPRs), which include tanks, lakes, rivers, ponds, wells, pasture lands, village forests, etc. They directly provide means of livelihood to hundreds of millions of people, particularly the rural poor, and directly and indirectly contribute to agricultural growth and economic development, and also the quality of environment.

Importance and Present Status of CPRs in India

Since the historical past, the CPRs have significantly contributed to the living conditions of the village dwellers. According to Kadekodi and Perwaiz (1998), the area under CPRs in Tamil Nadu in 1990-91 was 2.40 million hectares. They opined that across the states in India, there has been a decrease in CPR quality. They also found that the Common Property Land Resources (CPLRs) in Tamil Nadu in 1990-91 was 2.19 million hectares (3.21 per cent of the total area of India), of which 2.11 million hectares were non-forest CPLRs. The per capita CPLR was very low in Tamil Nadu and it was only 0.042 hectare against the national average of 0.178 hectare. Jodha (1986) had documented that about 84 to 100 per cent of the poor families collected fuel, fodder and fibre from the CPRs and their per capita household income varied between Rs. 530 and Rs. 830 in different pockets. Iyengar (1989) reported that in Gujarat State, the dependence on common property land resources (CPLRs) varied between 2.50 and 15 per cent and the dependents were found to be mostly landless and agricultural labourers. Nadkarni *et al.* (1989) found that the per capita household income received from forest in a year was Rs. 1,058 among agricultural labourers, Rs. 2,853 among poor farmers, Rs. 3,799 among middle class farmers and Rs. 6,537 among the richer classes in Karnataka. There is almost unanimity among the villagers, researchers and policy makers that the status of CPRs has deteriorated

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considerably during the last 30 years. Jodha (1986) reported a decline of 41 to 55 per cent in the area of village commons over a period of 30 years, i.e., from 1950-52 to 1980-82, which could be due to encroachment and policy of the governments to distribute common land to the landless poor. Chopra *et al.* (1990) reported decline in area under CPLRs in the states of Gujarat, Haryana, Himachal Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Punjab and Rajasthan. It varied from 4 per cent (Maharashtra) to 33 per cent (Haryana). The CPRs have strong relationships with agricultural development. The important use of CPRs for agriculture is in terms of use of river, tank and pond water and collection of top soil from tank bed for fertilisation of crop and to improve private farm's productivity and collection of green leaf from forest for fodder and manurial purposes.

Objectives of the Study

It is believed that CPR degradation due to industrial pollution has made catastrophic effects on agricultural productivity. Due to inefficient management and lack of investment, the water holding devices and groundwater table have gone down beyond replenishment and agricultural income in these areas started to crumble and the villagers had been exposed to high degree of risk and uncertainty. With this background, the present study was undertaken to understand the trend in the extent of dependence of river and tank CPRs by the farm, non-farm and agricultural labour categories in terms of crop area and production, impact on livestock, dependence on grazing lands and the social implications as related to changes in the nature and status of CPRs due to industrial pollution, and to evaluate the Willingness to Pay (WTP) of the village inhabitants in the protection of river CPR and to suggest the institutional mechanisms to be adopted to protect river and tank CPRs in the study village.

Muthalipalayam village in Coimbatore district of Tamil Nadu was purposively selected since the deterioration of river CPR consequent to the discharge of dyeing factory effluents and its impact on crop land, irrigation and drinking water, crop and animal production, labour employment, farm income, etc., were significantly pronounced. Both primary and secondary sources of information were used for the study. The primary data used for the analysis pertained to the year 1999-2000. Three types of respondents, viz., (i) farm households, (ii) non-farm households and (iii) landless agricultural labour households were selected purposively at the rate of 50 respondents from each category. Besides the percentage analysis, hedonic and contingent valuation models were employed to study the influence of river CPR degradation consequent to industrial effluents on land values, and the people's WTP to protect the river and tank CPRs in order to sustain the economic and environmental benefits.

Hedonic Model

A hedonic model was chosen to study the influence of CPR degradation and its effect on the characteristics of farm land in deciding the final value of crop lands. Miranowski and Hammes (1984), Bartic (1987) and Palmquist *et al.* (1989) in their studies had demonstrated the application of hedonic techniques to value farm lands, farm land sales and land improvements respectively. The model used was of the following form.

VCLN = f { LQI, WQI, PCLCPR, CCPRACL, SCPRITIE, SCATFA }

where

VCLN	=	value of crop land (Rs./ha),
LQI	=	land quality index (scale)*,
WQI	=	water quality index (scale)*,
PCLCPR	=	proximity of crop lands to local CPRs (distance in kilometre),
CCPRACL	=	condition of CPRs adjoining to crop land (scale)*,
SCPRITIE	=	share of CPR input contribution to total crop input expenditure (per cent),
SCATFA	=	share of cropped area to total farm land area (per cent).

* Poor = 1; Average = 2; Good = 3.

Contingent Valuation Technique (CVT)

An attempt was also made to examine the economic valuation of the river and tank CPRs using CVT. The WTP was used to assess the value of changes in the quantity and quality of CPRs in the study area. In order to get responses for the WTP, the following hypothetical situation was created. The households were asked to assume that some local agency manages the river and tank CPRs. It was explained to the respondents that the new system would be adequate enough to meet the needs of the inhabitants. The capital cost of the project was taken to be Rs. 5,000 for the farmers and Rs. 500 for the non-farming and agricultural labourers, while the cost on maintenance and running expenditure involved were assumed to be Rs. 1,200 for the farmers and Rs. 240 for the non-farmers and agricultural labour households. A part of the expenditure of new CPR management system was said to be met by the government. For meeting the rest of the expenses of the new systems of managements, each household's WTP towards its capital and maintenance cost in monetary terms as well as labour time was sought for. The WTP of the households towards capital and maintenance cost of the new system in money as well as imputed cost of labour time estimated in rupee terms was added after annualising the capital investment. Capital cost was annualised by taking a lifetime of 15 years for the capital investment at 12 per cent rate of interest.

WTP = {AGE, HHSIZE, HHEDN, HHINCOME, PCAL, PCSCU, IPCPR, PCPRD, PCLCPR}

where

WTP	=	willingness to pay (Rs. per household),
AGE	=	chronological age of the respondent (years),
HHSIZE	=	size of the household (number),
HHEDN	=	household head's education (scale)*,
HHINCOME	=	household income (Rs. per annum),
PCAL	=	per capita agricultural land (hectare),
PCSCU	=	per capita standard cattle units (number),
IPCPR	=	interest in protection of village CPR (scale)**,
PCPRD	=	perception of CPR degradation (scale)***,
PCLCPR	=	proximity of crop land to local CPRs (km).

* Illiterate - 0; Primary = 1; Secondary = 2; Collegiate = 3.
** Not interested = 1; Somewhat = 2; Fairly = 3; Very much = 4.
*** Very much = 1; Somewhat = 2; Not at all = 3.

The average family size of the respondents was 3.70, 3.76 and 4.13 for the farmers, non-farmers and agricultural labourers respectively during 1999-2000. Among the three categories, the average family size was found to be high for agricultural labourers. The educational status showed that 66 per cent of agricultural labourers, 44 per cent of non-farm households and 52 per cent of farm households were found to be illiterates. It was observed from the farming category that the area under cultivation since the seventies had shown drastic changes due to diversion of land from agriculture to industrial purposes and also due to the externality effect of the water let out by the dyeing industries into the river and the commonly available village tank. It was sympathetic to note that a majority of the wells had been polluted and the farmers were not in a position to use them either for drinking or agricultural purposes. The farmers started using their crop lands for grazing animals and practising only rainfed agriculture by utilising the monsoon rains during rainy seasons. During the early seventies and the eighties, farm activities were mainly dependent on river and wells for irrigation. Proliferation of industries like dyeing and bleaching since the eighties had created water scarcity and caused water pollution. The percentage of abandoned wells had increased from 8 per cent during the eighties to 62 per cent by the year 1999-2000 (Table 1). Deepening of wells had not been practised since the eighties because surface flowing of industrial effluents contaminated the well water to a great extent.

TABLE 1. DETAILS OF WELL IRRIGATION

Sr. No.	Particulars (1)	1970s (2)	1980s (3)	1990s (4)	1999-2000 (5)
1.	Number of wells	40	38	35	30
2.	Depth of wells (mts)	13.86	14.20	14.20	14.20
3.	Wells in use (per cent)	100.00	92.00	54.00	38.00
4.	Wells abandoned (per cent)	-	08.00	46.00	62.00
5.	Water quality (per cent)				
	Good	62	38	-	-
	Medium	-	50	25	12
	Poor	38	12	75	88

Due to the non-availability of grazing lands, insufficient quantities of fodder and agricultural crop residues and also due to the partial mechanisation of agriculture, the animal population had shown a declining trend since the seventies (Table 2). Erratic distribution of rainfall coupled with industrial pollution led to a decline in the area under cultivation. The increase in sheep population since the eighties was due to the utilisation of agricultural fallow lands consequent to the abandoning of agricultural activities. There was a decreasing trend in the dependence of farmers on grazing of livestock in river CPRs (from 32 per cent to 14 per cent) since the seventies but the dependence of farm households on own land grazing rose from 68 per cent to 86 per cent between the seventies and 1999-2000 due to the availability of agricultural fallow lands and non-availability of fodder in river banks and tank bunds, encroachment of common land, etc. The landless households were grazing their livestock in both community tank and *poromboke* (common) lands. It is interesting to note that about 60 per cent of the non-farmers mainly depended on common lands and 52 per cent of agricultural labour households purely depended on village community lands for cattle grazing during the year 1999-2000 (Table 3).

Area and Productivity – A Detailed Analysis

The data on area and productivity of crops during the four periods are presented in Tables 4 and 5 respectively. Table 4 indicates a decline in crop productivity of different crops like sorghum, cumbu, ragi, pulses, sugarcane, coconut, banana, etc., in spite of the advanced production technologies, mainly due to decline in soil fertility and water quality as a result of the effect of industrial effluents.

Averting and Defensive Expenditures

Because of the fact that the water and soil had been polluted by industrial effluents, it was found unsuitable for normal crop production. It has been revealed by

TABLE 2. FARM LEVEL AVAILABILITY OF LIVESTOCK

(*number*)

Sr. No.	Particulars	Farming				Non-farming				Agricultural labour			
		1970s	1980s	1990s	1990-2000	1970s	1980s	1990s	1990-2000	1970s	1980s	1990s	1990-2000
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1.	Bullock	38	39	20	12	-	-	-	-	11	-	-	-
2.	Buffalo	70	62	58	55	8	6	4	5	7	6	-	-
3.	Local cow	136	132	115	66	5	4	2	-	4	3		1
4.	Crossbred cow	26	21	15	16	3	3	2	-	4	2	2	-
5.	Sheep	190	166	234	282	62	92	140	148	150	152	154	202
6.	Goat	-	-	-	-	121	115	76	14	146	142	125	77
7.	Poultry	128	170	103	92	40	36	12	26	16	14	15	12

TABLE 3. SOURCES OF ANIMAL GRAZING

Sr. No.	Particulars	Sources	1970s		1980s		1990s		1999-2000	
			Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.	Farming	(i) Own land	34	68.00	37	74.00	40	80.00	43	86.00
		(ii) Own land + tank and river CPRs	16	32.00	13	26.00	10	20.00	7	14.00
2.	Non-farming	(i) Tank and river CPRs	42	84.00	37	74.00	34	68.00	30	60.00
		(ii) Other sources	8	16.00	13	26.00	16	32.00	20	40.00
3.	Agricultural labourers	(i) Tank and river CPRs	38	76.00	35	70.00	31	62.00	26	52.00
		(ii) Other sources	12	24.00	15	30.00	19	38.00	24	48.00

TABLE 4. DETAILS OF GROSS CROPPED AREA

(hectares)

Sr. No.	Name of the crop (1)	1970s (2)	1980s (3)	1990s (4)	1999-2000 (5)
1.	Sorghum	69.50	63.18	38.24	33.11
2.	Cumbu	6.18	2.17	0.05	0.07
3.	Ragi	4.09	1.08	0.02	0.07
4.	Pulses	2.02	13.24	9.64	8.59
5.	Pillipesra	33.39	30.34	21.27	11.34
6.	Paddy	6.07	4.05	-	-
7.	Groundnut	1.23	1.06	0.03	-
8.	Tobacco	10.22	10.0	5.99	2.02
9.	Coconut	1.05	4.05	-	-
10.	Cotton	-	-	11.73	12.34
11.	Vegetables	1.12	0.98	0.09	0.02
	Gross cropped area	134.87	130.15	87.06	67.56
	Gross irrigated area	29.96	21.44	6.18	2.11

TABLE 5. AVERAGE PRODUCTIVITY OF DIFFERENT CROPS

(kg/ha)

Sr. No.	Name of the crop (1)	1970s (2)	1980s (3)	1990s (4)	1999-2000 (5)
1.	Sorghum	1,256	1,242	1,102	1,053
2.	Cumbu	1,453	1,215	1,150	830
3.	Ragi	1,820	1,666	-	-
4.	Pulses	400	510	500	390
5.	Pillipesra	172	246	216	141
6.	Paddy	4,526	3,972	-	-
7.	Groundnut	1,125	1,062	1,050	-
8.	Tobacco	1,625	1,575	1,458	1,406
9.	Coconut (Nos.)	17,500	16,875	-	-
10.	Cotton	-	-	548	519
11.	Vegetables	7,875	8,297	8,282	7,375

the farmers that the germination of seeds in the crop fields irrigated with the polluted water was poor. The farmers are also applying averting inputs to improve the yield levels. The averting or defensive expenditures[1] for crop land included the additional input costs on the seed materials, organic fertilisers, tank silt, green manures, soil amendments like gypsum, etc. As such, the farmers had not been incurring any expenditure for the treatment of water used for irrigation purposes, while the respondents spent substantial amount on averting and defensive inputs[2] for good quality drinking water which included getting good quality water from the nearby non-polluted/less polluted areas, boiling water, purchase of water filters and other water purifying devices. Regarding protected drinking water, expenditures incurred on initial investment for infrastructure developments, viz., purchase of water purifying devices and annual maintenance cost were included, and for getting good quality water from non-polluted areas, only the labour cost was considered. The externalities caused by the changes in the quality of river CPR due to mismanagement and misuse included the common health disorders, viz., fever, jaundice, dysentery, headache, allergies and to some extent skin rashes, etc. The averting or defensive expenditures on human health included the cost of treatment viz., physician cost, cost of medicine and also the opportunity cost of time spent for taking treatment in health clinics. Reduction in animal population, poor health status, reduction in milk yield, pre-mature delivery/abortion were the external effects on animals due to the degradation of local commons (river and tank water) considered for the study. The averting and defensive expenditures on animal health included the treatment cost and loss of manpower in getting the animal treated.

The total averting expenditure for crop land, which included the expenditure on additional cost of seeds and application of soil ameliorative measures was worked out to Rs. 545 per ha and the expenditure involved in getting drinking water from non-polluted area was found to be Rs. 623 per year per household. The deterioration of soil and water qualities not only affected the crop yield but also affected the health of human beings and animals. It was estimated that the respondents had incurred an expenditure of Rs. 382.93 per family per annum towards the incidence of human health disorders and for animal health, the averting and defensive expenditure incurred was found to be Rs. 179.64 per annum and the loss in value of livestock products was worked out to be Rs. 947.62 per family per year due to reduction in animal population, poor milk yield, etc.

Willingness to Pay for Internalising Externalities

The WTP of the respondents showed that only 10 per cent of the farmers were willing to pay more than Rs. 1,000 per annum and 38 per cent between Rs. 500 and Rs. 1,000. A majority of the non-farmers (40 per cent) were willing to pay in the range of Rs. 250 to Rs. 500 and more than 40 per cent of agricultural labourers' WTP was less than Rs. 250 per annum (Table 6).

TABLE 6. WILLINGNESS TO PAY FOR INTERNALISING EXTERNALITIES

Sr. No.	Willingness to pay (Rs./annum)	Farmers		Non-farmers		Agricultural labourers	
		Number	Per cent	Number	Per cent	Number	Per cent
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	< 250	2	4.0	11	22.0	20	40.0
2.	250 - 500	14	28.0	20	40.0	9	18.0
3.	500 – 1,000	19	38.0	2	4.0	-	-
4.	> 1,000	5	10.0	-	-	-	-
5.	Not willing to pay	10	20.0	17	34.0	21	42.0

Hedonic Regression Model

The semi-logarithmic model (log-lin model) was used for the estimation of the parameters in the hedonic model. Only farm category respondents were considered for running the hedonic regression. The land quality index (LQI) was significant at 5 per cent level, while water quality index (WQI) was significant at 1 per cent level, implying the intensity of river CPR degradation. The PCLCPR was positive, showing that the crop lands adjacent to river CRP were fetching low values, which might be due to the seepage effect. The CCPRACL was also found to influence land value positively, which exhibited that the condition of the river CPR also played a major role in deciding the farm land value. The share of cropped area in total farm land area was also found to influence the farm land price significantly at 5 per cent level. The analysis also exhibited that about 83 per cent of the variation in land value was taken care of by the explanatory variables included in the model. The above findings clearly revealed the influence of CPR related qualitative attributes in deciding the farm land value. The outcome of the results supported the fact that the qualitative parameters like the river and tank water quality have influenced the land value to a great extent (Table 7).

TABLE 7. RESULTS OF THE HEDONIC MODEL

Name of variable	Partial regression coefficient	t-value
(1)	(2)	(3)
Constant	11.537	9.752**
LQI	0.349	1.928*
WQI	0.713	3.257**
PCLCPR	0.049	1.903*
CCPRACL	0.039	3.658**
SCPRITIA	0.003	0.073
SCATFA	0.039	1.076
R^2	0.826	

Note: * and ** Significant at 5 and 1 per cent level respectively.

Factors Influencing Willingness to Pay (WTP)

The factors influencing the WTP of the sample respondents were analysed using constant elasticity model for all the three categories. The estimates of the parameters presented in Table 8 showed the expected signs. The HHSIZE coefficient was significant and positive for the categories of farmers and agricultural labourers, implying that as the number of family members increased, the dependency for water, fodder, fuel also got increased which resulted in enhanced WTP. Among the three categories, the agricultural labourer's WTP was found higher. One per cent increase in HHSIZE, *ceteris paribus,* increased the WTP from the mean level by 0.11 per cent. HHEDN was another important variable considered. It was expected that a person with higher educational qualification was more concerned about the protection of river CPR. The HHEDN coefficient was significant and positive for non-farm households only. As expected, the variable HHEDN was not significant for agricultural labourers' category. As anticipated, HHINCOME was positive and significant for farm and non-farm categories. The PCAL was negative and significant only for farm categories, which indicated that as the per capita farm size increased, the WTP also increased because of pollution externality and enhanced dependence of river CPR by this category of respondents. The PCSCU was found positive and significant for agricultural labourers, indicating the greater dependence of CPRs by this category for rearing cattle and also to meet part of the fodder requirements. The IPCPR was positively significant, implying the interest shown by the farmers in conserving the river CPR, which had been one of the vital sources of input for agricultural activities.

TABLE 8. FACTORS INFLUENCING WTP - RESULTS OF CONTINGENT VALUATION MODELS

Variable	Farmers		Non-farmers		Agricultural labourers	
	Regression coefficient	t-value	Regression coefficient	t-value	Regression coefficient	t-value
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	10.472 **	2.948	9.188 *	1.946	-27.692 **	-4.297
AGE	0.060 *	1.757	0.079	1.163	0.004	0.126
HHSIZE	0.095 *	2.341	0.072	0.039	0.210 *	1.957
HHEDN	0.110	0.053	0.048 *	1.928	0.143	0.932
HHINCOME	0.137 *	1.867	0.047 *	2.372	0.095	2.541
PCAL#	-0.005 *	-1.762	-		-	
PCSCU	0.015	0.064	0.010	0.428	0.048 *	1.756
IPCPR	0.010	0.216	0.038	0.403	0.387 *	1.893
PCPRD	0.025 *	1.726	0.204 *	1.897	0.057	0.062
PCLCPR	0.071*	1.951	-0.092	-0.029	-0.039	-0.037
R^2	0.695		0.742		0.643	

Note: * and ** Significant at 5 and 1 per cent level respectively. # For farm category only.

The PCPRD variable was significant for farm and non-farm respondents. The PCLCPR was negative and significant for non-farm and agricultural labour households, indicating that as the distance increased, the WTP had declined since the people living very close to the river CPR were realising more benefit/externality than those living far away from the river CPR.

Public Failure Vs. Erosion of Local CPRs

It was unfortunate to note that the source of the externality problems associated with the management of village CPRs was not the users, but the other agencies. The traditional systems of CPR management were undertaken by the users themselves within the system framework of specified rules and regulations. Even today the villagers in the study area believed that the traditional management system was more efficient in terms of delivery of benefits. The absence of proper monitoring and control mechanisms at the grassroot level had encouraged polluting industries indirectly to let out the effluents in the above common water-bodies which had been supplying water not only for irrigation but also for household uses. The neglect of adequate and timely investment in the CPRs systems had also compounded the problem of the degradation of these resources. It could be conveniently argued that the river water pollution by the industries was the result of non-availability of specified regulatory mechanisms and community user groups to control the discharge of industrial effluents. Since the farmers, as individuals, did not have any rights to take actions against the offenders, they were simply the mute spectators, even though they knew that the local resources had been degraded continuously by these industries.

Conclusion

From the critical examination of the results, it was understood that the industrial effluents let out to river and tank CPRs increased the percentage of abandoned wells from 8 per cent during the eighties to 62 per cent by the year 1999-2000. The sheep population increased from 190 to 282 during the last 30 years, which was due to the utilisation of agricultural fallow lands. Since the seventies, there had been a decreasing trend in the dependence of grazing of livestock in river CPR from 32 per cent to 14 per cent by the farmers. The cropped area reduced by more than 60 per cent during the above period due to decline in soil fertility and water quality. The total averting expenditure worked out to Rs. 623 per ha. The WTP of the respondents showed that the majority of non-farmers (40 per cent) were WTP in the range of Rs. 250 to Rs. 500 and more than 40 per cent of agricultural labourers' WTP was less than Rs. 250 per annum.

From the foregoing analysis, it was revealed that the traditional means of management of village CPRs could not be managed in isolation from other systems of community life. At this juncture holistic village planning encompassing all CPRs is essential. Substantial amount of investment should also be made on training local people and communities who could interact with the resource users and negotiate on behalf of the villagers with the government institutions. As far as possible, a certain percentage of resources (at least one-fourth of the resources) for the initial investment for upgradation of village CPRs should be collected from the villagers to get the people involved in the system and make the project sustainable. The government institutions' involvement should be restricted to the extent of providing guidance for community participation not on community governance, i.e., the government's role should be through promotion and extension, like the counselling unit. This unit should have the responsibilities of refining and updating the technical inputs. This type of institutional arrangements will not only boost the moral responsibilities and duties of the user groups but also caution the violators about the consequences of free-riding behaviour.

NOTES

1. Averting and defensive expenditures are one, which are incurred to compensate the yield loss due to the discharge of untreated industrial effluents into the nearby CPR tanks and rivers. For instance, the additional input costs on the seed materials, organic fertilisers, tank silt, green manures, soil amendments like gypsum, etc., were considered to be the averting and defensive expenditures to keep the yield level as before.
2. Averting and defensive inputs are those inputs which are used to maintain the original yield level of the crops.

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