Utilization of ICESat-2 and Pleiades Stereo Datasets for assessments of Changes in Elevation in Complex Himalayan Terrain due to the Rockslide at Trishul Mountain Range near Ronti Glacier, Chamoli

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PRESENTED AT:

ABSTRACT

Openly accessible space-borne lidar, ICESat-2 datasets along with Pleiades stereo datasets provide a unique opportunity for estimation and monitoring of fragile sites in relatively inaccessible complex terrain for their changes in elevation and state. Two sets of over 100 lidar points (footprints) from ICESat-2 Track ID: 1354, dated 27 March 2019 were chosen in the flood-impacted Rishiganga and Dhauliganga valleys, i.e. at the place of the rock slide and a confluence Junction on the downstream side towards the severely affected Raini Village. These two locations depict the large-scale changes that occurred due to the flash flood initiated by the rockfall on 7th February 2021. The pre-and post-datasets from Google Earth optical images depict the large variations that occurred due to the event. Digital elevation model generated from Pleiades stereo datasets acquired on 10th February 2021 (post-event), is used for analysis with ICESat-2 datasets (pre-event). Before the event at the analyzed junction location, there was a width of about 30m channel with boulders and had tree-covered surrounding slopes. After the event lot of mud and debris have accumulated in a width of about 300 m without tree cover. The trees got unearthed in the processes involved in the event. The analysis shows a clear sign of erosion on the banks and the accumulation of debris along the river channel as well. The analysis depicted an accumulation of debris that raised the elevation from 0.1m to 44.86m at places with an average of 11.34m. Whereas the erosion varies from 0.15m - 15.76m with an average of 4.85m, mainly on the eroded river banks.

INTRODUCTION

A large number of remote sensing satellites, with the availability of United Nations (UN) / International Charter Space and Major Disasters (ICSMD) charter programs for disaster management combined with open-source datasets, are proving highly useful datasets for the fulfillment of societal benefits including emergency response or monitoring. Two useful open-source platforms with a global context along with the Indian context are the Google Earth (GE) and the Bhuvan platform, respectively. GE started HR digital rendering services beginning in 2005 whereas, the Bhuvan platform is developed by the National Remote Sensing Centre (NRSC), and provides a lot of thematic information besides the visualization capability with HR digital rendering to the user community since 2009. NDC, NRSC also act as key data providers for the Indian researchers and global community during disasters. The present study depicts the use of these datasets for the analysis of the changes that occurred in the topography with its impacts in the surrounding rockfall zone, which took place on 7th February 2021.

MATERIAL AND METHOD

The digital elevation model for the affected area is generated using the Pleiades stereo dataset (Multispectral) as per the standard photogrammetric method using rational polynomial coefficients (RPCs). Pleiades stereo dataset for the rockfall region is received under International Charter Space and Major Disasters (ICSMD) triggered (Call-803) by the Indian Space Research Organisation (ISRO) on February 7, 2021. The DEM at 10m point posting is also obtained from National Remote Sensing Center (NRSC), Hyderabad in a grid format. These two DEMs are then utilized for the computation of changes in elevations and volumes in ArcGIS software. RS&GIS and photogrammetric methods have become prominent in providing the solutions for the generation of DEMs, and orthoimages (Figure 1), whereas 10m CartoDEM provided by NRSC along with the ICESat-2 from NASA supported platform has been a good resource for study on elevation changes in topography.

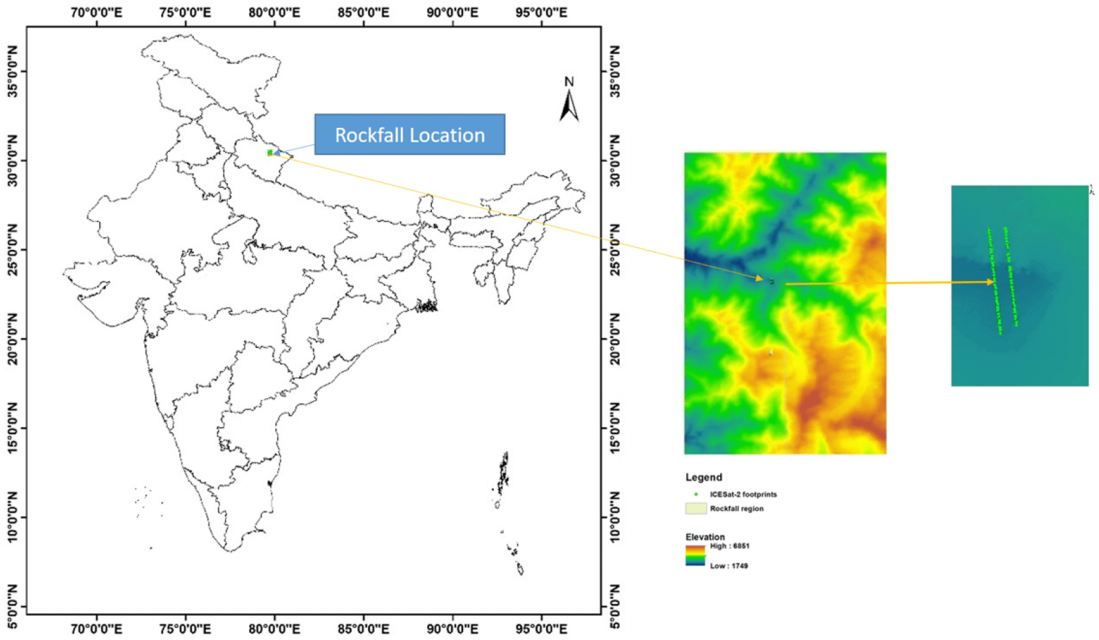


Figure 1: Study area with overlaid with Cartosat-1 DEM and ICESat-2 footprints (Green dots)

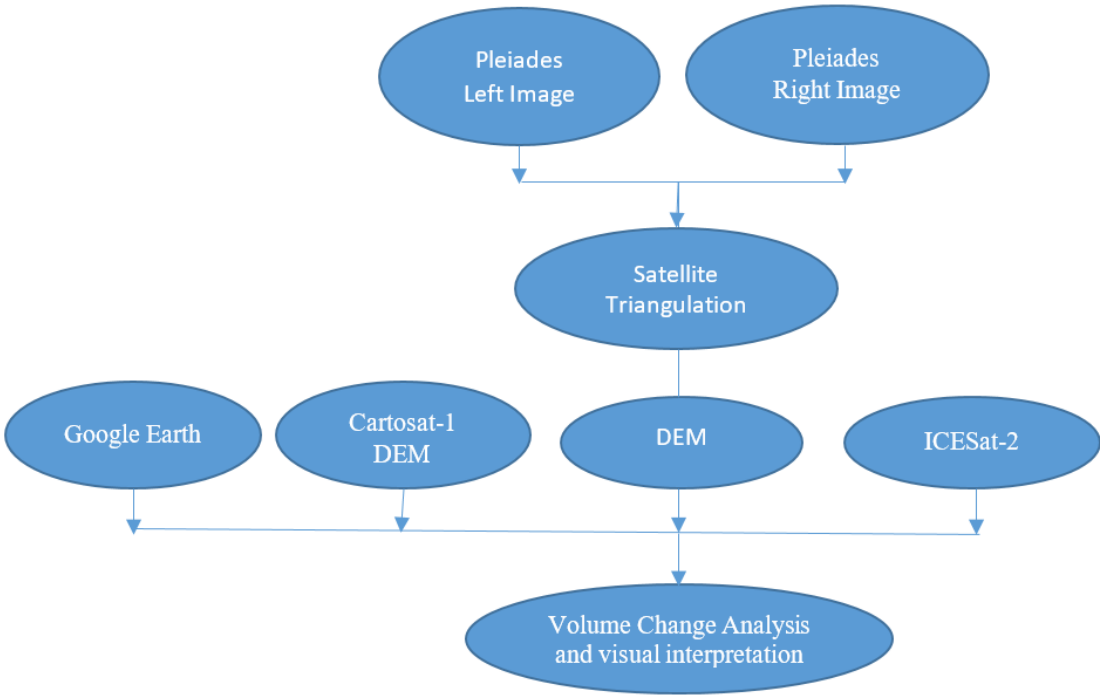


Figure 2: Flowchart of the adopted Methodology

RESULTS AND DISCUSSION

Figure 1 displays the rockslide for a major part at the top of the hill having a volume change of approximately 23 million cubic meters. Whereas analysis depicts a change in volume of 27.1 million cubic meters up to the bottom of the rockfall region in the valley. The analysis shows that the width of the affected area increased from 30m to 300m after the event at the depicted tri-junction indicating the massiveness of the energy generated due to the rockfall, which eroded the tri-junction (Figure 3). The analysis of ICESat-2 data depicted an accumulation of debris that raised the elevation from 0.1m to 44.86m at places with an average of 11.34m near the tri-junction area on the downstream side of rockfall. Whereas the erosion varies from 0.15m - 15.76m with an average of 4.85m, mainly on the eroded river banks. Thus it can be seen that both erosion and accumulation have occurred to a large extent due to the high energy generated by rockfall and movement of debris with ice/snow and water.

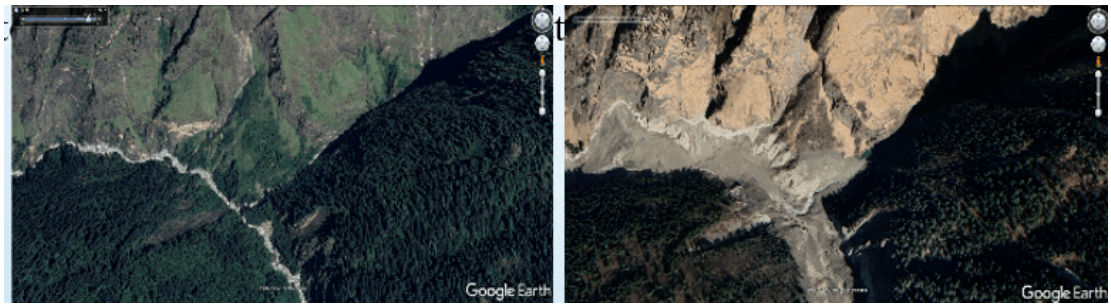
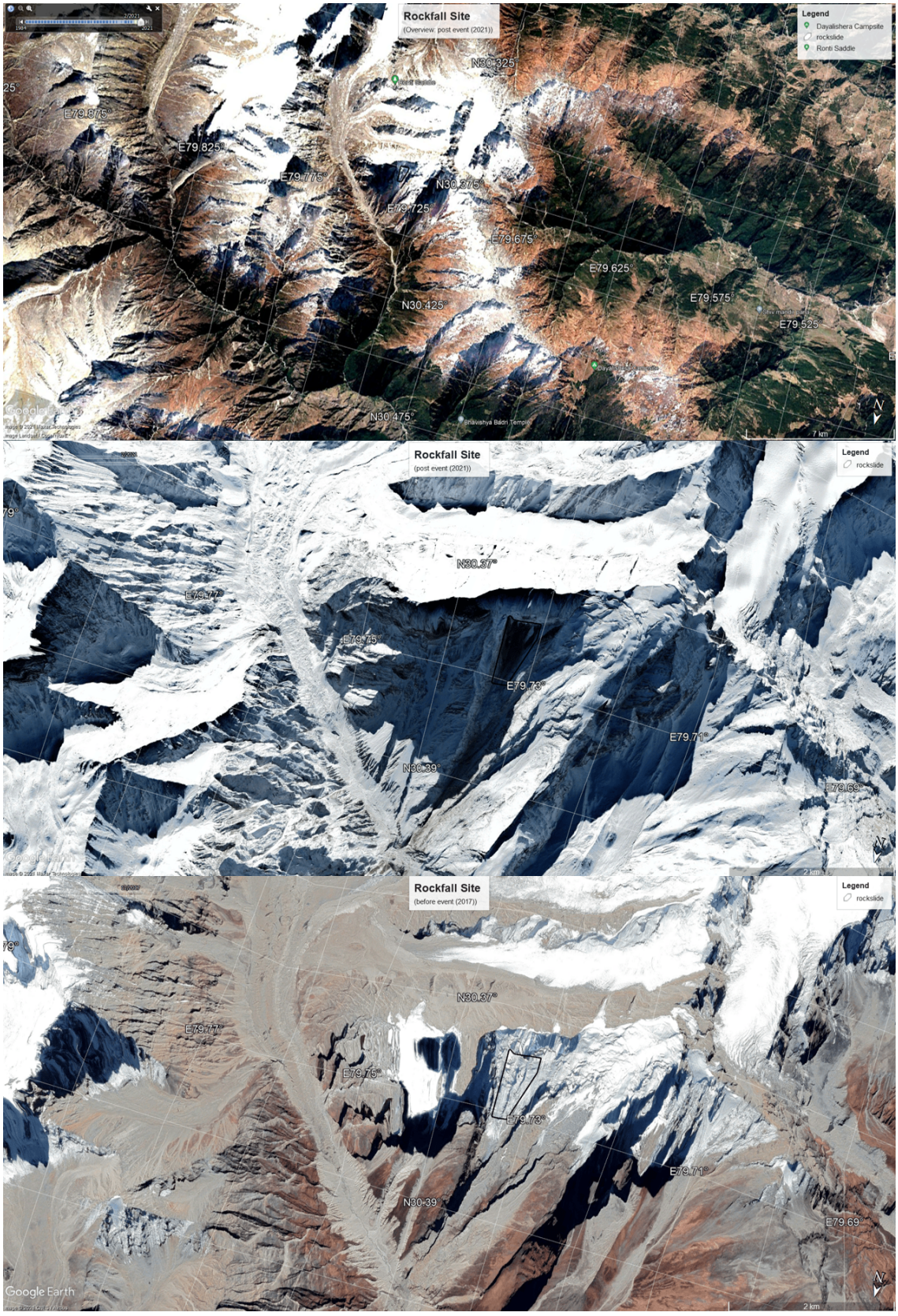
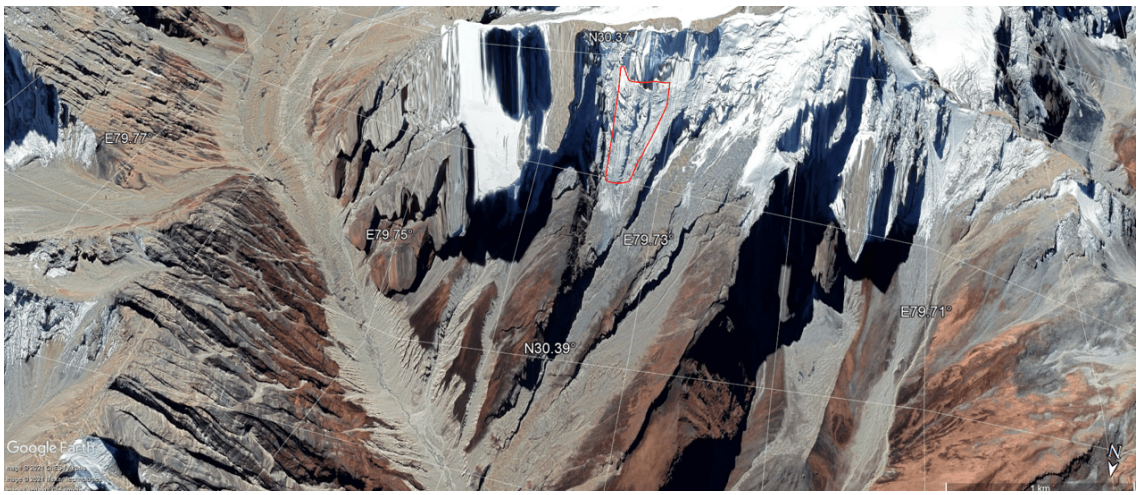


Figure 3 Displays the tri-junction where the change can be detected in the pre (Left) and post (Right) images of the region.

CONCLUSION

The study concludes that the DEMs generated from photogrammetric methods can be used for quick region-wise damage assessment with volume computations using cut and fill methods in a GIS environment, and has potential for disaster management-related applications. ICSMD charter is an important mechanism for timely delivery and utilization of remote sensing data for time-critical activities. A large number of openly accessible satellite images and DEM datasets further fulfill the need of users and institutions involved in Capacity Building and management for various applications.




N30.37°
E79.77°
E79.75°
E79.73°
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Google Earth
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DISCLOSURES

The authors have no conflicts of interest to declare that are relevant to the content of this article.

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