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ABSTRACT

Thriving in the Rain: Natural Shocks, Time Allocation, and Women's Empowerment in Bangladesh*

In low- and middle-income countries, differences between men and women in their time use patterns represent a major source of gender inequality. Among other factors, natural shocks can contribute to the widening of these differences. This paper examines the impact of the 2017 flood in Bangladesh on men's and women's time use patterns and women's empowerment. Using georeferenced and longitudinal data, we find that the flood decreased women's time spent on domestic work while increasing their engagement in paid activities and empowerment. In contrast, men spent less time at work and increased their participation in housework to substitute for women's domestic work. These responses to the shock are confirmed only for those individuals who were exposed to another flooding event that occurred in 2014. To better understand the underlying mechanisms, we look at the medium-term impact of the 2014 flood on women's empowerment and on their engagement in paid activities, and we find that the shock still positively affects both variables, suggesting that when endogenous, an increase in empowerment persists over time and influences reactions to the 2017 shock.

JEL Classification: J16, J22, J43

Keywords: time allocation, time poverty, natural shocks, women's empowerment

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1 Introduction

Gender differences in time use represent a major source of gender inequality worldwide: women tend to work more than men when both domestic and market activities are considered (Anxo et al., 2011; Ferrant et al., 2014); they tend to be more time-poor than men, i.e., lack the time for rest and leisure after considering the time spent at work, whether in the labour market or at home (Solotaroff, 2019); and they are usually responsible for the overall management of the household (Dean et al., 2022).

In low- and middle-income countries, such inequalities are even more exacerbated, and they are shaped by several factors, including natural shocks and climate change (Halliday, 2012; Kamei, 2019; Garg et al., 2020). In the aftermath of a natural shock, women may engage more in paid activities to contribute to the household's increased economic expenses, reallocating their time from domestic work to market and leisure activities (Canessa and Giannelli, 2021; Lee et al., 2021). By increasing women's labour supply, exogenous negative shocks can lead to long-term changes in women's economic position within the household, and they can shape prevailing social norms through the disruption of the traditional replication of gender roles within the household (Bradshaw and Fordham, 2013). Indeed, while women engage more in paid activities as a risk-coping mechanism (Canessa and Giannelli, 2021), the social acceptability of women's employment may grow, followed by a more gender-equal division of time spent within the household (Moreno and Shaw, 2018).

Understanding these mechanisms is critical for designing better policies that encourage a gender-driven response to adaptation to climate change, especially when considering that natural disasters are not gender-neutral and that women tend to be more vulnerable to them than men are (Jost et al., 2016; Rao et al., 2019). This paper examines whether and to what extent extreme weather shocks impact women's and men's time allocation and time poverty and women's empowerment. Specifically, by combining detailed panel data with high-precision satellite data, this study seeks to assess the impact of a severe flood that occurred in Bangladesh in 2017 on the reallocation of time by men and women. Then, this paper aims to deepen our understanding of the long-term impacts of natural shocks on women's empowerment. Building upon a recent paper showing that the flood that occurred in 2014 in Bangladesh led to an increase in women's engagement in paid activities and in their empowerment (Canessa and Giannelli, 2021), this study asks whether this increase persists over time and whether it leads men and women to react differently to the shock in 2017.

For the analysis, georeferenced data from NASA satellites are used to measure the impact of the flood as the share of inundated areas for each sampled household (Gröger and Zylberberg, 2016; Giannelli and Canessa, 2022). We match these data with the Bangladesh Integrated Household Survey (BIHS), a panel dataset representative of rural Bangladesh that was collected by the International Food Policy Research Institute (IFPRI) in 2012, 2015, and 2018. These data are particularly suited for this study for three reasons. First, they allow us to conduct the analysis of time allocation in the aftermath of both shocks. Indeed, the second and third waves were collected in a period ranging from three to nine months from the occurrence of the flood, depending on the month of the interview. Second, they include an

extensive module on time use that was administered to both spouses in a household. Third, they allow us to include both shocks in the analysis.

The identification strategy relies on a difference-in-difference approach. Following the recent literature (De Chaisemartin and d'Haultfoeuille, 2020; Goodman-Bacon, 2021; Callaway and Sant'Anna, 2021), we first assess the relevance of the documented problems of staggered adoption and heterogeneous treatment effects in our context. We compute the negative weights in our sample as suggested by De Chaisemartin and d'Haultfoeuille (2020), and we find positive evidence for using standard linear techniques. The treatment variable is the share of inundated areas in 2017 around each sampled household. Thanks to the nature of the data, we are able to conduct an in-depth analysis of the impact of repeated shocks on time use. Indeed, we estimate distinct equations at the individual level for men and women to assess the impact of the flood. Since the potential spillover effects of the flood in 2014 may bias the results on the impact of the flood in 2017, we then conduct the analysis on two subsamples of the population: those individuals who were exposed to the flood in 2014 and those who were not. We then check whether the increase in women's empowerment induced by the flood in 2014 persists in 2018, employing as a treatment variable the share of inundated areas around each sampled household in 2014. It is worth noting that the empirical analysis is conducted using only the waves in 2015 and in 2018, as we are mostly interested in analysing the impact of each shock separately.[1]

The results show that the 2017 flood significantly impacted time allocation for both men and women. Women spend less time on domestic labour and more time on leisure activities, and they become less time-poor, whereas men spend less time working outside the home and more time on domestic chores, and they become more time-poor. Floods lead women to work more and significantly increase their empowerment, which is measured using the Women's Empowerment in Agriculture Index (WEAI). When we disentangle these impacts for individuals who experienced the flood in 2014 and those who did not, the findings are confirmed only for those households who experienced both shocks. Indeed, among the households only affected by the 2017 flood, women spend more time on domestic chores, become more time-poor, and spend less time on reproductive agricultural activities. Men, on the other hand, spend more time on market and leisure activities and less on domestic work.

When we look at the long-term impact of natural shocks on women's empowerment, we find that the 2014 flood led to a persistent increase in empowerment. However, this increase seems to be driven mainly by the two economic subindexes of the WEAI, while all other subindexes either significantly decrease or do not increase. To extend this analysis, we also examine women's satisfaction with their lives, and we find that the shock led to a significant and long-lasting reduction in their subjective well-being, suggesting that we need to be extremely careful when using composite indexes to measure empowerment.

[1] We are interested in understanding the impact of the shock on time allocation between men and women in the short term, and the impact on women's empowerment in the long term. As shown in Table 13 in the Appendix, the shock in 2014 has no impact on time use variables for women in 2018, but it affects men's engagement in domestic and leisure activities. This is most likely because the 2014 flood also reduced men's likelihood of being employed in the 7 days prior to the interview in 2018.

This work contributes to the literature in three ways. First, it is one of the first studies to investigate the gender-specific impact of natural shocks on time use and time poverty. Time use data are particularly useful for conducting in-depth analyses of individual and social behaviours, as well as for gaining a better understanding of policy impacts on women, men, and children (Floro and King, 2016). This research expands on the use of such data to better understand how people react to recurrent climatic shocks. Extreme weather occurrences are becoming more common as a result of climate change, particularly in developing countries (Guiteras et al., 2015). To build more effective, gender-differentiated, and informed policies, it is necessary to have a thorough understanding of how households respond to shocks and how such shocks influence the daily activities of men and women differently.

Second, this study provides quantitative estimates of the long-term influence of natural shocks on women's empowerment and employment. Building on recent research that shows that the 2014 flood in Bangladesh led to an increase in women's paid labour and empowerment (Canessa and Giannelli, 2021), this analysis corroborates and expands on these findings by demonstrating that such changes are structural and persist over time. Indeed, by using the third wave of the panel, this research examines the medium-term impact of the 2014 flood on women's empowerment and shows that the increase in women's empowerment brought about by this flood has persisted over time, leading women to engage more in the market than in reproductive activities. These findings have far-reaching implications, as they demonstrate that when endogenous, an increase in women's empowerment actually persists over time and leads to long-term changes in women's and men's behaviours within the household.

Last, this paper contributes to the broader literature on the measurement of women's empowerment (Mahmud et al., 2012; O'Hara and Clement, 2018; Kabeer, 2020)by showing that the observed increase in the WEAI does not translate into an increase in women's subjective well-being but rather a reduction. These results are particularly important because they demonstrate that an increase in empowerment and employment does not always translate into an increase in women's well-being, implying that composite empowerment indexes, because of their natural scope, cannot reflect the different dimensions in which women are empowered or disempowered.

The paper proceeds as follows: Section 2 describes the context of the study; Section 3 presents the data employed for the study; Section 4 explains the empirical methodology adopted for the analysis; Section 5 introduces the results; Section 6 provides robustness checks; and Section 7 concludes.

2 The context: gender norms and time allocation in Bangladesh

Bangladesh is a patriarchal society where men control property, income, and women's labour (Cain et al., 1979). Women in rural Bangladesh find themselves trapped in a circle that sees their role changing from daughter to wife to mother with little possibility of expressing independent goals or aspirations (Solotaroff, 2019). Patriarchy generates a system in which men feel allowed to claim power over women's lives. A major example of such control is "purdah" (i.e., seclusion), a common practice that confines women's sphere of activities within the homestead, limiting their access to economic and social opportunities

(Kabeer, 1988; Solotaroff, 2019). For instance, the strict application of purdah prevents women from cultivating land themselves or from going to the market, and all these tasks must be interceded by male household members (Kabeer, 1988; Solotaroff, 2019). Purdah also hinders women's access to the labour market, as they have to engage in income-generating activities within the compound (Cain et al., 1979; Kabeer, 1988). These patriarchal norms have engendered a highly segregated labour market and a rigid division of labour that still persists today (Heintz et al., 2018; Kabeer et al., 2021).

Another common practice in rural Bangladesh is exogamy, i.e., marrying one's daughter to a man living in another village (Cain et al., 1979; Kabeer, 1988). The application of exogamy makes women vulnerable and powerless. Indeed, when they marry, women move to the village where their husband lives, weakening their ties with their family of origin (Cain et al., 1979). Once married, women's autonomy is particularly limited because they are subjected to the will and supervision not only of their husband but also of their mother-in-law, who plays an essential role within the family (Solotaroff, 2019). More generally, the practice of exogamy makes parents invest less in their daughter's education, as she leaves the household at an early stage of her life (Solotaroff, 2019). In addition, women tend to not claim their land inheritance because they live away from their father's property and have to rely on others to represent their interests (Kabeer, 1988).

These norms define a strict division of labour within the household. Women employ most of their time in domestic work, to which men mainly contribute by shopping for consumer goods since purdah severely limits women's ability to go to the market (Cain et al., 1979). While men specialize in the stage of agricultural production that is carried out in public space, women engage in activities that are carried out within the home (Kabeer et al., 2021). Consequently, women tend to specialize in activities that keep them close to the homestead, such as food processing and preparation, animal husbandry, and household maintenance (Cain et al., 1979). For agricultural work, while men specialize in harvest and preharvest activities, women specialize in postharvest activities (Cain et al., 1979). Women's peak periods of agricultural activity are in December-January and in June-July, while they engage more in income earning activities during February-March, which is a busy period for garden cultivation, hut repair, and handicrafts (Cain et al., 1979).

These well-defined gender roles make women particularly vulnerable to negative shocks (Islam et al., 2017; Solotaroff, 2019). Indeed, they are not only at higher risk of being physically injured by disasters such as floods (Cannon, 2002), but their coping strategies are also less effective because they lack access to crucial productive assets and resources (Solotaroff, 2019). Women are usually denied access to land (Solotaroff, 2019; Kabeer et al., 2021), and even if they are legally entitled to part of an inheritance, they usually trade this right with their kin in exchange for support in times of potential distress (Kabeer, 1988; Kabeer et al., 2021). Since land is usually not registered in their names, women cannot claim any compensation for any crop loss caused by regular flooding and erosion (Thomas, 2004). During floods, women have to plan and implement measures to mitigate disasters and risks. These measures include but are not limited to activities such as preserving fuels and storing food, preparing portable mud stoves for future use, collecting and storing firewood in dry places, and storing fodder for domestic animals

(Khandker, 1988). In the aftermath of the shock, women mitigate the household risk induced by the flood by participating in food processing and selling in local markets, rearing cattle and poultry, doing small business, and saving for children's education (Khandker, 2007).

3 Data

3.1 GIS data and floods

Between 2011 and 2018, Bangladesh experienced two severe flooding events in 2014 and 2017. From mid-August 2014 until the end of September 2014, heavy rains and overflows from the Brahmaputra and Ganges rivers caused severe flooding that affected almost 3 million people, with an estimated 275,000 individuals displaced. The flood was particularly intense in the northeastern part of the country, where more than 10,000 acres of crops were inundated and more than 600 schools remained closed. This event was registered as the worst event to affect the country since the flood in 2007.[2]

From August 2017 to mid-September 2017, Bangladesh was hit again by a dramatic flood that was recorded as one of the worst flooding events in recent history, affecting almost 7 million people and 9,000 villages. The overflows of the Brahmaputra and Ganges rivers led to the inundation of 31 districts in the northern part of the country. The flood caused significant damage to housing and infrastructures, particularly schools, roads, and railways, which resulted in the inundation of additional areas that otherwise would have been protected. In particular, the flood damaged the agricultural sector, causing losses in food crops (including the main staple, rice) and livestock and fish stocks.[3]

The treatment is defined as the households' exposure to the inundations. Following the literature (Zylberberg et al., 2015; Giannelli and Canessa, 2022), we adopt georeferenced data to build the treatment variable. More specifically, we adopt the NASA Flooding Map, a product composed of 250-mt resolution images, that defines flooded areas as water observations falling outside normal water levels.[4] As in Giannelli and Canessa (2022), we adopt a composite image for an interval of 15 days, in which an area is defined as flooded if it is recognized as such for at least 2 days. This time span of the composite image overcomes the issue of cloud coverage, thus providing more detailed data. We construct two treatment variables for the analysis, one for each flood. To decide which reference period to consider for the flood, we follow the information reported in the Official Reports in 2014 and in 2017 of the Bangladesh Water Development Board of the National Government. In 2014, the report stated that the flood reached its highest peak at the end of August and during the first 10 days of September, while in 2017, the highest peak was reached during the last two weeks of August.

The units of analysis for the shock are the 6,500 sampled households, which are nationally representative of the country's rural areas. While Giannelli and Canessa (2022) define their treatment at the village level, for this study, we had access to the georeferenced coordinates of the households, which

[2] https://reliefweb.int/sites/reliefweb.int/files/resources/a-i7876e_0.pdf

[3] https://reliefweb.int/disaster/fl-2014-000117-bgd

[4] All data are publicly available at the following link: https://floodmap.modaps.eosdis.nasa.gov/index.php

were released with the Harmonized Bangladesh Integrated Household Survey in September 2017. The treatment variable is then defined as the share of pixels identified as "flooded" in a 5-km radius for each household in the sample. As robustness checks, we repeat the analysis for 2- and 10-km radiuses. The 5 km radius should include the areas of agricultural activities of rural households(Zylberberg et al., 2015; Canessa and Giannelli, 2021). Indeed, data in Table 1 show that the average distance of the land from the homestead is approximately 0.5 km.

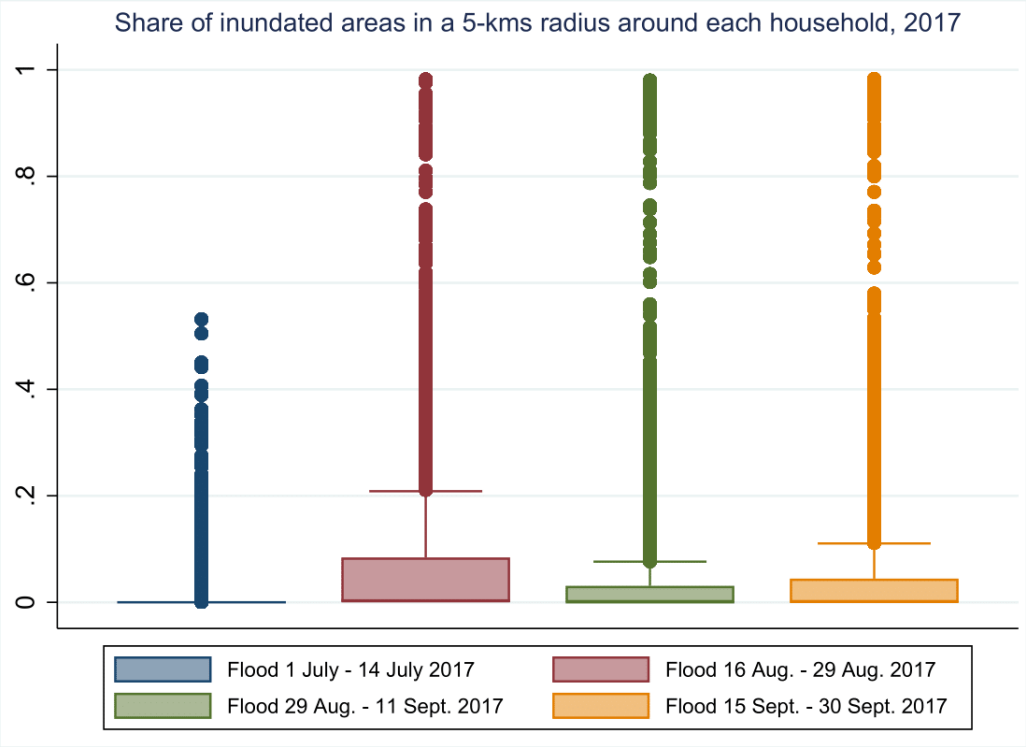

Figure 1: Share of inundated areas, 2017

For 2017, with the treatment specification of the 5-km radius, the mean share of inundated areas corresponds to 9 percent, with the maximum reaching 93 percent. In normal times (i.e., the first two weeks of July 2017), the mean share is very low, approximately 1 percent, while the maximum reaches 22 percent. Figure 1 shows the average share of flooded areas for selected intervals before (1st to 14th of July 2017), during landfall (16th to 29th of August 2017), and in two periods after landfall (29th to 11th of September 2017 and 15th to 30th of September 2017). The figure shows that 9 percent of the median household is inundated during the last two weeks of August. This number reaches 98 percent for the most affected households. It is important to note that after one month, approximately 7 percent of the households are still inundated, probably because of differences in soil absorption. This may differently impact time allocation among household members. Figure 2 in the Appendix shows the incidence of the flood during the last 2 weeks of August 2017.

3.2 BIHS data

The Bangladesh Integrated Household Survey is a panel dataset that was collected by IFPRI in three rounds, the first in 2011 (October 2011 - June 2012), the second in 2015 (January - June 2015), and the third in 2018 (November 2017 - March 2018). The survey is nationally representative of the rural areas in all seven divisions of the country, and it follows approximately 6,500 households over the three waves. The attrition rate at the household level is 4.4 between the first and second waves and 6.7 between the second and third waves.

The data provide detailed information at the household and individual level about socioeconomic characteristics, as well as agricultural production and practices, dietary intake, anthropometric measurements, and data to measure the Women's Empowerment in Agriculture Index (WEAI). One of the modules of the WEAI covers time use and was administered to both the head of the household and their spouse. The data were collected using time diaries, in which respondents were asked to recall the time spent on activities in the 24 hours prior to the interview, starting at 4:00 am of the day before the interview. Thanks to their sequential nature paired with a very short recall period (i.e., 15 minutes), time-use diaries are more likely than stylized questions to avoid recall bias because they help respondents accurately remember their daily activities (Seymour et al., 2020). The main threat of time-use diaries in agricultural settings is that a 24-hour recall does not adequately consider all factors of time allocation. For instance, time-use diaries do not capture seasonal variations or account for festivities – if the day prior to the interview was a holiday, the data may not capture the actual dimension of individuals' workload (Alkire et al., 2013; Seymour et al., 2020). To account for the former concern, we add dummy variables to control for the month of the interview in the analysis. Regarding the latter concern, in the sample, only 6 percent of the respondents reported that the day before the interview was a holiday.

Our sample consists of 16,230 observations at the individual level, specifically, 2,705 women and 2,705 men per year. Because gender roles within the household are particularly strict in Bangladesh and they greatly influence women's and men's time allocation, to have more accurate information on our outcomes of interest, we decided to focus only on household heads and spouses, and we included in the sample only individuals who were present in all three waves and who reported being the household head or the spouse in the time-use module.[5] In this way, approximately 20 percent of the observations from the original sample are dropped. Table 1 represents the summary statistics of the sample at baseline (2015). Notably, women spend disproportionately more time than men in domestic activities, while men are mostly engaged in market work activities. Men are also more likely to be time-poor than women, and they spend almost the same amount of time on leisure activities.

[5] Moreover, the time-use module is supposed to be administered to the main respondents of the household.

Table 1: Descriptive statistics at baseline (2015)

Variables	Obs	Mean	Std. Dev.	Min	Max
Women					
Time spent on domestic work (minutes)	2704	429.381	165.223	0.000	1140.000
Time spent on market work (minutes)	2704	151.925	154.738	0.000	1050.000
Time spent on leisure activities (minutes)	2704	191.233	132.526	0.000	840.000
Time poverty	2704	0.382	0.486	0.000	1.000
WEAI	2704	0.414	0.139	0.090	0.900
Engagement in paid activities	2704	0.786	0.411	0.000	1.000
Age	2704	38.515	10.533	15.000	73.000
Men					
Time spent on domestic work (minutes)	2704	65.581	113.159	0.000	855.000
Time spent on market work (minutes)	2704	511.731	248.279	0.000	1530.000
Time spent on leisure activities (minutes)	2704	197.674	169.082	0.000	1035.000
Time poverty	2704	0.443	0.497	0.000	1.000
Age	2704	46.557	12.217	22.000	105.000
GIS data					
Flood 16 Aug. - 29 Aug. 2017	5408	0.090	0.189	0.000	0.982
Flood 1 July - 14 July 2017	5408	0.009	0.040	0.000	0.532
Flood 28 Aug. - 10 Sept. 2014	5408	0.080	0.187	0.000	0.978
Flood 1 July - 14 July 2014	5408	0.037	0.113	0.000	0.854
Flood – dummy variable	1164	0.148	0.355	0.000	1.000
Household asset					
Number of electric iron owned by	5408	0.072	0.281	0.000	4.000
Number of metal pots owned by hh	5408	14.195	9.404	1.000	126.000
Number of stove owned by hh	5408	0.053	0.264	0.000	5.000
Number of tv owned by hh	5408	0.329	0.516	0.000	4.000

As aforementioned, the aim of this study is to analyse the impact of the two floods on the time use patterns of men and women, on their time poverty, and on their empowerment, which is first measured as the probability of engaging in paid activities and then with the WEAI. Thus, the outcome variables for time use patterns are the time (measured in minutes) spent on domestic work, on market work, and on leisure activities in the last 24 hours. Domestic work activities include caring for children and elderly individuals, cooking and cleaning, and shopping/obtaining services. The activities that are considered to be market work are working as employed or in one's own business, fishing, working in construction, farming, and commuting. Leisure activities include watching TV and listening to the radio, exercising, and engaging in social and religious activities. Time poverty is defined following Alkire et al. (2013) and Bardasi and Wodon (2006): an individual is time-poor if she worked more than 10.5 hours in the day prior

to the interview. As in Canessa and Giannelli (2021), to examine whether the floods had an impact on women's likelihood of engaging in paid activities, we refer to the question "Are you now doing any work or business that brings in cash, additional food, or allows you to accumulate assets for your household?". We constructed the WEAI, a survey-based index used to assess women's empowerment in agricultural settings, following Alkire et al. (2013). The index is composed of two subindexes: the Five domains of empowerment (5DE) and the Gender Parity Index (GPI), which are weighted at 90 and 10 percent, respectively, in the final index. The 5DE score is a weighted average of 10 indicators grouped into the following five domains: (1) decisions about agricultural production, (2) access to and decision-making power over productive resources, (3) control over the use of income, (4) leadership in the community, and (5) time allocation (Alkire et al., 2013). Women are considered adequate on each indicator if their score is equal to or higher than a specified threshold for each domain (Alkire et al., 2013).

4 Empirical methodology

4.1 Impact of the flood in 2017 on time use and women's empowerment

The identification strategy relies on the assumption that the flood, given its exogenous nature, is not correlated with other omitted determinants of time allocation within the household. To estimate the impact of flooding on the time use patterns of men and women, we adopt a difference-in-difference methodology, controlling for time-invariant unobserved individual characteristics of the respondents. The treatment is a continuous variable for the share of inundated areas in 2017 in a range of 5 km around each sampled household. We estimate the following specification for men and women separately:

$$\mathrm{Y}_{ihrt} = \beta_0 + \beta_1 \left(T_h * t_{=2018}\right) + \beta_2 \left(P_h * t_{=2018}\right) + \beta_3 W_r t + \beta_4 X_{iht} + \beta_5 D_t + \beta_6 Z_{ht} + \alpha_i + \varepsilon_{ihrt}$$

where Y_{ihrt} are the outcome variables for each individual i in household h residing in region r at time t; T_h is the treatment variable, i.e., the share of inundated pixels in a buffer of 5-km for each household; t is the time variable; and β_1 is the difference-in-difference coefficient of the treatment, which gives the difference in the outcome of interest after the flood between the treatment and the control group. Following the literature (Gröger and Zylberberg, 2016; Giannelli and Canessa, 2022), P_h is the household propensity to be inundated in normal times, measured by the percentage of water coverage in a buffer of 5-km for each household during the first two weeks of July 2017. This control is used to identify changes in time allocation due to the treatment for those households that have the same propensity to be inundated in normal times. W_{rt} are interactions between wave and region fixed effects to account for changes in regional characteristics over time; D_t are the dummy variables of the month of interview, taking January as a reference to avoid any problem of collinearity. X_{iht} are individual and household socioeconomic characteristics that may shape time-use patterns, namely, the number of members under the age of 15 and the age and education of both spouses. We also control for households' durable, agricultural, and livestock assets, as measured by principal component analysis. We control for the level

of wealth rather than for yearly income or expenditure estimates because the latter are usually prone to recall bias, which makes the available information less accurate (Arthi et al., 2016). Z_{ht} is a set of control variables that may influence the home production function, i.e., the number of electric irons owned by the household, the number of gas stoves, the number of cooking stoves, and access to electricity. Since individuals seem to spend most of their time for leisure activities watching television, we also added the number of televisions owned by the household as a control. To control for the household's probability of being inundated, we also control for the distance from the house to the river, the soil slope, and the soil type. The fixed effects at the individual level are α_i , and ε_{ihrt} is the error term. For the heterogeneity analysis, the identification strategy is the same, but we repeat the analysis separately for men and women for two subsamples of the population, i.e., those individuals who experienced the flood in 2014 and those who did not.

Recent literature has suggested that when the treatment effects are heterogeneous across time and places, the estimation of the average treatment on treated (ATT) may be biased (Callaway and Sant'Anna, 2021; De Chaisemartin and d'Haultfoeuille, 2020; Goodman-Bacon, 2021). To assess the extent to which this is the case in our context, we follow De Chaisemartin and d'Haultfoeuille (2020) and we estimate the share of negative weights in our sample. Table 9 in the Appendix reports the share of negative weights in the sample and their relevance (i.e., the share of their sum). The share is less than 2 percent, and their relevance is less than 5 percent, suggesting that the bias in our sample is small enough for us to adopt the aforementioned methodology.

4.2 Long-term impact of the flood in 2014 on women's empowerment

The study also examines whether the impact of the flood in 2014 on women's empowerment persists over time and whether it influences time allocation between men and women after the shock in 2017. We estimate the same identification strategy as before, employing the WEAI as the dependent variable and the share of inundated areas around each sampled household in 2014 as the treatment variable:

$$\text{WEAI}_{ihrt} = \beta_0 + \beta_1 (T_h * t_{=2014}) + \beta_2 (P_h * t_{=2014}) + \beta_3 W_r t + \beta_4 X_{iht} + \beta_5 D_t + \beta_6 Z_{ht} + \alpha_i + \varepsilon_{ihrt}$$

To check whether the results are different for women who have been exposed to both shocks or only to the first one, we run a heterogeneity analysis dividing the sample of women into those who experienced both floods and those who experienced only the flood in 2014. We control for the same variables at the individual and household levels as in the main time allocation analysis.

5 Results

This section presents the estimated effects of the flood on the time allocation of men and women, on time poverty, on the likelihood of women engaging in paid activities, and on their empowerment as measured by the WEAI. We first present the results of the impact of the flood that occurred in 2017, and we then

present the results of the heterogeneity analysis, and last, we report the results for the long-term impact of the shock in 2014 on women's empowerment and time allocation.

5.1 The impact of the flood in 2017 on time allocation

As shown in Table 2, the flood in 2017 has significant effects on our variables of interest. Time allocation changes significantly for both men and women who have been impacted by the flood. Indeed, while women engage 55 fewer minutes in domestic work, men increase their time spent on housework by 73 minutes. Men's market work and time spent in leisure activities are not significantly impacted. Their increased engagement in domestic activities leads them to be 17 percentage points more likely to be time-poor than men who did not suffer the flood.

Table 2: Impact of the flood of 2017 on time use variables for women and men

	Women				**Men**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Domestic work	Market work	Leisure time	Time poverty	Domestic work	Market work	Leisure time	Time poverty
Year 2018	3.631	10.65	38.15***	0.043	-3.681	-18.33	35.14***	-0.010
	(13.90)	(10.22)	(9.587)	(0.0295)	(7.278)	(15.05)	(11.52)	(0.0318)
Treat	**-55.55****	**-12.42**	**93.65*****	**-0.063**	**73.49*****	**-61.68**	**-28.63**	**0.171****
	(26.86)	**(27.29)**	**(22.47)**	**(0.084)**	**(20.13)**	**(37.57)**	**(25.19)**	**(0.0828)**
Year#July 2017	203.6*	-46.09	-157.8	0.279	-19.31	-136.3	-91.98	-1.076***
	(106.8)	(99.40)	(97.93)	(0.364)	(92.51)	(154.2)	(109.4)	(0.412)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,352	4,997	5,352	5,352	5,352	5,240	5,352	5,352
R-squared	0.061	0.077	0.091	0.033	0.018	0.013	0.034	0.010
Number of id	2,684	2,680	2,684	2,684	2,684	2,684	2,684	2,684

Note: Clustered standard errors at the household level in parentheses.*, **, *** denote significance at the 10%, 5% and 1% levels respectively. The reported time use variables denote the minutes spent in domestic work, in market work, in leisure activities and time poverty, defined as a dummy equal to 1 if the individual worked more than 10.5 hours in the previous day. Control variables are those reported in Section 4.1.

As shown in Table 3, the shock significantly increases women's likelihood of being employed in paid activities by 37 percentage points and women's empowerment at the 10 percent level.[6] We posit that this reallocation of time is due to the increased engagement of women in paid activities as a risk coping strategy. As predicted by Anderson and Eswaran (2009), women engage more in paid activities, reduce their time spent in domestic work and increase their time spent in leisure activities. Consequently, men reallocate their time towards increased engagement in housework to substitute for women's domestic work. Women's increased economic autonomy then generates an increase in their empowerment.

[6] It is worth noticing that we do not find any effect for women on our outcome variable "Market work", contrary to our variable defining whether women were employed in paid activities. Thus, the "market activities" as defined in time-use modules do not imply that women engage in jobs for which they earn an income they have direct access to.

Table 3: Impact of the flood of 2017 on women's employment and empowerment

	(1)	(2)
	Paid activities	**WEAI**
Year 2018	0.102***	-0.033***
	(0.022)	(0.010)
Treat	**0.373*** **	**0.035***
	(0.060)	**(0.026)**
Year#July 2017	-0.455*	-0.009
	(0.247)	(0.114)
Control	Yes	Yes
Observations	5,352	5,352
R-squared	0.090	0.033
Number of id	2,684	2,684

Note: Clustered standard errors at the household level in parentheses.*, **, *** denote significance at the 10%, 5% and 1% levels respectively. The dependent variables are defined as a dummy equal to 1 if the woman reported being engaged in paid activities, and the Women's Empowerment in Agriculture Index (WEAI), as defined by Alkire et al. (2013). Control variables are those reported in Section 4.1.

5.2 Heterogeneity analysis

If the flood in 2014 led to an increase in women's empowerment, its effect may influence the reaction to the flood of 2017. To check for this effect, we conduct a heterogeneity analysis on two subsamples of the population, i.e., inundated/not inundated individuals in 2014. The results show significant and opposite effects for the two groups for both women and men.

As shown in Tables 4 and 5, the sign of the impact of the flood of 2017 on time use is confirmed only for women who experienced the 2014 flood. Those women significantly decrease their time spent in domestic work by 100 minutes and increase their leisure by 122 minutes, while no significant effect on market work is detected. As a result, their likelihood of being time-poor decreases by 21 percentage points. In contrast, women who did not experience the flood in 2014 show the opposite reaction to the flood in 2017. They disproportionately increase their time spent in domestic work and increase their time spent in market work by 277 minutes, thus being very likely to be time-poor. Table 5 confirms the positive and significant impact on paid work, although when disentangling the effect of the flood for these two groups, it appears that only women who were flooded in 2014 are affected, becoming more likely to engage in paid activities by 20 percentage points. The effect on the WEAI is no longer significant for both groups. However, the empowering effect may be detected by disentangling the various dimensions of the WEAI (see the next section). Moreover, as shown in Canessa and Giannelli (2021), the flood may have an indirect impact on empowerment through the channel of their engagement in paid activities.

Table 11 in the Appendix shows that differences between men who have and have not experienced the

Table 4: Impact of the flood of 2017 on time use variables, heterogeneity analysis - women

	Flood 2014 = yes				Flood 2014 = no			
	(1) Domestic work	(2) Market work	(3) Leisure time	(4) Time poverty	(5) Domestic work	(6) Market work	(7) Leisure time	(8) Time poverty
Year 2018	13.47	39.77***	37.09***	0.158***	26.51*	43.14***	32.50***	0.162***
	(18.44)	(13.83)	(13.26)	(0.0384)	(15.10)	(15.36)	(12.50)	(0.0461)
Treat	**-100.1*** **	**-14.76**	**122.4*** **	**-0.213** **	**466.2*** **	**-277.1** **	**-73.77**	**0.711***
	(30.41)	**(31.89)**	**(26.47)**	**(0.0934)**	**(155.2)**	**(152.3)**	**(126.2)**	**(0.506)**
Year#July 2017	236.7**	-79.50	-185.7*	0.242	-445.7	370.6	-298.4	3.90
	(109.6)	(99.84)	(99.35)	(0.360)	(1986.2)	(1855.3)	(1583.15)	(7.44)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,152	2,908	3,152	3,152	2,202	2,091	2,202	2,202
R-squared	0.085	0.142	0.099	0.057	0.068	0.148	0.081	0.060
Number of id	1,582	1,578	1,582	1,582	1,103	1,103	1,103	1,103

Note: Clustered standard errors at the household level in parentheses.*, **, *** denote significance at the 10%, 5% and 1% levels respectively. The reported time use variables denote the minutes spent in domestic work, in market work, in leisure activities, and time poverty, defined as a dummy equal to 1 if the individual worked more than 10.5 hours in the previous day. Control variables are those reported in Section 4.1.

Table 5: Impact of the flood of 2017 on women's empowerment and employment, heterogeneity analysis - women

	Flood 2014 = yes		**Flood 2014 = no**	
	(1) Paid activities	**(2) WEAI**	**(3) Paid activities**	**(4) WEAI**
Year 2018	0.0864***	-0.0268**	0.163***	-0.0505***
	(0.030)	(0.013)	(0.033)	(0.013)
Treat	**0.204*** **	**0.0250**	**0.214**	**-0.142**
	(0.069)	**(0.029)**	**(0.377)**	**(0.132)**
Year#July 2017	-0.459*	0.003	-9.606**	0.004
	(0.244)	(0.115)	(4.761)	(1.432)
Control	Yes	Yes	Yes	Yes
Observations	3,152	3,152	2,200	2,200
R-squared	0.153	0.028	0.081	0.054
Number of id	1,582	1,582	1,102	1,102

Note: Clustered standard errors at the household level in parentheses.*, **, *** denote significance at the 10%, 5% and 1% levels respectively. The dependent variables are defined as a dummy equal to 1 if the woman reported being engaged in paid activities, and the Women's Empowerment in Agriculture Index (WEAI), as defined by Alkire et al. (2013). Control variables are those reported in Section 4.1.

flood in 2014 are less striking than for women. However, the results show that men who were inundated in 2014 increase their time spent in domestic activities by 55 minutes and decrease their time spent in market activities by 117 minutes. In contrast, for men who did not experience the flood in 2014, the results show a significant impact only in the reduction of time spent on market activities. These findings strengthen the results of Canessa and Giannelli (2021) and build on them by suggesting that the impact of the flood in 2014 on women's labour supply and empowerment persists over time and leads both spouses to react differently to the shock in 2017.

It is also interesting to note the differences in the impact of the control variable for "normal times". As previously explained, women in Bangladesh usually engage in specific activities to prepare for floods, such as collecting firewood, storing food, and securing the household. This preparation is reflected in the impact that the control variable for normal times has on the time spent in domestic work, which increases by 236 minutes for women who experienced the flood in 2014. For the other group, the effect is not significant, and in contrast, the time women spend in domestic work is reduced. The same results are valid for leisure activities: women exposed to the 2014 flood engage less in leisure activities in July 2017, while for those who were not exposed, there is no significant effect. Additionally, women who already experienced the shock reduced their time spent in market activities, while for those who did not experience the shock in 2014, their time spent in productive work increased, even if not significantly. The only similar effects are found in the probability of engaging in paid activities, which decreases for both groups.

These results suggest the presence of an adaptive capacity to climate change, which translates into a learning-by-doing adaptation strategy (Adger et al., 2003; Davidson-Hunt and Berkes, 2003). Adaptive capacity is a dynamic notion of adaptation that enhances the importance of learning about risks, exchanging information, and sharing knowledge to anticipate, forecast, and react more efficiently to future weather shocks (McGray et al., 2007; Osbahr, 2007; Tschakert and Dietrich, 2010). In this case, it seems that, after experiencing the first shock in 2014, women respond more promptly to the flood in 2017.

5.3 Impact of the flood of 2014 on women's empowerment

Table 6 shows very interesting results. As we can see when looking at the whole sample of women, the 2014 flood had a long-lasting impact on both women's empowerment and employment. In 2018, the shock increased women's probability of engaging in paid activities by 29 percentage points, and it increased their empowerment by 0.06 (the index ranges between 0 and 1). Table 11 in the Appendix shows the impact of the flood on the various dimensions of the WEAI. Floods have a positive and persistent impact on two specific indicators: input in productive decisions and control over the use of income. When looking at the other subindexes, we can see that the flood in 2014 reduced women's autonomy in productive decisions, their ownership of assets and access to credit, their membership in social groups, and their perception of leisure time. As the shock leads to an increase in women's engagement in paid activities, it is reasonable to think that the increase in control over the use of income and input in productive decisions outweighs the negative effect of the flood on the remaining WEAI indicators. This evidence

raises concerns about the use of these composite indexes to measure empowerment. Notwithstanding the usefulness of the WEAI for its adaptability to different countries, its standardization certainly has some limitations. Indeed, the index does not properly reflect collective or intrahousehold decision-making (Farnworth et al., 2018), and it fails to capture the notion that women's definition of empowerment is contextual (Richardson, 2018). When we look at Table 12 in the Appendix, we can see that the 2014 flood led women to be less satisfied with several dimensions of their lives and with their life more generally but not with the decision-making they have within the household. This is in line with the idea that by increasing their engagement in paid activities, the shock increased their control over resources, which drives the whole increase in empowerment. Following a recent paper (Seymour and Floro, 2021), we posit that this negative effect on life satisfaction is linked to social norms and women's identity. By working more in income-generating rather than domestic activities, women deviate from prevailing social norms, and this deviation leads to a reduction in their subjective well-being.[7]

As the long-term impact of the first shock may depend on the occurrence of the second shock, we also conduct the analysis for women who experienced the flood in 2017 and those who did not. We find no significant impact on empowerment for both the women who were exposed to both shocks and those who were not. However, the positive sign of the effect on the WEAI and the size of the coefficient and standard error that is very similar to that for the whole sample (Column (1)) for the group that was also affected in 2017 (Column (3)) suggests that empowerment may continue to increase. For the group that was not impacted in 2017, the level of empowerment in 2018 is not affected by the 2014 shock. For women who experienced both shocks, the likelihood of engaging in paid activities has a positive but nonsignificant sign. In contrast, for women who experienced only the 2014 shock, we observe a negative and significant effect. This result indicates that their engagement in paid activities increases in the aftermath of the 2014 shock to contribute to the increased household expenses, but it does not last over time because it is a short-term coping mechanism. For those women exposed to both shocks, their engagement in paid activities does not increase significantly, but it does not decrease either because of necessity.

Table 6: Impact of the flood of 2014 on women's empowerment in 2018

	All women		**Flood 2017 = yes**		**Flood 2017 = no**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Paid activity	**WEAI**	**Paid activity**	**WEAI**	**Paid activity**	**WEAI**
Year 2018	0.0889***	-0.0239**	0.0811**	-0.0184	0.132***	-0.0320**
	(0.0232)	(0.0105)	(0.0316)	(0.0134)	(0.0328)	(0.0142)
Treat	0.285***	0.0656*	0.107	0.0570	-3.431**	0.169
	(0.0877)	(0.0387)	(0.0917)	(0.0406)	(1.527)	(0.693)
Year#July 2014	0.0597	-0.0410	0.154	-0.0359	-21.58***	1.206
	(0.147)	(0.0619)	(0.145)	(0.0626)	(7.735)	(2.869)

[7] Unfortunately, the data do not provide any information on gender norms.

Constant	0.682***	0.613***	0.617***	0.720***	0.683***	0.404***
	(0.184)	(0.0958)	(0.237)	(0.109)	(0.245)	(0.0898)
Observations	5,352	5,352	3,271	3,271	2,081	2,081
R-squared	0.098	0.036	0.164	0.033	0.065	0.052
Number of id	2,684	2,684	1,642	1,642	1,042	1,042

Note: Clustered standard errors at the household level in parentheses.*, **, *** denote significance at the 10%, 5% and 1% levels respectively. The dependent variables are defined as a dummy equal to 1 if the woman reported being engaged in paid activities, and the Women's Empowerment in Agriculture Index (WEAI), as defined by Alkire et al. (2013). Control variables are those reported in Section 4.1.

6 Robustness checks

6.1 Attrition

We perform an attrition analysis to address the problem of potential bias due to the correlation between the occurrence of flooding and the failure to track individuals in the following wave because of the displacement of the households or changes in the composition of the family (e.g., men may have migrated to find work in urban areas or women may have become widowers.)[8] To account for attrition, we run the analysis for the balanced as well as unbalanced samples and compare the coefficient estimates (Wooldridge, 2010): as shown in Table 14 in the Appendix, the coefficients are very similar for the 2017 shock in the balanced and unbalanced samples, thus ruling out the possibility that attrition, in this case, may be selective.

When we look at the impact of the 2014 shock on women's empowerment in 2018 (Table 15), the coefficients between the balanced and unbalanced samples are similar but not the same: in the unbalanced sample, the impact of the flood is no longer significant. However, we observe no differences in the coefficients of the WEAI's subindexes between the balanced and unbalanced samples (Table 16). These results may raise concerns about a potential sample composition effect: women who experienced the 2014 flood and were interviewed only at baseline may have dropped out of the sample because they did not survive the shock (i.e., they were less empowered). To check for this concern, we look at differences in the mean empowerment at baseline between attritors and non-attritors. Table 7 shows that there are no significant differences, suggesting that the reason for dropping out from the survey was not linked to their empowerment levels.

Table 7: Mean differences in WEAI between attritors and non-attritors at baseline

	Non attritors	Mean	Attritors	Mean	Diff.	St. Err.	p value
WEAI	4010	.534	2262	.53	.004	.004	.346

[8] It is worth noticing that widows constitute 5.5 percent of the unbalanced sample and 4.3 percent of the balanced sample, and the attrition rate for widows in the sample is 2.11 percent.

6.2 Different definitions of the treatment

As a first robustness check of the results, we repeat the analysis with the treatment defined as the share of inundated areas in a radius of 2 and 10 kms around each sampled household. As shown in Tables 17 and 18 in the Appendix, results are confirmed with both buffers, suggesting that they are robust across different definitions of the treatment.

6.3 Self-reported data

As an additional robustness check, we also repeat the analysis using as a treatment variable the self-reported information of having been inundated or not in the year preceding the survey. The data provide detailed information on the shocks that the household experienced over the past 5 years. As an alternative treatment, we employ a dummy variable equal to 1 if the household reported loss of crops, livestock, productive assets, and consumption assets due to floods in the year prior to the survey of 2018. Results are shown in Tables 19 and 20 in Appendix. Women decrease their time spent in domestic work by 110 minutes, and they are 33 percentage points less likely to be time poor and 12 percentage points less likely to have any input in production decisions. In contrast, for men, there is no significant impact, even though the sign of the effect of the self-reported shock is consistent with the treatment variable derived from GIS data.

These results confirm that adopting GIS data to study the impact of weather events leads to more accurate, precise, and reliable results. Indeed, self-reported data are subject to several forms of cognitive biases, such as recall error and reference dependence (Guiteras et al., 2015). This last bias is of particular concern when studying the impact of flooding because people may set the average exposure conditions as a reference point and then consider deviations from that specific average. This can translate into different perceptions and, consequently, different reports of the magnitude of the shock between households that are frequently exposed to floods and those that are not (Guiteras et al., 2015).

6.4 Parallel trends

To check for ex-ante correlation between the treatment and the trends of our variables of interest, we follow Gröger and Zylberberg (2016) and Giannelli and Canessa (2022) by performing a balance test at baseline (i.e., 2015) to check for mean differences between treated and untreated individuals before the occurrence of the shock. Table 21 in the Appendix reveals that the treatment variable is correlated with some of the outcomes of interest. To ensure that such correlations are not driven by the flood that occurred in 2014, we repeat the analysis in 2011. As shown in Table 21, except for the time spent in leisure activities for men and the likelihood of being time poor for women, the results are not significant, suggesting that in the absence of the shock, the treatment and the control group would have followed the same path. To directly test for the presence of the parallel trend assumption, we then run a placebo test between the first two waves, those in 2011 and 2015. We replicate the benchmark strategy as if the flood hit in 2015, and we estimate the following specification:

$$Y_{ihrt} = \beta_0 + \beta_1 (T_h * t_{=2015}) + \beta_2 (P_h * t_{=2015}) + \beta_3 W_r t + \beta_4 X_{iht} + \beta_5 D_t + \beta_6 Z_{ht} + \alpha_i + \varepsilon_{ihrt}$$

The results are reported in Table 8. For women, the hypothesis of parallel trends seems to be confirmed except for one outcome variable, i.e., the probability of engaging in market work. Since this variable is likely to reflect the persistent impact of the flood in 2014, we add as a control variable the share of inundated areas in 2014. The results show that the impact of the treatment on the outcome is no longer significant. For men, the hypothesis of ex ante correlations between the outcomes of interest and the treatment seems to be insignificant except for two variables, i.e., the time spent in domestic work and the probability of being time poor. As before, to check whether such results are also driven by the impact of the flood that occurred in 2014, we add as a control variable the share of inundated areas in 2014. While the impact of the flood in 2017 on the time spent in domestic work is no longer significant, it is still significant for the variable capturing time poverty.

Table 8: Placebo test with the first two waves on the impact of the flood in 2015

		Women	**Men**
		Year 2015#Flood 2017	**Year 2015#Flood 2017**
(1)	Minutes spent on domestic work	14.38	-115.7***
		(30.36)	(39.73)
(2)	Minutes spent on work	44.89	21.71
		(27.89)	(66.67)
(3)	Leisure time	-22.60	40.35
		(17.72)	(41.26)
(4)	Time poverty	0.0954	-0.297**
		(0.0980)	(0.121)
(5)	WEAI	0.0170	
		(0.041)	
(6)	Paid activities	-0.217**	-
		(0.0844)	
Control for flooding in 2014			
(7)	Paid activities	0.121	
		(0.144)	
(8)	Domestic work		-28.25
			(55.77)
(9)	Time poverty		-0.427**
			(0.175)

Number of observations	4,944	4,335
Number of id	2,678	2,676

Note: Clustered standard errors at the household level in parentheses.*, **, *** denote significance at the 10%, 5% and 1% levels respectively. The reported dependent variables are the minutes spent in domestic work, in market work, in leisure activities, and time poverty, defined as a dummy equal to 1 if the individual worked more than 10.5 hours in the previous day; the Women's Empowerment in Agriculture Index, as measured in Alkire et al. (2013), and a dummy equal to 1 if the woman reported being engaged in paid activities. Control variables are those reported in Section 4.1.

7 Discussion and policy implications

Social and cultural norms highly influence time use differences between men and women. In low- and middle-income countries, while men usually engage in productive activities, women are in charge of reproductive work, which includes domestic activities such as cleaning, cooking, and caring for children and agricultural work in household farming. Climate change and extreme weather events risk increasing this disparity in time allocation in both the short and long term. While shocks such as droughts lead women to spend more time in activities such as fetching water or collecting firewood, in the aftermath of flooding, women risk finding themselves overloaded by their engagement in both market and reproductive activities. Although a large body of literature has focused on time use patterns in such contexts, gender-specific responses to weather shocks in time allocation have not yet received much attention.

This study assesses the impact of a dramatic flood that hit Bangladesh in 2017 on the time allocation of women and men and on women's empowerment. As the data allow for including another dramatic flood that occurred in 2014, we also analyse the heterogeneous impact of the flood in 2017, distinguishing between individuals who had been previously inundated and those who had not. Building on a recent paper showing that the flood in 2014 led to an increase in women's empowerment in the aftermath of the shock, we also examine whether this increase persists over time in the medium-long term. The use of GIS satellite data and panel data allows for the identification of the impact of the flood while controlling for unobserved time-invariant characteristics.

One of the strengths of this study is the use of georeferenced data, which is employed to construct both the treatment and control variables. As shown in the robustness checks, GIS data provide more robust and reliable results than self-reported data, which are usually prone to cognitive biases such as recall bias. In addition, the results seem to hold using an additional definition of the treatment variable. Finally, the use of the first and second waves as a placebo test confirms that the parallel trend assumption holds for this analysis.

The results of the difference-in-difference estimation suggest that after the shock, women's time allocation shifts towards market and leisure activities, while their time spent in domestic work decreases. On the other hand, men seem to engage less in market activities while substituting for women in housework

activities, their leisure decreases, and they become more time-poor. These results are in line with the cross-sectional analysis by Anderson and Eswaran (2009), according to which women's autonomy in Bangladesh increases as their engagement in paid activities outside the household does and men start contributing more to domestic work. The heterogeneity analysis sheds light on the mechanisms underlying such changes in time allocation. The results show that individuals exposed to the 2014 flood react differently from those that were not, suggesting the existence of an adaptive capacity to climate change. Indeed, it seems that individuals adopted a "learning-by-doing" mechanism that in the long term can help them reduce the damages of natural shocks and extreme weather events.

The 2014 shock leads to an increase in women's empowerment, regardless of exposure to the 2017 flood. However, when we examine WEAI's subindexes more closely, we find that the increase in empowerment is driven mainly by two indicators strictly related to the economic sphere, while all other indicators decrease significantly or do not increase. When we look at women's satisfaction with their lives, we find that exposure to the 2014 flood significantly decreases women's subjective well-being. An increase in empowerment, then, does not necessarily translate to an increase in well-being. As suggested by other studies (Farnworth et al., 2018; Richardson, 2018; Addison et al., 2021), this finding suggests that using composite, international indexes to measure empowerment may be tricky because they do not consider that women may view empowerment differently based on the social context in which they live. Rural women in Bangladesh are subject to a number of severe limitations. However, when they identify themselves with the roles imposed on them by patriarchal society, a deviation from such roles can lead to a reduction in their utility that translates into a reduction in their subjective well-being (Seymour and Floro, 2021; Kabeer et al., 2021). This is what we observe in our study: even though women engage more in paid activities and their empowerment increases, they do not seem to feel more satisfied with their lives.

From a policy perspective, the findings of this study could have important implications from different points of view. First, this study shows that women's and men's time use patterns react differently to weather shocks and are influenced by two factors: women's level of empowerment and individuals' adaptive capacity to climate change. Both of these factors are important targets for the attainment of the Sustainable Development Goals (SDGs), especially SGD 5 (i.e., "Achieve gender equality and empower all women and girls") and SGD 13 (i.e., "Take urgent action to combat climate change and its impact").[9] As already stated, women are more vulnerable than men to natural shocks because they lack access to and control over financial resources and extension services and because of the gender norms limiting their spheres of activity (Jost et al., 2016) Gender-specific development interventions should be designed to increase women's ability to cope with shocks and enhance their adaptive capacity.

Adaptive capacity, as considered in its dynamic perspective, could be boosted by skills development programs and farmer-to-farmer extension services(Jost et al., 2016). Importantly, such programs should target both spouses, or at least a male and a female member of the household, to overcome women's mobility restrictions that are linked to the practice of purdah and to increase their participation in such

[9] https://sdgs.un.org/goals

programs. Another important element to consider is information: improving women's access to weather and climate information, particularly seasonal weather forecasts (Diouf et al., 2020), could significantly improve their flood preparedness. In rural Bangladesh, information is primarily accessed via radio, but access via television could significantly improve understanding of the information itself (Jost et al., 2016).

Microcredit could be an effective instrument for enhancing women's access to resources to cope with natural shocks (Attanasio et al., 2014; Akhter and Cheng, 2020). These microcredit programs can shape local social norms and power dynamics between spouses, leading to an increase in women's decision-making within the household (Field et al., 2021). Group-based lending has been proven to have long-lasting positive effects on female decision-making within the household (Holvoet, 2005). Aside from increasing access to financial resources and savings, group-based lending could boost women's confidence and awareness of their rights (Holvoet, 2005), resulting in an increase in the acceptability of women working, thus increasing their engagement in paid activities while at the same time limiting the observed negative effects on their subjective well-being.

Last, women's empowerment has been the target of gender-driven policies and programs in many low- and middle-income countries. This study provides important results for such programs, as it shows that even if increased economic autonomy leads to a change in women's empowerment that persists over time, it does not lead to an increase in their subjective well-being but, rather, to a reduction. This has important implications for the use of such indexes to measure empowerment and to inform policy-makers on the policies to be adopted. Empowerment is a broad concept that needs to be contextualized every time it is used: it is indeed of fundamental importance to understand what women intend for empowerment before jumping to any conclusion that may lead to unintended negative effects on women's empowerment itself.

References

Addison, L., Schnurr, M. A., Gore, C., Bawa, S., and Mujabi-Mujuzi, S. (2021). Women's empowerment in africa: Critical reflections on the abbreviated women's empowerment in agriculture index (a-weai). *African Studies Review*, 64(2):276–291. 22

Adger, W. N., Huq, S., Brown, K., Conway, D., and Hulme, M. (2003). Adaptation to climate change in the developing world. *Progress in Development Studies*, 3(3):179–195. Publisher: SAGE Publications India. 16

Akhter, J. and Cheng, K. (2020). Sustainable empowerment initiatives among rural women through microcredit borrowings in bangladesh. *Sustainability*, 12(6):2275. 23

Alkire, S., Meinzen-Dick, R., Peterman, A., Quisumbing, A., Seymour, G., and Vaz, A. (2013). The Women's Empowerment in Agriculture Index. *World Development*, 52:71–91. 9, 10, 11, 14, 15, 18, 21, 33, 34, 35, 36, 37, 38, 39

Anderson, S. and Eswaran, M. (2009). What determines female autonomy? Evidence from Bangladesh. *Journal of Development Economics*, 90(2):179–191. 13, 22

Anxo, D., Mencarini, L., Pailhé, A., Solaz, A., Tanturri, M. L., and Flood, L. (2011). Gender Differences in Time Use over the Life Course in France, Italy, Sweden, and the US. *Feminist Economics*, 17(3):159–195. 3

Arthi, V., Beegle, K., De Weerdt, J., and Palacios-Lopez, A. (2016). *Not your average job: Measuring farm labor in Tanzania*. The World Bank. 12

Attanasio, O., Augsburg, B., De Haas, R., Fitzsimons, E., and Harmgart, H. (2014). Group lending or individual lending? evidence from a randomised field experiment in mongolia. Technical report, WZB Discussion Paper. 23

Bardasi, E. and Wodon, Q. (2006). Measuring Time Poverty and Analyzing Its Determinants: Concepts and Application to Guinea. page 22. 10

Bradshaw, S. and Fordham, M. (2013). Women and girls in disasters. 3

Cain, M., Khanam, S. R., and Nahar, S. (1979). Class, Patriarchy, and Women's Work in Bangladesh. *Population and Development Review*, 5(3):405. 5, 6

Callaway, B. and Sant'Anna, P. H. (2021). Difference-in-differences with multiple time periods. *Journal of Econometrics*, 225(2):200–230. 4, 12

Canessa, E. and Giannelli, G. C. (2021). Women's Employment and Natural Shocks. page 55. 3, 5, 8, 11, 14, 16

Cannon, T. (2002). Gender and Climate Hazards in Bangladesh. *Gender and Development*, 10(2):45–50. Publisher: [Taylor & Francis, Ltd., Oxfam GB]. 6

Davidson-Hunt, I. and Berkes, F. (2003). Learning as You Journey: Anishinaabe Perception of Social-ecological Environments and Adaptive Learning. *Conservation Ecology*, 8(1). Publisher: Resilience Alliance Inc. 16

De Chaisemartin, C. and d'Haultfoeuille, X. (2020). Two-way fixed effects estimators with heterogeneous treatment effects. *American Economic Review*, 110(9):2964–96. 4, 12

Dean, L., Churchill, B., and Ruppanner, L. (2022). The mental load: building a deeper theoretical understanding of how cognitive and emotional labor over load women and mothers. *Community, Work & Family*, 25(1):13–29. 3

Diouf, N. S., Ouedraogo, M., Ouedraogo, I., Ablouka, G., and Zougmoré, R. (2020). Using seasonal forecast as an adaptation strategy: Gender differential impact on yield and income in senegal. *Atmosphere*, 11(10). 23

Farnworth, C. R., Stirling, C. M., Chinyophiro, A., Namakhoma, A., and Morahan, R. (2018). Exploring the potential of household methodologies to strengthen gender equality and improve smallholder livelihoods: Research in malawi in maize-based systems. *Journal of Arid Environments*, 149:53–61. 17, 22

Ferrant, G., Pesando, L. M., and Nowacka, K. (2014). Unpaid Care Work: The missing link in the analysis of gender gaps in labour outcomes. page 12. 3

Field, E., Pande, R., Rigol, N., Schaner, S., and Troyer Moore, C. (2021). On her own account: How strengthening women's financial control impacts labor supply and gender norms. *American Economic Review*, 111(7):2342–2375. 23

Floro, M. S. and King, E. M. (2016). The present and future of time-use analysis in developing countries. *Asia-Pacific Population Journal*, 31(1):5–42. 5

Garg, T., Gibson, M., and Sun, F. (2020). Extreme temperatures and time use in China. *Journal of Economic Behavior & Organization*, 180:309–324. 3

Giannelli, G. C. and Canessa, E. (2022). After the flood: Migration and remittances as coping strategies of rural bangladeshi households. *Economic Development and Cultural Change*, 70(3):1159–1195. 3, 7, 11, 19

Goodman-Bacon, A. (2021). Difference-in-differences with variation in treatment timing. *Journal of Econometrics*, 225(2):254–277. 4, 12

Gröger, A. and Zylberberg, Y. (2016). Internal labor migration as a shock coping strategy: Evidence from a typhoon. *American Economic Journal: Applied Economics*, 8(2):123–53. 3, 11, 19

Guiteras, R., Jina, A., and Mobarak, A. M. (2015). Satellites, Self-reports, and Submersion: Exposure to Floods in Bangladesh. *The American Economic Review*, 105(5):232–236. Publisher: American Economic Association. 5, 19

Halliday, T. J. (2012). Intra-household labor supply, migration, and subsistence constraints in a risky environment Evidence from rural El salvador. *European Economic Review*, page 19. 3

Heintz, J., Kabeer, N., and Mahmud, S. (2018). Cultural norms, economic incentives and women's labour market behaviour: empirical insights from Bangladesh. *Oxford Development Studies*, 46(2):266–289. 6

Holvoet, N. (2005). The impact of microfinance on decision-making agency: evidence from south india. *Development and change*, 36(1):75–102. 23

Islam, M. R., Ingham, V., Hicks, J., and Manock, I. (2017). The Changing Role of Women in Resilience, Recovery and Economic Development at the Intersection of Recurrent Disaster: A Case Study from Sirajgang, Bangladesh. *Journal of Asian and African Studies*, 52(1):50–67. 6

Jost, C., Kyazze, F., Naab, J., Neelormi, S., Kinyangi, J., Zougmore, R., Aggarwal, P., Bhatta, G., Chaudhury, M., Tapio-Bistrom, M.-L., et al. (2016). Understanding gender dimensions of agriculture

and climate change in smallholder farming communities. *Climate and Development*, 8(2):133–144. 3, 22, 23

Kabeer, N. (1988). Subordination and struggle: Women in bangladesh. *New left review*, 168(1):95–121. 6

Kabeer, N. (2020). Women's empowerment and economic development: A feminist critique of storytelling practices in "randomista" economics. *Feminist Economics*, 26(2):1–26. 5

Kabeer, N., Huq, L., and Rahaman, M. M. (2021). Material barriers, cultural boundaries: A mixed-methods analysis of gender and labour market segmentation in bangladesh. Technical report, WIDER Working Paper. 6, 22

Kamei, A. (2019). Who is Walking More for Water? Climate-Shock on Women's/Children's Domestic Work Using Ugandan Panel Time-Use. *Climate-Shock on Women's/Children's Domestic Work Using Ugandan Panel Time-Use*, (July 2019):63. 3

Khandker, S. R. (1988). Determinants of Women's Time Allocation in Rural Bangladesh. *Economic Development and Cultural Change*, 37(1):111–126. 7

Khandker, S. R. (2007). Coping with flood: role of institutions in Bangladesh. *Agricultural Economics*, 36(2):169–180. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1574-0862.2007.00196.x. 7

Lee, Y., Haile, B., Seymour, G., and Azzarri, C. (2021). The heat never bothered me anyway: Gender-specific response of agricultural labor to climatic shocks in Tanzania. *Applied Economic Perspectives and Policy*, n/a(n/a). _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/aepp.13153. 3

Mahmud, S., Shah, N. M., and Becker, S. (2012). Measurement of women's empowerment in rural bangladesh. *World development*, 40(3):610–619. 5

McGray, H., Hammill, A., Bradley, R., Schipper, L., and Parry, J.-E. (2007). *Weathering the storm: options for framing adaptation and development*. OCLC: 952202181. 16

Moreno, J. and Shaw, D. (2018). Women's empowerment following disaster: a longitudinal study of social change. *Natural hazards*, 92(1):205–224. 3

O'Hara, C. and Clement, F. (2018). Power as agency: A critical reflection on the measurement of women's empowerment in the development sector. *World Development*, 106:111–123. 5

Osbahr, H. (2007). Building resilience: adaptation mechanisms and. page 38. 16

Rao, N., Lawson, E. T., Raditloaneng, W. N., Solomon, D., and Angula, M. N. (2019). Gendered vulnerabilities to climate change: insights from the semi-arid regions of africa and asia. *Climate and Development*, 11(1):14–26. 3

Richardson, R. A. (2018). Measuring women's empowerment: A critical review of current practices and recommendations for researchers. *Social Indicators Research*, 137(2):539–557. 17, 22

Seymour, G. and Floro, M. S. (2021). Signs of change: evidence on women's time use, identity, and subjective well-being in rural bangladesh. *Journal of Gender, Agriculture and Food Security*, 6(01):1–17. 17, 22

Seymour, G., Malapit, H., and Quisumbing, A. (2020). Measuring Time Use in Developing Country Agriculture: Evidence from Bangladesh and Uganda. *Feminist Economics*, 26(3):169–199. 9

Solotaroff (2019). *Voices to Choices: Bangladesh's Journey in Women's Economic Empowerment*. The World Bank Group. OCLC: 1117903096. 3, 5, 6

Thomas, H. T. (2004). Bangladesh: Gender, Poverty and the MDGs. *Bangladesh Resident Mission and Regional and Sustainable Development Department*, Asian Development Bank:67. 6

Tschakert, P. and Dietrich, K. A. (2010). Anticipatory Learning for Climate Change Adaptation and Resilience. *Ecology and Society*, 15(2). Publisher: Resilience Alliance Inc. 16

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data*. MIT press. 18

Zylberberg, Y., Nyqvist, M. B., Duflo, E., and Friebel, G. (2015). *Internal Labor Migration as a Shock Coping Strategy: Evidence from a Typhoon*. 7, 8

A List of figures

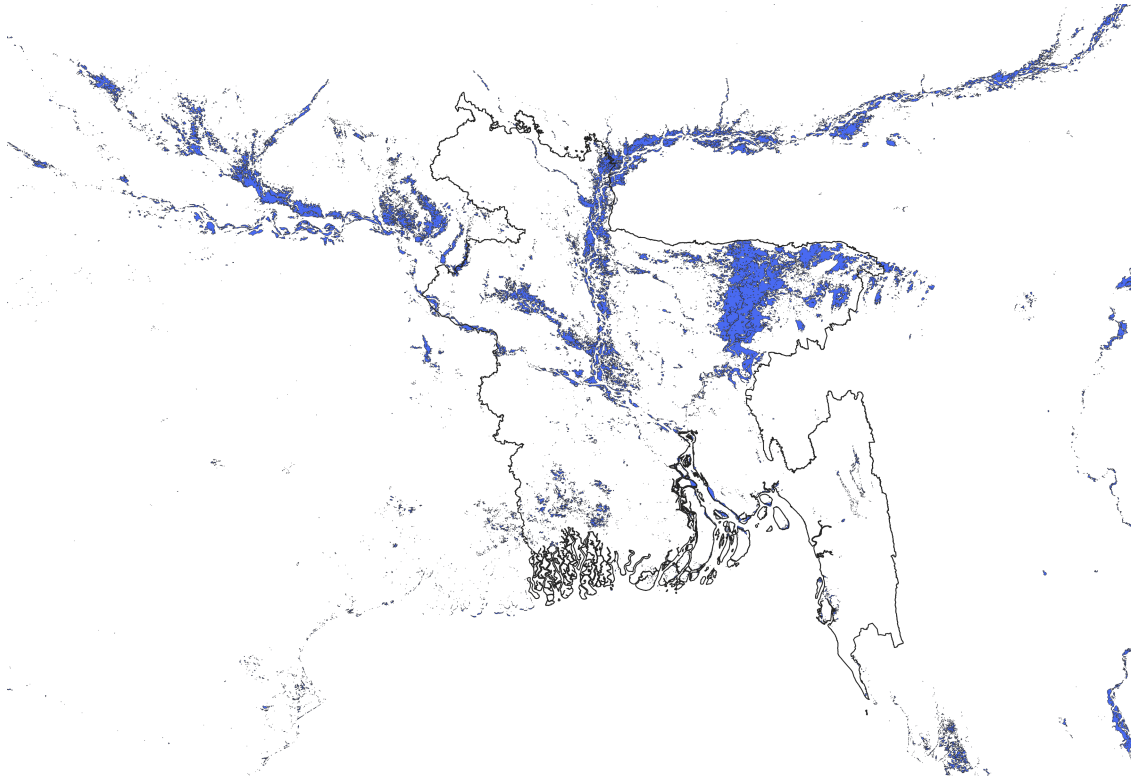

Figure 2: Incidence of the flood, 16-29 August 2017

B Additional tables

Table 9: Two-way fixed effects weights

	Flood 2017
Share of negative weights	0.0167
Share of sum of negative weights	0.0434

Table 10: impact of the flood of 2017 on time use variables, heterogeneity analysis - men

	Flood 2014 = yes				Flood 2014 = no			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Domestic work	Market work	Leisure time	Time poverty	Domestic work	Market work	Leisure time	Time poverty
Year 2018	23.45***	-9.600	40.72***	0.0809**	5.624	3.562	29.25*	0.0493
	-8.881	(20.02)	(13.27)	(0.0383)	-8.423	(20.55)	(17.06)	(0.0512)
Treat	**52.12****	**-106.2****	**2.566**	**0.00393**	**80.39**	**-461.9*****	**12.77**	**-0.430**
	(23.21)	**(43.40)**	**(29.30)**	**(0.0923)**	**(71.14)**	**(167.2)**	**(132.8)**	**(0.479)**
2018 Year#July 2017	25.35	-183.5	-86.41	1.209***	-979.2	524.95	-128.26	3.13
	(76.39)	(149.8)	(110.4)	(0.404)	(843.4)	(2028.3)	(1705.8)	(5.567)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,152	3,085	3,152	3,152	2,202	2,156	2,202	2,202
R-squared	0.062	0.031	0.030	0.038	0.040	0.019	0.051	0.023
Number of id	1,582	1,582	1,582	1,582	1,103	1,103	1,103	1,103

Note: Clustered standard errors at the household level in parentheses.*, **, *** denote significance at the 10%, 5% and 1% levels respectively. The reported time use variables denote the minutes spent in domestic work, in market work, in leisure activities and time poverty, defined as a dummy equals to 1 if the individual worked more than 10.5 hours in the previous day. Control variables are those reported in Section 4.1.

Table 11: Impact of the flood of 2014 on WEAI's sub-indexes in 2018

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Input	RAI	Asset own	Asset sale	Credit	Control	Group	Speak	Time poverty	Leisure
Year (2018)	-0.0313*	-0.0351	0.00199	0.0371	0.0513*	-0.0114	0.329***	-0.0435	0.0414	0.00678
	(0.0171)	(0.0336)	(0.00219)	(0.0338)	(0.0305)	(0.0215)	(0.0339)	(0.0396)	(0.0295)	(0.0244)
Treat	**0.062****	**-0.509*****	**0.022**	**-0.387*****	**-0.176***	**0.189*****	**-0.0516**	**-0.337*****	**-0.0619**	**-0.245****
	(0.0244)	**(0.109)**	**(0.013)**	**(0.119)**	**(0.095)**	**(0.054)**	**(0.108)**	**(0.120)**	**(0.134)**	**(0.102)**
Year#July 2014	-0.117**	0.236	0.033	0.196	0.215	-0.199**	-0.160	0.094	-0.060	0.571***
	(0.047)	(0.177)	(0.023)	(0.200)	(0.165)	(0.094)	(0.186)	(0.195)	(0.214)	(0.167)
Control	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,352	5,352	5,352	5,352	5,351	5,352	5,352	5,352	5,352	5,352
R-squared	0.035	0.059	0.030	0.052	0.012	0.035	0.321	0.079	0.034	0.096
Number of id	2,684	2,684	2,684	2,684	2,684	2,684	2,684	2,684	2,684	2,684

Note: Clustered standard errors at the household level in parentheses.*, **, *** denote significance at the 10%, 5% and 1% levels respectively. The reported variables are the WEAI's subindexes, notably: input in productive decisions, autonomy in production, ownership of assets; purchase, sale, or transfer of assets; access to and decisions about credit; control over use of income; group membership; speaking in public; workload; and leisure. Control variables are those reported in Section 4.1.

Table 12: Impact of the flood of 2014 on life satisfaction

	(1) Distribution of duties within hh	(2) Mobility	(3) Power to make decision	(4) Contacts with friends	(5) Overall life
Year 2018	-0.0550***	-0.0516*	0.00916	-0.0576**	-0.0808***
	(0.0204)	(0.0285)	(0.0342)	(0.0238)	(0.0219)
Treat	**-0.118***	**-0.216****	**-0.132**	**-0.340*****	**-0.239*****
	(0.0633)	**(0.106)**	**(0.0877)**	**(0.0903)**	**(0.0758)**
July 2014#Year	0.177*	0.483***	0.276*	0.517***	0.469***
	(0.0963)	(0.169)	(0.151)	(0.160)	(0.123)
Year#	-0.00331	-0.0539**	0.0650***	-0.0320	0.0460***
	(0.0183)	(0.0274)	(0.0236)	(0.0235)	(0.0172)
Constant	0.420**	0.242	1.094***	0.441**	0.386*
	(0.193)	(0.221)	(0.371)	(0.195)	(0.197)
Control	Yes	Yes	Yes	Yes	Yes
Observations	5,352	5,352	5,352	5,352	5,352
R-squared	0.026	0.034	0.049	0.039	0.045
Number of id	2,684	2,684	2,684	2,684	2,684

Note: Clustered standard errors at the household level at the household level in parentheses.*, **, *** denote significance at the 10%, 5% and 1% levels respectively. The reported variables are dummy variables denoting women's satisfaction with the distribution of duties within the household, with their mobility, with their power to make decisions, with their friends, and with their life. Control variables are those reported in Section 4.1.

Table 13: Impact of the flood in 2014 on time use variables in 2018

	Women				**Men**			
	(1) Domestic Work	(2) Market Work	(3) Leisure	(4) Time Poverty	(5) Domestic Work	(6) Market Work	(7) Leisure	(8) Time Poverty
Year 2018	1.912	10.26	40.42***	0.0338	-4.652	-15.89	35.27***	-0.00615
	(14.01)	(10.22)	(9.463)	(0.0296)	(7.124)	(15.21)	(11.63)	(0.0320)
2018#Flood 2014	**-18.88**	**-35.97**	**-16.89**	**-0.0617**	**62.44****	**-28.55**	**-75.00****	**0.0335**
	(40.88)	**(35.73)**	**(31.63)**	**(0.133)**	**(28.55)**	**(49.32)**	**(37.70)**	**(0.126)**
2018#July 2014	-28.99	-5.657	145.6***	-0.0659	20.18	-143.4*	100.8*	-0.156
	(68.38)	(54.25)	(54.25)	(0.213)	(52.22)	(84.19)	(56.54)	(0.205)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,352	4,997	5,352	5,352	5,352	5,240	5,352	5,352
R-squared	0.061	0.077	0.089	0.033	0.019	0.017	0.034	0.008
Number of id	2,684	2,680	2,684	2,684	2,684	2,684	2,684	2,684

Note: Clustered standard errors at the household level in parentheses.*, **, *** denote significance at the 10%, 5% and 1% levels respectively. The reported dependent variables denote the minutes spent in domestic work, in market work, in leisure activities and time poverty, defined as a dummy equals to 1 if the individual worked more than 10.5 hours in the previous day.Control variables are those reported in Section 4.1. Missing observations for the variable "Market Work" are for those individuals that reported not being employed in any work activities the day before the interview.

Table 14: impact of the flood of 2017 on time use variables, unbalanced sample (attrition)

	Women				Men			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Domestic work	Market work	Leisure time	Time poverty	Domestic work	Market work	Leisure time	Time poverty
Year 2018	-3.380	10.79	48.18***	0.0346	-6.977	-11.68	37.79***	0.00653
	(9.545)	(8.798)	(8.002)	(0.0266)	(6.191)	(12.68)	(9.977)	(0.0295)
Treat	**-59.28****	**-19.81**	**108.8*****	**-0.0770**	**72.01*****	**-61.76***	**-19.96**	**0.105**
	(24.88)	**(25.71)**	**(21.14)**	**(0.0791)**	**(19.20)**	**(35.32)**	**(23.92)**	**(0.0795)**
July 2017	264.4***	-19.39	-242.2***	0.557*	-20.61	-62.42	-104.5	-0.697*
	(96.85)	(91.78)	(85.22)	(0.316)	(79.79)	(144.9)	(102.7)	(0.379)
Constant	246.9***	104.3**	294.1***	-0.163	-34.70	488.0***	237.6***	0.531***
	(59.52)	(46.93)	(54.52)	(0.153)	(46.66)	(91.07)	(74.63)	(0.198)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,835	7,317	7,835	7,835	7,614	7,468	7,614	7,614
R-squared	0.063	0.074	0.089	0.031	0.016	0.014	0.031	0.008
Number of id	4,872	4,767	4,872	4,872	4,716	4,696	4,716	4,716

Note: Clustered standard errors at the household level in parentheses.*, **, *** denote significance at the 10%, 5% and 1% levels respectively. The reported dependent variables denote the minutes spent in domestic work, in market work, in leisure activities and time poverty, defined as a dummy equal to 1 if the individual worked more than 10.5 hours in the previous day. Control variables are those reported in Section 4.1.

Table 15: impact of flood 2014 on WEAI, unbalanced sample

	(1)	(2)
	WEAI	Paid activity
Year 2018	-0.035***	0.0799***
	(0.008)	(0.0218)
Treat	0.0432	0.218***
	(0.0344)	(0.080)
July	-0.0150	0.0788
	(0.0555)	(0.138)
Constant	0.544***	0.499***
	(0.0551)	(0.136)
Control	Yes	Yes
Observations	7,835	7,835
R-squared	0.039	0.099
Number of id	4,872	4,872

Note: Clustered standard errors at the household level in parentheses.*, **, *** denote significance at the 10%, 5% and 1% levels respectively. The reported dependent variables are the Women's Empowerment in Agriculture Index, as defined in Alkire et al. (2013), and a dummy equal to 1 if the woman reported being engaged in a paid activity. Control variables are those reported in Section 4.1.

Table 16: Impact of the flood of 2014 on WEAI's sub-indexes in 2018, unbalanced sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Input	RAI	Asset own	Asset sale	Credit	Control	Group	Speak	Time poverty	Leisure
Year 2018	-0.00592	-0.0637**	0.0122	-0.00355	0.0224	0.0212	0.326***	-0.0269	0.0363	-0.00715
	(0.00970)	(0.0281)	(0.0264)	(0.00440)	(0.0235)	(0.0152)	(0.0268)	(0.0286)	(0.0267)	(0.0237)
Treat 2014	0.0494**	-0.464***	-0.401***	0.0142	-0.194**	0.155***	-0.142	-0.390***	-0.00237	-0.323***
	(0.0216)	(0.0977)	(0.105)	(0.0117)	(0.0886)	(0.0486)	(0.103)	(0.111)	(0.115)	(0.0926)
July 2014	-0.0883**	0.209	0.278	0.0560*	0.262*	-0.174*	0.0460	0.261	-0.112	0.655***
	(0.0411)	(0.162)	(0.179)	(0.0293)	(0.151)	(0.0894)	(0.175)	(0.183)	(0.187)	(0.152)
Constant	0.989***	0.00654	0.109	0.941***	0.381**	0.590***	-0.0545	0.434**	-0.162	0.794***
	(0.0681)	(0.172)	(0.171)	(0.0330)	(0.154)	(0.0913)	(0.182)	(0.177)	(0.154)	(0.136)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,835	7,835	7,835	7,835	7,831	7,835	7,835	7,835	7,835	7,835
R-squared	0.023	0.057	0.054	0.035	0.015	0.035	0.312	0.072	0.031	0.091
Number of id	4,872	4,872	4,872	4,872	4,870	4,872	4,872	4,872	4,872	4,872

Note: Clustered standard errors at the household level at the household level in parentheses.*, **, *** denote significance at the 10%, 5% and 1% levels respectively. The reported variables are, respectively, the following WEAI's subindexes: input in productive decision; autonomy in decisions; ownership of assets; purchase, sale, or transfer of assets; access to and decisions on credit; control over use of income; group membership; speaking in public; workload; and leisure. All these variables have been constructed following Alkire et al. (2013). Control variables are those reported in Section 4.1.

Table 17: robustness check - buffer of 10 kms around each sampled household

	Women	**Men**
	2018#flood 2017_10km	**2018#flood 2017_10km**
(1) Domestic work	-64.07**	75.91***
	(30.10)	(21.29)
(2) Market work	-35.58	-75.78*
	(31.89)	(41.55)
(3) Leisure	97.21***	-19.64
	(0.0917)	(28.84)
(4) Time poverty	-0.189**	0.154*
	(0.0655)	(0.0921)
(5) WEAI	0.031	-
	(0.028)	
(6) Paid activity	0.442***	-
	(0.0454)	
Observations	5,354	5,353
Number of id	2,685	2,685

Note: Clustered standard errors at the household in parentheses.*, **, *** denote significance at the 10%, 5% and 1% levels respectively. The reported dependent variables denote the minutes spent in domestic work, in market work, in leisure activities, and time poverty, defined as a dummy equals to 1 if the individual worked more than 10.5 hours in the previous day, the Women's Empowerment in Agriculture Index (WEAI), as defined by Alkire et al. (2013), and women's likelihood of being employed in paid activities, defined as a dummy equal to 1 if the woman reported being engaged in paid activities. Control variables are those reported in Section 4.1.

Table 18: robustness check - buffer of 10 kms around each sampled household

	Women	**Men**
	2018#flood 2017_2km	**2018#flood 2017_2km**
(1) Domestic work	-34.91*	65.98***
	(24.10)	(17.48)
(2) Market work	-29.32*	-60.60*
	(22.56)	(33.64)
(3) Leisure	73.22***	-37.61*
	(20.80)	(22.24)
(4) Time poverty	-0.0803	0.0725
	(0.0748)	(0.0752)
(5) WEAI	0.034*	-
	(0.023)	
(6) Paid activity	0.388***	-
	(0.0548)	
Observations	5,354	5,354
Number of id	2,685	2,685

Note: Clustered standard errors at the household in parentheses.*, **, *** denote significance at the 10%, 5% and 1% levels respectively. The reported dependent variables denote the minutes spent in domestic work, in market work, in leisure activities and time poverty, defined as a dummy equals to 1 if the individual worked more than 10.5 hours in the previous day, the Women's Empowerment in Agriculture Index (WEAI), as defined by Alkire et al. (2013), and women's likelihood of being employed in paid activities, defined as a dummy equals to 1 if the woman reported being engaged in paid activities. Control variables are those reported in Section 4.1.

Table 19: robustness checks - impact of self-reported shock on outcome variables, women

	(1) Domestic work	(2) Market work	(3) Leisure time	(4) Time poverty	(5) Paid activities	(6) WEAI
year=2018	13.08	64.60*	24.69	0.113*	0.241***	0.0687**
	(20.71)	(35.29)	(16.17)	(0.0648)	(0.0419)	(0.0306)
year#flood	**-110.8****	**-9.715**	**62.11**	**-0.333****	**-0.0683**	**-0.001**
	(48.41)	**(51.87)**	**(42.18)**	**(0.157)**	**(0.0959)**	**(0.051)**
year#july 2017	145.8	-59.44	-121.5	0.124	-0.134	-0.0523
	(116.1)	(109.6)	(113.0)	(0.376)	(0.213)	(0.0915)
Control	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,257	2,902	3,257	3,257	3,257	3,257
R-squared	0.073	0.163	0.113	0.107	0.124	0.038
Number of id	2,68	2,394	2,68	2,68	2,68	2,68

Note: Clustered standard errors at the household in parentheses.*, **, *** denote significance at the 10%, 5% and 1% levels respectively. The reported dependent variables denote the minutes spent in domestic work, in market work, in leisure activities, and time poverty, defined as a dummy equals to 1 if the individual worked more than 10.5 hours in the previous day, the Women's Empowerment in Agriculture Index (WEAI), as defined by Alkire et al. (2013), and women's likelihood of being employed in paid activities, defined as a dummy equals to 1 if the woman reported being engaged in paid activities. Control variables are those reported in Section 4.1.

Table 20: Robustness checks - impact of self-reported shock on outcome variables, men

	(1) Domestic work	(2) Market work	(3) Leisure time	(4) Time poverty	(5)	(6)
Year = 2018	20.41*	26.80	-0.185	0.131*		
	(12.07)	(25.53)	(19.68)	(0.0679)		
Year#flood	**65.46**	**13.04**	**-23.80**	**-0.0737**		
	(40.65)	**(68.47)**	**(42.34)**	**(0.165)**		
Year#july 2017	191.9**	-383.1**	-62.48	-1.053**		
	(95.91)	(171.6)	(136.5)	(0.503)		
Control	Yes	Yes	Yes	Yes		
Observations	3,257	3,144	3,257	3,257		
R-squared	0.062	0.048	0.053	0.074		
Number of id	2,68	2,587	2,68	2,68		

Note: Clustered standard errors at the household level in parentheses.*, **, *** denote significance at the 10%, 5% and 1% levels respectively. The reported dependent variables denote the minutes spent in domestic work, in market work, in leisure activities and time poverty, defined as a dummy equals to 1 if the individual worked more than 10.5 hours in the previous day, the Women's Empowerment in Agriculture Index (WEAI), as defined by Alkire et al. (2013), and women's likelihood of being employed in paid activities, defined as a dummy equals to 1 if the woman reported being engaged in paid activities. Control variables are those reported in Section 4.1.

Table 21: balance test at baseline, 2011 and 2015

		OLS at baseline = 2011	**OLS at baseline = 2015**
		Flood 2017	Flood 2017
Women			
(1)	Domestic work	29.96	-22.00
		(34.83)	(36.75)
(2)	Market work	4.904	-15.92
		(27.25)	(21.79)
(3)	Leisure time	5.080	22.49
		(18.82)	(55.46)
(4)	Time poverty	0.237**	-0.242**
		(0.110)	(0.104)
(5)	Paid activities	-.0521	-.0535
		(0.119)	(0.095)
(6)	WEAI	0.052*	
		(0.033)	
	Number of observations	2,277	2,674
Men			
(7)	Domestic work	19.17	-22.00
		(53.73)	(36.75)
(8)	Market work	50.54	-33.12
		(68.74)	(33.88)
(9)	Leisure time	-72.12**	-92.21***
		(35.07)	(29.12)
(10)	Time poverty	0.0926	-0.153
		(0.150)	(0.111)
	Number of observations	1,661	2,674

Note: Clustered standard errors at the household level in parentheses.*, **, *** denote significance at the 10%, 5% and 1% levels respectively. The reported dependent variables denote the minutes spent in domestic work, in market work, in leisure activities and time poverty, defined as a dummy equals to 1 if the individual worked more than 10.5 hours in the previous day, the Women's Empowerment in Agriculture Index (WEAI), as defined by Alkire et al. (2013), and women's likelihood of being employed in paid activities, defined as a dummy equals to 1 if the woman reported being engaged in paid activities. Control variables are those reported in Section 4.1.