Chapter VI

Summary and Recommendations

6.1. Summary

In this study, numerical methods were developed to analyse the interaction of L-band microwaves with the tree trunks of tropical forest and the burnt coal seam of forest fire scars. The purpose of this research is to know the complex relations of the radar scattering mechanism between microwaves and tropical forest parameter (the diameter of a tree trunk and the thickness of burnt coal seam).

In analysis of scattered wave from a tropical tree trunk, proposed method approximated a tree trunk as an infinite length of two and three layers of cylindrical dielectric media that were illustrated in Chapter II and III, respectively. The horizontally and vertically polarised scattered fields were derived in order to calculate the relationship between trunk diameter and backscattering coefficient. The analysis result was confirmed by simulating the scattered wave on a tree trunk using Finite Difference Time Domain (FDTD) method. Both analysis and simulation results are similar. Then the relationship was used to estimate tree trunk diameters of pine (*Pinus merkusii*) forest around Saguling lake and rasamala (*Altingia exelsa*) around Mount Gede Pangrango National Park, west Java, Indonesia from Japanese Earth Resources Satellite (JERS-1) SAR data.

In analysis of burnt coal seam, simple and complicated methods were conducted to analyse scattered waves from burnt coal seam in order to estimate thickness of fire scars that were discussed in Chapter IV and V. The model is composed of three media namely; free space (air), burnt coal seam and peat (a perfectly conductor). For computation purposes, the equivalent circuit of this model is conducted using classical transmission line circuit method for a simple analysis, and the stationary-phase approximation is used to analyse scattered wave from the complicated rough burnt coal seam. The relationship between backscattering coefficient and thickness of burnt coal seam is obtained. The analysis result is confirmed by two-dimensional simulation using FDTD method for scattered waves from the burnt coal seam. Both analysis and the simulation results are similar. Subsequently, the developed model was applied to estimate the thickness of burnt coal seam in central Borneo fire events in 1997 using JERS-1 SAR data. Results agreed with ground measurement that was collected in period of 1995 to 1997.

6.2. Future work and Recommendations

The scattering models of tree trunk provided in this dissertation are illustrated in two-dimensional infinite length of a cylinder. Obtaining effective analytical models is an obvious extension of this work to three-dimensional finite length of cylinder. In Chapter II and III, there are shown that the roughness and soil moisture of land surface are ignored to

simplify calculation of the scattered fields. Establishing a connection between physical dimensions, geometry, moisture and dielectric constant of the roughness to the radar backscattering is the next step to complete the problems.

Numerous modification and improvements may be suggested for the model of the tree trunk to make the model more realistic, the ground layer may be considered rough. The cylinders in the trunk region may be considered to have an angular distribution, and the statistically inhomogeneous crown layer may be considered. In principle, obtaining solution to all these modifications is possible, but the added complexity also increases computation time. It will be necessary to evaluate the significance of each modification before integrating it in the model.

The analysis of scattered wave from the rough burnt coal seam is seemed completely enough. But to simplify calculation, surface current density was estimated by the Kirchhoff approximation only in the analysis of scattered wave from surface of layer 2 or a perfectly conductor (peat layer). Hence the cross-polarisation of fields are zero. To obtain solution to all these modifications is more complete and perfect, the standard iterative technique are arranged as a solution. But, in this case, we must give attention that the accuracy of the solution is strongly dependent on the initial guess.