

Tsunami Forecasting: A Framework for Advances in Tsunami Research

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1. The Problem:

A historical characteristic of tsunami research has been the episodic nature of advances that follow a pattern of rapid advances after a destructive tsunami then slowing advances before the next tsunami strikes. A consequence of this boom and bust cycle is that research advances are lost in the frenzy of activity immediately after the destructive tsunami. For example, the 2004 Indian Ocean tsunami, which killed over 230,000 people, motivated scientists and engineers from all types of backgrounds to assist in mitigating the effects from the next tsunami. In their eagerness to help, much effort was directed at problems that had been thoroughly studied in the past. The net result from this inefficient process is wasted resources, slowed progress, and frustrated scientists and engineers. A contributor to this inefficiency is random distribution of tsunami scientific publications making meaningful searches of past research almost impossible.

2. An Approach to the Problem

One advantage that tsunami research has over other disciplines is an operational tsunami warning system. The 2004 Indian Ocean tsunami was a watershed event that will be remembered as the tsunami that transformed tsunami warnings from only in the Pacific Ocean to the global oceans. As seen in Figure 1, tsunamis occur globally.

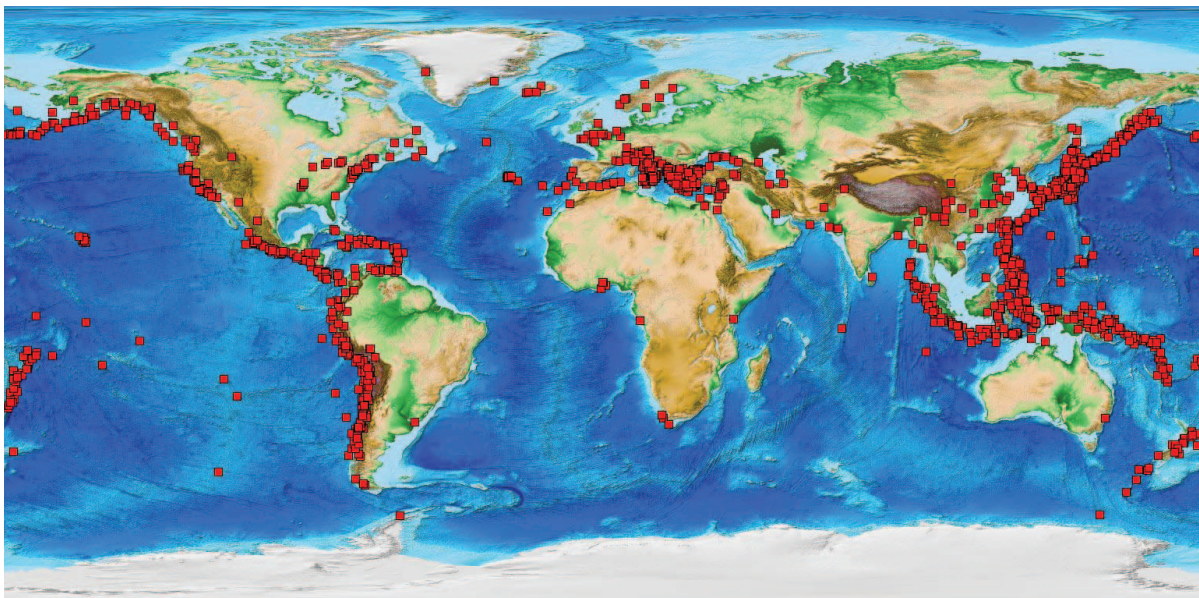


Figure 1. Historical Tsunami Sources: 2000 B.C. to Present. Source: NOAA's National Geophysical Data Center

Not only did the 2004 tsunami transform tsunami warnings globally, but advances in technology made real-time tsunami forecasting possible. The tsunami forecasting system is an integrator and assimilator of the past research efforts distilled into one operational system. As such, the tsunami forecast system, if properly designed and operated, could serve as the repository for a large portion tsunami research advances.

A Tsunami Forecasting Framework (Figure 2) is a forecasting capability that uses a standardized tsunami forecast system to serve

1. Real-time operational needs
2. Hazard/Risk Assessment needs
3. Research and development opportunities

Elements of a tsunami forecast system include: generating mechanisms, direct measurements of tsunamis in the deep ocean and along the coastline, and tsunami inundation models that are capable of forecasting the time evolution of tsunami flooding.

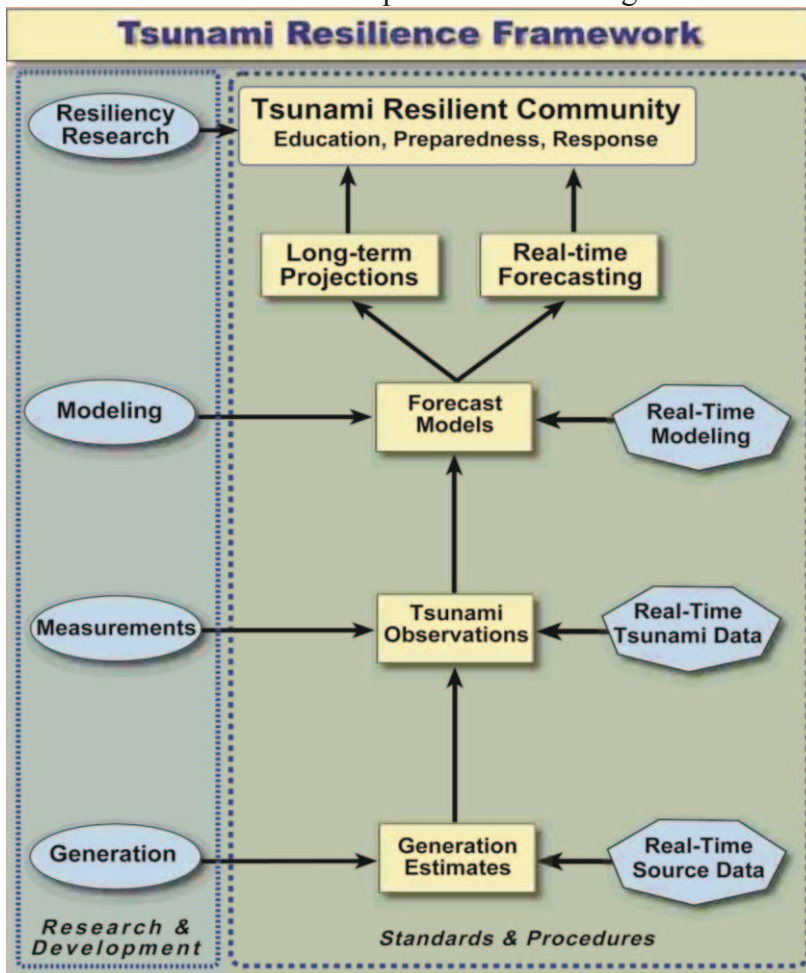


Figure 2. Tsunami Forecasting Framework

3. Conclusions

The tsunami forecast system would have two immediate applications:

1. Real-time operational forecasts of tsunami arrival time, tsunami amplitude over time for 12 hours, maximum wave height, and inundation areas
2. Long term assessments of hypothetical tsunamis based on plausible tsunami sources for a particular area. Such assessment could be used for the production of evacuation maps. Using the real-time forecast system has the advantage of compatibility of real-time forecast products and assessment products. The forecast approach has the advantage of having both regularly tested models (used in warning operations) and independent verification of results (tide gauges). Using a common system eliminates misinterpretation of results and ensures the two product lines can be placed on similar graphics to reduce confusion about the source of the information.

This operational forecast system could also have a research counterpart, which would accelerate advances in generation, propagation, and inundation by testing the ideas in the existing operational forecast system. The debate about the performance of certain models could be easily addressed by inserting the models in a research mode to evaluate the performance achieved by the new technology. The R&D use of the tsunami forecast system could also serve as training tool for tsunami operations, as a test bed for tsunami warning product development and improvements, and as research tool to explore technologies to create new forecast products and reduce operational costs.

References

Bernard, E.N., and A.R. Robinson (eds.) (2009): [Tsunamis. The Sea, Volume 15.](#) Harvard University Press, Cambridge, MA and London, England, 450 pp.