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# ENVIRONMENTAL MONITORING AT AND AROUND THE MATUAIL LANDFILL SITE OF DHAKA CITY USING REMOTE SENSING

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**ABSTRACT**

*Rapid urban population growth and flourishing incomes have increased waste production in Dhaka city. A part of daily produced Municipal Solid Waste (MSW) is disposed of at Matuail sanitary landfill located within Jatrabari Thana, Dhaka. This study has analyzed the environmental impacts at and around this landfill using remote sensing techniques. The objective of this research is to develop a means of environmental monitoring at the landfill site and its surroundings through the implementation of various time-series remote sensing indices e.g., Land Surface Temperature (LST), Normalized Difference Vegetation Index (NDVI), Soil Adjusted Vegetation Index (SAVI), and Modified Soil Adjusted Vegetation Index (MSAVI). LST is used to observe the Spatio-temporal pattern of temperature distribution. NDVI, SAVI, and MSAVI are the Bio-indicators and they are helpful to analyze the vegetation health condition at and around the landfill area. From the result of LST, it is observed that the average temperature of the Jatrabarithana has increased from 23.12℃ in 1993 to an optimum temperature of 35.20℃ in 2013, then it went down to 29.09℃ in 2018. The NDVI result for the study period shows that the percentages of 'Bare Soil' and 'Structural Object' have increased drastically from 10% to 41.20% and 13.30% to 31.52% respectively for these 25 years in Jatrabarithana. On the other hand, the percentages of 'Shrub and Grassland' and 'Moderate Vegetation' have decreased from 54.20% to 25.15% and 12.55% to 0% respectively. SAVI and MSAVI also show evidence of increasing the amount of bare soil and structural object and decreasing the amount of vegetation. Due to the waste stabilization process, and inappropriate management system at the Matuail landfill, along with urbanization, industrial activity, and deforestation, a harmful effect has been done to the surrounding environment. As an outcome, the temperature has risen rapidly and the amount of vegetation has declined to a significant extent.*

**Keywords:***Landfill Monitoring, Land Surface Temperature (LST), Modified Soil Adjusted Vegetation Index (MSAVI), Normalized Difference Vegetation Index (NDVI), Soil Adjusted Vegetation Index (SAVI)*

## 1. INTRODUCTION

Environmental monitoring is an essential part of natural science and strategy plans for every country. Without strategic environmental monitoring, any plan can be proved ineffective and uneconomical. Bangladesh is located in the South-East Asia region which has a population of over 166 million. Dhaka is the capital of Bangladesh. More than 21 million people live in this city (World Population Review, 2021). A study by the Department of Environment (DoE) revealed that Dhaka's problem regarding solid wastes is worse compared to cities in other developing countries. Total wastes produced in Dhaka city is about 4600 tons/day (Abedin & Jahiruddin, 2015). Besides, the amount of waste generation rises during the wet season (Alamgir & Ahsan, 2007). It seems impossible to dispose of that amount of waste as the city does not have enough resources. Dhaka City Corporation (DCC) uses two landfill sites specifically; Matuail which is a sanitary landfill and Amin Bazar is under operation process for sanitary condition. Matuail landfill is older than Aminbazar landfill.

Matuail landfill is not fully functioned to treat wastes and properly managed, it causes pollution at and around the landfill site. This hazardous process dangerously impacts human health, animal, aquatic life, and the surrounding environment. So, it is necessary to monitor the environmental effect over the landfill site. Among total wastes, 1150 tons/day to 1450 tons/day wastes are disposed of at Matuail landfill. The rest of the wastes are disposed of at Amin Bazar landfill (Bhuyan, 2010). Matuail landfill site is located around 8 kilometers from the center of the south of Dhaka city which is mainly used for disposal of municipal solid waste by the Dhaka South City Corporation (DSCC). It is located in the DSCC region in between latitude of 23°42.97' to 23°43.35' N and

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longitude of 90°26.83' to 90°27.2' E (Hossain, Jahan, Parveen, Ahmed & Uddin, 2018). Matuail landfill is located
in Jatrabari thana which has an area of 13.19 square kilometers and the total population is about 260772 and the population density is about 19770/km². Moreover, Jatrabari thana has an average monthly temperature of 30°C; average monthly rainfall of 100mm; average monthly wind speed of 15kmph, and average monthly humidity of around 50% from 2009 to 2021 (Bangladesh Meteorological Department, 2021). A location map of Jatrabari thana is given in figure 1 below.

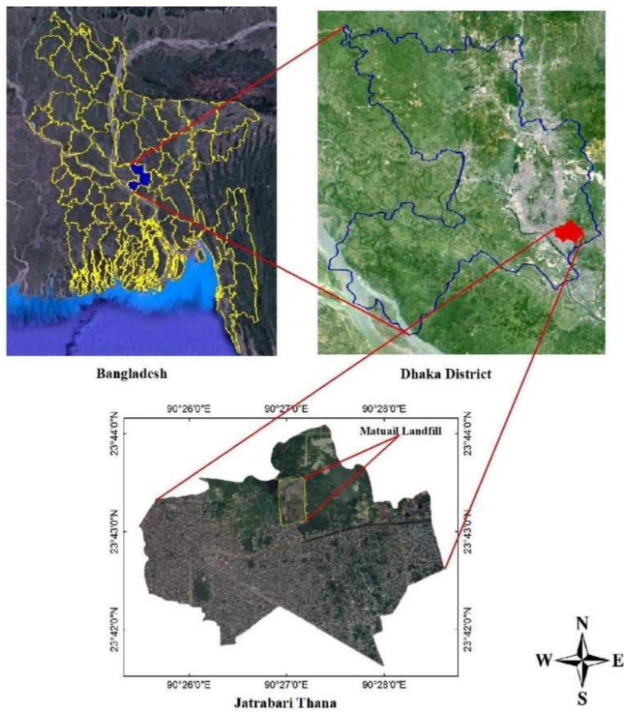



**Figure 1:** Location Map of Jatrabari Thana

The main water body in Jatrabari thana is the Balu river which carries floodwater from the Shitalakshya and the Turag during the flood season. The Balu river is important mainly for the local drainage and can be accessed by small boats. Land use can be classified as agriculture, residential, waterbody, bare land, industrial activities, transport & communication, and miscellaneous (Rajuk, 2015). From Google earth, it is assured that there is a huge amount of urban area in the south direction and a small portion of vegetation in the north-east corner, and some water bodies are scattered in the whole region of Jatrabari thana area. The main crops are paddy, potatoes, and various kinds of vegetables (Banglapedia, 2021). Figure 2 shows the Google earth image of Matuail landfill site and its surrounding.

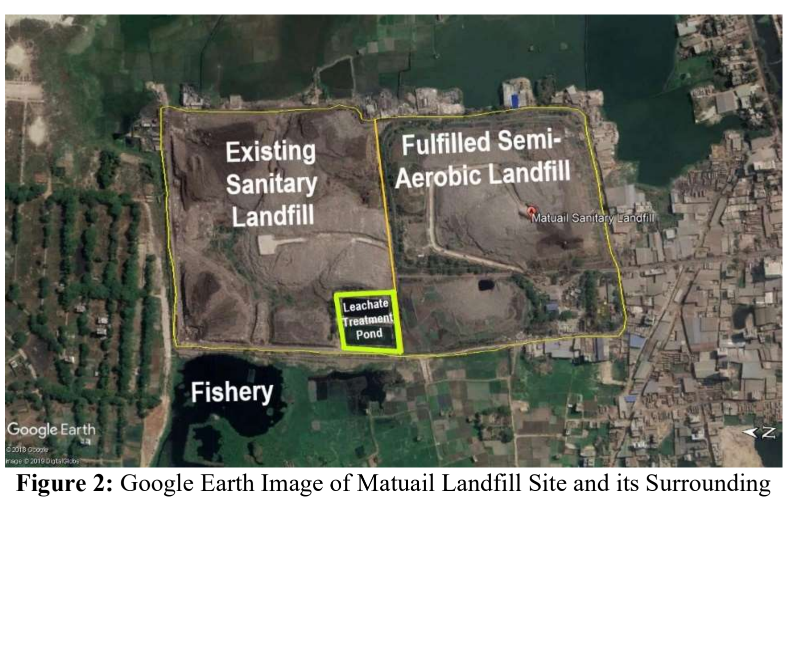



**Figure 2:** Google Earth Image of Matuail Landfill Site and its Surrounding

The overall objective of this research is to monitor the condition of Matuail landfill site and the surrounding area. The major objectives of this research are:

i. To calculate and analyze various remote sensing indices e.g., LST, NDVI, SAVI and MSAVI.
ii. To observe the temperature distribution pattern and vegetation health condition at the Matuail landfill site and the surrounding region.

## 2. METHODOLOGY

Matuail Landfill is used by the Dhaka South City Corporation (DSCC) to dispose of its municipal solid waste. It is now almost 27 years old. Matuail landfill has started with an open dump of 20 hectares of land in 1995. To make it a sanitary landfill, the construction was started in March 2006 to October 2007. It is the first sanitary landfill site in Bangladesh and the largest waste disposal site in Dhaka city. Matuail landfill now has an area of 40 hectares. About 75% of the waste of Dhaka city area is disposed of in Matuail landfill. (Bhuyan, 2010).

The methodology of the study comprises extracting the LST, NDVI, SAVI, and MSAVI of the Jatrabari thana area which covers the Matuail landfill. Systematic development of the methodology of this study is shown in figure 3 below with the help of a flow diagram.

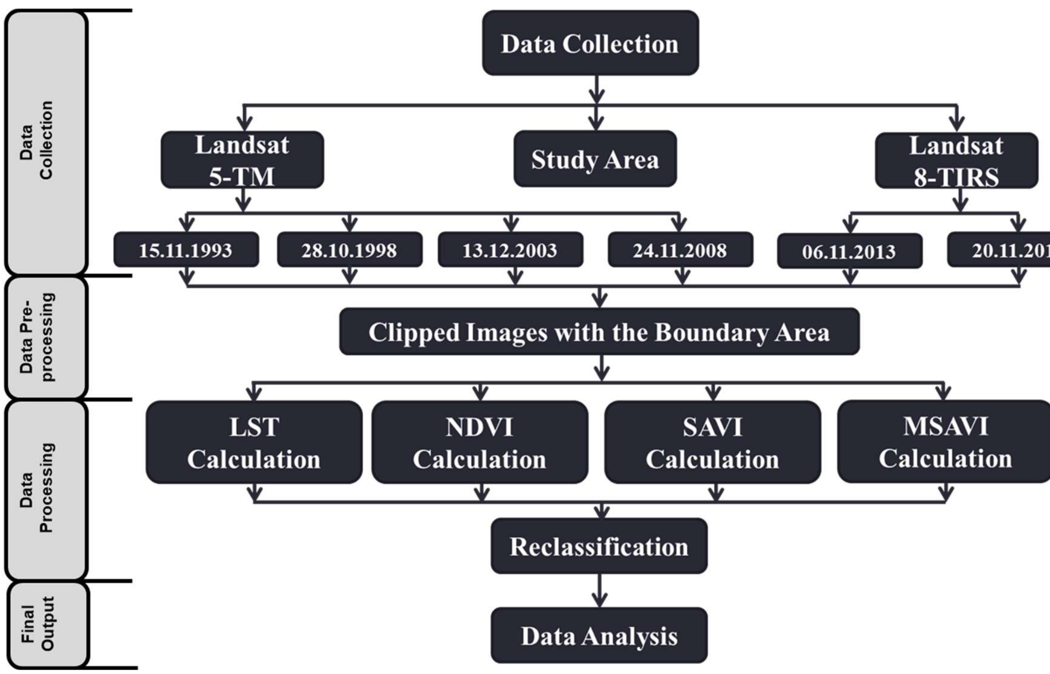



**Figure 3**: Methodology Flow Chart

### 2.1 Data Collection

The operational activities of Matuail landfill started in 1995. As the main focus of this study is to acquire the environmental effect of the Matuail landfill from its very beginning, images at a 5-year interval started from 1993 to 2018 are used in this study. Images used in this study were chosen based on the consideration of the availability of good quality images with (0-10) % cloud cover. The Landsat data were downloaded free of cost from USGS websites, namely www.glovis.usgs.govand www.earthexplorer.usgs.gov. The path and row are 137 and 44 respectively. ArcGIS 10.2.2 was used for data analysis. The shapefile of Jatrabari thana is collected from Bangladesh Agricultural Research Council (BARC).

### 2.2 Data Processing

Before data processing, the image is clipped with the help of the desired shapefile of the Jatrabari thana area. For estimating LST, a Thermal band is used. The process of estimating LST for two satellites is different. Required data were extracted from the respective metadata file and the digital number (DN) of the thermal band is converted to radiance. Then, LST is estimated by the required equation.

For Landsat-5,

$$TB = K2 / Ln ((K1 / L\lambda) + 1) \quad (1)$$

where, TB = Brightness temperature, K1 and K2 = Thermal conversion constant, $L\lambda$ = Top of Atmospheric spectral radiance (Rajeshwari & Mani, 2014).

For Landsat-8,

$$LST = TB10 + C1 (TB10-TB11) + C2 (TB10-TB11)^2 + C0 + (C3+C4W) (1- \varepsilon) + (C5+C6W) \Delta \varepsilon \quad (2)$$

where, TB10 and TB11 = Brightness temperature of band 10 and band 11 (K) respectively, C0 to C6 = Split-Window Coefficient values, $\varepsilon$ = Mean LSE of TIR bands, W = Atmospheric water vapor content (Generally taken as 0.5), and $\Delta \varepsilon$ = Difference in LSE (Rajeshwari & Mani, 2014).

For NDVI, Near Infrared Reflectance (NIR) and Red band are needed which represents the band reflectance obtained in the near-infrared and red (visible) wavelengths respectively. The equation is given below.

$$NDVI = (NIR - Red) / (NIR + Red) \quad (3)$$

Red and Near-Infrared Reflectance interpret the band reflectance obtained in the red (visible) and near-infrared wavelengths respectively. Then, SAVI was improved by conjoining a soil reconcilement factor L into the NDVI equation. The L value differs with the quantity of green vegetation. We used L= 0.5. The equation is given below.

$$SAVI = ((NIR - Red) / (NIR + Red + L)) \times (1 + L) \quad (4)$$

The L value differs with the quantity of green vegetation. L=1 defines no green vegetation cover, whereas L=0 means very high vegetation cover. In SAVI, L is generally left alone at a constant 0.5 (Huete, 1988). Lastly, MSAVI is a modification of SAVI that further diminishes soil brightness dominances, therefore, resulting in higher vegetation susceptibility (Chehbouni, Huete, Kerr, & Sorooshian, 1994).

$$MSAVI2 = (1 / 2) * (2(NIR + 1) – \text{Square Root} ((2 * NIR+ 1)^2 - 8(NIR - Red))) \quad (5)$$

Images of LST and NDVI are reclassified into categories to understand the variation of values to compare with each other and to analyze the values properly. The temperature classes are (19-22), (22-25), (25-28), (28-31), (31-34), (34-37), (37-40) and (40-44) Degree Celsius, while the categories for NDVI are (-0.5-<0), (0), (>0-0.05), (0.05-0.1), (0.1-0.3), (0.3-0.6) and (0.6-0.8) for water body, no vegetation, bare soil, structural object, shrub and grassland, moderate vegetation and high vegetation respectively (Bhandari, Kumar, & Singh, 2012).

## 3. RESULT AND DISCUSSION

### 3.1 Thermal Comparison

**Table 1:** Comparison of the Highest, Lowest, and Average Temperature of Jatrabari Thana

| Year | Highest Temp (°C) | LowestTemp (°C) | AverageTemp (°C) |
|---|---|---|---|
| November 15, 1993 | 26.67 | 19.28 | 23.12 |
| October 28,1998 | 30.42 | 22.81 | 25.89 |
| December 13, 2003 | 30.82 | 21.50 | 25.10 |
| December 10, 2008 | 29.18 | 21.06 | 24.69 |
| November 6, 2013 | 43.96 | 30.42 | 35.20 |
| November 20, 2018 | 34.84 | 25.32 | 29.09 |

From the overall comparison of the temperature of Jatrabarithana shown in table 1, it is observed that the highest temperature increases rapidly from 26.27°C in 1993 to 43.96°C in 2013 and then it goes down to 34.84°C in 2018. Additionally, the lowest temperature rises drastically from 19.28°C in 1993 to 30.42°C in 2013, and then it fells down to 25.32°C in 2018. The average temperature of the Jatrabarithana increases by 12.08°C by an interval of 20 years (1993 to 2013). A graphical comparison of the highest, lowest and average temperature of Jatrabarithana is shown in figure 4 below.

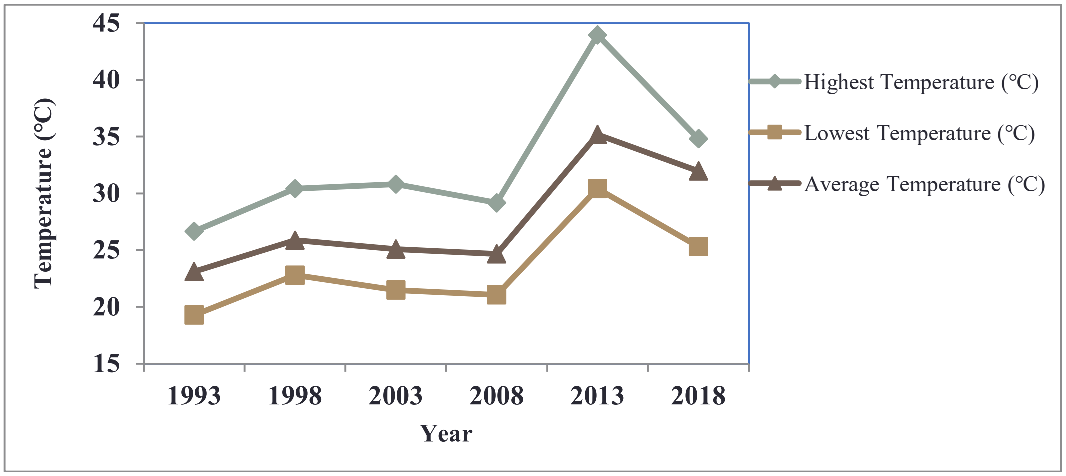



**Figure 4:** Graphical Comparison of the Highest, Lowest, and Average Temperature of Jatrabari Thana

The reclassified images of Land Surface Temperature (LST) of 1993, 1998, 2003, 2008, 2013, and 2018 are given in Figures 5 to 10 below.

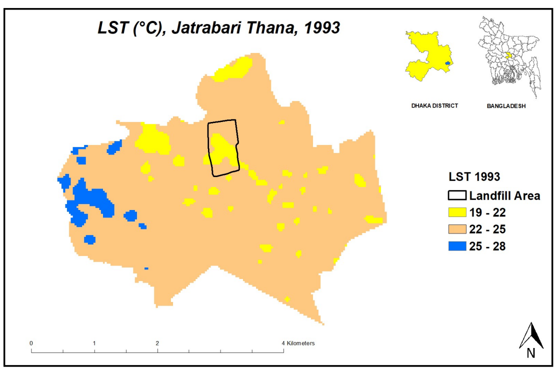



**Figure 5:** The reclassified LST Image (1993)

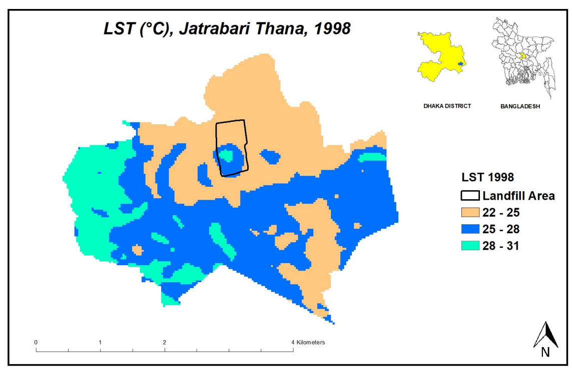



**Figure 6:** The reclassified LST Image (1998)

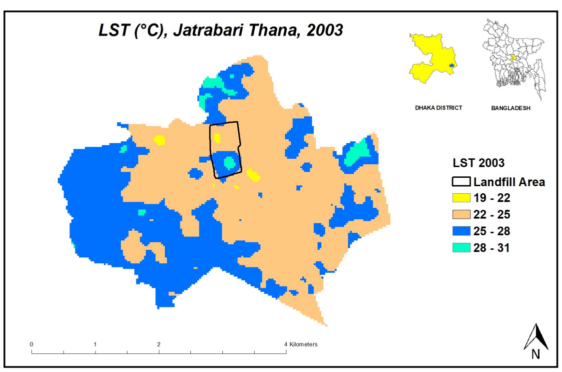



**Figure 7:** The reclassified LST Image (2003)

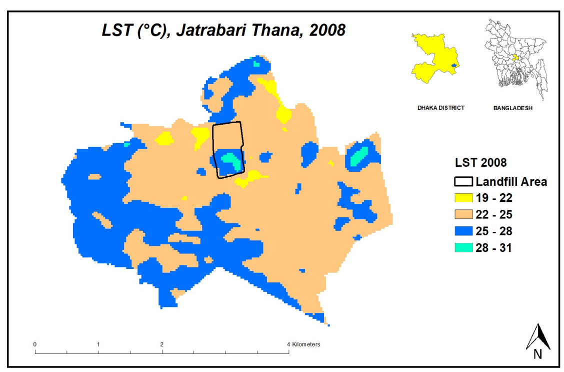



**Figure 8:** The reclassified LST Image (2008)

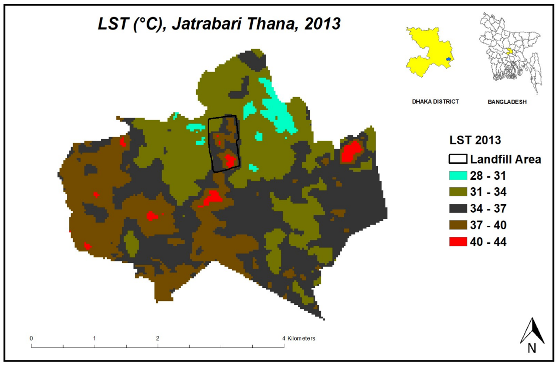



**Figure 9:** The reclassified LST Image (2013)

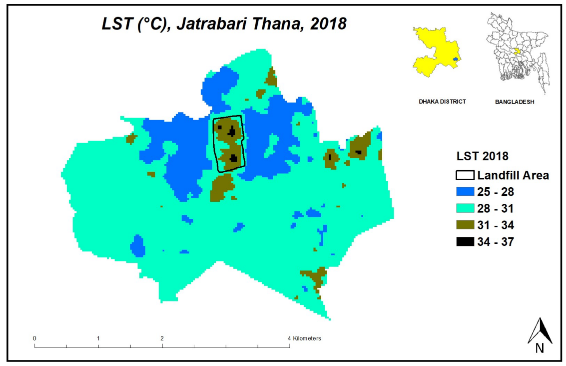



**Figure 10:** The reclassified LST Image (2018)

Table 2: The LST Pixel Percentage of Each Range over the Whole Area (Based on Pixel Count)

| Temp Range (°C) | Pixel Percentage of Each Range Over The Whole Area | | | | | |
|---|---|---|---|---|---|---|
| | Nov '93 | Oct '98 | Dec '03 | Dec '08 | Nov '13 | Nov '18 |
| **19-22** | 7.1 | - | 0.5 | 2.3 | - | - |
| **22-25** | 89.3 | 40.1 | 57.8 | 60.5 | - | - |
| **25-28** | 3.6 | 44.71 | 39.8 | 36.4 | - | 18.3 |
| **28-31** | - | 15.2 | 1.9 | 0.8 | 2.5 | 76 |
| **31-34** | - | - | - | - | 32 | 5.5 |
| **34-37** | - | - | - | - | 40.7 | 0.2 |
| **37-40** | - | - | - | - | 24.4 | - |
| **40-44** | - | - | - | - | 1.4 | - |

From table 2, it can be said that the 22-25 °C temperature range has a covering of 89.3% in 1993. In 2013, 34-37 °C has become the major covering temperature range. By the year 2018, 28-31 °C is the major covering temperature range, whereas some temperature ranges as 19-22 °C and 22-25 °C disappear in 2018. To find out the temperature variation pattern year by year, two polygons are generated within the Matuail landfill area which represents Existing Sanitary Landfill (ESL) and Fulfilled Semi-Aerobic Landfill (FSAL). A layout of ESL and FSAL within Matuail landfill is given in figure 11.

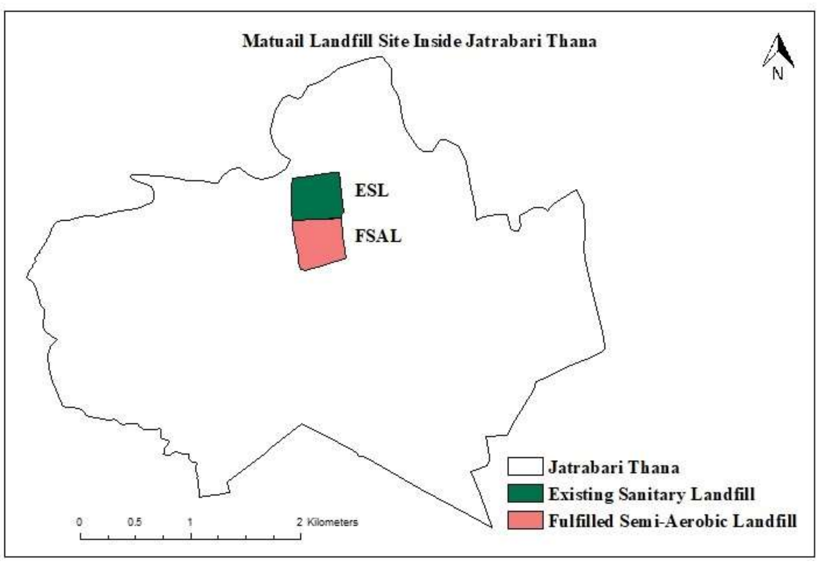



**Figure 11:** Layout of ESL and FSAL within Matuail Landfill

**Table 3:** Maximum, Minimum and Average Temperature of ESL and FSAL from 1993 to 2018

| Year | Polygon | 1993 | 1998 | 2003 | 2008 | 2013 | 2018 |
|---|---|---|---|---|---|---|---|
| Maximum Temp(℃) | ESL | 23.68 | 26.25 | 26.27 | 25.40 | 40.07 | 34.69 |
| | FSAL | 23.25 | 29.59 | 28.77 | 29.18 | 41.36 | 34.84 |
| Minimum Temp (℃) | ESL | 21.50 | 23.25 | 21.94 | 22.38 | 31.20 | 28.86 |
| | FSAL | 19.28 | 24.54 | 24.11 | 24.55 | 33.75 | 28.32 |
| Average Temp (℃) | ESL | 22.56 | 23.81 | 23.53 | 23.33 | 35.81 | 31.99 |
| | FSAL | 21.97 | 26.83 | 26.61 | 26.97 | 37.11 | 31.52 |

The capacity of FSAL was fulfilled by 2006, so the construction of ESL was required. From table 3, it can be concluded that temperatures of ESL are comparatively less than temperatures of FSAL for almost every particular year. In 1993, as these places were barren land, temperatures were stable. By the year 1998, the waste composition process of FSAL influences to increase in temperature for the surrounding area. Temperatures increase drastically between 2008 and 2013, striking at around 40-44℃ and this can be explained by the stabilization process of wastes. As it takes many years to stabilize the decomposed waste, it emits a huge quantity of heat during this long period. This stabilization process takes nearly 15-20 years sometimes depending on some major criteria. Moreover, recent research by GHGSat says that Matuail landfill emits 4000 kilograms' methane in an hour which is equivalent to the emissions of 190,000 passenger cars. Methane can increase the atmospheric temperature 80 times more than carbon dioxide (GHGSAT, 2021). The study revealed that as the landfill activities start, the temperature at and around Matuail landfill increases rapidly to 40-44 ℃ from 19-22 ℃ range.

## 3.2 Bio-Indicators

### 3.2.1 Normalized Difference Vegetation Index (NDVI)

The reclassified images of NDVI of 1993, 1998, 2003, 2008, 2013, and 2018 are given in Figures 12 to 17 below.

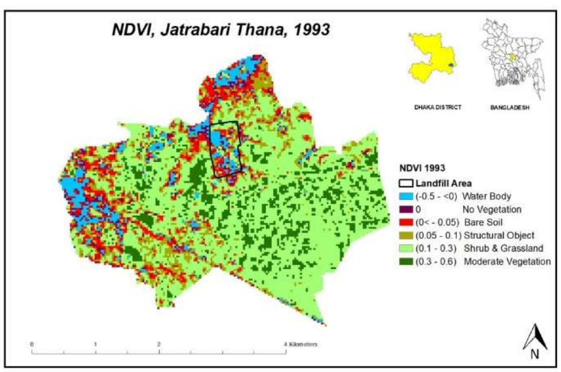



**Figure 12:** The reclassified NDVI Image (1993)

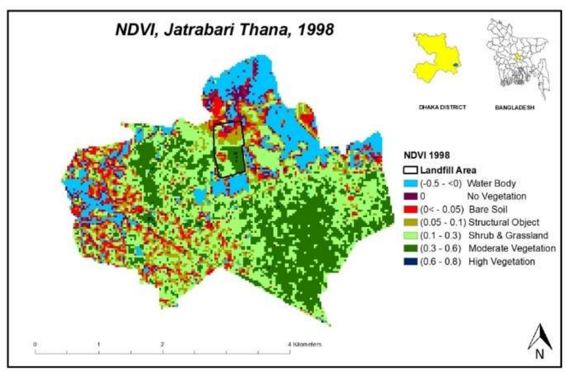



**Figure 13:** The reclassified NDVI Image (1998)

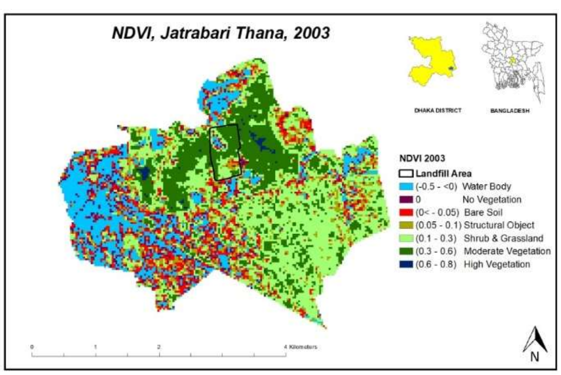



**Figure 14:** The reclassified NDVI Image (2003)

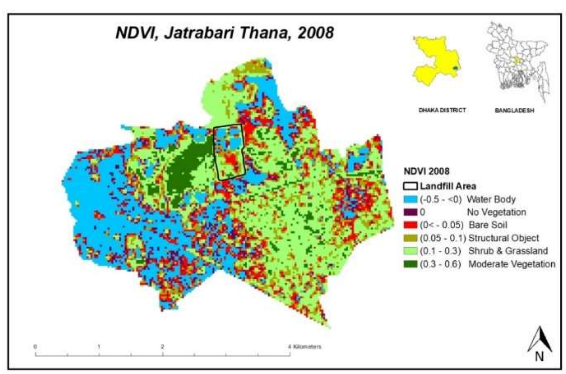



**Figure 15:** The reclassified NDVI Image (2008)

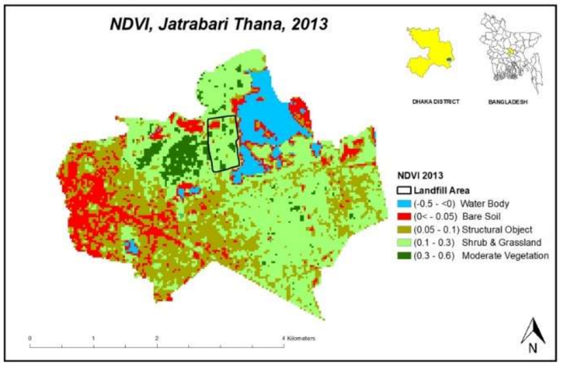



**Figure 16:** The reclassified NDVI Image (2013)

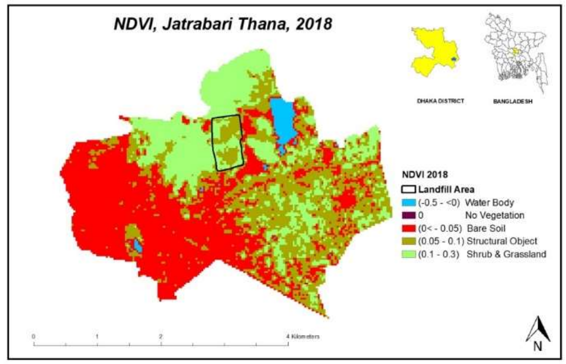



Figure 17: The reclassified NDVI Image (2018)

**Table 4:** The NDVI Pixel Percentage of Each Range over the Whole Area (Based on Pixel Count)

| NDVICategory | Pixel Percentage of Each Range Over The Whole Area | | | | | |
|---|---|---|---|---|---|---|
| | Nov '93 | Oct '98 | Dec '03 | Dec '08 | Nov '13 | Nov '18 |
| Water Body | 6.6 | 14.9 | 16.9 | 27.3 | 7.5 | 2.1 |
| No vegetation | 3.35 | 4.1 | 5.5 | 5.9 | - | 0.007 |
| Bare Soil | 10 | 10.1 | 11.5 | 13.1 | 14 | 41.2 |
| Structural Object | 13.3 | 12.1 | 10.5 | 13.9 | 30.6 | 31.52 |
| Shruband Grassland | 54.2 | 33.8 | 34.7 | 33.45 | 43.3 | 25.15 |
| Moderate Vegetation | 12.55 | 24.9 | 20.3 | 6.35 | 4.6 | - |
| High Vegetation | - | 0.1 | 0.6 | - | - | - |

Higher NDVI value represents healthy vegetation, whereas lower NDVI value represents defective and unhealthy vegetation. From table 4, it is exposed that within the 25 years, amounts of bare soil and structural object increase vastly, on the other hand, amounts of vegetation health and water body are diminishing. Graphical representation of Water Body, Bare Soil, Structural Object, Shrub and Grassland, and Moderate Vegetation percentage vs. Year are given in Figures 18 to 22 below.

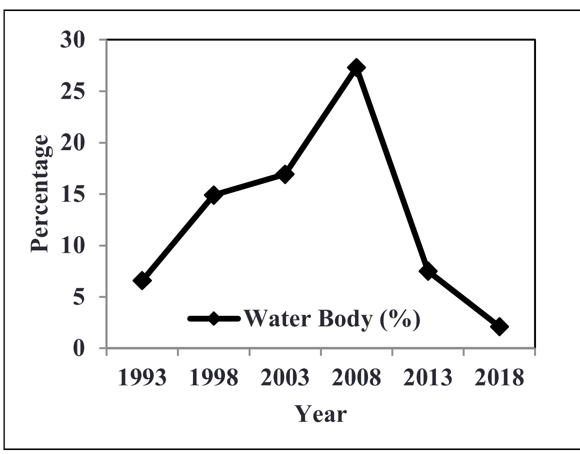



**Figure 18:** Percentage Variation of Water Body with time

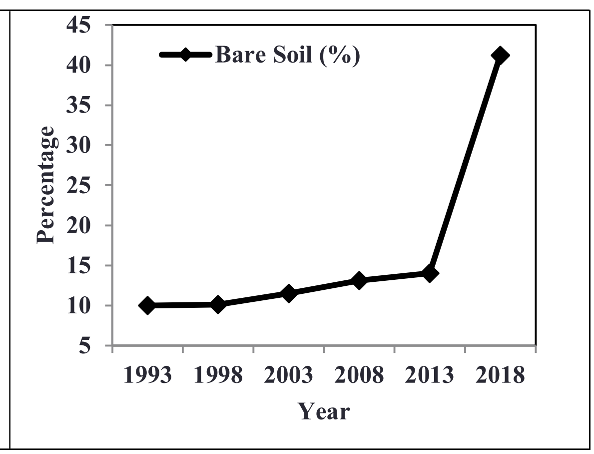



**Figure 19:** Percentage variation of Bare Soil with time

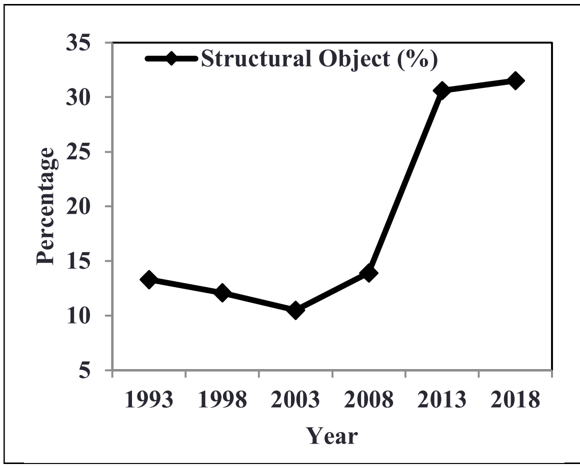



**Figure 20:** Percentage variation of Structural Object

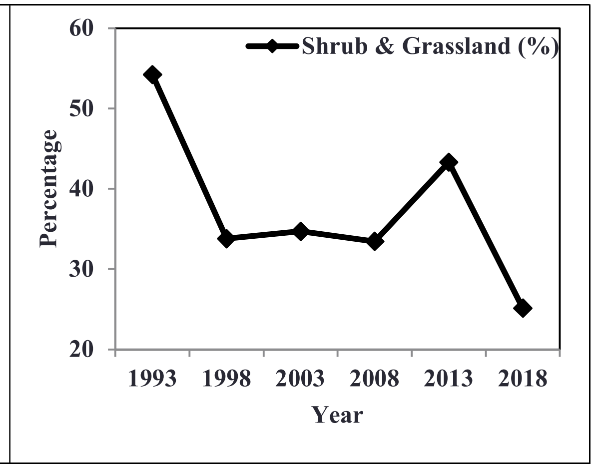



**Figure 21:** Percentage variation of Shrub & Grassland

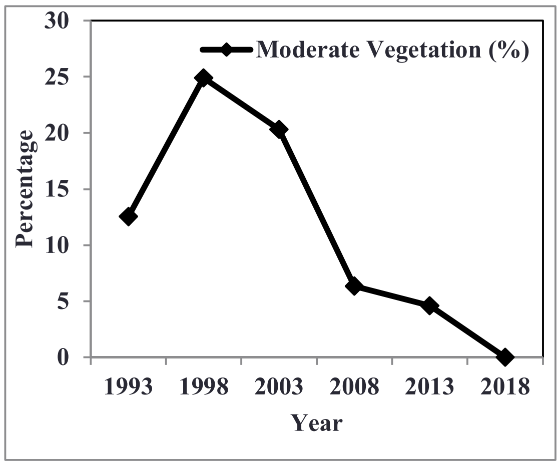
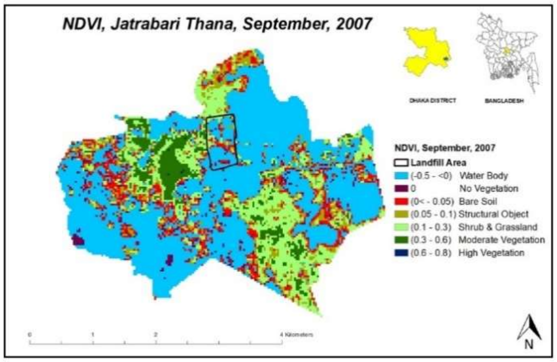



**Figure 22**: Percentage variation of Moderate Vegetation with time

'Bare Soil' category has a percentage ranging from 10-14% till 2013. In 2018, it climbed sharply to a percentage of 41.2%. Structural object percentage has risen to 31.52% from 13% in this 25-year interval. Moreover, the 'Shrub and grassland' category was 54.2% in 1993, which decreased rapidly to 33.8% in 1998, and by 2018, it went down to 25.15%. Lastly, the 'Moderate Vegetation' category shows a percentage of 12.55% to 20.3% in the first 10 years' interval. By the next 10 years' interval, it reaches only 4.6%, and in 2018 it disappears.

An improper waste management system is affecting the natural environment of the surroundings. The waterbody percentage is almost 27.3% in 2008, which seems unreal. Also, figure 15 shows the water body in some areas which are covered with structural objects and roadway in real (assured from Google Earth). Jatrabari thana is a low-lying area and also the drainage system of some parts of this area are mostly ineffective. 2007, 2008, and 2009, in these three consecutive years a huge amount of rainfall occurred (Bangladesh Meteorological Department, 2021). This creates a huge waterlogging problem in the area. Reclassified images of 2007 and 2009 are given in Figures 23 and 24. Comparing these images with the reclassified NDVI image of 2008 (Figure 15), it can be said that due to waterlogging problem the water body percentages have reached 27.3%.

SAVI is improved by the alteration of NDVI to be used in infertile areas whereas vegetative cover is little. The highest value decreases from 0.78 in 1993 to 0.43 in 2018. As lower value represents poor vegetation growth, so it can be said that the vegetation growth diminishes in a significant way. Here, the negative value represents the water body (The Landscape Toolbox, 2021). In these images, the higher the SAVI value, the brighter green the area is. It can be distinguished by looking at the images separately, the green areas are decreasing, which means the amount of vegetation cover is diminishing.



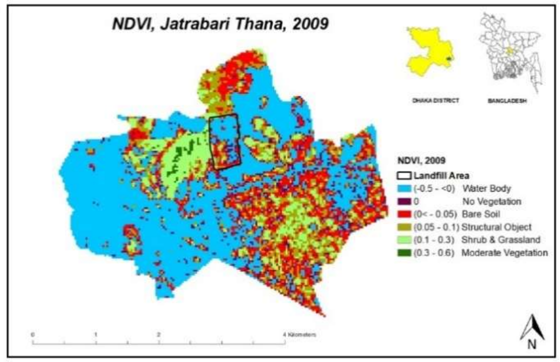
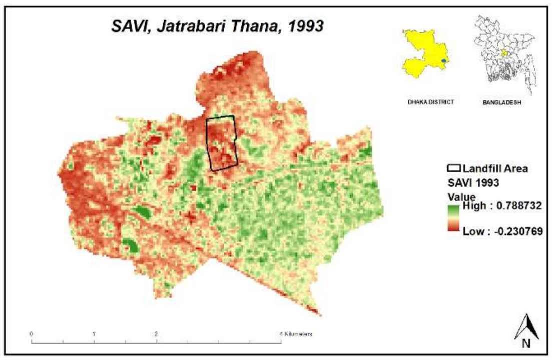




**Figure 23:** The reclassified NDVI Image (2007) **Figure 24:** The reclassified NDVI Image (2009)

### 3.2.2 Soil Adjusted Vegetation Index (SAVI)

The images of SAVI of 1993, 1998, 2003, 2008, 2013, and 2018 are given in Figures 25 to 30 below.



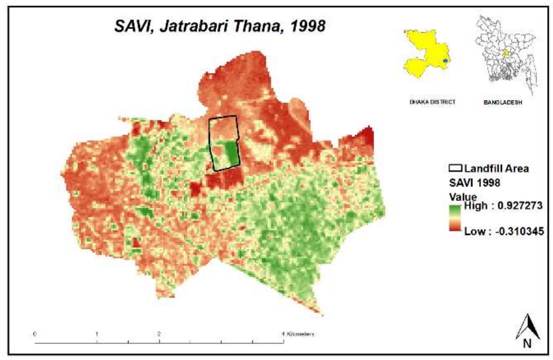
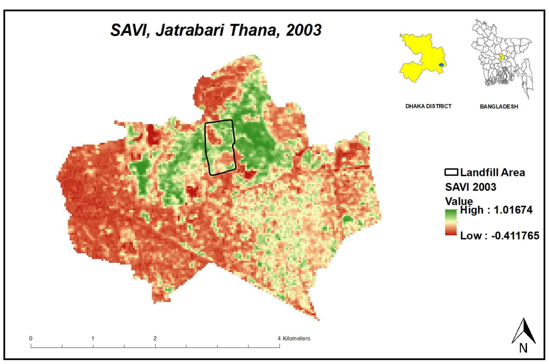




**Figure 25**: The reclassified SAVI Image (1993) **Figure 26:** The reclassified SAVI Image (1998)



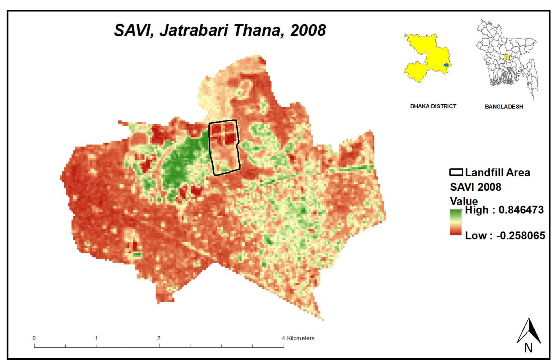
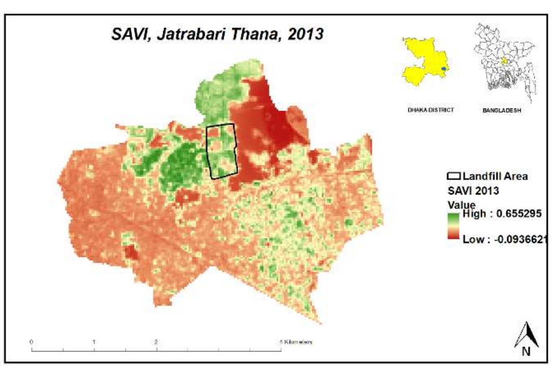




**Figure 27:** The reclassified MSAVI Image (2003) **Figure 28:** The reclassified MSAVI Image (2008)



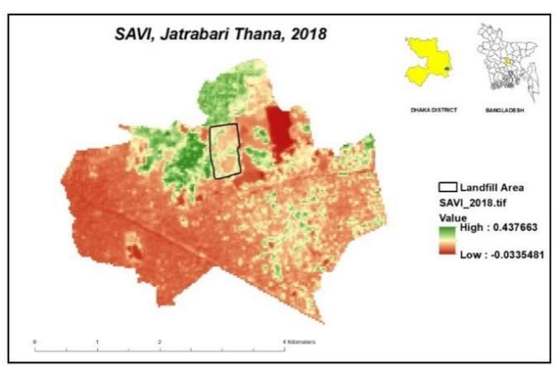




**Figure 29:** The reclassified MSAVI Image (2013) **Figure 30:** The reclassified MSAVI Image (2018)

### 3.2.3 Modified Soil Adjusted Vegetation Index (MSAVI)

The images of MSAVI of 1993, 1998, 2003, 2008, 2013, and 2018 are given in Figures 31 to 36 below.

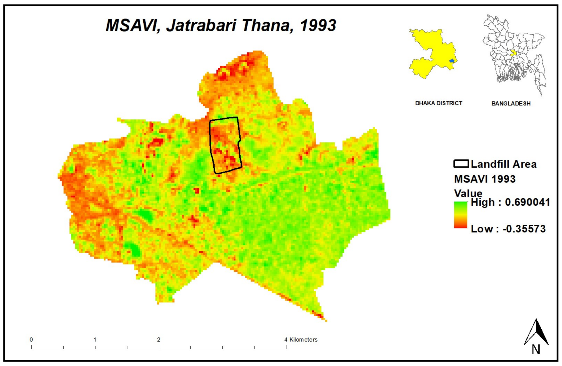



**Figure 31:** The reclassified MSAVI Image (1993)

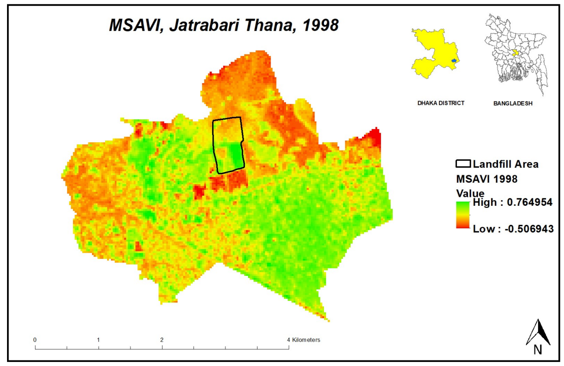



**Figure 32:** The reclassified MSAVI Image (1998)

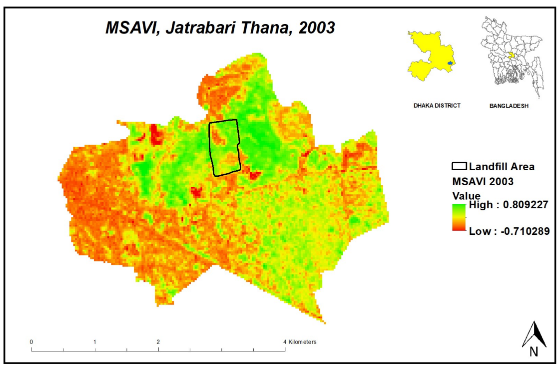



**Figure 33:** The reclassified MSAVI Image (2003)

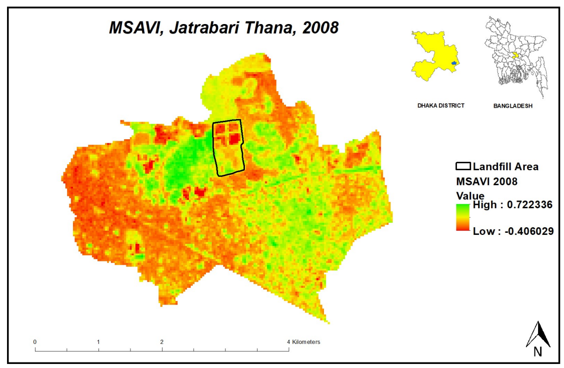



**Figure 34:** The reclassified MSAVI Image (2008)

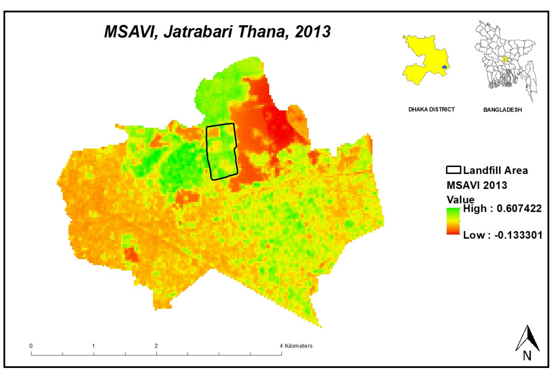



**Figure 35:** The reclassified MSAVI Image (2013)

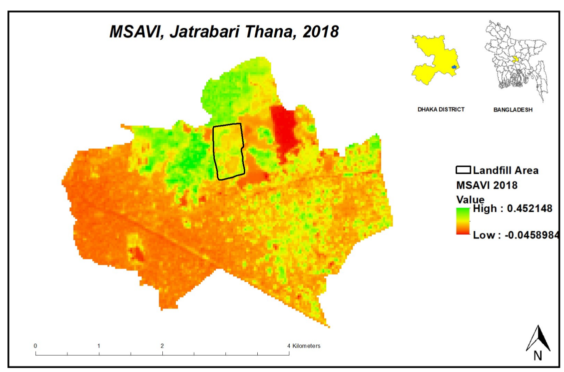



**Figure 36:** The reclassified MSAVI Image (2018)

MSAVI is the further modification of SAVI. In MSAVI, a higher value represents higher vegetation greenness. Here, the highest value reduces from 0.69 in 1993 to 0.45 in 2018. These values corelates with vegetation growth, which has diminished in a significant way (The Landscape Toolbox, 2021).

## 4. CONCLUSION

This research analyses the Spatio-temporal pattern of LST and interprets the vegetation health measuring indices such as NDVI, SAVI, and MSAVI as indicators of environmental degradation in Matuail landfill and its surrounding region between 1993 and 2018. Though global warming, the emission of greenhouse gases, and so on has an impact on the increase in global surface temperatures, and some industries also influenced the rise of the temperature in Jatrabari thana, mainly the landfill operations have a great impact on the LST increase of the study area. Moreover, NDVI and LST are vastly correlated. Poor vegetation growth obtained from NDVI at and around the Matuail landfill is connected with the increase of surface temperature. Also, the amount of vegetation has decreased because of the improper leachate management system and gas vent system; overall the whole process is affecting the natural environment of the surroundings. LST increases significantly in the study area mainly due to the landfill gases by rising the average air temperature from the decomposition process of wastes alongside some other factors as urbanization, deforestation, and so on. In addition, the overall activities that happened in the landfill severely impacts the output values of NDVI, SAVI, and MSAVI. Threateningly, more and more wastes are generating every day and little in the way of recycling and separation of waste will lead to a disastrous condition in the future.

## DECLARATION

This is to declare that a part of this paper has been presented in ICCESD 2020 conference.

## REFERENCES


Abedin, M. A., & Jahiruddin, M. (2015). Waste generation and management in Bangladesh: An overview. *Asian Journal of Medical and Biological Research*, 1(1), 114-120.

Alamgir, M., & Ahsan, A. (2007). Municipal solid waste and recovery potential: Bangladesh perspective. Iranian *Journal of Environmental Health Science and Engineering*, 4(2), 67-76.

Bangladesh Meteorological Department (2021).Climatic information of Jatrabari thana. Retrieved from http://datalibrary.bmd.gov.bd/maproom/Climatology/index.html

Banglapedia (2021). Geographical information of Jatrabari thana. Retrieved from http://en.banglapedia.org/index.php?title=Jatrabari_Thana

Bhandari, A. K., Kumar, A., & Singh, G. K. (2012). Feature Extraction using Normalized Difference Vegetation Index (NDVI): a Case Study of Jabalpur City. *Procedia Technology*, 6, 612-621.

Bhuyan, M. S. S. (2010). A Study on Quantity and Quality of Leachate of Matuail Sanitary Landfill (Master's thesis). Department of Civil Engineering, Bangladesh University of Engineering and Technology,Dhaka, Bangladesh.

Chehbouni, J. Qi. A., Huete, A. R., Kerr, Y. H., & Sorooshian, S. (1994). A Modified Soil Adjusted Vegetation Index. *Remote Sensing of Environment*, 48, 119-126.

GHGSAT (2021). Leaking Landfill Contributes to World's Mystery Methane Hostspot. Retrieved from https://www.ghgsat.com/en/newsroom/leaking-landfill-contributes-to-worlds-mystery-methane-hotspot/

Hossain, M. F., Jahan, E., Parveen, Z., Ahmed, S. M., & Uddin, M. J. (2018). Solid Waste Disposal and its Impact on Surrounding Environment of Matuail landfill Site, Dhaka, Bangladesh. *American Journal of Environmental Sciences*, 14(5), 234-245.

Huete, A. R. (1988). A soil-adjusted vegetation index (SAVI). Remote Sensing of Environment, 25(3), 295-309.

Rajeshwari, A., & Mani, N. D. (2014). Estimation of Land Surface Temperature of Dindigul District using Landsat 8 Data. *International Journal of Research in Engineering and Technology*, 3(5), 122-126.

Rajuk (2015). Final Report. Preparation of Detailed Area Plan (DAP) for DND North: Location-5.

The Landscape Toolbox (2021). Soil-Adjusted Vegetation Index. Retrieved from https://wiki.landscapetoolbox.org/doku.php/remote_sensing_methods:soil-adjusted_vegetation_index

The Landscape Toolbox (2021).ModifiedSoil-Adjusted Vegetation Index. Retrieved from https://wiki.landscapetoolbox.org/doku.php/remote_sensing_methods:modified_soil-adjusted_vegetation_index

World Population Review (2021). Dhaka Population 2021. Retrieved from https://worldpopulationreview.com/world-cities/dhaka-population.