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SUMATRA EARTHQUAKE AND TSUNAMI, 26 DECEMBER 2004

By

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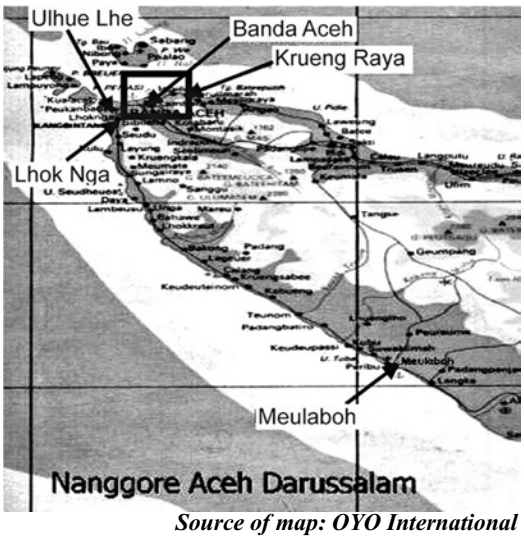
On December 26, 2004, a great earthquake of M9.0, followed by a devastating tsunami struck the Indian Ocean countries: Indonesia, India, Malaysia, Maldives, Myanmar, Sri Lanka, and Thailand killing more than 300 thousand people and leaving almost a million homeless. It was the 4th largest earthquake since 1900, sending a wave of shock, and drawing sympathy and assistance offers from across the world. In Indonesia, over 200 thousand people were killed and 700,000 were displaced. This was the worst natural disaster experienced in its history in which Banda Aceh and North Sumatra suffered the most. This article is a quick survey report giving the overall information on damages to the engineered and non-engineered buildings with a touch to infrastructure damages in Indonesia.

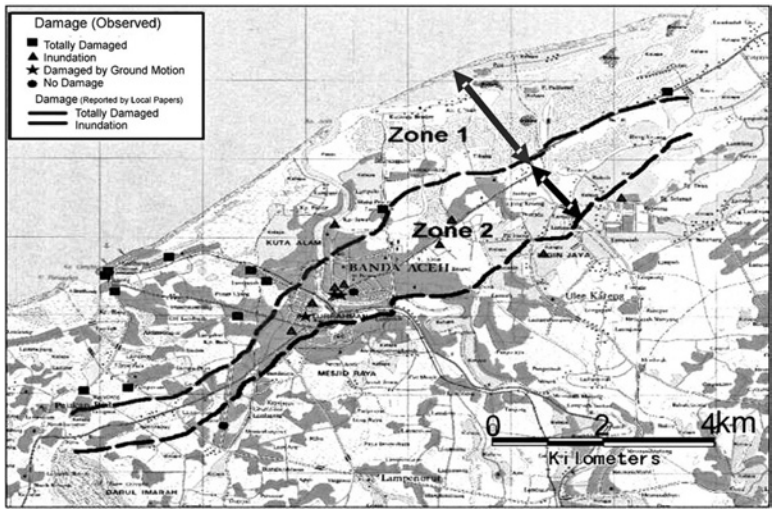
On Sunday morning Dec 26, 2004, Banda Aceh was holding a 10km marathon and some participants had already reached the finishing line. At 07:58:50 WIT (Western Indonesia Time), the earth was struck by a strong earthquake of M9.0. Almost everybody panicked and lay down on the ground. After the shaking stopped, people wandered watching some collapsed buildings in the city. A TV reporter even toured the city to check damaged and collapsed buildings. At around 08:42 WIT, the first tsunami wave reached the coastlines of Banda Aceh and some people started shouting: "water, water from the sea". Many people started running towards the city center. At around 08:53 WIT, a second wave, more

Area damaged by the tsunami disaster on December 26, 2004 (Meulaboh, Indonesia)



Source of map: OYO International

Sites surveyed



Damaged and inundation zones in Banda Aceh (enlarged map of small marked zone in the left side map)

powerful than the first one, swept the coastal area and caused significant catastrophe.

Approximately at 09:15 WIT, the third and most powerful wave hit the coastal area up to a distance of about 4km inland bringing destruction along its path. Most of the buildings that collapsed were non-engineered buildings and were subjected to tsunami forces such as battering, scouring impact and buoyancy. After the third wave, Banda Aceh was inundated up to a height of approximately 2m for about 30 to 40 minutes and subsequently, water started flowing back to the sea. At around 11:00 WIT, the water level was approximately 30-40 cm.

The tsunami curse throughout the coast

There were two zones affected by the tsunami: Zone 1 and Zone 2. The first includes the coastal areas which were destructed by tsunami forces such as battering, scouring, impact and buoyancy. In Banda Aceh, this zone goes up to 3km inland. Zone 2 was the inundated part, where the tsunami force was reduced but the wave caused flooding, dumping mud and debris. This area was approximately 0.5 to 1.5km further inland.

Disaster episodes along the tsunami waves

In areas where the beach is gently sloped, the tsunami waves were very powerful and this is evident in places like: Lhok Nga, Ulhue Lhe, Krueng Raya and Meulaboh. The damage was mostly by the battering and scouring forces of the tsunami. This was observed from the debris originating from frames of timber houses which were practically disintegrated into building components. In case of masonry construction, walls were shattered into pieces of almost equal size. Reinforced concrete columns were ripped off from the foundations, and beam and column connections were severely damaged.

In harbors with deep water, the tsunami wave strength was reduced and the dominant force was buoyancy. This was observed at Lhok Nga cement factory jetty at Ulhue Lhe harbor. The jetty was protected by breakwater walls.

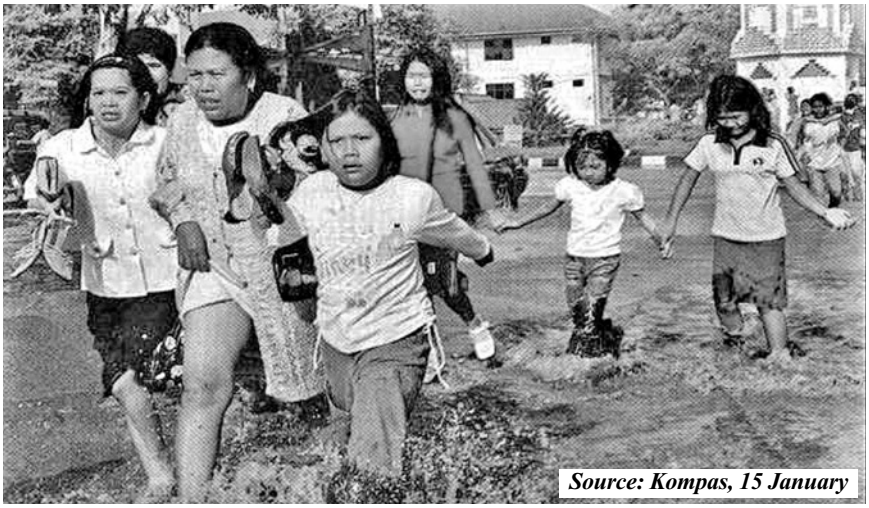
The areas closer to the center of Banda Aceh were damaged by impact force. This impact force was exaggerated by the mud density which is larger than that of the water. It was observed that the tsunami traveled upstream rivers and lagoons and subsequently spilled over the landward areas. It was also seen that, in hilly areas, tsunami waves run up to much higher elevation along hill slopes and valleys than those in plain areas, although the strength was less.

The tsunami wave heights were

Inundation height measured from house wall (Banda Aceh, Indonesia)

Inundation height measured from trees (Banda Aceh, Indonesia)

estimated from measurements of water level traces on walls and trees. They were: (a) Meulaboh (Western Coast), about 4 m, (b) Lhok Nga (West of Banda Aceh), about 15 m (run-up height against hillside), (c) Banda Aceh, about 8m in coastal areas Zone 1 and about 2-3m in Zone 2, and (d) Krueng Raya (North coast), about 6m (watermark on coastal side wall of the Mosque).



People ran to higher ground after the first wave – Banda Aceh.

People ran to higher ground after the first wave – Meulaboh.

"Water, water from the sea" .....An early warning

When people saw a huge wave approaching the coast, some people started shouting, warning that a flood was coming, and started running towards the center of the city. However, the people of coastal areas were not "trained" to evacuate immediately upon hearing this "early warning". Most of them did not have any idea that a tsunami wave could be dangerous to them. Due to this "early warning", approximately 30% of the coastal area population survived the tsunami while the other 70% were literally wiped out together with their houses. Similar "early warning" procedure was also practiced in Meulaboh.

The fate of the city

Two building types can be identified: a) Engineered Buildings, and b) Non-Engineered Buildings.

Engineered buildings consisted mostly of reinforced concrete structures

Almost all "engineered" buildings in Banda Aceh were unaffected by tsunami but some collapsed due to the shaking of the Dec. 26, 2004 earthquake.

The typical cause of damage to reinforced concrete engineered buildings in Banda Aceh during the Sumatra Earthquake was the vertical irregularities which created abrupt changes in stiffness and strength that concentrated forces in an undesirable way. Poor quality of concrete and detailing also contributed to the collapse of those engineered buildings.

Non-Engineered buildings consisted of: i) burnt brick masonry with sand and cement mortar, and ii) timber buildings

The majority of the buildings that collapsed in Banda Aceh city and villages in Lhok Nga, Krueng Raya, and Meulaboh city were

Kuala Tripa Hotel

Office of the Department of Finance

Lhok Nga (Zone 1)

Debris and mud at Meulaboh (Zone 2)

non-engineered buildings consisting of two types. The first type was a one or two-storey building made of burnt brick confined masonry using sand and Portland cement mortar. The roof mostly consisted of galvanized iron sheets. All those buildings used RC "practical" columns and beams as confinement. The second type was timber construction consisting of a timber frame and also timber planks walls and usually used galvanized iron sheets as roof. The ratio of these two types of structures estimated is to be 30 % to 70 %.

Most of the one to two-storey buildings collapsed due to the tsunami and not due to the earthquake ground motion though it was responsible for the walls to crack in some places.

The ill fate of infrastructure facilities

Roads: Most of the main roads in Zone 1 were covered by huge amounts of tsunami debris. Several parts of the road from Banda Aceh to Meulaboh were washed away by the tsunami. ***Bridges:*** Several bridges in Banda Aceh were destroyed: the one at Iskandar Muda area and the other leading to Lhok Nga. Along the road from Banda Aceh to Meulaboh (distance approx. 270 km), several bridges were washed away. ***Ports:*** A part of the Meulaboh Port was washed away but the supports were still in tact. ***Power supply:*** The main power plant in Banda Aceh was not affected by the shaking or tsunami. However, many distribution poles and wires in the affected areas collapsed. ***Telecommunication and Water supply:*** Though these were not very much affected, some telephone junction boxes and underground water piping system were damaged.

Emergency responses and needs after the disaster

Right after any disaster, it is essential to restore telecommunications immediately. This makes emergency response easier and faster, and reduces panic among the community.

The challenge of the recovery is not to repeat mistakes from past disasters, among others, how to prevent NGOs, local as well as foreign, from bringing in "alien" materials and products such as knockdown houses which are not compatible with the local culture. All government officers, community leaders and donors are discussing recommendations to relocate the destructed villages and almost all of them are relying on NGOs/donors who have shown willingness to "adopt" certain villages. Appropriate planning and analysis shall be made prior to recommendation for implementing post earthquake disaster relocation.

Risk to the Indonesian economy

It is predicted that the Aceh tsunami will not have a significant effect towards the Indonesian economy and the 2005 national growth would be 5-6%. It is also estimated that the tsunami will not cause negative effects towards the expectation and risk perception on the Indonesian economy and will not disrupt either investment plans or the exchange rate performance.

The last drop

In spite of the fact that the tsunami most probably will not disrupt the Indonesian economy, the loss of jobs could be crippling at the local level. Even though the damage to agricultural land is only 10%, it will take many years to recover. Farmers lost their livestock and equipments. The aquaculture losses were quite significant. Apart from all those mentioned earlier, the tsunami also swept and destroyed many roads, bridges, drainage systems, water piping, electrical lines, and telecommunication towers. The repair and rebuilding of those all and the resettlement of displaced people will take many years and will need a considerable amount of fund, which may be a substantial percentage of the country gross domestic product.

**ICUS Network Member from Indonesia*

Note: A comprehensive report on the damage survey of the 2004 Sumatra Earthquake and Tsunami disaster in the Indian Ocean Rim countries will soon be published as ICUS REPORT 2005-01. It can also be obtained from the ICUS website (http://icus.iis.u-tokyo.ac.jp/wwwe/publications/index.htm).

A Report on UN World Conference on Disaster Reduction in Kobe, Japan

The World Conference on Disaster Reduction, organized by the United Nations International Strategy for Disaster Reduction (ISDR), was held in Kobe, Hyogo Prefecture, Japan during January 18-22, 2005. The organizational activities of the conference were carried out by the Hyogo Cooperation Committee, which was formed for organizing the conference to bring together academics, government officials, representatives of NGOs and other experts in the areas of disaster reduction. The Mega conference included a variety of events during the five-day period including intergovernmental meetings, thematic sessions, public fora, workshops, exhibition booths, poster sessions and study tours. It drew about 5,000 participants from around the world that included representatives of 168 countries and numerous international organizations.

The conference was composed of three main processes: an intergovernmental segment, a thematic segment for knowledge exchange, and a forum for public participation. The Intergovernmental segment provided the venue for delegates to make statements, discuss and negotiate on the outcomes of the conference for final adoption. The Thematic segment consisted of three high-level round tables; 1) Disaster Risk: The Next Development Challenge, 2) Learning to Live with Risk, 3) Emerging Risks: What will tomorrow hold? and a number of parallel sessions clustered under five themes as well as a regional session for exchange of experience and lessons learned from each region.

Mr. Toshizo Ido, the Governor of Hyogo Prefecture, addresses the conference participants

Prof. K. Meguro and Dr. D. Dutta during their keynote presentations at the UNU Public Forum

The Open forum included a number of thematic seminars, open house meetings, exhibitions and poster sessions organized by NGOs and the academia.

The conference took place less than a month after the catastrophic tsunami disaster of the Indian Ocean of December 26, 2004 that claimed over 300,000 lives. It was dominated by various events and discussions related to tsunami disasters and development of early warning systems.

The conference also marked ten years since the Yokohama conference organized by the United Nations International Decade for Disaster Reduction (IDNDR) in May 1994, where United Nations member states drew up an action plan for a safer world. The Kobe conference aimed to review the progress on the plan since the Yokohama conference. In the conference, it was deliberated that although much progress had taken place on the technical front in the last ten years, disaster losses and poverty-based vulnerability were still out of control. The "Review of the Yokohama Strategy and Plan of Action for A Safer World" summarized the accomplishments since the adoption of the 1994 document. It noted the gaps and challenges for the future, including the need for "more tangible commitments" for translating promises into action.

In the closing session, the delegates adopted the "Hyogo Declaration" and the "Hyogo Framework for Action 2005-2015," which are aimed at assessing ongoing efforts to lessen the effects of natural hazards and determining what further action is needed. In the declaration, they emphasize the importance of translating the Hyogo Framework for Action into concrete actions to lessen risks and vulnerabilities to natural hazards through integrated cooperation and information-sharing mechanisms. The action plan for the upcoming decade seeks to substantially reduce losses from natural disasters and to develop an international early warning system and a global information network for that purpose. It also points out the need to establish international schemes to respond to disasters across borders and notes that unplanned urbanization, environmental destruction and climate change may raise disaster risks.

Coordinating disaster mitigation activities around the world is a daunting task due to various issues, level of priorities, participations, commitments, actions and funds. Through the IDNDR, UN have been successful in raising awareness against natural disasters around the world and information dissemination through the established national committees or focal points for the decade. However, its limitations in taking leadership in reduction of disaster impacts towards "sustainable development" in most vulnerable communities around the world have been witnessed.

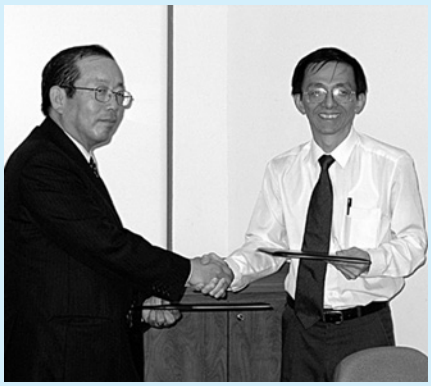
At the end of the Kobe conference, it appears that United Nations is up again in taking the leadership for disaster reduction worldwide, it is acting fast to see success in its efforts to setting up effective tsunami early warning systems around the world. But the task of coordinating and integrating efforts to enable all countries at risk to minimize losses from natural disasters is likely to be a complex and difficult one. The world will watch carefully how the words of "Hyogo Framework for Action 2005-2015" are translated into action in the coming decade to build resilience of nations and communities to disasters.

(by D. Dutta)

ICUS Signed MOU with NUS and NTU, Singapore

ICUS has signed a Memorandum of Understanding (MOU) with National University of Singapore (NUS) and Nanyang Technological University (NTU) to collaborate in research and other academic activities in the field of Urban and Safety Engineering on March 28 and 29, 2005, respectively.

These universities will be hosting the Fourth International Symposium on "New Technologies for Urban Safety of Mega Cities in Asia"



National University of Singapore

Nanyang Technological University

The 8th ICUS Open Lecture

The 8th ICUS Open Lecture was held at IIS in the afternoon of February 28th, 2005. The title of the lecture was "Messages from the Disaster Scene". About 100 people attended the lecture. There were four speakers, Mr. Shogo Hayashi, Dr. Takashi Tsuruda, Mr. Katsumi Seki and Prof. Masamitsu Tamura.

The TOPICS were as follows:

1. *Mr. Shogo Hayashi, Commissioner, Fire and Disaster Management Agency (FDMA): "FDMA's activities towards large-scale disasters in Japan during 2004 and it's future issues".*
2. *Dr. Takashi Tsuruda, Leader of Special Fire Research Group, National Research Institute of Fire and Disaster: "Investigation of Special Fire cases and lessons learnt".*
3. *Mr. Katsumi Seki, Director, Construction Planning Division, Policy Bureau, Ministry of Land Infra-structure and Transport: "Emergency Management for Disaster Reduction – A field perspective".*
4. *Prof. Masamitsu Tamura, Professor Emeritus, The University of Tokyo, Guest Professor of Yokohama National University: "Recent safety problems and potential issues in the 21st Century".*

Finally Professor Taketo Uomoto of ICUS made concluding remarks on this Open Lecture and expressed gratitude to the participants.

The 4th International Symposium on "New Technologies for Urban Safety of Mega Cities in Asia" on October 18-19, 2005

On October 18-19, 2005, the 4th International Symposium on New Technologies for Urban Safety of Mega Cities in Asia will be held at Nanyang Technological University in Singapore. Prof. Pan Tso-Chien, Professor of Nanyang Technological University will be hosting this symposium (TCPan@pmail.ntu.edu.sg). Application of registration and submission will start soon. Further details can be obtained from the Web sites listed below. http://icus.iis.u-tokyo.ac.jp/isus05/ and http://www.ntu.edu.sg/ptrc/USMCA2005.

ICUS Activity Records

- *Prof. Uomoto and Prof. Meguro visited Nanyang Technological University and National University of Singapore, Singapore to sign a Memorandum of Understanding (March 27-30).*
- *Prof. Meguro carried out Sumatra Earthquake and Tsunami disaster investigation in Sri Lanka (Feb. 17-25) and in Thailand (March 9-13).*
- *Prof. Ooka attended the "ASHRAE Winter Meeting" at Orland, USA. (Feb. 5-11), and "Geo Exchange meeting" at Vancouver, Canada (March 16-19), and the "Annual meeting on AGS" at Boston, USA. (March 20-24).*
- *Prof. Dutta visited AIT, Thailand for collaborative research at RNUS (Jan. 22-March 30), and attended the "Map India 2005 International Conference" at Delhi, India (Feb. 7-9). He also participated in field survey and meeting in Guwahati towards developing a project on urban flood risk management at Guwahati, India (Feb. 10-12).*
- *Dr. Susaki visited AIT, Thailand as a JICA expert of remote sensing (Feb. 1-Jan. 31, 2007).*
- *Dr. Endo visited Thailand for research on forest fire in Hauy Kha Khaeng Wildlife Sanctuary (March 13-17).*

RNUS hosted the Secretariat of the International Symposium on Transboundary River Basin Management organized by UNU, AIT and Thammasat University

In recent years, development activities and research surrounding Asian international rivers, especially the Mekong River has expanded. Yet, many efforts in the downstream are disconnected from those in the upstream and vice versa. These communications gaps seriously hamper improving the understanding of basin hydrology and forecasting its future status. To improve regional cooperation and facilitate discussion among scientific community in riparian countries who share interest and incentive to understand one another's views, United Nations University (UNU) organized the symposium on "Role of Water Sciences in Transboundary River Basin Management" together with the Asian Institute of Technology (AIT) and Thammasat University during March 10-12, 2005 in Ubon Ratchathani, Thailand.

The symposium was an academic meeting that served as a venue for information exchange among transboundary water stakeholders working on Asia's international rivers. The focal issues of the meeting were: 1) Modeling and Monitoring, 2) Stakeholder Participation, 3) Transboundary Cooperation and 4) Scientific Networking.

The symposium brought together over 50 water professionals and academicians from 12 countries to share their experience and knowledge in various case studies particular to their basins, emphasizing both risks and paths to cooperation.

The two-day technical program of the symposium included six technical sessions organized under the four focal issues of the meeting. A total of 31 papers were presented in these sessions. After the six technical sessions, a special session was held to discuss research cooperation on transboundary river basin management with special focus on Mekong River Basin.

On the finalday, a field trip was organized to visit the Khong Pha Peng waterfall, located in the Laos Part of the Mekong River and close to the Cambodian border, where the Mekong river slopes steep downwards over a 20km stretch to create a 30 m head and water passage is separated into narrow strips by numerous rocky islands.

The symposium was successful in establishing a network of researchers for future scientific cooperation on transboundary river basin management. The next event for follow-up acitivities is a brainstorming session going to be held at AIT in June 2005 to formulate an action plan for research and development.

The secretariat for organizational activities of the symposium was hosted by the Regional Network Office for Urban Safety (RNUS) of ICUS/AIT and Dr. D. Dutta, the Coordinator of RNUS, acted as the Secretary of the Organizing Committee. Those who are interested to obtain a set of the symposium proceedings can write to the Symposium Secretariat at rnus@ait.ac.th.

Participants of the symposium held at the Tohsaeng Khong Jiem Resort, Ubon Ratchathani, Thailand, March 10, 2005

Editor's Note

Four years have passed since I became a member of ICUS. Meanwhile, the lineup of ICUS had been established.

A large number of activities have been done. The results have been accumulated. However, the speed at which I am writing my manuscript is slow as usual. The reason though is not known.

The three main research subjects I am dealing with are

(1) Urban environmental problems that are related to atmospheric environment,

(2) Urban safety problems related to fire, and

(3) Urban energy problems related to environmental control

(1) and (2) have been conducted as an academic activity in ICUS.

Some students have graduated in these four years under my guidance.

As cooperation work with these students, a number of research results for the above-mentioned (1)-(3) have been achieved in these four years.

In the days to come, I will be informing these results through ICUS.

ICUS is able to offer a meeting venue for researchers coming from various countries around the world.

Personally speaking, I had opportunities to visit many countries through ICUS.

I am looking forward to meeting and working with people who are interested in my research.

(by R. Ooka)

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