PARADISE LOST: If a Tsunami Strikes the Orange County Riviera . . .

SUMMARY

Someday in the lifetime of today's toddlers building sandcastles on the beach, a tsunami may strike Orange County's 42-mile coastline, causing property damage and loss of life.

In the worst-case scenario envisioned by the county's emergency managers, a 32-foot high wall of water would storm across the sand and slam into densely populated beach communities. Its force could destroy buildings and turn cars and debris into dangerous projectiles. Surging and receding waves could wash out roads and bridges, and even cut new channels to the sea. Many lives may be lost, most due to drowning, with children and the elderly being the most vulnerable.

The 2007-2008 Orange County Grand Jury investigated the county's readiness for a tsunami. It concluded that beach communities here—thanks to the cities' emergency managers—are probably better prepared for a tsunami than communities along any other comparable stretch of California coastline. Their planning has resulted in new tsunami signs, inundation maps and public education.

Sign in Seal Beach

The Grand Jury found that these commendable efforts still fall short of what is required to adequately inform the public—especially tourists—of a tsunami hazard and how to respond. Existing signs are small, difficult to read from passing cars and may go unnoticed. Inundation maps are inconsistent from agency to agency. Public education largely overlooks visitors who, on summer days at the beach, may outnumber residents.

To reduce potential casualties sustained in a rare but dangerous tsunami, the Grand Jury recommends better signage and warning systems—and relentless public education for both residents ***and*** visitors.

REASON FOR INVESTIGATION

On December 26, 2004, in possibly the worst natural disaster of the modern era, a magnitude 9.3 earthquake off Sumatra unleashed a tsunami that killed more than 200,000 persons around the Indian Ocean. On June 14, 2005, following a 7.2 earthquake off Northern California, a tsunami warning was issued for the California coast including Orange County. The result was mass confusion. Some residents, heeding a televised warning to evacuate, were trapped in traffic congestion. The warning was soon cancelled and the small tsunami came ashore unnoticed. This tiny tsunami, reported the Associated Press, "exposed just how unprepared the region was to the threat."

The Grand Jury wanted to know: Is Orange County ready for a tsunami?

METHOD OF INVESTIGATION

The Grand Jury searched the internet websites of news publications, professional journals, and those institutions and government agencies studying tsunamis. Grand Jurors visited each of the county's coastal communities and conducted face-to-face interviews with emergency management staff. Tsunami emergency plans for the county and four of the six beach cities were reviewed. Two lectures on tsunamis and one on earthquakes were attended as was an American Red Cross disaster preparedness academy.

BACKGROUND AND FACTS

A tsunami is a series of large waves generated by an underwater earthquake or landslide, volcano eruption or meteor strike.

Once unleashed, tsunami waves travel across the ocean at 450 to 600 miles per hour. Spread out, they may pass unnoticed beneath ships at sea. Nearing the coast, the waves slow and begin to pile up. By the time they hit land, tsunami waves can reach great heights—the 1883 eruption of Indonesia's Krakatoa Volcano caused a 130-foot high tsunami—and strike with deadly force at 30 to 40 miles per hour, faster than victims can run. These waves can knock down buildings, turn cars and debris into battering-rams and run up bays and rivers to inundate inland areas. Tsunamis have carried ships and barges as far as a mile inland. In harbors, tsunamis cause destructive sloshing that can last for hours—*tsunami* is Japanese for harbor wave. The surge and withdrawal of succeeding waves can undermine roads, foundations and even cut new channels to the sea. Waves just waist high can knock adults off their feet and sweep them away.

Tsunamis are unpredictable. They may announce their approach by drawing water out to sea before rising up and striking the beach. Or, they may surge onshore without warning. Most tsunamis are associated with large underwater earthquakes with magnitudes of 7.5 or greater, though a smaller earthquake could trigger a submarine landslide to cause a tsunami. To generate a tsunami, an earthquake must violently lift or drop the sea floor and displace huge amounts of seawater to send a tsunami radiating out like ripples in a pond.

The National Weather Service operates a system of buoys throughout the Pacific Ocean that detects tsunamis as they cross the ocean. Launched in 1946 after an Alaskan earthquake spawned a tsunami that killed dozens in Hawaii and Northern California, this system now consists of 110 buoys, with nine installed in the last decade that transmit real-time sea-level data. Once a tsunami is detected, the National Weather Service's Alaska Tsunami Warning Center will issue warnings to the West Coast.

The amount of warning time given to coastal populations depends on where the tsunami originates. A "distant tsunami" generated across the Pacific Ocean would allow several hours warning. But a "regional tsunami" generated in mid-ocean may permit only 30 to

60 minutes warning. A "local tsunami" generated off the California coast could strike the shore in minutes, with possibly the only warning being a violent shaking of the ground.

It is this locally-generated tsunami that causes the greatest concern.

The Sleeping Danger Offshore

"Natural hazards that are less frequent tend to be ignored"
--USC Professor Costas Synolakis

State agencies estimate that Orange County is at "moderate" risk of a tsunami.[1] In 1855, two large waves surged up San Juan Creek. In 1877, an earthquake in Chile sent a three-foot high wave into Anaheim Bay in Seal Beach. In 1934, Newport Beach reported a wave 9.8-feet high that injured four persons, destroyed several cottages on Balboa Peninsula and washed away pavement, isolating some residents. In 1964, a tsunami caused by a 9.3 earthquake in Alaska sent a four- to five-foot high surge into Anaheim Bay-Huntington Harbour.

Recently, scientists at the University of Southern California's Tsunami Research Center have found geologic evidence that large tsunamis have struck Southern California's coast in the prehistoric past.[2] Moreover, they concluded Orange County's offshore geology could trigger tsunamis at any time.

Sign at Balboa Pier, Newport Beach

The continental shelf off Orange County mirrors the land above with underwater mountains, deep canyons, earthquake faults and unstable landslide areas. Newly discovered thrust faults and even some strike-slip faults could violently lift the seafloor to trigger a tsunami. Thrust faults do so by pushing one side of the fault up over the other. With strike-slip faults, one side slides past the other to cause violent shaking but usually no tsunami. But bends in a strike-slip fault that lock the fault in place could lift the seafloor when broken by an earthquake. USC researchers believe that uplifting at restraining bends created Catalina Island and the Palos Verdes Peninsula.[3] They are concerned that a restraining bend on an 80-mile section of a fault along the western side of Catalina Island could produce a magnitude 7.6 earthquake and send a six-foot high tsunami crashing onshore in minutes.

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[1] "Local Planning Guidance on Tsunami Response," Governor's Office of Emergency Services

[2] Lecture by geologist Mark Legg, Ph.D., on "Tsunami: Hazards from Slip-Strike Faults & the South Coast Thrust" to the Anaheim Community Emergency Response Team meeting at the Anaheim Emergency Operations Center, October 9, 2007. His talk was based on his own research and the report in the following footnote.

[3] "Evaluation of Tsunami Risk to Southern California Coastal Cities," by Mark R. Legg, Jose C. Borrero and Costas E. Synolakis, 2002 NEHRP Professional Fellowship Report, January 2003.

Deep canyons off Orange County are prone to landslides like those onshore. These landslides also could send a tsunami toward the coast. Recent offshore mapping, according to the professional journal *Civil Engineering*, found that a potential landslide site off Palos Verdes Peninsula could send a 15 to 60 foot wave ashore in less than a minute with a devastating impact on structures and the economy.[4]

The Orange County Sheriff Department's Emergency Management Bureau, which supports and helps coordinate local disaster planning by the cities, cited a probability study in its tsunami response plan on the likelihood of a tsunami striking the coast. This study found that Orange County can expect a four- to nine-foot high tsunami every 100 years and a seven- to 16-foot high wave every 500 years.

Consulting with scientists and citing field studies and inundation maps, the Sheriff Department arrived at its worst-case scenario: a tsunami wave 10 meters or 32.81 feet high. [5]

The Tsunami Threat in Perspective

> *"Low probability, high consequence"*
> *--One emergency manager's tsunami mantra*

Scientists make a distinction between tsunami **risk** and **exposure**. The risk of a tsunami striking the Orange County coast is low to moderate. But the county's exposure to possible death and destruction from a significant tsunami is enormous.

Thousands of residents now live in densely populated coastal areas vulnerable to a tsunami. The low-lying beach cities from Newport Harbor to Seal Beach lie partially on the deltas of rivers long-ago channeled and contained. From Corona del Mar in Newport Beach south to San Clemente, the exposure is limited due to their high coastal cliffs, although all of these cities have some small areas vulnerable to a tsunami.

In addition to permanent residents, this Riviera-like paradise attracts tourists from around the world. These visitors are both a burden on public services and a benefit to the economies of these beach cities. The Sheriff Department estimates that visitors on warm summer days can swell the county's coastal population by as many as 500,000.

The damage from an offshore earthquake may obstruct exit routes, thus compounding the hazard posed by the subsequent tsunami. The earth's shaking and possible liquefaction—when the sandy soil becomes soft mud and buildings sink into it—may bring down

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[4] "Could It Happen Here?" by Jose Borrero, Sungbin Cho, James E. Moore II, Harry W. Richardson, and Costas Synolakis, *Civil Engineering*, April 2005

[5] "County of Orange Operational Area Emergency Plan," Orange County Sheriff Department/Emergency Management Bureau, January 2004, and "Orange County Operational Area: Tsunami Planning Efforts, Tsunami Plan Annex, 2006 Tsunami Exercise, TsunamiReady® Program," Orange County Sheriff Department's Emergency Bureau, July 26, 2007.

buildings, bridges, trees, power lines and poles, thus blocking evacuation routes. Power failures may knock out traffic signals, and broken gas lines may result in fires. Those seeking to escape the tsunami by driving away could find themselves trapped in their cars and exposed to oncoming waves. Several emergency management staffers advised that the best and safest way to escape a tsunami is on foot.

A tsunami disaster would have other devastating and possibly long-lasting impacts. Rebuilding homes, roads and bridges could take months. Critical infrastructure such as sewage treatment plants and distribution systems for water, electricity and natural gas could be out of service for weeks. A key component of the coastal economy—tourism—may take years to bounce back. A tsunami disaster would impact not just the coast but inland cities which may see their own services disrupted as they receive evacuees from the coast and send mutual aid.

Sign on PCH, Laguna Beach

It is the sobering responsibility of Orange County's emergency managers to be prepared for a tsunami.

The O.C. Gets TsunamiReady®

After the 2004 Indian Ocean tsunami disaster, emergency managers along Orange County's coast began meeting to establish a more effective and coordinated response to a tsunami emergency. This effort received even greater urgency when the June 2005 tsunami warning resulted in confusion, miscommunication and, according to the group's minutes, "led to misinformed decisions."[6]

Early on, these emergency managers established as their objectives: 1) coordinating their tsunami planning; 2) preparing more effective tsunami plans for each jurisdiction; 3) developing standardized public education campaigns and messages, and 4) conducting a coordinated, countywide tsunami exercise.

They established as a common goal to have the entire 42-mile Orange County coast designated as TsunamiReady® by the National Weather Service (NWS). The NWS criteria for that designation requires these agencies to have: 1) multiple ways of receiving NWS tsunami warnings; 2) more than one way to pass these warnings on to the public; 3) public education to promote community readiness, and 4) a formal tsunami plan.

If the TsunamiReady® designation is any indication, Orange County's emergency managers have largely accomplished this mission. Of the eight California cities so designated, five are in Orange County: Seal Beach, Huntington Beach, Newport Beach,

[6] Source: Agendas and Minutes of Meetings of the Tsunami Planning Sub Committee of the Orange County Emergency Management Organization, cited in "Orange County Operational Area Tsunami Plan Annex, 2006 Tsunami Exercise, TsunamiReady® Program, Orange County Sheriff Department's Emergency Management Bureau.

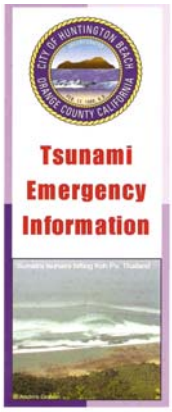
Dana Point and San Clemente. The County of Orange is the only California county designated as TsunamiReady®.[7]

Even so, a tsunami generated just off the California coast will give emergency management staff little time to warn and assist the public in evacuating vulnerable beach communities.

Countywide Tsunami Exercise

On May 4, 2006, emergency planners conducted a countywide disaster exercise coordinated at the Sheriff Department's Emergency Operations Center at Loma Ridge. The exercise assumed a 9.0 Alaska earthquake generated a tsunami that would strike the West Coast five hours later with five- to ten-foot high waves. The exercise focused on testing communication and coordination between 13 county departments, 26 cities, 13 school districts, 11 other local agencies, three state and two federal agencies, the Red Cross and ham radio operators. Emergency management staff interviewed by the Grand Jury said the exercise was a remarkable success.

Public Education



The importance of public education was emphasized in a 2005 report by the California Commission on Seismic Safety. "Californians are not adequately educated about tsunamis and the risk they pose," it said; "consequently, many are unaware how to respond to natural or official tsunami warnings."

Information about tsunamis is now included with information distributed coastal communities on how to respond to potential disasters, such as floods, wildfires and earthquakes. These efforts are largely directed toward permanent residents, not visitors who on warm summer days may outnumber residents at the beach.

Dana Point Refrigerator Magnet

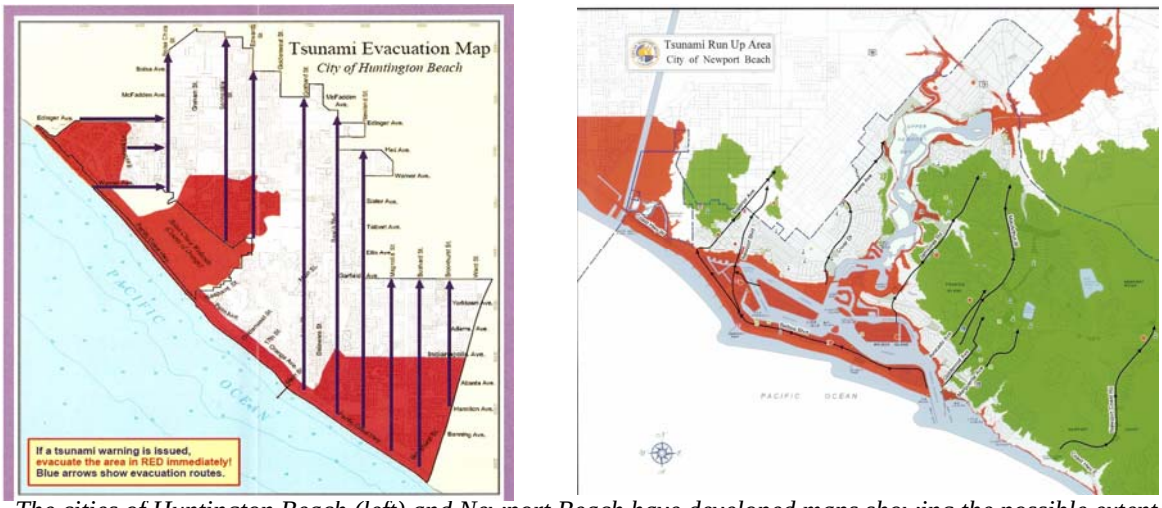
It appeared to the Grand Jury that beach cities make only a minimal effort to inform visitors about the tsunami hazard, primarily through signage. As a result, these visitors may be the least prepared and the most vulnerable to a tsunami. Yet, in the event of a tsunami disaster, these cities will be responsible for the evacuation and rescue of visitors.

Mapping the Tsunami Hazard Zone

[7] "TsunamiReady Communities," www.tsunamiready.noaa.gov/ts-communities.htm

Valuable tools in preparing for the big waves are maps of the tsunami hazard zone, known as run-up or inundation maps. They are based upon the characteristics of the local topography and an estimate of areas that would be inundated by the worst-case scenario, a 32-foot high wave.

The Grand Jury found that maps used by the Sheriff Department's Emergency Management Bureau are dramatically inconsistent with those used by the cities of Huntington Beach and Newport Beach and appear to minimize the threat. Its map for Huntington Beach shows a tsunami hazard zone limited to a narrow strip on the beach



The cities of Huntington Beach (left) and Newport Beach have developed maps showing the possible extent of inundation by a worst-case 32-foot high tsunami.[8] *State maps used by the Sheriff Department's Emergency Management Bureau t show a dramatically smaller impact zone.*

side of Pacific Coast Highway. The City of Huntington Beach's run-up map shows the hazard zone extending more than 2.5 miles inland in places. Emergency managers there estimate that 75 percent of the city lies at an elevation of 25 feet or less. Similarly, the Sheriff Department's map for Newport Beach shows a tsunami hazard zone following a narrow strip along the beach and including most but not all of the Balboa Peninsula. The City of Newport Beach's tsunami map shows the hazard zone covering the entire Newport Harbor area including the Upper Bay. The Sheriff Department responded that its maps are based upon those produced by the State of California Office of Emergency Services. Both sets of maps were produced by eminent scientists but both rely upon different assumptions.

For emergency management staff to effectively coordinate their responses before, during and after a tsunami disaster, they need to work from the same scientifically accurate maps. Failure to do so could lead to confusion and decisions based on misinformation which may unnecessarily jeopardize lives. An effective response to a tsunami requires coordinated maps using common assumptions and a consistent appearance for the county's entire coast.

[8]Source: Websites for the cities of Huntington Beach and Newport Beach.

Signage

Over the past year, new tsunami warning signs began appearing at the beach and along roadways in all Orange County coastal communities. The Grand Jury believes the placement of these signs in the tsunami hazard zones represents a bold, significant and laudable step in public education for residents and visitors alike. In at least one city, emergency planners met with chamber of commerce officials to address concerns about the effect of the tsunami signs on tourism and property values.

For purposes of consistency and public recognition, the California Department of Transportation—Caltrans—requires that all cities use the same tsunami sign images. The four types of tsunami signs authorized for use on California streets and highways read:

- "Entering/Leaving Tsunami Hazard Zone"
- "Tsunami Hazard Zone—In Case of an Earthquake, Go to High Ground or Inland"
- "Tsunami Evacuation Route" with or without arrows
- "Evacuation Site" with an image of people on high ground above a wave

The Grand Jury observed that only two cities, Seal Beach and Dana Point, utilized "Entering" signs, with most using the "Hazard Zone" and "Evacuation Route" signs.

Most roadside tsunami warning signs are small and difficult to read. These signs, from left, are in Seal Beach, Huntington Beach and Newport Beach.

The Grand Jury found the signs on roadways to be small and difficult to read and noted a great variation from city to city in their numbers, locations and orientation. Letters on the tsunami hazard signs are a fraction of the size of those on "Tourist Info," "Electric Vehicle Charging Station" and other common signs. Caltrans allows cities to use three different sizes of signs: small, medium and large. Large signs are twice the size of the small ones. Almost every Orange County coastal city chose to use the smallest signs, at least initially. No city uses the largest, most visible and legible signs.

The number of signs posted by Orange County's beach communities varies greatly from city to city and appears to bear no relationship to the length of coastline within their

boundaries. To some extent, this may be due to topography such as coastal bluffs. Following is a comparison of the length of coastline within each city (including state beaches) and the number of tsunami signs posted in those cities:

City	Miles of Coastline	Number of Signs in City
Seal Beach	2.0	66
Sunset Beach (County)	1.3	29
Huntington Beach	8.5	122
Newport Beach	6.0	61
Laguna Beach	7.0	6
Dana Point	6.0	42
San Clemente	5.5	33

The Grand Jury also noticed differences in the location and orientation of tsunami signs from city to city. Newport Beach, for example, has no tsunami signs on Pacific Coast Highway (PCH), the county's primary traffic corridor along the coast, while Huntington Beach has 21 tsunami signs on PCH. The orientation of tsunami street signage also reflects markedly different emphases. Visitors driving into Seal Beach, Huntington Beach and Dana Point, for example, will see tsunami signs as they enter the coastal tsunami hazard zone. Tsunami street signage in Newport Beach, primarily evacuation route signs, are directed toward vehicles leaving the city, with none directed at in-bound traffic. Due to these signage problems, visitors in some beach cities may be unaware that they have entered a tsunami hazard zone.

Indeed, the number of tsunami signs, as well as their location and orientation, could be interpreted as an indication of that city's level of commitment to informing visitors of the tsunami hazard.

Warning the Public

To obtain the TsunamiReady® designation, cities must have multiple ways of alerting the public to a tsunami warning. Most Orange County cities rely on issuing these warnings through radio and television, automated telephone calling systems, loudspeakers on police and fire emergency vehicles including helicopters, on lifeguard vehicles and at lifeguard stations, and in some cases through sirens on poles or structures.

In the case of sirens, the Grand Jury questioned their value if people at the beach—particularly non-resident visitors—do not know what the sirens mean. In two beach cities near San Onofre Nuclear Power Station, San Clemente and Dana Point, this is not a problem. For years they have had sirens in case of a nuclear accident and have educated residents to turn on a radio or television for an emergency message upon hearing the sirens. In addition, their sirens have voice public address capability so that verbal instructions can be broadcast to initiate an evacuation. Such is not the case in two other cities that are upgrading or purchasing beach area sirens. Huntington Beach has four sirens in beach areas while Newport Beach plans to install three or four sirens at its

beaches. These sirens lack public address capability, although lifeguards have a public address system on the Huntington Beach pier that can be heard a half mile away. Upon hearing the sirens, residents and visitors there are expected to know to tune their radios to the county's primary emergency alert station, 107.9 FM. Failure to inform beach visitors what the sirens mean could lead to confusion or cause the warning to be ignored.

It is important to note the difference between a "tsunami watch" and a "tsunami warning." A "watch" indicates that a tsunami may occur and that people should get ready to leave. A "warning" indicates that a tsunami has been detected and threatened areas should evacuate immediately. If an offshore earthquake has the potential to send a tsunami crashing ashore in two hours or less, the National Weather Service will issue a warning as a precaution.

Evacuations

Once a tsunami warning is confirmed, all Orange County beach cities plan to order evacuations of their tsunami hazard zones.

Sign in Dana Point

A distant tsunami would give local authorities several hours to warn the public, organize evacuations and even set traffic signals to green lights for departing traffic. Given sufficient time, Huntington Beach and Newport Beach will bring in public transit buses to pick up evacuees at pre-selected pick-up points and take them to evacuation sites on high ground. Emergency management staff in the low-lying, densely populated north coast believe they can evacuate their at-risk populations in three to five hours. Evacuation in south coast cities will be comparatively quick and easy with small populations at risk and short escape routes to high ground.

A regional tsunami with 30 to 60 minutes notice allows time to issue an official warning to the public, but an organized evacuation might not be possible. In fact, most cities plan to order their police, fire and lifeguard personnel out of the hazard zone for their own safety 30 to 60 minutes prior to the tsunami's predicted impact. Police helicopters, however, will continue broadcasting warnings and instructions above the beach throughout the emergency.

A locally generated tsunami that could hit the coast within minutes might not even allow time to issue an official warning. In this case, the Sheriff Department's tsunami plan states, "Local populations at risk should be able to recognize the signs of impending tsunami hazards, such as strong, prolonged ground shaking, and seek higher ground." The survival of coastal residents and visitors will depend on the level of information provided to them through targeted public education as well as their own individual preparation.

Most emergency managers recommend that residents avoid the use of cars and go to high ground on foot. The American Red Cross recommends that people fleeing a tsunami should try to get "100 feet above sea level or two miles inland…on foot within 15 minutes."[9] Using bicycles or motorbikes were other possibilities mentioned to avoid traffic congestion and road blocks. If there is not enough time to leave the threatened area, emergency managers recommend "vertical evacuation;" i.e., go up at least three floors in a tall, sturdy building, preferably one constructed of reinforced concrete. As a last resort, says an official U.S. government document, "climb up a strong tree."[10]

Some question the wisdom of ordering a mass evacuation based upon the worst-case scenario every time a tsunami warning is issued. "A poorly coordinated evacuation can actually put people in harm's way," says the California Seismic Safety Commission. "An evacuation has its risks and should not be undertaken lightly."[11] Frequent evacuations based on small tsunamis or false alarms, some worry, will cause a disbelieving public to ignore warnings. Because of their large populations at risk, Huntington Beach and Newport Beach plan phased evacuations starting with those areas closest to the beach. This suggests that an alternative approach might be to develop a graduated system with different levels or stages of tsunami hazard zones, warnings and evacuations. Because such a change would require considerable discussion at the local, state and national level, the Grand Jury makes no finding or recommendation on this suggestion.

At any rate, residents and visitors should have no confusion when they hear a tsunami warning. They should know exactly what to do—Get to higher ground as soon as possible.

The Local Tsunami and Self-Reliance

In a local tsunami, coastal residents and visitors will be on their own. Self-reliance will be the key to survival.

As is the case for any disaster, every household along the coast should have a plan for dealing with a tsunami. Emergency managers and the Red Cross recommend having a weather radio to keep people informed about weather- and water-related warnings. Residents should prepare "grab and go" bags such as a backpack with necessary supplies, such as food, water, medication and spare eyeglasses. No one should enter the water or attempt to ride the waves. A churning tsunami cannot be surfed. The waves will hurl debris with deadly force, and swimmers and boats may be crushed against buildings.

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[9] "Tsunami," The American Red Cross website, http://www.redcross.org/services/disaster/0,1082,0_592_,00.html

[10] "Surviving a Tsunami: Lessons from Chile, Hawaii and Japan," Brian F. Atwater, Marco Cisternas V., Joanne Bourgeois, Walter C. Dudley, James W. Hendley II, and Peter H. Stauffer, U.S. Geological Survey Circular 1187, revised and reprinted 2005.

[11] "The Tsunami Threat to California," State of California Seismic Safety Commission, December 2005.

In a local tsunami—as in a wildfire—individuals may be required to make split-second decisions with life-or-death consequences. According to San Clemente's emergency plan, a tsunami "may require self-evacuations through areas damaged by the earthquake and at high risk of aftershocks." The Newport Beach website leaves no room for equivocation. "When you hear a tsunami warning, you ***must*** assume a dangerous wave is on its way," the city's website states. "Leave the beach immediately! Move to higher ground or upper floors of buildings. Do not take the time to go to your car."

The better-safe-than-sorry rule applies. In the event of a major earthquake violent enough to make it difficult to stand, residents and visitors in the tsunami hazard zone must assume that a tsunami could strike within minutes. To ensure that they are prepared requires relentless public education directed toward visitors as well as residents.

CONCLUSION

Because of the efforts of its emergency planners, the Orange County coast is probably better prepared for a tsunami than any other comparable stretch of California coast. Developing coordinated, countywide tsunami response plans with new signage and public education tools and activities represents a significant improvement.

The Grand Jury concluded, however, that the information available to visitors and perhaps even to some residents is insufficient to reduce casualties in the event of a local tsunami disaster. The signage is too small and, in some cases, fails to provide adequate notice to visitors entering the tsunami hazard zone. Sirens may be ineffective unless those hearing the warning know what to do, through signage or other means. Public education is largely directed at permanent residents and overlooks visitors. Yet, on warm summer days, visitors may outnumber residents and be at greater risk in a tsunami due to inadequate information about tsunamis.

COMMENDATION AND ACKNOWLEDGEMENTS

The Grand Jury commends the emergency managers for Orange County coastal communities who, following the disastrous 2004 Indian Ocean tsunami, took the initiative and provided the leadership to re-examine local tsunami plans. Their efforts led to the May 2006 countywide tsunami exercise in which representatives of more than five dozen government agencies participated. Thanks to them, Orange County is the most prepared stretch of coast in California to respond to a rare but dangerous tsunami.

The Grand Jury also wishes to acknowledge the cooperation and professionalism of these emergency managers who answered the jurors' many questions quite graciously.

FINDINGS

In accordance with California Penal Code sections 933 and 933.05, each finding shall be responded to by the government entity to which it is addressed. The responses are to be

submitted to the Presiding Judge of the Superior Court. The 2007-2008 Orange County Grand Jury has arrived at the following findings:

F-1. The Sheriff Department's existing tsunami inundation maps are inconsistent with those used by the two largest coastal cities, appear to minimize the threat and could contribute to misinformed decision-making during a crisis.

F-2. Existing tsunami signs along roadways are small, difficult to read and, in at least one city, not visible to visitors driving into the tsunami hazard zone.

F-3. Sirens at the beach without public address capability are ineffective unless beachgoers know what the sirens mean and how to respond to the warning.

F-4. Public education directed at beach visitors is inadequate, making them the least prepared and highest at-risk population in the event of a tsunami.

Responses to findings F-1, F-2 and F-4 are required from:

- City Council, City of Newport Beach
- County of Orange Sheriff-Coroner
- City Council, City of Dana Point
- City Council, City of Laguna Beach
- City Council, City of Huntington Beach
- City Council, City of Seal Beach
- City Council, City of San Clemente

Responses to finding F-3 are required from:

- City Council, City of Huntington Beach
- City Council, City of Newport Beach

A response to finding F-2 is requested from:

- OC Infrastructure (formerly the County Resources and Development Management Department)

RECOMMENDATIONS

In accordance with California Penal Code sections 933 and 933.05, each recommendation will be responded to by the government entity to which it is addressed. The responses are to be submitted to the Presiding Judge of the Superior Court. Based on the findings of this report, the 2007-2008 Orange County Grand Jury makes the following recommendations:

R-1. The Sheriff Department's Emergency Management Bureau: Develop a plan in coordination with beach cities to standardize tsunami maps for the entire Orange County coast.

R-2a. All beach cities and the County on behalf of Sunset Beach: Replace all small and medium sized tsunami signs with the largest tsunami signs authorized by Caltrans.

R-2b. All beach cities and the County on behalf of Sunset Beach: Post the largest tsunami hazard zone signs visible to inbound traffic on major roads and on Pacific Coast Highway if tsunami hazard signs are not already posted there.

R-3. The cities of Huntington Beach and Newport Beach: Establish a means of informing non-resident visitors what the sirens mean and what visitors should do when the sirens sound.

R-4. All beach cities and the Sheriff Department's Emergency Management Bureau: Develop methods to communicate tsunami public education messages to beach visitors.

Responses to recommendations R-1, R-2a, R-2b and R-4 are required from:

- City Council, City of Newport Beach
- County of Orange Sheriff-Coroner
- City Council, City of Dana Point
- City Council, City of Laguna Beach
- City Council, City of Huntington Beach
- City Council, City of Seal Beach
- City Council, City of San Clemente

Responses to recommendation R-3 are required from:

- City Council, City of Huntington Beach
- City Council, City of Newport Beach

A response to recommendations R-2a and R-2b is requested from:

- OC Infrastructure (formerly the County Resources and Development Management Department)

REQUIRED RESPONSES

The California Penal Code specifies the required permissible responses to the findings and recommendations contained in this report. The specific sections are quoted below:

> §933.05(a) For purposes of subdivision (b) of Section 933, as to each grand jury finding, the responding person or entity shall indicate one of the following:
>
> (1) The respondent agrees with the finding.
>
> (2) The respondent disagrees wholly or partially with the finding, in which case the response shall specify the portion of the finding that is disputed and shall include an explanation of the reasons therefore.

(b) For purposes of subdivision (b) of Section 933, as to each grand jury recommendation, the responding person or entity shall report one of the following actions:

(1) The recommendation has been implemented, with a summary regarding the implemented action.

(2) The recommendation has not yet been implemented, but will be implemented in the future, with a timeframe for implementation.

(3) The recommendation requires further analysis, with an explanation and the scope and parameters of an analysis or study, and a timeframe for the matter to be prepared for discussion by the officer or head of the agency or department being investigated or reviewed, including the governing body of the public agency when applicable. This timeframe shall not exceed six months from the date of publication of the grand jury report.

(4) The recommendation will not be implemented because it is not warranted or is not reasonable, with an explanation therefore.