Tsunami research and its practical use for hazard mitigation

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Tsunamis are generated by deformation of the ocean floor caused by various processes such as earthquakes, landslides, and volcanic activities. Advances in theory, instrumentation and analysis methods have led to a better understanding of tsunami generation and propagation, and the resulting scientific knowledge will be able to effectively reduce the impact of tsunami on our society. However, difficulties exist in using modern scientific knowledge for effective tsunami hazard mitigation. Many of the difficulties are unique to earthquake and tsunami hazards, and possibly to many other natural hazards. The initiation of earthquakes, landslides, and volcanic activities is a typical stochastic process and precise prediction of the place, time, and size of these events is extremely difficult, especially on time scales of our daily life. Thus, we need to prepare for the unexpected. Disastrous tsunamis are relatively rare and infrequent (i.e., not daily or weekly) so we tend to forget them, and it is difficult to maintain good long-term preparedness. Unfortunately, when a rare event occurs, usually unexpectedly, its consequences are often extremely grave, as we have sadly experienced in Sumatra in 2004, and in Japan in 1896 and 2011. It is important to always have careful preparedness, land-use planning, evacuation drills, and education using the knowledge gained from our past experiences. Because of the sudden occurrence of tsunamis, it is critical to develop reliable infra-structures and warning systems using modern technology that can function flawlessly during an emergency.

Another difficulty which is also unique to tsunami hazards, or natural hazards in general, is the difficulty in getting financial support from the private industry. In medical and engineering sciences where promising academic research advancements can often interest industry's investment; good academic products can be picked up by industry for effective public use. This is less likely to happen in hazard science because of the lack of financial incentive that can attract business investment. Thus, to promote effective use of scientific products in hazard science, it is critically important for the local and central government to have a long-term vision for supporting research,

practical application, and education.

Regarding tsunami warnings, recent advances in ocean bottom sensors, advanced seismic networks, and real-time GPS networks are making significant impacts. Many countries like Japan, US, and Chile are developing a system that can issue warnings within minutes. However, effective use of such warnings are challenging especially for the tsunamis that originate close to the coast. Examples are the 1998 Papua New Guinea earthquake and the recent (2018) Sulawesi earthquake. In these cases, the tsunamis may have been caused by some secondary effects that cannot be easily foreseen within the context of traditional theory. Also, because of the proximity of the tsunami source to nearby population centers, little time is available for effective evacuation. Thus, careful land-use planning, assessment of the effect of local topography on tsunami generation and propagation, and developing local-infra structures (i.e., vertical evacuation structures etc.) are important in addition to warning systems, communication, training, and education.