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Stock assessment of brown seaweeds (Phaeophyceae) along the Bitung-Bentena Coast, North Sulawesi Province, Indonesia for alginate product using satellite remote sensing

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Abstract

Indonesia needs at least 1,100 tons of alginate per year for various food and non-food industries with a value of about 420,000 US Dollars. These needs are met through imports from aboard. The raw materials for alginate, namely brown seaweed (Phaeophyceae) are very abundant in Indonesian coastal zones, but its stock level is not yet known. This study aims: to explore the biomass of brown seaweeds along the coastal areas of Bitung-Bentena, North Sulawesi Province by mapping their habitat, distribution and density using the effective and efficient tool of satellite remote sensing; and to compile preliminary results on the quality of alginate extracted from brown seaweeds. Result show that based on the isocluster analysis of Landsat-7 ETM+ and field sampling, we successfully classified 6 different habitats in the reef flats of Bitung-Bentena with map which had accuracy of 73.6%. The total area of brown seaweeds was approximately 127.1 ha. Meanwhile, from 53 field transects, there were 6 species of brown seaweed with an average density for all species of 690.4 grams/m2. Thus, the biomass of brown seaweed was 2,133.5 tons wet weight, equal to 29.9 tons of alginate. This study proves that satellite remote sensing is an effective and efficient tool for such kind of works, and must be continued along the entire of Indonesian coastal zones. In this study, the preliminary results on extracting alginate from brown seaweed are also presented.

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Keywords: stock; brown seaweed; alginate; remote sensing; Landsat-7 ETM+; Bitung-Bentena

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1. Introduction

Indonesia is the largest archipelagic country in the world with more than 17,000 islands and 81,000 km of coastline, the second longest coastline after Canada, so there is no doubt that Indonesia has extensive coastal region. The coastal zones of Indonesia have three unique ecosystems, namely mangroves, seagrass and coral reefs. Each of these ecosystems has productivity that is higher than the productivity of a tropical rain forest [1]. Thus, those ecosystems are abundant with unexplored biodiversity and living resources that provide diverse goods and environmental services for the benefit of local communities.

One of those abundant resources is brown seaweed (Phaeophyceae) that is distributed on the reef flats. Some genus of phaeophyceae are: Padina, Sargassum and Turbinaria, which potentially produce alginates [2, 3, 4]. Alginate is an organic polymer family of polysaccharides that are composed of two monomer units β-D guluronic acid (G) and α-L acid mannuronat (M) or alternating both (GGMM) [5, 6]. Alginate in brown seaweed is commonly fused with sodium, potassium, calcium and magnesium which are not soluble in water [7, 8, 9], Alginate was first discovered by a British chemist ECC Stanford, which was extracted from brown seaweed in the form of alginic acid, then patented in 1881 [10, 7, 9].

Alginate is an important substance for the food and beverages industry, medical/pharmaceuticals (cosmetics), as well as for the non-food Industry, such as for textiles, paints and toothpastes, due to its ability as a thickening or emulsifier [4, 11]. Such kind of industries in Indonesia requires about 1,100 tons of alginate per year with a value of US $ 420,000 [12]. All of this alginate is imported from abroad (European countries, USA, China, Japan, and the Philippines). There is no factory that produces alginate in Indonesia, although in fact, the brown seaweed used as raw materials are very abundant here.

Although the raw material for alginate is abundant in wild, but the standing stock of the brown seaweeds is still not yet known. Furthermore, the brown seaweed grows and blooms at certain seasons only, with different times and places. Our limited previous study on the stock of brown seaweeds was done only in the west part of Indonesia, mainly in Java Island, and even in a very narrow areas such as in Pari Island (Jakarta), Baron Beach, Yogjakarta (Central Java), and in some wider brown algae/seaweeds beds (Sargassums pp) on the south coast of Pamengpeuk and Cipatujah (West Java) [13, 14]. Little is known about their stocks in the eastern part of Indonesia.

Therefore, accurate assessment of the biomass or standing stock of brown algae is very important for self-sufficing the national needs on alginate. Thus, this study aims: 1) to explore the standing stock of brown seaweeds along the coastal areas of Bitung-Bentena, North Sulawesi Province by mapping their habitat, distribution and density using the effective and efficient tool of satellite remote sensing, and 2) to compile preliminary results on the quality of alginate extracted from brown seaweeds.

2. Methods

2.1. Study sites and time

This study was conducted along the coastal areas between Bitung and Bentena (approximately 31 km), North Sulawesi Province. However, based on initial field survey, the reef flat where the brown seaweed was abundant was only in a restricted areas about 2.5 to 3.0 km long that lay 22.2 km from Bitung and 5.6 km from Bentena (Fig. 1). The width of the reef flat ranged from 100 – 200 m. The study was carried out in July and September 2012, which coincided with the season for the growth of brown algae. During December to February (west monsoon) the sea becomes rough and most of the brown algae are damaged by big waves.

2.2. Satellite data and analysis

In this study we used Landsat 7 Enhanced Thematic Mapper Plus (ETM+) satellite image. However, since May 31, 2003, the scan line corrector (SLC) failed, causing the scanning pattern to exhibit wedge-shaped scan-to-scan gaps. The ETM+ has continued to acquire data with the SLC powered off (SLC-off), leading to images that are missing approximately 22% of the normal scene area. To improve the utility of the SLC-off data, the U.S. Geological Survey (USGS) developed new products that use the data from multiple ETM+ scenes to provide complete ground coverage