

## POST TSUNAMI FIELD SURVEY OF 1977 SUMBA EARTHQUAKE IN KUTA, CENTER OF LOMBOK, INDONESIA

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**ABSTRACT:** A strong earthquake had been occurred on Friday, August 19<sup>th</sup> 1977 in Indonesia. The earthquake is known as Sumba Earthquake because originated at under the seabed south side of Sumba Island with magnitude 7.7 Richter Scale. The earthquake had triggered the tsunami wave, which is propagated toward south side of Sumba, Sumbawa, Lombok and Bali Island. Some post disaster field survey had been conducted immediately to asses the casualty and material losses of disaster. The information of this tsunami disaster is very limited due to the situation in that time. The access of some tsunami disaster locations are very difficult because the lack of transportation facility in that time especially in Lombok, Sumbawa and Sumba Island. This paper attempts to present the result of post tsunami field survey, which is conducted recently in Kuta Village, Center of Lombok District, Indonesia. Kuta Village is one location of tsunami disaster 1977 Sumba Earthquake. The tsunami characteristics were about 5 m tsunami height, and 300 m inundation length in this location according the initial report survey. The result of numerical simulation also will be presented to reproduce the propagation and inundation of tsunami disaster in this location.

**Keywords:** Tsunami, post field survey, sumba earthquake, kuta lombok.

### INTRODUCTION

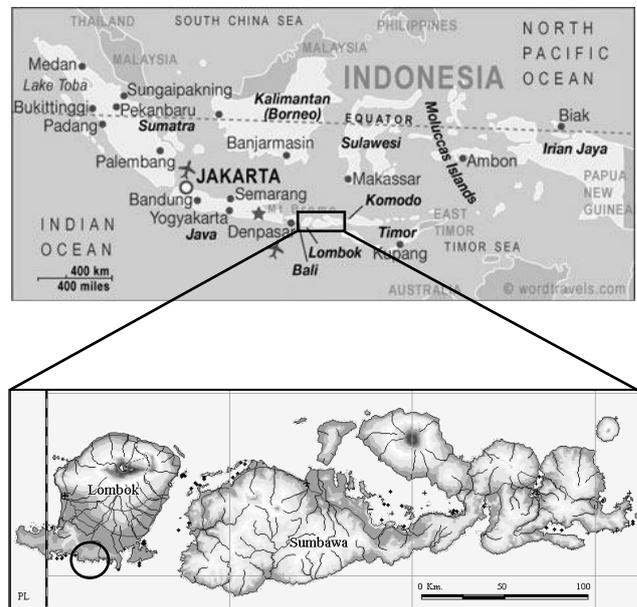
In addition to Kuta Beach in Bali, there is also another Kuta Beach in Lombok Island (east side of Bali Island). It is located in south side of Center Lombok District, West Nusa Tenggara Province (see Fig.1). The Kuta Lombok also has beautiful scenery and attracts many tourists to visit. In the beginning only fishermen and their family live in this place, but since 1997 the tourism activity had been developed by establishment the tourism development centre and construction of star hotel in Kuta Lombok.

The Kuta Lombok ever has suffered the tsunami disaster in 1977. Nakamura (1979) reported that a strong earthquake had been occurred on Friday, August 19<sup>th</sup> 1977 at 14h 08m local time with magnitude Mw 8.3. The epicenter is located at 11.80 S and 118.60 E, in south of Sumba Island which it make the earthquake is known as Sumba Earthquake The earthquake triggered tsunami wave which hit the south coast of Bali, Lombok, Sumbawa and Sumba Island in Nusa Tenggara Islands.

Immediately after disaster, the field survey was conducted by the joint team between the International Tsunami Information Center (ITIC from Hawaii) and the Institute of Meteorology and Geophysics (IMG from Jakarta) from 25 August to 7 September 1977 as reported by Nakamura (1979). The counted victims are 107 persons dead, 54 persons missing, 1,125 persons injured and all of them are from Lombok and Sumbawa.

The total damage cost is about Rp.239,474,000,- in both islands.

Fig. 1 Kuta Lombok Indonesia  
Kato and Tsuji (1995) also conducted the field



survey in October 1993. They collected and discussed the information from eyewitness about the tsunami magnitude, the explosion noise and the damage suffered. The numerical calculation was also performed to simulate the propagation of tsunami wave height from source area until the beach.

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Gusman et al. (2009) was also discussed the 1977 Sumba Earthquake and Tsunami. The numerical simulation was performed and validated by the recorded tide data at three locations in West Australia. The simulation of wave run-up at Lunyuk Sumbawa was also performed and validated by field survey data.

The 1977 survey, which was conducted by IMG and ITIC Joint Team, is correct and rapid action in order to record the trails and impacts of tsunami. However, the limitation condition in that time, such as the lack of transportation facility and the survey technology, restrict the data collection. The tsunami wave height is reported in average value, there is no spatial distribution of that information which is important in run-up analysis. The survey results of Kato and Tsuji (1995) also have no much improvement in data quality, especially in wave run-up condition. This research attempts to conduct again the post tsunami field survey, especially in Kuta Lombok, in order to reveal the spatial distribution of tsunami run-up. The GPS technology was utilized in this survey when identified the height and position of tsunami run-up. The survey and topographic data were analyzed to assess the tsunami run-up distribution.

## **METHODOLOGY**

The survey method follows the Guideline of Post-Tsunami Survey Field from UNESCO-IOC (2012). The survey conducted eyewitness interview, who still alive, about their experience facing the incoming tsunami wave. The witness was chosen in age minimum 10 years old in 1977 considering their awareness to surrounding. The maximum age is 50 years old in 1977 considering their healthy in recent time (86 years old now). The survey also identified the inundation wave as directed by the witness. The position was recorded by GPS device and inundation depth measured by measuring tape. The data is combined with topographic map, which is published by the National Mapping Bureau (Bakosurtanal), for next analyzing step.

The numerical simulation was performed and validated by the survey data. The simulation result, which has conformed to survey data, will give overview of tsunami inundation in that area. The Cornell Multi-grid Coupled Tsunami Model (COMCOT), which is developed by Professor Phillip L-F Liu from Cornell University (Liu et al., 1998), was utilized in the numerical simulation of this study. The COMCOT is open source and apply the long-wave equation or shallow water equation for simulating the propagation of

tsunami from source until coastal area. The model has been used to investigate several historical tsunami events, such as the 1960 Chilean tsunami, the 1992 Flores tsunami (Liu et al., 1994), and more recently the 2004 Indian Ocean tsunami (Wang and Liu, 2007).

## **SITE CHARACTERISTICS**

The Kuta Lombok beach is located at south side of Lombok Island Indonesia at coordinate 8<sup>o</sup>53'27.73"S, 116<sup>o</sup>16'37.26"E. The beach has bay shape about 3,000 m long, stretched from west to east and bounded by the hill. The beach consists of white spherical sand, which is result of coral reef abrasion. The bathymetric in front of beach is shallow in 2/3 east part, may dry during low tide, gentle about 800 m from beach line until sea end. The rest 1/3 west part is deep and become navigational pathways of fisherman boat going in-out the bay.

The topographic of coastal area is flat and gentle; stretch maximum about 2,000 m (west part) and minimum about 300 m (east part) from beach line to the land. The land is bordered by the line of hill in north side. The flat area is covered by tree in west part, but almost uncovered in middle and east part. There is flat tidal area in east side behind the star hotel. Two creeks are flowing out in west part and ones in flat tidal area of east part.

The people of Kuta Village (mostly fisherman) live centrally at west part between two creeks. They live cluster around this part because have deeper water area that make easy to go in-out the bay. Some people live in east side of second creek. Many tourism facilities such as hotel, souvenir shop, and travel office were built along the coastal line in middle part. Only one star hotel exists in east part.

## **SURVEY RESULTS**

There are only 7 person witnesses which can be interviewed, i.e. 5 men and 2 women. The age is minimum 57 (21 in 1977) and maximum 85 (49 in 1977) years old now. All witness still can communicate well even some person only capable by using local language. One people did not directly saw or was hit by the incoming tsunami wave. Two people saw but were not hit by the wave. Only four people were hit, i.e. first during run away to higher land, second during come back to home for saving her daughter, third during stayed at his home and fourth during climbed the tree. All of them reported 1.5m run-up depth, because their positions are almost closes each other.



Fig. 2 The witness and interview process

Six witness reported the same run-up depth is about 1.5 m based on damage of their house because the position of their house are close each other. In 1977, there were only about 20 families and their homes are centrally in one place. In that time, the home was mostly from wood and elevated about 1.5 m above the ground. Most of elevated home were not heavy damage because the run-up surface only reaches the home floor (about 1.5 m above the ground). Only one witness's home was free of tsunami run-up and its position is far from the other. The interview and measurement activity can be seen in Fig.2.

Fig.3 shows the run-up depth and its position. The contour line from the extraction of Google Earth are also plotted to see the overview of topographic condition. The result of analysis run-up data, topographic and numerical simulation will be presented in final manuscript.

## CONCLUSION

The initial survey was conducted and presented. The run-up depth is about 1.5 m with the positions are almost close each other. The analysis of survey data with topographic and numerical simulation will be conducted

to know the characteristics of tsunami run-up in Kuta Lombok.

## ACKNOWLEDGEMENTS

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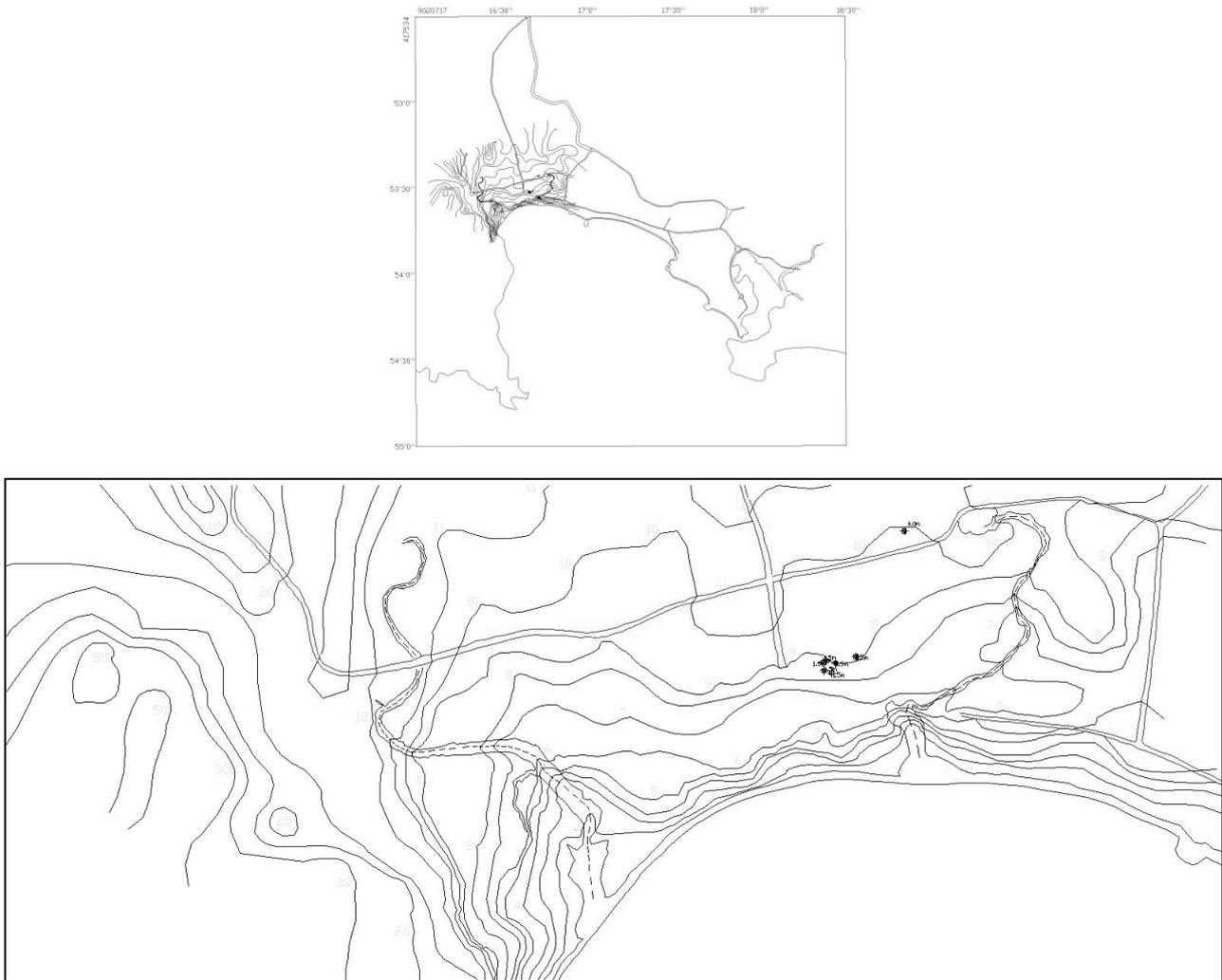


Fig. 3 The run-up depth and its location

#### REFERENCES

- Gusman, A.R., Tanioka, Y., Matsumoto, H. and Iwasaki, S. (2009). Analysis of the Tsunami Generated by the Great 1977 Sumba Earthquake that Occurred in Indonesia. *Bulletin of the Seismological Society of America*. Vol. 99, No. 4, pp.2169-2179.
- Intergovernmental Oceanographic Commission, (2012). *Post-tsunami Survey Field Guide*, 2<sup>nd</sup> edition, UNESCO IOC Manuals and Guides.
- Kato, K. and Tsuji, Y. (1995). Tsunami of the Sumba Earthquake of August 19, 1977. *Journal of Natural Disaster Science*. Vol. 17, No. 2, pp.87-100.
- Liu, Philip L.-F., Cho, Y.-S., Yoon, S.-B. and Seo, S.-N. (1994). Numerical simulations of the 1960 Chilean tsunami propagation and inundation at Hilo, Hawaii. *Recent Development in Tsunami Research*, ed. M. I. El-Sabh, Kluwer Academic Publishers.
- Liu, P.L.-F., Woo, S.-B. and Cho, Y.-S. (1998). *Computer Programs for Tsunami Propagation and Inundation*. Technical Report, Cornell University.
- Nakamura, S. (1979) A Note on the Indonesian Earthquake and Tsunami of 19 August 1977. *Southeast Asian Studies*. Vol. 17, No. 1, pp.157-162.
- Wang, X., and Liu, Philip L.-F. (2007). Numerical simulations of the 2004 Indian Ocean tsunamis: coastal effects. *Journal of Earthquake & Tsunami* **1**(3), 273–297.