



Tropentag, September 10-12, 2025, hybrid conference

“Reconcile land system changes
with planetary health”

Field margin vegetation mapping using satellite images and deep learning models in a tropical landscape

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Abstract

Field Margin Vegetation (FMV) is the land just adjacent to the crop field boundary with woody or other herbaceous vegetation (e.g., hedgerows), which plays a significant role in conserving biodiversity, enhancing soil stability, supporting carbon sequestration, and maintaining overall ecological integrity in the FMV system itself as well as in the adjacent crop field. Therefore, information about FMV is essential for understanding its status and for developing new policies to improve sustainable agricultural practices. Studies on field margin vegetation (FMV) in tropical landscapes remain largely unexplored, with only a few exceptions, unlike the numerous investigations conducted in Europe and North America. Traditionally, FMV and hedgerows have been identified through field surveys or manual digitisation, both of which were labour-, time-, and cost-intensive. Despite the potential of satellite imagery, delineating and mapping FMV in an agricultural environment is highly complex and requires very high-resolution satellite imagery. Therefore, the objective of this study is to comprehensively demonstrate the application of semantic segmentation techniques for FMV mapping using a very high-resolution WorldView-3 image (1.4 m), which was acquired in December 2023. Based on the field survey, identified FMVs were manually labelled on the images. We created a customized multispectral dataset for training, testing, and validating a deep learning model regarding boundaries, shapes, and class labels. We trained and tested U-Net semantic segmentation models with different configurations. Results indicate that among different configurations tested, U-Net with ResNet34 backbone, pre-trained on ImageNet and trained using three spectral bands, performed the best, achieving an overall accuracy of 95 %. We conclude the study with a comprehensive evaluation of model performance, highlighting the promise of semantic segmentation for automated FMV mapping. With these FMV maps, gathering agricultural landscape configurations in tropical regions, important information for sustainable farming practices and planning across spatial scales become available.

Keywords: Hedgerow-crop interaction, hedgerows, keywords: U-NET, semantic segmentation, transfer learning