JMHT Vol. XVII, (3): 89–94, Desember 2011
EISSN: 2089-2063
Artikel Ilmiah
ISSN: 2087-0469

Land Cover Types Differentiation through Normalized Difference Vegetation Index in the Lowland Rainforests of Papua New Guinea

David Lopez Cornelio

Department of Forestry, Papua New Guinea University of Technology, Lae-411, Morobe Province, Papua New Guinea

Abstract

The accurate estimation of above ground biomass in the natural forests of Papua New Guinea is a key component for the successful implementation of the REDD policy in the country. Biomass densities in a lowland rainforest site located at the northeast of the country were differentiated with Landsat digital images throughout normalized difference vegetation index (NDVI). Submaps of 4,377.69 ha of bands 3 and 4 were georeferenced with affine transformation and a RMSE of 0.529. The calculated NDVI map was sliced to separate its pixel values into 5 classes as they are distributed in the histogram with the assistance of ground truth points. The method is simple, fast and reliable, however swampy palm forest could not be discriminated from dense forests; and different bare land types had to be grouped into a single major class. Therefore other vegetation indexes and/or band ratios are recommended to be tested using images of higher spatial resolution to accurately differentiate more classes.

Keywords: land cover, biomass, normalized difference vegetation index, lowland rainforest, Papua New Guinea

Correspondence author, email: davlzo26@gmail.com, phone: +675-47-34661, fax: +675-47-34669

Introduction

Papua New Guinea (PNG) is the largest continuous forested area in the Asia-Pacific region and the third largest tropical rainforest on the planet (Brooks *et al.* 2006). Since forest ecosystems store approximately 80 and 40% of all above-ground and below-ground organic carbon respectively (IPCC 2001), their management should focus on keeping them as sinks rather than as sources of carbon. PNG has between 4,724–4,735 million tons (Mt) of above ground carbon stored in its native forests, 926.5Mt were lost during 1972–2002 due to logging (48.2%), farming expansion (45.6%), forest fires (4.4%), and urban and mining developments (0.6%) (UPNG 2008). The country is implementing a climate change and carbon trading program. One of the major problems is the lack of accurate data on the location, extent, and amount of carbon stocks. FAO (1997) estimated ranges of aboveground biomass (t ha^{-1}) for the main forest types of tropical American and Asian countries but no similar studies were done in PNG until now, as the local capacity (know how) regarding the quantification of total biomass on the ground, monitoring, reporting, and verification of emissions and removals over the time is limited and dispersed (Lopez 2010). The results of this study will upgrade the planning capacity of decision-makers in forest management and increase the information collecting capability of foresters, while reducing costs and saving time. A variety of approaches and data sources have been used to estimate above ground biomass (AGB) of the forest. Direct methods involve trees felling to measure their dry weight; they are costly and time consuming (de Gier 2003) but accurate (Lu 2004). Indirect methods such as remote sensing began with Landsat MSS sensor and continued with Landsat Thematic Mapper (TM) bands 3 and 4, NOAA AVHRR bands 1 and 2 and SPOT bands 2 and 3 (Gibson & Power 2000). Landsat TM red band discriminates vegetation types and the reflected IR band is useful for determining bio-

Table 1 Landsat TM ETM+ sensor characteristics

	Band	Wavelength (μm)	Resolution (m)
Blue	1	0.45–0.52	30
Green	2	0.52–0.60	30
Red	3	0.63–0.69	30
Near IR	4	0.76–0.90	30
SWIR	5	1.55–1.75	30
Thermal IR	6	10.40–12.50	120 (TM) 60 (ETM+)
SWIR	7	2.08–2.35	30
Panchromatic		0.50–0.90	15

mass content (Sabins 1996). Landsat MSS bands 7 and 5 and the amount of living biomass on the ground are strongly correlated. The LANDSAT program consists of a series of optical/infrared remote sensing satellites for land observation, it launched by the National Aeronautics and Space Administration (NASA) in 1972, currently only LANDSAT-5 and 7 are operational. They follow a Sun-Synchronous orbit at 705 km of altitude with a repeat cycle of 16 days (CRISP 2001). The spectral sensitivity and spatial resolution inbuilt in ETM+ sensor are given in Table 1.

The division of one spectral band by another suppress radiance variations arising from them and enhance radiance differences between soil and vegetation (Schowengerdt 1983). Ratios also enhance or reveal latent information when there is an inverse relationship between two spectral responses to the same biophysical phenomenon (Sabins 1996). The ratio of near-infrared MSS band 4 and red MSS band 2 has a significant correlation with the amount of green leaf biomass (Lyon *et al*. 1998). Ratios are effective in enhancing or revealing latent information when there is an inverse relationship between 2 spectral responses to the same biophysical phenomenon. If 2 features have the same spectral behaviour, ratios provide little additional information; but if they have quite different spectral responses, the ratio between the 2 values provides a single value that expresses the contrast between the 2 reflectances. Figure 1 shows 4 hypothetical materials are observed in 2 spectral bands. Materials A and B have similar patterns of response in bands 3 and 4. For A, the ratio of band 3 to band 4 is 0.916 (165/180); for B, it is 0.89 (125/140). Ratios therefore reveal little about the differences between them. The relationship between C and D is different, and the ratio reveals the contrast between the two materials. For C, it is 1.00 (165/165) and for D it is 1.67 (125/175).

A variety of vegetation indexes have been developed that have linear relationship with leaf area index (LAI), biomass, leaf water content, and chlorophyll content (Purevdorj *et al*. 1998) but no single index is effective for all ground conditions. They quantify the biomass in proportional terms but not in specific amounts (Gibson & Power 2000). Richardson and Everitt (1992) described eight indexes, being the most common the normalized difference vegetation index (NDVI) that measure the presence and condition of green vegetation by taking of the plant's strong absorption in the red band and high reflectance in the infrared band. It is less affected by the topography than DVI and RVI indices (Lyon *et al.* 1998) and better estimates LAI, biomass, and other vegetation characteristics when the vegetation density gradually increases its amount up to a certain value (Major *et al*. 1990). Vegetated areas generally yield high values due to their relatively high near-infrared reflectance and low visible reflectance, whereas water, clouds, and snow have larger visible reflectance than near-infrared reflectance, resulting in negative index values (Ilwis 2011). NDVI multitemporal spectra can classify vegetation in base of seasonal variations (Sabins 1996).

Methods

The study site encloses the area between Lae City and Omsis Village at 30 km from it alongside the Markham River in Morobe Province, northern coast of the country (Figure 4). The topography is mountainous with valleys and rocky alluvial floors subject to sudden flooding during periods of heavy rain. The area rises up to an altitude of > 500 m above sea level. Soils are acid brown, shallow, and with clay minerals. Highest rainfall occurs June–September, the mean annual rainfall is of 2.900 mm, with an average temperature of 24–30 °C (Breget *et al.* 2008). Common crops in the gardens were sweet potato (*Ipomoea batata*), chinese taro (*Colocasia esculenta*), cassava (*Manihot esculenta*), yam (*Dioscorea alata*), winged beans (*Psophocarpus tetragonolobus*), pumpkins (*Cucurbita moschata*), sugar cane (*Saccharum offiinarum*), pit pit (*Saccharum* sp.), corn (*Zea mays*), peanut (*Ararchis hypogaa*), pineapples (*Ananas sativus*), bananas (*Musa paradisiaca*), and papaya (*Carica papaya*). Grassed areas dominated by impediens cylindrical (*Cunae* sp.) and swampy sago palm (*Methroxylum sagu*) forests are wide-

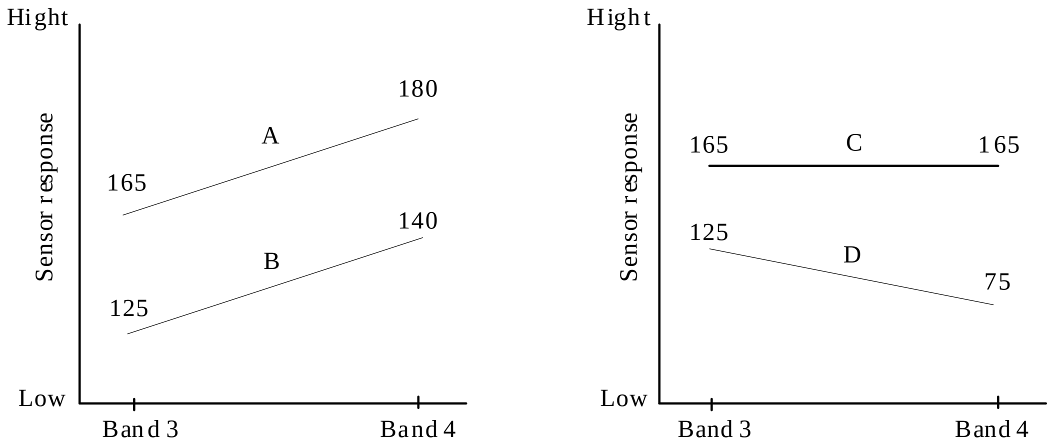


Figure 1 Example of band ratios (Morain 1978).

EISSN: 2089-2063
ISSN: 2087-0469

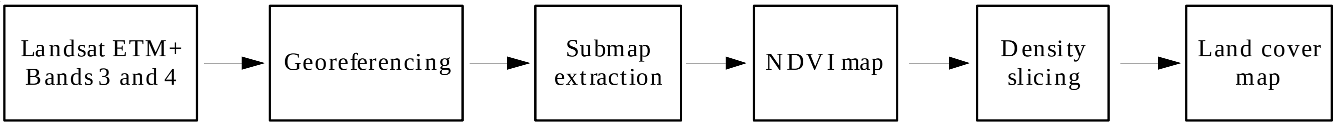


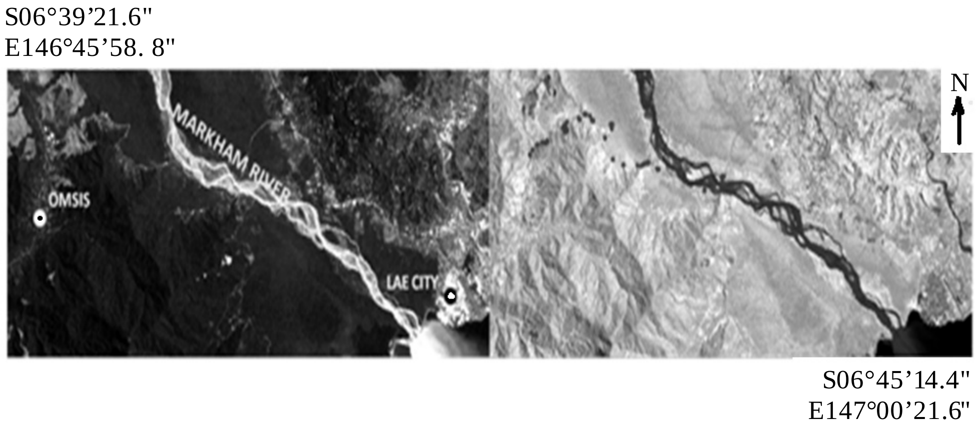
Figure 2 Flowchart of method.

spread. The lowland rainforest has typical tree species such as *Artocarpus altilis*, *Gnetum gnemon*, *Riteria* sp., *Lilia cotylon*, *Pterocymbium becarii*, *Pterocarpus indicus*, *Artocarpus brasialus*, *Endospermum medullosum*, *Croton choristadenius* (croton), *Intsia bijuga* (kwila), and *Pometia pinnata* (taun).

The method followed the sequence shown in Figure 3. Bands 3 (red) and 4 (infrared) of a Landsat TM image obtained in 1992-09-09 path row 096/065, downloaded from GLCF (2011), were georeferenced with 10 ground control points taken with an eTrex Vista HCx GPS of less than 5m accuracy. An NDVI map in which NDVI = (NIR – R)/(NIR + R) was calculated according to the example in Figure 4 for bands 3 and 4. Ten points were utilized for georeferencing pinpointing recognizable features such as road junctions, Nazdab airport and Markham bridge, and 35 points assisted on the identification of land cover types. Georeferencing defined the location of pixels in the raster by relating their rows and columns with XY-coordinates with affine transformation, with of RMSE OF 0.259 which measures the overall credibility of the active tiepoints (ILWIS 2011). A final submap of 127 lines and 383 columns (4377.69 ha) was derived with 6°40'04.79"S, 146°47'44.98"E top left and 6°42'06.47"S, 146°53'37.99"E bottom right geographical coordinates. Figure 3 shows the general area including Markham's River sea outlet and Lae City.

Results and Discussion

Results came out from GIS processing which in Ilwis Open 3.7 combines raster (satellite image analysis), vector (map making and analysis), and thematic data operations in one comprehensive integrated software package on the desktop, where raster and vector applications are linked and can be simultaneously adapted to the project's needs (ILWIS 2011). The resulting map in Figure 4 contains NDVI values ranging



a Band 3 shows Lae City and Omsis Village. b Band 4 shows GCP points alongside the road of access.

Figure 3 Location map.

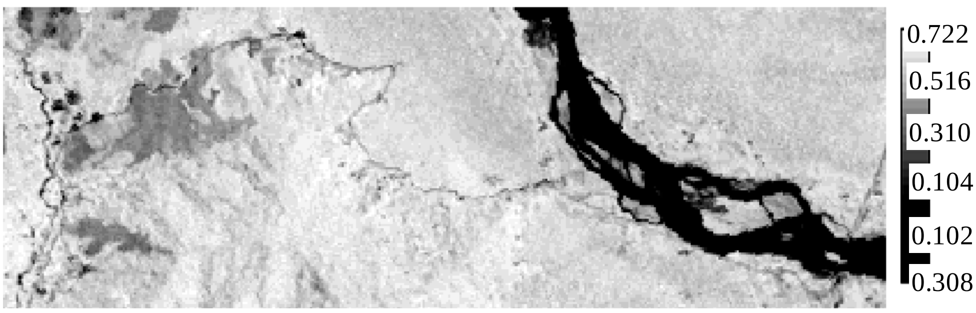


Figure 4 NDVI map. Areas with high vegetation density (non degraded forested areas) have brightest reflectance values.

Table 2 NDVI obtained from two image sub windows of 3×3 pixels

TM band 3			TM band 4			Out map		
18	25	28	28	30	34	0.217	0.091	0.097
?	53	44	39	44	55	?	-0.092	0.111
80	92	73	?	71	175	?	-0.129	0.411

from -0.308 (water bodies) to 0.722 (dense forest).

Density slicing classified the values of the NDVI map. Ranges of values of the input map were grouped together into one output class according to a domain. It requires a *domain group* created beforehand, which defines, i.e. stores, the information that can be available in the final sliced map (Figure 6) in which colors are arbitrary but are meant to signify differences on vegetation density. That information was decided by analysis of the histogram shown in Figure 6 which lists the number of pixels, the percentages, and the areas per class of the NDVI map. The upper limits of NDVI values (Table 3) for each of the classes was defined interactively by identifying pixel values of known areas recognized in the field.

Most of the area in the sub map is of dense forest (77.78%), degraded forest (7.83%), bare land/settlements/roads (5.82%), grassland (4.49%), and water bodies (4.07%). The relatively higher standard deviation for the bare land/settlements/roads class indicates that further differentiation is needed within this class as it includes grass thatched buildings, roads, and bare lands in general. Their reflectance values are obviously different but due to the sensor relatively low spatial resolution is not possible to subdivide the class into three subclasses. Swampy palm forest (sago forest) located between the road and the river banks could not be discriminated from dense forests as well (with standard deviation twice as high as the ones from grassland and degraded forest), it is suggested to review the spectral response of these areas in other bands of Landsat. To subsequently estimate biomass per cover type, randomly selected plots of 100 × 100 m^2 can be placed, in which tree biomass allometries are calculated by relating the dry biomass with the cylindrical bole diameter of sampled trees (Satoo 1982). Relationships can be generated between field measures and moderate spatial resolution remotely sensed data (e.g. Landsat), and then extrapolate these relationships over larger areas using comparable spectral properties from coarser spatial resolution imagery (e.g. MODIS) (Wulder *et al.* 2008).

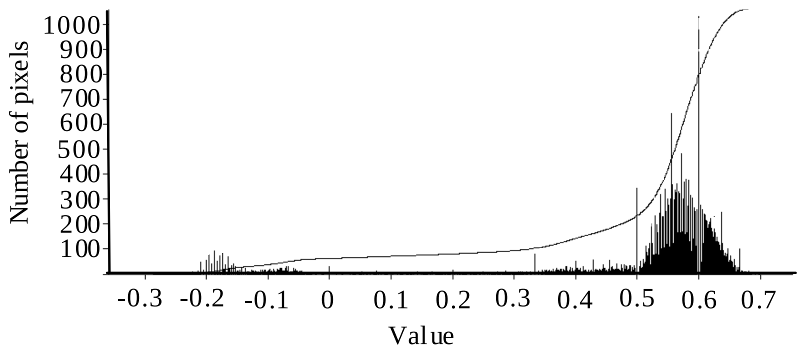


Figure 5 Histogram of NDVI map (the cumulative number of pixels is given by the red curve).

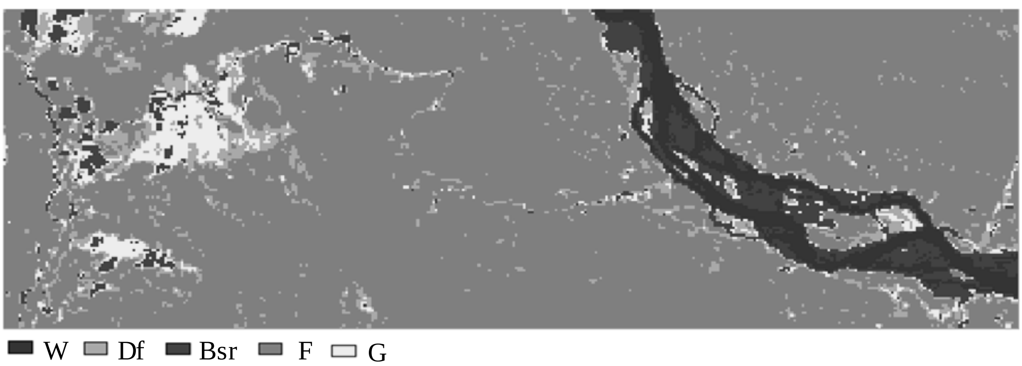


Figure 6 Final sliced map derived from Figures 4 and Figure 5.

Table 3 Statistics before (NDVI stat) and after (areas /class) image classification

Class name	Code	NDVI average	NDVI maximum	NDVI minimum	NDVI standard deviation	Upper bound limits	Number of pixels	Area (ha)
Water	W	-0.16	-0.08	-0.31	0.05	-0.0823	1981	178.29
Bareland/settlement/ road	Bsr	0.15	0.34	-0.08	0.13	0.3400	2831	254.79
Grassland	G	0.38	0.42	0.42	0.02	0.4150	2186	196.74
Degraded forest	Df	0.46	0.50	0.42	0.02	0.5000	3809	342.81
Dense forest	F	0.60	0.72	0.50	0.06	0.7220	37833	3404.97

Conclusion

The method is fast and reliable and can be applied as a preliminary survey for remote forest areas. Its accuracy will depend on the spatial resolution of the sensor to be employed. The application of vegetation indexes prior to land cover classification eliminates the adverse effect that the terrain relief may have in the final image classification. Slicing of NDVI values proved robust, it provides similar results than other supervised classifiers. Further analysis of other vegetation indexes are recommended, coupled with field estimation of total above ground biomass of major land cover classes for the province in order to obtain the final results in tons of biomass (dry weight) per hectare. It is also recommended to widely disperse ground truth data (GCP points) in the area in order to accurately delineate natural vegetation boundaries that are far away from the main roads.

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JMHT Vol. XVII, (3): 95─102, Desember 2011
EISSN: 2089-2063

Artikel Ilmiah
ISSN: 2087-0469

Tradisi dan Perubahan Budi Daya Pohon di Desa Rambahan Kuansing dan Desa Ranggang Tanah Laut

Tradition and Change of Tree Cultivation in Rambahan Kuansing and Ranggang Tanah Laut Villages

Didik Suharjito

Departemen Manajemen Hutan, Institut Pertanian Bogor, Jalan Raya Dramaga, Kampus IPB Dramaga, Bogor 16680

Abstract

The phenomenon of widespread tree cultivation by local community in some countries during the last three decades has been explained by researchers with a macro perspective. This study is to understand the phenomenon at the micro level and from the native (peasant or farmer) point of view. This study aims to explain the tradition and changes in tree cultivation. Theoris economic system were used as the basis to explain the tradition and changes in tree cultivation in Rambahan village community of the Kuansing District and Ranggang Village community of Tanah Laut District. Case study method was used in this study. The data were collected from informants through individual interviews and focused group discussions. The results of this study show that the cultivation of trees has been practiced and institutionalized in the everyday lives of local people and passed down from generation to generation, as well as a source of socio-economic stability of families. Factors that farmers take into consideration in the selection of tree crops to be cultivated are price, easy to sell, harvesting intensity, knowledge and skills, labor availability (particularly family labor), and capital availability. The results of this study also indicate that some elements of the economic system of Ranggang and Rambahan communities have the characteristics of capitalism adherent, while some other elements have the characteristics of pre-capitalism. In other words, two communities are in a transition between pre-capitalism and capitalism as shown in the practice of tree cultivation.

Keyword: tree cultivation tradition, tenancy system of land and tree, pre-capitalism community, Kuansing, Tanah Laut

Abstrak

Gejala perkembangan budi daya pohon oleh masyarakat di beberapa negara dalam tiga dekade terakir telah dijelaskan oleh beberapa peneliti dengan perspektif makro. Penelitian ini menggali pemahaman gejala pada tingkat mikro dan dari perspektif petani. Penelitian ini bertujuan untuk mendapatkan informasi tentang tradisi dan perubahan dalam budi daya pohon. Berbagai teori sistem ekonomi kapitalis digunakan sebagai landasan dalam menjelaskan tradisi dan perubahan budi daya pohon pada masyarakat Desa Rambahan di Kabupaten Kuansing dan Desa Ranggang di Tanah Laut. Metode studi kasus digunakan dalam penelitian ini. Data-data dikumpulkan dari para informan melalui wawancara perseorangan dan diskusi kelompok terfokus. Hasil penelitian ini menunjukkan bahwa budi daya pohon sudah dipraktikkan dan terlembaga dalam kehidupan sehari-hari warga masyarakat yang diturunkan dari generasi ke generasi, serta menjadi sumber stabilitas sosial ekonomi keluarga. Faktor-faktor yang dipertimbangkan oleh petani dalam pemilihan jenis tanaman pohon untuk dibudidayakan adalah harga, kemudahan pemasaran, intensitas panen, pengetahuan-keterampilan yang dikuasai, ketersediaan tenaga kerja, dan ketersediaan modal. Sebagian unsur-unsur dari sistem perekonomian masyarakat Rambahan dan Ranggang memiliki ciri-ciri sebagai penganut kapitalisme, sedangkan sebagian unsur-unsur yang lain masih memiliki ciri-ciri pra-kapitalisme. Dengan kata lain, kedua masyarakat desa sedang berada pada transisi antara pra-kapitalisme dan kapitalisme yang ditunjukkan dalam praktik budi daya pohon.

Kata kunci: tradisi budi daya pohon, bagi hasil dan gadai lahan dan pohon, masyarakat pra-kapitalisme, Kuansing, Tanah Laut

Penulis untuk korespondensi: dsuharjito@gmail.com, telp.+62-251-8621244, faks.+62-251-8621244

Pendahuluan

Gejala perkembangan hutan tanaman yang ditunjukkan oleh areal-areal baru penanaman pohon yang semakin luas di beberapa wilayah selama 3 dekade terakhir seperti dilaporkan oleh FAO (2006) telah menarik perhatian para peneliti. Di Asia selama periode 1990–2000 dan 2000–2005 terjadi penambahan luas areal hutan tanaman produktif (*productive forest plantation*) masing-masing 0,73 dan 1,64 juta ha tahun^{-1}. Rudel *et al*. (2005) menggunakan *forest transition theory* untuk menjelaskan hubungan antara perkembangan luas areal hutan dengan perkembangan penduduk, urbanisasi, ketersediaan tenaga kerja di pedesaan, dan perkembangan pasar global, sedangkan Mather (2007), menggunakan teori yang sama, menjelaskan bahwa gejala perkembangan hutan tanaman di China, India, dan Vietnam tidak dapat secara sederhana dijelaskan oleh hubungan faktor modernisasi dan pembangunan ekonomi, sistem politik (demokrasi, *authoritarian*, dan teknokratik) tetapi swasembada (*self-sufficient*) produksi pangan di 3 negara tersebut mungkin signifikan menentukan perkembangan hutan tanaman. Berdasarkan kenyataan perkembangan hutan tanaman di Afrika dan Asia, Rudel (2009) menyimpulkan bahwa baik *forest transition theory* maupun penjelasan politik tidak mengantisipasi pentingnya kepadatan penduduk yang tinggi dan mengkombinasikannya dengan inisiatif politik dalam mempromosikan perluasan budi daya pohon. Perkembangan hutan tanaman di China, Vietnam, dan India dilaksanakan oleh masyarakat dengan dorongan kebijakan pemerintah (NFCP di China, devolusi di Vietnam, *Joint Forest Management* di India).

Teori *forest transition* dibangun atas dasar gejala yang terjadi pada level makro dan sebaliknya kurang memperhatikan gejala di tingkat mikro, lebih khusus lagi di tingkat petani. Penelitian yang memberikan perhatian pada tingkat petani sangat penting terutama dikaitkan dengan program-program pembangunan. Program pembangunan seperti program hutan tanaman rakyat (HTR) membutuhkan partisipasi dan dapat diterima oleh masyarakat atau para pelakunya yakni petani agar berhasil, berkembang dan tidak berhenti. Seringkali pemerintah memandang bahwa programnya baik untuk masyarakat, tetapi kenyataannya masyarakat memandang sebaliknya. Ini masalah perbedaan pandangan antara pemerintah dan masyarakat. Wiersum (1997) menyatakan "*local communities often value forests in a rather different way than professional foresters and state organizations do. For such communities forest management is not a specialized resource management activity as is mostly the case in professional forestry*".

Penelitian ini difokuskan pada tradisi dan perubahan dalam budi daya pohon khususnya pada pemilihan jenis tanaman dan pola tanam, dan distribusi penguasaan lahan dan pohon yang dibangun melalui sistem hubungan-hubungan sosial (*land and tree tenancy systems*) yang berlaku di masyarakat. Pemilihan jenis tanaman dan pola tanam yang dilakukan dan sistem penguasaan lahan menunjukkan pengetahuan, pengalaman, dan orientasi usaha petani tentang pengelolaan sumber daya lahan dan pohon. Pemahaman tersebut dapat menjadi landasan kebijakan pembangunan kehutanan antara lain introduksi program HTR yang tepat (*appropriate*) dan adekuat (*adequate*). Program HTR secara normatif bertujuan untuk memajukan kehidupan masyarakat lokal. Introduksi tersebut akan menghadapi permasalahan apabila konsepsi kemajuan yang ditawarkan tidak sepaham dengan konsepsi kemajuan menurut masyarakat lokal. Tradisi tidak berarti tradisional, tradisi masyarakat dapat tergolong maju atau modern sejalan dengan perkembangan zaman. Tradisi tidak statis, melainkan dinamis, dan dapat mengalami perubahan.

Metode

Penelitian ini akan mengungkap tradisi dan perubahan budi daya pohon. Budi daya pohon dikategorikan sebagai suatu tradisi apabila kegiatan tersebut sudah menjadi praktik, kepercayaan, dan melembaga (*institutionalized*) yang diturunkan dari generasi ke generasi dan menjadi sumber stabilitas sosial dan legitimasi (Abercrombie *et al*. 1988). Program pembangunan HTR membawa konsep kemajuan atau modernisasi. Masyarakat pedesaan didorong untuk melakukan perubahan dari kehidupan tradisional menjadi kehidupan modern. Konsep kemajuan yang ditawarkan mengandung ciri-ciri usaha ekonomi yang produktif, komersial, dan industrialisasi khususnya dalam bidang usaha kehutanan. Jenis tanaman yang ditawarkan adalah jenis-jenis pohon yang dapat menghasilkan bahan baku untuk industri, pelaku budi daya pohon terikat dalam hubungan kerjasama dengan perusahaan industri, dan produk industrinya memasuki pasar baik nasional maupun global.

Introduksi program HTR tersebut akan menghadapi tradisi budi daya pohon oleh masyarakat. Introduksi tersebut dapat diterima atau ditolak oleh masyarakat. Penolakan dapat terjadi karena tradisi yang tradisional maupun tradisi yang modern. Dalam hal ini kesamaan pemahaman tentang konsepsi tradisional dan modern antara pembawa program dan pelaku tradisi dapat menentukan penerimaan introduksi program HTR. Teori Boeke (1966) tentang karakteristik *pre-capitalism* dan *capitalism economic system* digunakan untuk memperoleh gambaran tradisi budi daya pohon pada masyarakat Desa Rambahan di Kabupaten Kuansing dan Desa Ranggang di Tanah Laut mengandung ciri-ciri *pre-capitalism* atau *capitalism economic system* atau transisi di antara keduanya. Teori Boeke telah mendapatkan banyak kritik. Para peneliti pedesaan Asia menjelaskan bahwa pedesaan telah menunjukkan gejala transisi menuju *capitalism community* (Scott 1976; Popkin 1979) bahkan daerah pedalaman Indonesia responsif terhadap proses modernisasi ataupun intervensi ekonomi dan politik (Dove 1985; Li 2002). Namun, teori Boeke yang menjelaskan rincian karakteristik *pre-capitalism* dan *capitalism economic system* dapat dijadikan pedoman untuk identifikasi orientasi ekonomi masyarakat sehingga dapat dikenali unsur-unsur yang masih bertahan, sedang berubah, atau sudah berubah.

Di sini hanya beberapa unsur saja dari karakteristik *pre-capitalism* dan *capitalism community* yang digunakan untuk mencermati masyarakat Desa Rambahan dan Desa Ranggang (Tabel 1).

Teori Gladwin (1984) digunakan sebagai acuan untuk memahami proses sebuah keluarga petani dalam membuat keputusan dalam pemilihan jenis tanaman. Gladwin (1984) menjelaskan bahwa dalam pengambilan keputusan seharihari petani menempuh 2 tahap, yaitu petani mengeliminir semua alternatif yang tidak diinginkan. Pada tahap kedua, petani mengeliminir aspek-aspek yang tidak relevan, menyusun alternatif-alternatif pada satu aspek penting. Teori pengambilan keputusan dalam pemilihan jenis tanaman ini mengoperasional beberapa aspek yang disajikan pada Tabel 1.

Penelitian lapangan dilakukan di Desa Rambahan Kabupaten Kuantan Senggigi (Kuansing) Riau dan Desa Ranggang Kabupaten Tanah Laut Kalimantan Selatan. Desa-desa tersebut dipilih dengan pertimbangan (1) ada pengalaman budi daya pohon oleh petani dan ada budi daya pohon yang dilakukan oleh perusahaan skala besar untuk memenuhi bahan baku industri kayu, di Kuansing terutama untuk pulp dan kertas, sedangkan di Tanah Laut terutama untuk pertukangan; dan (2) di Kuansing sedang terus berkembang perkebunan sawit, sedangkan di Tanah Laut perkebunan sawit sedang berkembang tetapi dengan intensitas yang lebih rendah. Keberadaan perusahaan skala besar yang melakukan usaha kehutanan dan perkebunan sawit memberikan dorongan atau rangsangan kepada masyarakat petani untuk mengadopsi teknologi, motivasi, dan organisasi yang modern, namun masyarakat petani sudah mempunyai tradisi. Kondisi pemungkin ini menjadi prasyarat dalam mengungkap tradisi dan perubahan.

Penelitian ini dilakukan dengan menggunakan metode studi kasus (*case study*). Data-data dikumpulkan dari para informan, yakni petani pelaku budi daya pohon pada lahan miliknya, petani yang menjalin hubungan-hubungan sosial bagi hasil atau gadai dalam budi daya pohon, dan tokoh-tokoh masyarakat dan pegawai perusahaan hutan yang mempunyai informasi yang diperlukan. Data-data dikumpulkan melalui wawancara perseorangan dan diskusi kelompok terfokus (*focused group discussion*).

Hasil dan Pembahasan

Tradisi dan perubahan budi daya pohon Masyarakat Desa Rambahan dan Ranggang sudah terbiasa membudidayakan pohon. Pohon yang dimaksud berupa tanaman tahunan yang tidak hanya menghasilkan kayu, melainkan juga menghasilkan getah atau buah. Pohon dibudidayakan pada lahan kebun atau pekarangan. Pola budi daya pohon di kebun dilakukan secara monokultur didahului dengan pola tumpangsari dengan jenis tanaman palawija atau sayuran pada tahun-tahun awal. Pola budi daya pohon di pekarangan merupakan campuran berbagai jenis pohon dengan waktu penanaman yang berbeda-beda.

Jenis pohon yang dibudidayakan oleh masyarakat Desa Rambahan di kebun berupa karet (*Hevea brasiliensis*), kelapa sawit (*Elaeis guineensis*), sungkai (*Peronema canescens*), dan mahoni (*Swietenia mahagoni*), sedangkan jenis pohon yang dibudidayakan pada lahan pekarangan berupa cempedak (*Artocarpus champeden*), jambu (*Syzygium aqueum*), nangka (*Artocarpus heterophyllus*), manggis (*Garcinia mangostana L.*), kelapa (*Cocos nucifera*), jengkol (*Pithecellobium*

Tabel 1 Karakteristik masyarakat prakapitalisme dan kapitalisme

Prakapitalisme	Kapitalisme
Motivasi spiritual	
Pemenuhan kebutuhan-kebutuhan dasar	Keuntungan-keuntungan untuk individu
Tradisi dan pemeliharaan *status quo*	Rasional, diorientasikan pada pencapaian personal
Komunalisme	Individualisme
Ekonomi bagian dari religi	Ekonomi terpisah dari religi
Bekerja sesuatu yang tidak menyenangkan, waktu luang bernilai tinggi	Bekerja mempunyai makna dan basis kehidupan
Hubungan patriarkhi antara tuan dan pelayan	Hubungan kontraktual dan rasional antara pemilik usaha dan tenaga kerja
Kebutuhan-kebutuhan sosial mendominasi	Kebutuhan-kebutuhan ekonomi individu mendominasi
Organisasi	
Organisasi sosial tradisional	Individualial, organisasi perusahaan
Berbasis kekerabatan	Berbasis perkumpulan sukarela
Rumah tangga sebagai pusat produksi	Perusahaan sebagai pusat produksi
Ruang lingkup lokal	Ruang lingkup lokal ke *universal*
Teknologi	
Kecukupan diri/swadaya	Suplai pasar
Tanpa atau sedikit peredaran uang	Uang sebagai kapital, moneter, dan ekonomi
Tenaga kerja manual	Mekanisasi
Kegiatan sewaktu-waktu, musiman	Bekerja, kegiatan terus menerus
Industri rumah tangga, pedesaan	Perusahaan

Sumber: Boeke diacu dalam Koentjaraningrat (1975)