The relation between quality of the sediment (nitrate, phosphate) and *Avicennia sp* density, case study; Mangrove Center Bengkak, Banyuwangi Regency, East Java

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**Abstract.** Bengkak mangrove center as a natural environment has been managed by the society as a means of tourism and preservation. These areas were located on Bali strait, consist of fisheries activity and residential. This study aims to determine the density of *Avicennia* sp, nitrate and phosphate content and the relationship between both. Three stations were determined using purposive sampling and the sample was obtained using the belt transect technique. Linear regression analysis was carried out to determine the density of *Avicennia* sp, with nitrate, phosphate content. Results of this study showed that the highest density of *Avicennia* sp was found in station 3 with a value of 3.25, followed by station 2 of 1.38, and the lowest density at station 1 was 0.71. Nevertheless, the highest concentrations of nitrate and phosphate were found at station 3 of 207.27 mg/kg and 0.23%. The relationship between the density of *Avicennia* sp, with nitrate and phosphate showed a positive correlation.

1. **Introduction**
Mangrove forests are coastal forests found in protected estuaries along rivers and lagoons in tropical and subtropical areas. With the function of maintaining the balance of the coastal water's ecosystem, preventing abrasion and waves, and as nursery grounds for several species of terrestrial and aquatic fauna[1]. These were important resources for various local activities with high productivity [2]. Indonesia is one of the largest contributors to mangrove areas in the world, reaching 45% of the world's mangroves, along with Brazil and Venezuela. Mangrove were able to flourish to a height of 30 - 50 meter, especially in Indonesia and Thailand [3]. Banyuwangi Regency has a mangrove forest of 1.9 million hectares, one of which is the Bengkak Mangrove Center with total areas 7,150 hectares. This region is a natural ecosystem consisted of *Rhizophora* sp, *Avicennia* sp, *Nypah, Pempis acidula* etc. In addition, these regions have been used as marine tourism, where there are also aquaculture and settlement activities.[4,5] Reported that aquaculture expansion and anthropogenic pressure continuously to have a significant impact on mangrove ecosystems. In this study we evaluated correlated between the density of *Avicennia* sp with a characteristic of sediment on each stations samples.

2. **Materials and methods**
2.1. **Site study**
The study was conducted from March to April 2018 at the Bengkak mangrove center (BMC), Wongsorejo sub-district, Banyuwangi Regency, East Java, Indonesia. Three station sampling were determined by purposive sampling, based on differences land uses (Figure 1). Each sampling station was determined subjectively base on the representativeness of the location according to land used. Sampling point 1; this place was located in the vicinity of the residential areas, sampling point 2; around the shrimp farming region and sampling point 3; the most remote region from both operations and as a essential areas.
Figure 1. Site study; Bengkak Mangrove Center Banyuwangi Regency, East Java, Indonesia. SP-1; Sampling point 1, SP-2; Sampling point 2, SP-3; Sampling point 3

2.2. Mangroves data collection
The vegetation sample of the mangroves was carried out using belt transect technique. The length of the belt transect was 50 x 10 m² at each station with five square plots of 10 x 10 m² for the collection of mangrove vegetation. For each transect block, the number of individuals was calculated on the basis of the criteria; seedlings, saplings (young trees), and trees. Criteria of (seedlings); height < 1 m, saplings; diameters between 2 - 10 cm and heights > 1 m. Over more, trees are plants with of more than 10 cm diameters based DBH measurement. Measuring the diameter of the stem was done at breast height (DBH) or about 1.3 m from the ground using a tape diameter. Whereas, diameter measurements for seedlings were carried out under the part where branches were discovered [6]. More over, mangrove identification was done by referring.

2.3. Nitrat dan posphat
Sediment samples were collected horizontally on the 30 cm depth using PVC tubes with a diameter of 10 cm and a length of 100 cm [7]. Furthermore, the 500-gram sample was placed in a plastic clip and marked with the sample number and keep in a cool box before testing. For the determination of NO₃ and PO₄, use APHA ed, respectively. 22nd 4500-NO₃ B, 2012, and APHA ed. 21st 4500 – PO₄ D, 2005.

Table 1. The results of measurements of nitrate, phosphate and organic matter at the Bengkak Mangrove Center.

| Stations | Parameters          |
|----------|---------------------|
|          | Nitrate (mg.L⁻¹)    | Phosphate (g.L⁻¹) | Organic Material (g.L⁻¹) |
| SP - 1   | 89,48               | 1,6               | 57,5                     |
| SP - 2   | 199,66              | 2,3               | 60,3                     |
| SP - 3   | 207,27              | 2,3               | 69,5                     |

2.4. Data analysis
The data were analyzed by calculating the Important Value Index (IVI) which consisted of species density, relative density and relative dominance was determined based on calculations [8]. Furthermore, to explain the relationship of *Avicennia* density with nitrate and phosphate were analyzed based on Pearson coefficiency correlations.

3. Result and discussion
Vegetation types were found at stations 1 and 2 consisted of *Avicennia alba* and *Avicennia marina*, meanwhile, station 3 consists of *Avicennia alba*, *Avicennia lanata* and *Avicennia marina* (Figure.2). We found, that *Avicennia sp* were species that dominates compared to other species. This is due to *Avicennia sp* can tolerate environmental conditions and extreme conditions, so they can compete for more nutrients than other species [2,6]. *Avicennia sp*, is adaptive to environmental changing, despite the growth was not optimal.
on the high salinity [2]. In mangrove ecosystems, these species are generally at the forefront. Avianennia sp distribution that we discovered consisted of trees, sapling, and seedlings. The tree category was the largest distribution with a density of 8,000 individuals per hectare. Conversely, the distribution of sapling and seedlings were smaller than that of trees. Normally, in younger plantations (< 11 years), the size of the trees is homogeneous (diameter and height) and has a high density if there is no powerful competition [9]. Low regeneration of $\text{Avicennia}$ sp due to decreased environmental quality and anthropogenic pressure [10]. Over the last two decades, anthropogenic stress and aquaculture expansion have decreased mangroves by 35% in the world [4,5]. In addition, environmental parameters such as; increased salinity and decomposition of organic matter may have an impact on the survival of seeding [11]. This does not apply to adult $\text{Avicennia}$ when salt levels are too high they will excrete excess salt through leaves, seeds, and propagules [12].

Meanwhile, the largest density of $\text{Avicennia}$ sp was showed discovered at station 3 was 3.25, followed by station 2 was 1.38, and the lowest density at station 1 was 0.71. Refers to the Ministry of Environment Decree of the Republic of Indonesia Year 1998 number 02, the mangrove density at station 1 included in the medium category and very high categories for stations 2 and 3. These conditions were indicated that the vegetation community was not disturbed. The density of $\text{Avicennia}$ sp mostly grows in deep mud that is rich in the organic matter [8]. On the other hand, anthropogenic stresses such as; domestic waste from population activities were affect vegetation density on the station 1. Mangrove stability is influenced by salinity, soil type, and chemical content and nutrient dynamics, physiological tolerance, internal predation and competition, and human disturbance [13].

**Figure 2.** Distributions of $\text{Avicennia}$ sp vegetation on the site study (individu.Ha⁻¹)

| Station | Species | Tree  | Saplings | Seedling |
|---------|---------|-------|----------|----------|
|         |         | Di (Ind.m⁻²) | RDi (%) | Di (Ind.m⁻²) | RDi (%) | Di (Ind/m²) | Rdi (%) |
| SP - 1  | $A. \text{alba}$ | 0.05 | 71,43 | 0.44 | 68,75 | - | - |
|         | $A. \text{marina}$ | 0.02 | 28,57 | 0.20 | 31,25 | - | - |
|         | $\sum$ | 0.07 | 100 | 0.64 | 100 | - | - |
| SP - 2  | $A. \text{alba}$ | 0.30 | 27,27 | 0.00 | - | 1,00 | - |
|         | $A. \text{marina}$ | 0.80 | 72,73 | 0.28 | 100,00 | - | - |
|         | $\sum$ | 1.10 | 100 | 0.28 | 100 | - | - |
| SP - 3  | $A. \text{alba}$ | 0.01 | 1,30 | 0.12 | 25,00 | 1,00 | - |
|         | $A. \text{lanata}$ | 0.03 | 3,90 | 0.00 | - | - | - |
|         | $A. \text{marina}$ | 0.73 | 94,81 | 0.36 | 75,00 | - | - |
|         | $\sum$ | 0.77 | 100 | 0.48 | 100 | 2,00 | - |

**Table 2.** Species density and relative density of $\text{Avicennia}$ sp in the BMC

Descriptions; Di; species density, RDi; relative density
Furthermore, the relationship between phosphate and nitrate with mangrove density has a positive relationship. Which is, the higher the nitrate and phosphate content could affect the density of the mangrove species. The high content (N and P) of station 3 is caused by the location being in the river mouth and there are fisheries cultivation activities. The environment around mangroves is rich in nutrients [14], one is at the estuary [15]. Nutrients such as inorganic phosphorus, nitrogen, potassium, and organic carbon are provided by coastal and terrestrial ecosystems through active and passive transportation [16]. According [17], addition of organic matter can increase the population of decomposer microorganisms. The same thing happened at station 2, meanwhile, the lowest nitrate and phosphate content was at station 1 due to where the location is close to residential areas and mangrove recreation areas. One of the procedures that inhibit the formation of soil nutrients is the increase in the inorganic material, it can be to inhibit microbial decomposition [18]. Nitrate is a nitrification product that has a function to fertilize the mangrove ecosystem and is the primary nutrient for plant growth [17]. Similar to nitrate, phosphate was also needed by plants to transfer ADP and ATP, NAD and NADH energy by plants. In nature phosphate in organic and inorganic forms derived from cultivation activities such as; organic matter, excretion, and secretion.

4. Conclusion

Avicennia sp was most found in site studies, with the highest distribution in the tree category. Nitrate and phosphate have a significant influence on density. The highest Avicennia sp density was found at stations 2 and 3, where the area is nearest estuary and cultivation area. While the lowest density was at site station 1, which is the closest area to residential areas.

5. References

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