Urban Heat Island assessment.

Visualization - [Spatial Data Portal (runguma.github.io)]

Urban Heat islands in Gaza Palestine

The assessment of urban heat in Palestine unveiled an unanticipated aspect of urban heat islands, previously unforeseen at the outset of the study. The unexpected situation revolved around varying land cover types and their differential heat absorption capacities, as sandy and rocky bare lands absorb more heat during the day than urban areas.

The primary emphasis of this analysis centered on the effects of the war in Gaza when assessing urban heat islands. Among the key focal points were the mean land surface temperature (LST) and the consequences of land cover transformation from built-up to bare land, resulting from the destruction of urban infrastructure and green areas due to the conflict. The transition from built-up areas to exposed bare land significantly altered the heat absorption dynamics, leading to localized temperature increases and the formation of intense urban heat islands in the war-affected regions. The effects of the war, such as the reduction of agricultural activities, also increased the land surface temperatures in rural areas, making the urban areas in the region heat sinks, a situation only observed during the gaza strip summers.

Objectives.

1. The primary objective of this is to get the effects of the war in Palestine on urban heat in Gaza Strip.
2. Other objectives include.
    a. Assess urban heat islands and LST trends in Gaza strip.
    b. Assess and interpret the urban heat intensity of Gaza.
    c. Compare the urban heat means of the 3 major urban areas in gaza.
    d. Generate urban heat risk ad vulnerability maps.
    e. Make a comparison between urban heat, landuse and land cover, urban heat risk and urban heat vulnerability.

Methodology

1. Extract daytime surface temperature from Band 10 of landsat 8/9 imagery.
2. Extract nighttime surface temperature from LST 1km night of Modis aqua.
3. Merge the two datasets to get a mean day and night land surface temperature.
4. Get the mean temperatures for the 3 urban (Delineated using degurba) areas in Gaza, these include Gaza, An_Nusayrat and Khan_Yunis.
5. Get the Urban Heat Island intensity of Gaza Strip using the following formulat:
    a. $LST\ UHI = LSTurban - LSTrural$
6. Get the urban heat risk and vulnerability maps.
7. Get the different in land surface temperature (LST), of the affected areas(pixels), before the war, and after the war.

Hypothesis.

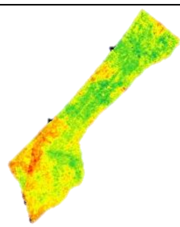
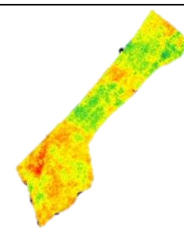
1. The sandy landcover will exhibit the highest levels of land surface temperatures during the day but will exhibit lower levels at night. However, there will be a radical decrease between the day and night temperatures. For urban areas, although the day LST will be below that of bare sandy areas, there will be minimal change between the day and night LST values.
2. The destruction of buildings, trees and other green items will result in increased daytime LST on those affected regions during the day.
3. The urban center with the least green cover in Gaza will have the highest LST values.

Findings.

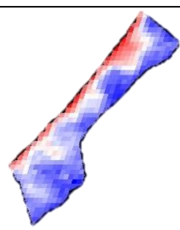
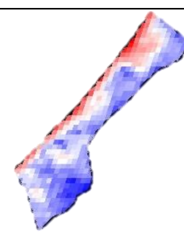
1. Sentinel Image

Pre_war start_date = '2022-12-01' end_date = '2023-04-30'	***Pre_war*** Start date = '2023-12-01' End date = '2024-04-30'
	

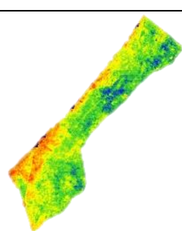
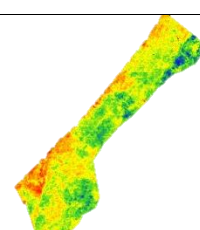
2. LST day time
    a. Band B10 of Landsat 8 and 9 imagery, transformed to degrees Celsius.

			
Minimum value:	21.02	Minimum value:	21.14
Maximum value:	36.07	Maximum value:	36.98
Mean value:	27.91	mean value:	29.32

3. LST night time
    a. Band LST_Night_1km, transformed to degrees Celsius.

			
Minimum value:	8.67	Minimum value:	8.30
Maximum value:	15.25	Maximum value:	15.94
mean value:	11.19	mean value:	11.47

4. Mean between day and night time LST
    a. This leverages the high spatial resolution of Landsat to capture temperature variations in vegetation, urban and bareland landcovers, while capitalizing on the frequent MODIS acquisitions to account for the rapid heating and cooling cycles in arid environments.

			
Minimum value:	16.65	Minimum value:	17.23
Maximum value:	23.96	Maximum value:	24.11
Mean value:	19.55	Mean value:	20.40

5. Comparison of LST in affected areas (pixels), before and during the war.

Minimum value:	22.73	Minimum value:	22.56
Maximum value:	34.85	Maximum value:	36.17
Mean value:	26.77	Mean value:	28.71

6. Urban Heat Island Intensity
    a. During the day

Urban mean value (Day):	27.55	Urban mean value (Day):	28.98
Rural mean value (Day):	27.25	Rural mean value (Day):	29.44
LST UHI (Day):	0.29	LST UHI (Day):	-0.461

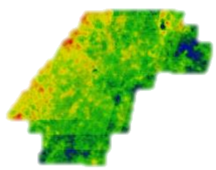
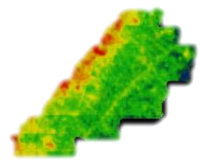
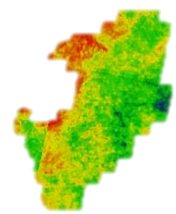
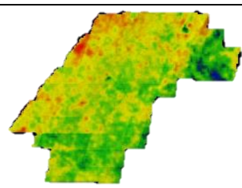
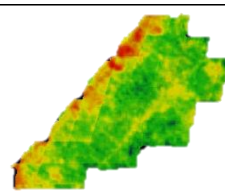
    b. At night

Urban mean value (Night):	11.56	Urban mean value (Night):	11.79
Rural mean value (Night):	10.22	Rural mean value (Night):	10.85
LST UHI (Night):	1.35	LST UHI (Night):	0.94

    c. Using mean of day and night

Urban mean value (Mean):	19.55	Urban mean value:	20.39
Rural mean value (Mean):	18.73	Rural mean value:	20.14
LST UHI (Mean):	0.82	LST UHI	0.24

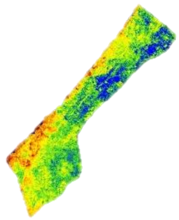
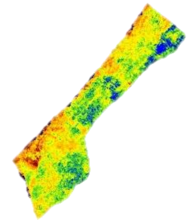
7. Comparison between mean day and night Gaza, An_Nusayrat and Khan_Yunis LST.

	Gaza	An_Nusayrat	Khan_Yunis
Before War			
During War			

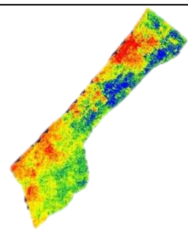
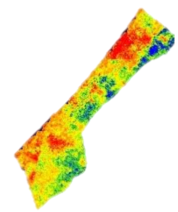
	Gaza	An-Nusayrat	Khan-Yunis		Gaza	An_Nusayrat	Khan_Yunis
Min value:	16.74	17.29	17.36	Min value:	17.38	17.80	17.61
Max value:	23.06	23.79	23.53	Max value:	23.64	23.80	24.00
Mean value:	19.27	19.37	19.81	Mean value:	20.27	20.02	20.59

8. Urban heat risk areas map
    a. The urban heat risk area map takes into consideration the mean day and night temperatures extracted, ndvi, bsi and ndwi at the time of interest.
        i. LST (Land Surface Temperature):
            1. Index: Measures the surface temperature of the land.
            2. Weight: Given a weight of 1 due to its direct correlation with urban heat.
        ii. NDVI (Normalized Difference Vegetation Index):
            1. Index: Indicates the presence and health of vegetation.
            2. Weight: Assigned a weight of -0.2 to account for its cooling effect in urban areas.
        iii. NDWI (Normalized Difference Water Index):
            1. Index: Identifies the presence of water bodies.
            2. Weight: Given a weight of -0.1 as water bodies contribute to cooling.
        iv. BSI (Built-up Area Index):
            1. Index: Identifies built-up areas.
            2. Weight: Assigned a weight of 0.3 due to the heat-absorbing nature of urban structures.
    b. Formula;

i. $Urban\ Heat\ Risk = (Normalized\ LST \times LST\ Weight) + (Normalized\ NDVI \times NDVI\ Weight) + (Normalized\ NDWI \times NDWI\ Weight) + (Normalized\ BSI \times BSI\ Weight)$

	
To assess levels of risk, the dataset can be classified and the area per class would indicate the level of risk Gaza strip has had. Increased areas of risk would indicate increased vulnerability in Gaza.	

9. Urban heat index

	
To assess levels of vulnerability, the dataset can be normalized to a scale of 0-1, then classified. The population within these classes would indicate the level of vulnerability within the area.	

Findings.

1. From sentinel 2 images observation, there was a decrease in built up area, and green area within Gaza Strip between the first observation period and the last observation period.
2. There was a slight increase in LST values. However, the increase was more prominent during the day than at night.
3. There were more areas exposed to higher temperatures during the day.
4. In pixels affected by change due to destruction by war elements, there was a mean increase in land surface temperature.
5. Both level of risk and vulnerability seem to increase. However, it should be noted that population 2020 was used in both cases, therefore, there might be a decrease in vulnerability due to population decrease, resulting from migration.

Conclusion.

- The analysis of satellite data reveals the severe environmental consequences following the onset of war in the Gaza Strip in October 2023. There has been a decrease in built-up and green areas, indicating loss of urban infrastructure, vegetation cover, and potential agricultural lands.
- The changes in min, max and mean nighttime temperatures suggest a reduction in urban green spaces, agricultural lands, and other green features, likely resulting from the destructive nature of the conflict and potentially impacting food production. These changes, increase the secondary heat radiating from the new bare land, into the urban infrastructure, that has a lower rate of heat loss, as compared to bare land or water.
- Areas affected by war-related destruction experienced even higher temperature increases, demonstrating the direct impact on the local daytime urban heat. Consequently, environmental based risk have increased since the war started.

These findings highlight the detrimental effects of war on the environment, living conditions, potential food security, and human well-being, necessitating urgent action, international cooperation, and sustainable recovery efforts. However, further evaluation on destruction/reduction of agricultural land, green areas and built-up area should be conducted to support this, and determine the direct, or indirect effect of war in the region.