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# REDUCED GREEN SPACE IN ITANAGAR-NAHARLAGUN OF NORTHEAST INDIA: A PRELIMINARY INVESTIGATION

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***Abstract:*** Urban Green Space (UGS) gives manifold benefits to human beings. Despite those benefits, rapid urbanisation causes a consequent loss of UGS. This paper emphasises the evaluation of the gradual but ongoing trend of reduced UGS in Itanagar-Naharlagun twin-city of Arunachal Pradesh, India, due to increased built-up area and declining vegetation over one decade, i.e., 2011 to 2021. Cloud-free satellite imagery from sources, i.e., USGS Earth Explorer, was used using Landsat 7 ETM+ and Landsat 8/9 OLI data at Level-1 preprocessing (L1TP) with geometric and radiometric corrections. Preprocessing steps include optional atmospheric correction and band stacking. NDVI and NDBI indices were calculated using specific band combinations (NIR, Red, and SWIR). Our findings indicate a marginal rise in the Built-up Area and a slight decline in the Non-built-up Area, as well as a noticeable decrease in areas with vegetation density from 2011 to 2021. Although these changes are relatively small, our results imply an urban expansion in the region over the decade. The author proposes that extensive research on UGS loss and its impact on the environment of Itanagar-Naharlagun be carried out to further investigate the negative impact of reduced UGS on human welfare and sustainability.

***Keywords:*** Arunachal Pradesh, environment, sustainability, urban green space, urbanisation

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## Introduction

Urban green spaces (UGS) are well known to provide a wide range of ecosystem services that could help combat many urban-related issues and

improve life for city dwellers. These *ecosystem services* largely depend on the physical *qualities* and *functions* of those spaces, and they give *benefits* and *values* for people (Haines-Young & Potschin, 2008). UGSs have a very important part in creating the space of cities because the quality of an urban area is a result of balanced distribution between buildings, transport infrastructure, and green spaces (Harasimowicz, 2018). Apart from ecosystem services, UGS provides several benefits to the urban dwellers in terms of environmental benefits, public health (Wolch et al., 2014; Jansson, 2014; WHO, 2016), psychological benefits (WHO, 2016), aesthetic value, and overall wellbeing (Dobson, 2018; Bertram & Rehdanz, 2015; WHO, 2016) apart from ecological, physical and economic benefits (MoUD, 2014; Jansson, 2014). According to the TCPO, GoI, MoUD (2014), urban green spaces are critical for making our cities sustainable, healthy, and energy efficient. It is unfortunate, however, that despite these benefits and services, green space cover is declining at a rapid pace worldwide, for which the reasons can be attributed to many factors, including urbanisation. Ongoing rapid urbanisation has resulted in various environmental hazards and climate change-related issues. In recent years, a lot of studies have documented urban growth and consequent loss of urban green spaces (Odindi & Mhangara, 2012). Few examples of such challenges include urban land use (e.g., Semararo et al., 2021; Sharma et al., 2022), impact on land surface temperature (Lian & Feng, 2022), urban climate (Rakhshandehroo et al., 2017; Volker & Neef, 2008), environmental degradation, loss of natural habitat and species diversity, changing local climate, the Urban Heat Island, and the rising level of pollution (Grimm et al., 2008). Harasimowicz (2018) has pointed out that increased population density and spatial expansion have exerted huge negative impacts on green areas and loss of urban green spaces (Odindi & Mhangara, 2012), which can transform green spaces into impervious landscapes.

Urban settlements transform the natural environment so greatly that people tend to see the city only as an employment site and an economic and cultural centre (Heidt & Neef, 2008). Thus, a growing number of people prefer to settle in the cities for various purposes such as employment, trade, education, medical purposes, and other conveniences. This trend has resulted in the rapid growth of urban populations across the globe, and the world's cities are becoming increasingly congested and polluted (Blanco et al., 2009). India is no exception. According to the Census of India (2011), 31.16% (37 crore) of the country's population resided in urban areas…and the urban component

is expected to rise to around 40% by 2026. Arunachal Pradesh, one of the northeastern states of India, shows a similar trend of a high urban growth rate of 37.55% and an annual growth rate of 5.44% (Census of India, 2011). In its Urban Mapping and Geo-database (December, 2021), the Department of Town Planning and Urban Local Bodies (ULBs), Government of Arunachal Pradesh, has pointed out that "the number of urban settlements in Arunachal Pradesh is experiencing relatively rapid growth and the percentage of state's population living in urban areas is expected to increase to nearly 40% by 2026 and cross 50% by 2051". This trend of unprecedented urbanisation has been fuelled by rapid economic growth and industrialisation (MoUD, 2014). This means that a larger number of settlements, as well as a larger percentage of the population, have to be planned for urgently to ensure the economic growth of the nation and the well-being of the people.

Therefore, ensuring sustainability in the urban environment has become a general concern among scientists and policymakers. Urban green space (UGS) has been suggested as an essential factor for advancing human wellbeing and sustainable urban development (Hunter et al., 2019; Maas et al., 2006; Lian & Feng, 2022). In other words, UGS is one such undertaking that is considered an important aspect of urban settlements as well as cities worldwide, as its contribution is a significant part of sustainable development. Urban green spaces play a remarkable role in reducing the bad consequences of the rapid rate of urbanisation (Li & Pussella, 2017).

## *Definition of Urban Green Space*

The definition of urban green space (UGS), which is generally agreed upon, is public space as well as private space in urban areas primarily covered by vegetation (Ali et al., 2018). According to Jim & Chen (2003), urban green spaces can be defined as vegetated areas which are found in urban environments and are named as semi-natural areas in a city. These areas can be covered with natural or man-made vegetation, but are present in built-up areas (Li & Pussella, 2017). The term "urban green space" is used to mean formal and informal green sites, and also to refer to "open spaces" that have the potential to provide ecological functions like sports clubs, playing fields, open barren land, etc. (Qureshi et al., 2010). In a general sense, however, "green space" also means any vegetated areas which are natural or man-made. They include forests, road trees, trees in parks, gardens and nature conservation areas…

parks, public gardens, road trees, etc. are intrinsic elements in urban planning as there are specific indications in urban plans that regulate the relationship between green and built spaces (Salbitano et al., 2016).

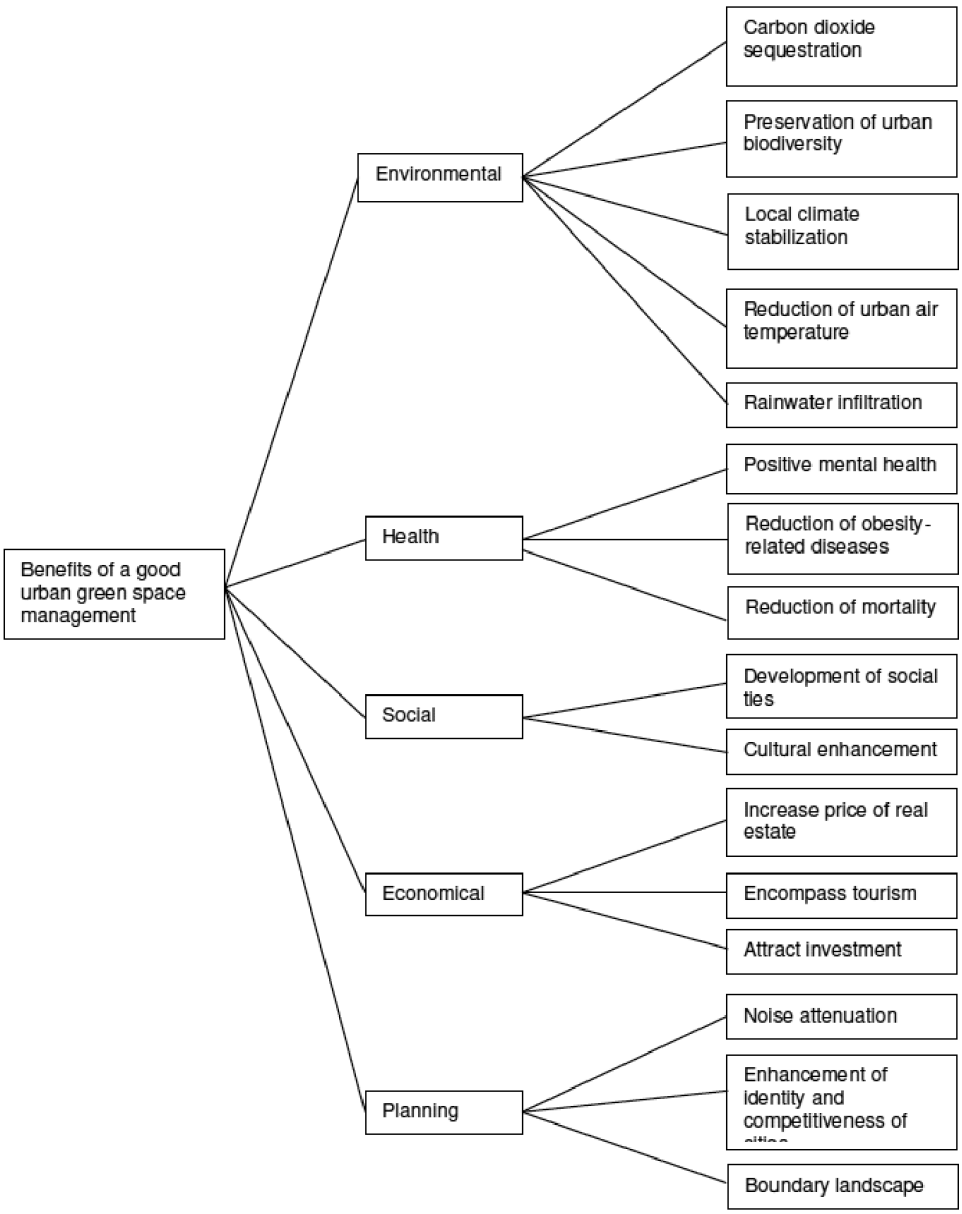


**Figure 1: Benefits of Good Urban Green Space Management**

*Source:* Yoong et al. (2017)

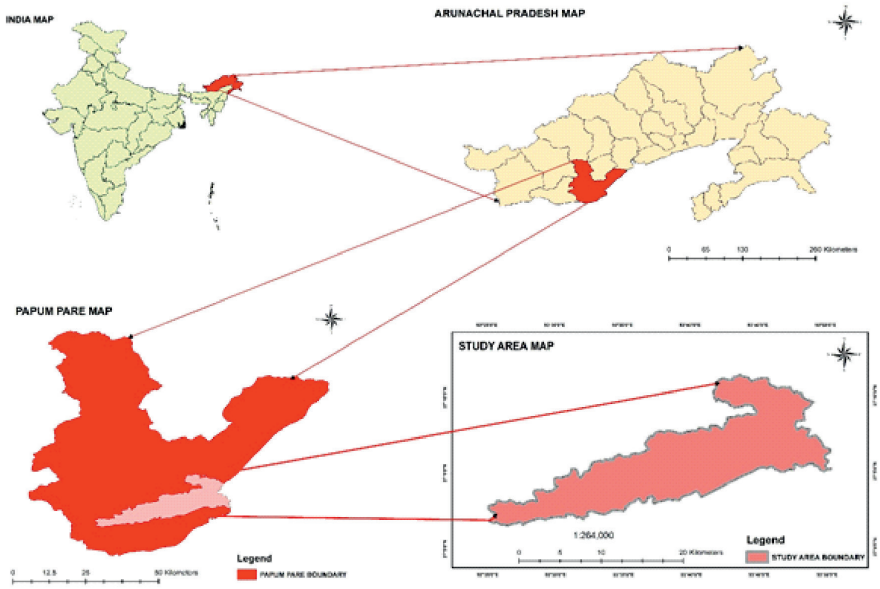


**Figure 2: Map of the study area**

## Objectives

The present study was carried out to examine if there is a decreasing trend in green space cover in Itanagar-Naharlagun twin-city, and if so, to propose an analytical approach for detailed investigations, which will help in effective and systematic development of green spaces.

## Materials and Methods

### *Study Area*

Itanagar and Naharlagun are the twin cities of Arunachal Pradesh, though the former remains the administrative capital of the state (Figure 2). The 'Itanagar-Naharlagun Complex' is often referred to so, to indicate the close proximity between the two as well as connectivity, which is closely connected in terms of economic, trade and marketing, travel, education, health facilities, etc. Itanagar is adjacent to Naharlagun with a road distance of 13 km. With its close correlates, Itanagar lies between 27.0844°N latitude and 93.6053°E longitude at an average altitude of 320 metres above sea level. Naharlagun, on the other hand, lies between 27.1086° N latitude, 93.6984° E longitude at an altitude of

155 metres above sea level. Both cities experience a humid subtropical climate, rich in natural resources and ecological conditions. The total geographical area of Itanagar is 167.09 sq km, and that of Naharlagun is 153.30 sq. km. According to the Department of Town Planning, Government of Arunachal Pradesh, the Itanagar-Naharlagun region comprises 18 urban wards (12 in Itanagar and 06 in Naharlagun region). For the purpose of the present study, the specific location of the study area was identified, where data was obtained from USGS Earth Explorer using Landsat 7 & Landsat 8-9 (Figure 2).

## *Extraction of Built-Up Areas*

To extract images classification of 2011 and 2021, we involved acquiring cloud-free satellite imagery from sources, i.e., USGS Earth Explorer, using Landsat 7 ETM+ and Landsat 8/9 OLI data at Level-1 preprocessing (L1TP) with geometric and radiometric corrections. Preprocessing steps include optional atmospheric correction and band stacking. NDVI and NDBI indices were calculated using specific band combinations (NIR, Red, and SWIR), with NDVI indicating vegetation density and NDBI identifying built-up areas. These indices were computed using formulas applied through GIS software like QGIS or ArcGIS (Rouse et al., 1974; Zha et al., 2003). Postprocessing includes thresholding, classification, and map generation with appropriate symbology. Final analysis involves interpreting high NDVI as dense vegetation and high NDBI as urban development, enabling spatial and temporal comparison for land use/land cover studies (Zha et al., 2003; Tucker, 1979).

The NDBI was calculated using the near-infrared band (NIR) and shortwave infrared band 1 (SWIR1) as follows (Xu, Liu, & Xu, 2018):

$$\text{NDBI} = \frac{\text{SWIR 1} - \text{NIR}}{\text{SWIR 1} + \text{NIR}}$$

*Where*, SWIR 1 is the Shortwave (Middle) infrared channel and NIR is the Near-infrared channel.

Similarly, the formula below was used for evaluation of NDVI:

$$\text{NDVI} = (\text{NIR-Red})/(\text{NIR+Red})$$

The values range from -1 to +1. A higher or more positive value indicates greater plant Vigour and general health.

## Results and Discussion

Between 2011 and 2021, there was a marginal rise observed in both the Built-up Area and the Non-Built-up Area (Table 1). The Built-up Area saw an increase from 35.75 sq km in 2011 to 36.31 sq km in 2021, representing an increase from 10.83% to 11.12% of the total area in 2011 and 2021, respectively. Conversely, the Non-Built-up Area experienced a slight decline from 294.37 sq km (89.17%) in 2011 to 293.81 sq km (88.88%) in 2021 (Figure 3).

As for green space cover (Table 1), the proportion of areas devoid of vegetation increased marginally by about 0.05% (from 0.23% to 0.28%), signifying a slight expansion in regions lacking vegetation cover. There was a notable decrease of approximately 4.36% (from 55.10% to 50.74%) in the portion of areas characterised by slightly dense vegetation, indicating a significant reduction in areas with lower vegetation density. Nevertheless, there was a slight increase of approximately 4.30% (from 44.67% to 48.97%) in the proportion of areas characterised by moderately dense vegetation, indicating a slight expansion in regions with moderate vegetation density (Figure 3).

**Table 1: Image classification of the study area based on NDBI & NDVI data**

| *Method* | *Year* | *Image Classification* | *Area (Sq. Km)* | *Area (%)* |
|---|---|---|---|---|
| NDBI | 2011 | Non-built-up area | 294.37 | 89.19 |
| | | Built-up area | 35.75 | 10.83 |
| | 2021 | Non-built-up area | 293.81 | 88.88 |
| | | Built-up area | 36.31 | 11.12 |
| NDVI | 2011 | No vegetation | 0.77 | 0.23 |
| | | Slightly density | 181.87 | 55.10 |
| | | Moderately density | 147.44 | 44.67 |
| | 2021 | No vegetation | 0.94 | 0.28 |
| | | Slightly density | 167.49 | 50.74 |
| | | Moderately density | 161.64 | 48.97 |

*Source:* NDBI & NDVI data

These results indicate an increase in the Built-up Area and a slight decrease in Non-Built-up Area, which suggests urban development or expansion in the region over the years. This could be due to factors such as population growth, economic activities, or infrastructure development. On the other hand, there has been a slight increase in regions without vegetation cover, possibly due to urbanisation, deforestation, or natural disturbances. Additionally, there

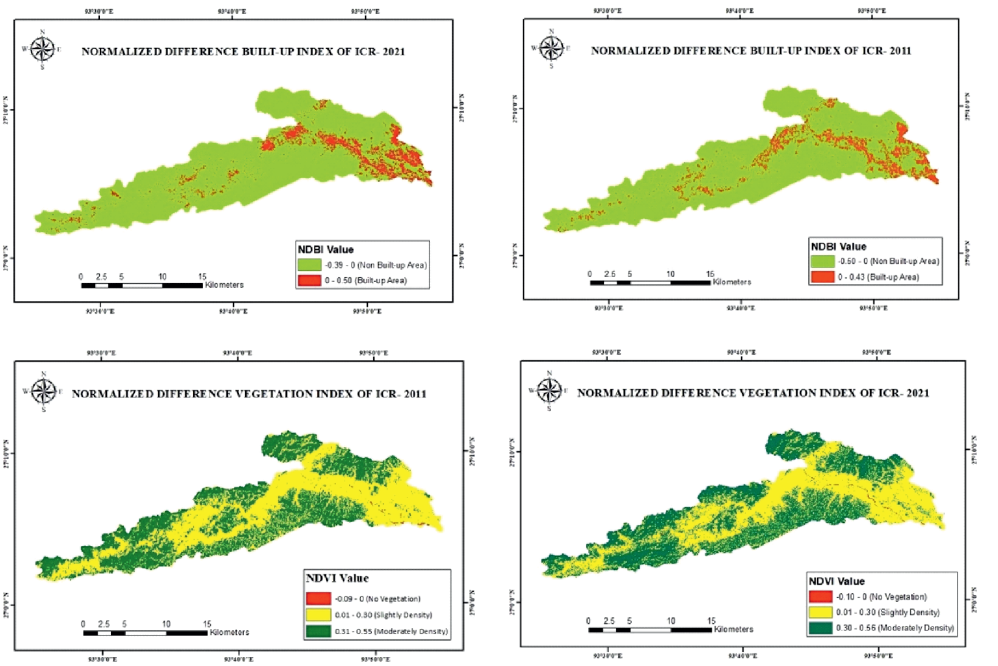


**Figure 3: Image classification of NDBI & NDVI (2011-2021)**

*Source:* NDBI & NDVI data

has been a noticeable decrease in areas with lower vegetation density, likely caused by changes in agricultural practices, land use, or environmental factors affecting vegetation growth. Furthermore, there has been a slight expansion in areas with moderate vegetation density. These changes suggest potential shifts in land use, environmental conditions, and human activities affecting vegetation cover in the region. Nevertheless, it is important to note that these changes are relatively small, indicating a relatively stable landscape over the decade.

## Conclusion

One of the primary objectives of this study is to evaluate if the green space cover (UGS) in the Itanagar-Naharlagun twin-city is declining similar to that of other cities in India, where reduced or loss of green space has led to various environmental challenges, such as impact on spatial patterns, settlements, land use, and loss of biodiversity. Although our results (overall) suggest a

subtle shift towards increased urbanisation or development in the region, as reflected by the slight increase in Built-up Area and corresponding decrease in Non-Built-up Area and Green Space over the decade from 2011 to 2021, this scenario of reduction of green space in Itanagar-Naharlagun twin-city cannot be overlooked. In its Urban Mapping and Geo-database (December, 2021), the report from the Department of Town Planning and Urban Local Bodies (ULBs), Government of Arunachal Pradesh, noted that "the number of urban settlements in Arunachal Pradesh is experiencing relatively rapid growth and the percentage of state's population living in urban areas is expected to increase to nearly 40% by 2026 and cross 50% by 2051", which is highly alarming. It is therefore a necessity that an analytical approach for detailed investigations, which will help in the effective and systematic development of green spaces in these cities, be initiated. Proper research model(s) with appropriate design in terms of data sources and processing, morphological spatial pattern analysis, etc., are important to be considered. Appropriate remote sensing images (with appropriate resolution) can be obtained from Optical Earth Observation Satellite (e.g., EOS-04 or Landsat) after which the same can be processed for radiometric calibration and atmospheric correction using appropriate RS software (Xu, Liu, & Xu, 2018). Land use and land cover (LULC) classification can be developed through random forest (RF) classifier; the image which can be classified into different LULC categories such as cultivated land, forest land, grass land, water area, construction land, and unused land. Further, appropriate data analysis can be employed to address the various issues pertaining to reduced green space and environment sustainability.

With this end in view, it is therefore hoped that future research(s) will shed insight on our deeper understanding of UGS and sustainability which would help other researchers and policy makers develop strategies to deal with the consequences of urbanisation, urban migration and industrialisation. No doubt, as Wolch et al. (2014) opined that urban green space strategies may be paradoxical, while the creation of new green space to address environmental justice problems can make neighbourhoods healthier and more aesthetically attractive, it also can increase housing costs and property values. Urban planners, designers, and ecologists, therefore, need to focus on urban green space strategies that explicitly protect social as well as ecological sustainability.

***Conflict of interest:*** None

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## Data availability

Data from this study will be made available upon reasonable request.

## References

Ali, F., Imran., M., Sajid, M., Ahmad, J., & Kumar, M. (2018). Urban green space: An approach to sustainable environment. *International Journal of Advance Research in Science and Engineering*, 7(1), 337-342.

*Bertram, C. & Rehdanz, K.* (2015). The role of urban green space for human well-being. *Ecological Economics*, 120(C): 139-152

Blanco, H., Alberti, M., Forsyth, A., Krizek, K. J., Rodriguez, D. A., Talen, E., & Ellis, C. (2009). Hot, congested, crowded and diverse: Emerging research agendas in planning. *Progress in Planning*, 71(4),153-205.

Census of India (2011). Census of India 2011, National Population Register & Socio Economic and Caste Census

Department of Town Planning and ULBs. (December, 2021). *Urban Mapping and Geo-Database generation with formulation of GIS based Comprehensive Master Plan for Lemmi, Tato & Basar district Headquarters of Arunachal Pradesh using Remote Sensing and GIS* (RFP). Government of Arunachal Pradesh.

Dobson, J. (2018). From contest to context: urban green space and public policy. *People, Place and Policy*, 12(2), 72-83.

Grimm, Nancy B., Stanley H. Faeth., Nancy E. Golubiewski, Charles L. Redman, Jianguo Wu, Xuemei Bai, and John M. Briggs. (2008). "Global Change and The Ecology of Cities," *Science* 319: 756-760.

Haines-Young, R. and Potschin, M. (2008). *England's terrestrial ecosystem services and the rationale for an Ecosystem Approach*. Full Technical Report for Defra.

Harasimowicz, A. (2018). Green spaces as a part of the city structure. *Environmental Policy and Management*, 2(65), 45-62.

Heidt, V., Neef, M. (2008). Benefits of Urban Green Space for Improving Urban Climate. In: Carreiro, M.M., Song, YC., Wu, J. (eds) *Ecology, Planning, and Management of Urban Forests*. Springer, New York, NY. https://doi.org/10.1007/978-0-387-71425-7_6

Hunter, R.F., Cleland, C., Cleary, A., Droomers, M., Wheeler, B.W., Sinnett, D., Nieuwenhuijsen, M.J., & Braubach, M. (2019). Environmental, health, wellbeing, social and equity effects of urban green space interventions: A meta-narrative evidence synthesis. *Environ. Int.*, 130, 104923. [CrossRef] [PubMed]

Jansson, M. (2014). Green space in compact cities: the benefits and values of urban ecosystem services in planning. *Nordic Journal of Architectural Research* 2, 139-160. http://arkitekturforskning.net/na

Jim C.Y., & Chen S.S. (2003). Comprehensive green space planning based on landscape ecology principles in compact Nanjing city, China. *Landscape Urban Planning*, 65, 95-116.

Li L., Pussella P.G.R.N.I. (2017). Is Colombo City, Sri Lanka secured for urban green space standards?. *Applied Ecology and Environmental Research*, 15(3), 1789-1799.

Lian, Z., & Feng, X. (2022). Urban green space pattern in Core Cities of the Greater Bay area based on Morphological Spatial Pattern Analysis. *Sustainability*, 14, 12365. https://doi.org/10.3390/su141912365

Maas, J., Verheij, R.A., Groenewegen, P.P., de Vries, S., & Spreeuwenberg, P. (2006). Green space, urbanity, and health: How strong is the relation? *J. Epidemiol. Community Health*, 60, 587–592. [CrossRef] [PubMed]

MoUD (2014). *Urban Green Guidelines, 2014*. TCPO, GoI, MoUD

Odindi J.O., & Mhangara P. (2012). Green Spaces Trends in the City of Port Elizabeth from 1990 to 2000 using Remote Sensing. *International Journal of Environmental Research*, 6(3), 653-662.

Qureshi S., Breuste J.H., & Lindley S.J. (2010). Green Space Functionality along an Urban Gradient in Karachi, Pakistan: A Socio-Ecological Study. *Human Ecology: An Interdisciplinary Journal*. 38, 283-294.

Rakhshandehroo, M., Yusof, M. J. M., Arabi R., Parva, M., & Nochian, A. (2017). The environmental benefits of urban open green spaces. *Alam Cipta*, 10(1), 10-16.

Rouse, J.W., Haas, R.H., Schell, J.A., and Deering, D.W. (1974). Monitoring Vegetation Systems in the Great Plains with ERTS. *Third ERTS-1 Symposium NASA, NASA SP-351, Washington DC*, 309-317

Salbitano, F., Borelli, S., Conigliaro, M., & Chen, Y. (2016). *Guidelines on Urban and Peri-Urban Forestry*. Food and Agriculture Organization of the United Nations: Rome, Italy. FAO Forestry Paper No.178.

Semeraro, T., Scarano, A., Buccolieri, R., Santino, A., & Aarrevaara, E. (2021). Planning of Urban Green Spaces: An Ecological Perspective on Human Benefits. *Land*, 10, 105. https://doi.org/10.3390/land10020105

Sharma, R., Pradhan, L., Kumari, M., & Bhattacharya, P. (2022). Urban Green Space Planning and development in urban cities using geospatial technology: A case study of Noida. *Journal of Landscape Ecology*, 15(1), 27-46.

Tucker, C.J. (1979). Red and photographic infrared linear combinations for monitoring vegetation. *Remote Sensing of Environment*, 8(2), 127–150.

Volker, H. and Neef, M. (2008). Benefits of urban green space for improving urban climate. In. M.M. Carreiro et al. (eds.), *Ecology, Planning, and Management of Urban Forests: International Perspectives.* © Springer 2008

WHO, (2016). *Urban green spaces and health.* Copenhagen: WHO Regional Office for Europe, 2016.

Wolch, J., Byrne, J., & Newell, J. (2014). Urban Green Space, Public Health, and Enviromental Justice: The Challenge of Making Cities 'Just Green Enough'. *Landscape and Urban Planning,* DOI: 10.1016/j.landurbplan.2014.01.017

Xu, R., Liu, J., & Xu, J. (2018). Extraction of High-Precision Urban Impervious Surfaces from Sentinel-2 Multispectral Imagery via Modified Linear Spectral Mixture Analysis. *Sensors*, 18(9):2873.

Yoong, H. Q., Lim, K. Y., Lee, L. K., Zakaria, N. A., & Foo, K. Y. (2017). Sustainable urban green space management practice. International Malaysia-Indonesia-Thailand. Symposium on Innovation and Creativity (iMIT-SIC), Vol 2 (2017) pp 362- 371. e-ISBN: 978-967-14017-5-0

Zha, Y., Gao, J., & Ni, S. (2003). Use of normalized difference built-up index in automatically mapping urban areas from TM imagery. *International Journal of Remote Sensing*, 24(3), 583–594.