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Reducing Greenhouse Gasses Emission from Energy Consumption in Floating Net Cage Aquaculture (FNCA)

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Abstract

Every sector including aquaculture should be prepared to cope with climate change impacts. Climate change impacts to aquaculture can bring any change to instability of socio-economy and the environment due to its role to support food security, employment and economic growth. Management of aquaculture needs to be modified to face this challenge, not only adaptation efforts but also mitigation efforts. Energy consumption is one of significant source of Green House Gasses (GHG) emission. Therefore, it is necessary to know the detail of energy consumption in aquaculture to find the proper strategy in reducing GHG emission from its operational. This study aimed: (1) to identify sort of energy source used in FNCA; (2) to identify the factors that influences the energy consumption of FNCA. This research was conducted in Cirata Reservoir, West Java Province, Indonesia. This research was conducted in Cirata Reservoir, West Java Province. Quatitative method was applied in this research. The research methodology involved: (1) in depht interview, (2) analysis of existing data through institutional reports and (3) observation. This study showed that: (1) farmers of FNCA in Cirata reservoir consume renewable and non-renewable energy for their daily activities; (2) factors that influence the energy consumption in FNCA are location, operational pattern, number of dwellers, types of boat and electricity sources.

INTRODUCTION

Sustainable development that is applied in every sector is having a huge contribution to climate change mitigation includes aquaculture. Mitigation refers to efforts in reducing or preventing emission of greenhouse gases (GHG) (OECD, 2008). Since there is no standard applicable list of mitigation measures that works universally, the appropriate practices should be evaluated specifically based on the sector. To find the suitable efforts, participation of all stakeholders is needed to have an effective process especially in developing countries that are lack of information regards to mitigation of climate change (IPCC, 2007).

Aquaculture, as with other agricultural activities, provides ecological services and also affects the environment by degradation that is caused by material utilization of input and resource to get expected output (FAO, 2011). Although it makes a minor but still contribute significantly to greenhouse gasses (GHG) emissions during its production operations and other stages such as transport, processing and storage. Aquaculture development represents a potential threat to greenhouse gas sinks and reservoirs since aquaculture practices compose a largely undefined source of greenhouse gas emissions. Sources of greenhouse gas emission especially carbon within aquaculture practice is related to energy consumption through fuel and raw material use and through management of distribution, packaging and other supply chain components (FAO, 2014).

This research is focused on energy consumption of floating net cage (FNCA) in Cirata Reservoir. Currently, the population of FNCA reached 54.699 slots in 2012 and 77.000 slots in 2015 (BPWC, 2012; Jalaludin, 2017), whereas only 12.000 slots are officially allowed according

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to the Governor's Decree No. 41/2002 (Lembaga Ekologi Unpad, 2017). Despite of its role in supplying fish consumption in Java, it puts pressure on the water quality and threatens the designed age of the reservoir. For the sustainable reservoir and FNCA management, it is important to take mitigation efforts into account. Therefore, it is necessary to identify sort of energy source used in FNCA and to identify the factors that influences the energy consumption.

RESEARCH METHOD

Qualitative method was applied in this research. In depth interview was conducted to several FNCA farmers as key informants in Cirata Reservoir, West Java Province. They represented three regencies: Bandung Barat Regencies, Purwakarta Regencies and Cianjur Regencies Key informants were selected based on several criteria: position in farmer groups (leader in farmer group), length of FNCA ownership (minimum 5 years) and type of energy sources used (solar cell and electricity from PLN). The questions are focused on source of energy used in FNCA, amount of energy used per month and their activity related to energy consumption such as transportation, cooking and lighting. Triangulation of methods was also applied in this research where interviews with key informants are combined with observation and literature analysis (desk study) to avoid any bias (Cresswell, 1994). Results were descriptively analyzed.

RESULTS

For FNCA operational, sort of energy that is used to support all activities consists of fossil fuel (diesel fuel, gasoline and kerosene), liquefied petroleum gas (LPG), electricity and solar cell. These information are summarized in Table 1.

Table 1. Energy Consumption in FNCA

No.	Energy Sources	Activity	Average amount/ household	Factor that influences the energy consumption
1.	Gasoline	• Running machined boat • Running pump (to cope with turn over) • Running electricity generator	5-40 l/month 2-40 l*/occasion 3-5 l*/occasion	• Location of FNCA • Type and number of boats • Operational pattern • Electricity Resources
2.	Diesel Fuel	Running machined boat	10-40 l /month	• Type and number of boats • Operational pattern
3.	Kerosene	A mixture for wood boat adhesive solution	1 l/month	Operational pattern
4.	Liquified Petroleum Gas (LPG)	Cooking	1-2 gas holders (netto 3 kg)/month	Number of dwellers
5.	Electricity from National Electricity Company (*Perusahaan Listrik Negara/PLN*)	• Lighting • Electronic appliances	300 kwh/month	• Location of FNCA • Number of dwellers

No.	Energy Sources	Activity	Average amount/ household	Factor that influences the energy consumption
6.	Solar Cell	• Lighting • Electronic appliances	Size 50 x 50 cm	Location of FNCA
7.	Others : Battery	Lighting	Size A2 and D	Operational Pattern

*) occasionally

Source: Primary Data, 2019

Gasoline becomes the most fossil fuel used in every house hold of FNCA. Every month, farmers buy gasoline for different purposes. They use gasoline mostly for running the small machined-boat, approximately 30 l/boat per month. Farmers use gasoline mostly to transport from their FNCA to land (the closest quay) and reversely. They do buy stuffs such as food, fuels and other things they need to live in their FNCA. For those who are living in FNCA without their family and own a house in the land usually go back to their home in the land to meet their family in the day after feeding their fish in the morning. They need to come back to their FNCA to watch and feed the fish particularly in the evening. They need to do it for security reason since robbery happened in the night. In contrast, those who stay with their core family or live alone far away from their family likely to stay in FNCA through day and night.

In several spot of reservoir, farmers have to face the turnover occasionally, minimum once a year. Gasoline is also needed to run the aeration pump and the electricity generator. Aeration pump is needed to minimize fish death when turnover is coming. They usually need 2-40 l for 5-7 days turnover. It enforce them to consume more gasoline to run their aeration pump. The aeration pump helps to enhance the dissolved oxygen during the turnover so that the fish death can be minimized. But for other farmers who have no aeration pump, they have no other way to solve it. They just try to do everything they can with any equipment they have such as using their rowboat to create the wave, swimming or even just let the turn over happen without trying any effort to avoid it. Other use of gasoline is for electricity generator which is needed to run the aeration pump during harvesting the fish. It consumes fuel 3-5 l/day. This amount of fuel is only consumed by farmer who use solar panel, which its electricity supply is not adequate for running the aeration pump.

Besides gasoline, farmers also use small amount of other fossil fuel diesel fuel and kerosene. Diesel fuel is only consumed by those who have big boats, 10-30 l/month. Not many farmers have this kind of boat which has large capacity to transport feed and fish. Most farmers use small boat with gasoline. Kerosene is consumed for boat maintenance, as a mixture for wood boat adhesive solutions. Its function is to dilute the solution. In a month, they use less than 1 l kerosene.

LPG is mostly used in every household for cooking. Farmers usually buy 1-2 gas holders of 3 kg LPG per month. They use LPG only for daily cooking. Some of them also prefer to buy food rather than to cook by themselves for practicality reason particularly those who stay alone in FNCA. Most household with minimum 2 dwellers likely to use LPG. Most of FNCA is daily inhabited by two people, the farmer (as head of family) and a member of family (son, wife, relative or a paid worker). Family of 4-5 members are rarely found since they usually have a house in the land and they spend most of the weekdays there. The whole family just visit the FNCA in the weekend.

To fulfill their fuel need both fossil fuel and LPG, they have to go to the land and buy the fuel in gas and petroleum station (SPBU) or the closest mini shop (*warung*) in the quay or floating mini

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shop. Some of them sometimes buy the fuel from the mobile seller who regularly visit their area. The seller provides little amount of gasoline besides other product such as coffee and snacks.

For the electricity, other than running the electricity generator, farmers also get the electricity supply from *PLN* (National Electricity Company). Electricity is used for lighting and using electrical appliances such as TV, radio, refrigerator, mobile phone and rice cooker. Farmers pay the electricity bill from Rp 50.000 – Rp 200.000 per month (900 kWh is usually divided into to three to four households). For those who cannot get the electricity from PLN, they decide to set the solar panel.

Solar panel is chosen since electricity instalment from PLN cannot reach their FNCA location or if it is reachable, the cost for the instalment is too expensive. They need to set the network cable from one of the house in the land to their FNCA in the water. Consequently, the further from the land, the more expensive cost as they have to pay to install the electricity. Thus, there are many farmers prefer to install solar cell rather than electricity of PLN.

Other than solar panel and electricity from PLN, some farmers use only a flash light with batteries to guard their unit. They find it simple yet cheap because they only need to watch small number or slot.

DISCUSSION

There are two kinds of energy used in FNCA, non-renewable (fossil fuel) and renewable energy (solar cell). Gasoline becomes the main fossil fuel used in FNCA. It is widely used not only for transportation but also for electricity generator and running aeration pump. Not only gasoline, diesel fuel is also used for running the machined boats. It shows that transportation become the main activity that potentially emit GHG in FNCA particularly CO_2 (Ulengin et al., 2018; Tayarani et al., 2018) It can be seen from the number of fossil fuel particularly gasoline and diesel fuel that can reach 40 l/month/household.

Amount of fuel used in transportation depends on several factors: location of FNCA unit, sort of boat, number of boat and operational pattern of FNCA. Small boat intends to consume more fuel because it is used for daily transport. Big boat is only used for transporting feed and fish seeds from the quay to the FNCA, one till two times within 3 months. Operational pattern of FNCA particularly for those who always go back to their house in the land in consuming more fuel than those who stay in the water. It influences how they transport and consume the fuel (Bunting & Prety, 2007).

Turnover which likely to happen minimum once a year cause farmers consume more fuel to tackle it. Larger scale farmer usually have more aeration pump (usually called *alcon* or blower) than those who have less slot. Per session turnover can take 5-7 days and spend 3-5 l gasoline per *alcon* (Nurani, 2014). This practice potentially emit GHG.

Amount of LPG consumed depends on how many people stay in the house (Amoah, 2019). Farmer who live with family in FNCA consume more LPG than those who only live with one worker or stay alone.

Location and the technical issue matter in electricity instalment (Almeshqab & Ustun, 2019). They set the network cable from one of the house in the land to their FNCA in the water. Consequently, the further from the land, the more expensive cost as they have to pay to install the electricity. Thus, there are many farmers prefer to install solar cell rather than electricity of PLN. In terms of GHG emission, this practice is already reducing the GHG emission.

CONCLUSION

Farmers use non-renewable energy (fossil fuel) and renewable energy (solar panel) as their energy source of FNCA. Gasoline is the most fossil fuel consumed in FNCA particularly for transportation.

The energy consumption in FNCA are determined by the location, operational pattern, number of dwellers, type of boats and electricity sources

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