Do women state legislators and administrators make any difference in preventing natural disaster mortality? Evidence from India

Joyita Roy Chowdhury[1*], Yashobanta Parida[1] and Prakash Kumar Sahoo[2]

[1]Department of Economics, FLAME University, Pune, India and [2]P. G. Department of Economics, Government College, Sundargarh, Odisha, India

[*]Corresponding author. E-mail: joyita.chowdhury@flame.edu.in, joyita.rc2006@gmail.com

Online Appendix

Appendix A

Table A1. Women's political empowerment in South Asia

	Overall political empowerment ranking	Women in parliament	Women in ministerial positions
Year 2006 (Out of 115 countries)			
Bangladesh	17	15% (56)	8% (80)
Bhutan	-	-	-
India	**20**	**8% (93)**	**3% (107)**
Maldives	-	-	-
Nepal	102	7% (103)	7% (85)
Pakistan	37	21% (99)	6% (13)
Sri Lanka	7	5% (105)	10% (73)
Year 2018 (Out of 149 countries)			
Bangladesh	5	20.3% (80)	6.3% (126)
Bhutan	138	8.5% (137)	10.0% (113)
India	**19**	**11.8% (123)**	**18.5% (77)**
Maldives	132	5.9% (141)	17.6% (80)
Nepal	66	32.7% (34)	3.7% (141)
Pakistan	97	20.6% (78)	0.0% (144)
Sri Lanka	65	5.8% (143)	4.3% (137)

Notes: Figures in parentheses represent the ranking of the countries. India scored 0.227 and 0.382 in the political empowerment subindex in 2006 and 2018, respectively.
Source: The Global Gender Gap Reports, 2006 and 2018. World Economic Forum.

Table A2. Two-way FE estimates: women in legislation and public administration and cumulative deaths from natural disasters

Part I			
Independent variable: Cumulative total **deaths** from natural disasters per mn population	**Dependent variable:** Women elected as Member of Legislative Assembly (as % of total contestants)		
	C1	C2	C3
Ln cumulative total deathsit-2	-0.0003 (0.0003)		
Ln cumulative total deathsit-5		-0.0004 (0.0003)	
Ln cumulative total deathsit-9			-0.0004 (0.0003)
Part II			
Independent variable: Cumulative total **deaths** from natural disasters per mn population	**Dependent variable:** Women IAS Officers per mn women in higher education		
	C1	C2	C3
Ln cumulative total deathsit-2	-0.006 (0.059)		
Ln cumulative total deathsit-5		-0.007 (0.060)	
Ln cumulative total deathsit-9			-0.018 (0.070)
Observations	714	705	693
No of States	20	20	20

Notes: Clustered standard errors at the state level are reported in parentheses. Time-invariant State and year-fixed effects are included. Natural disaster mortality includes deaths due to floods, cyclones, landslides, cold waves, heat waves, and lightning.

Appendix B

Disaster risks and women in state legislation and public administration

Historically, women have been underrepresented in Indian politics, comprising only 12% of national legislators in 2015 (Bhalotra *et al*., 2018). Although they constitute half of the Indian population, women remain in the minority in administrative and political decision-making

positions. The representation of women as members of legislative assemblies (MLAs) across all state assemblies of India is low, where they account for only 9% of Legislators.

State legislators are responsible for developing policies and implementing them. They influence the flow of public funds from the central government and are responsible for road infrastructure, electricity, health services, education, and law and order (Baskaran *et al*., 2015; Baskaran *et al*., 2024). In the context of disaster risk management, the State Legislative Assemblies (State Governments) are responsible for laying down the policies and plans for disaster management in the particular state, following the guidelines of the Central Government. This includes measures taken for mitigation, capacity building, and disaster preparedness by the different departments of the state government (Government of India, 2005).

Indian Administrative Service (IAS) is an essential part of the executive branch of the Government of India that remains politically neutral while guaranteeing administrative responsibilities to the ruling political party. Regarding responses to natural disasters, IAS Officers play an essential role in directing relief operations, evacuation, and rehabilitation activities in their jurisdictions.

In connection to highlighting the potential role of women in government, Tishkov (1993) argued that "women bring enriching values to the government." Women's representation in politics leads to adopting effective climate policies and measures to mitigate the impacts of climate change (Mavisakalyan and Tarverdi, 2019). As all types of natural disasters have increased in frequency and intensity due to changes in global climate (Field *et al*., 2012), it is essential to create gender-inclusive disaster planning (UNISDR, 2015).

Overall, in India, politics and public administration represent a patriarchal structure with a persistent gap in the representation of women in State Legislative Assemblies and Indian

Administrative Service. Figure A1 shows women's representation in legislative assemblies as a comparison of 1981 and 2019.

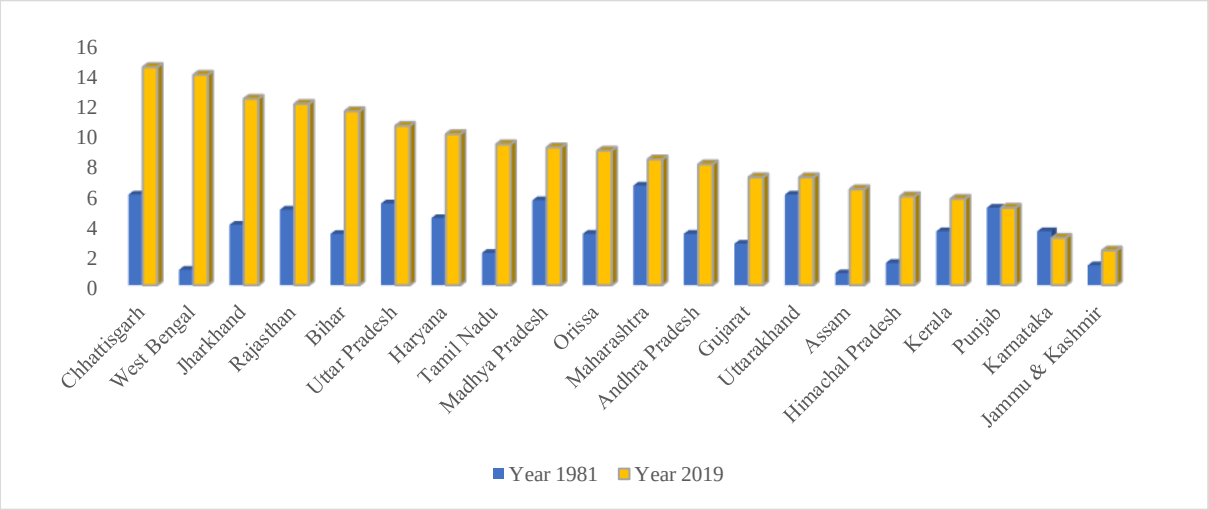

Figure A1. Proportion of women in state legislatures in different states of India in 1981 and 2019.

At the state level, we observe that women's political participation is abysmally low in many Indian states. In 1981, states that had experienced the lowest representation of women in politics were West Bengal, Assam, Himachal Pradesh, and Jammu & Kashmir. Of all states, Chhattisgarh and West Bengal recorded the highest proportion of women legislators, accounting for 14% each in 2019. This is followed by Jharkhand (12%), Bihar (12%), Uttar Pradesh (11%), Haryana (10%), Madhya Pradesh (9%), Maharashtra (8%), Gujarat (7%), and Uttarakhand (7%). Haryana, a state known for crimes against women, registered a 6-percentage point increase in women legislators from 1981 to 2019.

Bihar experienced a rise in 9 percentage points of women politicians from 1981 to 2019, and this could be a result of 50% of the reservations provided to women in local bodies in 2006. Amongst the 20 states, Karnataka (3%) and Jammu & Kashmir (2%) showed the lowest women's political representation rates in state legislative assemblies in 2019. Further, Karnataka registered a decline in women's political participation from 4% in 1981 to 3% in 2019. Punjab did not experience any change in the share of women in state legislatures from

1981 to 2019. Although Kerala is a highly literate state, it showed a small rise in the percentage of women in State Legislative Assemblies from 4% in 1981 to 6% in 2019.

Overall, in 20 Indian states, the share of seats occupied by women in State Legislative Assemblies increased from 3.5% in 1981 to only 8.6% in 2019 (see figure A2). Although women's political empowerment is considered a vital determinant of societal advancement, there are many obstacles, particularly in the context of developing countries. In the case of India, where many socio-cultural constraints hinder the liberty of females to engage in decision-making processes, women's political empowerment is still inadequate enough to give them a strong political position in the political sphere to be involved in policymaking (Chary, 2012).

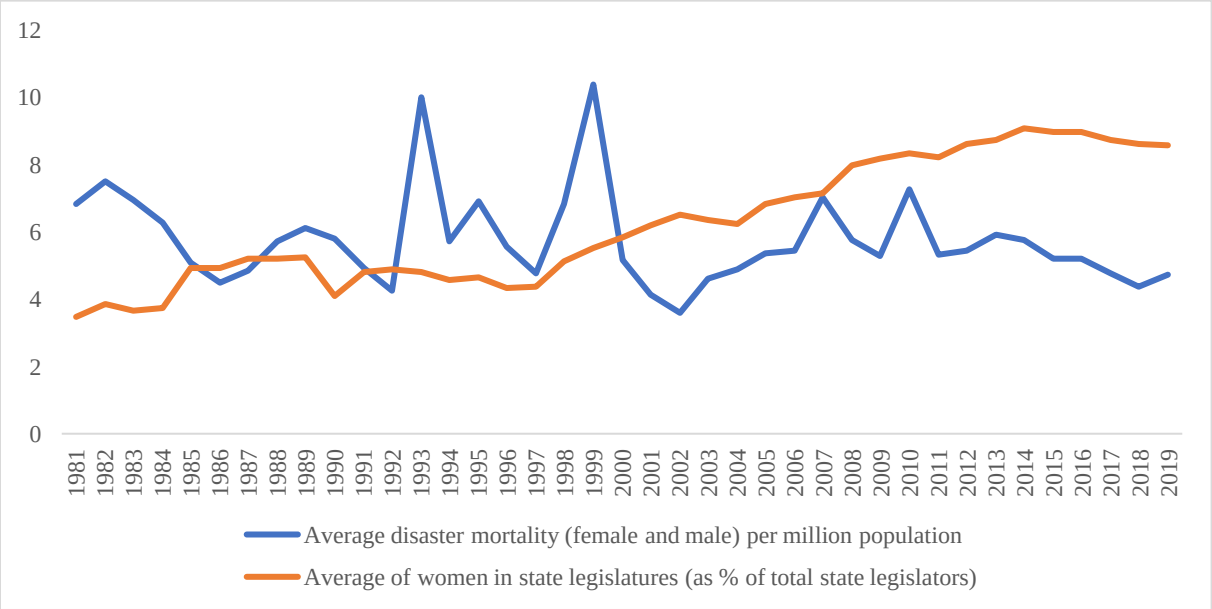

Figure A2. Women's political representation and natural disaster mortality.

Over the entire study period, 1981-2019, 20 major Indian states, on average, experienced only a mere 5.1 percentage point rise in the proportion of women legislators. The data reveals that women remain underrepresented in politics, which calls for public intervention to achieve gender equality in political participation. To minimize the inequality in political representation between men and women, the Government of India shifted the focus of policy

approaches from 'welfare' to 'development' during the 1980s and then to 'empowerment' in the 1990s and afterward, thus emphasizing the need for including women in decision-making in formulating public policy (Fadia, 2014).

In 1992 and 1993, the 73rd and 74th Amendments were implemented by the Indian government to provide 33% reservation of seats for women in Panchayats and local bodies (Gulati and Spencer, 2021). These constitutional amendments are vital in ensuring women's increased presence in politics and administration (Chadha, 2014). Bihar is the first Indian state that reserved 50% of the Panchayat seats for women candidates. Proposals were made to provide 33% of reserved seats for women in state legislative assemblies and the lower house of Parliament starting in 1997 (Rai, 2017). This indicates that the need for enhanced political representation of women at all levels of government got much recognition after the mid-1990s.

Our data shows that the share of women in state legislatures experienced a rise, particularly after 1997 (see figure A2). During the 1990s, quotas and reservations for women in institutions were introduced to achieve progress in increasing the percentage of women legislators and leaders and, therefore, tackle the problem of unequal political representation of men and women in India. In 1995, a landmark world conference on women took place in Beijing, China, to address the inequality of political power between men and women and decision-making at all levels of governance.[1] The Indian Government supported the Beijing Declaration and Platform of Action, worked toward the advancement of women, and ensured their political participation.[2] This commitment toward women's political empowerment was reflected in the 1996 general elections, where thousands of women were elected as local leaders (Fadia, 2014).

[1] Fourth World Conference on Women: https://www.un.org/womenwatch/daw/beijing/platform/decision.htm.
[2] India's Report on the Implementation of the Beijing Declaration and Platform for Action in Context of the Twenty-Fifth Anniversary of the Fourth World Conference on Women and the Adoption of the Beijing Declaration and Platform for Action 2019.

Furthermore, as part of the national policy, 2001 was declared the year of women's empowerment in India to strengthen women's decision-making in social, economic, and political spheres. All these public initiatives have contributed to the rise in the proportion of women legislators post-1997 (see figure A2). The commitment to establishing gender equality is not just restricted to political decision-making; however, the government of India encouraged such gender balance in public administrative services by setting specific targets and implementing policies that help achieve equal representation of men and women in all positions of public administration (Declaration B, 2015).

Although we have seen an increase in the share of seats occupied by women in State Legislative Assemblies, gender equality in political representation still needs to be achieved. As Chary (2012) pointed out, women do not have adequate political power and are not involved in political decision-making in Indian democracy proportionally to their numerical strength. Figure A2 reveals a slow progress in women's political participation and a decline in total disaster mortality between 2000 and 2003 and again after 2010.

Figure A3 shows the share of women in senior-level public administration in Indian states in 1981 compared to 2019. Women comprised only 7% of Officers in Administrative Services in India in 1981; the proportion of women senior-level administrators gradually increased to 28% in 2019.

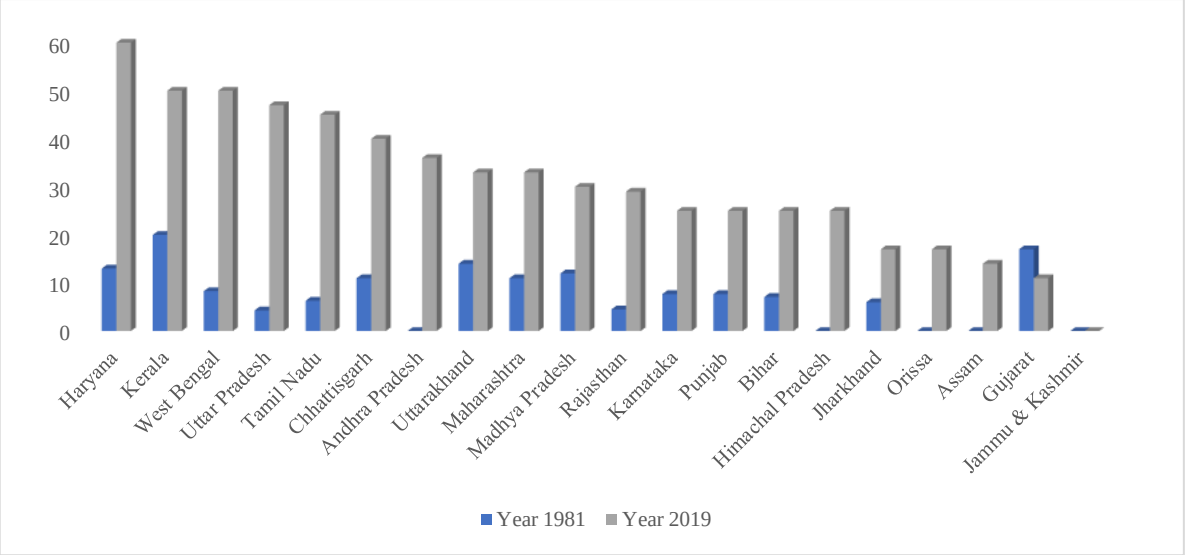

Figure A3. Proportion of women in public administration in different states of India in 1981 and 2019.

Over the study period (1981–2019), considering 20 major Indian states, we find a 21-percentage point rise in women IAS officers out of total IAS officers, on average. Women's participation in public administration has been enhanced over the years; however, progress has been slow. An analysis of the IAS data from 1981 to 2019 suggests heterogeneity across states concerning the proportion of women recruited as IAS officers. In 1981, Indian states that showed the most minor performance with relatively fewer or no female IAS officers were Andhra Pradesh (0%), Odisha (0%), Assam (0%), Himachal Pradesh (0%), Jammu & Kashmir (0%), Uttar Pradesh (4%), Rajasthan (5%). Amongst these states, Uttar Pradesh and Andhra Pradesh showed much improvement in women's representation in bureaucratic offices, with 47% and 36% of female IAS officers in 2019, respectively.

All four states – Karnataka, Punjab, Bihar, and Himachal Pradesh – experienced 25% of female IAS officers in 2019. The poor-performing states in 2019 are Jammu and Kashmir at 0% and Gujarat at 1%, followed by Assam (14%), Odisha (17%), and Jharkhand (17%). In 2019, Haryana performed best among all states, with a 60% share of women's representation in public administration. Other states, namely Kerala (50%), West Bengal (50%), Uttar Pradesh

(47%), Tamil Nadu (47%), and Chhattisgarh (40%), also performed well in terms of experiencing a larger proportion of women members in public administration.

With the increasing participation of educated women in public administration, we can expect to witness a powerful social transformation. This shift not only improves the functioning of the government but also holds it more accountable to various public interests, thereby enhancing the quality of public services (UNDP, 2021). The driving forces behind this change are the increased awareness and evolving societal outlook toward more gender-equal societies (The Print, 2024). Moreover, women are now more career-focused, seizing the educational opportunities made available through educational policy changes.

The National Policy on Education (NPE) introduced in 1986 emphasized gender equality with a commitment to structure the educational system to promote women's empowerment (Singh, 2007). Furthermore, the National Perspective Plan for Women (1998–2000) restated the same point of view of improving gender equality in education (Chanana, 2000). Statistics from the literature show 46 women in higher education per men in 1988–89, which increased to 52 women per 100 men in 1996–97 (Chanana, 2000). The positive changes in national education policy since the mid-1980s have encouraged more women to pursue more education and, therefore, enter public administration. The National Policy for the Empowerment of Women (2001) combined with the International Women's Conference in Beijing (1995) led to commitments to attain gender balance in public administrative entities and thus implemented measures to enhance the number of women in all government and public administrative positions (Declaration B, 2015).

As women's participation in decision-making strengthens, we expect to see a promising shift. Evidence from earlier studies suggests that the number of drinking water projects being set up in regions with women-led councils surpasses those governed by male leaders (Chattopadhyay and Duflo, 2004). This indicates the positive impact of women's involvement

in public affairs. We also observe an encouraging trend in the share of women IAS officers after 1997, accompanied by a corresponding reduction in disaster-related deaths from 1981 to 2019 (see figure A4).

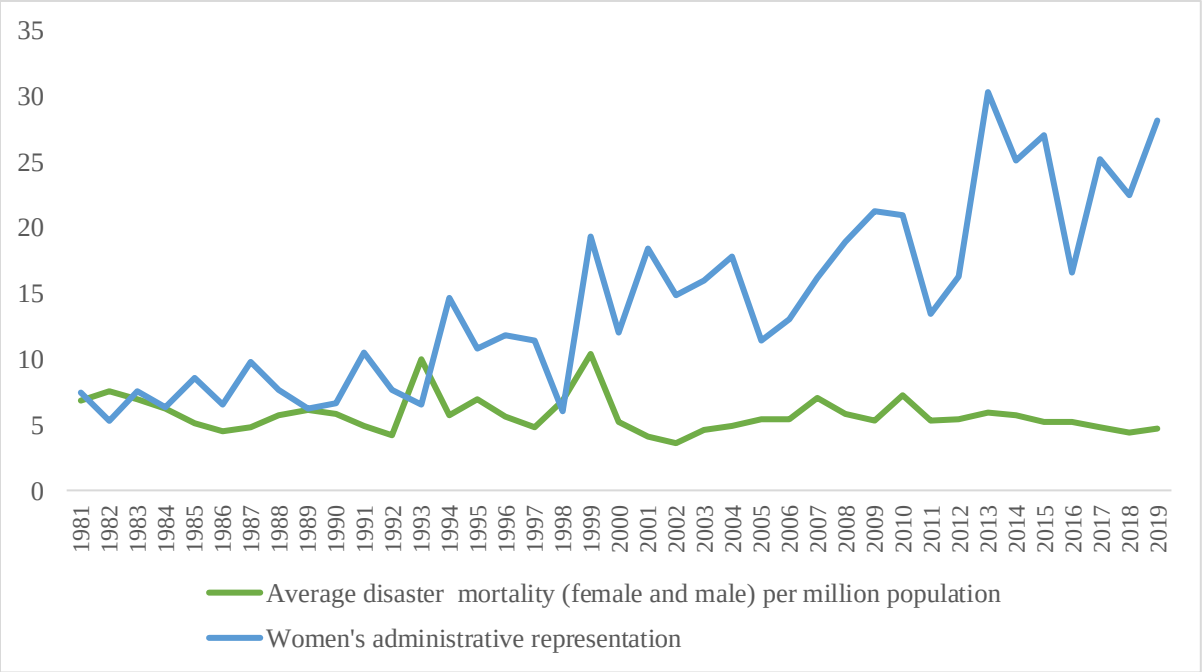

Figure A4. Women's administrative representation and natural disaster mortality.

Appendix C

Data and descriptive statistics

Natural disaster data: The data on gender-wise deaths due to natural disasters are taken from various annual reports of 'Accidental Deaths & Suicides in India' published by the National Crime Records Bureau, GoI. Our analysis includes deaths from natural disasters such as floods, cyclones, landslides, heat waves, cold waves, and lightning.[3] According to EM-DAT, overall, in India, among all types of natural disasters, floods account for 53%, followed by cyclones (21%), landslides (10%), cold waves (6.4%), earthquakes (4.2%), and droughts (2%) from

[3] See https://sansad.in/getFile/loksabhaquestions/annex/1712/AU3235.pdf?source=pqals.

1980 to 2011. Considering all six types of disasters, on average, 6 persons are killed in disaster events per mn population. All descriptive statistics are presented in table A3.

Electoral and administrative data: The information on women MLAs is obtained from the various volumes of "Statistical Report on General Election to the Legislative Assembly", published by the Election Commission of India. The IAS data is taken from the "TCPD Indian Administrative Service Officers Dataset (TCPD-IAS), 1951–2020", Trivedi Centre for Political Data, Ashoka University.[4]

Other political data: We use some political factors that can help reduce fatalities due to disasters. Data on state-level elections, the number of electors, and women voter turnout are collected from the Election Commission of India. Given that the state governments have a higher propensity to be more active in disaster management during the election year, which can enhance their possibilities of re-election (Parida, 2020), we use the state election year as a control. Deaths due to natural disasters could be lower during the years when an election is due in the state. The data from various State Assemblies' reports reveals that in 39 years, nearly 9% of the time, women held Chief Ministerial positions in India (see table A3a).

[4] See https://tcpd.ashoka.edu.in/bureaucrats-of-india/

Table A3a. Summary statistics

Variables	Definition of the variables	Mean	Std. Dev
Outcome variables			
Total (male and female) natural disaster mortality	Number of female and male deaths from cyclones, floods, and landslides per mn total population.	2.1	5.5
Male natural disaster mortality	Number of male deaths from cyclones, floods, and landslides per mn male population.	2.8	5.5
Female natural disaster mortality	Number of female deaths from cyclones, floods, and landslides per mn female population.	1.4	5.9
Total (male and female) natural disaster mortality	Number of female and male deaths from cyclones, floods, landslides, heat waves, cold waves, and lightning per mn total population.	5.7	6.2
Male natural disaster mortality	Number of male deaths from cyclones, floods, landslides, heat waves, cold waves, and lightning per mn male population.	8.1	7.1
Female natural disaster mortality	Number of female deaths from cyclones, floods, landslides, heat waves, cold waves, and lightning per mn female population.	3.1	6.2
Variables of interest			
Women elected as Members of the Legislative Assembly	Number of women elected as members of State Legislative Assembly (as % of total contestants)	0.75	0.44
Women IAS Officers	Women IAS Officers per mn women in higher education	13.2	33.9
Political control variables			
Women Chief Minister	Women held Chief Ministerial positions in different states and different years is equal to 1, otherwise 0	0.09	0.3
State election	State elections held in different years and different states are equal to 1, otherwise 0.	0.21	0.4
Women's participation in voting in elections	Women polling percentage in State Legislative Assembly elections	63.6	11.5
Economic control variables			
Female enrolment in higher education	Number of women enrolled in higher educational institutions in India as % of total enrolment.	39.4	9.6
Per capita education, health, and family welfare expenditure	The ratio of government expenditure on education, health, and family welfare over the state population (in Rupee)	1,623	1,938
Per capita income	Ratio of net state domestic product over state population (in Rupee)	47,303	32,081
Urbanization	Population living in the urban area (as % of the total population)	26.6	10.5
Female to male ratio	The ratio of the female to the male population	0.9	0.05
Forest cover	Forest cover as % of state geographical area	18.9	13.02
Disaster specific controls			
Precipitation	Average precipitation in depth (mm per year)	1135	514
Severe flood dummy	Area affected by floods as % of state geographical area lies more than 90 percentiles is equal to 1, otherwise 0.	0.27	0.44
Severe cyclone dummy	Severe cyclone landfall in coastal states of India is equal to 1, otherwise 0.	0.11	0.31
Landslide dummy	Major landslides occurred in states of India is equal to 1, otherwise 0.	0.2	0.4

Note: Authors' own calculation.

Table A3b. Summary statistics

Outcome variables	Definition of the variables	Mean	Std. Dev
Girls' school enrolment	Girl's primary school enrolment (as % total primary school enrolment)	45.06	4.73
Girls' school dropout	Girl's dropout rate in primary school	18.72	22.87
Overall school dropout	Dropout rate of boys and girls in primary schools	18.35	17.50
Female share in manufacturing employment	Female employment in manufacturing industries (as % of total workers)	13.29	15.57

Note: Authors' own calculation.

Table A3c. Summary statistics

Outcome variables	Definition of the variables	Mean	Std. Dev
High human development states			
Total (male and female) natural disaster mortality	Number of female and male deaths from cyclones, floods, and landslides per mn total population	2.68	5.42
Male natural disaster mortality	Number of male deaths from cyclones, floods, and landslides per mn male population	3.70	6.02
Female natural disaster mortality	Number of female deaths from cyclones, floods, and landslides per mn female population	1.59	5.41
Variables of interest			
Women elected as Members of the Legislative Assembly	Number of women elected as members of State Legislative Assembly (as % of total contestants)	0.78	0.47
Women IAS Officers	Women IAS Officers per mn women in higher education	14.13	43.34
Low human development states			
Total (male and female) natural disaster mortality	Number of female and male deaths from cyclones, floods, and landslides per mn total population	1.57	5.43
Male natural disaster mortality	Number of male deaths from cyclones, floods, and landslides per mn male population	1.90	4.60
Female natural disaster mortality	Number of female deaths from cyclones, floods, and landslides per mn female population	1.21	6.39
Variables of interest			
Women elected as Members of the Legislative Assembly	Number of women elected as members of State Legislative Assembly (as % of total contestants)	0.72	0.39
Women IAS Officers	Women IAS Officers per mn women in higher education	12.13	19.55

Note: Authors' own calculation.

Our data also shows that approximately 64% of women have actively participated in the state electoral process during state assembly elections (table A3a). As more women step out of their traditional roles and exercise their voting rights, they gain access to policy-based information, such as credit assistance, which can enhance their resilience and recovery from the adverse effects of natural disasters (Chowdhury *et al*., 2021). We also observe a considerable rise in women's participation in voting or electoral decision-making since 1990. This trend was further amplified after 1990, possibly due to the introduction of economic reforms that emphasized gender justice as a critical governance principle. Factors such as improved education levels, increased exposure to mass media, and a rising political consciousness have also increased women's voter turnout (Kumar and Prakash, 2012).

Education and population data: We include the proportion of adult women in higher education, including female enrolment in Ph.D./M.Phil., postgraduate, engineering, medicine, and undergraduate courses in various institutions in India. Concerning higher education in general, 39% of women have obtained graduate and postgraduate degrees in our data (table A3a).

The population data is taken from the Indian census. The state-wise male and female population data is available in census years, which occur every ten years and perform a complete enumeration of people across the country. The census years are 1971, 1981, 1991, 2001, and 2011. We estimate the population using the linear interpolation method for the gap years, where the census data is unavailable.[5] Urbanization indicates how much a state is

[5] Population data for India is available only in the census of India, and therefore, we have used state-wise male and female population data taken from the census. The limitation is that the Indian government conducts a census, which is a complete enumeration of people across the country every ten years. The state-wise population data are available decennially from the Census of India. Therefore, we estimate the population data using the linear interpolation method for the gap years, where the census data is unavailable. Some existing studies have also interpolated population data from the Census of India for their analysis (Arulampalam *et al*., 2009; Parida, 2020; Chowdhury *et al*., 2021).

urbanized and is measured as the ratio of urban population to total population (Besley and Burgess, 2002). On average, 27% of the population lives in urban areas.

Institutional Quality: The institutional quality is proxied by per capita public expenditure on education, health, and family welfare services. Data is collected from the State Finances: A study of Budget, Reserve Bank of India.

Other control variables: The information regarding additional control variables, Net State Domestic Product (NSDP), and state-wise forest coverage are compiled from the Economic and Political Weekly Research Foundation (EPWRF). The per capita NSDP lagged one period is used as a proxy for the state's per capita income level. Forest coverage is critical because forest ecosystems can help prevent adverse environmental shocks, such as floods and cyclones (Chowdhury *et al*., 2021). On average, nearly 19% of the area is under forest coverage.

The state-wise precipitation data is taken from the World Bank's Climate Change Knowledge Portal.[6] We control for the degree of severity of floods, cyclones, cold waves, and landslides. If the area affected by floods as a percentage of the state's geographical area is more than 90 percentiles, it is considered as severe. Data on the severity of disasters is compiled from the annual reports of Disastrous Weather Events, India Meteorological Department, Pune, India.

Appendix D

Possible mechanisms

The Hausman-Taylor (1981) estimation approach is used to examine the effects of women's political and administrative representation on education outcomes and the female share of manufacturing employment in 20 Indian states. We run the following specification:

$$y_{it} = \beta_0 + \beta_1 y_{it-1} + \beta_2 wl_{it-1} + \beta_3 ias_{it-1} + \phi^1 Z_{it}^1 + \phi^2 Z_{it}^2 + \theta_i + \mu_{it}. \quad \text{(A1)}$$

[6] See https://climateknowledgeportal.worldbank.org/download-data.

Outcome variable denoted by y_{it} shows (i) girls' primary school enrolment as a percentage of total primary school enrolment, (ii) girls' dropout rate in primary school, (iii) overall dropout rate in primary school, and (iv) female employment in manufacturing industries as a percentage of total workers.

In equation (A1), Z_{it}^{1} are control variables such as severe flood dummy, severe cyclone dummy, landslide dummy, and state election dummy that are uncorrelated with the state-specific effect, θ_i (weakly exogenous), and Z_{it}^{2} are control variables such as lag of the number of primary school per mn population, lag of the number of primary school teacher per mn population, lag ln per capita income, lagged female enrolment in higher education, lagged ln number of factories, and ratio of female to male population that are correlated with θ_i (endogenous).

The HT model addresses this issue in this context by including a time-invariant variable and simultaneously modelling unobserved individual heterogeneity (Cameron and Trivedi, 2010). The HT panel data estimator deals with the real-world empirical fact that some of the regressors are time-varying and others are time-invariant; in addition, some are correlated with the individual effects, and some are not (Baltagi and Bresson, 2012). The HT estimator uses a mixed structure by maintaining the consistency property of the FE estimation for panel data in addition to retaining the efficiency of the RE model by capturing the effects of time-invariant variables that are eliminated by the within transformation that takes place in the FE model.

HT proposed a step-wise instrumental variable procedure for identifying the coefficients of time-invariant explanatory variables (Kripfganz and Schwarz, 2019). The first stage involves obtaining the fixed-effect estimates of coefficients of the time-varying regressors that are consistent. In the second step, a Feasible Generalised Least Square (FGLS) method is used to get variances of time-invariant variables. In the third step, a weighted IV estimation is done using deviation from means of lagged values of time-varying regressors

serving as instruments (Noy, 2009). In our estimates, the HT procedure corrects for the correlation between the explanatory variables and individual-specific effects in the panel set-up and controls the endogeneity issue. Several studies (Noy, 2009; Birthal *et al*., 2021; Khurana *et al*., 2022) have used the HT method to estimate the effects of disasters.

(i) ***Primary education attainment***

Enhancing education opportunities can empower people's lives by providing them with the knowledge to enhance their adaptive capacities. Education has an impact on promoting access to information on various issues (Campbell, 2006) and various socioeconomic resources, which can help reduce vulnerability (Psacharopoulos, 1994). In this context, vulnerability is defined as an individual's reduced capacity to cope with and recover from the impact of a natural disaster (Wisner *et al*., 2004).

Due to existing gender inequalities, women generally experience greater loss of lives and livelihoods during natural disasters and a longer time to recover from disaster shocks (Rahman and Alam, 2016). In that situation, education opportunities can result in substantial socioeconomic benefits (Jamison *et al*., 2013) and help build resilience to natural disasters (Drzewiecki *et al*., 2020). Women leaders help improve girls' primary education attainment by increasing their school enrollment. Burchi and Singh (2020) found a 6-percentage point increase in the likelihood of children completing primary school education due to a 10-percentage point rise in women's political representation in India. They argue that female politicians emphasize welfare programs more than their male counterparts and, therefore, help enhance educational outcomes. Using state-level panel data, Clots-Figueras (2011) showed that female political representation has led to investment in primary school education in India. Girls tend to go to schools, and dropout rates are also lower in areas with women's representation in public offices (Clots-Figueras, 2012; Beaman *et al*., 2006).

In our study, we use three main indicators of education: girls' primary education enrollment, girls' dropout rates in primary schools, and the overall dropout rates at the primary school level. In the analysis, we control the number of primary schools per mn population and the number of primary school teachers per mn state population. This allows us to examine primary school attendance among girls, and the dropout rates show the extent to which students fail to complete primary schooling. Columns 1, 2, and 3 in table A4 present the results of the effects of women's representation on education, including all controls, time-invariant state-fixed, and time-fixed effects.

Our results show that women's political representation is positively associated with girls' primary education enrollment, and it is statistically significant, implying that enhancing women's political participation by one standard deviation results in improving girls schooling by 0.2 percent (see table A4, column C1). Furthermore, the administrative representation of women positively impacts girls' enrolment in primary education in India (see table A4, column C1). Although the coefficient on the administrative representation of women is statistically insignificant, it has economic significance. As Miller and Rodgers (2008) have argued, statistical significance alone is not adequate to assess the importance of one variable in affecting another variable; therefore, we focus on the economic significance of the impact of women in legislation and administration in bringing positive changes in society through enhanced educational attainment for girls and reduced disaster mortality risk.

Table A4(a). Hausman-Taylor (HT) estimation; Impact of women's political representation and women's representation in administration on education and manufacturing employment

Variables	Girl's primary school enrolment (as % total primary school enrolment)	Girl's dropout rate in primary school	Overall dropout rate in primary school	Female employment in manufacturing industries (as % of total workers)
	C1	C2	C3	C4
Lag women elected as Member of Legislative Assembly (as % of total contestants)	0.187 (0.111)	-4.227 (2.609)	-1.946 (1.451)	1.329 (0.482)
Lag women IAS Officers per mn women in higher education	0.0003 (0.0005)	-0.220 (0.099)	-0.078 (0.026)	0.017 (0.012)
Lag women chief minister dummy	0.270 (0.229)	-1.903 (1.375)	-1.487 (0.971)	0.274 (0.269)

Table A4(b). Two-way FE estimation, impact of women's political representation and women's representation in administration on education and manufacturing employment

Variables	C1	C2	C3	C4
Lag women elected as Member of Legislative Assembly (as % of total contestants)	0.641 (0.758)	-4.871 (2.563)	-1.670 (3.051)	1.481 (1.014)
Lag women IAS Officers per mn women in higher education	0.002 (0.001)	-0.175 (0.123)	-0.065 (0.023)	0.008 (0.010)
Lag women chief minister dummy	2.012 (1.171)	-1.134 (1.828)	-0.328 (2.445)	0.140 (0.466)
No. of States	20	20	20	20
Observations	654	402	385	408

Notes: Clustered standard errors at the state-level are reported in parentheses. Time-invariant State and year-fixed effects are included in all models.

In C1, we use information from 1981-2016 due to data availability. In HT estimation, we control the lag of girls' enrolment in primary education (as % total primary school enrolment). In FE and HT estimations, the control variables are the lag of the number of primary schools per mn population, the lag of the number of primary school teachers per mn population, the lag of Ln per capita income, the state election dummy, the ratio of female to male population, and other disaster-specific variables such as severe flood, severe cyclone, and landslide dummy.

In C2, we use information from 1997-2019 due to data availability. In HT estimation, we control the lag of girls' dropout rate in primary education schools. In FE and HT estimations, the control variables are the lag of the number of primary schools per mn population, the lag of the number of primary school teachers per mn population, the lag of Ln per capita income, the state election dummy, the ratio of female to male population, and other disaster-specific variables such as severe flood, severe cyclone, and landslide dummy. The mean of women elected as Members of Legislative Assembly (as % of total contestants) is 0.84, and the standard deviation is 0.45. The mean of women IAS Officers per mn women in higher education is 7.39, and the standard deviation is 11.53.

In C3, we use information from 1997-2019 due to data availability. In HT estimation, we control the lag of the overall dropout rate in primary school. In FE and HT estimations, the control variables are lag of the number of primary schools per mn population, lag of the number of primary school teachers per mn population, lag of Ln per capita income, state election dummy, ratio of female to male population and other disaster-specific variables such as severe flood dummy, severe cyclone dummy, and landslide dummy. The mean of women elected as Members of the Legislative Assembly (as % of total contestants) is 0.84, and the standard deviation is 0.45. The mean of women IAS Officers per mn women in higher education is 7.39, and the standard deviation is 11.53.

In C4, we use panel data for 20 major states from 1998-2019 due to data availability on women's employment in manufacturing industries in different states since 1998. In HT estimation, we control lagged female employment in manufacturing industries (as % of total workers). In FE and HT estimations, the control variables are- lagged ln number of factories, lagged ln per capita income, state election dummy, lagged female enrolment in higher education (as % total enrolment), ratio of female to male population and other disaster-specific variables such as severe flood dummy, severe cyclone dummy, and landslide dummy. We use panel data for 20 major states in different periods. The reason for choosing different periods is due to data availability in Indian states.

In addition to girls' primary education, we also examine if increased women's representation in political and administrative power is associated with reducing girl students' dropout rates. Results show that dropout rates for girls significantly decrease by 10.3 percent (of the sample mean) with one standard deviation increase in female political participation.[7]

Furthermore, the gains in improving the share of females in administrative positions translate into reducing girls' dropout rates. We find that one standard deviation rise in women's administrative representation results in a reduction in dropout rates for girls in primary schools by 13.7 percent, relative to the sample mean. Furthermore, one standard deviation rise in female administrative representation results in a decline in the overall dropout rates in primary schools by 5 percent relative to the sample mean.

Our findings suggest that as more women participate in political and administrative decision-making, the effect is realized in retaining more students in primary school and increasing educational attainment for children, which leads to societal development outcomes. The results are consistent with the findings of Beaman *et al*. (2006), who showed that women's leadership affected girls' education by increasing school attendance among girls in rural India. Studies show that educating girls and women in developing countries can help reduce their vulnerability to deaths during natural disasters, potentially reducing their families' vulnerability to the negative impacts of disasters (Blankespoor *et al*., 2010). Education of girls and women is a crucial indicator of improved human development and enhanced resilience to changing climate (Mundial, 2010).

In addition to providing education, schools in India are also meant to shelter vulnerable children and other people during floods and cyclonic storms (Dash and Walia, 2020). As part of the National disaster management and school safety policy, India has constructed Multi-Purpose Cyclone Shelters for disaster risk mitigation that are otherwise used as schools

[7] Summary statistics are presented in table A3b.

(Government of India, 2017). The primary aim of school safety policy is to ensure well-being and provide a safe learning environment for children in schools. Safety implies being safe from large-scale natural disasters, pandemics, and various environmental threats that negatively impact the lives of children (Government of India, 2017). Therefore, access to a safe school space and ensuring primary education by reducing dropout rates is a major step toward achieving gender equality in education.

It is imperative to recognize the role of education in helping individuals understand disaster preparedness, resilience, and recovery measures (Torani *et al*., 2019). KC (2013) found that communities in Nepal with a higher proportion of women with better years of schooling suffered lower deaths due to natural disasters. In India, education on disaster management has been introduced in the school curriculum by the Ministry of Human Resources Development (HRD) to educate individuals regarding disaster preparedness measures that help reduce risk before, during, and in the aftermath of disasters (Sharma, 2013). An international consensus has also developed that emphasizes the importance of disaster education programs among children to improve resilience (Torani *et al*., 2019). The Sendai Framework for Disaster Risk Reduction has called on national governments to ensure that children and young individuals are provided with lessons on different ways that can be adopted to tackle the threats caused by disasters.[8]

Several studies show that people commonly remember things they learned when they were young. Therefore, when children are given lessons on disaster risk reduction methods, particularly at an early age, it is very useful for disaster management (Bosschaart *et al*., 2016; Muzenda-Mudavanhu *et al*., 2016). Incorporating disaster preparation education in the primary school curriculum is an important step to ensure a reduction in disaster mortality (Torani *et al*., 2019). In the face of natural disasters, it can be assumed that educated individuals, households,

[8] See https://www.undrr.org/news/education-reduces-disaster-risk.

and societies are better prepared and can recover faster from the adverse impacts of disasters (Muttarak and Lutz, 2014). Hoffmann and Muttarak (2017) found that schooling increases disaster preparedness for individuals as education improves abstract reasoning capabilities and cognitive skills so that the educated ones undertake disaster preventive measures without even requiring them to experience the disaster event first. Therefore, formal schooling is one primary means of helping reduce disaster risk and minimize vulnerability to disasters (Muttarak and Pothisiri, 2013).

Based on our prior discussion that schools in India provide safe shelter to vulnerable people during and in the aftermath of a disaster and that the Indian government has introduced disaster management education for children in the school curriculum (Government of India, 2017), therefore it is most likely that education acts as a primary mechanism that helps individuals acquire knowledge and undertake disaster preparedness measures that contribute to reducing vulnerability to disasters (Muttarak and Lutz, 2014). The general skill that is obtained through education leads to a better understanding and ability to process risk-based information such as weather forecasting or any disaster warning message that can allow individuals to respond and prepare for disasters (Mileti and Sorensen, 1990), all of which can directly help reduce disaster mortality. Moreover, education is associated with establishing social networks (Department for Business Innovation & Skills, 2013) that increase the chances of receiving informal warnings and better responses to disasters (Mileti and Sorensen, 1990; Chowdhury and Parida, 2023).

Moreover, our results suggest that increased female political and administrative participation encourages children's education by reducing overall dropout rates and ensuring that more girls get education by increasing enrollment. Earlier studies have shown that higher welfare gains are realized as women engage in decision-making within the household (Duflo, 2003). So, if a larger share of women participates in government offices and engages in political

and administrative decision-making, it will improve overall social well-being. Striessnig *et al*. (2013) pointed out that higher social and human development can improve resilience to extreme weather events and reduce disaster-related mortality. The analysis suggests that having more women in IAS and politics is associated with more education and, therefore, greater human development that helps reduce disaster risks and mortality.

(ii) ***Financial independence of women***

In the context of India, where women are disproportionately vulnerable to disasters due to the existence of gender-based sociocultural norms (Chowdhury *et al*., 2021; Ahmed, 2004), access to employment opportunities in the non-agricultural sector can help address women's economic uncertainties in the aftermath of disasters (Chowdhury *et al*., 2022). A possible mechanism to ensure development and societal well-being is making women financially independent (Bhatia and Singh, 2019). In our study, we investigate women's increased access to manufacturing employment. Women in India are disproportionately concentrated in the agricultural sector and are likely to be heavily impacted by crop losses as Indian agriculture is highly vulnerable to disaster shocks (Chowdhury *et al*., 2022). In 2005, around 78% of women in rural India worked either on the family farm or were employed as casual wage laborers in the agricultural sector (Sarkar *et al*., 2019). In 2011-12, nearly 75% of women had to depend on the agricultural sector for their livelihoods, compared to 59% of the male workforce (Government of India, 2011-12).

Many women work on the family farm because they lack other alternative employment opportunities (Sarkar *et al*., 2019). Desai *et al.* (2010) pointed out that working on the family farm does not help generate independent income for women. Thus, females are disproportionately disadvantaged than males as they suffer the adverse consequences of extreme weather events because of their heavy dependence on climate-sensitive agriculture (Okai, 2022). In this context, access to alternate work in the manufacturing sector can act as insurance and help build resilience to natural disasters. Some studies have shown that access

to manufacturing jobs gives women greater autonomy and bargaining power, helps change gender norms, and eventually improves gender outcomes in developing countries like India and Bangladesh (Sivasankaran, 2014; Heath and Mobarak, 2015).

We investigate whether women legislators and administrators prioritize female employment in the manufacturing sector in India. Female manufacturing employment is constructed as the share of female workers employed as a percentage of total workers in the manufacturing industries. The annual data on the employment of male and female workers is compiled from various reports of the Annual Survey of Industries (ASI), Govt. of India.

To understand how greater employment opportunities in manufacturing can help build resilience to negative shocks, we examine the impact of women's political representation on female manufacturing employment in Indian states while controlling the socioeconomic and political covariates (see table A4, column C4). Our empirical findings show that a rise in women's political representation by one standard deviation leads to an increase in the proportion of females employed in manufacturing jobs by 4.6 percent relative to the sample mean.[9] Women's political representation can help increase labor force participation for females in the manufacturing sector, making women financially independent and helping in faster recovery from economic losses caused by natural disasters. Thus, it is important to have a greater representation of gender in politics to generate better welfare outcomes for society (Priyanka, 2020). Interventions by women state legislative members foster labor market outcomes, thus demonstrating an important policy aspect.

We find that increasing the share of women IAS officers leads to a rise in the proportion of female employment in manufacturing; the coefficient is statistically insignificant (see table A4, column 4). Improving women's participation rate in the manufacturing sector can lead to

[9] Annual data on the employment of workers is compiled from various reports of the Annual Survey of Industries (ASI), Government of India. See Government of NCT of Delhi (2021).

higher efficiency, better decision-making, and the undertaking of various risk management strategies (Hegewisch, 2023). Several studies have shown that the adverse impacts of natural disasters disproportionately affect women (Sapir, 1993; Pradhan *et al*., 2007; Chowdhury *et al*., 2021). Even in high-income countries, women are vulnerable to disasters because of their limited access to finance and their limited ability to cope with and recover from disasters (Stevens, 2010). In this regard, increasing women's participation in manufacturing can benefit women by making them financially independent. Financial well-being can boost women's ability to cope with the adverse effects of disasters and build economic resilience to disaster risks (Asian Development Bank, 2022). Based on this, improving the share of female employment in manufacturing is a critical channel that lessens dependence on climate-sensitive agriculture and reduces the vulnerability to natural disasters.

With the introduction of *Atmanirbhar Bharat,* employment opportunities in the Indian manufacturing sector have increased. However, it is important to mention that women enter the workforce to sustain themselves and their families (Hale, 2013). In the process of engaging in manufacturing work, women face gender-based inequalities as women and men receive unequal payment for the same type of work, and sometimes, women are rejected to perform tasks that are highly compensated (Caraway, 2007).

In addition, given the nature of work in the manufacturing sector, women face greater threats to their lives. For instance, in the brick manufacturing industry of India, brickfield workers have to perform various kinds of strenuous tasks that lead to work-related injuries in different parts of their bodies (Das, 2014). The incidence rate of workplace injuries was higher among female brickfield workers than among male workers in the brickfield region of West Bengal, India (Das, 2020). One of the main reasons for work-related injuries is the lack of responsibility of the factory owners, the differential treatment faced by women post-injury, and the negligence of the government towards providing worker safety (Paliath, 2023). Although

employment generation in manufacturing plays an important role in enhancing workers' financial stability, particularly women's financial independence, but the critical issues of occupational health and safety pose a major threat to achieving social welfare.

Appendix E

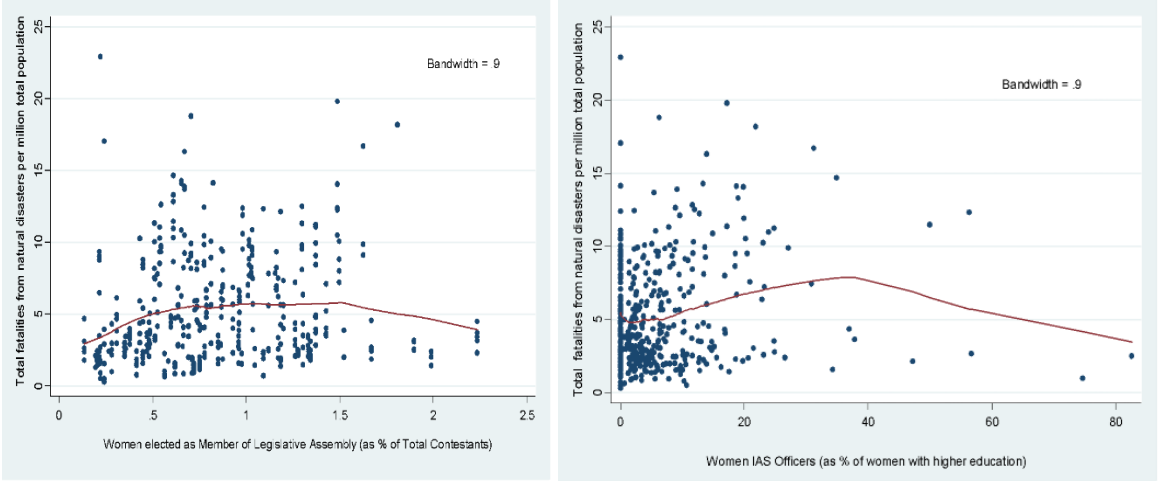

Figure A5. Natural disaster mortality and share of women MLA and women IAS. Time period: 2000-2019. Locally weighted scatterplot smoothing (lowess).

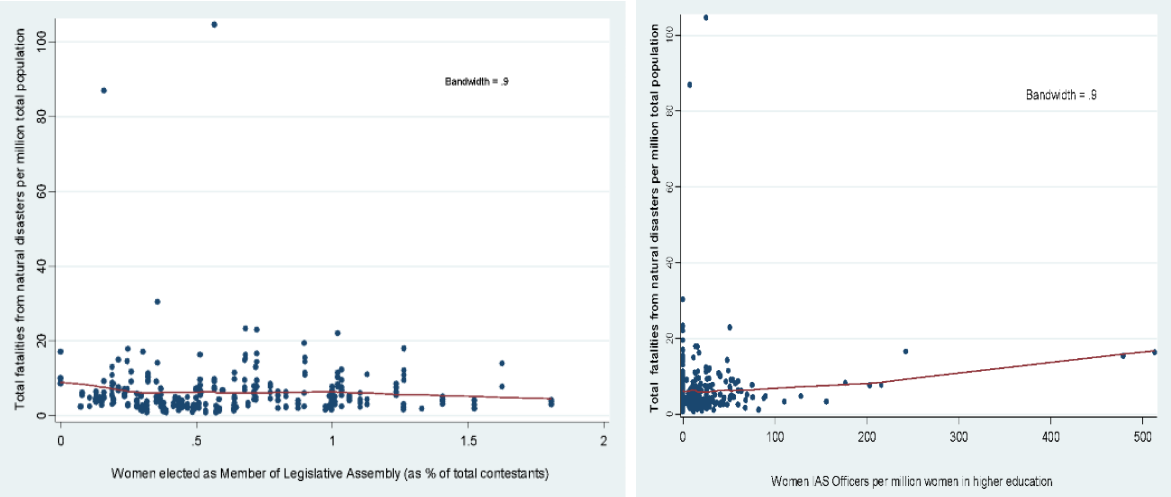

Figure A6. Natural disaster mortality and share of women MLA and women IAS. Time period: 1981-1999. Locally weighted scatterplot smoothing (lowess).

Appendix F

Robustness exercises

Combined analysis: For all 20 Indian states

We perform several robustness exercises, which are explained below with the empirical analyses. Table A5 presents the results of regression analysis, where the outcome variable is the number of total (female and male) deaths from natural disasters (cyclones, floods, landslides, heat waves, cold waves, and lightning) per mn total population. Here, we use standard errors clustered at the state level. Table A6 presents the results of the nonlinear model.

Table A5. Robustness analysis: two-way FE estimation, women's political and administrative representation and natural disaster mortality

Independent variables	**Total** (male and female) disaster mortality per mn total population	**Male** disaster mortality per mn male population	**Female** disaster mortality per mn female population
	C1	**C2**	**C3**
Women elected as Member of Legislative Assembly (as % of total contestants)(it)	-0.288 (0.847)	-0.155 (0.995)	-0.450 (0.758)
Women elected as Member of Legislative Assembly (as % of total contestants)($it-1$)	-0.714 (0.889)	-0.507 (1.031)	-0.931 (0.867)
Women elected as Member of Legislative Assembly (as % of total contestants)($it-2$)	-0.177 (0.799)	-0.156 (1.007)	-0.180 (0.709)
Women IAS Officers per mn women in higher education (it)	0.002 (0.003)	0.0001 (0.004)	0.003 (0.002)
Women IAS Officers per mn women in higher education ($it-1$)	-0.005 (0.003)	-0.003 (0.005)	-0.007 (0.003)
Women IAS Officers per mn women in higher education ($it-2$)	-0.006 (0.003)	-0.006 (0.004)	-0.005 (0.004)
State election dummy	-0.310 (0.268)	-0.183 (0.309)	-0.440 (0.295)
Women participation in election($it-1$)	0.0003 (0.023)	0.011 (0.029)	-0.013 (0.019)
Women chief minister dummy	-0.464 (0.643)	-0.934 (0.814)	0.049 (0.587)
Per capita education, health and family welfare expenditure ($it-1$)	-0.0008 (0.0003)	-0.001 (0.0004)	-0.0003 (0.0002)
ln per capita income ($it-1$)	-2.012 (3.075)	-1.966 (4.218)	-2.334 (2.175)
ln Precipitation	3.319 (1.157)	3.386 (1.070)	2.865 (1.318)
Severe flood dummy	0.928 (0.640)	0.730 (0.646)	1.110 (0.666)
Severe cyclone dummy	2.498 (1.062)	2.410 (1.012)	2.583 (1.305)
Landslide dummy	0.974 (0.859)	0.864 (0.912)	1.096 (0.854)
Forest share (as % of State area)($it-1$)	-0.035 (0.135)	0.003 (0.196)	-0.078 (0.102)
No. of States	20	20	20
Observations	699	699	699
State Fixed Effect	Y	Y	Y
Year Fixed Effect	Y	Y	Y

Notes: Clustered standard errors at the state-level are reported in parentheses. Natural disaster mortality includes deaths from floods, cyclones, landslides, heat waves, cold waves, and lightning. In all models, we control urbanization and the female-male population ratio.

Table A6. Two-way FE estimation, non-linear relationship between women's political and administrative representation and natural disaster mortality

Independent Variables	**Total** (Male and Female) disaster mortality per mn total population	**Male** disaster mortality per mn male population	**Female** disaster mortality per mn female population
	C1	**C2**	**C3**
Women elected as Member of Legislative Assembly (as % of total contestants)$(it-1)$	4.429 (1.657)	7.060 (2.377)	1.632 (0.895)
Women elected as Member of Legislative Assembly (as % of total contestants)$(it-1)$ *Squared*	-1.971 (0.775)	-3.020 (1.093)	-0.791 (0.433)
Women IAS Officers per mn women in higher education$(it-1)$	0.047 (0.018)	0.079 (0.029)	0.012 (0.020)
Women IAS Officers per mn women in higher education$(it-1)$ *Squared*	-0.0007 (0.0002)	-0.0009 (0.0003)	-0.0003 (0.0002)
State election dummy	-0.353 (0.256)	-0.372 (0.377)	-0.320 (0.137)
Women participation in election$(it-1)$	0.005 (0.018)	0.002 (0.028)	0.009 (0.012)
Women chief minister dummy	-0.789 (0.390)	-0.983 (0.538)	-0.584 (0.270)
Per capita education, health and family welfare expenditure$(it-1)$	-0.0005 (0.0002)	-0.0007 (0.0004)	-0.0002 (0.0001)
ln per capita income$(it-1)$	-5.808 (1.550)	-7.272 (2.213)	-4.329 (0.987)
ln Precipitation	1.094 (0.699)	1.697 (0.988)	0.450 (0.508)
Severe flood dummy	0.693 (0.396)	0.915 (0.478)	0.465 (0.338)
Severe cyclone dummy	0.234 (0.440)	0.092 (0.648)	0.387 (0.305)
Landslide dummy	0.108 (0.385)	0.104 (0.528)	0.097 (0.278)
Forest share (as % of State area)$(it-1)$	-0.068 (0.091)	-0.068 (0.091)	-0.054 (0.060)
Turning point: Women elected as Member of Legislative Assembly (as % of total contestants)	1.14 (93%ile)	1.17 (96%ile)	1.03 (70%ile)
Turning point: Women IAS Officers per mn women in higher education	36.27 (98%ile)	40.92 (99%ile)	19.98 (93%ile)
No. of States	20	20	20
Observations	376	376	376
State fixed effect	Y	Y	Y
Time fixed effect	Y	Y	Y

Notes: Conley standard errors are reported in parentheses. Natural disaster mortality includes deaths from floods, cyclones, and landslides. In all models, we control urbanization and the female-male population ratio. The mean of Women elected as Members of the Legislative Assembly (as a percentage of total contestants) equals 0.86, and the mean of Women IAS Officers per mn women in higher education equals 6.9.

In the quadratic model that shows the nonlinear relationship between women's empowerment and total disaster mortality from 1999 to 2019, we find that deaths from natural disasters decline increasingly with women's administrative representation (see table A6, column C1). These results are consistent with the main results reported in section 5 of the article (see table 3).

Disaggregated analysis: India's high and low human-development states

Female disaster mortality is significantly reduced in the high-HDI states with increased participation of women in political positions. With a one standard deviation increase in female political participation, we find a 75-percentage point decrease in female disaster-related deaths, which is 47 percent of the sample mean. The coefficient on the administrative representation of women is negative and significant at the 5% level (see table A7, column C3).

Increasing female participation in public administration by one standard deviation is estimated to reduce female disaster mortality by 5.7 percentage points, which is a 3.6 percent fall in female mortality relative to the sample mean. Therefore, states that are ranked higher in human development experience a significant decline in disaster-related deaths over time with more women's representation in politics.

We also examine the impact of political and administrative representation of women on disaster mortality in the case of Indian states with low achievements in human development. We find the existence of the effects of administrative representation of women on disaster mortality. With a one standard deviation increase in female administrative representation, disaster mortality declines by 27 percent of the sample mean. Results show that the coefficient on women's political participation is negative but insignificant, indicating that disaster mortality does not show a statistically significant relationship with women's political participation in the low-HDI states. Women's political underrepresentation corresponds with the weakened effects of their representation in political decision-making, as can be seen in no

Table A7. Two-way FE estimation, women's political and administrative representation and disaster mortality

	High Human Development (HDI) States			**Low Human Development (HDI) States**		
Variables	Total disaster mortality per mn population	Male disaster mortality per mn male population	Female disaster mortality per mn female population	Total disaster mortality per mn population	Male disaster mortality per mn male population	Female disaster mortality per mn female population
	C1	**C2**	**C3**	**C4**	**C5**	**C6**
Women elected as Member of Legislative Assembly (as % of total contestants) $(it-2)$	-1.359 (0.737)	-1.143 (0.808)	-1.567 (0.815)	-0.093 (0.399)	-0.059 (0.323)	-0.133 (0.516)
Women IAS Officers per mn women in higher education$(it-2)$	-0.003 (0.001)	-0.002 (0.003)	-0.004 (0.002)	-0.024 (0.012)	-0.019 (0.008)	-0.029 (0.016)
No. of States	10	10	10	10	10	10
Observations	364	364	364	335	335	335
State fixed effect	Y	Y	Y	Y	Y	Y
Time fixed effect	Y	Y	Y	Y	Y	Y

Notes: Conley standard errors are reported in parentheses. Natural disaster mortality includes deaths due to floods, cyclones, and landslides. We control the urbanization rate and the female-male population ratio in all models. Time period: 1981-2019. We also control the state election dummy, Women participation in the election, Women chief minister dummy, Per capita education, health, and family welfare expenditure, ln per capita income, ln Precipitation, Severe flood dummy, Severe cyclone dummy, Landslide dummy, Forest share (as % of State area). **High HDI States:** Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Kerala, Maharashtra, Punjab, Tamil Nadu, Uttarakhand, West Bengal. **Low HDI States:** Andhra Pradesh, Assam, Bihar, Chhattisgarh, Jharkhand, Karnataka, Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh.

significant reduction in disaster mortality. Iyer and Mani (2019) suggest that the underrepresentation of women in political positions is correlated with the substantive gender gap in several indicators of human development, such as health, education, and economic opportunities.

For instance, Bihar, located in northern India, experienced the second-largest female deaths from floods between 1983 and 2013, with the least achievement in the Human Development Index (Chowdhury *et al*., 2021). Bihar is one of the poorest states in India in terms of per capita income, and it faces multiple challenges, such as gender disparities in the labor market, high fertility rates, low enrolment in education, and a huge dependence on agriculture (Gupta, 2024).

On the contrary, Kerala, the southern Indian state, has made significant achievements in human development indicators, as reflected in the high score of HDI, and experienced the lowest number of female deaths due to floods (Chowdhury *et al*., 2021). This significant performance can be attributed to the gender-sensitive policies implemented by the Kerala government. In the 1990s, when economic reforms were implemented in India with a greater emphasis on limiting state intervention and emphasizing a market-based outlook, public interventionist policies implemented in Kerala started promoting community participation and women's empowerment (Ramakumar and Eapen, 2022). In 2015, the Kerala government initiated the 'Gender Equality and Women Empowerment Policy' to ensure equal access of women and men to social, economic, and political opportunities so that women and men can equally participate in the development of the state (Government of Kerala, 2015). This more inclusive policy emphasizes gender equality in social, economic, and political spheres.

Kerala has made substantial progress in achievements in the conventional social indicators of human development that contribute to enhancing the status of women in the society, such as high literacy rate, low infant mortality, favorable maternal mortality ratio and

female-male sex ratio, and higher life expectancy for females compared to males; however, women have not achieved well enough in other development indicators (Baskaran, 2011). Per statistics, Kerala's neonatal mortality rate is 2.6 per 1,000 births, which is less than one-tenth in the case of Bihar, and the highest sex ratio at birth in the country (951 females for every 1000 males). There remains a significant concern that the high levels of human development have not been able to address gender inequality in the political space, as evident in the poor political representation of women in Kerala and their voices being not equally heard in important decision-making bodies at the state level (Government of Kerala, 2015).

Bihar has experienced an increased participation of females in voting in elections. However, women's under-representation in state politics continues to persist as their influence over the male-dominated structure of state legislature is far less than their numerical strength (Verma and Yadav, 1996). Unlike other Indian states, the Bihar Government has introduced a 50 percent reservation of women in the state's rural government bodies to encourage higher participation of women in state politics. However, the gender quota in the 73rd amendment could not lead to a significant improvement in the survival of children in the bottom income groups as the infant and child mortality rates are already much higher in Bihar than in the rest of India (Kumar and Prakash, 2012).

Appendix G

Policy implications

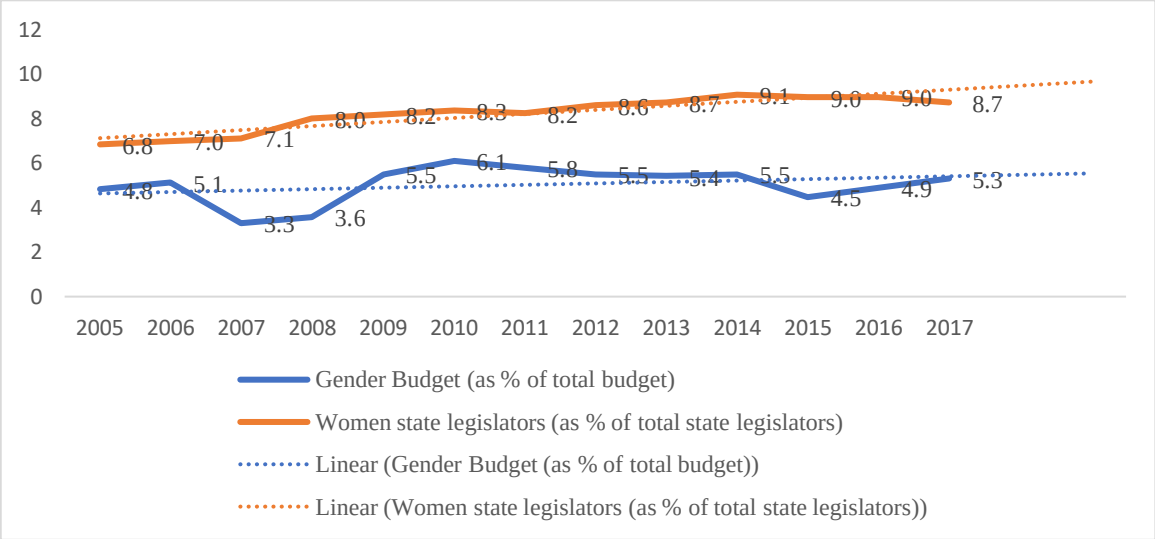

Figure A7. Gender budgeting and women's political participation.

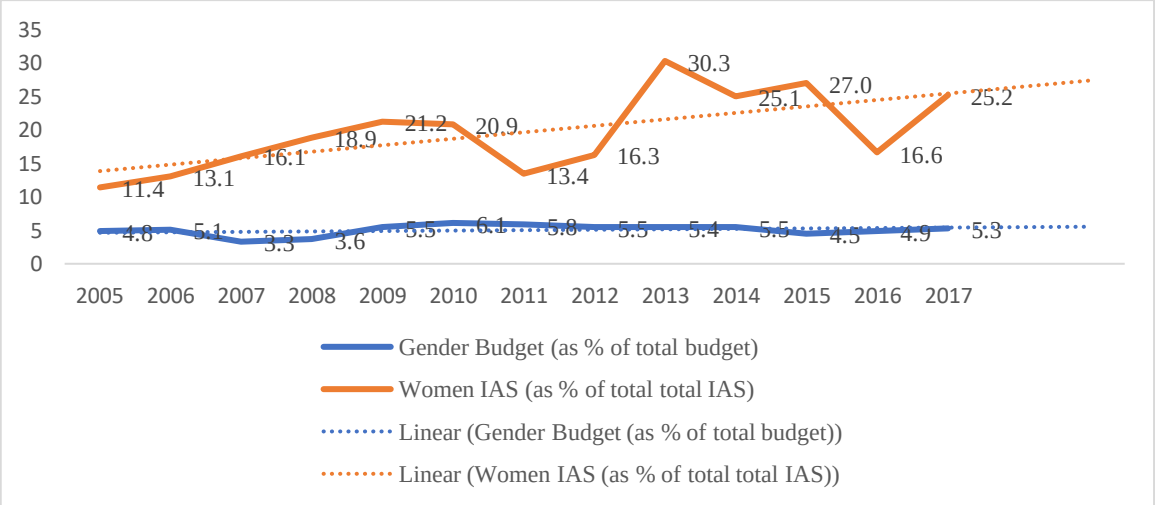

Figure A8. Gender budgeting and women's administrative representation.

References

Ahmed S (2004) The gendered context of vulnerability: Coping/adapting to floods in Eastern India. Gender and Development Researcher.

Arulampalam W, Dasgupta S, Dhillon A and Dutta B (2009) Electoral goals and center-state transfers: a theoretical model and empirical evidence from India. *Journal of Development Economics* **88**, 103-119.

Asian Development bank (2022) Financial inclusion boosts an individual's or household's ability to cope during and after a disaster. Manila, Philippines. Available at http://dx.doi.org/10.22617/TCS220335-2

Baltagi BH and Bresson G (2012) A robust Hausman–Taylor estimator. In Baltagi BH, Carter Hill R, Newey WK and White HL (eds). *Essays in Honor of Jerry Hausman*. Leeds, UK: Emerald Group Publishing Limited, pp. 175–214.

Baskaran T, Bhalotra S, Min B and Uppal Y (2024) Women legislators and economic performance. *Journal of Economic Growth* **29**, 151–214.

Baskaran T, Min B and Uppal Y (2015) Election cycles and electricity provision: Evidence from a quasi-experiment with Indian special elections. *Journal of Public Economics* **126**, 64–73.

Beaman L, Duflo E, Pande R and Topalova P (2006) Women politicians, gender bias, and policy-making in rural India. The state of the world's children 2007: Background Paper. UNICEF. December.

Besley T and Burgess R (2002) The political economy of government responsiveness: Theory and evidence from India. *The Quarterly Journal of Economics* **117**, 1415–1451.

Bhalotra S, Clots-Figueras I and Iyer L (2018) Pathbreakers? Women's electoral success and future political participation. *The Economic Journal* **128**, 1844–78.

Bhatia S and Singh S (2019) Empowering women through financial inclusion: a study of urban slum. *Vikalpa* **44**, 182–197.

Birthal PS, Hazrana J and Negi DS (2021) Impacts of climatic hazards on agricultural growth in India. *Climate and Development* **13**, 895–908.

Blankespoor B, Dasgupta S, Laplante B and Wheeler D (2010) Adaptation to climate extremes in developing countries: the role of education. World Bank Policy Research Working Paper, 5342.

Bosschaart A, van der Schee J, Kuiper W and Schoonenboom J (2016) Evaluating a flood-risk education program in the Netherlands. *Studies in Educational Evaluation* **50**, 53–61.

Burchi F and Singh K (2020) Women's political representation and educational attainments: a district-level analysis in India. *Journal of South Asian Development* **15**, 7–33.

Cameron AC and Trivedi PK (2010) *Microeconometrics using Stata,* vol. 2. College Station, TX: Stata Press.

Campbell DE (2006) What is education's impact on civic and social engagement. In *Measuring the Effects of Education on Health and Civic Engagement: Proceedings of the Copenhagen Symposium*, pp. 25–126.

Caraway TL (2007) *Assembling Women: The Feminization of Global Manufacturing*. Cornell University Press.

Chadha A (2014) Political participation of women: a case study in India. *OIDA International Journal of Sustainable Development* **7**, 91–108.

Chanana K (2000) Treading the hallowed halls: women in higher education in India. *Economic and Political Weekly*, 1012–1022.

Chary MR (2012) Women and political participation in India: a historical perspective. *The Indian Journal of Political Science* **73**, 119–132.

Chattopadhyay R and Duflo E (2004) Women as policy makers: evidence from a randomized policy experiment in India. *Econometrica* **72**, 1409–1443.

Chowdhury JR and Parida Y (2023) Flood shocks and post-disaster recovery of households: an empirical analysis from rural Odisha, India. *International Journal of Disaster Risk Reduction* **97**, 104070.

Chowdhury JR, Parida Y and Agarwal P (2022) How flood affects rural employment in India: a gender analysis. *International Journal of Disaster Risk Reduction* **73**, 102881.

Chowdhury JR, Parida Y and Goel PA (2021) Does inequality-adjusted human development reduce the impact of natural disasters? A gendered perspective. *World Development* **141**, 105394.

Clots-Figueras I (2011) Women in politics: evidence from the Indian States. *Journal of Public Economics* **95**, 664–690.

Clots-Figueras I (2012) Are female leaders good for education? Evidence from India. *American Economic Journal: Applied Economics* **4**, 212–244.

Das B (2014) Prevalence of work-related musculoskeletal disorder among the brick field workers of West Bengal, India. *Archives of Environmental & Occupational Health* **69**, 231–40.

Das B (2020) Prevalence of work-related occupational injuries and its risk factors among brickfield workers in West Bengal, India. *International Journal of Industrial Ergonomics* **80**, 103052.

Dash B and Walia A (2020) Role of multi-purpose cyclone shelters in India: last mile or neighbourhood evacuation. *Tropical Cyclone Research and Review* **9**, 206–217.

Declaration B (2015) India's Report on the Implementation of Beijing Declaration and Platform for Action in Context of the Twenty Fifth Anniversary of the Fourth World Conference on Women and the Adoption of the Beijing Declaration and Platform for Action 2019.

Department for Business Innovation & Skills (BIS) (2013) The benefits of higher education participation for individuals and society: key findings and reports "The Quadrants". BIS Research Paper No. 146, London, UK.

Desai SB, Dubey A, Joshi BL, Sen M, Shariff A and Vanneman R (2010) *Human Development in India.* New York: Oxford University.

Drzewiecki DM, Wavering HM, Milbrath GR, Freeman VL and Lin JY (2020) The association between educational attainment and resilience to natural hazard-induced disasters in the West Indies: St. Kitts & Nevis. *International Journal of Disaster Risk Reduction* **47**, 101637.

Duflo E (2003) Grandmothers and granddaughters: old-age pensions and intrahousehold allocation in South Africa. *The World Bank Economic Review* **17**, 1–25.

Fadia K (2014) Women's empowerment through political participation in India. *Indian Journal of Public Administration* **60**, 537–548.

Field CB, Barros V, Stocker, TF and Dahe Q (eds) (2012) *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation.* Special report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Government of India (GoI) (2005) The Gazette of India. The Disaster Management Act, 2005. Ministry of Law and Justice.

Government of India (2011–12) Employment and Unemployment Situation in India (EUSI). National Sample Survey Office, Ministry of Statistics and Programme Implementation, New Delhi.

Government of India (2017) Implementation of National School Safety Guidelines. Ministry of Human Resource Development, New Delhi, India.

Government of Kerala (2015) Gender Equality Women's Empowerment Policy. Social Justice Department. Thiruvananthapuram. Available at

https://document.kerala.gov.in/Porteddata/extensionpdf/documents/10180/ab87a57f-1502-4c2f-9f47-144c802366f0.pdf.

Government of NCT of Delhi (2021) Report on Annual Survey of Industries, 2018-2019. Directorate of Economics & Statistics, Delhi. Available at https://des.delhi.gov.in/sites/default/files/DES/generic_multiple_files/asi_report_2018-19_delhi_compressed.pdf .

Gulati N and Spencer E (2021) Leaders and citizens: women's political participation in India. International Growth Center (IGC), London.

Gupta P (2024) What can Bihar, with per-capita income 30% of national average, do to shed its low-income status? *The Economic Times*, 10 March 2024.

Hale L (2013) A critical analysis of women in manufacturing. *Race, Gender & Class*, 281–293.

Hausman JA and Taylor WE (1981) Panel data and unobservable individual effects. *Econometrica* **49**, 1377–1398.

Heath R and Mobarak AM (2015) Manufacturing growth and the lives of Bangladeshi women. *Journal of Development Economics* **115**, 1–15.

Hegewisch A (2023) Advancing women in manufacturing: perspectives from women on the shop floor. Institute for Women's Policy Research, Washington, DC.

Hoffmann R and Muttarak R (2017) Learn from the past, prepare for the future: impacts of education and experience on disaster preparedness in the Philippines and Thailand. *World Development* **96**, 32–51.

Iyer L and Mani A (2019) The road not taken: gender gaps along paths to political power. *World Development* **119**, 68–80.

Jamison DT, Summers LH, Alleyne G, Arrow KJ, Berkley S, Binagwaho A, Bustreo F, Evans D, Feachem RG, Frenk J and Ghosh G (2013) Global health 2035: a world converging within a generation. *The Lancet* **382**, 1898–1955.

KC S (2013) Community vulnerability to floods and landslides in Nepal. *Ecology and Society* **18**, 8.

Khurana R, Mugabe D and Etienne XL (2022) Climate change, natural disasters, and institutional integrity. *World Development* **157**, 105931.

Kripfganz S and Schwarz C (2019) Estimation of linear dynamic panel data models with time-invariant regressors. *Journal of Applied Econometrics* **34**, 526–546.

Kumar S and Prakash N (2012) Political Decentralization, Women's Reservation and Child Health Outcomes: A Case Study of Rural Bihar. Working paper No. 2012–18. University of Connecticut, Department of Economics.

Mavisakalyan A and Tarverdi Y (2019) Gender and climate change: do female parliamentarians make difference? *European Journal of Political Economy* **56**, 151–164.

Miller JE and Rodgers YVDM (2008) Economic importance and statistical significance: guidelines for communicating empirical research. *Feminist Economics* **14**, 117–149.

Mileti DS and Sorensen JH (1990) Communication of emergency public warnings: a social science perspective and state of-the-art assessment. Federal Emergency Management Agency (No. Report ORNL-6609). Oak Ridge, TN.

Mundial B (2010) The Cost to Developing Countries of Adapting to Climate Change. New Methods and Estimates. The Global Report of the Economics of Adaptation to Climate Change Study. Consultation Draft.

Muttarak R and Lutz W (2014) Is education a key to reducing vulnerability to natural disasters and hence unavoidable climate change? *Ecology and Society* **19**.

Muttarak R and Pothisiri W (2013) The role of education on disaster preparedness: case study of 2012 Indian Ocean earthquakes on Thailand's Andaman Coast. *Ecology and Society* **18**.

Muzenda-Mudavanhu C, Manyena B and Collins AE (2016) Disaster risk reduction knowledge among children in Muzarabani District, Zimbabwe. *Natural Hazards* **84**, 911–931.

Noy I (2009) The macroeconomic consequences of disasters. *Journal of Development Economics* **88**, 221–231.

Okai A (2022) Women are Hit Hardest in Disasters, so why are Responses Too Often Gender-Blind? United Nations Development Programme Blog.

Paliath S (2023) Auto sector businesses actively avoid reporting even serious accidents, injuries. *IndiaSpend*, 23 November 2023. Available at https://www.indiaspend.com/indiaspend-interviews/auto-sector-businesses-actively-avoid-reporting-even-serious-accidents-injuries-883001.

Parida Y (2020) Economic impact of floods in the Indian states. *Environment and Development Economics* **25**, 267–290.

Pradhan EK, West Jr KP, Katz J, LeClerq SC, Khatry SK and Shrestha SR (2007) Risk of flood-related mortality in Nepal. *Disasters* **31**, 57–70.

Priyanka S (2020) Do female politicians matter for female labor market outcomes? Evidence from state legislative elections in India. *Labour Economics* **64**, 101822.

Psacharopoulos G (1994) Returns to investment in education: a global update. *World Development* **22**, 1325–1343.

Rahman M and Alam K (2016) The impact of natural disasters on women: a case study from Bangladesh. South Asia@ LSE.

Rai P (2017) Women's participation in electoral politics in India: silent feminisation. *South Asia Research* **37**, 58–77.

Ramakumar R and Eapen M (2022) The legacy of public action and gender-sensitivity of the pandemic response in Kerala State, India. *Economia Politica* **39**, 271–301.

Sapir D (1993) Natural and man-made disasters: the vulnerability of women-headed households and children without families. *World Health Statistics Quarterly* **46**, 227–233.

Sarkar S, Sahoo S and Klasen S (2019) Employment transitions of women in India: a panel analysis. *World Development* **115**, 291–309.

Sharma N (2024) Family support, safety, study material a click away — what's driving more women to take UPSC exam. *The Print*, 14 January 2024.

Sharma RK (2013) Disaster management education at UG level in the Indian university system. *Journal of Advanced Pharmaceutical Technology & Research* **4**, 76.

Singh N (2007) Higher education for women in India – choices and challenges. *Forum on Public Policy* **2007**. Available at https://eric.ed.gov/?id=EJ1099426.

Sivasankaran A (2014) Work and women's marriage, fertility, and empowerment: evidence from textile mill employment in India. Job Market Paper, Harvard University.

Stevens C (2010) Are women the key to sustainable development? *Sustainable Development Insights* **3**, 1–8.

Striessnig E, Lutz W and Patt AG (2013) Effects of educational attainment on climate risk vulnerability. *Ecology and Society* **18**.

Tishkov V (1993) Women in Russian politics. *Economic and Political Weekly*, 2837–2840.

Torani S, Majd PM, Maroufi SS, Dowlati M and Sheikhi RA (2019) The importance of education on disasters and emergencies: a review article. *Journal of Education and Health Promotion* **8**.

UNDP (United Nations Development Programme) (2021) *Gender Equality in Public Administration*. New York, NY: UNDP and University of Pittsburgh.

UNISDR (2015) Women's leadership in risk-resilient development: good practices and lessons learned. United Nations.

Verma RK and Yadav GK (1996) Women in Bihar politics. *Economic and Political Weekly* **31**, 935–937.

Wisner B, Blaikie PM, Blaikie P, Cannon T and Davis I (2004) *At Risk: Natural Hazards, People's Vulnerability and Disasters.* Psychology Press.