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How the National Earthquake Hazards Reduction Program Is Advancing Earthquake Safety
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Collaborating and Assisting in Turkey

The 2011 Van Earthquake Sequence

In fall 2011, a series of earthquakes shook eastern Turkey in and around the cities of Van and Erciş. Preliminary reports put the death toll at 642, with more than 1,200 buildings collapsed or damaged beyond repair and 28,050 housing units rendered temporarily or permanently uninhabitable. The earthquake sequence consisted of a magnitude 7.1 main shock about 15 miles north of Van on October 23, 2011, followed by at least 11 aftershocks with magnitudes greater than 5. The most damaging aftershock, a magnitude 5.6 temblor, struck about 9 miles southwest of Van on November 9, 2011.[1]

NEHRP Responds

The U.S. Geological Survey (USGS), one of the four Federal agencies participating in NEHRP, deployed a team of three experts to Turkey to assist and collaborate with Turkish officials responding to the Van disaster and to promote seismic risk reduction at a time when earthquakes were the focus of much attention in Turkey. The team arrived within days of the November 9 aftershock, and over the next 2 weeks conducted an on-site assessment of conditions in the Van region and consulted with emergency managers, scientists, and engineers in Van, Ankara, and Istanbul.

Deployment of the team was supported as an Earthquake Disaster Assistance Team (EDAT) mission by the Office of U.S. Foreign Disaster Assistance, part of the U.S. Agency for International Development. EDAT missions are one of the many ways that NEHRP engages with earthquake professionals in other countries, not only to share U.S. resources that can be of help to others, but also to learn from the experiences of others and to expedite advancements in earthquake risk reduction through collaborative research and information exchange.

*Building collapse (38.49276N, 43.37539E) in Van, Turkey, caused by November 9, 2011, **M**5.6 earthquake. Structure was damaged by the October 23, 2011, **M**7.1 earthquake. Collapses caused by aftershocks created anxiety among the Van population and, combined with the wintry conditions, prompted a large migration of families from Van. Credit: T. Holzer, USGS.*

Challenges Encountered

The Van earthquakes dramatically demonstrated how earthquakes are not necessarily single events but sequences that can continue to threaten an area—through intermittent aftershocks—generating cumulative psychological, physical, and socioeconomic effects.[2] Life had reportedly been returning to normal in Van in the aftermath of the October 23 main shock. However, this earthquake, which collapsed 5 or 6 buildings in Van and 100 or more structures in Erciş (about 37 miles from Van), eroded confidence in the safety of the region's building stock.

This concern prompted a number of Van residents to jump from buildings during the November 9 aftershock, resulting in numerous injuries. The November 9 earthquake killed 38 people and collapsed approximately 30 additional buildings in Van. This exacerbated fears of aftershocks in the region, which added psychologically displaced residents to the migration

[1] This article is based upon the following report: Mehmet Çelebi, Thomas L. Holzer, and Katherine M. Scharer, "Van, Turkey, M7.1 Earthquake of October 23, 2011," Report to USAID/OFDA, Earthquake Science Center, U.S. Geological Survey, Menlo Park, CA, December 15, 2011, 27 pp.

[2] This was also demonstrated in a 2010–2011 sequence of earthquakes in the region around Christchurch, New Zealand. See "Learning from the Disasters in Japan and New Zealand" (SeismicWaves, July 2012), for information about efforts to learn from this sequence.

of physically displaced families to other parts of the country. By November 16, an estimated 150,000 of Van's 540,000 residents had left the area.

The USGS team observed that buildings in Van and Erciş consisted mainly of semi-engineered low- to mid-rise structures and mid-rise, reinforced-concrete-framed buildings with infill walls. Previous earthquakes in Turkey and other Mediterranean countries, where such structures predominate, have demonstrated that these buildings are vulnerable to earthquakes unless they are well designed and constructed. In each collapsed building that they inspected, the team found the same types of design and construction deficiencies that have been implicated in prior disasters.

The team also noted some information gaps that, if addressed, could help Turkish officials in planning for and responding to earthquakes in the Van region, and in reducing the public's confusion and anxiety in their aftermath. These gaps pertained to information flowing (1) to officials before earthquakes, such as the locations and seismicity of potentially active but poorly expressed faults; (2) to officials following earthquakes, such as where the ground shaking was more intense; and (3) from officials following earthquakes, such as official public announcements about earthquake magnitudes and the possibility of damaging aftershocks.

Collaboration and Assistance

The USGS team met and worked directly with leading earthquake scientists and engineers from several Turkish universities and from the Turkish Government's Disaster Response and Management Agency (AFAD). Team members provided additional eyes on the ground for post-earthquake field reconnaissance work in the vicinity of Van and Erciş. This included engineering surveys, which examined the seismic performance of commercial and residential buildings and of industrial and critical facilities. These inspections focused on the structural and geotechnical factors associated with the varying impacts found, which ranged from no damage to complete collapse.

The team also accompanied AFAD in geological reconnaissance activities, assisting in the search for fault ground ruptures and displacements that helped characterize the Van earthquakes and the faults that produced them. (The Van Fault, which generated the October 23 earthquake, was previously not known to be active.) In addition to assisting on the ground, the team also provided publicly available satellite imagery to AFAD to further this reconnaissance.

In a series of meetings held during their stay in Turkey, USGS team members helped emergency management officials and engineering faculty evaluate potential responses to the Van disaster. One of the actions discussed was changing building design and construction standards and practices in Turkey's seismic zones so that the predominant use of reinforced concrete frames with infill walls would be replaced by use of reinforced shear wall structural systems or reinforced concrete frame-shear wall dual systems with or without infill walls. There was general agreement that this change is feasible and would reduce casualties, economic losses, and displaced residents in future earthquakes.

Also discussed was the possible introduction of USGS ShakeMap technology to Turkey, which would enable officials to map ground shaking intensities in near-real time to help direct emergency response efforts, and to map the shaking that could occur in future earthquakes to help plan for potential response requirements. Other actions recommended by the USGS team included (1) issuing official public announcements following earthquakes that address the magnitude of the earthquake, probable aftershock activity, and the potential for triggered earthquakes; (2) using the moment magnitude scale in all such announcements, because this scale better characterizes the magnitude of large earthquakes; and (3) conducting a new and thorough investigation of the geology of the Van region, in order to better determine the location and rates of activity of other potentially active faults.