Remote Sensing of Wetland Types: Tropical Herbaceous Vegetation

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Abstract

The classification of wetland vegetation classes is conditional upon the variety of species or community of species present and seasonal changes in the extent and duration of water and flooding patterns occurring within the landscape. The capability of detecting and mapping water flow under vegetation using synthetic aperture radar (SAR) enables information to be determined about the structure, composition and extent of surface vegetation types.

Fully polarimetric C, L and P –band SAR data was acquired over the Cambodian Tonle Sap Basin in September 2000 and interrogated to map thirteen wetland vegetation ecosystem classes at the western end of the Basin.

In a second example both SAR and optical imagery were used to map wetland vegetation on Lake Chilwa, Malawi.

Keywords

Radar · Acquatic Plants · Classification · River Flow · Discharge Regime

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Introduction

In many tropical wetlands, herbaceous vegetation dominates and may be seasonal in its distribution (e.g., because of different water flows). As an example, in western Cambodia, the flow of water from the Mekong River system into the Tonle Sap Great Lake (TSGL; Fig. 1) during the wet season (July to October) expands the surface area of the lake from 250,000 ha to 1.25 million ha, with this including large areas of adjacent forests and woodlands, macrophytes, and floating grasses. This flow into the TSGL occurs because the distributaries of the lower Mekong downstream from Phnom Penh are unable to cope with the wet season flood discharge flowing into the Gulf of Thailand; the waters back up and flow into the TSGL. With the reversal of water flow back into the Mekong system from November each year, large areas of flooded land on the lakes edge (often with herbaceous vegetation) are successively exposed and used for agriculture. In this fertile zone of migrating waters about 48,000 ha are planted with "receding rice" and another 24,000 ha with other field crops. This water draining back into the Mekong increases downstream flow by an estimated 16% providing much needed water for irrigation in southern Cambodia and Vietnam and reducing the risk of salinity intrusion upstream from the immediate tidal regions.
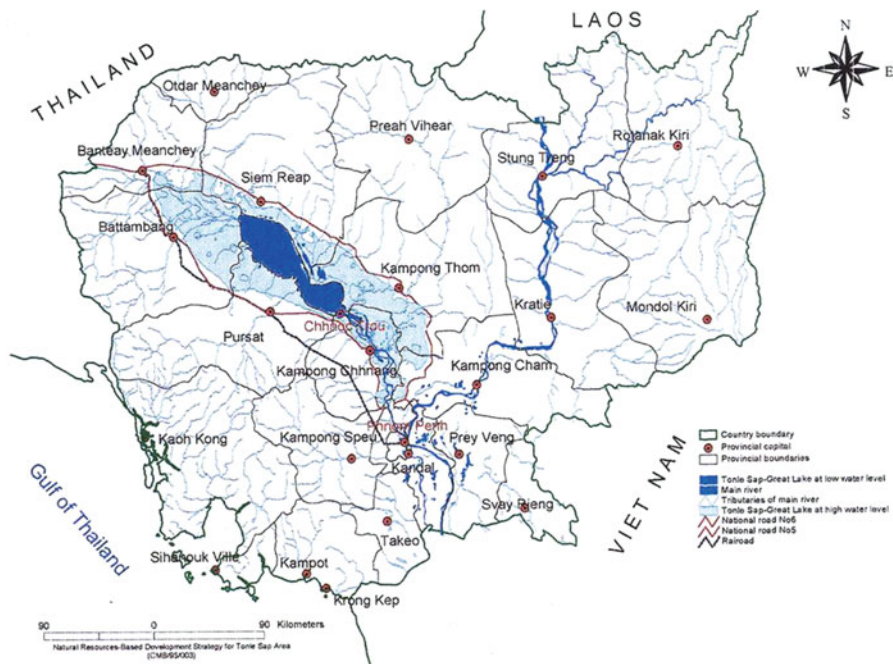

Fig. 1 The location of Lake Tonle Sap, Cambodia

PACRIM-2 Mission

As part of the NASA-Australia sponsor PACRIM-2 mission, airborne Synthetic Aperture Radar (AIRSAR) data were collected over the Tonle Sap and Angkor regions of Cambodia during high water (Fig. 2). The imagery were first segmented
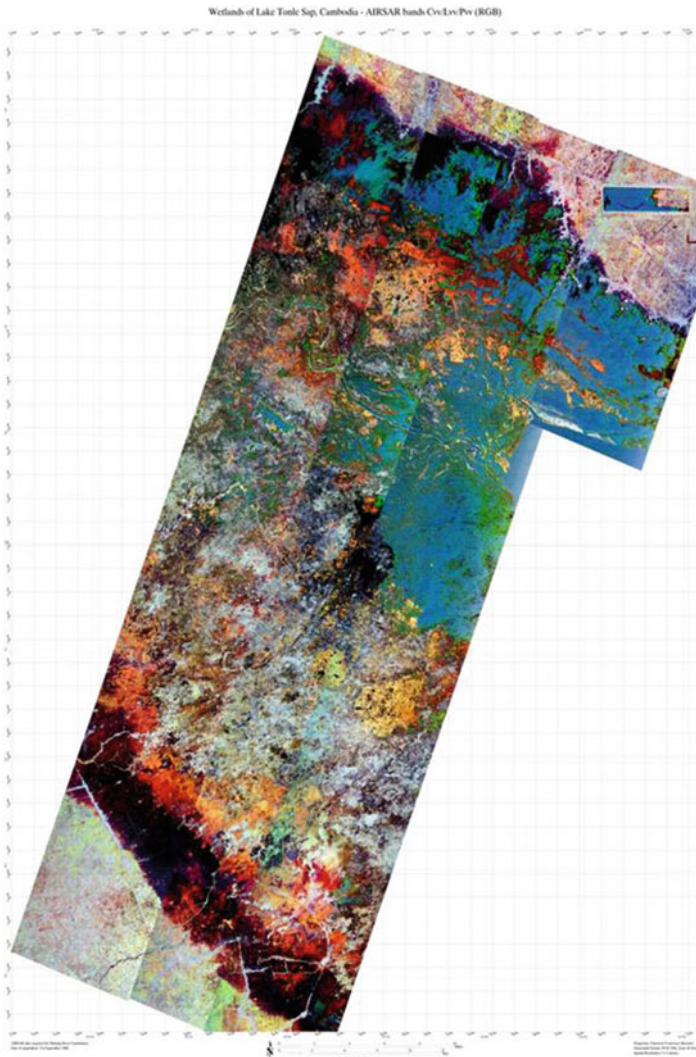

Fig. 2 Mosaic of four AIRSAR flight-lines displayed as an *RGB* colour composite of C-band VV, L-band VV, and P-band VV over the western end of Tonle Sap Great Lake. The data are georeferenced using the WGS 1984 horizontal datum and UTM Zone 48N map projection
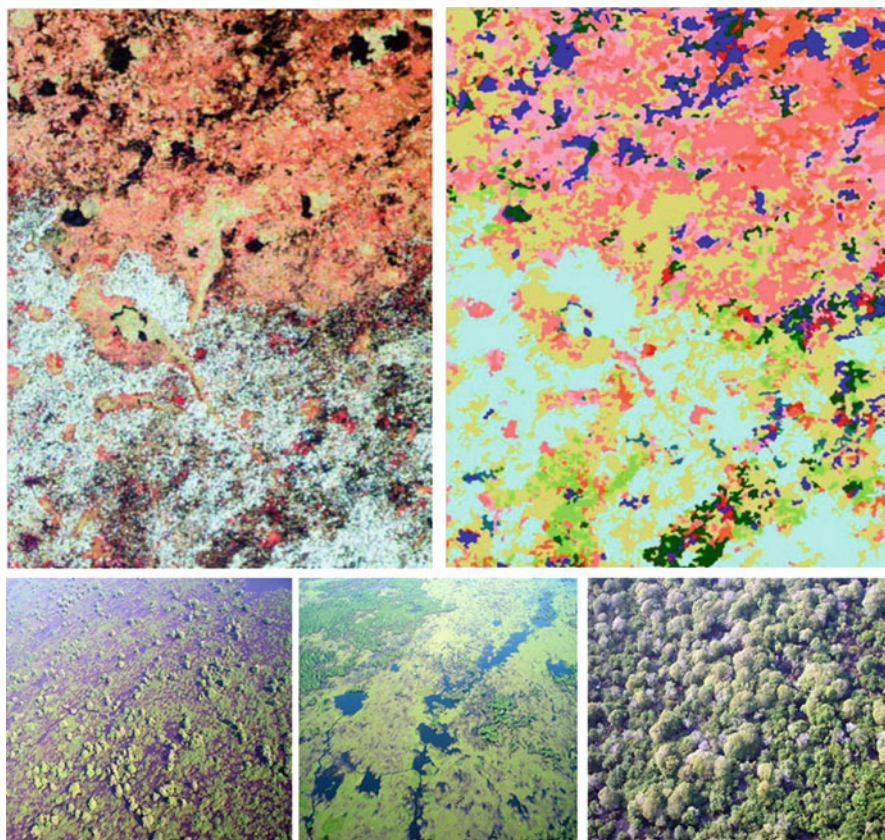
Class 1: Water - open
Class 2: Water - still
Class 3: Flooded fields / grasslands
Class 4: Macrophytes - continuous cover / no open water
Class 5: Macrophytes - broken surface cover / no open water
Class 6: Macrophytes - mixed surface cover / no open water
Class 7: Shrubland - dense / with trees / no open water
Class 8: Shrubland - open / with trees / with open water
Class 9: Shrubland - sparse / grasses / occ. trees / no open water
Class 10: Shrubland - sparse / no trees / with open water
Class 11: Forest trees - sparse/ no trees / with open water
Class 12: Forest trees - closed canopy
Class 13: Irrigated ricefields
Class 14: Nonstuff

Fig. 3 Classification of wetlands from AIRSAR data
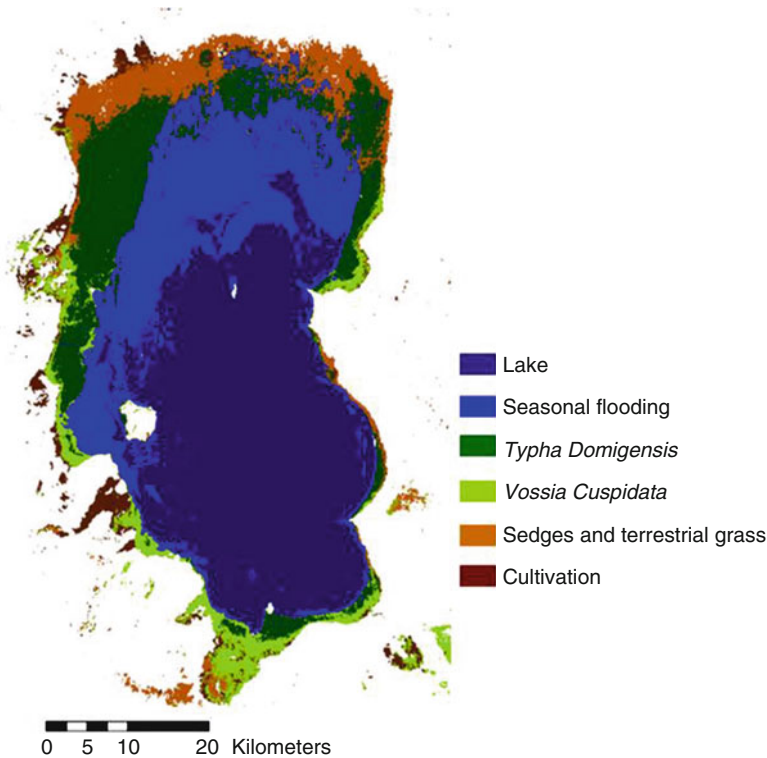
Fig. 4 Classified image of dominant vegetation species, Lake Chilwa, Malawi (© JAXA METI)

using a modified Gaussian Markov Random Filed Model (Dong et al. 2001; Horn and Milne 2002), with each segment associated with attributes such as the mean and standard deviation. An ISODATA classification was then performed on the AIRSAR C-, L-, and P-band imagery to map 13 wetland ecosystems, including macrophytes, floating grasses, shrublands, open and closed forests, mangroves, and open water surfaces (Fig. 3). As well as extent, consideration was given to structural form (e.g., trees, shrubs), growth stage, and condition. The classification scheme was consistent with guidelines listed in the Asian Wetlands Inventory (Wetlands International) for describing wetlands and addressed the needs of the Tonle Sap Biosphere Reserve Act, which requires data and information to assist in formulating management plans for the core, buffer, and transition zones of the Prek Toal Nature Reserve. A limitation of the approach was the fully polarimetric C-, L-, and P-band data were used which are not always available and certainly not from spaceborne platforms. However, further analysis indicated that the three channel combination of C-band HH and L-band VV and HV captured 72.2% of the information (Milne and Tapley 2004).

Both SAR and optical data can be used to map dominant herbaceous wetland vegetation and are often used in combination, as in the case of the Lake Chilwa wetland in Malawi (Fig. 4; Rebelo 2010) and the flooded Várzea forests of the Amazon (Hess et al. 2010). Data from airborne hyperspectral imaging spectrometers has also proved popular as they offer both high spectral and spatial resolution imagery that is ideally suited to monitoring wetland vegetation. Data acquired by hyperspectral sensors such as the Compact Airborne Spectrographic Imager-2 (CASI-2) have also proved useful for mapping the distribution of wetland plant species. For example, Hunter et al. (2010) used these data to map macrophytes in the Upper Thurne region of the Norfolk Broads, UK.

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