B. THE MANAGEMENT OF BEACH SAND MINING
ENVIRONMENTAL EFFECTS OF SAND EXTRACTION PRACTICES IN PUERTO RICO

Pedro A. Gelabert, Department of Natural and Environmental Resources, Puerto Rico.

ABSTRACT

Over the past four decades, sand has been extracted from the beaches, sand dunes, alluvial floodplains and residual sandy soils in Puerto Rico. This has resulted in accelerated beach erosion, among other impacts. The paper discusses various solutions to the problem of sand supply for the construction industry. Besides extraction from already utilized sources, other solutions are described: importation, manufactured sand, offshore deposits and substitute building materials. The paper recommends developing the offshore deposits and the use of manufactured sand.

INTRODUCTION

During the past four decades, the extraordinary development of Puerto Rico has altered the dynamic equilibrium between the supply and demand of sand in Puerto Rico. Progress is usually measured in terms of the concrete poured into structures. The availability of concrete as a construction material directly depends on the feasibility of extracting the sand resources. The increase in the consumption of sand depleted the accessible sources in the beaches and coastal dunes, and the price of the commodity rose abruptly. The extraction operations caused acute soil and beach erosion problems and the island lost expensive real estate properties to the sea. Thus, Puerto Rico began to lose its beaches, a natural resource of greater recreational and touristic potential than the use of sand as concrete aggregate. The Puerto Rican experience can serve as a guide to the smaller Caribbean Islands in the management of their beach resources.

As the Government limited the extraction from the beaches, the operations were transferred to river channels, alluvial floodplains, and residual sandy soils. These extractions caused problems related to soil erosion and sedimentation of the bodies of water. When the residual sandy soils were strip-mined, bedrock was exposed on the ground surface and agricultural terrain was lost. Also, coastal sandy areas were dredged leaving pools of stagnant waters. The coastal dunes were depleted eliminating the natural coastal protection along the shoreline from Loiza to Aguadilla.

CAUSES OF BEACH EROSION

Beach erosion is generated by either natural or artificial causes. Beach erosion is caused
locally by natural phenomena or man-made works. The natural causes are: (1) the world-wide rise in sea level, (2) recent diastrophic movement, and (3) destruction of the protective barrier reef.

Global warming causes the glacier ice to melt around the North and South Poles. The melting of the ice caps causes a world-wide rise in sea level. A rise of sea level in Puerto Rico or the Caribbean region, where the tide range is only one foot, could easily trigger a cycle of beach erosion.

Puerto Rico's and other Caribbean Islands' coastal geomorphic features show evidence of recent diastrophic movements. The island of Puerto Rico has suffered a major tilting in the past. The northeastern and southwestern coasts are coastlines of emergence, while the southeastern and northwestern coasts are coastlines of submergence. The island is also located close to the northern earthquake belt of the Caribbean Tectonic Plate. During the 1918 earthquake, the sea receded on the west coast. These changes in elevation of the land have generated beach erosion cycles.

Poor coastal management practices, marine pollution, dredging operations, and other human activities have degraded the water quality in the vicinity of the reefs. An imbalance between growth rate of the reef-forming corals and erosion generated by wave action has rapidly destroyed some coral reefs. A considerable retreat of the shoreline is attributed to the destruction of the protective barrier reefs by the devastating attack of swells, hurricane waves and tsunamis.

Beach erosion is caused artificially by man's action. During the past four decades, man was responsible for most of the beach erosion. The eroding human activities are outlined as: (1) reducing the supply of sand by damming most of the major rivers or building river improvement structures, (2) changing the configuration of the coastline by coastal development such as ports, groins, jetties, revetments, land reclamation projects, and sea bottom dredging operations, and (3) removing sand from the beach zone and coastal dunes for commercial purposes. The removal of sand from the beach zone has created the worst and most difficult erosion problem.

**SOURCES OF SAND**

The sources of sand are classified as marine and terrestrial deposits. The two most common marine sources are the deposits on the shore and offshore. The most common terrestrial sources are the river channel deposits, floodplain alluvial deposits, and residual soil deposits.

There are extensive deposits of sand on the shores of the island, occurring in the intertidal zone, where sand grains are deposited by the littoral drift. The beaches vary from narrow strips parallel to the coastline to broad inland deposits of more than a kilometer in width. Although these deposits were extensively mined in the past, the extraction of sand from the maritime zone for commercial purposes was prohibited by an Administrative Order of the Secretary of Natural Resources in 1993.

Some large sand deposits occur in the back beach zone. These are usually found as sand dunes and series of consecutive ancient beaches. Most of these deposits have been extracted in the past. The back beach deposits were usually in private land, where government had no jurisdiction until Law No. 138 was approved in 1968. Although it is possible to extract a portion of the dune without eliminating the coastal protection, the determination of the extraction area and buffer zone is difficult without detailed geologic studies.

The offshore deposits are classified into: (1) the submerged deposits of the island shelf, and (2) the deep sea deposits. The material available in the deep sea deposits is usually too fine-grained to meet the specifications and so deep that it is usually not economically feasible to dredge. Several deposits submerged under the island coastal shelf have been already explored by government and private enterprises. No permits have been granted to dredge these deposits. The explored deposits are the following:

<table>
<thead>
<tr>
<th>Locality</th>
<th>Estimated reserves in million cubic yards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Escollo de Arena, Vieques</td>
<td>46.0</td>
</tr>
<tr>
<td>Las Cabezas Bay, Fajardo</td>
<td>1.4</td>
</tr>
<tr>
<td>Ensenada Comezon, Rio Grande</td>
<td>0.9</td>
</tr>
<tr>
<td>Ensenada Boca Vieja, Toa Baja</td>
<td>2.5</td>
</tr>
<tr>
<td>Punta Verraco, Guayanilla</td>
<td>6.0</td>
</tr>
<tr>
<td>Punta Cachara, Ponce</td>
<td>6.4</td>
</tr>
<tr>
<td>Boqueron Bay, Cabo Rojo</td>
<td>5.7</td>
</tr>
<tr>
<td>Guanajibo Bay, Mayaguez</td>
<td>5.5</td>
</tr>
<tr>
<td>Anasco Bay, Anasco</td>
<td>0.1</td>
</tr>
<tr>
<td>Espiritu Santo Submerged River Channel</td>
<td>0.1</td>
</tr>
<tr>
<td>Loiza Submerged River Channel</td>
<td>0.2</td>
</tr>
<tr>
<td>Isabela Submerged Coastal Island Shelf</td>
<td>20-25.0</td>
</tr>
<tr>
<td>Cabo Rojo Submerged Island Shelf</td>
<td>8-13.0</td>
</tr>
<tr>
<td>Condado Lagoon</td>
<td>1.4</td>
</tr>
<tr>
<td>San Jose and Los Corozos Lagoons</td>
<td>0.5</td>
</tr>
<tr>
<td>Torrecillas and Pinones Lagoons</td>
<td>1.4-5</td>
</tr>
<tr>
<td>Guayanilla Bay</td>
<td>1-5.0</td>
</tr>
<tr>
<td>Radas Roosevelt</td>
<td>3-8.0</td>
</tr>
<tr>
<td>Cayo Largo Inshore</td>
<td>0.5</td>
</tr>
<tr>
<td>Boca de Cangrejos Submerged Island Shelf</td>
<td>0.6-1.0</td>
</tr>
<tr>
<td>Guanica Bay</td>
<td>0.5-1.0</td>
</tr>
<tr>
<td>San Juan Bay</td>
<td>2.6</td>
</tr>
<tr>
<td>La Plata Submarine River Channel</td>
<td>0.3-0.8</td>
</tr>
<tr>
<td>Total</td>
<td>135.6-150.5</td>
</tr>
</tbody>
</table>
SOLUTIONS TO THE PROBLEM

The immediate problem in Puerto Rico - a relative scarcity of sand - could be resolved by increasing the rate of extraction in the existing permits, but this action will reduce the life of the deposits. The long-range solutions studied are the following.

Exploiting Renewable Beaches

If the quantity of sand deposited in the beach is greater than the amount extracted, theoretically sand extraction should not cause beach erosion. However, the quantity to be extracted without causing erosion is insignificant to supply the construction industry. Comprehensive studies must be conducted on the supply of beach sand, littoral drift and accountability of the amount extracted.

Extraction from Coastal Dunes

The beach sand blown by the wind accumulates behind the beach deposits forming dunes which protect the coastal lowlands during storm surges. Most of the sand dunes have been excavated and eliminated in Puerto Rico due to poor management practices in the past. Thus, this will not be a feasible option to supply the construction industry at the present time.

Dredging River Channels

Since the principal rivers of Puerto Rico have been dammed, the sediment load does not reach the sea because it accumulates in the reservoir and the river sediments are not restored as in the past. The lower segments of the river channels are undernourished and the channels will not restore themselves; however, the higher reaches of the river have enough material to serve as a source of sand. These operations require washing and sorting which causes water pollution. Therefore, the wastewaters must be disposed into a sedimentation pond before discharging the clear overflow into the river. The upper reaches of the reservoir are areas where sand and gravel are deposited when the river flow is checked and loses its coarse sediment load.

Dredging the River Floodplains

Floodplains adjacent to river channels are usually dredged in Puerto Rico. Although large amounts of sand and gravel are obtained, ponds are often created losing the agricultural potential of the land. These excavations must be backfilled to regain the land use values. The material needs washing and sorting, thus, sedimentation ponds are needed before discharging overflow to the nearby bodies of water.

Extraction of Inland Residual Sandy Soils

Some rocks weather to sandy residual soils which can be excavated, washed and sorted to produce sand. These operations can initiate a cycle of soil erosion if not properly managed. Once the material is removed, the area should be planted with grass or any other suitable vegetation. Sedimentation ponds are also needed before the overflow is discharged to the environment.

Dredging Submerged Deposits

The submerged deposits can be dredged, but of all those deposits studied, only three could be dredged without damage to the environment: (1) Cabo Rojo Islands Shelf, (2) Isabela Island Shelf, and (3) Escollo Arena in Vieques. All the others will cause considerable environmental damage.

Substitution of Concrete

The concrete can be substituted by other materials such as steel, bricks, wood, plastics, dimension stone, light aggregate, and other materials. This presently is being done in Puerto Rico.

Importation of Sand

Oolitic sand has been imported from the Bahamas, but the physical properties of these materials do not always comply with the specifications for concrete. This sand is usually too fine, completely spheroidal, poorly sorted, and wears easily. On some occasions, it has been suggested to import sand from the Dominican Republic and other countries of Central America, but shipment must pass through the U.S. Department of Agriculture. Therefore, this option is feasible, but requires a period of quarantine. Anyway, Puerto Rico would be exporting its environmental problems to another country.

Manufacture of Sand

Crushing rock, recycled glass or recycled plastic to sand-size particles, can produce a sand which complies with specifications for concrete mixes. There is sufficient rock in Puerto Rico to make this operation economically feasible; however, the price of the commodity will be higher than extracting it from the beach, river bed or residual soil.
RECOMMENDATIONS

The construction industry could be facing a crisis by the end of this century, if an adequate supply of sand is not secured within this decade. In order to solve the problem the following measures are recommended:

A. Protection of Beaches, Dunes and Shorelines

- Legislation - A law should be enacted prohibiting the extraction of sand for commercial purposes from the beach zone.
- Enforcement - Wardens to patrol the beach zone should be entrusted with greater authority to reduce the clandestine extraction operations.

B. Research Needs

- Inventory of sand resources - A systematic study of the deposits of sand around the island of Puerto Rico should be conducted. The study should estimate the available reserves and the economic feasibility of mining operations.
- Development of submerged deposits - A promotional program for the development of the submerged deposits should be undertaken. Incentives, lines of credits, loans and technical aid should be offered by the government. Deposits could be exploited in conjunction with the development of other by-products. The establishment of coastal distribution points from stockpiles should be developed to maintain the independent truck owner with a steady supply of raw material.
- Beach erosion study - A comprehensive study of all the beaches of the island should be undertaken to determine the present conditions of each beach, their optimum potential, protective measures required and the order of priorities. This study should include the artificial nourishment of beaches by dredging offshore and depositing the sand on the under-nourished beaches. Financial aid can be obtained from the Federal Government to restore certain beaches.
- Manufacture of sand - A promotion program for the manufacture of sand must be undertaken. Incentives, lines of credit, loans and technical assistance should be offered by government. The existing quarries could easily manufacture sand and the production of sand from recycled materials could prove economically feasible.

SAND MINING IN GRENA DA
ISSUES, CHALLENGES AND DECISIONS RELATING TO COASTAL MANAGEMENT

Crafton Isaac, Fisheries Division, Ministry of Agriculture, Grenada.

ABSTRACT

Sand mining in Grenada has been identified as one of the main contributing factors to beach degradation. Beach sand accounts for 100% of fine aggregate used for construction purposes. In recent years rapid growth in tourism, building of private homes and businesses, and the laying down of new agricultural roads have generated a marked increase in the demand for beach sand. This increased demand for beach sand on the one hand and the heightened appreciation of the value of beaches as habitats, protective barriers and places of recreation among others have served to concentrate the attention of both resource managers and the general public on the urgent problems associated with beach degradation. This paper explores issues related to conflicts in uses, jurisdiction, legislation and education. While alternatives to beach sand exist, it is unlikely that they will be implemented soon. As an immediate strategy it is recommended that the existing legislation be rigidly enforced.

INTRODUCTION

The tri-island state of Grenada, Carriacou and Petite Martinique (population 93,830 in 1993) is located close to the southern end of the Caribbean archipelago. The state lies between Trinidad and Tobago in the south and St. Vincent and the Grenadines in the north. This state shall hereinafter be referred to simply as Grenada.

There are numerous sandy beaches in Grenada of various sizes, see Figure 1. Many of them, e.g. Grand Anse, Levera, La Sagesse, Paradise are very popular among Grenadians and visitors alike. The existence of these beaches has meant a ready supply of fine aggregate for use in the production of concrete for building and road construction. In addition beach sand is one of the main components of the filtering process used by the National Water and Sewage Authority (NAWASA) in the production of potable water.

In the absence of more accessible, or cheaper, natural sources of fine aggregate for the purposes outlined above, the mining of beach sand in Grenada has provided, and will continue to provide 100% of the requisite fine aggregate.

It is estimated that between 52,000 and 65,000 yd³/yr of beach sand are mined in Grenada (Gabriel, 1995). The negative impacts of sand mining on beach aesthetics and use, not to mention coastal stability have been recognized by many agencies and even by "the man on the street". 
These concerns are probably what prompted the enactment of the Beach Protection Act of 1979 which empowers the appropriate minister to impose controls on sand mining activities.

However, with the past expansion of the construction industry in recent years and the projected future increase (Francis et al, 1993), together with the failure of the relevant authorities to introduce an alternative to beach sand, sand removal will certainly increase the stresses on the mined beaches, and sooner or later those that are not presently mined.

It is clear that measures that have so far been instituted to manage and control sand mining activities have not been effective. There is sufficient evidence to suggest that the illegal removal of beach sand is more extensive than the authorities admit.

If observed changes in the public's attitude towards beach conservation persist, then there will more pressure for greater attention to be paid to protecting Grenada's coastline. However, the current administrative "grey areas" and legislative loopholes need to be sorted out in the interest of maintaining equity among beach users. Sand mining is increasingly coming into conflict with other beach use activities - a situation that is expected to exacerbate over time.

THE MINING OF SAND

Very few sandy beaches in Grenada are totally immune from sand mining no matter how small the scale. Table 1 shows the different levels of sand mining.

<table>
<thead>
<tr>
<th>Level</th>
<th>Equipment/Persons Involved</th>
<th>Estimated Quantity Removed per Trip (approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small scale</td>
<td>Shovel, buckets, bags, push cart/wheelbarrow, small pick-up truck 1 - 2 persons</td>
<td>50 - 1,400 lbs</td>
</tr>
<tr>
<td>Medium scale</td>
<td>Shovel, small trucks (&lt; 5 tons) Usually 3 persons</td>
<td>2 - 5 yds</td>
</tr>
<tr>
<td>Large scale</td>
<td>Shovels, front end loaders, large trucks (&gt; 5 tons) 4 - 6 persons</td>
<td>5 - 16 yds</td>
</tr>
</tbody>
</table>
Table 2 shows some examples of affected beaches (Cambors, 1995). Each of the beaches have been subjected to large and medium scale sand mining in the past.

### Table 2 Selected Beaches Affected by Sand Mining (Cambors, 1995)

<table>
<thead>
<tr>
<th>Site</th>
<th>Period</th>
<th>% Change</th>
<th>Change in Width m/yr</th>
<th>Trend</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Telescope:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West</td>
<td>1987-1990</td>
<td>-22</td>
<td>-1.1</td>
<td>Erosion</td>
<td>Sand mining</td>
</tr>
<tr>
<td>Central</td>
<td>1985-1990</td>
<td>-15</td>
<td>-0.7</td>
<td>Erosion</td>
<td>Sand mining</td>
</tr>
<tr>
<td>Beausejour:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Central</td>
<td>1985-1988</td>
<td>-24</td>
<td>-0.5</td>
<td>Erosion</td>
<td>Sand mining</td>
</tr>
<tr>
<td></td>
<td>1985-1990</td>
<td>-10</td>
<td>-0.15</td>
<td>Erosion from 1988</td>
<td>Sand mining</td>
</tr>
<tr>
<td>Grand Mal</td>
<td>1985-1990</td>
<td>+12</td>
<td>+0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palmiste:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South</td>
<td>1985-1990</td>
<td>-8.0</td>
<td>-0.4</td>
<td>Erosion</td>
<td>Sand mining</td>
</tr>
<tr>
<td>North</td>
<td>1987-1990</td>
<td>-30</td>
<td>-1.7</td>
<td>Erosion</td>
<td>Sand mining</td>
</tr>
</tbody>
</table>

The negative effects of sand mining have been well established and acknowledged even by those who are engaged in the practice both legally and illegally. Francis et al in a 1993 committee report on the question of sand importation states “The continued mining of sand on Telescope, Grand Mal and other beaches, coupled with high erosion rates on Grenada’s premiere tourist and recreational beach, Grand Anse, is of dire concern to the Government and people of Grenada.”

His sentiment was somewhat echoed by Gabriel (1995) when he observed that “notwithstanding natural causes, mining of beach sand seriously aggravates the situation.” Many others have written and spoken in a similar vein. The paradox here is that this acceptance and understanding has not been translated into affirmative action by way of mitigation. Clearly the question of how the issue of sand mining has been handled by the relevant authorities requires further examination.

### JURISDICTION AND CONTROL

There is no single agency in Grenada responsible for environmental issues (Caribbean Conservation Association, 1991).

The Beach Protection Act of 1979, Section 2 makes the removal of "sand, stone, shingle or gravel from the seashore" illegal. However, Section 6 of the same act empowers the "Minister to exempt any person(s) from the conditions of Section 2".

The Ministry of Communication and Works (which incidentally is the largest miner of sand) interprets the Beach Protection Act (1979) to give jurisdiction over beaches to the Minister and Permanent Secretary of that Ministry. The act itself does not specify any particular minister. This author, with assistance from the Legal Department of Grenada, has so far not been able to unearth any official document that thus specifically empowers the Minister of Communication and Works.

The office of the Attorney General submits that the expected appropriate Minister would be the one holding the portfolio of "The Environment." The Department of the Environment is located within the Ministry of Health and the Environment. This department is rarely consulted on environmental matters except as far as they relate human health. Indeed the department’s interpretation of “Environment” is restricted to “Environmental Health”, i.e., waste disposal. But the confusion does not end there because it is generally felt that the Fisheries Division (within the Ministry of Agriculture) is responsible for “Coastal Management” which would include beaches. Whereas the Fisheries Act (1986) and the Fisheries Regulations (1987) do provide limited power over beaches when considered as habitats, it has no power over sand mining.

A number of other agencies (including NGOs) have genuine concern and involvement in coastal management but none with decision making nor enforcement power.

The extent of the Ministry of Works’ management of sand mining has been limited to the reduction of the number of beaches that can be mined legally from six to two, (Gabriel 1995). These beaches are Pearls beach in St. Andrew’s on the mainland and Sabazan Beach in Carriacou, see Figure 1. This Ministry is also of the view that it has been effective in the prevention of illegal sand mining - a belief that contradicts the observation of other workers in the field.

Given the plethora of overlap and the amorphous distinctions between departments with regard to jurisdiction, it is not surprising that uncontrolled sand mining has proceeded unhindered. There is a clear need for cohesion here.

### POLICY AND PUBLIC ATTITUDE

In Grenada the issues related to sand mining have received attention at the policy making,
Alternatives to sand mining have been considered and a few studies undertaken. However, no definite policy has emerged as a consequence of these deliberations and/or studies. According to Ministry of Works officials, there are no plans to seek alternative aggregate to beach sand anytime soon.

Meanwhile there appears to be growing unease and dissatisfaction among the public regarding sand mining. Sand mining has received "negative press" at every public forum attended by this writer where coastal zone management (CZM) was discussed. In addition very often callers to radio call-in programmes have deplored the practice of illegal sand mining and have urged government intervention to curb the practice. There is no doubt that more people are taking beaches seriously - especially with the almost daily reinforcement by advertisements put out by the Grenada Board of Tourism.

In some instances public disapproval of illegal sand mining has been translated into action - some owners of beachfront property have resorted to digging deep trenches across roads in order to deny vehicular access to the beach. People from communities close to legally mined beaches often resent the fact that "their" beach is being mined thus robbing them of a "quality place" for rest and recreation.

THE FUTURE OF SAND MINING IN GRENA DA

The demand for fine aggregate for the production of concrete has not abated - in fact the demand is expected to increase. In the absence of any well formulated policy on the supply of fine aggregate, legal sand mining will continue. Illegal sand mining will also continue as a result of ineffective enforcement of the Beach Protection Act (1979). Illegal sand mining will probably increase if any alternative introduced is viewed as being comparatively too expensive.

In 1993 a "Seven Man Committee of Professionals" was formed by the Ministry of Communication and Works to analyse the "OECS/Guyana Sand and Supply Feasibility Study" (Atkins, 1993). The committee was mandated to make recommendations to the Ministry of Communication and Works.

In its report the committee gave a "thumbs down" to the proposal to import sand from Guyana. The committee was concerned about the inherent risks of inadvertently importing agricultural pathogens and other pests which could have disastrous effects on the islands vital agriculture sector - the so-called backbone of the nation's economy. Furthermore, the committee cited the loss of foreign exchange, together with the increased cost of the sand itself as well as its inland transportation, as additional arguments mitigating against the importation of sand.

The report also considered two other alternatives namely off-shore dredging and the use of crushed gravel. It was felt the first option "... could have severe impact on our environment, especially coral reefs..." and by extension the nation's fisheries. Experiments were then being conducted by the Gravel Rock Asphalt and Concrete products (GRACP) on the suitability of crushed gravel as an alternative aggregate. The committee found that preliminary work by GRACP suggested that concrete construction can be carried out "without the use of sand as we do now."

In its recommendations the committee proposed inter alia that more work should be done by GRACP on the crushed gravel and that the ministry involve building contractors in the testing of the resulting aggregate. The convening of a national consultation on sand mining was also recommended.

There are no indications that any recommendations made by the above mentioned committee, or any other similar body, has ever been implemented or even given serious consideration. It is a reasonable assumption that sand mining will continue for some time yet. Once this is accepted then in the interest of preventing further degradation the following ought to be strictly applied:

(i) Rigid enforcement of the Beach Protection Act (1979) to prevent illegal sand mining.

(ii) Where sand mining is legal there should be strict controls and a proper monitoring programme initiated and maintained.

(iii) Consideration should be given to the formation of a broad-based (government, NGOs, individual) committee receiving full parliamentary support with sufficient power to make certain decisions and/or recommendations on matters related to coastal zone management.

ACKNOWLEDGEMENTS

I wish to extend my appreciation to the undermentioned persons for their kind assistance in the preparation of this document: The Hon. Mark Isaac, Minister of Health and The Environment; Mr. Winston Gabriel, Chief Technical Officer, Ministry of Communication and Works; Mr. Peter Thomas and Ms. Gail Hypolite, National Science and Technology Council; Mr. Finlay, Gravel Rock Asphalt and Concrete Products; Mr. Paul E. Phillip, Mr. Junior McDonald and Mrs Fernette Sylvester of the Fisheries Division, Ministry of Agriculture and Fisheries.

REFERENCES


EFFECTS AND IMPLICATIONS OF SAND MINING IN TOBAGO

Charmaine O'Brien-Delpesh, Institute of Marine Affairs,
Trinidad & Tobago

ABSTRACT

Beach sand mining is a serious problem affecting coastal areas of Tobago. During the last fifteen to twenty years, there has been an increase in the construction industry, as a result of population growth and rapid development in the tourism sector. Unfortunately, Tobago lacks naturally occurring deposits of sand and gravel, which has resulted in a shortage of building aggregates. Historically, beach sand was the accepted source of aggregate. This practice is no longer acceptable, but has been difficult to stop. Within the last five years sand has been removed from beaches in increasing amounts to alleviate aggregate shortage. Several beaches such as Great Courland, Richmond, Goldsborough, Little Rocklyn and La Guira have been mined for sand and as a consequence have all undergone severe erosion. Even though beach sand mining has stopped at some of these beaches, few have been able to recover. Several alternatives to beach sand mining are being considered, with the importation of aggregate from Trinidad being the most viable option.

INTRODUCTION

Beach sand mining has been a traditional way of obtaining aggregate for construction in Tobago. This is because Tobago, unlike Trinidad, does not have natural deposits of sand and gravel. During the last fifteen to twenty (20) years, there has been a marked increase in construction activity related to population growth and rapid development in the tourism sector.

Part of the mandate of the Institute of Marine Affairs (IMA) is to conserve the marine resources for the benefit of Trinidad and Tobago and as such since the early eighties, the IMA has been assessing the impacts of sand mining on the beaches of Tobago. During these studies, the IMA indicated to the Tobago House of Assembly (THA) that the indiscriminate and uncontrolled extraction of sand from the beaches was impacting severely on the marine environment.

Besides coastal erosion, sand mining activities have caused such environmental problems for Tobago as:-

1. the creation of large sand pits along the beach;
2. a loss of coastal vegetation;
3. the penetration of the sea further inland;
4. loss of property; and


In 1984, the THA in conjunction with the IMA, designed a sand and gravel resource project the objectives of which were to compile a sand and gravel inventory, establish site selection criteria and extraction techniques, determine which beaches are appropriate for mining, and monitor mining sites.

The IMA in 1989, established a coastal conservation project to monitor the coastal erosion problems in both Trinidad and Tobago. These monitoring studies have recorded the dynamic nature of the beaches which exhibit a seasonal movement of sand. During the period November to April which coincides with the winter storm weather in the North Atlantic, sand is moved offshore and onshore during the summer months (May to October) when calmer conditions exist. The studies also revealed that the rivers in Tobago contribute very little sediment to the development of the beaches and as a consequence when sand is removed from a beach, the sediment budget suffers from an imbalance of sand and as a result erosion occurs.

This paper uses the data from these two projects to highlight the effects and implications of beach mining activities on some beaches in Tobago.

**DESCRIPTION OF THE STUDY AREA**

The island of Tobago with an area of 300 km² is located at the southeastern corner of the Caribbean Plate. The island can be described as having a humid tropical climate with a mean temperature of 26°C. Tobago is situated within the belt of the North East Trade winds and experiences two seasons annually, a dry season from January to May and a wet season between June and December.

The northeastern two-thirds of the island is mountainous and is made up of metamorphic and volcanic rocks. The coastline in this region is generally rocky and rugged (Bertrand et al., 1991) with indented bays. The south western region of the island is flatter and is covered mainly by coral-algal limestone of late Pleistocene age. The coastline in this region is less rugged and the bays are open and exposed.

**HISTORY OF BEACH SAND MINING AND ITS EFFECTS AND IMPLICATIONS**

Since 1980 the IMA has been monitoring and assessing the impacts of beach sand mining in Tobago. The first such study was undertaken at Turtle Beach, Great Courland Bay, see Figure 1, by Georges (1984). At the western section of this beach, the Black Rock River drains into the bay. The mouth of this river was the site of mining operations during the early eighties.
This study (Georges, 1984), indicated that Turtle Beach undergoes cyclical patterns of sediment accretion and erosion due to the seasonal variations in wave energy conditions that exist within this bay. The results of the study also indicated that there was a progressive reduction in berm height near the mining site which was attributed to the fact that sediment was being removed from the system faster than it was being replaced by natural processes, thus creating a disequilibrium. The mining activities within Turtle Beach resulted in the erosion of the western section of this beach. Recent monitoring studies conducted by the IMA (September, 1996) have indicated that the beach has not recovered from the sand mining activities and it is still undergoing erosion at a significant rate. This has resulted in the construction of coastal defence structures (rip rap revetment) by owners of property located along some areas of the western section of Turtle Beach.

After the closure of Turtle Beach to beach sand mining activities, the THA began to give licenses to remove sand from Goldsborough Beach, see Figure 1, in 1983. This beach also began to undergo serious erosion, which Bachew and Lewis (1985) attributed to the fact that there was no control in the quantity of sand which could be removed from the beach and there were not any restrictions as to the periods of the year when removal could take place. There were also no regulations to the mining techniques that should be employed. Bachew and Lewis (1985) indicated that if appropriate controls had been implemented, the adverse environmental impact would have been reduced. The impacts of beach sand mining at this beach were significant, as the beach was mined until the top soil layer became exposed. During mining at Goldsborough Beach, some of the lush vegetation was removed from the backshore areas, while some was destroyed as a result of saline intrusion. Beach sand mining also caused a change in the physiography of the beach, from gently sloping to steep, Figure 2a, with a distinct vertical scarp at the western section of the beach. This change in beach morphology resulted in the waves breaking closer to shore and as such the beach became more vulnerable to wave attack.

In 1986, Goldsborough Beach was closed to mining activities due to a reduction in the supply of sand and the THA moved mining operations to Richmond Beach, which is located along the south coast of Tobago, Figure 1. Studies were conducted within this bay as part of the IMA's sand and gravel project and a preliminary assessment was prepared by Bachew (1986) which recommended that this beach could be mined in the short term with certain controls and restrictions (such as location, duration and quantity), so as to minimise the environmental impacts.

These recommendations proposed by the IMA, were not adhered to which resulted in significant erosion taking place at this beach. Some of the impacts were: loss of mangrove vegetation which fringed the coast, intrusion of saline water into the backshore and loss of a recreational beach for the residents of the area. Figure 2b shows that the eastern section of Richmond Beach continued to erode up until September 1996.

A study on the nearshore processes and sedimentation at Queen's and Richmond Bays was undertaken by O'Brien and Lawson (1986) and it was recommended that Richmond Beach should not be mined as the beach was approaching dynamic equilibrium and any removal of sand...
from the beach would upset the sediment budget and erosion would occur. Prior to the closure of Richmond Beach to sand mining, as the supply became exhausted, the THA commissioned the IMA to identify another beach for the extraction of sand pending the establishment of a crushing plant in Tobago. Based on a study undertaken by the IMA at Goldsborough Beach in 1988, results indicated that the beach was in a process of rehabilitation and that sand mining activities could be reinitiated to satisfy the short term demand. The IMA (1988) gave recommendations for mining in order to avoid any further disastrous erosion effects on the beach as occurred previously. The IMA also recommended that mining should be completed by the end of May 1988. However, this recommendation was not adhered to, and Goldsborough Beach underwent significant erosion again.

Continued monitoring of Goldsborough Beach by the IMA as part of the Coastal Conservation Project, recorded that mining continued beyond the stipulated time (May 1988) and continued to 1992. Figure 2a, which shows the results of this study, reveals that up until 1993 the beach at Goldsborough Bay showed a progressive loss of sediment. Recent field visits by the IMA in September 1996, indicated that the beach is slowing recuperating from the sand mining activities which had taken place over the last thirteen years, Figure 2a.

During IMA monitoring studies of Tobago beaches it was also observed that the beaches located in Rockly and La Guira Bays, Figure 1, were also being mined for sand and were eroding as a result of this activity. At Little Rockly Bay, Figure 1, the proposed site of a large development, monitoring studies indicated that erosion taking place at the eastern end of this beach is due to the clearing of the river mouths. Sand bars usually form across the mouths of the rivers emptying into this bay. The THA clears away sand from these river mouths on the grounds that this reduces the breeding of mosquitoes. Figures 3a and 3b show that the beaches of La Guira and Little Rockly respectively, are undergoing erosion as a result of this sand mining.

PRESENT STATUS OF SAND MINING

Based on site visits to Tobago by the IMA, together with discussions with representatives of the THA, it is apparent that some of the beaches mentioned above (Goldsborough and Turtle Beaches) are no longer being mined for sand. However, recent site visits by the IMA (September 1996) revealed that at Richmond Beach which is officially closed to sand mining, sand is still being removed from this beach. In addition, the mouths of rivers are still being cleared and the sand trucked away. A study by Oliver (1996) indicated that the integrity of several bridges located across river mouths have been threatened due to the clearing of these rivers, and many are failing as a result of this activity.
ALTERNATIVES TO BEACH SAND MINING

Several alternatives to beach sand mining have been suggested by the Ministry of Energy and Energy Industries, Non-Governmental Organizations (NGO's) in Tobago and by a Beach Sand Mining Committee initiated by the IMA in association with the THA. The following are some options to beach sand mining which are presently being reviewed by the THA, The National Quarries Company Ltd. and the Ministry of Energy & Energy Industries (Quarries Division).

Offshore Mining

This alternative can also pose environmental problems. Dredging of sediments increases the turbidity of the water, which can impact on coral reefs and seagrass beds. There may be seabed sources of sand in the form of submerged sand banks, offshore from Tobago. However, this option cannot be considered at this time, as there is very little data on the location, quantity and quality of these seabed sand sources around Tobago. Scientific studies and environmental impact assessments would have to be undertaken before this option can be considered.

Rock Crushing at Studley Park Quarry, Tobago

The quarry/rock crushing plant at Studley Park supplies aggregate to the construction industry in Tobago. This process of crushing igneous rocks involves removal of overburden, drilling and blasting, excavating and loading, crushing and screening. This operation cost is very expensive and at present the plant cannot consistently produce the quantity and quality of sand needed by the construction industry, particularly the fine-grained sand used in the production of concrete mortar and plaster.

Crushing of North Coast Schist and Ultramafic Rocks

This option is being reviewed by the Ministry of Energy & Energy Industries. The two rock types are considered suitable because of their physical characteristics. They are severely jointed and weathered and therefore can be easily ripped and crushed without the use of explosives (Oliver, 1996). However, they are located in forest reserve areas and as such environmental impact assessments would have to be undertaken before this option can be considered.

Importation of Aggregate

Trinidad has adequate quantities of aggregate of various grades and of high quality which can be made available from the National Quarries Company Limited. Adequate quantities of aggregate of various grades are also available from foreign/regional sources - for example good quality river sands could be imported from Guyana. The importation of aggregate from Trinidad appears to be the most viable option in spite of the high cost of the aggregate and inadequate infrastructure such as marine transportation and docking facilities. At present this option is being implemented by the Tobago House of Assembly and the National Quarries Company Limited.

CONCLUSIONS AND RECOMMENDATIONS

Beaches are important natural resources of Tobago and they should be protected by the relevant authorities. The studies and site visits conducted by the IMA since the early eighties, have indicated that the beaches in Tobago cannot meet the demand for aggregate in the long or short term. Some beaches can recover from regulated sand mining, however most cannot. The authorities in the past have not shown the ability to properly regulate sand removal.

As discussed above there are other options which can be considered. It must be noted however, that all options would be more expensive to the developer, since beach sand is now treated as a “free resource”. A cultural change has to take place in order to resolve this problem. Enforcement of the law to prevent the illegal removal of sand would be one direct way of forcing cultural change.

Based on these findings it is strongly recommended that the mining of rivers and beaches must not be permitted and the relevant authorities take the necessary action to ensure that this activity ceases immediately. It is also recommended that sand of high quality should be imported from Trinidad in the interim, while all the options are being carefully evaluated.

ACKNOWLEDGEMENTS

The author would like to thank the Tobago House of Assembly (THA! for the use of their data; the Institute of Marine Affairs particularly Mr. Peter Joseph the Geological Technician for preparing the figures, Ms. Charmain Pontiflette-Douglas for the typing, and Dr. Avril Siung-Chang for reviewing the manuscript.

REFERENCES


ABSTRACT

PROFILE OF MONTSERRAT

Montserrat is a British Dependent Territory located within the Leeward group of the Lesser Antilles. It is 39.5 square miles (102 square kilometres) in area, approximately 11 miles (18 kilometres) long and 7 miles (11 kilometres) at its broadest point.

The island is volcanic in origin and comprises three mountain systems - Silver Hills, Centre Hills and the South Soufriere Hills. Chances Peak which is the highest point at 3,002 feet is located within the South Soufriere Hills. The topography is typified by heavily vegetated mountains through the centre of the island, with a number of deep ghaups radiating out from the peaks to the coast, see Figure 1. The coastal strip is relatively narrow and development is concentrated along the leeward and westerly coast.

The steep topography reflects in the marine and coastal environment which is characterized by a relatively narrow coastal shelf (in some places dropping to 100 fathoms (600 feet) in less than a mile). The shoreline is rugged consisting mainly of cliffs and rocky shores. The coastline totals 28 miles (45 kilometres), of which just over 8 miles (13 kilometres) comprise beaches. With the exception of one beach in the north of the island - Rendezvous Bay, all the beaches are of 'black volcanic sand'.

At the last census (1991) the population of Montserrat was 10,639. A mid year estimate in 1993 recorded a population of 10,481. A census undertaken in July recorded a population of
The decline of 23% since 1993 is directly attributable to the volcanic activity which commenced in 1995.

The volcano has caused the relocation of 4,051 persons into a defined 'safe area' which corresponds roughly to the northern half of the island. The capital, Plymouth, is inaccessible together with all the commercial, business, retail, health, education, recreational, community and administrative services and facilities. There have been three periods of evacuation and the current period, which commenced in April, is the longest and still ongoing.

The economy of Montserrat has been dominated by three sectors - real estate/housing, government services and construction. In 1993 these sectors comprised 12.44%, 22.27% and 10.23% of GDP (Gross Domestic Product by economic activity, at factor cost in constant 1977 prices) respectively. With the exception of government services, which has increased in value by over 50%, these sectors have performed constantly at these levels since 1977. Tourism was developing into a key growth sector in the economy. Tourism expenditure in 1993 was 35.4% of GDP. Tourism revenue was 16.4% of total government revenue. Tourism in Montserrat has been dominated by 'residential tourism'. This process involved the development of agricultural estates and their subdivision into lots for the construction of residential villas for expatriates for permanent or vacation occupation. This process commenced in the early 1960's and 1,332 acres were released for development. It has been estimated that only 37% of the lots have been developed.

Apart from community, personal and social services, construction is the major employer and 29% of the total employed labour force were employed in this sector in 1993. Although this proportion has been relatively constant over the past 10 - 15 years, it peaked in 1990 with the post-Hurricane Hugo reconstruction boom, and has declined since.

Montserrat's Public Sector Investment Programme plays a key role in the economy, particularly in the construction and real estate sectors.

In summary, construction primarily through the public sector investment programme and the residential tourism sector has, and will continue to play a significant role in Montserrat's economy.

REVIEW OF SAND MINING ON MONTSERRAT

Sand mining has been an accepted tradition in Montserrat for many years. However, the commencement of the residential tourism developments in the early 1960's and the increasing amount of public sector development created an unprecedented demand for concrete. Furthermore, the residential tourism developments introduced new materials, designs and construction techniques which reflected those in North America and Europe, from where the majority of investors and developers originated. This in turn led to the introduction of the same
techniques and materials being applied in housebuilding for the indigenous population. Out of the
total island housing stock 59% is of concrete construction and 82% was constructed after 1960
(1991 Census). A substantial increase in the amount of sand that was required in construction
was caused by this upsurge in construction activity and the changes in methods and designs. In
contrast, the traditional method of constructing in wood with concrete piers and pads was a low
consumer of sand.

The majority of construction activity took place along the west coast and the mining of
sand took place on the nearest beaches. In particular, Sugar Bay at Wapping, Jumbie Beach and
Isles Bay were heavily mined.

Concern over the loss of sand from the beaches prompted the passing of the Beach
Protection Ordinance No 9 of 1970. This Ordinance prohibited any person from using a motor
vehicle for the removal of sand, stones, shingle or gravel from any part of any beach, seashore,
foreshore unless a written permit has been issued by the Permanent Secretary, Ministry of
Communication and Works. This procedure did not apply to vehicles owned by the government.
The ordinance imposed penalties and powers to arrest offenders. The ordinance was amended
by the Beach Protection (Amendment) Ordinance No 24 of 1980. The amendments were minor
and did not alter the substantive provisions of the 1970 ordinance. Neither ordinances however
defined what comprised the beach.

The mining of the beaches continued resulting in their progressive destruction. As a
consequence it became necessary to close all the beaches on the island with the exception of
Carrs Bay and Trants. The degradation of the beaches particularly those along the western coast
prompted the Ministry of Agriculture, Trade & Environment (MATE) to seek assistance from the
Organization of Eastern Caribbean States Natural Resources Management Unit (OECS-NRMU) in
St Lucia in assessing the changes.

The measurement of beach changes along the west coast between 1966 and 1990 showed
that the position of the beaches had moved inland and that the average rate of retreat was 1.05
metres per year over the 24 year period. The mean value covers a range of 0.24 metres to 2.73
metres per year.

All the beaches measured showed an erosion trend. Analysis confirms that not only had
the beach width decreased, but also the land behind the beach had eroded. The reasons for the
high erosion rate include the effects of two major hurricanes in 1979, and the direct impact of
Hurricane Hugo in 1989 and the effects of extensive beach mining.

Coastline changes over the 24 year period were assessed using the 1970 OS 1:2500 scale
maps and the 1966 aerial photographs. The 1970 map shows a very wide beach in front of
Plymouth continuing north to Sturge Park. Over the 20 year period the edge of the cliff had
retraced inland by between 10 and 16 metres. Undermining of Sturge Park occurred and the loss
of an estimated 66,700 square metres of land along this coastal strip. It is possible that much of
this reduction was due to port relocation and jetties which were constructed since 1966.

The next significant event in the history of sand mining in Montserrat was the closure of
Carrs Bay in 1990, following excessive mining of sand. The result of this activity caused almost
total beach loss and threatened a historic site on the foreshore and the stability of a sporting
complex.

In recognition of the continuing problem and in particular the destruction caused by
Hurricane Hugo, MATE appealed for outside assistance. In response, OECS-NRMU held two
seminars on the island. The first in March 1990 established a beach monitoring programme and
as the situation continued to deteriorate, a second workshop was held in November 1990 to
review the position on sand mining. At the November workshop representatives of the Ministries
of Communication and Works and Agriculture, Tourism, truckers, contractors and the Montserrat
National Trust participated.

The outcome from the second workshop was the adoption of two goals.

1. A short term goal such that beaches would be closed to sand mining by February
1, 1991 and crusher dust and imported sand would be substituted for beach sand
in construction.
2. A longer term goal, whereby all sources of fine aggregate for construction would
be investigated, and the most suitable sources for Montserrat would be identified
and utilized for construction.

Sand mining continued however, and in April 1991 the Government’s Executive Council
(EXECO) resolved that barriers should be erected at Foxes Bay and Little Bay to prevent trucks
from going onto the beach to remove sand. The closure of the last beach - Trants, was delayed
beyond the February 1 deadline because a source of imported sand at a workable price and
sustained supply could not be identified.

At this time a modern quarry became operational in Montserrat. This enabled the local
province of aggregate for the construction industry. The quarry has a vast reserve of material
for extraction. With an alternative source available Executive Council took a decision early in 1992
to close the beach at Trants, thereby making it unlawful to remove sand from any of the beaches
on Montserrat.

From May 1992 attempts were made to utilise crusher sand from the quarry for concrete
blocks, plastering and structural works. Crusher dust was initially offered at EC$50 per cubic
yard, although it was immediately reduced to EC$35 per cubic yard following a public outcry.

In July 1992, a Government Research Study of the cost of construction concluded that
the price of quarry sand and its quality were cause for concern. It was found.
1. that the quarry dust or sand was of poor quality compared to the beach sand, and presented a difficulty for users, especially in plastering.
2. the quarry dust or sand was too expensive at ECS35 per cubic yard;
3. that in the long term the use of quarry dust instead of beach sand could provide a cost saving to the builder. For example, salt in beach sand causes the reinforcement in concrete buildings to corrode and shortens the life span of buildings. In addition, the salt content of the smooth plaster causes paint to eventually peel from walls.

The government commissioned a further study, which concluded that for a house which cost ECS100,000 and required 38 cubic yards of sand, the cost differential for quarry sand over free beach sand was 1.2%. However, quarry sand was perceived to have a number of disadvantages. The sand was said to require more water in order to improve workability and, as a consequence, a small increase in cement was necessary to maintain strength requirements. The high soil content in the aggregate used for plastering was also said to cause plaster shrinkage and cracking.

An education campaign was launched to inform the public of the efficiency and effective use of quarry sand and dust. It was also recommended that the quarry undertake a regular programme of testing to ensure that the crusher dust was maintained at the optimum standard.

After much political pressure, on October 8, 1992 government mandated MATE and the Ministry of Communication and Works to form a committee with the task of reviewing the issues as they related to sand, crusher dust and training, and to overcome the problems that existed.

The follow-up to this was that in February 1993 EXECO decided that beach sand would be available from Farm's Beach for a six month period. The sand was to be available for plastering only via a permit system administered by the Building Inspector. The sand was initially stockpiled at the quarry who in effect were selling the sand for Government. This arrangement lasted for three months and resulted in public opposition. Consequently, the stock piling was undertaken by the Public Works Department under supervision of MATE.

During the period between February and July 1993 plastering trials using quarry sand were undertaken, and in July the Public Works Department concluded that a 1:4 mix was acceptable for both interior and exterior plastering.

In April 1994 EXECO decided to fully open Farm's Beach and to make beach sand available to builders under a permit system administered by the Physical Planning Unit. Two beach wardens were employed for three days per week to police the movement of sand during normal working hours. Beach sand costs ECS$10 per cubic yard. The sand is loaded manually.

Since the introduction of the permit system the following quantities of beach sand have been extracted:

<table>
<thead>
<tr>
<th>Year</th>
<th>No. Of Permits Issued</th>
<th>Cubic Yards of Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993 (5 months)</td>
<td>56</td>
<td>291</td>
</tr>
<tr>
<td>1994 (8 months)</td>
<td>121</td>
<td>1082</td>
</tr>
<tr>
<td>1995 (7 months)</td>
<td>86</td>
<td>631</td>
</tr>
</tbody>
</table>

Source: Physical Planning Unit

The permit system is administered by the Building Inspector who assesses the request to extract sand on the basis of the type of building construction and the stage reached. The application form requests planning approval number, location, vehicle to be used in carrying the sand and registration number, applicant and amount required. A permit is then issued on payment of the requisite fee and a copy of the permit sent to the site warden.

A review of the system was undertaken by the Physical Planning Unit following concerns that sand was being extracted without a permit and outside the normal working hours and that government departments were able to extract sand without submitting applications to the PPU. A proposal for tightening up the process was recommended to limit potential abuses. This included more information on the application e.g. floor area of the building, and the introduction of an application form. These new procedures were not, however, introduced.

The Montserrat Building Code & Guidelines were also progressed to a final draft stage in 1994, and at present require that sand to be used in construction must be ‘clean, natural sand, preferably taken from an inland source as the use of beach sand will not be allowed’. The Building Code and Guidelines are at present going through a final consultative review stage and it is likely that this particular requirement will be amended.

During 1994, a new act, the Beach Protection Act 1994, was drafted. This sought to tighten up and clarify the legal provisions, particularly in respect of what constitutes the beach, and to up-date powers for enforcement. This act has not been enacted.

Farm's Beach is located within the unsafe area and with the advent of volcanic activity has been unavailable for legal extraction. However, extraction has continued on an ad-hoc and uncontrolled basis. The unavailability of access to the designated beach has also led to indiscriminate extraction at other beaches on the west coast. Although this has not been a frequent occurrence, it does demonstrate how precarious the balance is between controlled mining and a free-for-all. The likelihood is that as Montserrat moves into a phase of major construction and development in the safe area in response to the volcanic situation the demand for beach sand will increase. The quarry although bordering the unsafe area has continued to operate during the volcanic crisis.

Beach monitoring as it relates to sand mining started in February 1990 and was
incorporated into the COSALC programme in 1994. Regular monitoring continues up to the present day.

An overall assessment of the programme is done annually and the data analyzed using version 2 of the Beach Analysis Software.

The programme was instrumental in the formulation of a sand mining policy. Additional profile sites were added in July 1995.

The conclusion from the first monitoring phase was that 'the recovery phase (following Hurricane Hugo) is now over..... Against this background it is especially important to continue to control beach sand mining and to promote other materials such as crusher dust.'

In summary, Montserrat's beaches never had a formal management strategy until February 1990 when the COSALC monitoring programme commenced. As construction activity grew in economic importance, the island's beaches have become more and more vital to the economy, and although the use of beach sand is extremely destructive, significant growth in the late eighties and into the nineties in the construction sector, has made beach sand a valuable commodity.

As a consequence, the Government introduced a ban on all sand mining from the beaches. However, in 1993 one beach was opened for sand mining - Farms Beach. This decision was influenced by the results of the beach monitoring exercise which indicated in 1992 that beaches were showing signs of replenishment following indiscriminate mining and the ravages of Hurricane Hugo. The exception was one east coast beach which had been heavily mined during the post-Hugo period.

The permit system which has operated since 1993, has effectively led to a cessation of sand mining on other beaches. Since the 'approved' beach is located on the windward side of the island, the popular recreational beaches on the leeward side of the island have therefore been protected.

The commencement of volcanic activity in July last year has resulted in Farm's Beach being inaccessible for controlled sand mining. As a consequence, incidents of unauthorised mining on beaches in the 'safe area' have been recorded, often involving government departments or the utility companies.

Despite a controlled sand mining policy which was beginning to display benefits for the leeward recreational beaches, the volcano situation has demonstrated how precarious the system of control is and how the perceptions of both private and public sector agencies remain unchanged in regard to the accessibility of beach sand.

Beach changes are monitored on a regular basis, although this data is not fed into the development of management policies for the beaches.

THE ISSUES FOR MONTSERRAT

The issues that are facing Montserrat in its continued formulation of a position on sand mining are firstly to determine to what extent capacity exists at Farm's Beach to sustain sand extraction. This is critical given the possibility of a substantial increase in construction activity within the safe area in response to the volcanic crisis. This problem is compounded by the location of Farm's in the unsafe area.

Secondly, although beach changes have been regularly monitored and there is a good understanding of the impact of hurricanes and sand mining on beach profiles, this information is not utilised to any great extent in the formulation of management or development control policies e.g. setback guidelines etc. Furthermore data is not integrated into the physical planning process and the tools, such as GIS, that are available to assist in physical planning do not incorporate beach monitoring data.

Thirdly, the monitoring programme should be sustained because the data is so critical to understanding changes, either arising from hurricane damage or from sand mining, and has provided the basis for the formulation of the Government of Montserrat's sand mining policy.

Fourthly, the legislation needs to be up-dated and in particular, the definition of beach, foreshore etc. clarified. Similarly the Montserrat Building Code and Guidelines will need to adopt a clear position on the use of beach sand.

Beaches on Montserrat offer many benefits, and so, if there is to be a fair sharing of the benefits offered by the beaches, steps must be taken to plan and manage them so that they can be enjoyed by all.