

Chapter 25

Evaluating Differences in Barriers to Climate Change Adaptation Between the Poor and Nonpoor in Coastal Tanzania

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Abstract Understanding context-specific barriers to effective climate change adaptation encountered by individuals is necessary to elicit a nuanced understanding of adaptation processes in order to support decision-making. Recent scholarship highlights poverty as a critical element in barriers to climate change adaptation in developing countries. However, even within developing countries marked heterogeneities in poverty and barriers to climate change adaptation exist. As part of a larger study in countries along the Indian Ocean coastline, this paper examines the gap in barriers to climate change adaptation gap between the poor and nonpoor.

A nationally-representative cross sectional survey of 1253 individuals (606 males and 647 females) was carried out in Coastal Tanzania and four counterfactual decomposition techniques were used to analyse the primary data. Differentials in climate change adaptation barriers are predominantly due to group differences in the *magnitudes* of the determinants (differences in group character-

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istics) rather than differences in the *effects* of the determinants (estimated coefficients). Self-rated ability to handle personal pressure and unexpected difficulties accounted for the largest share of contribution to the overall explained gap in the barrier to climate change adaptation between the poor and non-poor, suggesting that climate change adaptation differentials between the poor and non-poor in coastal Tanzania are likely due to psychosocial factors.

Keywords Barriers • Climate change • Poverty • Adaptation • Differentials, coast • Tanzania

Introduction

Understanding the relationship between climate change, the human responses it necessitates, and how cognition and emotion (as potential personal barriers) shape such responses, is an increasingly urgent research and policy need. Not only have existing belief and knowledge systems, values, and norms affected how residents responded to environmental challenges in the past (Agrawal 2010), they are also the fundamental mediating mechanisms that will translate the impact of external interventions to facilitate adaptation to climate change (Adger et al. 2009; Agrawal 2010). Historical experience and knowledge about adaptation possibilities is critical to future policy formulations regarding adaptation (Füssel and Klein 2006; Tompkins and Adger 2005).

This paper directs attention towards a subset of such relationships, focusing on personal barriers and poor populations in the context of climate variability and change. The term *barriers* refer to the obstacles that hinder the planning and implementation of climate change adaptation (Biesbroek et al. 2013; Eisenack et al. 2014). Adaptation means anticipating the adverse effects of climate change and taking appropriate action to prevent or minimize the damage they can cause, or taking advantage of opportunities that may arise.

It is critically important to understand the role of personal barriers in shaping adaptation, especially the role of poverty, in order to address the challenges of the most vulnerable. Adaptation to climate change is highly local, and its effectiveness depends on local and extra-local initiatives through which incentives for individual and collective action are structured (Agrawal 2010; Burton et al. 2005; Rojas Blanco 2006). Future efforts to address climate change and design strategic initiatives to enhance the poor's adaptive capacity can, therefore, profitably examine personal adaptive responses, their socio-cultural context and correlates, and the role of poverty in facilitating or encumbering adaptation (Agrawal 2010).

Although the relationship between poverty and adaptation to climate change (and its associated barriers) is rather complex (Naser 2011; Thornton and Herrero 2008), it is frequently suggested that poverty translates into vulnerability, and by extension into weak adaptive capacity. For instance, it is widely accepted that wealthy nations are better prepared to bear the costs of adaptation to climate change

impacts and risks than poorer nations (Parry 2007). It is also recognized that poverty is directly related to vulnerability (Fothergill and Peek 2004; Lwasa 2010). Poverty should not be considered synonymous with vulnerability; it is a surrogate of the ability to cope (Dow 1992). There appears to be sufficient evidence that poorer nations and disadvantaged groups within nations are especially vulnerable to disasters (Munasinghe 2000; Parry 2007). However, this view which is rather widespread in the burgeoning literature on climate change adaptation has been critically interrogated. Magnan et al. (2009), for example, identify two underlying biases of this notion. In the first place, by considering the poor as being intrinsically unable to cope with climate variability and change (higher levels of barriers to adaptation) induces the risk of obscuring true, specific, and potentially replicable adaptive capacities. Also, equating poverty with low adaptive capacity leads to the conviction that the rich are presupposed to have high adaptive capacities. Other research scholars have critiqued this presupposition by noting the relationship is non-linear and a complex nexus (see Alwang et al. 2001; Cafiero and Vakis 2006; Naser 2011; Teller and Hailemariam 2011).

This dichotomy in the literature reflects partial understanding of the nexus between poverty and adaptation to climate change, which is a rather complex relationship. For this reason, disparities in climate change adaptation between the poor and nonpoor will continue to engage the attention of both research scholars and policy makers. Within such research milieu, it is imperative to decompose disparity in adaptation to climate change into contributing factors with a view to explaining its distribution by a set of factors that vary systematically with socio-economic status given that even within poor populations heterogeneities exist. This is a fundamental motivation for this study. In particular, variations in barriers to climate change adaptation may be explained by variations in education, income, insurance coverage, distance to health facilities, and quality of care at local facilities. Even if policy makers have managed to mitigate inequalities in some of these dimensions, inequalities between the poor and nonpoor may remain in others (O'Donnell et al. 2008). The decomposition methods used in this study will potentially reveal how far inequalities in barriers to adaptation to climate change can be explained by inequalities in, say, education rather than inequalities in, say, distance to health facilities.

We disaggregated existing disparities with the aim of eliciting a deeper understanding of the specific factors that account for the climate change adaptation outcomes gap between the poor and nonpoor in coastal Tanzania. This approach is novel for two reasons. First, it focuses predominantly on personal barriers, which have, until now, received negligible research and policy attention. Secondly, this study is one of the first to apply counterfactual decomposition techniques to barriers to climate change adaptation.

Theoretical Context

The capacity to adapt is dynamic and is influenced by a society's productive base, including natural and man-made capital assets, social networks and entitlements, human capital and institutions, governance, national income, health, and technology (Biesbroek et al. 2013; Moser and Ekstrom 2010; Parry 2007). It is also affected by multiple climate and non-climate stresses, as well as development policy. Many adaptation actions have multiple drivers, such as economic development and poverty alleviation and are embedded within broader developmental, sectoral, regional and local planning initiatives, such as water resources planning, coastal defense, and disaster risk reduction strategies (Dovers and Hezri 2010; Moser 2012; Parry 2007).

Adaptation to climate change together with its associated barriers is meaningless unless it is contextualized. In particular, clarity is required to identify whether it is individuals, households, communities, community sector organizations and/or local, state and federal governments that serve them that face barriers to effective adaptation (Adger et al. 2009; Dovers and Hezri 2010). This is important due to the significant heterogeneity in adaptive capacities of individuals even within the same community. Adaptation takes place in a social, political, and institutional context (Adger et al. 2009). It is not enough to consider the adaptation measures of individuals, households, and communities. It is imperative to take into consideration the broader social and political contexts in which local people strive to adapt to changing circumstances and to address barriers to adaptation (Adger et al. 2009; Eisenack et al. 2014). This will have significant implications for the way adaptation responses are framed and enacted (Biesbroek et al. 2013; Eisenack et al. 2014; Moser and Ekstrom 2012). Another important consideration is the distinction between adaptation as a climate change *response* and adaptation as climate change *readiness*.

Effective adaptation can be impeded by one type of barrier or as a result of multiple barriers interacting (Biesbroek et al. 2013; Moser and Ekstrom 2011). Potential barriers to effective adaptation take many forms, including market failures, policy and regulatory barriers, governance and institutional barriers, and behavioural barriers (Moser and Ekstrom 2012). These are the dominant categorizations of barriers to adaptation (see Biesbroek et al. 2013; Eisenack et al. 2014; Ford et al. 2011; Leary et al. 2008; Jantasami et al. 2010; Moser and Ekstrom 2010; Naess et al. 2005). It is of concern that the narrow categorization of barriers as 'market failures', 'regulatory barriers', 'behavioural and cultural barriers' and 'organizational barriers' does not give sufficient prominence to the structural barriers to adaptation facing many disadvantaged individuals in sub-Saharan Africa. Poverty and constrained choices due to the lack of resources and appropriate information are masked when barriers are articulated in the terms used in the foregoing literature on institutional barriers.

A greater focus on socioeconomic disadvantage and social exclusion as barriers to effective adaptation is needed (Hedger et al. 2008). Also, attention to personal

(psychosocial, cognitive and emotive) barriers is required. Studies have shown that the behaviour and attitudes of family members and friends can have a strong impact on the decisions and actions of individuals (Gifford 2011; Patt and Schröter 2008). For example, Ajzen and Fishbein (2005) found that individuals have difficulty maintaining an attitude that differs from that of those around them. Further, the way in which people process information is strongly influenced by existing attitudes (Gardner et al. 2009). People tend to ignore or not seek out information that is inconsistent with their current views, and additional information often tends to reinforce their pre-existing views (Kahneman 2011). The preceding theoretical constructs were used to explain the adaptive capacities of poor versus nonpoor in coastal Tanzania.

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 km² as territorial waters and 223,000 km² as offshore waters (EEZ) (Mngulwi 2003). Tanzania's coastline stretches for 800 km. It has five coastal regions-Tanga, Pwani, Dar-es-Salaam, Lindi and Mtwara. The five coastal regions cover about 15 % of the country's total land area and are home to approximately 25 % of the country's population. According to the 2012 Population and Housing census, the total population was 44,928,923 compared to 12,313,469 in 1967 (National Bureau of Statistics 2013), reflecting an annual growth rate of 2.9 %. The under 15 age group represented 44.1 % of the population, with 35.5 % being in the 15–35 age group, 52.2 % being in the 15–64 age group, and 3.8 % being older than 64 (National Bureau of Statistics 2013).

Overall Tanzania on average is sparsely populated with population density of 51 persons per km², lower significant variation exists across regions. The population density varies from 1 person per km² in arid regions to 51 per km² in the mainland's well-watered highlands to 134 per km² in Zanzibar (United Republic of Tanzania 2013). The population density for the Dar es Salaam region is 3133 persons per km² (the most densely populated) and that of Lindi is only 13.1 persons per km² (National Bureau of Statistics 2013). This suggests 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. Second, these regions were selected because of the five regions in the coastal zone, they are the most ethnically diverse (that is, representative of the different geographical locations) and thus, had better prospects of providing 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 center 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.

Data Collection

The study design was approved by the Committee of Research Ethics of the University of Western Ontario, Canada. Research approval was also granted by the Commission on Science and Technology (COSTECH) in Tanzania. A cross-sectional survey was conducted with 1253 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 (Armah et al. 2015a). Within each region, a list of villages based on the 2012 Population and Housing Census was divided further into households. Figure 25.1 presents a schematic overview of the site.

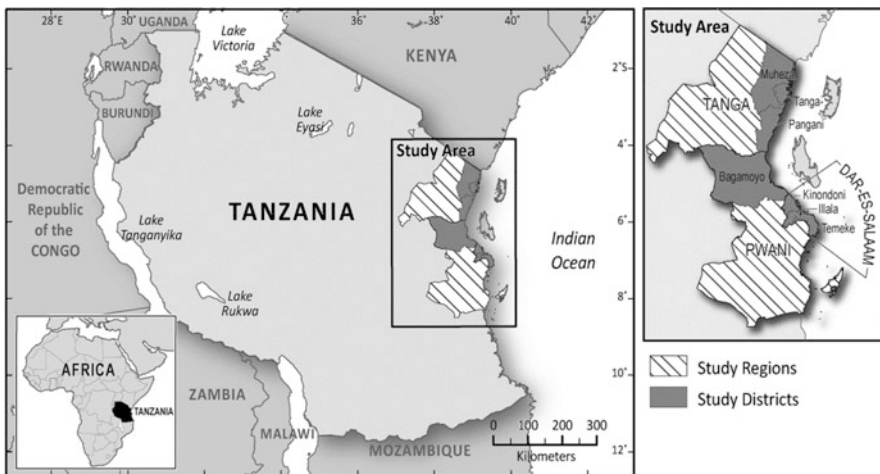


Fig. 25.1 Schematic overview of the study site (Source: Armah et al. 2015b)

According to Armah et al. (2015a), the list of villages was divided into clusters ensuring that each cluster would provide adequate numbers of eligible respondents to be included in the survey. 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, then 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 one 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. Households were randomly selected from these clusters for interview.

Measures

Outcome Variable

The literature indicates that complex approaches, such as factor analysis or latent variable analysis are very useful in providing deeper understanding of multi-dimensional constructs. Initially, all respondents were asked whether they experienced a barrier to adaptation to climate change or not. Out of 1253, 1130 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 ordered and were recoded such that higher values indicate a specific barrier. The questions are on a scale of 1–10 (lowest to highest) please indicate your level of agreement with the following: In order to adapt to climate change I don't know what steps to take (knowledge), I lack the skills needed (knowledge), I lack personal energy or motivation (cognitive), I lack the time (personal resources), I lack money or the resources needed (financial resources), I lack help from others (cultural), I feel I don't make a difference (cognitive, emotion), I don't believe in climate change (cognitive, personal values, cultural), and I 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 Independent Variables

Previous research have established links between health (both perceived and observed) and adaptation to climate change (see Haines et al. 2006; Kinney 2008; McCarthy 2001; Wolf et al. 2010). Perceived (self-rated or self-reported), which has both emotive and cognitive dimensions, mediates adaptive actions (Costello et al. 2009). Respondents were asked to evaluate their health status, ability to handle work pressure and responsibilities, and ability to handle personal crisis and unexpected responsibilities. Each of these three variables were coded as 1 = poor, 2 = fair, 3 = good, 4 = very good and 5 = excellent. Poverty, a binary variable coded as 1 when the household is below the poverty line, and otherwise as 0, was used to stratify the data. Socio-demographic variables (including age, sex, and marital status, level of education, income, occupation, and ethnicity) that have frequently been shown to be associated with barriers to adaptation to climate change were included as predictors. On the whole, 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. Socio-culturally, educated individuals are also less subservient to norms and practices that adversely affect their adaptation choices and adaptive capacity. Residential locality (rural, urban) was also included in the model since the common 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. In Tanzania, not only are rural populations disadvantaged socio-economically, but they are historically under served in disaster infrastructure and emergency relief personnel. Besides the availability of climate change adaptation infrastructure, urban residents are also more likely than their rural counterparts to flout customs and taboos that could negatively affect adaptation to climate change. Again, Tanzania displays a distinctive regional disparity in development with roots in colonial development policy.

Counterfactual Decomposition Techniques

Although this method has been most widely used in economics to study gender- and race-based discrimination in the labor market, it can be applied to explain differences in any continuous outcome across any two groups. The counterfactual decomposition method used in this study, known as the Blinder-Oaxaca decompositions (Oaxaca 1973; Jann 2008), explains the gap in the means of climate change adaptation barrier scores between two groups (in this instance, between the poor and the nonpoor/better-off) in coastal Tanzania. O'Donnell et al. (2008) gives a comprehensive account on the technique. The gap is decomposed into that part that is due to group differences in the magnitudes of the determinants of barrier to

climate change adaptation scores, on the one hand, and group differences in the effects of these determinants, on the other hand. For example, residents in coastal Tanzania may be less adaptive not only because they have less access to piped water but also because they are less knowledgeable about how to obtain the maximum health benefits from piped water (see Jalan and Ravallion 2003; Wagstaff and Nguyen 2003).

Barrier to climate change adaptation scores (y_i) is our outcome variable of interest. We have two groups, which we shall call the poor and the nonpoor. We assume climate change adaptation barrier score is explained by a vector of determinants, x , according to a regression model:

$$y_i = \begin{cases} \beta^{poor} x_i + \varepsilon_i^{poor} & \text{if } poor \\ \beta^{nonpoor} x_i + \varepsilon_i^{nonpoor} & \text{if } nonpoor \end{cases} \tag{25.1}$$

Where the vectors of β parameters include intercepts. The nonpoor are assumed to have a more advantageous regression line (lower scores on barrier to climate change adaptation) than the poor. Also, the nonpoor are assumed to have a higher mean of x . We assume exogeneity, thus the conditional expectations of the error terms in Eq. (25.1) are zero. The gap in mean barrier to adaptation scores between the poor (y^{poor}) and nonpoor ($y^{nonpoor}$) is given by:

$$y^{poor} - y^{nonpoor} = \beta^{poor} x^{poor} - \beta^{nonpoor} x^{nonpoor} \tag{25.2}$$

Where x^{poor} and $x^{nonpoor}$ are vectors of the independent variables evaluated at the means for the poor and nonpoor, respectively. For our set of independent variables, we write the following:

$$\begin{aligned} y^{poor} - y^{nonpoor} &= (\beta_0^{poor} - \beta_0^{nonpoor}) + (\beta_1^{poor} x_1^{poor} - \beta_1^{nonpoor} x_1^{nonpoor}) \\ &+ (\beta_2^{poor} x_2^{poor} - \beta_2^{nonpoor} x_2^{nonpoor}) \dots \\ &+ \dots (\beta_n^{poor} x_n^{poor} - \beta_n^{nonpoor} x_n^{nonpoor}) \\ &= G_0 + G_1 + G_2 \dots + \dots G_n \end{aligned} \tag{25.3}$$

so that the gap in adaptation barrier scores between the poor and the nonpoor can be thought of as being due in part to (i) differences in the intercepts (G_0), (ii) differences in x_1 and β_1 (G_1), and (iii) differences in x_2 and β_2 (G_2). For example, G_1 might measure the part of the gap in mean score of barrier to climate change adaptation (y) due to differences in educational attainment (x_1) and the effects of educational attainment (β_1), and G_2 might measure the part of the gap due to the gap in age of respondents (x_2) and differences in the effects of age of respondents (β_2). Estimates of the difference in the gap in mean adaptation score can be obtained by substituting sample means of the x 's and estimates of the parameters β 's into Eq. (25.2).

We further estimated how much of the overall gap or the gap specific to any one of the x 's (e.g., G_1 or G_2) is attributable to (i) differences in the x 's (sometimes

called the explained component) rather than (ii) differences in the β 's (sometimes called the unexplained component). In doing so, two options were considered. In the first, the differences in the x 's were weighted by the coefficients of the poor group and the differences in the coefficients were weighted by the x 's of the nonpoor group, whereas in the second the differences in the x 's were weighted by the coefficients of the nonpoor group and the differences in the coefficients were weighted by the x 's of the poor group. Either way, we had a way of partitioning the gap in outcomes between the poor and nonpoor into a part attributable to the fact that the poor have worse x 's than the nonpoor, and a part attributable to the fact that *ex hypothesi* they have worse β 's than the nonpoor. These formulations are expressed as follows:

$$y^{poor} - y^{nonpoor} = \Delta x \beta^{poor} + \Delta \beta x^{poor} + \Delta x \Delta \beta = E + C + CE \tag{25.4}$$

From Eq. (25.4), the gap in mean score of barrier to climate change adaptation can be thought of as deriving from a gap in x 's or endowments (E), a gap in β 's or coefficients (C), and a gap arising from the interaction of endowments and coefficients (CE). So, in effect, Eq. (25.5) places the interaction in the unexplained part, whereas the Eq. (25.6) places it in the explained part.

$$y^{poor} - y^{nonpoor} = \Delta x \beta^{poor} + \Delta \beta x^{nonpoor} = E + (CE + C) \tag{25.5}$$

$$y^{poor} - y^{nonpoor} = \Delta x \beta^{nonpoor} + \Delta \beta x^{poor} = (E + CE) + C \tag{25.6}$$

We also write Oaxaca's decomposition as a unique case of another equation

$$y^{poor} - y^{nonpoor} = \Delta x [D \beta^{poor} + (I - D) \beta^{nonpoor}] + \Delta \beta [x^{poor} (I - D) + x^{nonpoor} D] \tag{25.7}$$

Where, I is the identity matrix and D a matrix of weights. In the simple case, where x is a scalar rather than a vector, I, is equal to one and D is a weight. In this case, $D=0$ in Eq. (25.5), and $D=1$ in Eq. (25.6).

In addition to the above formulations, we consider three more formulations. Cotton (1988) suggested weighting the differences in the x 's by the mean of the coefficient vectors, which yields

$$\text{diag}(D) = 0.5(\text{Cotton}) \tag{25.8}$$

Where $\text{diag}(D)$ is the diagonal of D. Reimers (1983) suggested weighting the coefficient vectors by the proportions in the two groups, so that if f_{NP} is the sample fraction in the nonpoor group, we obtain

$$\text{diag}(D) = f_{NP}(\text{Reimers}) \tag{25.9}$$

Finally, we include the decomposition proposed by Neumark (1988), which makes use of the coefficients obtained from the pooled data regression, β^P :

$$\begin{aligned}
 y^{poor} - y^{nonpoor} = & \Delta x \beta^P \\
 & + [x^{poor}(\beta^{poor} - \beta^p) + x^{nonpoor}(\beta^p - \beta^{nonpoor})] \text{(Neumark)}
 \end{aligned}
 \tag{25.10}$$

The foregoing equations were implemented in STATA 13SE software. The detailed Blinder-Oaxaca decomposition of wage differentials is not invariant to the choice of reference group when a set of dummy variables is used. If we use dummy variable(s) as predictors, as in this study, then the detailed coefficients effect attributed to individual variables is not invariant to the choice of left-out group (s). This invariance or identification problem is well documented in the literature. The “normalized” regression equation where the estimate is simply the average of three sets of estimates with varying reference groups has been proposed to address this problem. The *oaxaca.ado* and *mvdcmp.ado* file in STATA 13 (StataCorp, College Station, TX, USA) SE was operationalized to address this issue.

Results

In this section, we present results on the characteristics of the participants and the findings based on the four counterfactual decomposition techniques. In particular, we show that while studies after studies on adaptation to climate change suggest large and statistically significant returns to education, only a small fraction of differences in barriers to adaptation can be accounted for by changes or differences in educational achievement between the poor and the nonpoor.

Sample Characteristics

Non parametric Pearson’s chi-square test for independence of the two categorical distributions (poor versus nonpoor) was calculated, using the observed frequencies of the background characteristics of the respondents as the expected frequencies against which to compare the frequencies of income poverty. The chi-square statistic reported for variables firmly rejects the hypothesis that respondents’ background characteristics and income poverty categories are independent (Table 25.1). The total number of respondents in Table 25.1 is 1253. Although, the chi-square statistic shows a significant relationship, Cramer’s V statistic values are less than 0.3, indicating that the association between the background characteristics of respondents and poverty is not strong. The exceptions are poverty and occupation (0.44), poverty and education (0.34), and poverty and residential locality (0.47). Only 2 % of respondents in the poor category rated their health status as excellent. None of the respondents in the poor category rated their ability to handle personal pressure and unexpected difficulties as excellent. Interestingly, not more than 2 %

Table 25.1 Background characteristics of respondents by income poverty status

Variables	Nonpoor (%)	Poor (%)	Pearson's χ^2 (df)
<i>Sex</i>			$\chi^2(1) = 33.1199$ Pr = 0.000
Male	82.5	17.5	Cramer's V = 0.16
Female	68.5	31.5	
<i>Self-rated health status</i>			$\chi^2(1) = 11.6577$ Pr = 0.001
Poor	65.5	34.5	Cramer's V = -0.09
Good	77.0	23.0	
<i>Self-rated ability to handle work pressure and responsibilities</i>			$\chi^2(1) = 6.4817$ Pr = 0.011
Poor	71.5	28.5	Cramer's V = -0.07
Good	77.8	22.2	
<i>Self-rated ability to handle personal pressure and unexpected difficulties</i>			$\chi^2(1) = 5.8781$ Pr = 0.015
Poor	59.3	40.7	Cramer's V = -0.07
Good	76.8	23.2	
<i>Age</i>			$\chi^2(3) = 48.5027$ Pr = 0.000
18–35	80.4	19.6	Cramer's V = 0.20
36–50	78.1	21.9	
51–65	72.0	28.0	
More than 65	45.8	54.2	
<i>Marital status</i>			$\chi^2(1) = 3.6375$ Pr = 0.056
Unmarried	72.1	27.9	Cramer's V = -0.05
Married	77.0	23.0	
<i>Ethnicity</i>			$\chi^2(2) = 15.3462$ Pr = 0.000
Zaramo	66.9	33.1	Cramer's V = 0.11
Sambaa	70.2	29.8	
Others	78.3	21.7	
<i>Religion</i>			$\chi^2(2) = 71.5999$ Pr = 0.000
Christian	89.3	10.7	Cramer's V = 0.24
Muslim	67.6	32.4	
Traditional religion	75.0	25.0	
<i>Employment status</i>			$\chi^2(1) = 57.6081$ Pr = 0.000
Unemployed	42.4	57.6	Cramer's V = -0.21
Employed	77.8	22.2	
<i>Educational attainment</i>			$\chi^2(3) = 279.4208$ Pr = 0.000
No Education	27.1	72.9	Cramer's V = 0.34
Primary	65.4	34.6	
Secondary	91.8	8.2	
Tertiary	98.6	1.4	
<i>Residential locality</i>			$\chi^2(1) = 146.4910$ Pr = 0.000
Rural	75.2	25.8	Cramer's V = 0.47
Urban	87.5	12.5	

of public servants (government worker) and civil servants (NGO staff) were in the poor category.

As observed in Table 25.2, several significant relationships (both direct and inverse) exist between the explanatory variables. However, most of them are weak except between self-rated ability to handle personal pressure and unexpected difficulties and self-rated ability to handle work pressure and responsibilities ($r = 0.62$ $p < 0.001$).

Table 25.3 reports the mean values of y (barriers to climate change adaptation scores) for the two groups, and the difference between them. It then shows the contribution attributable to the gaps in endowments (E), the coefficients (C), and the interaction (CE). Table 25.3 is the threefold Blinder-Oaxaca decomposition of the mean outcome difference. The endowments term represents the contribution of differences in explanatory variables across groups (poor and nonpoor), and the coefficients term is the part that is due to group differences in the estimated coefficients. The interaction term accounts for the fact that cross-group differences in explanatory variables and coefficients can occur at the same time. In this study, the gap in endowments accounts for the great bulk of the gap in outcomes (barriers to climate change adaptation scores).

Table 25.4 shows how the explained and unexplained portions of the gap in climate change adaptation vary depending on the decomposition used. The first and second columns correspond to the Oaxaca decomposition in Eqs. (25.5) and (25.6), where $D = 0$ and $D = I$, respectively (supplementary material). The third and fourth columns correspond to Cotton's and Reimers' decompositions, where the diagonal of D equals 0.5 and $f_{NP} = 0.749$ (in our case), respectively. The final column labeled "*" is Neumark's decomposition. Several variations of computing counterfactual do not change the main results qualitatively. Whatever decomposition is used, it is obviously the difference in the mean values of the x 's (explained component) that accounts for the vast majority of the difference in climate change adaptation between poor and nonpoor residents in coastal Tanzania. The only exception is the Oaxaca decomposition where $D = I$ in which case the differences in the effects of the determinants (coefficients or unexplained component) rather accounts for the main difference in climate change adaptation scores between poor and nonpoor residents in coastal Tanzania. By and large, however, differences in the effects of the determinants play a tiny part in explaining inequalities in climate change adaptation between the two groups.

Based on Oaxaca's decomposition $D = 0$, differences in the mean values of x 's (gaps in endowments) account for about 127 % of the differentials in barriers to climate change adaptation between the poor and nonpoor. Based on Cotton's decomposition, differences in the mean values of x 's (gaps in endowments) explain about 82 % of the differentials in barriers to climate change adaptation between the poor and nonpoor. About 59 and 63 % of the differentials in barriers to climate change adaptation between the poor and nonpoor in coastal Tanzania is explained by the mean values of x 's (gaps in endowments) using the Reimer's and Neumark's decompositions, respectively. Only, about 36 % of the differentials in barriers to climate change adaptation between the poor and nonpoor are explained by the

Table 25.2 Correlation coefficients of explanatory variables and poverty

	SRHS	SRWP	SRPD	Age	Marital	Ethnic	Religion	Occup	Locality	Educ	Poverty
SRHS	1										
SRWP	0.38 ^{***}	1									
SRPD	0.35 ^{***}	0.62 ^{***}	1								
Age	-0.28 ^{***}	-0.12 ^{***}	-0.07 [*]	1							
Marital	-0.23 ^{***}	-0.07 [*]	-0.11 ^{**}	0.47 ^{***}	1						
Ethnic	0.13 ^{***}	0.09 ^{***}	0.13 ^{***}	-0.11 ^{**}	-0.1 ^{**}	1					
Religion	-0.16 ^{***}	-0.14 ^{***}	-0.16 ^{***}	0.10 ^{**}	0.12 ^{***}	-0.36 ^{***}	1				
Occup	0.06 [*]	0.06 [*]	0.05 [*]	-0.10 ^{**}	-0.07 [*]	0.06 [*]	-0.04	1			
Locality	-0.18 ^{***}	-0.19 ^{***}	-0.19 ^{***}	0.14 ^{***}	0.08 ^{**}	-0.24 ^{***}	0.33 ^{***}	-0.14 ^{***}	1		
Educ	0.32 ^{***}	0.25 ^{***}	0.21 ^{***}	-0.18 ^{***}	-0.22 ^{***}	0.20 ^{***}	-0.37 ^{***}	0.20 ^{***}	-0.43 ^{***}	1	
Poverty	-0.18 ^{***}	-0.09 ^{***}	-0.14 ^{***}	0.14 ^{***}	0.17 ^{***}	-0.13 ^{***}	0.24 ^{***}	-0.04	0.34	-0.45	1

Key: ^{*} p < 0.05, ^{**} p < 0.01, ^{***} p < 0.001; SRHS = Self-rated health status, SRWP = Self-rated ability to handle work pressure and responsibilities, SRPD = Self-rated ability to handle personal pressure and unexpected difficulties, Occup = occupation, locality = residential locality, Educ = educational attainment

Table 25.3 Summary of decomposition results

Summary of decomposition results	
High: poverty = 0.0000	
Low: poverty = 1.0000	
Mean prediction high (H)	0.047
Mean prediction low (L)	-0.141
Raw differentials (R) {H - L}	0.188
Due to endowments (E)	0.239
Due to coefficients (C)	0.121
Due to interaction (CE)	-0.172

Table 25.4 Proportion of explained and unexplained components

D	0	1	0.5	0.749	*
Unexplained (U) {C + (1 - D) CE}	-0.051	0.121	0.035	0.078	0.069
Explained (V) {E + D * CE}	0.239	0.067	0.153	0.111	0.119
% Unexplained {U/R}	-27.3	64.3	18.5	41.3	36.7
% Explained {V/R}	127.3	35.7	81.5	58.7	63.3

Note: D in the 4th column = relative frequency of high group

*Reference = pooled model over both categories

differences in the mean values of x 's (gaps in endowments) when Oaxaca's decomposition $D = 1$ is used. This implies that, when Oaxaca's decomposition $D = 1$ is used, differences in the effects of the determinants (coefficients or unexplained component) rather accounts for about 64 % of the differentials in barriers to climate change adaptation between the poor and nonpoor in coastal Tanzania.

Table 25.5 affords us the opportunity to observe how far gaps in individual x 's contribute to the overall explained gap. For example, focusing on the final column corresponding to Neumark's decomposition, we realize that the gaps in the three demographic variables (i.e., self-rated ability to handle work pressure and responsibilities, age, and ethnicity) actually favor the poor whereas the gaps in the remaining variables all disfavor the poor. Of the latter, it is the gap in Self-rated ability to handle personal pressure and unexpected difficulties that accounts for the bulk of the explained gap. It is not so much the correlates of poverty (poor water and sanitation, low educational levels) that account for climate change adaptation inequalities between poor and nonpoor residents in coastal Tanzania; it is rather a psychosocial problem, in the form of lack of ability to handle stress (personal pressure) and unexpected difficulties.

Table 25.6 provides the coefficient estimates, means, and predictions for each x for each group, the "high group" in this case being the nonpoor and the "low group" being the poor. For the first Oaxaca decomposition (Eq. 25.5), columns 2 and 3 of Table 25.5 allow us to identify how the gap in each of the β 's contributes to the overall unexplained gap. For the other decompositions, the contributions of the individual β 's can be found by subtracting the explained part given in Table 25.5 from the group difference in the variable specific predictions given in Table 25.6.

Table 25.5 Decomposition results for variables

Variables	E(D = 0)	C	CE	D			
				1	0.5	0.749	*
SRHS	0.083	-0.681	-0.066	0.018	0.051	0.034	0.030
SRWP	-0.094	0.150	0.006	-0.088	-0.091	-0.089	-0.090
SRPD	0.131	-0.576	-0.056	0.076	0.103	0.090	0.086
Age	-0.051	-0.137	0.019	-0.032	-0.042	-0.037	-0.034
Marital	0.060	0.002	-0.000	0.060	0.060	0.060	0.064
Ethnicity	-0.018	0.063	0.013	-0.006	-0.012	-0.009	-0.009
Religion	-0.028	-0.293	0.040	0.012	-0.008	0.002	0.003
Occup	-0.008	0.045	0.011	0.004	-0.002	0.001	0.001
Locality	0.018	0.076	-0.017	0.001	0.009	0.005	0.007
Educ	0.147	-0.119	-0.124	0.023	0.085	0.054	0.060
_cons	0.000	1.591	0.000	0.000	0.000	0.000	0.000
Total	0.239	0.121	-0.172	0.067	0.153	0.111	0.119

Key: SRHS = Self-rated health status, SRWP = Self-rated ability to handle work pressure and responsibilities, SRPD = Self-rated ability to handle personal pressure and unexpected difficulties, Occup = occupation, locality = residential locality, Educ = educational attainment

*Neumark’s decomposition

Table 25.6 Coefficients, means and predictions of the models

Variables	High model			Low model			Pooled
	Coefficient	Mean	Predicted	Coefficient	Mean	Predicted	Coefficient
SRHS	0.065	3.108	0.203	0.305	2.835	0.866	0.110
SRWP	-0.774	2.786	-2.155	-0.830	2.673	-2.218	-0.791
SRPD	0.361	2.371	0.856	0.628	2.162	1.357	0.412
Age	0.041	4.779	0.194	0.065	5.567	0.363	0.043
Marital	-0.144	2.117	-0.306	-0.145	2.532	-0.368	-0.154
Ethnicity	-0.006	5.708	-0.035	-0.019	4.754	-0.092	-0.010
Religion	-0.046	1.608	-0.075	0.111	1.863	0.206	-0.012
Occup	0.003	7.498	0.019	-0.005	5.982	-0.030	0.000
Locality	-0.003	1.314	-0.003	-0.047	1.690	-0.080	-0.020
Educ	0.026	1.771	0.045	0.163	0.870	0.142	0.067
_cons	1.305	1.000	1.305	-0.287	1.000	-0.287	1.015
Total			0.047			-0.141	

Key: SRHS = Self-rated health status, SRWP = Self-rated ability to handle work pressure and responsibilities, SRPD = Self-rated ability to handle personal pressure and unexpected difficulties, Occup = occupation, locality = residential locality, Educ = educational attainment

We emphasize that the unimportance overall of the unexplained portion is due to offsetting effects from different β 's. The poor have a higher intercept in the decomposition equation, but this is largely offset by the fact that the ability to handle stress and unexpected difficulties is weaker for the poor.

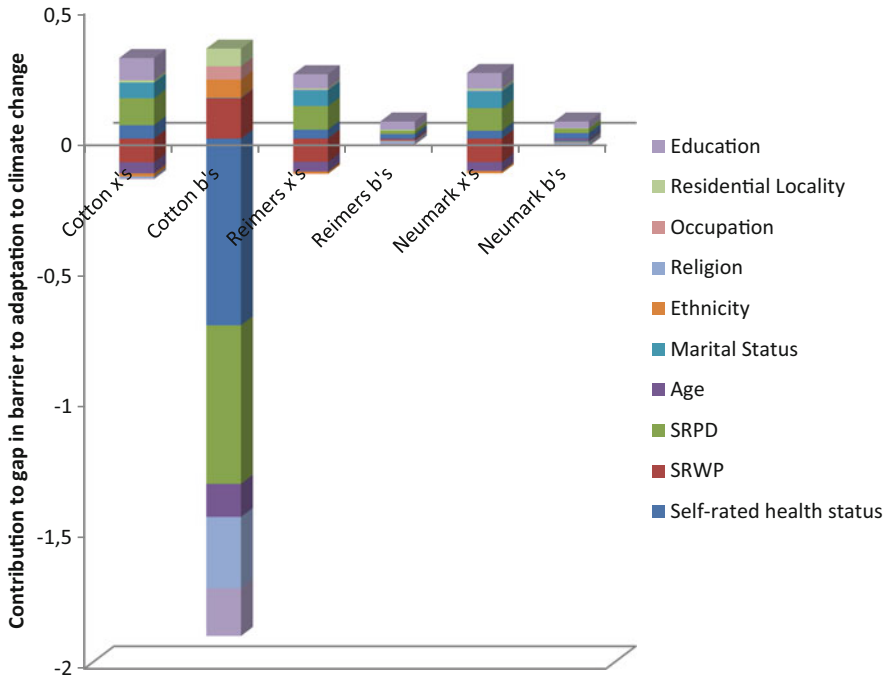


Fig. 25.2 Contributions of differences in means and in coefficients to the gap in barriers scores between the two groups

Figure 25.2 indicates the contribution of the difference in the means of each x and the difference in coefficients on each x . For the Cotton, Reimers and Neumark decompositions, the contributions of the individual x 's was obtained by taking the group difference in the variable specific predictions given in Table 25.6 and subtracting the explained part given in Table 25.5 from this. Regarding the means of the x 's, Fig. 25.1 suggests that most of the explained part of the climate change adaptation gap is attributable to the gaps in self-rated ability to handle personal pressure and unexpected difficulties and self-rated ability to handle work pressure and responsibilities.

Discussion

This paper set out to decompose the gap in climate change adaptation outcomes into the part that is due to group differences in the magnitudes of the determinants (i.e., the explained component) of barrier to climate change adaptation scores, on the one hand, and group differences in the effects of these determinants (i.e., the unexplained component), on the other hand. In other words, we disaggregated the characteristics effects (explained variation) and coefficients effects (unexplained

variation) for the two mutually exclusive groups (poor and nonpoor). This technique is especially useful for identifying and quantifying the separate contributions of group differences in measurable characteristics, such as education, age, marital status, and geographical location, to ethnic and gender gaps (Jann 2008) in climate change adaptation outcomes.

We found that difference in the mean values of the x 's (explained component) accounts for the vast majority of the difference in barriers to climate change adaptation between poor and nonpoor residents in coastal Tanzania. To the best of our knowledge, no previous research on climate change adaptation has attempted to decompose disparities in adaptation barriers by poverty status. Thus, it is difficult to compare our findings with other results in the existing literature.

The contribution of each of the variables to the overall explained gap using the various decompositions provides interesting insight on the relative importance of each of the variables. Using the Neumark decomposition, Self-rated ability to handle personal pressure and unexpected difficulties alone accounted for 75 % of the overall explained gap in barriers to climate change adaptation between the poor and nonpoor. This was followed by marital status (53 %), education (50 %) and self-rated health status (25 %) in that order. Occupation, religion and residential locality (rural-urban) jointly accounted for less than 10 % of the overall explained gap. Similar results were obtained using the Reimer's decomposition where self-rated ability to handle personal pressure and unexpected difficulties alone accounted for 81 % of the overall explained gap in barriers to climate change adaptation between the poor and nonpoor. This was followed by marital status (54 %), education (49 %) and self-rated health status (30 %) in that order. These trends change slightly when Cotton's decomposition is used. Although self-rated ability to handle personal pressure and unexpected difficulties still accounts for the largest proportion (67 %) in the overall explained gap, education overtakes marital status as the second largest contributor (56 %) to the explained gap. Marital status (39 %) and self-rated health status (33 %) then follow. In the Cotton's and Reimer's decompositions, occupation, religion and residential locality (rural-urban) still cumulatively accounted for less than 10 % of the overall explained gap. This implies that, although the magnitudes of contribution of each variable differ across decomposition techniques, the trends and order of contribution remains almost the same.

The fact that self-rated ability to handle personal pressure and unexpected difficulties accounted for the largest share of contribution to the overall explained gap in barriers to climate change adaptation between the poor and nonpoor in coastal Tanzania regardless of decomposition technique used suggests that climate adaptation differentials may be due to psychosocial issues rather than poverty *per se*. Across decomposition, the magnitude of self-rated ability to handle personal pressure and unexpected difficulties varies but is not surpassed by other biosocial or socio-cultural variables. This does not mean that biosocial or socio-cultural variables are not important. It simply implies that the issue is multi-faceted (Swim et al. 2009), and though important, the individual contributions of biosocial or

socio-cultural variables is lower in magnitude than the psychosocial factor, that is, self-rated ability to handle personal pressure and unexpected difficulties.

This finding highlights the importance of perception and cognition in stimulating or inhibiting adaptive actions of individuals. Human perceptions and judgments about climate change are important because they affect levels of concern and, in turn, the motivation to act (Swim et al. 2009). Adaptation includes a range of coping actions that individuals and communities can take, as well as psychological processes (e.g., appraisals and affective responses) that precede and follow behavioural responses (Swim et al. 2009). Available research suggests that the psychosocial impacts of climate change are likely to be moderated by a number of individual and contextual factors that increase or decrease the severity of the impact, as well as the perception of the impact (Leiserowitz 2007).

In general, cognitive adaptation approaches (Taylor and Stanton 2007) and protection motivation approaches (Weinstein et al. 2000) are premised on the kinds of cognitive and emotional appraisal processes and coping processes, which are elicited in the context of climate change and other risks that contain implicit or explicit threats and induce fear (Fiske and Taylor 2008; Swim et al. 2009). An individual's perceptions of climate change impacts can be moderated by social norms (Leiserowitz 2005) and by their environmental identity (Clayton and Opatow 2003). The impacts of climate change, and by extension adaptive actions are also likely to be mediated by various types of cognitive appraisals, such as estimates of personal risk and attributions of responsibility (Leiserowitz 2007), and media representations of climate change adaptation impacts (Reser and Swim 2011). Emotional reactions are critical components of information processing and also have a direct relation to physical and psychological health (Groopman 2004; Moser 2007). It is also hypothesized that certain strong emotional responses such as fear, despair, or a sense of being overwhelmed or powerless can inhibit thought and action (Moser 2007; Nichol森 2002), which in turn may either constrain or serve as a barrier to effective adaptation to climate change.

Limitations of the Study

A limitation of this study is that, while decompositions are useful for quantifying the contribution of various factors (psychosocial, biosocial, sociocultural) to a difference or change in barriers to climate change adaptation outcomes, they may not necessarily deepen our understanding of the mechanisms underlying the relationship between these factors and climate change adaptation outcomes. In that sense, decomposition methods do not seek to recover behavioural relationships or deep structural parameters. By indicating which factors are quantitatively important and which are not, however, decompositions provide useful indications of particular hypotheses or explanations to be explored in more detail. For example, if decomposition indicates that differences in educational attainment account for a

large fraction of the poverty-climate change adaptation gap, then exploring in more detail how the poor and nonpoor choose their adaptive behaviours is imperative.

Policy Implications

Climate change adaptation is a multi-faceted and complex phenomenon, rooted in an extensive body of interdisciplinary science and with deeply challenging policy implications (e.g., Prins et al. 2010). Given that the empirical evidence presented in this paper indicates that self-rated ability to handle personal pressure and unexpected difficulties, educational attainment and self-rated health status accounts for a large portion of the overall explained gap in barriers to climate change adaptation between the poor and nonpoor, there is need for policy that systematically addresses these gaps in endowments. In developing countries such as Tanzania, government can stimulate policy action to address the gaps in outcomes in two fundamental ways: information through extension services (e.g. community radios), and provision of social support services. In so far as self-rated ability to handle personal pressure and unexpected difficulties was the foremost factor explaining gaps in barrier to climate change adaptation between the poor and nonpoor, it may be that improved psychosocial health would improve climate change adaptation, although the precise mechanism underlying this is unclear. There are many area-specific differences in the propensity of coastal residents to adapt to climate change and further analysis would be required to understand the underlying factors. Adaptation, however, is undertaken only by those who perceive climate change. The perception of climate change appears to hinge on residents experiences and the availability of free advice on social support and services specifically related to climate change adaptation. However, while the policy options for promoting an increased adaptation to climate change are rather limited the perception of climate change is already high in coastal Tanzania. The opinions of residents of coastal Tanzania who perceive climate change as a risk should be taken into consideration with respect to the type, scale and form of adaptation strategies to be initiated across spatio-temporal scales. This is critical to the widespread acceptance or rejection of proposed climate adaptation strategies of individuals.

Conclusion

This study aimed to disaggregate disparities in climate change adaptation outcomes between two mutually exclusive groups (poor and nonpoor) in coastal Tanzania based on characteristics effects (explained variation) and coefficients effects (unexplained variation). Self-rated ability to handle personal pressure and unexpected difficulties accounted for the largest share of contribution to the overall explained gap in barriers to climate change adaptation between the poor and

nonpoor in coastal Tanzania regardless of the decomposition technique used. This indicates that climate adaptation differentials between the poor and nonpoor in coastal Tanzania are likely due to psychosocial issues rather than other biosocial and socio-cultural correlates of poverty *per se*. This paper is unique in two critical ways. First, it focused on personal barriers rather than the institutional barriers to climate change adaptation that has received much attention in the extensive body of literature on climate change adaptation. Secondly, it used decomposition techniques hitherto not considered in the climate adaptation research domain. Adaptation to climate change together with its associated barriers is meaningless unless it is contextualized. Specifically, clarity is required to identify whether it is individuals, households, communities, community sector organizations and/or local, state and federal governments that serve those who face barriers to effective climate change adaptation. This is imperative considering the significant heterogeneity in adaptive capacities of individuals even within the same community.

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