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Economics of Water Poverty: An Empirical Analysis in Dry Zone of Sri Lanka

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Abstract

The study attempts to estimate nexuses of water and poverty, using a surveyed data sample of 142 households in dry zone of Sri Lanka. Implicit ideas of monetary approach were followed in analyzing and discussing results. The production function estimates potential income lost in paddy cultivation due to water scarcity is SLRs. 6028.00 per acre per year. This accounts SLRs. 1,066,956.00 of income loss to the particular community. The cost of water accessibility is high and almost 1 kilometer distance is traveled for drinking water, especially in dry season. The potential income loss for a woman based on time cost of drinking water collection is SLRs. 428,556.00 for dry season. Significant incidents of malaria, diarrhoea, skin diseases and tooth discolorations are reported with seasonal water inadequacy. Policy implications on proper water management and storage, efficient water supply and distribution, and education on water and health issues would considerably decrease poverty.

Introduction

Adequate water supply is a prerequisite for human and economic development. Increasing water security improves income generation, sanitation, and food security of a community (Shah et al., 2009; Nellemann, et al., 2009). The concept of water poverty is closely linked to the question of extent that the poor have access to water resources and water services (ADB, 2003; Bird et al., 2009). The poor is the most vulnerable group related to water scarcities (ADB, 2010, 2006). Poor access to water contributes to an additional burden on women and girls in providing water for their families (Ray, 2007). Lack of access to safe sanitation affects female in their health, dignity and safety (Metwally et al., 2006). Especially, find their productivity impaired by their social roles, which often include time-consuming task of collecting and storing water (JMP, 2010; Metwally et al., 2006).

In Sri Lanka, majority of the rural population in dry zone are highly dependent on water, especially agricultural water in their livelihoods (Hussain & Giordano, 2004).

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They use water- based resources like fresh water fish, and aquatic plants and roots in meeting their general food needs (Renwick, 2001). It is not uncommon the use of irrigation water for domestic purposes in despite of farming in dry zone. Seasonal water scarcities are prominent in dry zone with the bi monsoon rainfall pattern of the country. United Nations Environmental Program [UNEP] (2008) indicates a declining trend of present per capita water availability of 2400 m^3 to 1,900 m^3 by 2025. LIFE-WRU (2005) indicates the potential spatial and temporal variations of water scarcity with increasing demand of water in dry zone. CDC (2008) indicates that most of the reported poor in dry zone are farmers. Interestingly, water availability and accessibility seem to be coincided with poverty issues in dry zone. Thus, studies on valuing water poverty nexus are essential and important.

The main objective of the study is to measure the economic value of water poverty and its impacts on prevailing economic poverty in dry zone of Sri Lanka. The article is organized into 4 sections. Section 2 covers the methods and data. Section 3 describes the empirical results and analysis. Section 4 presents the conclusion and policy implications.

Methodology

Sampling and Data Collection

Data were mainly collected from two divisional Secretariat Divisions (DSDs); Kaluwaragaswewa and Mahakumbukkadawala of Puttalam district in Dry Zone. From each DSD 3 to 4 Grama Niladari (GN) divisions were selected randomly and 70 to75 randomly selected households were interviewed with a pre-tested questionnaire. Face to face interviews were followed by trained enumerators with household heads. Secondary data were collected mainly from DSDs, Department of Census and Statistics, Department of Agriculture, Department of Irrigation, Department of Climate and Meteorology, Annual Central Bank Reports and other non-governmental organizations active in the district.

Puttalam district has a population of some 779,00 people. Almost 91 percent of the population lives in rural areas while the rest are in urban areas (CDC, 2010). Poverty is a persistent problem in Puttalam district and about 11 percent of the district population is living below the poverty line (CDC, 2011). About 31.4 percent of the district land is under agricultural activities. Paddy and coconut are the main cultivations, and paddy cultivation is significantly based on the rainfall intensity of the area. There are six major irrigation schemes in the district in supplying water for 12,990 acres for cultivation. The 22 medium irrigation schemes and 806 miner irrigation schemes are irrigating 4,105 acres and 25345 acres, respectively (CDC, 2004).

Methods

Theoretical Argument

Literature shows several approaches in measuring water poverty nexus (Gunewardena, 2004). Some of these approaches are conceptually precise and distinct, while some shows considerable overlapping of each other. Basically those approaches are classified as 'quantitative' or 'qualitative', though there are certain confusions on the meaning of these two terms. Monetary approach is one of the quantitative measurements that could be used to evaluate theoretically sound analysis of water poverty linkages. Monetary approach is a utilitarian approach where a preference ordering over goods is represented by a utility function where a consumer maximizes his utility under prevailing constraints. The poverty line in this approach is the minimum cost of poverty level of utility at prevailing prices and household characteristics. While the approach measurements solely based on goods and services consumed by the household, money measures provide some means of comparison of economic activity quantitatively which affect human wellbeing.

Empirical Models

Crop-water Consumption

The objective function of a profit maximizing firm can be written as;

(1) $\text{Max } \pi = P.Y - W_i.X_j$ Subject to $Y = Y(X_j, Z)$

Where, π, P, and W are profit, price of output and price of inputs (i), respectively. X denotes the variable inputs (j) while Z denotes the irrigated water. The first derivation with respect to irrigation water provides the value of water or the shadow price of water.

(2) $\partial\pi / \partial Z = P.MP_z$

Where MPz is the marginal product of the output with respect to irrigation water. The value can be quantified if parameters for the production and output price are available (Young, 1996).

A linear version of a production function can be estimated in valuing the irrigated water in paddy cultivation as equation 3.

(3) $Y = f(X_1, X_2, X_3, X_4, X_5, D_1)$

Where, Y is the total paddy yield (Kg/acre), X_1 is the family size, X_2 is the sex ratio(male/female), X_3 is the education level (grade), X_4 is the area of land cultivated (acre), X_5 is the total cost of for labor, machinery, pesticides and other chemicals (SLRs), X5 is the age of head of the household, and D_1 is a dummy variable for season ($D_1 = 1$ for wet season and $D_1 = 0$ dry season).

Domestic Water Consumption and Hygiene

A functional form for the time cost of domestic water supply is used in analyzing water poverty implications. The basic assumption is that water collection is done once per day and in each collection a household collects only the adequate amount of water for a day. Water only for drinking and household cooking is considered as the domestic water needy. Time cost of domestic water supply is calculated by multiplication of time spend for water collection (i.e. time walked and waited at the source) by hourly labor wage rate of the area. As some households were living close by water sources, sometimes with the seasonal changes time cost value is zero. Thus, a Tobit analysis was followed. Statistical package of STATA was used for analysis. Equation 4 indicates empirical model used for the analysis.

(4) $Y = f(X_1, X_2, X_3, D_1, D_2, D_3, D_4)$

Where Y is the total time cost of domestic water supply per month (SLRs/ Month), X_1 is the distance to water source (meter), X_2 is the monthly household income (SLRs), X_3 is the mitigation cost of water diseases in the previous year (SLRs), D_1 is the dummy for water collector which equals to one if housewife does the collection and zero otherwise. D_2 is the perception of water safety (D_2 =1 for no risk, D_2 =0 otherwise), D_3 is the dummy for Season (D3 =1 for wet season and 0 for dry season). D_4 is the dummy for type of water source (D_4=1 private well/tap, D_4 =0 otherwise).

Results and Discussion

The general characteristics of the sample indicate that average family size is 4 with a mean age of 46 years of the head of the household. Nearly 8.2 percent of households reported no schooling while 80 percent reported only up to primary level. Of the total sample, nearly 76 percent are farmers while 12 percent engaged in government or private sector. The average monthly income of a household was SLRs. 10640.00 which is below the average income of a general household of the area (Central Bank, 2005). The main sources of domestic water supply were from private/public wells. Some depends on rainwater harvesting also. Diarrhea, tooth discoloration and water related skin irritations are prominent with a cost of SLRs. 517.00 for mitigation in average per family.

Table: 1 Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
Family size	4.2384	1.1053	2	8
Age HHH (year)	46.0076	10.427	23	80
Sex ratio	1.1846	0.9042	0	6
Income (SLRs)	10640.85	5458.86	5000	37000
Time cost for water collection (SLRs)	1129.93	1179.99	0	10125
Distance to water source(meters)	357.26	359.54	0	1500
Total cost (SLRs)	6805.00	5762.92	0	30000

Table 1 indicates descriptive statistics of the variables considered in analyses of agricultural and domestic water consumption. Table 2 indicates the analysis of crop water production function for paddy cultivation. All the variables are with expected signs, and area cultivated, season, total cost of pesticides, labor, and machinery, and age of the household head are significant under 5 percent. According to the seasonal dummy for water for agriculture, with availability of water 274 kgs of more yield of paddy per acre of land could be expected. If the price of a paddy kilogram is SLRs. 22.00 it estimates that potential income lost due to water scarcity is around SLRs. 6028.00 per acre per year. The study sample reports 177 acres of arable lands for paddy cultivation. Thus, multiplying these numbers indicate a potential income loss of SLRs. 1,066,956.00 due to water scarcity. As majority of the farmers in Puttalam district are paddy farmers, this indicates the significant gains to the farming communities with adequate water for cultivation. Further, results indicate that if the area of cultivation is increased by one acre, paddy yield could be increased by 214 kgs per acre. Importantly, cultivation area can be increased with water availability, especially in dry season. According to the results nearly 50 percent of paddy lands are not cultivated in dry season.

Table: 2 Analysis for Paddy Production Function

Dependent variable: Paddy yield in Kg per acre

In variable	Coefficient	Std. Err.	P value	dy/dx (M. effect)	Std. Err.
Family size	110.1668	74.53422	0.142	74.4966	50.5952
Age HHH	-20.2146	8.52156	0.019***	-13.6695	5.7947
Sex ratio	-63.9223	85.6496	0.457	-43.2254	57.903
Edu	-48.7627	50.3798	0.335	-32.9742	34.138)
Area cultivated	405.5636	121.9424	0.001***	214.2492	83.321
Total cost	0.09221	0.0208	0.000***	0.06235	0.0139
Season	317.0815	164.5163	0.056**	274.0724	109.86
Cons	121.6462	548.6994	0.825	-	-

**** significant @ 1% level, ** significant @ 5% level,*

Log likelihood = -646.53146 , Pseudo R^2 =0.0834 , N = 142

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Table 3 indicates Tobit analysis of the time cost function for domestic water collection. All the variables are with expected signs and coefficients of water collector, distance to water source, type of water source, and season are significant. For better interpretation marginal effects were estimated. The coefficient of water collector indicates that time cost of a 'woman collector' is higher in SLRs. 503.00 than any other. Time cost of water collection is SLRs. 273.00 higher for dry season. The value for be considered as a direct cost of water unavailability. When water source is public it costs SLRs. 351.83 higher than a private source. One unit increase distance in meters to water source increases time cost by 1.06 units. Higher income seems lower time cost of domestic water supply. Presence of water diseases trends to increase cost of water collection.

Additional cost for a woman water collector means the additional burden bear by woman in domestic water supply. This loses opportunities for income generation activities and educational activities of children subsequently. If simply assume that time cost of water supply is equal to the opportunity cost of income generation of a woman, loss of income to women in the sample is SLRs.71,426.00 per month assuming one woman from each household (by multiplying marginal effect of water collector and sample size). The value would make nearly SLRs. 428,556.00 income loss to the surveyed sample for dry season.

Table: 3 Econometric Analysis for time cost of drinking water collection (Tobit Analysis)

Variable	Coefficients	Std .Err.	P>/t/	dy/dx	Std .Err.
Water Collector	638.6941	210.47	0.003***	**503.2837**	161.83
Water Safety	-173.1454	238.94	0.470	-137.1704	187.51
Distance to water source	1.245381	0.2913	0.000***	0.9956	0.23264
Season	-341.9464	204.802	0.097*	**-273.091**	163.53
Water source	-451.3892	235.365	0.057**	-351.8397	178.330
Income	-0.0074	0.0187	0.692	-0.0059	0.01496
waterdisea~s	78.0776	215.26	0.717	62.5691	172.84
Constant	616.899	330.78	0.064*	-	-
*Log likelihood = -1042.4289 ** significant @ 5% level, ** significant @ 5% level, *significant @10% level*					
Obs. summary:21 left-censored observations at cost<=0 121 uncensored observations					

Adequate water supply would certainly improve women's income earning opportunities making them micro level cash earners of their households; reducing household poverty. Secured health and sanitation with adequate water saves money while freeing time for more economic activities (Metwally et al., 2006). Increasing household income opportunities would make higher assurance of domestic water security. The study indicates prevalence of water borne diseases of malaria, diarrhoea, skin diseases, and tooth discolorations with respect to seasonal water inadequacy. Adequate accessibility of safe drinking water may reduce waterborne diseases of people.

Conclusion and Policy Implications

The study attempts to measure water poverty nexus basically on monetary approach. Results indicate significant economic losses due to crop water limitations and drinking water inaccessibility. The production function analysis indicates that potential income lost due to water scarcity; only in paddy cultivation is around SLRs. 6028.00 per acre per year. This results SLRs. 1,066,956.00 of income loss to the surveyed sample. The cost of drinking water accessibility is high especially in dry season. The potential income loss for a woman on time cost of drinking water collection is SLRs. 503.00 per month. This result SLRs. 428,556.00 of income lost for dry season. Results reveal significant incidents of malaria, diarrhoea, skin diseases and tooth discolorations related to seasonal water inadequacy. Despite direct estimated income losses indirect losses could occur with relation to water scarcity. With those loses significance of water poverty could be higher.

Estimated water values indicate that adequate water supply could reduce economic loses of farming communities. This may overcome cyclic poverty of farming communities in long term. Policies on improved knowledge on water management, water security, and health and sanitation practices would accelerate water poverty alleviation. Rainwater harvesting is such possible option of securing domestic water accessibility, especially in dry season. Adequate drinking water accessibilities would make time for additional earning activities and education of women and children which reduces women poverty subsequently.

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