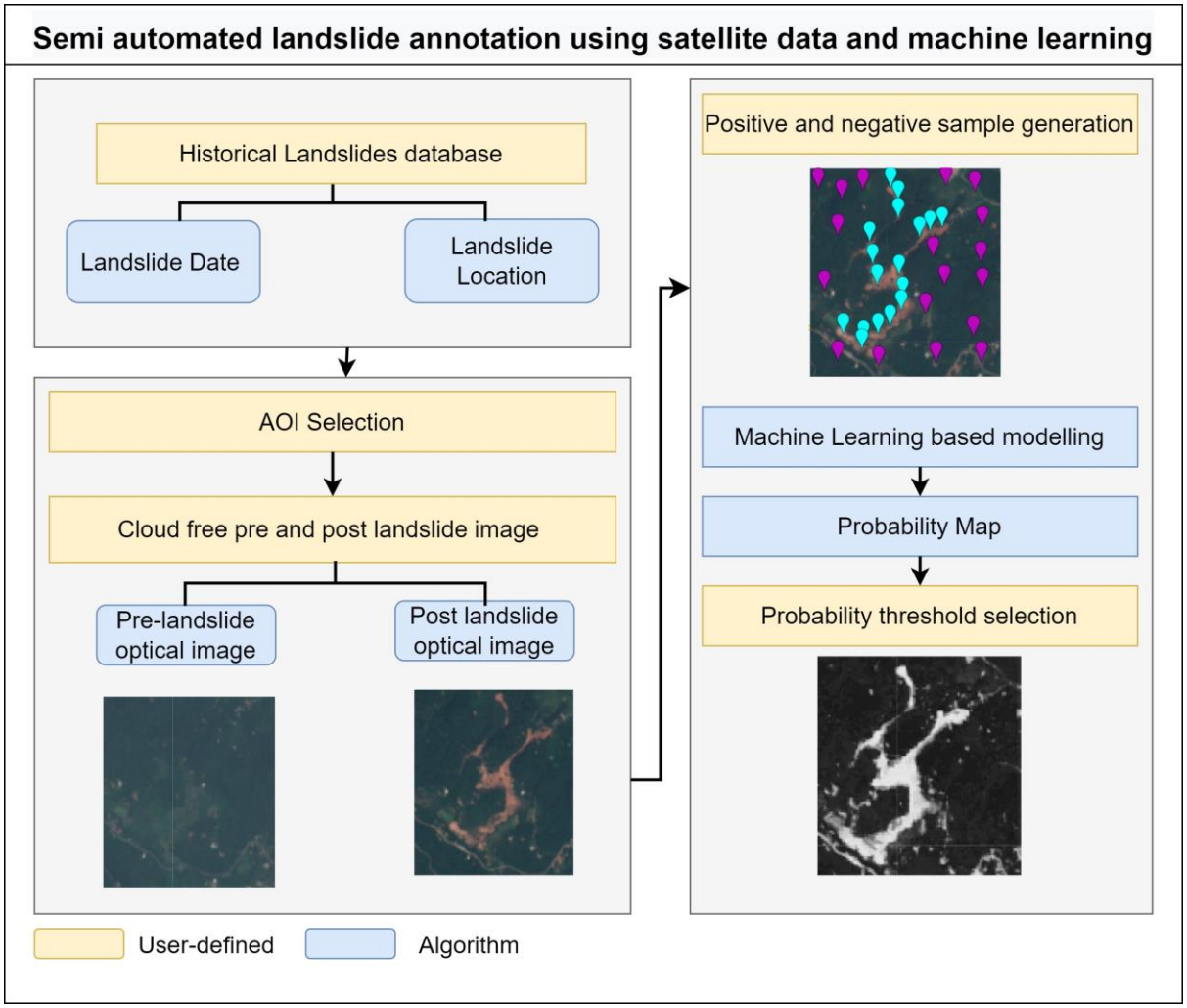
LANDMARK-APP

The landmark app is Machine learning based landslide annotation app based on Google Earth Engine developed at Hydrosense Labs IIT-Delhi. LANDMARK provides an easy and fast way to annotate landslides using sentinel 2 data in Google Earth Engine.

Disclaimer

1) There are two versions of this app. The first one is an easy to use Google Earth Engine based app hosted at https://hydrosense.users.earthengine.app/view/landmark. The usage of this app does not require any Google Earth Engine account, however there are two shortcomings associated with this app.
    a. Limited download size: The app uses getDownload Url which supports a maximum request size of 32MB and grid of 10000.
    b. Linked Maps copy: The app uses linked maps to show before and after images. The vector drawing in one map gets copied to the other map automatically however in app version this is an issue. This bug has been reported to google earth engine and will be resolved in future updates refer: (https://issuetracker.google.com/issues/289889245)
2) Another version of this application can be developed using the code provided on GitHub. The code has to be copied in text editor of Google earth engine and on run will create the same interface like the LANDMARK app with two distinct features.
    a. The Download button will be substituted for export to drive button and the export has to be done from GEE console. This permits larger exports of billion+ pixels.
    b. The linked maps will work as expected when using this codebase.



1. App Usage and Overview

LANDMARK is a web based app can be found at https://hydrosense.users.earthengine.app/view/landmark. The computations are performed in cloud in realtime making the app fast to use.

There are some prerequisites of running this app.

1) The landslide must be large enough so that sentinel 2 satellite can capture the spatial occurrence of landslide
2) The user must have an idea of the location and the date when landslide happened

1.1) An overview of the homepage

On visiting the LANDMARK homepage, you will see an interface as shown below.

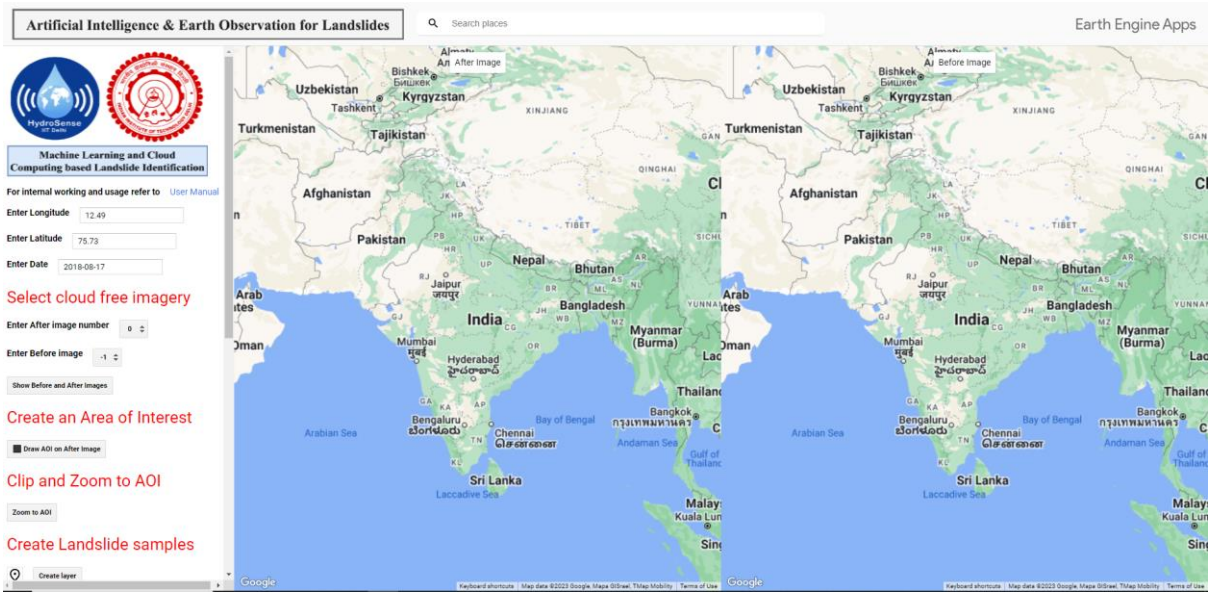


Fig 1

The homepage will zoom into India and contain three panels. One control panel and two map panels. The control panel contains buttons and widgets for the user to interact with the app as well as maps. The map panels contain titles of Before Image and After Image. These are linked maps and a process done on one map is automatically shown on the second map (e.g. Zooming on one maps automatically zooms in the other map).

The first line includes the link to this user manual links to this document and a thorough understanding of this document is necessary for running the application.

1.2) Using LANDMARK application

The usage of LANDMARK requires 12 steps which should be done sequentially. In case the user misses a step, it is requested that the user makes use of reset button at the end of the app since it might lead to unwanted behavior of the app.

STEP 1: Location and Date

The user is required to enter the approximate location of the area of interest and the date of landslide which can be acquired from various sources like news, social media or twitter. The algorithm in the backend will search for all images that cover the area of interest and where the cloud fraction in the image is less than 30%.

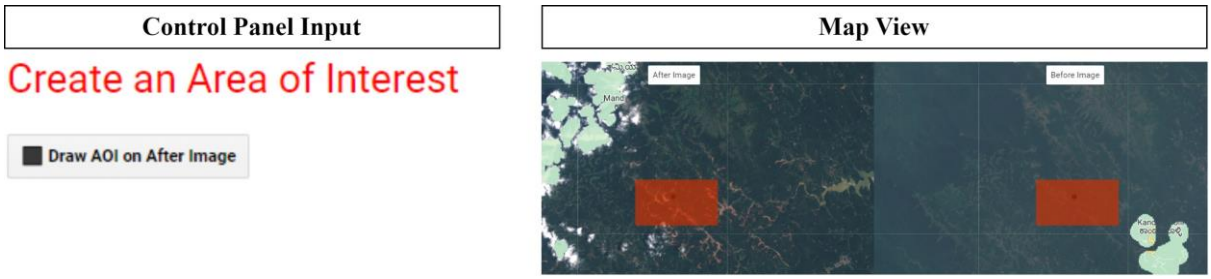
STEP 2: Load cloud free images

After the approximate location of the area of interest, we need to identify before landslide and after landslide images which are free of clouds at least in the areas where landslides have happened. It is to be mentioned the area which cloud masking algorithm of sentinel 2 considers as clouds will be masked and appear as Nan value. However, the cloud masking algorithm of sentinel 2 is unable to capture many clouds, hence there might be clouds in the area of landslide which has to be visually inspected.

To overcome this problem, we define before and after image selectors. The after-image selector should be increased by one step, and the before image selector should be decreased by one step until the user is able to find images where the landslide area is cloud free. After changing the before and after image number the user must click Show Before and After Images button to render images in Realtime

STEP 3: Create an Area of Interest

Once the before and after images are finalized the user needs to create a rectangular AOI by clicking on Draw AOI on After Image, which will change the cursor to + sign, and draw on on the map. The user must make sure that there is no missing overlap in before and after image. In case there is a missing overlap the landslide image will show NaN values for areas which don't overlap.

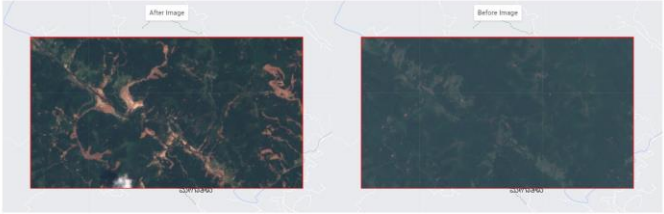


Note: The Geometry will copy over to before image only if app is run using GEE code editor. If using the landmark app the geometry will only be visible in after image, however this won't have any impact on further processing.

Note: In case inaccurate geometry is created, the user can create another rectangular geometry, although only most recent geometry will be saved and shown. Once the AOI geometry is finalized user should move on to step 4.

STEP 4: Zoom to AOI

Once the geometry is finalized click on Zoom to AOI which clips both before and after images and zooms to the area selected with a rectangular boundary over the AOI on both before and after images. If the user is not happy with the boundary selection, the user must go to STEP 2 and reload before and after images and then repeat STEP 3 and STEP 4.

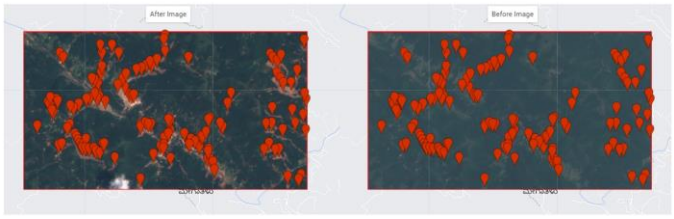
Control Panel Input	Map View
Clip and Zoom to AOI Zoom to AOI	

Step 6: Create landslide sample points

Once the AOI images are visible on the map we need to create landslide samples. To start creating landslide samples click button which will start the point tool. The user then clicks on the after image on the points that are landslides. For optimum annotation the user must make sure that

1) The landslide points are diverse and cover all the images.
2) The difficult areas must be marked adequately.

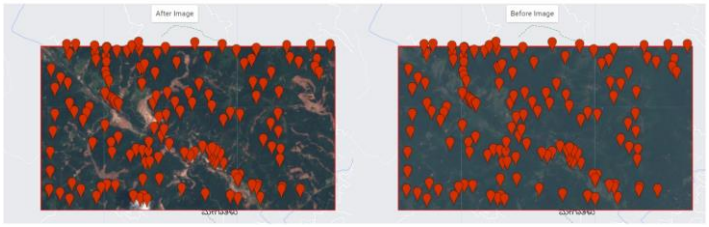
Once appropriate samples are selected, the user should click on Create layer button to create landslide points layer, this will remove points from the map and save them as landslide points with label value 1.

Control Panel Input	Map View
Create Landslide samples Create layer	

STEP 7: Create non landslide sample points

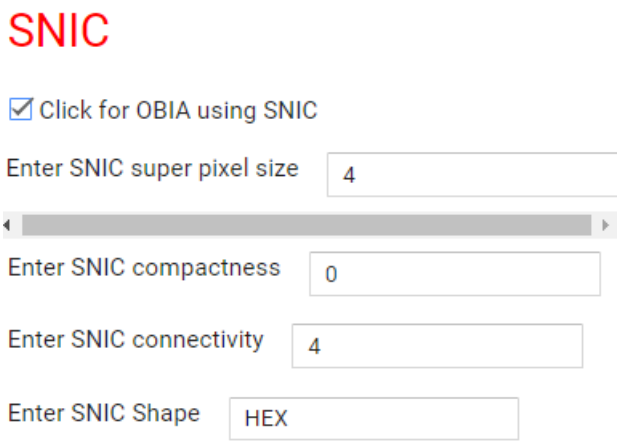
Now we need to add non landslide samples. To start creating non landslide samples click button which will start the point tool. The user then clicks on the after image on the points that are landslides. For optimum annotation the user must make sure that areas which can be confused with landslides but are non-landslides should especially be marked. User must also make sure to take into account the edge cases.

Once appropriate samples are selected, the user should click on Create layer button to create landslide points layer, this will remove points from the map and save them as non-landslide points with label value 0.

Control Panel Input	Map View
Create non Landslide samples Create layer	

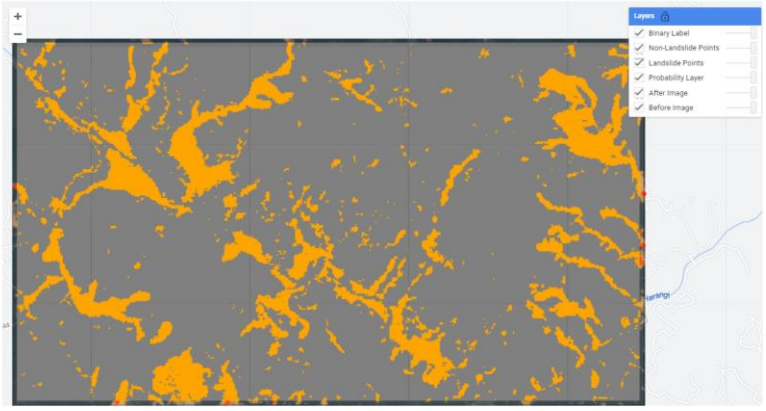
STEP 8 : SNIC parameters (Optional)

SNIC is an Object based non iterative algorithm to cluster similar pixels into objects. SNIC parameters can be used if check box is checked.



STEP 9: Label Generation

On providing all the data points the map, the user needs to click Run Algorithm, which will trigger GEE to run Random Forest in the backend and create a classification layer. On clicking the Run Algorithm button, the map will go from a linked map to a single map with 6 layers. The Before landslide image, the after-landslide image, the landslide points provided by the user in red color, the non-landslide points in green color. The two new layers generated will be the Random Forest probability layer and a binary layer of landslides.

Control Panel Input	Map View
Binary segmentation Run Algorithm	

STEP 10: Varying the probability

The binary layer is a threshold on the probability layer. Sometimes there might be an overestimation or underestimation of areas under landslides, these areas are mostly where model is not confident, hence varying the probability layer can help produce optimum landslide layer. The probability threshold can be adjusted from the slider. And will dynamically update the images on the map.

STEP 11: Download the data

Once all the results are satisfactory the user can download the images for further use and processing by clicking download. This will create two links to download the raw data as well as labels. In case the raw data is large only a link for label will be made available. If using the app version the Download will trigger an export to drive function.

Before Click	After Click
	

STEP 12: Reset

Congratulations!!! The data has been annotated and downloaded. Reset the app and annotate new landslides now