Understanding the Links Between Climate Change Risk Perceptions and the Action Response to Inform Climate Services Interventions

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Understanding what motivates people to act on climate change provides an opportunity to design more effective interventions, in particular, climate services interventions, by aligning them with factors that strongly influence action. Climate change risk perceptions have been shown to underlie action on climate change. Therefore, this study performs exploratory research to understand how various determinants of risk perceptions contribute and interact to influence climate change risk perceptions and professional action on climate change in East Africa, in order to inform the context-specific design of climate services. Using data collected through a region-wide survey, a model to risk perceptions and professional action was constructed through structural equation modeling. The model elucidates the cascading effects of variables such as age, gender, education, and personal values on action. In particular, it highlights a split in motivating factors among individuals with higher levels of self-enhancing values versus those with higher levels of self-transcending values. The model also highlights the prominent role that experience of extreme weather events, psychological proximity of climate change, climate change risk perceptions, and social norms play in motivating action. The model, therefore, offers a framework for prioritizing the various factors that motivate people to take adaptation action, which, in turn, provides a basis for informing climate services development going forward.

KEY WORDS: Action; Africa; climate change; climate services; risk perceptions

1. INTRODUCTION

Given the growing need to proactively prepare for a changing climate through adaptation, it is increasingly necessary to understand what factors drive people to act on climate change, what the relative contributions of these factors are, and how they interact to motivate action (van Valkengoed & Steg, 2019). This topic is particularly pertinent in the African context due to the disproportionate impact that climate change is likely to have in Africa (IPCC, 2014). Understanding what motivates people to take action on climate change provides an opportunity to identify and design effective adaptation action interventions (van Valkengoed & Steg, 2019) by aligning interventions with factors that strongly influence action. Of prominence in the suite of intervention activities for promoting adaptation action are climate services.

Climate services include the tailoring, delivery, and contextualization of decision-relevant climate information products (Vaughan, Dessai, & Hewitt, 2019).
2018) together with user engagement and coproduction of information as part of the service delivery activity (Vincent, Daly, Scannell, & Leathes, 2018). Understanding what drives motivation to act on climate change provides potential to improve the design of climate services such that they align to key motivating factors for adaptation action (Steynor & Pasquini, 2019). This may include, for instance, designing climate services engagements or messages to align with location-specific experience of extreme events, if these experiences are shown to increase people’s motivation to act.

To inform climate services, which are generally targeted at people in their professional capacity, it is important to understand what drives work-related adaptation action among people who have an ability to influence natural resource policy. In this study, these individuals are referred to as “policy decision influencers” and are defined as people who directly or indirectly influence the development of principles, plans, and courses of action around natural resource management at the local or national level. Examples of such individuals include government officials, researchers, trade union representatives, NGO practitioners, and others. These individuals are an important community because they are an accessible group for introducing adaptation-oriented interventions and are in a position of leadership to drive social adaptations around climate change (Mohamed, 2016). Therefore, an understanding of what factors are key in driving adaptation action in this community could provide the knowledge required for substantial innovation in climate services.

In light of the significant risks posed by climate change, risk perceptions provide a valuable entry point for understanding the factors that motivate climate change action, especially as risk perceptions have been shown to underscore both willingness to act on climate change (Lo & Chan, 2017; Smith & Mayer, 2018; Spence, Poortinga, & Pidgeon, 2012; Xie, Brewer, Hayes, McDonald, & Newell, 2019) and actual action on climate change (Blennow, Persson, Tomé, & Hanewinkel, 2012; Fahad & Wang, 2018; van Valkengoed & Steg, 2019). There is also a significant body of literature from the global North that outlines various antecedent determinants of risk perceptions, providing a basis from which to select factors for inclusion in an adaptation action model (van der Linden, 2015; van Eck, Mulder, & van der Linden, 2020).

On this basis, this study sets out to perform exploratory research to understand how antecedent determinants of risk perceptions interact to influence: (1) climate change risk perceptions and (2) professional action on climate change among policy decision influencers in East Africa, in order to inform (3) the development of more contextually-appropriate climate services. To this end, a selection of risk perception determinants was chosen for inclusion in the construction of a causal model (section 2). These risk perception determinants were then investigated through structured surveys with policy decision influencers in East Africa (section 3). The results were statistically analyzed using structural equation modeling in order to construct a model to professional action through climate change risk perceptions (section 4) and the results are discussed in light of how they could be used to design more effective climate services (section 5).

2. EXPLORING CLIMATE CHANGE RISK PERCEPTIONS AND THEIR DETERMINANTS

The literature regarding the ways in which risk perceptions can be measured is abundant and characterized by widespread disagreement about the “best” way to measure risk perceptions (Wilson, Zweckie, & Walpole, 2019). While some researchers have taken a general approach to measuring risk perceptions by asking “how risky is X activity?” (e.g., Safi, Smith, & Liu, 2012), others take the approach of dividing risk perceptions into the components of affect, probability, and consequence, choosing to focus on one or more of the components as a measurement of risk perceptions (e.g., Elshirbiny & Abrahamse, 2020; van der Linden, 2015). In light of this debate, and Wilson et al. (2019) meta-analysis conclusion that risk perceptions are largely a function of an individual’s affective reaction, a simplified measure of “worry about climate change” was chosen as the measure of risk perceptions for this study. This selection is supported by previous studies taking a similar approach (e.g., Carlton & Jacobson, 2013; Lujala, Lein, & Rød, 2015; Spence et al., 2012).

In addition to the debate about how to measure climate change risk perceptions, there are also various explanatory factors (or determinants) of climate change risk perceptions documented in the literature (e.g., Akerlof, Maibach, Fitzgerald, Cedeno, & Neuman, 2013; Poortinga, Whitmarsh, Steg, Böhm, & Fisher, 2019; van der Linden, 2015). While explanatory factors are various, no one set of factors purports to identify 100% of the variance in climate
change risk perceptions (van der Linden, 2017), although some models claim higher levels of explained variance than other models (van der Linden, 2015). In addition, previous models mostly hail from the global North, leaving the developing country context understudied in this respect.

Given the bias toward studies focused on developed countries, it is necessary to consider that the developing country context may display somewhat different characteristics, particularly when it comes to the determinants of risk perceptions. In order to tailor this study to the African context, a bespoke set of climate change risk perception determinants have been selected for inclusion, drawing from a suite of climate change risk perception determinants used in the literature. The selection of each risk perceptions determinant was based on appropriateness to the African context (as will be illustrated in the following sections). As a result, the following climate change risk perception determinants were selected for inclusion: psychological distance (closeness) of climate change, experience of extreme weather events, social norms, values (self-enhancing and self-transcending), and demographic variables (age, gender, and education). Each of these determinants are explained in further detail in the following sections.

2.1. Psychological Distance (Closeness) Of Climate Change

Psychological distance is a measure of an individual’s perception of a threat as either proximal and real, or distant, and abstract (Pahl, Sheppard, Boomsma, & Groves, 2014). It is measured taking into account four components of a threat, namely spatial distance (geographical proximity of the threat), temporal distance (the imminence of the threat), social distance (proximity of the threat to oneself or immediate social groupings), and the likelihood/certainty of the threat (Trope & Liberman, 2011). The psychologically distant nature of climate change has been well documented in the literature from the global north. In fact, it is often cited as a barrier to action on climate change (Jones, Hine, & Marks, 2017; Mcdonald, Chai, & Newell, 2015; Spence et al., 2012). There is less evidence on the psychological distance of climate change in developing countries, however, recent studies have posited climate change as psychologically proximal in the African context, substantially more so than in the global North (Steynor & Pasquini, 2019; Steynor et al., 2020). The psychological proximity of climate change in a developing country setting might be a significant driver of climate change risk perceptions and, hence, is likely to be an important factor to consider within risk perceptions models in Africa. Therefore, psychological closeness was considered to be a relevant and appropriate variable for inclusion in this study.

2.2. Experience of Extreme Weather Events

While it is scientifically challenging to attribute any one extreme weather event to climate change (van Aalst, 2006), personal experience of extreme events has been documented to increase climate change risk perceptions by invoking a concrete understanding of the effects of climate change in reality (Akerlof et al., 2013; Demski, Capstick, Pidgeon, Sposato, & Spence, 2017; Reser, Bradley, & Ellul, 2014). There is a growing body of evidence that suggests a belief, within Africa, that extreme and erratic weather events are increasing, primarily as a result of climate change (Ayal & Leal Filho, 2017; Ayanlade, Radeny, & Morton, 2017; Mahl, Guenther, Schäfer, Meyer, & Siegen, 2020; Sutcliffe, Dougill, & Quinn, 2016). These events, in east Africa, include increased average temperatures, decreased and/or more variable precipitation resulting in heavy rainfall events and flooding, a shorter or delayed rainy season, and longer dry spells and droughts (Chepkoech, Mungai, Stöber, Bett, & Lotze-Campen, 2018; Egeru, 2016; Gross-Camp, Few, & Martin, 2015; Mubiru et al., 2018). This growing awareness of changing weather events attributed to climate change suggests that the experience of extreme weather events in Africa may be an important factor in determining climate change risk perceptions.

While experience of extreme climatic events and the psychological distance of climate change have been viewed as interconnected or even interchangeable in the literature (Mcdonald et al., 2015), we treat them as separate entities for the purposes of this study. Motivation for this is primarily due to the prominence of the experience of extreme weather events in the African context in comparison to the developed world, which may render it an important variable in determining climate change risk perceptions. In addition, a previous study has noted the possible additional effect that exposure may have on mental construal (strongly linked to the role played by psychological distance in construal level theory) (Förster, 2009). The separation of the two concepts
therefore allows us to test the validity of the assertion, from recent literature, that experience of extreme weather events and psychological distance are interchangeable (McDonald, 2016; Mcdonald et al., 2015).

2.3. Observance of Social Norms

Social norms are external expectations about how one is supposed to feel, behave, or think in particular situations (Popenoe, 1983) and can be divided into descriptive norms (observing what others do) and prescriptive norms (what is generally socially approved/disapproved of) (Cialdini, Reno, & Kallgren, 1990), for instance, whether a carbon-intensive lifestyle is socially acceptable behavior (Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007). This social legitimacy often overrides cognitive knowledge of the damage that carbon-intensive lifestyles cause, aptly demonstrated by the carbon emissions from the air travel of many academics (Wynes, Donner, Tannason, & Nabors, 2019), including those in fields related to sustainability and climate change (this study’s authors included).

Observance of social norms has been shown to be a powerful influencer of human behavior, including different environmentally sustainable actions both personally (Griskevicius, Cialdini, & Goldstein, 2008) and in the workplace (Inoue & Alfaro-Barrantes, 2015; Ture & Ganesh, 2014) as well as of climate change risk perceptions (van der Linden, 2015). As such social norms warrant study in the context of the current research, because there is no reason why social norms should not be powerful influencers of action on climate change in the African context as well.

2.4. Values

Values are standards or criteria that guide individual action, judgement, choices, attitudes, and evaluations (Rokeach, 2008). They transcend specific situational contexts and underlie the moral composition of a person (Schwartz & Bilsky, 1990). For instance, if loyalty is a core value of a person, they will apply this principle universally in their workplace, at home, in friendships, and even with strangers.

The values of self-transcendence and self-enhancement have been shown to link to greater/lesser acceptance and action on a variety of environmental behaviors, including climate change. Previous literature has shown that people with predominantly self-transcending values show greater support for climate change policies and more easily accept the realities and risks of climate change (Poortinga et al., 2019; Poortinga, McD, Whitmarsh, Capstick, & Pidgeon, 2011; Whitmarsh, 2011). In contrast, predominantly self-enhancing values are associated with a lower perceptions of climate change risk (Smith & Leiserowitz, 2012). Therefore, a person’s values are important in informing climate change risk perceptions and action on climate change, yet there is a paucity in research on the values landscape in Africa and their influence on climate change perceptions (Corner, Markowitz, & Pidgeon, 2014).

2.5. Demographics

Sociodemographic characteristics such as age, gender, and educational attainment have all been shown to influence climate change risk perceptions (van der Linden, 2014) and are, therefore, important to consider in the African context. For instance, women are more likely to exhibit elevated perceptions of climate change risk when compared to men (Henwood, Parkhill, & Pidgeon, 2008; Sundblad, Biel, & Gärving, 2007). Educational attainment is inconsistently linked to either higher (Sundblad et al., 2007) or lower risk perceptions (Akerlof et al., 2013; Brody, Zahran, Vedlitz, & Grover, 2008). Similarly, age is inconsistently linked to climate change risk perceptions in the literature, with advancing age linked with both higher perceptions of climate change risk (Lazo, Kinnell, & Fisher, 2000), lower perceptions of climate change risk (Ballew et al., 2019; Gallup, 2018), or no effect on climate change risk perceptions (Shi, Visschers, Siegrist, & Arvai, 2016).

Using the outlined risk perception determinants, the following section presents a methodology for exploring the relationship between each of these selected risk perception determinants and how they influence two outcomes: risk perceptions (worry about climate change) and professional action on climate change.

3. MATERIALS AND METHODS

3.1. Procedure and Participants

Data to inform the study were collected through structured surveys and subjected to University ethical clearance procedures. Consent forms
acknowledging anonymity of the responses were collected from all participants. All respondents took part in the project on a voluntary basis with no reward for their participation.

The targeted participant group for this study consisted of policy decision influencers in the East Africa region. The majority of respondents (71%) were sourced from national and local government ministries. Other organisations included nongovernmental organisations, international development agencies, parastatals, trade unions, research organisations, and the private sector. The main criterion for inclusion was that the respondents’ organisations should be active in a field or sector related to natural resource management. Specific respondents at each organisation should be in roles where they would be expected to use, or benefit from using, climate information in the achievement of their professional activities.

During the design phase for the structured survey, the draft survey was pilot tested with academics from various African countries (N = 7) whose first language was not English. In response to the pilot phase, the survey was revised based on feedback, particularly with regards to clarifying ambiguous language and unclear questions.

Through a competitive process, in-country enumerators were selected to undertake surveying in their home countries (Ethiopia, Kenya, Rwanda, Tanzania, and Uganda). Prior to surveying, each enumerator was trained and provided with a detailed instruction sheet, in order to ensure that each country’s data were collected in a consistent manner. Enumerators were supplied with a proposed list of organisations to approach (which had been codeveloped with stakeholders in the region at a prior workshop based on the broader research project). Additional participants were then further identified through a snowball approach. Surveying took place between September 2018 and January 2019. Each survey was conducted in a one-on-one dialogue format between the respondent and the enumerator, with the exception of the values section, which is particularly susceptible to social desirability bias. This section was completed by the respondent, independent of the enumerator (i.e., the respondent filled in this section of the survey themselves), in order to minimize this potential bias.

The dataset comprised of a total of 474 complete surveys (representing a participant response rate of 77%) across the five east African countries. Given that the general guidance on sample size is to have at least 10 participants for each included parameter (Schreiber, Nora, Stage, Barlow, & King, 2006), the minimum criteria of 100 respondents was more than adequately met. The final sample consisted of 70.3% male and 29.7% female respondents with an average age of 30–39 years and an average educational level of an undergraduate university degree.

3.2. Measures for the Structured Survey

As the data collection activities formed part of a wider project on assessing climate change information use in decision making, only the constructs relevant to the findings reported here are detailed in this section.

3.2.1. Professional Action on Climate Change

One item was included with respect to whether the participant reported taking general action, as part of their job activities, to prepare for the impacts of climate change. This item was designed to elicit a response based on actual reported action as opposed to a willingness to act by asking the respondent to rate how strongly they agreed with the statement “As part of my job activities, I do things (at least sometimes) that help to prepare for the impacts of climate change.” This self-report single measure was chosen because the study was focused on the “internal landscape” of respondents, and therefore on which risk perception determinants play a greater/lesser role in respondents’ perceptions of risk, and their consequent effects on professional action. Therefore, this simple self-report measure about whether respondents perceive themselves to be taking action at work is more important for the purposes of this investigation than the details of the actions taken. For the purposes of this analysis, responses to this item were referred to as “professional action” on climate change. The response was recorded on a five-point Likert scale from “strongly disagree” to “strongly agree.”

3.2.2. Climate Change Risk Perceptions

As detailed at the outset, worry about climate change was used, in this study, as a measure of risk perceptions. Many previous studies have referred to the term “concern” when measuring this variable. However, it is important to draw a distinction between the terms “concern” and “worry.” It is possible to be concerned about something without being actively worried about it. When assessing action on climate change, previous studies have suggested that
“worry” is a better indicator to use than “concern” (van der Linden, 2017) because if someone is worried about something (as opposed to generally concerned) they are more likely to act on it (van der Linden, 2017). Therefore, for this study, items were phrased in terms of “worry” about climate change. Three items were used to assess overall worry about climate change, namely general worry about climate change, as well as worry at a personal and community level. These were measured on a five-point Likert scale from “not worried” to “very worried.” The responses from the three items were combined into a construct ($\alpha = 0.739$) for analytic purposes.

3.2.3. Psychological Distance (Closeness)

Building on items developed by Spence et al. (2012), a total of seven items were proposed to represent the spatial, temporal, social, and hypothetical dimensions of psychological distance, as described by Trope and Liberman (2011). The social distance component was disaggregated into two questions regarding (1) whether climate change will have a big impact on the respondent personally and (2) whether climate change will have a big impact in the respondent’s local area. The spatial distance component was similarly disaggregated into two questions regarding (1) whether the respondent’s local area is likely to be affected by climate change and (2) whether climate change will mostly affect areas far away. Hypothetical distance was measured through two questions regarding (1) whether climate change is happening and (2) whether the effects of climate change are certain. Lastly the temporal component was measured through a question eliciting responses as to when the effects of climate change will be felt. Participants were asked to rank their response along a five-point Likert scale from “strongly disagree” to “strongly agree,” except for the temporal distance question, which included timescales from “never” to “the effects are already being felt” as five response options. For analysis, a construct of psychological distance was created from six of those items ($\alpha = 0.679$) with higher values representing increasing psychological closeness (therefore this construct is henceforth referred to as psychological closeness).

The one excluded item pertained to whether the participants thought that climate change would mostly affect areas that are far away from their location (one measure of spatial distance). This item was excluded because it resulted in reduced internal reliability of the scale. The exclusion of this particular item of spatial distance is supported by previous literature which finds that perceptions pertaining to the distant impacts of climate change can be anomalous in direction when compared to the other dimensions of psychological distance (e.g., Gifford et al., 2009; Schultz et al., 2014; Spence et al., 2012). For this reason, the exclusion of this item was considered justifiable.

3.2.4. Experience of Extreme Weather Events

Four items were used to measure experience with extreme weather events. Survey participants were asked to recall how often, in the last five years, they had experienced (1) flood events, (2) droughts, (3) high temperatures/heat events, and/or (4) change to the rainy season pattern. A five-point Likert scale was used to record responses from “never” (zero times) to “very often” (more than 10 times) and assigned a value of one to five for analysis purposes. Each participant’s scores were combined into an additive scale in order to provide a total value relating to overall exposure to extreme weather events. Since experience with one type of extreme weather event is not necessarily related to experience of a different extreme weather event, an internal reliability measure is not sensible.

A further item was posed in order to assess whether those extreme weather events were personally attributed to climate change. The vast majority (96.42%) of the participants attributed their experience of either some or all of the extreme weather events to climate change. Therefore, as asserted by Akerlof et al. (2013) it can be assumed that personal experience of extreme events broadly equates to personal experience of climate change.

3.2.5. Social Norms

Six items were used to measure the observance of social norms. Three items were designed to assess descriptive norms: two measured the level of observance of social referents (friends/family and colleagues respectively) taking action on climate change. A third item measured the level of observance of colleagues using weather/climate information in a work environment. A further three items were designed to measure prescriptive norms: two measured the respondent’s perceptions as to whether family/friends and colleagues expect them to take action on climate change themselves (respectively in a personal and professional capacity). The third item
measured the respondent’s perceptions as to whether colleagues expect them to use weather/climate information themselves in their work capacity. Responses were measured on a five-point Likert scale from “strongly disagree” to “strongly agree.” For analysis, a construct of social norms was created from all six items ($\alpha = 0.761$).

3.2.6. Values

Values were assessed using the Schwartz (2003a) portrait values questionnaire on a seven-point Likert scale from “not like me at all” to “very much like me.” The 21-item modification of the original 57-item questionnaire (Schwartz, 1992) was used for the purposes of this study because the 21-item modification is designed to be more accessible across educational levels than the original portrait values questionnaire. This questionnaire is based on Schwartz’s (1992) theory of values, which breaks down human values into 10 fundamental categories.

Using the guidance from Schwartz (2003b), responses for each of the ten basic values were converted to centred value scores. Due to the documented link between self-enhancing and self-transcendent values to acceptance and action on climate change (described earlier), a focus was placed on the results of these two higher-order values for the purposes of this study. Therefore, combined centred scores for self-transcending values (benevolence and universalism) ($\alpha = 0.735$) and self-enhancing values (achievement and power) ($\alpha = 0.644$) were used for analytic purposes.

3.2.7. Sociodemographics

A range of sociodemographic information was collected including gender (male, female, and nonbinary), age range (in 10-year bands, e.g., 20–29, etc.) and educational level. Educational level data were arranged into an ordinal scale from 1 to 5 with, 5 representing a doctoral degree and 1 representing a school leaver’s certificate.

3.2.8. Use of Weather and Climate Information Services

Finally, in order to undertake a post hoc analysis that drew linkages between professional action and the design of climate services, a further question on the use of weather and climate information services was included. This question assessed the frequency of weather or climate information use as part of the respondent’s job. Responses were measured on a five-point frequency scale from “never” to “very frequently.”

3.3. Analysis

Using the data collected through the structured survey exercise, a series of statistical analyses were performed in order to construct a conceptual explanatory model for professional action. First, descriptive statistics were generated for each of the dependent and independent variables using Spearman’s correlation analysis, due to the ordinal nature of the Likert scale data as well as the nonnormality of many of the data distributions. Second, a multiple linear regression analysis was performed to better understand the predictors of climate change risk perceptions and professional action on climate change. In order to perform this regression analysis, where there was non-normality in the data, a reflect and logarithm or a reflect and square root procedure transformation was used, depending on the degree of skewness. Finally, a conceptual model was constructed and the validity and robustness of the model was tested through structural equation modeling. To examine the model fit, Schreiber et al. (2006) proposed cut-off criteria for fit were used. These include: $\chi^2/df \leq 3$, goodness of fit index (GFI) $\geq 0.95$, adjusted GFI (AGFI) $\geq 0.95$, comparative fit index (CFI) $\geq 0.95$, Tucker–Lewis index (TLI) $\geq 0.95$, and the root mean square error of approximation (RMSEA) $\leq 0.05$.

4. RESULTS

4.1. Intercorrelations and Descriptive Statistics

Through correlation analysis it was found that social norms, psychological closeness, and experience of extreme events were all significantly and positively correlated ($\rho = 0.01$) to both risk perceptions and professional action ($r = 0.149$ to $r = 0.366$). Social norms were most strongly correlated to professional action ($r = 0.366$) and psychological closeness was most strongly correlated to risk perceptions ($r = 0.409$) (Table I).

As a categorical variable, gender was analyzed separately through a Mann–Whitney test. The only statistically significant difference between the genders was found in self-enhancing values. Males had
significantly higher self-enhancing values than females ($\rho = 0.02, r = 0.11$).

4.2. Regression Analysis

As an initial multicollinearity test confirmed a lack of multicollinearity within the data, multiple linear regression was used to explore which of the independent variables explained the greatest variance in (1) climate change risk perceptions and (2) professional action on climate change.

4.2.1. Climate Change Risk Perceptions

The multiple linear regression revealed a statistically significant model, explaining a total of 18.4% of the variance in climate change risk perceptions ($F(8, 465) = 14.302, \rho < 0.001, Adj R^2 = 0.184$). The regression revealed that psychological closeness ($t = 8.734, \rho < 0.001$), social norms ($t = 2.327, \rho = 0.020$), and experience of extreme events ($t = 0.040, \rho = 0.040$) were significant predictors of climate change risk perceptions while psychological closeness was the dominant predictor ($\beta = 0.380$) (Table II).

4.2.2. Professional Action on Climate Change

For professional action, climate change risk perceptions were included as an additional independent variable because of the known positive influence that risk perceptions have on action, shown through the descriptive statistics (Table I) and supported by the literature (Singh, Zwickle, Bruskotter, & Wilson, 2017; Spence et al., 2012). Again, the multiple linear regression revealed a statistically significant model, explaining a total of 18.1% of the variance in professional action ($F(9, 464) = 12.615, \rho < 0.001, Adj. R^2 = 0.181$). The regression revealed that social norms ($t = 7.403, \rho < 0.001$) and risk perceptions ($t = 2.936, \rho = 0.003$) were both significant predictors of professional action, while social norms was the dominant predictor ($\beta = 0.321$) (Table III).

4.3. Conceptualizing a Model to Professional Action on Climate Change

Using this preliminary analysis, a conceptual model was constructed to map the interactions between each variable included in the analysis and how they lead to professional action on climate change. The model was then theoretically checked to simplify pathway interconnections and ensure that
As a final step, the conceptual model was tested through structural equation modeling (SEM) in AMOS 26. SEM is an appropriate technique for testing causality because it tests the measurement and structural model simultaneously, thereby testing direct and indirect effects of the model variables on the outcome while adjusting for measurement error (Dietz, Dan, & Shwom, 2007). The model was estimated based on maximum likelihood with 1,000 bootstrap samples and 95th percentile confidence intervals. The final causal model and fit statistics are presented in Fig. 1. Based on the Schreiber et al. (2006) accepted fit statistic criteria, the model represents a very good fit, therefore no post hoc tests were performed.

### 4.3.1. Statistical Interpretation of the Model Pathways

Tables IV and V break down the effects of each of the predictor variables into direct and indirect effects.

#### Climate change risk perceptions

The psychological closeness of climate change had the biggest direct effect on risk perceptions ($\beta = 0.38$) (Table IV). Experience of extreme climatic events also had a large effect on risk perceptions, however, this was shared between direct ($\beta = 0.093$) and indirect ($\beta = 0.085$) effects. Experience of extreme events had a comparatively large direct effect ($\beta = 0.214$) on psychological closeness, which explains its indirect effect on risk perceptions. However, the direct pathway from experience of extreme events to risk perceptions was also important, and statistically significant, in the model, signifying that experience of extreme climate events was important in influencing risk perceptions in its own right. Observance of social norms also had a small but direct effect ($\beta = 0.09$) on risk perceptions.

#### Professional action

The observance of social norms had the largest direct effect on professional action on climate change ($\beta = 0.311$) (Table V). The second largest effect on professional action came from risk perceptions ($\beta = 0.142$) through direct effects. A third major contributor toward professional action came from the psychological closeness of climate change. However, approximately half of this effect was indirect ($\beta = 0.115$), through risk...
Table III. Regression of Climate Change Risk Perceptions and its Determinants on Professional Action

| Independent Variables          | B    | β     | t     | ρ     | 95% Confidence Interval for B | 95% Confidence Interval for B |
|-------------------------------|------|-------|-------|-------|------------------------------|------------------------------|
|                               |      |       |       |       | Lower Bound                   | Upper Bound                   |
| Social norms                  | 0.088| 0.321 | 7.403 | 0.000 | 0.065                        | 0.111                        |
| Climate change risk perceptions| 0.094| 0.136 | 2.936 | 0.003 | 0.031                        | 0.156                        |
| Psychological closeness       | 0.056| 0.092 | 1.946 | 0.052 | −0.001                       | 0.112                        |
| Experience of extreme events  | 0.004| 0.075 | 1.745 | 0.082 | −0.001                       | 0.010                        |
| Self-enhancing values         | 0.003| 0.012 | 0.238 | 0.812 | −0.023                       | 0.029                        |
| Self-transcending values      | 0.019| 0.049 | 0.997 | 0.320 | −0.018                       | 0.056                        |
| Gender                        | −0.031| −0.077| −1.805| 0.072 | −0.065                       | 0.003                        |
| Education                     | 0.018| 0.080 | 1.862 | 0.063 | −0.001                       | 0.038                        |
| Age                           | −0.036| −0.064| −1.513| 0.131 | −0.082                       | 0.011                        |

Fig 1. Model showing the pathways from risk perception determinants to risk perceptions and professional action on climate change. The standardized regression weights are represented numerically on each pathway line and are all statistically significant. E1 to E8 refer to the error terms. Model fit statistics: $\chi^2/df$: 1.441; GFI = 0.983; AGFI = 0.968; CFI = 0.970; TLI = 0.953; RMSEA = 0.031; RMR = 0.029.

perceptions and the observance of social norms, while the remainder was from a direct effect on professional action ($\beta = 0.122$).

While the other antecedent variables of risk perceptions in the model did not have direct effects on risk perceptions or professional action, they were, nevertheless, important in influencing the antecedents of both. For instance, education had a direct effect ($\beta = 0.096$) on the presence of self-transcending values and a negative effect ($\beta = −0.176$) on self-enhancing values. In turn, the presence of self-transcending values had a direct effect ($\beta = 0.104$) on the reported experience of extreme climatic events and self-enhancing values had a direct effect on the observance of social norms ($\beta = 0.11$).

5. DISCUSSION

5.1. Conceptual Interpretation of the Paths

While the statistical interpretation of the model has been presented above, it is also important to
Table IV. Direct and Indirect Effects on Climate Change Risk Perceptions

| Climate Change Risk Perceptions ($R^2 = 0.191$) | B   | $\beta$ | SE  | $\rho$ |
|------------------------------------------------|-----|---------|-----|--------|
| **Direct effects**                              |     |         |     |        |
| Experience of extreme events                    | 0.008 | 0.093  | 0.004 | 0.028 |
| Psychological closeness                         | 0.338 | 0.380  | 0.038 | 0.000 |
| Social norms                                    | 0.037 | 0.092  | 0.017 | 0.028 |
| **Indirect effects**                            |     |         |     |        |
| Education                                       | 0.001 | 0.002  |      |        |
| Age                                             | 0.008 | 0.010  |      |        |
| Self-enhancing values                           | 0.000 | 0.001  |      |        |
| Self-transcending values                        | 0.010 | 0.019  |      |        |
| Experience of extreme events                    | 0.007 | 0.085  |      |        |
| Psychological closeness                         | 0.016 | 0.018  |      |        |

Table V. Direct and Indirect Effects on Professional Action

| Professional Action ($R^2 = 0.175$) | B   | $\beta$ | SE  | $\rho$ |
|------------------------------------|-----|---------|-----|--------|
| **Direct effects**                 |     |         |     |        |
| Psychological closeness            | 0.074 | 0.122  | 0.028 | 0.009 |
| Climate change risk perceptions    | 0.097 | 0.142  | 0.032 | 0.002 |
| Social norms                       | 0.085 | 0.311  | 0.012 | 0.000 |
| **Indirect effects**               |     |         |     |        |
| Gender                             | −0.001 | −0.003 |     |        |
| Education                          | −0.001 | −0.005 |     |        |
| Age                                | 0.019 | 0.034  |      |        |
| Self-enhancing values              | 0.009 | 0.032  |      |        |
| Self-transcending values           | 0.003 | 0.007  |      |        |
| Experience of extreme events       | 0.004 | 0.064  |      |        |
| Psychological closeness            | 0.070 | 0.115  |      |        |
| Social norms                       | 0.004 | 0.013  |      |        |

Theoretically check the model to ensure it makes conceptual sense. To this end, we start with the beginning of the pathway to action, which consists of the sociodemographic variables (age, gender, and education). Sociodemographic variables, particularly age and gender, are stable variables with limited influence from external stimuli so are, by necessity, represented as initial variables in the pathway to action. There was a positive correlation among the sociodemographic variables of age and education. This suggests that higher education levels are associated with advancing age, likely because advanced age affords greater opportunity (in terms of time) of enrolling and completing studies, particularly tertiary education, that may be progressively undertaken over the course of an individual’s lifetime.

Also, near the beginning of the pathway, yet significantly influenced by the level of education of an individual, are self-enhancing and self-transcending values. As education increased, so did levels of self-transcending values. This relationship was reversed for self-enhancing values, that is as education decreased, self-enhancing values increased. This finding supports studies such as the meta-analysis undertaken by Hyman and Wright (1979) documenting the effect that education has on promoting more self-transcendent values; it also aligns with the findings of Post and Meng (2018), who document that more education increases proenvironmental priorities over economic priorities. Conceptually, as an individual becomes more educated, they have an increased knowledge and understanding of the wider world and their place within it. As noted by Stevenson and Peterson (2015) this may, in turn, stimulate a focus to outside of themselves, underpinning a self-transcendent value system. The converse would then hold true for self-enhancing values resulting from lower education. Since self-enhancing and self-transcending values were found to be negatively correlated (as expected, based on being opposing values within Schwartz et al. (2012) multidimensional values structure), they are represented on either side
of the model in Fig. 1, signifying the beginnings of a split and dual pathway to action.

The first pathway to action (represented on the left-hand side of the model in Fig. 1), applies mainly to those with higher levels of self-enhancing values. In one prior study, norms have been shown to be mediators between self-transcending values and policy support for climate change action (Nilsson, von Borgstede, & Biel, 2004). However, our model showed that individuals with higher levels of self-enhancing values were also likely to observe social norms, presumably because such observance may best aid their individual achievement (as opposed to being motivated by the collective good). Traditionally seen as the bread-winners of society, males are more likely to have higher levels of self-enhancing values than females (Schwartz & Rubel-Lifschitz, 2009). The relationships between gender, values, and norms are reflected in Fig. 1 by a direct effect of gender (males) on self-enhancing values and a direct effect of self-enhancing values on observance of social norms. Social norms were the single most important driver of professional action on this side of the pathway. The positive relationship between social norms and climate change action has been documented in the literature (Fielding & Hornsey, 2016; Lo, 2013; van Valkengoed & Steg, 2019).

The second pathway to action (represented on the right-hand side of the model) applies to individuals holding higher levels of self-transcending values. Individuals with higher levels of self-transcending values were more likely to report experience of extreme weather events that were linked to climate change, perhaps due to a heightened awareness of the world around them (as self-transcending values are those that focus outward of the individual). This experience of extreme events was found to bring climate change psychologically closer and increase climate change risk perceptions, as noted before in the literature (e.g., Spence et al., 2012; Steynor et al., 2020). In our model, risk perceptions and psychological closeness were both important drivers of professional action on climate change.

Additional pathways to action were found from psychological closeness through social norms, and from social norms through risk perceptions. This pathway supports van der Linden’s (2015) positioning of social norms as a driver of risk perceptions. However, these links are likely context-specific to areas where the social norm is to take action on climate change. If the social norm was for inaction, the positive correlations between psychological closeness, social norms and risk perceptions would likely break down because of a logically incompatible response to the risk.

5.2. The Generalizability of this Model to Other Contexts

While the individual links between the different model variables are supported by current literature (refer to section 5.1), they have not, before, been analyzed in concert with each other in the context of reported climate change action, as done here. This model, therefore, fills a gap in understanding that was noted by van Valkengoed and Steg (2019) as critical to properly determining the effect sizes of each variable in influencing climate change adaptation behavior. While this model was developed within the context of East African policy decision influencers, the fact that each of the individual links has support in international literature, suggests that these connections may not be unique to the East African region. Therefore, the model presented here not only offers a model for how various risk perceptions determinants may link together to motivate climate change action in the wider African context but might be widely applicable to other international contexts too.

One situation in which the model presented here may not be generalizable elsewhere is in contexts where the social norm is for inaction on climate change. In this case, as noted above, the links from psychological closeness to social norms and from social norms to risk perceptions may differ. The relationship between social norms and risk perceptions is particularly complex because, while our model shows social norms influencing risk perceptions, it could be argued that risk perceptions may also influence social norms (Lo, 2013). Therefore, there could be a bidirectional relationship that is not explored through the current model because the data is cross-sectional in nature.

5.3. The Relationship Between Psychological Closeness and Experience of Extreme Events

The experience of extreme events and the concept of psychological closeness has previously been conflated in the literature (McDonald, 2016; Mcdonald et al., 2015). By separating them in this study, we are able to provide commentary on the validity of conflating these two concepts. The African context is a particularly good setting in which to test this interconnectivity because experience of extreme events is
documented as being high (Ayal & Leal Filho, 2017; Ayanlade et al., 2017; Below, Schmid, & Sieber, 2015; Sutcliffe et al., 2016).

Counter to current arguments, the relationship between experience of extreme events (thought to be due to climate change) and psychological closeness was not as high as one might expect, with a correlation coefficient of 0.218 (Table I). Based on effect size guidance from Gignac and Szodorai (2016) and Funder and Ozer (2019), the relationship between the two variables falls into the medium effect range ($r > 0.2$). This shows that the psychological distance variable was influenced by more factors than solely past experience of extreme events thought to be due to climate change. These additional factors may include personal values and education, as shown through this study, but also potentially other unexplored variables. This is an important finding from the study and supports the decision to separate the variables of experience of extreme events and psychological closeness in our model.

5.4. Using an Understanding of the Drivers of Climate Change Action to Inform the Development of Climate Services

In support of evidence-based decisions, one would expect there to be a positive correlation between professional action on climate change and the frequency of use of weather and climate information. However, the correlation analysis revealed a small ($r = 0.219; p = 0.01$) correlation between the two variables in this study, meaning that the frequency of use of weather and climate information in taking action on climate change was lower than one might expect.

Much literature suggests that the lack of climate information use (among those who would be expected to use it) is because of poorly designed climate information that is not accessible, understandable, or context-specific (Dilling & Lemos, 2011; Lemos, Kirchhoff, & Ramprasad, 2012; Porter & Dessai, 2017; Vogel & O’Brien, 2006; Vogel, Steynor, & Manyuchi, 2019). A better understanding of the factors that influence risk perceptions and action on climate change provides insight into the context-specific needs of climate services users. Therefore, this understanding helps to facilitate the design of climate services that better align to the underlying influencers of action among such users. In other words, the more climate services can account for factors that influence risk perceptions and actions, the more they will be used when taking action.

While the model presented here elucidates the cascading effects of variables such as age, gender, education, and values on action, it importantly highlights the prominent role that experience of extreme weather events, psychological proximity of climate change, climate change risk perceptions, and social norms play in motivating action. The model, therefore, provides a framework for prioritising the different factors that motivate adaptation action, suggesting which factors could be of focus for informing climate services development. For example, observance of social norms stands out as a prominent motivating factor for action, and, therefore, could offer low-hanging fruit for climate services interventions that leverage or align to the current social norms. Such interventions may include, for instance, interventions designed to highlight the frequency of desired climate information use behaviors, for example, messages such as “80% of urban planning professionals are using climate information in their planning.” As another example, an understanding of an audience’s psychological proximity to climate change would allow for an appropriate matching of climate information framings. Previous literature has suggested that if climate change is psychologically close then audiences may respond better to concrete, solutions-orientated information (Brügger, Morton, & Dessai, 2016; Spence & Pidgeon, 2010). Using the model developed in this study as a foundation, future research can usefully undertake detailed investigations into the ways in which individual action-motivating factors could be used as a basis for informing the development of climate services.

6. CONCLUSION

This study advances our understanding of the relative contributions of various risk perception determinants to professional action on climate change by providing a model to professional action through risk perceptions. While individual linkages between each of the determinants in the presented model are documented in the literature, the developed model responds to the call for the determinants to be examined in concert with each other (van Valkengoed & Steg, 2019). The results highlight a dual pathway to action on climate change, dependent on individual value systems, and demonstrate the importance of experience of extreme weather events,
psychological proximity of climate change, climate change risk perceptions, and social norms in motivating action.

The findings in this study offer a springboard for further investigating interventions that align with motivating factors for action on climate change. In particular, the model presented here informs the, currently, high profile intervention of climate services. Understanding the prioritisation of factors that motivate action on climate change allows for the design of climate services that better align to priority factors and are, therefore, better suited to the east African context and the specific audience of policy decision influencers.

It is acknowledged that further research is required to address some of the limitations of this study and fully elucidate the reasons behind the linkages within the pathway. For instance, this study took place among a very specific sample of people (policy decision influencers) who were purposefully identified rather than randomly sampled. The characteristics of this group may differ from the general population, for example the level of education among this sample is likely to be higher than the general population. While it is never possible to include all possible variables in a single study, further research may also reveal significant variables that have been excluded from the current model, such as affect or emotions. The inclusion of additional variables may, in turn, have the effect of increasing the explained variance in comparison to the current model. Furthermore, while this model investigates the individual action context, there are likely to be additional structural factors that affect professional action on climate change such as institutional priorities, shared decision making or resource capacities.

However, the current model can be viewed as a robust model for the individual action context from which further research could emanate and provides exciting possibilities for leveraging understanding of what drives action on climate change to encourage behavior change among policy decision influencers in Africa. These findings are valuable given that the majority of the current literature on climate change risk perceptions and adaptation action is rooted in the developed world.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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