Catastrophic Events in Petrópolis City (Rio de Janeiro State), between 1940 and 1990

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ABSTRACT: Petrópolis is located in the Sierra do Mar mountains. Its main physical characteristics are steep slopes, rivers controlled by structures such as faults, deep soil profiles and rains concentrated between December and March. The original vegetation was tropical rain forest, but this has been deforested since the beginning of the Brazilian colonization. The city was founded in 1843 and grew from 46,000 inhabitants in 1940, to 286,000 inhabitants in 1990, hastening deforestation.

Petrópolis has suffered 1,161 catastrophic events (1940-1990 only) including landslides, mudslides, rockfalls and floods. Most events are caused by heavy rains. A database has been constructed, which identifies details such as the location and the number of people who died in each event. The number of deaths appears to be increasing and nearly 90% of the events occurred within urbanized areas. Currently the principal responses are reactive, rather than preventive. This paper investigates the catastrophic events in Petrópolis, in order to understand why, where and how they occur.

Introduction

This paper investigates the causes and consequences of the catastrophic events which occurred in Petrópolis City, between 1940 and 1990. Natural hazards are often exacerbated by rapid urbanization (Cooke and Doornkamp 1974; De Ploey and Cruz 1979; Guilmore 1977; Gupta 1982), but detailed studies of the links between urbanization and disaster are lacking for most developing countries. One exception is the Brazilian city of Petrópolis. The Institute of Technological Research, sponsored by Sao Paulo State Government, has compiled a data base of more than 1,000 catastrophic events that occurred in Petrópolis, during the period between 1940 and 1990. This reveals that a rising toll of human fatalities is directly correlated with the spread of new urban settlements onto steep deforested hillsides. The majority of these events are due to heavy rains that occur during summer. They were responsible for the deaths of 526 people in the last fifty years. It is interesting to point out that the situation has been getting worse for the last twenty years, when nearly 300 people died due to these events.

The Historical Development of a Hazard-Susceptible Community

Petrópolis is a city of more than one quarter of a million people, located in the Sierra do Mar, approximately 60 km north of Rio de Janeiro city. It sits astride road and rail links to interior cities, such as Belo Horizonte and Brasilia (Fig 1). Petrópolis was founded in 1843, but did not grow significantly until a new highway connection with Rio was opened in 1928. Thereafter the city’s population increased rapidly, reaching 46,000 in 1940 and 286,000 in 1990 (CIDE 1990).

Petrópolis occupies an area that is characterized by extensively faulted and fractured rocks, steep slopes, deep soil profiles and heavy rainfall concentrated in the summer months between December and March. It is surrounded by increasingly degraded tropical rain forests that were partly cleared for coffee plantation agriculture, during the late 18th and early 19th century and again cleared in the face of burgeoning urban development during the past fifty years.
Urban growth imposed increasing pressures on the local environment during three successive periods: (1) 1843–1889; (2) 1889–1950; (3) 1950–1990. In the first period, the city was small and clearance of forests was limited. Deforestation increased after 1889, as immigrants and industries began to arrive and the city grew more rapidly. After 1950, the speed of urbanization accelerated and outpaced almost all attempts to apply planning and development controls. Even today, the city still lacks a sewer system and this contributes to the environment at risks. Sewage enters local rivers, bringing pollution and increased sediment loads; these in turn raise the elevation of river beds and promote the spread of moisture into the soil profiles of adjacent slopes, thereby destabilizing them – especially during summer rainy season. This process – together with deforestation and human occupation of talus deposits – makes Petrópolis a particularly risky municipality.

The Making of Contemporary Hazards

Although there is no systematic and reliable data regarding the evolution of deforestation in Petrópolis, today more than 70% of the original rain forest has been cleared, mostly to accommodate recently arrived immigrants from the Rio de Janeiro metropolitan area. These include both people who are relatively well-off and those who are poor. The more affluent have moved to Petrópolis in search of a “quiet” environment; they either buy or rent apartments and houses on already developed land, near the city center or in unoccupied tracts in the suburbs. Since the only available suburban land is steep and prone to landsliding, most of the newcomers are exposed to significant hazard. The poor – who either cannot afford to live in Rio or believe that Petrópolis offers them better opportunities – build inexpensive shacks on the steepest slopes and continue to clear the remaining vegetation. It is not uncommon to find shacks several storeys high clinging to the edges of precipitous hillsides in a manner that requires most of their occupants to climb to building entrances at street level (Fig 2).

The number of shacks is growing rapidly and they are spreading throughout the entire municipality. Every year slides and floods impose heavy losses. Recently, the World Bank loaned $US 10 million to the municipality to fund hazard management projects, but most of the money has