Actualize The Coastal Ecosystem Resilience: Determining The Location Of Artificial Reef.

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ABSTRACT
Oceanographic parameters that affect coral reef growth are clarity, temperature, salinity and water currents taken at 20 stations using AAQ Rinko 1183 and FLOWATCH FL-03 current meter. The data processing using the IDW (Inverse Distance Weighted) interpolation method and the determination of the suitability area through scoring and weighting. The identification value consist of: (a) Clarity ranges from 2 - 6 meters, (b) Water turbidity ranges from 0.3 - 4.32 NTU, (c) Bottom substrate type is fine black sand, (d) Current velocity ranges from 0.1 m/s - 0.4 m/s, and (e) TSS ranges from 35.6 - 351 mg / L. The suitability of placing artificial reefs is classified at the appropriate level (S2), as a support for the survival of fishermen and local communities in Damas Beach, Trenggalek Regency.

KEYWORDS
Growth of Artificial Reef, Location Suitability, Damas Beach Trenggalek.

Coral reef ecosystems are very important for biota in marine waters. [2], coral reef ecosystems provide a home for various marine life. Coral reef ecosystems are also important for ornamental fish fishermen because in general, ornamental fish live in coral reef ecosystems. According to [5], fish habitats that have been damaged will affect the sustainability and the life cycle of fish.

Climate change has a huge impact on coastal areas [8]. The impact of climate change will cause an increase in the intensity of extreme weather events in an area, rain patterns changes, and increase the sea surface temperature. This will directly affect the quality of life and growth of coral reefs. The growth of coral reefs is greatly influenced by the quality of marine waters, including temperature, salinity, sedimentation, and eutrophication. Damage to coral reefs is generally caused by destructive fishing activities, such as the use of explosives, toxic cyanide, coral mining for building materials, anchoring of boats, and sedimentation process [16].

The corals that compose coral reefs require very specific water conditions to grow, including not too hard currents and waves, clear waters with little sedimentation, no pollutants, low nutrient levels and ocean temperatures between 29 – 31 °C [23]. Coral is an animal that is very vulnerable to damage, because with an increase in sea water temperature of 1 °C above normal sea water temperature, coral becomes bleaching and has the potential to cause coral death.

The presence of aquatic sediment exceeding 79 – 234 mg/cm² will cause coral death [4]. The cyanide used by lobsters fishermen also has a devastating effect on corals, as it causes death within 30 minutes of being exposed to 10 ppt cyanide [10]. The characteristics of oceanographic parameters, such as clarity, temperature, salinity and water currents are the key to analyzing the relationship and influence of water conditions on coral reefs. According to
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[12], the growth of coral reefs is influenced by pH, light intensity, temperature, sediment, hydroseanography and sea surface temperature.

Damas Beach has darker sand, smooth textured, mixed with a little coral fragments. There are fresh water flows that enter the coastal area, causing the beach which look very natural. In addition, it also has a long coastline with a gentle pattern and several large towering rock clusters and relatively calm water conditions [14]. Damas beach has pressure on the coral reef ecosystem, the turbidity level of the waters in this location is relatively high because of the small river that stream down into this bay. Coral reefs are dominated by massive corals, and at the time of observation there were many pieces of related web found in the coral. This has resulted in the destruction of the coral reef ecosystem [24], so there is a need for recovery efforts by placing artificial coral reefs as a support for Coastal Ecosystem Resilience.

The purpose of this study was to determine the condition of the oceanographic parameters and the suitable location for the placement of artificial coral reef media in the waters of Damas Beach, Trenggalek Regency, East Java.

MATERIALS AND METHOD

The research was held in March 2020, at coordinates 8° 32' 60" S - 111° 69' 14" E. The data was collected at 20 station points with a distance of 300 meters each. The map of the research location is presented in Figure 1.

In-situ data collection includes parameters of clarity, turbidity, water base material, and current velocity using the AAQ Rinko 1183 and FLOWATCH FL-03 current meter. While ex situ data collection includes current velocity (last 1 year) and Total Suspended Solid (TSS). Parameter data processing is done by using IDW (Inverse Distance Weighted) interpolation method.

Determination of the suitability area for the placement of artificial coral reefs refers to the water suitability matrix compiled based on in situ and ex situ data, in the form of variable conditions consisting of observed oceanographic parameters to carry out scoring and weighting (Table 1).
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Table 1. Oceanographic Parameters

| Parameter       | Scale | S1          | S2          | S3          |
|-----------------|-------|-------------|-------------|-------------|
| Clarity (m)     | 4     | > 6 meters  | 3           | 2           |< 4 meters  | 1           |
| Current Velocity (m/s) | 4 | 0.3 – 0.4  | 3           | 2           |< 0.1      | 1           |
| TSS (mg/l)      | 4     | < 20 mg/l   | 3           | 2           |> 80 mg/l  | 1           |
| Turbidity (NTU) | 4     | < 5 NTU     | 3           | 2           |> 5 NTU    | 1           |
| Substrate Type  | 3     | Solid       | 3           | 2           | Soft, Muddy | 1           |

Total Scale x Score | 57  | 38  | 15

The analysis for the land suitability index for rehabilitation of damaged coral reefs on the Damas Beach, using a formula [15] can be seen in the following:

\[ IKR = \left( \frac{N_i}{N_{max}} \right) \times 100\% \]

explanation:

IKR : Coral reef rehabilitation suitability index
Ni : The value of parameter (scale x score)
Nmax: Maximum value of coral reef rehabilitation suitability parameters

The criteria or land suitability classes for coral reef rehabilitation are determined as follows (Table 2)

Table 2. Land Suitability Classes for Coral Reef Rehabilitation

| Number | Range of Values (Score) | Suitability Level | Conclusion   |
|--------|-------------------------|-------------------|--------------|
| 1      | 76 – 100 %              | S1                | Very Suitable|
| 2      | 50 – 75 %               | S2                | Suitable     |
| 3      | < 50 %                  | S3                | Not Suitable |

RESULT AND DISCUSSION

A. Current Velocity

The current velocity in the Damas Beach in March ranges from 0.1 m/s - 0.4 m/s with an average value of 0.141 m/s. The results of modeling carried out from field data collection show that the current is moving westward and partly to the northwestern direction. The current velocity at a depth of 0.2 m ranges from 0.1 to 0.4 m/s. At a depth measurement of 0.6 m ranges from 0.1 - 0.3 m/s. Measurement at a depth of 0.8 m, the current velocity ranges from 0.1 to 0.2 m/s (Figure 2).

Figure 2. Current Velocity (m/s)
The results of the current velocity measurement are in the low to moderate range, because it is still below 0.5 m/s which is classified as a strong current [26]. Current speed greatly affects coral growth. If the current speed is slow, the microalgae that threaten coral growth will also more easily stick to coral seedlings, so that the zooxanthellae becomes stressed and leaves the coral body [22]. Currents generally carry sediments that are on the surface and on the bottom of the waters. This will affect the habitat of underwater biota [20]. Currents has an important role in preventing coral ecosystems from accumulating sediment that can endanger coral growth and development [18].

B. Water Clarity

The results of measurements of the water clarity in the study area ranged from 2 - 6 m with an average value of 4.4 m, as in Figure 3.

![CLARITY MAP OF DAMAS BEACH](image)

**Figure 3. Clarity Map of Damas Beach**

The difference in clarity level in Damas Beach at each sampling location is thought to be related to the depth of the location and the time of observation. Low clarity will have an impact on light intensity and is influenced by the proximity of the location to the river mouth. The results of the clarity measurement show that the Damas Beach waters are classified as suitable for the location of laying artificial reefs. Clarity is greatly influenced by weather, measurement time, cloudiness, and total suspended solids [3]. Water transparency is an indispensable factor for coral transplantation, because waters with high clarity support coral growth. Corals are classified as animals and have symbiosis with microalgae that need sunlight to carry out the photosynthesis process in the coral body. High sunlight intensity can increase settlement success [13].

C. Water Turbidity

The results of the measurement of the turbidity were found to range from 0.3 to 4.32 NTU, which is below the water quality standard for biota, namely <5 NTU. The level of water turbidity is influenced by suspended organic or inorganic particles dissolved in the water column. The overall average yield obtained the highest turbidity is 4.32 NTU, due to the stirring of sand which is the main substrate in the area. The results of measuring the level of turbidity in the waters of Damas Beach, Trenggalek Regency can be seen in Figure 4.
Turbidity is strongly influenced by local weather such as wind, waves and tides as well as environmental conditions around the coral reef ecosystem such as depth, type of substrate and the location of the reefs whether they are in the reef flat or reef slope [25]. The high level of turbidity in the waters can affect the level of sunlight intensity into the water column, which causes a reduction in the photosynthetic rate of corals. High sedimentation rates can result in death in coral biota, because coral polyps will be covered by organic and inorganic particles causing a decrease in plankton capture in the water column [4]. The distribution of particles in the water column will slowly deposit and cause coral polyps to close. This causes the coral to not grow optimally. The higher the turbidity level, the coral growth will not develop [21].

D. Bottom Substrate

Sediment sampling at point 1 is located near the mouth of the river, point 2 is at a location close to the location of floating houses and fish cages, and point 3 is at a location close to the location of natural coral reefs. Visually, the sediment structure in the bottom substrate of Damas Beach waters is dominated by sand with a few shell fragments. The bottom substrate sample of Damas Beach waters can be seen in Figure 5.
Coral reef growth requires clear waters, if the condition of the water is cloudy it will have an impact on light penetration so that the growth rate and productivity of coral reefs will be hampered [6]. The condition of the muddy sand substrate is not suitable to be used as a location for placing artificial coral reefs, this is because the condition of the substrate of the muddy sand waters will cause the artificial coral reefs to sink into the muddy sand [1].

E. Total Suspended Solid (TSS)

According to [17], extreme weather during the period 2016-2018 had an impact on the coastal areas of East Java, including Damas Beach. Extreme weather accelerates the nutrient recycling process, which in turn has an impact on the existence of Total Suspended Solid. Landsat 8 OLI / TIRS C1 Level-1 image acquisition on March 16, 2020 with Path 199 and Row 66, shows that the TSS value in the waters of Damas Beach, Trenggalek Regency, ranges from 35.6 - 351 mg/L (Figure 10). The location of TSS data collection on Damas Beach, Trenggalek Regency can be seen in Figure 6.

![Figure 6. Distribution Map of Total Suspended Solid (TSS)](image)

The value of TSS levels towards the high seas will be lower, this is because the suspended solids are supplied by the mainland via river flows [19]. The photosynthetic activity of marine plants, both micro and macro, will decrease in line with the increase in TSS. This occurs due to decreased levels of oxygen released by plants and has an impact on fish survival [7]. The sustainability of fish life will affect the catch of fishermen, and will significantly affect the welfare of coastal communities who depend on fishing activities. According to [9], high TSS levels can result in increased sedimentation, so the TSS value is used as an indicator of sedimentation in waters.

F. Determination of Suitability of Artificial Coral Reefs Location

The measurements results of oceanographic parameters in Damas Beach waters are shown in Table 3.
Table 3. Evaluation of Suitability Level in Damas Beach

| Station | Longitude       | Latitude          | V (m) | W (m/s) | X (mg/l) | Y     | Z       |
|---------|----------------|-------------------|-------|---------|----------|-------|---------|
| 1       | 111°41'40.70"E| 8°19'28.28"S     | 3     | 0.13    | 60       | Sand  | 2.32    |
| 2       | 111°41'37.29"E| 8°19'37.29"S     | 4     | 0.13    | 65       | Sand  | 1.60    |
| 3       | 111°41'33.68"E| 8°19'46.90"S     | 4     | 0.13    | 74       | Sand  | 1.60    |
| 4       | 111°41'29.96"E| 8°19'56.39"S     | 3     | 0.10    | 78       | Sand  | 1.72    |
| 5       | 111°41'26.54"E| 8°20'5.59"S      | 2     | 0.13    | 123      | Sand  | 4.48    |
| 6       | 111°41'49.95"E| 8°19'31.68"S     | 5     | 0.10    | 39       | Sand  | 1.24    |
| 7       | 111°41'46.48"E| 8°19'40.82"S     | 4     | 0.10    | 41       | Sand  | 0.87    |
| 8       | 111°41'42.90"E| 8°19'50.06"S     | 4     | 0.17    | 45       | Sand  | 0.73    |
| 9       | 111°41'39.32"E| 8°19'59.56"S     | 5     | 0.27    | 69       | Sand  | 1.14    |
| 10      | 111°41'35.66"E| 8°20'9.04"S      | 3     | 0.13    | 113      | Sand  | 1.28    |
| 11      | 111°41'59.07"E| 8°19'35.00"S     | 6     | 0.10    | 57       | Sand  | 0.88    |
| 12      | 111°41'55.73"E| 8°19'44.31"S     | 6     | 0.10    | 40       | Sand  | 0.79    |
| 13      | 111°41'52.29"E| 8°19'53.21"S     | 5     | 0.10    | 59       | Sand  | 0.62    |
| 14      | 111°41'48.50"E| 8°20'3.02"S      | 5     | 0.17    | 66       | Sand  | 0.74    |
| 15      | 111°41'44.88"E| 8°20'12.52"S     | 5     | 0.10    | 79       | Sand  | 0.90    |
| 16      | 111°42'8.26"E | 8°19'38.46"S     | 4     | 0.23    | 49       | Sand  | 0.57    |
| 17      | 111°42'4.95"E | 8°19'47.37"S     | 5     | 0.13    | 46       | Sand  | 0.42    |
| 18      | 111°42'1.49"E | 8°19'56.68"S     | 4     | 0.17    | 50       | Sand  | 0.37    |
| 19      | 111°41'57.78"E| 8°20'6.47"S      | 6     | 0.20    | 66       | Sand  | 0.54    |
| 20      | 111°41'54.46"E| 8°20'16.09"S     | 5     | 0.13    | 71       | Sand  | 0.49    |

Explanation: V = Clarity (m), W = Current Velocity (m/s), X = TSS (Total Suspended Solid) (mg/l), Y = Bottom Material, Z = Turbidity (ftu).

The suitability map of leveling artificial coral reefs in the waters of Damas Beach, Trenggalek Regency is classified as Suitable (S2) for laying artificial reefs. The parameter that needs to be considered at this location is the bottom substrate in the waters of Damas Beach, because the bottom substrate is good for sandy coral reefs with low mud substrate. Meanwhile, from the substrate observation of the bottom of the waters in the waters of Damas Beach, the basic condition types are all fine black sand. The bottom condition of the waters with a sand substrate is not suitable for placing artificial coral reefs. This is presumably because the bottom conditions of the sand waters will submerge the artificial reef itself into the sand due to sedimentation. The location that is very suitable for submerging artificial reefs is the bottom of the waters with rubble substrate.

Quick and natural recovery of coral reef ecosystems takes a long time, because corals have a growth of 10 cm/month for branching coral species and 1-3 cm/month for stony coral species [10]. Therefore, the recommendation for placing artificial coral reefs in Damas Beach waters is to be placed close to natural coral reef.
locations, because the basic type of natural coral reefs has a hard substrate type, and artificial coral reefs will not [1].

CONCLUSIONS

The identification results of the oceanographic parameters value in the waters of Damas Beach, Trenggalek Regency consist of: (a). Clarity ranges from 2 - 6 meters, (b). The water turbidity ranges from 0.3 to 4.32 NTU, (c). The bottom substrate type of Damas Beach waters, fine black sand, (d). Current velocity ranges from 0.1 m / s - 0.4 m / s, and (e). Total Suspended Solid Damas Beach waters ranges from 35.6 - 351 mg / L. Assessment of the suitability of placing Artificial Coral Reefs in Damas Coastal waters is classified at the appropriate land level (S2), so that artificial coral reefs can be placed in Damas coastal waters as a support for the survival of fishermen and local communities.

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