

Very Preliminary, Please Do Not Quote

Willingness To Accept Carbon Payments Under Different Land Uses In Two Community

Forests Of Oaxaca, Mexico

Lindsey Roland Nieratka (Full family name is Roland Nieratka)

Florida International University

11200 SW 8th Street, Miami, FL 33199

309-253-9220

lnieratka@gmail.com

(Present Address: 3101 Port Royale Blvd #336, Fort Lauderdale, FL 33308)

Pallab Mozumder

Florida International University

11200 SW 8th Street, Miami, FL 33199

305-348-7146

Pallab.mozumder@fiu.edu

David Bray

Florida International University

11200 SW 8th Street, Miami, FL 33199

305-348-6236

brayd@fiu.edu

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ABSTRACT

The reduction of greenhouse gases in the atmosphere is essential for slowing down the climate change. One of the most effective ways to reduce emissions of greenhouse gases is by allowing emissions from land use change and protecting the forests which act as a carbon sink. Paying forest dwellers through a payment for environmental services (PES) program for reforestation, aforestation, forest conservation and management is a novel way to do both of these things. This study focuses on two indigenous communities in Oaxaca, Mexico who have been involved in a payment for hydrological services program and ask what they would be willing to accept (WTA) to participate in a program paying for carbon under two circumstances; paying for conservation on communal lands and paying for reforestation on individually held lands. The study used Heckman Selection Models to determine what factors influenced willingness to participate and willingness to accept and to generate predicted willingness to accept. The results show that WTA was higher for carbon payment programs requiring reforestation on individually owned lands and that WTA and that the prices named were independent of opportunity cost and that the market price of carbon only influenced WTA in the case of conservation. The most influential factors in determining WTA in either circumstance were factors related to the subject's experience and perception of the hydrological PES program in which they are currently enrolled. These results suggest that communities or individuals with positive experiences with PES programs should be targeted for future PES programs and that for forest dwellers who manage lands communally, programs that promote forest conservation for carbon mitigation are more viable than reforestation or aforestation programs that may have perverse incentives.

46 Keywords: Forest carbon, Payments for environmental services (PES), Willingness to accept
47 (WTA), REDD+, Oaxaca, community conservation.

48

49 1. Introduction

50 **1.1 Overview of PES**

51 Payments for Environmental Services (PES) programs function on the premise that
52 environmental problems are a result in a failure of the market to recognize the value of positive
53 externalities provided by natural ecosystems (Wunder 2005, Engel *et al.* 2008, Kosoy *et al.*
54 2007). PES address the problems of integrated conservation and development programs (ICDPs)
55 which, like PES, are concerned with conservation and also poverty reduction but, unlike PES,
56 failed to make program benefits contingent on conservation outcomes (Clements 2010). Though
57 PES were originally defined as a voluntary transaction where a well defined service is bought
58 buy a buyer from a provider conditional on the provision of the services (Wunder 2005), the
59 failure of many PES programs to completely meet these criteria led to the creation of more
60 general definitions. According to Muradian *et al.* (2009) PES is “a transfer of resources between
61 social actors which aims to create incentives to align individual and/or collective land use
62 decisions with the social interest in the management of natural resources.” The term PES can be
63 used as a blanket term for a wide range of incentive programs (Sommerville *et al.* 2009)

64

65 **1.2 Paying for Forest Carbon**

66 With climate change at the forefront of environmental concern, the reduction of
67 greenhouse gases is a goal in many national environmental policies. There are three main
68 methods of reducing the GHG concentration in the atmosphere. The first is reducing GHG
69 production by reducing fossil fuels use (Hanssen *et al.* 2008, Scarborough 2007). The second
70 method is reducing deforestation and forest degradation. Third, GHGs can be removed from the
71 atmosphere faster than they are being emitted through practicing agriculture and forestry in a
72 way which allows for carbon sequestration (Hanssen *et al.* 2008, Scarborough 2007).

73 The Clean Development Mechanism (CDM) was outlined in the Kyoto since 2006 and
74 allowed developed countries to meet their emissions reduction requirements by sponsoring
75 programs in developing countries that reduce emissions (UNFCCC 2008). These reductions earn
76 the sponsoring countries credits that could either be used or traded (UNFCCC 2008). However,
77 under the CDM, only carbon sequestered in new forests through afforestation and reforestation
78 projects were eligible for credits and within that only carbon that would not otherwise have been
79 sequestered without the program would be credited (Scarborough 2007). What the CDM didn't
80 include was the protection of existing forest for the purpose of reducing emissions.

81 In the period from 1993 to 2003 there was an estimated 3,300 MtCO₂ per year
82 sequestered in forests globally (Nabuurs *et al.* 2007). Of the terrestrial carbon storage, forty five
83 percent is held in forests. During the 1990's forests served to take in thirty three percent of all
84 anthropogenic emissions (Bonan 2008). Temperate forest in developed nations have historically
85 been carbon sources due to high rates of deforestation. Recent movements towards the
86 suppression of fire and reforestation have turned these European forests back into sinks (Bonan
87 2008), indicating that forest management is a successful method of carbon sequestration.
88 Tropical forests remain an important source of carbon dioxide and deforestation and forest

89 degradation globally account for 12-18% of anthropogenic carbon emissions, the second largest
90 source after energy (Stern *et al* 2006, Clements 2010). Carbon capturing can be achieved
91 through reforestation and afforestation projects along with forest management, protection against
92 fires and diseases and reduced deforestation (IPCC 2007, Nabuurs *et al.* 2007).

93 Despite the CDM's aversion, on a short time scale, reducing deforestation will be more
94 successful in reducing carbon in the atmosphere than afforestation or reforestation. Deforestation
95 in developing countries is the major source of emissions from within the forestry sector (Nabuurs
96 *et al.* 2007). Deforestation has the result of both releasing carbon and destroying existing carbon
97 sinks (Gibbs *et al.* 2007) making reducing deforestation an important goal for stabilizing climate.
98 Long term projects should aim to expand forests in order to increase the amount of carbon they
99 hold (Nabuurs *et al.* 2007).

100 An effective policy to increase carbon held in forests is offering financial incentives to
101 manage forests, reduce deforestation, and increase forest area (IPCC 2007). Payments for
102 ecosystem services, or PES, are widely promoted and well received in the developing world to
103 combine development and economic growth with conservation (Corbera *et al.* 2009). A policy
104 that will be successful that offers an economic incentive to conserve forests that outweighs the
105 economic incentives to degrade the forests (Nabuurs *et al.* 2007, Corbera *et al.* 2009).

106 The United Nations program REDD (Reducing Emissions from Deforestation and forest
107 Degradation) aims to create an economic value for the carbon stored in forests and promote
108 reforestation and afforestation projects (Parker and Mitchell 2008). Because REDD programs
109 pay for planting trees they can sometimes result in low diversity tree plantations. To remedy this
110 a second program called REDD+ includes programs of forest management and conservation.
111 The agreement on REDD+ that came out of Cancun in 2010 calls for developing countries to

112 (a) reduce emissions from deforestation and forest degradation; (b) conserve forest carbon stocks
113 and sustainably manage forests and (c) enhance existing forest carbon stocks (UNFCCC 2010).
114 By protecting existing forest carbon stocks REDD+ can significantly reduce emissions from land
115 use change. In addition, REDD+ will protect natural ecosystems, biodiversity and ecosystem
116 services, create resilience to climate change and, promote sustainable development and poverty
117 alleviation for forest dwellers. REDD+ programs are intended to compliment efforts to reduce
118 emissions from other sectors rather than create carbon offsets.

119 According to an economic review of forest carbon programs, the costs of reducing
120 emissions from the forest sector by half by 2030 would be around \$17-33 billion per year
121 (Eliasch 2008). The net benefits in present values over the long term will be up to \$3.7 trillion in
122 emission reduction alone. The value is much greater when other ecosystem services which will
123 be protected are taken into account (Eliasch 2008). The same review found that including REDD
124 programs in a system of cap and trade could reduce deforestation globally by 75% by 2030
125 which would provide the dual benefit of reducing emissions and providing a sink (Eliasch 2008).
126 Reducing emissions in the forest sector is more cost effective than other sectors and, as forest
127 grow, the cost will continually be reduced as the benefits increase (Eliasch 2008).

128 Mexico has been a UN-REDD partner since early 2010 and in September 2010 launched
129 a website, reddmexico.org, aiming to provide information about the efforts in Mexico to
130 implement REDD+ programs. Several pilot projects have been identified and Mexico is working
131 closely with the World Bank's Forest Carbon Partnership Facility (FCPF) to take advantage of
132 REDD+ (Corbera 2011). With the FCPF and under the government Climate Change Program,
133 Mexico aims to promote reforestation and sustainable forest management, bring 750,000 ha of

134 additional forest under federal protection, establish REDD+ projects in 40% of the protected
135 areas, promote wildlife conservation and expand existing PES programs (Corbera 2011).

136

137 **1.3 Measuring Willingness to Accept**

138 Before a carbon payment or any other PES program can be implemented, an appropriate
139 value must be placed on the service. In order to promote efficiency, the price paid to the service
140 provider must be more than their opportunity cost but less than negative externalities which
141 would result from land conversion (Kosoy *et al.* 2007, Wunder *et al.* 2008, Pagiola *et al.* 2005).
142 Determining local willingness to accept (WTA) for a carbon payment program is one way to
143 determine the viability of such a program in the area. By asking someone what they would be
144 willing to accept as compensation for giving up the ability to develop or otherwise alter a forest
145 for profit, you are performing a contingent valuation of the worth of that forest to the individual.
146 If the values the individual puts on the forest lie within the range that the service buyer is willing
147 to pay, then the program would be viable in that location.

148 Southgate *et al.* (2009) found links in willingness to accept and willingness to participate
149 in the amount of compensation being offered and the amount of land required respectively. In
150 Costa Rica they found that the farmers with a successful commercial crop were less willing to
151 forgo agricultural land and would require larger payments to participate. Lower WTA from poor
152 farmers means more poor can participate in PES as they demand less but unless they are the
153 owners of the important land in terms of service provision it may be worth it to pay higher prices
154 to wealthier land owners. If payments were not equal then the poor would tend to receive less
155 than more well off participants, thus placing the burden of conservation unfairly on the poor
156 (Southgate *et al.* 2009). Our study investigates WTA in a common property regime where the

157 recipients of the payments are communities with internal governance determining funds
158 distribution rather than payments to individual land owners. WTA is investigated in two
159 circumstances, one in which the burden of conservation is shared by the entire community and
160 one in which the burden of conservation is borne by individuals.

161

162 **1.4 Objectives**

163 This study was done in conjunction with an investigation of the results of the PES
164 program *Pagos por Servicios Ambientales Hidrologicos* (PSAH) in two indigenous communities
165 in Oaxaca, Mexico. In this paper I will present a summary of those results. Additionally I will
166 present an investigation of the willingness to accept compensation for carbon services under two
167 different land uses in the two communities. My objectives are as follow.

- 168 1. Determine the willingness to participate in a second PES program based on the success of
169 the existing PES program.
- 170 2. Assess willingness to accept carbon payments under two different land uses; conserved
171 forest and agricultural coffee parcels.
- 172 3. Determine the factors which influence willingness to accept compensation for carbon
173 services under the two different land uses.

174

175 **2. Materials and Methods**

176 **2.1 Study Sites**

177 The two study communities used in this project were Santa Cruz Tepetotutla and San
178 Pedro Tlatepusco. Both communities are indigenous Chinantec communities located in the
179 Sierra Norte region of Oaxaca, Mexico. Under Article 27 of the Mexican Constitution,

180 indigenous communities, or *comunidades*, own their territory collectively and the management is
181 the responsibility of the individual community members or *comuneros*. Within the community
182 the decision making body is called the Assembly and consists of all the *comuneros*, each of
183 whom has a single vote in majority rule decision making. Leadership roles are appointed,
184 mandatory, and last for three year periods.

185 Santa Cruz is the larger of the two towns with a population of 700 inhabitants and 120
186 *comuneros*. San Pedro has 200 inhabitants and 60 *comuneros*. Santa Cruz is accessible by a
187 road but San Pedro is not. In both communities coffee is a major source of income though less
188 important now than it had been in previous years.

189 The territories of both communities are zoned into three main areas. The smallest of the
190 areas is the urban zone. This is where community members have their homes and building a
191 residence outside of this zone is not allowed. The second zone is the agricultural zone. This
192 zone consists of corn fields, which are communal, and coffee fields which pertain to specific
193 individuals. The coffee fields are the closest thing in the communities to private property. The
194 owner of the fields can pass them to their children and alter them to an agricultural uses other
195 than coffee. Corn fields, on the other hand, only belong to an individual for a single harvest.
196 After the harvest the fields go into a mandatory fallow period after which it can be cleared and
197 planted by any *comunero*. The third and largest zone is the conservation area. Both
198 communities have large areas of forest designated for conservation and legally recognized by the
199 federal protected areas commission, CONANP, as certified conservation areas or community
200 conservation areas (CCAs). It is within these CCAs that both communities have land in the
201 national hydrological PES, called *Pagos por Servicios Ambientales Hidrologicos* or PSAH
202 program since 2004.

203

204 2.2 Methodology

205 The study took place during the summer of 2010 from June 4th to July 27th. Structured
206 household surveys were conducted in both Santa Cruz and San Pedro. The surveys were created
207 following the guidelines of Nardi (2003), Bernard (2002) and utilizing some questions taken
208 from a survey by David Runsten and Jessa Lewis on coffee and emigration in Oaxaca (the results
209 of which are presented in Lewis and Runsten 2005). The survey asked questions about
210 household income including remittances received, agricultural production, and payments from
211 government programs.

212 The final section of the structured survey captures willingness to accept in a carbon
213 payment project. Following Southgate *et al.* (2009), we first explained that forests are important
214 not only for their ability to conserve water but also for the capture of carbon, which is a
215 contaminant causing climate change. We also explained that governments and companies create
216 projects of conservation or reforestation for the purpose of creating carbon credits that can be
217 sold in the market. The subject was then asked if they would be willing to participate in a
218 program where the community would be paid either to continue conserving or to plant trees for
219 the sake of capturing carbon. If the subject responded negatively, the survey ended, but those
220 who replied in the affirmative were asked two following questions. Half of the participants were
221 told the market price of carbon which at the time of the study was \$0.10 according to the
222 Chicago Climate Exchange¹ (CCX, www.chicagoclimatex.com) and told that their forests would
223 be able to generate 200 carbon credits per hectare, a figure based on a meta-analysis of biome
224 level carbon stocks by Gibbs *et al.* (2007). Since the exchange rate at the time of the study was

¹ This price represents a collapse of carbon prices in 2010, down from a high of around \$10 a few years before. As of December 31, 2010 the Chicago Climate Exchange shut down its carbon trading system (Gronewold 2011)

225 roughly 11 pesos to the dollar subjects were given the round figure of 200 pesos per hectare.
226 The remaining half of the participants were not given this figure. The following questions asked
227 first about a payment for conservation and payment for reforestation. First, subjects were asked
228 to give an amount per hectare per year that was the least they would be willing to accept for
229 carbon sequestration within the certified Community Conserved Area (CCA). At the time of the
230 survey both communities were enrolled in the PSAH. Santa Cruz received payments for 4,000
231 hectares while 5,000 hectares remain without payments. In San Pedro 3,000 hectares receive
232 payments and they have 1,300 hectares without payment in their CCA. Of the 82 subjects who
233 were asked this question, 79 gave a response. In most cases, the response was difficult to obtain
234 because subjects were reluctant to give an opinion on something they thought should be a
235 community decision. Interviewers explained that the responses would be confidential and
236 subjects should give the response that they would suggest to the Assembly if this topic were
237 being discussed or the amount that they would vote for in the Assembly if it came to a vote.

238 The next question asked the subject the minimum amount they would be willing to accept
239 per hectare per year to plant trees in the coffee fields. During the pre-test we discovered that the
240 corn fields are communal and thus respondents were unwilling to alter corn fields as it is
241 something that would have to be determined by the Assembly. Most agreed it would be unlikely
242 that the Assembly would decide to remove land from the already small agricultural zone. Instead,
243 we asked the question in terms of how much they would be willing to accept to give up their
244 coffee fields for conservation. Since the coffee plots are considered as though they were private
245 property, individual subjects were able to give a response.

246 Structured survey data was analyzed using two different statistical packages, SPSS and
247 Stata 9.0. Summary statistics and most graphs were created using SPSS. The statistical package

248 Stata 9.0 was used to run multivariate regression analyses and to empirically estimate household
249 willingness to accept (WTA) for the described conservation payment programs using Heckman
250 Selection Models (Heckman 1979). This model considers the factors that influence whether or
251 not an individual was willing to participate in the described program and what factors influenced
252 the amount they were willing to accept. Because only those who were willing to participate
253 named a price they were willing to accept, I needed a regression that did not have a selection bias
254 from the self-censored sample. This is why the Heckman Selection Model was used, as it has
255 been used to eliminate selection bias in other WTA studies (Devkota and Paudel 2009).

256

257 3. Results

258 During the eight week field period we were able to conduct a total of 88 surveys. A
259 summary of the survey respondents is provided in Table 1. The variables collected from the
260 surveys and used in the Heckman models are listed, described and summarized in Table 2.

261 **3.1 Overview of PSAH and PSAH results in study communities**

262 Both Santa Cruz and San Pedro have been participating in the PSAH, *Pagos por*
263 *Servicios Ambientales Hidrologicos*, since 2004. The money received from the program is paid
264 in a lump annual sum to the community as a whole. Both communities invest a part of the
265 money into public goods before paying each household. In Santa Cruz the payment to the
266 household is given in part in a small cash payment and the rest is put in a bank account where it
267 can accrue interest for the community. Each household can withdraw their money from the
268 account with permission from the Assembly at any time. In San Pedro the money given to the

269 households is given in cash in one annual sum but additional money is earned by both
270 community members and non members for participation in community work days.

271 In both communities, the overall impression of the program was favorable. Over eighty
272 percent of those surveyed believed that the money from the program was distributed in an
273 equitable way to all the community members (85%) and that the money was used well within the
274 community (82.2%). Seventy percent of the respondents thought that participation in the
275 program was worth the restrictions on the forest and 83.9% thought that they were economically
276 better off because of the payments than they were before participating in the program. In fact,
277 the addition of the PSAH payments into the household income had the effect of raising both
278 communities above the poverty line determined by the government. In Santa Cruz mean income
279 was \$2.55 a day up from \$1.60 a day per person and in San Pedro the mean income per person
280 per day was \$1.49 compared to the \$0.88 it would have been without the PSAH payments.

281

282 **3.2 Willingness to Accept – Carbon Payments in Conservation Area**

283 The mean responses of willingness to accept are summarized in Table 3. Seventy nine of the
284 88 surveyed said they would be willing to participate in a new PES program. Those who
285 declined to respond did so because (1) they were uncomfortable discussing money, (2) they felt it
286 was a matter for the Assembly to decide or (3) they were simply bored with the survey and
287 wished to stop.

288 Responses from the subjects for what they would be willing to accept for participating in a
289 new PES program based on carbon capture within the conservation area that already exists
290 ranged from 150 to 8000 pesos (or 11.78 to 628.44 US dollars, Figure 1). The mean response

291 was 1180.87 pesos and the median response was 600 pesos. The results of three Heckman
292 Selection Models are shown in Table 3.

293 Whether or not the respondent was interested in a new PES program in the conservation
294 area was influenced by whether or not they have children living outside of the community, if
295 they agree with the use of the PSAH money within the community, if they feel their economic
296 situation has improved because of the PSAH and of which community they are a member.
297 Interestingly, in this model if a respondent did not agree with how the money is spent in the
298 community they were more likely to be interested in a new PES program. Similarly, those who
299 did not believe that the money from the PSAH is distributed equally among community members
300 had a higher WTA. Not surprisingly, the fewer children a respondent had living outside of the
301 community the more likely they were to want a new PES. Children living outside of the
302 community are often a source of remittance income. Those in Santa Cruz were more likely to
303 want a new PES program than those in San Pedro. By this model the predicted mean WTA was
304 M\$1,395/ha/yr (Table 5).

305 The second Heckman selection model included household size and composition (Table 3) by
306 including the number of residents, children and elderly. These variables factor in both how much
307 money is received from the PSAH and the costs and needs of the household. We found no
308 significance of any of those factors, however, once they were included, whether or not anyone in
309 the household had used money from the fund (meaning taken money from the bank in Santa
310 Cruz or asked for a loan in San Pedro) was no longer significant. By this model the predicted
311 mean WTA was \$M1,397/ha/yr (Table 5).

312 The third model adds whether or not the head of household has held any leadership positions.
313 The community's participation in the PSAH has meant extra work for those with leadership

314 positions. This and the idea that those who have held leadership positions would be more
315 knowledgeable about the PSAH were reasons to include this as a factor in the model but did not
316 influence WTA. The predicted mean WTA from model three was \$M1383.806/ha/yr (Table 5).

317

318 **3.3 Willingness to Accept- Carbon Payments in Coffee Plots**

319 The previous question explored WTA for a program in communal areas of the
320 community territory where access is already limited and conservation is already being practiced.
321 This second question explores WTA for carbon sequestration programs in the coffee fields. The
322 subjects were asked their WTA for converting coffee fields into tree plantations for carbon
323 sequestration. Responses were given in amount per hectare per year for a period of five years.
324 One response of \$M9,000,000 was dropped counted with the respondents who said that there
325 was no amount they would be willing to accept in order to give up coffee fields for conservation
326 since it was unreasonably high.

327 Thirty two percent responded that there was no amount of money they could be given to
328 abandon the coffee fields. The two reasons for this response were that (1) much land is already
329 in conservation and no need to expand into the agricultural areas and (2) that the coffee fields
330 were the only thing they owned and that they relied on them for food, firewood and income.

331 Heckman selection models found that factors influencing WTA in the coffee plots were
332 gender, whether or not the household receive remittance, the total amount the household receives
333 from PES, community, the total household income, and the percentage of the household income
334 that comes from PES (Table 4). Women respondents gave higher responses than men. The less
335 remittance by the household received or the less the household receives from PES the higher
336 their WTA. The higher the household income and the greater the amount of income came from

337 PES the more the respondent asked for WTA. The inhabitants of Santa Cruz had higher WTAs
338 than those of San Pedro. In this model the factors influencing whether or not the respondent
339 would be willing to receive payment for expanding conservation into coffee fields were the
340 community, whether or not the head of household has held leadership positions, the number of
341 hectares the household has in coffee, whether the respondent feels that what they receive for
342 PSAH is enough, if they feel their economic situation has improved and if the PSAH is worth the
343 restrictions. Respondents from Santa Cruz are more likely to accept payment for expanding
344 conservation into coffee plots than those in San Pedro. Those who have had positions of
345 leadership, who feel that the PSAH pays well, feel that their economic situation has improved
346 and believe the PSAH is worth the restrictions on the forest are most likely to accept expansion
347 of conservation into coffee fields. The respondents from households with fewer hectares of
348 coffee were more willing to accept payments for expanding conservation into coffee plots. With
349 these factors as predictors, the predicted mean response for WTA was M\$1,708.24/ha/year
350 compared to the actual mean of 3,714.13 pesos per hectare per year (Table 5).

351 When household size and non-coffee crop income were added to the model several of
352 these factors changed (Table4). Whether or not a household receives remittance loses some
353 significance for how much the respondent was willing to accept. Surprisingly, adding these
354 additional factors into the model made whether or not the respondent thought the payments were
355 worth the restrictions on the forest a much less significant determinant of whether or not they
356 would be willing to accept payment to plant trees for carbon sequestration into their coffee plots.
357 Using this model the predicted mean response was \$M1,709.88ha/yr (Table 8b).

358 I also wanted to take into account non-agricultural income and the number of adults in a
359 house. I added into the model the households other income which meant any income

360 unaccounted for at other points in the survey (Table 4). This is income that is not from
361 remittances, agriculture or government programs, all of which have already been considered in
362 the model. I found that there was no significant effect of non-agricultural income on the WTA
363 of respondents. Because most adults receive money from the PSAH the number of adults in the
364 household affects the amount of money received. However, the number of adults in a house did
365 not significantly affect the stated WTA of a respondent. Adding these factors to the regressions
366 changed the significance of the total income and whether or not the PSAH payments are worth
367 the restrictions. This model predicted the responses of the respondents and found a mean of
368 1685.65 pesos per hectare per year (9b).

369 Willingness to Accept payments in coffee plots elicited responses between \$M50 and
370 \$M10,000/ha/yr (Figure 2). The mean response was \$M3,714.13/ha/tr with the expected
371 response of \$M1708.24/ha/ty. The median response was \$M3000.

372

373 **3.4 Summary of results**

374 They results of all three WTA questions and the prediction models are shown in Table 5.
375 This is compared with opportunity cost, which was determined by taking the household income
376 from coffee and dividing it by the number of hectares of coffee owned by members of the
377 household, and also with the total income from coffee during the study year of July 2009 to July
378 2010. It is clear that willingness to accept is lowest for programs within the existing
379 conservation area and higher for programs that would require giving up coffee income.
380 Opportunity cost is lower than WTA in all cases but coffee income is higher than WTA per
381 hectare to abandon coffee plots for the purpose of tree plantations for carbon sequestration.

382

383 A two sample T-test with unequal variances shows that WTA_CONS and
384 WTA_COFFEE are significantly different from one another ($t=-5.8768$, d.f. = 64.8222, $p<0.01$)
385 meaning that subjects were willing to accept less where there was less personal loss or work
386 involved by participating in a program within the conservation area rather than one in which
387 coffee fields would be changed into tree plantations.

388 Both communities gave similar responses for WTA_CONSERVATION (Mann-Whitney
389 test, $z=-0.806$, $p=0.4202$). Because of the small number of observations made for willingness to
390 accept for the expansion of conservation into coffee plots for San Pedro, I could not determine if
391 the WTA in San Pedro was significantly different than WTA in Santa Cruz. However, when
392 comparing response rates between the two communities, respondents in Santa Cruz were more
393 likely to be willing to accept payment for the expansion of conservation into coffee plots (43 out
394 of 58) than those in San Pedro (3 out of 29) (Mann-Whitney, $z= 4.511$, $p=0.01$).

395

396 4. DISCUSSION AND CONCLUSIONS

397 The responses for willingness to accept payment for carbon programs was different
398 depending on whether the project would be within the conservation areas or in the coffee plots.
399 From Figures 1 and 2 it is evident that WTA responses were clustered towards lower numbers
400 where WTA in coffee fields responses were more spread out and were higher. Differences in
401 responses between respondents may be because opportunity costs differ between individuals.
402 The opportunity costs for the community as a whole may be low, but if an individual feels they
403 have lost important resources from the forest or if they had interests in logging of cattle, their
404 perceived opportunity cost will be higher than that of the community as a whole. The average of
405 WTA for coffee plots was higher than the average for conservation in both the actual data and

406 the predicted responses (Table 5). A carbon program in the conservation area is a proposal that
407 is not unfamiliar as the communities already have experience with water payments in the
408 conservation area. An Additional PES program within the conservation area would not be much
409 additional work for the community nor represent a personal loss for the survey respondents. A
410 carbon program that would require cutting down coffee plants and planting forest trees
411 represents a loss and a risk for the individual respondent. There is also a difference between
412 community property and property which is claimed by an individual. The conservation area is
413 communal, the costs and benefits of the program would be shared by all the community
414 members, while coffee plots are the closest to private property that exists in the communities.
415 The benefits of participating in a carbon program in the coffee plots would be shared by the
416 community but the costs would be borne mostly by the individuals.

417 A second main difference between WTA for carbon capture PES in the conservation area
418 and carbon capture PES in coffee plots was the response rate of the survey respondents. Most of
419 the respondents, 87.8%, were interested in participating in a carbon capture program in the
420 conservation area while only 67.14% were interested in participating if the program was in the
421 coffee plots. If separated by community, 73% of those surveyed in Santa Cruz were willing to
422 abandon coffee production in return for carbon payments but only 10% were willing to do so in
423 San Pedro. In San Pedro I was often told that they were unwilling to give up their coffee fields
424 because growing coffee is what they do. They also use coffee fields to grow other food crops for
425 consumption or sale, such as *tepejilote* or *guasmol*, and collect firewood from the plots. The
426 people in San Pedro have less land in their agricultural zone to begin with because much of it is
427 covered with bracken fern and already many community members have to walk an hour or more
428 to reach their fields. Additionally limiting their access to land to grow food is not something

429 most members of San Pedro were willing to consider. There was no price that they would accept
430 to give up that source of livelihood and security. These results show a difference in willingness
431 to participate not only between communal and private land, but also between individuals with
432 different risk acceptance abilities. Those who rely more on the coffee are less likely to take the
433 risk of accepting payments for an activity other than coffee.

434 The authors of the Southgate *et al.* (2009) study found that farmers with successful crops
435 were less willing to forgo agricultural land or would require a higher payment to do so. My
436 study obtained similar results. As seen in table 4, the less land a household had in coffee
437 production, the more willing they were to want to participate in a program for carbon capture in
438 coffee fields. Having less land in coffee may indicate less of a dependence on that crop and
439 other uses on that land for their livelihoods. Additionally, if a family receives remittance
440 income, they are willing to accept a smaller payment. Because the household receives this
441 additional income, they are able to take more risk. Also, the more that a household receives in
442 PES now, a function of the number of adults living in the house, the lower their WTA, which
443 indicated that they are satisfied with what they are receiving. The higher the total income in the
444 house the higher their WTA which is possibly a reflection of income generated by a combination
445 of coffee and other crops grown on coffee land which can be sold for profit. In this way my
446 results are similar to those of Southgate *et al.* (2009) in that those who have the most to lose, or
447 the highest opportunity cost in terms of land owned and income from that land, by participation
448 demand the most payments.

449 Whether or not respondents were willing to participate in a carbon capture program in the
450 conservation area and what they would be willing to accept was also influenced by their
451 perception of the current PSAH program. If the respondent feels their economic situation had

452 improved, they were more willing to participate in a second program. If the respondent was told
453 the current market price for carbon, at the time of the study it was estimated to be 200 pesos per
454 hectare of tropical forest, they were willing to accept a smaller payment than if they were not
455 explained the market price. Explaining carbon prices had no influence on the WTA for a
456 program in the coffee fields where income and opportunity cost factors were more important. If
457 the respondent had used money from the fund, by asking for their saved money in Santa Cruz or
458 requesting a loan in San Pedro, they reported higher willingness to accept. Using the fund may
459 reflect larger needs in the form of medical costs and thus desire for higher payments. Two
460 results that are difficult to explain are that agreement with the distribution of funds and whether
461 or not they thought community members received money equally were negatively correlated
462 with whether they would be willing to participate and what they would be willing to accept
463 respectively. It is possible that if a respondent thought that not everyone in the community
464 received their fair share of the PSAH money that receiving more money would help fix the
465 problem, but why those who don't agree with how the community uses the money would want to
466 participate in a new program is difficult to explain.

467 The prices given by the respondents of the survey are generally much higher than the
468 market price of carbon and higher than what is being offered by current government programs,
469 such as the PSAH program. In order to avoid this in future studies I would design the questions
470 to be more similar to the questions of Southgate *et al.* (2009) which provided respondents with
471 several different amounts and asked if they would be willing to accept each of them. In this way
472 I could avoid receiving responses which are above what might ever be offered and determine if
473 the communities would be willing to participate in programs at prices that are likely to be
474 offered.

475

476

477 4.1 Policy Implications

478 Santa Cruz and San Pedro are providing a great service to Mexico and to the world by
479 conserving their forests. The forests are providing water, clean air, biodiversity and carbon
480 sequestration services because of the management and protection provided by the communities.
481 It is just and fair that the communities be compensated for these service provisions as well as
482 important so that the provisions continue to be provided. Understanding the value that the local
483 community puts on the forest and what they will be willing to accept to continue conserving is
484 important knowledge to have before creating a PES program for carbon services.

485 Several policy implications can be learned from this study. First, these results clearly
486 show that the two communities studied here would be more open to and suitable for programs
487 like REDD+ which pay for conservation rather than other carbon payment programs which
488 require the planting of trees. Many forest dwellers may benefit from programs like REDD+
489 which pay for existing forests because they may not have land to reforest aside from that they
490 use for subsistence agriculture. Also, programs like REDD+ do not provide perverse incentives
491 for communities to deforest for the purpose of earning money to replant the trees they have
492 already cut.

493 Second, though subjects who were told the price of carbon tended to be willing to accept
494 less than those who were not told, the WTA stated was still almost always higher than the market
495 price. At the time of the study the market price of carbon was very low, \$0.10 a ton, and when
496 the price of carbon is this low it is not worth it for communities and other forest dwellers to
497 change their land use plans for that amount. What this signifies is that the prices offered to land

498 owners to conserve or manage their forests may not be able to be based on the market price for
499 carbon. It is important to recognize that the forests provide many services other than carbon and
500 there is often a high opportunity cost associated with conservation. For this reason the market
501 price of carbon alone cannot determine the payments offered to forest owners but should be
502 bundled with payments for other services.

503 Lastly, my study sites have a previous experience with PES programs which they found
504 positive and beneficial. As a result of this good experience they are willing to participate in
505 REDD+ or a REDD+ type program if it is offered to them. One of the main barriers to
506 participation in PES, especially by the poor, is a lack of trust in the intermediary offering the
507 payments (Pagiola *et al.* 2005). Finding project areas that have previously or are currently
508 participating in PES programs will be an efficient way to ensure that programs are accepted and
509 successful.

510

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Table 1: Socio-economic and Demographic Characteristics of Survey Respondents

Community	No. of interviews	No. Male	No. Female	Mean age	Average income	Average number of residents in household
Santa Cruz	59 (67%)	47 (80%)	12 (20%)	54.52	26,979.24 (2119.34)	3.62
San Pedro	29 (33%)	19 (66%)	10 (33%)	43.73	33,085.86 (2599.05)	5.38
Total	88 (100%)	66 (75%)	22 (25%)	50.92	29,014.78 (2279.24)	4.21

Table 2: Variable names, descriptions and statistics

Variable	Description	Mean	Std. Dev
CARGO	Holding leadership position in the community (0=no, 1=yes)	0.53	0.50
RESIDENTS	Number of individuals living in the home	4.21	2.17
EDUCATION	highest level of (1=preschool, 2= primary 1-3 rd grade, 3=primary 4-6 th grade, 4=secondary school, 5= preparatory school, 6= university, 0= did not attend)	3.29	1.24
GENDER	1=male, 2=female	1.25	0.44
CARBMARK	investigator explained carbon market price (1=yes, 2=no)	1.58	0.50
EQUALDIST	respondent believes the payments are distributed equally (1=yes, 0=no)	0.85	0.36
USEFUND	Used fund from account (1=yes, 0=no)	0.44	0.50
CHILDOUT	Number of children living outside of the community	2.8	2.85
AGREEDIST	Respondent agrees with distribution agreed on by assembly (1=yes, 0=no)	0.82	0.39
ECONIMPROVE	Perceived economic improvement resulting from PES (1=yes, 0=no)	0.84	0.37
COMMUNITY	1= Santa Cruz, 2=San Pedro	1.33	0.47
CHILDREN	number of children under the age of 15 in house	1.25	1.69
ELDERLY	The number of elderly over the age of 59 in house	0.66	0.83
REMITTANCE	receives income from remittance (1=yes, 0=no)	0.38	0.49
TOTAL-PES	Total amount received from PES* in Mexican pesos (US dollars)	7126.44 (559.81)	6209.34 (487.77)
TOTAL-INCOME	The total household income in Mexican pesos (US dollars)	29014.78 (2279.24)	14450.46 (1135.15)
GOV	% income from government programs not including PES	0.44	0.21
PAYENOUGH	believes that 400 pesos/ha/yr from the PSAH is sufficient (1=yes, 0=no)	0.21	0.41
COFFEEHA	Total hectares of coffee owned by residents	2.28	1.41
WORTHRESTRICT	believes that PES is worth restrictions on land use change (1=yes, 0=no)	0.72	0.45
COFFEETOTAL	Total income from coffee the previous year in Mexican pesos (US dollars)	2108.36 (165.62)	3497.87 (274.77)
CROPTOTAL	Total income from non-coffee crops last year in Mexican pesos (US dollars)	796.48 (62.57)	2323.24 (182.50)
WTA-CONS	What the respondent feels is the least they will accept to be paid for a carbon PES program in the conservation area. Price is given per hectare per year.	1,180.87 (92.76)	1518.05 (119.25)
WTA-COFFEE	What the respondent feels is the least they can accept to be paid for a PES program that requires them to give up their coffee fields. Price is given per hectare per year.	3,714.13 (291.76)	2647.86 (208)

*In Santa Cruz, total income and PES payments do not include money taken from the account as this is

money that would have been counted in previous years. (Not clear, I suggest dropping this sentence or making it more informative).

Figure 1: Distribution of responses for WTA, conservation: (WTA-CONS)

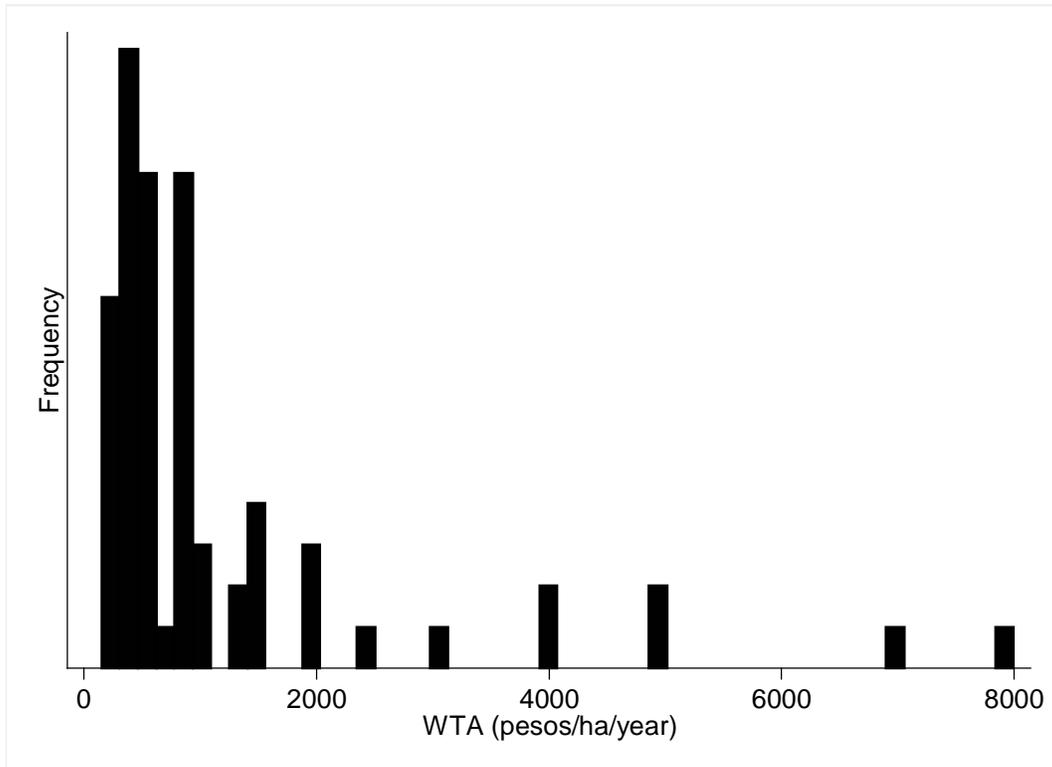


Table 3: Heckman Selection Models: WTA for carbon payments in conservation area
(Dependent variables: WTA-CONS, WANT-NEWPES)

Variable	Model 1		Model 2		Model 3	
	Z	p > z	Z	p > z	Z	p > z
GENDER	2.52	0.01	2.49	0.013	2.38	0.017
CARBMARK	3.92	< 0.00	3.61	< 0.001	3.09	0.002
EQUALDIST	-3.75	< 0.00	-4.62	< 0.001	-3.91	< 0.001
USEFUND	2.28	0.02	1.66	0.097	1.69	0.091
RESIDENTS	-	-	-0.72	0.470	-0.95	0.344
CHILDREN	-	-	0.52	0.604	0.96	0.338
ELDERLY	-	-	-0.35	0.727	-0.10	0.921
CARGO	-	-	-	-	1.00	0.319
_CONS	-0.24	0.81	0.42	0.675	0.05	0.957
WANT-NEWPES	12.49	< 0.00	8.08	< 0.001	7.21	< 0.001
CHILDOUT	-12.49	< 0.00	-5.69	< 0.001	-5.19	< 0.001
AGREEDIST	-2.2	0.03	-2.06	0.039	-6.05	< 0.001
ECONIMPROV	3.4	0.00	3.43	0.001	7.84	< 0.001
COMMUNITY	-7.9	< 0.00	-9.9	< 0.001	-5.44	< 0.001
_CONS	6.46	0.00	2.51	0.012	1.46	0.145
N=79	Log Likelihood = -586.14, prob. > chi2 = < 0.00		Log Likelihood = -585.88, prob. > chi2 = < 0.00		Log Likelihood = -585.36, prob. > chi2 = < 0.00	

Notes: The top variable influence the amount the subject was willing to accept for a second PES program in the conservation area and the bottom variables influence whether or not the subject was willing to participate in the proposed PES program.

Table 4: Heckman Selection Models: WTA for carbon payments in coffee plots
(Dependent variables: WTA_COFFEE, WTA_COFFEE_YESNO)

Variable	Model 1		Model 2		Model 3	
	Z	p > z	Z	p > z	Z	p > z
GENDER	646.09	< 0.001	2.93	0.003	3.01	0.003
REMITTANCE	-319.92	< 0.001	-1.79	0.074	-1.67	0.96
TOTAL_PES	-701.37	< 0.001	-2.06	0.039	-3.17	0.002
COMMUNITY	-3.92	< 0.001	-3.82	< 0.001	-3.73	< 0.001
TOTAL_INCOME	571.69	< 0.001	2.05	0.041	1.36	0.173
PER_INC_PES	621.26	< 0.001	-	-	2.40	0.016
PER_INC_GOV	-	-	2.72	0.006	-	-
RESIDENTS	-	-	-.35	0.726	-	-
OTHERINCOME	-	-	-	-	0.03	0.973
ADULTS	-	-	-	-	-0.16	0.873
_CONS	3.9	< 0.001	3.42	0.001	3.17	0.002
COMMUNITY	-4.99	< 0.001	-4.78	< 0.001	-4.88	< 0.001
CARGO	10.13	< 0.001	3.75	< 0.001	1.79	0.073
COFFEEHA	-10.13	< 0.001	-4.80	< 0.001	-2.45	0.014
PAYENOUGH	10.13	< 0.001	7.76	< 0.001	3.58	< 0.001
ECONIMPROVE	10.13	< 0.001	3.86	< 0.001	2.27	0.023
WORTHRESTRICT	10.13	< 0.001	1.39	0.765	1.35	0.178
CROPTOTAL	-	-	-0.75	0.450	-	-
_CONS	4.16	< 0.001	3.41	0.001	3.38	0.001
N=68	Log Likelihood = -441.47, prob > chi2 = < 0.00		Log Likelihood = -441.42, prob > chi2 = < 0.00		Log Likelihood = -441.46, prob > chi2 = < 0.00	

Notes: The top variable influence the amount the subject was willing to accept for a PES program on coffee land and the bottom variables influence whether or not the subject was willing to participate in the proposed PES program.

Figure 2: Distribution of Responses for Willingness To Accept for Carbon Payments in Coffee Plots (WTA-COFFEE)

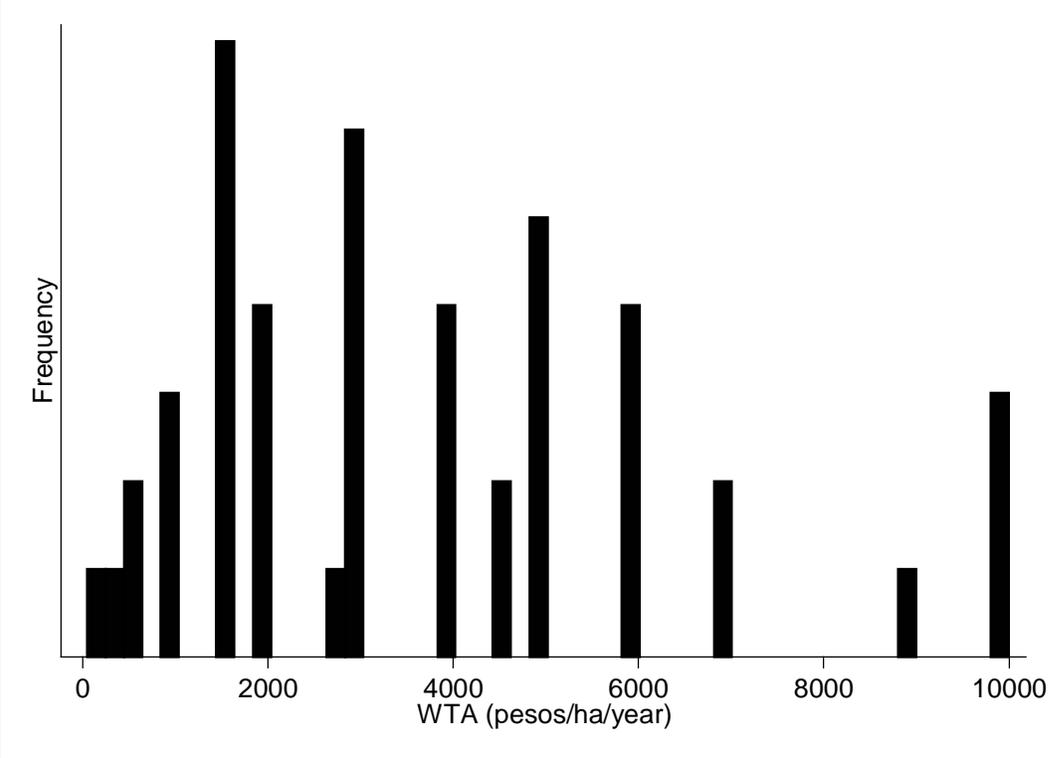


Table 5: Summary of WTA with predicted values and WTA by community

Variable	Obs	Mean	St. dev
WTA_CONS	69	1180.87 (92.76)	1518.05
CONS_M1	73	1395.85 (109.65)	936.21
CONS_M2	73	1397.11 (109.75)	946.85
CONS_M3	73	1383.81 (108.70)	945.768
WTA_CONS (Santa Cruz)	51	1174.12 (92.23)	1602.10
WTA_CONS (San Pedro)	18	1200 (94.27)	1291.60
WTA_COFFEE	46	3714.13 (291.76)	2647.86
COFFEE_M1	87	1708.24 (134.19)	2491.03
COFFEE_M2	87	1709.88 (134.32)	2481.66
COFFEE_M3	87	1685.65 (132.42)	2500.82
WTA_COFFEE (Santa Cruz)	43	3856.98 (302.98)	2680.99
WTA_COFFEE (San Pedro)	3	1666.67 (130.92)	288.68
OPPORTUNITY	87	986.68 (77.51)	1282.27
COFFEETOTAL	88	2108.37 (165.62)	24000.00