**Data sets on the characteristics and use of EbA practices by smallholder farmers in Central America**

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## 1. General overview of the research project and its objectives

The archived data on 'Characteristics and use of EbA practices by smallholder farmers in Central America' were gathered as part of the CASCADE project (Ecosystem-based Adaptation for Smallholder Coffee and Subsistence Farmers in Central America). The CASCADE project was an interdisciplinary research project led by Conservation International and Tropical Agricultural Research and Higher Education Center (CATIE) and funded by the International Climate Initiative (IKI) of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) from the German Government. The project collected data in 6 Central American landscapes (Turrialba and Los Santos in Costa Rica, Chiquimula and Acatenango in Guatemala and Choluteca and Yoro in Honduras), from 2012 to 2018.

The data archived here were gathered as part of Work Package 4 (WP4) of the CASCADE project. The specific goals of the WP4 research were to: a) document the use of Ecosystem-based Adaptation practices by smallholder maize and coffee farmers in Central America, and explore farmer perceptions on the effectiveness of these practices in helping farmers cope with the impacts of extreme weather events, and b) characterize the main ecosystem based adaptation practices present on smallholder farms (in terms of the extent/area, density, prevalence, location within the farms, etc.). The EbA practices documented in the study included: the use of shade in coffee plots, dispersed trees in maize or bean fields, live fences, windbreaks, home gardens, terraces, contour planting, use of crop cover, fallows, riparian forests, forest patches and forest plantations. The archived data include information obtained from farmer surveys (using structured interviews and participatory mapping) and field measurements of EbA practices on 300 smallholder coffee and basic grains (beans and maize) farms across the region (50 farms per study landscape) from June 2014 to July 2015.

The data archived here are also the basis for the publication by Harvey et al. 2017 (Harvey, C.A., M.R. Martínez -Rodríguez, J. M. Cardenas, J. Avelino, B. Rapidel, C.I. Donatti, and Vilchez-Mendoza. 2017. The use of Ecosystem-based Adaptation practices by smallholder farmers in Central America. Agriculture, Ecosystems and Environment 246, 279-290 (open access).

## 2. Data sets archived

This archive includes four related data sets that were collected on 300 smallholder farms (Table 1). Each data set has a glossary that provides a description of the variables, their units and potential responses. The glossary is available in both Spanish (the original language in which the work was conducted) and in English. Copies of the surveys used with farmers to collect data (in Spanish) and the protocol for field measurements (in Spanish) are also included. Details on the methods for each data set can be found below in the methods section.

Table 1. A summary of the data bases and glossaries archived here.

| Data set | Description of data set and contents | Name of accompanying glossary | Additional related files |
|---|---|---|---|
| 1.Farmer survey of EbA use and perceived effectiveness | This data set (**'1_Farmer_Survey_Database. xlsx'**) includes information from surveys of 300 smallholder farmers in Central America.<br><br>The data base includes general information on farmers' and their farming systems (e.g. land uses and land use change, crop management practices), prevalence of EbA practices, data on farmer perceptions of the effectiveness of these EbA practices in helping reduce the impact of climate change on their crops, limitations for the implementation and maintenance of EbA practices, problems affecting production and what support farmers need to cope with the impacts of climate change. | **'1_Farmer_Survey_Glossary.xlsx'** provides a description of all variables in the '1_Farmer_Survey_Database' and their respective units.<br><br>(Sheets 1 and 2 are in Spanish; Sheets 3 and 4 are in English). | **'1_Farmer_Survey_Instrument.docx'** is the survey instrument (in Spanish) used to collect the data in the 'Farmer Survey Database'. |
| 2.Field survey of EbA practices | This data base ('**2_Field_Survey_Database.xlsx'**) includes field measurements of EbA practices present on 300 smallholder farmers in Central America<br><br>The database includes information on: 1) plot and surrounding landscape level characteristics of coffee and basic grains plantations (including length, width, area, distance between plants, distance between lines, plant height, planted crop varieties, surrounding land uses, etc.), and 2) characteristics of EbA practices (i.e., live fences, windbreaks, shade trees, forest fragments, riparian forests), such as the width, length and area under the practice, species composition, and surrounding land uses. | **'2_Field_Survey_Glossary.xlsx'** provides a description of all variables in the '2_Field_Survey_Database' and their respective units.<br><br>(Sheets 1 and 2 are in Spanish; sheets 3 and 4 are in English). | **'2_Field_Survey_Instrument.docx'** is the field protocol used to conduct measurements of EbA practices in the field. The document is in Spanish. |
| 3. Database trees WP4 | This data set ('**3_Tree_Species_Database. xlsx'**) corresponds to plot-level records of trees in coffee and basic grains plantations and different ecosystem-based adaptation (EbA) practices used by smallholder farmers in six landscapes Central American countries (Turrialba and Los Santos in Costa Rica, Choluteca and Yoro in Honduras, and Chiquimula and Acatenango in Guatemala). | **'3_Tree_species_Glossary.xlsx**' provides a description of all variables in the 'Tree_Species_ database'.<br><br>(Sheet 1 is in Spanish, sheet 2 is in English). | N/A<br>(The methodology used to collect this information is described in the file **'2_Field_Survey_Instrument.docx').** |
| 4.Summary data set for publication by Harvey et al. 2017 | This database ('**4_Summary_Database.xlsx'**) is a summary dataset that contains information on the smallholder farmers and the prevalence and characteristics of EbA practices on their farms.<br><br>This data base was used as a basis for the publication by Harvey et al. (2017). | **'4_Summary_Glossary .xlsx'** provides a description of all variables in the data set.<br>(Sheet 1 is in Spanish, sheet 2 is in English). | N/A<br><br>(The methodology used to collect this information is described above). |

## 3. Methods

3.1. ***Study sites:*** The study was conducted in smallholder coffee and basic grain farms in 6 landscapes in Central America: (Turrialba and Los Santos in Costa Rica, Choluteca and Yoro in Honduras, and Chiquimula and Acatenango in Guatemala), that were typical of smallholder farmer landscapes in the region. Figure 1 shows the location of the six study landscapes.

We selected landscapes that a) were dominated by smallholder farming systems, b) had coffee and/or basic grain production (beans and maize) as the predominant agricultural land use, and c) had farming communities with low adaptive capacity to climate change. We focused our study on smallholder farmers who had either coffee or basic grain production as these are the two most common types of smallholder systems in the region. We characterized landscapes as having low adaptive capacity using expert mapping interviews, validation workshops and expert on-line surveys, in which experts from the region characterized landscapes on the basis of 20 variables (representing natural, human, social, physical and financial capital) that contributed to farmer adaptive capacity. Additional details on the methodology and analysis used to characterize the adaptive capacity of the landscapes are provided in Holland et al. (2017). Of the six selected landscapes, the Turrialba and Los Santos landscapes are dominated by coffee production, Choluteca is dominated by basic grain production, while the remaining landscapes (Yoro, Acatenango and Chiquimula) include a mix of coffee and basic grain production. Additional characteristics of the farmers and farming systems in each landscape are provided in Harvey et al. (2017).

Figure. 1. Location of six agricultural landscapes in Central America in which the use and perceptions of EbA practices by smallholder farmers was characterized.

3.2. ***Selection of 300 smallholder farms for household survey and field measurements:*** In each landscape, we had previously conducted an extensive household survey of randomly-chosen smallholder farms (as part of another work package- WP3- in the CASCADE project), using a rigorous sampling frame (see Alpizar et al., in press). In the Costa Rican landscapes, we selected farmers randomly from an existing list of coffee farms. In the Guatemalan and Honduran landscapes, we generated a sampling frame by using remote sensing imagery to detect household roofs and then randomly sampling households from this list of potential farms. As part of this larger group, we sampled 860 randomly-selected farmers (115–155 farmers per landscape). The household survey included information on farm management, farmer and household characteristics, and farmer-reported presence of EbA on farms, among other aspects.

In each landscape, we used information on the number of EbA practices reported by farmers in the household survey to stratify the farmers in each landscape into two groups (a group with a relatively 'high' number of EbA practices, and a group with a relatively 'low' number of EbA practices) based on the frequency of the number of reported EbA practices per farm. We then randomly selected 25 farmers from both the 'high' and 'low' groups for field work (for a total of 50 farmers per landscape), to ensure that our field survey covered the diversity of farm types present in each landscape. Our total sample size for the study of characteristics and use of EbA practices (archived here) was 300 farms (50 per landscape X 6 landscapes).

The following sections (3.2, 3.3., 3.4, and 3.5) provide the details of the data we collected on each of the 300 farms through farmer surveys and field measurements.

3.3. ***Data set 1: Farmer survey of EbA use and perceived effectiveness:***The overall aims of the surveys of smallholder farmers were to document farmer use of EbA practices, assess farmer perceptions of the effectiveness of these practices in reducing the impacts of extreme weather events, and identify what support farmers need to better cope with the impacts of climate change.

To achieve these goals, we first used participatory mapping methods with each of the 300 selected farmers to locate individual plots on the farm and characterize their land use (e.g., crop fields, pastures, fallows, forested areas, water bodies, etc.). We then asked farmers to identify which EbA practices they had on individual plots and to indicate on the map where each practice was applied. We focused on the following EbA practices: the use of shade in coffee plots, dispersed trees in maize or bean fields, live fences, windbreaks, home gardens, terraces, contour planting, use of crop cover, fallows, riparian forests, forest patches and forest plantations. This information was later used to orient the characterization of the EbA practices in the field (see section 3.4).

Using structured interviews, we then collected detailed information on how each EbA practice was implemented, as well info on data on farmer perceptions of the effectiveness of EbA practices in helping reduce the impact of climate change on their crops, barriers for the implementation and maintenance of such practices, problems affecting agricultural production and what support farmers need to cope with the impacts of climate change. Data was collected from July 2014 to June 2015 using tablets programmed with SurveyCTO software. A copy of the survey administered can be found in the file '**1_Farmer_Survey_Instrument.docx'.** The data collected from the survey can be found in the file '**1_Farmer_Survey_Database .xlsx',** and a

description of all variables (in both Spanish and English can be found in file '**1_Farmer_Survey_Glossary.xlsx**'.

The data set includes the information from surveys of 300 smallholder farms (including coffee farms and basic grain farms). The data include general information on farmers' and their farming systems (e.g. land uses and land use change, crop management practices), prevalence of EbA practices (the use of shade in coffee plots, dispersed trees in maize or bean fields, live fences, windbreaks, home gardens, terraces, contour planting, use of crop cover, fallows, riparian forests, forest patches and forest plantations), data on farmer perceptions of the effectiveness of these EbA practices in helping reduce the impact of climate change on their crops, limitations for the implementation and maintenance of such practices, problems affecting production and what support farmers need to cope with the impacts of climate change.

3.4. ***Data sets 2 and 3: Field surveys of EbA practices (and tree species***): The objective of the field work was to characterize the main Ecosystem-based adaptation (EbA) practices (in terms of their extent/area, density, prevalence, location within the farms, etc.) present on 300 smallholder farms in Central America.

As described above (see section 3.3), we first used participatory mapping methods with each of the 300 farmers to locate individual plots on the farm and characterize their land use (e.g., crop fields, pastures, fallows, forested areas, water bodies, etc.). We then asked farmers to identify which EbA practices they had on individual plots and to indicate on the map where each practice was applied, so that we could visit these areas and characterize the practices through field work. We focused on the following EbA practices: the use of shade in coffee plots, dispersed trees in maize or bean fields, live fences, windbreaks, home gardens, terraces, contour planting, use of crop covers, fallows, riparian forests, forest patches and forest plantations.

For each EbA practice present on the farm, we collected detailed information on how the practice was implemented on the farm (see Table 2 for a summary), using the instrument '**2_Field_Survey_Instrument.xlxs'**.

For forests fragments, we recorded the width, length and area of each forest fragment, the approximate height of the forest canopy, whether the forest was fenced or not, and what the adjacent land uses were. We also calculated the total area of forest on the farm.

For riparian forests, we recorded the area of the riparian forest on the farm, the approximate height of the forest canopy, whether the riparian forest was fenced or not, the approximate % of the river that was forested, and adjacent land uses.

For forest plantations, we recorded the width, length and area of each forest fragment on the farm, the type of plantation (monoculture or polyculture), the main species planted, and adjacent land uses.

For windbreaks, we recorded the length, mean width and area of each windbreak, the dominant species present, the species diversity of the live fence (monoculture, 2-3 species, >3

species), the number of rows of trees, tree density (trees/km), mean tree diameter and adjacent land uses.

For home gardens, we recorded the width, length and area of the home garden, and the list of tree and crop species present.

To characterize the use of EbA practices within coffee plots, we randomly selected up to three coffee plots per farm for field measurements. In each coffee plot, we recorded the main coffee varieties present and measured the coffee plot length, width and area, distance to the farmer's house, coffee plot slope, spacing of coffee plants within each row, and distance between coffee rows. We calculated the coffee density (plants/ha). We also measured the plant height of 8 randomly-chosen coffee plants. We then recorded whether the coffee plot had terraces (yes/no), whether or not the plot had been prepared using contour planting, and whether the coffee plot had a cover crop (and, if so, which species). We also recorded if the coffee plantations had shade trees, the type of tree shade present (rustic, polyculture, monoculture, none), the number of shade tree species present, and the spacing of shade trees (random, crumpled or systematically planted). Next, within each coffee plot, we established an area of 20× 50 m (1000 m2) in the center of the plot and measured the number, species and mean diameter at breast height (dbh) of all shade trees (dbh> 5 cm) in the plot, and calculated tree species richness, diversity (Shannon index) and tree density per plot.

We similarly randomly selected up to three plots of basic grain per farm for characterization. We characterized each plot by recording the length, width and area of each plot, the distance of the plot to the farmer's house, the crop species planted (bean, maize or a combination therefore), the specific crop varieties used, and the adjacent land uses. We measured the distance between crop plants in the same row and between rows and calculated the crop planting density (plants/ha). We then recoded whether the basic grain plot had terraces (yes/no), whether the plot had been prepared using contour planting, whether it had a cover crop (and, if so, which species) and whether the crop was intercropped with other species (and if so, which species). We also recorded if the maize of bean plantation had shade trees, the number of shade tree species present, and the spacing of shade trees (random, crumpled or systematically planted). Then, in each plot, we established an area of 20× 50 m (1000 m2) in the center of the plot to characterize the number, species and dbh of all dispersed trees (dbh > 5 cm) in the plot and calculated tree species richness, diversity (Shannon index) and tree density per plot.

Finally, for live fences, we randomly selected up to 6 live fences per farm and registered the number of trees, tree species, and tree diameters at breast height of all trees with dbh>5 cm in a randomly-chosen 100 m length of the fence. We also noted the land uses adjacent to the live fences.

The summary of data on the presence and characteristics of EbA practices on each farm can be found in the data base **'2_Field_Survey_Database.xlsx'**; the glossary of this data base can be found in the file **'2_Field_Survey_Glossary.xlsx'**. Information on individual tree species found within the coffee and maize/bean plantations and live fences is available in the data base **'3_Tree_Species_Database.xlsx'**; the glossary of this data base can be found in the file **'3_Tree_Species_Glossary.xlsx'**.

**Table 2.** Summary of field data that was collected to characterize the EbA practices being used on smallholder farms across the region.

| EbA practice or system | Variables collected in the field | Notes |
|---|---|---|
| Forest fragments | Width (m)<br>Length (m)<br>Area of each forest fragment<br>Total area under forest on the farm<br>Approximate height of tree canopy (categorical)<br>Whether the forest fragment was fenced<br>Land uses on either side | At farm level |
| Riparian forest | Mean width (m)<br>Length (m)<br>Area under riparian forest<br>% of the river/stream that has riparian forest<br>Whether the riparian forest was fenced<br>Approximate height of canopy (continuous)<br>Land uses on either side | At farm level |
| Forest plantation | - Width (m)<br>-Length (m)<br>-Forest plantation composition (monoculture, polyculture)<br>-Area of each forest plantation<br>-Tree species planted<br>-Land uses on either side of plantations | At farm level |
| Windbreaks | -Total number of windbreaks<br>-Length of individual windbreaks (and total)<br>-Mean width of individual windbreaks<br>-Dominant species in each windbreak<br>-overall species diversity of individual live fences (monoculture, 2-3 species, >3 species)<br>-origin of trees (planted, remnant or a mix)<br>-Number of rows of trees<br>-Tree density (trees/km)<br>-Mean tree diameter<br>-Land uses on either side | At farm level |
| Home garden | - Width (m)<br>-Length (m)<br>-Area under home garden<br>-List of crop and fruit trees present | At farm level |
| Coffee plantation-general information | -Distance to farmer's house<br>-Coffee plot length, width and area<br>-Coffee plot slope<br>-spacing of coffee plants in each row (and plot average)<br>-distance between coffee rows (and plot average)<br>- mean coffee plant height (of 8 randomly selected plants) (and plot and farm average)<br>- coffee density (plants/ha)<br>-varieties used<br>- whether or not terraces are used (yes/no)<br>-whether cover crops are used (yes/no) | Data was collected on 1-3 plots per farm. If the farmer had more than 3 plots, we randomly selected 3 plots for characterization. |

| | | |
|---|---|---|
| | - whether the coffee has been planted along contour lines (yes/no)<br>-whether coffee plantation has trees (yes/no) | |
| Shade in coffee plantations | -presence of trees in coffee plots (yes/no)<br>-type of tree shade present (rustic, polyculture, monoculture, none)<br>-# of shade tree species present and diversity (Shannon index)<br>-tree density (trees/ha)<br>-mean canopy height of shade trees (categorical)<br>-mean diameters of shade trees<br>- spacing of shade trees (random, clumped or systematic?) | Data collected in each plantation (up to 3 per farm) |
| Maize/bean plot-general information | - length, width and area of plot<br>--distance to farmer's house<br>-varieties used<br>whether or not the main crop is intercropped with other crops<br>-spacing of maize (or bean) plants in each row (and plot average)<br>-distance between maize (or bean) rows (and plot average)<br>- density of maize (or bean) plants<br>- adjacent land uses | Data was collected on 1-3 plots per farm. If the farmer had more than 3 plots, we randomly selected 3 plots for characterization. |
| Use of dispersed trees in maize/bean plots | -presence of trees in plots (yes/no)<br>-# of shade tree species present and diversity (Shannon index)<br>-tree density (trees/ha)<br>-mean canopy height of shade trees (categorical)<br>-mean diameters of shade trees<br>- spacing of shade trees (random, clumped or systematic?) | Data collected in each maize/bean plot (up to 3 per farm). If the farmer has more than 3 plots, we randomly chose 3 for characterization. |
| Use of cover crops | -presence/absence<br>-species present | Data collected in each coffee plantation or maize plot surveyed |
| Use of terraces | -presence/absence | Data collected in each coffee plantation or maize plot surveyed |
| Use of contour planting | -presence/absence | Data collected in each coffee plantation or maize plot surveyed |
| Live fences | -length of individual live fences (and total per farm)<br>-dominant species in each live fence<br>-mean width of live fence canopy<br>-mean height of the live fence<br>-overall species diversity of individual live fences (monoculture, 2-3 species, >3 species)<br>-origin of trees (planted, remnant or a mix)<br>- tree density (# trees/per 100 m)<br>Mean tree diameter<br>-location on the farm (land uses on either side) | Data collected on up to 6 live fences per farm.<br><br>Data on tree species, density, and dbh were based on a randomly selected 100m length of each windbreak. |
| Fallow area | - Width (m) | |

| | | |
|---|---|---|
| | -Length (m)<br>-Area under fallow<br>-Main vegetation composition (grasses, trees, etc.)<br>-Vegetation height<br>-Adjacent land uses | |

3.5. ***Data set 4: summary data set for publication by Harvey et al. 2017:*** This dataset (**'4_Summary_Database.xlsx'**) contains a high-level summary on the presence and characteristics of EbA practices on 300 farms and was the basis for the analysis published in Harvey et al. (2017). It includes some information on the general characteristics of the farmers and farms from the farmer survey (data set 1: **'1_Farmer_Survey_Database.xlsx'**), as well as summary statistics from the field characterization (data set 2: **'2_Field_Survey_Database.xlsx'** and data set 3: **'3_Tree_species_Database.xlsx'**). It is also accompanied by a glossary (**'4_Summary_Glossary.xlsx'**)

3.6. For further information please contact Dr. Celia Harvey (celiaharvey@stanfordalumni.org).

**References:**

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