Review Report on Tsunami Hazard Mitigation Program

Philip L.-F. Liu
Cornell University

The Tsunami Hazard Mitigation Program consists of five components:

1. Produce Inundation Maps
2. Improve Seismic Networks
3. Deploy Tsunami Detection Buoys
4. Develop Hazard Mitigation Programs
5. Develop State/NOAA Coordination and Technical Support

Since my background and expertise are in the area of numerical modeling of tsunami generation, propagation and inundation, I shall focus my review only on the first component of the program.

Produce Inundation Maps

Over the last five years inundation mapping efforts were completed in nineteen communities in five states, including two in Alaska, five in California, two in Hawaii, six in Oregon and four in Washington. Among them, seven communities have also developed the evacuation maps. Considering the limited time and resources available, I believe that the program has successfully met the goals of the implementation plan.

Four different academic institutions carried out the inundation mapping efforts: the Oregon Graduate Institute (OGI), the University of Southern California (USC), the University of Alaska at Fairbanks (UAF), and the University of Hawaii (UH). The OGI was responsible for the mapping efforts in both Oregon and Washington. Researchers and engineers in each academic institution worked with representatives from the state to determine high-risk communities and the specification of tsunami sources that represent "credible worst case scenarios". The staff at the center for tsunami inundation mapping efforts (TIME) prepared the bathymetric and topographic data for all four states except Hawaii. Apparently, each institution used different numerical model in simulating tsunami inundation. It is not clear if different grid sizes (or finite element sizes) have been used in each case to ensure that the numerical results are indeed the converged solutions for a specified scenario. Nevertheless, the quality of the maps was controlled by comparing the numerical results with any historic observations or pre-historic information that might be available. Given that there are significant uncertainties in determination of tsunami sources, I believe that the procedure for producing inundation maps is technically sound.

The impact of the mapping efforts is significant. First of all, the inundation maps are powerful educational tools. They raise the awareness of citizens residing in communities at risk to tsunamis. They influence the emergency planning and preparation for these communities. Moreover, the mapping efforts have also improved the collaboration between tsunami research community and emergency management community; the mapping program has indeed developed the essential infrastructure for transferring technology from research modes to operational applications.

The program plan for the next five-year is excellent. It calls for continuing supports for developing new maps ($750K/year), establishing a map improvement and maintenance program ($300K/year) and developing bathymetry and topography databases ($250K/year). These proposed activities are essential for producing high quality maps, which can be accomplished only if the correct physics is included in the model, accurate bathymetric and topographic data are employed, and accurate tsunami sources are estimated.

Here, I offer a few suggestions that might help to improve the program:

1. Submarine landslides have been considered as possible tsunami generation sources in many sites. The models used to generate tsunamis and run-ups are primarily based on the nonlinear shallow water equations (NSWE). These equations are adequate for describing tsunamis generated by coseismic seafloor movements in which the length scale of the source region is much larger than the water depth. However, in the case of landslide generated tsunamis, the length scale of the source region is much smaller and consequently, the wavelength of the resulting tsunamis is also shorter. Therefore, the frequency dispersion might become important, which is completely ignored in the NSWE. The alternative is to employ the Boussinesq-

type equations, which include various degree of the frequency dispersion. The program needs to consider this alternative seriously in order to produce accurate maps.

2. The description of the tsunami source determines the outcomes of the inundation map. At the present, initial surface profiles are described over the source regions, based on the geological and/or seismic data. This approach appears to be unreasonable for the submarine landslide generated tsunamis, because the duration of a landslide could be in the order of magnitude of one to ten minutes. The time history of the ground motion might be important in determining the final coastal runup.

3. Since several different numerical models are being used in different states, to ensure the uniform quality of the numerical results a minimum standard must be established. For instance, each map (final numerical results) must be based on the grid-independent solutions. The final results should also show that they satisfy the conservation laws, such as mass and momentum.

4. Increasingly sediment deposits have been used as data for determining the tsunami inundation area. However, the research work relating sediment transport to incident tsunamis is sparse. It seems that this is one of the topics needs to be investigated during the next five year.