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Abstract

Climate change impacts pose a great challenge to agriculture in sub-Saharan Africa as droughts become more frequent and more severe. A major roadblock to implementing climate change adaptation measures is poor governance. Given their experience with governing organizations, farmers are highly suitable respondents to assess the appropriateness of different governing organizations to implement adaptation measures on the ground. We surveyed 300 farmers in Makueni County in Kenya applying the choice experiment method to assess their preferences in relation to different attributes of a sand storage dam project to enhance rainwater harvesting as an adaptation measure. Attributes include the organization governing the dam construction, dam wall height and volume of water harvested, the type of pump used to distribute water, number of tree rows planted to prevent silting, and labor time farmers are willing to contribute to dam construction. Responses were analyzed using the mixed logit model. Our key result shows that farmers prefer an NGO as the governing organization, followed closely by a farmer network and, with some distance, a government institution. For the whole of Makueni County, we find that benefit losses of $ 482,766 occur if farmer networks are the governing organizations instead of NGOs and $ 2,679,706 if government institutions govern the dam construction instead of NGOs. While the importance of governance structures for development is well-known, our study is novel as it quantifies the benefit losses that occur due to poor governance in the field of climate change adaptation. On a methodological level, our study contributes to improving the application of choice experiments in developing countries as it draws attention to the careful selection of the payment vehicle. In terms of policy recommendations, our results suggest that substantial benefit losses may occur if appropriate governing organizations are not selected when implementing much needed climate adaptation measures.

Keywords: Good governance, climate change adaptation measures, governing organizations, choice modeling, payment vehicle, willingness to pay

1. Introduction

Climate change poses a major threat to agriculture in sub-Saharan Africa. Over the past 50 years, climate change-induced drought frequency and intensity have increased (Detges, 2017), exacerbating water scarcity problems affecting both surface and groundwater resources (Mishra and Singh, 2011). Further, rising temperatures have disrupted crop productivity and affected water availability at the important stages of crop growth (Zamasiya *et al.,* 2017). The vegetation cover has increasingly died off, reducing species richness and plant cover across the region (Epule *et al.,* 2017). Consequently, it is estimated that about half of the 1.033 billion people in sub-Saharan Africa are facing food insecurity associated with global climate change (Epule *et al.,* 2017).

Climate change adaptation is one of the policy options supported by the United Nations Framework Convention on Climate Change (UNFCCC) to help developing countries reduce the negative impacts of climate change on the agricultural sector (Deressa *et al.,* 2009; UNFCC report, 2015). Climate change adaptation measures can be classified as either private or public (IPCC TAR, 2001; Milman and Warner, 2016). Private adaptation measures are those implemented by individual farmers or small groups of farmers to address adaptation needs that are specific to them (Milman and Warner, 2016). They include: small scale irrigation of crops when rain fails, crop and livestock diversification, use of soil and water conservation techniques and changes in planting dates, among others (Francisco *et al.,* 2009; Bryan *et al.,* 2010). Public adaptation measures are actions on a larger scale that are implemented by government institutions through public and private partnerships or otherwise coordinated action at the local level (Milman and Warner, 2016). Examples of public adaptation measures include: prevention of flood and flood damage on crop land through construction of drainage pumping sytems and canals, construction of water resorvoirs (dykes and dams) for irrigation, and the development of hazard maps on floods and drought impacts (UNFCC, 2006; NPAICC, 2015).

A key challenge when implementing public adaptation measures is the selection of the appropriate governing organization to coordinate efforts and administer the available adaptation funds, which may come from the government, international donors or farmer networks. In principle, it would be the task of local or regional governments to provide a governance structure for the implementation of adaptation measures. However, in developing countries in general and sub-Saharan Africa in particular, there is a substantial risk that funds channeled through the government may not reach those who need them due to leakages resulting from corruption and excessive administrative costs (Besley and Ghatak, 2017).

Two main alternatives to goverment organizations have been proposed (Besley and Ghatak, 2017). First, NGOs as self-governing nonprofit organizations whose aim is to improve the livelihoods of vulnerable people in rural areas. Their general objective is to empower local communities by initiating people-centered projects that require local communities to participate in the design and implementation processes (Morgan, 2016). Second, farmer networks composed of groups of farmers who come together to share ideas on how they themselves can provide and/or participate in the provision of public goods, often also with support from governments and NGOs. Farmer networks are common in sub-Saharan Africa and they undertake different farm activities ranging from crop production and marketing of produce to community development projects (Fischer and Qaim, 2014).

Several studies have analyzed corruption and governance in relation to the implementation of climate change related projects in developing countries. For example, Robinson (2017) used a qualitative approach to understand climate change adaptation mainstreaming in small island developing countries. He found that bad governance, corruption and the selfishness of prominent leaders who have a mandate to make adaptation decisions hinder mainstreaming of adaptation. In a survey of empirical cases Shackleton *et al.* (2015) found that corruption and elite capture at the local level is one of the main barriers to the implementation of adaptation measures in sub-Saharan Africa. Pueyo (2018) analyzed the constraints of renewable energy investment in sub-Saharan Africa using the Growth Diagnostics framework and identified poor governance as a key constraint to the growth of renewable energy, especially in Kenya. Furthermore, a qualitative study by Binswanger-Mkhize and McCalla (2010) indicates that corruption and poor governance lead to loss of resources intended for agricultural and rural development projects before they reach service providers (Binswanger-Mkhize and McCalla, 2010).

However, there is a lack of studies that quantitatively evaluate different governing organizations for adaptation measures. In principle, the economic valuation method of choice experiments (CE) is a suitable approach to evaluate different governing organizations from the perspective of those for whom adaptation measures are implemented. CE is a stated preference method used to elicit individual preferences and marginal values for environmental goods and services through the creation of hypothetical scenarios that are presented to respondents in the form of choice cards (Navrud and Pruckner, 1997). CE is based on Lancaster's model of consumer behavior, in which consumers derive utility from the attributes of a good and not the good itself (Lancaster, 1966). Accordingly, respondents are asked to compare and value the provision of a specific good, based on different characteristics of these attributes (Hensher, 1994; Rai, 2012). In this context, a climate change adaptation measure can be considered an environmental good and the organization that governs its provision one of its attributes. Choice experiments have been widely employed to evaluate environmental goods in developed countries (e.g. Kuhfuss *et al.,* 2016; Markova-Nenova and Wätzold, 2017; Vaissière *et al*. 2018). On a much smaller scale, but increasingly, they have also been applied in developing countries (Birol and Das, 2010; Ndunda and Mungatana, 2013; Osiolo, 2017). Their increasing use in developing countries is accompanied by a debate on the specific challenges that arise when choice experiments are employed in such countries (Do and Bennet, 2009; Birol and Das, 2010; Kahn *et al.,* 2017).

We employed the choice experiment method to survey 300 farmers to evaluate different hypothetical scenarios of sand storage dam construction as an adaptation measure in Makueni County in Kenya. Attributes of the dam include: dam wall height and volume of water harvested, type of pump used to distribute water, number of *Grevillea robusta* tree rows planted to prevent silting, amount of labor time in weeks farmers are willing to contribute to dam construction and – most important in the context of this paper – the governing organization that administers and organizes the implementation of the dam project. Our key finding is that farmers prefer NGOs slightly over farmer networks and substantially over local governments as the governing organization for the implementation of adaptation measures. This finding is important in two ways.

First, we provide highly policy-relevant information on how farmers evaluate the different governing organizations and quantitatively assess the benefit losses that arise if government institutions or, much less so, farmer networks instead of NGOs administer adaptation measures. This is reliable information on the performance of the three governing organizations as farmers have on-the-ground experience with all of them. The information is valuable for policy implementation as it demonstrates the importance of selecting appropriate governing organizations when implementing adaptation measures and the benefit losses if inappropriate organizations are selected.

Second, from a methodological point of view our results draw attention to a key aspect that needs to be considered when applying choice experiments in developing countries, namely the careful selection of the payment vehicle. Here the "payment vehicle" refers to the mechanism presented in the CE of how the project in question would be financed if it were implemented (Ivehammar, 2009). The choice of payment vehicle and the potential bias that may arise and its impact on the willingness to pay for a good has been discussed in the context of developed countries (e.g. Bergstrom *et al.,* 2004; Campos *et al.,* 2007; Ivehammar, 2009). However, we did not find any studies that address in similar depth the importance of the payment vehicle in developing countries. Instead studies typically select a specific payment vehicle. Examples include tax increases (Birol and Das, 2010; Ndunda and Mungatana, 2013), increases in product prices (Roessler *et al.,* 2008; Osiolo 2017), crop yield losses (Waldman *et al.,* 2017), and donations to a nature conservation fund (Randrianarison and Wätzold 2017). Our results suggest that the stated willingness to pay of respondents in developing countries would be substantially different – and most likely this difference would be much larger than in developed countries – depending on whether an environmental project is supposed to be financed through, say, a tax paid to the government or a contribution to a fund administered by an NGO.

2. Choice experiments

We use CE to measure the preferences of farmers and their willingness to pay for the construction of a dam with multiple attributes as a climate change adaptation measure. A specific focus is the evaluation of the organization that governs the dam construction.

2.1 Econometric analysis

In our case, farmers are supposed to choose their most preferred sand storage dam option among different alternatives presented to them in the choice cards. Based on the assumption that farmers choose by maximizing their utility, we apply the random utility model (RUM) to estimate the probability of choosing one dam alternative over another (Thurstone, 1927; McFadden, 1974). According to the RUM framework, the utility that an individual *i* obtains from choosing alternative *s* is U_{is} .The utility U_{is} can be split into two components: a deterministic component composed of a vector of dam characteristics K_{is} that influence respondents' decisions, and an error component ε_{is}. The maximum utility that each farmer obtains from each dam alternative can be expressed as function:

$$U_{is} = \beta' K_{is} + \varepsilon_{is} \tag{1}$$

where β represents a vector of coefficient estimates. The random error component ε_{is} represents unobservable effects on respondents' choices and is expected to follow the identically and independently distributed (IID) Gumbel distribution (Meyerhoff *et al.,* 2014). Using equation (1), the probability of individual *i* choosing alternative *s* over alternative *j* in a choice set is P_{is} and can be represented by a multinomial logit (MNL) model (Meyerhoff *et al.,* 2014) as follows.

$$P_{is} = \frac{e^{V_{si}}}{\sum_{j=1}^{J} \mathrm{e}^{V_{ji}}}, \tag{2}$$

where $V_{si} = \beta' K_{is}$ and *J* is the choice set. The β represents the mean marginal utility for each of the dam attributes including the governing organizations. However, MNL has a disadvantage in that it assumes the Independence of Irrelevant Alternatives (IIA) property, which means the preferences for dam attributes and governing organizations remain the same across farmers' choices (Ghosh *et al.,* 2013). In some case studies this assumption holds but in other studies preferences are different across individuals and attributes. The mixed logit (ML) model overcomes the limitations of the MNL model by allowing the random parameter estimates to vary across respondents, alternatives and choice scenarios (Bliemer and Rose, 2010; Grigolon *et al.,* 2014). The ML model allows heterogeneity within the observed and unobserved attributes of the data set through the variation of the parameter estimates (β). The main characteristic of the ML model is the capacity to allow random taste variation, unrestricted substitution patterns and the correlation of error terms (Meyerhoff *et al.,* 2014). The ML model uses continuous mixed distribution to estimate heterogeneity, only that the researcher decides on the types of distribution, whether normal, lognormal or triangular distribution (Behnood *et al.,* 2014). Using the ML model, the probability that an individual i selects a sand storage dam s in choice set J is expressed as follows (Meyerhoff *et al.,* 2014).

$$P(y_i{}^n|\beta_{i,}K_i) = \prod_{n=1}^{N} \frac{e^{(Vsin)}}{\sum_{j=1}^{J} e^{(V_{jin})}}. \quad (3)$$

where $y_i{}^n$ represent the series of choices over N choice scenarios presented to individual i. It is not possible to predict parameter estimates accurately and as such random variation is accommodated to ensure preferences vary across individuals in the estimation process. The choice probability is thus obtained as an integral of the product of logit probabilities over the distribution of β_i as follows.

$$P\left(y_i{}^n|\beta_{i,}K_i\right) = \int \prod_{n=1}^{N} \frac{e^{(Vsin)}}{\sum_{j=1}^{J} e^{(V_{jin})}} f(\beta) d\beta. \quad (4)$$

In this study we assumed normal distributions for all attributes but lognormal distribution for our cost attribute. The confidence intervals for the willingness to pay coefficient estimates were generated using the Delta method. We estimate the choice probabilities as expressed in equation 4 using the maximum simulated likelihood (MSL) at 1200 Halton draws. We estimated a model with three alternative specific constants (ASCs) variables for the first, second and the status quo alternatives. ASCs were included to improve model fitness and reduce systematic bias resulting from respondents' tendency to choose the first alternative (Hasselbach and Roosen, 2015, and for an application, Markova-Nenova and Wätzold, 2018).

2.2 Benefit losses analysis

We calculated the willingness to pay (WTP) for each of the dam attributes as the negative ratio of the marginal utility coefficient of each attribute and the marginal utility for the cost coefficient (Hensher *et al.,* 2015).

$$WTP_{attribute} = -\frac{\beta_{attribute}}{\beta_{cost\ attribute}} \quad (5)$$

The WTP per farmer per season for the baseline level attributes was calculated as the negative (-) of the sum of the coefficient estimates (β_s) of the non-baseline levels due to hybrid coding (Cooper *et al.,* 2012; Hensher *et al.,* 2015). For instance, to estimate the marginal WTP for government institutions, we take the sum of the negative of the coefficient estimates of NGOs and farmer networks. The differences in the WTP values between different governing organizations represent 'part-worth' values for the WTP estimates, as one moves from governance by NGOs to governance by farmer networks and government institutions. We interpret these part-worth values as the benefit losses of individual farmers. The regional benefit losses are calculated by multiplying the part-worth values with the total number of households in Makueni County.

3. Case study area and survey design

The data was collected among farmers in Makueni County, which is located in the arid and semi-arid regions of Eastern Kenya. Its area is approximately 8,034.7 km^2 with a population of 989,050, of which about 61% are poor[1] (DoALFS, 2016). The County is divided into four sub-counties: Kilome, Mbooni, Makueni and Kibwezi (Figure 1). The sub-counties receive rainfall ranging from 300 mm to 1200 mm per year (GoK, 2013). Rain-fed agriculture predominates in the study area. The area is divided into three livelihood zones defined by the prevalent agricultural production: 1) mixed dairy, food crop and coffee farming, 2) mixed food crop and dairy farming, and 3) marginalized food crop and livestock farming (DoALFS, 2016; Reliefweb, 2017). All three livelihood zones are highly vulnerable to the frequent severe droughts that have occurred in Kenya. These droughts have reduced the effectiveness of existing crop and water conservation measures leading to either low yields or crop failure and water scarcity (Mutimba *et al.,* 2010).

The farmers in Makueni County have a homogenous culture and organize themselves into groups known as *Mwethya* (farmer networks). These farmer networks are registered with the government as self-help groups. In the networks, farmers share ideas, expertise and labor resources with the aim of developing different agricultural and community projects. They work together with NGOs and government institutions to improve water supply, food production, income and health, as well as advocate for inter-community education, peace and justice (UDO, 2013; ADS, 2015).

[1] A poor person is one who has one dollar a day to meet their food and water needs (Loewenberg, 2014).

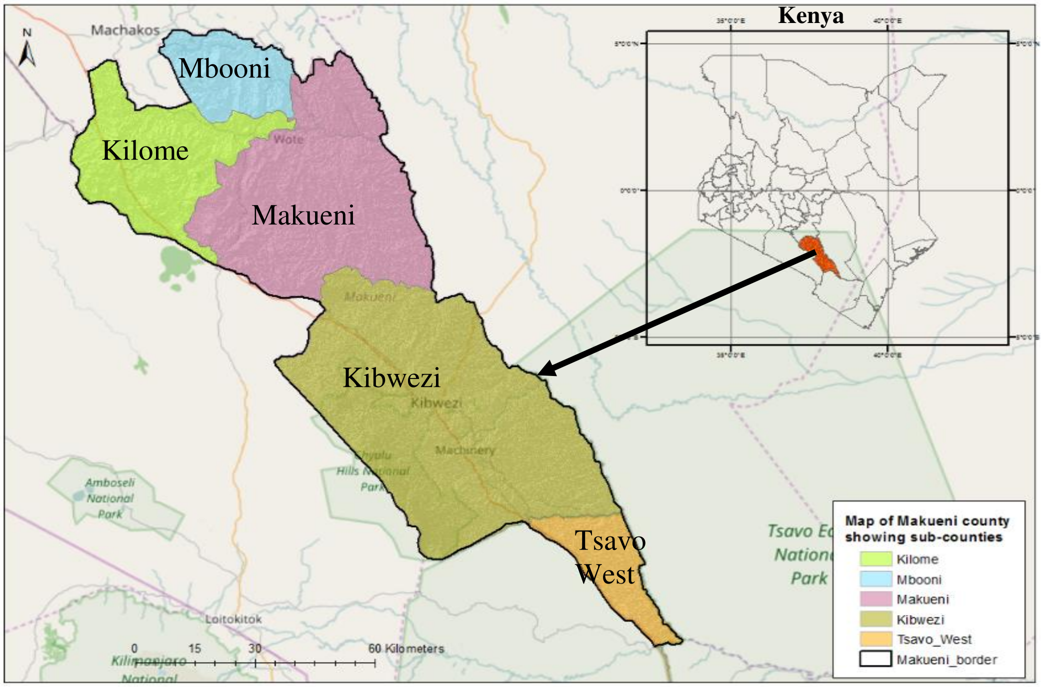

Figure 1: Map of Makueni County created by authors and overlaid on the world topographic map (Single fitting image)

3.1 Selection of attributes and attribute levels

Prior to the choice experiment, one of the authors conducted focus group discussions with farmers and semi-structured interviews with local NGOs, farmer networks and officials of government institutions. The purpose of these discussions was to understand the local situation, identify appropriate adaptation measures, farmers' possible contributions and potential governing organizations. Table 1 shows the choice of attributes and attribute levels for the adaptation measures and governing organizations selected. All the levels represent improvements on the current situation (status quo) at the point in time when the focus group discussions and semi-structured interviews took place.

Table 1: Attribute and attribute levels

Attribute	Levels
Different sand dam sizes and volume of water in US gallons	▪ 4 x 90m, 3 million US gallons of water ▪ 3 x 52m, 2 million US gallons of water ▪ 2 x 26m, 1 million US gallons of water
Installation of water pumps for water distribution	▪ Solar pump ▪ Diesel pump ▪ Hand pump
Afforestation on the steep areas of the sand dam	▪ 8km, 4 rows of *Grevillea* trees ▪ 4km, 2 rows of *Grevillea* trees ▪ 2km, 1 row of *Grevillea* trees
Governing organizations	▪ NGO ▪ Government ▪ Farmer networks
Labor time contribution in weeks	▪ 1, 2, 3, 5, 7, 8

The first attribute is related to the farmers' decision on the height of the dam wall to be constructed across the seasonal rivers and the estimated amount of water stored. The standard heights of sand storage dam walls are between 1 and 4 meters high (Onder and Yilmaz, 2005). An increasing height implies that more water and sand can be stored. The sand accumulated in the dam filters water and protects it from evaporation and pollution (Maddrell and Neal, 2012). The volumes of water stated were chosen according to *Utooni* Development Organization report (UDO, 2013).

The second attribute refers to the installation of surface water pumps for the distribution of the water that accumulates behind the dam wall. Different types of pumps are potentially available and they represent different attribute levels. The first level is a solar pump, the second level is a diesel pump and the third level, a hand pump involving manual extraction of water to the surface.

The third attribute is the farmers' decision on the afforestation of the steep areas of the dam site with *Grevillea robusta* tree species to prevent silting. *Grevillea robusta* tree species have been used by farmers in Makueni County for agroforestry purposes (Muthuri *et al.,* 2005). These tree species provide benefits in terms of climatic improvements, erosion control, shade provision, separation of farm boundaries and mulch provision (Muthuri *et al.,* 2005). The first attribute level is defined by 4 rows of *Grevillea robusta* trees species along a total of 8 km long terraces, which means that the highest volume of water and the least amount of silt accumulate in the dam. The second level is defined by 2 rows of *Grevillea robusta* trees along a total of 4 km long terrace, meaning there is moderate accumulation of water and less silt in the dam. The third level is defined by 1 row of *Grevillea robusta* trees along a total of 2 km long terrace implying an accumulation of a low amount of water and more silt in the dam.

To govern the construction of a dam with attributes 1-3, the farmers in Makueni County require an organization. Farmers' preferences for a specific governing organization are captured by the governing organization attribute. For this attribute, the first level represents non-governmental organizations (NGOs), the second, farmer networks and the third, government institutions.

The fifth attribute is the farmers' decision on the amount of labor time in weeks they are willing to contribute to dam construction. Labor time in weeks is chosen as the payment mode because during focus group discussions, farmers stated that they were familiar and comfortable with contributing labor time rather than paying cash for the dam construction. Labor time is required for providing stones, water and sand for the dam wall construction, for installing water pumps and planting trees along the steep areas of the dam site. Some of the officials interviewed were architects, particularly from the *Utooni* community development organization (UDO), who stated that it took 4-8 weeks to complete a dam wall installed with a pump and tree row(s) along the slopes. Based on this information, six labor time contribution levels were selected assuming that farmers are able to contribute 1-8 weeks, i.e: 1, 2, 3, 5, 7 and 8 weeks per dry season. Typically, dam construction takes place during the dry season in January, February to mid-March and June, July, August, and September to mid-October when most farmers are not too busy with farm work. The status quo represents zero (0) weeks meaning no labor time is contributed and thus no dam constructed.

3.2 Design of choice sets and survey administration

The construction of choice sets from the attributes of the dam follows a D-efficient design. The combination of attributes and attribute levels would be impossible if based on full factorial design with 3 x 3 x 3 x 3 x 6 = 486 hypothetical scenarios. This study uses the fractional factorial design, which focuses on the estimation of principal effects among other alternatives in the choice set (Hensher, 1994; Louviere *et al.,* 2000; Hoyos, 2010). To generate prior parameter estimates for the D-efficient designs, the preference ranks for the attribute levels identified were subjected to expert judgment and to the preference ranking method proposed by Bliemer and Collins (2016). The priors were used to optimize D-efficient designs for a multinomial logit model using Ngene software. The choice scenarios generated were pre-tested among 60 farmers in Makueni County. The responses collected from the pre-test process were used to generate prior parameter estimates for D-efficient designs for the final survey. The pre-test process also helped improve the questionnaire and choice scenarios. The final survey design was composed of a total of 12 choice cards in 3 blocks, with 4 choice cards per block among 300 farmers. An example of a choice card is shown in Figure 2.

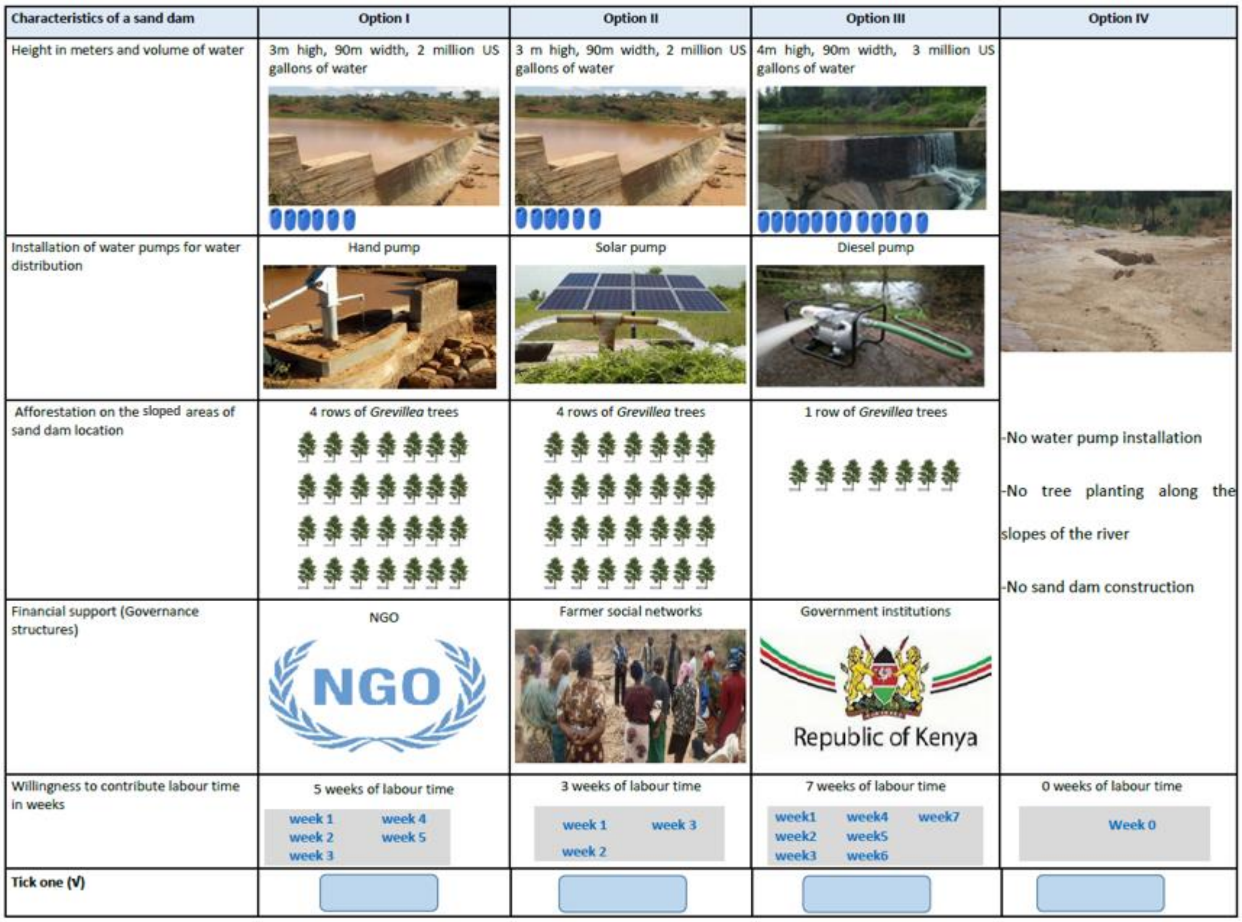

Figure 2. Example of a choice card presented to farmers (English translation)

(Single fitting image)

Each choice card had four options including a status quo option. The survey took place face to face and was administered by four enumerators who spoke the local dialect under the close supervision of one of the authors. A two-stage sampling procedure was employed to select the farmers. First, four divisions (Wote, Makueni, Kibwezi and Mtito Andei) were selected. Second, a simple random sampling of respondents in villages was done.

The choice scenarios were hybrid coded which means that there are two base levels: one effects and the other dummy coded. Hybrid coding was used to prevent a perfect confounding effect with the overall mean (Hensher *et al.,* 2015, pp.213-214). The status quo option (option IV) is dummy coded as zero (0) while the lowest level of each attribute is effects coded -1 (see Table A.1 in the appendix).

4. Results

4.1 Sample characteristics

Out of a total of 300 questionnaires issued to farmers in Makueni County, 283 were completed. However, 23 questionnaires were excluded from further analysis because they were considered protest responses. Excluding the protest responses helps to avoid any irregularities and underestimation of willingness to pay among respondents (Lo and Jim, 2015). The final sample size that was used for data analysis included 260 respondents. Table 2 shows the socioeconomic variables of the farmers interviewed.

Table 2: Sample statistics

Covariates	Count	% Sample
Gender		
Male	150	58
Female	110	42
Age in years		
18-39 years	138	53
≥40 years	122	47
Education level		
Formal education	158	61
No schooling	102	39
Farm income in $ per season		
≥ approx. 400	101	39
≤ approx. 400	159	61
Mean household size	260	6
Access to climate adaptation information		
Have access to climate information	103	40
Have no access to climate information	157	60
Membership to community-based organizations/groups		
Members to farmer groups	163	63
Non-members of farmer groups	97	37
Distance of homestead to the river in km		
Short to medium distance	210	81
Long distance (approx. ≥8Km)	50	19
Type of water source		
Surface water (river, dams, pond etc.)	93	36
Groundwater (hand-dug well etc.)	167	64
Mean TLU per household*	11	

* TLUs stands for tropical livestock unit and can be easily converted to livestock numbers using common units; cattle = 0.7, sheep = 0.1, goats = 0.1, pigs = 0.2, chickens = 0.01 (HarvestChoice, 2015)

Exchange rate (June 30th 2016) 1 USD=101.095 KES (www.xe.com, 2016)

4.2 Farmers' preferences for dam attributes

Table 3 represents the marginal utility coefficient estimates for the different dam attributes. The coefficient estimates were generated using the ML model. The McFadden Pseudo R^2 for the ML model was 0.30 indicating an acceptable model fit. The coefficients for the dam attributes are statisitically significant with a positive sign except for the wall of 3m high * 90m width with 2 million US gallons of water stored and 4 km 2 rows of *Grevillea robusta* trees planted. The cost attribute represented by labor time contributions in weeks in our estimations has a negative sign, which means that farmers have a negative utility if they contribute more labor time. This is not surprising as farmers face opportunity costs in terms of foregone earnings if they contribute time for the dam construction. The positive and significant alternative specific constants (ASCs) coefficients indicate heterogeinity of preferences where farmer-specific factors are assumed to influence the choice of dam options that farmers make. The standard deviations for all attributes are large and statistically significant, meaning that distinct clasess may exist within the sample analyzed.

Table 3: Marginal coefficient estimates for dam attributes

Attributes	Coefficients (Std. Errors)	Std. Devs (Std. Errors)
Dam height and water volume		
4 m* 90 m, 3 million US gallons of water	0.654***(0.166)	0.959*** (0.236)
3 m* 90 m, 2 million US gallons of water	0.161 (0.198)	0.849*** (0.264)
2 m * 90 m, 1 million US gallons of water[a]	-0.815	-1.808
Water distribution pumps		
Solar pump	1.213*** (0.166)	1.201*** (0.233)
Diesel pump	0.440*** (0.146)	0.884*** (0.193)
Hand pump[a]	-1.653	-2.085
Afforestation/tree planting		
8 km, 4 rows of *Grevillea* trees	0.606*** (0.164)	0.994*** (0.195)
4 km, 2 rows of *Grevillea* trees	0.046 (0.169)	0.924*** (0.233)
2 km, 1 row of *Grevillea* trees[a]	-0.652	-1.918
Governance structures		
Non-governmental organizations (NGOs)	0.521*** (0.175)	1.099*** (0.254)
Farmer networks	0.282** (0.139)	0.915*** (0.229)
Government institutions[a]	-0.803	-2.014
Cost-attribute		
Labor time contributions in weeks	-3.666*** (0.306)	3.666*** (0.306)
Alternative specific constants (ASCs)		
ASC1	4.425*** (0.404)	
ASC2	4.760*** (0.392)	
ASCsq	4.324*** (0.407)	
Number of observations	1040	
McFadden Pseudo R − squared	0.300	
Alkaike Information Criterion (AIC)	1.978	
Log-likelihood	-1007.623	
Restricted log likelihood	-1440.360	

Note: *** significant at 1%, ** significant at 5%, * significant at 10%
*Std. Errors - Standard errors, Std. Devs - Standard Deviations, ASCsq - Alternative Specific Constant status quo
[a]The estimates for the base levels are calculated as the negative sum of the other levels due to the effects/hybrid coding used (Cooper et al., 2012).

4.3 Farmers’ WTP for sand storage dam attributes

Based on the marginal utility coefficients (Table 3), we estimated farmers’ marginal willingness to pay for each dam attribute in terms of labor time contributions per season (Table 4). The standard errors were estimated at 95% confidence interval using the Wald procedure (Delta method). Table 4 reports the marginal willingnesss to pay estimates. The base scenario in our case is represented by the lowest level of each of the dam attributes. The differences in the WTP between level attributes is interpreted as the change of the incremental value resulting from the difference between levels (Table 5). The differences represent the ‘part-worth’ values in the WTP estimates and are calculated as differences between different attribute levels. For example, using government institutions as the baseline, farmers were willing to pay labor time equivalent to 0.361 (0.142 – (-0.219)) weeks per farmer per season when the governing organization supporting the dam construction was an NGO and not a government institution. Equally, farmers’ WTP was 0.296 (0.077 – (-0.219)) weeks per farmer per season if the governing organization to organize and support the dam construction is a farmer network and not a government institution.

Table 4: Marginal willingness to pay for dam attributes

Attributes	MWTP in weeks/farmer	Std. Error	95 % Confidence Interval	
Sand dam height and water volume				
4m * 90m, 3 million US gallons of water	0.178***	0.047	0.086	0.270
3m * 90m, 2million US gallons of water	0.044	0.054	-0.062	0.150
2m * 26m, 1 million US gallons of water[b]	-0.222			
Water distribution pumps				
Solar pump	0.331***	0.049	0.236	0.426
Diesel pump	0.120***	0.039	0.043	0.197
Hand pump[b]	-0.451			
Afforestation/tree planting				
8km, 4 rows of *Grevillea robusta* trees	0.165***	0.044	0.079	0.252
4km, 2 rows of *Grevillea robusta* trees	0.012	0.046	-0.078	0.103
2km, 1 row of *Grevillea robusta* trees[b]	-0.178			
Governance structures				
NGOs	0.142***	0.045	0.054	0.230
Farmer networks	0.077**	0.039	0.001	0.153
Government institutions[b]	-0.219			

Note: *** significant at 1%, ** significant at 5%, * significant at 10%

Std. Error – Standard Error, MWTP –Marginal willingness to pay

[b]The WTP values for the base levels equals the negative sum of the WTP for the other levels due to the effects/hybrid coding used (Cooper *et al.*, 2012).

4.3 Benefit losses due to inappropriate governing organizations

Table 5 reports the individual and total benefit losses in labor time and dollars that occur if dam construction is organized by farmer networks or government institutions and not by NGOs. We convert the benefit losses from labor time in weeks to dollars by multiplying with the average market wage rate that a worker receives after working for a week on a dam construction site. The average wage rate was obtained in Kenya shillings from farmer responses during the survey period and converted into dollars based on the market exchange rate (30th June, 2016) during the survey period in our estimation. In order to estimate the benefit losses at the regional level, we assume that dam construction projects are carried out throughout Makueni County and every household contributes labor time to these projects. The estimated benefit losses in Makueni County are $ 482,766 per season if farmer networks and a lot more, $ 2,679,706, if government institutions govern the dam construction instead of NGOs.

Table 5: Individual household and regional benefit losses

Attributes	Marginal willingness to pay	Individual benefit losses (for a corresponding change in governing organization)	Regional benefit losses
Governance structures		**in weeks per farmer per season**	
1. NGOs	0.142	-0.361 (from 1. to 3.)	-67,322
2. Farmer networks	0.077	-0.065 (from 1. to 2.)	-12,129
3. Government institutions	-0.219	-0.296 (from 2. to 3.)	-55,194
Governance structures		**in dollars ($) per farmer per season**	
1. NGOs	5.65	-14.37 (from 1. to 3.)	-2,679,706
2. Farmer networks	3.06	-2.59 (from 1. to 2.)	- 482,766
3. Government institutions	-8.71	-11.78 (from 2. to 3.)	-2,196,940
Total number of households in Makueni County		186,478	
Average market wage rate paid for sand dam construction per week		$39.80	
Exchange rate (June 30th 2016)		1 USD = 101.095 KES (www.xe.com, 2016)	
*The negative sign (-) indicates a benefit loss			

5. Discussion and conclusions

The objective of this paper was to assess farmers' preferences for good governance in implementing climate change adaptation measures in developing countries using the example of sand storage dam construction in Makueni County, Kenya. Applying a choice experiment, we surveyed 300 farmers and found that farmers prefer dam constructions to be governed by NGOs, closely followed by farmer networks. In contrast, farmers dislike government institutions governing dam construction. We take the willingness to contribute less labor time for the dam construction as an indicator of benefit losses that occur due to bad governance. Converting this labor time into monetary values and summing up individual values in the County as a whole, we are able to identify benefit losses due to bad governance in implementing climate change adaptation measures for the whole of Makueni County. We find that losses are $ 482,766 if farmer networks govern dam construction instead of NGOs, and $2,679,706 if government institutions implement the project instead of an NGO. Our findings are relevant in two respects.

(1) To our knowledge, this is the first study to quantify benefit losses due to poor governance in the area of climate change adaptation in developing countries. For a poor country such as Kenya, the identified amounts are substantial and suggest that careful selection of governing organization for climate change adaptation projects is highly relevant. This finding supports other more qualitative studies that identified poor governance as a main barrier to successful climate change adaptation in developing countries (Binswanger-Mkhize and McCalla, 2010; Robinson, 2017; Pueyo, 2018). The high willingness to contribute labor time if NGOs are the governing organization may be explained by comparatively low levels of corruption of NGOs and higher levels of trustworthiness. NGOs also have a reputation for addressing farmers' issues more directly (Islam and Nursey-Bray, 2017; Brass, 2012). Willingness to contribute labor time is still high if

farmer networks are the governing organization, which may be explained by a certain level of trust. This is in line with previous findings indicating the importance of farmer networks for local communities, for example in facilitating the access of inputs such as seeds, providing information, financial resources, and technologies and organizing social projects (Orsi *et al.,* 2017). In contrast, government institutions in Kenya tend to be marred by high levels of bureaucracy and corruption (Transparency International, 2017).

(2) Our study also contributes to the methodological discussion of the application of choice experiments in developing countries, namely the selection of the payment vehicle, i.e. the description in the choice experiment of how the project in question would be financed if it were implemented (Ivehammar, 2009). The selection of the payment vehicle and its impact on respondents' willingness to pay has received some attention in a developed country context (Bergstrom *et al.,* 2004; Campos *et al.,* 2007; Ivehammar, 2009) but not in a developing country context. Our study is relevant in this respect as the different governing organizations in our CE can also be interpreted as different potential payment vehicles that may be used in CE studies in developing countries. Our results suggest that the willingness to pay of respondents for environmental projects in developing countries substantially differs depending on whether the project is financed and organized through a governmental tax, a contribution to an NGO administered fund, or a contribution to a farmer network. The reason is obviously a different level of trust that the money will be appropriately used for the designated purpose. This result calls for a careful and clearly justified selection of a payment vehicle in CE studies in developing countries.

Two straightforward policy recommendations can de drawn from our results. First, the selection of appropriate governing organizations is essential for the successful implementation of climate change adaptation measures. In particular, channeling international support for climate adaptation measures such as from the Green Climate Fund through the government seems inadequate as it bears a high risk of efficiency losses resulting in highly needed climate adaptation measures being badly designed and implemented. Second, our research supports those who call for governmental reforms to improve governance structures and safeguard against corruption in the administration (e.g. World Bank, 2018). A badly functioning government is not only a barrier to climate change adaptation but in general to sustainable development that successfully addresses poverty and environmental degradation.

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Appendix

Table A.1: Sand storage dam attributes and attribute levels coding scheme

Variable	Description	Coding scheme
Attributes		
4 m high x 90m wide, with 3 million US gallons of water	The highest sand storage dam wall (DM1)	1, if yes, -1, if the wall height is 2m high x 90 wide, with 1 million US gallons of water, 0, otherwise
3m high x 90m wide, with 2 million US gallons of water	The moderate sand storage dam wall height (DM2)	1, if yes, -1, if the wall height is 2m high x 90 wide, with 1 million US gallons of water, 0, otherwise
Solar pump	Uses solar power to pump water (PMP1)	1, if yes, -1, if hand pump is installed, 0, otherwise
Diesel pump	Uses diesel to pump water (PMP2)	1, if yes, -1, if hand pump is installed, 0, otherwise
8km, 4 rows of *Grevillea trees*	4 rows of *Grevillea trees* to be planted along terraces (AFST1)	1, if yes, -1, if 1 row of *Grevillea trees* is planted, 0, otherwise
4km, 2 rows of *Grevillea trees*	2 rows of *Grevillea trees* to be planted along terraces (AFST2)	1, if yes, -1, if 1 row of *Grevillea trees* is planted, 0, otherwise
Non-governmental organization (NGOs)	Non-profit making organization	1, if yes, -1, if governance structure is government institutions, 0, otherwise
Farmer networks/groups	Organized groups composed of farmers	1, if yes, -1, if governance structure is government institutions, 0, otherwise
Labor time in weeks	Price per season in weeks (LAB)	0, 1, 2, 3, 5, 7 ,8