Analysis of Nitrogen and Carbon Content on Mangrove Forests in Tongke – Tongke, Sinjai

Ernawati Syahruddin Kaseng
Department of Agricultural Technology, Faculty of Engineering, Universitas Negeri Makassar, Indonesia
ernawatisyahruddin71@gmail.com

Abstract. This study aims to analyze Nitrogen and Carbon contents in the soil of a mangrove forest in Tongke-Tongke, East Sinjai. The stations were determined by purposive sampling based on the age of mangroves. As a comparison, one station was selected from the outside of mangrove areas (non-vegetation station). There were six stations: Non-vegetation, 1-years-old, 5-years-old, 10-years-old, 27-years-old, and 30-years-old stations. Each stations consist of two substations. Purposive sampling also employed to decide the soil and sediment sample from the mangrove forest. The sample were collected to find out textures and content of Nitrogen and Carbon. 200g sediments (1m x 1m) were taken from each stations used a spade and put them in the labelled plastics. The sample analyzed in laboratory.

The result showes that the value of organic Nitrogen is around 14.40 ton ha\(^{-1}\) to 28.80 ton ha\(^{-1}\) yr\(^{-1}\). Organic carbon content value ranged from 30.36 ton ha\(^{-1}\) to 31.14 ton ha\(^{-1}\).

1. Introduction
Mangrove is a natural resource has a strategic function in the tropical coastal region. It is the most productive ecosystem and fruitful to the life of sea creatures. The mangrove has a high economic value such as a source of food, building materials, medicines, firewood. It also is a complex ecosystem since it related to the land ecosystem and offshore ecosystems outside [1].

The existence of mangrove forests in the ecoton area between the land and the sea make the area is very influenced by tides of the sea. These conditions have made the area of mangrove forests was subjected to development of various sectors.

One impact of various activities that occur in mangrove area is the degradation in the area. The degradation will directly reduce the biodiversity of the beach, especially the specific organisms that live in the mangrove area [2].

Rehabilitation of mangrove forest in the Tongke-Tongke has been done since the 1986 by the local people. The efforts of re-greening the coastal area was conducted by a group of people who are concerns to the natural resources – Aku Cinta Indonesia (KPSDA-ACI). It is currently have started to see the change. By 2002, the area of mangrove forests has reached 34.78 Ha and the general types of mangrove is Rhizophora mucronata Lamarck [3].

The existence of mangrove rehabilitation activities in the region showed a good influence to ecological conditions. The ecological conditions also indirectly influenced the content of carbon and nitrogen in mangrove ecosystems.
Mangrove sediments is the place where many plants and animals at the water live. The character of sediments such as mud, sand, soil, clay, sand, gravel and stone tell composition, density, and distribution of makrozoobentos [4]. Mangrove forests are known as a very productive ecosystem. Litter from tree (leaves, propagul, and twigs) and root growth under the surface provide a significant input as organic carbon from sediments in mangrove [5]. The litters act as one-third of the net primary production [6], making the mangrove environment have a high potential as a global carbon storage [7][8]. It is still lack of information about the content of carbon and nitrogen in the rehabilitation mangrove ecosystem based on the age of mangrove. Therefore, this study focuses on the dynamics of carbon and sediment texture on the rehabilitation mangrove ecosystem based on the age of the mangrove.

2. Methods
This study was conducted on January to November 2016 at the rehabilitation and the natural mangrove forest in Tongke-Tongke, a village in East Sinjai, South Sulawesi, Indonesia. The stations were choosen by purposive sampling based on the age of mangroves. As a comparison, one station employed from outside of the mangrove area (Non-vegetation station). Each station consisted of two substations. The stations were non-vegetation, 1-year; 5-year, 10-year, 27-year, and 30 year stations.

200 grams sample of sediments (1 m x 1 m) scooped from the stations to look out the textures, organic carbon, and nitrogen. The sediment then put in labelled plastics and analyzed in the laboratory. The analysis aims to know the chemical composition of sediments (organic carbon and nitrogen) and type of sediment texture. The analysis carried out in the Laboratory of chemistry and soil fertility, Faculty of agriculture, University of Hasanuddin. Sediment texture analyzed using the hydrometric method. The content of organic carbon and nitrogen were analyzed using Spectrophotometer [9].

3. Result and Discussion
Mangrove forests can be found along the coastlines in the tropics. It supports a wide range of ecosystem, including fisheries production and nutrient cycles. Data about the potential of mangrove forests as a carbon sink until now is still difficult to find (Brown, 1997; Ketterings et al., 2001; Niklas, 1994; Reiss, 1991 in [10]). Whereas, the data about the potential of mangrove forests as a carbon sink is an important information that can be used by the government as a bid to gain compensation fund from investor.

The levels of organic matter in sediments of mangrove land originated from the primary productivity of the local. It is mostly donated by mangrove vegetation and the things from river flow. Therefore, the thickness of the mangrove and anthropogenic activities may affect the levels of total organic materials in the environment of mangrove. Table 1 shows the nitrogen and carbon content of sediment at each substation in each station.

Table 1 shows that the organic carbon content in each age mangrove group ranging from 2.53% to 2.60%. According to Hardjowigeno (1995 in [1]), content of organic carbon categorized very high if the value > 30%, high is 10%-30%, medium is 4%-10%, low is 2% - 4%, and very low is < 2%. Thus, the organic carbon content in this study included in low category. However, Dharmawan and Siregar [10] state that when the organic carbon content ranging from 2% to 3%, it is in medium category.

| Station | Kjeldahl N (%) | Wakley & Black C (%) |
|---------|----------------|----------------------|
| NV      | 0.12           | 2.53                 |
| R - 1   | 0.13           | 2.54                 |
| R - 5   | 0.16           | 2.54                 |
| R - 10  | 0.17           | 2.54                 |
| R - 27  | 0.18           | 2.60                 |
| R - 30  | 0.24           | 2.56                 |
The range of the organic carbon compared to other mangrove forests is lower. The range from the mangrove forest in the Kutai, East Kalimantan is 3.52%-8.48% [11]. Similarly, the mangrove forests in the BKPH Ciasem, KPH Purwakarta ranging from 2.28% to 3.87% [10]. The difference is due to the heavily mangrove forests at both places compared to the rehabilitation and natural mangrove forest Tongke-Tongke.

The highest organic carbon content was at the 27-years mangrove and the lowest was in non-vegetation station. The highest organic carbon due to the thickness and density of the mangrove in the location of the age groups was higher. Therefore, production of litter as the biggest contributor to the high content of organic carbon is more. The organic litter is the main constituent of organic matter [11]. According to [12], a mangrove ecosystem acts as a litter exporters that can reach 7.1 – 8.8 tons ha⁻¹ yr⁻¹. In addition, it derived from the supply of organic matter from the sea influenced by tidal currents suspended on the dusty clay or muddy substrate at this station. Similarly, Lovelock [13] states that the high tides brings organic material or suspended organisms to mangrove ecosystem and at the time of low tide will be filtered by the sediment.

Mangrove litter scattered in the forest and it has decayed and mingled with the sediment. Some types of makrozoobentos also were found foraging above the sediment when the water subsided. According to [14], the litter is an organic material undergoes several stages of decomposition process that produces a substance that is essential for life and aquatic productivity due to a source of nutrients for aquatic organisms [15]. The rate of decomposition of the litter are affected by dissolved oxygen, water, decomposer microorganisms, pH, temperature, and salinity [16]. Halima (2000) reported that the rate of weathering litter based on the planting age of R. mucronata in the forest of Sinjai, South Sulawesi, amounting to 74%/60 hr (8th); 90%/60 hr (9th); 96.5%/60 hr (10th).

The low of organic carbon content in the area of non vegetation due to its location which is on the coast so the alleged supply of organic matter derived from the litter that is lowest on the current flow ebbs and settles on the sandy mud substrate found in that location. Duarte and Cebrian [17] said that most of the mangrove litter resulting from biomass (± 90%), which is stored in the sediment (± 10%), decomposes (± 40%) and are carried by currents to other areas (± 30%).

The high content of organic carbon at 27-year mangrove than in any other age group station shows that age affects production of mangrove litter as a source of organic carbon in mangrove sediments. Sediadi (1991) [15] informs that the debris mangrove litter Rhizophora sp. rises in accordance with the age. It reaches maximum at the 10 years. Halidah and Sumedi [18] reported that production of the mangrove forest litter in Sinjai on 8-years about 14 tons ha⁻¹ yr⁻¹, 11.97 tons ha⁻¹ yr⁻¹ in 9-years and 13.27 tons ha⁻¹ yr⁻¹ in 10-years old. Sukardjo [19] reported that production of the mangrove forest litter in Tiris, Indramayu, with Rhizophora sp is 12.90 ton ha⁻¹ yr⁻¹. The low of organic carbon content at the 30-years of mangrove which were located in natural mangrove forests compared to the 27-years in the rehabilitation mangrove forest due to the thickness of mangrove which is thinner and the density in natural mangrove forest are lower due to deforestation at that location.

Table 1 also shows that the value of the content of nitrogen in each age group mangrove range 0.12%-0.24%. The range of the nitrogen content categories include low. According to Hardjowigeno (1993) in [1], that the content of nitrogen categorized very high when N > 0.7%, high is 0.5% - 0.7%, medium is 0.2% - 0.5%, low is 0.1% - 0.2%, and very low is < 0.1.

The highest nitrogen content was at the 30-years mangroves station and the lowest nitrogen content was in the area of non-vegetation. The low nitrogen in non-vegetation due to the area tends to be sandy and it has low nutrient elements. In addition, the waves of the sea has always take out the nutrient elements in the sediments. Similar with Bengen [20] opinion that the sand has a low nutrient.
Table 2. Sediment result (N and C)

| Station | Organic Material | N (ton / yrs) | C (ton / yrs) |
|---------|------------------|---------------|---------------|
| NV      |                  | 14.40         | 30.36         |
| R - 1   |                  | 15.00         | 30.46         |
| R - 5   |                  | 18.60         | 30.41         |
| R - 10  |                  | 19.00         | 30.41         |
| R - 27  |                  | 21.60         | 31.14         |
| A - 30  |                  | 28.80         | 30.65         |

Table 2 shows that the value of organic Nitrogen content at each station ranging from mangrove 14.40 ton ha\(^{-1}\) yr\(^{-1}\) to 28.80 ton ha\(^{-1}\) yr\(^{-1}\). The value of the highest Nitrogen content is present on the 30-year mangrove i.e. of 28.80 ton ha\(^{-1}\) yr\(^{-1}\). Meanwhile, the organic Carbon content value ranges from 30.36 ton ha\(^{-1}\) yr\(^{-1}\) to 31.14 ton ha\(^{-1}\) yr\(^{-1}\). Although it looks that at all age groups relatively have the same value, but it looks that 27-year mangrove has the highest among other mangroves i.e. 31.14 ton ha\(^{-1}\) yr\(^{-1}\). It is because at 27-years station produced the most leaves or litter since at this age, the mangrove categorized as a tree and this is the climax of the age of a mangrove tree as a pioneer. Bengen [21] reported that the organic carbon content of leaves of mangroves in the Berau coastal ranging from 183.78 to 412.86 gCm\(^{-2}\) yr\(^{-1}\) or 1,837.78 to 4,128.56 kg C ha\(^{-1}\) yr\(^{-1}\).

A study conducted by [22] in the area of coastal mangrove forests Camplong, Sampang Madura reported that the carbon stock of litter at the lowest tide zone is 48,521 ton ha\(^{-1}\). It means the resulting carbon stock is higher than the results of this study. According to Hairiah and Rahayu, [23], mangrove ecosystems play a role in mitigation of climate change due to global warming because it was able to reduce CO\(_2\) through the mechanism of "sekuestration" – carbon sequestration from the atmosphere and holding in a few compartments such as plants, litter, and soil organic matter.

According to [24], the plants absorbed carbon during photosynthesis, along with nutrients that are taken from the soil, producing raw materials for growth. In the process of photosynthesis, CO\(_2\) from the atmosphere is bound by the vegetation and stored in the form of biomass. A carbon sink is closely connected with the forest biomass. The number of biomass obtained from production and density of biomass that is allegedly from the measurement of the diameter, height and weight of tree. An advantage forest as forest woods is only 4.1%, while the optimal function of forests in carbon sequestration reached 77.9% (Darusman, 2006).

Ratnasari (2011) study in Mangrove area, Penunggul, Pasuruan, East Java, showed that the rate of litter decomposition of leaves of *Rhizophora mucronata* which is the rate of release of organic carbon is found to range 1.65-1.81% per day. This is equivalent to a range between organic carbon 168.46 - 177.82 gr m\(^{-2}\) per day or equivalent with 614873.4 - 649033.1 kg ha\(^{-1}\) yr\(^{-1}\). It is thought that the magnitude of nutrient release based on the production of litter generated or detached.

According to Prasty (2011), content of biomass in several age classes mangrove of *Rhizophora apiculata* in Kubu Raya, West Kalimantana, will increase in line with the increasing of the plant age. This is in line with Sjostrom (1980) that the greater potential of biomass the older mangrove forest due to the diameter of the tree through cell division which takes place continuously and will be getting slower at a certain age. The growth occurred in the the cambium so that new cells are formed which will add the diameter of the trunk.

4. Conclusion
The Organic Carbon content in each location of the mangrove ranging from 2.53% to 2.60% includes in the low category. The Organic Carbon is ranging from 30.36 tons/yr to 31.14 tons/yr. The age, the thickness, and the density of mangroves affects the litter production as the biggest contributor towards the high content of organic carbon sediments on the rehabilitation mangrove forest. Meanwhile, the content of Organic Nitrogen ranging from 14.40 tons/yr to 28.80 tons/yr. The Nitrogen in the
rehabilitation mangrove forest derived from mangrove litter and dusty clay that can absorb nutrient from the waters when the tidal is happening. It is affected the supply of nutrient elements originating from aquaculture wastes deposited in sediments. The highest Nitrogen contained in the 30-years mangrove station, 28.80 tons/yr and the lowest was in the Non-vegetation station. Meanwhile, the highest Carbon was at the 27-years mangrove, 31.14 tons/yr and the lowest was in the non-vegetation area.

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