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Social Vulnerability to Extreme Water Events and the Outcomes of Resettlement

A Case Study on the Women in Kannagi Nagar, Chennai

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Summary

Twenty one cities across India are expected to run out of water by 2020. Chennai, the southern metropolitan city, was a little early to the party this year. 'Day- Zero' was officially announced, meaning that as of June 19, 2019, the reservoirs that supplied water to more than 7 million people had run dry. Simultaneously, in the northern, eastern and western parts of India over 1600 people lost their lives and more than a million were severely affected and displaced between the months of June and October 2019. The neighbouring state of Karnataka being one of the most severely affected. Not so long ago, Chennai too was the recipient of a calamitous flood that was a result of both hydrological and man-made triggers. Flooding and drought, two disasters at the end of the same spectrum. One is an event involving an abundance of water and the other revolves around scarcity. Even though this thesis deals with two distinctly and drastically different hydrological disasters, the common ground they share is the recipient of their impacts. Given the rapid rate of urbanization in combination with these calamities, especially in the cities of the Global South, it is evident that displacement and resettlement of large populations is inevitable- scattering, unsettling and ruining livelihoods. In milieu of the now irreversible impacts of the global climate crisis, identification of the vulnerable becomes crucial and urgent. In order to assess and prioritize mitigation and adaptation actions, the most vulnerable need to be identified, aided, and most importantly, empowered if we are to prepare for the "Untold Suffering" that we are headed for, as at least 11,000 scientists have now endorsed.

This thesis, chose to look at a marginalized section of citizens in Kannagi Nagar, Chennai. People who were once inhabitants of the voids of the city. Pushed to the periphery by river-restoration and development projects, as well as the Tsunami of 2004 and the unprecedented flood of 2015. More than 15,000 dwellings, situated on a low-lying marshland deemed unfit for inhabitation and construction, became the basis for the Gynocentric Social Vulnerability Framework for displaced populations and Resettlement sites formulated in this thesis. The focus of the framework on women is founded on the established and scientifically endorsed fact that women are more vulnerable, not just in the spheres of disaster management and climate change, but also by resettlement and DIDR literature. Bridging the gaps in urban resettlement literature and the gendered experiential differences in socio-economic vulnerability to climate change was the objective of this thesis. The research revealed that what makes these settlements and their populations vulnerable is their positioning and location in undesirable areas; the unavailability of employment and services; compounded by the lack of foresight and planning in the construction of these colonies; in addition to the neglect of their physical and mental health outcomes of displacement. The women inhabitants of Kannagi Nagar see themselves as more prone to be socially vulnerable to the negative effects of drought than flooding. The outcomes of resettlement listed previously significantly influenced this vulnerability. Additionally, it was demonstrated that their inherent vulnerabilities that come with household and child rearing responsibilities significantly contributed to the strength of this relationship. This implied that demographically different women would display varied levels of vulnerability. This aspect was also explored and validated; showing that the woman's role in society and the household makes a significant difference to her resilience and vulnerability. The people, particularly the women, of Kannagi Nagar are caught in a feedback loop of the outcomes of resettlement and their vulnerabilities to flood and drought. This is further exacerbated by the stigma associated with these communities. Recommendations for climate adaptation and mitigation pathways, housing policy and construction of future tenements, as well as for further research, have been made. To conclude, in the words of Keller and Wilson, we "ought to recognize the importance of maintaining, intact, communities without broken windows".

Keywords

Acknowledgements

Abbreviations

A1- A3	Assumption 1- Assumption 3
ANOVA	Analysis of Variance
CARE	Cooperative for Assistance and Relief Everywhere
CDMP	City Disaster Management Plan
CNN	Cable News Network
CVA	Capacity and Vulnerability Analysis
DFID	Department for International Development
DV	Dependent variable
FGD	Focus-Group Discussions
GCC	Greater Corporation of Chennai
GCVCA	Gender-Sensitive Climate Vulnerability and Capacity Analysis
H1 – H22	Hypothesis 1 – Hypothesis 22
ID	Identification
IDP	Internally Displaced Persons
IFRC	International Federation of Red Cross and Red Crescent Societies
IHS	Institute for Housing and Urban Development
IPCC	Intergovernmental Panel for Climate Change
IRR	Impoverishment, Risks and Reconstruction model
IV	Independent Variable
M1-M4	Mediating/Moderating Variable 1- Mediating Variable 4
MOVE	Methods for the Improvement of Vulnerability Assessment in Europe
MIDS	Madras Institute of Developmental Studies
MV	Mediating/Moderating Variable
OXFAM	Oxford Committee for Famine Relief
PCA	Principal Components Analysis
PHC	Primary Healthcare Centre
SEZ	Special Economic Zone
SLA	Sustainable Livelihood Approach
SLF	Sustainable Livelihood Framework
SOVI	Social Vulnerability Index
SPSS	Statistical Package for the Social Sciences
SV	Sub-Variable

TAR	Third Assessment Report
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNHS	United Nations Human Settlements
VRA	Vulnerability and Risk Assessment

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Chapter 1: Introduction

1.1 Background

Two projects - one, the proposed restoration of river fronts, and the other, the construction of an elevated expressway over the river - displaced and resettled more than 18,000 families from different slums along the flood plains of Chennai city's infamous Cooum River (Coelho and Raman, 2010, p.19). Kannagi Nagar, a resettlement colony in the capital of Tamil Nadu, India, saw a surge of "resettlement drives" that not only shadowed these development projects but also the unprecedented tsunami (2004), the floods in 2015 and cyclone *Vardah* the following year. "For residents of Kannagi Nagar, their continued susceptibility to floods is now exacerbated by the added vulnerabilities of livelihood loss, severe liquidity crunches and chronic indebtedness, consequences of their distance from economic opportunities in the city" assert Coelho and Raman. (2010, p. 21) This resettlement site that is home to displaced flood victims is built on the Pallikaranai marsh that causes redundant flooding during the monsoon season (Coelho and Raman, 2010, p.21). At present, according to numerous media reports, as of February, 2019, the water that is available at present can cater only to a little over half the city's requirements, groundwater levels are the lowest they have been in the last three years, as are the storage levels in the reservoirs that deliver to Chennai (Chennai Citizen Matters, 2019; The New Indian Express, 2019); and if the floods in 2015 and the cyclone that followed are any indicator of 'how bad it can get', it can be said that in the face of climate change, occurrences of flooding and drought are only going to increase (Oliver-Smith, 2018, p. 2). The amplified vulnerability of people who are marginalized socio-culturally, economically, politically, institutionally or for other reasons is seldom due to a sole factor, as asserted by the Intergovernmental Panel on Climate Change (2014b, p. 50), it is the culmination of overlapping social processes that result in these inequalities, as well as exposure to shocks; "such social processes include […] discrimination on the basis of gender" (IPCC, 2014b, p.50).

A study on the work and livelihoods of the residents of Kannagi Nagar, after a span of 10 years of initial resettlement, showed that relocation had not affected everyone the same way (Coelho et al., 2012, p. 59). It revealed the "gendered segmentation of the market in terms of distribution of occupations" (Coelho et al., 2012, p. 63); it also stated that relocation was the reason for discontinued employment among high-skill and technical workers, increased costs of accessing work for those working in all sectors - particularly affecting women - and caused "loss of networks" (Coelho et al., 2012, p. 63) within the community. Coelho et al (2013, p. 45) showed that the inhabitants occupied themselves in the informal market - domestic work, odd jobs - as a coping method post-resettlement. Diwakar and Peter (2016, p.105) affirm that "the failure of the state to provide affordable, habitable houses with legal security of tenure, access to basic services in (an) appropriate location has violated the internationally acknowledged, 'human right to adequate housing'". At present, nearly twenty years down the line, the community in Kannagi Nagar's resilience is aided by not only their experience in living in already harsh slum conditions, both pre- and post-relocation, but also, the expansion of the city contributing to the slow integration of the otherwise peripheral community back into the city. However, it is contended that they remain more vulnerable than resilient to extreme water events as they reside in poverty and distress, and in a low-lying marshland without having adequate access to financial assistance, health care and basic services (Diwakar and Peter, 2014, p.102-105).

The case of Kannagi Nagar is neither a culmination of unique circumstances nor is it a new phenomenon. Dislocation or displacement of large populations is a phenomenon that has repeatedly occurred over centuries, caused by war, disasters, and large-scale infrastructure development projects (Oliver-Smith, 2018, p.2). Displacement caused by planned development projects is usually deliberate and premeditated and more often than not results in the population being more vulnerable and impoverished, as asserted by Cernea (2000, p.11-13). Within Chennai alone, the neighbouring resettlement colony of Ezhil Nagar, as well as Semmenchery, Perumbakkam (Phases I and II), face similar predicaments. According to the UNFCCC (Glemarec et. al, 2016, p.10), sections of the population that are most vulnerable to climate change impacts are the ones most reliant on biophysical capital for their livelihoods and/or have the least capacity to cope with or respond to drought, floods, hurricanes, and other climate change hazards. It has been repeatedly established that women face greater risk and burden from these impacts in situations of extreme-poverty because of this dependence on natural (biophysical) resources such as land and water, as well as other productive assets, and have unequal access to them because of the diverse social and cultural norms that exist in different parts of the world (Glemarec et. al, 2016, p.10-11). Kratzer and Le Masson (2016, p.15) assert that "*the vulnerabilities of people to environmental hazards are rooted in everyday inequalities and poverty*" in their research on why gender-sensitivity is required for strategies for both, development and climate change.

1.2 Problem Statement

As Arora-Jonsson (2011, p. 744) points out, existing literature on gender and climate change have two positions: women in the global North as relatively virtuous with regards to the environment, and women in the global South as an established vulnerable group in the face of climate change. This thesis seeks to formulate a gynocentric vulnerability framework while objectively establishing the experiential impacts and outcomes of resettlement, and its effects on their subjective current vulnerability and/or resilience of resettled women and women living in resettlement colonies to imminent risks of drought and flood. A framework that measures the current levels of vulnerability influenced by the outcomes of resettlement can provide an effective basis for future adaptation strategies and policies for the case of Kannagi Nagar, as well as for comparable cases of displacement and resettlement. In the context of women being an established vulnerable group, i.e. acknowledging the inherent vulnerabilities of women to floods and drought in resettlement sites by their traditional role in their families and society, and cultural norms that manifest in inequalities of access to services and opportunities, the outcomes of resettlement exacerbate the aforementioned socio-economic vulnerability.

1.2 Research Objective

The objective of this research is to enquire what factors explain the varying levels of vulnerability of women who have been resettled or are currently living in a resettlement colony to extreme water events of flooding, excessive rainfall and drought; with a broader goal of conceiving a framework that could generate adaptation strategies and pathways - a framework that can be applicable and adaptable to similar sites across the developing world. Using Kannagi Nagar, Chennai and the women who reside there as a case study, this thesis seeks to learn what makes the sites chosen vulnerable to flood and drought. It seeks to explore the strength of the effects or outcomes of resettlement - measured by their current living conditions - on the levels of social vulnerability among demographically different groups

of women, in the face of floods and drought. It pursues which factors contribute to making women more, or less, vulnerable, or resilient when confronted with these extremities - while taking into account factors that make them inherently vulnerable to extreme water-events and disasters.

1.3 Provisional Research Questions

The main research question of the paper is:

What are the factors that explain the levels of vulnerability of women to extreme water events such as flood, excessive rainfall and drought in resettlement colonies?

This question probes the following sub-questions that are answered using the context of Kannagi Nagar (Chennai, India) and the women who reside there as a case study:

- *How has resettlement impacted the women of Kannagi Nagar?*
- *Which factors explain the settlement's vulnerability to flooding and excessive rainfall on one hand, and drought on the other?*
- *Which factors explain the levels of vulnerability among women in Kannagi Nagar to flood and drought?*
- *Which factors explain how demographically different groups of women display varying levels of vulnerability to these extreme water events?*

1.5 Significance of the study

One of the key messages of a policy brief based on India emphasizes that urban residents, especially women and other marginalized groups, display different vulnerabilities than their rural counter parts for reasons like weaker social cohesion, making them "more dependent in times of distress and danger; (having a) higher likelihood of flooding and waterlogging due to poor infrastructure and basic services; and a higher likelihood of food insecurity" (Clements et al., 2016, p.1). These gender disparities in the outcomes and impacts of resettlement and in urban resettlement literature have often been ignored (Stanley, 2004, p.14, 15). Women face greater risk and burden from the impacts of disasters, especially in situations of extreme poverty because of their dependence on biophysical resources such as water and land, as well as other productive assets; this unequal access, as put forth by Glemarec et. al (2016, p.10-11) is rooted in the socio-cultural norms that differently manifest in different regions and countries. Clements et al. (2016, p.2, 3) report that many policies and strategies that are developed do not cater to reducing these inequalities and injustices, nor do they represent the participation of women and men equally, implying that the capacities of women are significantly under-estimated. For that reason, a comprehensive study on the capacities and opportunities, as well as the obstacles and vulnerabilities, of women, their families, their social network and their communities informed by contextual knowledge and the assessment of social drivers, as recommended by the IPCC (2014b, p.50), would influence the design and implementation of gender-sensitive policies, plans and strategies.

The UNDP (2012, p.12) promotes vulnerability as an essential part of understanding how and why women are differently impacted by disasters such as flood and drought; and indicates that "inequality, discrimination and socio-cultural barriers" are the main causes contributing to the widening differences in vulnerability between men and women. There is a gap in existing literature on gender and climate change when it comes to researching the coping and adaptation strategies of women in the urban context (Brody et. al., 2008, p.21-23). Therefore, this thesis proposes to address the gaps in gender,

climate change and resettlement literature to explain what exacerbates the vulnerabilities of the women in resettlement sites to flooding and drought. It will explore which outcomes of resettlement intensify this vulnerability and how. This would then give insight on their context-specific coping and adaptive capacities, and what could contribute to their resilience in the face of these impending risks.

1.6 Scope and Limitations

On establishing their biophysical vulnerability to extreme water events, this thesis will then measure and analyses the socio-economic vulnerability of the women in Kannagi Nagar. The indicators used can be generalized to other disasters, but a few are only applicable to situations of excessive rainfall, flooding, and drought. The data obtained from this research will be unique to this study, however the framework and methodology may be adapted and applied to other resettlement colonies facing similar predicaments. The research question has the scope to compare the before and after scenarios of resettlement, however it considers only their current conditions as factors that are the outcomes of resettlement because they concern not just a resettled population, but also residents who have moved (bought and rented) there voluntarily. This is done to avoid analyzing unreliable primary data as a result of probable memory bias among the respondents since the site is now nearly twenty years old. The inclusion of both genders was deliberated upon. However, it was opined that a vulnerability framework that concentrates on the differences in vulnerability would focus more on women being vulnerable. As corroborated by Peter (2019), the women from the slum are among the most resilient in terms of being able to cope irrespective of the shocks and conditions. Therefore, the gynocentricity, or in simpler terms, women being the primary focus of the framework would allow for exploring and explaining not just their vulnerabilities, but their strengths as well.

Chapter 2: Theory Review

2.1 Introduction

This literature review first introduces and reviews the concept of vulnerability to establish a workable definition. It then justifies the gendered focus of this thesis by reviewing and evaluating various gender-sensitive vulnerability assessments, the key factors that determine them and establish women as an inherent vulnerable group, as well as the challenges that arise with assessing the vulnerability of a group of people or a community to disasters. Specifically their social vulnerability to extreme water events that are continuously plaguing different parts of the world and affecting cities, towns and villages alike; and, yet the impacts are felt differently; impacts which depend on the kind of settlement, the kind of disaster, and the demographic group experiencing it. Based on the theory review, a definition of vulnerability that this thesis will adopt is established, specifically *social vulnerability*. An analyses of various social vulnerability models and assessments led to a theoretical framework that will answer the main research question and sub-questions. For the same purpose, it reviews the literature on resettlement and resettled communities. This literature on resettlement informs the independent variables that have been derived in Chapter 3 that measure their current living conditions, which are unquestionably a result or an outcome of resettlement. To support these views and more importantly the operationalization of the framework, qualitative data and reviews of previous research carried out in Kannagi Nagar have also been included (in Chapter 4) to give more clarity on the context of this case study.

2.2 The concept of Vulnerability:

There is no definite meaning of vulnerability and there are countless conceptualizations of the notion of vulnerability; "many of the discrepancies in the meanings of vulnerability arise from different epistemological orientations and subsequent methodological practices" (Weichselgartner, 2001, p. 87) as demonstrated in Table 1. From these closely linked yet varied definitions it can be observed that they stem from different disciplines - food and economic security (Chambers, 1989; Watts and Bohle, 1992, p.46-57), disaster-risk management (IFRC, 2019; Weichselgartner, 2001) - and inferred that definitions are largely contingent on the background of the researcher and context of the investigation depends on the definition adopted. The definitions in the climate change arena either view vulnerability "*in terms of potential damage to a system by a climate-related event or hazard* or as *a state within a system* before it encounters a hazard event" (Brooks, 2003, p.3). The most commonly used definition in climate change literature is based on the Third Assessment Report (TAR) (McCarthy et al., 2001) of the IPCC where vulnerability is expressed in terms of *exposure, sensitivity and adaptive capacity* (Table A).

In the context of a settlement such as Kannagi Nagar, DFID's Sustainable Livelihoods Approach (SLA) is extremely relevant; this relevancy is discussed further in section 2.8. In the framework (SLF), 'vulnerability', provides the context of the external environment, over which the people that are studied have limited or no control over, it views vulnerability "as a state within a system" as similarly expressed by Brooks (2003, p.3). The DFID guidance sheets caution that vulnerability is the consequence of multiple aspects relating to policies and institutions, legal status, defects of the built-up environment, asset deficiency, and wouldn't necessarily denote a trend, shock or seasonality (DFID, 2007, p.65). This is echoed by Cutter et al (2003, p. 243), "Social vulnerability is partially the product

of social inequalities - those social factors that influence or shape the susceptibility of various groups to harm and that also govern their ability to respond." Therefore, the recommended core considerations or determinants of vulnerability prescribed by the SLA are: i) people's *exposure* to a trend, shock or seasonality (in this case extreme water events), ii) how *sensitive* are their livelihoods to these factors (DFID, 2007, p.65).

Table 1: Definitions of Vulnerability, classified by discipline, framework, with components:

Author/s	Discipline/ Framework	Definition(s) of Vulnerability	Variables
Chambers (1989); Watts and Bohle (1992)	-	"exposure to contingencies and stress, and difficulty coping with them"	-
Watts and Bohle (1992)	Causal structure of Vulnerability- food security	"can be defined in terms of exposure, capacity and potentiality (to recover)"	**Exposure, Capacity, Potentiality**
McCarthy et. al. (2001); IPCC (2007); Brooks (2003); CARE International (2014); Fussel (2006); Fussel and Klien (2006)	Multiple frameworks – Climate change	"The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character magnitude, and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity"	**Exposure, Sensitivity, Adaptive Capacity**
Sustainable Livelihoods Approach (Guidance sheets, 2001)	Sustainable Livelihoods Framework	"Vulnerability context: A key component in the SL framework, the Vulnerability context refers to the shocks, trends, seasonality that affect people's livelihoods- often, but not always, negatively. The key feature of all the factors within the vulnerability context is that they are not controllable by local people in the immediate or medium term. Vulnerability or livelihood insecurity resulting from these factors is a constant reality for many poor people."	**Shocks, Trends, Seasonality**
United Nations, 2004	Review of disaster reduction initiatives- disaster risk managment	"the conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards"	**Physical factors, Social factors, economic factors, environmental factors**
Birkmann et. al, 2013	MOVE framework- risk/hazard climate change	"the concept of vulnerability here (in the context of climate change) includes external environmental factors of shock or stress… the magnitude and frequency of potentially hazardous events is to be included in the calculation of vulnerability to climate change, and hence, the vulnerability concept shifts towards a risk definition"	**Exposure, Susceptibility, Lack of resilience, Hazard**
IPCC (2014)	Fifth Assessment Report- climate change	"propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and a lack of capacity to cope and adapt"	**Exposure, Sensitivity, Adaptive Capacity-**
IFRC (2018)	Vulnerabilites and Capacities Assessment for Red Cross Staff and	"the diminished capacity of an individual or group to anticipate, cope	**Potential Risk, Vulnerabilities, Capacities, Needs**

Volunteers- management, security	Disaster-Risk Health	with, resist and recover from the impact of a natural or man-made hazard"

2.3 Women and the Gender-focus- a review of gender-sensitive vulnerability assessments

"T*he vulnerabilities of people to environmental hazards are rooted in everyday inequalities and poverty"* assert Kratzer and Le Masson (2016, p.15) inferring from their research on why gender-sensitivity is required for strategies for development and climate change. Their qualitative research was based on three case studies (India, Kenya and Peru) centered on projects that were implemented in urban areas and focussed on climate change adaptation, mitigation, and had dealt with issues of gender (Kratzser and Le Masson, 2016, p. 3-7). It conclusively showed that discriminatory social customs, disguised as culture, weaken marginalized groups - women, lower castes/classes - and affect the robustness of the system (community) and that these inequalities broaden from just 'needs' to 'choices, decisions, community structure, and power-roles' (Kratzser and Le Masson, 2016, p. 8-17). A report from India (Clements et. al, 2016, p. 1) showed that urban marginalised residents and women demonstrate different vulnerabilities and capacities than their rural counterparts for reasons of weaker social cohesion, poor infrastructure and service provision, and a higher probability of food insecurity. It also showed that the participation of women made a sizeable impact on developing sustainable solutions (Clements et. al, 2016, p.2-3). Yet many policies and strategies do not cater to reducing these inequalities nor are they formed with equal participation and representation of both men and women. This means that the capacities of women are under-estimated substantially. Therefore, a better understanding of their differential capacities and opportunities of individuals, households, and communities informed by the knowledge of the context-specific and clustered social drivers, will give researchers, policy-makers, and planners a better idea on how to implement strategies that holistically represent and include both genders (IPCC, 2014b, p.50). The UNDP (2012, p.12) refers to vulnerability being vital to gaining insight on the gender differential in climate change and points to inequality, discrimination and socio-cultural barriers being the factors contributing to the widening difference in vulnerability between men and women. This is echoed by the IPCC that assert that the differences in the way men and women are impacted by climate change stem from their distinct and divergent roles in society, "the way these roles are enhanced or constrained by dimensions of inequality, risk perceptions and the nature of their responses to hazards"(IPCC, 2014a, p. 50).

The Gender-Sensitive Climate Vulnerability and Capacity Analysis (GCVCA) published by CARE International involves a series of guiding questions at the national, local and community level. It builds on the CVA analysis and includes a series of participatory qualitative methods and tools to choose from, methods and tools that empower and engage the community but with a gender-sensitive focus (CARE International in Mozambique, 2014, p. 7-11, 22-25). The GCVCA carried out by CARE International in Mozambique included an assessment on the impacts of climate change on Mozambique and this assessment identifies climate change and gender inequality as the key drivers of poverty, and an analysis of the policy environment for gender and climate change identifies the critical inequalities that affect climate change (CARE International in Mozambique, 2014, p. 12-21). Oxfam's VRA framework is another tool that takes into consideration the multi-layered nature of vulnerability

and aims to unearth its root causes, drawing attention to not only impacts by climate-change-related hazards such as floods and drought, but also why and how gender inequality and discrimination manifest and contribute to vulnerability (Morchain et. al, 2015, p. 485,486). It advocates for an efficient gender analysis that takes into account context, conditions, policies and structures of governance which inform the bigger picture, uncover assumptions and aid in the implementation of solutions and strategies (Oxfam, 2019). It affirms that analysis of differences in experience between genders is vital in understanding who is more vulnerable and recommends on specifying the target group explicitly, rather than just 'men' or 'women', they need to be classified according to their livelihood or a specific situation/context, for example: "women employed in the informal market" or "men who are agricultural labourers" or "widows with no access to land entitlement" (Oxfam, 2019). Therefore, this thesis has streamlined the focus on "resettled women and women residing in resettled colonies".

2.4 Social Vulnerability- the rationale

The difficulty of operationalizing and measuring vulnerability is attributed to vulnerability being a partly intangible phenomenon with diversity and variability in its definition. The combined expression of vulnerability as a function of exposure and sensitivity is referred to as *biophysical vulnerability* (Brooks, 2003, p.4). It concerns itself with the properties of a system that enable or prevent the impacts of a hazard or disaster, the amount of damage done to a system (Brooks, 2003, p.4). These are indicators of the outcome (Brooks and Adger, 2003, p.2), rather than indicators of a "state within a system"- the view that this thesis adopts. This view stems from scholars who have studied the human aspects and the factors that make groups, societies and communities susceptible to probable future disaster events. It considers the internal characteristics of people, inherent qualities they possess that are a culmination of complex social processes and conditioning (Adger 1999, Adger and Kelly 1999, p. 256,257). Table 2 illustrates the variation between these views.

Table 2: The four categories of vulnerability classified by (Fussel, 2007, p.158) according to the dimensions, sphere and domain of knowledge with examples of indicators, highlighting the sphere and domain adopted by this thesis.

	Sphere	
Domain	*Internal vulnerability*	*External vulnerability*
Socio-economic vulnerability	Household income, social networks, access to information	National policies, international aid, economic globalization
Biophysical vulnerability	Topography, environmental conditions, land cover	Severe storms, earthquakes, sea-level change

Scholars have determined poverty and inequality, marginalization, food entitlements, access to insurance and quality of housing to be factors that make certain groups of people or communities vulnerable to disasters (Adger and Kelly, 1999, p.258.259). Downing and Patwardhan (2003, p.71-73) point out that this is the primary focus of field research that is conducted in combination with vulnerability mapping projects while examining and comparing geographically divided vulnerable sections of populations. This perspective implies that social vulnerability is one of the determinants of biophysical vulnerability (Brooks, 2003, p.4). Although it does not measure the severity of the disaster or the probabilities of occurrence, it does depend on the type of hazard that impacts the society in question (Brooks, 2003, p.4). Social vulnerability indicators that apply for a flood may not apply to drought. However, factors like poverty, inequality, health, access to resources and social standing or

status can be generalized across a range of disaster events (Brooks, 2003, p.4, Cutter et al., p.249). These inherent qualities will be accounted for in the framework which will be discussed in the next section. This thesis will measure the 'social vulnerability of women' to extreme water hazards - floods, excessive rainfall, and drought, in which their (social) exposure, sensitivity and adaptive capacity will be socially determined informing the dependent variable.

2.5 Inherent Demographic Vulnerability Characteristics

In view of women being an established vulnerable group, it becomes necessary to distinguish the difference between the vulnerability of women to hazards, such as flood and drought, and their inherent vulnerability. The former generally refers to "the potential for loss" (Cutter et. al, 2003, p. 242) and was discussed in the previous section. The latter - their inherent vulnerability, or their social vulnerability - is operationalized using their individual characteristics that make them intrinsically vulnerable to disasters. Cutter et al. (2003, p.246-249) list some of the key social vulnerability factors that are commonly accepted by the scientific community. From the array of factors listed, Table 3 illustrates the most applicable and generalizable factors that would influence the social vulnerability of the women in Kannagi Nagar.

Table 3: Inherent vulnerability characteristics (chosen for this thesis as illustrated and reviewed by Cutter et. Al (2003, p. 246-248)

Concept	Description	Sources
Age	"Extremes of age spectrum affect the movement out of harm's way."	Cutter, Mitchell, and Scott (2000), O'Brien and Mileti (1992), Hewitt and Ngo (2001)
Level of Education	"Education is linked to socio-economic status, with higher educational attainment resulting in greater lifetime earnings. Lower education constrains the ability to understand warning information and access to recovery information."	Heinz Center for Science and Economics, and the Environment (2000)
Type of Employment	"Wealth enables communities to absorb and recover from losses more quickly due to insurance, social safety nets, and entitlement programs."	Cutter, Mitchell, and Scott (2000), Burton, Kates, and White (1992), Blaikie et al. (1994), Peacock, Morrow, and Gladwin (1997, 2000), Hewitt (1997), Puente (1999), Platt (1999)
Civil Status	Married women and women with children often are limited culturally and by their responsibilities to their husband and household especially in patriarchal societies.	-
Religion & Caste	"Imposes cultural barriers that affect access to post-disaster funding"	Pulido (2000), Peacock, Morrow, and Gladwin (1997, 2000), Bolin with Stanford (1998), and Bolin (1993)

2.8 The Outcomes of Resettlement
Literature on DIDR & Resettled Communities

Rapid urbanization in countries like India, the increasing prevalence of disasters-both man-made and natural, or a combination of both, have made the discussion of urban vulnerability and displacement a pressing matter of contention (Pantuliano et al., 2012, p. 51). "Besides disrupting the family life of the displaced and the social fabric of communities, the movement of people to non-camp, urban settings

is further exacerbating the vulnerability of the already resident urban poor" expresses Tibaijuka, the Executive Director of the UN Human Settlements program (2010, p. 1). Displacement literature has its roots in the 1970's that was a consequence of rapid urbanization and the rapidly rising number of refugees in both rural and urban landscapes; as pointed out by Pantuliano et al (2012, p. 53) in their review of urban vulnerability and displacement literature. However, they found that most of the literature focused on rural displaced populations, particularly the populations residing in camps. The assessment of urban displacement populations faced impediments in the form of insecurity, the resettlers desire to remain anonymous and the biggest hitch was identification; since urban displaced populations tend to get absorbed by the urban host population. Access to livelihoods and socio-economic integration as themes within resettlement literature surfaced in the 1980s and regained momentum post-2000 (Pantuliano et al (2012, p. 53), and this brings us to the relevancy of the Sustainable Livelihoods Approach. The SLA approach recommends participatory methods like focus groups and key interviews, in conjunction with surveys and secondary data for such analysis that represent and engage all concerned members of the community

One such model that was developed is Cernea's Impoverishment Risks and Reconstruction (IRR) modelling of displacement risk. Cernea isolates the most prevalent components of the complex process that displacement entails (Cernea, 2000, p.19). They are *landlessness, joblessness, homelessness, marginalization, food insecurity, increased morbidity, loss of access to common property resources and community disarticulation* (Cernea, 2000, p.20. To summarize the view that the model takes in the words of Cernea (2000, p.12) himself "The most widespread effect of involuntary displacement is the impoverishment of considerable numbers of people." In a review of Cernea's model, Dwivedi (2002, p. 718) asserts that the model only focuses on capturing the losses that people have borne while there is a plethora of consequences that affect resettled populations. He lists: loss of assets, resources, livelihoods, institutions, networks, traditions, values, identities, rights, entitlements, securities, services and knowledge, half of which are intangible and subjective. The losses of assets and livelihoods that can be operationalized and computed, can also be prevented, and results in contradictory circumstances in which policies cannot account for, compensate or prevent for losses that cannot be computed (Dwivedi, 2002, p. 718). To account for these, social analysis using the SLA (DFID, 2000, p.57) delivers data on pertinent characteristics of vulnerability and social inclusion that includes social position, social axes, the aspects and impacts of exclusion of different groups, the presence and origins of community conflict, power and authority granted by local heads or leaders, as well as by the state and its agencies and other social institutions. This thesis will take these views forward and operationalize indicators based on Cernea's "components of reconstruction". If the 'risks' Cernea put forth are the immediate outcomes, his 'components of reconstruction' the basis for restoring livelihoods (intermediate outcomes), then an evaluation of these reconstruction components would be the ultimate measurement of the outcomes of resettlement.

Majidi and de Paris (2014, p. 78) reveal that women are considered "the vulnerable within the vulnerable" in the contexts of internally displaced persons (IDPs). In their paper on Afghani (urban) displaced women, they find that women struggle to re-establish sustainable livelihoods and their ability to develop coping strategies is highly constrained and depends on the geographic setting in which they evolve. They highlight the importance of the geographical setting of displacement among other things (Majidi and de Paris, 2014, p.79). A study on the women of a resettlement colony in Delhi in the context of food security shows that 77.2% are definitely facing food insecurity (Chinnakali et al., 2014,

p.231). The authors recommend the humanization of their environmental and built up conditions, the provision of employment opportunities and the fortification of the food distribution systems set up by the government (Chinnakali et al., 2014, p.235). The framework developed in this thesis takes these views, as well as Cernea's model into account during the operationalization and selection of indicators that will measure the outcomes of resettlement. With the intention of exploring and explaining the influence of these outcomes on their social vulnerability to the impending risks of climate change as reviewed in the next section.

2.6 Excessive rainfall & flooding

The view that women are more vulnerable i.e. more likely to be hurt or killed in a disaster than men and those who survive it are unlikely to be able to cope, is greatly substantiated and supported in scientific literature. A review of case studies by Rufat et al. (2015, p.472) identifies demographic characteristics, socio economic status, health, coping capacity and risk perception as the principal observed drivers of social vulnerability to floods. They found that their influence varied considerably by the stage of the disaster (pre-, during or post-), setting, and focus on the importance of context. Their socio-economic status is considered an outcome of resettlement. For the purpose of this thesis, their past experience of flooding, coping capacity, health risks, risk perception are considered functions of their social vulnerability to flood events. It has been found that across communities, countries and other socio-economic and cultural borders, women have varied living conditions, coping capacities and perception of risk. (Rufat et. al, 2015, p.474). For that reason, and because it is difficult to make generalizations about women's needs and dependencies some studies have found that gender had no impact on social vulnerability in the face of floods at all. In a study conducted by Ajibade et al. (2011, p. 1718-1723) in Nigeria, found that gender becomes a predictor only when it intersects with other factors like accessibility, income and occupation. The Townsend Index (Townsend et al. 1988) focuses on the consequences of deprivation: unemployment, overcrowding, non-car ownership and non-home ownership (Tapsell et al. 2002, p. 1520).   In the case of this thesis, we are looking at women in a particular urban context - women residing in a resettlement colony, women who have either been displaced and 'forced to the fringes' (Ramya and Peter, 2014) or women residing within this context. On narrowing down the population in question and context, it is possible to generalize certain indicators.

2.7 Drought

The social implications and impacts of drought are a pressing issue in many parts of the world today. "Drought is a slow- onset disaster which occurs cyclically..." "…cannot be treated as the result of natural and physical forces solely, but as the result of a combination of socio-economic and political forces, as cautioned by many scholars (Branco, 1995; Winchester, 1992; Cuny 1983; Maskrey 1989, 1993; Rogge 1992; Wiest et al., 1994; Wilches-Chaux, 1993; in del Melo Branco, 2009, p.262). More people are affected by drought than flooding or any other climatic event (Wilhite et al. 2007, p. 762-763). Kallis, (2008, p. 87) in his review of drought literature, mentions three key social approaches to drought: vulnerability, causation, and perception, further validating the framework developed in this thesis. However, the author (Kallis, 2008) also points out the lack of literature on urban vulnerability in the context of drought. It has been found that usually urban vulnerability to drought studies equate household vulnerability to water supply vulnerability. "We know very little about the characteristics of vulnerable groups in these cities and the structure of their vulnerability". He endorses the study of

differential vulnerabilities of various types of households (Kallis, 2008, p. 102). This recommendation corresponds with the objective of this thesis.

This thesis will take into account factors that directly impact the women in resettlement sites within their geographical, socio-political context in the event of drought. Knutson et al. (1998, p.) identified actions and steps that can be taken to reduce drought related impacts. Here they list and categorize the impacts of drought as Economic, Social and Environmental impacts. The social impacts include stress and health, nutrition, recreation, public safety, cultural values and aesthetic values. However, they too, highlight the importance of context and advise ranking of the impacts based on the population in question, the geographic context, and the cost.

2.8 Comparable case studies and their implications

The case of Kannagi Nagar is not a unique one. The colony not only shares physical, economic and social characteristics with other resettlement colonies in the developing world, but also the way these colonies are discussed, dealt with, and perceived is strikingly similar. This is substantiated by Oliver-Smith (2018, p.20) who reports that many resettlement colonies had the tendency to flood during the monsoon and lacked proper drainage and sanitation; water and electricity for the individual houses comes at a price the people can't afford. Furthermore, these views are shared by Rufat et al. (2015, p.477), in their review, views which state that some authors (Walker and Burningham, 2011) enquire into the bias towards this trend of positioning lower income housing in flood plain areas and the inequality it stands for. After the Indian Ocean Tsunami in 2004, the resettlement of displaced people in Sri Lanka was rushed and unregulated, resulting in poor built-up structures, land titling problems affected the matri-local traditions (gendered impact), contributed to disruption of livelihoods, lacked infrastructure and common facilities (Oliver-Smith, 2018, p.18-20). The people affected and displaced by the development of the Thilawa SEZ in Yangon, Myanmar, filed a complaint that included concerns like loss of economic, livelihood opportunities, and educational opportunities; substandard housing and basic infrastructure; and unavailability of clean water. Therefore, it can be inferred that in places where the complexities of development politics run deep, people that find their homes obstructing 'growth and progress' face resettlement. This is accompanied by a similar set of problems that impact communities - depending on the country, the context, the culture, and norms that exist in a place - and they confront varying impacts and demonstrate levels of vulnerabilities. In a study on the urban poor in Metro Manila (Philippines) it was reported that the most vulnerable communities are settled in low-lying areas, near wetlands or river beds. These populations suffer from the effects of flooding and inadequate access to healthcare. 'Social evils' like drug-abuse, violence and theft plague these areas. Danger zones that were underdeveloped became sites for relocation and housing for the urban poor starting from the 90's (Porio, 2014, p.85-88). These communities, much like Kannagi Nagar are stuck in a positive feedback loop of socioeconomic vulnerability and their vulnerability to the effects of climate change.

2.8 Theoretical Framework:
From the literature review it can be inferred that 'resettlement' can have both positive and negative outcomes on the social vulnerability of women. From various sources of literature that have been reviewed for this paper, their experience in living in undesirable conditions, as well as the slow expansion of the city's limits that brings economic opportunity closer to the community has contributed to their survival up until this day. However, under this silver lining is a grey cloud of

gendered segmentation, lack of information and education, the distance from sustainable economic opportunities, health facilities, bad construction, improper waste and sanitary management and reported lack of social cohesion that makes them socially vulnerable. In addition, women have inherent demographic characteristics that make them socially vulnerable to all disasters. Therefore, adapting Cernea's IRR model and literature on Social Vulnerability to disaster and hazards, this thesis, proposes
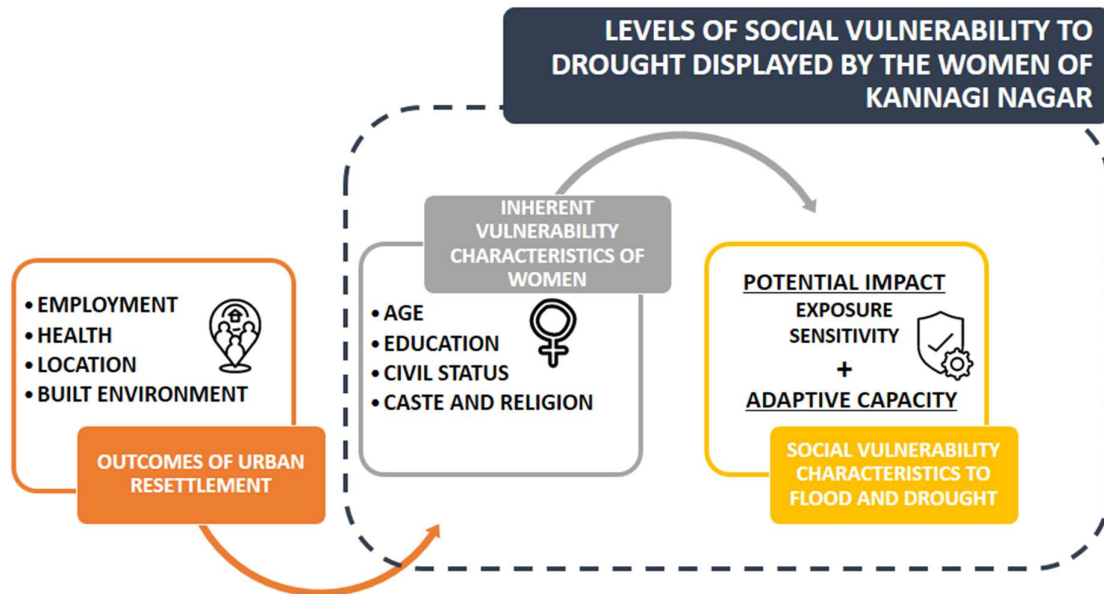
Figure 1: Gynocentric Social Vulnerability Framework to Extreme Water-Events for Urban displaced populations and Resettlement sites.

a 'Gynocentric, Social Vulnerability Framework for displaced urban populations and Resettlement sites. The framework extends Cernea's 'components of reconstruction' and is adapted to suit the urban and gendered context under the Independent variables- 'Outcomes of Resettlement', (as operationalized by Xiao et. al., 2018) that is measured by their current perceptions and living conditions- and its influence on the levels of Social Vulnerability (dependent variable(s)) displayed by women post-resettlement and women residing in urban resettlement colonies to flood and drought. The view of social vulnerability and its operationalization in the framework, adopts the view that the Sustainable Livelihoods Approach takes to vulnerability (refer section 2.2). Their exposure and the sensitivity of their livelihoods will be measured as the potential impact, in combination with their adaptive capacity (as recommended by McCarthy et. al, (2001) and acknowledged by the IPCC. The model will also take into account the mediating variable "inherent characteristics" that make women inherently vulnerable to all disasters. These inherent characteristics in combination with their social vulnerability to flooding and drought make for the various levels of social vulnerability displayed by the women.

Chapter 3: Research Design and Methods

3.1 Revised research questions

The literature review resulted in a slight rewording of the main questions and sub-questions for clarity and specificity. On researching the concept of vulnerability, defining, and operationalizing the elusive term stood out as a challenge. Due to the nature of the context in question and the gendered focus specifying the definition of *Vulnerability* and narrowing it down to *Social Vulnerability* became essential. Also, a part of the women residing in Kannagi Nagar today are the original resettlers, however there is a fair share who have moved into the colony as renters. This research has included all current (women) residents, resettlers, renters who endure and experience life in the settlement.

Consequently, the main research question is:

What are the factors that explain the levels of vulnerability of women, to extreme water events- flood, excessive rainfall and drought in resettlement colonies?

This question probes the following sub-questions that are answered using the context of Kannagi Nagar (Chennai, India) and the women who reside there as a case study:

- *Which factors explain the social vulnerability characteristics to the water events among women in Kannagi Nagar to flood and drought?*
- *How do their inherent vulnerability characteristics affect their social vulnerability?*
- *Which factors explain how demographically different groups of women display varying levels of vulnerability to these extreme water events?*
- *How do the outcomes of resettlement explain the levels of social vulnerability to flooding and drought demonstrated by these women?*

3.2 Research Strategy and methodology

To effectively examine this research question and sub-questions in depth, the Case Study strategy was adopted in this thesis. This was determined because many, mostly unknown variables are involved - factors that explain the levels of social vulnerability of women post-resettlement and women residing in resettlement colonies to extreme water events. "A case study is an empirical inquiry that: investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence is used" (Yin, 1989, p. 23 in Verschuren 2003, p.123). The case in question is of the women who currently reside in Kannagi Nagar and this definition aptly describes the nature of this research. This thesis proposed establishing a causal relationship between the outcomes of resettlement and the factors that make them socially vulnerable to flood and drought. Secondly, it established if the inherent vulnerability characteristics that these women possess strengthens or weakens this relationship. Thirdly, it sought to explain how and why demographically different groups of resettled women display varying levels of social vulnerability to flood and drought.

Therefore, this case study required quantitative data that was obtained from surveying the women who are residents of Kannagi Nagar. The questionnaire was designed to collect primary data required for all indicators independent, dependent and moderating variable(s) in question. This data was justified using interviews that were intercepted while conducting the field-work for the survey. Spontaneous

focus-group discussions were intercepted during survey collection when the respondents were willing.

3.3 Operationalization

3.3.1 Independent Variable(s)   : Outcomes of Resettlement

The impacts of resettlement on Kannagi Nagar were determined by the current state of affairs in Kannagi Nagar. A settlement that has had thousands of families move in since the early 2000s. It has been fifteen to twenty years since some of the residents have moved into this colony that was once at the periphery of Chennai city. Therefore, the risks of resettlement that Cernea (2000) has proposed in his Risks and Reconstruction model may not apply. Another reason they may not apply is because the model was more based on rural displacement and resettlement, or focused on refugee resettlement Xiao et al., (2018, p.4,5). As Xiao et al., (2018, p.3-5) have built on his risks and 'components of reconstruction', the sub-variables and indicators were operationalized and adapted to the context of Kannagi Nagar, under the independent variable *Outcomes of Resettlement.* The variables listed below in Table 5 were adapted based on the context of the site and the age of the resettlement site. Landlessness to Land-based resettlement was excluded because it is more relevant in a rural setting (Xiao et. al. 2019, p. 4).

Table 4: Derivation of Sub-variables for the Independent Variable (Author, 2019)

Primary Risks of Resettlement (Immediate Outcomes) Cernea (2000, p. 20)		Components of Reconstruction (Intermediate Outcomes, p.20) Cernea (2000)		Sub-Variables (Ultimate Outcomes) (Xiao et. al, 2019, p. 5)
Joblessness	⇒	Reemployment	⇒	**Employment and Income**
Homelessness	⇒	House reconstruction	⇒	**Built Environment**
Increased Morbidity and Mortality	⇒	Improved health care	⇒	
				Health status
Food insecurity	⇒	Adequate Nutrition	⇒	
Loss of Access to common property	⇒	Restoration of community assets and services	⇒	**Access to community assets and services**
				(Location)

3.3.2 Mediating Variable(s) : Inherent vulnerability characteristics of women

For the purpose of this thesis, vulnerability was viewed as a "state within a system" or as Brooks (2003, p.3) refers to it as 'inherent vulnerability'. Implying that there are some characteristics that make people, in this case the women of Kannagi Nagar, inherently vulnerable to disasters. The sub-variables and indicators for the mediating variables are based on the Social Vulnerability indicators listed by Cutter et al., (2003, p. 245-249). The four sub-variables were selected for their generalizability across contexts. Caste is the only variable that is applicable to the Indian context alone and could be replaced by any ethnic, racial or religious minority.

Table 5. Sub-variables explanation, justification (Cutter et al., 2003, p.245-249, Fatemi et al., 2016, p.223, 224)

Sub-Variable	Rationale	References
Age	Younger and Older members of a population are considered more vulnerable than others	Cutter, Mitchell and Scott (2000), O'Brien and Mileti (1992), Hewitt

			(1997), and Ngo (2001) in Cutter et. al (2003, p. 246)
Education	Education implies opportunity for employment, employment means an income. Also, education equips people with knowledge and capacity to deal with disasters.		Heinz Centre for Science, Economics and Environment (2000) in Cutter et. al (2003, p. 248)
Caste & Religion	Ethnic, racial and religious minorities are generally socially excluded making them more vulnerable than the majority.		Pulido (2000), Peacock, Morrow and Gladwin (1997, 2000), Bolin with Stanford (1998) and Bolin (1993) in Cutter et al. (2003, p. 246)
Civil Status*	Due to the case studies' context, civil status plays a huge role in decision-making and determines the position of the woman in the household		-

*These indicators were added by the author based on the context of Kannagi Nagar and the patriarchal traditions that exist in this context.

3.3.3 Dependent Variable(s): Social Vulnerability of the Women in Kannagi Nagar to extreme water events

The Social Vulnerability of the women in Kannagi Nagar to extreme water events was measured using recommended and tested Social Vulnerability indicators developed in the context of these events. The sub-variables and indicators are based on the Social Vulnerability indicators listed by Cutter et al., (2003, p. 245-249) and a review of various gendered Social Vulnerability Indices mentioned in the literature review, developed by various scientists to suit events of extreme rainfall, flooding and drought. The operationalization of all the various concepts and variables are given in Table 6, below.

Table 6: Operationalization (Author, 2019)

Variable (Key Concept)	Sub-Variable	Indicators	Survey Codes
Outcomes of Resettlement	**Employment Outcomes**	Satisfaction with current level of Employment, Income Adequacy, Savings Adequacy, Network through Employment	**Q14, Q15, Q16, Q17**
	Health Outcomes	Incidence of Illness, Quality of Diet, Access to Healthcare	**Q28, Q29, Q30**
	Location Outcomes	Employment Opportunities, Education Opportunities, Training Opportunities, Access to Public Transport	**Q18, Q19, Q20, Q21**
	Built Environment	Condition of home, Condition of roads and streets, Condition of Sanitation, Condition of Water Supply, Condition of Public Toilets	**Q22, Q23, Q24, Q25, Q26. Q27**
Inherent Vulnerability Characteristics	**Age**	Physical Fitness, Physical Challenges, Mental Challenges, Physical ability (to save oneself)	**Q1, Q2, Q3**
	Education	General Awareness, Satisfaction with Education, Education Level sufficiency for employment	**Q4, Q5, Q6**
	Civil Status	Influence of civil status on freedoms, Influence of household responsibilities on employment, social life and leisure, Influence of	**Q10, Q11, Q12, Q13**

		child rearing responsibility on employment and social life	
	Caste & Religion	Inequalities faced due to Caste, Religion, Opinion of respondent on caste and religion	**Q7, Q8, Q9**
Social Vulnerability Characteristics to Flooding and Excessive rainfall	**Exposure to Flooding**	Flooding of streets, roads, home, Frequency of Illness during Monsoon, Past experiences of Evacuation of Homes, Kannagi Nagar	**Q43, Q44, Q45, Q46, Q47**
	Sensitivity to Flooding	Occurrence of Property damage, Occurrence of Conflict, Access to Flood relief	**Q48, Q49, Q50**
	Adaptive Capacity to Flooding	Structural changes made inside homes, outside homes, Accountability of community leaders, Network Strength, Ability to Swim, Risk Perception of Flooding	**Q51, Q51, Q53, Q54, Q55**
Social Vulnerability Characteristics to Drought	**Exposure to Drought**	Water shortages during summer, Trend of water shortage, Access to Drinking water	**Q31, Q32, Q33**
	Sensitivity to Drought	Occurrence of Conflict, Disruption of household activities, Access to drinking water, Price trend of drinking water, Shortage of electricity	**Q34, Q35, Q36, Q37, Q38**
	Adaptive Capacity to Drought	Ability to Network, Contactable Network presence, Distribution of water collection responsibility, Risk perception to drought	**Q39, Q40, Q41, Q42**

3.4 Data collection methods

A partial mixed - methods approach was undertaken to conduct the research. Primary quantitative data was obtained from a survey that informs all the independent variable(s), mediating variable(s) and the dependent variable(s). The questionnaire used a 5-point Likert Scale for the questions that answered all the concerned variables. To get clarity on the profile of the respondent, questions of the single or /multiple-choice variety (nominal) were employed. This data was compiled using Microsoft Excel, and statistical analysis was conducted on SPSS. To triangulate this and give better insight qualitative data was obtained from semi-structured interviews and short focus-group discussions that were intercepted while the author conducted the surveys; with respondents who have lived for a long time in the colony and have in-depth experiential knowledge. The qualitative data was used for descriptive, reporting, and quoting purposes to support or challenge the conclusions drawn from the numbers.

3.5 Sample size and selection

For the purpose of this thesis, the random-sample method was chosen. Purposive sampling was an option, but due to the willingness and availability of respondents, feasibility and time constraint, called for a partial-snowball random sample. The respondents, on many occasions, led the enumerators to survey other women they knew. The interviews were purposefully sampled to cover women- young and old, married and unmarried, resettled and non-resettled, as well as owner and renter.

1. **Pilot- Survey:** A pilot survey was conducted with 15 respondents to inform the author of the redundant indicators, as well as to modify and rectify the operationalization of especially the indicators corresponding with the flood and drought-related survey questions (section 4.1.1, Tables 7 and 8)
2. **Survey:** Primary quantitative data was collected through a survey that was translated to Tamil by the enumerator. It surveyed 150 respondents - women who have been resettled and women residing in Kannagi Nagar. A random sample of respondents were surveyed covering most, if not all, age groups, ethnicities-caste and religion, women with varied household structures, single mothers, occupation and heads of households. The number of respondents depended on the feasibility of time and language, of both enumerator and the resident. The final questionnaire can be found in Annexe 1.1.
3. **Survey-intercept Interviews:** Given that most women in Kannagi Nagar are either uneducated or have primary education and speak only Tamil, the survey was in some parts a partial interview, with the researcher translating the questions and filling in the forms based on the answers of the respondent. The primary data collected from the survey was validated or challenged by in-depth interviews with willing residents. A purposive sample of 8 respondents intercepted during the survey field work by the researcher based on a few guidelines, as well as the willingness and knowledge of chosen residents.
4. **Focus-group Discussion:** Depending on the time available as well as the willingness of respondents and feasibility, two spontaneous in-depth focus group discussions were intercepted while conducting the surveys to get further insights on the impacts of resettlement, impacts of flood and drought, their perception of their own vulnerability. A purposive sample of 4-5 women per group was requested to participate, and the length of the discussions depended on their availability and willingness.

3.6 Data analysis

Majority of the analysis was done using the primary quantitative data obtained from the surveys conducted in Kannagi Nagar. Secondary qualitative literature was referenced to give a better understanding of the case and the context. The primary qualitative data obtained from in-depth interviews and FGDs were used as descriptive justifications for the quantitative findings. The quantitative data was first entered and coded on Microsoft Excel. After primary inspection and cleaning of the data, it was then entered into SPSS. The data was then further inspected and the sample was analysed. The indicators were then aggregated to give the sub-variables and the variables; that were then tested and the results analysed. The factors that influence the outcomes of resettlement, inherent vulnerabilities to disasters and social vulnerability to flood and drought were established through Principal Component Analysis (PCA) and checked for reliability. The variables then computed were checked for normality, multicollinearity and then on satisfying the assumptions, multiple linear regression was carried out. This was done to establish if there was a relationship between the outcomes of resettlement and the women's social vulnerability to flood and drought. Differences in the way demographically different groups feel these effects were carried out with one-way ANOVA tests.

3.7 Validity and reliability

One of the main challenges of the case study strategy in research, as mentioned earlier, was that its external validity was intrinsically compromised. The data that was collected was unique to this study

and may not be replicated. The bias of the researcher is another challenge that was (hopefully) overcome by a detailed log and transparent documentation processes from day one. Triangulation of data using secondary data sources is possible to overcome the biases of the respondents and interviewees. While both these biases contribute to the reduction of reliability, their influence on the data was weakened. Another limitation would be an exact translation of the respondents' answers in Tamil to English. The author is from Chennai, India, and although a Tamilian, is a native English speaker with limited Tamil language skills (only spoken). Translations were done to the best of her knowledge with help from students from both the Media Dept., Anna University and Crescent School of Architecture, B.S. Abdur Rahman Crescent Institute of Science and Technology in Chennai.

Chapter 4: Research Findings

4.1 The Context:

The significance of 'the context' has been a recurrent feature in scientific literature of today and the recent past, as well as in this thesis. The next sections will strategically shed light on crucial concepts, events, policies, events and characteristics of the case. To begin with, a brief introduction to Chennai and its propensity to the extremes of both flooding and drought to endorse the relevancy of this study. Furthermore, it becomes important to establish the biophysical vulnerability of Kannagi Nagar to flooding in particular. Drought, being a complex culmination of climatic, socio-political and economic events has been established at the city and state level. The section that follows briefly sheds light on the case: the women of Kannagi Nagar. It explores and reviews relevant studies that explored and evaluated the resettlement process, schemes, policies and acts that have been followed (or not), and the after-math of the resettlement processes and past experiences of the people in Kannagi Nagar. Additionally, based on relevancy, these studies have been used to triangulate and validate the quantitative findings (sections 4.2, 4.3) of this study.

4.1.1 Water-vulnerable Chennai
In the past, Chennai has had many encounters with disasters triggered by heavy rain. These are usually caused by depressions in the Bay of Bengal that progress into cyclonic storms (in 1943, 1976, and 1985). The flooding calamity of 2015 was the most recent and the consequence of unprecedented rain. Scholars caution that it is not just unprecedented rainfall that caused disasters of the scale that was witnessed in 2015; but also: "a) uncontrolled urban sprawl, and loss of natural drainage…", "... b) inadequacy of storm water drainage system and lack of maintenance…", "…c) increase in impervious surfaces…", and "…d) Lack of coordination between agencies" (Gupta and Nair, 2011, p.370). In fact, some scholars question if such events are really 'naturally' occurring (Stephen A., 2016, p. 37-39).

While seemingly paradoxical, Chennai is also particularly vulnerable to water shortages and drought, for the very same reasons. (Sreenivasan et. al. 2013, p. 229- 239). The Chennai Metro Water currently supplies an area 426 sq.km and 74.38 lakh people (Chennai Metro Water, 2018). Sreenivasan et al. (2013) in their study on the impact of urbanization on water vulnerability found generalizable links between the two: First, the water system being decentralized leads to unlawful conversion of irrigation wells to domestic wells; second, the infrastructure, land-use changes, adaptation strategies of households and the physiognomies of the water system; and lastly, that vulnerability of this kind is dynamic, spatially variable and scale dependent (Sreenivasan et al. 2013, p. 235-237). Historically, drought in Tamil Nadu occurs during June-September. In the last hundred years Chennai has been hit

by severe drought due to deficit rainfall a few times (1928-1931, 1968-1970, 2017-2019). There were recurring droughts from 1977 to 1991 that caused mild to severe drinking water shortages in the state (Murugesan, 2001, p. 3, 4). June 19, 2019 was declared "Day Zero" by city officials in Chennai; all four major reservoirs had run dry. In addition to the scarcity of water, the already existing drought conditions were exacerbated due to a major heat wave during May-June 2019 (Murphy and Mezzofiore, CNN, 2019). Droughts are accompanied by several long and short-term process that have been identified in the case of Chennai (Sreenivasan et al. 2013, p. 231, 232). Long-term processes such as the changing land uses (agriculture or barren to urban, unpaved to paved), economic changes (increase in commercial establishments, decrease irrigated area), demographic changes (population density, spatial location, wealth increase) and infrastructural changes were identified; that had equivalent long-term changes in the water system at the household level. Biophysical and socio-economic short term processes that have micro-scale changes at the household level were identified to be the decrease in rainfall, water utility decisions and household decisions (Sreenivasan et al. 2013, p. 232). Apart from flooding and drought, Chennai has also experienced the occasional earthquake (with their epicentres in the Bay of Bengal or neighbouring South-East Asian countries), one of which caused the calamitous Tsunami in 2004.

The after-effect of these disasters, compounded with development projects (restoration of the rivers, construction of elevated expressways) resulted in over 50,000 resettlement dwellings, constructed by the Government of Tamil Nadu in Chennai. Most of these located on the southern peripheries of the city. These housing projects funded by various schemes have been constructed on lands that were once deemed unfit for development. Kannagi Nagar, the host of 15,000 of these dwellings, is located on the
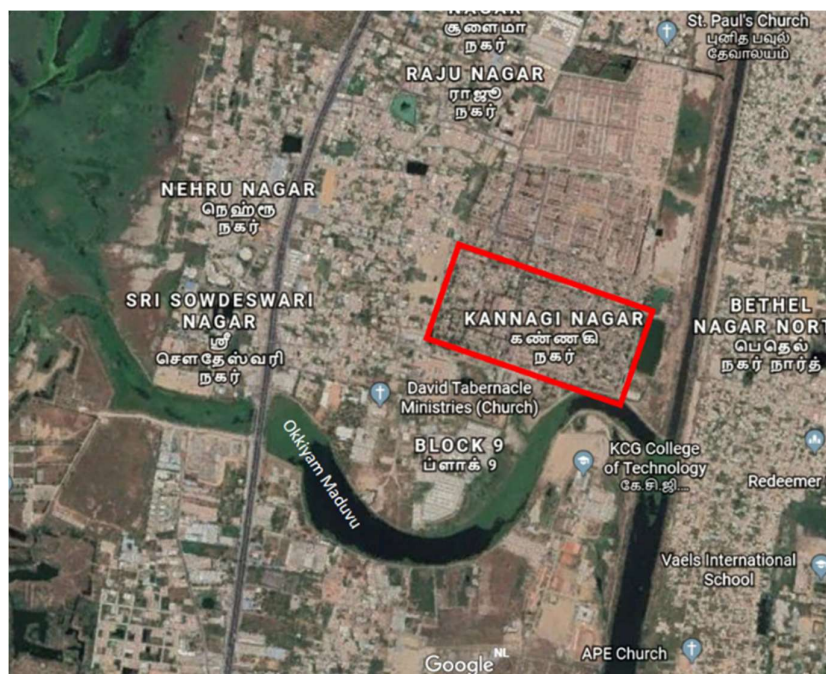
Figure 2: Kannagi Nagar Site Map (Google Earth, 2019)

low-lying Pallikaranai Marshland, very close to the Okkiyum Maduvu, a water channel that drains into the Buckingham canal. Over 90 percent of the Pallikaranai Marsh has been swallowed up by 'urban development'. Apartments owned by the rich and the poor, roads, infrastructure et al. have disturbed the natural pattern of drainage in this region, causing frequent flooding and water stagnation (Jain et al. 2017, p. 3). Many studies have reported the biophysical exposure to flooding of these sites has also been identified in the Chennai master plan. A few quotes from the studies that corroborate this have been listed below:

"Its (Kannagi Nagar) location on a marshland had contributed to degraded living conditions" (Coelho, 2016, p.128)

"The vast scale of construction on an ecologically fragile marshland exposed both the colony's (Kannagi Nagar) residents and the larger area to risks of disastrous flooding. These risks proved disastrous in the floods of December 2015, when large parts of Kannagi Nagar were submerged for several days." (Coelho, 2016, p. 131)

"An immediate and vital concern is the fact that these settlement colonies (Kannagi Nagar, Ezhil Nagar, Semmenchery) are sited amongst floodplains, catchment areas and marshlands. Therefore, the risk of re-flooding is significantly high, especially as these areas had suffered acute flooding in November-December 2015." (Mariaselvam, 2017, p. 20)

"The case studies (Kannagi Nagar and Muthamizh Nagar) also highlighted the understudied ecologies of resettlement. Floodplains, lakes and marshlands feature prominently both in squatters' geographies and in the states choice of resettlement sites." (Doshi, 2013; Coelho, 2013 in Coelho, 2016, p. 133)

The City Disaster Management Plan (CDMP) 2017 formulated by the Greater Corporation of Chennai (GCC) has been the recipient of much criticism. An extensive document (103 pages), that has been published online is only available in English defeating its purpose of being accessible to all citizens (most of whom do not have computer knowledge or access to internet or have literacy in English). This is reflected in their mission statement that underestimates the citizen and her/his role in building adaptive capacity (GCC, 2017, p. vi). Furthermore, the document asserts following the guidelines of the Sendai Framework for Disaster Risk Reduction (2015-2030) but evidently disregards plans to foster resilience among the inhabitants of Chennai (GCC, 2017, pg. 6). The biophysical vulnerability of Kannagi Nagar to Drought has already been established at city and state level in section 4.1.1. Therefore, based on the case and context the following *social* impacts of flooding and drought have been identified and listed below in Tables 7 & 8. These have been previously listed in Chapter 3, Table 6.

Table 7: Impacts of excessive rainfall and flooding and their implications on the social vulnerability in the context of the women of Kannagi Nagar (Author, 2019):

Impact of Flood	Increases Vulnerability (+) / Decreases Vulnerability (-)
Water-logging and flooding of streets	Low-lying areas (+)/ Elevated areas (-)
Structural changes made within house	No changes (+)/Changes that counter flooding (-)
Structural changes made outside the house	Changes that do not help with waterlogging and flooding (+)/ Changes that help with waterlogging and flooding(-)
Frequency of Illnesses	Higher frequency (+)/ Lower Frequency (-)
Strength of network	Weak network (+)/ Strong network (-)
Past experience of evacuation	Evacuation necessary (+)/ Evacuation unnecessary (-)
Past experience of property damage	Property heavily damaged (+)/ No property damage (-)
Ability to swim	Unable to swim (+)/ Able to swim (-)

Table 8: Impacts of drought and their implications on the social vulnerability in the context of the women of Kannagi Nagar (Author, 2019):

Impacts of Drought	Increases vulnerability (+)/ Decreases vulnerability (-)
Seasonal water shortages	Shortage during summer months (+)/ No shortages (-)

Water shortage trend	Shortages increase over last 2 years (+)/ No increase (-)
Access to drinking water	Purchase of drinking water (+)/ Drinking metro-water (+)*
Price trend of drinking water	Increase in drinking water prices(+)/ Steady water prices(-)
Disruption of household activities	Disruption of activities (+)/ No disruption (-)
Occurrence of Conflict	Conflicts occur (+)/ No conflicts (-)
Electricity shortage	Occurrence of shortages and power cuts (+)/ No shortages or power cuts (-)
Inequality of access to water	Some groups dominate access (+)/ Equally shared (-)
Distribution of responsibility of water collection	Responsibility falls on the women(+)/ Responsibility is shared (-)
Strength of Network	Weak network (+)/Strong network (-)
Risk Perception	Low risk perception (+)/ High risk perception (-)

4.1.2 Kannagi Nagar and its women, the Case

Located off, what was known as Old Mahabalipuram Road, now known as the Rajiv Gandhi IT Expressway in Chennai, Tamil Nadu, India, is the resettlement colony of Kannagi Nagar. It takes one around ten to fifteen minutes to cover the 2 kilometre (car) drive from the expressway to the centre of the site; while one narrowly misses colliding into the public buses that turn sharply avoiding rickshaws, bikes, street vendors and pedestrians on a narrow-two lane road. Coelho (2016, p.125) testifies that Kannagi Nagar "is one of a new generation of mass resettlement projects that currently marks the state of the art in slum clearance in Tamil Nadu…a vast working-class ghetto, located outside the city boundaries until 2011." The project, funded by the Flood Alleviation Programme (1998), constructed in phases between 2000 and 2004, had resettlers moving in from 2001. Families were displaced from prime locations in the city like Chetpet, Nungambakkam, Kilpauk, Triplicane, Teynampet, Saidapet, Mylapore, Adyar, Pudhupet and Chintadripet; as well as from Tsunami affected areas like Santhome, Srinivasapuram and Doming Kuppam (Ramya and Peter, 2014, p.126). The tenements vary in design, unit size and design allotted under 20-year hire-purchase arrangements. Peter (2014, p. viii) reports that the resettlement processes concerning notice and eviction, violated national level and state level policies, namely, the National Rehabilitation and Resettlement Policy (2007) and the Tamil Nadu Slum Areas Act (1971). Coelho (2016, p. 126, 129) reported that the greatest fatalities of resettlement for women were employment and education. Another recent study reported that the drop-out rate of children going to school has increased by 30% after relocation, that can be attribute to the lack of schools in the vicinity, shortage of transport and travelling the entailing distance to the nearest schools; adding to which, it reported lack of social cohesion within the residents of Kannagi Nagar as the residents had been evicted from different parts of Chennai (Diwakar and Peter, 2016, p.102-105). Diwakar and Peter (2016, p.105) affirm that "the failure of the state to provide affordable, habitable houses with legal security of tenure, access to basic services in appropriate location has violated the international human rights safeguards including the 'human right to adequate housing'…". Although, a few earlier studies share the view that "Far from being a ghetto of infirm, unproductive, criminalized poor, it (Kannagi Nagar) emerges as a vibrant settlement of working-class people struggling to rise out of poverty." They called for de-emphasizing the losses borne as a consequence of relocation and relocation as the only defining event in the vulnerability of the community's work-life, since it found that it "was no longer a bleak wasteland of despair, but a buzzing site of economic activity" (Coelho et al., 2012, p. 54, Coelho, 2016, p. 128) owing to the expansion of the city, and its proximity to the

now booming IT-sector of Chennai. On the other hand, Coelho el al. (2016, p. 128) ultimately conclude that "despite significant improvements in the last five years, Kannagi Nagar remains notorious and stigmatised as a ghetto of/for poor people."

4.2 Quantitative Data Analysis

The quantitative data obtained from the surveys conducted and coordinated by the author with the women of Kannagi Nagar in Chennai, was coded and analysed using SPSS. The variables were aggregated by performing Principal Component Analysis (PCA) and were tested for reliability by reporting either the Chronbach's α, when applicable (one-dimensional constructs), or the inter-item correlation mean for the multi-dimensional variables. A significant number of members from the scientific community do not recommend using Chronbach's α for testing the reliability of a two-item scale and hence the Spearman-Brown Coefficient is reported (Eisinga et al., 2013, p. 1-8). The variables thus aggregated answer the first two sub-questions, supported by the literature review. Multiple linear regression with moderation is performed to test the hypotheses and answer the third and fourth sub-questions. For an in-depth understanding of the results of the regression models, one-way ANOVA tests were also conducted to compare the means of the sub-variables and report statistically significant differences in the way the women feel the effects of resettlement, and the extreme water events. Similarly, the fifth sub-question is then answered by testing 20 hypotheses for a variety of demographically different groups of women based on the literature review and preliminary impressions from the survey and interviews. Eight in-depth interviews with women residents of Kannagi Nagar supported the quantitative findings. Interviews with the Chairperson of the Madras Institute for Development studies, Dr Karen Coelho and Vanessa Peter, a policy researcher at the Information and Resource Centre for Deprived Communities have been included and their transcriptions can be found in Annexes 2.10 and 2.11. Both researchers have previously conducted and published multiple studies, reports and articles on Kannagi Nagar that have been cited numerous times in this thesis.

4.2.1 Socio-economic characteristics of the women in Kannagi Nagar:

The survey was conducted in Kannagi Nagar and only dealt with women. The total number of respondents surveyed was n=150. The entire colony of Kannagi Nagar was surveyed by the author and students and the area was divided amongst 5 enumerators (including the author). This was done with the aim to include variations in age, income, employment, education, caste, religion and structure of tenement. Variation in civil status was also a requirement, however only 2 respondents were found who were unmarried, 1 was separated from her husband and 18 women (12%) were widowed- mostly due to alcoholism- meaning 86% of the women were married. The average age of the respondents was 42 (both mean and mode-pointing to central tendency), and 42% were in the age range 31-45; 30% were in the range 45-60 and the rest above 60 years or below 30 years of age. Most of the women were uneducated (45%), 28% had only obtained primary level education, while 22% had studied up to middle/higher secondary school. Only 5 respondents had diplomas and 1 had a college degree. Domestic work was the most common employer of the women

Table 9: Sample Characteristics: Age (Author, 2019)

Age Range	Frequency	Percent
18-30	31	20.7
31-55	91	60.7
56-85	28	18.7
Total	150	100.0

Table 10: Sample Characteristics: Civil Status (Author, 2019)

Civil Status	Frequency	Percent
Single	2	1.3
Married	129	86.0

Separated/Divorced	1	.7
Widow	18	12.0
Total	150	100.0

in Kannagi Nagar (32%), while 30% were self-employed or had small informal businesses like tailoring, vegetable/fruit/fish vending or water can businesses; 14% were employed by companies and had formal contracts and salaries, of which 5 respondents were in the public sector. Only 30 of the respondents were unemployed accounting for 20% of the sample population. Only 43% of the respondents drew steady monthly salaries and only 1 respondent was drawing a steady pension. However, 75% felt that their household incomes were inadequate and only 1% affirmed that they had adequate savings for an emergency. A little more than 70% of the respondents had been evicted from different parts of Chennai that were affected during the Tsunami as well as post flood (2015), 44% having already lived in Kannagi Nagar for 11-20 years. Of the women surveyed, 64% were living in houses that they owned and 36% were renters. Of the renters, only 13% were resettled, the rest moved into Kannagi Nagar for economic reasons. Of the house owners, 83% were previously evicted and resettled either after the Tsunami, or the more recent resettlers moved after the floods in 2015 or the Cyclone Vardah in 2016. The 17% that weren't resettled had either bought tenement from resettlers or had received the house as part of their dowry. More than 75% of the sample population belonged to the Scheduled Caste/Tribe category, while the rest belonged to either Backward or Most Backward Caste; 83% were Hindus- only 16 respondents were Christian and 6 were Muslim. More than 60% of the respondents came from male-headed households and 81% of the households were nuclear families; but 42% of the nuclear families were female-headed. In these cases, the head of the household is generally an older-woman (mother/mother-in-law). Less than 4% of the respondents claimed to have no food/water provision responsibilities; 96% said that they were in charge of food, water as well as other household chores on top of taking care of their children/grandchildren. More than 50% of the respondents said that they do not have the responsibility of income generation thrust upon them. Less than 25% have access to either their own vehicle or a family owned vehicle leaving more than 75% dependent on public transport or another person (spouse, family member) for their mobility. Less than 15% of the sample know how to and are using a smart phone with 4G connections but 68% use basic mobile phones without 4G. Only 1 responded reported using a landline connection. Almost 70% of the respondents' households had televisions with cable connections, a few

Table 11: Sample Characteristics: Education Level (Author, 2019)

Education Level	Frequency	Percent
Primary Education	42	28.0
Higher/Secondary Education	34	22.7
College Degree	5	3.3
Diploma	1	.7
Uneducated	68	45.3
Total	150	100.0

Table 12: Sample Characteristics: Employment Type (Author, 2019)

Employment Type	Frequency	Percent
Public servant	5	3.3
Self-employed	40	26.7
Informal Business	6	4.0
Domestic work	49	32.7
Employed by a company	17	11.3
Contract based employment	3	2.0
Unemployed	30	20.0
Total	150	100.0

Table 13: Sample Characteristics: Family Structure (Author, 2019)

Family Structure	Frequency	Percent
Male-headed Nuclear family	80	53.3
Female-headed Nuclear Family	42	28.0

Male-headed Joint family	21	14.0
Female-headed Joint Family	7	4.7
Total	150	100.0

respondents even had radios. Almost 80% of the respondents had Voter-IDs and actively voted in the local and general elections. Out of 150 women, 100 respondents said that they did not participate in community events/ gatherings/self-help groups/politics, 16% said that they were passive participants and less than 10% were leaders or were active participants of the community. Therefore, exploration of participation was not entirely possible. Half of the sample population live in ground floor apartments, with 58% having no access to the terrace of the building, but only 30% complained of poor quality construction and having to deal with cracks and leaks in the structure. Most women (60%) reported having a strong network and 68% said they were attached to Kannagi Nagar and their neighbourhood. Graphs and charts that represent this data can be found in the Annexe.

4.2.2 Aggregation of Variables

Guided by the literature review and the theoretical framework thus operationalized, the independent and dependent variables were aggregated on SPSS. Principal Component Analysis (PCA) was carried out to determine the most significant indicators for the multidimensional independent and dependent variables and then they were checked for consistency by reporting the inter-correlation mean and Chronbach's α. Two-item scales were tested for reliability by reporting the Spearman Brown Coefficient and its significance. Even though the Chronbach's α is not applicable for all variables (mulit-dimensional) the value of .5 is used as a baseline for consistency. Their significance level is marked by * and ** which mean that they are either significant at the 0.05 level or the 0.001 level respectively (the possibility of concluding the presence of a variance or influence between factors when there is no tangible difference is either 5% or 1%, respectively). Aggregation and investigation of the variables alone made for findings that were worthy of note. The associated SPSS output tables and graphs that were not included in the sections to follow can be found in Annexe 3.2.

Table 14: Sample Characteristics: Resetted/Ownership Status (Author, 2019)

Resettlled/Ownership Status	Frequency	Percent
Resettled Owner	88	58.7
Non-resettled Owner	6	4.0
Resettled renter	18	12.0
Non-resettled renter	38	25.3
Total	150	100.0

Independent Variable(s): Outcomes of Resettlement

IV1: Employment Outcomes

The intention, initially, was to use two indicators to compute the variable Employment Outcomes. The respondents' satisfaction with their current employment (*Satisfaction_Emp*); and if the respondent had an accessible network through her employment (*Emp_Network*). The other two indicators- if the respondent had an adequate income for expenditure (*Adeq_Income*); if the respondent had adequate savings for the future/emergencies (*Adeq_Savings*) - were added on noticing negligible correlation between the two employment variables. This negligible correlation could be attributed to qualitative findings that revealed that the distances they travelled to work really determined their employment satisfaction. "*I have to take the bus and then take a share-auto to go to work every day. The time I spend travelling I could be with my kids or take care of household chores.*" (Comment from Survey, Respondent 85). The income and savings adequacy indicators were supposed to be merged to form a two-item scale for Income-based resettlement. On hindsight the indicator- *Emp_Network*- would've better suited for Adaptive Capacity to either flooding or drought. PCA of all four indicators revealed similar results that showed that *Emp_Network* had negligible correlation to the other two indicators. Therefore, *Emp_Network* was excluded from the new variable. The three chosen variables tested

Graph 1: Employment Outcomes of Resettlement (Author, 2019)

for sampling adequacy (KMO= .670) and Bartlett's Test was significant (.000). Chronbach's α was .790 showing high internal consistency. On further inspection of correlations, it was found that all three had significantly high correlations with each other- meaning their satisfaction with their employment highly depended on income (Spearman's rho = .709**) and savings adequacy (Spearman's rho = .519**) and vice versa. The three were then merged to form the *Employment_Resettlement* variable. On aggregation it was found that the women of Kannagi Nagar were more unsatisfied than not, with the outcomes of resettlement on their employment on inspection of the variable. This finding is consistent with the findings of other scholars in Kannagi Nagar so far. The situation with respect to the employment has not improved almost 20 years down the line.

IV2: Health Outcomes

Similarly the variable 'Health' was measured using two indicators. The self-explanatory indicators *Incidence_illness* and *Quality_Diet* were used in this computation. *Access_Healthcare* was the third indicator that was supposed to be included but PCA revealed that the first two had heavier loadings on each other. Therefore for a two-item scale Chronbach's α does not apply and hence the split-half method was used to check reliability. The Spearman Brown Coefficient for the two-item scale was

Graph 2: Health Outcomes of Resettlement (Author, 2019)

then .767 which was very close to the Guttman Split-half coefficient at .766. Therefore the mean of these two scales was used to create the '*Health_Resettlement*' variable. On aggregation and inspection, it was found that the women of Kannagi Nagar are now moderately satisfied with the health outcomes of resettlement. The provision of primary healthcare and services in Kannagi Nagar was the reason for this.

IV3: Location Outcomes

Location is based on access to employment and education and the general accessibility of Kannagi Nagar. This variable was supposed to be measured using Emp_Opp, Edu_Opp, Training_Opp and Acc_PubTrans. However, the discarded *Access_Healthcare* variable was also included in the PCA. The Bartlett's Test revealed that they were significant (.000). On testing the reliability of the five variables, the Chronbach's α was less than .5. To adjust for this,
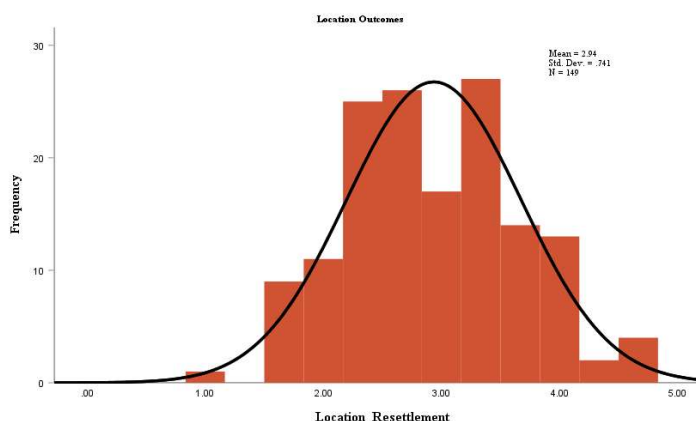
Graph 3: Location Outcomes of Resettlement (Author, 2019)

Access_Healthcare and *Acc_PubTrans* were extracted. The Chronbach's α value then increased to .560. The inter-item correlation mean was within range too (.311). As for access to healthcare, as mentioned earlier qualitative data reveals that the "Amma (referring to Tamil Nadu's former chief minister J. Jayalalitha) PHCs" set up in Kannagi Nagar serve the people who go to them well. Although, they are only primary healthcare centres and do not cater to major injuries or illnesses; for these the residents report they have to travel all the way to the General Hospital in the centre of the city which is 18.5kms away. This however is accessible to the residents via public transport. *"There is one bus every five minutes. Currently we have five lines that connect Kannagi Nagar to different places […]"* reports interviewee 3. Residents, many of whom are still unemployed or do not have steady jobs, report that they have to travel too far to get work and that not only becomes expensive for them, but time consuming as well. Their perception of training, education and employment opportunities available to them significantly correlated with each other. Some women knew of training

opportunities available, empowerment groups but some were entirely unaware of their existence. These were variables that were dependent on the respondent, her situation and circumstances. But when it came to the provision of health care and transport, most women were aware of and satisfied with the provision. On inspection of the variable once aggregated, it was found that the location outcomes of resettlement are quite close to normally distributed; meaning impacts were felt differently by different respondents. Similar findings in other studies have been discussed further in section 4.3.1.

IV4: Built Environment

Vulnerability due to the built environment is a multidimensional variable with various aspects. On component analysis, only 3 of the 5 planned indicators were significant (.000). The quality of their homes (*Cond_PubToilet*) and their streets and roads (*Cond_streets*) provided redundant answers, due to the lack of public toilets and they were mostly content with the streets and roads, most having been newly laid. However, the in-depth interviews and observation revealed that even though they had raised and laid new roads, the houses on the ground floor in some areas still suffered flooding. The

roads in some places were higher than the plinth level of the houses and so the water from the roads drained into their homes. PCA also revealed that these two factors did not have significant loadings. The inter-item correlation mean between *Cond_Sanitation*, *Cond_WaterSupp* and *Cond_home* was within the ideal range (.291). Chronbach's α was satisfactory at .548. Inspection of the correlations between indicators, the positive correlation between the sanitation infrastructure and the condition of their

Graph 4: Built Environment Outcomes of Resettlement (Author, 2019)

homes validated the flooding phenomenon explained above. Sanitation and water supply were strongly positively correlated meaning that satisfaction with the water supply meant sanitary conditions and vice-versa. The three indicators (excluding Cond_streets) were then merged to form the variable *BuiltEnv_Resettlement.* On aggregation, it was found that the built environment outcomes were again closer to normally distributed than even their location outcomes. This distribution is owed to the differences in their satisfaction with the quality of their homes, the sanitation infrastructure and the provision water supply in Kannagi Nagar.

Mediating Variable (s): Inherent Vulnerability Characteristics

Social Vulnerability to events not only comprises of their exposure, sensitivity or adaptive capacity to an event but also needs to take into account certain inherent vulnerability characteristics that populations possess. Gender is one of these inherent vulnerability characteristics. It has been established that women in the same conditions as those from Kannagi Nagar are indeed more vulnerable to climate-change related disasters. This is what justified the sample population for this thesis. However, there are more characteristics that play a role. Four of these have been taken into account for this study- Age, Education, the influence of their Civil Status, Caste and Religion on their vulnerability. These inherent vulnerability characteristics will be added to the regression as mediating variables.

Mediating Variable M1: Age

The sub-variable 'Age' directly depends on the ability of a person to move out of harm's way. Therefore the indicators used to measure this variable relate to the physical fitness of the respondent, their perception of their own fitness (*Physicalfit_recode*); their perception of their ability to escape the consequences of disasters (*PhysicalAbility_recode*); as well as the physical (*Physical_chall*) and mental challenges (*Mental_chall*) that come with age that they might face.

Graph 5: Inherent Vulnerability Characteristics due to Age (Author, 2019)

The former two variables were recoded because they would inversely affect the vulnerability scale. The KMO Measure of Sampling adequacy indicated that the sample is adequate (.605) and the Bartletts test of Sphericity was significant (.000), implying that the components are indeed correlated. The Scree plot indicated a dip after the second component- indicating the third and fourth be extracted. Upon inspection of the correlation matrix it became apparent that *Mental_chall* correlated with the other three indicators the least, and was therefore extracted from the sub-varibale. This was unsurprising because some respondents did not understand the implications of mental health on their day-to-day activities. *"What stress? If I start getting stressed about my problems… nothing will get done. Who will feed my children (if not for me)?"* said Respondent 29 (Comment from Survey), a domestic worker. On testing the remaining three indicators for reliability, it was found to be more reliable than when all four indicators were included (α= .817 > α= .701). On examination of the correlations between indicators, mental challenges were weakly influenced by their fitness and vice-versa. Undoubtedly, their physical challenges and their belief in being able to save themselves, increased with their physical fitness and decreased with age. On inspection of the aggregation, it was found that, on the whole, the women in Kannagi Nagar had moderate to low levels of inherent vulnerabilities due to age.

Mediating Variable M2: Education

Education and employment are closely linked when vulnerability to disasters is the consequence. Therefore this variable is aggregated using one indicator that link the two. The education level of the respondent being sufficient for a secure job (*Edu_LvlR*), the general awareness that comes with varying levels of education (*Gen_awarenessR*) and the respondents' satisfaction with her level of education (*Satisfaction_EduR*) were the three
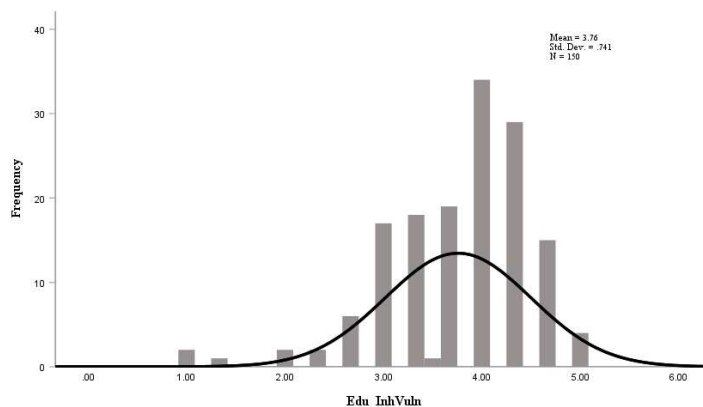
Graph 6: Inherent Vulnerability Characteristics due to Education (Author, 2019)

components that made the cut upon factor analysis and were significant (.000). They were all recoded and then analysed because the questions from the survey shared an inverse relationship with vulnerability. *Edu_LvlR* contributed to the variance the most (60.3%). Most respondents realized the value of education, even if they were uneducated themselves. They aspired to make sure their children received good education. Some residents sent their children to private schools to ensure a good education and learning environment. Some were even shy and embarrassed to admit to the author that they had only studied till primary school or middle school. Those women had to be probed in order to get accurate information on their education levels. *"Put whatever you want, what does it matter?"* joked a few older respondents, when asked about their level of education and if they thought it brought them general awareness and employment. Review of their correlations showed that their education satisfaction was weakly influenced (Spearman's rho = .184*) by their perception of their education level being sufficient for a job. It was however slightly more, but still weakly, influenced (Spearman's rho = .263**) by the general awareness that education gave them. On further investigation of the variables, it was found that their satisfaction was influenced the most by their satisfaction with their employment (Spearman's rho = .593**) and also their perception of the adequacy of their income (Spearman's rho = .468**). Nevertheless, the selected indicators proved to be reliable (α=.661) and the inter-item correlation mean justified the aggregation with a value of .394. On aggregation, the women of Kannagi Nagar displayed moderate to high levels of vulnerability due to education.

Mediating Variable M3: Civil Status

To compute the variable 'Civil Status' and its influence on vulnerability, four components were analysed. Firstly the influence of their civil status on freedom of choice (*CivilStatus_Infl*), the influence of household responsibilities on employment (*Infl_emp*) and on their social life and leisure (*Infl_Soc*), as well as the influence of child-rearing responsibilities on these (*Child_resp*). Most women laughed when asked if they had freedom of choice. *"My husband? He cannot stop me from doing*
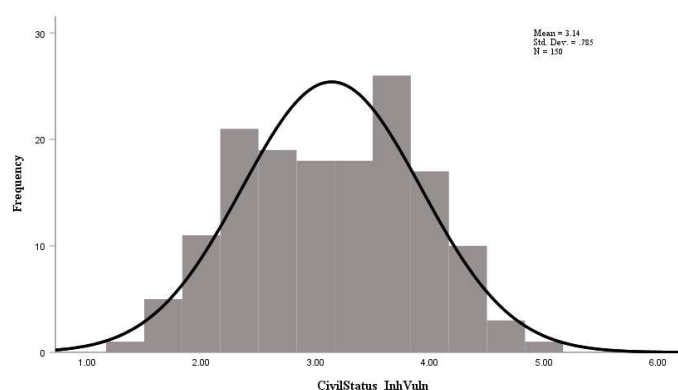
Graph 7: Inherent Vulnerability Characteristics due to Civil Status (Author, 2019)

anything. I don't stop him from drinking away (his earnings). He better not come in my way", said one strong woman, (Respondent 101, Comment from Survey) from Kannagi Nagar during the survey. She had raised both her children mostly on her own. Her husband's drinking problem had been exacerbated by the resettlement to Kannagi Nagar. Unfortunately, hers is not a unique case in Kannagi Nagar. Many resettled women complained of similar spousal problems due to losses of employment and income. However, the author felt that this phenomenon had only made these women more resilient and independent. On performing PCA, it was evident that *CivilStatus_Infl* could be used as a variable on its own, and weakly influenced only their social life and leisure (Spearman's rho = .215*), and therefore was excluded from the newly created variable. On inspection of the correlation matrix it is evident that it has insignificant correlations to all the other three variables. Reliability analysis also revealed a higher Chronbach's α .519 versus α= .572 when only *Infl_emp, Infl_Soc* and *Child_resp*

were counted. However, it is to be noted that the indicators are multi-dimensional and hence Chronbach's α does not apply. The inter-item correlation mean proved to be better in the case of three indicators (.321) rather than four (.213). The indicators were then merged to form the new variable: *CivilStatus_InhVuln.* On inspection of the variable, it was found that the inherent vulnerabilities due to civil status, displayed by the women residents of Kannagi Nagar, were close to normally distributed.

Mediating Variable M4: Caste & Religion

To calculate the vulnerability scores caused by caste and religion, three indicators were analysed. Two indicators that measured the respondents experience with inequalities faced in the community due to caste or religion (*Infl_Caste, Infl_Rel*) and one indicator that measured their opinion (bias/ no bias) on caste and religion (*CasteRel_Opinion*). Here too, the component analysis was significant (.000 < .01). On inspection *Infl_Caste*
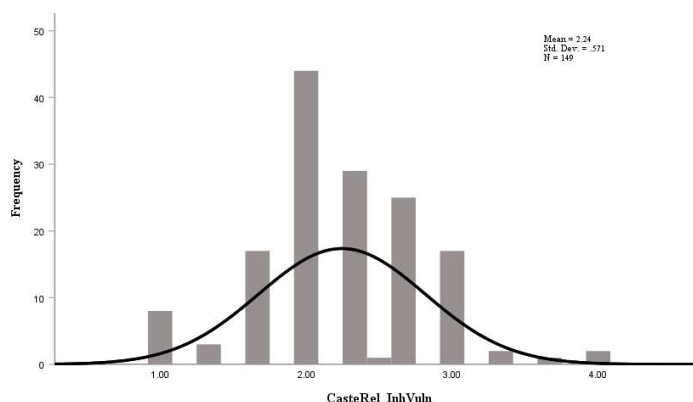
Graph 8: Inherent Vulnerability Characteristics due to Caste & Religion (Author, 2019)

was the highest contributor to the percentage of variance, but the correlation matrix revealed interesting insights. The inequalities they faced based on either caste or religion were also strongly correlated (Spearman's rho = .664**). But the *Infl_Rel* had significant correlation (Spearman's rho = .214**) with *CasteRel_Opinion.* This would mean that their opinion of caste and religion being defining characteristics for their judgement depends more on the inequalities faced by them because of religion, rather than caste. On aggregation of this variable, *CasteRel_InhVuln,* most women inhabiting Kannagi Nagar displayed low levels of inherent vulnerability due to caste and religion.

Dependent Variable(s) DV: Water-Event related Social Vulnerability Characteristics

Excessive rain-fall and flooding on one hand, and drought on the other. These are two extremes- one deals with too much water and the other with too little- and therefore are very different phenomena. This variable is therefore split up. We have the women's Social Vulnerability to Floods (DV2A) on one hand and their Social Vulnerability to Drought (DV2B) on the other. These deal specifically with their vulnerability to the events, measuring their (socio-economic) Exposure to the event, their (socio-economic) sensitivity to the event and their Adaptive Capacity. Not all indicators measured have been used due to either redundancy of data or negative covariance. The break-up of the sub-variables, how they are measured and tested, and the computation of the final variable is given below.

Sub-Variable SV5: Exposure to excessive rainfall and floods

The 'Exposure to Floods' variable is calculated using three of the five planned indicators. The indicators Street_flood and Home_flood were excluded because of negative average covariance and a very low Chronbach's α (0.308). However, it is interesting to note that the two excluded indicators had no correlation with each other or any of the other selected exposure indicators. The qualitative findings revealed and it was observed that where street flooding
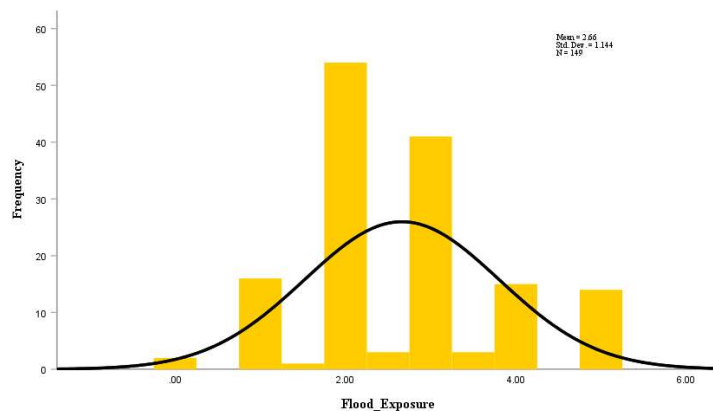
Graph 9: Exposure to Floods (Author, 2019)

does not usually occur, home flooding does. This is explained by the phenomenon mentioned previously. The lower (than the road) level of some ground floor houses causes flooding indoors. This was validated by the influence of the structural changes that were made inside and outside (Spearman's rho = .531**, 671**) their houses (adaptive capacity indicators). The other three indicators (frequency of illnesses, past experience of evacuation) were strongly and significantly correlated. The value of α for the three selected variables (Freq_Illness, Occur_EvacHome, Occur_EvacKN) is .691 which is acceptable. On conducting component analysis, the three variables were found to be significant (.000) and therefore were merged to create the '*Flood_Exposure*' variable. On checking frequency histogram of the vulnerability to flooding, a high percentage perceived themselves as minimally exposed to flooding.

Sub-Variable SV6: Sensitivity to excessive rainfall and floods

The indicators chosen to measure sensitivity to rainfall and floods were the occurrence of previous property damage during the 2015 Floods or the Cyclone Vardah in 2016 (Occur_PropDamage), Inequalities faced while trying to access flood relief during the floods (Acc_FldRel) and if conflicts occurred then (Occur_ConflictFlood). The component analysis revealed that the Occur_PropDamage had the least loading as compared to the Acc_FldRel and Occur_ConflictFlood. Also, the indicators Street_Flood and Home_Flood had better loading with these indicators and was added to sensitivity. On examination of the correlations, their experiences of inequality of access to flood relief and

Graph 10: Sensitivity to Floods (Author, 2019)

their experiences of conflict during the floods influenced each other very strongly (Spearman's rho = .840**). On reliability analysis of the five indicators the Chronbach's α (.751) with the three indicators

was more suitable than with the two new indicators (.551). Since the KMO test revealed that sampling adequacy was slightly lacking (.580) the Chronbach's α of .551 is above the baseline for an inadequate sample. Therefore the five indicators were computed to form the new variable *Flood_Sensitivity.* On checking frequencies of the vulnerability to flooding, a high percentage of the women were minimally sensitive to flooding.

Sub-Variable SV7: Adaptive Capacity to excessive rainfall and floods

The six indicators originally chosen to calculate their adaptive capacity to floods were, *StrucChanges_Inside, StrucChanges_Outside, Accountability, Network_strength, Ability_Swim and RiskPerc_Flood.* These were not recoded because of the inverse relationship that adaptive capacity has with vulnerability (higher their adaptive capacity, lower their vulnerability). Adaptive capacity was measured by the
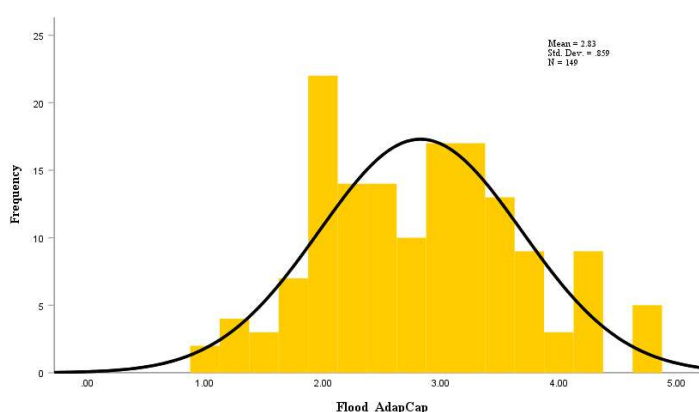
Graph 11: Adaptive Capacity to Floods (Author, 2019)

structural changes the households of the respondents made inside and outside the house as well as the accountability of the community leaders. These three were very strongly influenced by eachother, especially the structural changes made outside their homes and the accountability of their leader, T.C Karuna in this instance. Their ability to swim, network strength, and risk perception to floods was included in the PCA but did not prove to be correlated or consistent with the other indicators and was excluded. The component analysis then proved to be significant (.000) with the other three indicators. The indicators were also significantly correlated (inter-item correlation mean = .298). Chronbach's α was (.713) demonstrating correlation and reliability. The indicators were then computed to give the new variable '*Flood_AdapCap*'. Judging by the significant indicators, it can be said that their pro-active adaptive capacity to flooding highly depended on external factors like the accountability of their leader and the structural changes made outside. On inspection of the indicator for the structural changes made inside their homes depended highly on their income and if they owned their house. Given that the distribution of this variable indicated variances in the levels of adaptive capacity among the women in Kannagi Nagar.

Dependent Variable 1 (DV1): Flood-related Social Vulnerability Characteristics
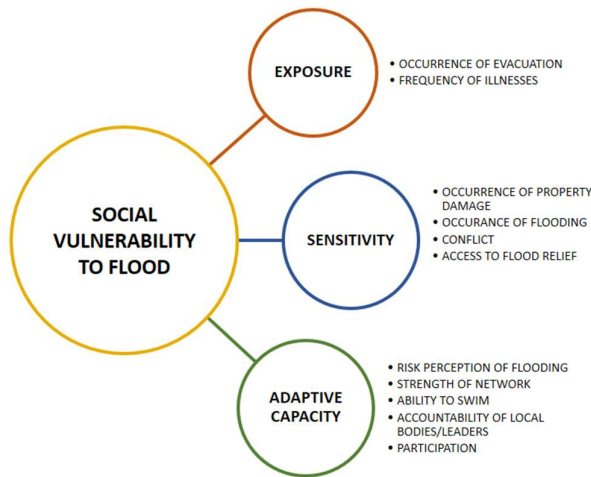
Figure 3: Structure of Social Vulnerability Characteristics to Floods (Author, 2019)

The first independent variable to be tested in the hypothesis is the women's 'Social Vulnerability to Floods'. The concept of vulnerability in the context of climate change and disasters is a function of exposure, sensitivity and adaptive capacity. Therefore the three sub-variables created were then merged to form Independent Variable 1 (IV1): Social vulnerability to Floods. Exposure and sensitivity have strong linear relationships with each other and adaptive capacity was found to have an inverse relationship with them both.

The sub-variables *Flood_Exposure, Flood_Sensitivity and Flood_AdapCap* were merged to compute the IV1. The positive skewness in the distribution (Graph 12) of this variable indicated that they perceived themselves as less to moderately vulnerable to flooding.

Flood_SocVulnChar = **Mean (Flood_Exposure, Flood_Sensitivity, Flood_AdapCap)**
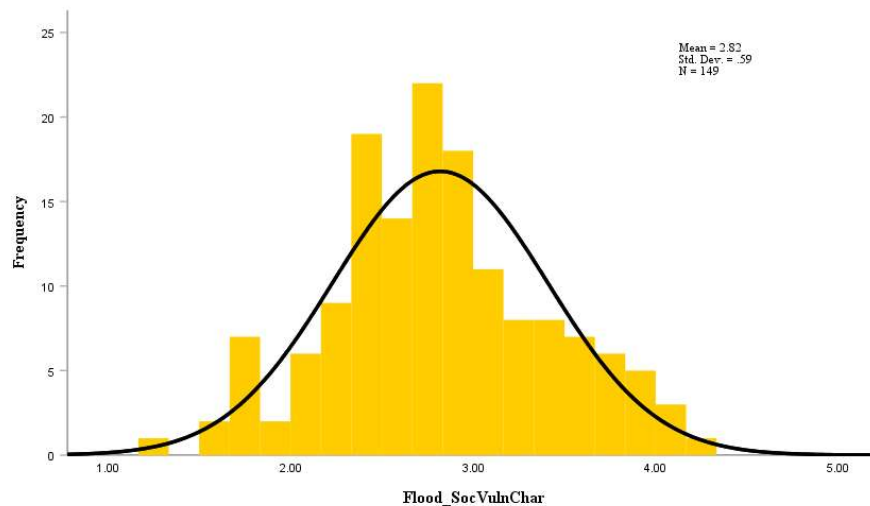
Graph 12: Social Vulnerability Characteristics to Floods- Histogram (Author, 2019)

Sub-Variable SV8: Exposure to drought

"Exposure to drought' variable was calculated using three indicators. The trend of watershortage in the summer (*Watershort_Summer*), trend of watershortage over the last two years (since 2017) (*Trend_Watershort*) and the availability of drinking water (*Acc_DrinkWater*). The component analysis proved significant (.000) and the sample was adequate (KMO= .638). Correlations between all three indicators were significant, positive, and strong. Chronbach's α showed

Graph 13: Exposure to Drought (Author, 2019)

reliability and internal consistency (.759). The inter-item correlation mean for this variable was high but within the acceptable range (.500).

Sub-Variable SV9: Sensitivity to drought

This variable was measured using two of the original four indicators. The indicators chosen to calculate their 'Sensitivity to drought' were the occurrence of conflicts due to shortage of water (*Conflict_Occurance_WtrColl*), if their household activities were disrupted (*HouseAct_Disrupt*). The three excluded indicators were *Access_Water, Electricity_shortage and Trend_WaterPrice.* On component analysis these three were negatively and weakly (almost negligible) correlated to the other two. Also reliability was below the baseline of .5 when all four indicators were considered. *"Electricity getting cut is not really a problem for us. We are used to it"* said one respondent (54, Comment from Survey). Also on investigation it was found that although the price of water had increased this summer (From Rs. 30.00 to Rs. 35.00 in June-July, 2019) the people expected it and didn't seem to mind spending the money as long as they had drinking water. Some people do not buy water and drink the metro water provided to Kannagi Nagar through
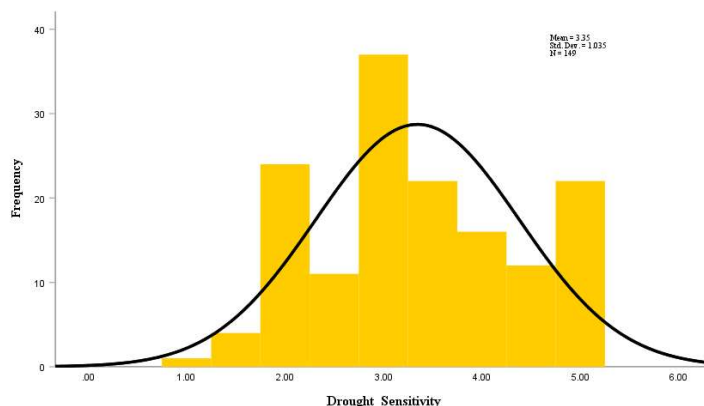
Graph 14: Sensitivity to Drought (Author, 2019)

pumps that are found outside the apartment buildings/houses. The third variable *Access_Water* was excluded because there was a system of water collection set up in most areas. They were allowed two pots per member of a household and the excess distributed equally among all houses. Conflicts occurred but directly because of inequality of access alone. This could explain why the two indicators had no significance on the other two. On checking for internal consistency for *HouseAct_Disrupt* and *Conflict_Occurance_WtrColl* the Spearman Brown Coefficient was just above the baseline (.521). The correlation between forms (Guttman Split-half) was .352.

Sub-Variable SV10: Adaptive Capacity to drought

Of the four indicators planned, two were merged to create this variable. 'Adaptive capacity to drought) in this study is measured using their risk perception to drought (*RiskPerc_Drought*) and their ability to network (*Ability_Network*) and if they have a network in Kannagi Nagar (*Contact_Network*). The indicator that measured if the responsibility of water collection was distributed among family members equally (*WaterColl_RespDist*) was
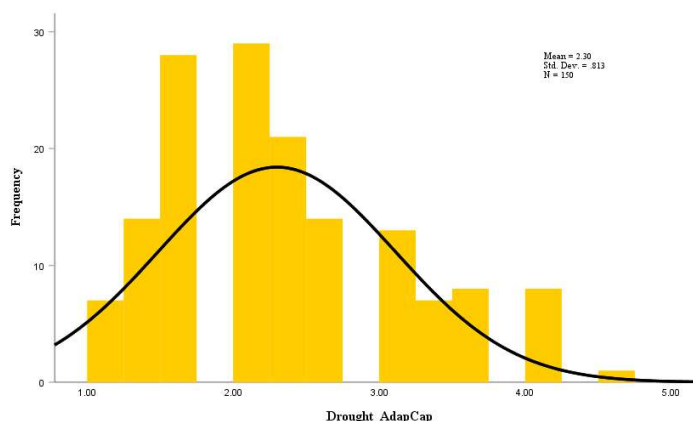
Graph 15: Adaptive Capacity to Drought (Author, 2019)

excluded because the answers were a resounding redundant "Yes/Strongly agree/Agree" because of the current water crisis in Chennai. It was interesting to note that their ability to network weakly, yet significantly negatively correlated (Spearman's rho = .272**) with their perception of risk from drought. The chosen components were then analysed and found to be significant. A split-half reliability was conducted even though it has three variables because the first two are highly correlated and talk about the network dimension of this variable. The Spearman Brown Coefficient for unequal length was .514 and hence the three were merged. The new sub-variable thus formed is *Drought_AdapCap.*

Dependent Variable (DV2): Drought-related Social Vulnerability Characteristics

The second independent variable is the women of Kannagi Nagar's Social Vulnerability to Drought. Here, the relationships between the sub-variables are different from IV1. Here, adaptive capacity has a positive significant linear relationship with exposure whereas there is no significance in its relationship to their Sensitivity. This means that higher their exposure to water shortages, the more their adaptive capacity increases. This phenomenon is probably because of Drought being a current crisis when the survey was conducted. Their exposure to drought however did significantly and strongly influence their sensitivity.
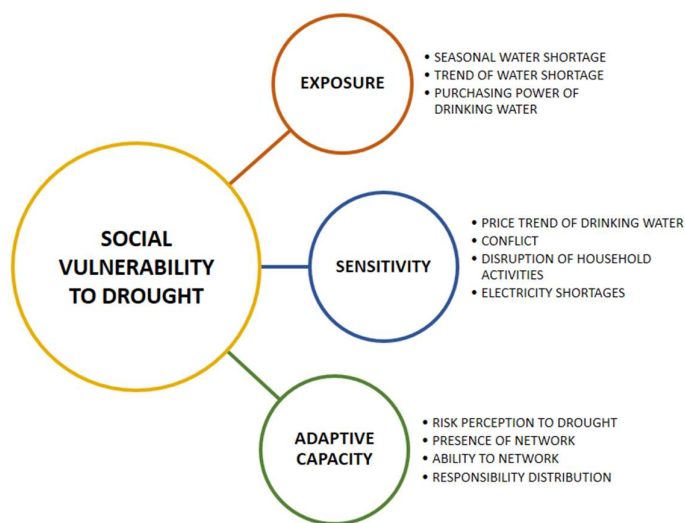
Figure 4: Structure of Social Vulnerability Characteristics to Drought (Author, 2019)

The sub-variables *Drought_Exposure, Drought_Sensitivity* and *Drought_AdapCap* were merged to compute the IV1. There are more respondents with intermediate and high levels of vulnerability than on the lower end, as indicated by the chart below.

Drought_SocVulnChar = **Mean (Drought_Exposure, Drought_Sensitivity, Drought_AdapCap)**
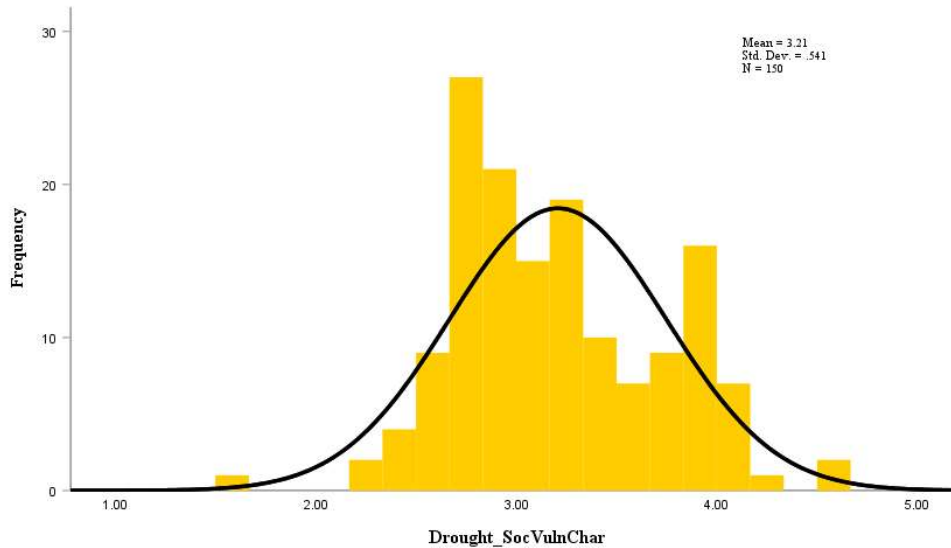
Graph 16: Social Vulnerability Characteristics to Drought- Histogram (Author, 2019)

Dependent Variables: Social Vulnerability Levels to Flood and Drought

The following dependent variables are computed to answer the fifth and final sub-question: *Which factors explain how demographically different groups of women display varying levels of vulnerability to these extreme water events?* This variable will be their social vulnerability score that takes into account not just their flood related vulnerability characteristics but also their inherent vulnerability characteristics.

DV3: Social Vulnerability to Flood
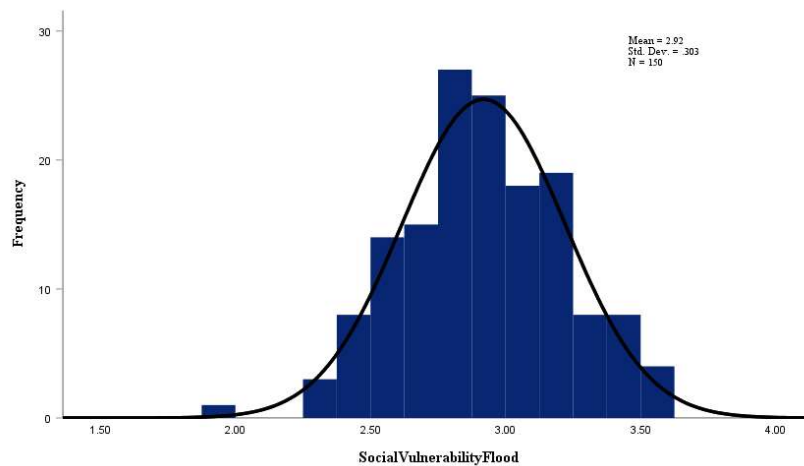
Graph 17: Social Vulnerability levels to Flooding displayed by the women of Kannagi Nagar (Author, 2019)

Their levels of social vulnerability to flood were calculated using all the selected vulnerability characteristics computed in this thesis. On examination of the variable it was found that the effects were close to normally distributed in the histogram. This implied various levels across the sample and is suitable for the one-way ANOVA tests that have been carried out to calculate demographic differences in the levels of social vulnerability the women display. However, this graph is positively skewed showing lower to moderate levels of vulnerability on the whole. The details and description of

the hypotheses tested (comparison of means of different demographic groups) can be found in Annexe 3.4. The discussion and conclusions drawn from these tests can be found in sections 4.3.2 and 5.1.3.

$$SocialVulnerabilityFlood = \text{Mean } (Flood\_SocVulnChar, Age\_InhVuln, Edu\_InhVuln,$$
$$CasteRel\_InhVuln, CivilStatus\_InhVuln)$$

DV4: Social Vulnerability to Drought

The combination of both their inherent and social vulnerability characteristics to drought resulted in this variable. The formula used can be found below. The histogram was close to normally distributed but here, it is negatively skewed. Pointing towards the women of Kannagi Nagar displaying moderate to higher levels of vulnerability to drought. This variable was used to test and compare the varying levels of social vulnerability displayed by demographically women (details in Annexe 3.4 and further discussed in sections 4.3.4, 5.1.3 and 5.1.4).

$$SocialVulnerabilityDrought = \text{Mean } (Drought\_SocVulnChar, Age\_InhVuln, Edu\_InhVuln,$$
$$CasteRel\_InhVuln, CivilStatus\_InhVuln)$$
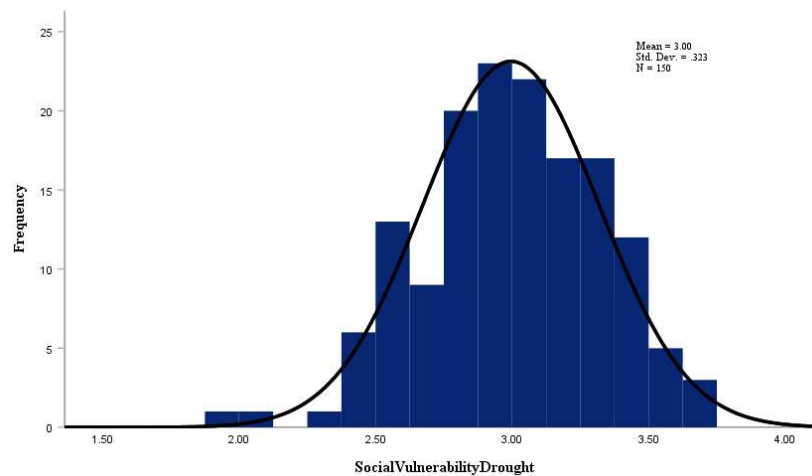
Graph 18: Social Vulnerability levels to Drought displayed by the women of Kannagi Nagar (Author, 2019)

4.2.3 Data Analysis and Hypothesis Testing

Once the variables were analysed tested and aggregated, a regression analysis was run between the DVs and the IVs. Before running the regression the data had to meet certain assumptions that were tested. It is not necessary for mediating variables to satisfy these assumptions.

A1: Normality of Data

The variables *Flood_SocVuln, Drought SocVuln, Employment_Resettlement, Location_Resettlement, BuiltEnv_Resettlement* and *Health_Resettlement* were tested for normality using the Shapiro-Wilk Test. Although considered outdated by some researchers, the Kolmogorov-Smirnov test was also checked. All six variables rejected the null hypothesis that the data is normally distributed (Sig<.05) in the KS test. In the Shapiro-Wilk the Flood_SocVuln was more than .05. The table is found below and the associated histograms in the Annexe.

Table 15: Normality tests for dependent and independent variables (Author, 2019)

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Flood_SocVulnChar	.077	149	.031	.987	149	.172
Drought_SocVulnChar	.103	150	.000	.965	150	.001
Employment_Resettlement	.146	150	.000	.925	150	.000
Health_Resettlement	.185	150	.000	.940	150	.000
BuiltEnv_Resettlement	.102	150	.001	.972	150	.004
Location_Resettlement	.125	149	.000	.972	149	.004

a. Lilliefors Significance Correction

The data was then checked for outliers (Std. Dev. < .329) and upon finding none the data was then transformed logarithmically to be normally distributed. On testing the transformed data the proved to be normally distributed.

A2, A3: Linear Relationship with no or little Multicollinearity

Spearman's rho was used for testing the correlations between data since it is ordinal. The correlation table can be found below with significant correlations between the IVs and the DVs. None were found to be more than 0.90 and therefore multicollinearity is not present.

Table 16: Correlation Coefficients of dependent and independent variables (Author, 2019)

		Correlations					
		Flood_SocVulnChar	Drought_SocVulnChar	Employment	Health	Built Env.	Location
Spearman's rho	Flood_SocVulnChar Correlation Coefficient	1.000	.107	.089	.007	.052	.168*
	Sig. (2-tailed)	.	.194	.282	.932	.533	.042
	N	149	149	149	149	149	148
	Drought_SocVulnChar Correlation Coefficient	.107	1.000	-.294**	-.006	-.498**	-.279**
	Sig. (2-tailed)	.194	.	.000	.947	.000	.001
	N	149	150	150	150	150	149
	Employment Correlation Coefficient	.089	-.294**	1.000	.137	.377**	.314**
	Sig. (2-tailed)	.282	.000	.	.095	.000	.000
	N	149	150	150	150	150	149
	Health Correlation Coefficient	.007	-.006	.137	1.000	.177*	.210*
	Sig. (2-tailed)	.932	.947	.095	.	.030	.010
	N	149	150	150	150	150	149
	Built Env. Correlation Coefficient	.052	-.498**	.377**	.177*	1.000	.413**
	Sig. (2-tailed)	.533	.000	.000	.030	.	.000
	N	149	150	150	150	150	149
	Location Correlation Coefficient	.168*	-.279**	.314**	.210*	.413**	1.000
	Sig. (2-tailed)	.042	.001	.000	.010	.000	.
	N	148	149	149	149	149	149

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Hypothesis 1 (H1): The outcomes of resettlement impact the Social Vulnerability to Flood in the case of the women in Kannagi Nagar (and this relationship is mediated by their inherent vulnerability characteristics)

IVs: Income, Location, Health and Built-Environment as Outcomes of Resettlement

DV1: Drought-related Social Vulnerability Characteristics

Upon inspection of the correlation matrix, it was found that their social vulnerability characteristics to flooding had no significant positive or negative linear relationships with the outcomes of resettlement. The Location variable had a very weak positive linear correlation (.168 significant at 0.05 level) with the dependent variable. This is explained probably by the phenomenon mentioned previously. The roads being at a higher level than the plinth levels of some home causes flooding of the bathroom at the very least. This could also be explained by the fact that Chennai, at the time of the field work, happened to be in the middle of a water crisis – drought. The problems faced by these people because of the lack of water made the floods of 2015 a distant memory. However, statistically this relationship is too weak to run a regression analysis with mediation. Therefore, this model results in validating the null hypothesis.

Null Hypothesis (H0): The outcomes of resettlement do not impact the Social Vulnerability to Flood in the case of the women in Kannagi Nagar

IVs: Income, Location, Health and Built-Environment (as Outcomes of Resettlement)

DV2: Drought-related Social Vulnerability Characteristics

The IV's, however, have significant relationships with the women's Social Vulnerability characteristics to Drought. This can be found in the table below. The significant correlations have been highlighted and flagged. The DV has significant correlations with all IVs except for Health. Health was still used in the regression analysis however because of its significant correlations with Location and built environment. The Negative correlation does not imply that lower the outcomes higher the vulnerability. But it actually means the converse. The measures that were used to score the outcomes were based on satisfaction. Lower the score, lower was their satisfaction and that makes the outcome negative.

Hypothesis 2 (H2): The outcomes of resettlement impact the Social Vulnerability to Drought

This hypothesis is tested with multiple linear regression in the first model with the IVs and DVs alone. This is done to establish a causal relationship between the outcomes of resettlement and their Social Vulnerability to Drought. On running the regression, an R square value of .256 indicated that the outcomes of Resettlement accounted for 25.6% of the variance in their Social Vulnerability to Drought. This may be low but in the context of Drought which is a culmination of complex social events it is an acceptable value. However on inspection of the standardized coefficients it can be seen that only Income and Built Environment are significant in this relationship. Health and Location have negligible significance. The f-test showed that the model explained for a high amount of
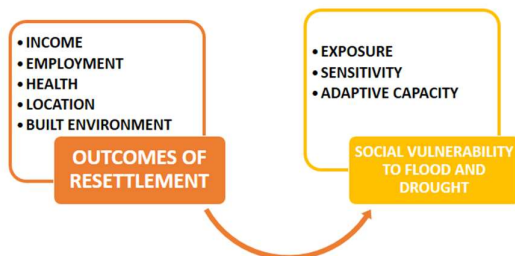
Figure 5: Model 1- Hypothesis, H1 (Author, 2019)

significance and therefore the null hypothesis can be rejected. The Tolerance and VIF for all predictors were below 0.1 and 10 respectively, therefore the assumption that there is little or no multicollinearity is justified further. The P-Plot shows that the points follow the normal line with no strong deviations indicating the residuals are normally distributed. The hypothesis (H2) is, therefore, confirmed.

Table 17: Model Summary of Hypothesis H2 (Author, 2019)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.506[a]	.256	.235	.47453

a. Predictors: (Constant), Location_Resettlement, Health_Resettlement, Income_Resettlement, BuiltEnv_Resettlement

Table 18: ANOVA table for Hypothesis H2 (Author, 2019)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.132	4	2.783	12.359	.000[b]
	Residual	32.426	144	.225		
	Total	43.557	148			

a. Dependent Variable: Drought_SocVuln

b. Predictors: (Constant), Location_Resettlement, Health_Resettlement, Income_Resettlement, BuiltEnv_Resettlement

Table 19: Regression Coefficients of variables in model for Hypothesis H2 (Author, 2019)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.063	.201		20.221	.000
	Income & Employment	-.113	.056	-.159	-2.035	.044
	Health	.062	.041	.112	1.529	.129
	Built Environment	-.287	.055	-.431	-5.257	.000
	Location	-.009	.059	-.013	-.159	.874

a. Dependent Variable: Drought_SocVuln

Hypothesis 3 (H3): The outcomes of resettlement impact the Social Vulnerability of Drought and this relationship is mediated by their inherent vulnerability characteristics

This hypothesis is tested with multiple regression and this model includes M1, M2, M3 and M4. On running the regression it can be seen that the R square value significantly changes to .324. These means
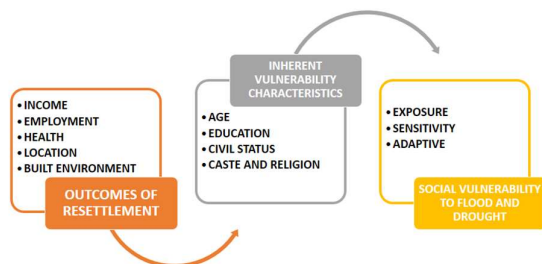
that in combination with the mediating variables the model accounts for 32.4% of the variance in their Social Vulnerability to drought. The ANOVA table showed strong significance. On inspection of the standardized coefficients it can be seen that the contribution the mediating variables make is low, the highest being Civil Status (.104). Tolerance and VIF showed that multicollinearity is not present. P-Plot shows normal distribution of the residuals.

Therefore, the hypothesis (H3) is confirmed.

Table 20: Model Summary of Hypothesis H3 (Author, 2019)

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.537[a]	.289	.269	.44949
2	.569[b]	.324	.285	.44456

a. Predictors: (Constant), Location_Resettlement, Health_Resettlement, Income_Resettlement, BuiltEnv_Resettlement
b. Predictors: (Constant), Location_Resettlement, Health_Resettlement, Income_Resettlement, BuiltEnv_Resettlement, Age_InVuln, CasteRel_InVuln, Edu_InhVuln, CivilStatus_InVuln
c. Dependent Variable: Drought_SocVuln

Table 21: ANOVA table for Hypothesis H3 (Author, 2019)

ANOVA[a]

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.735	4	2.934	14.521	.000[b]
	Residual	28.891	143	.202		
	Total	40.627	147			
2	Regression	13.155	8	1.644	8.321	.000[c]
	Residual	27.471	139	.198		
	Total	40.627	147			

a. Dependent Variable: Drought_SocVuln
b. Predictors: (Constant), Location_Resettlement, Health_Resettlement, Income_Resettlement, BuiltEnv_Resettlement
c. Predictors: (Constant), Location_Resettlement, Health_Resettlement, Income_Resettlement, BuiltEnv_Resettlement, Age_InVuln, CasteRel_InVuln, Edu_InhVuln, CivilStatus_InVuln

Table 22: Regression Coefficients of variables in model for Hypothesis H3 (Author, 2019)

Coefficients[a]

	Model	Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	4.141	.191		21.654	.000
	Income	-.135	.053	-.195	-2.552	.012
	Health	.064	.038	.120	1.669	.097
	Built Environment	-.274	.052	-.426	-5.290	.000
	Location	-.031	.056	-.043	-.552	.582

2							
	(Constant)	3.341	.414		8.063	.000
	Income & Employment	-.141	.054	-.203	-2.601	.010
	Health	.073	.039	.138	1.871	.063
	Built Environment	-.264	.052	-.411	-5.123	.000
	Location	-.020	.056	-.028	-.355	.723
	Age	.088	.047	.144	1.873	.063
	Caste & Religion	.095	.068	.102	1.405	.162
	Civil Status	.104	.052	.154	2.014	.046
	Education	-.013	.054	-.019	-.251	.802

a. Dependent Variable: Drought_SocVuln

4.2.4 Summary

The tested hypotheses are tabulated below with confirmation or refutation with statistically significant substantiation. Hypotheses H1- H3, test the theoretical framework. To be precise, the relationship between independent variables (Outcomes, IV1-IV4) and dependent variables, DV1 and DV2, i.e. the social vulnerability characteristics to flooding and drought that are moderated by the inherent vulnerability characteristics (M1-M4). The description, details, associated tables, graphs and charts of the testing of the statistically significant different levels (DV3 and DV4) of the social vulnerability to flooding and drought (Hypotheses H4-H23) displayed by different demographic groups of women in Kannagi Nagar can be found in Annexe 3.4.

Table 23: Summary (Author, 2019)

Abbr.	Hypothesis	Method/ Test	Statistical Evidence	Deduction
H1	**Hypothesis 1:** The outcomes of resettlement impact the Social Vulnerability to Flood in the case of the women in Kannagi Nagar (and this relationship is mediated by their inherent vulnerability characteristics)	Spearman's rho correlation coefficient	Weak correlation between the DV and IVs.	**Null Hypothesis (H01) confirmed.** The outcomes of resettlement do not have an impact on their social vulnerability to flooding and excessive rainfall.
H2	**Hypothesis 2:** The outcomes of resettlement impact the Social Vulnerability to Drought	Multiple linear regression	R square value of .256 indicated that the outcomes of Resettlement accounted for 25.6% of the variance in their Social Vulnerability to Drought (.000 sig.)	**Hypothesis (H2) confirmed.**
H3	**Hypothesis 3:** The outcomes of resettlement impact the Social Vulnerability of Drought and this relationship is mediated by their inherent vulnerability characteristics	Multiple linear regression with mediation	R square value significantly (.000 sig.) changes to .324, implying that the mediating variables strengthen the relationship of the DV and IVs.	**Hypothesis (H3) confirmed.**
H4, H5	**Hypothesis 4, 5:** The levels of Social Vulnerability to Flood and Drought are significantly higher	One-way ANOVA (Comparison of means)	F values (21.877, 17.516) are statistically significant (.001 > .000, .000)	**Hypotheses (H4, H5) confirmed.**

	depending on the age of the women in Kannagi Nagar.			
H6, H7	**Hypothesis 6, 7:** The levels of Social Vulnerability to Flood and Drought are significantly different depending on the number of years the women have lived in Kannagi Nagar.	One-way ANOVA (Comparison of means)	F values insignificant.	**Null Hypotheses (H$_{06}$, H$_{07}$) confirmed.** The levels of Social Vulnerability to Flood and Drought do not significantly differ depending on the number of years the women have lived in Kannagi Nagar.
H8, H9	**Hypothesis 8, 9:** The levels of Social Vulnerability to Flood and Drought are significantly higher or lower depending on the education level of the women in Kannagi Nagar.	One-way ANOVA (Comparison of means)	F values (9.280, 11.244) are statistically significant (.001 > .000, .000)	**Hypotheses (H8, H9) confirmed.**
H10, H11	**Hypothesis 10, 11**: The levels of Social Vulnerability to Flood and Drought are significantly higher or lower depending on the women's type of employment.	One-way ANOVA (Comparison of means)	F values insignificant.	**Null Hypotheses (H$_{010}$, H$_{011}$) confirmed.** The levels of Social Vulnerability to Flood and Drought do not significantly differ depending on the women's type of employment.
H12, H13	**Hypothesis 12, 13:** The levels of Social Vulnerability to Flood and Drought are significantly higher or lower depending on the caste of the women in Kannagi Nagar.	One-way ANOVA (Comparison of means)	F values insignificant.	**Null Hypotheses (H$_{012}$, H$_{013}$) confirmed.** The levels of Social Vulnerability to Flood and Drought do not significantly differ depending on the caste of the women in Kannagi Nagar.
H14, H15	**Hypothesis 14, 15:** The levels of Social Vulnerability to Flood and Drought are significantly higher or lower depending on the religion of the women in Kannagi Nagar.	One-way ANOVA (Comparison of means)	F values insignificant.	**Null Hypotheses (H$_{014}$, H$_{015}$) confirmed.** The levels of Social Vulnerability to Flood and Drought do not significantly differ depending on the religion of the women in Kannagi Nagar.
H16, H17	**Hypothesis 16, 17**: The levels of Social Vulnerability to Flood and Drought are significantly different depending on the civil status of the women in Kannagi Nagar.	One-way ANOVA (Comparison of means)	F-value (3.908) significant (.05 = .05). F-value (2.618) insignificant (.108 > .05)	**Hypothesis 17 confirmed.** **Null Hypothesis (H$_{016}$) confirmed.**
H18, H19	**Hypothesis 18, 19:** The levels of Social Vulnerability to Flood and Drought are significantly different depending on the family structure of the women in Kannagi Nagar.	One-way ANOVA (Comparison of means)	F- value (3.301) significant (.05 > .020) F-value (1.219) insignificant (.305 > .05)	**Hypothesis 18 confirmed.** **Null Hypothesis (H$_{019}$) confirmed.**

H20, H21	**Hypothesis 20, 21:** The levels of Social Vulnerability to Flood and Drought are significantly different depending on the number of members residing in the households of the women in Kannagi Nagar	One-way ANOVA (Comparison of means)	F values insignificant.	**Null Hypotheses (H_{020}, H_{021}) confirmed.** The levels of Social Vulnerability to Flood and Drought do not significantly differ depending on the number of members residing in the households of the women in Kannagi Nagar
H22, H23	**Hypothesis 22, 23:** The levels of Social Vulnerability to Flood and Drought are significantly different depending both their resettled status and their ownership	One-way ANOVA (Comparison of means)	F values insignificant.	**Null Hypothesis (H_{022}, H_{023}) confirmed.** The levels of Social Vulnerability to Flood and Drought do not significantly differ depending both their resettled status and their ownership

4.3 Discussion

The main finding of this research, conducted among the women of Kannagi Nagar, Chennai, is that the outcomes of resettlement have a significant effect on their levels of social vulnerability to drought. Unlike pluvial flooding, that is a primary result of excessive rainfall, drought is not just a hydrological consequence but also the culmination of socio-economic events. Also, their inherent social vulnerability characteristics strengthens the effects that the outcomes of resettlement have on their vulnerability to drought. Lastly, it was established that certain groups of demographically different women display statistically significant differences in the levels of their vulnerability to both flooding and drought. The following discussion is classified by the main concepts explored, described and explained in this thesis.

4.3.1 The Outcomes of Resettlement- as experienced by the women of Kannagi Nagar

The independent variable(s) 'Outcomes of Resettlement' structured the context of the Gynocentric Social Vulnerability Framework to extreme water events that resulted from this thesis. To demonstrate the effect of this variable, informed at the outset by a review of resettlement and sustainable livelihoods literature, but primarily and predominantly shaped by the case in hand- the women of Kannagi Nagar, Chennai. Derived from Cernea (2000)'s IRR model and the study conducted by Xiao et al. (2018, p. 3-5) to suit, and by some means simplify, the complex urban context of Chennai, one of India's biggest metropolitan capital (of Tamil Nadu) regions. Kannagi Nagar, at present is neither at risk from the immediate consequences of displacement, nor at an intermediate stage of reconstruction. *"In the beginning (life in) Kannagi Nagar was extremely difficult, but we have come this far- having lived here for 14-15 years now- and it cannot be said that (the colony) has not improved."* said interview partner 1, mother of two grown children, displaced and resettled in Kannagi Nagar after the Tsunami. After almost 20 years, having endured and experienced displacement and resettlement and the resultant stresses, shocks and trends, when it comes to the 'Outcomes of Resettlement', Kannagi Nagar is undoubtedly a case in point.

The outcomes of resettlement that were explored and explained were the employment (and Income) outcomes, the health outcomes, and the attributes of location and the built environment as experienced and perceived, exclusively by the women of Kannagi Nagar. The possibility of including education

outcomes was deliberated upon, however in the case of this framework that considers the inherent vulnerabilities of women, their education levels had more theoretical and statistical bearings on their social vulnerability to disaster events. Of the 150 respondents, 70% had inadequate incomes for their expenditure and 90% had no savings, 60% were unsatisfied with their employment and only 30% believed that their place of work gave them a strong network. Women who were employed by companies, engaged in domestic work or were public servants felt they had stronger networks than those on contract-based employment or, the unemployed (statistically significant difference .001 > .000). Studies by Coelho et al. conducted in Kannagi Nagar in 2013 and 2014 showed that domestic work, among others, gave the women an income that they could control and it gave them access to emergency loans and assistance from their employers; they saw it as a way to educate their children and the additional advantage of flexible work timings gave them the flexibility to run their own homes (Coelho et. al, 2013, pg. 43-46) while, the formal sector jobs were found to be segmented by gender, women more vulnerable than the men (Coelho et. al., 2012, p. 62). Other groups that were tested (classified by age, education level, caste, religion, civil status, family structure, and resettler-status or owner/renter status) showed statistical differences in terms of income and savings adequacy, or in terms of employment satisfaction. Their dissatisfaction with their employment, however, was also significantly correlated (Spearman's rho = .314, .001 > .000) to the distances (Location outcomes) between Kannagi Nagar and their place of work. Most women were happy with the public transport system. In fact, one of the resettled respondents (Respondent 31, Comment from Survey) felt like the provision of the bus line to and from Kannagi Nagar would not have happened if not for the upheaval caused by residents. *"(While building,) they did not even think about it till we created a scene […] we had to remind them that we were voters,"* she said. This was echoed by Coelho (2019), who said *"They have brought water through their protests and demands; they have been able to ensure regular water supply (pre-drought) […] they have become a political constituency that has brought them certain things (infrastructure)."* However, the women of Kannagi Nagar still feel the burden of distance. *"The time I take to travel, I could be spending time with my kids or doing house-work"* said one interviewee 6 (Annexe 2.7). These findings were consistent with previously conducted studies in Kannagi Nagar, women were found to be concentrated in jobs that were specific to location and therefore highly vulnerable to the effects of relocation (Coelho et. al., 2012, p. 63). Additionally, they spend more time commuting than the women and men of centrally located Sreenivasapuram, Chennai (Srinivasan and Rogers, 2005, p. 268). Furthermore, the residents of Kannagi Nagar (men and women) spend significantly more time and money on travelling to work. The same study even found that the residents of Kannagi Nagar had lower incomes than when they resided in their more centrally located tenements. The study concluded that location indeed plays a significant role in the travel behaviour of low income residents in Chennai using the inhabitants of Kannagi Nagar as the sample population (Srinivasan and Rogers, 2005, p. 266-273).

Her observation was made pre-drought. During the survey, a respondent complained that the distance and time it takes to travel to and from Kannagi Nagar caused numerous inconveniences and disruption, especially during this drought season of scarcity and uncertainty, *"I am almost always at work when they supply water at the pumps and even if I leave from there… by the time I am home the water is over."* The common water-pump facilities, shared by at least two-four apartment buildings, was found to be inconvenient to 60% of the respondents. Although, this inconvenience could also be attributed to the water being supplied only once in six or seven days during the time of the fieldwork. On comparing

the means (one-way ANOVA) between different age-groups it was seen that the negative effects of the location of Kannagi Nagar affected the women aged 31-55 the most. Most of the women younger than that have lived in the area all their lives or had gotten and were now married to someone who lived there. The older women who did not work or travel much seemed unaffected by the outcomes of location. All age groups, but especially the youngest and oldest age groups (18-30, 56+) were more strongly (statistically significant) dissatisfied with the employment and skill training opportunities lacking in the vicinity of the colony. The younger women found it difficult to travel to work and manage their household and child rearing responsibilities. The older (56+) women, most of whom were unemployed, either by choice or because they had never got employment opportunities since moving into Kannagi Nagar and had just given up. *"I get opportunities to sweep (the roads, parks, schools) but once in a while [...] I have now given up the idea of a steady income, my husband also makes a little (money) [...] we manage between the two of us."* Women who were employed based on informal contracts, employed by companies (far away from KN), and unemployed had also faced the brunt of location outcomes of resettlement. It is certainly evident that location outcomes are heavily entwined with the outcomes of employment, income and the built environment. However, statistically, the built environment outcomes play the biggest role in terms of its effect on their social vulnerability to drought. Peter (2014, p. 13) reported that the sizes of the individual units were inadequate for families. The initial tenements were only 195 sq. ft. This was then increased to 310 sq. ft. under the JNNURM scheme, which grossly undermines the size (538 sq.ft.) recommended by the national resettlement policy (2007[1]), as well as the act passed in 2013[2] (Peter, 2014, p. 13). The effect of the quality of the built environment and its effects on their social vulnerability to drought will be discussed in section 4.3.4. The health outcomes explored, contributed to negligible variances in their levels of social vulnerability. The negative health outcomes were faced women who were employed based on contract (construction work, cleaners) and widows based on the answer frequencies. Women mostly complained of skin issues (rashes, discoloration) due to the quality of water supplied to Kannagi Nagar. One respondent even complained that the water, sometimes, smelt like urine. The ill effects of the health outcomes were distributed randomly over the sample since the differences in the means of any of the tested groups were not statistically significant when it came to the health indicators. However, their statistically significant correlations to the Location and Built Environment outcomes was the reason they were included in the model that tested and confirmed the hypothesis.

4.3.2 The Inherent Vulnerability Characteristics of the women of Kannagi Nagar to disaster events

During the review of vulnerability and disaster literature, it became evident that establishing four parameters became crucial: First, the definition and view of vulnerability that the study and framework has adopted. Second, the time period/s the study has assessed and explored. Third, the study area and its larger context; and finally, the sample population and their demographic characteristics. The fourth parameter became a crucial factor in the framework developed in this thesis. The framework takes a gynocentric point of view to Social Vulnerability to extreme water-events which functions under the presupposition that the women are an established vulnerable group in the face of disaster events. This entailed scientific acknowledgement that they possess certain inherent vulnerability characteristics that make them susceptible to risk in the event of any kind of climate-related disaster event; as carried out

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[1] National Rehabilitaion and Resettlement Policy, 2007
[2] Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013

in Chapter 2. Consequently, Age, Education level, Caste, Religion and, Civil Status were the individualities that were generalizable across various contexts and have sufficient scientific evidence to support their selection. These variables also became the basis for selecting the different groups tested to verify or refute Hypotheses 4-23.

On further inspection of their inherent vulnerability characteristics and their indicators, it was found that the younger women (18-30 years old) in the sample saw themselves as fit, physically able to save themselves from a disaster event, and face lesser physical and mental challenges. The women aged 31-55, faced significantly more mental challenges (Tukey HSD, Mean Difference IJ = +/-.941) as compared to their younger counterparts. Interestingly, the uneducated women and widows in the sample saw themselves as less able to save themselves in a disaster event, by a statistically significant (F-values, .001>.000, .05>.001, respectively) margin. This was predicted by Coelho (2019), *"There are widows who would be vulnerable […] (they may not) have jobs and they do not have any support, so they have actually- zero. […] Another huge issue is illness […] one cannot find job because (one's) illness doesn't allow (one) to go out in the crowded city."* Similarly the uneducated women also seem to have more physical challenges due to age than the educated women. Likewise, the women who have been displaced and relocated, perceive themselves as less able to save themselves from a disaster than their non-resettled counterparts, irrespective of their owner/renter status. Their employment levels, caste and religion did not make a difference to their levels of perception of their fitness, ability or experiences of physical and mental challenges. Women between the ages of 18 and 30 were found to be the most satisfied with their education level, the amount of general awareness that it brought them and if their level of education was enough to get a secure job. This brings us to the second inherent vulnerability characteristic explored: Education level. Most of them had received a higher/secondary level of education but 11 out of the 31 respondents were unemployed. All of them having at least one child found that to be more of a priority and did not mind being unemployed as long as their partner supported them. Informal business owners (street vendors) and contract based employees were unsatisfied with their education levels, almost all of them (but one) being uneducated and drawing unsteady incomes. Significant differences in the means of the three age groups were found. The women between the ages of 18-55 felt the brunt of this inherent vulnerability more than their older counterparts. The youngest age group (18-30) felt that their household and child-rearing responsibilities had a significantly high impact on their employment and leisure. When it came to their inherent vulnerability due to Civil Status, investigation revealed that the influence of their spouses on their choices and decision making however was closer to neutral, than positive or negative for all groups. Statistically, non- resettled women felt the brunt of their household responsibilities affecting their employment and vice-versa. Most of the phenomena described above is illustrated by one woman who participated in an impromptu FGD with the author and three other women. A 38 year old widow who ran a small tailoring business out of her home, who had moved to Kannagi Nagar due to economic reasons. Her husband had passed away in 2015. She had two children to take care of. Her circumstances limited her to her home-tailoring business because she could not travel too far outside Kannagi Nagar to work. She was not able to get loans from banks because of the *"bad name that Kannagi Nagar has"*. She had been trying for months to get a small personal loan of 5 lakh Rupees (around $7000) to expand her tailoring business, educate her children and make repairs at her house. *"The bank people send me away after hearing that I live in Kannagi Nagar."* In addition, the affirmation by Coelho in 2016 (p. 129), that their household responsibilities in a poorly serviced site, the lack of networks and their

responsibilities of child care combined with distance, timing and transport compelled many women to leave their jobs. The implication of this finding is that rather than spousal restrictions, it was their pre-defined role in society as a home-maker and the responsibilities that come with it make them intrinsically vulnerable.

Finally, the implications of India's infamous Caste system and the complexities of religion: The data revealed that that their opinion of caste and religion correlated more with the inequalities experienced by them because of religion, rather than caste. This is unsurprising because most people in Kannagi Nagar are either from the Scheduled Castes/Tribes or Most/Backward Classes. Some people had strong biases towards people of other religions. *"I do not talk to Muslim families."* said one older lady (Respondent 84, Comment from survey)v. On pursuing that declaration, the author was told, *"They could be good people, maybe [...] I would rather keep my distance."* The inter-item correlation mean was within range (.334) for the three indicators. They were then merged to form the sub-variable-*CasteRel_InhVuln*. Age-wise, the older women felt that they faced significantly (statistically, .05 > .016 F-value) more inequalities due to their caste. The younger women, however, almost always disagreed. The mean differences of the means (Tukey HSD, Mean Difference IJ = +/-.776) between the Muslim women and their Hindu counterparts for *Infl_Rel,* were statistically significant. On inspection of the Means plot, the Muslim women faced inequalities due to religion more than their Hindu counterparts, and the Christians featured somewhere in between. There were no significant differences in terms of Caste and Religion between the other various groups of women (education level, employment type). In conclusion, their inherent vulnerability characteristics made for several noteworthy findings as variables on their own, as well as a part of the larger theoretical framework of this thesis. The role they play in their levels of social vulnerability to extreme water events is discussed in the sub-sections that follow.

4.3.3 Levels of Social Vulnerability, to Pluvial Flooding displayed by the women of Kannagi Nagar, and comparisons of the levels displayed by demographically diverse groups of women

On establishing the definition, domain and sphere of vulnerability that this thesis adopts, the framework attempts to bridge the gaps in resettlement literature in the context of the imminent risks of climate change to extreme water-events; specifically pluvial flooding and drought. They are disasters at two ends of the spectrum when it comes to water. This section deals with one end of the spectrum-too much water, a consequence of unprecedented amounts of rainfall. The case at hand involves a resettlement colony in Chennai, India and focuses on the women that reside in the colony who have experienced the severest of consequences of 'too much water'. On one hand we have the city that experienced a catastrophic pluvial flood in 2015 and the devastating Cyclone Vardah one year later. Most resettlers in Kannagi Nagar were displaced and
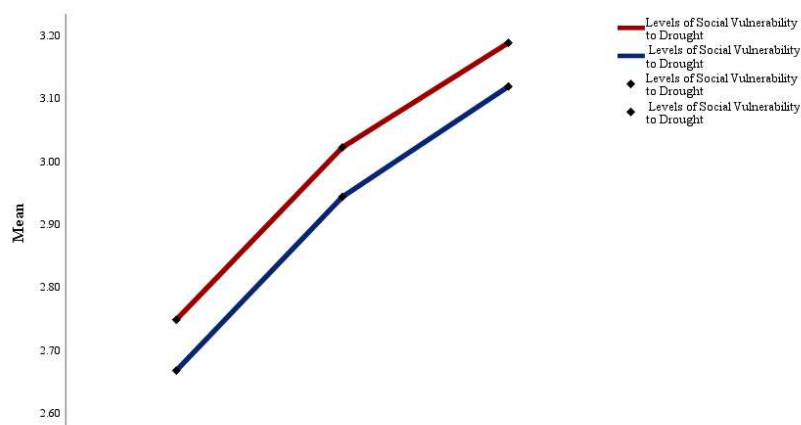
Graph 19: Levels of Social Vulnerability to extreme water-events by Age Group (Author, 2019)

relocated post-Tsunami in 2004. Therefore, this thesis examines their perceptions of their exposure, sensitivity and adaptive capacity to flooding and drought. Consequently, combining these socio-economic vulnerability characteristics with their inherent vulnerability scores how different demographic groups perceive their levels of social vulnerability to flooding (and in the next section drought). The first hypothesis tested was the relationship between the outcomes of resettlement and their social vulnerability characteristics (Exposure, Sensitivity, and Adaptive Capacity) to flooding. On finding that only the Location outcomes had a weak yet significant correlation with these characteristics (.168, significant at the 0.05 level), the model was not pursued. If the correlations were stronger and more significant, the second step would have been to check if their inherent vulnerability characteristics strengthened or weakened this relationship. Nevertheless, having already identified and established them as a vulnerable group to these water-events, the levels of their composite Social Vulnerability scores (including inherent vulnerability individualities) of various demographic groups were compared and tested for statistically significant differences. Of the ten hypotheses tested, three were confirmed statistically. It should be noted that since a random sample was collected, limitations were present in the form of unequal group sizes. On the whole the women displayed low-moderate levels of social vulnerability to flooding. They perceived themselves as minimally exposed and sensitive to flooding as compared to drought, with higher levels of adaptive capacity.

Graph 20: Levels of Social Vulnerability to extreme water-events by Family Structure (Author, 2019)

On further scrutiny of their exposure, sensitivity and adaptive capacity indicators and variables. On comparing the means between groups who varied in the length of their residence in Kannagi Nagar, it was found that women who had lived there longer than 10 years and the women who had moved in the last five years and had experienced the 2015 floods were more aware of their exposure to flooding. Additionally, it can be inferred that the built environment does play a role in their social vulnerability to flooding. The occurrences of street and home flooding did not correlate (Spearman's rho = -.036) due to occurrences of home flooding even without occurrences of street flooding. Similarly the indicators measuring structural changes made outside and inside were highly positively correlated (Spearman's rho = .800**). Owed to the raising of the main roads and pavements, the low lying houses get flooded and water stagnates from the run-off of the roads. Houses that had made structural changes inside (raising plinth, bathroom levels) had higher adaptive capacity to this phenomenon than ones who had not. The structural changes outside was highly influenced by the accountability of the community leader, the local councillor TC Karuna, in this case. Whereas, the structural changes were

owed to adequacy of income as well as being on the ground floor. However, this is an indicator of household level vulnerability and not just the women of Kannagi Nagar. The implications of this will be discussed further in the conclusions (sections 5.1.1, 5.1.4)

The women displayed statistically significant differences in social vulnerability to flood by i) Age (H4, F value = 21.877, .001>.000 sig.), ii) Education Level (H8, F value = 9.280, .001>.000 sig.) and iii) Family Structure (H18, F value = 3.301, .05>.020 sig.). The youngest age group (18-30) tested were within the ranges of 18-30 and they were found to be the least vulnerable (Tukey HSD and Games-Howell, Mean difference IJ, 31-55 = +/- .27593; 56+ = +/- .45142, .05 sig.); with the levels of vulnerability increasing with age. Predictably, the women aged 56+ were found to have the highest levels of vulnerability. Confirming the hypothesis that social vulnerability increases with age. It was also found that it was not because they perceived themselves as more or less exposed, sensitive or adaptive to flooding but because of the interaction of those variables with their inherent vulnerabilities. With respect to education levels, it was found that more educated the woman, the lesser are her social vulnerabilities to flooding. Unlike age, their adaptive capacity made a difference to their vulnerability (decreased) and not just their interaction with their inherent individualities. Additionally, it was learnt that the female-headed households, irrespective of them being nuclear or joint families are more vulnerable than the male-headed families. On inspection, it was found that this difference was owed to their inherent vulnerabilities and not differences in their exposure, sensitivity or adaptive capacity. These findings are not unique to Kannagi Nagar and they only reinforced the experiential differences of gender when it comes to disaster events.

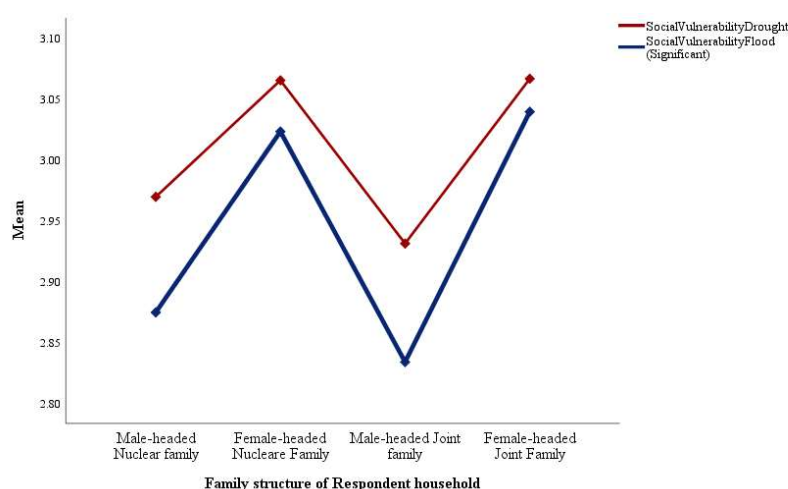### 4.3.4 Levels of Social Vulnerability to Drought displayed by the women of Kannagi Nagar, and comparisons of the levels displayed by demographically diverse groups of women

Unlike pluvial flooding, drought is a slow-onset hydrological disaster that is a culmination of multiple events across various societal scales, some of which are beyond the scope of this research. Nevertheless, it is an event that can be summarized as 'the absence of water'. As much as it is a consequence of a complex set of events, it also entails a complex set of consequences. The city of Chennai has experienced the failure of the monsoons multiple times in the past and was experiencing severe drought whilst the data for this thesis was being collected. *"Right now, one of the biggest problems we are facing is the 'thanni-prachanai' (water problem)"* report most of the respondents. *"We used to get water very regularly, every alternate day- maximum once in two days. But now, it quite unpredictable. It comes maybe once every week, twice a week if we are lucky,"* said one of the interviewee 8. This research confirmed that the outcomes of resettlement faced by the women of Kannagi Nagar does have an effect on their exposure, sensitivity and adaptive capacity to drought. Strong and significant correlations were found with all outcomes, except for health. The most statistically significant factor in the regression model was found to be the built environment contributing to 22.5% of the variance. This variance was because of their unhappiness with the current water situation and ranked the water supply infrastructure the least, which correlated with the water-shortage. This in turn affected the sanitation infrastructure and the condition of their homes. Also, the condition of their homes heavily depended upon their employment and income outcomes which in turn heavily depended on location. The model was then tested with the inherent vulnerability characteristics as moderating variables and this too was found to be significant. The inherent vulnerability triggered by their civil status had a significant effect on the relationship between the outcomes of resettlement

and their water-event related vulnerability characteristics. Age and Education inherent vulnerability characteristics significantly linearly correlated with their civil status vulnerabilities and vice-versa. This finding validates the gendered experiential differences in vulnerability especially in societies with patriarchal tendencies. It was found that resettled renters found themselves most exposed to the social effects of drought (statistically significant difference (.05 > .010). Joint families had significantly higher exposure to drought than nuclear families, irrespective of the gender of the household head.All factors considered, the women of Kannagi Nagar perceived themselves as highly exposed and sensitive, with moderate to low adaptive capacities. Therefore, they displayed moderate-high levels of social vulnerability to drought.
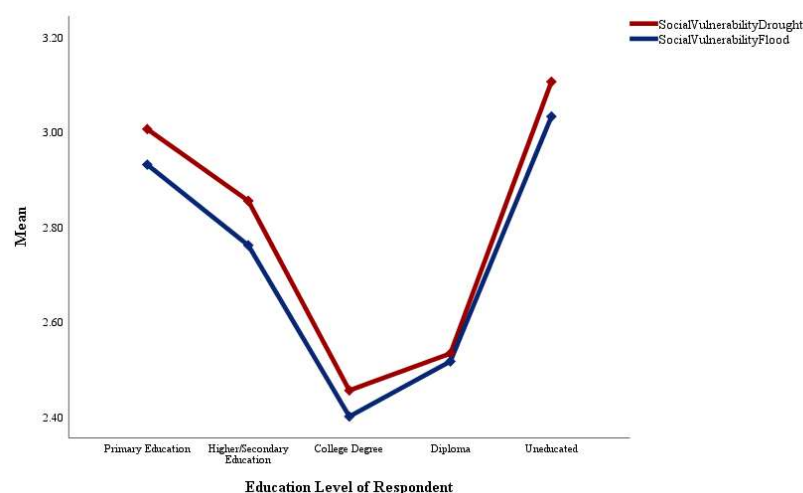
Graph 21: Levels of Social Vulnerability to extreme water-events by Education Level (Author, 2019)

Similar to pluvial flooding, differences in the means of their composite social vulnerability scores was found between women of different age groups and different education levels. The differences in levels were similar in both cases. It was found that the women of Kannagi Nagar are highly socially exposed and sensitive to the adverse effects of drought and had medium levels of adaptive capacity. The older the respondent the more socially vulnerable they are to drought. Conversely, the more educated the respondent, lesser are their social vulnerabilities to drought. Civil Status was the third statistically significant difference found. Widows were more vulnerable and significantly more exposed to drought than their married counterparts. The two single respondents scored higher than the widows but lower than the married respondents. *"When I marry, I think I will have more freedoms than I do right now in my (parents) house."* said one of the single respondent ((146, Comment from Survey). This phenomenon/ideology might explain why the author and other enumerators did not find too many single respondents. The one separated respondent scored higher than the means of the other groups. It was also interesting to note that most respondents reported conflicts during water-collection, but also corroborated that they never escalated beyond verbal sparring matches. Most streets had a system for water collection, at the time of the study each person was allowed two pots of water and any excess water was distributed equally among the residents. Some residents attributed equal access of water to their own organizational skills but some residents said that TC Karuna (local councillor) makes sure they all get equal access to water. Also, the responsibility of water collection was distributed equally for most part amongst all members of the household, although this contradicted reports that the

majority seen at the pumps were women. Most women had strong networks, at least in the vicinity of their household. *"Some of the ladies are like family. We have to take care of each other right? […] See, that one… (referring to a younger neighbour) she just got married and came (to Kannagi Nagar). She is like a younger sister to me."* (Interviewee 3) This aspect of the built environment affected them the most- the water supply affecting the condition of their homes, the sanitary conditions in Kannagi Nagar, disrupting household activities, and straining relationships. This had the most significant effect on their social vulnerability characteristics to drought as shown in Hypotheses 2 and 3. The families that had been resettled around the same time also have decently strong networks in the community, those who did rarely complained of conflict. However, there were a few respondents who really seemed to dislike life in Kannagi Nagar and were very reminiscent of the 'old days' (pre-displacement). These women had the tendency to have strained relationships because of the water shortage in Kannagi Nagar. On the very same street, the author had two women telling him different stories of conflict and distribution- the aspect that gave reason for this difference was their network strength and place attachment. Most women did not understand the questions about their participation levels in the community. But, the few women who did were very active and some even claimed to be leaders. However, this is an aspect that was out of scope and feasibility of this research, it could be explored in-depth in terms of risk perception, length of stay, and place attachment.
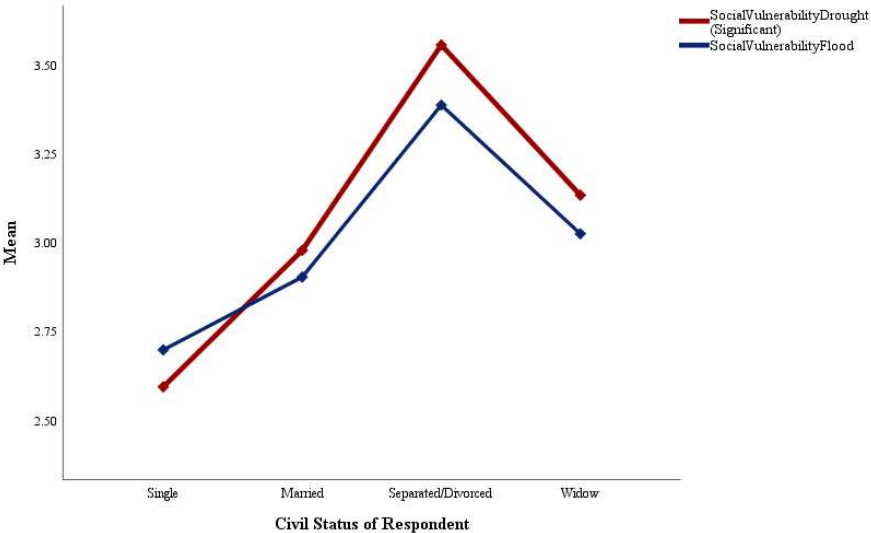
Graph 22: Levels of Social Vulnerability to extreme water-events by Civil Status (Author, 2019)

Chapter 5: Conclusion and Recommendations

5.1 Conclusion

On the recommendation of Weichselgartner (2001, p. 86), the concept of vulnerability to natural disasters had to be restructured and revisited. His suggestion implied general acceptance of the idea that complete prevention is ultimately unattainable. This ideology has been getting more support with the implications of climate change, which has been deemed potentially irreversible (Solomon et al. p. 1704-1709). Emphasis on mitigation efforts in the event of natural disasters- highlighting the social, rather than purely physical approaches; engaging in pro-active measures, instead of just reactive measures; with a attention to society's internal structure rather than merely external forces- are the propositions of this perspective. (Weichselgartner, 2001, p. 86). To accurately sum up the view that this research takes- "Climate change has the potential to be a threat multiplier on the varied social and economic challenges currently facing cities. […] The ability of urban areas to cope with these challenges depends on governance at a variety of levels and on adequate understanding of local underlying vulnerabilities. […] with attention to the most vulnerable groups and the variation within these groups" (Gasper et al., 2011, p. 155). Clements et al. (2016) have previously demonstrated that in India urban relegated residents exhibited varied vulnerabilities than their rural equivalents. According to the UN DESA (2014), as per the 2011 census, 31% of the population live in urban regions and Chennai is one of the cities that are predicted to become megacities by 2030. Additionally, India is likely to add 404 million more urban residents by 2050 (UN DESA, 2014). Climate change, in combination with rapid and rampant population growth, undoubtedly strains resources like water that would rapidly decline in abundance and quality. As was experienced and validated by the water scarcity in Chennai, during the course of this research.

The drought in Chennai was the result of failed monsoons for three years leading up to the summer of 2019. Prior to the failed monsoons, Chennai had been the recipient of a devastating pluvial flood in November-December, 2015. Followed by a severe depression in the Bay of Bengal (Cyclone Vardah) in mid-December, 2016. These events have plagued Chennai in the most recent years (4 year period, prior to this research). On December, 26th, 2004, an earthquake off the west coast of Sumatra triggered Tsunamis in coastal cities that bordered the Indian Ocean; Chennai, being one of those cities that suffered tragic losses. As a result many fisher people and their families were displaced and relocated. Originally around 1200 built houses were purchased as Permanent Housing for the Seashore Fisher People/Families affected by the Tsunami Disaster, from there Kannagi Nagar has steadily grown under various schemes like the Emergency Tsunami Reconstruction Project, Flood Alleviation Programme and the Chennai Metropolitan Area Infrastructure Development Plan. Two Special Problem Grants- 'Rehabilitation and Resettlement of Families living in 'Objectionable Areas' in Chennai City' and 'Resettlement of Slums living in Mega Cities' (Ramya and Peter, 2014, p.121). Almost fifteen years after its origins, a number of resettlement drives after the 2015 Floods was the reason for some of the tenements for the Tsunami-affected being reallocated to the flood-affected (Peter, 2017, p. 2-4). The residents who now occupy the 15, 656 tenements (Peter, 2017, p. 5) in Kannagi Nagar have been subject to forced eviction, displacement or have simply been "forced to the fringes" due to economic reasons. They have been resettled in a colony that violates their rights to adequate, inclusive housing, to land and property, to the human rights to employment, education, health, resettlement and women's rights (Peter, 2017, p. 19-43). Undoubtedly, projects like Kannagi Nagar and their inhabitants are prone

to the risks of impoverishment (Cernea, 2000). Resettlement literature has continually focussed on rural and refugee displacement, and displacement of indigenous populations, but rarely focuses on urban IDPs even though they have been identified as crisis-affected populations by academics from the 1970s (Pantuliano et al. (2012, p. 52-53). However, as Pantuliano (2012, p. 52) points out that the growing pace of urbanization in combination with climate-change has drawn the attention of urban academics and policy makers to their implications on the vulnerabilities of urban-displaced populations in the past decade. In accordance with this, the objective of this thesis is to bridge gaps in urban climate change resettlement literature focussing on the "vulnerable within the vulnerable" (Majidi and de Paris, 2014, p. 78) - the women inhabiting resettlement colonies. Vulnerabilities to disasters are rarely equally distributed owing to unsustainable patterns of settlement, resource management, social organization and political economy. Kratzer and Le Masson (2016, p. 3-7) established that social customs, masqueraded as culture, further weaken the already weak- women, lower castes- which in turn makes them more vulnerable. Gendered differences in vulnerability to disaster events have been identified by scores of academics and has been acknowledged by the IPCC. Additionally, resettlement literature has pointed out similar differences, particularly socio-economic differences, in the way that men and women are at risk.

For these reasons, this thesis proposed a Gynocentric Social Vulnerability framework for displaced populations and Resettlement sites Chennai, Kannagi Nagar and its women, have made for a suitable and relevant case study for the application and demonstration of this framework. On answering the main research questions and sub-questions, the framework was modified to suit the context of Kannagi Nagar and the statistical findings of this research. Policy recommendations, guidance for the application of the framework, as well as suggestions for further research have been proposed. The intention of understanding the complexities of the vulnerabilities faced by urban marginalized women in the face of imminent threats of extreme water-events prompted the following research question and sub-questions that were answered in the context of the women in Kannagi Nagar, Chennai:

What are the factors that explain the levels of social vulnerability of women, to extreme water events- flood, excessive rainfall and drought in resettlement colonies?

- *Which factors explain the social vulnerability characteristics to the water events among women in Kannagi Nagar to flood and drought?*
- *How do their inherent vulnerability characteristics affect their social vulnerability?*
- *Which factors explain how demographically different groups of women display varying levels of vulnerability to these extreme water events?*
- *How do the outcomes of resettlement explain the levels of social vulnerability to flooding and drought demonstrated by these women?*

5.1.1 Explaining the levels of social vulnerability characteristics of women, to extreme-water events

Foremost, the first sub-question required establishing a definition and view of vulnerability that was accomplished by a systematic review of literature covering the spheres of disaster management, specifically water-events of pluvial flooding and drought, climate change and sustainable livelihoods. Additionally, the review included an assessment of reputed vulnerability frameworks with a gendered focus. The view and approach that this research adopted was constructed from the definition established by McCarthy et al. (2001) that has been acknowledged by the Intergovernmental Panel on

Climate Change (IPCC), in combination with social approach towards vulnerability that the Sustainable Livelihoods Approach (SLA) adopts. The Social Vulnerability Characteristics were operationalized as functions of i) the Exposure of the concerned population (women of Kannagi Nagar) to a shock, trend or seasonality (extreme water-events), ii) the Sensitivity of their livelihoods to the selected factor (extreme water-events) (DFID, 2007, p.65); and finally the Adaptive Capacity of the women in Kannagi Nagar to flooding and drought (McCarthy et al., 2001). On establishing a perspective and definition of social vulnerability to extreme water-events, they were then operationalized and computed. Analysis revealed that between the extremes of pluvial flooding and drought, the women were found to be more vulnerable to drought, than flood; foreseeable, given the circumstances at the time of this research. Correlations between the sub-variables indicated that higher was their exposure to flooding and drought, the more sensitive were their livelihoods to these water-events; the more sensitive were they to these drastically different disasters, the capacity of these women to adapt decreased. Indicating that the potential negative impacts of these events outweigh their capability to adapt to them. Additionally, one of the indicators revealed that resettled/displaced women saw themselves as less able to save themselves from a disaster than their non-displaced counterparts. Overall, it can be said that the women of Kannagi Nagar display high levels of social vulnerability to the extreme water –events discussed in this research.

5.1.2 The effect of their inherent individualities

The gynocentricity of the framework developed and the view that vulnerability is an inherent state entails the acknowledgement that as a vulnerable group, women display inherent vulnerability characteristics. These are generalizable factors that make them more or less vulnerable to all disaster events. The generality of Age, Education Level, Caste, Religion and Civil Status characteristics made for their selection. The indicators were then developed to be generalizable across all major disaster events. These were then entered in the regression analysis as moderating variables to test if they strengthened or weakened the relationship between the women's social vulnerability and their subjective experiences of the outcomes of resettlement. The model proved to be significant and showed that this strengthened the relationship. The impact of the outcomes of resettlement on the social vulnerability to drought of the women residents in Kannagi Nagar is exacerbated by their inherent vulnerabilities. However, of the tested moderating variables, the only significant influencing factor was their Civil Status. Most women were neutral about the freedoms they experienced when it came to their spouses. The widows, however, faced the brunt and were significantly more vulnerable in this aspect due to unsteady incomes and their dependency on their children. Women with young children felt like their responsibilities did not allow them to seek employment, also because they might have to travel far and for a long time. Most women felt like their social lives were unaffected and this correlated with the strength of their network in Kannagi Nagar. Women with good networks were able to share the responsibility of their children as well. This finding goes to show that a woman's role in society, and more importantly her household, does strengthen or weaken her social vulnerability to drought.

5.1.3 Explaining the varying levels of demographically different women to extreme water-events

Age: The social vulnerability of women to both extremes of water-events significantly increased with their age. Women between the ages of 18-30 displayed significantly lower levels of vulnerability to flooding and drought. They perceived themselves as more fit and able to save themselves in case of a disaster than their older counterparts. They were more educated and had more general awareness too.

This is in accordance with most social vulnerability indices that predict that older women and younger children (not part of this sample) are the most vulnerable in the face of disaster. However, the group in between (31-55) faced more mental stresses and challenges because of this than the other groups. There were no significant differences in their exposure, sensitivity or adaptive capacity, which showed that their inherent vulnerabilities had more bearing on their social vulnerability to these water-events.

Education: Conversely, the more educated the woman in Kannagi Nagar, the lesser was their social vulnerability score. Here, it was the high levels adaptive capacity that comes with being educated that made the differences and not just their inherent vulnerabilities. Older women (56+) faced the brunt of this vulnerability the most, having the bare minimum to no education at all. Education levels also influenced the way the women perceived themselves as fit or able to save themselves, the more educated the more she saw herself as able to save herself.

Caste and Religion: It was found that caste and religion had no impact on the inequalities and vulnerabilities that they faced. However, the survey revealed that their opinions/biases stem from their religious biases and not because of the inequalities of caste; at least, not within their own community. Here, it was found that age had a role to play in their opinion, younger women being more liberal. It was also found that Muslims faced more inequalities than their Hindu counterparts, and Christians fell in-between. However, this variable had the least significance in any of the models.

Family structure: Female-headed households, irrespective of the size of the household, were significantly more socially vulnerable to flooding than male-headed households. In the case of family structure, it is the inherent vulnerabilities of household responsibilities and income generation that made these women more vulnerable.

Civil Status: Civil status had a significant impact on their social vulnerability characteristics to drought as a moderating variable. On comparing the married women to the widows it was found that the widows were more vulnerable than their married counterparts, owing to significantly more exposure to drought. Qualitative data revealed that the single women felt that they might have more freedoms when they get married, that explained a lesser mean score than their married equivalents. In addition, the younger women (18-30) were more likely to face the brunt of their household and child-rearing responsibilities. Non-resettled women, who moved to Kannagi Nagar for economic reasons, were also found to be more vulnerable because of the responsibilities thrust upon them.

5.1.4 The outcomes of resettlement and their effect on the social vulnerability of women to drought

The indicators that were identified by Xiao et al (2018) who adopted and adapted Cernea's (2000), Impoverishment, Risks and Reconstruction model were modified to suit the context of the women in Kannagi Nagar. The four outcomes of resettlement that were operationalized and analysed are: (i) Employment outcomes, (ii) Health outcomes, (iii) Location Outcomes and (iv) Built Environment outcomes. The women of Kannagi Nagar were the least negatively impacted by the Health outcomes and the most negatively impacted by the Employment (and Income) outcomes. The Location and Built environment outcomes were almost normally distributed across the population sample. With the exception of Heath, the outcomes of resettlement strongly negatively correlated with their social vulnerability to drought. However, none correlated with their vulnerability to flooding. The variable
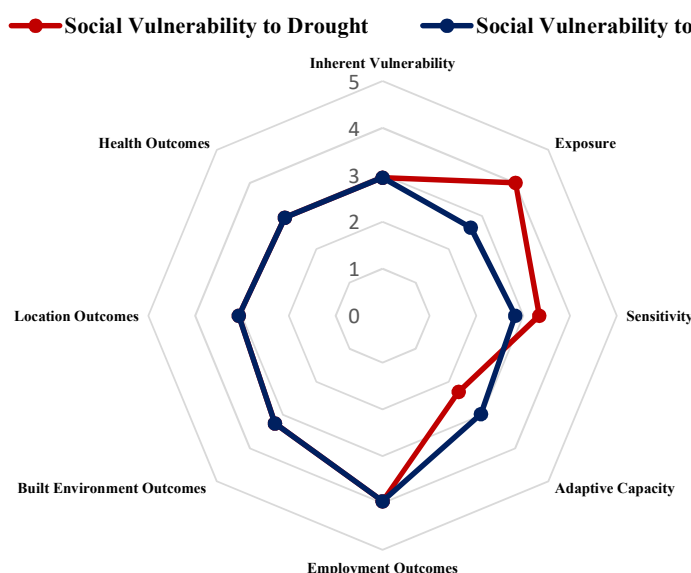
Graph 23: Levels of Social Vulnerability to extreme water-events and the Outcomes of Resettlement (Author, 2019)

'outcomes of resettlement' was not given a normative assignment. Low scores indicate negative impacts and high scores indicate positive impacts. So a negative correlation in this case, meant that higher their social vulnerability the more negatively were they impacted by the outcomes of resettlement, and vice-versa. However, in the radar chart above (Graph 23), they were re-coded to indicate the same scale of impact as the social vulnerability characteristics. On finding strong correlations with between the social vulnerability of the women in Kannagi Nagar to drought and the outcomes of resettlement, regression analysis proved a significant statistical relationship between the two. Since the sample population displayed high levels of social vulnerability to drought, multiple linear regression showed that the outcomes of resettlement influence their social vulnerability to drought. Given that they were facing the harsh impacts of drought at the time, the author opines that the correlations with flooding were not strong, probably due to memory-bias.

Employment outcomes contributed significantly, in fact the highest impact from their point of view. However, the built environment had more of an influence than employment on the women's social vulnerability to drought. Inadequate incomes, inadequate savings, dissatisfaction with current employment and the network that it provides- were the negative impacts of employment that the

women of Kannagi Nagar encountered. The high dissatisfaction levels with their employment was owed to the Location outcome of resettlement determined by their access to employment, education and training. Nevertheless, it was found that the Built Environment- the provision of water, the sanitary conditions and the quality of the tenements- had the largest significant effect on their social vulnerability to drought. Strong correlations between location and the built and environment and their employment meant that these outcomes were heavily dependent on the other. Health outcomes were weakly yet significantly correlated to Location and the Built Environment but not Income and Employment. They received free primary health care at the government-run PHCs, as well as the government general hospital. However, the distance they have to travel to the hospital for major illnesses, injuries and emergencies, as well as the unsanitary conditions in some parts of Kannagi Nagar contribute to negative health impacts. Location and Built Environment outcomes were strongly correlated to one another too. It was apparent that the women were caught in a tangled web of the effects of resettlement even almost twenty years later. Location made them vulnerable in terms of income and employment, which did not allow some of them to rectify their own built-up environment. Additionally, examination of the indicators of their exposure and adaptive capacity revealed that the built environment had a role to play in the case of their vulnerability to flooding, ad-hoc measures taken to raise the road only caused more flooding, water stagnation, and consequently unsanitary conditions that lead to illnesses, in lower-lying areas. An FGD with four residents, who had moved to Kannagi Nagar due to economic reasons, revealed that it was the stigma attached to Kannagi Nagar that made them vulnerable. Employment opportunities and bank loans have been denied to the residents of Kannagi Nagar on multiple occasions. Additionally interviews revealed that the built environment is one of the perpetrators of crime, alcoholism and drug abuse in the settlement. These findings are reflective of Wilson and Keller's (1982) 'Broken Windows Theory' that suggests that disorder is a social construct and that disorder in neighbourhoods are moulded by much more than merely the empirical levels of disorder (Sampson and Raudenbush, 2005, p.8). Sampson and Raudenbush, in their research, found that both residents and outsiders perceive a neighbourhood from what they actually observe and see on the streets; coupled with social structure and "stigmatization of modern urban ghettos, in which geographically segregated minority groups were (are) linked by poverty, economic disinvestment and visible signs of disorder."

5.1.5 Explaining the Gynocentric Social Vulnerability Framework for Displaced populations and Resettlement sites and its application in Kannagi Nagar, Chennai

Followed by a thorough review of literature, the theoretical framework thus developed was a generalized framework, applicable across similar resettlement sites. The modified, applied framework
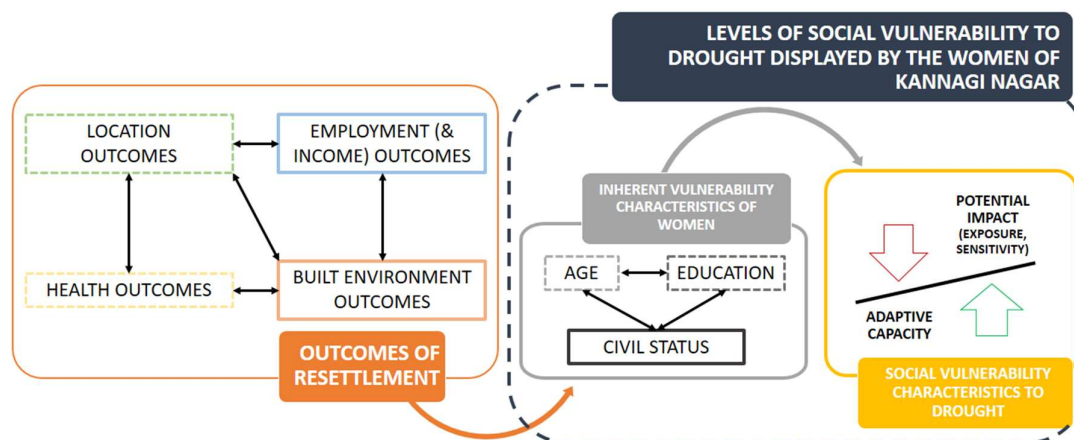
Figure 6: Gynocentric Social Vulnerability Framework for Urban displaced population and Resettlment sites applied to the case of the Women in Kannagi Nagar, Chennai (Author, 2019)

found above is unique to the case of Kannagi Nagar. The primary data collected and analysed first proved the applicability of the framework and revealed interesting relationships between the variables. The inherent vulnerabilities of caste and religion were found to be insignificant and did not cause for any variance. Therefore, they were excluded. The relationships between the various outcomes of resettlement in terms of strong correlations are depicted. Location and Health outcomes that did not cause for significant variation in regression and therefore are in dashed-boxes. The two significant contributors (Income and the Built-Environment) are in solid boxes. Similarly in the case of inherent vulnerability characteristics of the women, only Civil Status was significant in regression while the other two (Age, Education) were only strongly correlated to Civil Status. The dependent variable, or the social vulnerability characteristics of the women in Kannagi Nagar contain the sub-variables of Exposure and Sensitivity, clubbed together as potential impact, and Adaptive Capacity on the opposing end. This is again representative of the primary quantitative data collected in Kannagi Nagar. The bigger box that encapsulates the inherent and social vulnerabilities of the women indicate their ultimate Social vulnerability levels to Drought (and flood) were compared and tested for differences between demographically different women. However, this framework was only applicable entirely to their social vulnerability to drought. Their outcomes of resettlement, except for Location, had no significant correlations with their social vulnerability to pluvial flooding.

5.2 Recommendations

For the application of the framework to other resettlement sites, a few guidelines and improvisations have been recommended. From the data collected and analysed, four policy recommendations have been made by the author. Finally, this thesis concludes with recommendations to broaden this research.

5.2.1 Climate Adaptation Pathways, Housing Policy and Design Recommendations for Kannagi Nagar:

At the outset, it is fairly evident that the built environment plays a major role in the vulnerability of the resettlement colony of Kannagi Nagar. The sites propensity to flooding, water stagnation and unsanitary conditions have been exacerbated by the raising the main roads and neglecting smaller lanes and not paying heed to the plinth level of the tenements. On the other hand, the built environment had a role to play in their vulnerability to drought, the scarcity of water also meant unsanitary conditions due to improper cleaning, water supply was irregular and most respondents found the water provision inconsistent. The effects of location had an impact on their employment and incomes and this in turn made them economically vulnerable. Identification of the demographically vulnerable groups was the first step in the process of engaging and empowering the women of Kannagi Nagar in community driven adaptation strategies for flooding and drought. The next step would be to map these vulnerabilities in congruence with their biophysical vulnerability to aid and empower the most vulnerable parts. Reactive measures, such as road laying and raising pavements, as much as they aid in accessibility during disaster events, need to be constructed and designed efficiently and include proper storm water drainage systems. In the case of drought, mapping would help to empower women to come together and come up with collective strategies to save water and help each other, just as they got together and brought water and public transport to Kannagi Nagar. As Peter (2019) asserted, *"Abundance is never a problem […] (unclear) every year this happens during monsoon, people just became used to the floods. 2015 changed it all because of the intensity of floods."* This ideology is supported by Weichselgartner (2001, p. 86), "What people have formerly regarded as a substantial resource is called a flood today." Human interventions are what exacerbates the intensity of damage done by flooding. Interventions like the positioning and construction of a resettlement colony on a marshland that is meant to flood. Peter (2019) also asserted that it was *"Scarcity (that) is always a bigger problem."* Scarcity, compounded by inadequate incomes and zero-savings made the women of Kannagi Nagar more prone to being socially vulnerable to drought. In addition to climate adaptation strategies, communities like Kannagi Nagar also need livelihood strategies. This comes with education, participation, engagement and integration of all members of the community. Vulnerability mapping that takes into account these social factors, would be able to inform on weaker and more vulnerable sections of society than can be targeted and prioritized, empowered and aided. In the case of the women of Kannagi Nagar, it is the resettled renters who have not received allotments, the widows, the old, the physically challenged, female-headed households, the unemployed and uneducated that require prioritization.

In terms of housing policy and design, the TNSCB should prioritize the participation of these women in the process of eviction, displacement, as well as in the resettlement site selection and location, tenement design and implementation. The people can even be employed as skilled or un-skilled labourers and kept engaged in building their own homes. In terms of location, integration with the city and employment is of utmost importance. In the case of rural resettlement, their livelihood depends on land and hence Cernea's (2000), land-based resettlement applies. It is evident that urban resettlers are dependent on location, and hence it could be termed location-based resettlement. Urban planners, managers and the contractors who carry out these projects, need to take into account the entire site with its contours and slopes to prevent stagnation. Proper planning and execution of the structures,

ensuring good roads and accessibility of the site right from initiation would ensure the prevention of correction measures that only make them more vulnerable eventually.

5.2.2 Guidelines and recommendations for the Gynocentric Social Vulnerability framework for displaced populations and Resettlement sites

During the course of this research establishing four parameters became essential:

1. **The definition and view of social vulnerability** (refer 3.2 Operationalization)
2. **The time period/s the study will assess and explore**

   The outcomes of resettlement used in this thesis were specific to a 20 year old urban resettlement colony. Therefore, ultimate outcomes were measured. If the displaced population has been recently resettled (1-5 years) then the immediate outcomes (Primary Risks of Resettlement) are to be measured. Similarly a site in-between these extremes would experience intermediate outcomes (Components of reconstruction) - for these outcomes refer Table 5.

3. **The study area and its larger context**

   The framework developed as a result of this research is applicable only to a pre-defined and established vulnerable population. The variables are applicable to sites similar to Kannagi Nagar. Kannagi Nagar was not chosen for its uniqueness but because of certain characteristics that are generalizable across various resettlement sites in the developing world. The check-list for the physical and social characteristics are listed below.

   i. Urban Context
   ii. Internally-displaced and Resettled population
   iii. Location in low-lying/ lands deemed unfit for construction/ periphery of the city
   iv. Inaccessibility of site, low-quality built-up environment, inadequate infrastructure and services
   v. Biophysical vulnerability must be justified

   Indicators for the variables and sub-variables must be developed according to the context and location of the site chosen. For example, the caste system is prevalent in India but will not be elsewhere. This can be replaced with other forms of class, minority or race. Similarly, the structures of family and households are different from country to country, even within India there are distinct cultural differences within states.

4. **The sample population and their demographic characteristics.**

5.2.3 Research Recommendations

This research was site specific, but it had to be generalizable too. Hence, the generalizable factors and the random sample. Additional factors, like their place attachment, risk perception, culture specific roles and responsibilities can be added to determine the effect of the outcomes of resettlement on their vulnerability. The framework can also be applied to other groups that are inherently more vulnerable than the others, like physically/mentally challenged, racial/ethnic minorities and so on. The inherent vulnerabilities can be changed to suit other disadvantaged populations but would remove its gynocentricity. It can also be adapted to suit other disaster events using the indicators developed by Cutter et al. (2003, p.245-249). The study could also be taken from micro to macro level- comparison of resettlement sites, with purposive sampling can give better insight on the factors that make them inherently and socially vulnerable to flooding and drought. Additionally, the possibility of comparing

the resettled women to the women who are still residing in their original areas of residence (pre-resettlement) exists.

References

Adger, W. N. and Kelly, P. M. 1999. Social vulnerability to climate change and the architecture of entitlements. *Mitigation and Adaptation Strategies for Global Change,* 4 (3-4), pp. 253-266 .

Ajibade, I., McBean, G. and Bezner-Kerr, R. 2013. Urban flooding in Lagos, Nigeria: Patterns of vulnerability and resilience among women. *Global Environmental Change,* 23 (6), pp. 1714-1725 .

Anthony Oliver-Smith, 2018. Disasters and Large-Scale Population Dislocations: International and National Responses. Oxford University Press.

Anthony Oliver-Smith, 2018. Disasters and Large-Scale Population Dislocations: International and National Responses. Oxford University Press.

Arora-Jonsson, S., 2011. Virtue and vulnerability: Discourses on women, gender and climate change. *Global Environmental Change,* 21 (2), pp. 744-751 .

Brody, A., Demetriades, J. and Esplen, E. 2008. Gender and climate change: mapping the linkages. *Sussex: Institute of Development Studies,* .

Brooks, N., 2003. Vulnerability, risk and adaptation: A conceptual framework. *Tyndall Centre for Climate Change Research Working Paper,* 38 (38), pp. 1-16 .

Brooks, N. and Adger, N. W. 2003. Country level risk measures of climate-related natural disasters and implications for adaptation to climate change.

CARE International in Mozambique, 2014. Care International Poverty, Environment and Climate Change Network, et al. Gender-sensitive Climate Vulnerability and Capacity Analysis (GCVCA) Practitioners Guide. Mozambique: Care International in Mozambique. Available at: https://careclimatechange.org/wp-content/uploads/2016/02/GCVCA_Practitioners-Guide-FINAL-July-2014.pdf [Accessed January 29, 2019].

CBGA, Centre for Budget and Governance Accountability, 2018. Open Budgets India Portal. Available at: https://openbudgetsindia.org/budget-basics/municipal-budget.html#what-is-an-urban-local-government [Accessed December 11, 2018].

Cernea, M. M., 1995. Understanding and preventing impoverishment from displacement: Reflections on the state of knowledge. *Journal of Refugee Studies,* 8 (3), pp. 245-264 .

Cernea, M. M., 2000. Risks, safeguards and reconstruction: A model for population displacement and resettlement. *Economic and Political Weekly,* pp. 3659-3678 .

Cernea, M. M., 1993. The urban environment and population relocation. The World Bank.

Chinnakali, P., Upadhyay, R. P., Shokeen, D., Singh, K., et al., 2014. Prevalence of household-level food insecurity and its determinants in an urban resettlement colony in north India. *Journal of Health, Population, and Nutrition,* 32 (2), pp. 227-236 .

Clements, R., Viswanathan, K. and Sogani, R. 2016. *How do Gender Approaches Improve Climate Compatible Development? Lessons from India,* .

Clements, R., Viswanathan, K. and Sogani, R. 2016. *How do Gender Approaches Improve Climate Compatible Development? Lessons from India,* .

Coelho, K., 2016. Tenements, Ghettos, or Neighbourhoods? Outcomes of Slum-Clearance Interventions in Chennai. *Review of Development and Change,* 21 (1), pp. 111-136 .

Coelho, K., Venkat, T. and Chandrika, R. 2012. The spatial reproduction of urban poverty: Labour and livelihoods in a slum resettlement colony. *Economic and Political Weekly,* pp. 53-63 .

Coelho, K., Venkat, T. and Chandrika, R. 2013. Housing, homes and domestic work: a study of paid domestic workers from a resettlement colony in Chennai. *Economic and Political Weekly,* pp. 39-46 .

COELHO, K. and RAMAN, N. V. 2010. Salvaging and Scapegoating: Slum Evictions on Chennai's Waterways. *Economic and Political Weekly,* 45 (21), pp. 19-23 .

COELHO, K., VENKAT, T. and CHANDRIKA, R. 2012. The Spatial Reproduction of Urban Poverty: Labour and Livelihoods in a Slum Resettlement Colony. *Economic and Political Weekly,* 47 (47), pp. 53-63 .

COELHO, K., VENKAT, T. and CHANDRIKA, R. 2013. Housing, Homes and Domestic Work: A Study of Paid Domestic Workers from a Resettlement Colony in Chennai. *Economic and Political Weekly,* 48 (43), pp. 39-46 .

Cutter, S. L., Barnes, L., Berry, M., Burton, C., et al., 2008. A place-based model for understanding community resilience to natural disasters. *Global Environmental Change,* 18 (4), pp. 598-606 .

Cutter, S. L., Boruff, B. J. and Shirley, W. L. 2003. Social vulnerability to environmental hazards. *Social Science Quarterly,* 84 (2), pp. 242-261 .

del Melo Branco, A., 2009. Women responding to drought in Brazil. *Women, Gender and Disaster: Global Issues and Initiatives,* pp. 261-272 .

DfID, U., 2007. *Sustainable Livelihoods Guidance Sheets.UK DFID Department for International Development: London,* .

Diwakar G., D. and Peter, V. 2016. Resettlement of Urban Poor in Chennai, Tamil Nadu: Concerns in R&R Policy and Urban Housing Programme. *Journal of Land and Rural Studies,* 4 (1), pp. 97-110 Available at: 10.1177/2321024915616675 .

Downing, T. and Patwardhan, A. 2003. Vulnerability Assessment for Climate Adaptation: APF Technical Paper 3. *New York: United Nations Development Programme,* .

Dwivedi, R., 2002. Models and methods in development–induced displacement. *Development and Change,* 33 (4), pp. 709-732 .

Eisinga, R., Te Grotenhuis, M. and Pelzer, B. 2013. The reliability of a two-item scale: Pearson, Cronbach, or Spearman-Brown? *International Journal of Public Health,* 58 (4), pp. 637-642 .

Enarson, E. and Morrow, B. H. 1998. Why gender? Why women? An introduction to women and disaster. *The Gendered Terrain of Disaster: Through Women's Eyes,* pp. 1-8 .

Fatemi, F., Ardalan, A., Aguirre, B., Mansouri, N., et al., 2016. Social Vulnerability Indicators in Disasters: Findings from a Systematic Review.

Füssel, H., 2007. Vulnerability: A generally applicable conceptual framework for climate change research. *Global Environmental Change,* 17 (2), pp. 155-167 .

Gasper, R., Blohm, A. and Ruth, M. 2011. Social and economic impacts of climate change on the urban environment. *Current Opinion in Environmental Sustainability,* 3 (3), pp. 150-157 .

GCC, G. C. C., 2017. City Disaster Management Plan.

Glemarec, Y., Qayum, S. and Olshanskaya, M. 2016. Leveraging Co-benefits between Gender Equality and Climate Action for Sustainable Development: Mainstreaming Gender Considerations in Climate Change Projects. *UN Women, .*

Gupta, A. K. and Nair, S. S. 2010. Flood risk and context of land-uses: Chennai city case. *Journal of Geography and Regional Planning,* 3 (12), pp. 365-372 .

Heredia-Ortiz, E. and Rider, M. 2005. INDIA'S INTERGOVERNMENTAL TRANSFER SYSTEM AND THE FISCAL CONDITION OF THE STATES. *Proceedings.Annual Conference on Taxation and Minutes of the Annual Meeting of the National Tax Association,* 98 pp. 362-371 .

IFRC, 2018. *What is Vulnerability?* © The International Federation of Red Cross and Red Crescent Societies. All rights reserved. Available at: https://www.ifrc.org/en/what-we-do/disaster-management/about-disasters/what-is-a-disaster/what-is-vulnerability/ [Accessed 2019].

IPCC, 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. ([Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)].; Geneva, Switzerland: IPCC. Available at: https://archive.ipcc.ch/report/ar5/syr/ [Accessed January 25, 2019].

IPCC, 2014a. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. (Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)].; Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Jain, G., Singh , C. and Malladi, T. August 2017b. Rethinking post-disaster relocation in urban India. *Briefing,* Available at: http://pubs.iied.org/17430IIED .

Jain, G., Singh, C. and Malladi, T. 2017. Rethinking post-disaster relocation in urban India.

Joshi, R. and Ahmed, S. 2016. Status and challenges of municipal solid waste management in India: A review. *Cogent Environmental Science,* 2 (1), pp. 1139434 .

Jothi Sivagnanam, K. and Naganathan, M. 2000. Federal Transfers and the Tax efforts of the States in India. *Indian Economic Journal,* 47 (4), pp. 101-110 .

Kallis, G., 2008. Droughts. *Annual Review of Environment and Resources,* 33 pp. 85-118 .

Knutson, C., Hayes, M. and Phillips, T. 1998. How to Reduce Drought Risk. *Western Drought Coordination Council, .*

Kratzer, S. and Le Masson, V. 2016. 10 Things to Know: Gender Equality and Achieving Climate Goals.

Majidi, N. and Hennion, C. 2014. Resilience in displacement. *Journal of Internal Displacement,* 4 (1), pp. 78-91 .

Maru, Y. T., Smith, M. S., Sparrow, A., Pinho, P. F., et al., 2014. A linked vulnerability and resilience framework for adaptation pathways in remote disadvantaged communities. *Global Environmental Change,* 28 pp. 337-350 .

McCarthy, J. J., Canziani, O. F., Leary, N. A., Dokken, D. J., et al., 2001. Climate change 2001: impacts, adaptation, and vulnerability: contribution of Working Group II to the third assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Morchain, D., Prati, G., Kelsey, F. and Ravon, L. 2015. What if gender became an essential, standard element of Vulnerability Assessments? *Gender & Development,* 23 (3), pp. 481-496 Available at: 10.1080/13552074.2015.1096620 .

Murphy, P. and Mezzofiore, G., June 20, 2019. Chennai, India is almost out of water. Satellite images show its nearly bone-dry reservoirs. [Accessed 2019].

Murugesan, A., 2001. Droughts in India. *Eco News,* 7 pp. 3-6 .

Oxfam, 2019. Oxfam's online guide to the Vulnerability and Risk Assessment Methodology. Available at: http://vra.oxfam.org.uk/ [Accessed February, 2019].

Oxford University Press, 2019. *Definition of 'vulnerability ' in English: vulnerabiltiy (n)*. 2019 Available at: https://en.oxforddictionaries.com/definition/vulnerability [Accessed February, 2019].

Pantuliano, S., Metcalfe, V., Haysom, S. and Davey, E. 2012. Urban vulnerability and displacement: a review of current issues. *Disasters,* 36 pp. S1-S22 .

Peter, V. and Chaudhry, S. 2017. From Deluge to Displacement: The Impact of Post-flood Evictions and Resettlement in Chennai. *Information and Resource Centre for the Deprived Urban Communities, and Housing and Land Rights Network,* .

Porio, E., 2014. Climate change vulnerability and adaptation in Metro Manila: Challenging governance and human security needs of urban poor communities. *Asian Journal of Social Science,* 42 (1-2), pp. 75-102 .

Ramya, S. P. and Peter, V. 2014. Forced to the Fringes: Disasters of 'Resettlement' in India. Report Two: Kannagi Nagar, Chennai. *Housing and Land Rights Network, New Delhi,* pp. 105-174 .

Rufat, S., Tate, E., Burton, C. G. and Maroof, A. S. 2015. Social vulnerability to floods: Review of case studies and implications for measurement. *International Journal of Disaster Risk Reduction,* 14 pp. 470-486 .

Sampson, R. J. and Raudenbush, S. W. 2005. Neighborhood stigma and the perception of disorder. *Focus,* 24 (1), pp. 7-11 .

Sogani, R., 2016. Gender approaches in climate compatible development: lessons from India. *Climate Development Knowledge Network (CDKN).Http://cdkn.org/wpcontent/uploads/2016/05/CDKN_India-Gender_report_WEB.Pdf Retrieved on October,* 3 pp. 2016 .

Srinivasan, S. and Rogers, P. 2005. Travel behavior of low-income residents: studying two contrasting locations in the city of Chennai, India. *Journal of Transport Geography,* 13 (3), pp. 265-274 .

Srinivasan, V., Seto, K. C., Emerson, R. and Gorelick, S. M. 2013. The impact of urbanization on water vulnerability: A coupled human–environment system approach for Chennai, India. *Global Environmental Change,* 23 (1), pp. 229-239 .

Srinivasan, V., Seto, K. C., Emerson, R. and Gorelick, S. M. 2013. The impact of urbanization on water vulnerability: A coupled human–environment system approach for Chennai, India. *Global Environmental Change,* 23 (1), pp. 229-239 .

Stanley, J., 2004. Development-induced displacement and resettlement. *Forced Migration Online Research Guide, Refugee Studies Centre, University of Oxford,* .

Stanley, J., 2004. Development-induced displacement and resettlement. *Forced Migration Online,* .

Stephen, A., ed., 2016. Natural disasters: Are they really natural, Anonymous [Proceedings of ICSSR sponsored national seminar on infrastructural development and environment: issues and challenges].

Tapsell, S. M., Penning-Rowsell, E. C., Tunstall, S. M. and Wilson, T. L. 2002. Vulnerability to flooding: health and social dimensions. *Philosophical Transactions of the Royal Society of London.Series A: Mathematical, Physical and Engineering Sciences,* 360 (1796), pp. 1511-1525 .

Tibaijuka, A., 2010. Adapting to urban displacement. *Forced Migration Review,* (34), pp. 4 .

Tibaijuka, A., 2010. Adapting to urban displacement. *Forced Migration Review,* (34), pp. 4 .

UNDP, 2016. *Overview of the linkages between Gender and Climate Change.* (http://www.undp.org/content/dam/undp/library/gender/Gender%20and%20Environment/UNDP%20Lin kages%20Gender%20and%20CC%20Policy%20Brief%201-WEB.pdf ; New York, USA: United Nations Development Programme.

Verschuren, P., 2003. Case study as a research strategy: some ambiguities and opportunities. *International Journal of Social Research Methodology,* 6 (2), pp. 121-139 .

Walker, G. and Burningham, K. 2011. Flood risk, vulnerability and environmental justice: Evidence and evaluation of inequality in a UK context. *Critical Social Policy,* 31 (2), pp. 216-240 .

Watts, M. J. and Bohle, H. G. 1993. The space of vulnerability: the causal structure of hunger and famine. *Progress in Human Geography,* 17 (1), pp. 43-67 .

Weichselgartner, J., 2001. Disaster mitigation: the concept of vulnerability revisited. *Disaster Prevention and Management: An International Journal,* 10 (2), pp. 85-95 .

Wilhite, D. A. and Glantz, M. H. 1985. Understanding: the drought phenomenon: the role of definitions. *Water International,* 10 (3), pp. 111-120 .

Wilhite, D. A., Svoboda, M. D. and Hayes, M. J. 2007. Understanding the complex impacts of drought: A key to enhancing drought mitigation and preparedness. *Water Resources Management,* 21 (5), pp. 763-774 .

Xiao, Q., Liu, H. and Feldman, M. 2018. Assessing livelihood reconstruction in resettlement program for disaster prevention at Baihe county of China: Extension of the impoverishment risks and reconstruction (IRR) model. *Sustainability,* 10 (8), pp. 2913 .

Annexe 1: Survey

The survey that were conducted were partly interviews as well. Notes of comments made by the author during the surveys were taken and used as qualitative findings as well.

Annexe 1.1 Questionnaire

Institute for Housing and Urban Development Studies (IHS)
Erasmus University-Rotterdam, The Netherlands
Vulnerability Survey, Kannagi Nagar, Chennai, India
Purpose: The purpose of this survey is to gather data from **women** respondents residing in Kannagi Nagar, Chennai. This will aid a student of IHS in the analysis of their research in order to complete their master's thesis. The results and data gathered from this survey shall be solely used for academic purposes and the anonymity of respondents maintained.

Enumerator: **Control No:**   **Date:**

A. **Respondent Profile:**
Name:

Age:

No. of Years lived in Kannagi Nagar:

Resettled:
☐ Yes
☐ No

Highest Level of Education obtained:
☐ Primary Education
☐ Higher/Secondary Education
☐ College Degree
☐ Diploma
☐ Uneducated

Civil Status:
☐ Single
☐ Married
☐ Separated
☐ Widow
Others: _____

Ownership:
☐ House owner
☐ Rented

Which Caste do you belong to? (Any-one)
☐ OC
☐ BC
☐ MBC
☐ SC
☐ ST

Which religion do you follow? (Any-one)
☐ Hindu
☐ Muslim
☐ Christian

Mobility: (All that apply)
☐ Individually owned vehicle
☐ Borrowed/Rented vehicle
☐ Access to family owned vehicle
☐ Dependent on public transport
☐ Dependent on another person for transport

Employment
☐ Public servant
☐ Self-employed
☐ Informal business
☐ Domestic work
☐ Employed by a company
☐ Contract-based employment
☐ Unemployed
Others: _____

Salary type:
☐ Steady monthly salary
☐ Contract/Job based
☐ Unsteady salary
☐ No income
Others: _____

Number of members in household
☐ 1-3
☐ 4-6
☐ More than 6

Family Structure: (All that apply)
☐ Male-headed Nuclear family
☐ Female-headed Nuclear family
☐ Male-headed Joint family
☐ Female-headed Joint family

Household Responsibilities (All that apply)
☐ Food provision
☐ Water provision
☐ Household chores
☐ Income generation

Participation:
☐ Official community leader
☐ Unofficial community leader
☐ Active participation in community
☐ Passive participation in community
☐ Little/No participation

☐ Presence of voters ID

Connectivity: (All that apply)
☐ Personal mobile phone with no internet
☐ Personal smar phone with internet
☐ Landline
☐ Internet/Wi-Fi connection at home
☐ Television
☐ Radio

Which of the following apply to you and your household?
☐ Ground Floor House
☐ Access to terrace
☐ Cracks and leaks in the walls

B. **<u>Answer the following on a scale of 1-5:</u>**
1- Strongly disagree; 2- Disagree; 3- Neutral; 4- Agree 5 - Strongly agreed

S. No. **<u>Questions</u>**
A. **Inherent Vulnerabilities**
  i. **Age – Physical fitness**
1. I am physically fit for my age*
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
2. Due to my age I face physical challenges that limit my performance at work/at home
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
3. Due to my age, I face mental challenges (anxiety, stress) that affect my work and social life
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
  ii. **Education**
4. My literacy (reading, writing) level is sufficient for my general awareness*
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
5. My education level is sufficient to get a secure job*
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
6. I am satisfied with my current education level*
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
  iii. **Caste & Religion**
7. My caste causes me to feel excluded in my community
   Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
8. My religion causes me to feel excluded
   Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
9. Caste and/or religion of a person determines their character
   Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
  iv. **Influence of Civil Status**
10. My civil status does not allow me freedom of choice
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
11. My household responsibilities and duties interfere with my employment
   Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
12. My household responsibilities and duties interfere with my social life/leisure time
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
13. The responsibility of my children interferes with my employment and social life
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
B. **Outcomes of Resettlement**
  v. **Employment**
14. I am satisfied with my current job
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
15. My employment gives me an accessible network
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree

  vi. **Income**
16. My current income is adequate for my expenses
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
17. My current savings are adequate in case of an emergency
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree

  vii. **Location**
18. I am satisfied with the employment opportunities available near Kannagi Nagar
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
19. I am satisfied with the schools and educational institutions available around Kannagi Nagar
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree

20. I am satisfied with the skill training opportunities available
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
21. I am easily able to access public transport from Kannagi Nagar
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree

viii. **Built-Environment**
22. I am satisfied with the condition and quality of my house
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
23. I am satisfied with the quality of roads and streets in Kannagi Nagar
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
24. I am satisfied with the water provision infrastructure
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
25. I am satisfied with the provision of public toilets
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
26. I am satisfied with the water provision infrastructure
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree

ix. **Health**
27. There are PHCs and hospitals nearby that my family and I can access easily
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
28. My family members and/or I fall sick often after moving to Kannagi Nagar
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
29. I am satisfied with the quality of my diet
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree

C. **Drought:**
ix. **Exposure**
30. During the summer Kannagi Nagar faces water shortages
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
31. Water shortages have increased over the last few years
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
32. Drinking water must be bought in Kannagi Nagar
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree

x. **Sensitivity**
33. Water has become increasingly expensive in Kannagi Nagar
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
34. Household chores suffer because of water -shortages
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
35. Conflicts arise over water in Kannagi Nagar
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
36. Electricity is cut often in Kannagi Nagar during summer months
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
37. Some groups have an advantage over access to water than the others
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree

xi. **Adaptive Capacity**
38. Water collection responsibility is distributed among all members of the household
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
39. I have a strong contactable network of family in Kannagi Nagar
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
40. I have many friends in Kannagi Nagar
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
41. Kannagi Nagar is susceptible to drought
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree

D. **Floods:**
xii. **Exposure**
42. During the monsoon, your street is affected by flooding and waterlogging
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
43. During the monsoon, your home is affected by flooding
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
44. During the 2015 floods, we had to evacuate our homes
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
45. During the 2015 floods, we had to leave Kannagi Nagar
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
46. When it rains and floods, members of my family or I fall sick often
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree

xiii. **Sensitivity**
47. During the cyclone in 2016, we faced heavy property damage
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree

48. During the 2015 floods there were conflicts at the relief centers
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
49. There was inequalities of access to flood relief and compensation
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree

xiv. Adaptive Capacity

50. We made structural changes inside our house because of flooding and water logging (raise plinth, bathroom level)
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
51. Structural changes were made on the roads and streets after the floods (raise pavement, new roads etc)
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
52. In the event of a flood I have people who will accommodate me if needed
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
53. In the event of a flood I can swim and possibly save myself
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
54. I would be physically able to save myself in the event of a disaster
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
55. I am satisfied with the decisions made by decision-making bodies in Kannagi Nagar
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree
56. Kannagi Nagar is susceptible to flooding
   ☐ Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐Strongly Agree

Annexe 2: Interviews and Focus-group Discussions

Annexe 2.1 Guidelines for the Interviews with the residents of Kannagi Nagar

The survey questionnaire also served as a guideline for the interviews. Nevertheless, the gist of the questions asked based on the respondent and the time available is given below.

Outcomes of Resettlement

- How long have you lived in Kannagi Nagar? How has it changed since you moved in?
- How did life change after you and your family moved here? What would you say are the biggest impacts?
- Do you think Kannagi Nagar has improved over the years? What do you think can improve?
- Do the residents actively try to improve living conditions in Kannagi Nagar?
- What is your opinion of the neighbourhood? Do you like it here? Do you have many friends/family here with you?

Pluvial Flooding

- What was your experience during the flood of 2015?
  (Evacuation/ Shelters/ flood relief)
- How have you/family adapted after that? (Structural changes/ swimming lessons/)
- Did you face a lot of property damage during the cyclone Vardah in 2016?
- How accountable were the government/ community leaders in response to the floods?
- Do you have family members/friends who can help you in case of a flood?
- Does your employers network (if applicable) give you support if required, and not just in the event of a flood?

Drought

- How have you and your family been managing with the water-shortage?
- Are there fights during water collection? Is there a system of organization? Do you feel that distribution is unfair?
- In the previous years have you experienced water-shortages?

The following transcriptions were translated from Tamil to English to the best of the author's ability and knowledge. The quotations and references that were used in the thesis can be found in **bold text.**

Annexe 2.2 Interview 1

Outcomes of resettlement

"**In the beginning (life in) Kannagi Nagar was extremely difficult, but we have come this far- having lived here for 14-15 years now- and it cannot be said that (the colony) has not improved.** We moved here after the Tsunami. I did not have a job for a very long time, but my husband was able to get a few jobs here and there. Now I work in the school as a maid. We used to be in Santhome, they threw us here."

"Ah yes, they have given us buses, some health care centres […] in the beginning there was no water connection only"

"I don't have a choice. This is where I live now."

Pluvial Flooding

"We went to the school for a few days when the flood came. They gave us **Rs. 5000 compensation**. We came back home after four, five days."

"I have a few friends. But we all have our own families to take care of in these situations. I wouldn't want to burden them. I have no other family here. My children live in the city now with their families."

"The school where I work is where we were staying during the flood. So you could say it helped many people."

Drought

"We are only two of us so we are able to manage. This year it (water-shortages) is worse, we used to get water every alternate day. "

"(Laughs) There will always be fights. But not violent, just words. **Everyone gets two buckets per person and then they share the remaining (water, if there is) with all the houses**."

Annexe 2.3 Interview 2

Outcomes of resettlement

"I have been living here for almost ten years now. We used to live in Mylapore. I do not like this place one bit. It was so nice there. I had friends and family. Now, nothing. Just this man (points to her husband)"

"They have laid all the main roads. But what about us? These (inner roads) no one cares about because you cannot see it from outside"

"These people lay one road one day, next day they ask for votes. These people give them the votes also"

"There is a lot of nonsense that happens in that building there. It has been empty and these youngsters are up to no good there. Alcohol, marijuana, fights everything goes down in that building."

"I have this shop. He used to work but now he's (her husband) also old. So he just sits here with me most of the time."

Pluvial Flooding

"I am on the second floor so we were fine. The people downstairs came to our house for a few days."

"We did not get anything. We got some food for a few days but that's it."

"What property do I have for it to get damaged?"

"My son lives with his family (elsewhere). He has his own life and problems to deal with. As long as we can manage, (the two of us) we will.

Drought

"Yes ma, this year the water problem is very bad. Even if we try to save and collect water, how much can we save? We sometimes go without bathing for a few days."

"Last year and all it was fine (the water supply)."

"There are fights once in a while, but nothing major. It is quite organized. Everyone realises, but sometimes it gets the better of us […] (we know) that we need to share it at this point when it is coming once in five days."

Annexe 2.4 Interview 3

"I have been living here for more than fifteen years now. Initially there was nothing here. No water, no electricity, no proper roads. Nothing. **Now we have one bus every five minutes. Currently we have five lines that connect Kannagi Nagar to different places**. **Karunan has managed to get us good roads**."

"Initially both me and my husband could not find a job. But now both of us are employed so things are better. I work in the canteen of a company."

"I told you they gave us roads, buses and water. Now we even have good schools. Things are definitely improving around here"

"Yes yes I have my older brother not so far away and my in-laws live downstairs. Some of the ladies (in the neighbourhood) are like family. We have to take care of each other right? See, that one… (referring to a younger neighbour) she just got married and came (to Kannagi Nagar). She is like a younger sister to me."

Pluvial Flooding

"Water came into my in-laws house downstairs so they came up to live with us. For a few days we were stuck (in the house) but we managed with whatever we had. Also I told you I have a lot of sisters here, we helped each other out."

"What can we do? If it floods, it floods. How are we supposed to know when it is going to happen? How to prepare?"

"I have some friends at work but we only meet there. My superiors, what do they care about me and my problems?"

Drought

"We store water and try not to waste it. It is difficult only but what to do?"

"No never (regarding fights). Everyone takes their share and someone always makes sure it is shared equally"

"Not really, this year is bad. In the beginning yes we didn't have proper water provision but once they installed these pumps. We have been getting water very regularly up until now"

Annexe 2.5 Interview 4

Outcomes of Resettlement

"5 or 6 years now. We moved here for financial reasons. Could not afford a house in the city, so we are here now."

"It's been the same since I moved in not much difference. Now we have better roads after the floods."

"Its not as bad as some people say it is. Initially before I moved people warned me against it. But my neighbours are quite nice"

Pluvial Flooding

"We went to my sister's house in Triplicane when the rains started getting bad. There also it was flooded but at least we were all together."

"**They have raised the roads and now the water here doesn't stand. There are some parts where it still floods but we don't have issues with water stagnation and flooding here, thankfully. In my house we haven't made changes no**."

Drought

"We used to get water very regularly, every alternate day- maximum once in two days. But now, it quite unpredictable. It comes maybe once every week, twice a week if we are lucky."

"**Everyone gets two buckets per person per house. So it is distributed equally here. Big household or small every person gets equal money**"

"We know how many people are there in each house so they keep count of the buckets. We have to (stay organized) if we have to survive this water shortage problem."

Annexe 2.6 Interview 5

Outcomes of Resettlement

"**I have lived here for almost twenty years now and they still haven't given me my allotment.** I am renting a house here with my husband. They threw us out of Santhome and we have been here ever since."

"**I get opportunities to sweep (the roads, parks, schools) but once in a while […] I have now given up the idea of a steady income, my husband also makes a little (money) […] we manage between the two of us**."

"No one helps here. I have asked Karunan to help me (about the allotment) so many times. Nobody does anything"

Pluvial Flooding

"**We had to leave the house and go to the school**. They gave us food and everything there. There were a few fights but I don't get involved in such things. They gave us Rs. 5000 after everything."

"Nothing here ma (when asked about adaptive strategies). If the rains come now it will be good don't you think?"

Drought

"It is just me and my husband now at home so we manage. We always have an extra couple of buckets full of water in case the water doesn't come. Or we buy water. What else to do?"

"They've increased the prices of water also now. Between that and the rent I don't know where to go for food next month."

"Yes I can ask my children. But I don't want to burden them. They have their own children studying in private schools and everything. I will manage for the few years I have left."

Annexe 2.7 Interview 6

Outcomes of Resettlement

"It has been around 6 years since we came here. My husband got a job in a company nearby as a peon. So we came here."

"For me it has been very difficult. I work in two houses in Thiruvanmayur. **The time take to travel, I could be spending time with my kids or doing house-work.** (Its) difficult but what to do"hey recently laid the roads and built some parks for the kids. Other than that I don't know much."

"My in-laws live with me. I have a few women on the street who I chit-chat with now and then."

Pluvial Flooding

"This area was fine. Near the canal only there was a lot of flooding I heard. Only thing was the roads were inaccessible so we couldn't leave Kannagi Nagar for a few days. We had to ration the food and water then."

"We did not receive any compensation as we were not so badly affected"

Drought

"This year has really been terrible for us. Before this we never ran short at home. Also, **I am almost always at work when they supply water at the pumps and even if I leave from there… by the time I am home the water is over.** My in-laws and husband manage to catch the water, but now my mother-in-laws back is hurt because of this. We really have to conserve the water. Drinking water of course we buy but for housework we depend on the pumps"

"Now and then there are arguments between the ladies."

Annexe 2.8 Interview 7

The recording for this interview was unclear due to background noise from traffic and the low voice of the respondent for transcription.

Annexe 2.9 Interview 8

Outcomes of Resettlement

"I got married and moved here three years ago."

"**Right now, one of the biggest problems we are facing is the 'thanni-prachanai' (water problem). We used to get water very regularly, every alternate day- maximum once in two days. But now, it quite unpredictable. It comes maybe once every week, twice a week if we are lucky**."

Pluvial Flooding

"I got married in 2016 so I was here only during the cyclone. My husbands bike crashed on our house wall because of the wind. It was so scary."

"Water stagnates around the house, not on the main road no."

"We haven't made any changes inside our house as far as I know"

Drought

"Yes, before even the timing was regular. Now the water comes and we all have to run with our buckets."

"Yes lots of fights happen. There are some families that have many people that really dominate and take all the water. The water at the bottom is always dirty. They leave that for us behind. How many times to fight with them also? My mother in law is the one who usually takes care of them. I just stay away."

"No we manage. There are five of us at home. We buy drinking water and use that for bathing sometimes. The water from the pump smells like urine sometimes. This has only been happening this year"

Annexe 2.10 Interview 9 – Dr. Karen Coelho, Chairperson, MIDS

The following transcript is an excerpt from an interview conducted with Dr. Karen Coelho at the Madras Institute of Developmental Studies, Adyar, Chennai on 10th July, 2019.

Dr. Coelho: They have brought water through their protests and demands; they have been able to ensure regular water supply (pre-drought) […] they have become a political constituency that has brought them certain things (infrastructure). […] you probably better try to get some sense before, and one person you should ask about this is Vanessa who has done a lot of work on vulnerability mapping. So there are widows who would be vulnerable, because they [...], or they don't have a job and they don't have any support, so they have actually zero, anything. Another huge issue, is illness, even if you are slightly ill, just a problem with blood pressure and something, then you can make because it's [...] to gout. So you're not able to get a job because you illness doesn't allow you to go out in the crowded passenger traffic in the city.

So that would be the other thing, I'm just giving you another example, and then there are, the elderly with no support. Then you have things like disability, elderly and simple household, caste.

Ishita Vedamuthu: Do you think there will be a difference between these micro-neighborhoods (that we spoke of earlier). Some neighborhoods might have a more powerful person who probably get the water to come to them first, rather than to other areas?

Dr. Coelho: There is quite a lot of differences among them, and some of the mare like this middle class neighborhoods, and some are very crime ridden, and some of them are swollen with police service. so you will find some differences. But how does vulnerability play out among those, I am not really sure, I think in your case you should make focus groups, and ask who are the people in different groups, and then to explain vulnerability to people, operationalize it, no one will understand this word.
[…]
Dr. Coelho: yeah, so then I think trying to understand the [...]. So, one of the issues you have is that on the ground floor you're vulnerable then what are your back up resources, can you go elsewhere, to people, do you have a network, is there a neighborhood organization that makes sure the widows or single mothers are taken care of well. […] you see the family structure. so you'll get this from narratives, how will people cope, what are the challenges they faced, how [...] in different situations, then you know that some are better than other because of what factor.

Annexe 2.11 Interview 10- Vanessa Peter, Policy Researcher

The following excerpt is from the interview with Vanessa Peter conducted by Atika Almira at Kodambakkam, Chennai on 24th, July 2019. The interview recording had a lot of background noise and could not be transcribed entirely.

Vanessa Peter: I am working against the usage of the word slums because now days they are always there is stigma always judge when they use the word slum. So we will say Habitation of the poor that is a fairly decent word in different way and there are different types of communities, it is not homogeneous. So you have those technically residing in slums and they have those urban homeless who reside in streets, who live under the flyovers, on the footpaths and so on and then you have migrants workers, then Tamil Nadu or other parts of coastal India so we have a lot of fishermen ,coastal community ,but not only fishing but also livelihood activities of the community […] even the urban homeless there is heterogeneous nature, a lots of classifications of migrants, migrants there is occupation migrants, district migrants is too many […]when we talk about urban poverty the only solution think and everybody think about is housing because we think ,of course one of the problem is housing, so the problem to address is housing right, so we fail to understand that there the issues of urban poor to address beyond housing has being one problems.[…]
People should be treated in a dignified way, they should not even trust any processes. It is very easy to blame a community, they are not coming together, they are not doing this. (unclear) Certainly, the resilience part of it [unclear]. Communities are really resilient. (unclear) You and I would never be able to [unclear]. Throughout their lives they have struggled. If you ask a woman in the slum, she is the most resilient person I have ever seen. Self-resilience, right. She has faced a harsh life, she knows how to take care of her children, she knows how to earn for her family. (unclear)She is being beaten up for the rest of her life by her husband. There is so much of domestic violence. She has strength for her children, she has strength for herself. (unclear) Quite naturally she is still continuing [unclear], she wants to educate her child. (unclear) That is resilience. I think we should celebrate that resilience. The moment you celebrate that resilience, the moment you celebrate diversity, the moment you celebrate the fact that this people are somehow different […]
In Kannagi Nagar every day you survive (unclear). Scarcity is always a bigger problem. Abundance of anything is never a problem. Anything in abundance. Surplus of water is (unclear) every year this happens during monsoon, people just became used to the floods. 2015 changed it all because of the intensity of floods. The floods were (unclear). That's what I said, it's not abundance that is the issue, scarcity that's always the issue. Always live in a place that (unclear). The problem about Kannagi Nagar is that the entire neighborhood around Kannagi Nagar will have a water connection (unclear) because there is a problem that the water provision is a department, this guy is a different department, (unclear) is a different department (unclear) is in a different district, then it became part of Chennai district and all jurisdiction and all things are there. That's an answer in just a (unclear). What I learned from my work, we all have the habit of looking at it from our perspective (unclear) bottoms-up perspective. What they see the issue and how we see it an issue is very different. […]
Because when your life is full of struggle, you don't have a damn time to think about any of these things. You have struggles based on a daily basis.

Annexe 2.12 Notes and Comments from FGDs

The main take away from one spontaneous focus group discussion was the stigma associated with Kannagi Nagar. This discussion was with four women (35-40 years old) who were not resettlers but had moved to Kannagi Nagar because of economic reasons. They said that they were not able to get loans from banks and their children were not able to secure jobs (no matter how much they have studied) because of the "bad name that Kannagi Nagar has". "My son has been trying to find a job for months. Everyone turns him away. Another respondent said that she had been trying to get a small personal loan of 5 lakhs to expand her tailoring business and make repairs at her house. "The bank people send me away after hearing that I live in Kannagi Nagar." Another woman implored "Madam, you can write whatever you want about the water problems and flooding but for all our sakes please put it out there that we are good people trying to earn an honest living. Kannagi Nagar is no longer a 'bad place'." They informed the author that they were actually quite happy with

Kannagi Nagar otherwise and that the schools were good. They got basic health care. The roads being raised and the creation of parks made them feel like Kannagi Nagar is less neglected than before.

The second spontaneous group discussion that emerged was with three older (50-65) women. These women were light hearted about their problems. They said that the water problems are so bad now that "who even remembers the flood?". They also were from the school of thought that the floods of 2015 were an act of god and that if he wills such an event, so be it. When asked how they dealt with it, two women said they went to their children's houses. The other woman and her husband took shelter at the local school. All three got Rs.5000/- compensation for their losses. When asked about community leaders all three (and 80% of the survey respondents) spoke about the local councillor TC Karuna. They were all praises for him and gave him credit for the roads being laid and water reaching them on time.

Annex 3: Data Analysis

Annex 3.1 Aggregation of variables – Associated and additional tables and graphs

Inherent Vulnerability: Age

Indicators	Survey Question
PhysicalFit_recode	Q1. I am physically fit for my age
PhysicalAbility_recode	Q55.I would be physically able to save myself in the event of a disaster
Physical_chall	Q2, Q3. Due to my age I face physical challenges/ mental challenges that limit my performance at work/at home
Mental_chall	

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.605
Bartlett's Test of Sphericity	Approx. Chi-Square	199.867
	df	6
	Sig.	.000

Annexe Table 1: Age- KMO Sampling Adequacy and Bartlett's Test of Sphercity

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	2.248	56.209	56.209
2	.977	24.430	80.638
3	.573	14.314	94.953
4	.202	5.047	100.000

Extraction Method: Principal Component Analysis.

Annexe Table 2: Age- Variances

Annexe Table 3: Age- Chronbach's Alpha

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.701	.700	4

	Mean
Inter-Item Correlations	.368

Annexe Table 4: Inter-Item Correlation Mean

	Cronbach's Alpha if Item Deleted

PhysicalFit_recode	.599
PhysicalAbility_recode	.581
Physical_chall	.467
Mental_chall	.817

Annexe Table 5: Chronbach's Alpha if item deleted

Inherent Vulnerability: Education

Edu_LvlR   : My education level is sufficient to get a secure job

Gen_awarenessR : My literacy (reading, writing) level is sufficient for my general awareness

Satisfaction_EduR   : I am satisfied with my current education level

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.593
Bartlett's Test of Sphericity	Approx. Chi-Square	81.296
	df	3
	Sig.	.000

Annexe Table 6: Education- KMO Sampling Adequacy and Bartlett's Test of Sphericity

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	1.809	60.305	60.305
2	.789	26.310	86.615
3	.402	13.385	100.000

Extraction Method: Principal Component Analysis.

Annexe Table 7: Education- Variances

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.661	.661	3

Annexe Table 8: Education- Reliability

	Mean
Inter-Item Correlations	.394

Annexe Table 9: Inter-Item Correlation Mean

Inherent Vulnerability: Civil Status

Indicator	Survey Question
CivilStatus_Infl	: My civil status does not allow me freedom of choice

Infl_Emp	: My household responsibilities and duties interfere with my employment
Infl_Social	: My household responsibilities and duties interfere with my social life/leisure time
Child_resp	: The responsibility of my children interferes with my employment and social life

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.570
Bartlett's Test of Sphericity	Approx. Chi-Square	56.625
	df	6
	Sig.	.000

Annexe Table 10: Civil Status- KMO Sampling Adequacy and Bartlett's Test of Sphericity

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	1.706	42.646	42.646
2	.974	24.347	66.993
3	.823	20.570	87.563
4	.497	12.437	100.000

Extraction Method: Principal Component Analysis.

Annexe Table 11: Civil Status- Variances

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.519	.520	4

Annexe Table 12: Civil Status- Reliability

	Mean
Inter-Item Correlations	.213

Annexe Table 13: Civil Status- Inter-Item Correlation Mean

	Cronbach's Alpha if Item Deleted
CivilStatus_Infl	.572
Child_resp	.478
Infl_Social	.257
Infl_Emp	.432

Annexe Table 14: Civil Status- Chronbach's Alpha if Item deleted

Inherent Vulnerability: Caste and Religion

Indicator	Survey Question
Caste_Infl	: My caste causes me to feel excluded in my community

| Rel_Infl | : My religion causes me to feel excluded |
| Opinion_CasteRel | : Caste and/or religion of a person determines their character |

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.528
Bartlett's Test of Sphericity	Approx. Chi-Square	74.748
	df	3
	Sig.	.000

Annexe Table 15: Caste & Religion- KMO Sampling Adequacy and Bartlett's test of Sphericity

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	1.713	57.098	57.098
2	.899	29.968	87.066
3	.388	12.934	100.000

Extraction Method: Principal Component Analysis.

Annexe Table 16: Caste & Religion- Variances

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.590	.601	3

Annexe Table 17: Caste & Religion- Reliability

	Mean
Inter-Item Correlations	.334

Annexe Table 18: Caste & Religion- Inter-Item Correlation Mean

Outcome of Resettlement: Employment

Indicator	Survey Question
Emp_Network	: My employment gives me an accessible network
Adeq_Income	: My current income is adequate for my expenses
Adeq_Savings	: My current savings is adequate in case of an emergency
Satisfaction_Emp	: I am satisfied with my current job

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.634
Bartlett's Test of Sphericity	Approx. Chi-Square	159.464
	df	6
	Sig.	.000

Annexe Table 19: Employment- KMO Sampling adequacy and Bartlett's Test of Sphericity

Initial Eigenvalues			
Component	Total	% of Variance	Cumulative %
1	2.153	53.817	53.817
2	1.046	26.151	79.968
3	.504	12.591	92.559
4	.298	7.441	100.000

Extraction Method: Principal Component Analysis.

Annexe Table 20: Employment- Variances

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.501	.578	4

Annexe Table 21: Reliability

	Mean
Inter-Item Correlations	.255

Annexe Table 22: Employment- Inter-Item Correlation Mean

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Emp_Network	6.13	5.306	-.057	.079	.790
Adeq_Income	6.67	3.940	.469	.555	.275
Adeq_Savings	7.01	4.658	.423	.396	.358
Satisfaction_Emp	6.43	3.293	.572	.437	.134

Annexe Table 23: Employment- Chronbahc's Aplha if Item deleted

Outcome of Resettlement: Built Environment

Indicator	**Survey Question**
Cond_home	: I am satisfied with the condition and quality of my house
Cond_streets	: I am satisfied with the quality of roads and streets in Kannagi Nagar
Cond_watersupp	: I am satisfied with the water provision infrastructure
Cond_Publictoilets	: I am satisfied with the provision of public toilets
Cond_Sanit	: I am satisfied with the sanitary conditions

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.580
Bartlett's Test of Sphericity	Approx. Chi-Square	41.162
	df	3

	Sig.	.000

Annexe Table 24: Built Environment- KMO Sampling Adequacy and Bartlett's test of Sphericity

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	1.596	53.206	53.206
2	.840	27.995	81.202
3	.564	18.798	100.000

Extraction Method: Principal Component Analysis.

Annexe Table 25: Built Environment- Variances

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.548	.552	3

Annexe Table 26: Built Environment- Reliability

	Mean
Inter-Item Correlations	.291

Annexe Table 27: Built Environment- Inter-Item Correlation Mean

Outcome of Resettlement: Location

Emp_Opp	: I am satisfied with the employment opportunities available near Kannagi Nagar
Edu_Opp	: I am satisfied with the schools and educational institutions available around Kannagi Nagar
Training_Opp	: I am satisfied with the training opportunities available near Kannagi Nagar
Satisfaction_Emp	: I am easily able to accesss public transport from Kannagi Nagar

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.538
Bartlett's Test of Sphericity	Approx. Chi-Square	59.785
	df	10
	Sig.	.000

Annexe Table 28: Location- KMO Sampling Adequacy and Bartlett's test of Sphericity

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	1.655	33.094	33.094
2	1.269	25.373	58.467
3	.861	17.219	75.686

4	.676	13.529	89.215
5	.539	10.785	100.000

Extraction Method: Principal Component Analysis.

Annexe Table 29: Location- Variances

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.560	.559	3

Annexe Table 30: Location- Reliability

	Mean
Inter-Item Correlations	.297

Annexe Table 31: Location- Inter-Item Correlation Mean

Outcome of Resettlement: Health

Indicator	Survey Question
Quality_Diet	I am satisfied with the quality of my diet
Incidence_Illness	My family members and/or I fall sick often after moving to Kannagi Nagar
Access_healthcare	There are PHCs and hospitals nearby that my family and I can access easily

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.499
Bartlett's Test of Sphericity	Approx. Chi-Square	66.935
	df	3
	Sig.	.000

Total Variance Explained

Initial Eigenvalues

Component	Total	% of Variance	Cumulative %
1	1.613	53.769	53.769
2	1.000	33.322	87.091
3	.387	12.909	100.000

Extraction Method: Principal Component Analysis.

Annexe Table 32: Health- KMO, Bartlett's test and Variances

Correlation Between Forms		.623
Spearman-Brown Coefficient	Equal Length	.767

Unequal Length		.767
Guttman Split-Half Coefficient		.766

Annexe Table 33: Health- Correlations (Spearman-Brown Coefficient)

Social Vulnerability Characteristic: Exposure to Flooding

Indicator	Survey Question
Street_flood	During the monsoon, your street is affected by flooding and waterlogging
Home_flood	During the monsoon, your home is affected by flooding
Freq_Illness	When it rains and floods, members of my family or I fall sick often
Occur_EvacHome	During the 2015 floods, we had to evacuate our homes
Occur_EvacKN	During the 2015 floods, we had to leave Kannagi Nagar

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.570
Bartlett's Test of Sphericity	Approx. Chi-Square	107.619
	df	10
	Sig.	.000

Annexe Table 34: Exposure to Flooding- KMO and Bartlett's Test

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	1.894	37.877	37.877
2	1.036	20.721	58.598
3	.965	19.309	77.907
4	.791	15.821	93.729
5	.314	6.271	100.000

Extraction Method: Principal Component Analysis.

Annexe Table 35: Exposure to Flooding- Variances

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.691	.698	3

Annexe Table 36: Exposure to Flooding- Reliability

	Mean
Inter-Item Correlations	.435

Social Vulnerability Characteristic: Sensitivity to Flooding

Indicator	Survey Question
OccurPropDamage	During the cyclone in 2016, we faced heavy property damage
Conflict_OccurFlood	During the 2015 floods there were conflicts at the relief centers
Acc_Floodrel	There was inequalities of access to flood relief and compensation

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.737
Bartlett's Test of Sphericity	Approx. Chi-Square	415.980
	df	15
	Sig.	.000

Annexe Table 38: Sensitivity to Flooding- KMO and Bartlett's Test

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	3.009	50.156	50.156
2	1.026	17.106	67.262
3	.964	16.069	83.332
4	.660	11.000	94.332
5	.210	3.508	97.840
6	.130	2.160	100.000

Extraction Method: Principal Component Analysis.

Annexe Table 39: Sensitivity to Flooding- Variances

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.551	.550	5

Annexe Table 40: Sensitivity to Flooding- Reliability

	Mean
Inter-Item Correlations	.196

Annexe Table 41: Sensitivity to Flooding- Inter-Item Correlation Mean

Social Vulnerability Characteristic: Adaptive Capacity to Flooding

Indicator	Survey Question

StrucChanges_Inside,	We made structural changes inside our house because of flooding and water logging (raise plinth, bathroom level)
StrucChanges_Outside	Structural changes were made on the roads and streets after the floods (raise pavement, new roads etc)
Accountability	I am satisfied with the decisions made by decision-making bodies in Kannagi Nagar
Ability_Swim	In the event of a flood I can swim and possibly save myself
RiskPerc_Flood	Kannagi Nagar is susceptible to flooding
Network_strength	In the event of a flood I have people who will accommodate me if needed

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.526
Bartlett's Test of Sphericity	Approx. Chi-Square	188.153
	df	15
	Sig.	.000

Annexe Table 42: Adaptive Capacity to Flooding- KMO and Bartlett's Test

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	2.056	34.266	34.266
2	1.275	21.255	55.521
3	.943	15.720	71.242
4	.844	14.066	85.308
5	.692	11.535	96.844
6	.189	3.156	100.000

Extraction Method: Principal Component Analysis.

Annexe Table 43: Adaptive Capacity to Flooding- Variances

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.713	.701	3

Annexe Table 44: Adaptive Capacity to Flooding- Reliability

	Mean
Inter-Item Correlations	.438

Annexe Table 45: Adaptive Capacity to Flooding- Inter-Item Correlation Mean

Social Vulnerability Characteristic: Exposure to Drought

Indicator	Survey Question
Watershort_Summer	During the summer Kannagi Nagar faces water shortages
Trend_Watershort	Water shortages have increased over the last few years
Acc_DrinkWater	Drinking water must be bought in Kannagi Nagar

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.689
Bartlett's Test of Sphericity	Approx. Chi-Square	109.622
	df	3
	Sig.	.000

Total Variance Explained

Initial Eigenvalues

Component	Total	% of Variance	Cumulative %
1	2.030	67.662	67.662
2	.536	17.862	85.524
3	.434	14.476	100.000

Extraction Method: Principal Component Analysis.

Annexe Table 46: Exposure to Drought- KMO, Bartlett's Test and Variances

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items
.759	.761

	Mean
Inter-Item Correlations	.515

Annexe Table 47: Exposure to Drought- Reliability and Inter-Item Correlation Mean

Social Vulnerability Characteristic: Sensitivity to Drought

Indicator	Survey Question
Conflict_Occurance_WtrColl	Conflicts arise over water in Kannagi Nagar
HouseAct_Disrupt	Household chores suffer because of water -shortages
Electricity shortage	Electricity is cut often in Kannagi Nagar during summer months
Trend_Waterprice	Water has become increasingly expensive in Kannagi Nagar
Access_Water	Some groups have an advantage over access to water than the others

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.478
Bartlett's Test of Sphericity	Approx. Chi-Square	72.128
	df	10
	Sig.	.000

Annexe Table 48: Sensitivity to Drought- KMO and Bartlett's Test

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	1.650	32.993	32.993
2	1.270	25.394	58.387
3	.990	19.809	78.196
4	.620	12.391	90.587
5	.471	9.413	100.000

Extraction Method: Principal Component Analysis.

Annexe Table 49: Sensitivity to Drought- Variances

Correlation Between Forms		.352
Spearman-Brown Coefficient	Equal Length	.521
	Unequal Length	.521
Guttman Split-Half Coefficient		.517

Annexe Table 50: Sensitivity to Drought- Reliability (Spearman-Brown Coefficient)

Social Vulnerability Characteristic: Adaptive Capacity to Drought

Indicator	Survey Question
RiskPerc_Drought	Kannagi Nagar is susceptible to drought
Ability_Network	I have many friends in Kannagi Nagar
Contact_Network	have a strong contactable network of family in Kannagi Nagar
WaterColl_RespDist	Water collection responsibility is distributed among all members of the household

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.581
Bartlett's Test of Sphericity	Approx. Chi-Square	82.456
	df	6
	Sig.	.000

Annexe Table 51: Adaptive Capacity to Drought- KMO and Bartlett's Test

Component	Total	% of Variance	Cumulative %
		Initial Eigenvalues	
1	1.819	45.466	45.466
2	1.120	27.990	73.456
3	.593	14.834	88.290
4	.468	11.710	100.000

Extraction Method: Principal Component Analysis.

Annexe Table 52: Adaptive Capacity to Drought- Variances

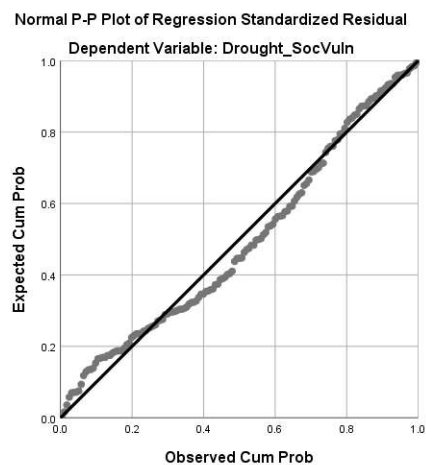|		
Correlation Between Forms		.363
Spearman-Brown Coefficient	Equal Length	.533
	Unequal Length	.553
Guttman Split-Half Coefficient		.516

Annexe Table 53: Adaptive Capacity to Drought- Reliability (Spearman-Brown Coefficient)

Annexe 3.2 Hypotheses Testing, Description and Graphs
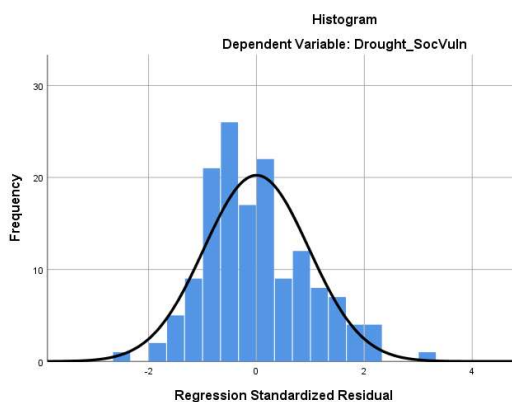
Hypothesis 2: Model 1
Description in Section 4.2.3
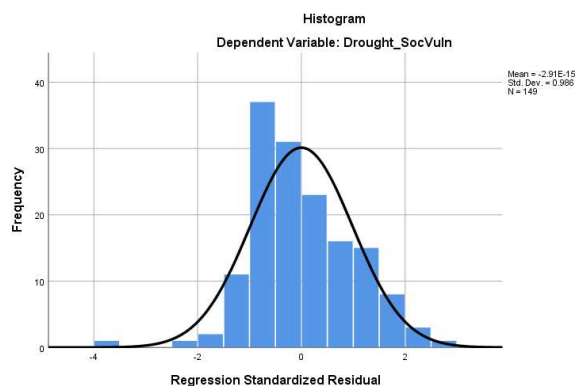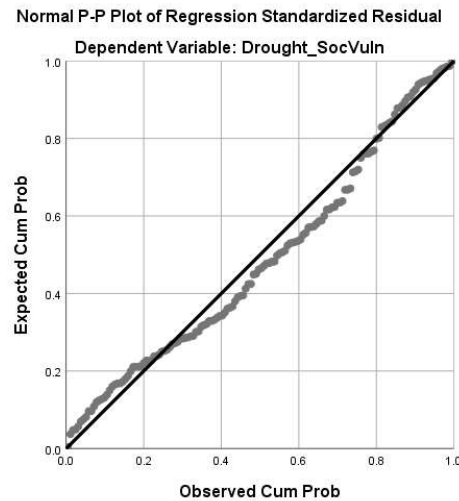

Graph 24: Model 1: Residuals (Author, 2019)

Graph 25: Model 1: P-Plot (Author, 2019)

Hypothesis 3: Model 2
Description in Section 4.2.3

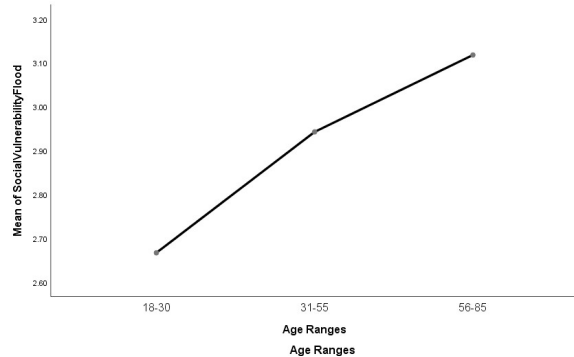**Graph 26: Model 2: Residuals (Author, 2019)**

Graph 27: Model 2: P-Plot (Author, 2019)

Hypothesis 4, 5
The levels of Social Vulnerability to Flood (H4) and Drought (H5) are significantly higher depending on the age of the women in Kannagi Nagar.

DV3, DV4: Social Vulnerability levels to Flood and drought

Factor: Age

Graph 28: Means Plot- Age Group (Author, 2019)

The respondents were divided into three groups based on age, the first group were women between the ages of 18 and 35. The second group were in the 36-55 age range. The last group were women who were aged either 56 or more. To test this hypothesis a one-way ANOVA was run on SPSS with the dependent variables, D3 and D4- their social vulnerability scores to flood and drought, respectively. The Lavene statistic is not significant for both DVs and hence the requirement of homogeneity of variances has been met and the test is robust. On inspection of the ANOVA result we can see that both models are significant (.001>.000) with the F values at 21.877 for flood and 17.516 for drought. This implies that there is a statistically significant difference between the means of the age groups. Looking at the Multiple Comparisons table, it can be seen that the mean differences between ALL the groups are significant at the 0.05 level with largest differences between the youngest group and the oldest. This **confirms our hypotheses, H4 and H5.**

Table 31: One-way ANOVA for comparing means of levels of Social Vulnerability by Age group (Author, 2019)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
SocialVulnerabilityDrought	Between Groups	2.999	2	1.500	17.516	.000
	Within Groups	12.586	147	.086		

	Total	15.585	149			
SocialVulnerabilityFlood	Between Groups	3.134	2	1.567	21.877	.000
	Within Groups	10.530	147	.072		
	Total	13.664	149			

Hypothesis 6, 7

The levels of Social Vulnerability to Flood (H6) and Drought (H7) are significantly different depending on the number of years the women have lived in Kannagi Nagar.

DV3, DV4: Social Vulnerability levels to Flood and drought

Factor: Length of residence in Kannagi Nagar

The respondents were divided into three groups depending on the number of years they have lived in Kannagi Nagar. The ranges are: 1-5, 6-10 and longer than 10 years. The rationale behind this grouping was because the previous studies done in Kannagi Nagar was 10 years ago. There were only twenty respondents who had moved to Kannagi Nagar in the last 5 years as compared to the other two groups having 63 and 67 respondents each. This irregularity is accounted for in the one-way ANOVA test in SPSS. The Lavene Statistic was not significant but so was the significance of the F value (.258, .803 > .05). Therefore, although the variances were homogeneous, there were no significant differences in the means of the groups. Thus, **rejecting** both the hypotheses, H6 and H7.

Hypothesis 8, 9

The levels of Social Vulnerability to Flood (H8) and Drought (H9) are significantly higher or lower depending on the education level of the women in Kannagi Nagar.
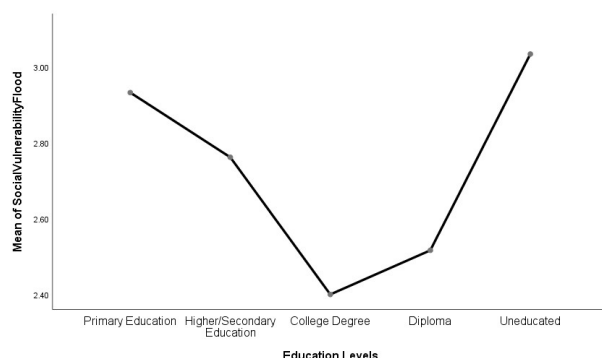
Graph 29: Means Plot- Education Level (Author, 2019)

Five groups were tested in this case, uneducated women, women who have received primary education, women who have received Higher/Secondary education, Women with College Degrees and Diplomas. The women with college degrees (5) and diploma (1) were very few in comparison to the uneducated (68), primary educated (42) or women with Higher/Secondary education (34). However, they were still included in the test to show the variance. Lavene Statistic revealed homogeneous variance. The ANOVA table showed that both models were significant (.001>.000). The Means plots reveal that the women with college degrees and diplomas had the lowest levels of vulnerability and the women who were uneducated had the highest vulnerability to Flood and drought. This **confirmed both hypotheses, H8 and H9.**
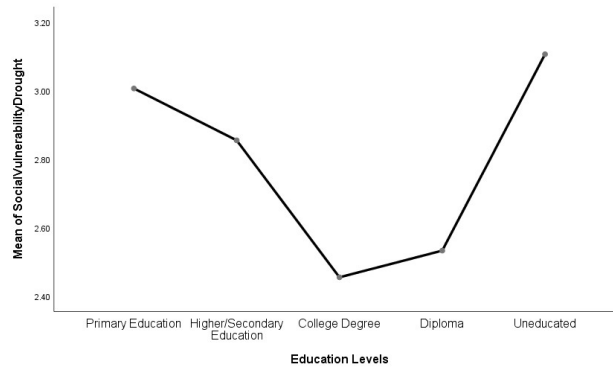
Graph 30: Means Plot- Education Levels (Author, 2019)

Table 32: One-way ANOVA for comparing
means of levels of Social Vulnerability by Education level (Author, 2019)

<u>**ANOVA**</u>

		Sum of Squares	df	Mean Square	F	Sig.
SocialVulnerabilityDrought	Between Groups	3.177	4	.794	9.280	.000
	Within Groups	12.409	145	.086		
	Total	15.585	149			
SocialVulnerabilityFlood	Between Groups	3.235	4	.809	11.244	.000
	Within Groups	10.429	145	.072		
	Total	13.664	149			

Hypothesis 10, 11

The levels of Social Vulnerability to Flood (H10) and Drought (H11) are significantly higher or lower depending on the women's type of employment.

DV3, DV4: Social Vulnerability levels to Flood and drought

Factor: Type of employment

The means of seven types of employment groups were compared: Domestic work, Public servant, Unemployed, Employed by a company, Self-employed, Contract-based employment and Informal Business. The number of respondents per group greatly varied but this is accounted for by reporting the Brown-Forsythe test for robustness of equality of means that accounts for these differences and reduces the error. The Lavene Statistic rejected the null hypotheses for homogeneity of variances. However, both one-way ANOVA models were insignificant, **rejecting the hypotheses**. Nevertheless on inspection of the post-hoc tests, there were a few significant differences at the 0.05 level that were flagged. They were between Informal business and Domestic Work for vulnerability to drought. The Means plot showed the highest levels of vulnerabilities were displayed by those running informal businesses and those who were employed based on contract (informal or formal contracts). These are mostly women who sometimes clean streets, backyards, public spaces or employed in small construction sites on a regular or irregular basis. Both these categories receive irregular salaries/profit making them more vulnerable. Unemployment had a lower mean comparatively, usually because their spouses' income sufficed.

Hypothesis 12, 13
The levels of Social Vulnerability to Flood (H12) and Drought (H13) are significantly higher or lower depending on the caste of the women in Kannagi Nagar.

DV3, DV4: Social Vulnerability levels to Flood and drought

Factor: Caste

Most of the respondents belonged to either the Scheduled Caste/Tribe or to the Most/Backward Classes. These four groups were tested, however only one respondent belonged to the Scheduled Tribes. This respondent displayed a higher level of vulnerability compared to the means of her counterparts. The Lavene Statistic was found to be not significant, however, the ANOVA revealed that the F values for both models were insignificant as well. This showed that the difference in means was not statistically significant. Therefore, it is safe to assume that caste is not a factor that affects their levels of vulnerability to flood or drought. Thus, the hypotheses H12 and H13 are **refuted**.

Hypothesis 14, 15
The levels of Social Vulnerability to Flood (H14) and Drought (H15) are significantly higher or lower depending on the religion of the women in Kannagi Nagar.

DV3, DV4: Social Vulnerability levels to Flood and drought

Factor: Religion

Hinduism accounted for most of the surveyed population, however there were Muslim and Christian respondents. The three groups were entered in the one-way ANOVA test. Lavene Statistic, a comparison of medians, was insignificant. Having met the requirement for homogeneity of variance, the ANOVA test was inspected. Both models proved to be insignificant meaning there was no significance in the differences of their vulnerability scores for both flood and drought. As a result, both hypotheses H14 and H15 are **rejected**.

Hypothesis 16, 17
The levels of Social Vulnerability to Flood (H16) and Drought (H17) are significantly different depending on the civil status of the women in Kannagi Nagar.

DV3, DV4: Social Vulnerability levels to Flood and drought

Factor: Civil Status
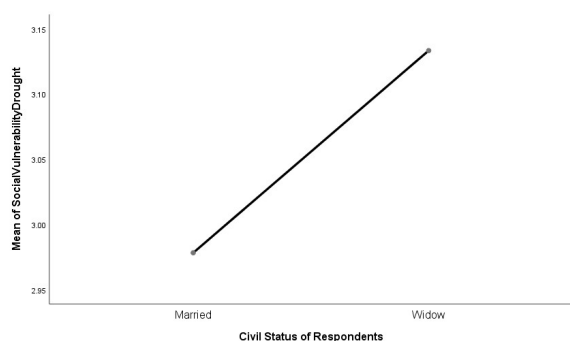
Graph 31: Means Plot- Civil Status (Author, 2019)

Of the 150 respondents, only one was separated from her husband and only two women were single. These three respondents were excluded from the ANOVA. The number of Married women exceeded the widows. However, on inspection of the results of the test, and meeting the requirement of homogeneity of variances, the differences in the means were statistically significant only in the case of drought. Consequently **rejecting the hypothesis H16**. The Means plot revealed that the married women are indeed less vulnerable than the widowed women. Hence, **confirming the hypothesis H17**.

Table 33: One-way ANOVA for comparing means of levels of Social Vulnerability by Civil Status (Author, 2019)

ANOVA

|		Sum of Squares	df	Mean Square	F	Sig.
SocialVulnerabilityDrought	Between Groups	.380	1	.380	3.908	.050
	Within Groups	14.102	145	.097		
	Total	14.482	146			
SocialVulnerabilityFlood	Between Groups	.234	1	.234	2.618	.108
	Within Groups	12.955	145	.089		
	Total	13.189	146			

Hypothesis 18, 19

The levels of Social Vulnerability to Flood (H18) and Drought (H19) are significantly different depending on the family structure of the women in Kannagi Nagar.

DV3, DV4: Social Vulnerability levels to Flood and drought

Factor: Family structure

Four groups were created to test these hypotheses: Male, and Female-headed Nuclear Families, and Male, and Female-headed Joint Families. The test of homogeneity of variances proved insignificant, thus meeting our assumptions. The ANOVA table showed that the model for their levels of vulnerability to Drought was insignificant (.305>.05), thus **rejecting hypothesis H19**. However, the F value for Flooding was significant (.05>.022). On inspecting the post hoc tests, there were significant differences flagged (0.05 level) in the mean for Male and Female-headed Nuclear Families, Female-headed Nuclear Family and Male-headed Joint Family. The Means plot revealed that both the male-headed families displayed significantly lower levels of vulnerability to both flood and drought than the female-headed families. However, statistically, the model only **confirms the Hypothesis H18**.
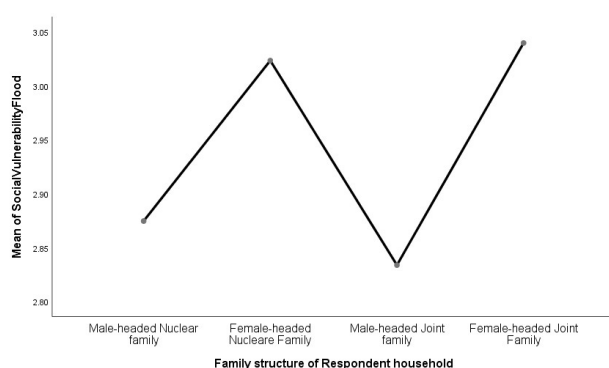
Graph 32: Means Plot- Family Structure (Author, 2019)

Table 34: One-way ANOVA for comparing means of levels of Social Vulnerability by Family Structure of Respondents' household (Author, 2019)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
SocialVulnerabilityDrought	Between Groups	.381	3	.127	1.219	.305
	Within Groups	15.204	146	.104		
	Total	15.585	149			
SocialVulnerabilityFlood	Between Groups	.868	3	.289	3.301	.022
	Within Groups	12.796	146	.088		
	Total	13.664	149			

Hypothesis 20, 21
The levels of Social Vulnerability to Flood (H20) and Drought (H21) are significantly different depending on the number of members residing in the households of the women in Kannagi Nagar.

DV3, DV4: Social Vulnerability levels to Flood and drought

Factor: Household strength

Three groups: 1-3 members, 4-6 members and more than 6 members in a household were created to test these hypotheses. Upon meeting the requirement for homogeneity of variances, these hypotheses (H19, H20) were rejected based on the significance of the F values in the ANOVA table. Multiple comparisons revealed no significant differences in the means of their levels of social vulnerability depending on the size of their household. The Means plot showed that the more crowded houses were more vulnerable however, the differences being not statistically significant, **reject the hypotheses**.

Hypothesis 22, 23
The levels of Social Vulnerability to Flood (H22) and Drought (H23) are significantly different depending both their resettled status and their ownership.

DV3, DV4: Social Vulnerability levels to Flood and drought

Factors: Resettled/Non resettled, Owner/Renter

This hypothesis was tested by combining two binary categorical variables to make a categorical variable with four groups. This was done in order to test if their resettled status in combination with owner/renter status makes a difference in their levels of vulnerability. On inspection of the Lavene
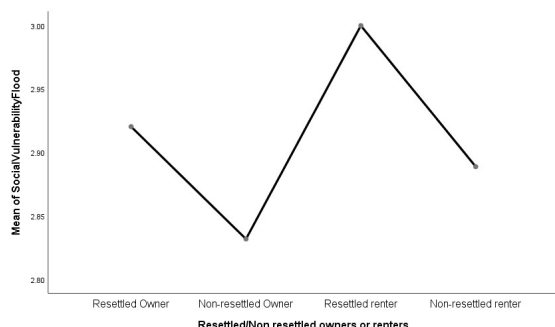
Graph 34: Means Plot- Owner-Resettler Status (Author, 2019)
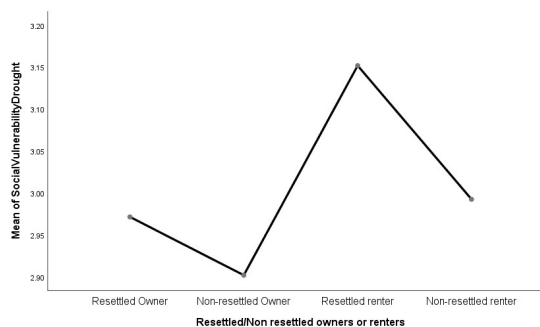
Graph 33: Means Plot- Owner-Resettler Status (Author, 2019)

statistic, the requirement for homogeneity of variances is met (p-value > .05). The ANOVA table however revealed that the F-values for both models are insignificant, as well. Hence, rejecting both hypotheses, H22 and H23. Nevertheless, on reviewing the means plot it can be seen that the resettled renters have higher vulnerability (3.15 to drought and 2.99 to flood) than their peers. The renters, both resettled and non-resettled (2.99 to drought and 2.88 to flood) have higher means than the owners in Kannagi Nagar. However, these are not statistically significant differences. As previously mentioned, on performing another one way ANOVA, it was found that resettled renters found themselves most exposed to the social effects of drought. This was a statistically significant difference (.05 > .010).

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