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Environmental monitoring for rooftop green flooring in Lahore, Punjab, Pakistan using geospatial techniques

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Abstract

The rural exclusion and urban sprawl in the Metropolitan area after the 1950s resulted in diverse environmental issues, which include mistreatment of natural resources and pollution of the environment, while the unrestricted urban growth caused too much pressure on existing structures affecting buildings, public services, quality water, and public health. Several research studies have suggested vegetated roofing can reduce ecological issues by reducing heat flow and solar reflection, reducing energy use in building buildings, minimizing air pollution, air cooling, and managing effectively the effect of urban heat island. Urban green areas have supplied a variety of opportunities for residents and can play a major part in developing economics, social and environmental interpretation. The review investigates the capability of the green rooftop and evaluates its benefits in contrast with the Model Town with the Ganj Kalan Union Councils of the city Lahore. High goal symbolism was utilized from which developed region were removed and dissected the proportion among NDVI and NDBI from these pictures. Land Surface temperature and get various reaches in regards to high and low, then, at that point, we need to do weighted overlay with the high-temperature region and developed (vector data).so we need to distinguish the rooftops which required the rooftop top green deck. As per examination which has a high advantage with a high worth of temperature that spots are recommended for green ground surface. It's an activity strategy to plan profoundly appropriate regions.

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The old green rooftops were the Hanging Gardens around 500BC. (Vijayaraghavan K. 2016). UGI would natural be able to woodland fixings, amusement regions, arranged nurseries, golf resorts, local plants, and more refined choices like green rooftops, green dividers, bio channels, and trickle water system (Barnhill. 2012). This review talks about the absorption of UGI further into the local area aspect to change monstrous metropolitan mugginess and considers the distinctive UGI types and potential regions (Norton. 2015). Green rooftops are capable, at the structure and city level, to give additional free green regions without adversely affecting the essential administrations of occupants or the everyday life (Hag. 2011). Files are valuable on the off chance that they are viable in connecting them to correspondence organizations to follow changes (Berardi. 2014). It is clear vegetated cover was powerful for lessening the air temperature (Bowler. 2010). As indicated by (Copas. 2013) report, neighborhoods are wonderful, driving social-regular frameworks that depend on the adequacy related standard surfaces for constant worthiness. A concentrated green rooftop as a rule has a higher thickness, somewhere in the range of 150 and 400mm. A semi-concentrated green rooftop has a thickness of 120-250mm, while a broad green rooftop has a thickness of 60–200mm (Porcaro, et al., 2019). Vegetation is being diminished because of the great pace of Urbanization (Van de Voorde, 2017). Addition of dormant thawing out by evapotranspiration, by rising air stickiness (Köhler, 2003).

Materials and methods

For the appraisal of the advantages of a limited scale green rooftop execution for the city of following angles were analyzed: The spatial express assessment of the accessible green rooftop regions. The appraisal of the development regions by the digitization. Work out the proportion of developed and vegetated regions. Compute the Land surface temperature. Do a correlation among NDVI and LST. Do a correlation among NDBI and LST. Overlay the developed and LST. Proposed the region which has high LST. Lahore is the populated district of Pakistan. Land surface temperature is a basic part/pointer for all pieces of ecological components inside a space still hanging out there. The perceptual assortments in leftovers surface temperature can be investigated using warm datasets from Landsat. Such data sources have all the earmarks of being enthused about the shot at working out temperature regards reliant upon pixels. We surveyed perceptual models and endeavored their consistency with different affiliations like the Normalized Built-up Difference Index (NDBI), Normalized Difference vegetation record (NDVI). There were different other reliable advantages of this examination which are sincere to dissect the environmental impact of temperature and vegetation on metropolitan regions. To depict spatiotemporal separations in made water and vegetation consolidates, the Landsat symbolism list in the table under is accessible on the United States Geological Survey site. These datasets have various social events that are significant for enrolling NDVI, NDBI, and LST of a given day.



Fig. 2. Flow Chart of Study.

Fable 1. Landsat image acquisition dat	es.
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SN	Date	Landsat Series
1	May 30, 2000	Landsat 5
2	May 26, 2010	Landsat 5
3	May 18, 2013	Landsat 8
4	May 19, 2019	Landsat 8



Fig. 1. Study area map.

Find the Land Surface Temperature

Conversion to TOA Radiance

1. Upper Atmosphere:

UA= Radiance_multiband*Band + radiance additive band

2. Resplendence Temperature:

BT= (k2_constant_band/ln ((k1_constant_band /TOA) +1))-273.15

- 3. Normalized Difference Vegetation Index:
- NDVI= NIR-RED/NIR+RED
- 4. Relationship of Vegetation:
- PV= squ((NDVI+Min)/(MAX-MIN))
- 5. Inactivity:
- EM= 0.004*PV+0.986
- 6. Temperature of Land Surface:
- LST= (BT/(1+(0.0115*BT/1.4388*LN(EM))))

Calculate the Built-up and vegetation index

NDVI is a crop record commonly associated with crop improvement / oxygenation to articulate vegetation levels and strengths. Vegetation index using infrared detection and red band. Similarly, we undoubtedly take those ranges to account for nutrition zones. Vegetation is generally ridiculous in the near infrared and is rarely represented by the red band. NDVI is not resolved with going with conditions

NDVI = NIR-Red/ NIR+ Red

- NDVI = -1 to 0 portrays irrigation
- NDVI = -0.1 to 0.1 portrays Barren land, sand, or snow
- NDVI = 0.2 to 0.5 portrays forestry and greenery
- NDVI = 0.6 to 1.0 portrays highly vegetation

Normalized derivative development indexes are often used to represent urban areas and vacant lots. The ground is clearly visible in the near infrared and much lower in the near infrared. These two bands are useful for urban calculations. The NDBI estimation formula is as follows

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

Results and discussions

NDVI and NDBI of Union Council Model Town This review deciphers the survey by creating legitimate guides, tables, and charts that show that the aftermath

of the survey is interrelated, and uses a geological data framework that occupies a significant part in the complex. Spatial understanding by establishing links between collections of variational information that will help you achieve your goal of approving and displaying the results you are doing. The study included two Lahore Association committees in the review area. Model Town and Gunji Karan.



Fig. 2. NDVI and NDBI Calculation Map of Union council Model Town 2000-2019.

Table 2. Union Council area of Model Town based on NDVI and NDBI.

Year	NDVI Area (Km²)	NDBI Area (Km²)
2000	0.5958	0.4797
2010	0.9765	0.6300
2013	1.2447	0.6732
2019	1.2789	0.6870

The Normalized Difference Vegetation Index (NDVI) represents the readings of satellite sensors. The magnitude of the NDVI lies between the reflectance value and the tendency to radiate (Li and Liu, 2008). The value of NDVI I is definitely between 1 and +1. Little but not wide, zero features indicate barren land, rocks, and snow, and features in the range 0.6 to 1 indicate dense vegetation.

The normalized qualified vegetation list records green patches on a pixel-by-pixel basis. NDVI is controlled using the near-infrared and red bands of Landsat data (Nageswar. 2005). Similarly, we used the NDVI results to calculate the surface temperature. As you can see from the fig. above, the area of NDVI was 0.5958 km2 in 2000 and 0.9765 km2 in 2010, which is the same as 1.2447 km2 in 2013 and 1.2789 km2 in 2019. This shows that the overgrown area has expanded considerably over time.

This has a reasonable effect on lowering the temperature. NDBI is a normalized dataset created by diffs for locales created using the better caliber (Zha). 2003). Overall, the NDBI range is between 1 and +1. Negative values place more emphasis on body of water and poor vegetation quality.

Two Landsat bands are used to notice the SWIR and the IR NDBI. SWIR reflects more areas of improvement and soil revealed than NIR. The infrared range does not consider the body of water. The NIR range is more important than the SWIR range because the surface is green. As you can see from the fig. above, the area of NDBI in 2000 was 0.4797 km2 and the area in 2010 was 0.63 km2. This is the same as the 2013 NDBI area of 0.6732 km2 and the 2019 area of 0.687 km2. The area of the model city will expand over time. This is not a fair impact on the environment.

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Fig. 3. NDVI and NDBI Calculation Map of Union council Gunj Kalan 2000-2019.

Table 3. Union Council area of Gunj Kalan basedon NDVI.

Year	NDVI Area (Km ²)
2000	0.2124
2010	0.0621
2013	0.0189
2019	0.0081



Fig. 4. Land Surface Temperature of Union Council Model Town.

Table 4. Comparison between NDVI and LandSurface in Model Town.

Year	NDVI Area (Km²)	Total Area of Model Town (Km²)	Perc entage (%)	LST_ High	LST_ Low
2000	0.5958	6.2388	9.5	33.3743	27.5934
2010	0.9765	6.2388	15.7	48.506	36.8208
2013	1.2447	6.2388	20.0	37.7236	31.6457
2019	1.2789	6.2388	20.5	38.2207	32.5759

The maximum temperature ranges from 2000 to 2019 is 4.8464°C and the minimum temperature is

4.9825°C. This is covered as there are genuine plans for the expansion of vegetation.

Year	NDVI Area (Km ²)	Total Area of Model Town (Km ²)	Percentage (%)	LST_High	LST_Low
2000	0.2124	0.6951	30.6	32.8702	30.0181
2010	0.0621	0.6951	8.9	50.3086	46.6877
2013	0.0189	0.6951	2.7	39.2504	37.5192
2019	0.0081	0.6951	1.2	38.0398	36.245

Table 5. Comparison between LST and NDVI in Gunj Kalan.

Table shows the mapping between NDBI and LST. as. As the NDBI locale grows, there are more choices for temperature. Overall, the minimum temperature value does not drop unnecessarily. In 2019, the difference between cold and hot is only 2 degrees. This does not help with periodic effects. The model city is an organized membership room that pays little attention to Gunj Kalan.

Table 6. Comparison between LST and NDBI in Union Council Model Town.

Year	NDVI Area (Km ²)	Total Area of Model Town (Km²)	Percentage (%)	LST_High	LST_Low
2000	5.6430	6.2388	90.5	33.3743	27.5934
2010	5.2623	6.2388	84.3	48.506	36.8208
2013	4.9941	6.2388	80.0	37.7236	31.6457
2019	4.9599	6.2388	79.5	38.2207	32.5759

Table 7. Comparison	between L	LST and ND	BI in G	unj Kalan
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Year	NDVI Area (Km²)	Total Area of Model Town (Km ²)	Percentage (%)	LST_High	LST_Low
2000	0.4797	0.6951	69.0	32.8702	30.0181
2010	0.6300	0.6951	90.6	50.3086	46.6877
2013	0.6732	0.6951	96.8	39.2504	37.5192
2019	0.6870	0.6951	98.8	38.0398	36.245



Fig. 5. Roof top flooring proposed areas from 2000-2013.



Fig. 6. Temperature variation.





Map deals with the proposed location of the upper earth surface of the greenhouse roof, and Fig. 3.5 shows the different ranges of temperature in Ganj Kalan. From the above evaluation, we conclude that Fig. 3.6 shows that different locations of green roofs of Gandikaran are proposed for a better environment, thereby lowering the temperature of Gandikaran that is lowered by the rooftop greening surface of the model city.

Conclusion

Research shows that between 2000 to 2019 there are varieties in the developed region, vegetated region, and LST. There is a significance enlargement in Land Surface Temperature during the maximum current 19 years, round 5°C expansions in Land Surface Temperature in Model Town. There is large extrude due to augmentation within side the vegetated location and decrement within side the advanced document location, which assists with controlling the LST extrude. In Gunj Kalan maximum insignificant LST changed into 30.0181°C, and the maximum raised Land Surface Temperature changed into 32.8702°C recuperated.

In the 12 months 2010, the maximum negligible LST changed into 46.6877°C and the maximum raised Land Surface Temperature changed into 50.3086°C evaluated. In the 12 months 2013, the maximum insignificant LST changed into 37.5192°C and the maximum raised Land Surface Temperature 39.2504°C recuperated. In the 12 months 2019, the maximum insignificant LST is 36.245°C and the maximum raised Land Surface Temperature is 38.0398°C. Arranged region has enormous upsides of NDVI and less upsides of NDBI additionally there is less variety of temperature in Model Town. In Gunj Kalan impromptu region quick increment found in developed which causes high temperature.

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