

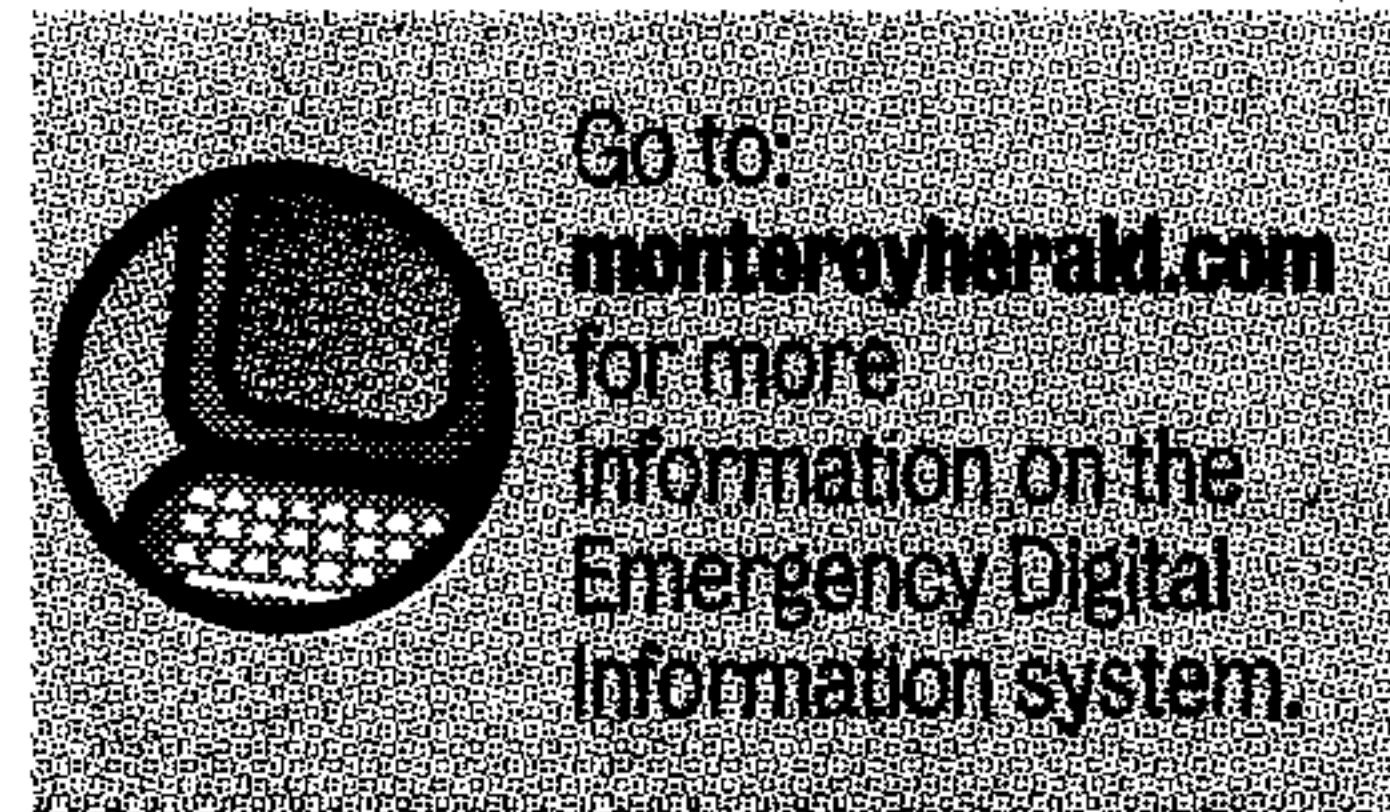
A growing system of ocean buoys is the best warning signal — and a guard against false alarms

County expanding tsunami readiness

By **ANDREAS von BUBNOFF**
Herald Correspondent

In the weeks since the Indian Ocean tsunami in December, Monterey County officials have been discussing ways to improve local tsunami preparedness, and the Bush administration last month said it wants to expand a tsunami warning system in the Pacific Ocean that protects the California coast.

The system uses buoys close to earthquake-prone zones. They detect tsunamis generated by earthquakes as far away as Alaska, Russia and Japan, leaving enough time for the authorities to warn the



coastal areas in danger.

But while earthquakes far away are considered the most likely source for a tsunami reaching Monterey, experts say residents shouldn't rely on the tsunami warning system alone. In some cases, tsunamis can be generated too close to Monterey to be picked up by

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Tsunami

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the buoy system. If people close to the shoreline feel an earthquake, experts say, they should immediately seek high ground, even if there is no tsunami warning.

One close tsunami source — though not the most likely — is the Cascadia subduction zone about 80 miles offshore where the Juan de Fuca plate migrates underneath the North American continental plate. It, too, generated a gigantic earthquake of magnitude 9.1, but that was in 1700.

"Expect the next Cascadia quake to be as large or larger than the Sumatra (Indian Ocean) event," said Steven Ward, a tsunami expert at the University of California at Santa Cruz.

Another close source would be an earthquake generated by the San Gregorio fault about 20 miles off Monterey, Ward said. That fault is part of the boundary between the Pacific and North American plates.

"The San Gregorio fault would be the most likely source for an earthquake close to Monterey," he said, adding that such an earthquake would perhaps leave only ten minutes before the tsunami reaches the coast.

But Gerard Fryer, who models tsunamis at the University of Hawaii, said that while San Gregorio earthquakes probably occur once every few hundred years, they wouldn't cause large tsunamis because they don't generate much vertical motion.

"It wouldn't be hazardous more than a block from the beach," Fryer said.

Landslides in the bay

Underwater landslides could also cause tsunamis close to the Monterey coast.

Monterey Bay harbors an underwater chasm the size of the Grand Canyon. The canyon's steep walls have seen many underwater landslides in the past, said Ward, who is modeling tsunamis generated this way.

"See all these bites?" said Ward, pointing to numerous gaps in the rim of the canyon. "All these are landslides that have happened at some time and they are all over the place."

Ward said most landslides in the so-called Monterey Canyon didn't leave any trace, because underwater currents flushed the material away. This makes it difficult to know how often they occur.

But researchers at Moss Landing Marine Laboratory found evidence of a landslide that happened as recently as several hundred years ago 30 miles south of Monterey, about a mile off the coast. The

landslide probably started on land when material broke off high in the mountains on land and then slid into the ocean, said H. Gary Greene, a marine geologist at Moss Landing who was involved in the research.

"We suspect there are other (landslides) down there as well," Greene said.

But Ward said most landslides are likely caused by earthquakes, so as long as people immediately seek higher ground in case they feel an earthquake, they should be safe.

Dan Miller, a resident of Pacific Grove, said that as long as people remember the recent Indian Ocean tsunami, people know what to do once a tsunami strikes. But that, he said, creates a new problem: it could make it more difficult to leave the coast in case there is a tsunami.

"Getting out of Pacific Grove would be a nightmare," he said.

It was just 10 years ago when many people in and around Monterey did just the opposite.

"Tsunami Watchers Disappointed," read a headline in the Watsonville Pajaronian on Oct. 5, 1994, the day after a tsunami warning for the West Coast when many people went to the beaches to watch. Fortunately, the tsunami, generated by a magnitude 8.1 earthquake near Russia's Kuril islands, measured only about 3 feet once it reached the coast in Crescent City.

In Monterey, dozens, if not hundreds of people went to the beach to see the tsunami, Miller

said.

"I thought it was pretty amazing that people could be that ignorant. I guess people had forgotten what had happened in Alaska years before," he said, referring to the tsunami generated by an Alaskan earthquake in 1964 that killed 16 people in California, most of them in Crescent City.

The best tsunami warning system is useless if people don't know what to do, said Ward. "The last link in the chain is the man in the street."

Local measures

To improve tsunami preparedness, many West Coast communities already have signs indicating tsunami danger zones and what to do in case there is a warning. Some also use sirens to warn people. Monterey County uses neither signs nor sirens.

County officials met Jan. 21 to discuss how to improve tsunami preparedness. Kyle Oden of the county's Office of Emergency Services said the county is working on updating maps to indicate which areas must be evacuated in case of a tsunami.

The officials also discussed whether Monterey County should become a TsunamiReady community. That is a voluntary program under the National Weather Service, with promised funding from the federal government. It establishes certain preparedness requirements for communities — such as street

signs and certain ways to communicate warnings to the public.

Now Monterey County uses the Emergency Alert System, said Harry Robins of the Emergency Services office. However, that system only notifies people who are watching TV or listening to the radio. All others, he said, could be notified by police and fire officials who would use the loudspeakers on their vehicles. Sirens, which cost \$35,000 each, are another option, Robins said.

People who don't want to wait until sirens are installed can sign up for a free service called Emergency Digital Information System, said Sheryl Tankersley, a spokeswoman for the State Office of Emergency Services. The system alerts people via pager if there is a tsunami.

Improving tsunami detection

Even if people know what to do after a tsunami warning, they will probably take such alarms less seriously if they are too often false. That was the case in 1986 and 1994 in California.

"Aleutian quake sets off false tsunami alarm," read a headline in *The Herald* on May 8, 1986. The day before, officials had issued a tsunami warning for Hawaii and the West Coast after a 7.7 magnitude earthquake struck near the Aleutian Islands.

The evacuation of low-lying coastal areas in Hawaii and the West Coast was recommended. The warning was later called off once the tsunami turned out to be small.

A similar earthquake struck 17 years later in the same

region. But this time, on Nov. 17, 2003, officials didn't issue a tsunami warning, nor did they order any evacuations. The National Weather Service was operating three buoys off the Aleutian Islands that measured a tsunami wave only about an inch high. Authorities concluded from this data there was no tsunami danger, and the forecast turned out to be correct.

"November 17 was the first time a warning was not issued because of the buoy readings," said Delores Clark, a spokeswoman for the National Oceanic and Atmospheric Administration.

Currently, six such buoys are deployed in the Pacific, all operated by NOAA.

The Bush administration last month said it plans to add 25 such buoys in the Pacific and seven in the Caribbean by mid-2007. The buoys cost about \$250,000 apiece and \$50,000 annually to maintain.

"The benefit of these buoys is that they do reduce the false (alarms)," John Marburger III, science adviser to the president, said on the day of the announcement, Jan. 14. Congress is expected to approve the funding.

The buoys are close to earthquake-prone areas to give authorities enough time to issue a warning before the tsunami reaches the coast. It can take a tsunami generated in Alaska more than five hours to reach the California coast. The three buoys off the Aleutian Islands are meant to provide warnings for those tsunamis.

The 25 new Pacific Ocean buoys are going to protect against tsunamis from other earthquake sources, such as Russia or Japan, that aren't currently covered.

How the buoys work

The buoys measure wave height, which is key, since not every earthquake causes a tsunami, experts say. Earthquakes have to move the ground under water in a vertical direction to cause a tsunami, said Ward, of UC-Santa Cruz.

In the open ocean, potentially dangerous tsunamis are often only a few inches to 3 feet high, while their wavelength can measure more than a hundred miles, Ward said. As a result, they are not noticeable by people on a ship in the open ocean, even though they move at the speed of a jetliner. But tsunamis slow to about 30 mph and grow severalfold once they near the coast, said Ward.

The buoys receive data from nearby pressure recorders at the ocean bottom. The recorders measure changes in water pressure so small that they correspond to changes in water level as little as a half-inch, said Christian Meinig, an engineer with the Pacific Marine Environmental Laboratory in Seattle who was involved in developing them.

Such precise measurements are only possible because tsunamis, unlike regular waves, reach all the way down to the seafloor, Ward said. The pressure recorders aren't disturbed by wind-generated waves, which don't reach very far below the surface. Once the bottom pressure recorders measure a difference of more than about an inch from the expected wave height, they send an alarm to the surface buoy floating nearby which in turn sends the alarm to a satellite. The satellite sends the data to the tsunami warning centers in Ewa Beach, Hawaii, and Palmer, Alaska, which is in charge of the West Coast

The warning centers combine the tsunami wave height data with seismic and tide gauge data. They feed the information into computer models to simulate the way the tsunami waves will spread across the ocean.

Buoys not operational

But while the buoys are considered the gold standard in tsunami protection, they aren't always functioning.

Fryer at the University of Hawaii said he is concerned because two of the three buoys off the Aleutian Islands are currently not operating.

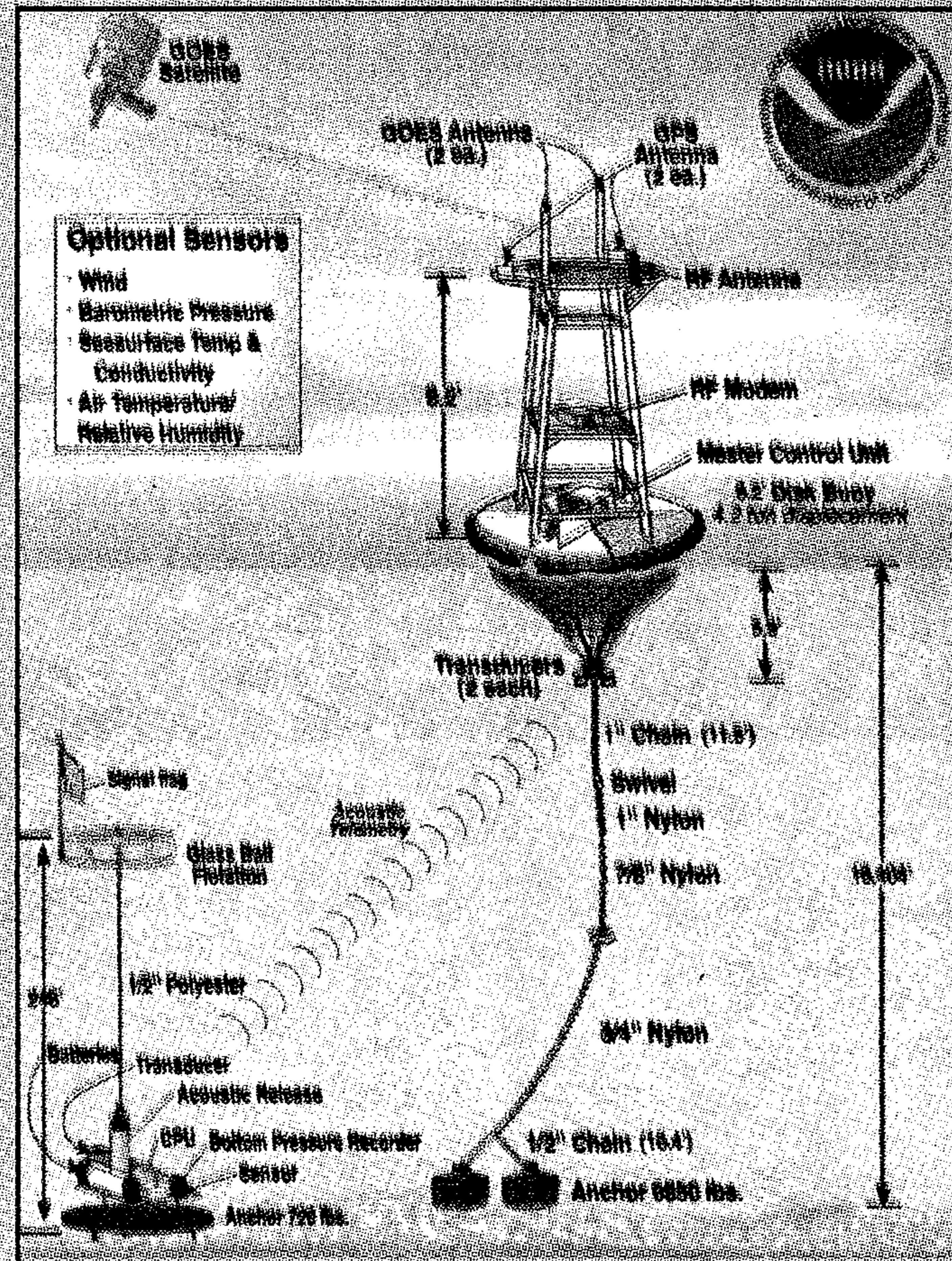
"It's a little unnerving," he said, adding that if there was an earthquake off the Aleutian Islands, Hawaii's safety would depend on just one buoy.

The National Weather Service said the two buoys are being repaired, a process sometimes hampered by severe weather conditions.

Even when additional buoys are deployed by mid-2007, they won't be able to protect against all possible tsunami sources, experts say. Buoys are useless if a tsunami is generated close to the coast, because it leaves too little time for people to seek high ground.

How the buoys detect tsunami waves

Pressure recorders on the ocean floor measure tiny changes in water pressure. If the changes correspond to a change in wave height of greater than about an inch, the pressure recorder sends an alarm to the buoy floating nearby. The buoy sends the alarm to a satellite, which notifies tsunami warning centers.



Proposed tsunami protection system

Six buoys that can detect tsunamis are currently deployed close to earthquake zones in the Pacific Ocean. The Bush administration plans to add 25 in the Pacific and seven in the Caribbean by mid-2007.

