Large-scale estimation of surficial sediment size in alpine landforms using UAV photogrammetry and machine learning.

Zegers, G., Garces, A., Hayashi, M.
gerardo.zegers@ucalgary.ca

Intro

Accurate estimation of surficial sediment size in alpine landforms such as talus slopes, rock glaciers, and moraines is crucial for understanding geomorphologic processes, anylzing the potential impact of natural hazards and predicting the permafrost extent. Traditional methods for measuring sediment size in these environments can be time-consuming and labor-intensive. Additionally, they are usually applied to selected areas and are rarely used to cover larger areas, making the development of more efficient approaches essential. This study presents a new method for estimating large-scale surficial sediment size based on unmanned aerial vehicle (UAV) photogrammetry and combining SediNet and PebbleCountAuto image analysis methods.
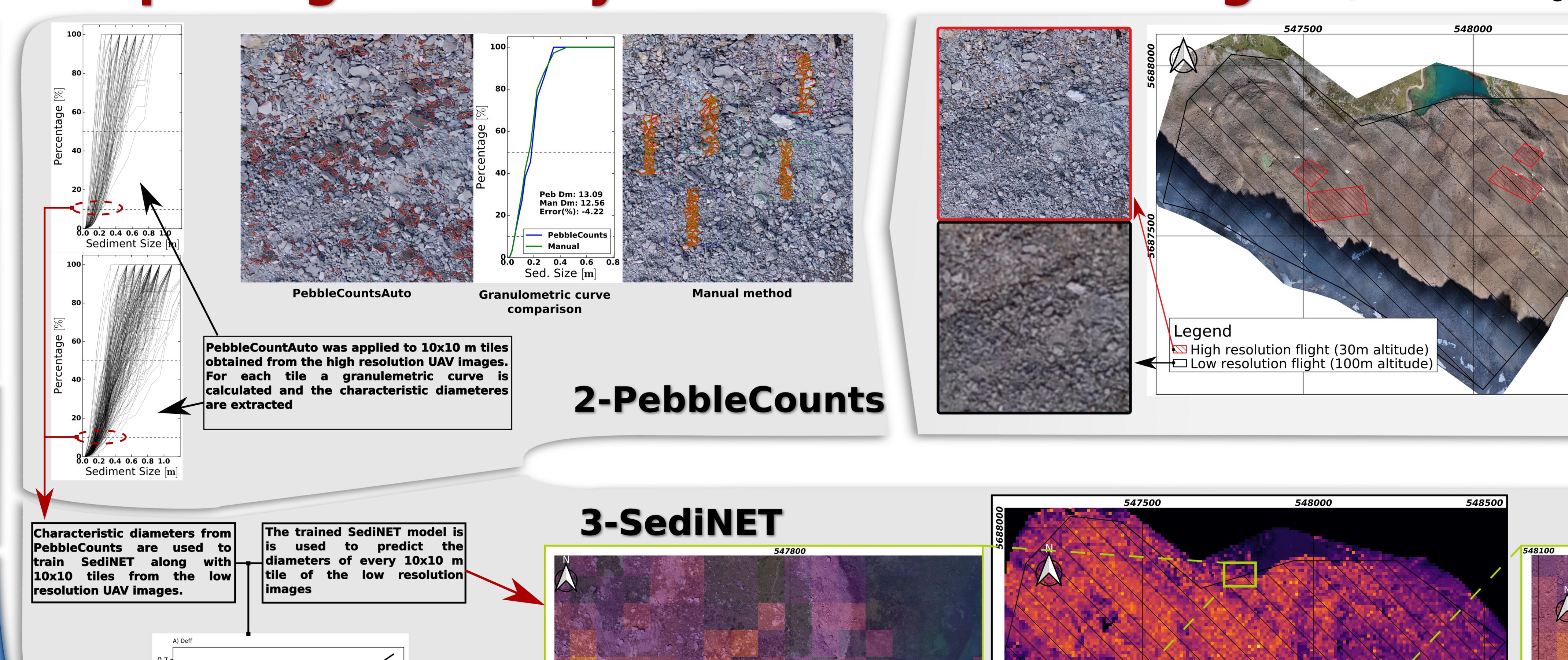
Objectives

- Develop a methodology to determine grain-size distribution at a basin scale.
- Analyze the transferability of this methodology in different basins of the Canadian Rocky Mountains.
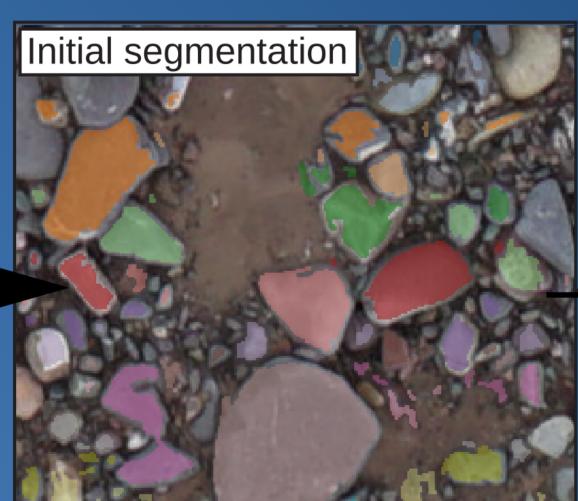
1-UAV

We performed a **UAV survey at 6 sites in the Canadian Rockies**. Each survey consisted in permorfing two types of UAV flights:
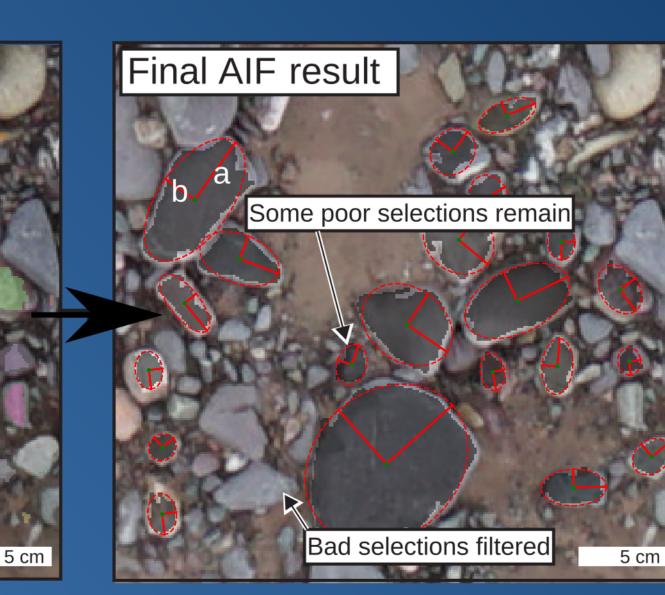
- **Low-altitude flights (~25 m height)** at smaller patches to achieve high-resolution orthomosaic (pixel resolution 5-8 mm). **These images were analzyed with PebbleCounts.**
- **High-altitude flights (~100 m height)** to cover the whole study area with medium-to-high resolution orthomosaic (pixel resolution 3 cm). **These images were analyzed with Sedinet.**

2-PebbleCounts

PebbleCountsAuto

Granulometric curve comparison

Peb Dm: 13.09
Man Dm: 12.56
Error(%): -4.22

Manual method

PebbleCountAuto was applied to 10x10 m tiles obtained from the high resolution UAV images. For each tile a granulmetric curve is calculated and the characteristic diameteres are extracted

1-UAV

Legend
High resolution flight (30m altitude)
Low resolution flight (100m altitude)

Legend
Study sites

3-SediNET

Characteristic diameters from PebbleCounts are used to train SediNET along with 10x10 tiles from the low resolution UAV images.

The trained SediNET model is is used to predict the diameters of every 10x10 m tile of the low resolution images

A) Deff
11.98 %

D_{sim} (m)
D_{obs} (m)

Legend
D20 (cm)
60
2

2-Pebblecounts

Original image

Initial segmentation

Final AIF result

Some poor selections remain

Bad selections filtered

5 cm

3-SediNET
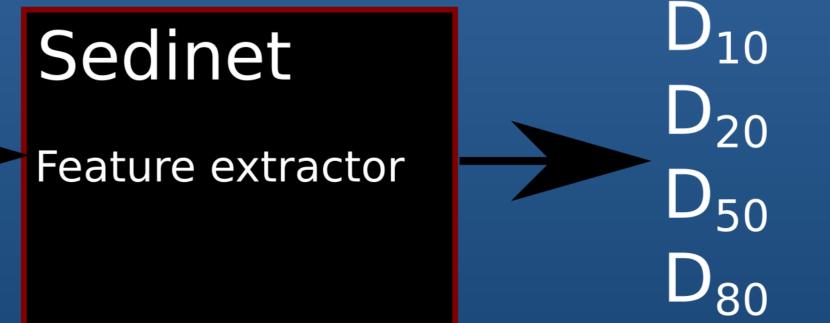
SediNet is a configurable machine-learning framework for estimating either (or both) continuous and categorical variables from a photographic image of clastic sediment. SediNet can achieve subpixel resolutions because the dimensions of the grains aren't being measured directly. Here we trained SediNET to calculate D_{20} with 1750 images.

Input

Sedinet
Feature extractor

D_{10}
D_{20}
D_{50}
D_{80}

Conclusions

- Cost-efficient method using UAV photogrammetry, SediNet, and PebbleCountAuto.
- Efficient for large areas, providing robust estimates of sediment size.
- Unique and reliable methodology with subpixel resolutions and automatic grain delimitation.
- Crucial to define diameter ranges for accurate results.

UNIVERSITY OF CALGARY