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# Communicating disaster risk in the context of climate change in Tanzania: Are the most vulnerable onboard?


## Abstract

Climate information can help vulnerable populations anticipate disasters before they happen and enable communities prepare for and cope with them. A complementary log-log regression model based on quantitative study in coastal communities in Tanzania was used to assess the likelihood of the rural poor, rural non poor, urban poor, and urban non poor to receive early warning information about flood, drought and other disasters. Individuals in the urban poor category were 35% less likely to receive early warning information about flood, drought and other disasters whereas urban non-poor residents were 49% more likely to receive same. This disadvantage to the urban poor persists even when adaptive capacity, geographical location and socio-environmental factors are accounted. Nuclear households consisting of a male head and female partner who have children or not had higher likelihood of receiving early warning information on flood, drought and other disasters (OR = 1.47, $p < 0.001$) compared with their counterparts in female-centred households (no husband or male partner). Residents with tertiary education were more likely (OR = 1.91, $p < 0.001$) to report that they had received early warning information about flood, drought and other disasters compared with their counterparts without any formal education. This zero-order relationship was completed mediated by geographical location and socio-environmental factors in the multivariate model. The results underline the key role access to climate- and disaster-related information play in enhancing adaptive capacity to reduce vulnerability to natural hazards, as well as the importance of targeting the most vulnerable households in policy interventions to improve resilience in the face of a changing climate.


Key words: Climate change; natural hazard; urban poverty; early warning; information; Tanzania

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## Introduction

Climate change (CC) as a natural hazard is a potential threat to humanity. Over a twenty-year period, in excess of 8500 disasters occurred, affecting more than 2.6 billion people (World Bank, 2005). By 2030, the total number of people living on earth is anticipated to hit 8.6 billion and further rise to 11.2 billion in 2100 (UN DESA, 2017). This projection will take place predominantly in developing countries, a large proportion of which will be urban dwellers. Megacities and fragile lands will take center stage and this will constrain resource use and existing capacities to reduce vulnerability to disaster. Almost all death attributable to natural hazards ensue in poor countries. Extensive poverty and underdeveloped adaptation and coping capabilities predispose Africa to the deleterious environmental and health effects of climate change (Hellmuth et al., 2007; UN DESA, 2017; World Risk Report, 2016). Sentinel sectors such as energy, agriculture, health, and transport are most susceptible to climate variability and change. Disasters that are intrinsically linked to climate including protracted droughts and floods have deep-seated economic and social impacts that can undo years of development progress (Armah et al., 2015a; Wilhite et al., 2014).

Africa south of the Sahara is disproportionately affected by certain natural hazards as it is more prone to hydro-meteorological disasters and epidemics (World Bank, 2016; World Risk Report, 2016). Since the 1970s, the number of disasters documented on the continent has risen markedly with more than one thousand disasters recorded in the region (Bhavnani et al., 2008; The International Bank for Reconstruction and Development/The World Bank, 2010). Disasters pose significant threats to the growth and development of the continent and extreme hydro-meteorological events partly due to the frequency and magnitude of climate change. Africa's disaster outlook is intrinsically linked to its climate related vulnerability and weak economy. Every four out of ten of the world's poor reside in sub-Saharan Africa, where environmental disasters have a substantial social impact culminating in considerable increase in poverty, inequality and food insecurity. The joint effect of structural factors and environmental disasters characterise countries in the region among the most vulnerable to natural hazards in the world (Van Niekerk and Nemakonde, 2017; World Risk Report, 2016).

Africa south of the Sahara is currently disadvantaged and not gaining in-depth knowledge from climate science. Knowledge generated by climate experts is expected to inform climate-related decisions in poor countries yet, they seldom reach their target and when they do their impact is not felt (IRI, 2006). Three types of climate information (historical data, real-time data, and climate forecasts) matter for decision making and for the people in sub-Saharan Africa. Historical data are helpful in providing climate statistics, predicting trends, setting context for existing data, and indicating variability and the occurrence of extremes to be quantified. Real-time data assist with short-term calculations of the magnitudes of

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certain climate events (i.e., severe rainfall which causes flooding). Climate forecasts are climate information spanning long-term weather forecasts, from seasonal forecasts, to medium (10–30 year) and long-term climate change projections. Yet, African countries generally do not have either the capability to capitalize and invest in disaster risk management or the fiscal resources to support relief and rescue efforts after catastrophic events.

It is apparent that strategic approaches to combat the climate change crisis require a comprehensive plan that takes into account all three types of climate data in multidisciplinary development planning and projects. Such plans ought to be inclusive and participatory, ensuring that voices of key stakeholders are taken into account and the essential requirements are met. The types of tools used to measure climate are important and must capture the needs and enhance the decisions of the stakeholders by giving appropriate new information that can also be included and used in practice (Hellmuth et al., 2007). When deciding on effective approaches to use, one must recognize that climate is one component of a complex web of factors potentially impeding development. It is well established that improving infrastructure and agriculture as well as diversifying off-farm activities may be the most effective strategy for strengthening livelihoods and reducing vulnerability to climate-related events and disasters among the poor (Hellmuth et al., 2007; Hyndman and Hyndman, 2014; Moser et al., 2010; Wolshon et al., 2013). Additionally, integrating climate information into development initiatives potentially ensures synergistic outcomes.

In the past few decades, experts have studied various topics on climate change, poverty, urbanization, and disaster risk management (Baker, 2012). Despite the advances, there are gaps in our knowledge. In particular, there are few comprehensive quantitative analyses from developing countries that jointly distinguish poor from non-poor and urban from rural. There is also no clear association between disaster risk reduction (DRR) and climate change for the urban poor as well as paucity of practical examples of best practices in climate adaptation for the urban poor including distribution of disaster risk information. While empirical evidence of the benefits of integrating climate information into decision making is copious (Baker, 2012; Giles, 2005; IRI, 2006; Patz et al., 2005), studies that investigate whether vulnerable sub-groups that are predisposed to the effects of climate-related disasters actually obtain this information are nascent. This knowledge gap provides impetus for this study.

Due to limited knowledge and awareness of the risks that large segments of the population are liable to face during dangerous weather events, most people are at increased risk from climate-related disasters, such as landslides, flooding, storms, heat waves and drought (Hardoy and Pandiella, 2009; Hellmuth et al., 2007; Hyndman and Hyndman, 2014). Effective strategies to avoid further climate-related

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catastrophic occurrences for the most susceptible require sound scientific and technical as well as systematic approaches that emphasize early warning for natural hazards and plans that integrate all of the key factors in that risk, whether stemming from social vulnerabilities, natural hazards, and from short-term or long-term processes (Basher, 2006). Yet, the most vulnerable particularly the urban poor are usually the least informed about potential hazards to which they may be exposed. The objective of the study is to use communities in coastal Tanzania to test the hypothesis that the vulnerable urban poor who often have the worst health and adverse development outcomes are least likely to receive early warning information about flood, drought and other disasters from the relevant statutory institution.

Tanzania was chosen for four reasons. First, about 33 percent and 20 percent of the population subsist below the poverty line and food poverty line, respectively (World Bank, 2010). Secondly, between 1980 and 2008, Tanzania faced about 65 disasters—twenty-six epidemics, six droughts, and twenty-four flood events (Costella and Machume, 2009). About 90% of the population has been affected by droughts. Thirdly, there is paucity of research in Tanzania on how access to early warning information, which is critical to disaster risk management systematically, varies across the population in coastal areas, which is one of the hotspots for flooding in Tanzania. Furthermore, previous studies indicate that coastal areas in Tanzania are already experiencing climate change based on analyses of 50-year temperature and rainfall data (Armah et al., 2015b).

## Materials and Methods

### *Study area*

Tanzania is located in East Africa with large variation across regions, a large but sparse country with density of 51 persons per $km^2$ (Tanzania National Bureau of Statistics, 2013).

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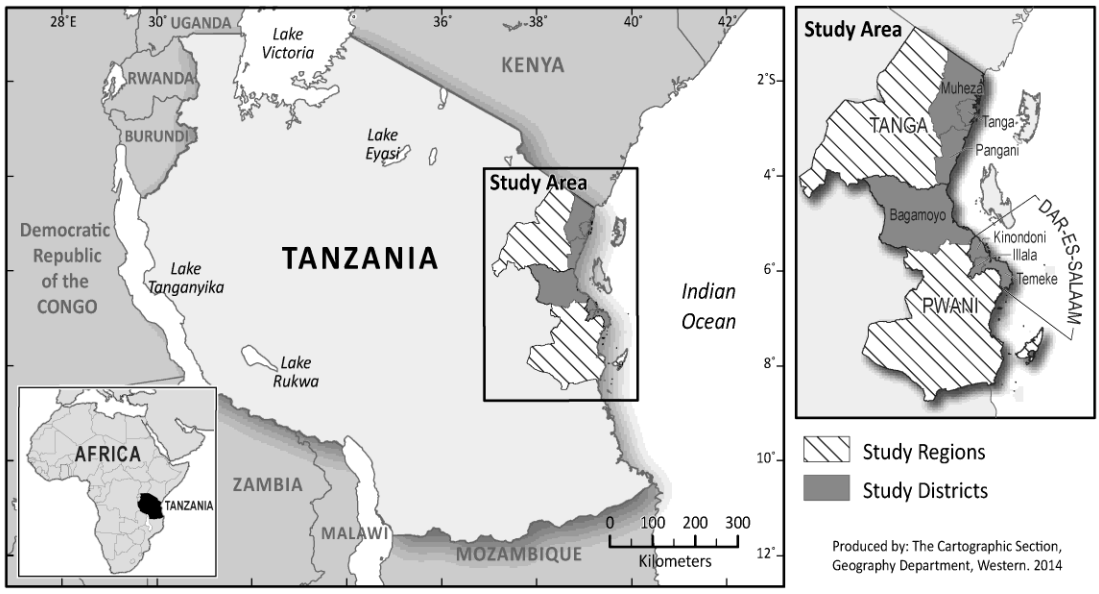


Figure 1: Map of Tanzania showing the study area (Source: Armah et al., 2015c)

Tanzania (Figure 1) has land area of 64 000 km$^2$ and 223 000 km$^2$ of territorial and offshore waters, respectively with an eight hundred kilometre coastline approximately fifteen percent of the entire coastal land area (Bryceson and Francis, 2001; Mngulwi, 2003). The country comprises five regions: Pwani, Dar-es-Salaam, Mtwara, Lindi and Tanga, but the work described here is confined to Tanga, Pwani and Dar-es-Salaam regions. The population of Tanzania was 59 million in 2018 (World Population Review, 2018).

*Data collection*

The survey design was cross-sectional consisting of 1253 persons in the Dar es Salaam, Tanga, and Pwani regions. Data were collected between March and September 2013 along the coastline of Tanzania. The sample consists of 606 men and 647 women between 18 and 70+ years. A multistage sampling technique was used to acquire a representative estimate of the population in the three regions. A detailed description of the data collection method is presented in Armah et al. (2015) and Armah et al. (2017). Ethical approval for the study in was obtained from the Western University, Canada Non-medical Research Ethics Board. In Tanzania, study approval was granted by the Commission on Science and Technology (COSTECH).

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*Measures*

Outcome variable

The response variable of interest is *receiving early warning information about flood, drought and other disasters* from the relevant statutory authority (meteorological agency). Each of the 1253 individuals in the survey were coded '0', that is, for those who indicated they did not receive early warning information or coded '1', that is, for those who received early warning information. On this basis, 62% of participants (377 males and 405 females) responded in the affirmative.

Independent factors

Theoretically relevant variables were categorized into adaptive capacity, contextual/geographical location, and socio-environmental factors. Factors that reveal adaptive capacity include self-rated ability to handle work pressure and responsibilities (SRWP), *a priori* disaster protection plan, emergency kit, self-rated ability to handle personal crisis and unexpected difficulties (SRPD), and coping strategies. Categories in both self-rated ability to handle work pressure and responsibilities, and self-rated ability to handle personal crisis and difficulties were coded as poor '0', fair '1', good '2', very good '3', and excellent '4'. *A priori* disaster protection plan, emergency kit, and coping strategies were considered as dummy variables. Contextual factors include district of residence, and length of stay in the community. Recognizing that the nexus between poverty and rural-urban residence is rather complex, a combined variable was generated, which accounted for heterogeneities in social status within urban and rural areas, that is, urbanicity wealth index. This variable consists of four mutually exclusive groups: rural poor, rural non-poor, urban poor, urban non-poor that were coded 1 through 4, respectively. Social factors include educational attainment, age, gender and ethnicity. Education was coded as none '0', primary education '1', secondary education '2' and tertiary education '3'. Age comprises four groups namely 18-25, 26-50, 51-65 and greater than 65 years; these were coded 1 through 4, respectively. Gender was operationalised as a dummy variable, with male as reference category. Ethnicity consists of three groups namely Zaramo, Sambaa and others, which were coded as 1, 2 and 3, respectively. Environmental factors include household structure, and relative household quality in the community. Household quality takes into account the quality of the built environment in relation to others within the same neighbourhood. This variable comprises five categories ranging from worst to excellent and coded 1 through 5.

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*Statistical analyses*

In this paper, three levels of analysis were carried out. First, frequencies and percentages of sub-groups in the sample are presented to show the distribution of responses on the likelihood of receiving early warning information about flood, drought and other disasters from the relevant statutory institution. Next, zero order relationships between independent variables and the likelihood of receiving early warning information about flood, drought and other disasters from the relevant statutory institution were analysed. At the multivariate level, three nested models were employed to examine the relationship between predictors and the likelihood of receiving early warning information about flood, drought and other disasters from the relevant statutory institution; the first was an unadjusted multivariate model consisting of factors that reveal adaptive capacity. The second set of factors in the multivariate model examined the relationship between place-based determinants and the response variable. The final set of factors focused on socio-environmental factors and the outcome variable while adjusting for the effect of theoretically relevant variables.

The dependent variable, receiving early warning, is binary; however, the responses are not equally distributed. About 62% of participants reported getting early warning information while 38% reported otherwise, suggesting that using a probit or logit link function that is based on a symmetrical distribution may yield estimates that are biased. Consequently, a complementary log-log model is appropriate for asymmetrical distributions in which higher categories are more likely, was employed. The standard complementary log-log models are based on the assumption of independence of observations but the cross-sectional survey data has a hierarchical structure with participants nested within households and survey clusters. This illustrates the responses provided by participants in the same households and neighbourhoods are likely to be similar to each other, and this may possibly bias the standard errors. STATA 13 software was used to analyze the models by imposing a ‘cluster’ variable on the models, using the identification numbers of participants at the cluster level. In doing so, the standard errors were adjusted thereby producing unbiased estimates (Armah et al., 2015a). The model outputs of the relationship between socio-environmental determinants, adaptive capacity, geographical location, and resident’s receipt of early warning information are presented as odds ratios (ORs). OR = 1 implies that there is no difference between those who receive early warning and those who do not. When OR is greater than 1, it indicates that there is a higher likelihood of receiving early warning, and an OR of less than 1 suggests a lower likelihood of receiving early warning information.

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## Results

*Summary statistics of study sample*

Seven hundred and forty-three and five hundred and ten individuals were urban and rural residents, respectively. Approximately 9% had no formal education, 46% had primary education, 27% had secondary education and 18% had attained tertiary education. Majority of respondents (80%) were between 26 and 60 years old. More than three-fourths of the sample lives below the poverty line. There were four hundred and thirty-nine Christians and eight hundred and ten Muslims. Only four respondents were adherents of traditional African religion. About 93% of the sample were employed either in the formal or informal sector.

Table 1: Association between access to early warning information about flood, drought and other disasters and theoretically relevant characteristics of respondents (n=1253)

| Predictors | No (%) | Yes (%) | Inferential Statistics |
|---|---|---|---|
| ***Coastal District*** | | | Pearson $\chi2(6) = 34.5040$ Pr = 0.000 |
| Kinondoni | 34 | 66 | Cramér's V = 0.1659 |
| Illala | 56 | 44 | |
| Temeke | 40 | 60 | |
| Bagamoyo | 42 | 58 | |
| Tanga Town | 29 | 71 | |
| Muheza | 30 | 70 | |
| Pangani | 30 | 70 | |
| ***Length of stay in present community*** | | | Pearson $\chi2(1) = 7.2600$ Pr = 0.007 |
| Less than 5 years | 30 | 70 | Cramér's V = -0.0761 |
| 5 years or more | 39 | 61 | |
| ***Household Structure*** | | | Pearson $\chi2(5) = 53.9494$ Pr = 0.000 |
| Female centred (No husband or male partner in household) | 38 | 62 | Cramér's V = 0.2075 |
| Male Centred (No wife or female partner in household) | 34 | 66 | |
| Nuclear (Male partner and wife with or without children) | 23 | 77 | |
| Extended (Both partners and children and relatives) | 46 | 54 | |
| Child-centred (Headed by a child) | 0 | 100 | |
| Polygynous (Husband with more than 1 wife) | 68 | 32 | |
| ***Relative household quality in the community*** | | | Pearson $\chi2(4) = 142.7422$ Pr = 0.000 |
| The Worst | 65 | 35 | Cramér's V = 0.3375 |
| Among the Worst | 71 | 29 | |
| About the Same | 33 | 67 | |
| Better | 21 | 79 | |
| Best in the community | 19 | 81 | |
| ***SRWP*** | | | Pearson $\chi2(4) = 38.5792$ Pr = 0.000 |
| poor | 41 | 59 | Cramér's V = 0.1755 |
| fair | 46 | 54 | |
| good | 36 | 64 | |

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| | | | |
|---|---|---|---|
| very good | 25 | 75 | |
| excellent | 7 | 93 | |
| ***SRPD*** | | | Pearson $\chi2(4) = 68.0396$ Pr = 0.000 |
| poor | 59 | 41 | Cramér's V = 0.2330 |
| fair | 41 | 59 | |
| good | 26 | 74 | |
| very good | 31 | 69 | |
| excellent | 4 | 96 | |
| ***Does your household currently have a plan for how to protect you and your family in the event flood or drought*** | | | Pearson $\chi2(1) = 7.0190$ Pr = 0.008 |
| No | 39 | 61 | Cramér's V = 0.0748 |
| Yes | 28 | 72 | |
| ***Does your household have emergency kit in the event of flood, drought or other disasters*** | | | Pearson $\chi2(1) = 13.9596$ Pr = 0.000 |
| No | 39 | 61 | Cramér's V = 0.1056 |
| Yes | 19 | 81 | |
| ***Do you have any coping strategies in the event of flood, drought or other disasters*** | | | Pearson $\chi2(1) = 130.0887$ Pr = 0.000 |
| No | 49 | 51 | Cramér's V = 0.3222 |
| Yes | 17 | 83 | |
| ***Age of respondent*** | | | Pearson $\chi2(3) = 9.2129$ Pr = 0.027 |
| 18-25 | 35 | 65 | Cramér's V = 0.0857 |
| 26-35 | 35 | 65 | |
| 36-50 | 43 | 57 | |
| More than 50 years | 47 | 53 | |
| ***Urbanicity wealth status*** | | | Pearson $\chi2(3) = 31.9791$ Pr = 0.000 |
| Rural Poor | 38 | 62 | Cramér's V = 0.1598 |
| Rural Nonpoor | 36 | 64 | |
| Urban Poor | 65 | 35 | |
| Urban nonpoor | 34 | 66 | |
| ***Education*** | | | Pearson chi2(3) = 24.3470 Pr = 0.000 |
| No formal education | 50 | 50 | Cramér's V = 0.1394 |
| Primary | 36 | 64 | |
| Secondary | 43 | 57 | |
| Tertiary | 26 | 74 | |

Based on measures of association (chi-square statistics), receipt of early warning information about flood, drought and other disasters was associated with geographical location (district), length of stay in present community, household structure, relative household quality in the community, and age group to which an individual belongs (Table 1). Similarly, receipt of early warning information about flood, drought and other disasters was significantly associated with urbanicity wealth status, self-rated ability to handle personal crisis and unexpected difficulties (SRPD), and self-rated ability to handle work pressure and responsibilities (SRWP). Based on Cramér's V, it is discernible from Table 1 that all the associations were weak (less than 0.3) except the association between likelihood of receiving of early warning information

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about flood, drought and other disasters and relative household quality in the community, and whether the individual has any coping strategies in the event of flood, drought or other disasters.

*Bivariate relationships between receiving early warning information about flood, drought and other disasters and socio-demographic attributes of respondents*

Table 2: Zero-order relationships predicting receipt of early warning information about flood, drought and other disasters in coastal communities in Tanzania (n=1253)

| | OR | Robust SE | p-value | [95% Conf. | Interval] |
|---|---|---|---|---|---|
| Predictors | | | | | |
| ***Urbanicity wealth status (Ref: Rural Poor)*** | | | | | |
| Rural Nonpoor | 1.04 | 0.12 | 0.710 | 0.830 | 1.316 |
| Urban Poor | 0.45 | 0.09 | **0.000** | 0.306 | 0.663 |
| Urban nonpoor | 1.10 | 0.11 | 0.358 | 0.898 | 1.345 |
| ***Coastal District (Ref: Kinondoni)*** | | | | | |
| Illala | 0.54 | 0.08 | **0.000** | 0.409 | 0.725 |
| Temeke | 0.86 | 0.13 | 0.321 | 0.644 | 1.155 |
| Bagamoyo | 0.80 | 0.08 | **0.035** | 0.656 | 0.985 |
| Tanga Town | 1.16 | 0.15 | 0.247 | 0.901 | 1.502 |
| Muheza | 1.13 | 0.16 | 0.393 | 0.853 | 1.497 |
| Pangani | 1.13 | 0.15 | 0.366 | 0.868 | 1.468 |
| ***Length of stay in present community (Ref: Less than 5 years)*** | | | | | |
| 5 years or more | 0.78 | 0.07 | **0.006** | 0.655 | 0.930 |
| ***Household Structure (Ref: Female centred)*** | | | | | |
| Male Centred (No wife or female partner in household) | 1.13 | 0.14 | 0.344 | 0.878 | 1.451 |
| Nuclear (Male partner and wife with or without children) | 1.53 | 0.18 | **0.000** | 1.216 | 1.927 |
| Extended (Both partners and children and relatives) | 0.81 | 0.09 | 0.053 | 0.652 | 1.003 |
| Child-centred (Headed by a child) | 15.01 | 1.46 | **0.000** | 12.398 | 18.162 |
| Polygynous (Husband with more than 1 wife) | 0.40 | 0.17 | **0.027** | 0.173 | 0.902 |
| ***Relative household quality in the community (Ref: The Worst)*** | | | | | |
| Among the Worst | 0.79 | 0.24 | 0.444 | 0.430 | 1.448 |
| About the Same | 2.55 | 0.72 | **0.001** | 1.463 | 4.444 |

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| | | | | | |
|---|---|---|---|---|---|
| Better | 3.64 | 1.07 | **0.000** | 2.052 | 6.462 |
| Best in the community | 3.78 | 1.32 | **0.000** | 1.912 | 7.484 |
| ***Self-rated ability to handle work pressure (Ref: Poor)*** | | | | | |
| fair | 0.86 | 0.17 | 0.448 | 0.589 | 1.263 |
| good | 1.13 | 0.22 | 0.527 | 0.775 | 1.643 |
| very good | 1.53 | 0.31 | **0.036** | 1.028 | 2.284 |
| excellent | 2.98 | 0.94 | **0.001** | 1.609 | 5.511 |
| ***Self-rated ability to handle personal crisis and unexpected difficulties (Ref: Poor)*** | | | | | |
| fair | 1.69 | 0.24 | **0.000** | 1.278 | 2.229 |
| good | 2.58 | 0.38 | **0.000** | 1.936 | 3.432 |
| very good | 2.27 | 0.57 | **0.001** | 1.392 | 3.702 |
| excellent | 6.08 | 2.04 | **0.000** | 3.154 | 11.734 |
| ***Disaster protection plan (Ref: No)*** | | | | | |
| Yes | 1.34 | 0.14 | **0.006** | 1.089 | 1.649 |
| ***Does your household have emergency kit in the event of flood, drought or other disasters (Ref: No)*** | | | | | |
| Yes | 1.76 | 0.24 | **0.000** | 1.343 | 2.302 |
| ***Do you have any coping strategies in the event of flood, drought or other disasters (Ref: No)*** | | | | | |
| Yes | 2.52 | 0.20 | **0.000** | 2.166 | 2.936 |
| ***Age of respondent (Ref: 18-25 Years)*** | | | | | |
| 26-35 | 1.01 | 0.09 | 0.944 | 0.846 | 1.197 |
| 36-50 | 0.81 | 0.08 | **0.035** | 0.668 | 0.985 |
| more than 50 years | 0.72 | 0.12 | **0.047** | 0.519 | 0.996 |
| ***Educational Attainment (Ref: No formal schooling)*** | | | | | |
| Primary | 1.44 | 0.22 | **0.014** | 1.076 | 1.931 |
| Secondary | 1.19 | 0.19 | 0.277 | 0.872 | 1.616 |
| Tertiary | 1.91 | 0.31 | **0.000** | 1.390 | 2.627 |

At the bivariate level, there was no significant relationship between categories of urbanicity wealth status and the likelihood of respondents to receive early warning information about flood, drought and other disasters (Table 2). The only exception was the urban poor categories who were 55% less likely to receive early warning about

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disasters compared with their rural poor counterparts. Residents in Illala and Bagamoyo districts were 45% and 20% less likely to receive early warning information about flood, drought and other disasters from statutory authorities compared with their counterparts who are resident in Kinondoni district. Respondents who had lived in their present community for 5 years or above were 22% less likely to receive early warning information about flood, drought and other disasters compared with their counterparts who had been resident for less than 5 years in the community. Household structure was a significant predictor of likelihood of receiving early warning information about flood, drought and other disasters. In this context, nuclear households consisting of male partner and wife with or without children were more likely to report receiving early warning information about flood, drought and other disasters (OR = 1.53, $p < 0.001$) compared with their counterparts in female-centred households (no husband or male partner).

Interestingly, residents in child-centred households were far more likely to report receiving early warning information about flood, drought and other disasters (OR = 15.01, $p < 0.001$) compared with their counterparts in female-centred households (no husband or male partner) unlike those in polygynous households (husband with more than 1 wife) (OR = 0.40, $p < 0.05$). The quality of the household in relation to analogous households in the community was a significant predictor of receipt of early warning information about flood, drought and other disasters. Individuals resident in households of better quality (OR = 3.64, $p < 0.001$) and best quality (OR = 3.78, $p < 0.001$) in the community were both far more likely to report receiving early warning information about flood, drought and other disasters compared with those living in the worst households in the community.

Individuals who had very good self-rated ability to handle work pressure and responsibilities (OR = 1.53, $p < 0.001$) and excellent self-rated ability to handle work pressure and responsibilities (OR = 2.98, $p < 0.001$) were both more likely to indicate that they receive early warning information about flood, drought and other disasters. Participants who rated their ability to handle personal crisis and unexpected difficulties as fair, good, very good or excellent were all more likely to report receiving early warning information about flood, drought and other disasters compared with those who rated their ability as poor. Respondents who had *a priori* disaster protection plan, emergency kit, and coping strategies were all more likely to receive early warning information about flood, drought and other disasters compared with those who lacked these preparedness attributes.

Individuals in the 36–50 age group were less likely (OR = 0.81, $p < 0.05$) to report that they had received early warning information about flood, drought and other disasters compared with those in the 18-25 age

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group. Similarly, individuals who are older than 50 years were less likely (OR = 0.72, $p < 0.05$) to receive early warning information about flood, drought and other disasters compared with those in the 18–25 age group.

Respondents who had attained primary education (OR = 1.44, $p < 0.05$) and those who had attained tertiary education (OR = 1.91, $p < 0.001$) were more likely to report that they had received early warning information about flood, drought and other disasters compared with their counterparts who had no formal education.

*Multivariate relationships between receipt of early warning information about flood, drought and other disasters and adaptive capacity, contextual and socio-environmental factors*

In the nested multivariate model, the magnitude, direction and level of statistical significance of the original bivariate relationships changed indicating the complex relationship between adaptive capacity, contextual and socio-environmental factors that independently or jointly influence access to early warning information about flood, drought and other disasters.

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Table 3: Multivariate complementary log-log regression model predicting receipt of early warning information about flood, drought and other disasters in coastal communities in Tanzania (n=1253)

| | Adaptive Capacity | | | | | Geographical location | | | | | Socio-environmental | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OR | SE | p-value | [95% Conf. Interval] | | OR | SE | p-value | [95% Conf. Interval] | | OR | SE | p-value | [95% Conf. Interval] | |
| ***Does your household currently have a plan for how to protect you and your family in the event of a disaster or emergency (Ref: No)*** | | | | | | | | | | | | | | | |
| Yes | 0.82 | 0.11 | 0.153 | 0.63 | 1.07 | 0.83 | 0.12 | 0.188 | 0.63 | 1.10 | 0.89 | 0.14 | 0.477 | 0.65 | 1.22 |
| ***Does your household have emergency kits-first aid, flashlight, batteries, sufficient drinking water, food stock, etc (Ref: No)*** | | | | | | | | | | | | | | | |
| Yes | 1.77 | 0.32 | **0.001** | 1.25 | 2.52 | 1.69 | 0.31 | **0.004** | 1.18 | 2.43 | 1.16 | 0.25 | 0.504 | 0.76 | 1.77 |
| ***Do you have any coping strategies during flood, storms, drought (Ref: No)*** | | | | | | | | | | | | | | | |
| Yes | 2.54 | 0.20 | **0.000** | 2.18 | 2.97 | 2.57 | 0.21 | **0.000** | 2.20 | 3.01 | 2.59 | 0.25 | **0.000** | 2.14 | 3.14 |
| ***Urbanicity weath status (Ref: Rural poor)*** | | | | | | | | | | | | | | | |
| Rural Nonpoor | | | | | | 1.11 | 0.14 | 0.398 | 0.87 | 1.41 | 0.86 | 0.12 | 0.265 | 0.65 | 1.12 |
| Urban Poor | | | | | | 0.65 | 0.14 | **0.042** | 0.42 | 0.98 | 0.43 | 0.10 | **0.000** | 0.27 | 0.68 |
| Urban nonpoor | | | | | | 1.49 | 0.24 | **0.012** | 1.09 | 2.04 | 0.93 | 0.17 | 0.714 | 0.65 | 1.34 |
| ***District of residence (Ref: Kinondoni)*** | | | | | | | | | | | | | | | |
| Illala | | | | | | 0.65 | 0.10 | **0.003** | 0.48 | 0.86 | 0.64 | 0.10 | **0.006** | 0.46 | 0.88 |

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| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Temeke | 1.04 | 0.16 | 0.799 | 0.77 | 1.40 | 1.02 | 0.17 | 0.911 | 0.73 | 1.42 |
| Bagamoyo | 1.08 | 0.18 | 0.648 | 0.78 | 1.48 | 0.96 | 0.17 | 0.806 | 0.67 | 1.36 |
| Tanga Town | 1.69 | 0.26 | **0.000** | 1.26 | 2.27 | 1.81 | 0.30 | **0.000** | 1.31 | 2.51 |
| Muheza | 1.38 | 0.24 | 0.064 | 0.98 | 1.94 | 1.08 | 0.21 | 0.693 | 0.74 | 1.57 |
| Pangani | 1.63 | 0.30 | **0.009** | 1.13 | 2.35 | 1.30 | 0.28 | 0.211 | 0.86 | 1.98 |
| ***Length of stay in present community (Ref: Less than 5 years)*** | | | | | | | | | | |
| 5 years or more | | | | | | 0.90 | 0.11 | 0.395 | 0.72 | 1.14 |
| ***Household Structure (Ref: Female centred)*** | | | | | | | | | | |
| Male Centred (No wife or female partner in household) | | | | | | 1.17 | 0.17 | 0.305 | 0.87 | 1.56 |
| Nuclear (Male partner and wife with or without children) | | | | | | 1.47 | 0.21 | **0.006** | 1.12 | 1.94 |
| Extended (Both partners and children and relatives) | | | | | | 0.84 | 0.11 | 0.163 | 0.65 | 1.07 |
| Child-centred (Headed by a child) | | | | | | 21.39 | 3.86 | **0.000** | 15.03 | 30.46 |
| Polygynous (Husband with more than 1 wife) | | | | | | 0.47 | 0.22 | 0.111 | 0.19 | 1.19 |
| ***Relative household quality in the community (Ref: The Worst)*** | | | | | | | | | | |
| Among the Worst | | | | | | 0.70 | 0.22 | 0.253 | 0.37 | 1.30 |
| About the Same | | | | | | 1.86 | 0.55 | **0.035** | 1.04 | 3.32 |
| Better | | | | | | 2.45 | 0.78 | **0.005** | 1.31 | 4.56 |
| Best in the community | | | | | | 2.76 | 1.07 | **0.009** | 1.29 | 5.92 |
| ***Self rated ability to handle work pressure (Ref: Poor)*** | | | | | | | | | | |
| fair | | | | | | 0.56 | 0.12 | **0.008** | 0.36 | 0.86 |

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| | | | | | |
|---|---|---|---|---|---|
| good | 0.56 | 0.13 | **0.010** | 0.36 | 0.87 |
| very good | 0.42 | 0.11 | **0.001** | 0.25 | 0.69 |
| excellent | 0.70 | 0.37 | 0.510 | 0.25 | 2.00 |
| ***Self rated ability to handle personal crisis and unexpected difficulties (Ref: Poor)*** | | | | | |
| fair | 1.68 | 0.27 | **0.001** | 1.22 | 2.31 |
| good | 2.92 | 0.55 | **0.000** | 2.02 | 4.22 |
| very good | 3.68 | 1.11 | **0.000** | 2.05 | 6.63 |
| excellent | 4.08 | 2.26 | **0.011** | 1.38 | 12.05 |
| Age of respondent (Ref: 18-35 Years) | | | | | |
| 36-50 | 0.85 | 0.09 | 0.135 | 0.69 | 1.05 |
| 51-65 | 0.77 | 0.09 | **0.028** | 0.61 | 0.97 |
| more than 65 years | 0.78 | 0.14 | 0.174 | 0.54 | 1.12 |
| ***Educational Attainment (Ref: No formal schooling)*** | | | | | |
| Primary | 0.96 | 0.16 | 0.825 | 0.70 | 1.33 |
| Secondary | 0.73 | 0.14 | 0.092 | 0.50 | 1.05 |
| Tertiary | 0.96 | 0.21 | 0.862 | 0.63 | 1.46 |

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The significant relationship between the likelihood of receiving early warning information about flood, drought and other disasters and households that had a plan for how to protect respondents and their family in the event of a disaster or emergency was not robust and disappeared completely at the multivariate level indicating that contextual and socio-environmental factors completely mediate this relationship. There was a marginal increase in the magnitude of the relationship between receiving early warning information about flood, drought and other disasters and households that have emergency kits-first aid, flashlight, batteries, sufficient drinking water, and food stock. The magnitude and direction of the relationship between receiving early warning information and having *a priori* coping strategies during flood, storms, and drought were reversed. In the geographical location model, the foregoing relationships remained statistically significant (Table 3).

Individuals in the urban poor category were 35% less likely to receive early warning information about flood, drought and other disasters whereas urban non-poor residents were 49% more likely to receive early warning information about flood, drought and other disasters. Residence in three of the six districts in which the study was undertaken (Illala, Tanga Town and Pangani) was significantly related to likelihood of receiving early warning information from the statutory authorities. This is inconsistent with the trend at the bivariate level where residence in Illala and Bagamoyo Districts was significantly related to receipt of early warning information. This suggests that urbanicity wealth status and factors that confer adaptive capacity jointly suppressed the relationship between district of residence and receipt of early warning information about flood, drought and other disasters. The statistically significant relationship between urban non-poor status and receipt of early warning information manifested only at the multivariate level.

In the socio-environmental model, the original significant relationship between having an *a priori* disaster plan and likelihood of receiving early warning information was not robust and disappeared altogether at the multivariate level. Similar trends were observed for individuals in households that had emergency kits, urban non-poor residents and individuals who had resided in their present community for more than 5 years suggesting that these associations are completely mediated by adaptive capacity, geographical location and socio-environmental factors. However, the relationship between coping strategies and likelihood of receiving early warning information persisted even after controlling for contextual and socio-environmental factors.

Nuclear households consisting of male partner and wife with or without children were more likely to report receiving early warning information about flood, drought and other disasters (OR = 1.47, $p < 0.001$) compared with their counterparts in female-centred households (no husband or male partner). The

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magnitude of odds ratio reduced marginally from the value observed in the zero-order relationship. Child-centred households were consistently far more likely to receive early warning information about flood, drought and other disasters compared with their counterparts in female-centred households.

After controlling for geographical location and socio-environmental factors in the multivariate model, individuals resident in houses of better quality (OR = 2.45, $p < 0.001$) and best quality (OR = 2.76, $p < 0.001$) in the community were both far more likely to report that they had received early warning information about flood, drought and other disasters compared with those living in the worst households in the community. However, the magnitudes of the odds ratios were substantially lower than observed in the original one-to-one relationship.

Counter-intuitively and in stark contrast with the trends at the bivariate level, individuals with fair, good and very good self-rated ability to handle work pressure and responsibilities were all less likely to report that they had received early warning information about flood, drought and other disasters compared with those who had poor self-rated ability. However, the magnitude and direction of the categories of ability to handle personal crisis and unexpected difficulties were consistent with the trends observed at the bivariate level. It is remarkable that none of the categories of educational attainment was statistically significant at the multivariate level suggesting that adaptive capacity, contextual and socio-environmental factors completely mediate the relationship between the highest level of education attained by a respondent and the likelihood that the individual would receive early warning information about flood, drought and other disasters.

**Discussion**

This paper quantitatively evaluates the likelihood of the urban poor to access climate information, which is most critical to disaster risk reduction. The emphasis on the urban poor in relation to other population sub-groups is predicated on the fact that country level measures on intrinsic population attributes do not reflect the experiences of specific social groups that form majority of society and may be dealing with extreme poverty. The attention on coastal communities is relevant since almost 66 percent of urban dwellers are living in a low-lying coastal region (McGranahan et al., 2007).

Nuclear households consisting of male partner and wife with or without children were fifty-three percent more likely to report receiving early warning information about flood, drought and other disasters compared with their counterparts in female-centred households (no husband or male partner). Female-

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centred households are potential high-risk groups to the effects of disaster especially within the context of a changing climate. A growing body of literature is lately drawing attention to the fact that disaster experiences are gendered and that women are predominantly vulnerable before, during and after climate events (Alston, 2014; Enarson, 2009; IPCC, 2012; Lambrou & Nelson, 2010; Neumayer & Pluemper, 2007). However, other scholars suggest that women are heterogeneous and that there are complex interactions between gender and other forms of disadvantage based on age, ethnicity and context variability (Demetriades and Esplen, 2008). Context-specific knowledge and experience generated through participatory research where existing coping strategies and adaptation priorities regarding climate change and disasters are assessed is needed especially within sub-Saharan Africa where there has been limited documented research of the needs of men and women regarding climate change information and disaster risks.

When building societal capacities, the priority should be on the disadvantaged and most vulnerable groups to reflect the needs of the sub-groups. In doing so, it will facilitate in achieving three key goals: (1) access to various forms of effective capital (e.g., financing, education and land property); (2) transform institutions in ways that encourages citizen participation and involvement in decision making and resolve exclusion mechanisms; (3) eradicate poverty through provision of social services.

Although intuitive, it is ironic that residents living in better and best quality housing were far more likely to receive climate and natural hazard information compared with the worst households in the community. The poor predominantly inhabit low quality housing that is predisposed to collapse and damage at some stage during flooding and other hydro-meteorological disasters. Given that those who are economically empowered and live in formidable housing structures are part of low risk groups regarding the deleterious effects of disaster, it is logical to expect that climate information should not necessarily target them for attention but the findings of this study revealed otherwise.

In this study, zero order relationship revealed that those who had tertiary education were more likely to report that they had received early warning information about drought, flood, and other disasters compared with their counterparts without any formal education. This suggests that highly educated individuals tend to be more prepared for disasters which lower their potential susceptibility to climate risk. In this context, Muttarak and Lutz (2014) assert that when confronted with climate-related disasters, people who are highly educated are more equipped to take initiatives in response to, and preparation for disasters recovery and management. Education leads to vulnerability reduction through enhanced risk

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perception, problem solving skills and cognitive skills (Muttarak and Lutz, 2014; Nisbett, 2009, Reynolds et al., 2010) all of which indirectly affect poverty reduction, access to information and social capital (KC and Lutz, 2014; Muttarak and Lutz, 2014; Rodriguez et al., 2007). Individuals and communities encounter heterogeneity in exposure and vulnerability based on several factors including education, gender, and other socioeconomic factors which has impact on how individuals prepare, respond and recover from disasters and natural hazards (Armah et al., 2017; Morrow, 2008).

According to Rodriguez et al. (2007), level of education is very much connected to a person's access and understanding of the types of technologies used to report weather information. It has also been suggested that education enhances the acquisition of knowledge on disaster risks and how to access and respond to such risks, and the capability to plan for the future and improve acquisition of resources (Muttarak and Lutz, 2014). Yet, the fact that the one-to-one relationship between higher educational attainment and higher likelihood of receiving early warning information about drought, flood, and other disasters disappeared completely when geographical and socio-environmental factors were controlled in this study suggests that the relationship is much more complex than we originally thought. The risks for various hazard— heat waves, drought, landslides, and floods —differ significantly and have unique impact on different population sub-groups (e.g., the proportion of urban poor who are women or elderly). In this context, a helpful distinction for risk assessment is the notion of intensive and extensive risks established in the disaster risk literature (see Baker, 2012). Intensive risk refers to situations in which certain areas with severely vulnerable people with limited access to economic assets are exposed to very brutal hazards such as severe flooding. Conversely, extensive risks dwells on situations when wide regions are susceptible to more commonly occurring low-or moderate-intensity losses (for example, localized flooding, fires, and landslides in informal settlements). Such widespread low-intensity losses are associated with other risk impacts, such as a large number of affected people and damage to housing and local infrastructure, particularly affecting the urban poor. The heterogeneities in the impacts of disaster between the rich and poor emanates from both prior vulnerability and response post event. Consistent with previous studies (Grothmann and Reusswig, 2006), this study showed that factors such as personal resources, geographical location and infrastructure jointly affect the emergence, persistence and magnitudes of disasters.

Disadvantaged populations live in marginal lands and vulnerable regions in urban locations such as flood plains (Armah et al., 2009). Often, such neighbourhood lacks the communication infrastructure required for effective dissemination of disaster-related or climate relevant information. Environmental exploitation, created for economic gains (e.g., hillside deforestation), predisposes vulnerable populations

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and increases their risks to disasters such as floods and landslides. Further to this, the limited resources that poor persons have hitherto used on daily survival is likely to be used in the event of a disaster, further constraining the otherwise limited resource. Communication, access to transportation and infrastructure are key challenges to poverty endemic communities. For instance, hospital and community health facilities which are often deprived of resources even before a disaster occurs are over extended and stretched beyond capacity during a disaster (Hoffman 2009; Lall and Deichmann, 2009). Even worse, the urban poor have limited access to basic resources and welfare services such as food and energy security, drinking water, solid-waste management services, drainage and sanitation, and transport (Hoffman 2009; Lall and Deichmann, 2009).

Poor communities disproportionately bear the brunt of changing weather patterns and natural hazards, and have limited adaptive capacity to cope with climate change and its associated health risks, for which reason they deserve to be isolated as priority targets of risk reduction policies, including capacity creation as well as recovery of losses in disastrous events (Blaikie et al., 2014; Hyndman and Hyndman, 2014; Moser et al., 2008). In this context, Moser et al. (2008) draws attention to the mechanism by which assets including physical, natural, financial, social, and human capital"—mediate adaptive capacity of the urban poor. These assets are particularly important because city authorities may not have adequate financial resources to provide services, and may be reluctant to work with the poor, particularly in informal settlements, where formalizing the assets of the poor could increase the likelihood of holding local governments accountable for provision of services. In climate change and disaster management planning, focus must be on priority population sub-groups for risk reduction policies. A key feature of such policies should be capacity creation and recovery of losses in disastrous events. Hopefully, such policies should take into a greater account the needs of deprived neighbourhoods that bear the brunt of variable weather patterns and hazards and have fewer adaptive capacity to cope with climate-related events and its associated health risks (Blaikie et al., 2014; Hyndman and Hyndman, 2014; Moser et al., 2008).

A recurrent theme in this paper is the fact that early warning systems for alerting the most vulnerable or the poor in urban settings are weak and not participatory (not people-centred). Basher (2006) has identified four fundamental elements of people-centred early warning systems. The first is risk knowledge which encompasses the knowledge of the relevant hazards, and of the vulnerabilities of people and society to these hazards. Next is monitoring and warning which comprises the technical capacity to monitor hazard precursors, to forecast the hazard evolution, and to issue warnings. The third dimension focuses on dissemination and communication which entails the diffusion of understandable warnings, and prior preparedness information, to those at risk. The final element refers to response capability that is the

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knowledge, plans and capacities for timely and appropriate action by authorities and those at risk. All four elements and dimensions are critical to addressing the shortcomings of the existing framework for communicating with the most vulnerable sub-groups in coastal Tanzania.

Limitations are a defining characteristic of all empirical research work. The cross-sectional nature of the study design suggests that the predictors and outcomes were measured contemporaneously. Therefore, the results of the study preclude any statements of causality. Steps were taken to reduce bias in the design of the study as the most valid and reliable measures were chosen. Another limitation concerns data collection and the unit of analysis. The data for this study were collected at the individual and household levels and the statistics were conducted on self-reported responses, which is prone to recall bias. For this reason, future research could include multi-source data such as objective ratings of actual disaster outcomes, which may complement the findings of this study.

**Conclusion**

Four separate and largely autonomous research and policy communities—disaster risk reduction, climate change adaptation, environmental management and poverty reduction have been actively engaged in reducing socio-economic vulnerability to natural hazards during the past half century especially in developing countries. Within this research—policy milieu, the urban poor who are most susceptible to the deleterious effects of climate change and natural hazards have not received the attention they deserve. Using coastal Tanzania as context, this paper quantified the likelihood of four mutually exclusive groups (rural poor, rural non poor, urban poor, and urban non poor) to receive early warning information about flood, drought and other disasters. Of the four groups, the urban poor are the worst in terms of access to early warning information about flood, drought and other disasters. The magnitude and direction of this relationship persist even when adaptive capacity, geographical location and socio-environmental factors are taken into account. Higher levels of self-efficacy expressed as good or better self rated ability to handle personal crisis and unexpected difficulties were associated with higher likelihood of access to early warning information about flood, drought and other disasters. The independent relationships between access to information and education, household structure, age, and duration of residence in the community are complex based on the variability in the magnitude and direction of the parameter estimates when the outputs of the bivariate and multivariate regression models are compared. The present and clear message is that the urban poor are being left behind regarding access to early warning information about flood, drought and other disasters—they are not onboard. Since urban poverty is

complex, and the urban poor have many climate- and disaster-related information needs which vary over time, with location, and circumstances, single sector approaches to delivering their information needs may not be the most effective. Relevant statutory institutions often discriminate against the urban poor when they seek access to information, or are simply inefficient. They consequently seek help from non-governmental and private institutions, who are more trusted and efficient, but also cannot cope with the scale of the demand, and only occasionally have managed to empower the poor to demand what legitimately belongs to them. Owing to this, the urban poor, for the most part, have to rely on their own social networks and key informants within their communities, or sometimes outside, for support in developing their livelihoods and coping with disasters and climate change. Given that climate change and disaster preparedness are both multi-sectoral, there is opportunity for researchers and policymakers to tap the unique attributes of the urban poor in order to deepen their involvement in climate change adaptation and disaster risk reduction.

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