The April-May 2015 Nepal Earthquake Sequence

The April 25, 2015 M 7.8 Gorkha Earthquake and its Aftershocks, including the May 12, 2015 M 7.3 Event

Earthquake Educational Slides
Created & Compiled by Gavin Hayes
U.S. Geological Survey, National Earthquake Information Center

Contributions from:
Rich Briggs, Kishor Jaiswal, Dan McNamara, David Wald, Harley Benz, Mike Hearne, Paul Earle
USGS Geological Hazards Science Center
Mainshock fatalities - 8,500 (as of 05/15)
05/12 Aftershock: fatalities > 100
Event pages linked directly from text messages; instant access to all event-based info in new, phone-friendly web format.
Overview

M 7.8 mainshock on 04-25, ~80 km NW of Kathmandu.
Overview

M 7.8 mainshock on 04-25, ~80 km NW of Kathmandu.

~100 subsequent aftershocks, most east of mainshock.

M 7.3 aftershock on 05-12, ~80 km NE of Kathmandu.
Overview

M 7.8 mainshock on 04-25, ~80 km NW of Kathmandu.

~100 subsequent aftershocks, most east of mainshock.

M 7.3 aftershock on 05-12, ~80 km NE of Kathmandu.

Most EQs shallow angle thrust faulting; likely on decollement of Himalaya Thrust. Some normal fault aftershocks.
Mainshock slip directed east from hypocenter, towards Kathmandu.

Peak slip >4m.
Dimensions ~120 x 80 km.

Similar location and extent to 1833 M~7.7 EQ. Adjacent to 1934 M 8+ EQ.
Overview

Mainshock slip directed east from hypocenter, towards Kathmandu.

Peak slip >4m. Dimensions ~120 x 80 km.

Similar location and extent to 1833 M~7.7 EQ. Adjacent to 1934 M 8+ EQ.

M7.3 aftershock at NE extent of mainshock; slip close to 4m, dimensions ~40 x 30 km. Resolvable NW rotation wrt 4-25 EQ.
Time History

Aftershocks are earthquakes that occur following a large EQ, in the same general area as that EQ, during the following days-to-years. Both the M 7.8 Gorkha mainshock and the M 7.3 aftershock, have triggered aftershocks.

Two M 6.6-6.7 aftershocks within 48 hrs of mainshock.

Subsequent aftershock sequence decayed rapidly, until M7.3 aftershock on 05-12, 17 days after mainshock.

Increase in aftershock activity since M7.3 event, including a M6.3 aftershock soon after that EQ.
Generalized cross section showing the approximate locations of slip during the 25 April and 12 May 2015 ruptures on the Main Himalayan Thrust, and approximate aftershock locations of both events.

MFT = Main Frontal Thrust, MBT = Main Boundary Thrust, MCT = Main Central Thrust.

Cross section generalized after Lave and Avouac, 2001 and Kumar et al., 2006.
The Ganges Delta of northern India has extremely high population density, in an area very close to historic great earthquakes, and/or plate boundary sections with demonstrated high strain accumulation.
Broad, very strong-severe shaking, elongated eastward from hypocenter by EQ finiteness.

Shaking estimates in epicentral region are poorly constrained due to fewer intensity observations (as well as lack of strong motion data).
Predominantly strong-very strong shaking, focussed around aftershock hypocenter (smaller source dimensions).
Combined shaking intensity dominated by mainshock.
Combined shaking intensity dominated by mainshock.

Aftershock shaking only higher than mainshock in eastern Nepal, where population is lower.
Combination of broad, very strong-severe shaking leads to high exposure and thus an international-level alert; large numbers of fatalities, and economic losses.

Median loss estimation:
- ~9,000 fatalities
- ~$4B direct economic loss
- EQ occurred during work hours (many people were outdoors)
- Housing in rural areas are one-two story construction, with a relatively lighter roof (Tins/GI sheets). High damage rate even at low shaking, but often leads to low fatality rates.
- Majority of newer, multi-story buildings performed reasonably well (sustained damage, but did not collapse).
Exposure
April 25th 2015

bars represent population/km²; color shaking intensity by Kishor Jaiswal, USGS GHSC
Smaller sized EQ, and smaller source dimensions, leads to strong-very strong shaking in a more focussed, lower population area.

Median loss estimation:
- ~160 fatalities
- ~$60M direct economic loss
bars represent population/km²; color shaking intensity by Kishor Jaiswal, USGS GHSC
**Estimated Fatalities**

- **Median Est.**

  - Red alert for shaking-related fatalities and economic losses. High casualties and extensive damage are probable and the disaster is likely widespread. Past red alerts have required a national or international response.

  Estimated economic losses are 10-70% GDP of Nepal.

**Estimated Economic Losses**

- **Median Est.**

  - Orange alert level for shaking-related fatalities. Significant casualties are likely and the disaster is potentially widespread. Past events with this alert level have required a regional or national level response.

  Yellow alert level for economic losses. Some damage is possible. Estimated economic losses are 0-1% GDP of Nepal.

---

**Selected City Exposure from GeoNames.org**

<table>
<thead>
<tr>
<th>MMI City</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIII Kathmandu</td>
<td>1,442k</td>
</tr>
<tr>
<td>VIII Patan</td>
<td>183k</td>
</tr>
<tr>
<td>VIII Kirtipur</td>
<td>45k</td>
</tr>
<tr>
<td>VIII Bhaktapur</td>
<td>&lt; 1k</td>
</tr>
<tr>
<td>VIII Banepa</td>
<td>17k</td>
</tr>
<tr>
<td>VIII Panaoti</td>
<td>28k</td>
</tr>
<tr>
<td>VI Pokhara</td>
<td>200k</td>
</tr>
<tr>
<td>VI Muzaffarpur</td>
<td>333k</td>
</tr>
<tr>
<td>V Gorakhpur</td>
<td>674k</td>
</tr>
<tr>
<td>V Patna</td>
<td>1,600k</td>
</tr>
<tr>
<td>V Dhankuta</td>
<td>22k</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MMI City</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>VI Zham</td>
<td>&lt; 1k</td>
</tr>
<tr>
<td>VI Kodari</td>
<td>2k</td>
</tr>
<tr>
<td>VI Bhaktapur</td>
<td>&lt; 1k</td>
</tr>
<tr>
<td>VI Kathmandu</td>
<td>1,442k</td>
</tr>
<tr>
<td>VI Zuobude</td>
<td>&lt; 1k</td>
</tr>
<tr>
<td>VI Cambayi</td>
<td>&lt; 1k</td>
</tr>
<tr>
<td>V Patna</td>
<td>1,600k</td>
</tr>
<tr>
<td>IV Gorakhpur</td>
<td>674k</td>
</tr>
<tr>
<td>IV Dhankuta</td>
<td>22k</td>
</tr>
<tr>
<td>IV Pokhara</td>
<td>200k</td>
</tr>
<tr>
<td>IV Gangtok</td>
<td>311k</td>
</tr>
</tbody>
</table>
The Ganges Delta of northern India has extremely high population density, in an area very close to historic great earthquakes, and/or plate boundary sections with demonstrated high strain accumulation.