The impact of environmental pollution on aquaculture development: The case of Vietnam

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CHRONICLE	ABSTRACT
	This research is conducted to analyze and point out the relationship between environmental pollution and aquaculture development in the coastal areas in Vietnam. In this study, we use the binary Logit model ($Y = 1/0$) where the variable, Y, reflects the risks and losses in the household's aquaculture; and X is a vector of factors affecting the event. The results show that, among determinants, household's aquaculture experience (X_1), the water pollution degree of the household (X_4), intensive farming mode of the household (D_1) influence household losses, while other variables such as educational attainment of the household head (X_2) and farming area (X_3) are not correlated with household losses. Based on the findings, some recommendations are given in the aspect that aquaculture households in the region to use new, more effective methods to protect the aquaculture environment in developing countries, including Vietnam.

1. Introduction

Around the world, many countries use a combination of economic measures to protect the environment and manage the environment for aquaculture development. These measures often incorporate both economic and regulatory tools. Sustainable aquaculture development is a trend that many countries are aiming to mitigate for negative impacts, especially environmental impacts. Sustainable aquaculture requires a harmonious combination of many factors to achieve sustainability at the same time economic, social and environmental (Charles, 2001). Therefore, aquaculture in this direction often has higher costs, but at the same time, the quality is also higher. In this sense, the BPP (payee benefit) principle is being implemented (consumers have to pay more for cleaner products). Directly, many countries apply more technical and administrative solutions. Specifically, choose the construction location and scale of aquaculture farms, farm and waste management, disease management, species selection and technology innovation (Primavera, 2006). China is the country with the potential to develop fisheries in the second-best category in the world (Chu et al., 2006). Previously, due to overheating development, Chinese aquaculture was also affected. In 2010, China's aquaculture production reached 36.7 million tons, accounting for 61.2% of the world's total aquaculture production and increasing by 22% compared with 1999, corresponding to the average growth of 2% / year (FAO: Fisheries and Aquaculture Department, 2012) The Chinese government has focused on applying environmental management tools and policies to sustainably develop aquaculture. Specifically: (i) The Government limits the number and scale of aquaculture farms in areas where tourism can be developed such as Hainan Island and closes a number of aquaculture farms in Giang Province. To (Jiangsu), the direction to develop aquaculture farms in purer provinces like Sichuan (Sichuan), Chongqing (Chongqinh), and Yunnan (Yunnam) (Godfrey, 2012); (ii) Application of "aerobic technology" to treat water to farms and aquaculture households. Water treated with this technology will reduce the amount of nitrogen and ammonia, increasing the amount of oxygen in the water. (iii) The Chinese government also promotes and encourages the application of new,

environmentally friendly technologies and techniques. Eco-friendly inoculants (probiotics) are also allowed and business-friendly to make it easy for aquaculture farms to use (Netherlands Business Support Office, 2010).

Thailand is a major country in Southeast Asia, with potential for fisheries development including fishing and aquaculture. To sustainably develop aquaculture, Thailand has also enacted and applied many different measures. The first, Thai Government has issued a policy in two directions: (i) the production of industrial feed for aquaculture must meet the standard and (ii) reduce the proportion of industrial feed use. In the first direction, the Ministry of Fisheries of Thailand has required businesses producing fish feed to register to meet the standards of ingredients for aquatic feed of the 'Aquatic Ingredients' Organization (The marine Ingredients Organization). In the second direction, Thailand's Ministry of Agriculture has encouraged aquaculture farmers to use locally available alternative feed. This reduces the ratio of feed cost to total cost but also reduces the residue of feed in aquaculture (Harris, 2010). The second, Southern Provinces of Thailand, farmers have just transplanted rice, vegetable and aquaculture. They use many chemicals and pesticides for rice and vegetables. In order to reduce the impact on water resources, Thailand encourages farmers to reduce chemical fertilizer and pesticide use on rice and vegetables to reduce the amounts of chemical residues for sewage and groundwater, which is the source of water use for aquaculture. Initially, about 14% of farmers accepted to reduce the use of chemicals and pesticides for rice (Harris, 2010). The third, for the sustainable development of the fisheries and aquaculture industry, the National Fisheries Association of Thailand together with 8 private organizations (International Fisheries Association, Food Production Association) for fish, Frozen Products Association, (Food Processing Association) signed cooperation in the whole supply chain of aquatic products from food suppliers to final consumers. The actors involved in unifying production and business comply with safety standards and protect the ecological environment. The first measure given is technological innovation, but technology should be chosen so that the cost increases and price increases that consumers can accept (The Fish Site, 2013). The fourth, Thailand encourages farmers to turn to diversified aquaculture, researching new breeds and species to be able to take advantage of feeds in different aquifers, combining farming models using Traditional food, locally available (Tan et al., 2006). Vietnam is a country with the east coast called the East Sea and the southwest part along the Gulf of Thailand, with a coastline of about 3,444 km. Vietnam currently has 28 coastal provinces and cities with 125 coastal districts, stretching along the coast longer than 3,260 km, from Quang Ninh to Kien Giang. From the North to the South, the coastal provinces are: Quang Ninh, Hai Phong, Thai Binh, Nam Dinh, Ninh Binh, Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri, Thua Thien Hue, Da Nang, Quang Nam, Quang Ngai, Binh Dinh, Phu Yen, Khanh Hoa, Ninh Thuan, Binh Thuan, Ba Ria - Vung Tau, Ho Chi Minh City, Tien Giang, Ben Tre, Tra Vinh, Soc Trang, Bac Lieu, Ca Mau and Kien Giang. Therefore, Vietnam has a big potential in aquaculture development. However, the spontaneous and massive development of aquaculture has also led to many shortcomings, causing the space of the water surface system for aquaculture to be fragmented, ragged, the aquaculture environment is seriously polluted, aquatic resources in recent years have been reduced, a significant part of the population has a low and precarious life. Most aquaculture households use natural water directly for aquaculture without checking input quality, waste water is not treated but discharged directly into the environment, chemicals and antibiotics are used arbitrarily, ineffective solid waste management, the air environment, especially at the time of product harvest, is heavily polluted. These are pressing economic, social and environmental issues that need to be addressed and they have a great impact on the development of other economic sectors.

This research is structured as follows. Section 2 presents theoretical framework. Section 3 describes the data sample collection and methodology employed in the conduct of the research. Section 4 sets out a discussion of key results, while Section 5 shows some key conclusions.

2. Theoretical framework

To analyze the influence of factors on the probability of an event, most studies often model this relationship based on mathematical modeling. Some studies use linear probability model and estimate by the Ordinary Least Square method. However, this method is easy but does not guarantee the accuracy of the model (Gujarati, 2004; Wooldridge, 2005). To overcome this problem, Halvorsen and Palmquist (1980), and Kennedy and Gentle (1980) used a non-linear probability model (Logit and Probit models) and used the Maximum Likelihood Estimation method. In the model, the relationship between the factors and the probability of an event is a two-nature relationship depending on the characteristics of the problem, that is, if an event does not occur, the result is No (0), and if an event occurs, the result is Yes (1). That means in this case the choice model is binary and it is the most appropriate model (Wooldridge, 2005). Logit model (form Y = 1/0) can be presented as follows:

$$\text{Prob } (Y=1) = \frac{e^{\beta X}}{1+e^{\beta X}} = F(\beta'X),$$

(1)

and Prob (Y = 0) = 1 - F(β'X), where Prob is the probability of occurrence; Y is the result of the event (then Y = 1). X is a vector of factors affecting the event; β is a vector of parameters to be estimated (β' is the transposed matrix of β). In this model, determining the probability of an event (Y = 1) when changing a certain factor, we need to determine the first derivative according to that element. This is the "Marginal effect". The formula to calculate the "Marginal effect" is as below:

$$\frac{\partial E(Y)}{\partial X} = F(\beta'X) \, [1 - F(\beta'X)] \, \beta = f(\beta'X) \, \beta.$$

(2)

In this topic, we use the binary Logit model (Y = 1/0). The variable Y reflects the risk and damage in aquaculture of the household. X is a vector of factors affecting the event.

The experimental model is as follows:

$$F(\beta' X) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \delta_1 D_1 + u \tag{3}$$

In which:

Y reflects that in five households, there were losses due to aquaculture diseases (Y = 1 if there was damage and Y = 0, if the households had never had damage); X_1 Experience of the head of household (year); X_2 is the education of the householder (year); X_3 is the aquaculture area of the household (ha); and X_4 is the Pollution level, including 5 levels as assessed by aquaculture households: (1) Very good, (2) Fairly good, (3) Normal, (4) Polluted, and (5) Very polluted. Moreover, D_1 is a dummy variable reflecting the farming method (D1 = 1, if the farmer is intensive, D1 = 0, if the farmer is semi-intensive).

β_j (j=0,1,..4) and δ_1 are the parameters to be estimated;

u is the random error.

To identify the factors that influence the decision of households to use environmental protection measures (using separate waterway or chemicals), the topic uses multi-logit model (discrete variable model with different levels). Theoretical model like Prob:

$$\left(Y = j \mid X\right) = \frac{e^{\beta'_{ji} X_i}}{1 + \sum_{j=0}^{n} e^{\beta'_{ji} X_i}} \tag{4}$$

with j = 0,..., n ; $i=1,...m$ and $\beta_0 = 0$.

where:

Y is the result of event j happening; X_i is the ith element that affects the result j. In this topic, we use the empirical model:

$$\beta'_j X = \beta_0 + \sum_{i=1}^{5} \beta_i X_i + \delta_1 D_1 + u \tag{5}$$

In which:

Y reflects the household's use of environmental protection measures;

Y = 0, Households do not use any measures;

Y = 1, Households only use chemicals;

Y = 2, Households use chemicals and have their own separate waterway;

X_1 is the aquaculture experience of the householder (years);

X_2 is the education of the householder (year);

X_3 is the farming area (ha);

X_4 is the expense for industrial food (million Vietnamese dong - VND/ha)

X_5 is the expense for disease control (million VND/ha)

D_1 is a dummy variable reflecting the farming method (D1 = 1, if the farming intensive farming).

3. Research methodology

We selected four provinces as research sites. Criteria for selecting the research site are provinces that represent Vietnam's aquaculture practices, water sources for different aquaculture in the study area. In addition, the area of aquaculture, the number of aquaculture households, and the level of urbanization and industrialization of the province are also considered. Specifically, the provinces selected for research are below:

Quang Ninh Province represents intensive aquaculture near the city, which is at great risk from industrial pollution and urban living. Quang Ninh has the lowest number of households and aquaculture area.

Thanh Hoa province represents a low-lying area, average number of households, labor and aquaculture area compared to other provinces and has little change over the years.

Quang Binh province has 2 modes of aquaculture, with the extent and rate of increase in area, the number of aquaculture households is at an average level compared to the whole region.

Khanh Hoa province has a high aquaculture area, the number of households and laborers working in aquaculture has increased rapidly. The province also has rapid industrialization in the southern region.

Each province selected 60 households to investigate, while Quang Binh selected 45 households. The number of households in the provinces differed due to different aquaculture areas and limited time for research. The total number of households selected for research is 225.

In the process of statistical disaggregation to compare the differences of indicators reflecting aquaculture according to farming methods, area size and by farming area, we conducted testing the difference in the average number between groups (t-test). The t-test is performed as:

Hypothesis H_0: $m_1 = m_2$ with the argument H_1: $m_1 \neq m_2$

where m_1 and m_2 are the expected (or average) values of the sum of 1 and 2.

Assume that the number of observations of sample 1 is n_1 and sample 2 is n_2; The mean value of sample 1 is $\overline{X}_1$ and sample 2 is $\overline{X}_1$; The sample variance S_1^2 and S_2^2. Then:

$$t_{k\mathrm{d}} = \frac{\left| \overline{X}_1 - \overline{X}_2 \right|}{\sqrt{\dfrac{S_1^2}{n_1} + \dfrac{S_2^2}{n_2}}}$$

If: $t_{kd} \geq t_\alpha$ Hypothesis H_0 is rejected and cannot be rejected hypothesis H_1;
If $t_{kd} < t_\alpha$ hypothesis H_0 cannot be rejected.

Value t_α is the value of looking up the T (Student) distribution table with statistical significance α, and levels of freedom ($n_1 + n_2 - 2$).

4. Results and discussion

4.1. Impact of environmental pollution on aquaculture of households

Impact on aquaculture results

In this content, we will discuss the impact of environmental pollution on aquaculture through the result indicators of aquaculture. Pollution level for water sources used in aquaculture is based on the household's experience with water sources in aquaculture and ponds and lakes in aquaculture. The results are presented in Table 1.

Table 1
Relationship between aquaculture results and pollution level by households' assessment

Assessment of household groups	Productivity (ton/ha)	Output (ton)	Cost / ha (million VND)	Income/ha (million VND)	Level of damage (million VND)
Very polluted (n=41)	5.32	11.57	148.78	63.95	20.93
Polluted (n=108)	10.63	27.75	225.92	162.03	14.06
Normal (n=69)	7.49	21.07	131.76	109.61	5.84
Fairly good (n=7)	7.51	18.71	166.75	135.86	0.00
Has the household ever suffered badly from disease?					
+ Had suffered damage n=64)	6.58	12.58	142.30	51.78	43.44
+ Never suffered any damage (n=161)	9.41	26.41	196.58	157.28	0

Source: Compilations by the authors

In the survey sample, 28.5% of households (64 households) said that they had suffered losses, they had lower productivity and aquaculture output than those who had never been damaged. In particular, the number of aquaculture households in Khanh Hoa province said that they suffered the most losses (56.7% of households). The two least damaged districts (and not even damaged) are Quang Ninh and Quang Binh. This indicates that losses in aquaculture are mainly due to diseases and epidemics occurring by region. On average, each household in the study area suffered a loss of 43.44 million dong, of which Khanh Hoa province suffered the most, on average 85.3 million dong / household. Particularly, a household in Khanh Hoa with 8.5 ha of fish farming claimed that due to the disease, the family had suffered 366 million Vietnamese dong (VND).

The results also show that households that claim that water in their ponds or lakes are polluted have higher results in aquaculture production. This may explain that aquaculture households only think that water pollution in ponds and lakes is due to the main aquaculture process, is not mainly due to water sources. Therefore, in the region, the main aquaculture households use only two methods to treat water pollution: using separate waterway and chemical treatment (mainly lime powder, copper sulfate and pentolite). Another reason is that these households often invest in highly intensive cultivation so they think that the water is polluted, but the result of aquaculture is still high. Or it could be due to the various sources of information, they think that it is polluted but the reality may not be so.

To analyze the factors, including environmental pollution, affecting aquaculture productivity of households in the study area, we use the production function (as described in section 2). In the four surveyed provinces most households raise fish. The dependent variable was identified as the fish productivity of households achieved in 2018 (tons/ha). Determinants included in the analysis include fish farming area of the household, cost of breed, cost of fresh feed, cost of industrial feed, labor costs, farming methods and behaviors of households towards environmental protection in aquaculture (having separate waterway or treating pond chemicals). The topic does not have conditions to measure environmental and pollution specifications. Therefore, the topic uses criteria such as using separate waterway and chemical treatment in ponds. These are measures to protect the environment in aquaculture of households. The estimation results are presented in Table 2.

Table 2
Estimated results of production function of aquaculture households in coastal provinces of Vietnam

Variables	Coefficient	Standard error	t–test
Free coefficient (C)	1.8098***	0.0965	18.7602
LnX_1 (Area)	-0.2008***	0.0426	-4.7122
LnX_2 (Breed)	-0.0058^{ns}	0.0265	-0.2198
LnX_3 (Fresh food)	0.0516***	0.0085	6.0550
LnX_4 (Food industry)	0.0356***	0.0097	3.6573
LnX_5 (Labor cost)	0.0060^{ns}	0.0135	0.4446
D_1 (Intensive farming)	0.2668***	0.0985	2.7071
D_2 (Separate waterway)	0.2798***	0.0997	2.8075
D_3 (Using chemicals to treat ponds)	0.1175*	0.0678	1.7339
R^2	0.5634		
Adjusted R^2	0.5454		
Number of observation	202		
F – Statistic	31.2889***		

Note: *, **, *** are respectively significant at 10%, 5%, 1%; ns is not statistically significant.
Source: Compilations by the authors

The model results show that the construction model is suitable with the actual data of the study area (F value = 31.2889 and statistically significant at 1%, the adjustment determination coefficient reaches 0.55). Although there is no direct indicator to reflect pollution, we use a separate waterway and use chemicals in the pond to reflect environmental protection or reduce pollution. If a household uses a separate waterway or chemical, it is shown that these households will be less polluted than other households that do not use these two measures. The model results show that the households who use their separate waterways or use chemicals to treat ponds (mainly using pentolite to disinfect or copper sulfate to treat ponds) have higher productivity, equivalent to nearly 0.28 and 0.12%. In the region, there are very few households using biological products to treat ponds (especially pond bottoms), so the effect of the household's use of separate waterway is relatively stronger than using chemicals to treat ponds. In the future it is recommended that households should use new finished products such as EMC. This result shows that two environmental protection measures of households have an influence on the productivity of aquaculture. It also reflects that households have initially learned how to deal with environmental protection in aquaculture. Aquaculture farmers (farmers) strive to have access to clean water in aquaculture.

For the farming method, the results showed that the intensive farming mode was more productive (nearly 0.27%) compared to the semi-intensive farming methods. Among the factors, the cost of breed and the cost of hiring labor are not statistically significant. So, these two factors are not necessarily correlated with productivity in the study area. With the breed factor, due to experience and exchanging with each other to invest, on 1 unit area (1 ha), the breed are not very different from households. With the cost of hired labor, there is a big difference between households in 4 provinces (for example: in Thanh Hoa and Quang Binh provinces, there are very few hiring labors, if any, the number is small, while in Quang Ninh province households hire more laborers.). With a high cost of food (both fresh and industrial food), the productivity of households tends to be higher (respectively 0.05 and 0.04%). This result is consistent with the comment that intensive farms are often more productive.

Household area has a negative effect on productivity (coefficient of -0.2). This means that in the study area, the aquaculture sector is being effective on a declining scale, households with more area, the productivity is lower. This result reflects that the level of management of the households is still low, so when the area is large, the production results of the households are usually not high. Another reason is that households with large areas are often bidding or renting areas, with short-term, so the level of investment in renovation is not high. The goal of these households is mainly to take advantage of the area.

Impact on risks and damages in aquaculture

To estimate the factors that affect the losses of aquaculture households, we use the Logit model. The dependent variable is the household that suffered from aquaculture losses during the farming period or during the aquaculture years, there were at least five (or crops) of households suffering from disease or damage in aquaculture (due to environmental pollution) (Y=1). The independent variables that correlate (or affect) household losses include the household's Aquaculture Experience (X1), Educational background of the householder (X2), Farming area of the household (X3), Level of water pollution (X4), and Method of farming (intensive or not, D1). The estimation results are presented in Table 3.

The results show that the Likelihood Ratio Test Statistic is 50.958 with the statistical significance at 1%. This result allows us to refute the hypothesis H1, the hypothesis that not all individual regression coefficients are zero. Therefore, the given model is reasonable and consistent with the data of the study area. This reflects, logit model has significance in assessing the factors affecting household losses, especially in the study area. The ability to predict correctly of the model is quite good, the rate of correct prediction of households who have never been damaged reaches 84.0% while the actual is 71.6%.

Table 3

Estimated results of the Logit function

Variables	Coefficient	Marginal effect
Free coefficient (β_0)	- 5.5366***	-1.0073
Aquaculture experience of the householder (X_1)	0.0658**	0.0120
Educational background of the householder (X_2)	- 0.0561 ns	-0.0102
Farming area (X_3)	- 0.0549ns	-0.0010
Pollution level (X_4)	1.1629***	0.2116
Farming method (D_1)	- 0.9878**	-0.1545
Likelihood ratio test statistic	50.9580***	

*Note: *, **, and *** are respectively significant at 10%, 5%, and 1%; ns is not statistically significant. The unit of calculation and definition of variables are presented in section 3.*
Source: Compilations by the authors

For the logit function, coefficients and levels of statistical significance indicate the correlation between independent and dependent variables, while magnitude (influence) is reflected through marginal effects. The estimation results show that: Among the above-mentioned factors, aquaculture experience of the householder (X1), the extent of water pollution of the household (X4), the intensive farming method of the household (D1) are the factors that affect household losses, while other variables such as Educational background of the householder (X2) and farming area (X3) are not correlated with household losses in the study area.

The level of water pollution in aquaculture of households is divided into 4 levels according to the reality (i) Fairly good, (ii) Normal, (iii) Polluted, (iv) Very polluted. The higher the pollution level, the easier the damage level of households (including disease) (at 21.16% with a statistical significance of 1%). The household's aquaculture area and educational background of the householder are not correlated with the household's loss in aquaculture. Results showed that aquaculture households mainly learned from their relatives or neighbors and accumulated practical experience in previous aquaculture years. In the study area, the occurrence of risks in households with large and little farming area did not differ.

Households who practice intensive farming have reduced the frequency of damage (15.45%). This is consistent with household aquaculture practice at the study site. The surprising result is that if the household is experienced in aquaculture, the probability of risk increases. According to our quick interview, more than 90% of the interviewed households, most of them learn about aquaculture experience together. Long-term aquaculture will cause disease outbreaks, so households with experience due to many years of farming often face risks and damages. Based on the survey, households with experience in aquaculture mainly rely on their own experiences, with little consideration of forecasts and techniques. While in recent years due to the effects of climate change, the weather has been erratic and unpredictable. As a result, this household suffered a high loss.

In the study area, aquaculture households use two basic methods to treat water for aquaculture, including (i) Using chemicals (using pentolite to disinfect or sulfate co-treating ponds); and (ii) having separate waterway. Among 225 surveyed households, 35% of households did not use these two methods, nearly 39% of households used chemicals for treatment, about 1/4 of households combined using chemicals and separate waterway. We use a multi-logit model to study the factors affecting the use of two measures to protect the water environment (water treatment) of the households. Estimated model results are shown in Table 4. The model results show that the variables "Educational background of the householder, Pollution level, Farming area and farming method" influence the decision on whether or not aquaculture households apply two environmental remedies. With high educational level, households will also apply more than two measures to treat aquatic environment. Intensive farming households also use these two methods more. A different result is that in the study area households with experience in aquaculture applying these measures are no different from inexperienced households. This shows that these two measures are applied in households that are highly dependent on farming methods and the level of environmental pollution of their aquaculture water (expressed from the value of the marginal effect, Table 4). In the future, it is recommended to encourage aquaculture households in the area to use other new, more effective methods to protect the aquaculture environment.

Table 4
Determinants influencing the application of environmental remedies

Variables	Households only use chemicals (Y=1)		Households use chemicals and have their own separate waterway (Y=2)	
	Coefficient	Marginal effect	Coefficient	Marginal effect
Free coefficient (β_0)	- 7,8594***	-0,7351	-10,7958***	-1,0874
Aquaculture experience of the householder (X_1)	0,0264ns	0,0080	-0,0128ns	-0,0053
Educational background of the householder (X_2)	0,1393**	0,0129	0,4175***	0,0607
Farming area (X_3)	0,0054ns	0,0218	0,2049**	0,0369
Pollution level (X_4)	1,6823***	0,2371	1,6065***	0,1038
Farming method (D_1)	2,0157***	0,1794	2,8492***	0,2936
Likelihood ratio test statistic	79,7707***			

*Note: **, and *** are respectively significant at 5%, and 1%; ns is not statistically significant.*
Source: Compilations by the authors

5. Conclusion

The adjustment of the policy system appropriately and in accordance with international regulations to participate in the world aquaculture organization, implementation of international agreements on environment and aquaculture have created the legal environment for aquaculture households to increase their competitiveness and awareness of environmental issues related to aquaculture activities. The requirements of organizations for eco-friendly products will be a pressure for businesses and aquaculture households to improve the technology and organization method to meet market requirements. This on the one hand is to increase the competitiveness of fishery products while reducing the risk of environmental pollution.

Environmental protection activities are regular, long-term jobs, requiring synchronous implementation of measures to connect socio-economic activities with environmental protection of all levels, sectors and communities to gradually change behaviors more and more environmentally friendly, contributing to promoting socio-economic development associated with environmental protection.

Expansion of safe concentrated aquaculture areas: Safe concentrated aquaculture areas in each commune with many aquaculture areas are established. Aquaculture households are encouraged to participate in safe aquaculture following the Vietnamese Good Agricultural Practices in the concentrated aquaculture area. At the same time, strengthening the implementation of environmental taxes, fees and charges. Raising the responsibility of farmers in protecting the environment. Increasing the number of aquacultures participating in environmental taxes, fees and charges; Adding funds for environmental protection funds.

Implementing economic and environmental management solutions for aquaculture development is an indispensable task of agricultural production towards the current sustainable development. The relationship between environment and aquaculture has existed. That requires us to research and gain experience in coordinating environmental policies and aquaculture. Economic relationships and environmental management for aquaculture development are not just socio-economic development that causes environmental problems; the environment has the opposite effect on socio-economic development and aquaculture. Environmental protection today is at different levels considered a tool or driving force for economic development in developing countries. Especially for aquaculture, environmental policy has in many cases become part of the aquaculture policy. The implementation of environmental policies associated with socio-economic development in general and aquaculture development in particular in developing countries has become more necessary than ever.

In environmental protection, various economic and environmental management solutions can be used. There are different trends in the use of economic instruments such as polluters who need to pay or those who want a "clean" environment to pay. In essence, these tools are economic and environmental management solutions. Depending on the country and region, these tools are applied to different levels.

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