Modeling Forest Transition Using Deep Learning

A remote sensing study of Taucamarca, Peru

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CAL POLY

Area of Interest:

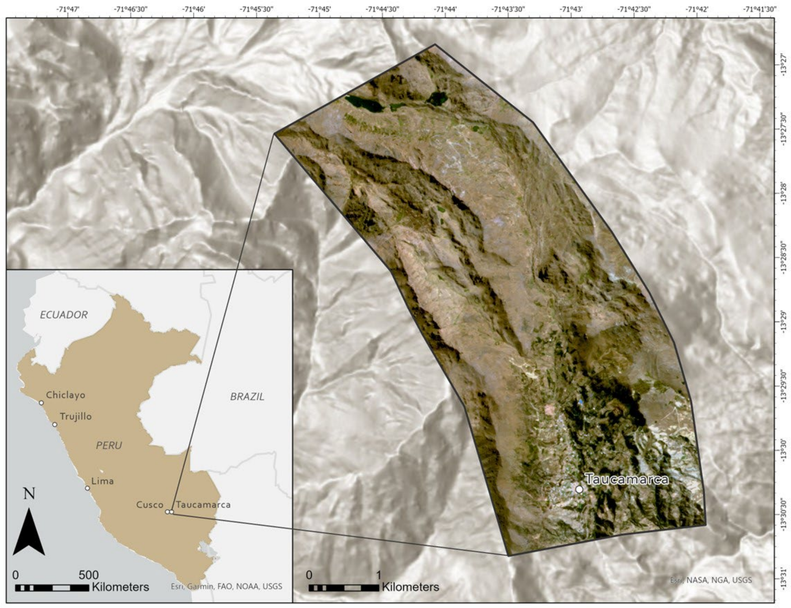
Taucamarca, Peru

74 Families

320 People

3,700 Meters

22 km²



Introduction

Wood is a vital resource to the Indigenous people of the rural Peruvian Andes, and a history of intensive lumber use has led to wide-spread deforestation. In primarily subsistence rural economies, it is depended on to supplement incomes and is used locally in construction, heating, and cooking. Since 2015, previous qualitative research has investigated various components of the political ecology of eucalyptus, pine, and native Andean species. In 2012, Taucamarca, Peru began an extensive pine planting project that will transform the town's landscape which was previously dominated by Eucalyptus.

This research builds off past senior projects attempting to quantify tree species land-cover in Taucamarca using supervised classification. Our project introduces Arc GIS's integrated deep learning frameworks to classify land-cover and tree species maturity.

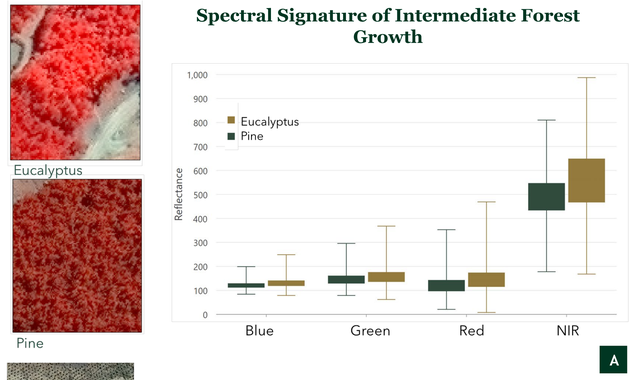
Methods

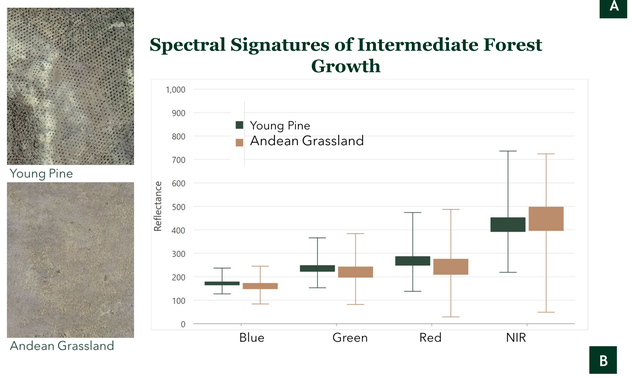
Throughout Spring of 2022, a preliminary deep learning model was built using WorldView-2 50 cm resolution satellite imagery from September 6, 2018. This process proved difficult without on-the-ground knowledge of the landscape, and how tree plantations and native shrubs appear in imagery.
Throughout the month of August, under a CLA Latin American studies grant, Calhoun, Atwell, and Keese traveled to Cusco, Peru with Keese to participate in interviews and to ground truth.
On this trip, Community boundaries were redefined through conversations with Taucamarca locals. A total of 139 data points were collected that include land cover type (forest, grassland, agricultural pasture, and other), forest type (native, pine, eucalyptus), growth stage (young, intermediate, and mature), comments, and photos of each tree. These GPS points, along with field notes will assist in the training a new deep learning model that can differentiate between pine, eucalyptus, and native species and ideally classify the trees' growth stage within the community of Taucamarca. This model will be trained on Jilin-1 50 cm Imagery from 10/12/2022 and 6/9/2022.

WHY DEEP LEARNING?

Deep learning models can pick up on patterns and textures. They look at a pixel and its surrounding pixels in "batches". These batches run through a non-linear network of algorithms. This allows the machine to pick up on patterns the same way our brains do. These models can also be trained continuously with more data, including training samples from other imagery and other types of data such as elevation models and SAR.

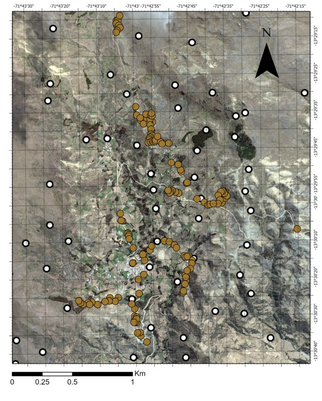
SUPERVISED CLASSIFICATIONS	DEEP LEARNING
Only looks at individual pixel's spectral signature or area's average	Looks at area surrounding pixels (can see patterns and texture)
Linear, single layer algorithm	Non-linear, Multi-layer convolutional neural network
One-time training	Continuous training





Charts A and B compare the spectral signatures of vegetation that previous students' supervised classifications struggled to differentiate between. Unlike supervised classification, deep learning can pick up on minute differences in patterns and textures between landcover types.

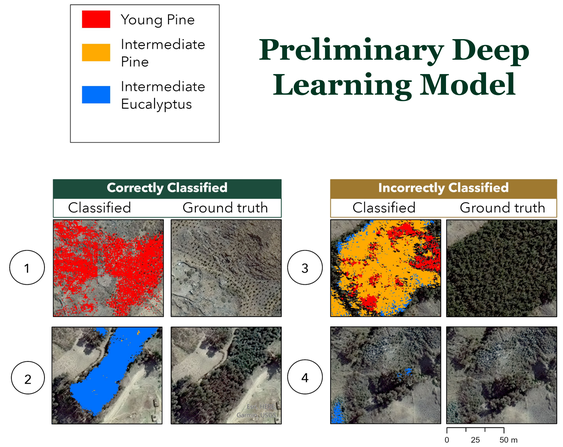
Plans vs Reality of Fieldwork



Limiting Factors in Data Collection

- Time constraints
- Property boundaries
- Physical constraints
  - Steep slopes
  - Oxygen at 14,000 feet
- Technological difficulties
- Inaccessible areas

Figure C displays the project's planned data collection points in comparison to the 139 collected points. Due to the constraints listed, data collection focused on regions of transition between eucalyptus and pine trees. Given that eucalyptus is growth is stunted at extreme altitude, there is a clear line of transition at 3,940 meters. Below this line the trees grow together, and above it only pine grows. As a result of this, ground truthing was focused at the base of the community.



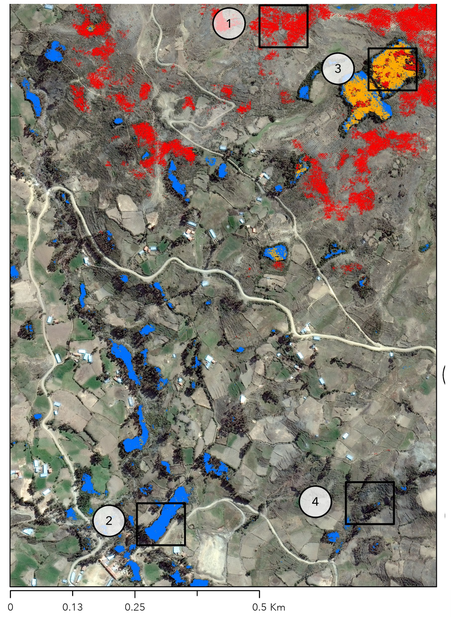


Figure D displays the projects preliminary deep learning model classified on the 2018 worldview imagery. Panels one and two, show the model's successful recognition of pine and intermediate eucalyptus. The incorrectly classification is not completely incorrect. The larger pine plantation is partially mis-classified as young pine likely because it had only been trained on a single sample of intermediate pine. Panel four is an area with a plot of young eucalyptus that was not classified as anything. This is likely a result of the minimal eucalyptus present in the 2018 imagery to train the model on.

REFERENCES

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