Disaster's Shadow: The Overlooked Impact of Floods, Cyclones, and Tornadoes on Violence against Women and Girls in Mexico

Miriam Berretta   Daria Denti

February 2025

1 Background and research questions

This study investigates the impact of exposure to natural hazards—specifically floods, cyclones, and tornadoes— declared as disasters, on the incidence of gender-based violence in Mexico from 2008 to 2023. International organisations and other bodies of research have long denounced the increase in violence, including gender-based violence, in the aftermath of disasters. Despite that, the current body of causal evidence linking natural hazards to gender-based violence is limited to a few papers. Recent causal studies from Perù (Díaz & Saldarriaga, 2023), Russia (Otrachshenko et al., 2021), and Mexico (Silverio-Murillo et al., 2024; Aguilar-Gómez & Salazar-Díaz, 2025) suggest that droughts, extreme temperatures, and earthquakes can increase intimate partner violence. However, the literature is mixed regarding the potential psychological impact of disasters on violent behaviours, social cohesion and solidarity, highlighting how the specific contexts in which disasters occur affect people's reactions differently. While the literature on this relationship is gradually expanding, quantitative measures remain limited and largely descriptive. To the best of our knowledge, no prior research has examined the effects of floods, cyclones, and tornadoes on violence against women and girls (VAWG) using counterfactual methods.

2 Data

2.1 Violence against women and girls

To identify instances of VAWG at the municipal level, we utilized official hospitalization data provided by the Mexican government's health department. These data span from 2007 to 2023, encompassing 34,348 violent events across 602 municipalities. The dataset offers daily information on diagnoses and hospitalization causes, classified according to the 10th International Classification of Diseases (ICD-10), a medical classification list of 69,000 codes released by the World Health Organization. The dataset includes details on the primary and secondary diagnoses, the 'external cause' of the diagnosis, and the location where the event occurred. Following established literature, we selected 495 codes from the external causes codes that are highly likely to be associated with episodes of VAWG. Additionally, the dataset provides supplementary information such as the patient's residence, hospital location, marital status, sex, age, and language (including whether the patient speaks an indigenous language).

2.2 Natural hazards and disasters

We obtained information on the natural hazards recorded as disasters by the Mexican National Centre to Prevent Disasters (CENAPRED). The 2007-2023 dataset includes 5456 municipalities hit by disasters of which 3721 are storms, 1437 tropical cyclones, 399 floods, 3 tornadoes.

2.3 Additional variables

We use additional data provided by the observatory for sexual and reproductive rights in Puebla (Odesyr), the Intimate Partner Homicide maps developed by María Salguero Bañuelos ('Mapa Nacional de Feminicidios en México'), Sonia Madrigal ('Los feminicidios en México'), and the Mexican Government death registry. These data include geolocalised information at the municipality level on other types of violent crime which could confound gender-based violence. Specifically, we retrieved data on the local level of political violence, organized crime violence and social-unrest-related violence by combining figures from researchers, NGOs and observatories (DataCivica-MéxicoEvalúa, 2024; ACLED, 2024; Esparza & Mancera, 2018; INTERSECTA-DataCivica, 2023; Trejo & Ley, 2021). Figures on the local presence of organized crime were provided by the OCVED project (Osorio & Beltran, 2020). We collected municipal-level data on the disappeared people by gender from the Mexican Government Registro Nacional de Persona Desaparecidas y No Localizadas; figures on the share of female population, and share of unemployment by gender by the Mexican National Statistics and Geography Office (INEGI). We also use data on the share of informal economic activities at the State level. The final dataset includes all the variables matched by the municipality and aggregated at the monthly level.

3 Identification strategy and method

We have identified the disasters as those events for which the Mexican government released a declaration of disaster based on the estimated damages and functional to access recovery funds from the FONDEN program, a financial recovery government program for natural disasters. Since the criteria to access FONDEN is also based on a certain level of the heavy rainfall index, these events can be considered exogenous. They are heterogeneous across time and space, allowing to clearly identify treated and control municipalities. In this study, the treatment group consists of municipalities that have experienced at least one disaster, while in the control group, the municipalities never experienced a flood, cyclone, storms, or tornado. In order to have pre-treatment years to compare, we have chosen 2010 as the first treatment period since the severe storms occurred in that year caused the highest levels of economic damages in the last 25 years. We examined different lengths of treatment, ranging from 1, 6, 12, 24 months, or more, since the time of recovery may vary. This variation in treatment length is also useful for conducting sensitivity tests. To establish a causal relationship between the exposure to the disasters and the occurrence of VAWG, we employed a staggered difference-in-difference methodology. Following the recent development of the staggered diff-in-diff (Borusyak et al., 2024; de Chaisemartin & D'Haultfoeuille, 2024) we run a two-way fixed effects model that allows for heterogeneous treatment effects between groups and over time. The estimation considered two settings: the hit by the disaster by using a disaster binary indicator, and the different intensity of the disaster (continuous treatment) according to the economic effect and deaths caused by each disaster, or other measures of intensity.

4 Preliminary results

We have run the model on a subset excluding the years of the Covid pandemic to avoid biases given the use of the hospitalization data. Our main outcome is the log ratio of the codes related to VAWG on the total diagnosis codes of women patients, weighted for the female population at the municipal level. The balancing tests run on population and organised crime do not show significant differences between treated and control municipalities. Preliminary results, which need further validation, show a significant increase of 0.41 of the VAGW hospitalizations four months after the occurrence of the disaster. The results hold with different length of the treatment. Several factors may contribute to the delay in the observed increase. For instance, in the aftermath of a disaster, hospitals may be overwhelmed, preventing victims of violence from seeking medical attention. Additionally, women affected by violence in the context of a disaster may prioritize caring for their families and may lack the means to visit a hospital. Another possibility is that incidents of violence gradually rise after a disaster but only escalate to the point of requiring hospitalization after some time.

5 Next steps

In the next months we will run a number of different analysis to validate our results. First, to comprehensively analyze the impact of different lengths of treatment, we will run the model for other durations. Additionally, we will conduct balancing tests on other variables such as employment rates, the number of disappeared people, and instances of political violence to ensure treated and control municipalities are similar enough. We will further explore different measures of violence, including feminicide rates, emergency calls, and, possibly, police records. We will also run the same analysis with a smaller selection of ICD-10 codes to identifying episodes of intimate partner violence rather than general VAWG. Additionally, the same analysis will be repeated, taking into consideration any kind of disaster to understand its broader implications. Robustness checks will be performed using placebo tests, different subsets of hospitalization codes, and focusing on municipalities that have never declared an emergency event, rather than just a disaster event. Furthermore, we will investigate whether the disaster forced people to change hospitals due to the disruption of the healthcare services. To run the analysis on the continuous treatment, we will gather additional data on the economic damages of the disasters, the number of people affected, deaths, and the impact on infrastructures at the municipality level.

References

ACLED (2024). Armed conflict location & event data. Mexico Outlook.

Aguilar-Gómez, S. & Salazar-Díaz, A. (2025). *Droughts and domestic violence: Measuring the gender-climate nexus*. Technical report, IDB Working Paper Series.

Borusyak, K., Jaravel, X., & Spiess, J. (2024). Revisiting event-study designs: Robust and efficient estimation. *The Review of Economic Studies*, 91(6), 3253–3285.

DataCivica-MéxicoEvalúa (2024). *Votar entre balasa: Entendiendo la violencia politico-criminal en México*. Technical report.

de Chaisemartin, C. & D'Haultfoeuille, X. (2024). Difference-in-differences estimators of intertemporal treatment effects. *The Review of Economics and Statistics*, (pp. 1–45).

Díaz, J.-J. & Saldarriaga, V. (2023). A drop of love? rainfall shocks and spousal abuse: Evidence from rural peru. *Journal of health economics*, 89, 102739.

Esparza, D. P. & Mancera, H. D. P. (2018). *Mayoral Homicide in Mexico: A Situational Analysis on the Victims, Perpetrators, and Locations of Attacks*. Technical report, Rice University's Baker Institute for Public Policy.

INTERSECTA-DataCivica (2023). *Base Oculta*. Technical report.

Osorio, J. & Beltran, A. (2020). Enhancing the Detection of Criminal Organizations in Mexico using ML and NLP. In *2020 International Joint Conference on Neural Networks (IJCNN)* (pp. 1–7).: IEEE.

Otrachshenko, V., Popova, O., & Tavares, J. (2021). Extreme temperature and extreme violence: evidence from russia. *Economic Inquiry*, 59(1), 243–262.

Silverio-Murillo, A., Marquez-Padilla, F., & Balmori-de-la Miyar, J. (2024). Earthquakes and crimes against women. *Feminist Economics*, 30(4), 153–179.

Trejo, G. & Ley, S. (2021). High-Profile Criminal Violence: Why Drug Cartels Murder Government Officials and Party Candidates in Mexico. *British Journal of Political Science*, 51(1), 203–229.