Journal of Coastal Research 11 (3), iii-v Summer 1995

Journal of Coastal Research 11 3 iii–v Fort Lauderdale, Florida Summer 1995

# EDITORIAL

## The Fox Guarding the Hen House

Orrin H. Pilkey

Department of Geology
Duke University
Durham, NC 27708

To date more than 200 beaches in the U.S. have been replenished on coasts in a wide variety of oceanographic settings. A careful review of that experience should provide a sound basis for improvement of beach design parameters.

A recent report by the U.S. Army Corps of Engineers provides such a review of the federal experience with replenished beaches. Unfortunately, the document presents a defense of the agency's actions rather than an objective analysis of them. The report can not provide a basis for objective examination of beach design.

In 1992 the Office of Management and Budget (OMB) requested that the Corps of Engineers report on their record of success in predicting the costs and sand volumes required for replenished beaches. The OMB request was in response to the public debate concerning our findings (For example, PILKEY and DIXON, 1989; LEONARD *et al.*, 1990; HOUSTON, 1990, 1991a,b; PILKEY and LEONARD, 1990; PILKEY, 1991, 1992) that the Corps has consistently underestimated the costs and required sand volumes for replenished beaches, with a few exceptions in South Florida. The result of the Corps' self examination, published in 1994, is IWR Report 94 PS-1 entitled "Shoreline Protection and Beach Erosion Control Study—Phase I: Cost Comparison of Shoreline Protection Projects of the US Army Corps of Engineers." It is available from The U.S. Army Corps of Engineers, Water Resources Support Center, Casey Building, 7701 Telegraph Road, Alexandria, VA 22310-3868. This 119 page report is sandwiched between striking purple covers and is hereafter referred to as the purple report. Aspects of the report were also summarized by HOUSTON (1995) and SUDAR *et al.* (1995).

Using data from more than 100 replenished beaches, all Corps of Engineer projects, the purple report concludes that Corps cost performance has been excellent: "Considering the program as a whole, the actual and estimated costs for those projects . . . are $1,340,900,000 and $1,403,000,000 respectively." Similar success is claimed for the Corps sand volume predictions ". . . there has been an actual placement of 72.5 m cu yds of sand fill compared to an estimated 64.7 m cu yds." "For both volumes and costs the actual and predicted totals fall within 5% of one another." "Costs and volume estimates have been quite good in the aggregate" according to HOUSTON (1995).

I don't dispute these numbers but they are misleading. I disagree with the interpretation that the report demonstrates that the Corps knows how to successfully estimate replenished beach lifespans. Perhaps the most fundamental problem is that the OMB, an agency that impacts on the budgets of other agencies, has asked an agency to evaluate its own success. The truth is best served by an independent review.

The Corps' review of the national beach replenishment experience and their assertion of successful beach behavior prediction has other problems.

Problem #1. Was a beach always present throughout the duration of the project? The purple report fails to take into account whether or not the beach was maintained between nourishments. PILKEY (1988) summarizes published reports on the success of East Coast replenished

beaches. In many cases, replenished beaches are substantially gone before the time has come for the next nourishment. If between scheduled nourishments, a beach has disappeared or if a significant number of erosion hot spots has resulted in total beach loss in front of previously recognized critically eroding shoreline reaches, the beach is not a success. Shoreline retreat was not halted, a recreational beach was not maintained and buildings were not protected. In this situation, simple comparison of cost and sand volumes predictions is not a measure of the agency's success.

For example, the Corps notes correctly that the 1976 to 1987 Tybee Beach, Georgia, project was under budget in terms of both dollars and sand volume but fails to note that the beach disappeared within a year along the critically eroding north and south ends of the island. For 10 years (between 1977 and 1987) Tybee Beach had no beach where it needed one or when it needed one had a hurricane occurred. The Corps assertion, in the purple report, of being under budget at Tybee Beach is meaningless!

Problem #2. What was used as the "original" estimate to be compared with the actual experience? During the long process of justification, planning and design before a project is emplaced, a number of sand volume and dollar estimates are made. The Northern New Jersey project has at least tripled in cost since the first estimate. What should count is the estimate that the Corps used as a basis for determining the economic viability of the project (the benefit/cost ratio). This is the estimate of cost used to determine the feasibility of other management alternatives such as the retreat option or the do-nothing option. These are the estimates of societal importance but the report does not document which estimates are used. The lack of documentation in the purple report makes it impossible to directly compare our actual/estimated ratios with theirs. Clearly, however, the Corps' view is more optimistic than ours. According to PILKEY and DIXON (1989), the actual/estimated cost ratio (inflation corrected in all cases) at one point for the Wrightsville Beach and Carolina Beach, North Carolina, projects are 6.53 and 13.12 respectively. The same ratios in the purple book are 1.10 and 0.87.

Problem #3. The importance of U.S. beach replenishment. The purple report notes that only 0.3% of our shoreline has been replenished. In determining this number the Corps uses the total mileage (84,000 plus) of all U.S. shorelines including bays, estuaries, the Great Lakes and Alaska! But replenishment is primarily an open ocean or lake phenomenon. Including vast areas of estuarine, rocky and undeveloped shoreline downplays the importance of beach replenishment in application and in ultimate cost. A more realistic value would be the percent of the total length of developed open ocean shoreline fronted by preexisting sandy beaches that has been replenished. All major coastal resort communities on the U.S. east coast are replenished or soon will be. Fully 50% of the developed open ocean shoreline mileage along the East Coast of Florida, south of Cape Canaveral, is replenished or is about to be. Sound coastal management in the future requires an accurate understanding of the role that beach replenishment is playing.

Problem #4. Part of the analysis in the purple report involves comparison of the actual and estimated costs and sand volumes for the *initial* replenishment. Such comparisons, concerned with the first time sand is pumped on a beach, have little bearing on the Corps design success or predictive capabilities. Not surprisingly, the purple report finds that the agency has been quite successful in predicting how much sand would be pumped in the initial effort. How could they miss?

The drumbeat continues. Beaches continue to be emplaced using non-probabilistic design methods which would only work if we knew the schedule and intensity of storms for the next few decades. Since this will obviously not happen, such a design approach can't possibly work. Costs and sand volumes for the latest new projects on the East Coast have been very poor. Ocean City, Maryland, has already emplaced (in three years) about one-third of the volume of sand predicted to be needed over the next fifty years. The initial 1993 nourishment project at Folly Beach, South Carolina, was predicted to have a nourishment interval of 8 years. Sand loss has been very rapid and based on our own observations, the nourishment interval stage was achieved in less than one year. New projects on the drawing board have predicted cost and sand volume requirements which are highly unlikely. Predicted nourishment intervals of ten years for Myrtle Beach, South Carolina and North Myrtle Beach and a prediction of six years for the Northern New Jersey project are at considerable odds with experience on nearby earlier replenished beaches (*e.g.*, Folly Beach, South Carolina and Sandy Hook, New Jersey).

The shortcomings in the purple report highlight what is needed in the American approach to beach replenishment.

(1) Monitoring of all beach replenishment projects.
(2) Consistent reporting of economic, environmental and engineering aspects of replenishment projects. Currently it is nearly impossible to do more than a cursory analysis of the national replenishment experience which has limited value for evaluation of design principles.
(3) Measures of replenished beach success that are not simply internal accounting. Success measures must consider community views of the situation.
(4) Recognition of the random occurrence of storms which would lead to probablistic estimates of beach durability.
(5) Recognition that foxes should not be recruited to guard hen houses. A government agency should not be requested to evaluate the success of its own activities. The purple report should be done again, this time by an independent panel of scientists and engineers.

## LITERATURE CITED


HOUSTON, J.R., 1990. Discussion of Pilkey, O.H. and *Leonard et al.* 1990. *Journal of Coastal Research*, 6, 1023–1036.

HOUSTON, J.R., 1991a. Beachfill performance. *Shore and Beach*, 59(1), 15–24.

HOUSTON, J.R., 1991b. Rejoinder to discussion of Pilkey and Leonard (1990). *Journal of Coastal Research*, 7, 565–577.

HOUSTON, J.R., 1995. Beach replenishment. *Shore and Beach*, 63(1), 21–24.

LEONARD, L.; DIXON, K., and PILKEY, O.H., 1990. A comparison of beach replenishment on the U.S. Atlantic, Pacific and Gulf coasts. *Journal of Coastal Research*, Special Issue No. 6, pp. 127–140.

PILKEY, O.H. and DIXON, K., 1989. Testimony of Orrin H. Pilkey Jr. before the Environment, Energy and Natural Resources Subcommittee of the House Committee on Government Operations, April 28, 1989.

PILKEY, O.H., 1988. A thumbnail method for beach communities: Estimation of long term beach replenishment requirements. *Shore and Beach*, 56, 23–32.

PILKEY, O.H. and LEONARD, L.A. 1990. Reply to Houston (1990). *Journal of Coastal Research*, 6, 1047–1057.

PILKEY, O.H., 1991. Reply to Houston (1991). *Journal of Coastal Research*, 7(3), 879–894.

PILKEY, O.H., 1992. Another view of beach fill performance. *Shore and Beach*, 60, 20–25.

SUDAR, R.A.; POPE, J.; HILLYER, T., and CRUM, J., 1995. Shore protection projects of the U.S. Army Corps of Engineers. *Shore and Beach*, 63(2), 3–16.

| Journal of Coastal Research | 13 | 1 | 259–264 | Fort Lauderdale, Florida | Winter 1997 |
|---|---|---|---|---|---|

DISCUSSION

# Discussion of: Pilkey, O. H., 1996. The Fox Guarding the Hen House (editorial), *Journal of Coastal Research*, 11(3), iii–v.

**Theodore M. Hillyer and Eugene Z. Stakhiv**

Policy and Special Studies Division
Water Resources Support Center
U.S. Army Institute for Water Resources
7701 Telegraph Road, Casey Building
Alexandria, VA 22315, U.S.A.

ABSTRACT

HILLYER, T.M. and STAKHIV, E.Z., 1997. Discussion of: Pilkey, O. H., 1996. The Fox Guarding the Hen House (editorial). *Journal of Coastal Research*, 13(1), 259–264. Fort Lauderdale (Florida), ISSN 0749-0208.

This paper discusses the editorial of Pilkey (1996). The discussion responds to a number of questions raised by Pilkey about the Corps evaluation methodology and the underlying premise that the Corps should not be conducting a self-examination.

## INTRODUCTION

This responds to an editorial "The Fox Guarding the Hen House" by Orrin H. Pilkey on the U.S. Army Corps of Engineers (Corps) shore protection program. Dr. Pilkey's review was on a report prepared by the Corps and published by the Institute for Water Resources (IWR Report 94-PS-1) in January 1994 (CORPS, 1994). The report was the first of a two-phase effort performed by the Corps on its shoreline protection program under the direction of the Office of Management and Budget (OMB). The purpose of the first phase effort was to provide early input to OMB regarding the scope and cost of the Federal shore protection program. Dr. Pilkey refers to this report as the "purple report." The second phase of the study has now been completed. This final report (CORPS, 1996) incorporates additional analysis of project cost and sand quantities, provides an overview of risk management in the coastal zone, presents a discussion on environmental considerations, and gives a unique analysis of any induced development effects associated with the Federal shore protection program. With the recent release of the final report, many of Dr. Pilkey's questions are readily answered. A paper on this final report of the Corps is contained in this edition of the *Journal of Coastal Research*. Since a report on the initial effort of the Corps (CORPS, 1994) was reported by Sudar *et al.* (1995), the accompanying *Journal* article, while updating some of the costs to 1995 price levels, focusses on the new data, *i.e.*, benefits of shore protection projects, the question of induced development, and environmental considerations associated with shore protection projects.

On some points, regardless of the information, there will be disagreements. This is principally because much of what is done, is derived from legal and institutional requirements. These laws influence project benefit-cost methodologies, impact assessments, and decisions regarding the extent and duration of beach erosion/storm damage reduction projects. It is a constantly moving baseline for the Corps, as is the science, engineering and technology that support our program. Assuming all planning and design processes are constant and that all projects must be judged by a single standard is incorrect. It is clear that the overall performance of the Corps shore protection program has improved over the years, as our knowledge has grown and our engineering experience in beach nourishment has increased. The entire set of projects in the Corps portfolio cannot be reviewed on the same basis, however, because they have been modified periodically under different sets of laws, rules and procedures.

Regarding charges that the Corps should not be evaluating its own work, one must remember that evaluation is the final step in a scientific method and all federal agencies conduct evaluations of their own programs. This evaluation may be performed as a status report to Congress, a report on the condition of the environment, or as an assessment of future "needs." This report is not one internally generated by the Corps to serve "marketing" purposes, but rather as indicated previously, was in response to a request from OMB. The purpose of the request was primarily for budgetary reasons in

*96063 received and accepted 9 July 1996.*

order to update the current portfolio, provide an overview of project performance and to develop an estimate of future commitments. The questions asked were those submitted by OMB. The Corps had little to do with the study agenda or the underlying premise of this inquiry. An independent review would have required additional budgetary commitments.

Certainly, the General Accounting Office or the Office of Technology Assessment could have conducted this analysis as independent entities. The Corps, however, would still have had to undertake much of the *analysis* in the report, because the data and information available were internal and piecemeal, reflecting different authorizations, changing complex cost-sharing rules and varying analytical requirements. A great deal of effort went into the analysis and evaluation of the information by people who understood the history of those changes and their analytical implications. The federal world is one of varying Congressional authorizations, appropriations and executive orders under which the Corps and all federal agencies operate.

Finally, a study by the National Research Council (NRC) was recently completed. This report (NRC, 1995) was developed independently of, but simultaneously with, the Corps shoreline study and includes the Phase I effort of the Corps (CORPS, 1994) as a reference. The NRC report examined all aspects of beach nourishment and protection including the federal role in beach nourishment. The report (NRC, 1995) supports the Corps shore protection program.

This discussion is not meant to imply that the Corps shoreline protection program is perfect or that improvements cannot be made. It is only an effort to set the record straight.

## RESPONSE

To begin with, the Corps did not use data from more than 100 replenished beaches for the "purple report." As quoted from page 33 of the report (CORPS, 1994):

> "As previously noted, the portfolio of constructed Federally sponsored shore protection projects contains 82 specifically authorized projects of various types which span a combined shoreline distance of approximately 226 statute miles. Of the total 82 projects, 26 were very small in scope and covered only 16 of the 226 miles of protected shoreline distance. These 26 small projects, which cost a total of $4.56 million at time of construction, were not considered in the detailed analysis which follows in this chapter. Therefore, the cost analysis presented below includes only the 56 large constructed projects."

The total number of Corps projects that was considered for comparison was "82," which was reduced to 56 for a detailed cost comparison analysis. Of these 56 projects, 49 contained initial beach restoration, 40 projects had been renourished, and 42 of the projects contained a structural component.

Next, "more than 100 projects" were not used to arrive at an actual cost of $1,340.9 million and an estimated cost of $1,403.0 million. We do not want to be misleading; these numbers are not total costs for all Federal shore protection projects. These numbers are updated costs for only those projects that could be compared. The report (CORPS, 1994) explains:

> "Estimated and actual costs for the 56 larger projects were adjusted to 1993 dollars so that cost estimating performance could be evaluated. There were 49 out of 56 large shore protection projects involving the use of sand fills for purposes of initial beach restoration, 40 involving periodic beach nourishment and 42 with a structural component. In order to present a meaningful evaluation, certain projects were not included in the comparison analysis due to the unavailability of complete cost data or because the constructed project differed from that envisioned at the time of preconstruction estimate. The numbers of projects which had sufficient information to make a valid comparison of actual and estimated costs are given in the table below."

The report (CORPS, 1994) then goes on to show that for the 56 larger projects only 40 of the 49 projects that included initial restoration, 33 of the 40 that contained nourishment and 35 of the 42 that included structural features had sufficient information to make valid cost comparisons. Only these 40 restoration, 33 nourishment and 35 structural portions of the total 56 larger projects were used in the comparison of the total cost performance of $1,340.9 million actual cost and $1,403.0 million estimated cost (both in 1993 dollars) that is quoted in the editorial. The actual funds expended on the total 56 projects were $670.6 million, and when updated to 1993 price levels, the cost becomes $1,489.5 million. Of this total cost, approximately 60 percent were Federal expenditures and the remaining 40 percent was contributed by the local sponsor. The procedure used for adjusting the costs of beach restoration and nourishment projects for the report involved the volumes of sand placed and the current cost of sand in each area for obtaining, transporting, and placing the sand at the respective project sites. Only structural costs were adjusted by means of the *Engineering News Record* Construction Cost Index. If all project costs were adjusted using only the *Engineering News Record* Construction Cost Index, the total cost of the 56 projects in 1993 dollars would be about 20 percent less, at $1,177.3 million.

Specific problems identified in the editorial are addressed in the following paragraphs.

### Problem #1

Was a beach always present throughout the duration of the project?

### Answer

In the past, monitoring of Corps beach nourishment projects, on the whole, has not been as good as it should have been. However, since enactment of the Water Resources Development Act of 1986 (Public Law 99-662) (WRDA '86), and the advent of more strict cost sharing and local cooperation agreements, monitoring has, and will continue to improve. Adequate funds must be included in the Corps budget and in local cooperation agreements to carry out this most valuable

activity. When this has been accomplished, many of these concerns can be more satisfactorily answered.

The NRC report (1995) recognized this issue. Under the paragraph (page 150) on "Environmental and Monitoring Issues," the report states:

> "Most beach nourishment programs are inadequately monitored following construction. Monitoring of the physical environment and the performance of the fill material is often too limited in scope and duration to quantify project performance adequately."

> The report then goes on to recommend: "Sponsors of all beach nourishment projects and programs should establish adequate monitoring programs to evaluate changes in the physical and environmental conditions."

The Corps final report (1996) addresses this issue in the conclusions, which state: "Historically, funding has not been provided to perform post-storm surveys of beach nourishment areas. Therefore, Corps districts have been unable to measure project performance of completed projects." Another conclusion is: "There is no funding mechanism to maintain a national data base of Federal shore protection projects. This makes it difficult to access the costs and other project specifics of the program and respond to inquiries from the Administration, Congress and others." These conclusions are repeated in the accompanying *Journal* article.

We are uncertain as to what is meant by "maintained" in the discussion of problem 1. If it means "periodic nourishment" then the report does address this comment. Table 13 in the report (CORPS, 1994) (as well as Table 4-2 in the final report [CORPS, 1996]) shows actual expenditures by project, including "periodic nourishment." This table shows that for the Tybee Island, Georgia project, it had an actual periodic nourishment cost of $1,989,000. Table 16 of the report (CORPS, 1994) (as well as Table 4-10 in the final report [CORPS, 1996]) gives the volume of sand used in "periodic nourishment." For Tybee Island, both tables show a placement of 1,300,000 cubic yards. This shows the project was "maintained."

The current Tybee Island project was initiated in 1975–1976 with the placement of 2,237,330 cubic yards of material. Eight years later in 1984, 1,529,960 cubic yards, or 68 percent of the volume was still in place. While the first renourishment did not occur until 1986, 10 years after initial nourishment, the latest Tybee Island Reevaluation Report, dated 1994, calls for a 7-year renourishment cycle. We believe the project is performing as designed and is a successful project.

There could be some confusion between the terms "dry sand beach" and "designed beach." Just because sand is not visible does not mean it is not useful. A similar misunderstanding was raised earlier by Leonard *et al.* (1990). These comments were addressed by Dr. James R. Houston (1991). In his article Dr. Houston states:

> "A major deficiency in beachfill design in the past was failure to realize that the subaerial beach was a part of a larger beach system and the entire profile down to a closure depth had to be nourished. The idea of nourishing the entire active profile is based on equilibrium beach concepts and the Bruun rule. The Bruun rule is an assumption stating that beaches erode such that the equilibrium profile remains constant, and there is a simple lateral displacement of the profile as erosion occurs. A logical extension of this concept is that the effects of erosion can be countered by building the profile back out uniformly, and this requires fill volumes to include material to build out the subaqueous portion of the active profile."

In other words, sand does not have to be seen to be a part of the protection system. Standard engineering practice for estimating nourishment rates (long term erosion) is to first develop a sediment budget. When determining a sediment budget for a given area, compartment boundaries are established. The seaward limit of such a boundary is usually established at or beyond the seaward limit of the active sediment movement. The landward boundary is established beyond the anticipated erosion limit for the life of the study (normally 50 years). The long term erosion rate is normally defined as the net loss of material from within these boundaries. The long term erosion rate is "not" the loss of dry beach sand only.

The underwater portions of the beach profile play more of a role than the dry beach in reducing wave energy. Recent experience with near shore berms placed in deep water indicates there is significant wave energy reduction from such berms. Even if instances occur where the dry beach is under water during storm events, the beach nevertheless still plays a significant role in reducing damages. Hurricane Andrew overtopped the beach projects in the southern portions of Broward County, Florida in August 1992 and yet physical damages from waves and storm surge were minimal. Similar conditions were experienced earlier at Myrtle Beach, South Carolina during the passage of Hurricane Hugo in 1989, due to the presence of a locally funded beach project.

While there may be a necessity to have a "dry" beach for recreation purposes, since enactment of WRDA '86, Corps projects are not justified on recreation but on storm damage reduction. So a "dry" beach to provide recreation opportunities is an incidental benefit. See Figure 1 in the accompanying *Journal* article for the relative importance of recreation benefits versus storm damage reduction benefits.

The NRC report (1995) on page 149, under a paragraph heading of "Measures of Success," recognizes that:

> "There is no single measure of success for beach nourishment programs because programs usually serve a variety of objectives. Therefore, various measures of success need to be defined for beach nourishment programs. A program may or may not be successful in meeting all objectives underlying its establishment. Some of the performance measures may occur in the near term, such as a program's response to physical forces. Other objectives may occur over a much longer term—for example, the realization of related shore community economic development goals and reduction of shoreline retreat . . . <u>The fundamental measure of success is the life span of the beach fill and how nearly actual performance conforms to predicted performance.</u>" (Underline added by author).

The report goes on to recommend: "Sponsors of beach nourishment programs should quantify and report on four measures of performance of beach nourishment projects. The measures are:

- dry beach width,
- total sand volume remaining,
- poststorm damage assessments, and
- residual protection capacity."

The final report (CORPS, 1996) and the accompanying *Journal* articles do not address this issue directly, only that as indicated above, that additional funds need to be provided to perform adequate beach surveys.

## Problem #2

What was used as the "original" estimate to be compared with the actual experience?

### Answer

The "purple report" does not address what was used as "an original estimate." This oversight was rectified by the final report (1996). This final report clarifies what is meant by "original" (see following paragraphs) and presents the detailed project history of six projects: Ocean City, Maryland; Carolina Beach and Vicinity, North Carolina; Tybee Island, Georgia; Grande Isle and Vicinity, Louisiana; Presque Isle Peninsula, Erie, Pennsylvania; and Surfside/Sunset and Newport Beach, Orange County, California. This history provides a succinct profile of how projects change over time.

A fundamental question to ask regarding project evaluation is what is the reference point for "before" and "after" cost estimates. There is no single answer, however, due to the planning, design and construction process. This process often takes 10–15 years for these projects. Cost estimates change through the process each time new information is obtained, new models are developed, or analysis is conducted for an update. It would be foolish for the Corps or any entity to stay with an initial cost-estimate, despite the fact that a decade passes and circumstances change.

The NRC report (1995) also addresses this "time lag" between the start of study and the start in construction. On page 150 under the paragraph heading "Measures of Success" the report states:

"The federal process for renourishing a beach from the reconnaissance study through the first nourishment typically takes 10 to 15 years . . . These long planning times burden the local sponsor with years of uncertainty about storm damage. Some of the delays are caused by the rigid and sequential federal process, which includes detailed agency reviews and waiting times for next-phase funding. Other delays are caused by slippage in USACE planning schedules." The report goes on to recommend: "The federal government should reduce the time now needed to process a beach nourishment project. The following steps should be taken:

- revise the federal approval process to streamline approvals and funding time frames,
- increase the level of contracting for technical services by consultants to the USACE, and
- modify the laws and regulations to make federal funding for locally constructed federal projects available upon approval of preconstruction engineering and design by the Assistant Secretary of the Army for Civil Works."

It should be emphasized, however, that the benefit-cost ratio must always be positive, regardless of the change in costs and that decision criterion is the most essential one to meet. Federal water resources development projects are the only Federal projects subject to rigorous benefit-cost methods. This benefit side of the equation was addressed in the final report (CORPS, 1996). The attached *Journal* article also provides information on benefits of Corps shore protection projects (see Table 4 in the accompanying writeup).

Projects can change drastically over what is normally the extended period of time between first authorization and construction. During the course of these years, land conditions, Federal cost sharing and design requirements, and non-Federal needs and concerns change. For example, approximately half of all the beach erosion control and storm damage reduction projects were first authorized by Congress by the mid-1960's. Most of these early beach projects planned to utilize borrow areas located in inland waterways, rivers, estuaries, or dry land quarries, due to limited offshore dredging technology. Because of uncertainties involved, Federal participation in periodic nourishment was limited to ten years from completion of construction. The Coastal Engineering Research Center, which was established in 1963, was just starting to develop the technology that is now available to all the Corps districts. Cost estimates for these early Corps projects contained in the Congressional documents did not always accurately reflect what was finally constructed. Federal participation in periodic nourishment was subsequently extended to 15 years in the Water Resources Development Act of 1976 (Public Law 94-587) and to 50 years in WRDA '86.

The Corps final report (1996) attempts to compare "actual/estimated" for like projects rather than "actual/estimated" for projects which changed drastically from authorization to construction. This explains why, in the above paragraph on comparing costs, not all of the projects could be compared. To measure performance, the report used the preconstruction cost estimates available at the time the local cooperation (the project) agreement was signed by the Corps and the non-Federal sponsor. Agreements are normally signed after preconstruction documents are completed. The execution of the agreement and project funding by the local, state and Federal interests is, in reality, the legal commitment by all parties to fund and construct the project. As projects change over time, Congress is made aware of these changes during the yearly budget testimony and the non-Federal sponsor through refinements to the project cooperation agreements.

If the "Northern New Jersey" project referenced to in problem 2 is the Sandy Hook to Barnegat Inlet (Seabright) project, the report (CORPS, 1994) lists the total cost at $394 million. This project is included in Table 22 under "Authorized/Awaiting Initiation of Construction." It was beyond the scope of the study to analyze costs for projects which were not con-

structed. The final report of the Corps (CORPS, 1996) lists this project as "Under Construction" with a total 1995 cost estimate of $516.5 million.

### Problem #3

The importance of the U.S. beach replenishment.

### Answer

It is true that the Corps Phase I report (CORPS, 1994) reports that only 0.3 percent of the nations' total shoreline is protected by Corps projects. The report, recognizing that this number could be misleading, also shows that the Corps projects are located in the 2,700 miles of coastline identified in the Corps (1971) shoreline study as "critical erosion areas." As further indicated in the report, 226 miles of the nation's coastline is protected by 82 specifically authorized and constructed projects. These projects protect 1.1 percent of the significant erosion areas and 8.4 percent of the critical erosion areas. The final report (CORPS, 1996) further subtracts the coastline of Alaska and arrives at (respectively) percentages of 0.6, 1.5 and 8.7. Under any standard, the Corps shore protection program is minor and does not provide comprehensive, continuous protection as some would have us believe.

Another indication of the scope of the nations' shore protection was explored by Houston (1995). In an article for *Coastal Forum 1*, Dr. Houston shows figures for shore protection in West Germany, Japan, Netherlands and Spain. He notes that the Netherlands spends twice as much annually as does the United States; Germany six times as much; Spain 15 times that of United States expenditures and Japan 100 times as much on an annual basis. Those expenditures are for much shorter coastlines than those of the United States. Further, each country spends a much greater share of its GNP for shore protection than does the United States.

With respect to the southeastern coast of Florida, which may be the most heavily developed coastal area in the United States, the coastline from Canaveral Harbor to Key Biscayne is about 195 miles. Of this distance, almost 75 percent or 145 miles is developed. Of the developed area, 39.1 miles are protected by completed Corps projects (27 percent) and an additional 31.5 miles (22 percent) are covered by authorized projects which may or may not ever be constructed. To state that "Fully 50% of the developed open ocean shoreline mileage along the East Coast of Florida, . . . is replenished or is about to be," (underline added) is overstated. Please note that these authorized projects can only be constructed with full Federal and local support, including funding. The final report (CORPS, 1996) contains this information as well as additional information on the Florida coastline. As noted above, project selection is based largely on benefit cost analysis. The fact that the Corps is more involved in some locations than in others, merely suggests that there is a great deal of economic activity at risk. The NRC (1995) reports that for the Miami Beach area (included in the above Canaveral Harbor to Key Biscayne stretch of beach):

> "[F]or example, foreign tourists spend $4 billion a year at Miami Beach. The Miami Beach fill has been in place since the late 1970s at a cost of $52 million. The capitalized cost of the fill is about $3 million per year. Thus the fill provides about $700 annually in foreign revenue for each $1 invested in beach nourishment. This amount is a remarkable return considering that agricultural subsidies do not result in much more than $1 in revenue per $1 in subsidy."

### Problem #4

Beaches continue to be emplaced using non-probabilistic design methods which would only work if we knew the schedule and intensity of storms for the next few decades.

### Answer

Nourishment intervals are estimates and may vary depending upon the number and magnitude of storms. There is no one model that can predict exactly what nature will do to beach nourishment projects and the associated renourishment. We believe, however, that the Corps' numerical modeling capabilities which are based on engineering and scientific principles are as close to state of the art as is available, to date. In addition, methodology is currently being developed by the Corps to incorporate risk analysis in planning and design procedures. Actual nourishment intervals are also a function of Federal and local budget constraints as well as other nontechnical constraints (e.g., availability of dredges). The report (CORPS, 1994) focuses on the total amount of sand placed versus the estimated volume; the nourishment interval was not a feature of the report. Over a 50-year project life, actual nourishment intervals will vary, some shorter than predicted and some longer, but on the average, only time will tell if Corps' estimates are accurate. As noted earlier in the discussion of problem 1, the NRC report (1995) states on page 149;

> "The fundamental measure of success is the life span of the beach fill and how nearly actual performance conforms to predicted performance."

The enactment of WRDA '86 has changed the role of the Corps in executing civil works projects. Provisions of WRDA '86 require the increased participation of local cost sharing partners and imposed specific restrictions on all cost growth, not just for shoreline protection projects, but for all projects. A project cost estimate for each civil works project is established, which if exceeded by 20 percent, requires additional Congressional action. These changes have resulted in a commitment by the Corps to more efficiently and effectively manage civil works projects by establishing an increased accountability for project estimates, budgets and schedules. As an example, in the Jacksonville District, recent experience has been that work for shoreline protection projects is being bid consistently under or near the Government estimate (Manatee County, Sarasota County, and Dade County).

Concerning the Ocean City, Maryland project, the editorial is correct in that about 30 percent of the 50-year estimate of sand has already been placed on the beach. This project was subject to back to back severe storms in the winter of 1991–1992, just as the original beach restoration project was near-

ing completion. During this period, Ocean City mayor Roland Powell was quoted as telling the *Baltimore Evening Sun* on November 1, 1991 that "Millions of dollars of property have been saved . . . it's very comforting to have that protection." On January 6, 1992, after the second major storm, mayor Powell praised the project for saving the boardwalk, one of the area's major economic assets. Maryland Governor William D. Schaefer said that public and private property in Ocean City would have been damaged more seriously if the dunes had not existed. He also said the cost of maintaining the dunes is justified. The development at Ocean City currently exceeds a value of $2,000 million. The cost of the Ocean City project through 1993, at 1993 dollars, is estimated at $45 million. The Baltimore District estimates a total of $93 million in storm damage reduction benefits for the 1991–1992 period alone. From a cost-effective standpoint, Ocean City, Maryland is one of the Corps' most effective projects.

The NRC (1995) made specific reference to the Ocean City project. In the writeup beginning on page 37 under the paragraph heading "Public Expectations About Design Performance," the report in part stated:

> "The media generally report the visual results of a storm but often fail to note that designers expected and planned for significant movement of sand off a beach during a storm . . . Media coverage of beach fill performance at Ocean City, Maryland, is a case in point . . . The Ocean City project has attracted widespread news media attention owing to its visibility, scale, and large investment of federal and state funds. Damage prevented has limited news value, especially to the broadcast news media. In the absence of damage to buildings, news coverage has focused on apparent storm impacts on the beach and dune. Much of the sand that had moved off the beach was later determined through site surveys to still be present in the designed project profile, just seaward of the visible beach . . . Through public education it was explained that the sacrificial nature of beach nourishment is an essential element of such projects. As a result there is strong and continued local and state-level support for the project and planned renourishment program. However, members of the public outside the local area generally lack this background and depend on news media coverage, which has ranged from accurate technical reporting to sensationalistic live reports from the beaches during the height of the storms."

In further discussion of problem 4, at Folly Beach, South Carolina, technological advances in numerical modeling for beach projects had occurred by the time the Folly Beach study was conducted. The methodology used for the project was based on historical data of beach loss for the area which incorporated all erosive factors into the calculation. For the Myrtle Beach area, the Corps used the best methodology available at the time the project studies were conducted. The renourishment cycles for the area were based on long-term erosion rates in accordance with Corps' policy for determining the amount of advanced nourishment at the time of the analysis. Modeling by the Corps indicates, that for the Seabright, New Jersey area, the average nourishment interval over a 50-year period should be 6-years. It will take many years of project life to prove or disprove this average interval.

The final report (CORPS, 1996) contains sufficiently more comparison data on sand emplacements, including project by project data for both initial restoration and periodic nourishment. The data show there is significant deviation on a project by project basis. For example, for *initial restoration*, there were 39 projects which could be analyzed. Of these 39 projects, estimates ran from an underestimation in sand required of up to 85 percent, to overestimation of the sand required by 73 percent. For the program as a whole, there were nine more projects which showed underestimations than showed overestimation. Similarly, the report (CORPS, 1996) shows data for 31 *periodic nourishment* projects. Of these, estimates ran from an underestimation of 298 percent to overestimation of 100 percent. For the *program as a whole*, there were 16 more projects which showed overestimation than showed underestimations. An overestimation of 100 percent (for ten of the projects) showed that nourishment was not carried out as planned for several reasons. In some cases, the local sponsor withdrew from the project agreement, in some recently constructed projects the schedule had slipped so that nourishment was really not due yet and in only two cases was the lack of nourishment an indicator of less-than-expected erosion rates.

Because of the highly variable and largely unpredictable nature of coastal storms, the total actual cost of projects and the volume of sand required can differ greatly from those forecasted during planning and design. The key to this analysis of project performance is based on a probabilistic assumption that, over the period of analysis (generally 50 years), a comparable sequence of events will occur as in the past. Hence, the longer the period of record, the more likely that the "estimated" costs and quantities of sand will converge on the "actual" or measured costs and quantities of sand. However, as expressed in the "purple report," for the *program as a whole*, from 1950 to 1993, the Corps estimates of both quantities of sand and cost of projects is excellent, with quantities of sand being slightly greater than estimated and costs being slightly less than estimated.

## LITERATURE CITED


HOUSTON, J. R., 1991. Beachfill performance. *Shore and Beach*, July 1991.

HOUSTON, J. R., 1995. Coastal Engineering Research Center, Waterways Experiment Station, *Coastal Forum 1*, January 1995.

LEONARD, L. *et al.*, 1990. An analysis of replenished beach design parameters on U.S. East Coast Barrier Islands, *Journal of Coastal Research*, 6(1), 15–36.

NATIONAL RESEARCH COUNCIL (NRC), Committee on "Beach Nourishment and Protection," *Beach Nourishment and Protection*, Marine Board Commission on Engineering and Technical Systems, 1995.

PILKEY, O. H., 1996. The fox guarding the hen house. *Journal of Coastal Research*, 11(3), iii–v.

SUDAR, R.A.; POPE, J.; HILLYER, T., and CRUMM, J., 1995. Shore protection projects of the U.S. Army Corps of Engineers. *Shore and Beach*, 63(2), 3–16.

U.S. ARMY CORPS OF ENGINEERS. 1971. *National Shoreline Study*.

U.S. ARMY CORPS OF ENGINEERS, Shoreline Protection and Beach Erosion Control Study; Phase I: Cost Comparison of Shoreline Protection Projects of the U.S. Army Corps of Engineers. *IWR Report 94-PS-1*, January 1994.

U.S. ARMY CORPS OF ENGINEERS, Shoreline Protection and Beach Erosion Control Study; Final Report: An Analysis of the U.S. Army Corps of Engineers Shore Protection Program, *IWR Report 96-PS-1*, June 1996.

| Journal of Coastal Research | 13 | 1 | 265–267 | Fort Lauderdale, Florida | Winter 1997 |
|---|---|---|---|---|---|

REPLY

# Reply to: Hillyer, T. M. and Stakhiv, E. Z., 1997. Discussing of: Pilkey, O. H., 1996. The fox guarding the hen house (editorial). *Journal of Coastal Research*, 11(3), iii–v.

Orrin H. Pilkey

Duke University Program for the Study of Developed Shorelines
Department of Geology
Durham, NC 27708, U.S.A.

## WHEN THE FOX PREACHES, LOOK TO YOUR GEESE*

Hillyer and Stakhiv discuss my editorial entitled "The Fox Guarding the Henhouse" (Pilkey, 1995). I welcome the opportunity to continue a dialogue on this important issue. The discussion of the success or failure of the Corps in predicting beach nourishment costs is a critical one at this time. The current administration in Washington is attempting to reduce federal funding of such projects and the Corps is in the middle of a large campaign to assure their future financial well being by continuing to replenish American beaches.

The original editorial (PILKEY, 1995) described numerous shortcomings in the 1994 Corps of Engineers report entitled *Shoreline Protection and Beach Erosion Control Study; Phase 1: Cost Comparison of Shoreline Protection Projects of the US Army Corps of Engineers* (hereafter referred to as the "purple report" in reference to the color of it's cover). My editorial basically argued that the Corp's claims of excellent success in predicting the upkeep needs or the long term costs of replenished beaches were wrong. This was primarily because the report compared actual and predicted cost and sand volume numbers without considering whether or not the beach remained in place between nourishments. In addition, the purple report failed to note which of the many cost predictions that come out during the planning phase of a project were used for comparison. However, predictions given to the Congress and the public are the only ones that count.

Hillyer and Stakhiv don't fundamentally dispute my conclusions. The point brought forth in my editorial, that cost prediction success does not equate to project success, remains uncontested. We are told that the situation is complex, that storms are highly variable and unpredictable, that the required volumes of sand can vary widely, that there has been little monitoring of beach behavior, that things are improving, that we have learned from past mistakes, and that if you consider underwater sand to still be part of the project, things aren't all that bad. I wish that the public was told about all of these things during the societal debate about whether or not to nourish a beach. Because the public is not told about these uncertainties and because replenished beaches are regularly underestimated in terms of cost and sand volumes, the procedure amounts to a bait and switch operation. Perhaps even worse, the underestimation of costs precludes consideration of other modes of shoreline management such as relocating buildings from the shoreline.

Hillyer and Stakhiv note that some of the shortcomings in the purple report have been addressed in purple report, part 2. At the time of this writing, we have been unable to obtain a copy of purple report, part 2 although organizations promoting Corps participation in beach replenishment have already quoted from it extensively.

Although they do not contest my conclusions, accompanying Hillyer and Stakhivs article is a large fogging cloud of beside-the-point statements (paraphrased below in italics) some of which I will address.

- *Why shouldn't the Corps be evaluating its own work, other agencies do it.* The Corps is different from other agencies such as the Environmental Protection Agency and the U.S. Geological Survey. These agencies have been assigned long term tasks and are not required to live from task to task. Corps districts must survive on project funding. This means that proof of success is a life or death matter for the agency, realistically making objectivity an impossibility.
- *Hillyer and Stakhiv claim a misunderstanding of a critical phrase in my Tybee Beach example. I agreed with the purple report that predicted and actual costs for the Tybee beach project were close but I pointed out that the purple report did not address the point of "whether or not the beach was maintained between nourishments".* This seems like a very clear statement to me but Hilyer and Stakhiv claim to be uncertain as to the its meaning. They note "we are

* A German proverb.

*96101 received and accepted 23 August 1996.*

uncertain what is meant by 'maintained' in the discussion [by Pilkey on the Tybee Island project]. If it means [maintenance through] 'periodic nourishment' then the [purple] report does address the comment." As it turns out the beach was basically gone for a decade between the initial and the second emplacement which was the point I made and the point they chose to ignore. Putting it another way, the purple report seems to have been written by accountants concerned only with the numbers of sand volume and costs and unconcerned with the critical public issue of whether the beach stayed in place.

- *In evaluating project success, underwater sand should be taken into account and therefore the disappearance of the subaerial beach is not a good measure of beach performance.* The evidence (*e.g.* THIELER *et al.*, 1995) indicates that eroded replenishment sand eventually is spread across and well beyond the shoreface. There is no study, theoretical or field, that shows that this layer of sand impacts in any significant way on storm damage mitigation or on the quality of the recreational beach. Such a sheet of sand is not part of the storm damage mitigation discussed in project design documents. Damage prevention is assumed in Corps documents to be a function of berm or dune design. Certainly the public is not warned ahead of time that, even after the subaerial beach has disappeared, the project may be considered a success. The underwater sand argument is a sham.
- *The Corps numerical modeling capabilities are based on engineering and scientific principles which are as close to the state of the art as is available.* The computer modeling (*e.g.* HANSON, 1989) may be state of the art but it is not even close to the state of nature (PILKEY *et al*, 1993; YOUNG ET AL, 1995; RIGGS *et al*, 1995)). Beach design which assumes a sandy shore face of uniform grain size without rock outcrops, an erosion rate unaffected by underlying geology, an equilibrium grain size, a system in which all sand movement is by wave orbital interaction with the bottom bounded by a sediment fence called closure depth and a system where wave height is the only controlling factor in beach changes depends on oceanographically invalid assumptions.
- *On the basis of HOUSTON's (1995) report, it is apparent that the US national nourishment effort is a small one compared to other countries.* Houston's 1995 estimates of the national federal expenditures for beach replenishment ($15 million per year for the last 40 years) are used by Hillyer and Stakhiv to make the point. We are currently reviewing and updating a summary of the national beach replenishment experience and I believe Houston's numbers for the annual cost of beach replenishment in this country will prove to be off by one order of magnitude. His numbers are vastly understated because of the long time frame for averaging beach nourishment costs (in the last decade, US nourishment costs have skyrocketed) and because he does not include many federal projects, such as mitigation and navigation dredge disposal projects and no state and local projects. Replenishment in this country consists of far more than the federal effort (LEONARD *et al*, 1990a).
- *Miami Beach has been a huge success.* This has nothing to do with the subject at hand; the predictive success of Corps beach nourishment cost and sand volume estimates. In fact, although underestimation is the norm, the Corps greatly overestimated costs and sand volumes for Miami Beach (LEONARD *et al.* 1990b).
- *The mayor, the governor and the Corps are all happy with the way the Ocean City, Maryland beach performed during a storm. [This assertion comes in response to my assertion that close to a third of the volume of sand predicted to be needed in 50 years has already been placed on the Ocean City beach in 3 years.]* The fact that the beach did what it was supposed to do in a few storms has absolutely nothing to do with the predictive success of the Corp's nourished beach design. The design predictions of cost and sand volumes for the Ocean City beach are spectacularly off target. As in the case of Ocean City, underestimation of sand requirements is frequently explained away by unexpected or unusual storm events.
- *Broward County, Florida, and Myrtle Beach, South Carolina, replenished beaches successfully prevented property damage from hurricanes.* Neither of these beaches was struck by the brunt of the storms. Broward county experienced only a small storm surge in Hurricane Andrew. In the case of Myrtle Beach, there was, in my opinion, no replenished beach remaining when Hurricane Hugo struck. And of course whether damage was prevented by the beach is beside the point. I did not argue this point in my editorial.
- *"The key to analysis of project performance is based on a probabilistic assumption that over the period of analysis (generally 50 years) a comparable sequence of events will occur as in the past" This is in response to my criticism that the Corps uses deterministic models rather than probabilistic ones recognizing the random occurrence of storms.* A probabilistic approach should provide a prediction with an error bar; "the nourishment interval will be 5 years plus or minus 4 years." But this does not happen. Making the assumption that the shoreline will behave in the next 50 years like it did in the last 50 years is wrong. It's wrong because this assumes that replenished beaches behave like natural beaches which is decidedly not the case.

In summary, my conclusions concerning the lack of validity of the purple report remain unchallenged. If one reads the Hillyer and Stakhiv discussion, keeping in mind the original criticisms in my editorial, it should be clear why the corps should not evaluate its own projects. Hillyer and Stakhiv wander far from the point throwing in numerous facts and assertions which serve only to befuddle and baffle the reader and prevent a clear objective analysis of the national replenishment program.

## LITERATURE CITED

HANSON, H., 1989. GENESIS, A generalized shoreline change numerical model. *Journal of Coastal Research*, 5, 1–27

HILLYER, T.M. and STAKHIV, E.Z., 1996. Discussion of Pilkey, O.H., 1996, The fox guarding the hen house (editorial). *Journal of Coastal Research*, 13(2), xxx–xxx.

HOUSTON, J.R., 1995. COASTAL FORUM I. *Shore and Beach*, January,

LEONARD, L.A.; DIXON, K.L. and PILKEY, O.H., 1990a. A comparison of beach repienishment on the US Atlantic, Pacific and Gulf Coasts. *Journal of Coastal Research*, SI #6, 127–140

LEONARD, L.A.; CLAYTON, T. and PILKEY, O.H., 1990b. An analysis of replenished beach design parameters on U.S. East Coast barrier Islands. *Journal of Coastal Research*, 6, 15–36

PILKEY, O.H.; YOUNG, R.S.; RIGGS, S.R.; SMITH, A.W.S.; WU, H. and PILKEY, W., 1993. The concept of shoreface profile of equilibrium. *Journal of Coastal Research*, 9, 255–278

RIGGS, S.R.; CLEARY, W.J. and SNYDER, S.W., 1995. Influence of inherited geologic framework on barrier shoreface morphology and dynamics. *Marine Geology*, 126, 213–234

THIELER, E.R., BRILL, A.L.; CLEARY, W.J.; HOBBS, C.H. and CAMMISCH, R.A., 1995. Geology of the Wrightsville Beach NC shoreface; implications for the concept of the shoreface profile of equilibrium. *Marine Geology*, 126, 271–287

YOUNG, R.S., PILKEY, O.H., BUSH, D.M. and THIELER, R.S., 1995. A discussion of the generalized model for simulation of shoreline change (GENESIS). *Journal of Coastal Research*, 11, 875–886