

ESCUELA SUPERIOR POLITÉCNICA DEL LITORAL

Facultad de Ciencias Sociales y Humanísticas



**“THE ECONOMIC VALUE OF ECOSYSTEM SERVICES PROVIDED
BY ALBARRADAS IN THE SANTA ELENA PENINSULA”**

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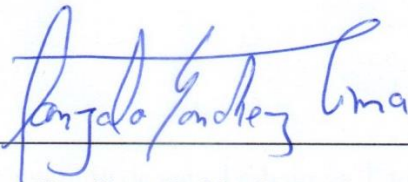
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DEDICATION

To my mother and my aunts

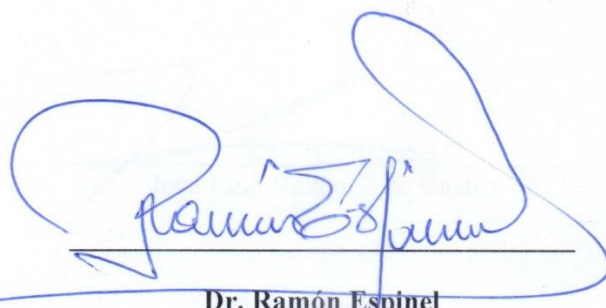
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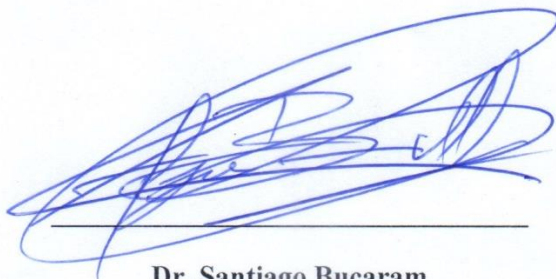
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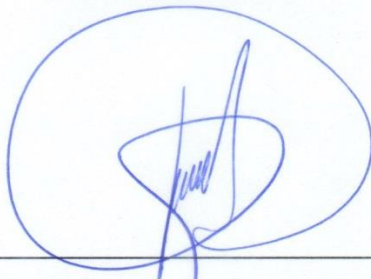
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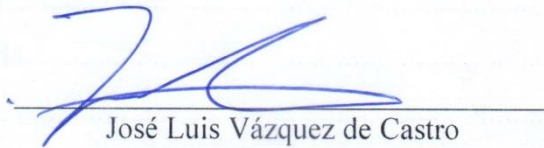
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ABSTRACT

The albarradas are manmade wetlands located throughout the coast of Ecuador that date back to around 2,000 B.C. While many of these ecosystems have remained and keep providing a wide range of provisioning, regulation and cultural services to their local communities, in recent years they have been facing threats of deterioration and even outright destruction, mainly due to their scarce perceived monetary value.

With the aim of including these ancestral constructions in current policy considerations, a local estimate of the economic value provided by the albarradas is obtained using a contingent valuation survey in order to elicit the willingness of the inhabitants of the communes to accept the disruption of their ecosystem. We develop a base model to include both use and non-use values and find that cultural values account for the majority of the total economic value generated by these ecosystems.

Keywords: ecosystem services, contingent valuation, willingness to accept, wetlands

RESUMEN

Las albarradas son humedales de construcción humana localizados a lo largo de las costas del Ecuador que datan del año 2,000 A.C. Si bien muchos de estos ecosistemas han permanecido hasta el día de hoy y continúan proporcionando una amplia gama de servicios de provisionamiento, regulación, y culturales a sus comunidades locales, en los últimos años han enfrentado amenazas de deterioro e incluso destrucción, principalmente debido a la escasa percepción de su valor monetario.

Con el objetivo de incluir estas construcciones ancestrales en consideraciones actuales de política, un estimado local del valor económico proporcionado por las albarradas es obtenido usando una encuesta de valoración contingente para conocer la disposición de los habitantes de las comunas a aceptar el deterioro de su ecosistema. En este estudio desarrollamos un modelo base que incluye tanto valores de uso como de no uso y encontramos que los valores culturales conforman la mayor parte del valor económico total generado por estos ecosistemas.

Palabras clave: servicios ecosistémicos, valoración contingente, disposición a aceptar, humedales.

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1 INTRODUCTION

Around the year 2,000 B.C., the indigenous populations living in the South American pacific coast began to construct catchment areas in strategic topographic locations in order to collect rainwater for human consumption. As these hollow areas started to fill up, they became host to a wide range of endemic species of flora and fauna, which provided local communities with additional benefits such as agricultural products, timber, pests control and microclimate regulation.

These manmade wetlands, presently known as albarradas, have persisted to this day in the Santa Elena peninsula located in the coastal region of Ecuador and remained the primary water source for their communities up until the last few decades, when local governments began the implementation of public water supply infrastructure.

At the present time, these albarradas are still providing numerous ecosystem services to their communities. Recent studies have identified several provisioning services related to the use of the albarradas as a secondary water source as well as cultural services to the local residents that use them as a recreation site and to anthropologists and archeologists who have found various ancient artifacts in their vicinity (Marcos, Alvarez, Valverde, Veintimilla, & Tobar, 2004).

In spite of this, the last decades have seen these ecosystems experience varying degrees of deterioration or even outright destruction, mainly due to agricultural expansion, improper alterations by local authorities or private land acquisitions (Zulaica & Alvarez, 2016). This state of affairs could arguably be attributed to the fact that the value of the services provided by these wetlands is not immediately apparent from an economic perspective.

Furthermore, this economic value could probably not be obtained with an acceptable level of precision through a purely theoretical approximation or a benefits transfer study, since the practice of extrapolating previous findings introduces a high degree of uncertainty, especially in ecosystems that are assumed to hold historical and cultural importance to their communities (Farber, Costanza, & Wilson, 2002).

Consequently, this research focuses on trying to estimate the monetary value, if any, of the ecosystem services provided by the albarradas located in the Santa Elena region. Specifically, we come up with a local estimation of the total economic value of these services by way of a contingent valuation survey conducted on rural communes that have one or more albarradas in their surrounding areas.

2 METHODOLOGY

There were several factors we needed to take into account when selecting the valuation techniques for this project. The first point to consider was the scope of the valuation. Namely, we elected to perform a local estimation of the economic value the albarradas are generating for their communes. While this approach leaves out of the estimation values that individuals from outside of these communities could obtain from the albarradas, such as archaeological or tourism values, it has two main advantages for the purposes of our research. From a theoretical standpoint, it lets us clearly delineate the target population for the study and provides a lower bound for the potential total value generated by the albarradas. From a normative standpoint, this exercise gives us monetary estimates that can be associated to a specific commune, which increases their relevance for policy considerations and contributes to the growing effort of linking valuation studies to development goals of the region (Balvanera et al, 2012).

For the second point, we decided to focus on the ecosystem services provided by the albarradas as our theoretical framework, as opposed to valuing the ecosystem functions themselves. While the inhabitants of the Santa Elena communes might not be fully aware of the biological mechanisms at work in the albarradas, they are presumably highly familiar with the ecosystem services they are obtaining as a result of said mechanisms. This familiarity is important for the validity of our estimations, since it ensures that individuals will give informed responses to our inquiries (Barkmann et al, 2008). Additionally, this approach allows us to avoid the potential issue of double-counting values that might be related to the same ecosystem function (de Groot, Wilson, & Boumans, 2002).

After establishing the theoretical framework, the next step consisted on selecting the specific valuation methodology. Given the historical connections between the albarradas and the people from this region, it was reasonable to expect that non-use values would constitute an important component of their total economic value. This helped us rule out cost-based methods, since they would only provide us with estimates of use values, and narrow our focus towards stated preference methods that could encompass both use and non-use values (Carson, 2000). Therefore, we selected a contingent valuation survey in order to capture the total economic value of the albarradas by presenting respondents with a hypothetical market scenario that would, in theory, elicit their complete preferences for these ecosystems.

The next point to consider was the form of elicitation for the contingent valuation questions. According to the national law of communes, the property rights of an albarrada are held by the commune as a whole. In light of this, we employed a willingness-to-accept scenario in which the respondents are asked for the minimum monetary compensation they would accept in order to forgo their rights to the ecosystem and/or allow for its disruption

Finally, the specific technique for the contingent valuation survey was selected with the aim of accommodating for the socioeconomic characteristics of the target populations and finding the right balance between straightforwardness of the questions and precision of the estimates. In order to accomplish this, we conducted in-person surveys with double-bounded dichotomous choice questions. This method consists of asking two yes/no questions to the respondents. In the first question, they are presented with a specific dollar amount and asked if they would be willing to accept it as a monetary compensation for the loss of the ecosystem. Depending on whether the respondent accepts or rejects this initial compensation, the second question lowers or raises the amount being offered, respectively. The advantages of choosing this technique are twofold. On one hand, it is much simpler to answer than an open-ended question as it simulates a real world market scenario, like a sell offer, and thus makes it more likely that the answer will reflect the respondent's true preferences. On the other hand, the two-question format has been shown to increase the precision of the estimations when compared to a single-question format (Hanemann, Loomis, & Kanninen, 1991).

2.1 Econometric model

Assuming utility maximization on the part of the respondent, their minimum willingness-to-accept amount can be modeled as follows:

$$WTA_i(z_i, u_i) = z_i^s \beta^s + z_i^a \beta^a + u_i \quad ; \quad u_i \sim N(0, \sigma^2)$$

Where z_i^s is a vector of socioeconomic variables with parameters β^s , z_i^a is a vector of uses and attitudes towards the albarrada with parameters β^a and u_i is an error term which is assumed to be independent from the explanatory variables and normally distributed.

As previously discussed, the WTA_i amount is not asked directly, but inferred through the use of the double-bounded dichotomous choice questions. Defining b_1 as the bid offered in the first question and b_2 as the bid offered in the second one, we can outline four possible response scenarios. If the respondent accepts both b_1 and b_2 , we can infer

that their minimum willingness-to-accept amount lies somewhere between \$0 and b_2 , that is, $0 \leq WTA \leq b_2$. Similarly, if the respondent accepts b_1 but rejects b_2 , it can be inferred that $b_2 < WTA \leq b_1$. On the third scenario, the respondent rejects b_1 but accepts b_2 , and so $b_1 < WTA \leq b_2$. Finally, when the respondent rejects both b_1 and b_2 , it is assumed that $b_2 < WTA < \infty$.

Then, in order to estimate the WTA_i amount, each of these four response scenarios can be assigned a probability function. For example, if we define x_i^1 and x_i^2 as the dichotomous variables that capture the answers to the first and second offers, then the probability of the third scenario, a “no” answer followed by a “yes” answer, can be expressed as:

$$Pr(x_i^1 = 1, x_i^2 = 0 | z_i) = Pr(n, y)$$

Finally, by using these probability functions along with our base econometric model, we can obtain the estimations for β and σ by maximizing the following likelihood function¹:

$$\begin{aligned} & \sum_{i=1}^N d_i^{ny} \ln \left[\phi \left(z_i' \frac{\beta}{\sigma} - \frac{b_1}{\sigma} \right) - \phi \left(z_i' \frac{\beta}{\sigma} - \frac{b_2}{\sigma} \right) \right] + \\ & d_i^{nn} \ln \left[\phi \left(z_i' \frac{\beta}{\sigma} - \frac{b_2}{\sigma} \right) \right] + \\ & d_i^{yn} \ln \left[\phi \left(z_i' \frac{\beta}{\sigma} - \frac{b_2}{\sigma} \right) - \phi \left(z_i' \frac{\beta}{\sigma} - \frac{b_1}{\sigma} \right) \right] + \\ & d_i^{yy} \ln \left[1 - \phi \left(z_i' \frac{\beta}{\sigma} - \frac{b_2}{\sigma} \right) \right] \end{aligned}$$

Where d_i is a set of dummy variables corresponding to each of the four possible responses given by any individual.

¹ For a detailed derivation of this result, see (Lopez-Feldman, 2012)

3 SURVEY DESIGN

3.1 Exploratory interviews

Before conducting the willingness-to-accept surveys, a series of exploratory interviews were carried out during the months of March through May of 2017. This preparatory phase proved to be instrumental for tailoring the language and structure of the final survey in accordance with the socioeconomic characteristics of the Santa Elena commoners. Specifically, these interviews allowed us to define two key components of the survey.

First, we assessed the principal uses of the albarradas in order to include them as possible determinants of the WTA response. Namely, we identified livestock farming, recreation and water extraction through nearby wells as the three most widespread uses for the albarradas. For each of these, we included questions regarding the monthly frequency of usage as well as the cost of its nearest substitute.

Second, we were able to formulate the hypothetical scenario for the WTA questions as well as the initial and subsequent bid offers. For the hypothetical scenario, we learned that there is a history of conflicts regarding illegal communal land acquisitions by private entities, which helped us rule out this type of scenario as it would be loaded with negative preconceptions and distort our results. Instead, we devised a scenario of a public road construction plan that would necessitate the drainage and closure of the albarrada. While this option is certainly not exempt from possible biases, it was the most realistic and easy to understand, which contributes to our main goal of making sure respondents search and report their true preferences. Regarding the bid amounts, we came up with an initial compensation of \$50 per month and follow-up compensations of \$25 or \$100 per month depending on whether the respondent accepts or rejects the first offer. The initial amount was arrived at by averaging out the reported replacement costs of the three main uses for the albarrada, while the follow-up amounts halve or double the first one.

3.2 Final survey

After completing the design and preparation phase, the final survey took place during the months of May through July of 2017 at the Santa Elena communes of Pechiche, El Real, Tugaduaja and Buenos Aires. All of these communes featured one or more albarradas that were still in active use at the time of this research. Using a technique of stratified random sampling by commune, we conducted a total of 303 completed surveys

which were divided into three main sections. In the first section we collected demographic and socioeconomic information on commune, gender, age, monthly household income and years of education of the respondent. The second section consisted on proxies for use and non-use values of the albarrada and included the frequency and replacement costs of the three previously identified uses as well as a five-point likert scale in which the respondents were asked to rate their perceived importance of the albarrada in terms of their cultural identity. Finally, on the third section we presented the hypothetical market scenario and asked the WTA questions.

4 RESULTS

4.1 Survey validation

Before proceeding with the econometric estimations, it is important to verify the validity of the WTA responses. For this purpose, the survey included a final open-ended question in which respondents gave their reasons for accepting or rejecting the compensation offered to them. After completing the survey process, these answers were grouped into nine categories for rejecting the offer and six categories for accepting it. Table 1 presents a summary of these responses along with the frequency they appear in our sample. For the rejection categories, this table also shows the type of value being reflected in the response (Pascual, Muradian, Brander, Gómez-Baggethum, Martín-López, & Verma, 2010).

Table 1
reasons given for accepting or rejecting the willingness-to-accept questions

	Type of response	Number	% of sample
(1) Rejects the compensation			
(1.1) The albarrada is useful for recreation/tourism/livestock/agriculture	use value	45	14.85%
(1.2) The albarrada is a patrimony/is ancestral	bequest value	17	5.61%
(1.3) The albarrada constitutes a water reservoir/is useful for emergencies	option value	5	1.65%
(1.4) Nature is a priority/is irreplaceable	existence value	5	1.65%
(1.5) The albarrada is more important/more valuable	non-specific	61	20.13%
(1.6) The compensation is too low	non-specific	50	16.50%
(1.7) The original offer is not being fulfilled	protest*	3	0.99%
(1.8) Does not believe the compensation will be paid	protest*	7	2.31%
(1.9) No response	protest*	1	0.33%
(2) Accepts the compensation			
(2.1) Compensation is sufficient/necessary		85	28.05%
(2.2) The construction of the road is preferable		11	3.63%
(2.3) The albarrada is dangerous		5	1.65%
(2.4) The albarrada is useless/unnecessary		6	1.98%
(2.5) Does not believe the project would happen	protest*	1	0.33%
(2.6) The compensation is enough to build a new albarrada	protest*	1	0.33%

* Protest responses are excluded from the estimations

Aside from the responses that state the compensation is low or the albarrada is important but fail to elaborate on the nature of its importance, use values constitute the most prominent reason for preferring the albarrada, making up 14.85% of our sample. By contrast, non-use values appear as the top priority for preserving the albarrada only 8.91%

of the time. However, it is important to note that this in no way implies that use values are more important for the respondents than non-use values, but merely that they are more salient and/or easier to elaborate on.

The remaining 5.67% of reasons for declining the compensation constitute what are commonly referred to as protest answers, since they represent a rejection of the hypothetical market scenario (González-Cabán & Loomis, 1996). On one of these categories, respondents rejected the compensation not because they valued the albarrada, but because they did not believe the local government would go through with the payments. Given that this reflects a mistrust of public institutions rather than a value judgment on the albarrada, these responses were excluded from the final sample. Although this screening procedure is usually limited to rejection responses, by including the follow-up question in all the surveys we were also able to identify a few of the reasons for accepting the compensation as protest answers. After this filtering process, the final sample used for the statistical analysis consisted of 290 valid surveys.

4.2 WTA determinants

After making the final adjustments to the sample, we obtained the maximum likelihood estimates for the determinants of the WTA questions using a custom STATA module for double-bounded dichotomous choice studies (Lopez-Feldman, 2010). Table 2 shows the values obtained from these estimations along with their standard errors, Z-values and confidence intervals at the 95% level.

Table 2*determinants of the minimum willingness to accept the loss of an albarrada*

	Coef.	Std. Err.	z	P> z	95% Conf. Interval	
Gender	-23.839	13.589	-1.75	0.079	-50.473	2.796
Age	-0.232	0.420	-0.55	0.580	-1.056	0.591
Income	0.114**	0.050	2.31	0.021	0.017	0.212
Education	0.859	2.350	0.37	0.715	-3.746	5.465
Importance	21.630***	5.701	3.79	0.000	10.457	32.804
Recreation	-0.049	0.065	-0.76	0.450	-0.176	0.078
Livestock	0.600	0.499	1.20	0.229	-0.377	1.578
Wells	-0.459	0.443	-1.04	0.300	-1.327	0.410
El Real	13.692	17.187	0.80	0.426	-19.994	47.377
Tugaduaja	91.411***	18.795	4.86	0.000	54.573	128.249
Buenos Aires	28.810	35.751	0.81	0.420	-41.261	98.881
Constant	-24.754	37.695	-0.66	0.511	-98.634	49.127

* Significance at the 10% level

** Significance at the 5% level

*** Significance at the 1% level

For this estimation, we included all of the demographic variables collected, the use and non-use value proxies, as well as dummy variables to account for possible differences between communes, with Pechiche being the default one. Starting with the demographic variables, it is clear that most of them appear to have no influence on the decision to accept or reject the compensation. For the education variable, this result is likely due to the relatively small variation of the responses. In our sample, the majority (55.86%) of respondents reported exactly six years of primary education, which had historically been the maximum schooling available in this region up until the last few years. Overall, the only influential variable from this group was monthly household income, which shows a significant and positive coefficient. This result agrees with economic theory --all things being equal, we would expect to see respondents with lower incomes be more inclined to accept the compensation— and it supports the validity of this study, since it suggests that respondents took the WTA questions seriously.

Moving onto the value proxies, none of the reported use values seem to factor into the WTA decision. One possible explanation for this is that all of these uses have relatively close substitutes. Namely, public water infrastructure is now widely available in the region and it could potentially replace the albarrada for the activities of livestock farming and

water extraction through wells, and there are several beaches near these communes that could be visited for recreational purposes. On the other hand, the reported cultural importance of the albarrada turned out to be significant at the 99% level, which seems to indicate that non-use values constitute an important component of the total economic value of these ecosystems.

Finally, only the inhabitants of Tugaduaja show statistically higher rates of rejection than the other three communes. This result was expected given that the “San Javier” albarrada located in Tugaduaja is by far the largest out of the four communes surveyed in this study and thus it is more valued by its commoners.

4.3 WTA estimation

After estimating the regression coefficients $\hat{\beta}$, the expected average willingness-to-accept amount is simply the linear combination of its explanatory variables, that is, $\bar{z}'\hat{\beta}$. Table 3 shows the result of this estimation with its corresponding Z-value and confidence intervals at the 95% level.

Table 3
minimum willingness to accept per household

	Coef.	Std. Err.	z	P> z	95% Conf. Interval	
WTA	87.659***	6.599	13.28	0.000	74.726	100.593

* Significance at the 10% level

** Significance at the 5% level

*** Significance at the 1% level

At an average of \$87.66 per month per household, the WTA estimate for the total economic value generated by the albarradas represents 32.15% of the mean household monthly income of our sample, which amounted to \$272.66. For comparison purposes, table 4 presents this result along with the use value estimate obtained by averaging the reported replacement costs. The second column also shows the estimated total values for the four communes calculated by extrapolating our results to all 1,825 households.

Table 4
economic value estimates

	value per household	total value (4 communes)
Use Value (replacement cost)	\$ 35.42	\$ 64,635.63
Total Economic Value (contingent valuation)	\$ 87.66	\$ 159,978.04

For our sample, the use value estimate obtained with the replacement cost method accounts for only 40.4% of the total economic value estimate obtained through contingent valuation. While these results are not directly comparable, they certainly support our initial hypothesis that cultural values represent a significant component of the total ecosystem services that these communes are receiving from their albarradas.

5 CONCLUSIONS

Even though they no longer constitute the primary water source, the albarradas of the Santa Elena peninsula continue to provide valuable ecosystem services to their communes, as evidenced by our monetary estimates and the reasons given by the respondents for wanting to preserve them.

Regarding the survey validation process, the inclusion of follow-up questions when respondents accepted the compensation proved useful for identifying additional protest answers. While this practice requires additional time investments in the analytical phase, its standardization could potentially improve the validity and reliability of results from contingent valuation surveys, and so further research regarding its benefit-cost ratio is recommended.

Finally, on the topic of valuation methods, our findings reinforce the notion that stated preference methods that aim to capture both use and non-use values should be the primary option to consider for any valuation study where the ecosystem is perceived to have cultural or historical values for its community.

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ANNEX A – Contingent valuation survey

Comuna: Pechiche

Parte I: Información de referencia

En los últimos años, algunas albarradas han sufrido deterioros por:

- Explotación de la flora y fauna de las albarradas
- Adquisición de terrenos por parte de empresas privadas
- Construcción de obras públicas en el terreno de albarradas

Hasta ahora, no se sabe qué impacto ha tenido la destrucción de estas albarradas. Por lo tanto, en este estudio estamos tratando de entender mejor cómo las personas utilizan las albarradas.

Parte II: Preguntas

a) Datos personales

A1) Edad

A2) Género

Femenino

Masculino

A3) Ingresos mensuales en el hogar

A4) Educación (en años)

b) Uso de albarrada

B1) Recreación

B1.1) ¿Cuántas veces al mes visita la albarrada por recreación?

B1.2) Si no existiera la albarrada, ¿Qué lugar visitaría para recreación?

B1.3) ¿Cuánto dinero gastaría por mes en esta alternativa?

B2) Ganadería

B2.1) ¿En su hogar utilizan la albarrada para actividades de ganadería?

B2.2) Si no existiera la albarrada, ¿A qué lugar llevaría el ganado?

B2.3) ¿Cuánto dinero gastaría por mes en esta alternativa?

B3) Pozos

B3.1) El agua que se filtra de la albarrada crea depósitos subterráneos que permiten extraer agua con pozos. ¿En su hogar utilizan el agua de algún pozo cercano a la albarrada?

B3.2) Si no pudiera obtener agua de un pozo ¿Qué alternativa usaría para obtener agua?

B3.3) ¿Cuánto dinero gastaría por mes en esta alternativa?

c) Percepción de valor

C1) ¿Qué tan importante es la existencia de la albarrada para su identidad cultural?

1. Irrelevante
2. Poco importante
3. Medianamente importante
4. Muy importante
5. Indispensable

C2) Suponga que el municipio de Santa Elena tiene planes para construir una calle que atraviese por el terreno donde se encuentra la albarrada, por lo que tendría que teparla para construir encima. Como este terreno es propiedad de la comuna, el municipio le ofrece a cada hogar un bono de \$50 al mes como compensación. ¿Usted estaría a favor o en contra de ese plan?

A favor

En contra

[Si vota a favor]

C2.1) Si el presupuesto del municipio cambia y solo puede ofrecer a cada hogar \$25 al mes a cambio del terreno ¿Seguiría estando a favor de esta medida o ahora estaría en contra?

A favor

En contra

[Si vota en contra]

C2.2) Si el presupuesto del municipio aumenta y ahora puede ofrecer a cada hogar \$100 al mes a cambio del terreno ¿Seguiría estando en contra de esta medida o ahora estaría a favor?

A favor

En contra

C3) ¿Por qué está *[a favor/en contra]* de esta medida?
