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Post-Tsunami Field Surveys are Essential for Mitigating the Next Tsunami Disaster

BY LAURA KONG FOR THE UNESCO-IOC POST-TSUNAMI FIELD SURVEY WORKING GROUP

Post-tsunami field investigations are an essential component for improving our understanding of tsunamis and in developing the tools and programs necessary to mitigate their effects. A destructive tsunami can attract a large number of international, national, and local tsunami professionals interested in conducting post-tsunami science surveys to investigate and document its scientific, economic, and social impact on affected coasts and communities. Science data collected immediately after a damaging tsunami are equally important for government decision makers. In the short term, these data help to better organize and deploy often-limited resources to the most critical areas needing response. In the long term, these data are used for recovery planning that will mitigate losses from the next tsunami. Without a coordination plan that is integrated into government emergency response operations, perishable data may prove to be logistically difficult to gather before erosion or bulldozers eliminate the evidence, and in all likelihood, the operations could interfere and conflict with emergency activities. Additionally, during catastrophic tsunamis, affected areas and local jurisdictions may be simultaneously overwhelmed by many government agencies, nongovernment organizations, and the media all demanding information and/or access, thus making collection of useful data even more challenging unless a coordination and information sharing plan is already in place.

LAURA KONG *(l.kong@unesco.org) is Director, UNESCO Intergovernmental Oceanographic Commission-National Oceanic and Atmospheric Administration (IOC-NOAA) International Tsunami Information Center, Honolulu, HI, USA. Other members of the UNESCO-IOC Post-Tsunami Field Survey Working Group are:* ***Lori Dengler****, Professor, Humboldt State University, Arcata, CA, USA;* ***Dale Dominey-Howes****, Co-Director, Australian Tsunami Research Centre and Natural Hazards Research Laboratory, University of North South Wales, Sydney, Australia;* ***Hermann Fritz****, Associate Professor, Georgia Tech Savannah, Savannah, GA, USA;* ***Fumihiko Imamura****, Professor, Tsunami Engineering Laboratory Disaster Control Research Center, Tohoku University, Sendai, Japan;* ***Brian McAdoo****, Associate Professor and Chair, Earth Science and Geography, Vassar University, Poughkeepsie, NY, USA;* ***Kenji Satake****, Professor and Deputy Director, Earthquake Research Institute, University of Tokyo, Tokyo, Japan;* ***Ahmet Yalciner****, Professor, Department of Civil Engineering, Ocean Engineering Research Center, Middle East Technical University, Ankara, Turkey;* ***Masahiro Yamamoto****, Senior Advisor, UNESCO-IOC, Paris, France;* ***Eko Yulianto****, researcher at the Indonesian Institute of Science, Research Center for Geotechnology, Bandung, Indonesia. Other contributors are* ***Paula Dunbar****, Physical Scientist, National Geophysical Data Center, Marine Geology and Geophysics Division, NOAA, Boulder, CO, USA; and* ***Shunichi Koshimura****, Associate Professor of Civil Engineering, Tohoku University, Sendai, Japan.*

INTERNATIONAL TSUNAMI SURVEY TEAM HISTORY

Through coordinated International Tsunami Survey Teams (ITSTs), international scientists can assist governments in more efficiently responding to and recovering from tsunami disasters. Starting with the September 29, 2009, Samoa tsunami (Kong et al., 2009), this coordination role has been most actively led by the International Tsunami Information Center (ITIC) and the United Nations Educational, Scientific, and Cultural Organization's Intergovernmental Oceanographic Commission (UNESCO-IOC). IOC also coordinates the global tsunami warning and mitigation system; warning systems have been in place in the Pacific since 1965, and new ones were started in the Indian Ocean in 2005 immediately following the December

2004 Indonesia tsunami, and in 2006 in the Caribbean and Mediterranean Seas, and North Atlantic Ocean (see http://ioc-tsunami.org).

The ITST concept originated in the 1990s when several scientists began to collect data immediately after a destructive tsunami; the runup and inundation data they collected were used to validate and benchmark tsunami numerical models (Synolakis and Okal, 2005; tsunami runup is the observed onshore measurement of the height of the water above mean sea level). Formation of a team was necessary to quickly gather perishable data. Although often focused on water height data, these early ITSTs recognized the importance of an interdisciplinary approach and included researchers from different fields. They also shared information about tsunamis with the people and officials in the affected country.

A major change in the study of tsunami hazards and in post-tsunami surveys followed the December 2004 Indian Ocean disaster. The scale of the event in area and impact was unprecedented in modern times. Dozens of teams and hundreds of researchers worked in the 16 affected countries over the following year (Synolakis and Kong, 2006). Not only was the amount of data much larger than ever collected in previous ITST efforts but it also included different types of data measured in different ways by different groups. With the increase in data volume came concerns about how to archive and process the data, and about quality issues, including collection methodology, terminology, base levels, and ambient tidal conditions. The 2004 tsunami made it clear that the ad hoc, informal way of conducting post-tsunami surveys was no longer adequate.

Tsunami research has also changed since 1998. There have been advances in modeling and the availability of space-based technologies, including satellite imagery and global positioning satellite navigation. Methods of recording impacts, such as the proliferation of amateur digital video and still imagery, need to be addressed. Tsunami sediments now play a new and important role as key data that extend the tsunami historical record back in time and thus provide an indication of its recurrence intervals. In addition to advances in techniques, many more disciplines have become involved in post-tsunami investigations, such as the social and economic sciences, ecology, and engineering. Post-tsunami surveys have moved beyond traditional approaches of measuring maximum inundation, runup, and flow depth to include a detailed, varied, rich, and contextual understanding of the effects of tsunamis at different places, such as upon people and their communities, infrastructure, agricultural systems, marine and terrestrial ecology, geomorphological systems, and engineered structures.

ITST tasks should now encompass:

- Measuring maximum tsunami inundation, flow depths, and maximum runup, and to the extent possible, "walking the inundation" line in order to collect an exact summary of the inundation of impacted communities
- Collecting geological samples of sediments left by the tsunami
- Measuring the type and severity of damage to different types of buildings and recording what factors appeared to control damage levels
- Collecting and measuring information about the environmental and biophysical system impacts of the tsunami
- Collecting information about survivor experiences and stories through interviews
- Exploring the human and community vulnerability and resilience factors at work in different places

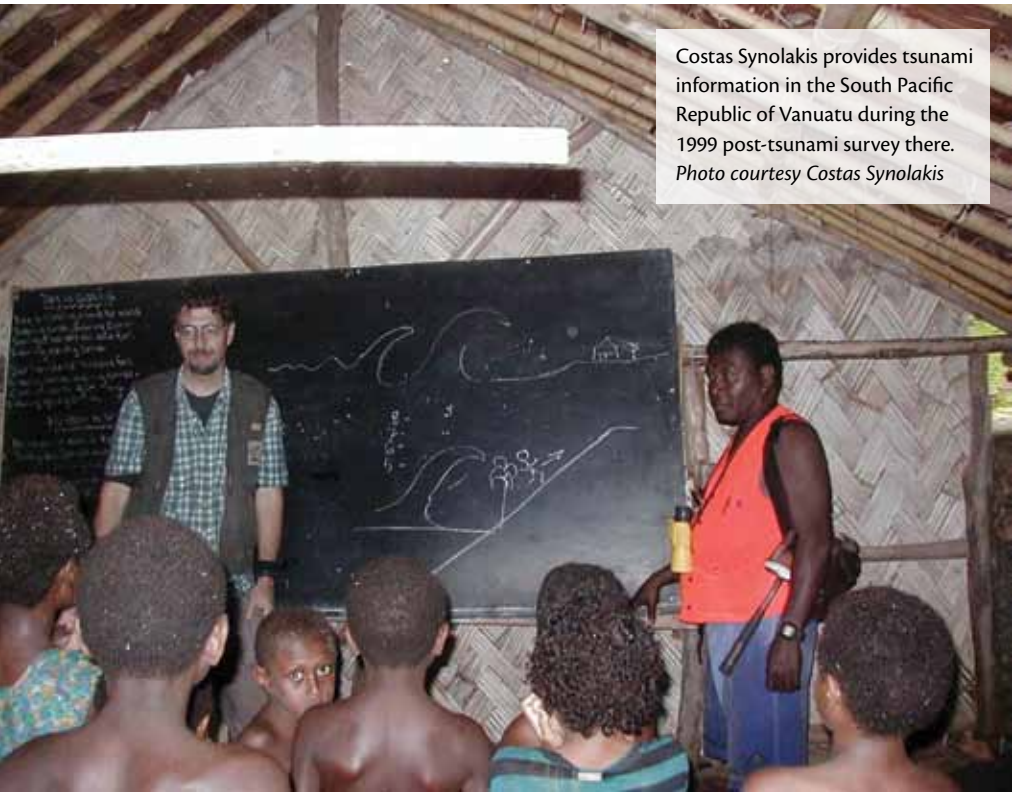
Indonesian scientists Iwan Tejakusuma (left) and Eko Yulianto (right) interviewing residents about the 1994 East Java tsunami. *Photo courtesy Brian Awater*

RECENT ITSTs

Since September 2009, five ITSTs have been organized, each distinct in their arrangements. For the September 29, 2009, Samoa tsunami (ITST-Samoa; Kong et al., 2009), a single, coordinated team of more than 60 scientists conducted surveys from October 14 to 23 (two weeks after) in collaboration with the Samoa Ministry of Natural Resources and Environment; the teams stayed at a central compound, shared data, and compiled one preliminary report that was presented to the Samoan Government on October 26. This ITST, with support from SPC/SOPAC (Secretariat of the Pacific Community/Applied Geoscience and Technology Division), UNESCO, and ITIC, set the benchmark for a coordinated ITST to support early recovery, and demonstrated that working together will produce a much stronger and valuable outcome than working individually. A similar smaller effort was coordinated for the same tsunami in Tonga (ITST-Tonga, November 2009) where two teams (New Zealand, Japan) with Tongan government logistics collaborated with their government scientists to survey Niuatoputapu island. The ITST-Mentawai conducted after the October 25, 2010, Mentawai, Indonesia, tsunami also followed a similar process; because access was arduous, only five teams conducted surveys, and because of the small number, coordination and submission of preliminary reports was promptly achieved.

After the February 27, 2010, Chile tsunami, UNESCO and ITIC worked to coordinate the ITST-Chile where more than 25 teams and 70 scientists conducted surveys between mid-March and May. Unlike Samoa or Tonga, where the impact was localized and the area small, the survey area was extensive, covering 1000 km of coast. In this ITST, coordination consisted of briefings where incoming and outgoing teams could share information. Identification badges and letters of support in Spanish were also provided to facilitate access, but no government officials were able to participate because of their very busy schedules. ITIC implemented a secure information-sharing environment for posting files and sending messages among all the scientists. Due to the dispersed nature of the surveys (in survey time and area), it has been difficult to compile a summary report for ITST-Chile because most teams have yet to post their findings.

Coordination of ITST-Japan after the March 11, 2011, tsunami in northern Japan has been less complex due to strong national post-tsunami survey arrangements and the nuclear safety issue. In this situation, it was announced through the ITIC Tsunami Bulletin Board that Japan requested that no international teams visit until later April, respecting search-and-rescue operations due to the high number of casualties (25,000+), difficult logistics, and knowing that many Japanese scientists were extremely busy as part of the national response. ITST-Japan also directly informed the US National Science Foundation (NSF) in March, and through its Dear Colleague Letter in April, NSF strongly suggested coordination with UNESCO/NOAA (ITIC) when funded. It is envisioned that later surveys, such as those of ITST-Japan, should ideally concentrate on detailed investigations of specific locations or topics in collaboration with Japanese colleagues who were part of the national data collection efforts.



Costas Synolakis provides tsunami information in the South Pacific Republic of Vanuatu during the 1999 post-tsunami survey there. *Photo courtesy Costas Synolakis*

Information sharing, inquiries of interest, and plans for conducting a post-tsunami survey begin immediately after a tsunami. The Tsunami Bulletin Board (TBB), a listserve hosted by ITIC since 1995, has been used to share tsunami event information, including survey plans. The TBB is open to tsunami professionals and includes many international research scientists; members also receive Pacific Tsunami Warning Center and West Coast/Alaska Tsunami Warning Center messages, so they are immediately aware when a tsunami occurs.

The arrangements for each ITST are unique to the situation and are intended to strike a balance between addressing information requests from the host government and research questions from scientists. For collaboration, it is vital that there is no sense or perception that incoming scientists are there only to collect data that will advance their careers. ITSTs can and should meet the needs of both affected communities and participating survey scientists and experts—but one should not be to the disadvantage of the other. Logistics need to be flexible. For small surveys with limited geographic scope, individual scientists should coordinate directly with the UNESCO-IOC/ITIC. For large surveys involving many teams (more than 10), an ITST Science Focal Point (Coordinator, Chief Scientist) can be identified to lead the science efforts.

ITST SURVEY DATA REPOSITORY/TECHNICAL CLEARINGHOUSE

It is important that data collected during post-tsunami field surveys be contributed to a data repository and eventually assimilated into a long-term tsunami data archive. Tide-gauge recordings provide immediate confirmation that a tsunami has occurred and are useful for model validation, but the majority of data that describe the full extent and severity of a tsunami are collected during field surveys. All of these data are essential for tsunami hazard assessment, forecast and warning, inundation modeling validation, preparedness, mitigation, education, and research.

Data collected are often stored by individual field investigators, making access by others difficult. Therefore, during and following field surveys, the data should be shared through a data repository or tsunami technical clearinghouse (TTC) coordinated through UNESCO-IOC or other agency. The establishment of a TTC after a major tsunami can provide the central framework for coordination of activities and integration of scientific investigations with government response. The goals of a TTC, which include at a minimum an electronic information server but could also include a physical location, are to assist in the response to, damage assessment of, and early recovery from the natural disaster without increasing the burden on emergency officials; facilitate researcher access to the affected areas; and contribute to the capture of valuable and perishable data. Central to an ITST and its TTC is the tenet that the data collected are owned by the investigators themselves and will be proprietary for a length of time to allow them to conduct research and publish their results.

After the end of each ITST and its information-sharing through a TTC, principal investigators should submit all tsunami survey data to the International Council for Science (ICSU) World Data Center (WDC)-Marine Geology and Geophysics (collocated with the US NOAA National Geophysical Data Center [NGDC]) whose personnel are responsible for maintaining the world's long-term tsunami data archive. NGDC-WDC and ITIC work together to collect tsunami event data. The archive so far consists of tsunami histories (event and runup), hazard photos, videos, and references, as well as data on tsunami deposits, coastal water levels, and deep-ocean bottom pressure recorder measurements.

Hideo Aochi measures a 35+ m runup in Japan in 2011. *Photo courtesy Bunichiro Shibazaki*

COORDINATION CHALLENGES

Coordination is triggered by a request from the affected country to UNESCO-IOC for assistance, knowing that many research post-tsunami survey teams may be or are arriving. The coordination goal is to foster a

Boat stranded in Otsuchi, Japan, during the March 2011 tsunami. *Photo courtesy of Yushiro Fujii*

cooperative relationship so that scientists are working with, and not against, the government as it assesses impact and responds to the needs of its people. In each ITST, UNESCO-IOC and ITIC work with government agencies and regional partners to facilitate smooth-running surveys endorsed by the country, especially if access is provided; in return, it is expected that scientists will share their preliminary findings, preferably before they leave.

To date, finding and implementing a cooperative, collaborative framework has been challenging because funding lines drive activity goals, and the two parties have fundamentally different missions. In large part, survey scientists have been funded by their research agencies (such as NSF), and there has been no requirement to check in with authorities and then debrief them on exit, nor has there been a requirement to share their data to support disaster response as a humanitarian good will effort. Additionally, as post-tsunami disasters and the collection of perishable data are time sensitive (e.g., rushed), the situation is often chaotic, with a variety of activities needing to be coordinated among many players and jurisdictions at the same time, and with often less-than-ideal communications infrastructures and logistics. Nonetheless, with experience and the increasing support of scientists and their organizations, ITIC is seeing that the process is getting smoother and moving toward the most flexible and most accommodating framework possible.

POST-TSUNAMI SURVEY FIELD GUIDE, SECOND EDITION

The UNESCO-IOC *Post-Tsunami Field Survey Guide (First Edition)* was first published in 1998 to provide governments and the scientific community with guidance on collecting perishable tsunami data immediately after the event (UNESCO-IOC, 1998; Dengler et al., 2010). IOC is now updating the guide in order to publish the second edition. The 2011 revision will provide guiding principles for undertaking post-tsunami surveys, and include best practices and templates for individuals and groups considering forming or participating in post-tsunami surveys. Up-to-date descriptions of types of surveys, data to be collected, and the techniques, tools, and equipment required will be included. A framework for data sharing and archiving is proposed that aims for the conduct of a comprehensive post-tsunami survey but at the same time ensures data remain proprietary until results are published. Members of an IOC Post Tsunami Survey Field Guide Working Group, consisting of practitioners from around the world, are sharing their experience and expertise to revise the guide. For more information and to provide input to the guide, please contact Laura Kong (l.kong@unesco.org).

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