Virtual Earthquake Reconnaissance Team (VERT): Phase 1 Response to M7.4 Mexico City Oaxaca 06/23/2020


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Please Note: This report is based on publicly available data within 48 hours of the events. The assessment provided in the report is performed by the judgment of the authors with limited access to ground-truthing.
Topic: Earthquake Characteristics

VERT Phase 1 Response for:
Oaxaca, Mexico City M7.4 Earthquake
Earthquake Characteristics

Date: June 23, 2020  15:29:05 (UTC)

Magnitude:  Mw 7.4

Location:
- Epicenter located 12 km SSW of Santa María Zapotitlán, Mexico
- 16.029°N and 95.901°W

Depth: 26.3 km

Epicenter of the Earthquake
Summary of Location, Fatalities, Fault Mechanism, and other Statistical Data

Fault Mechanism:

- The earthquake resulted from reverse fault mechanism along the interface between the Cocos Plate and North America Plate
- Earthquake depth is 20 km
- Maximum Slip ~9 meters

Max Intensity:

- Strong shaking
- Moderate damage

Intensity Map
Summary of Location, Fatalities, Fault Mechanism, and other Statistical Data

Impact on human safety:
- 2:25 PM PDT 06/23 - at least 6 casualties
- Several injuries reported

Impact on society:
- Yellow Alert for economic losses
- Estimated economic losses < 1% of GDP
Rupture occurred on either a shallowly dipping thrust fault striking towards the west or on a steeply dipping reverse fault striking towards the ESE.

The depth and focal mechanism solutions of the event are consistent with its occurrence on the subduction zone interface between these plates, approximately 100 km northeast of the Middle America Trench, where the Cocos plate begins its descent into the mantle beneath Mexico.
Summary of Location, Fatalities, Fault Mechanism, and other Statistical Data

Landslides
Estimated Area Exposed to Hazard

- Little or no: 1 km²
- Limited: 10 km²
- Significant: 100 km²

Landslides triggered by this earthquake are estimated to be significant in number and (or) spatial extent.

Estimated Population Exposure

- Little or no: 240
- Limited: 1,000
- Significant: 10,000

The number of people living near areas that could have produced landslides in this earthquake is limited. This is not a direct estimate of landslide fatalities or losses.

Liquefaction
Estimated Area Exposed to Hazard

- Little or no: 30 km²
- Limited: 100 km²
- Significant: 1,000 km²

Liquefaction triggered by this earthquake is estimated to be limited in severity and (or) spatial extent.

Estimated Population Exposure

- Little or no: 4,000
- Limited: 10,000
- Significant: 100,000

The number of people living near areas that could have produced liquefaction in this earthquake is limited. This is not a direct estimate of liquefaction fatalities or losses.

Landslide Map
Liquefaction Map
References

1. USGS M 7.4 - 12 km SSW of Santa María Zapotitlán, Mexico
   https://earthquake.usgs.gov/earthquakes/eventpage/us6000ah9t/executive


2. USGS Earthquake Hazards Program Event Executive Summary, v. 1, 2020/06/23
Topic: Tsunami/Earthquake
Early Warning

VERT Phase 1 Response for:
Oaxaca, Mexico City M7.4 Earthquake
# Overview of early warning system

<table>
<thead>
<tr>
<th>Location</th>
<th>Type</th>
<th>Warning time</th>
<th>Distance (km)</th>
<th>Anticipation (s)*</th>
<th>Notes</th>
</tr>
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<tbody>
<tr>
<td>Oaxaca City</td>
<td>Public</td>
<td>10:29:19</td>
<td>157</td>
<td>22</td>
<td></td>
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<tr>
<td>Puebla</td>
<td>Public</td>
<td>10:29:20</td>
<td>427</td>
<td>82</td>
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<td>Chilpancingo</td>
<td>Public</td>
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<td>Acapulco</td>
<td>Public</td>
<td>10:29:19</td>
<td>424</td>
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<tr>
<td>Mexico City</td>
<td>Public</td>
<td>10:29:19</td>
<td>517</td>
<td>102</td>
<td>Gov’t of CDMX reported that 97.5% of speakers worked, the rest in review¹</td>
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<tr>
<td>Morelia</td>
<td>Public</td>
<td>10:29:19</td>
<td>695</td>
<td>142</td>
<td></td>
</tr>
</tbody>
</table>

*These numbers are as first reported by the SASMEX twitter feed the day of the earthquake (23/6), which differ somewhat from values reported in a later tweet for Oaxaca, Chilpancingo, Puebla, and Mexico City (30, 105, 100, and 129 s anticipation time reported in the later tweet, respectively).²
Overview of early warning system

Note: These anticipation times are different (longer) than reported on the earlier slide, potentially due to differences in the determination of when the strongest shaking (PGA) occurred and/or refined data.
The Mexican Seismic Alert System (SASMEX) has been in operation since 1991 in Mexico City, and began services in Oaxaca in 2003$^{3a}$.

As of 25 June 2020, SASMEX has issued 77 public alerts and 98 preventative alerts$^{3b}$. 
Performance of SASMEX during event

The Centro de Instrumentación y Registro Sísmico, A.C. (CIRES) posted a video of the performance of SASMEX during the 23 June earthquake event on Youtube.⁴
Tsunami Early Warning System

**Figure.** Earthquake wave propagation and potential tsunami impact

Summary of Tsunami

- The earthquake triggered a tsunami wave of 2 feet (60 cm) off the coast of Oaxaca. No damage from the tsunami was observed.

- Timeline of events:
  - Earthquake: 15:29 (UTC)
  - Tsunami warning: 15:39 (UTC) Pacific Tsunami Warning System (PTWS)
  - Tsunami wave landing: 17:24 (UTC) in Acapulco, Mexico

- Tsunami warnings issued initially for coasts of Mexico, Honduras, El Salvador and Guatemala
Tsunami Arrival Time Estimates

**Figure.** Estimated time of coastal tsunami wave arrival

Ref: PTWS

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>REGION</th>
<th>COORDINATES</th>
<th>ETA(UTC)</th>
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</thead>
<tbody>
<tr>
<td>ACAPULCO</td>
<td>MEXICO</td>
<td>16.9N 99.9W</td>
<td>1616 06/23</td>
</tr>
<tr>
<td>SALINA CRUZ</td>
<td>MEXICO</td>
<td>16.5N 95.2W</td>
<td>1623 06/23</td>
</tr>
<tr>
<td>PUERTO MADERO</td>
<td>MEXICO</td>
<td>14.8N 92.5W</td>
<td>1641 06/23</td>
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<td>LAZARO CARDENAS</td>
<td>MEXICO</td>
<td>17.9N 102.2W</td>
<td>1643 06/23</td>
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<td>SIPICATE</td>
<td>GUATEMALA</td>
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<td>ACAJUTLA</td>
<td>EL SALVADOR</td>
<td>13.6N 89.8W</td>
<td>1703 06/23</td>
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<td>MANZANILLO</td>
<td>MEXICO</td>
<td>19.1N 104.3W</td>
<td>1706 06/23</td>
</tr>
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<td>AMAPALA</td>
<td>HONDURAS</td>
<td>13.2N 87.6W</td>
<td>1800 06/23</td>
</tr>
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</table>
**Observed Tsunami Wave Impact and Location**

<table>
<thead>
<tr>
<th>Location</th>
<th>Time</th>
<th>Wave height</th>
<th>Wave period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acapulco, MX</td>
<td>17:24 (UTC)</td>
<td>0.68 m / 2.2 ft</td>
<td>20 min</td>
</tr>
<tr>
<td>Salina Cruz, MX</td>
<td>17:45 (UTC)</td>
<td>0.71 m / 2.3 ft</td>
<td>20 min</td>
</tr>
</tbody>
</table>

**Table.** Tsunami wave observations
References


5. NWS Pacific Tsunami Warning Center, Tsunami Threat Message #1, 15:39 UTC TUE JUN 23 2020, https://www.tsunami.gov/events/PHEB/2020/06/23/20175001/1/WEPA40/WEPA40.txt


7. NWS Pacific Tsunami Warning Center, Twitter Feed, https://twitter.com/nws_ptwc?lang=en


Topic: Aftershocks

VERT Phase 1 Response for:
Oaxaca, Mexico City M7.4 Earthquake
Summary of Aftershocks

- More than 300 aftershocks had been registered by June 23, with magnitudes as high as Mw4.6\(^1\).
- “By Wednesday, the country’s civil protection force said there had been more than 1,400 aftershocks.”\(^2\)
Summary of Aftershocks

- USGS map of latest earthquakes shows a small cluster of aftershocks of up to M5.0 in the area

Snapshot from USGS Latest Earthquakes, with the main event in cyan

USGS$^2$


3. USGS Latest Earthquakes Interactive Map, accessed June 24, 2020, 17:04 PST. https://earthquake.usgs.gov/earthquakes/map/#%7B%22autoUpdate%22%3A%5B%22autoUpdate%22%5D%2C%22basemap%22%3A%22terrain%22%2C%22feed%22%3A%22day_all%22%2C%22listFormat%22%3A%22default%22%2C%22mapposition%22%3A%5B%223A%5B5B%5B14.42404044435422%2C97.55859375%22%5D%2C%5B17.58643052828743%2C94.09790039062499%5D%22%2C%22restrictListToMap%22%3A%22plates%22%2C%22search%22%3A%22null%22%2C%22sort%22%3A%22newest%22%2C%22timezone%22%3A%22utc%22%2C%22viewModes%22%3A%22list%22%2C%22map%22%2C%22settings%22%3A%22event%22%3A%22null%7D
Topic: Other building damage

VERT Phase 1 Response for:
Oaxaca, Mexico City M7.4 Earthquake
Summary of other building damage

- “more than 30 buildings in the capital suffered damage, officials said, including buildings still scarred from a 2017 earthquake that killed 355 people in the capital and the surrounding states” [3]
- Claudia Sheinbaum (Mexico City Governor): There was minor damage in 32 buildings. This damage is only to facades and [non-building] walls. Two of the buildings that suffered damage were slated be demolished due to the 2017 earthquakes. A structural assessment is being conducted on the building at Tlalpan 605 in the Alcaldía Benito Juarez. Four city buildings were damaged, in addition to the 32 previously reported [Paraphrased from the article in Spanish by T. Rodriguez-Nikl]. Details of damage in the 32 buildings is reported in reference 9. All the damage is minor. The reference can be consulted for further details.
Hospital Damage in Oaxaca

- Seven hospitals reported damage: the General Hospitals of Pochutla, Puerto Escondido and Pinotepa Nacional, and the Community Hospitals of Santa Catarina Juquila, Santa María Huatulco, Río Grande and Santos Reyes Nopala. The IMSS unit in the Los Naranjos de la Costa community reports structural damage, while the "Hospital de Regional de Alta Especialidad de Oaxaca" (HRAEO), one of the best prepared to care for COVID-19 patients and at 100% occupancy, was vacated and a structural damage assessment is being carried out. Similar information in English in Reference 12.

- Civil protection coordinator David Leon said that more than 20 hospitals were damaged in the country, Deutsche Presse reported. Mexican newspaper El Universal reported that in some cases, patients had to be temporarily evacuated [11].
Summary of other building damage

Damage to a building in Oaxaca State [4]

Damage to a building in Oaxaca State [5]
Summary of other building damage (Mexico City)

Building at Quintana Roo#3 and Medellín, Col. Roma, Previously damaged in 2017\textsuperscript{13}
Summary of other building damage

The state-run oil company known as Pemex said the quake caused a fire at its refinery in the Pacific coast city of Salina Cruz, which was relatively close to the epicenter. It said one worker was injured and the flames were quickly extinguished.\(^1\) The rest of the refinery is operating in normal conditions. Only one person was hurt was the quake.\(^2\)
References

2. https://twitter.com/Pemex/status/1275482020525662208
Topic: Housing (Single-Family Homes)

VERT Phase 1 Response for: Oaxaca, Mexico City M7.4 Earthquake
Summary of Housing

- Oaxaca Governor Alejandro Murat stated that more than 5,000 homes across 117 municipalities have been affected by the earthquake. [1]

- 200 houses in the Pacific coast resort town of La Crucecita (23 km away north of the earthquake’s epicenter) were damaged, including 30 that were badly impacted [6].

- The towns of La Crucecita and San Juan Ozolotepec have reported the most severe damage to homes.

- Housing related casualties: A 70-year old man was killed in an apparent house collapse in the mountain village of San Juan Ozolotepec. [2,7]
Types of housing damage

- Most of the affected homes sustained minor damage according to the Oaxaca government. [2]

- Types of damage reported include: cracks in walls, broken windows, and collapsed walls.

- No reports of cripple wall or foundation damage were available.

Cracks in the Walls of a Home in Huatulco [8]
Types of housing damage

Damage at a garage opening [3]

Broken windows in Huatulco [4]

Collapsed home in Ozolotepec [5]
References


[3] https://twitter.com/diarioelfortin/status/1275463114172104704


[5] https://twitter.com/realidadoaxaca/status/1275493241031401472


[8] https://twitter.com/alejandromurat/status/1275888742134353921
Topic: Geotechnical Damage

VERT Phase 1 Response for:
Oaxaca, Mexico City M7.4 Earthquake
Summary of Geotechnical Damage

- A preliminary estimate of ground failure is made by USGS based on ground-motion estimates from ShakeMap version 3(point source) [1].

- The extent of shaking and ground-failure estimates generally improve as more details are incorporated into ShakeMap [1].

- ShakeMap is currently approximating this earthquake as a point source, and the mapped extent of ground failure commonly changes significantly when a fault model is added, especially for larger earthquakes [1].
Summary of Geotechnical Damage

Landslides

Estimated Area Exposed to Hazard

<table>
<thead>
<tr>
<th>Area (km²)</th>
<th>Little or no</th>
<th>Limited</th>
<th>Significant</th>
<th>Extensive</th>
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<tr>
<td>16</td>
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</table>

Landslides triggered by this earthquake are estimated to be significant in number and (or) spatial extent.

Estimated Population Exposure

<table>
<thead>
<tr>
<th>Population</th>
<th>Little or no</th>
<th>Limited</th>
<th>Significant</th>
<th>Extensive</th>
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</thead>
<tbody>
<tr>
<td>110</td>
<td>▲</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The number of people living near areas that could have produced landslides in this earthquake is limited. This is not a direct estimate of landslide fatalities or losses.

Liquefaction

Estimated Area Exposed to Hazard

<table>
<thead>
<tr>
<th>Area (km²)</th>
<th>Little or no</th>
<th>Limited</th>
<th>Significant</th>
<th>Extensive</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>▲</td>
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<td></td>
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</tbody>
</table>

Liquefaction triggered by this earthquake is estimated to be limited in severity and (or) spatial extent.

Estimated Population Exposure

<table>
<thead>
<tr>
<th>Population</th>
<th>Little or no</th>
<th>Limited</th>
<th>Significant</th>
<th>Extensive</th>
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<tr>
<td>3,800</td>
<td>▲</td>
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</tbody>
</table>

The number of people living near areas that could have produced liquefaction in this earthquake is limited. This is not a direct estimate of liquefaction fatalities or losses.

USGS [1]
Summary of Geotechnical Damage

Landslides Probability Map [1]
Summary of Geotechnical Damage

Liquefaction Probability Map [1]
Summary of Geotechnical Damage

- Sinkholes in Iztacalco, Col. Los Picos and Campamento 2 de Octubre, CDMX [5,6]
- Rockslides in highways of Oaxaca, Sola de Vega-Juchatengo-Cerro del Vidrio, Copalita-Santa María Huatulco, Oaxaca-Istmo, etc.[7]
Summary of Geotechnical Damage

Copalita-Santa María Huatulco [2]

Oaxaca-Istmo [3]

Copalita-Santa María Huatulco [2]
Landslide and Highway Interruption

According to the highway authorities, a landslide caused a blockage on the highway between Oaxaca City and the Isthmus of Tehuantepec on the Totolapan-El Camarón section. Federal highway 200 was impassable in the Pochutla-Huatulco area. [4]
References

2. https://twitter.com/josuasilva/status/1275586579462074368?s=21
3. https://twitter.com/vicmanoaxaca/status/1275478495137632256?s=21
5. https://twitter.com/telediario/status/1275774028565880832?s=20
Topic: Emergency Response

VERT Phase 1 Response for: Oaxaca, Mexico City M7.4 Earthquake
Emergency Response

List of responding agencies:

- Cmte. Isaac Oxenhaut Gruzko
  Mexican Red Cross
  https://www.cruzrojamericana.org.mx/

- Carlos Ernesto Hernández Colín
  Deputy Director of Salvage and Rescue, Squadron of Rescue and Medical Emergencies, CDMX
  https://www.ssc.cdmx.gob.mx/micrositios/escuadron-de-rescate-y-urgencias-medicas

- Norma Maleni Ávila Escalona
  Rescue, Squadron of Rescue and Medical Emergencies, CDMX
  https://www.ssc.cdmx.gob.mx/micrositios/escuadron-de-rescate-y-urgencias-medicas

- José Manuel Martínez Murillo
  First Regional Commander, State Unit for Civil Protection and Fire, Jal.
  https://proteccioncivil.jalisco.gob.mx/
Emergency Response

List of responding agencies:

- Moisés Alfredo Aladro Ramírez
  Firefighter and member of the USAR group, Heroic Tijuana Fire Department
  https://es-la.facebook.com/bomberostj/

- Miriam Isela Díaz Ávila
  Alpine Relief Brigade of Mexico
  http://socorroalpinomexico.org/

- Jan Uribe Pérez
  Cancun International Rescue Brigade
  https://briccancun.org/
Emergency Response

- Mexico is combating one of the world’s most severe coronavirus outbreaks, and emergency management officials had expressed concern about what it would mean to respond to a large earthquake in the middle of a pandemic [1].

- “So far no major damage has been reported - just the collapse of a few walls and building fronts,” Claudia Sheinbaum, the city’s mayor, said in a video from Mexico City’s emergency response centre [2].
San Juan Ozolotepec is about 175 km away from the epicenter.

99.5% of the residents of San Juan Ozolotepec live in poverty according to federal statistics.

Due to the town’s location, cell phone coverage is spotty at best, and after the earthquake several residents climbed hills trying to get cell phone service to plead for help.

Several ranches and small settlements remain cut off due to rubble-covered roads as rescue crews set out on foot to try to reach them and offer assistance. [8]
A Healer: Juana Lopez Cruz

- Juana Lopez Cruz is a 58-year old retired general nurse who supports affected communities in South Oaxaca as reported by Oaxaca Politico [9].

Nurse Lopez Cruz attends to the injured, by walking through roads obstructed by landslides [9]
Emergency Response

National Coordination of Civil Protection maintain communication with the State and Municipal to carry out a preliminary evaluation - immediate after the earthquake @ProteccionCivilSeguridad

Alejandro Murat have installed the Damage Assessment Council; as a team with the @CEPCO_GobOax - 3 hours after the earthquake @alejandromurat

Update of the earthquake in Oaxaca confirmed 6 deceased and 4 injured throughout the state. Landslides on 3 federal and 5 state highways, 500 homes affected, 4 archaeological zones with damage, 15 health centers with damage - 11 hours after the earthquake @ProteccionCivilOax
References


2. https://twitter.com/cepco_goboax

3. https://twitter.com/CNPC_MX

4. https://twitter.com/hashtag/Protecci%C3%B3nCivil?src=hashtag_click


6. https://fronterasdesk.org/content/1595105/6-dead-reports-damaged-homes-after-earthquake-oaxaca-mexico


8. https://www.facebook.com/crisisresponse/3528185977227153/?alias=3528185977227153&source=search