MHT

WOMEN'S ACTION TOWARDS CLIMATE RESILIENCE OF URBAN POOR IN SOUTH ASIA: PROJECT EVALUATION REPORT

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Vol 1 : Quantitative Research Report

Abstract

In seven cities of South Asia, women from slum communities have undertaken climate vulnerability assessments as well as developed and implemented resilience action plans as part of the Global Resilience Partnership (GRP) project. This evaluation report documents the impacts of the project on climate resilience within these communities.

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1. Introduction

1.1. Project Overview

The "Women-led Resilience Building of Urban Poor in South Asia" project was developed by Mahila Housing SEWA Trust (MHT) and its partners as a part of the Global Resilience Partnership (GRP) challenge. The project aimed to build the resilience capacities of 25000 low income families living in slums/informal settlements in seven cities of South Asia, to take the lead in action against four climate risks. These four climate stressors **(a) heat waves; (b) flooding and inundation; (c) water scarcity; and (d) increased climate change-related incidence of water and vector borne diseases;** are slower-onset and less apparent, often impacting the poor most but attract less attention compared to disasters and extreme events.

Resilience Capacities is defined as ability of communities to survive, adapt and progress in the face of stress, without distress or loss of assets. We aim to build capacities which will be evolutionary in nature with an increase in risk retention capacities; improved access to basic services (like water, sanitation, adequate shelter and health) and a continued effort to transform to a

The project worked to create an integrated model wherein women take a lead through collective action and technology incubation, to devise locally relevant pro-poor and gender sensitive climate resilient solutions and promote a culture of sustainable development and resilience among the urban poor in South Asia.

Success for this project meant a demonstration of how women-led initiatives build the necessary social capital, policy influence, technical expertise, for poor urban communities to respond effectively to climate change, thereby sustaining their health and livelihood options. The project worked to do achieve this by significantly changing;

1. The knowledge and behaviour of slum communities, particularly women, to better understand the inherent climate risks so that they plan and make investments with strong consideration for the future, to improve their standards of living and resilience.
2. The sphere of influence of women leaders and slum communities within the city governance systems to enable policies and programs which include the concerns of the poor.

1.2. Design of Programmatic Intervention

The project intervened in seven cities within three nations. These cities fall into three categories: established cities (which have well-established networks of women leaders in both the informal settlements and citywide, emergent out of MHT's long history of intervention, i.e., Ahmedabad); emergent cities (which are in the process of establishing networks of women leaders at both the informal settlement and city levels, emergent out of MHT's shorter history of working in these cities (i.e., Jaipur, Bhopal and Ranchi); and partner cities, which contain neither an established network of women leaders nor an existing NGO with experience in creating such networks, where MHT is training local partner NGOs in the application of its community-based model for capacity-building (i.e., Dhaka (Bangladesh), Katmandu (Nepal) and Bhubaneshwar (India)).

The project thus intervened into seven cities in the following conditions:

- **Established**:

  Ahmedabad (India)
- **Emergent**:

  Jaipur,

  Bhopal and

  Ranchi (India)
- **Partner**:

  Dhaka (Bangladesh),

  Kathmandu (Nepal) and

  Bhubaneswar (India)

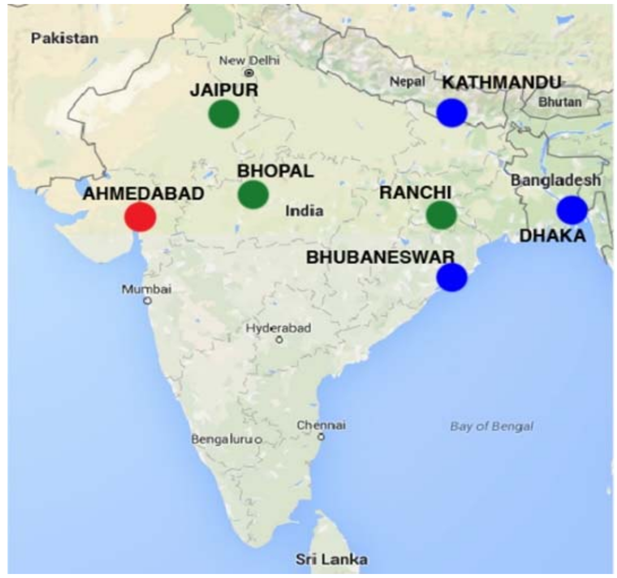


Figure 1: Project Cities

The following programmatic interventions were designed to achieve the changes indicated above:

Creation of Community Action Groups (CAGs): The project formed 100 CAGs at slum levels by training 1,200 women and youth leaders to act as local community advocates and climate specialists on climate risk, surveillance and vulnerability assessment, collective response action and technical solutions. In the four established and emergent cities, MHT worked with CAGs to form Vikasinis (city-level women led federation of CAGs) which will represent the voice of 125,000 people in their slum communities in discussion with local government and technical groups.

Surveillance and Vulnerability assessment: A household level Community Based Vulnerability Assessment toolkit (CBVAT) calculator was developed and administered to more than 5,000 families through CAG trainings, workshops and surveys.

Climate Risk Communication and Training to Urban Poor toolkit: Local videos and audio programmes on climate change, incorporating local knowledge, expert guidance and technical scientific knowledge were disseminated through audio podcast through IVR mobile applications including videos for smart phone users. The IVR based model included a call-back facility to help communities share their issues and feedback.

Improved investment practices and social capital development: The project focused on building increased knowledge-seeking behaviour of 15,000 women and their families on climate risk and available solutions. It incentivized (financially and non-financially) communities to invest in resilience with support of credit organizations for adoption of gender sensitive resilience technologies.

Pro-poor and Gender sensitive technologies: A compendium of pro-poor, gender sensitive climate resilient solutions, customized and validated by community groups, was developed and made as a catalogue, with city-level recommendation. The catalogue included: a wide range of technologies that promote climate resilience (including indigenous technologies), an online database of community developed videos of successful demonstration of technologies, and the design and piloting of financial products (savings, credits and insurance) for making technology accessible to poor.

1.3. Theory of Change

The project builds upon the conviction that if the urban poor are provided with the requisite knowledge to undertake vulnerability and risk assessments and are equipped with available resilient-technologies, they will be able to devise and implement locally relevant and pro-poor climate resilient solutions. Moreover, if the poor are empowered to implement their own resilience plans, and the institutional mechanisms representing their voices are in place, they will be able to better influence city planning and governance on pro-poor adaptation and resilience action. Our model focuses on building the capacities of the community themselves to take action and prepare for future climate risks.

Figure 2: Core Model

More specifically, the model of change posits seven key expectations that serve both to shape the intervention and to focus the evaluation. These are as follows:

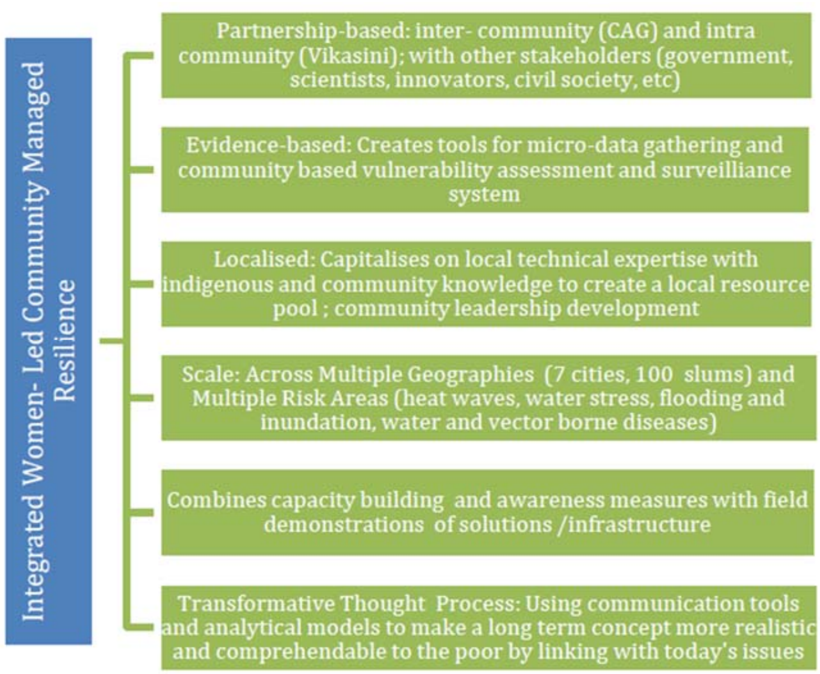


Figure 3: Elements of Intervention

1. Resilience in informal settlements requires coordinated action at the slum, community and city level. Therefore, leadership works best when it is developed and interacts at all these levels. This includes development of effective leadership within individual slums (Community Action Groups) and citywide leagues of CAG leaders (Vikasinis), as well as enabling and liaisoning between technical and governmental stakeholders and community leaders. MHT will identify barriers and facilitate knowledge transfer amongst each of these groups.
2. Resilience in informal settlements requires coordinated action amongst many local actors over time. Leadership will not be effective if it is too concentrated amongst a few members of the slum community, or not maintained over time. Therefore each communities' leadership must work within their community with different communication tools to share knowledge and understanding of possible paths to resiliency.

3. **3.** Scientific Knowledge sharing to communities requires systematic, repeated and innovative communication tools to enable future-oriented thinking, especially with communities which are used to thinking short-term. Tools for accomplishing this include basic climate change training and advanced training modules for educating community “consultants” who in turn provide advice to other community members.
4. **4.** Community-based data collection leads to an increased understanding of the community’s vulnerabilities and opportunities for action, thereby leading to more resilient actions and investments. Vulnerability assessment and surveillance, sharing the results with the community and making it available at the city level, provide incentives and a basis for decision making.
5. **5.** Technologies to promote resilience fail not only because they are not cost effective but also the supply is not market enabled. Therefore, demonstration projects must be linked to creation of markets for suppliers through partnering with providers and developing private or community investment sources (community level action plans directly taken by the community, government action, or micro-lending supports)
6. **6.** Facilitating interactions between communities and technical experts enhances the capacity of both to communicate clearly and develop mutually agreeable solutions to resilience problems. This involves direct contact, identification of legitimate concerns of all partners, outreach to technical experts, and media.
7. **7.** Empowering women for advocating in a non-confrontational/collaborative manner increases municipal support to address resilience needs. This involves Local Coordinators helping Vikasini to interact at the city level, strategies to reach out to Municipal Corporations, and strategies for media relations and data sharing.

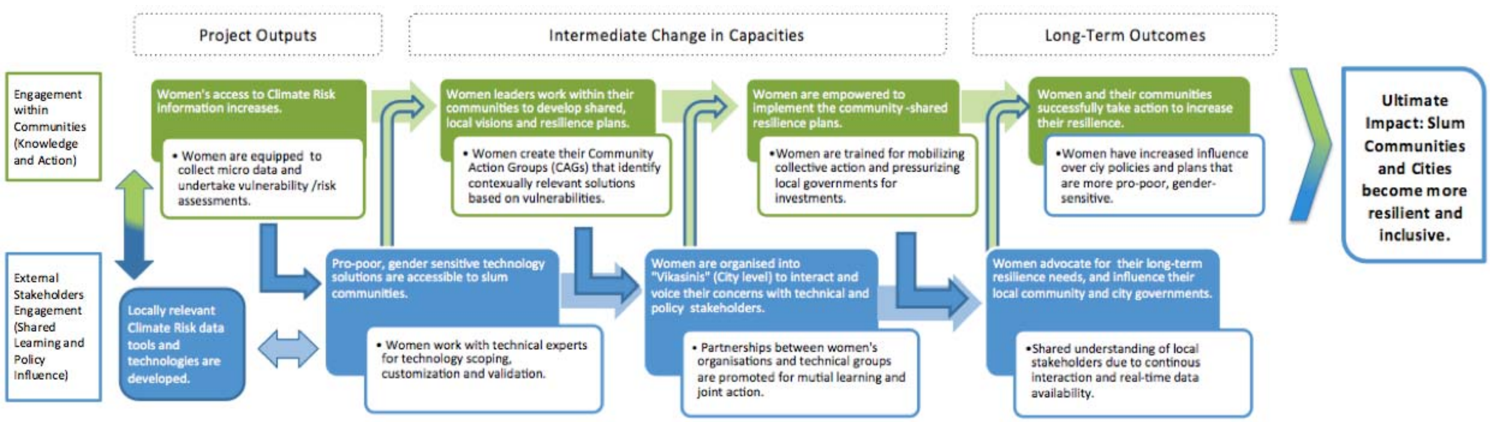


Figure 4: Diagram of Model of Change

1.4. Scale of Interventions

This project operated at three scales: city level, slum level and household level. Before discussing the research methodology used in this assessment and its results, we will first clarify the context of our work at these three scales.

City

The term “City” has been used to connote the total area which is covered as part of the city municipal corporation as well as peri-urban areas which are typically covered under a parastatal body called the (city) urban development authority. For example, Ahmedabad city would include the area covered under Ahmedabad Municipal Corporation (AMC) as well as the periphery areas around AMC which are being developed and managed by Ahmedabad Urban Development Authority (AUDA).

As noted above, the project is being implemented in seven cities of South Asia: Ahmedabad, Bhopal, Bhubhaneshwar, Jaipur and Ranchi in India; Dhaka in Bangladesh and Kathmandu in Nepal. Most of these cities are regional (or State) capitals, emerging as strong economic hubs within their respective region, and are therefore subject to high ongoing and future in-migration. A significant percentage of the population of each city resides in slums.

All seven cities are in either the Central India belt or corresponding climatic zones in Bangladesh or Nepal. Only one of the seven cities is prone to climate-related shocks (Bhubhaneshwar is prone to cyclones) but all are extremely vulnerable to ongoing climate related stresses.

While Ahmedabad has been the most progressive in its efforts to promote slum development, the other cities are also striving to improve slum development and enhance quality of life for the urban poor.

MHT involvement in these cities varies considerably. MHT has been active in Ahmedabad over two decades. Ahmedabad therefore has strong community-based institutions supported by well-established MHT operations. MHT also enjoys a strong rapport with the local city government here. Within the context of this project, Ahmedabad is an "Established City" in the sense that the city already has a well-established social capital base for resilience work.

Jaipur, Bhopal and Ranchi are three other cities in India wherein MHT has begun work over the last few years. While some progress has been made, slums in these cities are only beginning to be organized and citywide collaboration amongst the urban poor remains weak. In the context of this project, these cities are "Emergent cities" in the sense that social capital within the cities is emerging from current work. Resilience work will be the nucleus of community organizing in these cities, thereby contributing to and growing from improvements in social capital.

Finally, MHT is not actively working on the ground in Bhubhaneswar, Dhaka and Kathmandu. In these communities, MHT is partnering with local NGOs and CBOs who work on climate change and resiliency issues and wish to adapt MHT's social capital models to local conditions. The project is therefore testing the transferability of the model to local partners in other cities. These cities have been termed as "Partnered cities".

While the overall evaluation looks at all three types of cities, this quantitative assessment was conducted only in established and emergent cities. In addition, since all slums in Jaipur, Bhopal and Ranchi are emergent slums (slums with little prior community organization and MHT activity) while project slums in Ahmedabad are evenly split between established slums (ones with a CBO already organized) and emergent slums (slums where MHT began organizing through the GRP project), the surveys are over-weighted to Ahmedabad. This has been done mainly to be able to test the theory of change in the specific context of the project, which is that increased social capital can lead to better resilience action. Thus it was essential that the evaluation components aimed at understanding individual and slum-level change identify slums possessing different levels of social capital prior to the interventions. Since project interventions in the partnered cities were limited to working with partners and did not involve slum level work, and given the short duration of the project, these cities were not covered in the baseline and endline surveys.

Slum

The term "slum" has multiple definitions in international and national parlance. UN Habitat defines slums as an urban area typically being deprived of one or more shelter-related conditions, including durable housing, sufficient living space, access to safe water and sanitation, and security of tenure. The Census of India defines slums as residential areas unfit for human habitations by reasons of dilapidation, overcrowding, arrangements or design of buildings and streets, or lack of ventilation and light which are detrimental to the safety and health. In India, slums can be notified (governed under the national Slum Act), recognized (acknowledged as slums by state and local officials but not directly governed under the Slum Act), or identified (any area that is neither notified nor recognized but which consists of compact areas of at least 300 population or about 60 to 70 households of poorly built, congested tenements in unhygienic environments, usually with inadequate infrastructure and lacking in proper sanitary and drinking water facilities).

Local development plans and policies like the Urban Health Plans go further to define slums as neighbourhoods characterised by lower incomes, lacking quality housing and basic services and unhygienic living conditions. Ahmedabad Health Action Plan's definition of slums includes not only recognized slums, but also chawls, gamtals, newly merged villages, walled city areas, and other neighborhood characterized by lower incomes, lack of quality housing and basic services, and unhygienic living conditions.

In the areas that are considered under GRP project, over 55% of the region's slum households have one or two shelter deprivations, 22.6% suffer from three shelter deprivations, and 16% lack four or more basic shelter needs. This last group, in particular, live in extremely poor conditions. Generally, the lack of sanitation and water in the area are compounded by insufficient living space for families and inadequate, makeshift housing.

MHT works beyond "recognised" slums and includes areas like chawls and low income housing societies. Most of these areas lack access to secure land tenure systems with a constant threat of eviction, although actual eviction is not common. The tenure systems in these areas are also very complicated, ranging from completely illegal residences to incremental tenure security systems (such as properties recognized in municipal property tax systems or with land lease or no-eviction certificates from the government). Most of the residences are poorly constructed and lack basic amenities like water supply and sanitation. Even when available, provision of water and sanitation are often inadequate and of poor quality. For example, even with individual water connections available, a typical household would not receive water supply for more than 2 to 3 hours every day and would typically face significant reductions in water supply during summers. The quality of water available in the areas is also an issue, as most areas either lack sewage systems or have frequent breakage leading to mixing of sewage water with water supply lines. Storm water drainage systems are also often non-existent or clogged (due to lack of solid waste management) leading to water logging in monsoons. Inefficient living spaces (with 5 to 6 people sharing a home) and lack of ventilation due to the high population density in the neighbourhoods are also common phenomena.

The residents are mostly low-income communities working in the informal sector as daily wage labourers, construction workers, iron smiths, tailors, embroiderers, domestic help, bamboo basket makers, necklace makers, sweepers and rag pickers, vegetable and food vendors, or sellers in clothes markets and home-based workers (papad, agarbatti makers). Some also work in factories, or as autodrivers, plumbers, masons, electricians, etc. Most of them lack access to secure incomes or to any form of social security.

Typically, a slum in India would constitute a group of people living in unhygienic conditions and constantly struggling and fighting for access to basic services, especially water. (This condition is so common it is reflected in government advertisements for housing schemes). Literacy within these families is low. Households also suffer due to a lack of social capital.

2. Evaluation Design

2.1. Research Overview

A critical outcome of the project was to increase evidence-based advocacy and decision-making on resilience issues at the city level. To achieve this outcome, the project incorporated a strong monitoring and evaluation component. This was designed primarily to answer the following three questions in mind:

(1) Does the model of change and corresponding interventions improve resiliency in slums with existing internal and citywide social networks?

(2) Can the model be used to simultaneously build such networks and to improve resilience within the slum communities that currently lack internal and citywide social networks?

(3) Can the model be transferred to other NGOs for implementation in cities where MHT does not work?

3. Research Methodology, Baseline - Endline Assessment

3.1. Intervention Slums

Slums were selected for inclusion in the project based on a dearth of basic amenities within the slums and to provide diversity in the level of pre-existing social capital. This was verified based on a slum profile developed interactively with slum residents, focused on level of individual water supply connections, sanitation, housing pattern and existence of a Community Action Group (CAG). Altogether, 100 slums were identified for intervention, as shown in Table 1 below.

3.2. Stratified Sampling Technique, Slum Selection – HHs selection – Baseline, Endline

The baseline survey was designed to provide baseline data from which post-intervention changes could be compared. While baseline conditions are measured at the household level, interventions occur primarily at the slum-level. The household to be interviewed were therefore selected using a stratified random sample method, with slums randomly selected for inclusion, then individual households within each slum randomly sampled from the households living in each slum.

The study was undertaken to evaluate the effect of the intervention on climate vulnerability. The same HHs that were surveyed during the baseline were re-surveyed for the Endline survey. The baseline survey was conducted in June - December 2016 with the sample size of 1241 HHs. The Endline survey was conducted in October - December 2017 with the sample size of 996 HHs.

19.7% of the sample pre-intervention survey could not be found or declined to participate in the post-intervention survey. No pattern to the missing households could be identified, and the number of slums which were included in the baseline remained unchanged. The detailed account of sampled HHs in Baseline and Endline by City, Slum type and Treatment type is given in table 2.

Table 1. Treatment Type and Sample Slums, by City Baseline

City	Slum Type	Treatment Slums in Sample				Control Slums in Sample	
		No. of Slums	No. of CAG Households per Slum	No. of Non-CAG Households per Slum	Total No. of Households	No. of Slums	No. of Households
Ahmedabad	Established	10	10	15	250	10	150
	Emergent	10	10	15	250		
Jaipur	Emergent	5	10	15	125	5	75
Bhopal	Emergent	5	10	15	125	5	75
Ranchi	Emergent	5	10	15	125	5	75
					875		375

Sixty informal settlement communities from the four cities were included in the study. The intervention slums were categorized into two types; 1. Established slum and 2. Emerging slum. Established slums are the slums where MHT is working for more than 10 years and Emergent slums are ones where MHT had either recently began work or became operational as a result of this project.

Table 2: No. of Sampled HHs by City, Slum type and Treatment Type for Baseline and Endline survey

		Baseline (Count)			Endline (Count)		
City	Slum Type	Treatment HHs		Control HHs	Treatment HHs		Control HHs
		CAG HHs	Non-CAG HHs		CAG HHs	Non-CAG HHs	
Ahmedabad	Established	94	150	150	83	108	125
	Emergent	98	150		86	92	
Jaipur	Emergent	49	75	75	43	57	60
Bhopal	Emergent	50	75	75	48	54	69
Ranchi	Emergent	50	75	75	46	69	56
Total		341	525	375	306	380	310

The missing 19.7% of HHs in the endline survey are a result of one of four conditions:

1. The same respondent was not available,*

2. Relocation of family – (Within slum/city/to other city),

3. Challenges in relocating the same Household, or

4. Woman head of household declined to participate in the survey.

(*The House was visited several to survey the same respondent before dropping that HHs from the sample)

3.3. Risk, Susceptibility and Vulnerabilities

In addition to demographic data, the questionnaires included variables to calculate scores for household climate vulnerability. These vulnerability scores are based on risk (potential exposure to climate change hazard) and susceptibility (incapacity to access financial and social capital resources needed to cope with hazards either by preventative investments or coping strategies).

Five risk and two susceptibility scores have been constructed for each of the surveyed households.

The risk scores included:

1. Heat stress
2. Water adequacy/quantity,
3. Water quality,
4. Flooding and
5. Vector-borne disease risks.

The susceptibility scores included:

1. Financial capital** and
2. Social capital.

(**Financial capital was not calculate for the Endline, considering that there will not be significant change in financial status in a year)

The risks and susceptibility scores were developed from the household survey data, and standardized to a 0 to 10 scale. Each scale indicates the household's liability to be adversely affected by the climate risk or their precariousness due to socio economic conditions. Scale value of "0" indicates lower risk/susceptibility, a "5" indicates average risk/susceptibility, and "10" indicates higher risk/susceptibility. The level of risk or susceptibility indicated by these scores are relative measures, measured along the lines of typical risks and susceptibilities faced by urban poor in South Asia. Even slum dwellers with "lower" risk or vulnerability remain at significant risk compared to wealthier South Asia residents, and especially compared to most residents of more developed nations located in more temperate climates. We used these Risks and Susceptibility scores to classify households into low, moderate and severely vulnerable.

3.4. Calculating Risk Stress, Susceptibility, and Vulnerability Scores

Sixty-one questions were used to calculate the risks and susceptibilities. The remainder of the surveys were used to document general demographic backgrounds and conditions of interest to the project.

Accessibility, availability and adequacy of different types of resources, facilities and services in slum communities differ from more wealthy urban communities. Thus, the presence or absence of a particular service or facility and its impacts on the household's vulnerability is calculated relative to general slum community conditions. For example, while the possession of a motor scooter is a common attribute of urban middle-income group family, the possession of a motor scooter in a slum community indicates a relatively sound financial state.

Below is a sample of the variables used to calculate risk and susceptibility scales.

Table 3: Examples of Indicators Used to Construct Risk and Susceptibility Scales

Risk					Susceptibility	
Heat stress	Water quantity	Water quality	Flooding	Health	Financial	Social capital
Type of house, Type of Roof	Main source of water	Source of water	Incidences of House and street flooding	Incidence of malaria and dengue	Average family income	Type of family, caste, literacy, education
Type of cooking fuel	Discontinuity in the water supply	Water purification practice	Loss of property due to flooding	Use of window screens or mosquito nets to block mosquitoes	Household assets	CC awareness, feel in change of climatic condition
Number of doors and windows, ventilation	Purchase of water	Water contaminat ion due to sewage overflow	Children missed school due to flooding	Domestic water storage container	House ownership	Involvement in CBO, participation in training, benefits from government

These and other relevant variables were compared and discussed by the investigating researchers to determine the degree to which the variable contributes to the relevant risk or susceptibility. The values given to varying conditions within each risk or susceptibility scale were designed to indicate the relative contribution of the variable to the risk or susceptibility, such that higher values indicated more risk or susceptibility. The scores implicitly weighted both the magnitude and the significance of each variable relative to all other variables. The variable scores within each group were summed to produce a total risk or susceptibility scale. The totals were then standardized to 0 to 10 scales based on either setting 10 at a threshold determined to be highest risk or at the highest score found within the sample.

Risk Scales

Generally, the risk and susceptibility scales were calculated as follows:

Heat stress

Heat stress vulnerability is function of a heat gain and heat retention associated with the structural properties or a household's residence. Heat gain score is the measure of the residence's heat resistance and transmission capacity (R-values and U-values, as determined by http://www.inspectapedia.com/heat/HVAC_Definitions.php#RValue and similar sources) of the building material, including type of house, roofing and walls. Tin roofs without underlayment created the greatest risk. The heat score also included other sources of heat, including the impact of overcrowding (person/room) and type of cooking fuel. Heat retention factor is the measure of capacity of the residence to cool by means of ventilation (number and location of doors and windows) and electric fans. See Appendix 2 for the full list of variables and calculations.

Water quantity

Variables used to calculate water availability (quantity) include direct indications by the respondent as to water availability, both generally and seasonally, as well as indirect measures indicating the main source of water, presence/absence of a motorized pump, and the type of flush and bathroom facility. For example, households with a municipal water line connection within their house are presumed to receive sufficient water regularly (score of 1, least vulnerable), whereas households who must fetch their water from a neighboring community are more vulnerable (score of 4, more vulnerable). In the same context, households that use motorized pumps to suction water from the supply line are less vulnerable because they are capable of extracting sufficient amounts of water in case of limited supply hours or low water pressure. (Note, the measures of vulnerability are estimated at the individual household level; while use of pumps decreases the household's vulnerability, it increases vulnerability of neighboring residents who lack a pump).

Water Quality

Water quality is measured based on the respondent's perception and experiences. Variables considered include the respondent's perception of the quality of water available, whether water ever gets contaminated due to mixing with the sewage water, etc. Questions such as these directly reflect the status of water quality.

Flooding

Flooding risk was calculated primarily based on HHs experience about street and house flooding. It also envisages variables like loss of property or raw material, missed days of work and school for children. Higher score was given for *loss of property or raw material* variable, because this tends to lead to financial crisis as well.

Vector-borne Diseases

Vector-borne disease risk was calculated based on the family's medical history of malaria and dengue, the use of mosquito nets and screens to block access of mosquitoes, and total number of containers used for storing water for domestic use. Members of HHs who have suffered from both malaria and dengue are more at risk. The use of mosquito nets and/screens to block access of mosquitoes reduce the health risk. Water storage containers provide opportunity for breeding, thereby increasing risk.

Susceptibility Scales

Susceptibility scales were calculated as follows:

Financial Susceptibility

Financial susceptibility is based on four components: 1. household income, 2. house ownership and tenure status, 3. structural/physical properties of house, and 4. Assets and durable goods owned by the household. Income encompasses household income relative to the poverty line, number of employed household members, and type of occupation. Housing status is measured through tenure (ownership of land, certifications for tenure rights, payment of household tax, etc.) and type of house. Assets and durable goods are measured as the possession or lack thereof of 18 assets. Each of the four components were scaled from 0 to 10, then combined into a single scale with income weighted 40%, house ownership and tenure status 17.5%, structural/physical properties of house 17.5%, and assets and durable goods 25%.

Social Capital Susceptibility

Social capital susceptibility is measured with three components: 1. General social capital, 2. Climate change awareness social capital and 3. Community governance social capital. General social capital includes variables associated with the household's caste and education, dependency ratio, marital status, residence time in city, etc. Climate change awareness social capital is based on respondent's experience with, understanding of, and perception about climate change. Community governance social capital measures whether the community has a CBO, the respondent's perception of how well it works, participation in the CBO by the respondent, and similar measures. The three components are combined into a single scale of overall social capital susceptibility with equal weightings.

Vulnerability Assessment

Vulnerability to climate change is seen as the potential for exposure to health-threatening changes (risks) linked to the lack of resources needed to resist these changes (susceptibility). For purposes of analysis, the research team ranked households by their degree of vulnerability: low, moderate and high. Households were determined to be at moderate or high vulnerability if either their social or financial capital susceptibility is above the group mean AND the household was exposed to above average risks in less than two (low vulnerability), two (moderate vulnerability), or more (high vulnerability) of the five risk categories.

On scales of 0 to 10, we used a cut-off score of 5 for all the climate risk factors, 6 for social capital susceptibility and 7 for financial capital susceptibility. These scores were closest whole numbers to group means for each of these risks and vulnerabilities. Those households which scored higher than these cut-offs were considered to be more significantly risk-exposed and socially/financially susceptible.

4. Socio-Demographic Characteristics of Sampled Population

4.1. Characteristics of Baseline Respondent Households

The survey was conducted in urban poor communities across 4 cities, namely; Ahmedabad, Bhopal, Jaipur and Ranchi. As noted above, households living in urban poor informal settlements (slums) were sampled. For sampled households, the female head of the HHs were surveyed. Over 90% of households sampled responded to the Baseline survey. Nonresponding households were replaced with another household randomly selected from the same slum.

Table 4 provides the descriptive statistics related to the background demographics of the sampled population.

Sixty percent of the respondents were between 30 to 50 years of age; 93.7% were married. Caste composition of surveyed households compared reasonably closely to the 2011 Census of India except for the Schedule tribe caste, with surveyed household population of STs being higher by 7.4 %. Almost half of the women did not go to school. More than 70% of the households reported monthly incomes between Rs. 5,000 to 20,000 and 37.2% of them possessed below-poverty-line (BPL) cards which indicate that they were poor and eligible for state subsidies. Nearly 90% of the households reported that they owned their homes and 76.8% of them are residing in their city for more than 15 years.

Table 4: Socio-Demographic Characteristics of Sampled Population – Baseline (1241), by Membership in CAG

		Ahmedabad					Bhopal, Jaipur & Ranchi			Total
		Established		Emergent		Control	Emergent		Control	
		CAG	Non CAG	CAG	Non CAG		CAG	Non CAG		
Age of the Respondent	Up to 20	12.8%	0.0%	11.2%	0.0%	1.3%	5.4%	1.8%	.9%	3.1%
	21-30	10.6%	16.0%	12.2%	15.3%	11.3%	32.2%	32.4%	25.3%	21.3%
	31-40	26.6%	32.7%	32.7%	38.7%	39.3%	38.9%	40.4%	38.7%	37.0%
	41-50	31.9%	28.0%	22.4%	31.3%	16.0%	18.8%	20.9%	24.0%	23.7%
	51 & above	18.1%	23.3%	21.4%	14.7%	32.0%	4.7%	4.4%	11.1%	14.9%
Marital status	Married	85.1%	99.3%	86.7%	99.3%	94.0%	87.2%	98.2%	97.3%	94.6%
	Unmarried	14.9%	.7%	10.2%	0.0%	6.0%	10.7%	1.8%	2.7%	4.8%
	Separated	0.0%	0.0%	1.0%	.7%	0.0%	.7%	0.0%	0.0%	.2%
	Divorced	0.0%	0.0%	2.0%	0.0%	0.0%	1.3%	0.0%	0.0%	.3%
Caste composition	General	35.1%	4.0%	43.9%	5.3%	6.0%	19.5%	11.6%	28.4%	17.6%
	Other backward class	42.6%	62.0%	43.9%	65.3%	54.7%	32.2%	38.7%	33.3%	45.6%
	Scheduled castes	14.9%	22.0%	8.2%	22.0%	28.7%	28.9%	19.1%	17.3%	20.6%
	Scheduled tribes	7.4%	12.0%	4.1%	7.3%	10.7%	19.5%	30.7%	20.9%	16.2%
Education	Didn't go to school	29.8%	64.0%	25.5%	56.0%	52.0%	36.9%	44.0%	40.0%	44.7%
	Primary (up to 5th class or below)	28.7%	22.7%	15.3%	20.7%	24.0%	10.1%	28.9%	20.0%	21.6%
	Secondary (up to10th)	28.7%	7.3%	48.0%	18.0%	12.0%	41.6%	20.9%	25.8%	23.9%
	Higher secondary (up to 12th)	6.4%	2.0%	6.1%	4.0%	7.3%	7.4%	3.6%	6.7%	5.3%
	Graduate/Post-graduate/Diploma	6.4%	4.0%	5.1%	1.3%	4.7%	4.0%	2.7%	7.6%	4.4%
Average monthly family income	Below 5000	7.4%	3.3%	10.2%	1.3%	2.7%	16.1%	23.1%	24.4%	12.8%
	Between 5000 to 10000	37.2%	25.3%	37.8%	15.3%	33.3%	55.7%	57.8%	37.3%	38.7%
	Between 10000 to 20000	38.3%	47.3%	34.7%	62.0%	46.7%	15.4%	18.2%	13.3%	32.1%
	Above 20000	17.0%	24.0%	17.3%	21.3%	17.3%	12.8%	.9%	24.9%	16.4%
House ownership	Yes	95.7%	96.0%	79.6%	95.3%	90.0%	88.6%	83.1%	81.3%	88.0%
BPL card	Yes	58.5%	40.7%	16.3%	26.0%	23.3%	48.3%	37.3%	34.7%	35.5%
Aadhar card	Yes	96.8%	80.0%	98.0%	84.0%	88.0%	97.3%	96.9%	95.1%	92.0%
Residence time in city	0-3 years	0.0%	2.7%	1.0%	2.0%	4.0%	2.0%	.9%	4.0%	2.3%
	4-6 years	8.5%	12.7%	7.1%	16.0%	22.0%	9.4%	4.9%	14.7%	12.0%

	7-10 years	1.1%	1.3%	2.0%	4.7%	5.3%	.7%	2.7%	7.6%	3.5%
	11-15 years	3.2%	10.7%	8.2%	12.7%	11.3%	7.4%	3.1%	5.8%	7.6%
	15+ years	87.2%	72.7%	81.6%	64.7%	57.3%	80.5%	88.4%	68.0%	74.6%

[1] The Scheduled Castes (SCs) and Scheduled Tribes (STs) are officially designated groups of historically disadvantaged people in India. The terms are recognized in the Indian Constitution and, according to the 2011 census, comprise 16.6% and 8.6% of India's population. The Constitution lays down general principles of positive discrimination for SCs and STs. Other Backward Castes are also recognized by the constitution, are less socially disadvantaged (than SCs and STs) and compose the largest bulk of the Indian population.
[2] A BPL card is issued to households below the poverty line, an economic threshold set by the government of India, based on a survey which scores household assets to indicate households targeted for social welfare programs.
[3] An Aadhar card is issued to every Indian resident and carries a unique identification number. Demographic and biometric information is recorded in a central repository during the enrolment process. The Aadhar card is used to transfer benefits directly to beneficiaries' bank accounts.

4.2. Characteristics of Endline Household Non-Repondents (Missing HHs)

Compared to the Baseline survey, 19.7 % of the HHs were not involved in Endline survey. Losses were higher from Jaipur and Ranchi, and from Non-CAG and Control category.

Table 5: Missing HHs by City (301)

		Total Baseline Count	Missing Count	% Missing from category	% Missing from City
Ahmedabad	Established	244	55	22.5%	24.0%
	Emerging	248	70	28.2%	
	Control	150	29	19.3%	
Bhopal	Emerging	125	23	18.4%	14.5%
	Control	75	6	8.0%	
Jaipur	Emerging	124	30	24.2%	34.7%
	Control	75	39	52.0%	
Ranchi	Emerging	125	30	24.0%	24.5%
	Control	75	19	25.3%	

Table 6: Missing HHs by CAG category (301)

	Total baseline count	Missing count	% Missing from category
CAG	341	36	10.6%
NonCAG	525	172	32.8%
Control	375	93	24.8%

The missing households are demographically similar to the Endline respondents except that the respondents from the missing households were considerably less likely to be pursuing higher education and less likely to possess a BPL card.

Table 7: Demographics of Missing HHs (301)

		Ahmedabad	Bhopal	Jaipur	Ranchi	Total %
Age of the Respondent	Up to 20	2.6%	0.0%	1.4%	0.0%	1.7%
	21-30	13.6%	31.0%	26.1%	22.4%	19.6%
	31-40	37.7%	41.4%	34.8%	53.1%	39.9%
	41-50	27.9%	24.1%	29.0%	22.4%	26.9%
	51 & above	18.2%	3.4%	8.7%	2.0%	12.0%
Marital status	Married	96.1%	100.0%	97.1%	100.0%	97.3%
	Unmarried	3.9%	0.0%	2.9%	0.0%	2.7%
	Separated	0.0%	0.0%	0.0%	0.0%	0.0%
	Divorced	0.0%	0.0%	0.0%	0.0%	0.0%
Caste composition	General	9.1%	17.2%	33.3%	6.1%	15.0%
	Other backward class	61.7%	41.4%	53.6%	18.4%	50.8%
	Scheduled castes	20.1%	27.6%	8.7%	16.3%	17.6%
	Scheduled tribes	9.1%	13.8%	4.3%	59.2%	16.6%
Education	Didn't go to school	59.1%	44.8%	42.0%	28.6%	48.8%
	Primary (up to 5th class or below)	17.5%	20.7%	30.4%	26.5%	22.3%
	Secondary (up to10th)	13.6%	20.7%	15.9%	28.6%	17.3%
	Higher secondary (up to 12th)	6.5%	0.0%	4.3%	10.2%	6.0%
	Graduate/Post-graduate/Diploma	3.2%	13.8%	7.2%	6.1%	5.6%
Average monthly family income	Below 5000	7.1%	13.8%	15.9%	32.7%	14.0%
	5000 - 10000	29.2%	65.5%	47.8%	38.8%	38.5%
	10000 - 20000	48.1%	20.7%	21.7%	12.2%	33.6%
	Above 20000	15.6%	0.0%	14.5%	16.3%	14.0%
House ownership	Yes	91.6%	93.1%	78.3%	81.6%	87.0%
BPL card	Yes	28.6%	79.3%	10.1%	14.3%	26.9%
Aadhar card	Yes	79.2%	100.0%	92.8%	98.0%	87.4%
Residence time in city	0-3 years	3.9%	3.4%	2.9%	4.1%	3.7%
	4-6 years	15.6%	3.4%	10.1%	8.2%	12.0%
	7-10 years	3.2%	0.0%	4.3%	10.2%	4.3%
	11-15 years	16.2%	13.8%	5.8%	12.2%	13.0%
	More than 15 years	61.0%	79.3%	76.8%	65.3%	67.1%

Table 8: Ratio of count Total baseline to Missing HHs (940) – Remaining

		Total Baseline count	Missing count	% Missing from category
Age of the Respondent	Up to 20	39	5	12.8%
	21-30	264	59	22.3%
	31-40	459	120	26.1%

	41-50	294	81	27.6%
	51 & above	185	36	19.5%
Marital status	Married	1174	293	25.0%
	Unmarried	60	8	13.3%
	Separated	3	0	0.0%
	Divorced	4	0	0.0%
Caste composition	General	218	45	20.6%
	Other backward class	566	153	27.0%
	Scheduled castes	256	53	20.7%
	Scheduled tribes	201	50	24.9%
Education	Didn't go to school	555	147	26.5%
	Primary (up to 5th class or below)	268	67	25.0%
	Secondary (up to10th)	297	52	17.5%
	Higher secondary (up to 12th)	66	18	27.3%
	Graduate/Post-graduate/Diploma	55	17	30.9%
Average monthly family income	Below 5000	159	42	26.4%
	5000 - 10000	480	116	24.2%
	10000 - 20000	398	101	25.4%
	Above 20000	204	42	20.6%
House ownership	Yes	1092	262	24.0%
BPL card	Yes	440	81	18.4%
Aadhar card	Yes	1142	263	23.0%
Residence time in city	0-3 years	28	11	39.3%
	11-15 years	149	36	24.2%
	4-6 years	44	13	29.5%
	7-10 years	94	39	41.5%
	More than 15 years	926	202	21.8%

5. Overall Shfts in Household Vulnerability to Climate Change

Ninety-four percent of our sample (1181 households) was susceptible in terms of financial or social capital or both, and was also exposed to one or more climate risks of heat stress, water scarcity, poor water quality, flooding and vector-borne diseases. We therefore set a higher threshold to be considered moderately and highly vulnerable. Those households which were socially and/or financially susceptible and were exposed to (i) no or one risk, (ii) two risks or (iii) three and more climate risks were classified as low, moderate and highly vulnerable households.

Based on these thresholds, 33% of the Baseline survey households are least vulnerable, 36% of the households (455) were moderately vulnerable and 30% (375) were highly vulnerable.

Table 9: Conversion of socio-economic susceptibilities and climate risk exposures to vulnerabilities

	Exposure to climate risks						
Susceptibility	**No risk**	**One risk**	**Two risks**	**Three risks**	**Four risks**	**Five risks**	**Total**
No susceptibility	60	73	42	16	6	0	197
Financial or Social susceptibility	196	217	138	41	14	4	610
Financial and Social susceptibility	82	196	110	39	7	0	434
Total	338	486	290	96	27	4	1241
Least vulnerable 411 households (33.12%)							
Moderately vulnerable 455 households (36.66%)							
Highly vulnerable 375 households (30.22%)							

5.1. Who Are the Most Vulnerable?

As shown in Table 8, households were least vulnerable in Ahmedabad and most in Bhopal. A slightly higher proportion of CAG households were highly vulnerable, compared to non-CAG residents of intervention slums and to controls.

As expected, lower incomes were associated with higher levels of vulnerability. While scheduled castes were more highly vulnerable as expected, the most vulnerable population did not belong to any protected caste (they were designated as ‘general’), indicating that for urban poor, caste reservations may in fact help protected castes to some extent. Forty percent of Muslim households in the sample were highly vulnerable. While vulnerability decreased with increases in education, nearly 30% of women with higher secondary and 15% of women with graduate level education were in highly vulnerable households. Vulnerability was not clearly correlated to years of residency in the city. The most highly vulnerable were households which had been living in the cities since more than 15 years (33% highly vulnerable). Surprisingly, greater tenure rights is associated with higher vulnerability. This finding will require further analysis. Finally, average family size did not vary much across vulnerability categories, but gender ratio of under 18 year olds was skewed against women in the least and moderately vulnerable households.

Table 10. Characteristics of vulnerable households

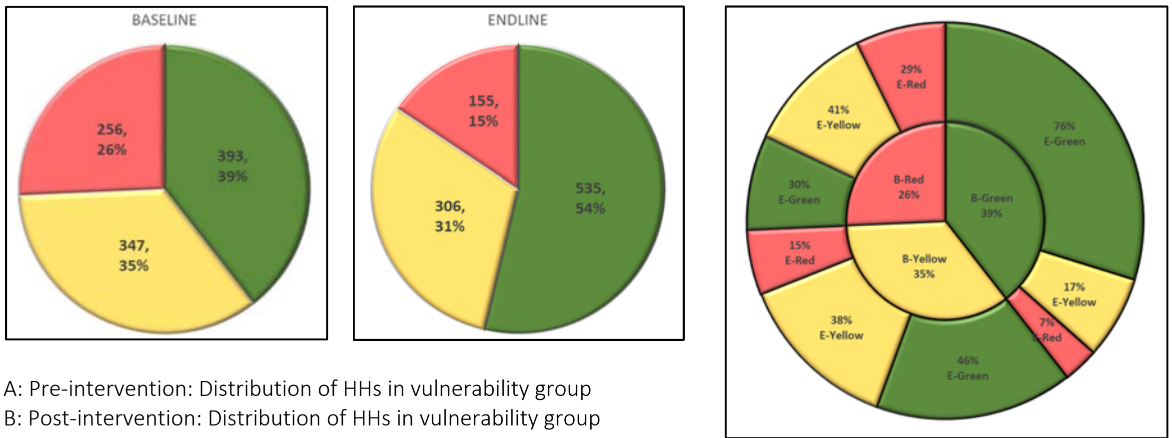
		Total households	Least Vulnerable (411 hhs)	Moderately Vulnerable (455 hhs)	Highly Vulnerable (375 hhs)
City	Ahmedabad	642	45.2%	35.8%	19.0%
	Bhopal	200	13.5%	31.5%	55.0%
	Jaipur	199	21.6%	39.7%	38.7%
	Ranchi	200	25.5%	41.5%	33.0%

CAG/ Non-CAG	CAG	341	36.7%	30.2%	33.1%
	Non-CAG	525	33.3%	37.0%	29.7%
	Control	375	29.6%	42.1%	28.3%
Average family income, in Rs	Above 20,000	204	46.6%	38.7%	14.7%
	Between 10,000 to 20,000	398	42.7%	34.2%	23.1%
	Between 5000 to 10,000	480	25.6%	39.4%	35.0%
	Below 5000	159	14.5%	32.1%	53.5%
Caste	General	218	28.4%	35.8%	35.8%
	Other backward class	562	34.7%	37.7%	27.6%
	Scheduled castes	256	32.0%	32.8%	35.2%
	Scheduled tribes	201	35.3%	38.8%	25.9%
	Other	4	25.0%	75.0%	0.0%
Religion	Hindu	801	37.5%	35.8%	26.7%
	Muslim	315	24.1%	35.9%	40.0%
	Christian	14	28.6%	42.9%	28.6%
	Other	110	27.3%	44.5%	28.2%
Education	Post-Graduate/ Graduate/Diploma	55	52.7%	32.7%	14.5%
	Higher Secondary (11th-12th Std.)	66	43.9%	28.8%	27.3%
	Secondary (6th-10th Std.)	297	33.3%	39.4%	27.3%
	Primary (up to 5th class)	267	33.7%	40.1%	26.2%
	Didn't go school	555	29.5%	35.0%	35.5%
Period of residence in city	More than 15 years	926	32.5%	34.3%	33.2%
	11-15 years	149	37.6%	43.6%	18.8%
	7-10 years	94	39.4%	36.2%	24.5%
	4-6 years	44	18.2%	54.5%	27.3%
	0-3 years	28	32.1%	50.0%	17.9%
Owner-ship of land	Legal	656	32.5	38.1	52.9
	Partially legal	216	41.2	30.6	17.4
	Illegal	369	29.5	37.7	29.7
Family size			5.39 $\pm$ 2.87	5.50 $\pm$ 2.50	5.74 $\pm$ 2.81
Gender ratio of population below 18 years of age			0.75	0.73	0.96

5.2. Shifts in Vulnerability from Pre- to Post Intervention Periods

The Endline survey reveals large shifts in the vulnerability levels of the sampled households. The proportion of less vulnerable (green) has increased by 15%, while moderately (yellow) and highly (red) vulnerable have decreased by 4% and 11% respectively.

A B C



A: Pre-intervention: Distribution of HHs in vulnerability group
B: Post-intervention: Distribution of HHs in vulnerability group
C: Shift of vulnerability level from pre-intervention to post-intervention

Chart C presents the proportional shift of baseline vulnerability groups in post-intervention scenario. Majority of the Baseline Low (green) vulnerable remained the same, 17% shifted to Moderate (yellow) and 7% into High (red) vulnerability group. From the baseline Moderate (yellow) and High (red) vulnerability households, 46% and 30% respectively shifted into the low (green) vulnerability group. Only 29% of the baseline red vulnerability group remained highly vulnerable, 1/3 of which became low vulnerable and 2/5 became moderately vulnerable. Out of the total moderately vulnerable households in the pre-intervention period, 46% became low vulnerable, 38% remained moderately vulnerable and 15% have increased vulnerability level to high.

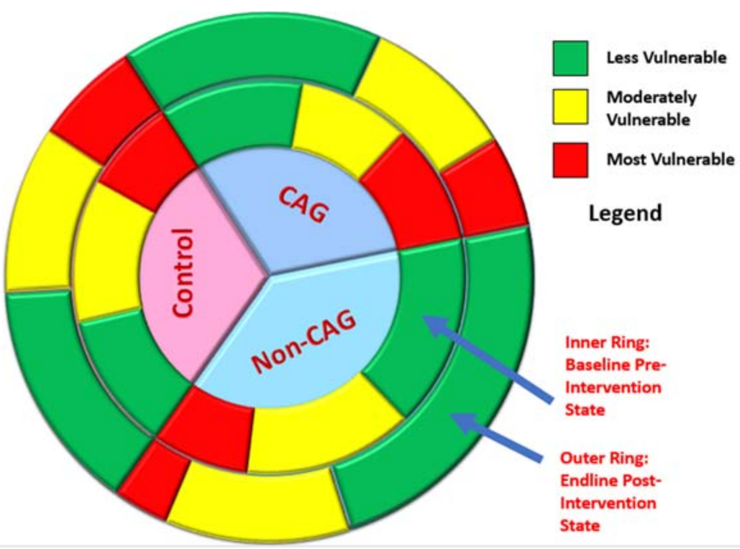


Figure 5: Changes in Vulnerability from Pre- to Post-Intervention

Wilcoxon Signed Rank Test indicates that median post-intervention vulnerability level ranks were statistically lower than median pre-intervention vulnerability level ranks Z = -8.378 (Appendix 3).

As shown in the table and figure below, decreases in vulnerability are not uniform across all groups. In particular, the most significant improvements occur in CAG and non-CAG treatment groups (as compared to controls). We also note that vulnerability is lowest in Ahmedabad, where MHT has worked the longest.

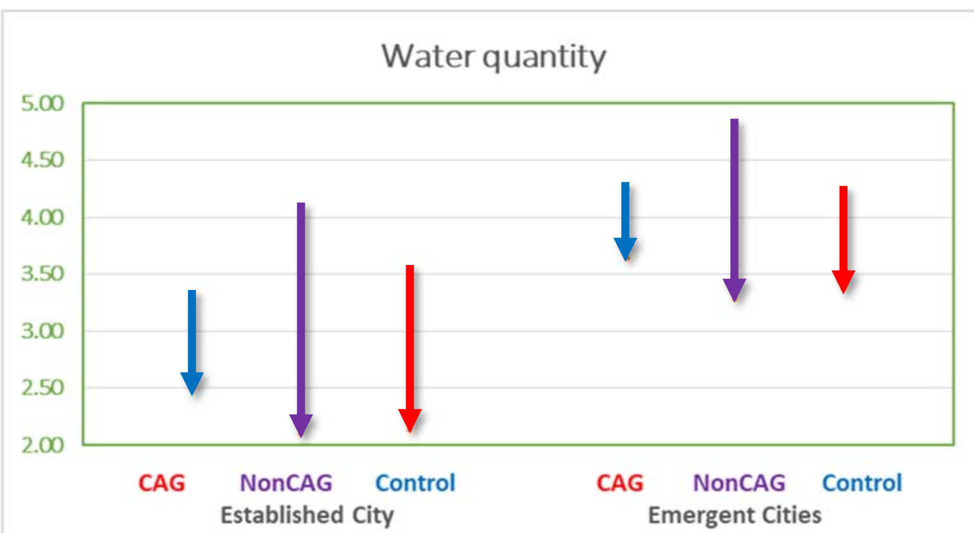
Table 11: Vulnerability proportion, by Baseline, Endline

	Baseline			Endline		
	Green	Yellow	Red	Green	Yellow	Red
CAG	38.6%	29.7%	31.7%	52.3%	29.7%	18.0%
Non CAG	42.4%	36.6%	21.1%	61.3%	29.7%	8.9%
Control	36.8%	37.7%	25.5%	45.8%	32.9%	21.3%
Ahmedabad	56.7%	30.0%	13.4%	73.3%	21.7%	5.1%
Bhopal	18.7%	35.7%	45.6%	37.4%	45.6%	17.0%
Jaipur	23.1%	35.0%	41.9%	30.6%	40.0%	29.4%
Ranchi	25.7%	48.0%	26.3%	35.1%	33.3%	31.6%

6. Changes in Risk and Susceptibility Indicators between Baseline and Endline States

While the overall index of climate vulnerability shows a consistent pattern of greater improvement amongst intervention groups (CAG and Non-CAG) compared to controls, the changes observed amongst the various indicators of risk and susceptibility (that make up the overall vulnerability index) are more variable. In this section we present the results for changes in each of the risk indicators and for changes in social capital susceptibility. Given the short time period, the research team concluded that changes in financial susceptibility could not be reliably measured, and therefore this indicator is not included.

6.1. Water quantity risk



Water quantity risk is a function of availability and adequacy of the water throughout the year. The above chart indicates the average initial state (the base of the arrow) and the average end state (the tip of the arrow). The length of the arrow indicates the degree of change, from baseline to endline states. The X-axis indicates categories of respondents and the Y-axis indicates the mean water quantity risk score. In all six classes water quantity risk is considerably lower in Endline with respect to the baseline scenario. Paired comparison of the CAG category suggest that there is significant difference in the mean score between pre- and post-intervention periods for all three categories and Endline mean score is significantly lower than baseline mean score:

- CAG (t(305)= - 5.52, p<0.05),
- NonCAG (t(379)= - 17.27, p<0.05) and
- Control(t(309)= -1.08, p<0.05) (see Appendix 1).

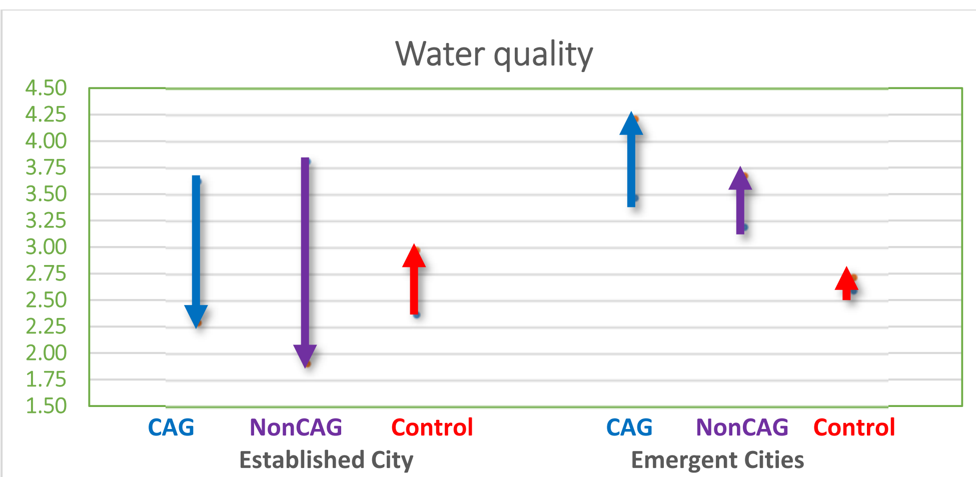
Multiple regression analysis was used to test if the Baseline score, City category and CAG category significantly predicted the Delta (change in water quality risk indicator). The result of the OLS model indicated that the three independent variables explained 46% of the variance (R^2 =.46, F(4,991)=211.43, p<.01) (Appendix 2). Predicted change in the risk score is:

Delta = 1.36 - 0.77 (Baseline) + 0.34 (CAG) - 0.20* (NonCAG) + 1.01 (Emergent city)

Where, Delta = Endline water quantity risk score – Baseline water quantity risk score
Baseline = Baseline water quantity risk score,
CAG, NonCAG = Dummy variables with Control being the base category
Emergent city = Dummy variable with Established city being the base category.

OLS regression reveals that reduction in the water quantity risk is primarily dependent on CAG category, and NonCAG HHs are better off as compared to CAG and Control.

6.2. Water quality risk



Water quantity risk scores indicate the acceptability of chemical and physical parameters associated with whatever water is available. As can be seen above, water quality improved in CAG and NonCAG treatment groups in Ahmedabad (the established city) but worsened in the control group and in all groups located in emergent cities.

Paired comparison of the CAG category suggest a significant decrease in the mean score of CAG and NonCAG HH water quality risk while there is no significant difference in the mean score of Control HHs;

CAG (t(305)= -2.35, p<0.05), NonCAG (t(379)= -4.70, p<0.05) and Control(t(309)= 1.90, p>0.05) (Appendix 1).

Multiple regression analysis was used to test if Baseline score, City category and CAG category significantly predicted change in Delta. The result of the OLS model indicated that the three independent variables explained 51.9 % of the variance (R^2 =.519, F(4,991)=267.35, p<.01) (Appendix 2).

The predicted change in the risk score is;

Delta = 1.95 - 0.94 (Baseline) + 0.45 (CAG) + 0.01* (NonCAG) + 1.21 (Emergent City Category)

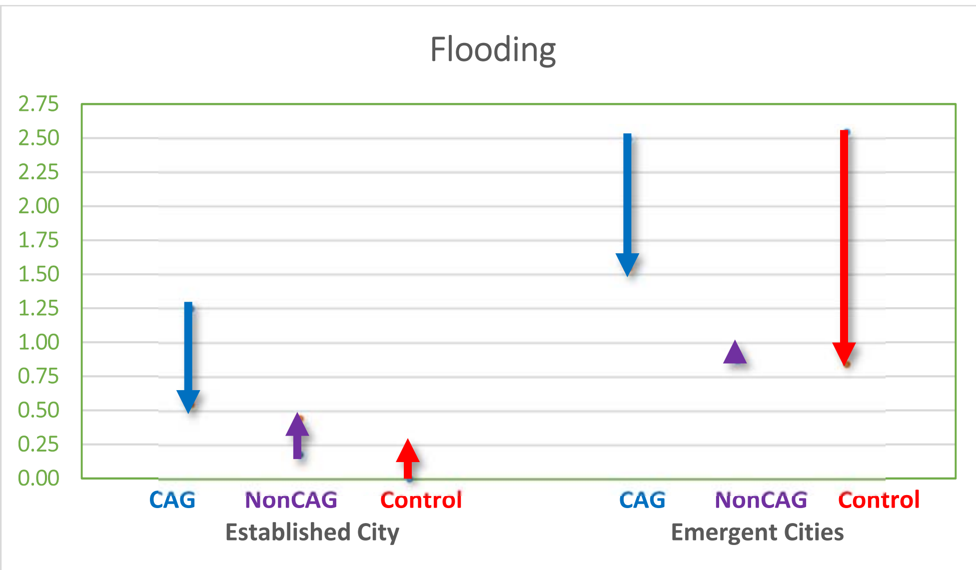
Where, Delta = Endline water quality risk score – Baseline water quality risk score

Baseline = Baseline water quality risk score,

CAG, NonCAG = Dummy variables with the Control Category serving as the base category

Emergent City category = Dummy variable; Established category serving as base category

6.3. Flooding



Flooding risk for all six categories is low, the maximum risk score being 2.6. Statistically, a significant difference in post and pre intervention risk score exist for CAG and Control HHs and post intervention score is lower than pre-intervention score. Difference in the risk in pre and post intervention is insignificant in NonCAG HHs.

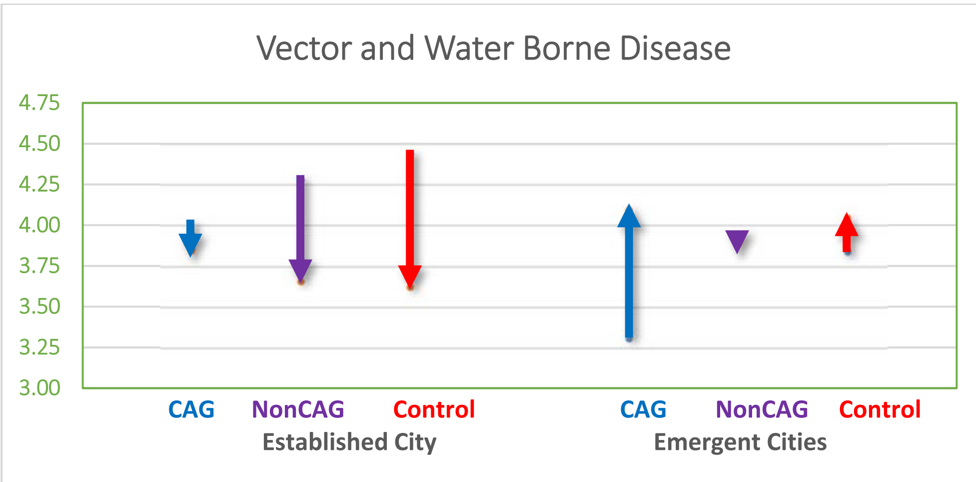
- CAG (t(305)= - 6.01, p<0.05),
- NonCAG (t(379)= 1.42, p>0.05) and
- Control(t(309)= -6.68, p<0.05) (Appendix 1).

Multiple regression analysis was used to test if Baseline score, City category and CAG category significantly predicted change in Delta. The result of the OLS model indicated that the three independent variables explained 66.6 % of the variance (R^2 =.666, F(4,991)=493.53, p<.01) (Appendix 2).

The predicted change in the risk score is;

Delta = - 0.09* - 0.89 (Baseline) + 0.47 (CAG) + 0.26 (NonCAG) + 0.54 (Emergent City Category)
Where, Delta = Endline flooding risk score – Baseline flooding risk score
Baseline = Baseline flooding risk score,
CAG, NonCAG = Dummy variables with the Control Category serving as the base category
Emergent City category = Dummy variable; Established category serving as base category.

6.4. Vector and Water Borne Diseases



In established city risk has reduced for NonCAG and Control while risk for CAG HHs remained unchanged. In emerging cities, there is meagre increase of risk in NonCAG and Control while, increase of risk in CAG HHs is prominent.

Overall there is significant difference in pre and post intervention risk score for CAG and NonCAG HHs, while difference in Control HHs is insignificant.CAG (t(305)= 2.75, p<0.05), NonCAG (t(379)= -2.88, p>0.05) and Control(t(309)= -1.64, p>0.05) (Appendix 1).

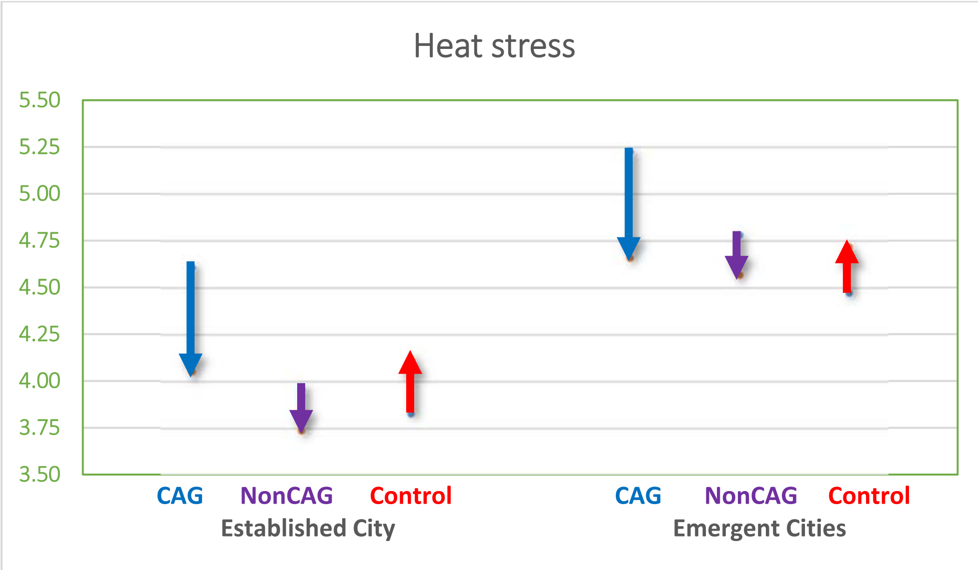
Multiple regression analysis was used to test if Baseline score, City category and CAG category significantly predicted change in Delta. The result of the OLS model indicated that 3 predictor variables explained 59.4 % of the variance (R^2 =.594, F(4,991)= 362.87, p<.01) (Appendix 2).

Predicted change in the risk score is;

Delta = 3.30 - 0.91 (Baseline) + 0.17* (CAG) - 0.07* (NonCAG) + 0.34 (Emergent City Category)
Where, Delta = Endline health risk score – Baseline health risk score
Baseline = Baseline health risk score,
CAG, NonCAG = Dummy variables with the Control Category serving as the base category
Emergent City category = Dummy variable; Established category serving as base category

OLS model suggest that predicted value of delta is least for Established NonCAG HHs and highest for Emerging CAG HHs.

6.5. Heat stress



The change in risk score is similar for CAG category in pre and post intervention. While in CAG and NonCAG risk has decreased, in Control HHs it has increased. Statistically analysing the difference, CAG and NonCAG HHs has lower post intervention risk score, while control has higher post-intervention risk score; CAG (t(305)= -4.91, p<0.05), NonCAG (t(379)= -2.62, p>0.05) and Control(t(309)= 2.91, p<0.05) (Appendix 1).

Multiple regression analysis was used to test if Baseline score, City category and CAG category significantly predicted change in Delta. The result of the OLS model indicated that 3 predictor variables explained 23.5 % of the variance (R^2 =.235, F(4,991)= 76.11, p<.01) (Appendix 2). Though the model fit is good with the p<0.01, the R^2 suggest that prediction potential of the model is very less.

Predicted change in the risk score is;

Delta = 2.28 - 0.53 (Baseline) - 0.41 (CAG) - 0.36 (NonCAG) + 0.36 (City Category)

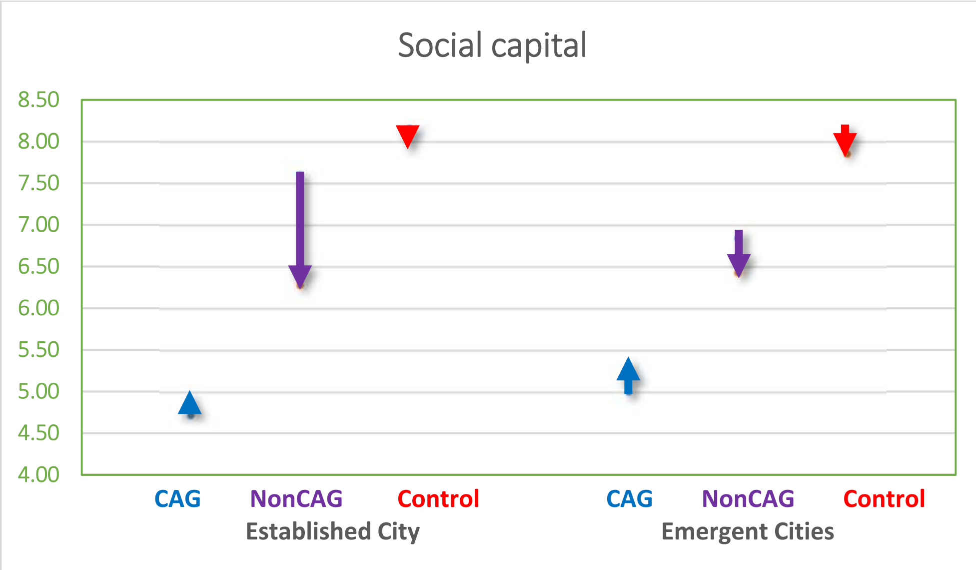
Where, Delta = Endline heat stress risk score – Baseline heat stress risk score

Baseline = Baseline heat stress risk score,

CAG, NonCAG = Dummy variables with the Control Category serving as the base category

Emergent City category = Dummy variable; Established category serving as base category

6.6. Social capital



The analysis shows that only the Established NonCAG HHs show apparent significant improvement in social capital. Paired comparison suggest that there is significant difference in NonCAG and CAG HHs only; CAG (t(305)= 2.16, p<0.05), NonCAG (t(379)= -8.00, p>0.05) and Control(t(309)= -2.61, p>0.05) (Appendix 1).

Multiple regression analysis was used to test if Baseline score, City category and CAG category significantly predicted change in Delta. The result of the OLS model indicated that 3 predictor variables explained 33.2 % of the variance (R^2 =.332, F(4,991)= 122.97, p<.01) (Appendix 2). Though the model fit is good with the p<0.01, the R^2 suggest that prediction potential of the model is very less.

Predicted change in the risk score is;

Delta = 5.56 - 0.72 (Baseline) - 1.97 (CAG) - 1.34 (NonCAG) + 0.19 (City Category)

Where, Delta = Endline social capital susceptibility score – Baseline social capital susceptibility score
Baseline = Baseline social capital susceptibility score,
CAG, NonCAG = Dummy variables with the Control Category serving as the base category
Emergent City category = Dummy variable; Established category serving as base category

7. Parameters Change

Variables that show considerable change post-intervention are described in the table below. Of particular note, the proportion of population having sufficient amount of water during the summer rose significantly. Use of water purifiers has also increased by 67.2%.

Table 12: Parameter change

		Baseline	Endline	% Delta (E-B)
Main source of water	Municipal water supply	50.6%	59.1%	8.4%
	Well/stand post/Hand pump	21.4%	10.0%	-11.4%
	Community water supply	25.4%	23.9%	-1.5%
	From neighbors	2.5%	6.6%	4.1%
	Purchasing water	0.0%	0.4%	0.4%
Discontinuity in water for more than 2 days	Yes	20.5%	30.9%	10.5%
Water adequacy in summer	Yes	39.1%	69.6%	30.5%
Water purification practices	Water purifier	2.4%	69.6%	67.2%
	Drops	2.4%	2.8%	0.4%
	Alum	0.1%	0.3%	0.2%
	Boiling everyday	5.5%	6.1%	0.6%
	Boiling when dirty	4.5%	3.7%	-0.9%
	Straining with cloth	18.6%	26.9%	8.3%
	Don't do anything	66.5%	56.1%	-10.3%
Flooding	No flooding	70.3%	73.2%	2.9%
	Only street flooding	10.9%	20.8%	9.9%
	Only house flooding	2.7%	1.3%	-1.4%
	House and street flooding	16.2%	4.7%	-11.4%
Involvement with CBO/CAG	Yes	40.9%	41.5%	0.5%
Mosquito nets	Yes	17.5%	20.8%	3.3%
Mosquito screens	Yes	34.9%	25.8%	-9.2%

8. Differences-in-Differences Regression Analysis

We come now to the question of whether the changes (delta) in the risk and susceptibility indicators between the pre-treatment condition and the post-treatment condition differ significantly between the two treatment groups (resident of treatment communities that are either a member of the Community Action Group (CAG) and not (nonCAG), as compared to residents of control communities.

8.1. Analysis

To test for this, the project employed a differences-in-differences regression analysis. Conceptually, an OLS regression model was developed to compare variables that might account for the delta (changes in indicators) against controls. A regression model was created for each of the risk and susceptibility indicators. All variables included are dummy variables indicating the state of the respondents, as follows:

Dependent Variable = Delta (the absolute change in the risk or susceptibility indicator (e.g., water quantity)

Independent variables =

Baseline – condition found when all dummy variables are absent (0), which is exists for households with lower vulnerability located in the Established City (Ahmedabad) living in control slums.

Emergent City -- a dummy variable indicating that the respondent lives in one of the three emergent cities: Bhopal, Jaipur and Ranchi. Respondents who live in the Established City of Ahmedabad serve as the base condition.

Community Type -- two dummy variables indicating whether the respondent resides in a treatment slum and is a member of a Community Action Group (CAG) or resides in a treatment slum and is not a member of a Community Action Group (NonCAG). Respondents who reside in a control, non-treatment slum serve as the base condition.

Vulnerability – two dummy variables indicating whether the respondent's household was categorized as moderate vulnerability or higher vulnerability. Respondent households characterized as lower vulnerability in the baseline survey serve as the base condition.

The results of the differences-in-differences regression models are presented in Appendix 5 and summarized as follows:

Water Quantity

Overall regression R^2: .466, Significance: .000

Delta =

Variable	B	Beta	Significance
(Constant)	1.23		.000
Baseline		-0.73	.000
CAG		0.39	.004
NonCAG		-0.23	.076
Emergent city		1.06	.000
Moderately Vulnerable		0.11	.376
Highly Vulnerable		-0.37	.024

Water Quality

Overall regression R^2: .520, Significance: .000

Delta =

Variable	B	Beta	Significance
(Constant)	1.99		.000
Baseline		-0.92	.000
CAG		0.44	.015
NonCAG		-0.01	.967
Emergent city		1.29	.000
Moderately Vulnerable		-0.21	.226
Highly Vulnerable		-0.20	.350

Flooding

Overall regression R^2: .668, Significance: .000

Delta =

Variable	B	Beta	Significance
(Constant)	-0.01		.935
Baseline		-0.91	.000
CAG		0.47	.000
NonCAG		0.25	.018
Emergent city		0.47	.000
Moderately Vulnerable		0.24	.022
Highly Vulnerable		0.31	.015

Vector and Water Borne Disease

Overall regression R^2: .596, Significance: .000

Delta =

Variable	B	Beta	Significance
(Constant)	3.28		.000
Baseline		-0.91	.000
CAG		0.15	.189
NonCAG		-0.06	.547
Emergent city		0.27	.006
Moderately Vulnerable		0.07	.507
Highly Vulnerable		0.24	.046

Heat Stress

Overall regression R^2: .237, Significance: .000

Delta =

Variable	B	Beta	Significance
(Constant)	2.28		.000
Baseline		-0.55	.000
CAG		-0.40	.002
NonCAG		-0.36	.003
Emergent city		0.32	.003
Moderately Vulnerable		0.20	.110
Highly Vulnerable		0.14	.352

Social Capital

Overall regression R^2: .335, Significance: .000

Delta =

Variable	B	Beta	Significance
(Constant)	5.50		.000
Baseline		-0.72	.000
CAG		-1.95	.000
NonCAG		-1.34	.000
Emergent city		0.19	.056
Moderately Vulnerable		0.18	.100
Highly Vulnerable		-0.04	.747

8.2. Results

Before interpreting the results of the analysis, it is important to remember that improvements in the risk and vulnerability indicators are negative numbers. The measures are of risk levels and susceptibilities, and therefore the lower the value, the better the condition.

Our theory of change would therefore predict that

1. Residents of treatment communities would experience greater improvements than residents of control communities, as indicated by negative and significant betas.
2. Residents of Emergent Cities would experience lesser improvement than residents of our Established City, as indicated by positive and significant betas.
3. The theory of change does not explicitly predict improvements based on initial state of vulnerability, although we had hoped that the most vulnerable would experience the greatest improvements, as indicated by negative and significant betas.

The differences-in-differences analysis provides mixed substantiation of the first proposition, strong substantiation of the second, and no evidence of the third.

Treatment vs. Control Communities

Do residents of treatment slums experience greater improvements than do residents of control communities?

The analysis provides strong evidence that both CAG and NonCAG members of treatment slums experience greater improvements in heat stress and social capital, mixed or insignificant results for water quality, water quantity and vector/water based diseases, and strong evidence that they experienced weaker improvements in flooding from the baseline to the endline conditions.

We note that when CAG and NonCAG respondents are compared for the mixed results variables, NonCAG experience greater improvements than do CAG respondents. This is counter to expectation since both CAG and nonCAG respondents come from the same communities and therefore experience the same community improvements. This unexpected result is best explained by the nature of our measures of improvement. The project did not objectively measure such improvements, but rather compared respondent observations before and after interventions. As such, even though the respondents were asked to respond to factual questions (e.g., number of days of flooding), perceptions will alter their responses. During the project, CAG respondents were trained to make more accurate assessments of climate change risks, to recognize them more readily and to understand their impact. As such, CAG members became more sensitive to these measures, which consequently made them more perceptive of the conditions.

The relative improvement of flooding impact in control slums is hard to evaluate. Control slums were paired to treatment slums in both geography and demographics, but without external data on stormwater flooding, it is unclear as to how well the slums matched on this dimension.

Emergent vs. Established Cities

Do residents of emergent cities (where MHT has only recently started to build social capital) experience greater improvements than do residents of established cities (where MHT has worked in slums to build social capital over many years, and where citywide federations of women slum leaders exist)?

The analysis provides strong and significant evidence that residents of emergent cities experience lower levels of improvement than do residents of established cities, for all variables. As noted above, established cities have pre-existing networks of women leaders with strong social capital while emergent cities must build these networks during the project.

Moderate and High Risk/Susceptibility vs. Lower Risk/Susceptibility

Do household with moderate and high levels of risk and susceptibility in the pre-intervention period experience greater improvements than do households with lower levels of control risk and susceptibility?

While the project's theory of change did not predict improvements based on initial conditions of vulnerability or susceptibility, the research team evaluated this to ascertain relative impact of the project on the most vulnerable. Only in improvements in water quality did the most vulnerable show relatively stronger improvements that were significant. In vector based disease, the most vulnerable showed weaker improvements that were significant, and no significant relationship could be found in all other indicators.

9. Conclusions

This report provides a series of tests as to whether the project improved the climate resilience of households living in treatment communities.

At the most comprehensive scale, we found strong evidence that households in treatment communities have significantly greater reductions in overall vulnerability, as measured by overall shifts in all risks and susceptibilities.

At the level of specific risks and susceptibilities, we found mixed evidence that households of treatment communities have significantly greater reductions in heat stress and improvements in social capital, and mixed or insignificant results for all other variables except for flooding risk, where households living in control communities experienced significantly greater reductions.

Overall, we also found that all groups, including controls, improved in vulnerability over the project period, possibly reflecting citywide efforts to improve climate resilience found in several of the project cities.

For treatment communities, we can also highlight the following improvements:

1. 32.7 % increase in population having sufficient water during summers
2. A significant number of households with decreases of respective risks and susceptibility by more than 20 % (relative to baseline condition)

	Water quantity	**Water quality**	**Flooding**	**Health**	**Heat stress**	**Social capital**
No. of HHs in which risk has Decreased by 20% or more	424	339	162	224	253	224
% of HHs in which risk has decreased	61.8%	49.4%	23.6%	32.7%	36.9%	32.7%

3. More than 70 % (72.3%) of the HHs have reduced risk by 20% for 2 or more risks/susceptibility
4. Significant increase in the proportion of lower-risk vulnerability group by 16.6 % and decrease in moderate-risk and higher-risk vulnerable population by 3.8 % and 12.8 % respectively.
5. Statistically significant reductions in vulnerability relative to pre-intervention period.
6. Statistically significant decreases in the risks for water quantity risk, water quality risk, Flooding risk, Heat stress risk and Social capital susceptibility.
7. Reduction in water quantity, water quality risks and Social capital susceptibility are more pronounced in NonCAG HHs in comparison with CAG HHs.

10. Appendices

10.1. Appendix 1: Significance of Pre- to Post-Intervention, Individul Indicators

		Paired Differences		t	df	Sig. (2-tailed)
		Mean	Std. Deviation			
Water quantity	CAG	-0.72	2.29	-5.52	305	0.00
	Non CAG	-1.78	2.01	-17.27	379	0.00
	Control	-1.08	2.27	-8.42	309	0.00
Water quality	CAG	-0.40	3.00	-2.35	305	0.02
	Non CAG	-0.77	3.21	-4.70	379	0.00
	Control	0.32	2.95	1.90	309	0.06
Flooding	CAG	-0.81	2.36	-6.01	305	0.00
	Non CAG	0.16	2.14	1.42	379	0.16
	Control	-0.94	2.49	-6.68	309	0.00
Health	CAG	0.31	1.95	2.75	305	0.01
	Non CAG	-0.35	2.34	-2.88	379	0.00
	Control	-0.20	2.16	-1.64	309	0.10
Heat stress	CAG	-0.56	2.00	-4.91	305	0.00
	Non CAG	-0.22	1.62	-2.62	379	0.01
	Control	0.26	1.59	2.91	309	0.00
Social capital	CAG	0.19	1.56	2.16	305	0.03
	Non CAG	-0.89	2.17	-8.00	379	0.00
	Control	-0.12	0.83	-2.61	309	0.01

10.2. Appendix 2: Changes in Variables Included in Analysis

Multiple regression analysis was used to test if the Baseline score, City category and CAG category significantly predicted the Delta (change in water quality risk indicator).

	Model Summary			
	R	R Square	Adjusted R Square	Std. Error of the Estimate
Water quantity	.679[a]	.460	.458	1.63681
Water quality	.720[a]	.519	.517	2.15265
Flooding	.816[a]	.666	.664	1.37543
Health	.771[a]	.594	.593	1.39517
Heat stress	.485[a]	.235	.232	1.54577
Social capital	.576[a]	.332	.329	1.41298

	Coefficients[a]					
		Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
Water quantity	(Constant)	1.36	0.15		9.13	.000
	Baseline	-0.77	0.03	-0.66	-27.49	.000
	CAG	0.34	0.13	0.07	2.54	.011
	Non CAG	-0.20	0.13	-0.04	-1.58	.116
	Emergent city	1.01	0.11	0.23	9.46	.000
Water quality	(Constant)	1.95	0.17		11.60	.000
	Baseline	-0.94	0.03	-0.68	-30.31	.000
	CAG	0.45	0.18	0.07	2.53	.011
	Non CAG	0.01	0.17	0.00	0.08	.933
	Emergent city	1.21	0.14	0.20	8.81	0.00
Flooding	(Constant)	0.09	0.10		0.96	.340
	Baseline	-0.89	0.02	-0.85	-42.07	.000
	CAG	0.47	0.11	0.09	4.21	.000
	Non CAG	0.26	0.11	0.05	2.46	.014
	Emergent city	0.54	0.09	0.11	5.82	0.00
Health	(Constant)	3.30	0.14		22.76	.000
	Baseline	-0.91	0.02	-0.75	-36.48	.000
	CAG	0.17	0.11	0.04	1.52	.128

	Non CAG	-0.07	0.11	-0.02	-0.63	.528
	Emergent city	0.34	0.09	0.08	3.79	.000
Heat stress	(Constant)	2.28	0.16		13.95	.000
	Baseline	-0.53	0.03	-0.47	-16.13	.000
	CAG	-0.41	0.13	-0.11	-3.24	.001
	Non CAG	-0.36	0.12	-0.10	-3.06	.002
	Emergent city	0.36	0.10	0.10	3.53	.000
Social capital	(Constant)	5.56	0.32		17.20	.000
	Baseline	-0.72	0.04	-0.74	-19.14	.000
	CAG	-1.97	0.17	-0.53	-11.76	.000
	Non CAG	-1.34	0.11	-0.38	-11.81	.000
	Emergent city	0.19	0.09	0.06	2.14	.033

	ANOVA[a]					
		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Water quantity	Regression	2266	4	566.45	211.43	.000[b]
	Residual	2655	991	2.68		
	Total	4921	995			
Water quality	Regression	4956	4	1238.89	267.35	.000[b]
	Residual	4592	991	4.63		
	Total	9548	995			
Flooding	Regression	3735	4	933.66	493.53	.000[b]
	Residual	1875	991	1.89		
	Total	5609	995			
Health	Regression	2825	4	706.33	362.87	.000[b]
	Residual	1929	991	1.95		
	Total	4754	995			
Heat stress	Regression	727	4	181.85	76.11	.000[b]
	Residual	2368	991	2.39		
	Total	3095	995			
Social capital	Regression	982	4	245.51	122.97	.000[b]
	Residual	1979	991	2.00		
	Total	2961	995			

10.3. Appendix 3: Vulnerability Assessment

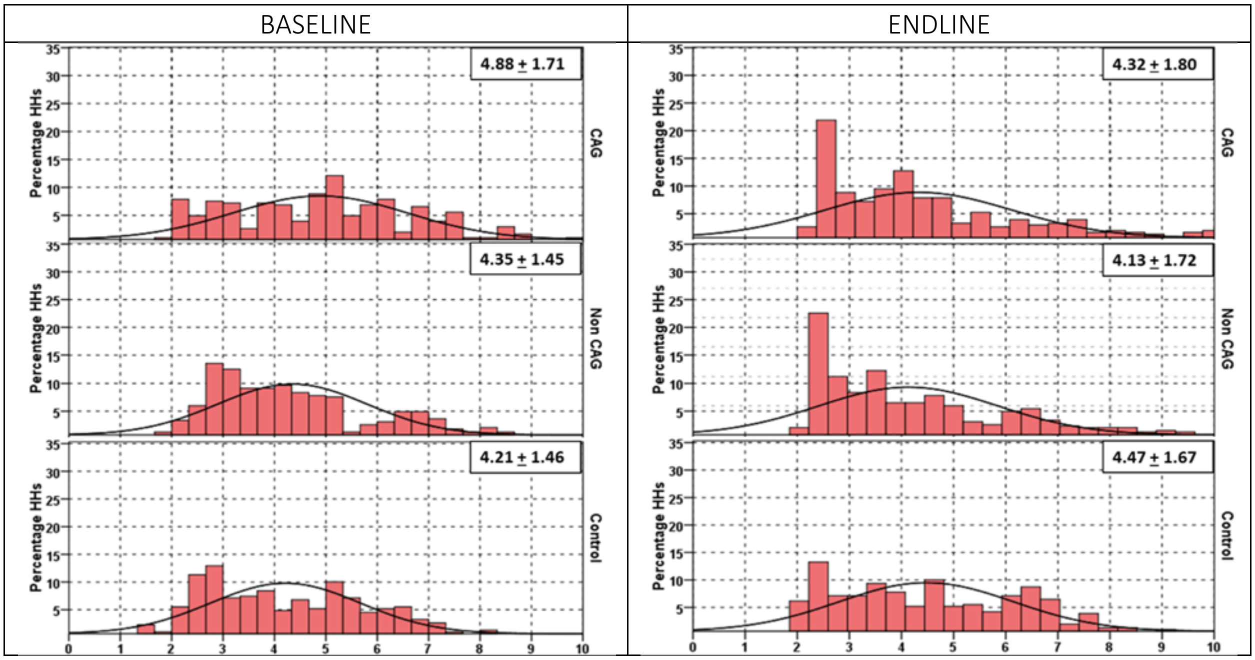
		N	Mean Rank	Sum of Ranks
E-B	Decreased in vulnerability	344[a]	249.18	85716.50
	Increased in vulnerability	149[b]	241.98	36054.50
	Ties	503[c]		
	Total	996		
a. ENDLINE < BASELINE (vulnerability decreases)				
b. ENDLINE > BASELINE (vulnerability increases)				
c. ENDLINE = BASELINE (vulnerability remains constant)				

Test Statistics[a]	
	E-B
Z	-8.378[b]
Asymp. Sig. (2-tailed)	.000

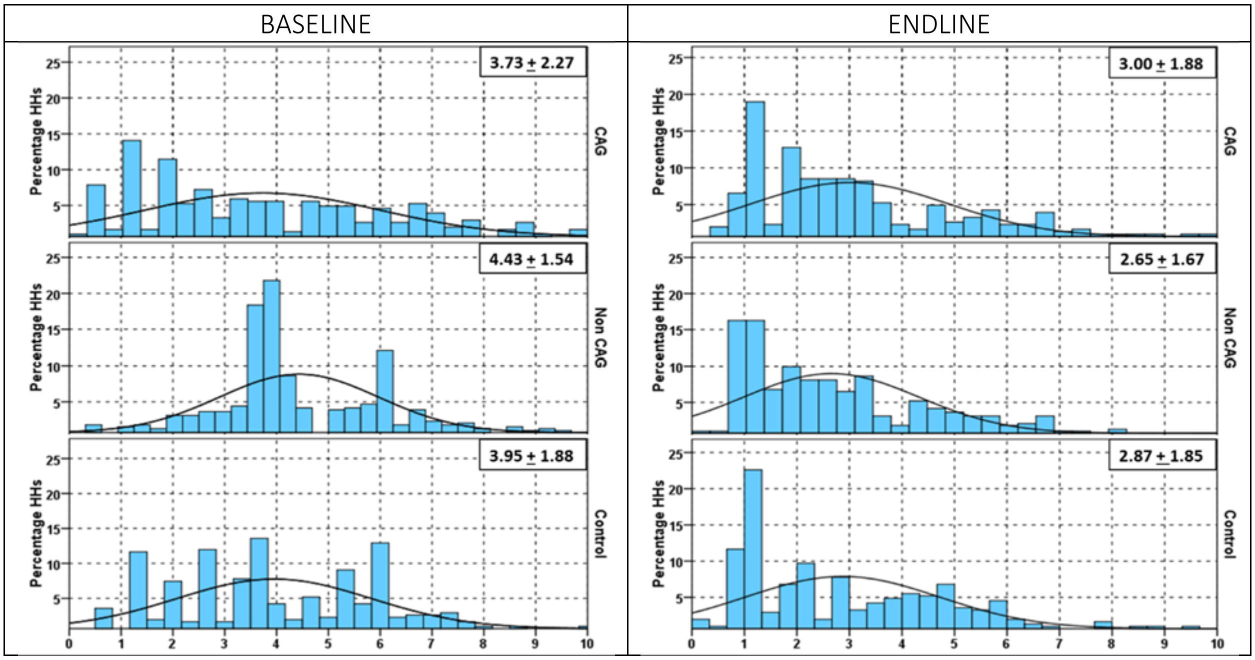
a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

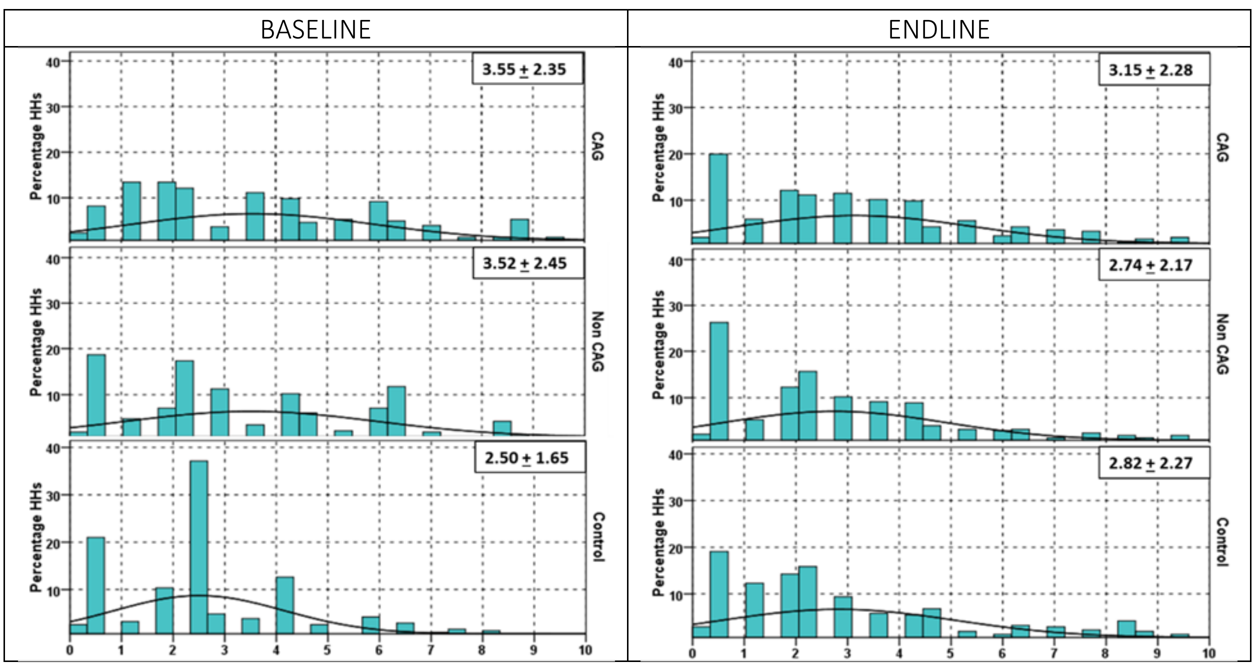
10.4. Appendix 4: Susceptibilities and Risks Histograms



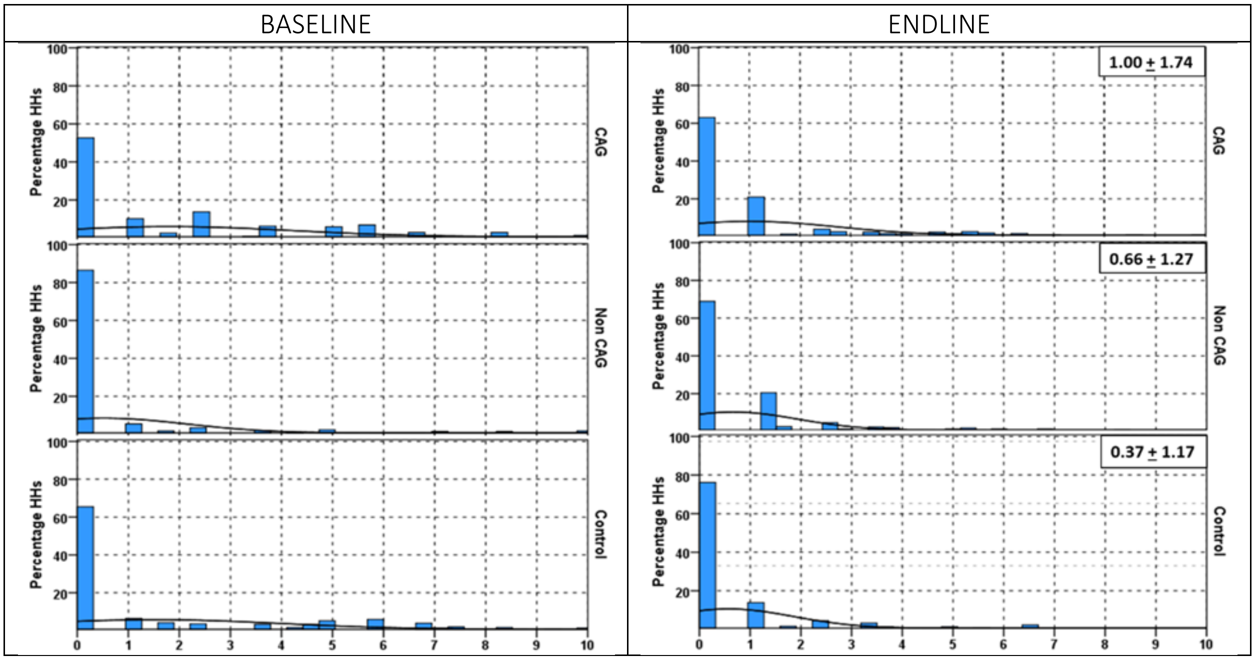
2. Water quantity



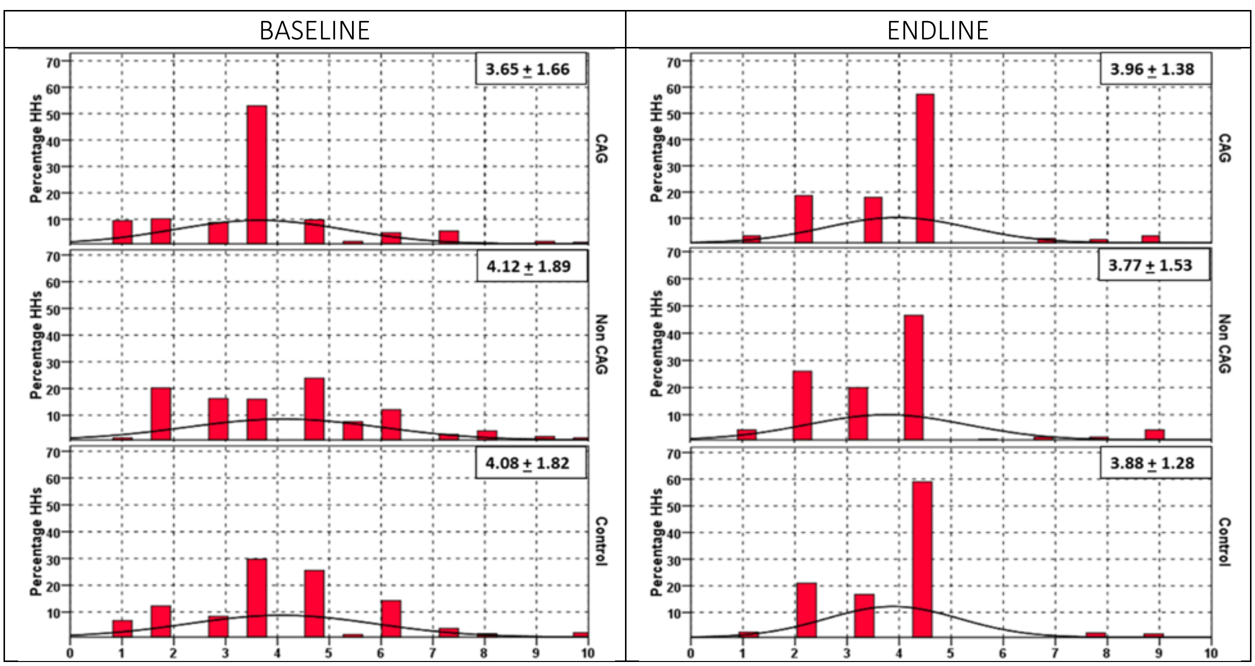
3. Water quality



4. Flooding

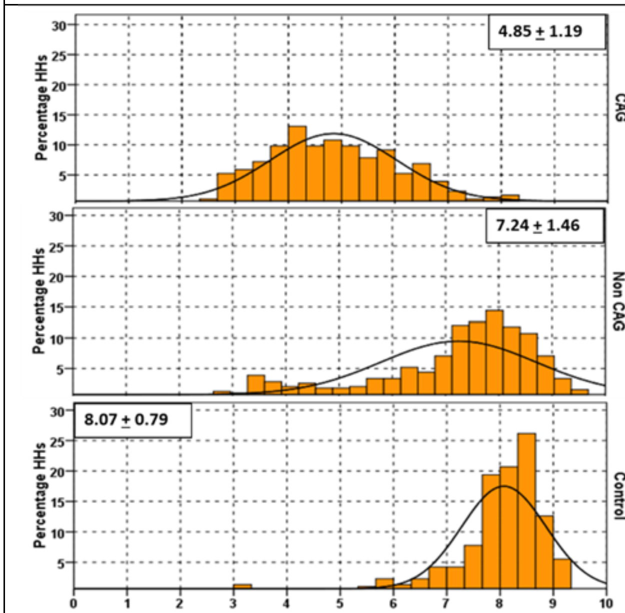


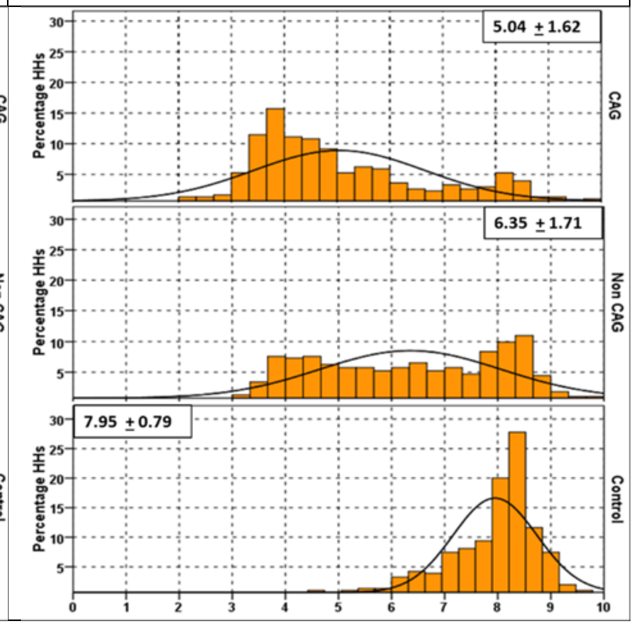
5. Health/ VBD



6. Social capital

BASELINE	ENDLINE





10.5. Appendix 5: Differences-in-Differences Regression Results

For all Regressions:

Dependent Variable = Delta (the absolute change in the risk or susceptibility indicator (e.g., water quantity)

Independent variables =

Baseline

Emergent City -- a dummy variable indicating that the respondent lives in one of the three emergent cities: Bhopal, Jaipur and Ranchi. Respondents who live in the Established City of Ahmedabad serve as the base condition.

Community Type -- two dummy variables indicating whether the respondent resides in a treatment slum and is a member of a Community Action Group (CAG) or resides in a treatment slum and is not a member of a Community Action Group (NonCAG). Respondents who reside in a control, non-treatment slum serve as the base condition.

Vulnerability – two dummy variables indicating whether the respondent's household was categorized as moderate vulnerability or higher vulnerability. Respondent households characterized as lower vulnerability in the baseline survey serve as the base condition.

Water Quantity					
R	R Square	Adjusted R Square	Std. Error of the Estimate		
.683[a]	.466	.463	1.62933		
	Sum of Squares	df	Mean Square	F	Sig.
Regression	2295	6	382.555	144.104	.000[b]
Residual	2626	989	2.655		
Total	4921	995			
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.23	0.15		8.07	.000
Baseline	-0.73	0.03	-0.63	-22.96	.000
CAG	0.39	0.13	0.08	2.90	.004
NonCAG	-0.23	0.13	-0.05	-1.78	.076
Emergent city	1.06	0.11	0.24	9.47	.000
Moderately Vulnerable	0.11	0.13	0.02	0.89	.376
Highly Vulnerable	-0.37	0.16	-0.07	-2.27	.024

Water Quality					
R	R Square	Adjusted R Square	Std. Error of the Estimate		
.721[a]	.520	.517	2.15313		
	Sum of Squares	df	Mean Square	F	Sig.
Regression	4963	6	827.135	178.417	.000
Residual	4585	989	4.636		
Total	9548	995			
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.99	0.17		11.55	.000
Baseline	-0.92	0.04	-0.67	-26.11	.000
CAG	0.44	0.18	0.06	2.45	.015
NonCAG	-0.01	0.17	0.00	-0.04	.967
Emergent city	1.29	0.15	0.21	8.40	.000
Moderately Vulnerable	-0.21	0.18	-0.03	-1.21	.226
Highly Vulnerable	-0.20	0.21	-0.03	-0.94	.350

Flooding					
R	R Square	Adjusted R Square	Std. Error of the Estimate		
.818[a]	.668	.666	1.37155		
	Sum of Squares	df	Mean Square	F	Sig.
Regression	3749	6	624.829	332.153	.000[b]
Residual	1860	989	1.881		
Total	5609	995			
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-0.01	0.10		-0.08	.935
Baseline	-0.91	0.02	-0.86	-40.28	.000
CAG	0.47	0.11	0.09	4.15	.000
NonCAG	0.25	0.11	0.05	2.37	.018
Emergent city	0.47	0.10	0.10	4.80	.000
Moderately Vulnerable	0.24	0.10	0.05	2.30	.022
Highly Vulnerable	0.31	0.13	0.06	2.44	.015

Vector and Water Borne Disease					
R	R Square	Adjusted R Square	Std. Error of the Estimate		
.772[a]	.596	.593	1.39371		
	Sum of Squares	df	Mean Square	F	Sig.
Regression	2833	6	472.203	243.099	.000[b]
Residual	1921	989	1.942		
Total	4754	995			
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	3.28	0.15		21.77	.000
Baseline	-0.91	0.03	-0.76	-36.37	.000
CAG	0.15	0.11	0.03	1.31	.189
NonCAG	-0.06	0.11	-0.01	-0.60	.547
Emergent city	0.27	0.10	0.06	2.77	.006
Moderately Vulnerable	0.07	0.11	0.02	0.66	.507
Highly Vulnerable	0.24	0.12	0.05	1.99	.046

Heat Stress					
R	R Square	Adjusted R Square	Std. Error of the Estimate		
.487[a]	.237	.232	1.54533		
	Sum of Squares	df	Mean Square	F	Sig.
Regression	734	6	122.254	51.195	.000[b]
Residual	2362	989	2.388		
Total	3095	995			
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	2.28	0.17		13.60	.000
Baseline	-0.55	0.04	-0.49	-14.52	.000
CAG	-0.40	0.13	-0.10	-3.10	.002
NonCAG	-0.36	0.12	-0.10	-3.00	.003
Emergent city	0.32	0.11	0.09	3.00	.003
Moderately Vulnerable	0.20	0.13	0.05	1.60	.110
Highly Vulnerable	0.14	0.15	0.04	0.93	.352

Social Capital					
R	R Square	Adjusted R Square	Std. Error of the Estimate		
.578[a]	.335	.331	1.41134		
	Sum of Squares	df	Mean Square	F	Sig.
Regression	991	6	165.103	82.888	.000[b]
Residual	1970	989	1.992		
Total	2961	995			
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	5.50	0.32		16.97	.000
Baseline	-0.72	0.04	-0.74	-19.05	.000
CAG	-1.95	0.17	-0.52	-11.57	.000
NonCAG	-1.34	0.11	-0.38	-11.82	.000
Emergent city	0.19	0.10	0.05	1.91	.056
Moderately Vulnerable	0.18	0.11	0.05	1.65	.100
Highly Vulnerable	-0.04	0.12	-0.01	-0.32	.747

MHT

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