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Bio-Keramba Design Innovation as an Effort to Overcome The Waters Pollution of Local Fish Cultivation in Saguling - Jatiluhur Reservoirs, West Java

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ABSTRACT : The development of floating nets (KJA) by farming communities is very rapid in fish cultivation in Indonesia. The fact that the use of keramba became environmental unfriendly since it leaves waste within the water body. The presence of fish feed deposits contaminate the water column to lake bottom sedimentation which can pose a threat of pollution. This study is aimed to find a solution to mitigate the lake pollution by proposing Bio-Keramba as the eco-techno engineering design to minimize the pollution of aquatic environments and sedimentation; using organic waste decomposition micro bacterial technology developed in sub-based buoyancy. It's explores the technology concept on readiness levels to support government policies in enhancing aquatic friendly of fisheries cultivation especially in lakes or reservoirs. This study uses a contextual-interpretative-design methods on where as the Saguling and Jatiluhur reservoirs are selected to be the case studies. Besides resulting the Bio-Keramba engineering design innovation. This research is also expected can benefit to the development of architectural design engineering to water environmental management, that will lead to the education of fish farming community activities in Indonesia.

KEYWORDS: waters pollution, eco-technology, friendly-fish farming, bio-keramba, Saguling and Jatiluhur reservoirs.

I. INTRODUCTION

The cultivation of floating net (KJA) is has been widespread activity in Indonesian waters bodies, either rivers, lakes, reservoirs or even sea. Although it provides opportunities for farmers for fish farming, but the cultivation of the KJA system is a serious matter that causes water pollution. Saguling and Jatiluhur reservoirs in West Java are exemples how the overfeeding in fish farming activity has caused servere pollution to the water body[1][2][3][4][13]. The phenomenon of initial observations was carried out in the Saguling and Jatiluhur reservoirs, where KJA resulted not only eutrophication but also sedimentation. Worse situation is found, in the dry season as the increasing of methane gas in water column, has caused the death of fishes and damage of hydropower facilities [16]. To comply with the increasing pollution impact, the regional government is trying to eliminate the KJA system within the reservoirs. However, the process is very difficult since KJA system has been an economic support to many local communities for years. This study is initiated to develop an environmental friendly bio-keramba that may offer an alternative solution to the problem by applying the eco-technology to decompose fish feed waste [17]

II. LITERATURE REVIEW

The following literature review outlines the theoretical foundation for these design ideas related to various aspects, such as: environment, socio-economy, spatial law, eco-technology, cultural adaptation and resilience, and bio-cage design. This study has three research pillars [1][2][3][4] [13][14],

1. Ecological aspects, sustainaquality environmental
2. Social aspects of regard to increase the awareness of related community in utilizing the lake; and
3.The economic aspects, to improve the benefits of local community by introducing bio-keramba technology

These actions are absolutely important to support the government's policy to develop lake tourisms in Indonesia to meet the standards of UNESCO-Global-Networks, namely Geo-Bio-Cultural Diversity.

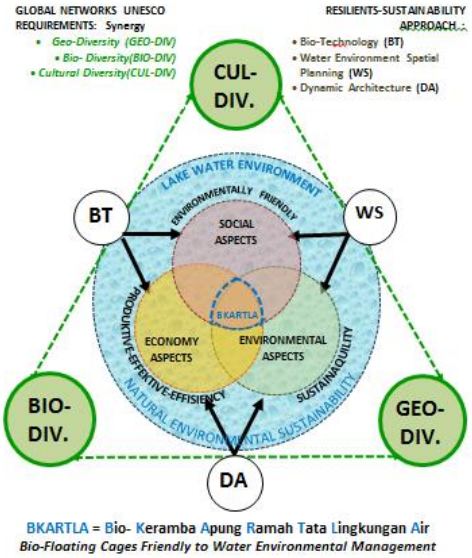

Figure 1: Eco Engineering Research Concept Bio-Keramba Technology
Source: (Kusliansjah,2018)

Floating Net (KJA) : Floating nets (KJA) is a mean of maintaining fish using nets as the main part. By using KJA, fish maintenance can be done in the sea or freshwater media such as lakes or reservoirs, which have more depth than rivers or ponds [5]. The application of KJA for fish farming in Indonesia starts from the construction of simple cage buildings. In today's modern era, fish farming no longer requires a large place to be used as a maintenance pond. Besides being used for fish farming, KJA can also be used for the cultivation of vanamae shrimp and lobster shrimp. In principle, all ingredients for making KJA are almost the same.

Figure2: Traditional Floating Net (KJA)
Source: Permadi,2016

Construction of Floating Net (KJA)

Table.1: Construction of Floating Net

No.	Components	Technical specifications
1.	Skeleton or Raft	It serves to place cages or enlargement nets, as well as a foundation, a place to install nets and supporting facilities for cultivation. Conventional floating net frameworks made of wood beams, boards and bamboo.
2.	Net bag	It is an important component in a series of KJA. The size of the net used is adjusted to the size of the fish that is maintained. The type of material used for making mesh bags, namely hapa and waring, each of which has a different eye size. Hapa is a small woven monofilament plastic string The hapa and waring bags are made by stitching and both are used for seeding.
4.	Buoy	It serves to float the entire cultivation facility, as a place to lay the framework and also the crossing pontoon. The buoys used are mostly plastic drums with a capacity of 200 liters.

5.	Net weight	It is intended to stretch the net vertically and horizontally. Net ballast usually has a weight of approximately 5 kg and is hung on the outside of the net, in each corner and center with a distance of about 1.5 meters.
6.	Anchor	It is equipped with a weight of around 2 x 50 kg installed as much as necessary to maintain the position of the floating net in the water. The anchor is anchored slightly at each corner.

Source : (Syafitrianto,2015) [17]

Various types of floating net : However, the shape and size are different because they are tailored to the needs. There are several types or types of floating net currently used by farmers, namely circle, square and octagonal floating net [9].

Figure 3: Circle Floating Net
Source : (PTGani ArtaDG, 2015)

Figure 4: Square Floating Net
Source : (Permadi, 2016)

Figure 5: Octagonal Floating Net
Source : (PTGani Arta DG, 2015)

Technical Requirements for Floating Net

Table. 2: Technical Requirements for Floating Net

No	Requirements	Technical Location Description
1	Water flow	The water flow at the chosen location is not too strong, but there is still a flow so that water changes are still good and the dissolved oxygen content in the fish culture container is sufficient. In addition, with the flow, it can wash away the remaining food and fish droppings that fall on the bottom . In conditions of non-flowing waters, the cultivation unit should be placed in the middle of the water parallel to the coastline.
2.	Depth of water	The depth of the waters greatly affects the quality of water at that location. As the basis for benchmarking at the lowest ebb, the water depth should be more than 3 meters from the bottom of the net.
3.	Fertility rate	In public waters and reservoirs in terms of fertility levels can be grouped into waters with low fertility (oligotropic), moderate (mesotropic) and high (eutropic) waters. Water types that are very good for use in fish farming in floating nets with intensive systems are waters with low to moderate fertility levels.
4.	Free from pollution	In the world of fisheries, what is meant by water pollution is the addition of something in the form of material or energy into the waters which causes changes in water quality so as to reduce or damage the water use value and water resources of the water. If the cultivation location contains pollutants it will affect the life of the fish that is kept in the container.
5.	Water quality	In fish farming, in general water quality can be interpreted as any change (variable) that affects the management, survival and productivity of cultivated fish. Water quality includes physical, chemical and biological properties.
6	Location KJA	This location is protected from up-welling, which can cause mass deaths.

Source : (Permadi, 2016)[6],

Economic Advantages of Floating Net-based Fish Cultivation : Fish farmers spread fish seeds at the beginning of the maintenance period until the harvest arrives. The farmers prefer to use floating net rather than maintaining them in the conventional way, because this cultivation system is technically and economically proven to be productive, efficient and effective. Some economic advantages of fish farming in floating net: a. Increase the efficiency of resource use; b. Increase the fish production; c. Provide more regular income to fishermen.

Bio-Keramba Floating Net

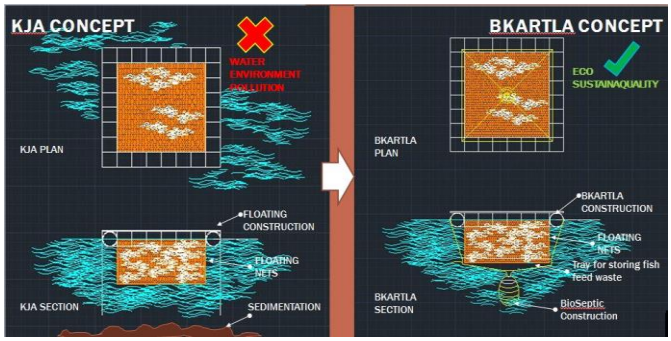

Figure 6: Bio-Keramba Floating Net Concept
Source : (Kusliansjah, 2018)

Reforming the fish culture in floating net Bio-Keramba using microbacteria, certainly cannot be separated from social paradigm that needs to be enhanced through the process adaptation of cultural techno striving to maintain a culture good (resilience) in fish farming communities and water based environment communities.

Floating Net Pollutes the Environment. The problem with fish farming using in floating net is basically the remaining feed. The rest of the feed according to Syafitrianto (2015)[5], which is not consumed and metabolically in the form of nitrogen and phosphorus compounds, if it is wasted in the water column and is not utilized by organisms around the lake or reservoir (fish, benthic organisms), it will become suspended particles in the form of colloidal particles on the bottom of the water. These particles will be used by micro-organisms, especially bacteria for their growth and breeding. In addition to pollution due to nitrogen and phosphorus, the remaining feed can also cause high turbidity[8]. As a result, the sunlight will be difficult to penetrate the water column. Toba lakes or Saguling and Jatiluhur reservoirs as a few examples of the natural water reservoirs that has a vital role as well as extraordinary cultural and beauty content, is currently threatened with pollution. In addition to organic waste originating from domestic activities of household residents, one of the activities that also becomes a public spotlight is fish farming activities using floating net [15].

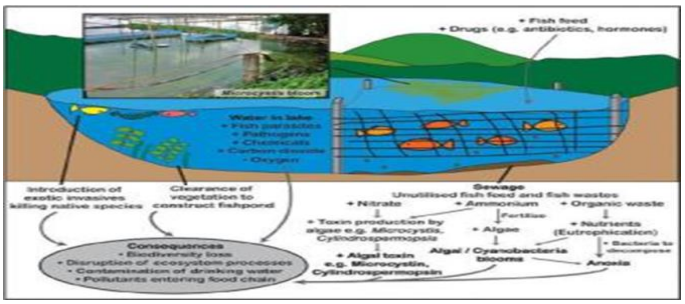

Figure 6: Application of Fish Farming with Waste, Sedimentation and Turbidity of Water**.**
Source : (BP Geopark Toba Caldera, 2017)[14]

Aspect of Environmental Law

Table 3:Aspects of Environmental Law

Law No. 32/2009 RPPLH		
1	Article 12	Natural resource utilization is carried out based on RPPLH. In the event that RPPLH has not been compiled, the utilization of natural resources is carried out based on the carrying capacity and capacity of the environment
2	Article 17. 2.b	All businesses and / or activities that have exceeded the carrying capacity and capacity of the environment are no longer permitted.

3	Article 98, (1)	Any person who intentionally commits an act resulting in exceeding ambient air quality standards, water quality standards, sea water quality standards, or standard criteria for environmental damage, shall be punished with imprisonment for a minimum of 3 (three) years and a maximum of 10 (ten) years and a fine of at least Rp. 3,000,000,000 (three billion rupiah) and a maximum of Rp. 10,000,000,000 (ten billion rupiah).
4	Article 99, (1)	Anyone who, due to his negligence, has exceeded ambient air quality standards, water quality standards, or standard criteria for environmental damage, shall be punished with imprisonment for at least 1 (one) year and no more than 3 (three) years and the most fine a little of Rp1,000,000,000 (one billion rupiah) and a maximum of Rp.3,000,000,000.00 (three billion rupiahs).
5	Article 100,(1).	Any person who violates waste water quality standards, emission quality standards, or quality standards for crimes is punished, with a maximum imprisonment of 3 years and a maximum fine of Rp. 3,000,000,000 (three billion rupiah).
6	Perpres 81/ 2014, Pasal 6	Development of a world-scale tourism area that is integrated with the control of cultivation areas in accordance with the capacity to support and accommodate the environment as well as adaptive to natural resources.

Source : (BP. Geopark Toba Kaldera , 2017)[14]

Efforts to Overcome Water Environmental Pollution due to Cultivation of Floating Net Fish

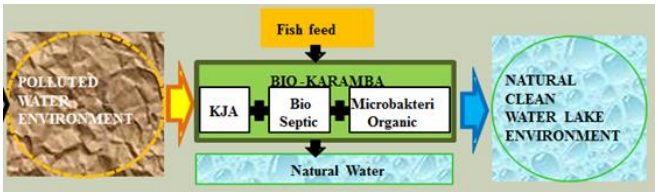

Figure 7: Efforts to Overcome Water Environmental Pollution due to Cultivation of Floating Net Fish Framework Chart.
Source : (Kusliansjah, 2018)[13]

The efforts to overcome water pollution due to traditional KJA fisheries culture are engineered by applying KJA principles that are refined with waste bags (bio-septictank) fish feed and can be neutralized with environmentally friendly Eco-Technology. This concept is the basis of Bio-Keramba engineering using this microbacteria. This effort needs to understand and apply understanding of adaptation and resilience as follows.

Biological waste treatment system : Basically a water body has the natural ability to restore its carrying capacity if it experiences a decrease in water quality, especially caused by organic waste. However, this restoration process is strongly influenced by the concentration of the load of organic waste that pollutes the water body. Water bodies that receive large amounts of waste will need more time to be able to restore their carrying capacity, because the process involves the role of microorganisms, especially bacteria to decompose organic waste. In very bad conditions, it is not possible for the body to lose its ability to recover. Along with the rapid development of science and technology in the field of microbiology, including the use of bacteria to restore polluted water bodies, it has become the center of attention in a number of countries, such as the United States, Japan and China. Especially in China, the use of bacterial technology has been applied not only in the processing of factory wastes [11], but also in communal septic tanks, lake waters [12], and river waters cleaning [7][11].

Environmental Adaptation and Resilience : Adaptation is the ability of living things to adapt to their environment. There are several ways of adjusting that can be done [13]; 1). adjusting the shape of organs, 2). adjusting the work of organs; and 3). Adapting the behavior in response to environmental changes. Based on the definition of adaptation, there are three kinds of adaptations: 1) physiological adaptation; 2) behavioral adaptation; and 3) morphological adaptation. Resilience is a proactive approach in preparing to deal with natural / non-natural disasters better which through appropriate planning will help a community accelerate its recovery. Resilience is the ability to adjust to changing circumstances and maintain or regain functionality and vitality in the face of pressure or interference. This is the ability to bounce back after a disturbance or obstacle. On various levels of individuals, families, communities, and regions through resilience, we can maintain conditions that can be inhabited in the event of natural or non-natural disasters, or other disturbances in available resources.

III METHODOLOGY

The methodology of this study applies the resilience-based approach based on the synergy of Geo-Bio-Cultural Diversity for Saguling and Jatiluhur reservoirs. At the beginning, the works would be done for one year, The applied contextual-interpretative-design development methods approach can be systematically understood on the research framework as presented in Figure 8

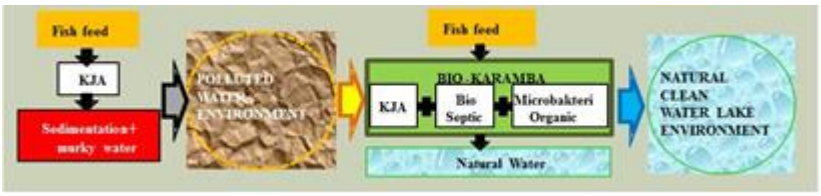

Figure 8: Research Framework Chart
Source : (Kusliansjah, 2018)[13]

IV. RESULTS AND DISCUSSION

Innovation of Tumpangsari Bio-Keramba Floating Net : The process of changing traditional KJA fisheries culture to be environmentally friendly needs to be engineered with eco-technology-based aquaculture in the form of Tumpangsari Bio-Keramba. The process of using microbacteria is of course certainly inseparable from paradoxical social problems, through processes of education and adaptation that require to be adapted through a culture of local wisdom, which maintains good cultural habits or resilience in the community of fish farmers and community water environments. This effort needs to learn and apply to understand the process of adaptation and resilience to reduce pollution due to aquaculture in the KJA system, including: 1) using the right dose in feeding, 2) using feed ingredients with high digestibility, 3) if possible, it can use probiotic bacteria to increase digestibility, 4) using nutritional composition that is suitable for the organism that is maintained, 5) treatments for waste are carried out, 6) it is necessary to analyze the suitability of the land before conducting cultivation activities.

Biological waste water treatment system : This research study is intended to design environmentally friendly floating net based on bacterial technology that can be utilized by aquaculture farmers

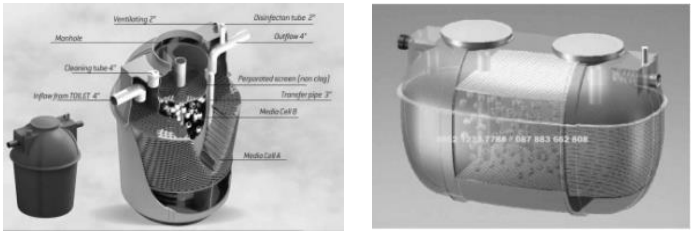

Figure 9: Variety of Bio-Septic Containers that can be Used to Neutralize Fish Feed Waste for The Water Environment
Source : (Biosong Manufacturer,,2018)

Tumpangsari Bio-Keramba Structure and Construction Design : The innovation of eco technology – Tumpangsari Biokeramba can be formulated based on sustainable principles of innovation as follows.

Table 4: Designing Phases, Output and Indicators

Stages	Output:	Indicator:
Stage1. Orientation; Formulation of problem statements, especially related to the environmental and cultural significance of living in the Lake Region	Physical data, Eco, Socio-Cultural and Quality analysis, resilience, and water based culture	Data available; There are results of data analysis.
Stage 2. Conceptualization;	Design criteria for the	Compilation of

The process of understanding conceptual concepts related to problem statements must be found solutions (design as problem solving). In this stage, we study how to solve the idea of Bio-cages, related to the environment and culture of the activities of the fish farming community in the lake area, so that they can be conceptualized as the initial design of the Bio Keramba Lake.	Bio- Keramba Lake model; The design concept of the Bio-Keramba Lake model	design criteria; The composition of the Bio-Keramba Lake Concept
Stage 3: Investigation The process of exploration, experimentation, collection and analysis of data through laboratory tests. Information retrieval process and primary data collection, secondary data and institutional data. Investigation of the study and formulation of the design criteria for the Bio-Keramba model; for laboratory tests	Construction of models, laboratory tests	Test model available; Laboratory test results were successful.
Stage 4: Design and Development Making relations and formulation or making syntheses that give rise to the beginning of new knowledge. This research produced new ideas in the design and development of the Bio-Keramba Lake model	DED Tumpangsari Bio-Keramba Lake model design,	Figure DED design of the Tumpangsari Bio-Keramba Lake model

Source : (Kusliansjah, 2018)[13]

This type of nets consists of two layers of net. The 'inner cage' layer to maintain small fish; while the 'outer cage' layer is to maintain larger fish. In construction, the type of Tumpangsari Bio-Keramba is connected to the microbiosepticktank system in the outer layer cage. In principle, the recycling process of fish feed waste is carried out in stages. 1). the waste from the inner layer cage will fall into the outer layer cage to eat the fish there. 2). remaining wastes in the outer layer cage will enter micro bio-septictank. 3). microbacteria will work to decompose the remaining fish feed waste in biosepticktanks until the results of the waste will be environmentally friendly if they are released from the surrounding lake waters.

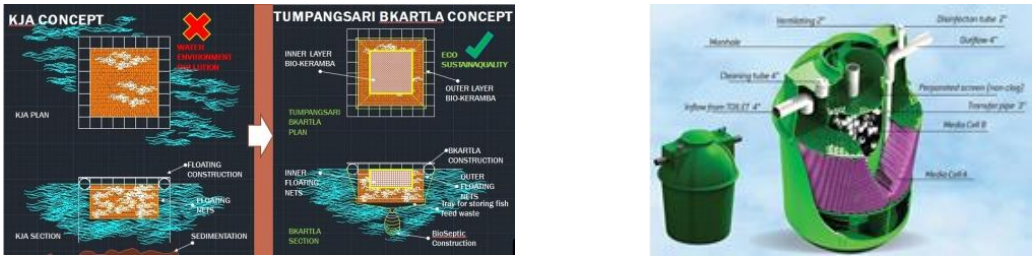

Figure 10 : Tumpangsari Bio-Keramba with Components
Source : (Kusliansjah,2018)

Local Bacterial Technology : Restoration efforts by utilizing local bacterial technology in Indonesia is highly expected, even though today's bacterial engineering in the world has achieved much success. The success of this technology in addition to producing clear water conditions, at the end of the period river restoration is identified as meeting the required water quality criteria, especially dissolved oxygen known as 1) dissolved Oxygen (DO) 2) biochemical Oxygen Demand (BOD) and 3) chemical Oxygen Demand (COD). Although a number of illustrations above illustrate the successful application of bacterial technology in an effort to improve the performance of sewage treatment plants and the recovery of polluted water bodies, practically applying this method requires certain conditioning. Especially the river [5], given that the injected bacteria will be conditioned by the flow of the river, it is very possible that waterways need to be modified to control the flow rate and to avoid unnecessary rinsing of bacteria. In addition, the performance of the bacteria itself is basically strongly influenced by local conditions such as the following: 1) dissolved oxygen concentration, 2) amount of nutrient content, 3) air temperature, 4) toxic waste content, and so on.

Eco-Sustainaquality : From the analysis of the quality of the water environment, it is known that excessive fish food nutrition is one of the sources of water pollutants that can cause water to experience eutrophication conditions and eventually lead to death in its aquatic ecosystems. This is as experienced in a number of large reservoirs, namely Saguling, Jatiluhur reservoirs, and others. The government has so far sought to control or limit the amount of floating net cultivation that is now increasingly interfering with the waters of many reservoirs

and lakes. However, it cannot be denied that floating net aquaculture has become a source of income for local residents, which of course will have a serious impact if it is prohibited

V. CONCLUSION

Environmental pollution is a serious problem, which needs to be addressed immediately by the local government. The water environment of reservoirs, lakes and other water environments will be polluted if the aquaculture is still allowed. Prohibition is certainly not a wise solution. Need to select a suitable location for aquaculture. In order not to disrupt infrastructure operations do not be in the location of a critical water environment or a protected location due to the presence of vital infrastructure, such as power plants, raw water sources, etc. It is strongly recommended that academic research can recommend suitable locations, and can propose the development of findings of Tumpangsari Bio-Keramba based on eco-technology to provide environmentally friendly solutions for aquaculture in the reservoir or lake water environment.

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