UNIVERSITY of DAYTON

VISION LAB
Center of Excellence

Zhiyuan Xie
Dr. Umesh Haritashya

Mapping both accumulation and ablation zone of the glacier using deep-learning

Introduction

The increased temperature over the past decades has affected the health, dynamics, and processes of the alpine-type glaciers. To understand these glacier changes, we used Landsat satellite images, digital elevation model (DEM), DEM-derived land-surface and drainage basin parameters to develop a deep-learning algorithm to map glaciers. The alpine glacier includes the debris-covered glacier (DCG) in the accumulation zone and snow-covered glacier (SCG) in the ablation zone. For this work, we take advantage of the deep-learning algorithm, GlacierNet, which we have already developed to map debris cover ablation zone. The architecture of GlacierNet is based on the commonly used feed-forward neural network – convolutional neural network (CNN). The GlacierNet exploits the spatial pattern present in the debris cover ablation zone; however, the SCG has less distinguishable features when compared with the snow present inside and outside the glacier accumulation zone. Therefore, we utilize the drainage basin algorithm to accurately classify the snow and SCG by using the GlacierNet generated DCG as the reference region.

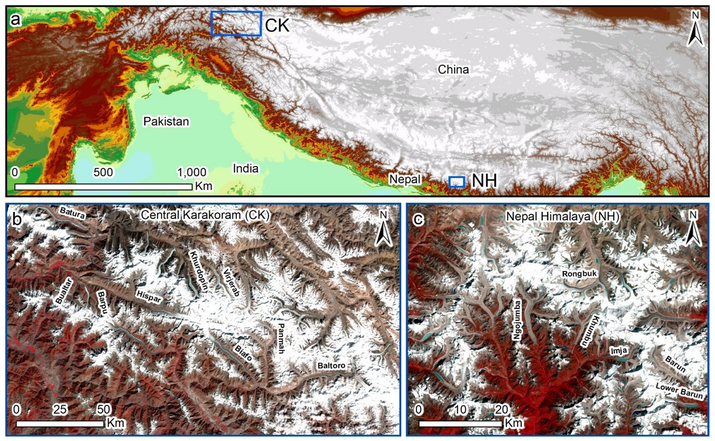

Figure 1: Algorithm Testing area

Method

We used a sliding window to subset it to fit the study area. One sub-image only contained a part of the glacier. The network structure of GlacierNet includes two main processes: encoding and decoding (Figure 2). The encoding process extracts the features from input image data and thereby many small feature maps, which is in the latent space, are generated. The decoding process fuses all the small feature maps that are from the encoding process to obtain size restored binary mapping results. The small images are combined into a large binary image that marks the glaciers and background pixels. Then, the Region size thresholding, normalized difference water index, and hole fill processes are applied to improve the DCG mapping accuracy.

After the DCG is mapped, the snow-covered accumulation zone within the glacier basin can be mapped by incorporating NDSI and Drainage Basin Algorithm (DBA) into the deep learning algorithm (Figure 2). The NDSI maps all snow pixels in a satellite scene by increasing the intensity difference between snow and non-snow pixels. The DBA is utilized to accurately distinguish the snow and accumulation zone, since each glacier can be considered as a drainage basin and the source of the ice in DCG is the snow from the accumulation zone.

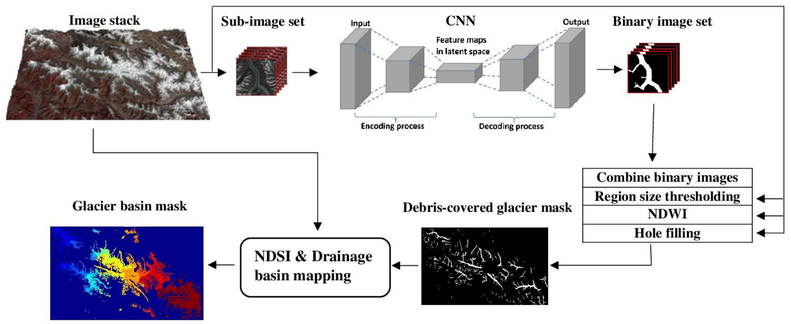

Figure 2: The Glacier Mapping Method

Results

The GlacierNet has a good performance for drawing the debris-cover glacier boundary (Figure 3), and the DBA and NDSI estimate the whole glacier basin boundary with high accuracy (Figure 3).

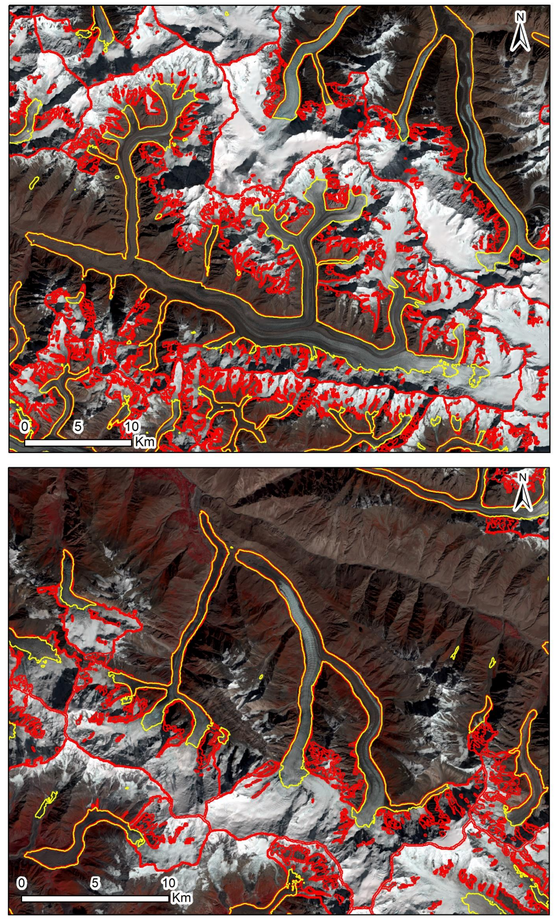

Figure 3: The Glacier Mapping Results

UNIVERSITY of DAYTON
Vision Lab
Kettering Laboratories
300 College Park
Dayton, OH 45469-0232

Center of Excellence for Computer Vision and Wide Area Surveillance Research
visionlab.udayton.edu

Dr. Vijayan K. Asari
Director
(937) 229-4504
vasari1@udayton.edu