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MODELLING OF THE AREAL DISTRIBUTION OF PRECIPITATION IN THE SERRA DO MAR ESCARPMENT, SAO PAULO, BRAZIL

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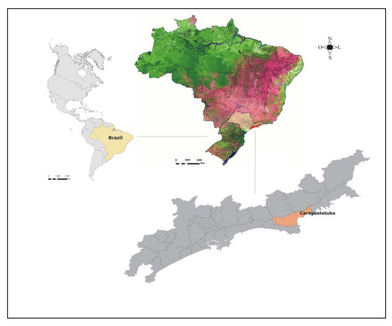
THE AREA

The Serra do Mar Region is a place of interactions among the terrestrial, maritime and atmospheric environments. The region is also an articulating economic centre, with a major concentration of industries, 29 municipalities and 13,652,822 inhabitants. These aspects bring both benefits to the economy and environmental problems: vast areas of the Atlantic Rainforest were devastated and the remained sectors continue to be threatened by urban and industrial expansion. Landslides triggered by precipitation are a common hazard, especially in summer.

The area is affected by tropical, subtropical and mid-latitude controls, and patterns of climatic fluctuations are to some extent organized on a global scale. At local level, the morphology influences climatic conditions. Convective activity is greater in summer and when SACZ and frontal systems interact, rainfall remains semi-stationary for several consecutive days. Annual rainfall average ranges from 4,750mm to 1,300mm, but it can reach approximately 7,000mm in some years. Intensity can also be very significant: amounts greater than 400mm/day were already registered in some sectors.

OBJETIVES

The whole study aims to evaluate the spatial pattern of extreme rainfall in the central-Northern coast of Sao Paulo State, Brazil. Here, emphasis is done for a dramatic episode which ravaged Caraguatatuba city (see FIG. 1), which triggered planar landslides, causing a major catastrophe.



DATA AND METHODS

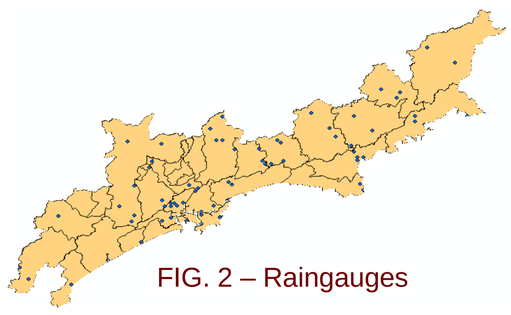


FIG. 2 – Raingauges

Two spatial scenarios were created: the former considered precipitation only and the latter, precipitation and topography. Both were generated by using daily amounts of precipitation (69 rain gauges – Figure 2) and data from Digital Elevation Model (DEM), SRTM (Shuttle Radar Topographic Mission), with interpherometry technique from InSAR, version 2, with spatial resolution of 90 m.

RESULTS

Caraguatatuba presented a sequence of 4 months of precipitation above the climatological average (FIG. 3), which culminated at 244mm on 18th. March (FIG. 4).

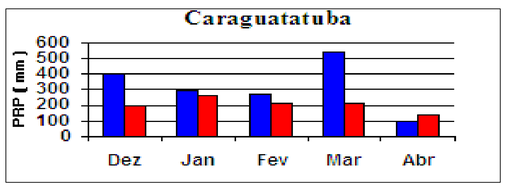


FIG. 3 – Montlhy precipitation in 1967 (blue) in relation to the climatology of the area (1944-2003)

Source: Sousa Jr. et al., 2007

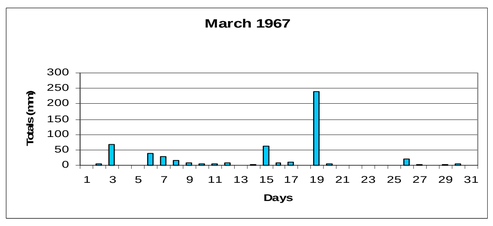


FIG. 4 – Daily rainfall in Caraguatatuba, March 1967.

Caraguatatuba experienced a major catastrophe, with more than 400 casualties, 3,000 people displaced and severe damages (FIGS. 5a and 5b). However, although the whole area registered high amounts of rainfall, the episode was particularly severe in Caraguatatuba.

FIGS. 5a and 5b –Caraguatatuba on 20 March 1967

Source: FAB, Brazilian Air Force

The slope map of the area (FIG. 6) enhances some steep hillslope within the Serra do Mar Region, especially in the North, including Caraguatatuba. The hypsometry map (FIG. 7) complements such an information.

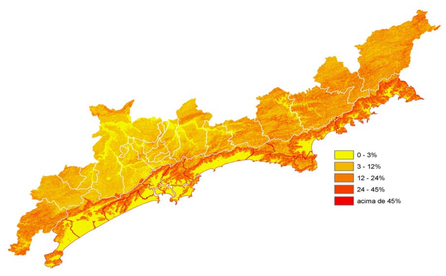


FIG. 6 – Slope Map of S. do Mar Region

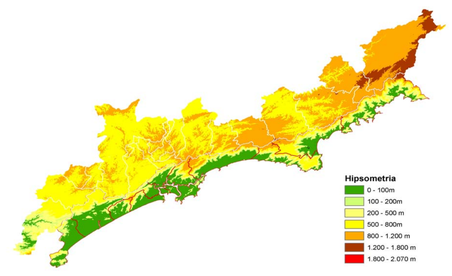


FIG. 7 – Hypsometry of S. do Mar Region

The precipitation areal distribution was performed by using kriging technique. FIG. 8, generated with rainfall data only, enhanced that Caraguatatuba was the area more severely hit within the region. Notwithstanding, it is important to underline that the central coast do not have rain gauges (FIG. 2) and this fact probably caused underestimation of the real rainfall volumes.

FIG. 9 shows that the incorporation of topography to precipitation by cokriging generated a more realistic scenario in the geographical viewpoint, but underestimated the impressive amounts in Caraguatatuba.

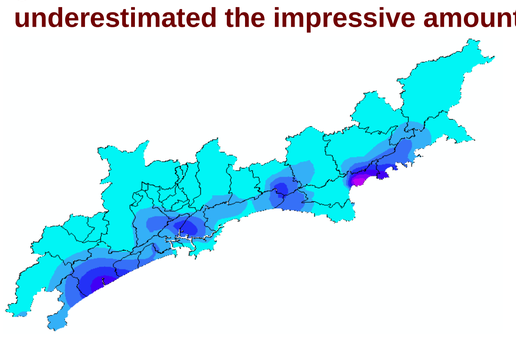


FIG. 8 – Rainfall distribution with precipitation data only

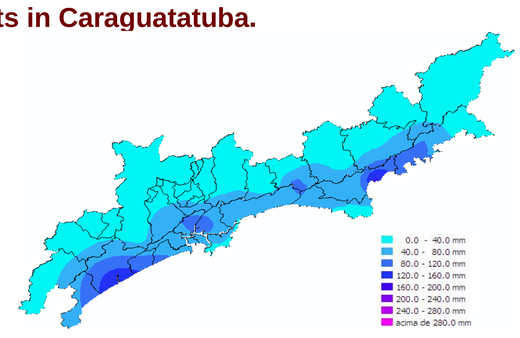


FIG. 9 – Rainfall distribution with precipitation and topography data

FINAL REMARKS

Topography played an important role in controlling the spatial distribution of rainfall and consequently landslides in the tragic hazard registered on 18th. March 1967, in Caraguatatuba, confined to the windward of the Serra do Mar Escarpment. SRTM proved to be useful and quite accurate for obtaining the topographic data for the region.

Slope angle and hillslope form were probably relevant aspects for defining critical conditions for heavy rainfall and landslides, but such relationship deserve further studies.

Although landslides triggered by heavy precipitation is a common feature in Serra do Mar Escarpment, their predictability are low and require more reliable forecast, with limited area models with high resolution, which is under development by other studies that integrate a comprehensive project (see below).

This investigation integrates a comprehensive project funded by FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo – Projeto "Serra do Mar", FAPESP 04/09649-0 (http://www.cptec.inpe.br/serradomar))

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