Spatial Assessment of Flood Impacts on Wetland Vegetation using Remote Sensing

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1. Introduction

Wetlands play a significant role in the hydrological cycle, in water retention and flood control and protection, and habitat for a vast diversity of plants and animal species such as red-crowned crane and Japanese huchen in Kushiro wetland.

However, there has been an increase in sediment yield and nutrient-rich water in the wetland from the upper reach due to development in the surrounding land, riverbed degradation and deforestation. As a result, there is a change in vegetation distribution pattern predominantly in the increase in number and density of alder trees. Because of this, the wetland has becoming arid, thus it is important to understand the preservation of the wetness of the wetland.

This study aims to evaluate the response of the wetland vegetation before and after extreme flood events which is significant for planning of restoration of the wetland.

2. Data and Methodology

For this study, remotely sensed data was utilized to have preliminary assessment of the land surface condition of the wetland. Landsat 8 data consist of sensors, the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS). Reflection and absorption to sunlight on the surface gives information on its conditions.

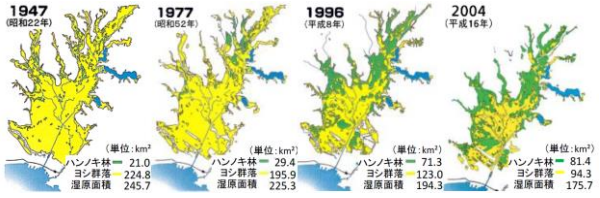

Figure 1. Vegetation changes in Kushiro Wetland from 1947, 1977, 1996 and 2004 (Sakuma, 2004)

Index	Equation	Definition
Normalized Difference Vegetation Index (NDVI)	$NDVI = \frac{NIR - Red}{NIR + Red}$	NDVI quantifies vegetation.
Normalized Difference Soil Index (NDSI)	$NDSI = \frac{SWIR - NIR}{SWIR + NIR}$	NDSI examines the soil conditions
Normalized Difference Water Index (NDWI)	$NDWI = \frac{Green - NIR}{Green + NIR}$	NDWI maximizes the reflectance properties of water .

Table 1. Equations used for evaluating land surface conditions.

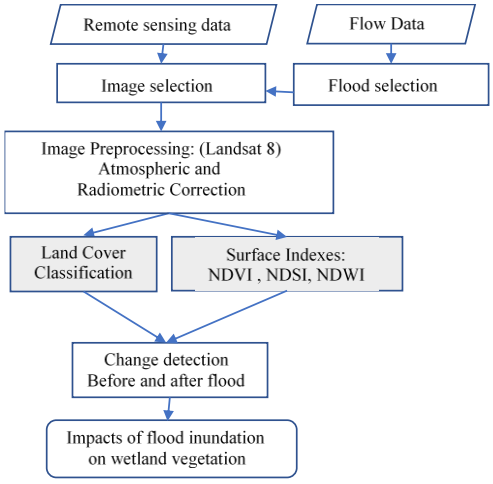

Figure 2. Proposed Workflow of the study

3. Results and Discussion

The impact of flood inundation on vegetation was determined on the peak date of the significant flood of Kushiro river as basis for the selection of remotely sensed images. September 16, 2013 with peak discharge of 318.19 m^3/s and August 21, 2016

Keywords: wetland, remote sensing, NDVI, NDSI, NDWI
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with peak discharge of 469.10 m^3/s were selected. To determine the extent for the vegetation change in the wetland, the land cover classification after August flood was used.

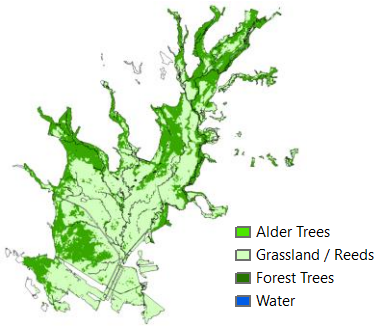

Figure 3. Land cover classification of 2016

Spectral Angle Mapper method was used for land cover classification shown in Fig 3. Based on the classification, the alder woodland increased approximately 70% of the woodland area on 2004. Thus, alder trees have dramatically increased in the wetland area.

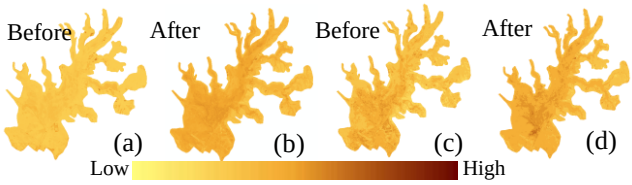

Figure 4. NDSI distribution (a) Aug 2, 2013 (b) Oct 12, 2013 (c) Jun 7, 2016 (d) Oct 2, 2016

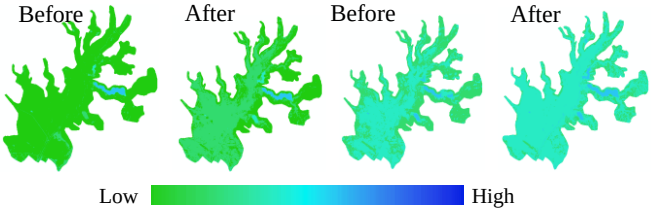

Figure 5. NDWI distribution (a) Aug 2, 2013 (b) Oct 12, 2013 (c) Jun 7, 2016 (d) Oct 2, 2016

Figure 4 shows the spatial distribution of the moisture of the ground after and before flood event based on NDSI. Dark brown relates with greater soil reflectance. Figure 5 shows the spatial distribution of water content in the surface of the wetland based on NDWI. Cooler color represents higher water content. In the central wetland shows the concentration of changes in soil and water conditions.

Based on the flow data, the non-flood period is selected. NDVI during non-flood event shows an increasing trend on the vegetation as shown Fig 6.

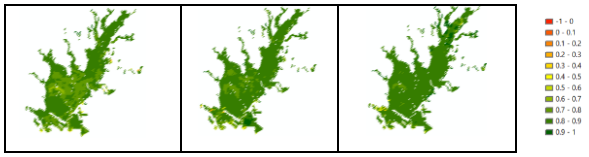

Figure 6. NDVI change during non-flood period

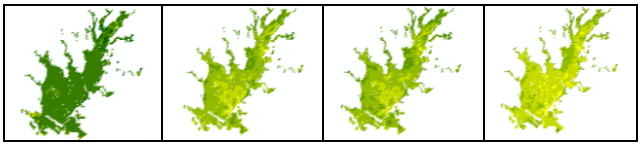

Figure 7. NDVI change during 2016 flood period

During the August 2016 flood event, the NDVI from August 4, 2016 (before the flood event) until October 8, 2016 was investigated. However, it is seen that there is a decrease trend on vegetation based on NDVI.

4. Conclusion

This study spatially evaluated the impacts of flood on the vegetation of the Kushiro wetland utilizing remote sensing data. The land surface conditions on the influence of flood was preliminary investigated using remote sensing. Further investigation is necessary. However, the preliminary investigation can be utilized for initial assessment on the wetland.

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