

RESULTS FROM CSMW TASK 1

(Coastal Erosion – Needs for Beach Nourishment)

TASK 1 – Compile available and known beach nourishment needs along the entire California coast (locations, reasons, severity of need, and consequences); identify critical beaches that would benefit most from beach nourishment and compile a list of known erosion hot spots.

BACKGROUND

The issues of coastal erosion and beach replenishment/nourishment are commonly related. Coastal erosion manifests itself through two processes: natural and man-induced. An important challenge is our capability to separate the two for a given geographic location or episode. Beach replenishment or nourishment has increasingly become a preferred method of reducing or halting erosion along coastlines throughout the world. The reasons can range from purely economic (e.g., recreation; tourism) to public safety (e.g., collapse of cliffs above occupied beaches; destruction of houses and businesses).

One of the first steps to manage sediment along a regional coastline is to identify the physical locations and rates of erosion from a geologic perspective only, regardless of cultural conditions and influences. After this identification is complete, a next step would be to then overlay the cultural conditions and influences. These could include such variables as population, development, jurisdiction (public, private), economics, safety, and anticipated future conditions, among others. These variables could be weighted and then combined in a quantitative fashion to rank “severity of need” for intervention with beach replenishment/nourishment.

An issue related to severity of need is that of “erosion hot spots.” Erosion hot spots can be defined from a scientific perspective (high erosion rates with no “value” assigned) or from a cultural perspective (erosion is causing economic or safety hardships even though actual amount of erosion may not be severe compared to other locations). The National Research Council (1995) defined an “erosion hot spot” as one or more areas along a beach project that will erode more rapidly than their neighbors and more rapidly than predicted using accepted methodologies. Indeed, the definition of an erosion hot spot can be different depending on one’s purpose and interests. Is it based on purely geologic variables such as measured erosion rates? Is it based on economic losses? Is it based on jurisdictional location (public land or private property)?

The “benefit” of beach replenishment/nourishment is also an important part of ranking locations along a coastline for intervention. If considering economic benefits (tourism, recreation), King’s study (California Department of Boating and Waterways and State Coastal Commission, 2002, Part 1, Chapter 3) provides an example of a monetary

benefit/cost approach to ranking. If considering public safety benefits (which do not as easily lend themselves to monetary benefit/cost analysis), the approach would have to consider human exposure at sites (e.g., potential injuries or fatalities from collapse of cliffs or structures because of erosion).

EROSION ALONG THE COAST OF CALIFORNIA

Because of its dynamic geologic setting, the coast of California is subject to the natural processes of erosion along its entire length. Uplift of the coastal land mass by geologic forces in combination with rising sea level since the last ice age have created a complex interplay of erosion and deposition of sediment that varies from place to place. This coastal environment differs substantially from the more passive environments of the U.S. Atlantic and Gulf Coasts.

With the advent of man's intense settlement and development of the state since the 1800s, this natural condition has been significantly modified: the rate of erosion has been exacerbated in many places by the construction of inland dams and artificial channeling of rivers (which block or hinder movement of sediment to the ocean) and of coastal structures such as harbors, jetties, and seawalls/revetments.

Whether natural or man-induced, erosion along the coast of California affects beaches; cliffs and bluffs associated with terraces; and steep mountain slopes that front the ocean. The first two categories of features are by far the most important to humans because they are the sites where many people live, work, and pursue recreation. The coastline from the Oregon border to Point Conception is characterized generally by short, narrow beaches and rocky shorelines; the segment from Carmel to San Simeon is notably rugged. The coastline from Point Conception to the Mexico border is generally more subdued with longer, wider beaches, and bluffs and terraces interspersed with alluvial plains.

The significance of erosion along the coast largely correlates with the location of population centers. Population is relatively sparse north of the San Francisco Bay region. From the San Francisco Bay region to Monterey, population and development are much higher. The segment from the Monterey area to the San Simeon region is sparsely populated. Farther south, there is a cluster of population centers and associated development in the Morro Bay-San Luis Obispo region. The most intensively populated and developed part of the coast is from the Santa Barbara area to the Mexico border. Correspondingly, concerns and complaints about erosion are greatest along this part. To the north, concerns about erosion are less overall, with most expressed in the San Francisco Bay and Monterey Bay regions.

Statewide Documentation of Erosion

Documentation and interpretation of erosion along the entire coast of California are summarized in inventories published inventories by the U.S. Army Corps of Engineers

and Dames and Moore (1971), Habel and Armstrong (1977), and Griggs and Savoy (1985). Each of these reports provides observations and interpretations of erosion plotted on base maps for the entire length of the coastline. Each has an advantage of observation at different periods of time, which can be important because of changes in coastal development. These reports represent relatively consistent “baseline” views of the coastline of the state.

Our research did not reveal a detailed systematic statewide survey of erosion done subsequently to the inventory of Griggs and Savoy (1985). In the last few years, however, two reports (Noble Consultants, 2000; California Department of Boating and Waterways and State Coastal Commission, 2002) have documented the locations of several dozen sites of critical erosion that are threatening the economic/recreational well-being and/or public safety of citizens along the coast of California. These sites include both beach and cliff/bluff erosion and are briefly summarized in Table 1. This list is not comprehensive, but it does give an idea of the distribution of erosion problems based on a cultural perspective.

Currently, the California Coastal Commission is developing a database of cliff and bluff erosion rates and locations of armoring along the entire state coastline. The database, which is being prepared by Jennifer Dare (jdare@coastal.ca.gov), a National Oceanographic and Atmospheric Administration (NOAA) Fellow with the Commission, is being designed in a GIS format. One of the main sources of data being researched for data on erosion rates is the large collection of consultant reports in the files of the Commission. As of April 2004, detailed research and population of the database was underway for San Diego County, which is serving as a template for the project. When completed, this GIS layer will be a valuable source of information for incorporation into the statewide Coastal Sediment Management Master Plan.

Concerning erosion of beaches in California, there is relatively poor understanding of both this phenomenon and the character of sediment budgets along the coast (Griggs and others, 2003). To improve understanding of these phenomena, Gary Griggs at the University of California, Santa Cruz, is researching beach erosion and sediment budgets along selected segments of the coast of California (Gary Griggs, personal communication, 2003).

Regional and Local Documentation of Erosion

Coastal managers and researchers have increasingly recognized the importance of studying and managing the coast of California from a regional and statewide approach, with focus on natural (system) boundaries rather than jurisdictional boundaries. Correspondingly, relatively recent reports reflect this perspective. Among the most noteworthy are those associated with the Coast of California Storm and Tidal Wave Study prepared by the U.S. Army Corps of Engineers (e.g., 1991, 1993, 2002). The first two installments of this study cover the San Diego and Orange County coastlines. In particular, the 1991 report for San Diego County identified the coastal segments from Oceanside to La Jolla and from Imperial Beach to the border with Mexico as locations of

“critical erosion.” Another important study is that of Flick (1994), which is a detailed atlas of erosion along the coast from Dana Point in southernmost Orange County through all of San Diego County to the Mexico border.

Historically, academic researchers have studied some topical issues related to coastal erosion as exemplified by some of the references included in the accompanying bibliography. More recently, local government, as exemplified by the San Diego Association of Governments (SANDAG) and the Beach Erosion Authority for Central Operations and Nourishment (BEACON) in Santa Barbara and Ventura Counties, have embraced the concept of regional management of sediment and correspondingly prepared reports that identify locations of erosion and strategies to manage them (Noble Consultants, 1989; San Diego Association of Governments, 1993).

At the local, or project, level, numerous published and unpublished reports and information are available that document beach and cliff/bluff erosion along the coast of California. The three main sources of this literature are the U.S. Army Corps of Engineers (some are readily available; others are difficult to obtain), private-consultant reports (the California Coastal Commission has a large holding related to permit applications), and academic/professional journals (generally readily available at university libraries where coastal and marine studies are emphasized). Examples from each group are in the accompanying bibliography.

Compilation of Information from Reports

Because of the short length of the present study, detailed research and compilation of information from the wide array of literature and files on coastal erosion was beyond the scope of this study. Not only must the information be located, it must be evaluated for its timeliness; commonly, present conditions are not the same as when the information was gathered and reported for the individual studies.

The importance of compiling the available information on statewide beach and cliff/bluff erosion from the sources described above into a GIS format cannot be overestimated. The integration of the observations and interpretations, particularly those of the three state inventories published between 1971 and 1985, can significantly aid a modern systematic compilation and evaluation of erosion along any segment of the coast of California. The systematic compilation for cliff/bluff-erosion locations and rates is already underway through Jennifer Dare’s project. The systematic, detailed compilation for beach-erosion locations and rates remains to be accomplished.

NEED FOR BEACH NOURISHMENT

Coastal managers and researchers of the coast of California are increasingly looking to replenishment/nourishment as a way to maintain the size of beaches and to protect the landforms and associated development behind the beaches. The progressive diminishment of beaches along the coast, particularly in southern California, can

negatively affect recreation and tourism as well as lead to hazardous cliff/bluff failure and flooding that affects public safety.

The need for replenishment/nourishment at any particular beach in the state depends on many variables as described previously. To establish a list of beaches requires evaluation and weighting of these variables. As one approach, Coyne (2000) presented a GIS-based decision-support tool for identifying potential sites of beach nourishment, with examples focused on southern California. Also, the “need” of many beaches in California has been met by a history of successive nourishment episodes (e.g., Surfside/Sunset). These beaches are either on a prescribed schedule of nourishment or may be irregularly nourished because they depend on receiving fill from sources that are defined as “opportunistic” (e.g., harbor dredging or channel maintenance, which must dispose of the excavated material). Need can also be “performance-dependent.” In other words, timeliness of the next nourishment episode can depend on how well the fill from the previous episode has performed according to design specifications.

For the coast of California, Table 1 lists selected beaches identified in previous reports as having a critical need for replenishment/nourishment. Also listed are the potential consequences if there is no intervention. Nearly all sites are in southern California, from Point Conception to the Mexico border. The main reason for this geographic bias is the distribution and density of coastal population and development. This list is not necessarily comprehensive, but represents sites evaluated and selected by consulting specialists and government officials in recent years. To prepare a comprehensive list would require research and evaluation of many published and unpublished reports and documents on all individual beaches along the coast. Furthermore, we believe at this point in development of the Master Plan that severity of need cannot be rigorously established for individual sites along the coast of California until a protocol for ranking is established. Consequently, we have not made judgments on severity of need for the sites listed in Table 1.

CGS RECOMMENDATIONS TO THE CSMW

- For the CSMW Master Plan, prepare a clear definition of the term “erosion hot spot.”
- For the CSMW Master Plan, prepare a set of criteria to clearly define and rank beach nourishment needs. To identify and rank based on economic effects, a benefit/cost analysis could be one approach. To identify and rank based on public health and safety will require other criteria such as previous fatalities or injuries.
- As part of CSMW Master Plan, annually maintain a GIS -based list of beach-nourishment needs, perhaps categorized by littoral cell.

- Digitize and attribute in GIS-format the data and interpretations from the following reports to establish baselines to aid interpretation of beach erosion and needs for nourishment. This process should be coordinated with the current project of Jennifer Dare at the California Coastal Commission.
- There is a need to investigate nourishment opportunities for areas that need sand for shore protection recreation, or habitat, as well as that lost to erosion.

U.S. Army Corps of Engineers and Dames and Moore (1971)

Habel and Armstrong (1977)

Griggs and Savoy (1985)

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