

PRECIPITATION EVENTS ASSOCIATED WITH LANDSLIDES IN THE TROPICS - GUARUJÁ CITY, AN EXAMPLE OF BRAZIL



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Introduction

Landslides in slopes with urban occupation has been intensified in many regions of the world, exposing the necessity of studies focused on the evaluation of their causes, in view of preventing and/or mitigating the associated losses.

They are particularly common and severe in tropical regions, where the impoverishment of significant population segments, their disarticulation to demand essential rights, the lack of alternatives for living in safer areas, and the inadequacy of basic infrastructure and organizational systems to prevent or limit the impacts, contribute to the continuous growth of the society's vulnerability to these episodes.

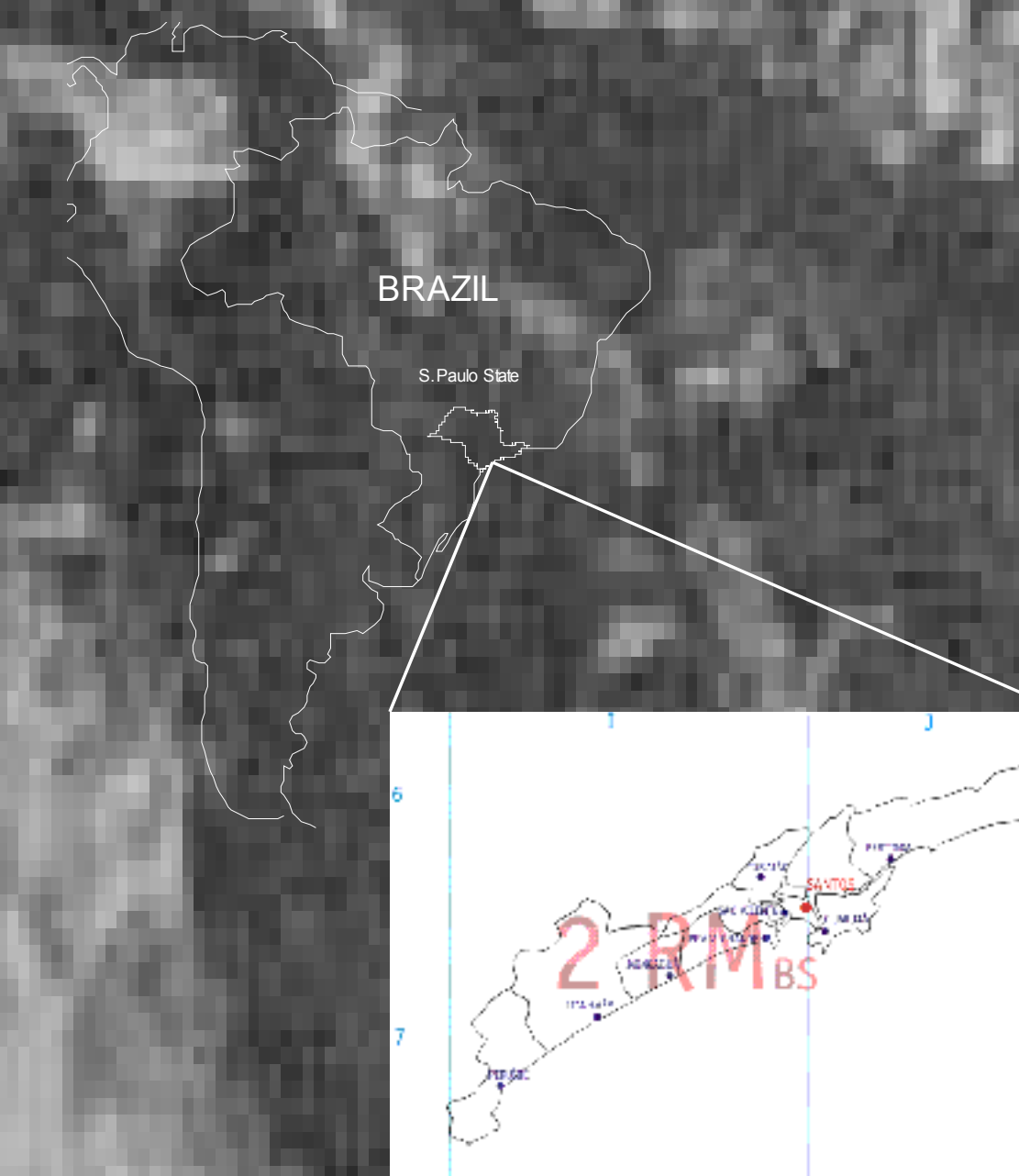
The Study Area

The city of Guarujá, Southeastern coast of Brazil has been experiencing an increase in environmental problems such as landslides, despite its "glamour aura": in the last decades Guarujá became an elegant resort for the higher classes of São Paulo city and surrounding areas (easy access by fast and modern highways, paradisiacal beaches, constant good weather conditions) so that the city witnessed a *boom* in the buildings, which brought in turn an important contingent of workers who occupied the unstable slopes of Serra do Mar Escarpment. It is noteworthy that summer time coincides with the period of more intense and frequent rainfall, with more events of landslides, floods and associated victims.

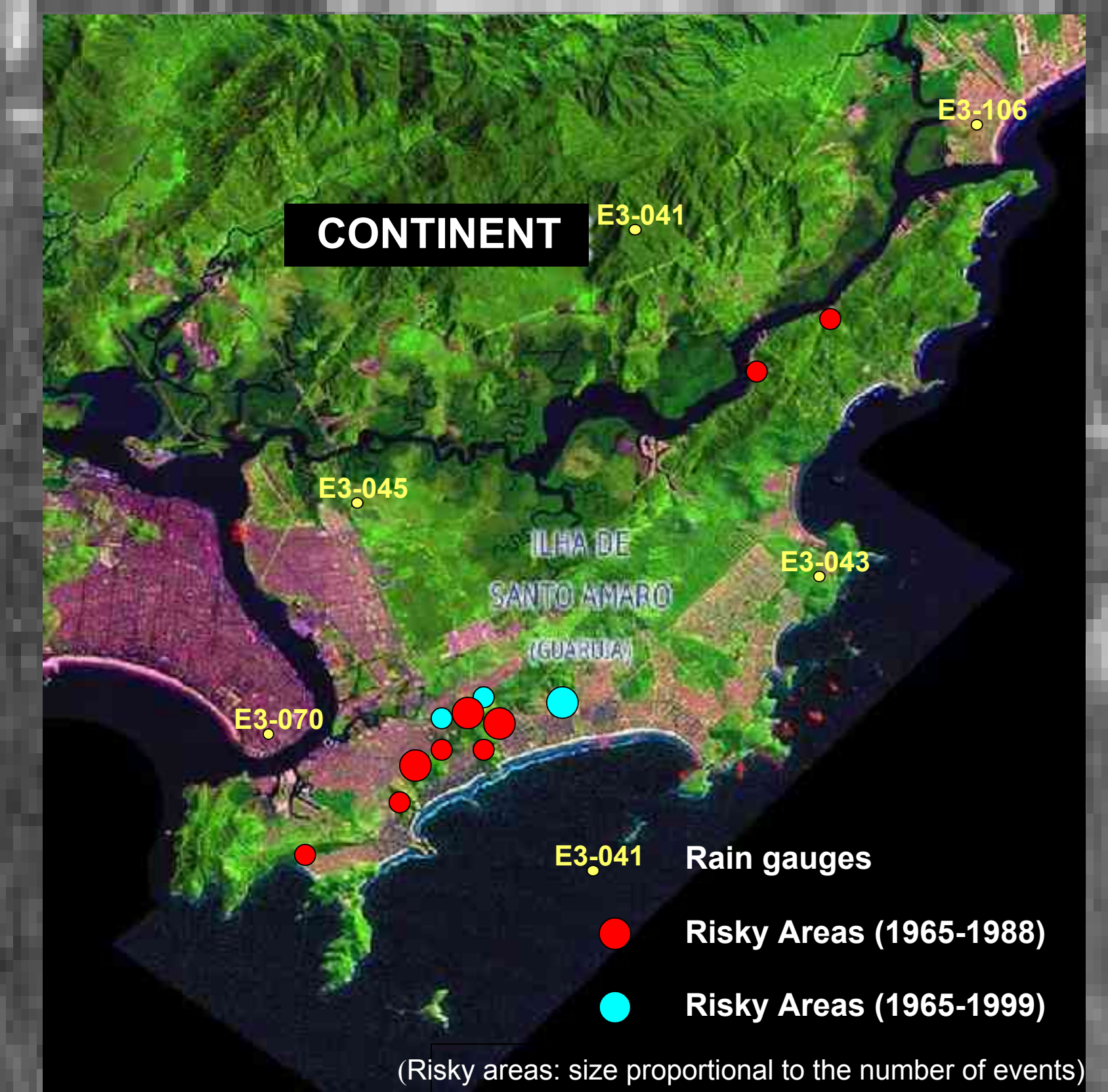
Data and Methods

The study aimed to correlate precipitation to landslides in Guarujá in order to evaluate their spatio-temporal distribution pattern. Rainfall analyses were carried out at annual, monthly and daily levels, considering the data of five rain gauges spread up into the area, comparing two periods (1965–1988 and 1991–1999). Events of landslides were collected from local newspapers and the Municipal Civil Defense.

Localization



Baixada Santista Metropolitan Region



Results

The results revealed a substantial increase of landslides triggered by rainfall in the recent period (1991-99): 518 events against 81 in the previous period (1965-88). However, any appreciable change in the rainfall totals was found; besides, the recent events were engendered by lower daily rainfall amounts, emphasizing the impressive environmental degradation of Guarujá due to changes such as deforestation of the Atlantic Rainforest, damages to mangroves, as well as fast and aggressive modifications in the land use, many times without any planning. Moreover, these aspects brought in turn an increase in the associated vulnerability of the inhabitants of the risky areas.

The strongest rainfall episode (February 19th, 1993; 135mm registered) induced 60 landslides. It was caused by convective rainfall, a regular process within the area, but other atmospheric mechanisms, such as cold fronts and ZCAS, play important role in triggering landslides, terrain collapses and floods.

Conclusions

- Specific combinations of rainfall volumes, lithology, topography, sparse vegetation, impervious ground, past soil moisture conditions and land use trigger landslides, but their impacts depend upon the vulnerability of the social groupings;
- Strong relation between population growing and landsliding events was found. This study did not aim to evaluate this aspect deeply, but it enhanced the need in evaluating this factor in future studies (population living in slopes with low threshold);
- The areas that present landslides remained the same for both periods, so that public authorities have indications of the risky areas and should take more effective measures to both preserve lives and this important ecosystem;
- In recent years it was noticed that landslides were triggered by low rainfall amounts in the most of the rain gauges revealing the aggravation of the environment problems in the area, which are strongly correlated with inappropriate land uses.

References

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Photo: classical event of landslide, March 10th, 1928 – city of Santos (next to Guarujá, Brazil)

