Determining The Value of Water for The Aquaculture in The Red River Delta Using Different Cultivation Methods

Bui Anh Tu
Thuyloi University, buianhtu@tlu.edu.vn

Abstract
This study presents an approach and method for determining the value of water for aquaculture in the Red River Delta using two different cultivation methods. The goal of this study is to help determine the value of water supply for the aquaculture so that water providers can allocate water volume to meet water demand based on the value of water. The study uses cost method, descriptive statistical method, and cost components in water pricing for aquaculture land based on Decree 96/2018/NĐ-CP on detailed regulations on pricing of water resources products and services, and support for the use of public water resources products and services. The results of this study provide a reference basis for water providers to optimize the value of water allocation.

Keywords: water value, water resource allocation, aquaculture.

1. GENERAL INTRODUCTION

The Red River Delta has diverse natural terrain, which facilitates various forms of aquaculture such as cage fish farming on reservoirs, rivers, ponds, and integrated farming with rice cultivation. The aquaculture target species are diverse, with potential for high-value specialty aquatic products. According to the report of the Directorate of Fisheries, the potential area for aquaculture development in the Red River Delta is still large, about 328,252 hectares, 90% of which is for freshwater aquaculture. Therefore, the demand for freshwater allocation for aquaculture is significant. However, climate change has been strongly affected the water resources used for aquaculture. Developing a process for valuing water resources for aquaculture will help determine the actual value of water, create a mechanism for water users to pay for and use water efficiently, aswellas their responsibility in protecting water resources. This is one of the necessary tasks to ensure the efficient and sustainable use of water resources.

In the Red River Delta, there are two main aquaculture scenarios related to the water supply system:

Scenario 1: Aquaculture in ponds, where the water source is supplied through the irrigation system from waterworks.

Studies by Berk (1991), Calatrava (2005), Velazquez (2007), and Mezgebo (2013) have shown that converting water from agricultural production areas to tourism and aquaculture areas increases the demand for water for river and reservoir systems. Tax and water pricing policies will help make water use more efficient and increase the ability to reallocate it for other purposes such as domestic water supply and aquaculture.

2. RESEARCH METHODS

2.1. Context of aquaculture and calculation principles

Scenario 2: Aquaculture by leasing water surface at irrigation reservoirs (typical study in Tam Dao district, Vinh Phuc province).

The choice between Scenario 1 or Scenario 2 for aquaculture depends on production

households or enterprises. Each method has a different way of calculating the water value.

The following principles are used to determine the water value for aquaculture:

(i) Maintenance and operation cost of the water supply system for aquaculture in the provinces of the Red River Delta is an overall technical and economic indicator, which is the cost per hectares of aquaculture land converted to paddy, per ha of irrigation after offsetting revenue with cost.

(ii) The converted irrigation and consumption area is used as a basis for calculating the cost per ha of aquaculture land converted to paddy, per hectares of irrigation, which is the actual area that uses irrigation and consumption services in 2020.

(iii) The cost components in the water price for aquaculture land are based on Decree 96/2018/ND-CP on detailing the price of water resources, water utility services and support for the use of public utility products and services.

2.2. Valuation of water value for aquaculture in ponds and lakes

For the form of aquaculture using water supplied from irrigation through canal systems in ponds, users are required to pay similar costs as for using water for agricultural production.

The value of water in aquaculture includes (1) the value of water in aquaculture as determined by the Irrigation Company, plus (2) internal water supply costs and (3) the willingness to pay of the service users.

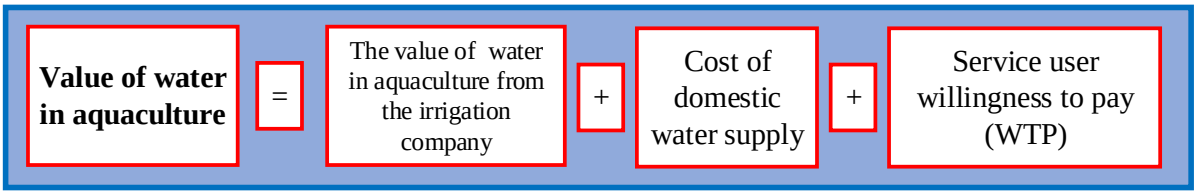

Figure 1. Components of water value for aquaculture

In which:

- The value of water in aquaculture from the irrigation company is calculated based on cost accounting method, including the following components: production costs, expected profits (if any), financial obligations according to legal regulations (if any).
- Domestic water supply costs are determined from the Decision of the Provincial People's Committee.
- The willing-to-pay level of service users is determined by random valuation method through surveying service users.

2.2.1 The value of water in aquaculture from the irrigation company

The value of water for aquaculture can be calculated per unit of agricultural land area converted to rice (VND/ha) or per unit of water used for irrigation (VND/m^3). Based on the market at the time of valuation under normal weather conditions (without natural disasters, fires, or other abnormal conditions), the owner of the irrigation works or the organization/individual exploiting the irrigation works establishes the price level for the irrigation works' products and public utility services using the pricing method for goods and services

regulated by the Ministry of Finance for state authorities to assess the pricing plan and set maximum and specific prices for the irrigation works' products and public utility services:

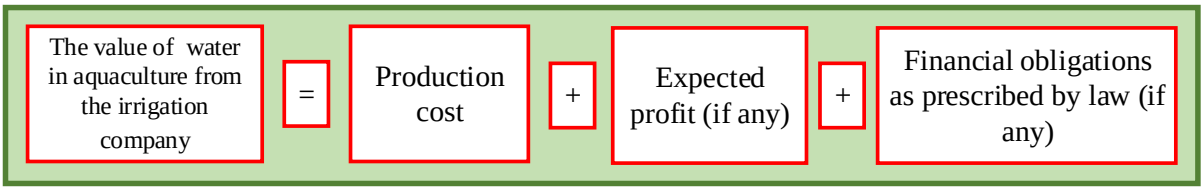

Figure 2. Method of determining the value of water for aquaculture from the irrigation company

Due to the multipurpose of the irrigation system (agriculture, aquaculture, industrial crops, etc.), it is necessary to separate the cost of providing water services for each different purpose of use according to the method of converting water use quotas for each purpose based on the water use quota per hectare converted to rice.

$$\text{Conversion rate of different land areas to paddy field area} = \frac{\text{The revenue rate for non-rice cultivation areas according to Decision 1050a/2018/QD-BTC}}{\text{The revenue rate for rice cultivation areas according to Decision 1050a/2018/QD-BTC}}$$

Applying the water pricing calculation results for agricultural production, we have the value of water used for aquaculture from the perspective of the aquaculture company calculated by the following formula:

$$\text{The value of water in aquaculture from the irrigation company (VND/ha)} = \text{Unit price of water supplied from irrigation (VND/ha)} \times H_{qđ} \text{ for aquaculture}$$

In which:

- The unit price of water supplied by the irrigation system is the price of water supplied by the multipurpose irrigation system determined by the cost accounting method of the irrigation company.
- $H_{qđ}$ is the conversion coefficient, calculated by the following formula:

$$H_{qđ} \text{ for aquaculture} = \text{Area of aquaculture converted to local rice (ha)} : \text{Total area serving the fields converted to rice of the irrigation system (ha)}$$

The production cost of water for agricultural production includes all operating costs, maintenance costs, depreciation of fixed assets, management costs, and other reasonable actual costs of the entire waterworks exploitation organization for

each irrigation measure or type of product, service or work content. The cost items in the total cost of public utility water products and services include cost items determined in Decree 96/2018 detailing the prices of water products and services and support for the use of public utility water products and services.

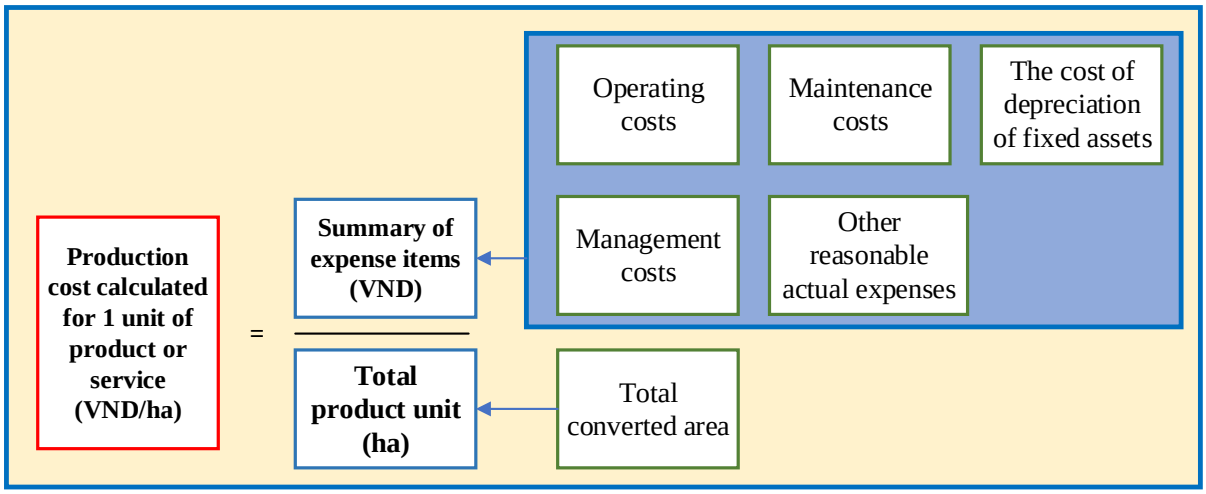

Figure 3. The components determining the production cost for one unit of product or service

2.2.2. Cost of domestic water supply

Cost of domestic water supply is calculated from the position after the head of the canal of the water user cooperative to the cultivated land. This fee is announced by the provincial People's Committee, and the water user cooperative negotiates with organizations or individuals using water from the canal head to the cultivated land according to regulations. This fee also reflects the value of irrigation water and does not include value-added tax.

However, due to different management and operation models for water exploitation among provinces, some localities announce and collect the domestic water supply cost, while others do not use this fee and incorporate it directly into the water price proposed by the water management company.

By applying the calculated cost of domestic water supply to agricultural production, the cost of domestic water supply for aquaculture from the cooperative is calculated using the following formula:

Cost of domestic water supply for aquaculture (VND/ha)	=	Cost of domestic water supply (VND/ha)	x	$H_{qđ}$ for aquaculture

In which: Internal water supply cost (VND/ha) is the cost determined by the provincial People's Committee.

2.2.3. Service users' willingness to pay

A general model for determining the willingness-to-pay is as follows:

$$WTP = \beta i.Xi + \varepsilon$$

Where: WTP is the willingness to pay for irrigation water by the service users; Xi is the i-th independent variable, the factor affecting the willingness to pay; βi is the parameter reflecting the degree of impact of Xi on the dependent variable WTP; ε is the error term

Applying the results of calculating the willingness to pay of service users for

agricultural production water supply, we have the willingness to pay of service users for aquaculture water supply calculated by the following formula:

Willingness to pay of aquaculture water service users (VND/ha)	=	Willingness to pay of irrigation service users (VND/ha)	x	$H_{qđ}$ for aquaculture

The value of water in aquaculture is expressed in two units "VND/ha" and "VND/m3" according to the following variation:

Water unit price per unit "VND/m3"	=	Water unit price per unit "VND/ha"	:	Irrigation norms (m3/ha)

2.3. Valuing the water value for aquaculture on rented water surface in irrigation reservoir

For the form of aquaculture by renting water surface in irrigation reservoirs, users of the service must pay expenses similar to the cost components in agricultural production, such as: wages, salaries, meal allowances, deductions based on salary, protective equipment and labor safety costs, site protection and safety assurance costs, maintenance costs, depreciation of fixed assets, management costs, and other reasonable costs (if any).

However, when calculating the value of water for aquaculture by renting water surface in irrigation reservoirs, it is necessary to apply the calculation principles according to Clause 9, Article 7 of Decree No. 96/2018/ND-CP dated June 30, 2018. In case of aquaculture companies that do not separately account for the expenses for renting water surface for aquaculture in the reservoir, when calculating the cost allocation, it is based on the ratio of revenue from renting water surface for aquaculture in the reservoir to the total revenue of the company settled in the previous year.

Therefore, the formula for calculating the value of water for aquaculture when renting water surface in a reservoir is as follows::

Value of aquaculture water when renting reservoir surface water (VND/ha/year)	=	Total cost of aquaculture when renting reservoir surface water (VND)	:	Aquaculture area in lakes (ha)

In which:

- The aquaculture area in the ponds (ha) is the total area of aquaculture in the ponds of the aquaculture company.
- The total cost of aquaculture by renting water surface in reservoirs (VND) is calculated using the following formula:

Total cost of aquaculture when renting water surface at irrigation reservoir (VND)	=	Cost of aquaculture production to rent surface water	+	Expected profit (VND)	+	VAT (VND)

(VND)

In which:

- Expected profit, VAT calculated according to current regulations.
- The production cost of aquaculture by renting water surface in reservoirs is determined according to Article 7 of Decree No. 96/2018/ND-CP as follows:

Cost of aquaculture production to rent surface water (VND)	=	Production cost (VND)	x	$K_{đc}$

In which:

- Production cost is the necessary expenses to provide the service, determined by the cost accounting method of the aquaculture company.
- $K_{đc}$ is the adjustment coefficient, determined by:

$$K_{đc} = \frac{Revenue\ from\ renting\ aquaculture\ water\ surface}{Company\ revenue} \times 100\%$$

3.1. Aquaculture form in ponds or reservoirs using water supply from the irrigation system

1. CALCULATION RESULTS

For aquaculture in ponds using water supply from the irrigation system, the water price in the provinces of the Red River Delta is shown in table 1:

Table 1. The value of water resources for aquaculture in ponds using water supply from the irrigation system

ID	Province	Area of aquaculture converted to rice (ha)	Value of water for aquaculture (VND/ha)	Value of water for aquaculture (VND/m3)
	(1)	**(2)**	**(3)**	**(4)**
1	Nam Dinh	17,973.2	487,510.2	94.1
2	Ha Noi	15,402.6	2,274,409.7	382.1
3	Hung Yen	3,297.6	42,564.9	6.7
4	Vinh Phuc	3,297.6	101,922.6	17.3
5	Ninh Binh	3,564.4	277,905.4	42.3
6	Thai Binh	974.6	59,782.7	10.2
7	Bac Ninh	6,753.8	251,915.9	44.9
8	Quang Ninh	128.9	16,543.0	2.9
9	Hai Phong	2,324.0	298,977.9	51.1
10	Ha Nam	32,000.0	1,013,225.6	175.7
11	Hai Duong	14,885.4	379,115.4	67.1
	Average	***100,602.0***	***852,686.5***	***147.7***

3.2. The form of aquaculture that involves leasing water surfaces in irrigation reservoirs for cultivation of aquatic products

In the Red River Delta, the form of aquaculture that rents water surface in irrigation reservoirs is currently being applied in Tam Dao district, Vinh Phuc province. The quantity of aquaculture products and services within the irrigation works is determined by the total area of aquaculture in the reservoirs: Dong Mo (49 ha); Xa Huong (85.5 ha); Vinh Thanh (35.2 ha); Lang Ha (35 ha); Gia Khau (14.3 ha); Ban Long (37.8 ha); Thanh Lanh (132 ha). The total area of 7 reservoirs is 389 ha.

The adjustment coefficient ($K_{đc}$) is determined by:

$$K_{đc} = \frac{115.000.000}{24.534.321.507} = 0,5\%$$

In addition, some cost components in the production cost of the company must be calculated based on the Water Law as a basis for calculating the value of water. The value of water in aquaculture under the form of renting water surface in the irrigation reservoir in Tam Dao district, Vinh Phuc province is shown in Table 2:

Table 2. The value of water in aquaculture under the form of renting water surface in the irrigation reservoir in Tam Dao district, Vinh Phuc province

ID	Content	Value (VND)
A	Reservoirs (ha)	389
B	Expense categories	
I	Operating costs	670,394,201
II	Maintenance costs	124,149,567
III	Depreciation cost of fixed assets	4,145,532
IV	Management costs	55,238,067
V	Other actual and reasonable expenses directly related to activities of the same level, other irrigation products and services (if any)	260,232,931
VI	Cost allocated to by-products (if any)	
VII	Full cost (I+II+III+IV+VI)	1,114,160,299
VIII	Expected profit: 10%	111,416,030
IX	Tax	122,557,633
X	Price of irrigation products and services/product unit (VII+VIII+X)/A	3,465,640

2. CONCLUSION

By analyzing the production costs of the service provider unit and using the contingent valuation method (CVM) to determine the price of other water-related services, the study has found two different contexts for the price of water for aquaculture:

Scenario 1: Aquaculture in ponds, where the water source is provided through a water system via canals and channels.

Scenario 2: Aquaculture using rented surface water from a reservoir.

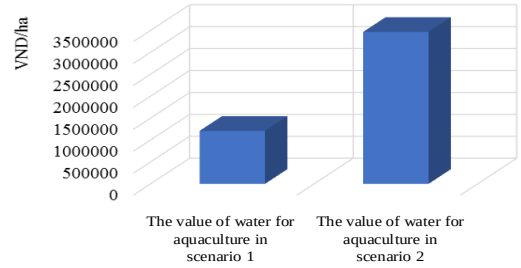

Figure 4. Summarizing the value of water for aquaculture in the Red River Delta

The research results indicate that renting surface water from reservoirs will bring much higher water resource values than supplying water for aquaculture in ponds for local farmers. However, it is necessary to ensure an appropriate amount of water in the reservoirs to serve both aquaculture and other multi-purpose production activities.

The method and process of valuing water resources for aquaculture in the Red River Delta have significant contributions to both research and practical applications. This is a reliable reference source for state management agencies and irrigation system management agencies in developing effective policies for water resource management and conservation.

REFERENCES

Government (2018). Decree no. 96/2018/ND-CP dated June 30, 2018 providing guidelines for prices of irrigation products and services and financial support for use of public irrigation products and utilities.

Tam Dao Irrigation Company (2020). Summary report on production and business activities of the company in 2020.

Berk Peter (1991). *The use of computable general equilibrium models to assess water policies, in Arial Dinar and David Zilberman*. The Economics and Management of water and drainage in agriculture, Kluwer academic publishers, Boston.

Calatrava, J.L. and Sayadi, S. (2005). *Economic valuation of water and willingness to pay analysis with respect to tropical fruit production in south eastern Spain*. Spanish Journal of Agricultural Research 3(1): 25-33

Velazquez (2007). *Water price and water reallocation in Andalusia: A computable general equilibrium appoach*. Working paper ECON 07.04: Universidad Pablo de Olavide.

Mezgebo, A., Tessema, W., and Asfaw, Z. (2013). *Economic Values of Irrigation Water in Wondo Genet District, Ethiopia: An Application of Contingent Valuation method*. Journal of Economics and Sustainable Development, 4(2): 23-36