



Citra Landsat 8 on Environmental Spatial Analysis for Determining the Zone of Mangrove Distribution in Langkat District

Nurhasanah^{1*}, A. Hadian Pratama Hamzah¹, Sri Harijati¹

¹ Universitas Terbuka, Indonesia.

Received: May 20, 2023
Revised: July 26, 2023
Accepted: November 25, 2023
Published: November 30, 2023

Corresponding Author:
Nurhasanah
nenganah@ecampus.ut.ac.id

DOI: [10.29303/jppipa.v9i11.3950](https://doi.org/10.29303/jppipa.v9i11.3950)

© 2023 The Authors. This open access article is distributed under a (CC-BY License)



Abstract: Langkat Regency has the largest mangrove forest in North Sumatra. Lubuk Kertang Langkat Village from 2014 to 2018 there has been an increase in the area of mangrove forest by 69.3 Ha. Mangroves 2014-2016. By collecting data on the pattern of mangrove distribution zones in the mangrove area, it will reduce changes in the area of the mangrove area, so that the possibility of distribution of mangroves in the Langkat Regency area is known. Remote sensing using Citra Landsat 8 is part of the way to determine the distribution of mangroves. The purpose of this study was to examine the distribution of mangrove zones in the Langkat area using Citra Landsat 8. The research results found that there were 18 types of mangrove plants in Langkat district, namely *Avicennia marina*, *Nypa fruticans*, *Sonneratia alba*, *Rizophora apiculata*, *Avicennia officinalis*, *Avicennia rumphiana*, *Aegiceras corniculatum*, *Rizophora rumphiana*, *Aegiceras hydrophyliacea*, *Scyphiphora hydrophylicea*, *Avicenniam marina*, *Scyphiphora hydrophyliacea*, *Sonneratia alba*, *Aegiceras corniculatum*, *Lumnitzera littorea*, *Rhizophora apiculata*, *Rhizophora mucronata*. the type of mangrove plant that ranks first is *Rhizophora* where this plant has the highest species density value of all existing mangrove species, which is equal to 900 Ind/400m. *Rhizophora* is a type of mangrove plant that has a fruit length of 1.9 cm, an average of 52 cm, and a fruit weight of 56 gr. The pattern of distribution of mangrove plants in groups is based on the tendency of mangrove species to inhabit their preferred environment.

Keywords: Citra Lansat 8; Mangrove Distribution Zone; Spatial Analysis

Introduction

In coastal places, the transition between land and water has created diverse ecosystems that are highly productive and can provide enormous economic value to humans. As a result of increasing coastal pressure, management problems arise due to use conflicts caused by diverse interests in coastal areas. Remote sensing has long used vegetation indices to track temporal changes related to vegetation (Shahrokhnia & Ahmadi, 2019). Many alternative vegetation indices have been developed in recent years for various purposes (Lasaiba & Saud, 2022).

Landsat satellite data is used to classify land cover using remote sensing. According to the latest data, information collected using remote sensing is considered to be superior to information provided

through government agencies. Satellite data used in remote sensing is probably the most recently recorded data (Gumma et al., 2011).

The use of Landsat 8 satellites to calculate the index value of the number of normalized vegetation differences (NDVI) using infrared calculations (Mancino et al., 2020). Comparing near-infrared (NIR) data, namely by calculating the NDVI and red values. The Normalized Difference Vegetation Index value is NDVI, NIR is Landsat 8 band 5 imagery, and Red is Landsat 8 band 4 imagery (Ali & Pour, 2014). By setting the value of vegetation canopy density using NDVI calculation results, the analytical approach uses Geographic Information Systems (GIS) (Aboelnour & Engel, 2018). The NDVI class is categorized into five categories, namely very dense vegetation, dense vegetation,

How to Cite:

Nurhasanah, Hamzah, A. H. P., & Harijati, S. (2023). Citra Landsat 8 on Environmental Spatial Analysis for Determining the Zone of Mangrove Distribution in Langkat District. *Jurnal Penelitian Pendidikan IPA*, 9(11), 10028–10032. <https://doi.org/10.29303/jppipa.v9i11.3950>

moderately dense vegetation, sparse vegetation, and very sparse vegetation.

Landsat 8 satellite imagery is part of enhancing the image which has many electromagnetic wave channels (Adiri et al., 2020). Visual identification (using Landsat satellite imagery with supervised categorization) can help accurately describe the physical conditions and things in a particular area (Phiri & Morgenroth, 2017). Furthermore, Landsat satellite imagery can be used to identify places that may experience ground motion.

The main characteristics of remote sensing of mangrove plants are: The optical characteristics of chlorophyll absorb the red light spectrum while reflecting the infrared spectrum brightly (Tran et al., 2022). Mangroves contain green leaf material (chlorophyll) and grow near the coast (Castellanos-Basto et al., 2021). Phytoplankton chlorophyll in saltwater can be distinguished from mangrove chlorophyll, and mangrove vegetation can be identified from the surrounding area, the infrared spectrum cannot be absorbed because mangrove chlorophyll has water properties (Rahmadi et al., 2020).

Spatial analysis is a series of calculation procedures and mathematical logical judgments to find possible connections or patterns that (maybe) include geographical aspects stored in digital data with certain geographical boundaries (Adnyana & As-syakur, 2012). Geographical analysis is part of a geographic information system (GIS), which is a system that can analyze geographic and non-spatial problems and their combinations to provide spatial solutions (Prahasta, 2009). This system is intended to facilitate the analysis of disparate geographic information, such as a way to explore data from a geographical viewpoint to increase understanding and insight (Burrough et al., 2015).

The characteristics of Indonesia's coastal areas vary from region to region. Langkat Regency has the largest mangrove forest in North Sumatra, with an area of 11,709.16 Ha in 2010, and there was a shift in the area of mangrove forest from 1980 to 2010 covering an area of 25,816.01 Ha. In 2005, the mangrove forest in Lubuk Kertang Village was badly damaged, resulting in flooding (Restu & Damanik, 2012). According to Rahmadi's research (2020) in Lubuk Kertang Langkat Village from 2014 to 2018 there has been an increase in the area of mangrove forests by 69.3 Ha. Mangrove 2014-2016 (Rahmadi et al., 2020).

By collecting data on the pattern of mangrove distribution zones in the mangrove area, it will reduce changes in the area of the mangrove area, so that the possibility of distribution of mangroves in the Langkat Regency area is known. Remote sensing using Landsat 8 imagery is part of the way to determine the distribution of mangroves (Chuvieco, 2020). Remote sensing is a

technique for identifying, obtaining, and analyzing objects by utilizing sensors at research sites. The purpose of this research is to examine the distribution of mangrove zones in the Langkat area using Landsat 8 imagery.

Method

The location of this research was conducted in Langkat Regency. The satellite used is Landsat 8 imagery acquired in 2015 and adjusted geometrically and radiometrically. The variables of this study include the area, distribution, and density of mangrove forests in Langkat Regency. The tools and materials used in this research are maps of mangrove forest research locations; Landsat 8 image data; GPS, meter, camera, stationary, boat and pen. The software used in digital mapping to make maps of its distribution area include Ermapper 6.4, ArcGIS 10, and ENVI 4.6 software.

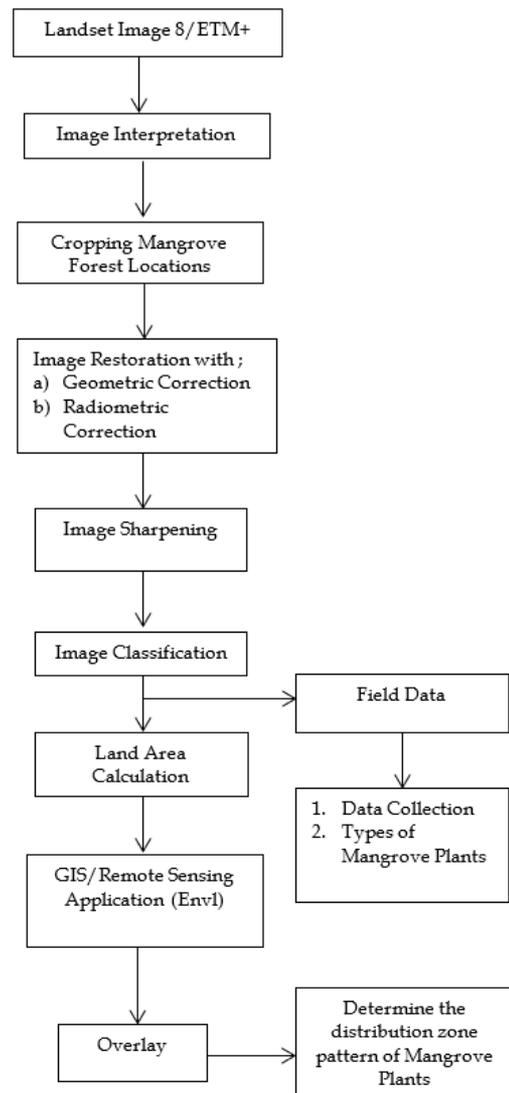


Figure 1. Landsat 8 Image Flow Diagram

Result and Discussion

Mangroves survive in locations with steep slopes, big waves, and strong currents because they prevent the deposition of silt, which is necessary for life and growth. Mangroves are dicot plants that thrive in brackish water environments. Mangrove environments are often found where river mouths meet the ocean. This site was later designated as land protection against large sea waves. The global mangrove area is estimated at 15,429,000 hectares, with 25% covering the coastlines of the Caribbean islands and 75% covering other coastal areas such as South America and Asia. According to a 1999 estimate, the area of mangrove forests in Indonesia was around 8.60 million hectares, of which 5.30 million hectares were damaged.

The most common types of mangroves found in Indonesia include api-api mangroves (*Avicennia* sp.), (*Rhizophora* sp.), tancang (*Bruguiera* sp.), and bogem or pedada (*Sonneratia* sp.). One example of the Langkat district is Lubuk Kertang. Lubuk Kertang is the coastal village of Brandan Barat, Langkat Regency. It is the largest village among other villages and sub-districts, with an area of 34% of the total area of the sub-district, which is 3,026 Ha. In 2010, the mangrove forest area was 1200 Ha. With good forest conditions around 235 Ha (19.58%), moderate conditions around 225 Ha (18.75%) (Hafni, 2016).

From the observations made by researchers, there were about 18 species of mangrove vegetation including *Avicennia marina*, *Nypa fruticans*, *Sonneratia alba*, *Rizophora apiculata*, *Avicennia rumphiana*, *Scyphiphora hydrophyliacea*, *Lumnitzera littorea*, *Aegiceras corniculatum*, *Avicennia officinalis*, *Rizophora rumphiana*, *Aegiceras hydrophyliacea*, *Scyphiphora hydrophyliacea*, *Sonneratia alba*, *Aegiceras corniculatum*, *Rhizophora apiculata*, *Avicenniam marina*, *Rhizophora mucronata*.

The form of distribution of spatial analysis is now known with three varieties, namely: random, clustered (clustered or aggregated), and uniform (Cressie, 2015). Random Spatial Distribution does not require unique demands and does not depend on few and limited resources (generalist species) created by homogeneous environmental conditions (Barrachina-Munoz et al., 2019; Schabenberger & Gotway, 2017). Meanwhile, the distribution pattern of groups and uniforms can indicate whether or not there is a limiting variable in the environment that determines the existence of a species population at that location (MacArthur, 1984). If a tree species is known to spread in groups, it can be assumed that individuals from the same tree species will be found in the same location (Irni, 2022).

Remote sensing method (Image Representation) is used to collect information about the area spread across the Pangempang Muara Badak bay (Schott, 2007). First, the image data is cropped because a single scan image data usually covers a large area, but the research area is very limited, so the image data is cropped because the data obtained from the scene is not all of the data used. The cropped image is then used to attempt image recovery using geometric and radiometric corrections (Gao et al., 2017; Shorten & Khoshgoftaar, 2019). The purpose of using Edit Transform Limit is to enhance the original data obtained from the uneven surface of the earth, as well as to improve the visual quality and correct each pixel value in the processing process (Sheikh & Bovik, 2006). The image is then sharpened using the Contrast Enhancement technique at 99% or by combining the three Green, Blue, and Red bands in the Edit Transform Limit tool (Somvanshi et al., 2018). From the results of the analysis found mangrove plant species at 3 coordinate points, namely in Table 1.

Table 1. Types of Mangrove Plants

Coordinate Point	Type of Mangrove	
0:13:6:17S_117:25:7:55E	<i>Avicennia marina</i>	
	<i>Nypa fruticans</i>	
	<i>Sonneratia alba</i>	
	<i>Avicennia rumphiana</i>	
	<i>Lumnitzera littorea</i>	
	<i>Avicennia officinalis</i>	
	<i>Avicennia officinalis</i>	
	<i>Rizophora apiculata</i>	
	<i>Avicenniam marina</i>	
	<i>Avicennia rumphiana</i>	
	<i>Scyphiphora hydrophyliacea</i>	
	0:12:40:46S_117:26:1:52E	<i>Aegiceras corniculatum</i>
		<i>Lumnitzera littorea</i>
<i>Rizophora apiculata</i>		
<i>Scyphiphora hydrophyliacea</i>		
<i>Rizophora rumphiana</i>		
<i>Aegiceras hydrophyliacea</i>		
<i>Avicennia marina</i>		
<i>Avicennia officinalis</i>		
0:12:31:99S_117:25:57:16E	<i>Scyphiphora hydrophyliacea</i>	
	<i>Avicennia marina</i>	
	<i>Rizophora apiculata</i>	
	<i>Lumnitzera littorea</i>	
	<i>Avicennia officinalis</i>	
	<i>Nypa fruticans</i>	
<i>Nypa fruticans</i>		

From the data above, the type of mangrove plant that ranks first is *Rhizophora* where this plant has the highest species density value of all existing mangrove species, which is equal to 900 Ind/400m. *Rhizophora* is a type of mangrove plant that has a fruit length of 1.9 cm, an average of 52 cm, and a fruit weight of 56 gr (Matatula

et al., 2021). This mangrove variety contains bioactive substances such as triperthenoids, flavonoids, tannins, saponins, and steroids, as well as hydroquinone phenolic compounds, which can be obtained from mangrove fruit extracts (Purwaningsih et al., 2013). Mangroves grow on the shoreline and are most commonly seen near estuary-river boundaries. This mangrove plant has the characteristics of living in groups, has large roots, and produces fruit (Victório et al., 2020).

Conclusion

There are 18 types of mangrove plants in Langkat district, namely *Avicennia marina*, *Nypa fruticans*, *Sonneratia alba*, *Rizophora apiculata*, *Avicennia officinalis*, *Avicennia rumphiana*, *Aegiceras corniculatum*, *Rizophora rumphiana*, *Aegiceras hydrophyliacea*, *Scyphiphora hydrophyliacea*, *Avicenniam marina*, *Scyphiphora hydrophyliacea*, *Sonneratia alba*, *Aegiceras corniculatum*, *Lumnitzera littorea*, *Rhizophora apiculata*, *Rhizophora mucronata*. The pattern of distribution of mangrove plants in groups is based on the tendency of mangrove species to inhabit their preferred environment.

Acknowledgments

We would like to express our gratitude to all of people who has contribution to this research.

Author Contributions

This article has been written by three authors namely N, A.H.P.H, and S.H were cooperative every stage.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

References

- Aboelnour, M., & Engel, B. A. (2018). Application of remote sensing techniques and geographic information systems to analyze land surface temperature in response to land use/land cover change in Greater Cairo Region, Egypt. *Journal of Geographic Information System*, 10(1), 57-88. <https://doi.org/10.4236/jgis.2018.101003>
- Adiri, Z., Lhissou, R., El Harti, A., Jellouli, A., & Chakouri, M. (2020). Recent advances in the use of public domain satellite imagery for mineral exploration: A review of Landsat-8 and Sentinel-2 applications. *Ore Geology Reviews*, 117, 103332. <https://doi.org/10.1016/j.oregeorev.2020.103332>
- Adnyana, I. W. S., & As-syakur, A. R. (2012). Aplikasi Sistem Informasi Geografi Berbasis Data Raster Untuk Pengkelasan Kemampuan Lahan Di Provinsi Bali Dengan Metode Nilai Pikel Pembada (Application of Geographic Information System (Gis) Based Raster Data to Classify Land Capability in Bali). *Jurnal Manusia Dan Lingkungan*, 19(1), 21-29. <https://doi.org/10.22146/jml.18448>
- Ali, A. S. O., & Pour, A. B. (2014). Lithological mapping and hydrothermal alteration using Landsat 8 data: a case study in ariab mining district, red sea hills, Sudan. *International Journal of Basic and Applied Sciences*, 3(3), 199. <https://doi.org/10.14419/ijbas.v3i3.2821>
- Barrachina-Munoz, S., Wilhelmi, F., & Bellalta, B. (2019). Dynamic channel bonding in spatially distributed high-density WLANs. *IEEE Transactions on Mobile Computing*, 19(4), 821-835. <https://doi.org/10.1109/TMC.2019.2899835>
- Burrough, P. A., McDonnell, R. A., & Lloyd, C. D. (2015). *Principles of geographical information systems*. Oxford University Press, USA.
- Castellanos-Basto, B., Herrera-Silveira, J., Bataller, É., & Rioja-Nieto, R. (2021). Local Drivers Associated to Temporal Spectral Response of Chlorophyll-a in Mangrove Leaves. *Sustainability*, 13(9), 4636. <https://doi.org/10.3390/su13094636>
- Chuvieco, E. (2020). *Fundamentals of satellite remote sensing: An environmental approach*. CRC press.
- Cressie, N. (2015). *Statistics for spatial data*. John Wiley & Sons.
- Gao, F., Anderson, M. C., Zhang, X., Yang, Z., Alfieri, J. G., Kustas, W. P., Mueller, R., Johnson, D. M., & Prueger, J. H. (2017). Toward mapping crop progress at field scales through fusion of Landsat and MODIS imagery. *Remote Sensing of Environment*, 188, 9-25. <https://doi.org/10.1016/j.rse.2016.11.004>
- Gumma, M. K., Thenkabail, P. S., Hideto, F., Nelson, A., Dheeravath, V., Busia, D., & Rala, A. (2011). Mapping irrigated areas of Ghana using fusion of 30 m and 250 m resolution remotesensing data. *Remote Sensing*, 3, 816-835. <https://doi.org/10.3390/rs3040816>
- Hafni, R. (2016). *Analisis Dampak Rehabilitasi Hutan Mangrove Terhadap Pendapatan Masyarakat Desa Lubuk Kertang Kabupaten Langkat, Sumatera Utara*. Universitas Muhammadiyah. Retrieved from <https://core.ac.uk/download/pdf/290536391.pdf>
- Irni, J. (2022). Analisis Pola Sebaran Spasial Beberapa Jenis Pohon di Hutan Penelitian Darmaga. *Jurnal Agroindustri, Agribisnis, Dan Agroteknologi*, 1(1), 18-27. Retrieved from <https://akses.ptki.ac.id/jurnal/index.php/agrotritek/article/view/18>
- Lasaiba, M. A., & Saud, A. W. (2022). Pemanfaatan Citra

- Landsat 8 Oli/Tirs Untuk Identifikasi Kerapatan Vegetasi Menggunakan Metode Normalized Difference Vegetation Index (Ndvi) Di Kota Ambon. *JURNAL GEOGRAFI: Geografi Dan Pengajarannya*, 20(1), 53-65. <https://doi.org/10.26740/jggp.v20n1.p53-65>
- MacArthur, R. H. (1984). *Geographical ecology: patterns in the distribution of species*. Princeton University Press.
- Mancino, G., Ferrara, A., Padula, A., & Nolè, A. (2020). Cross-comparison between Landsat 8 (OLI) and Landsat 7 (ETM+) derived vegetation indices in a Mediterranean environment. *Remote Sensing*, 12(2), 291. <https://doi.org/10.3390/rs12020291>
- Matatula, J., Afandi, A. Y., & Wirabuana, P. (2021). A comparison of stand structure, species diversity and aboveground biomass between natural and planted mangroves in Sikka, East Nusa Tenggara, Indonesia. *Biodiversitas Journal of Biological Diversity*, 22(3). <https://doi.org/10.13057/biodiv/d220303>
- Phiri, D., & Morgenroth, J. (2017). Developments in Landsat land cover classification methods: A review. *Remote Sensing*, 9(9), 967. <https://doi.org/10.3390/rs9090967>
- Prahasta, E. (2009). *Sistem Informasi Geografis: Konsep-Konsep Dasar (Perspektif Geodesi & Geomatika)*. Bandung: Informatika.
- Purwaningsih, S., Salamah, E., Yudha, A., Sukarno, P., & Deskawati, E. (2013). Aktivitas antioksidan dari buah mangrove (*Rhizophora mucronata* Lamk.) pada suhu yang berbeda. *Jurnal Pengolahan Hasil Perikanan Indonesia*, 16, 3. <https://doi.org/10.17844/jphpi.v16i3.8057>
- Rahmadi, Mt., Suciani, A., & Auliani, N. (2020). Analisis Perubahan Luasan Hutan Mangrove Menggunakan Citra Landsat 8 OLI di Desa Lubuk Kertang Langkat. *Media Komunikasi Geografi*, 21(2). <https://doi.org/10.23887/mkg.v21i2.24197>
- Restu, R., & Damanik, M. R. S. (2012). Kajian Perubahan Tutupan Mangrove Menggunakan Citra Landsat TM Di Kabupaten Langkat Propinsi Sumatera Utara. *Jurnal Geografi*, 4(2), 69-78. <https://doi.org/10.24114/jg.v4i2.8069>
- Schabenberger, O., & Gotway, C. A. (2017). *Statistical methods for spatial data analysis*. CRC press.
- Schott, J. R. (2007). *Remote sensing: the image chain approach*. Oxford University Press.
- Shahrokhnia, M. H., & Ahmadi, S. H. (2019). Remotely sensed spatial and temporal variations of vegetation indices subjected to rainfall amount and distribution properties. In *Spatial Modeling in GIS and R for Earth and Environmental Sciences*, 21-53. <https://doi.org/10.1016/B978-0-12-815226-3.00002-8>
- Sheikh, H. R., & Bovik, A. C. (2006). Image information and visual quality. *IEEE Transactions on Image Processing*, 15(2), 430-444. Retrieved from <https://ieeexplore.ieee.org/abstract/document/1576816/>
- Shorten, C., & Khoshgoftaar, T. M. (2019). A survey on image data augmentation for deep learning. *Journal of Big Data*, 6(1), 1-48. <https://doi.org/10.1186/s40537-019-0197-0>
- Somvanshi, S. S., Kunwar, P., Tomar, S., & Singh, M. (2018). Comparative statistical analysis of the quality of image enhancement techniques. *International Journal of Image and Data Fusion*, 9(2), 131-151. <https://doi.org/10.1080/19479832.2017.1355336>
- Tran, T. V., Reef, R., & Zhu, X. (2022). A review of spectral indices for mangrove remote sensing. *Remote Sensing*, 14(19), 4868. <https://doi.org/10.3390/rs14194868>
- Victório, C. P., Dos Santos, M. S., de Mello, M. C., Bento, J. P. S. P., da Costa Souza, M., Simas, N. K., & do Carmo de Oliveira Arruda, R. (2020). The presence of heavy metals in *Avicennia schaueriana* Stapf & Leechman ex Moldenke leaf and epicuticular wax from different mangroves around Sepetiba Bay, Rio de Janeiro, Brazil. *Environmental Science and Pollution Research*, 27, 23714-23729. <https://doi.org/10.1007/s11356-020-08606-6>