BEACH NOURISHMENT: THE MAGIC BULLET FOR GEORGIA'S SHORE?

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Abstract. In recent years, shoreline development has increased exponentially, especially in the Southeast. As a result, concern about coastal erosion has mounted. In order to minimize the economic risk of shoreline erosion and to address recreational and business interests, coastal managers have adopted various beach modification practices, including beach nourishment. Each of these has significant financial, hydrological, and ecological impacts, with associated political consequences. By altering the physical structure of the beach and the near-shore environment, beach nourishment can have significant short and long term effects on beach ecology, including the invertebrates, birds, fish, and even nesting sea-turtles. Economically, beach nourishment procedures are very expensive because it enlists a large amount of equipment and man-hours, requires costly maintenance, monitoring, and assessment, and lasts only a few years. This paper will focus mainly on the many potential economic and biological impacts of beach nourishment, leading to recommendations about the precautions and analysis needed in responsibly undertaking such projects.

INTRODUCTION

In the past few decades, shoreline development has exploded, so much so that now two-thirds of the world's population resides within the coastal zone (Komar 1998). As a result of this increased development, concern about coastal erosion has mounted. Worries about the loss of recreational beaches, coastal homes, and other coastal amenities, have led to increased action towards controlling the erosion "problem." Actions are typically implemented that attempt to control erosion rather than addressing the actual problem (i.e. what to do about development along an eroding beach).

Beaches are naturally dynamic systems, often receding or building out on a regular basis due to sea level rise, storms, sediment transport, and other factors. In order to halt this natural movement of beaches, coastal engineers have adopted many different techniques designed to minimize the impacts of shoreline change on coastal structures. In response to local pressures to stabilize the shoreline, Georgia's Department of Natural Resources (DNR) has indicated a preference for beach nourishment as an alternative to engineered structures. This preference comes in the face of heavy debate among the scientific, environmental, political, and engineering communities about nourishment. Georgians must first understand both the pros and cons of beach nourishment, and then must critically analyze the both sides before deciding on its implementation. If nourishment is selected as the primary erosion management alternative, then much thought and care must be taken to ensure that beach nourishment projects are both economically efficient and environmentally sound.

COASTAL EROSION AND NOURISHMENT

Alongshore and cross-shore sediment transport shape the shoreline profile on both pristine and developed beaches. These sediment transport systems work together to create a dynamic geological setting that is constantly changing under the influences of tides, currents, storms, and sea level rise. Many interpret this movement as beach erosion. However, scientists who study beaches over long periods see it as a natural process of migration. Beachfront development ignores the dynamic movement of the shoreline, dictating instead that the beach maintain a constant position. Despite these efforts, sediment transport systems and sea level rise will continue to shape even an artificially stabilized coastline. This ongoing battle between development and the sea leaves behind a heavily modified, unstable coast that may erode even faster because the beach has not been allowed to move as it naturally would.

Property owners have found many ways to protect man-made structures from an eroding shoreline, including beach nourishment (Valverde 1999). Beach nourishment involves the placement of sand on a beach in order to increase its width and/or to keep the beach in the same place. Nourishment is considered a "soft" response to shoreline erosion, unlike seawalls, groins, and jetties, which are considered "hard" responses. Thus, nourishment is often permitted, while many of the "hard" responses are not. However, there are still many issues that need to be addressed when evaluating a beach nourishment project. Although there are many benefits which can result from beach nourishment, the adverse impacts are often given much less press, and thus are not well-understood by the general public. This paper

provides an overview of the many potentially negative economic and ecological impacts that nourishment may bring to the Georgia coast.

Economic Impacts

The average beach nourishment project is estimated to cost upwards of $5 million per kilometer (Komar 1998). Nourishment projects are funded by a variety of sources that typically include a combination of federal, state, and local tax dollars. Historically, federal funds have been a major component of project funding, but in recent years, as federal funds shrink, state and local governments have borne more of the project costs. (Valverde et. al. 1999). Thus, it is important that tax payers become better informed and better able to weigh the costs and benefits of beach nourishment in order to decide whether public tax dollars should be used for beach nourishment.

Nourishment is a long term financial commitment because it must be carried out repeatedly in order to maintain the location of the beach (Minerals Management Service 2002). Furthermore, the time between nourishment events depends on the rate of erosion (Minerals Management Service 2002). For example, one project in South Carolina lost all of its nourished sand within six months of completion because of storm activity (Komar 1998). A section of Tybee Island GA (18,000 ft.) has been nourished multiple times since 1976 at a net cost of over 10 million federal dollars (Valverde et. al. 1999).

The cost of nourishing a beach is also dependent upon the characteristics of the borrow sediment, which include mineral composition, sediment size, sediment content, thermal capacity, color, and sorting properties (National Research Council 1995).

Sediment grain size influences the durability and aesthetic quality of the project, which in turn affects the economics (Duke PSDS 2002). Fine sand is typically more desirable because it produces a more aesthetically pleasing beach. However, it is more expensive and will result in a shorter-lived project (Duke PSDS 2002). Conversely, coarse sand will produce a more durable project, but the beach may be unpleasant for beachgoers (Duke PSDS 2002). Harvested sand may also be an unsuitable color, which has the potential to adversely affect tourism because dark sediment is viewed as unsightly and may produce a surface that is too hot for bare feet (Duke PSDS 2002).

An additional consideration is an insufficient long term supply of compatible sediment for nourishment. This has become a reality in the state of Florida, which has adopted nourishment as its standard erosion management practice (Davis et. al. 2000). Appropriate nourishment material has become scarce in Florida, which has led to a dramatic increase in project costs as the state begins an international search for usable sand (Davis et. al 2000).

Beach nourishment can also have secondary economic impacts on the local economy. For example, sand used in nourishment projects often migrates over time to sites where it is much less desirable (Komar 1998, Valverde et. al 1999). There is a high probability that sand placed on St. Simons Island could migrate into the navigation channel traversing St. Simon's Sound, which lies between St. Simon's Island and Jekyll Island. Increased sedimentation in the channel will require more frequent dredging, thereby escalating the channel's maintenance costs.

The general approach to addressing beach erosion is comprised of the following options: (1) take no action, (2) retreat – remove and relocate structures, (3) nourish the beach, or (4) use "hard" stabilizing structures (Komar 1998). Beach managers should conduct a cost benefit analysis to determine which of these strategies makes the most economic sense for the Georgia coast. When conducting the cost benefit analysis, managers should remember that factors in addition to tourism revenue, such as the value of the sport fishery, must be considered. The long-term sustainability of the state's beaches may rely on a combination of approaches.

Ecological Impacts

Many different organisms, including invertebrates, fish, birds, and turtles, inhabit the coastal region of Georgia at some point in their life cycle. Beach nourishment can potentially have a large impact on all of these groups. Invertebrates such as coquina clams (*Donax* spp.) and mole crabs (*Emerita talpoida*) inhabit the wet beach. These species make up a significant portion of the prey base for ecologically and economically important coastal birds and fish (Peterson et al. 2000). A few different studies have investigated the impacts of beach nourishment on these invertebrates, and have shown the consequences, in the short term, to be negative (Peterson et al. 2000, Engineers 2001). Long-term recovery time, however, is variable, depending upon the length of the project, the timing of the project, and the interval between nourishment episodes (Rice 2002).

The post-nourishment loss of invertebrates from the beach ecosystem has wide ranging ramifications for many different organisms, especially fish. Invertebrates make up a large portion of the prey base for many of shoreline fish, and their loss may mean the loss of many fish as well (Rice 2002). Additionally, nourishment stirs up sediments around the project site, which can lead to gill damage and possible death of near-shore fishes (Rice 2002). As with invertebrates, the long-term impacts to fish may vary widely (Engineers 2001, Rice 2002).

Invertebrates and fish reside in the beach ecosystem year round, so are disturbed no matter when a nourishment project is carried out. However, other organisms use the beach on a seasonal basis. Many types of birds use the

Georgia shore either as a stopping point during migration, or as a nesting site during the breeding season. When migrating, birds utilize all of their fat stores as they fly from one location to another. Without suitable food sources at each stopover, these birds risk, at best, not being able to complete their migration, keeping them away from their breeding habitat, and at worst, starvation and death. If nourishment is carried out at the same time that birds are migrating, then the loss of invertebrates and fish could have devastating affects on the bird populations (Rice 2002). Similarly, if nourishment is carried out during breeding season, then nests will be disturbed (and sometime destroyed), birds will be stressed, and food sources necessary to help young chicks grow will be lost (Rice 2002). These issues need to be taken into account when designing and planning a nourishment project, or it could have dire consequences for the North American shorebird population.

The threatened loggerhead sea turtle (*Caretta caretta*) also uses Georgia beaches for nesting, and this nesting process can be significantly impacted by nourishment procedures. Often, after nourishment projects are completed, the rapid erosion of the beach leads to the creation of escarpments (small cliffs) in the sand. If these "cliffs" are over 18 inches tall, it may be impossible for a turtle to climb over them, thus preventing the turtle from ever reaching its nesting sites (Rice 2002).

If these barriers are not an issue, and turtles can reach their desired nesting sites, a whole other set of issues comes into play. First, beach compaction due to the use of fine-grained sand may make it harder to excavate a nest (Mortimer 1990). On the other hand, overly coarse sand may lead to the collapse of nests during excavation (Mortimer 1990).

Another critical factor to nesting success is the temperature of the sand into which eggs are laid. The sex of turtle hatchlings depends on the temperature of the environment in which they are incubated, and the temperature of the beach is highly dependent upon the color of the sediment (Mrosovsky and Yntema 1980). Therefore, a nourishment project that utilizes the wrong color sediment could alter the sex ratio of emerging turtles. This could, in turn, have a significant impact on the future breeding success of an already threatened species (Milton et al. 1997).

Policy Recommendations

a. **Establish a series of goals and objectives for Georgia's oceanfront beaches**: The first step that the Coastal Resource Division (CRD) of the DNR must undertake before investigating the potential nourishment of Tybee Island, Sea Island, St. Simons Island, and Jekyll Island is to establish a set of long term and short term goals and objectives for the management of the beaches of these islands. A successful management strategy must consider all of the dynamics that shape the shoreline if it is to achieve the public's goals. Additionally, these goals must be flexible in order to adapt to physical and natural changes in the beach ecosystem, as well as to changing political and social paradigms.

b. **Educate the community**: The majority of Georgians are unaware of the impacts that sea level rise will have on the developed beaches of Georgia. Sea level rise means that an aggressive strategy of shoreline protection must be undertaken if existing structures are to be adequately protected. If nourishment is the shoreline protection strategy of choice in Georgia, then Georgians must be fully aware of the environmental impacts and financial burdens that nourishment will bring.

c. **Determine if an adequate, long-term source of compatible sediment exists**: Georgia should undertake a comprehensive background study to determine the long-term availability and cost of securing appropriate fill material before adopting nourishment as the primary protection strategy. To date, nourishment has been undertaken a total of eight times along the Georgia coast: Tybee Island has been nourished four times with the use of government funds and Sea Island has used private funds to nourish four times (Valverde 1999). Now, nourishment is proposed for St. Simons Island and Jekyll Island. Yet, Georgia has not looked into the long-term availability of appropriate fill material. Georgia must learn from the mistakes of other states, such as Florida, where nourishment projects are becoming increasingly expensive due to a lack of suitable sediment (Davis 2002).

d. **Establish a comprehensive ecological monitoring system**: It is imperative that the long term ecological impacts of nourishment projects are studied. Without this understanding, managers and the public may make decisions that will lead to the demise of many beach-dwelling creatures. Beach nourishment projects, when undertaken, must be timed to avoid interfering with the crucial life-stages of the many organisms which inhabit the beach ecosystem. Additionally, a monitoring system must be established to analyze the ecological effects of all nourishment projects. Beach ecology should be assessed before, during, and at regular intervals after nourishment. The short and long term effects on the biota should be analyzed to determine if, and how, the nourishment project is negatively

affecting the ecology. This knowledge can then be used to guide future nourishment projects

e. **Establish a comprehensive economic monitoring system**: The economics of all nourishment projects should be carefully scrutinized and cost-benefit analyses performed to determine if nourishment projects remain worthwhile. Coastal managers must assess if nourishment efforts become more costly than the value of the benefits received.

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