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# Biases and Environmental Risks in Urban Africa: Household Solid Waste Decision-Making

**DISCUSSION**

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**Abstract**

We argue in this paper that the urban environmental planning and management literature has paid insufficient attention to the nexus of risk and human psychology in urban dynamics, particularly for the rapidly urbanizing areas of the Global South. We then draw on two household surveys in Dar es Salaam, Tanzania to present two empirical examples that incorporate these dimensions, using solid waste management as a contemporary urban environmental challenge. These examples illustrate the sensitivity of behavioral preferences to the framing of risks, and the influence of risk preferences on solid waste behavior. Incorporating such concepts into environmental planning and management research offers the potential to increase understanding of urban dynamics and to improve the environmental quality of life in urban Africa and elsewhere.

**Key Words:** risk, decision bias, decision heuristic, Africa, solid waste, psychology, decision making under uncertainty, behavioral economics, behavioral public policy, choice experiments, informal settlements, Dar es Salaam

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# **Biases and Environmental Risks in Urban Africa: Household Solid Waste Decision-Making**

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## **1. Introduction**

We have entered the second decade of a majority urban world, more focused and interested in how cities function and provide services to their residents than ever. In this paper, we focus on urban sub-Saharan Africa and a largely neglected field of urban environmental planning and management research in the Global South and elsewhere, namely behavioral responses to risk and uncertainty in urban environments. To the best of our knowledge, this represents the first effort to link environmental and infrastructure services in sub-Saharan Africa to psychological dimensions of urban decision-making. We draw on long-standing work on risk perceptions and heuristics to frame our work.

Our goals are two-fold. First, we aim to provide empirical evidence of how risk considerations can shape behavioral preferences in one particular urban environmental infrastructure realm, namely household solid waste. Second, we seek to encourage the urban environmental planning and management research community to take advantage of the large amount of work on the role of psychological dimensions of risk to interpret urban dynamics throughout the world, particularly in developing countries. We use the city of Dar es Salaam (Dar), Tanzania as a case study. More specifically, we draw on a 2017 survey of nearly 500 Dar households to discuss two examples of linking risk to the behavior and preferences of urban residents with respect to solid waste.

Why a study on risk and behavioral dimensions of the environment in urban sub-Saharan Africa? We offer three motivations.

First, from a well-known but sometimes-ignored numbers perspective, Africa urban areas will play an enormous role in world urban dynamics over the next several decades.

Projections indicate that every region's share of the world's urban population will decline between now and 2050 except for Africa's, whose share may nearly double to 21 percent by

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mid-century (United Nations 2015, 38). The environmental dimensions of Africa's urbanization will dominate world urbanization this century.

Second, from a practical perspective, a better understanding of behavioral aspects of Africa's urban dwellers may help to identify pragmatic strategies to improve their environmental quality of life. While more urban residents now access basic infrastructure services in Africa's cities than ever before, the proportion of urban households with these services has declined due to population growth outstripping service expansion (Foster and Briceño-Garmendia 2010, 129-130). The disparity in infrastructure sophistication between Africa and western European and North American countries likely will remain wide for the near future (World Bank 2017), but less complex infrastructure that incorporates behavioral elements of users may reduce environmental performance gaps (Shealy and Klotz 2017).

Third, from a scholarly vantage, the junction of risk perceptions, human psychology, and environmental decision-making among Africa's urban populations represents an untapped area of research. Researchers focused on environmental management of urban areas and other scholars have been aware of the limits of rational actor assumptions in decision-making for decades, yet urban research generally has not explored this formally in Europe or North America, let alone Africa or other parts of the developing world. Similarly, while most urban scholars may recognize nudging and other concepts in behavioral economics, and the influence of psychology on decision-making more generally (Hardman and Hardman 2009, Thaler and Sunstein 2008), this area so far has seen little discussion in the urban environmental planning and management literature. A study drawing on such ideas could usefully highlight the broader relevance of these concepts for both Global North and Global South urban populations.

We organize the remainder of this paper, first, to justify our focus on risk, psychology, and behavior, and, second, to demonstrate how risk and behavior shape the dynamics of urban environments in our study area and elsewhere. In section 2, we review several well-known concepts in risk and decision-making under uncertainty that we use to help structure our analysis. We follow this in section 3 with a brief overview of solid waste management in our Dar es Salaam case, using this discussion to prompt the particulars of our analysis. In section 4, we describe our methods. We discuss our results and findings in section 5 and offer summary comments in section 6.

## 2. Risk and decision-making

Herbert Simon's (1957) oft-cited depiction of decision-making as characterized by bounded rationality and satisficing rather than utility maximization accepts the cognitive and analytical limits of individual and public decision makers. Kahneman and Tversky (1979) have expanded this insight, most famously in their work on prospect theory. This frame departs from the standard utility maximizing model of rational choice by assuming that the psychological impacts of gains and losses differentially shape decision calculations of individuals. This makes people appear more risk averse in the domain of gains, and more risk tolerant in the domain of losses (Abdellaoui, Bleichrodt, and Paraschiv 2007, Kahneman and Tversky 1979). The concepts of endowment effect, reference dependence, and status quo bias (Kahneman, Knetsch, and Thaler 1991, Morewedge et al. 2009, Samuelson and Zeckhauser 1988, Thaler 1980, Tversky and Kahneman 1991) relate to this, wherein individuals become attached to what they own or have claim to and violate the rational expectation that they would readily give up their claim for a greater gain. More broadly, this work falls under research in biases and decision heuristics—automatic, rule-of-thumb decision shortcuts that individuals use to cope with uncertainty, such as basing the likelihood of an event happening on how easy it is to recall a similar event (Tversky and Kahneman 1974, 1983).

One practical implication of these insights is that framing uncertain situations in different ways may influence how individuals respond. Message framing, falling under the umbrella of “choice architecture” (Thaler, Sunstein, and Balz 2010), has received attention in urban environmental management in recent years, such as in examinations of its relevance in public interventions promoting densification, growth management, and infrastructure provision, as well as in other urban dimensions such as affordable housing (Doberstein, Hickey, and Li 2016, Goetz 2008, Shealy et al. 2016, Whittemore and BenDor 2018). In an analogous vein, prospect theory suggests that posing a situation in a loss frame may promote more risk taking behavior, while a gain frame may encourage more risk averting behavior.

Numerous studies from law, economics, political science, and other fields have examined and productively applied insights from this work and, more generally, the psychology of decision-making under risk and uncertainty (Asgary and Levy 2009, Viscusi 1990). The fields of

behavioral economics and behavioral public policy manifest this broadly (Shafir 2013). However, we argue that while certainly cognizant of Simon's seminal contributions, and the heuristics and biases research program, the field of urban environmental planning and management has not ventured far in applying these concepts. To support this assertion, we reviewed nearly 400 articles appearing in the *Journal of Environmental Planning and Management* (JEPM) and 11 urban studies and planning journals appearing over 12 years from 2007-2018.<sup>1</sup> While many of these papers do in fact examine risk and decision-making under uncertainty—most commonly risks associated with complex project finances, climate and weather changes, disasters, public health, access to water, transportation and housing, power transmission, and vulnerable populations (Adelekan 2010, Campos et al. 2015, Cartwright et al. 2013, Elliott, Wadley, and Han 2016, Hochrainer and Mechler 2011, Jabeen, Johnson, and Allen 2010, Nastiti et al. 2017, Pelling 2011, Rumbach 2017, Salet, Bertolini, and Giezen 2013, Solecki 2012, Ziervogel et al. 2017)—we found only 11 that focused directly on the influence of risk and heuristics on the psychology of behavior, with most of these examining non-environmental themes.

The majority of these 11 studies stress economic angles, consistent with that discipline's decades-long attention to risk perceptions and biases. For example, in a pair of studies on transportation, De Borger and coauthors (De Borger and Fosgerau 2008, De Borger and Glazer 2017) show how tradeoffs between money and travel time and support for congestion pricing depend on loss aversion and reference dependence preferences of individuals. In another transportation economics example, Schmidt (2013) finds that greater uncertainty in commuting costs associates with fewer household relocations, leading to greater residential immobility and higher opportunity costs from this immobility. In urban housing, both Deng, Gan, and Hernandez's (2015) study of the 2008 earthquake in Wenchuan, China and Wong's (2008) study of the 2003 Severe Acute Respiratory Syndrome (SARS) epidemic in Hong Kong, draw on an element of prospect theory that suggest individuals tend to overweight the impact and probability of rare events (in the absence of experience with these events) on short-run demand and pricing in the housing market. Also in the housing realm, Clark,

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<sup>1</sup> We used the SCImago Journal & Country Rank listing, developed from the Scopus database, to identify the 11 journals with the highest number of weighted citations ([www.scimagojr.com/aboutus.php](http://www.scimagojr.com/aboutus.php), accessed 3 January 2019). At the time of our review, they included *Cities, City, Environment and Urbanization, International Journal of Urban and Regional Research, Journal of the American Planning Association, Journal of Planning Education and Research, Journal of Urban Affairs, Journal of Urban Economics, Urban Affairs Review, Urban Geography*, and *Urban Studies*.

Almond, and Strauss (2011) examine the role of risk preferences in shaping the propensity of individuals in London to use housing investment as a retirement savings vehicle. They find a positive and significant relationship between the level of risk aversion and the likelihood of relying on their family home for retirement income.

This limited number (half-dozen) of risk and behavior papers with economic perspectives, the *most* represented discipline in our review, amplifies our claim that risk and behavior research remains limited in urban studies, particularly within the sub-realm of urban environmental planning and management. Within urban planning, Spencer's (2011) study of the influence of perceptions of environmental and health risks on water supply decisions in Vietnam specifically notes the persistence of the rational household actor assumption in planning practice, and a shortage of studies on how "expectations, perceptions, and inaccurate and insufficient information may also matter." Mohamed (2013) echoes this concern, pointing out that the literature on takings, a touchstone issue in US land use planning, continues to assume rational decision makers among planning stakeholders. In contrast, his work suggests that the presence of endowment effects plays a role in judicial review of regulations. He also suggests that regulations that emphasize losses rather than gains appear more likely to survive judicial review. In an earlier study, Mohamed (2006) provides one of the few counter examples to the rational actor assumption, employing behavioral insights to explain the risk aversion of developers of residential real estate projects. In that work, he calls for more research to understand better the psychology of decision-making among these important land use players to address their Simonian satisficing behavior. Two recent studies—Chiang (2018) on the influence of environmental degradation on risk perceptions and the role these perceptions play in climate change adaptation and Nastiti (2017) on the influence of risk perceptions on averting behavior related to health impacts from water supplies—represent the only other examples of environmental risk perception work we found in the 12 years of research reported in *JEPM* and the 11 urban studies and planning journals.

We recognize that research on the influence of risk perceptions and psychology on behavior relevant to urban environmental planning and management has appeared outside our 12-year period and in outlets other than the journals we reviewed. The latter include most obviously urban applications research in disciplinary journals in risk and economics (e.g., Arbel, Ben-Shahar, and Gabriel 2014, Greenberg et al. 2014, Prager et al. 2011), as well as in more targeted venues for topical applications in urban transportation, energy, housing, climate



change, hazards, public health, and water supply, among others (e.g., Asgary and Levy 2009, Chakraborty et al. 2017, Dunning 2017, Gaker, Zheng, and Walker 2010, Klotz et al. 2010, Mann and Wolfe 2016, Shealy and Klotz 2017, Viscusi and Zeckhauser 2006). However, we contend that this diaspora of risk and behavioral work over time and outside the high impact journals in urban environmental planning and management misses an opportunity to take advantage of behavioral insights for broader understanding of urban environmental systems and influencing their trajectory. In short, while the risk and behavior literature illustrates example urban applications, the urban environmental planning and management literature as a whole has not consistently adopted a risk and behavior perspective to inform its development.

The paucity of attention to behavioral aspects of risk and decision-making under uncertainty in urban environmental planning and management is particularly acute in Africa. To be sure, investigators have conducted a range of risk perception studies in the continent, particularly those related to HIV, drug safety, and other health concerns (e.g., Doodoo and Hugman 2012, Grant and Soler-Hampejsek 2014, Kohler, Behrman, and Watkins 2007, Tenkorang, Maticka-Tyndale, and Rajulton 2011, van Rie et al. 2013, Williams et al. 2010, Woodward et al. 2014). In addition, comparative studies have contrasted African and western risk perceptions on various issues (e.g., Martin 2004, Nordenstedt and Ivanisevic 2010, Nordfjærn, Rundmo, and Jørgensen 2011) and Doss (2008) has investigated the socioeconomic and demographic correlates of risk perceptions in east Africa. Nonetheless, no work on decision heuristics or the psychology of behavioral responses in risk contexts in Africa has appeared to our knowledge in urban planning or management contexts. This is particularly striking since long-standing cultural theory emphasizes the central role that social-constructs play in forming risk perceptions (Douglas and Wildavsky 1982)<sup>2</sup> and strong evidence indicates that the way people make decisions in African cultures differs from that of the West (Zoogah and Beugré 2012).

To augment our storyline on the missed opportunities to incorporate the psychological elements of risk and behavior in both African and other urban environmental planning and management contexts, we next develop an empirical example of a risk and behavior approach

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<sup>2</sup> See Coyle (1993) and Skuzinski (2018) for applications of cultural theory in urban and regional planning in the US.

to environmental service infrastructure in urban Tanzania. This example considers household solid waste collection in Dar es Salaam, a rapidly growing conglomeration expected to reach mega-city status by 2030 (United Nations 2015).

### **3. Solid waste in urban Tanzania**

Informal settlements in Dar es Salaam, Tanzania—the unplanned urban neighborhoods that currently house 70 percent of the city’s nearly 6 million residents—face large-scale solid waste problems. Although private and municipal trash collectors, community based organizations, and informal door-to-door waste collectors provide trash pickup throughout the city, less than 50 percent of the city’s household solid waste ends up in Dar’s official waste disposal site. This leaves over 2,000 tons of waste *per day* to illegal disposal. Of these 2,000+ tons, the vast majority ( $\frac{3}{4}$  by some estimates) end up scattered in open spaces and drainage channels courses around the city. In addition to contaminating land with organic pollutants, degrading neighborhood aesthetics, and contributing to flooding, this practice has enhanced breeding grounds for vectors responsible for dengue and malaria transmission and increased the risk of water-borne diseases such as cholera and typhoid (Adeyeba and Akinbo 2002, Castro et al. 2010).

In contrast to the paucity of attention to risk perceptions in the African context noted above, numerous studies have examined such household solid waste challenges in Dar and other African cities. None of these has framed their work formally in a risk and behavior context, but a number have relied on household-level surveys to collect residents’ experiences and attitudes about different aspects of the solid waste system that shape behavior (Awunyo-Vitor, Ishak, and Jasaw 2013, Batley 1996, Cheng and Urpelainen 2015, Kassim and Ali 2006, Oduro-Kwarteng et al. 2015, Owusu, Boaheng, and Sundberg 2011, Post, Broekema, and Obirih-Opareh 2003, Tadesse 2009). We use these to frame our risk and behavior focus.

As we describe below, our study relies on surveys in 2017 of household residents in Dar. The surveys examine both how uncertainty can influence behavior related to solid waste, and how risk dimensions can shape preferences for different approaches that aim to improve solid waste practices. These approaches reflect the privatization and payment elements discussed in the literature referenced above, as well as system characteristics related to collection cost, frequency, and reliability.

#### 4. Method and sample characteristics

Our empirical analysis of urban solid waste risk and behavior draws on results from two surveys in two areas in Dar es Salaam city that we conducted in 2017, one focused on risk perception in the Hananasif ward ( $n_h = 198$ ) and the other on the influence of risk aversion on solid waste payment preferences in the Makuburi ward ( $n_m = 300$ ). Roughly one-half of the questions remain consistent across the two versions, with the other half of questions in each version addressing its respective theme. We adopted this approach to capture a broader range of topics while accommodating respondent attention span and fatigue with a 20-minute survey length.

Our two study areas do not yield a representative (probability-based) sample of households across Dar as a whole, but rather allow us to examine high-density informal (unplanned) areas, low and middle-income residents, and areas with mixed ease-of-access for waste collection. This is because we seek to explore risk and behavior phenomena, not to draw population-level inferences across the entire city. Having noted this, our ward selection criteria do not place our respondents in the tails of the Dar population in a statistical sense, as we describe below, but rather represent a fair characterization of the environment for much of Dar's population.<sup>3</sup>

Within each ward, we first conducted interviews of local government leaders and households to inform development of the questionnaires. Prior to administering the final questionnaire in each ward, we pre-tested prototype versions to solicit feedback on the design. We then used a random sampling scheme to target respondent households, stratified by sub-ward (*mtaa*) in proportion to its share of the ward population as a whole. Enumerators, native speakers of Kiswahili, administered each questionnaire in Kiswahili, recording responses in hard copy and transferring these later to an electronic database.

The question remains whether our respondents could constitute outliers of Dar es Salaam households. Table 1 shows several household characteristics of our sample (the Makuburi

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<sup>3</sup> We also chose a small set of wards for pragmatic reasons, namely the need to secure both formal ward-level approval for our research and the inclusion of community residents on each enumeration team.

and Hananasif subsamples in columns 2-3) along with a subsample of the 2015-2016 Tanzania DHS, the country's latest Demographic and Health Survey (column 4).<sup>4</sup>The DHS constitutes a nationally representative, cluster-randomized sample of Tanzanian households and includes anonymized geo-coded identifiers to allow approximate location of respondents. The DHS subsample in Table 1 represents the subset of DHS households who reside in one of Dar's five constituent municipalities. The bottom part of the table comprises variables from our sample not found in the DHS subsample—seven variables for different aspects of solid waste and one variable representing risk. The top-part of the table, however, allows us to compare our subsamples with the DHS one on a number of socio-economic indicators. In general, our collective sample appears comparable to the DHS subsample on most socio-economic indicators, although our subsamples individually fall on either side of it. Our Makuburi subsample (column 2) has generally higher-status indicators, particularly on domestic help and on refrigerator and house ownership. In contrast, our Hananasif subsample (column 3) generally has lower indicators for socio-economic status than the DHS subsample, except on land ownership and domestic help.

We can document the similarity among the subsamples more systematically by borrowing an approach from the DHS program, which regularly employs principal component (PC) analysis of asset ownership and other household indicators (such as the variables in the top part of Table 1) to summarize a proxy wealth measure in a single index. This PC approach allows consistent investigations in different areas of the world of the relationships between household economic status and social and health indicators (Rutstein and Johnson 2004). With relatively small sample sizes and little-to-no variation in many potential wealth indicators in our small, geographically confined study area, we employ a simple PC model of the six variables appearing in the top part of Table 1.<sup>5</sup>The first principal component captures over 46 percent of the total variation in the six variables. Its associated PC scoring shows, relative to the overall sample constructed by combining our two subsamples with the DHS sample, a low mean wealth in Hananasif and a high mean wealth in Makuburi, consistent with the above discussion. We return to this wealth proxy in our analysis below.

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<sup>4</sup> The Tanzanian DHS is conducted on a regular basis as part of internationally-funded DHS Program, which supports countries around the world in collecting population, health, and nutrition data. See <https://dhsprogram.com/> for more information.

<sup>5</sup> Most of our variables are dichotomous rather than continuous, so we use a polychoric correlation matrix for our principal components analysis (the user-written *polychoricpca* routine in Stata). See Kolenikov and Angeles (2004) for more details.

**Table 1: Characteristics of Study and DHS Subsamples**

Variable (HH = households) (1)	Makuburi subsample (n = 300) (2)	Hananasif subsample (n = 198) (3)	DHS subsample (n = 589) (4)
share toilet, % HH	53	81	40
house owner, % HH	54	28	35
refrigerator in house, % HH	66	24	47
number sleeping rooms/household, average	2.5	2.2	2.4
own other land, % HH	18	41	16
domestic help, % HH	19	30	12
waste collection cost/month, \$USD average	3,496	2,072	
waste fee, government, % HH	4	88	
waste fee, private hauler, % HH	67	7	
waste fee, government & hauler, % HH	29	5	
# waste collection pickups/month, average	3.9	2.3	
# waste fee payments/month, average	--	1.0	
satisfied w/ waste collection, % respondents	60	46	
low willingness to take risk, % respondents	14	see text	

In the following section, we present two examples of risk analysis related to solid waste. In the first, we report results from a survey-based experiment we conducted with the respondents to examine the relevance of prospect theory in solid waste management in Dar. This relies on a split sample of our Hananasif respondents. In the second illustration, we use our Makuburi sample to examine preferences for different waste collection payment features and the association of these preferences with wealth and risk measures.

## 5. Results and findings

### *Example 1: Prospect theory*

The literature and our other studies in Dar suggest that risk perceptions vary systematically with individual demographic and socioeconomic characteristics, but predicting the likely behavior of individuals facing uncertain solid waste risks also requires evidence on aversion to risk. To examine this feature, we presented to roughly 40 of our respondents the following question about a possible flood in their sub-ward (*mtaa*) associated with solid waste practices:

Imagine that a flood threatens 500 houses in your *mtaa*. Your *mtaa* has two options to respond to the flood. Which of these two options do you prefer?

- a) *Your mtaa takes an action guaranteed to result in the flooding of exactly 375 houses.*
- b) *Your mtaa takes an action that has a 75% chance that 500 houses will be flooded, and a 25% chance that 0 houses will be flooded.*

The expected value of these two choices are equal (125 houses not flooded and 375 houses flooded), but option (a) is more risk averse since it guarantees 125 houses will be not be flooded, while option (b) is more risk tolerant since it could result in all 500 houses (or none) not being flooded. Our respondents show a roughly equal division of option (a) risk averse (51 percent) and option (b) risk tolerant (49 percent). These do not differ significantly from a 0.5 probability.

The more interesting result comes from comparing responses to different framing of this question. When we present the question in a “gain” frame of saving houses from flooding instead of the above “loss” frame of losing houses from flooding,

Imagine that a flood threatens 500 houses in your *mtaa*. Your *mtaa* has two options to respond to the flood. Which of these two options do you prefer?

- a) *Your mtaa takes an action guaranteed to save exactly 125 houses from being flooded.*

- b) *Your mtaa takes an action that has a 25 % chance of saving 500 houses from being flooded, and a 75% chance of saving 0 houses from being flooded.*

we see different results. Again, the expected value is 125 houses not flooded (375 houses flooded), but the results show an unequal division of option (a) risk averse (71 percent) and option (b) risk tolerant (29 percent) respondents. This represents a significant difference at the 0.01 level using a simple proportions test.

The gain frame appears to motivate risk aversion, in absolute terms and relative to the loss frame. The loss frame, in contrast, does not indicate a statistically distinguishable difference between aversion and tolerance, although it does associate with more risk tolerance relative to the gain frame. From this result, consistent with prospect theory, we cannot conclude that one frame outperforms the others in terms of encouraging better performance and outcomes. However, it clearly suggests potential opportunities to shape behavior through different framing. Stated differently, urban residents appear more likely to be willing to undertake risky actions to reduce threats related to solid waste when the outcomes of these actions appear framed as potential avoided losses rather than as potential gains.

*Example 2: Endowment effect and preferences for solid waste interventions*

The above example portrays a risk dimension related to solid waste practices in Dar, but does not address how risk aversion might interact with specific characteristics of these practices. The bottom part of Table 1 shows that they vary across neighborhoods. Unfortunately, residents face limited choices within each sub-ward, making it difficult to discern the role of risk and preferences in shaping decisions about actual practices by observing or even asking about actual behavior. We can pose hypothetical situations and ask about preferred practices, however. We thus include a series of choice experiments in our Makuburi survey ( $n = 300$ ).

“Choice experiments”—also known as factorial surveys and vignette studies (Atzmüller and Steiner 2010, Louviere 1996, Louviere, Hensher, and Swait 2000, Rossi and Nock 1982)—present hypothetical combinations of different levels of attributes. Our attributes represent solid waste collection cost, collection frequency, payment schedule, entity collecting payment, and reliability of payment collection. Table 2 shows each attribute. Each

experiment presents two options to survey respondents, both with the same five attributes but with the attributes set at different levels. Respondents then indicate their preferred option. From their choices, we can estimate the relative weighting of each attribute.<sup>6</sup>

**Table 2: Attributes and Levels in Choice Experiments**

Attribute/variable	Level 1	Level 2	Level 3
<b>chargecollect:</b> total charge per month of waste collection...	1,000 Tanz. Shillings	10,000 Tanz. Shillings	(in 500 Tanz. Shillings increments)
<b>payfreq:</b> # payments per month...	1	2	4
<b>collectfreq:</b> # times waste collected per month...	2	4	8
<b>entity:</b> entity collecting payments...	local government	private hauler	both hauler and local government
<b>reliable:</b> schedule payment collection guaranteed...	yes	no	

*each alternative contains one value for each of the five attributes*

We chose the particular attributes in Table 2 out of a list of potential candidates based on the literature on solid waste in Africa referenced above and on interviews of residents and waste collectors in our study wards. Four of the attributes center on aspects of waste collection payment, since residents identify the payment process as a concern. Both residents and waste haulers note the inconvenience of the fee collection process, which typically relies on unscheduled door-to-door visits by the waste hauler, local government representative, or both. Payment collection often occurs irregularly due to the difficulty of finding residents at home with the necessary money on hand to make payment (and thus a need for multiple visits) and disruptions to waste haulers schedules due to unanticipated breakdowns and/or flooding of collection routes. In addition, while the monthly charge appears affordable to most households, some residents suggest that a single, monthly payment requires households

<sup>6</sup> We present four separate binary choices (experiments) to each of our nearly 300 respondents, asking each respondent to make four choices. After accounting for missing responses and missing data on covariates, this yields a dataset of over 1,090 choices for our full model runs. A random utility model undergirds our approach, which assumes respondents will consistently select from the different options of attributes that we offer them, those options that maximize their utility (Greene 2012, Louviere, Hensher, and Swait 2000). We use a conditional logit model to estimate the probability of choosing each option and the attributes that influence this probability.



to accumulate and save a relatively large lump sum. Higher frequency payments could facilitate fee recovery by allowing households to amass smaller amounts.

The results from analyzing responses to our choice experiments appear in Table 3 as odds ratios. The base model in column 2 includes only the five attributes. However, four of these entail categorical levels, which we include in the model as effects-coded variables. This includes two numerical indicators, *collectfreq* and *payfreq*, that have limited ranges and that we cannot justify *a priori* as interval measures. We use a weighted coded-effects approach to include all categories of each categorical variable instead of omitting those categories that serve as their respective base cases. This atypical approach allows us to report coefficients and their significance for each level presented in the bottom four attributes of Table 2.<sup>7</sup>

**Table 3: Conditional Logit Regression of Choice Experiments Selections**

variable	BaseModel (n=1,030)	Full Model (n=1,030)
(1)	(2)	(3)
<i>chargecollect</i>	0.4271**	0.5507**
<i>wealth*chargecollect</i>		1.1299**
<i>chargemore-yes</i>		0.2854**
<i>chargemore-no</i>		1.3505**
<i>payfreq-1</i>	0.9219	0.8666*
<i>payfreq-2</i>	0.8695	0.9155
<i>payfreq-4</i>	1.3868**	1.5307**
<i>collectfreq-2</i>	0.0565**	0.0600**
<i>lorisk*collectfreq-2</i>		0.4113
<i>hirisk*collectfreq-2</i>		1.1510
<i>collectfreq-4</i>	3.3591**	3.3904**
<i>lorisk*collectfreq-4</i>		1.5474*
<i>hirisk*collectfreq-4</i>		0.9332*
<i>collectfreq-8</i>	1.0114	0.9229
<i>lorisk*collectfreq-8</i>		0.8519
<i>hirisk*collectfreq-8</i>		1.0257
<i>entity-govt</i>	1.3878**	1.6002**
<i>entity-private</i>	0.9704	0.9624
<i>entity-both</i>	0.8845	0.8369**
reliable-yes	1.0205	0.9207
reliable-no	0.9607	1.0427
McFadden's R <sup>2</sup>	0.45	.48

\*\*significant at 0.01 level, \*significant at 0.05 level

<sup>7</sup> See te Grotenhuis (2017), Johnson and coauthors (2007), Viney, Lanscar, and Louviere (2002), and Louviere, Hensher and Swait (2000) for more discussion.

Of our five attributes listed in Table 2, elements of all but one (*reliable*) appear significant at the 0.01 level in our base model in Table 3. We can see in column 2 that respondents are more likely to choose options that have a payment frequency of 4 times/month (*payfreq-4*), a collection frequency of 4 times/month (*collectfreq-4*), and/or local government collection of fees (*entity-govt*), and less likely to choose options that have a collection frequency of 2 times/month (*collectfreq-2*) and/or higher charges (*chargecollect*). This result is consistent with the argument that residents prefer smaller, more frequent payments to larger, less frequent ones, even with the same overall monthly charge.

Column 3 displays the results of our Full Model that includes several interactions with our attributes (choice experiments require us interact fixed features such as respondent characteristics with the varying attribute levels to examine the influence of the fixed features). The highly-significant odds-ratio for the *wealth\*chargecollect* variable in column 3, for example, indicates that higher wealth households—as measured by the principal components approach described earlier—are more likely to choose options with higher monthly charges than are lower wealth households (although the magnitude of the difference is very small). In addition, with the additional interactions, *payfreq-1* now becomes significant at the 0.05 level, and represents a lower probability of choosing a larger, single-time lump sum payment compared to a smaller, more frequent one (*payfreq-4*). Similarly, the interactions in column 3 lead to the *entity-both* variable becoming significant, indicating a lower probability of choosing an option that includes both the local government and private waste hauler as fee collectors.

The *chargemore* variable represents whether the waste collection charge offered to the respondent exceeds the respondent's current monthly charge. Its odd ratio appears significant at the 0.01 level, and lies far below 1.0, indicating a strong preference for options that do not increase the current collection charge. This captures a status quo effect, since the actual charge itself appears as a separate variable.

We also see that risk aversion influences preferences for the frequency of waste collection, again leading to a status quo bias. This binary measure, *lorisk*, represents respondents who self-identify as both being generally unwilling to take risks in life and preferring lower

payouts with high probabilities in games of chance.<sup>8</sup> Its complement, *hirisk*, represents all other respondents (the prefixes “hi” and “lo” are relative to each other). The *lorisk\*collectfreq-4* odds-ratio and *hirisk\*collectfreq-4* odds-ratio show statistical significance, as does the **collectfreq-4** attribute itself. The magnitudes of the *lorisk* (>1.0) and *hirisk* (<1.0) interactions suggests that those with lower risk tolerance are more likely to choose the *collectfreq-4* schedule than are those with higher risk tolerances. This also may indicate the presence of a status quo bias, since most respondents in Makuburi currently experience four collections/month (Table 1). We would expect lower risk respondents to be more likely to embrace maintenance of this schedule.

## 6. Conclusions

Our empirical work does not represent rocket science. However, two important, inter-related takeaways emerge from it.

First, framing matters. When we present to urban residents a situation asking them to choose one of two possible actions in response to a hypothetical flood, their responses depend on how we present the question. The two actions themselves have identical expected outcomes, but one provides a certain outcome (a risk averse sure bet) and the other an uncertain outcome that might turn out better than the certain bet and might turn out worse (a more risky gamble). Neither action is inherently better on rational grounds. In fact, our residents divide evenly between the sure bet and risky gamble when we present the hypothetical situation as one of losing houses to flooding. Yet, most residents choose the sure bet when we present the hypothetical situation as one of saving houses from flooding.

Why is this expected finding important? The fact that individuals arrive at different choices depending on whether they perceive the situation as one of avoiding losses or of securing gains implies that loss and gain framing can influence individual responses to environmental stressors. As noted earlier, Mohamed (2013) has used this insight to explore regulatory takings, but the urban environmental planning and management literature has been almost silent on this phenomenon and on other psychology-driven aspects of behavior.

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<sup>8</sup> We asked each respondent two risk aversion questions, the first related to their general willingness to take risks in life (on a 0-10 scale) and the second about their preferences for different hypothetical lotteries. Neither risk question is rigorous or incentive-compatible, unfortunately, since each collects general expressions of risk without requiring any “skin in the game,” so we combine them to develop a rough indicator of risk aversion.

Second, urban dwellers do not necessarily respond in a predictable, rational manner to situations they encounter, such as in the provision of urban environmental services. Rather, our choice experiments demonstrate that psychological considerations may play a role in environmental decision-making. When we present residents in Dar with a hypothetical new waste collection system, we find these residents reluctant to deviate upwards from the current payment they make, even after accounting for their dislike of the higher fee itself; that is, not only the magnitude of the hypothetical fee appears important but also whether that amount exceeds their current fee. In addition, we see that risk averse individuals prefer to stick to their status quo waste collection frequency more than do risk tolerant individuals.

This “irrationality” implies room for environmental planners and managers to employ incentives and nudges to move urban residents toward socially desirable goals, as well as a different perspective from which to interpret urban dynamics. It may be possible, for example, to expand household participation in formalized solid waste collection in our study area through revenue- and cost-neutral payment nudges that allow risk-averse residents to maintain their status quo payments and risk-tolerant residents to weigh higher payments against potentially higher rewards. We have explored in two areas in Dar support for just such a scheme, wherein residents would have the option to direct their waste collection payments into a chance-based lottery that randomly awards cash prizes to participants. The more regularly an individual or *mtaa* pays for waste collection, the greater the chance of winning an award. This concept draws on lottery-linked savings accounts, an approach already implemented in South Africa, Latin America, and other parts of the world to increase household savings (Cole, Iverson, and Tufano 2014, Guillén and Tschoegl 2002, Tufano 2008). Nearly 55 percent of the residents we surveyed in Dar indicated potential interest in participating in such a lottery system if it were implemented.

This does not mean we should immediately race to implement this nudge in the field, of course. Actual participation in such a lottery would depend on its details, including payout probabilities and amounts and trust in its fairness. In addition, we acknowledge several limitations in our overall approach documenting the relationships between risk, heuristics, and behavior, including the limitation of any stated preference technique for capturing true underlying values and preferences (Sagoff 2004). The possibility that respondents may perceive that our choice experiments force them to trade off attributes that they perceive as

incommensurate, taboo, or too morally significant to compromise on (Baron and Spranca 1997, Tetlock et al. 2000) also represents a potential shortcoming. Moreover, we already have noted that our study does not provide a representative cross-section of Dar, let alone other large cities of the Global South.

Notwithstanding these imperfections, that our work yields confirmatory rather than path-breaking findings illustrates its importance. The dearth of such dog-bites-human behavioral storylines in the urban environmental planning and management literature exemplifies this field's inattention to the behavioral elements associated with risk and decision-making under uncertainty that some other fields have taken up with alacrity. While few urban environmental planning and management scholars may embrace the rational actor paradigm as an accurate model of behavior, overlooking the human psychology elements of decision-making under risk uncertainty in urban environments can tacitly privilege this paradigm as a frame for interpreting urban environments and policy interventions to change these. We argue that greater heed to risk, behavior, and decision heuristic considerations in mainstream urban environmental planning and management research offers the potential both to understand better urban dynamics and to identify avenues to improve the environmental quality of life in urban Africa and elsewhere.

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