CHAPTER 225

JUSTIFICATION FOR BEACH NOURISHMENT

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ABSTRACT

Sand balance of the littoral system determines whether erosion or recession will occur. Adding sand to the system is the only engineered way to restore the balance and prevent erosion or recession. Justification of beach nourishment as a shore protection measure depends on the benefits criteria used in the analysis, and societal goals will decide the criteria.

INTRODUCTION

Mankind, in its love affair with the coast, has often encroached on sandy areas which are basically unstable - at least as far as lines on a map are concerned. Sandy coasts are particularly attractive as recreation sites, and in the last half century they have been the target of intensive development. In the United States, about 50 percent of the population lives within 30 miles of a coast. Erosion of those shores has become a national concern.

THE EROSION PROBLEM

Sand is in constant motion along the shores of this country due to waves, currents, and wind. As long as the sand leaving a stretch of beach is balanced by the same quantity of sand arriving on the beach, there is no erosion or recession. But if the balance is not maintained (either by the arriving sand being interrupted by a structure such as a jetty or by a lack of sand on the updrift beach), erosion/recession will result.

When the user of a beach wants to construct some fixed structure in the immediate vicinity, such as a road or a house, then, if the shoreline moves in the direction of the fixed structure, that is called a problem.

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There are three basic responses to an erosion threat: reduce the hazard, adjust human use, or accept the cost. Only the first one is amenable to an engineering approach; the others are either management options or the do- nothing alternative with its attendant increased costs. To reduce the hazard, the choices are to modify the physical process or to reduce the impact. From an engineering viewpoint, it is usual to pursue some combination of those hazard-reduction options.

A BEACH NOURISHMENT SOLUTION

For developed coasts, the serious problem of coastal erosion is caused by a deficit of sand in the littoral system. Adding sand to the system (beach nourishment) is the only engineering solution that remedies the basic problem. All other potential engineering solutions (groins, seawalls, breakwaters, etc.) may stop the erosion at a particular point, but the deficit of sand in the littoral system will cause erosion to occur at some other location. And the cost of mitigation of those adverse effects is one of the strong reasons for a beach nourishment approach.

When sand is first installed as part of a beach nourishment project, it is placed on the existing beach to raise it to a higher elevation and to widen the dry beach in the seaward direction; the seaward face is thus on a steep slope. The filling procedure is dictated by the least total cost of the operation. If the fill is made from the land side, say by truck haul, then the trucks dump near the waters edge and continually push that edge seaward. If the fill is by hydraulic dredge, then the pipes are positioned so that the effluent moves the edge of the fill seaward. If the fill is by offshore mounding, a split-hull hopper dredge or barge is maneuvered as close to shore as the draft of the vessel will allow, and the fill is placed in shallow water so that waves will move the sand toward the shore.

When first placed, the sand slope in the water is not at the equilibrium slope. As waves work on that slope, the sand tends toward the equilibrium position, that is, a slope which is stable under the wave regime present. Since the waves are not of constant height, period, or direction, each wave climate tries to put the beach slope in an equilibrium position for that instant. Seconds later, the regime has changed, thus the process of equilibration is continuous.

So as the sand pile is reshaped by waves, some of the dry beach sand is moved into the water to provide the material for a flatter equilibrium slope. And the perception that the beach was "lost" comes to those who only consider the subaerial beach. Without the subaqueous beach, surely the beach *is* lost.

BENEFITS

The recent study by a blue-ribbon committee of the Marine Board of the National Research Council found that, when used in appropriate situations, beach nourishment does indeed become a cost-effective measure to combat the effects of coastal erosion. The key is to determine what are the appropriate situations for the use of beach nourishment. First, a determination must be made of the benefits to be derived from such a project. Those benefits are not only in terms of dollars of increased revenues and decreased losses, but also social and environmental benefits. The costs associated with the project are not only the planning, design, construction, and maintenance costs, but also the social and environmental costs.

In an effort to stem what many consider unwise development on pristine shores in this country, the Coastal Barrier Resources Act precludes (with some exceptions) the federal government from expending funds on undeveloped coastal barriers. For developed shores, the rules for U.S. federal participation in shore protection projects are quite explicit about how and how much benefits can be claimed. The benefits in the category of storm damage reduction must be at least one half the costs of design and construction. After that benefit requirement is fulfilled, other benefits (such as recreation) can be added to bring the total benefits up to something greater than the total costs. However, these are not all the benefits that should be considered.

Justification usually has the connotation of financial break-even or better. Justification on the national, state, local, or personal levels uses different yardsticks and different elements of measure. Measures that would justify a project on the local level may not be counted on the national level, since benefit gains in one region may be offset by losses in another. And on the personal level, hard to quantify aesthetics may be the most important element for some people. And for environmentalists, the fill material as habitat for birds, turtles, and other creatures may be the important elements.

One of the major benefits not considered in beach nourishment cases involving federal participation are those benefits outside the project boundaries caused by sand being transported to property beyond those boundaries. In the recreation benefit category, the benefit to the non-federal sponsor is usually far greater than that allowable under U.S. federal rules. Those rules require the benefits to be national economic development (NED) benefits, but the local entities realize benefits in addition to NED benefits. An often overlooked cost is a navigation project that causes a sediment deficit in the littoral system by trapping sand in the channels and harbor areas, or in ebb-tide deltas that effectively divert sand away from a beach area.

CONSTRAINTS

The major problem with beach nourishment is not technical, but perception. The person who views a beach nourishment project has a certain expectation from that project. If it is a property owner in the vicinity, he looks for protection. If it is visitor, he looks for a recreation site. And if it is a taxpayer from a distant location, he looks for a return on his investment.

Beach nourishment mimics what nature does, so that sand is not held in one place but is allowed to move under the influence of the waves and current. Although beach nourishment is not appropriate for all locations, it is the preferred option in many problem areas. A beach nourishment project is sacrificial; that is, it is designed so that sand is removed from the beach rather than buildings being removed from the backshore. Sand replenishment restores the beach to the design dimensions upon which the benefits are derived, and if the project is well designed, constructed, and maintained, and if there is the political and financial will to continue the periodic renourishment program, the benefits will continue to accrue. While hard structures (groins, seawalls, etc.) require a large, up-front, construction-cost investment, beach nourishment involves a smaller, periodic expenditure for construction over the life of the project. In almost all cases, the benefits of beach nourishment outweigh those of hard structures.

It was once said that anyone could build a bridge, but it took an engineer to build one economically. The same can be said for beach fills.

Beach nourishment projects need to use state-of-the-art engineering principles, which includes a thorough understanding of shore processes. It is not enough that an adequate supply of sand is available to a project for it to be successful; there must also be an understanding of the goals of the project and the criteria for success. If the public does not understand how success is measured, and that beach nourishment is meant to be sacrificial, then when some of the subaerial beach is lost during a storm, the project may be labeled a failure, even when much of the sand is returned to the dry beach by natural processes in a few months, and the engineer has expected those results.

So beach nourishment (or renourishment) is the preferred solution to the sand deficit problem. To properly engineer the sand fill, the characteristics of the native sand and the proposed fill material must be known, as well as the forces acting on it, i.e., waves, current, wind, etc.

A recent (1995) legislative proposal by the Clinton administration would redefine the US Army Corps of Engineers' (the federal agency charged with

shore protection) mission as "nationally significant missions." If enacted, the cost sharing for federally-funded water resources projects would change to 25/75 (federal/non-federal), and the benefit/cost ratio would be at least 2. Federal participation in storm damage reduction projects would be eliminated on the basis that these projects are local (not national or interstate), and should be paid for by non-federal dollars. As of the date of this paper, the proposal has been rejected by the Congress, but the administration is using the budget process to put shore protection in a low priority position.

CONCLUSION

The expense of a nourishment program (initial plus subsequent re-nourishments) is not inconsequential. However, the loss of property during storms and loss of revenue from tourism on a neglected beach can be much greater.

BIBLIOGRAPHY

Adams, J.W.R., "Florida's Beach Program at the Crossroads", *Shore and Beach*, v 49, nr 2, Apr 81, pp 10-14.

Adams, J.W.R., "The Politics of Beach Nourishment", *Shore and Beach*, v 50, nr 1, Jan 82, pp 2-5.

Basco, D.R., "Boundary Conditions and Long-Term Shoreline Change Rates for the Southern Virginia Ocean Coastline", *Shore and Beach*, v 59, nr 4, Oct 91, pp 8-13. Discussion by E.R. Thieler, R.S. Young, and O.H. Pilkey in *Shore and Beach*, v 60, nr 4, Oct 92, pp 29-30. Closure by D.R. Basco in *Shore and Beach*, v 60, nr 4, Oct 92, pp 31-34.

Bodge, K.R., "Damage Benefits and Cost Sharing for Shore Protection Projects", *Shore and Beach*, v 59, nr 2, Apr 91, pp 11-18.

Camfield, F.E., "Different Views of Beachfill Performance", *Shore and Beach*, v 61, nr 4, Oct 93, pp 4-8.

Campbell, T.J. and R.H. Spadoni, "Beach Restoration - An Effective Way to Combat Erosion on the Southeast Coast of Florida", *Shore and Beach*, v 50, nr 1, Jan 82, pp 11-12.

Davison, A.T., C.P. Ulrich, and R.J. Nicholls, "Accreditation of Beach Nourishment Projects: An Issues Discussion", *Shore and Beach*, v 61, nr 4, Oct 93, pp 9-15.

Denison, P.S., "The North Carolina Experience", *Shore and Beach*, v 49, nr 2, Apr 81, pp 15-16.

Domurat, G.W, "Beach Nourishment - A Working Solution", *Shore and Beach*, v 55, nr 3-4, Jul-Oct 87, pp 87-91.

Herron, W.J., "Sand Replenishment in Southern California", *Shore and Beach*, v 55, nr 3-4, Jul-Oct 87, pp 87-91.

Houston, J.R., "Beachfill Performance", *Shore and Beach*, v 59, nr 2, Jul 91, pp 15-24.

Houston, J.R., "Beach Nourishment", *Shore and Beach*, v 63, nr 1, Jan 95, pp 21-24.

Magoon, O.T., "A Letter to President Bill Clinton", *Shore and Beach*, v 62, nr 2, Apr 94, pp 2-3.

O'Brien, M.P., "Beach Stabilization by Sand Replenishment", *Shore and Beach*, v 52, nr 4, Oct 84, p 19.

Pilkey, O.H., "Another View of Beachfill Performance", *Shore and Beach*, v 60, nr 2, Apr 92, pp 20-25.

Seymour, R.J., "An Introduction to the Marine Board Study on Beach Nourishment and Protection", *Shore and Beach*, v 64, nr 1, Jan 96, p 3.

Seymour, J.R. et al., "Beach Nourishment and Protection: Executive Summary", *Shore and Beach*, v 64, nr 1, Jan 96, pp 5-10.

Stone, K.E. and B. Kaufman, "Sand Rights: A Legal System to Protect the 'Shores of the Sea'", *Shore and Beach*, v 56, nr 3, Jul 88, pp 7-14.

Stronge, W.B., "Beaches, Tourism and Economic Development", *Shore and Beach*, v 62, nr 2, Apr 94, pp 6-8.

Stronge, W.B., "The Economics of Government Funding for Beach Nourishment Projects: The Florida Case", *Shore and Beach*, v 63, nr 3, Jul 95, pp 4-6.

Smith, A.W.S., "Beaches and Tourism - An Example of the Results of a Dramatic Beach Erosion Episode: Gold Coast, Queensland, Australia", *Shore and Beach*, v 63, nr 3, Jul 95, pp 7-8.

Smith, A.W.S. and L.A. Jackson, "The Siting of Beach Nourishment Placements", *Shore and Beach*, v 58, nr 1, Jan 90, pp 17-24.

Sudar, R.A. et al., "Shore Protection Projects of the U.S. Army Corps of Engineers", *Shore and Beach*, v 63, nr 2, Apr 95, pp 3-16.

Wiegel, R.L., "Beaches - Tourism - Jobs", *Shore and Beach*, v 62, nr 2, Apr 94, pp 4-5.

Wiegel, R.L., "Beach Nourishment, Sand By-Passing, Artificial Beaches: Bibliography of Articles in the ASBPA Journal *Shore and Beach*", *Shore and Beach*, v 60, nr 3, Jul 92, pp 3-5.