Tropical Wetland Journal
Journal homepage: twj.ulm.ac.id | Published by Postgraduate Program - Lambung Mangkurat University | e-ISSN: 2654-279X

Original article
DOI 10.20527/twj.v8i1.107

The Distribution Mapping for Environmental Evaluation of Waterlily (Nymphaea pubescens Willd.) Growing in Lebak Swampland in Kalimantan Selatan Province

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Received: 04 April 2022; Accepted: 07 July 2022; Published: 27 July 2022

ABSTRACT

Nymphaea pubescens is one of the aquatic plants that grow in the lebak area and is widely used as food and medicine by the local community. The N. pubescens growing environment determines its growth. The distribution of N. pubescens plants has not been well identified. This study aimed to determine the distribution of N. pubescens mapping for environmental evaluation of N. pubescens growing in Teluk Sinar Village, Sungai Pandan District, Hulu Sungai Utara Regency, Kalimantan Selatan Province. The study used data collection methods with primary and secondary data survey techniques. Primary survey through delineation of N. pubescens plant boundaries in the field. Field measurements were also carried out to identify the environmental variables of N. pubescens growing. In addition, the interpretation of high–resolution satellite imagery and low–resolution satellite imagery for spectral analysis. The environmental variables for growing N. pubescens include water depth, light penetration depth, water pH, and sediment pH. The N. pubescens distribution map was obtained through overlaying several thematic maps, image interpretation, and field measurements using ArcView and ArcGIS software. The results of the study revealed a map of the distribution of N. pubescens plants can grow optimally in the middle lebak with an environment that has a water depth of 50–100 cm, a light penetration depth of 23–100 cm, a water pH of 6.25–8.37, and a sediment pH of 3.33–4.69. The results of the N. pubescens Distribution Mapping and the N. pubescens growing environment obtained can be used as a basis for determining the potential distribution of N. pubescens in each region.

Keywords: environment, evaluation, lebak swampland, mapping, nymphaea pubescens

1. Introduction

The N. pubescens is a species with leaves that float on the surface of the water while the roots are on the ground (Fitrial, 2009; Ismuhajaroh et al., 2022). The N. pubescens can live in tropical to temperate climates occupying freshwater, ponds, swamps, shallow lakes, and calm flowing rivers (Fitrial, 2009; Guruge et al., 2016; Raja et al., 2010). Indonesia is one of the countries that has a fairly large swamp

area, which is 33.3 million hectares and there are 11.61 million hectares including swamps (Suriadikarta, 2005). Kalimantan itself has 3.58 million ha of swamps (Alwi & Hairani, 2007). Lebak is in the form of a basin (bowl) according to (Nursyamsi et al., 2008) the basin will be filled with abundant water when the rainy season arrives with different height variations and the duration of inundation between the edges to the middle. The division of lebak based on height and duration of inundation according to (Subagyo, 2006) is divided into three typologies, namely: 1) shallow lowland lebak (0.25–50 cm) middle lebak (50–100 cm), and 3) depth or very depth lebak (more than 100 cm).

Hulu Sungai Utara Regency (HSU) is an area of Kalimantan Selatan which has a fairly large lebak and is overgrown with various kinds of N. pubescens. Nymphaea pubescens or what local people call "talipuk" is a type of N. pubescens that is widely used as food and medicine. Almost all parts of the N. pubescens plant can be utilized and consumed every day. According to (Biswas & Rahmatullah, 2011), when there is a food shortage, the family's nutritional needs can be met by consuming all parts of the N. pubescens. The people of Teluk Sinar Village mostly use the flower stalks as vegetables and seeds, processed in various traditional foods. According to (Fitrial, 2009)the N. pubescens seed contains carbohydrates (88.36% of dry weight), protein (10.39% of dry weight), amino acids (8 non–essential and 10 essential), and fat (0.58%), and fiber (7.9%). This high nutritional content enables the N. pubescens seed to be used to combat various diseases related to malnutrition (Aliyu et al., 2017) .

Preservation and development of N. pubescens need to be done to prevent the reduction or even extinction of N. pubescens due to uncontrolled use as a food source or land conversion. The step in the development is to collect distribution data and to evaluate where the N. pubescens grows. Data collection on distribution mapping in the lebak accompanied by an analysis of the N. pubescens growing environment is expected to be able to identify areas with a suitable growing environment and potential as a location for development. The condition of swampland with puddles of water is not easy if an analysis of the environment where the N. pubescens grows is carried out. According to (Suwargana et al., 2008) it takes a lot of money and a long time to carry out a terrestrial survey. The use of remote sensing technology (Remote Sensing) needs to be done to make it easier to evaluate the N. pubescens growing environment in the context of developing and preserving food-producing land. Remote sensing is carried out to obtain an object in aerial photographs and Ikonos images can be done using elements of image interpretation (Sutanto., 1986) while field investigation needs to be done to test the accuracy in interpretation Treman, 2012) and to look for environmental variables where the N. pubescens grows.

It is very important to know the distribution of the N. pubescens and the environment of the N. pubescens growing so that it can be used to determine the potential distribution of the N. pubescens in each region. Based on the above background, it is necessary to conduct research entitled "Mapping the distribution of N. pubescens for environmental evaluation of N. pubescens growing in Teluk Sinar Village, Sungai Pandan District, Hulu Sungai Utara Regency, Kalimantan Selatan Province". The research's objective was to analyze and evaluate the distribution and environment of N. pubescens growing using remote sensing techniques and geographic information systems.

2. Materials and Methods

The research was conducted in Teluk Sinar Village, Sungai Pandan District, Hulu Sungai Utara Regency, Kalimantan Selatan Province. The area includes the lowland swamp area which is located at coordinates between 02O29'40.15''S, 115O10'07.0''E and 02O30'06.85''S, 115O10'25.1''E. Coordinates were taken using GPS (Global Positioning System) around the lebak in Teluk Sinar Village using a "Jukung" or canoe with a capacity of 3 people.

The satellite data used is non–commercial Landsat 8 satellite imagery downloaded via https://earthexplorer.usgs.gov with a resolution of 30 meters, with cloud coverage of at least and less than 10% in the study area. Image processing is done using GIS (ER Mapper) software. According to Agoes et al., (2018) ER Mapper software is able to take a unique approach to image data processing that combines file–based and band–based.

Corrections need to be made to simplify the analysis. The combination of three wavelength channels or the best band is selected for the observation of the water element. Image Sharpening is done to facilitate the interpretation of objects in the image. Visual interpretation is based on the principle of interpretation of images and maps of the earth of Indonesia at a scale of 1:50.000. Indonesia's topographical map is needed to assist in image interpretation. Maps of the earth are downloaded via www.big.go.id. The results of image interpretation that have been carried out will determine the spatial

distribution and environment of the N. pubescens plant in the swampland. Monthly rainfall data is needed as supporting data.

Measurements of water depth and light penetration were carried out using a "Secchi–disk" (Carruthers et al., 2001), which is a black and white disc with a measuring tape at the top and a weight at the bottom. The depth measurement was carried out by submerging the Secchi–disk to the bottom where the N. pubescens grew, while the light penetration measurement was measured by submerging the Secchi until the difference between the black and white quadrants was no longer visible. Measurement of the acidity of water and sediment was carried out in the Chemistry laboratory of the Faculty of Agriculture, Universitas Lambung Mangkurat. Measurements were carried out using Thermo Scientific.

3. Results and Discussion

Environment of The Growing N. pubescens

Hulu Sungai Utara Regency (HSU) is an area consisting of 10 sub–districts. The sub–districts are Danau Panggang, Paminggir, Babirik, Sungai Pandan, Sungai Tabukan, Amuntai Selatan, Pusat Amuntai, Banjang, Amuntai Utara and Haur Gading. Geographically, HSU Regency is located at 2O17' South Latitude – 2O33' South Latitude and 114O52' East Longitude – 115O24' East Longitude. The total area of HSU Regency is in the form of a land area of 892.70 km2 (Figure 1). According to the Badan Pusat Statistik–HSU (BPS–HSU, 2016) is a lowland area with an altitude of 0–7 meters above sea level. The area of HSU Regency is seen from the drainage of groundwater that is periodically inundated, reaching 88.220 hectares, for Sungai Pandan Sub–district, HSU, all land is periodically inundated, which is 4.500 hectares.

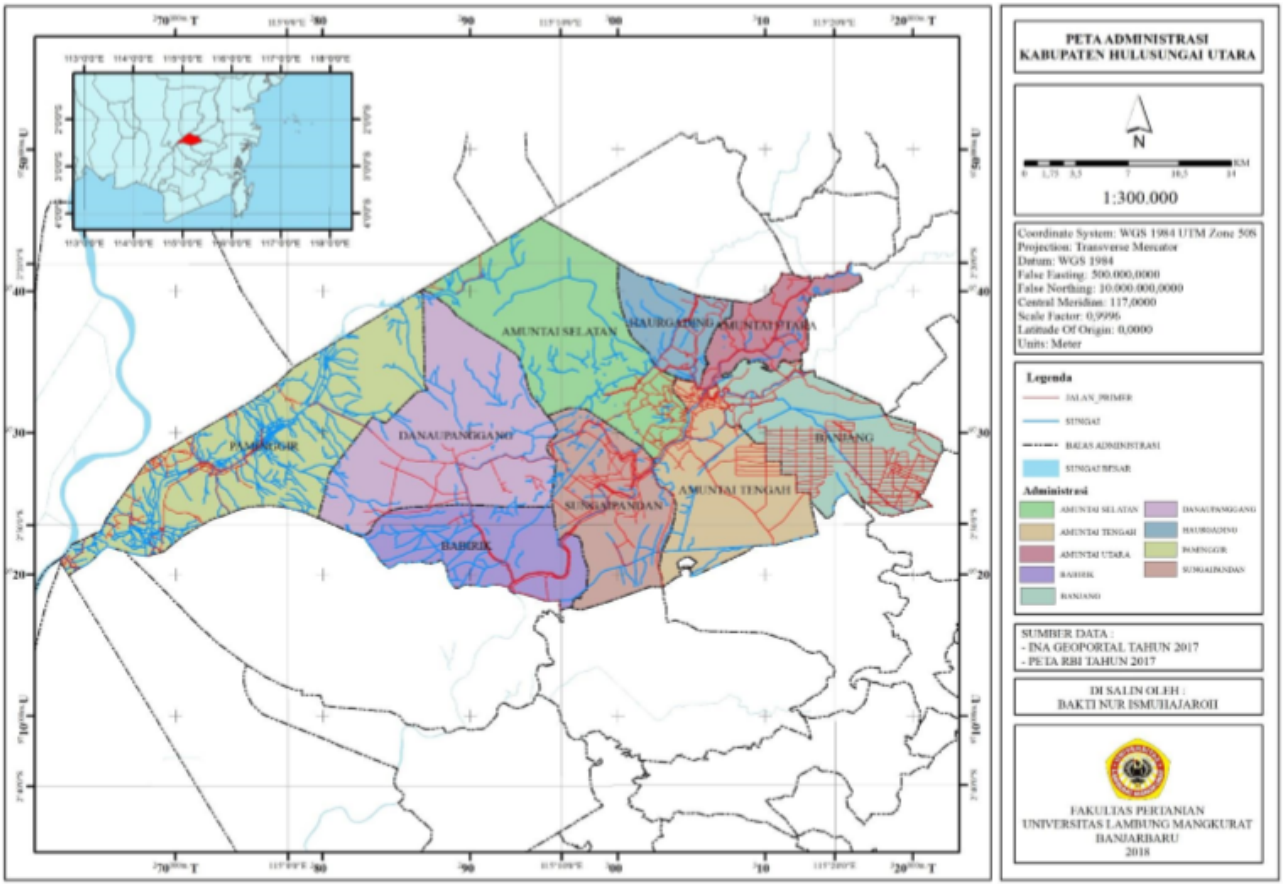

Figure 1. Administrative map of HSU Regency

The condition of the area that is periodically inundated in the swamp is influenced by the presence of rainfall. Teluk Sinar Village, Sungai Pandan District, HSU Regency is an area that is periodically inundated, so that during the rainy season and inundation the swampland is overgrown with water plants, one of which is N. pubescens (Figure 2). The N. pubescens naturally grows along the lebak. The existence of the N. pubescens is very dependent on the presence of rainwater, when it starts to rain and the water floods the swamp, N. pubescens seeds begin to grow. The growth and development of N.

pubescens plants along with the increase in water depth, the deeper the water, the longer the N. pubescens leaf stalk.

Figure 2. Lebak swampland in Teluk Sinar Village, Sungai Pandan District, HSU Regency which is overgrown with N. pubescens

Mapping the distribution of N. pubescens in the lebak swampland and environmental evaluation growing

The N. pubescens distribution pattern is delineated by visual interpretation of the image by examining photos or images to identify N. pubescens plants. Evaluation of a N. pubescens growing site can use a combination of band 321 with a composition of band 3 for red which is useful for distinguishing plant types, band 2 for green which is useful in detecting plants, and band 1 for blue is useful for distinguishing water clarity and also distinguishing between soil and plants (Figure 3).

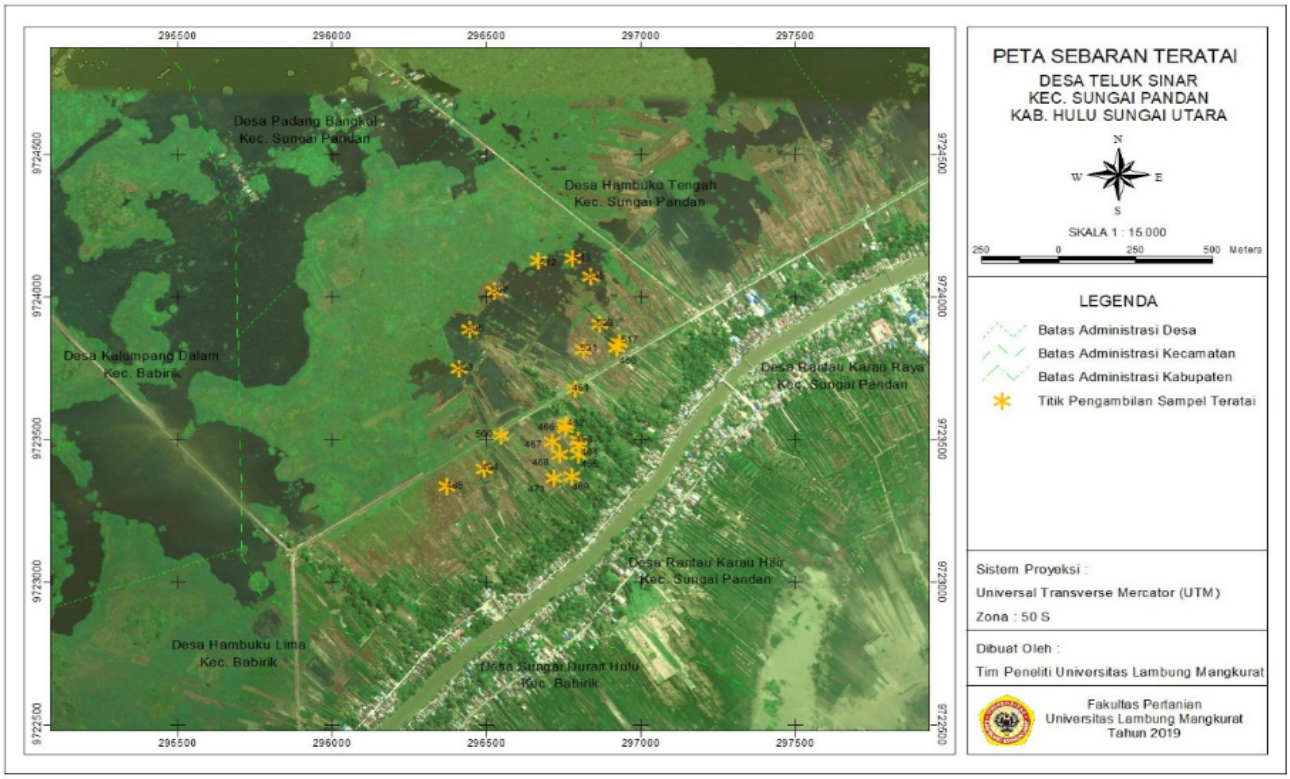

Figure 3. Distribution Pattern of *N. pubescens* in HSU Regency

The distribution pattern of *N. pubescens* plants around the *lebak* (Figure 3). This distribution pattern seems to be influenced by the depth of the *lebak* water. The results of the survey measuring the depth of water where the *N. pubescens* grows ranges from a depth of 35 cm to 121 cm (Table 1). The middle lebak type is the most overgrown with *N. pubescens*, reaching 60.87% of the total sample of 23 coordinate points, followed by deep lebak 21.74% and finally in shallow *lebak* 17.39%. This distribution pattern indicates that the *N. pubescens* requires an environment that is not too shallow and not too deep, so it can be seen that in Figure 3 the *N. pubescens* only occupies the edge of the *lebak*. The level of water depth affects the environment in *lebak* swampland. According to (Chambers, 1987) the level of water depth affects the total nitrogen, phosphorus, and organic matter, although there is no consistent pattern with the level of water depth.

Table 1. The Depth and Acidity of the *N. pubescens* Growing Place in Teluk Sinar Village, Sungai Pandan District, HSU Regency

Lebak Typologies	Point	Coodinate	Water Depth (cm)	Light Penetration Depth (cm)	pH Water	pH Sediment
Shallow *Lebak*						
(0.25 – 50 cm)	461	02°29'55.7''S, 115°10'20.4''E	35	30	7.43^{n}	4.55^{vsa}
	465	02°30'03.2''S, 115°10'20.8''E	36	36	6.25^{sac}	4.32^{ea}
	469	02°30'05.7''S, 115°10'20.1''E	45	23	7.28^{n}	4.39^{ea}
	515	02°29'42.9''S, 115°10'22.1''E	46	46	7.66^{n}	4.46^{ea}
Middle *Lebak*						
(50 – 100 cm)	462	02°29'59.8''S, 115°10'19.5''E	62	62	7.52^{n}	4.64^{vsa}
	463	02°30'01.6''S, 115°10'20.8''E	51	51	6.91^{n}	4.10^{ea}
	464	02°30'02.2''S, 115°10'20.9''E	55	55	7.27^{n}	3.33^{ea}
	466	02°30'02.2''S, 115°10'19.4''E	73	30	7.41^{n}	4.59^{vsa}
	467	02°30'01.7''S, 115°10'18.0''E	88	35	7.79^{sal}	4.30^{ea}
	468	02°30'03.2''S, 115°10'18.8''E	75	35	7.29^{n}	4.66^{vsa}
	471	02°30'05.9''S, 115°10'18.2''E	89	89	8.13^{sal}	4.28^{ea}
	500	02°30'01.0''S, 115°10'12.6''E	87	40	8.37^{sal}	4.69^{vsa}
	505	02°29'48.9''S, 115°10'09.4''E	90	90	7.75^{n}	4.14^{ea}
	513	02°29'40.8''S, 115°10'20.2''E	98	76	7.92^{sal}	4.40^{ea}
	517	02°29'50.5''S, 115°10'25.1''E	85	66	8.14^{sal}	4.23^{ea}
	523	02°29'48.3''S, 115°10'23.0''E	93	93	7.90^{sal}	4.30^{ea}
	503	02°29'53.4''S, 115°10'08.3''E	100	100	7.82^{sal}	4.27^{ea}
	531	02°29'51.2''S, 115°10'21.3''E	64	53	8.14^{sal}	4.34^{ea}
Depth *Lebak*						
(> 100 cm)	460	02°29'51.0''S, 115°10'24.8''E	107	80	6.92^{n}	4.04^{ea}
	486	02°30'06.8''S, 115°10'07.0''E	106	80	8.23^{sal}	4.44^{ea}
	494	02°30'04.8''S, 115°10'10.9''E	121	60	8.40^{sal}	4.39^{ea}
	507	02°29'44.5''S, 115°10'12.0''E	110	70	7.79^{sal}	4.34^{ea}
	512	02°29'41.1''S, 115°10'16.6''E	110	75	7.82^{sal}	4.16^{ea}

Source : Results of primary data measurement, processing and analysis, 2021

Description: BP Tanah Bogor (2009) defined the following soil and water reactions as follows: extremely acidic (ea, pH < 4.5); very strongly acidic (vsa, pH 4.5–5.5); slightly acidic (sac, pH 5.6–6.6); netral (n, pH 6.6–7.5); slightly alkaline (sal, pH 7.6–8.5); strongly alkaline (sta, pH > 8.5).

Not all of the sunlight reach the bottom of the swamp. The depth and level of turbidity of swamp water is the cause of not getting sunlight to the bottom of the swamp. The presence of sunlight is very necessary in the process of photosynthesis. According to (Bodhipadma et al., 2011) aquatic plants carry out the photosynthesis process around water so that the photosynthesis process is different from plants on land. Figure 4 shows that the shallow *lebak* has a water inundation depth of 35–46 cm, the middle *lebak* 51–100 cm, and the deep lebak 106–121 cm. *Nymphaea pubescens* can still grow well, although the penetration of sunlight does not reach the bottom of the swamp. The *N. pubescens* plant can meet the needs of light for photosynthesis because it's leaf floats on the surface of the water, so that the top part of the plant can catch sunlight. According to (Scheffer, 1998) water depth has a direct effect on aquatic plants in the form of net assimilation results, indirectly also affects changes in sediment characteristics, water clarity and exposure to water waves caused by wind. The depth of light penetration varies depending on the level of water depth and the degree of turbidity of the water. The

lebak part is shallow, light can penetrate the water to the bottom of the swamp. The more the depth of the water surface increases, the light cannot penetrate the bottom of the swamp. The *lebak* swampland has a depth of more than 100 cm. The *N. pubescens* plant is able to adapt by elongating the leaf stalks to the surface, so that even when the inundation conditions reach 121 cm, the *N. pubescens* can still grow well.

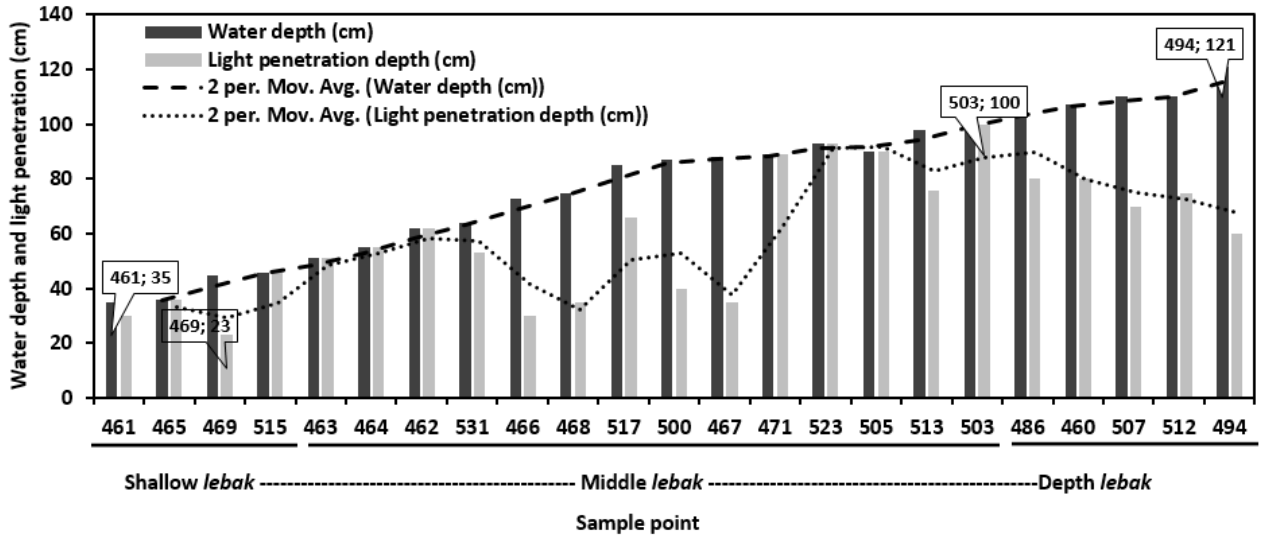

Figure 4. Depth and Light Penetration of *Lebak* Water, Teluk Sinar Village, Sungai Pandan District, Hulu Sungai Utara Regency

The degree of acidity can affect whether or not nutrients are easily absorbed by plants. Figure 5 shows that the *lebak* has a sediment pH of 4.32–5.55, middle *lebak* 3.33–4.69, and deep *lebak* 4.04–4.44. According to (Subagyo, 2006) a pH less than or equal to 3.5 includes extreme acidity, it can be seen that the pH of the sediments in the middle *lebak* includes extreme acidity. The extreme pH conditions in the *lebak* can still be overgrown with *N. pubescens*, this shows that the *N. pubescens* is a plant that is able to adapt to conditions of extreme acidity of sediments, even seen from the acidity of the water media in the *lebak*, the acidity reaches 8.4 but *N. pubescens* can still grow well. According to (Shen-Miller et al., 2002) cit. (Orozco-Obando et al., 2005) *N. pubescens* can thrive despite alkaline conditions even according to Les, (2018) *N. pubescens* can grow up to pH 9. Nevertheless, according to Kai et al., (2012) under alkaline conditions with a pH above 7, could cause the iron, manganese, copper, zinc, and boron ions less available to plants.

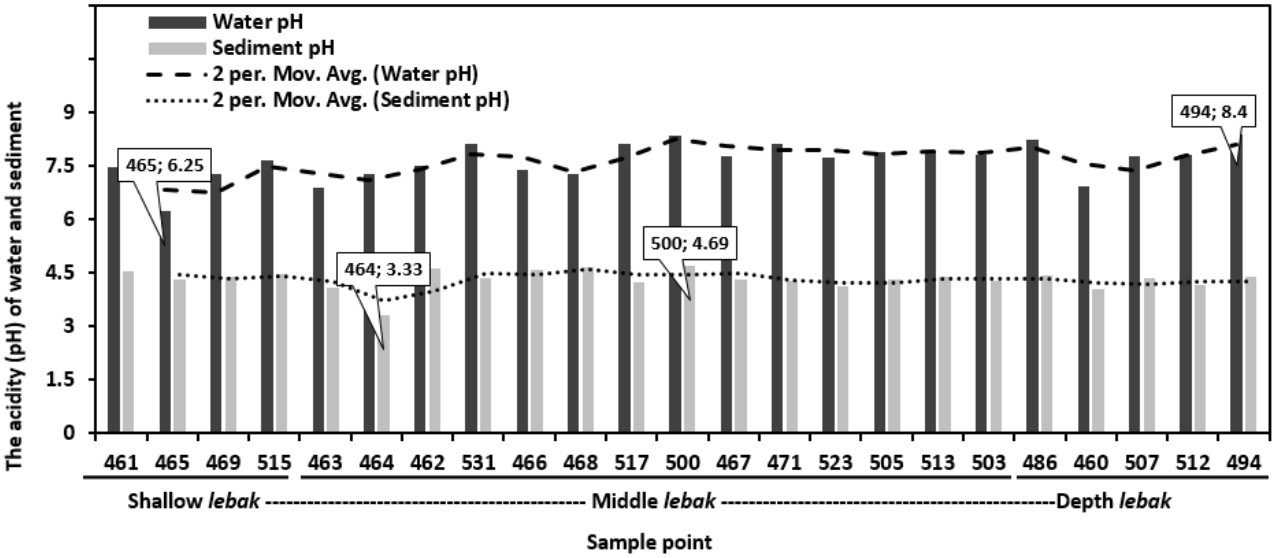

Figure 5. Acidity of Water and Soil in *Lebak*, Teluk Sinar Village, Sungai Pandan District, Hulu Sungai Utara Regency

4. Conclusions

The highest population of N. pubescens is in the middle lebak swampland, which is about 60.87% dominating all parts of the swampland. Nymphaea pubescens plants can grow optimally at a water depth level of 50–100 cm with an average depth of high light penetration, that is, up to the bottom of the swamp. The nature of the plant N. pubescens is a plant that has a high adaptability. The middle lebak with a neutral to slightly alkaline water pH (pH 6.91–8.37) and an extremely acidic to acidic sediment pH (pH 3.33–4.66) N. pubescens is able to adapt and grow optimally.

References

Aliyu, M., Kano, M. A., Abdullahi, N., Kankara, I. A., Ibrahim, S. I., & Muhammad, Y. Y. (2017). Extraction, characterization and fatty acids profiles of Nymphaea Lotus and Nymphaea Pubescens seed oils. Biosciences Biotechnology Research Asia, 14(4), 1299–1307.

Alwi, M., & Hairani, A. (2007). Karakteristik kimia lahan gambut dangkal dan potensinya untuk pertanaman cabai dan tomat. Jurnal Agronomi Indonesia (Indonesian Journal of Agronomy), 35(1).

Biswas, K. R., & Rahmatullah, M. (2011). A survey of non-conventional plants consumed during times of food scarcity in three adjoining villages of Narail and Jessore districts, Bangladesh. American-Eurasian Journal of Sustainable Agriculture, 5(1), 1–5.

Bodhipadma, K., Noichinda, S., Wachirabongkoth, P., Pukpoomin, E., Punnakanta, L., & Nathalang, K. (2011). Nymphaea nouchali var. versicolor 'Bua Phuean': Seed Morphology and Germination In Vitro. Environment and Natural Resources Journal, 9(2), 19–25.

Carruthers, T. J. B., Longstaff, B. J., Dennison, W. C., Abal, E. G., & Aioi, K. (2001). Measurement of light penetration in relation to seagrass. Global Seagrass Research Methods, 370–392.

Chambers, P. A. (1987). Light and nutrients in the control of aquatic plant community structure. II. In situ observations. The Journal of Ecology, 621–628.

Fitrial, Y. (2009). Analisis potensi biji dan umbi teratai (Nymphaea pubescens Willd) untuk pangan fungsional prebiotik dan antibakteri Escherichia coli enteropatogenik K1. 1.

Guruge, D. P. G. S. K., Yakandawala, D., & Yakandawala, K. (2016). Confirming the identity of newly recorded Nymphaea rubra Roxb. ex Andrews discerning from Nymphaea pubescens Willd. using morphometrics and molecular sequence analyses. Bangladesh Journal of Plant Taxonomy, 23(2), 107–117.

Ismuhajaroh, B. N., Indradewa, D., Kurniasih, B., & Utami, S. N. H. (2022). Interrelationships of Air Canal Adaptation in the Leaves of Water Lilies and Water Depth of Lebak Swampland in Kalimantan Selatan. Journal of Environmental Management and Tourism, 13(1), 110–197.

Nursyamsi, D., Idris, K., Sabiham, S., Rachim, D. A., & Sofyan, A. (2008). Dominant soil characteristics influencing available potassium on smectitic soils. Indonesian Journal of Agriculture, 1(2), 121–131.

Orozco-Obando, W., Hirsch, G. N., & Wetzstein, H. Y. (2005). Genotypic variation in flower induction and development in Hydrangea macrophylla. HortScience, 40(6), 1695–1698.

Raja, M. K. M. M., Sethiya, N. K., & Mishra, S. H. (2010). A comprehensive review on Nymphaea stellata: A traditionally used bitter. Journal of Advanced Pharmaceutical Technology & Research, 1(3), 311.

Scheffer, M. (1998). Ecology of shallow lakes (Vol. 1). Springer.

Shen-Miller, J., Schopf, J. W., Harbottle, G., Cao, R., Ouyang, S., Zhou, K., Southon, J. R., & Liu, G. (2002). Long-living lotus: germination and soil γ-irradiation of centuries-old fruits, and cultivation, growth, and phenotypic abnormalities of offspring. American Journal of Botany, 89(2), 236–247.

Subagyo, H. (2006). Lahan Rawa Lebak" dalam Didi Ardi S, et al.(eds), Karakteristik dan Pengelolaan Rawa Balai Besar Penelitian dan Pengembangan Sumberdaya Lahan Pertanian, Bogor. Hlm.

Suriadikarta, D. A. (2005). Pengelolaan lahan sulfat masam untuk usaha pertanian. In Jurnal Litbang Pertanian (Vol. 24, Issue 1, pp. 36–45). http://203.190.37.42/publikasi/p3241055.pdf

Sutanto. (1986). Penginderaan jauh.

Suwargana, N., Santo, J., LAPAN, J. L., & Timur, P. (2008). Updating Informasi Spasial Tutupan Lahan Propinsi Kalimantan Selatan Dengan Menggunakan Citra Landsat-7/ETM+. LAPAN, Jalan LAPAN, 70.

Treman, I. W. (2012). Pemanfaatan Penginderaan Jauh Untuk Kajian Densifikasi Rumah Mukim Perkotaan. Media Komunikasi FPIPS, 11(2).