Mapping Methodology of Public Urban Green Spaces Using GIS: An Example of Mysuru City, India

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Abstract- Urban green spaces (UGS) offer social and environmental benefits to urban life. However, the urban green spaces are not distributed equally. Urban parks constitute critical biodiversity hotspots in crowded, concrete and dominated city environment the study explored mapping methodology to create thematic map of public urban green spaces using GIS, a thematic map of Mysuru city, India was prepared. The objective of the study is to map UGS in Mysuru, using the Normalized Difference Vegetation Index (NDVI), uncover differences in the spatial distribution of urban parks and to find out various served, over served and unserved areas of the city. Change in amount of greenness of the study area during the specified year is compared by finding Normalized difference vegetative index values with help of Arc GIS. Fish net is created to find the distribution of parks within the study area. And observed that there is increase in vegetation cover within specified period and the distribution. This study helps planners and policy makers for sustainable development of the city by conserving the urban green spaces.

Indexed Terms- Public urban green space, Normalized differential vegetation index, Buffer analysis, FishnetServed, Underserved, Overserved.

I. INTRODUCTION

Cities, towns, and settlements cover less than 1% of the earth's surface and account for only 0.49–0.65 percent of global built-up land, but they house more than half of the world's population and have widespread ecological impacts. Various studies have attempted to highlight the importance of UGS for urban inhabitant well-being and urban sustainability. The heat island effect has been reduced thanks to UGSs. It also maintains ecological balance, protects biodiversity, improves physical and mental health and promotes quality of life and health equity. Green infrastructure is seen as a natural way to improve urban resiliency in the face of climate change. Researchers, policymakers, and international organizations are increasingly supporting and advocating the change in built-up environment by making provisions for effective and cost-efficient UGS to support population health. However, within urban regions, these UGSs are dispersed and unevenly distributed. According to studies, UGSs become uniformly distributed along the rural–urban gradient, but they are very dynamic and sensitive to percentage change in the city core. The cause for disproportionate distribution differs per city and is a subject of further investigation According to studies; UGSs are unequally distributed in cities, putting marginal people at risk of health and climate-related consequences. The issue of environmental justice arises due to unequal access to UGS. It is stated that a thorough investigation of UGS distribution within the context of environmental justice can lead to improved planning concepts. For planning officials, a similar perspective on the quantitative and qualitative use of UGS spatial data and its distribution is essential. In the environmental justice movement, addressing concerns of inequitable distribution of natural resources or environmental amenities is critical. The distributional justice theory is founded on the notion of balancing advantages throughout society's segments because the availability of green spaces is linked to city dwellers' physical and emotional well-being, their distribution has a significant impact on the quality of life of many segments of society. Environmental justice concerns the availability of UGS and their accompanying environmental benefits. The focus has switched in the last decade to the spatial distribution of UGS and their equitable distribution across all socioeconomic groups. According to studies, major environmental justice challenges develop in the global north due to a lack of enough income and access to various environmental amenities, particularly for non-white people. Due to different urban issues, the discussion on environmental amenities for diverse strata of society is particularly essential, especially in light of India's social and economic situations. For Indian cities, issues of urban sustainability and human well-being are critical. The study is being carried out against this backdrop in order to achieve the following goals (1) to map UGS in Mysuru, using the Normalized Difference Vegetation Index

(NDVI), and to calculate the change in UGS from 2000 to 2020 (2) to uncover differences in the spatial distribution of urban parks across Mysuru, India and perform buffer analysis and (3) to find out various served, over served and unserved areas of urban parks for the year 2022 and relate it with spatial distribution.

II. STUDY AREA

Mysuru, Karnataka's second most populus city, is located at the foot of the Chamundi Hills and is one of the most important cities in the state. According to Census 2011, Mysuruhas a population around 9.95 lakh. Since a decade, the city has expanded swiftly, including a 20-kilometer radius and is well-known for its culture and tradition. Mysuru is a major educational, commercial, and governmental centre as well as a popular tourist destination. Mysuru City is located at 12.30°N 76.65°E and is 770 metres above sea level. Mysuru is located in the tropics, with winter temperatures ranging from 16° C to 27°C and summer temperatures ranging from 27° C to 35°C. The average annual rainfall is around 800 mm. Parks and open spaces, as well as water bodies, occupy 13.74 percent and 2.02 percent of total land area in Mysuru, respectively.

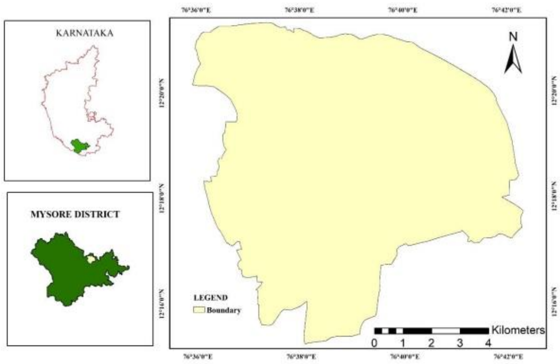

FIG 1: Study area of Mysuru city

III. MATERIAL AND METHODOLOGY

City boundary is downloaded from urban development department, government of Karnataka. Boundary of the study area is obtained by geo-referencing the municipal city boundary with a reference map. Landsat 8 images are downloaded from USGS Earth explorer to find out the normalized difference vegetation index (NDVI). Road network within the study area are downloaded from Indian administrative boundary is obtained from Diva GIS.

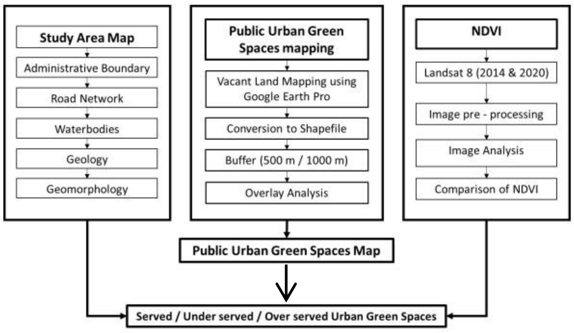

FIG 2: Flow chart of methodology

A. Study Area Map

Shape file of the boundary is obtained by geo-referencing the reference map in ArcGIS. Polygon shape file created in the name of boundary and digitized in the ArcGIS. The boundary shapefile is then converted to kmz format to digitize vacant land, water bodies and buildings. The road network of the study area is downloaded from OSM and performing clip operation in ArcGIS. Geology and Geomorphology of India is obtained from Bhukosh in shapefile format. Then geology and geomorphology of the study area is obtained by performing clip operation Indian shapefile respect to boundary/ study area.

B. NDVI Comparison

To find out NDVI satellite images of Landsat 8 were downloaded from USGS Earth explorer. Study includes NDVI values comparison for the year 2014 1nd 2020, So Landsat 8 images of the study area downloaded for the year 2014 and 2020. For the better comparison both the images are downloaded from post monsoon season means November month. B4 AND B5 bands of both the images are pre-processed before calculating the NDVI values. B4 and B5 band layers are selected and clip operations are performed using raster clip processing tool. Then NDVI index was calculated using spatial analyst tool, map algebra, raster calculator using the formula mentioned below

NDVI for Landsat 8 = (Band 5(NIR)-Band 4(R)) / (Band 5(NIR)+Band 4(R))

Where, NIR = near-infrared bands (0.85–0.88 micrometre) of Band 5,

R = red bands (0.64–0.67 micrometre) of Band 4.

Green vegetation reflects less in red band of visible spectrum band, and more in near-infrared band. Less vegetation reflects more in red band of visible spectrum and lesser in near- infrared band. By using these characteristics in ratio the NDVI index is formed, its index related to photosynthetic capacity.

Higher the index results in greater the chlorophyll content.

Table 1 : NDVI Classification range

CLASS	NDVI RANGE
Areas of barren rock, sand or snow	Less than 0.1
Sparse vegetation – shrubs, grassland, seasoning crops	0.2 to 0.5
Dense vegetation	Greater than 0.6

C. Urban Green Space Mapping

Google earth pro software is used to digitize the features of vacant land, buildings and water bodies. Public urban green spaces include Playground area, park area, forest area, scrub area, open land and agricultural are, Building includes single and multi-storey buildings and water bodies includes river and tanks. Boundary shapefile is opened in Google earth pro desktop, create a respective folder and create a polygon under the folders. The polygons area converted to shapefile using conversion tool in ArcGIS 10.8. Parks alone are considered for the buffer analysis. Using this buffer analysis, we find the area of single and multiple which are benefited from the parks with in the 500 m and 1000m zone. Buffer of 500m and 1000m are created for the parks within the study area from analysis tool (proximity tool). Created buffer areas are clipped with respect to boundary. Fishnet creates feature class containing a net of rectangular cells. Fishnet of 90m * 90m was created by Data management tool, sampling, create fishnet. Created fishnet is clipped with respect to 500m buffer to classify the area based on serve. To calculate the amount of served, underserved and overserved area Road network, parks, fishnet, and buffer of 500m are used in a layer of table of contents. Serve of the park is updated in the fishnet shapefiles attribute table. Differentiate each grid with served, underserved and overserved and update it with fishnet layer.

IV. RESULTS AND DISCUSSION

A. Inference of NDVI index 2014 and 2020

From the figure 3 NDVI values for the year 2014 lies in between -0.005 to 0.5. The highest NDVI index value for the year 2020 is 0.64 and the lowest value is -0.007. The satellite images are taken during post monsoon season which is favourable for vegetation. NDVI index for the year 2020 is considerable increased compare to 2014. Overall increase in green space is good in the year 2020. The vegetation is converted from low and moderate vegetation to moderate and dense vegetation.

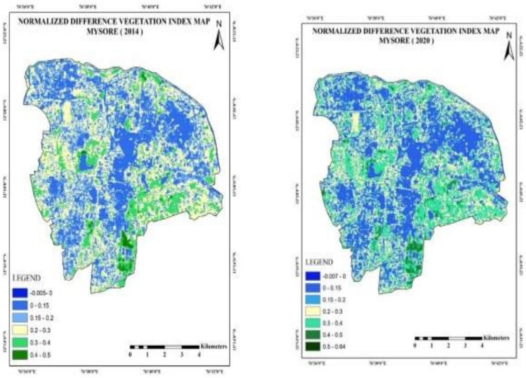

FIG 3: NDVI results for the year 2014 and 2020

B. Inference of buffer analysis

From the figure 4 buffer analysis of 500m and 1000m were performed to know the spatial distribution of urban green parks across the city. For 500m buffer we come to know that the parks are not evenly distributed throughout the city. Southern, northern and some middle part of the Mysuru city is not benefited from urban parks of 500 m buffer. The total area of Mysuru city is 85151125m^2 (85. 15 square km), but the area benefited considering 500m radius is 70125755m^2 (70.12 square km) and the area of single building and multiple building benefited for the 500 m buffer is 5628190 m^2 and 22715426 m^2 For the buffer analysis of 1000m the parks are distributed evenly except in southern part of the city but it is near to forest cover. Over the total area of the city boundary, the city benefited for 1000m buffer is about 81869130m^2 (81.86 square km). Area of single building and multiple building are benefited for the 1000m buffer is 8122550m^2 and 26042170m^2.

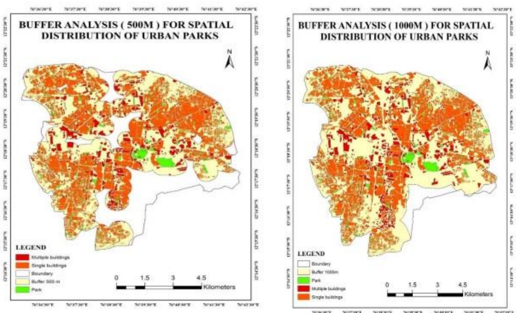

FIG 4:Buffer analysis results for 500m and 1000m

C. Spatial distribution of serve of the area

The spatial distribution of served, over served and underserved area in the study area is found by dividing the area into 90m * 90m grids by creating a fishnet Underserved area is situated towards outside of the 500-meter buffer zone. Amount of served area is 28155208m^2. And amount of overserved area is 23157428m^2.amount of underserved area is 18809014m^2.

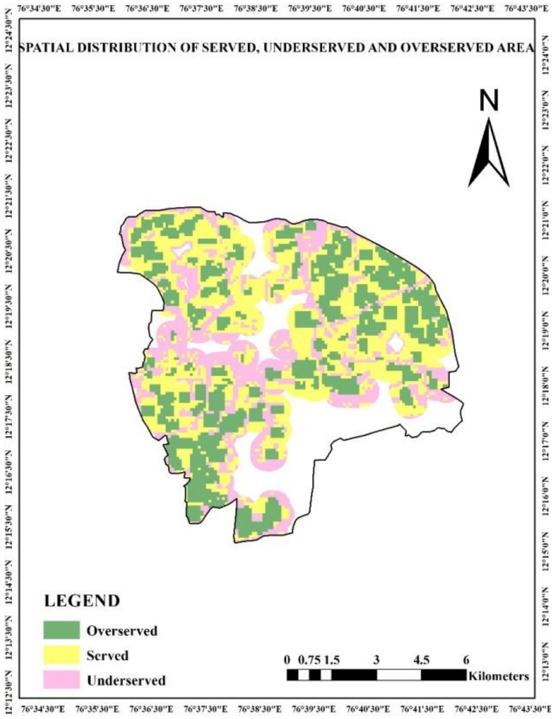

FIG 5:Spatial distribution of serve of the area

CONCLUSION

The study has shown spatial distribution of urban green spaces and the health of the vegetation is examined in the study area using NDVI index. The vegetation cover increased from the year 2014 to 2020 and also the built-up area increases. Buffer analysis is performed to know area single and multi-storey buildings which are benefited within the buffer area. The effectiveness of parks serve to the public is determined by creating a fishnet. The adopted methodology is time consuming, also manual mapping of buildings and vacant land includes road networks which results in overestimation of building area and vacant land. However spatial distribution shows within the 500m buffer served and overserved area is more compare to underserved area. Underserved areas are improved by constructing roads for public to access roads. In addition to this, in future per capita availability of UGS mapping, heat island effect with USG mapping, public healthiness mapping is suggested. Strengthening green cover from household to city level will decrease the environmental degradation.

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