Water quality study in several seaweeds culture sites in the post-earthquake tsunami Palu Central, Sulawesi Province

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Abstract. On September 28, 2018 the Palu City and its surroundings experienced an earthquake of M 7.4 and Tsunami. This incident had a major impact on the community, especially seaweed farmers. The study aims to determine the effect of water quality on the production of seaweeds (Kappaphycus alvarezi and Spinosum sp) post-earthquake tsunami in Central Sulawesi. This study are located Parigi Moutong and Donggala Regency. The research variables were observed include quality of the seawater and seaweeds production before-after the earthquake-tsunami Palu. Suitability of seaweed culture identification using Principal Component Analysis (PCA). The results showed that the location most suitable seaweeds culture is at a spacing of 300-500 meters from the river mouth while the water quality such as temperature, salinity, brightness, depth, dissolved oxygen, pH, surface current, pH, phosphate, nitrate, TDS and TSS, still within acceptable limits for the growth and production of seaweeds. Gracilaria sp. can no longer be cultivated after an earthquake disaster due to the pond water quality not supporting its growth. Spinosum sp is more cultivated than Kappaphycus alvarezi in Parimo and Donggala, with a decrease in seaweeds production 50-60% after the earthquake-Tsunami Palu.

1. Introduction
An earthquake measuring M 7.4, centred 26 km north of Donggala and 80 km northwest of Palu City with a depth of 10 km, caused a total economic collapse, especially people who inhabited the coastal areas of Central Sulawesi [1]. Seaweed cultivation in Parimo Regency and around Palu City failed miserably, while in Donggala District around 20% were saved to this day. This problem is very troubling for farmers because their economic resources are solely from seaweed sales. Central Sulawesi Province is one of the producers of seaweed in Indonesia. After the earthquake and tsunami disaster seaweed cultivation activities were 90% totally paralyzed, the declining environmental conditions of the aquaculture sites in Donggala District, Palu City, Parigi and Mautong Regencies after the earthquake and tsunami caused the economy of the cultivating community to be of great concern. The purpose of this study is to study the potential of seaweed that can still be cultivated by looking at the level of suitability of the aquatic land of several cultivation locations that are considered still suitable to be used.
as seaweed cultivation locations in Donggala Regency, and Parimo Regency after the earthquake and tsunami in Palu Bay.

2. Material and Methods

Primary data collection locations were carried out by surveying several seaweed cultivation locations in Donggala, Palu City and Parigi Moutong in May-August 2019. Primary data on cultivation potential were recorded before the earthquake and tsunami occurred and after the earthquake and tsunami remained only in Parigi Moutong and Donggala as the basis for determining the location of observation points (figure 1). The point of observation is simple random design [2], and distributed proportionally so that it can describe the location of the waters surveyed. Measurement of water quality parameters in this study is divided into two, namely measurements made on the surface of the water and measurements made on the basis of water. Descriptive statistical results of water quality parameters obtained in waters at seven location stations (6 in Parimo Regency and 1 in Donggala Regency) namely Leumanta Village (station 1), Silampayang Village (station 2), Sumber Tani Village (station 3), Paningka Village (station 4), Ogotion Village (station 5), Lalombi Village (station 6), and Surumana Village (7) Important data affecting the development of seaweed cultivation have been collected including changes in water quality measured directly in the field (temperature, salinity, brightness, depth, dissolved oxygen, acidity, current speed) and variables analyzed in the laboratory (phosphate, nitrate, TDS, and TSS).

Figure 1. The research location was in Parigi Moutong Regency and Donggala Regency in Central Sulawesi Province and the distribution of water quality observation points

Surface water and bottom waters quality are used Principal Component Analysis (PCA) conducted to describe competent variables that influence each other based on the distribution of water quality data in the form of a PCA diagram using SPSS 16 program.
3. Results and Discussion

The research location of Parigi Moutong Regency is located on the East coast of Sulawesi Island which stretches along Tomini Bay and Donggala Regency. Geographically, Parigi Moutong Regency is bordered by Buol, Toli-Toli and Gorontalo Provinces in the North, Poso Regency and South Sulawesi Province in the South, Palu City and Donggala Regency in the West and Tomini Bay in the East. As a coastal district, this regency has land and water resources that are very suitable for the development of aquaculture activities. With relatively shallow water characteristics provide opportunities for the development of marine culture, including seaweed cultivation.

Seen from the aspect of cultivation, seaweed has many advantages: it does not require high capital, simple cultivation technology so it is easily done by anyone, can be integrated with other cultivation or polyculture (for example milkfish cultivation with Gracilaria sp.), No need to use feed, the equipment used is easy to obtain, easy to handle at harvest (usual seaweed is only washed and dried), the cultivation cycle is short (only takes 45 days), can be processed domestically to be a product ready for consumption, and can be done as a side business.

Table 1. The measurement of water quality in coastal of Parigi Moutong and Donggala Regency Central Sulawesi Province.

| Parameter                     | Minimum  | Maximum  | average | standard deviation |
|-------------------------------|----------|----------|---------|--------------------|
| **Surface water quality**     |          |          |         |                    |
| 1. Temperature (°C)           | 30.23    | 30.97    | 30.45   | 0.30               |
| 2. Salinity (ppt)             | 29.22    | 32.33    | 30.61   | 1.00               |
| 3. Brightness (m)             | 4.33     | 9.44     | 7.18    | 1.87               |
| 4. Depth (m)                  | 14.11    | 20.67    | 18.04   | 2.93               |
| 5. Dissolve Oxsigen/DO (ppm)  | 5.50     | 7.41     | 6.47    | 0.82               |
| 6. pH                         | 7.71     | 8.10     | 7.93    | 0.14               |
| 7. Current Speed (m/seconds)  | 0.06     | 4.69     | 0.84    | 1.88               |
| 8. Phosphate (mg/L)           | 0.0080   | 0.0988   | 0.0260  | 0.0358             |
| 9. Nitrate (mg/L)             | 0.0052   | 0.0550   | 0.0139  | 0.0201             |
| 10. TDS (mg/L)                | 1820.02  | 3778.02  | 3368.05 | 760.76             |
| 11. TSS (mg/L)                | 12.66    | 1890.86  | 327.88  | 765.70             |

| **Bottom of the water quality** |          |          |         |                    |
| 1. Temperature (°C)            | 29.37    | 30.97    | 29.58   | 0.14               |
| 2. Salinity (ppt)              | 31.11    | 32.39    | 32.33   | 0.87               |
| 3. Brightness (m)              | 4.33     | 9.44     | 7.18    | 1.87               |
| 4. Depth (m)                   | 14.11    | 20.67    | 18.04   | 2.93               |
| 5. Dissolve Oxsigen/DO (ppm)   | 5.67     | 7.41     | 6.52    | 0.87               |
| 6. pH                         | 7.70     | 8.10     | 8.00    | 0.21               |
| 7. Current speed (m/seconds)   | 0.06     | 4.69     | 0.64    | 1.40               |
| 8. Phosphat (mg/L)             | 0.0071   | 0.0988   | 0.0184  | 0.0195             |
| 9. Nitrate (mg/L)              | 0.0050   | 0.0550   | 0.0067  | 0.0020             |
| 10. TDS (mg/L)                 | 1826.67  | 3778.02  | 3388.04 | 773.72             |
| 11. TSS (mg/L)                 | 13.44    | 1890.86  | 316.19  | 735.35             |

Seaweed cultivation is also inseparable from various threats, such as ice-ice disease attacks, and there are still many farmers who are tempted to use various chemical products made in factories that are not suitable for their purpose. The use of chemical products, in fact, can also fertilize weeds that are pests for seaweed and can reduce the quality of waters if used excessively. The quality of seaweed is dropped because it was harvested prematurely, there is no management of seaweed nursery, the use of seeds that are not quality, low selling prices (due to the middlemen who come directly to the location of cultivation...
to buy seaweed), and the use of pesticides in preparation. The pond also adds to the long list of seaweed cultivation issues. Various aspects of social and business legality, such as business licensing for cultivation and location of seaweed cultivation in accordance with their respective spatial plans, should be taken into account. Seaweed cultivation is often carried out in areas around coral reef and seagrass ecosystems, which can potentially damage these important marine ecosystems. Another important factor is the quality of the waters where the seaweed grows. Water quality factors that affect the growth of seaweed include acidity, phosphate, nitrate, dissolved oxygen, depth, current speed, brightness, total dissolved solids and total suspended solids (table 1).

![Scree Plot](image1)

![Component Plot in Rotated Space](image2)

![Scree Plot](image3)

![Component Plot in Rotated Space](image4)

**Figure 2.** Distribution and Classification of Water Quality Characteristics: (a) (b) Surface water quality (c) (d) Bottom of the water quality

The correlation of sea surface quality variables between the F1 and F2 axes (figure 2a and figure 2b) shows that the positive F1 axis is characterized by salinity and temperature parameters, while the negative F1 axis is characterized by the DO, current speed and TDS variables. Correlations on the positive F1 and F3 axes are characterized by temperature variables, while negative F1 axes are characterized by brightness, phosphate, nitrate, TSS, depth and pH variables. In the correlation between the F1 and F3 axes, seen on the positive F3 axis is characterized by parameters TDS, brightness and current speed. Based on the contribution of physicochemical parameters on the surface of the water, salinity, temperature, DO, current speed are the main variables that characterize the characteristics of the research station. While the other variables are the next variables that have not been explained on the main axis.
The correlation of water quality variables at the bottom of the waters (figure 2c and figure 2d) between the F1 and F2 axes shows the dominant characteristics characterized by variables of salinity, brightness, current speed, DO and depth. Unlike the case with the correlation of variables between the axes F1 and F3, which shows that most research stations are characterized by parameters pH, nitrate, phosphate and TSS.

3.1. Temperature
Water temperature shows normal results both on the surface of the waters and the bottom of the waters. The temperature of these waters is the natural temperature measured directly (in situ) at the time the study was conducted. In general, the average water temperature from the lowest to the highest during the study at the location of Station 1 to Station 7 obtained ranged from 29.7ºC - 31.44ºC. The difference is due to the results of surface and bottom surface water measurements, but the temperature in that range at all stations is still suitable for seaweed cultivation. Water temperature on the surface is influenced by meteorological conditions such as rainfall, evaporation, air humidity, air temperature, wind speed, and intensity of solar radiation. Therefore, surface temperatures usually follow seasonal patterns [2]. Water temperature for seaweed cultivation ranges between 27ºC-30ºC and temperature changes not more than 4ºC every day. Temperature can affect photosynthesis in the sea both directly and indirectly. The direct effect is temperature which plays a role in controlling enzymatic reactions in photosynthesis. High temperatures can increase the maximum rate of photosynthesis, while the indirect effect is in changing the hydrological structure of the water column which can affect the distribution of phytoplankton [3].

3.2. Salinity
Water salinity shows normal results at the bottom of the waters, but not at the surface of the waters. The value between the minimum and maximum shows quite far results, this is likely to occur because when the measurement process is carried out the waters of the research location are mixed with freshwater from rivers. Salinity has an important role in supporting the life of aquatic biota. Salinity levels in sea waters vary with geography and time, where the increase in salinity is caused by evaporation and the result of sea ice freezing whereas, the decrease in salinity is caused by precipitation and freshwater input from rivers [4]. Salinity plays an important role in seaweed cultivation. Salinity range that is too high or too low can cause the growth of seaweed to be disrupted. Based on the results of research that has been done by measuring salinity at each station three times with a time interval per seaweed cultivation shows the difference in the average value of salinity at each station. Salinity measurement from the lowest to the highest based on the data obtained is 22.92-32.33 ppt on surface water and 31.11-32.39 ppt on bottom water. Salinity measurement results obtained in this study are included in the range of salinity that does not support the growth and development of seaweed cultivation. This is in accordance with the opinion of [5], stating that the range of good and optimal salinity needed for the growth of Eucheuma cottoni seaweed is 28-34 ppt.

According to the seaweed cultivators affected by the disaster, after the disaster occurred a significant change occurred in the growth of cultivated seaweed which also affected the production of seaweed per cycle up to 50%. This happens because of the various problems that occur including the rise of basic sediments and moss from the surface and stick around the seaweed plants, seaweed susceptible to disease, seaweed is easily broken, and the occurrence of turbidity in the waters. The difference in salinity obtained in waters is often due to various factors such as water circulation, evaporation, rainfall and river flow. Many factors cause changes in salinity, one of which is the season. In the West season, the influence of rainfall, while in the East season the salinity will increase again [6].

3.3. Brightness
The results of brightness measurements based on data taken during the study were ranged from 4.33-9.44 meters (table 1). In general, the brightness of the waters from the lowest to highest during the study at the location of Station 1 to Station 7 shows varied results because there are waters that are quite turbid
and those that are not. This is likely to occur because at the cultivation site there is a station that is quite close to the estuary that is far away. The depth of the seaweed cultivation location is quite normal, this depends on the cultivators as long as the seaweed cultivation is not too choppy and strong currents.

Brightness is the distance that can be penetrated by sunlight into the waters. The farther the distance through the sun, the wider the area that allows photosynthesis. The ability of sunlight to penetrate into waters is largely determined by the color of the waters, the content of organic and inorganic materials suspended in the waters, plankton density, microorganisms and detritus [7].

Water brightness is influenced by the penetration of sunlight entering the waters. This is because the higher the level of brightness of the waters, the clearer the waters will be. Thus, all the beauty of the seabed can be seen clearly from the surface of the water [8]. The low value of water brightness is generally caused by high turbidity by the amount of dissolved and suspended organic matter, floating objects and light intensity. The brightness conditions obtained during the observation were still within reasonable limits for seaweed growth. The condition of clear waters with a brightness level of 1.5 - 12 meters is good enough for seaweed growth [9].

Respondent seaweed cultivator information that was affected by the disaster, that during the post-disaster yesterday happened that the water conditions are often murky. This happened because the mud in the bottom of the water rose up, causing the waters to become turbid. This statement is proven by the presence of mud that sticks around the cultivated seaweed plants and can only be lost if the stretch cord is stretched or shaken. at very low sunlight intensity, the growth of seaweed that occurs will be very slow, because it can not carry out photosynthesis completely [10]. Increased photosynthesis process will cause metabolic processes so that it stimulates seaweed to absorb more nutrients which will support the growth process. Turbid water usually contains mud so that it can block the translucence of sunlight in the water so that the process of photosynthesis is disrupted. Besides that, dirt can cover the surface of the thallus and cause the thallus to rot and break. This condition will disrupt the growth and development of seaweed [11].

3.4. Depth
The results of the measurement of the depth of water at the study site at each station based on observational data obtained an average range of 14.11 to 20.67 meters. The suitability for the depth value indicates the appropriate value for seaweed cultivation. The depth of good waters for Eucheuma spp seaweed cultivation is 5-20 m using the longline method [12]. This is to avoid the seaweed experiencing drought and optimize the acquisition of sunlight. Seaweed requires sunlight for the process of photosynthesis, therefore seaweed can only grow in waters with a certain depth where sunlight can get to the bottom of the waters [11].

3.5 Dissolved Oxygen (DO)
Dissolved oxygen (DO) in the waters of the study site showed a normal and good value for seaweed cultivation. Dissolved Oxygen (DO) is a very important parameter because oxygen is needed by aquatic biota both for metabolic and respiration processes. Dissolved oxygen is a limiting factor for all living organisms. Dissolved oxygen is a basic need for the life of living things in water. In general, the value of dissolved oxygen waters from the lowest to the highest based on measurement data in observations during the study at the location of Station 1 to Station 7 obtained ranged from 5.50 ppm - 7.41 ppm on surface water and 5.67-7.41 on bottom water. Dissolved oxygen measurement results obtained in this study indicate that the location of cultivation is sufficient to support for seaweed farming activities. Dissolved oxygen to support the seaweed cultivation business is 3-8 mg/L [12]. The difference in dissolved oxygen content due to the movement and mixing of water masses. In the open water condition, dissolved oxygen is in a natural condition, so that water conditions that are poor or lacking in dissolved oxygen are rarely found [13].

3.6. Acidity (pH)
Measurement of pH at the bottom of the water is higher than the surface value of the water, but still categorically feasible to be used as a location for seaweed cultivation. The degree of acidity or pH is one of the important parameters in monitoring water stability. Changes in the pH value in a water will affect the life of biota because each biota has certain limits on the pH value that varies. The increase in pH value from the estuary to the high seas is caused by the input of waste from land (rivers) to the aquatic environment. Based on the measurement of the degree of acidity (pH) that has been done at the study site, the results obtained with a range between 7.70-8.10 (Table 1). The temperature of these waters is the natural temperature measured directly (in situ) at the time the study was conducted. The pH condition during the observation was still within reasonable limits in supporting the growth of seaweed. The change in pH during the study was relatively small because the waters had a buffer system for drastic ion changes. Sea and coastal waters have a relatively more stable pH and are in a narrow range, usually ranging from 7-8 [14]. pH is influenced by buffering capacity, namely the presence of carbonate and bicarbonate salts they contain [15].

3.7. Current Speed
Current Speed measurements using a kite current in which the measurement results show varying speeds with an average range of 0.64-0.72 m/s. In general, the value of water flow velocity from the lowest to the highest during the study at the location of Station 1 to Station 7 obtained from 0.06-0.4 m/s. The difference in current speed is due to location. Currents are very influential for seaweed in taking nutrients and carrying food sources. The existence of coral reefs is one of the causes of currents to be weak because the incoming ocean currents are hampered by the barrier formed naturally by coral reefs. At other times, turbulence and open waters are other predictions of strong current differences. The current velocity conditions obtained during the observation are still within reasonable limits for seaweed growth. The good current velocity for seaweed growth ranged from 0.2 to 0.4 m/s [16]. Current velocity in the waters of the study site shows abnormal results, but this is common if seaweed is cultivated in the high seas due to the influence of wind, weather and season. Currents play an important role in the movement of nutrients in the waters. These nutrients are useful for the growth of aquatic organisms such as plankton. Currents greatly affect the fertility of seaweed because, through the movement of water, much-needed nutrients can be supplied and distributed and then absorbed through the thallus. Current speeds of more than 40 cm/s can damage the construction of cultivation and break the branching of seaweed. Each process of occurrence of tides and ebb in water will cause currents. This is common because at the time the research is being carried out only in a relatively short period of time and only done once, so it is concluded that the currents that occur are local currents due to tidal waters. Current velocity plays an important role in water, for example, mixing water mass, transporting nutrients and transporting oxygen [18].

3.8. Phosphate
In general, the distribution pattern of phosphate levels that have been measured in stages in the waters of the study site ranged from 0.02 ppm to 0.03 ppm. The average measurement results from the lowest to the highest during the study at the location of Station 1 to Station 7 obtained ranged from 0.01 to 0.10 ppm. Phosphate measurement results obtained during the measurement process indicate that the waters of the study site are still suitable and ideal for seaweed cultivation, waters with high fertility, which have total phosphate levels of 0.051 - 0.1 mg/L [20].

Phosphate is an essential element for plants and aquatic algae and greatly influences the level of aquatic productivity. Differences in phosphate content are usually caused by differences in the time of measurement and the location of sampling. In addition, the presence of organic matter in the form of domestic waste (detergent), agricultural waste or erosion of phosphorus rock by water flow can be a factor that causes differences in the level of phosphate content obtained. According to [21], most of the phosphate comes from the input of organic material by land in the form of industrial or domestic waste (detergents).
3.9. Nitrate
Nitrate content (NO$_3^-$) obtained at survey locations ranged from 0.0052 to 0.0550 mg /L on surface water and 0.0050 to 0.0106 mg /L on bottom water. The range of values is still relatively high for marine aquaculture activities. The nitrate content of coastal waters desired for aquaculture activities is 0.008 mg /L [23]. sediment in the waters of the district dominated by coral. Coral fragments, sandy loam and sandy loam, which are indicators of the habitat of seaweed plants so that the substrate of the waters is suitable for seaweed farming activities. In addition to influencing the ease of installation of aquaculture facilities, the substrate can also affect water productivity, turbidity, and sedimentation. Seaweed cultivation activities should have sandy loam and coral base, clear water and avoid siltation can influence the development of talus, water quality, and cultivation business [19]. The growth of seaweed plants requires a substrate of sandy clay and coral with smooth water movement, high brightness, phosphate, silicate, salinity, and high dissolved oxygen [6].

Based on measurements that have been made at the study site, it has been obtained the results of aquatic nitrate content ranging from 0.01 ppm to 0.06 ppm. The results of measurements of the average level of nitrate in the waters from the lowest to the highest during the study at the location of Station 1 to Station 7 obtained ranged from 0.01 to 3990.00 ppm. The high concentration of nitrate at the research site at station 7 is caused by different water conditions from the research sites at stations 1-6. This happens because the location of station 7 is the pond waters close to the residents' settlements. The high levels of nitrate can be caused by input from land and surrounding activities in the form of liquid waste both from agriculture and plantation activities [8]. Differences in mean values of the nitrate parameters are due to the presence of settlements that allow the entry of nitrates into the waters. The results of measurements of nitrate levels obtained during the observation took place, showing that the research location at station 1-6 was still in a proper condition for seaweed cultivation. However, the results of measurements of nitrate levels obtained at the research site of Station 7 showed that the location was not feasible for seaweed cultivation. The range of nitrate suitable for seaweed cultivation in pond waters ranges from 0.2525 to 0.6645 ppm [22]. The range of nitrate content in waters during the rainy and dry seasons ranges between 0.20-1.20 ppm and 0.01 and 0.45 ppm. The high nitrate content in the waters during the rainy season at the location of the waters that empty into the river and the source of nitrates comes from the mainland [20].

Nitrate in the study location waters as shown on the surface and bottom waters data shows abnormal and unfavorable results for seaweed because nitrate is one of the nutrient parameters needed by seaweed. Nitrate is an important nutrient for phytoplankton and other aquatic organisms. In marine waters, nitrogen is a limiting element for primary productivity in the ocean. Nitrogen used by phytoplankton is in the form of nitrate. Specifically in the sea, more nitrate nutrients are needed than phosphate nutrients for the ideal growth of phytoplankton. Nitrates can be formed by three processes, namely electric storms, nitrogen-binding organisms, and bacteria that use ammonia. Increased ammonia concentration is due to an increase in the decomposition of plant or animal residues [21].

3.10. TDS
The results of the Total Dissolved Solids (TDS) measurements in general at the research location at each station were based on observational data ranging from 2889.66-3388.04 mg / L. While the results of measurements of the average TDS in waters from the lowest to the highest during the study at the location of Station 1 to Station 7 obtained ranged from 19.27-3834.52 mg / L. The high concentration of TDS can be caused by the activities of the population around the location of cultivation where the population is increasingly dense so that both domestic and industrial waste discharges are increasing [22]. The presence of TDS in water is caused mainly by the remnants of inorganic materials and wastewater waste molecules, such as soap molecules, detergents and water-soluble surfactants. The low TDS value in the study site waters is due to the location of the cultivation that is not dense settlements compared to other stations as well as the low activity that produces organic and inorganic waste around the location of the cultivation site. The low TDS concentration in water is due to the location of the waters which is far from all human activities so that the waste that enters the liquid is very minimal and
does not even exist. TDS in the waters of the study site showed normal and good value for seaweed growth. TDS are solids smaller than suspended solids. Native aquatic organisms are acclimated to some level of existing TDS and TSS concentrations, but increases in loads can degrade aquatic ecosystems through several mechanisms [25].

3.11. TSS
Measurement results in general Total Suspended Solid (TSS) in the study location at each station based on observational data ranged from 283.79-316.19 mg/L. While the average TSS measurement results in waters from the lowest to the highest during the study at the location of Station 1 to Station 7 obtained ranged from 13.44-1890.86 mg/L. The high value of TSS concentrations can be caused by the amount of solids originating from domestic and industrial waste around the seaweed cultivation location so that it affects the clarity of the waters. The low concentration of TSS in several locations where cultivation can be due to environmental conditions around it are still awake, there is green land and obtain additional oxygen from the photosynthesis of aquatic plants that grow and spread in the surrounding area. TSS in the waters of the research location based on the results of measurement has been carried out showing abnormal values, but still in the proper category for seaweed cultivation.

Total Suspended Solid (TSS) consists of particles which are smaller in size and weight than sediments, such as microorganism cells, certain organic materials and others. The level of Total Suspended Solid is a characteristic of the erosion process that can increase the level of turbidity in water. The content of TSS which consists of fine sand, mud and microorganisms is mainly caused by the erosion of soil carried into the water body [24]. The excessive TSS content can cause turbidity and affect the process of photosynthesis due to obstruction of sunlight to enter the waters. The major ecological parameters of suspended solids which would affect photosynthetic systems include a reduction in light penetration, sedimentation, and habitat alteration, abrasive action, and effects of adsorbed toxins [26].

Desired waters for seaweed farming activities have a water movement that is able to carry nutrients evenly, ie with current speeds ranging from 20-40 cm/sec (Mubarak et al., 1990). Current velocity in the waters of Parigi Moutong Regency ranges from undetectable to 30 cm/sec. The temperature of the waters of Parigi Moutong Regency is around 28.94°C-33.56°C is a supportive range for seaweed farming activities. The salinity of the water ranges between 22.85 and 33.56 ppt with an average of 32.95 ppt which conditions are quite stable. Low water salinity is found around existing river mouths.

The location of seaweed cultivation is very suitable around 30%, suitable around 50% and less appropriate 20%. The location of seaweed cultivation that is very suitable is less than 50% because it is still affected by natural disasters that occurred a year ago. Turbid waters condition especially in the location of the pond so that until now it has not been possible to do aquaculture in the pond. Whereas E. cottoni and E. spinosum seaweed cultivation activities carried out in sea waters have begun to increase. This is a good start considering that several months after the earthquake the seaweed was totally dead. In addition, seaweed is in need of sunlight to carry out the process of photosynthesis. The amount of sunlight is greatly influenced by the brightness of seawater. So that the need for sunlight is available in an optimal amount, it must be regulated in the depth of cultivation. The ideal depth is 30-50 cm from the water surface. Seaweed photosynthesis process is not only influenced by sunlight but also requires nutrients in sufficient quantities both macro and micro. These nutrients are mostly obtained from the water environment which is absorbed directly by all parts of the plant. To supply these nutrients, fertilization is usually carried out during cultivation.

4. Conclusions
*E. cottoni* and *E. spinosum* seaweed are still suitable to be cultivated in post-earthquake locations despite a decrease in water quality. *Seaweed Gracilaria sp* can no longer be cultivated after the earthquake disaster due to the quality of pond waters not supporting its growth.
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