The study of the impact of Maninjau lake pollution on economic and public health

E S Tasri*, K Karimi¹, and I Muslim¹
¹ Bung Hatta University, Padang West Sumatra, Indonesia
*evitasri@yahoo.com

Abstract. Environmental damage does not only because the decline in the ability of the nature to provide human needs, but it also causes socio-economic losses to humans. Although Maninjau lake has been polluted in the last ten years, it still remains a source of life for the surrounding community. This study focuses on the impact of the damage of Maninjau Lake on economic and public health experienced by the surrounding community. This research uses parametric and non-parametric approach with regression analysis and Mc-Nemar test. The data were collected by doing survey to the household of fish cage farmers. This research reveals that the variables such as the cost of fish cage cultivation, maintenance and the size of fish cage area determine the level of economic losses of fish cage farmers. This finding is important to determine which economic factors that have significant effect. A review of the health impacts found that there were no significant changes in the health condition of the household of fish cage farmer before and after the pollution of Maninjau lake. Until now, Maninjau lake is still the main source of livelihood of the local people. The community is accustomed to the pollution of Maninjau lake.

1. Introduction

Human activities for economic development often damage the environment and therefore negatively affect humans themselves. Exploitation of natural resources sometimes exceeds the threshold of natural capacity itself [1].

*The limit to growth* by Meadows of the Rome group warns that the current pattern of natural resources consumption will cause depletion of the resources and damage the environment which will lead to the limits of world economic growth [2]. This marks the emergence of sustainable economic thought, sustainable income and green income, which underlies green economic thought.

The problem of water quality is a serious problem facing mankind in the era of globalization. In research carried out by chemical pollution, especially in inorganic and organic micropolutants including toxic metals and metalloids as well as various kinds of synthetic organic chemicals. Several aspects of waterborne diseases and the urgent need for improved sanitation in developing countries are also discussed. Organic pollutants that have affected water systems on a global scale for more than five decades have been a source of long-term water pollution. Agricultural chemicals and wastewater sources have short-term effects on a regional to local scale [3].

Many countries are also experiencing water quality crisis problems. The lake water quality crisis is also one of the biggest environmental challenges currently facing China. Since the 1970s, lakes and rivers in China have experienced increased water damage. In the 1990s several major water basins were so seriously polluted that China's central government initiated a project called the "three rivers and three lakes" (the Liaohe, Huaihe and Haihe rivers, and the Taihu, Chaohu and Dianchi lakes), which aimed to reduce or overcome water pollution [4].
Lake pollution can occur due to soil erosion and nutrient concentrations, pollution from fertilizers and chemicals, industrial pollution. The causes of water damage can specifically be caused by natural factors and man-made factors. These factors include natural conditions, population, settlement activities, economic activities, culture and education as well as governance. The research was carried out at Mogan and Eymir Lakes in the vicinity of Ankara, Turkey. Finds that the potential impacts from extensive agriculture, recreation, infrastructure and other human activities, such as settlements, contribute to lake water pollution.[5]

The case of Lake Maninjau pollution is a portrait of the use of natural resources which does not take into account the negative impacts on the environment and on the community itself. The pollution occurs due to pressure from the fish cage farming activities. Therefore it is considered important to study the impact of the pollution on economic and health experienced by the community in the area of Lake Maninjau.

Often, lake water pollution occurs suddenly. For this reason, the ability to identify sources of pollution quickly is necessary for providing early warning of accidents and implementing emergency control measures [6].

Due to changing water conditions and ongoing climate change, many inland lakes around the world are shrinking and dry lake beds can be a significant source of particulate matter air pollution [7]. This will have an impact on human health and the productivity of the lake as a resource for the livelihoods of local residents.

The development of economic activity with an increase in capital causes bad consequences in the form of habitat and species loss [8]. This is expected to reduce the exploitation of natural resources. This was supported by [9] that the impact on economic of palm oil industry in Malaysia was much higher than in Indonesia because Malaysian infrastructure was much better.

Every production process, which produces output, also produces environmental impacts. There for, part of the production output must also be allocated to improve the environment. Therefore, it is not all resources or inputs that can be allocated for production [10], [11].

Lake pollution has a direct impact on humans. One of the impacts is the pressure on economic resources, availability of water, electricity generator and irrigation for the agricultural sector. Even further, pollution threatened sustainability of several species that live around the area of the lake [12].

Awareness to protect resources and limit usage ratios must be risen. Fundamental changes in the economy are required to reduce inequality between rich and poor countries using socio-political approaches and government institutions [1]. It means a policy of utilization of natural resources is required that takes into account the limitations of ecological capabilities. The costs to build a clean economy are much lower compared to negative extradition to the environment, the risks of economic and political security.

1.1 The Condition of Maninjau Lake
The deteriorating water quality occurred in Maninjau Lake, which is one of volcanic lakes in West Sumatra Province. The development of fish cages in Lake Maninjau greatly affects the quality of the water. In 2016 the number of Floating Fish Cage (FFA) reached ± 17,226 plots. The carrying capacity of Maninjau Lake was 1,500 units or 6,000 plots with a size of 5 x 5 square meters per cage plot. In February 2016, there had been mass fish deaths in the East of Lake Maninjau. The East region was shallower than other regions. According to Indonesian Institute of Science (LIPI), at Lake Maninjau, with wind speeds only ± 28 kmh from the east and north, it could lift toxic compounds at a depth of 18.5 m[13]

1.2 Impact of Maninjau Lake Pollution
Lake is expected to provide economic and social ecological values. Its sustainability has been threatened because the waste contained in it is very dangerous for public health. A high content of Fe which will be harmful found by[14] at Manggar lake in the city of Balikpapan. Similar study done by [15], [16], [17]. The impact of aquatic environmental pollution is reinforced by the findings of [18], that the
degradation of the river or lake water environment was strongly influenced by the number of populations, industry and tourism and the agricultural sector. This confirms that pollution can occur due to human activities.

Even more robust findings from studies of the mercury deposits in the atmosphere of Lake Marboré reflect global emissions, particularly from the Almadén mine (central Spain). These findings reveal a strong mining-related pollution legacy in alpine lakes and watersheds that need to be considered in the plan. management of mountainous ecosystems due to global warming and the effects of human pressure can contribute to future degradation [19].

The results of the research shows that the management of Maninjau Lake has not yet taken into account the sustainable aspects of natural resources. This pollution causes enormous losses and decreases in economic activities. The socio-economic impacts of pollution experienced by the community include impacts on livelihoods, community income, employment and public health. It has also led to various social changes in the community.

One of the impacts on livelihoods is the disruption of community business activities in the lake which further encourages the community to change to other jobs or profession. Changes in livelihoods occurred in several forms, including communities who survived their original livelihoods, re-engaged in agricultural business, engaged in new business fields and migrated. In its development, there were also additional types of businesses that people were engaged in before pollution occurred. Various changes mentioned above require the community to learn new skills.

This research will increase knowledge about how to minimize the impact of pollution in Maninjau Lake and what factors need to be investigated further.

2. Method
The research was conducted to develop an environmental impact analysis based on the Solow economic growth model as stated by [11] that pollution will result in low output, because some outputs must be used for pollution prevention. By taking into account the production process in fish cage activities, determinants of the level of loss experienced by farmer were identified.

Impact analysis is divided into studies on economic losses experienced by farmers with input production as variables that are assumed affecting farmer’s losses and the analysis of the impact of health losses is conducted to find out the health changes experienced by the community before and after the lake pollution occurs.

Method of analysis used is as follows:
1. Study of determinants of the level of household economic losses
Maninjau lake pollution affects the level of economic loss of the community, which is determined by the level of farmer productivity. The level of productivity is determined by the inputs used in the production process of cage farmers.

Based on the literature study conducted [20] the model that will be analyzed in this study can be derived using Generalized Least Squared (GLS) for data analysis. The least squares estimation form of GLS, is a form of estimation that is used when the classical assumptions required by the OLS method (homokedastic and nonautocorrelation) are not met. The use of OLS in such conditions will result in estimation of regression parameters that are no longer efficient and can lead to misleading conclusions (conclusions). GLS has the ability to maintain the efficiency of its estimator without losing its unbiased and consistent nature. The research model that will be analyzed in this research is:

The model of analysis used to examine the determinants of the level of economic loss of fish cage farmers as follows:

\[ Y = \alpha_0 + X_1 MC_1 + \beta_2 BA + \beta_3 MC_2 + \beta_4 CA + \beta 5 TL + \varepsilon \]
2. The assessment of health impact
Lake pollution has a direct impact on people living around the lake. Residents are in direct contact with polluted lake water, so lake pollution has a direct impact on people's health (Owiti & Oswe, 2007). To find out the changes in public health conditions due to lake contamination, non-parametric statistical analysis of the Mc-Nemar test was used. Chi-square distribution is generally used to evaluate Mc-Nemar test statistics, which actually approaches the binomial distribution.

The research method used in this study was exploration with a qualitative descriptive approach. This approach was used to analyze and interpret factors that determine the level of economic loss and health impacts on communities affected by the lake pollution. The object of research was the level of economic losses experienced by the community and the public health burden carried out in the area around Maninjau lake.

3. Results and Discussions

3.1 The Study of Defining Factor of the Level of Household Economic Losses
Factor model that affects economic losses used Ordinary Least Square (OLS), but in the data analysis the results obtained did not meet the requirements of statistical analysis with OLS. Therefore, the Generalized Least Squared Model was used. Generalized Least Squared is able to explain economic loss variables, with variables that affect independent variables Management Costs (MC_1), Business Age (BA), Maintenance Costs (MC_2), Cage Area (CA), and Total Labor (TL).

The results of data analysis are as follows:

| Dependent Variable/ Economic Loss | Coefficients | Significant |
|----------------------------------|--------------|-------------|
| Management Costs Log Zstatc      | 0.519821     | (3.29)***   |
| Business Age log Zstatc          | 0.0529833    | (0.39)      |
| Maintenance Costs Log Zstatc     | 0.425878     | (5.30)***   |
| Cage Area Log Zstatc             | 0.7942378    | (6.64)***   |
| Total Labor Log Zstatc           | -0.1891451   | (-1.20)     |
| Constan                          |              |             |
| Wald Chi2(2)                     | 0.4577427    |             |
| Prob>Chi2                        | 158.24       |             |
| Prob>Chi2                        | 0.0000       |             |
| Source: own calculations, 2019   |              |             |

From the Table 1, it can be seen that the economic loss rate of cage farmers due to Maninjau lake pollution is significantly determined by processing costs, maintenance costs and cage area. While cage age and total labor have no effect on the level of loss of cage fish farmer.

It can be seen that the values of Prob> Chi2 are 0.0000 and Wald Child2 (2) 158.24 are quite good which means the ability of the five predictors to explain the variation of variables could be accepted statistically.

The Cage Area variable have no effect on the level of economic losses incurred by the cage farmers. This is because the area of ponds owned by fish farmers is relatively constant through out the year. From the data, it can be seen that the economic loss to the area of the Cage has a constant trend, this indicates that the area of the pond is statistically not a variable that affects the level of pond loss. This means that the level of loss of tons of production is relatively the same for the farmer.
3.2 Health Impact Assessment

Analysis of the impact of lake pollution on public health on 120 households in fish cage farmer community using Mc-Nemar test are as follows:

| Before | After |
|--------|-------|
| .0     | 114   |
| 1.0    | 5     |
|        | N     |
|        | 120   |

| Source: own calculations, 2019 |

To test the hypothesis the 0.05 level of significance was used. If the probability of significance is <0.05, then H0 is rejected. On the other hand, if the probability of significance is > 0.05, then H0 cannot be rejected. From the results of the Mc-Nemar analysis test above, the probability value = 0.219 > 0.05. It means the null hypothesis which says that the probability is equal before and after the lake pollution cannot be rejected. In other words, that there are not enough events to say that there are health changes experienced by the community before and after the Lake Pollution Disaster. To be more precise, out of 120 subjects, there were 5 subjects who experienced a change in health impact and 114 subjects did not experience any changes.

The results of the study on health impacts found that there was no significant difference in the health conditions of the public before and after the Maninjau Lake pollution disaster. This condition is understandable, because residents do not use lake water for household consumption needs and residents have anticipated the impact by driving fish directly out of the lake.

The case of lake Maninjau pollution is a portrait of the use of natural resources that does not pay attention to negative impacts on the environment and also ultimately has a negative impact on the community itself. Lake Maninjau pollution in West Sumatra has risen and has become a concern, this is due to pressure from cage fishery activities. Lake should be a natural resource with great potential if managed properly, including as a source of clean water, fisheries, irrigation and agro-tourism. This potential will be very attractive for investors to increase investment which in turn can increase the quality of the regional economy. The lake should also be able to carry out its function as a function of vegetation, namely regulating the hydrological environment through protection of the soil surface from the onslaught of rainwater.

The loss experienced by fish cage farmers due to the pollution of Lake Maninjau did not stop the farmers from doing cage business. There was no significant decrease in the number of fish cage farmers and the to other jobs. The results of field research found a number of factors that led to the persistence of farmers, among others; the benefits gained are far greater than the losses suffered by farmers even after the pollution disaster occurs. Farmers' income increased after the pollution because they get more fish and fat fish. Farmers were not in direct contact with fish and polluted water. Dead polluted fish were taken out of the fish cage. Therefore, farmers did not feel disturbed by the pollution of the lake because lake water was not used for household consumption.

Society accepts the lake disaster as normal, a phenomenon they will routinely receive, so the loss and restlessness of disaster was relatively low. The government was quite responsive by calling people’s attention to how fish cage farming activities are carried out in order to reduce the impact of the lake pollution. Less developed economic activity, namely the lack of diverse economic activities, makes people have no alternative to other types of businesses besides farming.
4. Conclusions
The results of field research revealed that the level of loss of farmers due to pollution of Lake Maninjau was determined by Management Costs (MC1), Maintenance Costs (MC2) and Cage Area (CA). While Business Age (BA) and Total Labor (TL) have no effect on the level of loss of fish cage farmers due to lake pollution. The results of the study on health hazards found that there was no significant difference in the health conditions of the community before and after the lake pollution occurred. This condition was understandable, because the population did not use lake water for household consumption and the population has anticipated the impact by directly taking the dead fish out of the lake.

For fish cage farmer in Maninjau lake, pollution of the lake was a common thing. The community was not too disturbed and has been able to adjust to the disaster. Economic development has a positive impact as well as negative impacts on the environment. Therefore, the economic development system needs to be improved, economic development which considers the environment must be implemented for the sake of sustainability of life because it will guarantee the sustainability of the existence of nature and the environment.

The findings are in line with Hong’s finding in China [4], which argue that restoring the Lake ecosystem in China requires a comprehensive policy and governance model at regional and provincial levels, which must also be built on the implementation of national sustainability strategies. This will achieve the goals of the National Climate Change Program.

This study is expected to be useful for carrying out strategic policies for communities affected by the Lake Maninjau pollution disaster. Where a lot of research conducted is still only in studies related to the chemical problem of lake pollution and there has not been found a specific study on the impact felt by households both economically and in health. The results of this research can be used as material for study and evaluation as well as the effectiveness of the implementation of Maninjau Lake management policies and community empowerment policies affected by Lake Maninjau pollution disaster. Environmental impact analysis is a study of the impact of a planned activity on the environment, which is necessary for the decision-making process.

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