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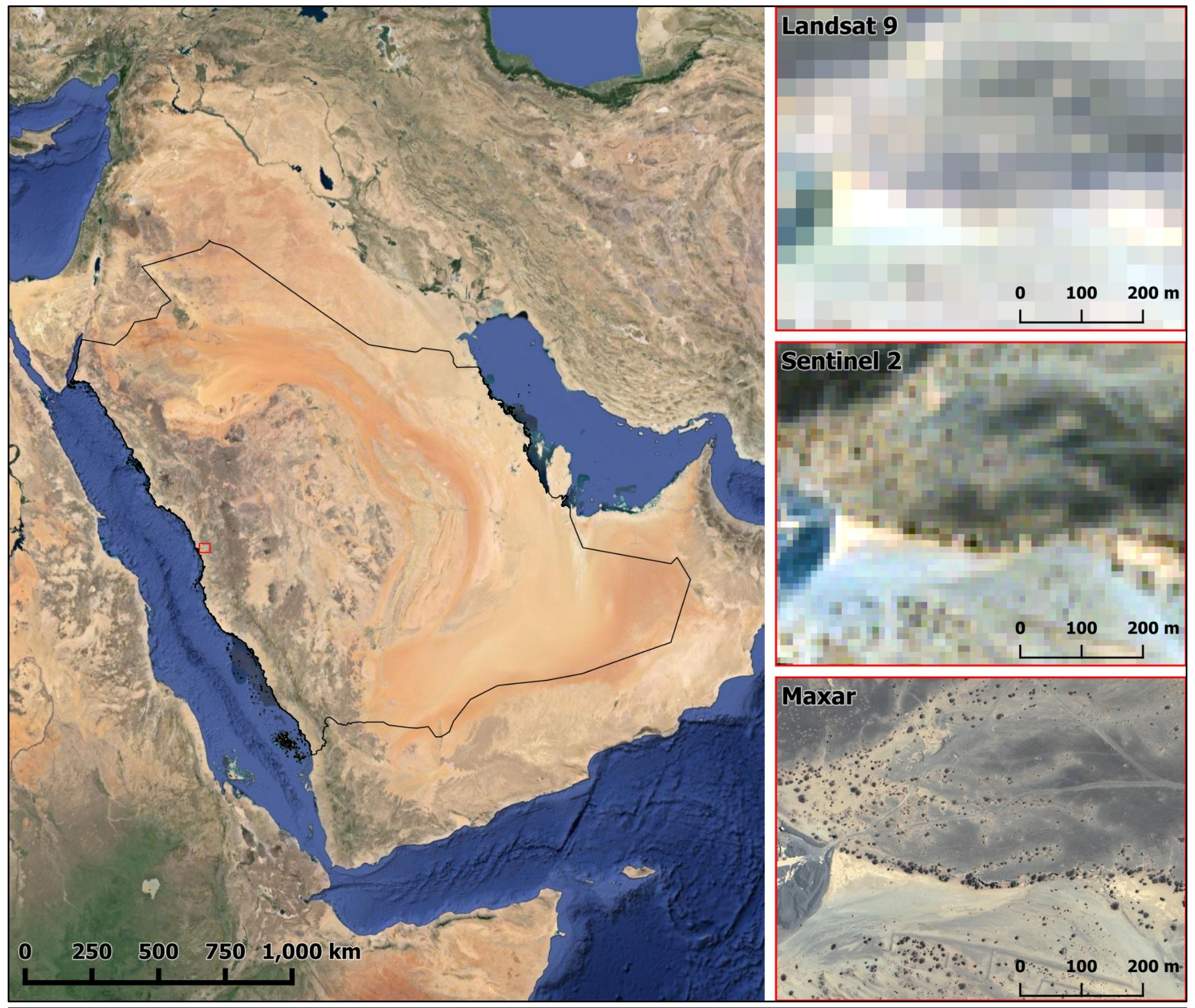
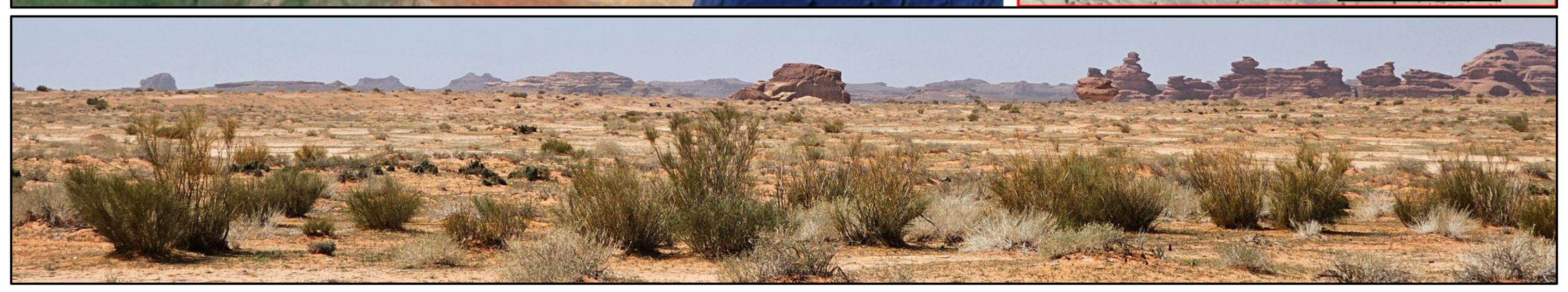
Biodiversity Assessment in Drylands Using Augmented Satellite Imagery Through Deep Learning Models

Introduction

Global biodiversity faces increasing threats from habitat loss due to human activities and climate change impacts. Hence, developing effective methods for assessing and monitoring biodiversity is essential, particularly in drylands, which are highly vulnerable to climate change. Remote sensing and deep learning can greatly enhance ecological monitoring. Accurate biodiversity assessment involves identification of individual trees and shrubs and associated carbon stock, which generally require high-resolution imagery. This research focuses on improving vegetation identification in dryland ecosystems using a Vision Transformer (ViT) model, to analyze high-resolution Maxar satellite imagery and predict near-infrared (NIR) spectral band from RGB input images. This approach delivers enhanced spectral detail, which enables more precise vegetation discrimination from non-vegetative elements like rocks and shadows, despite their visual similarities in RGB imagery.

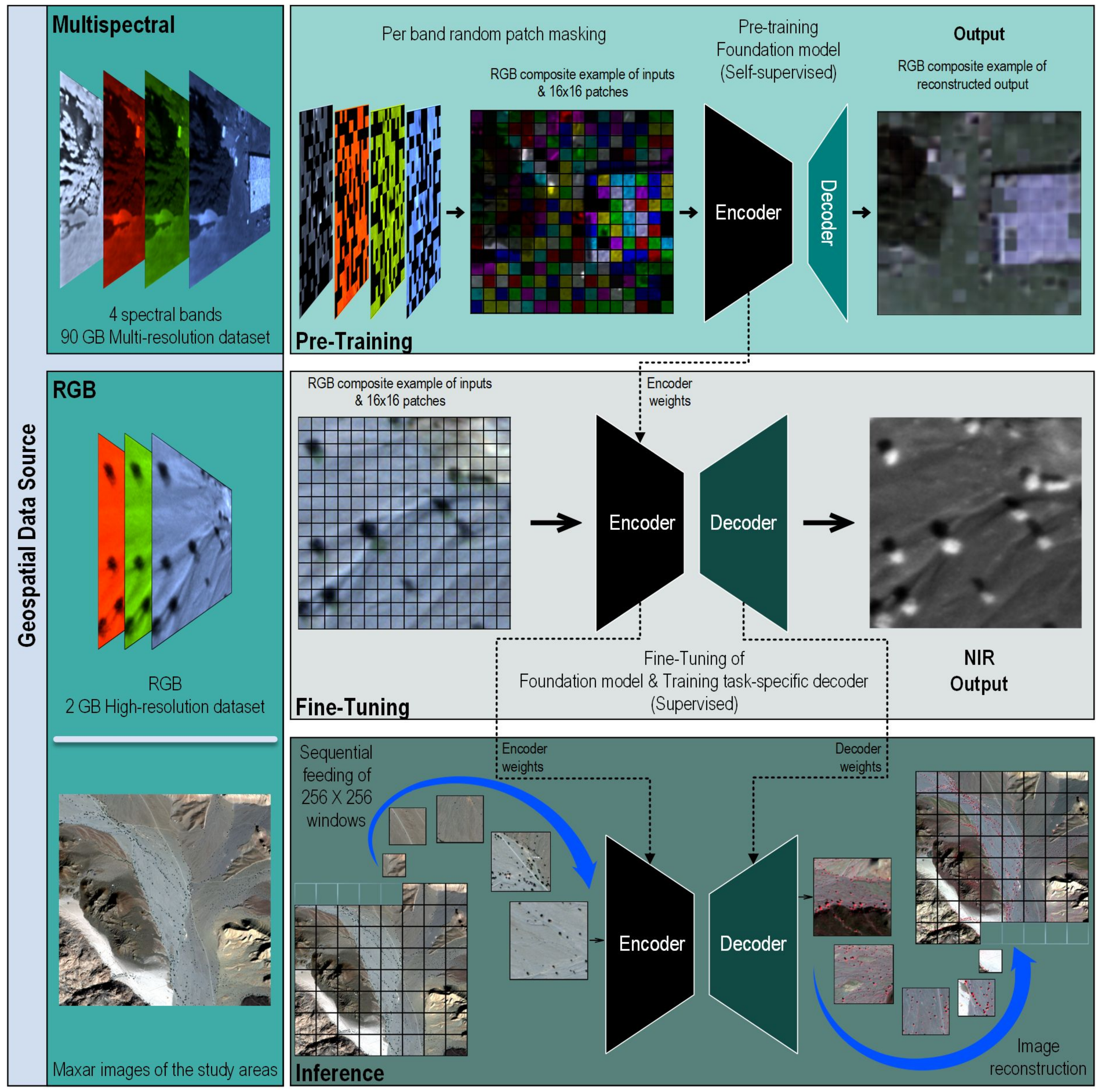
Study Area



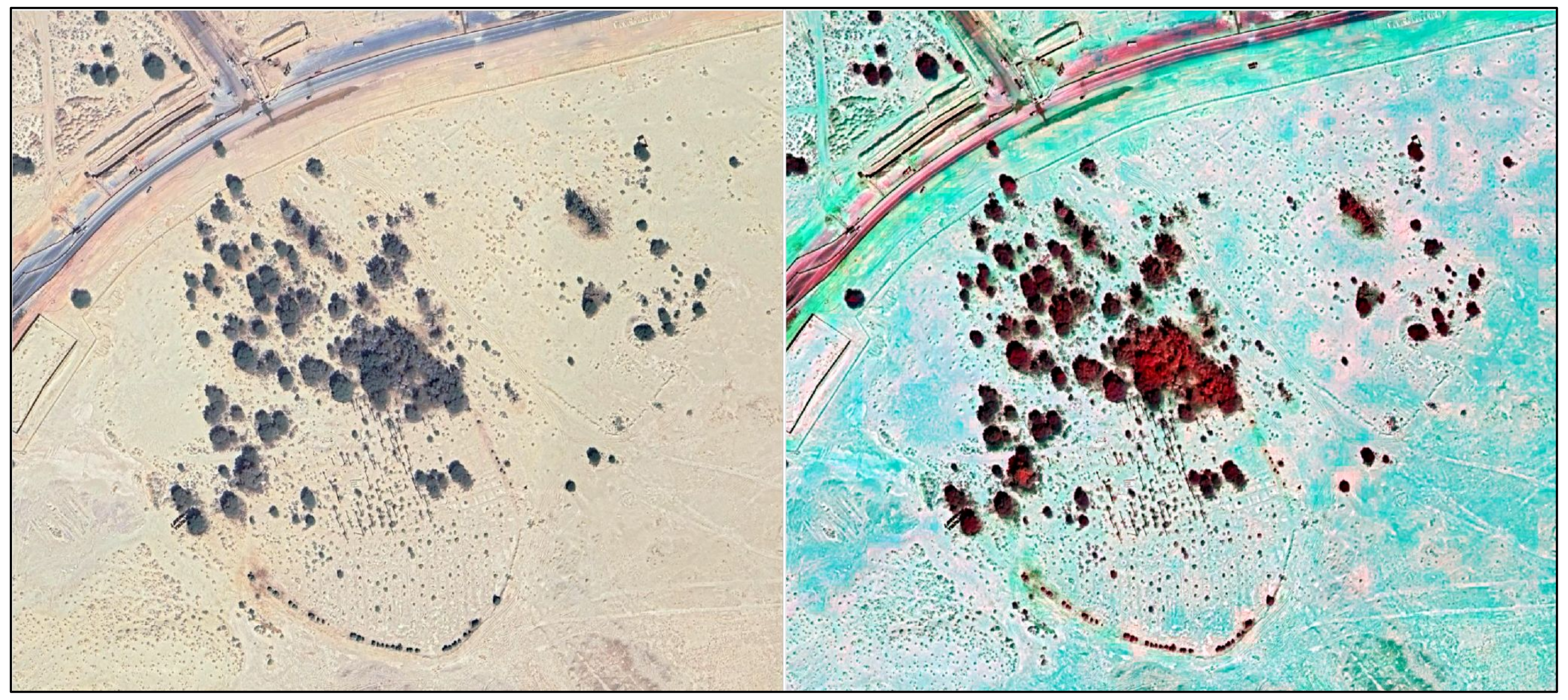


An example of drylands highlighting the differences in the level of detail across spatial resolutions of some common remote sensing satellite systems. Bottom image depicts a typical dryland landscape in Saudi Arabia.

Methodology

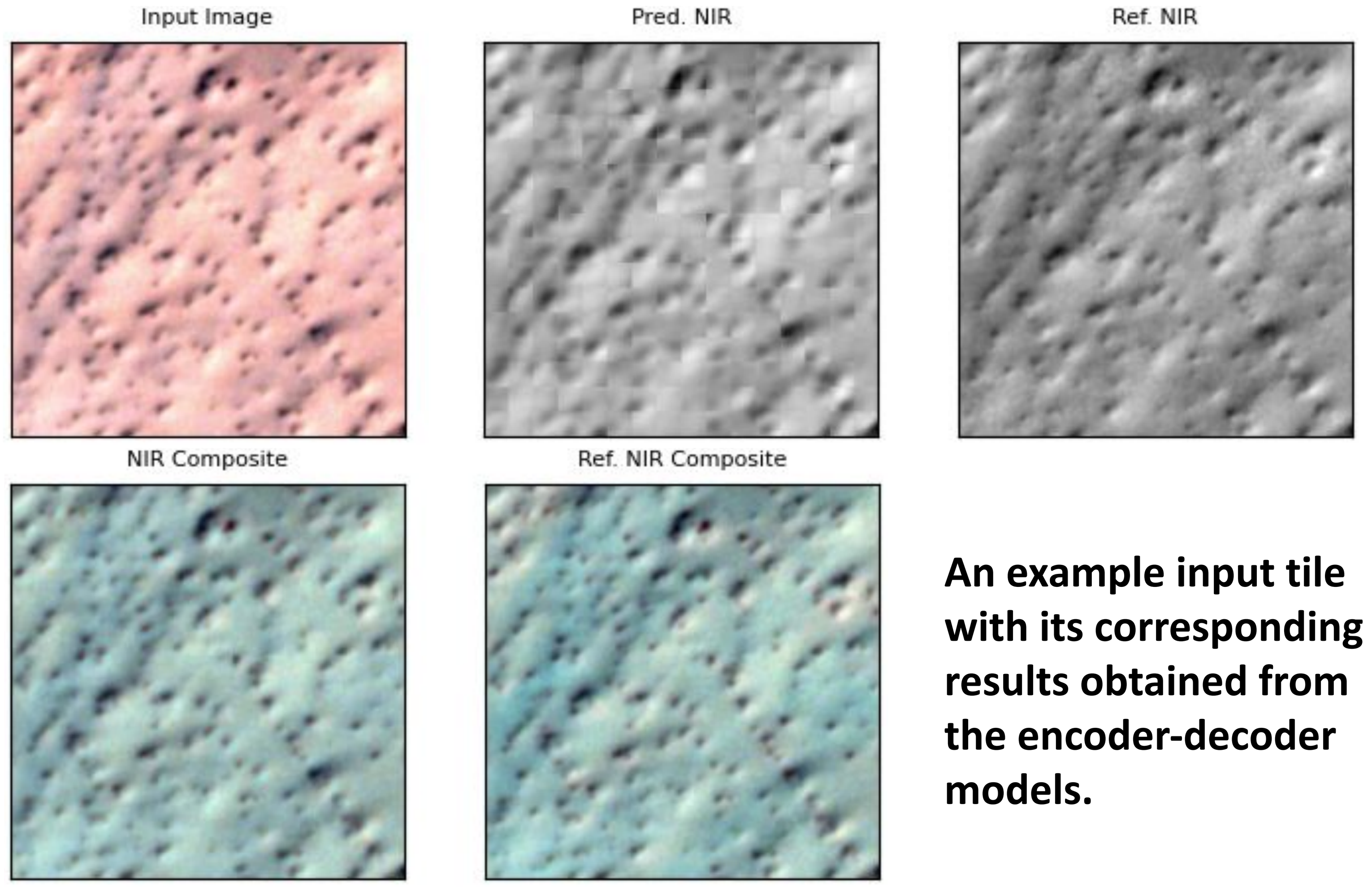


Results

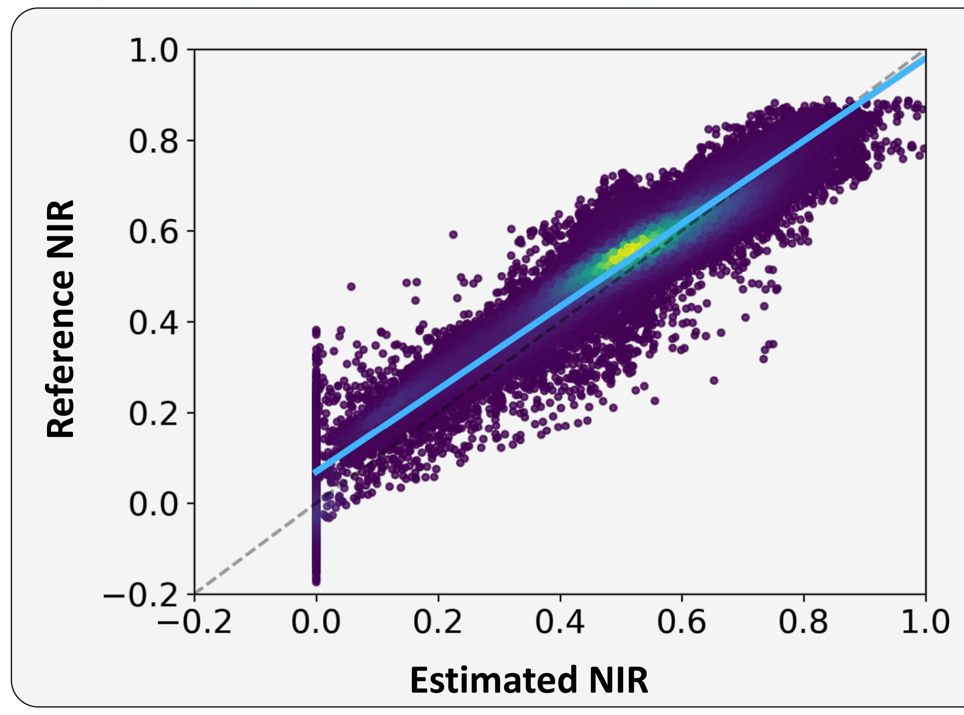


NIR composite (right) created from an RGB image (left) using an estimated NIR band using the deep learning model. The vegetation response resembles that of a composite produced by a satellite image with an actual NIR band.

Evaluation



An example input tile with its corresponding results obtained from the encoder-decoder models.



Scatterplot of a subset of data showing the relationship between the reference NIR band vs the estimated NIR band.

Conclusion

The use of deep learning to estimate a synthetic NIR band proved to be efficient for large-scale identification of individual trees and shrubs in drylands, overcoming the limitations of medium-resolution satellite imagery. The findings of the study are crucial to the conservation of biodiversity and offer a practical approach for environmentalists and researchers. Future work will focus on larger datasets to include various dryland environments and integrating additional data sources such as soil and topographic data for a more comprehensive analysis.

References

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[2]. Wang D, Zhang Q, Xu Y, Zhang J, Du B, Tao D, Zhang L. Advancing plain vision transformer toward remote sensing foundation model. IEEE Transactions on Geoscience and Remote Sensing. 2022 Nov 21;61:1-5.

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