



Methodology to determine amount and composition of Construction wastes from collapsed buildings



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1. Introduction

The occurrence of earthquakes is unpredictable. Therefore, it is not possible to predict when they could happen. However, the places in the world with the highest seismic activity have been identified. Figure 1 presents the seismic activities regions in the world (Time, 2017)

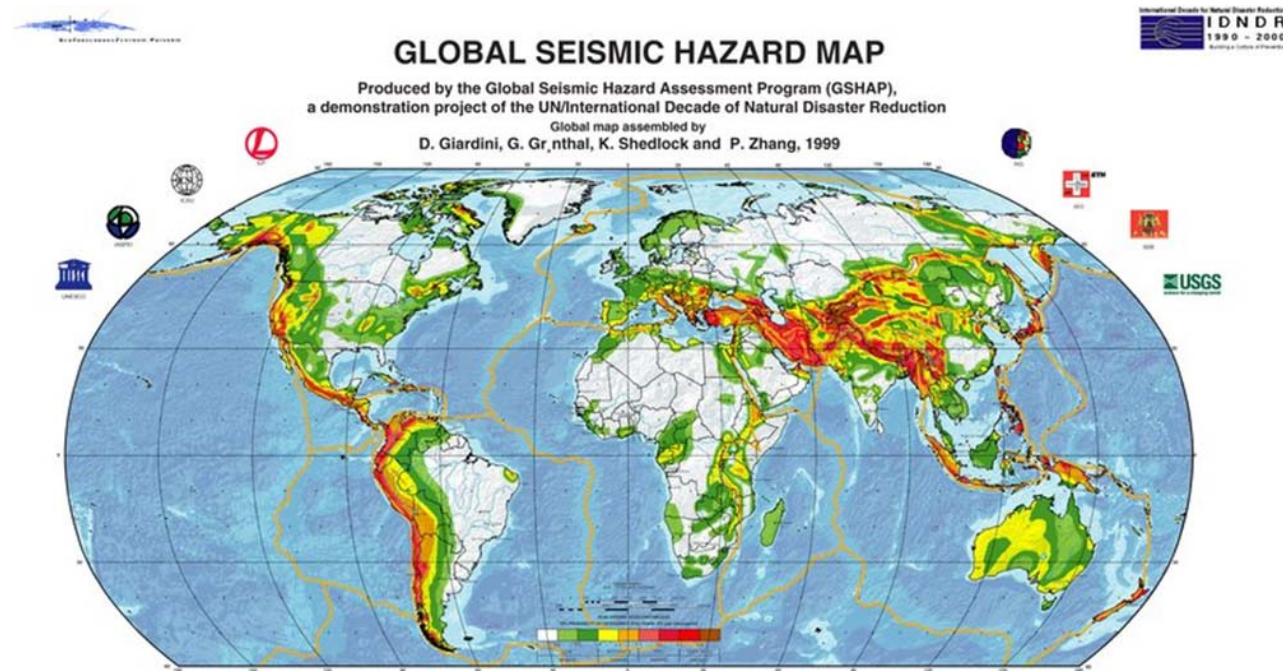


Figure 1

Mexico is located in the context of five tectonic plates: Caribbean, Pacific, North America, Rivera and Cocos. The last two plates are submerged under the North American plate (Fu Wang et al, 1998). Figure 2 presents the hazards of seismic activity in Mexico.

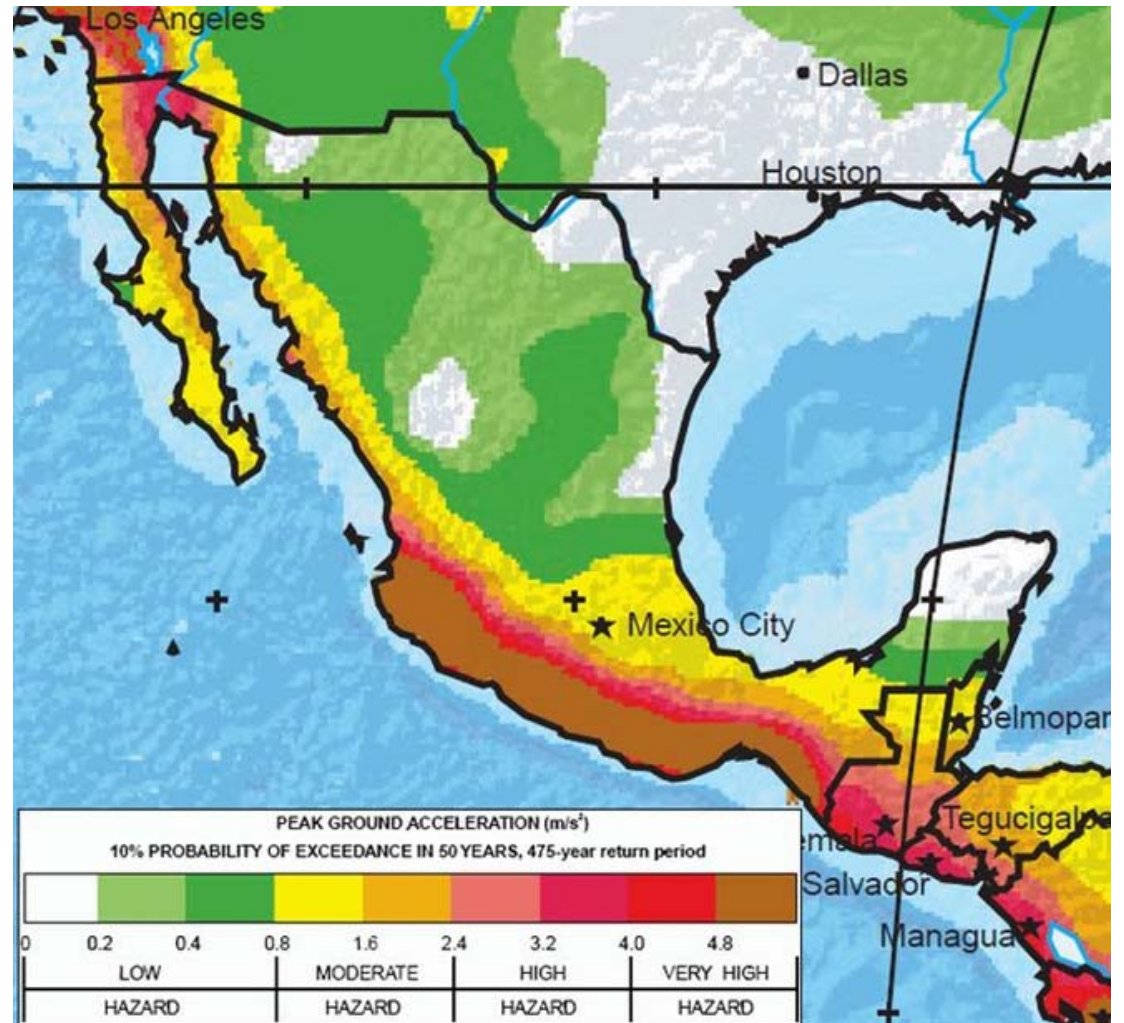


Figure 2

2. Objective

To develop a methodology to determine amount and composition of construction and demolition waste, C&DW, in case of a disaster due to earthquakes.

Most of international bibliographic on Construction and Demolition Wastes, C&DW, management are oriented to normal or daily construction activities such as:

- Source reduction
- Recycling and re-use
- Deconstruction
- Collection
- Transport
- Disposal of



These practices normally are planned and several entities and actors participate: owners of the buildings, constructors, municipal authorities, public and private enterprises. Moreover, in developed countries, C&D wastes represent an important economic activity and care of the environment is considered.

However, when a natural catastrophe happens, such as flooding, hurricanes, tornadoes and earthquakes, there is insufficient information on criteria and methodologies for environmental management of construction and demolition waste in contingencies.



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LESS THAN 3.5	Generally, is not detected, but registered.
3.5 – 5	Constantly noticed, but only causes minor damages.
5.5 – 6.0	Causes light damages to buildings.
6.1 – 6.9	It can cause sever damages in populated areas

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6.1 – 6.9	It can cause sever damages in populated areas
7.0 – 7.9	Major earthquake. Causes grave damages.

In this Table it is presented a method to classify damaged buildings based on the level of damage. Mexico City authorities used this classification after 19th July 2017 earthquake.

Category	Significance	Requirements	Affectations
Green	Minor damages	Minor repairs	Building may be used
Yellow	Significant non-structural effects	Major repairs	Building can not be used during repair
Red	Major damages	Demolition	Inhabited

Buildings in the "green" category have minimal effects and are still habitable as it is exemplified in figure 3.



Figure 3

Buildings classified with "yellow" color show moderate damages; they require major repairs and can not be used by their owners during the repair period. Figure 4 presents an example of a building classified as yellow color.



Figure 4

Buildings classified with "red" color, almost collapsed, they necessary have to be demolished. In figure 5 a building classified as Red color is presented.



Figure 5

In Mexico City the authorities reported 10 thousand buildings of "green" color, between 2 thousand and 3 thousand buildings of "yellow" color and around 500 of "red" color after the 19th September 2017 earthquake. Figure 6 shows a map presented by Mexico City authorities of damaged buildings.

Mapa de Edificios Derrumbados y
Dañados por el Sismo del 19/09/2017
9,435,916 vistas

COMPARTIR

☑ Daños y Derrumbes OFICIAL

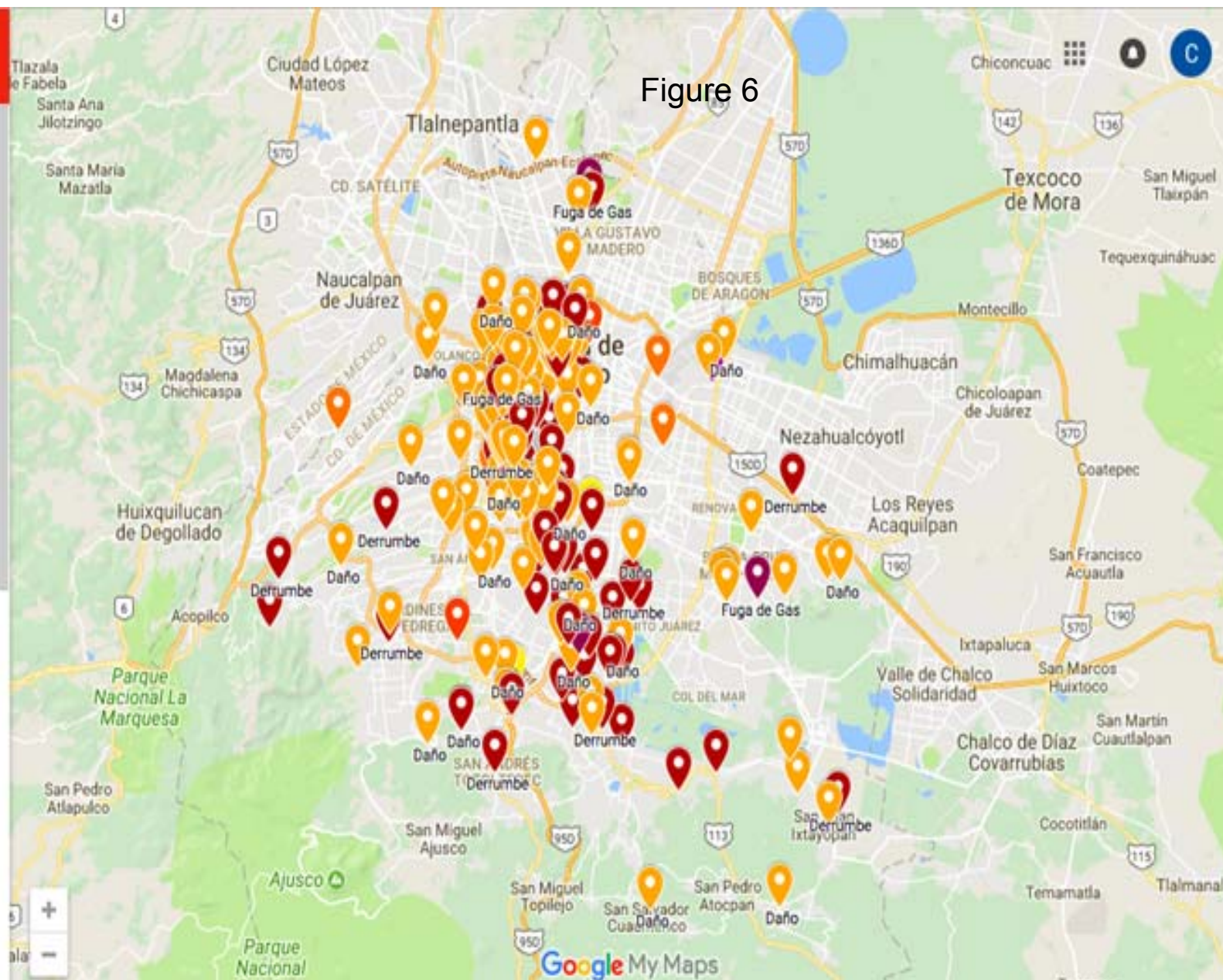
- ▼ 📍 Derrumbe
- 📍 Daño Mayor
- 📍 Daños
- 📍 Derrumbe de Barda
- 📍 Otro/Sin datos

☐ Albergues Oficiales

☐ Base Datos Waze

☑ C5 CDMX

- ▼ 📍 Daño
- 📍 Derrumbe



3.Method to quantify the amount of C&DW

3.1 Location of the damaged buildings

This fundamental step can be done by several ways:

- a) Reports of inhabitants
- b) Video cameras in the streets
- c) Satellite photographs

3.2 Inspection of damaged buildings

It is necessary to inspect and check damaged buildings after they were located in a map.

3.3 Compilation of building information

Persons in charge to attend damaged buildings have to gather minimum information and data of these structures to estimate as follows:

- Number of building floors
- Constructed surface
- Surface of each floor
- Volume of each flat
- Average specific weigh



3.4 Example

Determination of the amount of Construction and Demolition Waste after a collapsed building.

Data:

- Number of floors: 8
- Dimensions of a floor: width → 20 m, length → 15m and height → 3m.

Considerations:

1. Main composition wastes:

A. Concrete

B. Furniture and appliances

2. Percentage of structural volume 10%

3. Percentage of furniture and appliance volume 30%

4. Volumetric weight of concrete 2 400 kg/m³

Solution.

- Floor volume: $w \cdot h \cdot l = (20 \text{ m}) (15 \text{ m}) (3 \text{ m}) = 900 \text{ m}^3$ per floor.
- Which give us a total volume, for the 8 floors, of 7200 m³.
- For each floor, we will have 90 m³ of concrete volume, as it is the 10% of the total floor volume, and considering the 8 floors we have a total volume of 720 m³. Expressed in weight, we have 216 000 kg or 216 tons.
- Now, as we have the 30% of the floor occupied by furniture and appliances, the volume of these appliances will be of 270 m³ per floor. Which give us a total furniture volume of 2160 m³.

4. Methods to identify and classify residues.

1. Classification in groups:

- Hazardous, non-hazardous
- Recyclable, and disposable waste.

Hazardous

a. Automobile maintenance:

- Engine oil.
- Warn-out lubricant oil.
- Fuel additives.
- Antifreeze liquid.
- Engine cleaner.
- Carburetor cleaner.
- Acid-lead batteries.
- Fuels.
- Transmission liquid.



b. Home cleanliness and maintenance products:

- Liquid plunger.
- Metal cleaner and polishing products.
- Tartar removers.
- Solvents (turpentine).
- Epoxy glues.
- Paint and varnish removers.
- Sealers.
- Wood ink.



c. Biocides:

- Wood keepers.
- Insecticides.
- Weed-killers.
- Naphthalene in all its presentations.
- Rat poison



d. Medical and health assistants.

- Expired medicines for people and pets.
- Puncture stuff and recovery materials.



HOME HEALTH AIDE
SERVICES

Non Hazardous

a. Recyclable

- Concrete
- Metals
- Wood
- Glass
- Bricks



5. Guidelines for an adequate management of C&DW after collapsed buildings

- Site Inspection
- Separation and classification.
- Temporary Storage.
- Separated Collection.
- Reuse and recycle.
- Final disposition sites.



6. Conclusions

1. In Mexico there is not procedures for an adequate management of C&DW in cases of disasters due to earthquakes

2. Environmental problems and human health could occur due to an inadequate management of hazardous waste present in C&DW

3. As part of an environmental and beneficial management of C&D wastes after collapsed buildings, it is necessary to classify them in a form to ensure minimum negative impacts to human health and to environment.