World Agency of Planetary Monitoring & Earthquake Risk Reduction
2 rue de Jargonnant, www.wapmerr.org
1207 Geneva, +41 (0)22 700 5544

The Use of Hypocenter Estimates Derived From InSAR Images in Near-Real-Time: Errors in Fatality Estimates can be Reduced by a Factor of Ten

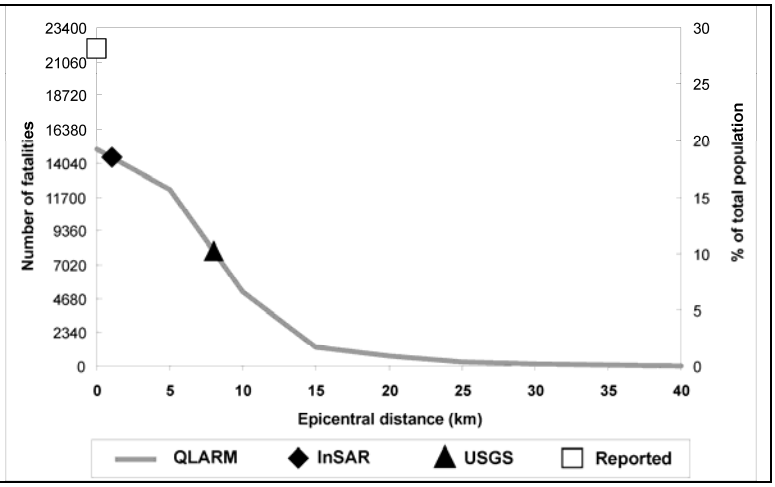
Max Wyss

For launching appropriately scaled rescue efforts after an earthquake, reliable estimates of human losses are necessary. Teleseismic hypocenter uncertainties in near-real-time are about 25 km, which can lead to errors of an order of magnitude in estimates of fatalities. Using InSAR techniques, the source of energy release can be determined with errors 10 times smaller, allowing approximately correct estimates of fatalities.

***Figure 1**: Damage in the old city of Bam due to the M6.6 earthquake of 26 December 2003. The fatalities numbered 22,500, which was about 1/3 of the population, an unusually high rate due to the poor construction. Rapid mobilization of rescue efforts is important because injured trapped beneath the rubble can be rescued alive for a few days only.*

In case of the Bam earthquake, we vastly underestimated the numbers of fatalities at first, but we did classify it as a disaster (Wyss et al., 2006) and called the Swiss rescue team, who supports our alert service. In work in preparation, we show that the first manually reviewed teleseismic epicenters are afflicted by errors of about 25 km, median (Wyss et. al., 2010), and we calculated the decrease of fatality estimates with distance form Bam (Figure 2). With a possible error of 25 km, the fatality estimates range from 0 to 15,000.

***Figure 2:** Theoretically estimated fatalities as a function of distance from Bam, using the dataset of building stock contained in our software QLARM. The observed number is shown by the open square, the result obtained with the USGS epicenter nearest to the city is marked by the triangle, and that derived from InSAR analysis by the diamond.*



However, if radar images had been available soon after the earthquake, then the source of energy release would have been known with a very small error (about 1 km, Figure 3), and the fatalities would have been calculated correctly to within a factor of 2 (Wyss et al. 2006), and in general, maps of mean damage to settlements (Figure 4) would reflect disaster situations more accurately.

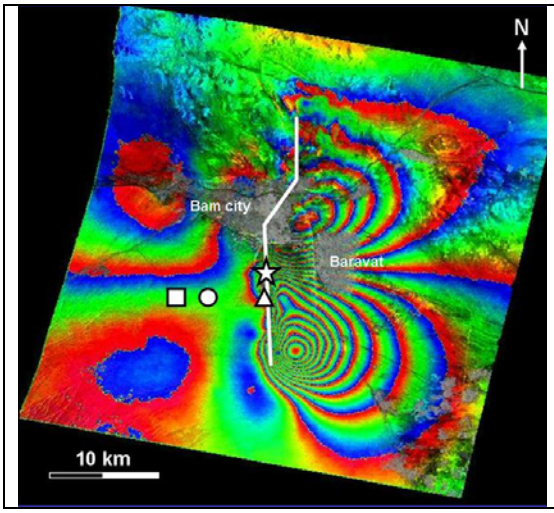
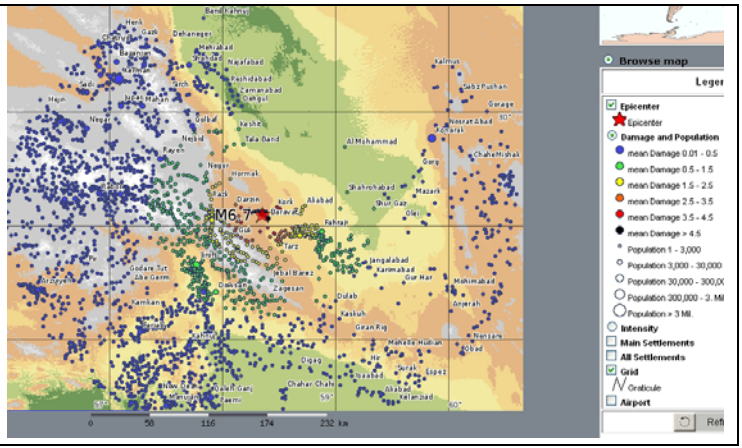


Figure 3: *Map of the fault model (solid white line), based on InSAR interferometry for the Bam, Iran, earthquake of 26 December 2003. The colored fringes map the deformation of the surface of the Earth in the direction of the view from the satellite in units of the radar wavelength (2.8 centimeters) from red to red. The star denotes the center of maximum slip derived by InSAR, and the circle, square, and triangle mark USGS sequential epicenter estimates 1, 2, and 4, respectively. (From Wyss et al., 2006).*

Figure 4: *Theoretically calculated map of mean damage in settlements affected by the Bam, 2003, earthquake. We distribute such maps within 1 hour of earthquakes worldwide. Estimates of human losses are important because information from the devastated area is typically not available for several days. Subscriptions to our alert service are free and available to anyone.*



We advocate establishing a ready team that can analyze radar images and model earthquake energy release accurately within a few hours, day or night, if images are available. This would provide a great service in developing countries with few experts, poor means of communication, and a highly vulnerable population. It is clear that this will require a high level of dedication by the team and a bit of good luck, so that useful data become available within about a day.

References

Wyss, M., R. Wang, J. Zschau, and Y. Xia (2006), Earthquake loss estimates in near real-time, *EOS* 477-479.

Wyss, M., G. Trendafiloski, M. Elashvili, N. Jorjiashvili, and Z. Javakhishvili (2010), Uncertainties in teleseismic epicenter estimates: implications for real-time loss estimate, *Bull. Seism. Soc. Amer.*, submitted.