Annex 9.2. Ground check procedure for land cover accuracy assessment

CHAPTER I INTRODUCTION

A. Basic Implementation

Land cover is one of the main data required in the forestry planning. Until presently, the data of national land cover is attained from the medium resolution images (10-50 meters), among others from the Landsat satellite image. The Landsat image is selected under the consideration that its spatial resolutions are sufficient for the requirements of observation in the national scale, as well as the relatively continuous warranty on the sustainability of data availability.

The land cover map based on the sensing image should be tested on its precision to acquire the level of produced accuracy. The precision level of the produced land cover data will affect greatly on the users' trust. The estimation on the precision level of the land cover is conducted statistically (random sampling) with the method of 'point sampling accuracy' based on the 'confusion matrix' to test the precision of the detection results and classification on the image and the condition on the field.

Solid statistics and the transparency of the approach used to measure the accuracy on the data of land cover based on the satellite imaging is crucial to ensure the integrity of the land cover data produced. One of the approaches used to measure the data accuracy on the land cover is the ground truth activity. This particular activity is needed to measure the accuracy and precision level of the national land cover data based on the Landsat Image transcription in 2016.

B. Purpose and Intention

The ground truth activity with the intention of ensuring accuracy assessment of the land cover data based on the Landsat image is conducted to measure the level of accuracy and precision of the produced national land cover data in 2016.

The purposes of this ground truth activity are to:

a) Acquire the truth of the land cover observation conducted previously.

b) Collect additional data and information from the field that is impossible to be gathered from the remote sensing image, including the latest changes of the land cover that has yet to be detected by the remote sensing image used.

CHAPTER II METHODOLOGY

The used methodology on the ground truth testing activity to reassure the land cover data based on the Landsat image for the accuracy assessment purposes is aligned with the Technical Guidelines No. 2/Juknis/PSDH/2015 on the Ground Truth on Medium Resolution Images to Produce Land Cover Data and the Guidelines of Ground Truth Application on the Land Cover Data from the Landsat Image for the Accuracy Assessment of the Year 2017. The ground truth testing is divided into three (3) stages, which are the ground truth preparation, ground truth execution and post-ground truth activity.

A. Preparation

1. Equipment and Material Preparation

The materials and field equipment prepared for the ground truth activity are as follows:

a) Material

1) Land cover data from the Landsat 8 OLI image in 2016 that is overlaid with the satellite image data. This data is equipped with the sample points planning and the road data from the Indonesian map. To ease the sample extraction on the field, the sample points planning data is also uploaded to the GPS.
2) Supporting data on the Forest Area Map and the Utilization Permit Map.

b) Field Equipment

1) GPS (Global Positioning System) Garmin Monterra with external and internal batteries
2) Camera
3) Measuring tape (20-30 m)
4) Phi band measuring tape
5) Compass
6) Writing utensils

b) Recording Equipment for the Ground Truth Observation

1) Tally sheet
   - Tally sheet for land cover observation;
   - Tally sheet for the measurement of sample plot stands (tree diameter, tree height, and title density).
2) Digital recording equipment for data recording as follows:
   - Digital photo of field observation;
   - Routing data for GPS tracking;
   - Data from other field observations.

2. Coordination with Related Institutions

Coordination is conducted with the Regional Sustainable Forest Management Station, Provincial Forestry Agency and the authority (KPH) located in the ground truth activity. This coordination is related to the field observation location (data and map) and additional manpower.

B. Sample Point Mapping

Sample point mapping on the ground truth activity is based on the stratified random sampling method, which is the determination of samples based on the types/classes of random land cover. The foundation for sampling is the number of classes of land cover, variety of ecosystem (landscape condition) and the accessibility of the sampling point location.

The sample types in the ground truth activity are divided into two:

1) Sample point of land cover observation, designed to gather information on administrational area, topography condition, soil condition, land cover condition, as well as sample location measurement;
2) Sample plot to measure dimension of stands, designed to gather information such as the sample points for land cover observation, added with the measurement of stand dimension. Every sample plot is instantly recognized as sample point.

The position, amount, distribution and chronological order of the samples are determined under the consideration of:

1) The representation of land cover class in each observation location;
2) The representation of ecosystem type on each land cover class at the location of the field observation;
3) The location of the object which type is doubted, or the object covered by the cloud on the satellite image;
4) Accessibility of sample points, plots, or transects.

The provisions used to design the sample points and plots are as follows:

1) The total amount of sample points collected for one field observation is 30 points at the minimum. The amount of forested class samples is two (2) points at the minimum for every class.
2) Every sample point should be at the most homogenous point or line or polygon as possible.
3) The amount of sample plots for the measurement of the dimension of stand respectively is at one (1) plot for forested class and one (1) plot for grove class.

The determined sample will further be plotted at the image map used on the field, as the field observation route plan is to be made. The route is produced based on the ease of accessibility level from the sample location.

C. Field Observation

1. Observation of Land Cover Data from the Landsat Image with the Actual Condition on the Field

a. Sample Location Research

Sample location research is conducted based on the list of samples produced and the coordinates of these samples as well as the navigational direction on the travel route with considerations on the accessibility of the sample location. If there are any unreachable, or cancelled, or diverted land cover classes, it shall be recorded on the cause of its inaccessibility.

b. Measurement of Sample Point Position

Measuring the position of sample points is executed by the use of GPS. The results of the coordinate measurement of the sample locations are stored in the GPS and also recorded in the tally sheet.

c. Observation, Recording and Documentation

Observation is applied towards the following conditions:

1) Regional administration area and forest management area
2) Land cover condition
    a. Current condition

        The observed objects are the land covers visible at the time from various directions, which are the north, the west, the south and the east, or the front, left, back and right. The observation of the objects that are farther can be assisted by binoculars.

    b. Dynamics / changes

        Observation is conducted on the objects that appear to have changed, examples on the land opening, mining, land and forest fire, as well as other sightings. The supporting information for the observation is gathered from the statement from local officials or residents. The observation on the dynamics is not necessary to be executed on the stable object.

3) Topographic condition (landscape visibility)
    a. Land;
    b. Wavy, if the topographic condition has a gap of less than 50 meters;
    c. Hilly, if the gap between the highest and lowest points is between 50 to 300 meters;
    d. Mountainous, if the gap between the highest and the lowest point of the location exceeds 300 meters.
4) Land formation materials
    a. Main rocks
    b. Coral
    c. Sandy
    d. Clay
5) Drainage condition
    a. Good, if the land formation materials are capable of absorbing water (e.g. sandy)
    b. Medium, if the land formation materials are partly capable of absorbing water
    c. Bad, if the land formation materials are incapable of absorbing water (e.g. main rocks or clay)
6) Land forms
    a. Marin, if the main factor of land formation is the sea (e.g. beach cliffs)
    b. Alluvial, if the main factor of land formation is the material sediments on lower land (e.g. alluvial land)
    c. Fluvio-marine, if the main factor of land formation is the influence of the energy from the sea and the river (e.g. delta)
    d. Volcanic, if the main factor of land formation is the volcanic activity (e.g.

volcano)

e. Denudational, if the main factor of land formation is the wind or water activities that have shifted the original form (e.g. canyon or karst)

7) Slope

a. 0-2%

b. 2-8%

c. 8-16%

d. 16-25%

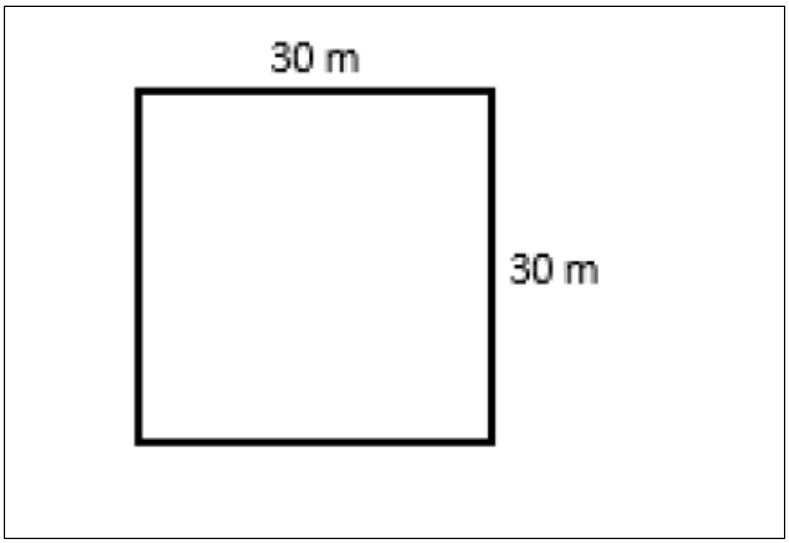
e. 25-40%

f. >40%

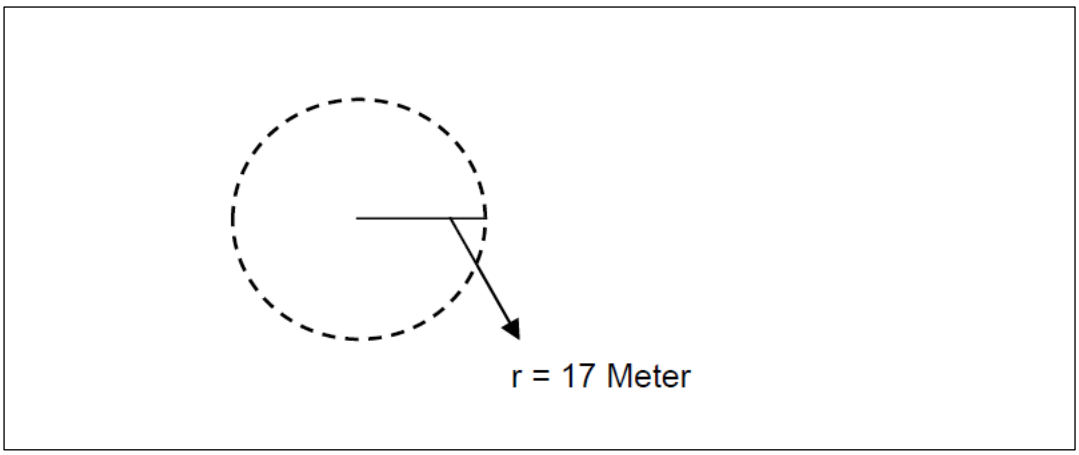
These observation results are recorded on the tally sheet and documented through cameras connected directly to the GPS for GeoTagging.

2. Measurement of Stands in the Samples of Forest and Grove Land Cover Class

The measurement of the dimensions of stands is only applied on the sample plot with the object of forests and groves. The space of the plot measured is at 0.09 hectares. The sample plots may take form as a square (with the side lengths of 30 meters) or a circle (with the circle radius of 17 meters) such as described on picture 2.1 and picture 2.2.



Picture 2.1. Diagram for the Square Sample Plot



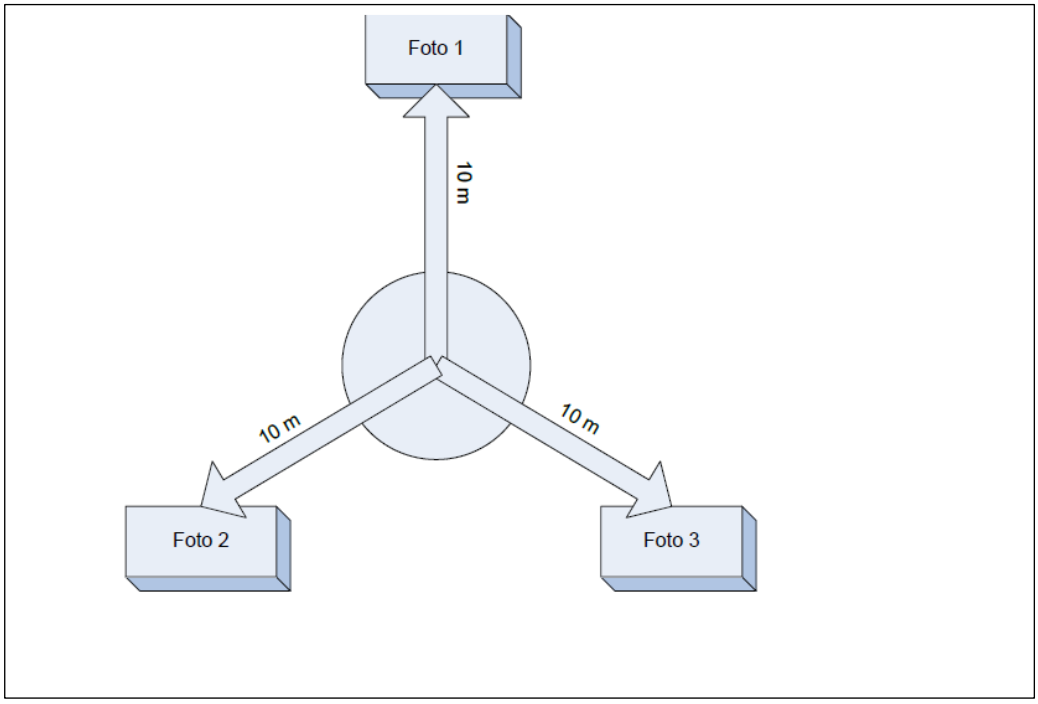
Picture 2.2. Diagram for the Circle Sample Plot

The dimensions measured in this plot are:

1) The plot's general information, which are:

a) Header density

The header density measurement is implemented with a photographic approach. The photo taking is applied through the camera with the lens facing to the zenith (straight up) on three points with the distance of 10 meters from the center point of the plot. Each photographic point is separated with the same distance / angle with the other points. The illustration of photo-taking position is provided in the Picture 2.3. The density value of the header is stated in percentage.



Picture 2.3. Header photo-taking on the land cover class on forests and grove

b) Stands density

The density of stands may be calculated with the formula of:

Where p is the density of the stand (stand / hectare), N is the amount of stands in the plot and A is the range of the plot (0.25 hectares).

2) Individual information on the stands, which are:

a) The diameter of the stand

Measurement is applied by using phi band at the chest height (~1,3m)

b) Offshoot free height

The measurement of offshoot free height refers to the Technical Guidelines of Forest Inventory;

c) Total height of stand

The measurement of the total height of the stand refers to the Technical Guidelines of the Forest Inventory.

3) Other information (if needed) may be included within the information column on the tally sheet, e.g. the information on forest succession, ecosystem, area functions and others.

D. Post Field Observation

1. Recapitulation of Field Observation Results

The recapitulation of the field observation results are:

a) List of Sample Points
b) List of Sample Plots
c) Contingency Table
d) Tally Sheet for Sample Points
e) Tally Sheet for Sample Plots

2. Calculation of Accuracy Level

The calculation for the Accuracy Level is based on the recapitulation of the field observation results, which covers:

1) Calculation of the general accuracy level on all classes (23 classes)

2) Calculation of the general accuracy level on the forest class
3) Calculation of the general accuracy level on the non-forest class
4) Calculation of the general accuracy level on the forest and non-forest class

Results of the measurement of sample points on the field observation is mapped in the forms of geo-database, which will then followed by the formulation of report on the results of field observation tests on the events of field observation of the land cover data based on the Landsat image for the accuracy assessment.

CHAPTER III ACTIVITY IMPLEMENTATION

The activity implementation on the field observation tests in the respect of the field observation on the land cover data based on the Landsat image for the accuracy assessment in 2017 is conducted in three locations as included within table 3.1. The activity is implemented by two technical staff from the Directorate of Inventory and Observation of Forest Resources for each team, assisted by a regional technical manpower.

Table 3.1 The Implementation of the Field Observation Activity

No.	Executor	Location	Time of Implementation
1.	a. Iid Itsna Adkhi b. Melisa Elisabeth P.	West Nusa Tenggara Province	17 - 29 April 2017
2.	a. Anna Tosiani b. Wadjito	East Kalimantan and North Kalimantan Provinces	5 - 17 June 2017
3.	a. Muhammad Yazid b. Suhanda	East Nusa Tenggara Province	5 - 17 June 2017

CHAPTER IV ACTIVITY RESULTS

Based on the field observations in three (3) locations, there are 802 sample points to be used for the calculation of the accuracy assessment on the land cover data in four (4) provinces (West Nusa Tenggara, East Nusa Tenggara, East Kalimantan and North Kalimantan). The accuracy numbers are the accuracy number of the national land cover data in 2016. The quality control process of the samples from the field observation is applied prior to the accuracy calculation process, with the intention of obtaining a more accurate sample data. With this quality control process, several samples were left out. The criteria used to eliminate the unused samples are, among others: (1) sample point is at the delineation border; (2) several sample points occurring in one polygon; and (3) double samples within the same coordinate.

After the quality control process is conducted, 362 sample points were acquired. The entire sample points represent 20 classes of land cover, which is the primary dry forest, secondary dry forest, primary mangrove forest, secondary mangrove forest, plantation forest, groves, mangroves, dry land farm, mixed dry land farm, plantation, residential area, transmigration, paddies, mining, swamp, open land, mining, fish plantation, ports/airports and water body.

The accuracy level of the land cover data is calculated based on the sample data from the field observation that has gone through quality control by using confusion matrix. The accuracy accounted on the closure of the land cover data in 2016 is the overall accuracy, divided into four levels of accuracy, which are: (1) 23 land cover classes accuracy; (2) forest classes accuracy; (3) non-forest – non-forest class accuracy, and (4) forest – non-forest class accuracy. The confusion matrix for the overall calculation of the accuracy level is presented on table 4.1. to table 4.5.

Table 4.1 Accuracy Level of the National Land Closure Data in 2016

No	Accuracy Classification	Accuracy (%)
1.	23 classes of land cover accuracy	61.3
2.	Forest – non-forest class accuracy	86.5
3.	Forest – forest class accuracy	90.5
4.	Non-forest – non-forest class accuracy	64.9

Table 4.2. Confusion Matrix Data on the Land Cover Based on the Interpretation of Landsat 8 OLI Images in 2016 with the Direct Field Observation on 23 Classes of Land Cover

		PL Hasil Pengecekan Lapangan																				Total
		Hp	Hs	Hmp	Ht	B	Pk	Pm	T	S	A	Hms	Br	Pt	Pc	Sw	Tm	Bdr	Tr	Pb	Rw	
PL Hasil Penafsiran 2016	Hp	2	1		1																	4
	Hs		48		1	2																51
	Hmp			1								1										2
	Ht		2		6		1								1							10
	B		6		5	26	3		1	1		1	2	1	4	1		1				52
	Pk				2		2															4
	Pm				3	2		36				4			3			2				50
	T				2	2			1	1						1		1	1			9
	S				1	2				8				1	2							14
	A										2	1			1							4
	Hms			1								10										11
	Br					2							3		1							6
	Pt		1		1	2		1			1			9	2	1		1				19
	Pc		5		7	17	2	1		1		2		1	25	1				1		63
	Sw				1	1		3						4	3	24				1		37
	Tm											3					9					12
	Bdr																	7				7
	Tr														1				3			4
	Pb							1														1
	Rw												1		1							2
Total		2	63	2	30	56	8	42	2	11	3	22	6	16	44	28	9	12	4	2	0	362

Table 4.3. Confusion Matrix Data on the Land Cover Based on the Interpretation of Landsat 8 OLI Images in 2016 with the Direct Field Observation on Fores-Non Forest Class

	PL Hasil Pengecekan Lapangan			Total
PL 2016		Hutan	Non Hutan	
	Hutan	74	4	78
	Non Hutan	45	239	284
Total		119	243	362

Table 4.4. Confusion Matrix Data on the Land Cover Based on the Interpretation of Landsat 8 OLI Images in 2016 with the Direct Field Observation on Forest-Forest Class

		PL Hasil Pengecekan Lapangan					Total
		Hp	Hs	Hmp	Ht	Hms	
PL Hasil Penafsiran 2016	Hp	2	1		1		4
	Hs		48		1		49
	Hmp			1		1	2
	Ht		2		6		8
	Hms			1		10	11
Total		2	51	2	8	11	74

Table 4.5. Confusion Matrix Data on the Land Cover Based on the Interpretation of Landsat 8 OLI Images in 2016 with the Direct Field Observation on Non-Forest-Non-Forest Class

		PL Hasil Pengecekan Lapangan															Total
		B	Pk	Pm	T	S	A	Br	Pt	Pc	Sw	Tm	Bdr	Tr	Pb	Rw	
PL Hasil Penafsiran 2016	B	26	3		1	1		2	1	4	1		1				40
	Pk		2														2
	Pm	2		36						3			2				43
	T	2			1	1					1		1	1			7
	S	2				8			1	2							13
	A						2			1							3
	Br	2						3		1							6
	Pt	2		1			1		9	2	1		1				17
	Pc	17	2	1		1			1	25	1				1		49
	Sw	1		3					4	3	24				1		36
	Tm											9					9
	Bdr												7				7
	Tr									1				3			4
	Pb			1													1
	Rw							1		1							2
Total		54	7	42	2	11	3	6	16	43	28	9	12	4	2		239