Hazards of the Jamaican Coastline
ERODING BEACHES: A RESPONSE TO RISING SEA LEVEL?

This is the fourth in a series of articles on Hazards of the Jamaican Coastline contributed by the Marine Geology Unit, Department of Geography and Geology, University of the West Indies, with funding support from the Environmental Foundation of Jamaica.

Edward Robinson
Deborah-Ann C. Rowe
Shakira A. Khan
Contributors

In the South Pacific, Papua New Guinea's Carteret islands are being drowned by rising sea level. Over the past 20 years the inhabitants of these islands have watched their homes being washed way by waves and their fruit trees die as the water supply became increasingly saline, contaminated by rising sea levels. As their food supplies diminished and their water became too salty to drink, the people have had to rely on the larger islands for nourishment. Eventually, the government came to the decision that the island's 2000 people had to be evacuated. The inhabitants are now being relocated 10 persons at a time to the sister island of Bougainville. Two uninhabited Kiribati islands, Tebua Tarawa and Abanuea, disappeared underwater in 1999. The president of the drowning 33 islands said they were moving back from the shoreline but were in danger of falling off the back side of the islands.

Is this a true glimpse into the near future for Jamaica, the shape of things to come, perhaps a hundred years' from now? Will the people of the low-lying and coastal areas of Jamaica have to be relocated to higher ground?

The results of severe erosion of the Jamaican coastline

Having traced the progress of sea level rise in a previous article we now look at some of the problems of eroding beaches, and why some beaches seem more prone to erosion than others. Reports of beaches being seriously eroded usually hit the newspapers after a spell of stormy

weather, be it from a tropical depression or a norther. The fact that many beaches recover following erosion is not so often reported. This is one reason it can be quite difficult sometimes to figure out how much erosion of a permanent nature is taking place. Another reason is that concerns about beach erosion and checks on the amount of erosion going on have only been carried out over the past 30 years or so for Jamaica. This is a miniscule amount of time to use as a baseline for predictions of erosion in the future. The only sure way of keeping track is to monitor and survey beach changes periodically indefinitely into the future, and to examine historical maps and air photos in order to extend the baseline into the past.

Beach erosion and recovery over a one-year period on Jamaica's north-east coast.

Seasonal Erosion

Seasonal erosion results mainly from bad weather conditions along the coast, such as winter northers and summer tropical depressions and hurricanes. These raise storm waves that erode the beach and either deposit the eroded sand offshore or move it inland, out of the beach area. On an eroding beach the position of the actual shoreline may recede, or the erosion may only involve the removal of the top layer of sand from the beach area. Usually both kinds of erosion take place and the lateral extent of sand removal may be indicated by the formation of an erosion scarp at the back of the beach.

Normally, in calm weather, any sand deposited offshore is gradually brought back to the beach by gentle wave action. In a stormy year, the recovery of the beaches may be delayed or inhibited. A severe hurricane can cause excessive beach erosion that may not be repaired for several years and the offshore reserves of beach sand may be swept over the edge of the island shelf into deep water – gone forever. Beach recovery can also be inhibited by poor beach management, such as removing protective seagrass beds, mining beach sand and constructing the wrong kind of hardened sea defences such as seawalls and groynes.

Apart from the annual cycles imposed by the weather, there are longer-term cyclical changes governing whether beach erosion or deposition will be dominant. These are, driven by long-term patterns in the circulation of the ocean's warm and cold currents and the climate. Some of these may extend over a few years. Others may take centuries to complete one cycle. The pattern of annual hurricane frequency and intensity is one such cycle that appears to extend over several decades.

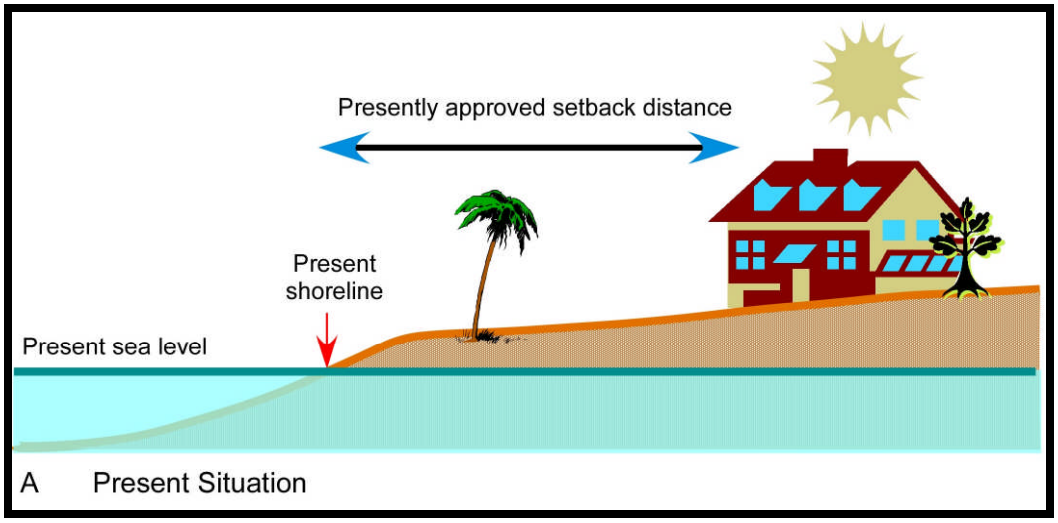
Not All Beaches Are the Same

Whether or not a beach will survive a period of unusually intense erosion depends on the nature of the beach and the sediments of which it is composed. The white sand beaches of the north and west coast are made up of fragments of the skeletons of marine organisms, mainly algae. As the waves wash to and fro over the beach, these particles become abraded and will eventually become

so small that they are washed from the beach out to sea. Thus it is essential for the beach's well-being that the marine organisms supplying this sediment are not killed off by poor beach management. Disposal of chemical pollutants such as untreated sewage into the sea, and removal of the seagrass that supports the growth of these organisms are both factors that, in the end, will lead to a white sand beach's disappearance.

On the other hand, the beaches common along the south and northeast coasts are composed of sand and pebbles eroded and brought down by rivers from the rocks of the island's interior. If this material does not reach the coastline to replace beach sand lost into deep water through severe storms, or transported along the coast to other places, then these beaches will also shrink and disappear. The intensification of sand and gravel mining in the river beds is one way in which the quantity of sediment reaching the beaches might be reduced. Building dams that trap the sediment on its way to the coast is another.

Setbacks



The amount of erosion that is observed to occur for any given beach will help to determine the "safe" distance from the shoreline, behind which one can build a dwelling without the fear that the sea might destroy it. This so-called setback distance is defined as the distance from the shoreline behind which it is permitted to build permanent structures, such as houses or hotels. In front of the setback limit it is advisable, even a legal requirement, to build only temporary or easily replaceable structures. Most countries, including Jamaica, impose setback limits by law. Here the recommended limit has recently been revised to a minimum of 50 metres. Legal setback distances are usually set in reference to predictions about the amount of erosion and other coastal damage expected to result from a storm of a particular intensity. The "hundred year storm" is a popular basis for evaluating this distance. It takes into account an estimate of the amount of erosion that might be caused by the most severe storm likely to occur in any hundred year period. A typical setback is shown in diagram **A**.

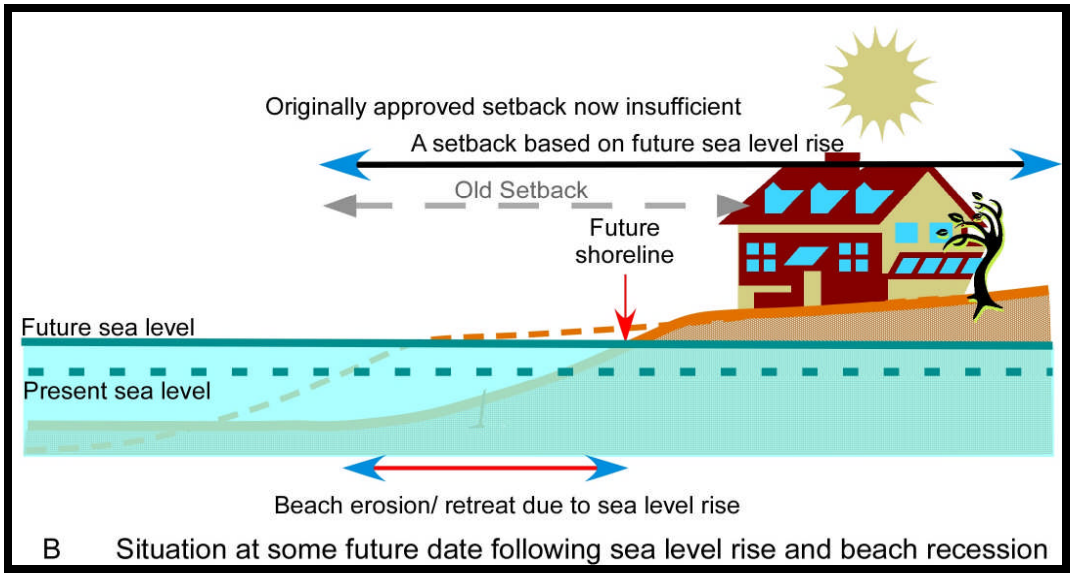
Although it is normal to impose a setback distance that is generally applied to the whole coastline of a region or country, it must be realized that all coastlines are not equal. In addition to imposing a general limit of 50 m, it may be necessary to increase this minimum due to the special conditions of a particular bit of coastline. For example, where a beach or cliff is being rapidly eroded, say because of the weak nature of the rocks in that area, it may be that long term erosion would eat away the legal setback distance to the point where new houses would be affected

within, say, 20 years time, unless the legal limit were to be increased. In reality each part of the coast needs its own evaluation, but this costs time and money, so a generalised setback is applied in Jamaica. However, in Cuba, the setback distance is defined as the distance from the waterline to a point behind the coastal sand dunes, so the actual setback distance may vary a lot from place to place. This policy ensures that the dunes, which provide a shield against storm erosion, are not degraded by human interference. In Jamaica, coastal dunes are usually subdued or absent. But it is worth noting that, if such a rule were to be applied to Negril, many permanent structures could be sited no closer to the beach than the coastal highway. Our own surveys of historical erosion have shown several places along the Jamaican coast where erosion rates are such that 100 metres or more of beach have been lost over the past 60 years and others where no significant erosion has taken place.

The kind of damage experienced by housing also depends on the nature of the coastline. On low-lying coasts with beaches, damage from storms is likely to result from breaking waves causing beach erosion that undermines the foundations of houses or other buildings, as has happened at places like St. Margaret's Bay and Orange Bay in Portland, and Caribbean Terrace in Harbour View. If a house is built on a cliff of hard limestone, there will probably be little or no erosion of the coastline, but the force of the storm waves surging against the cliff can generate breaking waves that overtop the cliff and damage structures some distance from the cliff top, as happened recently at the West End of Negril from Hurricane Wilma, and has been documented for past storms in such communities as Galina and Manchioneal..

Progressive Erosion and Beach Retreat

In addition to the seasonal erosion caused by storms, the slow rise in sea level described in our previous article means that the oceans are gradually encroaching on the land, and the beaches are retreating landwards as a result. The amount of retreat varies with the local conditions. On a steeply rising shoreline the rate of retreat is relatively low. On very flat lying shores the rate of retreat can be very high. It is possible to forecast a likely rate of shoreline retreat for any particular part of the coast, using tested modelling methods and by choosing the most likely rate of future sea level rise. In our studies we have made one or two preliminary estimates that suggest there will be at least a 30 metre retreat of some of the flatter lying Jamaican beaches by the end of the century due to sea level rise alone.



B Situation at some future date following sea level rise and beach recession

This long-term retreat of the shoreline has implications for deciding the amount of setback that should be recommended. Diagram **B** illustrates the position. If a setback is determined solely on the erosion expected from a storm of given strength the distance will be progressively underestimated as conditions are extended into the future, because sea level rise is not taken into account. With the prospect of the rate of sea level rise accelerating in the future it is not probable, but certain, that beach erosion and shoreline retreat will continue, probably at a faster pace.

Join us next time for further insights into the Hazards of the Jamaican Coastline.

Marine Geology Unit mgu@uwimona.edu.jm