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Assessing and Mitigating the Global Freshwater Crisis (6)

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ACCURATE FLOOD MAPPING VIA COLORIZED SAR IMAGES

Abstract

Synthetic Aperture Radar (SAR) imagery plays a pivotal role in the field of remote sensing, prized for its ability to penetrate atmospheric conditions that would hinder other imaging methods. Despite its invaluable applications, SAR imagery is inherently limited by its monochromatic nature and the presence of speckle noise, which complicates interpretation and analysis.

To mitigate these limitations, a common approach involves the fusion of SAR with Multispectral (MS) images, taking advantage of the complementary strengths of each. This method, however, introduces its own set of challenges, primarily the need for precise co-registration between the SAR and MS images to ensure accurate overlay. This alignment is often difficult to achieve due to the distinct characteristics of each imaging modality.

In response to these challenges, SAR colorization has emerged as a promising alternative. This relatively recent approach involves the direct addition of color to SAR images, aiming to enhance their interpretability while preserving their original spatial and radiometric details. Such a strategy sidesteps the complexities associated with image fusion. Despite the potential of SAR colorization, its practical application, especially in critical areas like flood mapping, has not been investigated.

This study aims to fill this gap by exploring the effectiveness of SAR colorization in improving the accuracy of flood mapping. Employing advanced supervised learning techniques, we utilize state-of-the-art Convolutional Neural Networks (CNNs), including the conditional Generative Adversarial Network (cGAN) and the spatial-spectral Convolutional Neural Network (CNN4ColSAR), for the task of colorizing SAR images. Moreover, we propose the use of 3D-UNet to further enhance flood mapping capabilities. This innovative approach is designed to better capture and utilize the enriched information provided by colorized SAR images, offering a significant improvement over traditional models.

Our comprehensive evaluation employs the OMBRIA dataset, covering scenarios before and after flood events, to assess the impact of SAR colorization on the accuracy of flood mapping. The collaborative use of the CNN4SARcolor for image colorization and the 3D-UNet for flood mapping demonstrates remarkable success, achieving results that closely align with reference flood maps. This success is quantitatively supported by performance metrics, such as the F-score and mean Intersection over Union, underscoring the potential of our approach.

Additionally, this research provides a visual comparison of flood mapping accuracy using colorized versus non-colorized SAR images from the OMBRIA dataset. These comparative analyses further highlight the benefits of SAR colorization, showcasing its ability to enhance the precision and reliability of flood mapping efforts.