Economic Consequences of the 2004 Tsunami
for Households and Individuals in Indonesia

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On December 26, 2004 the Sumatra-Andaman earthquake occurred in the Indian Ocean. Registering a magnitude of 9.3 on the Richter scale, the quake's vibrations were felt all the way to Bangkok, some 2000 miles away from the epicenter, which was located just off the coast of Aceh, Indonesia (Sheble 2005). The quake generated a 1200 mile rupture, displaced a trillion tons of water, and generated a tsunami surge that slammed into the island of Sumatra shortly after the earthquake (Kerr 2005; Lay et al., 2005; Marris 2005).

The tsunami ultimately wreaked havoc on 10 countries and some 4500 kilometers of coastline throughout the region. Indonesia was the country hardest hit. Deaths there account for over two-thirds of total mortality from the tsunami and the damage to public infrastructure, productive assets, and private property is estimated at a value of $US 4.5 billion—which is 97% of Aceh's GDP.

The earthquake and tsunami constitute one of the largest natural disasters in recorded history, with enormous consequences for the population and the environment of the affected areas. It is important to point out, however, that the effects of the disaster were not uniformly distributed along Sumatra's west coast. In general the waves diminished in force and magnitude as one travels southeast along the coast of Aceh, towards Sumut (Black 2005). On a more localized scale, the height of water from the tsunami on shore was a complex function of slope, wave type, water depth, and coastal topography (Romakrishnan 2005).

This paper will examine the economic consequences, broadly interpreted, for households in the Indonesian provinces of Aceh and North Sumatra. We analyze a unique dataset collected as part of the Study of the Tsunami Aftermath and Recovery (STAR). STAR is a multiwave longitudinal study that draws on a subset of respondents to the 2004 National Socioeconomic Survey (SUSENAS), implemented in 10 months before the tsunami. With Statistics Indonesia assistance, we fielded the first wave STAR between May 2005 and July 2006. We sought to recontact 39,500 individuals originally interviewed in 9100 households in 585 enumeration areas in Aceh and North Sumatra. We were able either to interview or establish the survival status of over 90% of the original respondents. Additional follow-ups have been conducted in 2006/07 and 2007/08.

Among the areas encompassed by the baseline survey, those that were closest to the epicenter of the earthquake and that experienced the greatest inundation of water suffered the greatest damage from the disaster. Other areas suffered no damage because of the shape of the coastline. Using high resolution MODIS satellite imagery of the damage to the land immediately after the tsunami, we have stratified the study areas into three zones of damage: heavily damaged, moderately damaged and not directly damaged. Each study household is allocated to one of these zones based on the GPS co-ordinates of their location at the baseline survey, prior to the tsunami.

In the first panel of table 1, we present preliminary summary statistics of the impact of the disaster on the composition of households first interviewed in 2004, stratified by the satellite-based measure of damage.

Household size falls by almost half a member among households who, pre-tsunami, were located in the zone that subsequently sustained heavy damage. In contrast, average size of the households in the other areas increase, although only by a small amount. The mortality impact of the tsunami is made clear by the next two rows of the table. In the heavily damaged zone, an average of one member per household died between 2004 and 2005, and fully one-quarter of households experienced the death of the person who in 2004 had been designated the household head. The corresponding numbers for the zones of light and no damage are much smaller.

Clearly the changes in household composition are substantial. They are accompanied by large changes in the asset positions of households as well. These are summarized in the second panel of the table, which reports the percentage of households that experienced damage to assets (conditional on owning the asset pre-tsunami) and the value of the estimated loss. Damage to assets was very common for households in the heavy damage zone, and translated into average losses of millions of Rupiah (US$1 was approximately equal to 9200 Rp in 2005).

These results greatly simplify the nature of the losses households in the heavy damage zone faced, but they paint a compelling picture of both the magnitude of change and the dose-response nature of the relationship.

This paper will take the results presented here forward on several different dimensions. First, we expand our results to encompass one dimension of response to the disaster, which is the partitioning of households and rearrangement of members across households (so far we have presented results only for the "origin" households that were present in the 2004 baseline survey, but not for the split off households formed when members of the 2004 households left to form new households). Second, we will consider a far wider array of economic outcomes, including changes in the operation of businesses and employment more generally. Third, we will consider the evolution of economic outcomes over time, bringing in the second and third waves of the STAR survey.

Changes in Household Characteristics
among Households Interviewed in 2004 and 2005

| | Damage Zone | | |
	Heavy	Some	None
Changes in Household Composition			
Average household size, 2004	4.46	4.46	4.55
Average household size, 2005	4.06	4.55	4.65

Average # members dead by 2005	1.04	0.19	0.05
% of HH in which head in 2004 died by 2005	25%	6%	3%
Changes in Household Economy			
% reporting asset damage (conditional on ownership)			
House	62%	29%	4%
Land	29%	8%	0%
Livestock	59%	15%	1%
Estimated Loss (in millions of Rp)			
House	22.39	6.40	0.15
Land	3.11	0.84	0.21
Livestock	0.15	0.10	0.00
N	1566	4572	2962