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Session 2 (continued): The Indian Ocean Earthquakes and Tsunamis of December 2004 and March 2005

Chairpersons: K. Fujima and Z. Kowalik

08.15-08.30

SEREE, S. , SHUTO, N.: The 2004 Sumatra tsunami: Tsunami intensity scale, damage assessments at the Kamala beach, Phuket, Thailand

08.30-08.45

LOBKOVSKY, L.I., MAZOVA, R.KH., KATAEVA, L.YU.: To Source Mechanism of Indian Ocean Tsunami of 26 December 2004

08.45-09.00

KATUPOTHA, K.: Impacts of Earthquakes and Tsunamis on the Stable Landmass of Sri Lanka

09.00-09.15

CHANDRASEKAR, N.: Tsunami of 26th December 2004: observation on inundation, sedimentation and geomorphology of Kanyakumari coast, South India

Impacts of Earthquakes and Tsunamis on the Stable Landmass of Sri Lanka

Many of the large stable areas of low relief in the Earth's crust are composed of Precambrian crystalline rocks. The age of these rocks is in all cases greater than 540 million years. Geologically, nine-tenths of Sri Lanka is made up of highly crystalline, non-fossiliferous rocks of the Precambrian age belonging to one of the most ancient and stable parts of the earth's crust, the Indian Shield. The rest of the island, particularly the northern part, is formed of Jurassic, Miocene and Quaternary formations, some of which are fossiliferous.

Thus Sri Lanka is located in an ancient part of the earth's crust, between latitudes 5^0 50' – 10^0 00'' and longitudes 79^0 40'' – 81^0 50'' in the Indian Ocean. The Indian Ocean region is comprised of three submarine ridges namely the Carlsberg Ridge, the Mid-Atlantic Ridge and the Mid-Indian Ridge system. Further, the Indian Ocean has the fewest narrow trenches (about 80 km), as well as volcanic areas. The seismically active Java Trench is the world's second longest, stretching more than 2600 km southwest of Java and continuing northward as the Sunda Trench past Sumatra, with an extension along the Andaman and Nicobar Islands. The submarine ridge system coincides with the boundaries of Indo-Australian, African and Antarctic Plates. Likewise, the Java Trench separates the Eurasian and Australian Plates, and the Andaman and Nicobar Islands cover the Burma micro plate. The submarine ridge system and Sumatra-Java trench system and plate boundaries of the Indian Ocean are associated with belts of earthquake epicenters and, hence, are seismically active. In this manner, Sri Lanka is located alone away from the boundaries of the Indo-Australian Plate, and considered as volcanic- and earthquake-free zone. But Table 1 shows significant earthquakes, which have shaken the stable landmass of Sri Lanka.

TABLE 1. SIGNIFICANT HISTORICAL EARTHQUAKES IN SRI LANKA

DATE	Region	MAG	LAT/LON
14 April 1615	Colombo area		
09 February 1823	Colombo area,	M ?	07.00 N, 80.00 E
January 1882	Trincomalee area	M ?	08.60 N, 81.20 E
10 September 1938	- Gulf of Mannar,	M 5.8?	07.50 N, 79.00 E
30 September 1973 -	Off the eastern coast of Sri Lanka.	M 5.9	07.10 N,84.30 E
06 December 1993 - Sri Lanka.	Gulf of Mannar (Felt in Colombo)	Mb 5.2, Ms 4.7	06.81 N, 78.30 E,

Besides, a number of earthquakes, between 2.5 and 4.5 in magnitude have been reported in and around Sri Lanka. Likewise, powerful earthquakes in the Tamil Nadu area in India also sometimes cause tremors in Sri Lanka. If there had been marine thrust and reverse faults, at that time, tsunamis could have hit the coast of Sri Lanka.

The first reported tsunami earthquake in Sri Lanka was around 2090 BP?. It extended along the west and northwest coasts submerging coastal fishing and pearl-fishing

villages. Likewise, catastrophic tsunami earthquakes in the Indian Ocean have been reported along the Java-Banda trench in the years 1833, 1843 and 1861. Besides, catastrophic tsunami waves hit Sri Lanka as a result of the eruption of Krakatoa in 1883. The December 26, 2004 tsunami earthquake off the West Coast of Sumatra (Magnitude 9.0) claimed a death toll greater than 300,000 in Sumatra, Sri Lanka, Thailand, India and many countries facing the Indian Ocean and Islands in the Indian Ocean by January 15, 2005.

On December 26, 2004 the deadliest tsunami in the history of the world hit Sri Lanka, triggered by a massive earthquake of magnitude 9.0 - the largest earthquake recorded worldwide in 40 years. The inundation distance, due to this tsunami earthquake, measured by the Sri Lanka ITST varied from less than 50 meters to more than one kilometer. In general, the inundation distance was greatest on the East Coast of Sri Lanka towards the South. There was, however, considerable variability caused by a number of factors, including slope of the land, underwater topography, and orientation of the coastline. The South and West coasts of Sri Lanka are characterized by rocky headlands and intervening embayments with narrow beaches and low, coastal plain topography. Run-up elevation measured by the Sri Lanka ITST varied from less than 3 meters to more than 12 meters. In general, run-up elevation increased on the East Coast of Sri Lanka towards the South. On the South and West coasts run-up elevation typically was greatest at the headlands.

The Sumatra tsunami earthquake hit 12 coastal districts out of 24 districts in Sri Lanka. This event affected 202,272 families , displaced 84,735 families and 396,170 persons and killed 30,957 depths by January 27, 2005. Most of the displaced families are sheltered in 321 camps. Besides, 5,644 people are reported missing and 15,196 people are reported injured by this tsunami. Further, 78,407 houses were completely destroyed and 42,047 partly damaged. The December 26 tsunami also damaged various types of structures (harbors, including fishing harbors, road networks, rail tracks, bridges and culverts, hotels, government and other public buildings, different types of service stations etc.). Furthermore agricultural activities (crop farming and animal husbandry), industries and various types of livelihood were swept away by the tsunami waves.

The Government of Sri Lanka and UNDP indicate preliminary estimates of losses (assets and output) at $1,316.5 million (asset loss $986.5 million and output loss $330 million. Likewise, financial needs (short term and medium term) are estimated at $1560 million (short term $503 million and medium term $1057 million). Overall tsunami damage was concentrated in major sectors such as housing, roads and railways, health, water and sanitation, education, agriculture and fisheries, tourism, power and environment, But it is impossible to calculate the damage to fauna and flora (micro, meso and mega types), natural resources including coastal habitats and changes of coastal configuration. All this information reveals that the impact and damage caused by the tsunami of December 26, 2004 cannot be calculated in terms of monetary value.