Protocol for land features description in Bangladesh

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), the Food and Agriculture Organization of the United Nations (FAO) and SilvaCarbon are supporting the development of technical and financial resources that will assist in institutionalising 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, 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.

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LIST OF ACRONYMS

BFD - Bangladesh Forest Department
BSGI - Bangladesh Society of Geoinformatics
CEGIS – Center for Environmental and Geographic Information Services
DEM – Digital Elevation Model
DGPS – Differential GPS
FAO – Food and Agricultural Organization
FRA – Forest Resources Assessment Programme
GHG – Green House Gas
GIS – Geographic Information Systems
GLCN – Global Land Cover Network
GPS – Global Positioning System
LC - Land Cover
LCCS - Land Cover Classification Systems
LCML - Land Cover Meta Language
LU - Land Use
MMU – Minimum Mapping Unit
NFA - National Forest Assessment
NFI – National Forest Inventory
NGO – Non-governmental Organization
REDD – Reducing Emissions from Deforestation and Forest Degradation
SOB - Survey of Bangladesh
SPARRSO – Space Research Remote Sensing Organization
SRDI - Soil Resource Development Institute
UML – Unified Modeling Language

1 Introduction

This manual describes the field data collection method for classifying land features in Bangladesh. The classification of land feature is useful for various purposes including land cover map development, accuracy measurement of satellite imagery and contributing to the national forest inventory. The use of this manual will aims to strengthen the link between field data and satellite imagery used in remote sensing by clearly describing the attributes, that are referred to in this process as 'objects', that form the basis of land cover classes and their definitions.

Establishing consistency between the various classification systems in the field and using remote sensing increases management efficiency as standardized information can be used for multiple purposes. However, defining a unified classification system that both allow interoperability across discipline and space responding to the needs of the varying agencies is difficult due to their inherently differing priorities.

The aim of this process is to address the imprecise, ambiguous or, sometimes absent descriptive attributes of traditional land classes and problems related to inconsistency between field data collection and remote sensing. Without such detailed description, it is impossible to compare LC/LU information between across different data sets. To overcome the classification problems, the descriptive attributes of field data forms the basis of the classification system.

In parallel, FAO launched Open Foris initiative. This initiative aims at providing open source software for countries aiming at improving tree and forest management using various advanced technologies such as remote sensing, androids for field data collection. Open Foris Collect is one of the available tools for improving field data collection. Because, several errors occur during the field data collection, the standardization of the field data collection using applications on tablets or androids is one way to reduce error related to field measurement.

In consequence, this manual is based on the latest technological and methodological advances related to classification systems, field data for land cover/use and forest monitoring and assessment in Bangladesh and internationally.

1.1 Rationale for creation of land classes

Because classifications change over time with evolving societal demand, technical, human and financial means, identification of a land feature in the field using a class name does not help to solve problems of inconsistency between and within field measurements and remote sensing efforts over time. In consequence, the field data collection process aims to describe the physical attributes of homogeneous land features in as much detail as possible. Information will be captured on both biotic and abiotic surface. Biotic attributes relate to the detailed characteristics of vegetation including species type, height, density, leaf phenology and type, management practices etc. Abiotic attributes relate to built-environment including houses, buildings, industries, roads and railways, bare soil, open field, water bodies etc. Each of these features also can be categorized into many subclasses based on their characteristics.

1.2 Objectives and methodology of field data collection

The basic aim of field data collection is to describe the physical features (objects) of a homogeneous area of land (land feature). The data will be used to verify information derived in through satellite imagery, usually by people who have not been to the field or have limited idea of the landscape being described. Therefore, it is important to be as descriptive as possible.

Objects within a landscape are categorized into two broad classes: Abiotic and Biotic. Under these classes, additional attributes may be added to provide a more detailed description. For example, a pineapple crop may be considered in the following way:

Pineapple > is type of vegetation > is a herbaceous perennial > within a cultured landscape > with a vegetative cover of 80-90% > receiving rain fed irrigation > receiving organic fertilizer > with a cropping pattern between April and July > at an elevation of between 200 – 500m > a slope of 10%.

By describing land features in this way, the pineapple crop can be considered at any one of its descriptive points: simply as a type of vegetation, or as a crop that is planted in April and harvested in July, or as crop grown on a hill side. The benefit of this level of description is that different users of the information can use the described attributes in different ways; placing emphasis on the attributes best suit their needs.

The final stage in the process is to organize the different objects in to a pattern of vertical or horizontal strata. This process is not required in the field, but is illustrated in the example below, once the description has been entered into the LCCS software.

Example

Trees and shrubs in this ecosystem found in the hill region are clearly identifiable in the left picture and the right picture illustrates the disturbances found in the same location. Two stratums are identified in this ecosystem. The first stratum corresponds to trees and the second stratum to shrubs. Additional elements to describe this ecosystem can be related to the management (plantation), the phenology (deciduous) and the leaf type (broadleaved).

Picture 1: Case one

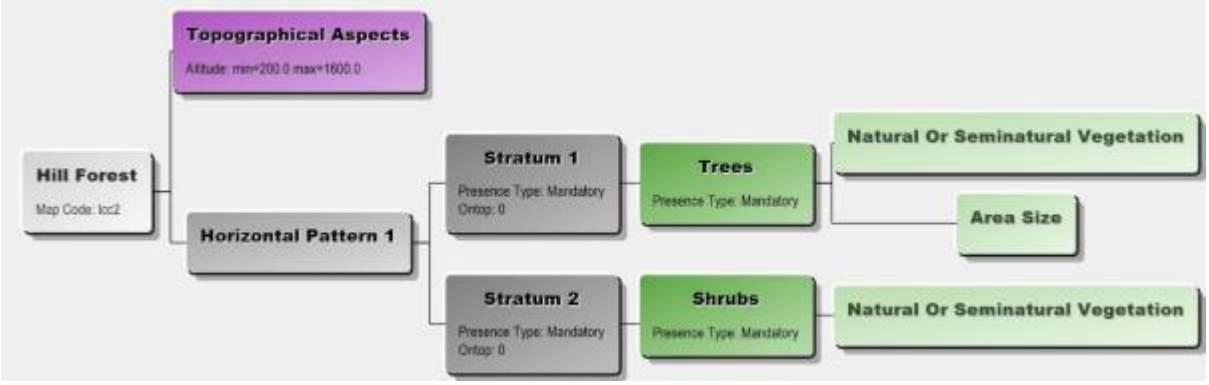


Figure 1: LCCS Diagram: Hill Forest

2 Preparation

2.1 Sampling

The field data collection for the development of the classification system will not require any particular sampling strategy. The objective is such that the field crews should identify all the different land features that are representative of the study area and should be able to collect data for each of those land features. Identification of the exact location where the field measurements have to be taken is subject to expert judgment. The selected sample location should characterize a homogenous area comprising different "objects" that describe a "land feature". Some principles must be followed in using 'expert judgment' for the identification of representative field location of each land features.

2.2 Equipment Required

The field observer must have a precise understanding of the field data collection objectives, adequate familiarity of the study location, familiarity with devices to be used in the field (GPS, Tab, Densitometer etc.), understanding of scale differences of land attributes (example: slope differences, height differences etc.).

To start the field work, the field observer must acquire and carry the following items:

1. Smart tab (installed Open Foris application and configured survey form)
2. Handheld GPS
3. Densitometer

4. Power bank
5. Data and power cable
6. Lap top (to down load data on to at the end of each day)
7. Data storage devices
8. Location map
9. Paper field forms (in case of technology failure)
10. Paper/Pen/Clip Board/knapsack etc.

2.3 Field crews

Each field team must consist of minimum two members. One member will be responsible for using the table device, another should take a backup on the paper form.

The qualification of field crews: crew must be graduate and having at least diploma in forestry or in agricultural science or in any other natural sciences with intensive field perpetration training.

All field teams should receive predatory training before field survey commences.

3 Data Collection Process and Description of the Field Form

Field data is collected using an Android mobile tablet device through the application Open Foris. Open Foris is an open source android application for designing and managing field-based inventories and biophysical, socio-economic or biodiversity surveys.

As a failsafe, a hard copy field data form is also available if technology fails in the field. **(See Annex A).**

Both the hardcopy and the digital forms have four sections.

- The **first** section records location and descriptions of the study unit.
- The **second** section describes 'how to captures photographs' of the study unit.
- The **third** section records canopy measurement information.
- The **final** section records the attributes of the study unit.

When accessible, land feature must be measured at its center. However, accessibility may be limited because of physical obstructions like slope, water, legal obstructions, boundary barrier/fences and other factors. In these cases, the observer needs to collect information from outside of the land feature and clearly indicate the relative position in the data collection form.

3.1 Operating the Open Foris Application

Touch the icon  to launch the application in your smart device. Depending on the android version, screen background will appear white or black. It is good practice to use the white background as they are more readable in sunlight.

To change the background colour, press the three small dots in the top right of the screen. A dropdown window will provide three options. Choose 'Settings' and change the theme to 'Light'.

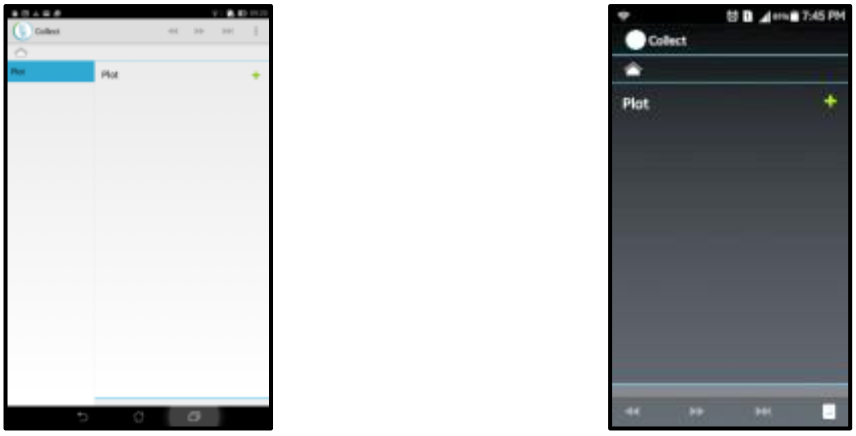
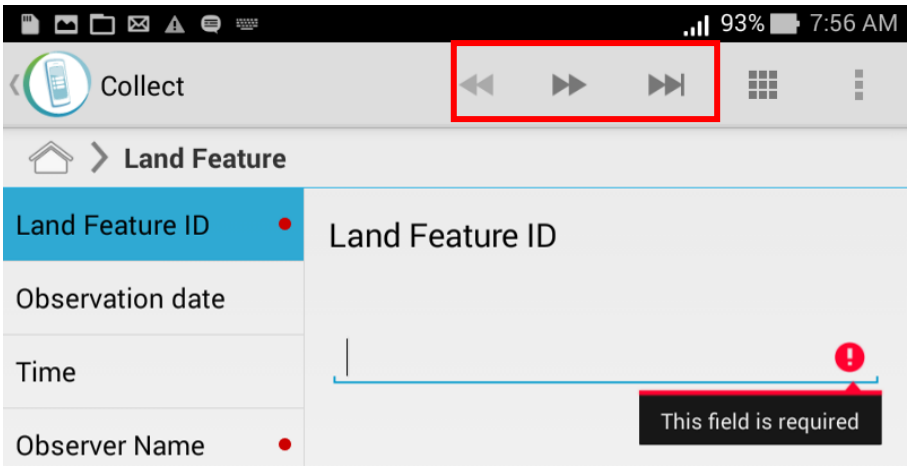


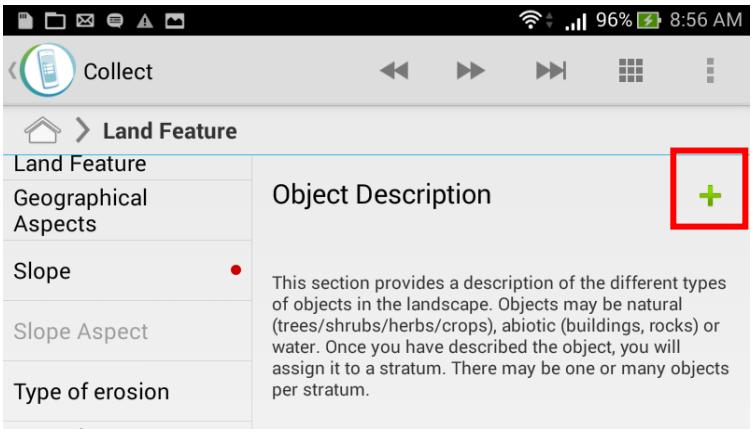
Figure 2 The left screen shows two panels while the right screen shows single panel of of two different devices. However, both of the interfaces record the same data.

3.1.1 Navigating the questions

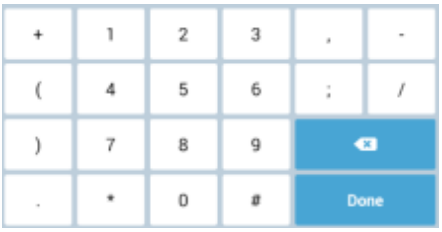
To navigate through the application you can swipe right or left with you finger. Alternatively you can use the arrows at the top of the screen. The >> icon takes you to the next attribute. The >>| icon takes you to the next section.



Each section of the form begins with a green + sign. To start input data you need to touch/click the + (Green) symbol.

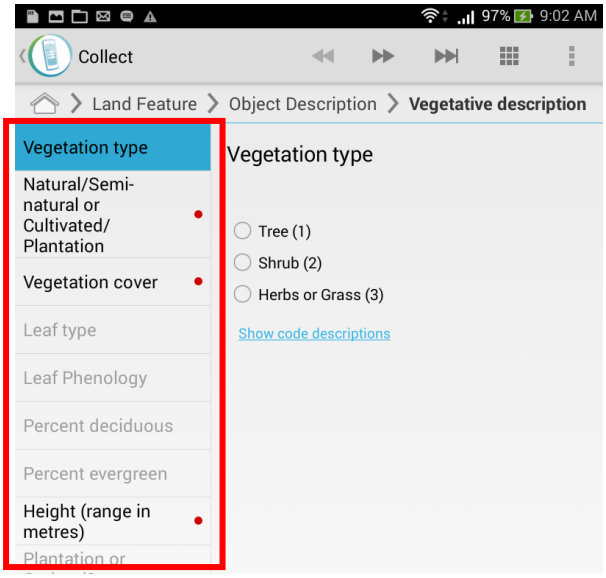


When entering data, a key pad will automatically pop-up.



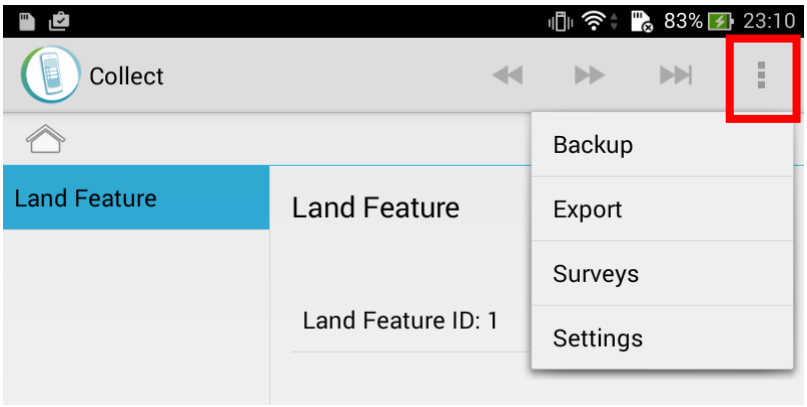
To navigate to different section of the form, use the side panel on the left (Note, the navigation pane only appears on tablet devices – not on mobile phones.

The **Red dots** that appear in the left hand side navigation pane identify if it is a required field. If these fields are left empty, the form will have errors. ***All fields with red dots should be completed in full.***



3.2 Back up procedure

Data can be backed up using either the ***Back up*** or ***Export*** functions. These are accessed via the three small dots in the top right hand corner of the device. ***Field crews are instructed to perform data back ups at the end of each working day***.



3.2.1 Export

The Export function allows OF Collect Mobile data to be transferred both on-line or off-line. If the logistic is set up in a way that field crew leaders periodically visit the main office or a district office with IT facilities, off-line data transfer can be done by connecting the tablet via cable to a PC or by extracting the SD card from the tablet and inserting it into a PC or via bluetooth.

One of the advantages of OF Collect Mobile is its ability to transfer data to the main office directly from the field. Whichever transfer method is chosen, data export is done by selecting the Export button which creates a file named: surveyname.collect-data(*). Collect Mobile will then present a number of options to export the data to. One way is to export the data file via email as an attachment however if multiple photos have been taken, this may not be practical. Alternatively, the data files can be sent to a cloud storage system (eg. Dropbox, Google Drive).

3.2.2 Backup

The backup function creates a new file containing all data entered up to that moment, so each consecutive file will contain additional information and will be bigger. If size becomes an issue, old back-up files can be deleted. The back up file will be named “Survey” followed by a series of numbers (the active working file is named “Survey”. Unlike the Export function, the back up process saves the file to the device. The back up file is then downloaded to the computer via cable.

3.2.3 Downloading data to the computer

To download the back up file, connect the device to the computer via the USB cable. Navigate to the working directory which may be in one of two places:

- Internal storage > Android > Data > org.openforis.collect
- SD card> Android > Data > org.openforis.collect

Cut and past the back up file to the laptop and save in a folder named with the data of the data collection

4 Data Collection Attributes

4.1 Section 1: Location and description of the land feature

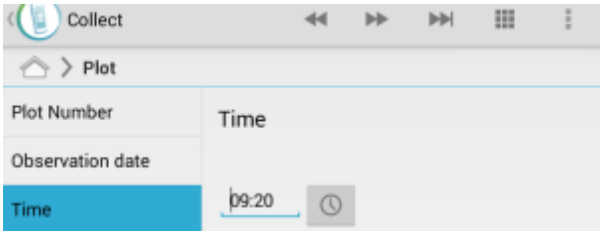
4.1.1 Land feature ID

This is a unique identifier of the observation point for data management purposes. ***If multiple data collectors are in the field simultaneously, it is important to avoid duplication of this number***. Therefore, consecutive teams should start from 1000, the next from 2000, the next from 3000 and so on.

Once your entry is done, touch the highlighted >> icon or swipe  the screen to go for the next entry.

4.1.2 Observation date and time

The current date will be added automatically when you press the calendar () icon. This is the same for the time field.

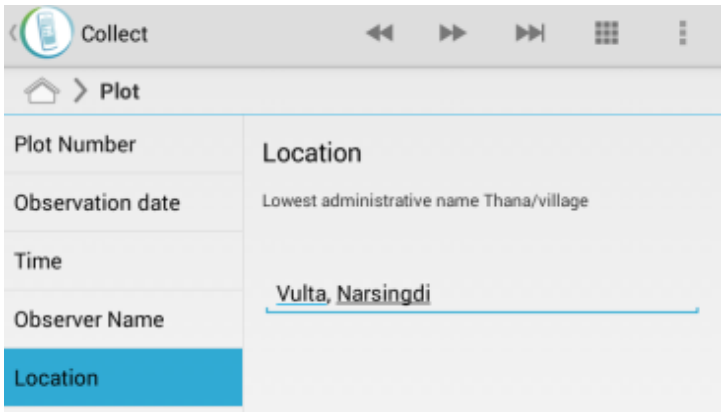


4.1.3 Observer Information

The full initial/full name of the observer/surveyor involved in describing the observed location is entered as follow:

4.1.4 Location

Provide the location of the land feature as accurately as possible, or to the lowest administrative unit. You may also provide road-junction, water body, permanent structures etc. This description should allow other users to locate the relative position of the land feature on a map.



4.1.5 Accessibility

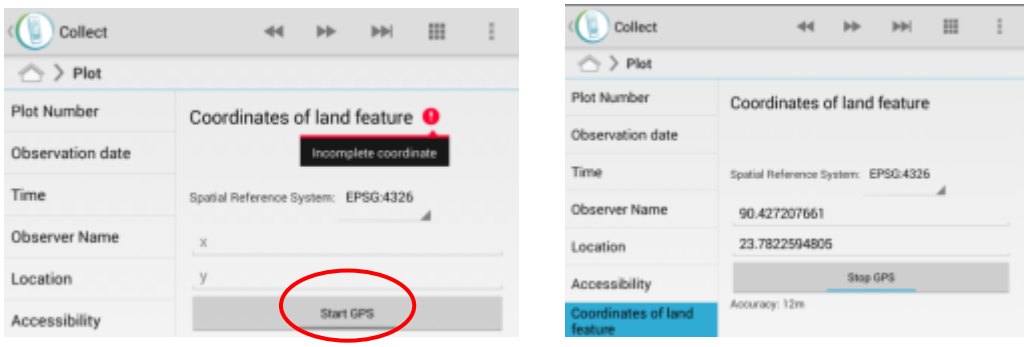
After observing the land feature, the surveyor needs to measure the accessibility and choose the best possible matches from the given options:

Item code	Item label	Item description
0	Accessible	Access to the area is uninhibited
1	Inaccessible - slope	Very steep hill making the field work dangerous
2	Inaccessible - restricted area	E.g. military areas, border areas, land mines areas
3	Inaccessible - water body	Cannot cross water
99	Inaccessible - other reasons	Provide details

4.1.6 Coordinate of the Feature (Easting/X and Northing/Y)

Wherever possible, GPS coordinates should be recorded using the hand held GPS to ensure appropriate accuracy. If no GPS is available, the internal GPS on the tablet may be used as a last resort.

The tablet device generally uses AGPS in background to capture the coordinates. The default coordinate system has been set EPSG: 4326 (which refers to WGS 1984 geographic coordinate system). In the Open Foris app you need to click/touch ***Start GPS*** to capture the coordinate:



4.1.7 GPS Coordinates taken outside land feature?

Where possible, the GPS coordinate should be recorded from within the land feature that you are describing. This is a Yes No field. If your access to the land feature is inhibited, and you are recording the coordinate from outside the land feature, select NO.

4.1.8 Distance to the observation point

This variable is dependent on a "No" answer from 4.1.7. If your position is inside of the land feature, you do not need to fill in the Distance to Land Feature, or Bearing to Land Feature.

If your position is outside of the land feature you need to measure **approximate** distance to the center of your target land feature and input the value in meters.

4.1.9 Directional bearing to land feature

This variable is dependent on a "No" answer from 4.1.7 Facing north, use your compass to identify the directional bearing to the land feature. The answer is entered in degrees.

4.1.10 Approximate Size of the Land feature

Provide an estimate to the size of the land feature. The smallest option is 0.5ha, or an area of 50m x 50m. In the field, the crew has to indicate (expert judgment) the land area into one of the following categories:

Item code	Item label
1	< 0.5 ha
2	0.5 – 2 ha
3	>2 ha

4.1.11 Geographical aspects

Provide information regarding any distinct Geographical aspect of the location considering physical, ecological and environmental characteristics. If there is nothing distinct, select 'Not relevant'. If your select 'Other', provide a comment when prompted (See 4.1.14).

Item code	Item label
0	Not relevant
1	Flood-plain
2	Basin
3	Coastal plain
4	Tract
5	Hill
6	Charland/Island
7	Beach
8	Estuary
9	Other

4.1.12 Slope Type:

The surveyor needs to judge slope of the whole land feature based on visual observation. Slope means the ratio of rise (height) to run (distance) between two points. Using a leveler with a straight stick, you can calculate the slope. The actual value of the slope is not necessary. The following options are given to help the observer making the estimate:

Item code	Item label
1	Flat/Almost Flat (0-1%)
2	Gently Undulating to Undulating (2-10%)
3	Rolling (11-20%)
4	Hilly slope (21-40%)
5	Steeply slope (40+%)

4.1.13 Slope aspects

If the slope is flat to almost flat, the slope aspect will not be relevant. Otherwise slope exists and the face of the slope may be selected from among the following options:

Item code	Item label
99	Not relevant
1	North
2	East
3	South
4	West

1.1.1. Type of erosion

Any type of erosion activity inside the observation unit must be recorded as per the following options:

Item code	Item label	Description	
99	No erosion		
1	Erosion (general)	Erosion present - type unknown	
2	Sheet	Uniform removal of soil in thin layers by the forces of raindrops and overland flow. Common on agricultural fields	
3	Rill	Removal of soil by concentrated water running through little streamlets, or headcuts.	
4	Gully	Removal of soil along drainage lines by surface water runoff.	
5	River	Erosion noticed along river side and embankments caused by hydraulic forces of water	
6	Gravitational	Evidence of land slides present	

4.1.14 Comments

Provide further description or comments about the location, physical description, identification problem, accessibility or any other issues that are not listed in the form may be recorded here. **If you selected Other for any attributes, describe them here.**

4.2 Section 2: Capturing Photograph

In the app, you need to touch the icon Capture image to capture photos of the land feature. You have option to take maximum four (4) photos. **At least four photos should be taken wherever possible.**

All photos should be taken in landscape orientation as shown in the image on the right below.

Incorrect orientation (portrait)

Correct orientation (landscape)

4.2.1 Photo position

The aspect the photo was taken from should be recorded based on the diagram below. If you are inside of the land feature you have option 1 to 4 numbers to input as name according to the direction to capture the image and if your position is outside of the land feature the photo name will be 5 to 8 as per the direction you considered to take the image.

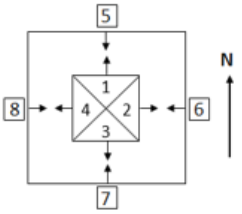
For example: your position is inside of the land feature and you captured a photo to the south direction, it means your photo name will be '3'.

PHOTOS

Shot	Position
1	
2	
3	
4	

Relative position of photograph

(if you capture photo from inside the plot then use 1 - 4 and from outside use 5 - 8 according to direction)



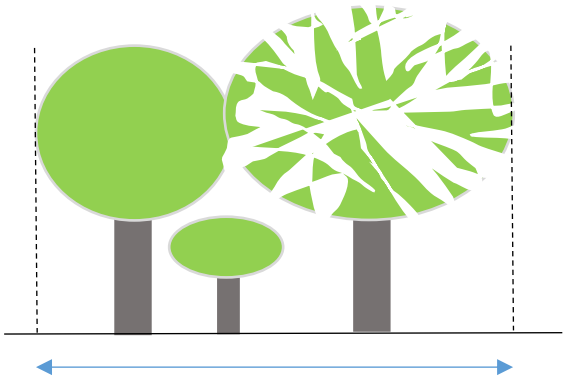
4.3 Section 3: Measuring Canopy Cover

4.3.1 Tree Canopy Cover

This field is only measured if trees greater than 3m are present within the land feature.

The Canopy cover is measured in two directions, namely North-South and East-West directions. The Canopy cover table (shown below) in the inventory form has been provided to help calculate tree canopy cover. Using the GRS Densitometer, the field crew will measure the crown cover and tree cover along the two transect (length = sub-plot diameter) as follow:

100% - Crown cover (for definition purpose)



70% - Tree cover (for remote sensing application)

Looking at the canopy cover with a GRS Densitometer and stepping at each direction (see below). Values of '1' for canopy covered area and '0' for the sky may be recorded for each step (each foot-step is approximately 1 m long) to each direction in the forms. The following picture shows example to define '1' or '0' using through densitometer:

Canopy: 1 (YES) Canopy: 2 (NO)

If more than 50% of the black circle in the densitometer is covered it is '1' for canopy measurement.

Calculation of Canopy measurement: In the above survey using the densitometer, 12 '1's out of 15 steps in the North-South direction and 9 '1's out of 15 steps in the East-West Direction the canopy cover will be calculated as follows:

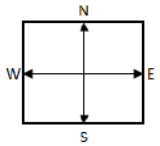
$$\text{Canopy Cover} = \frac{(12+9)}{(15+15)} x\ 100\% = 75.0\%$$

After the calculation of canopy cover you can input the value in your data collection tablet.

TREE CANOPY COVER OF PLOT:

For each point take one step (approx 1m) and mark '1' for canopy or '0' for sky in North-south and East-West directions (Use densitometer to mark '1' or '0')

STEPS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
N<-->S																

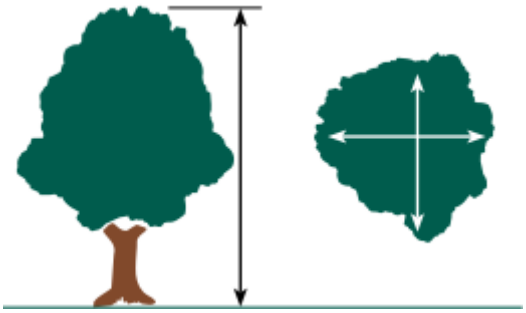


STEPS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
W<-->E																

Canopy Cover = no. of canopy points/no. of sampling points x 100%

4.3.2 Tree Crown Cover

Crown cover is different to the canopy cover as it measures the crown as a solid mass. The measurement is taken using the same methodology provide above in 4.3.1, however a densometer is not explicitly required. The measurement can be taken by pointing a finger in the air, If any area of tree crown is above you, you mark a '1' and make the calculation of percent over two 15m transects as described above. A dropdown list of ranges is provided for this value.



The 'crown' is treated as a single area so the variability of leaf area/canopy density is not considered.

4.3.3 Any other comments

Any additional information that may contribute to any special characteristics of the selected observation unit should be recorded in this section. The record should provide a crisp description of the key attributes of the site.

4.4 Section 4: Object description

To begin describing an object, press the green + sign. Continue swiping through the attributes until you reach the last attribute (Comments 4.6.3). Pressing the  icon will return you to this page where you can enter another object.

4.4.1 Natural/Semi-natural or Cultivated for management

Natural/Semi natural vegetation implies a non-cultivated area in the sense that the vegetation is not actively managed. It may be native or exotic plants. It may include a lesser proportion of planted species. Naturally occurring regrowth is likely to be present.

Cultivated vegetation may be an agricultural field, a timber plantation or other vegetation grown for its productive potential.

4.4.2 Object Type

Multiple objects can be recorded based on observed layers from the field. Two major groups of objects namely, biotic and abiotic cover is recognized. However, for clarity data recording using the following three objects are suggested here:

1. Vegetation (Biotic features)
2. Abiotic Surface (Abiotic Features)
3. Water (Abiotic Features)

4.5 OBJECT TYPE: VEGETATION (1)

Trees are generally described as woody plants greater than 5m tall, shrubs 0.5-5m and herbaceous plants and grasses are less than 0.5m in height. For each type of vegetation's existence in the land feature are required to collect information as different object.

4.5.1 Vegetation type (Tree / Shrub / Herbs Grass)

The vegetation is an intricate mixture of different *Life Forms* (e.g., trees and shrubs form a closed cover where its upper surface is so uneven that neither one nor more distinct separate layers of cover can be distinguished).

Plants essentially herbaceous but with a woody appearance (e.g., bamboos and ferns) are classified as Trees if the height is more than 5 m, and as Shrubs if the height is less than 5 m. [Source: FAO]

Item code	Item label	Item description
1	Tree	Woody vegetation greater than 5m, generally with a single stem
2	Shrub	Multi-stemmed herbaceous to woody plants between 0.5-5m tall.
3	Herbs or Grass	Graminoid/forbs/vegetable crops

4.5.2 Leaf type (Broadleaved, Needle leaved)

Broadleaved trees are most common Bangladesh. Needle leafed trees include the casuarinas in the coastal region By default the leave type will be broadleaved trees.

Needle leaf

Broad leaf

4.5.3 Leaf Phenology (Deciduous / Evergreen)

This is relevant for trees only. The leaf phenology is for the general behavior of woody plants throughout the year. Two types have to be distinguished: Evergreen and Deciduous. A description of a mixed class can also be assigned.

Deciduous trees, such as Sal trees, seasonally lose their leaves. Evergreen trees keep their leaves all year round.

Deciduous Sal tree

Evergreen Forest

4.5.4 Percentage of Each type of Phenology

If mixed phenology is selected, the crew is required to calculate the percentages of each type leaved phenology.

4.5.5 Height (Meter)

The height of the vegetation is entered here. Height is to be entered as a range in metres– ie: 10-15. This is relevant for all classes of tree, shrubs, herbs or grasses.

4.5.6 Vegetation cover (%)

This field is defines the vegetation cover of the object you are describing. For a rice field may have a cover of 80This is separate from the Canopy Cover described in 4.3.1. The field allows you to select from the following values:

Item code	Item label
1	1-10%
2	10-20%
3	20-40%
4	40-60%
5	60-80%
6	80-100%
7	10-60%
8	60-100%
9	10-100%
10	40-100%

In relation to tree height, if more than one height class exists within the same land feature, the 'objects' should be entered in separately. For example, if there are two distinct tree species, and one ranges from 15m-20m and the other ranges from 5m-7m, the two will be entered in as separate objects.

4.5.7 Growth Form Age (Even/Uneven)

Most of the cases naturally developed trees are uneven and plantation trees are even aged. The observer needs to carefully look at the tress to identify the maturity of the trees.

Item code	Item label	Item description
1	Uneven age	Typically natural forest or agro-forestry systems
2	Even age (Sapling)	Young planation, just planted
3	Even age (semi-mature)	Semi-mature plantation or orchard
4	Even age (Mature)	Mature tree population

4.5.8 Plantation or Orchard

Enter YES if the object being described is a plantation or an orchard. This field is dependent on Cultivated and Managed being selected in 4.4.1.

4.5.9 Felling type

If Yes is answered for 4.5.8, select felling type from the options below:

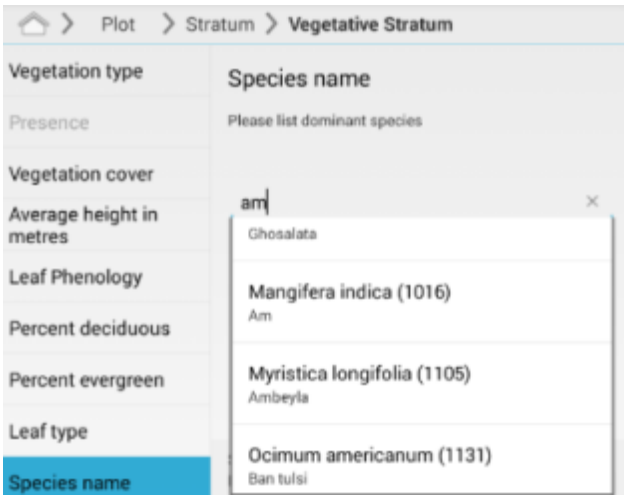
Item code	Item label	
1	No felling	No evidence of tree harvesting identified in the area
2	Clear felling	Broad scale (whole field) tree harvesting
3	Selective felling	Selected trees harvested from an area. This may include illegal tree removal.
4	Strip felling	Harvesting of trees in a linear pattern
5	Unknown	Tree harvesting but type unknown. Provide further description in the comments.

4.5.10 Rotation

Provide a range in years of rotation period if known - ie: 15 - 20

4.5.11 Species name(s) (or description of species group)

The Open Foris application has a pre-defined list of Tree species named. When you begin to type the predictive list of names will appear. **Here the dominant tree species should be entered.** For example, in recording Mango tree as the dominant species of the observation area first write 'Mango', if that is not listed in the app type 'am' (which is the Bangla word for Mango) and scroll down the list that appears (see below) and select the appropriate match. The existence of secondary species should be recorded in next field.. If you do not know the actual name of the tree but can describe it, go to the next section.



4.5.12 Secondary species / details

Enter 2-3 secondary species names as relevant. For example, in a typical agro-forestry system, you may list Jackfruit, Mango, Coconut. If species names are not found in the previous attribute field they should be entered here.

4.5.13 Status of cultivation land

Enter the current status of land present at the time of assessment.

Item code	Item label
1	Fallow
2	Ploughed
3	Initial Stage
4	Fully Matured
5	Recently Harvested

4.5.14 Crop and cropping pattern

Information about the temporal sequence of crop land can be entered here. This information is required only if the observed location is agricultural/cropland. Since, most of our agricultural lands are being used for single to multiple cropping in a year so the observer needs to collect information for all rotation crops as in temporal sequences.

For example: The land feature you have selected may produce three crops per year with following sequences (discussed in reference example two) and the floristics variations of each season also needed to record from the field.

Enter the information into the Open Foris in the following format:

Robi crops (Nov – Feb), Jute (Mar – Jun) and T.Aman (Jul/Aug - Nov)

If taking notes on paper, you may enter as shown below:

Month / Season	1 JAN	2 FEB	3 MAR	4 APR	5 MAY	6 JUN	7 JUL	8 AUG	9 SEP	10 OCT	11 NOV	12 DEC	Crop Name
1	—	H									S	—	Veg.(Potato)
2			S	—	—	H							Jute
3							S	—	—	—	H		T. Aman
4													-

'S' indicates sowing time and '**H'** indicates harvesting time.

4.5.15 Water supply (Irrigated/ Rain-fed/ Flooded/NA)

The field crew must record information of water supply from the local people for crop land. The option can be more than one depends on season. This field is not mandatory to record for trees or shrubs as mentioned earlier.

Item code	Item label	
0	Not irrigated	Select this option if no active irrigation regime is in place
1	Irrigated	Sprinklers or other irrigation infrastructure is present
2	Post Flooding	Water is pooled and stored for irrigation
3	Rainfed	Applies to crop field reliant on rain for irrigation
4	Both Rainfed and Irrigated	Combination of options 3 and 4
5	Other	Provide details in the comments.

4.5.16 Fertilization

Preferably this information is derived from speaking with the land owner. In the case of organic fertilizers this information may be physically observed. Leave blank if unknown.

Item code	Item label	Description
99	Unknown	
1	None	
2	Organic	Animal manures, seaweed etc
3	Inorganic	Synthetic mineral compounds
4	Organic and Inorganic	

4.5.17 Frequency of fertilization

How many months per year does fertilization occur. Leave blank if unknown

4.5.18 Rotation period/Presence time

For this field, crews can ask the owner in case of social or homestead forest plantation and forest officer for the reserve plantation forest to get the information.

- For crops, how many months are crops grown
- For plantations, how long is the rotation period

4.6 Disturbance type

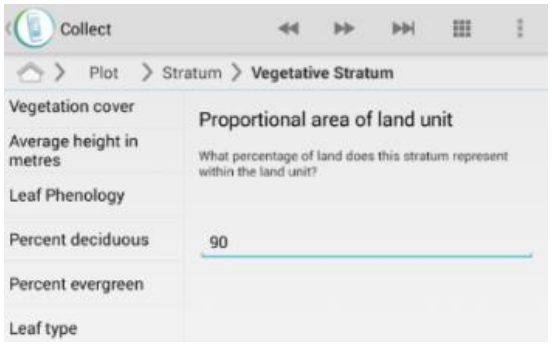
In case of any disturbance existence observed by the crew should be recorded here. For example, % of pest attacked or disease observed, % burnt or grazed areas are seen in the observed location must be filled.

4.6.1 Disturbance options

Four options are provided under this heading. A percentage of area should be provided for: burnt, grazed, pests, and other.

4.6.2 Proportional area of land unit

The percentage of the object you have described as a proportion of the total land feature. If only one Object is described (such as in a plantation forest) then it will be 100%, if multiple, then the percentage of land represents as individual object considering total number of strata). It means, ratio between each layer is recorded as proportional land unit.



4.6.3 Comments

Any other important and additional information those are not recorded in above list can be written here.

Now touch  icon to return to the Stratum root to add another new stratum.

4.7 OBJECT TYPE: ABIOTIC (2)

When the field crew identify non-vegetation surface and not water or associated features will be recorded as 'abiotic' surface which could be both natural and artificial/manmade land surfaces. This type of feature can be linear and non-linear. A linear feature may be a road, railway or powerlines. Non-liner features include sand, clay, bare soil, built up area etc..

4.7.1 Abiotic surface

Select the type of abiotic surface to be described:

Item code	Item label	Item description
1	Building / Construction	Any building type
2	Linear surface	Road, railway, communications infrastructure
3	Natural abiotic surface	Rocks, sand, bare soil
4	Extraction / Dump	Mine, extraction areas, dump site

4.7.2 Type of structure present

If 1: Building / Construction is selected, the following option will be available for selection:

Item code	Item label
1	House
2	School
3	Shopping/Commercial Area
4	Factory/Warehouse
5	Cultural/Recreation Area
6	Heavy Industrial Area
7	Historical Site
8	Religious site/structure (Mosque/Church/Temple)
9	Cemeteries
10	Sewage Treatment Plant
11	Sports and Leisure Faciities
12	Station
13	Urban Playground
14	Terminals
15	Airport
16	Others

4.7.3 Predominant construction material

As above, if 1: Building / Construction is selected, select the most dominant construction material from the list below:

Item code	Item label
1	Brick
2	Concrete
4	Steel
3	Wood
5	Bamboo
6	Rock
7	Fibre/Reed
8	Mud
9	Mixed materials
10	Other

4.7.4 Construction users for Artificial Surface

The crew is required to record construction use if the observed surface is artificially constructed as per following option:

Item code	Item label
1	Brick
2	Concrete
4	Steel
3	Wood
5	Bamboo
6	Rock
7	Fibre/Reed
8	Mud
9	Mixed materials
10	Other

4.7.5 Linear Surface details

If 2: Linear Surface is selected, provide a description of the linear surface.

A linear surface is a road, railway, communication/electricity lines, wall etc.

4.7.6 Abiotic features present

If 3: Natural abiotic surface is selected in 4.7.1, select from the list below:

Item code	Item label	Item description
1	Bare soil	
2	Mud flat	
3	Bare rocks	
4	Salt flat	
5	Sand deposit	
4	Other	

4.7.7 Proportional area of land unit

Proportional area of land unit refers the percentages/ratios between the observed object or defined elements of the land features.

From the example case three: the relative proportions are houses: 20-30% and path/walkway: 20%, Trees: 40-60%, Water (pond): 10-20% and others: 5-10% are recorded to define rural settlement.

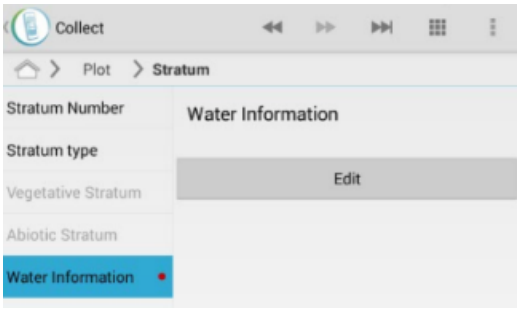
4.7.8 Other Comments

Provide any addition comments including those related Dump site/Extraction if selected in 4.7.1.

4.8 STRATUM TYPE: ABIOTIC (3) WATER AND ASSOCIATES

In case of existence of water and associated features in the observed location will be recorded as abiotic water and associated features. It can be declared as different stratum or an element of a stratum. In the first example (mangrove forest) water is declared as an individual object on the other hand to define rural settlement the existence of water as 'pond' can be declared an element of common stratum. Nevertheless, the crew do not require to worry about for stratum separation. They must collect information without bias. Any type of objects can be recorded as different object in the app.

To input water and associated information for the observed object the crew is needed start edit to get access to the detail of the object/stratum:



4.8.1 Water body type: (Pond/Lake/ River/inundated)

Item code	Item label	Description
1	Pond	Small water body, typically man made
2	Lake	Large water body, typically natural but can be man made
3	River	A liner flowing body of water
4	Inundated	Area affected by flood however water has not been able to recede and remains in situ for longer than normal (6 – 9 months)
5	Haor	A wetland ecosystem in the NE area of Bangladesh
6	Beel	A saucer shaped shallow depression periodically containing water.
7	Baor/Oxbow Lake	A U-shaped body of water formed from disconnection of a river
8	Estuary	A confluence of sea water and fresh water near the coast
9	Stream /creek	A small river or tributary, sometimes called a creek.
96	Other	

4.8.2 Water Artificiality: (Artificial/Natural)

A water body may be natural or man made. Ponds and canals are examples of mad made water bodies. Rivers and lakes may be natural.

Item code	Item label_en	Description
1	Natural	River, natural lake
2	Artificial	Pond, canal
3	Aquaculture	Fish pond

4.8.3 Water dynamics (Flowing/ Standing/ Stagnant)

Other than river water most of the cases the water dynamics are standing or stagnant. The crew has to identify the water dynamics during the field visit and record information as like below:

Item code	Item label	Item description
1	Flowing	Moving water
2	Standing	Non-moving water
3	Waterlogged	Inundated area with restricted outflow

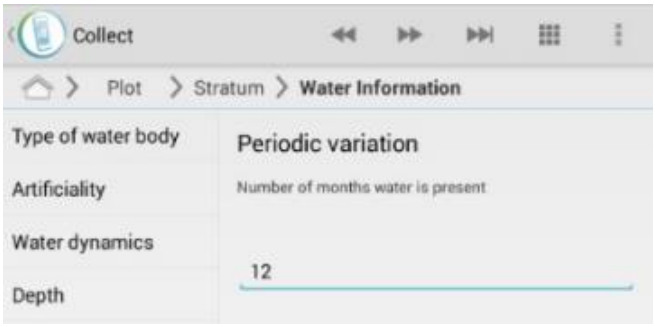
4.8.4 Water Salinity Type (Brackish/ Saline/ Fresh)

In Bangladesh, the saline and brackish water can be observed in the lower reaches of Meghna estuary, near the Bay of Bengal and the Sundarbans forest area those are also influenced by river inflow and tides. Other than those are the water type can be identified as fresh water. The field crew can measure by the taste of the water or from local people to select the following option:

Item code	Item label	Item description
99	Unknown	
1	Saline	Salty water
2	Fresh	Non-salty water
3	Brackish	Salt water and fresh water mixed together

4.8.5 Periodic variation (1 - 12 months)

If the water is only present at certain times of the year, list how many months the water is present, or specify a range January = 1 and December = 12 (ie: 1-12)



4.8.6 Depth (Meters)

The approximate depth is required to collect from the field. It may not be possible to collect the actual average depth of the observed water unit however, local people can help to record the depth. **Depth is recorded in meters**

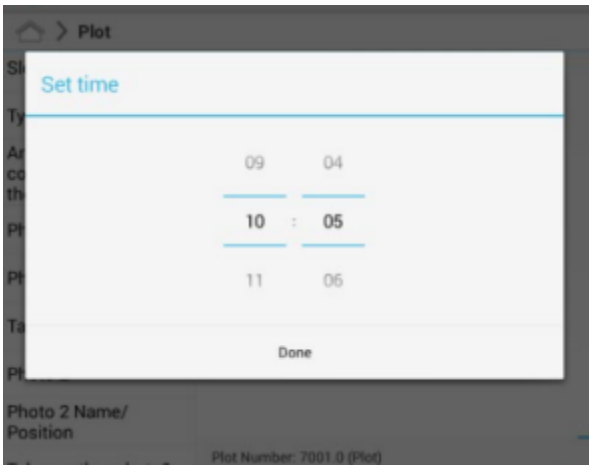
4.8.7 Water Comments

Provide any other comments relevant to the water.

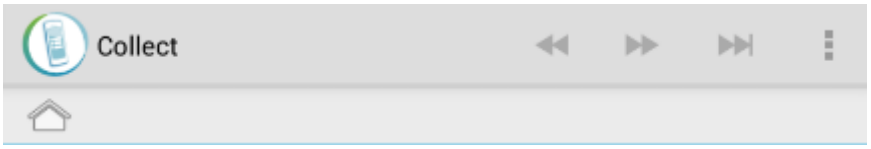
This is the last field in the application. Move to next section using the arrows >>|. This will return you to the Stratum page. If you have no more objects to enter, swipe right to continue.

4.9 Finalising the land feature description

Once you have completed the description you will be prompted to enter the time signifying completion. Then press the home icon to return to enter a new land feature.



To finish the land feature entry touch  icon. You also can use home icon  to end any point of data entry.


Collect

5 APPENDICES

5.1 Annex1: Inventory Form

National Land Cover Field Inventory Form: 2016
BANGLADESH

OBSERVATION ID		EASTING/LONGITUDE (X):		Relative position of coordinates (5 means you are inside the plot)
DATE	d / m / 2016	NORTHING/LATITUDE (Y):		
OBSERVER NAME:		Position of Coordinate relevant to the plot : (Refer to the diagram)		135 180 225 N 1 2 3 90 4 5 6 270 7 8 9 45 0 315
LOCATION: (Thana/Village)		If you observing the plot from a distance:		
		Distance to land feature: (in metres)		
Approximate size of plot: (in ha)		Bearing to land feature: (in deg) (User compass to calculate bearing) The diagram also helps to calculate		
□ < 1 ha □ 1 - 5 ha □ 5+ ha				

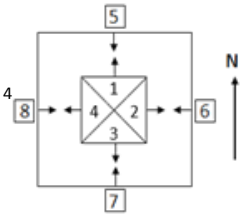
ACCESSIBILITY:	□ accessible □ inaccessible - slope □ inaccessible - restricted area □ inaccessible - waterbody □ inaccessible - other reason
GEOGRAPHICAL ASPECTS:	◯ Flood-plain ◯ Basin ◯ Coastal plain ◯ Tract ◯ Hill ◯ Charland/island ◯ Beach ◯ Estuary ◯ Other
TOPOGRAPHICAL ASPECTS:	Slope face ◯ North ◯ South ◯ East ◯ West ◯ Not relevant
Slope Type:	◯ Flat/Almost Flat (0-1%) ◯ Gently Undulating to Undulating (2-10%) ◯ Rolling (11-20%) ◯ Hilly slope (21-40%) ◯ Steeply Slope (40+%)
Type of Erosion:	□ No erosion □ Erosion (general) □ Sheet □ Rill □ Gully □ Wind
COMMENTS:	

PHOTOS

Shot	Position
1	
2	
3	
4	

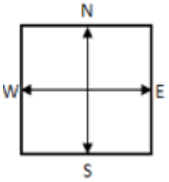
Relative position of photograph

(if you capture photo from inside the plot then use 1 - 4 and from outside use 5 - 8 according to direction)



TREE CANOPY COVER OF PLOT:

For each point take one step (approx 1m) and mark '1' for canopy or '0' for sky in North-south and East-West directions (Use densitometer to mark '1' or '0')



STEPS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total (N-S)
N<-->S																

STEPS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total (W-E)
W<-->E																

Canopy Cover = no. of canopy points/no. of sampling points x 100%

POINT ID:			DATE:	/ / 2016

S/N	OBJECT TYPE	VEG. TYPE 1 - Trees 2 - Shrubs 3 - Herbs 4 - Lichen & Mosses 5 - Algae	*Mandatory for Trees & Shrubs*				*Mandatory for Trees*		*Mandatory Gen.* →	
			LEAF TYPE (Note-a)	LEAF Phenology (Note-b)	% of Each Phenology (in case of mixed)	HEIGHT (Metres)	Growth Form Age Note-c	SPECIES NAME(S) /description of Species Group	ARTIFICIALITY 1. Natural or Semi- natural 2. Cultivated and Managed	COVER (%)
	Vegetation									

S/N	→ *Mendatory for Herbs (Crops)*				*Extra Attributes/Optional*				*ABIOTIC (2): Artificial/ Natural Surface*		
	CULTIVATION STATUS (Note-d)	Temporal Secquence for Crops (Ref. Diagram)	WATER Supply (Note-e)	Fertilization 1. Organic 2. Inorganic (with Frequency)	ROTATION PERIOD (in year)	DISTURBANCE			OBJECT TYPE	ABIOTIC SURFACE TYPE (Note-f)	Constr-uction Use (Note-g)
						Burnt (%)	Pest (%) / Disease (%)	Grazed (%)			
									Abiotic Surface		

S/N	→ *ABIOTIC (3): Waterbody and Associated Surface*							ALL OBJECTS	
	OBJECT TYPE	WATER BODY TYPE (Note-h)	Artificiality 1.Natural 2.Artificial 3.Aquacul	WATER DYNAMICS 1.Flowing 2.Standing 3.Stagnant	SALINITY 1. Brackish 2. Saline 3. Fresh)	PERIODIC VARIATION (1-12 months)	DEPTH (in m)	PROTIONING between Objects (%)	OTHER LISTED CHARACTERISTICS (see table) and/or user defined
	Waterbody								

Temporal Sequence of Crops Diagram

Month / Season	1	2	3	4	5	6	7	8	9	10	11	12	Crop Name
1													
2													
3													
4													

For each cropping season draw a line from sowing month (or part of months) to harvesting month (or part). You have options maximum four (4) lines to draw for showing four seasonal crops

5.2 Annex 2: Fields Notes:

a- Vegetation (Trees/Shrubs)
Leaf Type:
1. Broad leaved
2. Needle leaved
3. Mixed

(In Bangladesh there is no existence of needle leaved trees. So this field by default can be filled with Broad Leaved)

b- Leaf Phenology:
1. Deciduous
2. Evergreen
3. Mixed
4. Annual
5. Biennial
6. Perennial

1-3 is for Trees or Shrub

4-5 in case of Herbs/Grass

c- Growth Form Ages (Maturity):
1. Uneven age/
2. Even age (sapling)/
3. Even age (semi-mature)/
4. Even age (mature)/
5. Even age (very old/senescent)

d- Status of Cultivated Field:
1- Fallow,
2- Ploughed,
3- Initial Stage,
4- Fully Mature,
5- Recently Harvested

e- Water Supplying status:
1 - Irrigated,
2- Post Flooding,
3. Rainfed,
4. Both Rainfed and Irrigated,
5. Other

f- Artificial/Natural Surface types:
1. Building,
2. Road,
3. Railway,
4. Sand Deposits,
5. Industrial Structure,
6. Dump site
7. Other

g- Construction type:
1. Airport,
2. Cemeteries,
3. Shopping/Commercial Area,
4. Warehousing C/A,
5. Cultural/ Recreation Area,
6. Heavy Industrial Area,
7. Historical Site,
8. Religious Site,
9. School Premises,
10. Sewage Treatment Plant,
11. Sports and Leisure Facilities,
12. Station,
13. Urban Playground,
14. Terminals,
15. Others

h- Water Type:
1. Pond,
2. Lake,
3. River,
4. Inundated,
5. Haor,
6. Beel,
7. Oxbow Lake/Baor
8. Other

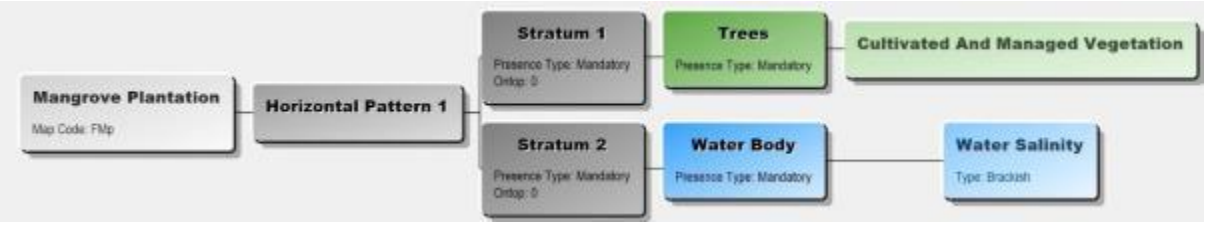
5.3 Annex 3: Classification Descriptions

Example A)

This ecosystem located in the south-eastern area (Maheshkhali, Cox's Bazar) of Bangladesh is characterized by the presence of trees, shrubs and fluctuation of tidal water.

Picture 2: Second example

Data records in this case should indicate two different types of objects, where the first object is vegetation (Trees) and the second object is water and the other attributes of water are: salinity type is 'brackish', periodic variation is 'tidal'.



LCCS Diagram: Mangrove Plantation

Example B

In this example, the land feature is cultivated cropland. The agricultural practices in a single land varies from one to maximum three crops per year (rotation patterns of the crops) and each of the crops correspond to a particular season (in this case winter season). During the field observation the crew cannot collect seasonal data by observation only. The field observer must collect and record information on the cropping practices of the other seasons through querying local people. Other season crops in this case are recorded: Jute/Fallow followed by Transplanted Aman rice. These

means all the crops produce in this land have sequential temporal relationship.

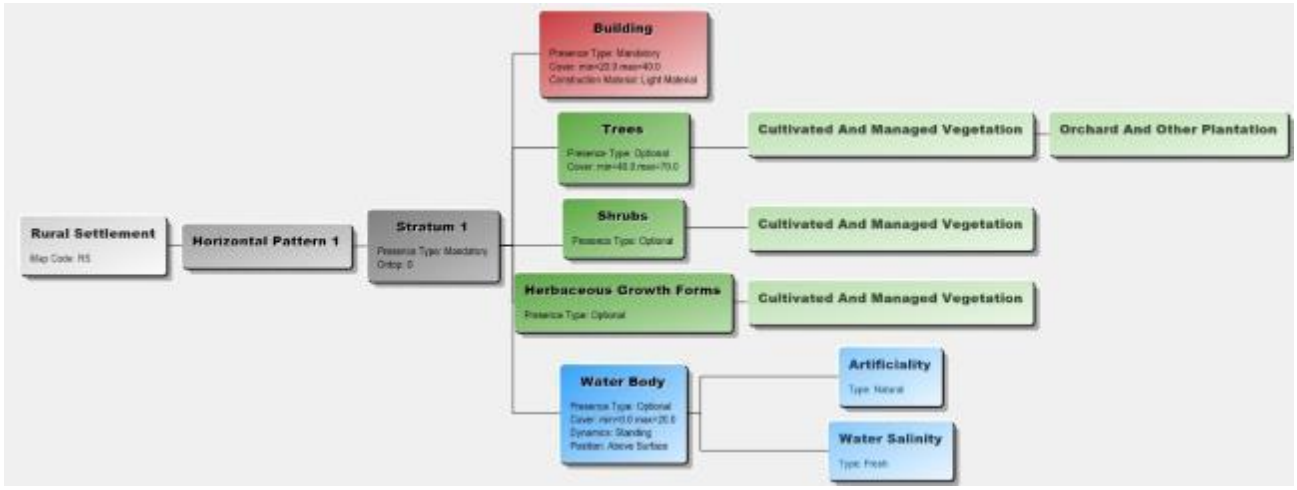
Picture 3: third example

LCCS Diagram: Multiple Crops

Example C

In this example, land features include houses, trees, yards, water (pond), path/walkway. All these elements are to be recorded under a single stratum and the relative proportions in this scene are houses: 20-30% and path/walkway: 20%, Trees: 40-60%, Water (pond): 10-20% and others: 5-10%.

Picture 4: Rural Settlement



LCCS Diagram: Rural Settlement

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