Individual choices and universal rights for drinking water in rural Africa

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More than 500 million rural Africans lack safe drinking water. The human right to water and United Nations Sustainable Development Goal SDG6.1 promote a policy shift from building water infrastructure to sustaining water services. However, the financial calculus is bleak with the costs of "safely managed"' or "basic" water services in rural Africa beyond current government budgets and donor funds. The funding shortfall is compounded by the disappointing results of earlier policy initiatives in Africa. This is partly because of a failure to understand which attributes of water services rural people value. We model more than 11,000 choice observations in rural Kenya by attributes of drinking water quality, price, reliability, and proximity. Aggregate analysis disguises alternative user priorities in three choice classes. The two larger choice classes tolerate lower service levels with higher payments. A higher water service level reflects the smallest choice class favored by women and the lower wealth group. For the lower wealth group, slower repair times are accepted in preference to a lower payment. Some people discount potable water and proximity, and most people choose faster repair times and lower payments. We argue policy progress needs to chart common ground between individual choices and universal rights. Guaranteeing repair times may provide a policy lever to unlock individual payments to complement public investment in water quality and waterpoint proximity to support progressive realization of a universal right.

choices | human rights | drinking water | Africa | Kenya

Rural Africa is home to more than 500 million people without safe drinking water (1). Since the 1980s, billions of dollars have been invested to improve and sustain better outcomes (2). However, progress has been uneven and ephemeral, resulting in high and avoidable health costs (3–6). In response, shifting policy trajectories over the last 50 y have promoted a basic needs approach, community management, a rights-based framework, and result-based contracts (7). Common across global policy and national practice is the growing recognition that sustainable delivery of drinking water services is a defining though elusive outcome (8–10). With projected annual costs for basic water services in Africa at around $1 billion per year (11), this raises the question of which attributes of drinking water services by levels of quality, price, proximity, or reliability matter most to rural water users. The answer has implications for the extent to which consumer choices and citizen rights may intersect to achieve and maintain universal drinking water services in rural Africa.

From the 1990s, the concept of a human right to water has grown in influence leading to a resolution passed by the United Nations General Assembly in 2010 (8). Though lacking legal force, the political resolution translated into constitutional commitments to the human right to water already established by South Africa in 1996 and followed by Kenya in 2010. However, measured outcomes have not matched policy aspirations. In 2019, over one in five Kenyans (24%) reported in a national census that their main drinking water source is surface water, including rivers and streams (12). Kenya is not alone in struggling to reconcile political ambition of basic service delivery with measured performance. A sample of 34 countries in Africa found

roughly half of 43,544 respondents between 2016 and 2018 reporting that governments were handling water and sanitation delivery "very badly" or "fairly badly" in both rural and urban contexts; fewer than 1 in 10 respondents thought that governments were doing "very well" (13).

African governments face multiple challenges, including the lowest relative coverage of drinking water access, increasing costs of maintaining existing waterpoints, and the need to provide new services over time. These challenges are magnified in rural areas where multiple levels of deprivation and a history of unsatisfactory service delivery compound affordability challenges for rural water users (3, 14, 15). For example, it is estimated that one in four waterpoints in rural Africa is not functioning at any one time, with average repair times taking a month, and often much longer (16, 17). Water quality is rarely tested or monitored and there are limited or no data for most countries (18, 19). Drought events increase pressure on rural waterpoints, with usage increasing in comparison to wetter periods (20–22). Women, children, and other vulnerable groups are known to carry the burden of rural waterpoint failure, reproducing intersectional inequalities in education, health, and welfare outcomes (1, 23, 24).

The cost implications of delivering safe drinking water to everyone by 2030 has revealed a multibillion-dollar gap between political ends and funding means (11). For example, for a "basic" water service from an improved water source with a return trip time of less than 30 min, the estimated global operational and maintenance cost is set to increase eightfold between 2015 and 2030 from $4.1 billion to $31.1 billion per year (ref. 11, p. 17). Safely managed drinking water, which is on-site, available on demand, and free of contamination is five times more costly than basic water at a projected

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Significance

Globally, four out of five people without safe drinking water live in rural areas. The human right to water identifies inalienable attributes of drinking water services in terms of affordability, proximity, quality, and reliability. It is unknown how specific attributes correspond to people's priorities to address the multibillion-dollar costs of maintaining services in rural Africa to 2030. Evidence from Kenya indicates that improving reliability by repairing waterpoint faults within 2 d is the dominant attribute in securing user payments. Attributes of water quality and proximity register less support and seem more suited to public funding. Charting common ground between universal rights and individual choices can inform public policy in the design of sustainable funding for rural water service delivery.

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cost of $5 billion per year in rural Africa. Given the growing funding gaps are compounded by health, climate, and economic shocks, understanding the choices of rural water users is beneficial to design policy goals which intersect with local realities and resources.

Choice experiments offer a method to model this type of trade-off matrix to estimate preferences (25, 26), subject to at least two conditions. First, an identification question reduces real-world complexity to a hypothetical modeled experiment with appropriate attributes and levels. Second, the experimental design has to be understandable and relevant to respondents. Coastal Kenya is chosen as the study context, with a remote, rural, and low-welfare population depending on hand pumps offering parallels to the wider challenges across rural Africa (27, 28).

The identification question rests on a simplification of the water service attributes and attribute levels. For example, water quality is simplified from multiple hazards from bacteriological and physicochemical parameters to the term "potable water." Following stakeholder engagement and piloting, it is a term familiar to the local population conveying a locally salient framing. Reliability and price are less ambiguous. Reliability is defined by repairing a broken waterpoint in 2, 4, 6, or 8 d. The household monthly payment is set in Kenyan Shillings (KES) at KES 50, KES 100, KES 150, or KES 200 per household per month; this corresponds to $0.50, $1.00, $1.50, and $2.00, respectively. Proximity is presented as the option to halve the distance from the household to the hand pump. For the modeling specification, we use Global Positioning System coordinates from each household to their main hand pump to calculate the distance in meters (Fig. 1).

To promote a more accessible experimental design, pictorial cards were used, which permitted greater inclusivity for respondents with low or no education attainment. Across the sample population of 1,185 households, participants had an average of 3 y of education, with half the respondents achieving primary level education and one in seven respondents completing secondary school (Table 1). Two-thirds of the respondents were women living in a household with an average of just under five people, high mobile phone ownership (83.4%), and low access to electricity (5.6%). Hand-pump reliability featured as the main water concern for respondents (35.5%). We find respondents

closer to hand pumps are less likely to vote for change and that women are more likely to pay more than men (Fig. 2). Two-thirds of the total choice cards selected rejected the status quo option. The respondent profile for rejecting the status quo is characterized by higher welfare and education and greater water concerns for seasonality and cost. We further examine the heterogeneity in preferences in the model specifications.

Results

Conditional Logit Model. Results of the conditional logit model (CLM) provide an aggregate assessment of preference behavior across the four choice attributes. Overall, we find evidence that participants value safe water at closer hand pumps with fast repair times and are willing to pay a share of the higher service costs (Table 2). Fixing hand pumps within 2 d appears as a threshold to guide reliability standards. Repairs of 4 d or more generate limited or negative utility. Payment tolerance is nonlinear with a preference for the lowest household monthly payment of $0.50 more than double the coefficient values for the higher payments ($1.0, $1.5, or $2.0). The higher payments are all positive, suggesting variation across the sample by wealth and gender, which we discuss in the following section. Providing water which is potable has a positive coefficient. Finally, bringing hand pumps closer to households is a positive preference, although the effect is small given the specification is measured in meters rather than a more imprecise categorical metric (say, "near").

To explore choices by wealth and gender, we model interactions by the lower 40% of the wealth distribution and by female respondents. We examine their preferences for repairs within 4 d and payments of $1.0 or less to understand the choices of the more vulnerable. The lower-wealth group gain utility from lower payments (0.278) but not faster repairs (−0.067), while women benefit from both faster repairs (0.654) and lower payments (0.444). We explore respondent preferences by their stated concerns with seasonality, reliability, safety, and cost also. In all four cases, lower payments increase utility for people identifying these concerns. In contrast, faster repairs matter to people concerned with reliability (0.303) and safety (0.741). Finally, we find that closer hand pumps increase utility for people concerned by water safety (0.005).
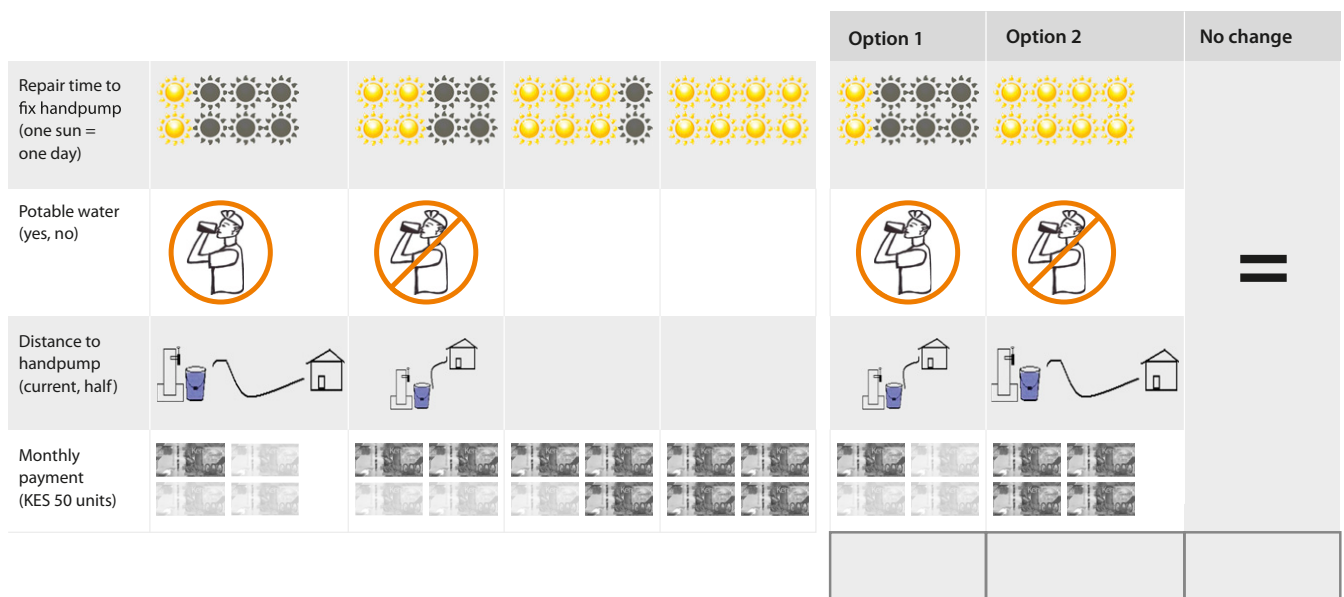

Fig. 1. Pictorial design of choice attribute levels (*Left*) and a test choice card (*Right*).

Table 1. Respondent profiles by choice card preferences for change and status quo options

Characteristic	Preference for change options	Preference for status quo option	Total
No. of choice cards	7,528	4,322	11,850
Percent	63.5	36.5***	100.0
Characteristics of the respondent*			
Female, %	63.4	36.6***	65.6
Highest level of completed education			
Primary school, %	63.5	36.5***	50.3
Secondary school, %	65.1	34.9***	14.3
Being in the bottom 20% of the wealth distribution, %	60.0	40.0***	20.2
Being in the top 20% of the wealth distribution, %	64.1	35.9***	19.7
Access to electricity, %	58.6	41.4***	5.6
Mobile phone ownership, %	64.2	35.8***	83.4
Water concerns*			
Seasonality, %	70.8	29.2***	12.9
Reliability, %	64.0	36.0***	35.5
Safety, %	62.5	37.5***	16.2
Cost, %	70.5	29.5***	11.1

Statistics are row-conditional frequencies summing to 100% (for a given characteristic). Statistical differences are tested using paired sample tests. This allows accounting for the presence of the same respondent in change and status quo options across cards. ***Indicates statistically significant differences between change and status quo groups at 1% level.
*Frequencies are computed over 11,850 cards.

Latent Class Model. To account for preference heterogeneity among participants, we specify a latent class model (LCM). We find that a three-class model increases model performance and explanatory power (log-likelihood, pseudo-R^2) compared to the aggregate assessment of the CLM. Each of the three choice classes has a probability of group membership inferred from multinomial logistic regression: Class 1 (LCM1, 26%), Class 2 (LCM2, 39%), and Class 3 (LCM3, 35%). This approach avoids potential bias in data disaggregation by self-chosen and arbitrary categories (age, education, gender, wealth, etc.) in preference to exploiting the unobserved structure and patterns of user choices (29, 30). The three classes provide a more nuanced understanding of individual choices with a rough approximation to water service ladders moving from unimproved water (Class 3) to basic water (Class 2) to safely managed water (Class 1).

Class 1 may be loosely characterized as the safely managed water group as all main attributes are larger than the other two classes and the CLM. Of note is the high utility for paying $0.50

(6.646) with low or negative utility for higher payment values and the large and positive coefficient for potable water (5.038). Hand-pump proximity is also one order of magnitude higher (0.013) than the CLM value (0.001). Finally, fixing repairs in 2 d is the only positive coefficient across the repair times, suggesting a clear rejection of slower repairs.

For the lower-wealth group, lower payments generate positive and higher utility than any other model specification, and the faster repair category is nonsignificant. In contrast, female respondents generate positive values for both of these categories, implying that women gain most from the Class 1 specification. Results for the interaction by concerns for seasonality, reliability, safety, and cost provide an overall positive picture too. All four interactions with payment level are positive with larger values for concerns by safety (4.572) and cost (3.260). This aligns with the wider results suggesting that this class has payment limitations reflecting affordability challenges. The interaction with faster repair times is highest with respondent concerns for reliability
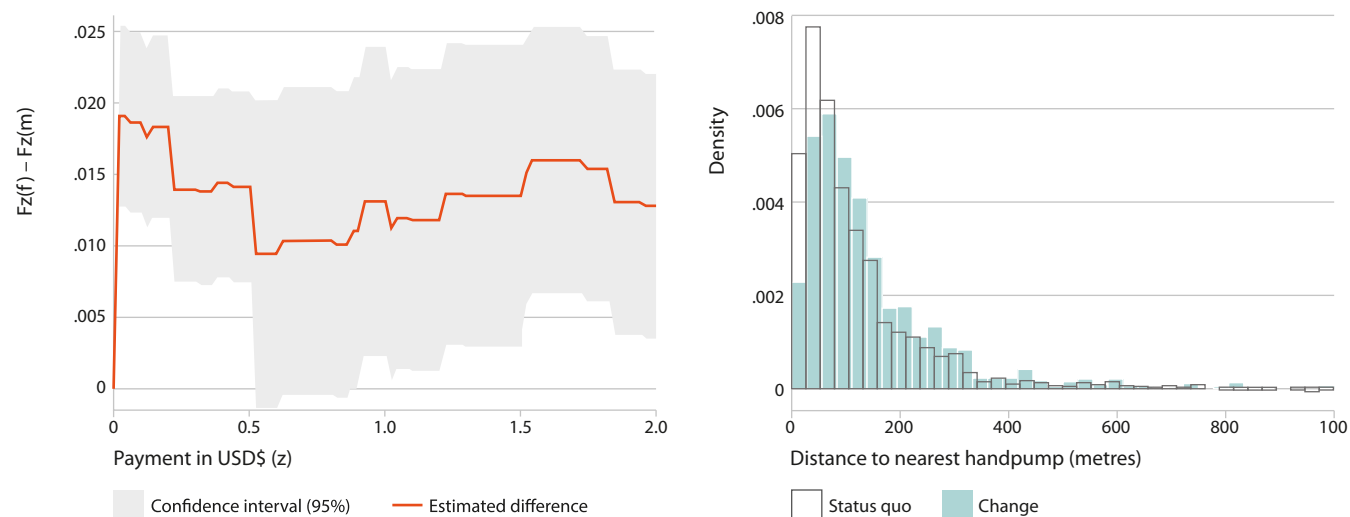
Fig. 2. Payment behavior by sex (*Left*) and distance to nearest hand pump by type of voter (*Right*). (*Left*) Plot of the difference between cumulative density curves of payment of females minus males. (*Right*) Plot of the density curve to the nearest hand pump by preference for change or the status quo.

Table 2. Conditional logit and latent class models

Dependent variables – choice attributes	CLM coefficient	LCM 1 coefficient, estimated class probability 26%	LCM2 coefficient, estimated class probability 39%	LCM3 coefficient, estimated class probability 35%
I. Preference for no. of days to repair				
2 d	1.175***	2.215***	1.465***	2.080***
4 d	−0.110	−3.265***	1.178***	0.345***
6 d	0.360***	−1.191***	0.833***	1.070***
8 d	−0.649***	−3.207***	0.704***	−0.198***
II. Preference for payment				
Pay $0.5	3.237***	6.646***	2.371***	4.796***
Pay $1.0	1.591***	0.733***	2.072***	2.815***
Pay $1.5	1.618***	0.957***	1.802***	2.894***
Pay $2.0	1.448***	−1.461***	2.307***	3.115***
III. Preference for type of water				
Potable water	1.721***	5.038***	2.898***	0.601***
IV. Distance to hand pump				
In meters	0.001***	0.013***	0.000	0.002***
Interactions				
Being in the bottom 40% of the wealth distribution with:				
Days to repair - less than 4 d	−0.067	0.208	−0.403***	−0.084
Payment - less than USD $1.0	0.278***	1.333***	0.435***	0.392***
Being a female with:				
Days to repair - less than 4 d	0.654***	2.523***	0.602***	0.681***
Payment - less than $1.0	0.444***	2.267***	0.732***	0.160**
Concern for seasonality with:				
Days to repair - less than 4 d	0.030	0.436	0.464***	0.022
Payment - less than $1.0	0.190***	1.419***	1.248***	−0.077
Concern for reliability with:				
Days to repair - less than 4 d	0.303***	1.885***	0.124	0.477***
Payment - less than $1.0	0.141***	2.072***	0.740***	−0.212***
Concern for safety with:				
Days to repair - less than 4 d	0.741***	0.738***	1.410***	1.697***
Payment - less than $1.0	0.592***	4.572***	2.627***	0.821***
Distance	0.005***	0.928***	0.005***	0.016***
Concern for cost with:				
Days to repair - less than 4 d	−0.217**	0.729**	−0.440***	−0.101
Payment - less than $1.0	0.445***	3.260***	0.076	−0.132
Distance	−0.002**	0.225**	−0.002	−0.031***
Model summary				
No. of observations, no. of parameters	11,740; 24		11,740; 74	
Log likelihood at convergence	−8,925.5		−12,897.7	
Pseudo R²	0.292 (adjusted)		0.407 (McFadden)	
Information criteria AIC	17,899		15,386	
Normalized AIC	1.525		1.311	

***, **, * denote statistical significance at 1, 5, and 10% levels, respectively. No asterisk(s) denotes nonsignificance.

(1.885) and a nonsignificant result for a concern with seasonality. Finally, we see large and positive values for the interaction between distance to the hand pump and concerns for safety (0.928) and cost (0.225). The interaction between distance and water safety is noteworthy in the size of the coefficient and associated importance for Class 1 compared to all other specifications.

Class 2 is characterized by a positive and large coefficient for potable water (2.898), indifference to increasing payments, and tolerance of slower repair times. The distance coefficient tends to zero and is nonsignificant. While repairs in 2 d are preferred (1.465), there is modest utility loss in increasing the repair time to 8 d (0.704). Equally, paying $0.50 per month (2.371) is almost equivalent to paying four times the sum (2.307). These suggest Class 2 may face lower affordability challenges compared to all other classes. The overall profile of slower repairs at potentially more distant hand pumps is broadly aligned to the classification of "basic water," an improved water supply within a 30-min-return collection time (1).

The interaction terms for Class 2 correspond to low or negative values for faster repair times. The lower wealth group has a negative coefficient for faster repairs (−0.403) along with the interaction term with a concern for cost (−0.440). In contrast,

female respondents and concerns with seasonality and safety have positive coefficients. Of note, Class 2 is the only example where seasonality and repair time interact positively. As with Class 1, women and the water safety concern positively interact to faster repairs. Distance has a low and positive interaction with the water safely concern (0.005) and is nonsignificant with the cost concern.

Class 3 is a group which tends to the lower water service ladder of "unimproved supply." This is illustrated by the lowest coefficient for potable water (0.601) across all specifications and a small but positive coefficient for distance (0.002). Repairs within 2 d provide positive and high utility (2.080), though there is tolerance for repairs in 6 d too (1.070). While lower payments are preferred, the highest positive coefficients for four or six repair days are recorded. Class 3 may be willing to pay though has lower service delivery expectations than Class 1.

The interaction terms for Class 3 suggest indifference to higher payments is not shared by the lower-wealth group who gain positive utility from payments of $1.0 or less (0.392). This is more muted for women (0.160). In contrast, women gain utility from repairs within 4 d (0.681), which is a negative and nonsignificant value for the lower-wealth group. Interactions with concerns indicate no seasonal relationship for Class 3. However, we see positive interactions between faster repairs and concerns with reliability (0.477) and safety (1.697). Lower payments once again interact positively with concerns for safety (0.821), though much lower than Classes 1 or 2. Finally, we see a similar and consistent positive interaction between distance and a concern for safety (0.016) falling between the Class 1 and Class 2 coefficients. However, distance negatively interacts with a concern for cost in juxtaposition to the result for Class 1.

In summary, choice hierarchies vary across the three classes with dominant attributes qualified by interactions with gender, welfare, and concerns. The nuanced choices reflect the complex nature of individual decision-making and offer behavioral clues to inform wider policy and practice.

Discussion

Progress to achieve and sustain universal delivery of safe drinking water in Africa will benefit from understanding of and responding to the choices of rural water users. Reconciling individual choices with a universal right may be guided by three findings from this study.

First, if policy and practice are to benefit the most in need, affordability of services demands payments guaranteed by water service levels. Vulnerable groups, such as women and lower-wealth individuals, prioritize a household monthly payment of $1 or less. Increasing waterpoint reliability by fixing failures within 2 d resonates across all choice classes. While there is evidence this level of service delivery may be achieved through professional service delivery models in some countries in Africa, this is the exception with the norm of often a month or more to repair waterpoints (16, 17).

Second, providing potable water has a large and positive response in two of the three choice classes. This preference corresponds to individuals with "water safety" concerns positively interacting with payments of $1.0 or less. Without rehearsing the known values of drinking water for health, development, and productivity (5, 6), we see a promising but partial synergy with public health goals. The delivery of safe and affordable water to rural areas is a major challenge for the United Nations Sustainable Development Goal SDG6.1 with few examples of models that work in practice today. These results suggest there is common ground and payment support to advance this goal if management and monitoring arrangements can be designed and executed effectively.

Third, while we purposively decompose water services by attributes, the interaction analysis shows people understand and

value the complementary nature of water services. For example, while the distance attribute gained variable uptake across the choice classes, for those individuals concerned by water safety or the cost of services the proximity to a waterpoint mattered significantly. Given the difficulty of ensuring good water quality from water source to the point of use, there is evidence that investing in closer or on-site services would be of value to users and influence their payment behaviors.

We conclude with implications for theory, policy, and practice. Our primary argument is that there is common ground as well as contested space between individual choices and a universal right to safe drinking water (31). The notion of "progressive realization" of the human right to water recognizes that a right alone is insufficient (32, 33)—changes in policy and practice are also required. Indeed, theory has often hindered policy progress with dogmatic separation between legal positivists' unflinching assertion of inviolable and universal rights and economic consequentialists' unconditional embrace of consumer choices, which can ignore structural inequalities for the most vulnerable in society. In the practical space between theoretical tussles lies the enduring challenge of delivering services in rural areas characterized by unpredictable political, economic, infrastructure, environmental, and social interactions.

Institutions matter in charting how individual choices and a universal right can be delivered in rural Africa. In rural Kenya, as in much of Africa, community-based management has dominated with unsatisfactory results. Respondent choices for this study are informed and shaped by decades of poor water service delivery (27). The government, donors, and private sector play limited and often unaccountable roles in managing, monitoring, and enforcing safe drinking water goals despite a constitutional commitment since 2010. Rethinking the roles and responsibilities between stakeholders is central to create value by delivering services professionally and sustainably (7) and can be informed by better understanding the preferences and circumstances of water service users.

To address Africa's funding gap to achieve and sustain safe drinking water services requires narrowing the space between individual and societal choices. Water user payments provide a lens to determine value and inform a shift in government thinking and funding, beyond building water supply infrastructure to regulating service delivery. The findings from Kenya suggest that rural water users have a nuanced understanding of the attribute space characterizing safe drinking water services. Their individual choices discern areas of value and preference hierarchies with an approximation to a universal human right to water and supportive of SDG6.1. Future work needs to design and test effective service delivery models which deliver high-quality services to unlock user payments within an independent regulatory framework for government and other actors to accountably implement at scale.

Materials and Methods

Experimental Design. Kwale County is located on the south coast of Kenya and as in many parts of rural Africa relies on community hand pumps. One in eight of Kwale County's 783,189 residents identify hand pumps (boreholes) as their "main water supply," a figure slightly higher than the national average of 1 in 10 people (12). During drier periods when surface water becomes less available, water for hand pumps has been measured to increase threefold (21), with seasonal demand reflected in pronounced payment peaks and troughs (34). Community management of waterpoints often leads to delays in repairs of a month or more, reflecting a common challenge across rural Africa (3). Water quality is affected by variation in salinity by geological profiles and borehole depth with an observed negative impact on payment behaviors over multiple decades (34). Bacteriological contamination of rural hand pumps is a health hazard, though reliable monitoring of *Escherichia coli* is problematic (35). However, it is unclear if, and how, bacteriological risk affects waterpoint choices and payment behaviors as opposed to more

direct taste or visual cues, for example when water is salty or discolored due to iron or other substances.

The experimental design followed an orthogonal design for the main attributes (30). The attribute levels for days to repair hand pumps are informed by a study in rural Kenya demonstrating the potential to reduce hand-pump repair times to 3 d (36). The payment levels reflect the range of volumetric and flat tariffs charged in rural Kenya. We did not include peak prices which can occur in extended dry periods and can exceed our upper limit ($2); interviews and pilot work supported this approach. Water quality is a subjective measure of being perceived "safe" to drink. Estimating distance by respondents is difficult and we simplify to halving the current distance as a heuristic. In line with the experimental design, the econometric specification considers number of days for repairs and payment as categorical variables (or nonfixed sensitivity covariates*).

Pilot surveys and stakeholder discussion finalized the design including careful testing of the pictorial figures. Enumerators provided a standardized protocol to explain and test the experiment. A test (dummy) card with two extreme choice outcomes allowed locally trained enumerators to ensure each participant had a good understanding of the method before starting the full set of 10 choice cards. A "no change" (status quo) choice was available for all 10 cards to avoid forcing respondents to vote for change. The distribution of choices across the 10 cards ranged from over 1 in 5 (22.2%) never selecting a status quo option to fewer than 1 in 10 (8.6%) always selecting the status quo option. The mode for a respondent choosing a status quo choice was 4 out of 10 cards (33.3%).

Based on an audit of 531 functional and nonfunctional hand pumps in Msambweni and Matuga subcounties (34), a stratified random sample of six households near each hand pump were sampled in October 2013 through to February 2014. A total of 3,500 households were surveyed, of which a random draw of 1,185 households participated in the choice experiment. A pilot survey was conducted with 19 enumerators recruited from communities across the study area who administered the survey in local languages (Swahili, 54%; Digo, 43%; Duruma, 2%; other, 1%). The main survey ensured informed consent with sections on demographic, welfare and assets, water supply, and the choice experiment. All respondents were adults (>18 y) and generally the "mother" or "father" in the household. Where a household was unavailable, one return trip would be made and, if no one was available, a random replacement near the household would be selected.

Before starting the survey, enumerators explained the primary focus was on the household's hand-pump use and management. While adult women were identified as the main water collector (83%), other household members contributed during different periods of the day, particularly after 4 PM (end of school day) when girls (10%) and boys (5%) would contribute along with male adults (6%), still a fraction of the women's burden (58%). Data were collected on tablets using doforms software (https://www.doforms.com/), uploaded to a server each evening for analysis to allow guidance to the enumerators on a daily basis. Ethical permission for the experiment was provided by the Central University Research Ethics Committee at the University of Oxford and a research permit from the Government of Kenya's National Council for Science and Technology.

Econometric Specification. The modeling strategy has two stages. First, a conditional logit model estimates the main attributes followed by interactions across three hypotheses of behavioral change: 1) multidimensional wealth, 2) sex of respondent, and 3) household concerns. Second, a latent class model specified by a discrete distribution of preferences to estimate heterogeneity following the assumption the variance in the error term is not constant but depends on individual observations (37–40).

The conditional logit model assumes that a person has preferences defined over a set of unordered alternatives and choses one while accounting for alternative specific (x) and individual specific (z) exogenous characteristics.

Alternative-specific variables x_{ij} vary among the alternatives (as well as among individuals), reflecting the attribute levels of each option. Individual-specific variables z_i vary only among individuals and provide information on the socioeconomic profile of each person. This leads to a random-utility model,

$$U_{ij} = \beta^T \mathbf{x}_{ij} + \Gamma^T \mathbf{w}_{ij} + \varepsilon_{ij}, \qquad \text{[1]}$$

where U_{ij} denotes the utility of the i-th person associated with option j; β and $\mathbf{x}_{ij}$ are vectors of alternative-specific regression coefficients and variables, respectively. The interaction effects between alternative-specific variables and individual-specific ones is represented by $\mathbf{w}_{ij}$ and by an associated vector of regression coefficients Γ. The disturbances ε_{ij} denote individual heterogeneity and are assumed to be independently and identically distributed with the same type I extreme value distribution

Under these assumptions the probability that a person i choses alternative j is

$$\pi_{ij} = Prob\left[y_{im} = j\right] \frac{\exp[\beta^T \mathbf{x}_{ij} + \Gamma^T \mathbf{w}_{ij}]}{\sum_{m=1}^{J} \exp[\beta^T \mathbf{x}_{im} + \Gamma^T \mathbf{w}_{im}]}, \qquad \text{[2]}$$

where y_{im} is the index of the choice made. The model defined by Eq. 2 is estimated through maximum likelihood and is subject to the limitation of the "independence from irrelevant alternatives," or IIA property resulting from the assumptions made on the disturbances.

To overcome the limitation imposed by the IIA property we specify an LCM. This model accounts for parameter heterogeneity across individuals through a discrete distribution or set of classes unknown to the researcher. Estimates consist of the class-specific parameters and for each individual a set of probabilities defined over the classes. Within the class, choice probabilities are assumed to be generated by a multinomial logit model. For a given person, the model's estimate of the probability of a specific choice is the expected value (over classes) of the class-specific probabilities (41).

We selected a three-class LCM model based on the corrected Akaike performance information index (AIC), likelihood-based tests, and domain usefulness (29). The corrected AIC index for a three-class model indicated a better fit to the data compared to a two- or four-class model. Similarly, when testing between a three-class model and an alternative two-class or four-class model the likelihood-based tests also supported the choice of a three-class model. We compared these statistics with those from a two- or four-class model where both AIC and likelihood-based tests indicated a better fit, supporting the choice of a three-class model. Domain usefulness of statistical significance and interpretability of the estimated parameters also supported the choice of a three-class model.

Data Availability. Anonymized survey and model code data have been deposited in the UK Data Service at https://reshare.ukdataservice.ac.uk/853912/.

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*Lack of systematic pattern in the preferences for payments suggests caution with the finding that there is nonlinearity in payment preferences, which would require estimation with fixed instead of nonfixed sensitivity to the payment options. Modifying the specification to fixed sensitivity, however, will violate the design of the experiment and lead to inconsistencies between methods of data collection and analysis.

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