EROSION AND ACCRETION WAVES FROM OCEANSIDE HARBOR

Douglas L. Inman and Scott A. Jenkins

Center for Coastal Studies
Scripps Institution of Oceanography
La Jolla, California 92093

ABSTRACT

Coastal structures that interrupt the longshore transport of sand along beaches cause erosion. The erosion "event" travels downcoast as an erosion wave with speeds of about 2 km/yr (1.2 mi/yr). Alternatively, the placement of large quantities of dredge spoil on the beach, and the natural deposition of flood deposits from rivers, initiate accretion waves that also travel downcoast. The presence of erosion/accretion waves traveling down the coast causes local cycles of erosion/accretion on downcoast beaches.

TEXT

Oceanside Harbor is built on the sandy coast of the Oceanside Littoral Cell. It is about midway along the cell which extends for 90 km (56 miles) from Dana Point to Point La Jolla, California. On the average, the net littoral transport of sand along the coast is southerly at a rate of 200,000 m^3/yr (260,000 yd^3/yr). A description of the cell and its sediment transport rates is given in Inman (this conference) and Inman and Jenkins (1983).

The antecedent harbor began with construction of the Del Mar Boat Basin and its jetties in 1942. There have been six significant modifications and enlargements since then, leading to the present harbor, essentially as shown in Figure 1. The original construction and two of the six enlargements have made major impacts on the downcoast beaches. The latter are the 1957/58 extension of the north breakwater and the dredging of the extended harbor in 1962.

The 1942 breakwater intercepted sand, causing a fillet beach to form upcoast while the jetty formed a rip current that carried sand seaward beyond the surf zone. This phase of harbor construction produced a downcoast erosion wave that had proceeded over 4 km downcoast by 1950. This is shown in Figure 2 by the comparisons of the 1934 and 1950 surveys. It is to be noted that the actual erosion from the harbor is more extensive than shown in the figure because large volumes of sand were supplied to the coast by the March 1938 floods on the Santa Margarita and San Luis Rey Rivers.

The north breakwater at Oceanside was extended 2300 ft to its present position in 1957/58. The configuration of the north jetty produces high transport rates and strong rip currents for waves approaching from the northwest as shown in Figure 1. The central portion of the jetty nearly parallels the crests of waves from the northwest, producing a steep slope and strong currents. This relation produces a maximum transport of sand at this point because the transport rate increases with increasing slope (White and Inman, 1985).

The rip current causes sand to be deposited offshore of the southern portion of the north jetty and out to depths in excess of 10 meters (33 ft.). 1,209,000 m^3 (1,580,000 yd^3) of sand was deposited by rip current action between 1942 and 1950. An additional 815,000 m^3 (1,065,000 yd^3) was deposited offshore between 1950 and 1972 (Inman and Jenkins, 1983).

In 1954 3.1 million m^3 (4.0 million yd^3) of sand was deposited on the beach outside of Agua Hedionda Lagoon, 9 km (5.6 mi) downcoast from Oceanside Harbor (Shaw, 1980). The lagoon was dredged so that it could be used as a settling basin for the cooling water intake for the Encinitas Power Plant.

During 1962 2.9 million m^3 (3.8 million yd^3) of dredge spoil was placed on the beaches south of Oceanside Harbor. This material was from the dredging of Oceanside Small Craft basin, and marked the beginning of periodic sand nourishment for the beaches of south Oceanside. Prior to 1958 material dredged from the harbor was used as inland fill (Inman and Jenkins, 1983). The large amount of material placed on the beach during 1962 produced the first significant accretion wave in the harbors near-field since the harbor was built in 1942. A minor flood on the San Luis Rey River in February 1969 supplied about 300,000 m^3 of sand to the coast (Brownlie and Taylor, 1981).

The beaches downcoast from the Oceanside Harbor have not been monitored systematically. Surveys by the U.S. Army Corps of Engineers extended

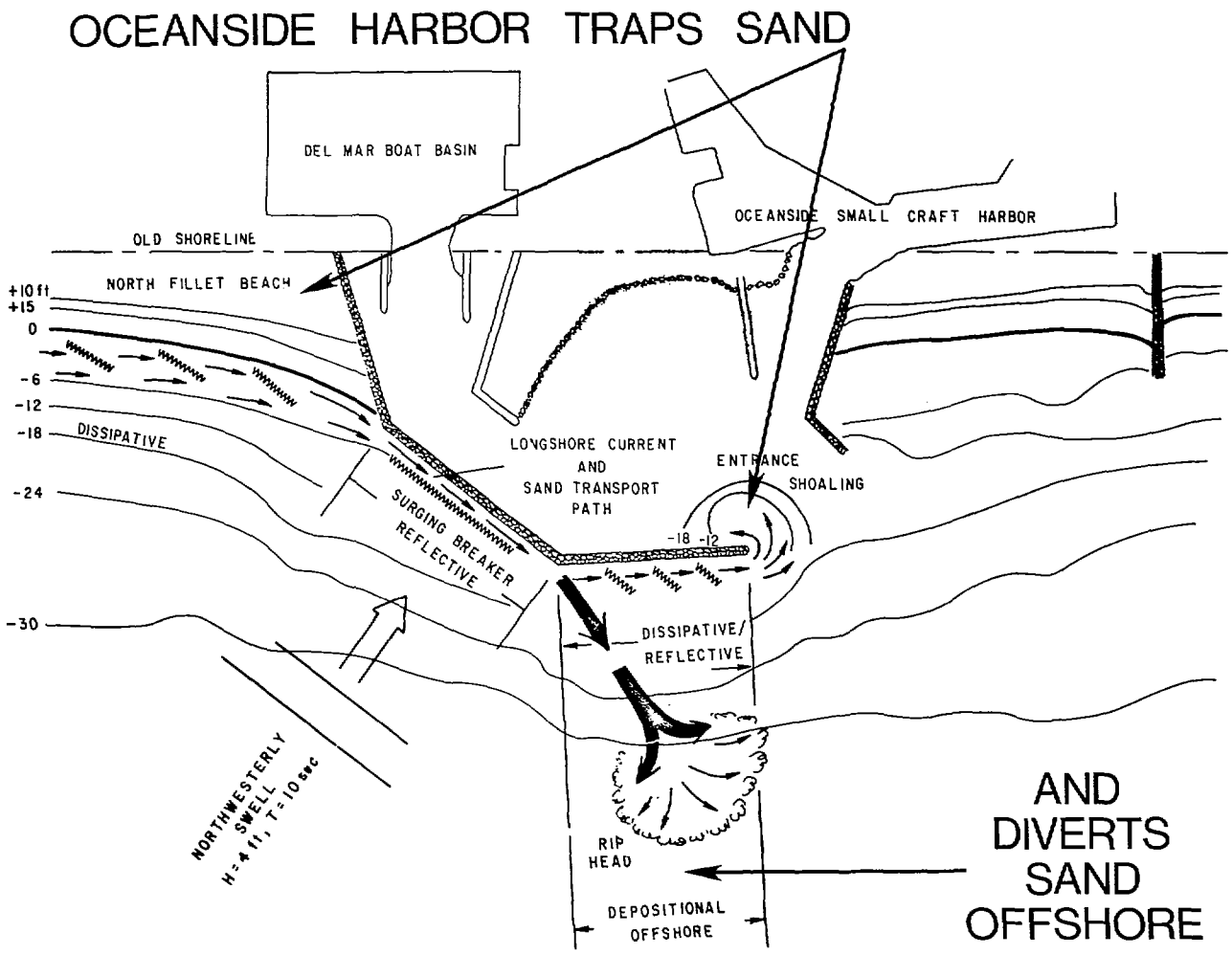

Figure 1. Formation of a rip current and the offshore deposition of sand caused by the Oceanside Harbor (from Inman and Jenkins, 1983).

downcoast about 11 km (7 mi) in 1950 (e.g. Figure 2), and about 7 km (3-1/2 mi) in 1972 (Inman and Jenkins, 1983). Beaches at Del Mar 29 km (18 mi) downcoast from the harbor were monitored from 1974 through 1983 (Waldorf and Flick, 1983). The beach at Torrey Pines, 34 km (20 mi) downcoast was monitored each winter from 1960 to 1973. Detailed and frequent beach surveys were made at a different location on Torrey Pines beach for a period of two years from June 1972 to May 1974 (Nordstrom and Inman 1975). The time span of the 1972/74 surveys was insufficient to aid in determining the arrival of erosion or accretion waves, but did establish that the annual on-offshore cross-shore seasonal migration of sand averaged 92 m^3 per m of beach length.

Thus there appear to have been two erosional events at Oceanside Harbor; its antecedent construction in 1942 and extension of the north breakwater in 1957. The 1942 event shows up clearly as a "near field" event in Figure 2. Downcoast monitoring at Torrey Pines Beach shows erosion beginning in 1971 and becoming extreme by 1973. It would appear that the 1942 erosional event was not observed that far downcoast. Possibly it attenuated and dispersed before reaching Torrey Pines Beach.

However, the 1957 breakwater extension appears as a downcoast erosion wave at Torrey Pines Beach beginning in 1971. This gives a speed for the erosion wave of 2.4 km/yr (1.5 mi/yr).

There were two accretionary events of significance near Oceanside Harbor. The deposition on the beaches at Agua Hedionda Lagoon in 1954 and the dredging of the Oceanside Harbor basin in 1962.

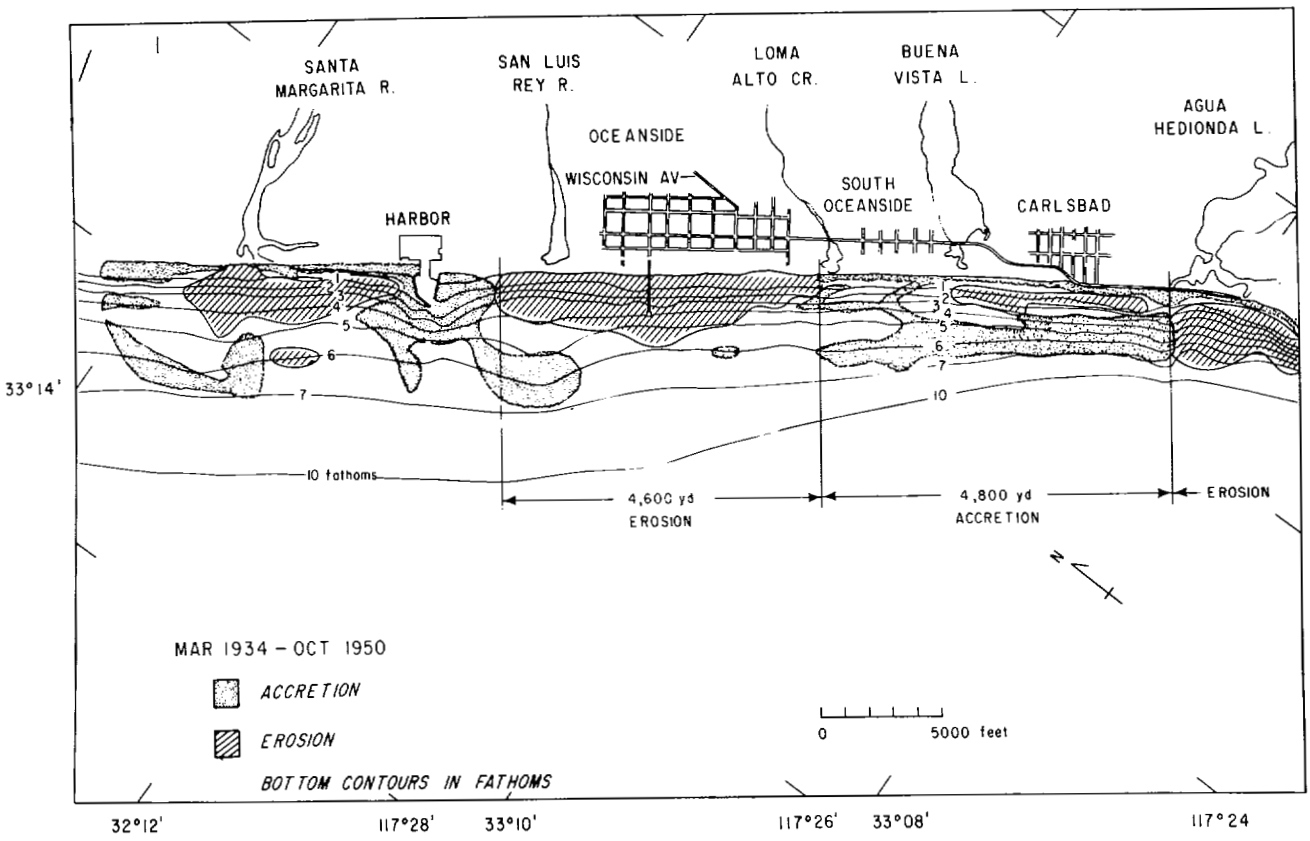

Figure 2. Nearfield cycles of erosion and accretion at Oceanside, California. Erosion, caused by construction of antecedent harbor in 1942, is superimposed on the accretion wave from the 1938 flood on the Santa Margarita and San Luis Rey Rivers (Data from USACE LAD, 1955).

The accretionary wave from the 1954 deposition at Agua Hedionda appears to have reached Torrey Pines Beach between 1960 and 1963. This gives a speed for the 24 km distance between them of between 2.7 to 4.0 km/yr (1.7 to 2.5 mi/yr).

It appears that the 1962 accretion wave had reached Del Mar when the surveys began in 1974. This gives a speed for the 26 km separating these points of $\geq$ 2.2 km/yr ($\geq$1.3 mi/yr). These observations indicate that accretion/erosion waves range in speed from 2.2 to 4 km/yr (1.3 to 2.5 mi/yr) as they travel downcoast from the vicinity of Oceanside.

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