

Manual for **Forest Land Boundary Digitization**

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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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Executive Summary

Forest boundaries in Bangladesh need to be accurately demarcated to ensure their complete protection and optimal use. Buried pillars for the demarcation of forest land do not exist for all forest types. The Forest Department manages its land according to gazette notifications and uses hard copies of Cadastral, Revisional and Bangladesh Survey maps. These maps need to be digitalized to delineate the precise location and extent of forest land. Digital boundaries for some stretches of forest in the country have been digitalized previously by several initiatives of the Forest Department, but no complete boundary is available for the forest types except Sundarban. Hence this manual has been prepared on the subject of precise delineation of forest land boundaries from mouza/sheet maps through digitalization and processing.

Two pilot studies were conducted to develop the methodology for preparing a GIS layer of forest land boundaries. The pilot areas were Banstail Range of Tangail Forest Division and Mirsharai Range of Chittagong Coastal Forest Division. National consultation with stakeholders was conducted to share and discuss the methodology. The gaps and next steps identified in the consultation were taken into consideration for the finalization of the methodology.

The preferred method of boundary delineation is a combination of scanning and on-screen digitalization. Digitalization results in the generation of vector data. This can be done using two platforms- ArcGIS and AutoCAD. Both the procedures have been discussed in this manual.

Acronyms

BFD	Bangladesh Forest Department
BS	Bangladesh Survey
BTM	Bangladesh Transvers Mercator (Projection System)
CEGIS	Center for Environmental and Geographic Information Services
CS	Cadastral Survey
datEx	Data Experts (Pvt) Limited
DFO	Divisional Forest Officer
DGPS	Differential Global Positioning System
DLRS	Directorate of Land Record and Survey
FAO	Food and Agriculture Organization of the United Nations
GCP	Ground Control Point
GIS	Geographic Information System
RS	Revised Survey
RTK	Real Time Kinematic

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1. Introduction

The development of a methodology for forest boundary digitalization is begun under the project “Strengthening National Forest Inventory and Satellite Land Monitoring System in support of REDD+ in Bangladesh”. Forests on the CS, RS and BS maps, have been declared in the Gazette Notification. It is possible to identify those forests and prepare a digital forest land boundary database using GIS technology. Importantly, the accuracy of the database depends on the methodology used for this purpose.

A study was carried out at two pilot sites: (i) Mirsharai Range of Chittagong Coastal Forest Division and (ii) Banstail Range of Tangail Forest Division; to develop the methodology of forest boundary delineation. The forest land boundaries of Mirsharai Range and Banstail Range were delineated using BS map and CS map respectively. A national consultation was conducted on 12th April 2016 to share the results of both pilot studies. Comments from the consultation were incorporated for refining the methodology of forest land boundary digitization in future.

The objective of the pilotings was to develop a methodology to delineate the forest land boundary from available CS/RS/BS mouza map sheets following the gazette notifications of the Government. This manual describes the methodology based on the findings of both pilot sites of Mirsharai Range and Banstail Range.

2. Objectives

The main objective of this manual is to document the methodology of forest land boundary delineation so that the Forest Department can prepare a GIS database of forest land boundaries following this manual in future. It will provide specific guidelines for digitalizing the forest land boundary from mouza sheet maps.

3. Users of the Manual

The users of the manual are the people who will be engaged in digitalizing the forest land boundary. It is important that the users of the manual have:

- a) Basic training on GIS, digitalization and editing using ArcGIS and AutoCAD Map software
- b) Working experience in digitalizing mouza sheet maps
- c) A good understanding of the relational database

4. Required Dataset and Software

4.1 Mouza Sheets

The mouza sheets for the pilot areas are collected from the respective forest divisions. They usually contains natural and manmade features such as plots, channels/khals, road/halots, hills, vegetative cover, trees, ponds, permanent structures etc. Some mouza sheets also contain forests and jungles.

In general, the mouza sheets are damaged due to age: some mouza sheets have unwanted spots due to deposition over time of dust and soot, and also insect damage ; some mouza sheets are illegible. These issues should be handled during scanning and digitalization of the mouza sheets using informed judgment and discussion with experts in the relevant field.

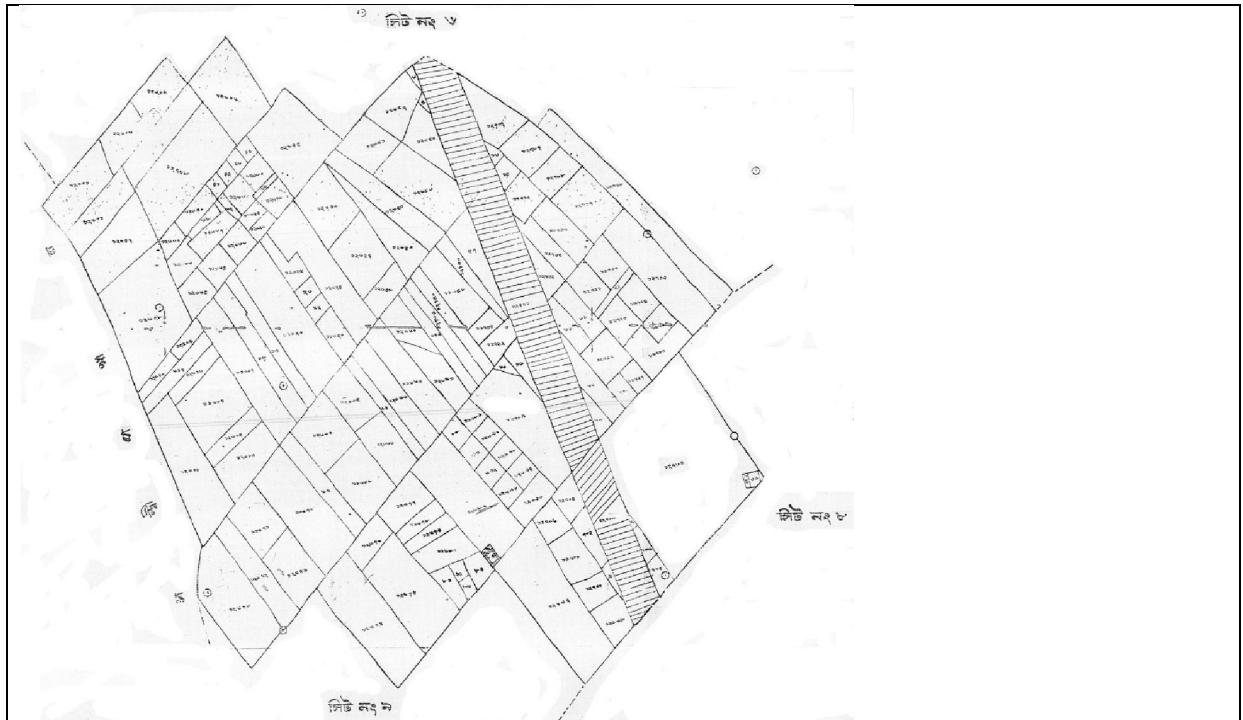
All the mouza maps basically contain: a) the plots with plot number and different symbols and names of peripheral mouza sheets b) locational information and scale of mouza map and c) legend and plot schedule of the mouza sheet, and d) signature of the authority with the date of preparation. These are shown below and detailed symbolization used by DLRS for mouza maps are given in Annex-A at the end of this user manual. Figure-1 shows the different information given on a mouza sheet.

4.2 Gazette Notifications

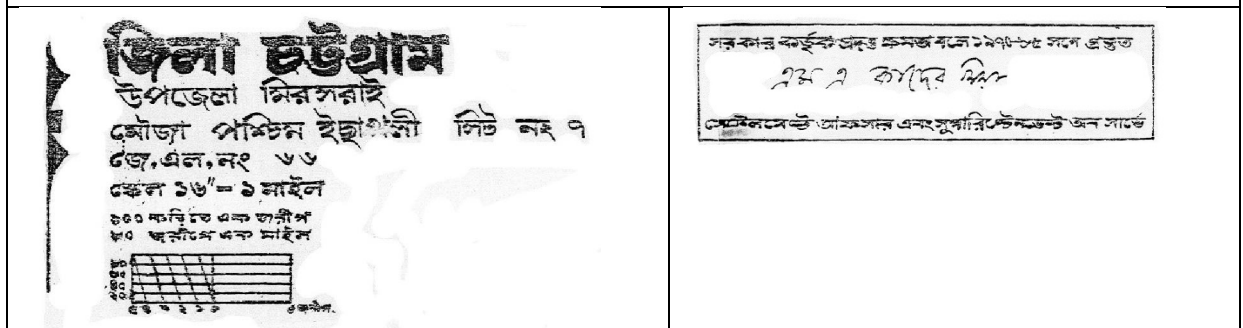
These documents may be collected from Forest Department head office or local forest offices. It contains the discrete plot numbers (dag number) of the mouza plot which are declared as forest land by the Government of Bangladesh. These numbers are used to identify the forest plots in the mouza sheets. Those identified plots help to delineate forest land boundaries.

4.3 Software Used

Table-1 shows the name of the software used for forest land boundary database preparation. The ArcGIS or AutoCAD software may be used to digitalize mouza sheets. The ArcGIS software is designed to handle spatial data and attribute data preparation and GIS analysis. On the other hand, the AutoCad Map is designed for managing precise engineering drawings. It is much faster for digitalization of precise engineering drawings. Whatever the software is, the outcome is the same. The attribute database of the mouza plots which are declared in the Gazette Notification as forest plots may be prepared using Microsoft Access software or Microsoft Excel.



a) plots with plot number and , different symbols and names of peripheral mouza sheets



b) locational information and scale of mouza map

d) Signature of the authority with preparation time



c) Legend and plot schedule of that the mouza sheet

Table-1: Software used for forest land boundary database preparation

Software	Purpose
AutoCAD Map	For mouza map digitization, Edge-matching
ArcGIS	For mouza map digitization, Geo-referencing, Edge-matching, Forest boundary delineation by linking database of gazette, Map preparation.
Microsoft Access or Microsoft Excel	For preparing database of forest lands according to GOB gazette

5. Building the Forest Boundary Database

The forest land boundary was delineated following a step by step procedure (Figure-1). The collected mouza map sheets were scanned into digital image files. The mouza plot boundaries were digitized from each scanned digital image file using on-screen digitization technique and attributes of each plot were added with digitized plot data. The detailed description of the methodology of this study is given below.

5.1 Collection of Hardcopy Mouza Sheets

The latest mouza sheets may be collected from the corresponding local forest offices or DLRS. The collection of mouza sheets is a very lengthy process. The direct involvement of higher officials of BFD and DLRS in the process may help to collect mouza sheets within a short time. Only the photocopies of the mouza sheets are available from sources. It is recommended collecting good quality of photocopies of mouza sheets to minimize digitization error.

5.2 Preparing the Manuscript for Digitization

Feature wise, four manuscripts was used for digitizing the mouza maps. All the features of mouza sheets were stored in dwg files of AutoCAD and ArcGIS shape file with a unique ID or code number of the respective features. All the types of manuscripts are described and illustrated below:

Manuscript-1: Line Features

This manuscript is for digitizing all linear features and plot boundaries such as mouza boundary, mouza sheet boundary, mouza plot boundary, roads, halots, khals, rivers, north line etc. After digitization, all the features were stored as line with unique ID (Code) representing feature type. The naming convention for the shape file is xx_xxx_xx_L (where 'L' denotes Line). The detail of the Manuscript-1 is given in the Table-2.

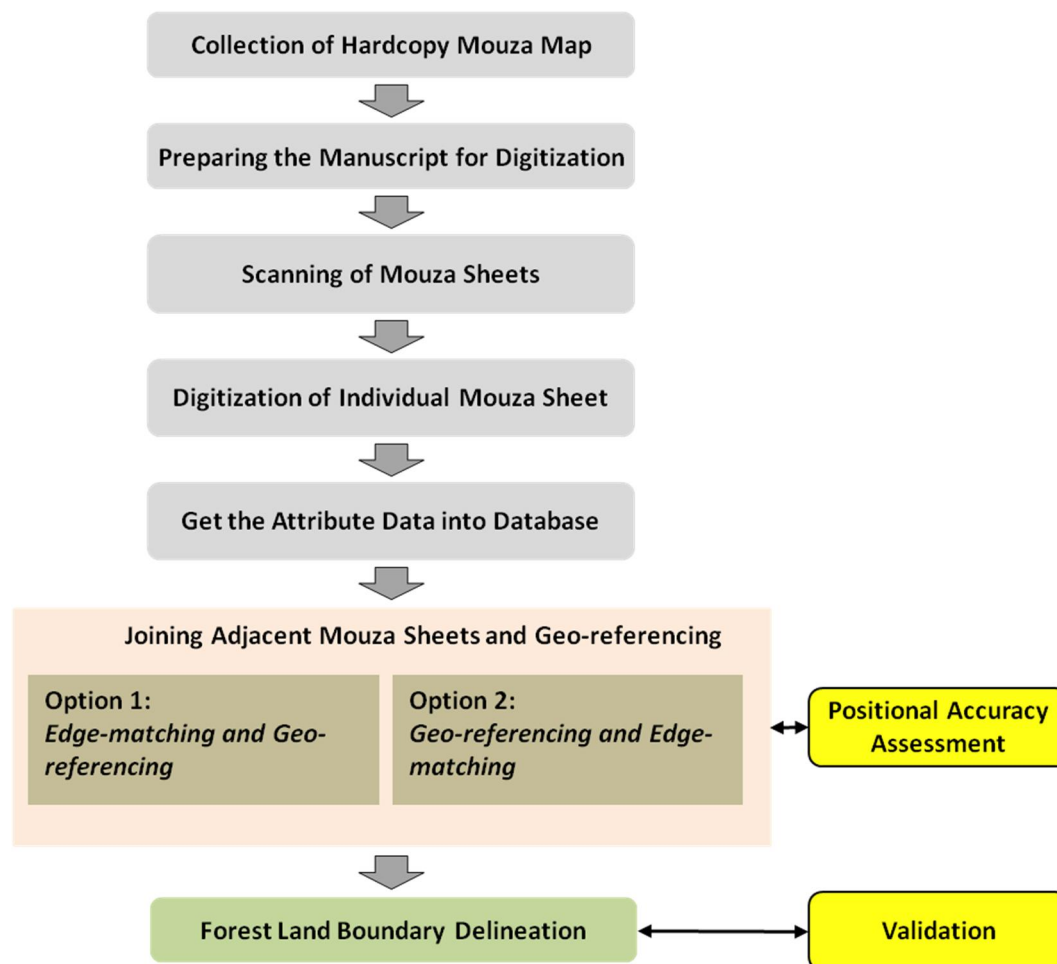


Figure-1: Methodology of Forest Land Boundary Generation.

Table-2: Manuscript for line features

Sl. No	Feature Type	Code (ID)	Shape Type	Shape Name
1.	BND (Mouza)	11	Line	xx_xxx_xx_L (where 'L' denotes Line)
2.	BND (Sheet)	12	Line	
3.	Match Line	13	Line *	
4.	Plot	14	Line	
5.	Embankment	16	Line	
6.	Road	21	Line	
7.	Khal/Canal	23	Line	
8.	River	24	Line	
9.	North Line	27	Line *	

* These lines wouldn't be used for polygon building.

Manuscript-2: Plot Numbers

The manuscript-2 was used for digitizing all the plot numbers of the mouza sheets. The code used for plots, unidentified plot numbers, missing plot numbers, and disputed plots and plot lines can not be identified are shown in the Table-3.

Table-3: Manuscript for line features

Sl. No	Feature Type	Code (ID)	Shape Type	Shape Name
1.	Plot No.	As in mouza sheets	Point	xx_xxx_xx_N (where 'N' denotes Number)
2.	Unidentified Plot Number (not readable)	999991, 999992...	Point	
3.	Missing plot numbers (not mentioned in the original map)	888881, 888882...	Point	
4.	Disputed plots, plot lines can't be identified	777771, 777772...	Point	

The features digitized using Manuscript-1 and (excluding the * marked items) and Manuscript-2 were used to create polygon database of mouza plot. The naming convention for the mouza plot database is xx_xxx_xx_M (where 'M' denotes Mouza).

Manuscript-3: Other Features

This manuscript was used for digitizing the linear features such as different types of structures, ponds, pan boroj, graveyard, etc. The digitized features were stored as line having unique ID (Code). The detail of the Manuscript-3 is given in the Table-4.

Table-4: Manuscript for other features

Sl. No	Feature Type	Code (ID)	Shape Type	Shape Name
1	Permanent Structure (Dalan)	31	Line	xx_xxx_xx_S (where 'S' denotes Structure or Other polygon features)
2	Tin Shed Structure	32	Line	
3	Other Structure	33	Line	
4	Pan Boroj	34	Line	
5	Pond/Water-body	35	Line	
6	Unidentified Structure	35	Line	
7	Graveyard	36	Line	

Manuscript-4: Point Features

The point features of the mouza maps such as Bench Mark, Traverse Station, GT Station, Iron Pillar, Other Pillars, etc. were digitized following the Manuscript-4. Each point feature was stored with a user ID (Code) representing the feature type. The Table-5 shows the detail of the Manuscript-4.

Table-5: Manuscript for point features

Sl. No	Feature Type	Code (ID)	Shape Type	Shape Name
1.	Boundary Pillar	41	Point	xx_xxx_xx_P (where 'P' denotes Point features)
2.	Bench Mark	42	Point	
3.	Iron Pillar	43	Point	
4.	Traverse Station (Old)	44	Point	
5.	Traverse Station (New)	45	Point	

Sl. No	Feature Type	Code (ID)	Shape Type	Shape Name
6.	GT Station	46	Point	
7.	Other Pillars	47	Point	
8.	Pucca Well	51	Point	
9.	Tube Well	52	Point	
10.	Mosque	53	Point	
11.	Temple	54	Point	
12.	Adjacent Mouza/Sheet	61	Point	
13.	Other Info	62	Point	
14.	Demarcation Pillar	71	Point	
15.	Settlement Pillar	72	Point	
16.	Stone	73	Point	
17.	Station	74	Point	
18.	Pucca Pillar	75	Point	
19.	CS Iron Pillar	77	Point	
20.	Other Point Feature	88	Point	

5.2 Scanning of Mouza Sheets

The mouza map sheets were scanned following the scanning specifications given in the Tabel-6. Figure-2 shows the scanned map of the mouza sheet of Pashchim Ichhakhali, JL No. 66, Sheet No. 7 of Mirsarai Upazila, Chittagong District.

Table-6: Mouza sheet scanning specifications

Image type	Grayscale
Image format	JPG
Image Resolution	300 dpi
Image Scale	100% (1:1)

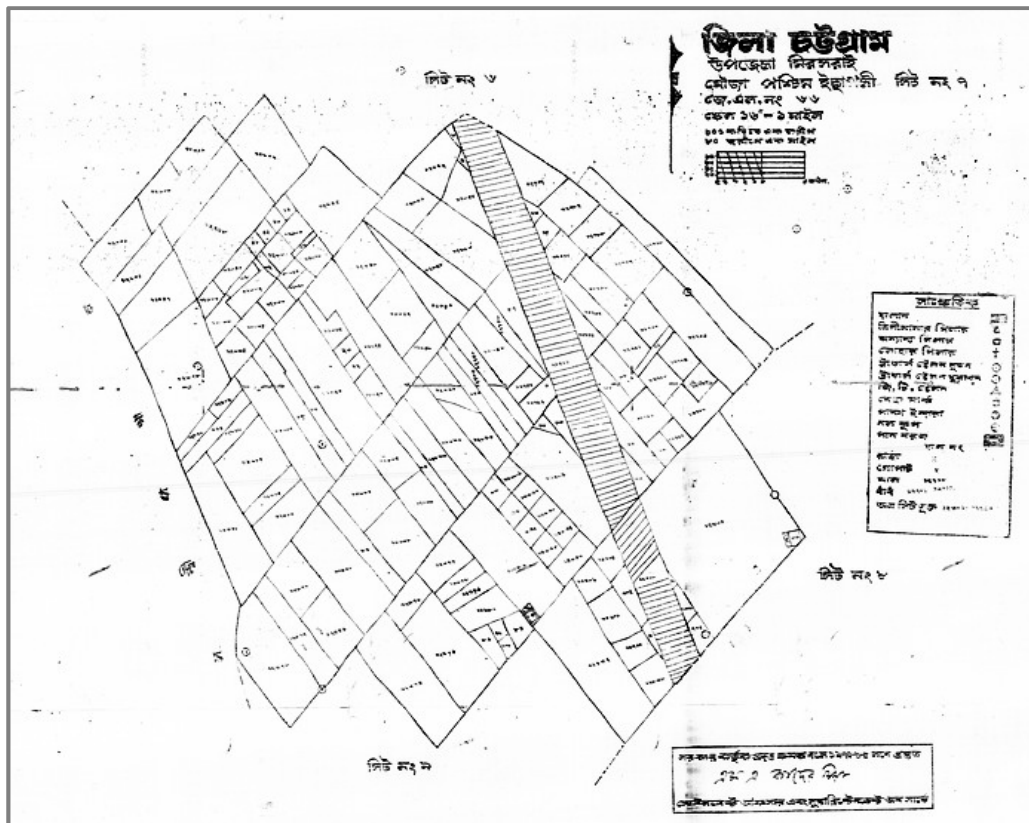


Figure-2: Mouza Map Sheet of Pashchim Ichhakhali, JL No. 66, Sheet No. 7 of Mirsarai Upazila, Chittagong District (prepared in 1970-85).

After scanning, the digital mouza sheets were saved following the naming convention described in the Table-7.

Table-7: Naming convention of Digital Mouza Sheets

District-Upazila Code

District Name	Upazila Name	District-Upazila Code
Chittagong	Mirsarai	CM

Nomenclature of Mouza map sheet Image

File Name	xx_xxx_xx				
	xx				District & Upazila Code (2 digit string)
		—			An underscore as separator
			xxx		JL No. (3 digits string)
				—	An underscore as separator
				xx	Sheet No. (2 digits string)
Example: CM_080_02.jpg represents the image file in JPG format of Dakshin Moghadia Mouza sheet no. 2 having JL no. 80 of Mirsarai upazila, Chittagong district.					

5.3 Onscreen Digitization

ArcGIS or AutoCAD Map offers easy data capturing using on screen digitization technique. The AutoCAD Map capture and store all features in three different feature types (Line, Point, Annotation) in separate layers along with different database embedded in (.dwg) files. During digitization, make zoom to double or at most triple the actual size on screen. Try to follow the centerline for digitization. It should be noted that, a line width of mouza map measures eight foot in reality.

A. Digitization Using ArcGIS

Open the ArcGIS program and follow the steps described in Figure-5 and BOX-1 to create the shape file.

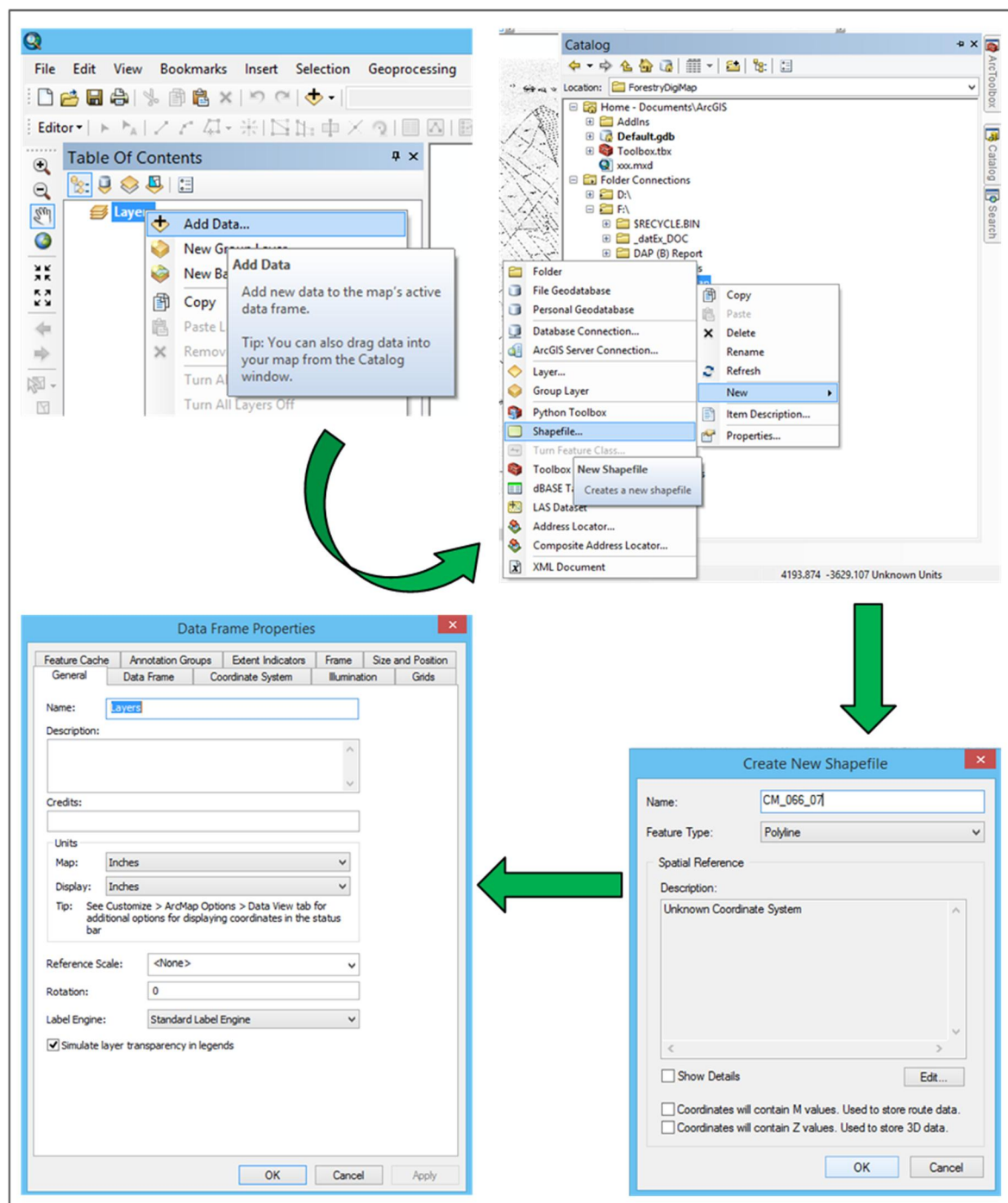


Figure-5: Flowchart for Starting Digitization in ArcGIS

BOX-1: Steps of digitization in ArcGIS

- a) Open scanned mouza sheet image;
- b) Create three new shape files, one for line features (line), one for point features (point), and the third one is also point type and for plot numbers;
- c) Go to “Data Frame Properties” and set ‘Inches’ for both ‘Map Unit’ and ‘Distance Unit’;
- d) Start editing the line shape file and go for digitization of the map (follow the *Manuscript-1: Line Features*);
- e) Afterwards, digitize the point symbols and other text information (except plot numbers) in the file name ending with “P” (follow the *Manuscript-4: Point Features*);
- f) Lastly digitize the entire plot numbers in the point file name ending with “N” (follow the *Manuscript-2: Plot Numbers*)

B. Digitization Using AutoCAD Map

Start digitization with AutoCAD Map (Figure-6) and follow the instructions given in the BOX-2.

BOX-2: Steps of digitization in AutoCAD

- a) Create all the “Layer”s as per need and follow a proper nomenclature for the purpose;
- b) Go to “Map” manue → “Image” → “Insert”;
- c) Choose the Image file (CM_066_07) for example;
- d) Now a new window named “Image Correlation” will appear. Put your “Scale” factor (it depends on the resolution of the image, dpi will be the scale factor. Here it is ‘300’. Be sure, “Unit” must be in ‘Inches’;
- e) After inserting the mouza map image, select the image and ***move the Top-Left corner of the image to the Bottom-Left corner.***

[This has to be done to keep symmetric between AutoCAD and ArcGIS digitization position. Better knowing that, ArcGIS treats the top-left corner of an image as ‘0, 0’ position, whereas AutoCAD treats the bottom-left corner as the same.]
- f) Now you can start digitizing the mouza map.

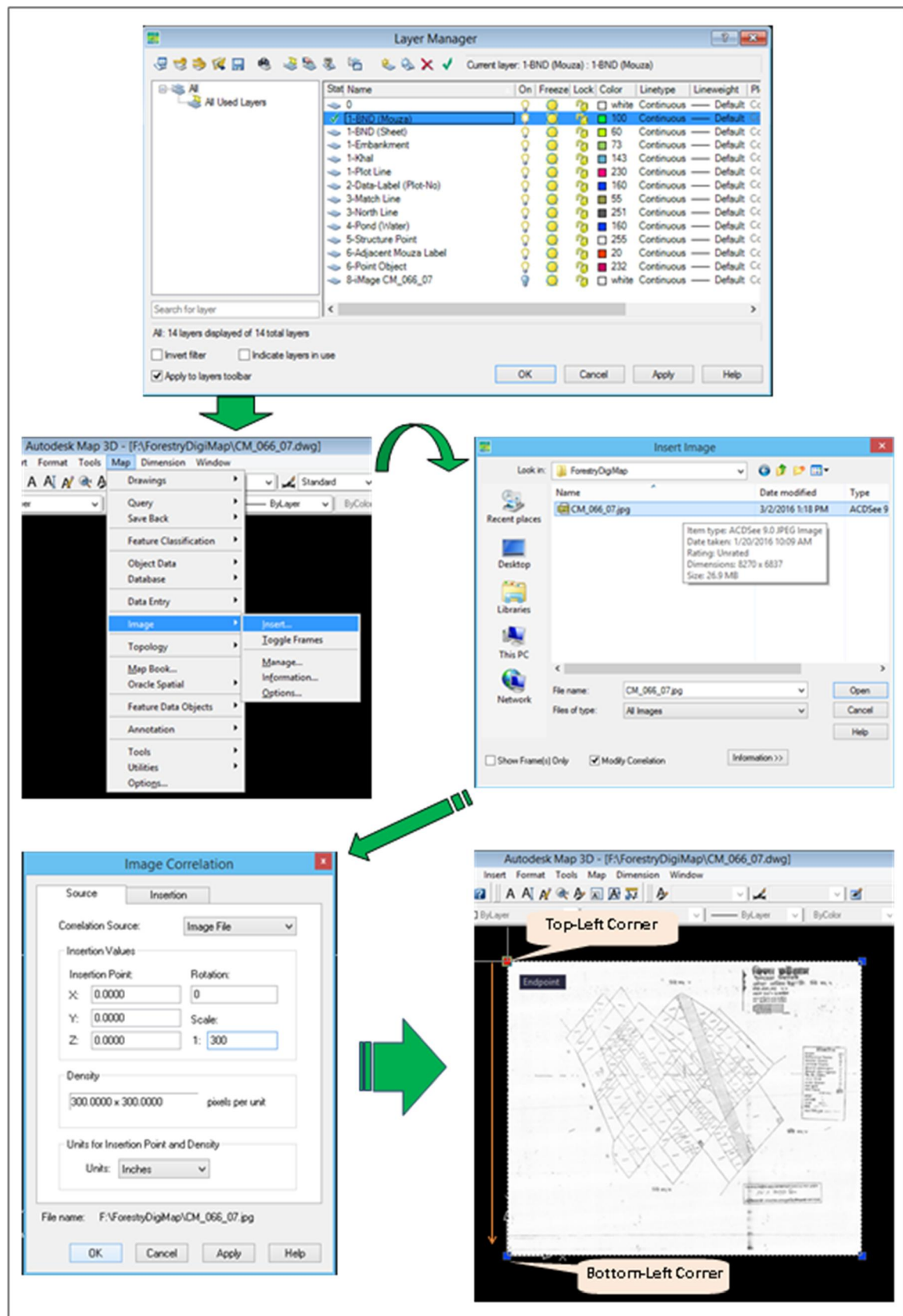


Figure-6: Flowchart of Starting Digitization in AutoCAD Map

After digitization, necessary processing (clean & build, topology building, etc.) should be done for creating Polygon in AutoCAD platform, then export the digitized mouza map sheets to ESRI shape

file. You can also perform the clean, build (topology building) process in ArcGIS platform. These outputs are the 'Digitize Base File' and contain three types of feature – Line, Polygon and Point. You can use AutoCAD or ArcGIS platform to build the topology. Build Polygons with relevant attribute database of each mouza map sheet.

5.4 Get the Attribute Data into Database

Each of the mouza maps contains important information such as mouza name, mouza code, Upazila or Thana name, district name, JL and sheet number, scale, etc. Table-8 shows the attribute database mormat for digitized mouza map. This information were added to the attribute tables of the shape files of point features, line features and polygon features. In addition, the specific uses of different plots (i.e. road, halot, khal, etc) specified in the mouza sheet maps were also added in the attribute table of polygon shape file of mouza.

The digitized files are shown in the Figure-7, Figure-8 and Figure-9. The outcomes of digitization process after assigning attribute database are given below as example:

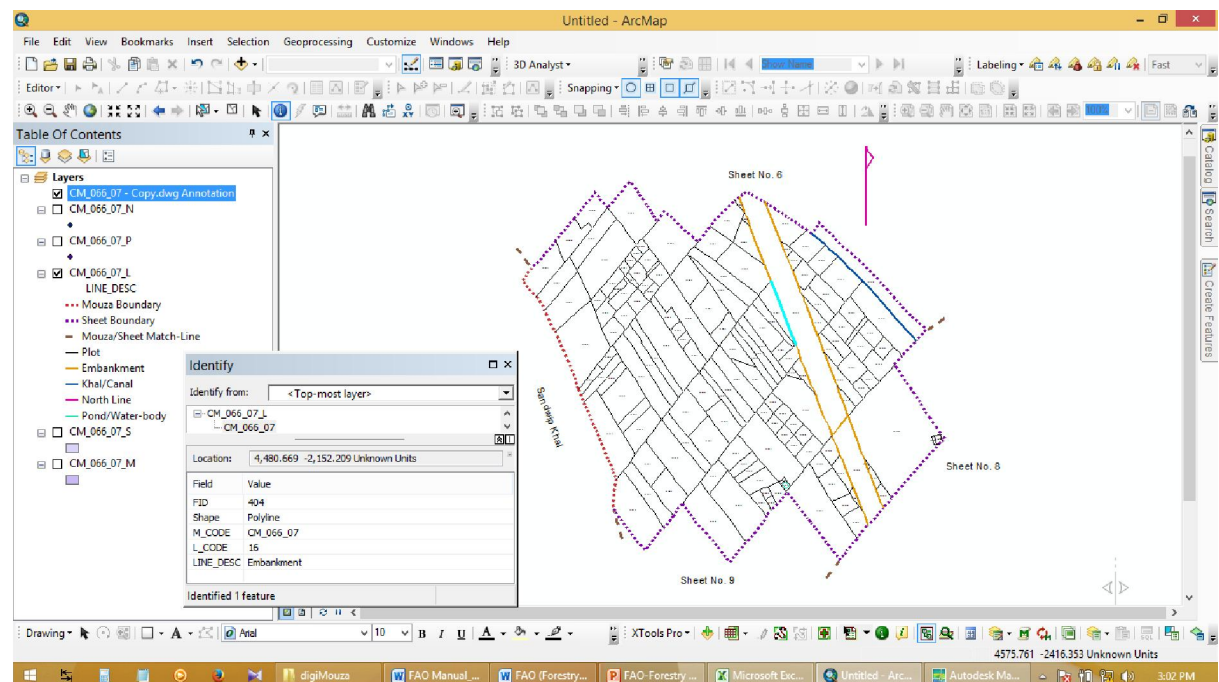


Figure-7: Sample Attribute Data of Line Features: Pashchim Ichhakhali, JL No. 66, Sheet-7

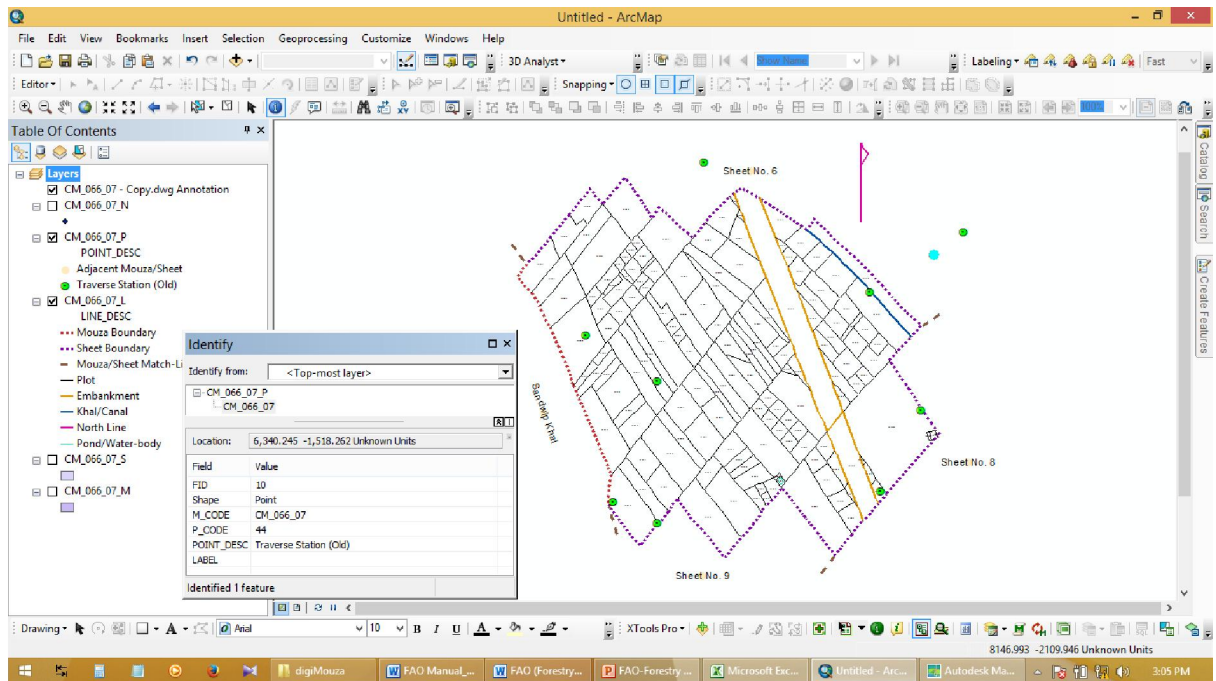


Figure-8: Sample Attribute Data of Point Features: Pashchim Ichhakhali, JL No. 66, Sheet-7

Table-8: Attribute Database Format for Digitized Mouza Map

Field Name	Description	Data Example
MZ_VER	Mouza Map Version	CS, RS, BS, etc
M_CODE	Mouza Code	CM_082_01: This code represents the example for Domkhali mouza sheet no. 1 having JL no. 82 of Mirsarai upazila, Chittagong district.
LAYER_CODE	ID of different Features	11, 12, 22, 31, etc
LAYER	Name of the Feature which the field contains	Mouza Boundary, Sheet Boundary, Mouza/Sheet Match-line, Plot Boundary, Road, Halot, Embankment, etc.
PLOT_NO	Mouza plot/dag number	1, 55, 619, 1321, etc
MOUZA	Name of the Mouza (as in Mouza Map)	Domkhali, Pashim Ichhakhali, etc.
JL_NO	JL Number (as in Mouza Map)	082, 066, etc.
SHEET_NO	Sheet Number (as in Mouza Map)	01, 02, 03, etc. (this would be '00' where the Mouza is within a single sheet)
M_THANA	Name of Thana (as in Mouza Map)	Mirsarai, etc.
M_DIST	Name of District (as in Mouza Map)	Chittagong
SCALE	Original Scale of the Mouza Map (as in Mouza Map)	16" = 1 Mile, 64" = 1 Mile, etc.
SV_PERIOD	Survey Period (as in Mouza Map)	1999, 2012, etc.
REVENUE_NO	Revenue Survey Number (as in Mouza Map)	153, 196, etc.

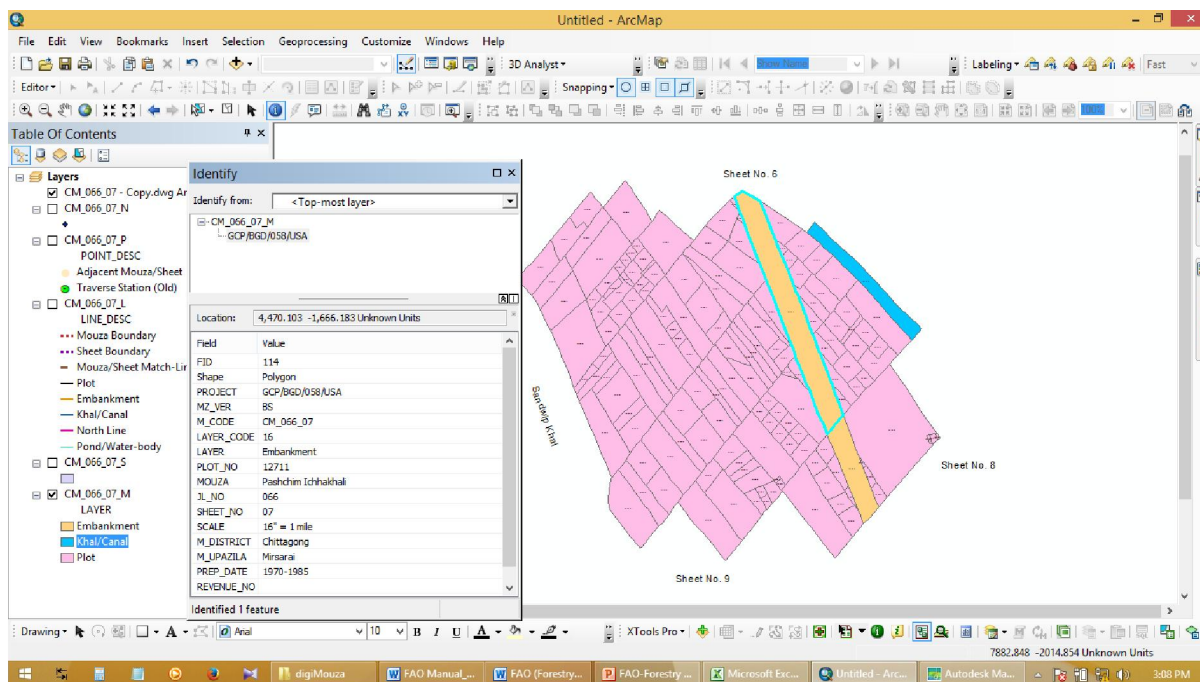


Figure-9: Sample Attribute Data of Mouza Plots: Pashchim Ichhakhali, JL No. 66, Sheet-7

5.5 Joining Adjacent Mouza Sheets and Geo-referencing

Considering cost and time constraint, edge-matching of adjacent mouza sheets can be done before geo-referencing (Option 1). As an alternative option, edge-matching can be carried out after geo-referencing of individual mouza sheets (Option 2). The second option is much time consuming and costly, but it will give better accuracy comparatively. In the dense forest area it is difficult to identify plot boundaries and in that case the second option may be found inappropriate.

Option 1: Edge-matching and Geo-referencing

Edge-matching

Edge-matching of adjacent mouza sheets should be performed to make a mosaic of all mouza sheets. Spatial Adjustment tool of ArcGIS 10 (or later) software should be used to perform the purpose. During spatial adjustment process, Transformation-Similarity method should be selected because the shape of the edge-matched mouza sheets do not distort.

Figure-10 shows how the edges of Sheet no 3 are matched with the edges of Sheet no 4. The source and target points are linked and adjusted using “New Displacement Link Tool”. Then topological errors of adjacent plots such as “must not overlap” and “must not have gaps” should also be checked.

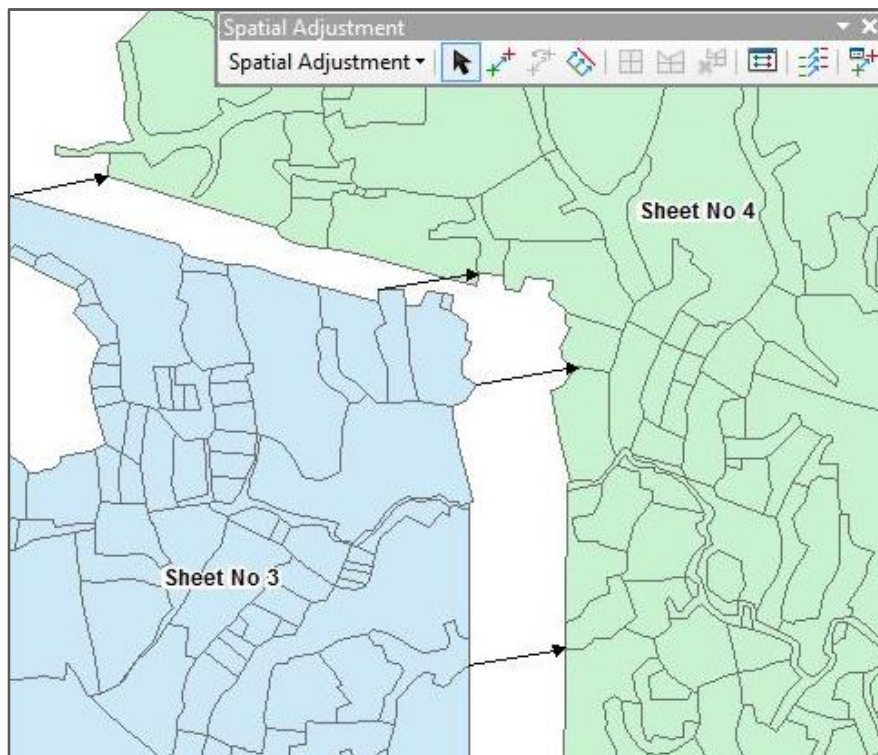
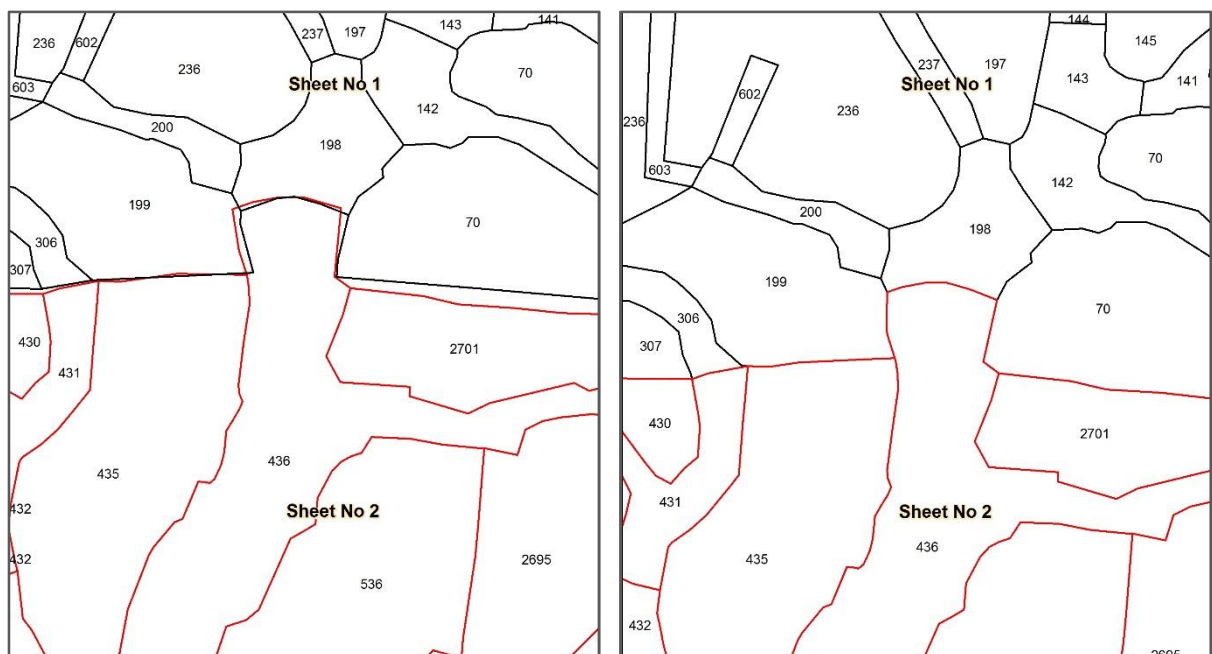


Figure-9: Edge-matching Process in ArcGIS

After checking topological error, adjacent polygons within the edge-matched zone may gain or lose area extent. Following this method all mouza sheets should be edge-matched and merged together.



a) Before edge-match and topology correction.

b) After edge-match and topology correction.

Figure-10: Overview of Adjacent Plot Boundary Before and After Edge-matching and Topology Correction.

Geo-referencing

The edge matched mouza sheets can be geo-referenced using reference coordinates collected from BBS mouza map, from field data using RTK GPS and from RTK GPS corrected high resolution satellite images.

a) Ground Control Points from BBS Mouza

After edge-matching the mosaic mouza sheets can be geo-referenced using geo-referenced mosaic mouza data of BBS. Its coordinate system is in Bangladesh Transverse Mercator (BTM). The geo-referenced BBS mouza data contain mouza boundary. But it does not contain any plot boundary within the mouza. Use Transformation-Affine option of Spatial Adjustment tool of ArcGIS 10 (or later) software can be used for geo-referencing.

b) Real Time Kinematic Points

By collecting Ground Control Points (GCPs) at different Mouza plot corners from the Study Area using Real Time Kinematic GPS system, mosaic mouza map can be geo-referenced. Due to time difference, it may be difficult to locate the plot corners in the mouza sheet maps on the ground. A local land surveyor can be helpful for the purpose. It is very important to involve local land surveyor in this process to identify GCP points on the ground accurately and to save time.

c) DGPS corrected high resolution satellite image

The digitized edge matched mouza sheets were also geo-referenced using DGPS corrected high resolution pan-sharpened IKONOS (Resolution: 1m) satellite images (Figure-9). A total of 20 GCPs were identified both in the digitized edge matched mouza sheets and DGPS corrected IKONOS satellite image. The Transformation-Projective method of Spatial Adjustment tool of ArcGIS 10.1 was used for geo-referencing into BTM coordinate system.

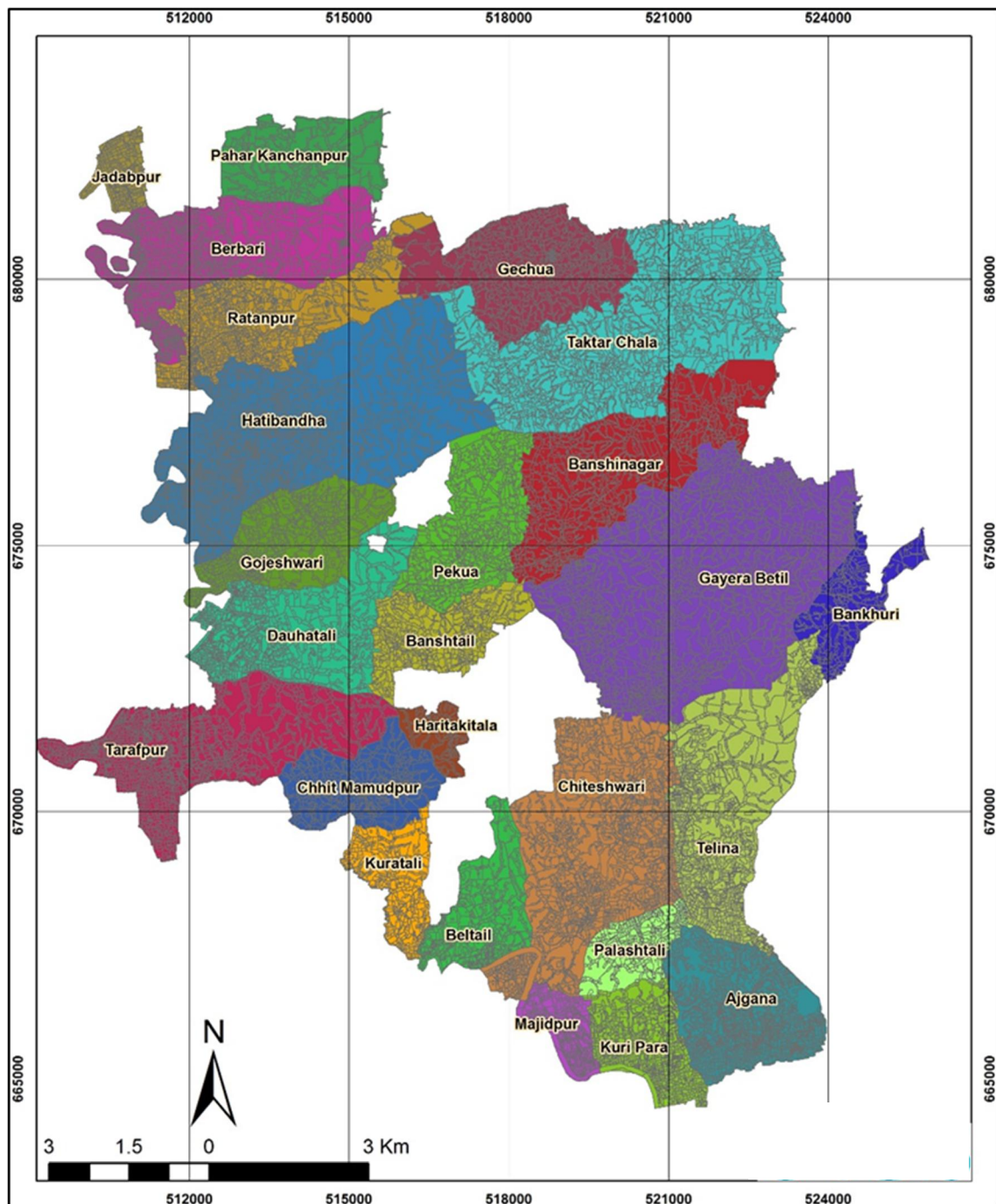
Option 2: Geo-referencing and Edge-Matching

Geo-referencing

This is an alternative option; geo-referencing individual sheets before any edge matching. It requires minimum three to four GCPs for geo-referencing an individual mouza sheet. This method is time consuming and costly. It is sometimes very difficult to find even one GCP on the ground for one individual sheet.

Edge-matching

After the completion of geo-referencing, a mosaic mouza map of the project area has to be prepared integrating all the mouza features (points, lines, and polygons) with GCP points, in different layers. Since, traditionally, the mouza maps were prepared with bare hands; these have their own errors mostly along common boundary lines. Thus resultant mosaic map will show, at some places,



overlapping as well as gaps between boundaries of adjoining mouza maps/sheets at other places. Then check topological errors of adjacent plots such as “must not overlap” and “must not have gaps”. Adjust these manually by splitting the errors in between two adjacent mouza plots.

Projection System

For transformation, the following projection parameters can be used which is locally (in Bangladesh) known as Bangladesh Transverse Mercator (BTM). Figure -11 and Figure-12 shows maps of the geo-reference images of mouza of Banshtail Range, Tangail Forest Division and mouza of Mirsari Range, Chittagong Coastal Forest Division.

<u>Projection System:</u>	
Bangladesh Transvers Mercator (BTM)	
Scale Factor	: 0.9996
Central Meridian	: 90 Degree East
False Easting	: 500000 Meter
False Northing	: -2000000 Meter
Latitude of Origin	: 0 Degree (Equator)
Spheroid	: Everest 1830
Semi-major axis (a)	: 6377276.345m
Semi-minor axis (b)	: 6356075.41511m
Invers Flattening 1/f	: 300.8017
Seven-parameter (User Defined Datum)	
dx [X Axis Translation] (meters)	= -283.729
dy [Y Axis Translation] (meters)	= -735.942
dz [Z Axis Translation] (meters)	= -261.143
rx [X Axis Rotation (seconds)]	= 0.00
ry [Y Axis Rotation (seconds)]	= 0.00
rz [Z Axis Rotation (seconds)]	= 0.00
ds [Scale Difference (ppm)]	= 1 ppm

Figure-11: Geo-referenced Mouza of Banshtail Range, Tangail Forest Division.

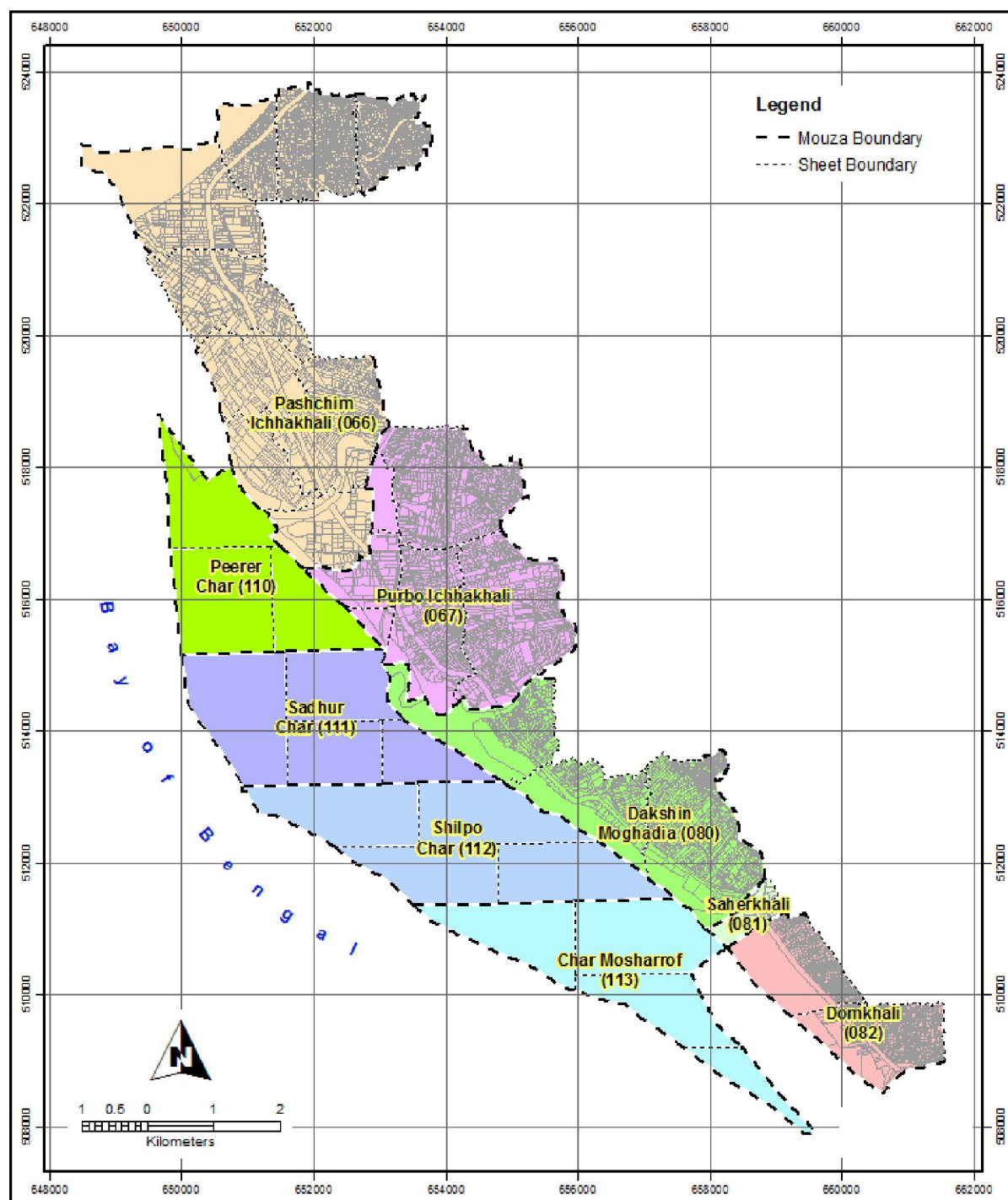


Figure-12: Geo-referenced Mouza of Mirsari Range, Chittagong Coastal Forest Division.

5.6 Forest Boundary Delineation

A data table of forest plot land has to be generated in MS Excel or MS Access software from the Gazette Notifications. A sample of the data table structure is shown in the Table-9.

Table-9: Data Table Structure

Field Name	Data Type	Field Width	Example	Description
BFD_Range	Text	50	Mirsari Range	Name of the concerned Forest Range
Bit_Name	Text	50	Bamon Sundar Bit	Name of the concerned Forest Bit
DU_Code	Text	2	CM	District & Upazila Code
Mouza	Text	50	Pashchim Ichhakhali	Mouza Name
Mouza_Ver	Text	2	BS	Mouza version (CS/RS/BS)
JL_No	Text	3	066	JL or Jurisdiction number
Sheet_No	Text	2	03	Sheet number
Plot_No	Number	7	4194	Mouza plot number
Plot_Code	Text	17	CM_066_02_4194	Unique Code of each plot (combination of DU_Code, JL_No, Sheet_No and Plot_No separating every item by an underscore '_')
Forest_Acre	Number	Double	0.65	Area (in acre) of forest land declared in the gazette
Present_Con	Text	50	Planted	Present condition mentioned in the gazette
Status	Text	150	Tafshil of Proposed Individual Land for Establishment of Industrial Park/Economic Zone	Status of the land as per gazette and/or other Govt. document
Forest_BND	Text	3	Yes	Gazette as forest or not (Yes/No)

After preparation of the table, it should be joined with the geo-referenced mouza plot sheets. The mouza plots with attribute of 'Forest_BND' = "Yes" to identify forest plot boundaries. After getting a complete and satisfactory forest boundary, save those in separate shape file. Figure-13 and Figure-14 shows the forest land boundary of Banshtail Range of Tangail Forest Division and Mirsarai Range of Chittagong Coastal Forest Division respectively.

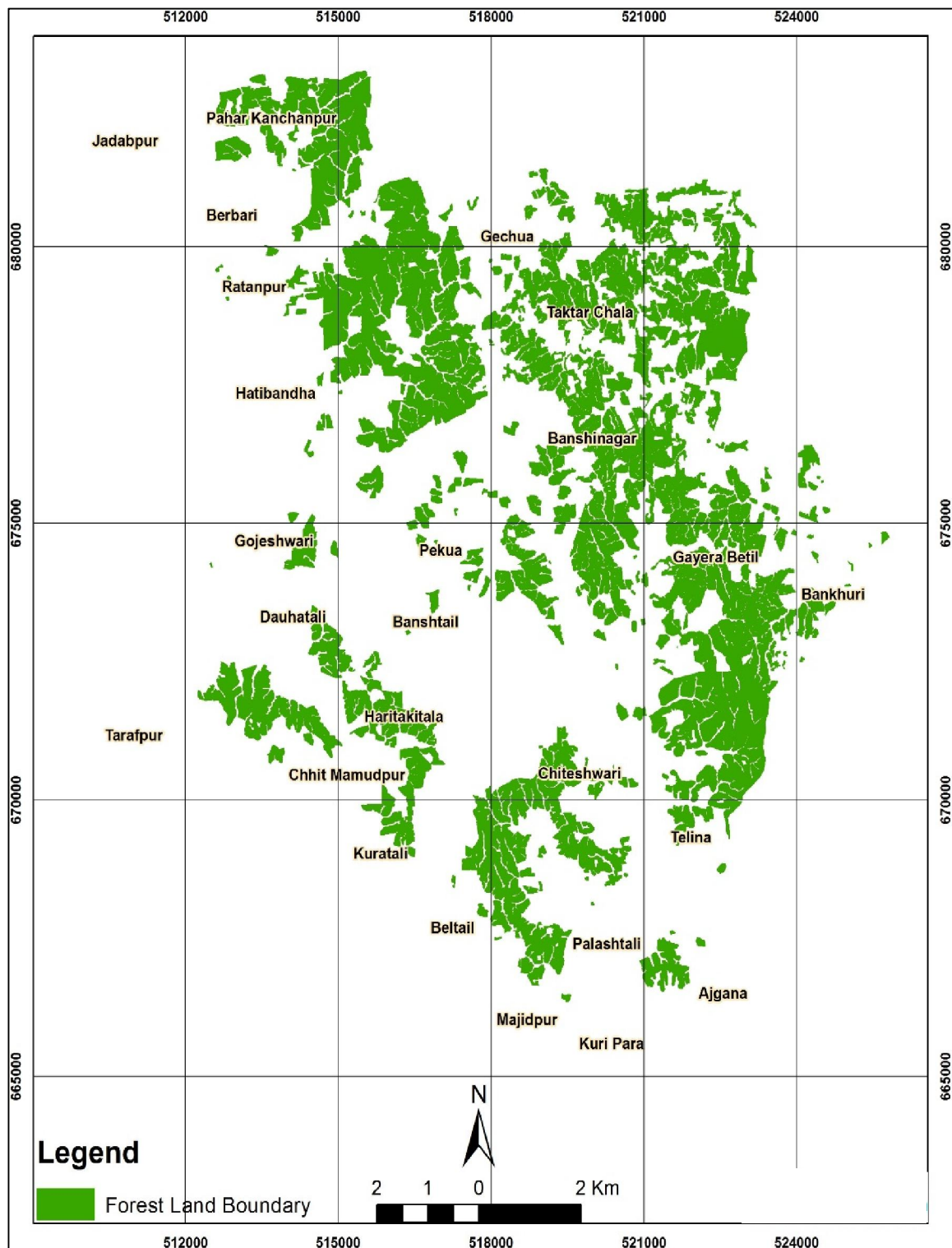


Figure-13: Forest Land Boundaries Banshtail Range of Tangail Forest Division.

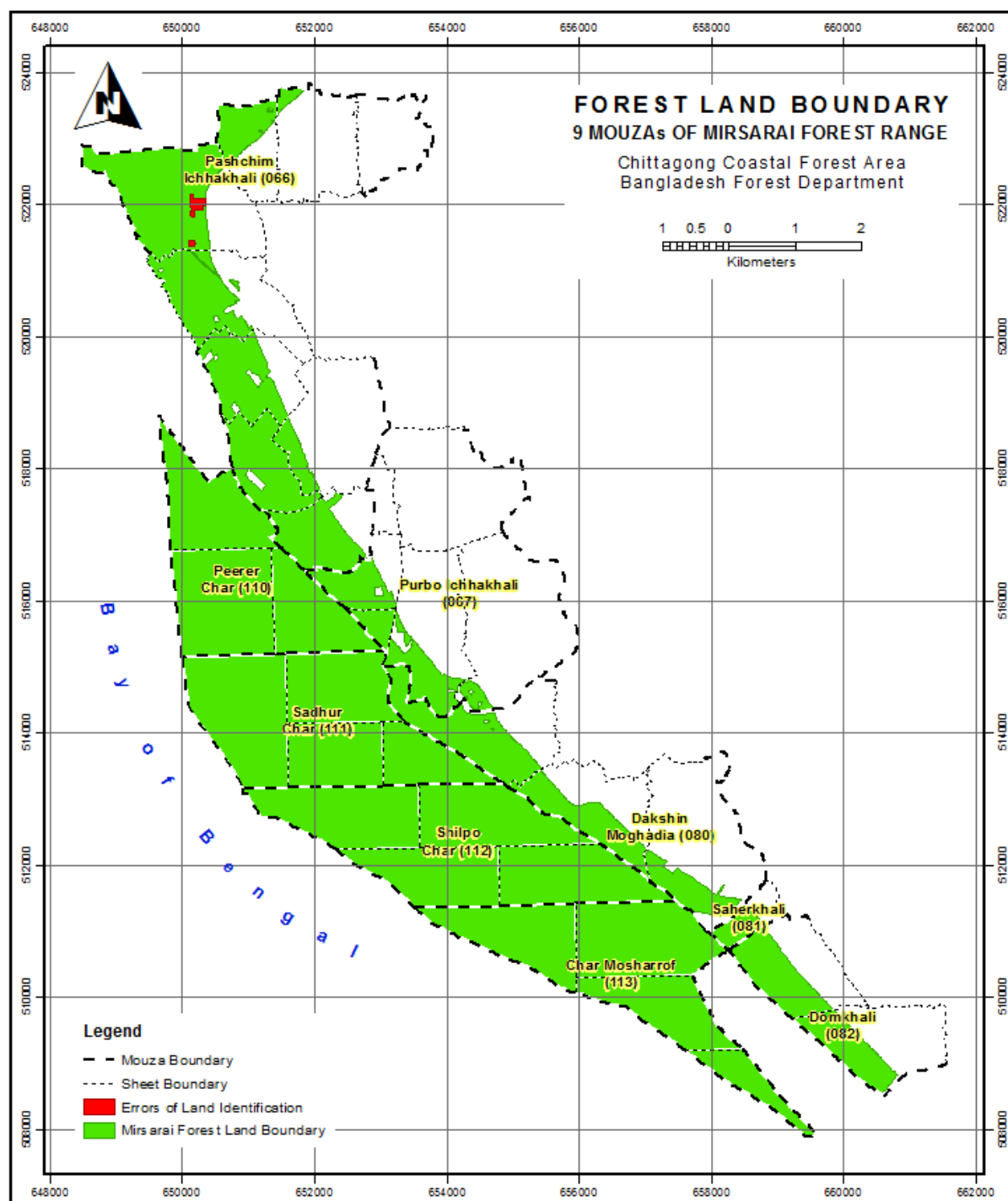


Figure-14: Forest Land Boundaries Mirsarai Range of Chittagong Coastal Forest Division.

5.6 Validation of Forest Land Boundary Datasets

A number of locations on the geo-referenced data should be selected randomly and those locations will be visited for validation of the Forest land boundary data. This validation process will be done by a joint team of all the parties concerned.

The errors still remaining will be corrected at this stage. The maiden draft boundary map, ground truthing findings and the all-party validation outcome will all be discussed here in details for a complete and precision output of the total exercise. Use the same process in all your future such operations.

6. Special considerations

To ensure a reliable and precise database of the forest land boundary, the following issues should be considered carefully.

1. Quality of collected mouza map sheets

The very old mouza maps are not of very good quality. Hence there will be problems in digitization of illegible features and then photocopy offering the inevitable distortion. In this case, the best solution is using your own experience and judgment in fixing those problems. Also, consult with experts in this field.

2. Scanning quality

The quality of scanning is important for on screen digitization using visual technique. Always use better resolution (e.g. 300 dpi) during scanning for better edge-matching and minimize struggling with overlaps or gaps.


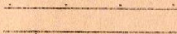

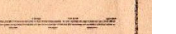
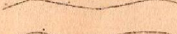
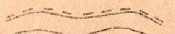

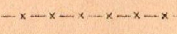
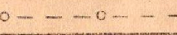
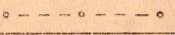
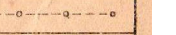
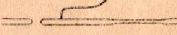
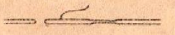
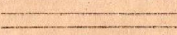
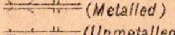
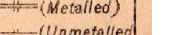
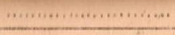
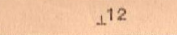
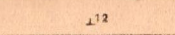
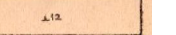
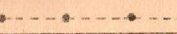
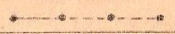
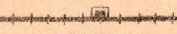
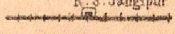
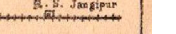

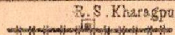
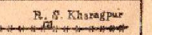
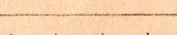
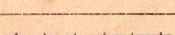
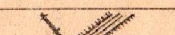
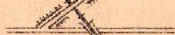
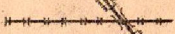
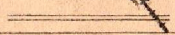

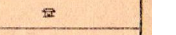
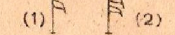
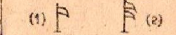
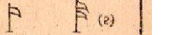

3. Availability of Secondary Data/INFO

It is important to use reliable inventory, gazette and other materials for delineation of forest land boundary accurately. Close cooperation and discussion with BFD, DLRS and DC officers are required for reliable and precise mapping.

In addition, Google Earth images are a very good source of reference points of GCP which can be used for geo-referencing the digitized mouza sheets.

Annexure-A

The Meaning of different symbols used in Mouza Sheets

Serial No.	Item	বিবরণ	Symbol on the scale of 16" = 1 Mile	Symbol on the scale of 4" = 1 Mile	Symbol on the scale of 1" = 1 Mile
1	District Boundary	জিলার সীমানা।			
2	New Revenue Unit Boundary	নতুন রেভিনিউ ইউনিটের সীমানা।			
3	Police Station Boundary	পুলিশ ষ্টেশনের সীমানা।			
4	Old Revenue Thana Boundary	পুরাতন রেভিনিউ থানার সীমানা।			
5	Forest Reserve (1) Village Boundary (2)	বনভূমি (১) গ্রামের সীমানা (২)	 (2)	(1) (2)	(1) (2)
6	Boundary along River or Road common to two units	দুই ইউনিটের মধ্যবর্তী সাধারণ সীমানা জলাশয় বা রাস্তার তীরে।			
7	Ditto not common to both units	এ কিন্তু এক ইউনিট তুচ্ছ।			
8	Limit of assessment of diara	দিয়ার এসেসমেন্টের সীমানা।			
9	Municipal Boundary	মিউনিসিপ্যালের সীমানা।			
10	Canal with distributary bridge and lock	জল প্রবেশ ও নির্গমন জন্য ফটক বিশিষ্ট খাল।			
11	Road with bridge & culvert and road side lands	পুল এবং সীলকো বিশিষ্ট রাস্তা ও তাহার পাশবর্তী জমি।	 If Metalled mention in reference list at the side of sheet	 (Metalled) (Unmetalled) (Cart-track)	 (Metalled) (Unmetalled) (Cart-track)
12	Foot path	চলিবার সমর্থন রাস্তা।			
13	Mile post	মাইলের চিহ্ন।	 12	 12	 12
14	Telegraph posts and line	টেলিগ্রাফের খাম ও লাইন।			
15	Railways with Station (Single line)	স্টেশন সহ একদিকের রেলের রাস্তা।		 R. S. Jangipur	 R. S. Jangipur
16	Railways with Station (Double line)	স্টেশন সহ দ্বিধিকার রেলের রাস্তা।		 R. S. Kharagpur	 R. S. Kharagpur
17	Tram line	ট্রামের রাস্তা।			
18	Road way over Railway	রেলের উপর চলাচলের রাস্তা।			
19	Road way under Railway	রেলের নীচে চলাচলের রাস্তা।			
20	Railway over Railway	রেল পথের উপর অন্য রেলপথ।			
21	Level crossing	ক্রেল রাস্তার উপর পারাপারের পথ।			
22	Dak or Inspection Bungalow	ডাক বা ইন্সপেকশন বাড়ি।			
23	Police Station (1) Dt. or Sub Dvn Hd. Quarters (2)	থানা (১) জিলা বা মহকুমার সদর (২)।		(1)  (2) 	(1)  (2) 
24	Post office	ডাক ঘর।		P.O.	P.O.
25	Post & Telegraph office combined	সম্মিলিত ডাক ও তার ঘর।		P.T.O.	P.T.O.

The Meaning of different symbols used in Mouza Sheets

26	Market with days	হাট বা বাজার (নির্ধারিত দিন সহ)		MX Th	MX Th
27	Mosque	মসজিদ			
28	Hindu Temple	হিন্দু দেবালয়			
29	Church	কির্জা			
30	Pukka House	দালান			
31	Katcha Houses	কাঁচা ঘর			
32	Dispensary	দ্রুত পীতাল		Dispensary	Disp.
33	Graveyard	কবর স্থান			
34	Tank with fields on bund (1) without fields on bund (2)	পুকুরি পাড়ার পাড়ের জমি আছে (১) এর পাড়ার পাড়ের জমি নেই (২)	(1) (2)		
35	Tank without bund	পাড় খুন্ড পুকুরি			
36	Pukka well (1) Tube well (2)	ইন্দ্রা (১) নলকূপ (২)	(1) (2)	(1) (2)	
37	Katcha well	কাঁচা কূয়া			
38	Factory with chimney	ফ্যাক্টরি মলের মল সহ কারখানা			
39	Coal incline	কয়লার খনিতে প্রবেশের ঢালু পথ			
40	Coal Pit	কয়লার খান			
41	Pan Bari	পান বরজ			
42	G.T.S. with name	নাম সহ গ্রি. টি. পিলার			
43	Bench mark with number	নম্বর সহ বেঞ্চ মার্ক (সমুদ্র স্তরে উচ্চতা জ্ঞাপক চিহ্ন)			
44	Trijunction Station with number	ত্রিসীমানার পাইল (নং সহ)			
45	Temporary Traverse Station (other than Trijunction)	অস্থায়ী ট্রান্সভার্স স্টেশন (যদিও ত্রিসীমানার স্টেশন নহে)			
46	Special Boundary mark	বিশেষ সীমানার চিহ্ন			
47	Iron Pillar	লোহার পিলার			
48	Tree (surveyed in position)	বৃক্ষ (যদিও স্থানে অঙ্কিত)			
49	Tree (not surveyed in position)	বৃক্ষ (যদিও স্থানে অঙ্কিত নহে)			
50	Bamboo clumps	বঁশ জাড়			

* Note:— The number should be inked up in Crimson Lake on the Original map.

The Meaning of different symbols used in Mouza Sheets

51	Mixed Tree Jungle	জঙ্গল ।			
52	Bush Jungle	গোশ ।			
53	Jhao Jungle	খাউ বন ।			
54	High Grass	লটা ঘাস (বড় ঘাস)			
55	Unculturable Fallow	পুষ্কণ পড়িত জমি ।			
56	Tari Palm	তাল গাছ ।			
62	Swampy land or Marsh	বিল			
63	Tidal Stream	জোয়ার ভাটা বিশিষ্ট নদী ।			
64	River with Sand bank and Ferry and Khals	বালুময় তট বিশিষ্ট নদী এবং খেয়াঘাট ও খাল ।			
65	Direction of flow of River	নদীর প্রবাহের দিক ।			
66	Steamer Station	ষ্টীমার ঘাট ।		Steamer Station	SL

The Meaning of different symbols used in Mouza Sheets

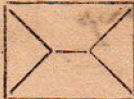
67	Nala with Ravine	ਅਰਬਾ ਬਿਲਿਏ ਨਾਲਾ ।			
68	Fields with numbers	ਦਾਸ ਸਭ ਖੇਤ ।			
69	Irrigation Channel	ਪਾਣੀ ਆਨਾਈ ।			
70	Embankment	<div> <div>ਥਾਂਬ (ਬਡ)</div> <div>ਥਾਂਬ (ਸਾਕਾ ਲੀ)</div> <div>ਥਾਂਬ (ਛੋਟ)</div> </div>	 	 	
71	North point	ਉੱਤਰ ਦੱਖਿਨ ਆਪਣੇ ਟਿਕੇ ।			
72	(1) Town, Basti site or Village (2)	ਸ਼ਹਰ (੧) ਬਾਸਤੀ ਜਾਂ ਗਾਮ (੨)		(1)	(2)
73	Cultivation limits	ਆਬਾਦਿਤ ਸੀਮਾਨ ।			
74	Hillock with declivity	ਹਿਲਾ ਪਾਹਾੜ ।			

Note:- Only important cart-tracks which serve more than one village should be shown in the 1" maps. Items 22 to 29, 32, 38, 66, should be given in the Reference List in the 16" maps. In all maps the J.L.No. should be given below the village name. In 1" maps village boundaries and names and topographical details should be shown to an average breadth of two miles beyond the Police Station limits.

The meaning of different symbols used in Mouza Sheets

(7) Appendix "X" form No. 174, page 517 :—

After serial 30 add the following as a new item.


Serial No.	Item	বিসয়	Symbol on the scale of 16" to a mile.	Symbol on the scale of 4" to a mile.	Symbol on the scale of 1" to a mile.
30 (a)	Masonry structure with corrugated iron roof.	টিনের ছাদ বিশিষ্ট পাকা বাড়ী			

* Note :—Generally to be shown in urban and semi-urban area.

Bengal Survey and Settlement Manual, 1935.

Correction Slip No. 26.

Calcutta, the 21st June 1937.

Appendix X, Form No. 174, item No. 43.—Substitute the symbol  in place of those existing and also insert it in the last column.

G. T. S.
O 108
B.M.

Annas 2.

