A Different Perspective on the Concept of Planned Retreat

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ABSTRACT

Reflect back for a moment, 20 years ago, when virtually no seawalls existed in San Diego's North County. Man's urbanization of the upland watershed essentially severed the principal source of sand to this county's beaches, causing a sand deficit and triggering accelerated coastal erosion. Seawalls were constructed in response to this loss of sand and removal of those seawalls will not bring the sand back. In the ensuing 20 years, the only thing that has occurred is additional urbanization within the upland watershed and the more effective severing of any upcoast sediment supply. It is important to emphasize that the beaches in San Diego's North County did not disappear because seawalls were built. The opposite is true: seawalls are needed because the beaches disappeared.

In recent years, the environmental community is now blaming seawalls for all of San Diego County's shoreline problems. Environmental groups are now stating, "Seawalls and other types of shoreline armoring deprive the beach of sand and can narrow it until the beach is inaccessible ." Proponents of the recently authored Assembly Bill 2943, intended to limit future seawall construction in California, propose that "this amendment will close loopholes in the Coastal Act that have allowed reckless armoring of the California coast. With increased population and shoreline erosion, Californians need an improved policy on coastal erosion."

There is a fundamental flaw in this logic. However, this environmental plea to the masses has definite curb appeal. Those that would propose that we do nothing and return to nature to let the "shoreline heal itself" essentially guarantees a vision for the California shoreline of planned neglect, unplanned retreat, devastation of coastal property values, and a serious trashing of the state's $15 billion coastal recreational resource.

In many areas of Southern California, there is today little to no sandy beach, essentially eliminating lateral access and significantly degrading the recreational experience that all Californians and the millions of beach-going visitors at one time enjoyed. Although the environmental community would argue to the contrary, in the absence of a proactive plan, and assuming no future seawalls and no future significant beach renourishment projects on the immediate horizon, there will continue to be a total absence of any sand beach, and there will never be any lateral access along much of this state's coastline, nor any recreational beach to enjoy. Moreover, coastal

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erosion will continue unabated, with Southern California's coastal bluffs releasing sediment at a rate that is several orders of magnitude less than the available sediment transport capacity that the waves have to carry the sediment away. What this means is that, even as erosion continues and sea cliffs collapse and the upper bluffs retreat, eventually undermining structures, there will never be any sand on the beach. The unfortunate reality is that the healthy, recreational resource envisioned by the environmental coalition, i.e., the wide sandy beach, which would provide greater recreational opportunities resulting in increased beach use and economic benefits to the State of California, is only possible with artificial beach replenishment, not the elimination of seawalls.

CALIFORNIA'S BEACHES

California's beaches define our quality of life, and they generate over $15 billion annually in tax revenue. California's beaches are its most popular recreational destination, with over 550 million visitors in 1995, 85 percent of whom were non-coastal residents (State of California, 2002). To quote from the state's January 2002 Beach Restoration Study, "the state's beaches provide California with an enriched quality of life, worldwide recognition, and unparalleled tourist opportunities for economic enhancement."

Fig. 1. San Diego's Mission Beach

Figure 1 shows San Diego's Mission Beach. Undeniably San Diego County's most popular recreation beach, a beach that was stabilized in 1950 by the construction of the Mission Bay Entrance Jetty and the subsequent placement of over a million cubic yards of sand associated with the dredging of Mission Bay.

COASTAL HAZARDS, IMPACTS & RETREAT

This conference session addresses the hazards, impacts, and retreat of this state's coastline, and this paper focuses on the erosion of San Diego County's coastal bluffs and the sandy beaches that at one time fronted many of these coastal bluffs.

One of the hazards affecting Southern California's coastal bluffs is those relatively infrequent large waves often associated with El Niño storms.

In the absence of a healthy sand beach, these large waves impact our coastal bluffs, and these coastal hazards quickly start to impact the quality of life for those living atop those coastal bluffs, as well as the beach-going public that recreate on these beaches.

The real hazard, however, adversely impacting a significant portion of Southern California's coastline is the many people that now live in this state's coastal watershed. Over 80 percent of Southern California's residents live on the west side of the coastal range, with all of this urban development clearly impacting the sediment supply to this state's beaches.

It has been said that seawalls deprive the beaches of sand. The facts prove otherwise. There is no question that San Diego's North County beaches' loss of sand is the result of extensive urbanization of the coastal watershed, the construction of dams and flood control facilities, the relatively effective elimination of sediment production within the watershed, and the extensive mining of the alluvial sands from the lower reaches of the county's rivers, all of which has effectively severed the natural supply of historical sediment to the littoral zone. These conflicting societal interests, presumably for the benefit of the citizens of Southern California, have proven to be to the detriment of Southern California's coastal resources.

Although dam construction in San Diego County has effectively severed over 60 percent of the County's 3,849-square-mile watershed (Nordstrom and Inman, 1973) from the littoral zone, more troublesome is man's exhaustive sand mining activities in the lower reaches of Southern California's major rivers to enable the many construction activities that we as a state embrace. In the 52-mile-long Oceanside Littoral Cell today, there is a 30 million cubic yard sand deficit. Yet, in the last 60 years, sand mining alone in San Diego County, almost exclusively downstream of the county's dams and reservoirs, has removed over 100 million cubic yards of beach quality sand originally destined for the county's beaches.

There has been much discussion of the cumulative impacts of seawall construction. But what of the cumulative impacts of development within the upland watershed? The wholesale elimination of littoral sands reaching much of Southern California's beaches has had a significant cumulative environmental impact on this coastal resource.

The environmental community continues to blame seawalls for all of this state's shoreline problems. However, the facts would indicate otherwise. California, and Southern California in particular, has been one of the most studied coastal environments in the world. The U.S. Army Corps of Engineers' Coast of California Storm and Tidal Waves Study Reports probably represent one of the most comprehensive compendiums of coastal knowledge in any area, and countless other studies of the California coastline, from the universities and from the private sector, provide a wealth of additional knowledge.

The State of California Department of Boating and Waterways and the State Coastal Conservancy published, in January 2002, the California Beach Restoration Study, which provides an excellent summary of the state of the California coastline and what the State considers necessary to restore the quality of this immensely valuable natural resource.

Table 8.4 Sediment Inputs to the Oceanside and Santa Barbara Littoral Cells

Oceanside Littoral Cell			
Inputs	**Natural (cy/yr)**	**Actual (cy/yr)**	**Reduction (cy/yr)**
Rivers	286,500 44.7%	132,500 27.9%	154,500 53.8%
Bluff Erosion	67,300 10.5%	54,900 11.6%	12,400 18.4%
Gullies/Terraces	287,000 44.8%	287,000 60.6%	0 0.0%
Total Littoral Input	641,500 100.0%	475,100 100.0%	166,400 26.7%
Santa Barbara Littoral Cell			
Inputs	**Natural (cy/yr)**	**Actual (cy/yr)**	**Reduction (cy/yr)**
Rivers	3,642,773 99.6%	2,167,000 99.5%	1,475,773 40.5%
Bluff Erosion	14,028 0.4%	11,312 0.5%	2,716 19.3%
Total Littoral Input	3,656,801 100.0%	2,178,312 100.0%	1,478,489 40.4%

Fig. 2. Table 8.4 from California Beach Restoration Study

Figure 2, reproduced from the California Beach Restoration Study (2002), lists the sediment inputs to the Oceanside and Santa Barbara Littoral Cells. Focus on the Oceanside Littoral Cell for a moment, where under natural conditions, total littoral transport into the system averaged 641,500 cubic yards per year. Today, within the Oceanside Littoral Cell, about 7 miles of this 52-mile coastline has been armored, admittedly removing some potential source material from this littoral cell. However, this reduction in source material from 7 miles of coastal armoring amounts to a little over 12,000 cubic yards per year, or less than two percent of the natural sediment supply.

In the Santa Barbara Littoral Cell, about 11 miles of the 144-mile-long coastline has now been armored, but this impact is even significantly less, with a reduction of only 2,700 cubic yards compared to a natural total littoral input of over 3½ million cubic yards. To quote from the California Beach Restoration Study, "what is clear from Table 8.4 is that bluff erosion plays an insignificant role as a source of sand for the Santa Barbara Littoral Cell." One must also conclude that seawalls have an insignificant impact on the Oceanside Littoral Cell. This is clearly in contrast to the story that the environmental community is pushing to the public.

One of the truly significant impacts of urbanization of the upland watershed is only obliquely mentioned in the State's Beach Restoration Study, and that is, the true significance of sand mining, and particularly within San Diego County, where there has been over 100 million cubic yards of sand mined in San Diego County in the last 60 years, all of which was originally destined for San Diego County beaches. And yet, in the Oceanside Littoral Cell, in the last 60 years and assuming natural conditions, there would only have been 38,500,000 cubic yards of sand delivered to the beach during this same period.

In other words, 60 years of sand mining has removed 155 years of natural sediment supply from the littoral system. Bottom line, today, we have few sandy beaches in San Diego's North County, and the bluff-top property owners did not contribute to the sand deficit problem that exists along the North County shoreline today. Moreover, forbidding coastal protection projects or, for that matter, by removing all of the existing seawalls in San Diego's North County, will not have any measurable impact on this littoral sand deficit. We have proven it is not the seawalls that are the culprit.

AN ANALYTICAL APPROACH

Coastal erosion can be mathematically described as being a function of both the wave energy, f_w and the strength of the sea cliff, or the rock resistance, f_r. In its simplest expression, predictive cliff-erosion models take the following form (Sunamura, 1997):

$$dx / dt \; \alpha \; \ln (f_w / f_r)$$

What this simply says is that for a given wave energy, the stronger the rock resistance, the less erosion that occurs. Of particular interest, however, is the fact that a minimum or critical wave energy capable of causing erosion exists, below which, for a given rock lithology, no erosion would occur. This is important, as it explains why highly erosion-resistant rock sea cliffs often do not have sandy beaches and relatively deep water at the base of the sea cliff.

Fig. 3. Sunset Cliffs on the Point Loma Peninsula

Figure 3 is looking down the Point Loma Peninsula in San Diego. Note the deep water adjacent to the cliffs. The sea floor fronting this Cretaceous-age (80 million years old) sea cliff is around elevation -5 feet MSL and, as a result, considerable wave energy assails the coastline. The rock is so hard that, to initiate any erosion and retreat of the coastline, deeper water is required, and hence more wave energy, to compensate for the stronger rock strength. With deeper water, there is obviously no lateral access along the base of the sea cliff and of course no sand beach.

Fig. 4. Encinitas Sea Cliffs in San Diego's North County

In San Diego's North County, where the sea cliffs are of Eocene age (45 million years old), and the rock strength (unconfined compressive strength) is several hundred psi, more rapid marine erosion occurs, particularly when the protective sand beach is absent. Figure 4 shows the sea cliff in Encinitas, in northern San Diego. The actual mechanism of erosion is the formation of a notch, the collapse of the overhang, and progressive failures of the upper bluff.

The elevation of the bedrock at the base of the sea cliff and underlying the transient sand beach is near sea level in Encinitas. Also of importance is that, 25 to 30 years ago, San Diego's North County had healthy sand beaches, essentially 12 to 13 feet higher than the bedrock shore platform. Today, in the absence of this protective sand beach, there is increased erosion. However, the erosion rate, with these Eocene sediments, although somewhat weaker than those along Point Loma, is still so slow that these coastal bluffs are still releasing sediment at a rate that is several orders of magnitude less than the available sediment transport capacity that the waves have to carry the sediment away.

What this means is that, even as accelerated erosion continues in San Diego's North County, and as sea cliffs collapse and the upper bluffs retreat, eventually undermining bluff-top structures, there will never be any sand on the beach. Although the environmental community would argue to the contrary, in the absence of a proactive plan, and assuming no future seawalls, and no future significant beach renourishment projects on the immediate horizon, and even assuming we remove every seawall in San Diego's North County, there will continue to be a pervasive absence of any sand beach.

The unfortunate reality is that the healthy, recreational resource envisioned by the environmental coalition, i.e., the wide sandy beach, which would provide greater recreational opportunities resulting in increased beach use and economic benefits to the State of California, can only occur with artificial beach replenishment, not the elimination of seawalls.

PUBLIC SAFETY

While the beach can be a dangerous place, all of the coastal-related dangers with the single exception of bluff instability, have existed along San Diego's North County beaches in the past. These potential "natural" dangers are presumably familiar to the beach-going public. Since people are now often forced to walk along the beach immediately adjacent to the bluff, there is a much greater risk from a bluff failure injuring or killing them on the beach. The stability of portions of San Diego's North County coastline has degraded in recent years, creating a new, previously non-existent danger to the beach-going public. This danger presents the very real possibility of a bluff collapse injuring or killing someone on the beach.

It is unreasonable to assume that the beach-going public possesses the same level of recognition regarding the potential for a bluff collapse injuring them then from a rip current carrying them out to sea. It is fair to assume that the majority of the beach-going public has at least some familiarity with the dangers of waves, rip currents, cold water, and the many other natural hazards that exist along ocean shorelines. However, it is also fair to say that the vast majority of the beach-going public has little knowledge of the potential risks associated with a bluff collapse along the landward edge of the beach.

Coastal bluffs do not back most of the beaches along the U.S. East and Gulf coasts. Therefore, many visitors to our beaches probably have no idea that the bluffs present any danger to them. Even in Southern California, many of the more popular beaches, including Santa Monica, Newport, and Mission Beach, are similarly not backed by coastal bluffs. Moreover, most coastal bluffs are reasonably stable, including the majority of those within Point Loma and La Jolla. It is only those that are actively eroding, most notably in San Diego's North County, and where the upper bluff face has not had a chance to equilibrate, that the biggest risk to the beach-going public exists. This risk is relatively new to San Diego, and atypical of most recreational beach areas throughout the country.

THE URBAN COASTLINE

As an urban society living within the coastal watershed, we have not been kind to this state's coastline. Twenty-five years ago, when there were virtually no seawalls along the California coast, man's urbanization of the coastal watershed stopped the supply of sand, causing accelerated coastal erosion and a desire by many to protect their properties. Again, Southern California's beaches did not disappear because seawalls were built. Seawalls were needed because the beaches disappeared. The facts bear this out, and simply eliminating seawalls will not even begin to fix the problem.

As a society, we must all come to grips with the real hazards and impacts affecting our coastal resource. Only then can we work together to improve the quality of this resource. The coastline along much of Southern California is totally developed, and this must be considered in future coastal land use policies. As a society, we are primarily responsible for the loss of this resource and we must consider renourishing these coastal areas that would clearly benefit from this effort. In San Diego's North County, 25 years ago, we had healthy, albeit relatively narrow, beaches, with the elevation of the back beach typically around +12 feet. In the last two decades, competing societal interests have caused the loss of this ribbon of sand that many have come to enjoy. Its loss, however, has also significantly increased the erosive wave energy, f_w, acting on our coastal bluffs, and the cumulative impacts of this 12 to 13 foot [12 foot back beach elevation, minus the bedrock shore platform elevation] loss of sand is an order of magnitude more severe than the impact of passive erosion from a seawall. With beach renourishment, in the absence of sufficient sand to preclude its loss from say a 100-year storm, seawalls can protect the coastal bluffs that back the beach.

There may also be locations along even an urban coastline where certain bluff-top properties could be purchased in a given location, where the engineering and environmental constraints dictated that removal and planned retreat made more economic sense than beach renourishment or the construction of seawalls. With everyone working together and armed with the facts, and giving reasonable consideration to property rights and the impacts that we as a society have created to the detriment of our coastlines, we can truly improve the quality of the coastal experience for everyone that visits the California coastline.

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