Bangladesh Forest Inventory (BFI)
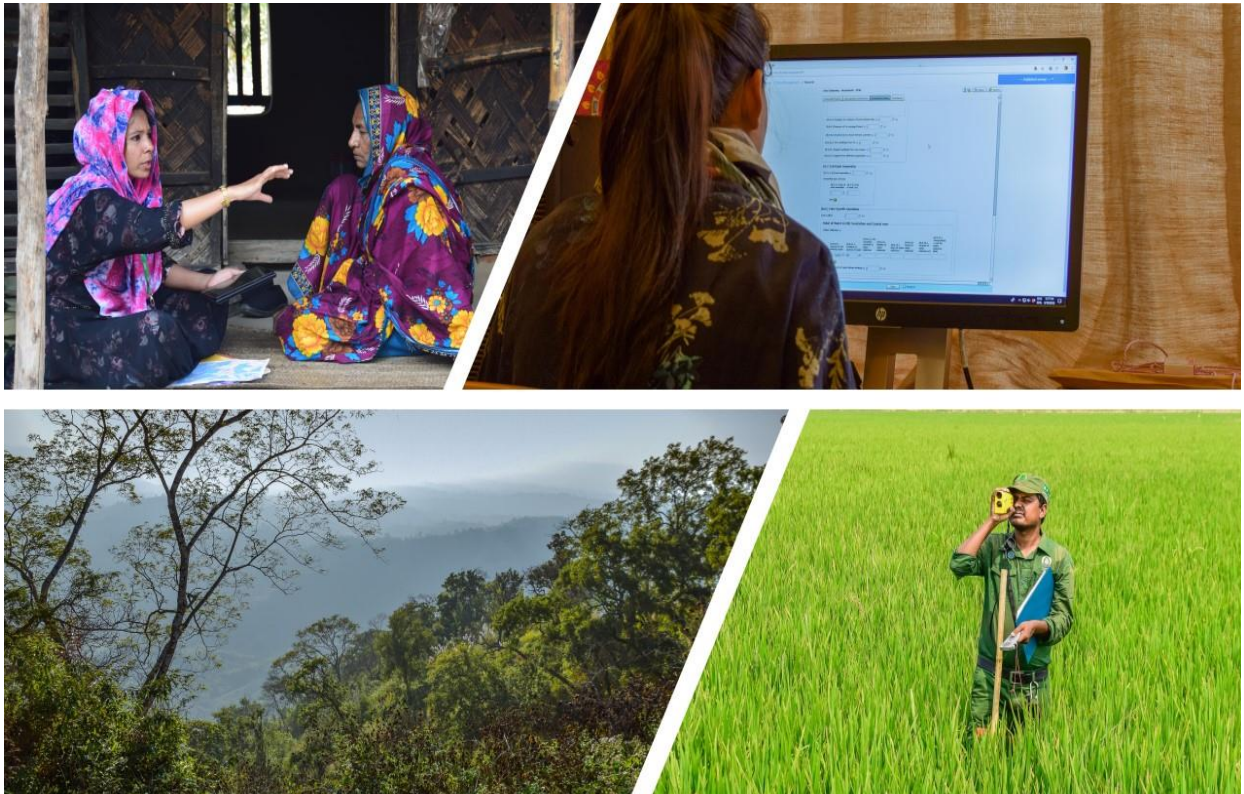# Data Management Report: Bio-physical and Socioeconomic component

Bangladesh Forest Department

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 institutionalizing the process.

This survey will enable Forest Department to estimate the economic value of the ecosystem services (ES) provided by different forest zones in Bangladesh, and thus the contribution of forestry sector to country's GDP more accurately.

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1 INTRODUCTION

Bangladesh Forest Inventory (BFI) is a process of collecting information about the tree and forest resources of the country; initiated by the Forest Department (FD) under the leadership of Ministry of Environment, Forest and Climate Change (MoEFCC) of Bangladesh. It will provide robust and reliable data for the decision makers towards establishing and implementing sustainable forest management policy and develop a permanent tree and forest resource monitoring system (BFD, 2016). BFI is the first complete national level forest inventory which is done in a large and acceptable level of data collection sample plots (Ref. design document). Advance technical and methodical approaches, along with latest inventory equipment are used in BFI. For the first time socio-economic components are included in National Forest Inventory (NFI) to evaluate the tree and forest services used the people (Rahman & Jashimuddin, 2017). The dependency of people on tree and forest services will be evaluated and this will help to evaluate the ecosystem service besides providing information about the bio-physical components (Barua et.al, 2017).

2 OBJECTIVES

Bangladesh Forest Inventory includes both Bio-physical and Socioeconomic component survey. Both surveys are done separately, and data are also managed separately under BFI unit. This report is about the data management of BFI surveys. The specific objectives are-

1) To outline the process of BFI 1st cycle data management;
2) To make a record of the common issues identified during the process;
3) To provide a guideline to improve the efficiency of data management system for the next cycles.

3 IMPLEMENTATION OF BFI

Bangladesh Forest Department took the responsibility of collection of Bio-Physical component data by themselves with the support of Forest Science and Technology Institute (FSTI) (Akhter & Costello, 2016). For the soil samples analysis under Bio-Physical Components survey a Letter of Agreement (LOA) was signed with Khulna University. The Nutrient Dynamics laboratory of Forestry and Wood Technology Discipline under Khulna University did the Soil analysis part (Hossain, 2016.). 12 field teams conducted the bio-physical survey throughout the whole country and five Quality Assurance and Quality Control team performed the data quality controlling activities through Hot checks and Cold Checks (BFD, 2016). A Non-Government Organization (NGO), Centre for Natural Resource Studies (CNRS) has been hired through tender for the Socio-Economic components data collection. Four teams are formed per zone by CNRS and five QA/QC teams are formed under the BFI socioeconomic unit for ensuring data robustness through hot check and cold check (BFD, 2017).

Bio-physical survey started in November 2016 and closed on April 2019 on the other hand Socio-Economic survey started from January 2018 and ended in June 2018.

4 OVERVIEW OF BFI DESIGN AND DATA COLLECTION

4.1 Zones

In BFI, Bangladesh is divided into five ecological zones for data collection considering the area

which remains stable with time, it will allow to detect the change of land cover with time (BFD, 2016). BFI zoning or stratification is done prioritizing- soil types, digital elevation model 2013, climate types and salinity maps (BFD, 2016) The zones are-

1) Hill zone
2) Sal zone
3) Sundarbans Zone
4) Coastal Zone
5) Village zone

But there is no people or community live within the Sundarbans, that's why for the Socio-economic survey it is the Sundarbans periphery zone instead of the Sundarbans Zone (Barua et.al, 2017).

4.2 Survey Design and Sampling

4.2.1 Bio-physical survey design

In Bio-physical survey a total of 1858 plots were selected all over the country using Stratified Random sampling method. Each plot is a cluster of five sub-plots, exception for Sundarbans (three subplot). Each Subplot radius is 19m and constructed with three different plots within having different radiuses of 19m, 8m and 2.5 m. Measurement of different plots attributes and conditions are different. Mainly tree, sapling, seedling attributes and Down Woody Materials are measured along with collecting soil and litter samples (BFD, 2016).
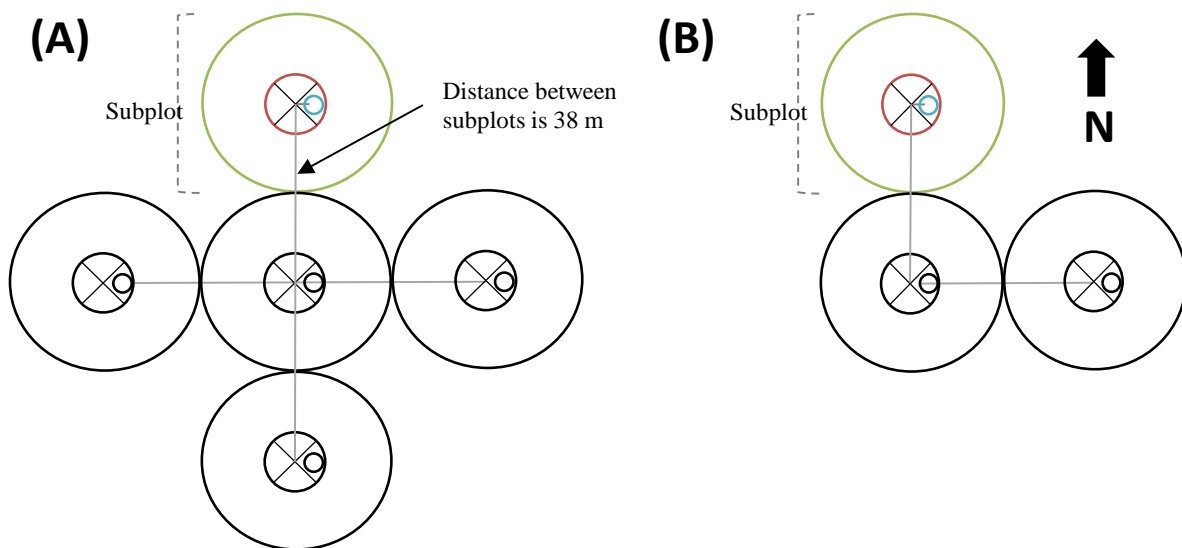

Figure 1: Bio-physical plot design layout

Here are the distribution of 1858 plots within five BFI zone-

Table 1: Plot distribution of Bio-physical survey

Zone	Plots
Coastal	113

Hill	429
Sal	145
Sundarbans	173
Villages	998
Total	**1858**

4.2.2 *Socio-economic Survey Design*

The samples are selected according to a random stratified sampling design. Each zone was divided into 4 classes of tree cover/number of households/areas. As a result, 20 strata were defined. Once the strata have been identified, a random sample of unions or wards is selected from each, the drawing being made independently in each stratum. A total of 6400 households from 320 unions/wards were selected for the final socioeconomic survey to represent national scale (GOB, 2017).

Beside the household survey, community survey was conducted to collect the information related to trends of population size, land use, access to services, price of tree and forest products based on market value. The survey was administered among the community people using FGD (Focus Group Discussion). From each zone 20 household, in total 100 household was surveyed for the community survey (Rahman & Jashimuddin, 2017).

Table 2:Household and FGD distribution of Socioeconomic survey

Zone	Strata	Number of unions	Total numbers of Households per stratum	Total numbers of FGD per zone
Coastal	Coastal1	16	320	20
	Coastal2	16	320	
	Coastal3	16	320	
	Coastal4	16	320	
Hill	Hill1	16	320	20
	Hill2	16	320	
	Hill3	16	320	
	Hill4	16	320	
Sal	Sal1	16	320	20
	Sal2	16	320	
	Sal3	16	320	
	Sal4	16	320	
Village	Villages1	16	320	20
	Villages2	16	320	
	Villages3	16	320	
	Villages4	16	320	
Sundarbans	Sundarbans1	16	320	20
	Sundarbans2	16	320	
	Sundarbans3	16	320	
	Sundarbans4	16	320	
Total	20	320	6400	100

4.3 Data Collection

In BFI digital tablet based electronic data collection method is used for the first time in Bangladesh. Latest real time da collection application "Open Foris" is used to collect both Bio-physical and Socio-economic data. Open foris is data collection forms are designed and using tablet data collection is implemented throughout the country. This the first national scale inventory done by "open Foris" and it is proved successful. It saves the uses of lots of paper proms which contributed to conservation, besides is it easy and quick to manage data using the application, so field team gets time to time feedback of the data collection. Open foris allows easy ways to check the data quality and shows the common mistakes based on validation and condition. It allows easy data importing, cleansing, exporting, archiving and data supply (Kumar et.al, 2017).

5   PROGRESS AND STATUS OF DATA MANAGEMENT

5.1 Bio-physical Survey Data Management

5.1.1   Plot measurement status (accessibility)

Table 3: Plot accessibility status

Row Labels	Count of plots
Accessible - Sampled completely	1479
Inaccessible (LCCS parameters only)	42
Non-sampled	35
Partially accessible	302
Grand Total	**1858**

80% of the total plots are completely accessible, 16% are partially accessible, non-sampled and Inaccessible are nearly 2% for each-
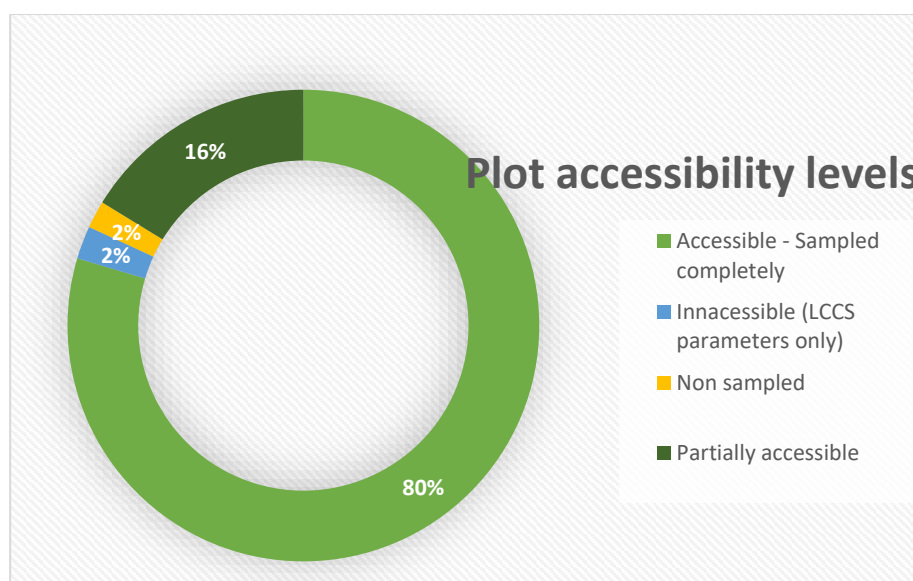

Figure 2: Accessibility status percentage

5.1.2 Zone wise plot completion status

Table 4: Zone wise distribution of measured and unmeasured plots

Zones	Count of measured plots	Count of inaccessible plots	Count of Non-sampled plots
Coastal	109	3	1
Hill	376	23	30
Sal	142	3	0
Sundarbans	173	0	0
Villages	981	13	4
Grand Total	**1781**	**42**	**35**

5.1.3 Team wise plot measurement status

Table 5: team wise field team distribution

Team Numbers	Count of plots
Inventory Team 1	36
Inventory Team 10	241
Inventory Team 11	137
Inventory Team 12	172
Inventory Team 13	210
Inventory Team 2	100
Inventory Team 3	148
Inventory Team 4	181
Inventory Team 6	137
Inventory Team 7	110
Inventory Team 8	203
Inventory Team 9	122
Other (CHT team and BFI team)	61
Grand Total	**1858**

* Non-sampled plots are distributed among different teams. But the plots left unmeasured in Hill zone are declared non-sampled and those plots are entered in the open foris database and in case of team name "Other" is mentioned for those plots and in note "BFI Team" is written.

5.1.4 Bio-physical data-management process

The field team's record data on the tablet provided by the BFI unit using the Open Foris collect mobile application. After recording data field team export the data into their preassigned Dropbox folder prepared for this purpose. Data manager download the data from that folder and import into Open Foris collect desktop. Initial "Data cleansing" is performed in open foris desktop and later all data are exported from Open Foris collect desktop into .csv format. An "R" script named "QA/QC R checks" is prepared for data quality checking, is used to recheck the data. The problems and inconsistencies found in the data are reported back to the data manager. The issues are identified are tried to solve by doing "Data cleansing" second data cleansing. If anything identified which can't be solved by the data manager and BFI unit, those

are asked to the field team for clarification and crosscheck. In extreme cases plots are revisited by the field team to ensure the robustness. After getting the correct information open foris database is updated and the updated data is exported into .csv format. Using those excel files BFI access database is updated and the process is done according to the BFI data management protocol (Mondal, 2017).
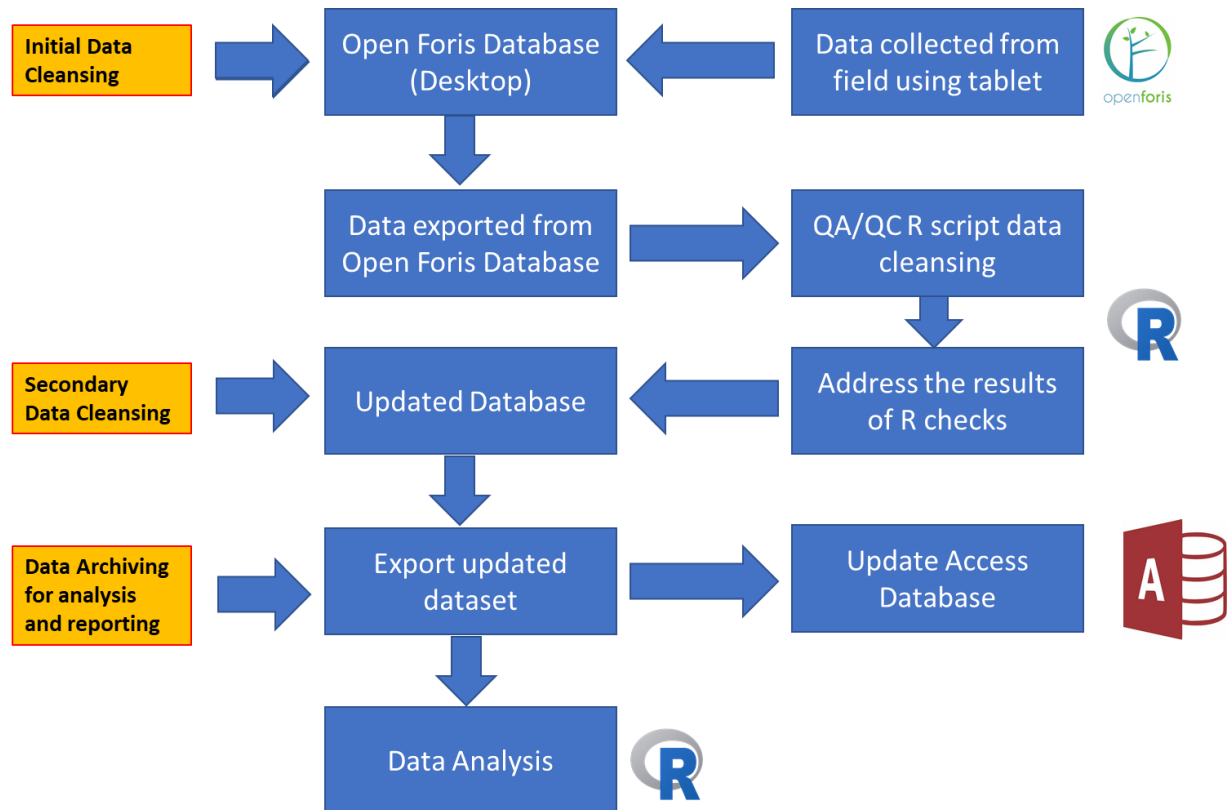

Figure 3: Bio-physical data management procedure

5.1.5 *Major Issues encountered in field data*

Some issues identified are resolved with the consultation of field teams and BFI unit. But in some cases, some inconsistency cannot be solved.

Table 6: Some common Issues encountered in data management

Issues	Description	Status of issues
Inconsistency H-D	Outlier in Height-Diameter relationship	Can't be solved, it needs to measure again.
Inconsistency LF/Trees	Tree is not mentioned as LF object but lots of trees are present in the plot. Trees are present in a no-veg plot, may be wrong LF.	Can be checked and solved centrally
LF Proportioning	LF Proportioning of Subplots are incomplete	Can be checked and solved centrally
Missing data	WO, height, DBH, distance, species etc. are missing	Can't be solved centrally

Plot not completed	Plot data is incomplete, LF is mentioned but no description of LF objects	May be checked using LF photos and satellite image
Inconsistency in RP	Erroneous or incomplete description of RP	Can be checked centrally but putting RP details is not possible
Time on plot	Negative value for time and Over 12 hours for plot measurements	Can be checked and solved centrally
Unknown species	No proper description and information of unknown species.	Can't be solved centrally
Miss identification of Land class	Assigned land classes are not correct, field teams identified the land class by observing it partially.	Some cases it can be corrected but not prescribed to do so. It should be confirmed from field.

5.1.6 *Soil samples distribution*

Among the total of 1858 BFI plots 1781 plots are measured and soil samples are found from 1761 plots. Here finds the zone-wise soil sample distribution-

Table 7: Soil sample collection distribution per zone

Row Labels	Soil sample collected	Soil sample missing	Total plots
Coastal	109	4	113
Hill	369	60	429
Sal	135	10	145
Sundarbans	173	0	173
Villages	975	23	998
Grand Total	**1761**	**97**	**1858**

Some plots are sampled completely (16) but somehow soil samples are missing for those plots-

Table 8: Plots completely sampled but missing soil samples

Plot	Team	District	Zone	POINT_X	POINT_Y
146	Inventory Team 3	Bandarban	Hill	92.441963	22.161678
148	Inventory Team 3	Bandarban	Hill	92.45863	22.086678
365	Inventory Team 7	Gazipur	Sal	90.40863	24.086678
369	Inventory Team 7	Gazipur	Sal	90.441963	24.136678
370	Inventory Team 7	Gazipur	Sal	90.375296	24.111678
868	Inventory Team 8	Tangail	Villages	90.10863	24.136678
869	Inventory Team 8	Tangail	Villages	89.841963	24.036678
870	Inventory Team 8	Tangail	Villages	89.841963	24.011678
871	Inventory Team 8	Tangail	Villages	89.90863	24.061678
949	Inventory Team 1	Chittagong	Villages	91.491963	22.886678
991	Inventory Team 7	Gazipur	Sal	90.375296	24.161678
1004	Inventory Team 7	Gazipur	Sal	90.325296	24.211678

1005	Inventory Team 7	Gazipur	Sal	90.325296	24.236678
1078	Inventory Team 2	Khagrachhari	Hill	92.075297	23.011678
1485	Inventory Team 8	Tangail	Villages	89.80863	24.186678
1782	Inventory Team 13	Rajshahi	Villages	88.591963	24.361678

5.1.7   *Number of soil samples for different categories*

Soil samples are collected for different attributes measurements, such as- Bulk density, Soil Carbon, soil texture, litter carbon etc. For soil, samples are collected from different layers. Here is the number of samples per attributes and layer-

Table 9: Number of Soil samples per attributes

Attributes	Number of samples	
Bulk density	**10869**	
	Layers	**Number of samples**
	5-10	4985
	20-25	4985
	65-70	899
Litter Carbon	**1074**	
Soil Carbon	**4352**	
	layers	**Number of Samples**
	0-15	2006
	15-30	2006
	30-100	340
Soil texture	**4356**	
	layers	**Number of samples**
	0-15	2008
	15-30	2008
	30-100	340

5.1.8   *Recommendation for the next cycles bio-physical data collection*

- Before starting field activity data collection and submission modalities should be finalized;
- Data management system should be established and experimented before;
- Database should be checked and should re refreshed to store and process data;
- Before starting field work the payment modalities must be finalized, in which cases field team will get which money or not; and how they will be paid.
- Data manager should ensure that open foris application used in all devices are updated;
- Basis on the first cycle experience field plan should be processed;
- Try to avoid measuring more plots in a single;
- Refresher training is needed for the field crews and pay attention in use of equipment;
- Maintain the movement plan as much as possible, if any changes in movement plan is occurred then inform BFI unit as soon as possible.

5.2 Socioeconomic Survey Data Management

5.2.1 Households data collection status

Among the 6400 households all survey data has been collected and handed over by CNRS in June 2018. The data was share in Open foris collect format. Alongside that, 100 community survey data also handed over. Both the soft copy and hardcopy of the community survey was provided.

5.2.2 Socio-economic data management process

The Field Enumerators collect the data from the field using tablet. QA/QC team give feedback from their hot check when there is problem raised in the field. Beside that QA/QC team's cold check report is used to cross check any dissimilarity between the two data. Survey questioners have unique code number for all the questions and they are coded down in the Open foris survey form. Field team entered all their survey answers using this tab version of the open foris. The data are recorded on the tab provided by the BFI team using the tab version of Open Foris collect application. After recording data, enumerators exported the data into the predetermined Dropbox folder prepared for this purpose. CNRS and BFI unit both can access to the dada and download for data management download the data from that folder and import into Open Foris collect desktop. Data has been checked manually in the Open foris and in Excel csv file. Data also checked by using R scripts. If there was any error found in the data, an error report is sent to the CNRS for necessary steps. They corrected the error and resend the data for finalization.
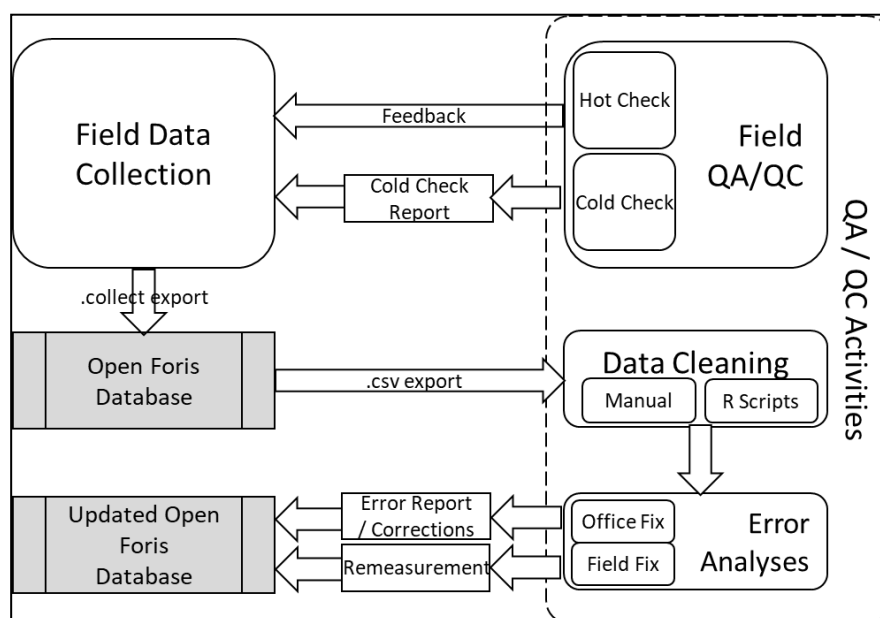

Figure 4:Flow diagram of the data QA/QC and data cleaning procedures used in the BFI process.

Every time there is new data send by the field team, open foris database is updated. After addressing necessary cleansing data are exported from Open Foris collect desktop to create a new updated open foris database. R scripts also. If errors are found from R checks an error report is generated mentioning the error type and cleansing status.

Figure 5: Data cleansing in open foris desktop

The cleansing was done in two ways. If the error is fixable it is fixed in the office and if not, then an error report is sent to the CNRS team for rechecking. Usually in every week one error report was send to the CNRS for fixing the error.

CNRS collected all necessary data from the field for correcting the errors. The modality of data re-collection process is that they were communicating with the enumerator who made the mistake and provide necessary support to recollect the information. Then the enumerators used to collect necessary information again and send the information for correcting the error. After receiving the corrected data CNRS cross check it again and for checking data looked for errors on open foris one by one, and also using MS Excel for sorting out all errors in the database which are difficult to identify through direct observation on open foris. Then they send the corrected version with an error correction report to the office.

Besides CNRS and BFI unit called the HH to clarify any short of confusion and to cold check the data accuracy. After the final correction, all the corrected information is update din Open foris and the new version is shared with others for further analysis.

By data cleansing the data inconsistencies are tried to resolve to get a more robust database ready for analysis. With the consultation of different expert group, data analysis tools have

been developed. Experts used these tools for the final socioeconomic data analysis.

5.2.3 *Major issues with the data cleansing*

There was some common error that are primarily found in the data set. Those errors were fixed mostly by the enumerator. No data was changed without the consultation of office. Bellow errors were easily fixable by the enumerators.

Table 10: Common issues in socioeconomic data management

Issues	Description
Data mismatch	Age class and gender is required to filled
Data mismatch	Age class distribution does not match
Data missing	Age class has not added
Data missing	Animal species in the past information missing
Data missing	HH income related to tree and forest missing
Data mismatch	HH money spend on energy for cooking and heating not recorded.
Data missing	Household survey point is required
Data missing	Local Administration information is required to fill
Data missing	Location of human made disturbances missing
Data missing	Location of tree and forest product collection
Data missing	Mauza and village missing
Data missing	Members of the house hold is 16 which cross the limit
Zero has been added for no member	Money spent on energy is not recorded
Data missing	Month of selling tree and forest products
Data missing	More than 5data has been entered
Data missing	Moth of selling tree and forest products way to high
Data missing	Penalties for violation of forest related rules
Data mismatch	Presence of co-managed forest missing
Data mismatch	Quantity of energy consumption, money spent and dependency has not recorded.
Data missing	Same species name has been entered twice
Data missing	Time start and interviewer name, end time is missing
Data missing	Total number of HH members employed
Zero has been added for no member	Zero can change the analysis for the age class group

Some of the errors needed the expert opinion. To fix those errors BFI Unit and CNRS seat together in order to take decision-

- HH 4458 was missing the GPS coordinate. This problem was solved by cross checking the GPS coordination of the 2-3 HH near that HH. Zone wise land cover class was input incorrectly.
- Land cover class for collection of primary forest products at Sundarbans zone was recorded as FDp when there is no existence of FDp land cover class in Sundarbans zone. From the

zone wise land cover class data that has the HH number this problem was solved.

- HHs number 4104 has a double entry. One of which was surveyed by enumerator 'Amrita Lal Gupta' should be '5104'.
- HHs number 6000 has a double entry. One of which was surveyed by enumerator 'Mostofa' should be '5600'.

5.2.4 Recommendation for the next cycles of socio-economic survey

- The tree cover strata and zoning need to be done by using proper statistical tool. Sample size (now-6400 HHs) should be increased to cover all the districts.
- Design of the questioner should be approved by BFD and all other experts before finally using it.
- Before starting the survey, the questioner needs to be fully finalized along with a good number of test survey.
- Questionnaire including Open Foris form should be modified for smooth field survey.
- The enumerators as well as the QC persons should be made aware about the errors presence of which may cause cutting off the payments for the respective interview.
- Integration issues should be well consulted and defined prior to starting the survey.
- Training on the analysis can be organized with target to develop at least 2 experts in BFD on the socio-economic data analysis.
- Quality checked data supply should be given priority to timely accomplishment of the analysis.
- Ten days extensive training (indoor and outdoor) is necessary to capture all the necessary data from the field effectively
- QAQC team need to be involved at questionnaire preparing stage for effective monitoring so that they can identify and check the important variables
- Data should be inserted in the field rather than recording them in other means likes paper, writing pads etc. which create problem (error) in post insertion.
- Open foris should be updated regularly both in tab and data management computer.
- A hub should be developed between open foris developer and user in the forest department for discussing and solving software related problem.
- Dedicated computer and manpower should be ensured for smooth data management

6 CONCLUSION

Bangladesh Forest inventory first cycle is designed and implemented considering the availability of data robustness. Different stages of data cleaning and quality checking was involved with the total data management process. Manual and programmed checking systems were involved with the whole process. BFI unit combined of Bio-physical and Socioeconomic experts carried the responsibility of Data management and to provide robust data for analysis. The data will enable establishment the baseline for forest monitoring and change monitoring with time. It will help policy makers to take proper decision based on bio-physical data and carbon stock estimation. It will enable the value of ecosystem services will be better understood through the integration of the biophysical and the socio-economic component.

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