

Volcanic Eruption of the 15th of January 2022

Activation-744 (call-855)



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## The impact of Tonga volcanic eruption on the vegetation of the surrounding islands

### Key messages:

- The vegetation is covered by a large amount of volcanic ash and the NDVI values are almost smaller than 0 on the islands within 138km of the volcano eruption.
- The vegetation is almost unaffected by the volcanic ash and the NDVI values are greater than 0.1 on the islands more than 138 km away from the volcanic eruption location.

Satellite Image: PlanetScope, Resolution: 3m, Copyright: @ Planet Labs.



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To analyze the impact of the Tonga volcanic eruption on the vegetation of the surrounding islands, the normalized difference vegetation index (NDVI) values are calculated for 11 islands using remote sensing images. The remote sensing images used in this report are all from the Planet satellite, with the same band parameters and consistent vegetation indices for comparative analysis. Specifically, each island was numbered according to its distance from the volcanic eruption (Fig. 1). The list of remote sensing images is in Table 1, where the numbers correspond to that in Fig. 1. Island #1 is covered by 2 views of Planet images, acquired on January 14, 2022, and January 16, 2022, respectively, and all the other islands are covered by the images acquired on January 16, 2022.

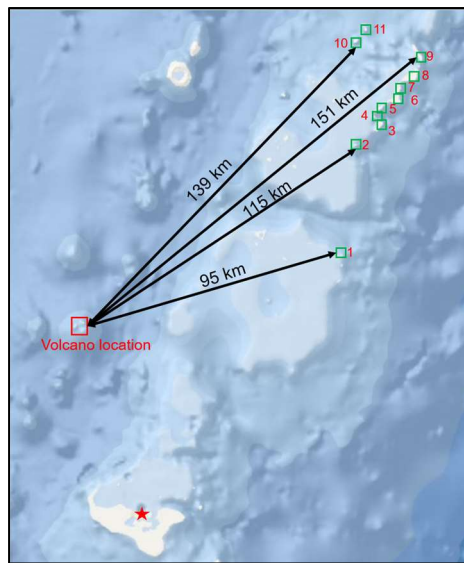


Fig. 1 Location of the 11 islands

Table 1 List of remote sensing images

Island number	Satellite	Acquisition dates	Spatial resolution (m)	Distance from volcanic eruption (km)
1	Planet	2022.Jan.14	3	95
		2022.Jan.16		
2	Planet	2022.Jan.16	3	115
3	Planet	2022.Jan.16	3	124
4	Planet	2022.Jan.16	3	125
5	Planet	2022.Jan.16	3	128
6	Planet	2022.Jan.16	3	133
7	Planet	2022.Jan.16	3	138
8	Planet	2022.Jan.16	3	142
9	Planet	2022.Jan.16	3	151
10	Planet	2022.Jan.16	3	139
11	Planet	2022.Jan.16	3	143

The normalized difference vegetation index (NDVI) is a commonly used indicator that can be used to assess whether or not the target being observed contains live green vegetation. The NDVI is calculated as follows:

$$NDVI=(NIR-Red)/(NIR+Red),$$

where Red and NIR stand for the spectral reflectance measurements acquired in the red and near-infrared bands, respectively. The NDVI ranges from -1 to 1, and generally greater than 0 indicates vegetation cover. Higher NDVI values indicate greener vegetation and higher coverage. When the vegetation is covered with a large amount of volcanic ash, the NDVI will be relatively low.

We calculate the NDVI for all the 11 islands, and analyze the NDVI curves for the typical sections (Fig.2; 3; 4; 5). Results show that after the eruption of the Tonga volcano, the volcanic ash covered the surrounding islands, but the degree of ash coverage was different in different islands.

Specifically, the vegetation on #1 island was green and the NDVI of the vegetation area was greater than 0.1 on January 14, 2022 (Fig. 2a), however, on January 16, 2022, the image was dark, and part of the vegetation was destroyed and covered with a large amount of volcanic ash, and the NDVI was less than -0.1 (Fig. 2b). In addition, there is a large amount of volcanic pumices in the offshore regions of #1 island in the 16th image, indicating that the eruption has a serious impact on this area. Moreover, according to Fig 3(a)-(c), the vegetation in the Planet image is in dark brown color and the NDVI is less than -0.2, which indicates that the areas on #2 island are obviously affected by the volcanic ash. According to Fig. 4(a1)-(a4), it can be found that most of the areas on #3, #4, #5, and #6 islands are in gray color and only a few areas are in green color, indicating most of the vegetations are covered by volcanic ash. The NDVI of the volcanic ash-affected areas on these islands is less than 0, while the NDVI of the less-affected areas is between 0 and 0.1 (Fig.4). The NDVI of the vegetation area is greater than 0.1, and the maximum value can reach 0.4 on the #7, #8, #9, #10 and #11 islands, which suggests that the vegetation is almost unaffected by the volcanic ash on the islands which are more than 138 km away from the volcanic eruption location (Fig. 5)

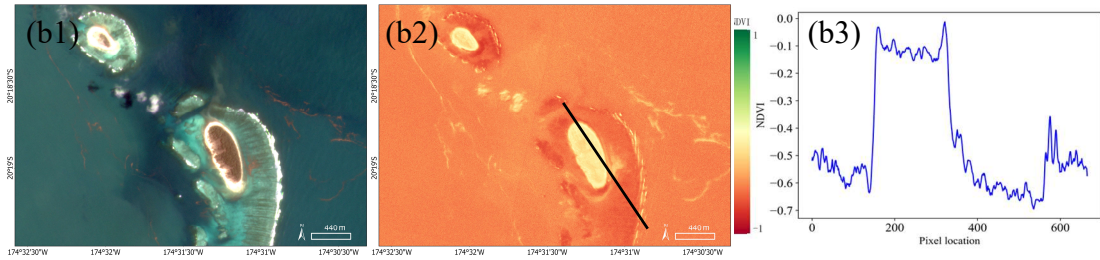
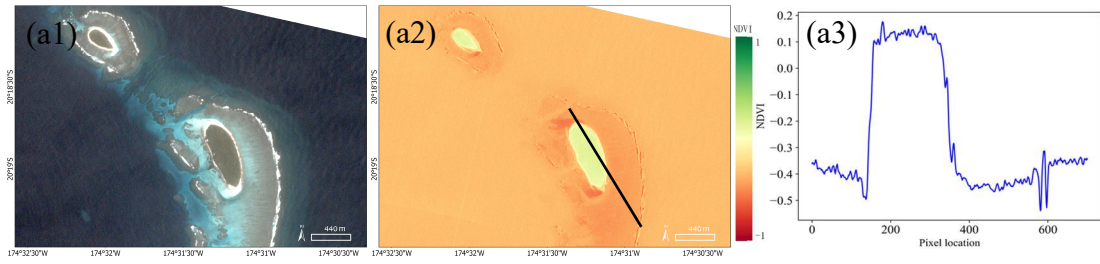


Fig. 2 The Planet images (a1, b1), NDVI images (a2, b2), and NDVI curves of the section (a3, b3) for #1 island on January 14, 2022 (a), and January 16, 2022(b)

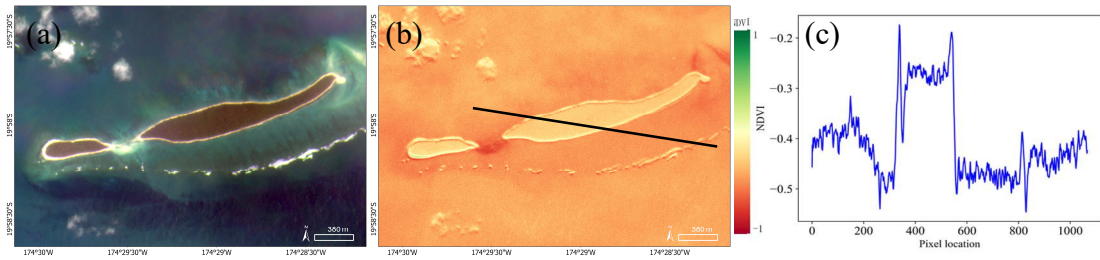
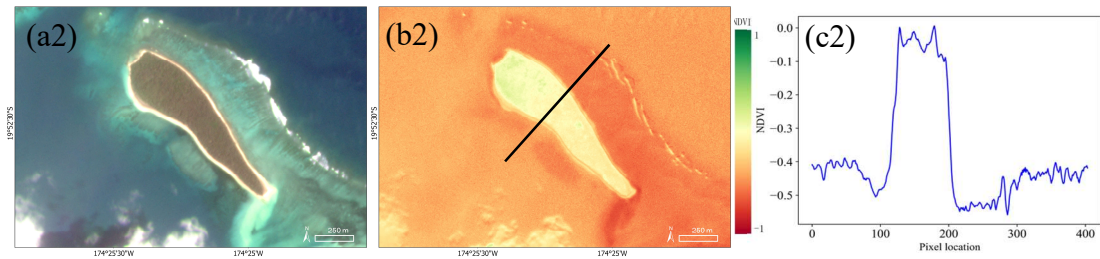
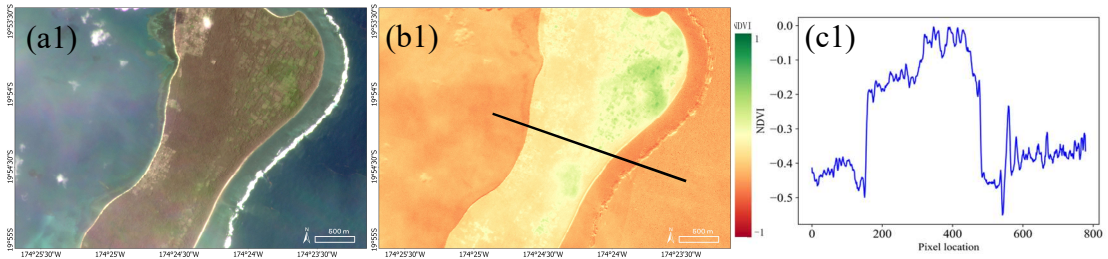


Fig. 3 The Planet image (a), NDVI image (b), and NDVI curve of the section (c) for #2 island on January 16, 2022





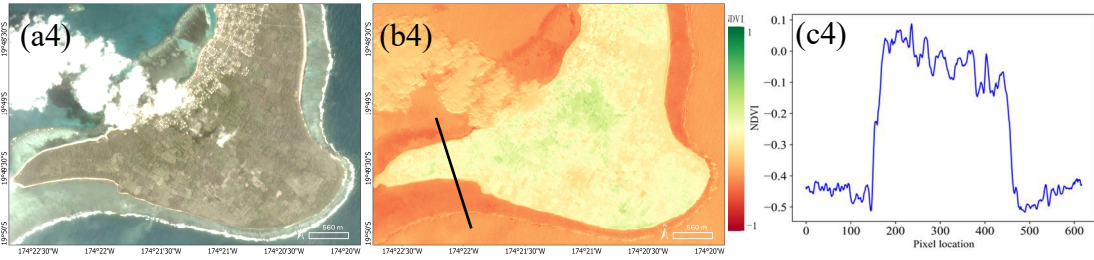
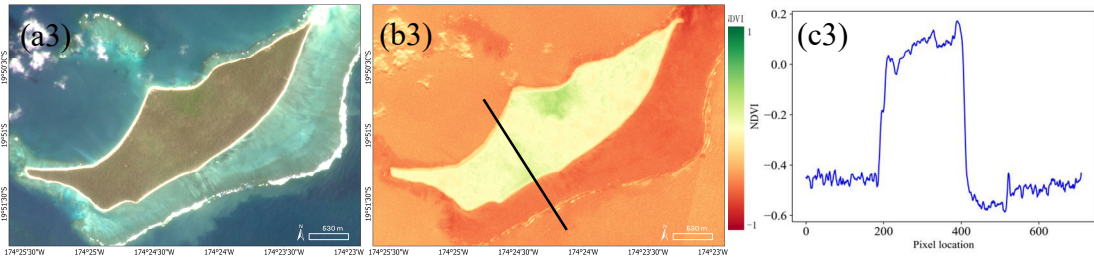
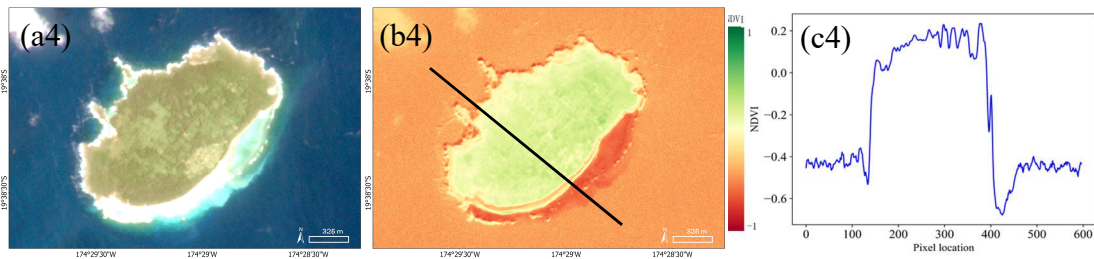
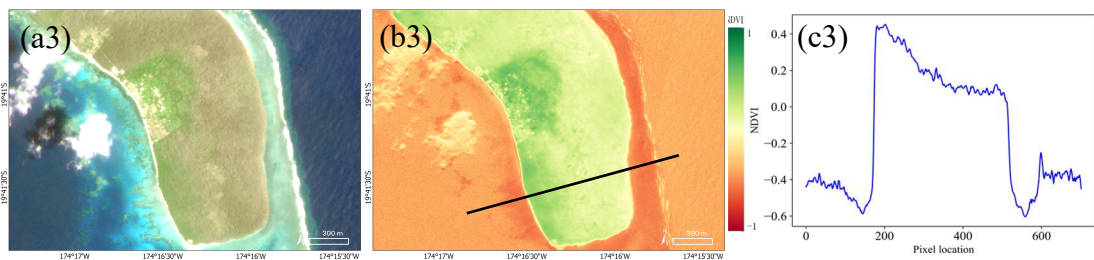
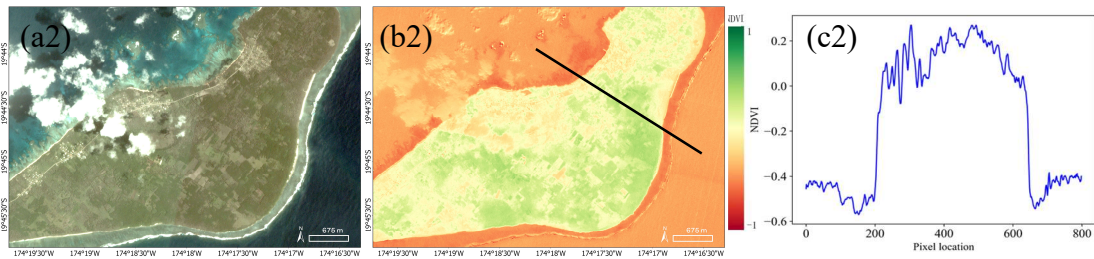
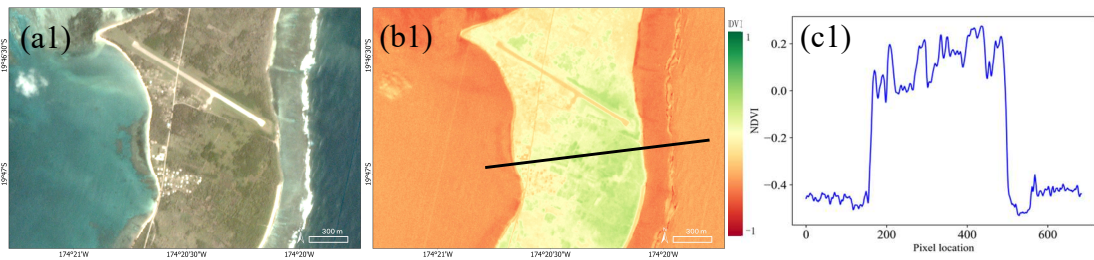


Fig. 4 The Planet images (a1, a2, a3, a4), NDVI images (b1, b2, b3, b4), and NDVI curves of the sections (c1, c2, c3, c4) for #3, #4, #5, and #6 islands on January 16, 2022



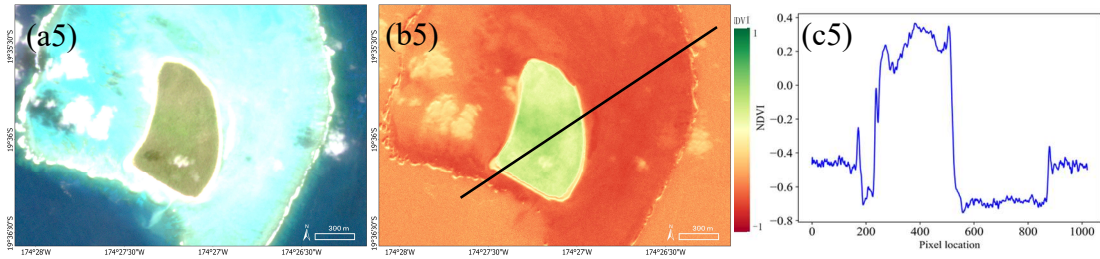


Fig. 5 The Planet images (a1, a2, a3, a4, a5), NDVI images (b1, b2, b3, b4, b5), and NDVI curves of the sections (c1, c2, c3, c4, c5) for #7, #8, #9, #10, and #11 islands on January 16, 2022

In order to better understand the influence of the distances between the islands and the eruption location on the NDVI changes, the NDVI curves of the vegetated areas of the sections in Figs 2-5 were shown in Fig.6a and the average NDVI values for each island were calculated (Fig.6b). In general, NDVI increases with the increase of the distances between the islands and the eruption location. In particular, the vegetation is covered by a large amount of volcanic ash in the islands nearby the eruption location, therefore, the remote sensing image becomes gray-brown and the NDVI values are almost smaller than 0. As the distance becomes larger than 138 km, the effect of volcanic ash on NDVI is small, therefore, the vegetation color in the remote sensing image is green and the NDVI values are greater than 0.1.

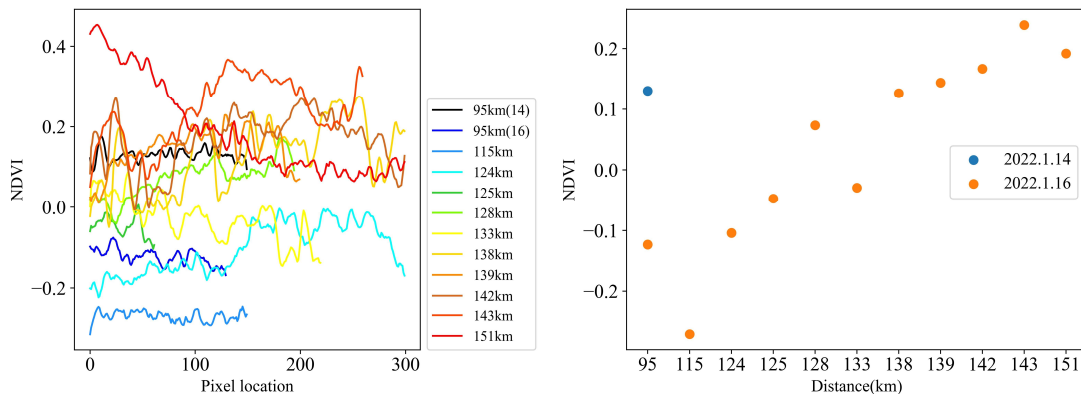


Fig.6 (a) the NDVI curves of the vegetated areas of the sections on the 11 islands. The 95 km (14) and 95 km (16) are the curves on Jan. 14, 2022, and Jan.16, 2022, respectively. (b) the average NDVI values for each island.