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Preliminary Proposal for Debris Management in the city of Guayaquil due to disaster situations

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Abstract - *The Guayaquil canton, located on the southwest coast of Ecuador, currently has efficient management of the collection, transportation and final disposal of solid waste. The city of Guayaquil, being located in a region of high seismicity, faces the need for an emerging waste management plan as part of its preparation for possible natural disasters such as earthquakes. The importance of waste management after a natural disaster lies in several aspects such as the proper management of debris to minimize the risks of damage to public health and for the restoration of infrastructure and the reconstruction of the city.*

The present investigation addresses the quantification of the volume of debris in the central area of the city covering an area of 1396 Ha and an initial proposal for management and identification of areas for rubble dumps in the Guayaquil canton due to disaster situations is presented.

Key Words: Debris Management, Disaster Situations, Solid Waste, risks, earthquakes.

1.INTRODUCTION

The geographical areas in the city of Guayaquil that are most likely to be affected by earthquakes were determined, based on historical data of seismic activity and the tectonic characteristics of the region. For this research, data from the RADIUS project [1] were used to quantify the debris and an initial management of debris management location of waste dump sites was proposed.

1.1 Debris Quantification

The figure of the map of expected seismic intensities in the city of Guayaquil and their risks: very high, high, moderate and low as shown in figures 1 for a seismic scenario of VIII, VII and VI presents a visualization of the distribution of seismic forces in the city. Through differentiated colors, the map shows the different areas and their respective levels of seismic intensity anticipated in the event of an earthquake of magnitude 8 or more.

The extension of the urban area of Guayaquil is 33,825 hectares. The area of the center of Guayaquil was selected, which is characterized by its dense concentration of infrastructures with more than 50 years of construction, there are medium-rise buildings, commercial and residential types, and in addition, it is limited to the north with Avenida 7 NE - Coronel Gregorio Escobedo y Rodríguez, To the south with Cjón. 11 S-E – Ayacucho, to the east with Av. Simón Bolívar Palacios and to the west with AV. 1N-O- Machala (See figure 2).

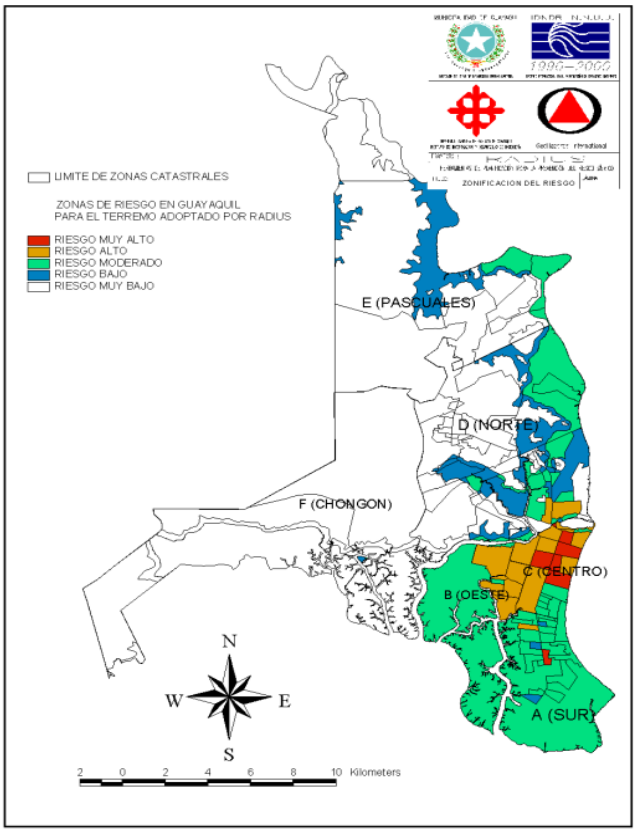

Fig -1: Seismic Zoning of soils in the city of Guayaquil [1]

It should be noted that according to the RADIUS Project [1]; A 10% estimated damage to buildings was estimated in the event of a Magnitude VIII earthquake, so this situation will be considered. The estimation of the volume of debris generated in the city of Guayaquil after an earthquake was carried out by analyzing a specific area (a) in the city center, considering 1 ha with medium and high-rise buildings and

another area (b) of one hectare considering low-rise one and two floors, as seen in figure 2.

Furthermore, if the density of debris is considered to be 1.1 Ton/m3 [2], and the results are shown in Table 1.

Table -1: Quantification of Debris generated in the central area of Guayaquil

Study zone	Volume (m3)	Density (Ton/m3)	Quantification (Ton)
a	2´607.171,84	1.1 [2]	2´867.889,02
b	3´655.798,00		4´021.377,80
TOTAL	**6´262.969,84**		**6´889.266,82**

1.2 Results

Furthermore, if the density of debris is considered to be 1.1 Ton/m3 [2], the following results table would be obtained with an approximate quantification of 6´889.266,82 tons of debris in the central area of the city where the risk of disaster is greater.

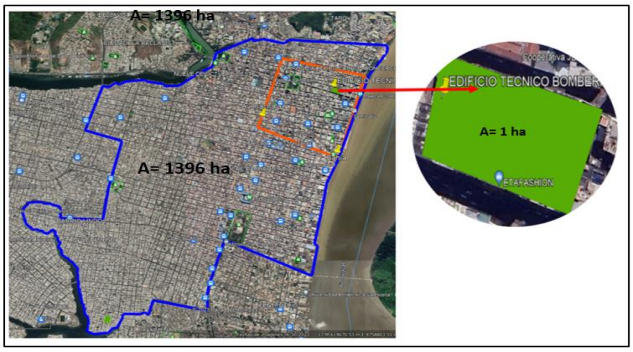

Fig -2: Delimitation of the study area in the central area of Guayaquil to determine the volume of debris [3]

2.PRELIMINARY POST-EARTHQUAKE DEBRIS MANAGEMENT PROPOSAL

Earthquakes generate a considerable amount of debris, which consists of waste according to an estimated percentage [4].

Table -2: Types of debris generated Vs Percentage

Waste Generated	Percentage (%)
Construction debris	65
Domestic	14
Biological	10
Dangerous	3
Electronics and appliances	8
Total	100%

A preliminary proposal is presented for the management of debris in a disaster situation with the priority considerations of:

- Handling of Corpses;
- Debris management and,
- Identification of areas for debris disposal

In addition, 5 possible areas for the final disposal of the debris were identified in the city of Guayaquil and Durán, with the characteristics noted in the Summary Table detailing:

- Location in UTM coordinates - WGS84,
- Available area,
- Approximate volume of debris to be deposited,
- Approximate length from the disaster site (center of Guayaquil and the waste dump)
- Approximate mobilization time per dump truck

Table -3: Preliminary Debris Management Proposal

Preliminary Debris Management Proposal					
i. ***Corpse Management***			**ii.** ***Preliminary Debris Management***		
• Situation Assessment • Information gathering • Victim Registry • Identification of Corpses • Transfer of Corpses: • Temporary storage of corpses			• Damage Assessment • Immediate Removal of Debris in First Aid Care Areas and Areas of Critical and Essential Facilities • Removal of Debris That May Represent a Threat • Demolition of Affected Structures • Collection and transportation of debris • Classification • Recycling • Transportation • Final Debris Disposal		
iii. ***Identification of Areas for Final Debris Disposal after an Earthquake***					
SITIO	**Area 1** **Monte Sinaí**	**Area 2** **Sergio Toral II**	**Area 3** **Landfill Las Iguanas sector E**	**Area 4** **Cantera vía la costa**	**Area 5** **Durán**
CoordinatesWGS84	612856E, 9763665S	611549E, 9767648S	614373.04E, 9770749.97S	613884E, 9759399S	635999E, 9758150S
Area (Ha)	84,00	30,2	112	71,72	94,8
Volume of debris that can be received (m3)	9´74.887,70	1´030.421,93	22´715.974,32	884,12	737.532,16
Length from the center of gravity of the study area to the waste dump (km)	21,5	21,6	19,2	10,8	25,8
Mobilization time per dump truck (min)	45	55	45	25	45

3. PRELIMINARY APPROXIMATE BUDGET

Among the items considered in the preliminary approximate budget were included:

The execution of cleaning tasks, the demolition of structures considering a percentage of 50% of the total volume of debris and the efficient transportation of this debris using dump trucks, over a distance of 19.2 kilometers to the site designated for its disposal final (Area 3: Las Iguanas Sanitary Landfill Sector E).

The approximate cost of transportation and final disposal is approximately $28.49/ton, which represents an essential component in the analysis of debris generation due to disaster situations.

4. CONCLUSIONS

In disaster situations, especially collapses in the drinking water and sanitation system due to earthquakes, various considerations must be taken to guarantee the supply of safe water. This involves accurate damage assessment, finding alternative water sources, gradually restoring the system, storing clean and safe water, and promoting personal hygiene practices. Furthermore, it is essential to collaborate with local authorities for an organized distribution of drinking water, prioritizing the basic needs of the affected population.

To improve waste management in disaster situations, it is essential to establish and maintain:

Complete database that records available equipment and machinery, operating status such as excavators and dump trucks, by public entities such as the Municipality of Guayaquil and the Government. A constant update of this database guarantees the accuracy of the information and avoids operational delays.

The use of standardized sheets provides essential details about the equipment, facilitating informed decision-making during emergencies and considering aspects before and after an earthquake, environmental impact, waste management, and handling of corpses.

In addition, the importance of staff training and awareness about resource conservation is highlighted, as well as coordination between institutions at the local and regional level for an effective and strategic response to disasters, including public service companies must have emergency plans to avoid difficulties after an earthquake

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