Creating a Landslide Hazard Mapping for La Paz City-Bolivia

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Abstract

This research also focuses on describing institutional and community capacities necessary to increase resilience to natural disasters in an urban context. As this is a broad subject, the research delimitated a specific urban area and only the type of natural hazard with the potential to become a disaster, in La Paz city this hazard is landslides. The overall objective of this research is to design a methodology with which the Municipality can work with the communities incorporating a prevention topic in their daily lives in order to develop a culture of prevention in La Paz. The Hazard Mapping and Risk Assessment theme will provide guidance to help those in authority address the affects of natural, technological, and human hazards on a community's vision for the future.

Key Words : Hazard map, education, landslides, prevention, evacuation simulation, La Paz, Bolivia.

1. Urban Growth and Urban Natural Disasters

It is expected that by the year 2030, 80 per cent of the human population will be living in urban cities. The majority of these people are from developing countries. This means that disasters coupled with a lack of sufficient socio-economic resources in developing countries will continue to perpetuate the cycle of poverty in these new urban areas. The future of humanity depends very much on decisions made now in preparation for this increased concentration of people. [1].

2. Research Outline

This research sets out to motivate and educate societies to create policies and strategies in DRM. The objective is to motivate actions to reduce risks.

As this is a broad subject, the research delimitated a specific urban area and only the type of natural hazard with the potential to become a disaster.

La Paz, administrative capital of Bolivia in South America, is the subject for this study. The rapid urbanization of the city, the irregular topography of the mountain system, and its location in an area susceptible to landslides during heavy rain makes of La Paz a city where hazards and vulnerability can create risk.

As the city continues to grow and new settlements occupy the slopes of mountain zones, landslides are of particular concern.

Increased urbanization in La Paz puts the communities that live in those areas at risk making them highly vulnerable to the effects of a landslide.

The reason for selecting Japan as a comparison object, is that it has one of the most developed and effective DRM systems in the world. Although the administrative structural configurations between Japan and Bolivia differ, they both promoted 'mitigation' as a national policy priority during the last decade.

La Paz urban area is $3,240 \text{ Km}^2$, it's Population is about one million. The Altitude 3,650 meters above sea level and the Average Annual rainfall is 600 mm/m^2

Why La Paz?

Landslides and their effects are particularly relevant to La Paz for different reasons, some of they are:

- The landslide environment of the city is active because of steep slopes covered with easily dislodged unconsolidated superficial deposits.

- The hydrological environment of the region from fluctuating water tables to the city and intense summer rainfalls, guaranties sufficient slope wetting to release the slides.

- Rapid population growth and increasing numbers of poor people in the city have produced a massive housing demand. This demand has resulted over time in large areas of informal, self-built housing being constructed on the steep unstable slopes of the city.

- A weak urban planning framework has exacerbated the situation by allowing an expanding population to buy and build properties in the city's treacherous slopes, without providing information on buildings design and standards, or highlighting the actual risk of the landslide hazard.

Most low-income, self-built housing in La Paz is located in the periphery of the city where slope gradients and landslide risk increase. The main self-built settlements in the city are found on the highest and steepest slopes of the northern city. [2]

In the early 1905's government policy was to maintain the higher slopes as parkland for the city, but the need to secure cheap building land for the rapidly increasing inflow of poor migrants changed such thinking.

In the other hand, Japanese cities are exposed to the same natural phenomena as La Paz city, nevertheless the capacity of the government to generate an integral plan have been developed for decades.

Geographically, one subject to consider is that Bolivia is three times bigger than Japan, but the first has only 10% of the population number.

The different approach these societies have about urban planning will be considered by this research in order to generate a hazard map that people from La Paz, with different vision, culture and education about disasters will be able to understand, use and promote it to the future generations.

3. Guide and Tools for the Generation of Landslide Hazard Mapping for La Paz City-Bolivia.

3.1 Hazard Mapping for the Community

Hazard maps provide clear, attractive pictures of the geographic distribution of potential hazard sources and impacts. These maps frequently provide motivation for risk management actions that would be difficult to obtain without a compelling visual. The colors and detail of the map should reflect the application.

Hazard maps are produced through the integration of spatial data and local community knowledge. The availability of a reliable hazard map are important risk assessment tools providing relevant information essential for community planning and decision making, especially in emergency response, and disaster preparedness and mitigation.

3.2 Target Users

One of the most relevant and important aspects about this research will be the identification of the Final User and the attempt to find the gaps between a Japanese hazard map user community and its potential equal in La Paz City.

3.3 Optimal outcomes for end users

There are two primary requirements:

1- Clearly identify the end users that the risk management program intends to target.

2- Involve those end users in the process. End users will be the most aware of the issues that concern them.

As part of the process, there is also a greater opportunity to provide education on the nature and impacts of risks that the end users have yet to experience first hand.

3.4 Surveys

In order to generate a final product that is accurate and deliver an understandable and accepted hazard map, the user should be involved in the development of it.

Surveys will provide to this research the possibility to create an appropriate hazard map.

The surveys were developed for the community leaders, neighborhood residents, government technicians and different organizations.

From this information, the research will determine the level of resilience of the community, and some of the community's perceptions and capacities in place in regards to landslide risk management.

3.5 Evacuation

In events like landslides, emergency preparedness plays a vital role in mitigating the damage to property, personal injury and loss of life. One response action under such events is to evacuate.

The main objective of evacuation is to move people out from an endangered area as quickly as possible so as to avoid casualties.

This work also will be focused on no-notice evacuation in urban areas, where notification of a need for evacuation may be only minutes prior to the event that might cause the need for an evacuation.

The goal of this study is to acquire useful findings in disaster prevention information, setting signals for evacuation and thereby assist people in developing appropriate evacuation plans.

To achieve this objective, a literature review will be completed and Yokohama city neighborhoods interviews with experienced persons on evacuation and representatives from these areas will be conducted.

Another objective to achieve is to test different signs and evacuation maps and offsets that will be proposed and implemented as part of the plans for an evacuation.

A simulation will be developed, composing evacuation routes in La Paz.

The simulation after analysis will permit the identification of potential problems that could result from implementation of these plans.

4. Evacuation Simulation

Simulation can be used to analyze and optimize the safety of pedestrians of large-scale infrastructures.

An important safety aspect of an infrastructure is its evacuation capacity during an emergency situation. During an evacuation, the pedestrians need to be evacuated in a fast and efficient manner. Solid infrastructure design and reliable crowd management are necessary for a successful evacuation of pedestrians. A simulation model of the pedestrian flow during evacuation is the way to analyze and improve the performance of the infrastructure design and crowd management.

4.1 Event Simulation Software

It is now possible through the use of computer simulations to model the behavior of human movements during evacuations that include events that impact the simulated humans' ability to successfully egress.

The simulation updates agent positions and paths each time step during the model run.

This software enables its users to model pedestrian flows through large-scale infrastructures. The user can build the infrastructure, define routes and eventually conduct experiments to analyze and optimize the pedestrian flows through the infrastructure during an evacuation.

With an evacuation simulation model, the user is able to:

Analyze the pedestrian flow through any infrastructure. Optimize the pedestrian flow by adapting the routing of

the pedestrians Analyze the pedestrian flow during all kinds of "what if..." scenarios

Create clear dynamic visualizations, which can be used as communication tools.

Typical performance indicators of an evacuation simulation model are:

Evacuation time to a safe area

Densities (pedestrians/m2) of walking areas

Throughput capacity of passages

Thunderhead Engineering Pathfinder is an emergency egress simulator that includes an integrated user interface and animated 3D results.

Pathfinder for evacuation simulation modeling gives the user insights into the evacuation performance of an infrastructure and the possibility to improve this performance. [3]

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