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USE OF PLANETSCOPE IMAGERY TO IDENTIFY GALODO IN SUNGAI JAMBU, PARIANGAN, TANAH DATAR, WEST SUMATRA

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ABSTRACT: This study aims to identify and analyze the impact of the Galodo disaster in Sungai Jambu (Pariangan, Tanah Datar, West Sumatra) using PlanetScope satellite imagery. Galodo disasters, which are flash floods that transport materials such as soil and rocks, often occur in mountainous areas and cause significant damage to the environment and infrastructure. Located on the slopes of Mount Marapi, Sungai Jambu is one of the areas prone to galodo due to its geomorphology and high rainfall. The research methodology involved using PlanetScope images before and after the Galodo accident on May 13, 2024. Data processing included radiometric and geometric correction as well as image composite analysis to detect changes in land cover and river flow. The 3-2-1 and 4-3-2 composite images were used to detect changes in vegetation, stream conditions and degraded open land. The results showed significant changes in land cover and river flow due to the Galodo disaster, characterized by increased water turbidity and damaged vegetation.
This study confirms the effectiveness of PlanetScope images in monitoring and identifying the impacts of the Galodo disaster. These findings provide important information for post-disaster mitigation and recovery planning and help identify areas that require restoration. Thus, the use of PlanetScope images can improve our understanding of environmental damage caused by disasters and support more effective and sustainable mitigation measures.

Keywords: Galodo, PlanetScope,Remote Sensing ,Jambu River, Mitigation

1. INTRODUCTION

Galodo disaster or flash flood is a natural phenomenon that often occurs in mountainous areas[1][2], including in West Sumatra. One of the areas prone to galodo disasters is Jambu River, Pariangan which is on the slopes of Mount Marapi with an altitude of ± 700mdpl. Jambu River has a fairly heavy flow and often experiences flash floods, on May 13, 2024 there was a Galodo disaster in Pariangan District, Nagari Sungai Jambu was hit by Galodo on Sunday which caused severe damage and loss of houses[3][4].

The condition of the rocks around Mount Marapi is fragile, the slope is steep, and high rainfall makes the watersheds upstream of the volcano prone to lava flooding[5][6]. According to Hendra, Mount Marapi's Disaster Prone Area (KRB) I zone has been established along the mountain's headwaters. The area included in KRB I of Mount Marapi includes more than 20 rivers, with a high risk of lava flooding, especially at the bends of the river with low cliffs.

Some areas that are included in KRB I include the flow of Batang Air Rimbo Piatu River, Batang Air Bonjol, Batang Air Gadang, Batang Air Sitapu, Batang Air Sereh Silintak, Batang Air Jabur, Batang Air Anau, Batang Air Mandailing, Batang Air Bangkahan, Batang Air Sigarunggung, Batang Air Sungai Jambu, Batang Air Sabu, Batang Gadis, and Talang River.

According to PVMBG (Center for Volcanology and Geological Disaster Mitigation), KRB I of Mount Marapi has volcano-related hazards. This threat is in the form of cold lava floods and high rainfall. In line with this, BMKG (Meteorology, Climatology and Geophysics Agency) stated that May 8, 2024 showed the potential for rain with moderate to very heavy intensity in the West Sumatra region. And at the same time the BMKG Meteorology Team issued an early warning of the potential for extreme weather resulting in hydrometeorological disasters, such as floods and landslides in West Sumatra.

In relation to disasters, the utilization of PlanetScope imagery is indispensable. PlanetScope imagery has high spatial resolution and the ability

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to provide regular monitoring, making it an invaluable tool in identifying environmental changes before and after disasters[7][8]. The use of PlanetScope imagery for researchers and decision-makers can monitor changes in vegetation, soil, and river flow conditions with a high level of detail [9][10]. This becomes more complex with the utilization of PlanetScope imagery in post-disaster ecosystem recovery efforts, especially in Jambu River, West Sumatra.

Figure 1: The appearance of Jambu River after the galodo of May 13, 2024

PlanetScope imagery can be used to identify areas of vegetation damage or soil degradation from flash floods, as well as to map changes in river flow and sedimentation that occur after a disaster[11]. This information is invaluable in environmental restoration planning, as it provides a deeper understanding of field conditions and allows for the identification of hotspots that require more attention for the recovery process.

In addition, PlanetScope imagery can also be used to monitor the effectiveness of restoration actions taken after a disaster. By comparing pre- and post-restoration imagery, it is possible to evaluate whether restoration actions have successfully returned ecosystem conditions to an adequate level[12][13]. This helps in evaluating the success of the restoration program and determining the next steps that need to be taken.

Thus, utilizing PlanetScope imagery not only improves our understanding of the damage that occurred after the galodo disaster in Jambu River, but also enables more effective and sustainable restoration planning and implementation. With the information provided by PlanetScope imagery, post-disaster ecosystem restoration can become more targeted and successful in restoring the function and diversity of affected ecosystems.

2. METHODS

2.1 Study Area

This research focuses on Jambu River, Pariangan, West Sumatra, which is included in the Disaster Prone Area (KRB) I Zone of Mount Marapi. Jambu River is one of the rivers upstream of Mount Marapi and has a high risk of lava flooding. Jambu River often experiences flash floods, especially during the rainy season when rainfall is high and river water discharge increases rapidly.

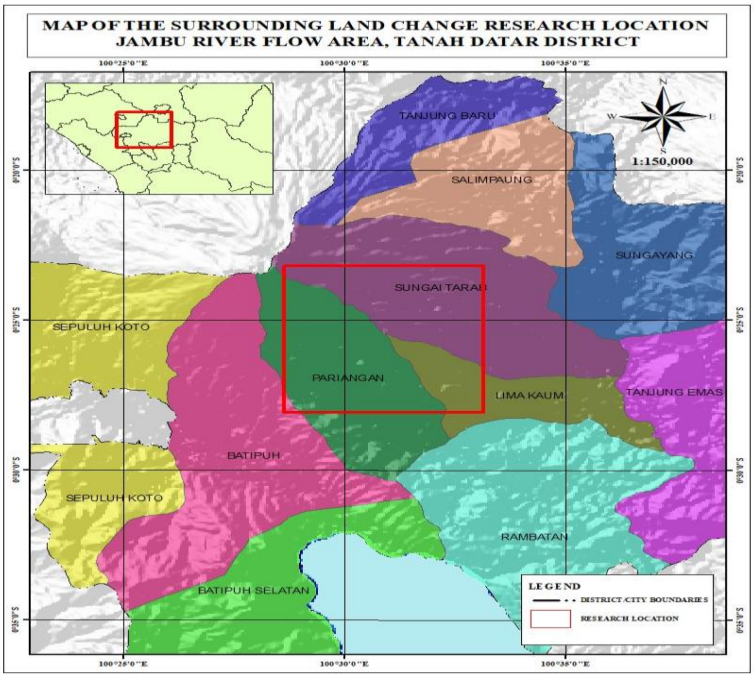

Figure 2. Research Location

This study uses third-generation PlanetScope imagery, with the PSB.SD (SuperDove) sensor, which began operating April 29, 2022 until now. The spatial resolution of PSB.SD is 3.7 meters to 4.2 meters for multispectral channels, with a total of 8 spectral channels. PlanetScope image characteristics are:

Table 1. PlanetScope PSB.SD (SuperDove) Image Characteristics PlanetScope PSB.SD (SuperDove) Image Characteristics (PlanetScope Product Specifications, 2023)

Mission Characteristics	Sun-synchronous Orbit
Orbit Altitude (reference)	475 - 525 km (~98° inclination)
Field of View	4.0° (swath) 2.3° (scene length)
Sensor Type	Eight-band frame imager with butcher-block filter providing coastal blue, blue, green I, green II, yellow, red, red-edge, and NIR stripes
Spectral Bands	Coastal Blue 431-452 nm Blue: 465-515 nm Green I: 513. - 549 nm Green: 547. - 583 nm Yellow: 600-620 nm Red: 650 - 680 nm Red-Edge: 697 - 713 nm NIR: 845 - 885 nm
Ground Sample Distance (nadir)	3.7 m-4.2 m (approximate, altitude dependent)
Revisit Time	Daily at nadir
Image Capture Capacity	200 million km²/day
Imagery Bit Depth	12-bit
Availability Date	March 2020 - present

Source: https://assets.planet.com/docs/Planet_PSScene_Imagery_Product_Spec_letter_screen.pdf

In this research, various materials and hardware were used to carry out image data processing and visualization. ArcGIS and ENVI software were used to pre-process, process and post-process the data. In addition, Microsoft 365 was used for additional documentation and analysis. The materials used were PlanetScope images before the Galodo disaster on February 27, 2024 and images after the Galodo disaster on May 25, 2024.

The PlanetScope imagery used was Surface Reflectance, which has been optimized for scientific and quantitative analysis. This imagery offers an analytical or 'ground truth' representation

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of spatially accurate data, with atmospheric effects and sensor characteristics minimized.

2.2 Research flow chart

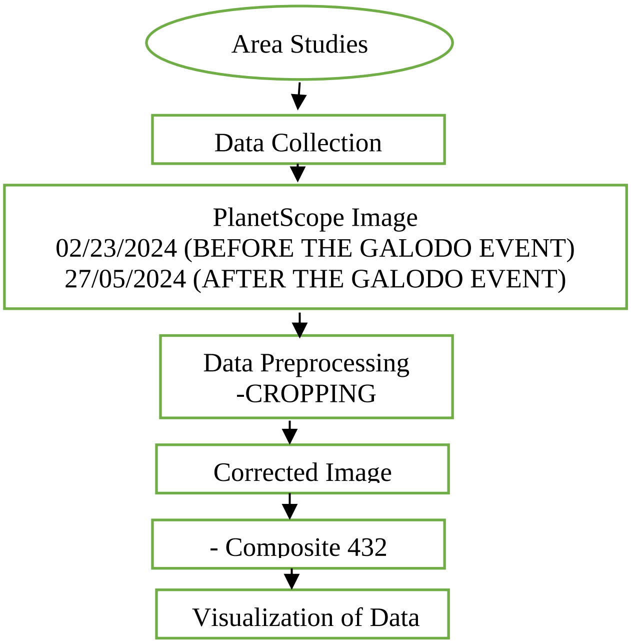

Figure 3. Research Flow Chart

The method is descriptive research with a comparative study approach. Descriptive research aims to visualize images before the disaster and before the Galodo disaster. Research using a comparative approach is expost facto, where the data collected is data after the event and before the event, then interpreting, This study compares the appearance of Jambu River on satellite images dated February 23, 2024 (before the Galodo event) and May 27, 2024 (after the Galodo event).

3. RESULTS AND DISCUSSION

This study used the 3-2-1 composite of PlanetScope imagery to analyze land use change before and after the Galodo event in Batang Anai. In the 3-2-1 composite, the red band captures red light visible to the human eye and detects vegetation and bare soil[14]. The green band captures green light which is useful for identifying healthy vegetation that usually reflects a lot of green light, as well as water bodies. The blue band captures blue light which is also visible to the human eye. Healthy vegetation in this composite will appear green, water bodies such as rivers will appear blue, and soil and other non-vegetative areas will appear brown or yellow.

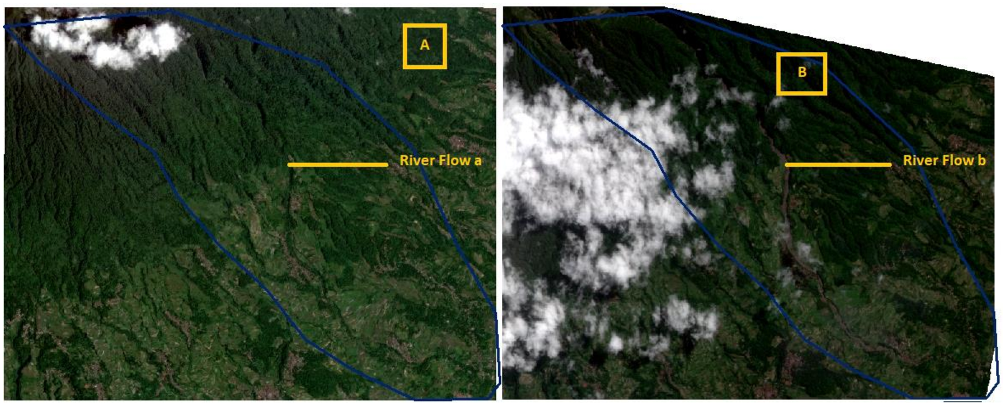

Figure 4. Composite Image 321 (True Color) Image a (river flow before galodo event), Image b (river flow after galodo event)

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Before the galodo event, the river was still covered with vegetation, making the river appear green with vegetation. After the galodo event, the image shows significant changes, especially in the brown color of the river. This color change is caused by the river flow that carries sediment from the galodo material. During the galodo, materials such as soil, rocks and vegetation were released and flowed into the river, causing an increase in turbidity and discoloration of the water. These sediments come from soil erosion and rockfalls that are carried by gravity-driven water flow. This shows that the galodo has caused a major disturbance to the environment, with sediments carried down the river indicating significant soil erosion and a wide distribution of landslide material. This discoloration provides important visual information on the direct impact of the galodo on water quality and aquatic ecosystems downstream.

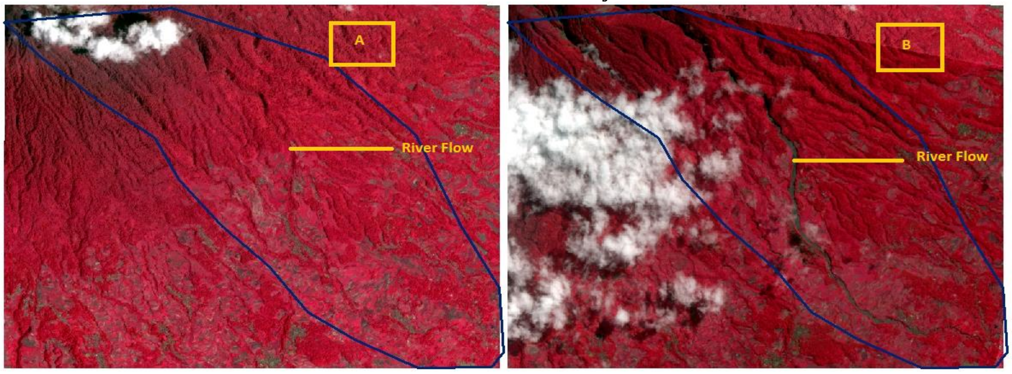

Figure 5. Composite image 432 (False color) Image a (river flow before galodo event), Image b (river flow after galodo event)

Figure 6. Jambu River after the Galodo disaster

The 4-3-2 composite from PlanetScope satellite imagery to analyze land-use change and environmental impact due to galodo (landslide or flash flood) in the Jambu River area. The 4-3-2 composite, which consists of near infrared (NIR), red, and green bands, enables effective visualization of the condition of vegetation, bare soil, and water bodies before and after a disaster event.

3.1 Analysis of Vegetation

Comparison of images before and after the galodo can be used to more accurately assess changes in vegetation conditions. Healthy vegetation, which reflects a lot of light in the NIR band, usually appears bright red in this composite

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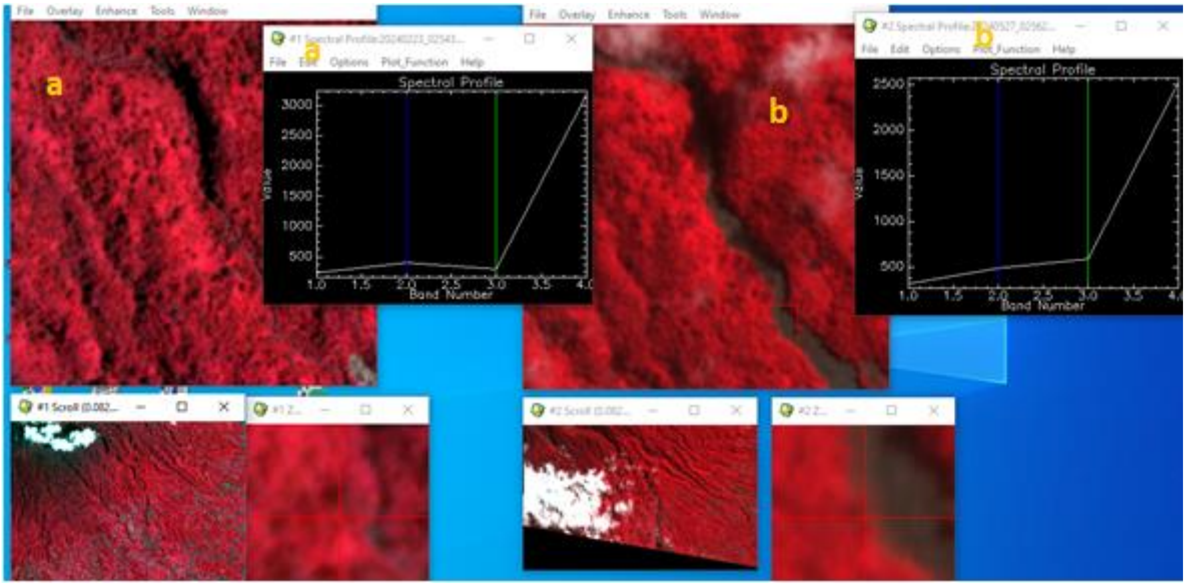

Figure 7. Composite Image 432 (False color) Image a (river flow before galodo event and vegetation reflection curve), Image b (river flow after galodo event and vegetated area reflection curve)

Healthy vegetation, which reflects a lot of light in the NIR band, usually appears bright red in this composite. Before the galodo, areas of healthy vegetation dominated the image, indicating good land cover. However, after the galodo, many areas that were previously covered with healthy vegetation experienced significant discoloration. Severely affected areas show darker colors or turn brown or gray, indicating vegetation damage or complete removal of vegetation cover due to avalanches and other material carried by the flow.

3.2 Identification of River Flow

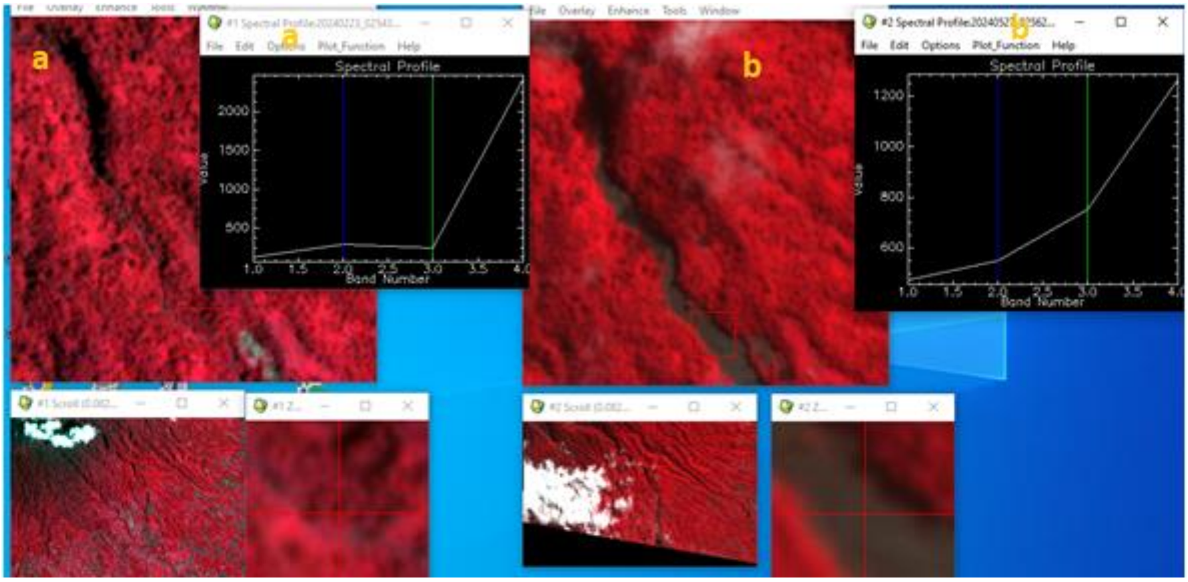

Figure 8. Composite Image 432 (False color) Image a (river flow before galodo event and reflection curve of river flow), Image b (river flow after galodo event and reflection curve of river area)

The color change of the stream after the galodo is also clearly visible in the 4-3-2 composite image. Before the galodo, the stream appears clear and dark in the image (due to light absorption in the NIR band). However, after the galodo, the stream turned bright brown or yellowish. This change is caused by the high levels of sediment and suspended particles carried by the water flow, resulting from soil erosion and deposition of landslide material into the river. This phenomenon provides strong visual evidence of the increased sedimentation and potential water quality degradation caused by the galodo.
Degradation Area

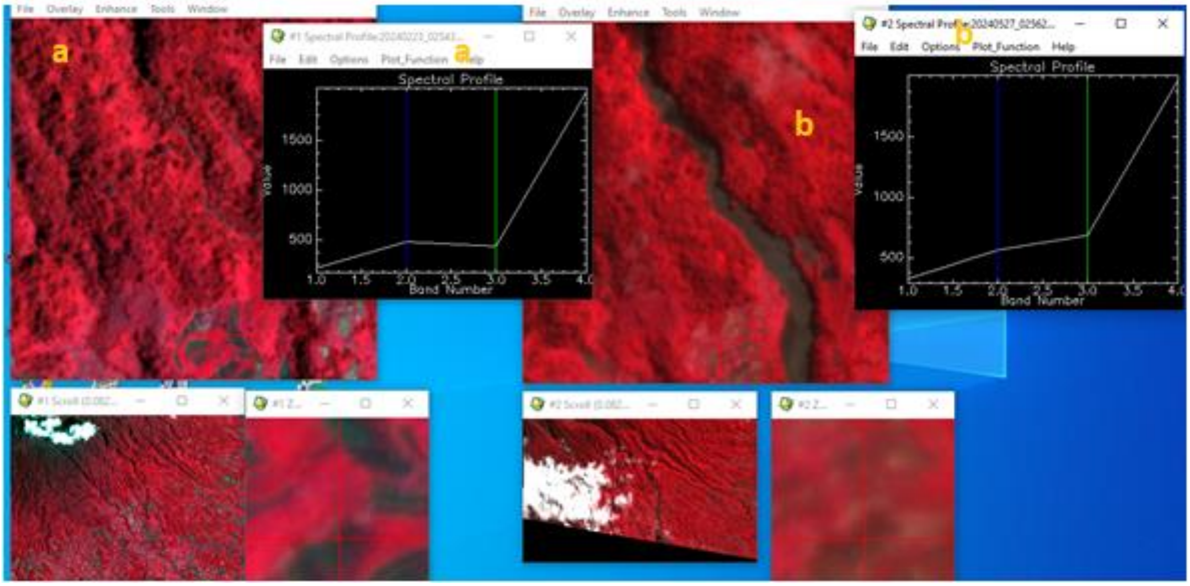

Figure 9. Composite image 432 (False color) Image a (river flow before galodo event and open land reflection curve), Image b (river flow after galodo event and open land reflection curve)

Comparing images before and after the galodo, the 4-3-2 composite helps to identify areas of bare soil and land degradation[16]. Before the galodo, many areas covered by vegetation appeared stable. However, after the galodo, many areas that were previously covered by vegetation now appear as bare soil, shown in brown or gray. These areas indicate locations where landslide material has covered vegetation or where the ground is exposed due to erosion and loss of land cover. These changes indicate the extent of damage to the local ecosystem and provide an indication of areas that require rehabilitation and replanting efforts.

3.3 Implications for Mitigation and Recovery

Findings from the 4-3-2 composite analysis provide critical information for post-disaster mitigation and recovery strategies. Identification of areas with vegetation damage and increased sedimentation in rivers can assist in planning restoration actions[15], such as reforestation and slope stabilization to prevent further erosion. Monitoring of water quality and sedimentation can be conducted to manage broader environmental impacts and ensure the recovery of aquatic ecosystems.

By comparing pre- and post-event imagery, it is possible to identify in detail the impact of the galodo on land use and environmental conditions. The results of this study confirm the importance of remote sensing in disaster monitoring and recovery planning, and provide data that can be used to improve future mitigation strategies.

4. CONCLUSION

This study provides an in-depth understanding of the changes that occurred in the ecosystem after the galodo. Analysis with the 4-3-2 composite showed significant changes in the condition of vegetation, river flow, and open land area after the galodo. These findings have important implications for post-disaster mitigation and recovery. This research confirms the important role of remote sensing in natural disaster monitoring and recovery planning. By understanding the changes that occurred after the galodo, appropriate mitigation can be done to reduce negative impacts and to restore the affected ecosystems.

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