Letter of Acceptance

Number : 008/LoA-Pb/ICBEAU/XII/2020 **Date** : 02nd December 2020
Subject : Article Acceptance
Dear : **Zuldadan Naspendra**

Andalas University

Based on the initial review process performed by our reviewers, we are pleased to inform you that your article entitled:

Digital Mapping and Soil Carbon Stock Distribution on Various Landuse of Tropical Peatland in Pesisir Selatan, Sumatra Barat.

is **accepted** to proceed into the IOP Conference Series (https://iopscience.iop.org/journal/1755-1315) submitting process. For your information, the time of publication and other policies are determined by the publisher of the IOP journal.

Sincerely,
Managing Editor

Bastian Nova, M.Si.

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ABSTRACT BOOK and SEMINAR PROGRAM

2nd ICBEAU

International Conference of Bio-Based Economy for Application and Utilization

Via Zoom Meeting on December 16th, 2020

Welcome Address by The Head of LPPM in Andalas University

Assalamu'alaikum wr. wb,
Good morning to all of you.
Dear respected keynote speakers
Members of the organizing committee
Dear participants and observers
Distinguished guests, respected colleagues, ladies, and gentlemen

We are very happy to welcome all participants of the International Conference on Bio-Based Economy for Application and Utilization (ICBEAU-2020). This conference has a very strategic position in responding the global development. Need on an agricultural product is not dominated currently in food aspect, but is becoming more broadly to the new aspect beyond the food. Fossil based energy currently contributed to many pollution issues in the whole of the world, beside its existence which is more scarce in the future. Drug development, based on synthetic chemicals and materials is believed and regarded plays a significant role in the occurring of new health problem and disease. For that reason, a shifting in medical treatment back to nature is becoming a trend nowadays. Thus, this ICBEAU-2020, should have a very significant impact on the above-mentioned issues.

Respected Ladies and Gentlemen

As the Head of LPPM in Andalas University, I personally very support to this event. We thanks to all parties supporting and contributing to implementing this International Conference.

Especially I would like to thank for all keynote speakers who responded positively our request to share their insight, experience, and expertise in this conference.

- Prof. Dr. Inez H. Slamet Loedin from International Rice Research Institute, Philippines
- dr. Rauza Sukma Rita, Ph.D from Andalas University, Indonesia
- Assoc. Prof. Dr. Pasupuleti Visweswara Rao from Universiti Malaysia Sabah, Malaysia
- Asst. Prof. Saowakon Wattanachant, Ph.D from Prince of Songkla University, Thailand
- Dr. Rosewine Joy from Presidency University, India

And who kindly join this seminar and share their experience and expertise in this conference.

Finally, I would like to congratulate the organizing committee for their tremendous efforts in organizing the conference.

Success for all of us,

Head of the LPPM in

Andalas University,

Dr.-Ing. Ir. Uyung Gatot Syafrawi Dinata, M.T.

Welcoming Speech of The Committee's Chairman

Good Morning, ladies and gentlemen,

On behalf of the committee, first of all let me welcome you and express our great thanks for participating in this 2nd International Conference of Bio-Based Economy for Application and Utilization 2020 (ICBEAU-2020).

Nowadays, we are still facing the CoVID-19 pandemic issue, which is significantly impact our activities and thus also our lifestyle as well. Many economic sectors are now facing difficult situation and force them to shift their work into an adaptive condition, otherwise they will suffer or fail to survive. However, this difficult situation on the other sides provide many opportunities particularly in the application and utilization of bio-based drugs and materials. In this context, this seminar event of the 2nd ICBEAU 2020 should meet its relevancies and urgencies.

Dear honored participants,

In this opportunity let me sound my great thanks to all parties involving and contributing to the implementation of this seminar. Special thanks to our respected keynote speakers; Prof. Dr. Inez H. Slamet Loedin. from International Rice Research Institute, Philippines; dr, Rauza Sukma Rita, Ph.D from Andalas University; Assoc. Prof Dr Pasupuleti Visweswara Rao from Universiti Malaysia Sabah, Malaysia; Asst Prof Saowakon Wattanachant Ph D, from Prince of Songkla University Thailand and Dr. Rosewine Joy, Presidency University India -for their collaboration and their kindness to share their experience and their expertise in this forum. Many, many thanks also addressed to the Rector of Andalas University and head of Institution of Research and Community Service of Andalas University, Dr. Uyung Gatot also all parties and valuable participants that could not be mentioned in this opportunity.

Finally, we hope this seminar could bring a significant impact and contribution to the future application and utilization of Bio-Based economy.

Regards,

Chairman of the Committee

Prof. Dr.sc.agr. Ir. Jamsari, MP.

Committee Structure

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Rundown of Event

International Conference on Bio-based Economy for Application and Utilization

Date : Wednesday, 16th December 2020
Via : Zoom Meeting
ID : 842 5470 7508
Passcode : ICBEAU

Time	Schedule	Person in charge
07.45–08.00	Log in zoom	IT/LPPM
08.00–08.02	Opening Ceremony	MC
08.02–08.05	Singing National Anthem "Indonesia Raya"	Recorded Song/IT/LPPM
08.05–08.10	Opening Video of ICBEAU 2020	IT Team
08.10–08.20	Opening Speech from Chief of Committee	Prof. Dr.sc.agr. Ir. Jamsari, MP.
08.20–08.30	Opening Speech from Head of LPPM Andalas University	Dr.-Ing. Ir. Uyung Gatot Syafrawi Dinata, M.T.
08.30–08.45	Wonderful of West Sumatera	IT Team
	Keynote speech (1st Panel Discussion)	
08.45–09.45	**1. Assoc. Prof. Dr. Pasupuleti Visweswara Rao** (Bio-based Drugs and Medicines for Metabolic Disease) **2. dr. Rauza Sukma Rita, Ph.D** (Antidiabetic Potential of Catechin Gambir (*Uncaria gambir* Roxb))	Assoc. Prof. Dr. Aisyah Ellyanti, MD
	Appreciation and Photo Session	

09.45–10.00	Introduction of Unand	IT/LPPM/Int. Office
10.00–11.30	Keynote speech (2nd Panel Discussion) **1. Asst. Prof. Saowakon Wattanachant, Ph.D** (Application of Retort in Meat Product Processing) **2. Prof. Dr. Inez H. Slamet Loedin** (New Rice Breeding Technology : The CRISPR Gene Editing Researches at IRRI) **3. Dr. Rosewine Joy** (Sustainable Transition, Transformation and Disruption in Agro-Ecological Systems)	Prof. Dr. Sumaryati Syukur, M.Sc
	Appreciation and Photo Session	
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11.45–13.00	Break	Committee
13.00–13.30	Log in	IT/LPPM
	Paralel Session	
13.30–15.40	**Room I** (Agriculture and Food Technology) **Room II** (Bio-based Enzyme and Material) **Room III** (Bio-based Drugs and Medicine) **Room IV** (Bioengineering and Bioremediation) **Room V** (Natural Resources and Conservation)	IT/Room Coordinator/LPPM
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"Digital Mapping and Soil Carbon Stock Distribution on Various Landuse of Tropical Peatland in Pesisir Selatan, Sumatra Barat"

author(s):

Zuldadan Naspendra*, Aprisal, Nurul Hijri, Mimien Harianti, and Junaidi

presented in

2nd ICBEAU

International Conference of Bio-Based Economy for Application and Utilization

Authorized by
Institution of Research and Community Services (LPPM)
of Andalas University
West Sumatera, Indonesia
Via Zoom Meeting on December 16th, 2020

Dr.-Ing. Ir. UYUNG GATOT S. DINATA, M.T.
Chairman of Institution of Research and Community Services (LPPM) of Andalas University

2020 ICBEAU

Prof. Dr. sc. agr. Ir. JAMSARI, M.P.
Chairman of Committee

*Oral Presenter

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Digital mapping and soil carbon stock distribution on various landuse of tropical peatland in Pesisir Selatan, West Sumatra

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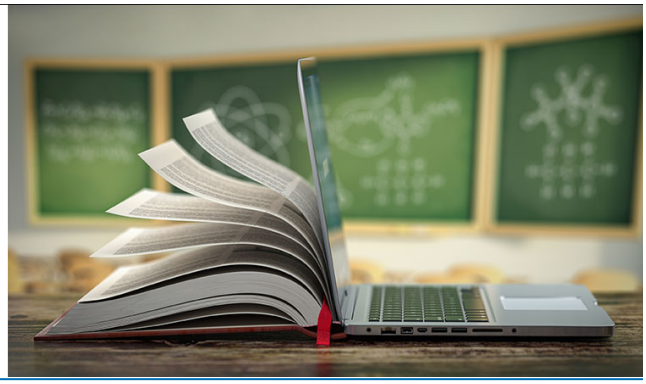

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Digital mapping and soil carbon stock distribution on various landuse of tropical peatland in Pesisir Selatan, West Sumatra

Z Naspendra[1], A Aprisal[1], N Hijri[1], M Harianti[1], and Junaidi[1]*

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Abstract. Indonesia has the largest tropical peatlands in the world covered an area of 14.91 million ha. Peatlands play an important role in global carbon sequestration. This study aimed to: a] map the peatland in Pesisir Selatan, Sumatra Barat calculate the soil carbon stock in the peatlands on various land use and peat thickness and c] identify the relationship of soil characteristics to the soil carbon. We investigated thirty soil samples in Pesisir Selatan. The land-use types on peatland in Pesisir Selatan consisted of forest [GH], shrub [GS], oil palm plantations [GPs], annual cropland[GLp], and bareland [GLp]. The results showed that the total area of peatlands inPesisir Selatan is 78,998.74 ha, while the total amount of soil carbon stocks is 244 million tonnes, and the sequence follows GPs> GS> GH> GT>GLp. The average value of soil carbon stock is 3,090.89 per ha, the sequence follows GH> GS> GT> GPs>GLp. Hence, the average amount of soil carbon stock based on depth is 8,529 tons for peat depth >600cm, 4,082 tons for peat depth 300-600 cm, and 525 tons for peat depth 0-300 cm. Differences in average values of soil carbon stock per ha are highly influenced by the differences in peat thickness. The dynamics of total carbon show a higher its content in the subsurface layer rather than in the surface layer. The soil carbon is linearly correlated with water content and it is inversely proportional to bulk density.
Keywords: digital mapping, peat, satellite imagery, soil carbon stock

1. Introduction

Indonesia has the largest peatland in the world with an area of 14.91 million ha [1] or 47% of the total peatland's area in the world [2]. This land can be found in Sumatra, Kalimantan, and Papua [1,3, 4, 5]. On the west coast of Sumatra, the largest distribution of peatlands can be found in Pesisir Selatan, Sumatra Barat, with an area of 95,000 ha [4] which is spread over various land-use types.

The use of peatlands for agriculture and plantations in Indonesia has been initiated since the 1970s and has developed rapidly from 1990 until now after published the Presidential Decree No.32 of 1990 about the Management of Protected Areas. Calculating the carbon stock of peat is needed in assessing the importance of soil in the carbon cycle [6], estimate the potential for greenhouse emissions [7], and as a basis for making policies for sustainable peatland management.

In Indonesia, several studies examining the carbon stock of peatlands had been conducted with various approaches[8, 9, 10, 11]. The results of the research indicated that the value of soil carbon stock in different land uses is varied[11, 12]. Also, there is no information about the carbon stock in Pesisir Selatan under several classes of peatland-uses and depths.

One of the requirements in calculating soil carbon stock in the area is the availability of a peatland map and its thickness. However, the peatland mapping data provided in Indonesia is currently still at a

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reconnaissance scale of 1: 250,000 [1]. Hence, the information does not accurate as a basis for calculating carbon stock. Based on this problem, this study aimed to: a] map the peatland in Pesisir Selatan, b] calculate the soil carbon stock on various peatland-use and peat thickness, and c] identify the relationship of soil characteristics to the soil carbon content.

2. Research Method

2.1 Setting of the research and processing the satellite imagery data

This research was conducted in the peatland ofPesisir Selatan Regency, Sumatra Barat. The peatlands formed above the alluvium substratum, [13]. We used satellite imagery data [Landsat 8 OLI level 1, 2020] to produce a land-use map by using ArcGIS® 10.8. Bands 1-7 of the satellite imagery were composited for interpretation. The sharpening of the image resolution was enhanced by using band 8. Since the peatlands in Pesisir Selatan were distributed on 2 image data sheets, the numeric null value for each image was omitted. Subsequently, both image sheets were processed to mosaics. The satellite imagery data was analyzed using a supervised method. Visual interpretation of plant vegetation used a 6-5-4 band [Figure 1]. The appearances of natural color by using a 4-3-2 band. Training sample manager processes [25 samples] were conducted for each land use.

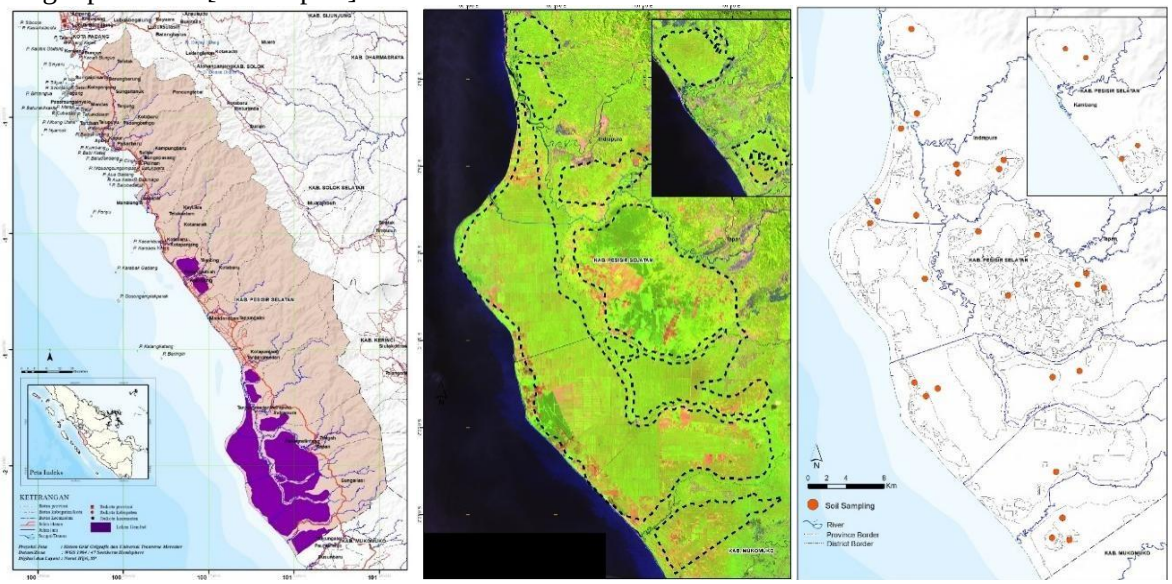

Figure 1. Peatland map Pesisir Selatan [left] [15], Landsat satellite imagery Level 1 Band 654 [center], and soil sampling points [right]

2.2 Soil Sampling

Soil sample points were determined based on land use, soil map, and peat thickness data [14, 15], Geological map sheets [13], and contour data from SRTM images used for estimating peat thickness and for distinguishing the peat topography, hills, and plains. Each of these data was overlaid to generate the polygons containing information of peat thickness with certain land uses. This technique was chosen to minimize the number of samples but still produce accurate data. Based on the analysis, 509 polygons with 30 diversity of peatland units were collected[Figure 1]. Soil observations were conducted in each land unit. Guidelines for soil observation and soil sampling were adopted from Schoeneberger, et al [16].

2.3 Data Analysis

Soil analysis laboratory consisted of bulk density [BD], water content [17], total carbon, and ash/mineral content byLOI [Loss of Ignition] method [18, 19]. Calculation of peatland carbon stock

per area was adopted from Robertsonet al[20]. Determination of the amount of carbon content for each land use with a certain depth was adopted from Gorham[21].

3. Results and Discussion

3.1 Distribution of peatlands

Based on our results, the total area of peatlands in Pesisir Selatan is 78,998.74 ha. The total land area is smaller than Puslittanak [14], namely 86,567.83 ha and mostly similar with Degraded Peatland Mapping data [15] with an area of 79,538.88 ha. The difference is caused by several land units [Figure 1, left] that do not have a minimum peat layer of 40 cm and do not fulfill other Histosols soil classification criteria based on Soil Survey Staff 2014 [22]. These land units are located in Limau Manih Nagari Lakitan Timur, Lakitan Utara, and Kambang Barat with an area of 1,909.8 ha.

We include some additional peatland units with an estimated area of 1,518.89 ha [Figure 2] located in Tarok Nagari Lakitan Selatan, Padang Laban, and the Sungai Liku, which extend from 1°43'4.1"S, 100°45'0.5"E to 1°43'4.1"S, 100°48'15"E and 1°46'7.4"S, 100°45'0.5"Eto 1°46'7.4"S, 100°48'15"E. The area has a thickness of peat layer varying from 40 to 500 cm, BD 0.11-0.32 g.cm^{-3}, Total Carbon 50.3% and fulfills the criteria of the histic epipedon [22].

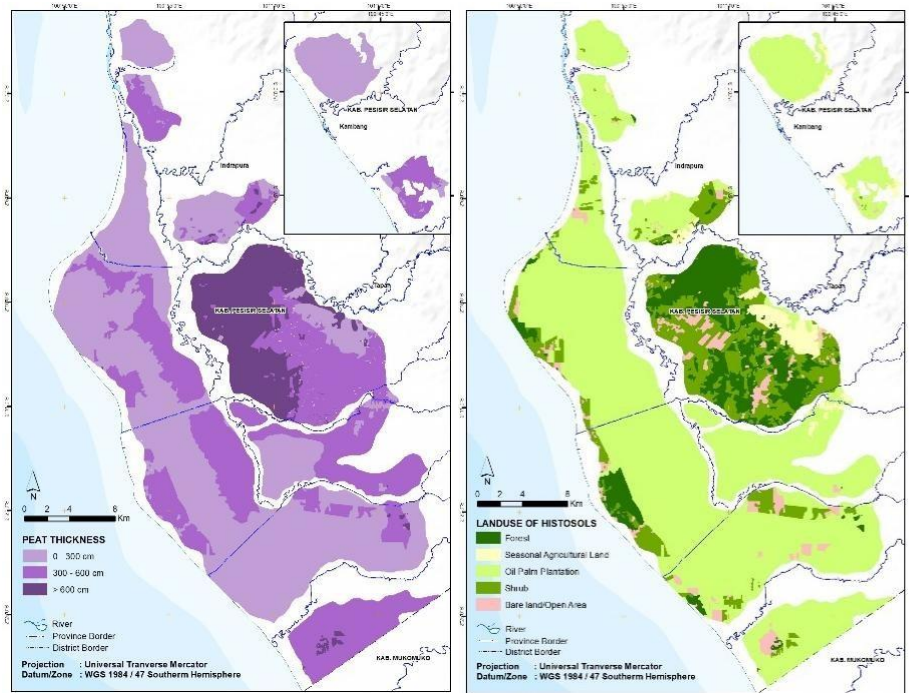

Figure 2. Peatland thickness map [left] and peatland use map [right], in Pesisir Selatan

3.2 Land use of peatlands

Most of Pesisir Selatan's peatlands have peat thickness of 0-300 cm with an area of 40,335.99 ha [51%], a thickness of 300-600 cm covering an area of 29,237.68 ha [37%], and a thickness of> 600 cm or a peat dome [9,426.06 ha or 11.9%]. The peatland-use are categorized into four classes [Tabel 1]. Most of the peatland is used for oil palm plantations [68.42%] which are located on a thickness of 0-300 cm [34,564.21 ha or 64%], and a small part is on thickness > 600 cm [257.43 ha or 0.47%]. Those are used by local farmers and agriculture companies. Development of oil palm plantations in Pesisir Selatan had initiated in the early 1990s, based on presidential Decree No.32, 1990. The smallest peatland-use is for annual crops [3.19%] [Table 2] which are cultivated on peat with a thickness of 0-300 cm, such as food crops and several palawija [secondary plants].

Table 1. land use of peatlands

No	Class	Explanations
1	Forest [GH]	Primary and secondary forests
2	Shrub [GS]	An open field that is not cultivated, so it is dominated by high vegetations with a height average of 1-3 m.
3	Oil Palm Plantation [GPs]	All oil palm plantations were possessed by both farmers and agriculture companies.
4	Annual crops [GLp]	Paddy fields, corns, and other food crops. This land also covers other seasonal plants cultivated on peatlands. Generally, the land is cultivated with semi-intensive to intensive management.
5	Bare Land [GT]	This land has 0-20% vegetation covers.

The plantation sector has improved the local farmers' economy. However, the utilization of forests as conservation areas on peatlands also needs to maintain, especially forest areas with a thickness of> 300 cm. Based on Table 2, the area of GH in peatlands is around 8,743.53 ha or 11.06%. Hence, 6.2% of them with > 600 cm thickness are found in forest land. It means that the distribution of peat thickness is critical to maintaining the function of forests with a thickness of> 300 cm.

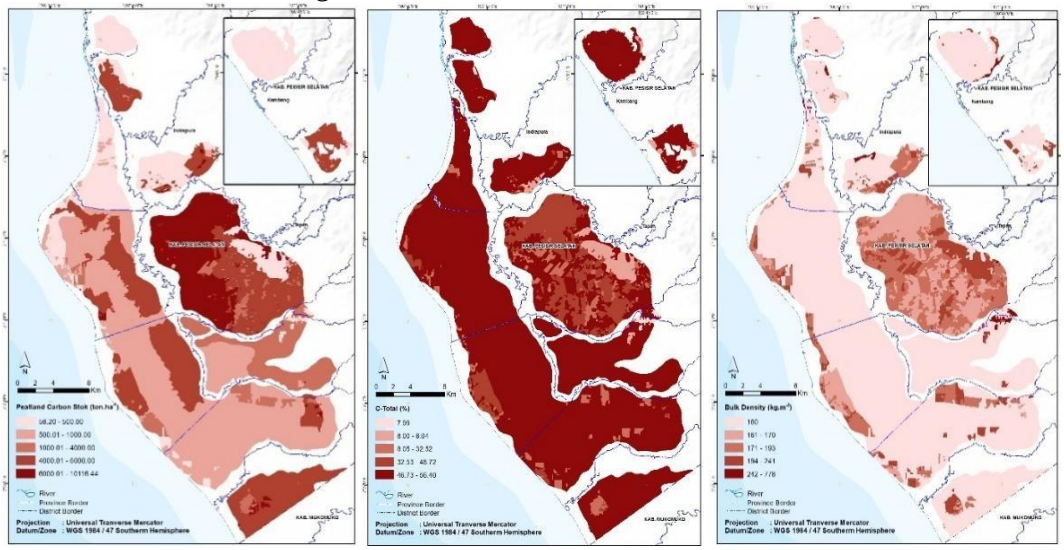

Figure 3. The value of Carbon Stock [ton/ha] [left], Total Carbon [%] [center], and Bulk Density [kg.m^{-3}] [right] of the peatland, Pesisir Selatan

3.3 Soil carbon stock of the peatland based on the classes of land use and peat thickness

Table 2 shows the total carbon stock reaches 244 million tons with an average value of 3,090.89 C per ha. The sequence of carbon stock follows GPs> GS> GH> GT> GLp. The soil carbon stock storageatGPs reaches 49% out of the total carbon stock in the peatland and only 0.07% was found in GLp with an area of178 thousand tons. In this case, the high carbon stock in GPs land use is dominantly related to the large such area [r^2 = 0.755, Figure 4].

Table 2. Soil carbon stock based on the land use and peat thickness in Pesisir Selatan

Land Use/ Soil Depth	Area [ha]	Carbon Stock [ton]	Average Carbon Stock [ton C.ha^{-1}]
GH	**8,734.53**	**55,778,796.40**	**6,386.01**
1 [0-300 cm]	408.82	250,015.08	611.56
2 [>300-600 cm]	3,425.64	16,399,802.27	4,787.37
3 [>600 cm]	4,900.08	39,128,979.05	7,985.38

GS	**10,677.55**	**61,274,984.79**	**5,738.68**
1 [0-300 cm]	1,279.09	787,748.53	615.87
2 [>300-600 cm]	5,638.81	22,453,002.91	3,981.87
3 [>600 cm]	3,759.65	38,034,233.35	10,116.44
GLp	**2,526.28**	**178,300.66**	**70.58**
1 [0-300 cm]	2,526.28	178,300.66	70.58
GPs	**54,054.17**	**119,875,065.10**	**2,217.68**
1 [0-300 cm]	34,564.21	25,991,564.92	751.98
2 [>300-600 cm]	19,232.53	91,554,530.60	4,760.40
3 [>600 cm]	257.43	2,328,969.58	9,047.12
GT	**3,006.21**	**7,069,523.15**	**2,351.64**
1 [0-300 cm]	1,557.60	897,914.93	576.47
2 [>300-600 cm]	940.70	2,632,746.94	2,798.71
3 [>600 cm]	507.92	3,538,861.28	6,967.41
Total	**78,998.74**	**244,176,670.10**	**3,090.89**

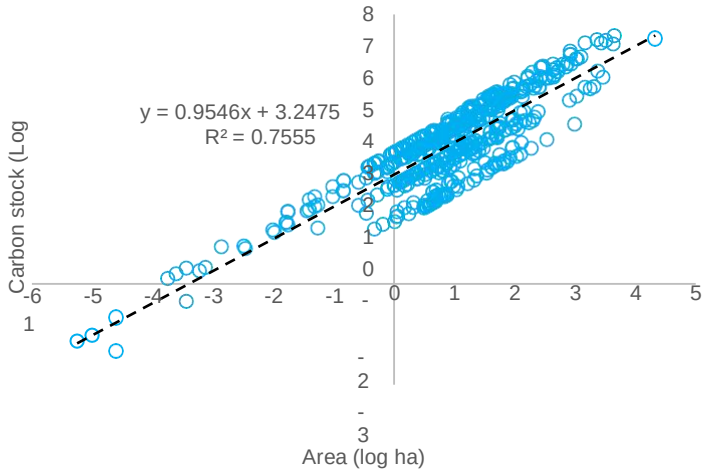

Figure 4. The correlation of soil carbon stock and peatland area

The average value of carbon stock in Pesisir Selatan is 3,090.89 tonnes C.ha^{-1}. This value is relatively higher than other studies, such as research of [23] around 250 ton C.ha^{-1}. This is due to the influence of the peat thickness, where peatland with a thickness of > 600 cm reaches 11.9%, and a thickness of 300-600 cm is 37% of the total area. However, this average value is consistent with the results of the research by [24] in the Irish Wicklow peatlands with values of 530 - 3303 tonnes C.ha^{-1} at depths of 100-650 cm. For the same land area and peat thickness, the value of carbon stock depends on peat characteristics: total carbon and soil bulk density [25, 26]. Based on the land use, the sequence of mean carbon stock is GH> GS> GT> GPs> GLp due to the difference of the peat thickness [24, 27].

3.4 Characteristics of peatlands in Pesisir Selatan

The average percentage of total carbon among land uses [Figure 5] shows that the highest total carbon is found in land use GH 20-40 cm at 61.6%. The value tends to be higher in the subsurface layer20-40 cm, compared to the surface layer [0-20 cm]. This dynamic is in line with [28] indicating the ash [mineral content] in the soil surface layer is higher than the subsurface layer. Since the peat material in the surface layer would be easily decomposed due to aerobic conditions leaving mineral content in the layer.

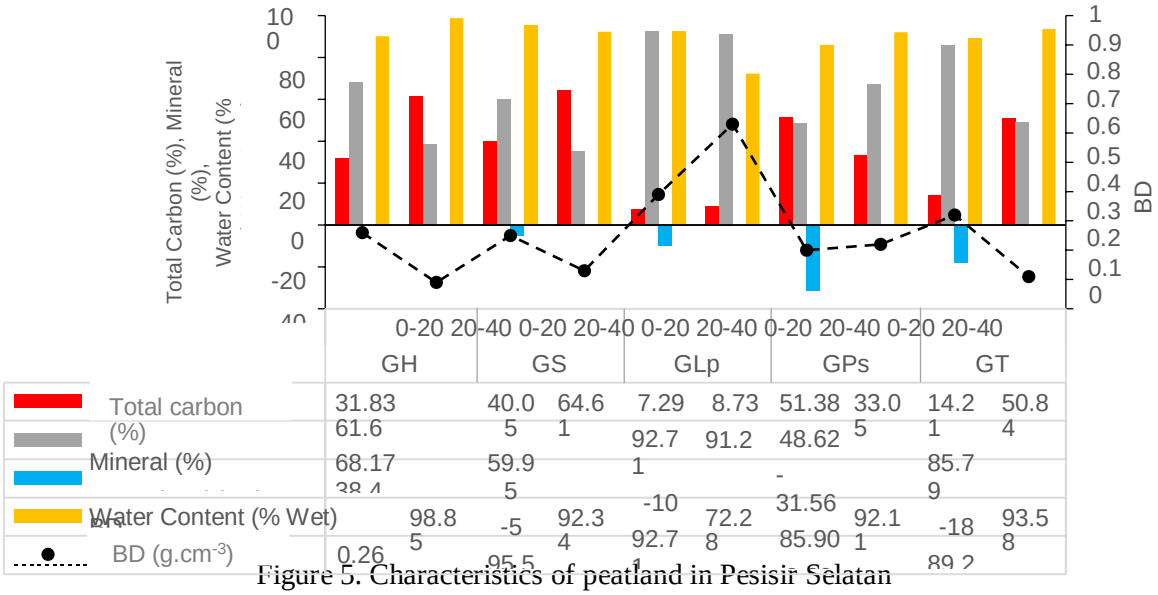

Figure 5. Characteristics of peatland in Pesisir Selatan

Figure 5 shows that BD tends to be lower in the subsurface than in the surface layer. This pattern is contrary to mineral soils that tend to be higher in the subsurface layer. In mineral soils, BD generally is determined by soil texture and organic matter [29,30]. However, in the peatland, the soil texture is not acceptable. The determining factor of BD in the peatland is organic carbon content[Figure 6]. It is also shown in Figure 5 that total carbon is higher in the subsurface layer.

Figure 5 also presents that most agricultural areas have a higher BD. It is caused by the peat soil is mixed with mineral material. The mixing is due to the shallow peat thickness. Intensive agricultural activity before planting causes the mixing of peat material with mineral soil so that the BD will be getting higher [Figure 5].

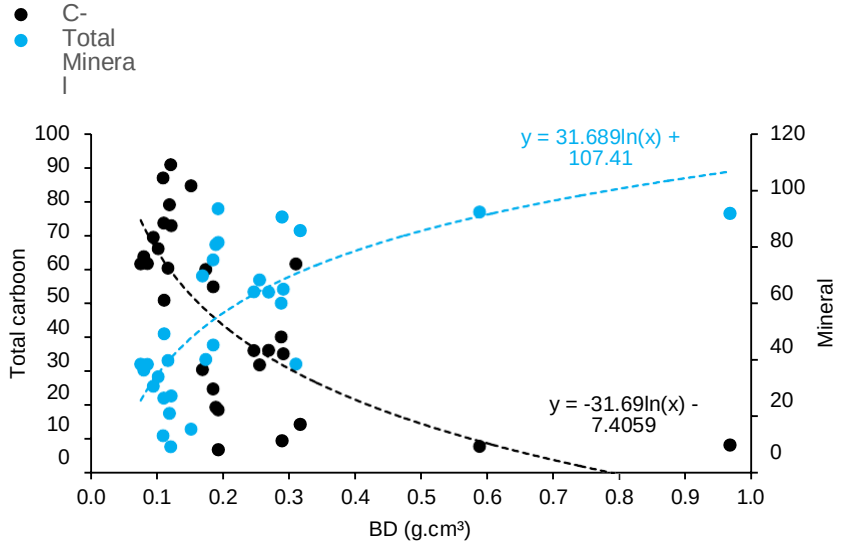

Figure 6. Relationship between Bulk Density and Total Carbon and Mineral Content in Pesisir SelatanPeatlands

Figure 6 shows that the higher the BD, the lower the total carbon content. Soil with higher BD indicates that the most of soil volume is filled with mineral-dense material. Due to the decomposition, the peat experiences a reduction in volume. It affects on decreasing of total C content.

Figure 7 shows the relationship between total carbon and soil water content [r^2 = 0.2434]. If water content increases, so does the total carbon; since when the soil is saturated with water, the environmental condition becomes anaerobic. This condition will reduce the rate of oxidation and microbial activities. If this condition occurs continuously, the dead organic matter will accumulate and the peat layer will become thick so that the soil carbon increased.

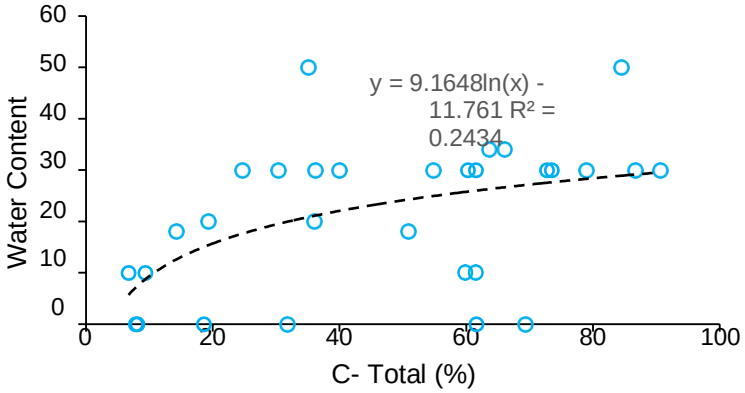

Figure 7. Relationship between C-Total and water content [%wet weight]

4. Conclusion

The total area of peatlands inPesisir Selatan is 78,998.74 ha. The total amount of peat carbon stock is 244 million tonnes, while the land-use-related sequence follows GPs> GS>GH> GT> GLp. The average value of carbon stock is 3thousandtonnesC.ha^{-1}, with the sequence GH> GS> GT> GPs> GLp. The difference in the average value of carbon stock per ha is influenced by the differences in peat thickness. However, the dynamics of total soil carbon indicate the increase in the carbon content increases with soil depth. The relationship between soil carbon content and water content is linear and inversely proportional to BD.

Conflict of Interest

No potential conflict of interest was reported by the authors.

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