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Water quality analysis of post-event up welling and step anticipation in aquaponics locations of maninjau lake

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ABSTRACT

In up welling events that occurred on 22 February 2016 has led to rising toxic gas from the bottom, so the fish are reared in floating net cages mass death. Aquaponics has been developed since 2015 yet has not been able to work optimally in the recycling of waste fish feed, because it has not unbalance amount aquaponics with floating net.Therefore, we take samples two times, February 28, 2016 and March 19, 2016 using a depth of 1m, 5m and 15m, and the results are as follows: sampling I (D0 0-4.1 mg/L, turbidity 0-359 NTU, pH 7,8-8,2, temperature 28-28.3°C, Ammonia 16.45-27.3 mg/L phosphates 13.65-15.53 mg/L, and sulfide 1.36-1.62mg/L), while sampling II (D0 0-4.2 mg/L, turbidity 6-1265 NTU, pH 7,8-8,1, temperature 28.2-29.5°C, Ammonia 20.65-24.85 mg/L, phosphate 2.25-2.91mg/L, and sulfide 1.0 -1.42 mg/L). Based on the above data, the water quality of Maninjau Lake after up welling is not feasible for fish farming in floating net cages , mainly the depth more than 10 m.

Key words: water quality, up welling, floating net cages, aquaponic, not feasible

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INTRODUCTION

Maninjau is a complex ecosystem, and a lot of physical phenomena that affect the stability of the ecosystem of the lake, one of which is up welling. Up welling is a phenomenon that is common in some waters such as lakes / reservoirs and seas / oceans are affected by wind-driven motion (wind moving) strong, cold usually brings water masses rich in nutrients toward the surface of the sea. Conversely, marked by the convergence downwelling currents and warm water intrusion [1]. In addition up welling can also be interpreted as a phenomenon of the increase in mass of water of the lake. Rising movement of water mass is also caused due to the stratification of such layers have different densities in each layer as with increasing depth of water, the temperature will fall and the density increases, causing energy to move water masses vertically.

Unlike the events of up welling in the ocean, where rising water brings lots of useful nutrients, overturn or reverse flow in the reservoir/lake actually cause a rise in toxic gas from the seabed to the surface of the water, because it can turn off kultivan in it. This is due to the increasing number of organisms are cultured in fish floating net cages resulting residue buildup artificial feed/pellets. Besides the metabolism of cultivan such as urine and feces. Accumulation of organic materials causes the decline in oxygen levels and increased levels of NH_3, NO_2 and H_2S at certain concentrations can be deadly fish. Fish waste can lead to increased deposition at the bottom, next to eutrophication in the bottom.

Fish farming with the fish floating net cages on the lake is a pellet-based cultivation, in other words the efficient operation of micro, but macro inefficient, especially when viewed in terms of its impact on the environment. Growth in the number of cages continue to increase, which means continuously increasing number of farmed fish will produce a large amount of organic waste as a result of feeding is not effective and efficient [2].

At the moment the amount exceeds a certain limit may result in sedimentation process form feed residue buildup on the bottom, the waste will cause a decrease in water quality (reduction of oxygen supply and water pollution of the lake/reservoir) which in turn affects the animals are reared. Food remains and metabolism of activity pisciculture in the fish floating net cages and domestic waste originating from agricultural activities as well as from household waste into major cause of declining ecosystem functions of the lake which ended in pollution of the lake, ranging from eutrophication caused the explosion (blooming) phytoplankton and aquatic weeds such as water hyacinth (Eichornia crassipes), up welling and others that can lead to aquatic organisms (especially fish farming) and ending with the increasingly thickening anaerobic layers in lake water bodies [2].

Fish feed is the highest contributor of organic matter in the lake/reservoir (80%) in producing environmental impact. The amount of feed that is not consumed or wasted in the bottom of the water by the fish around 20-50%. Various opinions regarding the amount of feed that decomposes in the lake / reservoir [3-7].

Fish waste can lead to increased deposition in the bottom waters, subsequently resulting in decreased oxygen levels in the base. According to [6], the supply of oxygen in the management of fish floating net cages is for biota respiration, decomposition of fish feces and decaying leftover fish feed. According to every gram of organic (waste fish farming) is required 1.42 grams of oxygen. The concentration of available oxygen directly affect aquatic life, especially aerobic respiration, growth and reproduction.

Most of the nitrogen in the water contained in the form of gas, while the rest is in the form of ammonia, nitrate, nitrite, urea, and dissolved organic compounds. 0rophosphate an inorganic form of phosphorus that can be directly used by phytoplankton for growth, although needed in small amounts, phosphorus is usually the limiting factor in the waters [8].

On one hand, the development of fish farming in the fish floating net cages will have a positive impact in the form of creation of new jobs and increase the income of local people, but on the other side of this business will also bring a negative impact on the aquatic ecosystem, caused by waste feed. If the concentration exceeds the threshold, can pollute and poison the biota in the lake waters. Genesis mass mortality of fish is not only the economic impact but also caused social impact to the community. The social impact in terms of loss of livelihoods number of workers, the increase in debt to continue the effort and decreasing quality of public consumption directly affected. Furthermore [9] suggest to look for the right policy option that the utilization of the waters of Maninjau lake can take place on an ongoing basis in accordance with the principles of sustainable fisheries development.

Use of Aquaponics offers solving solutions, for applications aquaponics technology makes it possible to recycle the waste feed in the waters into nutrients for plants (Figure 1). Similarly, waste from fish waste are soluble in water may be used as a natural fertilizer for plants hydroponically [10-11]. Aquaponics is unable to anticipate the existence of the above issues, because the numbers are still very small compared with the number of floating net cages [11].


Figure 1. Aquaponics

Problems always arise in the culture system is the floating cages environmental pollution caused by various activities around the waters and farming itself. This contamination can be either physical-chemical pollution in particular (temperature, turbidity, pH, DO, ammonia, phosphates and sulfides). Although aspects of physics - the chemical was never investigated, but experts and water managers have always advocated that the water pollution research needs to be conducted continuously remember every time can only change the environment.

Various problems have arisen, disrupt and threaten the functions Maninjau for lake environmental degradation has occurred as a result of the process of up welling. To that end, the information about the water quality parameters need to be raised to be used as an indicator of water quality as well as a comparison in monitoring the development of the waters by referring to Government Regulation No. 82 of 2001 on the Management of Water Quality and Water Pollution Control.

This study aims to determine the condition of the water quality of some areas of aquaponics in floating net cages. From this research is expected to be known water quality parameters that play a role in the fish floating net cages.

MATERIALS AND METHODS

Purpolsive research method uses random sampling with eight sampling sites in fish floating net cages, each with a depth of 5 m, 10 m and 15 m. Water quality parameters were measured: temperature, turbidity, pH, DO, ammonia, phosphates and sulfides. In situ parameters analyzed are temperature, turbidity, pH, DO. While the parameters of ammonia, phosphate and sulphide were analyzed in the Analytical Chemistry Laboratory of the Andalas University.

RESULTS AND DISCUSSION

Comparison of the results of field measurements and laboratory analysis with quality standards for freshwater fish farming activities (class II) in accordance with Government Regulation No. 82 of 2001.

Table 1. Condition of water quality sampling waters of I and II

Parameter	Unit	Quality standards	Sampling value	
			I	II
Temperature	°C	20-32	28-28.3	28.2-29.5
Turbidity	NTU	<5	0-359	6-1265
pH	-	6-9	7.8-8.2	7.8-8.1
DO	mg/L	>3	0-4.1	0-4.2
Ammonia	mg/L	<0.02	16.45-27.3	20.65-24.85
Phosphate	mg/L	<0.1	13.65-15.53	2.25-2.91
Sulfide	mg/L	<0.002	1.36-1.62	1.01-1.42

Temperature

Solar radiation that arrives and goes into the waters will provide heat energy in a body of water. If the amount of radiation absorbed by the waters managed differently, then the temperature generated will also differ. The measurement results obtained showed that the temperature was still in accordance with quality standard value Government Regulation No. 82 of 2001 grade II for freshwater aquaculture, which is 28-28,3^{0}C on 28,2-29,5^{o}C sampling I and II (Table 1; Figure 2). Temperature is very important for the life of aquatic organisms because it can directly affect the metabolism and solubility of other gases such as oxygen and power toxicity nitrogen compounds such as nitrites and ammonia.

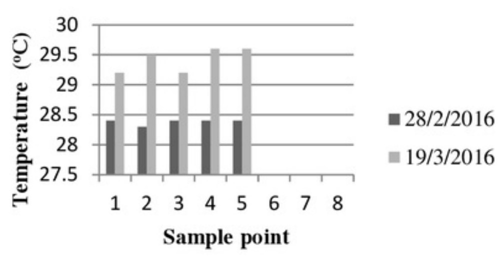

Figure 2. Temperature (°C) at different sample point

Turbidity

Turbidity caused by the presence of fine suspended solids and dissolved solids in the water. Suspended solids and dissolved inorganic and organic nature such as quartz, clay, loam, crop residues, plankton and so on. Turbidity value in the region of Maninjau lake cages ranged from 0-359 NTU for sampling I and 6-1265 NTU on sampling II has passed the quality standard value Government Regulation No. 82 of 2001 Class II for freshwater aquaculture (Table 1, Figure 3). The high value of the turbidity of sampling II due to the sampling time rainy day. Turbidity is also caused by the presence of sediment in water bodies into the lake as a result of erosion in watersheds in the area around the catchment area Maninjau as well as organic and inorganic materials from aquaculture cages and dead fish because dumped in the waters of Maninjau lake, water hyacinth plants are rotting in the bottom waters.

According [12] that the waters are high sedimentation may endanger life in aquatic environments, including sediments causing an increase in turbidity of the water by blocking light penetration into the water so that it can disrupt the life of the organism in it.

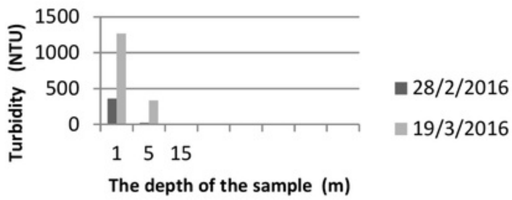

Figure 3. Turbidity (NTU) at different depth

The degree of acidity (pH)
pH is an environmental factor that can act as a limiting factor on the water. The pH value of the sampling I (7.8 to 8.2) and II (7.8 to 8.1) are still classified as normal in accordance with the value of the quality standards Goverment Regulation No. 82 of 2001 Class II for freshwater aquaculture ranged between 6-9 (Table 1, Figure 4). The pH value is very important as water quality parameters for fish and other aquatic life in a certain pH range, with a known pH value then we can determine whether the water is suitable or not to support their life. According [13] Tilapia life at pH values ranging between 6-8.5. Furthermore [14] says that the pH value of water can affect the accumulation of heavy metals in the animal body of water, because the lower the pH of water and the pH of the sediment, the heavy metals more soluble in water (ionic form) so that more easily into the body of the animal, either through the gills, groceries or diffusion.

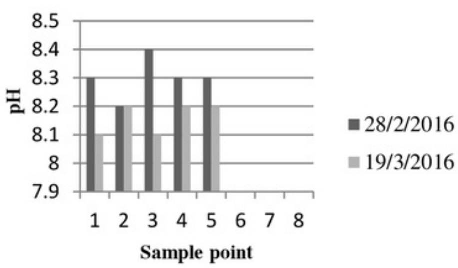

Figure 4. pH at different sample point

Dissolved Oxygen (DO)
Dissolved oxygen (Dissolved oxgen) is the amount of oxygen dissolved in the water that comes from photosynthesis and the absorption of the atmosphere / air. The results show the value of DO in part still outside the range of the value of the minimum quality standard in accordance Government Regulation No. 82, 2001 to Class II at sampling I (0 to 4.1 mg/L) and sampling II (0 to 4.2 mg/L) (Table 1, Figure 5). DO Low mainly occur in waters with a depth>10 meters, where the high turbidity caused photosynthetic activity does not work optimally so that the oxygen supply is reduced, even oxygen 0 mg/l. By contrast, in the shallow waters (depth<5 m) the presence of more oxygen produced by fotosintes of aquatic plants.

More and more organic waste entering and staying in the lining of aerobic bacteria, the greater the need for oxygen for microbes that decompose, even if the purpose of the oxygen for the microbes exceeds the concentration of dissolved oxygen, the dissolved oxygen can be zero and microbial aerobpun will disappear replaced by microbial anaerobic facultative for his activities do not require oxygen. This is supported by research that states that the floating net cages has caused a decrease in dissolved oxygen in the waters of Maninjau lake, so until very low.

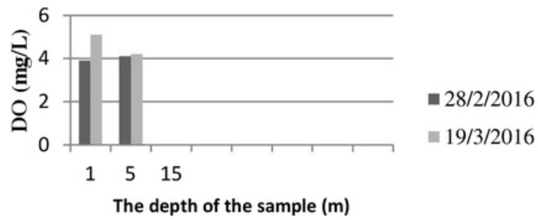

Figure 5. DO (mg/L) at different depth

Ammonia (NH_3)

Ammonia is a nitrogen compound that will turn into ammonium (NH^{4+}) at low pH and ammonia themselves are in reduced circumstances. The ammonia compounds very toksit for aquatic organisms albeit at relatively low levels. Observations ammonia content in the sample I of 16.65 to 27.3 mg/L and the sampling II of 20.65 to 24.85 mg/L has exceeded grade quality materials II (Government Regulation no. 82/2001) (Table 1, Figure 6), meaning ammonia as a water quality parameters that contribute to mass mortality of fish.

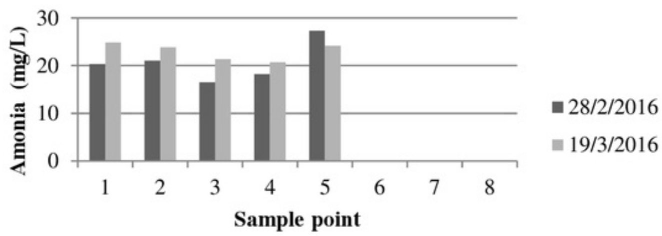

Figure 6. Ammonia (mg/L) at different sample point

Phosphate

Total phosphorus in waters of the compound are as orthophosphate, polyphosphate and organic phosphate. Organic phosphate is an element of P which is bound to organic compounds in solution to not be separated. Each phosphate compound is present in dissolved form, suspended and bound in organic compounds. Value phosphate sampling I (13.65 to 15.53 mg/L) and II (2.25 to 2.91 mg/L) already exceed the quality standards of Government Regulation No. 82 of 2001 grade II for freshwater aquaculture (<0.1 mg/L) (Table 1, Figure 7). The high phosphate can be caused by oxidation or decomposition of organic material by microorganisms decomposer in water bodies and through the introduction of organic phosphate discharges such as feces population and household waste from residential areas.

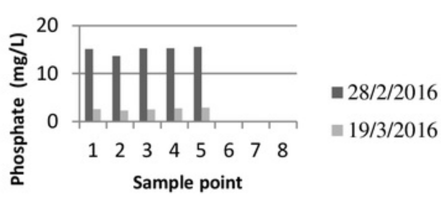

Figure 7. Phosphate (mg/L) at different sample point

Sulphide

Exploitation of fish farming in floating net cage since 1997 has led to poor water quality in Maninjau lake with increased accumulation of organic material content in the bottom of the lake. The accumulation of organic carbon compounds due to discharge residual activity feed on the maninjau lake of floating net cages has increased sulfide production results from the activity of sulphide reducing bacteria in the lining hipolimnion. Value sulfide in sampling I (1.36 to 1.62 mg/L) and II (1.01 to 1.42 mg/L) already exceed the quality standards of Goverment Regulation No. 82 of 2001 grade II for freshwater aquaculture (<0.02 mg/L) (Table 1, Figure 8). The implications of the production of hydrogen sulfide in the lake not only can lead to exhaustion of dissolved oxygen and loss of iron in the water, but also can lead to phosphate irrespective of sediment and accumulate in water bodies, which in turn have an impact on the eutrophication of the lake. The study aims to assess the implications of the dynamics of the sulfide to the release of phosphate in layers hipolimnion Maninjau lake.

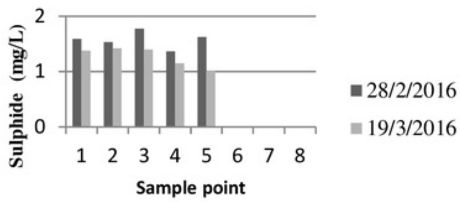

Figure 8. Sulphite (mg/L) at different sample point

Step Anticipation
Some emergency measures that should be done to anticipate and prevent the massive fish mortality due to up welling are: (1) Awareness of the fish farmers on the signs of impending up welling, among others:. or cloudy weather and rain continuously for 2-3 days in a row (no sunlight into the body of water), and the water quality of the lake began to show a decline; (2) Perform oxygenation/aeration to reduce the negative impact of toxic substances; (3) Choose the type of fish that are more tolerant to changes in water quality is not optimal; (4) Reduce the number of floating net cages operating or decreases the density of the farmed fish. (5) As soon harvest the fish that size is approaching the size of consumption, to reduce losses greater; (6) Move the floating net cages on a regular basis, to a position with better water conditions; and (7) Utilizing Aquaponics to improve water quality and reduce the risk of dying fish.

CONCLUSION

From the results of this study concluded the water quality of Maninjau lake unfit for freshwater fish farming, particularly at a depth of more than 10 m. Therefore necessary measures in order to anticipate the negative impact of up welling can be minimized.

Acknowlegment
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