CONFERENCE PROCEEDING

INTERNATIONAL CONFERENCE ON SUSTAINABLE COMMUNITY DEVELOPMENT 2010 (ICOSCD 2010)

21st – 22nd July 2010
Marriot Hotel Putrajaya
Malaysia

Hosted by:
Institute for Social Science Studies
Universiti Putra Malaysia

ISBN 978-983-44616-5-2

A publication of the Institute for Social Science Studies :

Institute for Social Science Studies
Universiti Putra Malaysia
43400 UPM Serdang,
Selangor Darul Ehsan

ISBN No.:978-983-44616-5-2

CONFERENCE PROCEEDING

INTERNATIONAL CONFERENCE ON SUSTAINABLE COMMUNITY DEVELOPMENT 2010
(ICOSCD 2010)

21st – 22nd July 2010
Marriot Hotel Putrajaya
Malaysia

Hosted by
Institute for Social Science Studies
Universiti Putra Malaysia

Committee of Technical Papers & Proceedings of ICOSCD 2010 :
Jegak Uli
Bahaman Abu Samah
Jeffrey Lawrence D'Silva
Abdul Lateef Abdullah
Nurul Akhtar Kamarudin
Md Salleh Hassan
Inon Beydha Lukman
Musa Abu Hassan
Mazanah Muhamad
Jamilah Othman
Haslinda Abdullah
Arnida Ayu Che Mee

CONTENT

PARTICIPATORY COST ASSESSMENT OF AGRICULTURAL WATER SERVICE IN TIDAL LOWLANDS

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

[1]Faculty of Agriculture, Sriwijaya University
Jalan Palembang – Prabumulih KM 32 Indralaya, South Sumatra
Indonesia

[2]Faculty of Environmental Studies, Universiti Putra Malaysia
43400 UPM Serdang, Selangor D. E.
Malaysia

[3]Faculty of Economics and Management, Universiti Putra Malaysia
43400 UPM Serdang, Selangor D. E.
Malaysia

[4]Department of Geography, Universiti Pendidikan Sultan Idris
Tanjong Malim, Perak Darul Rizuan
Malaysia

Abstract

Farmers are key stakeholders in agricultural water management. Work collectively in water users association (WUA), they are responsible for conducting and financing the operation and maintenance (OM) of tidal irrigation at tertiary level to complement government responsibility at secondary and primary levels. In order to properly finance the OM, a participatory cost assessment of water service is considerably needed. The study aimed at assessing the cost of agricultural water service through a participatory approach in Telang Delta, the rice production center for tidal lowlands of South Sumatra, Indonesia. The study results in three cost estimates for agricultural water service, namely the supply cost, the economic cost, and the full cost. Three estimates for water service fee (WSF) are also derived for water users to contribute in financing the OM of tidal irrigation. The study suggests that the collection and management of WSF be handed to WUA.

***Keywords**: water service, tidal lowland, agriculture*

INTRODUCTION

Indonesia has some lowlands with an estimated total area of about 33.4 million hectares (ha). These areas are predominantly located on the islands of Sumatra, Kalimantan (Indonesia's Borneo), Sulawesi (Celebes), and Papua. Out of 33.4 million ha, about 60 percent (approximately 20.1 million ha) are tidal lowlands and the remaining 40 percent are non-tidal lowlands. Tidal lowlands are mainly located along the lower reaches down to the coastal areas of these islands. Whilst, non-tidal lowlands are located on the upper part to which river water fluctuations frequently cause inundation of these areas in the wet season.

Tidal lowland ecosystem bears many functions, from the uniqueness of landscape and the abundant of biodiversity that creates conservation functions, environmental protection functions against storm, saline intrusion, erosion and sedimentation, to the potential for resource based activities such as agriculture. Agriculture in tidal lowland in Indonesia has continuously become a choice to compensate the decrease in irrigated farm land area in Java due to conversion of irrigated land to non-agriculture activities. Conversion has taken 40,000 ha irrigated farm land per year in Java. During newly economic growth period of 2001-2003, total area of conversion has reached a tremendous number of 610,590 ha. In addition, further effort to improve the productivity of tidal lowland agriculture has become a must to compensate rice supply deficit due to prolonged drought and flooding which took turn since 1991. Either drought or flooding has caused harvesting to fail at approximately 90,000 ha per year. Rice supply deficit due to these constraints has put Indonesia as rice net-importer of about 4.5 million tons.

Expansion of farmland to tidal lowland areas has been carried out through reclamation. Reclamation of lowlands in Indonesia has reached 1.8 million ha. Out of 692,000 in Sumatra, 373,000 ha of which is located in South Sumatra Province. In spite of the quite large reclaimed area, its utilization for agriculture production is yet considered low. Until recently only about 30 percent of the area suitable for rice has reached the productivity above 5 tons per ha. In addition, only 10 percent of the area can be cultivated twice to three times a year. This diversity is due to the limited implementation of water management in tidal lowlands.

Agriculture water management in tidal lowland areas is directed towards fulfilling crop water need. It requires water structures for feeding, maintaining, and distributing water. Therefore, it also requires cost for operation and maintenance of the structures. This cost includes labor cost for gate operators for proper operation of gates and maintenance costs of canals and gates such as grass cutting, sediment removal, greasing, and rehabilitation of damaged structures.

In the past, operation and maintenance of water structures in tidal lowland areas were funded through government budget. Severe economic crises in the late nineties which cut government budget followed by the enactment of the Water Resource Law (UU No. 7/2004) require the contribution from water users, particularly farmers through so-called water service fee (WSF).

This study aims at assessing the cost of water service based on its cost components that provides estimate of WSF for agriculture activities in tidal lowlands. The scope of this study is limited to the scope of works of water users' association (WUA) which covers an area of a secondary block of 256 ha farmland.

WATER MANAGEMENT IN TIDAL LOWLAND AGRICULTURE

Water management is a key factor in tidal lowland agriculture. It has three-fold objectives of improving water distribution, recovering costs, and achieving efficient water distribution. In order to achieve these objectives, water infrastructures must be properly operated and maintained. Therefore, besides the established guidelines for operation and maintenance (OM), the availability of fund is required to enable proper OM and ensure the achievement of water management objectives.

Despite its various objectives from improving water allocation and pollution control to achieving cost recovery of water resource use (Cornish et al., 2004), water management in tidal lowland agriculture is focused in fulfilling crop water needs. In achieving this objective, besides equipped with canals and structures, proper operation and maintenance of these canals and structures are also required.

Water management in tidal lowland to fulfill crop water needs has two levels, namely macro level and micro level water management. Macro level water management refers to the operation and maintenance of primary and secondary structures (primary and secondary canals and gates), whereas micro level deals with the tertiary structures that directly connected to the farmlands. Therefore, the latter is also known as on-farm water management.

Operation and maintenance of water infrastructures require institutions at all levels. Normally, the management of macro structures is the authority of the government (either central or local), whereas the management of tertiary structures is authorized to water users and water users' associations (WUAs). With this shared authority, responsibility of carrying out operation and maintenance is also shared.

A WUA is established to carry out operation and maintenance of tertiary structures within a secondary block of about 256 ha, which is bordered by two parallelized secondary canals. This area is considered as one water management unit. Within a water management unit, there are 17 tertiary canals which constitute 17 tertiary blocks. A tertiary block consists of 16 ha farm land lying along the side of a tertiary canal. Operation and maintenance of water infrastructures (tertiary gates and canals) takes place in these tertiary blocks. Considering the average ownership of farmland is 2 ha per farmers, each WUA in tidal lowland has an average of 128 members. Accordingly, the costs of carrying out the operation and maintenance of tertiary structures are born to water users within this association.

THE COST OF WATER MANAGEMENT TIDAL LOWLAND AGRICULTURE

Studies on water management are focused in various aspects from water pricing policies, water use efficiency (Singh, 2007; Gonzalez-Alvarez et al., 2006), cost recovery (Molle et al., 2008) to the environmental and institutional aspects of water charging (Bar-Shira et al., 2006; Esteban et al., 2008). In these studies, some cost concepts are used such as fixed costs and variable costs (Gonzalez-Alvarez et al., 2006), marginal social cost of water delivery (Bar-Shira et al., 2006), "environmentally optimal price" and "socially optimal price" (Esteban et al., 2008), and water demand (Schoengold et al., 2006).

In line with the above focus, the objectives of the study on water pricing and water charging also vary from determining the optimum use of water (Gonzalez-Alvarezet al., 2006), reducing water use (Bar-Shira et al., 2006), internalization of environmental cost of water (Esteban et el., 2008), development of water market (Goetza et al., 2008), estimation of the best allocation of water (Latinopoulos, 2005), to water saving and improvement of efficiency (Molle et al., 2008).

In addition to the above, more specific assessments were directed to obtain the price elasticity of irrigation water demand (Schoengold et al., 2006) and rational pricing of irrigation water to enhance efficiency (Singh, 2007).

Referring mainly to the methods used in the works' of Gonzalez-Alvarez et al (2006), Bar-Shira et al (2006), Esteban et al (2008), and Molle et al (2008), the basis for estimating the cost of water (WSF) in this study were established to include different cost components that may be factored into a calculation of the costs of delivering water for agriculture. The proposed cost components are operation and maintenance (OM) costs, capital depreciation and replacement, opportunity costs, and environmental costs. Three types of water service fee (WSF) are estimated accordingly. WSF type 1 includes the costs associated with the supply of water (OM costs and capital depreciation and replacement). WSF type 2 includes all of the above costs plus the opportunity costs. WSF type 3 includes all of the above costs plus the environmental externalities associated with the use of water for agricultural purposes.

METHODOLOGY

In this study, a participatory approach is used. Farmers and officials of water user association (WUA) were involved actively throughout field data collection. Two main instruments were employed consecutively, namely *walkthrough* and focus group discussion (FGD). The former was used to understand current problems of agricultural water management in the study area. The later was used to obtain solutions to the problems through proposed operation and maintenance (OM) of infrastructures to achieve the objectives of agricultural water management in the area. In FGD, OM needs and financial means were discussed and consensus achieved was proposed.

RESULTS AND DISCUSSION

Based on the data from walkthrough and focus group discussion, results of this study are presented according to the cost components of water service in tidal lowland agriculture.

Operation and Maintenance Costs

Operation of gates is technically carried out by gates keepers. A gate keeper is in charge of opening and closing of two tertiary gates at each end of a tertiary canal. In WUA management a gate keeper is the head of a tertiary block. A gate keeper operates tertiary gates according to the following conditions: types of crop, crop growth stage, tide, rainfall, and farming activities (fertilizing, pesticide spraying, weeding, harvesting). Therefore, in doing so he frequently coordinates with his member farmers prior to operating the gates.

Maintenance of water infrastructures (tertiary gates and canals) consists of the following activities: (1) grass cutting and cleaning of canal banks, (2) sediment removal, (3) gates repair, (4) gates replacement. According to the need, grass cutting and cleaning of canal banks are carried out as many as 3 times per year at the beginning of each planting season. Sediment removal is done once every year. Minor damage on gates is repaired immediately, while replacement of gates is estimated once in 10 year since tertiary gates are made of fiberglass.

Up to now, most of the operation and maintenance of water infrastructures have been carried out by WUA officials and members through so-called 'gotong-royong', which means working together as social responsibility as members of WUA. Within this system, almost no financial means is involved. Financial cost when applies is shared among members. The following costs are estimated to indicate financial cost of operation and maintenance of water infrastructures within a tertiary block.

Table 1: Financial costs of operation and maintenance of water infrastructures within a tertiary block per year

Item	Frequency	Unit	Unit Cost (Rp)	Cost (Rp)
Operation:				
Salary of the gate keeper	1	year	500,000	500,000
Maintenance:				
1. Grass cutting and cleaning of canal banks	3 times/year	4 man day	50,000	600,000
2. Sediment removal	1 time/year	8 man day	50,000	400,000
3. Gates repair	Incidental	-	-	100,000
4. Gates replacement[1]	1 time/10 year	1	4,000,000	(400,000)
Total				1,600,000

Note: [1]Gates replacement is part of maintenance, but its cost is counted in the cost of capital (investment cost). Therefore, number between parentheses is not counted.

Depreciation and Replacement Costs

Capital depreciation and replacement is derived from investment costs of water infrastructures. Investment costs are amount of money spent at the first installation of tertiary gates. These costs include provision cost of 2 tertiary gates and 2 culverts for every tertiary canal and construction cost of gates and culverts. Breakdown of investment costs is presented in Table 2. Gates need to be replaced once in 10 year, whereas culverts should be replaced after 20 year installed. Following the replacement of culverts, reconstruction must be done once in 20 year.

Management Costs

Management cost of WUA is the expenditures made to carry out the organizational functions of WUA which include the salary of officials, administration cost, and spending for meeting and coordination. The breakdown of WUA management cost is presented in Table 3.

Table 2: Investment costs and annual depreciation of water infrastructures at a tertiary canal

Item	Quantity	Unit Cost (Rp)	Cost (Rp)	Age (years)	Depreciation (Rp/year)
Provision cost:					

1. Gates	2	4,000,000	8,000,000	10	800,000
2. Culverts	2	8,000,000	16,000,000	20	800,000
Total A			24,000,000		1,600,000
Construction cost (once in 20 year):					
1. Building materials	1	26,000,000	26,000,000		
2. Labor	112 man day	50,000	5,600,000		
Total B			31,600,000		1,580,000
Total A and B			55,600,000		3,180,000

Table 3: Breakdown of WUA management cost per year

Cost Components	Volume	Unit	Unit Cost (Rp)	Cost (Rp)
Salary:				
1. Head	1	man year	1,000,000	1,000,000
2. Secretary	1	man year	750,000	750,000
3. Treasurer	1	man year	750,000	750,000
4. Gate keepers[1]	16	man year	500,000	(8,000,000)
Administration cost	1	year	100,000	100,000
Meeting & coordination:				
1. Meeting of officials	12		100,000	1,200,000
2. Plenary	1		300,000	300,000
Total				4,100,000

Note: [1] Has been counted in operational cost

Opportunity Costs

In addition to the above financial costs, an economic cost of water service is also estimated using the concept of opportunity cost. Thomas and Maurice (2008) proposed that opportunity cost is the cost of using resources in production. In this case, opportunity cost is the cost of using the money for the payment of WSF estimated based on the cost of water supply which amounted Rp 315,000 per hectare per year (Rp 1,600,000/16 ha + Rp 3,180,000/16 ha + Rp 4,100,000/256 ha). Therefore, the estimated amount of opportunity cost is Rp 31,500 per year, which is the annual interest rate (assuming 10 percent) from that amount.

External Costs

External costs are costs imposed to water users for the internalization of externalities in water management at tertiary blocks. The externalities involved in the operation and maintenance of water infrastructures at tertiary blocks is the negative impacts from fertilizer and pesticide residuals discharged to the secondary canals from the farmland through the tertiary canals. As a result, water in the secondary canals which was previously utilized for drinking is no longer safe. The external cost associated with this is estimated as avoidance cost of not drinking the contaminated water. Therefore, it is the cost of consuming bottled water for at least three months, a period when canal water is undrinkable due to chemical contamination. According to the data, each household with 4 members consumes 6 liter per day. In 3 months for the total of 128 households, the amount of bottled water consumed is 69,120 liters. This amount of avoidance cost is for a secondary block similar to one water management unit.

The use of avoidance cost, however, tends to be overestimated since the price of bottled water does not only include treatment cost in order to make the water drinkable. It also includes other costs such as packaging costs, marketing costs, profit of the owners, etc. In order to approach the actual external cost of the contaminated canal water, ideally a treatment cost is used. Treatment cost is the amount of money needed to improve the quality of contaminated canal water to the level that avoids external cost. However, the pollution level of water in irrigation canal was not easy to detect as reported by Bakri et al. (2006). As a result, treatment cost can not be easily formulated. Consequently, avoidance cost as has been discussed is used as a proxy for the external cost in case of tidal lowland agriculture.

Water Service Fee Estimation in Tidal Lowland Agriculture

Water service fee is imposed to water users on area basis. In this case, WSF is a fee for every hectare farmland served by the existing water infrastructures. Therefore, WSF is the summation of all cost components that are required to carry out all of water management activities. Table 4 presents the summary of the costs of water service which includes operation and maintenance (OM) costs, capital depreciation and replacement costs, WUA management costs, opportunity cost, and external cost or avoidance cost.

As discussed earlier, OM costs are estimated for one tertiary block which covers an area of 16 ha. Similarly, capital depreciation and replacement costs are calculated with reference to a tertiary block. WUA management costs are estimated for the whole area of its service which is a secondary block of 256 ha farmland. The summation of these three costs components with reference to its respective block indicates WSF of the first type (notified as WSF_1).

The estimation of opportunity cost is based on individual farmland. As discussed earlier, opportunity cost is estimated as the interest rate of the amount of money forgone for the payment of WSF_1. Therefore, opportunity cost is applied for each ha of farmland. The summation of opportunity cost to WSF_1 indicates WSF of the second type (notified as WSF_2).

External cost is estimated based on avoidance costs not to consume unsafe water in the secondary canal due to fertilizers and pesticides contamination from the farmlands. Therefore, it is applied for 256 ha farmland served by the secondary canal. The summation of avoidance cost to WSF_2 indicates WSF of the third type (notified as WSF_3).

Table 4: Summary of costs of water service (per year) and WSF estimates (per ha per year)

Type of Cost	Cost Components	Block Area Applies		Total (Rp)	WSF (Rp/ha/year)
		Tertiary	Secondary		
Supply Cost	OM cost	1,600,000		80,580,000	WSF_1 =
	Capital depreciation and replacement cost	3,180,000		(per 256 ha)	315,000
	WUA management		4,100,000		

	cost			
Economic Cost	Opportunity cost	31,500 (per ha)	88,644,000 (per 256 ha)	WSF_2 = 346,500
Full Cost	Treatment cost of contaminated water in the canals	45,000 (per ha)	100,164,000 (per 256 ha)	WSF_3 = 391,500

CONCLUSION

Assessing the cost of water service through stakeholder participation is a simple approach in estimating the cost of water service. Thus, it is also a simple way for the estimation of water service fee.

Water service fee is simply estimated by employing five cost components in accordance to achieving three-fold water management objectives which are improvement of water distribution, cost recovery, and achievement of efficient water distribution.

Water service fee of the first type is directed towards the improvement of water distribution. Thus, its cost components only include operation and maintenance costs, capital depreciation, and management cost. Second type WSF is meant to recover costs of water management. Therefore, its cost components also cover the opportunity cost in addition to the first three cost components. Finally, WSF of the third type is considered when the efficient water distribution is the target. It, therefore, covers all cost components involved in water management.

REFERENCES

Bakri, A. Hermawan, and Syahrial. (2006). *Evaluasi Residu Pestisida di Daerah Irigasi Teknis Belitang*. Sriwijaya University, Unpublished Research Report.

Bar-Shira, Z., I Finkelshtain, A. Simhon. (2006). Block-rate Versus Uniform Water Pricing in Agriculture: An Empirical Analysis. *Amer. J. Agr. Econ.* 88(4): 986–999.

Cornish, G, B. Bosworth, C. Perry, and J. Burke. (2004). *Water Charging in Irrigated Agriculture: An Analysis of International Experience*. Food and Agriculture Organization of the United Nations, FAO Water Reports 28.

Esteban, C., P. Martínez de Anguita, J. I. Elorrieta, M. Pellitero, C. Rey. (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.

Goetza, R. U, Y. Martinez, J. Rodrigoa. (2008). Water allocation by social choice rules: The case of sequential rules. *Ecological Economics*: 304 – 314.

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

Latinopoulos, D. (2005). Derivation of irrigation water demand functions through linear and non-linear optimization models: Application to an intensively irrigated area in northern Greece. *Water Science and Technology: Water Supply* 5 (6): 75-84.

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

Schoengold, K., D. L. Sunding, G. Moreno. (2006). Price elasticity reconsidered: Panel estimation of an agricultural water demand function. *Water Resources Research* 42 (9).

Singh, K. (2007). Rational pricing of water as an instrument of improving water use efficiency in the agricultural sector: A case study in Gujarat, India. *International Journal of Water Resource Development* 23 (4): 679-690**.**

Thomas, C. R., S. C. Maurice. (2008). *Managerial Economics 9th edition*. Boston: McGraw-Hill Irwin.