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AI-POWERED ALGERIAN FOREST MAPPING

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INTRODUCTION & AIM

Accurate forest maps are essential for conservation, wildfire risk management, carbon accounting, and land-use planning in Algeria. While global products like ESA WorldCover offer wide coverage, they often misclassify forest boundaries and mixed vegetation at a local level, which reduces their reliability. We present a noise-aware segmentation pipeline that addresses this challenge. Our approach combines Sentinel-2 multispectral bands and vegetation indices with a DeepLabV3+ architecture, prioritizes clean manual annotations during the training process, and produces abstention maps to flag uncertain areas. This allows for targeted validation and supports an improved, more accurate local forest assessment.

METHOD

Our methodology is based on Sentinel-2 multispectral imagery, enhanced with NDVI, EVI, and SAVI as additional vegetation indices, creating a 9-channel input. High-quality ground truth was established by manually extracting and labeling 22 distinct regions using Google Earth.

The core of our approach is a DeepLabV3+ architecture adapted for the 9-channel input, featuring a custom Spectral Projection layer. This layer processes spectral bands and indices in separate streams before concatenating and projecting them with a 1x1 convolution. The model's final output is a pixel-wise forest/non-forest mask.

For training, the data was divided into 256x256 pixel patches. We used a strategic batch sampling of 85% clean data and 15% noisy data. A differentiated augmentation strategy was employed: aggressive augmentation for clean data to improve generalization, and conservative for noisy data to avoid reinforcing errors. The model was optimized using a composite loss function of focal, Dice, and a Deep Abstaining Classifier (DAC), with an Adam optimizer, a ReduceLROnPlateau scheduler, and early stopping.

Figure 1: Example of the manually extracted ground truth

RESULTS & DISCUSSION

On the validation dataset, our model achieved a strong F1 score of 91% and an IoU of 83%. A key result is the model's high recall of 95.40%, significantly outperforming a baseline U-Net's 89.74%. This high recall is critical for conservation and monitoring, as it reduces the number of missed forest areas. We accept a small precision tradeoff to ensure the comprehensive detection of all real forest cover.

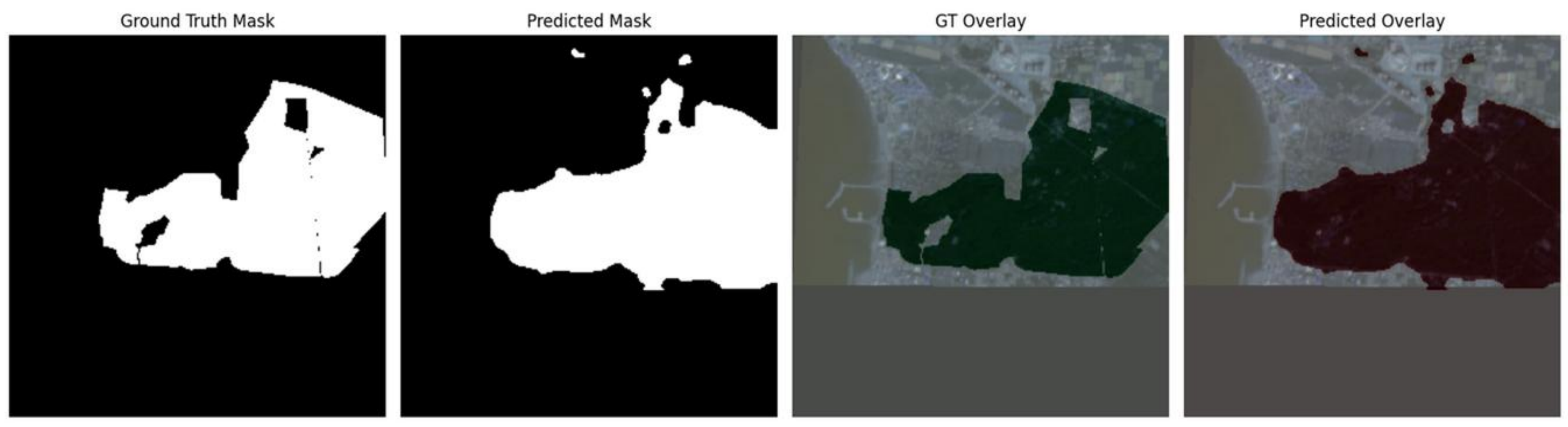

Figure 2: Segmentation results on a validation sample.

A core component of our model is the Deep Abstaining Classifier (DAC), which assigns an abstention probability to pixels during training. This allows the model to defer learning on highly uncertain labels, effectively concentrating uncertainty at boundaries and in noisy regions, which in turn can guide targeted manual review. Analysis of the model shows a mean abstention of 27.76%, with 2.91% of pixels having a high uncertainty margin.

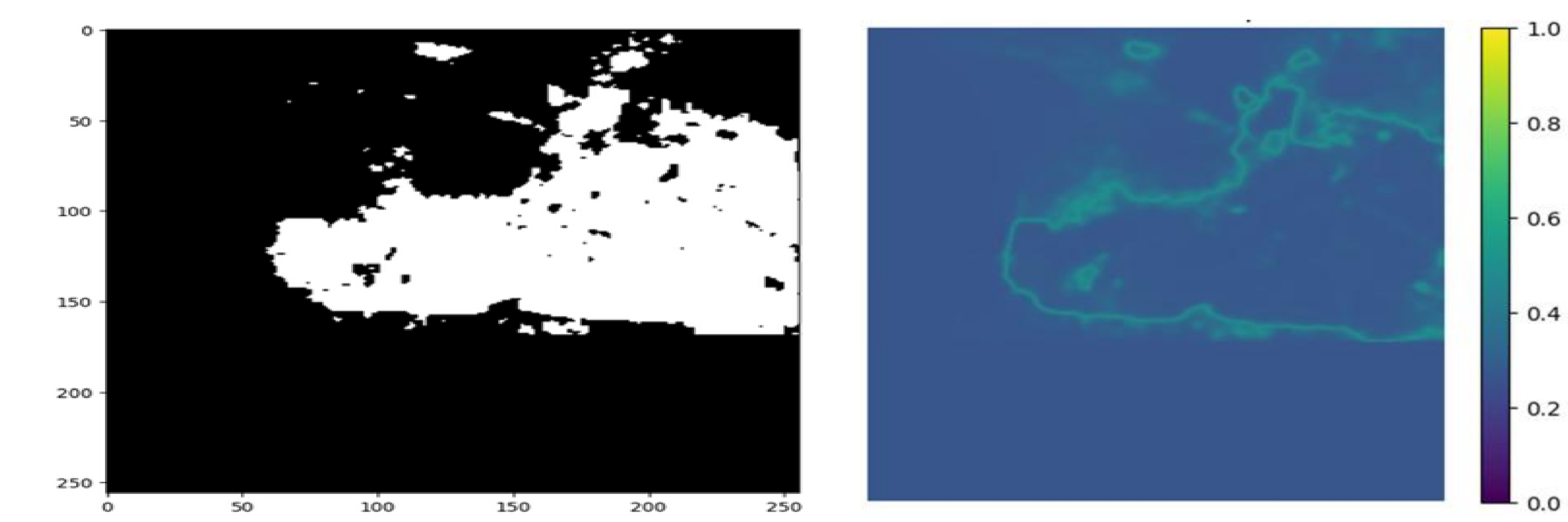

Figure 3: (Left) ESA WorldCover labels (demonstrating noisy classifications). (right) The Abstention map generated by the DeepLabV3+ model,

CONCLUSION

We introduce a noise-aware DeepLabV3+ pipeline that effectively improves forest detection in Algeria, achieving an F1 score of 91% and an IoU of 83%. By prioritizing clean data and using the Deep Abstaining Classifier (DAC), our method successfully reduces false negatives and provides valuable uncertainty maps to aid manual validation.

FUTURE WORK / REFERENCES

- Refine DAC parameters and boundary-aware loss terms.
- Train with more manually labeled data on larger regions.

1. Lu, X., Jiang, Z. and Zhang, H. (2024) ‘Weakly Supervised Remote Sensing Image Semantic Segmentation with PseudoLabel Noise Suppression’, IEEE Transactions on Geoscience and Remote Sensing, 62, pp. 1-12, Art. no. 5406912.