



Can remittances contribute to financing climate actions in developing countries? Evidence from analyses of households' climate hazard exposure and adaptation actors in SE Nigeria

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Abstract

Migrant remittances are potentially significant sources of funding for climate change adaptation and resilience building in developing countries. However, very little is understood about the linkages between climate actions and remittances at the household level. It is not clear how remittances can affect households' responses to climate change. This paper presents evidence from analyses of the associations between remittances to households, their climate hazard exposure, and adaptation actors. It uses concurrent data on international remittances receipts, three climate change related hazards (flooding, intense and irregular rainfall), and main adaptation actors (self/family, community, government, and NGOs) from over 600 households in South Eastern Nigeria. The results showed that household incidence of remittances is low (15%) while exposure to climate hazards is higher (flooding: 41.2%, intense rainfall: 47.1%, irregular rainfall: 29.9%). Nominal (contingency coefficient) associations between remittances and household climate hazard exposure and remittances and household adaptation actors were mostly moderate and insignificant. Therefore, households that received remittances and those that did not were not significantly different in terms of their exposure to climate hazard and main actors in climate adaptation. Self/families were the main actors in household climate actions. Governments and NGO actors were less prominent. The results suggest that unregulated remittances have limited impact on household climate hazard exposure and adaptive actions. However, there are indications that the contribution of remittances to financing climate adaptation may be enhanced by addressing issues with cost of remitting and remittee understanding of climate change to increase remittances volumes, incidence, and use.

Keywords Remittances · Climate hazards · Climate financing · Adaptation actors · Households · Developing countries

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1 Introduction

Building up adaptive capacity and resilience of societies against climate change is an important component of the sustainable development goals (SDGs). Funding for the SDGs in general and their climate change goals is threatened by emerging global challenges: increasing protectionism, fluctuation in commodity prices, and the COVID-19 pandemic global economic reality. This reality will be dire for climate change programs in most countries. For developing countries (DCs), emerging funding constraints will compound the problem of perennial lack of finance to build climate change resilience and adaptive capacity especially for households and communities (WBG 2019a; UNFCCC 2007). Mobilizing sources of sustainable funding for climate actions in DCs was a major objective of the recently concluded United Nations Climate Change Conference (COP26). Failure to fully achieve this objective was a significant shortcoming of the conference (Vanhala 2021).

However, adequate financing for climate actions in households and communities in DCs like Nigeria remains imperative for a number of reasons. For one, households and communities in these countries are highly vulnerable to climate change. Thus, they would require significant levels of funding to enhance their adaptation and resilience (Skjeflo 2017; Mertz et al. 2009). Another, existing bilateral and multilateral arrangements—for example, within the UNFCCC, the Kyoto protocol, and the Paris Agreement—to bridge climate financing gaps in DCs are not only insufficient but are mostly targeted at the formal sector (IIED 2018; Cui and Huang 2018; Premium Times 2017; Schaeffer et al. 2015). Even when multilateral climate financing is targeted at projects directly relevant to households and communities, their effectiveness is often limited by issues bordering on poor social and ecological contextualization, tokenism, lack of community consultation and participation, and corruption (Maduekwe 2016).

Climate change funding shortages have spurred the recent push to increase private sector participation in climate change adaptation funding in Nigeria and other DCs (Uwaegbulam 2019; Fayole et al. 2019; Atteridge 2010). The objective is to leverage on the enormous resources (financial, technical, and human) within the sector to fund and facilitate climate change actions (UNEP 2012; Atteridge 2010; Asian Tiger Capital Partners 2010; Pauw et al 2016). However, the private sector in most LDCs is dominated by low and medium scale ventures with very poor financial capacity. This is a major limitation to their climate financing participation. In addition, existing arrangements for private sector climate financing may not be directed to the needs of households and communities. Transformational, multi scale, and economy-wide changes are required to produce mechanisms to drive private sector participation in climate actions for households (UNDP 2018). The foregoing accentuates the climate change financing dilemma of DCs and the need for alternative sources of financing especially for the household sector.

One such alternative source of climate funding is migrant and diaspora remittances (Bendandi and Pauw 2016; Babagaliyeva, et al 2018). Remittances have emerged as a robust, regular, and high volume source of financial flows between points of availability to points of need (Bettin et al. 2014). Remittances have been shown to contribute to recipient economies and communities through poverty alleviation, small and medium scale business development, health care, and even environmental protection and sustainability (Maduekwe and Adesina, 2015; Iheke, 2012; Încălțărău and Maha 2011; Hostettler 2007). This contribution is potentially amplified by the 50% increase in the flow of remittances to developing countries since 2010 (WBG 2018). Given its potentials, remittances may be expected to

play important roles in areas in which financial flows from developed economies to developing countries can make significant difference like climate change adaptation.

2 Paper objectives

The relationship between remittances and climate change is multidimensional and beyond the scope of a single study. This paper explored evidence related to potential contributions of remittances to financing climate change adaptation and resilience building actions in households by evaluating associations between remittances and household climate hazard exposure and between remittances and household climate actors. In this respect, it executed three main objectives. First it identified and defined the types (categories) of associations between (i) remittances and household climate hazard exposure, and (ii) remittances and household adaptation actors. Second, it measured the significance of these associations. Third, it attempted to determine whether remittance receiving and non-receiving households differ significantly in terms of their climate hazard exposure and main adaptation actors. The paper also identified and discussed some strategies to facilitate the contributions of remittances to the financing of climate actions in developing countries.

Association is a statistical term used to denote relationships between two or more variables. In this paper, association is used to describe how the exposure of households to climate hazard and their main adaptation actors are (or not) related to their receipt of remittances. Household climate hazard exposure denotes a household's contact with or experience of a particular climate hazard, i.e., whether a household is exposed to a climate hazard or not. Households and communities may experience differential exposure to climate hazards, contingent on different natural and socio-economic variables (Rumbach and Shirgaokar 2017; Cardona, et al. 2012). Actors are individuals, households, communities, governments, and other organizations involved in the implementation of climate adaptations actions for households. A wide range of actions are taken by different actors at various levels of society to meet various climate change adaptation and resilience building needs (Lorenz et al. 2019). These actions may impinge directly or indirectly on household adaptation. For this study, the adaptation actions implied are mostly those impinging directly on household living conditions—their safety, health, and livelihoods.

3 Literature review: migrant remittances as sources of climate change adaptation funding

There are indications that remittances can be harnessed as a (complementary) source of climate adaptation funding especially for households (Musah-Surugu et al. 2017; ADB 2018). Evidence from literature seems to suggest that migrant remittances can enhance household well-being, conditions, and productivity, especially during natural or socio-economic stresses or shocks. Yang and Choi (2005) suggest that remittances can act as an insurance to households during rainfall shocks. A multi country study by Mohapatra et al. (2009) indicates that average consumption was higher in remittance receiving households after the 1998 flood in Bangladesh; in Ethiopia, households receiving remittances were less likely to dispose of their capital assets during droughts. However, discussions on usage of remittances in households do not point to climate change adaptation as a prime or even deliberate application of remittances. One possible explanation is that household use

of remittances is determined within the context of a field of socio-cultural and economic forces (Rodima-Taylor et al. 2012; Scheffran et al. 2012). Another possible explanation is that traditional household use of remittances seems to follow economic-psychology theories of human motivation especially Maslow's hierarchy of needs (Aruma and Hanachor, 2017; Huiitt, 2007; Maslow 1943). First, urgent household survival needs like foods, medicine, clothing, and, to some extent, shelter are satisfied. There are indications that in some circumstances as much as 80% of remittances receipts are spent on basic needs (Sander and Maimbo, 2005; Batista et al., 2014).

But, there are also indications that with repeated and regular inflows and subsequent to meeting basic needs, household use of remittances may include higher order needs like security or safety needs (ADB & World Bank 2018). Environmental security and protection, including needs for measures to adapt to changes in the climate, may be included in this second order of needs. Societies, including those in SE Nigeria, have exhibited consciousness of needs to adapt to environmental and climatic challenges (Maduekwe 2014). Apart from a propensity to order needs, there are indications that households' responses to climate change may be mediated by knowledge, attitudes, and perceptions (KAP) leading to mixed results. Thus, while some KAP studies report significant levels of general (including household/layman) awareness, knowledge, and understanding of climate change issues (Hope 2016; Falaye and Okwilagwe 2016; CIMC 2012), others indicate high levels of awareness but low understanding of climate change. Studies in Nigeria by Oruonye (2011) among students of tertiary institutions and by Ayanlade and Olusolape Jegede (2016) among post tertiary education youth groups also follow this pattern.

But, taking these mixed results for granted, do high levels of climate change awareness provide impetus for use of remittances for climate adaptation actions, and resilience building at the household level? Recent studies by Musah-Surugu et al. (2017) and Babagaliyeva, et al. (2018) exploring migrant remittances as complementary local level climate change adaptation funding in Ghana and Tajikistan respectively indicate that remittances can enable adaptation funding to get to the most vulnerable households. However, whether receiving households would (on their own) use their remittance accruals for deliberate adaptation actions is not clear. Also not clear is whether remittances can impact some elements critical to household climate change adaptation and resilience. For example, do remittances impact households' climate de facto hazard/risk exposure? That is, can remittances impact household climate hazard exposure ex ante? Is the climate hazard exposure of remittance receiving and non-receiving households significantly different? Similarly, can remittances impinge on how and who will implement household adaptation actions? The latter questions focus on adaptation strategy and actors and underline the fact that a number of key actors are involved in implementing adaptation actions and projects for (or impinging on) households and communities (Kirrane et al. 2012; Oberlack 2012). Both hint on complex issues of climate change adaptation governance and stakeholder management. Governance and stakeholder issues related to household adaptation, though not often extensively or explicitly addressed in adaptation research and climate adaptation fund administration, have diverse ramifications and implications for climate change adaptation and financing in all sectors (Biesbroek 2012; Geerdink et al 2015; Braunschweiger et al. 2018).

This paper posits that analysis of associations between remittances and the two climate change-related variables (household exposure to climate hazard and main actors in household adaptation) can provide some answers to the issues raised above. It argues that analyzing these associations can help in demonstrating (i) a possible linkage between remittances and household adaptation to climate change, pointing to a possible contribution

of remittances to financing climate action for households and (ii) if remittance receiving and non-receiving households differ significantly in terms of their climate hazard exposure and main adaptation actors. Analyzing differences in actors, in particular, may help in understanding the prevalence of autonomous (self/family or community)-initiated adaptation actions. A prevalence of autonomous adaptation may be indicative of adaptation role failures of official governance processes and institutional weaknesses common to many DCs (IIED 2018). In such situations of governance failures, households and communities have taken responsibility for the provision of even basic social amenities for themselves (Olanipekun et al. 2014). This may have implications for funding models for adaptation to climate change in general and for the management of remittances as a supplementary or alternative source of household climate change adaptation funding in DCs.

The paper analyzed these associations (between remittances and the two climate change variables) using matched (concurrent) data on household international migrant remittances receipts, climate hazard exposure, and adaptation actors in South East (SE) Nigeria. First, it determined the main countries of origin of remittance inflows to the households and calculated household incidence of remittances and climate hazard exposure. Next, it defined possible household climate hazard/remittances and adaptation actor/remittance association categories in the area and constructed graphical profiles showing their incidence among the households. Then, it evaluated levels of association between remittances and household climate hazard exposure, and between remittances and adaptation actors. It also tested hypotheses that remittance receiving and non-receiving households differ significantly in terms of climate hazard exposure and adaptation implementing actors. The next section describes the methodology applied in implementing these analyses.

4 Methodology

4.1 Study area, data sources, and variables.

Nigeria is the top migrant remittance recipient in Sub-Saharan Africa (World Bank 2018). Thus, remittance management is a key multi-sectoral issue in the country. SE Nigeria, in particular, is an appropriate testing ground for the remittance climate hazards/change adaptation association issues raised above for at least two reasons. For one, the region is characterized by significant volumes of both internal and international migrant outflows with consequent appreciable levels of migrant remittance receipts (Maduekwe and Adesina 2015). This has spawned significant numbers of remittance research interest in the area (Nwa-jiuba 2013; Maduekwe 2014). Another, climate change will have far reaching impacts in the region and, given its tropical location, rainfall and related changes are likely to provide the most noticeable evidence of a changing climate. Climate change predictions indicate that the area is likely to experience more intense rainfall events and irregularities in rainfall regimes with increased risks of flooding (UNDP 2018). There are indications that these climate change-related issues are already major challenges in the region—a situation complicated by interlinked socio-ecological issues like high population density, urbanization, land-cover loss and land degradation, and other overarching regional and national issues of insecurity, poverty, weak and deteriorating infrastructures, poor governance, and institutional weaknesses.

Data for the study was extracted from a Coupled Human Environment System (CHES) dataset. Among others, the CHES dataset includes household data on diverse

threats/hazards, adaptation, and remittance receipts. Among these are data on three climate hazards likely to hallmark climate changes in the area: flooding (FL), intense rainfall (INR), and irregular rainfall (IR). The dataset was edited to select corresponding data on household exposure to the three climate phenomena, their main adaptation actors, and sources of international remittances. Selection was carried out at two administrative levels: localities (communities) and local government areas (LGAs). The entire dataset comprised 25 communities within ten LGAs in Anambra state, SE Nigeria. Data for 21 localities in 6 LGAs (Idemili North, Idemili South, Njikoka, Dunukofia, Oyi, and Ogbaru) were found suitable for the analyses. This produced a subsample of 678 households of which 98 (15.5%) reported receiving remittances from international sources (Maduekwe and Adesina 2015).

Four string (nominal) variables (Table 1) derived from remittances, climate hazard, and adaptation data fields in the sub dataset are used in the study. Values for each variable are derived from questions designed to elicit nominal scale responses. For their international remittance receipt status (HIRS), the households indicated whether they received (yes = Y) or did not receive (no = N) international remittances. For their main sources (countries) of international remittances (MSIR), households provided names of countries from which they received most of their remittances. For their exposure to climate hazard (HCHS), households indicated whether they faced a hazard (yes = Y), did not (no = N), or did not know (DK). For their main actors in adaptation (MAHA), households chose from four options (self/family, community, government, NGOs), indicated if they did not know (DK), gave no response (NR), or question was not applicable (NA).

4.2 Data analysis

Using the four nominal variables, three sets of analyses related to the paper's objectives were implemented. The first analysis determined the main sources (countries of origin) of remittances to the households. It used the MSIR variable to calculate the percentage of households receiving remittances from a particular foreign country. Values were determined for each country of origin as indicated by the sampled households. The last two sets of analyses evaluated associations between remittances and household climate exposure and between remittances and adaptation actors. Both were based on cross classification or cross tabulation of HCHS and HIRS values for remittance/climate hazard association analyses and MAHA and HIRS values for remittance/adaptation actor association analyses. Both sets of analyses were implemented separately for each of the three climate hazards (flooding, intense rainfall, and irregular rainfall). Local Government Areas (LGAs) were included as third layer cross tabulation variables to show inter LGA variations in household climate hazard exposure and climate hazard remittance associations. The procedures (implemented in an SPSS package) generated contingency tables, contingency coefficients (cc), and chi-squared tests of climate hazard/remittances and adaptation actors/remittance associations for each LGA and entire subsample. Climate hazard exposure/remittance (HCHS/HIRS) association analyses generated households' climate hazard/remittance association categories, constructed their frequency profiles, and evaluated and tested hypotheses on the significance of the association. Similarly, adaptation actor/remittance (MAHA/HIRS) association analyses generated household adaptation actor/remittance association categories, constructed their frequency profiles, and evaluated and tested hypotheses on the significance of the association.

Table 1 Study variables and indicators

Variables	Code	Questions	Households' nominal response options
Household international remittance receipt status	HIRS	Does your household receive international remittances?	Yes = Y; no = N
Main source of international remittances	MSIR	From which country does your household mainly receive remittances?	Name of main country of origin of remittances
Household climate hazard situation	HCHS	Does your household face this climate threat/hazard?*	Yes = Y; no = N; don't know = DK
Main actors in household climate hazard adaptation	MAHA	Who are the main actors in household adaptation to climate-related hazard?*	Self/family = S; community = C; government = G; NGOs = N; don't know = DK; no response = NR; not applicable = NA

* Asked discretely for each of the three climate change hazards: flooding, intense rainfall, and irregular rainfall.

Table 2 Climate hazard exposure/remittance association category matrix

		Remittances	
		Yes (Y)	No (N)
Climate hazards	Yes (Y)	YY	YN
	No (N)	NY	NN
	(DK) (E)	EY	EN

Table 3 Adaptation Actors/Remittance Association Categories Matrix

		Receiving remittances	
		Yes (Y)	No (N)
Adaptation actors	Self/family (S)	SY	SN
	Community (C)	CY	CN
	Government (G)	GY	GN
	NGOs (N)	NY	NN
	(DK) (E)	EY	EN

4.3 Definition of HCHS/HIRS and MAHA/HIRS association categories

Household climate hazard/remittance association categories were derived from HCHS/HIRS contingency table or matrix (Table 2). Generally, households can be in one of four HCHS/HIRS association categories: (i) households facing a hazard and receiving remittances (YY), (ii) households facing a hazard and not receiving remittances (YN), (iii) households not facing a hazard and receiving remittances (NY), and (iv) households not facing a hazard and not receiving remittances (NN). Also, households may indicate they don't know (DK) if they face a hazard. Such households may be receiving remittances (EY) or not (EN). Similarly, adaptation actor/remittance association categories emerge from MAHA/HIRS contingency tables. Thus, in Table 3, SY, CY, GY, and NY are households receiving remittances with self/family (S), community (C), government (G), and NGOs (N) respectively as main adaptation actors. SN, CN, GN, and NN are households not receiving remittances with self/family (S), community (C), government (G), and NGOs (N) respectively as main adaptation actors. DK households are those that did not indicate their main adaptation actors. Such households may be receiving remittances (EY) or may not (EN). For both HCHS/HIRS and MAHA/HIRS, DK statuses may give an indication of the level of climate hazards and adaptation actor awareness among the households. However, both are treated as uncategorized responses or compositional errors (E) in the analyses.

4.4 Construction of HCHS/HIRS and MAHA/HIRS association category profiles

Remittance/climate hazards and remittance/adaptation actor association categories frequency profiles are graphical representations of the frequency of occurrence of each HCHS/HIRS and MAHA/HIRS association category for each of the three climate hazards. It follows the principle of compositions which describe how various components of a whole make up the whole or “vectors of positive values summing up to a unit” (Aitchison 1986; Gallo 2015). In this case, it shows the proportion (in percentages) of households in the entire sample (‘all’ in the frequency profiles) or an LGA reporting

each HIRS/HCHS (YY, YN, NY, NN) association category or each HIRS/MAHA (SY, CY, GY, NY, SN, CN, GN, NN) association category. Also shown are proportions of households covered by compositional errors (EN + EY). For HIRS/HCHS and HIRS / MAHA association categories and error values, the profiles are presented as composite horizontal bar charts for each climate hazard by LGAs.

4.5 Evaluation of remittance climate hazard and remittance adaptation actor associations

Contingency coefficients (cc) generated by cross tabulation procedure in SPSS were used to evaluate degrees of HIRS/HCHS and HIRS/MAHA associations for each climate hazard by LGAs and for the entire sample. cc is a chi-squared-based statistics given as:

$$\sqrt{\chi^2/(\chi^2 + N)}$$

where

χ^2 chi square.
 N sample Size.

cc values range between 0 and 1. Like other correlation coefficient measures, higher values of cc indicate higher levels of associations between variables. However, cc values are sensitive to size of N . As the formula indicates, higher values of N will result in lower cc. Thus, cc results are sometimes treated with precaution. For this study, N value is the same for all climate hazards. As such variations in cc results between climate hazards cannot be due to differences in N values. For individual LGAs, however, N values range between 49 (for Dunukofia LGA) and 216 (for Idemili North LGA) reflecting differences in LGA populations and sample size allocation as well response rates and data quality. In this situation validity of LGA by LGA analysis of HCHS/HIRS and MAHA/ HIRS, associations suffer some limitations. However, for all analyses, a general rule of the thumb was applied for interpreting the strength of association between remittances and climate hazard and between remittances and adaptation actors—cc values: <0.10 (weak), 0.11 – 0.30 (moderate), > 0.30 (strong).

4.6 Hypotheses testing

Null type hypotheses (H_0) testing was implemented to evaluate the significance of associations between HCHS and HIRS, and MAHA and HIRS. For HCHS/HIRS analysis, the study tested hypotheses that associations between international remittances and household climate hazard exposure were not significant. For MAHA/HIRS analyses, it tested hypotheses that associations between remittances and household adaptation actors were not significant. Significance of associations was tested for each climate hazard by LGAs and at aggregate sample levels. Significance was determined based on calculated contingency coefficient (cc), chi-squared (χ^2), and critical values of (p) at 0.05 significance (P 0.05) level.

4.7 Paired analyses of actors in receiving and non-receiving households

Apart from testing the significance of MAHA/HIRS associations, complementary analyses and tests were carried out to determine significance of differences in climate actors between remittance receiving and non-receiving households. This was to test the assertion that receiving households are more likely to depend on or have the capacity to implement self and community (autonomous) climate change adaptive actions. In this case, SPSS crosstab-generated counts of each category of actors for each climate hazard were used to implement paired analyses of differences in adaptation actors between receiving and non-receiving households. First, a graphical comparison of proportions of main actors within receiving and non-receiving households for each hazard was carried out. Then, paired sample *T* test procedures generated Pearson product moment correlation coefficients (*R*) to measure degree of similarity in adaptation actors between the two sets of households for each climate hazard. The hypotheses were tested with values of *R* and accompanying *t* statistics. Results of the various analyses are presented below starting with origins of international remittances to the households.

5 Results

5.1 Main origins of international remittances, incidence of remittances, and climate hazards.

On a country level, households in the sample receive their remittances mainly from the US (21%), UK (16%), South Africa (14%), Ghana (9%), and Dubai (6%) (Fig. 1). Other individual countries from which at least 2% of households receive remittances include Angola (3%), China (3%), Germany (2%), and Russia (2%). At regional aggregate levels, the result shows, unexpectedly, that remittances to households in the sample originate more from other African countries (32%) than from European (28%) and Asian countries (18%).

Overall (all, in Table 4), 15.5% of the households received international remittances. By LGAs, the proportion of households receiving remittances ranges from 6.8% for Ogbaru to 25% for Njikoka. General household exposure to flooding (FL) hazard is 41.2%, intense rainfall hazard (INR) (47.1%), and irregular rainfall hazard (IR) (30%). Households in Ogbaru LGA (a low-lying and riverine LGA) are most exposed to flooding (97.3%) and Idemili North (an upland LGA) the least exposed (6.8%). Exposure to intense rainfall hazard is also highest in Ogbaru (82.4%) and least in Oyi (13.2%). Irregular rainfall hazard exposure ranges from 16.2% in Idemili North and Ogbaru LGAs to 49.7% in Idemili South LGA.

5.2 Frequency profiles of households' climate hazard exposure/remittance (HCHS/HIRS) association categories.

Frequency of occurrence of various household HCHS/HIRS association categories varies with hazard type and LGAs. For flooding (FL, Fig. 2), the overall (all) profile is YY 5.5%, YN 35.7%, NY 9.0%, and NN 49.1% with compositional error (no response) of 0.74%. This shows that 5.5%, 35.7%, 9%, and 49.1% of households are in YY, YN, NY, and NN association categories respectively for flooding hazard. Thus, 5.5% of the

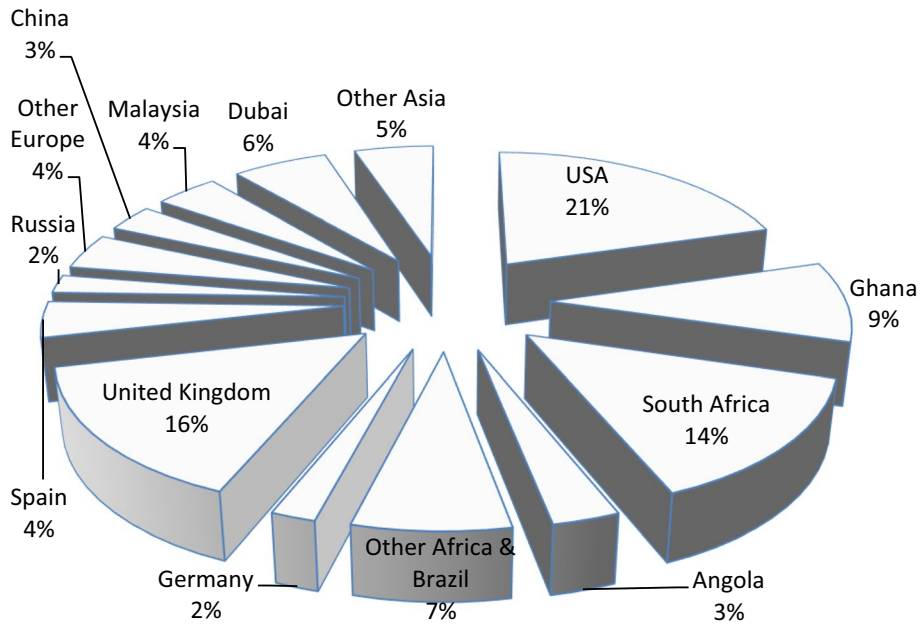


Fig. 1 Main sources of international remittances inflow to sampled households in South East Nigeria

Table 4 Summary of household incidence of remittances and climate hazard exposure

LGAs	% receiving international remittances	% of households facing climate hazards			N
		Flooding	Intense rainfall	Irregular rainfall	
Idemili North	9.7	6.9	35.6	16.2	216
Idemili South	16.6	64.3	64.3	49.7	199
Njikoka	25.0	37.5	31.9	38.9	72
Dunukofia	14.3	12.2	43.9	20.4	49
Oyi	20.6	45.6	13.2	27.9	68
Ogbaru	6.8	97.3	82.4	16.2	74
All	15.5	41.2	47.1	29.9	678

households are exposed to FL hazard and are receiving remittances (YY), 35.7% are exposed and are not receiving remittances (YN), 9% are not exposed and are receiving remittances (NY), and 49.1% are not exposed and are not receiving remittances (NN). Consequently, 41.2% of households (YY + YN) are exposed to FL hazard with 5.5% (YY) having the potential use remittances for adaptation. For individual LGAs, the proportion of households indicating both FL hazard exposure and remittance receipt (YY) varies between 0.9 (for Idemili North) and 11.1% (for Njikoka); FL hazard exposure and no remittances (YN) between 6.1 (for Idemili North) and 91.9% (for Ogbaru); no FL hazard exposure but receive remittances (NY) between 7.0 (for Idemili South) and 14.7% (for Oyi); and no FL hazard exposure and no remittances (NN) between 28.1 (for

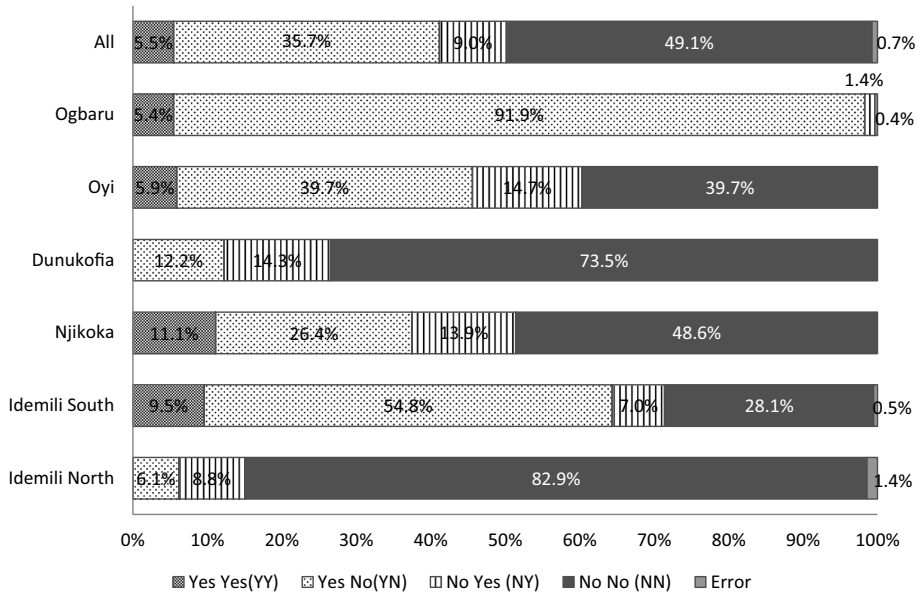


Fig. 2 Flooding hazard exposure/remittance association categories: frequency profiles by LGAs

Idemili South) and 73.5% (for Dunukofia). Low compositional error (no response) values (0–1.4%) may indicate either high awareness or high concern for FL related hazard in the LGAs.

Overall (all) frequency of various HCHS/HIRS association categories (Fig. 3) for intense rainfall hazard (INR) is YY 5.0%, YN 42%, NY 9.3%, and NN 40.3% with error

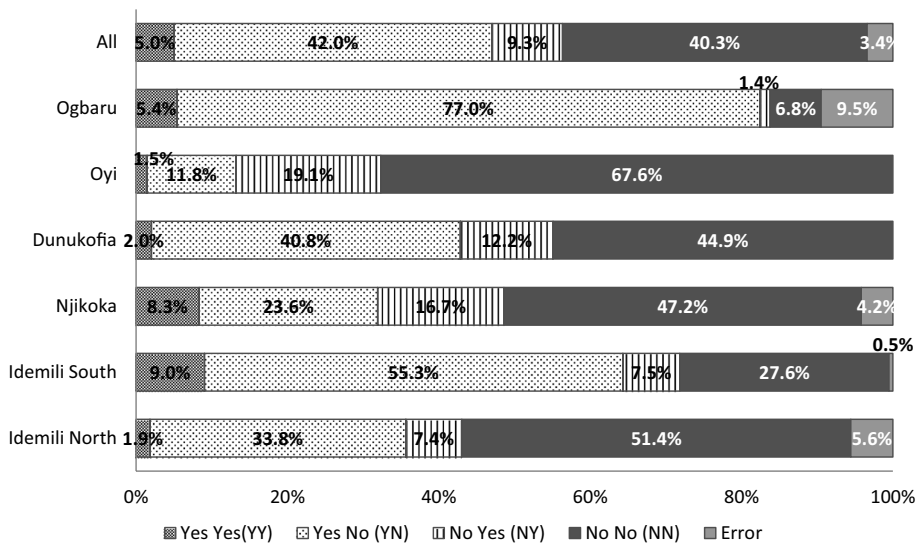


Fig. 3 Intense rainfall hazard exposure/remittance association categories: frequency profiles by LGAs

of 3.4%. This indicates that 5.0% of the households are exposed to INR hazard and are receiving remittances (YY); 42% are exposed to INR hazard but are not receiving remittances (YN); 9.3% are not exposed to INR hazard but receive remittances (NY); and 40.3% are neither exposed to the hazard nor receiving remittances (NN). Some 47% (YY + YN) of the households are exposed to INR hazard of which 5.0% have the potential to use remittances for adaptation. The percentage of households in various LGAs reporting YY category for INR hazard varies between 1.5 (for Oyi) and 9.0% (for Idemili South); YN category between 11.8 (for Oyi) and 70.0% (for Ogbaru); NY category between 1.4 (for Ogbaru) and 16.7% (for Njikoka); and (NN) category between 6.8 (for Ogbaru) and 67.6% (for Oyi). The range of compositional error (0–9.5%) for INR is higher than that for FL. This may indicate a lower appreciation or awareness or concern for INR-related hazard or impact in the LGAs.

Overall (all) frequency of various HCHS/HIRS association categories for irregular rainfall (IR) (Fig. 4) is YY 5.2%, YN 24.8%, NY 8.4%, and NN 57.4% with average error of 12.7%. Thus, 5.2% of the households are exposed to IR hazard and are receiving remittances (YY); 24.8% are exposed to IR hazard and are not receiving remittances (YN); 8.4% not exposed to IR hazard and are receiving remittances (NY); and 57.4% neither exposed to IR hazard nor receiving remittances. This shows that 30% (YY + YN) of the households are exposed to IR hazard with only 5.2% having the potential to use remittances for adaptation. At 12.7%, the average composition error for IR is the highest for the three climate hazards, possibly indicating lower awareness, understanding, or appreciation of the hazard relative to others.

For the selected LGAs, proportion of households exposed to IR hazard and are receiving remittances (YY) varies between 0.0 (for Ogbaru) and 11.1% (for Njikoka); exposed to IR hazard and are not receiving remittances (YN) between 15.3 (for Idemili

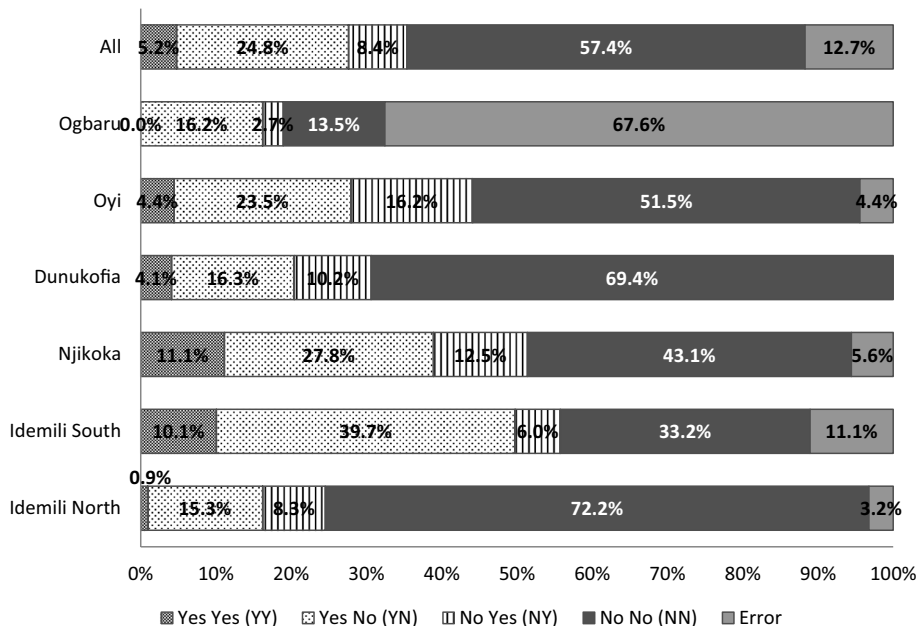


Fig. 4 Irregular rainfall hazard exposure/remittance association categories: frequency profiles by LGAs

North) and 39.7% (for Idemili South); not exposed to IR hazard but receive remittances (NY) between 2.7 (for Ogbaru) and 16.2% (for Oyi); and no IR hazard and no remittances (NN) between 13.5 (for Ogbaru) and 72.2% (for Idemili North). The range of error for IR is highest (0.0–67.8%) of the three climate related hazard. The exceptionally high error for Ogbaru LGA (67.8%) may be indicative of poor perception of IR hazard in the area.

5.3 Test of hypotheses for climate hazard exposure/remittance (HCHS/HIRS) association

Frequency profiles of HCHS/HIRS association categories for the three climate hazards indicate that the proportion of the sampled households receiving remittances is generally low even among hazard experiencing households. This impinges on the number of households with the potential to use remittances for climate adaptation action. Consequently, associations between household remittance receipt and climate-related hazard are mostly weak ($cc < 0.10$) to moderate ($cc = 0.11$ – $cc = 0.30$) (Table 5). Overall (all) cc values are 0.047 for FL, 0.124 for intense rainfall, and 0.087 for irregular rainfall. For individual LGAs, remittance climate hazard association is strongest for FL in Ogbaru LGAs ($cc = 0.399$) and moderate in two other LGAs (Dunukofia and Oyi) for the same hazard. It is also moderate in Idemili North, Dunukofia, and Ogbaru LGAs for INR and in Idemili South for IR ($cc = 0.128$). Taking together values of cc , χ^2 , and p , the hypothesis that association between household climate hazard exposure and international remittances is not significant is accepted overall and for the three climate hazards in the six LGAs. One possible exception is for FL in Ogbaru LGA ($cc = 0.399$, $p = 0.001$) where a significant association may be inferred. However, even for this LGA, the assertion that association between climate hazard and remittances is not significant has to be maintained since only 5.5% of the 97% of households in the area experiencing the climate hazard actually receive remittances. One implication of this is that households receiving remittances have no de facto advantage over non-receiving one in terms of climate hazard experience or exposure.

Table 5 Climate hazard exposure and remittance associations: contingency coefficients and test parameters

	Flooding			Intense rainfall			Irregular rainfall			<i>N</i>
	<i>cc</i>	χ^2	Sig (<i>p</i>)	<i>cc</i>	χ^2	Sig (<i>p</i>)	<i>cc</i>	χ^2	Sig (<i>p</i>)	
Idemili N	0.050	0.550	0.760^	0.117	3.022	0.221	0.064	0.884	0.643	216
Idemili S	0.073	1.070	0.586	0.099	1.975	0.373	0.128	3.323	0.190	199
Njikoka	0.083	0.494	0.482	0.12	1.043	0.593	0.067	0.324	0.851^	72
Dunukofia	0.151	1.140	0.286	0.229	2.722	0.099	0.082	0.335	0.563	49
Oyi	0.171	2.058	0.151	0.091	0.570	0.45	0.140	1.356	0.508	68
Ogbaru	0.399	14.037	0.001*	0.138	1.446	0.485	0.190	2.786	0.248	74
All	0.047	1.502	0.472	0.124	10.632	0.005	0.087	5.177	0.075	678

*Association significant at 0.05 level.

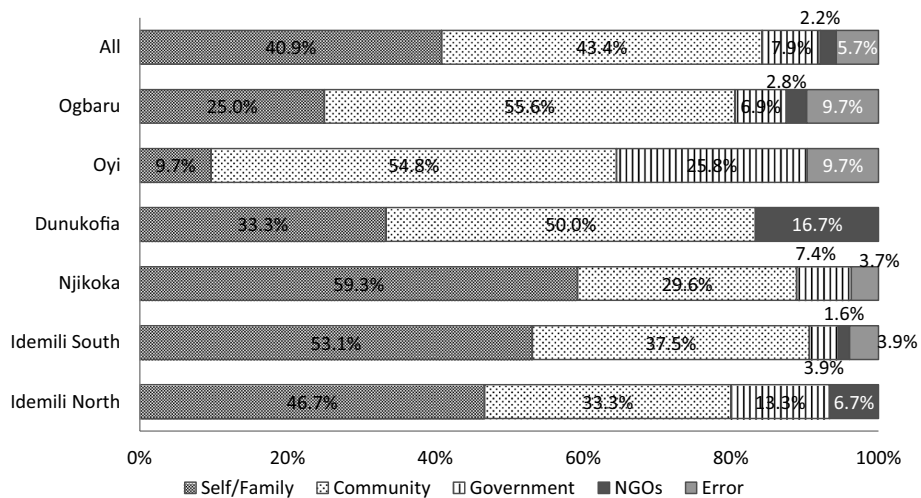


Fig. 5 Actors in household adaptation to flooding hazard: frequency profiles by LGAs

5.4 Adaptation actor/remittance (MAHA/HIRS) association category profiles

Main actors in household adaptation to the climate hazards vary with hazard type and from one LGA to another. Overall (all, in Fig. 5), for FL hazard, 40.9% of the sampled households indicate self or family while 43.4% indicate communities as their main adaptation actors. Only 7.9% of the households indicate government and 2.2% non-governmental/civil society organizations (NGO) as their main actors with a compositional error of 5.7%. The preponderance of self/family and community actors in adaptation to FL hazard is also true from LGA to LGA: ranging from 65.5% in Oyi LGA to 90.6% in Idemili South LGA. Government and NGO/CSO sources generally comprised <30% of FL hazard adaptation actors.

Self/family and community actors are also preponderant in household adaptation to intense rainfall (INR) hazard with 62.1% (self/family: 35.7%, community: 26.6%)—see all in Fig. 6. Over 2% of the households indicate governments and 16.6% NGOs as main actors. By LGAs, the percentage of households indicating self/family as main actors in adaptation to INR ranges from 6.5% for Idemili North LGA to 90.5% for Dunukofia LGA; community actors from 9.5% in Dunukofia LGA to 52.5% in Ogburu LGA. Government actors in adaptation to INR are reported for only three LGAs: Ogburu (4.9%), Idemili North (5.2%), and Oyi (11.1%) while NGO actors are reported for only two: Idemili South (3.1%) and 63.6%. An overall compositional error of 18.8% for adaptation to the climate hazard is much higher than for FL hazard. The error is pronounced in some LGAs especially Oyi (77.8%) and Ogburu (32.8%) and has implications for interpretation of the results.

Actors in household adaptation to irregular rainfall (IR) hazard is more evenly spread (Fig. 7). Self/family and community actors are indicated by <50% of the households. Government actors comprise just 0.5%, while NGOs 32%. By LGAs, self/family actors in adaptation range from 24.2% for Idemili South LGA to 50% for Dunukofia. Community actors range from 2% for Idemili South to 50% for Dunukofia. Government actors in adaptation for the hazard are reported in only one LGA (Idemili North 2.9%) while NGO actors are reported in two (Idemili North 5.7%; Idemili South 63.6%). Average

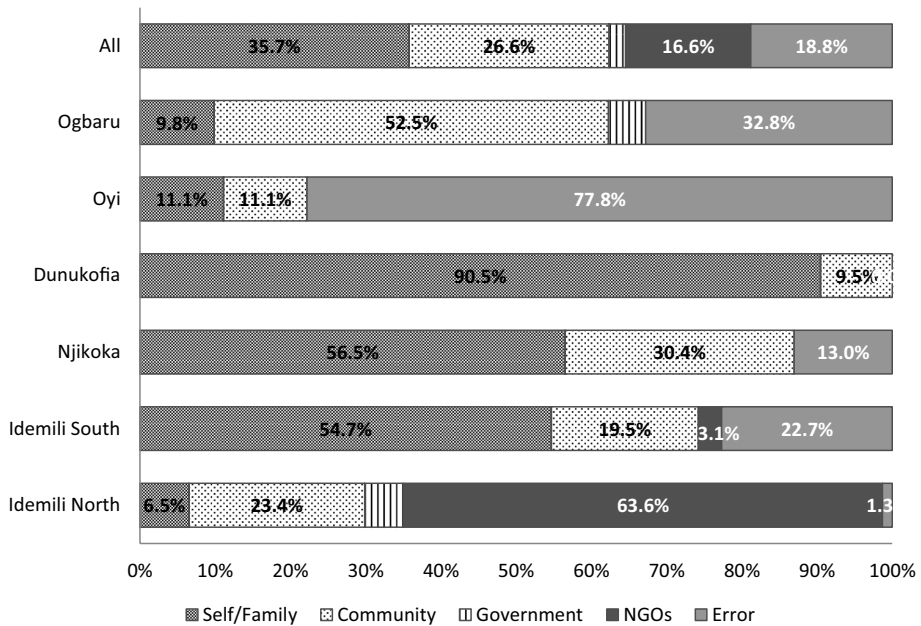


Fig. 6 Actors in household adaptation to intense rainfall hazard: frequency profiles by LGAs

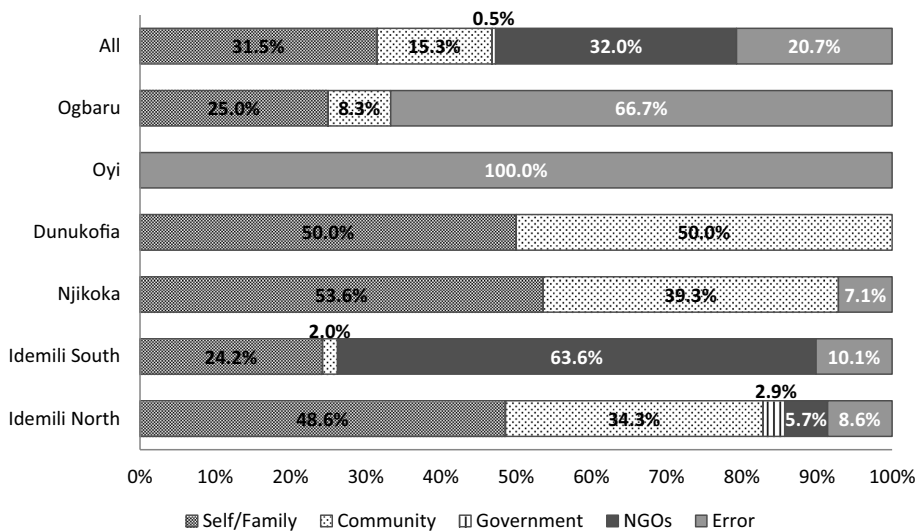


Fig. 7 Actors in household adaptation to irregular rainfall hazard: frequency profiles by LGAs

compositional error of adaptation to the hazard (20.7) is highest compared to other two hazards. The error is particularly pronounced for Oyi (100%) indicating that no adaptation is reported and for Ogbaru LGAs (63.6%). The relatively high level of errors in reporting actors for intense rainfall and irregular rainfall hazards may be indicative of

the low level of awareness or understanding of the problems among households in the area.

5.5 Test of hypotheses for adaptation actor/remittance (MAHA/HIRS) association

As with climate hazard and remittances, association between adaptation actors and remittances (MAHA/HIRS) ranges mostly from weak to moderate: with $cc=0.097$ (for FL), 0.111 (for IR) to 0.123 (for excess rainfall) (see all, in Table 6). For individual climate hazard and LGAs, the association is strongest for FL in Ogbaru LGA ($cc=0.340$), for INR in Oyi LGA ($cc=0.285$), and for IR in Dunukofia LGA ($cc=0.262$). The weakest MAHA/HIRS associations for FL occur in Dunukofia LGA ($cc=0.151$) for FL, in Ogbaru LGA ($cc=0.15$) for excess rainfall, and in Oyi LGA ($cc=0.074$) for IR. Taking together values of cc , χ^2 , and p as a basis for assessing the null hypothesis, differences in climate hazard adaptation actors between remittance receiving and non-receiving households are not significant for the three climate hazards overall and in each of the six LGAs. Exceptions may be taken for FL in Ogbaru LGA (with $cc=0.340$) and IR in Idemili North LGA (with $p=0.008$). Generally, it can be inferred from these results that (i) main actors in household adaptation to the hazards do not vary significantly with hazard and LGA and (ii) adaptation actors for households receiving remittances are not significantly different from those that do not.

5.6 Paired analysis of adaptation actors in remittance receiving and non-receiving households

Paired analysis of actors for receiving and non-receiving households throws additional light on the pattern of MAHA/HIRS associations shown above. Figure 8a–c indicates similarity in adaptation actors, between remittance receiving and non-receiving households especially for flooding (FL) and intense rainfall (INR). Figure 8a–c also highlights the dominance of self/family and community actors for both remittance receiving and non-receiving households as shown by the profiles. In both classes, the proportion of the sampled households indicating self/family and community as main actors in adaptation is $>80\%$ for FL and $>60\%$ for INR hazards. However, self/family and community actors are less dominant

Table 6 Adaptation actor/remittance (MAHA/HIRS) associations: contingency coefficients and test parameters

	Flooding			Intense rainfall			Irregular rainfall			<i>N</i>
	<i>cc</i>	χ^2	Sig (<i>p</i>)	<i>cc</i>	χ^2	Sig (<i>p</i>)	<i>cc</i>	χ^2	Sig (<i>p</i>)	
Idemili N	0.169	6.316	0.177	0.259	15.534	0.008*	0.122	3.260	0.86	216
Idemili S	0.16	5.253	0.512	0.178	6.534	0.258	0.17	5.948	0.311	199
Njikoka	0.158	1.852	0.763	0.222	3.747	0.441	0.146	1.568	0.667	72
Dunukofia	0.151	1.140	0.768	0.231	2.763	0.251	0.262	3.602	0.165	49
Oyi	0.239	4.103	0.392	0.285	6.007	0.199	0.074	0.371	0.542^	68
Ogbaru	0.340	9.672	0.139	0.15	1.709	0.888	0.118	1.038	0.904	74
All	0.097	6.442	0.376	0.123	10.342	0.17	0.111	8.417	0.297	678

*Association significant at 0.05 level.

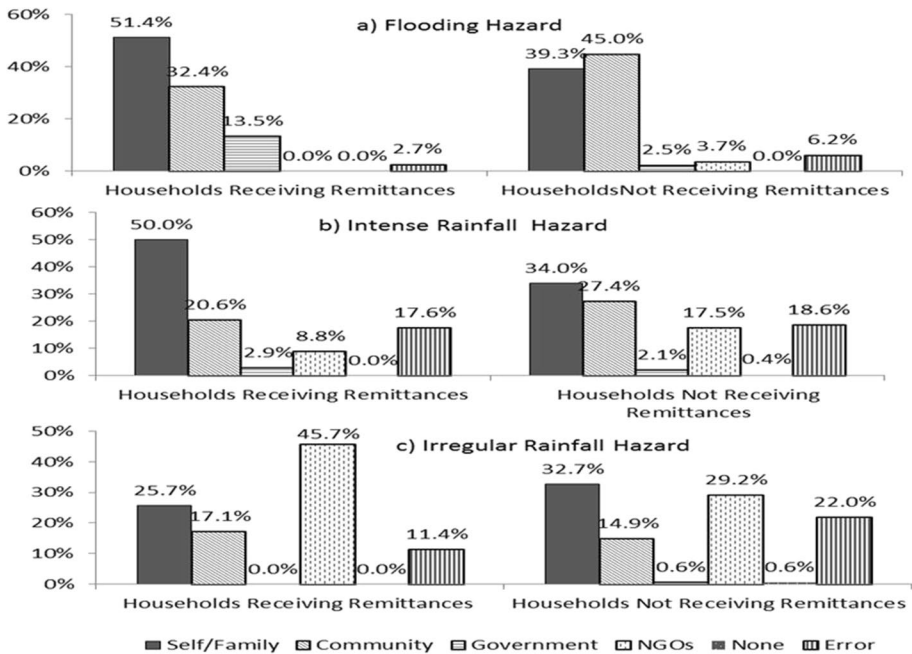


Fig. 8 Main adaptation actors of remittance receiving and non-receiving households by climate hazard

for IR adaptation, contributing <50%. For both receiving and non-receiving households, governments and NGOs are less prominent as actors in adaptation to the three climate hazards. Percentage of remittance receiving households indicating governments as main actors in adaptation ranges from 0 (for IR hazard) to 13.5% (for FL hazard), and NGOs from 0 (for FL hazard) to 45.7% (for IR hazard). For non-receiving households, the proportion for government actors ranges from 0.6 (for IR) to 2.5% (for FL hazard); NGOs from 3.7 (for FL hazard) to 29.2% (IR hazard). Compositional error in the analysis is <20% for all hazards for receiving households and <25% for non-receiving households.

Table 7 indicates, based on paired t statistic, rejection of the null hypothesis overall and for each of the climate hazards given that $t > p$ (2 tailed test) in each case. However, high values of correlation coefficient (R) indicate similarity in adaptation actors between receiving and non-receiving (overall: $R=0.865$) and for each climate hazard (FL : 0.914; INR :

Table 7 Correlation coefficient and t test of similarity of adaptation actors for remittance receiving and non-receiving households

	Correlation between actors in:		t tests				
	Non-receiving	Receiving	R	Sig (p)	t	Df	Sig (p)
Hazards							
Flooding	Flooding	Flooding	0.914	0.011	-2.034	5	0.098
Intense rainfall	Intense rainfall	Intense rainfall	0.898	0.006	-3.027	6	0.023
Irregular rainfall	Irregular rainfall	Irregular rainfall	0.891	0.007	-2.96	6	0.025
All			0.865	0.000	-4.368	19	0.000

0.898; *IR*: 0.891). As such existence of a significant difference between the two cannot be maintained. In effect, main actors in climate hazard adaptation are similar for remittance receiving and non-receiving households. Furthermore, the hypothesis that receiving households have advantage in terms of the dominance of self/family or community actors in adaptation cannot be sustained.

5.7 Summary, conclusions, and discussion of strategies to enhance the contribution of remittances to financing climate change adaptation actions in households

This paper analyzed some aspects of the linkages between remittances and climate change adaptation: associations between remittances and household exposure to climate hazards and their main adaptation actors. Key findings of the analyses add important insight into potential contributions of remittances to financing climate change adaptation actions for the households in developing countries. Evaluation of remittances and climate change-related hazards and their association shows that the household incidence of international remittances is generally low (15.5%) while incidence of household climate change-related hazard exposure is much higher (flooding: 41.2%, intense rainfall: 47.1%, irregular rainfall: 29.9%). This underlies the mostly weak association between remittances and household climate hazard exposure, indicating a limited effect of remittances on household climate hazard exposure. The incidence of remittances is even lower among households facing hazards. As shown by the hazard/remittance association category profiles, proportions of households receiving remittances among those exposed to hazards are 5.2% of 30% for irregular rainfall, 5.0% of 47.1% for intense rainfall, and 5.5% of 41.2% for flooding. Thus, remittances are not available to most households facing climate hazards. In addition, as has been shown elsewhere, most households in the area use remittances mainly to meet basic needs (Maduekwe and Adesina 2015). As such, a very low proportion of remittance receipts is left for other purposes including climate action. This situation is likely reinforced by the low understanding of climate change issues in DCs. Thus, households may not appreciate the need to channel remittances to climate change adaptation.

The associations between remittances and adaptation actors are also mostly weak. Therefore, remittance is not a significant determinant of main actors in household climate hazard adaptation. One implication is that receiving and non-receiving households do not differ significantly in terms of climate adaptation actors. This is affirmed by high positive correlations ($R > 0.850$) in paired analysis of main adaptation actors in remittance receiving and non-receiving households. The paper shows a preponderance of autonomous (self/family and community actors) in both classes of households and the relative absence of government and NGO actors. The result tends to support the assertion that autonomous adaptation dominates in contexts of weak governance, institutions, and corruption characteristic of many LDCs (Kirrane et al. 2012). They also raise issues on the management of adaptation funding including the practice of channeling adaptation funds through formal government structures and processes.

The results, however, do not necessarily imply that remittances cannot contribute to funding household climate adaptation actions in DCs. Rather, they seem to highlight existing bottlenecks limiting the utility of remittances as sources of climate funding. Consequently, a number of strategies may be needed to enhance the household climate change adaptation utility of remittances. For example, interventions may be needed to improve households' climate change understanding. This can build on existing interventions

promoting education on adaptive actions necessary to tackle specific aspects of climate change impacts, like water management and conservation measures, agricultural practices to adapt to intense and or irregular rainfall, and sustainable livelihood practices. Others include flood sensitive building and settlement planning practices. Another set of interventions is needed to improve the potential of remittances to contribute to climate change adaptation financing for households. For example, strategies to induce higher remittance flows to households may help in tackling the challenge of low incidence and per capita receipts. A strategy to encourage more remittances to DCs under the SDGs is based on the reduction of cost of remitting to 3% (IFAD 2017). Currently, Sub-Saharan Africa has the highest cost of remitting at 9% (WBG 2018). Remittance cost reduction may be the key to increasing both incidence and average amount of remittances to households.

In addition, administration of remittances and other sources of external funding for climate change adaptation in developing countries can build on existing autonomous adaptation capacities in households and communities. Strategies used in other programs channeling funds to deprived households can be applied. Targeted cash transfers (conditional or unconditional), for example, have been used to address specific household challenges in DCs like poverty (Bastian et al. 2017; WBG 2009; Van Domelen 2007), livelihoods (Ragno et al 2016), education (Bauchet et al 2018), and maternal health (Okoli et al. 2014; Bastian et al. 2017). Programs involving direct transfers to households and communities for climate action may be implemented as alternative or complementary to funds granted to centralized administrations for adaptation (IIED 2018). Remittance pooling may be a source of funds for cash transfer programs targeting household adaptation. Remittance pooling-based cash transfer programs targeted towards household climate change adaptation may be feasible if well-conceived and implemented (IFAD 2017). Such transfers may also be applied to building social safety nets against climate hazard ex ante or ex post (Pelham et al. 2011).

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