The 8th International Symposium for Sustainable Humanosphere (The 8th ISSH 2018)

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The 8th International Symposium for Sustainable Humanosphere (The 8th ISSH 2018)

Editorial

The 8th International Symposium for Sustainable Humanosphere (The 8th ISSH 2018) was held at Hotel Grandika, Medan (Indonesia) on 18-19 October, 2018. The forum was organized by Research Center for Biomaterials – Indonesian Institute of Sciences (RC Biomaterials – LIPI), and co-organized by University of Sumatera Utara (USU), Indonesia, and co-hosted by Research Institute for Sustainable Humanosphere (RISH) – Kyoto University, Japan. The symposium was also hugely supported by Japan Science and Technology Agency (JST) through Japan-ASEAN Science, Technology, and Innovation Platform (JASTIP) program; JST – JICA (The Japan International Cooperation Agency) collaborative program through SATREPS (Science and Technology Research Partnership for Sustainable Development); and also National Institute of Aeronautics and Space (LAPAN), Indonesia.

The Symposium was held in conjunction with Humanosphere Science School (HSS) 2018, an important and prestigious scientific forum organized by RC Biomaterials – LIPI and RISH – Kyoto University, since its first initiation in 2006. HSS provides learning experience by sharing knowledge, science, and technology delivered by prominent scientists and experts specializing in the field of humanosphere. The forum was also marked as The 384th Symposium on Sustainable Humanosphere for RISH – Kyoto University, Japan.

The present symposium captured a tagline of “Sustainable Humanosphere: On the Verge of Global Challenges and Human Security”. Humanosphere has always been an important field of interdisciplinary science, as we are facing many issues threatening humanity and our very survival such as global warming, resources depletion, energy and environmental issue, etc. Humanosphere is a concept describing the human living environment and the sphere that covers us, including the forest sphere and atmosphere.

The symposium was originated from the need to provide an interdisciplinary forum where the most serious problems affecting human security and global challenges could be discussed. We recognize that the best approach for sustainability in humanosphere is to employ an integrated perspective from Applied Science & Technology, Bioscience, Community-based development & Socioeconomic science, Earth & Atmospheric Science, and Forest & Biomaterials Science. Therefore, the selected 72 papers presented at The 8th ISSH 2018 were clustered in those five topics for the present proceedings.
The organizers appreciate the support and assistance of the co-operating institutions, the participants, the presenters and supporting staffs. We are very proud to announce that the present event had generated a great success, as shown by impressive numbers of quality papers with wide-ranging backgrounds and interdisciplinary topics. We hope the proceedings of the 8th ISSH 2018 could provide significant contribution to global research in the field of humanosphere science.

We look forward to see you all again in the future symposium.

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Dr. S Khoirul Himmi
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**OPEN ACCESS**

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<table>
<thead>
<tr>
<th>Open Access</th>
<th>012061</th>
</tr>
</thead>
<tbody>
<tr>
<td>The flexural properties of medium density fibreboard overlaid with veneer from three species of wood</td>
<td>T D Cahyono, M Y Massijaya, A H Iswanto, H Yanti and L N Anisah</td>
</tr>
</tbody>
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<tr>
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<th>012062</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anatomical observation and characterization on basic properties of Agarwood (Gaharu) as an Appendix II CITES</td>
<td>W Dwianto, S S Kusumah, T Darmawan, Y Amin, A Bahanawan, D A Pramasari, E Lestari, S K Himmi, E Hermiati, W Fatriasari, R P B Laksana and R Damayanti</td>
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</tbody>
</table>

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<tr>
<th>Open Access</th>
<th>012063</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study on the existence and characteristics of Sonokeling (<em>Dalbergia latifolia</em> Roxb) as an Appendix II CITES Wood</td>
<td>W Dwianto, A Bahanawan, S S Kusumah, T Darmawan, Y Amin, D A Pramasari, E Lestari, F Akbar and Sudarmanto</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Open Access</th>
<th>012064</th>
</tr>
</thead>
<tbody>
<tr>
<td>The heavy metal of cuprum (Cu) and lead(Pb) content in <em>Avicennia marina</em> and <em>Rhizophora mucranata</em></td>
<td>Yunasfi, Desrita and K P Singh</td>
</tr>
</tbody>
</table>
In vitro cytotoxicity of Alstonia scholaris (R.Br) bark on Vero and HeLa cell lines

Zuraida and S Mariya
Analysis of vegetation density change in coastal villages of Tapanuli Tengah and Sibolga using landsat images

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Analysis of vegetation density change in coastal villages of Tapanuli Tengah and Sibolga using landsat images

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Abstract. Indonesia is an archipelagic country that has a long coastline of approximately 99,093 km. Most of the areas are intensively exploited by human activities. The increased population and development activities in the coastal area of Tapanuli Tengah and Sibolga have caused degradation and conversion of forests that cause the density of vegetation change. This research was conducted by overlaying some spatial data of the year 2007 and 2017 to analyze the changes of vegetation density and NDVI (Normalized Difference Vegetation Index) values between 2007 and 2017. The research result showed that the largest area of vegetation density changes was the decreased of very dense class, which was 62.48%. The largest area increased occurred in the dense class of 50.75%. This research is expected to provide information for considering the management of coastal areas in Tapanuli Tengah and Sibolga.

1. Introduction
Indonesia is an archipelagic country that has a long coastline of approximately 99,093 km [1]. Tapanuli Tengah Regency and Sibolga City are in those areas. In these regions, the demand for land has soared, and existing lands have been intensively exploited for human activities such as settlement, industry, seaport, aquaculture, agriculture, and tourism. These have caused new problems in the coastal areas: coastal erosion and sedimentation.

Human beings have various needs to fulfill in order to support their livelihood, and it becomes one of the factors contributing to forest degradation and conversion. The rapid population increase has significantly affected land utilization. The use of land without adhering to spatial planning principles may hamper environmental quality, lead to environmental degradation, as well as reduce natural resources. These occur in coastal areas with increasing population density. The high population increase and rapid development of the coastal areas of Tapanuli Tengah Regency and Sibolga City have put higher ecological pressure on the regions’ coastal ecosystem. The increased pressure will surely be a threat to the existence and sustainability of local coastal ecosystem and resources [2].

Based on the aforementioned condition, monitoring should be conducted on the change of vegetation density in Tapanuli Tengah Regency and Sibolga City. Data on vegetation density change are very much needed as a preventive measure and a basis for forest area management and must be collected periodically. Therefore, coastal area spatial data with sustainable planning are required. A study was conducted to analyze the vegetation density in the coastal villages of Tapanuli Tengah Regency and Sibolga City in 2007 and 2017.
The objectives of this research are to differentiate and measure the changes of vegetation density in the coastal villages of Tapanuli Tengah Regency and Sibolga City in 2007 and 2017, as well as to measure land cover of each density class in the coastal villages of Tapanuli Tengah Regency and Sibolga City in 2017.

2. Research methods

2.1. Research location and time
The research was conducted from August 2017 to May 2018. It was located in the coastal villages of Tapanuli Tengah Regency and Sibolga City in North Sumatra Province (figure 1). Data processing was completed at the Forest Management Laboratory of Forest Management Department, Faculty of Forestry, University of North Sumatra.

2.2. Research tools and data
The tools used in this research consisted of data collection and data analysis tools. The tools used for field data collection were GPS (Global Position System), measurement tape, haga hypsometer, camera, writing tools, and so forth. Meanwhile, data analysis was conducted by using Computer, Excel, ArcGis 10.3, and ERDAS Imagine 9.2.

Data used in this research were primary data namely field ground check and secondary data namely Landsat 5 images of the year 2007 and Landsat 8 images of the year 2017 as well as administrative maps of Tapanuli Tengah Regency and Sibolga City of 2017.

2.3. Data collection method
Data collection method in this research was performed by downloading Landsat 5 path/row 129/58 images of 2007 and Landsat 8 OLI path/row 129/58 images of 2017 from earthexplorer.usgs.gov which were needed as secondary data according to the analysis objectives. Primary data are the data obtained
through direct observation at the research location (ground checking) by recording field observation point coordinate from GPS as well as the condition surrounding that particular point along with vegetation pictures and analysis.

Vegetation analysis was done using the transect method. Forty plots were used based on purposive sampling, that is a sampling method where the research sample is determined by the researchers based on certain criteria [3]. Observation transect was made by sample plots with specific stand level, namely tree level of 10 x 10 m (mangrove forest) and 20 x 20 m (coastal forest); while sub-plot sizes were 5 x 5 m (mangrove forest) and 10 x 10 m (coastal forest) for sapling level and 2 x 2 m (mangrove forest) and 5 x 5 m (coastal forest) for seedling level.

Vegetation analysis for trees, saplings, and seedlings was calculated with the following formula [4]:

\[
\text{Density per ha} = \frac{\text{total number of species} \times 10000 \text{ m}^2}{\text{total number of quadrat studied} \times \text{area of quadrat}}
\]  

(1)

\[
\text{Relative density} = \left( \frac{\text{density per ha of a species}}{\text{total number of density all species}} \right) \times 100\%
\]  

(2)

\[
\text{Frequency of species} = \left( \frac{\text{total number of quadrat in which species found}}{\text{total number of quadrat studied}} \right)
\]  

(3)

\[
\text{Relative frequency} = \left( \frac{\text{frequency of a species}}{\text{total number of frequency all species}} \right) \times 100\%
\]  

(4)

\[
\text{Basal area m}^2 = \frac{3,1416 \times \text{(diameter)}^2}{4}
\]  

(5)

\[
\text{Dominance} = \frac{\text{basal area of a species}}{\text{total number of quadrat studied}}
\]  

(6)

\[
\text{Relative dominance} = \left( \frac{\text{dominance of a species}}{\text{total dominance of all species}} \right) \times 100\%
\]  

(7)

\[
\text{Important Value Index}_{\text{tree}} = \text{Relative density} + \text{Relative frequency} + \text{Relative dominance}
\]  

(8)

\[
\text{Important Value Index}_{\text{treesapling, seedling}} = \text{Relative density} + \text{Relative frequency} + \text{Relative dominance}
\]  

(9)

2.4. Data analysis methods

2.4.1. Image processing

a. The merge of image band
Landsat images downloaded from earthexplorer.usgs.gov consisted of separated bands. Thus, the image bands must be merged first to do a radiometric correction. The image bands were merged using ERDAS Imagine 9.2.

b. Radiometric correction
A radiometric correction was done in order to eliminate noises on the images caused by the atmosphere. A radiometric correction was performed by sharpening the image contrast. The sharpening process was completed using a linear model in ERDAS Imagine 9.2.

c. Image cropping
Image cropping was conducted to obtain a picture of the research location that would be studied more specifically. Image cropping was conducted using ArcGIS 10.3 software on the administrative maps of Tapanuli Tengah Regency and Sibolga City obtained from the Forest Area Designation Agency (BPKH).
d. **NDVI transformation**

NDVI transformation was done using ArcGis 10.3 software on the red and near-infrared band, namely band 3 (red) and 4 (near infrared) for Landsat 5 and band 4 (red) and 5 (near infrared) for Landsat 8.

The main principle of NDVI is measuring the greenness level. Greenness intensity on the Landsat images was correlated with the density level of vegetation and might detect greenness level with leaf chlorophyll content. The NDVI transformation values which range from -1 to +1 have a different presentation on land utilization. The higher the NDVI value, the denser the vegetation will be, and, vice versa, the lower value means that the area is a water body. According to Verhulst and Govaerts [5], the formula used is:

\[
NDVI = \frac{IR - R}{IR + R}
\]

NDVI values are classified into five different classes namely: non-vegetation, sparse, intermediate, dense, and very dense. The classification was determined by using an equal interval in ArcGIS software [6]. Its function is to know the vegetation density in the coastal villages of Tapanuli Tengah Regency and Sibolga City.

2.4.2. **Land cover analysis on density class**

a. **The merge of image band**

Landsat images downloaded from earthexplorer.usgs.gov consisted of separated bands. Thus, an image band must be merged first to do a radiometric correction. The merge of image band was done using ERDAS Imagine 9.2.

b. **Radiometric correction**

A radiometric correction was done in order to eliminate noises on the images caused by the atmosphere. A radiometric correction was performed by sharpening the image contrast. The sharpening process was completed using a linear model in ERDAS Imagine 9.2.

c. **Image cropping**

Image cropping was done to obtain a picture of the research location that would be studied more specifically. Image cropping was done using ArcGis 10.3 software on the administrative maps of Tapanuli Tengah Regency and Sibolga City obtained from the Forest Area Designation Agency (BPKH).

d. **Supervised classification**

Supervised classification is a classification process that is supervised and controlled by the user. User intervention starts from the selection of research location until the clustering process. Supervised classification was done based on a field survey by creating polygon samples on land cover classes. Land cover classification is based on the Indonesian National Standard 2010. The method used for this classification is the maximum likelihood in ERDAS Imagine 9.2 software.

e. **Image classification accuracy calculation**

The accuracy level of image classification can be determined by comparing the results of image classification and actual data obtained from the field. The calculation of accuracy is a step that determines whether the image classification result, in fact, represents the actual condition or not. Accuracy is usually analyzed in a contingency matrix, i.e., a square matrix containing the number of
pixels in the classification, which is often called an error matrix or confusion matrix [7, 8]. Mathematically, the formula to calculate accuracy is as follow:

$$\text{Kappa accuracy} = \frac{\sum_{i=1}^{n} \sum_{j=1}^{N} X_{ij} \times x_{100\%}}{\sum_{i=1}^{N} \sum_{j=1}^{n} X_{ij}}$$  \hspace{1cm} (11)

where:
- $N$ = Total pixel used for observation
- $N_i$ = The number of line/path on the $i$ error matrix (equal to the number of class)
- $X_{ni}$ = Total column on $n$ row

f. Land cover analysis on vegetation density class

Land cover analysis on vegetation density class was conducted by overlaying the 2017 land cover map with NDVI map from the same year. The overlaying process was performed using ArcGis 10.3 software, and then the table data was processed using Excel software.

3. Results and discussion

3.1. NDVI value distribution in Coastal Villages of Tapanuli Tengah Regency and Sibolga City in 2007 and 2017

Image processing of 2007 and 2017 data was done using vegetation density index resulted in NDVI values and distribution. The NDVI values and distribution of vegetation in the coastal villages of Tapanuli Tengah Regency and Sibolga City are presented in table 1.

<table>
<thead>
<tr>
<th>No</th>
<th>Vegetation Density Class</th>
<th>NDVI</th>
<th>2007 Total Area (Ha)</th>
<th>2007 Percentage (%)</th>
<th>2017 Total Area (Ha)</th>
<th>2017 Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Non-vegetation</td>
<td>&lt; 0</td>
<td>526.84</td>
<td>0.61</td>
<td>5,772.93</td>
<td>6.67</td>
</tr>
<tr>
<td>2</td>
<td>Sparse</td>
<td>0 – 0.16</td>
<td>1,173.75</td>
<td>1.36</td>
<td>1,893.91</td>
<td>2.19</td>
</tr>
<tr>
<td>3</td>
<td>Intermediate</td>
<td>0.16 – 0.32</td>
<td>3,076.20</td>
<td>3.56</td>
<td>7,257.80</td>
<td>8.39</td>
</tr>
<tr>
<td>4</td>
<td>Dense</td>
<td>0.32 – 0.48</td>
<td>7,959.38</td>
<td>9.20</td>
<td>51,852.18</td>
<td>59.95</td>
</tr>
<tr>
<td>5</td>
<td>Very Dense</td>
<td>&gt; 0.48</td>
<td>73,745.01</td>
<td>85.27</td>
<td>19,704.37</td>
<td>22.78</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>86,481.19</td>
<td>100.00</td>
<td>86,481.19</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Based on the data in table 1, in 2007, the largest area with highest NDVI value is a very dense vegetation class, with NDVI range of > 0.48 and a total area of 73,745.01 ha or 85.27% of total coastal village area in Tapanuli Tengah Regency and Sibolga City. Meanwhile, in 2017, the dense vegetation class has higher value with NDVI value of 0.32 – 0.48 and a total area of 51,852.18 ha or 59.95%. The NDVI distribution map can be seen in figures 2.

3.2. Land cover analysis on vegetation density class in Coastal Villages in 2017

The results of the land cover analysis found eight types of land cover namely forest, plantation, shrub, undeveloped land, rice field, settlement, mangrove, and water body, as presented in table 2 and figure 3. On the classified image, there was an unidentified land cover. It was because there were many clouds in the research location and their shadows hid the land cover. The large quantity of cloud cover has affected the quality of the classification data result, as mentioned by Jaya[9] who said that one of the issues in processing satellite images is the presence of noise that causes a visual disturbance. Among noises that are often found are clouds. Clouds are considered a disturbance because they cover several areas of satellite images.
Figure 2. NDVI distribution map in Coastal Villages of Tapanuli Tengah Regency and Sibolga City in 2007 (left) and 2017 (right).

Table 2. Land cover in Coastal Villages of Tapanuli Tengah Regency and Sibolga City in 2017.

<table>
<thead>
<tr>
<th>No</th>
<th>Type of land cover</th>
<th>Total area (ha)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Forest</td>
<td>24,618.72</td>
<td>28.47</td>
</tr>
<tr>
<td>2</td>
<td>Plantation</td>
<td>26,525.48</td>
<td>30.67</td>
</tr>
<tr>
<td>3</td>
<td>Undeveloped land</td>
<td>10,740.75</td>
<td>12.42</td>
</tr>
<tr>
<td>4</td>
<td>Rice field</td>
<td>10,425.67</td>
<td>12.06</td>
</tr>
<tr>
<td>5</td>
<td>Water body</td>
<td>2,799.39</td>
<td>3.24</td>
</tr>
<tr>
<td>6</td>
<td>Settlement</td>
<td>2,549.18</td>
<td>2.95</td>
</tr>
<tr>
<td>7</td>
<td>Shrub</td>
<td>1,745.52</td>
<td>2.02</td>
</tr>
<tr>
<td>8</td>
<td>Mangrove</td>
<td>39.64</td>
<td>0.05</td>
</tr>
<tr>
<td>9</td>
<td>Unidentified</td>
<td>7,036.84</td>
<td>8.14</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>86,481.19</td>
<td>100.00</td>
</tr>
</tbody>
</table>

The overlay result of 2017 land cover map with 2017 vegetation density map resulted in land cover types on vegetation density class for that particular year. The type of land cover on vegetation density class used for vegetated land cover showed the condition of each land cover on the vegetation density in the research location, as presented in table 3.

Based on data presented in table 3, a land cover class with the highest value was found in dense density class of 37.74% in the form of forest land cover class. In the plantation land cover class, the highest value was dense density class of 27.11% of total area. Meanwhile, the highest value of mangrove land cover class was dense density class of 0.14%. It is due to the fact that many land conversions from mangrove forest to plantation are owned by the community or the private sector. From the survey result, plantations in the coastal villages of Tapanuli Tengah Regency and Sibolga City have expanded to the coastal regions. It is confirmed by data from Tapanuli Tengah Regency and Sibolga City Statistics.
Agencies in 2016 stating that increased land opening for plantation and settlement was the cause for changes in coastal regions resulting in the reduced area of mangrove forest.

### Table 3. Types of vegetated land cover on vegetation density class in 2017.

<table>
<thead>
<tr>
<th>Land cover</th>
<th>Density level</th>
<th>Total area (Ha)</th>
<th>Total area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest</td>
<td>Sparse</td>
<td>173.79</td>
<td>0.33</td>
</tr>
<tr>
<td>Forest</td>
<td>Intermediate</td>
<td>1,516.34</td>
<td>2.86</td>
</tr>
<tr>
<td>Forest</td>
<td>Dense</td>
<td>20,036.31</td>
<td>37.74</td>
</tr>
<tr>
<td>Forest</td>
<td>Very dense</td>
<td>2,972.65</td>
<td>5.60</td>
</tr>
<tr>
<td>Mangrove</td>
<td>Sparse</td>
<td>12.68</td>
<td>0.02</td>
</tr>
<tr>
<td>Mangrove</td>
<td>Intermediate</td>
<td>32.06</td>
<td>0.06</td>
</tr>
<tr>
<td>Mangrove</td>
<td>Dense</td>
<td>75.55</td>
<td>0.14</td>
</tr>
<tr>
<td>Plantation</td>
<td>Intermediate</td>
<td>13.48</td>
<td>0.03</td>
</tr>
<tr>
<td>Plantation</td>
<td>Dense</td>
<td>14,392.49</td>
<td>27.11</td>
</tr>
<tr>
<td>Plantation</td>
<td>Very dense</td>
<td>12,119.44</td>
<td>22.83</td>
</tr>
<tr>
<td>Scrub</td>
<td>Intermediate</td>
<td>543.44</td>
<td>1.02</td>
</tr>
<tr>
<td>Scrub</td>
<td>Dense</td>
<td>1,198.06</td>
<td>2.26</td>
</tr>
<tr>
<td>Scrub</td>
<td>Very dense</td>
<td>3.86</td>
<td>0.01</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>53,090.15</td>
<td>100.00</td>
</tr>
</tbody>
</table>

**Figure 3.** Land Cover Map in Coastal Villages of Tapanuli Tengah Regency and Sibolga City in 2017.

3.3. Analysis on vegetation density change in coastal villages of Tapanuli Tengah Regency and Sibolga City in 2007 and 2017

In analyzing the vegetation density in Tapanuli Tengah Regency and Sibolga City. Landsat images 2007 and 2017 were used. From the 2017 images, there are clouds covering the land which has made it difficult to fully identify the land cover. Therefore, the resulted NDVI values were affected by this factor [10] stated that other factors causing variations in NDVI value are fogs that may cause NDVI value to be lower than the actual condition. Another short coming of Landsat satellite images is on their passive...
sensor, which makes the resulted data to be highly dependent on the atmosphere condition during the recording. Changes in vegetation density class were obtained from the subtracation of the total area of vegetation density in 2007 with that in 2017. The result of vegetation density change is presented in table 4.

**Table 4.** Changes in vegetation density in coastal villages of Tapanuli Tengah Regency and Sibolga City in 2007 and 2017.

<table>
<thead>
<tr>
<th>No</th>
<th>Vegetation density class</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total area (Ha)</td>
</tr>
<tr>
<td>1</td>
<td>Non vegetation</td>
<td>5,246.09</td>
</tr>
<tr>
<td>2</td>
<td>Sparse</td>
<td>720.16</td>
</tr>
<tr>
<td>3</td>
<td>Intermediate</td>
<td>4,181.60</td>
</tr>
<tr>
<td>4</td>
<td>Dense</td>
<td>43,892.80</td>
</tr>
<tr>
<td>5</td>
<td>Very dense</td>
<td>54,040.64*</td>
</tr>
</tbody>
</table>

*Note (*): Decrease*

Based on data in table 4, there were changes in the total area of vegetation density class on each NDVI value range in 2007 and 2017. The change in a total area of vegetation density class on each NDVI value range consisted of increased and decreased density area according to the vegetation density class. In 2017, the total area of very dense vegetation decreased by 54,040.64 Ha or approximately 62.48%. Meanwhile, in dense vegetation area, there was an increase in total area in 2017 as much as 43,892.80 Ha or approximately 50.75%. Changes occurred in very dense class in 2017 were very substantial, which was caused by forest degradation and conversion in the coastal areas. Forest degradation and conversion were triggered by human activities. Rapid population increase has encouraged human to clear and convert forests for their livelihood. It is in line with Zaitunah et al. [11] statement that areas with dense population and intense human activity as well as high accessibility may trigger and encourage human to change land utilization. Humans are interested in converting land to generate a new source of income.

Impacts of vegetation density change consisted of erosion, flood, and sedimentation. Besides, the changes will also reduce the chance to dampen the tsunami wave. In addition to human activities, a tsunami is another cause of vegetation density change. After the 2004 tsunami, as of 2007 half of coastal forests and mangrove forests in Tapanuli Tengah Regency and Sibolga City were converted into settlements and plantations [12] which continued to expand until 2017. Based on the study by Onrizal and Mansor [13] before the tsunami, the coastal vegetation in North Sumatra was dominated by healthy mangrove forest and coastal forests dominated by *Casuarina equisetifolia* with 171 individu/Ha density.

Based on field observation, the government recently conducted rehabilitation of mangrove forests, but the government infrequently monitored it so that many rejuvenated plants did not grow well. Communities surrounding the coastal and mangrove forests in Tapanuli Tengah Regency and Sibolga City did not care about the forests’ condition. The lack of community awareness towards the environment has caused damages on mangrove forest and coastal forest, as well as contamination on seawater that may damage the sea ecosystem.

Based on the overlay result of vegetation density map in 2007 and 2017, changes in each vegetation density class in Tapanuli Tengah Regency and Sibolga City can be identified. In the very dense class, there is a significant change towards a dense class. Changes in each vegetation density class in Tapanuli Tengah Regency and Sibolga City from 2007 to 2017 can be seen in figure 4.

### 3.4. Basal area value on NDVI value distribution

Analysis of mangrove vegetation in Jago-Jago village and Tapian Nauli village in Tapanuli Tengah Regency showed that there were seven types of mangrove namely *Avicennia marina, Bruguiera gymnorrhiza, Ceriops tagal, Rhizophora apiculata, Rhizophora mucronata, Rhizophora stylosa* and *Soneratia alba*. Analysis of coastal vegetation in Pandan village and that in Binsasi village showed that
there were six types of coastal plan namely acacia (*Acacia auriculiformis*), Australian pine (*Casuarina equisetifolia*), beach hibiscus (*Hibiscus tiliaceus*), butterfly tree (*Bauhinia purpurea*), sea almond (*Terminalia catappa*) and rain tree (*Samanea saman*).

![Figure 4. NDVI change map in Coastal Villages of Tapanuli Tengah Regency and Sibolga City in 2007 and 2017.](image)

Based on the correlation between Basal Area and NDVI distribution value, we may know the accuracy of mangrove and coastal vegetation density in the field with vegetation density using NDVI. There was no sparse vegetation density found in the mangrove forest because based on field observation, mangrove forests on the research location consisted of young plants as a result of rehabilitation efforts. NDVI distribution value of mangrove forest ranges from 0.16 – 0.32 to > 0.48 as mentioned in table 5. Meanwhile, there was no very dense vegetation class found in the coastal forest, It is because coastal villages in Tapanuli Tengah Regency and Sibolga City were mostly converted into plantation and settlement. In addition to that, there were many tourism spots developed in the area without taking into account environmental conservation. NDVI distribution value for coastal forest ranges from 0 – 0.16 to 0.32 – 0.48 as mentioned in table 6.

Based on the overlay result of NDVI distribution map of 2017 with field point in 2017, the correlation between mangrove and coastal vegetation with their NDVI values can be identified. Table 5 and 6 show that the higher the value of the basal area, the higher the vegetation density level. Basal area value is determined by the diameter of each plant. The larger the diameter of the plant, the higher the basal area value. Abdurachman [14] stated that the basal area value for fewer trees with a large diameter is almost equal to the basal area value for a higher number of trees with a smaller diameter. According to Sumarna [15] diameter can also indicate canopy area of a plant, where the increase in diameter will affect the growth of the tree’s canopy. The diameter of a tree significantly correlates with its canopy area.
Table 5. Basal area value of mangrove vegetation with NDVI distribution value in 2017.

<table>
<thead>
<tr>
<th>Plot</th>
<th>Basal area m²/Ha</th>
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<th>Vegetation density class</th>
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Table 6. Basal area value of coastal vegetation with NDVI distribution value in 2017.

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<tr>
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<th>Basal area m²/Ha</th>
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4. Conclusion and recommendation

4.1. Conclusion
The largest area of vegetation density class in the coastal villages of Tapanuli Tengah Regency and Sibolga City in 2007 was very dense class with a total area of 73,745.01 Ha or 85.27%, while in 2017 the largest area was the dense class with a total area of 51,852.18 Ha or 59.95%. The biggest changes in vegetation density class from 2007 until 2017 were the 62.48% decrease in very dense class and the 50.75% increase in dense class. The land cover of the largest vegetation density class was the forest land cover type in dense vegetation density class.

4.2. Recommendation
Several human activities have the potential to damage and threaten the coastal vegetation conservation such as illegal logging and land conversion for other uses. Therefore, the preservation of coastal vegetation is very much needed to maintain its sustainability. Community participation, thus, is essential in the management of coastal vegetation.

Acknowledgment
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5. References
