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ORIGINAL PAPER

Assessing barriers to adaptation to climate change in coastal Tanzania: Does where you live matter?

Frederick Ato Armah · Isaac Luginaah · Herbert Hambati · Ratana Chuenpagdee · Gywn Campbell

Abstract Research on barriers to climate change adaptation has, hitherto, disproportionately focused on institutional barriers. Despite the critical importance of personal barriers in shaping the adaptive response of humanity to climate change and variability, the literature on the subject is rather nascent. This study is premised on the hypothesis that place-specific characteristics (where you live) and compositional (both biosocial and sociocultural) factors may be salient to differentials in adaptation to climate change in coastal areas of developing countries. This is because adaptation to climate change is inherently local. Using cross-sectional survey data on 1,253 individuals (606 males and 647 females), barriers to adaptation to climate change were observed to vary with place, indicating that there is inequality

F. A. Armah (✉)
Environmental Health and Hazards Laboratory, Department of Geography, University of Western Ontario, 1151 Richmond Street, London, ON N6A 5C2, Canada
e-mail: farmah@uwo.ca

I. Luginaah
Department of Geography, University of Western Ontario, 1151 Richmond Street, London, ON N6A 5C2, Canada
e-mail: iluginaa@uwo.ca

H. Hambati
Department of Geography, University of Dar es Salaam, Dar es Salaam, Tanzania
e-mail: hhambati@udsm.ac.tz

R. Chuenpagdee
Department of Geography, Memorial University of Newfoundland, St. John's, NL A1B 3X9, Canada
e-mail: ratanac@mun.ca

G. Campbell
Indian Ocean World Centre (IOWC), Peterson Hall, 3460 McTavish Street, Room 100, Montréal, QC H3A 1X9, Canada
e-mail: Gwyn.Campbell@mcgill.ca

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in barriers to adaptation. In the multivariate models, the place-specific differences in barriers to adaptation were robust and remained statistically significant even when socio-demographic (compositional) variables were controlled. Observed differences in barriers to adaptation to climate change in coastal Tanzania mainly reflect strong place-specific disparities among groups indicating the need for adaptation policies that are responsive to processes of socio-institutional learning in a specific context, involving multiple people that have a stake in the present and the future of that place. These people are making complex, multifaceted choices about managing and adapting to climate-related risks and opportunities, often in the face of resource constraints and competing agendas.

Keywords Place · Biosocial · Sociocultural · Human–environment · Indian Ocean · Tanzania

Introduction

This study is part of 'the Indian Ocean World: The Making of the First Global Economy in the Context of Human Environment Interaction' major collaborative research initiative (MCRI) project. Rejecting environmental determinism, the larger project predominantly highlights human agency in responding to and reshaping the environment within the context of the making of the Indian Ocean World (IOW) global economy. The project broadly investigates the rise and development of the world's first 'global economy' in the context of human–environment interaction from the early centuries BCE to the present day. The focus is the IOW, an arena of primary geopolitical importance that includes Eastern Africa, the Middle East, Southeast Asia and emerging superpowers, China and India. The present study focuses on Eastern Africa, specifically three regions along the coastline of Tanzania in the modern era (since c.1915). The paper examines how place-specific characteristics (where you live) influence barriers to adaptation to climate change in coastal Tanzania. Also, the paper examines how the relationship between place-specific characteristics in coastal Tanzania and barriers to adaptation to climate change evolves when compositional (biosocial and sociocultural) factors are taken into consideration.

Climate change may be conceptualised in several ways. For instance, it may refer to systematic trends in aspects of climate (e.g. precipitation, temperature ranges) that deviate from relatively recent patterns. It may also refer to changing conditions that are seen in regular environmental fluctuations (e.g. predictable seasonal changes) and in stochastic events or perturbations (e.g. 50-year droughts). For purposes of conceptual clarity, policy and understanding people's actions related to it, we distinguish between these two conceptualisations. In the study and throughout this paper, unless otherwise stated, climate change refers explicitly to systematic trends in aspects of climate (e.g. precipitation, temperature ranges) that deviate from relatively recent patterns. Also, the term 'negative impacts of climate change' refer to participants' responses to an open-ended question on what they perceive as the

deleterious effects of climate change. Respondents considered a plethora of issues as potential negative impacts of climate change. These include prolonged episodes of hot weather, more frequent storms, drought condition or water shortage, increased frequency and magnitude of forest fires, coastal erosion, average temperature increase, and increase and spread of infectious diseases. Other perceived negative impacts of climate change are sea level rise, increased frequency and magnitude of flooding, reduced food production, loss of wildlife habitat, heat strokes or sunburns, water borne diseases, skin cancer and stress or anxiety.

Tanzania's National Adaptation Programme of Action admits that the country is already experiencing the effects of climate change, including frequent and severe droughts leading to serious food shortages; the country has experienced six major droughts over the past 30 years (AF 2011; Hove et al. 2011). Coastal zones are particularly vulnerable to existing climate threats as well, putting natural ecosystems, infrastructure and agriculture in danger (AF 2011). There is evidence that mean annual temperatures have increased by 1 °C since the 1960s, experiencing relatively small increases in hot days and much larger increases in the frequency of hot nights during the same period (McSweeney et al. 2010a, b). Observations of precipitation patterns also reveal statistically significant decreasing trends (McSweeney et al. 2010a, b).

Regarding the future impacts of climate change, models predict that temperatures could increase by 1.0 to 2.7 °C by the 2060s and 1.5 to 4.5 °C by the 2090s, with certain parts of the country experiencing increases in rainfall and others experiencing decreases along with an increase in the proportion of rain that falls in heavy events (McSweeney et al. 2010a, b). Jack (2010) argues that temperature increases across Tanzania are in line with larger-scale projections with some variations caused by the proximity to water bodies and altitude effects. Broadly, most studies project that temperature and rainfall changes will adversely affect the population of Tanzania through food insecurity (Arndt et al. 2012), climate volatility (Ahmed et al. 2011), vulnerability (Ahmed et al. 2011) and economic impacts (Kithiia 2011; Watkiss et al. 2011). Given that the majority of Tanzania's population depends on natural resources for their livelihoods, the country is particularly vulnerable to the impacts of climate change, with vulnerability compounded by poverty, population density and environmental degradation (AF 2011). The International Institute for Environment and Development (IIED) argues that should Tanzania fail to address the impacts of climate change in the agriculture sector, the nation's GDP could decline by 0.6 to 1 percentage in 2030; the effects of climate change post-2030 on Tanzania are predicted to be extreme (IIED 2009). Despite these potential threats, Hepworth (2010) suggests that Tanzania is still not well prepared to adapt to climate change, citing inadequate policy and planning, and a need to better coordinate government and non-government initiatives.

Adaptation to climate change has the potential to alleviate adverse impacts, as well as to capitalise on new opportunities posed by climate change (Parry et al. 2007). While the term adaptation is in wide circulation, there is no single definition that is applied universally. The broad description given by the Intergovernmental Panel on Climate Change is a useful starting point. The panel defines adaptation as 'adjustment in natural or human systems in response to actual or expected climatic

stimuli or their effects, which moderates harm or exploits beneficial opportunities' (McCarthy 2001). At its simplest, adaptation within social systems relates to the processes people use to reduce the adverse effects of climate on their livelihood and well-being, and take advantage of new opportunities provided by their changing environment (Wiseman et al. 2011). Adaptation is a continuous, ever-changing process involving cycles of decision-making, planning, action, observation and, above all, social learning and continuous adjustment (Wiseman et al. 2011). Adaptation can be categorised more specifically into various types and forms: in terms of timing, it can be 'anticipatory' or 'reactive' and on the level of preparation and outside intervention, it can be either 'planned' or 'autonomous' (Tol et al. 2008). In practice, adaptation actions tend to constitute 'ongoing processes, reflecting many factors or stresses, rather than discrete measures to address climate change specifically' (Parry et al. 2007: 720). There are many types of adaptation processes, including incremental improvements though the transformation of existing structures and processes, planned or proactive anticipatory actions, or post-impact reactions (Mukheibir et al. 2013). In this study, adaptation to climate change specifically refers to the anticipatory plans and actions by individuals to avoid or reduce the negative impacts due to the projected climate change through, for example, extreme temperatures, droughts, flooding and storm surges. This study does not consider in its analysis any plans and actions to mitigate greenhouse gas emissions.

Inevitably, efforts to facilitate successful adaptation face a number of constraints and barriers to promoting the adaptive capacity of those who are most vulnerable (Jones 2010). As the need to adapt to a changing environment is increasingly recognised, it is imperative to characterise and quantify the barriers to adaptation in order to ameliorate the risks associated with a changing environment. Identifying barriers or constraints to adaptation is an important process in supporting successful adaptation planning, particularly where reworking the path-dependent institutional structures, cultures and policy-making procedures is required (Burch 2010). In the context of this paper, a 'barrier' to effective climate change adaptation restricts people's ability to identify, evaluate or manage risks in a way that delivers the highest level of community wellbeing. Lately, extensive research is being focused on barriers to adaptation within the burgeoning literature on climate change (Biesbroek et al. 2013; Jones 2010; Moser and Ekstrom 2010). This critical research interest in barriers to adaptation to climate change hinges on several factors. Biesbroek et al. (2013) argue that barriers to adaptation have scarcely been defined in the literature and no clear indicators exist in order to identify and assess them systematically. Also, a disproportionately large number of studies have hitherto focused on institutional and social dimensions of adaptation. Besides, barriers have predominantly been studied in developed countries with a strong emphasis on water-related areas. Furthermore, most studies on barriers use small-n inductive case approaches while quantitative approaches using social indicators across various contexts are inadequate. Adaptation to climate change is seldom undertaken in a stand-alone fashion, but as part of broader social and development initiatives. Adaptation has limits, some posed by the magnitude and rate of climate change, and

others that relate to financial, institutional, technological, cultural and cognitive barriers (Parry et al. 2007).

Local studies on non-institutional forms of barriers to climate change adaptation are missing from the literature. We contribute to the literature by focusing on personal barriers to climate change adaptation. The novelty of this paper resides in the attention we pay to personal barriers. To develop a successful adaptation strategy for change, we need to understand the personal barriers faced by individuals in local settings. Using this knowledge, we can consider which barriers and levers may operate in local communities and which may be relevant to a particular climate change-related problem. Following careful consideration, it is possible to develop a tailored approach to overcome the personal barriers, encourage changes in behaviour and ultimately implement adaptation. In this paper, we argue that there is a place-specific component to climate change adaptation. Understanding the reason why certain areas and neighbourhoods have poorer adaptation is a major concern for policy makers, planners, and hazard and disaster services providers in cities around. Locations usually characterised by socio-economic disadvantage, social exclusion and poorer physical environment have consistently poorer outcomes in terms of well-being and adaptation. These spatial inequalities in adaptive capacities are increasingly becoming subject of much research and academic discussion (Adger et al. 2009). The capacities for adaptation and the processes by which it occurs vary greatly within and across regions, countries, sectors and communities (Parry et al. 2007). There are significant outstanding research challenges in understanding the processes by which adaptation is occurring and will occur in the future, and in identifying areas for leverage and action by government. It is within this research context that this study was conducted in Tanzania.

Theoretical context

Observed differences in adaptation to climate change between places have traditionally been attributed to one of two possible explanations: compositional (biosocial and sociocultural) and contextual (place-specific). The first explanation is that differences in adaptation between places are a result of the differences in the characteristics of people who live in these places (a compositional explanation). Often linked to this explanation is the fact that lower individual socio-economic status is associated with lower adaptive capacities and poorer adaptation outcomes (see Bryan et al. 2013; Grothmann and Patt 2005; Reser and Swim 2011; Reser et al. 2012; Unsworth et al. 2013). The other explanation is that differences in adaptation to climate change between places are due to differences in the characteristics of these places (a contextual explanation). This explanation is given when differences cannot be explained by individual factors (see Artur and Hilhorst 2012). However, it is plausible to argue that this distinction is somewhat artificial due to the evidence of the interrelationship between people and places.

Barriers to adaptation have been conceptualised in different ways in the literature. Moser and Ekstrom (2010) drew from the international literature and

synthesised a set of cross-cutting barriers to adaptation. The set reinforces a number of key barriers that are frequently cited in the adaptation literature (Measham et al. 2011), namely the lack of information, the lack of resources, institutional limitations, poor communication, and the deeply held values and beliefs that show how people respond to climate risks and their management. The degree to which the barriers appear in each stage of the adaptation process is dependent on contextual features, but it is important to highlight that they have been posed as significant barriers in every documented case of adaptation (Moser and Ekstrom 2010). The work by Moser and Ekstrom (2010) provides a useful diagnostic framework for characterising and organising barriers at different phases of the adaptation process across space and time, and locates possible points of intervention to overcome a given barrier. Moreover, it questions how best to support adaptation at all levels of decision-making and thereby improve the allocation of resources and strategically design processes to address the barriers. The framework draws on theories of coupled socio-ecological systems thinking, as well as multi-level governance theories by paying attention to scale, contextual processes, structures, etc., enabling a flexible approach to examining barriers (Cash et al. 2006).

Similar to Moser and Ekstrom (2010), Smit and Pilifosova (2001) also highlight barriers to adaptation except they emphasise equity and technology. Amundsen et al. (2010), however, follow a governance framework in conceptualising barriers to adaptation, whereas Naess et al. (2005) analysed barriers from an institutional perspective. Jones (2010) broadly structured barriers to adaptation into three distinct, yet interrelated groupings: natural, social and informational. In this context, natural barriers consist of ecological and physical domains. Social barriers comprise of normative, cognitive and institutional aspects. It is increasingly clear that adaptation responses to climate change can be limited by human cognition (Grothmann and Patt 2005; Moser 2005). Social and cultural barriers to adaptation can be related to the different ways in which people and groups experience, interpret and respond to climate change. Individuals and groups may have different risk tolerances, as well as different preferences about adaptation measures, depending on their worldviews, values and beliefs (Matasci et al. 2013; Moser and Ekstrom 2010; Parry et al. 2007). Conflicting understandings can impede adaptive actions. Differential power and access to decision-making processes may promote adaptive responses by some, while constraining them for others. In addition, diverse understandings and prioritisations of climate change issues across different social and cultural groups can limit adaptive responses (Ford and Smit 2004).

Some studies have explored the behavioural foundations of adaptive responses, including the identification of thresholds or points at which adaptive behaviour begins (e.g. Grothmann and Patt 2005). Key findings from these studies point to different types of cognitive limits to adaptive responses to climate change. For example, Niemeyer et al. (2005) found that thresholds of rapid climate change may induce different individual responses influenced by trust in others (e.g. institutions and collective action), resulting in adaptive, non-adaptive and maladaptive behaviours. Calls for effective climate change adaptation have focused on conveying a consistent, sound message, with the reality of anthropogenic climate change at its core. This call, coupled with making climate change personally

relevant through messages of practical advice on individual actions, helps to embed responses in people's locality.

Informational barriers encapsulate knowledge, technological and economic domains. These include the various spatial and temporal uncertainties associated with forecast modelling, and low levels of awareness and information among policy makers on the impacts of climate change, as well as a lack of financial resources and assistance to facilitate adaptation interventions. Knowledge of climate change causes, impacts and possible solutions does not necessarily lead to adaptation. Well-established evidence from the risk, cognitive and behavioural psychology literatures points to the inadequacy of the 'deficit model' of public understanding of science, which assumes that providing individuals with scientifically sound information will result in information assimilation, increased knowledge, action and support for policies based on this information (Sturgis and Allum 2004; Lorenzoni et al. 2005). Individuals' interpretation of information is mediated by personal and societal values and priorities, personal experience and other contextual factors (Irwin and Wynne 1996). As a consequence, an individual's awareness and concern either do not necessarily translate into action, or translate into limited action (Baron 2006; Weber 2006). This is also known as the 'value-action' or 'attitude-behaviour' gap (Blake 1999) and has been shown in a small number of studies to be a significant barrier to adaptation action (e.g. Patt and Gwata 2002).

Perceptions of adaptive capacity can either stimulate or constrain adaptation to climate change. Psychological research, for example, has provided empirical evidence that perceived barriers to adaptation by the vulnerable, in fact, limit adaptive actions, even when there are capacities and resources to adapt. Grothman and Patt (2005) found that action was determined by both perceived abilities to adapt and observable capacities to adapt. They conclude that a divergence between perceived and actual adaptive capacity is a real barrier to adaptive action. Similarly, Moser (2005) found that perceived barriers to action are a major constraint in coastal planning for climate change adaptation. Broadly, the literature indicates that an individual's awareness of an issue, personal experience and a sense of urgency of being personally affected are necessary but insufficient conditions for behaviour or policy change. Perceptions of risk, vulnerability, motivation and capacity to adapt will also affect behavioural change. These perceptions vary among individuals and groups within populations, and some can act as barriers to climate change adaptation.

Taking cognisance of the wider literature on barriers to climate change adaptation, we conceptualise personal barriers to climate change adaptation as a product of both compositional factors (biosocial and sociocultural) and contextual factors as shown in Fig. 1. Biosocial factors (age, sex and ethnicity) are intrinsically personal. These personal attributes have an underlying physical or biological component and as such are ascribed at birth and not easily amenable to change (Pol and Thomas 2013). The second set of compositional factors, namely sociocultural attributes, reflects the position of individuals within the social structure. These attributes are achieved rather than ascribed through an individual's place in the social system. Further, these attributes are inherently 'cultural' in that those affected take on characteristics assigned by society (Pol and Thomas 2013).

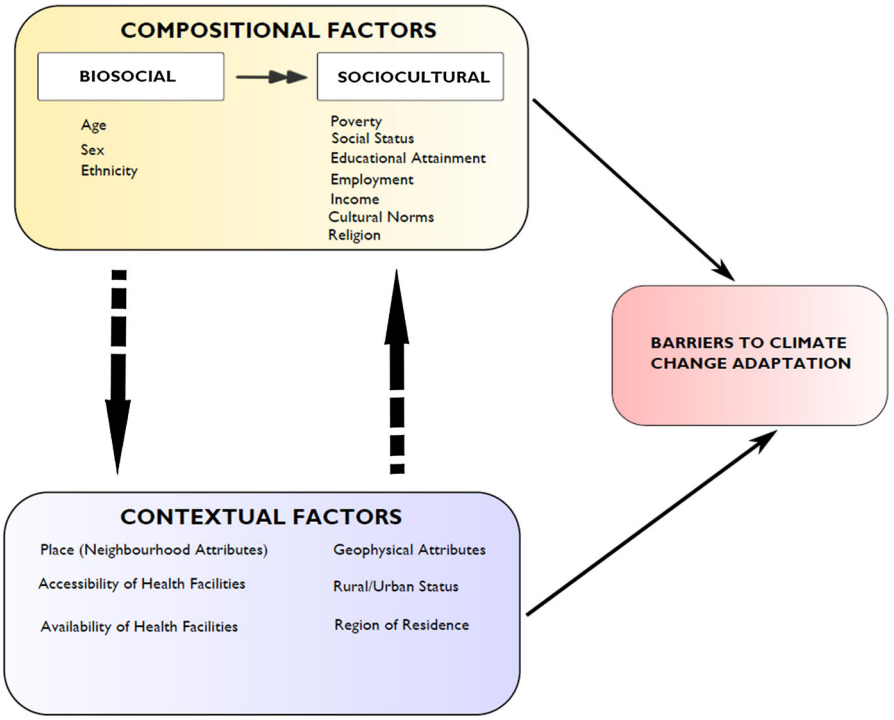

Fig. 1 Conceptualisation of the relationship between personal barriers to climate change adaptation and compositional and contextual factors

Materials and method

Study area

Tanzania is a coastal country lying between longitude 29° and 49° East and latitude 1° and 12° south of the Equator (Francis and Bryceson 2001). The marine waters comprise 64,000 km^2 as territorial waters and 223,000 km^2 as offshore waters (Mngulwi 2003). Tanzania's coastline stretches 800 km with five coastal regions: Tanga, Pwani, Dar es Salaam, Lindi and Mtwara. The five coastal regions cover about 15 percentage of the country's total land area and are home to approximately 25 % of the country's population (TCMP 2003). According to the 2012 Population and Housing census, the total population was 44,928,923 compared with 12,313,469 in 1967 (National Bureau of Statistics 2013), reflecting an annual growth rate of 2.9 percentage. Forty-four percentage of the population are under the age of 15, 35.5 % 15–35, 16.7 % 36–64 and 3.8 % are over the age of 64 (National Bureau of Statistics 2013). Overall, Tanzania, on average, is sparsely populated with a population density of 51 people/km^2. The population density varies from 1 person/km^2 in arid regions, to 51 people/km^2 in the mainland's well-watered highlands, to 134 people/km^2 in Zanzibar (United Republic of Tanzania 2013). Dar es Salaam

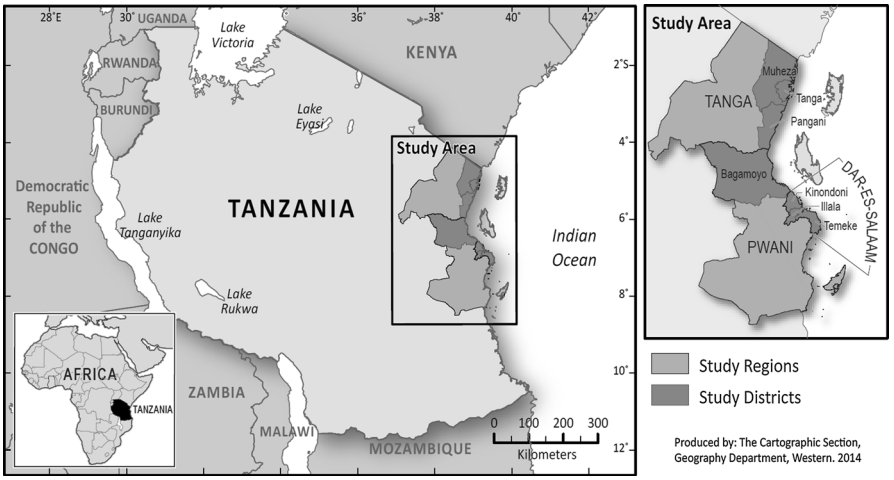

Fig. 2 Map of Tanzania showing study area, regions and districts

region is the most densely populated area (3,133 people/km^2), while Lindi has a much lower population density (13.1 persons/km^2) (National Bureau of Statistics 2013). This shows wide disparities in population density across regions. This study specifically focuses on Dar es Salaam, Pwani and Tanga. The three coastal regions selected for analysis were chosen for two main reasons. First, the three regions are of historical significance to the Indian Ocean World project. Secondly, these regions were selected because of the five coastal regions they are the most ethnically diverse (i.e. representative of the different geographical locations) and thus had better prospects of providing representative heterogeneous survey responses. Dar es Salaam is the capital of the Dar es Salaam Region, which is one of Tanzania's 26 administrative regions. The Dar es Salaam Region consists of three local government areas or administrative districts: Kinondoni to the north, Ilala in the centre of the region and Temeke to the south. Pwani (coast) is the 21st most densely populated region. It is bordered to the north by the Tanga Region, to the east by the Dar es Salaam Region and the Indian Ocean, to the south by the Lindi Region and to the west by the Morogoro Region. Tanga region has a population of 2,045,205 (United Republic of Tanzania, 2013). It is bordered by Kenya and Kilimanjaro Region to the north, Manyara Region to the west and Morogoro and Pwani regions to the south. Its eastern border is formed by the Indian Ocean (Fig. 2).

Data collection

The study design was approved by the Western University Research Ethics Board Canada. The Commission on Science and Technology (COSTECH) in Tanzania also granted research approval. A cross-sectional survey was conducted with 1,253 individuals in three regions (Dar es Salaam, Tanga and Pwani) along the coastline of Tanzania. The data were collected between March and September 2013. The study

population included male (606) and female (647) participants between the ages of 18 and 70 years. The study used multistage sampling to obtain representative estimates of the population of residents of the three regions. Within each region, a list of villages based on the 2012 Population and Housing Census was divided into clusters ensuring adequate numbers of eligible respondents and then further into households. This approach both corrects for sampling bias and weights the cases to match census percentages of males and females of various age groups and by ethnicity. The enumeration areas (EAs) and their total number of households were listed geographically by urban and rural areas. Where EAs did not include the minimum number of households, geographically adjacent EAs were amalgamated to yield sufficient households. This provided the frame for selecting the clusters to be included in the survey according to a stratified systematic sampling technique in which the probability for the selection of any cluster was proportional to its size. A sampling interval was calculated by dividing the total number households by the number of clusters. A random number between 1 and the sampling interval was computer generated. The EA in which the random number fell was identified as the first selected cluster. The sampling interval was applied to that number and then progressively until the 20 (urban) and 15 (rural) clusters were identified. These clusters made up the sample for the survey. Individuals in the households were randomly selected from these clusters for interview.

Measures

Outcome variable

Conceptually, barriers to climate change adaptation are complex and have several distinct but interrelated components (Adger et al. 2009; Bryan et al. 2009; Moser and Ekstrom 2010; Howden et al. 2007; O'Brien et al. 2006). Given the complexity of the concept and measurement of barriers to adaptation, a combination of domain-specific measures of adaptation was believed to be better than a single measure—this approach is increasingly becoming standard practice (see Moser and Ekstrom 2010). Further, the literature indicates that complex approaches, such as factor analysis or latent variable analysis, are very useful in providing a nuanced understanding of multidimensional constructs. Initially, all respondents were asked whether they experienced a barrier to adaptation to climate change or not. Out of 1,253, about 1,130 responded in the affirmative and were further asked to identify specific barriers to adaptation to climate change they had previously experienced. From exploratory analyses of the questions capturing barriers to adaptation to climate change, we retained nine questions, all of which were dichotomous and were recoded such that higher values indicate a specific barrier. The questions are whether or not to adapt to climate change respondents: don't know what steps to take (knowledge), lack the skills needed (knowledge), lack personal energy or motivation (cognitive), lack of time (personal resources), lack of money or the resources needed (financial resources), lack help from others (cultural), feel I don't make a difference (cognitive, emotion), don't believe in climate change (cognitive, personal values, cultural) and believe government will protect me (cognitive,

institutional). We derived a composite index of barriers to adaptation to climate change through principal component and factor analysis. All factors loaded on a single construct. Cronbach's alpha for the index was 0.789.

The primary independent variables

Adaptation to climate change is place dependent. By extension, therefore, barriers to adaptation to climate are also place specific or context specific. Five place-specific factors were the main predictors in this study. Two variables, geographical location (coastal administrative regions of Dar es Salaam, Pwani and Tanga) and residential locality (rural and urban), constitute the first set of place-specific factors. The second set is availability of health facilities in the neighbourhood (categorical), distance to nearest health facility (continuous), and accessibility of health facility in the neighbourhood (categorical).

Control variables

Socio-demographic variables that have frequently been shown to associate with barriers to adaptation to climate change were included as controls: age, sex, marital status, level of education, income, occupation and ethnicity. A number of theoretical links have been identified. First, educated individuals are less likely to experience deleterious consequences of climate change and to encounter maladaptation because they supposedly have a better understanding and appreciation for effective adaptation related matters (Brooks et al. 2005; Deressa et al. 2009; Halsnæs and Verhagen 2007). Socioculturally, educated individuals are also less subservient to norms and practices that adversely affect their adaptation choices and adaptive capacity (Lowe et al. 2006). The general presumption in the literature is that rural–urban residence distinguishes clearly between poor and good sanitation, housing structure and availability of disaster relief and adaptation resources (Laukkonen et al. 2009). In Tanzania, not only are rural populations disadvantaged socio-economically, but they are historically under served in disaster infrastructure and emergency relief personnel. Urban residents are also more likely than their rural counterparts to flout customs and taboos that could negatively affect adaptation to climate change (Swim et al. 2009). Again, Tanzania displays a distinctive regional disparity in development with roots in colonial development policy.

Statistical analysis

Inferential and multivariate techniques were applied to examine associations between barriers to adaptation to climate change and the place-specific factors while controlling for theoretically relevant sociocultural and biosocial variables using STATA 13SE software. The ordinary least square technique was employed for the analysis. Analyses were preceded by diagnostic tests to establish whether variables met the assumptions of the regression model. Univariate analysis of the predictors on each of the nine questions that measure barrier to adaptation was operationalised via Pearson's Chi-square statistics. Bivariate analysis was initially performed to

examine zero-order correlations between the dependent variable and theoretically relevant independent variables. Further, multivariate models were estimated to explore the net effects of the predictor variables using the stepwise selection approach. For analytical purposes, the unstandardized regression coefficients were estimated. Positive coefficients for any of the predictors indicate higher barrier to climate change adaptation scores, while negative coefficients show lower barrier to climate change adaptation scores. The ordinary least square (OLS) regression models in this study are built under the assumption of independence of subjects, but the cross-sectional survey has a hierarchical structure with respondents nested within survey clusters, which could potentially bias the standard errors. STATA 13 SE (StataCorp, College Station, TX, USA), which has the capacity to address this problem, is used by imposing on our models a 'cluster' variable, that is, the identification numbers of respondents at the cluster level. This in turn adjusts the standard errors (SE) producing statistically robust parameter estimates.

Results

Descriptive and bivariate results

Contingency tables showing the distribution of the barriers to adaptation to climate change by place-specific and compositional (biosocial and sociocultural) variables are shown in "Appendix". There were no age differences between residents who were familiar with protective measures against the negative consequences of climate change and those did not know. Further, these two groups of residents did not differ in availability of health facilities in their neighbourhood. However, there were differences between residents who knew what steps to take and those who did not know what steps to take to protect themselves against the negative consequences of climate change by sex, ethnicity, religion, occupation, educational attainment, and district of residence, accessibility of a health facility in the neighbourhood, residential locality, and by administrative region (Appendix).

There were no differences in age, marital status, religious, accessibility to and availability of a health facility, and ethnicity among residents who had or lacked the skill needed to protect themselves against the negative consequences of climate change. However, differences in sex, occupation, education, district, residential locality and region were observed between these two groups.

Regarding lack or not of personal energy or motivation to protect oneself against the negative consequences of climate change, there were differences in marital status, occupation, district, accessibility to a health facility in the neighbourhood, residential locality and region.

There were no differences in sex, age and marital status among respondents when examining lack of time to protect themselves against the negative consequences of climate change. Regarding lack of money or resources as a barrier to adaptation, there were differences among respondents by all compositional and place-specific variables except residential locality. In terms of lack of help from others as a barrier

to adaptation, there were no differences among respondents by sex, marital status, religion and residential locality.

There were no differences found in sex, marital status or accessibility of a health facility in their neighbourhood between respondents who believed in climate change or otherwise. Further no differences in sex, age, religion or educational attainment were observed between respondents who believed God will protect them from the negative consequences of climate change or otherwise.

Table 1 shows zero-order relationships between the explanatory variables and barrier to climate change adaptation. The bivariate level analysis shows biosocial differences regarding barriers to adaptation to climate change among respondents. For instance, individuals in the 26–30 age group had lower barrier to adaptation scores compared with their counterparts in the 18–25 age group. Also, individuals belonging to the Mwera, Makonde and Wayao ethnic groups had increased scores on barrier to adaptation to climate change compared to their Zaramo ethnic counterparts. However, individuals belonging to the Nyamwezi ethnic group had reduced scores on barrier to adaptation.

It also emerged that sociocultural/socio-demographic factors were associated with barriers to climate change adaptation. For instance, individuals who had very easy and easiest accessibility to health facilities in their neighbourhoods had reduced scores on barrier to climate change adaptation compared with those without access to health facilities in their neighbourhood. Also, individuals with higher levels of education had reduced barrier to adaptation scores, compared with those without formal education. However, the relationship between gender and barrier to climate change adaptation was not statistically significant.

Table 1 Bivariate regression predicting barriers to adaptation to climate change

	Barrier to adaptation to climate change		
	Coefficients	Robust SE	Intercept
Availability of health facility in the neighbourhood	0.38***	0.09	−0.34
Distance to nearest health facility	−0.05*	0.02	0.08
Accessibility of health facility in the neighbourhood	−0.32***	0.06	0.19
Residential locality (Rural)	0.008	0.06	−0.01
Region	−0.08*	0.03	0.15
Sex	−0.01	0.06	0.02
Educational attainment	0.02	0.03	−0.04
Marital status	0.26***	0.06	−0.42
Age	0.06*	0.03	−0.13
Ethnicity	0.003	0.04	−0.01
Religion	−0.03	0.06	0.06
Employment	−0.22	0.11	0.21
Income	−7.2e−08	7.4e−08	0.02

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Multivariate analysis

In the multivariate model (Table 2), with the exception of residential locality, the relationships between barriers to climate change adaptation and all place-specific

Table 2 Multivariate regression predicting barriers to adaptation to climate change

	Model 1: place-specific factors		Model 2: place + compositional factors	
	Coef.	Robust SE	Coef.	Robust SE
Intercept	−0.04	0.15	−0.23	0.24
Region (Ref: Dar es Salaam)				
Pwani	−0.33**	0.12	−0.34**	0.12
Tanga	−0.25*	0.09	−0.25*	0.10
Residential locality (Ref: Urban)				
Rural	0.30**	0.11	0.24*	0.10
Availability of health facility in the neighbourhood (Ref: no)				
Yes	0.59***	0.12	0.53***	0.12
Distance to nearest health facility	−0.08**	0.03	−0.08**	0.02
Accessibility of health facility in the neighbourhood (Ref: not easy)				
Easy	−0.54***	0.07	−0.53***	0.07
Sex (Ref: Male)				
Female			0.04	0.06
Educational attainment (Ref: no education)				
Primary			0.27*	0.11
Secondary			0.28*	0.13
Tertiary			0.27	0.15
Marital status (Ref: unmarried)				
Married			0.24***	0.06
Age (Ref: 18–35)				
36–50			0.09	0.07
31–65			0.20*	0.08
More than 65			0.18	0.12
Ethnicity (Ref: Zaramo)				
Sambaa			−0.11	0.12
Others			−0.02	0.08
Religion (Christian)				
Muslim			−0.03	0.07
Traditional			0.38	0.48
Employment (Ref: unemployed)				
Employed			−0.19	0.12
Income			−1.25e−07	9.34e−08
R^2 (Adjusted R^2)	**0.10 (0.09)**		**0.13 (0.12)**	

The effective size are shown in bold values

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

explanatory variables were robust and remained statistically significant even when biosocial (age, sex, ethnicity) and sociocultural factors were controlled. Except marital status and age, there were no statistically significant relationships between barrier to climate change adaptation and any of the biosocial and sociocultural factors. Once marital status was controlled, the relationship between residential locality and barrier to climate change adaptation disappeared, suggesting that marital status fully mediates the relationship between residential locality and adaptation to climate change.

Individuals who lived proximal to health facilities had reduced scores on barrier to climate change adaptation compared with their counterparts who lived distal from health facilities. Similarly, individuals with easy, very easy and easiest access to health facility in the neighbourhood had reduced scores on barrier to climate change adaptation compared with their counterparts without access to such services. Rural dwellers had increased barrier to climate change adaptation scores compared with their urban counterparts. Surprisingly, individuals who had attained primary or tertiary education had increased barrier to climate change adaptation scores compared with their counterparts with no formal education.

Divorced and widowed individuals both had increased scores on barrier to climate change adaptation compared with their counterparts who were single. Fishermen/fishmongers, farmers, public servants, civil servants, private company workers and other workers all had reduced barrier to adaptation scores compared with their unemployed counterparts. However, religion, ethnicity and gender had no relationship with barriers to climate change adaptation in the multivariate model.

Discussion

This paper evaluates how place-specific characteristics (where you live) influence barriers to adaptation to climate change in coastal Tanzania. Understanding differentials in adaptation to climate change from place to place is crucial to designing and targeting public policy to reduce climate-induced excess vulnerability, especially in developing countries. We stress that we are not suggesting that compositional (biosocial and sociocultural) attributes are not (potentially) important for adaptation to climate change. Based on the results in this study, however, adaptation to climate change is much more a reflection of place-specific attributes than compositional attributes.

In studying the role of space in shaping adaptive capacity and vulnerability, individual-level (compositional) and place-level (contextual) factors have traditionally been identified (Adger et al. 2009). Barriers related to high vulnerability, low levels of adaptive capacity, weak institutional environments and low priority of adaptation have hitherto been the focus in low-income countries (Biesbroek et al. 2013; Nielsen and Reenberg 2010) compared to other pressing societal issues. Particularly, non-climatic socio-economic variables, such as inequality, inequity, religious tensions and poverty, are mentioned as conditions that influence social vulnerability and constrain adaptive practices in low-income countries (Nielsen and Reenberg 2010).

Interestingly, we found no gender differences in barriers to adaptation to climate change among respondents in coastal Tanzania. This may be because the sample

was drawn from more urbanised areas where gender inequality is reduced compared to rural settings. Several researchers generally (Agrawal 2010; Arora-Jonsson 2011; Demetriades and Esplen 2008; Nellemann et al. 2011; Terry 2009) and specifically in Tanzania (Paavola 2008) highlight gender disparities in adaptation to climate change and its role in reinforcing inequality and unintended adaptation policy outcomes in varying contexts.

Place (either physical or social) is central to a nuanced understanding of the coupling of the local and national political economy, and how this mediates knowledge on climate change adaptation. In this context, place is regarded as complex, socially constructed, unbounded, fluid and dynamic. Place-specific differences in barriers to adaptation were robust and remained statistically significant even after controlling for socio-demographic (compositional) variables in the multivariate model. This underscores the fact that observed differences in barriers to adaptation to climate change along the coastline of Tanzania mainly reflect place-specific disparities among groups rather than intrinsic biosocial and sociocultural attributes. Empirical evidence shows that climate risks, local capacity to adapt and causes of vulnerability are all place specific. Variations in public and aid policies and historical, geographical and other factors, likely result in substantial differences in vulnerability to climate stress across regions and groups (Eriksen et al. 2007). Each specific context demands a different set of measures; therefore, sustainable adaptation measures must be place specific. There is no one-size-fits-all solution that will contribute to both vulnerability and poverty reduction (Eriksen et al. 2007).

Geographic analyses emphasise the importance of the scale and location of social relationships and have explored how adaptive capacity or adaptation to environmental (climate) change is directly linked to access to social services (e.g. health facilities), especially in resource-dependent societies (Adger 2010; McGranahan et al. 2007; Morton 2007; Wilby and Dessai 2010). A change from empirical research intended to differentiate between contextual and compositional effects to research that focuses on the processes and interactions occurring between places and people and over time is important and warranted for adaptation research. Such a conceptualisation of place may inform evidence-based public policy on climate change adaptation.

Age had no statistically significant relationship with barriers to climate change adaptation. According to Adger et al. (2009), factors such as age operate at individual decision-making levels but also constrain collective action regarding adaptation decision-making. This is especially true for very old individuals with limited mobility. Structural and group characteristics such as gender, race, ethnic affiliation and age, even when they are not consistent predictors, are often closely related to vulnerability and adaptation (Agrawal 2010). However, Grothmann and Patt (2005) found that age, gender and highest school degree had limited explanatory power for proactive adaptation regarding flooding in Cologne, Germany.

Counter-intuitively, individuals who had attained tertiary education had increased barrier to climate change adaptation scores compared with their counterparts with no formal education. Some evidence suggests that there is a positive relationship between the education level of individuals and adaptation to climate change (Maddison 2006; Deressa et al. 2009). Therefore, individuals with

higher education levels are more likely to better adapt to climate change. Our findings indicate that highly educated individuals rather had increased barriers to climate change adaptation scores and, by extension, lower adaptation. This rather novel finding is inconsistent with the findings of Madison (2006) and Deressa et al. (2009). We assume that beyond a threshold level of formal education, either complacency on adaptive choices sets in for the highly educated or the benefits of adaptive choices for the highly educated levels off.

We found no relationship between income and barriers to climate change adaptation. This is not entirely surprising as Grothmann and Patt (2005) also found similar results in Germany. A narrow focus on low income as a barrier to climate change adaptation is inadequate because it ignores both the non-material or non-income aspects of poverty and the processes of exclusion and marginalization that generate poverty. Mertz et al. (2011), however, underscore the importance of income, which generates opportunities, especially in marginal rural areas, for long-term adaptation strategies to climate variability and change.

Tanzania developed a national climate change adaptation strategy in 2012. This strategy has identified the need to build the capacity of key economic sectors and relevant institutions to address climate change adaptation and mitigation. Cross-cutting issues include the establishment and implementation of awareness creation programmes to sensitise the public on climate change impacts, as well as adaptation and mitigation options; establishment of adequate research capacity for various research and development and training institutions to address issues related to climate change; building sufficient capacities of social facilities to address climate change-related health risks; supporting acquisition of appropriate disaster risk management technologies (for example, enhancing early warning systems and weather forecasting systems); and promoting effective documentation of indigenous knowledge on climate change adaptation and mitigation in diverse sectors. The National Climate Change Technical Committee (NCCTC) and National Climate Change Steering Committee (NCCSC) have the mandate to guide the coordination and implementation of this strategy. The NCCTC provides technical advice to the National Climate Change Focal Point (NCCFP), while the NCCSC provides policy guidance and ensure coordination of actions as well as cross-sector participation. Although the climate change adaptation strategy underscores the need for place-specific climate campaigns, institutional barriers are the main focus of the strategy. No attention, whatsoever, is paid to personal barriers although such barriers have potentially far-reaching impacts.

Conclusion

This paper shows that differences in barriers to adaptation to climate change along the coastline of Tanzania mainly reflect place-specific disparities among groups rather than intrinsic biosocial and sociocultural attributes. In any given context, it is critical to understand the specific barriers to climate change adaptation and how people specifically adapt. Climate risks, local capacity to adapt and causes of vulnerability are all place specific. We conclude that where you live definitely

affects the barriers to climate change adaptation encountered by individuals in coastal Tanzania. Except residential locality, the relationships between barriers to climate change adaptation and all place-specific explanatory variables were robust and refused to disappear even when biosocial and sociocultural factors were controlled. Therefore, sustainable adaptation measures must be place specific since there is no one-size-fits-all solution that will contribute to both vulnerability reduction and weak adaptive capacity reduction. Most studies have hitherto focused on institutional barriers to climate change adaptation rather than paying attention to personal barriers. The uniqueness of this study lies in its attention to the latter, especially in the context of a developing country. Adaptation to climate change and risks takes place in a dynamic social, economic, technological, biophysical and political context that varies over time, location and sector. This complex mix of conditions determines the capacity of individuals to adapt. Although scholarship on adaptation is quite limited in the climate change field, there is considerable understanding of the conditions that influence the adaptability of societies to climate stimuli in the fields of hazards, resource management and sustainable development. Addressing the plethora of barriers to climate change adaptation at the individual-level will, thus, require a comprehensive and dynamic policy approach covering a range of scales and issues. This will almost certainly involve a chain of actions ranging from a nuanced understanding of a spectrum of adaptation options to the establishment of efficient social services that facilitate adaptation strategies of the vulnerable in society.

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Appendix

Contingency tables show the distribution of the barriers to adaptation to climate change by Place-specific and compositional (biosocial and sociocultural) variables

Distribution of self-reported barriers to adaptation to climate change: don't know what steps to take to protect myself ($n = 1{,}130$)

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
Compositional factors			
Sex			$\chi^2\,(1) = 9.9300$, Pr $= 0.002$, Cramer's $V = 0.09$
Male	45.3	54.7	
Female	54.7	45.3	
Age			$\chi^2\,(3) = 0.5389$, Pr $= 0.900$, Cramer's $V = 0.02$
18–35	49.8	50.2	
36–50	50.9	49.1	

continued

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
51–65	48.9	51.1	
More than 65	53.2	46.8	
Marital status			χ^2 (1) = 0.7202, Pr = 0.396, Cramer's $V = -0.02$
Unmarried	51.9	48.1	
Married	49.2	50.8	
Ethnicity			χ^2 (2) = 11.2682, Pr = 0.004, Cramer's $V = 0.10$
Zaramo	59.8	40.2	
Sambaa	45.4	54.6	
Others	48.0	52.0	
Religion			χ^2 (2) = 32.4003, Pr = 0.000, Cramer's $V = 0.16$
Christian	39.5	60.5	
Muslim	55.8	44.2	
Traditional	0.0	100.0	
Employment			χ^2 (1) = 3.3447, Pr = 0.067, Cramer's $V = -0.05$
Unemployed	60.0	40.0	
Employed	49.4	50.6	
Income*	–	–	–
Educational attainment			χ^2 (3) = 50.0298, Pr = 0.000, Cramer's $V = 0.21$
No education	64.4	35.6	
Primary	57.8	42.2	
Secondary	44.9	55.1	
Tertiary	31.4	68.6	
Place-specific factors			
Availability of health facility in the neighbourhood			χ^2 (1) = 0.6692, Pr = 0.413, Cramer's $V = 0.02$
Yes	54.2	45.8	
No	49.8	50.2	
Region			χ^2 (2) = 60.5685, Pr = 0.000, Cramer's $V = 0.23$
Dar es Salaam and Zanzibar	38.3	61.7	
Pwani	63.9	36.1	
Tanga	58.6	41.4	
Distance to nearest health facility*	–	–	–
Accessibility of health facility in the neighbourhood			χ^2 (1) = 13.3316, Pr = 0.000, Cramer's $V = 0.11$
Not easy	43.3	56.7	
Easy	54.4	45.6	
Residential locality			χ^2 (1) = 41.7254, Pr = 0.000, Cramer's $V = 0.19$
Rural	61.7	38.3	
Urban	42.2	57.8	

* Income and distance to nearest health facility are continuous variables

Distribution of self-reported barriers to adaptation to climate change: lack the skill needed ($n = 1{,}130$)

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
Compositional factors			
Sex			χ^2 (1) = 8.0164, Pr = 0.005, Cramer's $V = 0.08$
Male	66.2	33.8	
Female	73.9	26.1	
Age			χ^2 (3) = 4.2596, Pr = 0.235, Cramer's $V = 0.06$
18–35	69.0	31.0	
36–50	68.7	31.3	
51–65	71.8	28.2	
More than 65	79.2	20.8	
Marital status			χ^2 (1) = 3.9051, Pr = 0.048, Cramer's $V = 0.06$
Unmarried	66.6	33.4	
Married	72.2	27.8	
Ethnicity			χ^2 (2) = 4.7400, Pr = 0.093, Cramer's $V = 0.06$
Zaramo	75.9	24.1	
Sambaa	67.2	32.8	
Others	69.1	30.9	
Religion			χ^2 (2) = 5.4271, Pr = 0.06, Cramer's $V = 0.07$
Christian	66.1	33.9	
Muslim	72.4	27.6	
Traditional	50.0	50.0	
Employment			χ^2 (1) = 12.0575, Pr = 0.001, Cramer's $V = -0.09$
Unemployed	86.2	13.8	
Employed	69.1	30.9	
Income*	–	–	–
Educational attainment			χ^2 (3) = 59.7848, Pr = 0.000, Cramer's $V = 0.23$
No education	83.9	16.1	
Primary	77.9	22.1	
Secondary	65.3	34.7	
Tertiary	51.0	49.0	
Place-specific factors			
Availability of health facility in the neighbourhood			χ^2 (1) = 0.5051, Pr = 0.477, Cramer's $V = 0.02$
Yes	67.5	32.5	
No	70.6	29.4	
Region			χ^2 (2) = 16.9107, Pr = 0.000, Cramer's $V = 0.12$
Dar es Salaam and Zanzibar	64.5	35.5	
Pwani	75.7	24.3	
Tanga	75.6	24.4	
Distance to nearest health facility*	–	–	–
Accessibility of health facility in the neighbourhood			χ^2 (1) = 4.5675, Pr = 0.033, Cramer's $V = -0.06$

continued

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
Not easy	73.9	26.1	
Easy	68.0	32.0	
Residential locality			χ^2 (1) = 33.9572, Pr = 0.000, Cramer's $V = 0.17$
Rural	63.8	36.2	
Urban	79.6	20.4	

Distribution of self-reported barriers to adaptation to climate change: lack of personal energy or motivation ($n = 1{,}130$)

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
Compositional factors			
Sex			χ^2 (1) = 3.4068, Pr = 0.065, Cramer's $V = 0.05$
Male	51.2	48.8	
Female	56.7	43.3	
Age			χ^2 (3) = 7.9184, Pr = 0.048, Cramer's $V = 0.08$
18–35	58.9	41.1	
36–50	52.2	47.8	
51–65	48.5	51.5	
More than 65	57.1	42.9	
Marital status			χ^2 (1) = 22.1577, Pr = 0.000, Cramer's $V = -0.14$
Unmarried	63.5	36.5	
Married	49.0	51.0	
Ethnicity			χ^2 (2) = 0.8937, Pr = 0.640, Cramer's $V = 0.03$
Zaramo	56.8	43.2	
Sambaa	53.8	46.2	
Others	53.3	46.7	
Religion			χ^2 (2) = 0.0800, Pr = 0.961, Cramer's $V = 0.0084$
Christian	53.6	46.4	
Muslim	54.3	45.7	
Traditional	50.0	50.0	
Employment			χ^2 (1) = 0.7637, Pr = 0.382, Cramer's $V = -0.03$
Unemployed	58.8	41.2	
Employed	53.7	46.3	
Income*	–	–	–
Educational attainment			χ^2 (3) = 12.5329, Pr = 0.006, Cramer's $V = 0.10$
No education	71.3	28.7	
Primary	52.0	48.0	
Secondary	51.9	48.1	
Tertiary	55.7	44.3	

continued

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
Place-specific factors			
Availability of health facility in the neighbourhood			χ^2 (1) = 3.3476, Pr = 0.07, Cramer's $V = -0.05$
Yes	53.1	46.9	
No	61.8	38.2	
Region			χ^2 (2) = 13.7881, Pr = 0.001, Cramer's $V = 0.11$
Dar es Salaam and Zanzibar	58.4	41.6	
Pwani	55.4	44.6	
Tanga	45.3	54.7	
Distance to nearest health facility*	–	–	–
Accessibility of health facility in the neighbourhood			χ^2 (1) = 38.6438, Pr = 0.000, Cramer's $V = 0.18$
Not easy	42.3	57.7	
Easy	61.3	38.7	
Residential locality			χ^2 (1) = 13.9949, Pr = 0.000, Cramer's $V = -0.11$
Rural			
Urban			

Distribution of self-reported barriers to adaptation to climate change: lack of time (n = 1,130)

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
Compositional factors			
Sex			χ^2 (1) = 1.9559, Pr = 0.162, Cramer's $V = -0.04$
Male	16.1	83.6	
Female	13.2	86.8	
Age			χ^2 (3) = 2.8717, Pr = 0.538, Cramer's $V = 0.05$
18–35	14.5	85.5	
36–50	12.7	87.3	
51–65	16.3	83.7	
More than 65	18.2	81.8	
Marital status			χ^2 (1) = 0.8748, Pr = 0.350, Cramer's $V = -0.03$
Unmarried	15.9	84.1	
Married	13.9	86.1	
Ethnicity			χ^2 (2) = 18.8154, Pr = 0.000, Cramer's $V = 0.12$
Zaramo	10.6	89.4	
Sambaa	5.0	95.0	
Others	17.3	82.7	
Religion			χ^2 (2) = 5.8896, Pr = 0.053, Cramer's $V = 0.07$
Christian	18.1	81.9	
Muslim	12.8	87.2	
Traditional	25.0	75.0	

continued

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
Employment			χ^2 (1) = 1.291, Pr = 0.000, Cramer's $V = -0.03$
Unemployed	18.8	81.2	
Employed	14.3	85.7	
Income*	–	–	–
Educational attainment			χ^2 (3) = 9.6827, Pr = 0.021, Cramer's $V = 0.09$
No education	14.9	85.1	
Primary	11.6	88.4	
Secondary	15.9	84.1	
Tertiary	20.6	79.4	
Place-specific factors			
Availability of health facility in the neighbourhood			χ^2 (1) = 3. 9668, Pr = 0.046, Cramer's $V = 0.06$
Yes	8.9	91.1	
No	15.3	84.7	
Region			χ^2 (2) = 39.2638, Pr = 0.000, Cramer's $V = 0.18$
Dar es Salaam and Zanzibar	21.2	78.8	
Pwani	10.4	89.7	
Tanga	6.8	93.2	
Distance to nearest health facility*	–	–	–
Accessibility of health facility in the neighbourhood			χ^2 (1) = 16.5106, Pr = 0.000, Cramer's $V = 0.11$
Not easy	9.3	90.7	
Easy	17.9	82.1	
Residential locality			χ^2 (1) = 37.7121, Pr = 0.000, Cramer's $V = 0.17$
Rural	7.4	92.6	
Urban	19.6	80.4	

Distribution of self-reported barriers to adaptation to climate change: lack of money or resources needed (n = 1,130)

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
Compositional factors			
Sex			χ^2 (1) = 4.5769, Pr = 0.032, Cramer's $V = 0.06$
Male	61.6	38.4	
Female	67.7	32.3	
Age			χ^2 (3) = 6.6403, Pr = 0.084, Cramer's $V = 0.07$
18–35	63.3	36.7	
36–50	66.8	33.2	
51–65	61.1	38.9	
More than 65	75.3	24.7	

continued

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
Marital status			χ^2 (1) = 3.9364, Pr = 0.047, Cramer's $V = -0.06$
Unmarried	68.6	31.4	
Married	62.7	37.3	
Ethnicity			
Zaramo	65.2	34.8	χ^2 (2) = 0.6799, Pr = 0.712, Cramer's $V = 0.02$
Sambaa	61.3	38.7	
Others	65.1	34.8	
Religion			χ^2 (2) = 6.7887, Pr = 0.034, Cramer's $V = 0.08$
Christian	59.7	40.3	
Muslim	67.4	32.6	
Traditional	50.0	50.0	
Employment			χ^2 (1) = 6.5310, Pr = 0.011, Cramer's $V = -0.07$
Unemployed	77.5	22.5	
Employed	63.8	36.2	
Income*	–	–	–
Educational attainment			χ^2 (3) = 34.1185, Pr = 0.000, Cramer's $V = 0.17$
No education	86.2	13.8	
Primary	68.0	32.0	
Secondary	60.5	39.5	
Tertiary	53.1	46.9	
Place-specific factors			
Availability of health facility in the neighbourhood			χ^2 (1) = 49.8885, Pr = 0.000, Cramer's $V = -0.21$
Yes	95.0	5.0	
No	61.3	38.7	
Region			χ^2 (2) = 15.2163, Pr = 0.000, Cramer's $V = 0.12$
Dar es Salaam and Zanzibar	59.5	40.5	
Pwani	72.9	27.1	
Tanga	66.8	33.2	
Distance to nearest health facility*	–	–	–
Accessibility of health facility in the neighbourhood			χ^2 (1) = 21. 7830, Pr = 0. 000, Cramer's $V = 0.14$
Not easy	56.3	43.7	
Easy	70.0	30.0	
Residential locality			χ^2 (1) = 1.5169, Pr = 0.218, Cramer's $V = 0.04$
Rural	66.9	33.1	
Urban	63.3	36.7	

Distribution of self-reported barriers to adaptation to climate change: lack of help from others ($n = 1{,}130$)

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
Compositional factors			
Sex			χ^2 (1) = 2.3778, Pr = 0.123, Cramer's $V = -0.05$
Male	65.7	34.3	
Female	61.3	38.7	
Age			χ^2 (3) = 8.1575, Pr = 0.04, Cramer's $V = 0.08$
18–35	63.8	36.2	
36–50	59.7	40.3	
51–65	69.6	30.4	
More than 65	57.1	42.9	
Marital status			χ^2 (1) = 1.1464, Pr = 0.284, Cramer's $V = 0.03$
Unmarried	61.2	38.8	
Married	64.5	35.5	
Ethnicity			
Zaramo	64.8	35.2	χ^2 (2) = 3.7892, Pr = 0.150, Cramer's $V = 0.06$
Sambaa	70.6	29.4	
Others	61.8	38.2	
Religion			χ^2 (2) = 2.7308, Pr = 0.255, Cramer's $V = 0.05$
Christian	64.5	35.5	
Muslim	62.6	37.4	
Traditional	100.0	0.0	
Employment			χ^2 (1) = 1.2519, Pr = 0.263, Cramer's $V = 0.03$
Unemployed	57.5	42.5	
Employed	63.8	36.2	
Income*	–	–	–
Educational attainment			χ^2 (3) = 40.0745, Pr = 0.000, Cramer's $V = 0.19$
No education	37.9	62.1	
Primary	60.2	39.8	
Secondary	72.3	27.7	
Tertiary	69.1	30.9	
Place-specific factors			
Availability of health facility in the neighbourhood			χ^2 (1) = 15.6198, Pr = 0.000, Cramer's $V = 0.12$
Yes	46.7	53.3	
No	65.3	34.7	
Region			χ^2 (2) = 52.2237, Pr = 0.000, Cramer's $V = 0.21$
Dar es Salaam and Zanzibar	72.9	27.1	
Pwani	61.4	38.6	
Tanga	48.2	51.8	
Distance to nearest health facility*	–	–	–
Accessibility of health facility in the neighbourhood			χ^2 (1) = 16.3284, Pr = 0.000, Cramer's $V = -0.12$

continued

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
Not easy	70.7	29.3	
Easy	58.9	41.1	
Residential locality			χ^2 (1) = 2.9761, Pr = 0.085, Cramer's $V = -0.05$
Rural	60.4	39.6	
Urban	65.4	34.6	

Distribution of self-reported barriers to adaptation to climate change: feel I don't make a difference ($n = 1{,}130$)

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
Compositional factors			
Sex			χ^2 (1) = 0.0229, Pr = 0.880, Cramer's $V = -0.004$
Male	55.1	44.9	
Female	54.7	45.3	
Age			
18–35	53.4	46.6	χ^2 (3) = 3.2677, Pr = 0.352, Cramer's $V = 0.05$
36–50	52.8	47.2	
51–65	59.3	40.7	
More than 65	57.1	42.9	
Marital status			χ^2 (1) = 20.0352, Pr = 0.000, Cramer's $V = 0.13$
Unmarried	45.8	54.2	
Married	59.7	40.3	
Ethnicity			
Zaramo	53.8	46.2	χ^2 (2) = 0.6465, Pr = 0.724, Cramer's $V = 0.02$
Sambaa	52.1	47.9	
Others	55.6	44.4	
Religion			χ^2 (2) = 2.7983, Pr = 0.247, Cramer's $V = 0.05$
Christian	57.9	42.1	
Muslim	53.3	46.7	
Traditional	75.0	25.0	
Employment			χ^2 (1) = 8.2399, Pr = 0.004, Cramer's $V = -0.08$
Unemployed	70.0	30.0	
Employed	53.7	46.3	
Income*	–	–	–
Educational attainment			χ^2 (3) = 3.9816, Pr = 0.263, Cramer's $V = 0.06$
No education	44.8	55.2	
Primary	55.7	44.3	
Secondary	56.4	43.6	
Tertiary	54.6	45.4	

continued

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
Place-specific factors			
Availability of health facility in the neighbourhood			χ^2 (1) = 22.0902, Pr = 0.000, Cramer's $V = 0.14$
Yes	35.0	65.0	
No	57.3	42.7	
Region			χ^2 (2) = 5.2663, Pr = 0.072, Cramer's $V = 0.07$
Dar es Salaam and Zanzibar	58.4	41.6	
Pwani	52.1	47.9	
Tanga	51.1	48.9	
Distance to nearest health facility*	–	–	–
Accessibility of health facility in the neighbourhood			χ^2 (1) = 9.5747, Pr = 0.002, Cramer's $V = -0.09$
Not easy	60.7	39.3	
Easy	51.3	48.7	
Residential locality			χ^2 (1) = 0.0039, Pr = 0.950, Cramer's $V = 0.001$
Rural	55.0	45.0	
Urban	54.8	45.2	

Distribution of self-reported barriers to adaptation to climate change: I don't believe in climate change ($n = 1{,}130$)

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
Compositional factors			
Sex			χ^2 (1) = 1.3781, Pr = 0.240, Cramer's $V = 0.03$
Male	6.3	93.7	
Female	8.1	91.9	
Age			χ^2 (3) = 4.9499, Pr = 0.176, Cramer's $V = 0.07$
18–35	8.9	91.1	
36–50	5.3	94.7	
51–65	6.7	93.3	
More than 65	10.4	89.6	
Marital status			χ^2 (1) = 0.0256, Pr = 0.873, Cramer's $V = 0.005$
Unmarried	7.1	92.9	
Married	7.3	92.7	
Ethnicity			χ^2 (2) = 12.9632, Pr = 0.002, Cramer's $V = 0.09$
Zaramo	6.8	93.2	
Sambaa	0.8	99.2	
Others	8.4	91.6	

continued

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
Religion			χ^2 (2) = 10.4669, Pr = 0.005, Cramer's $V = 0.09$
Christian	10.4	89.6	
Muslim	5.6	94.4	
Traditional	25.0	75.0	
Employment			χ^2 (1) = 2.9819, Pr = 0.084, Cramer's $V = -0.05$
Unemployed	12.5	87.5	
Employed	6.9	93.1	
Income*	–	–	–
Educational attainment			χ^2 (3) = 8.8704, Pr = 0.031, Cramer's $V = 0.09$
No education	3.4	96.6	
Primary	5.8	94.2	
Secondary	8.3	91.7	
Tertiary	11.3	88.7	
Place-specific factors			
Availability of health facility in the neighbourhood			χ^2 (1) = 8.5152, Pr = 0.004, Cramer's $V = 0.09$
Yes	0.8	99.2	
No	8.0	92.0	
Region			χ^2 (2) = 64.8263, Pr = 0.000, Cramer's $V = 0.24$
Dar es Salaam and Zanzibar	13.6	86.4	
Pwani	2.9	97.1	
Tanga	0.0	100.0	
Distance to nearest health facility*	–	–	–
Accessibility of health facility in the neighbourhood			χ^2 (1) = 6.1195, Pr = 0.013, Cramer's $V = 0.07$
Not easy	4.9	95.1	
Easy	8.7	91.3	
Residential locality			χ^2 (1) = 38.2802, Pr = 0.000, Cramer's $V = -0.18$
Rural	1.5	98.5	
Urban	11.2	88.8	

Distribution of self-reported barriers to adaptation to climate change: believe God will protect me ($n = 1{,}130$)

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
Compositional factors			
Sex			χ^2 (1) = 0.1709, Pr = 0.679, Cramer's $V = -0.01$
Male	40.6	59.4	
Female	39.4	60.6	

continued

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
Age			χ^2 (3) = 8.1728, Pr = 0.043, Cramer's $V = 0.08$
18–35	34.7	65.3	
36–50	41.6	58.4	
51–65	43.7	56.3	
More than 65	46.8	53.2	
Marital status			χ^2 (1) = 1.6277, Pr = 0.202, Cramer's $V = 0.04$
Unmarried			
Married			
Ethnicity			χ^2 (2) = 5.7772, Pr = 0.056, Cramer's $V = 0.07$
Zaramo	42.8	57.2	
Sambaa	30.2	69.8	
Others	40.7	59.4	
Religion			χ^2 (2) = 0.5618, Pr = 0.755, Cramer's $V = 0.02$
Christian	38.7	61.3	
Muslim	40.6	59.4	
Traditional	50.0	50.0	
Employment			χ^2 (1) = 2.6996, Pr = 0.100, Cramer's $V = -0.05$
Unemployed	48.8	51.2	
Employed	39.3	60.7	
Income*	–	–	–
Educational attainment			χ^2 (3) = 2.2766, Pr = 0.517, Cramer's $V = 0.24$
No education	34.5	65.5	
Primary	39.1	60.9	
Secondary	42.7	57.3	
Tertiary	40.7	59.3	
Place-specific factors			
Availability of health facility in the neighbourhood			χ^2 (1) = 3.9549, Pr = 0.047, Cramer's $V = 0.06$
Yes	31.7	68.3	
No	41.0	59.0	
Region			χ^2 (2) = 24.4885, Pr = 0.000, Cramer's $V = 0.15$
Dar es Salaam and Zanzibar	45.3	54.7	
Pwani	42.5	57.5	
Tanga	28.3	71.7	
Distance to nearest health facility*	–	–	–
Accessibility of health facility in the neighbourhood			χ^2 (1) = 14.0137, Pr = 0.000, Cramer's $V = -0.11$
Not easy	47.0	53.0	
Easy	35.7	64.3	

continued

Variables	Yes (%)	No (%)	Pearson's χ^2 (*df*)
Residential locality			χ^2 (1) = 9.3832, Pr = 0.002, Cramer's $V = -0.09$
Rural	34.6	65.4	
Urban	43.7	56.3	

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