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Beach nourishment and public policy after Hurricane Floyd: where do we go from here?

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Abstract

This paper examines the public policy and implementation of beach nourishment within the context of the aftermath of Hurricane Floyd. It further examines the deficiencies of current policies impacting decision making. Some of the factors ignored in the decision making are: enhancement of the ecology of the beach, especially in terms of sea turtle nesting grounds; socio-cultural impacts, i.e. cost–benefit analysis of tourism, historical life-way patterns, community tax base; sand source allocation and forward contracting; and the adverse impact of current FEMA disaster insurance policies. The findings indicate a need for major revisions to FEMA's policies, the parameters used for designing nourishment projects, and the need to include other cost/benefits, such as tourism, when scoping the project. Recommended policy changes are included in the concluding section as a basis of discussion — not as definitive procedures. © 2001 Elsevier Science Ltd. All rights reserved.

1. Introduction

One major factor has guided beach nourishment projects whether private, state, or federally funded: storm mitigation [1]. Since the hurricanes of the mid-1990s, however, a new dimension of nourishment has come into play: that of habitat enhancement and cultural preservation. Public policy of nourishment for mitigation purposes is well established. As of this writing, there is virtually no beach nourishment policy designed primarily for habitat enhancement or cultural/historical preservation.

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This paper examines existing beach nourishment policy, the recent findings concerning habitat enhancement, and a case for cultural preservation. Future federally funded nourishment projects need to account for the impact of the project on habitat and the cultural resources of affected communities. Economically based cost–benefit analysis, using ACOE standards, inadequately addresses ecological and social impacts [2]. The ACOE policy, and the procedure to determine project viability, need to be reconsidered. A revised approach is presented in the concluding section.

2. Background

The interface of ocean and land—the beach—is essentially a storm barrier. Beaches protect both developed and man-made areas during storms. They also provide recreational outlets for millions of people each year. Beaches are dynamic: eroding in the winter, accreting in the summer, constantly shifting with waves, currents, and wind. This natural erosion/accreting cycle moves the shoreline over time [3].

The forces of nature change the face of the beach considerably. Seasonal changes from storms and long term geological movement of the sub-aerial portion of beaches are more readily seen than sub-aquatic changes. Because of such fluctuation, beaches may accrete or even disappear for periods of time. The normal movement of sand is offshore during storms and in the winter. Generally, the sand moves back on-shore during the relative calm of spring and summer. Sand also moves laterally with longshore currents, oblique wave action, and the recently discovered microwaves. Because of this movement, beaches, especially those of barrier islands, tend to migrate [4]. The migration movement on the East Coast, Mid-Atlantic Region is in a north–south direction. The coastline of the United States can be divided into regions, as indicated previously. Each region has its own beach characteristics, erosion rates, accretion rates, etc. The focus area in this paper is the Atlantic Coast, central/southern region. This region can best be described geographically as the coast from Maine to the east coast of Florida. Conveniently this area may be divided into three regions, north (Maine–New York), central (Long Island–the Carolinas), and southern (Georgia–Florida). North Carolina fits geographically into the central region but geologically into the southern region. This conclusion is based upon the geological make-up of the sand found on the beaches of North Carolina. Made up of biogenically derived, rather than glacial moraines, sand, the beaches in North Carolina reflect the more southern aspects of beach erosion and natural movement than does that of the central region [1].

The most severe storms for the North Carolina coast come during the winter months, the infamous nor'easters. Along with these storms come erosion problems that typically would resolve themselves during the accreting summer months. Summer, however, also is the hurricane season and, with it, the potential for devastating damage to beaches, property, and the economy of the region. While the natural beaches may well survive massive erosion during a storm, beaches altered by structures may not fare so well.

With the coming of humans to the beach, and their associated hardened structures, the natural cycle is often altered. Structures tend to impede the movement of sand needed for beach accretion, exacerbating down-shore erosion processes. The technological fix of seawalls, groins, jetties, and other hardened structures have all been shown to intensify down-shore problem [5]. The only acceptable engineered system for the protection of natural and man-made areas from the effects of erosion may be beach nourishment [1].

Beach nourishment is an engineered system that entails the placing of sand on an eroding or limited-width beach, in design contours of natural proportions both on the subaerial and subaquatic landscape, for the purpose of extending the beach seaward. Other engineering techniques have been tried with some success, but nourishment is the only engineered shore protection system that addresses the problem of sand deficit. The addition of sand to the beach and, therefore, widening the beach seaward, creates a larger barrier to storm surge and wave action [1,3,6]. The public only vaguely understands sacrificing sand to storm surge and wave action as a protective measure [7]. Opponents of nourishment point to the sacrificial nature of the projects and claim that the money spent is wasted; that nourishment cannot check the advancing sea. Opponents also debate the economic issues of restoration, the appropriate use of nourishment as flood protection in conjunction with the National Flood Insurance Program, and nourishment's role in pre-disaster prevention and post-disaster assistance [8]. Regardless of its shortcomings, beach nourishment has been accepted as the shore protection system of choice in the United States, Australia, and Europe [1].

There are side effects from nourishment projects not anticipated by the engineers. A wider beach means more beach goers. Whether used for strolling, sunbathing, swimming, surfing, or just plain hanging out, a wider beach means more people. This, in turn, means more business to the beach communities dependent upon their beaches for survival. As the coastal economy retreats from traditional maritime pursuits, such as fishing, crabbing, and shrimping, and becomes more service oriented, their continued viability becomes more dependent upon tourism. Tourists, in turn, are drawn to the "pristine" beaches of the coast, and the wider the beach, the better. The economic engine fueled by high property values and tourism (the largest industry in the US) has brought increasing attention to the problem of beach erosion and beach nourishment. From 1955 to the present the US spent approximately $15 million per year to protect the nation's beaches. In contrast, the tourist industry created a $17 *billion* trade surplus, in the US, in 1992 alone [9]. A good example of the economic value of beach nourishment to tourism is found in the Miami Beach area [10,11].

In economic terms, business activity and new economic development in one region of the country does not necessarily mean increased overall economic wellbeing. While a new plant or construction project may increase economic activity in one location, there is usually a loss of economic activity somewhere else. Thus the gains and losses cancel, producing a net gain of zero. The exception to this "rule" is when gains (or losses) are generated by outside, i.e. foreign, sources. This is the situation found in the Miami Beach area [11].

Foreign tourists spend about $2 billion a year at Miami Beach businesses. The beach nourishment project for Miami Beach cost $52 million in 1972 with a capitalized cost of approximately $3 million per year. Simple math indicates that for every $1 invested in nourishment, there is approximately $700 in return from foreign tourists. Every beach and every nourishment project is not going to see this kind of return on investment, but the increase in tourism will more than likely off-set the investment. The foreign revenues from tourism reach approximately $80 billion per year, and beaches are the number one attraction for these tourists [10,11]. This being the case, the benefits from tourism should be accounted for in any cost–benefit analysis of nourishment projects. Unfortunately, federal guidelines state that these benefits are "indirect" benefits and thus are omitted from the B–C analysis [12].

One of the problems associated with an increase in tourism to an area is the accompanying development required to house, feed, and entertain the influx of new tourists. Overburdened infrastructure may need upgrading and new buildings reduce open space, increase congestion, and change the "character" of the community. The beach nourishment issue, in its broader context, is a policy problem. Land use planning, the Federal Emergency Management Agency (FEMA) and the National Flood Insurance Policy (NFIP) considerations, and the desired rate-of-growth all need to figure into the nourishment equation with federal, state, and local input invested.

Another unintended side effect of nourishment projects is the enhancement and protection of wildlife habitat, especially that of endangered species, most notably sea turtles. Although there are only a few scientific studies completed concerning turtle habitat restoration and/or enhancement, primarily because of beach nourishment, every one of the studies has found either (1) no harm or no change in turtle behavior or (2) an increase in hatchings, nesting, and initial survival of turtle young. The positive environmental effects of nourishment projects also include enhancement of shorebird habitat and fishery enhancement. Furthermore, research indicates that infaunal communities of the intertidal portion of the beach recover rapidly from unavoidable burial during the nourishment process [1,11].

Although burial of infaunal species is a fact when undertaking a nourishment or renourishment project, the more important issue is recovery time. How long does it take for a species to return to pre-nourishment levels and activity? There have been only a few studies completed and most were limited in scope, time, or species. All studies, however, show that only temporary alterations in abundance, diversity, and species composition of the infaunal assemblages of the subaerial beach habitat occur. This alteration lasts from a few weeks to a few months. Going hand-in-hand with the subaerial studies are the subtidal areas and fauna.

The biota of the subtidal areas range from sand-dwelling invertebrates to reef-dwelling invertebrates to fish to crustacean assemblages. Many of the species, especially the infaunal assemblages, are the same as the lower inter-tidal zone but of much greater density. The finfish populations of the near-shore sand bottom habitat are also abundant, diverse, and commercially important. For example, penaeid shrimp are found in large populations in the southeast, like North Carolina, and are a major part of the fisheries industry. These small shrimp, in turn, attract many of the recreational and commercial nearshore or epibenthic finfish and motile crustacean species [1,13,14]. Sub-aquatic species can be negatively impacted by a nourishment project in the following ways: (1) burial of infaunal species; (2) increased sedimentation seaward of the surf zone as the beach profile redistributes the sand; (3) alteration in depth of water and wave action; and (4) temporarily elevated turbidity levels.

The results of burial of infaunal subtidal species is much the same as on the sub-aerial beach. Disruption of species diversity and density occurs followed by rapid recovery to pre-nourishment levels. Increasing the sedimentation is usually only temporary, depending on the composition of the fill material and the length of time it takes for the project to redistribute to a more stable profile. This sedimentation process, however, has not been found to have any ill effects on the nearshore biota [14]. Physical alteration of the surf and nearshore zone and its effect is not well documented. Any direct effect as a result of the nourishment project on the motile crustacean and finfish populations should be avoidable by the species affected. It is possible that the larval forms could be adversely impacted by the increased turbidity; further study is required before a definite conclusion can be made.

Turbidity and its impact on nearshore zones are greatest when hardbottom or seagrass species are impacted. The increase in turbidity and silt loading may result in long term damage to resources by inhibiting filter-feeding processes, decreasing photosynthesis, and smothering some organisms. Nearshore reef systems may be buried by redistribution of sand fill resulting in harm to the reef. Much of this negative impact, however, is undocumented and built on possibilities and speculation. More in-depth studies need to be conducted on these biosystems to verify impacts. In contrast, studies conducted on soft-bottom nearshore zones indicate only a relatively modest alteration in species diversity, abundance, and composition. Further, such alteration is of a short-term nature with the area typically returning to pre-project levels within a few months.

Another issue concerning environmental issues for nourishment projects is the impact on the borrow site itself. Sand for such projects may be obtained from deposits in the upland area, estuarine or inlet systems, sandy shoals in nearshore areas, from dredging operations, or maybe bought from other sources [15]. This latter source of sand will be examined later in conjunction with the discussion on policy problems and decision-making processes.

Using sand from upland sources is a good news–bad news situation. If the source of the sand is close enough to the project area, the cost of mining and trucking would be minimal compared to dredging, thus reducing the overall cost of the project considerably. That is the good news. The bad news is that the sand material from upland sources frequently is not adequate for a fill project in terms of grain size, composition of primary sand, and inappropriate materials often mixed in the fill material. More bad news is the increased use of heavy equipment can damage the road system, disrupting the flow of beach traffic and, therefore, beach recreation. The rest of the bad news is that trucking costs increase almost geometrically as the distance from the project site increases [15]. The next low cost sand source is from inlets-sand shoals deposits in estuarine areas.

While the sand from inlet areas can sometimes contain too many fines for nourishment purposes, it usually can be used. Like the upland sources, however, there are problems associated with this source. Obtaining dredging permits is becoming increasingly more difficult as we recognize the fragility of the nearshore and estuarine communities. On a positive note, however, if the nourishment project can be tied to a navigational dredging project, the cost of obtaining the sand drops way off and a marginally viable (economically) project becomes possible. Another positive with the nearshore deposits is the capacity of dredges to work nearly year round. This should not be overlooked, as wintertime operations are mandatory for some areas that may impact breeding habitat, such as for sea turtles. Offshore deposits account for the majority of the sand sources for nourishment projects at the present time [16].

The impact on offshore sources is even less well understood than the effects on nearshore borrow areas. Few long-term studies have been conducted and monitoring projects have yielded varying results. For the most part, the findings have been comparable to the nearshore infaunal studies. That is, borrow areas return to normal levels of bio-diversity and abundance within a relatively short period of time, usually within 1 year. Factors that could increase the intensity of damage and the long term recovery process are: (1) creation of pits at the borrow site which disrupt natural wave energy, beach stability, and reduce sediment transport down-current; (2) removal of benthic species from the surface of the borrow area affecting the food supply of other species; (3) reduction of dissolved oxygen levels due to deep holes. Finally, silting of adjacent reefs and hard-bottoms could endanger species dependent upon the reef systems for food and shelter [1].

The environmental assessments that have been carried out, along with the monitoring of active projects, indicate temporary disruption to the immediate ecosystem during a nourishment project. The recovery period appears to be swift in duration, less than a year. The effects to the ecosystem in which the subaerial and subaquatic fauna live seem minimal. One of the biggest concerns to environmental activists is the effect of nourishment on sea turtles. The effect of nourishment projects on sea turtles appears to be an enhancement of habitat with few negative side effects.

Loggerhead (*Caretta caretta*) turtles, along with the green (*Chelonia mydas*) and leatherback (*Dermochelys imbircata*) turtles, nest on the shores of southern region beaches during the spring through late summer. Sea turtles come onshore during the night, dig their nesting holes, lay their eggs, and return to the sea. Eroded beaches greatly reduce the nesting area for the endangered animals. Nourishment projects can, and have, restored beaches and provided improved sites for nesting areas, which results in an increase in nests, hatchlings, and survival rate of young turtles. Several monitoring studies show nest densities increase after the completion of a nourishment program [17]. There are a few concerns, however, about the timing of restoration projects.

Projects scheduled during the spring and summer months must be monitored to assess the impact on nesting turtles. The pipeline for sand transport may pose an impassable barrier to egg-laying females, thus denying them necessary nesting opportunities. The noise of machinery at night may also impact nesting location choice. A nesting relocation project may be needed. Many of these concerns can be mitigated by thoughtful construction sequencing and minor adjustments to normal construction practices. Monitoring aspects for nourishment contracts must be spelled out in the contract documents. Monitoring phases and what should be monitored are discussed later in the policy section. Most published studies have shown either (1) no change in the turtle nesting habits or hatching rates or (2) an increase in both nesting density and an increase in hatchling survival [17,18].

3. Policy: past and present

Policy makers, until recently, have tended to ignore the impact of nourishment projects on the biota and ecosystems of the subaerial and subaquatic beaches. The economics of these projects also, traditionally, discount the biologic, cultural, and recreational aspects of beaches and, therefore, the beach communities that the projects would impact. A number of pieces are needed to complete the policy puzzle as it now stands such as economic analysis, disaster assistance from FEMA and NFIP, and the decision-making process itself. The first step is identification of the stakeholders.

4. Stakeholders

Key stakeholders include the beach communities where the project is to take place, the federal agency in charge of the project, and the contractor. The less obvious stakeholders are the "day-trippers" or beach users, the ecosystem of the beach, and the non-market user. Even within the obvious stakeholder group, there are occasions when they are left out of the decision-making process or only given a minimal opportunity to participate. The decision to undertake a nourishment project, and the planning and execution of the project may all be done without adequate input from all of those significantly affected by the project. Public hearings are seldom held, and much of the design work and impact analysis is conducted in a public vacuum [1].

The federal agency in charge of nourishment projects is the US Army Corps of Engineers (ACOE). They are a major stakeholder, in that, without these projects and other related projects, they would be out of business. ACOE authority to administer, design, and implement nourishment projects is derived from several statutes. Among these laws are: The Rivers and Harbors Act amendments of 1968, Section 111; Public Law 84-99; Water Resources Development Act of 1976; Water Resources Development Act of 1986; and the Water Resources Development Act of 1992 [1]. Included within this authorization, however, is a great deal of administrative discretion in which Corps responsibilities are not clearly defined. Essentially the ACOE has operated in a vacuum with regard to nourishment projects. For example the division that handles nourishment projects has poor communications with the division which designs dredging projects. As noted in the discussion on sources of sand, dredging is the major source of sand for nourishment projects. Inlet dredging projects *and* nourishment dredging projects are often conducted along side one another, with the dredging company dumping its sand offshore while the nourishment contractor brings offshore sand onto the beach. Not only is this economically a waste of time and money, but it is poor public policy. Last but not least, the ACOE's Shore Protection Manual is seriously outdated technologically and requires updating. In fact, although the ACOE requires private designers to use the manual, the ACOE does not use its own manual for design reference [1,2,7].

Contractors also have a large stake in nourishment/dredging projects. It is commonly thought that contractors like large projects, the bigger the contract the greater the amount of money. Such a perception may not necessarily be true. A great deal of the money in federal projects, especially ACOE projects, is inflated, because of the number of redundant procedures required by the Corps. For example: the project manual spells out the materials requirement and equipment standards that ACOE requires, as part of the project which a contractor submits to the ACOE. A contractor often will simply duplicate the list required in the manual and submit it. The paperwork requirements are extensive and expensive.

Local communities have a limited voice in the allocation of resources for nourishment projects. The projects are usually conceived at the state level which then inform communities that a nourishment project is forthcoming. However, the Water Resources Act of 1992 specifies that local governments need to be more involved in the planning of projects, this has not happened though because of the requirement that communities fully fund the studies.

Furthermore, beach users (as a distinct group separate from the owners of beachfront property) and non-market users (those who may not go to the beach but derive pleasure knowing it exists) are seldom, if ever involved in decision-making processes concerning the state of our beaches. A recent study has shown that, in North Carolina, there are 140 beach users for every beachfront property owner [9]. The decision-making process not only involves who gets a project and how the project is designed, but also the source of the sand for nourishment.

5. Sand sources

Increasing demand for suitable sand sources for nourishment projects has fostered a bidding war and increased the scarcity of the material. Economics dictates that as demand rises so does prices — that is true but in this case it also means the possibility of not having a project started because the cost cannot be justified. Sand allocation is a complex problem which is becoming more difficult to address [19,20]. As discussed previously, simply possessing sand may not be sufficient, it must be the right kind of sand for the particular beach, it must be economically obtainable, and in sufficient quantities for not just the initial project but for periodic renourishment required for the life of the project.

Several communities and states, most notably Florida, have begun to look to foreign sources for their sand. There have been talks between Florida and the Bahamian government concerning sand-mining operations for nourishment projects. These talks have not led to any formal negotiation and probably will not, but the implication for project-by-project planning is clear. The major objections to the foreign (Bahamian) sand prospects are threefold: (1) although economic incentives are great, the Bahamians do not want to nourish Miami's beaches at the expense of their own, (2) the Bahamians will not agree to, or allow, the ACOE to test the sand as required by contracts [2,19] and (3) foreign sand sources increase the possibility of introducing exotic biota into the ecosystem.

Earlier possible environmental impacts of sand mining and a lack of monitoring were discussed. For policy purposes, inadequate levels of knowledge may lead to improper and costly decisions. Ranging from the destruction of benthic populations to alteration of the ocean bottom, beach project designers have yet to consider the side effects of their decisions. In addition to the environmental impacts are economic concerns and long-range planning issues for beach nourishment.

6. Project timing

Typically it takes up to 15 yr to get a nourishment project from idea stage to initial completion. This timeframe includes the 5–6 years between the time a project is authorized and the time it actually starts [2]. This is a significant amount of time that is unnecessarily wasted and may pose a major threat to the communities involved. A good example is evident in the recent destruction of 50% of oceanfront homes and businesses on the east side of Oak Island, NC during Hurricane Floyd. This small community experienced $100–200 million in damages to one portion of its town while the west side received very little damage; in fact, the western portion of the town lost no homes or businesses to the storm surge, winds, or accompanying flood. Why the difference in damage? The west side of the island has had an ongoing nourishment project that built up its beach and thus the erosion and surge protection necessary to weather such storms as Bonnie, Dennis, and Floyd. The east side of the island, however, was awaiting final go-ahead from the federal government for its own nourishment project. This go-ahead was given ironically, just days after Floyd left the village devastated. The delay in the decision-making process by the federal agencies is matched by the short-range planning of various local and state governments concerning the life of a project.

Often communities do not understand that a nourishment project is a long-range commitment, typically 50 yr according to the ACOE. State and local government planning efforts hardly ever parallel the life cycle planning of the ACOE [1]. Thus the availability of a sand source, the monetary commitment required, and technical understanding of a project is lost on the officials who most need to understand the implications of the projects.

Another concern is the lack of advance planning for emergency renourishment of projects that have a storm event exceeding the design capabilities of the project. Such storms create the immediate need to restore beaches for mitigation and recreational purposes, as well as local economic reasons. Economic issues are another policy concern that needs to be examined.

7. Economics and insurance

Current planning regulations, concerning a nourishment project, require a cost–benefit study to be conducted in order to justify a project. The ACOE regulations, however, do not allow economists or economic evaluators to incorporate such economic indicators as tourism, property tax values, quantity of users or the quality of the beach as a variable, or the impact on the cultural heritage of the community in their calculations. Such economic planning is clearly behind the curve when it comes to assessing the true cost or benefit of a project [11]. The scope of a project may also determine its viability. Normally, the larger the project, the more economically viable it is because the cost is spread out among more users. However, such issues do not seem to be taken into consideration by the controlling federal agencies. Regional planning by the ACOE and other agencies is needed to produce a more cohesive and coherent planning scheme. Consolidation of adjacent projects would also improve the situation by lowering the cost of a project and producing greater benefits for all investors. In addition to the direct cost–benefit considerations, indirect cost potential of insurance losses must be addressed.

FEMA and NFIP have long provided insurance to property owners who are in "harms way." Disaster after disaster, FEMA and FEMA-managed NFIP have provided funds for rebuilding of property but none to protect this property from future harm. In 1994 FEMA was reorganized and acquired a new mission statement which included four management objectives: (1) mitigation; (2) preparedness and training; (3) response and recovery effort; and (4) operations support. Most individuals are familiar with roles 2–4, however, the mitigation role is relatively unknown and basically unused in the day-to-day operation of FEMA [8].

There are at least two reasons why FEMA, and through its management, NFIP, should turn to beach nourishment as a mitigation practice that would lower disaster costs of coastal storm events. The first reason is authorization. The Robert T. Stafford Disaster Relief and Emergency Assistance Act, which is administered by FEMA, authorized the president to distribute monies to state and local governments to help them respond to disasters. The Act provides for: (1) emergency work to save lives, property, etc (and more importantly for our discussion); (2) permanent work to restore public facilities to pre-disaster levels [1,8]. This provision would allow immediate funds to be applied to restoration of previously nourished beaches to pre-storm levels. Such funding is needed in many coastal communities.

Additional reasons that FEMA should be looking to beach nourishment programs for mitigation against storm damage are included in the following five items related to NFIP. Beach nourishment mitigation factors important to NFIP are: (1) although nourishment does not halt erosion it does return the beach to its former erosion pattern; (2) nourishment widens the buffer zone between structures, roads, and other infrastructure and wave energy; (3) nourishment reduces over-wash and thus flooding; (4) nourishment adds sand to the overall littoral budget, reducing down-current erosion patterns; and (5) it may be repeated as required. The coastal floodplain, according to NFIP, is divided into two areas: the special flood hazard area, the "100 yr flood plain"; and the V-zone or "high hazard" area. The V-zone is described as "an area of special flood hazard extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high-velocity wave action from storms or seismic sources" [21]. Nourishment projects have proven effective storm mitigation programs and need to be considered for additional funding by NFIP. Legal authority exists for such activities in the form of the Riegle Community Development and Regulatory Improvement Act of 1994 [22]. This law included NFIP reforms which made NFIP responsible for administering mitigation assistance grants for beach nourishment. The problem is that while NFIP is charged with this responsibility for administering P.L. 103-325, FEMA is charged with administering NFIP. This double layer of bureaucracy is stifling the intent of the mitigation programs and, in effect, increasing the cost of disaster relief [1,8].

8. Conclusions and recommendations

Beach nourishment works. Whether one is talking in terms of storm mitigation or in economic terms such as tourism and community growth, it is inescapable that beach construction is a viable and economically feasible alternative to erosion control. North Carolina provides a good example of the type of storm protection such projects can provide. Contrast the huge amount of destruction caused by Hurricane Fran to North Wrightsville, Topsail, and Surf City beaches, which were not nourished, to the relatively light damage to South Wrightsville Beach, Carolina Beach, and Kure Beach which had completed nourishment projects in place. Mitigation projects such as these are authorized by law and need to be implemented wherever it is cost efficient and feasible. Therefore, government, whether federal, state, or local needs to approach beach nourishment as *the* alternative for storm protection *and* recreational restoration of their beaches. The governmental agencies involved should require a multi-disciplinary approach to planning, design, implementation, monitoring, and ongoing evaluation for these projects.

The design manual of the ACOE is technically outdated. As stated previously, the Corps does not even use its own manual when designing nourishment projects, although it requires private sector design firms to do so. This manual was last published in 1984 and technological advances have outstripped its usefulness. The ACOE needs to either (1) update the existing manual to reflect the technological advances in beach nourishment design or (2) publish a new manual specifically devoted to the subject at hand.

Sand sources are becoming scarce, and long range planning concerning these resources has not been a part of the ACOE planning process. A better methodology is needed for assessing these resources. It should include: a design parameter of quality and quantity of sand for a particular project; effect of removing the sand on adjacent beaches; an examination of sand by-pass systems, if necessary. Forward contracting for sand should be a requirement of every nourishment contract. The need to identify and obtain suitable sand for the long term is vital to nourishment projects. There needs to be a procedure in which two or more communities can share sand sources. Sand from one area may not be suitable for the closest beach but suitable for the one down current and vice versa.

Heretofore public involvement in the decision-making process for beach nourishment has been minimal at best. Such lack of involvement has generated misinformation and a misconception concerning the nature of beach nourishment. Local communities with proposed nourishment projects need to address the concerns of its citizens by holding public information meetings, disseminating relevant informational material concerning the long term management process, and involve their citizens more effectively in the decision-making process. Federal and state agencies also need to become more involved in the information process. Public hearings, progress reports, and technical explanations would fall into the sphere of ACOE responsibility.

Contingency plans for emergency renourishment after a major storm event need to be in place. FEMA, through its administration responsibilities for NFIP's mitigation program, is required to have in place such programs – it is time they were made to do so. Emergency designs could be part of the original contract documents, sand source allocations reserved, and contractors identified in advance in order to shorten the time between disaster and recovery.

The time between the initial request for a nourishment project and its actual start must be decreased. A 10–15 yr time span is inexcusable. The process needs to be streamlined by (1) allowing local governmental entities to contract for feasibility studies, (2) outsourcing, as much as possible (from ACOE) the engineering/design of projects, (3) streamlining the environmental and cultural investigations necessary to acquire a suitable sand source. The environmental/cultural/economic impact of a project needs to begin earlier in the design phase, indeed should be incorporated into the feasibility study done prior to design.

Economic evaluation of projects needs updated. Judging the economic feasibility of a project solely on storm mitigation is light years behind current economic theory and practice. The impact of increased tourism, beach-users, and non-market uses should be considered in the decision-making process. This evaluation should also include the environmental benefits of wildlife habitat enhancement.

FEMA should reassess its role in flood/disaster insurance in view of the success of nourishment programs. This reassessment should not be construed to encourage development of on-the-beach structures. Such structures should not be rebuilt with taxpayer monies, but relocated or, if necessary, bought out and abandoned after a storm event. FEMA and NFIP should include emergency nourishment plans in their arsenal of disaster management tools and consider pre-disaster funding of eligible projects to prevent disaster relief from being needed.

In conclusion, beach nourishment repeatedly has proven to be the most effective engineering method for storm mitigation now available for our coastal communities. These projects have proven to be economically viable. In many cases beach nourishment programs return more to the local communities in terms of economic prosperity, state revenues in terms of taxes, and to the federal government as seen in the increase in GNP, than the initial investment cost. The environmental benefits are just now being acknowledged as the increasing numbers of studies show increased nesting densities and sea turtle hatchling survival and an increase in endangered shore birds. The lack of long-term harm from turbidity, infaunal disruption, and bethnic invasion enhances beach nourishment as the alternative of choice for our coastal communities, state legislatures, and the federal government.

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