Development of National Level Forest Base Map in Lao PDR

Author Names: 1) Ryota KAJIWARA, 2) Masamichi HARAGUCHI, 3) Hideto YAMAZAKI, 4) Soukanh BOUNTHABANDID, 5) Sombath PANYASAK, 6) Khamkhong INTHAVONG, 7) Souvanna CHANTHALEUSY
Affiliation: 1) 2) 3) Kokusai Kogyo Co., Ltd., 4) 5) 6) Forest Inventory and Planning Division, Department of Forestry, Ministry of Agriculture and Forestry in Lao P.D.R
Address: 1) 2) 2-24-1 Harumicho, Fuchu City, Tokyo, 183-0057, Japan, 3) 2 Rokubancho, Chiyodaku, Tokyo, 102-0085, 4) 5) 6) Phontong Street, Chanthabouly District, Vientiane, Lao P.D.R
Email: 1) ryota_kajiwara@kk-grp.jp, 2) masamichi_haraguchi@kk-grp.jp, 3) hideto_yamazaki@kk-grp.jp, 4) skbtpd@hotmail.com, 5) sombath_09@hotmail.com, 6) khamkhong1980@gmail.com, 7) chanthaluesy@gmail.com

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ABSTRACT

The forest cover in Lao People's Democratic Republic (hereinafter Lao PDR) was reduced from 70% or more in 1940's to approximately 40% in 2010. On the other hand, since the land of Lao PDR is mostly mountainous, many people live on the resources of forest and forest land. Therefore, forest conservation is urgent issue for Lao PDR. To understand exact forest situation for forest conservation, the government of Lao PDR requested Japan to support development of national level forest base map through the capacity building. Draft national level forest base map was developed based on RapidEye imagery. Then, accuracy assessment of forest base map was conducted based on pansharpen imagery created by ALOS/PRISM and AVNIR-2 imagery. As a result of accuracy assessment, overall accuracy of Forest and Non-Forest was 72.8% and Forest Type was 62%. Following the result of accuracy assessment, correction of map is being conducted by interpretation. To correct the classification in shifting cultivation area, a method of change detection in shifting cultivation area based on multi-temporal ALOS/PALSAR data analysis was examined. As a result of the examination, a possibility to improve the accuracy of classification in shifting cultivation area was confirmed.

1. Introduction

Lao People's Democratic Republic (hereinafter Lao PDR) is one of most mountainous countries in South-East Asia. Therefore, many people live on the resource of forest so far. However, the forest coverage in Lao PDR was reduced from 70% or more in the 1940's to approximately 40% in 2010. Therefore, since forest conservation is urgent issue for Lao PDR, the government of Lao PDR (hereinafter GOL) endorsed the "Forestry Strategy 2020" with the objective of restoring a forest coverage of 70%. GOL also views REDD+ (Reducing Emissions from Deforestation and forest Degradation in developing countries) as valid means for strengthening of management capacities on all levels. In order to promote forest conservation through REDD+, GOL requested the government of Japan to support

the development of infrastructure for forest information management through the procurements of hardware/software and the capacity building which contributes forest conservation.

Figure 1: Location of Lao PDR


Figure 2: Typical vegetation in shifting cultivation area in Lao PDR

At the request of GOL, the government of Japan has been supporting GOL to develop the capacity for forest information management through two projects which are “The Programme for Forest Information Management in Lao People’s Democratic Republic” (FIM) which is grant aid cooperation project and “The Capacity Development Project for Establishing National Forest Information System for Sustainable Forest Management and REDD+” (NFIS) which is technical cooperation project. Through the projects, draft of national forest base map in 2010 was developed and assessed accuracy of classification. Following the result of accuracy assessment, the correction of map is being conducted at present. In near future, national level forest type maps in 2005 and 2000, and national level forest carbon maps in 2010, 2005 and 2000 will be developed through the projects. In addition, these works have been being conducted by Lao engineers mainly.

This paper reports the interim result of development of national level forest base map in 2010 in Lao PDR. Especially, it focuses on the interim result of accuracy assessment and study of change detection based on multi-temporal ALOS/PALSAR data analysis to correct the classification in shifting cultivation area in Lao PDR.

2. Materials and Methods

Lao PDR is one of very difficult countries to observe satellite imagery without cloud due to tropical climate.Since RapidEye has high frequent observation ability which can observe daily by 5 satellites constellation, RapidEye can avoid cloud mostly. Therefore, RapidEye imagery was used for development and correction of national forest base map in 2010. Pansharpen imagery which was created based on ALOS/PRISM and AVNIR-2 imagery (hereinafter ALOS/Pansharpen imagery) has higher resolution than RapidEye imagery. Therefore, ALOS/Pansharpen imagery was used for accuracy assessment. ALOS/PALSAR is one of synthetic aperture radar (SAR) satellite sensors. SAR can observe a land cover without cloud and is good at change detection by using multi-temporal data. Therefore, ALOS/PALSAR data are being used for correction of forest base map in 2010 though change detection (Table 1).

Table 1: Specification of used satellite

Satellite		Type of Sensor	Resolution (Resampled)	Target Area	Observation Term	Remark
RapidEye		Multispectral	5m	Whole Country	Nov. 2010 – Mar. 2011	
ALOS	PRISM	Pancromatic	2.5m	Whole Country	Nov. 2010 – Mar. 2011	
	AVNIR-2	Multispectral	10m	Whole Country	Nov. 2010 – Mar. 2011	
	PALSAR	SAR	10m	Whole Country	Nov. 2010 – Mar. 2011	Single Polarization
					Nov. 2009 – Mar. 2010	Single Polarization
					Nov. 2008 – Mar. 2009	Single Polarization
					Nov. 2007 – Mar. 2008	Single Polarization
					Nov. 2006 – Mar. 2007	Single Polarization

Decision tree method for supervised classification based on ground truth data and object-based classification method was selected (Figure 3). eCognition Developer which is one of major object-based classification software was used. RapidEye mosaic imagery, NDVI and slope raster data which was created based on ASTER GDEM Version 2 were used for supervised classification in eCognition Developer. After supervised classification, manual interpretation was conducted for classification of some classes and correction of the result.

Table 2: Current class items for national level in Lao PDR

Class Groups	NFIS Proposed (Final)	Code
Current Forest	Evergreen Forest	EF
	Mixed Deciduous Forest	MD
	Dry Dipterocarp Forest	DD
	Coniferous Forest	CF
	Mixed Coniferous/Broadleaved Forest	MCB
	Forest Plantation	P
Potential Forest	Fallow Land	FL
	Slash and Burn Land	SB
Other Wooded Area	Savannah/Open Woodland	SA
	Scrub, Heath	SR
Permanent Agriculture Area	Rice Paddy	RP
	Agriculture Plantation	AP
	Other Agriculture Area	OA
Other Non-Forest Area	Grassland	G
	Swamp	SW
	Rock	R
	Barren Land	BL
	Urban Area	U
Water	Water	W
Other Land	Other Land	O

Reference: Forest Inventory and Planning Division under Department of Forestry in Lao PDR

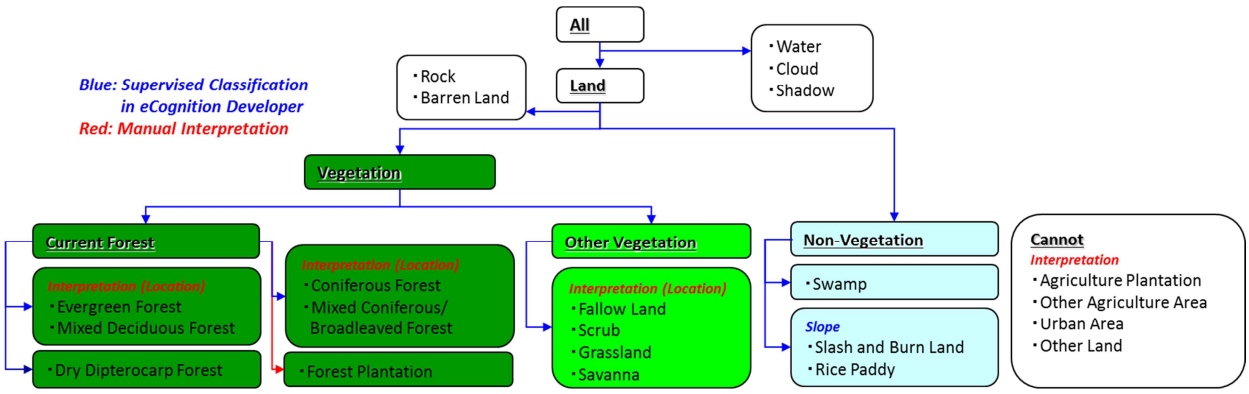


Figure 3: Decision Tree of Classification for national level forest base map in 2010

Systematic stratified random sampling method which used 4km grid was selected. Sample size of accuracy assessment was calculated based on ratio of area for each classes and provinces. However, if the area is especially large or there are a large number of classes, the minimum number of samples should be increased 75 or more per class experientially (Congalton, RG., Green, K., 1999). Therefore, in case of small sample size which is less than 75 due to small area, it was increased to 75 if there is enough spares on 4km grid, all samples for that classes was used if there isn't enough spares. All samples were selected randomly on 4km grid based on the calculated sample size.

Large land of Lao PDR is covered by shifting cultivation area. According to draft national level forest base map in

2010, “Fallow Land (hereinafter FL)” which is mostly abandoned land in shifting cultivation area and “Mixed Deciduous Forest (hereinafter MD)” which is mostly secondly forest in shifting cultivation area cover approximately 75% of nation land. Cycle of shifting cultivation is shown in Figure 5. FL and MD are difficult to separate due to they are continuous. However, “Slash and Burn Land (hereinafter SB)” which is just after slashed and burnt is easy to identify because there is no vegetation. Multi-temporal ALOS/PALSAR data analysis can detect it easily because SB has very low backscatter coefficient and forest before SB has very high (Figure 6). Since there is the threshold of average abandoned year between FL and MD which is approximately four years based on experiences of Lao people and the small field survey result, classification accuracy of FL and MD can be improved theoretically if some years SB are detected by multi-temporal ALOS/PALSAR data analysis above (Figure 7).

Next, color composite backscatter coefficient imageries of ALOS/PALSAR (hereinafter color composite imagery) which are composited backscatter coefficient imageries for three years in 2006, 2007 and 2008, and 2008, 2009 and 2010 were created to display detected SB for each year (Figure 8). If SB is happened once from 2007 to 2009, it should be classified as FL. If SB is never happened from 2007 to 2009, it shouldn’t be classified as FL. Following the method above, the classification accuracy between FL and MD is being corrected at present.

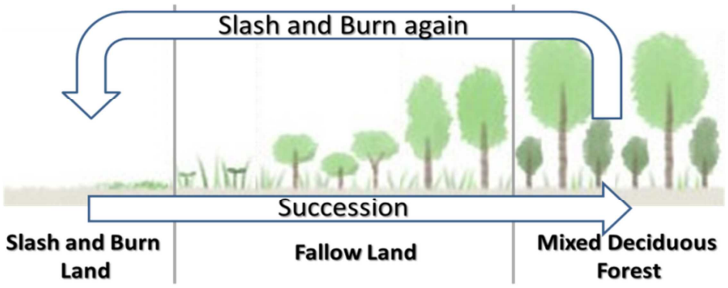


Figure 5: Cycle of shifting cultivation in Lao PDR

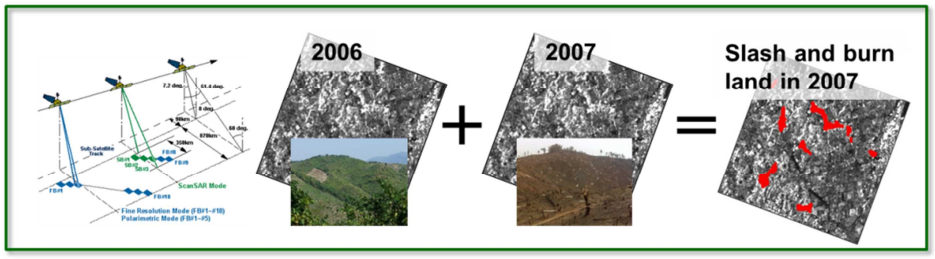


Figure 6: Change detection based on multi-temporal ALOS/PALSAR data analysis

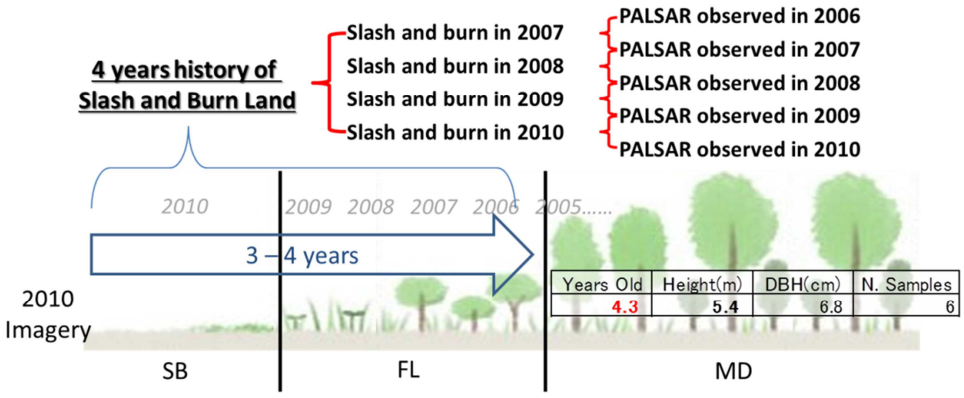
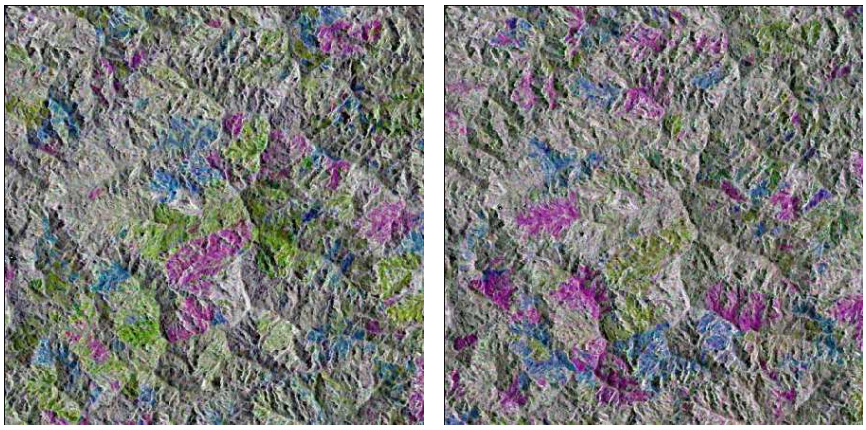


Figure 7: Method for improvement of classification accuracy of FL and MD



Left (R: 2007 G: 2008 B: 2006), Right (R: 2009 G: 2010 B: 2008)

Left (SB in 2007: Cyan, SB in 2008: Magenta), Right (SB in 2009: Cyan, SB in 2010: Magenta)

Figure 8: Color composite imagery of ALOS/PALSAR (HH)

3. Results

The developed draft national level forest base map in 2010 has only 2.3% of cloud and shadow. The result of accuracy assessment of developed draft national level forest base map in 2010 is shown in Table 3 and 4. The overall accuracy of Forest and Non-Forest which is shown in Table 3 is 72.8%. In addition, the overall accuracy of Forest Type which is shown in Table 4 is 62%.

Table 3: The draft result of accuracy assessment for Forest and Non-Forest

		Reference data			
		Forest	Non-Forest	Total	U.A
Map	Current Forest	**530**	213	743	71.3%
	Potential Forest	175	**510**	685	74.5%
	Total	705	723	1428	
	P.A	75.2%	70.5%		
Overall Accuracy		**72.8%**			

Table 4: The draft result of accuracy assessment for Forest Type

			Reference data								
			Current Forest						NF	Total	U.A
			EF	MD	DD	CF	MCB	P	NF		
Map	Current Forest	EF	**15**	48					5	68	22.1%
		MD	35	**291**	20	3	1		147	497	58.6%
		DD		9	**34**			1	31	75	45.3%
		CF	1	15	4	**15**	3		11	49	30.6%
		MCB		2		8	**5**		2	17	29.4%
		P		5				**17**	15	37	45.9%
	NF	NF	15	117	34	5	2	4	**508**	685	74.2%
	Total		66	487	92	31	9	22	719	1428	
	P.A		22.7%	59.8%	37.0%	48.4%	55.6%	77.3%	70.7%		
Overall Accuracy			**62.0%**								

According to the accuracy assessment of Forest Type, MD and FL which is most of Non-Forest (NF) occupy the big part of total number of samples. Furthermore, MD and FL are misclassified for each other. This means that improvement for classification accuracy between MD and FL has biggest impact for improvement of the overall accuracy. Comparison of RapidEye imagery which is false color band combination and ALOS/PALSAR color composite backscatter coefficient imagery is shown in Figure 7. Magenta color in ALOS/PALSAR color composite imagery means SB in 2010. White color in RapidEye imagery means SB in 2010 as well. Locations of these colors correspond for each other. It is shown that multi-temporal ALOS/PALSAR data analysis has possibility to detect SB. Next, possibility for improvement of classification accuracy between FL and MD based on multi-temporal ALOS/PALSAR data analysis was examined. Some incorrect samples on the result of accuracy assessment which are MD or FL in draft map and FL or MD in reference data were selected randomly from samples for the accuracy assessment. It was examined if incorrect samples can be corrected by manual interpretation on color composite

imagery. As a result of the examination which is shown in Table 5, 11 samples were corrected from FL to MD among 14 incorrect samples, 9 samples were corrected from MD to FL among 29 incorrect samples. Totally, 46.5% of incorrect samples were corrected.

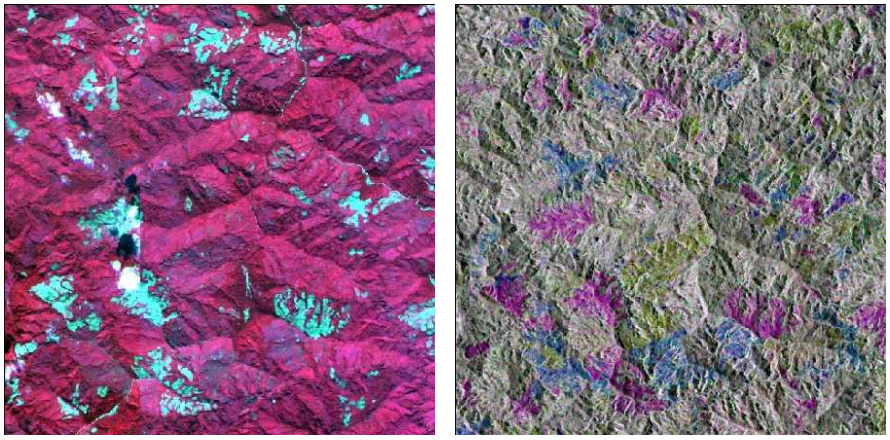


Figure 7: Comparison of RapidEye imagery and color composite backscatter coefficient ALOS/PALSAR

Table 5: Result of correction for FL and MD

Draft national level forest base map	Reference data	After correction	Numberof samples	Number of corrected samples	Ratio of corrected samples
FL	MD	MD	14	11	78.6%
MD	FL	FL	29	9	31.0%
Total			43	20	46.5%

4. Conclusion

Though there is no official international standard of classification accuracy for national level, Verified Carbon Standard (VCS) is developing a standard of classification accuracy in Jurisdictional and Nested REDD+ (JNR) requirement (VCS, 2013). According to this requirement, though classification accuracy of Forest and Non-Forest should be more than 75%, classification accuracy of Forest Type isn't required for national level. Therefore, though these results of accuracy assessment don't slightly achieve JNR requirement yet, it seems to be possible that the accuracy achieves JNR requirement through the correction work under conducting at present.

Furthermore, it was shown that change detection based on multi-temporal ALOS/PALSAR data analysis has high potential to improve classification of fallow land and secondly forest in shifting cultivation area which is distributed in many developing countries. Possibility of correction for FL and MD will be verified in more detail through the final accuracy assessment after the correction work. In addition, we hope these methods to examine in the other developing countries in the future.

References

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Verified Carbon Standard, 2013. Jurisdictional and Nested REDD+ (JNR) Requirements version 3.1