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The Use of Wavelet Transforms and Deep learning algorithms to identify risk caused by landslides from multitemporal satellite images

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Landslide risk assessment is ineludible for communities in mountainous regions of the world. Life and habitat loss plague these communities due to rapid mass movements. Cloud burst conditions and strong earthquake tremors trigger thousands of landslides that can run amuck in the terrain. One way to assess the risk is by field investigations. Vast areas cannot be covered on foot and other limitations such as a lack of accessible roads. The next viable alternative is aerial photography and unmanned aerial vehicles (UAV). The range and accuracy of the deployed drones and aircraft also limit this method of earth observation. Overcoming these limitations, optical satellite images give us information for a vast area and can observe the surface daily, which is only limited by cloud cover. These satellites have advanced to give highly accurate images with a resolution of 3m/pixel.

Remote sensing image processing techniques are used to generate automated inventory of landslides. Most of the current algorithms use segmentation algorithms to map the landslide polygons but do not include the urban settlements that are vulnerable to these mass movements. Planet lab images (3m/pixel) and Google earth images (0.2m/pixel) can be acquired at a daily temporal scale. These images can be further processed to identify the scars caused by the landslides and the outlines of urban settlements. Sridharan et al 2020 and 2022 have looked at discrete wavelet transforms (DWT) and deep learning algorithms for assessing the proximity of these landslide scars to urban settlements.

In this work, we extend these algorithms with high-resolution satellite images and identify the risk caused by landslides to communities. We collected images for landslides from various parts of the world that are observed to be active and added them as one class of training dataset. From the urban settlements that are in steep terrain, we collect a second set of images as another training class. More than 3000 images are used for training and validation with a 70:30 train-test split. The models are then tested by classifying a set of images that contain both classes to assess their potential in identifying landslide risk to communities. Classic Support vector machine is used as a

classifier after extracting features by DWT. Traditional deep learning algorithms such as AlexNET and ResNET are trained and tested on the satellite images. We observe both DWT and Deep learning algorithms have good overall accuracy in extracting features and validating them while there are some accuracy differences in identifying the risk in mixed images that have both the classes. The models are rated based on the confusion matrix and AUC-ROC. While various DWT give an accuracy in range of 90 – 96%, the deep learning models have a range of 95 – 98%.