The achievement of water management objectives based on willingness to pay for a water service fee in tidal lowlands

by Muhammad Yazid

Aquatic Ecosystem Health & Management
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/uaem20

The achievement of water management objectives based on willingness to pay for a water service fee in tidal lowlands

Muhammad Yazid [a], Mad Nasir Shamsudin [b], Khalid Abdul Rahim [c], Alias Radam [c] & Azizi Muda [d]

[a] Faculty of Agriculture, Sriwijaya University, Indralaya, South Sumatra, Indonesia

[b] Faculty of Environmental Studies, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

[c] Faculty of Economics and Management, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

[d] Universiti Pendidikan Sultan Idris, Tanjong Malim, Perak, Malaysia

Version of record first published: 18 Mar 2013.

To cite this article: Muhammad Yazid , Mad Nasir Shamsudin , Khalid Abdul Rahim , Alias Radam & Azizi Muda (2013): The achievement of water management objectives based on willingness to pay for a water service fee in tidal lowlands, Aquatic Ecosystem Health & Management, 16:1, 119-124

To link to this article: http://dx.doi.org/10.1080/14634988.2013.763574

AQUATIC ECOSYSTEM
HEALTH & MANAGEMENT

Taylor & Francis
Taylor & Francis Group

The achievement of water management objectives based on willingness to pay for a water service fee in tidal lowlands

Muhammad Yazid,[1,*] Mad Nasir Shamsudin,[2] Khalid Abdul Rahim,[3] Alias Radam,[3] and Azizi Muda[4]

[1]Faculty of Agriculture, Sriwijaya University, Indralaya, South Sumatra, Indonesia
[2]Faculty of Environmental Studies, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
[3]Faculty of Economics and Management, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
[4]Universiti Pendidikan Sultan Idris, Tanjong Malim, Perak, Malaysia
*Corresponding author: yazid_ppmal@yahoo.com

The objective of this study was to estimate willingness to pay for a water service fee (WSF) in order to assess the expected achievement of water management objectives in tidal lowlands. A survey was conducted in Telang, a tidal lowland area on the eastern coast of Sumatra, involving 500 water users randomly drawn from approximately 60,000 people living in the delta. Each respondent was interviewed to obtain information regarding socioeconomic status and the willingness to pay for WSF. The data were analyzed using multiple regresion to obtain the estimate of WSF and its affecting factors. Results indicated that the mean WSF was $11.40 US. With this WSF, only the improvement of water distribution objectives could expect to be achieved.

Willingness to pay for WSF was significantly affected by the income of water users. Therefore, efforts to increase this willingness in order to achieve cost recovery and efficient water allocation should be directed towards the increase of income of water users.

Keywords: water management, tidal lowland area

Introduction

Among various objectives of water management, the goals of improving water distribution, recovering cost, and achieving efficient water allocation are likely to be priorities in tidal lowlands. Not only do these objectives support the sustainable use of lowland resources, they also provide proper treatments for surrounding coastal areas. To achieve these objectives, a fee that covers the cost of water management is required, besides functional water structures and established water management guidelines (Schultz, 2007; Land and Water Management Tidal Lowlands [LWMTL], 2006). Since this fee is used to carry out operation and maintenance of the system, it is considered as a water service fee (WSF).

WSF has been estimated using various different cost concepts employing various different methods (Gonzalez-Alvarez et al., 2006; Bar-Shira et al., 2006; Esteban et al., 2008; Molle et al., 2008). The cost of water depends on a number of hydrological, environmental, and agricultural social and economic variables and is determined by the amount of water received, the number of structures serving an

Aquatic Ecosystem Health & Management, 16(1):119–124, 2013. ISSN: 1463-4988 print / 1539-4077 online
DOI: 10.1080/14634988.2013.763574

area, installation costs, and the presence of water rights (Tarimo et al., 1998). Cornish et al. (2004) noted that water charges may vary according to water sources, degree of water scarcity, irrigation scheme and technology, and farm types. Global Water Partnership (2000) proposed three types of costs for water charges, namely supply cost, opportunity cost, social and environmental costs.

Based on the above discussion, the basis for estimating the cost of water (WSF) in this study was established to include different components that could be factored into a calculation of the cost of water management. These cost components include operation and maintenance (OM), capital depreciation and replacement, opportunity and environmental costs. Accordingly, three types of water fees were set to include supply cost (OM costs, and capital depreciation and replacement), economic cost (supply and opportunity costs), and the full cost (economic cost taking into account environmental externalities associated with the use of water) as depicted in Figure 1.

Different costs incurred reflected different water management objectives. Water distribution improvement objective required only operation and maintenance (OM) costs. Cost recovery objective considered OM costs including capital depreciation and replacement costs, whilst efficient water distribution objective required even higher costs in order to cover opportunity and external costs as depicted in Figure 2. This study examined the achievement of water management objectives based on water users' willingness to pay for the cost of water service.

Methodology

This study was designed as a survey, conducted in the deltaic area of Telang, South Sumatra, Indonesia. Telang, a reclaimed tidal lowland area for agriculture, is located in the lower reaches of Musi River. Research sample of 500 farm water users were drawn using random sampling from some 10,000 farm water users. Data were collected through field observation, focus group discussion (FGD) and structured interview. Field observation was conducted in order to confirm the area under one tertiary block and the required construction, operation and maintenance activities within each tertiary block. All these required activities were brought in the FGD along with the management activities and economic and environmental issues to be considered in estimating the costs of water management. The estimated costs were then presented to the respondents in the personal interview sessions as estimates of water service fee in order to elicit their willingness to pay.

Willingness to pay reflected water users' current abilities to pay for operation and maintenance of an irrigation system. Therefore, it represented the expected achievement of water management objectives. Water users' actual WTP has three consequences on water management achievement:

1. If actual WTP for is less than or equals OM costs, only water distribution objective is expected to be achieved.

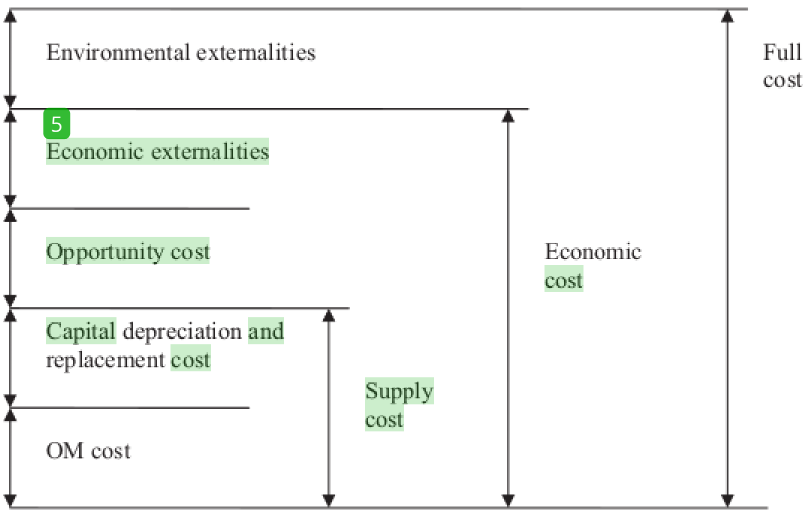

Figure 1. Three types of cost in water charging (adapted from GWP, 2000). OM is operation and maintenance.

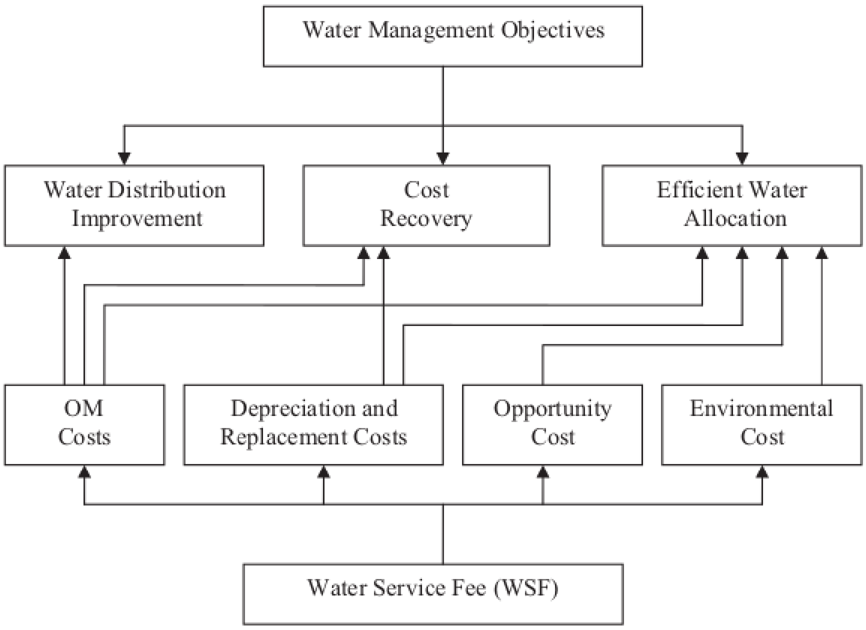

Figure 2. Framework for assessing the achievement of water management objectives.

2. If actual WTP also covers depreciation and replacement costs and WUA management cost in addition to OM costs, then the cost recovery objective is expected to be achieved.
3. If actual WTP covers all the costs, the efficient water allocation is expected to be achieved.

The WSF for which water users are willing to pay is affected by farmers' socio-demographic characteristics such as age, education, and family size (Fakayode et al., 2010; El Chami et al., 2009; Chandrasekaran et al., 2009; Amponin et al., 2006). It is also influenced by the land area owned (Chandrasekaran et al., 2009; Laoubi and Yamao, 2008), length of settlement, socio-economic index, and income (Fakayode et al., 2010; Amponin et al., 2006). The effect of these variables on the actual WSF is modeled in the following equation:

$$W_i = f(Q_i) \quad (1)$$

where Q_i represents socio-demographic characteristics

Assuming multiple regression is sufficient to predict the actual WSF, the above model is specified as the following:

$$W_i = \beta_0 + \beta_1 AGE + \beta_2 EDU + \beta_3 FAM + \beta_4 SET + \beta_5 SEI + \beta_6 ARE + \beta_7 INC + \varepsilon_i \quad (2)$$

where

W_i = actual WSF farmers were willing to pay (in $US)
AGE = age of farmer (year)
EDU = farmer's education attainment (years of schooling)
FAM = family size
SET = years of settlement in the area
SEI = index of some socio-economic factors
ARE = farmland area owned (ha)
INC = income from cultivation ($US)

The above regression equation was predicted using ordinary least square method to yield with the predicted actual WSF based on its affecting factors (Norusis, 2006). Subsequent to predicting this equation, some statistics were employed to examine the goodness-of-fit of the overall model and the significance of each of the affecting factors. In addition, interpretations on the significant factors were made in term of direction and magnitude of their effects on the actual WSF the farmers were willing to pay (Hair et al., 2008).

Results and Discussion

Willingness to pay may reflect the achievement of water management objectives (WMO). While WSF was assessed through focus group discussion (FGD)

Table 1. Costs of water management, WSF estimates and WMO achievement.

Cost Components	Cost per Unit ($US)[a]	Total Cost ($US per 256 ha)[b]	WSF ($US ha^{-1} $year^{-1}$)	Expected WMO Achievement
Operation and maintenance cost	206.25 (per 16 ha)	8,953.33	$WSF_1 = 35.00$	Water distribution improvement
Capital depreciation and replacement cost	353.33 (per 16 ha)			
Opportunity cost	3.50 (per ha)	9,849.33	$WSF_2 = 38.50$	Cost recovery
External cost	5.00 (per ha)	11,129.33	$WSF_3 = 43.50$	Efficient water allocation

[a]Unit varies according to the block wherein the cost was applied (secondary block = 256 ha; tertiary block = 16 ha; farmland = 1 ha). [b]Equal to one water management unit or area of a water users association.

with members of water users association, based on the cost of water management within a tertiary block, willingness to pay was estimated based on the results of the interview following the FGD. Three estimates of WSF were obtained from the cost of water management and achievement of water management objectives was derived from corresponding WSF estimates (Table 1).

Operation and maintenance costs included salary of gatekeeper and maintenance cost of tertiary gates and canal which consisted of grass cutting and cleaning of canal banks, sediment removal, and incidental gate repair. Depreciation and replacement costs were investment made in the installation of 2 tertiary gates and 2 culverts for each tertiary block and construction cost of the gates and culverts. Management cost was the expenditure made to carry out the organizational functions of WUA which included the salary of officials, administration cost, and expenditure for meeting and coordination. Similar cost components have been used in other studies, but calculation of costs were based more on technical and engineering approaches (LWMTL, 2006). The total cost was similar to that estimated by the LWMTL when opportunity and external costs were not considered. In addition, the area-based cost calculation (Cornish et al., 2004) was found to be the most appropriate in tidal lowlands since neither volumetric nor crop-based were technically applicable.

The sum of the first two cost components presented in Table 1 was used to estimate WSF_1. Opportunity cost was the cost of using resources in production (Thomas and Maurice, 2008). In this case, opportunity cost was the cost of using money for the payment of WSF_1 and the amount was assumed to be the annual interest rate of WSF_1. The sum of WSF_1 and the opportunity cost was the WSF_2. WSF_3 was the sum of WSF_2 and the external cost of contaminated canal water due to the operation and maintenance of water infrastructures.

Based on the WSF estimates, water distribution improvement can be achieved if actual WTP for WSF is less than $35 US per ha per yr; cost recovery can be achieved if actual WTP is from $35 up to $38.50 US per ha per yr; efficient water allocation can be achieved if actual WTP is $38.50 US

Table 2. Descriptive univariate statistic of variables affecting the actual WTP for WSF.

Variables	Mean	Standard Deviation	Minimum	Maximum
Actual WSF ($US)	11.40	10.95	0.56	55.56
Age (years)	46.78	12.23	22.00	90.00
Education (years of schooling)	6.61	2.10	0.00	14.00
Family size	3.20	1.06	1.00	8.00
Years of settlement	25.73	5.59	5.00	45.00
Socio-economic index	17.26	1.82	10.00	20.00
Land area owned (ha)	1.84	0.99	0.25	12.00
Income ($US)	1,383.33	831.11	201.11	11,666.66

Table 3. Results of regression on the actual WTP for WSF.

	Un-standardized Coefficients			
Variables	B	Standard Error	t	Sig.
(Constant)	10.77	6.23	1.729	0.084
Age (years)	−41.177	436.05	−0.094	0.925
Education (years of schooling)	−636.34	2,314.61	−0.275	0.783
Family size	2,763.15	4,326.24	0.639	0.523
Years of settlement	−321.96	833.61	−0.386	0.699
Socio-economic index	−2004.51	2410.31	−0.832	0.406
Land area owned (ha)	−13,732.52	8,732.07	−1.573	0.116
Income ($US)	0.006	0.001	4.895	0.000*

F-test = 8.116; *Sig. of F-test = 0.000.

per ha per yr or higher. Actual WTP was respondents' reported amount of WSF they were willing to pay, obtained from the interview with individual respondents which indicated current status of operation and maintenance of the system. Therefore, it was utilized in the evaluation of achievement of water management objectives.

In order to measure the achievement of water management objectives based on the amount of actual WSF respondents were willing to pay, univariate and multivariate analyses were conducted. Amount of actual WTP was directly affected by several socio-demographic variables such as age, education, family size, years of settlement, household's socio-economic progress (an index variable), land area owned, and income. Descriptive univariate statistics of these variables were presented in Table 2. The mean actual WTP for WSF was considerably lower compared to the cost of operation and maintenance. Based on the figures presented in Table 1, water management objectives that could be achieved with the mean actual WTP as presented in Table 2 ($11.40 US) was limited to the improvement of water distribution.

The result of regression analysis on the actual WTP is presented in Table 3. Out of 7 independent variables assumed to affect the actual WSF, income was the only variable that has statistically significant effect on the actual WSF. The coefficient of income indicated that every dollar increase in income would increase the actual WSF by $0.006 US. In addition, the effect of land area owned needed to be considered since its effect was close to the significant level and its coefficient was negative. Its negative coefficient implied that every ha increase in land area owned would decrease the actual WTP by $1.53 US.

Achievement of higher water management objectives is a necessity in order to support sustainable water management in tidal lowlands. Considering WSF as one of the required components in achieving this (cost recovery and efficient water allocation) rather than currently achieved objectives (water distribution improvement), the effort to increase farmers' incomes that affects their willingness to pay for WSF should be facilitated. The effort to increase farm incomes could be directed towards improvement in farming practices through optimum use of labor, chemicals, and fertilizers. Through these practices not only WSF payment could be increased, but also sustainable use of chemicals and fertilizers could be realized. In addition, accumulation of land ownership should be avoided since it would negatively affect the WSF payment. Finally, as proved by Hofwegen (2003) sufficient WSF may facilitate strengtheing the role of water users in agricultural water management, thus enhancing a cyclical process that leads to agricultural development in tidal lowlands.

Conclusions

It can be concluded from the study that:

1. Three objectives of water management were recognized in tidal lowland agriculture, namely, improvement of water distribution, cost recovery, and efficient water allocation. The achievement of these three objectives should be planned gradually with regard to

the ability of water users to pay for a water service fee (WSF) and shared responsibility in water management among policy makers, managers and water users.
2. With the value of actual WTP for WSF, the achievement of water management objective was limited to the improvement of water distribution. Neither cost recovery nor efficient water allocation could be realized with this actual WTP for WSF. In this situation, government support is expected to maintain current capacity of operation and maintenance of water infrastructures.
3. Among socio-demographic variables assumed to affect actual WTP for WSF, only income significantly affected it. Therefore, efforts towards improving farming practices that may immediately lead to increasing farm income should be directed.

References

Amponin, J.A.R., Bennagen, M.E.C., Hess, S., dela Cruz, J.D.S., 2006. Willingness to pay for watershed protection by domestic water users in Tuguegarao City, Philiphines. Poverty Reduction and Environmental Management (PREM) Working Paper: PREM07/06.

Bar-Shira, Z., Finkelshtain, I., Simhon, A., 2006. Block-rate versus uniform water pricing in agriculture: an empirical analysis. Amer. J. Agr. Econ. 88, 986–999.

Chandrasekaran, K., Devarajulu, S., Kuppannan, P., 2009. Farmers' willingness to pay for irrigation water: a case of tank irrigation systems in South India. Water 1, 5–18.

Cornish, G., Bosworth, B., Perry, C., Burke, J., 2004. Water charging in irrigated agriculture: an analysis of international experience. FAO Water Reports 28, Rome.

El Chami, D., El Moujabber, M., Scardigno, A., 2009. Regional water balance and economic assessment as tools for water management in Coastal Lebanon. Water Resource Management 23, 2361–2378.

Esteban, C., Martínez de Anguita, P., Elorrieta, J. I., Pellitero, M., Rey, C., 2008. Estimating a socially optimal water price for irrigation versus an environmentally optimal water price through the use of Geographical Information Systems and Social Accounting Matrices. Environ. Resource Econ. 39, 331–356.

Fakayode, B., Ogunlade, I., Ayinde, O, Olabode, P., 2010. Factors affecting farmers' ability to pay for irrigation facilities in Nigeria: the case of Oshin Irrigation Scheme in Kwara State. Journal of Sustainable Development in Africa 12, 334–349.

Global Water Partnerships, 2000. Integrated Water Resources Management. Background Papers No. 4. Technical Advisory Committee, GWP, Stockholm.

Gonzalez-Alvarez, Y., Keeler, A.G., Mullen, J.D., 2006. Farm-level irrigation and the marginal cost of water use: evidence from Georgia. Journal of Environmental Management 80, 311–317.

Hair, J.F., Black, W.C., Babin, B.J., and Anderson, R.E., 2008. *Multivariate Data Analysis A Global Perspective*. Pearson Education Inc., Upper Saddle River, NJ.

Land and Water Management Tidal Lowlands (LWMTL), 2006. Technical Guidelines on Tidal Lowland Development Volume II: Water Management. Report of the Joint Indonesia – Netherlands Working Group. Jakarta, Indonesia.

Laoubi, K., Yamao, M., 2008. Algerian irrigation in transition: effects on irrigation profitability in irrigation schemes: the case of the East Mitidja Scheme. World Academy of Science, Engineering and Technology 48, 293–297.

Molle, F., Venot, J.P., Hassan, Y., 2008. Irrigation in the Jordan Valley: are water pricing policies overly optimistic? Agricultural Water Management 95, 427–438.

Norusis, M.J., 2006. SPSS 15.0 Statistical Procedures Companion. Prentice Hall Inc., Upper Saddle River, NJ.

Schultz, B., 2007. Development of tidal lowlands: potentials and constraints of the tidal lowlands of Indonesia. Paper presented in the General Lecture in the School of Graduate Studies 2007 June 30. Sriwijaya University, Indonesia.

Tarimo, A.K.P.R., Mdoe, N.S., Lutatina, J.M., 1998. Irrigation water prices for farmer-managed irrigation systems in Tanzania: a case study of Lower Moshi Irrigation Scheme. Agriculture Water Management 38, 33–44.

The achievement of water management objectives based on willingness to pay for a water service fee in tidal lowlands

ORIGINALITY REPORT

14%	%	14%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Ortiz Palacios Jesus. "Síntesis y caracterización de nuevos azo-dendrones líquido-cristalinos ópticamente activos", TESIUNAM, 2013 Publication	5%
2	Kaffashi, Sara, Mad Nasir Shamsudin, Alias Radam, Khalid Abdul Rahim, and Mohd Rusli Yacob. "We are willing to pay to support wetland conservation: local users' perspective", The International Journal of Sustainable Development and World Ecology, 2013. Publication	3%
3	Sara Kaffashi, Mad Nasir Shamsudin, Alias Radam, Khalid Abdul Rahim. "Socio-economic reason to save an international wetland", Journal of Integrative Environmental Sciences, 2015 Publication	2%
4	T. R. Pritchard, R. S. Lee, P. A. Ajani, P. S. Rendell, K. Black, K. Koop. "Phytoplankton Responses to Nutrient Sources in Coastal Waters off Southeastern Australia", Aquatic	2%

Ecosystem Health & Management, 2003
Publication

5	Global Issues in Water Policy, 2015. Publication	1 %
6	Valle Hernández Brenda Liz. "Identificación y cuantificación de hidrocarburos aromáticos policíclicos y de sus nitro-derivados en partículas suspendidas emitidas por la combustión de diesel y biodiesel en el sector transporte", TESIUNAM, 2014 Publication	1 %
7	D. Budianta. "Short-term evolution of phosphorus in an ultisol", Communications in Soil Science and Plant Analysis, 11/2000 Publication	1 %

Exclude quotes On
Exclude bibliography On
Exclude matches < 1%