TASK 1: FIRE DAMAGE ASSESSMENT IN CAPE TOWN

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GEOSPATIAL ANALYSIS

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Introduction

Cape Town, South Africa, faced a significant fire incident in 2021 that left substantial damage to its landscapes and infrastructure. This report aims to provide a comprehensive analysis of fire damage assessment in Cape Town using data obtained from USGS Landsat 8 satellite images. The assessment period spans from 2018, before the fire occurrence, to 2024, allowing for an evaluation of the post-fire landscape recovery.

Data Acquisition and Preprocessing

Data was acquired from USGS Landsat 8 satellite images covering the timeframe from 2018 to 2024. These images were chosen due to their high spatial resolution and spectral capabilities. Surface reflectance bands were utilized, ensuring accurate representation of the earth's surface and minimizing atmospheric interference, which is crucial for reliable fire damage assessment. All cleaning and processing of data was done using ArcGIS Pro.

The downloaded image tiles were processed through several steps:

1. **Band Compositing**: The individual bands of each satellite image were composited to create multiband images, enhancing the interpretability and analysis potential.

2. **Image Mosaicking**: The images were mosaicked to create a seamless representation of the Cape Town area, facilitating comprehensive analysis and assessment.

3. **City of Cape Town Extraction**: The extract by mask tool was employed to isolate the city of Cape Town and its boundaries from the satellite imagery, focusing the assessment on the affected area.

4. **Colour Adjustment**: The colour bands red, green, and blue were adjusted to 7, 5, and 4(shortwave Infrared), respectively, optimizing visualization and highlighting relevant features for analysis.

Analysis Methodology

The Normalized Burn Ratio (NBR) index was utilized to assess fire damage and vegetation recovery in Cape Town. NBR is particularly effective in distinguishing between areas affected by fire and those with healthy vegetation cover. The formula for NBR is given by:

$$NBR = \frac{NIR - SWIR}{NIR + SWIR} \quad (1)$$

- NIR represents the near-infrared band,
- And SWIR represents the short-wave infrared band.

Results

The analysis resulted in the classification of the landscape into seven distinct classes, each representing different levels of fire damage and vegetation recovery:

Table 1: Burn severity levels obtained calculating dNBR, proposed by USGS.

Severity Level	dNBR Range (scaled by 10^3)	dNBR Range (not scaled)
Enhanced Regrowth, high (post-fire)	-500 to -251	-0.500 to -0.251
Enhanced Regrowth, low (post-fire)	-250 to -101	-0.250 to -0.101
Unburned	-100 to +99	-0.100 to +0.99
Low Severity	+100 to +269	+0.100 to +0.269
Moderate-low Severity	+270 to +439	+0.270 to +0.439
Miderate-high Severity	+440 to +659	+0.440 to +0.659
High Severity	+660 to +1300	+0.660 to +1.300

Source: https://un-spider.org/advisory-support/recommended-practices/recommended-practice-burn-severity/in-detail/normalized-burn-ratio.

- **Unburned Vegetation**: Areas with healthy vegetation cover, unaffected by the fire incident.
- **Partially Burned Vegetation**: Vegetation areas showing partial fire damage, with some signs of recovery.
- **Moderately Burned Vegetation**: Areas displaying moderate fire damage, with varying degrees of recovery.
- **Severely Burned Vegetation**: Regions with extensive fire damage and limited vegetation recovery.
- **Infrastructure**: Developed areas and infrastructure within Cape Town, generally unaffected by the fire incident.

- **Water Bodies**: Natural water bodies and reservoirs, remaining unchanged by the fire event.

Upon analysing the outcomes derived from the NBR assessment, it became evident that certain areas of Cape Town were significantly impacted by the recent fire incident. Philippi emerged as one of the most severely affected regions, with most of its areas being classified under high severity, as indicated by the external marker on the map. Additionally, the iconic Table Mountain area also experienced adverse effects from the fire, underscoring the widespread nature of the incident. The high severity classification on figure 1 serves as a crucial external indicator, emphasizing the extent of the damage and helping prioritize necessary interventions and recovery efforts.

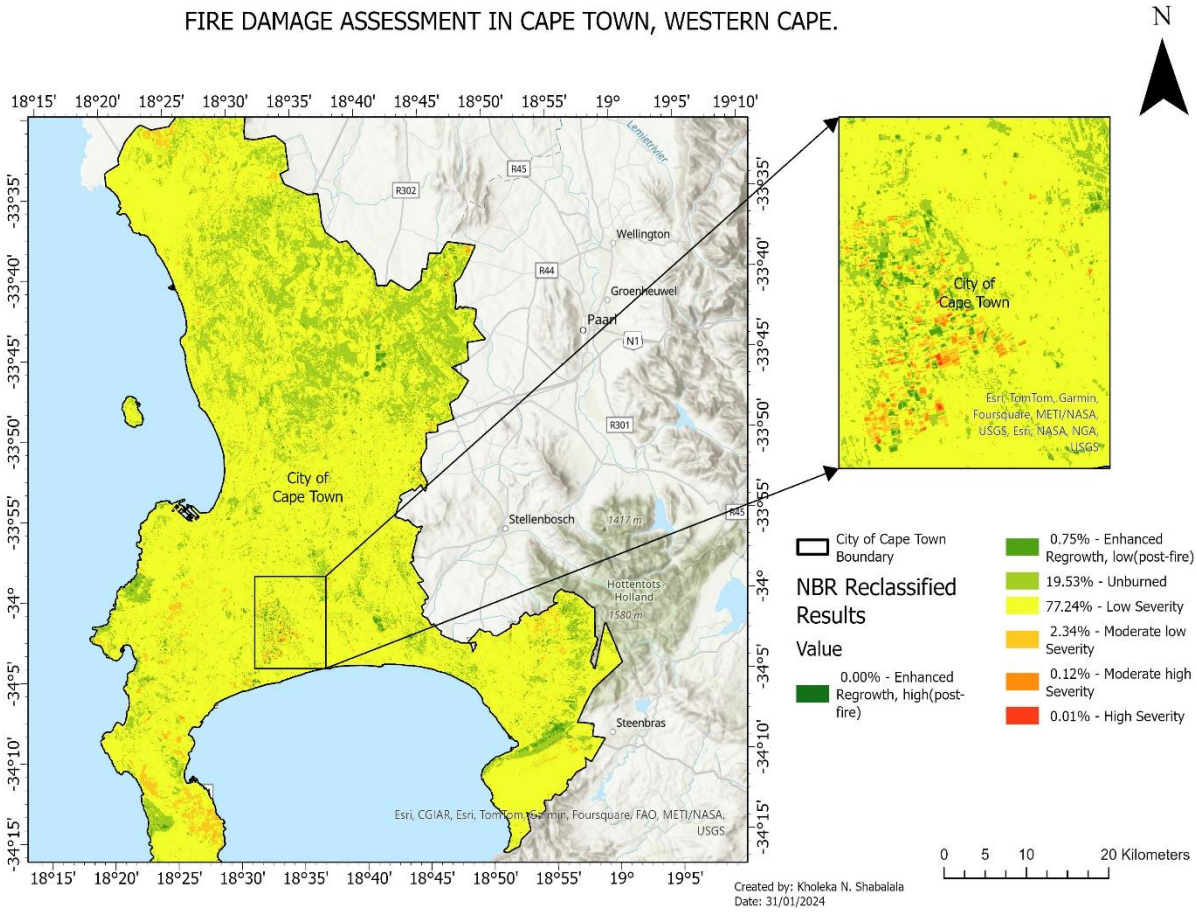

Figure 1: Fire damage assessment in Cape Town, (source: this study).

Conclusion

In conclusion, the comprehensive analysis of the NBR assessment, coupled with Landsat 8 satellite imagery, highlights the significant impact of the recent fire incident on various areas in Cape Town. Philippi stands out as a severely affected region, with most of its areas classified under high severity, as indicated by the external marker on the map. Furthermore, the renowned Table Mountain area has also suffered adverse effects, underscoring the widespread nature of the incident.

The utilization of the high severity classification on Figure 1 as a crucial external indicator serves to emphasize the extensive damage caused by the fire. This information is instrumental in prioritizing interventions and directing recovery efforts effectively. The fire damage assessment, incorporating Landsat 8 satellite imagery and the NBR index, not only provides valuable insights into the immediate aftermath of the 2021 fire but also contributes essential data for understanding the ongoing recovery of vegetation.

The outcomes of this analysis have far-reaching implications, offering key information to inform mitigation strategies, facilitate resource allocation, and guide long-term planning efforts. By enhancing our understanding of the extent of damage and recovery patterns, these insights contribute to building resilience against future fire events. Moreover, they support initiatives for ecosystem restoration, ultimately fostering a more sustainable and resilient environment in the Cape Town region.