BOA VIAGEM EROSION PREVENTION AND BEACH NOURISHMENT PROJECT

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RESUMO
Recife está diante de uma importante decisão a respeito do destino da paria da Boa Viagem (BV). Partes da praia experimentam problemas de erosão que ameaçam prejudicar a propriedade adjacente. Uma proposta foi feita para se criar uma estrutura artificial para proteger a linha de costa e aumentar a área de praia disponível para uso. As proteções da linha de costa e aumento da área de praia, devem incrementar o bem estar social. Haverá impactos negativos de magnitude desconhecida associados a construção dessa estrutura. Esses incluem perda de acesso a água, aumento da erosão da praia a jusante do sentido da corrente, impactos ecológicos nos sistemas recifais, perda de retorno financeiro do turismo, e impactos negativos nos residentes de Boa Viagem, dentre outros. Este trabalho examina como conceitualizar a decisão de se implementar ou não essa estrutura que foi projetada. Enfocamos a incerteza e a irreversibilidade associada com efeitos positivos e negativos associados ao projeto, e como essa incerteza deve ser incorporada ao processo decisório. Também enfocamos a necessidade de mais informação ser recolhida antes que a decisão final seja tomada.

ABSTRACT
Recife faces an important decision concerning the fate of Boa Viagem Beach (BV). Portions of the beach experience problems with erosion that threaten to damage the adjacent property. A proposal has been advanced to create an artificial beach structure to protect the shoreline and increase the area of sand available for beach recreation. Protection of the shoreline and the increase in sand area will improve social welfare. There will be negative impacts of unknown magnitude associated with the development of the structure. These include loss of access to the water in the affected area, increased beach erosion down-current of the structure, ecological impacts on the reef ecosystems, loss of tourism revenue, and negative impacts on the local residents of the Boa Viagem area, among other negative impacts. Our work examines how to conceptualize the decision of whether or not to implement the beach structure project. We focus on the uncertainty and irreversibility associated with both positive and negative outcomes associated with the project, and how this uncertainty should be incorporated into the decision process. We also focus on the need for more information and discuss what types of information should be gathered before the decision is finally made.

Palavras chave: praia da Boa Viagem, engordamento de praias, urbanização costeira, participação pública
Keywords: Boa Viagem beach, beach renourishment, coastal development, public participation

1 INTRODUCTION

Boa Viagem (BV) is part of a 16 km coastline that flanks Recife, Brazil. A thriving center of recreational, commercial, and tourist activity, it is valued as one of Recife's greatest assets by residents and visitors alike. As with other environmental resources, different people have different ideas about how it should be utilized.

The local government plans to undertake a project that will alter a section of the beach where erosion has occurred.

This work aims to inform decision makers of the potential risks (environmental, social, and economic) involved in undertaking this project and to illustrate how additional information can improve the efficiency of decision-making. At present, little is known about the probability or magnitude of the impacts this project may have on BV and its surrounding community. Without adequate knowledge of the magnitude of the risk and the potential impacts involved, decision makers may arrive at an outcome that generates significant and possibly irreversible ecological and economic damage. The project is intended to create benefits by expanding the available sand area and protecting economic development, however, there is a significant probability that the project will create more costs than benefits. A structure of that magnitude is highly likely to disrupt sand movement and spread the erosion problem further north, where the beach is healthy. It is not known if beach recreationists do prefer the proposed changes over the state of existing beaches.

A decision of this magnitude warrants waiting for further information. The purpose of this work is to organize the type of information needed by: (i) discussing the role of risk in decision-making and its specific influence on the BV project; (ii) presenting the potential direct and indirect impacts involved in implementing the project through a conceptual cost-benefit analysis; (iii) highlighting the need for more information and further research in order to address BV's erosion problem in an informed and efficient manner.

BV is characterized by reefs that run parallel to the shore. The reef lies just offshore and forms tidal pools at low tide, providing an attractive and safe venue for swimming. People cannot swim beyond the reef for danger of strong currents and shark attacks. Locals and tourists use the beach for swimming, fishing, sports and

recreation, socializing, and commerce. A path for walking, running, and bicycling runs the length of the beach between the road and the sand, providing additional recreational, social, and economic activities.

In the southern half of the 16 km coastline, the governing municipality changes from Recife to Jaboatão dos Gararapes. The section of beach in question is in Recife's jurisdiction. Policies concerning the beach are not coordinated between Jaboatão and Recife, even though actions that alter one portion of the beach have the potential to create unintentional, but significant, effects both down and up-current.

There has been experience with artificial beach protection structures in Brazil. Unfortunately, this experience has been predominantly negative. In Recife, the primary concern with existing erosion is that it affects a major road that borders the beach and the first block of tall, closely packed hotels and apartment buildings. The road is under constant threat from the sea. In the section of beach where the proposed project will be built the erosion has been significant. In order to help prevent these impacts, a granite wall has been built along the whole two-kilometer length of this portion of the beach, in close proximity to the walkway on the beach side.

The 16km of beach can be separated into four general zones. The northernmost zone is characterized by large sand dunes that were not completely occupyed by the road here, although it may have covered the back side of the dunes in some places. This undeveloped area provides the beach natural sand recharge. Between the road and the beach are many recreational facilities.

The second zone stretches from the southern edge of the dune area to the granite wall. The beach is narrower in this zone, but still functions as a center of recreation and commercial activity

The third zone contains the eroded 2km of BV. This section is where the project would be. The existing wall has been unsuccessful against erosion, and aesthetically unattractive. The wall is approximately 4m high with flights of wooden steps to provide access to the beach. Few people use this section of the beach for recreation, which is totally covered by water at high tide and is rendered virtually useless until the tide recedes. In the southern two kilometers of this zone, the wall ends and the beach widens. The property behind it is largely undeveloped.

The southernmost zone of the 16 km is in the Jaboatão dos Gararapes municipality. In this zone, the dune area has been eliminated by development near the shoreline

The beach provides employment and income for a large portion of the population, from ice cream vendors to multi-million hotel chains. Refreshment stands are interspersed along the walking path that parallels the beach. On the beach, vendors sell a variety of products aimed at beach users. Also on the beach, locals rent out chairs and umbrellas. The thriving, small-scale commerce that occurs up and down BV is the only source of income for much of the population.

On a larger scale, there is income from hotels, restaurants, and apartment buildings. The 16km of coastline hosts five luxury hotels, five additional hotels, dozens of apartment buildings and numerous restaurants. These enterprises bring money into the community, and are significant as employers of the local population. The beach is a tourist attraction and draws a large number of visitors, primarily from Portugal, Germany, and other parts of Brazil. Although these visitors often use Recife as a gateway to visit nearby beaches in Pernamuco that are less urban and less developed, the visitors all spend at least several days in Recife, often more. These visitors are a critical component of the commercial activity that goes on in the city of Recife and BV. This gateway function of Recife makes it vulnerable to losing tourists to other potential gateways.

BV is also valuable to the community as a source of recreation and leisure. This value is difficult to quantify because it cannot be measured as market transactions. For many of the residents of Recife and BV, the beach is their only option for leisure. They gather there to socialize, relax, exercise, swim, fish, and play sports. In the mornings the beach is full of walkers and joggers, while swimmers make use of the safe water inside the reef. Volleyball and tennis courts are constantly filled, and dozens of young men gather on the sand for impromptu games of football. The residents of Recife value and use the beach more than any other group, and they would suffer the most at its loss, as few affordable leisure substitutes are available.

The local government intends to undertake a project that will address the erosion. A granite wall will be built perpendicular to the shore 250m into the ocean, and a second wall parallel to the beach will be connected. The area boxed in by the walls will then be filled with sand dredged from the continental shelf or from estuaries. The anticipated result is a sand area available for recreation. The project is intended to take two years to complete at an estimated cost of R$15 million. This project will require hundreds of thousands of tons of granite that must be quarried elsewhere and transported to the project site. Additionally, millions of tons of sand must be dredged and filled into the area. The filled in area will cover the existing reefs, thus eliminating the tidal pools, which are a traditional feature of the beach, and the only place where water-based recreational activity can occur.

2 PROJECT PROPOSAL AND ALTERNATIVES

2.1 Current Proposal

It is very probable that this project will cause extensive erosion down-current (north) of the project area and endanger the shoreline and existing structures as well as destroy the recreational beach. The alteration of water currents in the vicinity of these structures will endanger swimmers; debris accumulation and microbiological contamination will likely increase next to the structures. Extensive beach damage will likely incur significant social, economic, and environmental costs down-current of the project. One cannot ascertain the ability of the proposed structures to effectively trap sediment; without beach nourishment, it may be likely that more sand will be lost than gained by natural processes. One argument for delaying the project is the lack of scientific data that predicts the likelihood of success or failure.

2.2 Scaled-back Version

Studies of groins and breakwaters indicate that they cause more erosion and environmental harm than good. Consequently, we recommend that any alternative version that only utilizes components of groins or breakwaters should not be implemented. We consider breakwaters as a proxy for artificial reefs; the artificial reefs will likely display similar characteristics of breakwaters and thus should not be implemented. These structures would only repeat harmful erosion practices.

2.3 Removal of Structures

The removal of currently existing structures is also a viable option. However, structure removal is very rare and a lack of data exists concerning the impacts of projects to remove structures. Pilkey & Wright (1988) and Hall & Pilkey (1991) both note that beach processes often must be observed for decades to reach meaningful conclusions about the success or failure of coastal projects. In general, two principles apply to hard stabilization. First, it has largely proven to be irreversible (Pilkey & Dixon, 1996). Second, once a process is starting of protecting the beach, it is politically difficult to stop constructing additional structures at other beaches, because the down-current localities suffer beach erosion as a result of the original project, and these localities then demand that structures be constructed to protect their beaches.

3 RISK

3.1 Theoretical Introduction

There are significant risks and uncertainties associated with the proposed project surrounding the economic, social, and ecological impacts. Risk refers to the fact that many outcomes are probabilistic. Risk can be better understood and uncertainty can be lessened through the development of more knowledge about both the probability distribution of physical changes associated with the proposed structure, and the probability distribution describing how human activity may respond to these physical changes.

The second major implication has to do with the interplay of risk and irreversibility. If an outcome is irreversible, than this warrants a special consideration in the analysis.

3.2 Irreversibility

Another major risk is irreversibility. Impacts, good and bad, that will result from this project will be irreversible. Once the structure has been built, the role of the beach in the economy and environment of Recife will be forever altered. All of the changes that occur to the physical nature of the beach will also cause changes in the overall level of social welfare. While it is difficult to predict whether the overall change in social welfare will be positive or negative, it is important to understand that either change is likely to be permanent. The decision that is made concerning this project will affect future generations.

The implications of irreversibility are important to the policy process. The presence of an actual or potential irreversibility is a signal to be more cautious, and put projects to a severe cost-benefit test before implementation. In the presence of irreversibilities, a project needs to demonstrate a net present value of benefits far in excess of the net present value of costs in order to justify its implementation. If the irreversibilities cause negative implications for equity, environmental justice, or other decision-making criterion, this is another reason to be extra cautious about implementing the project.

Although the payoff for the project may be large if the project does not cause irreversible damage, there might not be any positive payoff if it does result in permanent damage. Indirect irreversibilities have a particularly high level of uncertainty associated with them.

When making decisions involving irreversibility it is essential that decision-makers gain enough information to make an informed decision. However, in situations where a high degree of uncertainty exists due to a lack of adequate information, policy-makers should act with greater prudence when forming their decision.

Two types of irreversibility are present in the context of this project. The first type, physical irreversibility, is an impact resulting from some anthropogenic activity that cannot be physically undone (Krutilla & Fisher, 1985).

The second type of irreversibility is economic irreversibility. Economic irreversibilities are not necessarily impacts that cannot be undone. Instead, they are impacts for which the cost of reversal is prohibitively high (Krutilla & Fisher, 1985).

Indirect economic irreversibilities also exist for the project. Vendors, other people who make their income from the beach and beach-goers in general tend to pick an area of the beach that they like and then return to that spot every time they go to the beach. Access to the 2 km stretch of beach that has been designated for this project will be unavailable to beach users for at least the 2-year estimated time of construction. If the people who used this stretch prior to construction are forced to go to a different section of the beach, it is quite possible that they will remain using those sections even after construction of the project is completed. This change in beach use would constitute an alteration of preferences, and the economic impacts may prove to be irreversible.

The most frightening economic aspect of irreversible changes in beach behavior has to do with tourists. The construction or the existence of the beach structure may deter visitors from visiting Recife. If these tourists choose to visit other beaches such as Salvador or Natal they may continue that pattern of behavior and never return.

Recife functions as a gateway, where tourists stay for several days before and after visits to neighboring beaches. Other gateway cities and their neighboring but less congested beaches are a perfect substitute for Recife, BV, and their surrounding beaches. Small changes in the quality and characteristics of BV could cause large changes in tourist preferences, and a great deal of the Recife tourist industry could move to other gateways. These changes may be irreversible because foreign tourist preference would become more oriented to another part of the coastline. Irreversible impacts, physical and economic, could potentially be devastating to the local

environment and economy, and thus must be taken into consideration.

The existence of irreversibilities, and the uncertainty regarding them, must be taken into account when gauging the potential welfare changes that accompany policy decisions.

4 POTENTIAL IMPACTS

Direct positive and negative impacts are:

- **Positive Impacts**

Increased sand area in area of project

Protection of waterfront property directly inland of project

Increased market activity and job opportunities in the project area

Rise in recreational possibilities in the project area.

- **Negative Impacts**

Probable loss of water access

2 year loss of beach access (as a result of construction)

Damage to near-shore ecosystems

Maintenance costs of project structure

Increase in the hazardous nature of the beach

Loss in aesthetic value.

Indirect positive and negative impacts are:

- **Positive Impacts**

Multiplier effect resulting from economic benefits in project area

Recreational fishing benefits by increased ease of access

Development in protected areas.

- **Negative Impacts**

Erosion of down-current beaches

Loss of tourist revenue (down-current)

Lower property values (down-current)

Loss of job opportunities (down-current)

Lost utility for beach-goers

Increases in road maintenance costs as a result of construction

Offshore marine ecosystem damage

Multiplier effect resulting from economic losses in the area.

5 PROJECT ALTERNATIVES

One of the principals of cost-benefit analysis is to focus on more than the proposed project, because alternatives to the project may have greater net social benefits. A properly constructed cost-benefit analysis would compare these alternatives to the proposed project:

- No action
- Scaled back version of the project
- Artificial reef
- Restoration of natural character of the beach through removal of current obstructions
- Soft stabilization

6 DECISION MAKING

Cost-benefit analysis is often used to measure economic impacts associated with potential projects. Such an approach centers the analysis on economic efficiency. Although economic efficiency is an important criterion in the decision-making process, other criteria such as equity, sustainability, ecological impact, environmental justice, public participation, ethics, and advancement of knowledge should also be considered.

Economic efficiency aims to maximize the difference between the social benefits and social costs of the proposed project. In theory, all social benefits and social costs could be incorporated into the measure of economic efficiency. In practice, however, cost-benefit analysis only accounts for the benefits and costs that can be easily assigned monetary values. As a result, environmental impacts, equity, and other important societal concerns are often overlooked. In these instances non-market valuation methods can be used to assign monetary values to costs and benefits that do not have market value. Since some impacts cannot be quantified in monetary terms, decision-makers must take into consideration other criteria that focus on these impacts.

Equity is one such criterion that cannot be measured in monetary values but still must be addressed. The project could disproportionately distribute costs or benefits to different sub-groups of Recife's population. Unequal distribution could intensify differences in the quality of life between different sub-groups of Recife. The concept of intergenerational equity is important because the project might have negative impacts that adversely affect future generations. Since future generations cannot participate in the current decision-making process, they may unfairly pay the price for poor policy choices (Kahn, 1998). The concept of sustainability entails the improvement of the quality of life of the current generation without detracting from the ability of future generations to improve their quality of life. If a project benefits current generations but could detract from the quality of life of future generations, it does not meet the sustainability criterion.

Environmental justice addresses the concern that some portions of the population are exposed to disproportionate amounts of negative environmental impacts (Kahn, 1998). The negative environmental impacts of the proposed project could be disproportionately borne by the poorer population of Recife.

Ethics are particularly important to include in decision-making, but are also very difficult to quantify into indicators. Using social welfare as the primary objective in decision-making has ethical implications because "deep ecologists," would argue that it is unethical to manage ecosystems for human benefit (Kahn, 1998). The government faces particularly difficult ethical decisions because it has an ethical obligation towards environmental stewardship and enhancing social welfare. It could be unethical to cause an environmental impact, which seems to improve social welfare. This may be the case, so the decision obviously cannot be made solely by analysts, but must be decided by society under the realm of their ethical obligations.

Public participation is very important in the decision-making process. Experience has shown that some people are more willing to accept negative impacts if they have been actively involved in the process of developing the

decision (Kahn, 1998). Overall public participation will yield a project that is more accurately suited to the needs of the population.

Advancement of knowledge is also a criterion that should be considered in the context of the project The proposed project would lead to a better understanding of how hard and soft stabilization techniques affect erosion. This advancement of knowledge could have a high price in terms of negative environmental, economic, and social impacts if the project is a failure. Nevertheless, the costs of an unsuccessful project may be offset by the gains in knowledge of erosion because this knowledge could be used worldwide, but this would be of little conciliation to the residents of Recife.

7 INFORMATIONAL NEEDS

Additional information includes scientific and socio-economic information, on developing and understanding of cause and effect relationships. This includes:

- Beach profile surveys
- Wave climate (seasonal height variation, strength, period, angle of incidence to the shore)
- Longshore drift (prevalent direction, intensity m/s, sediment carrying capacity, how far north does it go?)
- Sedimentary balance of the beach (done by a two dimensional yearly averaged topographic profile)
- Beach volume variation (calculated in 3D from the same profiles)
- Climatic conditions specific to the beach.
- Detailed biological surveys of the benthos.
- Importance of alternative beach characteristics to BV users.
- Determinates of beach choices of Brazilian and foreign tourists
- Impacts of truck activity on Recife's and surrounding municipalities' roads
- The true costs of project construction and maintenance of the structures.

8 CONCLUSIONS

There is an erosion problem that is threatening a major road and adjacent property. A plan must be implemented to prevent further damage; however, it is imperative that decision-makers do not act without carefully examining the potential costs and benefits associated with all possible solutions. There are many unconsidered costs and benefits of unknown magnitude associated with the project. Some of these unknown impacts may be better understood through further research and more comprehensive information concerning the preferences of tourists and other affected populations.

In order to insure that the final decision on this project results in the best outcome, certain steps must be taken before a responsible decision can be made. In depth research into the preferences of tourists and local beach users would allow decision-makers to better judge the magnitude of impacts such as preference changes, and the impact on the economy of Recife. More scientific research in the area would allow for more accurate predictions of the impact that this structure is likely to have. The collection of more information will help diminish the uncertainties that currently hinder the accurate prediction of the costs and benefits associated with this project, allowing for a responsible decision to be made concerning the threat of erosion to BV.

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