Analysis of climate impacts in Costa Rica, Central America, from local historical information sources

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Abstract: Central America and Mexico is a region that account for many World Heritage Sites (**Fig. 1**). Among the climate hazards that affects these rich world heritage place of the world are the boreal winter cold fronts intrusions, also known as cold outbreaks or more locally as "Nortes" (**Fig. 2a**). During summer-autumn the region is affected by easterly waves (**Fig. 2b**) and by the activity of two tropical cyclone regions, the Atlantic-Caribbean and the Eastern Tropical Pacific (**Fig. 2c**). For the study of regional impacts caused by these hazards are generally used public data bases like HURDAT (**Fig. 3a**) or EMDAT (**Fig. 3b**), but these data bases have two major concerns for local impact studies. First, the methodologies used and the centers in charge to quantify them are sometimes different trough the history. For example, besides the satellite technologies use, the study of tropical cyclones in the Eastern Tropical Pacific, was in charge by centers located in San Francisco & Redwood City-California and finally in Coral Gables-Florida (National Hurricane Center until today) during the 1970-1980 decades. Second, some events are not consider relevant for regional or basin scale, but are very important for local purposes. An example of this was the low pressure system in May 2010 located in front of the Costa Rican pacific coast (**Fig. 4a**). These system developed later in Tropical Storm Agatha (**Fig. 4b**), but its major impacts in Costa Rica were associated with the first cyclone stages, e.g. low pressure and tropical depression. For the reasons mentioned above, this study review local information sources like national newspapers and bulletins produced by the National Weather Service, to account for relevant climate events and their associated impacts in Costa Rica. Cold fronts (**Fig. 5a**), easterly waves (**Fig. 5b**) and tropical cyclones (**Fig. 5c**) were considered as study objects from 1977 to 2011. It is state that this kind of study is very important to complement regional data bases and to avoid underestimation in the event-impact accounts (**Fig. 5d**). Impacts associated with cold fronts, **Figure 6a** (tropical cyclones, **Figure 6b**) were located mainly in the Costa Rican Caribbean (Pacific) slope while those associated with easterly waves have a more even spatial distribution trough the country (**Fig. 6c**). Finally, because of their nature, it is also important to develop these kind of works within a multidisciplinary team, that include for example researchers from climatology, history and geography fields.

Some references:

-Alfaro, E. y A. Quesada, 2010. Ocurrencia de ciclones tropicales en el Mar Caribe y sus impactos sobre Centroamérica. *Revista Intersedes*, **11**(22), 136-153.
-Magaña, V. (ed.), 1999: *Los Impactos de El Niño en México. UNAM, México.* 229pp.
-Peña, M and M. W. Douglas. 2002: Characteristics of Wet and Dry Spells over the Pacific Side of Central America during the Rainy Season. *Monthly Weather Review*: Vol. 130, No. 12, pp. 3054-3073.
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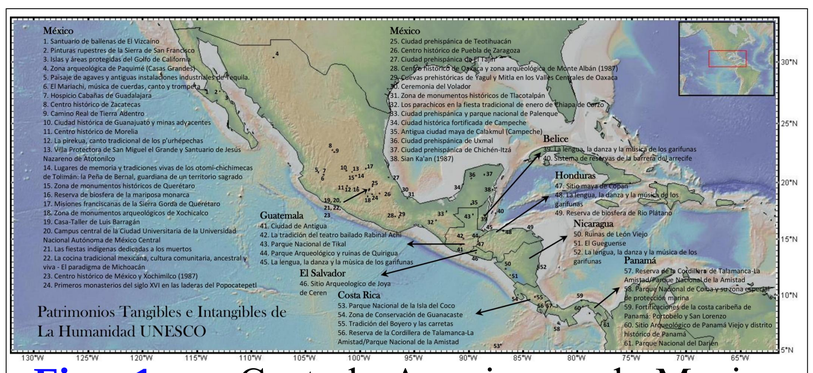

Fig. 1 – Central America and Mexico UNESCO-World Heritage.

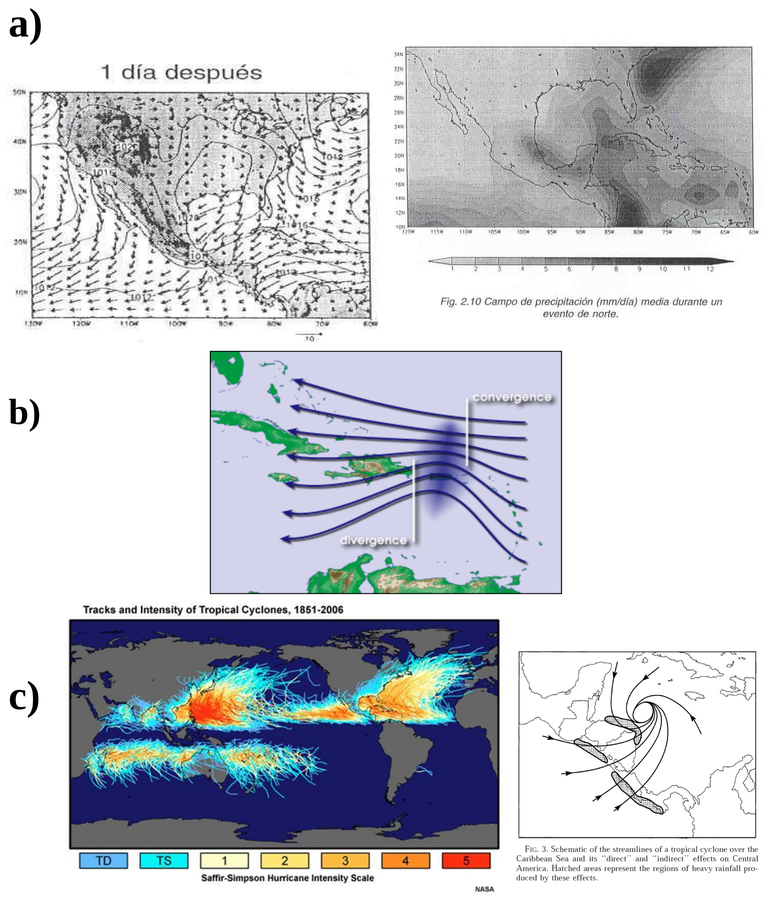

Fig. 2 – Some climate hazards in Central America: **a)** winter cold fronts intrusions (cold outbreaks or "Nortes", see Magaña *et al*. 1999), **b)** summer-autumn easterly waves (see COMET) and **c)** the activity of two tropical cyclone regions, the Atlantic-Caribbean and the Eastern Tropical Pacific (see Peña & Douglas 2002).

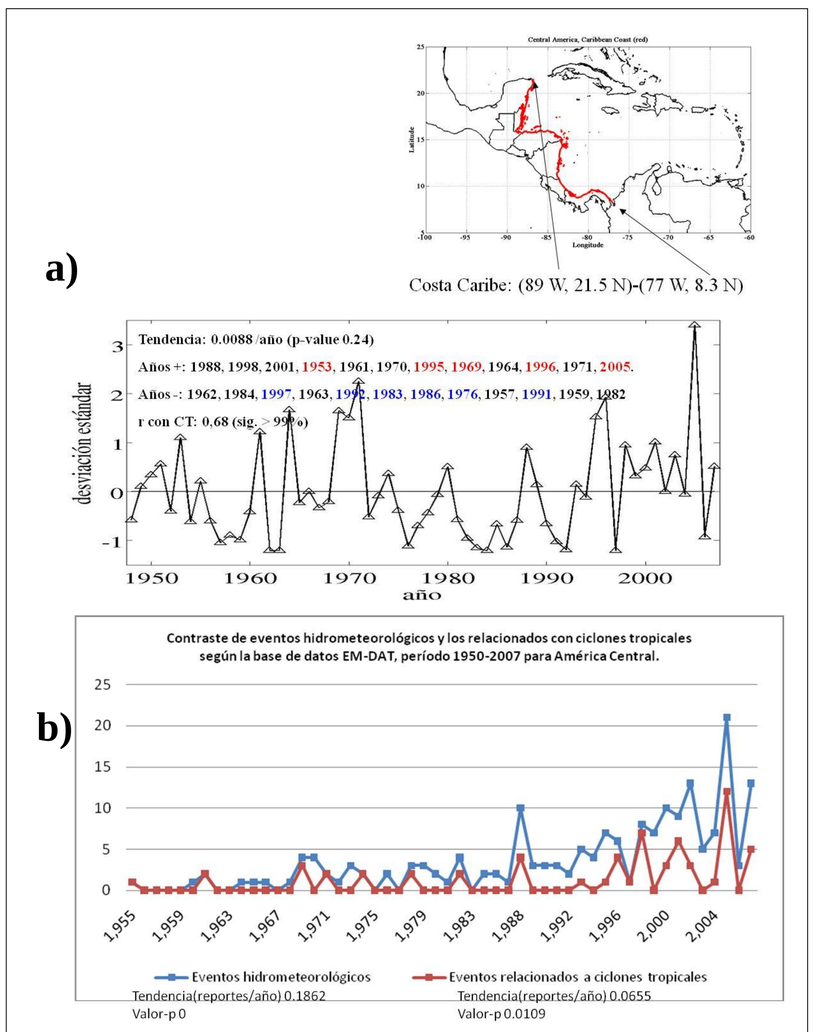

Fig. 3 – **a)** The Tropical Cyclone occurrence index for Central America counts the number of Central American Caribbean Coast points equal or closer than 7º from any tropical cyclone position recorded in HURDAT. In spite that its trend is positive, its p-value > 0.1. **b)** Annual number of disaster reports found in EM-DAT Data Base associated with hydro meteorological events (blue line) and with Tropical Cyclones events (red line). All have positive trends, p-values < 0.05. Series associated with tropical cyclones have positive correlations with the index shown in **Figure 3a** (Alfaro & Quesada, 2010).

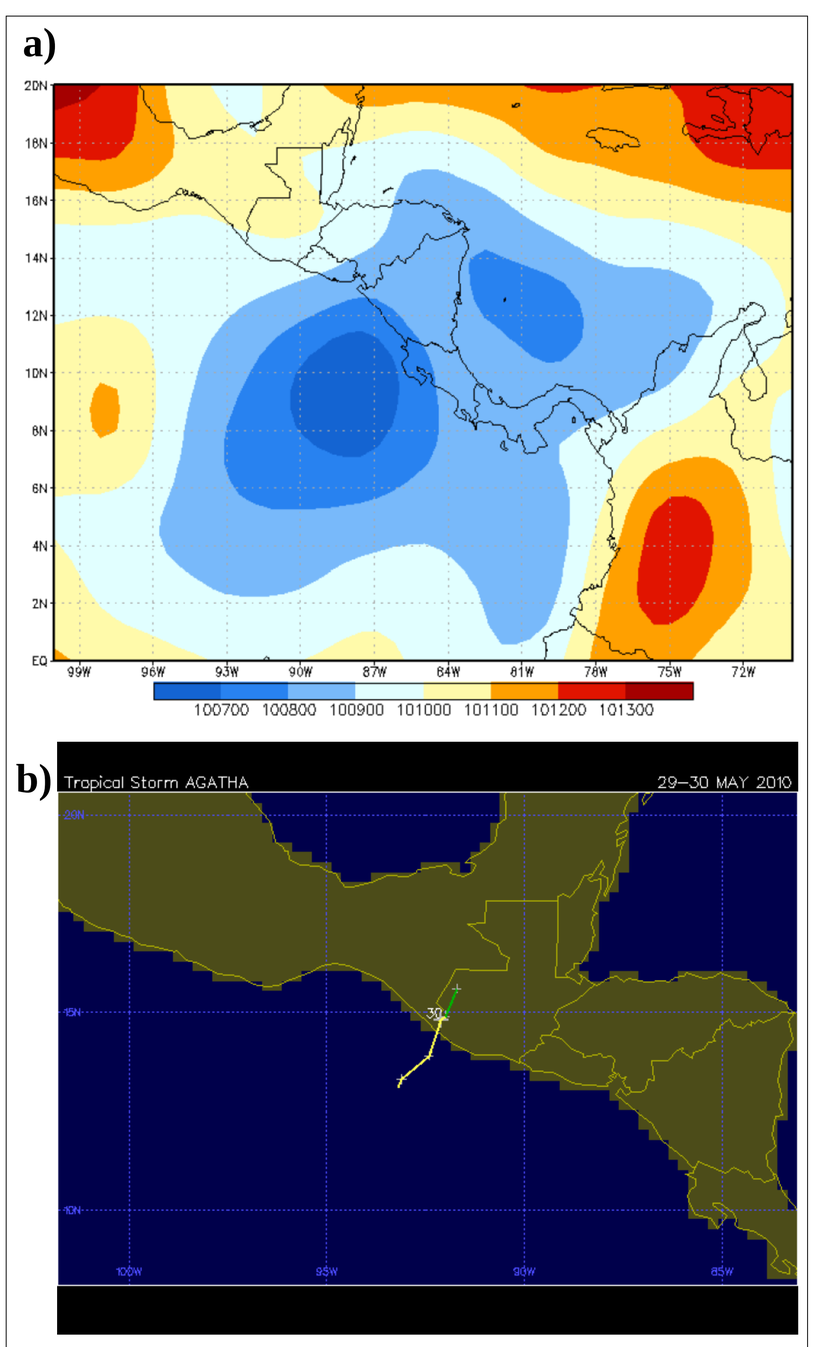

Fig. 4 – **a)** SLP NCEP/NCAR Reanalysis 12z (06:00 am local hour) May 22, 2010 **b)** Track for Tropical Storm Agatha, May 29-30, 2010 (source: Unisys Weather).

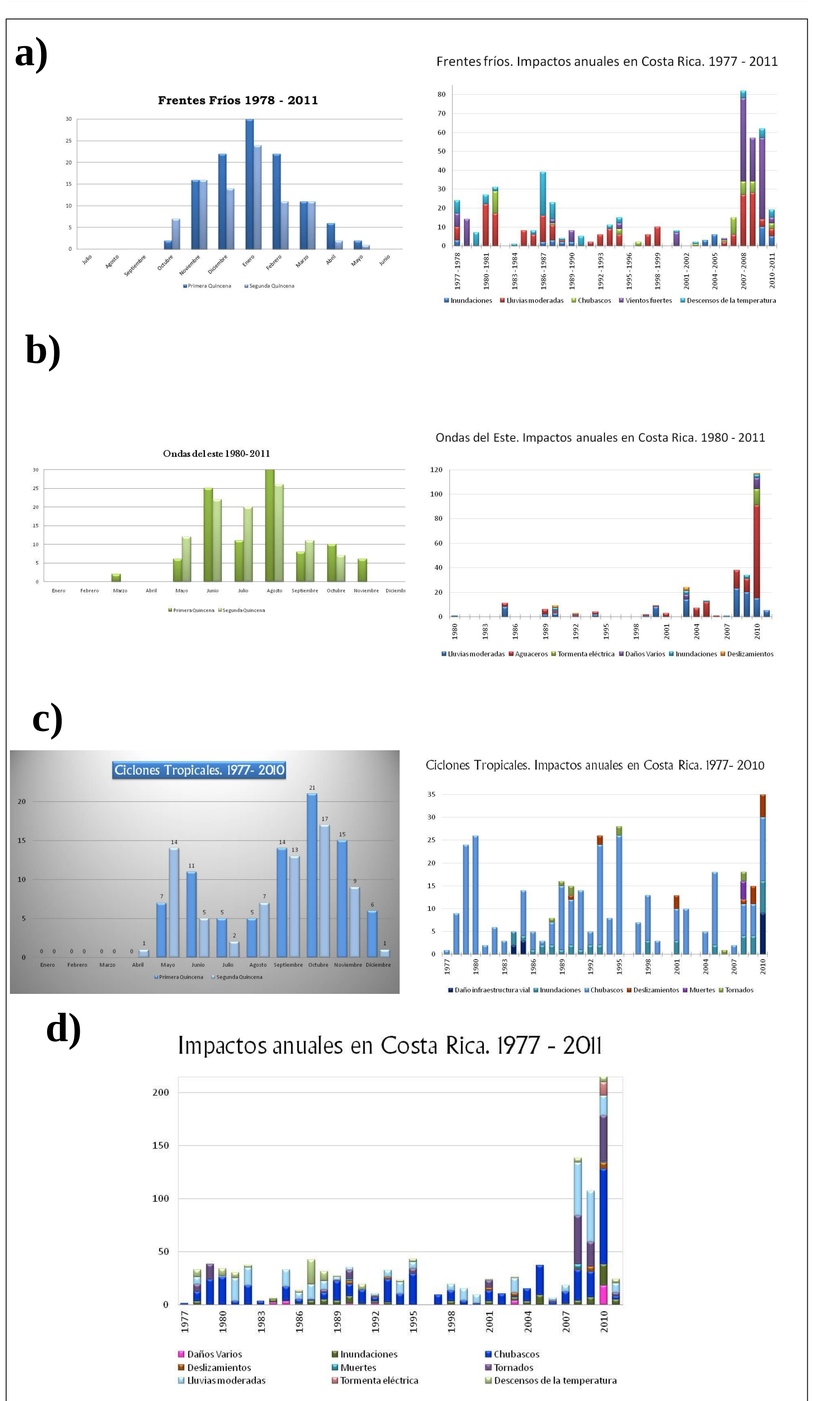

Fig. 5 –Bi-weekly climatology and associated annual impact time series for **a)** cold fronts, **b)** easterly waves and **c)** tropical cyclones. **d)** The aggregated impact time series (source: monthly bulletins produced by the National Meteorological Institute, Costa Rica).

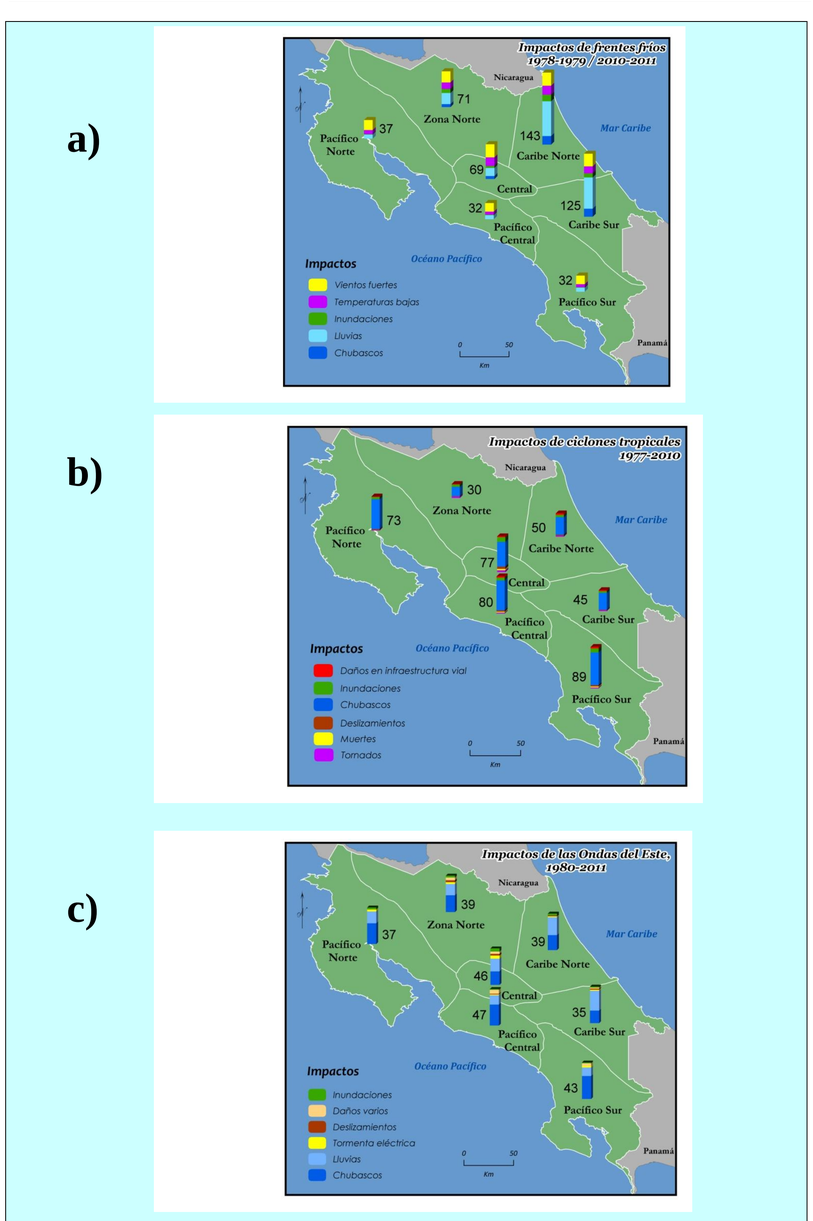

Fig. 6 – Geographical distribution, by province, for the time series showed in **Figure 5**. **a)** cold fronts, **b)** tropical cyclones and **c)** easterly waves.

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