Review of the U.S. National Tsunami Hazard Mitigation Program

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1. Summary

The U.S. National Tsunami Hazard Mitigation Program (NTHMP) has made a significant progress in the first 5 years, and has met the program goals outlined in the Implementation Plan prepared in April, 1996. The program has successfully raised the community awareness for tsunami hazard in the west coast of U.S. through production of inundation and evacuation maps, improvement of seismic networks, development of deep-ocean tsunami detection buoys, and development and coordination of tsunami risk mitigation efforts. The state/federal joint efforts have been effectively executed under the strong leadership of the NTHMP Steering Group.

The progress during the first 5 years is significant enough to warrant augmentation of the program in the future.

2. Evaluation

What follows is my evaluation of the program for each of the criteria defined in the review document, with a special emphasis on the areas of my expertise.

1. Has the program successfully met the goals of the implementation plan?

The oral and poster presentations made at the August 7 review meeting summarized the accomplishments and products of the first 5-year effort. There have been some inevitable delays in deployment of seismic instruments mainly because of the funding delays, but the overall progress is remarkable considering the difficult deployments at many sites in harsh natural environments.

The development of deep-ocean tsunami detection buoys was an ambitious attempt, but the development team has successfully deployed 6 units. The data are disseminated on a W.W. Web site. The overall performance is encouraging. The evaluation of the real merit of this system may have to wait for a few more recordings of significant tsunamis in the future.

2. Are the products technically sound?

The production of inundation and evacuation maps utilized the state-of-art methodology. With future improvements in the coverage and methodology, the product will prove to be useful for implementing more concrete emergency management procedures.

The seismic data produced by the new network are now providing the tsunami warning centers with earthquake information which is vastly improved both in quality and quantity compared with that available only a few years ago.

The information on the water wave provided by the tsunami detection buoy system is critically important for increasing the reliability of tsunami-warning

information and for decreasing the frequency of false alarms. The present number of sites (6) is not sufficient to completely monitor tsunamis. Because of the relatively sparse distribution of the buoys and strong directivity of tsunami radiation, some tsunamis may escape notice. Obviously, more development in this area is critically important for building a more reliable tsunami warning system that will minimize false alarms.

3. Is the state/federal partnership working?

As far as I could judge from the presentation, the partnership worked very well. In particular, the partnership between NOAA and USGS in building modern seismic networks was very successful. The USGS has a long experience and excellent expertise in building modern seismic networks, and through this partnership the NTHMP made a good use of the USGS expertise in seismic telemetry. This is a good use of available resources, as reflected in the large in-kind contributions from USGS.

4. Are the products expected to have a positive impact on tsunami mitigation?

The enhanced seismic networks and the availability of water-wave information from the deep-ocean buoy system would significantly improve the speed and reliability of tsunami warning information in the future. The frequency of false alarms can be minimized significantly through the use of these modern networks.

Effective mitigation measures cannot be achieved by enhanced instrumentation alone. The good progress in coordination between Federal and State agencies demonstrated in this program will have a strong positive impact on the use of information coming from these new networks for effective tsunami warning.

5. Are plans for the future appropriate?

The plan would be adequate for the "status quo" option, but as I will describe in the next section, a significant enhancement of the program is desirable to accomplish truly effective tsunami warning. Judging from the good progress demonstrated in the first 5 years, I believe that this program can accomplish it, if proper budgetary support is available.

6. Suggestions for improving the program.

6-1. Development of new instrumentation for water-wave monitoring.

I believe that the most important element is monitoring tsunamis in the ocean. The buoy system that has been developed in this program is promising in this regard, but for effective tsunami warning, for both teleseismic and local tsunamis, a more dense network of such instruments will be critically important. In parallel with the buoy system, a development of new instrumentation which would allow less expensive and more dense deployment would be important. For example, the use of the large horizontal particle-motion amplitude of tsunamis (as opposed to pressure changes due to the vertical particle motion) may be advantageous and should be explored. Also, several studies have been made to map propagating water waves

using atmospheric and ionospheric responses. As far as I know these studies have not been carried far enough to be used for practical tsunami monitoring.

In order to achieve high-density deployment of tsunami measuring instruments in the ocean, exploratory work by taking advantage of modern technology is encouraged.

6-2. Collaborative work with academic institutions.

In order to explore new methodologies for tsunami monitoring, basic studies on energy coupling between ocean and atmosphere-ionosphere should be encouraged. Some studies along this line have been made in seismology, but these studies are not necessarily related to tsunami problems. Also, with the deployment of new seismic networks, it is desirable to develop methods to utilize such high-quality data more effectively for tsunami warning purposes.

Some collaborative works on these basic problems with university and other research organizations are advisable.

6-3. Stress-test of seismic networks

The seismic networks built for warning purposes must function well when a large earthquake occurred. However, such a large earthquake is relatively rare, and a network tends to be tested with relatively small routine earthquakes. However, large earthquakes are very different from small earthquakes in terms of complexity of the event sequence, data volume, and the amount of necessary processing. It is critically important to conduct a "stress test" of seismic tsunami warning networks simulating the situation that will be encountered during large tsunamigenic earthquakes. Such stress tests should be made at regular intervals.

6-4. Utility of data for basic studies of tsunami

Since large tsunamis are relatively infrequent, the data collected by seismic networks and the buoy system will not be used frequently for warning purposes per se. However, these networks can provide the general scientific community with critical data for basic studies on earthquake source processes and water wave propagation. Such basic studies are fundamentally important for understanding the nature of tsunamigenic sources (earthquakes, submarine volcanic eruptions, and landslides) and for improving the tsunami warning capability in the future. Thus, easy availability of the data collected for tsunami warning purposes for use by the general scientific community is important. The present program made a good effort so that the new seismic data can be used through the existing data center, and the tsunami data from the buoy system through a website. Continuation and enhancement of this effort should be encouraged.