MULTIBAND RADAR FOR MAPPING INUNDATION PATTERNS IN SEMI-ARID WETLAND ENVIRONMENTS; MACQUARIE MARSHES, NEW SOUTH WALES

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While mapping the extent of flooded forests and wetlands in humid and tropical areas using radar has been readily demonstrated, the detection and analysis of flood patterns in semi-arid environments is less well known and understood. Flood events in these environments often depend on the release of environmental flows from upstream storage dams the discharges of which are often confined to in-channel rather than to overbank flows. This pattern of flow occurs especially within dispersive or braided stream systems.

The Macquarie Marshes are located in the Macquarie River catchment in central-western New South Wales. The Macquarie River flows north west through the marshes and eventually feeds into the Australian Murray-Darling River system. The marshes are an alluvial fan system, developed from sequences of deposition prior to the Quaternary period. The river forms an anatomising channel system extending through the marshes. Prior channels are observed on either side of the floodplain, but particularly on the western side of the marshes.

These Marshes along with other inland semi arid riverine wetlands environments in eastern Australia, have all experienced significant long-term declines in stream flow as a result of river regulation and water storage diversions to support irrigated agriculture and from periods of prolonged drought. In the case of the Macquarie Marshes, the reduced frequency and extent of inundation has resulted in the contraction of floodplain wetland vegetation, the death of extensive River Red Gum forests, and less breeding opportunities for water birds. The southern part of the marshes has suffered the most, with a reduction of around 73 % of the floodplain area, compared to ~53 % in the northern section. Increased erosion due to low flows and grazing pressure has lead to the widening and deepening of some channels, which increases the volume of water required to achieve overbank flow and hence flooding of the adjacent wetlands. Overall 40-50% of the wetlands have already been lost and less than 10% of the original wetland area of the Marshes is considered healthy.

This paper focuses on the application of multi-frequency L-, C- and X-band (ALOS PALSAR, Radarsat-1and TerraSAR-X) imaging radar to the detection and mapping of wetland communities and inundation patterns in the Macquarie Marshes. Suitable images were acquired in both dry (Jan and Oct, 2007), wet (Jan, 2008) and transitional wet-dry (Feb to Apr, 2008) conditions. The study demonstrated the use of multi-frequency radar for the following:

i. Detection of flooded forest in areas of very high backscatter at all wavelengths. The bright response at L-band originates from multi-path (i.e., single and double bounce interactions) between the tree trunks and/or large branches and the inundated surface. The bright response at C- and X-band is attributed to backscatter enhancement due to the presence of water beneath the tree canopy. Enhanced backscatter was observed in the River Red Gum forests and along tree-lined channels throughout the extensive wetland area..

ii. Detection of surface water in areas which display either a dark response (i.e., areas of wet mud or open water) with no vegetation and hence result in specular scattering, or a bright response, (i.e., wet soil with high dielectric and roughness) from vegetation cover inducing a strong backscatter return and a bright appearance on the imagery.

iii. Inundation mapping can be undertaken using multi-temporal PALSAR data.. Decorrelation stretches and Minimum Noise Fraction (MNF) transforms assist by enhancing the visual detail in imagery. Segmentation and supervised classification approaches were used to map surface water, marshland and potentially inundated ground.

iv. Suitability of SAR data for change analysis as related to changes in surface wetness and vegetation cover. The PALSAR data, and to some extent the TerraSAR-X StripMap imagery, were most useful for change detection. The Radarsat-1 data were of lower quality and hence of limited use in detecting change.

v. PALSAR data was particularly useful for discriminating between flooded and non-flooded forest and for wetland characterisation. The PALSAR data were superior to the TerraSAR-X and Radarsat-1 data for wetland class discrimination. Ponded water can be discriminated at all wavelengths.

vi. Of the advanced processing techniques tested for wetland discrimination, Canonical Vector Analysis (CVA) and Decorrelation Stretching provided the best separation between classes.

vii. The combined use of longer wavelength L-band data and the shorter wavelength C- and X-band SAR data confirmed the presence or absence of vegetation in areas suspected to be either bare ground or open water. Dark areas at all wavelengths included water holes and bare ground. Dark areas at L-band appeared to be bare ground, but a brighter response from the corresponding area at C- or X-band indicated some vegetation cover.

The wet conditions in the Macquarie Marshes during December 2007 and January 2008 presented an opportunity to refine techniques employing imaging radar for inundation mapping in semi-arid wetland environments. The result presented show that an operational system for monitoring environmental flows in New South Wales inland wetlands using imaging radar could be developed.