ADVANCES IN THE INTEGRATION OF ALOS PALSAR AND LANDAT SENOR DATA FOR FOREST CHARACTERISATION, MAPPING AND MONITORING

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1. INTRODUCTION

Since 2006, Japan's Advanced Land Observing Satellite (ALOS) Phased Arrayed L-band SAR has been providing systematic observations of the world's forests. Increasingly, the benefits of these data are being realized with an increasing number of studies reporting on their use for detecting deforestation, degradation and regeneration of forests and retrieving structural attributes and biomass. In this paper, we report examples of how ALOS PALSAR data have been used, singularly or in combination with Landsat sensor data, to enhance capacity for characterizing, mapping and monitoring forests that are vulnerable to human-induced events and processes or climate change. The research focuses on our own studies of forests and woodlands (including savannas) in Queensland, Australia, peat swamp forests in Indonesia and tropical regenerating forests in Brazilian Amazonia.

2. CASE STUDIES

5.1. Queensland, Australia

Forests (including wooded savannas) are extensive across the north and east of Australia although large areas have been cleared since European settlement, including in the past few decades. These forests are also vulnerable to the adverse effects of climate change (e.g., increased fire activity and drought). In the savanna regions, in particular, regeneration following clearance and woody thickening is commonplace. Given the vast extent of these ecosystems, such changes have significant implication for regional and also global carbon budgets.

To establish the potential of the ALOS PALSAR for retrieving the above ground biomass (AGB; carbon stocks) of forests in Queensland, 50 m spatial resolution strip data acquired in 2007 to 2009 were made available as part of the Japanese Space Exploration Agency (JAXA) Kyoto and Carbon (K&C) Initiative. Using data acquired during periods of minimum and maximum surface moisture, as determined from Advanced Microwave Scanning Radiometer (AMSR-E) and regional rainfall data, statewide mosaics were generated. Relationships were then established between the L-band HH and HV backscattering coefficient (σ^o) and AGB estimated by applying a consistent set of allometric equations to over 2500 plot-based measures of tree size acquired across a range of forest structural types [1]. Contrary to many previous studies where saturation was observed to occur at less than 100 Mg ha^{-1}, L-band HV σ^o was sensitive to an AGB exceeding 400 Mg ha^{-1} when data were extracted from 'dry' mosaics. However, lower saturation levels were observed when data acquired during wetter conditions were used. The relationships between AGB and L-band HH and HV σ^o also differed between sparse woodlands, open woodlands and forests, which was attributable in part to variations in stem size distributions and density. Within woodland areas, the biomass was naturally low but for forests, lower amounts of biomass were associated with non-remnant (regrowth) at various stages of growth. For open forests, and using techniques developed previously by [2], several stages of regrowth could be discriminated by integrating ALOS PALSAR and Landsat-derived FPC data and associated subsequently with an estimate of AGB.

2.1. Indonesia

To further investigate the impacts of surface moisture on the capacity to retrieve the AGB of forests, ALOS PALSAR data acquired during periods of relatively low and high rainfall and soil moisture have been obtained for Riau Province in Indonesia. In 2008, 150 900 m^2 plots were located in intact and logged peat swamp forest and the AGB was estimated using allometric equations generated through on-site destructive harvesting (51 trees). To chronicle the history of logging, time-series of Landsat sensor data were obtained. For each year of observation, areas affected by logging activities were classified using an object-orientated classification undertaken within eCognition. The recovery of the forest was then tracked using trajectories of reflectance, vegetation indices and also endmember fraction images (shade, photosynthetic and non-photosynthetic vegetation). At the time of writing, relationships are currently being established between the AGB and L-band HH and HV σ^o as a function of logging history and surface moisture and the outcomes of these will be reported.

2.2. Brazilian Amazonia

Across the Brazilian Amazonian, over 35 % of deforested areas support regenerating forests with the majority being younger than 40 years. Whilst maps of regenerating forests have been generated, these provide limited insight into the future state and dynamics of forests in terms of carbon uptake and recovery of biodiversity. Using time-series of Landsat sensor data (17 scenes) acquired over a 30-year period for an area north of Manaus in

Brazil, maps detailing the age of regenerating forests and also the periods of land use prior to abandonment were generated [3]. Using SIR-C SAR data acquired earlier in the time-series, and for forests of the same age, L-band SAR HV σ^o was noticeably reduced for those regenerating on land with a higher intensity of use (frequency of reclearance, burning and periods under grazing), with this attributed either to a lower AGB of the regenerating forests or differences in structure as a function of dominant pioneer genera. The analysis suggested that when L-band SAR data are integrated with time-series of Landsat or other optical sensor data, potential exists for quantifying and also predicting the carbon dynamics of regenerating forests as a function of prior land use at a landscape scale. Research currently being conducted is establishing whether similar differences are observed using ALOS PALSAR data acquired in the later years of the time-series, thereby assessing potential for regional assessment of regrowth and carbon dynamics.

3. CONCLUSIONS

The ALOS PALSAR provides capacity for mapping and monitoring deforestation, degradation and regeneration and retrieving biomass and structural attributes. However, additional information on the dynamics of forests and impacts of human activities can be obtained by integrating data or derived products (e.g., biomass) with those generated from single date or time-series of Landsat sensor data.

4. REFERENCES

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