ASSESSMENT OF PEATLAND ECOSYSTEM CHARACTERISTICS IN THE PEAT HYDROLOGICAL UNIT OF GONGAN RIVER- NILO RIVER, RIAU PROVINCE

(Kajian Karakteristik Ekosistem Gambut pada Kesatuan Hidrologi Gambut Sungai Gongan-Sungai Nilo Provinsi Riau)

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ABSTRACT

Minister of Environment and Forestry Regulation No. P.14/MENLHK/SETJEN/KUM.1/2/2017 establishes protocols for assessing and defining the function of peat ecosystems, involving 13 criteria. Among these, survey points must align with map coordinates, with a displacement limit of 200 meters. The research aims to meticulously control the characteristics of peatlands in the Peat Hydrological Unit (PHU) of Gongan River-Nilo River, Riau Province, following the work plan to ensure that observations align with actual conditions. The Haversine method gauges the distance between planned and actual observation points, revealing an average shift of 19.9 meters, ranging from 3.38 to 198.9 meters, indicating surveyor accountability. Field data shows 68% of the area with groundwater levels below 30 cm, and 32% between 30 and 60 cm. Channel water heights are predominantly between 50 and 100 cm (68%), with 22% lower and 10% higher. Soil pH consistently measures below 4 (100%), similar to channel water (73%), and substratum (81%) with most below 4. Only 3.1% of groundwater exceeds 300 μS/cm in electrical conductivity, while 96% are below 300 μS/cm, including low substratum conductivity. Total dissolved solids are mostly below 75 ppm (97%), with 3% between 75 and 150 ppm. The average peat thickness is 367.9 cm, primarily clay/river sediment at the hemic level. It can be concluded that all field survey results in the PHU Gongan-Nilo River can be accepted as valid data that can be used as a basis for development planning/regional determination in this area.

Keywords: haversine, point relocation, peatland ecosystem, survey, water quality

ABSTRAK

Peraturan Menteri Lingkungan Hidup dan Kehutanan No. P.14/MENLHK/SETJEN/KUM.1/2/2017 menetapkan protokol untuk menilai dan menetapkan fungsi ekosistem gambut, yang melibatkan 13 kriteria. Di antaranya, titik-titik survei harus sesuai dengan koordinat peta, dengan batas pergeseran 200 meter. Penelitian bertujuan untuk mengontrol secara cermat karakteristik lahan gambut di Kesatuan Hidrologi Gambut (PHU) Sungai Gongan-Sungai Nilo, Provinsi Riau, mengikuti rencana kerja untuk memastikan bahwa observasi sejalan dengan kondisi aktual. Metode Haversine mengukur jarak antara titik pengamatan yang direncanakan dan yang sebenarnya, menunjukkan pergeseran rata-rata sebesar 19,9 meter, dengan rentang 3,38 hingga 198,9 meter, yang mengindikasikan akuntabilitas surveyor. Data lapangan menunjukkan 68% area dengan ketinggian air tanah di bawah 30 cm, dan 32% di antara 30 dan 60 cm. Ketinggian air saluran sebagian besar berada di antara 50 dan 100 cm (68%), dengan 22% lebih rendah dan 10% lebih tinggi. pH tanah secara konsisten berada di bawah 4 (100%), serupa dengan air saluran (73%), dan substratum (81%) dengan sebagian besar berada di bawah 4. Hanya 3,1% air tanah yang memiliki konduktivitas listrik melebihi 300 µS/cm, sementara 96% berada di bawah 300 µS/cm, termasuk konduktivitas substratum yang rendah. Total padatan terlarut sebagian besar di bawah 75 ppm (97%), dengan 3% di antara 75 dan 150 ppm. Ketebalan gambut rata-rata adalah 367,9 cm, terutama terdiri dari lempung/endapan sungai pada tingkat hemik. Dapat disimpulkan bahwa seluruh hasil survei lapangan di PHU Sungai Gongan-Nilo dapat diterima sebagai data valid yang dapat digunakan sebagai dasar perencanaan pembangunan/penetapan kawasan di wilayah ini.

***Kata kunci**: haversine, titik relokasi, ekosistem gambut, survei, kualitas air*

INTRODUCTION

Indonesia has 13 million hectares of peatland, and 1.67 million hectares, or around 13.37% of those, are utilized for plantations. With an annual production of 20–25 tons/ha, oil palm plantations occupy 700–800 thousand hectares, a value comparable to other land uses (Sari et al., 2019). Peat depth and peat quality data from the survey will help with (1) designing and arranging the site to minimize disturbance to the peatland; (2) creating a plan for the management of peat and habitat; (3) calculating carbon savings and losses; (4) evaluating the site, including assessing the carbon calculator; (5) planning drainage and hydrological systems; (6) assessing the risk and hazard of peat landslides; and (7) managing habitat after construction and site restoration. Desk research, site walk-over surveys, and more "disruptive" techniques such as "ground investigations" must all be used in conjunction with site investigations. Methods for field surveys should be chosen based on the type and location of the data needed. The Ministry of Agriculture is one of the ministries and institutions required by Law Number 4 of 2011 concerning Geospatial Information and One Map Policy to use one base map source (Peta Rupabumi Indonesia) issued by the Geospatial Information Agency (BIG) to compile thematic maps related to peatland mapping.

Indonesia is facing a big challenge in meeting the Nationally Prepared Contribution (NDC) target, namely the commitment to reduce greenhouse gas emissions set through the Paris Agreement. Referring to the NDC, Indonesia is targeted to be able to reduce greenhouse gas emissions by 29% under the business-as-usual scenario in 2030 with its own efforts or reduce emissions by up to 41% if it receives international support. In many parts of Indonesia, peatlands have been mostly turned into plantations for oil palm and forests. Such contradicts vows to combat deforestation, which include prohibiting the conversion of forests and peatlands. The quality of the ecosystem declines as peatlands are converted to agricultural land. As a result, there is a threat to the environmental resilience of peatlands (Irma et al., 2018). One of the primary causes of harm to ecosystems, both natural and man-made, is land and forest fires. The susceptibility of a region to forest and land fire catastrophes will change depending on changes in the land cover (Dicelebica et al., 2022).

The 15th Sustainable Development Goals (SDGs), which aim to stop biodiversity loss, combat land degradation, and safeguard, restore, and promote the sustainable use of terrestrial ecosystems, are at odds with the detrimental effects of land cover change on social and environmental aspects. Consequently, spatial techniques that make use of remote sensing and an understanding of the factors that contribute to land use and cover change become crucial challenges and sources of advice in the fight against climate change, zero deforestation, and the SDGs (Juniyanti et al., 2020).

Due to peat deterioration brought on by drainage, climate, and cultural practices throughout the past 20 years of bog clearance, peatlands have become more vulnerable to fire. The ultimate aim of peat restoration is to restore wet peatlands. However, milestones are needed to connect the stages of hydrological peatland restoration to meet production needs on peatlands. The management of non-fire peatlands is a technique; combining it with techniques to provide nutrients in wet, moist, anaerobic peatlands will result in cutting-edge technology (Gunawan et al., 2020).

Thirteen parameters make up the features of the peatland ecosystem, according to Minister of Environment and Forestry No. P.14/MENLHK/ SETJEN/KUM.1/2/2017. The following 13 criteria or parameters are in issue: (1) Coordinated location of observation points with photo geotagging; (2) Elevation of the land; (3) Groundwater, flooding, or inundation; (4) Land cover, land use, and conditions related to the use of forest products; (5) Presence of protected species; (6) Natural and artificial drainage conditions; (7) Water quality; (8) Overflow type; (9) Thickness of the peat layer; (10) Features of the substratum beneath the peat layer; (11); Weight percentage of peat material; (12); Evolution of the state or degree of degradation of the bog; and (13). Soil characteristics and pyrite layer depth.

The team from the Ministry of Environmental and Forestry of the Republic of Indonesia (KLHK) prepared the survey points in question, which are bore points that have been accommodated as a work plan map. The survey point and the coordinate point on the work plan may not coincide, as surveyors must consider the topography of the field and decide the most efficient path to the location. The track log pattern, which has also been digitally mapped, illustrates the surveyor's efforts and the timeline of his accomplishments (shapefile). Land plot mapping and measurement tasks can be completed quickly and efficiently with external techniques utilizing highly accurate GPS receivers.

Observing soil and the environment, taking samples, and confirming land unit boundaries are the three main goals of field surveys. Soil observations were made along the transect path in the pilot area to ascertain changes in the characteristics of peat soil. Illustration of determining transect routes and sampling points for the Peat Hydrological Unit (PHU) inventory as follows (**Figure 1**)

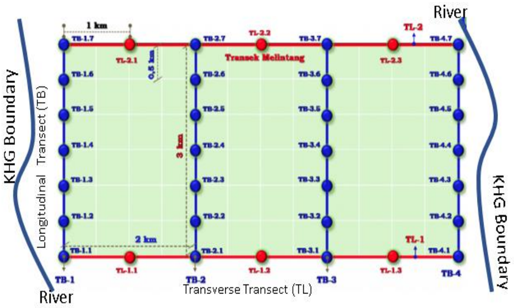

Figure 1. Ilustration of transect route.

The creation of transects refers to the ecological boundaries of the PHU, namely the existence of two rivers that border the land area. The cross distance is around 1000 m, while the distance between longitudes is 500 m, and observations represent 25–50 ha, depending on the amount of land cover change.

Peat drills are used to observe the soil down to the mineral soil layer, or substratum. The observation form documents the parameters that were observed. These include the color, drainage, thickness, and maturity of the peat soil, sulfidic and pyrite material content, groundwater depth, mineral soil inserts, pH and salinity of the soil, and peat water. Color, texture, consistency, pH, and levels of sulfidic and pyrite minerals are among the substratum observations; environmental observations include flooding, inundation or overflow, the existence of drainage channels, and vegetation or land cover.

The following variables affect how accurate the position (coordinates) derived from GPS observations are: (1) Accuracy of data: This depends on the kind of data used, error rate, bias, and receiver quality. (2) Satellite geometry: The duration of observation sessions is contingent upon the quantity, position, and dispersion of satellites. (4) Data processing strategy: Depending on the strategy, whether in real-time, post-processing, quality control, network alignment, and so on. (3) Positioning technique: Depending on the method used, whether it is absolute, differential, number of reference points (GPS control or receiver involved), and so on.

The Haversine Formula is a navigational equation that uses latitude and longitude to determine the radius (big circle) between two points on the surface of the sphere (earth) (Nugroho et al., 2020). The Haversine Formula is a technique for estimating the distance between two points by assuming that the earth has a certain degree of curvature and is not a flat plane. By measuring the length of a straight line connecting two points on a latitude and longitude, the Haversine Formula approach determines the distance between two points. The Haversine Formula takes the ellipsoidal into account, believes the world is a sphere, and ignores the earth's height and the depth of valleys on its surface. In actuality, we are aware that the earth is shaped like an ellipse. The estimated polar radius of Earth's minor axis, which travels through the poles, is 6,356.8 kilometers. At the equator, the main axis is equal to a radius that is roughly 6,378,137 kilometers in radius. As a result, if the coordinate position is not on the equator, the radius of the earth's circle must be determined to compute the distance using the haversine formula in the application of the ellipse-shaped earth (Maulana et al., 2018). The Haversine formula is a technique for figuring out how far something is from another location. Based on the length of the longitude between two places on longitude and latitude, the Haversine formula determines the distance between two points (Azdy & Darnis, 2020).

The Euclidean Method and the Haversine Formula are the two techniques that can be used to calculate the closest distance between two places. When compared to the Haversine formula, the Euclidean method yields different results when used to determine the distance between two points on a flat plane (Maria et al., 2020). Surveyors must take great care in identifying the predicted survey coordinate points based on the coordinate points on the work map to conduct field surveys that yield correct data and information. The reality on the ground frequently differs from the map, in part because there are roadblocks to overcome for a variety of economic.

The quality of the ecosystem declines as peatlands are converted to agricultural land. Peatlands' ability to withstand environmental shocks will be jeopardized as a result (Irma et al., 2018). For more peatland processing, peat layer research is crucial (Evaliani et al., 2021). As a gauge of the state of peat ecosystems, information on the presence of plants and fauna in Peat Hydrological Unit (PHU) is crucial. Conversely, the less endemic flora or the quantity of cultivated plants and fauna is not widely found, indicating that peat ecosystems have experienced disturbances, especially due to human activities. The presence of a greater number of endemic flora and fauna in typical peat ecosystems indicates that these ecosystems are relatively undisturbed or have not undergone significant disruptions.

In addition to peat thickness, maturity, and level of enrichment, the substratum, or mineral soil layer beneath the peat, also plays a significant role in determining the properties of the material. This includes the effect of the sea and adjacent rivers, particularly in the case of coastal peat (the presence of marine deposits). Sand or clay make up the substratum in most cases. Due to their coastal clay substratum, some peatlands are vulnerable to exposure or drought that increases acidity and causes hazardous metal ions like Fe2+

and Mn2+ to dissolve. If peatlands need to be managed for oil palm plantation areas, there are several constraints. The limited supply of soil nutrients is one of the constraints in the management of oil palm farms in peatlands. This is because the majority of nutrients are in the absorption complex with organic matter on peatlands with low pH and large levels of organic matter (Manurung et al., 2022). Total Dissolved Solids is an additional crucial metric (TDS). Parts per million, or PPM, are used to measure TDS. TDS, like EC, is used to calculate the concentration of a body of water's solution material. This suggests that more nutrients are impacted by a higher TDS value, indicating a higher rate of peat decomposition.

The oxidation of pyrite (Fe2S) in peat soils results in a decrease in pH (increased acidity) and the conversion of organic molecules into organic acids. When pyrite, a marine deposit, undergoes oxidation, it releases an excess of H+ ions, leading to a pH drop to 2.0–3.0. Consequently, only plants resistant to pH 3.0, such as pineapples, can thrive in this environment. The land will become quartz sandy soil if the substratum is quartz sand, which will become exposed as a result of the peat layer being lost. The two primary parameters used to measure water quality are electrical conductivity (EC) and pH. Groundwater surrounding the drill site is measured using portable EC meters and pH meters, which are tools used to measure water quality. Electrical Conductivity, or EC of a hydroponic fertilizer solution is a measure of its concentration, expressed in millisiemens per centimeter, or mS/cm. In other words, a higher EC value indicates a greater need for nutrients, which suggests that the rate of peat decomposition has increased.

As drained peatlands' dry surface is so flammable, they are particularly vulnerable to both intentional and incidental burning, thus making deforestation and drained peatlands the most fire-prone locations. Unusual weather is not a need for peat fires, even though the most serious fires in recent years have been linked to droughts brought on by the ENSO climate anomaly (Page 2016). Robust policy measures (such as no-burn and no-drain regulations), coupled with efficient policy execution, acknowledge the heightened susceptibility of altered landscapes to fires. Undoubtedly, the extended dry spell linked to El Niño occurrences has intensified peat fires, but these occurrences are not the primary reasons, necessitating a change in course. Field survey problems that refer to work maps, which are predetermined transect routes, sometimes have to shift due to inaccessible point locations. The provisions of Minister of Environment and Forestry Regulation No. P.14/MENLHK/SETJEN/ KUM.1/2/2017 states that there is a limitation that the movement of survey points cannot be carried out further than 200 meters on the work map. In this regard, the Haversine method is needed to quickly determine the shift of points in the field carried out by the surveyor. This research aims to ensure that the observation point shifts do not exceed 200 m from the working map so that the data sample filled in on the tally sheet is available (13 peatland characteristics) and is representative.

METHOD

The method refers to Peatland Ecosystem Characteristics (Minister of Environment and Forestry No. P.14/MenLHK/SETJEN/ KUM.1/2/2017, where 13 elements of the characteristic should be found in the field. Administratively, PHU Sungai Gongan-Sungai Nilo covers an area of 23,790 hectares and acrossess Kesuma Village and Pangkalan Godai Village. Both of which are part of the Pelalawan District in the Province of Riau. The coordinates are 0°9'49" S – 0°8'43" S and 101°51'19" E – 102°0'41" E.

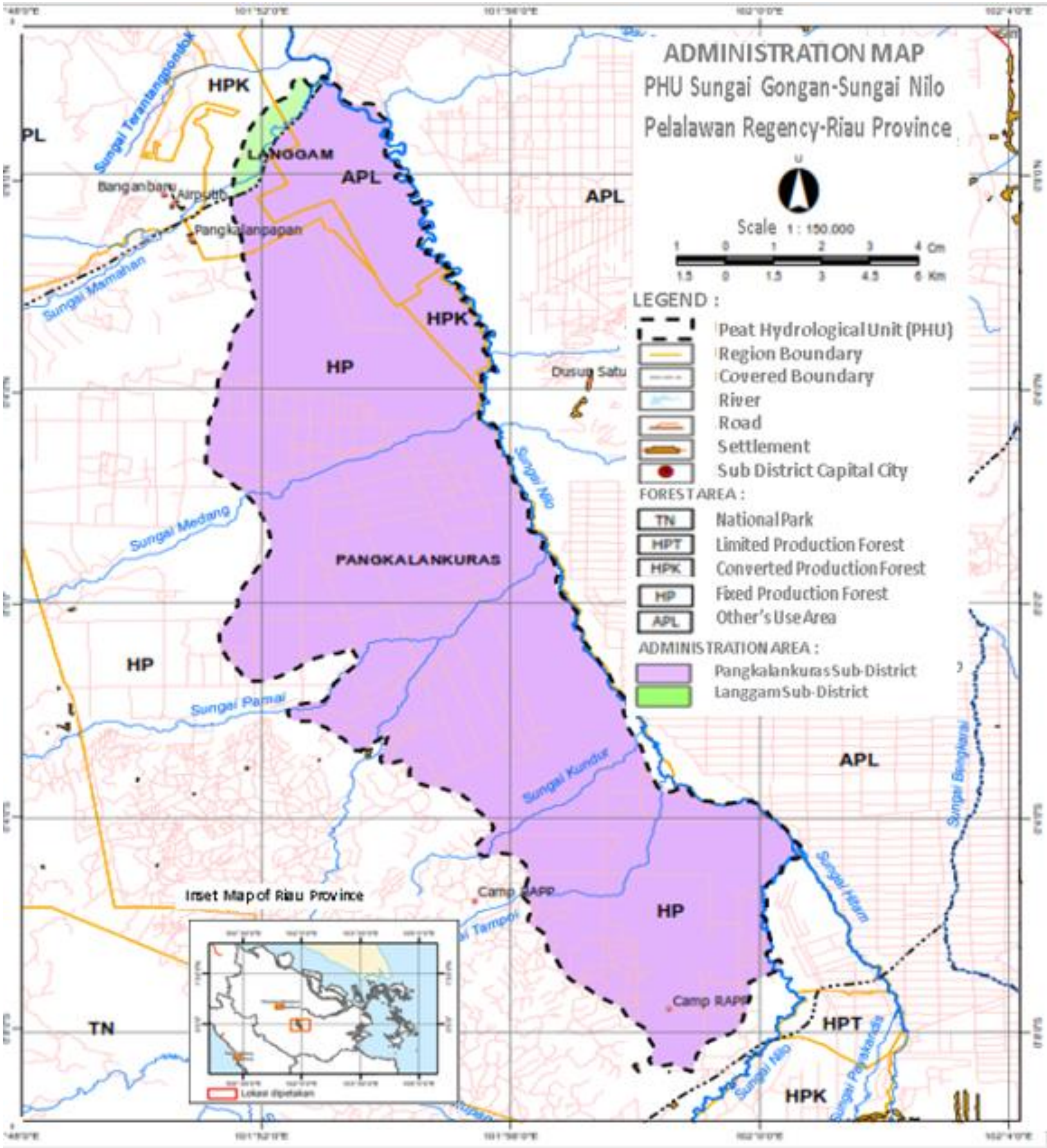

Figure 2. Gongan river-Nilo River PHU Filed map.

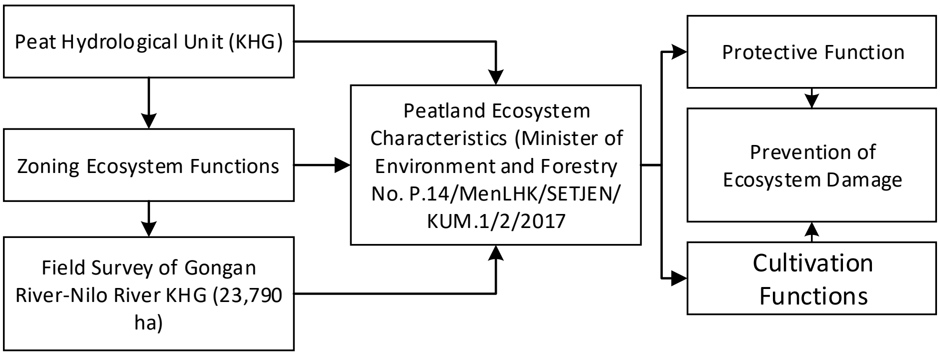

Figure 3. Research approach.

The research approach used in the inventory of peatland ecosystem characteristics is presented in the following **Figure 3**. The method refers to the Minister of Environment and Forestry Regulation Number P.14/MenLHK/SETJEN/KUM.1/2/2017 concerning Characteristics of Peat Ecosystems, where the 13 characteristic elements must be found in the field.

To calculate the length of a diagonal line in a triangle, one can utilise the Euclidean heuristic function, which relies on straight distances without any obstacles. Meanwhile, the Haversine equation calculates the arc length between two locations specified by latitude and longitude.

RESULTS AND DISCUSSION

In general, the results of field inventories of 13 peat characteristic parameters are described as follows:

Point Location or coordinate

After computing the average distance of Euclidean deviation using the average data value, 2.539764 is the result, and 2.536912 is the Haversine. This demonstrates that there is a 0.002852 discrepancy in the ratio of distance measurements between the Euclidean and Haversine methods, or 99.89 percent of the total distance measured by the two methods. Haversine, out of the two approaches, yields results that are most comparable to measurements on Google Maps. Haversine's formulation is as follows **Equation 1**, **Equation 2**, and **Equation 3** (Maria et al., 2020).

$$d = R.c \quad \text{..} (1)$$

$$c = 2 * atan2\left(\sqrt{a}, \sqrt{1-a}\right) \quad \text{............................} (2)$$

$$a = Sin^2\left(\frac{\Delta Lat}{2}\right) + Cos\,(Lat_1) * Cos\,(Lat_2) * \; Sin^2\left(\frac{\Delta Long}{2}\right) \quad \text{..} (3)$$

Where:

d is the distance between two points (in units of Earth-km radius)

Lat_1 and Lat_2 are the latitude of the first and second points (in Radians)

$\Delta\, Lat$ is the difference in latitude of the two points (in radians)

$\Delta\, Long$ is the longitude difference of the two points (in radians)

R is the radius of the Earth (± 6,371 km)

For the 31 GCP Points, there is a shift in points to plan points on the working map, as presented in the Calculation **Table 1** with Haversine's formulation. Average coordinate point shift as far as 19.9 m with a minimum value of 3.38 m and a maximum value of 198.9 m).

Table 1. The distance of deviation of the field coordinate point.

No.	Code	Working Map Coordinates		Field coordinates		Distance (m)
		Longitude	Latitude	Longitude	Latitude	
1	TB-7.4	102.00092	(0.06403)	102.00089	(0.06398)	6.09
2	TL-6.6	101.95244	(0.00956)	101.95142	(0.00809)	198.88
3	TB-5.46	101.91774	0.05954	101.91770	0.05950	6.92
4	TL-9.4	101.90777	0.06072	101.90781	0.06071	5.01
5	TB-5.47	101.91620	0.06379	101.91616	0.06323	62.27
6	TL-9.5	101.92463	0.06686	101.92455	0.06685	9.36
7	TB-5.48	101.91466	0.06803	101.91461	0.06801	5.69
8	TB-5.49	101.91311	0.07228	101.91308	0.07228	3.38
9	TB-5.50	101.91157	0.07652	101.91153	0.07652	4.00
10	TB-5.51	101.91002	0.08077	101.90995	0.08077	7.89
11	TB-5.52	101.90848	0.08502	101.90842	0.08502	6.27
12	TL-10.3	101.89850	0.08619	101.89845	0.08619	5.29
13	TB-5.53	101.90693	0.08926	101.90688	0.08926	5.73
14	TL-10.4	101.91537	0.09233	101.91525	0.09231	13.03
15	TB-5.54	101.90539	0.09351	101.90535	0.09348	5.03
16	TB-3.42	101.86238	0.10670	101.86258	0.10728	67.64
17	TL-11.2	101.88923	0.11166	101.88918	0.11166	5.54
18	TB-4.60	101.87771	0.11709	101.87775	0.11682	30.13
19	TL-11.3	101.90610	0.11780	101.90604	0.11708	80.51
20	TB-4.61	101.87616	0.12133	101.87609	0.12133	7.96
21	TB-4.62	101.87462	0.12558	101.87455	0.12558	7.45
22	TL-12.1	101.86464	0.12676	101.86458	0.12675	6.49
23	TB-4.63	101.87307	0.12982	101.87302	0.12982	5.85
24	TL-12.2	101.88151	0.13289	101.88144	0.13289	7.42
25	TB-4.64	101.87153	0.13407	101.87148	0.13407	5.32
26	TB-4.65	101.86998	0.13831	101.86992	0.13831	7.07
27	TL-12.3	101.89838	0.13903	101.89832	0.13903	6.12
28	TB-4.66	101.86844	0.14256	101.86854	0.14246	15.86
29	TB-4.67	101.86689	0.14681	101.86684	0.14680	6.08
30	TB-5.69	101.88222	0.15719	101.88216	0.15718	6.56
31	TB-5.70	101.88067	0.16143	101.88062	0.16143	6.02
Average deviation (m)						19.90
Minimum Deviation (m)						3.38
Maximum deviation						198.88

Land Elevation

Low-elevation areas also allow for nutrient accumulation from water flowing into the area, which supports excessive plant growth and peat accumulation. Elevation readings are taken concurrently with the recording of coordinate data using GPS. The results of data processing and analysis of 31 location points that have been surveyed that elevation at all points is less than 16 m above sea level (asl).

Groundwater, Puddle and Flood

Many peatland resources have declined and degraded as a result of land-clearing operations, and many places are no longer considered to be peatlands. Through sustainable water resource management, water table management measures have been implemented to slow down the rate of ~~of~~ peatlands sinking. These efforts include overcoming flooding and inundation on these lands to prevent physical and biochemical degradation. According to field measurements, 32% of all survey stations had depths between 30 and 60 cm, while 68% of groundwater levels were less than 30 cm. While the water level in channels between 50 and 100 cm reaches 68%, it is only 10% in channels under 50 cm and 22% in those beyond 100 cm.

Land Cover, Land Use and Condition

The distribution of observation points based on land cover conditions on the Gongan River – Nilo River PHU from 31 points consists of÷ Forest (Ht) as many as 6 points (19.35%); Plantations (Pb) as many as 23 (74.19%) and shrubs (Sb) as much as 2 (6.45%).

Table 2. Landuse and land cover.

No	Landuse	Sampling Points	(%)
1	Forest	6	19.35
2	Mixed Farming	0	0.00
3	Crop Estate	23	74.19
4	Open Land	0	0.00
5	Shrubs	2	6.45
Total		31	100

The Existence of Protected Flora and Fauna

In the PHU Sungai Gongan–Sungai Nilo area in Pelalawan Regency, no endemic flora and fauna classified as significant species or protected flora and fauna were encountered or identified through interviews. This absence is attributed to the surveyors being instructed solely to document observations of rare flora and fauna encountered in the field.

Natural and Artificial Drainage Conditions

Groundchecking of the coordinates of the canal/drainage meeting was carried out. The depth of the drainage channel is min 27 cm, max 200 cm, and average 75.3 cm (**Table 3**).

Table 3. The results of drainage gorundchecking.

No.	Code	Koord_X	Koord_Y	Drainage	Channel	Water Level (cm)
1	TB-7. 4	102.0009	-0.06398	Natural	Open Channel	70
2	TL-6. 6	101.9514	-0.00809	Natural	Open Channel	200
3	TB-5. 46	101.9177	0.05950	Artificial	Open Channel	71
4	TB-5. 47	101.9162	0.06323	Artificial	Open Channel	52
5	TL-9. 5	101.9246	0.06685	Natural	Open Channel	70
6	TB-5. 48	101.9146	0.06801	Artificial	Open Channel	52
7	TB-5. 49	101.9131	0.07228	Artificial	Open Channel	27
8	TB-5. 51	101.9100	0.08077	Artificial	Open Channel	58
9	TB-5. 52	101.9084	0.08502	Artificial	Open Channel	72
10	TL-10. 3	101.8985	0.08619	Artificial	Open Channel	68
11	TB-5. 53	101.9069	0.08926	Artificial	Open Channel	56
12	TL-10. 4	101.9153	0.09231	Artificial	Open Channel	78
13	TB-5. 54	101.9054	0.09348	Artificial	Open Channel	85
14	TB-4. 60	101.8778	0.11682	Artificial	Open Channel	130
15	TL-11. 3	101.9060	0.11708	Artificial	Open Channel	79
16	TB-4. 62	101.8746	0.12558	Artificial	Controlled Channel	42
17	TL-12. 1	101.8646	0.12675	Artificial	Open Channel	120
18	TB-4. 63	101.8730	0.12982	Artificial	Controlled Channel	56

No.	Code	Koord_X	Koord_Y	Drainage	Channel	Water Level (cm)
19	TL-12. 2	101.8814	0.13289	Artificial	Controlled Channel	85
20	TB-4. 64	101.8715	0.13407	Artificial	Controlled Channel	67
21	TB-4. 65	101.8699	0.13831	Artificial	Open Channel	90
22	TL-12. 3	101.8983	0.13903	Natural	Open Channel	60
23	TB-4. 66	101.8685	0.14246	Natural	Open Channel	70
24	TB-4. 67	101.8668	0.14680	Artificial	Open Channel	70
25	TB-5. 69	101.8822	0.15718	Natural	Open Channel	70
26	TB-5. 70	101.8806	0.16143	Natural	Open Channel	60

Source: Channel Groundchecking, 2023

Water Quality

It is crucial to understand the characteristics of water quality, such as pH, TDS, and Electrical Conductivity (DHL), particularly if you intend to utilize peatlands in a way that does not disrupt ecological processes (Howson et al., 2023). The chemical property known as pH tells us how acidic or alkaline the soil is. The kind of plant influences peat's acidity, the type of rock, the availability of oxygen, and the amount of humic acid present (Sapar et al., 2020). Field measurements of groundwater pH 100% <4, channel water pH 73% <4 and 27% between 4-5, and Substratum pH 81% <4 and 19% between 4-5. In general, it can be said that the pH of water is acidic to very acidic.

The ability of water to conduct an electric current is known as electrical conductivity (EC), and it can reveal information about the concentration of dissolved salts or ions in groundwater. Higher EC water often has more dissolved salts in it. In comparison to water in other places, peat water often has a lower EC, and peatlands are typically acidic. Because peat groundwater interacts with organic matter in peatlands, it often has a lower mineral content and produces lower electrical conductivity (EC) than water in locations with mineral soils. Rainfall and drainage patterns are examples of environmental variables that can impact peat groundwater's EC. To manage peatlands, EC monitoring of the groundwater is crucial, particularly to comprehend the features of the water that influence nearby ecosystems and agricultural practices. Management actions that can lessen the impact on the land and flora above it are required if a high EC implies a high concentration of salt. 96% of groundwater has DHL < 300 μS/cm, while just 3.1% has DHL > 300 μS/cm, according to data analysis. Likewise, DHL's low DHL tendency also applies to the Substratum.

TDS quantifies all ~~of~~ the solutes—minerals, salts, and microorganisms—that are present in water. When compared to water in regions with mineral soils, TDS in peat groundwater typically tends to be lower in peatlands. This is because peat water typically contains fewer minerals, and peatlands have acidic qualities. Water quality can be inferred from TDS levels on peatlands, which can also impact the amount of water available for ecosystems and human requirements. One of the key metrics for managing and keeping an eye on peatland water resources is TDS measurement. The sustainability of the ecosystem and the use of peatlands may be impacted by an increase in TDS, which could be a sign of an increase in the concentration of salts or other solutes in the groundwater of peatlands. The results of field surveys show TDS of channel water less than 75, as much as 97%, and between 75-150 only as much as 3% of the number of points surveyed.

Overflow Type

On peatlands, two kinds of overflow happen frequently: surface runoff and subsurface flow. When rainfall surpasses the ability of peat soils to absorb it, surface overflow transpires, resulting in water flowing over the soil's surface and possibly causing surface erosion and nutrient carryover. If there is a denser layer underneath the peat layer or if there is a variation in height within the peatland, profound overflow takes place in the deeper layers of the peat soil. Both kinds of overflow affect peatlands' water cycle, which in turn affects ecosystems and the long-term viability of these lands.

The overflow type consists of 4 types, namely: Type A (Lands with low elevation and always inundated by both large and small tides); Type B (Land that is only flooded by high tide); Type C (Lands that are not inundated by large or small tides, but the groundwater depth is very shallow (< 50 cm); Type D (Lands that are not inundated by large or small tides and have a groundwater depth of > 50 cm). In the survey area, the relief in the rainy and dry seasons is relatively the same as Type C Overflow by 52% and Type B by 48%.

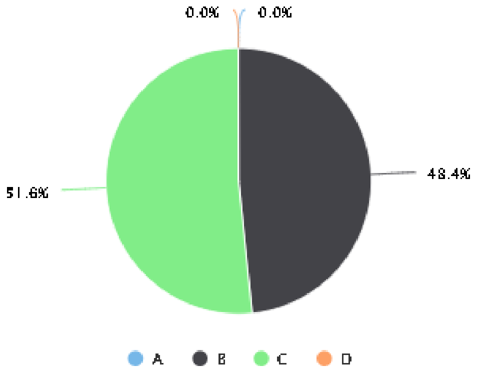

Figure 3. Overflow type

Peat Thickness

Numerous activities include the use of peat soil, but different restrictions on the qualities of the soil and the technology of usage lead to abuse that destroys peatlands, which is very different from the idea of sustainable development (Wang et al., 2021). Based on the results of observations and verification in the field, in the Gongan River – Nilo River PHU with a total number of observation points of 31 observation points, the PHU was found to consist of 10 non-peat soils (32.26%) and 21 peat soils (67.74%). In PHUPHU Gongan River – Nilo River has a minimum peat thickness of 160 cm, a maximum of 685 cm, and an average of 367.9 cm.

Substratum Characteristics

The bottom layer of peat soil is known as the "peat substratum," and it often comprises minerals, occasionally sand or pebbles. Peat substratum, which lies beneath a layer of decomposed peat, can provide peat ecosystems more structure and stability. Beneath a layer of degraded peat is mineral material, such as sand, mud, or boulders, which makes up the peat substratum. When opposed to the peat layer that has broken down on top, the peat substratum typically has a thicker or denser physical consistency. Depending on the geology and topography of the area, the peat substratum may be a thin layer that lies right next to the layer of decomposed peat on top, or it may be deeper. The characteristics of peat substratum are important to know in the context of peatland management, especially because they can affect the structure and function of the peatland ecosystem. Substratum characteristics are 68% in the form of clay/river sediments, the rest are in the form of non-peat soils.

Peat Bulk Density

The moisture content and content weight of peat have the opposite relationship. The content weight decreases as the soil water content increases, while the fill weight increases as the soil water content decreases. Regarding porosity, peat generally has a high porosity and a relatively low weight value, which means that it has a strong capacity for absorbing and dispersing water. There is a significant correlation between these two variables. Fibric peat, which is typically found in the lowest layer, has a content weight lower than 0.1 g/cm3, which results in a low weight of the contents, soft peat, and low load-bearing power (Yulianti et al., 2022).

Peat Maturity Level

According to (Wahab et al., 2022), peat soils are soft soils with weak properties, including high moisture content, poor shear strength, and compressibility. Sapric peat is more effective at holding onto water than fibric peat, although it absorbs less of it. This is because fibric (raw peat) has a larger OH-phenolic group, which is polar and has a significant capacity to bind water. Furthermore, cellulose content in fibric peat is higher than in sapric peat. Hydrophilic organic material with a larger capacity to bind water is cellulose. The results of laboratory analysis using the gravimetric method for moisture content and porosity of peat soil samples at depths of 0 – 50 cm and 50 – 100 cm in each peat soil sample are as follows **Table 4**. Degree of remodeling or development: (1) sapric peat soil; (2) hemic peat soil; (3) fibric peat soil; and (4) peat soil, which is the final stage of peat soil development before it becomes mature peat. The organic matter has nearly finished decomposing at this point, and the peat soil is getting close to mature peat status. The results of field observations show that the level of peat development in the survey area is dominated by hemic peat soil (94.1%).—Only a small number of them have had fibric peat soil development, and no peat soil has a perfect peat maturity level. Based on the groundchecking results with a total number of 31 observation points, 21 points (67.74%) exhibited peat with a hemic maturity level, while the remaining spots consisted of mineral soil

Table 4. Water content and porosity.

No.	Code & Depth	Results (%)	
		Water Content	Porosity
1	TB-4.67 (0-50cm)	55.2	56.3
2	TB-4.67 (50-100cm)	56.9	58.5
3	TL-10.4 (0-50cm)	49.3	53.8
4	TL-10.4 (50-100cm)	49.9	54.2
5	TB-5.54 (0-50cm)	36.4	38.2
6	TB-5.54 (50-100cm)	39.0	41.5
7	TL-12.2 (0-50cm)	60.0	62.1
8	TL-12.2 (50-100cm)	50.2	52.1

Source: Laboratory Analysis Results, 2023

The stage of evolution that peat soils go through throughout time is referred to as the pace of peatland reshuffling or development. Plant debris accumulates and decomposes in locations that are wet during this process. Peat soils can be classified into four primary groups based on the soil characteristics and depth of pyrite layer

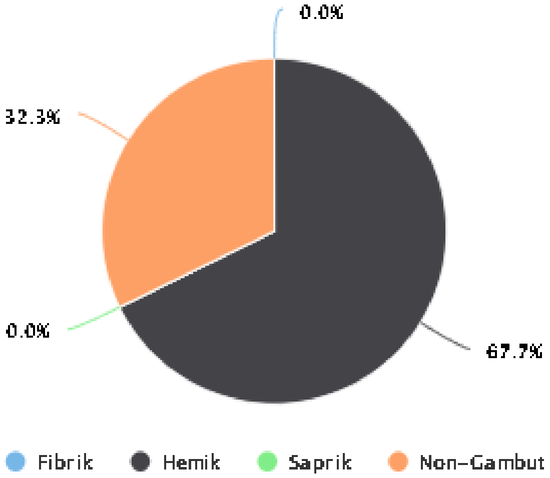

Figure 4. Peat maturity level.

The oxidation of pyrite (Fe2S) results in increased acidity (a decrease in pH) in peat soils, along with the conversion of organic molecules into organic acid compounds. When pyrite, a marine deposit, oxidizes, it releases an excess of H+ ions, leading to a pH drop to 2.0–3.0, a level unsuitable for plant growth. However, no pyrite layer was discovered in the Substratum in the PHU Area of Gongan River-Nilo River.

CONCLUSION

Field surveys are conducted based on a clear Work Plan that has generated data and information related to the inventory of 13 peat characteristics. A total of 31 drilling points in the PHU Sungai Gongan-Nilo area meet the criteria set by the Ministry of Environment and Forestry No. P.14/MENLHK/SETJEN/KUM.1/ 2/2017, with displacement not exceeding 200 meters but varying only with a minimum value of 3.38 meters and a maximum value of 198.9 meters, with an average value of 19.9 meters. Thus, all data/information on the 13 peat characteristics obtained from the survey results are valid and accountable. The maturity level of the peat according to observations is of Hemic type, with a minimum thickness of 160 cm and a maximum of 685 cm, with an average value of 367.9 cm. All field survey results in the PHU Sungai Gongan-Nilo area can be accepted as valid data that can be used as the basis for development/planning of the area in this region.

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