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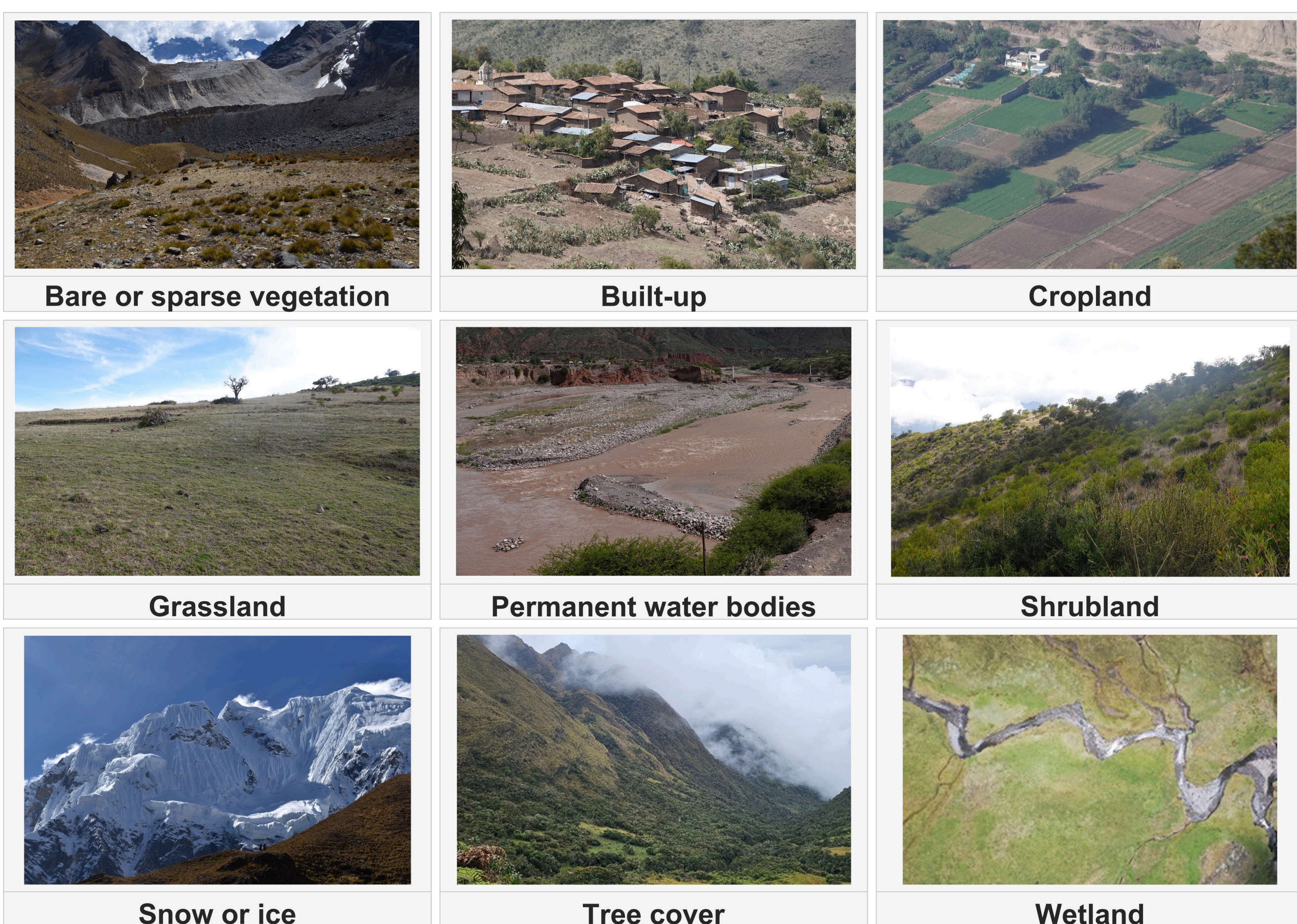
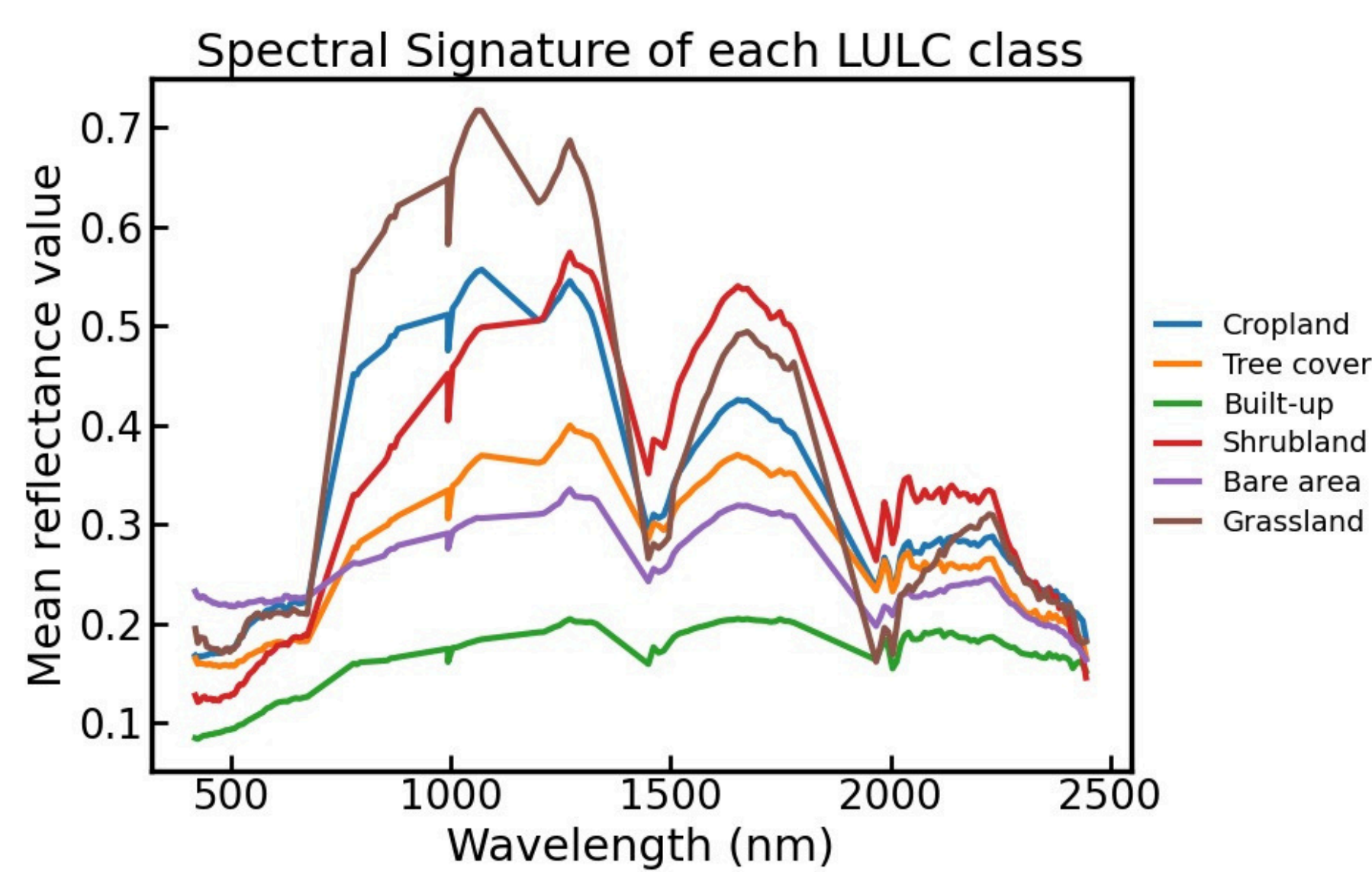

 SCAN TO
 CONNECT

LULC Mapping of the Peruvian Andes using EnMAP Hyperspectral Imagery and Machine Learning

1. Introduction

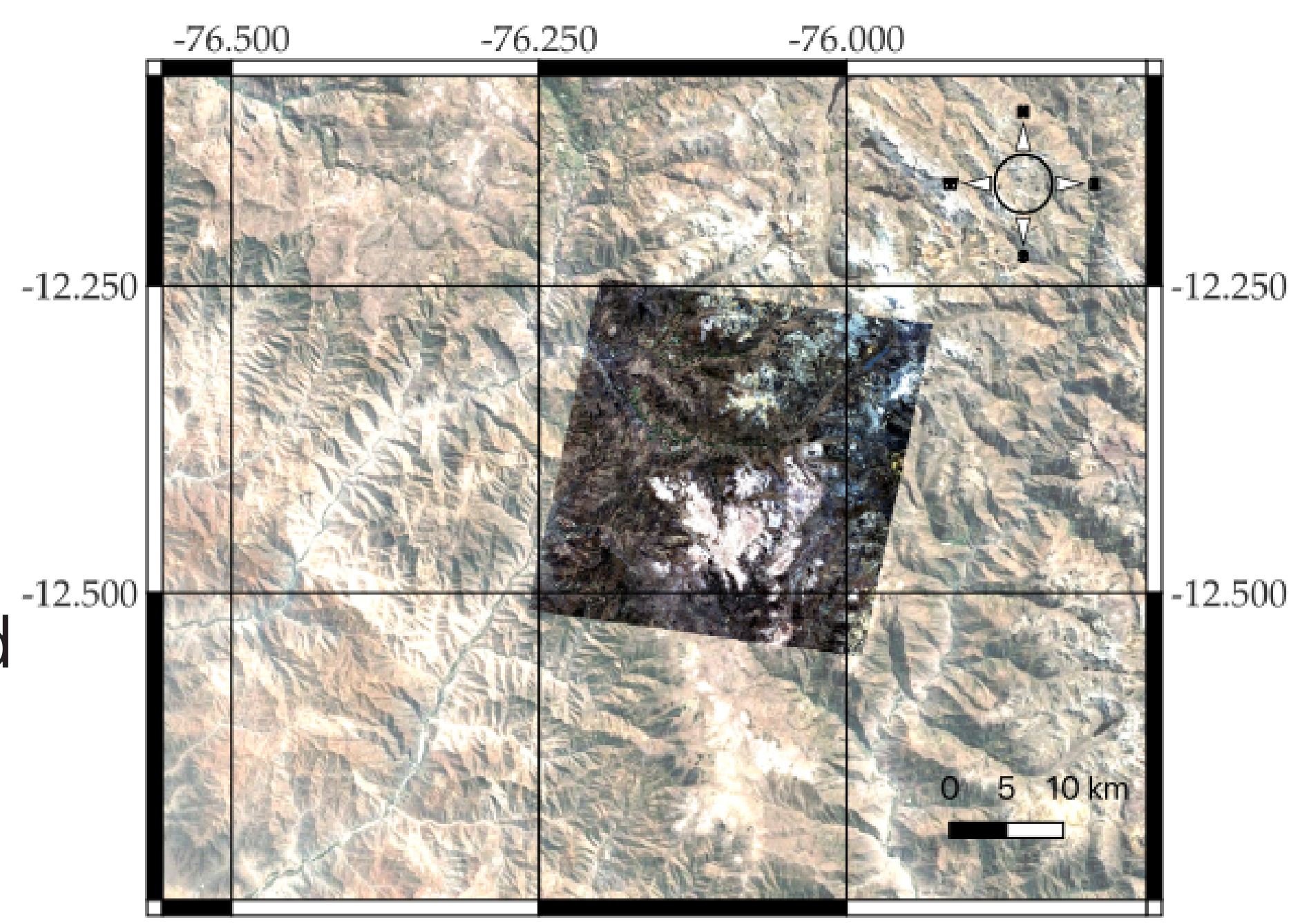
Mapping high-altitude regions through field visits imposes financial and safety burdens on research teams. This work presents a case study that uses *limited ground-truth data* and *EnMAP hyperspectral imagery* (HSI) to generate **prototype land use and land cover (LULC) maps** for regions from the Peruvian Andes. Additionally, we trained random forest and neural network classifiers using Landsat data and ESA WorldCover 2021 labels and tested their performance against domain shift.

2. LULC types

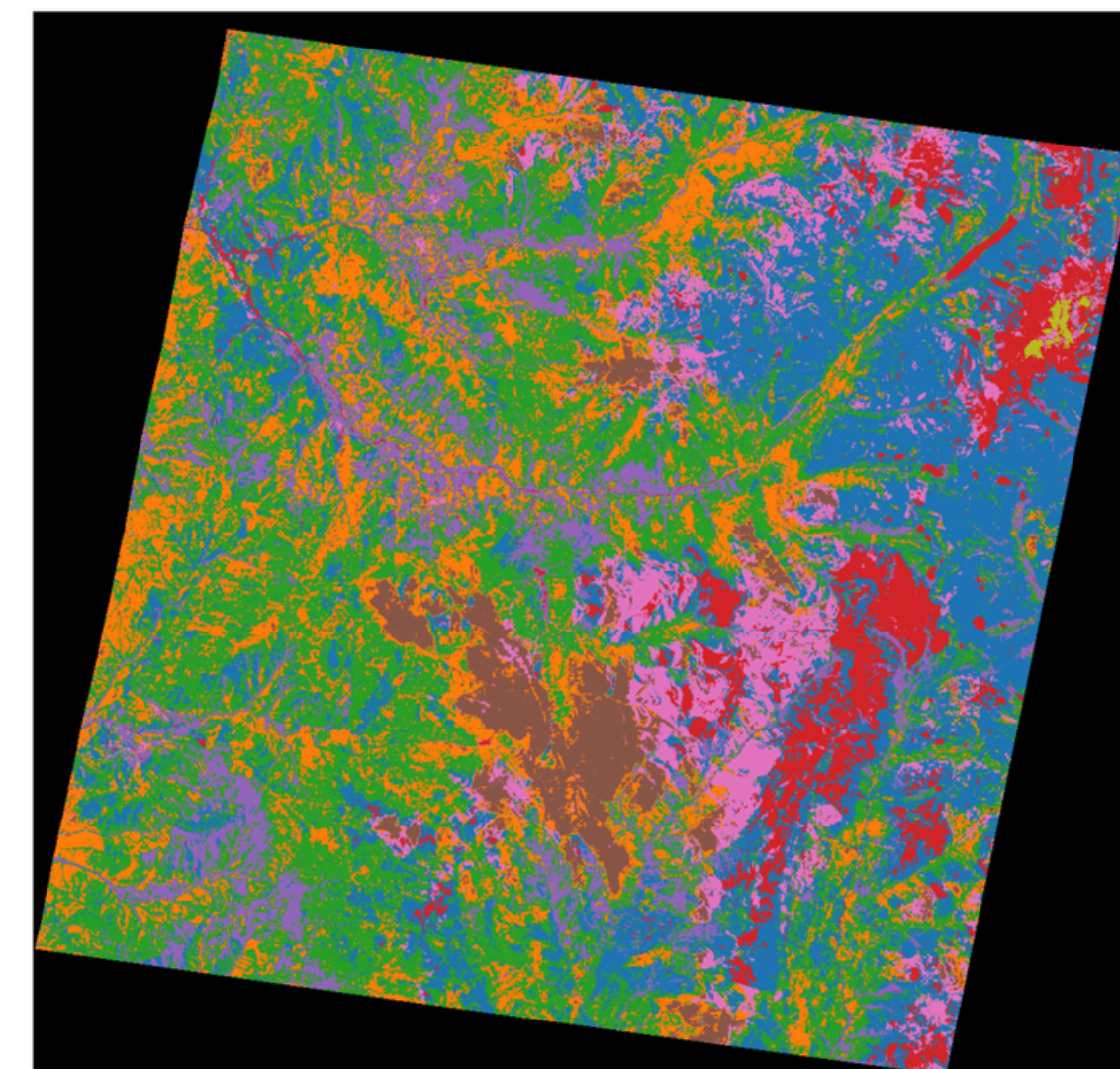
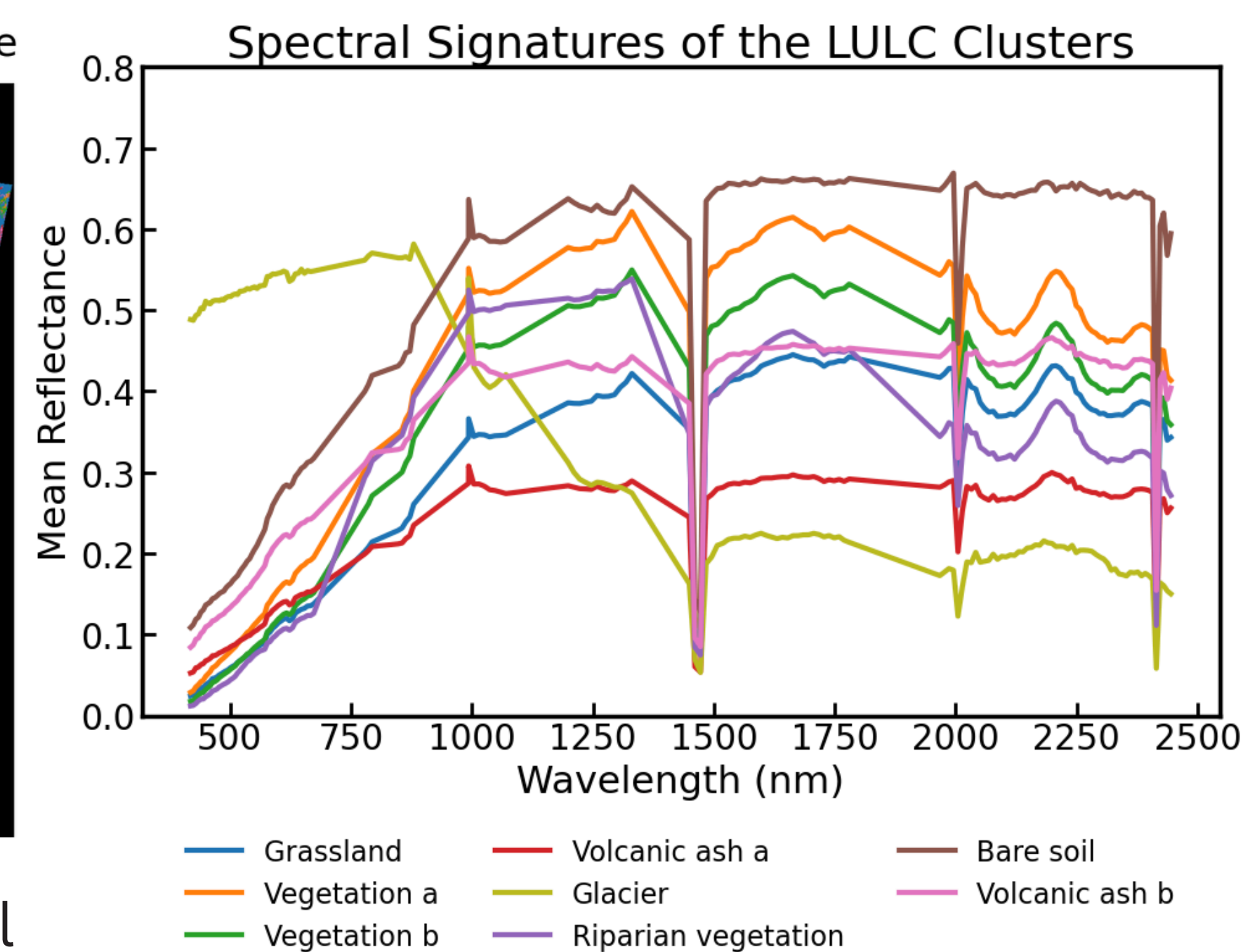
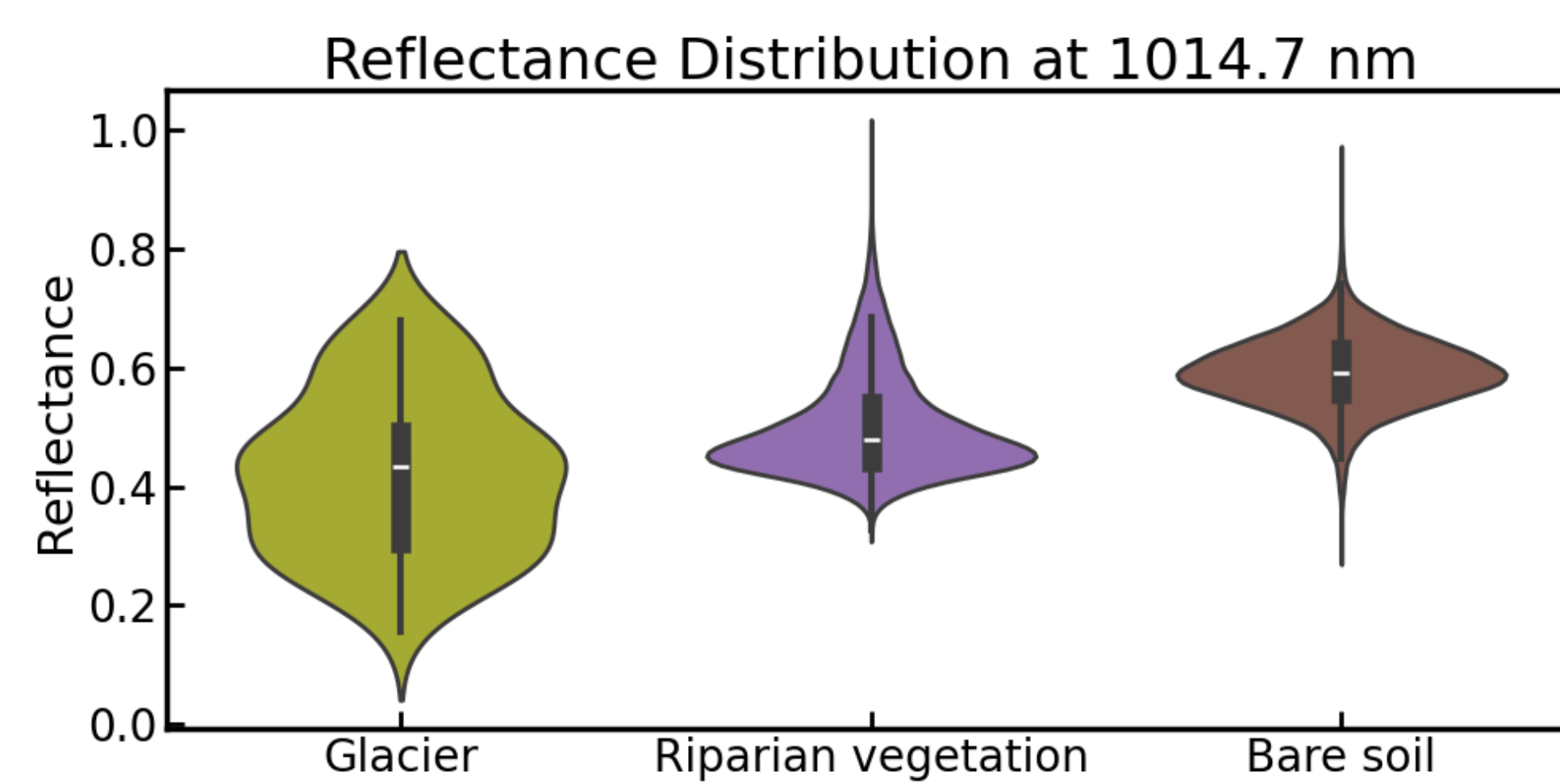

Figure 1: LULC classes identified in the Peruvian Andes.

Figure 2: Characteristic spectral signatures for the Andean LULC classes obtained using representative polygons.

3. Clusters with EnMAP HSI

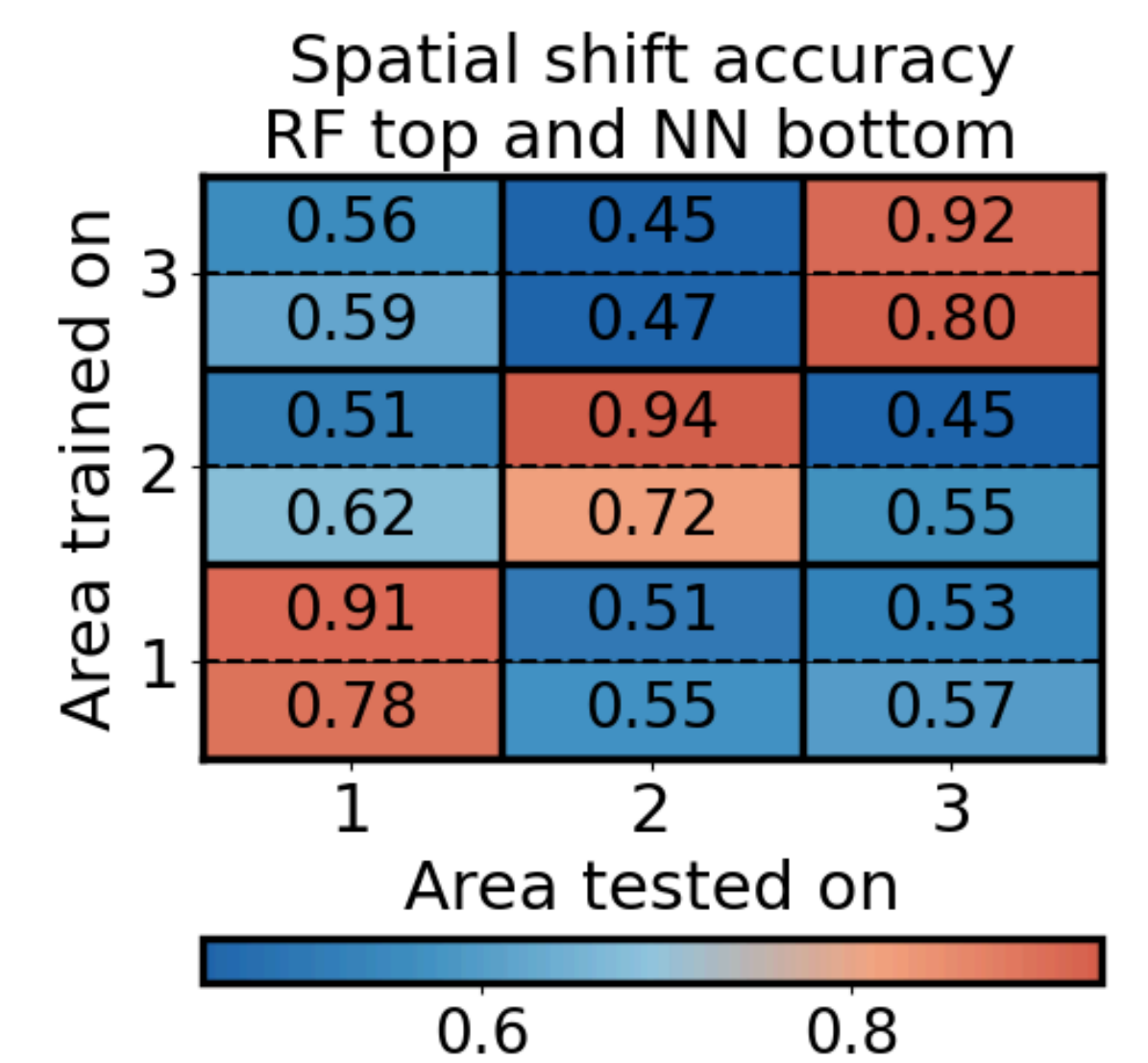
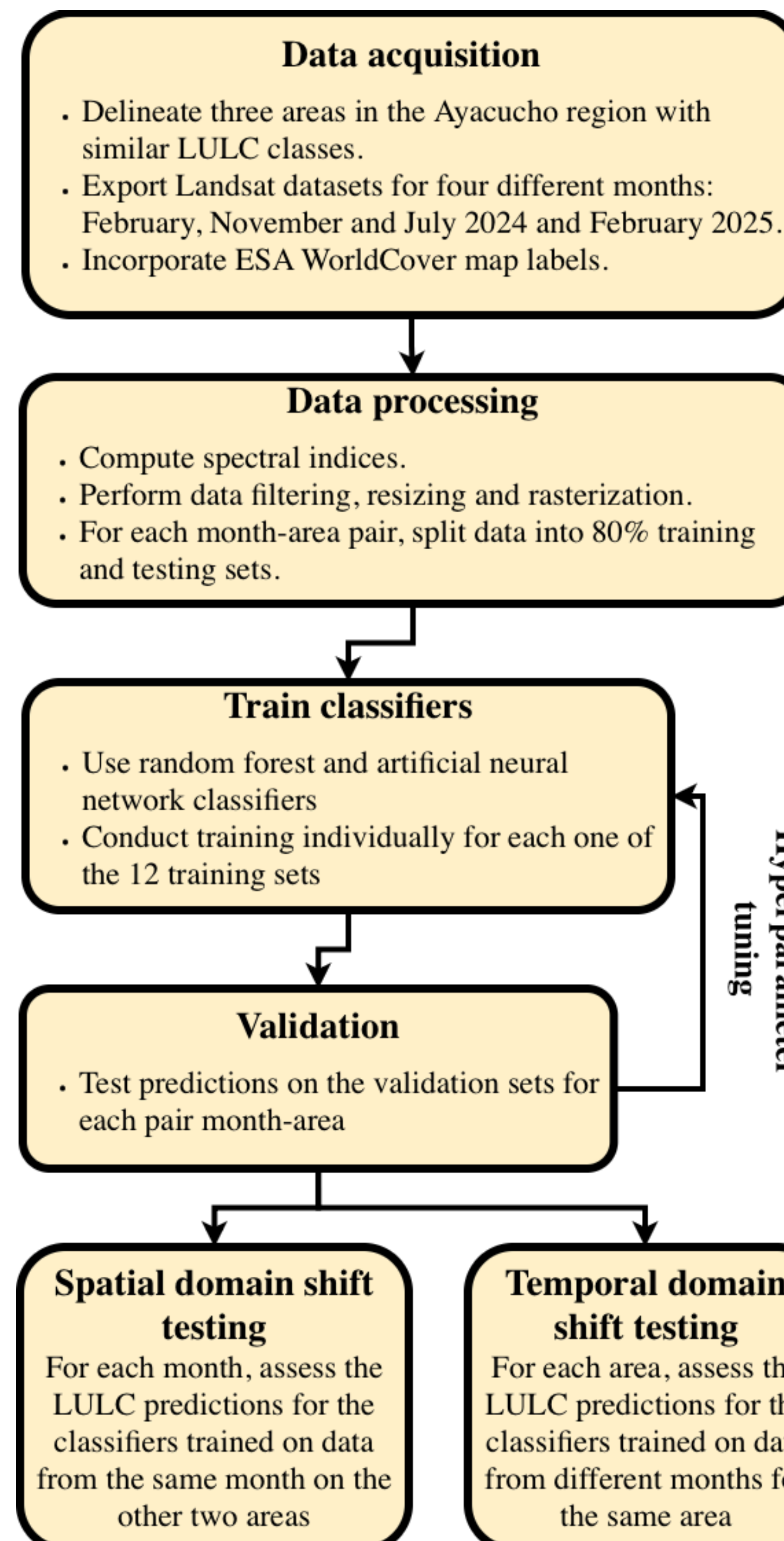
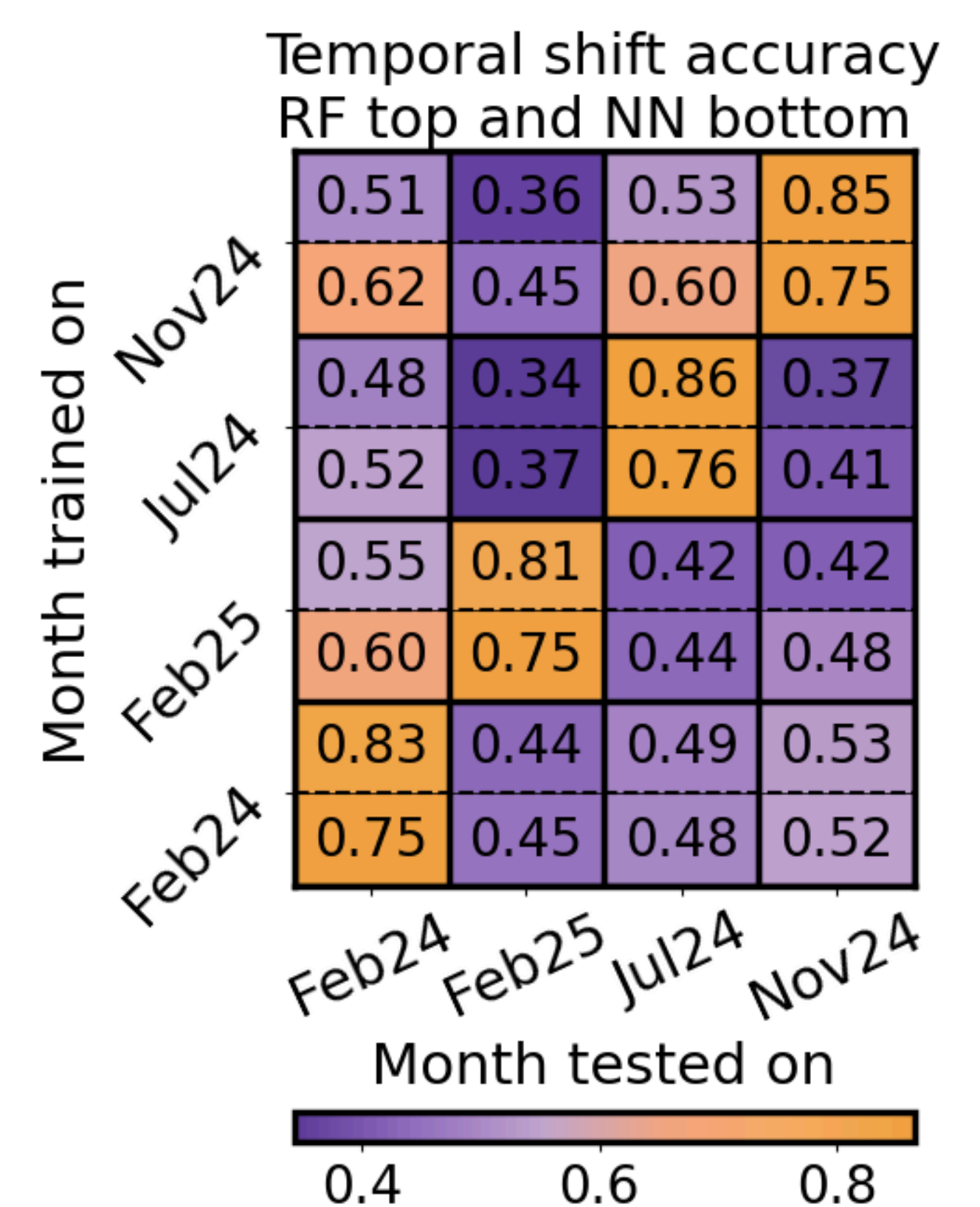
K-means clustering was applied to EnMAP HSI data to generate clusters that align with the real LULC classes from the area of interest. The selected number of clusters (K=8) is the minimum value that effectively separates glacier pixels from vegetation pixels.


Figure 3: EnMap HSI from the Peruvian Andes.

Hyperspectral data LULC map prototype


Figure 4: K=8 hyperspectral data LULC clusters from the Peruvian Andes.

Figure 5: Hyperspectral signatures for the K=8 LULC clusters.

Figure 6: Violin plots of reflectance at 1014.7 nm (near-infrared) for pixels belonging to three selected clusters.

4. Domain shift performance


Figure 7: Spatial shift heatmap.

Figure 8: Time shift heatmap.

5. Conclusions

- PCA and K-means clustering effectively capture key features from the ground-truth field and laboratory soil datasets.
- Accurate LULC map prototypes were generated using EnMAP HSIs and K-means clustering.
- RFs outperform NNs on in-distribution data, but NNs display a slightly better out-of-distribution robustness.