FOREST TYPE CLASSIFICATION USING AIRSAR IMAGE DATA

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In the era of rapid and advance information and communication technology, more precise information can be captured using remote sensing satellite. Large amounts of data can be gathered cost-effectively and utilised to formulate and develop effective forest management plans (Lillesand & Kiefer 2000). The input of large amounts of inventory data using remote sensing technology helps enhance planning for sustainable management, especially in hilly areas where bulk of the remaining production and protection forests are located. Remote sensing data has wide application in forestry and is being commonly used in mapping of different forest types and in monitoring changes in the extent of forest cover. However, the application of remote sensing in assessing the quality of forest, such as tree species composition and distribution, stocking (volume, height and dbh), growth and yield, is still very limited (Mohd Ibrahim *et al.* 2001). This is crucial for an effective decision-making process especially after logging where forecasting future timber production and length of the next rotation by forest managers depends largely on the compilation of these data.

The objective of this study was to evaluate the potential and capability of AIRSAR imagery data in classifying the lowland forest types. This study was carried out in a logged-over forest and was aimed at investigating the type and condition of the forest after several years of logging. The data collected would be useful for managers to prepare the forest for the next cutting cycle in terms of rehabilitation, treatment or other silvicultural techniques (Khali Aziz *et al.* 2001).

The study area is part of a lowland forest of Gunung Arong Forest Reserve, Mersing, Johore, which is south-east of Peninsular Malaysia. The forest is situated between 103° 47' and 103° 50' E and 2° 32' and 2° 34' N. The imagery used in this study was an airborne AIRSAR data captured for PACRIM I Project in late 1996 over the area of Gunung Arong Forest Reserve (Figure 1). The ancillary data including maps for compartment map, forest type and logging years were obtained from the Forestry Department, Johor Bahru, Johore.

The raw AIRSAR image was geocoded (Figure 2). The geometric correction was carried out in order to position the image according to its exact and real location. A total of eight ground control points were employed using first-degree polynomial transformation with root mean square error (RMSE) of 0.527 pixel. Once the image had been positioned to its real location, each pixel of a particular location was also corrected. For this purpose, the image was resampled using the nearest neighbour technique.

Since the image covered a large area and took longer time to be processed, a subset of the study area was determined. The subset product was a quadrat of the Gunung Arong Forest Reserve as shown in Figure 3. In the subset image, there were other features like water bodies, residential areas and agricultural land, which were not required for this study. Therefore, these area were deleted from the actual image by a process called masking. In this process, first, a polygon of the forest area was digitised based on the topographic map. Then, the area outside the polygon was darkened to differentiate non-forest from the forest area as shown in Figure 4. The masked image was then filtered to minimise speckle and noise. Few filters were tested and Gamma 3 × 3 was found to be the best for the image. The unfiltered and filtered images are shown in Figure 5. The image of the study area was then classified to show different forest classes. Classification was carried out to prepare the area for ground truthing. Three types of unsupervised classifications available
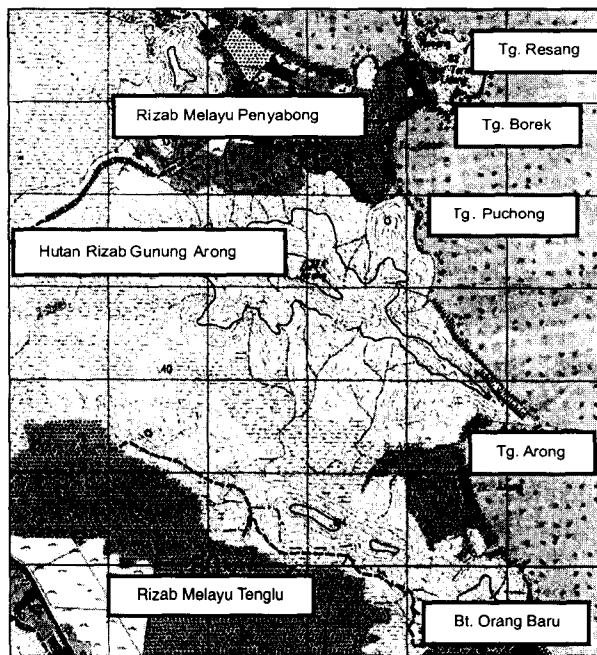
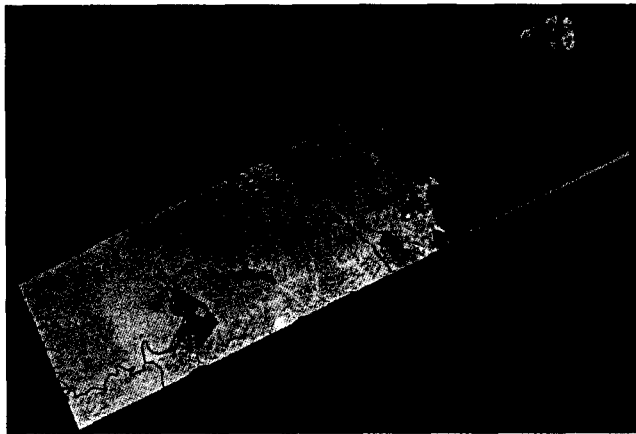**Figure 1**   Study site—Gunung Arong Forest Reserve, Mersing, Johore

Figure 2   Geocoded image of the study site

in the ENVI 1999 software, Version 3.2 were applied and tested, namely, unsupervised, density slicing and synthetic colour. Ten classes were assigned and Figure 6 shows the results of the classification. Unsupervised classification was considered the best classification among the three. Following this, for verification of classes, ground truthing was carried out and the classes were determined. It was found that from the ten classes obtained, only seven classes could be identified. Thus, the other three classes were dissolved by combining them with other classes which were similar. The ground truthing data were integrated with the unsupervised classification image to produce the supervised classification image of different forest types at Gunung Arong (Figure 7). The overall classification accuracy was 85%.

From the results of this study, it is concluded that the AIRSAR radar data has the potential and capability in classifying forest types in lowland forest.
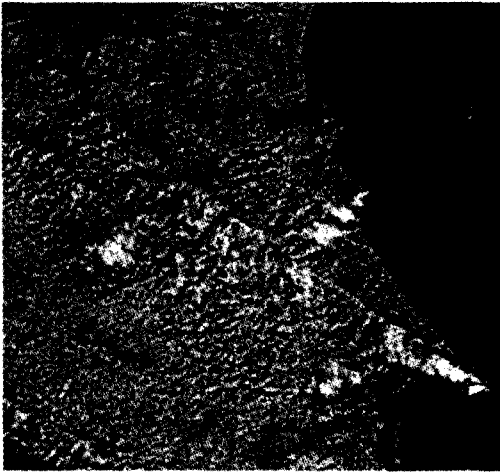
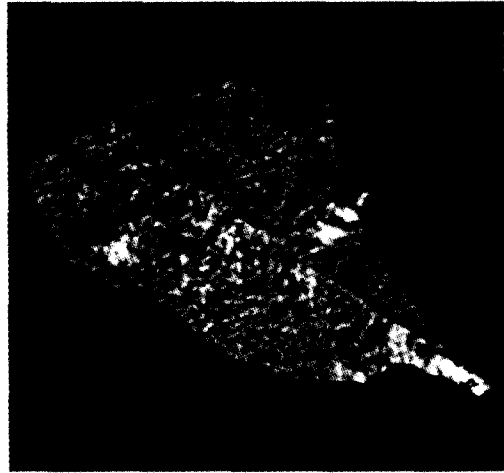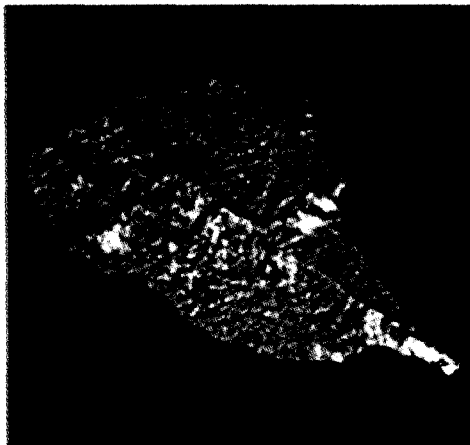**Figure 3**   Subset of the study area
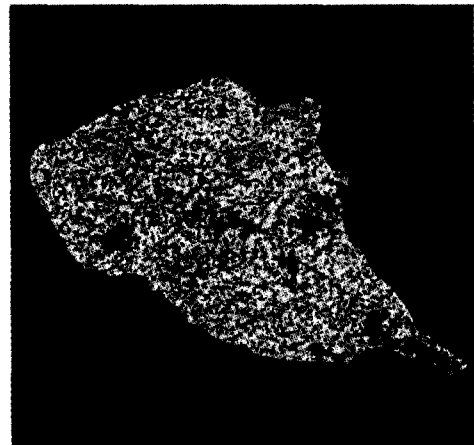

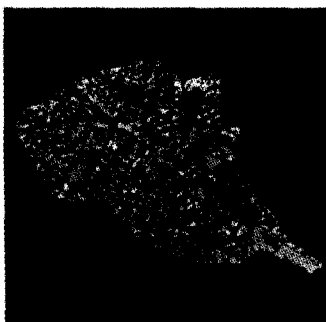**Figure 4**   Masked image of the study area
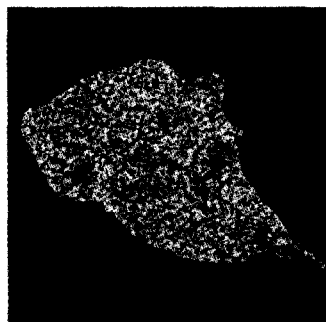

(a) Unfiltered image

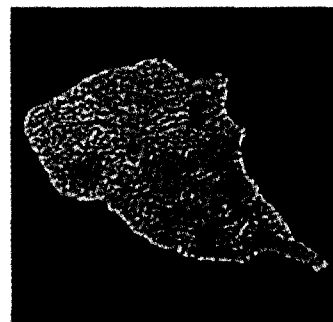(b) Filtered image

Figure 5   Difference between unfiltered and filtered images

(a) Unsupervised

(b) Density slicing

(c) Synthetic colour

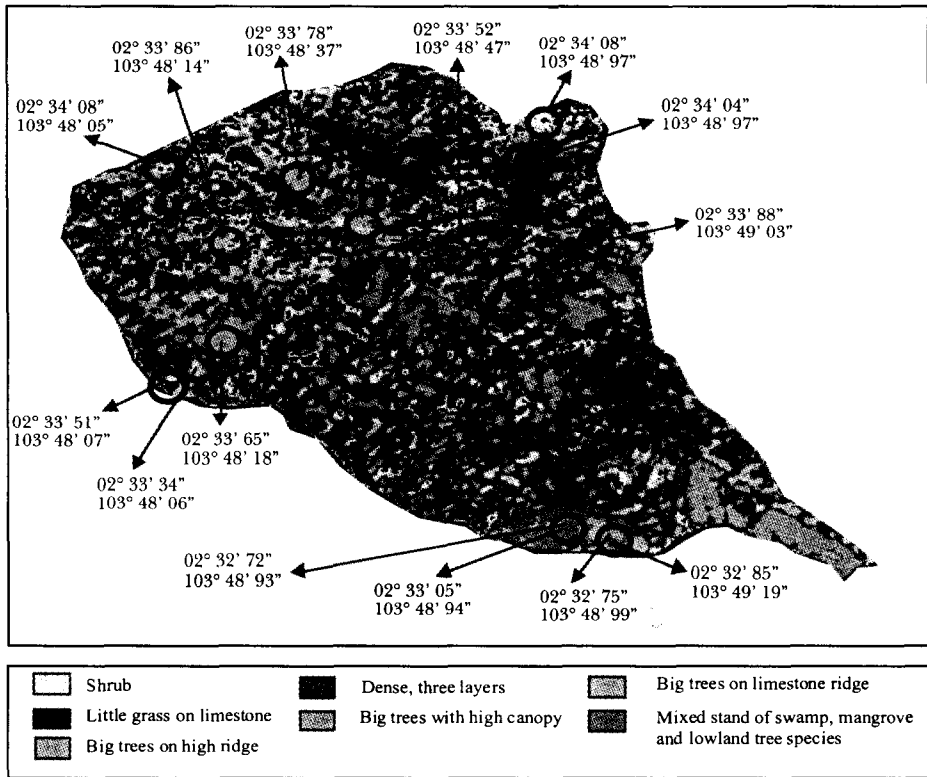**Figure 6**   Three types of classifications, each with 10 classes

Figure 7   Forest type classification map

Acknowledgements

References

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LILLESAND, T. M. & KIEFER, R. W. 2000. *Remote Sensing and Image Interpretation*. 4th edition. John Wiley and Sons, New York. 724 pp.

MOHD IBRAHIM, S. M., ERIC SIOU, C. Y. & SAFIAH YUSMAH, M. Y. 2001. Forest type mapping from airborne polarimetric SAR data. Pp. 1043–1048 in *Proceedings of the 22nd Asian Conference of Remote Sensing*. 5–9 November 2000. Singapore.

BOOK REVIEW

KRISHNAPILLAY, B. (Ed.) 2002. **A Manual for Forest Plantation Establishment in Malaysia.** Malayan Forest Records No. 45. Forest Research Institute Malaysia, Kepong. xviii + 268 pp. USD68.
ISBN 983-2181-28-3
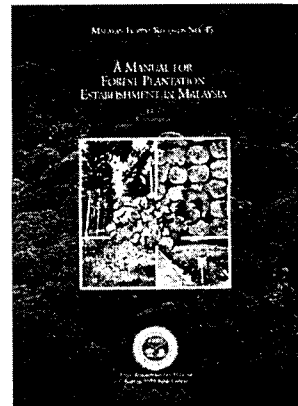
Plantation forests will be an essential component of future management and development of the rich forest resources of Malaysia. The reasons for this, as clearly articulated in the first chapter (A1) of this important new book, result from several forces affecting Malaysia's forest sector. First, the implementation of sustainable logging practices coupled with declining forest cover will soon reduce the supply of timber from natural forests below the processing capacity of the country. Second, there are an estimated 153 900 hectares of unproductive, degraded land in Malaysia, and an even larger area of under-stocked forest. Third, forest-related programmes are required to help alleviate rural poverty. Fourth, labour shortages in the rural sector require the expansion of opportunities for low-labour demanding land-use developments. Finally, developments are required that will reduce the pressures on forest reserves and enable Malaysia to achieve the Government's objective of retaining at least 50% of the land area under forest cover. For these critical reasons the publication of a manual on the establishment of timber plantations in Malaysia is of considerable importance.

This book is organised into three sections (A–C). Section A includes 13 chapters addressing general topics in plantation forestry, namely, the history of forest plantations in Malaysia (A1), a short summary of species for plantation consideration (A2), soils (A3), seeds (A4), seedlings and planting stock (A5), improvement of planting stock through selection and management of seed production (A6), land clearing techniques without burning (A7), plantation preparation (A8), planting and tending (A9), plantation diseases (A10), insect pests (A11), approaches to agroforestry (A12), and an introduction to financial analysis of plantation development with some worked examples (A13). Section B includes eight chapters that detail the silviculture of species that are currently being recommended for plantation development in Malaysia: *Dyera costulata* (B1), *Shorea leprosula* (B2), *Hopea odorata* (B3), *Azadirachta excelsa* (B4), *Acacia mangium* and hybrids (B5), *Khaya ivorensis* (B6), *Hevea brasiliensis* (B7), and *Tectona grandis* (B8). Section C includes two chapters summarising the state of forest plantations in the state of Sabah (C1), and providing some brief comments on the experiences from one plantation company in Sabah (C2).

Each of the 23 chapters is prepared by a different author or group of authors. In this respect, the book is an edited compilation which, therefore, results in some variation in detail and quality among the chapters. The book is well illustrated with numerous colour plates. Cited references are included at the end of individual chapters, which is unfortunate since it makes browsing for relevant literature more difficult. There is a general index and an index to scientific names, both of which are extensive and make accessing information in the book efficient. Overall, the book is well organised and includes a huge amount of information that will be of value to students, researchers and forestry practitioners.

The 13 chapters in Section A provide a broad and relatively general introduction to plantation forestry. They serve as an excellent background to plantation forestry research in Malaysia. Several of these chapters are particularly informative. Chapter A1 provides a detailed description of the history of plantation forestry in Malaysia, emphasising the factors motivating the establishment of plantations. Chapters A8 an A9 provide specific practical suggestions on establishing and managing the crop of trees in the field. Chapter A13 provides a description of how to conduct an investigation of financial viability of a proposed plantation, and provides some worked examples that will be very useful for students and foresters alike.

One drawback of trying to provide a broad background to plantation forestry is that Section A is less like a manual and more like a review of plantation research. Several of the chapters do not provide sufficient detail on specific treatments that could be readily implemented by the forestry practitioner. For example, the descriptions of grafting and micropropagation for producing planting stock in Chapter A5, and the descriptions of methods for disease control in Chapter A10 are not sufficiently detailed that they could be used in the field. Nevertheless, these chapters do provide background and references that could be followed up on by the forester.

Section B provides, in my view, the most valuable part of this book. The chapters greatly expand on earlier work on the silviculture of these species in Malaysia (Appanah, S. & Weinland, G. 1993. *Planting Quality Timber Trees in Peninsular Malaysia: A Review.* Forest Research Institute of Malaysia, Kepong. 247 pp.). Each of the eight chapters provides an extensive review of the technical aspects of planting the selected species. Data on growth rates, stand volume increments, and the impacts of different planting treatments are clearly presented in tables. Practical details of collecting and treating seeds, establishing seedlings, and treating diseases and pests are also provided. Each of these chapters is well referenced and includes descriptions of results from some "in-house" and less widely distributed literature. The degree of detail provided under some of the species (e.g. *Hevea*) is greater than under others (e.g. *Khaya*) due to the extensive plantation studies on the former species. Two of the eight species treated in Section B are dipterocarps, and only four of the species are native to Malaysia. Given the already large size of this book it might have been impractical to treat more than these eight species. However, several very important potential plantation species which have been the subject of considerable silvicultural research, and are currently under trial in Malaysia, were not covered in this section. For example, the dipterocarps, *Shorea parvifolia*, *S. platyclados* and *Dryobalanops aromatica*, and the non-dipterocarps, *Gonystylus bancanus* and *Paraserianthes falcataria* were not treated. Clearly a broader range of species will be required to satisfy the objectives of plantation establishment in Malaysia. Despite this limitation the information provided on the eight species will be of considerable practical value.

Section C provides a short description of the current status of plantation forestry in Sabah. While this section seems slightly out of place in a plantation manual, the authors do cite the key institutions involved in plantations in Sabah and this will provide useful contacts for foresters in other states, and for students and researchers requiring more information.

Overall, the Editor has done an excellent job in bringing together this extensive set of information and resources for plantation establishment in Malaysia. As the private sector and research institutions address the important objectives of the forest management and timber production in Malaysia over the coming decades, this book will prove an invaluable resource. It should be required reading for all students of Malaysian forestry. I finish by reiterating the Director-General of FRIM's comment in his forward to the book, that this

manual is really the beginning of a new phase of plantation establishment and plantation research in Malaysia. It provides an excellent basis for new research into the development of forest plantations in Malaysia.

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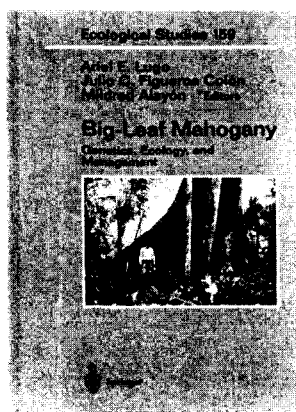
LUGO, A. E., FIGUEROA-COLÓN, J. C. & ALAYÓN, M. (Eds.) 2003. **Big-Leaf Mahogany: Genetics, Ecology and Management.** Springer-Verlag, New York. 433 pp. USD139.00. ISBN 0-387-98837-8

The "mahogany issue" was one of the main natural resource controversies worldwide for the 1992–2002 period. For 11 years, environmental groups tried to get big-leaf mahogany, *Swietenia macrophylla* King, listed on Appendix II of CITES (Convention on International Trade of Endangered Species). They succeeded in November 2002.

Ironically, few suggest that mahogany is in danger of extinction, now or in the future. The battle has centred instead on control over which, if any, trees should be harvested in a given area, and when. Technical forest management matters are largely ironed out. The issue has evolved from one of management to one of political bearing.

This book is the result of a conference held in Puerto Rico in 1996. If the editorial process had not been so delayed, the book might have played a role in the CITES debate. However, now that Appendix II rules will be governing the harvest of mahogany, the excellent background information presented in the book should be quite useful to governmental, industrial and non-governmental organisation (NGO) decision-makers.

The list of authors is quite impressive, many with broad, tropical forest expertise, T. C. Whitmore (deceased), A. E. Lugo, E. Medina, J. K. Francis and F. H. Wadsworth among them. Others, with renowned mahogany-specific expertise, include C. Navarro, J. Grogan, J. C. Figueroa-Colón, P. Negreros-Castillo, L. K. Snook, R. E. Gullison, A. Newton and J. E. Mayhew.

The four sections of the book are entitled The Tree and its Genetics, Ecophysiology and Regeneration, Silviculture, and Shoot Borer. The tone of the writing tends to be encouraging. In short, the species is silviculturally ideal, with regeneration in natural forest conditions or in plantations technically feasible and promising. More than most other species, the value of big-leaf mahogany wood justifies managerial expense.

The last chapter, Recent Literature on Big-Leaf Mahogany, is quite helpful. A chapter with summary conclusions to bring focus to the wide variety of presentations would have been a good addition. The species, geographical and general indices, often the weak points in an otherwise good book, are excellent.

Problems with sustainable management of mahogany stands, or even plantations, tend to be more socio-political than biological or technical. They relate to conversion of forest to non-forest, and illegal logging, among other issues. These problems were rampant prior to listing on Appendix II, and I suspect they will continue to be rampant after listing. To be proven wrong on this is my fervent hope.

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