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Storm Damage Assessment for the January 1988 Storm Along the Southern California Shoreline

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INTRODUCTION

DEVELOPMENTS ALONG THE HEAVILY populated coastal segments of southern California and northern Baja California sustained serious structural and flooding damage during the high intensity storm of January 1988. The magnitude and extent of damage was directly related to the size, distribution and duration of the storm waves attacking each segment of coastline, as well as the relative timing of the waves, tides and storm surge. These factors, as well as the meteorology of this fast developing storm event, are discussed in the accompanying papers of this volume.

The purpose of this paper is to catalog the types and extent of damage to coastal structures, including dollar amounts where these are available. The primary source of information for this chronicle is a reconnaissance and photo documentation of the coastline between Malibu and San Diego, conducted by the authors on 19 to 21 January 1988. This survey did not include inspection of offshore facilities, such as drilling rigs or the offshore islands. Survey information was heavily supplemented with published newspaper accounts of the damage. Figure 1 shows a map of the southern California and northern Baja coastline, indicating place names referred to in the text.

The one day duration of the storm of 1988 was relatively short for its' intensity². The resulting damages were therefore relatively minor compared with the El-Niño winter of 1982-83. Except for a few areas, notably Redondo Beach, Huntington Beach and Ensenada, structural damage to coastal property was minor. Widespread cosmetic damage and debris deposition did occur, however.

Our conclusion is that the southern California shoreline is everywhere vulnerable to at least minor flooding damage from high waves associated with coastal storms³. The location of areas vulnerable to severe damage change and depend on the timing and duration of storm wave attack, and particularly on the precise deep water wave approach angle.

STORM DAMAGE COST ESTIMATES

Newspaper reports from various coastal areas were reviewed during the weeks following the January 1988 storm, and these were the primary sources for the cost estimates quoted below. Table 1 summarizes the dollar damage as a function of location. We estimate total property damage from the storm at over \$28 million.

Table 1.
 January 1988 Storm Damage and Cleanup Cost Estimates

Locations	\$ Damage
Ventura	\$ 300,000
Malibu	
Zuma Beach	2,000
Manhattan Beach	1,500
Hermosa Beach	13,000
Redondo Beach	16,000,000
LA-Long Beach	
Seal Beach	25,000
Huntington Beach	4,500,000
Pacific Coast Highway	250,000
Laguna Beach	1,150,000
San Diego	6,700,000

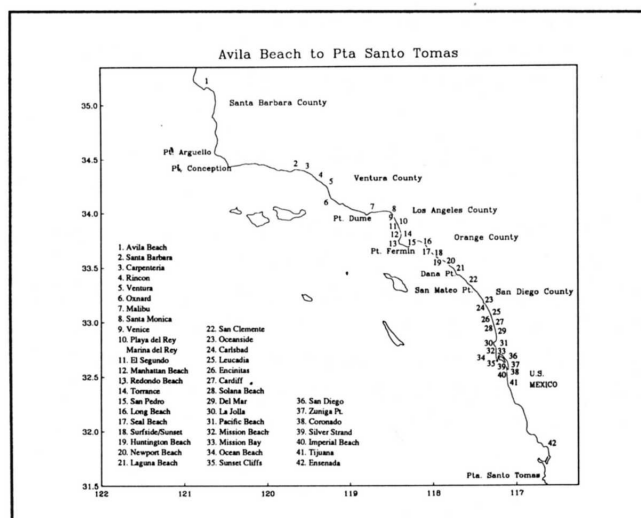


Figure 1. Map of southern California and northern Baja showing place names referred to in the text.

The major effects of the storm were highly localized. The largest concentration of property damage occurred at Redondo Beach where the breakwater was breached and overtopped. A hotel, restaurants, piers and harbor boating facilities were destroyed or severely damaged (Figure 2). A detailed account of these damages is presented by Domurat and Shak¹.

The next largest dollar damage was inflicted at San Diego, where a number of restaurants were flooded and some boats on San Diego Bay were damaged or sunk. In addition, major costs were incurred to clean up kelp and other debris that covered all low lying roads between Oceanside and Imperial Beach.

Huntington Beach suffered costly damage when the seaward 250 feet of the city pier was lost, along with the recently constructed "End Cafe". The breakwater at Ensenada in Baja California was overtopped and damaged. Fishing boats moored in the harbor were washed ashore and some were sunk. No dollar damage estimates were available. No estimates could be made of the dollar value of sand loss to the southern California beaches. The magnitude of beach retreat (and subsequent recovery) is discussed by Domurat and Shak².

STORM DAMAGE BY LOCATION

Santa Barbara and Ventura Counties

As shown in the accompanying papers by Strange et. al and Flick and Badan Dagon (this issue), the storm made landfall at Avila Beach (Figure 1) with record setting low barometric pressure and very strong, gusty winds. The storm moved south-east and inland, exposing the shore south of Point Conception to intense rainfall as well as high storm surge.



Figure 2. Photo showing collapsed roof section of Portofino Inn, located on Mole B, inside King Harbor, Redondo Beach. Hotel guests were rescued off the roof of the damaged structure by a news helicopter on Sunday evening, 17 January 1988.

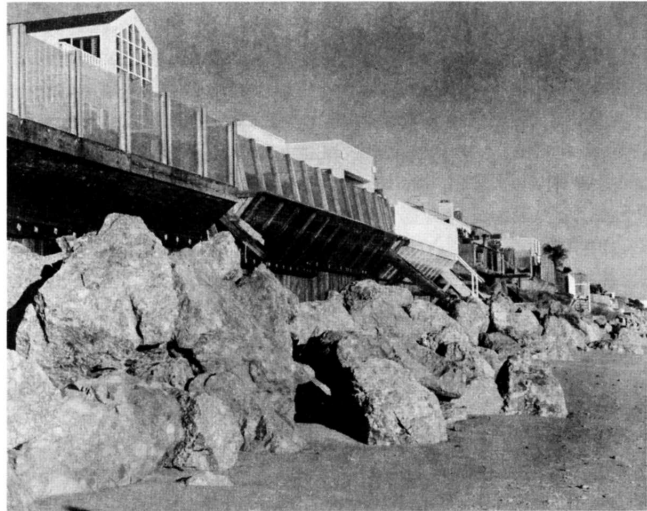


Figure 3. Photo of Malibu Beach showing sand loss and widespread damages to beach access stairs, windscreens and patios. Rock rip-rap protection was placed after 1982-83 winter storm damage.

Minor damage occurred at Santa Barbara Harbor and Sterns Wharf, but little if any erosion was observed at Leadbetter Beach. Damage to boats in the harbor and at the yacht club was largely avoided by moving the boats. Waves broke over the harbor breakwater causing large harbor surge and mooring line tugging, but little damage.

Homes along the shoreline in Carpinteria were damaged when the seasonally maintained, artificial dune was breached. High breakers washed through the gap and inundated the entire back beach, starting the evening of 17 January. Eleven beach front homes along Sandyland Road were flooded, and some sustained foundation damage. Truckloads of sand were transported in to plug the break in the dike, and sand-bagging operations were carried out.

Highway 101 in the Rincon area, from Punta Gorda south to Emma Wood State Beach, was overtopped and covered with sand, cobbles and debris during the storm. The entire reach was closed to traffic from late 17 January through 18 January and campers along the shoreline were evacuated.

Ventura area parking lots, promenade and beach access points were flooded and covered with sand, cobbles and debris. Extreme beach erosion and flooding occurred between Groin # 1 and Groin # 2 upcoast of Greenock Lane, flooding upland homes and destroying the cul-de-sac beach access point. Damage to the groin and the rock rip-rap revetment along the shore of Marina Park was minor. No major structural damage was sustained by the Ventura pier during the storm.

Oxnard Shores beach was overtopped and Mandolay Beach Road was flooded and covered with sand and debris between Fifth Street and Breakwater Way. Wave overtopping and flooding also occurred landward of Capri and Neptune Way.

Los Angeles County

The Malibu area sustained no major damage, in contrast to the damages inflicted during the severe 1982 - 83 winter. However, there was frequent cosmetic damage to beach access stairs, windscreens, beach level decks and other private facilities at the very expensive beach front homes (Figure 3). Breakfast diners fled when a huge wave crashed through the door of Malibu Sand Castle restaurant, flooding the dining room with sand and surf on 18 January. The beach along the west end of Malibu Colony was lowered about 5 - 6 feet and narrowed by 80-100 feet. This is a common occurrence for the south facing Malibu beaches during storms approaching from a southerly direction.

Parking lots and bicycle paths in Santa Monica, Venice, Playa del Rey and Manhattan Beach were overwashed and covered with sand and debris. The Venice Beach Safety Headquarters was flooded. About 90 homeless persons living in tents along Venice Beach were evacuated when wind and surf tore away their shelters. Venice Pier withstood the storm even though waves broke over the end.

Playa del Rey and Dockweiler State Beach were eroded severely enough to expose the root of the Marina del Rey south jetty and groin, as well as about 200 feet of storm drain outfall. The beach area upcoast from the Chevron Groin in El Segundo and the adjacent refinery was cut back 100-150 feet at the upcoast end of the sand fill, with less erosion near the groin. Estimates of sand loss within the groin pocket range from 40-50 percent (Los Angeles County Department of Beaches and Harbors). The beach downcoast of the groin was eroded back to the bicycle path and the rip-rap revetment along the ocean side of the path was damaged at numerous locations. The path was closed for several weeks until debris was removed and the path repaired.

There appeared to be no major damage to the numerous storm drains crossing the beach in the reach south of Redondo Beach to Torrance State Beach, although the beach width was substantially diminished. The walking and bike path between Torrance Beach and Malaga Cove was overtopped and littered with debris, and protective rock was displaced along the seaward side of the path. Royal Palms State Beach and White Point County Recreation Area parking lots were covered with debris and long strands of up-rooted kelp. Pavement at the downcoast end of the Whites Point parking lot was peeled back and washed away.

Cabrillo County Beach, located downcoast from Point Fermin retreated 100-150 feet and lowered 4-5 feet within the cove area. The ocean view parking lot, located near the end of San Pedro Breakwater, and just upcoast of the rock-rubble groin anchoring Cabrillo Beach, was totally destroyed (Figure 4). The parking lot pavement was scoured away and the entire area was littered with rocks and cobble displaced and carried on shore from the rock-rubble revetment.

The San Pedro Breakwater was breached at two locations. The major breach was 285 feet long, located halfway



Figure 4. Photo showing overwashed and destroyed parking lot at Cabrillo Beach located at the western root of the San Pedro Breakwater.



Figure 5. Abrupt end of Huntington Beach Pier photographed 20 January 1988. The seaward 250 feet of pier and "The End" Cafe were washed away Sunday evening 17 January 1988.

between the root and the easterly end adjacent to the ship channel.

Orange County

The beach north of the Seal Beach pier and groin eroded to the parking lot. The 8th Street parking lot was overwashed, covered with debris and had pavement unraveled. The restrooms landward of the parking lot were flooded. Several concrete sheet-piles on the groin were displaced but did not fail. Two pier piles were sheared off and 8-10 cross-members were damaged.

The seasonally constructed artificial dune on the downcoast beach was overtopped and eroded by the high waves, but was not breached. No major flooding occurred between the pier



Figure 6. The trailer park at El Morro Beach suffered extensive damage to pipe pilings that support the trailer platforms. The entire cove area was stripped of sand.



Figure 7. Sections of the main boardwalk at Laguna Beach collapsed after heavy wave surge eroded the sand and undermined piling foundations.

and the West Anaheim Jetty. The Surfside/Sunset Beach area did not have any structural damage to beach front homes, although the outer sand dike, constructed each winter to reduce wave overwash, was breached at numerous locations and was entirely obliterated toward the southern end of Sunset Beach, near Warner Avenue.

Bolsa Chica State Beach was overwashed along its entire length. Restrooms were inundated and floors covered with sand. Pacific Coast Highway from Warner Avenue to the bluff area was closed due to flooding and debris coverage from 17 to 19 January. This particular section of roadway, at the foot of the Huntington Beach bluff area near Golden West Street, has been closed during each recent major storm, due to overwash and flooding. The cost of cleanup in this area was \$250,000.

The most severe damage along the Orange County shoreline occurred at Huntington Beach where the outer 250 feet of the municipal pier were lost (Figure 5). This section had been re-constructed after it had been damaged during the 1982-83 winter. The end section of pier was built 6 or 7 feet lower than the original 1430 feet to conform to construction that had taken place in the re-building of 1940. The current replacement cost is estimated at \$4.5 million. The pier section, along with "The End" cafe, collapsed and was washed away when waves exceeding 18 feet broke over it on Sunday, 17 January. Additional damage was inflicted the next day.

The beach at Newport between the Santa Ana River and the Newport Pier was overwashed. No residences were flooded, but parking lots were covered with sand and debris and the parking area south of the Safety Headquarters was washed away. The Newport Pier sustained only minor damage, while the Balboa Pier had none.

El Morro State Beach mobile home park, located in the cove upcoast of Abalone Point, sustained serious damage during the storm (Figure 6). Numerous units mounted on pipe piling platforms were washed off their mountings. Several of the beachfront decks attached to the mobile homes were uplifted by breaking waves, while the entire cove was stripped of sand.

In downtown Laguna Beach, about 100 feet of the Main Beach boardwalk collapsed after high wave runup scoured the beach below the ends of the supporting piles (Figure 7). Aliso County Beach was eroded back to the parking lot sidewalks and base of the bluff. The concrete walkway and boardwalk were undermined and damaged. The Aliso Fishing Pier, damaged in the 1982-83 storms, received additional damage and was closed during the storm. Wave overwash and debris covered the entire parking area to the Pacific Coast Highway. Scouring occurred at all of the small and medium sized pocket beaches along this stretch of the Laguna coastline to Mussel Cove. Damage to the pier and boardwalk was about \$150,000.

In South Laguna Beach twenty-four beachfront homes were damaged by debris and cobbles carried by the high waves. The majority of the damage consisted of broken windows, flooding and exterior structural damage. Several ocean view homes on Lagunita Drive came close to falling from their bluff-top perches as the high wind driven waves breached the protective seawall along the base of the bluff and began eroding it away. The covered glassed-in patio of one home was ripped away from the main structure and fell halfway down the face of the bluff. More than 20 units in the adjacent Blue Lagoon condominiums were flooded by the ocean waves. Damage to homes and condominiums in this area was around \$1 million.

The Dana Point Harbor jetty was overtopped by huge waves, but all transmitted energy was dissipated in the main entrance channel. No damage was reported to the jetty. In the southern basin several boats were reported damaged from storm surge.

Capistrano Bay County Beach parking lot and restroom area were flooded during the storm. Sand and debris covered the area shoreward of the entrance to the Capistrano Bay Colony. The beach was lowered several feet along the oceanside. The curbing of the parking lot was undermined, although no structural damage to county park facilities was observed. The Capistrano Shores mobile home park took waves over the timber seawall, flooding several homes.

San Clemente City Beach retreated of 75-100 feet at the upcoast end of the beach along Estacion Avenue. The storm berm was only a few feet seaward of the restrooms and concession building (which were destroyed during the 1982-83 storms). Debris and sand were carried beyond the Santa Fe Railroad tracks and partially covered the adjacent parking lot. The beach was eroded to within 50 feet of the tracks. During the peak of the storm waves broke at the end of the San Clemente City Pier, flooding Fisherman's Gallery. The railroad pedestrian underpass at the pier was filled with sand and debris and closed for several days. San Clemente State Beach was overwashed and eroded to the railroad, where sand and debris littered the tracks and street shoreward to the base of the cliffs.

San Diego County

Structural damage was reported in the county in both beachfront and inland areas. The San Diego Port Authority sustained almost \$2 million in damage, split evenly between public and private property. Waterfront homes and businesses had windows shattered in Oceanside and there was flooding in seaside communities south to Imperial Beach. In La Jolla Cove the beaches were void of sand, eroded down to the underlying cobble beach.

In Oceanside, the North Pacific Drive ford over the San Luis Rey River was overwashed and closed through the five day storm period. Numerous shorefront homes, condominiums and motel properties were flooded and damaged by overwash and flying cobbles. Along the central Oceanside shoreline at least three people were injured by flying glass when waves burst through the windows of their homes. The newly reconstructed Oceanside Pier took breaking waves exceeding 20 feet over its' end but was not damaged.

In Carlsbad, the newly renourished beach sand (dredged from Agua Hedionda Lagoon and placed seaward of the Carlsbad Avenue seawall) was carried away during the first high waves on 17 January. The pavement on Carlsbad Avenue at the Agua Hedionda spit was partially stripped off by the wave overwash, and was closed from 17 to 19 January waiting for debris to be removed. The parking area pavement seaward of the main roadway was completely destroyed.

Highway 101 over the Batiqutas Lagoon spit was overtopped, flooded and closed during the storm. The narrow sandy beach along the base of the high cliffs in Leucadia and Encinitas was stripped of sand. Moonlight State Beach in Encinitas was also stripped of sand and the restrooms and

concession stand were flooded and closed during the storm period. The beach access stairs at Swami's Park were damaged by waves which carried away the lower landing.

In Cardiff, wave overwash and flooding closed the Pacific Coast Highway across San Elijo Lagoon spit. The Charthouse, Charlies Grill and the Triton restaurants were flooded (Figure 8). The Fish House West, Pastels and Krake Grill and other restaurants and shops were closed for several days after the storm due to flood damage and subsequent cleanup. The beach fronting the highway was eroded 5-6 feet vertically, uncovering cobbles, concrete and timber piles and other remnants from earlier structures (Figure 9).

At the north end of Solana Beach a house, located on Circle Drive, clings to the edge of a retreating cliff just above Cardiff State Beach. This home has been endangered for

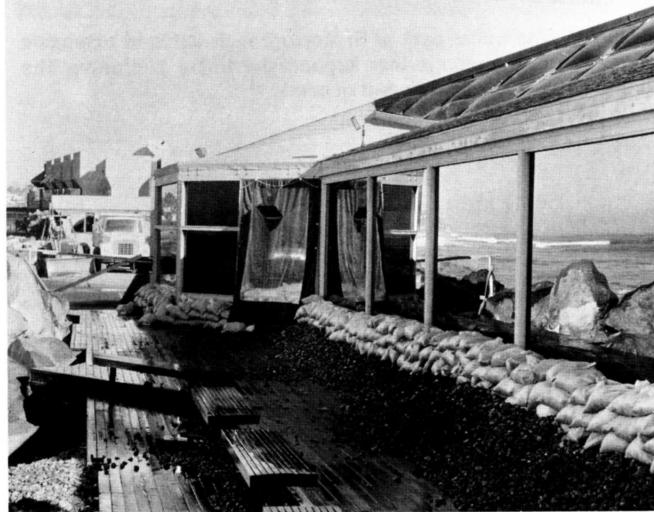


Figure 8. Wave overwash flooded the Chart House and other restaurants in Cardiff and along the shoreline in North San Diego County. Note cobbles thrown shoreward against the building.



Figure 9. North San Diego County shoreline at Cardiff showing bared cobble and bedrock beach stripped of sand. Old pilings and foundations of previous structures are rarely exposed.

several years but the storm of January 1988 increased the probability that the property will be undermined soon.

The high cliff fronting Del Mar Beach and Tennis Club at 825 Sierra Avenue in Solana Beach has continued to erode to within 10 feet of some units.

Along the Del Mar shoreline numerous beach front homes and the Poseidon restaurant were flooded. Jakes Restaurant and the Del Mar Motel survived without severe damage, but numerous businesses were closed during the storm, largely because of extensive flooding along the Coast Highway.

The beach at La Jolla Shores was littered with debris and clumps of kelp that washed up and over the wall along the seaside walk. The beach narrowed along the entire reach from the Scripps Pier to the La Jolla Beach and Tennis Club. The small pocket beaches along Point La Jolla were stripped of sand and received huge deposits of kelp uprooted from the beds immediately offshore. Continued cliff erosion and minor slides, caused by the high waves and rainfall, endangered homes in the Bird Rock area.

The entire Pacific Beach and Mission Beach oceanfront was littered with thick mats of kelp and debris, that required weeks of cleanup effort. Along the reach from Crystal Pier to Mission Bay channel entrance, wave surge and ocean spray, propelled by high sustained winds, overtopped Ocean Front Walk, flooding adjacent homes. The wind shattered large plate glass windows in homes facing the beach. Debris, sand and kelp were carried along the numerous streets and alleys inland to Mission Boulevard.

Off Mission Bay, extremely large waves sheared off the Mission Bay Tower, a local offshore landmark, that was used many years for naval oceanographic research. At the inside of the entrance channel, breaking waves dislodged smaller rocks along the jetty and partially destroyed the revetment on the curved channel section. The waves overtopped the rock revetment, flooding the parking lot and restrooms about 200 feet inland. Reflected waves battered the revetment near Mission Point, overtopping the parking lot and park area, and fracturing piles on the timber baffle across the Quivera Basin entrance. Surge beached some boats in Mariners Basin and damaged moored smallcraft from Ventura Point to Santa Clara Point.

Debris deposition and beach face erosion was noted within Ventura Basin, Santa Barbara Cove and on the Bahia Point spit into San Juan Cove. Debris and kelp were strewn along the entire northern portion of Sail Bay. Debris and some dislodged rocks were noted along the western portion of Vacation Island. Additional damage was inflicted to piers, pile guides, boarding floats and moorings along the shore, including Dana Basin, from Sunset Point, up Mission Channel, to Stony Point and the Vacation Island bridge.

Storm damages at Ocean Beach were similar to those in Pacific and Mission Beach. The seawall fronting the parking lot upcoast of the Ocean Beach Pier, off Newport Avenue, and along Abbot Street was overtopped by breaking waves flooding the streets and depositing debris and kelp.

At Coronado, the south facing stretch of beach from Zuniga Point to the Hotel Del Coronado was overwashed and minor flooding occurred inland to the bathhouses and restrooms. Wave overtopping and minor flooding occurred along the seawall walkway at the Coronado Towers complex. At Silver Strand State Beach, the parking lot and restrooms were flooded and covered with sand and debris, as were large portions of Silver Strand Boulevard.

The entire shoreline of the City of Imperial Beach was inundated by high waves. Waves overtopped the beachfront boardwalk and parking lot at the foot of the Imperial Beach fishing pier. Wave overwash flooded the Surfside Motel and parts of Ocean Lane. The central city beach receded back to the rock revetted, timber seawall. Wave damage and flooding occurred at numerous apartments and homes.

In San Diego Bay, historic ships moored at the Maritime Museum along the Embarcadero were battered by high winds and storm surge during Sunday night, 17 January, as winds reached 65 mph with gusts greater than 80 mph. Many private boats anchored in the live-aboard area from Laurel Street along the Embarcadero near Lindbergh Field were torn from their mooring's and battered against rock-rip bank protection at the promenade. Other boats sank at their anchorages along the shoreline off Harbor Island and Shelter Island.

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