The 9.0 Sumatra-Andaman earthquake was an undersea earthquake that occurred at 00:58:53 UTC (07:58:53 local time) on December 26, 2004. As a typical reverse fault earthquake along a plate boundary, the earthquake generated a megatsunami that was among the deadliest disasters in modern history, killing over 200,000 people. This disaster is known as the 2004 Indian Ocean Tsunami. Various values were given for the magnitude of the earthquake, initially reported as 8.1 by the USGS and recently ranging from 9.0 to 9.3. This difference was due to a lack of accurate and seismic wave records at or near the seismic zone as well as a long rapture time of nearly ten minutes. The earthquake originated in the Indian Ocean just north of Simeulue Island, off the western coast of northern Sumatra, Indonesia. The hypocenter of the main earthquake was at 3.316°N, 95.854°E, some 160km west of Sumatra, at a depth of 30km (initially reported as 10km) below MSL. This is the extreme western end of the Ring of Fire. The India Plate is part of the great Indo-Australian Plate, which underlies the Indian Ocean and Bay of Bengal. The India Plate is drifting northeast at an average of 6 cm/year. The India Plate meets the Eurasian Plate at the Sunda trench. As well as the sideways movement between the plates, the sea bed is estimated to have risen by several meters, displacing an estimated 30 km$^3$ of water and triggering the devastating tsunami waves. The total energy released by the earthquake in the Indian Ocean has been estimated as 4.3x10$^{18}$ joules. This is equivalent to 100 gigatons of TNT. There was a 10m movement laterally and a 4 to 5 m movement vertically along the fault line. In the south-north direction of the seismic zone, we have three segments (south, middle and north) which last generated earthquakes in 1861, 1881 and 1941 respectively. The magnitude of these three quakes was near or more than 8. At this time, three segments moved simultaneously.

The resulting tsunami devastated the shores of Indonesia, Sri Lanka, India, Thailand, the Maldives and other countries with waves up to 48.9m high. The westward propagated tsunamis were offensive (surging) waves and hit Sri Lanka and India, and the eastward ones were defensive (recession) waves and invaded Indonesia and Thailand. It caused serious damage and deaths as far as the east coast of Africa. Because the 1,200 km of fault line affected by the quake was in a nearly north-south orientation, the greatest strength of the tsunami waves was in an east-west direction. Bangladesh, which lies at the northern end of the Bay of Bengal, had very few casualties despite being a low-lying country relatively near the epicenter. It also benefited from the fact that the earthquake proceeded more slowly in the northern rupture zone, greatly reducing the energy of the western coast of India, and the western coast of Sri Lanka also suffered substantial impacts. If the north segment were to generate a normal (not slow rupture) earthquake, the estimated tsunami height hitting Bangladesh would be more than 5 to 6m, killing more than one million people. Because of the distances involved, the tsunami took anywhere from fifteen minutes to seven hours (for Somalia) to reach the various coastlines.

The reported death toll from the earthquake, the tsunami and the resulting flooding varied widely because of confusion and conflicting reports, but could total over 265,000 people, with tens of thousands reported missing, and over a million left homeless. In the last ten years, urbanization has developed in Asian
developing countries, so many people live places close to coastal areas in which flooding due to heavy rainfall, storm surges and tsunamis are very common. Some relief agencies report that one-third of the dead appear to be children. This is a result of the high proportion of children in the population of many of the affected regions and because children were the least able to resist being overcome by the surging waters. Oxfam went on to report that as many as four times as many women than men were killed in some regions because they were waiting on the beach for the fishermen to return and looking after their children in the houses. In addition to the large number of local residents, up to 9,000 foreign tourists enjoying the peak holiday travel season were among the dead or missing, especially Scandinavians. There were 36 Japanese people lost (24 in Thailand and 12 in Sri Lanka).

From 200,000 to 300,000 people are thought to have died as a result of the tsunami, and the count is not yet complete. The true death toll may never be known due to bodies having been swept out to sea. To reduce human casualties, it is necessary to prepare integrated tsunami reduction systems including a tsunami warning system for the Indian Ocean. An effective tsunami warning systems in the Pacific Ocean was established after the 1960 Chilean Tsunami and 26 countries located in the “Ring of Fire” support it financially under UNESCO.

We have just started learning the lessons from the Indian Ocean Tsunami Disaster. As a first step, we tried to understand the impact of the tsunami disaster along the coastal zone of the Indian Ocean, focusing on the following matters:

1) Surveying the tsunamis’ impact on coastal zones
   1-1) Comprehensive analysis of the damage by the Indian Ocean tsunami disaster
       We surveyed the tsunamis’ impact on coastal zones, building a GIS database of extent of inundation zone, damage on structures, local tsunami height, and current velocities, through the analysis of various data, such as, satellite imageries, videos and photos taken by survivors, and numerical model results.
   1-2) Post tsunami field survey
       We deployed the post tsunami survey team to investigate the damage, measure the extent of the tsunami inundation zone, local tsunami run-up, and current velocities, and to collect eyewitness accounts.

2) Ethnological study to illustrate the cause of extensive tsunami casualties
   Using the ethnological approach, we attempt to illustrate the cause of extensive tsunami casualties and missing people that have been counted at more than 200,000 people over the entire Indian Ocean through interviews with survivors, tourists, coastal residents, emergency management officials, and employees of resort facilities

In the following chapter, we report our survey results and analysis. In Chapter 1, we describe an overview of the Indian Ocean tsunami and seismic/ tectonic setting in the Indian Ocean, including the results of the numerical modeling of trans-oceanic propagation of tsunamis. In Chapters 2, 3, 4 and 5, we report the results of a post tsunami survey of Indonesia, Sri Lanka, Thailand and the Maldives, where the most
significant damage were reported. These are mainly focusing on measuring the tsunami height, current velocity, and extent of inundation zone, such as the physical aspects of the Indian Ocean tsunami disaster. Then in Chapter 6, we report on the social impact of the tsunami disaster in Indonesia, Thailand, Sri Lanka, and India, through a field investigation on the emergency response and relief activities. In the last chapter, Chapter 7, we introduce how we understood and disseminated lots of information, to develop a sort of “clearinghouse” and database through the internet to share the information and the survey results.

This research and the survey results reported here are the result of the contribution of not only the researchers in our projects but also lots of other people involved in this tragic disaster. We thank all the people who helped us and contributed to the achievement of our research objectives. Also we hope this report will help to reduce the loss and damage of any tsunami disasters in the future. This research is financially supported by the Ministry of Education, Culture, Sports and Technology of Japan.