Proceedings for the training on national land cover classification systems using LCCS 3

Bangladesh Forest Department

29 November – 03 December 2015

USAID FROM THE AMERICAN PEOPLE

Food and Agriculture Organization of the United Nations

The Forest Department of Bangladesh leads actions to improve forest management and conservation, adopting forward thinking, innovative approaches in its management of approximately 1.55 million hectares of land across the country.

In 2015, the Forest Department began a process to establish a National Forest Inventory and Satellite Land Monitoring System for improved forest and natural resource management. The process supports national objectives related to climate change mitigation and provides information in support of the UN-REDD programme aimed at Reducing Emissions from Deforestation and Forest Degradation (REDD+). The process also addresses domestic information needs and supports national policy processes related to forests and the multitude of interconnected human and environmental systems that forests support.

The activities implemented under the Bangladesh Forest Inventory process are collaboration between several national and international institutions and stakeholders. National partners from multiple government departments and agencies assist in providing a nationally coordinated approach to land management. International partners, including the United Stated Agency for International Development (USAID) and the Food and Agriculture Organization of the United Nations (FAO) are supporting the development of technical and financial resources that will assist in institutionalizing the process.

The results will allow the Forest Department to provide regular, updated information about the status of trees and forests for a multitude of purposes including for assessment of role of trees for firewood, medicines, timber, and climate change mitigation.

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Disclaimer

This report is designed to reflect the activities and progress related to the project GCP/GD/058/USAID "Strengthening National Forest Inventory and Satellite Forest Monitoring System in support of REDD+ in Bangladesh". This report is not authoritative information sources – it does not reflect the official position of the supporting international agencies including USAID or FAO and should not be used for official purposes. Should readers find any errors in the document or would like to provide comments for improving its quality they are encouraged to contact one of above contacts.

Executive Summary

On 29 November 2015, FAO's National Forest Monitoring project conducted a five day training on the Land Cover Classification System software "LCCS 3". The training supports the development of a national land cover classification system for land cover and forestry resource monitoring. It also supports the longer term objective to integrate and harmonise national legends prepared by various government agencies related to soil, agriculture, forests and natural resources.

LCCS 3 is a new approach allowing the semantic interoperability between datasets ensuring a robust, transparent and documented methodology. During the training, participants collect field data from Sal forests, agricultural fields, homestead gardens and agro-forestry systems north of Dhaka City. For the first time, LCCS data was collected using the FAO developed android application "Open Foris Collect", specifically designed for the process by the training participants. Once back in the office, the data was combined with available satellite images and cross referenced with google earth and photos taken in the field to develop detailed land classes in LCCS3.

Eighteen participants (33% women, 67% men) attended the event from various organizations including the Bangladesh Forest Department, Bangladesh University of Engineering and Technology (BUET), Survey of Bangladesh (SOB), Soil Resource Development Institute (SRDI), Centre for Environment and Geographical Information Systems (CEGIS), Bangladesh Society of Geo Informatics (BSGI) and Bangladesh Space Research and Remote Sensing Organization (SPARRSO). In the post training evaluation, ninety percent of participants agreed that the training was relevant to their daily work and half of the participants feel confident they could carry out the tasks without supervision.

The training was implemented by FAO with support from the UN-REDD Programme and USAID, in association with Forest Department of Bangladesh. The event was held at the Bangladesh Bureau of Statistics.

Contents

1. Introduction

Several global and regional datasets have been produced over the years in response to the need for information on land cover and land cover changes. Although there have been many efforts in harmonization for almost all mapping initiatives, there are still limitations on the compatibility and comparability between different maps and related legends. Indeed, to answer the request for a coordinated, harmonized and systematic approach to land cover data collection, on year 2004 Global Land Cover Network (GLCN) has been launched as a joint initiative between FAO, UNEP and IAO. In particular, GLCN is intended to support countries in facilitating access to reliable and comparable land cover and land cover changed data. In this context, on year 2004, LCCS was identified as an appropriate classification system to harmonize and standardize existing land cover data. LCCS (Land Cover Classification System) is the only universally applicable classification system in operational use at the present time and several initiatives (e.g. GLC 2000, Globcover, GLCN and Africover) are based upon this system. It enables a comparison of land cover classes regardless of data source, allowing the translation, into LCCS language, of legends generated with other classification systems. LCCS is able to describe land cover features by combining the land cover classifiers (rules and conditions) all over the world and at any scale or level of detail and therefore to standardize classes definitions across legends and mapping initiatives.

Bangladesh has a history of depletion of forest resources resulting in fragmented forests distributed throughout the country. FAO (2009) reports a decrease in total forest volume from 2.27 million m2 in 1985 to 0.650 million m2 in 1996. According to the Bangladesh REDD+ Readiness Roadmap, the data available on forest cover change are limited in Bangladesh. Only one national land use assessment was performed at national scale (FAO, 2007) and several sub-national land use/cover analyses have been performed however these cannot be used to assess the national performance because they are not integrated and consistent with the data available at national scale.

2. Objectives

The objectives of the training were to introduce the LCCS3 approach to support the implementation of the current land cover mapping activities in Bangladesh.

In particular:

- Build synergy and support the integration of DECCMA and GCP/BGD/058/USAID projects' activities;
- Follow up the LCCS training in Rome and provide support to DECCMA and GCP/BGD/058/USAID projects' activities;
- Focus on (1) concepts on land cover classification and LCCS/ LCML, (2) hands-on exercises on tools for land cover mapping (LCCS3 and ADG) (3) national classification system, (4) visual and semi-automatic interpretation, (5) identification of field descriptors to develop a national legend.
- Provide recommendations for the preparation of a national land cover map, and integration of the existing land cover/ use mapping activities;
- Present an automated approach for maps analysis based on LCCS3 methodology with ADG software;
- Develop training materials to support land use mapping activities in an integrated approach;
- Discuss how best we can deliver capacity building as regard the LCCS3 for land cover mapping activities for REDD+.

3. Summary of Sessions

3.1 Introduction to LCCS

The workshop was inaugurated by the Forest Department's Chief Conservator of Forest Mr. Yunus Ali. Mr. Ali emphasised the importance of integration of legends to allow greater collaboration in environmental management that will support national objectives. Dr. Matieu Henry, provided an introduction to the LCCS process explaining the importance and potential efficiency gained from government agencies working together to develop a harmonised approach to land cover classification. Mr. Gianluca Franceschini, FAO's Geographic Information Systems expert and LCCS resource person explained the new and innovative approach provided by LCCS 3 can solve current problems related to inconsistency of data and semantics related to land cover representation.

Following the introductions, a series of presentations were provided by government partners to provide a background on the variety of approaches to land cover classification.

3.1.1 Overview of presentations

PRESENTATION OF THE DIFFERENT LAND COVER MAPPING ACTIVITIES IN BANGLADESH (MR. MD. DELAWAR HOSSAIN MOLLA, SRDI)

The Soil Resource Development Institute has extensive experience in land use mapping. Between 1997 and 2005 SRDI have created numerous maps at both regional and national scales. The maps have a focus on agricultural production and have been increasing in their scope and sophistication during this period.

IDENTIFICATION OF TOPOGRAPHICAL FEATURES FROM AERIAL PHOTOGRAPHY (MR. SYED MOHAMMAD MASUM, SOB)

Survey of Bangladesh have extensive experience in the use of remote sensing to identify topographic features. This has been completed using aerial photos, satellite imagery, field survey as well as in coordination with other departments. The datasets developed through this process support: administrative boundaries, annotation, building and structure, facilities, geodetic control points, hydrographic features, industries, relief, transportation and vegetation.

CASE STUDY – COMPARISON AND DISCREPANCIES ON LAND COVER REPRESENTATIONS (MR. ABDUL HADI – BSGI)

Land Cover is the physical/bio-physical cover of the earth surface. Land cover can be determined by analyzing satellite and aerial imagery and may include trees, water, bare soil, artificial surface, etc. This process refers to classifying data into defined category that represent the whole or part of earth's surface.

There are many issues related to land cover representation when the objectives of various agencies are considered. For example:

- Different purposes: Every organization produces Land Cover or Related maps based on the organizational requirements
- Common definition of the land cover between the organizations are not considered
- Classification methods are different
- MMU/Scale, Projection System, Data used for classification etc. are different
- Discrepancies on land representation may be influenced:
    - Due to difference Land Cover classification scheme/definition
    - Due to seasonal variation of source data
    - Due to difference on spectral resolution of satellite image

- Due to difference on spatial resolution/Scale/MMU
- Due to difference on image interpretation
- And so on....

To address these issues, the following is proposed:

- National Land Cover Legend development with definition
- Prepare the standards and codes of the LC legends and share other stakeholders
- Translation the existing land cover map into the developed definition for data harmonization
- Development of NSDI

LAND COVER CLASSIFICATION SYSTEMS (MOHAMMED ABED HOSSAIN - BUET)

Land cover classification can be done in two ways: *a priori or a posteriori*. A *priori* classification system can be considered as *abstract conceptualizations.* In this case the definition are created before data collection. Some examples include the *Revised Legend of the Soil Map of the World (FAQ, 1988) and the USDA Soil Taxonomy (SCS, 1975).* The advantage of this methodology is they are standardized and independent of the area and/or the means. The disadvantage is that the method is rigid.

A posteriori classification can be considered as direct and free from preconceived notions. The approach is based on definition of classes after clustering a series of field samples. The advantages of this system is that it better fits with collected field observations in a specific area. The disadvantage is that it may be dependant on the specific area.

The problems with existing classification systems is that they are either vegetation classifications, broad land cover classifications, or related to the description of a specific feature; They are limited in their capacity to define the whole range of possible land cover classes. Moreover, in most current classifications, the criteria used to derive classes are not systematically applied.

To develop a reference classification system, the methodology must be comprehensive, scientifically sound & practically oriented; capable of meeting the needs of a variety of users; neither single-project oriented nor taking a sectoral approach; users can use just sub-sets of the classification and develop them to their own specific need.

In this way the reference system may be potentially applicable as a common reference system and facilitate comparisons between classes derived from different classifications

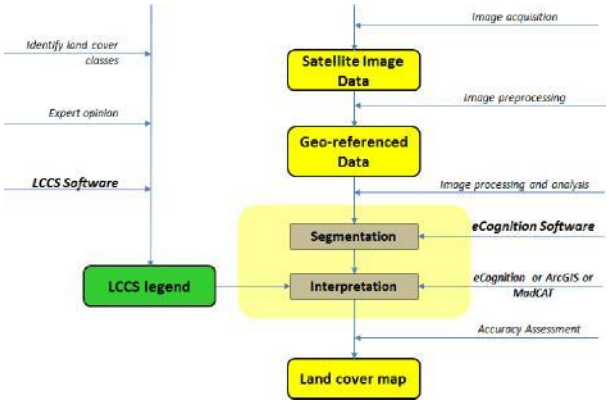
PLANNING A LAND COVER MAPPING ACTIVITY – FROM THEORY TO PRACTICE (MOHAMMAD SHAHIDUL ISLAM - CEGIS)

Land cover is determined by direct observation while land use requires socio-economic interpretation of the activities that take place on that surface. Land cover interpretation can therefore be achieved predominantly through observation and interpretation of aerial imagery, followed by ground trothing and accuracy assessments. The key steps in developing a land cover map using LCCS include: legend development, satellite image acquisition, processing, image processing and interpretation, and accuracy assessment.

Images must be carefully selected to ensure they are of appropriate quality in terms of resolution and are cloud free, but also that they are comparable – if comparability is something that is required. For example, an image taken in the wet/monsoon season could not be merged or compared with those taken in the dry season.

Image segmentation is a partitioning of an image into constituent parts using image attributes such as pixel intensity, spectral values, and/or textural properties. Image segmentation produces an image representation in terms of edges and regions of various shapes and interrelationships. In this process, neighboring pixels or

small segments that have similar spectral properties are assumed to belong to the same larger segment and are therefore merged. Using the LCCS methodology, one can have a very detailed legend



3.1.2 The Land Cover META Language[1]

A classification process aims at structuring a specific knowledge domain in order to create consistency and stability in communication between individuals. In other terms classification is a way to create order and stability for knowledge communication.

The Land Cover META Language (LCML) is an attempt to classify the "real world features" (specifically Land Cover features) with a very simple groups of elements arranged in different ways that act as building blocks to describe the more complex semantic in any separate application ontology (legends).

LCML should be able to work as "boundary object" to mediate and support negotiations of different ways to represent Land Cover around which similarities and differences can be understood and expressed. This means that classes derived by LCML can be customized to user requirements but must have common identities between users.

The most distinctive theoretical characteristics of LCML are:

- Essential elements of the language allowing to balance the goal of a global standardization of Land Cover terms with the need for enough detail of Land Cover description to ensure practical applicability. In other words the "elements' must be the as much as possible limited in number , representing very well accepted terms and being able to represent also very distinctive land cover situations.
- Reduction as much as possible of complex descriptions and definitions.
- Fundamental idea of the language is that a predefined set of land cover basic elements (called BASIC OBJECTS) enriched on their semantic significance with external qualities and attributes and arranged in different types of strata can be used to describe a wide variety of distinctive and detailed land cover situations.

1 The following text was adapted from FAO's Global Land Cover Network website (http://www.glcn.org/ont_2_en.jsp)

3.2 Exercises with LCCS

3.2.1 Introduction to the LCCS3 software[2]

The FAO LCCS v.3 (derived by the more general LCML) allows the description of any land cover at any scale by combining basic biophysical objects: grass, shrub, tree, rock, sand, snow, ice, water etc. Basic objects can be qualified according to their characteristics (e.g. type or size of a tree) and properties (e.g. natural grass vs. crop). Basic objects can be as well combined according to their spatial arrangement in the real world where they exist as geographical units which can be observed, mapped and analyzed as land systems.

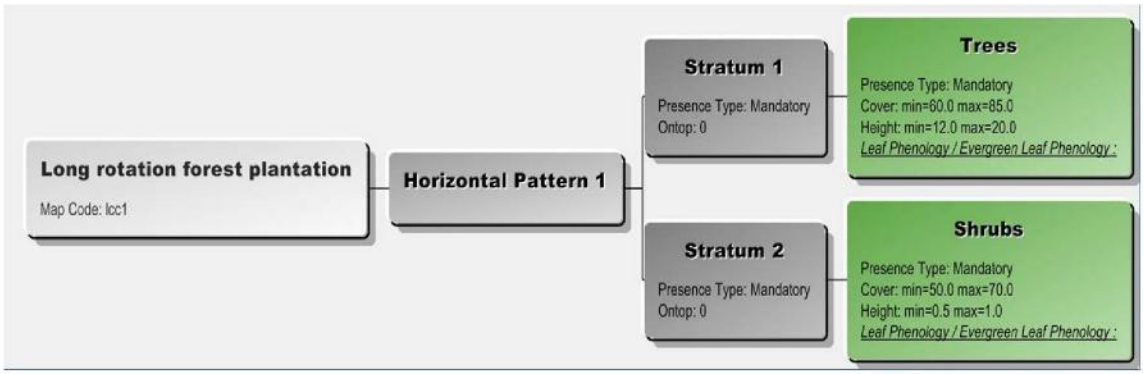
This is achieved in LCCS by combining objects according to rules defining vertical and horizontal patterns. With such approach, whatever land cover classification is documented in the same way, which makes possible precise translations which are necessary when analysis requires using several data sets, either different maps, or maps and statistics or maps and georeferenced data from monitoring systems when they contain land cover attributes.

3.2.2 Using Open Foris Collect with LCCS

Open Foris Collect is a database system that is traditionally used to create field forms for forest inventory projects. The technology can be adapted to create LCCS field forms, allowing data to be collected on mobile tablet devices and thereby reducing the requirement for post process data entry. The system's functionality includes logic checks, drop down menus, GPS and photographic capacity through the mobile device. The system can be used on any Android mobile device. Open Foris is completely free and open source. More information can be found at http://www.openforis.org/.

3.2.3 Using field survey data to create the LCCS legend

During the field exercise to Gazipur, participants collected a number of survey points documenting LCCS data. Once back in the lab, the GPS points were extracted into kml format and viewed on google earth. On a separate screen, the field photos were examined. Using the data in combination with the visual elements, the data was used to create a specific LCCS feature.



[2] The following was adapted from Gregorio, Jaffrain and Weber 2011

3.2.4 Exercises with LCCS and ADG[3]

ADG is a crosscutting interrogation software that allows the easy and fast recombination of land cover polygons according to the individual enduser requirements. Aggregated land cover classes can be generated not only by name, but also using the set of existing classifiers. ADG uses land cover data with an LCCS legend. These data can be local, or can be downloaded from a remote server.

Using an image segmentation processed through the eCognition software package, the LCCS legend can be associated with the polygons in the segmentation. The field survey data are therefore directly associated with the remote sensing data.

4. Recommendations for next steps

The forest department and SRDI have both prepared land cover maps in the past and are therefore best placed to carry the LCCS process further. With initial trainings conducted, the process can now move the translation of both the FD and SRDIs maps, and the development of the national LCCS legend. For this to be achieved, further, more targeted support will be required.

In the context of interagency collaboration, departments are well placed to engage in data sharing activities, particularly related to the procurement of aerial imagery. This topic should be well identified in upcoming national consultations related to national land cover legend, data sharing and national forest monitoring.

5. References

FAO. N.d Global Land Cover Network website. *Land Cover Classification System v. 3 (or Land Cover Meta Language) design criteria* (http://www.glcn.org/ont2en.jsp)

FAO. N.d Global Land Cover Network website. *Advanced Database Gateway (ADG)* (http://www.glcn.org/sof_4_en.jsp)

Gregorio, A. Jaffrain, G. Weber, J L (2011). *ISSUE 3: Land cover mapping, land cover classifications, and accounting units.* Expert Meeting on Ecosystem Accounts, 5 7 December 2011, London, UK

[3] The following text was adapted from FAO's Global Land Cover Network website (http://www.glcn.org/sof_4_en.jsp)

Appendix 1. Agenda

Date	Programme	Resource person
Day 1: Introduction to LCCS		
Session 1: Opening Session		
09:30	Registration of the participants	
10:00	Opening of the workshop (Welcome Address)	Mr. Rakibul Hassan Mukul, ACCF, FD
10:15	Introduction of participants	
10:20	Presentation of the different land cover mapping activities in Bangladesh	Mr. Md. Delawar Hossain Molla, SRDI
10:30	Identification of topographical features from aerial photography	Mr. Syed Mohammad Masum, SoB
10:45	Presentation of the content and objectives of the training	Matieu Henry (FAO)
11:00	Address by the Chair	Mr. Md Yunus Ali, CCF, FD
11:15	Break	
11:45	Case study – Comparison and discrepancies on land cover representations	Mohammad Abdul Hadi (BSGI)
12:05	Land cover classification systems	Mohammed Abed Hossain (BUET)
12:30	Planning a land cover mapping activity – from theory to practice	Mohammad Shahidul Islam (CEGIS)
12:45	lunch Break	
Session 2 :		
14:00	Introduction to LCCS	Henry Matieu (FAO)
14:20	The Land Cover Meta Language (LCML)	Gianluca Franceschini (FAO)
14:45	LCCS in two case studies	Mariam Akhter (FAO-FD)
15:00	Introduction to the LCCS3 software	Gianluca Franceschini (FAO)
15:20	Coffee break	
15:30	Introduction to the LCCS3 software and practice	
17 :00	End of the day	
Day 2: Exercises with LCCS		
Session 3 :		
09:00	Recap of previous day	One participant
09:30	LCCS Land cover legend for DECCMA Project	Mohammad Shahidul Islam (CEGIS)
10:00	Land, forest and tree cover monitoring (concepts and methodologies	RIMS of FD (UMD Work)
10:30	Coffee break	
10:45	Exercise 1: Hands on exercises on creation of land cover classes using LCCS3	Gianluca Franceschini (FAO),
12:45	lunch Break	

14:00	LCCS3 advanced concepts	Gianluca Franceschini (FAO)
14:45	Exercise 2: Translation of national legends	by group
15:30	Coffee break	
15:45	Exercise 2: Translation of national legends	By group
17 :00	End of the day	
Day 3: Exercises with LCCS and ADG		
Session 4 :		
09:00	Recap of previous day	One participant
09:30	Presentation of a LCCS legend (Group presentation)	By group
11:00	Coffee break	
11:15	Exercise 3: Data base design development for data collection using open foris	By group
13:00	lunch Break	
14:00	Exercise 3: Data base design development for data collection using open foris	By group
15:30	Coffee break	
15:45	Exercise 3: Data base design (field form) development for data collection using open foris	By group
Day 4: Field Work		
07:00	Field Work – collection of field data using open foris collect and field form	by group
Day 5: Harmonization of the existing maps		
09:00	Recap of previous day	One participant
09:30	Download the field inventory data from Tab and mobile	by group
10:00	Preparation of KML file of the survey points	by group
10:30	Coffee Break	
10:45	Image interpretation for the field area surveyed and Image segmentation using eCognition	Gianluca Franceschini (FAO)
11:30	Concepts on ADG and image classification	Gianluca Franceschini (FAO)
12:45	lunch Break	
14:00	Practical: Classification using the LCCS legend with ADG software	by group
15:45	Discussion and way forward	
16:30	Closing ceremony and certificate distribution	

Appendix 2. Participant List

	Name	Organization	Email
1	Mr. Babluzzaman	RIMS, FD	zzaman1978@gmail.com
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16	Mr. Mohammad Saidur Rahman, Junior Specialist, RS Division	CEGIS	msrahman@cegsibd.com
17	Mr. Mohammad Mahbubur Rahman	BSGI	
18	Mr. Fazle Reza suman	BSGI	

Appendix 3. Evaluation

How often do you participate in training related to forest monitoring?		
First time	6	60%
1-3 every year	4	40%
More than 3 per year	0	0%
Regularly (approximately one per month)	0	0%
I would describe myself as:		
A professor/academic	0	0%
A student	0	0%
Forest Department staff	5	50%
Government staff (outside Forest Department)	3	30%
NGO staff	0	0%
Private consultant	0	0%
My professional background relates most closely to:		
Forester	2	20%
GIS/RS	5	50%
Statistics	0	0%
Social survey/assessment	0	0%
Economics	4	40%
Natural Resource Management	0	0%
Ecology	2	20%
My years of relevant experience is:		
1-2 years –	5	50%
3-5 years –	2	20%
5-7 years –	1	10%
8-10 years–	2	20%
More than 10 years –	0	0%
The training was relevant to my daily work		
Strongly agree–	0	0%
Agree–	9	90%
Neutral–	1	10%
Disagree–	0	0%
Strongly disagree –	0	0%
The training met my expectations in terms of the content and learning outcomes		
Strongly agree–	0	0%
Agree–	6	60%
Neutral–	4	40%
Disagree–	0	0%
Strongly disagree–	0	0%
The resource person presented information in a way that i could understand and was easy to		

follow

Strongly agree –	4	40%
Agree–	4	40%
Neutral –	2	20%
Disagree–	0	0%
Strongly disagree –	0	0%

I feel confident to be able to carry out the tasks described in the training without supervision

Strongly agree–	0	0%
Agree–	5	50%
Neutral–	5	50%
Disagree –	0	0%
Strongly disagree –	0	0%