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| **Leveraging Aerial RGG Imagery and Machine Learning for Monitoring Vegetation Encroachment in Dynamic Braided River Ecosystems of New Zealand** |
| Invasive weed species pose a significant threat to unique native ecosystems across New Zealand. Traditional ground-based monitoring is unable to address the widespread nature of this issue, being both time and resource-intensive. The coarse resolution of freely available satellite imagery limits its utility for detailed vegetation analysis, especially in complex and dynamic environments such as braided riverbeds, where vegetation encroachment is negatively impacting the ecosystem. This research harnesses the potential of high-resolution aerial imagery, utilizing visible Red-Green-Blue (RGB) bands to offer a novel and cost-effective solution for vegetation analysis.  The study employs RGB-based vegetation indices such as the Visible Atmospherically Resistant Index (VARI), Red-Green-Blue Vegetation Index (RGBVI), and Visible Vegetation Index (VVI). alongside a conversion from sRGB to linear RGB. This conversion is crucial for aligning the aerial image data with the raw reflectance values typically used in remote sensing, thereby significantly improving the reliability of vegetation analysis. The very high and statistically significant correlation between RGB-based indices and the well-established Normalized Difference Vegetation Index (NDVI) demonstrates the efficacy of RGB indices in reflecting vegetation dynamics, validating the potential of this approach for large-scale environmental monitoring.  Combining RGB-based vegetation indices with 3D canopy height models generated from overlapping image mosaics and applying machine learning algorithms, we present an integrated approach that significantly enhances the discrimination and monitoring of vegetation types. The methodology leveraged the conversion from standard RGB to linear RGB for improved accuracy in vegetation indices and employed support vector machine learning for refined classification, offering a comprehensive and nuanced understanding of vegetation encroachment patterns.  The methodology combined the simplicity and accessibility of RGB imagery with advanced analytical techniques, including the conversion from standard RGB (sRGB) to linear RGB to enhance the accuracy of vegetation indices. These indices, alongside machine learning classification and 3D canopy height models derived from aerial photogrammetry, provide a multi-dimensional view of vegetation structure and health. The incorporation of 3D rendering techniques to develop canopy height models adds a vital dimension to the analysis, enabling a detailed examination of vegetation structure and facilitating the differentiation of vegetation types. Machine learning algorithms, support vector machines, are harnessed to refine the discrimination of vegetation types, showcasing the potential of integrating aerial imagery with advanced computational techniques for vegetation analysis monitoring. The results underscore the efficacy of this approach in capturing detailed vegetation dynamics, thereby providing a scalable and efficient alternative to conventional methods and high-cost multispectral imaging. |