Seismic Risk of Water Supply System of Kathmandu Valley and Risk Reduction Measures

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Seismic Hazard of Nepal
Water System Damage Map from KVERMP

Larger portion of water supply system of Kathmandu Valley Could be damaged
Scenario One Week After

Main City Areas could not get water even after one week of a large seismic event

More detail study was felt necessary to assess the seismic vulnerability of water supply system
Recently a study on seismic vulnerability of Drinking Water Supply in Kathmandu Valley was conducted with the support from UNICEF Nepal.

The ATC-25-1 Methodology was used for the assessment of vulnerability with some adaptation to suit the local condition.

The study came up with recommendations for long term and short term mitigation measures.

Some of the recommendations for immediate action has been carried out.
Kathmandu Valley Water Supply System

Study on Seismic Vulnerability of Drinking Water Supply System in Kathmandu Valley

Legend
- Major Roads
- Transmission Pipeline
- Reservoir
- Well
- Intake

7 major supply networks – all very old and complex
Kathmandu Valley Seismic Hazard

Ground Shaking Hazard

Liquefaction Hazard

Study on Seismic Vulnerability of Drinking Water Supply System in Kathmandu Valley

Legend

Ground Shaking Hazard

Intensity_VII

Intensity_VIII

Intensity_X

Intensity_IX

Maj or Road

Distribution Pipeline

<10

100-200

200-300

300-400

400-500

>500

Kathmandu Valley Seismic Hazard

Ground Shaking Hazard

Liquefaction Hazard
Study on Seismic Vulnerability of Drinking Water Supply System in Kathamandu Valley

Legend
- Ground Shaking Intensity
  - Intensity IX
  - Intensity VII
  - Intensity VIII
  - Intensity X
- Transmission Pipeline
- Distribution Pipeline
- Intake
- Well
- Reservoir
- Major Road

Damage due to Ground Shaking Hazard

Valley Water Supply System with Ground Shaking Hazard

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10 0 10 20 Kilometers
Damage due to Liquefaction Hazard

Valley Water Supply System
Liquefaction Hazard

Study on Seismic Vulnerability
Drinking Water Supply System
Kathmandu Valley

Legend
Liquefaction Hazard
High
Low
Medium
Not Liquefy

Transmission Pipeline
Major Road
Intake

Distribution Pipeline
<100
100-200
200-300
300-400
400-500
>500

National Society for Earthquake Technology

10 0 10 20 Kilometres

10 0 10 20 Kilometres
### Total Damage and Direct Damage Cost

<table>
<thead>
<tr>
<th>Diameter of Pipes (mm)</th>
<th>Damage (No. of Breaks)</th>
<th>Cost of Replacement per break (NRs)</th>
<th>Total Cost of Repair (NRs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Due to Liquefaction</td>
<td>Due to Ground Shaking</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Damage</td>
<td></td>
</tr>
<tr>
<td>&lt;100</td>
<td>1666</td>
<td>2600</td>
<td>4267</td>
</tr>
<tr>
<td>100-200</td>
<td>556</td>
<td>916</td>
<td>1471</td>
</tr>
<tr>
<td>200-300</td>
<td>288</td>
<td>462</td>
<td>750</td>
</tr>
<tr>
<td>300-400</td>
<td>165</td>
<td>267</td>
<td>431</td>
</tr>
<tr>
<td>400-500</td>
<td>90</td>
<td>141</td>
<td>231</td>
</tr>
<tr>
<td>&gt;500</td>
<td>113</td>
<td>158</td>
<td>272</td>
</tr>
<tr>
<td>Total</td>
<td>2879</td>
<td>4545</td>
<td><strong>7423</strong></td>
</tr>
</tbody>
</table>

Breaks in distribution pipes alone costs USD 1.75 million (Present Repair Rate)
Water during Emergency

Major Probable Evacuation Points

17 Major Evacuation Points in KV
## Water during Emergency

<table>
<thead>
<tr>
<th>Evacuation Places</th>
<th>People holding capacity</th>
<th>Water (ltrs/day)</th>
<th>Reserve tanks for three days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Golf Course and Pashupati area</td>
<td>68,099</td>
<td>1,021,479</td>
<td>383</td>
</tr>
<tr>
<td>Birendra Intl. Conference Hall</td>
<td>14,286</td>
<td>214,286</td>
<td>80</td>
</tr>
<tr>
<td>Trally Park</td>
<td>8,893</td>
<td>133,393</td>
<td>50</td>
</tr>
<tr>
<td>Tudikhel (Khula Manch, Tudinkhel, Ratna park, Stadium, and Bhricuti Mandap area)</td>
<td>66,571</td>
<td>998,571</td>
<td>374</td>
</tr>
<tr>
<td>Exhibition Road area</td>
<td>4,957</td>
<td>74,350</td>
<td>28</td>
</tr>
<tr>
<td>Bhadrakali Military Camp area</td>
<td>10,809</td>
<td>162,141</td>
<td>61</td>
</tr>
<tr>
<td>Thapathali campus area</td>
<td>3,305</td>
<td>49,569</td>
<td>19</td>
</tr>
<tr>
<td>Chhauni Military area</td>
<td>28,055</td>
<td>420,822</td>
<td>158</td>
</tr>
<tr>
<td>National Trading Corporation</td>
<td>10,136</td>
<td>152,044</td>
<td>57</td>
</tr>
<tr>
<td>Balaju Buspark area</td>
<td>12,237</td>
<td>183,551</td>
<td>69</td>
</tr>
<tr>
<td>Total</td>
<td>227,347</td>
<td>3,410,205</td>
<td>1279</td>
</tr>
</tbody>
</table>

Tube wells in Evacuation Points require about a quarter million USD.
### Emergency Establishment of pipe system to serve Evacuation points

**Optimum Route for immediate recovery**

<table>
<thead>
<tr>
<th>Route</th>
<th>Total breaks</th>
<th>Required Skill Manpower at hand</th>
<th>Cost (NRs ‘000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Shivapuri-Tudikhel</td>
<td>149</td>
<td>12</td>
<td>8737.00</td>
</tr>
<tr>
<td>2. Sundarijal-Pashupati</td>
<td>156</td>
<td>13</td>
<td>10,028.00</td>
</tr>
<tr>
<td>3. Manohara-Pashupati-Birendra Intl Conf. Hall</td>
<td>118</td>
<td>10</td>
<td>6485.00</td>
</tr>
<tr>
<td>4. Sundarighat-National Trading-Tundikhel</td>
<td>143</td>
<td>12</td>
<td>5864.00</td>
</tr>
<tr>
<td>5. Balaju- Chauni</td>
<td>135</td>
<td>12</td>
<td>4567.00</td>
</tr>
<tr>
<td>6. Takhel-Military-Khumaltar</td>
<td>115</td>
<td>10</td>
<td>2122.00</td>
</tr>
</tbody>
</table>
### Emergency Establishment of pipe system to serve Evacuation points

<table>
<thead>
<tr>
<th>Optimum Route for immediate recovery</th>
<th>Total breaks</th>
<th>Required Skill Manpower at hand</th>
<th>Cost (NRs ‘000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Pharping-Pulchowk campus</td>
<td>88</td>
<td>7</td>
<td>5656.00</td>
</tr>
<tr>
<td>8. Sundarighat-Pulchowk campus</td>
<td>130</td>
<td>12</td>
<td>5136.00</td>
</tr>
<tr>
<td>9. Basbari- Industrial area-Military camp</td>
<td>158</td>
<td>13</td>
<td>4977.00</td>
</tr>
<tr>
<td>10. Manohara- Sallaghari-Military Camp</td>
<td>56</td>
<td>5</td>
<td>2690.00</td>
</tr>
</tbody>
</table>

Required money for restoration of optimum route = about a quarter million USD

Required time = about one month
Institutional Capacity to respond disaster

Institutional Setup

- NO Mitigation, Emergency and Recovery plan
- Inter-intuitional coordination not explored

Operation & Maintenance

- Annual maintenance program for reservoir and treatment plan, not for conduits
- Very few trained personnel, just for small scale regular maintenance
- Equipments at centre, not enough to cope disaster
Institutional Capacity to respond disaster

Administrative support

- Centralized funding for repair
- Staff reassignment possible
- NO pre-contract with private companies for supply and service during emergency. No legal hurdle to do so.

Hardware system

- Drawings with all key components not available
- Heavily interdependency with other infrastructure (electricity). Not all plants have backup generator
- One branch for tanker supply. Private tankers are also in operation
Institutional Capacity to respond disaster (Municipalities)

- NO plan for emergency case
- NO responsibility assigned in regards to water service to citizen
- NO dialogue with NWSC for coordination work required for emergency
- Ready to provide institutional support to NWSC for disaster
**Recommended Actions**

Specific for Emergency Response

- Maintain Accurate Facility maps
- Ensure Inter-institutional coordination for emergency response
- Maintain agreements with contractors, suppliers to provide service and material in case of disaster
- Maintain Redundancy in system operation. Back up generator, extra battery back at sites.
- Maintain Pre-positioning of Drinking water at identified evacuation points. Perform Detail investigation for point source at evacuation sites
- Maintain fund provision for immediate recovery of water supply system to evacuation points
Achievements

- Some of the immediate action are being implemented
  - Some deep tube wells for supply during emergencies are established in some locations
- Many emergency response institutions are concerned now
- Wide discussion about the mitigation process
Thank You!