Elders Recall an Earlier Tsunami on Indian Ocean Shores

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Ten years later, the Indian Ocean tsunami of 26 December 2004 still looms large in efforts to reduce tsunami risk. The disaster has spurred worldwide advances in tsunami detection and warning, risk assessment, and awareness [Satake, 2014].

Nearly a lifetime has passed since the northwestern Indian Ocean last produced a devastating tsunami. Documentation of this tsunami, which was in November 1945, was hindered by international instability in the wake of World War II and, in British India, by the approach of independence and partition.

The parent earthquake (magnitude 8.1) was centered west of Karachi along the Makran subduction zone (Figure 1). The tsunami registered on tide gauges, but intelligence reports and newspaper articles say little about inundation limits, and the consequences in terms of lives lost differ by an order of magnitude among the estimates in today's geophysical catalogs. What has been established about the 1945 tsunami falls short of what is needed today for ground-truthing inundation models, estimating risk to enlarged populations, and anchoring awareness campaigns in local facts.

Recent efforts to reduce tsunami risk around the Arabian Sea include a project in which eyewitnesses to the 1945 tsunami were found and interviewed (Figure 1) and related archives were gathered. Results are being made available through the Indian Ocean Tsunami Information Center (IOTIC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) in hopes of increasing scientific understanding and public awareness of the region's tsunami hazards.

Makran Tsunami Hazards

Tsunamis of nearby origin, which account for most tsunami fatalities worldwide [Yulianto

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Fig. 1. (top) Rabia, age 74, recalls childhood memories of the 1945 Makran tsunami during an interview in Pasni, Pakistan, in 2013. Photo by Ghazala Naeem. (bottom) The tsunami originated along the Makran subduction zone, the seaward edge of which is marked by the white barbed line. An approximate source area of the parent earthquake (yellow) has been inferred from seismograms and coastal uplift [Byrne et al., 1992]. Tsunami fatalities, most of which occurred in what is now Pakistan, were previously documented at the sites marked by blue circles [Ambraseys and Melville, 1982]. Red dots locate recent interviews about the 1945 disaster. The fractions give round numbers of credible first-hand accounts (numerator) and total interviews (denominator) by country.

Fig. 2. Reported effects of the 1945 tsunami at the port of Karachi. The marigram mentioned is discussed by Neetu et al. [2011].

et al., 2010], pose hazards on the rim of the Arabian Sea [Okal and Synolakis, 2008]. The hazards originate along the Makran subduction zone, an active boundary between converging tectonic plates that descends northward beneath Iran and Pakistan. Were the zone to break along its entire 800-kilometer length, the resulting earthquake might attain magnitude 9 [Smith et al., 2013], and the ensuing tsunami might exceed 10 meters in height in parts of Oman, Iran, Pakistan, and India [Heidarzadeh et al., 2009].

This worst-case scenario scales up the 1945 Makran earthquake and tsunami. The magnitude 8.1 earthquake resulted from thrust rupture along an eastern part of the subduction zone [Byrne et al., 1992]. Submarine slides probably contributed to the ensuing tsunami, a mechanism also involved in the small 2013 tsunami in the Arabian Sea [Heidarzadeh and Satake, 2014]. The shaking and flooding in 1945 took place early on 28 November local time. Thirteen tsunami deaths were confirmed in Bombay (Mumbai). The rest of the known fatalities occurred in what is now Pakistan, along a coast then divided among two Baluchi states, an Omani enclave, and a British province. The fatality estimates range between about 300 [Ambraseys and Melville, 1982] and 4000 (http://www.ngdc.noaa.gov/hazard/tsu_db.shtml).

Spoken Histories of the 1945 Disaster

Memories of the 1945 Makran tsunami have been gathered through recent interviews in Oman, Iran, Pakistan, and India. Some

60 eyewitnesses testified in Pakistan, and smaller numbers of people testified elsewhere (Figure 2). Most were children and a few were young adults in 1945. Written summaries of the accounts from Iran and Oman [Hamzeh et al., 2013; Hoffmann et al., 2013] are being augmented by videos and transcripts from Pakistan and India at a UNESCO website (<http://iotic.ioc-unesco.org/1945makrantsunami/>).

Although some of the accounts sound like hearsay, others contain striking details. For example, the shaking in Ormara brought down a stone house that entrapped one eyewitness's recently married sister. The noisy approach of a wave in Pasni cut short the pre-dawn Fajr prayer. The sea at Konarak entered a mosque and injured some who were praying there. No storm preceded flooding of a graveyard in Fins. Victims found near Karachi included a woman in Hindu bridal dress. Too many died in the Indus Delta for each one to receive a Muslim burial shroud. A boy aboard a ship moved by a sudden surge at Karachi learned of similarly unusual seas upon returning to his home port of Mandvi. Disaster relief from Baluchi tribes arrived by green jeep in Pasni and by black, white, and red horses in Ormara. Traumatic events can register as sharp memories [Berntsen and Thomsen, 2005; Sharot et al., 2007], and the 1945 disaster probably had that effect.

Next Steps

The eyewitness accounts offer chances to clarify tsunami hazards around the Arabian Sea. Inundation limits identified by eyewitnesses

can be used to improve simulations of tsunami sources and maps of tsunami hazards. A fuller picture of tsunami hazards in Karachi may emerge from comparing the spoken histories with newspaper archives (Figure 2). Whether the sea initially receded, as expected of a tsunami triggered mainly by submarine slides, might be tested through follow-up interviews.

The eyewitness accounts may find greatest use in tsunami awareness campaigns. Tsunami stories handed down from one generation to the next are said to have saved thousands of lives on an Indonesian island hit by the 2004 Indian Ocean tsunami [McAdoo et al., 2006]. A preparedness campaign in Pakistan in 2009 featured a local eyewitness who broadcast by radio his authoritative recollections of the 1945 disaster. It is hoped that such community-based efforts will save lives during the next large tsunami on Arabian Sea shores.

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