WATER BODIES DELINEATION AND CHANGE DETECTION USING GIS AND REMOTE SENSING: A CASE STUDY IN PASIR PUTEH, KELANTAN

by

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A report submitted in fulfillment of the requirements for the degree of Bachelor of Applied Science (Natural Resource Science) with Honours

FACULTY OF EARTH SCIENCE
UNIVERSITI MALAYSIA KELANTAN

2024

DECLARATION

I declare thesis entitled "Water Bodies Delineation And Change Detection Using GIS And Remote Sensing: A Case Study In Pasir Puteh, Kelantan" is the result of my own research except as cited in the references. The thesis has not concurrently submitted in candidature of any degree.

Signature : ………………………….

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Date :2 August 2024

ACKNOWLEDGEMENT

In the efforts of completing this thesis, it would not possible without the guidance and the help from several individuals and parties who in a way or another had contributed their valuable times and idea. It is great pleasure to address people who help me throughout this project to echanced my knowledge and practical. Sincerely thanks to my supervisor, Gs.Ts. Dr. Shaparas binti Daliman for her timely advice and help for their invaluable guidance, encouragement, and support throughout this project. Their expertise and insightful feedback have been instrumental in shaping the direction and focus of my research.

Finally, my gratitude also be extended to my heartfelt thanks go to my family and friends for their unwavering encouragement, understanding, and patience during the course of this project. Their moral support has been a constant source of motivation.

Water Bodies Delineation and Change Detection Using GIS And Remote Sensing: A Case Study In Pasir Puteh, Kelantan

ABSTRACT

Water bodies are vital to the survival of ecosystems and human livelihoods, hence it is imperative to accurately delineate and monitor them in order to manage resources effectively. This study uses remote sensing and geographic information systems (GIS) to identify water bodies and track changes over time in Pasir Puteh, Kelantan. A thorough examination of the dynamics of water bodies is made possible by the combination of Landsat satellite imagery spanning several years.Water bodies are first identified by applying image classification techniques that are verified against high-resolution imagery and ground truth data. Change detection analysis then finds differences in the form and extent of water bodies between the baseline year and the years that follow. The results offer significant perspectives to local government officials and interested parties concerning the management of water resources, supporting the design of sustainable development and environmental preservation initiatives. This study emphasises how crucial GIS and remote sensing technologies are to improving spatial analysis skills for managing water resources in changing terrain such as Pasir Puteh, Kelantan. The overall area of water bodies decreased by about 1.27%, from 10.5498 km² in 2014 to 9.2349 km² in 2023, according to the results. This decrease is a reflection of both possible effects on nearby water resources and continuous environmental changes.

Pengenalpastian dan Pengesanan Perubahan Badan Air Menggunakan GIS dan Penderiaan Jauh: Kajian Kes Di Pasir Puteh, Kelantan

ABSTRAK

Badan air memainkan peranan penting dalam kelangsungan ekosistem dan kehidupan manusia, oleh itu, pengenalpastian dan pemantauan yang tepat adalah penting untuk pengurusan sumber yang berkesan. Kajian ini menggunakan penderiaan jauh dan sistem maklumat geografi (GIS) untuk mengenal pasti badan air dan mengesan perubahan dari masa ke masa di Pasir Puteh, Kelantan. Gabungan imej satelit Landsat yang merangkumi beberapa tahun membolehkan pemeriksaan menyeluruh terhadap dinamika badan air. Badan air dikenalpasti dengan menggunakan teknik klasifikasi imej yang disahkan dengan imej resolusi tinggi dan data lapangan. Analisis pengesanan perubahan kemudian mengenal pasti perbezaan dalam bentuk dan keluasan badan air antara tahun asas dan tahun-tahun berikutnya. Hasil kajian memberikan perspektif yang penting kepada pegawai kerajaan tempatan dan pihak berkepentingan mengenai pengurusan sumber air, menyokong perancangan pembangunan lestari dan inisiatif pemuliharaan alam sekitar. Kajian ini menekankan betapa pentingnya teknologi GIS dan penderiaan jauh dalam meningkatkan kemahiran analisis untuk mengurus sumber air dalam keadaan geografi yang berubah seperti di Pasir Puteh, Kelantan. Hasilnya menunjukkan bahawa luas keseluruhan badan air telah berkurang sebanyak kira-kira 1.27%, daripada 10.5498 km^2 pada tahun 2014 kepada 9.2349 km^2 pada tahun 2023. Penurunan ini mencerminkan kemungkinan kesan terhadap sumber air berhampiran serta perubahan persekitaran yang berterusan.

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LIST OF ABBREVIATION

GIS	Geographical Information System
IFOV	Field of vision
MSS	Multi Spectral Scanner
NDWI	Normalized Difference Water Index
NIR	Near-Infrared
OLI	Operational Land Imager
SWIR	Shortwave Infrared
TM	Thematic Mapper
USGS	United States Geological Survey

LIST OF SYMBOLS

km^2	Square kilometer
%	Percentage
^{o}	Degree

CHAPTER 1

INTRODUCTION

1.1 Background of Study

The most prevalent land type is water area, which is increases the area's ability to cool down because of the high population density, increases heat stress, fluctuating temperatures and lack of green space caused by urban and industrial growth. However, the research area's thermal dissimilarity and heat balance were reduced by water body. For the purpose of identifying the water area of various satellite images, such as Landsat data, remote sensing techniques are commonly utilized (Halder & Bandyopadhyay, 2022). The main source of water for residential consumption, irrigation, and industrial growth is surface waterways. Many land-based activities are supported by the coastal and deltaic region yet, extensive activities have the potential to harm the coastal ecosystems. Thus, one of the most important components of any region's sustainable development is by monitoring of water bodies.

One of the most popular methods for mapping and keeping an eye on the water bodies in any given area is spatial technology. Lakes are valuable water resources, therefore protecting them is essential to maintaining water security and the benefits they provide to the environment and the economy. Lake areas and their water quality status can be a significant indicator of the state of the world environment and the effects of climate change. Hence anthropogenic, or natural processes are to blame for the decrease of lakes' water surface areas (Deoli et al.,2022).

Compared to the old manual procedures, surface water mapping is now considerably simpler and takes less time thanks to remote sensing technologies. Since digital image processing techniques can be used to extract, process, and analyse a wealth of information from images taken by airborne sensors or remote sensing satellites, numerous straightforward and effective water mapping approaches have been proposed and developed over time. Multi-spectral and hyperspectral images are the two main categories for remote sensing images. Hyperspectral photos will have more small bands than multispectral images, which typically consist of fewer larger bands (three to ten bands). Combining digital imagery with spectroscopy, multi-spectral imaging generates an image as a function of wavelength (Bijeesh & Narasimhamurthy, 2020).

1.2 Problem Statement

The environmental conservation which is ecosystems are in grave danger of losing their delicate balance due to unsustainable water management methods and rapid environmental degradation. The health of water bodies and biodiversity are under risk due to the increasing demand for water resources, pollution, the effects of climate change, and insufficient conservation efforts. Sustainable resource management faces a myriad of challenges, including increasing demand, climate change impacts, and inadequate governance structures. The escalating pressure on water resources from population growth threatens the delicate balance required for long-term sustainability. Community well-being which the decreasing water can causes a short water for community surround the area.

1.3 Objective

I. To delineate water bodies in Pasir Puteh, Kelantan using remote sensing and GIS.

II. To quantify the water bodies changes for year 2014 and 2023 in Pasir Puteh, Kelantan.

1.4 Scope of Study

The scope for this study is in in Kelantan, Malaysia, there is a district called Pasir Puteh District .Situated around 30 kilometres south of Kota Bharu, on the banks of the Semerak River, is the settlement of Pasir Puteh. The southeast of Pasir Puteh district is Besut District, Terengganu that latitude 5.8333° N and longitude 102.4167° E.. This study is using Landsat 8 to get the changes imagery of water bodies for 2014 and 2023 in Pasir Puteh, Kelantan. The temperatures of Pasir Puteh, which range from 24°C to 32°C, are tropical with significant humidity. Monsoon season from November to March, the northeast monsoon, which brings with it a lot of rain, affects the district.

1.5 Significant of Study

Data on water bodies is essential for sustainable development, well-informed decision-making, and the general welfare of a state's citizens. It assists governments with planning for the wise use of this essential resource, addressing environmental issues, and guaranteeing water security. Since water bodies have an immediate impact on people's health, economics, ecology, and general quality of life, information about them is crucial for communities. The identification and preservation of aquatic and semi-aquatic species' habitats is aided by the precise demarcation of water bodies. Maintaining the region's ecological balance can be made easier with an understanding of changes in water bodies.

CHAPTER 2

LITERATURE REVIEW

2.1 Water Bodies

Monitoring surface water bodies with GIS is not a new concept. It was used a long time ago in Malaysia and other nations. Keeping spatially referenced data organized into layers is the goal of GIS. As output data, these many data layers can be edited and seen visually. However, the quality of the incoming data determines how helpful the output data. Areas of land covered in water that show both seasonal and perennial variability are known as wetlands. Numerous plant and animal species that are acclimated to seasonal variations in water levels find home in wetlands. It provides food, energy, clean drinking water, and climate stabilization, among other necessities for human habitation (Ramaraju&Mittapalli,2014). Accurately identifying and separating water bodies from their surroundings is a crucial component for many scientific applications in agriculture and hydrology. The traditional methods, which entail visiting the site in person and using survey techniques, are time-consuming and difficult to execute. Remotely sensed data, particularly Landsat data, can be used to successfully delineate water borders over a large area at a specific moment in time. Knowing the spectral band and classification technique to utilise for the optimal hydrological categorization, in addition to knowing how to use Landsat's several bands, is essential.

2.2 Importance of Water Bodies

Numerous benefits that directly and indirectly impact human health and well-being are provided by the biodiversity of water bodies. Aquatic ecosystems provide humans with access to resources like food, drink, and building materials. They also provide spaces for leisure, tourism, and commercial fishing. The aquatic life and the ecological roles it play in ensuring human survival are another major benefit of water bodies. Everyday nutrients, and dangerous pollutants that we dump into our rivers and streams or flush down the toilet are broken down by aquatic organisms (fungi and bacteria). In addition to preventing flooding, blue spaces also trap pollutants and sediments, hold onto nutrients, and preserve biodiversity, all of which are crucial for the ecosystem's ability to operate. A body of water also acts as a barrier against the spread of disease, generates employment in tourist-heavy areas, and serves as a source of medication (Ogoyi, 2022).

Water is important for supply both humans and animals can obtain drinking water from bodies of water. They also supply water, which is necessary for irrigation in agriculture. Water can provide food production that is variety of fish and other aquatic species can be found in water bodies, which provide food for people. Additionally, they aid in the growth of plants like algae that fish and other animals eat. Water is also important for transportation of people and products that can be transported by waterways. Since ancient times, people have utilized rivers and canals to move cargo, and now they play a significant role in the world's transportation system (Raj, 2023).

2.3 Remote Sensing and GIS to Detect Water Bodies Delineation and Changes

Researchers can now extract information from remote sensing images that would otherwise be obscured because to developments in digital image processing techniques. To detect and map surface water with comparatively less expense, time, and effort, a number of techniques and algorithms based on digital image processing on remote sensing data have been developed over the past few years. Since no technique or algorithm has been shown to be effective for all data sets and all circumstances, surface water mapping is still an ongoing research topic (Bijeesh & Narasimhamurthy, 2020). For several reasons, including the assessment of water resources and the development of wetland inventories, precise information about the geographic spread of the water bodies is crucial. This is difficult to get using traditional survey approaches because of the unpredictability and instability of some water bodies as well as their potential for fast movement due to floods, tides, and storm surges. Remote sensing data provides a means of identifying different water borders that are present over a large area at a given time.

Rapidly changing hydrological quality data must either have a high temporal resolution or be a part of a big archive covering a variety of hydrological conditions. Over a long period of time typically more than 25 years high resolution geographic data is provided at various intervals by Thematic Mapper (TM) and Landsat MSS (Multi spectral scanner). The data are especially helpful for mapping water bodies at a regional scale under a variety of various hydrological circumstances because of the extended period and repeated capture at intervals. Researchers compare the categorization and the raw data to assess accuracy. A formal accuracy assessment approach, involving the development and implementation of statistical accuracy assessment methodologies, has also been employed in several research. Using real ground data obtained from the satellite image, they have two options they can use a random sample technique, or they can compare the amount or size of wetlands (Mishra et al.,2013).

2.4 Integration of GIS and Remote Sensing Data

In a GIS, remote sensing data is easily combined with information from other geocoded sources. This enables practically infinite forms of data processing and the overlapping of many information layers with the remotely sensed data. One way to use the information in a GIS is to help in picture classification. However,the land cover information producedby a categorization may be put to use in later GIS database searches and manipulations. The success of geographic information systems is contingent upon the availability of current and accurate digital geographic data, which is becoming increasingly necessary as their use grows. .It is a need that the user expects to be readily satisfied. The utilisation of satellite images in conjunction with the enhanced processing powers of contemporary image analysis systems has enabled the production of significant data sets that embody novel insights unavailable through earlier technological advancements (Chidambaram, 2010). Any method used to obtain data about a thing, location, or phenomenon without physically being there is known as remote sensing. One great example of a remote sensing device is the eye (Noah Bandelow, 2015).

CHAPTER 3

MATERIAL AND METHOD

3.1 Study Area

This research was carried out in Kelantan that is situated in the north-east of Peninsular Malaysia. Kelantan is located at 5.836 º N, 102.4083° E. One of Kelantan's ten districts, Pasir Puteh is close to the districts of Bachok, Kota Bharu, and Machang. The 433.80 sq km of Pasir Puteh is divided into eight sub-districts. Currently, 81.97 percent of the district's land is used for agriculture, followed by residential (0.4%), industrial (0.3%), business (0.02%), government (2.8%), and forest (14.51%) (Hashim et al., 2019). Figure 3.1 shown the overall of the whole Kelantan that have 10 distract while figure 3.2 shown that zoom in to Pasir Puteh distract where the research was conducted.

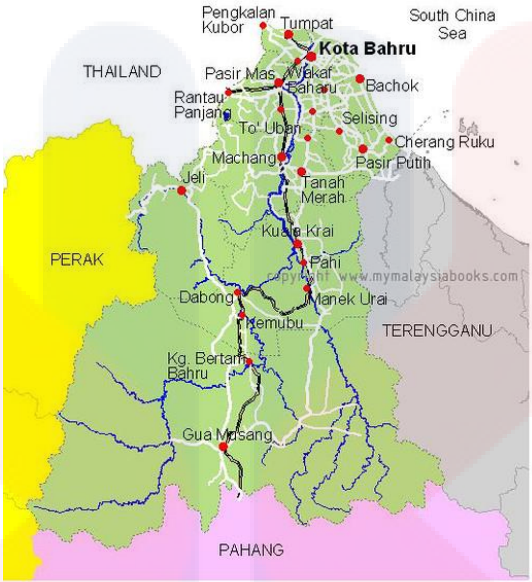

Figure 3.1: Kelantan

Figure 3.2 :Pasir Puteh ,Kelantan

3.2 Material

3.2.1 Landsat 8

Landsat 8 that use Operational Land Imager (OLI) nine bands total (Bands 1–9).30 metres for Bands 1–7 and 15 metres for Band 8 (panchromatic) is the spatial resolution. Visible, Near-Infrared (NIR), and Shortwave Infrared (SWIR) are the three spectrum ranges. The Landsat 8 satellite sensor is a component of the Landsat Data Continuity Mission Launched safely from Space Launch Complex-3 at Vandenberg Air Force Base in California on February 11, 2013. The procedure of obtaining Landsat 8 data is simple, as Landsat imagery is freely and publicly accessible via USGS platform (Roy et al., 2014). Ball Aerospace & Technologies Corporation's Operational Land Imager (OLI) is a tool for measuring in the visible, near-infrared, and short wave infrared regions of the spectrum. With an 185 km (115 mile) wide swath, its photos offer 15-meter (49 ft) panchromatic and 30-meter multi-spectral spatial resolutions,covering a large portion of the Earth's geography while maintaining enough detail to discern features like cities, farms, forests, and other land uses. Landsat 8's near-polar orbit means that once every sixteen days, the entire Earth will be visible. (Landsat NASA,2023).Other than that, satellite image which is to sensing microwave radiation, infrared light, visible light, and more to create high-resolution pictures (Pielke ,2013).

Table 3.1: Information of dataset

Sensor	Data acquistion
Landsat 8 Operational Land Imager (OLI) AND Thermal Infrared Sensor (TIRS)	02 April 2014
Landsat 8 Operational Land Imager (OLI) AND Thermal Infrared Sensor (TIRS)	23 December 2023

Table 3.2: Information of Landsat 8

Landsat 8 OLI and TIRS	Wavelength(Micrometer)
Band 1	0.45-0.52
Band 2	0.52-0.60
Band 3	0.63-0.69
Band 4	0.76-0.90
Band 5	1.55-1.75
Band 6	10.40-12.50
Band 7	2.08-2.35

3.2.2 ArcGIS

ArcGIS also one of the material which is geographic information system (GIS) software, which makes it possible to handle and analyse geographic data via layer-building maps to visualise geographical statistics like trade flows or climate data (Shaktawat, 2020). Software for this material is Remote Sensing, the procedure for identifying and keeping track of an area's physical attributes by measuring its radiation, both emitted and reflected, at a distance usually from a satellite or aeroplane. The science and methods of gathering data on an object, land area, phenomenon, or ecological process using a technology that is not in direct contact with the thing, area, or phenomenon being studied are known as remote sensing (Chawla et al.,2020).

3.2.3 United State Geological Survey (USGS) Earth Explorer

The data of image is provided in United State Geological Survey (USGS) Earth Explorer website. The USGS was established in 1879 with the goal of researching and disseminating trustworthy scientific data regarding the country's ecosystems, landscapes, natural resources, and risks. The United States Geological Survey (USGS), with its proficiency in Geographic Information Systems (GIS) and remote sensing technologies, is essential to the delineation of water bodies and the detection of changes in them. The United States Geological Survey (USGS) delivers high-resolution imagery and multispectral data which are critical for precisely mapping and monitoring water bodies by utilising remote sensing data from satellite missions like Landsat. This information is useful for recognising and defining water bodies, determining their geographic extent, and tracking alterations over time.

3.3 Method

3.3.1 Image Acquisition

Image acquisition of Landsat 8 that from United State Geological Survey (USGS) Earth Explorer.

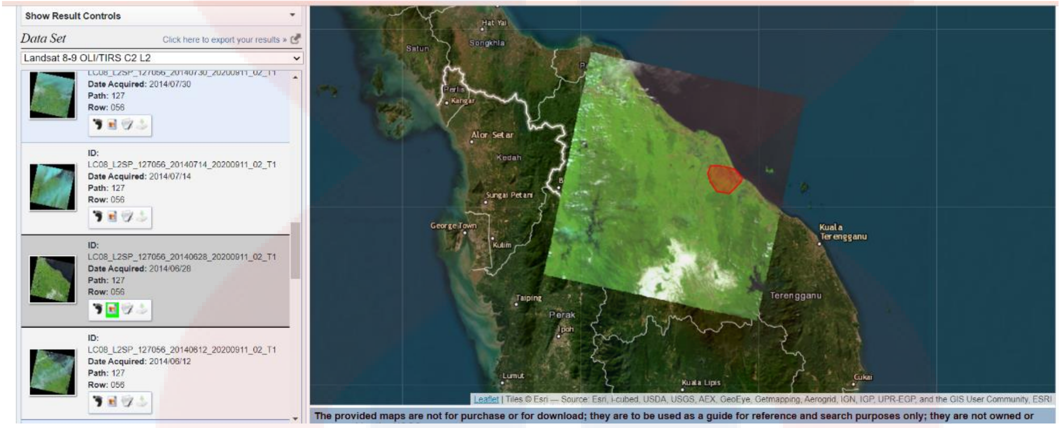

Figure 3.3 The acquisition of Landsat 8 image for 2014

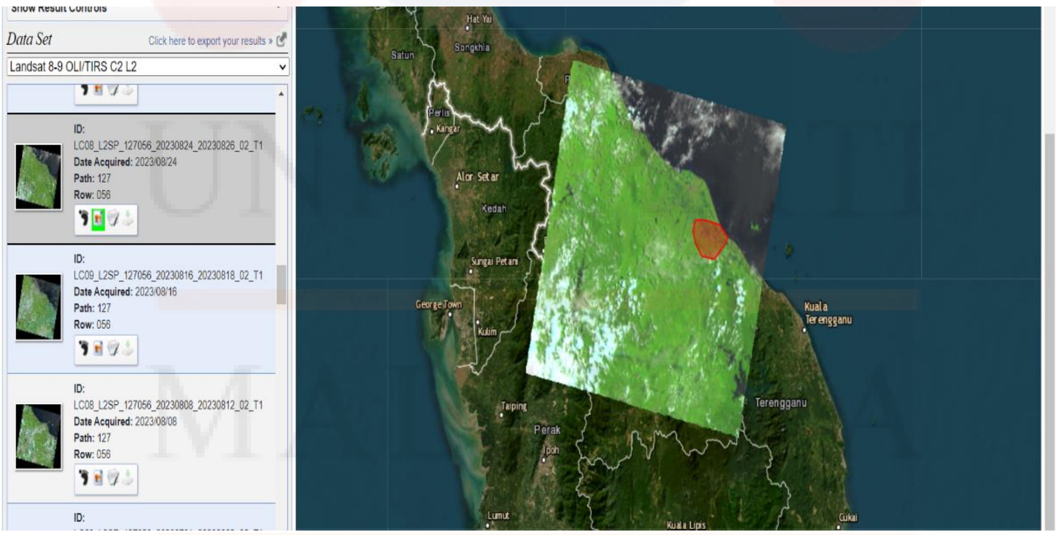

Figure 3.4 :The acquisition of Landsat 8 image for 2023

3.3.2 Image Pre-processing

Next is by pre-processing the image pre-processing techniques, also called image restoration and rectification, aim to rectify data for radiometric and geometric aberrations specific to a sensor or platform. Variations in air conditions, sensor noise and responsiveness, scene illumination and viewing geometry, and other factors may necessitate radiometric corrections. Each of these will change based on the particular sensor, platform, and circumstances that were present when the data was acquired (Canada, 2015). Pre-processing is the clipping between the all the band layer with the shapefile of the Pasir Puteh district.

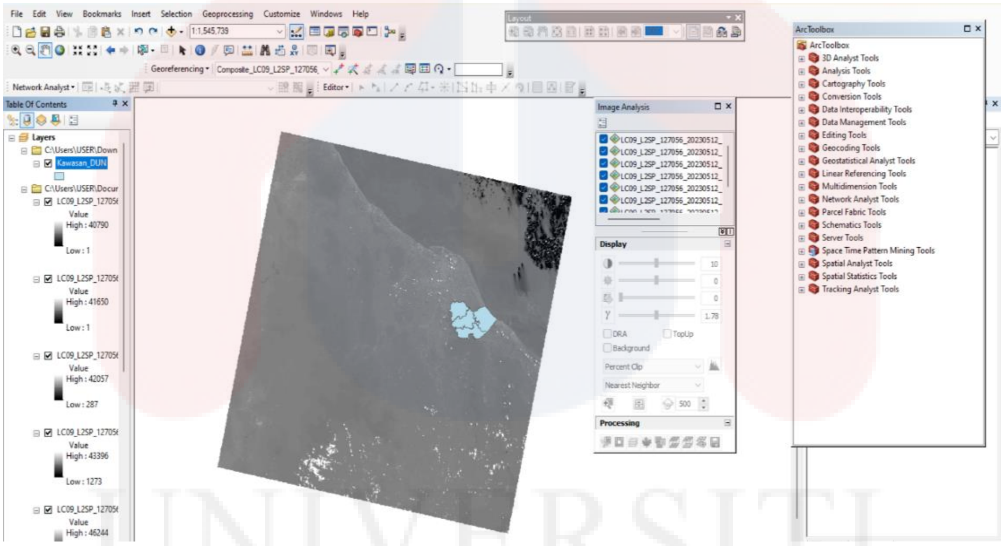

Figure 3.5: Clipping image

3.3.3 Image Processing

The essential field of image processing deals with the analysis and manipulation of images to enable a variety of applications, improve image quality, and extract relevant information. It includes a variety of methods for enhancing image quality, removing distortions, and finding features in images. Acquiring photos from satellites or aerial platforms is the first step in this procedure. To assure accuracy, preprocessing measures including geometric and radiometric corrections are next performed. To draw attention to characteristics and objects of interest, methods like segmentation, edge detection, and picture enhancement are used. Both supervised and unsupervised classification algorithms are used to group image pixels into distinct classes,and change detection techniques examine temporal variations to spot changes in the environment or in land use (Weijie Zhou,2021).

3.3.4 Composite Band

Composite band using 3 different band to see the merge of land and water that band 5, band 6 and band 4. There are several factors considered when choosing band combinations, and knowing the spectrum reflectance profiles of the features you want to investigate will help. For instance, healthy vegetation appears bright red in the NIR false colour composite above because it reflects more near infrared light than green. The shortwave infrared (shown as red), near infrared (represented as green), and green visible band (represented as blue) are used in a popular combination. The flora appears brilliant green, the bare ground appears reddish, and the snow appears bright blue in this fake colour composite. While there are countless ways to combine wavelength bands, the table on the left includes a selection of several that are frequently utilised. Band numbers are used to list the band combinations in the following order red, green,blue (RGB).

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3.3.5 Normalised Difference Water Index (NDWI)

The analyse the data by using a multiband raster object's Normalised Difference Water Index (NDWI) and yields a raster object containing the index values. Surface water content variations can be identified and tracked using the Normalised Difference Water Index (NDWI) approach. Green and NIR bands are used to compute it $\frac{band\ 3 - band\ 5}{band\ 3 + band\ 5}$ (Gao, 1996). Currently, the United States Geological Survey's EROS Data Centre oversees the Landsat remote sensing satellite system. There are two multispectral sensors on Landsat. The first is the multi-spectral scanner (MSS), which gathers data in the near-infrared, green, red, and blue spectral regions.

The addition of a co-registered 15 m panchromatic band is intended to continue the thematic mapper images with Landsat 8 (Noah Bandelow,2015). Digital image processing with four basic operations processing digital images using four fundamental techniques image restoration,image enhancement,image classification, and image transformation. The goal of image restoration is to achieve the most accurate representation of the earth's surface through image correction and calibration, which is a crucial factor in any application.

The main focus of image enhancement is on altering photographs to best suit their visual appeal. An essential function of GIS is image categorization, which is the computer-assisted interpretation of photographs. Image transformation is the process of creating new imagery by applying a mathematical technique on the original image bands (Noah Bandelow, 2015). The last one is getting the result which is clear image and get the result of the image.

$$NDWI = \frac{Band\ 3 - Band\ 5}{Band\ 3 + Band\ 5} \tag{3.1}$$

One of two liquid water-related remote sensing-derived indices, the Normalised Difference Water Index (NDWI), can be used to track variations in the water content of leaves or aquatic bodies.

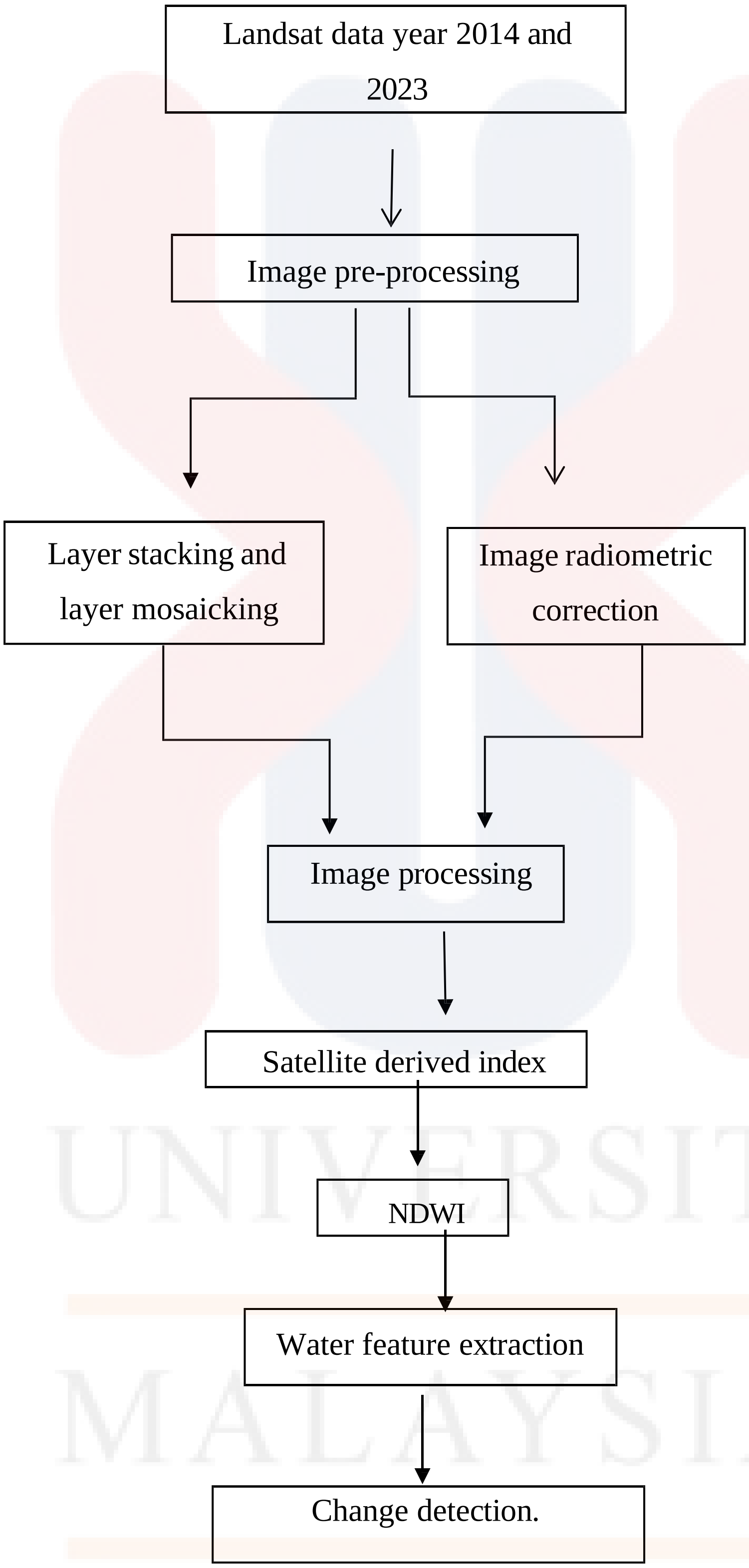


Figure: 3.6 Research Flow

CHAPTER 4

RESULT AND DISCUSSION

4.1 Composite Band

Surface water extraction, the nearby bodies of water at Pasir Puteh, Kelantan, were chosen based on Landsat 8 OLI images. Various colour mixtures were investigated in order to interpret remotely sensed images, as seen in Figure 4.1. Red, green, and blue bands that are visible in the visible spectrum combine to form the natural or true colour composite. Based on the figure 4.1 both composite band map using band 5,6 and 4 to detect the different between land and water. Band 5 is for near infrared, this shown for healthy vegetation, NIR wavelengths are extremely reflective. Because it reflects so much NIR light, vegetation frequently appears brilliant on the composite map. Water bodies seem darker because it absorbs NIR radiation. While band 6 is shortwave infrared Stress on vegetation and moisture content are detectable at SWIR wavelengths.

Healthy vegetation is shown on the composite map as dark red, while sparse or nonexistent vegetation is shown as light. Same as band 5 it's also effect the color of water bodies that seem black because it absorbs SWIR radiation. Band 4 is red that plants' absorption of chlorophyll can be detected by the red band. The vegetation in the composite image is represented by red hues, with healthy vegetation standing out as vivid red. Red light is absorbed by water, also make water bodies look black. When these three bands are combined into a single composite image, distinct patterns emerge that allow for identification of land and water features that displayed the map in figure 4.1. By this map shown that water bodies absorb both NIR and SWIR radiation, which causes them to appear dark in the composite image. The non-water bodies appears bright color that green for vegetation and red for non-vegetation

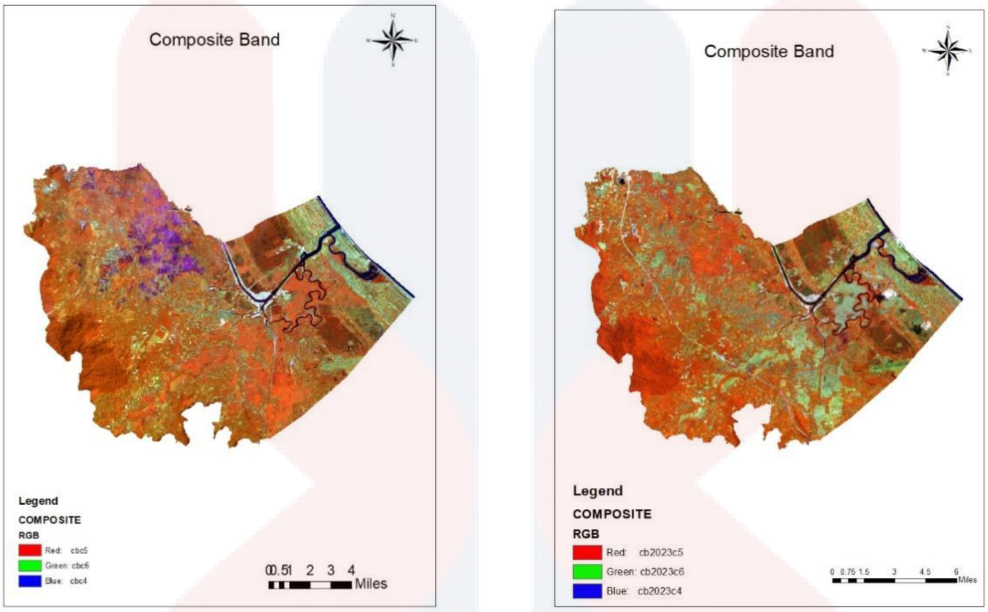
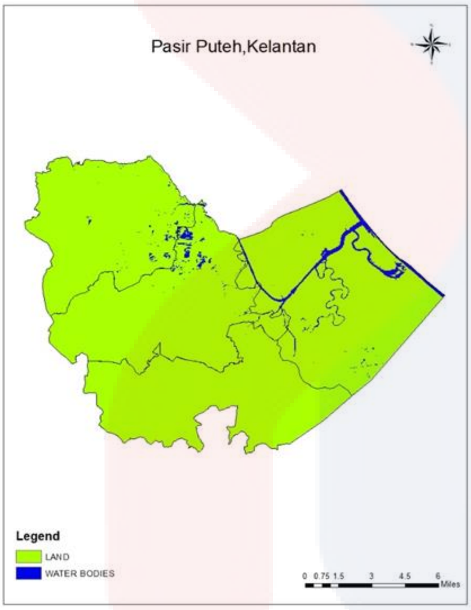
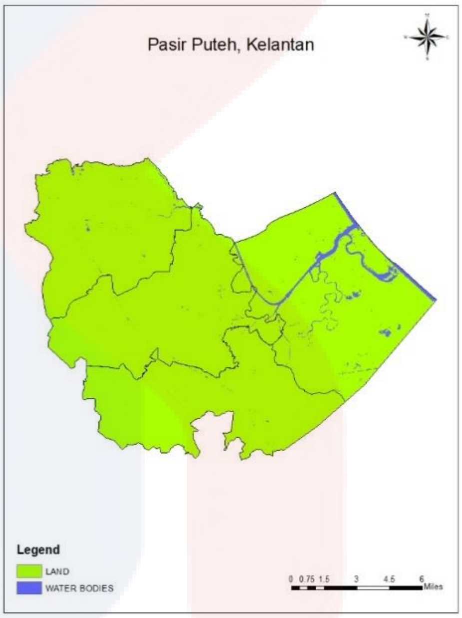


Figure 4.1: Composite band of 2014 and 2023

4.2 Water Bodies Delineation

The result of water bodies delineation for satellite images of years 2014 and 2023 in the District of Pasir Puteh were showed in Figure 4.2. In year 2014 the area of water bodies area is 10.5498 km^2. However, it was decreased in 2023 to 9.2349 km^2 .The water bodies area and non-water bodies were then created using the notified water indices. Using the kappa coefficient and an accuracy assessment of the classification maps, several satellite photos were classed and validated.





B) Year 2023

Figure 4.2 :Delineation and change detection of water bodies in Pasir Puteh, Kelantan

The significant shift in water bodies between 2014 and 2023 is seen in Figure 4.2. When compared to water bodies in 2023, the number from 2014 indicates that the area of water bodies was the largest. As the result in 2014 is recorded higher compared to 2023 due to the cloud interference that involve in radiometric correction that may disturb the result of water in 2014.

4.3 Water Bodies Change

In 2014, the number of water bodies is higher than 2023 which is 10.5498 km^2

while the number of non-water bodies is 412.3116 km^2. Meanwhile area of water bodies in 2023 is decreased this shown the changes for water bodies to 9.2349 km^2 by the decrease area of water it's influence the area of non-water bodies that is 413.6211km^2 due to the changes of water bodies which is the factor of non-water bodies areaincrease is because the water bodies area become more smaller from 2014 until 2023. This shown the number recored from 2014 until 2023 is decline 1.27 km^2 for water bodies meanwhile for non-water bodies shown the increase for number in percentage is 0.3172%.

Table 4.1 : Water bodies 2014 and 2023 changes in km^2

Year	**Land(km^2)**	**Water body (km^2)**
2014	412.3116	10.5498
2023	413.6211	9.2349
Total	422.8614	422.85

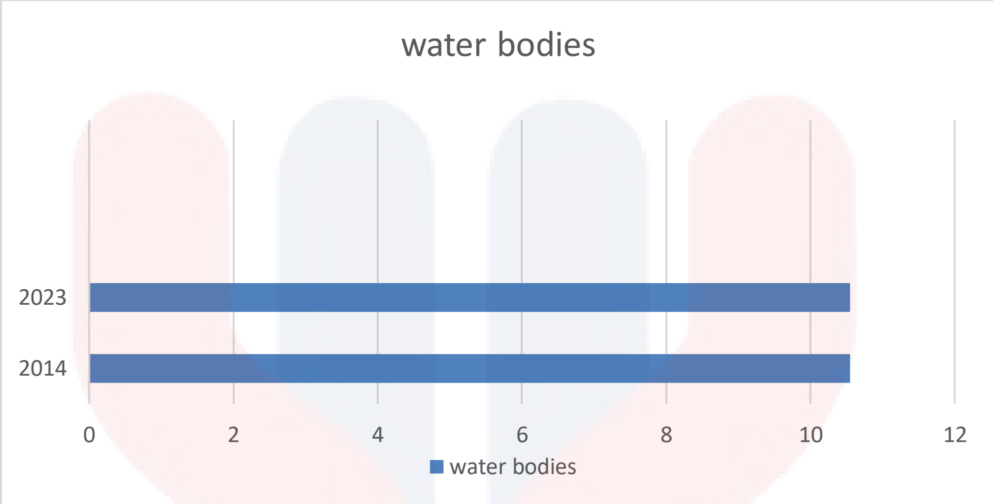


Figure 4.3: The illustrate of changes water bodies in graph form

Laporan Catatan Aras Air Tertinggi Mengikut Tempat

Tempoh	01-12-2014 sehingga 10-02-2015								
								Kemaskini Pada : 10-02-2015 08:37:21	
Bil	Sungai	Tempat	Aras Normal (M)	Aras Berjaga (M)	Aras Amaran (M)	Aras Bahaya (M)	Catatan Tertinggi	
							Tarikh & Waktu	Sukatan (M)
1	Sungai Semerak	Pasir Putih	0.40	2.00	2.30	3.00	12/18/2014 7:00	2.67

Figure 4.4: The highest water level recorded in 2014 (source:Portal Rasmi ebanjir Negeri Kelantan)

Laporan Catatan Aras Air Tertinggi Mengikut Tempat

Tempoh : 01-01-2023 sehingga 31-12-2023
Sungai : Sungai Semerak
Kemaskini Pada : 31-05-2024 03:02:26

Bil	Sungai	Tempat	Aras Normal (M)	Aras Berjaga (M)	Aras Amaran (M)	Aras Bahaya (M)	Catatan Tertinggi	
							Tarikh & Waktu	Sukatan (M)
1	Sungai Semerak	Pasir Putih	0.40	2.00	2.30	3.00	22-11-2023 08:00	2.06

Figure 4.5: The highest water level recorded in 2023 (Source: Portal Rasmi ebanjir Negeri Kelantan)

Based on the Figure 4.4 and 4.5 this shown that the highest level of water in 2014 until 2015 and compared to 2023. The comparison made that can conclude the highest level of water is in end of 2014 which is the biggest flood happen in Kelantan .This happen due to moonson season At the end of the year, Malaysia's East Coast states see strong winds and a lot of rainfall because to the northeast monsoon. This time of year is marked by heavy and frequent rainstorms, which can occasionally cause floods, particularly in low-lying areas and river basins. The displayed number in 2014 that is 2.67 meter in between warning and danger level. Meanwhile in highest number in 2023 also at the end of the year but the different is it’s only 2.06 meter shown in the table that in water level monitoring as a result the water bodies in Pasir Puteh, Kelantan is decrease eventhough it’s monsoon season

4.3 Accuracy Assessment

Table 4.2: Overall Occuracy Calculation

NDWI classes	No. of taken sample	No.of sample match with google earth image	Average accuracy level in %
1	**20**	**20**	**66.67%**
2	**20**	**10**	**50%**
Overall accuracy level in %			**75%**

Table 4.3: User and Producer Point

	Non-Water Bodies	Water Bodies	User
Non-Water Bodies	20	10	30
Water Bodies	0	10	10
Producer	20	20	40

Table 4.4: Overall User's and Producer

Classification Accuracy	2014	2023
	User's Accuracy	Producer's Accuracy
Non-Water Bodies	66.67%	66.67%
Water Bodies	50%	50%

The user's accuracy values provide insights into the performance of the classification method for distinguishing between water bodies and non-water bodies. 20 samples were collected for non-water bodies, and all 20 samples matched the Google Earth image with the number recorded for User's accuracy is 66.67%. This metric signifies the percentage of correctly classified non-water pixels relative to the total classified non-water pixels. While above the chance level of 50%, the accuracy of 66.67% indicates a moderate level of success in classifying non-water areas. For water bodies 20 samples, only 10 matched with the Google Earth image with achieving 50% accuracy for water bodies is commendable, indicating that all pixels classified as water bodies were accurately identified.

Accuracy of non-water bodies producer is 66.67 % that is the percentage of correctly detected non-water pixels relative to all classified pixels in the non-water category is represented by the producer's accuracy for non-water bodies, which is computed at 66.67%. This poor accuracy shows how difficult it is to accurately identify places that are not covered by water. The accuracy of the producer with regard to water bodies is 50%, which is a relatively higher percentage. In relation to the total number of categorised pixels in the water category, this measure shows the proportion of correctly classified water pixels. In the land-water categorization problem, a Kappa coefficient of 0.50 denotes a reasonable level of agreement between the actual and expected classification. Out of all categorised pixels, the percentage of correctly classified pixels is represented by the overall accuracy level, which is computed at 75%.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The integration of GIS applications can fulfield the study aim to delineate and change detection water bodies in Pasir Puteh,Kelantan by using the formula NDWI that is Normalized Different Water Index for years 2014 and 2023. The research shown that from 2014 until 2023 total number of water bodies in km^2 is decreasing from 10.5498 km^2 to 9.2349 km^2 that display 1.27% differences in 9 years. If this trend keeps up, Pasir Puteh, Kelantan most certainly won't have any water throughout in the foreseeable future and causes the shortage water. The results emphasise how dynamic water bodies are and how crucial it is to track and comprehend these changes in order to manage water resources effectively and preserve the ecosystem. The impact also for ecology which is aquatic ecosystems, biodiversity, and ecosystem services can all be impacted by changes in the amount and quality of the water.

5.2 Recommendation

The study of water bodies delineation and change detection is important to to enhance water management practices and facilitate sustainable development To give thorough evaluations of water bodies, implement integrated monitoring systems that include field observations, hydrological modelling, and satellite imaging. By using this method, change detection analyses can become more accurate and reliable, allowing for prompt interventions to address the decline in water levels. Moreover, encourage cooperation between governmental organisations, academic institutions, and nearby communities to exchange information, knowledge, and resources for the management and monitoring of water bodies. Broadening participation and improving the efficacy of monitoring initiatives can be achieved through providing open access to satellite imagery and GIS databases.

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