Coastal dynamics in the Pacific of Panama: an analysis of historical records and their implications for coastal risk management

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Introduction

Vulnerable coastal regions, particularly in Panama, have suffered significant erosion, threatening local infrastructure and economies. To address this, a methodological framework was proposed for analyzing historical coastal data, using Panama's Pacific coast as a pilot zone. This approach integrates social media advisories, particularly from Twitter, with historical data, enabling cross-validation and trend analysis. The findings aim to improve the accuracy of risk communication and inform coastal management strategies.
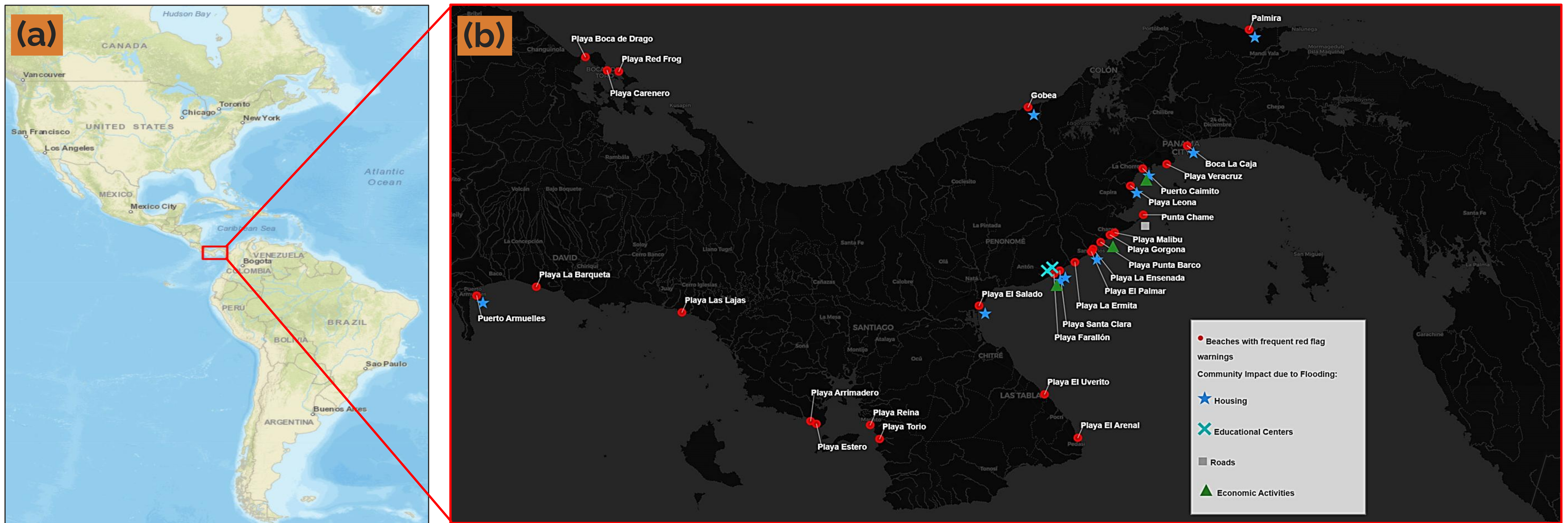

Figure 1. (a) Study area location. (b) Identification of coastal risk zones, including beaches where coastal flooding has been recorded, causing damage and loss of houses, impacts on educational centers, roads, and economic activities.
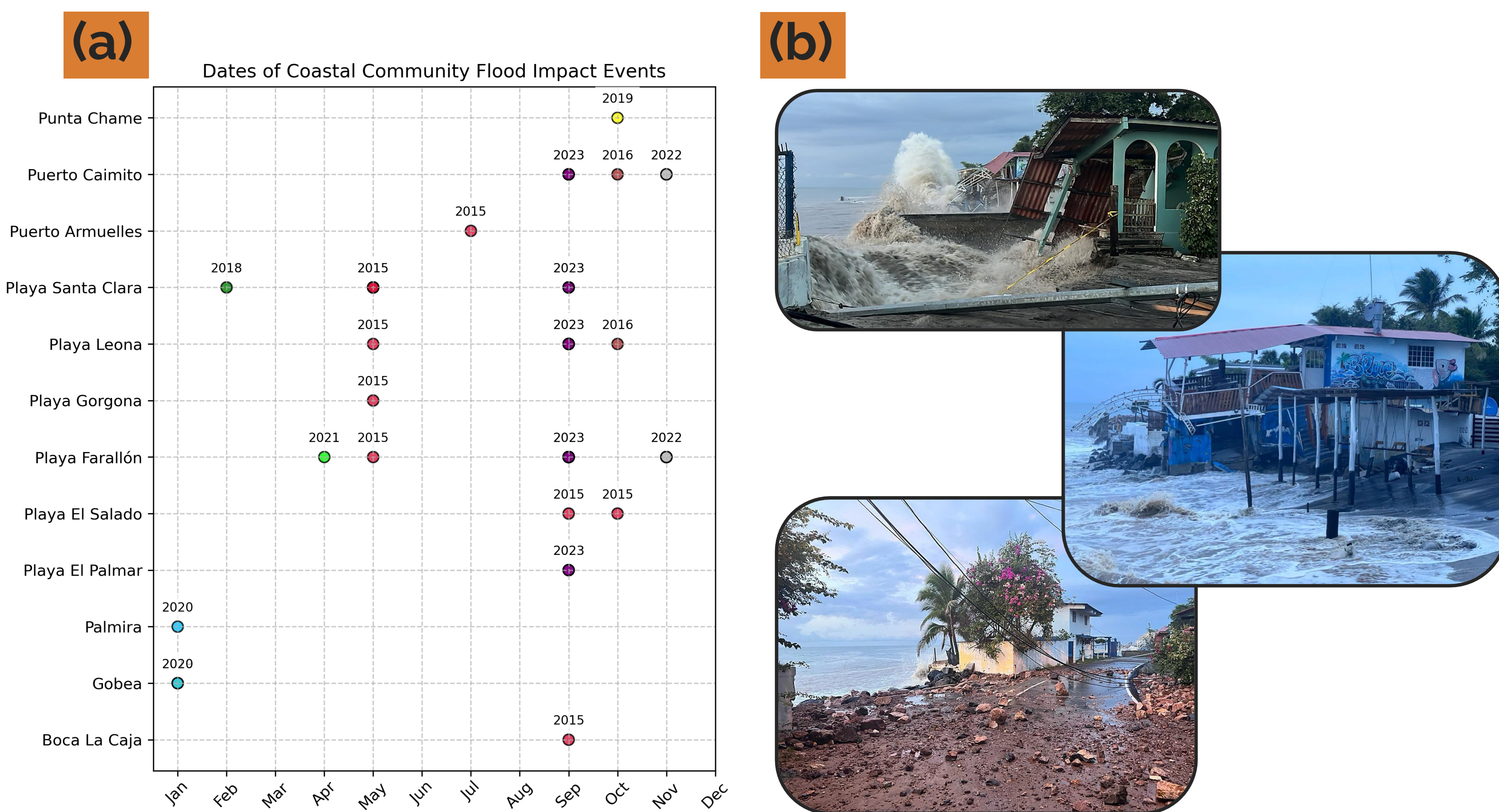

Figure 2. (a) Dates of coastal events associated with reported impacts on coastal communities in the Pacific coast of Panama. (b) Example of the impacts caused by extreme waves during the event recorded in 2023 at Playa Farallón. Photos Courtesy of **Manuel E. Gómez Sánchez (SINAPROC – Republic of Panama)**

During Panama's rainy season, from May to November, atmospheric systems that influence southward wave patterns become more pronounced. These systems, coupled with the warm phase of ENSO, increase wave energy, thereby heightening the risk of coastal impacts. A notable example occurred in May 2015, when significant wave heights exceeded 1 meter, resulting in flooding that affected more than 10 houses, a school, and several commercial establishments.

The beaches most affected by coastal flooding events are located between Puerto Caimito and Playa Farallón. Previous studies have shown that the bathymetric configuration in this area facilitates the convergence of waves coming from the south, exacerbating the erosion process. On average, the region experiences more than 2.00 meters of beach recession per year in terms of shoreline change.

1. Monitoring of reports on coastal impacts on social media
Identification of mentions and posts related to coastal impacts on social media platforms.

2. Comparison between reports of impacts in coastal communities and data generated by coastal modeling
Analysis of the consistency and discrepancies between community reports and data obtained through coastal modeling.

3. Analysis of the recurrence of past events in previously validated areas
Study of the frequency and historical patterns of events in previously verified coastal areas to identify trends.

RESEARCH OPPORTUNITIES

4. Projection of future events in flood-risk zones
Estimation of potential coastal events in areas identified as vulnerable to flooding using predictive models.

5. Assessment of the impact of these events on coastal erosion
Analysis of the potential effect of projected events on the erosion dynamics in the affected coastal areas.

Figure 3. Methodological framework for identifying coastal risk areas using insights gathered from social media, validated with historical wave and tide data.

Conclusions

Integrating social media advisories into coastal risk analysis offers a valuable tool for identifying vulnerable areas and monitoring their dynamic changes. By tapping into real-time data, it is possible to establish a reliable baseline for coastal conditions, which can be used to project and mitigate potential future impacts. This approach not only enhances the early detection of extreme events but also supports proactive coastal management strategies.

It is particularly beneficial for regions like Central America, where limited scientific studies and data gaps often hinder comprehensive risk assessments. Using social media as a supplementary data source allows for timely, localized insights, making it an essential tool for areas that lack extensive research, ultimately contributing to more informed decision-making and resilient coastal communities.