Household survey of climate change perception and adaptation strategies of smallholder coffee and basic grain farmers in Central America

A household survey for the CASCADE Project

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1) General overview of the CASCADE research project (under which these data were collected)

The archived dataset 'Household survey of climate change perception and adaptation strategies of smallholder coffee and basic grain farmers in Central America' was collected 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 the Tropical Agricultural Research and Higher Education Center (CATIE), implemented in coordination with CIRAD, 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 overall goal of the CASCADE project was to help vulnerable smallholder farming communities adapt to climate change by identifying and testing Ecosystem-based Adaptation (EbA) strategies that can help farmers and building local capacity to support the implementation of these strategies in smallholder farming communities. The project was developed from 2012 to 2017 in three Central American countries (Costa Rica, Honduras and Guatemala) and focused on subsistence farmers (cultivating maize and beans) and smallholder coffee farmers. The CASCADE project conducted wide range of research activities, including the assessment of past historical changes in temperature and rainfall across the region (e.g. Hidalgo et al. 2015 and 2017), projections of future climate change (e.g., Imbach et al. 2015), assessment of the impacts of climate change on key ecosystem services such as water (Imbach et al. 2015) and pollination (Imbach et al. 2017), a review of how climate change has impacted coffee leaf rust (Avelino et al. 2015), reviews of the impact of climate change on agricultural systems across Central America (Imbach et al. 2017, Hannah et al. 2017), an analysis of vulnerability of smallholder farming communities in the three target countries (Holland et al. 2017, Donatti et al. 2018), studies of the use of Ecosystem-based Adaptation practices in farms and the benefits associated to their use (Harvey et al. 2017), a discussion highlighting the opportunities and constraints for using EbA practices to help smallholder farmers adapt to climate change (Vignola et al. 2015), an analysis of how farmers perceive climate change to be impacting their livelihoods and production systems (Harvey et al. 2018), and studies of the information needs of policy maker to implement adaptation strategies to help smallholder farmers adapt to climate change (Donatti et al. 2017), among other topics. For a full list of scientific, technical and policy publications from the project, please see https://www.conservation.org/projects/Pages/cascade-program.aspx.

2) **General overview of the household survey data set**

The data archived here were collected as part of a household survey of smallholder coffee and basic farmers' perceptions and adaptations to climate change. The data includes information from 860 smallholder coffee and maize/bean farmers in Guatemala, Honduras and Costa Rica.

The main objective of the household survey was to explore how smallholder farmers are being affected by climate change and whether (and how) they are adapting their farm management strategies in response to climate change.

The specific objectives of the household survey were:

1. To document smallholder farmer perceptions of whether (and how) the climate has changed over the past decade and to document the perceived impacts of climate change household livelihoods and production systems;
2. To characterize whether and how smallholder farmers have changed their farm management practices in response to climate change (with a special emphasis on the use of Ecosystem-based Adaptation (EbA) practices);
3. To understand the reasons why agricultural households implemented particular adaptation practices and identify barriers to the use of different adaptation practices;
4. To explore the role of organizations and institutions in promoting the use of Ecosystem-based Adaptation practices; and
5. To identify opportunities for the use of EbA practices to help smallholder farmers adapt to climate change.

In addition to collecting information related to the five objectives outlined above, the survey also collected basic information on smallholder farmer household demographics, socioeconomic conditions, livelihood strategies, farm and crop characteristics, and farm management strategies. The EbA practices documented in the study included the use of shade and manual weeding in coffee plots, the use of dispersed trees, mulching, fallows and minimum tillage in maize or bean fields, and the use of live fences, home gardens, contour planting, windbreaks and cover crops, and the conservation of riparian forests and forest patches. In addition, we collected information on why farmers did- or did not- use certain EbA practices, the year in which they began to use individual EbA practices, and any changes they had made in these practices over the last 10 years.

All surveys were conducted in person with the head of the household. All questions and responses were in Spanish. Surveys were conducted in the field between April and September 2014. Additional details on the design and implementation of the surveys are presented below.

3) Publications related to this data

The data archived here are the basis for the publications by Harvey et al. (2018), Saborío-Rodriguez et al. (under review), Alpizar et al. a. (in prep.), Alpizar et al. b. (in prep.), Viguera et al. a, b (under review), and Viguera et al. c (in prep).

4) Description of the archived data files

This archive includes the following six files:

1. A copy of the household survey used, in Spanish (Household survey.pdf). The survey includes the instructions provided to interviewers.
2. A comma-separated values (.csv) file containing the database of farmer responses to the household survey (Household database.csv). Please note that all personally identifiable information and household location data has been removed from this data base to comply with IRB requirements.
3. The glossary for the database (Glossary.xlsx) that describes all the variables, units, potential responses and coding used in the data base. The file provides information both in Spanish (Codesheet_ES) and in English (Codesheet_EN).
4. Appendix 1 containing the policy statement followed, based on Conservation International Research Ethics Policy (Appendix 1_ Policy statement_RBA_research ethics.pdf). .
5. Appendix 2 containing complementary information regarding survey filter, FPIC and participant consent form that was used with each farmer before starting the survey (Appendix 2_Survey filter, FPIC and consent statement.pdf).
6. This document (Methodology), describing the methodology used (methodology.pdf).

5) Methods

5.1 Study landscapes

The study was conducted with small coffee and basic grain farmers in 6 Central American landscapes: Turrialba and Los Santos in Costa Rica, Choluteca and Yoro in Honduras, and Chiquimula and Acatenango in Guatemala. Figure 1 shows the location of the six study landscapes.

Landscapes were selected based on the following requirements: a) they were dominated by small-scale farming systems, b) they had coffee and/or basic grain production (beans and maize) as main crop, and c) they 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 most important crops for smallholder farmers: coffee is the main cash crop in the region, and basic grains are staple crops that are key for food security. We used expert mapping interviews, validation workshops and expert on-line surveys to assess adaptive capacity in farming landscapes of Costa Rica, Guatemala and Honduras, based on 20 variables (representing natural, human, social, physical and financial capital) that contributed to farmer adaptive capacity, and then used this

information to inform landscape selection. 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. Although both Costa Rican landscapes are characterized as 'coffee landscapes', the Los Santos landscape is predominantly coffee plantations, while Turrialba presents a mixture of coffee, livestock and sugar cane, among other crops. Additional characteristics of the farmers and farming systems in each landscape are provided in Harvey et al. (2017) and Harvey et al. (2018).

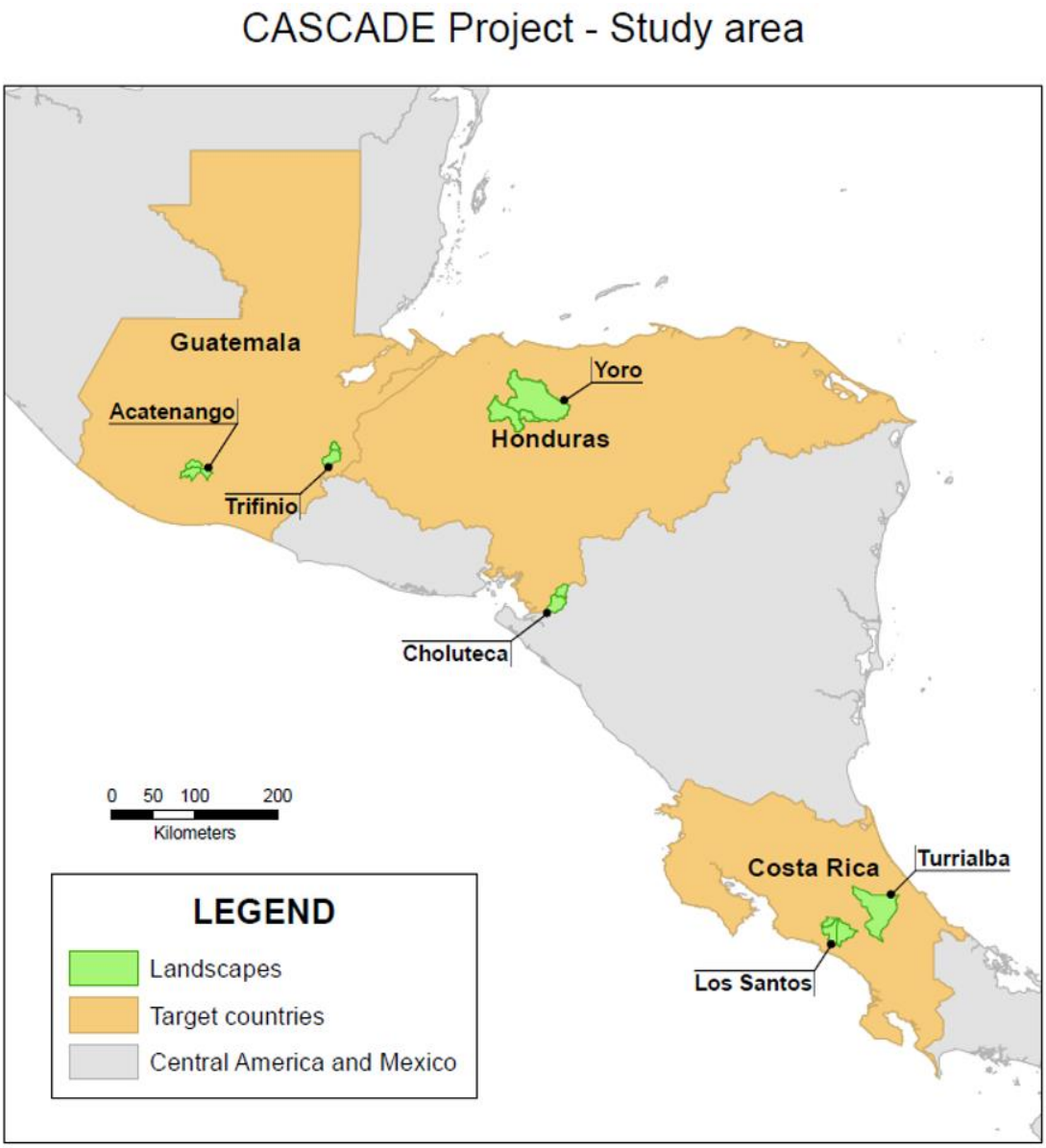

Figure. 1. Location of six agricultural landscapes and the target countries in Central America where the household survey was carried out.

5.2. Selection of smallholder farmers for household survey

In each of the six landscapes, we randomly selected smallholder farmers to be interviewed about changes perceived in local climate during the last decate, climate change impacts on their crops and livelihoods, responses implemented in response to perceived changes in climate and adaptation needs. The sampling method varied across countries due to differences in the availability of secondary information on farmer populations and their distribution in each country, but in all cases, the selection of farmers was random. In the Costa Rican landscapes, we selected farmers randomly from an existing list of coffee farms from the 2003-2006 coffee census (INEC, 2007). 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. To ensure our sample size consisted of only smallholder farmers, we deleted observations of smallholder farmers whose farm area was more than two standard deviations from the mean of the sampled population (calculated per landscape and farm type). The final sample consisted of 860 randomly-selected farmers (115-155 farmers per landscape), of whom 674 were men. Table 1 provides details on the number and types of farmers surveyed in each landscape. Additional details of the selection criteria, study sites and methodology can be found in Alpizar et al. (under review) and Harvey et al. (2018).

Table 1. A summary of the number and type of smallholder farmers surveyed in each of the six Central American landscapes.

Country	Landscape	Number of farmers surveyed	% of farmers who were men	Type of farmer (%)		
				Coffee only	Basic grains only	Both coffee and basic grains
Costa Rica	Turrialba	144	85%	91%	0%	9%
	Los Santos	151	90%	97%	0%	3%
Guatemala	Acatenango	149	77%	37%	38%	25%
	Chiquimula	115	74%	0%	85%	15%
Honduras	Choluteca	155	71%	0%	100%	0%
	Yoro	146	73%	14%	57%	29%
	Total	**860**	**78%**	**41%**	**44%**	**15%**

5.3. Household survey: description and data collected

The household survey was designed to address five research key questions (see section 2). The survey collected information on farmer and farm characteristics, farmer perception of climate change, farmer perceptions of the impacts of climate change on farming systems and local livelihoods, implementation of changes in farm management (and use of EbA practices) in response to climate change, and key adaptation needs of smallholder farmers. The survey was structured in 11 main sections, as detailed in Table 2.

The survey was piloted in the field prior to data collection and underwent a formal ethics review with the Internal Review Board at Conservation International before implementation (Buppert and McKeehan, 2013), which required the completion of an ethical protocol. All potential participants were informed about the advantages and inconveniences of participating in the survey, the type of data to be collected and how confidentiality and privacy would be maintained; and were asked for their consent to participate. Participants signed a form indicating that they had agreed freely to participate (illiterate participants provided oral consent in front of witnesses). Surveys were administered in the field by a team of enumerators who underwent formal training before implementing the surveys.

Surveys were conducted (in Spanish) with the household head or family member in charge of the farm at the farmer's house or on the farm. Surveys took approximately one hour to complete. All surveys were conducted between April and September 2014. All data was collected in hand-held tablets using SurveyCTO software (www.surveycto.com), to minimize data entry errors. Data from the tablets were uploaded to the cloud daily so that researched could review the data collected and ensure quality control.

The basic structure of the household survey was similar across all 6 landscapes; however, there was a subset of questions that was added to the surveys in Honduras and Guatemala to better capture information on maize and bean production, as well as some questions added to better reflect country and landscape details that were not considered in the initial Costa Rican sites which were surveyed first. Consequently, there are some variables in the data base that have data only for certain landscapes (see Section 6 for detail). Survey questions included closed questions (i.e., yes/no questions, single answer multiple-choice questions and multiple answer multiple-choice questions) as well as a few open-ended questions. Answers to open-ended questions (except numerical and text ones) were categorized before entering them into the database. A description of the different types of questions included in the survey is provided in the glossary file ('glossary').

Table 2. Summary of the 11 sections contained in the survey, their objective, the groups of variables in each section, the code names and the number of variables in each section.

SURVEY STRUCTURE			DATASET STRUCTURE		
Section		**Objective**	**Groups of variables**	**Meaning of the variable code**	**Number of variables**
I	Socio-economic variables I	To characterize household head and family in terms of education, migration, etc.	**hhea**	Household head	27
			migr	Migration	19
II	Farmers' perceptions of climate change	To identify changes in temperature and rainfall patterns observed by farmers in the last decade (2004-2014), and the changes made in farm management to face the perceived changes	**perc**	Perception of changes in climate	75
III	General productive activities	To characterize farms managed by the family, including home gardens and livestock, as well as other productive activities carried out by the family	**land**	Land	9
			opro	Other production activities	59
IV	Coffee management	To describe coffee farming systems and their management. Includes basic management of the crop, conventional and EbA practices used in the coffee farms, pest and diseases affecting coffe, production data and commercialization channels.	**pcof**	Farming practices coffee	226
			coff	Production coffee	90
			padc	Pests and diseases coffee	78
V	Basic grains (maize and beans) management	To describe basic grain farming systems and their management. Includes basic management of the crops, conventional and EbA practices used in the farms, pest and diseases affecting the crops, production data and commercialization channels.	**pmab**	Farming practices maize and beans	352
			maiz	Production maize	84
			padm	Pests and diseases maize	78
			bean	Production beans	73
			padb	Pests and diseases beans	78

VI	Natural resources	Collect data about natural resources at farm and community level (water, forests, etc.) and changes in those resources	**watr**	Water	47
			fort	Forest	34
VII	Extreme weather events	Register main extreme hydrometeorological events suffered by farmers in the last decade (2004-2014), their impact, damages and strategies used to cope with impacts (coping strategies) by families	**extm**	Extreme weather events	251
VIII	Access to services and support	To explore the opportunities, access to resources and financial, technical and social support of the families	**accs**	Access to social capital, information, credit and training	140
IX	Attitudes	To evaluate farmers' attitudes facing climate change and social values	**atts**	Attitudes	6
X	Socio-economic variables II	Otras variables socioeconómicas como tenencia de activos y seguridad alimentaria en general.	**socv**	Socioeconomic variables	55
XI	Survey information	Details about the implementation of each survey and evaluation of the survey (quality, credibility). Filled by the enumerator	**sinf**	Survey information	9

6) Data management and quality control

The final data base consists of responses from 860 smallholder farmers. It includes 1843 variables, of which 1750 are variables that came directly from farmer responses to questions, 56 are summary variables that synthesize information from farmer responses to multiple questions (e.g., calculations of the total land area based on the sum of the areas of individual farm plots, or a summary of the number of adaptation measures implemented by a farmer based on their responses to questions about individual adaptation measures, etc.), and 37 were filled in by enumerators. Details on each variable, including the variable name, question it responds to, response options, type of variable, and units are provided in the glossary file ('glossary').

There are three types of missing values in the data set. Some of these missing values reflect the fact that certain questions were not relevant to some of the interviewed farmers, and so were not asked. Other missing values reflect the fact that some farmers did not know the answer to a particular question. Finally, other missing values are due to the differences among versions of the survey; as explained in the previous section, some questions were added or deleted from the questionnaire in order to better reflect landscape specificities and therefore not all of the same questions were asked in all 6 landscapes. Different types of missing values must be taken into account during data analysis. Table 3 provides details on the types of missing values present in the dataset and the symbols used to interpret different types of missing values in the database.

It is also important to realize that there are multiple filter questions in the survey, so not all questions were asked to all 860 farmers. For example, if a farmer answered that he or she did not grow maize, we did not ask this farmer all of the questions related to maize management. All filters are clearly indicated in the 'survey' document, in the instructions for individual questions.

Table 3. Types of missing values in the dataset

Missing value	Meaning
" . "	The farmer wasn't asked this question because it was not relevant to his or her context (e.g. a question about management practices used in maize to a farm who didn't cultivate maize)
". a"	The farmer "Does not know / Does not answer" as response to the question (equal to 999)
". z"	The question was not included in this version of the survey (e.g. questions about certification were included from the second landscape on)

7) Related data sets

This dataset is complementary to a dataverse archive containing information about the use of Ebba practices in a subsample of 300 farmers in the 6 landscapes (Harvey et al. 2018a), the perceived effectiveness of those practices (Harvey et al. 2018b) and a biophysical characterization of their farms (Harvey et al. 2018c) and trees in their farms (Harvey et al. 2018d).

References

Alpizar, F., T. Capitán, F. Castillo, C.A. Harvey, R. Martínez and B. Viguera. Challenges in collecting data from smallholder farmers in developing countries: implications for climate change adaptation research. Climate Change and Development (in review).

Alpízar, F., M. Saborío-Rodríguez, R.M. Martínez-Rodríguez, R. Vignola, B. Viguera, B., T. Capitán, and C.A. Harvey. Determinants of recurrent versus extreme, weather-driven episodes of food insecurity in smallholder farming communities of Central America (in prep).

Avelino, J., Cristancho, M., Georgiou, S., Imbach, P., Aguilar, L., Bornemann, G., Laderach, P., Anzueto, F., Hruska, A., & Morales, C. (2015). The coffee rust crises in Colombia and Central America (2008–2013): impacts, plausible causes and proposed solutions. Food Security, 7(2), 303-321.

Buppert, T. and A. McKeehan. 2013. Guidelines for Applying Free, Prior and Informed Consent: A Manual for Conservation International. Arlington, VA: Conservation International.

Donatti, C. I., Harvey, C. A., Martinez-Rodriguez, M. R., Vignola, R., & Rodriguez, C. M. (2017). What information do policy makers need to develop climate adaptation plans for smallholder farmers? The case of Central America and Mexico. Climatic Change, 141 (1) 107-121.

Donatti, C., C.A. Harvey, M. R. Martinez-Rodriguez, R. Vignola, and C. M. Rodriguez. (2018). Vulnerability of smallholder farmers to climate change in Central America and Mexico: current knowledge and research gaps. Climate and Development, 5529: 1–23. doi.org/10.1080/17565529.2018.1442796

Hannah L., Donatti C.I., Harvey C.A., Alfaro E., Rodriguez D.A., Bouroncle C., Castellanos E., Diaz F., Fung E., Hidalgo H.G., Imbach, P., Läderach, P., Landrum, J.P., Solano, A. L. (2017). Regional modeling of climate change impacts on smallholder agriculture and ecosystems in Central America. Climatic Change, 141 (1) 29-45.

Harvey, C.A., M.R. Martínez -Rodríguez, J. M. Cardenas, J. Avelino, B. Rapidel, R Vignola, C.I. Donatti, and Vílchez Mendoza. 2017. The use of Ecosystem-based Adaptation practices by smallholder farmers in Central America. Agriculture, Ecosystems and Environment 246: 279-290.

Harvey, C.A., M.R. Martínez -Rodríguez, J. M. Cardenas, J. Avelino, B. Rapidel, C.I. Donatti, and Vílchez-Mendoza. 2017. The use of Ecosystem-based Adaptation practices by smallholder farmers in Central America. Agriculture, Ecosystems and Environment 246, 279-290 (open access).

Harvey, C.A., M.R. Martínez-Rodríguez, J. M. Cárdenas, J. Avelino, Jacques, B. Rapidel, R. Vignola, S. Vilchez-Mendoza, and A. Chain-Guadarrama. 2018. a. 1. Farmer survey of EbA use and perceived effectiveness, https://doi.org/10.7910/DVN/GYNCEN, Harvard Dataverse, V1.

Harvey, C.A., M.R. Martínez-Rodríguez, J. M. Cárdenas, J. Avelino, Jacques, B. Rapidel, R. Vignola, S. Vilchez-Mendoza, and A. Chain-Guadarrama. 2018. b. 2. Field survey of EbA practices", https://doi.org/10.7910/DVN/PGYPML, Harvard Dataverse, V1.

Harvey, C.A., M.R. Martínez-Rodríguez, J. M. Cárdenas, J. Avelino, Jacques, B. Rapidel, R. Vignola, S. Vilchez-Mendoza, and A. Chain-Guadarrama. 2018. c. 3. Database trees WP4, https://doi.org/10.7910/DVN/IVUJM9, Harvard Dataverse, V1.

Harvey, C.A., M.R. Martínez-Rodríguez, J. M. Cárdenas, J. Avelino, Jacques, B. Rapidel, R. Vignola, S. Vilchez-Mendoza, and A. Chain-Guadarrama. 2018. d. 4. Summary data set for publication by Harvey et al. 2017", https://doi.org/10.7910/DVN/Y1NALL, Harvard Dataverse, V1.

Harvey, C.A., M. Saborio-Rodriguez, M. R. Martinez-Rodriguez, B. Viguera, A. Chain, R. Vignola and F. Alpizar. 2018. Perceptions of climate change, impacts and adaptation among smallholder farmers in Central America. Agriculture and Food Security, 7:57, https://doi.org/10.1186/s40066-018-0209-x.

Hidalgo H.G., Alfaro E.J., Quesada-Montano B. (2017). Observed (1970--1999) climate variability in Central America using a high-resolution meteorological dataset with implication to climate change studies. Climatic Change, 141 (1):13-28.

Hidalgo, H.G., and Alfaro, E.J. (2015). Skill of CMIP5 climate models in reproducing 20th century basic climate features in Central America. International Journal of Climatology, (35) 3397-3421.

Holland, M.B., S. Shamer, P. Imbach, J.C. Zamora, C. Medellin, E. Leguia, C. Donatti, R. Martinez and C.A. Harvey. 2017. Mapping agriculture and adaptive capacity: applying expert knowledge at the landscape scale. Climatic Change 141:139-153 (open access).

Imbach, P., E. Fung, L. Hannah, C. Navarro--Racines, T.H. Ricketts, C.A. Harvey, D. Roubik, C. Donatti and P. Läderach. (2017). Coffee, bees and climate: coupling of pollination services and agriculture under climate change. Proceedings of the National Academy of Sciences, 114 (39) 10438-10442.

Imbach, Pablo et al. 2015. “Impacts of Climate Change on Ecosystem Hydrological Services of Central America: Water Availability.” Climate Change and Ecosystem Services in Central America (Conapas 2006):65–90.

Imbach, P., Locatelli, B., Zamora, J.C., Fung, E., Ciais, P., Molina, L. (2015). Impacts of climate change on ecosystem hydrological services of Central America: water availability. In Chiabai, Aline

(Ed.). 2015. Climate Change Impacts on Tropical Forests in Central America: An Ecosystem Service Perspective. Abingdon: Routledge.

Imbach, P., Beardsley, M., Bouroncle, C., Medellin, C., Läderach, P., Hidalgo, H., Alfaro, E., Van Etten, J., Allan, R., Hemming, D., Stone, R. Hannah, L., Donatti, C.I. (2017). Climate change, ecosystems and smallholder agriculture: An introduction to the special issue. Climatic Change, 141 (1) 1-12.

INEC (Instituto Nacional de Estadística y Censos). 2007. Censo cafetalero: Turrialba y Coto Brus 2003, Valle Central y Valle Central Occidental 2004, y Pérez Zeledón, Tarrazú y Zona Norte 2006. Principales resultados. Instituto del Café de Costa Rica, San José, CRC. http://www.inec.go.cr/censos/censos-cafetalero (consultado 9 ago. 2017).

Saborío-Rodríguez, M.; Alpízar, F.; Aguilar-Solano, L.; Martínez-Rodríguez, R. M.; Vignola, R.; Viguera, B.; Harvey, C.A. Vulnerability to extreme weather events in farm households: A case study of smallholder maize and bean farmers in Central America. Castillo et al. (Eds.) Extreme Events and Climate Change: A Multidisciplinary Approach. Wiley & Sons (in review).

Vignola, R., Harvey, C.A., Bautista-Solis, P., Avelino, J., Rapidel, B., Donatti, C., Martinez, M.R. (2015). Ecosystem-based adaptation for smallholder farmers: definitions, opportunities and constraints. Agriculture, Ecosystems and Environment 211: 126-132.

Viguera, B.; Alpízar, F.; Harvey, C.A.; Martínez-Rodríguez, M. R.; Saborío-Rodríguez, M. Small-scale coffee farming in Costa Rica facing climate change: perceptions and adaptive responses. Mesoamerican Agronomy (in review).

Viguera, B.; Alpízar, F.; Harvey, C.A.; Martínez-Rodríguez, M. R.; Saborío-Rodríguez, M. Climate change perceptions and adaptive responses of small-scale farmers in two Guatemalan landscapes. Mesoamerican Agronomy (in review).

Viguera, B.; Alpízar, F.; Harvey, C.A.; Martínez-Rodríguez, M. R.; Saborío-Rodríguez, M. Honduran family farming in a climate change context: current state and perspectives. Mesoamerican Agronomy (in prep).