PARTNERSHIP FOR LAND USE SCIENCE (FOREST-PLUS) PROGRAM

Forest Data Management System (fDMS) user guide

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APRIL 2017

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INTRODUCTION

USAID Forest-PLUS has developed a data system for forest carbon inventory, quantification and reporting.

This is called the Forest-PLUS Data Management System or FDMS. The Forest-PLUS Data Management System (FDMS) is a web-based platform supporting the collection, organization, and management of forest inventory data and forest carbon reporting. The FDMS includes a suite of tools for forest carbon accounting and reporting, including estimating Tier 3 level emission factors (EFs), carbon stocks and GHG emissions. The FDMS supports several key reporting requirements consistent with international standards under the UNFCCC Warsaw Framework from COP 19, in particular, for the National Forest Monitoring System (NFMS) element, for a REDD+ program. The FDMS can be used at project, jurisdictional or national scales. It includes options for reporting at Tier 1 or Tier 2 levels, but has a core focus on providing robust, accurate computational tools to estimate and report forest carbon emission factors and stocks at the Tier 3 level. The information the FDMS is capable of computing feed directly into REL and FREL reporting. NFI and State Forest Department Working Plan data can be directly input to the FDMS through a data ingest tools. The FMDS includes an allometric equation library with the Forest Survey of India's (FSI) species-specific volume and biomass equations organized by regional catalogues. This allometric equation toolkit allow for user-defined equations and includes functionality for creating a custom catalogue of allometric equations for use in a project. The FDMS is a secure password protected system that can be set up to run locally or as an open, publicly accessible web-based platform and lastly, it incorporates a set of multi-user levels from admin to read only.

DESCRIPTION OF THE FOREST-PLUS DMS

The FDMS includes a suite of tools designed to organize and manage data required for estimating forest carbon emission factors and carbon stocks as well report emissions and removals over time. The tools are organized into three data systems. Each tool is described below in detail.

The core components of the system are:

1. Project information management tool
2. Data system for sampling design
    a. Plot sample design tool
    b. Geographic data management (Mapping) tool
3. Data system for measurement and reporting
    a. Forest carbon measuring tool
        i Plot inventory manager
        ii Allometric equation library
        iii Forest carbon reporting
4. Data system for reporting
    a. Emissions calculator tool
    b. Reporting tool
5. Project documents tool
6. Project settings and management tool

PROJECT INFORMATION MANAGEMENT TOOL

The project information management tool establishes project management information including team roles and responsibilities. It also defines a set of project parameters (region, country, soil type and climate zones, as well as duration in years) that are used in the emissions calculator tool. User complete the Project Related Information and the Contact Related Information fields through entering text or pull-down menu selections. The Edit Project and Review Project Information tabs at the top of the tool set are used for the Project Related Information and the Contact Related Information.

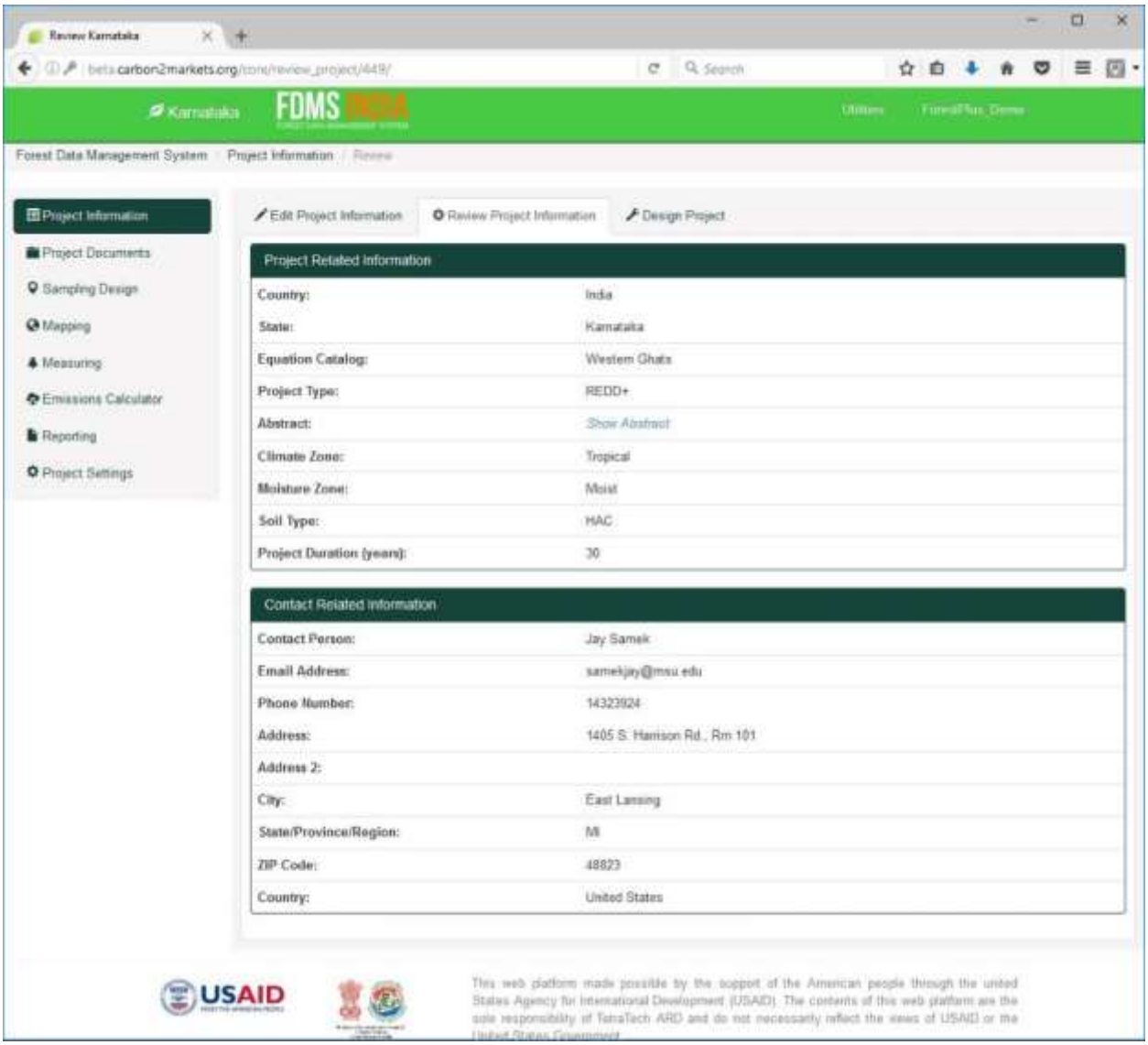


Figure 1 Project information management tool

Two pop-up maps are available for the Climate, Moisture and Soil Type fields. The Climate Zone "I" tool will show the user a map of India with the IPCC Climate/Moisture Zones. The Soil Type "I" tool will show the user a map of India with the IPCC soil types.

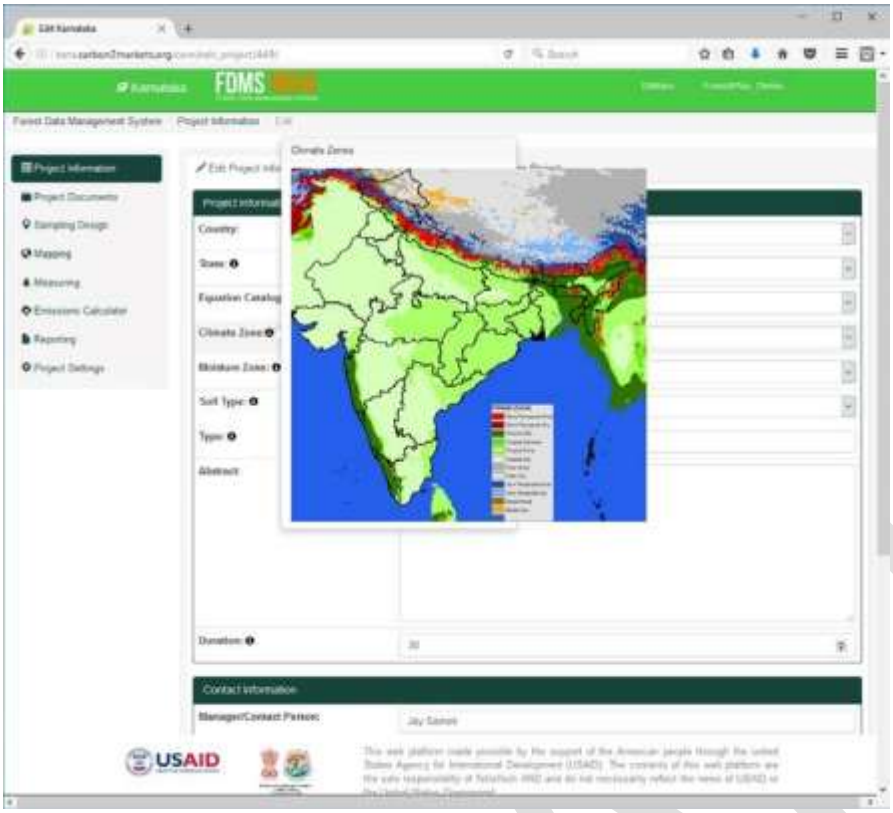


Figure 2 Climate zone tool

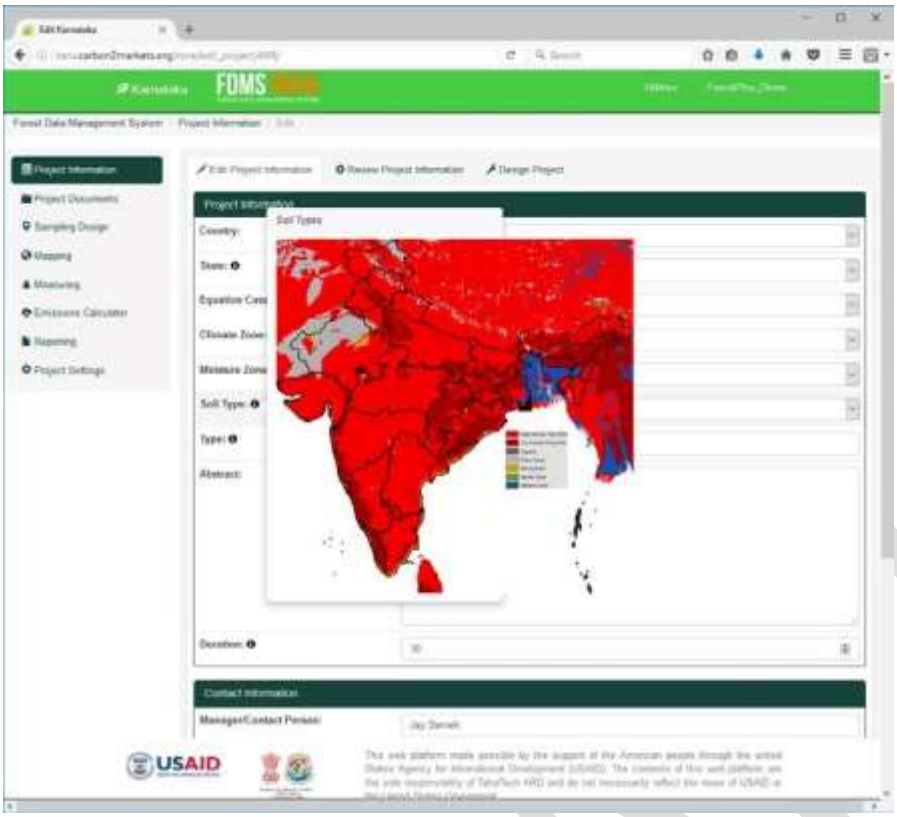


Figure 3 IPCC soil types map

The Design Project tab is used in the set-up of a project prior to adding spatial or tree measurement data for computing carbon stocks and emission factors. Computation of carbon will be done at the plot, parcel and project levels. The Design Project tool is where the user defines the strata or parcels that will be used for computing carbon. Most common are Forest Class or Forest Type categories. Users enter as many parcel (strata) names as required for their project.

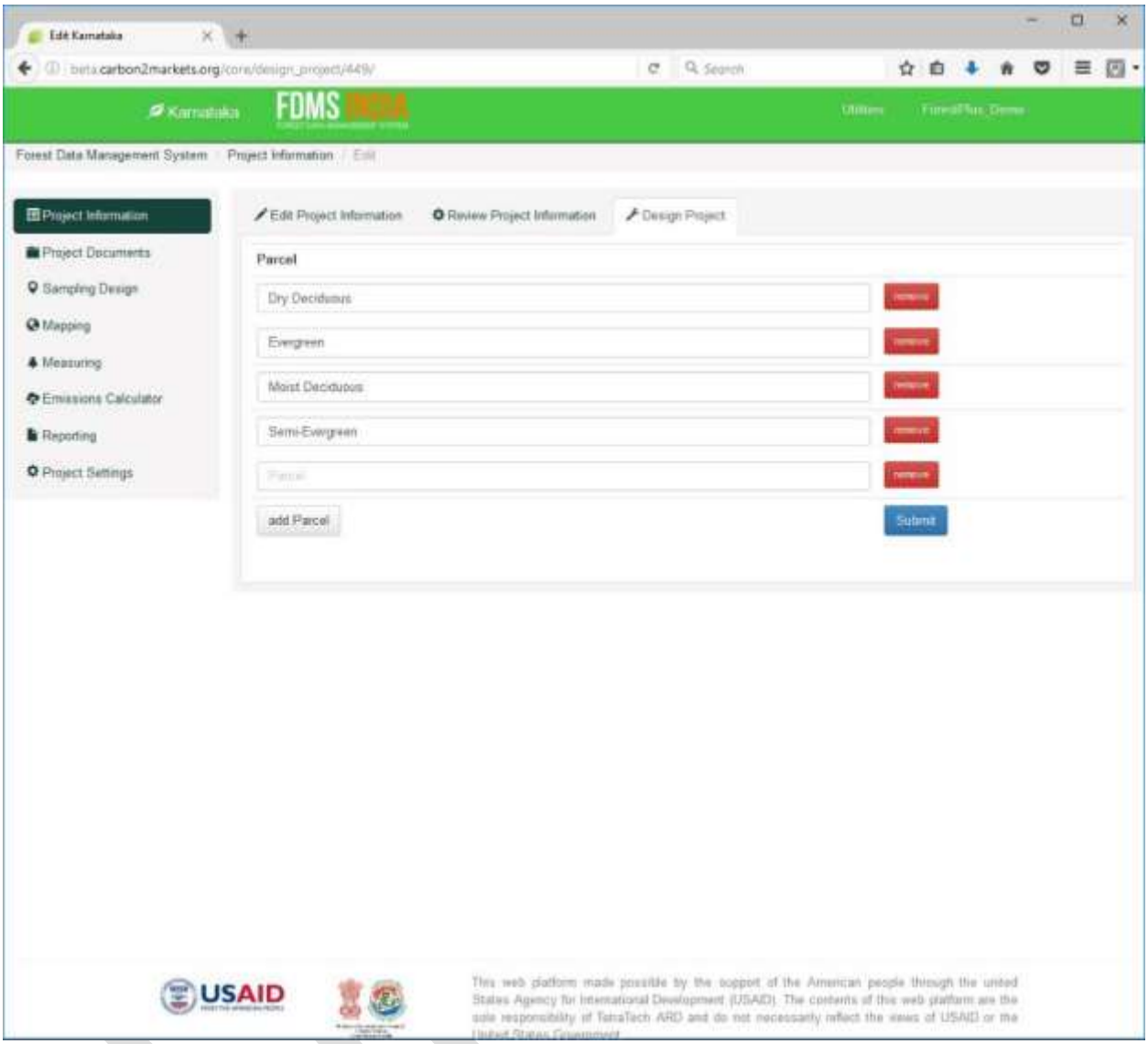
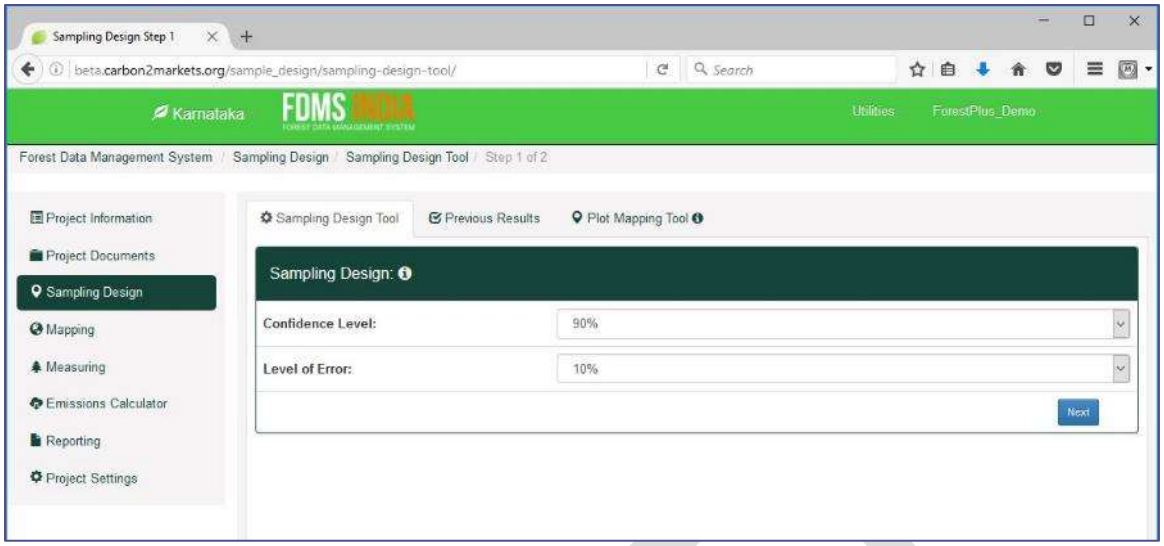


Figure 4 Design project tool

SAMPLING DESIGN TOOL

The plot sample design tool supports a project's requirement for statistically valid plot numbers and plot locations with reporting documentation. Users define the level of error acceptable and the desired precision for their project, the mean carbon and standard deviation for each stratum in a project and the plot size used to collect tree measurement data. A statistical algorithm calculates the number of plots needed for each stratum to meet the error and precision requirements of the project.

The tool includes a plot locator tool so that the geographic locations of the plots meet statistical rigor avoiding bias. Users chose between a simple random and a systematic sample approach to the placement of plots. These locations are then integrated with the next tool for geographic data management.



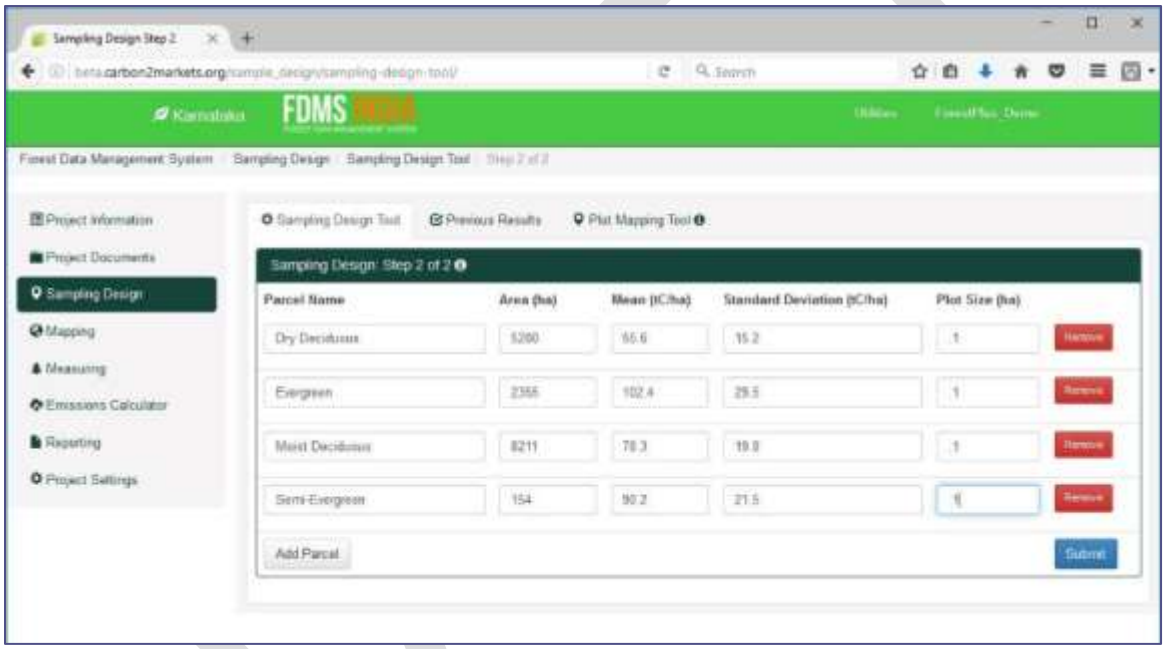


Figure 5 Sampling design tool (1 of 2)

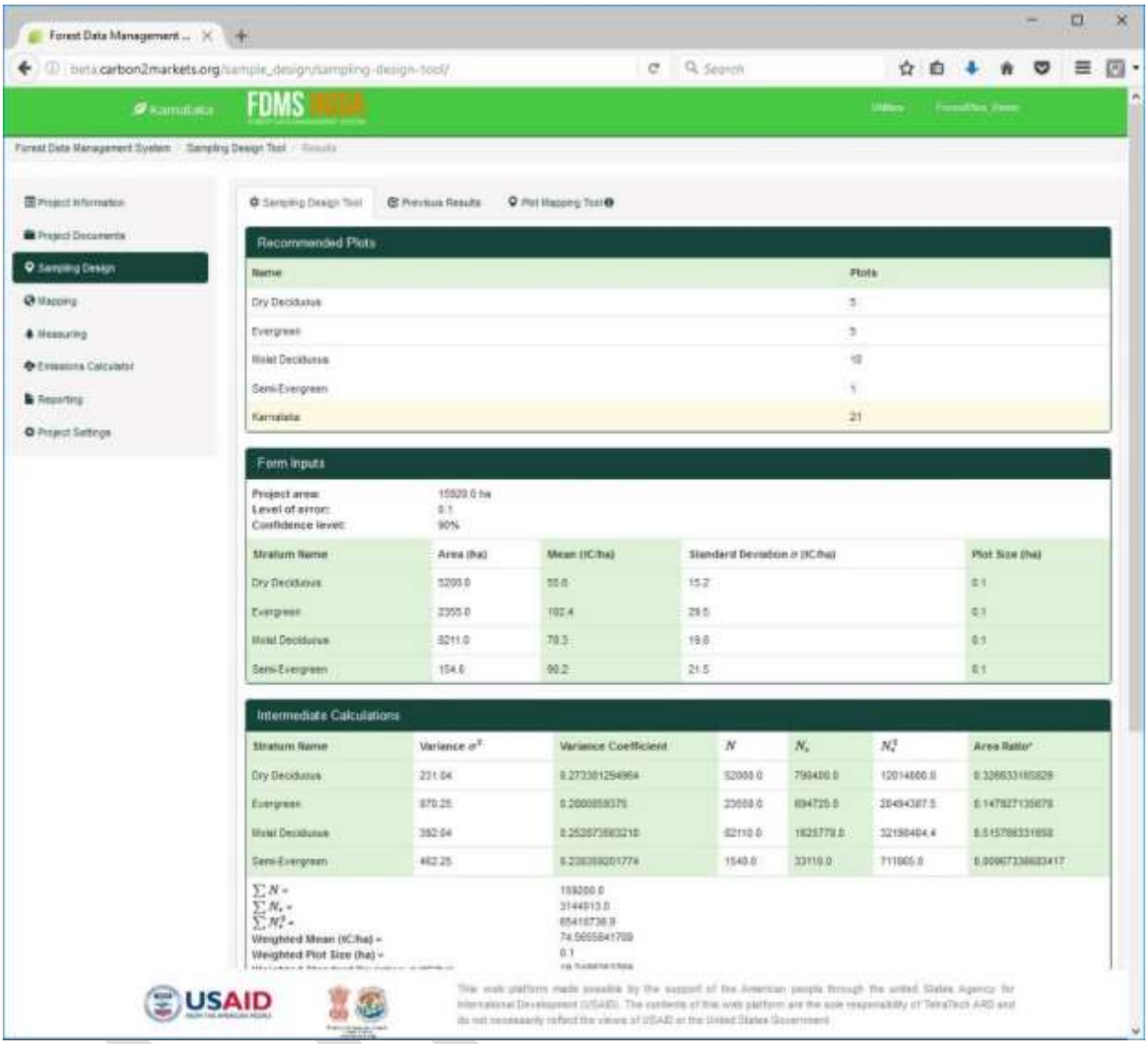


Figure 6 Sampling design tool (2 of 2)

MAPPING TOOL

The geographic data management tool organizes project boundary, stratum (parcel) boundary and plot location files in web-based GIS platform integrated with a relational database. It includes an interface to draw project or strata (parcel) boundaries and place point markers on screen. Geographic data may also be uploaded to system as an ESRI shapefile, or a comma delimited text file. There is a hierarchical relationship between plots and parcels that is required for reporting carbon.

MEASURING TOOL

There are three core modules in the forest carbon measuring toolkit: 1) a plot inventory manager, and allometric equation library and a reporting module for forest carbon (Emission Factors).

PLOT INVENTORY MANAGER

The plot inventory manager module is used to upload and organize raw plot inventory data. This would include plot metadata (e.g. plot dimension, plot type, plot area, geographic conditions, etc.) and tree level mensuration data such as species, diameter at breast height (DBH), total tree height, tree crown dimension, wood density, etc.). Plot data are uploaded through the plot inventory manager using a preformatted Excel (xls or xlsx) file or through a multi-plot ingest tool. Plot-strata (parcel) relationships can be managed through this module as well as can the use of specific or general allometric equations for quantifying biomass at the plot and strata (parcel) levels.

For computing the soil pool of carbon, a separate xls file is completed after laboratory analyses of soil organic carbon and uploaded to the system.

ALLOMETRIC EQUATION LIBRARY

The forest carbon measurement toolkit includes an allometric equation library. The full library includes a number of general equations (e.g. IPCC, Brown and Chavez et al. equations) as well as the full list of volume and biomass equations from the "Carbon Stocks in India's Forests" (FSI) publication. This module as includes a "model builder". As new allometric equations are developed or old ones improved the module allows the user to input the equation form and factors (measurement variables) into the library. This provides future flexibility for computing forest carbon.

FOREST CARBON (EMISSION FACTOR) REPORTING

This module outputs reports of carbon stocks for plot, strata (parcel) and project levels. The reporting includes above ground biomass (AGB), below-ground-biomass (BGB) as well as the other pools of carbon (soil, deadwood, and litter) if they are included in the plot inventory data. Carbon stocks values are computed for all plots as tons of carbon per hectare (tC/ha). Mean values of tC/ha are computed for all plots associated with a strata (parcel). And, total carbon is computed for all strata using the mean value of tC/ha and the total area of the stratum. The mean value of tC/ha for each strata are the Emission's Factors for these land cover types.

EMISSIONS CALCULATOR TOOL

The Activity Data Emissions System is used to develop reference emissions baselines and emissions reductions based on project interventions. The system supports ex ante reporting often required for project development and it supports project monitoring and ex post reporting. Core components of the system are:

1. System defined (Tier 1) or user defined (Tier 2 or Tier 3) land cover emission factors
2. IPCC AFOLU GHG Stock-Change quantification of emissions
3. Reference emissions level calculation and reporting
4. Project emissions/removals level calculation and reporting
5. Emissions reductions calculations and reporting

SYSTEM DEFINED (TIER 1) OR USER DEFINED (TIER 2 OR TIER 3) LAND COVER EMISSION FACTORS

The activity data emissions system includes the IPCC Tier 1 land cover classes for all regions and the associated Tier 1 emission factors for above- and below-ground biomass, soil, deadwood, and litter. The system also has default emissions for agricultural practices and burning. The system, however, allows for integration with the Forest Carbon Inventory System and the Tier 3 land cover (stratum) and

emissions factors. Land cover classes can, therefore, be added to the system based on user requirements and information and Tier 3 (or Tier 2) emissions factors used.

IPCC AFOLU GHG STOCK-CHANGE QUANTIFICATION OF EMISSIONS

The system runs annual projections of greenhouse gas fluxes based on the user defined time period for the project. Fluxes can either be emissions sources to the atmospheric pool of carbon or removals (sequestration) from the atmosphere into biomass or soil organic carbon. The quantification is based on the difference between carbon stocks on land cover types over time and the loss/gain

(emissions/removals) is a sum result of 1) disturbance (land cover conversion, agricultural practices, fire, and logging) 2) uptake through biomass growth, 3) decay rates and 4) long-term storage in the case of harvested wood products.

REFERENCE EMISSIONS LEVEL CALCULATION AND REPORTING

The system runs a reference emission level calculation for any Business-As-Usual land cover change or degradation emissions scenario. This is a baseline calculation for estimating what the greenhouse gas emissions to the atmosphere will be in the absence of any project or intervention. The emissions could be from deforestation from conversion to agriculture or plantation, or forest degradation from selected harvesting, fire, or grazing.

PROJECT EMISSIONS/REMOVALS LEVEL CALCULATION AND REPORTING

The system runs emissions/removals level calculations for impacts from implementing a project or intervention aimed at improved land management. This is a project calculation that can operate across multiple strata and include more than one intervention opportunity over the course of a project. For example, a project may plan to reduce land conversion from natural forest to agriculture in a particular parcel, in another parcel allow deforestation but convert the deforested area to a long-rotation plantation, and in a third parcel convert a degraded grassland to an agroforestry system in year three and this to a mixed plantation in year ten. The first parcel will be an emissions source, the second parcel will be an emissions source that becomes partially offset by removals, and the third parcel will be a small remove in year's three to ten and then become a larger removal after year ten.

EMISSIONS REDUCTIONS CALCULATIONS AND REPORTING

The system compares project emissions/removals calculations against the reference emissions level in a Business-As-Usual scenario and computes both emissions avoided and greenhouse gas removals from the atmosphere. The tool is run at the start of the project to provide ex ante calculations. It can provide important information for decision-making as an ex ante reporting system to look at trade off in different project intervention strategies in terms of emissions avoided and removals gained over the course of a project. With activity and emissions factor data collected through a monitoring protocol in the project area, the tool supports reporting of actual emissions avoided and removals gained against a reference level baseline. These ex post runs can be completed on time steps appropriate for the project intervention plans and at the end of the project.

REPORTING TOOL

The reporting tool provides three types of reports: 1) the Project Information, 2) Geographic Map Information and 3) Carbon Stock information. Both the Project Information and the Carbon Stocks can be downloaded as a PDF or a CSV file with access to data.

PROJECT DOCUMENTS TOOL

The project documents tool is a user-defined file management system where users define a set a folders and sub-folders that can be used to archive and distribute project documents and files to team members. For example, folders might include Project Design Documents, Field Manuals, Protocol Documents, Budgets and Accounting, Field Operations, and the like. File types that can be uploaded include: .doc, .docx, .xls, .xlsx, .ppt, .txt, .zip, .jpg. There is a file size limit of 250 MB.

PROJECT SETTINGS TOOL

The project settings tool includes three tabs at the top of the tool: Project Settings, Add User and List

User. The tools under the project settings tab allow a user to copy a project and to delete a project. The

Add User tab tool allows a user to add a user to the project. The user name is entered into the field and Add User button is then clicked. This means that the new user will also have access to the project. The list users simply shows what users are part of the project.

USING THE SYSTEM

GETTING STARTED

The Forest Data management system can be hosted and managed on the servers of any institution approved by USAID. It is also available for demonstration on the servers of Michigan State University for access there, go to DMS URL: http://beta.carbon2markets.org/cas/login/

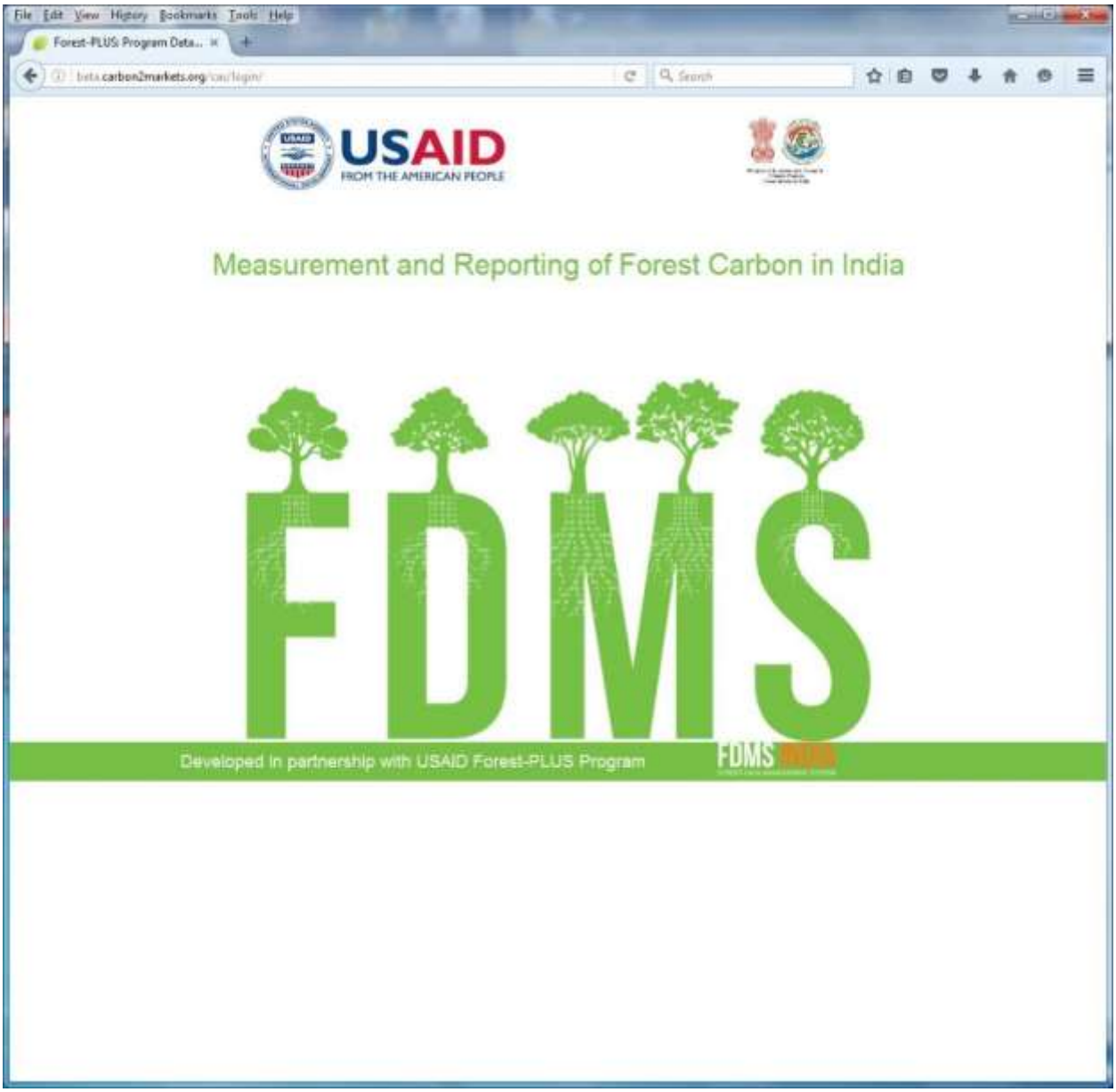


Figure 7 DMS splash page

A login and password must be requested for access to the system.

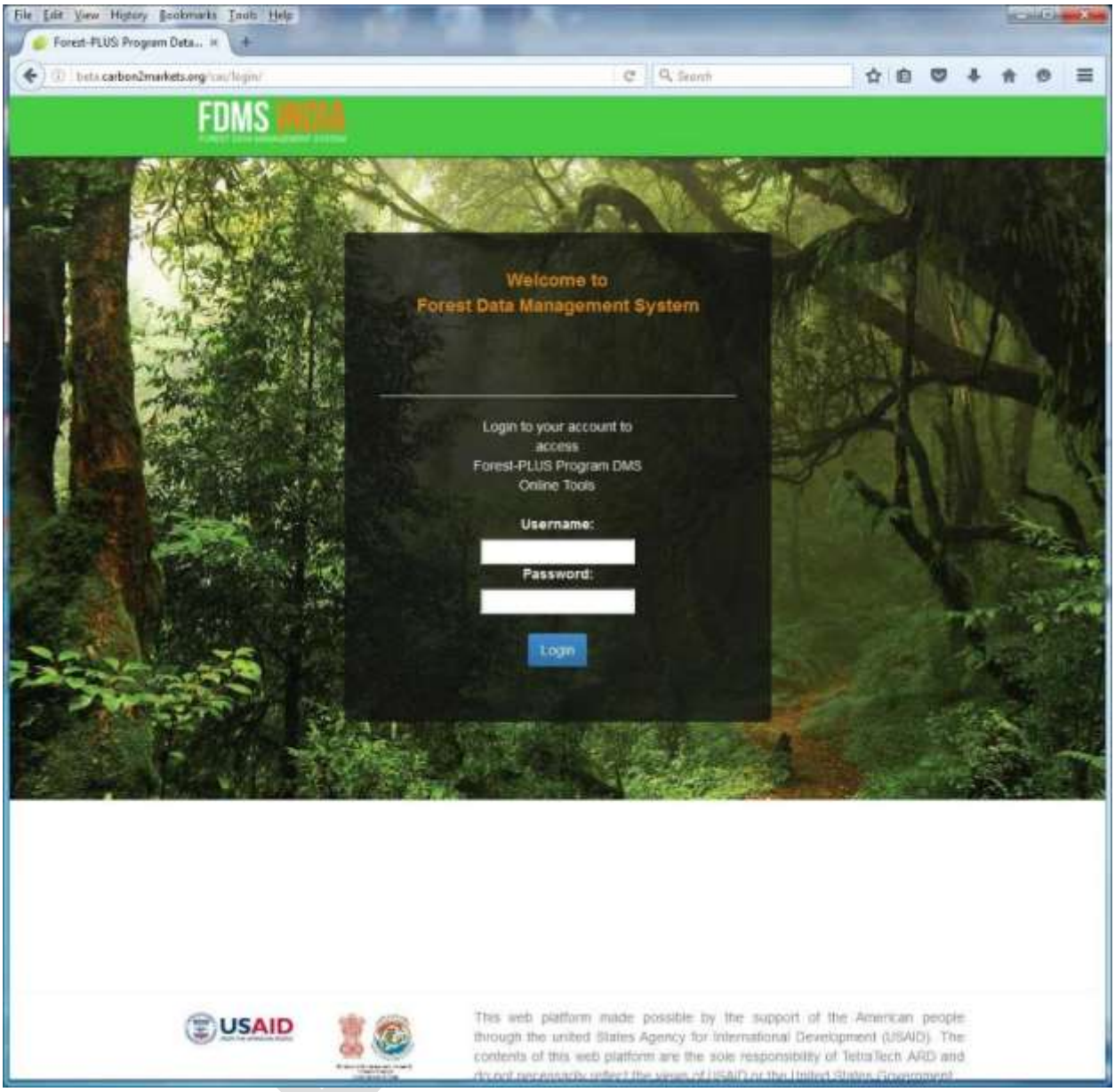


Figure 8 DMS login page

MANAGEMENT OF PERMISSIONS AND ACCESS

Project administrators may define permissions and access for the project.

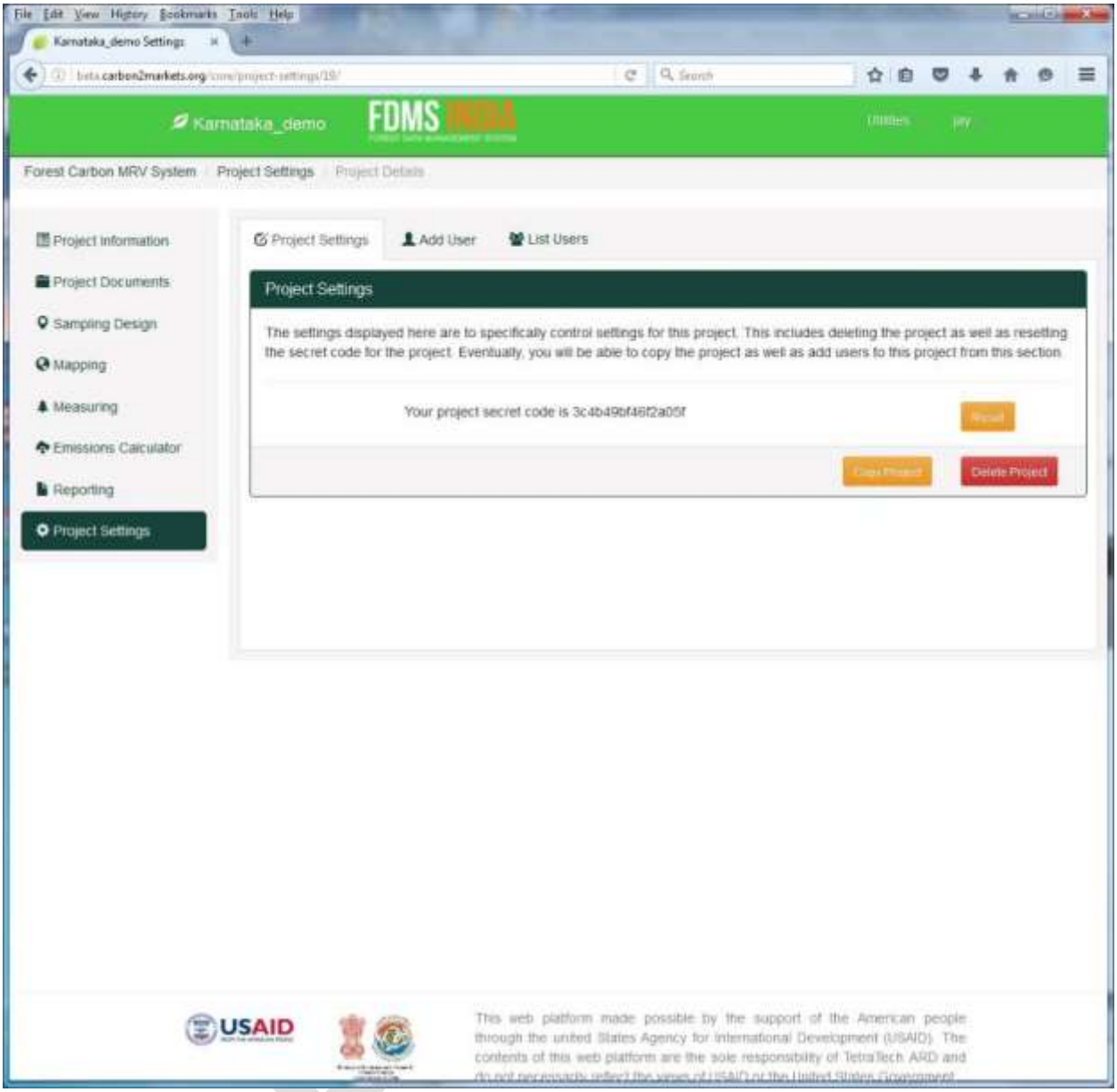


Figure 9 Permissions management

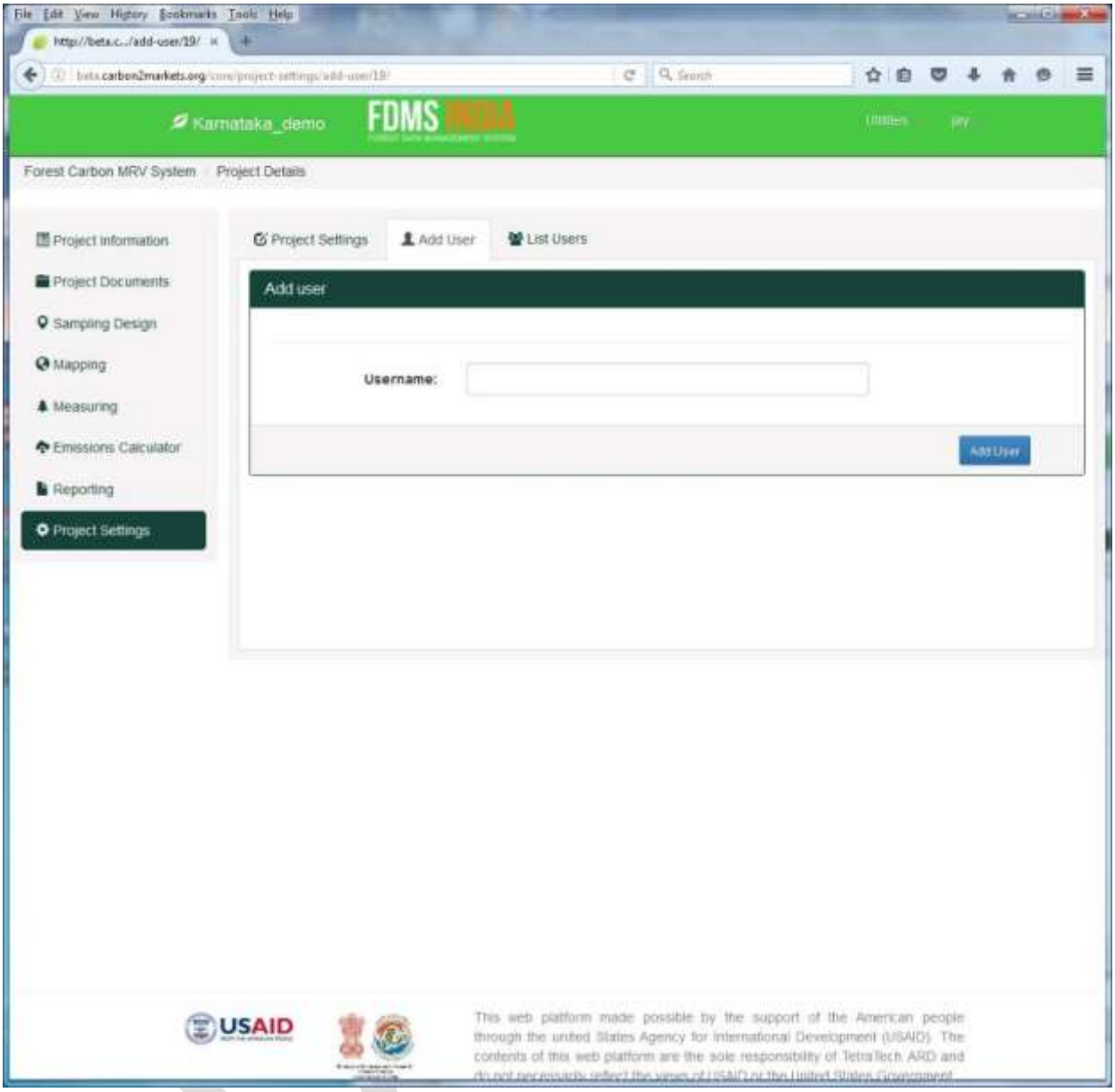


Figure 10 Adding a user

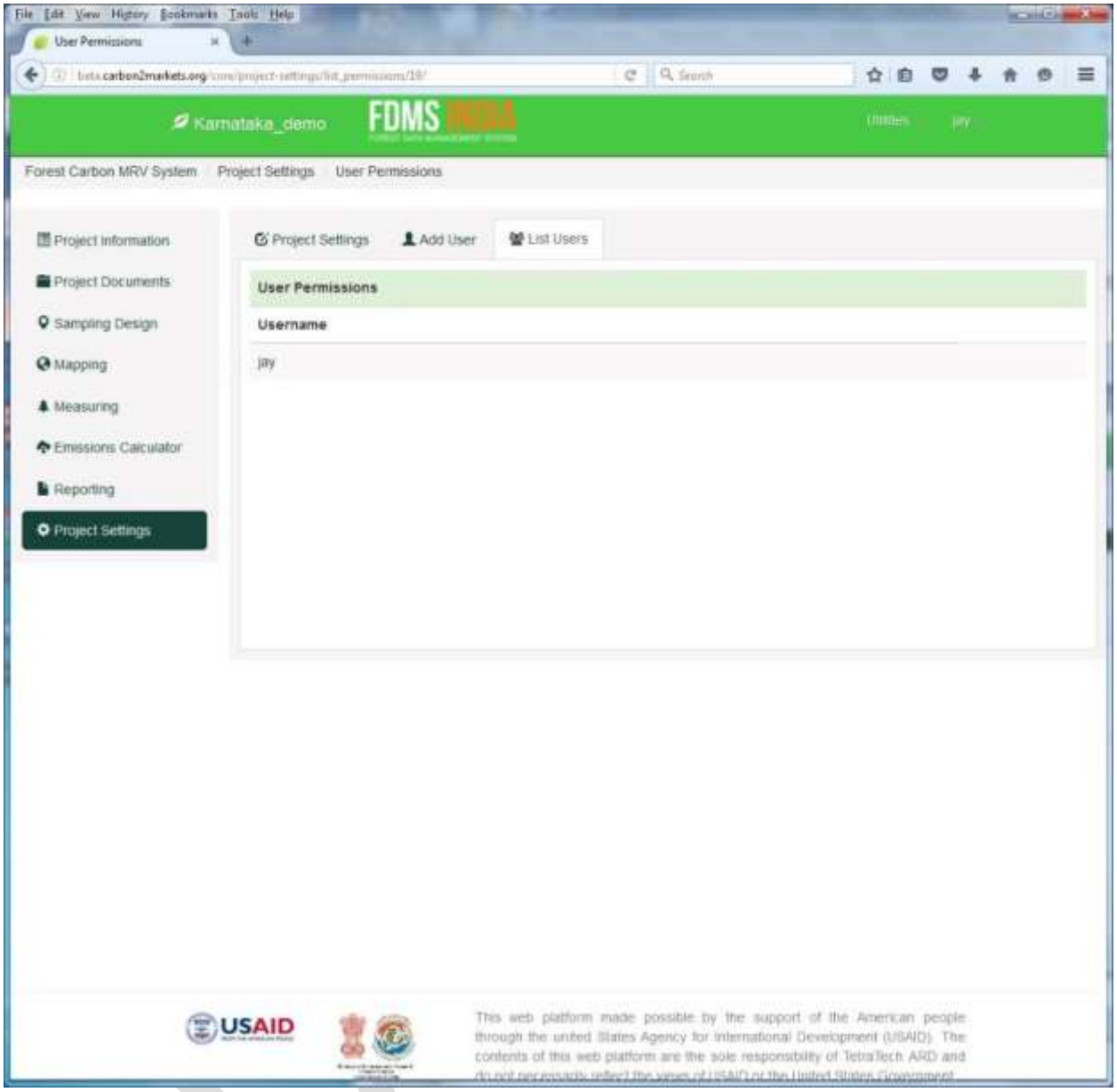


Figure 11 Setting user permissions

STARTING WORK ON A PROJECT

The highest level of the management hierarchy in the system is a project. A new project must be created before work can begin in the system.

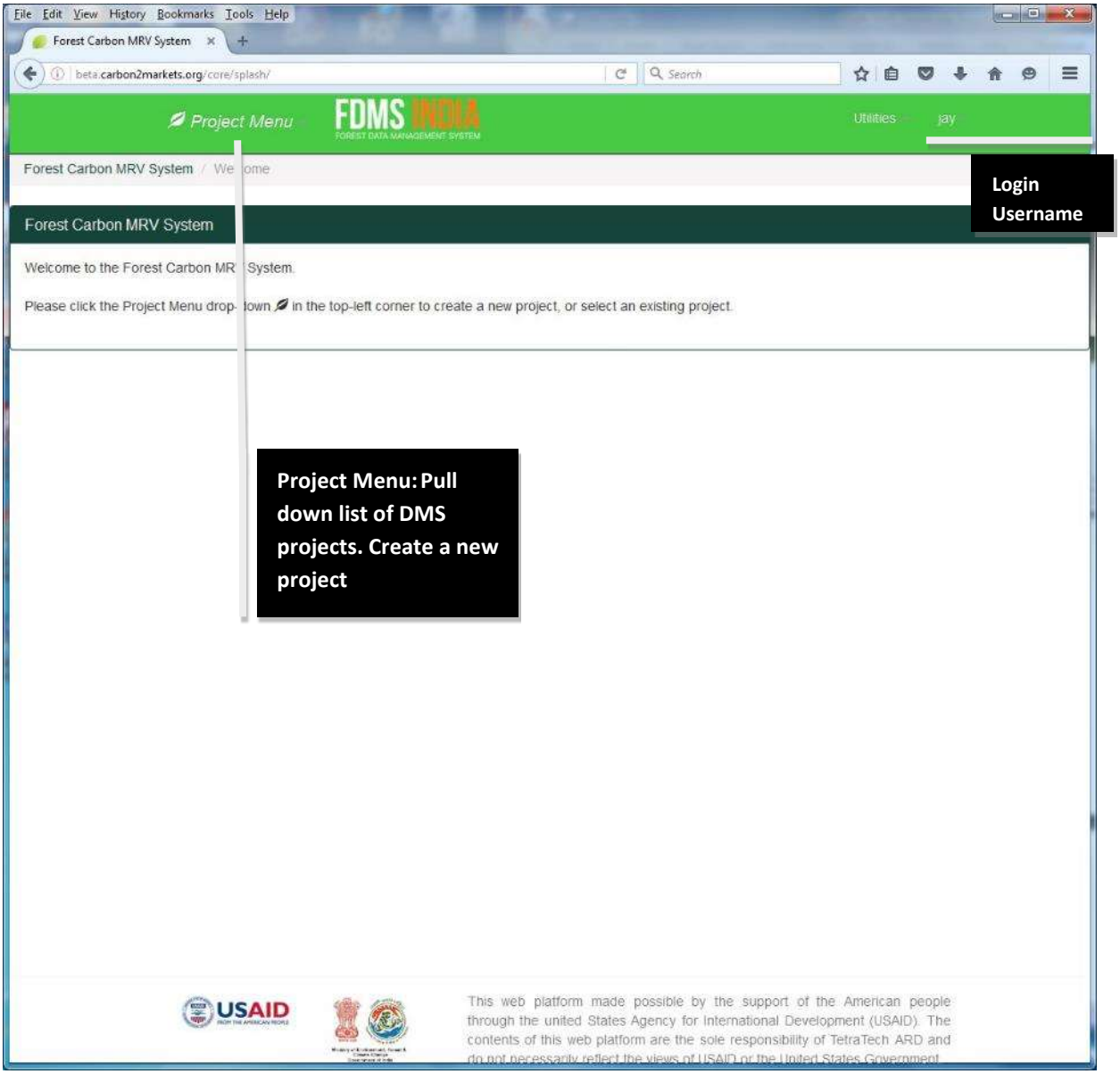


Figure 12 Initial project workspace

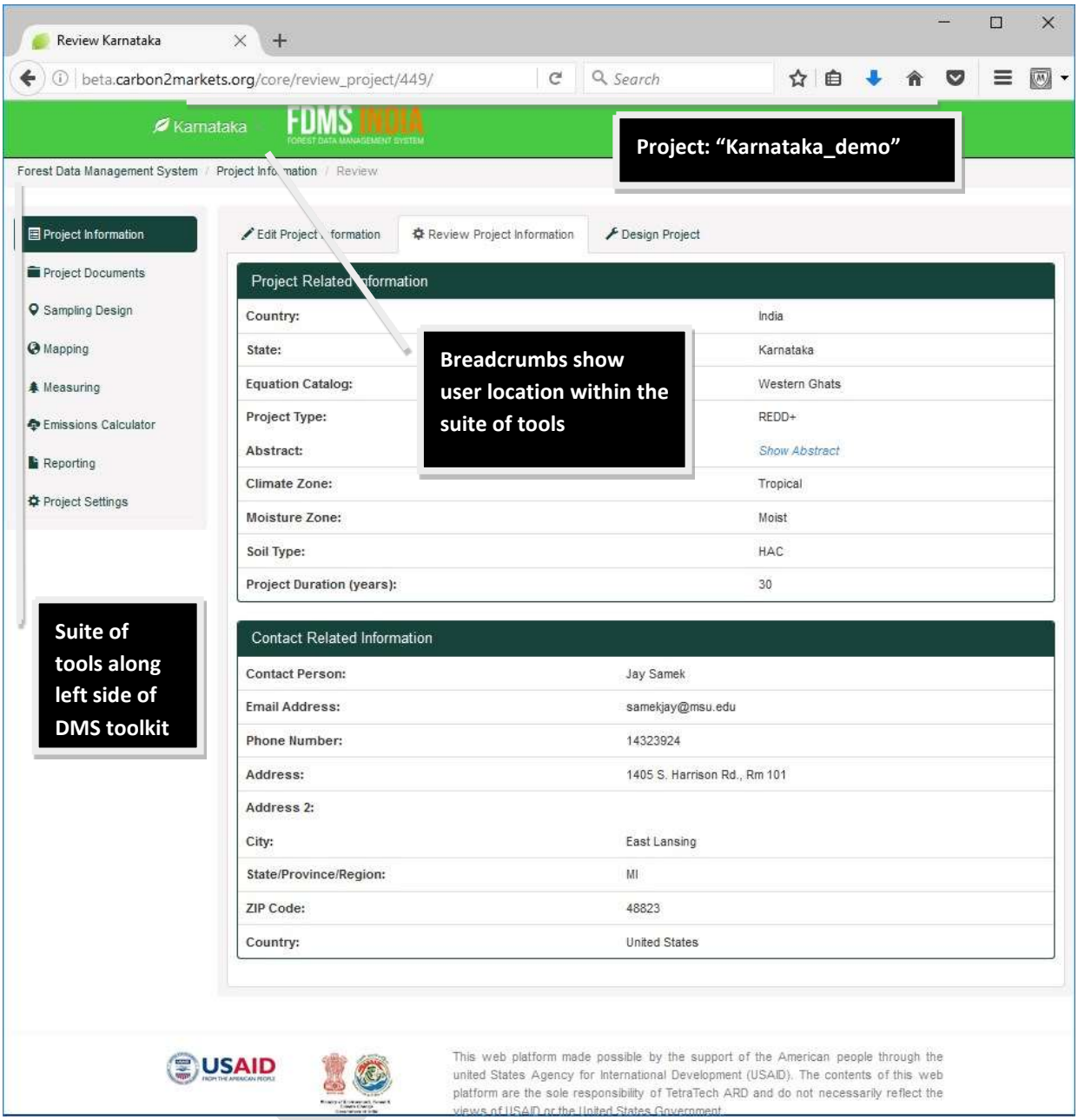


Figure 13 Navigating the DMS tools

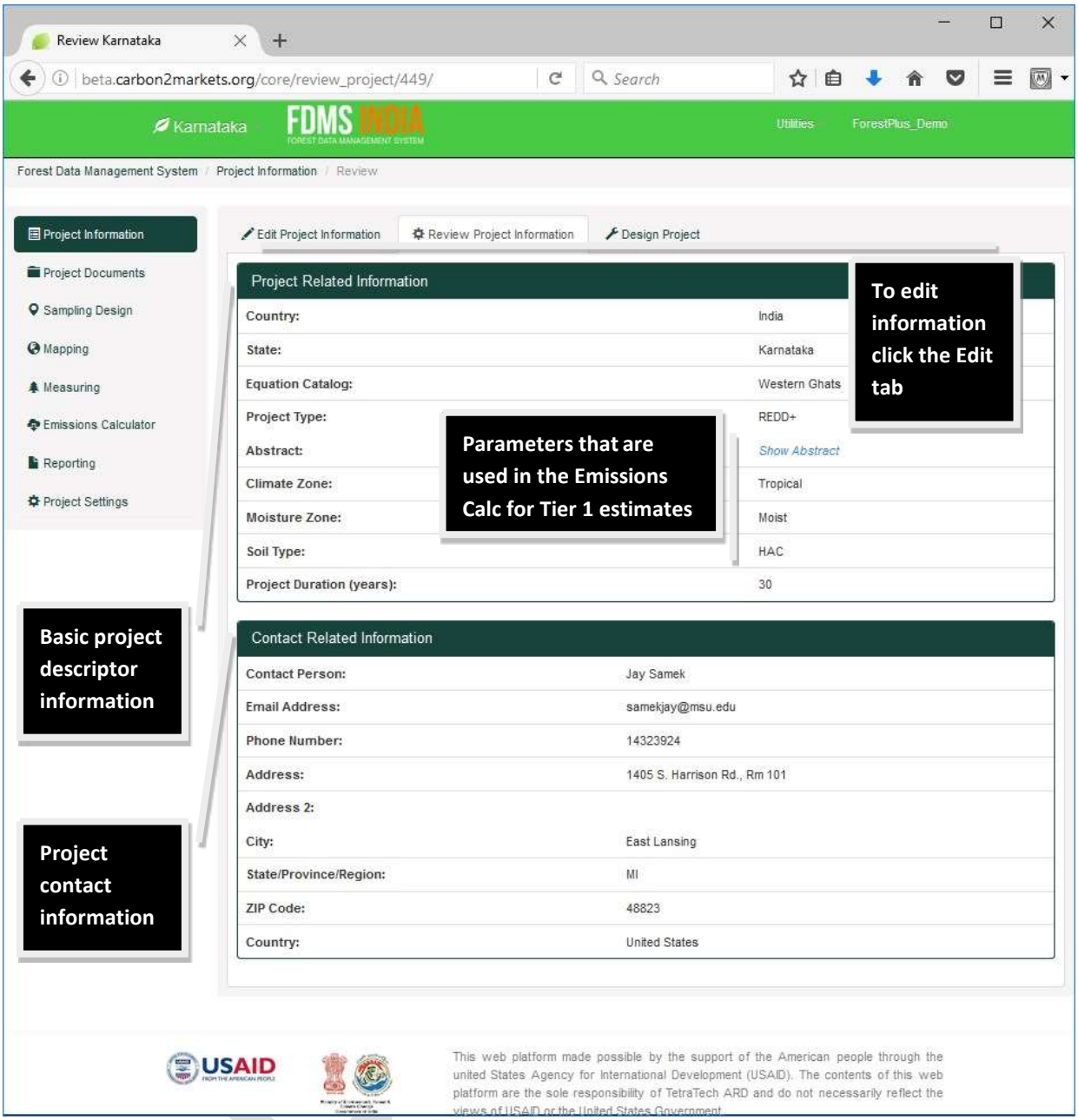


Figure 14 Project information

PROJECT DOCUMENTS REPOSITORY

The DMS has a documents repository available for each project, so that common references can be easily maintained and referenced.

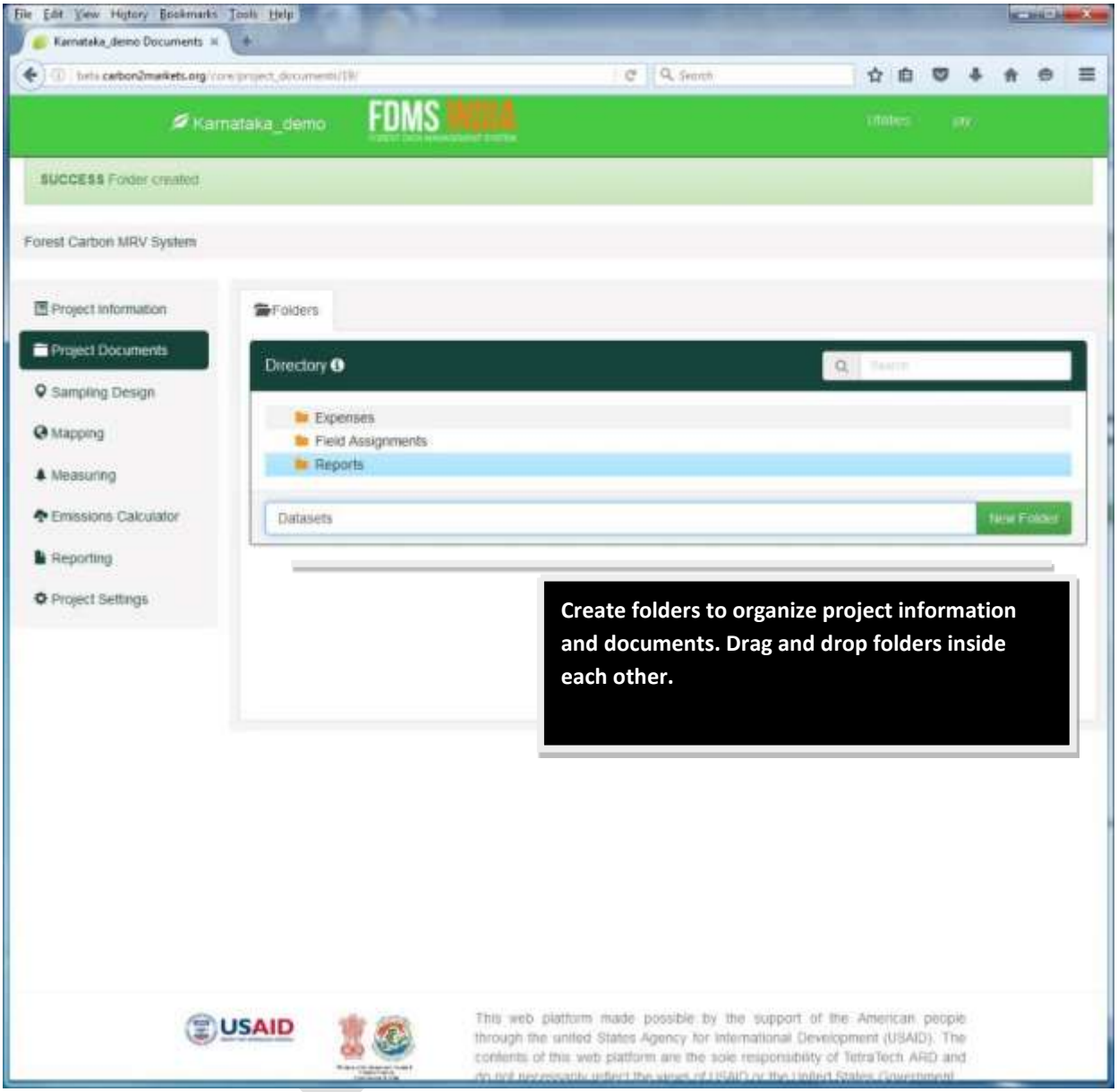


Figure 15 Project documents repository (1 of 4)

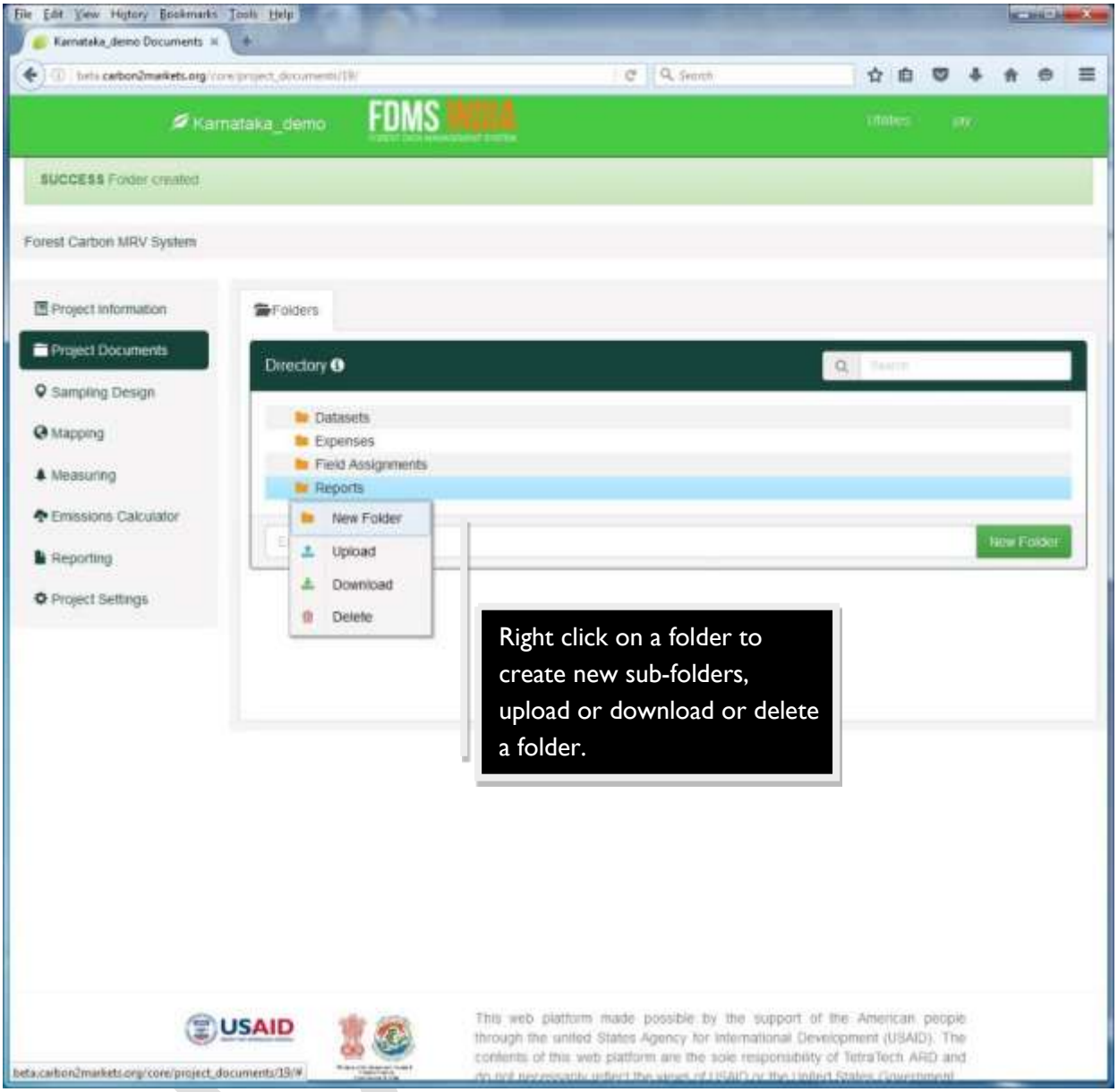


Figure 16 Project documents repository (2 of 4)

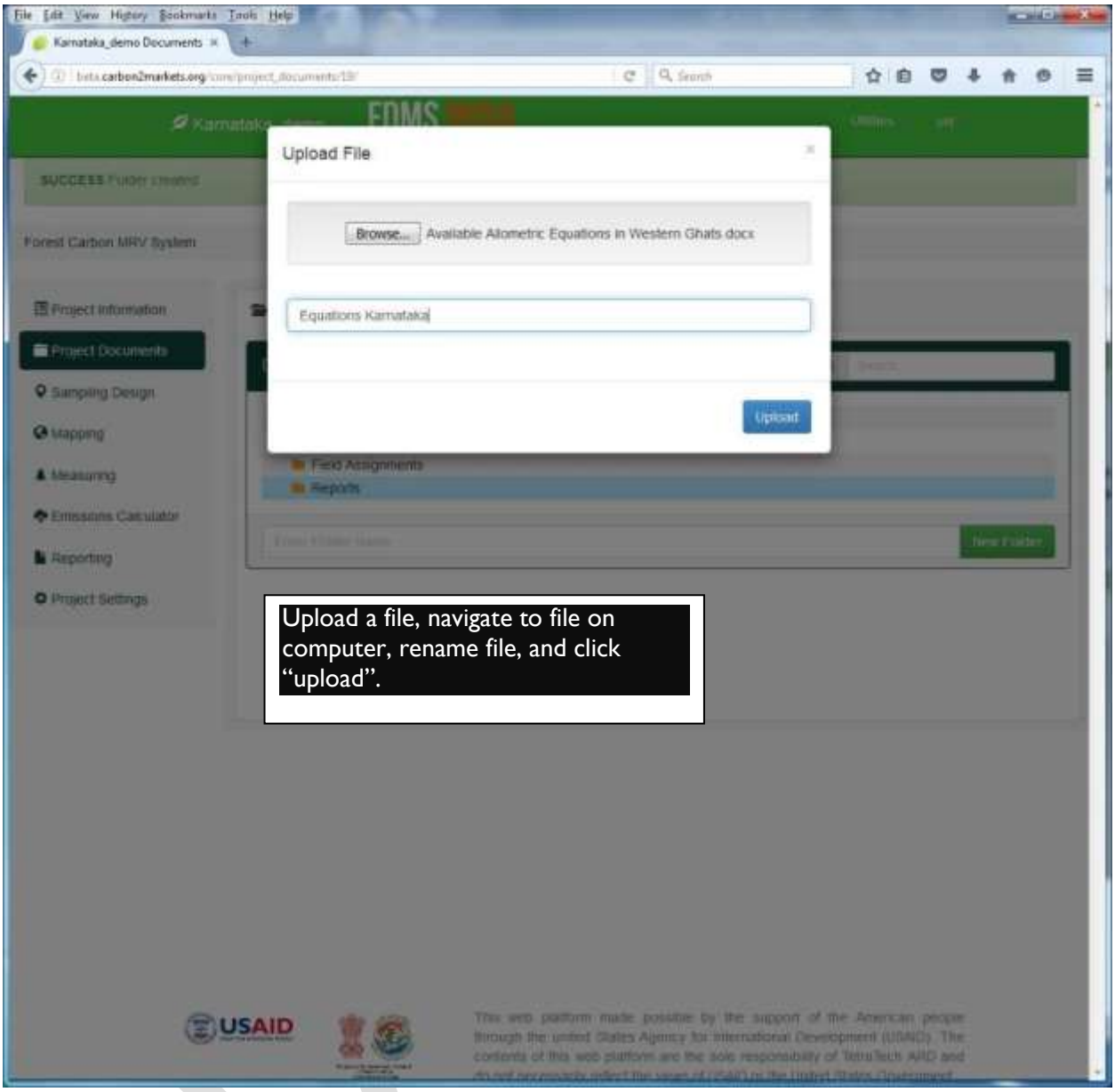


Figure 17 Project documents repository (3 of 4)

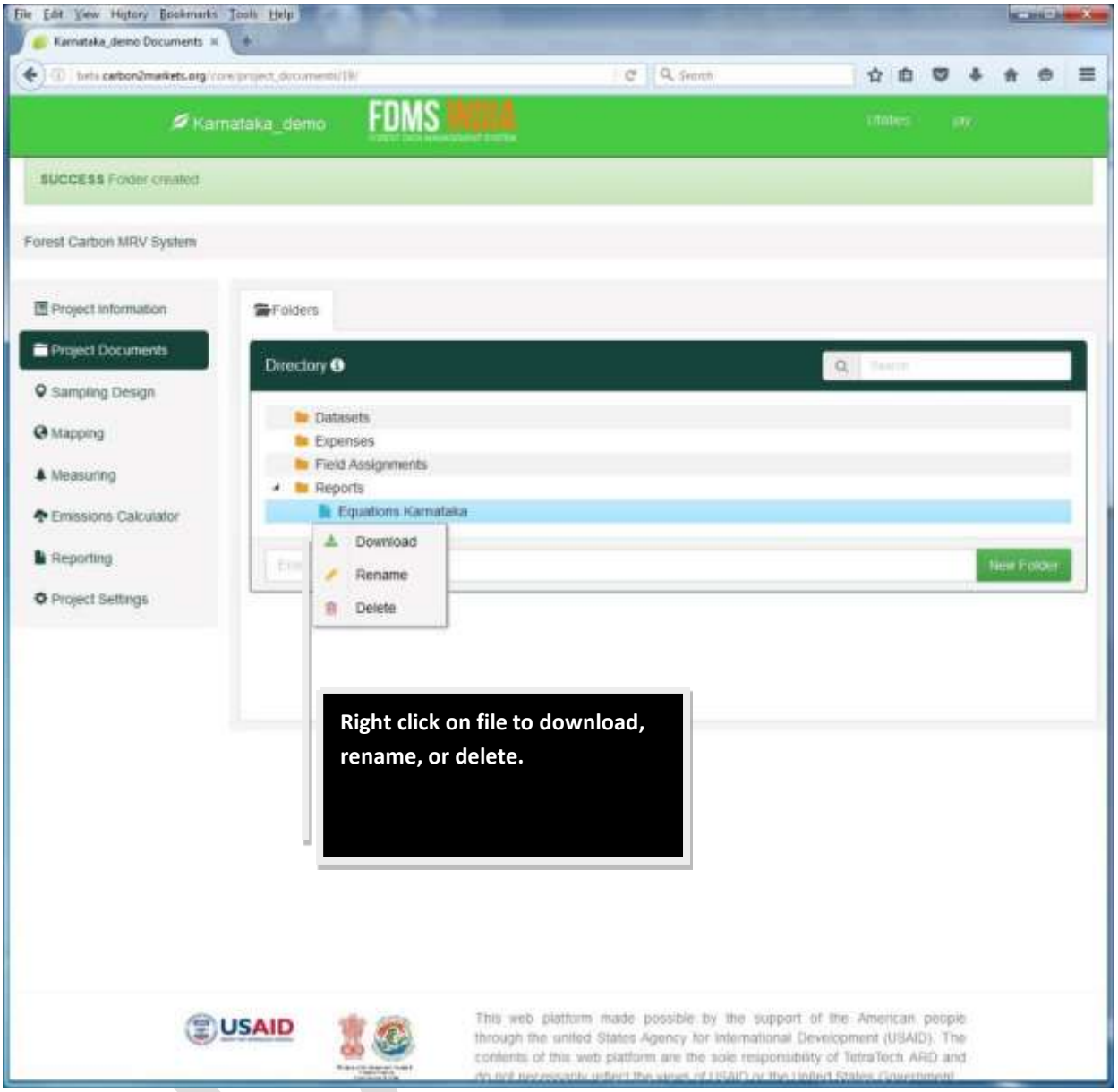


Figure 18 Project documents repository (4 of 4)

DESIGNING A SAMPLE

The DMS has functionality to calculate an appropriate sample size for a stratified random or grid-based sampling design. Stratification must be done outside of the system. These strata as .shp or .kml files can be ingested by the DMS.

Confidence levels, error, and stratum (i.e. parcel) level mean and varience must be supplied by the user, ideally through a pilot sample.

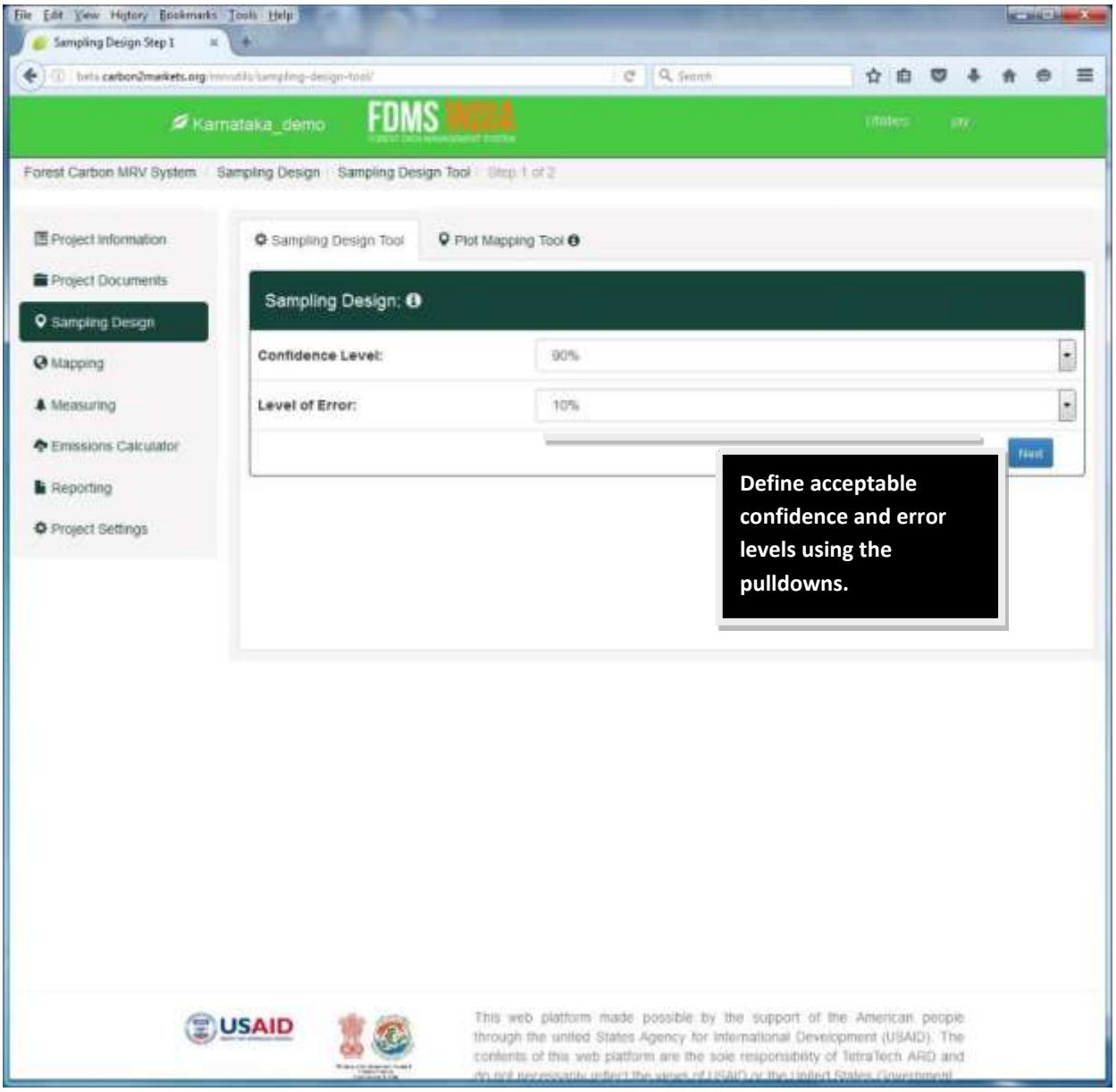


Figure 19 Setting confidence levels

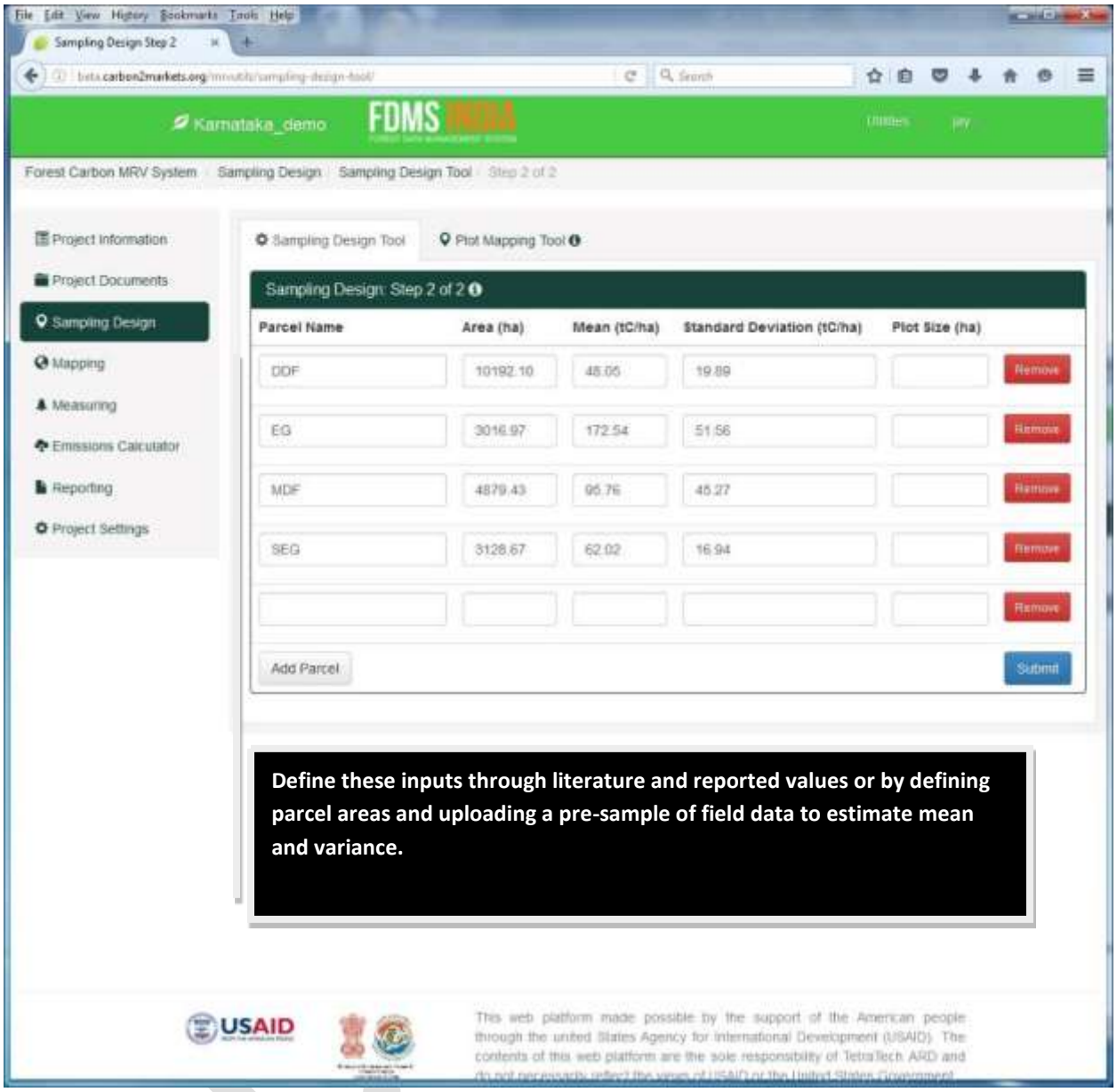


Figure 20 User-defined information for each stratum

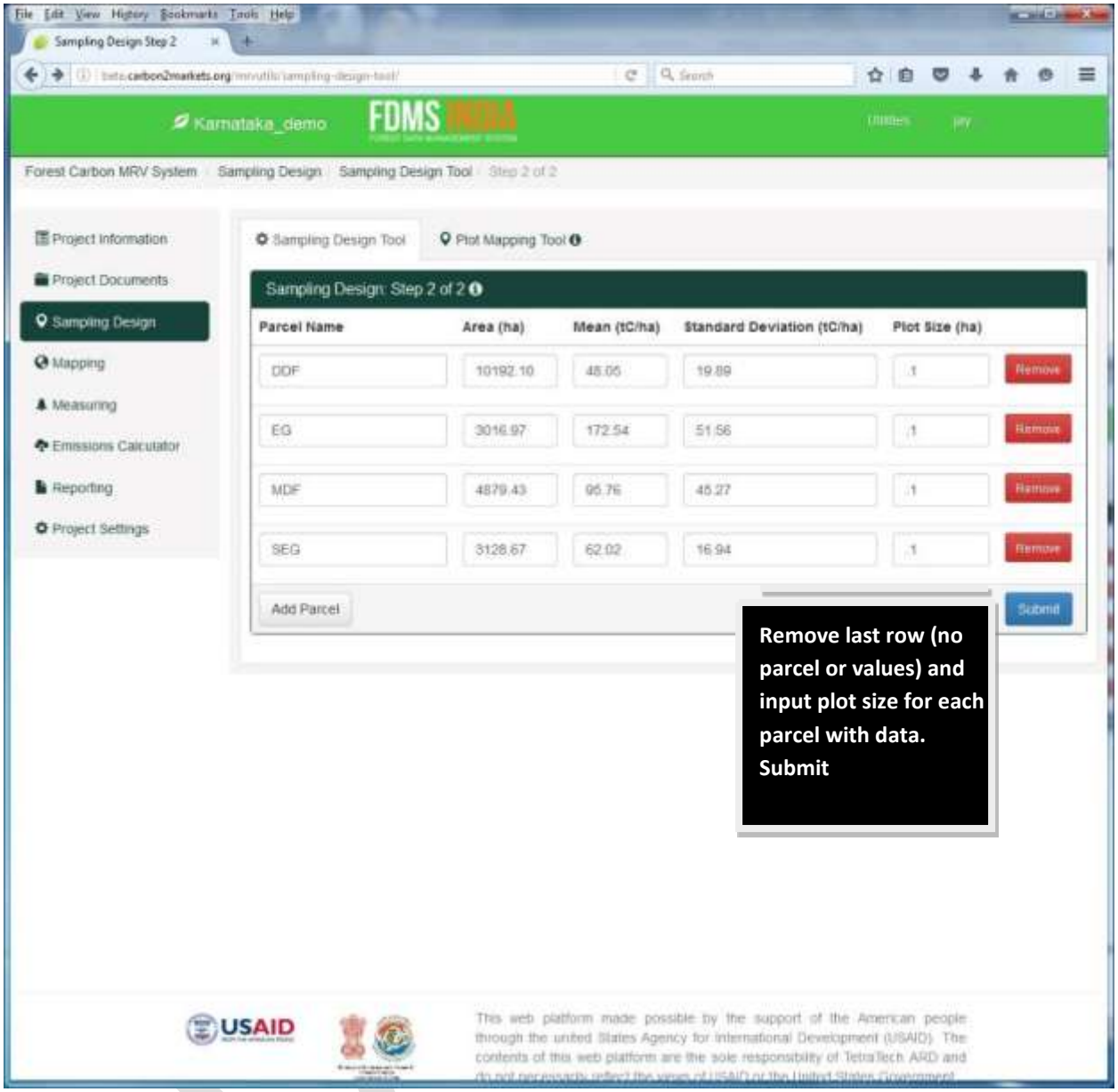


Figure 21 Finalize information by stratum

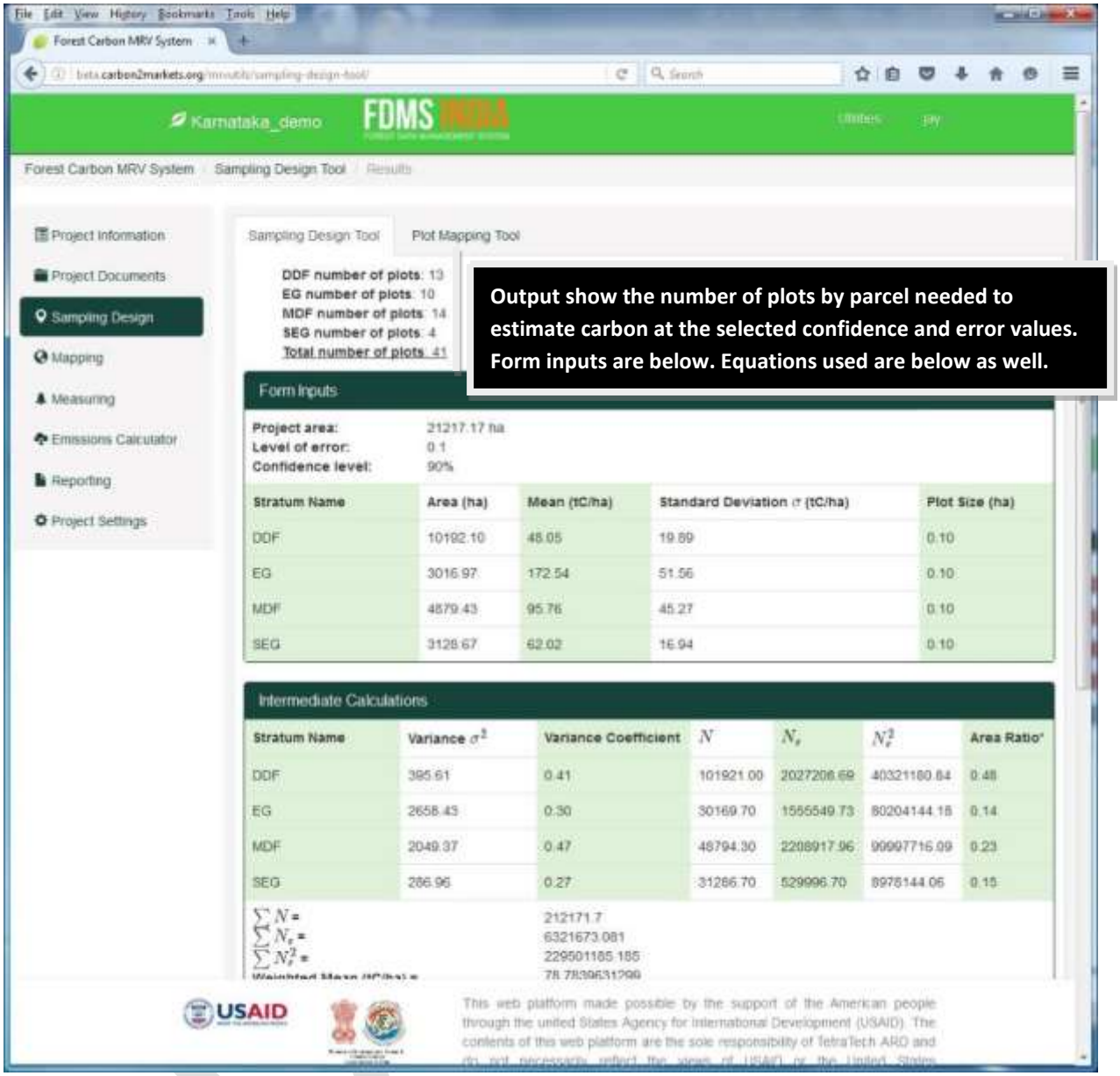


Figure 22 Sampling tool output

MAPPING AND PLOT ALLOCATION

Once the sample size is set, the DMS can allocate the plots by strata or using a grid-based approach as FSI prescribes.

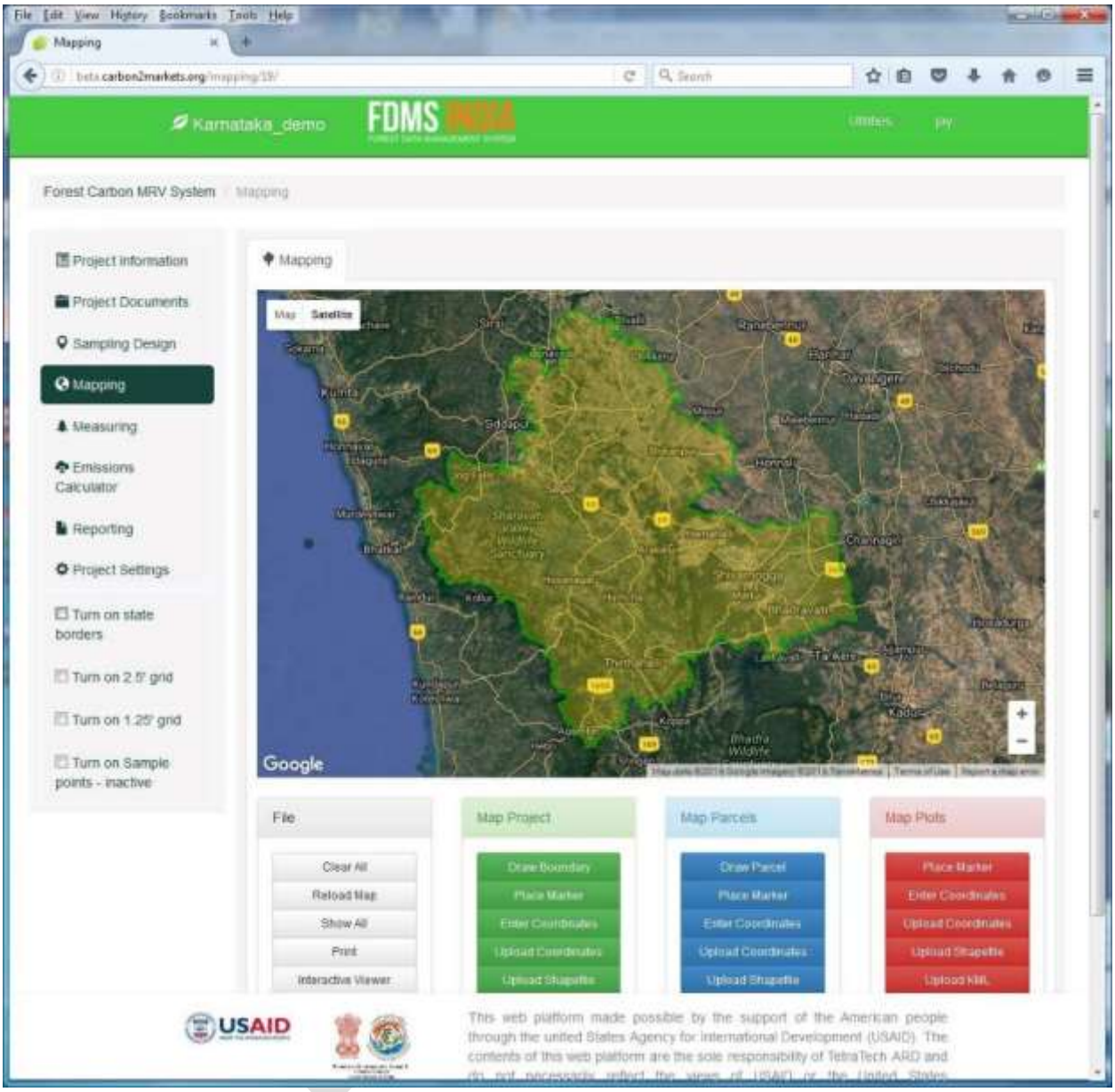


Figure 23 Map of a project area

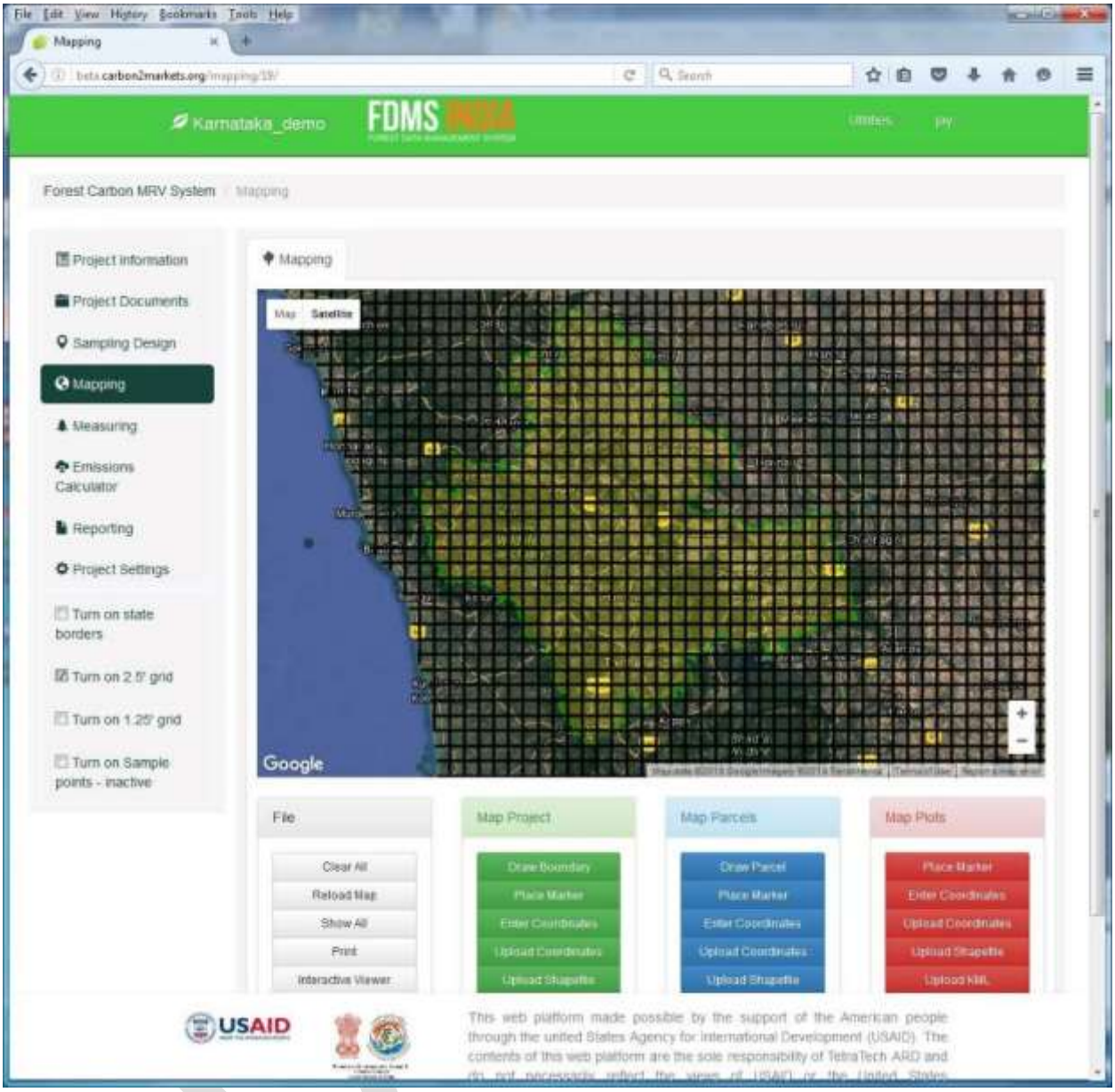


Figure 24 Grid-based sampling approach (Following FSI)

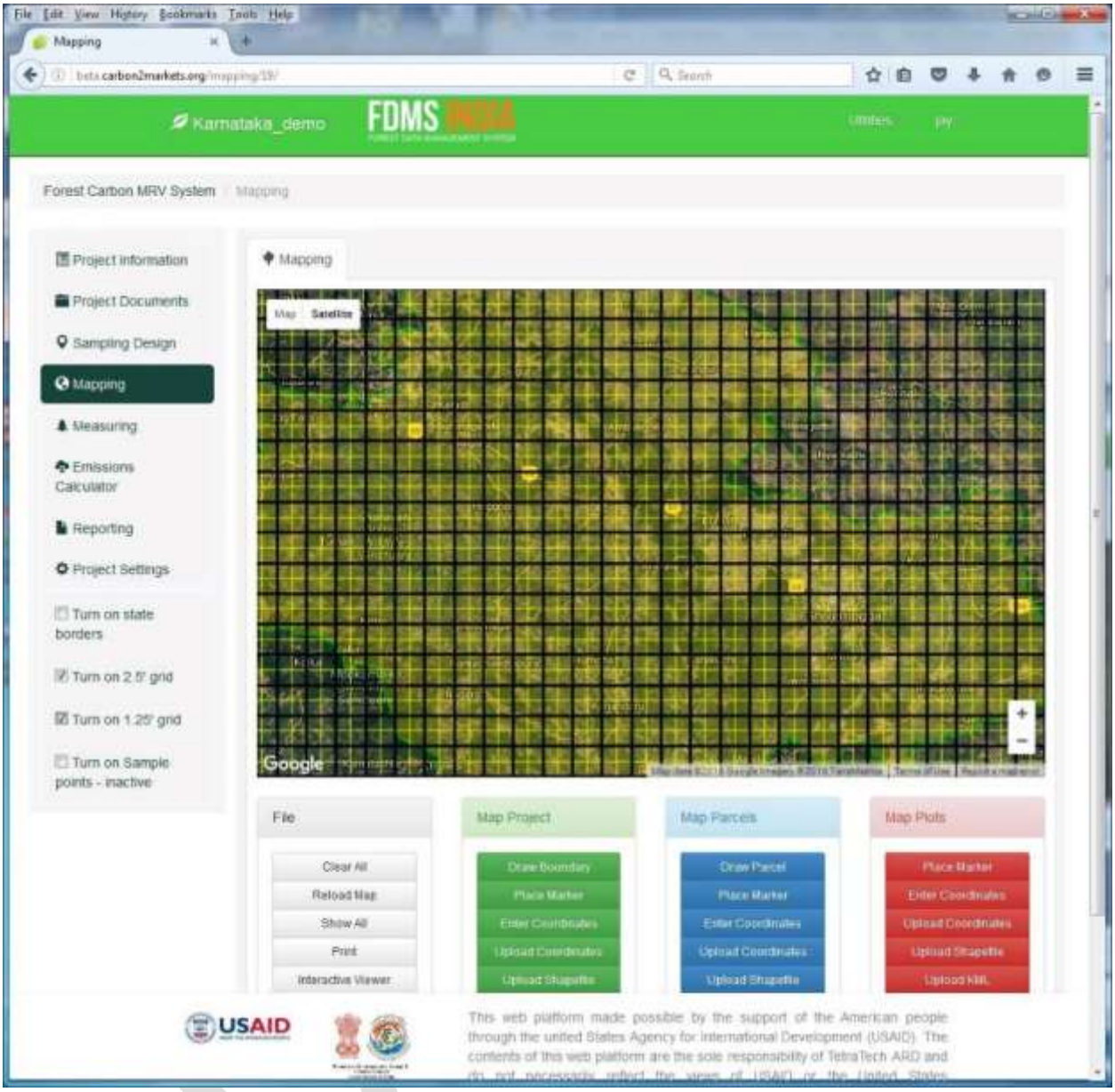


Figure 25 Grid-based sampling approach, subdivided quadrants

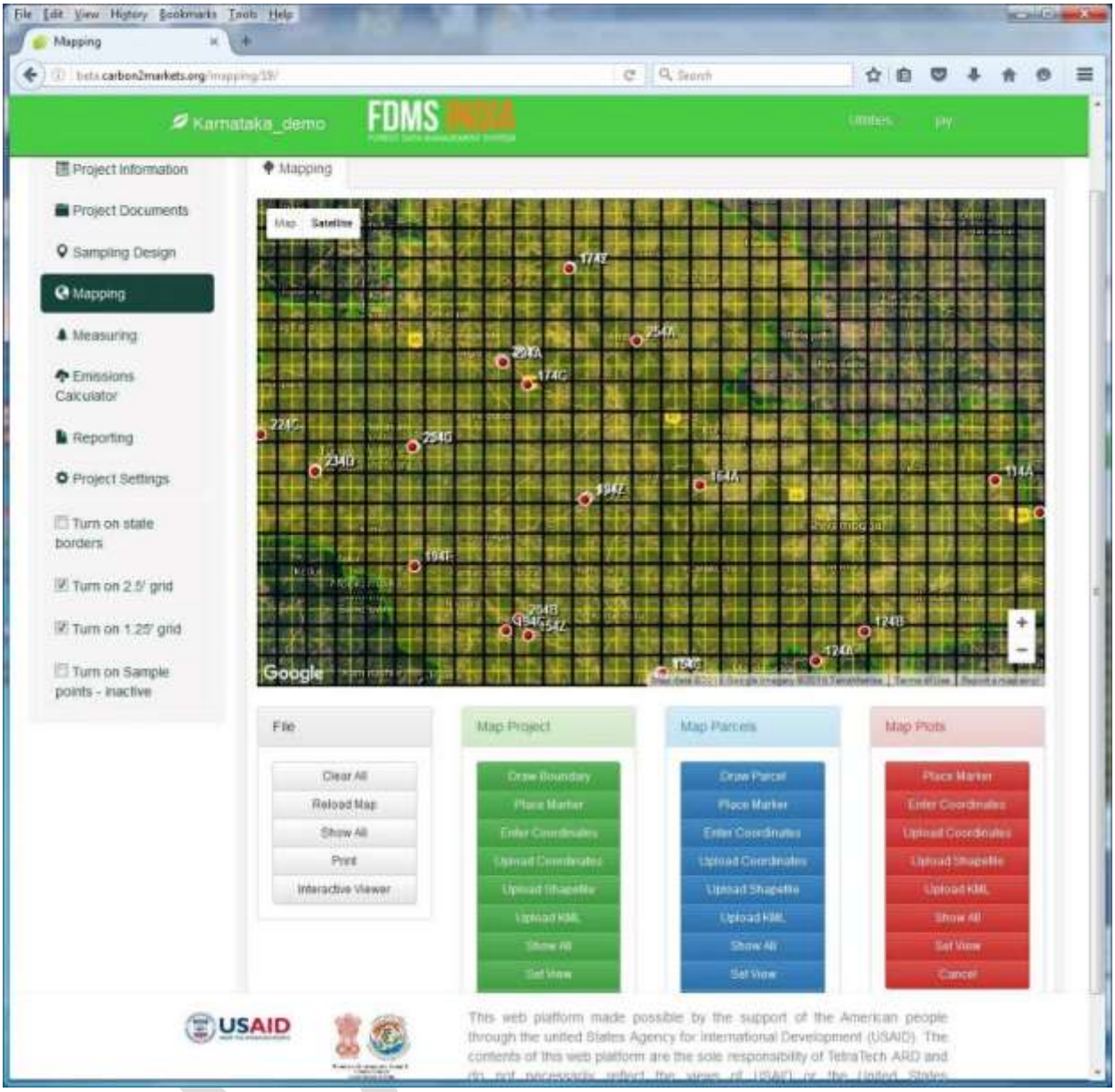


Figure 26 Grid-based sampling approach, sub-divided quadrants with plots allocated

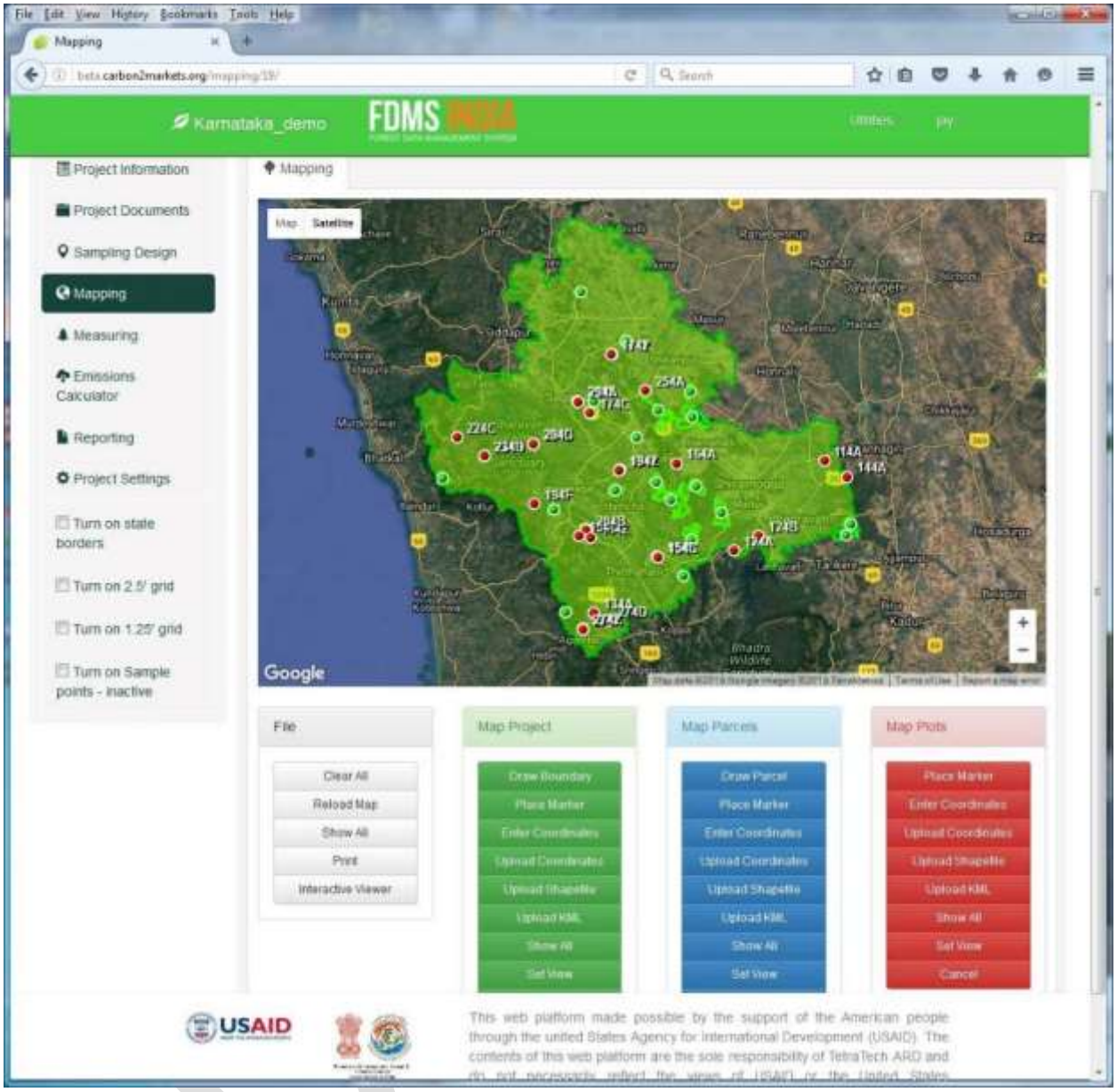


Figure 27 Plots allocated against project area

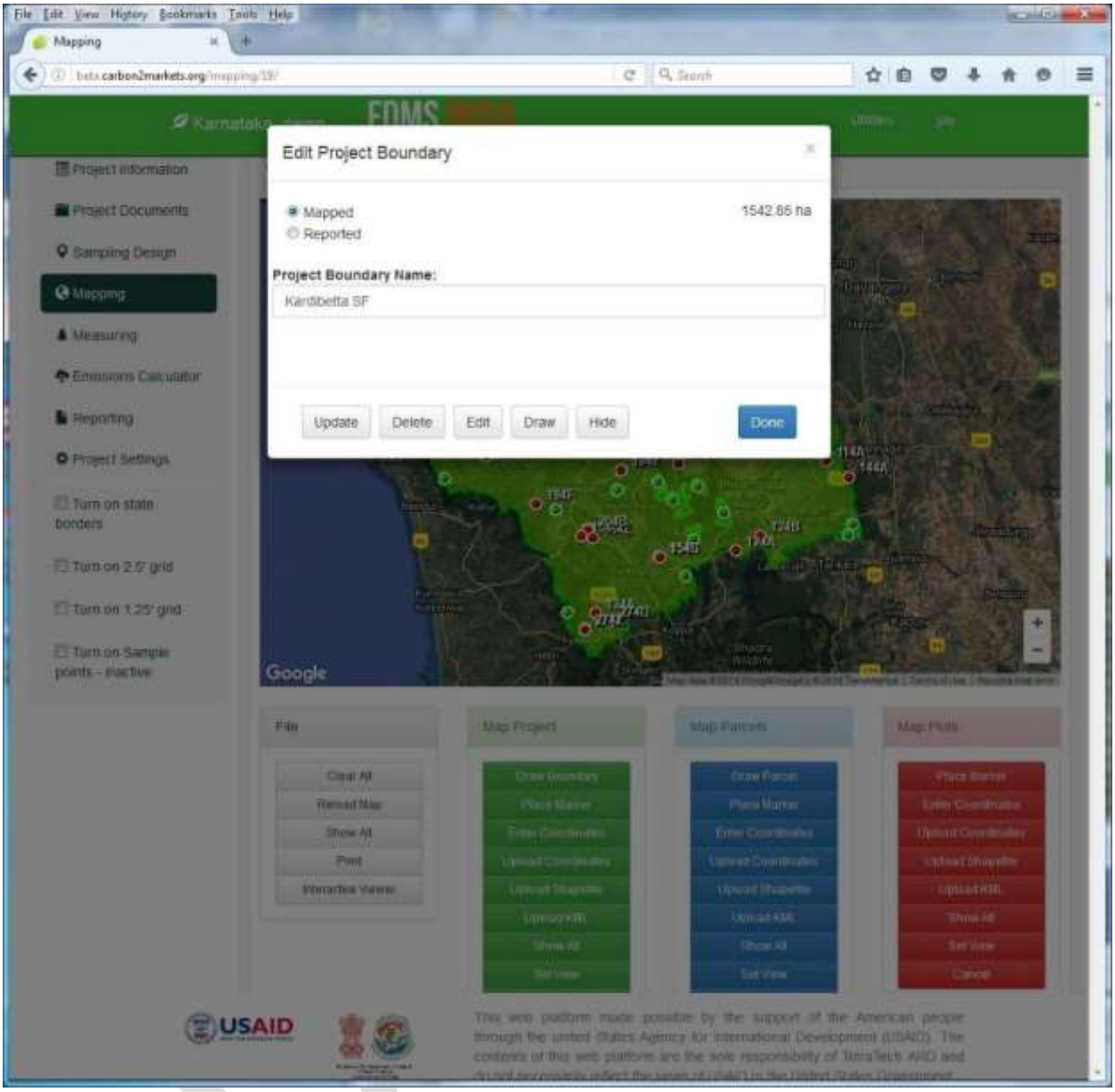


Figure 28 Naming and editing a project boundary

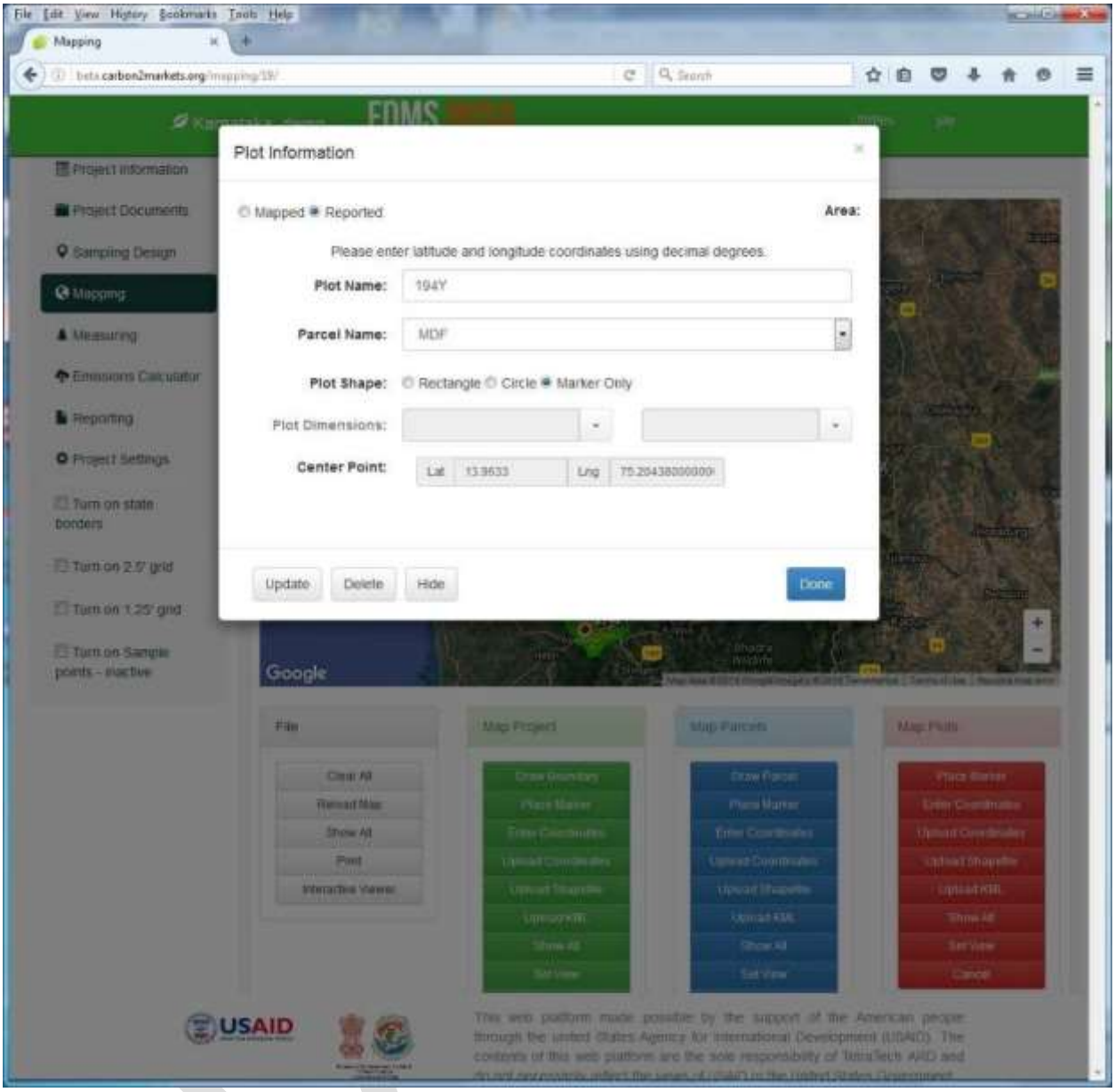


Figure 29 Setting plot names and attributes

MEASURING

Once the plots have been selected, field data must be collected for input into the DMS. The DMS is designed to connect to mForest, a mobile android-based application for data collection. The DMS can push plot locations to mForest for field teams, and mForest will provide the data to the DMS in real-time or whenever the user returns to a location with internet access.

Data can also be ingested by the DMS from .csv or .xls files.

Once data is ingested, the user can review the tree list by plot and select allometric equations to convert field measurements to stocks.

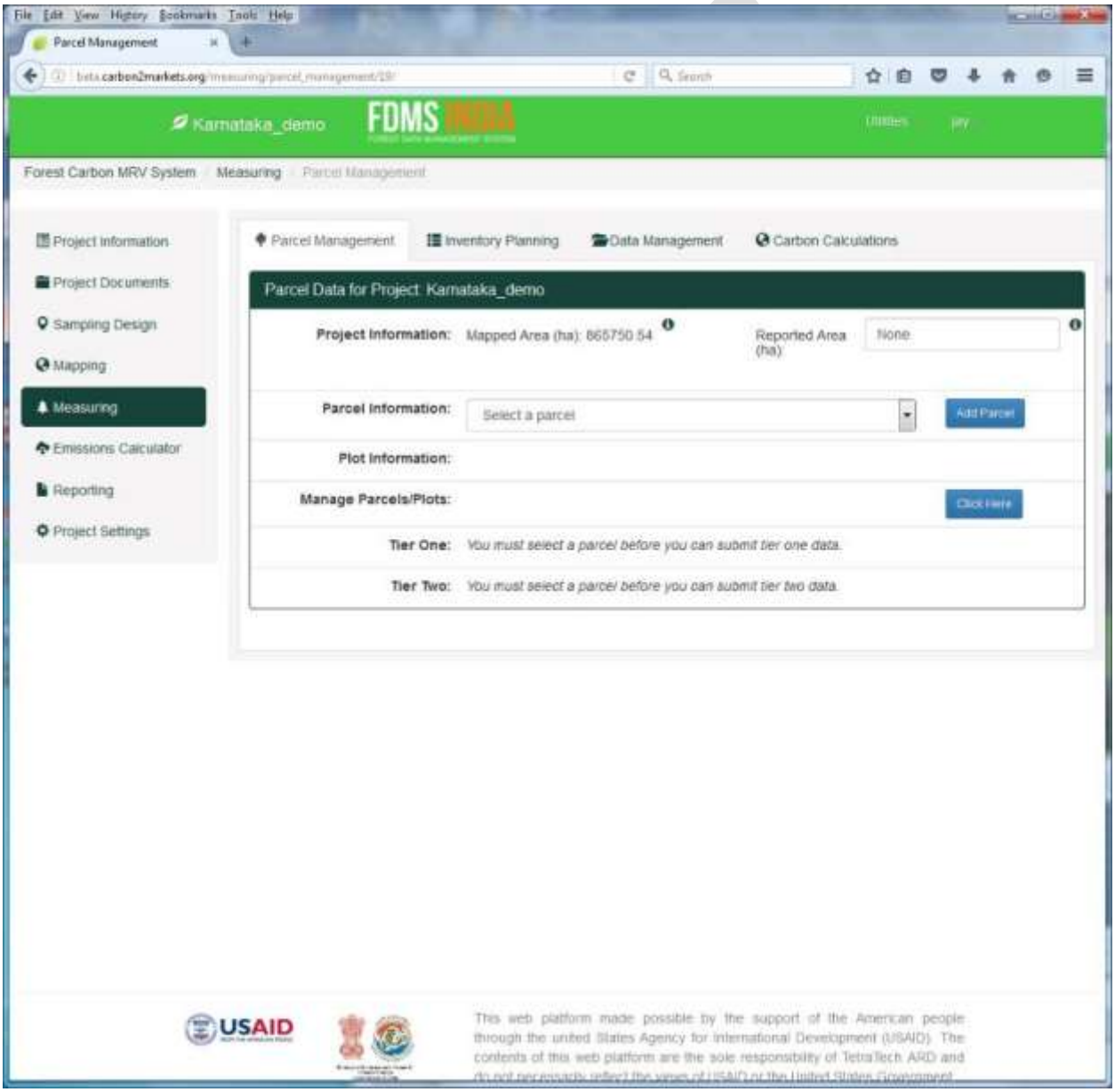


Figure 30 Parcel management and selection for calculation of stocks

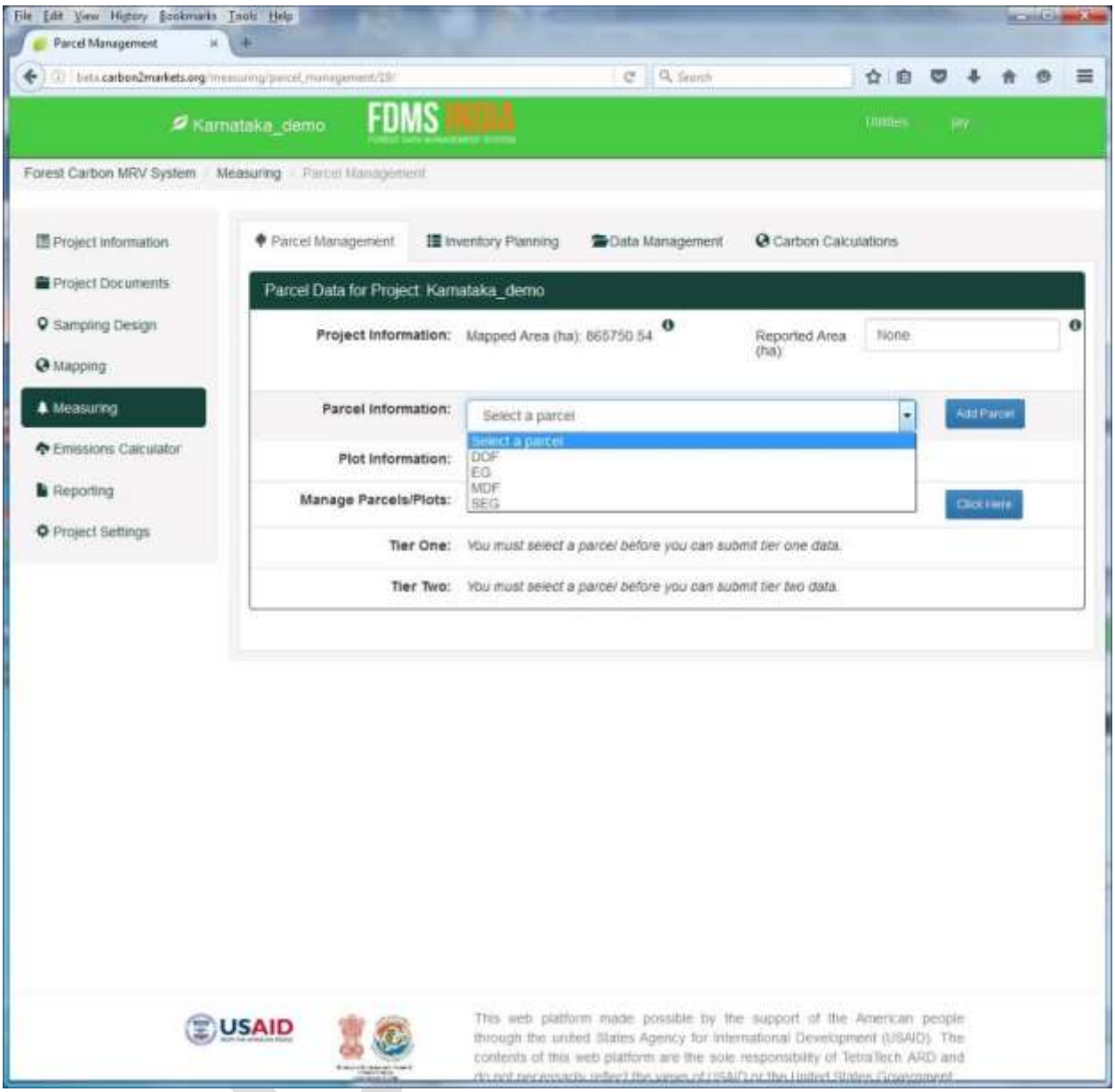


Figure 31 Select a parcel

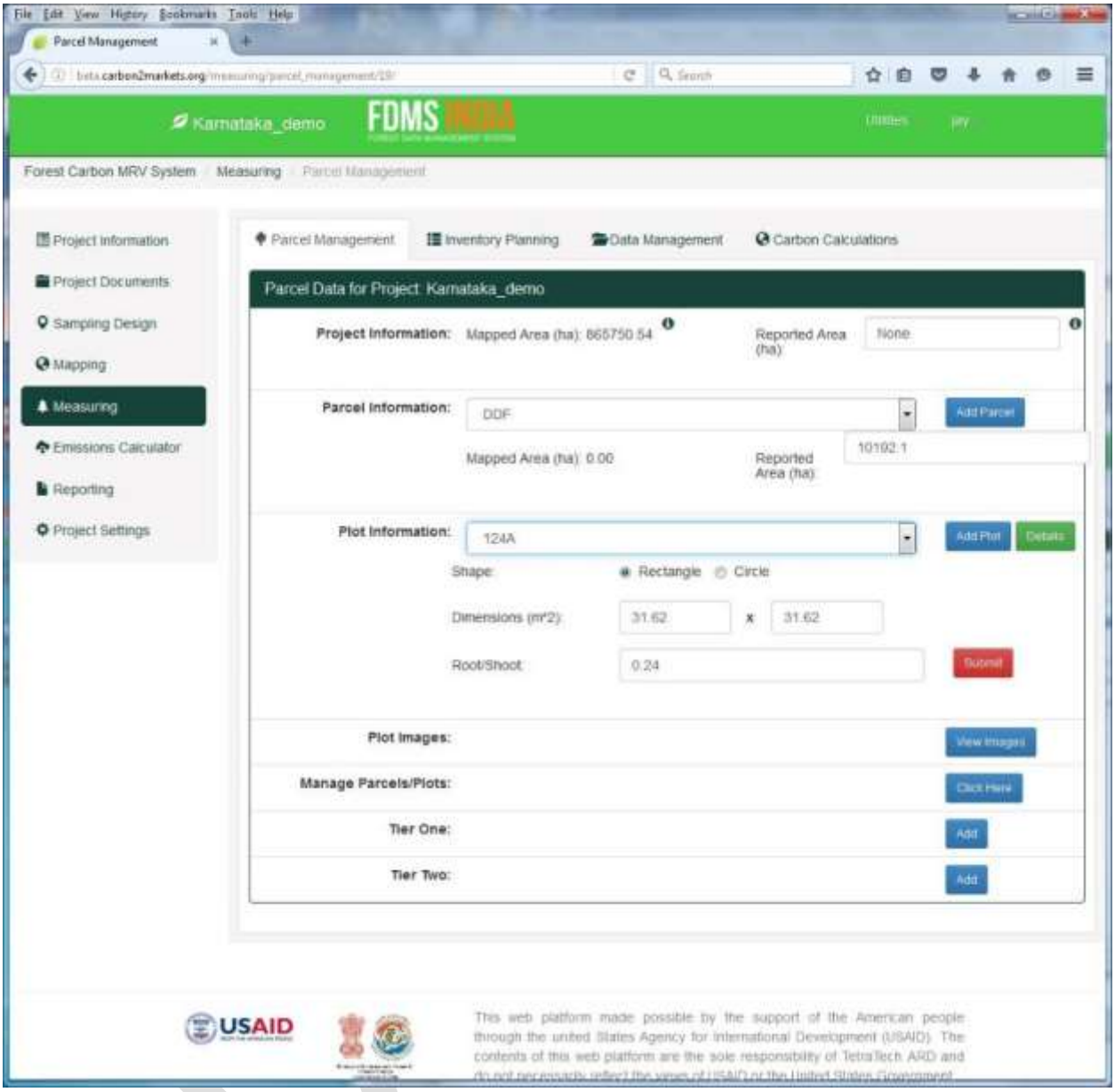


Figure 32 Plot-wise information by parcel

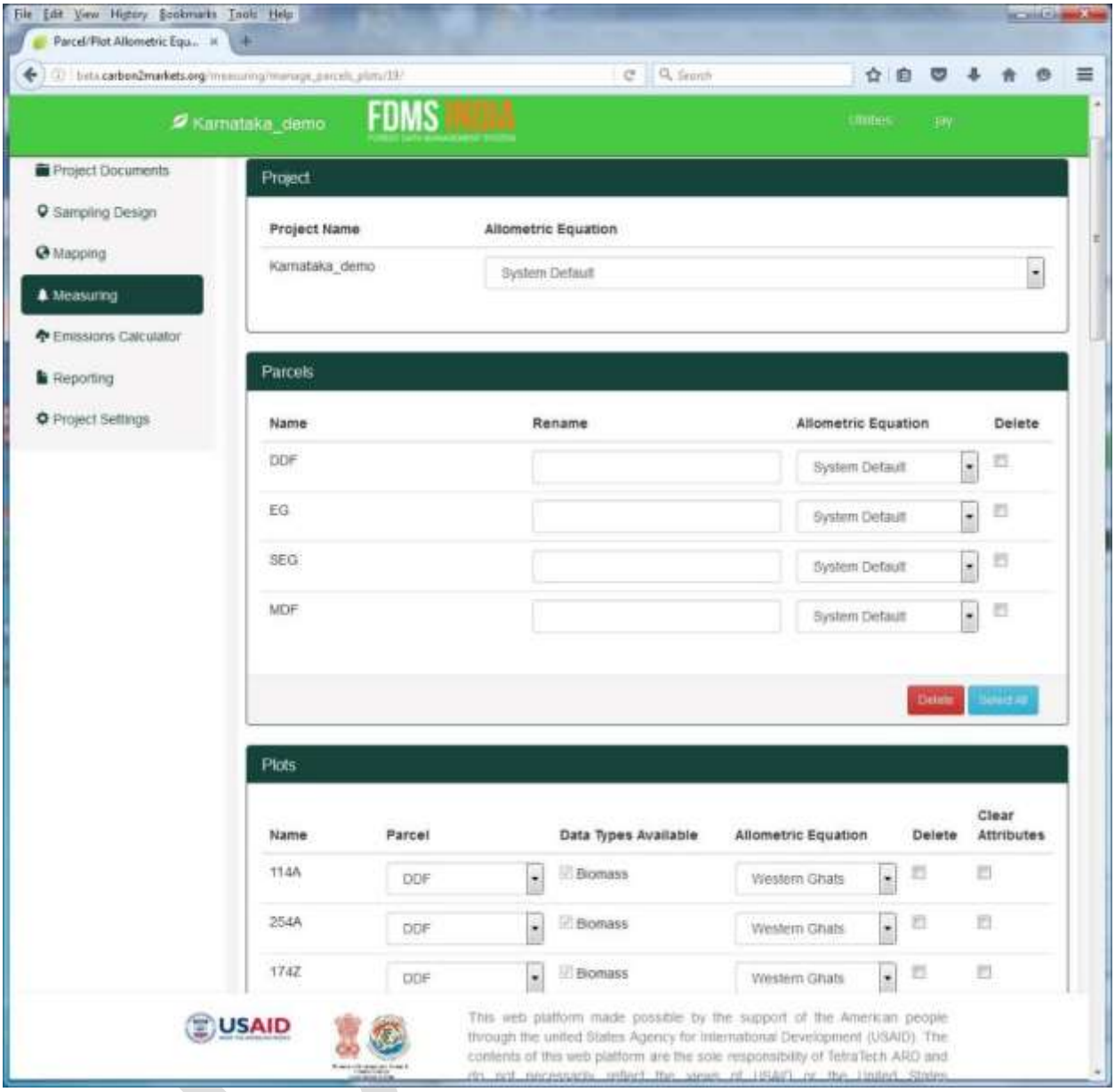


Figure 33 Allometric equations for trees in plots must be set for parcels or by plots

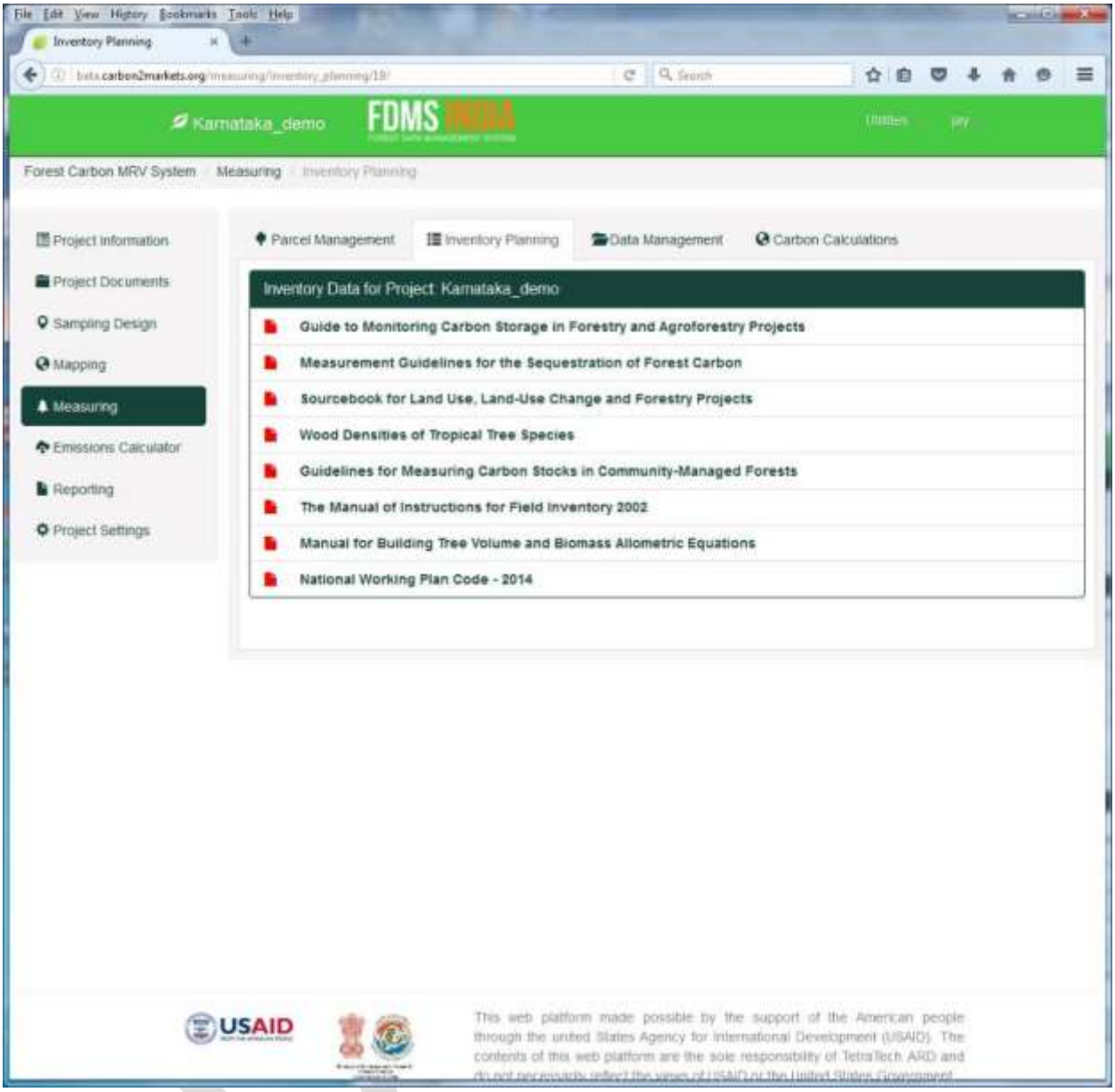


Figure 34 Reference documents for measurement based on inventory

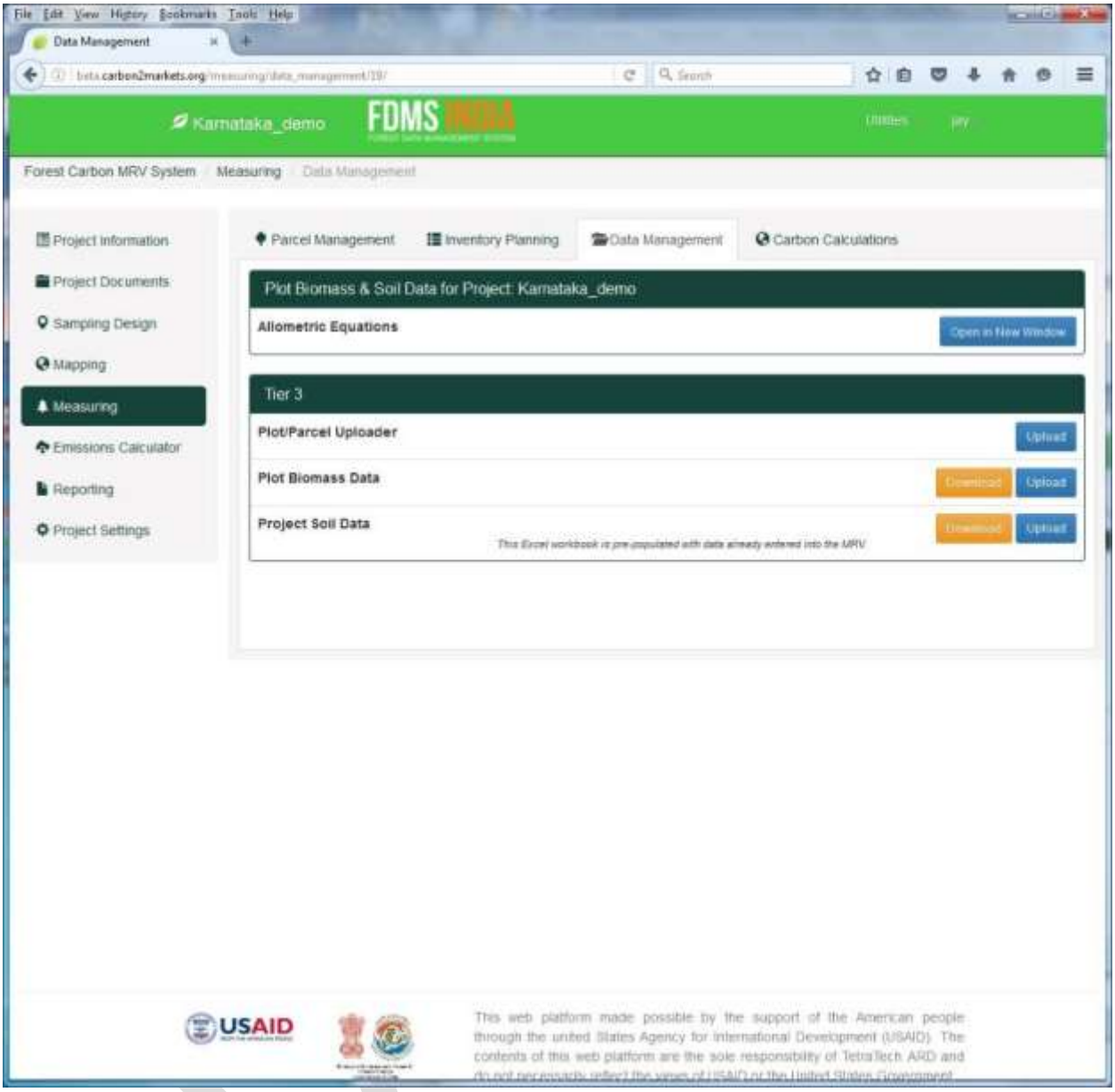


Figure 35 Data from inventory ingestion

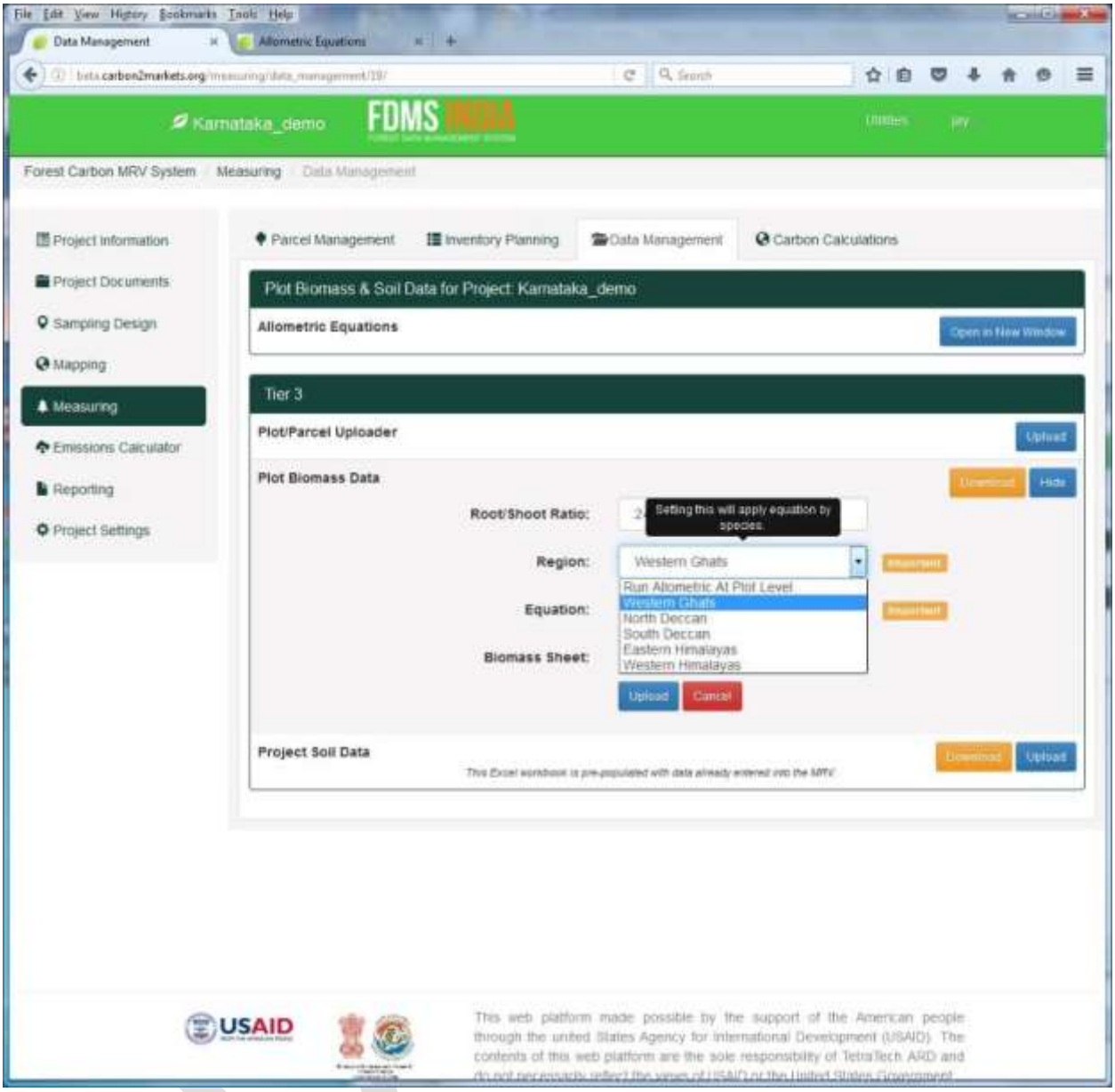


Figure 36 Selection allometric equations by species

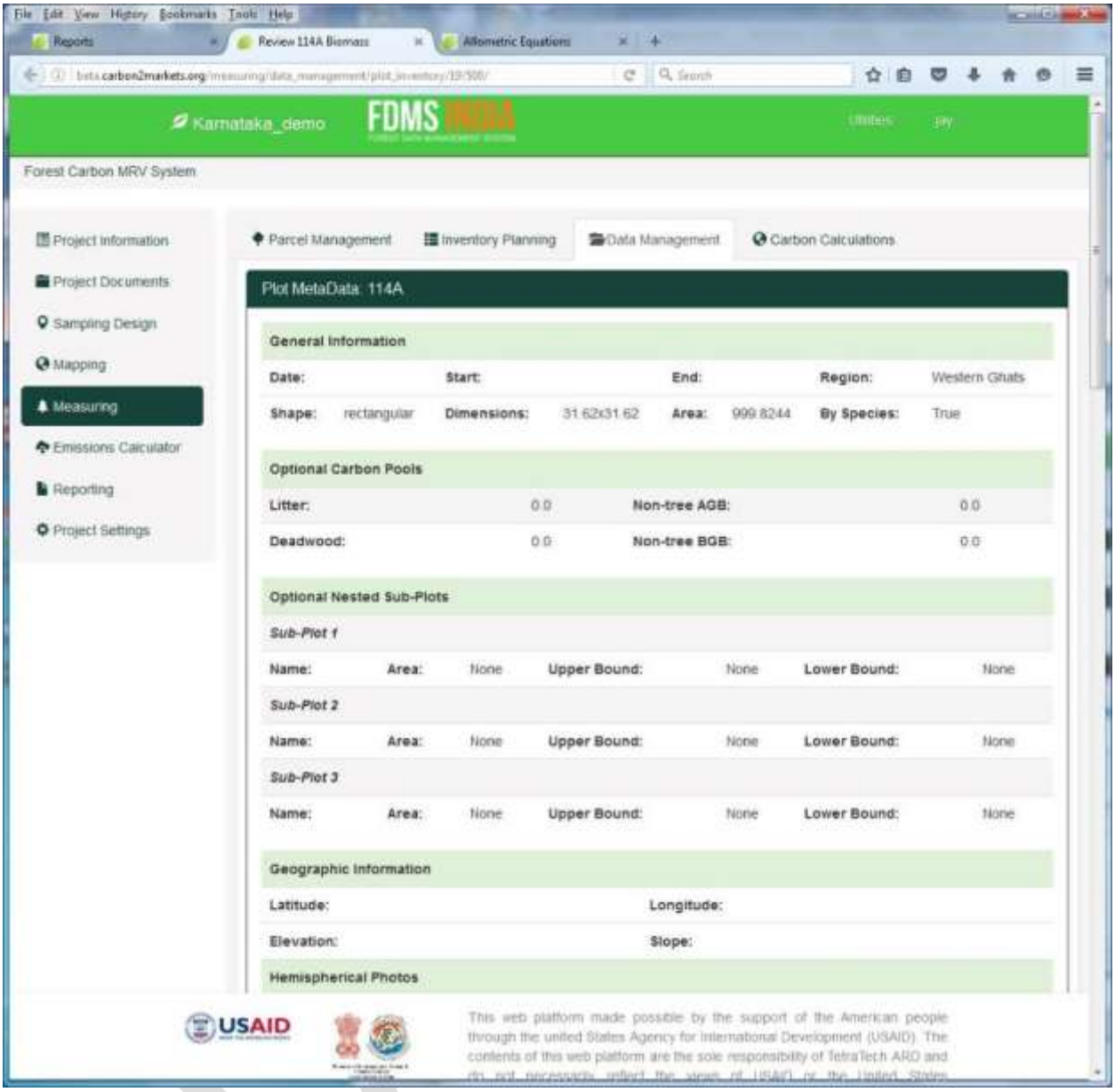


Figure 37 Reviewing plot metadata

Figure 38 Reviewing data in the tree list by plot

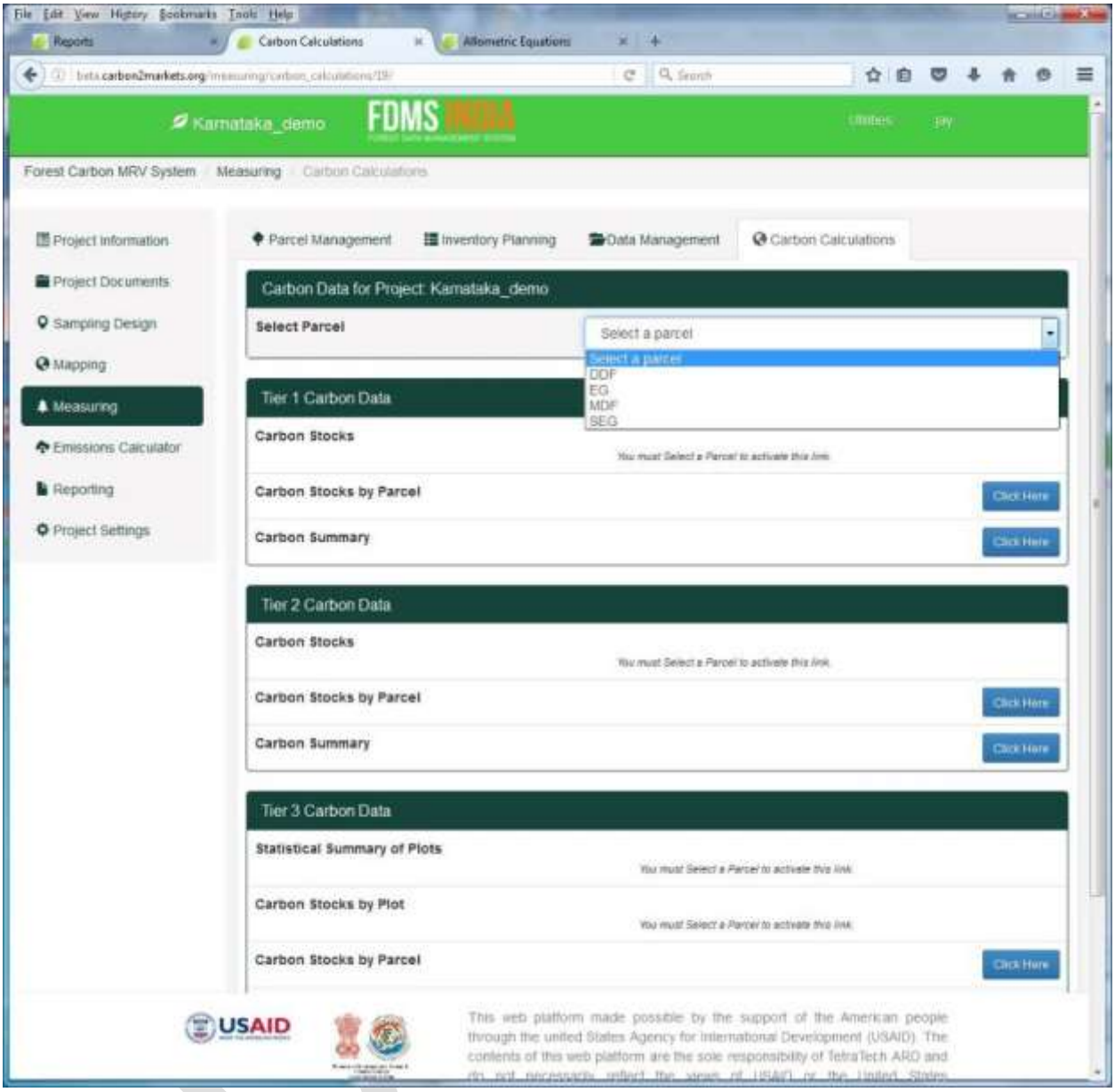


Figure 39 Select a parcel to calculate stocks

REPORTING

The DMS will provide reports, by plot, parcel and project. Measured and calculated data is provided, as well as the uncertainty of the estimate. Outputs are in terms of carbon or can be expressed in terms of biomass.

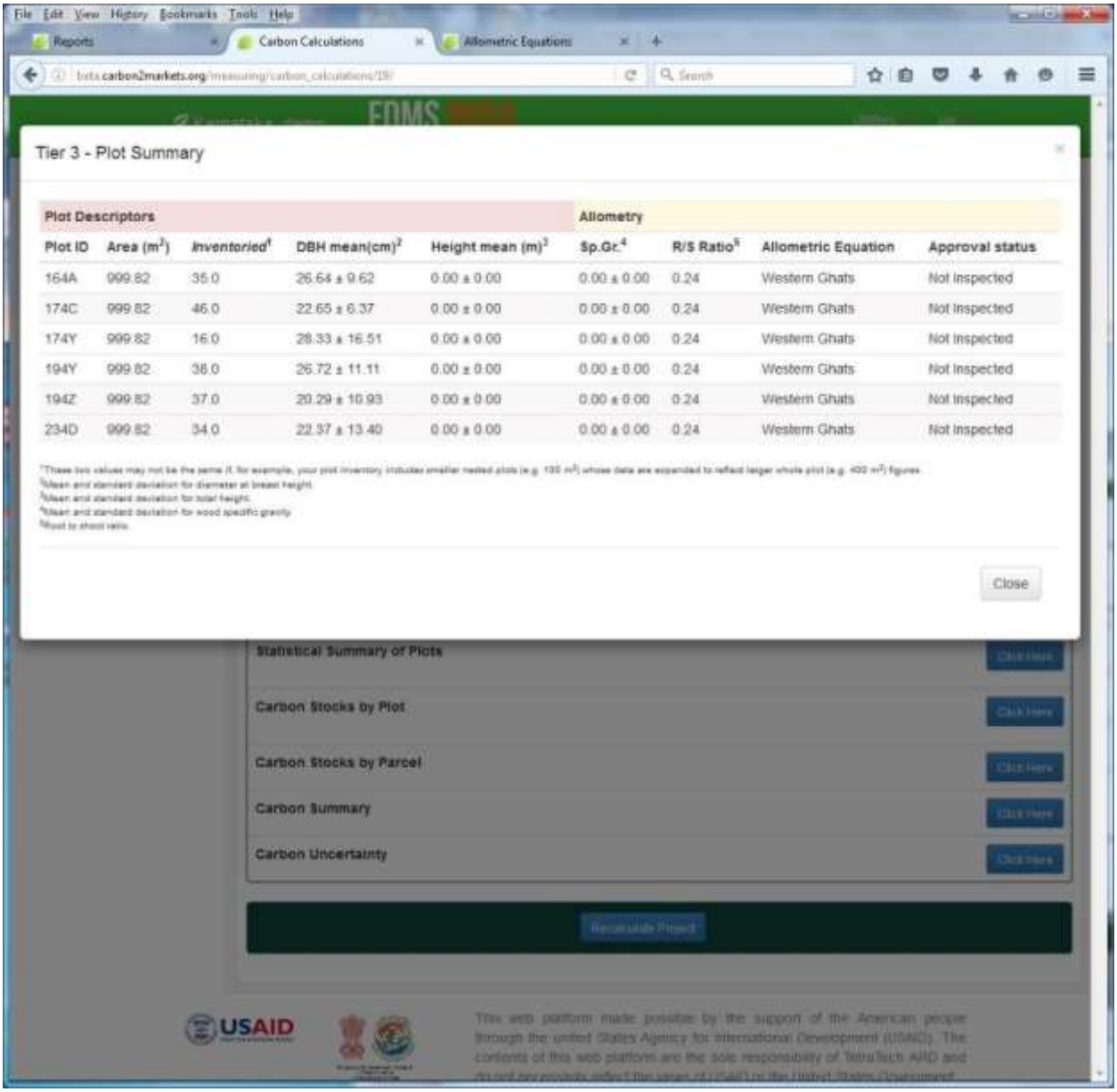


Figure 40 Plot summary

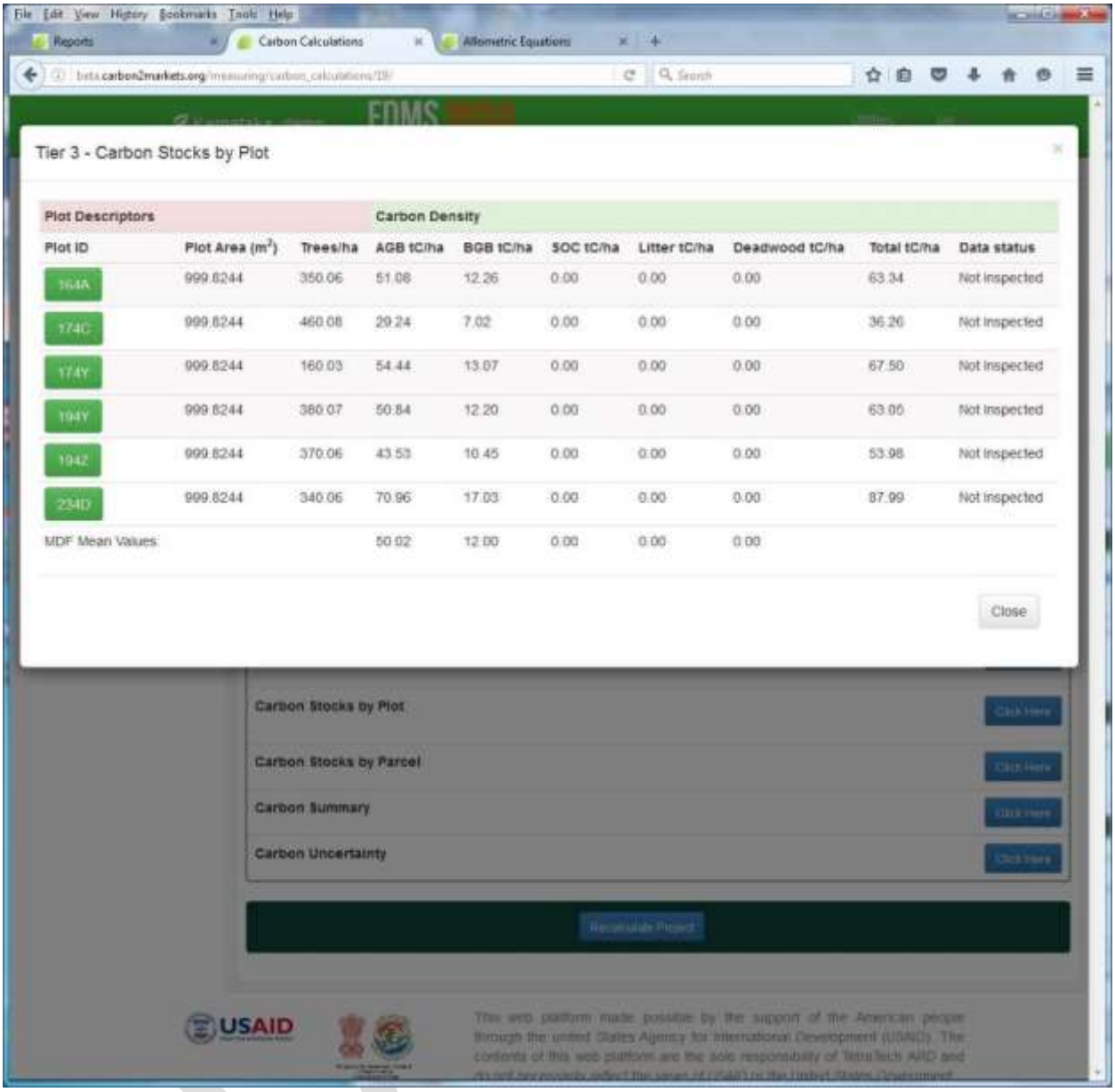


Figure 41 Carbon stocks by plot

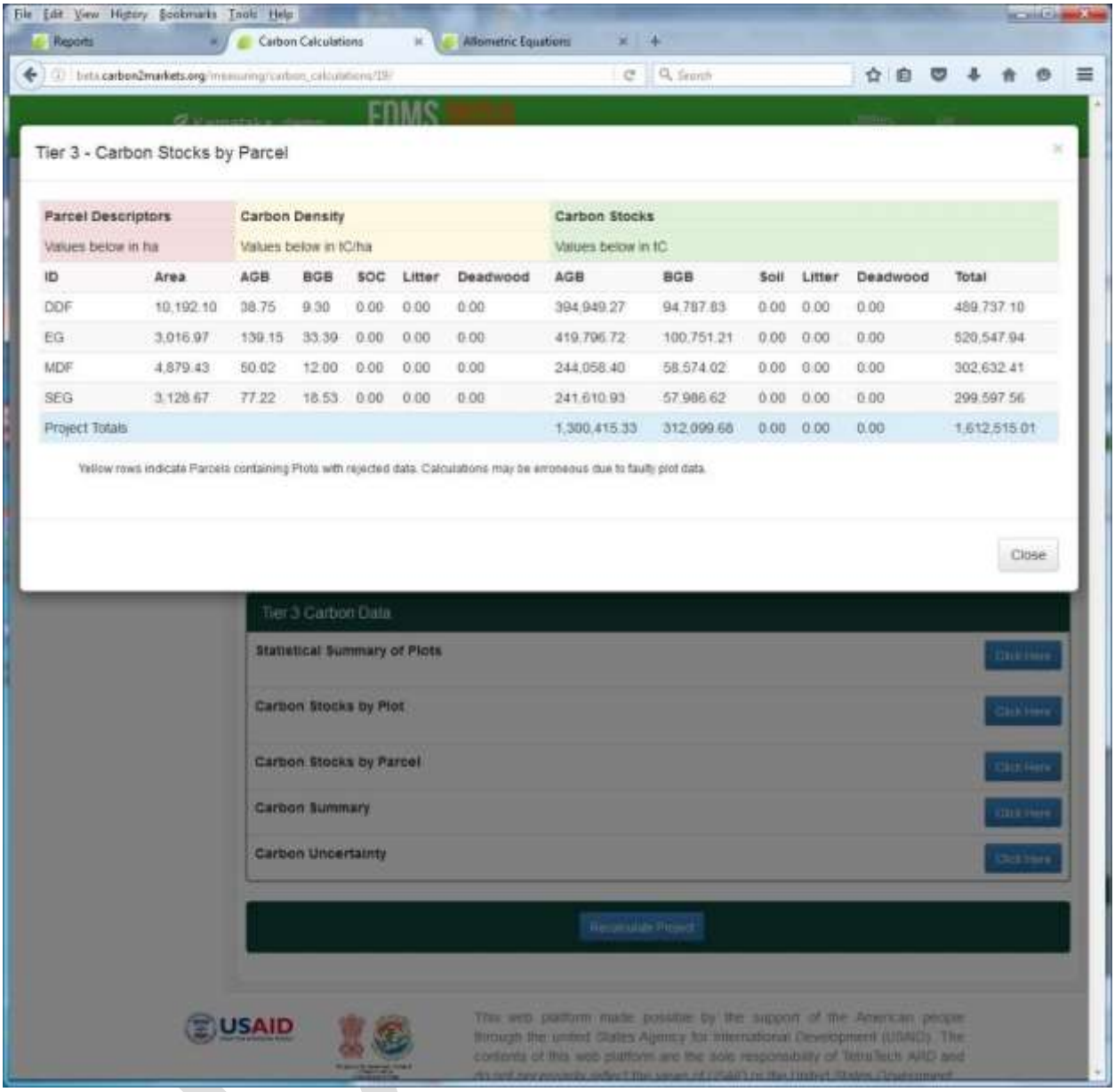


Figure 42 Carbon Stocks by Parcel

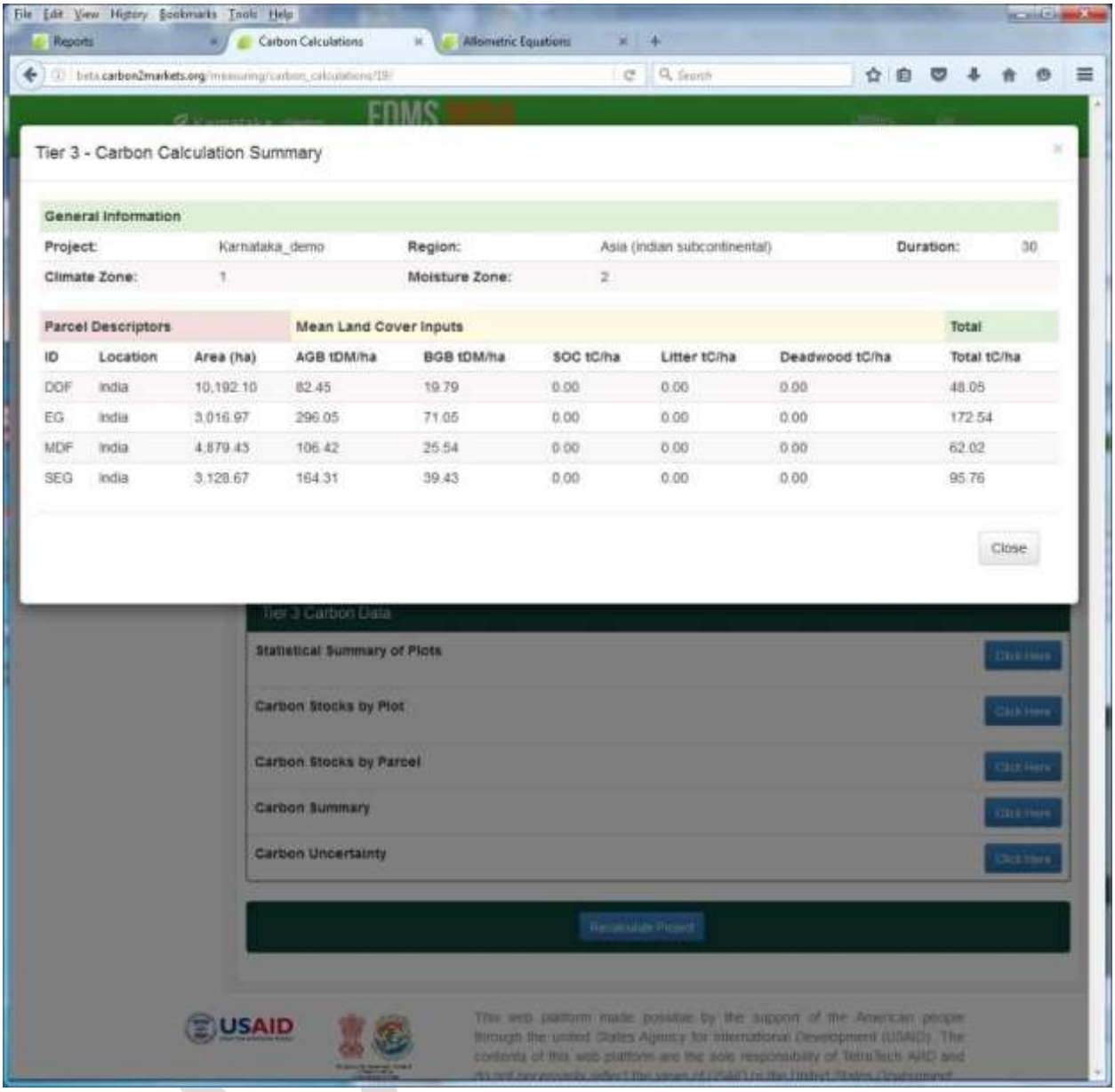
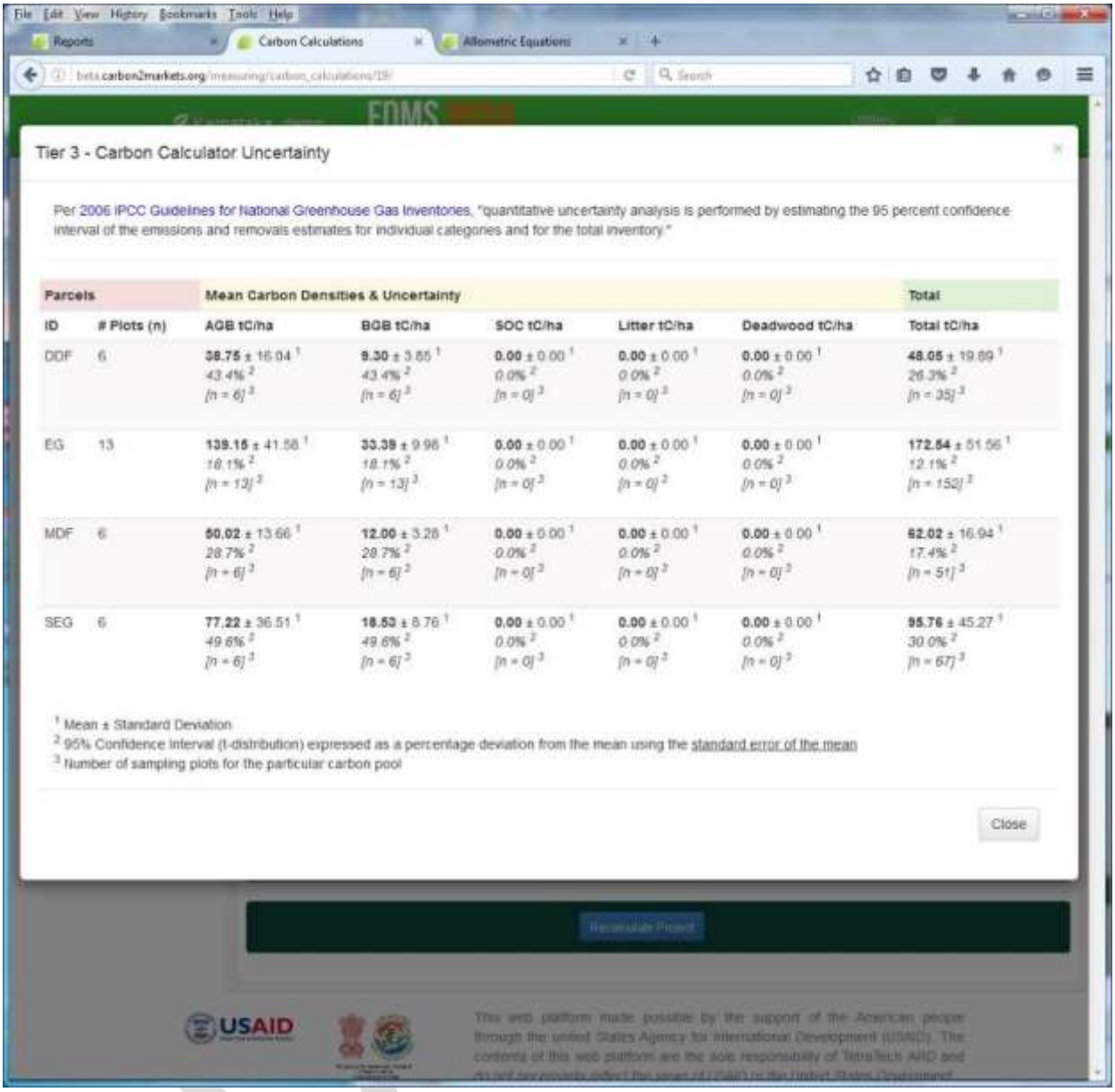


Figure 43 Carbon calculation summary



Tier 3 - Carbon Calculator Uncertainty

Per 2006 IPCC Guidelines for National Greenhouse Gas Inventories, "quantitative uncertainty analysis is performed by estimating the 95 percent confidence interval of the emissions and removals estimates for individual categories and for the total inventory."

Parcels		Mean Carbon Densities & Uncertainty					Total
ID	# Plots (n)	AGB tC/ha	BGB tC/ha	SOC tC/ha	Litter tC/ha	Deadwood tC/ha	Total tC/ha
DDF	6	**38.75** ± 16.04 [1] *43.4%* [2] *[n = 6]* [3]	**9.30** ± 3.65 [1] *43.4%* [2] *[n = 6]* [3]	**0.00** ± 0.00 [1] *0.0%* [2] *[n = 0]* [3]	**0.00** ± 0.00 [1] *0.0%* [2] *[n = 0]* [3]	**0.00** ± 0.00 [1] *0.0%* [2] *[n = 0]* [3]	**48.05** ± 19.69 [1] *26.3%* [2] *[n = 35]* [3]
EG	13	**139.15** ± 41.58 [1] *16.1%* [2] *[n = 13]* [3]	**33.39** ± 9.98 [1] *16.1%* [2] *[n = 13]* [3]	**0.00** ± 0.00 [1] *0.0%* [2] *[n = 0]* [3]	**0.00** ± 0.00 [1] *0.0%* [2] *[n = 0]* [3]	**0.00** ± 0.00 [1] *0.0%* [2] *[n = 0]* [3]	**172.54** ± 51.56 [1] *12.1%* [2] *[n = 152]* [3]
MDF	6	**50.02** ± 13.66 [1] *28.7%* [2] *[n = 6]* [3]	**12.00** ± 3.28 [1] *28.7%* [2] *[n = 6]* [3]	**0.00** ± 0.00 [1] *0.0%* [2] *[n = 0]* [3]	**0.00** ± 0.00 [1] *0.0%* [2] *[n = 0]* [3]	**0.00** ± 0.00 [1] *0.0%* [2] *[n = 0]* [3]	**62.02** ± 16.94 [1] *17.4%* [2] *[n = 51]* [3]
SEG	6	**77.22** ± 36.51 [1] *49.6%* [2] *[n = 6]* [3]	**18.53** ± 8.76 [1] *49.6%* [2] *[n = 6]* [3]	**0.00** ± 0.00 [1] *0.0%* [2] *[n = 0]* [3]	**0.00** ± 0.00 [1] *0.0%* [2] *[n = 0]* [3]	**0.00** ± 0.00 [1] *0.0%* [2] *[n = 0]* [3]	**95.76** ± 45.27 [1] *30.0%* [2] *[n = 67]* [3]

[1] Mean ± Standard Deviation
[2] 95% Confidence Interval (t-distribution) expressed as a percentage deviation from the mean using the standard error of the mean
[3] Number of sampling plots for the particular carbon pool

Close

CUSTOMIZING ALLOMETRIC EQUATIONS

Default global and Indian-subnational allometric equations are provided. If users choose to develop their own allometric equations, they may do so within the DMS.

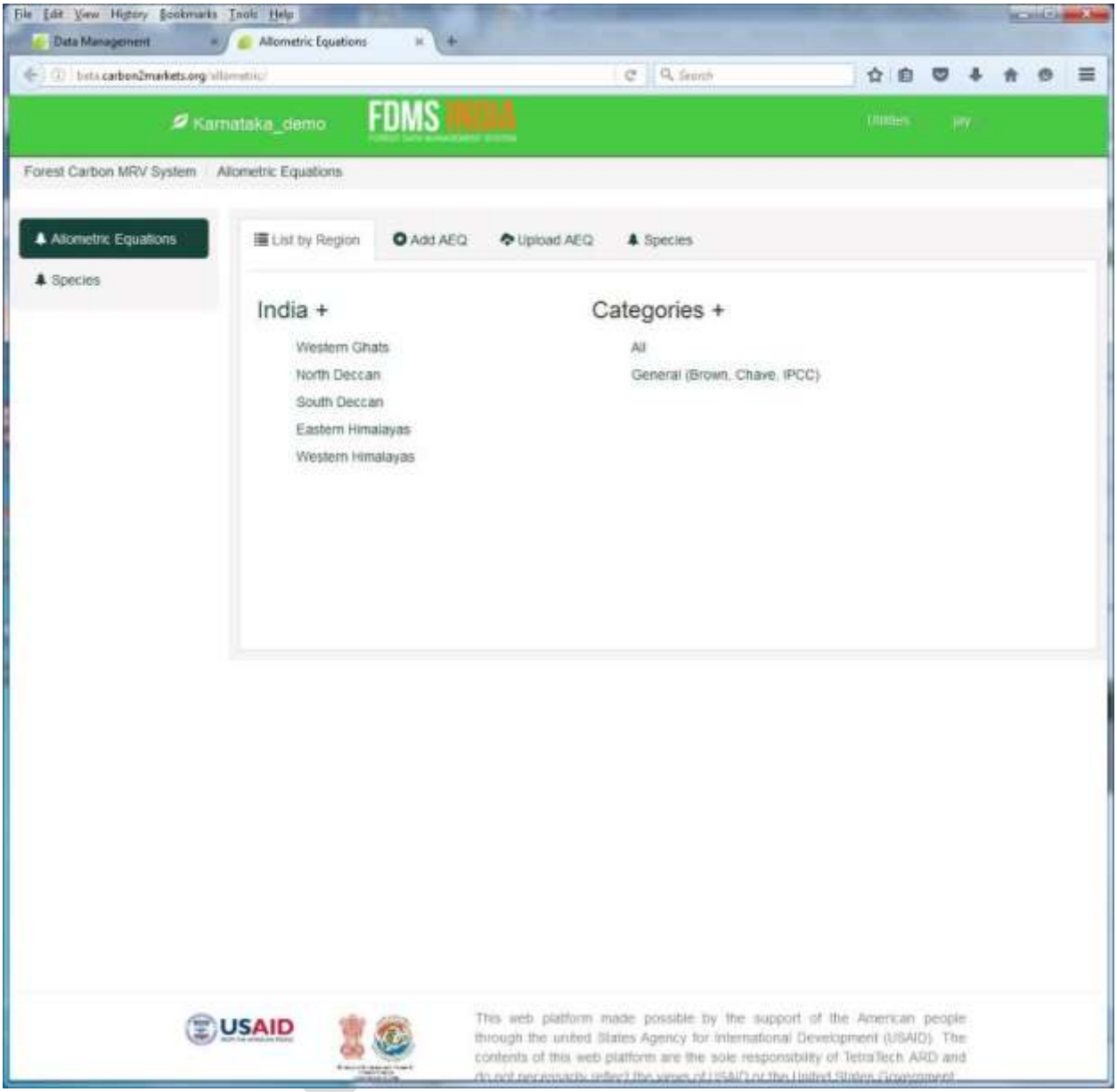


Figure 44 Default allometric equations available (FSI and IPCC)

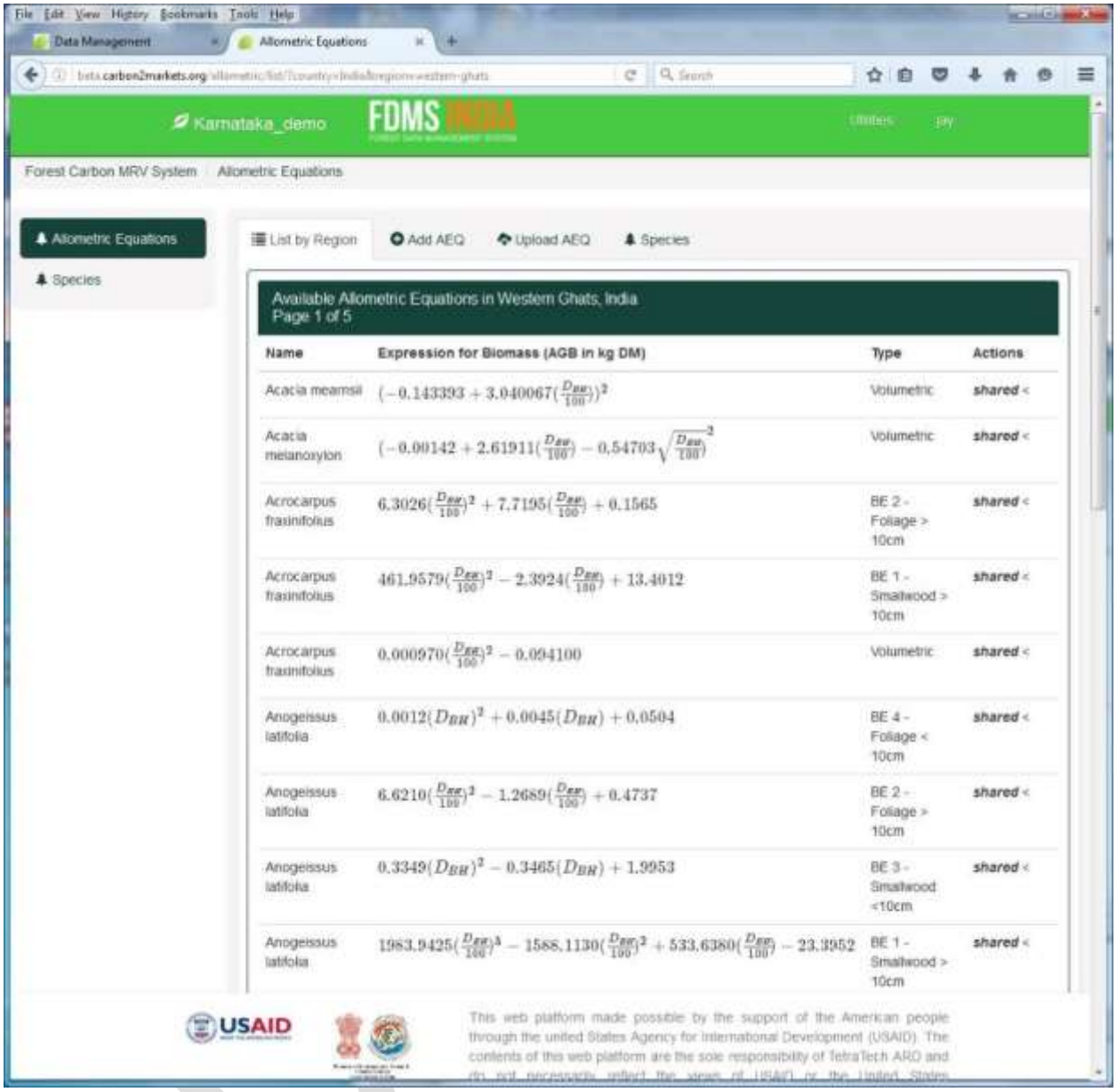


Figure 45 Review of the equations by species from FSI

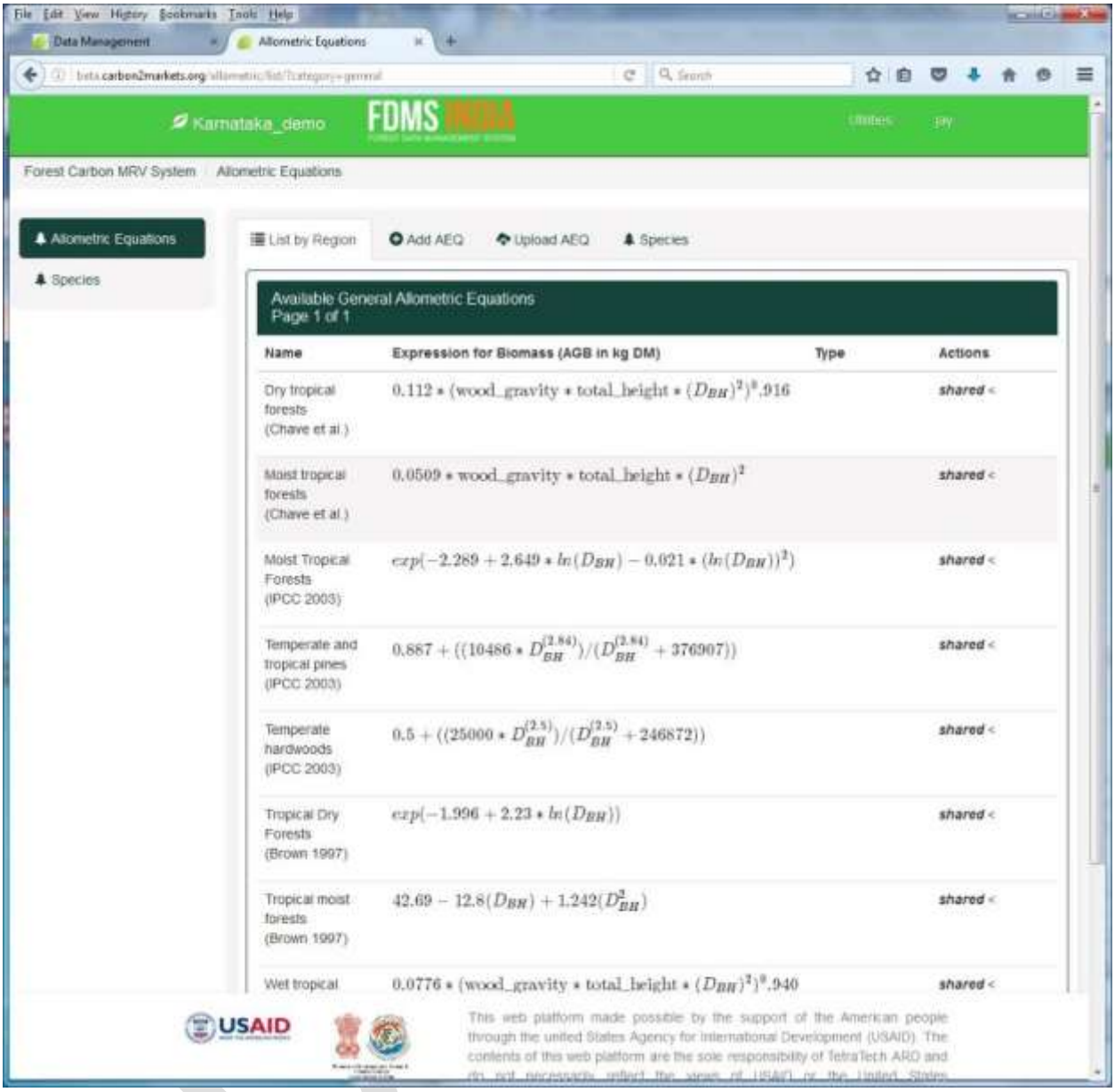


Figure 46 Review of the equations by species from IPCC

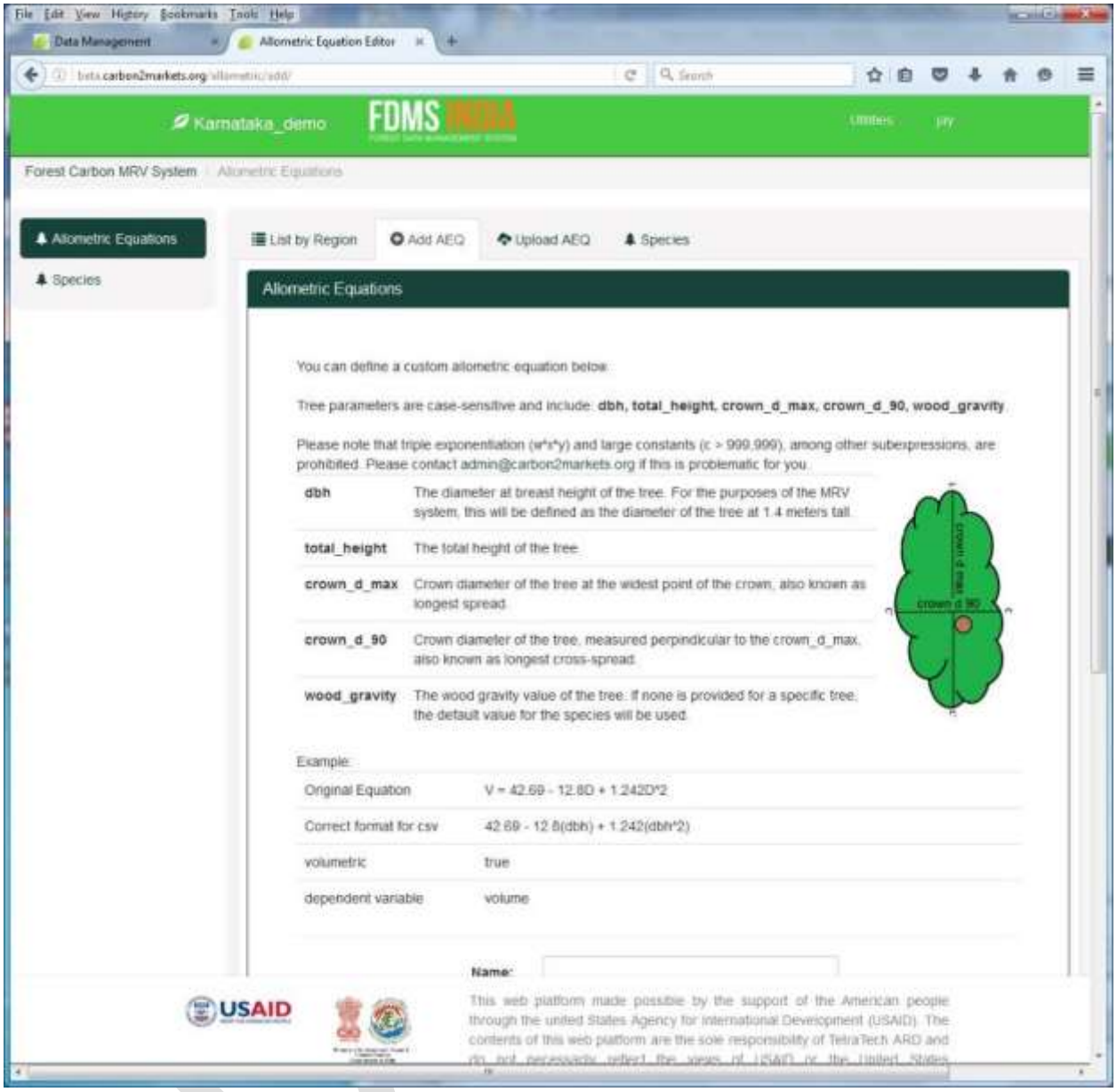


Figure 47 Defining a custom allometric equation

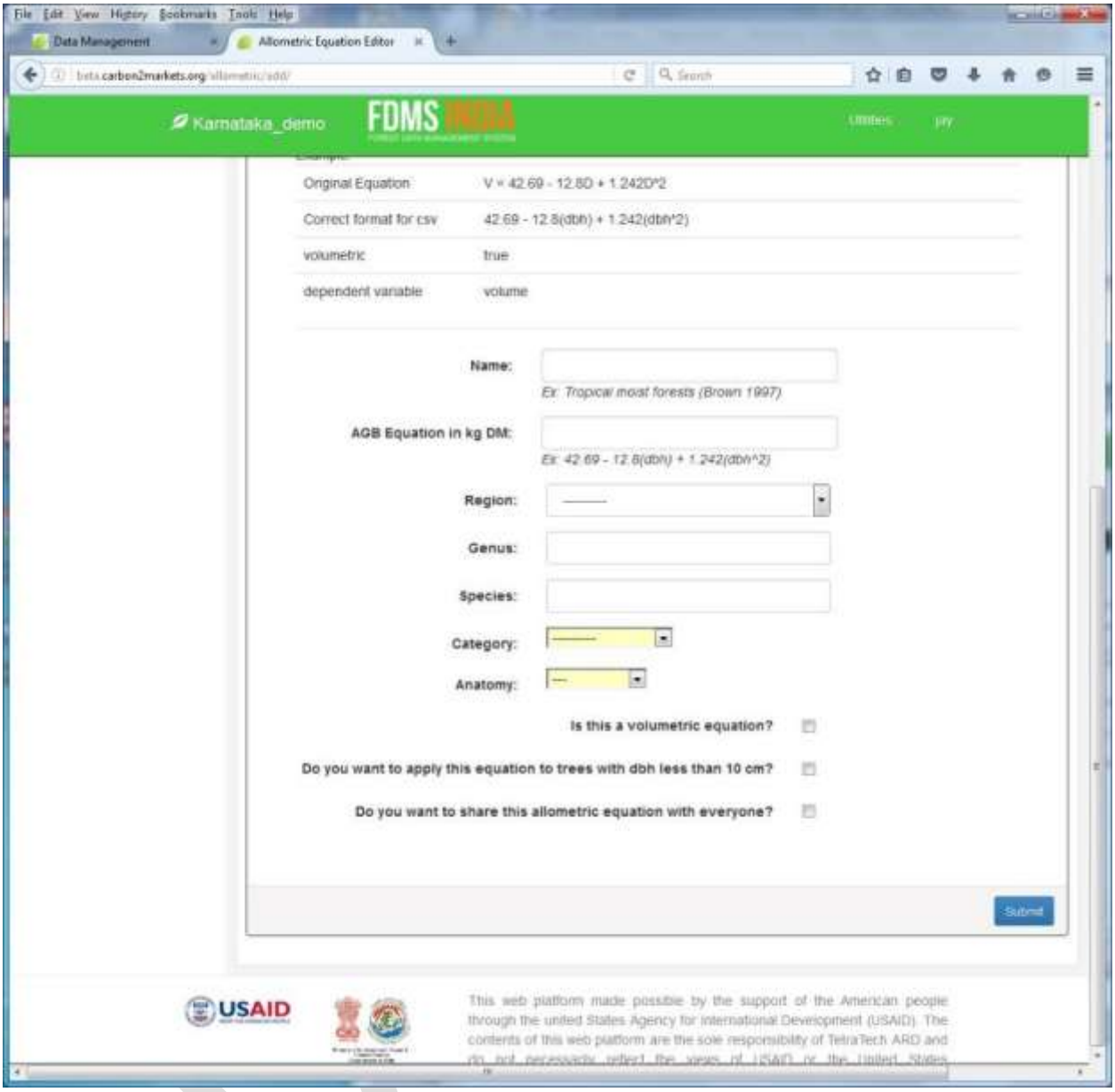


Figure 48 Application of a custom allometric equation

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