

The Study of the Tsunami Aftermath and Recovery (STAR): Resilience and Recovery in Sumatra after the 2004 Indian Ocean Tsunami¹



The 2004 Indian Ocean tsunami devastated thousands of communities in countries bordering the Indian Ocean. Destruction was greatest in the Indonesian provinces of Aceh and North Sumatra, where an estimated 170,000 people perished and the built and natural environment was damaged along hundreds of kilometers of coastline. The disaster was one of the world's most destructive, generating an enormous flow of assistance to the region from the Indonesian government, NGOs, and bi- and multi-lateral donors. By 2007, efforts to build back the affected areas in Indonesia constituted the largest reconstruction project ever undertaken in a developing country.

The Study of the Tsunami Aftermath and Recovery (STAR) is a longitudinal survey of individuals, households, communities, and facilities in the provinces of Aceh and North Sumatra, Indonesia. The study is designed to provide evidence on the immediate and longer-term consequences of the 2004 Sumatran-Andaman earthquake and tsunami and the recovery efforts that were initiated in its wake.

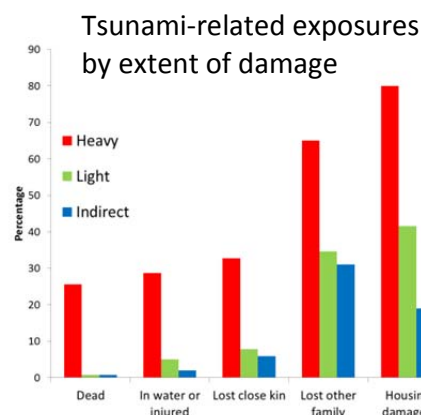
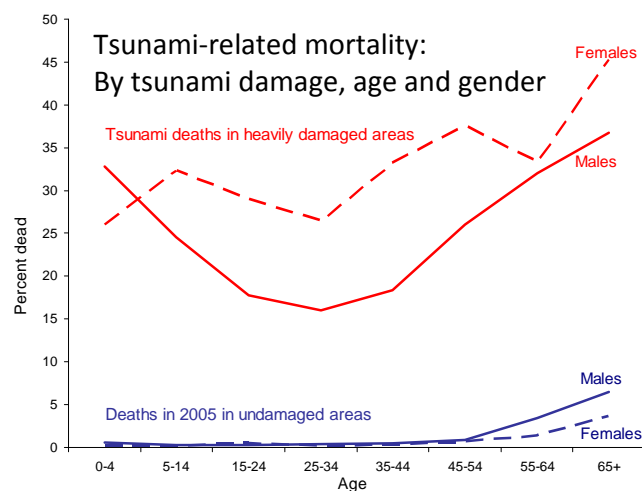
To shed light on how individuals, communities, and families were affected by and responded to the disaster in the short- and intermediate-term, we established the STAR project. Beginning in 2005, STAR has followed over 30,000 people who were first enumerated in 2004 (pre-tsunami) in 487 communities, as part of a population-representative household survey conducted by Statistics Indonesia. Interviews were conducted annually for 5 years after the tsunami; the ten-year follow-up is currently in the field. We ascertained survival status for 98% of the original pre-tsunami respondents and have interviewed 96% of survivors. The data provide information on the short-term costs and longer-term recovery for people in very badly damaged communities as well as in comparison communities where the disaster had little or no direct impact. We summarize some of the findings from our research based on data collected from 2004 through 2010.

SHORT-TERM IMPACTS

Mortality: The tsunami's impact on mortality was immense. In some STAR communities more than 80% of people enumerated in the 2004 pre-tsunami survey were killed. As shown in red in the figure, in areas that were heavily damaged, about a quarter of the population perished with women, children and older people being more likely to die than prime-age men.

Our results indicate that household composition played a key role in survival. The number of men age 15-44 living in the household is associated with lower tsunami mortality for same-age women, children, and for other men age 15-44. Going beyond composition to consider the types of kinship ties, our data provide evidence that survival chances are most tightly linked for husbands and wives, followed by mothers and their children. Taken in combination, the research suggests that when the tsunami came ashore, stronger members of the household tried to help weaker members, sometimes successfully and sometimes not.²

Trauma and loss of resources: Among survivors, in heavily damaged communities, about one in five were caught up in or injured by the tsunami, and more than 1/3 witnessed family or friends struggle in the water. While these traumatic events were rarely experienced by individuals who lived in communities that the tsunami did not reach, many of these people did lose family members who lived in coastal locations at the time of the disaster. Damage to housing and land – especially paddy and aquaculture – as well as roads and infrastructure was extensive in communities inundated by the tsunami. There was also earthquake-related damage in other locations. As food and housing prices spiked after the tsunami, there were benefits to

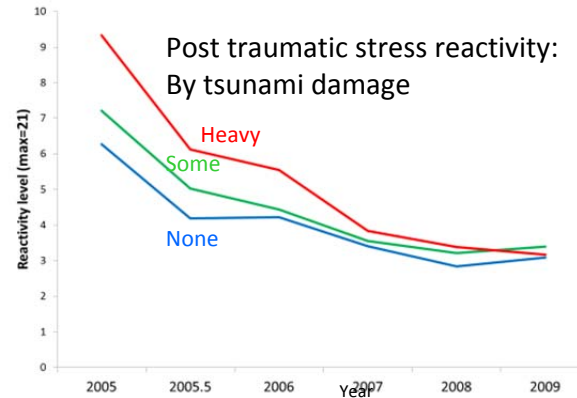


¹ STAR is a collaborative project involving investigators at Duke University, SurveyMETER (Indonesia), University of California, Los Angeles, University of Pennsylvania, University of Southern California, World Bank and Statistics Indonesia. The project is directed by Elizabeth Frankenberg and Duncan Thomas (Duke) with Cecep Sumantri (SurveyMETER). STAR is funded by grants from the National Institute for Child Health and Human Development (HD051970, HD052762) National Institute on Aging (AG031266), MacArthur Foundation (05-85158-000), National Science Foundation (CMS-0527763), Hewlett Foundation and World Bank.

communities that were not directly damaged. These results underscore the importance of STAR's design, which targets individuals from communities across the entire north and west coasts of Aceh and North Sumatra, rather than only those in the direct path of the waves.

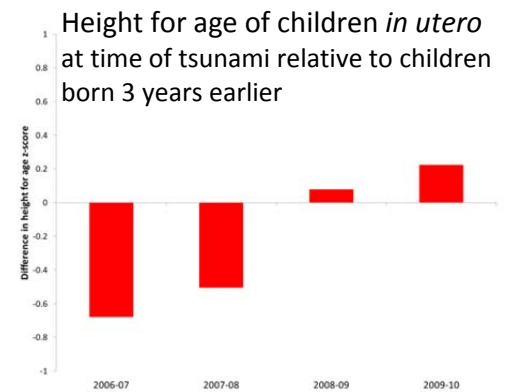
LONGER-TERM IMPACTS:

Mental Health: In the period immediately after the disaster, symptoms of post-traumatic stress reactivity (PTSR) such as feelings of numbness or intrusive reminders of the event were highest among those who had been living at the time of the tsunami in heavily damaged communities, but were elevated among respondents from other communities as well. PTSR is also higher among individuals who experienced traumatic events. But it is not only one's own experiences that matter. Being from a community that was badly damaged also results in higher PTSR, net of individual experience. As the figure shows, over time, symptoms diminished, but the pace of recovery was faster among those from heavily damaged communities. By 2007, average levels of post-traumatic stress reactivity did not differ by location of residence at the time of the tsunami. It is unlikely that these results reflect receipt of counseling or other mental health interventions, as only 7-10% of respondents report receipt of such services. One factor associated with faster recovery is education. Although educational levels were not associated with reduced vulnerability to PTSR in the immediate aftermath, individuals with more education did experience a more rapid reduction in symptom intensity over time.^{3,4,5,6}



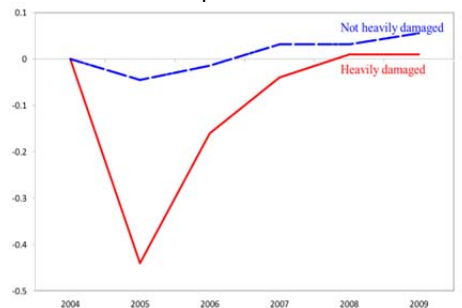
Family Formation and Fertility: The tsunami took a terrible toll on young lives, killing over a third of children under age seven in heavily damaged communities. Our research shows that in the five years after the tsunami, a sustained increase in fertility occurred in communities that had been affected by tsunami mortality, but not in other communities. The fertility response is explained by two groups of women: mothers who lost one or more children had additional children earlier and women who had not yet had any children at the time of the tsunami initiated childbearing in its aftermath earlier than similar women in communities that did not have tsunami-related mortality. New families were formed through marriage and childbearing at a faster pace in communities that experienced tsunami-related mortality, relative to other communities.⁷

Children's Human Capital: STAR is designed to understand how children fared after the tsunami. A significant fraction of children lost one or both parents in the disaster. Among children between 9 and 17 years of age at the time of the tsunami, we compare changes over time for children who lost a mother, a father, or both parents to changes over time for children whose parents survived. Five years after the tsunami, the deleterious impacts of losing one or both parents in the tsunami are substantial for older boys (who leave school and enter the work force) and older girls (who marry), whereas the effects on younger children are far more muted.⁸ We also consider height of children, a marker of health and nutrition that is predictive of later life health and prosperity. Children who were *in utero* at the time of the tsunami and born 3 to 6 months after the tsunami are shorter, for their age, at eighteen months than earlier cohorts. This height deficit likely reflects the combined effects of maternal stress during pregnancy and reduced resources at that time. However, three years later, these children have caught up to or surpassed height-for-age of their older counterparts suggesting that the post-tsunami reconstruction will have long-term impacts on health and well-being. The results are also important because they suggest recovery of height deficits in early childhood is possible.⁹



Housing and Migration: In the four months following the tsunami, nearly two-thirds of individuals from severely damaged communities changed residences—a rate 10 times higher than among individuals living elsewhere. About half of those who moved stayed at a camp or shelter at some point after the tsunami.¹⁰ Individuals whose homes were damaged in the tsunami were far more likely to move. Consistent with these results, the fraction of individuals who report living in a home owned by a family member falls dramatically between 2004 and 2005 for individuals living in heavily damaged areas at the time of the tsunami, but not at all for those living elsewhere at the time of the tsunami. Remarkably, by 2010, individuals are back in family-owned homes, at the same rate observed before

SES relative to pre-tsunami level: Position on 6-step ladder relative to 2004



the tsunami.¹¹

Remarkable post-tsunami recovery is reflected in respondents' subjective evaluation of their overall well-being relative to their status after the tsunami. Respondents located themselves on a 6-step ladder. Those who were living in heavily damaged areas reported their overall well-being was ½ a step lower the year after the tsunami but, by 2008, their position had recovered to the pre-tsunami level and was no different from those not directly affected by the tsunami.

OVERALL FINDINGS:

The tsunami's toll on the province of Aceh was enormous. Kinship networks were torn apart, those who survived lost homes and business assets, saltwater and silt inundation changed landscapes and soil composition, and physical infrastructure including roads, bridges, schools, and health facilities, was destroyed. In the decade since the disaster, efforts to rebuild Aceh have absorbed the money and time of individuals from throughout the province, as well as from elsewhere in Indonesia and throughout the world. The results of these efforts are nothing short of remarkable.

Within five years, individuals were back in homes they owned, often on their original land, in communities with new schools and in many cases improved infrastructure. Ten years later, these communities have new residents as well as old, as a result of births and of in-migration.

This is also evident from high resolution satellite imagery taken from the same location immediately before the tsunami and a few days after the tsunami. The tsunami swept away the houses, roads, bridges and livelihoods of the entire village. Five years later, the roads and infrastructure had been rebuilt and people were prospering in a new village.

The overall impression is of a province and a population that have recovered from a disaster of immense proportions. Data collected by STAR provides scientific evidence that this impression is correct although there are some population groups who have not recovered. Continued follow-ups of the respondents will provide a wealth of information about the longer-term impacts of the tsunami and the reconstruction program on these people and the entire population. Evidence-based measures of the success of efforts to rebuild Aceh speak to the benefits of long-term and well-financed recovery efforts in the aftermath of a disaster--- something that is all too easy to forget once the initial humanitarian crisis has been assuaged.



² Frankenberg, E., T. Gillespie, S. Preston, B. Sikoki and D. Thomas. 2011. "Mortality, the family, and the Indian Ocean tsunami." *The Economic Journal*. 121 (August), F162-182.

³ Frankenberg, E., J. Friedman, T. Gillespie, N. Ingwersen, R. Pynoos, I. Rifai, B. Sikoki, C. Sumantri, W. Suriastini and D. Thomas. 2008. "Mental health in Sumatra after the tsunami." *American Journal of Public Health*. 98(9): 1671-1677.

⁴ Frankenberg, E., B. Sikoki, C. Sumantri, W. Suriastini and D. Thomas. 2013. Education, vulnerability, and resilience after a natural disaster. *Ecology and Society* 18 (2): 16.

⁵ Frankenberg, Elizabeth, Jenna Nobles and Cecep Sumantri. 2012. "Community destruction and traumatic stress in post-tsunami Indonesia." *Journal of Health and Social Behavior*. December 2012 vol. 53 no. 4 498-514.

⁶ Frankenberg, Elizabeth, Jed Friedman and Duncan Thomas. 2014. "The evolution of mental health after a large-scale disaster." Manuscript.

⁷ Nobles, J., E. Frankenberg, D. Thomas. 2015. "The effect of mortality on fertility: Population dynamics after a natural disaster." *Demography*, 52(1):15-38.

⁸ Cas, A., E. Frankenberg, W. Suriastini, D. Thomas. 2014. "The impact of parental death on child well-being." *Demography*. 51(2): 437-57.

⁹ Frankenberg, E., J. Friedman, N. Ingwersen and Duncan Thomas. 2014. "The impact of a natural disaster on child health." Manuscript.

¹⁰ Gray, C., E. Frankenberg, C. Sumantri, D. Thomas. 2014. "Studying displacement after a disaster using large scale survey methods: Sumatra after the 2004 tsunami." *Annals of the Association of American Geographers*. 104(3): 594-612.

¹¹ Frankenberg, Elizabeth, Cecep Sumantri, and Duncan Thomas. 2013. "The evolution of well-being in the aftermath of a disaster: Evidence from Aceh and North Sumatra." Forthcoming in *"The Demography of Disasters: Implications for Future Policy on Development and Resilience."* Australian Demographic and Social Research Institute.