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Lesson Learnt from the 2018 Tsunamis in Palu and Sunda Strait

Jakarta, Indonesia | 26-28 September 2019

Summary Statement

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The Symposium

The Symposium was held as one-year commemoration of the Palu and Donggala tsunami in Central Sulawesi, Indonesia. 270 participants from 24 countries representing UN agencies, universities, research institutions, Tsunami Warning Centres, Disaster Management Agencies, NGOs, and media organizations attended the 3 days symposium. The participants came from a variety of backgrounds, including physical and social scientists, warning system operators, emergency and response managers, planners, policy and decision makers, and journalists. The symposium was organized by UNESCO-IOC (Indian Ocean Tsunami Information Centre and ICG/IOTWMS Secretariat), and the Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG), in collaboration with the Indian Ocean Rim Association (IORA), the Coordinating Ministry for Maritime Affairs (CMMA), the Ministry of Research, Technology, and Higher Education (MORTHE), the National Disaster Management Agency (BNPB) and the Indonesian Tsunami Experts Association (IATsI).

The Director and Representatives of UNESCO Office Jakarta, the representatives of Indian Ocean Rim Association (IORA), the Coordinating Ministry for Maritime Affairs, and the Executive Secretary of UNESCO-IOC gave welcoming remarks. Prof. Dwikorita Karnawati, chair of the Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG) officially opened the symposium. She stressed that preparing for earthquakes and tsunamis in Indonesia and their monitoring often prove to be a complex and uncertain challenge, which is largely induced and influenced by diverse submarine and local active faults. She emphasized the need to learn from the tsunamis in Palu and Sunda Strait noting that the science and technology and the socio-cultural aspects are both important dimensions that need to be addressed simultaneously.

A total of 32 lectures, 25 posters and 25 photo exhibits were presented at the Symposium covering scientific findings from the International Post Tsunami Survey Teams (ITST), critical issues surrounding warning systems and possible improvements. The Symposium highlighted that tsunami warning systems are always faced with the dilemma of time versus uncertainty. It is important to assess the possibilities and limitations of scientific knowledge and technology ***vis-à-vis*** the information needs of disaster managers, and make continuous improvements in both technical and social components of tsunami early warning systems. The Symposium reiterated the importance of post-event surveys, and the need to conduct them as soon as practically possible based on well-established protocols and national regulations.

A number of other events and activities took place in the margins of the symposium:

- IORA held a half-day workshop focusing on enhancing collaboration among its members on tsunami early warning system learning from recent tsunamis in Indonesia.
- A publication by UNDRR, UNESCO-IOC, BMKG and BNPB on the "Limitations and Challenges in Tsunami Early Warning Systems: A Case Study of 28 September 2019 Palu-Donggala Tsunami" was launched during the symposium.
- A field trip to Pandeglang-Banten was organised for the participants to visit coastal areas impacted by the Anak Krakatau Tsunami of 22 December 2018.

The Symposium was followed by meetings of the ICG/IOTWMS subsidiary bodies during 29 September to 02 October 2019.

Background

Indonesia was hit by two destructive tsunamis in late 2018, which challenged traditional understanding of tsunami hazard, warning and response mechanisms. The first event was the Palu and Donggala tsunami of 28 September 2018, following the 7.5 magnitude earthquake in Central Sulawesi, that killed about 1,252 people. The second was the Sunda Strait tsunami of 22 December 2018, following an eruption and partial flank collapse of the Anak Krakatau volcano, that killed about 437 people.

Following the Palu and Donggala tsunami, UNESCO's Intergovernmental Oceanographic Commission (IOC) in collaboration with Indonesian authorities led by the CMMA coordinated post-tsunami surveys. 7 teams comprising of 68 scientists from 19 countries and Indonesia undertook these surveys to understand the characteristics and impacts of the tsunami, and to provide information to the Government of Indonesia for enhancement of tsunami risk management practices. The Symposium was held to make these results available to a broader audience.

The UNESCO-IOC's Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWMS), at its 12th session in Iran (March 2019), recognised the Palu and Sunda Strait tsunamis as being very complex from an early warning perspective, emphasising the urgent need to update hazard assessments, strengthen warning capabilities and enhance community response. This is not only of relevance for Indonesia, but also for many other countries in the Indian Ocean region and beyond that are affected by tsunami threats.

Objectives

The main objectives of the Symposium were:

- ❑ To promote scientific dialogue on tsunami science, based on lessons learnt from Palu-Donggala and Sunda Strait events;
- ❑ To undertake critical dialogue on future direction of the Tsunami Early Warning and Mitigation System especially for effective warning chain for events other than tectonic origins and with short warning times; and
- ❑ To stimulate public dialogue on the relevance of scientific findings to policies and actions.

Format

The Symposium was organized into three sessions. Each session started with keynote speeches and presentations followed by a moderated discussion and concluded with a question and answer session. Session rapporteurs provided a synthesis of presentations and discussion as summarized in the following sections.

Synthesis & Recommendations

Session 1 - Lessons learnt from the scientific findings of the recent tsunamis in Indonesia.

Post-event surveys and modelling of the Palu and Sunda Strait tsunamis point to a complex tsunami generation mechanism resulting from co-seismic deformation and also secondary sources including coastal subsidence and/or subaerial/submarine landslides and volcanic eruption.

Key highlights and recommendations:

- ❑ Due to the complex nature of Palu earthquake and tsunami, there is still uncertainty in the tsunami generating mechanism, but it is clear that coastal and submarine landslides contributed and/or amplified the tsunami.
- ❑ Mapping of deep-water bathymetry and fault line configuration in Palu areas is essential to accurately constrain the source.
- ❑ Rapid re-growth of volcanoes (such as the case with Anak Krakatau) needs to be monitored and considered as a highly-probable future hazard.
- ❑ Landslide coeval with the seismic wave radiation and volcanic eruption may generate a tsunami. Monitoring seismic activity at low frequency bands may be useful to detect the collapse of a volcano and hence provide early warning for tsunamis.
- ❑ Video footage of landslides was very useful to develop time varying tsunami sources. The simulated solutions for tsunami run-up compared well with field survey data at several locations.
- ❑ Surveying techniques such as air reconnaissance, 3D LIDAR, drones, and videography to deduce flow velocity were found to be efficient in estimating and calibrating damage index.
- ❑ Tsunami surveys, based on established protocol, need to be conducted soon after the event in order to have evidence before and after tsunami.
- ❑ There is a need to update the 2014 2nd edition of UNESCO-IOC International Tsunami Survey Team (ITST) - Post Tsunami Survey Field Guide with lessons learnt from recent events (IOC Manuals and Guides, 37).
- ❑ Lessons learnt from post-event surveys provide useful guidance for enhancing mitigation – both structural (walls, vegetation/mangroves, elevated roads) and non-structural mitigation (policy/land use/building codes).
- ❑ Structural damage such as building by type and infrastructure (roads, electrical) should be documented during post-event surveys, as such information can help to build back better through development of construction guidelines and building codes for tsunami resistant structures.
- ❑ Cultural awareness and sensitivity issues are to be considered when talking to victims, eyewitness, and the public. Tsunami survey team members should have experience in interview techniques and human behavioral research.
- ❑ Past tsunamis should be documented for the benefit of future generations through eyewitness interviews, especially for areas with few historical tsunamis and no quantitative observational records.
- ❑ More research needs to be done on tsunamis triggered by volcanoes and other atypical sources to enhance early warning and preparedness.

Session 2 - Lessons learnt on End-to-end Tsunami Warning and Mitigation System.

While tsunami-warning systems have proven to be effective in mitigating the impact of tsunamis globally, Palu and Sunda Strait tsunamis highlighted the challenges that we continue to face. The national warning issued by BMKG within 5 minutes of the earthquake was of limited practical use for the Palu tsunami especially in coastal areas where tsunami waves arrived in less than 3 minutes. No early warning was possible for the Anak Krakatau tsunami that was triggered by volcanic flank collapse.

Key highlights and recommendations:

- ❑ Tsunami early warning systems are faced with the dilemma of time verses uncertainty due to short response times, obvious limitations of technology and currently available scientific knowledge. It is important for Disasters Managers, Public, and Media to understand the possibilities and limitations.
- ❑ Current early warning systems are most effective for tsunami generated by subduction zone earthquakes, but have limitations to handle atypical (landslide and volcanic) and/or near-field tsunamis. Tsunamis such as the one in Palu are

often associated with multi-hazard threats with cascading effects (earthquake, liquefaction, etc.)

- ❑ Other important factors that resulted in these disasters include low level of public knowledge related to a near-field tsunami risk, lack of capacities of disaster management offices to deal with near-field tsunamis, lack of proper evacuation plans and related infrastructure during tsunami emergency, poorly implemented/ineffective spatial planning, and policy related issues.
- ❑ Developing and maintaining a culture of self-evacuation is critical for saving lives from locally generated tsunamis. It is important to build capacities of communities to respond to natural warning signs in addition to official warnings. It is also important to recognize the useful role as well as limitations of traditional knowledge in tsunami early warning.
- ❑ Community preparedness was found to be low in coastal areas impacted by both the tsunamis. Communities should be encouraged to participate in tsunami drills and performance based community recognitions programmes such as UNESCO-IOC Tsunami Ready.
- ❑ Ensure development of effective timeline driven early warning chains and Standard Operating Procedures to deliver simple and actionable messages to the public, with clear documentation of roles and responsibilities of all stake holders.

Session 3 - Strategies for development of End-to-end Tsunami Early Warning and Mitigation System.

The symposium reiterated the need to update hazard assessments, and enhance warning systems by densifying and strengthening existing observing networks (seismic and sea level) and use of new technology (undersea telecommunication cables, and real-time GNSS). The symposium also appealed to countries to share more of their "real-time" data from their detection networks. Monitoring of volcanic activity, seismic activity (low frequency bands) associated with volcanic eruptions / flank collapse; automatic detection of sea-level variations from tide gauges and tsunameters could be promising indicators for early warning of tsunamis from atypical sources.

Key highlights and recommendations:

- ❑ There are still gaps in hazard assessments with the current ones being either too broad to facilitate detailed local planning or not addressing all potential sources. These need to be revised based on more recent data and scientific understanding.
- ❑ There is a need to enhance early warning systems by strengthening real-time observing technologies (SMART cable solutions, GNSS, sea level monitoring networks), advanced modelling and new technologies (Artificial Intelligence).
- ❑ Real-time sharing of data from existing and new observing networks is extremely important to strengthen tsunami early warning.
- ❑ Increase the focus over the next 10 years on downstream / last mile component of the end-to-end warning system. Priority in building capacity at community level to understand natural and official warnings and the appropriate response.
- ❑ Managing and improving warning systems require a strong governance mechanism (inter-institutional coordination, joint learning and planning) and policies at the national and local levels with an end-to-end perspective and multi-hazard approach.
- ❑ Policy and decision makers should have differentiated strategy to mitigate for more frequent tsunamis (50-150 years) and less frequent but extreme events (for planning resilient cities, land use, reconstruction, and Build Back Better).
- ❑ Establish national governance framework to ensure effective warning systems and assure common understanding of responsibility and authority.
- ❑ Continue strong national, regional and international collaboration for sharing of experiences, enhancing science, guiding mitigation measures and building best-practice tsunami warning systems.

Key highlights and recommendations from the IORA Workshop:

- ❑ Enhance regional collaboration between IORA, UNESCO-IOC and other regional organisations to assist Member States in establishing and strengthening early warning systems.
- ❑ Member States to share national risk maps to develop an overall IORA risk map which may be used as a baseline document by the Core Group on Disaster Risk Management (CGDRM).
- ❑ Build a risk reduction culture through educational and regional programmes and capacity building to strengthen disaster preparedness and disaster response.
- ❑ Develop an IORA educational programme to create awareness amongst the youth for disaster risk preparedness, educate and communicate to the public about hazard and risk management of earthquakes and tsunamis.
- ❑ Develop emergency evacuation procedures for IORA Small Island Developing States (SIDS), with a specific focus on overcoming the limitation of national evacuation sites.

Key highlights and recommendations from the field trip:

- ❑ The 22 December 2018 tsunami of Anak Krakatau inundated Banten areas on Java during the peak tourism season when hotels and resorts were full and many tourists became casualties of the tsunami.
- ❑ The tsunami occurred during heavy rain in the evening making it difficult to see the natural sign

of volcanic eruption.

- ❑ Most of the local people were aware of areas for evacuation based on training and exercises conducted by NGOs and the government in the past years.
- ❑ The Indonesian Government already started to strengthen the tsunami early warning system in the Sunda Strait in cooperation with international organizations, such as the European Commission on tide gauges, the Chinese Government on earthquake early warning system, and the Japanese Government on tsunami radar.
- ❑ Continue to implement community education, preparedness, conduct exercises and build Tsunami Ready capacity of the hotels, tourism as well as other industries in Banten area.

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References

Presentations as well as further details of the programme, moderators, presenters, panellists and participants are available at: http://www.ioc-tsunami.org/palu

UNESCO IOC 2019. Limitations and challenges of early warning systems: A case study of the 2018 Palu-Donggala Tsunami (IOC Technical Series 150):https://unesdoc.unesco.org/ark:/48223/pf0000371083

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