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Climate Change and Women's Voice & Agency beyond the Household

Insights from India

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Abstract

Women's Voice & Agency beyond the household (VABH) has increasingly been recognized as critical to strengthening resilience, increasing women's access to important resources, improving women's decision-making power, and facilitating broader social networks (Njuki et al. 2022). Despite rapidly intensifying climate change in recent years, a knowledge gap persists as to how climate change may affect women's VABH in developing countries. This has been particularly challenging in countries like India, which host one of the largest numbers of the poor and has been increasingly plagued by droughts, floods, cyclones, rising temperatures, and increasing rainfall fluctuations. This study provides a conceptual discussion on the linkages between climate change and VABH and analyzes their empirical relationship using multiple rounds of nationwide household data from India (India Human Development Survey 2005, 2012; World Values Survey 2001, 2006, 2012); climate data; and data on women's political representation at the district level. Our results suggest that in rural parts of India, adverse climate change and natural disasters, such as cyclones and/or floods, have consistently negative associations with a broad range of VABH-related outcomes. Moreover, in rural areas, greater political representation by women in district assemblies broadly mitigates the potential effects of adverse climate change on VABH-related outcomes. These patterns generally hold across various populations, differentiated by marriage status and age groups, and are more robust in rural compared to urban areas. There are also generally consistent gender differences in these associations. Specifically, results indicate that women's VABH are disproportionately more negatively affected by adverse CC than men's VABH, while greater female representation at local district assemblies has greater effects in mitigating adverse CC on VABH among women than men. The results underscore the importance of enhancing women's political representation as a means to improve women's VABH.

Keyword: gender, voice, agency, beyond the household, climate change, India

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1 Background

Women's voice & agency (VA) has been increasingly recognized as one of the important instruments to enhance women's welfare in gender-neutral ways through empowerment and increased integration of women's needs into the social and policy agenda in development. The importance of incorporating agency into food security policy and analysis frameworks has been increasingly recognized (Clapp et al. 2021).

Women's VA plays critical roles in various contexts, both within and beyond households. While household-level VA relates closely to women's bargaining power, VA beyond households (VABH), including at the community level (World Bank 2012; Paganini et al. 2021; Njuki et al. 2021; 2022) strengthens resilience, increases women's access to important resources, improves women's decision-making power, and facilitates broader social networks (Njuki et al. 2022). Women's VABH at the food system level contributes to strategic changes that strengthen women's representation in science, research, and development (Njuki et al., 2022). Women's VABH is often crucial to shifting social norms around gender roles and women's abilities, which, in turn, can enhance VA within the household. The ability to have a voice in society and influence policy through participation and representation in formal politics and engagement in collective action and associations is an important outcome associated with women's ability to make choices, for example, on jobs, consumption, use of resources outside households (World Bank 2012). Women's collective voice, which can emerge when women have VABH, can be especially powerful in contributing to changes in laws, policies, services, institutions, and social norms that will eventually increase women's individual voice and agency (World Bank 2012).

Enhancing women's VABH has been continuously challenged by various external factors. Among others, climate change (CC) has emerged as a potential key factor affecting women's VABH. A growing literature recognizes a multitude of different effects of CC on gender, given its broad-ranging impacts on resources and capital, economic opportunities, and institutions supporting women. These include effects on poverty (Masika 2002), domestic work burden for women (Denton 2004; MacGregor 2010), behaviors to seek advice (Patt et al. 2009), physical and psychological stress and autonomy (Dankelman et al. 2010; Moosa & Tuana 2014), access to natural resources (Arora-Jonsson 2011), asset holdings (Goh 2012), collective action (Bryan & Behrman 2013; Behrman et al. 2014), power and social and political relations (Djoudi et al. 2016), nutritional outcomes (Bryan et al. 2017), and the ability to achieve economic independence, enhance human capital, and maintain health and wellbeing (Eastin 2018). However, despite this growing body of evidence, there remains a knowledge gap as to how CC affects women's VABH. Understanding these effects is critical to ensuring inclusive welfare improvements in developing countries faced with growing climatic uncertainty.

Similarly, a greater political representation by females, which is itself an important component of women's VABH as described in the later section, has been considered an important instrument in addressing gender disparity along various dimensions (Chattopadhyay & Duflo 2004; Kalsi 2017). However, knowledge gaps remain as to how female representation can mitigate the negative effects of adverse CC on women's VABH.

This study aims to partly fill these knowledge gaps using data from India. We combine information on climate events and women's political representation, nationally representative household and individual-level panel data from the India Human Development Survey (IHDS) 2005 and 2012, and repeated cross-sectional data from the World Values Survey (WVS) 2001, 2006, and 2012 to assess the relationship between CC and various measures of and proxies for women's VABH.

India is a good case to investigate such relationships for several reasons. First, women in India fare worse than men along several dimensions, with extremely low (and declining) levels of female labor force participation, relatively low levels of literacy, and limited ownership over land and other assets (World Bank, 2011; Government of India 2011, Jayachandran 2015). Second, India has seen an alarming increase over the past several decades in the incidence of extreme climate events, including extreme heat, droughts, floods, groundwater depletion, and some of the worst air quality in the world (citation needed). More broadly, South Asia is an area with a high degree of vulnerability to future CC (IPCC 2021). Third, India's extensive geographical coverage provides significant variation in CC patterns across space, allowing for more precise identification of the effects of CC.

This paper is structured as follows. Section 2 provides conceptual discussions of women's VABH and their associations with adverse CC. Section 3 describes the empirical methods and data. Section 4 discusses the empirical results, while section 5 concludes.

2 Conceptual discussions

Women's lack of agency or limited ability to define and act on goals, make decisions that matter to them, and participate in the economy and public life is one of the four main dimensions of gender inequality in agrifood systems (Njuki et al. 2021). Some of the key questions include (A) What the key/salient elements of VABH are; (B) How CC affects the capacity for/ costs for women of improving VABH (supply of VABH); (C) How CC affects returns to/ preferences for women's VABH (demand for VABH); and (D) How CC effects (B) and (C) for women can be mitigated, without exacerbating the impacts on men (to be assessed more in empirical analyses in sections 3-4).

Issues (A) consider the key indicators of women's VA with particular attention to those that are more relevant in contexts beyond, rather than within, the households, such as in the local community; they include access to social networks, engagement in collective action, and various forms of political participation, among others.

Issues (B) and (C) relate to potential pathways through which CC affects women's demand for VABH, as well as the extent to which society promotes the exercise of (i.e., supplies) aspects of VABH. For (B), CC can affect women's capacity to enhance VABH, for example, through its effects on women's time endowment required for community-level collective actions and political participation, ability to maintain social capital, and mobility, among others. For (C), to the extent that CC affects women disproportionately, and enhancing VABH is a way to mitigate such effects, CC affects the demand for VABH. Lastly, (D) regards how any negative effects of CC in (B) and (C) may be mitigated or improved through external factors and innovations.

2.1 Voice and agency beyond the household

2.1.1 Voice and agency

"Agency," i.e., the ability to assert and act upon one's interests, is one of the three dimensions/domains of "empowerment," together with resources and transformative changes, where empowerment is the process by which those who have been denied the ability to make strategic life choices acquire that ability (Kabeer 1999; Njuki et al. 2016). Agency refers to the capacity of individuals and groups to exercise a degree of control over their own circumstances and to provide meaningful input into governance processes (Clapp et al., 2021). In the literature on women's empowerment, women's voice and agency (VA) is key in transforming unequal

power relations (Njuki et al., 2016). Some common measurements of women's agency include women's participation in public collective action; mobility in the public domain; freedom from male violence; and having the skills, capacities, and confidence to act in one's own interest and meet one's own aspirations (Kabeer 1999; Njuki et al., 2016). In the context of domestic violence, Klugman et al. (2014) categorize key dimensions of agency as freedom from violence, control over sexual and reproductive health, and ownership and control over land and housing. Klugman et al. (2014) also considers that "voice" can be one of the dimensions of the agency.

Agency is multidimensional. Its dimensions are intrinsic, instrumental, and collective. Voice can be thought of as being closely related to intrinsic agency, as it embodies self-confidence, self-efficacy, and autonomy, although it is clearly also influenced by instrumental and collective agencies. All domains of the agency are important, as reflected in the adoption of metrics like the WEAI. Collective action, greater participation in the public sphere (with or without political representation), access to information, influence and are influenced by the agency. The suite of Women's Empowerment in Agriculture indices (Alkire et al., 2013; Malapit et al., 2019) provides validated measures of women's empowerment that are grounded in these feminist theories of empowerment, and measure intrinsic agency (power within), instrumental agency (power to), and collective agency (power with) (Ibrahim & Alkire 2007; Alkire et al., 2013; Paganini et al. 2021).

2.1.2 Voice and agency beyond household

Women's V&A beyond the household (VABH) is often characterized by VA vis-à-vis the local community (and interactions women have within) and VA at the food system level (World Bank 2012; Paganini et al. 2021; Njuki et al. 2021, 2022).

VABH vis-à-vis the local community may be proxied by involvement in collective action, the size or quality of social networks or other measures of social capital, and mobility. These indicate the ease with which an individual can access the broader community beyond her household and signal having the means to exercise her agency.

Participation in various community groups is also a proxy for women's VABH and is often associated with higher levels of women's empowerment (Brody et al., 2017; Kumar et al., 2019; Aberman et al., 2020; Kumar et al., 2021; Díaz-Martin et al. 2022; Njuki et al., 2022). Participation in community groups and in community leadership is associated with larger and more active social networks, greater awareness and use of government entitlement schemes, greater access to information on agricultural practices, and higher agricultural productivity in several contexts (Kabeer 2017 for Bangladesh, Kumar et al. 2019 and Raghunathan et al. 2019 in the case of India, and Diiro et al., 2018 in the case of Kenya), though constraints on women's time and slow-changing social norms can limit the translation of information into action (Raghunathan et al., 2019). Greater participation by women in collective action is also found to facilitate community-based adaptation (CBA) to CC (Bryan & Behrman 2013).

Large, active social networks, especially those that contain well-connected or influential members, and other forms of social capital are also key to capitalizing on opportunities determined by local communities or market conditions rather than within-household resource endowments (World Bank 2012, section 4). Social networks can also act as safety nets and important social capital for women beyond households (Goh 2012; Roy et al., 2019). Participation in collective organizations is closely linked to greater social capital and improved social networks (Deininger & Liu, 2013; Desai & Joshi, 2014; Feigenbaum et al., 2014; Kumar et al., 2019), though this relationship is not universal (Ban et al., 2020).

Mobility, including women's ability to leave the household and their freedom of movement in public spaces and domains, is also an important indicator of VABH, especially through its effects on women's bargaining power (Kabeer 1999; World Bank 2012; Klugman et al., 2014; Njuki et al., 2016).

Political participation—that is, the degree of participation in formal politics and representation in its upper echelons (World Bank 2012) —is both an element of VABH for individual women, as well as a factor that can affect such individual VABH through enhanced VA at the food system level. Individual women's ability and willingness to participate in community decision-making or positions of leadership is, in turn, dictated by prevailing social beliefs and norms, such as the belief that women are not effective leaders or norms that limit public speaking, interactions with male non-family members, and so on (World Bank 2012, Morley & Crossouard 2015; Njuki et al. 2022). At the same time, greater political representation by women at a higher level, such as local district assemblies, which is VA at the food system level, has been shown to lead to improved investment in public works that are closely linked to women's concerns, like clean drinking water, and improved survival of higher-order girl children (Chattopadhyay & Duflo 2004; Kalsi 2017). Our empirical assessment in the later section differentiates these two aspects of political participation—i.e., individual women's political participation and political representation by women at a higher level, such as local district assemblies.

2.2 Climate change's effects on women's VABH

Climate change (CC) can affect livelihoods, with different impacts according to gender, in various ways. Here we focus on the effects of CC on key elements particularly associated with women's VABH described in the previous section.

CC impacts physical and ecological systems and the availability of natural resources that, in turn, have implications for productivity, incomes, and livelihoods. For example, agricultural yields are lower under extremes of temperature and rainfall, as well as when there are delays in rainfall or fluctuations in weather conditions. Labor productivity also declines during weather extremes (Somanathan et al., 2021). Extreme weather events such as floods and droughts can also erode household assets and reduce the value of land (e.g., Hossain et al. 2020). All of these have implications on household livelihoods, incomes, and financial capital (Meinzen–Dick et al. 2010; Bryan & Behrman 2013). CC can also affect natural resources capital, such as water and energy sources (e.g., fuelwood), which women are often responsible for collecting. Such effects on resources can affect women's time endowments, reducing their free time or mobility available to participate in community groups or political activities (Meinzen–Dick et al. 2010).

The impacts of these outcomes of CC for women's VABH are complex. On the one hand, distress migration due to declining agricultural productivity is largely undertaken by men. Women who choose to stay might experience a rise in their autonomy and decisionmaking ability out of necessity (Mueller et al. 2014). On the other hand, there is evidence that in times of income shocks, female members of the household are worse hit than male members (Rose 1999; Behrman & Deolalikar 1990; Shah & Steinberg 2012). During crises, including those linked to CC, a coping strategy may involve women becoming more likely to eat last, consuming fewer calories and nutrients, skipping meals, or eating non–traditional foods—all of which can hamper their ability to adapt to climate shocks (Patt et al. 2009; Bryan & Behrman 2013), including efforts to exercise their VABH through aggravated health that affects their mobility. In Bangladesh, women tend to be more calorie–deficient than men and often cannot recover as well

from the negative health effects of climate shocks such as flooding (Bryan & Behrman 2013), as well as vector-borne, water-borne, water-washed diseases, often caused by temperature and precipitation fluctuations, and heat/cold stress (World Bank 2012). CC's effects on financial capital (especially that controlled by women) can affect financial resources to engage in collective action and also jeopardize their social capital (Goh 2012) by limiting their ability to make gifts, a practice often used to secure women's status in important social networks.

Additional factors at the individual, household, and societal levels work to mediate the impacts of CC: these include individual-level education and access to information, including on climate risks and appropriate adaptation methods (Ngigi et al. 2017); individual and household social, economic, and political capital (Meinzen–Dick et al. 2010; Bryan & Behrman 2013); markets, laws, policies, organizations, and social and cultural norms that can influence how climate risks and impacts are distributed across different social groups and populations; how residents access and control resources and assets; and how individuals and groups participate in and benefit from collective action (Bryan & Behrman 2013). For example, rigid patriarchal social norms manifest in limited mobility and lower skill levels and also often prevent women from saving themselves in disaster situations (Aguilar, 2006; Dasgupta et al., 2010: p.65; Demetriades & Esplen, 2010; Mearns & Norton 2010). Such limitation on mobility in the face of adverse CC and skills in coping with CC can weaken women's ability to engage in VABH in response to adverse CC.

CC can also affect women's priorities or preferences related to VABH (Meinzen–Dick et al. 2010; Bryan & Behrman 2013). Because women often hold greater responsibility for family food production, processing, and food preparation for the household, they tend to prioritize VABH that can contribute to climate adaptation strategies that promote long-term food and nutrition security within the community, such as community-level projects, training, and facilities focused on food storage and preservation or development of community gardens with micronutrient–rich food (Bryan & Behrman 2013). Similarly, women may prioritize VABH that contributes to community–level investments in domestic water supplies, such as rainwater collection or other types of community water storage, since such investments can both lighten women's workload and reduce their exposure to waterborne diseases such as cholera and dysentery (Denton 2004).

2.3 Potential roles of local political representation by females on relationship between CC and women's VABH

The relationships between adverse CC, and women's VABH, can also be affected or mitigated by greater local political representation by females. Greater political representation by women at a higher level, such as local district assemblies, which is VA at the food system level, has been shown to lead to improved investment in public works that are closely linked to women's concerns, like clean drinking water, and improved survival of higher-order girl children (Chattopadhyay & Duflo 2004; Kalsi 2017). Our empirical assessment in the later section differentiates these two aspects of political participation—i.e., individual women's political participation and political representation by women at a higher level, such as local district assemblies.

3 Empirical approach

In this section, we empirically assess the relationship between CC and various indicators of and proxies for women's VABH discussed in the previous section. Specifically, we assess

whether and what VABH-associated outcomes for women as well as men are relatively consistently predicted by CC in India, whether these estimates consistently differ across gender, and whether women's political participation at district levels appears to moderate any observed relationship.

3.1 Data

Household data

We investigate these questions using nationwide household survey data from India, as well as various supplementary datasets constructed at the district and state levels. Our primary household survey data are India Human Development Surveys (IHDS) from 2005 and 2012 (Desai et al. 2018a, 2018b) and World Values Surveys (WVS) data for India for 2001, 2006, and 2012 (Inglehart et al. 2018a, 2018b, 2018c).

IHDS data are nationally representative, multi-topic panel data of 42,152 households and approximately 150,000 individuals in 420 villages and 1,042 urban neighborhoods across India, collected in 2005 and 2012 (more details are available in Desai et al. 2018a, 2018b). The nationwide coverage of IHDS data is suitable for capturing correlations with significant spatial variations in decadal weather patterns. The data contain district identifiers, which can be matched with climate and other supplementary data constructed at district levels described below.

WVS are nationwide household data that capture a range of stated perceptions and preferences related to women's VABH, discussed in the previous section (Klugman et al. 2014). WVS data are repeated cross-sectional data, which contain state identifiers that can be matched with supplementary data, as described below, constructed at the state levels.

Climate data

Our historical climate data are the following; monthly rainfall data for 1980 – 2012 are obtained from the Climate Hazards group Infrared Precipitation with Stations (CHIRPS) (Funk et al., 2015). Tropical cyclone data between 1975 and 2012 are extracted from Knapp et al. (2010; 2018) and converted into a 0/1 variable indicating whether any cyclone passed through each district. Drought data between 1975 and 2012 are from the Standardized Precipitation Evapotranspiration Index (SPEI) (Vicente-Serrano et al. 2010). Flood data between 1975 and 2012 are from India Flood Inventory (Saharia et al. 2021). Historical temperature data between 1980 and 2012 are obtained from NOAA (2022a).

Climate related infrastructure (large dams)

We further include whether each district had large dams (FAO 2022; Government of India 2022) and whether there were also large dams in adjacent upstream districts, which have differential spatial effects of mitigating climate risks (Duflo & Pande 2007). From these data, figures for corresponding years of IHDS and WVS are extracted.[1]

[1]As is described in the subsequent sections, our analyses assume that all district-level effects are captured through observed district-level variables, including district-level climates and other district-level socioeconomic variables. While this can be a debatable assumption, it allows us to avoid the need to further control for district-level effects through district dummy variables (which can be in the order of 500 variables or so) and allow us to identify the effects of climate on VABH outcomes.

Election data

Lastly, we use district-level historical election data (Bhavnani 2009, 2014), from which we extract the share of female lawmakers in district assemblies.

All climate data, data on dams, and election data are extracted at the district level and merged with IHDS using its district identifiers. In the analyses using WVS, we constructed state-level data for these variables, except data on dams which become hard to interpret at the state level. Climate data are extracted as state-level averages, and election data are extracted by taking the average of all districts within each state.

3.2 Variable construction

3.2.1 VABH outcome variables

VABH outcome variables are constructed in the following ways for both the IHDS and WVS datasets based on the key indicators and proxies described in the previous sections and the availability of variables in these datasets.

Membership from IHDS is a binary variable indicating whether the respondent is an active member of any of Mahila mandal,[2] youth club/sports group/ reading room, Self Help Groups, credit/savings groups, religious/social group or festival society, development group/NGO, agricultural, milk, or other co-operatives. *Membership* in WVS is a binary variable indicating whether the respondent is an active member in any religious organization, labor/ trade union, political party, environmental organization, professional association, or consumer organization.

A personal acquaintance from IHDS, which relates to a social network, is a binary variable indicating whether the respondent or any member of the household has personal acquaintance with doctors, teachers, or is a member/official of the village panchayat, nagarpalika, ward committee.

Mobility from IHDS is a count variable measured as a sum of binary variables indicating whether the respondent visits natal family regularly (at least monthly); can go alone to the local health center; can go alone to the home of relatives or friends (in the village/neighborhood); can go alone to the kirana shop; and can go out by herself or with children to the cinema, mela, or restaurant. When one or more of these variables are missing, the entire sample is dropped from the analyses.

Mobility-related health from IHDS is a count variable measured as a sum of binary variables indicating whether the respondent had an illness in the last 30 days, whether the respondent had a fever, whether the respondent had a cough, whether the respondent had short/rapid breath or diarrhea; has difficulty walking 1km; going to the toilet without help; dressing without help; hearing normal conversation; speaking normally; seeing distant things; seeing nearby objects (such as reading/sewing), and having overall health that is bad.

Intimate partner violence from IHDS is a count variable summing the binary indicators of whether the respondent believes it is uncommon to beat the wife if he suspects her of having relations with other men; if her natal family does not give expected money, jewelry, or other items; if she neglects the house or the children; or if she doesn't cook food properly. *Intimate*

[2]Mahila mandal are women's clubs, such as traditional local organisations of women. At the most basic level, mahila mandals are informal community level associations of women who come together in celebration, sorrow or crisis. (Das 2000)

partner violence in WVS is a binary variable based on whether the respondent believes it is not justifiable for a man to beat his wife.

Decision-making right from IHDS is a count variable summing binary indicators of whether the respondent and spouse talk about things that happen at work/ on the farm, what to spend money on, whether the respondent thinks that women have the decision-making power on what to cook on a daily basis; whether to buy an expensive item; how many children you have; what to do if a child falls sick; or whom the respondent's children should marry. Decision-making right in WVS is whether the respondent believes he/she has more freedom of choice or sees herself/himself as autonomous in decision-making.

Financial independence from IHDS is a count variable summing binary variables of whether the respondent has their name on bank accounts held by someone in the family or has off-farm wage employment. Financial independence in WVS is a binary variable of whether the respondent believes being a housewife is not as fulfilling as having employment outside the household.

Welzel voice sub-index from WVS is constructed as in Welzel (2013) using the various responses within WVS, used as a proxy that measures the level of the strength of voice by respondents. Welzel voice sub-index is constructed as a cross-culturally reliable indicator related to the voice, which is computed based on the responses in WVS on whether the respondent believes it is important to give people more say in important government decisions, to protect freedom of speech.[3]

Political participation from IHDS is a binary variable indicating individual women's political participation, i.e., whether the respondent and his/her spouse talk about things that happen in the community, such as elections or politics; whether the respondent is a member of a trade union, business or professional group; whether the respondent voted by themself in the most recent national election; and whether they acquainted personally with members of government/ the police/ the military/ politicians. Political participation in WVS is a count variable based on whether the respondent believes that women have the same rights as men in democracy, that women make as good of a political leader as men, and whether they are interested in politics.

Confidence in politics in WVS is a count variable based on whether the respondent has confidence in the government, in political parties, or in parliament.

Women's representation at local district assemblies is proxied as the district-level share of female lawmakers in the local assembly, constructed based on the local assembly election results.

Climate change related variables

For CC indicators, we focus on rainfall, drought, cyclone, flood, and average temperatures, which have been identified as key climate parameters in developing countries (Ramirez-Villegas & Challinor 2012), and India in particular (Krishnan et al. 2020).[4]

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[3]Please see https://www.worldvaluessurvey.org/WVSContents.jsp?CMSID=welzelidx&CMSID=welzelidx for more details.

[4]Each of these climate parameters can uniquely affect VABH-related outcomes. Drought can induce greater migration than the flood in some countries (Mueller & Osgood 2009). While the impact of floods depends on elevation, slope, and soil density, drought effects depend on soil depth and quality (Just & Weninger 1999).

Cyclones may sometimes reduce school enrolment by young men and women (Marchetta et al. 2019). Also, in Bangladesh, the destruction caused by cyclone Aila in 2009 had different social impacts on women than

We also followed Stocker et al.'s (2013) definition of CC, i.e., any changes in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer (Stocker et al., 2013, p. 187). Specifically, we computed 10-year averages of each of the aforementioned climate parameters leading up to each survey year used. In other words, for IHDS, we use 1996-2005 for IHDS 2005, and 2003-2012 for IHDS 2012, while for WVS, we use 1992-2001 for WVS 2001, 1997-2006 for WVS 2006, and 2003-2012 for WVS 2012, and use changes as the CC indicators. For rainfall and temperature, we further converted them into indicators of anomalies, using historical mean and standard deviations to construct z-scores between 1980-2012. We then used absolute values of z-scores as proxies of rainfall and temperature anomalies and used their changes based on the decadal averages mentioned above as indicators of CC.[5]

3.3 Empirical model

Using the VABH-outcome variables and climate-change indicators described in the previous section, we estimate the following specification for IHDS data:

$$Y_{ijt} = \alpha + \beta_S \cdot S_{jt} + \beta_{SG} \cdot S_{jt} \cdot G_{jt} + \beta_{SW} \cdot S_{jt} \cdot W_i + \beta_{GW} \cdot G_{jt} \cdot W_i + \beta_{SGW} \cdot S_{jt} \cdot G_{jt} \cdot W_i + \beta_G \cdot G_{jt} + \beta_Z \cdot Z_{ijt} + \beta_t \cdot t + c_i + \varepsilon_{ijt} \quad (1)$$

For WVS repeated cross-section data, we estimate the following specification:

$$Y_{ijt} = \alpha + \beta_S \cdot S_{jt} + \beta_{SG} \cdot S_{jt} \cdot G_{jt} + \beta_{SW} \cdot S_{jt} \cdot W_i + \beta_{GW} \cdot G_{jt} \cdot W_i + \beta_{SGW} \cdot S_{jt} \cdot G_{jt} \cdot W_i + \beta_G \cdot G_{jt} + \beta_Z \cdot Z_{ijt} + \beta_t \cdot t + \varepsilon_{ijt}. \quad (2)$$

In (1), various outcome indicators for respondents i (either household or an individual within the household) in district j in year t (Y_{ijt}) are regressed on normalcy indicators of climate-change parameters (S_{jt}) (decadal averages of aforementioned drought, cyclone, flood, rainfall and temperature anomalies leading up to *t*), as well as potential factors that mitigate the effects of CC at district level (G_{jt}), interacted with a dummy variable W_i indicating the gender of the

men (Kartiki 2011). After disasters like windstorms and tropical cyclones, women, young people, and people with low socioeconomic status are sometimes more likely to experience anxiety and mood disorders (WHO 2014).

Rainfall (aside from drought and flood) may correlate with clouding coverage and solar radiation, which affects agricultural production. In contrast, flood is more often associated with the destruction of assets (e.g., Alvi & Dendir 2011), effects on agroforestry (e.g., Takasaki et al. 2004), the spread of pests (Urama & Hodge 2004), while also inducing migration in some cases (Giannelli & Canessa 2022).

Temperature, including higher nighttime temperature or daily minimum temperature, can affect yield, aside from heat stress (Sarker et al. 2012; Tao et al. 2017). In India, generally, higher temperature induces labor allocation to the nonagricultural sector (Colmer 2021) but also reduces labor productivity in the manufacturing sector in India (Somanathan et al. 2021). A general increase in temperature may also increase the transmission of malaria in some locations (WHO 2014). Higher overall temperatures are also associated with heat stress that damages agricultural productivity in India (Birthal & Hazrana 2019; Dubey et al. 2020; Birthal et al. 2021).

[5]We also checked results replacing average temperatures by heat stress, which is constructed from NOAA (2022) following definitions in Birthal & Hazrana (2019) and India Meteorological Department (IMD) of the Government of India, whereby heat-stress is identified if the daily maximum temperature at a location (in our case district) remains at least 3 °C higher over its long-term mean consecutively for three or more days. We found that heat stress is significantly correlated with average temperature, and results are found similar between using average temperature and heat stress.

respondent (=1 if female), and other control variables Z_{ijt} as well as time dummies t. In (2), notations are adjusted for the repeated cross-section nature of WVS. Notations α, β's, and ε are estimated parameters, while c_i are time-invariant respondent fixed effects.

Equations (1) and (2) estimate the associations with climate normalcy indicators S_{jt}, their heterogeneity across gender W_i, and G_{jt}, where the latter is share of female lawmakers in the district assemblies.

In both (1) and (2), Z_{ijt} includes night-time luminosity data (district average for IHDS and state average for WVS) (NOAA 2022b) which has been used as a good indicator of the spatial and temporal variations in local economic development. Z_{ijt} also include Socioeconomic High-Resolution Rural-Urban Geographic Dataset on India (SHRUG data) (Asher et al. 2021) which provide various spatial data on multidimensional socioeconomic development, specifically the proportion of district population with access to general electricity supply, electricity supply for agriculture, electricity supply for domestic use, and access to tar roads.

In (2), which is a repeated cross-sectional model, Z_{ijt} additionally includes age, marital status, number of caregiving children, highest education received, household wealth indicators like the amount of family savings made during the previous year, household income scales (decile among all India households based on respondents peceptions), and perceptions on which social class respondents belong at t0 (among 5 choices, i.e., Upper class, Upper middle class, Lower middle class, Working Class and Lower class) , and the size of the town in which the respondent lives.

3.4 Descriptive patterns of women's and voice / agency beyond households, and climate change

Table 1 through Table 3 summarize the descriptive statistics of VABH-outcome variables, CC variables, and other exogenous variables described in the previous sub-sections.

Table 1 suggests that most respondents are not members of any organizations, have some key acquaintances, engage in political participation, and have moderate levels of perceptions against intimate partner violence and decision-making while having no financial independence. WVS data indicate that respondents have a moderate level of confidence in politics, and similar patterns as IHDS on political participation, perceptions against intimate partner violence, decision-making, and financial independence. Respondents also have relatively modest voices based on the Welzel voice index.

Table 2 shows that the share of female lawmakers in the local assembly is generally low, about 5-8% on average, depending on datasets and years. Table 2 also shows that the respondents experienced moderate levels of drought, about 9 – 17% of respondents resided in districts where cyclones passed through, experienced about 0.5 floods per year, and experienced increased levels of rainfall and temperature anomalies over the years.

Table 3 indicates that respondents typically live in districts with 4 dams and 6 upstream dams, generally with low nighttime lights. About half or less have access to electricity for all-purpose, agricultural, and domestic uses. A little over half of the respondents are in villages that have access to tar roads. Among WVS, respondents are on average 41 years old, mostly married with about 3 children, have completed 4-5 years of education, think that they made somewhat more loss in net family savings in the past year, think that they mostly belong to lower social classes and live in towns with about 50,000 population.

4 Results

Table 4 through Table 10 present our main results on the associations between adverse CC, female-representation at local district assemblies, and differences in these two associations across gender. Table 4 and Table 5 show the results for urban and rural samples using IHDS data, respectively. Table 6 and Table 7 show the same set of results for rural sample (Table 5), for married and non-married respondents, respectively. Table 8 and Table 9 show results for the youth (15-34 years old) and the non-youth (35 years old or above) for the rural sample. Table 10 shows analogous results using WVS data.

Figures are shown as the associations between one-standard deviation changes in each variable with one-standard deviation changes in outcome variables. Interacted variables are standardized with mean = 0, so that non-interacted variables capture the average associations.

For ease of interpreting results specifically from women's perspectives, results shown refer to averages levels of associations among the women sample, which is computed controlling for gender (W_i), as well as how average associations with CC differ by gender.

As our analyses are not strictly causal, coefficients should be interpreted as "associations" rather than causal effects. We, however, use the term "effects," where doing so eases our interpretations.

4.1 Relatively negative average associations with adverse climate change

The first 5 rows of Table 4 and Table 5 show the average levels of associations between adverse CC and VABH for women.

Generally, the associations with drought, rainfall, or temperature anomalies are ambiguous in both rural and urban samples. However, among rural samples (Table 5, first 5 rows), both greater numbers of cyclones and/or floods have relatively consistently negative associations with all the VABH-related outcomes with statistical significance. None of these outcomes are positively associated with more cyclones or floods with statistical significance. These patterns are also generally consistent among married (Table 6) and non-married populations (Table 7). In urban samples (Table 4), the associations with cyclones and floods are less consistent.

More cyclones also have generally consistently negative average associations with VABH-related outcomes in WVS data (Table 10). Together, these results suggest that adverse climates, particularly cyclones and, to some extent, floods, consistently negatively affect a broad range of VABH-related outcomes.

4.2 Generally positive associations with greater female representation and mitigating adverse climate changes

The second 5 rows of Table 4 and Table 5 show how increased political representations of women (share of female lawmakers in the district assemblies) interact with the associations between adverse CC and VABH-outcomes. Positive coefficients indicate that greater female representation has more positive associations in the face of adverse CC.

Importantly, among the rural sample in Table 5, greater female representation has generally consistently positive coefficients, with no statistically significant negative coefficients. These consistent patterns suggest that greater female representation at district assemblies broadly mitigates the associations between adverse CC and VABH outcomes. These patterns generally hold also for married- and non-married individuals among rural samples (Table 6 and Table 7),

as well as among both youth (15-34 years old) and elderly (35 years or older) (Table 8). These are contrasting with the urban sample (Table 4), in which patterns are more ambiguous.

Similarly, in WVS data (Table 10), while not all coefficients are statistically significant, all statistically significant coefficients are positive, suggesting that greater female representation generally mitigates associations between adverse CC and VABH-related outcomes.

4.3 Gender differences

Table 4 and Table 5 show how the average levels of associations and associations with female representations vary across genders of individual respondents (rows with interactions with "Female").

Among rural samples (Table 5), females' VABH tend to be more negatively affected by adverse CC, as indicated by a large number of statistically significantly negative coefficients for "Female" variable interacted with CC variables (Female*Drought, …, Female*Temperature). This is consistent with the literature discussed earlier that women are more negatively affected by CC for their capacity to enhance VABH. An exception is the that positive association between greater rainfall and decision-making by women. This may be because temperature anomalies or rainfall anomalies may be less destructive than cyclone or flood, and allow women to play greater decision-making roles especially when these anomalies derive men to out-migrate (e.g., Mueller et al. 2014). However, coefficients of cyclone or flood are negative, and thus overall associations with adverse climate-change are ambiguous.

The effects of female-representations to mitigate adverse CC effects are also generally more positive among women than men, as are indicated by several positive coefficients in rows for variables that interact CC with Female*FR (Female*FR*Drought, …, Female*FR*Temperature). In particular, relatively more coefficients for drought (Female*FR*Drought) are positive, suggesting that, greater female-representations particularly mitigate the effects of drought on decision-making rights among women relative to men.

These results generally hold across marriage status and age-group among women (Table 6 and Table 9).

Similarly, among WVS data (Table 10), gender-differences are also somewhat in the direction of more negative effects of adverse CC, but more positive effects of female-representation in mitigating the adverse effects of CC, among women than men.

5 Conclusions

Women's Voice & Agency beyond household (VABH) has been increasingly recognized as playing critical roles in strengthening resilience, increasing women's access to important resources, improving women's decision-making power, and facilitating broader social networks (Njuki et al. 2022). Despite the intensifying CCs in recent years, a knowledge gap exists as to how CC may affect women's VABH in developing countries. In this study, we aimed to provide some insights into conceptual discussions on the linkages between CC and VABH based on the review of literature on women's VABH, and on the climate effects on various elements of VABH, and simple empirical relations using nationwide household data from India (India Human Development Survey 2005, 2012; World Values Survey 2001, 2006, 2012), various climate data, and data on women's political representations at district levels.

Our conceptual discussions suggest that key elements of VABH are associated, among others, with participation in collective action, social network, capital, mobility, belief, and attributes toward social norms, as well as political participation, including women's

representation in local politics, at community-level and food systems levels. We also highlighted how climates could potentially affect women's capacity to enhance these VABH-related elements, through physical, financial, and social capital and access to natural resources, potentially in gender-differentiated ways.

Our empirical results verify some of these potential impact pathways. CC can be associated with many of the outcomes associated with VABH elements for women, with sometimes significantly different associations across gender. First, we find that in rural parts of India, adverse climate change and natural disasters, such as cyclones and/or floods, have consistently negative associations with many of the aforementioned VABH-related outcomes with statistical significance. Second, in rural areas, greater female representation at district assemblies broadly mitigates the negative associations between adverse CC and VABH outcomes. Third, these patterns generally hold across various populations, differentiated by marriage status, age groups, as well as IHDS and WVS data. Fourth, these consistent patterns of associations contrast with an urban sample where patterns are more ambiguous. Fifth, there are also generally consistent gender differences in these associations. Specifically, results indicate that women's VABH are disproportionately more negatively affected by adverse CC than men's VABH, while greater female representation at local district assemblies has greater effects in mitigating adverse CC on VABH among women than men.

There are, however, still significant knowledge gaps that remain which future studies can explore. First, more in-depth studies are needed to better understand the detailed pathways of the observed linkages between greater female political representation, and more enhanced VABH for women, in the face of adverse CC and consequent natural disasters like cyclones and floods. Second, as is emphasized in the literature (e.g., Klugman et al. 2014), micro-level data on variables related to women's VABH are still generally limited in developing countries including India. A richer set of data on broader aspects of VABH should be collected and continue to be investigated by monitoring the effects of climate changes and related natural disasters that is expected to keep intensifying in the foreseeable future.

Table 1. Proxies of VABH

Descriptions	Sample size (all rounds combined)	Mean (all rounds combined)	Standard deviations (all rounds combined)
IHDS data[a]			
Membership (yes = 1)	270,211	0.358	0.479
Personal acquaintance (yes = 1)	257,977	0.690	0.462
Mobility index (min = 0, max = 5)	186,376	2.982	1.378
Mobility related health index (yes = 1)	190,463	0.379	1.249
Political participation (yes = 1)	192,376	0.574	0.393
Perceptions against intimate partner violence index (min = 0, max = 4)	203,551	1.831	1.319
Decision-making index (min = 0, max = 7)	199,879	3.865	2.312
Financial independence index (min = 0, max = 1)	283,935	0.219	0.422
WVS data[b]			
Membership (yes = 1)	4,676	0.421	0.426
Political participation index (min = 0, max = 1)	3,448	0.675	0.217
Confidence in politics (min = 0, max = 3)	5,392	1.333	0.820
Perceptions against intimate partner violence index (min = 0, max = 10)	4,722	2.200	2.338
Decision-making index (min = 0, max = 1)	4,255	0.435	0.231
Financial independence index (min = 0, max = 3)	3,946	0.192	0.712
Welzel index: greater voice (min = 0, max = 1)	6,659	0.244	0.241

Source: Authors.

[a]IHDS data figures are from 2005 and 2012 combined.

[a]WVS data figures are from 2001, 2006 and 2012 combined.

Table 2. Political representation and climate variables

Variables	Sample means				
	IHDS sample		WVS sample		
	2005	2012	2001	2006	2012
Sample size[a]	150,988	150,984	2,019	2,017	4,033
Share of female lawmakers in local assembly in each district (IHDS) / state (WVS)	0.076	0.074	0.055	0.070	0.064
Drought index (more positive values = more drought)	0.156	0.140	0.090	0.160	0.173
Cyclone (=1 if any cyclone passed through the district in the year)	0.063	0.063	0.066	0.064	0.072
Flood (number of flood incidence in the district in the year)	0.492	0.534	0.469	0.435	0.442
Rainfall (absolute value of z-score with respect to historical distribution)	0.358	0.616	0.343	0.556	0.735
Average temperature (absolute value of z-score with respect to historical distribution)	0.511	1.141	0.351	0.925	1.406

Source: Authors.

[a]Sample sizes include all observations for which district or state identifiers are available and thus election data and climate data can be matched. These sample sizes are larger than the sample size of regressions because outcome variables are not always reported and those observations are dropped in the analyses.

Table 3. Other exogenous variables

Variables	Mean (all rounds combined)	
	IHDS data	WVS data
Number of large dams within the district	3.713	
Number of large dams in the upstream districts	6.372	
Nighttime light index (0 = minimum, 60 = maximum)	6.061	5.741
Access to electricity for all residents (all-purpose, share of villages within the district)	0.522	0.469
Access to electricity for all residents (agriculture, share of villages within the district)	0.300	0.301
Access to electricity for all residents (domestic use, share of villages within the district)	0.421	0.423
Tar road in the district (share of villages within the district)	0.591	0.581
Time-invariant variables included for repeated cross-section analyses with WVS		
Female (yes = 1)		0.434
Age (years)		41.018
Married (yes = 1)		0.825
Number of children		2.775
Education completed (years)		4.477
No formal education (yes = 1)		0.304
Incomplete primary school (yes = 1)		0.088
Completed primary school or above (yes = 1)		0.608
Net family savings in the past year (subjective)		
Positive (saved money) (yes = 1)		0.270
Break-even (yes = 1)		0.380
Negative (spent more money than saving) (yes = 1)		0.350
Social class (subjective)		
Upper class (yes = 1)		0.033
Upper middle class (yes = 1)		0.161
Lower middle class (yes = 1)		0.385
Working class (yes = 1)		0.233
Lower class (yes = 1)		0.188
Income percentile (subjective, 0 = lowest, 100 = highest)		40.834
Size of town (population)		46126.390

Source: Authors.

Table 4. Effects of climate change on various VABH related outcomes, their differences across gender, and the effects of greater political representation of women among urban sample (India Human Development Survey data)[a, b]

Variables	Membership	Personal acquaintance	Mobility	Mobility – health	Political participation	Intimate partner violence (less of)	Decision-making	Financial independence
Drought	–0.045**	0.030*	0.102***	0.007	0.107***	0.056***	0.040***	0.016
Cyclone	0.047***	–0.053***	0.001	0.045***	0.010	–0.100***	–0.018*	0.007
Rain anomaly	0.019	0.005	–0.134***	–0.021	–0.242***	0.086***	0.121***	–0.042**
Flood	–0.038***	–0.021*	0.012	–0.015	0.001	0.075***	0.037***	0.004
Temperature anomaly	–0.048*	–0.011	–0.001	0.017	–0.106***	0.128***	–0.022	0.026**
FR	0.017	–0.012	0.072	0.149***	–0.141**	–0.004	–0.071*	0.042
FR*Drought	–0.023	–0.006	–0.073***	–0.036**	0.004	0.000	–0.014	–0.010
FR*Cyclone	0.028*	0.047***	0.011	–0.027**	0.015	0.045**	0.026**	0.006
FR*Rain	0.029	–0.104***	0.096**	–0.032	–0.009	0.199***	–0.028	0.024
FR*Flood	–0.034*	–0.007	–0.060***	0.059***	–0.054**	–0.005	–0.026*	–0.026*
FR*Temperature	0.072*	0.076*	–0.084*	–0.160***	0.160***	–0.175***	0.078***	0.018
Female*Drought	0.011***	–0.003	0.008	–0.006	–0.007*	–0.002	0.003	0.007*
Female*Cyclone	0.002	0.003	0.004	0.009*	0.002	0.000	–0.008	–0.001
Female*Rain	0.011*	0.004	0.009	–0.016*	0.000	–0.018**	0.107***	–0.006
Female*Flood	0.005	–0.012***	0.001	–0.006	–0.002	0.008*	0.033***	0.005
Female*Temperature	–0.014**	–0.006	0.012	–0.040***	–0.003	0.010	0.025*	0.008
Female*FR	0.016	0.020*	–0.013	–0.045**	–0.017	–0.021	0.007	–0.006
Female*FR*Drought	–0.008*	0.006	–0.005	0.002	–0.001	–0.009*	0.018*	–0.010*
Female*FR*Cyclone	–0.003	–0.000	–0.006	–0.013*	–0.005	–0.005	–0.017*	0.002
Female*FR*Rain	0.001	0.004	–0.001	–0.031***	–0.016	0.018*	–0.038***	0.015*
Female*FR*Flood	–0.006	0.008	–0.003	0.012	–0.003	–0.006	0.021**	–0.007
Female*FR*Temperature	0.008	0.004	–0.009	–0.030*	–0.008	–0.024*	0.023	–0.004
Other controls	Included	Included	Included	Included	Included	Included	Included	Included
Number of obs.	83,162	80,817	60,485	61,642	61,979	64,627	63,248	86,046
p-value (H0: variables jointly insignificant)	.000	.000	.000	.000	.000	.000	.000	.000

Source: Authors' estimations. *** 0.1% ** 1% * 5% FR = Female representation (share of female in district assembly)

[a] Effects of one-standard deviation change of explanatory variables on one-standard deviation change in outcome variables.

[b] In this and subsequent tables, for ease of interpretation, average effects for women (rows 1 – 10) already include the female specific effects (rows 11 – 21) in variables interacted with Female.

Table 5. Effects of climate change on various VABH related outcomes, their differences across gender, and the effects of greater political representation of women among rural sample (India Human Development Survey data)[a]

Variables	Membership	Personal acquaintance	Mobility	Mobility – health	Political participation	Less intimate partner violence	Decision-making	Financial independence
Drought	–0.103***	0.024*	0.022*	–0.021*	0.057***	0.009	–0.041***	–0.000
Cyclone	–0.010	–0.033***	–0.028**	0.022**	–0.030***	–0.033**	–0.013*	–0.023***
Rain anomaly	0.039*	–0.054***	–0.127***	–0.092***	–0.063**	–0.075**	0.091***	0.025*
Flood	–0.016*	0.002	0.005	–0.032***	–0.006	0.006	–0.019**	0.004
Temperature anomaly	–0.044**	–0.033*	–0.001	–0.037**	–0.029*	0.112***	0.032**	–0.012
FR	–0.076	0.107**	0.000	0.005	0.075*	0.061	–0.011	0.011
FR*Drought	0.022*	0.020*	0.039***	–0.017	0.054***	0.001	0.039***	0.004
FR*Cyclone	0.023*	0.015	0.010	0.018*	0.065***	0.029	–0.037	–0.009
FR*Rain	0.015	–0.020	0.045*	0.049**	0.015	0.127***	–0.023	0.006
FR*Flood	–0.007	–0.009	0.023*	0.014*	0.012	0.024*	–0.005	–0.014
FR*Temperature	0.000	0.028	0.016	–0.101	0.006	–0.141	0.042*	0.049***
Female*Drought	0.002	–0.004*	0.004	–0.000	–0.008***	0.002	–0.017***	0.003
Female*Cyclone	–0.003	0.002	0.002	0.005	–0.001	–0.001	–0.009*	0.000
Female*Rain	–0.000	–0.001	0.001	–0.014*	0.005	–0.011*	0.101***	0.005
Female*Flood	–0.001	–0.000	0.004	–0.012***	–0.006*	–0.006*	0.006	–0.005**
Female*Temperature	0.007	–0.011**	–0.012**	–0.026***	–0.006	0.001	–0.090***	–0.011***
Female*FR	–0.000	0.011*	0.006	–0.026**	–0.004	0.000	–0.004	0.018***
Female*FR*Drought	0.000	0.007**	0.004	0.010**	0.003	–0.004	0.022***	–0.002
Female*FR*Cyclone	0.002	–0.002	–0.003	0.010*	–0.002	0.004	–0.020	–0.000
Female*FR*Rain	0.001	0.005	0.012*	0.007	–0.005	0.009*	–0.014	0.005
Female*FR*Flood	0.001	0.005*	0.005	0.001	0.003	0.004	–0.004	–0.003
Female*FR*Temperature	–0.002	0.001	–0.002	0.026**	0.007	0.021***	0.030*	0.003
Other controls	Included	Included	Included	Included	Included	Included	Included	Included
No. obs	187049	177160	125891	128821	130397	138924	136631	197889
p-value (H0: variables jointly insignificant)	.000	.000	.000	.000	.000	.000	.000	.000

Source: Authors' estimations. *** 0.1% ** 1% * 5%

FR = Female representation (share of female in district assembly)

[a] Effects of one-standard deviation change of explanatory variables on one-standard deviation change in outcome variables..

Table 6. Married individuals (those who had married prior to 2005 including widows / divorced) [a]

Variables	Membership	Personal acquaintance	Mobility	Mobility – health	Political participation	Intimate partner violence (less of)	Decision-making	Financial independence
Drought	–0.101***	0.038***	0.014	–0.047***	0.075***	0.013	–0.038***	0.002
Cyclone	–0.013	–0.037***	–0.034***	0.024**	–0.031***	–0.033**	–0.008	–0.030***
Rain anomaly	0.035*	–0.056***	–0.130***	–0.083***	–0.072***	–0.079**	0.086***	0.017
Flood	–0.019*	0.003	0.001	–0.022**	–0.003	0.008	–0.020**	–0.002
Temperature anomaly	–0.050***	–0.026	–0.001	–0.016	–0.034*	0.117***	0.030*	–0.026**
FR	–0.078	0.111**	–0.136	–0.007	0.046	0.069	–0.002	0.034
FR*Drought	0.018*	0.007	0.040***	–0.013	0.045***	0.000	0.034**	0.000
FR*Cyclone	0.031**	0.013	0.019	0.007	0.068***	0.032*	–0.040	–0.001
FR*Rain	0.015	–0.019	0.042*	0.043*	0.026	0.126***	–0.033	0.010
FR*Flood	–0.006	–0.011	0.023*	0.012	0.005	0.028*	–0.007	–0.008
FR*Temperature	0.005	0.029	0.023	–0.085	0.018	–0.134	0.043*	0.037*
Female*Drought	–0.000	–0.002***	–0.000	–0.002	0.000	–0.000	0.017***	–0.000
Female*Cyclone	0.000	0.001	–0.001*	0.001	0.000	–0.001*	0.006	0.003*
Female*Rain	–0.001	0.000	–0.002**	0.002	–0.000	–0.001	–0.104***	–0.003
Female*Flood	–0.000	0.000	–0.001*	–0.001	0.001	0.000	–0.007	0.001
Female*Temperature	–0.002*	–0.000	0.001	0.004	–0.002**	–0.001	–0.089***	–0.005**
Female*FR	–0.001	–0.002	–0.001	–0.017	0.001	–0.001	–0.019	0.002
Female*FR*Drought	0.000	0.001***	0.001	0.020***	0.001*	–0.000	0.016*	–0.002
Female*FR*Cyclone	0.000	0.000	–0.000	0.005	0.001	–0.001	–0.022	0.004*
Female*FR*Rain	–0.000	0.000	–0.001	–0.012	0.003**	–0.002	–0.026	0.001
Female*FR*Flood	–0.000	0.001***	–0.001	–0.006	0.001*	–0.001	–0.007	0.004*
Female*FR*Temperature	–0.001	–0.001	0.000	–0.006	–0.002	–0.001	0.026*	–0.004
Other controls	Included	Included	Included	Included	Included	Included	Included	Included
No. obs	94396	89198	62881	64232	65767	69386	69068	100353
p-value (H0: variables jointly insignificant)	.000	.000	.000	.000	.000	.000	.000	.000

Source: Authors' estimations. *** 0.1% ** 1% * 5%

FR = Female representation (share of female in district assembly)

[a] Effects of one-standard deviation change of explanatory variables on one-standard deviation change in outcome variables.

Table 7. Rural – unmarried individuals (never have married at baseline in 2005) [a]

Variables	Membership	Personal acquaintance	Mobility	Mobility – health	Political participation	Intimate partner violence (less of)	Decision-making	Financial independence
Drought	–0.107***	0.014	0.031*	–0.003	0.044***	0.006	–0.045***	–0.002
Cyclone	–0.008	–0.031***	–0.021*	0.016	–0.030**	–0.033*	–0.020***	–0.015*
Rain anomaly	0.039*	–0.059***	–0.133***	–0.101***	–0.059**	–0.075**	0.093***	0.030*
Flood	–0.015*	0.000	0.010	–0.039***	–0.008	0.007	–0.021**	0.009
Temperature anomaly	–0.035*	–0.034*	0.002	–0.057***	–0.021	0.101***	0.043***	–0.005
FR	–0.087*	0.102**	–0.094*	0.008	0.092*	0.035	–0.019	–0.009
FR*Drought	0.026*	0.033***	0.034***	–0.012	0.059***	0.004	0.045***	0.007
FR*Cyclone	0.016	0.008	0.003	0.037**	0.056***	0.025	–0.031	–0.018
FR*Rain	0.014	–0.015	0.053*	0.060***	0.010	0.129***	–0.009	0.005
FR*Flood	–0.009	–0.006	0.024*	0.015	0.015	0.018	0.002	–0.020**
FR*Temperature	–0.002	0.024	0.006	–0.112	–0.005	–0.132	0.038*	0.060***
Female*Drought	0.005	–0.003	0.007	–0.006	–0.012**	0.008*	–0.017**	0.007*
Female*Cyclone	–0.004	0.001	0.008	0.009	–0.003	0.001	–0.014**	0.005
Female*Rain	–0.000	–0.000	–0.004	–0.023	0.012	–0.020*	0.101***	–0.006
Female*Flood	–0.003	–0.005	0.011**	–0.016*	0.013**	–0.007	0.001	0.004
Female*Temperature	\0.010	–0.017	0.025**	–0.045**	0.000	–0.007	0.098***	0.006
Female*FR	–0.005	0.013	0.022	–0.014	–0.003	0.014	0.013	0.025**
Female*FR*Drought	–0.002	0.009*	0.006	0.000	0.001	–0.006	0.026***	–0.003
Female*FR*Cyclone	0.001	–0.007	–0.002	0.018**	–0.011	0.010	–0.018	–0.008
Female*FR*Rain	–0.004	0.007	0.036**	0.000	–0.010	0.015	0.005	0.012
Female*FR*Flood	–0.001	0.008*	0.007	–0.006	0.008	0.003	0.003	–0.005
Female*FR*Temperature	–0.006	–0.003	–0.004	–0.030*	0.014	–0.028	0.029*	–0.005
Other controls	Included	Included	Included	Included	Included	Included	Included	Included
No. obs	92653	87962	63010	64589	64630	69538	67563	97536
p-value (H0: variables jointly insignificant)	.000	.000	.000	.000	.000	.000	.000	.000

Source: Authors' estimations. *** 0.1% ** 1% * 5%

FR = Female representation (share of female in district assembly)

[a] Effects of one-standard deviation change of explanatory variables on one-standard deviation change in outcome variables.

Table 8. Results among rural youth (15-34 years old) [a]

Variables	Membership	Personal acquaintance	Mobility	Mobility – health	Political participation	Intimate partner violence (less of)	Decision-making	Financial independence
Drought	–0.108***	0.024*	0.019	–0.025*	0.086***	0.012	–0.035***	–0.003
Cyclone	–0.004	–0.035***	–0.029**	0.009	–0.035***	–0.033**	–0.010	–0.032***
Rain anomaly	0.051**	–0.051**	–0.105***	–0.104***	–0.053*	–0.059*	0.108***	0.025*
Flood	–0.020*	0.002	0.000	–0.024*	0.003	0.014	–0.022**	0.001
Temperature anomaly	–0.040**	–0.044**	–0.012	–0.019	–0.024	0.130***	0.018	–0.010
FR	–0.099**	0.092**	–0.115**	0.042	0.053	0.088*	–0.003	0.006
FR*Drought	0.022*	0.023**	0.034***	–0.022	0.047***	0.007	0.035***	0.002
FR*Cyclone	0.014	0.024*	0.014	0.027*	0.079***	0.036*	–0.042	0.007
FR*Rain	0.011	–0.015	0.031	0.048*	0.022	0.136***	–0.030	0.008
FR*Flood	–0.015	–0.008	0.027*	0.010	0.004	0.038**	–0.007	–0.011
FR*Temperature	0.014	0.022	0.021	–0.128	0.006	–0.157	0.041*	0.053**
Female*Drought	–0.003	–0.011**	0.002	0.008	–0.005	–0.005	–0.017**	–0.003
Female*Cyclone	0.004	0.007	–0.001	–0.006	–0.006	–0.011*	0.006	–0.009
Female*Rain	0.012	–0.002	0.021	–0.027**	–0.008	–0.008	–0.107***	–0.029***
Female*Flood	0.000	0.001	0.001	–0.008	0.001	–0.010*	0.006	0.006*
Female*Temperature	–0.014*	–0.015	0.005	–0.016	–0.007	–0.002	–0.084***	–0.030***
Female*FR	–0.024*	–0.033**	0.048**	0.065**	–0.003	–0.023	–0.004	–0.043**
Female*FR*Drought	0.001	0.014**	–0.007	–0.005	–0.002	0.010*	0.019**	0.004
Female*FR*Cyclone	–0.011	–0.003	–0.002	0.028***	0.002	0.013*	–0.020*	0.011
Female*FR*Rain	–0.001	0.014*	–0.032**	–0.022	0.000	0.032**	–0.023	0.002
Female*FR*Flood	–0.003	0.006	0.007	0.001	–0.011	0.019**	–0.009	–0.001
Female*FR*Temperature	0.007	0.001	–0.004	–0.054	0.010	–0.021	0.036*	0.030**
Other controls	Included	Included	Included	Included	Included	Included	Included	Included
No. obs	56559	53507	37967	39087	39579	42190	41477	61937
p-value (H0: variables jointly insignificant)	.000	.000	.000	.000	.000	.000	.000	.000

Source: Authors' estimations. *** 0.1% ** 1% * 5%

FR = Female representation (share of female in district assembly)

[a] Effects of one-standard deviation change of explanatory variables on one-standard deviation change in outcome variables.

Table 9. Results among rural non-youth (35 years old or above) [a]

Variables	Membership	Personal acquaintance	Mobility	Mobility – health	Political participation	Intimate partner violence (less of)	Decision-making	Financial independence
Drought	–0.101***	0.038***	0.013	–0.048***	0.050***	0.014	–0.042***	0.005
Cyclone	–0.019*	–0.039***	–0.028**	0.037***	–0.027**	–0.026*	–0.014*	–0.021***
Rain anomaly	0.040*	–0.049**	–0.141***	–0.075***	–0.071**	–0.069**	0.074***	0.012
Flood	–0.021**	–0.001	0.005	–0.027***	–0.012	–0.007	–0.018*	0.005
Temperature anomaly	–0.051***	–0.027	–0.002	–0.029	–0.040*	0.113***	0.023*	–0.019
FR	–0.045	0.127***	–0.117	–0.034	0.095*	0.000	–0.007	0.032
FR*Drought	0.017*	0.005	0.039***	–0.016	0.054***	–0.005	0.030**	0.003
FR*Cyclone	0.039***	0.023*	0.013	–0.005	0.070***	0.031	–0.037	–0.010
FR*Rain	0.015	–0.026	0.024	0.045*	–0.006	0.117***	–0.039	–0.001
FR*Flood	0.002	–0.006	0.014	0.017*	0.019	0.029*	–0.015	–0.009
FR*Temperature	–0.006	0.027	0.027	–0.066	0.013	–0.141	0.048**	0.041**
Female*Drought	0.002	–0.003	–0.001	0.002	–0.005	0.002	–0.018***	0.004
Female*Cyclone	–0.005*	–0.002	–0.007*	0.005	0.005	0.003	–0.009*	0.004
Female*Rain	–0.011**	0.000	–0.001	–0.010	0.008	–0.011	–0.091***	–0.015***
Female*Flood	–0.000	–0.001	0.004	–0.007	–0.003	–0.007**	0.008	0.005
Female*Temperature	0.002	–0.004	0.003	–0.023*	–0.012*	0.007	0.070***	–0.001
Female*FR	–0.003	0.009	–0.010	0.004	0.036***	0.024*	0.024	–0.001
Female*FR*Drought	0.001	0.000	0.004	–0.019**	0.005	–0.007	0.016*	–0.001
Female*FR*Cyclone	0.008*	0.004	–0.007	0.001	0.000	–0.004	–0.022***	0.001
Female*FR*Rain	0.009	–0.004	–0.007	0.003	–0.021**	–0.003	–0.033**	0.002
Female*FR*Flood	0.005	0.005	–0.001	0.005	0.010*	0.002	–0.008	0.000
Female*FR*Temperature	–0.004	–0.002	0.012	–0.008	–0.006	–0.020*	0.029*	–0.010
Other controls	Included	Included	Included	Included	Included	Included	Included	Included
No. obs	67341	63786	42193	42803	43409	46289	45549	68816
p-value (H0: variables jointly insignificant)	.000	.000	.000	.000	.000	.000	.000	.000

Source: Authors' estimations. *** 0.1% ** 1% * 5%

FR = Female representation (share of female in district assembly)

[a] Effects of one-standard deviation change of explanatory variables on one-standard deviation change in outcome variables.

Table 10. Effects of climate change on various VABH related outcomes, and their differences across gender, based on World Values Survey data [a]

Variables	Membership	Political participation	Confidence in politics	Intimate partner violence (less of)	Decision-making	Financial independence	Welzel voice sub-index
Drought	–0.073	–0.227	0.306***	–0.093	–0.004	0.112	0.106
Cyclone	–0.077	–0.318	–0.139	0.022	0.006	0.160*	–0.158
Rain anomaly	–0.319*	–0.316*	0.177*	–0.166	0.223	0.025	–0.111
Flood	0.186	0.026	–0.397***	–0.145	–0.215**	0.100	0.074
Temperature anomaly	–0.099	–0.055	–0.284**	–0.220	0.241	0.195*	–0.293*
FR	–0.149	0.146	0.680***	0.231	–0.034	–0.479	0.083
FR*Drought	0.087	–0.160	0.187*	–0.039	–0.059	0.298**	0.121
FR*Cyclone	–0.042	–0.134	–0.303**	0.162	–0.035	0.281*	–0.392
FR*Rain	–0.032	–0.064	0.041	–0.059	0.148	–0.004	–0.096
FR*Flood	0.344***	–0.176	0.376***	0.165*	–0.133	0.273***	0.003
FR*Temperature	–0.006	0.029	–0.198	0.326*	0.164	–0.155	0.217*
Female*Drought	0.020	–0.086	0.038	0.044	–0.181*	0.019	0.044
Female*Cyclone	0.035	0.169	0.003	–0.083	0.003	0.178	–0.033
Female*Rain	0.061	0.069	0.093	0.021	0.028	0.110	–0.033
Female*Flood	0.059	0.048	–0.145**	–0.010	–0.031	0.006	0.030
Female*Temperature	0.074	0.099	–0.103*	–0.054	0.135	–0.058	–0.059
Female*FR	0.229	0.107	0.025	–0.040	0.012	0.082	0.012
Female*FR*Drought	0.089	–0.099	0.158**	–0.051	–0.145	0.035	–0.000
Female*FR*Cyclone	0.144	0.353**	–0.036	–0.158	0.097	0.228	–0.029
Female*FR*Rain	0.103	0.097	0.132*	0.018	–0.023	0.116	–0.003
Female*FR*Flood	0.078	–0.106	–0.037	–0.009	–0.002	–0.051	–0.038
Female*FR*Temperature	–0.052	–0.013	–0.063	0.084	0.058	–0.095	0.004
Other controls	Included	Included	Included	Included	Included	Included	Included
No. obs	4676	3448	5392	4722	4255	3946	6659
p-value (H0: variables jointly insignificant)	.000	.000	.000	.000	.000	.000	.000

Source: Authors' estimations. *** 0.1% ** 1% * 5%

FR = Female representation (share of female in district assembly)

[a] Effects of one-standard deviation change of explanatory variables on one-standard deviation change in outcome variables.

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