COASTAL RESEARCH

The shoreline erosion problem: lessons from the past

Orrin H. Pilkey

Terry Hume

How can we deal with the natural process of coastal erosion when it becomes a problem? And how can research help? An overseas expert presents his view of the issues in relation to New Zealand.

Teachers:

for ideas on how to use this article in the classroom, visit: www.niwa.co.nz/pubs/wa/resource.htm

House undermined by erosion of the sand dune at Nags Head, North Carolina, USA.

AROUND THE WORLD there are some spectacular examples of the damage caused by retreating shorelines. And there are equally spectacular examples of the expense to which some governments will go to hold their shorelines in place. More than 80% of the world's shorelines are eroding at rates varying from centimetres to metres per year. In undeveloped areas, of course, a retreating shoreline is no problem. Usually we are not even aware that it is happening, though often there are signs of erosion such as fresh cliffs in sand dunes or trees that have fallen onto a beach. Erosion only becomes a problem when a human-made structure is threatened.

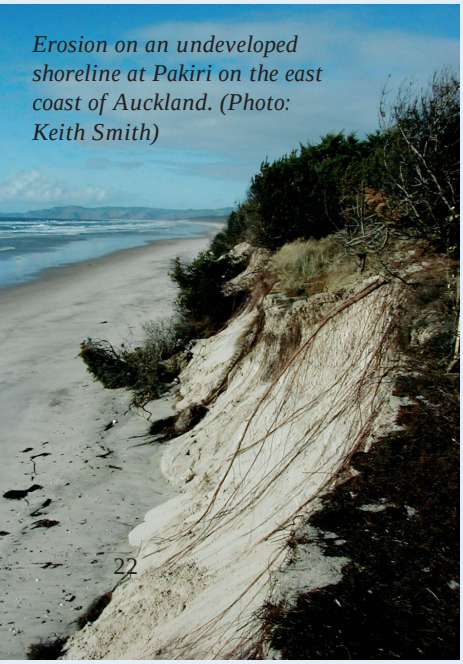
Why are shorelines retreating?

Beaches exist in a dynamic equilibrium involving four factors:

1. the supply of sand to a beach;
2. the wave energy (related to wave height);
3. sea-level change;
4. location of the shoreline.

Sand supplies

Sand is food for beaches. Sand sources include rivers, eroding bluffs, adjacent beaches and the continental shelf (seabed sands are combed ashore by fair-weather waves). The amount of sand available can vary a lot. On the west coast of the North Island rivers feed black sand to the coast from the rocks of Mt Taranaki. Towering Pleistocene sand cliffs crumble into the sea and this light-coloured sand is driven far up the coast so that the beaches are less black to the north. In contrast, on the east coast of Northland and Auckland, rivers and cliffs provide only a trickle of sand to the coast. Headlands cause the sand to get locked up in small bays.



Erosion on an undeveloped shoreline at Pakiri on the east coast of Auckland. (Photo: Keith Smith)

Human activities can affect the sand supply. Extracting sand near the shore can upset the balance of erosion and accumulation in bays where sand supplies are meagre. Damming rivers and extracting water for irrigation changes the flow condition in the rivers and supplies of gravel and sand to the Canterbury coast. Construction of ports which project offshore, such as Taranaki, alter the patterns of sand transport along the shore.

Waves

Waves, combined with tides and wind, are critical components of beach evolution. The higher the waves and the greater the angle at which they strike a beach, the larger the volume of sand carried. During storms, waves move sand offshore and flatten the beach. Most often shorelines retreat in jumps, each jump corresponding to a storm. Typically, after a storm sand builds up again, though recovery is much more gradual than erosion. However, when viewed over time spans of a few decades, storms are a constant and really are not the fundamental cause of the world's eroding shorelines.

Sea-level rise

Sea-level rise may underlie much of the world's coastal erosion. In New Zealand sea level is currently rising at a rate of about 15 cm per century. The rising sea brings each storm a tiny increment farther inland than the preceding storm. A huge debate is underway about the origin of sea-level rise and likely movement in the future. Sea-level rise is due primarily to the thermal expansion of sea water and melting of glaciers and ice caps. (New Zealand's glaciers are almost the only ones that are advancing at present.) Because New Zealand is an area with lots of volcanic and earthquake activity, it is a certainty that the sea-level rise is not the same on all beaches here.

Shoreline location

This is the visible part of the problem. Shorelines move back and forth between storms and periods of fair weather. It is when the shoreline movement impacts on human-made structures that it becomes a beach erosion problem.

Managing shoreline erosion

There are three approaches to erosion management.

Hard stabilisation

This is holding the shoreline in place using fixed hard structures, such as walls perpendicular to the shoreline (groynes, as at Hokitika), or sea walls parallel to the shoreline (for example, Milford

Beach, Auckland). Hard shoreline stabilisation is the best way to protect beachfront property, and the bigger the wall the better. However, walls are costly, lead to the loss of sand on the beach in front, restrict access to the beach and are ugly.

Soft stabilisation

This is fighting erosion at one location by bringing in sand from another. At Omaha and Orewa sand was dredged from the estuary and piped to the beach, at Napier sand and gravel is trucked to Westshore Beach, while sand from Pakiri Bay was barged south to nourish Mission Bay. This so-called beach nourishment "improves" the beach and also protects buildings while the beach is in place. However, the procedure is costly and only temporary.

Relocation

Sometimes referred to as retreat, this is the do-nothing (and let houses fall in) or move-'em-back approach (e.g., at Omaha during the 1978 storms). However it is done, this alternative allows nature and the sea-level rise to roll on. Relocation saves the beach and saves shoreline stabilisation costs. However, it can be politically very difficult and it could be financially costly if government is required to purchase land. Also, land is lost.

No solution?

There are heavily developed shorelines in North America and Japan, from which hard lessons may be taken and applied to the New Zealand situation.

Lesson 1. Usually the obvious answer to an erosion problem is to build a hard structure. But it is best to start soft and then go hard, especially if preservation of the beach is a priority.

Lesson 2. The soft solution can become very costly. On the major nourished beaches of the east coast of the USA the cost is about US$10,000 per beachfront lot per year.

Lesson 3. Take a hard look at what is being preserved. Does it really create problems to let park beaches retreat? Can the buildings be moved? Are they worth the cost of nourishment?

Lesson 4. Once erosion control has been started, it has to continue. Hard stabilisation is generally never removed; it is just made bigger. Even more critical, hard structures often cause erosion on adjacent beaches leading to even more hard structures.

In New Zealand we have perhaps been fortunate that circumstances have conspired to preserve the coast from large engineering works and armoured shores. A relatively long coastline (11,000 km) and sufficient natural harbours, combined with a small population, have ensured little coastal development. Apart from ports, few developments demand protection from coastal erosion. Funds for protection have been small because coastal communities provide only a modest rating base. Furthermore, there are no central government subsidies for coastal protection, territorial local authorities fund protection only of public assets and subsidies for works to protect private property are much more difficult to obtain, and regional councils serve a regulatory and advisory role and provide no funding. And, unlike in some other countries, there are no powerful lobby groups for engineering the coast.

A seawall left battered by the July 1978 storm at Omaha on the east coast of Auckland.

Unfortunately the lack of funding for coastal works and poor understanding of coastal processes in the past have left the coast peppered in places with small ad-hoc structures, now in various states of disrepair and usefulness. There are 400 structures on the Environment Waikato coast. Auckland's North Shore beaches, now lined with very expensive real estate, are fronted in places by ancient and ugly protection works.

While it is still not easy to solve the erosion problem, we can conclude on a bright note. The New Zealand circumstances, our much-improved scientific knowledge of coastal processes, and the uptake of this knowledge into coastal hazard and erosion management initiatives by regional councils, mean there should be no excuses for not "living by the rules of the sea" and getting it right from now on. ■

Orrin Pilkey is based at Duke University, North Carolina, USA; Terry Hume is at NIWA in Hamilton.

Orrin Pilkey is the James B. Duke Professor of Geology and Director of the Program for the Study of Developed Shorelines (PSDS) within the Division of Earth and Ocean Science at Duke University, North Carolina, USA. Orrin is well known for his outspoken criticism of engineering intervention on the coast, a philosophy spelt out in his books "Living by the Rules of the Sea" and "The Corps and the Shore". Orrin was in New Zealand in April 2000, when he was a keynote speaker at the ICS2000, an international coastal symposium held in Rotorua.

Shore protection by massive concrete armour units fronting a resort in Japan. (Photo: Jess Walker)

Research can help

NIWA's research programme "Natural physical hazards affecting coastal margins and the continental shelf" provides improved knowledge, tools and models to assist the development of strategies to plan for and mitigate against hazards associated with storms, coastal flooding, inundation, erosion and tsunami events.