TOLEDO FIRE REPORT

Annual Assessment of Fire Occurrence & Burned Areas in the Toledo District 2026

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List of Acronyms

BA	Burned Area
BCEP	Boden Creek Ecological Preserve
BERDS	Biodiversity & Environmental Resource Data System of Belize
BFREE	Belize Foundation for Research and Environmental Education
BNR	Bladen Nature Reserve
CRFR	Columbia River Forest Reserve
dNBR	Difference Normalized Burn Ratio
ENSO	El Niño Southern Oscillation
FAO	Food and Agriculture Organization of the United Nations
FD	Forest Department
FIRMS	Fire Information for Resource Management System
GEE	Google Earth Engine
GIS	Geographic Information System
Ha	Hectares
LULCC	Land Use Land Cover Change
GSCP	Golden Stream Corridor Preserve
MGL	Maya Golden Landscape
MMNFR	Maya Mountain North Forest Reserve
MODIS	Moderate Resolution Imaging Spectroradiometer
NASA	National Aeronautics and Space Administration
NBR	Normalized Burn Ratio
NIR	Near Infrared Radiation
NPAS	National Protected Areas System
PA	Protected Area
PPA	Privately Protected Area
SBC	Southern Biological Corridor
SWIR	Short-wave Infrared Radiation
VIIRS	Visible Infrared Imaging Radiometer Suite
Ya'axché	Ya'axché Conservation Trust

Summary

This report presents the assessment of fire activity and Burned Areas (BA) across the Toledo District and the Maya Golden Landscape (MGL) during the 2026 dry season (January - June) using remote sensing techniques and satellite-based fire monitoring data. The analysis was conducted to estimate annual burned area extent, identify fire affected areas, and evaluate fire patterns within the wider landscape and Ya'axché managed protected areas (PAs). Sentinel-2A satellite imagery was processed in Google Earth Engine to generate Normalized Burn Ratio (NBR) and differenced Normalized Burn Ratio (dNBR) products, while NASA Fire Information for Resource Management System (FIRMS) active fire detections were used to support the interpretation of fire occurrence and spatial distribution.

The analysis estimated that approximately 10,022 ha (24,765 acres) of the Toledo District were affected by fire during the 2026 season, representing 2.3% of the district's total area. This represents a substantial reduction compared to 2025, when approximately 24,396 ha (60,289 acres), or 7.7% of Toledo, were classified as burned. Fire activity during 2026 was more localized, with the largest concentrations of burned areas occurring in the northeastern portion of the district, particularly within savanna and mixed land use areas. Additional smaller and fragmented burn scars were observed across central and southern Toledo. Within the MGL, approximately 5,939 ha (14,676 acres) were classified as burned, representing 1.9% of the landscape. Burned areas were primarily concentrated along the agricultural interface, savanna areas, and the southern and northeastern boundaries of the MGL, while the central forested areas remained largely unaffected. Compared with the 2025 fire season, burned area within the MGL decreased by approximately 8,433 ha, indicating a less extensive fire season across the conservation landscape.

The integration of FIRMS active fire detections and Sentinel-2 dNBR analysis provided complementary information on fire occurrence and impacts. FIRMS data identified where active fires were detected during satellite overpasses, while dNBR analysis quantified the extent of vegetation changes associated with fire. The combined results showed that fire activity was concentrated mainly outside the core forest areas and along agricultural and savanna landscapes where fire occurrence is more common. Fire impacts within Ya'axché managed protected areas remained minimal. The dNBR assessment identified limited areas classified as potentially burned within Boden Creek Ecological Preserve (BCEP) (48.32 ha), Maya Mountain North Forest Reserve (MMNFR) (36.00 ha), Bladen Nature Reserve (BNR) (10.16 ha), and Golden Stream Corridor Preserve (GSCP) (5.00 ha). However, no corresponding FIRMS detections were recorded within these protected areas, suggesting that some mapped burned pixels may represent spectral changes unrelated to fire, such as cloud shadows, haze, terrain effects, or other sources of uncertainty. Overall, the results indicate that Ya'axché managed protected areas remained largely protected from significant fire impacts during the 2026 season.

The reduction in burned area compared to 2025 is likely associated with differences in seasonal weather conditions, including rainfall patterns, fuel moisture availability, and broader climate variability. Wetter conditions during the 2026 dry season likely reduced fuel dryness and limited the spread of large fires across the landscape. However, recurring fire prone areas, particularly agricultural boundaries and savanna ecosystems, continue to require monitoring and targeted fire management interventions.

Introduction

Ya'axché's main goal is to promote the sustainable use and management of forest resources and biodiversity conservation in southern Belize through collaborative efforts with local communities, government agencies, and other stakeholders. Its focus is primarily within the Maya Golden Landscape (MGL), an area of 780,200 acres found in the Toledo District. Within the MGL, there are 28 Protected Areas of which Ya'axché manages or co-manages four: the Bladen Nature Reserve (BNR), Boden Creek Ecological Preserve (BCEP), Golden Stream Corridor Preserve (GSCP), and Maya Mountain North Forest Reserve (MMNFR), encompassing approximately 165,300 acres, or 15% of the Toledo District and 21% of the MGL.

The BNR is the largest nature reserve in Belize with the highest level of protection under the NPAS Act. Encompassing roughly 100,000 acres in the core zone of the Maya Mountain Massif, the nature reserve benefits from its remote location, which provides a natural barrier against most human induced disturbances affecting other PAs (Gutierrez al., 2023). Ya'axché shares co-management of the reserve with the Government of Belize, with the former assuming significant responsibility for day to day operational activities. This collaborative approach promotes effective management and conservation efforts, which will contribute to long-term protection of this ecologically significant area.

The BCEP is a Privately Protected Area (PPA) in the Toledo District. This preserve has been privately owned well before the 1960's and was predominantly used for agriculture in many forms, including citrus, banana, and cattle (Bowen, Jones 2001). It currently covers an area of approximately 12,876 acres along the Southern Highway adjacent to the village of Indian Creek. As with the adjacent GSCP, the property was acquired in tandem for conservation purposes in the late 90's and established as the BCEP circa 2007 under continued private ownership and management. Since 2007, the area has been managed as the BCEP under different owners culminating in 2021 with the acquisition of the property by Fauna & Flora and final transfer of ownership Ya'axché in 2024. Combined with the GSCP, these two form an integral part of the Southern Biological Corridor (SBC).

The GSCP is a PPA situated in the Toledo District of Belize. It was established in 1998 through the collective efforts of Ya'axché, a consortium compromising local community members and both national and international conservation experts. The PPA spans about 15,070 acres, comprising lowland broadleaf forests serving as a vital ecological corridor linking the Maya Mountains' foothills to the coastal lowlands of the Toledo District (Lenox et al., 2020).

The MMNFR is an extractive reserve in the Toledo District. Historically, the reserve lacked management presence until 2015 when Ya'axché undertook co management responsibilities. The PA spans over 37,700 acres, with most of its land characterized by rugged terrain that predominantly remains a forested landscape. Presently, there is an agroforestry concession that is closely monitored by the Belize Forest Department (FD) and managed by Ya'axché on behalf of a community group from Trio Village (Garcia et al, 2014). In this report GIS & Remote Sensing analysis methods are used to measure and provide extensive data on the location and intensity of fire over time by detecting, characterizing, and monitoring BA.

Goals and Objectives

The goal of this study is to use Remote Sensing Technology and Sentinel-2A imagery to study fire patterns in Toledo, Belize, for the dry season period January to June 2026. Our objectives are as follows:

- Estimate the amount of land burned each year
- Identify dNBR thresholds for burned land
- Identify any fire hotspots in Toledo

Methodology

Study Area

Toledo is the southernmost and least populated district in Belize. The average annual maximum temperature is 85°F (30°C), while the average annual minimum temperature is 73°F (23°C). Toledo comprises approximately 1,064,547 acres of terrestrial and inland aquatic ecosystems. The district is characterized by a diverse landscape that includes broadleaf forests, savannas, wetlands, mangroves, rivers, and agricultural lands. The MGL is the portion of Toledo where Ya'axché focuses on its conservation and community development efforts (Figure 1.). The MGL consists mainly of forest, savanna, mangrove, wetland, agricultural land, and coastal ecosystems, and contains 24 rural communities that depend on the landscape for their livelihoods. Within the MGL, Ya'axché manages BNR and MMNFR and co-manages GSCP and BCEP; together, these protected areas protect large areas of forest and provide important habitat for Belize's biodiversity while supporting ecosystem services that benefit the surrounding communities.

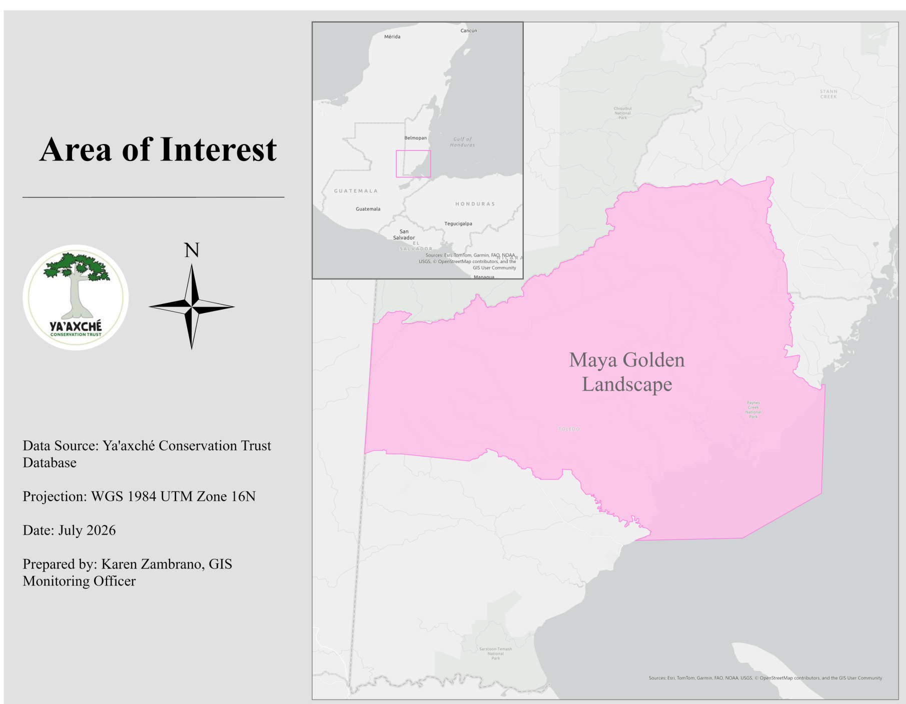

Figure 1. Map of the study area found within Belize.

The data collected and used for this study include Sentinel-2 satellite data, a base map for Belize, a Belize PAs map, and the MGL boundary. The Belize base map and PAs map were created using geospatial data files obtained from the Biodiversity and Environmental Resource Data System for Belize (BERDS) (Meerman, 2013; Meerman, 2017). The MGL map was obtained internally from Ya'axché's geodata sets. Maps and burn indices were generated from Sentinel-2 imagery using spectral index analysis based on the Normalized Burn Ratio (NBR) and differenced Normalized Burn Ratio (dNBR).

Remote Sensing Data Collection

This study used Sentinel 2 Level 2A satellite imagery obtained from the European Union's Copernicus Programme. Sentinel-2 provides atmospherically corrected surface reflectance data suitable for vegetation and fire related analyses, with spatial resolutions ranging from 10 m to 60 m. The imagery was accessed and processed using Google Earth Engine (GEE). Sentinel-2 images were filtered spatially to the Toledo District boundary and temporally to capture conditions before and after the 2026 fire season. To minimize the influence of clouds, the analysis used the Google Cloud Score+ dataset, which provides a per pixel estimate of clear sky conditions. Pixels with a Cloud Score+ cumulative distribution value of 0.65 or greater were retained, while lower quality pixels were masked before image compositing. This approach reduces cloud and haze contamination while preserving the clearest observations available during each period.

To represent pre-fire and post-fire conditions, two cloud minimized composite images were created using a median reducer:

Pre-fire composite: 15 January – 15 March 2026
Post-fire composite: 15 May – 30 June 2026

All composite images were clipped to the Toledo District boundary. The spatial resolution of the analysis was standardized to 20 m, corresponding to the native resolution of the Near Infrared (NIR) and Short Wave Infrared (SWIR) bands used to calculate the Normalized Burn Ratio (NBR). Burn severity was assessed by calculating the differenced Normalized Burn Ratio (dNBR), obtained by subtracting the post-fire NBR from the pre-fire NBR. A focal median filter with a one-pixel radius was then applied to reduce isolated pixel noise before identifying burned areas.

In addition to Sentinel-2 imagery, active fire data from the Fire Information for Resource Management System (FIRMS) were used to support the interpretation of burned areas. FIRMS provides near real time satellite detections of active fires and thermal anomalies derived from the Moderate Resolution Imaging Spectroradiometer (MODIS) and the Visible Infrared Imaging Radiometer Suite (VIIRS). Each FIRMS point represents the location of a thermal anomaly detected during a satellite overpass and includes information such as the detection date and time, confidence level, fire radiative power, and the satellite sensor. In this study, FIRMS data were used to verify the timing and spatial distribution of fire activity and to complement the burned area assessment (NASA FIRMS, 2026).

Exporting and Preparing Indexed Images

Sentinel-2 imagery includes twelve spectral bands; however, this study focused on bands relevant to fire detection and vegetation response. Bands 8A (NIR) and 12 (SWIR 2), both at 20-meter resolution, were used to generate fire indices (Table 1.). Band 4 (Red) was used in combination with bands 8A and 12 to produce false colour composites highlighting BA and vegetation condition.

After cloud masking and compositing in GEE, indexed raster layers were generated and prepared for export. True colour and false colour composites were created for visual inspection, while the dNBR raster and BA mask were exported as GeoTIFF files. All exported rasters were clipped to the Toledo District boundary, kept at 20-meter spatial resolution, and prepared for further visualization and spatial analysis in ArcGIS Pro.

Table 1. Characteristics of Sentinel 2 multi spectral instrument (MSI).

Band	Resolution (m 2)	Wavelength (nm)	Description
B1	20	443	Aerosols
B2	10	490	Blue
B3	10	560	Green
B4	10	665	Red
B5	20	740	Red Edge 1
B6	20	783	Red Edge 2
B7	20	842	Red Edge 3
B8	10	842	Near Infrared (NIR)
B8A	20	865	Near Infrared (NIR) focused
B9	60	940	Water Vapor
B11	20	1610	Short-Wave Infrared (SWIR) 1
B12	20	2190	Short-Wave Infrared (SWIR) 2

Following image collection and compositing, indexed images were generated in GEE to support fire analysis. NBR was calculated for both pre-fire and post-fire composite images using the NIR and SWIR bands. The dNBR was then derived by subtracting post-fire NBR values from the pre-fire baseline, allowing for the identification of fire affected areas. All index calculations were performed on cloud masked, median composited imagery to minimize atmospheric and cloud related artifacts. The resulting NBR and dNBR images were clipped to the Toledo District boundary and exported at a spatial resolution of 20 m for subsequent burned area and severity analysis.

Constructing the dNBR Index Rasters

The NBR and dNBR were used to identify and map burned areas (BA) within the Toledo District. The NBR is a widely used spectral index that exploits the contrast between NIR and SWIR reflectance to detect vegetation damage and fire effects (Figure 2.). Alcaras et al. (2022) summarize the value of this index well. The NIR and SWIR spectral regions are relevant for detecting burned areas: NIR highlights changes in canopy cover and brightness of leaf burn, whereas SWIR detects changes in landscape dryness.

The NBR was calculated for both pre-fire and post-fire composites using the formula:

NBR=(NIR−SWIR) (NIR+SWIR) *NBR=NIRSWIRNIRSWIR*

where NIR corresponds to Sentinel-2 Band 8A and SWIR corresponds to Band 12. The dNBR raster was then calculated by subtracting the post-fire NBR from the pre-fire NBR:

dNBR=NBRpre−fire−NBRpost−fire*dNBR=NBRpre−fire−NBRpost−fire*

Higher dNBR values indicate greater change in vegetation structure and moisture associated with fire disturbance. Following established practices, a threshold of dNBR ≥ 0.20 was applied to delineate BA. Pixels meeting or exceeding this threshold were classified as burned, while lower values were excluded. This threshold-based approach allows for consistent BA mapping without the use of supervised classification or training samples Miller & Thode (2007). At this stage of the study, training samples were not incorporated and are planned for use in future validation of the burned area BA results.

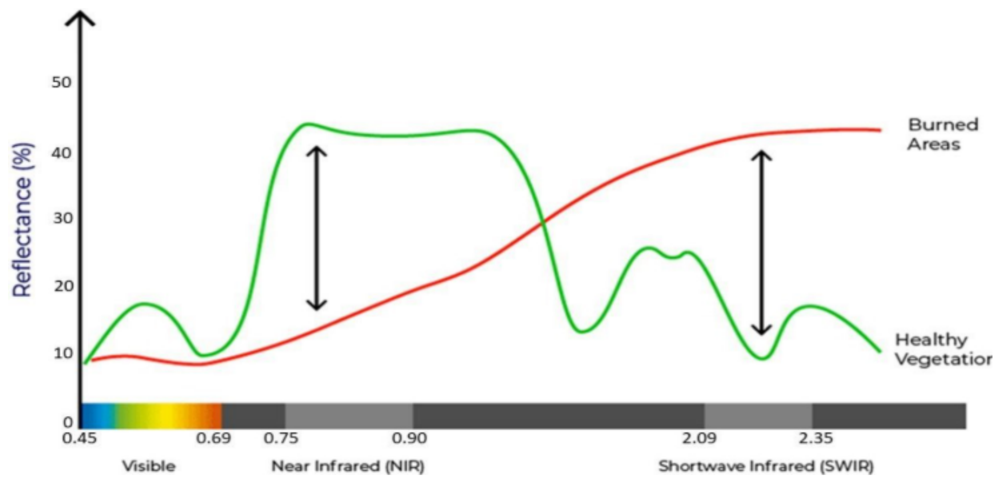

Figure 2. Graph showing the percent reflectance of healthy vegetation and burned areas at different points along the visible and infrared light spectrum (in micrometres). From Alcaras et al, 2022.

Accuracy Assessment

To evaluate the reliability of the 2026 burned area (BA) assessment, an accuracy assessment was conducted using a confusion matrix approach to compare the dNBR-derived BA classification with independent reference data. Reference points were generated using a combination of NASA FIRMS active fire detections, Sentinel-2 imagery interpretation, and randomly distributed points representing areas classified as not burned. 200 validation points were used for this assessment with 100 random not-burned points and 100 burned area points. 184 of the 200 validation points were classified correctly and only 16 were misclassified (Table 2.). The assessment evaluated the ability of the dNBR threshold approach (dNBR ≥ 0.20) to correctly distinguish burned and non-burned areas across the Toledo District.

Table 2. Confusion matrix and accuracy statistics for burned area classification (2026).

Reference \ Classified	Not Burned	Burned	Total	User's Accuracy (%)
Not Burned	94	6	100	94.0
Burned	10	90	100	90.0
Total	104	96	200	
Producer's Accuracy (%)	**90.4**	**93.8**		

Overall Accuracy:

$$(94+90)/200=92.0\%$$

Cohen's Kappa (κ): 0.84

The accuracy assessment resulted in an overall accuracy of 92.0%, with a Cohen's Kappa value of 0.84, indicating strong agreement between the dNBR-derived burned area classification and the reference dataset. The high producer's accuracy for BAs (90.4%) suggests that the majority of fire-affected areas were successfully identified, while the user's accuracy of 90.0% indicates that most areas classified as burned corresponded with confirmed fire-related observations.

Although the assessment indicates strong classification performance, some uncertainty remains due to limitations associated with satellite-based burned area detection. Factors such as cloud contamination, vegetation recovery following fire events, small agricultural burns, and spectral similarities between burned areas and other land cover changes may contribute to occasional misclassification. Nevertheless, the dNBR threshold approach provides a consistent and repeatable method for estimating BAs across the Toledo District and the MGL.

Results

BAs across both the MGL and Toledo District were quantified directly from pixel counts of the severity raster, using an average pixel size of approximately 20 m × 20 m at the study latitude. This approach provides accurate and reproducible estimates of fire affected hectares, clearly illustrating the spatial distribution and magnitude of fire at both the landscape and PA scales. These results offer robust, data driven insights to support effective fire management and conservation planning across the region.

Fire Occurrence

Figure 3 is a spatial distribution of NASA FIRMS active fire detections recorded across the Toledo District during the 2026 fire season. Fire detections were distributed throughout the district, with the highest density occurring in the northeastern region. Additional concentrations of detections were observed in the central and southwestern portions of Toledo, while relatively few detections were recorded within the Ya'axché managed protected areas. The map includes detections from the MODIS C6.1, Suomi VIIRS C2, NOAA-20 (J1 VIIRS C2), and NOAA-21 (J2 VIIRS C2) satellite sensors, providing a comprehensive representation of active fire locations recorded during the reporting period. These fire detections served as the primary dataset for identifying areas of fire activity and guided the subsequent burned area and burn severity analyses.

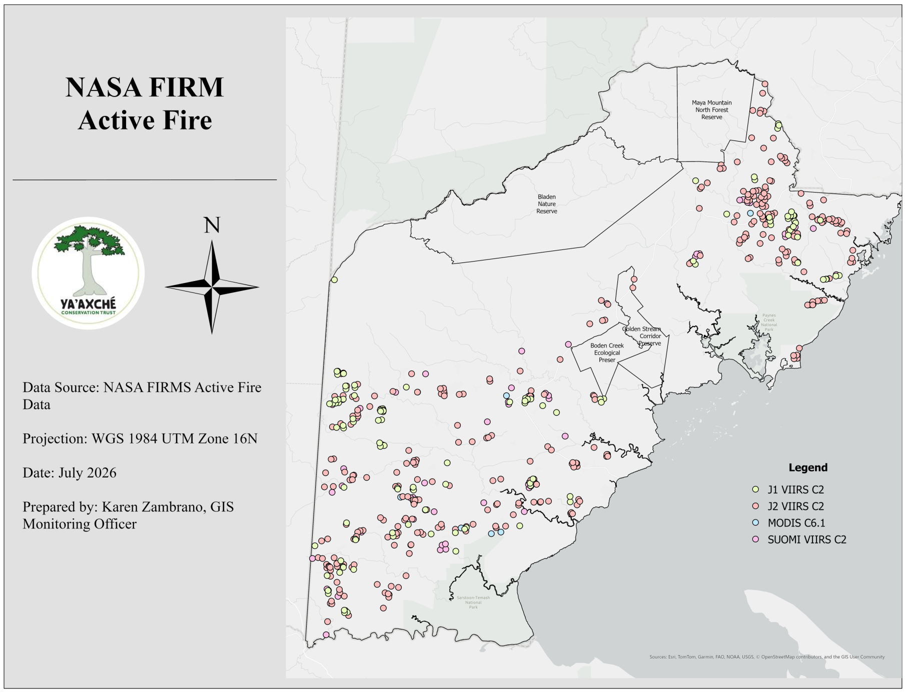

Figure 3. Spatial distribution of active fire detections recorded by NASA FIRMS across the Toledo District during the 2026 fire season.

Burned Areas

Toledo Burn Assessment

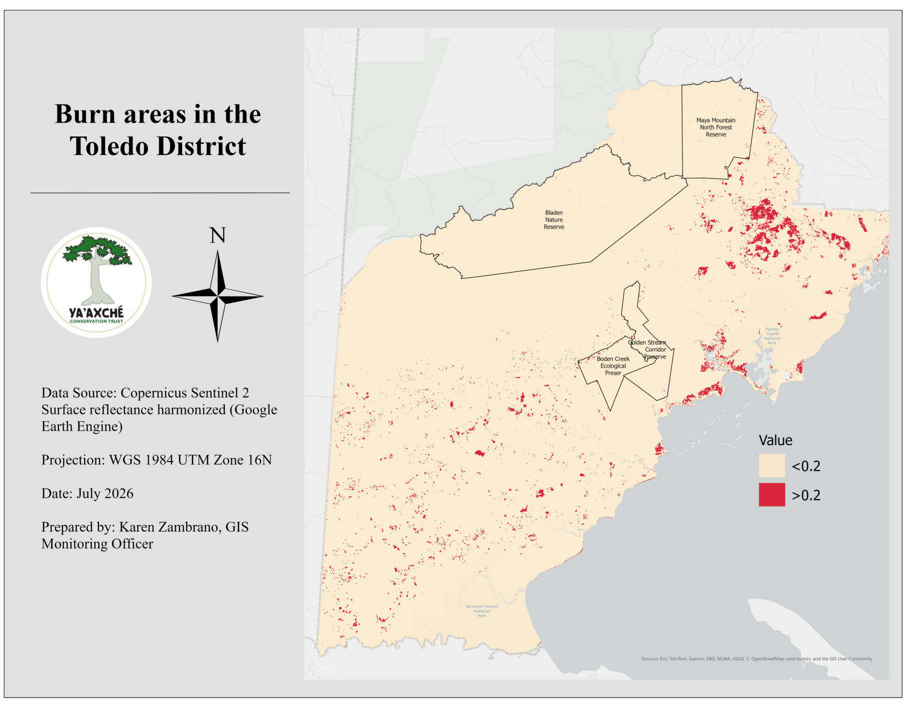

Figure 4. BA in Toledo District, 2026.

Total burned area (BA) within the district was estimated at approximately 10,022 ha (24,765 acres), corresponding to 2.3% of the district's total area. These results indicate that fire activity during the 2026 fire season was substantially lower than that recorded in 2025, with burned areas occurring across the district but remaining more localized in extent. The largest and most continuous burn scars were concentrated in the northeastern portion of the district, while smaller and more fragmented burned areas were distributed across the central, southern, and coastal regions (Figure 4.). Burned areas within the Ya'axché managed protected areas remained limited, with most fire activity occurring outside these conservation areas. The dNBR analysis provides a spatial representation of fire impacts and forms the basis for the quantitative assessment of burned area presented in the following sections.

Maya Golden Landscape Burn Assessment

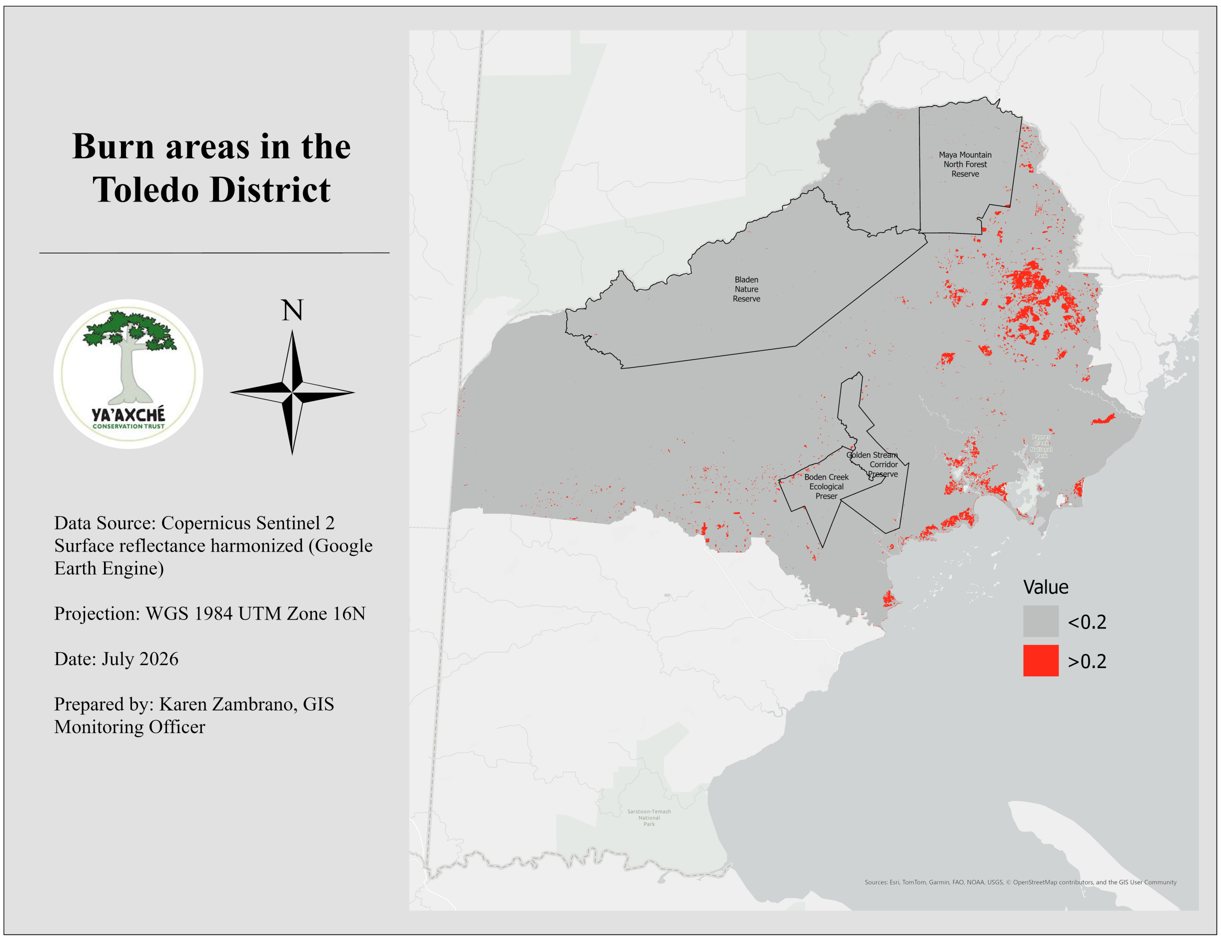

Figure 5. BA in the Maya Golden Landscape for the period 2026.

Approximately 59% of all burned area in Toledo occurred within the MGL. Total burned area (BA) within the MGL was estimated at approximately 5,939 ha (14,676 acres), corresponding to 1.9% of the landscape's total area. These results indicate that fire activity within the MGL remained relatively low during the 2026 fire season and accounted for a smaller proportion of the burned area observed across the wider Toledo District. The dNBR map shows that burned areas were concentrated primarily along the northeastern boundary of the landscape, with additional smaller and more fragmented burn scars occurring in the southern and coastal portions of the MGL (Figure 5.). The central forested core, including many of the Ya'axché managed protected areas, remained largely unaffected by fire. The spatial distribution of burned areas highlights the concentration of fire activity along the landscape margins and provides a basis for assessing fire impacts within this important conservation landscape.

Discussion

Fire Occurrence & Burn Areas

Active fires were detected across much of the Toledo District, with the greatest concentration occurring in the northeastern portion of the district as seen in Figure 3. Additional clusters of fire detections were observed in the central and southern regions. The distribution of fire detections indicates that fire activity was concentrated primarily within agricultural areas and along the forest agriculture boundaries. FIRMS point data represent the locations where satellites detected active fires or thermal anomalies at the time of the satellite overpass. These detections provide an indication of where fires occurred during the season but do not represent the total area burned. A single fire may produce multiple detections, while other fires may not be detected because of cloud cover, dense vegetation, low fire intensity, or the timing of the satellite overpass. Consequently, the FIRMS data are used to identify the spatial distribution of fire occurrence and are interpreted together with the burned area assessment derived from the dNBR analysis presented in the following section. Overall, the spatial pattern of FIRMS detections corresponds well with the distribution of burned areas mapped from Sentinel-2 imagery, particularly in the northeastern portion of the district where both datasets indicate the highest level of fire activity.

Toledo

Burn severity across the Toledo District was assessed using the differenced Normalized Burn Ratio (dNBR), with pixels exceeding a threshold of 0.20 classified as burned, representing areas of low to high fire severity. The analysis estimated a total burned area of 10,022 ha (24,765 acres) in 2026, representing 2.3% of the Toledo District as can be seen in Table 3. This represents a substantial decrease compared to 2025, when 24,396 ha (60,289 acres), or 7.7% of the district, were classified as burned (Zambrano & Gutierrez, 2025). The spatial distribution of burned areas closely corresponds with the patterns of active fire detections shown in Figure 3. The largest burned areas were concentrated in the northeastern portion of the district where a larger portion of savannah ecosystems lie. These ecosystems are prone to fires and to a large extent dependent on fire to sustain vital reproduction cycles of dominant species such as the Caribbean Pine (*Pinus caribaea*). Savannah ecosystems also harbour wildlife, with some species being actively hunted during the dry season. Hunters are known to burn the savannah grass to encourage new growth which attracts some species such as the White-tailed deer (*Odocoileus virginianus*) among others (Smith, et al., 2024). The burning of these savannahs is an annual occurrence and the fire instances in this assessment period likely reflect a combination of escaped agriculture fires, hunters lighting fire and natural causes. Smaller burn scars distributed across the central and southern regions are more likely attributed to agriculture activity with the likely cause being slash and burn agriculture. While the FIRMS data identify where active fires were detected during satellite overpasses, the dNBR analysis captures the full spatial extent of the resulting burn scars, providing a more complete assessment of fire impacts across the landscape. High severity burn scars were most apparent within savanna and mixed land use landscapes, particularly in areas known to experience recurring fires. By applying a threshold of dNBR ≥ 0.20, this analysis provides a consistent and conservative estimate of burned areas while reducing the influence of minor spectral changes and seasonal vegetation variability.

Table 3. Comparison of burned area extent in the Toledo District and Maya Golden Landscape (MGL) from 2021 to 2026.

Year	Toledo Burned Area (ha)	% of Toledo	MGL Burned Area (ha)	% of MGL
2021	10,358	2.4%	10,107	1.9%
2022	4,210	1.0%	2,790	0.2%
2023	13,354	3.1%	3,879	1.2%
2024	43,992	10.2%	25,360	8.0%
2025	24,396	7.7%	14,372	4.5%
2026	10,022	2.3%	5,939	1.9%

Maya Golden Landscape

Burn severity within the MGL was assessed using the dNBR, with pixels exceeding a threshold of 0.20 classified as burned, representing areas affected by low to high fire severity. The analysis estimated a total burned area of 5,939 ha (14,676 acres), representing approximately 1.9% of the MGL (Table 3). Burn scars within the MGL were generally smaller and more localized, occurring primarily along the agricultural interface and within savanna areas, while the larger forest blocks remained largely unaffected. This pattern aligns with the distribution of active fire detections and suggests that fire activity was concentrated in more accessible and managed areas rather than spreading extensively into the forested portions of the landscape. The location of the fire scars coincides with the farming practices in the landscape of the MGL which typically involves the use of fire for slash and burn as traditionally practiced by the Maya communities of the district.

In 2025, Fire scar and regrowth areas within the MGL accounted for approximately 1.51% of the landscape, indicating that a relatively small portion of the MGL remained associated with recent fire impacts or areas undergoing vegetation recovery (Zambrano & Gutierrez, 2026). This figure is very similar to the 2026 fire scar assessment which suggests that despite recurring fire activity in some areas, most of the landscape maintained stable vegetation cover, particularly within the larger forested blocks. The 2026 dNBR assessment identified 5,939 ha (14,676 acres), equivalent to approximately 1.9% of the MGL, as burned areas in Table 3. Compared with the previous fire season, this represents a reduction of approximately 8,433 ha in burned areas. This decline suggests less extensive fire activity during the season which may be attributed to annual variations in weather conditions including increased precipitation, fuel availability, and the timing and location of agricultural burning.

Ya'axché Managed Protected Areas

The dNBR assessment identified very limited burned areas within Ya'axché managed protected areas during the 2026 fire season. Burned areas were estimated at 48.32 ha in BCEP, 36.00 ha in MMNFR, 10.16 ha in BNR, and 5.00 ha in GSCP. Although these areas were classified as burned based on spectral changes detected by Sentinel-2 imagery, we suspect that the classifications as fire scars in these protected areas are false positives. No active fire detections were recorded within any of the protected areas by the FIRMS dataset during the same period, suggesting that some of the mapped burned pixels may represent image misclassification caused by cloud shadows, residual haze, water, terrain effects, or other spectral anomalies rather than actual fire. Therefore, the burned area estimates should be regarded as potential fire affected areas rather than confirmed fire events. The findings were generally consistent with the 2025 Land Use Land Cover Change (LULCC) Report, which showed that Ya'axché managed protected areas maintain high levels of forest cover and experience very limited fire impacts (Zambrano & Gutierrez, 2026). Together, the dNBR, FIRMS, and LULCC results indicate that these reserves continue to function as effective barriers to fire spread despite fire activity occurring in the surrounding landscape.

MMNFR

MMNFR recorded approximately 36.00 ha classified as burned. Although this represents the second largest mapped burned area among the protected areas, the absence of corresponding FIRMS detections indicates that some of these pixels may result from classification uncertainty and cloud cover during fire activity. The surrounding landscape along the southeastern boundary line of the reserve has been under constant agriculture development with large tracts of land now established as cattle farms. While these cattle farms are not likely to be set on fire as part of pasture management, they are susceptible to fires during prolonged dry periods and drought conditions. The reserve remains overwhelmingly forested, and as highlighted in the 2025 LULCC Report, intact broadleaf forest is considerably less susceptible to fire than surrounding agricultural lands. The results therefore suggest that any fire impacts within the reserve during 2026 were minimal (Figure 6.).

BNR

Approximately 10.16 ha were classified as burned within BNR. Given the absence of FIRMS detections and the reserve's extensive intact forest cover (99.80%), these isolated pixels classified as burned areas are likely associated with spectral anomalies rather than widespread fire occurrence. The patches are far too spread out and there is little to no evidence from ground teams that fires were prevalent across the BNR. Previous assessments have shown that edge effects, shadows, and water features can occasionally produce false burn signals in remote sensing analyses. Although lightning and anthropogenic factors may cause occasional fires within the reserve, its remoteness, hydrology, and climate would make fires highly unlikely. Overall, there is no evidence of significant fire impacts within the reserve during 2026.

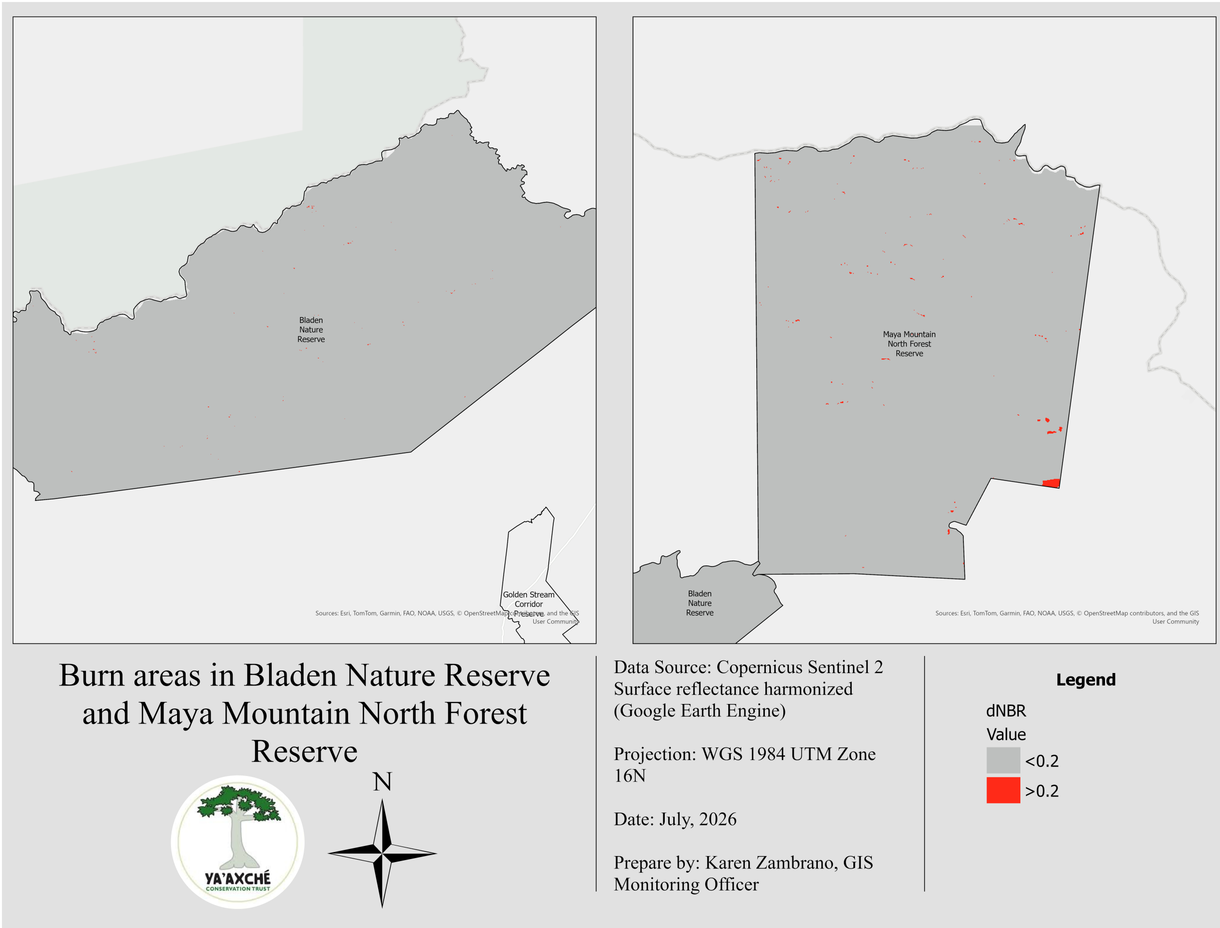

Figure 6. Burned area assessment for BNR and MMNFR, 2026.

BCEP

BCEP recorded the largest mapped burned area among the protected areas, with approximately 48.32 ha classified as burned. Most of the affected pixels occurred near the reserve boundary, where agricultural activities are concentrated. However, no corresponding FIRMS detections were recorded within the reserve and may reflect significant cloud cover during active fires resulting in non-detections. Over the last two years there has been a significant increase in agriculture activity associated with slash and burn practice from the nearby community. This activity occurs along the Southern Highway up to 1.3 km into the reserve. Consistent with the 2025 LULCC assessment, BCEP remains predominantly forested (92.17%), with the bulk of its area under forest cover (Figure 7.)

GSCP

Golden Stream Corridor Preserve recorded approximately 5.00 ha of mapped burned area, representing the smallest burned extent among the protected areas. Similar to the other reserves, no active fires were detected by FIRMS within the preserve. The limited extent and scattered distribution of the pixels classified as burned areas reflect localized spectral changes rather than fire activity or burn scars. The predominantly forested landscape (97.88%) and seasonally flooded ecosystems continue to limit fire spread under normal conditions.

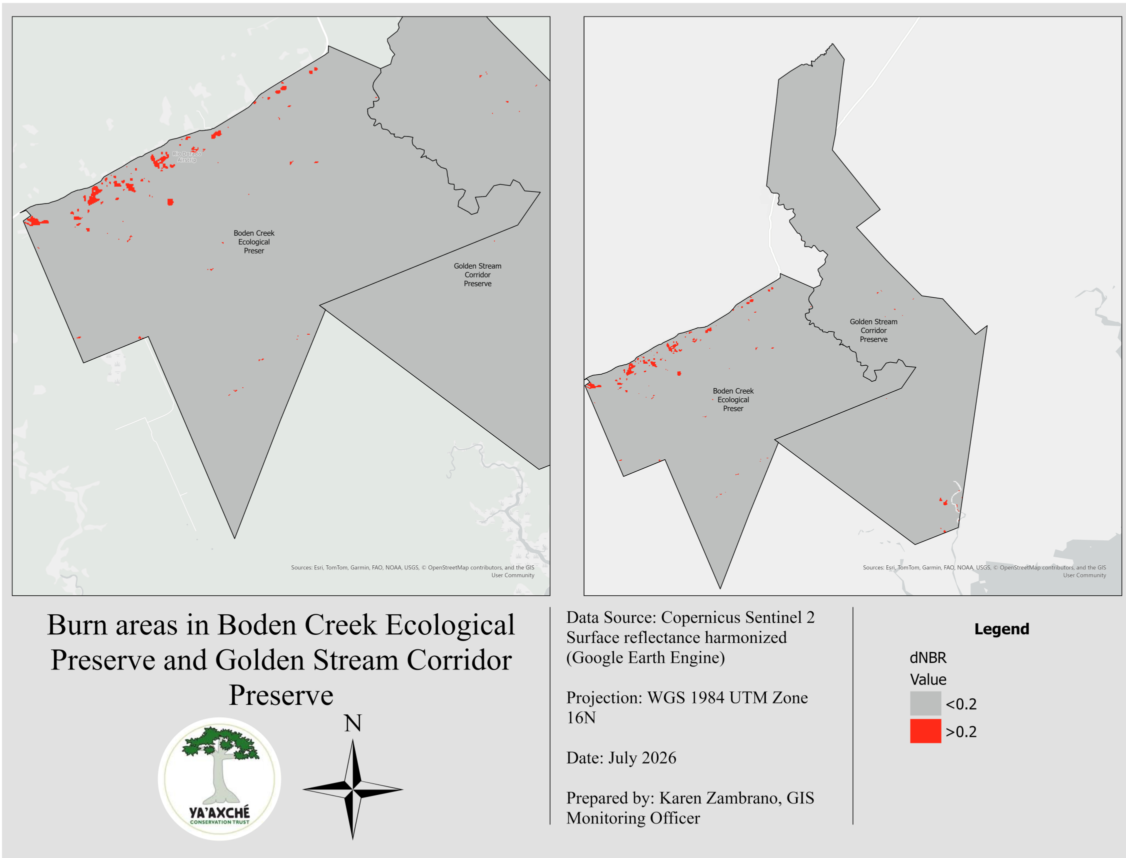

Figure 7. Burned area assessment for Boden Creek Ecological and Golden Stream Corridor Preserve, 2026.

Conclusion

The 2026 fire season was considerably less severe than the 2025 season across both the Toledo District and the MGL. Burned area declined from approximately 24,396 ha (7.7%) in 2025 to 10,022 ha (2.3%) in 2026 within the Toledo District, while the MGL recorded 5,939 ha (1.9%) of burned area. Although active fires and burn scars were recorded throughout the district, fire activity was more localized, with the largest burned areas concentrated in the northeastern portion of Toledo which is dominated by savanna ecosystems. Within the MGL, a noticeable pattern of burned areas was observed in and around BCEP and the Indian Creek area, reflecting continued fire activity along the landscape's southern boundary and adjacent agricultural zones. In contrast, BNR, GSCP, and MMNFR showed no major or concerning signs of burning, indicating that these protected areas remained largely intact during the 2026 fire season.

The reduction in burned areas compared to the previous year is consistent with differences in seasonal weather conditions. Fire occurrence and spread in southern Belize are strongly influenced by rainfall patterns, prolonged dry periods, and broader climate variability associated with the El Niño Southern Oscillation (ENSO). Wetter conditions during the 2026 dry season likely reduced fuel dryness and limited the spread of fires, resulting in fewer large fire events than were observed in 2025.

Looking ahead to the 2027 fire season, fire risk will depend largely on regional weather and climate conditions. If below average rainfall or prolonged dry periods occur, fire activity may increase, particularly in areas that experience frequent agricultural burning.

Recommendations

Annual fire assessments should also incorporate weather and drought indicators, such as rainfall anomalies, soil moisture, and drought indices, to better explain differences in fire activity between years. Linking burned area results with climatic conditions would improve interpretation of fire patterns and could help identify periods of increased fire risk before the peak of the fire season. Future assessments should also include annual fire hotspot analysis using multi-year FIRMS data to identify persistent fire prone areas. This approach would help determine whether areas such as BCEP, Indian Creek, and the northeastern Toledo District continue to experience recurring fire activity and would allow fire prevention and monitoring efforts to be more strategically targeted.

Continued integration of NASA FIRMS with Sentinel-2 dNBR analysis is recommended to combine near real time fire detection with post-fire impact assessment. FIRMS provides timely information on where fires are occurring, while dNBR provides a measure of the spatial extent of burned areas, allowing for a more complete assessment of fire occurrence and impacts across the Toledo District and MGL. These combined datasets provide a strong foundation for improving future fire monitoring, reporting, and management decisions.

Limitations

Several limitations may have influenced the accuracy of the burn area assessment. The analysis relied heavily on satellite derived data, which can be affected by cloud cover, seasonal vegetation changes, and variations in fire intensity. Small scale fires, understory burns, and agricultural fires may be difficult to detect due to the spatial resolution of available imagery, potentially resulting in underestimation of burned areas.

Additionally, changes in vegetation unrelated to fire, such as natural seasonal variation or land management activities, may influence spectral responses and affect burn severity classification. Incorporating higher resolution imagery, additional fire datasets, and improved processing approaches in future assessments would help reduce uncertainty and strengthen burn area estimates.

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Toledo Fire Report

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2026

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