Wetland Surface Water Detection Using Multi-Incident Angle Sentinel-1 Images

Introduction

Wetlands are an important natural resource that provide critical habitat to plants and animals. The timing and duration of flooding within a wetland largely determines the ecosystem services. Synthetic Aperture Radar (SAR) is a useful tool to understand wetland dynamics because of the all-weather capability. Each pixel in a SAR image stores backscattering intensity that reflects geospatial characteristics (e.g. surface roughness, soil moisture) of its corresponding area. Because of specular reflection, water surfaces have lower backscattering intensity than land surfaces. Many researchers have proposed classification models considering this phenomenon (White et al. 2015).

However, previous studies reported that a large local incidence angle of microwave decreases backscattering intensity of land surfaces (Oh et al. 1992). To mitigate the misclassification derived from this effect, this study proposes multi-incidence angle SAR image analysis, which uses two images that are taken from the ascending and descending path. In the following, the proposed model is compared with the previous model that consider one image taken from either orbit.



Studyarea and Dataset

The classification ability was tested on two Sentinel-1 images (Ascending:2018/05/07, Descending:2018/05/11) and a Sentinel-2 image (2018/05/15) capturing wetlands in Okanogan County, Washington.



Sentinel-2

Sentinel-1 (Descending)

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Overview of the Classification and Evaluation Workflow

Firstly, Sentinel-1 and Sentinel-2 images were preprocessed and coregistered using the Sen2Cor processor and the SNAP software. Note that the Sentinel-2 image was used as reference map in this study, each pixel was classified into water or land based on Normalized Difference Water Index value. Secondly, Probability Density Function (PDF) of each class was calculated using training data. In Scenario1 and Scenario2, the classifier only considered an intensity value taken from either path. In Scenario3, the classifier utilized a two-dimensional space defined by both of the intensity values. Finally, classification ability of these model was evaluated using testing data.



Density Estimation

This study supposed that PDF of each class follows multivariate gaussian distribution. Sufficient statistics were calculated using the pomegranate library (Schreiber 2017). The below figure is an example of density estimation in Scenario3. The dotted line denotes a disicion boundary.



Mapping Result and Classification Accuracy





Conclusion

We applied multi-incidence angle SAR image analysis, which uses two images that are taken from the ascending and descending path, to wetland surface water detection. This study successfully demonstrates that combining two images can detect water surfaces more accurately than the previous model that considers only one image.

References

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