Mirador Deforestation 2017, 2021 and 2022 (5 and 1 year analysis)

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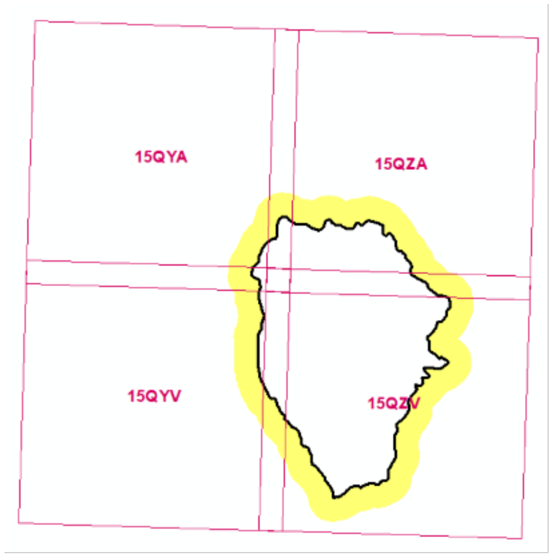
Mirador is in the North of Guatemala and South of Mexico; this location has an approximate area of 6,500 km^2. To analyze the deforestation for 5 and 1 year, we used Sentinel-2 images of 10 meters of spatial resolution from ESA. The results revealed a loss of forest of 24.03 km^2 from 2017-2021 and a loss of forest of 25.32 km^2 from 2021-2022. Majority of deforestation occurred in the last period (2021-2022). The most loss of forest was identified in the buffer area of 10 km around the Mirador, mainly in the borders and areas with agricultural activities, inside the park we can find some paths and relatively less deforestation, but the paths can be susceptible to increased deforestation and require a follow-up to check that the deforestation won't increase inside Mirador.

Mirador National Park in the ancient city of El Mirador, was home to one of the most advanced civilizations. The Maya built massive cities two-and-a-half thousand years ago. Lidar based aerial survey recently revealed a 1,700 km^2 large Maya site dating back approximately to 1000 B.C. to 250 B.C. (Hansen et al., 2022). As the Mayan Biosphere Reserve, Mirador is an important area, it is one of the biggest forests in Centro America and has great importance as a cultural treasure and it serves as a valuable ecosystem to the population.

The kind of forest in Mirador is mostly wetlands and broadleaf forest. This kind of forest has phenological changes during the year mainly in summer and winter because the level of the water changes, so it is easy to mistake these phonological processes as deforestation.

Working with Global Conservation, i-Cultiver has monitored the Mirador through remote sensing to determine the deforestation for years 2017-2021 and 2021-2022. The satellite data available to process the timelines was Sentinel-2 from ESA with a spatial resolution of 10 meters. The total images used to process data were 12 images, four for each year (Fig. 1)

Figure 1. Sentinel 2 Path/Row. In black Mirador and yellow 10 km buffer.



Materials and Methods

The timelines five and one year 2017-2021 and 2021-2022 respectively were analyzed with Sentinel-2 satellite data from ESA, the images were downloaded from Copernicus ESA Hub (Table 1). Although the location had several clouds during the year, we could find images with less than 20% cloud cover (Fig.1).

Table 1. List of downloading images form ESA Hub.

Name	Sensor	ID	Fecha
S2A_MSIL1C_20170425T162331_N0204_R040_T15QYA_20170425T163242	Sentinel-2A	T15QYA	25/04/2017
S2A_MSIL1C_20210325T161921_N0209_R040_T15QYA_20210325T201022	Sentinel-2A	T15QYA	25/03/2021
S2A_MSIL1C_20220330T161851_N0400_R040_T15QYA_20220330T201945	Sentinel-2A	T15QYA	30/03/2022
S2A_MSIL1C_20170405T162331_N0204_R040_T15QYV_20170405T163141	Sentinel-2A	T15QYV	5/04/2017
S2A_MSIL1C_20210325T161921_N0209_R040_T15QYV_20210325T201022	Sentinel-2A	T15QYV	25/03/2021
S2A_MSIL1C_20220519T161841_N0400_R040_T15QYV_20220519T213727	Sentinel-2A	T15QYV	19/05/2022
S2A_MSIL1C_20170425T162331_N0204_R040_T15QZA_20170425T163242	Sentinel-2A	T15QZA	25/04/2017
S2A_MSIL1C_20210203T162501_N0209_R040_T15QZA_20210203T182712	Sentinel-2A	T15QZA	3/02/2021
S2A_MSIL1C_20220330T161851_N0400_R040_T15QZA_20220330T201945	Sentinel-2A	T15QZA	30/03/2022
S2A_MSIL1C_20170425T162331_N0204_R040_T15QZV_20170425T163242	Sentinel-2A	T15QZV	25/04/2017
S2A_MSIL1C_20210305T162141_N0209_R040_T15QZV_20210305T201220	Sentinel-2A	T15QZV	5/03/2021
S2A_MSIL1C_20220330T161851_N0400_R040_T15QZV_20220330T201945	Sentinel-2A	T15QZV	30/03/2022

The remote sensing analysis to monitor deforestation requires images without clouds, which is difficult because the forest areas frequently have many clouds. However, we could find good images to monitor the Mirador. For year 2017 we found images with cover cloud less than 5 % (Fig. 2), for year 2021 it was possible to find images less than 10% as well (Fig. 3) and for 2022, we only found images with less than 40%. (Fig. 4). Although the images for 2022 had several clouds, it was possible to make the loss of forest detection.

Figure 2. 2017 Sentinel-2 mosaic.

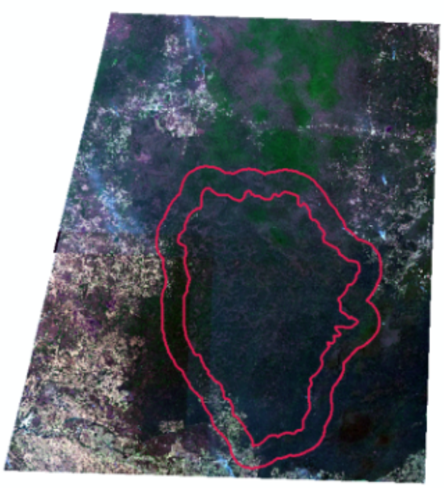
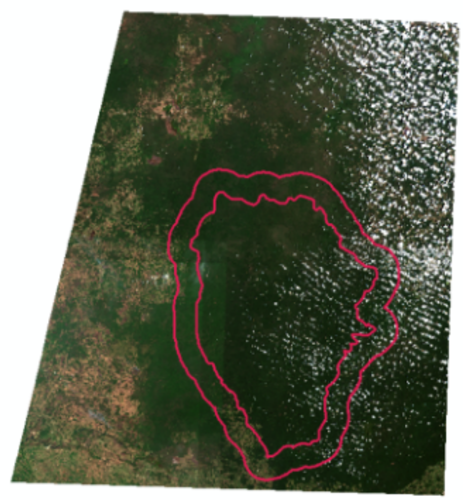


Figure 3. 2021 Sentinel-2 mosaic.

Figure 4. 2022 Sentinel-2 mosaic.



Results

2017-2021 (5 years)

The analysis revealed **24.03 km² of forest loss in past 5 years.** Mostly these changes could be detected in the borders of the park, particularly the areas marked 1-5 (Fig. 5). Deforestation is indicated (yellow), and areas under pressure from human and agricultural activities are shown (green). In some of the locations, the forest loss was replaced for agriculture, and in some areas (maybe in the rest of the effected areas), the forest grew back again.

The agricultural activities in the peripheral areas is dynamic, occurring with high intensity. To maintain the health of the forest in these areas, it is critical to follow-up routinely to make sure the agricultural activity won't impact the forest in the following years. (Fig. 5). Particularly of concern are also the forest loss areas (1, 2, 4 and 5, Fig. 5). The area 3 (blue outline) showed deforestation in the 5-year analysis, and it appears to have had less degradation in the past 1-year analysis. Continued monitoring of these areas can help strategize efforts to reduce further degradation and quantify forest regeneration.

Figure 5. Loss of forest detection for 2017-2021. In pink Mirador, yellow deforestation, and green areas under pressure for human and agriculture activities. Areas of degradation are marked.

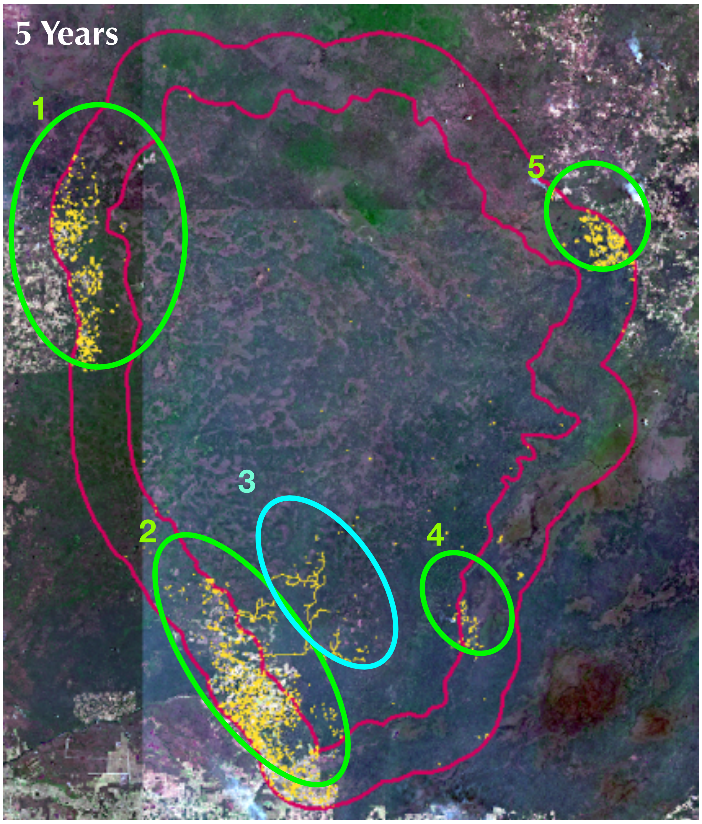
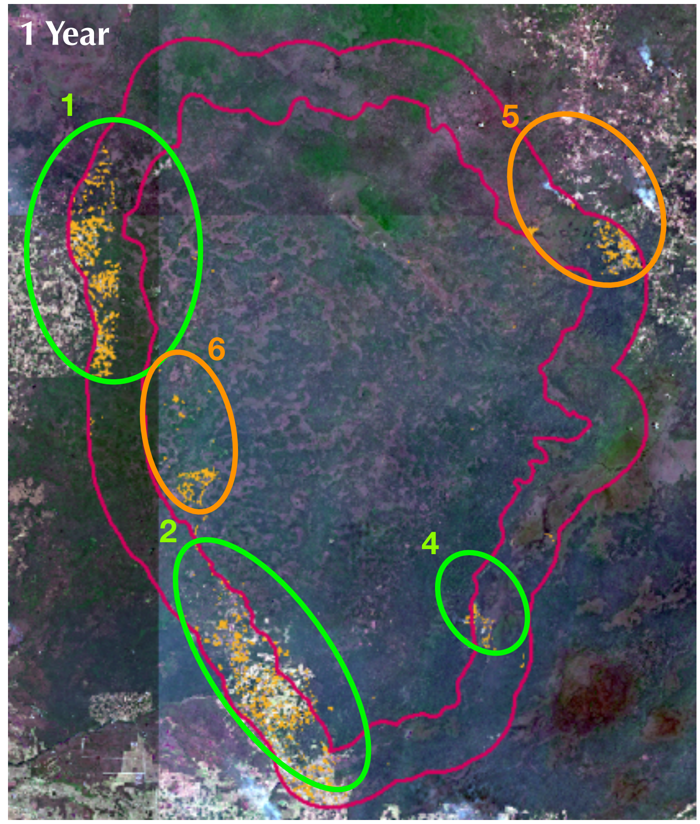


Figure 6. Loss forest detection for 2021-2022. In pink Mirador, yellow deforestation, and green areas under pressure for human and agriculture activities. Areas of degradation are marked.



2021-2022 (1 year)

The analysis revealed **25.32 km² of forest loss in the past 1-year**. Most of these changes could be detected in the buffer area. where exists productivity activities. The forest loss in areas 1, 2 and 4 can be seen in both 5- and 1-year analyses (Figs .5 and 6). Area 5 changed in the 5- and 1-years with some regrowth, but also some additional forest loss. Area 6 appeared in the 1-year analysis as an additionally affected area compared to the 5-year data (Fig. 6). This is a region with more recent forest loss.

Like in the 5-year analysis, there were some areas in the 1-year analysis where the forest loss was replaced for agriculture (green). It is particularly important to pay attention to the paths that are mapping inside the Mirador polygon. These paths are indication of increased activity. At this moment, this disturbance only exists as paths, which are most likely are being used to extract water for the wetland. But, maybe in the coming years this accessibility inside the polygon would become a convenience to change the land use for the fertility and availability of water in the ground (Fig. 6).

Most alarming is the comparison between the 5-year (2017-2021) and 1-year (2021-2022) results. The deforestation detected was the same in areas 1, 2 and 4 (green outlines), indicating that the productivity activities are increasing significantly, resulting in accelerated forest loss within 1-year, which puts conservation efforts at risk, marked throughout with new access paths appearing inside the Mirador.

Areas 5 and 6 (orange outlines) showed an increase in the overall area of impact, mixed with marginal regrowth in 5, but a new area of forest loss 6, detected in 1-year analysis. The area 3 (blue outline) showed overall less change within the past year (See Figs. 5 and 6).

The impact of deforestation by area can be seen in Table 2. Note that the largest amount of deforestation occurred in the buffer area. However, the marked increase in deforestation is evident in the last year analyzed (2021-2022).

Conclusion

During the period of 5 years between 2017-2022, the agricultural productivity activities have caused forest loss around the Mirador, mainly in the buffer area. However, the productivity activities gained access to resources of the Mirador, like its water sources. The detection of paths inside the Mirador are concerning because that indicates the presence of human activities likely increasing inside the Mirador. In the last year, between 2021-2022 the deforestation measured was almost the same as in the past 5 years (2017-2021), which is evidence of increased human activities. These paths are of utmost concern, as they can expand giving more access to the inside of the forest and its resources, a trend of marked increase in forest loss. The location with more risk of deforestation is at the South-West of the park where paths have appeared with more agriculture.

Continuous monitoring with remote sensing combined with on-the-ground targeted-strategies specifically for the identified vulnerable areas is needed to minimize deforestation. Frequent analysis of any further deforestation and of successful regeneration of the impacted areas will provide a quantitative assessment to evaluate the success rate of conservation efforts.

Contact Information

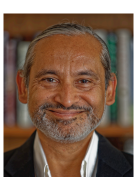


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Table 2: Deforestation results by year showing a significant increase in forest loss during the past year.

Name	2017-2021 (km^2)	2021-2022 (km^2)
Mirador	1.98	1.81
Buffer (10 km)	22.05	23.51
Total	**24.03**	**25.32**
Deforestation	**in 5 years**	**in 1 year**

References

Hansen, R.D. et al. (2022) LiDAR analyses in the contiguous Mirador-Calakmul Karst Basin, Guatemala: an introduction to new perspectives on regional early Maya socioeconomic and political organization. Ancient Mesoamerica, 1–40. doi:10.1017/S0956536122000244

Image: Mirador National Park, Guatemala. Shown using Global Earth Pro. Global Conservation.

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Mission: To bring technical solutions for modernizing agriculture, food systems and resource conservation to improve the human condition and its impact on our planet.
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