

Rainfall-induced sediment disasters during hurricane incidence in Nuevo Leon, Mexico

¹⁾ Laura Sanchez-Castillo, ²⁾ Tetsuya Kubota, and ³⁾ Israel Cantú-Silva

¹⁾ Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, ²⁾ Faculty of Agriculture, Kyushu University, ³⁾ Faculty of Forestry Sciences, Universidad Autonoma de Nuevo León, Mexico

Introduction

The consequences of rainfall-induced sediment related disasters in areas where meteorological events such as cyclones, hurricanes or typhoons are recurrent are ravaged. Throughout its history, the state of Nuevo Leon have been hit by major tropical storms and hurricanes in summer and part of fall developed in the Atlantic and Caribbean sea, reaching the gulf of Mexico coast affecting all the state. From the years of 1851 to 2011 the frequency of tropical storms and hurricanes appears to increase, especially from 2000 to 2010. This increasing in the frequency of hurricanes has led to an increase of the number of landslides occurred in the area of the state of Nuevo Leon. Although there is not a complete landslide database in Mexico, preliminary statistics show that most catastrophic sediment related disasters have been associated with rainfall.

Study Area

The state of Nuevo Leon is located in the northeast part of Mexico; its territory covers 64,220 square kilometers. The Sierra Madre Oriental, one of Mexico's major mountain ranges, crosses the state (Figure 1). Nuevo León has an extreme climate, and there is very little rainfall throughout the year. The average annual rainfall is between 300 and 600 mm. Due to the extreme climate of the state of Nuevo Leon and the presence of hydro meteorological phenomena like hurricanes and drought the presence and spread of forest fires are promoted. Also the lack of regulations in the Sierra Madre Oriental area makes the immoderate logging and overgrazing that are huge problems for this area of the state, which is affecting the vegetation coverage and causing erosion problems. In recent years, the urban sprawl has spread to the Sierra Madre Oriental Area, the construction of houses, buildings and roads had change the natural topography of the area affecting the hydrology. Even with all these risks, some of these buildings are raised without considering the consequences of the steep terrain and runoff water running down the slopes in the rainy season, and even more of the ones when hurricane strikes the metropolitan area.

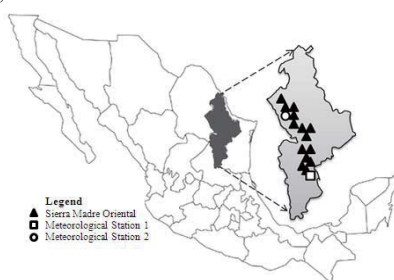


Figure 1. The state of Nuevo Leon in Mexico and Sierra Madre Oriental

Methodology

Historical Information of the incidence of hurricanes and severe storms that impacted Nuevo Leon state from the year of 1971 to 2010 was gathered and analyzed along with the total accumulated rainfall during each incidence in two different meteorological stations in Nuevo Leon state; these are to establish the pattern of accumulated rainfall during each hurricane event during this period of time. Rainfall data from two different stations was analyzed: Station 1 and 2 respectively. Station 1 is located in southern part the Sierra Madre Oriental and the Station 2 in the metropolitan area of the capital of Nuevo Leon state: Monterrey city. The rainfall data from these meteorological station was obtained from the SMN (Meteorological National Service of Mexico), and the described meteorological stations above were chosen because their proximity to severe sediment disasters in the state of Nuevo Leon. Sediment disasters information was obtained from the records from Civil Protection of Nuevo Leon and historical records from the local newspapers.

Results

A total of nine hurricane events that impacted Nuevo Leon state from the period of 1971 -2010 were analyzed. During the occurrence of hurricane Alex in 2010 the number of landslides that occurred just in the metropolitan area of Monterrey city was counted as 13. The section of 843.65 Km length in roads were damaged, the bridges and drainage system in the metropolitan area adjacent to the Sierra Madre Oriental were destroyed, a total of 3,340 million of Mexican pesos were invested in the reconstruction of infrastructure damages from hurricane Alex (Figure 2). The daily accumulated rainfall during each hurricane event in Nuevo Leon state from the years of 1971-2010, showed an increasing tendency in the rainfall intensity during each hurricane event (Figure 3). The increasing tendency in rainfall intensity came along with an increasing number and severity of sediment disasters during hurricane events in the Metropolitan Area of Monterrey city and Sierra Madre Oriental (Figure 4).



Figure 2. A) Sediment related disasters in the Metropolitan Area, and B) Mountainous Area of NL state

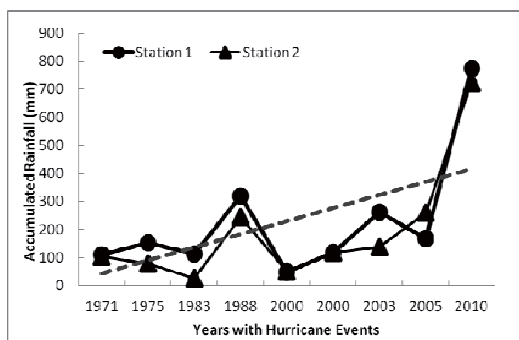


Figure 3. Accumulated Rainfall during each hurricane event in NL state.

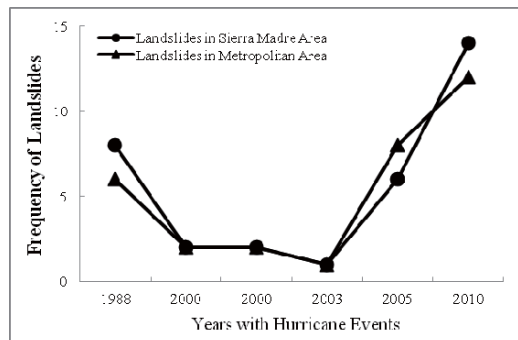


Figure 4. Longterm fluctuation of landslide frequency during hurricane events in Metropolitan and Mountainous area of NL state.

Conclusion

Between the period of 1971-2010 the hurricane event which brought the highest cumulative rainfall was Alex with 862 mm. All the hurricane events and severe storms analyzed shown an accumulated rainfall bigger than the minimum average annual rainfall in the state of Nuevo Leon, also every event analyzed in this study caused several infrastructure and facilities damages, citizen casualties and several landslides in the state of Nuevo Leon. The lack of a precise landslide inventory and historical records of the landslides registered in the state of Nuevo Leon, deduces a big problem to solve for the development of a accurate warning system in this northeast area of the country of Mexico.

References

Sanchez-Castillo L, Kubota T, Cantu-Silva I (2012): Hurricane Incidence and Sediment disasters under the climate change in Nuevo Leon, Mexico. Proc. 3rd Conference on Forest and Water in a Changing Environment, p96.