Enhancing Flood Management in Canada: Leveraging SAR and AI for Improved Emergency Response

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Abstract:

Since 2004, Natural Resources Canada's (NRCan) Emergency Geomatics Services (EGS) has utilized satellite remote sensing to produce vital maps for emergency management, supporting federal, provincial, and territorial governments. Floods, among Canada's most dangerous natural disasters, are monitored using Synthetic Aperture Radar (SAR) satellite data, which provides reliable information even in poor weather conditions. Over the past 20 years, EGS has delivered hundreds of flood mapping products to Canadian stakeholders during emergencies. While NRCan's unique process of transforming SAR data into flood maps that include flooded vegetation areas has been streamlined through automation, manual editing is still necessary to ensure quality, which can be time-consuming.

To address this, NRCan EGS, in collaboration with NRCan's GeoAI team, is leveraging Convolutional Neural Networks (CNNs) to enhance automated flood map production using high resolution data from the RADARSAT Constellation Mission. CNNs are particularly effective for image analysis tasks due to their ability to automatically learn and extract features from georeferenced data. The AI model also leverages an extensive training dataset, compiled from the numerous EGS flood mapping products across Canada. Doing so, the team has previously demonstrated the potential of CNNs in improving the speed and accuracy of open water flood mapping, obtaining Precision, Recall, F1 scores and IoU all above 90%.

However, mapping flooded vegetation areas is particularly challenging because their backscattering values are similar to those of various landscape features, such as urban land cover and steep banks. These similarities can not only confuse traditional mapping techniques, but also CNNs if proper auxiliary datasets are not used. By incorporating auxiliary data such as land cover, water frequency and SAR local incidence angles, the identification of flooded vegetation has significantly improved (see figure 1). This enhancement has also accelerated data processing, greatly reducing the flood extraction processing time.

The collaboration between NRCan's AI and EGS teams underscores the synergy of interdisciplinary expertise in addressing complex challenges. By harnessing CNN capabilities and integrating diverse data sources, the project developed an innovative flood mapping technique and established new standards in emergency geomatics. SAR satellite remote sensing and advanced AI techniques signify significant progress in Canadian flood management, with ongoing efforts promising improved disaster response capabilities through precise and timely flood maps.
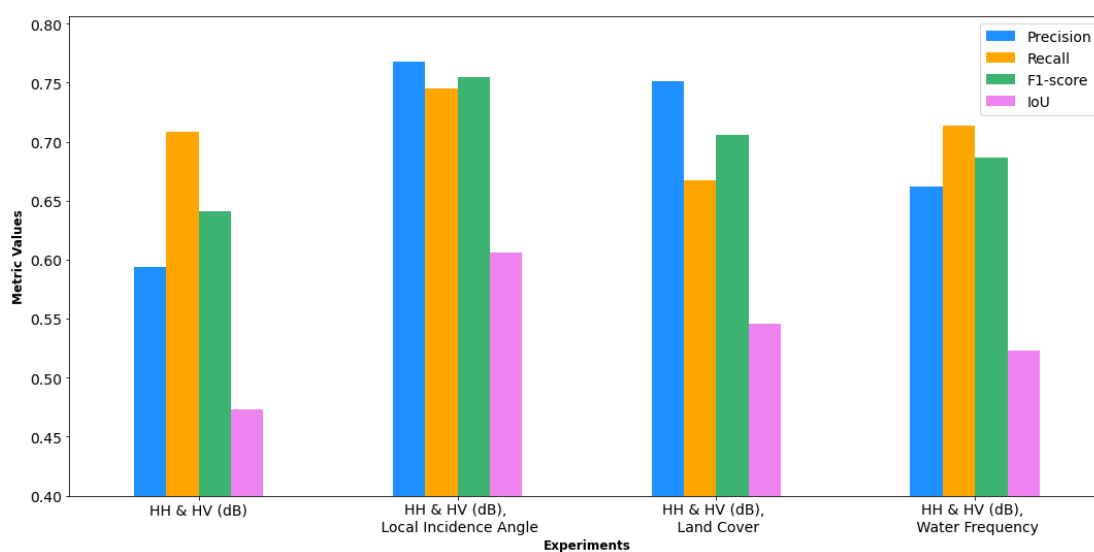
Figure 1: Average performance metrics for Flooded Vegetation across 5 runs for each experiment configuration. The metrics are calculated on the entire test image.).

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