Short Run Impact of Climate Shock on Married Women's Unpaid Household Labor: Evidence from Indian Coastal Hotspot

Jheelum Sarkar*

March 25, 2024

Abstract

This paper explores the impact of extreme climate events on women's unpaid household labor, focusing on domestic and caregiving responsibilities in India, a country highly vulnerable to such occurrences. Utilizing Becker's time allocation theory, the study theorizes that changes in household income due to climate shocks affect individuals' time allocation, considering the influence of spouses' involvement in unpaid and paid labor. Employing the 2019 August floods in Kerala, India, as a case study, the research employs a difference-in-difference strategy to compare women's unpaid household work time between affected and unaffected districts. Data is drawn from the 2019 Indian Time Use Survey supplemented by climate data from the Indian Meteorological Department and the Institute of Climate Change Studies under the Kerala state government. Key results from double difference estimates indicate that the climate shock from floods increases time spent on unpaid household labor by married women in affected districts. However, triple difference estimates presents that climate shock induced women's unpaid labor declines in presence of their husband's participation in unpaid labor. This highlights the significance of redistribution of household activities. Additionally, ethnicity and caste play significant roles, with minority and lower-caste women experiencing exacerbated burdens. This study highlights that the policymakers should prioritize gender-inclusive resilience-building strategies.

Keywords: Climate Shock, Unpaid Labor, Time Use, Married Women

*PhD Student, American University, Washington, DC, United States.

1 Introduction

Globally, anthropogenic activities have led to rampant destruction and degradation of natural ecosystems resulting from greed, neglect, and the insatiable appetite of mankind. Human-led actions such as rapid urbanization, agricultural intensification, and industrial pollution have caused over-exploitation of natural resources, affecting their structure and functions. According to the Intergovernmental Panel on Climate Change's (IPCC's) Sixth Assessment Report, the global average temperature is likely to rise by at least 1.5°C by the next two decades (IPCC, 2021). This is expected to further intensify the incidence of heatwaves, result in longer summers, increase the frequency of occurrence of droughts in more regions, cause variability in precipitation across regions, raise sea levels, and trigger severe flooding. The recent Global Climate Risk Index report indicates that the top ten most affected countries by long-run climate events are from the global south, especially from sub-Saharan Africa and South Asia, characterized by widespread poverty and overwhelming dependence on climate-sensitive occupations for living (Eckstein et al., 2021).

Discriminatory actions in the form of marrying off young girls, limiting access to women's education, sexual or domestic violence are some critical predominant aspects of gender inequality in the patriarchal societies of the global south. Despite improvements made in educational attainment and economic opportunities, biased attitudes towards women continue to be an acute social hazard, amplifying various dimensions of gender imbalances in the global southern countries.

An important outcome of differential attitudes towards men and women in global south is due to sociocultural division of labor. In most countries of global south, women are primarily responsible to carry out unpaid household chores. These include various domestic and caregiving activities such as cleaning, cooking, childcare, producing food for which women do not receive any financial compensation. For example, nearly 81.2 percent women spend

about eight hours per day on domestic and care work related to household members in India (Time Use Survey of India, 2019). Average time spend by women to collect water is 9 times more than that of in Malawi (UNICEF, 2016). Globally, women and girls devote a staggering 12.5 billion hours of unpaid work every day which would equate to an annual contribution of at least $10.8 trillion to the global economy (Oxfam International, 2022). This amount surpasses the size of the global tech industry by more than three times (Oxfam International, 2022). Women dwelling in rural areas spend up to 14 hours per day on unpaid care work in low-income countries (Oxfam International, 2022).

Extreme climate events such as floods, cyclones, droughts have had substantial harm to human life, with heterogenous effect on various population subgroups, broadly between men and women. There exists a growing number of studies that examine the impact of climate change on gender issues such as child marriages, intimate partner violence, educational attainment and health problems (e.g., Corno et al., 2017; Sorensen et al., 2018; Khanna and Kochhar, 2020; Cools et al., 2020). However, this group of literature has largely overlooked the association of climate change, especially, climate events on the unpaid work burdens of women who are dwelling in ecologically fragile regions. Similarly, there are macroeconomic studies that highlights the economic costs of unpaid work done by women (Folbre and Yoon; 2008; Hirway, 2015; Samman et al., 2016). There are some microeconomic studies that explore unpaid work burdens but have not incorporated environmental shocks in their analysis (Chowdhury, 2009; Cook and Dong, 2011). However, there has been no study, so far in my knowledge, that examines the causal relationship between exogenous shock such as climate events and allocation of time use. According to social norms, women are endowed with the responsibility of domestic chores and caregiving responsibilities. The underlying hypothesis of this paper is that direct effects of climate events such as health hazards, negative income shocks contribute to an increase in women's unpaid domestic and care work.

Using the case study of flash floods in Kerala, a southern Indian coastal hotspot, this research investigates the correlation between climate shocks—specifically floods—and women's unpaid labor, encompassing domestic and caregiving responsibilities. By employing difference-in-difference strategy the key findings show that climate change-induced flood shocks lead to a significant increase in the time married women dedicate to unpaid work, including household chores and care duties. Post-climate shock, there is a notable increase in daily unpaid household labor among women, ranging from 84 to 93 minutes per day. Moreover, the inclusion of demographic and district-level controls amplifies this impact, suggesting nuanced variations across different factors. Husbands' participation in household work emerges as a crucial mitigating factor, correlating with a reduction of 10.1-18.9 percentage points in women's unpaid labor in affected districts compared to control groups.

The rest of the paper is organized as follows. Section 2 scrutinizes the intricate relationship between women's unpaid work and climate change, shedding light on the dynamic interactions between these phenomena. Section 3 depicts the underlying theoretical framework. Section 4 discusses the case study utilized for empirical analysis. Section 5 gives sources of data and variables used in this study. Section 6 discusses the empirical strategy. Section 7 shows the results from the empirical analysis. Section 8 draws the conclusion of the study, shedding light on the relevant policy implications.

2 Relationship Between Climate Shock and Gender Division of Unpaid Household Labor

Majority of less developed countries are characterized by the patriarchal society that restricts women to unpaid activities within the household such as collecting water, gathering fuelwood, cooking, cleaning as well as taking care of family members especially children and elderly. On the contrary, men are expected to earn money from participating in recognized

economic activities outside home. Climate change constricts livelihood opportunities such as agricultural labor as well as physical and natural assets such as land, hydrological systems, livestock (Navone, 2021; McKinsey, 2020; Connolly-Boutin and Smit, 2016). The resultant increased stress on natural resources and negative health effects on vulnerable population, such as, children and elderly (Muttarak and Dimitrova, 2019; Delbiso et al., 2017; Kumar et al., 2016) enhance time spent by women on taking care of dependent family members as well as domestic activities dependent on environmental resources such as walking long distances in order to fetch water and collect of fuel wood. Thus, it reduces time available for participating in paid work activities. This is summarized in figure 1.

Lack of access to paid employment opportunities not only limits women's empowerment but also hinders overall household income and economic development in communities where women constitute a significant portion of the workforce. For instance, when extreme climate events like flood, drought hit a region, it disrupts income of households relying on climate sensitive activities such as agriculture (Mekonnen et al., 2021; Miraglia et al., 2009). This, in turn, compels individuals, primarily men, to migrate in unaffected regions to search employment in relatively resilient sectors (Chindarkar, 2012; Nellemann et al., 2011). Thus, the unequal distribution of unpaid labor reinforces traditional gender roles and social norms, hindering progress towards gender equality and women's empowerment.

2.1 Implications For Women's Well-being

Gender division of unpaid household labor poses significant challenges for women's well-being in the aftermath of climate change. For example, a research conducted by Oxfam International (2005) in India, Sri Lanka, and Indonesia revealed a disproportionate increase in female mortality following the 2004 tsunami. While the absence of early warning systems in the Indian Ocean and inadequate preparedness contributed directly to widespread

devastation and high death tolls, the social division of labor played a crucial role in the heightened vulnerability of women. In rural coastal regions like southern India, it is customary for women from fishing communities to wait at the shores to receive catches from their male counterparts. When the tsunami struck, the relatively calm waves passing over the water left fishermen on boats unaware of the impending disaster. However, women waiting at the shores became immediate targets of the tsunami waves as they ravaged the coastline. Meanwhile, those women who were not at the shores were typically at home performing domestic duties such as caring for children and cooking. Consequently, when the tsunami hit, most women lost precious seconds trying to gather their children around them in an attempt to protect them. In contrast, most men were usually away from the seafront, engaged in agricultural activities or transporting produce to markets.

To effectively tackle these challenges, it's imperative to adopt gender-sensitive strategies for climate adaptation and disaster preparedness. Therefore, it becomes crucial to evaluate whether a causal relationship exists between climate shocks and women's unpaid labor. The subsequent section provides a theoretical framework that elucidates the dynamics within households.

3 Theoretical Framework

The theoretical framework is based on the economic theory of time allocation by Becker (1965). Prior to Becker (1965), there were earlier theories on household production function by Gorman (1956, published in 1980), and on married women's trade-offs between housework and paid employment by Mincer (1962). But Becker's uniqueness lay in the integration of goods consumption and time utilization in the production of household utility. Becker (1965) emphasized the diverse forms of time use, akin to the variety of consumption goods,

and how they combined to generate commodities, such as prepared meals, that contributed to utility. He drew several significant conclusions from the insight that different types of time use, and consumption could be combined into a unified household utility function.

The objective of the household is to maximize that single utility function subject to an overall single budget constraint. Here, the household utility function is $U(Z_1, Z_2, \ldots, Z_m)$ where Z_i is a household good (e.g., childcare) produced using a production function $Z_i = f_i(x_i, T_i)$, where x_i is a vector of market good purchased at price p_i and T_i is the vector of time used to produce Z_i. The rationale behind introducing time variable as vector is to distinguish between various measures, say, nighttime hours from daytime hours. To arrive at a single budget equation, he internalizes vector of wage rates, w_i to time T_i so that the budget constraint becomes $\sum_{i=1}^{m} p_i\tilde{x}_i + w_i\tilde{T}_i \leq S$, where S is the income achieved if all time were devoted to work. Jenkins and O'Leary (1995) introduced gender in modelling time allocation. Based on unitary household model, they separated time constraints between paid work, unpaid work and leisure activities for men and women. By virtue of algebra, they also arrived at a single overall budget constraint that combines time constraints of men and women, and expenditure incurred in consuming market goods by them. The uniqueness of this study lies in that it accounts for the differential patterns of time use by men and women.

3.1 The Framework

I develop a simple theoretical framework for analyzing unpaid labor decisions within a household in response to climate shocks in a two person model where one agent is female or wife (f) and the other is maleor husband (m). Here, I made an additional assumption that husband's participation in paid labor contributes to positive utility of the wife since the monetary gains can contribute to consumption of market goods and creation of household wealth.

The utility maximization of the female or wife is given by

$$U^f = u^f(c^f, H^f, l^f, L^m) - f(L^f) - v(d^f); f'() > 0, f"() < 0, v'() > 0, v"() < 0$$

subject to

$$l^f + L^f + d^f = T - (l^m + L^m + d^m) \tag{1}$$

$$p(c^f + c^m) = w^m L^m + w^f L^f + rA \tag{2}$$

$$H^f + H^m = \theta d_f^{\alpha} d_m^{1-\alpha} \tag{3}$$

Here, $c^f, c^m, H^f, H^m, l^f, l^m, d^f, d^m, L^f, L^m$ are respectively market consumption of female, market consumption of male, domestically produced goods by female, domestically produced goods by male, amount of time devoted to leisures by female, amount of time devoted to leisure by male, amount of time devoted to unpaid household labor by male and unpaid household labor by female. For sake of simplicity, let $u^f(c^f, H^f, l^f, L^m) = logc^f + logH^f + \phi(L^m, l^f)$, where$\phi'_{lf} > 0, \phi'_{L^m} > 0$

The eq 1 is the time constraint of female where by sum total of time spent on leisure, paid labor and unpaid household labor of female is equal to total time available to female. It should be noted that the this total time of female equals to overall time (T) in excess of the sum total of labor, leisure and unpaid labor of male in the household. The eq 2 is the usual budget constraint which states that the total expenditure on market goods by female and male is given by the total income of male and female in household. The latter is the sum of labor income of female ($w^f L^f$), labor income of male ($w^m L^m$), and non-labor income (rA), where r is rate of interest on assets owned, A. Lastly, the sum total of unpaid household goods produced by male and female is function of productivity parameter (θ) unpaid labor by female (d^f) and male (d^m). For simplicity, the function is Cobb Douglas function of (d^f) and (d^m), where α is share of labor by female on unpaid household labor.

The Lagrangian function is given by

$$L = logc^f + log(\theta d_f^{\alpha} d_m^{1-\alpha} - H^m) + \phi(L^m, l^f) - f(L^f) - v(d^f) + \lambda_1(T - (l^m + d^m + L^m) - (l^f + L^f + d^f)) + \lambda_2(w^m L^m + w^f L^f + rA - p(c^f + c^m)) \quad (4)$$

F.O.C w.r.t d^f:

$$\frac{\partial L}{\partial d^f} = 0 \implies \frac{\theta\alpha d^{f(}\alpha - 1)d^{m(}1-\alpha)}{H^f} - v'(d^f) - \lambda = 0 \implies \frac{\theta\alpha d^{f(}\alpha - 1)d^{m(}1-\alpha)}{H^f} - v'(d^f) = \lambda \quad (5)$$

w.r.t d^m:

$$\frac{\partial L}{\partial d^m} = 0 \implies \frac{\theta(1-\alpha)d^{f(\alpha)}d^{m(-\alpha)}}{H^f} - \lambda = 0 \implies \frac{\theta(1-\alpha)d^{f(\alpha)}d^{m(-\alpha)}}{H^f} = \lambda \quad (6)$$

Here, I assume that H^m is given since I am only looking from the perspective of the female. Comparing 5 and 6,

$$\frac{\theta\alpha d^{f(\alpha-1)}d^{m(1-\alpha)}}{H^f} - v'(d^f) = \frac{\theta(1-\alpha)d^{f(\alpha)}d^{m(-\alpha)}}{H^f} \quad (7)$$

$$\implies \frac{\theta\alpha d^{f(\alpha-1)}d^{m(1-\alpha)}}{H^f} - \frac{\theta(1-\alpha)d^{f(\alpha)}d^{m(-\alpha)}}{H^f} = v'(d^f) \quad (8)$$

Since $v'(d^f) > 0$, so eq 8 can be written as the following inequality:

$$\frac{\theta\alpha d^{f(\alpha-1)}d^{m(1-\alpha)}}{H^f} - \frac{\theta(1-\alpha)d^{f(\alpha)}d^{m(-\alpha)}}{H^f} > 0 \quad (9)$$

From the above, $\frac{\partial L^f}{\partial \theta}$ can be written as

$$\frac{\partial L^f}{\partial \theta} = \frac{1}{\alpha\theta}(A - B - C)^1$$

By the given condition, $B > 0, C > 0 \implies (B + C) > 0$. Thus, $\frac{\partial L^f}{\partial \theta} < 0$ if $A < (B + C)$ or at least $\frac{1}{d^f} < \frac{(1-\alpha)}{\alpha}$, that is, $d^f > \frac{\alpha}{1-\alpha}$

When a climate shock occurs, it diminishes the household productivity parameter (θ). Consequently, the amount of unpaid household labor performed by females increases if it surpasses the proportion of unpaid household labor performed by males. In the following section, I discuss the case study which is going to be utilized for empirical analysis.

4 The Case Study: 2019 Kerala Flood

Kerala, situated on the southwestern coast of India, is known for its ecological fragility. In 2019, the state faced unprecedented challenges during the Southwest monsoon, resulting in devastating floods and landslides. This event wreaked havoc across Kerala, impacting numerous villages and districts, leading to loss of lives and extensive damage to various sectors.

Between August 8 and 31, 2019, Kerala experienced a deluge, affecting 1038 villages across 13 districts (Disaster Management, Government of Kerala, 2019). Sadly, the disaster claimed 125 lives and severely affected sectors like housing, power, and agriculture (Disaster Management, Government of Kerala, 2019). The onset of the monsoon was initially weak and delayed, but the situation escalated in August due to a low-pressure area and depression over the Bay of Bengal, resulting in 123% excess rainfall compared to the long-term average (Disaster Management, Government of Kerala, 2019). Figure 2 shows the map of the state where affected districts are marked with blue color.

[1] A=$\frac{1-\alpha}{\alpha d^{f(\alpha-1)} d^{m(-\alpha)} - (1-\alpha) d^{f(\alpha)} d^{m(-\alpha)}}$; $B = \frac{1}{d^f}$; $C = \frac{v'(d^f)}{v(d^f)}$

The agriculture sector, crucial to Kerala's economy, suffered significant damage. Small and marginal farmers were particularly affected, leading to substantial losses in crop production. Over 33% of agricultural areas were damaged, resulting in estimated losses of INR 358.667 million (Disaster Management, Government of Kerala, 2019). Approximately 6244.37 hectares of agricultural land were affected, with districts like Palakkad and Malappuram bearing substantial losses (Disaster Management, Government of Kerala, 2019).

The floods also severely impacted Kerala's fisheries sector, with fishing assets such as boats and nets destroyed. A total of 54 boats were fully damaged, and 696 nets were fully destroyed, resulting in a total financial loss of INR 1.8 million (Disaster Management, Government of Kerala, 2019). Additionally, fish farms across the state incurred significant losses, with approximately 7081.85 hectares affected, particularly in districts like Thrissur (Disaster Management, Government of Kerala, 2019).

Public infrastructure, especially roads and bridges, suffered extensive damage, hampering transportation and connectivity. Around 3900.17 kilometers of roads were damaged, with districts like Idukki and Thrissur being the most affected (Disaster Management, Government of Kerala, 2019). The estimated cost for immediate restoration of roads stands at nearly INR 390 million (Disaster Management, Government of Kerala, 2019). Additionally, 95 bridges were damaged, with Palakkad district reporting the highest number of damaged bridges (21), necessitating approximately INR 164.5 million in funding for repairs (Disaster Management, Government of Kerala, 2019).

5 Data

This analysis relies on the most recent Indian Time Use Data (ITUS) from 2019, which collects information on the daily routines of individuals across India. The dataset, comprising information from 138,799 households, offers a rich understanding of how people allocate their time. Within this dataset, a total of 447,250 individuals aged 6 years and above were surveyed, with 273,195 residing in rural areas and 174,055 in urban areas.

The overarching goal of the survey is to shed light on the involvement of both men and women in various activities, whether paid or unpaid. It goes beyond mere time tracking, capturing a plethora of socioeconomic details at both the individual and household levels. These encompass factors such as religion, caste, per capita consumption expenditure, household assets (including housing structures and technological amenities like energy sources for cooking and lighting), and personal characteristics like age, gender, marital status, educational attainment, and occupation.

Spanning four sub-rounds across the year—January to March, April to June, July to September, and October to December—the survey meticulously documents the temporal dynamics of daily activities. Of particular interest for this analysis is the allocation of time to unpaid household activities, broadly classified as domestic chores and care work.

In the context of this study, attention is directed towards women residing in households within 13 districts of Kerala. Notably, data from sub-round 3 is excluded from the analysis because the flood event occurred in August 2019 and the objective is to compare the time spent by married women on unpaid household work between districts affected and unaffected by this event, providing valuable insights into potential disparities in workload distribution. Further details regarding the sampled households and surveyed married women in each sub-round are provided in Table1, while Table 2 outlines the variables employed in the analysis.

6 Estimation Strategy

Impact of climate shocks on women's unpaid work burden is estimated using the following two specifications:

$$\text{unpaid}^{f}_{ihdt} = \beta_0 + \beta_1 \text{Time}_t + \beta_2 \text{Treat}_{ihd} + \beta_3 \text{Time}_t * \text{Treat}_{ihd} + X'_{ihdt}\beta_4 + Z'_{hdt}\beta_5 + \beta_6 C_{dt} + \epsilon_{ihdt} \tag{10}$$

$$\begin{aligned} \text{unpaid}^{f}_{ihdt} &= \gamma_0 + \beta_1 \text{Time}_t + \gamma_2 \text{Treat}_{ihd} + \gamma_3 \text{UP}^{m}_{ihdt} \\ &+ \gamma_4 \text{Time}_t * \text{Treat}_{ihdt} + \gamma_5 \text{Treat}_{ihdt} * \text{UP}^{m}_{ihdt} + \gamma_6 \text{Time}_{ihdt} * \text{UP}^{m}_{ihdt} + \gamma_7 \text{Time}_t * \text{Treat}_{ihd} * \text{UP}^{m}_{ihdt} \\ &+ \text{X}'_{ihdt}\gamma_7 + \text{Z}'_{hdt}\gamma_8 + \gamma_9 \text{C}_{dt} + \eta_{ihdt} \end{aligned} \tag{11}$$

Here, the main outcome of interest, unpaid^{f}_{ihdt} is the number of minutes spent on unpaid household work by a married woman-i from household-h, located in district-d during 24 hours a day. Because there are different types of unpaid household work that are carried out by women, I broadly categorized this into domestic and care work. In this analysis, the unpaid household work is the aggregate of domestic and care work. To estimate how the climate shock affect the unpaid household work, I utilize difference-in-difference strategy. In eq. 10, the underlying assumption is that married women belonging to households located in affected districts and unaffected districts would have followed the same trend in the absence of flash flood event. As mentioned in the theoretical framework, participation of spouse in unpaid household work raises utility of the individual since this is likely to reduce the work-load of that individual. Hence, I account for husband's participation in unpaid household work by using a dummy UP^{m}_{ihdt}. This dummy takes value 1 if the husband of i^{th} woman participates in household work and 0 otherwise. In order to see whether this participation influences unpaid household work burden of wives, I interact this dummy with the first difference-in-difference variable $\text{Time}_t * \text{Treat}_{ihd}$ in eq. 11. These two equations respectively

test the following two hypotheses:

$Hypothesis - 1$: The flash flood event increases the amount of time that married women spend on unpaid household work in the affected districts of Kerala.
$Hypothesis - 2$: The presence of men's participation in unpaid work mediates the climate shock-induced rise in unpaid household work of their wives.

Individual characteristics are captured by the vector X'_{ihdt} that include age, education, and occupation. The vector Z'_{hdt} represents a set of observable household characteristics, including household-specific factors like religion, caste, monthly consumption expenditures, household assets of household h located in district d during sub-round t in each equation. To account of heterogeneity within households in terms of gender and age, dependency burden and sex ratio are also computed and controlled for within the vector Z'_{hdt}. Here, dependency burden refers to the share of household members aged less than or equal to 6 years and those aged 65 years and above. Sex ratio refers to the ratio of female to male household members.

Because the climate event occurred during the late monsoon season, it is important to control for the monsoon rainfall in district d and sub-round t. This is captured by the variable , evaluated by computing the squared deviation of usual monthly average monsoon rainfall from that of 2019.

7 Results

Table 3. reports summary statistics of (a) household-level continuous variables, namely, unpaid household work, care work and domestic work, monthly consumption expenditure (MCE), sex ratio and dependency ratio; (b) district-level continuous climate variable: mon-

soon precipitation in Kerala during the past 15 years. It should be noted that the unpaid work is measured in terms of minutes per week for each woman in each sample household.

In addition, the frequency of social group, religion and main occupation of the sample individuals are shown in Table 4. It exhibits that nearly 71 per cent of total population belonged to socially minor group, that is, an aggregate of Scheduled Caste (SCs), Scheduled Tribes (STs) and Other Backward Classes (OBCs). Table 5 shows that more than half of the rural households depended on agriculture and related activities for sustaining their livelihood. Though the absolute numbers as displayed in Table 5, the proportion of population with regular income was higher in the urban areas (33 per cent) compared to rural areas (19.5 per cent).

7.1 Parallel Trend Assumption

The difference-in-difference approach relies on the parallel trend assumption, which states that the difference in trend of unpaid household labor of women from treatment group (those women coming from households of affected districts) and control group (those women dwelling in households located in unaffected districts) would been constant, in absence of any treatment (climate shock, in this case). The graphical illustration is shown in fig 3. This graph shows that the difference in time spent by women on unpaid household work in affected and unaffected regions is constant before the climate shock happened (corresponding to sub-round period 1 (January-March) and sub-round period 2 (April-June)) while the line graph of unpaid household work shoots up for those women belonging to affected districts after the event has occurred but slopes downward for those located in unaffected districts. In other words, the difference in time spent by women on unpaid work no longer remains constant after the flood happened.

In case of triple differences strategy, the parallel trend assumption asserts that, in the

absence of climate shocks, any differential change (a) in the time spent on unpaid work by married women between affected districts and unaffected districts, and (b) in the time spent by husbands of married women on unpaid household work between affected and unaffected districts, would remain constant over time. This assumption implies that, prior to the occurrence of climate shocks, the trends in both the outcome variable for married women and their husbands' participation in household work would evolve similarly across affected and unaffected districts. Consequently, any observed disparities in the outcome variable post-treatment are solely attributable to the impact of the climate shocks and not influenced by pre-existing differential trends between the treatment and control groups.

Following Muralidharan and Prakash (2017), I consider seven months prior the occurence of flood event to test the parallel trend assumption. Based on the ITUS 2019, I utilize two pre-event sub-rounds that is, January-March and April-June of 2019. Table **??** shows that the coefficients of both double and triple differences are not statistically significant (panel A and B). Moreover, the coefficient on the double difference is nearly negligible and that of on the triple difference is also marginal (about 3 minutes per day). Hence, I do not reject the null hypothesis of parallel trends.

7.2 Key Findings

The double-difference estimate of the impact of climate shock on unpaid household labor of married women, based on eq. 10 are presented in table 6. The estimates with no controls and with demographic as well as district level controls (columns 1, 2 and 3) suggest a statistically significant impact on married women's unpaid household labor of 84-93 minutes per day. While including individual level demographic controls raises the estimate by 8.1 percent, inclusion of household and district level controls further raises the estimate by 11.31 percent.

First, the coefficient on the "time" dummy (an indicator that takes value 1 if event has al-

ready occurred and 0 before the event happened) is *positive*. This reflects that women spend more time on unpaid household work after the climate event has occurred than they would do before the climate event. In absence of no household and individual level of controls, this coefficient was not statistically significant but it increases once demographic controls are included. Second, the coefficient on the "treatment" dummy (an indicator which takes value 1 if the dwelling district is affected by the climate event and 0 otherwise) is *negative*. In affected districts, women may spend lesser amount of time on unpaid household work by nearly 12-18 minutes per day than the women in unaffected districts.

Moreover, the triple difference estimate of the effects of climate shock, based on 11, are shown in table 7. The coefficient γ_7 remains negative and statistically significant with and without controls. It highlights that the effect of climate shock on women's unpaid household labor can be mediated by about 21-35.5 minutes per day if their husbands also participate in household work. In absence of household or individual level of controls, husbands' participation reduces climate induced women's unpaid household work by 35.5 minutes per day. By including individual level covariates, the contraction in unpaid labor minutes drops by 8.8 percent to 32.4 minutes per day. This, further, decreases to 21.3 minutes when household and district level controls are also included. As indicated in the second row, without husband's participation, climate shock induced unpaid household labor of women increases to more than 100 minutes per day.

It is noteworthy that the husband's participation (indicated by coefficient, γ_3) reduces time spent by their wives on unpaid labor in absence of any demographic control while it increases the same by about 42-53 minutes per day, when demographic factors are controlled (column (2) and (3)). In other words, individual factors such as age, educational attainment and occupation, and household characteristics like ethnicity, dependency burden, sex ratio, presence of household production technology (washing machines, electricity for cooking,

sweeping floors) influence husbands' time allocated to household work.

7.3 Heterogeneity Effects

I address any remaining omitted variable concerns by looking at heterogeneity of the triple difference estimate as function of the type of region, that is, whether the women are coming from rural or urban areas. Table 8 shows quadruple difference (DDDD) results based on estimating 11, where I decompose the triple difference estimates in table 7 by whether the woman lived in rural or urban areas. For women located in rural areas, husbands' participation in household work reduces climate-induced unpaid work of women by 56.69 minutes per day compared to their urban counterparts. After controlling for individual, household and district level factors, the magnitude of this DDDD coefficient reduces by about 3 percent (column 3). The results suggest that the triple differences, presented in 7 are mainly influenced by women living in rural areas. In absence of husbands' participation in unpaid household work, married women belonging to rural areas spend about 14-30 minutes per day more than those dwelling in urban areas. Compared to those located in urban areas, husbands' participation in household work reduces workload of their wives by about 2-18 minutes per day in the rural areas. The magnitude declines to almost as low as 2 minutes per day after controlling for all demographic and district characteristics.

When examining the dynamics of women's unpaid labor, it is crucial to consider the influence of societal structures, often delineated by caste. Studies have shown that women from lower castes frequently face heightened vulnerability to discriminatory treatment compared to their counterparts from higher castes (e.g., Islam et al., 2021; Khubchandani et al., 2019). Hence, I estimate another quadruple differences (DDDD) where the fourth factor is the caste of households where the married women are coming from. The results are presented in table 8. Initially, the coefficient of the quadruple differences (in the first row) appears sta-

tistically insignificant when no demographic or district controls are applied. However, upon introducing these controls, the coefficient becomes statistically significant, with an increase in magnitude by approximately 48 minutes. This indicates that factors such as household characteristics and monsoon patterns play a significant role in shaping the impact of caste on husbands' participation in household activities as a mediator for climate-induced women's unpaid work. Furthermore, caste demonstrates a discernible influence on women's unpaid workload. Specifically, compared to women from higher caste households, those from lower caste backgrounds experience an increase in unpaid work by approximately 44 minutes (as shown in column (3), eighth row).

7.4 Robustness check

One limitation of my analysis is that my data consists of a single cross-sectional time use survey conducted over a span of 8 months before the climate shock and covered 3 months after the shock occurred. I do not have panel data that would allow me to observe history of such married women by age, marital status, and employment. A further limitation of the single cross section of data is that women or their husbands in any surveyed household may be underrepresented in the data if they were to migrate out to seek employment in unaffected regions. I therefore examine the robustness of my estimates to (a) alternative measure of dependent variable; (b) alternative definition of the treatment and control groups.

7.4.1 Alternative Measure of Dependent variable

I begin by considering different measure of dependent variable. Instead of measuring time spent on women's unpaid household work by minutes per day, I utilize inverse hyperbolic sine transformation. This transformation takes into account zero values for unpaid labor use per day for an individual. The advantage of this transformation is that it is defined at zero and the regression coefficients can be interpreted as a percentage point change in the outcome variable (unpaid^{f}_{ihdt}) due to a flood. Utilizing equations 10 and 11, the outcomes

derived from this new measure for unpaid household labor are showcased in tables 10 and 11.

In the absence of any controls, according to Table 10, treated women exhibit an increase of 8.1 percentage points in daily unpaid household labor compared to those in the control group. However, incorporating individual-level covariates in equation 10 mitigates this increase, reducing women's daily unpaid labor by 7.9 percentage points. Nevertheless, upon further adjustment for household-level characteristics and district-level rainfall, alongside individual-level characteristics, Table 10 indicates a rise of 10.7 percentage points in the time spent on unpaid household work by women in affected regions post-climate shock, compared to women in the control group.

The triple difference estimate results, based on equation 11 and employing the transformed dependent variable, are showcased in table 11. Notably, when husbands engage in unpaid household work, the time allocated by women to such tasks diminishes by 10.1-18.9 percentage points within the treatment group compared to their counterparts in the control group, as depicted in the first row of table 10. It's worth emphasizing the negative coefficient γ_5, indicating that husbands' involvement in unpaid household work correlates with a reduction in their wives' unpaid labor. Specifically, in affected districts, this reduction amounts to 3.3 percentage points, contrasting with an increase of 3.6-4.9 percentage points when demographic controls are absent.

7.5 Alternative Definition of Treatment and Control Groups

I consider one alternative definition of treatment and control group. Using the report by State Disaster Management Authority of Kerala, I restrict myself only to those districts which are affected by flood-induced landslides as treatment group and remaining as control group. By doing so, the number of affected districts decline by 14.3% and unaffected districts rise from 7 to 9 districts. The objective is to see whether this change in definition of

treatment and control group matter for women's unpaid labor. Based on eqs. 10 and 11, the results are presented in table 12 and table 13.

In the absence of demographic controls, women's unpaid labor increases by 96 minutes per day among the treatment group compared to the control group, a figure higher than that reported in table 7, where it stands at 84 minutes per day. This notable increase might be attributed to the disruptive impact of landslides, which can lead to displacement and subsequently reduce the time available for unpaid household work due to the need to address immediate concerns related to safety, shelter, and recovery efforts. After controlling for all demographic and district-level rainfall factors, this increase diminishes to 93 minutes per day in table 7, suggesting that some of the initial impact may be explained by these factors. However, the reduction in the coefficient to approximately 80 minutes per day in table 13 indicates a further attenuation of the effect. Plausible reasons behind this change could include the gradual adaptation and coping mechanisms employed by households in response to the aftermath of the disaster, such as improved access to resources or the establishment of support networks, which may mitigate the impact on unpaid labor over time.

Additionally, the reduction in women's unpaid labor in the treatment group when husbands' participation in household activities is considered—11-17 minutes per day, a decrease from the 21-36 minutes per day reported in table 8—might be explained by the out-migration of husbands to more resilient areas in pursuit of better income opportunities. This out-migration could lead to an increase in dual-income households among the remaining population, a shift in traditional gender norms within households, and the establishment of community support networks, all of which contribute to the observed reduction in women's unpaid labor.

8 Concluding Remarks

The intertwining challenges of climate change and women's unpaid labor demand urgent attention and decisive action. The observed increase in daily unpaid household labor among women post-climate shock underscores the need for nuanced responses, considering demographic and district-level variations. Notably, husbands' participation in household work emerges as a significant mitigating factor, particularly in affected districts, highlighting the importance of contextual factors, such as rural-urban disparities and caste backgrounds. Robustness checks reaffirm these findings, emphasizing the complexity of climate-induced labor dynamics and the imperative for comprehensive resilience-building strategies.

In addition to recognizing the gendered dimensions of climate change, it's imperative to delve deeper into the underlying causes of gender inequality and the complexities surrounding women's unpaid labor. This holistic approach involves challenging entrenched patriarchal norms and attitudes that perpetuate unequal caregiving responsibilities and limit women's participation in decision-making processes. Investing in women's access to education and economic opportunities is crucial for breaking down barriers and empowering women to actively engage in climate adaptation and mitigation efforts. Moreover, providing support for unpaid caregivers through initiatives such as childcare services and social protection programs can alleviate the burden of unpaid labor and enable women to pursue other opportunities for personal and professional development.

Moving forward, collaborative efforts between policymakers, local communities, and civil society organizations are essential to ensure the effectiveness and inclusivity of interventions aimed at addressing the gendered division of unpaid labor. By fostering partnerships and engaging diverse perspectives, policymakers can develop strategies that are culturally appropriate and responsive to the unique needs of women in different contexts. Moreover, meaningful involvement of women in decision-making processes at all levels is crucial for

designing policies and programs that reflect their realities and priorities.

Furthermore, enhancing data collection methodologies and investing in research are essential for better understanding the complexities of women's unpaid work and its intersection with climate change. By generating robust evidence and insights, policymakers can make informed decisions and tailor interventions to effectively address the underlying drivers of gender inequality and unpaid labor. This requires a concerted effort to close existing data gaps and ensure that gender perspectives are integrated into all stages of research and policy development.

Moving forward, there is a need for collaborative efforts between policymakers, local communities, and civil society organizations to ensure the effectiveness and inclusivity of interventions. By fostering partnerships and engaging diverse perspectives, policymakers can develop strategies that are culturally appropriate and responsive to the unique needs of women in different contexts.

To sum up, by prioritizing gender equality and addressing the gendered dimensions of unpaid labor, policymakers can lay the groundwork for a more equitable and sustainable response to the impacts of climate change on women's well-being and livelihoods. It is imperative that we act decisively to create a future where all individuals, regardless of gender, have the opportunity to thrive in changing climate scenarios.

References

Arnell, N. W., Lowe, J. A., Challinor, A. J., & Osborn, T. J. (2019). Global and regional impacts of climate change at different levels of global temperature increase. *Climatic Change*, *155*(3), 377–391. https://doi.org/10.1007/s10584-019-02464-z

Becker, G. S. (1965). A Theory of the Allocation of Time [Publisher: [Royal Economic Society, Wiley]]. *The Economic Journal*, *75*(299), 493–517. https://doi.org/10.2307/2228949

Becker, G. S. (1974). A Theory of Social Interactions [Publisher: University of Chicago Press]. *Journal of Political Economy*, *82*(6), 1063–1093. Retrieved March 10, 2024, from https://www.jstor.org/stable/1830662

Chindarkar, N. (2012a). Gender and climate change-induced migration: Proposing a framework for analysis [Publisher: IOP Publishing]. *Environ. Res. Lett.*, *7*(2), 025601. https://doi.org/10.1088/1748-9326/7/2/025601

Chindarkar, N. (2012b). Gender and climate change-induced migration: Proposing a framework for analysis. *Environ. Res. Lett.*, *7*(2), 025601. https://doi.org/10.1088/1748-9326/7/2/025601

Chowdhury, S. K. (2010). Impact of infrastructures on paid work opportunities and unpaid work burdens on rural women in Bangladesh [Publisher: John Wiley & Sons, Ltd.]. *Journal of International Development*, *22*(7), 997–1017. Retrieved March 10, 2024, from https://ideas.repec.org//a/wly/jintdv/v22y2010i7p997-1017.html

Connolly-Boutin, L., & Smit, B. (2016). Climate change, food security, and livelihoods in sub-Saharan Africa. *Reg Environ Change*, *16*(2), 385–399. https://doi.org/10.1007/s10113-015-0761-x

Cools, S., Flatø, M., & Kotsadam, A. (2020). Rainfall shocks and intimate partner violence in sub-Saharan Africa [Publisher: SAGE Publications Ltd]. *Journal of Peace Research*, *57*(3), 377–390. https://doi.org/10.1177/0022343319880252

Corno, L., Hildebrandt, N., & Voena, A. (2020). Age of Marriage, Weather Shocks, and the Direction of Marriage Payments [Publisher: [Wiley, The Econometric Society]].

Econometrica, *88*(3), 879–915. Retrieved March 10, 2024, from https://www.jstor.org/stable/48584105

Dazé, A., & Echeverría, D. (n.d.). Review of Current and Planned Adaptation Action in Ghana.

Delbiso, T. D., Altare, C., Rodriguez-Llanes, J. M., Doocy, S., & Guha-Sapir, D. (2017). Drought and child mortality: A meta-analysis of small-scale surveys from Ethiopia [Publisher: Nature Publishing Group]. *Sci Rep*, *7*(1), 2212. https://doi.org/10.1038/s41598-017-02271-5

Exploring Opportunities for Women Entrepreneurs Driving Climate Solutions: A Discussion Note. (n.d.).

Harsh Choices: Chinese Women's Paid Work and Unpaid Care Responsibilities under Economic Reform - Cook - 2011 - Development and Change - Wiley Online Library. (n.d.). Retrieved March 10, 2024, from https://onlinelibrary.wiley.com/doi/full/10.1111/j.1467-7660.2011.01721.x?casa_token=B-Pii6CWHKUAAAAA%3ASQx3jf_hKE4y9WJPCcwEhAV42BFrj9115NAXkOl6NlfwJFQcnelNUxRUFuOp1wWUma9jT_Josk9F3g

Intergovernmental Panel On Climate Change (Ipcc). (2023). *Climate Change 2022 – Impacts, Adaptation and Vulnerability: Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (1st ed.). Cambridge University Press. https://doi.org/10.1017/9781009325844

Islam, A., Pakrashi, S., D.and Sahoo, Wang, L. C., & Zenou, Y. (2021). Gender inequality and caste: Field experimental evidence from india. *IZA Discussion Paper No. 14713*, *21*, 163–170. https://docs.iza.org/dp14713.pdf

Khanna, M., & Kochhar, N. (2020). Do Marriage Markets Respond to a Natural Disaster? The Impact of Flooding of River Kosi in India. *SSRN Journal*. https://doi.org/10.2139/ssrn.3644052

Khubchandani, J., Soni, A., Fahey, N., Raithatha, N., Prabhakaran, A., Byatt, N., Moore Simas, T. A., Phatak, A., Rosal, M., Nimbalkar, S., & Allison, J. J. (2018). Caste matters: Perceived discrimination among women in rural india. *Archives of Women's Mental Health*, *21*, 163–170. https://doi.org/10.1007/s00737-017-0790-1

Klepp, S., & Herbeck, J. (2016). The politics of environmental migration and climate justice in the Pacific region. *JHRE*, *7*(1), 54–73. https://doi.org/10.4337/jhre.2016.01.03

Kochar, A. (1999). Smoothing Consumption by Smoothing Income: Hours-of-Work Responses to Idiosyncratic Agricultural Shocks in Rural India [Publisher: The MIT Press]. *The Review of Economics and Statistics*, *81*(1), 50–61. https://www.jstor.org/stable/2646785

Kossin, J. P. (2018). A global slowdown of tropical-cyclone translation speed. *Nature*, *558*(7708), 104–107. https://doi.org/10.1038/s41586-018-0158-3

Kumar, S., Molitor, R., & Vollmer, S. (2016). Drought and Early Child Health in Rural India [_eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1728-4457.2016.00107.x]. *Population and Development Review*, *42*(1), 53–68. https://doi.org/10.1111/j.1728-4457.2016.00107.x

Mekonnen, A., Tessema, A., Ganewo, Z., & Haile, A. (2021). Climate change impacts on household food security and farmers adaptation strategies. *Journal of Agriculture and Food Research*, *6*, 100197. https://doi.org/10.1016/j.jafr.2021.100197

Mincer, J. (1962). Labor Force Participation of Married Women: A Study of Labor Supply. In *Aspects of Labor Economics* (pp. 63–105). Princeton University Press. Retrieved March 10, 2024, from https://www.nber.org/books-and-chapters/aspects-labor-economics/labor-force-participation-married-women-study-labor-supply

Miraglia, M., Marvin, H. J. P., Kleter, G. A., Battilani, P., Brera, C., Coni, E., Cubadda, F., Croci, L., De Santis, B., Dekkers, S., Filippi, L., Hutjes, R. W. A., Noordam, M. Y., Pisante, M., Piva, G., Prandini, A., Toti, L., van den Born, G. J., & Vespermann, A. (2009). Climate change and food safety: An emerging issue with special focus on

Europe. *Food and Chemical Toxicology*, *47*(5), 1009–1021. https://doi.org/10.1016/j.fct.2009.02.005

Tables

Survey Sub-Rounds	No. of Households (No. of Females (*Aged above 6 years*))	Sample Size	Period Covered
1	80,529	45,206	January-March
2	81,816	45,349	April-June
4	92,727	50,465	October-December

Table 1: Author's own compilation of various sub-rounds of ITUS used in this study.

Category	**Descriptions**	**Sources**
Dependent Variables	time spent on overall unpaid work by woman-i in household-h; time spent on unpaid domestic chores by woman-i in household-h; time spent on unpaid care work by woman-i in household-h from district-d in sub-round-t	ITUS 2019
Independent Variable	Dummy that takes value 1 if the woman is from household located in affected district after the flood, 0 otherwise.	ITUS 2019
Household level Controls	Religion, caste, primary sources of energy for cooking (proxy for household technology and wealth), Type of washing clothes (proxy for household technology and wealth), type of housing structure (proxy of wealth), monthly consumption expenditure (MCE) (proxy for household wealth), Dependency Burden (Share of individuals aged 0-6 years and 65 years & above), Sex ratio (ratio of females to males in a household)	ITUS 2019
Individual level Controls (only for married women in each household)	Age (both linear and squared) Education Level, Marital Status, and Occupation	ITUS 2019
Monsoon Rain	Squared deviation from mean monsoon rainfall during past 30 years (measured in mm)	Kerala State Disaster Management Authority (KSDMA)

Table 2: Description of Variables and Sources

Variable	No. of Observations	Mean	Std. Deviation	Minimum	Maximum
Unpaid Household Work	343,590	665.55	359.82	0	2820
Unpaid Care Work	343,678	128.49	211.72	0	1650
Unpaid Domestic Work	343,706	538.43	243.05	0	2130
Dependency Ratio	335,726	0.19	0.41	0	18
Sex Ratio	324,363	1.43	0.99	0	7.41
Monthly Consumption Expenditure (INR)	344,926	12975.12	7955.47	700	131833

Table 3: Summary Statistics of All Continuous Variables.

	Religion		Caste	
Region	**Minor**	**Major**	**Minor**	**Major**
Rural	34,853	134,463	116,550	52,766
Urban	26,968	148,642	126,926	48,684
Total	61,821	283,105	243,476	101,450

Table 4: Statistics of Religion and Caste by Region

Sector	**Agrarian**	**Self-Employed**	**Regular**	**Casual**
Rural	29,567	23,189	18,669	24,326
Urban	9,557	20,299	24,253	19,378
Total	39,144	43,488	42,922	43,704

Table 5: Household Type by Sector

Panel A. Testing Parallel Trends for the Difference-in-Difference	
Treat×Time	-0.659
	(4.82)
Time	-20.401***
	(3.71)
Treat	-18.186***
	(3.48)
Constant	707.33
Obs.	103,999
R-Squared	0.0014
Panel B. Testing Parallel Trends for the Triple Differences	
Treat×Time × Husband's Participation	3.626
	(12.003)
Treat×Time	0.991
	(5.359)
Treat×Husband's Participation	-1.733
	(8.638)
Time×Husband's Participation	-4.974
	(9.302)
Treat	-18.705
	(3.877)
Time	-20.358
	(4.123)
Husband's Participation	89.292***
	(6.699)
Constant	688.43
Obs.	103,980
R-Squared	0.01

Table 6: Difference-in-Difference (DD) Estimate of the Impact of Climate Shock on Women's Unpaid Labor (Minutes/day)

Women's Unpaid Labor	**(1)**	**(2)**	**(3)**
Treat×Time	83.93***	86.44***	93.426***
	(3.663)	(3.53)	(3.598)
Treat	-18.52***	-11.77***	-18.50***
	(2.41)	(2.32)	(2.36)
Time	6.72	20.05***	11.36*
	(6.45)	(6.21)	(6.42)
Individual level Controls	No	Yes	Yes
Household level Controls	No	No	Yes
Climate Change Controls	No	No	Yes
Obs.	162,318	162,318	154,274
R-Squared	0.004	0.09	0.123

Table 7: Triple Differences (DDD) Estimate of the Effects of Climate Shock and Husband's partcipation in on Women's Unpaid Labor (Minutes/day)

Women's Unpaid Labor	**(1)**	**(2)**	**(3)**
Treat×Time × Husband's Participation	-35.54***	-32.37***	-21.33***
	(7.69)	(7.11)	(7.14)
Treat×Time	101.67***	100.18***	102.27***
	(3.663)	(3.53)	(3.598)
Treat×Husband's Participation	10.97***	7.83***	3.85***
	(4.65)	(4.70)	(4.73)
Time×Husband's Participation	11.19*	11.01*	6.925*
	(5.77)	(5.19)	(5.23)
Husband's Participation	-44.45***	53.46***	41.74***
	(3.58)	(3.99)	(4.03)
Treat	-18.52***	-11.77***	-18.50***
	(2.41)	(2.32)	(2.36)
Time	6.72	20.05***	11.36*
	(6.45)	(6.21)	(6.42)
Individual level Controls	No	Yes	Yes
Household level Controls	No	No	Yes
Climate Change Controls	No	No	Yes
Obs.	162,318	162,318	154,274
R-Squared	0.0065	0.092	0.108

Table 8: Quadruple Differences (DDDD) Estimate of the Effects of Climate Shock and Husband's partcipation in on Women's Unpaid Labor (Minutes/day): **Role of Region (Rural vs Urban)**

Women's Unpaid Labor	**(1)**	**(2)**	**(3)**
Treat×Time × Husband's Participation × Region	-56.691***	-78.342***	-55.126***
	(14.969)	(14.47)	(14.60)
Treat×Region	-100.728***	-102.069***	-102.241***
	(9.849)	(6.187)	(6.36)
Time×Region	0.493	-16.48***	-6.656
	(7.18)	(6.84)	(7.14)
Husband's Participation×Region	-17.591***	-6.295***	-1.913***
	(7.83)	(7.596)	(7.592)
Treat×Time × Husband's Participation	29.74***	6.668	-21.33***
	(11.014)	(9.796)	(7.14)
Time×Husband's Participation × Sector	29.74***	32.013***	14.207
	(11.014)	(10.689)	(10.805)
Treat×Husband's Participation × Sector	29.103***	25.349***	16.319*
	(9.985)	(9.622)	(9.701)
Treat×Time × Region	72.319***	107.576***	106.629***
	(9.849)	(9.277)	(9.623)
Treat×Time	62.79***	41.997***	47.151***
	(6.616)	(6.327)	(6.565)
Treat×Husband's Participation	-3.519	-5.528	-3.828
	(6.334)	(6.204)	(6.287)
Time×Husband's Participation	11.19*	-2.281	0.929
	(6.73)	(6.547)	(6.624)
Region	-44.45***	48.318***	58.145***
	(3.58)	(4.93)	(5.041)
Husband's Participation	-36.74***	44.557***	41.973***
	(4.42)	(4.664)	(4.682)
Treat	24.424***	33.89***	30.997***
	(4.243)	(4.056)	(4.209)
Time	-51.119***	29.376***	25.601***
	(4.436)	(7.022)	(7.329)
Individual level Controls	No	Yes	Yes
Household level Controls	No	No	Yes
Climate Change Controls	No	No	Yes
Obs.	162,318	162,318	154,274
R-Squared	0.0099	0.096	0.108

Table 9: Quadruple Differences (DDDD) Estimate of the Effects of Climate Shock and Husband's partcipation in on Women's Unpaid Labor (Minutes/day): **Role of Caste**

Women's Unpaid Labor	**(1)**	**(2)**	**(3)**
Treat×Time × Husband's Participation × Caste	-1.59	-23.605	-49.202***
	(24.116)	(23.523)	(23.445)
Treat×Caste	80.78***	43.076***	62.91***
	(10.53)	(9.864)	(10.112)
Time×Caste	43.453***	15.871	31.544***
	(10.491)	(10.095)	(10.301)
Husband's Participation×Caste	21.865**	0.748	-8.35
	(10.501)	(10.095)	(10.301)
Treat×Time × Husband's Participation	-35.688***	-31.31***	-18.251**
	(7.807)	(7.527)	(7.602)
Time×Husband's Participation × Caste	-1.047	4.503	19.554
	(15.4)	(15.24)	(15.27)
Treat×Husband's Participation × Caste	-2.986	23.111	35.829**
	(15.675)	(15.144)	(15.348)
Treat×Time × Caste	8.853	43.678***	44.496***
	(16.03)	(14.99)	(15.187)
Treat×Time	102.782***	96.735***	101.846***
	(5.138)	(4.823)	(4.974)
Treat×Husband's Participation	10.946**	5.488	0.903
	(5.154)	(4.991)	(5.03)
Time×Husband's Participation	10.772*	10.165*	4.006
	(5.754)	(5.561)	(5.634)
Caste	-102.031***	-72.543***	-87.118***
	(7.218)	(6.841)	(7.065)
Husband's Participation	-45.675***	54.451***	43.954***
	(4.026)	(4.273)	(4.319)
Treat	-33.74***	-20.635***	-24.233***
	(3.394)	(3.189)	(3.286)
Time	-55.41***	13.359***	13.119***
	(3.739)	(6.67)	(6.911)
Individual level Controls	No	Yes	Yes
Household level Controls	No	No	Yes
Climate Change Controls	No	No	Yes
Obs.	162,318	162,318	154,274
R-Squared	0.0099	0.096	0.108

Table 10: Difference-in-Difference (DD) Estimate of the Impact of Climate Shock on Women's Unpaid Labor: **Alternative Measure of Dependent Variable (Inverse Hyperbolic Sine)**

Women's Unpaid Labor	**(1)**	**(2)**	**(3)**
Treat×Time	0.081***	0.079***	0.107***
	(0.012)	(0.012)	(0.011)
Treat	-0.044***	-0.027***	-0.049***
	(0.0083)	(0.008)	(0.0079)
Time	0.023	0.013	0.20***
	(0.009)	(0.009)	(0.023)
Individual level Controls	No	Yes	Yes
Household level Controls	No	No	Yes
Climate Change Controls	No	No	Yes
Obs.	162,318	162,318	154,274
R-Squared	0.001	0.027	0.075

Table 11: Triple Differences (DDD) Estimate of the Effects of Climate Shock and Husband's partcipation in on Women's Unpaid Labor: **Alternative Measure of Dependent Variable (Inverse Hyperbolic Sine)**

Women's Unpaid Labor	**(1)**	**(2)**	**(3)**
Treat×Time × Husband's Participation	-0.189***	-0.182***	-0.101***
	(0.025)	(0.0246)	(0.0236)
Treat×Time	0.17***	0.161***	0.149***
	(0.013)	(0.127)	(0.126)
Treat×Husband's Participation	0.049***	0.036***	-0.033**
	(0.017)	(0.017)	(0.016)
Time×Husband's Participation	0.0289	0.0241	-0.0202
	(0.018)	(0.018)	(0.017)
Husband's Participation	-0.178***	-0.0001	0.0079***
	(0.013)	(0.015)	(0.0146)
Treat	-0.066***	-0.043***	-0.042***
	(0.009)	(0.010)	(0.0098)
Time	0.011	0.003	0.188***
	(0.009)	(0.10)	(0.0242)
Individual level Controls	No	Yes	Yes
Household level Controls	No	No	Yes
Climate Change Controls	No	No	Yes
Obs.	162,318	162,318	154,274
R-Squared	0.0067	0.027	0.078

Table 12: Difference-in-Difference (DD) Estimate of the Impact of Climate Shock on Women's Unpaid Labor (Minutes/day): **Alternative Treatment and Control groups**

Women's Unpaid Labor	**(1)**	**(2)**	**(3)**
Treat×Time	95.91***	84.25***	79.56***
	(3.860)	(3.655)	(3.716)
Treat	-61.01***	-64.16***	-73.051***
	(2.41)	(2.292)	(2.38)
Time	-32.68	-34.69***	43.96***
	(2.23)	(2.17)	(6.27)
Individual level Controls	No	Yes	Yes
Household level Controls	No	No	Yes
Climate Change Controls	No	No	Yes
Obs.	162,318	162,318	154,274
R-Squared	0.0048	0.089	0.119

Table 13: Triple Differences (DDD) Estimate of the Effects of Climate Shock and Husband's partcipation in on Women's Unpaid Labor (Minutes/day): **Alternative Treatment and Control groups**

Women's Unpaid Labor	**(1)**	**(2)**	**(3)**
Treat×Time × Husband's Participation	-16.72***	-20.002***	-10.81***
	(7.75)	(7.441)	(7.47)
Treat×Time	103.57***	93.88***	85.29***
	(5.16)	(4.74)	(4.86)
Treat×Husband's Participation	-12.024***	-7.1***	-8.71***
	(4.84)	(4.70)	(4.71)
Time×Husband's Participation	-0.738	2.53	-0.059
	(4.5)	(5.19)	(4.45)
Husband's Participation	-33.93***	62.30***	49.02***
	(3.05)	(3.38)	(3.46)
Treat	-55.98***	-61.69***	-69.48***
	(3.22)	(2.95)	(3.09)
Time	-31.91	-36.64***	44.75***
	(2.934)	(2.809)	(6.53)
Individual level Controls	No	Yes	Yes
Household level Controls	No	No	Yes
Climate Change Controls	No	No	Yes
Obs.	162,318	162,318	154,274
R-Squared	0.0080	0.093	0.121

Figures

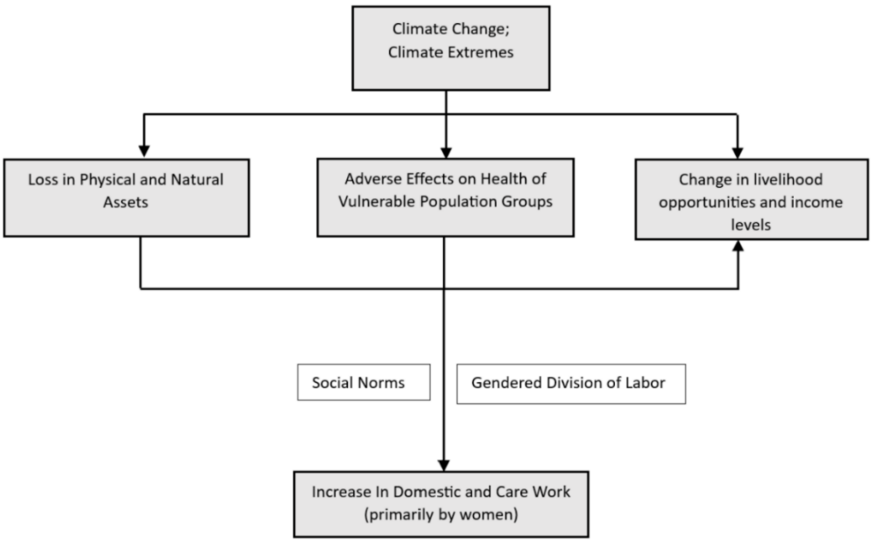


Figure 1: Climate Change and Women's Unpaid Labor.

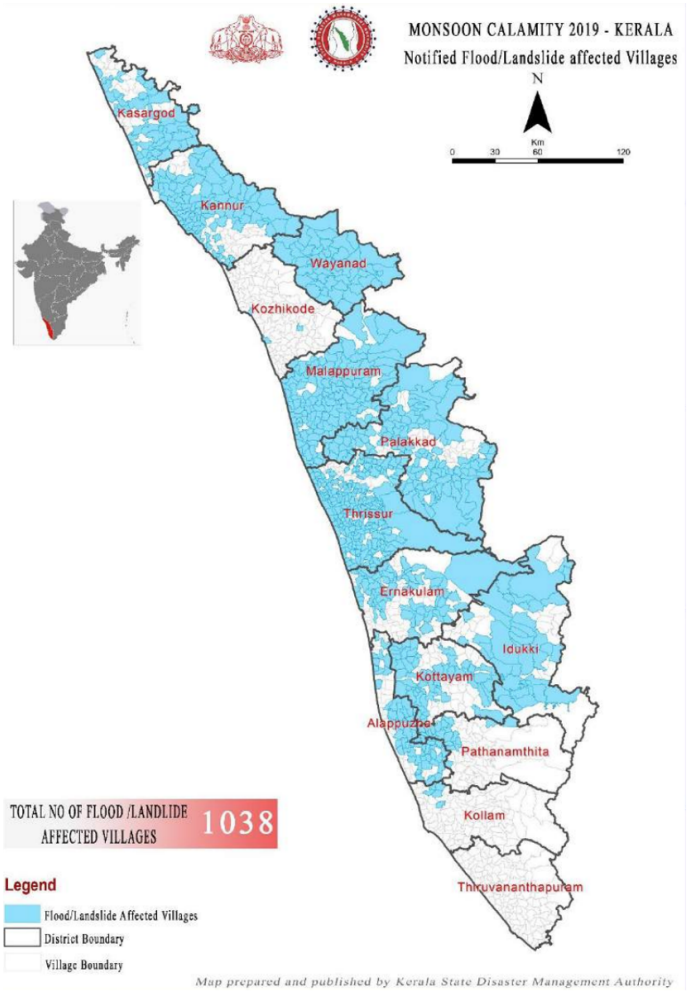


Figure 2: Map of 2019 Flood Affected Districts.*Source: State Disaster Management Authority of Kerala*

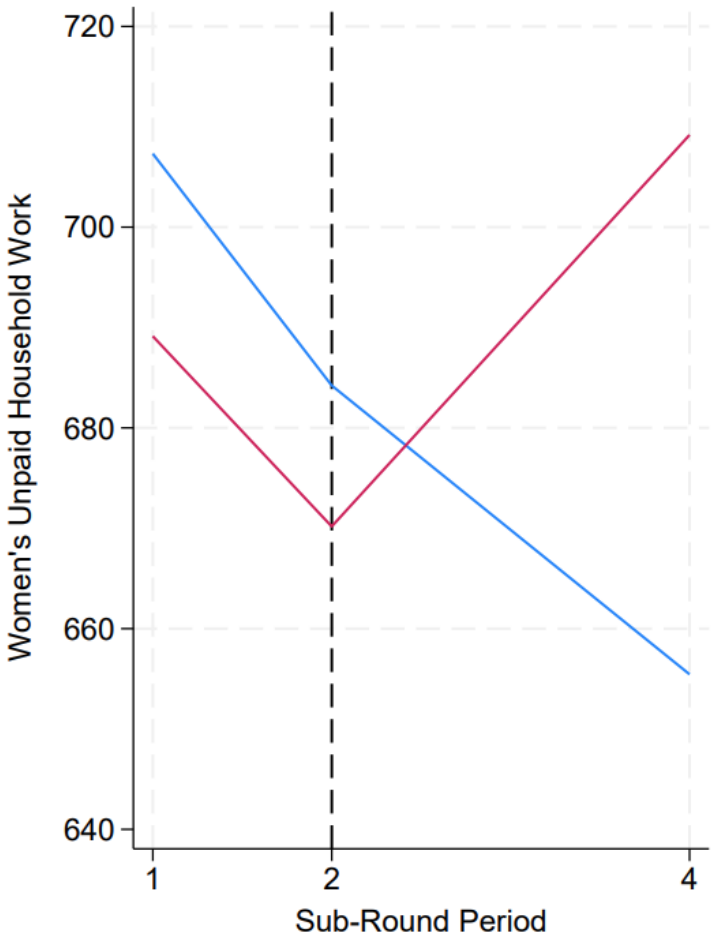


Figure 3: Graphical Diagnostics of Parallel Trend. Note: Here the red colored line denotes the time spend on unpaid household group of treatment group and the blue colored line denotes the same for the control group.