GEOSPATIAL ANALYSIS OF TEMPERATURE FLUCTUATIONS DUE TO THE RAPID PHYSICAL DEVELOPMENT IN THE GREATER HAMBANTOTA PROJECT

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Introduction

The Greater Hambantota project is a large development project in Sri Lanka. The major goal of this new super city plan is to make it the second-biggest regional and urban development centre or just to work as a deterrent to Colombo and, as a result, decentralize economic growth in Sri Lanka. The town's profitable location to be developed for a prosperous city centred on the port of Hambantota is vital for international interconnections due to its efficiency and the benefit of the 25-kilometre quick journey between the harbour and Mattala Airport.

Those development plans were implemented within a short time and it causes changes mainly through reductions of green areas, an increase of manmade features like buildings, and even changing the land use in some areas. Such factors affect temperature fluctuations. Through this research, a study is conducted on the temperature variation due to the rapid development of the Greater Hambantota project. Remote sensing (RS) technology integrated with the Geographic Information System (GIS) system was used to conduct this study (Yue et al., 2013).

Methodology

Environmental parameters can be collected, investigated, and modelled using thermal infrared (TIR) remote sensing. It enables one to determine the land surface temperature (LST). This study used Landsat satellite images considering pre-development, during-development, and post-development phases. Different pre-processing techniques were used for this analysis.

Table 1: Satellite images used for the analysis

Satellite series	Year	Date Acquired	Weather
Landsat_5	2004	27.02.2004	Sunny
Landsat_8	2017	13.01.2017	Sunny
Landsat_9	2022	04.02.2022	Sunny

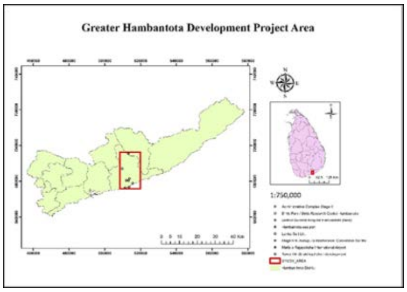

Figure 1: Study area

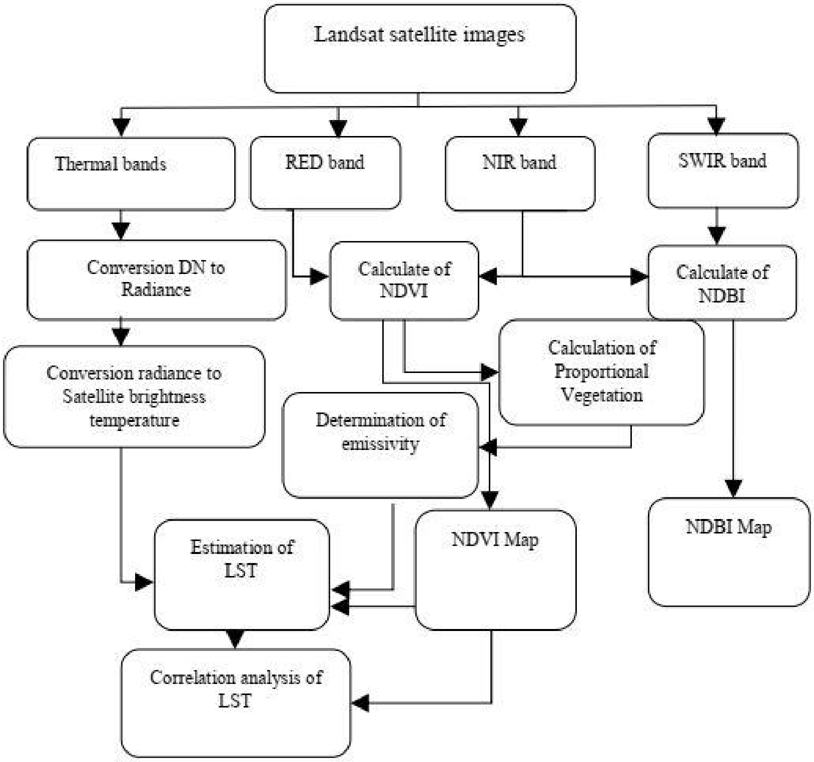

Figure 2: Experimental workflow

Results and Discussion

The findings addressed the study's objectives and analysed how the Arc GIS program was used to achieve results. It specifically addresses the temperature variations with the development processes conducted in each period. In addition, derived the relationships of temperature fluctuations with NDVI and NDBI.

A. LST analysis

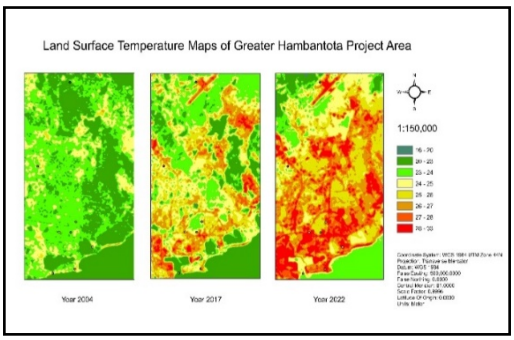

Figure 3: LST map

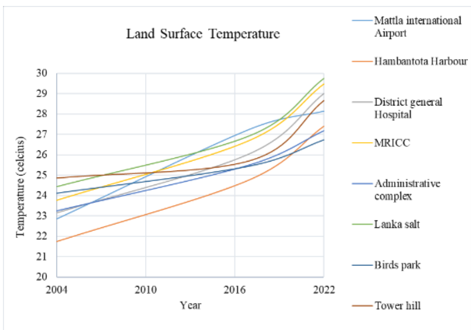

Figure 4: LST variation at project locations

When considering LST 2004, the highest area corresponds to the temperature range of 23-24, and in 2022, it moves toward to 25-26 range.
It reveals that land surface temperature gradually increased with the development activities.

B. NDVI analysis

Diverse NDVI variations were shown at the Mattala international airport project and NDVI value gradually decreased with time at all the project areas. When comparing the LULC changes in the Greater Hambantota development project area it illustrates that development processes mostly affected the reduction of sparse vegetation areas and shrub and grasslands. In addition, it demonstrated the increment in water areas due to the development of Hambantota Harbour (Deardorff, 1978).

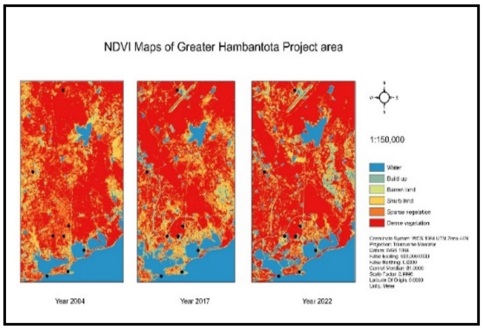

Figure 5: NDVI map

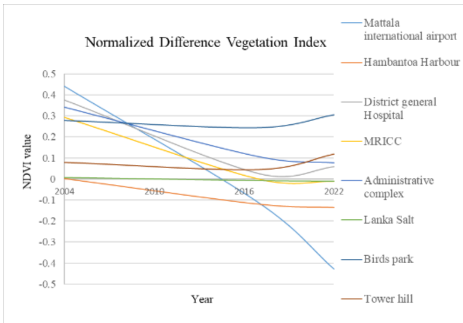

Figure 6: NDVI variation at project locations

C. NDBI analysis

Diverse NDBI variations were shown at the Mattala international airport project and NDVI value gradually increased with time at all the project locations.

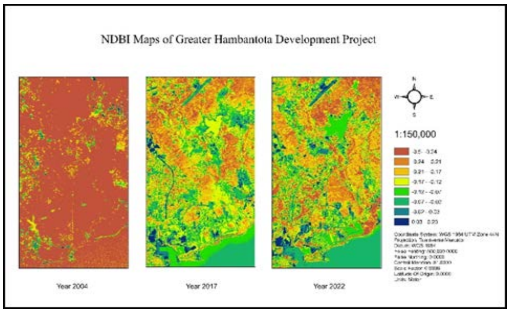

Figure 7: NDBI map

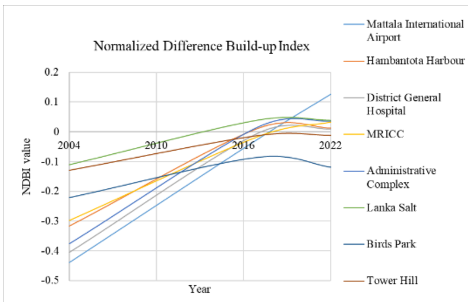

Figure 8: NDBI variation at project locations

According to values given by NDVI and NDBI calculations it was considered the temperature changes at the determined project locations with the LULC changes. As a final point, it was determined temperature fluctuation and correlations with LST with NDBI and NDVI value.

D. Correlation analysis

Table 2: Pearson product correlation coefficients

	2004	2017	2022
NDVI & LST	-0.15448	-0.30076	-0.18993
NDBI & LST	0.737439	0.127401	0.396544

The study demonstrates a positive correlation between LST and NDBI values and a negative correlation between NDVI and LST values. In summary, it can define that the reduction of NDVI values causes an increase in surface temperature. In addition, a positive correlation between LST and NDBI values means that it causes to increase in land surface temperature.

Conclusion

LST has a significant negative association with the NDVI, which is -0.15 in 2004 and -0.19 in 2022, and a largely positive relationship with the NDBI, which is 0.74 in 2004 and 0.40 in 2022. According to these values, it can be identified that an increase in NDVI values means the growth of vegetated areas caused to the reduction in the LST. Furthermore, an increase in build-up areas caused to rise in LST due to the raw materials and a decrease in green areas.

As an overall outcome, it depicted development processes and changes in LULC patterns' effects on the gradual increment of LST. As the LULC varied with the development, there may be a change in the land surface temperature also. Steel, concrete, tar, iron, chemicals, and other artificial substances are added to the environment. Then the heat radiation pattern can change according to the materials. With these constructions, the land surface temperature can be increased by a few more degrees. In addition, it reveals that NDVI values increased in the post-development phase caused the species' beginning of the reproductive period and ability to produce fruit or grain when exposed to temperature extremes (Hatfield and Prueger, 2015).

References

Deardorff, J. W. (1978). *Efficient prediction of ground surface temperature and moisture, with the inclusion of a layer of vegetation*. Journal of Geophysical Research, 83(C4), 1889. https://doi.org/10.1029/jc083ic04p01889

Hatfield, J. L. and Prueger, J. H. (2015) '*Temperature extremes: Effect on plant growth and development*', Weather and Climate Extremes, 10, pp. 4–10. doi: 10.1016/j.wace.2015.08.001.

Yue, W., Xu, J., Xu, L., (2013) '*International Journal of Remote The relationship between land surface temperature and NDVI with remote sensing: application to Shanghai Landsat 7 ETM + data*', (December 2013), pp. 37–41. doi 10.1080/01431160500306906.