Assessing Health and Education Services in the Aftermath of a Disaster

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RESULTS ARE EXTREMELY PRELIMINARY, DO NOT QUOTE OR CITE

I. INTRODUCTION

On December 26, 2004 the Sumatra-Andaman earthquake struck in the Indian Ocean, creating a tsunami that slammed into the nearby island of Sumatra some 45 minutes later, resulting in unparalleled devastation. The tsunami ultimately wreaked havoc on 10 countries and some 4500 kilometers of coastline throughout the region. Estimates suggest that worldwide casualties likely number over a quarter of a million people. The vast majority of deaths occurred in Indonesia, where some communities were almost completely wiped out.

Less than a year later, Hurricane Katrina devastated the Gulf Coast of the United States and the city of New Orleans in particular. Though Katrina's impact was underestimated, her arrival was forecast several days in advance—sufficient time for many to evacuate, and far fewer lives were lost.

The costs of these disasters have been huge and have underscored our limited knowledge of how people cope in the aftermath of such catastrophes, and of how the institutions that provide social services are both affected by and respond to such events.

This overall project, the Study of the Tsunami Aftermath and Recovery (STAR), aims to provide scientific evidence on the magnitude of the shock associated with the tsunami, on the pace and shape of the recovery process, and the roles that institutions play in helping or hindering that recovery process in both the short and the longer term. Our focus is on Indonesia, the country most affected by the tsunami. Broadly speaking, the project's goals are threefold: to document the immediate, medium term, and longer term consequences of the disaster for mortality, family disruption and relocation, physical and mental health, economic resources and opportunities, and housing stock and physical infrastructure; to trace the reconstruction of lives and livelihoods in the aftermath of the disaster; and to identify the characteristics of individuals, households and communities that are associated with mitigating the deleterious consequences of the shock on a broad array of indicators of well-being.

To accomplish these goals we are in the process of assembling, collecting and analyzing uniquely rich longitudinal survey data from households, communities, and facilities in the Indonesian provinces of Aceh and North Sumatra. We will combine these data with satellite-based measures of destruction caused by the tsunami. Baseline data are provided by a broad-purpose household survey conducted by Statistics Indonesia in early 2004 in tsunami-affected areas, and in comparable areas that were not directly affected by the tsunami. STAR locates and, if alive, re-interviews the same respondents in 2005. In this paper we describe the design of the project and provide a detailed discussion of the design of the community and facility components of the survey. Design features are illustrated by exploratory tables constructed from the subset of data currently available from the community and facility survey. These data are preliminary and incomplete, as data entry is still in progress, and we currently have electronic data for only about 20% of the Community and Facility questionnaires.

II. THE DISASTER AND ITS CONSEQUENCES

The tsunami of December 26, 2004 was preceded by the Sumatra-Andaman earthquake, the epicenter of which was about 150 kilometers off the coast of the Indonesian province of Aceh. The quake generated a rupture some 1200 miles in length, which forced the sea floor upwards by about 10 metres. This movement displaced a trillion tons of water and generated a tsunami surge that moved at speeds of over 500 miles an hour, slamming into the nearby island of Sumatra only 45 minutes after the earthquake (Kerr 2005; Lay et al., 2005; Marris 2005). In some instances the inundation extended as many as five kilometers inland. The tsunami was extreme by any standard-- in the past 100 years estimates put the cumulative death toll from tsunamis at less than 10,000, compared to the some 250,000 who are likely to have lost their lives on December 26, 2004.

This disaster has had immense consequences for Indonesia. As of March 2005, 120,600 people had been confirmed dead and another 114,900 were missing (BBC 2005a). In the capital city of Banda Aceh about one-

third of the population is thought to have died. Estimates suggest that as many as 700,000 survivors were displaced. The psychological consequences of the tsunami for survivors are likely to be profound and long-lasting. In addition to whatever the survivors themselves experienced during the inundation, many witnessed the deaths of family and friends and spent weeks after the event looking for information about those who were missing, surrounded by reminders of the event, including corpses and numerous aftershocks from the earthquake.

Other costs of the disaster encompass damage to infrastructure, productive assets, and the natural environment. As of May 2005 the World Bank estimated the disaster's costs at about 4.5 billion dollars, 78% of which represented damage and losses in the private sector. The costs represent 2.2% of national GDP and 97% of Aceh's GDP. Full recovery is expected to take at least five years (BBC 2005a).

The disaster has wreaked havoc with many different aspects of life, community, and the broader economy. Vast tracts of housing, schools, health facilities, and business were destroyed or damaged, as were roads, bus and ferry terminals, fuel depots, ports, telecommunications facilities, and water sources (BAPPENAS 2005). The individuals who lost their lives included teachers, health care providers, and community leaders, which has made getting services up and running again that much more difficult. Some 20% of public health facilities were destroyed and MOH officials estimate that rebuilding the public health infrastructure may take up to five years (Weekly Epidemiological Record 2005; Zipperer 2005).

The consequences 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 variation, which is extremely hard to predict, in combination with the fact that our interviews cover respondents who resided at varying distances from the beachfront, means that we will capture experiences ranging from physical devastation and loss of life to far more muted effects of infrastructure damage and price changes, to very few effects for those living further inland and in the southern portion of North Sumatra.

III. DATA

STAR provides data from the two provinces on the island of Sumatra, Indonesia, that sustained damage from the disaster: Aceh and North Sumatra. Aceh, which is where the tsunami struck with greatest force, is located at the northwestern end of Sumatra (see Figure 1, the STAR enumeration areas for which GPS measurements had been obtained as of February 2006 are indicated with dots). As one travels in a southeasterly direction along the coast of Sumatra that borders the Indian Ocean (the west coast), the degree of devastation from the tsunami lessens, although even within short sections of the coast the degree of devastation varies. This is illustrated in Figure 2, which is an infrared image of a section of Aceh's coast in January 2005. Damaged areas show up as grey and healthy vegetation shows up as red. On this image, the stars depict enumeration areas that fall into the damaged zone while the circles depict enumeration areas that are in the red zone.

Variation in how hard the tsunami struck and how far it traveled inland provides scenarios of change ranging from a true demographic catastrophe of almost unparalleled proportions in much of coastal Aceh to an economic shock of reduced food supply, price increases, job loss and infrastructure damage further away from the epicenter of the earthquake. Coastal areas of North Sumatra were relatively unaffected by the tsunami.

STAR1 assesses the disaster's immediate impact. This assessment consists of a resurvey of over 10,000 households (in some 600 communities) first interviewed in Aceh and Sumut in early 2004 as part of a much larger survey, Statistics Indonesia's annual cross-sectional socioeconomic survey (known as SUSENAS). We refer to the data from the 10,000 households in the baseline survey as STAR0. Fieldwork for STAR1, the first post-tsunami follow-up of the STAR0 households, began in May, 2005, and will be completed by June, 2006.

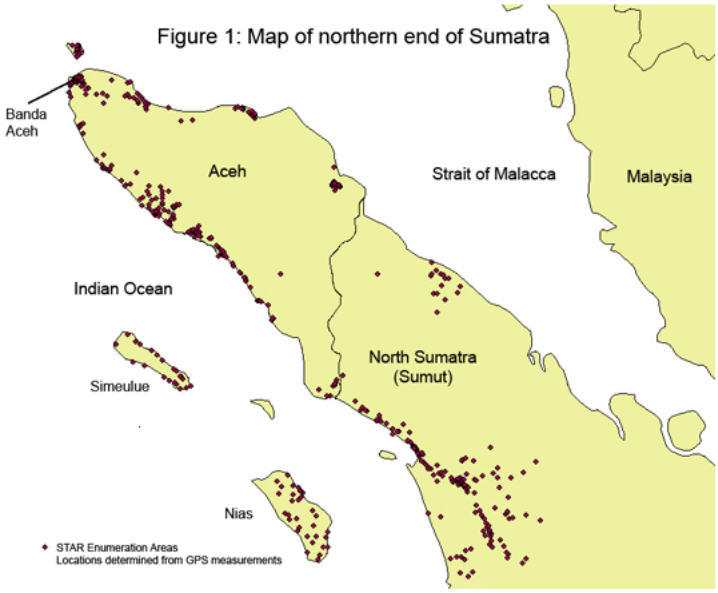
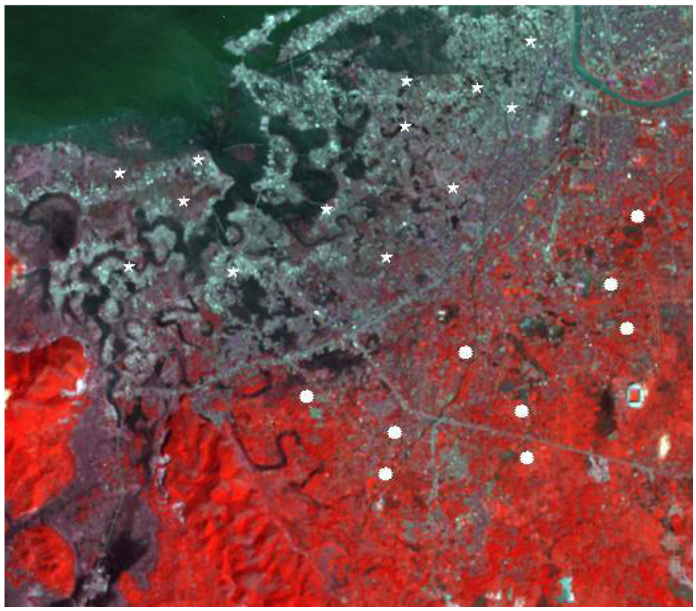


Figure 2 post-tsunami ASTER image of damaged (grey) and healthy (red) vegetation in coastal Aceh
(stars and dots indicate survey enumeration areas in this section of coast)



A central task in describing and analyzing the tsunami's impact is to develop multiple measures of the physical devastation it caused. Satellite images provide critically important information on change in the built and natural environmental in the immediate aftermath of the tsunami, as well as information on subsequent regeneration and reconstruction of the environment. As part of our current fieldwork, we are collecting GPS-based measures of latitude and longitude in every enumeration area included in 2004, in all locations in which people are living at the time of the STAR1 interview, and from all the schools and health facilities identified as sources of services. In each subsequent wave of STAR, locations of movers will be recorded by GPS (along with a sub-sample of people who did not move for quality control purposes).

The combination of these GPS-based locations with a GIS database of remotely sensed images of the study site spanning the period prior to the tsunami through (ultimately) 5 years after the tsunami provides an exceptionally rich resource for the measurement of destruction and reconstruction. With these data, alternative measures of destruction will be explored. These include the degree of water inundation in the enumeration area immediately after the tsunami as well as change between late 2004 and early 2005 in vegetation cover and extent of bare earth. We will also be able to construct estimates of damage to buildings, roads and bridges and damage to arable land and rice paddies in the tsunami's immediate aftermath. A key advantage of the satellite imagery is that it is possible to measure the pace of vegetation re-growth and reconstruction of buildings, roads, bridges and paddy walls and thereby develop a time- and location-specific database of reconstruction for the five years of STAR.

Measures constructed from remotely-sensed data provide one means of characterizing the destruction caused by the tsunami and the subsequent recovery process. Measures constructed from data collected on the ground, from direct observations by our fieldworkers, community informants and at health facilities, schools, and markets provide another source of information.

As a first pass at ground-based measures of community-level conditions, in STAR1 the supervisors of the household field teams were asked to fill out a short "direct observation questionnaire" for each enumeration area in which they recorded their own impressions of the degree of destruction in the community as well as conducting a brief interview with the community leader regarding the impact of the tsunami. The STAR fieldworkers digitally photograph the enumeration areas to complement interviews and direct observations.

In addition to these measures, shortly after the fieldwork for the STAR1 household survey began, we also put into the field a detailed community and facility survey in each of the 591 villages in which our STAR enumeration areas are located.

STAR includes an extensive community and facility survey that builds on the community and facility surveys we designed for the Indonesia Family Life Survey. In each community we conduct a lengthy interview with the village leader. One of the domains about which we collect information involves change in the leadership structure of the village since the tsunami and whether positions remain unfilled given deaths of former leaders and staff. Other modules assess the availability of markets, transport hubs, public phones and post offices, and banks, and whether such entities have become less accessible in the aftermath of the tsunami, either because the ones previously used were destroyed or because public transportation has become less available. Questions are included on damage to roads, bridges, docking facilities, farmland, livestock, and fishing enterprises in the community, and on the availability of electricity and clean drinking water at the time of the interview, immediately after the tsunami, and before the tsunami. A useful aspect of these data is that they can be compared to estimates of destruction constructed from the satellite data and thus serve as a source of ground truthing for that information.

Other modules assess damage to and changes in the accessibility of health facilities, schools, and credit institutions. Sections that were specially designed for the tsunami focus on population change as a result of deaths, in- and out-migration, community needs and the availability of basic services, and activities geared around community development and reconstruction—both those conducted by community residents themselves and those provided by NGOs and the government in the aftermath of the disaster. Many of these modules are repeated with an additional informant, the head of the village women's group. This second set of responses provides a different perspective on conditions and problems in the community and helps to build a more thorough picture of the extent of destruction and reconstruction, and community life in general.

In addition to assessing conditions in the village as reported by its leadership, as part of STAR we conduct interviews in the health facilities (government clinics, private practices, and community health posts) and schools at the primary and secondary level that are available to community residents. Facilities are chosen for interview based on being mentioned by household respondents as a place they (or their children, in the case of schools) use. In most communities it has been possible to interview all the facilities mentioned by the household respondents (when this hasn't been possible, a sample was chosen with the probability of selection based on popularity with household respondents). Questions asked at health facilities focus on the availability and prices of key services and drugs and on the needs of the facility with respect to improving service provision. Respondents are also asked questions on the needs of the population they serve in the aftermath of the tsunami. Questions asked at schools assess similar sorts of issues but focus on education. At each school and health facility, a GPS reading of location is taken, so that we can construct measures of distance from the community center to the facility.

As part of the STAR Community and Facility data collection effort interviewers also visit markets and stalls to collect data on the availability and prices of food and other basic goods. These data will be essential in adjusting expenditure data for the inflation that has occurred in the aftermath of the tsunami.

IV. THE SERVICE ENVIRONMENT IN THE AFTERMATH OF THE TSUNAMI

An important objective of STAR is to provide information on the service environment in Aceh and North Sumatra in the aftermath of the disaster and, where possible, to contrast the situation after the disaster with the situation before the tsunami.[1] The Community and Facility component of the survey is tightly linked to the household survey, which ultimately will enable us to describe the service environment from three perspectives: individuals (who are the end users of services), communities (the level at which basic allocation decisions are often made), and facilities. In this paper we focus primarily on the latter two perspectives, but we describe our approach for each level.

To build a picture of the population's access to services, we begin by asking individuals (as part of our household survey instrument) to identify the health and school facilities that are of greatest relevance to them. For schools, any individual who attended school at any point since November 2004 (i.e. before the tsunami) is asked to provide precise information on the name and location of the school, even if it is no longer functioning. For health facilities, any individual who used outpatient care in the month before the survey is asked to identify the facility, and individuals who did not use care are asked to provide information on where they would go if they needed care. These responses are used to construct community-specific lists of facilities (stratified by

[1] This is possible by using data from STAR that asks about the situation in both 2004 and in 2005 (or about changes over this period).

school level and by type of health care provider). In most communities in Aceh and North Sumatra, the number of facilities is small enough so that all may be visited. When that is not the case, a sample of facilities is drawn. These facilities are visited and staff members are interviewed.

To build a picture of service availability at the community level, we also list every facility identified by the household respondents on a Service Availability Roster (SAR), which is administered to the community leader. For each facility, we ask the leader to give us information about the facility. This information includes data on the distance, cost, and travel time to reach the facility from the community, and also information on whether the facility was damaged or forced to close in the aftermath of the tsunami. The community leader is also asked to supplement the list with any additional facilities that he or she thinks of as service options for the community but that are not yet listed. In the context of the tsunami, leaders were also asked to list facilities that were in use prior to the tsunami but that were destroyed by the tsunami. The enumerator visits each facility on the SAR in order to obtain GPS information on its location.

Beyond the SAR, community leaders and the head of the village women's group are asked more general (rather than facility-specific) questions on service availability and the community's needs for services in the aftermath of the tsunami. To illustrate the kinds of information provided, we have constructed some preliminary tables based on the small number (116) of communities from which electronic data are available from STAR1. We divide these communities into two groups: those directly affected by the tsunami (as indicated by inundation with flood waters detected by the LANDSAT satellite) and the remainder, which we classify as indirectly or unaffected communities.

In Table 1 we see that for educational services, in more than 60% of the tsunami-affected communities, access to schools has worsened in the aftermath of the tsunami, whereas this is true for about one quarter of indirectly or unaffected communities. With respect to primary health care overall, in just over half of the tsunami-affected communities, the community leader reports that access to primary health care worsened in the aftermath of the tsunami, whereas only about 15% of the leaders in the indirectly or unaffected communities report a worsening of access.

For health services community leaders were also asked to report on whether disruptions occurred for particular types of providers. In tsunami affected areas lower levels of disruptions are reported for private health practices than for government and community sources of care, but it is unclear whether this reflects reality, or less knowledge on the part of the leaders with respect to services that are not directly connected to their mandate as a community leader.

Table 1 also provides information on whether emergency provisions were put in place in the aftermath of the tsunami. Clearly emergency provisions were far more likely in the tsunami-affected communities, and were more likely for primary health care for elementary schools than for secondary schools.

As described above, the Community-Facility Survey of STAR includes a detailed service availability roster from which a picture of community-level access to health services and schools can be constructed for the period before and after the tsunami. Table 2 presents illustrative descriptive statistics based on aggregating up to the community level information on specific facilities (in this example, government health centers and elementary schools) in the Service Availability Roster.

The first row presents the percentage of communities in which any facility was damaged or destroyed in the disaster. About half of the directly affected communities experienced damage or destruction of at least one elementary school and at least one government health center, whereas about 30% of the indirectly affected communities did. It is important to note that although the community itself may not have sustained sufficient damage to be classified as directly affected, community members may well have used services in areas that were affected. If so, our approach will capture the disruption to nearby facilities. Whether staff of available facilities were killed in the tsunami is another measure of disruption. In 16-17% of directly affected communities, at least one available facility had its capacity diminished by the death of its staff in the tsunami. For none of the indirectly or unaffected communities is mortality of facility staff members reported.

The third row reports on service disruptions because of facility closures. Most directly affected communities experienced the closure of at least one elementary school and about half experienced closure of a health center, but closures were also common in the less affected areas. The majority had reopened (row 4) by the time of the community interview (as had almost all of those facilities reported as having closed by leaders of the indirectly and unaffected communities).

Finally, in the fifth row we explore whether community members now have access to "newly" available facilities (facilities they only began to use after the tsunami), either because they didn't exist before or because they weren't needed. This is rare.

The next table, Table 3 turns to data collected at the facilities through interviews with facility staff. To demonstrate the nature of the data that are available, we present illustrative statistics from government health facilities and from schools on dimensions of the facility that have become somewhat or much worse in the immediate aftermath of the tsunami. Facilities are divided according to whether they are located in sub-districts that were "directly" affected by the tsunami versus sub-districts that were indirectly or unaffected. As a preliminary indicator of whether a sub-district was affected, we designate any sub-district that falls into the top quartile with respect to the 2005 mortality level as a "directly affected" sub-district (that is, using the household survey data from 2005, we rank sub-districts according to the proportion of 2004 household members who are reported as dead as of 2005, and classify the top 25% as directly affected).

The first panel of Table 3 records whether various salient dimensions of health service in Public Health Centers were detrimentally affected in the aftermath of the tsunami. Clear differences are readily apparent between health facilities in directly affected sub-districts versus those in indirectly affected or unaffected areas. 22% of affected-area clinics reported reduced number of staff as opposed to only 2% in other clinics. Half of all affected-area clinics received at least some damage to the building and 41% suffered reduced access to adequate water supplies while the same figures for the other clinics are 9 and 8% respectively (reflecting at least in part the damage conferred by the earthquake preceding the tsunami). Pharmaceutical supply was also disrupted for 22% of the affected-area clinics while only 7% of other clinics suffered a similar situation.

The picture for schools, in the bottom panel of Table 3, is qualitatively similar. There was a substantial disruption of service and a worsening of facility quality in the tsunami aftermath for affected-area schools as opposed to those schools in the more unaffected areas. A substantially higher proportion of schools in affected areas lost teachers and staff (32% vs. 7%) as well as suffered physical damage to the building (59% vs. 14%). The reduced availability of books and other school supplies occurred 46% of affected-area schools as opposed to 9-10% of other schools.

Table 3 conveys information on the status of the facility in the immediate aftermath of the tsunami and the disruptions to available services are readily apparent. The following tables (Tables 4 and 5) instead present selected dimensions of education and health service delivery in the present (defined as time of survey, which can be up to 1 year after the tsunami).

Table 4 explores student enrollment and school staffing measured in December 2004 (immediately before the tsunami) and today. Schools in tsunami affected sub-districts witnessed a decline in total students from 381 to 343 students, on average. This decline reflects in part the mortality impacts of the tsunami as well as the displacement of affected households to other areas. On the other hand, the average number of teachers in the schools actually increases from 24 to 28. This rise in the number of teachers, which may be a result of increased resources devoted to schools in tsunami affected areas, reduces the student-teacher ratio from 16 to 12. At the same time, the mean number of enrolled students in unaffected-area schools increases from 367 to 411 while the number of teachers decreases from 28 to 24. These schools actually experienced a rise in the student-teacher ratio from 13 to 17 following the tsunami. These changes suggest that disaster impacts on service delivery may be felt more broadly than in the immediate disaster area because some households relocate from affected to unaffected areas *and* because limited local resources may be reallocated to affected areas from unaffected areas.

The final table, Table 5, presents some simple differences in the current state of community health center physical infrastructure between affected and unaffected sub-districts. Since the survey does not record retrospective dimensions of infrastructure from before the tsunami, we can only infer that any difference in infrastructure is largely a result of the tsunami without being able to definitively claim as such. Regardless, a substantially lower proportion of community health posts in affected sub-districts have electricity (56% vs. 78%) and piped water (39% vs. 63%), suggesting the lingering impacts of tsunami related damage on existing health facilities.

The tables included in this report serve the illustrative purpose of suggesting the type of analyses enabled by STAR. Clearly there is much to be done and will be done as the complete data from the first survey round arrives. This future work includes the linking of household and individual service utilization patterns and service-related outcomes to the community and facility data in order to measure both the lingering effects of disaster on service availability as well as the efficacy of subsequent reconstruction aid.

Table 1
Disruptions in service provision and access and
availability of emergency services in the aftermath of the tsunami

	Directly affected communities	Indirectly or unaffected communities
% of communities experiencing worsened access or service disruptions after the tsunami		
Elementary schools	63%	22%
Junior secondary schools	67	28
Senior secondary schools	63	24
Primary health care (general)	54	15
Community health post	50	22
Village Midwife	56	9
Government health center	50	16
Private health practices	33	15
% of communities in which emergency services were put in place		
Primary health care	42	5
Elementary schools	17	3
Junior secondary schools	4	4
Senior secondary schools	3	3
N	25	91

Based on community leaders' reports to questions about services in their community In the aftermath of the tsunami, relative to before the tsunami.

Table 2
Percentage of Communities experiencing changes in
Availability of Elementary Schools and Government Health Centers, by Magnitude of the Disaster

	Elementary Schools		Government Health Centers	
	Directly affected communities	Indirectly or unaffected communities	Directly affected communities	Indirectly or unaffected communities
Any facilities were damaged or destroyed	52%	30%	46%	29%
Staff of facilities were killed	16	0	17	0
Any facilities were closed after the tsunami	72	26	50	17
All closed facilities have subsequently reopened	68	99	79	97
Any facilities are now used that were not used before the tsunami	8	0	8	10

Table 3
Facility Respondent's Reports of Worsening Facility Quality in the Immediate Aftermath of the Tsunami

	Directly affected sub-districts	Indirectly or unaffected sub-districts
Government Health Centers		
Number of staff	21.9%	2.0%
Condition of buildings	50.0%	9.1%
Adequacy of water	40.6%	8.1%
Adequacy of toilets	29.0%	5.1%
Adequacy of sterile treatment conditions	25.8%	3.0%
Supply of pharmaceuticals	21.9%	7.1%
Supply of equipment	28.1%	7.1%
Availability of family planning	3.1%	2.0%
Schools		
# of teachers and staff	31.9%	6.9%
Training of teachers	24.6%	4.4%
Condition of building	59.4%	14.2%
Availability of books	46.4%	10.3%
Availability of other supplies	46.4%	8.8%
Adequacy of extracurricular infrastructure	36.2%	5.4%
Adequacy of water and hygiene	34.8%	9.3%
Availability of scholarship funds	14.5%	1.5%

36 government health facilities and 69 schools in the directly affected sub-districts, 101 and 204 in the indirectly and unaffected sub-districts.

Table 4
School student enrollments and staffing just before the tsunami and currently

	Tsunami affected subdistricts			Non-tsunami affected subdistricts		
	Before	After	Difference	Before	After	Difference
Number of students	380.5	342.9	-37.6	366.8	411.0	44.2
Number of teachers	24.0	28.3	4.3	28.2	23.6	-4.6
Student/teacher ratio	15.9	12.1	-3.7	13.0	17.4	4.4
Number of other staff	3.3	3.1	-0.2	2.6	2.7	0.1
Student/teacher and staff ratio	13.9	10.9	-3.0	11.9	15.6	3.7

72 and 204 schools in the affected and unaffected sub-districts respectively

Table 5
Current state of physical infrastructure in community health centers

	Tsunami affected subdistricts	Non-tsunami affected subdistricts
Facility has electricity?	55.6%	78.2%
Has piped water?	38.9%	63.4%
Has interior water source?	55.5%	60.4%
Has private toilet w/ septic tank?	69.4%	71.3%
Has running waste water system?	75.0%	71.3%

36 and 101 health posts in the affected and unaffected sub-districts respectively