ECONOMIC AND SOCIAL VALUE OF IRRIGATION WATER: IMPLICATIONS FOR SUSTAINABILITY

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ABSTRACT

The economic value of irrigation water was determined through Contingency Valuation Method and Crop-Water Production function during wet and dry season of paddy cultivation. Factors namely, area under rice and water requirement influenced the willingness to pay for water by farmers. Social values of farmers' over water were found to be high. The comparison of the economic value of water estimated using different methods strongly suggests that the present water use pattern will not lead to sustainable use in the tank command areas. Policy options for sustainable use of irrigation water and management of tanks in India were suggested.

Keywords: Economic, Value, Irrigation, Sustainability

1. INTRODUCTION

Water has unique characteristics that determine both its allocation and use as a resource in agriculture. Irrigation is a vital component of agricultural production in many developing countries. Over the years, many researchers have examined the valuation of water as an instrument for improving water allocation, reducing water consumption and management of the irrigation systems (World Bank [1], Dudu and Chumi [2]). The Fourth Principle of the 1992 Dublin Statements defines water as an economic good in order to achieve efficient and equitable use, and encourages conservation and protection of water resources. The Fourth Dublin Principle denoted a landmark shift in emphasis to the economic dimensions of water use in general, and irrigation development in particular, WMO [3].

Willingness to pay (WTP) is an economic concept, which aims to determine the amount of money a consumer is willing to pay for the supply of water. The consumers' WTP is becoming increasingly popular and is one of the standard approaches that is used by market researchers and economists to place a value on goods or services for which no market-based pricing mechanism exists (Koss and Khawaja [4], Gil et al.

[5]). Experiences show that a very high level of WTP for water is observed in developing countries (Zekri and Dinar [6], Rodriguez [7]).

Literature suggests that two approaches are being used to analyse the consumers' WTP. The direct approach, involves taking a survey through a structured questionnaire of consumers' WTP specified prices for hypothetical services, also referred as contingent valuation method (CVM). The direct approach used in CVM has been to directly ask survey respondents to state their exact maximum WTP for the particular use or non-use value of the water. The WTP is defined as the amount that must be taken away from person's income while keeping his utility constant FAO [8]. The CVM still have serious methodological and theoretical shortcomings when used to assess WTP for non-market based goods and services, such as format bias, embedding effect, ordering problem, starting bid effects, strategic bias, information bias, non-response bias, payment vehicle, free rider problem, warm glow effect (Venkatachalam [9], Chilton and Hutchinson [10]). However, CVM is still useful tool for water resource management in developing countries (Altaf et al. [11], Griffin et al. [12]). The indirect approach involves observing consumers' behaviour and modelling of behaviour based on the approximate expenditure in terms of time and money to obtain the goods or services and infer about WTP through measurement of revealed preference (Kristrom and Laitila [13], Raje et al. [14]). The revealed preferences approach derives WTP values indirectly from the actual market behaviour of individuals. In this study, both direct (CVM) and indirect (crop-water production function analysis) methods were used to determine the economic value of irrigation water considering tank irrigation system as a case in South India.

1.1 Background

The Tamil Nadu State in India is deficient in water resources. The annual available water resource per capita in Tamil Nadu is estimated at 600 M^3, which is quite small when compared to 4,000 M^3 of the national average. Hence, it becomes necessary to utilize the limited water resources efficiently in the State. Since total surface water sources in the State is estimated about 340 million M^3 and the developed surface water is 333 million M^3, it is difficult to develop new water resources for irrigation. Wells are the major source of irrigation in the State accounting for 46.4 per cent of the net irrigated area followed by canals (29.1 per cent) and tanks (23.9 per cent). Over years, the area irrigated by tanks is decreasing while the area irrigated by wells is increasing, Palanisami et al. [15]. The current State water policy stressed the importance of equitable use of scarce water resources, and in the planning and operation systems, water allocation priorities were given for drinking purposes followed by irrigation, hydropower, industrial and other uses. Hence, it is imperative that optimal and sustainable patterns of water use be established to meet the requirements of a growing population and need for basic agricultural foodstuffs.

In many parts of the world both the free distribution and under pricing of water have led to inefficient allocation of the scarce resource. Both under pricing of water and lack of cost recovery mechanisms in government managed irrigation systems have resulted a poor operation and maintenance, Bandara [16]. Actions are necessary to use the water sustainably and manage the tank irrigation systems in South India. One strategy is to reduce water demand by adopting water conservation programs and improving water use efficiency, while another strategy involves a water pricing policy. This policy has the advantage that the income could be used to finance developments like the operation and maintenance of irrigation system. The objective of this paper is to analyze the social values attached by farmers over the irrigation water, determine the economic value of irrigation water, that farmers would be willing to pay under dry and wet (season) conditions and thereby draw policy implications for sustainable management of the tank irrigation systems.

1.2 The Study Area

Tamil Nadu state covers a total area of 130,069 KM^2. Its climate is basically tropical, benefited both by Southwest and Northeast monsoons. The average number of rainy days in the State is 50 per year with an annual rainfall of 925 mm. The total population of the State is 55.60 million. Agriculture is the traditional and major industry of the State, employing about 60 per cent of its labour force and it contributes for about 25 per cent of the Net State Domestic Product. The net cultivated area of the State is 5.85 million hectares which accounts for about 45 per cent of the State's land area. The average size of operational holdings in the State is 0.93 hectares.

An irrigation tank is a small reservoir constructed across the slope of a valley to catch and store water during rainy season and use it mainly for irrigation besides rearing fishes, growing trees and domestic purposes like washing and bathing as well. The tanks have existed in India from time immemorial, and have been an important source of irrigation especially in Southern India. They account for more than one-third of the total irrigated area in South India. The tank irrigation system has a special significance to the resource poor marginal and small farmers who depend on tank for irrigation. There are more than 39,000 tanks in the State, with varying sizes and types. The tanks are classified into system tanks (which receive supplemental water from major streams or reservoirs in addition to the yield of their own catchments area) and non-system / rain fed tanks which depend on the rainfall in their own catchments area and are not connected to major streams / reservoirs. The tanks are also classified into Panchayat Union (PU) tanks and Public Works Department (PWD) tanks based upon the management authority. This study concentrates on rain fed tanks that are managed by PWD and PU authorities.

2. METHODOLOGY

The CVM method was employed in this study to measure farmers' WTP for irrigation water. For the purpose, thirty one tanks were randomly selected from the tank intensive districts of Tamil Nadu state. The command area of these tanks was divided into two zones: head and tail for the purpose of conducting survey. Totally, 62 respondents who depended on tanks as the sole source of irrigation were drawn from the selected 31 tanks for the WTP survey. Among the respondents, 54 depended on PWD and 15 on PU tanks. The purpose of a WTP survey is to elicit farmers' WTP for the tank water drawn for irrigation use. The WTP interview schedule designed for the survey consisted of both close-ended and open-ended questions. In the case of close-ended, farmers were asked whether or not they would be willing to pay a specific amount under improved levels of water supply from tanks for irrigation. In the case of open-ended questions, farmers were asked on how much they would be willing to pay at the existing water supply conditions both in the dry (when water is too scarce) and wet seasons (when water is insufficient for few farmers). Survey was conducted during 2008, which is a normal year in terms of water availability in the tanks. The monetary unit used is Indian Rupees (INR) and area in ha.

2.1 Factors Affecting Farmers' Willingness to Pay (WTP)

The objective is to identify the factors which influenced the willingness to pay behavior of farmers. The responses were discrete and therefore, a logit model was developed to examine the WTP behavior of farmers for tank irrigation water. The logit model which is based on cumulative logistic probability function has the advantage to predict the probability of farmers' WTP for the irrigation water.

The Logit model: The Logit model assumes that the random variable Zi predicts the probability of farmers' WTP. Thus,

$$Pi = \frac{e^{Zi}}{1+e^{Zi}} \tag{1}$$

Thus for the i^{th} observation,

$$Zi = \ln\left(\frac{Pi}{1-Pi}\right) = \beta_0 + \sum \beta_j X_{ji} \tag{2}$$

The probability of farmers' WTP for irrigation water is modeled as a function of various individual, household level and farm level factors. The model is represented as follows:

WTP = f (EDN, FSIZE, AGE, FLABOUR, AREA, WREHACM) (3)

where,

WTP	: Farmers' willingness to pay for irrigation water
EDN	: Education level of the head of the household (grade)
FSIZE	: Family size (numbers)
AGE	: Age of the respondent (years)

FLABOUR : Family labor force (number)
AREA : Area under rice cultivation (hectares) and
WREHACM : Water requirement (ha cm).

The dependent variable is the farmer's decision on WTP for the irrigation water. It assumes 1 if the farmers is willing to pay for irrigation water and 0, otherwise. Logit model is used to describe the farmer's decision on whether or not they agree to pay for existing supply of irrigation water as well as under improved water supply conditions. The model was estimated by LIMDEP 7.0.

In the case of close-ended questions, the probability of obtaining a 'Yes' or 'No' responses is explained through limited dependent variable analysis, Dhrymes [17].

3. FINDINGS AND DISCUSSION

This section presents the results of the study regarding the economic value of irrigation water determined by both direct and indirect methods, social value of water to draw conclusions on the sustainability of water use pattern and propose implications for sustainability of the irrigation system.

3.1 Socio-Economic Characteristics of Farmers

The socio-economic profile of the sample respondents revealed that 76.81 per cent were male and 23.19 per cent were female. A majority of the respondents (62.31 per cent) were between 41 to 60 years old followed by 36.23 per cent in 20-40 years category. Educational status of the respondents was found to be at high school level (46.37 per cent) followed by primary level (24.63 per cent). About one-fifth of them were illiterates. Three-fourth of the respondents lived in joint family system and had more than five members in their family followed by one-fourth of them adopted nuclear family system with less than five members.

Majority of the respondents (68.12 per cent) were engaged in agriculture followed by both agriculture and business (29 per cent). As regards the size of the holding, a majority of the respondents (68.12 per cent) operated less than one ha farm followed by 23.19 per cent with farms ranging between 1.1- 3.0 ha and 7.25 per cent had 3.1-4.0 ha. Almost all the farmers belonged to either middle or lower socio–economic class in their society. This group of farmers will have significant impact on the average WTP value as their WTP for water is usually expected to be low.

3.2 Farmer's Perception on Availability and Pricing Irrigation Water

Farmers' perception about irrigation water availability assumes important for their WTP. Of the total command area of 5927.07 ha, only 2691.69 ha was found to be cultivated using the tank water. Rice was cultivated on 2691.69.7 ha using tank water supply during dry season. Of the total respondents, only 79.73 per cent cultivated rice during dry season and the rest could not be cultivated due to unavailability of irrigation water from tanks. A majority of these respondents (63.77 per cent) revealed that the water received by them was insufficient to harvest a successful crop and the rest were not certain about whether water was sufficient or not. The perception of the farmers on availability of irrigation water during wet season was analyzed. Majority (60.87 per cent) of them perceived that the water in the tank would be sufficient to raise single rice crop successfully during the wet season.

The reasons attributed to the insufficient availability of water from the tank to irrigate their crop were: seasonal failure of monsoon (60.32 per cent), poor maintenance of tank and channels (53.67 per cent), inequitable water distribution (35.33 per cent), and increased number of wells leading to poor water storage and recharge of tanks (25.43 per cent). The suggestions were elicited from the respondents for possible improvement in the tank system to overcome the present situation. A majority of them suggested for regular maintenance of tanks in terms of desilting, cleaning the supply and distributory channels (50.42 per cent) followed by effective functioning of the water users association to distribute the water equitably (43.23 per cent) and eviction of encroachments (19.32 per cent).

The farmers were asked to react to the opinion about pricing the irrigation water as a way to recover the operation and maintenance cost of the tank system. Nearly half of the respondents (49.52 per cent) reacted positively stating that pricing of irrigation water might enhance the functioning of the tank system and/or enhance the water use effectively by the farmers. It is expected that the farmers' perception on water availability and pricing might have a bearing on their WTP for water.

3.3 Rice Yield, Per Unit Production Cost, And Existing O & M Costs

The average yield of rice in the study area during wet season was 4748.03 Kgs/ha and its average cost of cultivation was INR2216.51/ha. The land revenue including water cess paid by farmers according to the three land grade classification was known to be INR5.27, INR5.01 and INR6.00 per ha of the land in the tank command. For every rupee of land revenue, the water cess works out to INR 0.33.

The state average Operation and Maintenance (O&M) expenditure on tanks considering the past 10 years data (1989-1999) was about INR55 /year/ha for Panchayat Union managed tanks and INR78 per year per ha for Water Resources Organisation managed tanks. Normally the O&M expenditures were met from the local irrigation grant which is made available to the local panchayats (local governing body at village level) to maintain the tanks in a five-year repair cycle Palanisami et al. [15].

3.4 Farmers' Willingness to Pay for irrigation water

Nearly 45 per cent of the farmers were willing to pay for the irrigation water during the wet season. Among these willing farmers, two-third of the farmers was willing to pay INR160-250/ha/year and one-third at INR250-350/ha/year. While in dry season, 56.52 per cent of the farmers responded positively for the WTP. Of the willing farmers, nearly one-third (31.88 per cent) were willing to pay to an extent of INR160-240/ha/year followed by INR110-150 /ha/year by 13.0 per cent and the higher extent of INR251-350/ha/year by 11.59 per cent of the farmers.

The negative response for the WTP for irrigation water was due to the belief of the farmers that tanks do not get filled to its full capacity either due to failure of monsoon or due to poor maintenance bestowed by the management authorities over the common property resource in the past. Some also felt that tanks are common property resource for open access by farmers in the command area.

3.5 What affects farmers Willingness to Pay for Irrigation water?

The estimated results of factors affecting the farmers' WTP for irrigation water across seasons are presented in Table 1. It could be seen that the family labour force (FLABOUR), area under rice cultivation (AREA) and the water requirement (WREHACM) found to be significant factors influencing farmer's WTP in the wet season. While in dry season, the variables AREA and WREHACM are found to be significantly influencing the farmers' WTP for irrigation water. Area under rice cultivation has significant bearing on WTP by farmers. The small and marginal farmers had relatively higher WTP for water when compared to medium and large farmers. Generally this is true, as large farmers use to own wells and their dependency over tank water is relatively less when compared to small and marginal farmers who solely depended on tank water for irrigation. It is also evident that as family labour force increases the WTP decreases. The decision making is easier in the case of a small/nuclear family compared to joint family. Besides, allocation of money for irrigation water is also more feasible as the family expenditure would also be relatively less. The positive relationship between water requirement and WTP might be due to farmers' perceived fact that water requirement at critical growth stages of the rice would severely affect the yield and hence farmers willing to pay for the irrigation water irrespective of the season.

It is evident from the analysis that irrespective of seasons, the significant and most influencing factors that determine the farmers' WTP for irrigation water from tank were found to be the area under rice and water requirement. Most of the CVM studies carried out in developing countries are limited to the measurement of users WTP under improved water supply conditions for drinking water supply. As the respondents' need for drinking water is somewhat different compared to the tank irrigation water the results cannot be directly compared. However, comparison with some of the earlier studies can help to provide useful insight on the contribution of this study to a limited works in this field with special reference to tank irrigation. Studies on the WTP for improved drinking water services show a positive relationship with the respondents' attitude, education, income and distance for water source (Whittington et al. [18], Bohm et al. [19]) and negative relations with the age, sex, water quality index, distance and family size (Whittington et al. [18], Bhom et al.[19], Loomis [20]).

Table 1. Logit estimation of factors influencing farmers' WTP for irrigation water

Variable	**Estimated Coefficients**	
	Wet	**Dry**
Constant	0.6766	0.0423
	(1.514)	(0.106)
EDN	-0.0661	-0.1090
	(-0.705)	(-1.361)
FSIZE	-0.02121	0.0141
	(-0.799)	(0.557)
AGE	-0.0057	0.0031
	(-0.732)	(0.410)
FLABOUR	-0.1831***	-0.0477
	(-1.814)	(-0.537)
AREA	-0.3293***	-1.0023 ***
	(-1.898)	(-1.918)
WREHACM	0.0051**	0.0174 ***
	(2.335)	(1.929)
Number of observations	62	62
Log-likelihood function	-41.41	-43.51

NOTE: *** significance at 1 per cent level; ** significance at 5 per cent level;
Figures in parentheses indicate estimated 't' ratios

3.6 Determining the Economic Value of Irrigation Water

Following Gibbons [21] the economic value of irrigation water was determined by employing production function approach. The marginal value of water of each ha cm is the marginal physical product times the output price. A quadratic production function was estimated with Yield (Kgs/ha.) as dependent variable and volume of irrigation water used in ha.cm (WATER) as independent variable. The estimated production function is as follows:

Wet season: The estimated equation was obtained as:

$$\text{Yield} = \underset{(3.985)}{1807.93} + \underset{(5.370)}{31.97}\ \text{WATER}^{***} - \underset{(-0.491)}{0.01}\ \text{WATER}^2$$

Adjusted R Square = 0.55

Note: Figures in parentheses indicate estimated't' ratio. ***: significant at 1 % level

Marginal Value Product = Marginal Physical Product * Price of one unit of Paddy (Rs/kg)

= INR236.94

Dry season: The estimated equation was obtained as:

$$\text{Yield} = \underset{(1.134)}{1247.75} + \underset{(2.086)}{39.25}\ \text{WATER}^{**} - \underset{(-0.584)}{0.04}\ \text{WATER}^2$$

Adjusted R Square = 0.57

Note: Figures in parentheses indicate estimated't' ratio. **: significant at 5 % level

Marginal Value Product = Marginal Physical Product * Price of one unit of Paddy (Rs/kg)

= INR243.07

The estimated values of quadratic production function were used to derive the marginal value product of water across seasons. It is evident that the marginal productivity of water is worked out to INR243.07 in dry season while it is INR236.94 in wet season. It is lucid from the analysis that the marginal value productivity of water in dry season is little higher than in wet season. This may be true due to the fact that farmers face water scarcity in dry season and produce their crop with inadequate water.

3.7 Comparison of Economic Values of Water

The opportunity cost of irrigation water was calculated on the basis of ground water extraction costs, i.e., assuming that the only source of irrigation for the farmers is ground water and if the existing tank source was not available. The cost of ground water sold by the well owners in the tank command area ranged between INR30 and INR40 per hour of extraction using 5HP motor. It is also worth to note that the farmers in Tamil Nadu enjoyed free electricity for agriculture purpose. To irrigate one ha cm of land by well water it needs an average of 3 hours/irrigation. On an average 15 irrigations were needed for raising a successful rice crop in the study area. Hence, for rice cultivation involving 45 hours of irrigation with the average cost of INR35/hr works out to INR1575/Ha cm. Compared to the value of irrigation water estimated from other methods the opportunity cost of irrigation water appears to be very high.

The comparison of the economic value of water estimated using different methods strongly suggests that the present water use pattern and ultimately the rice based cropping pattern will not lead to sustainable resource use pattern in the tank command area. Although the indirect methods of valuation has resulted in a higher value compared to the mean value of WTP, it is difficult to arrive at definite conclusions as the way in which the maximum WTP is supposed to vary due to water scarcity during the dry season. However, the WTP is found to be higher than the O & M costs of the state average and almost close to the marginal value product of water. This is a positive sign to make appropriate policy decisions on cost recovery for meeting out the O & M expenditures of the tank. Hence, based on the results of this study, policy implications for achieving the sustainability of water use for irrigation from the tank system are proposed.

4. CONCLUSIONS

The results revealed that the mean WTP value of farmers for irrigation water was INR 218.50/Ha/Year. The marginal productivity of water was INR243.07 in dry season while it is INR236.94 in wet season. The state average O & M expenditure on tanks was INR55/year/ha for tanks managed by PU and INR78 per year per ha for PWD tanks. The opportunity cost of tank irrigation water was INR1575/Ha cm.

The study also indicated that farmers were willing to pay considerably more than the average O&M costs incurred by the state on tanks and were also willing to pay almost equal or slightly lesser amount than the marginal value product of water. The average value of WTP irrespective of seasons for the tank irrigation water was found to be considerably less than the opportunity cost of the irrigation water, indicating the unsustainable use of irrigation water from the tank system at present. Hence it can be concluded that charging water depends highly on farmer's WTP from the standpoint of feasible revenue collection.

Sustainability of irrigation systems is very important from both farmers' and government perspectives. Conversely, developing countries like India are facing tremendous budgetary pressure arising from the need to defray irrigation costs. Quite often, farmers do not receive adequate service owing to an insufficient O&M budget. This undoubtedly affects crop productivity and farming income. It is therefore important to decrease the budgetary burdens of government through local control and support. The evidence assembled from the Philippines suggests that there are significant financial, economic and social benefits generated from irrigation charges. If the charging system is appropriate, it will result in improved irrigation performance (Svendsen [22], Maskey, [23]).

Pricing water is important not only for generating revenues but also for promoting efficient use of water resource Takase [24]. Lusk and Parlin [25] stress that a free or very low water charge encourages overuse, reduces the incentive for farmers to cooperate or participate in irrigation originations, and may result in low system productivity and poor conservation. The charges could also bring an ownership feeling to the farmers (Uphoff, [26], Vincent [27]) which will ultimately lead to better use of available water and increased crop production. Of course, collecting irrigation fees should not create any disincentive for farmers to irrigate, which means that the cost recovery mechanism should be compatible with resource use. This can be achieved if the fees are treated as payment for service, not a tax. One way to do so is the charges can be related to the value of crop income. Experience from Taiwan suggests the need to use an institutional mechanism for promoting managerial performance of irrigation systems Moore [28].

Our results reveal that farmers are willing to pay for the irrigation water from the tanks. As the marginal value productivity of water is positive in both the dry and wet seasons, providing assured irrigation water through improved maintenance of the tanks will help farmers to achieve increased productivity. Hence the study recommends the strengthening the existing Water users' association by empowering them to fix water charges for irrigation and collect it from the farmers to meet out the O & M activities of the tanks. Later based on the performance of the empowered WUA, turning over the responsibility of managing the tank irrigation system and its maintenance, right to control the other benefits of tank namely auctioning fishing rights and trees rights completely to the WUA can be thought of by the Government in future. This policy option would promote the sustainable use and management of irrigation water in the tank command.

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REFERENCES

[1] World Bank. Reengaging in agricultural water management: challenges, opportunities, and trade-offs. Water for food team, Agriculture and Rural Development Department (ARD), Washington, DC. 2006.

[2] Dudu, H. and Chumi, S. Economics of irrigation water management: A literature survey with focus on partial and general equilibrium models. Policy Research Working Paper 4556. The World Bank, Development Research Group, Sustainable Rural and Urban Development Team, 2008.

[3] World Meteorology Organization (WMO). The Dublin Statement on Water and Sustainable Development (2007) Available on: http://www.wmo.ch/ (Retrieved on May 2008).

[4] Koss, P. and Khawaja, S.M. The value of water supply reliability in California: a contingent valuation study. Water Policy 2001, 3 (2), pp. 165–174.

[5] Gil, J.M., Gracia, A. and Sánchez, M. Market segmentation and willingness to pay for organic products in Spain. Int. Food Agribusiness Manage. Rev. 2000, 3 (2), pp. 207–226.

[6] Zekri, S., and Dinar, A. Welfare consequences of water supply alternatives in rural Tunisia Agric. Econ. 2003, 28 (1), pp. 1–12.

[7] Rodriguez, F.F. Local resolution for watershed management: the case of water and land allocation in Cotacachi, Ecuador. PhD Dissertation. School of Natural Resource, Ohio State University, Columbus, USA. 2003.

[8] Food and Agriculture Organisation (FAO). Application of the contingent valuation method in developing countries: a survey, economic and social development paper 146. Rome, Italy, p. 9, 2000.

[9] Venkatachalam, L. The contingent valuation method: a review. Environ. Impact Assess. Rev. 2004 24 (1), pp. 89–124.

[10] Chilton, S.M., Hutchinson, W.G. A qualitative examination of how respondents in a contingent valuation study rationalise their WTP responses to an increase in the quantity of the environmental good. J. Psychol. 2003 24 (1), pp. 65–75.

[11] Altaf, M.A., Whittington, D., Jamal, H. and Smith, K. Rethinking rural water supply policy in Punjab, Pakistan. Water Resour. Res. 1993 29 (7), pp. 1943–1954.

[12] Griffin, C.C., Briscoe, J., Singh, B., Ramasubban, B. and Bhatia, R. Contingent valuation and actual behavior: Predicting connection to new water systems in the state of Kerala, India. World Bank Econ. Rev. 1995 9 (3), pp. 373–395.

[13] Kristrom, B. Laitila, T. Stated Preference methods for environmental valuation: a critical look. In International Yearbook of Environmental and Resource Economics; Folmer, H., Tietenberg, T., Eds.; Edward Elgar Publisher, Cheltenham, UK. 2003.

[14] Raje, D.V., Dhobe, P.S. and Deshpande, A.W. Consumer's willingness to pay more for municipal supplied water: a case study. Ecol. Econ. 2002, Vol. 42 (3), pp. 391–400.

[15] Palanisami, K., Paramasivam, P., Karthikeyan, C. and Rajagopal, A. Sustainable management of tanks in South India. Report 99, Water Technology Centre, Tamil Nadu Agricultural University, Coimbatore, India. 1999.

[16] Bandara, K.R.N. A national water policy for Sri Lanka, Concept paper, Interim National Water Resources Authority. 2005.

[17] Dhrymes, L. Limited Dependant Variables, Handbook of Econometrics; Kneese, V. and Arrow, K.J., Eds., North-Holland Publishers, Amsterdam. 1987.

[18] Whittington, D., Briscoe, J., Mu, X., and Barron, W. Estimating the WTP for water services in developing countries: a case study of the use of contingent valuation surveys in the southern Haiti, Econ. Dev. and Cultural Change, 1990 38, pp. 293-311.

[19] Bohm, R.A., Essenburg, T.J., Fox, W.F. Sustainability of potable water services in the Philippines, Water Resour. Res., 1993 29, pp. 1955-1963.

[20] Loomis, B.J. Some Empirical Evidences on Embedding Effects in Contingent Valuation of Forest Protection, J. Environ. Management, 1993 25, pp. 45-55.

[21] Gibbions, D.C. The economic value of water, Resources for the Future, Washington, D.C. 1987.

[22] Svendsen, M. The impact of financial autonomy on irrigation system performance in the Philippines, World Dev., 1993, Vol 21(6), pp. 989-1005.

[23] Maskey, R.K. Sustaining rural development through irrigation: An agro-ecological analysis under spatial and natural resource constraints, PhD dissertation Asian Institute of Technology, Bangkok. 1994.

[24] Takase, K. ADB Experience in irrigation development and management, Irrigation Engineering and Rural Planning, 1987 11, pp. 1-7.

[25] Lusk, M.W., Parlin, B.W. Bureaucratic and Farmer Participation in Irrigation Development. In Farmer Participation and Irrigation Organization Studies in Water Policy and Management, Parlin, B.W.; Lusk, M.W. Eds.; Boulder, CO, Westview Press. 1991.

[26] Uphoff, N. Improving international irrigation management with farmer participation: Getting the process right, Studies in Water Policy and Management No. 11 Boulder, CO, Westview Press, 1986.

[27] Vincent, L. Sustainable small-scale irrigation development: Issues for farmers, governments and donors, Int. J. Water Resour. Dev., 1990 6(4), pp. 250-259.

[28] Moore, M. The fruits and fallacies of neoliberalism: The case of irrigation policy, World Dev., 1989 17(11), pp. 1733-1750.