Chapter 12
"Alternative" Shoreline Erosion Control Devices: A Review

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Abstract A variety of patented approaches have been devised in efforts to halt shoreline erosion. Commonly termed 'alternative' or 'innovative' technologies, these are typically variations on the traditional approaches. A categorization of these approaches is presented that identifies devices placed in the water and devices placed on the beach. These categories are further subdivided. Despite their innovative nature and the claims of their inventors and promoters, these devices suffer from a variety of weaknesses when deployed in the real world. We present a non-exhaustive list of 110 devices for which US patents were awarded since 1970.

The view of success of 'alternative' devices often differs between reports made by the developer and those of the end-user and only in a few cases have objective assessments been made. Using a variety of sources we review experiences with artificial surfing reefs and beach drainage systems. We conclude that 'alternative' devices offer the same range of shortcomings as traditional shoreline stabilization approaches because of the inherent inability to control such a dynamic sedimentary environment and the failure to address the underlying causes of shoreline recession (sea level rise, sediment supply, other engineering structures, and the presence of infrastructure in the active coastal zone).

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12.1 Introduction

Coastal managers faced with shoreline retreat (coastal erosion) problems, typically seek a mitigation remedy. At the broadest level, the decision usually involves a choice between soft stabilization (beach nourishment), hard stabilization (seawalls or other structures), and retreat from the shoreline. This initial decision is made difficult because holding the shoreline in place, especially by hard stabilization, interferes with the coastal sedimentary system and creates additional problems including loss of beaches. Soft stabilization or beach nourishment avoids this problem in the first instance or is used to remedy the problems caused by hard stabilization, but it is costly and temporary. In addition, in a time of rising sea level it will become more expensive as more sand and more frequent nourishments are required to hold the beach in place. Purely from the standpoint of maintenance of the coastal ecosystem and preservation of beaches for future generations, the best approach is moving development back from the retreating shoreline. But there are other considerations besides the beach. What will be the fate of the buildings lined up along a beach, especially high-rise buildings which are, in all practicality, immovable? The retreat option is usually beyond the scope of the coastal manager's authority and this restricts the response options to some kind of engineered approach.

Preservation of buildings and infrastructure has been deemed the highest priority in many, if not most, of the world's coastal communities and, as a consequence, hard stabilization is a common erosion response. The hard engineering of shorelines, usually in relation to construction of harbors, has been carried out for more than 3,000 years. Over centuries of engineering, the principles of seawall, groin, and offshore breakwater construction in surf zone conditions have been developed. Today, as an unprecedented rush to the shore is occurring and at a time when the sea level is rising and expected to do so at ever-increasing rates, engineering of shorelines is becoming an ever more widespread societal endeavor.

In this paper, we focus on a category of engineering structures known as *alternative (non-traditional)* or *innovative erosion control technologies*. Those who harbor skepticism about such structures sometimes refer to them as *snake-oil devices*,[1] an uncomplimentary term derived, in large part, from the often exaggerated claims commonly made by manufacturers. Non-traditional ideas abound concerning how to halt shoreline retreat and hold shorelines in place. Most of these ideas have led to patented inventions, particularly in the last three decades. Many such devices have not been tried or have been installed along only a few shorelines, and thus exist mainly on paper. Coastal managers and coastal politicians are faced with a choice from an array of coastal engineering devices being promoted by their inventors or patent holders. The claims of the promoters regarding the positive

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[1] Snake oil was once advocated as a solution to a variety of medical ailments by unscrupulous salesmen in the American west.

benefits of their devices and the lack of objective assessment of their performance data make decision-making difficult for coastal managers.

Perusal of the technical and commercial literature about these structures usually reveals little monitoring of them post-emplacement, except for that done by the engineering firm that installed them. The State of Florida, in recognition of this problem, has a limited device-monitoring-and-evaluation program (Woodruff 2006), and an evaluation of ‘alternative’ stabilization methods was carried out in Puget Sound (Gerstel and Brown 2006) but, for the most part, coastal communities are on their own when attempting to judge the claims of manufacturers or installers regarding the efficacy of their devices.

In addition to protecting resources at risk, community-level coastal managers must usually assess the potential impact of any erosion response on environmental and economic issues, such as turtle and beach bird nesting, the sand supply of adjacent beaches, beach quality, and the tourist industry, but also must consider the role of continued sea level rise in the future.

The devices listed and briefly described here represent a cross section of the available alternative technology for shoreline stabilization. Of the hundreds of alternative devices, most follow the standard basic principles of sea walls, groins, and breakwaters that attempt to trap sand or in some way reduce wave energy. However, they differ from “standard” coastal engineering structures either in configuration and/or the type of materials used.

12.2 US Patents – An Overview of ‘Alternative’ Devices

A non-exhaustive analysis of US patent records reveals at least 110 patents, since 1970, that fall into the category of beach erosion mitigation. The oldest such patent we found (for a ‘sand and water break’) dates from 1881. The list below includes 6 from the 1970s, 30 from the 1980s, 46 from the 1990s, and 27 from the 2000s. The list is certainly not complete, because such devices may be classified in different ways, but it provides an impression of the types of devices being contemplated.

The 110 US patent applications are a sometimes wild collection of ideas ranging from the ingenious to the ridiculous. The former include instant and temporary seawalls to be put up within a few hours as a storm approaches and the latter include a sand-trapping device so efficient that it is said to form a small protective barrier island just offshore. Classification of these patents is difficult because many do not fall conveniently into recognizable categories. However, roughly 40% can be considered breakwaters in that they are emplaced parallel to the shoreline but are at least partially submerged most of the time. Broadly-defined seawalls of various types make up another 25% of the total, and groins an additional 10%. The remainder includes various kinds of mats, drainage systems, artificial seaweed, and a variety of nearshore current manipulators with pumps.

The various patented devices include ones described as permeable, adjustable, and even biodegradable. A few are designed to be emplaced immediately before storms and removed after storm passage. Many include an element of sand trapping that is envisaged as being accomplished by reducing the size or the velocity of the backwash in the surf zone. One patented device is supposed to reduce backwash by removing water from the swash zone, and another proposes to reduce longshore transport by pumping water against the current. Other devices include:

- Prefabricated seawalls deemed to be easy to construct and remove
- Seawalls that protect other seawalls
- Erosion mitigation devices that incorporate wave or tidal power generators
- "Fluid dynamic repellers" that create turbulence that dissipates wave energy
- Fish net groins
- Permeable, removable, adjustable, and biodegradable groins
- Structures that imitate kelp and coral reefs
- Reefs, breakwaters, seawalls, mats, and groins made of used tires
- Various breakwaters that break, block or realign waves
- Artificial surfing reefs (breakwaters)
- Sand-wetting devices that reduce wind sand loss
- Various beach dewatering systems, and
- Repeated removal of sand from shallow shore-parallel troughs expected to be refilled naturally in future tidal cycles

Few patent descriptions indicate any concern for or recognition of the impact on the quality of beaches or other coastal issues. Attention seems rather to focus on shoreline stabilization and preservation of oceanfront buildings and infrastructure. The ecosystem function of a beach was not mentioned in any patent with the occasional exception of turtle nesting but in all cases (when it was mentioned) the impact was declared to be negligible.

The likelihood of survival of most of these structures in major storms under open-ocean conditions is very low. Most design descriptions did not recognize the wide variety of wave conditions to which a particular structure might be subjected, and limitations related to where the device was to be installed (for example, fetch-limited bay shorelines versus open-ocean shorelines) were rarely stated. Putting it another way, "one solution fits all" is a common underlying assumption. Understandably, given the motivations behind filing a patent, optimism prevails in the descriptions of these devices.

12.3 A Classification of 'Alternative' Devices

While the 'alternative' devices portfolio contains an eclectic mix of approaches, most are derivations of or modifications of the traditional shoreline engineering approaches. The structures are categorized by placement location (in the water or on the beach) and functional similarity to well-recognized engineering structures such as seawalls, breakwaters and groins. There is some overlap, as some of the alternative devices do not necessarily conform to the criteria for any particular

Fig. 12.1 Beach prisms on the Maryland shoreline of Chesapeake Bay

category. They are subdivided into devices placed in the water (breakwaters and artificial seaweed) and devices placed on the beach (groins, seawalls, dewatering systems, dune stabilizing systems and other devices).

An internet survey of currently or recently available devices, mostly US in origin, was undertaken. The survey was not intended to be exhaustive but includes examples from nearly every available type of alternative structure. The essential characteristics and problems associated with each category of devices are described in the following tables. The left-hand column shows the commercial name (if one exists), a very brief description of the device, and the name of the company that installs it, if available. The middle column lists some locations where the device has been installed, and the right-hand column notes some of the claims made by the manufacturer.

12.3.1 Devices Placed in the Water

12.3.1.1 Breakwaters

The devices described in this category are shore-parallel structures placed offshore, either submerged or floating. Their intended purpose is to modify the incoming wave so as to create a "wave shadow" on the beach causing sand deposition (Fig. 12.1).

Problems commonly associated with breakwaters are that they may cause scour in the vicinity of the device and may increase downdrift erosion by removing material from the littoral current. They can impact water quality because of reduced water circulation and they can be a hazard to swimmers or boaters.

Table 12.1 lists 22 variations on the offshore breakwater theme. They vary in design, material and in the claimed secondary effects (e.g. surfing, benthic habitat).

12.3.1.2 Artificial Seaweed

These features involve some type of "imitation kelp" anchored to the seafloor. They are intended to slow waves and reduce energy, causing sand carried by the waves to be deposited. They are also intended to slow return wave energy, so that sand carried off the shore by return flow is deposited nearshore (Table 12.2).

The devices are placed in shallow water and may be hazardous to swimmers and boaters. Many are not suitably anchored and do not withstand storms. When they are dislodged they create debris on the beach.

Table 12.2 lists four variations on the artificial seaweed theme showing a wide divergence in materials.

12.3.2 Devices Placed on the Beach/Dunes

12.3.2.1 Groins

Groins are constructed perpendicular or at a high angle to the shoreline. They commonly are located on the inter- or supra-tidal beach but occasionally extend into the subtidal zone. Their primary purpose is to trap sediment that is moving alongshore in the littoral current. Groins cause erosion of downdrift beaches, they often create rip currents that are hazardous to swimmers and cause loss of sediment offshore, and they act as a barrier to activities on beaches, for example walking.

Table 12.3 provides details of seven variations on the groin theme. These vary in material and design.

12.3.2.2 Seawalls

Seawalls are walls placed at the base of a bluff, at the edge of shoreline property or at the landward edge of a beach. They are designed to protect land from the impact of waves.

Seawalls cause both active and passive erosion of the front beach. By preventing erosion they cut off the local sediment supply while waves that hit the wall are reflected downward, scouring the toe of the wall. In the passive mode, seawalls provide a barrier to the landward movement of beaches preventing them from adopting a storm profile and inhibiting a natural response to sea level rise.

The alternative devices surveyed include six variations on the seawall theme (Table 12.4).

Table 12.1 Name, description, installation and manufacturer's claims for 22 devices in the offshore breakwaters category

Device	Installation examples	Manufacturer's claims
Artificial surfing reefs **–** sand bag offshore breakwaters	Gold Coast, Australia Mount Maunganui, New Zealand	Reduces waves onshore acting as a breakwater Realigns wave crests and/or spreads wave energy to reduce wave driven currents Enhances surfing, providing several types of waves for surfers with different skill levels
Atlas shoreline protection system – Stacked timber, laid horizontally, held together by steel supports. Arranged in a sawtooth pattern on the nearshore, parallel to beach		Prohibits erosion & allows for accretion inward & outward of system Long life, low maintenance
Beach cones – Concrete donut 6″ high, 2′ across, 40″ across the bottom weighing 92 lb each	1992 – Shell Island in Lower Plaquemines, LA	Provide hard bottom stabilization for sand accretion No loss during Hurricane Andrew of an installation that included 300 cones and 13–72 cu. yds. of sand Average accretion 6′, max gain 3′
Beach prisms – Concrete blocks, with a triangular cross-section. Each unit is 6′ high, 12′ long and 84″ wide with a concave, openwork front face	1988 – Chesapeake Bay	Openwork face allows more water to flow through, which reduces scour
Beach protector tire mat – Tires anchored to each other & to the seafloor in a section 30–60′ wide & at least 1 mile long. Can be shorter if between 2 promontories & close to end of one of the promontories		Slows the return of "sand laden" waves
Beachsaver reef **–** Interlocking, concrete units, triangular in cross-section. Each is 10′ long, 6′ high, 16′ wide. The front face is ridged to reduce wave reflection, with a slotted opening at the top (Breakwaters International, Inc.)	1993 – Avalon, NJ 1994 – Cape May Pt. & Belmar/ Spring Lake, NJ	Water flows through slotted openings at top, sand is suspended & carried forward by incoming waves Stabilizes beach nourishment, requiring less sand for renourishment Attracts wildlife
Burns beach erosion device – Concrete block (5′ × 2′ × 8″) with rubber tire strips (1″–2″ wide) attached to the top of the block. Acts as artificial seaweed		Dissipates wave energy reducing offshore transport of sand Allows for greater accretion of sand during storm conditions May provide protection for turtles & substrate for crustaceans

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Table 12.1 (continued)

Device	Installation examples	Manufacturer's claims
Flow and erosion control system – breakwater – zigzag louvered 6–10-foot long, 4-foot high panels (Sandi Technologies)		Traps sand by slowing backwash Widens beach – four times cheaper than beach nourishment Reduces rip tides and storm impacts
Menger submerged reef – Triangular in cross-section; welded iron frame covered with steel screen mesh & concrete. Submerged offshore by filling with sand		Prevents sand from washing seaward by slowing wave energy Units can withstand severe weather changes, because the materials expand and contract Re-usable; not permanent Environmentally friendly because it can be moved with ease
MOTO – Primary function is to harness wave energy but also acts as a breakwater to reduce coastal erosion. Installation – 3 toroids, 10′ in diameter, weighing 4 tons each, placed at least 20′ deep		Waves lose power by creating energy, thus reducing erosion Provides clean energy and fresh water
Pep (Prefabricated Erosion Prevention) reef – Concrete units, triangular in cross-section, 6′ high, weighing 20 tons. Placed 2–4′ below surface at low tide (Designed by American Coastal Engineering, West Palm Beach, FL)	1988 – Palm Beach, FL (Privately funded) 1992–1993 – Palm Beach, FL (removed in 1995 because of increased erosion) 1996 – Vero Beach, FL	Builds trough and bar areas beyond the foreshore which shifts the foreshore outward Stabilizes the shoreline Reduces wave energy 40–70% Can be relocated easily Shelter and habitat for animals
Reef balls – Concrete balls with holes; mimic natural coral heads; sometimes integrated onto articulating concrete mats to create a breakwater in nearshore waters; range from 1.5′ × 1′ (30–45 lb) to 6′6″ × 3″ (4,000–6,000 lb) (The Reef Beach Co., Ltd.)	1996 – Turks & Caicos 1998 – Dominican Republic 2003 – Dade County, FL	Reduces wave energy that reaches the shore in area of chronic erosion Protects beach from erosion or builds up eroded beach Serves as an artificial reef structure providing hard bottom substrate for attachment of corals Provides shelter and habitat for fish
Reef mitigation gardens – Method of encouraging biological colonization of nearshore hardgrounds (Surfbreak Engineering Sciences, Inc.)		Especially applicable off East Florida where abundant hardgrounds occur

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Table 12.1 (continued)

Device	Installation examples	Manufacturer's claims
Seabox – 7.5 ton concrete box can be deployed as floating breakwater, reef breakwater, semi-submerged (on lower beach), as seawalls on upper beach or buried within frontal dunes (Seament Shoreline Systems)	Colonial Beach, VA Carolina Yacht Club, Wrightsville Beach, NC	Modular long-lasting concrete box Easily transported and installed Can be moved readily by truck, train, barge Fills with sand in most situations
Sealift – Shoreline breakwater, triangular in cross-section, placed beyond foreshore where it is shallow at low tide. Angled, so as to slow wave energy	1990 – proposed for Palm Beach	Pollution free installation Waves lose much of their destructive power Reduces long-term erosion Compresses the configuration of wave cells
Shore guard – high energy structure – High grade carbon steel coated with environmentally friendly coating; install 7′ or deeper (Seabull Marine, Inc. Shoreline Erosion Reversal Systems)		Patented zigzag design supports Mother Nature in supplying nourishment to build up shoreline Reinforces the natural balance of Mother Nature
Shoreprotector – Submerged sand fence, placed 400′ offshore. Made of openwork steel frame with 4 baffles on each side; 7′ tall, 16′ wide at base, weighing 650 lb	1975 – Virginia Beach, Va. Removed due to failure. Installation cost: $108,000 Removal cost: approx. $67,700	Flexible design Removable
Surge breaker – Permanent, steel reinforced "prisms", 4′ high, 4′ wide and 6′ deep; placed in 3–8′ deep water. Can be joined by steel cables for higher energy environments. Recommend installing 2 systems parallel to each other	*1976 – Highlands Park, IL 1979 – Bayou State Park, FL 1984 – Kuala Regional Park, Oahu, HI	Simulates offshore sandbars and reefs Stimulates accretion, reduces erosion Will work on any beach Will withstand extreme weather *In 8 months beach accreted 50′ in width in IL
Temple beach system – Reinforced concrete, triangular in cross-section, placed at mean low-tide/12-18″ below high tide, parallel to the shore. Metal rods are used to anchor		Does not interfere with boaters, bathers or turtles Mitigates against storm damage Moves high & low tide line an average of 200′ outward Protects beach nourishment
Waveblock – Modularized, permeable, steel reinforced concrete. Structure is an angled tower		Absorbs wave energy before it reaches the shoreline

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Table 12.1 (continued)

Device	Installation examples	Manufacturer's claims
Waveshield **–** Floating system made of steel; each unit is 80′ long, 20′ wide & 18′ high, weighing 40 tons. Unit of 3 compartments. Best in 25–30′ deep water		Provides protection against wave damage and erosion Breaks 8–10′ roller waves Economical, simple & easy to make Can be floated to any location, thereby avoiding high accretion on the landward side
Wave wedge – Concrete, interlocking units; triangular in cross-section, weighing 5,000 lb. Three slots/holes on the front face	1985 – Michiana, MI	Slots on front absorb energy Builds up foreshore & sandy beach Restores sand lost during storms

Table 12.2 Name, description, installation and manufacturer's claims for four devices in the artificial seaweed category

Device	Installation examples	Manufacturer's claims
Cegrass – Synthetic seaweed made of foamed polypropylene, attached to open grid mat, held to seafloor by ballasts. The length of the mat is tailored to the environment	1985 – Germany, to fix scour caused by pipeline – Italy – Wetlands in Europe	Reduces nearshore current velocities, thereby sand is dropped in sandbars which build up to 1.6 m high Reduces offshore sand movement and scour
Coil system – 9-gauge wire, 24–30″ in diameter, intertwined with smaller wire, attached to the ocean floor. Installed between inlets, 500′ to 2000′ from shore, in grid system 100′ between units, which are placed at an angle to the shore		Sand is captured within the coil grid and returned to the shore by tides & wind Coils interrupt ocean currents, allowing for sand to be trapped while currents pass through If properly emplaced, there will be no sand loss to adjacent beaches
Seabee – A series of six-sided concrete blocks, weighing 35 lb to 1 ton, with holes (honeycomb design), placed on slope in the nearshore. 20% of construction material is recycled ash	1989, Tidewater Community College – Portsmouth, VA. Monitored by VIMS	20″ of sand and silt collected between 1989 and 1996 on Tidewater Test Site Reduces energy of wave run-up, causing sand to be deposited
Seascape – Synthetic seaweed. Plastic filaments attached to a bag which is filled with sand to anchor the device	1981 – Cape Hatteras, NC 1983/1984 – Barbados	Controls shoreline erosion Fronds reduce current flow, sand is dropped

Table 12.3 Name, description, installation and manufacturer's claims for seven devices in the groins category

Device	Installation examples	Manufacturer's claims
Brush fence – Christmas trees or discarded lumber laid out in a "crib" fashion; 4′ wide, 72′ long	Jefferson Park, LA	Wave stilling device; decreases wave energies, capturing suspended sediment; protects the shoreline
Holmberg undercurrent stabilizer – A series of concrete-filled tubes buried at angles to the shore. "Interlocked network of geotextile forms injected with concrete." Site-specific design with longshore & offshore components laid perpendicular & parallel to the waterline. Accretion template which builds the submerged nearshore profile	1982-Manasota Key, FL 1983 – Michigan near Buffalo; Captiva, FL and Ogden Dunes, IN 2000 – Najmah Beach, Ras Tanura, Saudi Arabia USACE has permitted approx. 100 installations to date	Energy dissipator; slows currents so that inlets & jetties don't divert sand Nearshore sand stays nearshore Sand coming from offshore no longer transported downshore by littoral currents, therefore beaches accrete. This induces nearshore shoaling
NuShore beach reclamation system – Porous net groin system (Benedict Engineering Co., Inc.)	Okaloosa County, FL	Accumulate sand on the dry portion of the beach Intercept cross-shore transport without significantly restricting long-shore transport Removable netting material
Parker sand web system – Series of fish nets (50–100′ apart) perpendicular to the shore, strung from the high tide line, into the water. Nets are made of heavy nylon material. Work similar to a groin, trap suspended sand (Parker Beach Restoration, Inc.)	1987 – Pelican Bay Beach, FL. Had to be removed after 20 days because the installation did not have a permit 2001 – Naples, FL (not successful)	Nets cause a build-up of sand Promoting onshore movement of sand
Sealogs – (Sediment Shoreline Systems) – Attached approximately 3 foot concrete "logs" forming mats on beach surface	1994 – Colonial Beach, VA	Scour protection at seawall base Boat launch ramp on beach
Shoreline construction corp. groin – Low profile sill and groin system. Sill placed at an angle to the shore; acts as an artificial bar. Groin, perpendicular to the shore on either end of the sill & in the middle. The groin directs the flow of the sediment & water & reduces currents		System is at or below the water level, so waves can still overtop which eliminates scouring, flanking and reflection Eventually the whole system is covered by sand
Stabilito – Plastic groin/artificial ripple, 5 m long, 1.8 m wide, 60 cm high; placed perpendicular to shore on a submerged beach or dune		Slows & "elevates" currents, thereby creating sand ripples Stabilizes coastlines, riverside erosion and dunes

Table 12.4 Name, description, installation and manufacturer's claims for six devices in the seawall category

Device	Installation examples	Manufacturer's claims
High energy return wall – Concave seawall that causes wind and water to work against each other, thereby flattening the sea surface. Individual sections are 33′ by 44′ at base. Wall is 30′. Perforations in "splash pad" allow for water to pass through & sand to be deposited on back side of wall		Reduces toe scour common with traditional seawalls Causes beach accretion
L wall bulkhead and T groins – Primarily used as a seawall but can also be used as a groin; 4-ton concrete L-shaped units (Shoreline Systems, Inc.)	Several locations in Chesapeake Bay, VA	Modular Easy installation and removal Long-lasting Can be used in conjunction with sealogs and seaboxes
Marine bin walls – Steel bin filled with "granular material" to withstand freezing & thawing. Placed at shoreline or base of bluff	Protects homes	Best suited for marine construction
Ravens retaining wall – Aluminum, corrugated retaining wall placed at the water's edge at the base of a bluff	Unspecified	Protects property from slippage & erosion by tides
Wave buster – Seawall with angled top to reduce wave reflection. Associated drainfield above & behind bluff to reduce hydrostatic pressure. Base secured with geotextile bed	Great Lakes-unspecified	Deflects water up & back without reflecting the waves-reduces toe scour
Z-wall – Low-lying concrete wall placed in a saw-tooth pattern at the base of a bluff or, ideally, offshore, submerged halfway	1973, Buttersville Park, Luddington, MI	Reduces erosion & encourages the build-up of sand in front of the wall Redirects wave energy so that sand is dropped

12.3.2.3 Dewatering

These installations extract water from the beach allowing for more percolation of water from incoming waves and reducing backwash. As the groundwater is pumped out, it is funneled to the ocean or collected as a resource.

Like all structures on beaches, such devices can be damaged or destroyed during storms. In Nantucket, the system broke down during every major storm. The pipes pose a hazard for swimmers and other beach users. On turtle nesting beaches, they must be turned off during the nesting season because groundwater extraction affects the temperature of the sand.

Three beach dewatering devices are tabulated in Table 12.5.

Table 12.5 Name, description, installation and manufacturer's claims for three devices in the beach dewatering category

Device	Installation examples	Manufacturer's claims
HDSI – Buried wells extract groundwater, thereby leaving an unsaturated zone. Waves run up & the water percolates below ground, depositing sand		Easier to install & more cost effective than traditional dewatering devices Not susceptible to storm damage Environmentally friendly, even to turtles Can be operated at variable rates
Pressure Equalizing Modules (PEM) – Beach dewatering with vertical pipes that have slits cut into the walls of them (ECO Shore International)	Several installations in Jutland, Denmark Old Skagen Lonstrup Skodbjerge	Turtle friendly Can be used in conjunction with groins and offshore breakwaters Invisible installation Easily installed and removed using light equipment on the beach
Stabeach – System includes a pump placed on the high tide beach with drain pipes attached. The pipes run underground & discharge into the ocean	1988–Sailfish Pt., FL 1994–Englewood, FL 1996–Nantucket, MA	Builds beaches while reducing erosion – less water washes back to the ocean in return flow, so less sand is carried with it Installation causes relatively little disturbance to the beach

12.3.2.4 Bluff/Dune Stabilization

These are low-lying barriers placed on the beach to prevent erosion of the back-beach topography, whether a dune or bluff. They also include structures that aim to trap wind-blown sand to build artificial dunes. Revetments protect only the land behind the structure and have little influence on the beach which may continue to erode. They may, however, act like seawalls in cutting off sediment supply from inland. A range of such interventions is listed in Table 12.6.

12.3.3 Miscellaneous Devices

A number of devices that are not easily categorized are described in Table 12.7.

Table 12.6 Name, description, installation and manufacturer's claims for six devices in the dune and bluff stabilization category

Device	Installation examples	Manufacturer's claims
Biodune sand gel – Spray gel-mixture of 97% beach sand & water with non-toxic biodegradable aqueous polymer gel	St. Augustine, FL Melbourne Beach, FL Ft. Fisher, NC	Stabilizes dunes Doesn't deter marine turtles Withstood 3 years of storms (dunes lost elevations, but were not undercut) Damage can still be caused by walkover Does not impede growth of vegetation
Dune guard – Similar to sand fencing but made of polymer grid attached to poles	Avalon, NJ	Captures wind-blown sand Especially suited for storms Lasts longer than ordinary sand fencing, partially because it resists weathering Can resist 9-ton force
Fabric fence – Sand fence made from yarn impregnated & coated with foam vinyl plastic, attached to poles & placed at the high tide mark or base of the dune line. Rolls are 150′ long, 46″ high		Highly visible Easy to install Stable & weather resistant
Nicolon geotubes – textile tube made from woven polyester; 30′ in circumference & variable lengths. Bags are filled with sand and placed in a trench at the toe of a dune	1995-Atlantic City, NJ	Stabilizes dunes & prevents landward erosion Can also be used as a groin
Soukup rubber tire revetment – Tires placed in a 16–18″ deep, 15′ wide trench, lined with filter cloth on the low-tide dry beach. Tires are covered with the sand that is dug out		Tires act as a more stable sandbag Stabilize the shoreline behind the revetment
Subsurface dune restoration – A dune is created by burying sandbags on a re-contoured slope. Vegetation is then established to protect the dune	Caledon Shores 1997-Long Island, NY	Dissipates storm wave energy which reduces erosion Designed for a 25 year storm Also allows for percolation of waves which builds up sand on the surface
Subsurface dune stabilization (Advanced Coastal Technologies, LLC) Three sloped, wedge-shaped, sand-filled geotextile tubes underlying frontal dune system, covered by 3–5 ft of sand	1986 – Satellite Beach, FL 1988 – Long Boat Key, FL	Soft solution Turtle friendly Wedge shape provides gradual wave force dissipation Rapid deployment capability Subject to puncture and tearing by waveborne debris
Triton marine mattress – Stone filled mattresses used for bluff or dune stabilization	Trinidad Boston Harbor, MA	Stabilization of bluffs & dunes Protection from scour

Table 12.7 Name, description, installation and manufacturer's claims for five diverse types of devices in the 'miscellaneous' category

Device	Installation examples	Manufacturer's claims
Beachbuilder technique – Elastomer coated industrial fabric, 25′ wide, anchored from the high beach to the tide line. Uses the energy of waves to build the beach (maximum winter buildup) by preventing the removal of sand during wave retreat		Restricts the return flow of sand carried by a retreating wave "Accretion concentration of 60 cu yd/ft in less than 4 days"
Beachbuilder (Project Renaissance, public domain) Perforated pipes through which compressed air is pumped		Produce curtains of air bubbles to slow water and cause sediment deposition Principle same as snow fence
Biorock – Use of electrical current in the water to precipitate calcium carbonate (Biorock, Inc.)	1996 – Maldives 2002 – Bali	Low voltage electrolysis of seawater to grow limestone structures and accelerate growth of coral reefs, oysters, seagrasses and salt marshes Could act as breakwater like a natural coral reef
Stabler disks – Concrete disks, 4′ in diameter, attached to pilings & placed at the storm high tide line (Sold by Erosion Control Corp., Livingston, NJ)	1993-Spring Lake, NJ 1996-Myrtle Beach, SC	Protects beaches & dunes by reducing storm wave energy Waves are slowed, sand is dropped & disks are covered
WhisprWave – Floating plastic breakwater (Wave Dispersion Technologies, Inc.)	Iraq Dubai California	Reduces wave energy on the shoreline Used mostly for security

12.4 Impacts of Alternative Devices

Despite the lack of acknowledgement of the negative impacts of these alternative devices, it is obvious that any artificial device placed on or near a beach will interfere with the natural dynamic equilibrium that controls beach behavior. Different devices interfere or impact to different degrees and in different ways. The alternative erosion control devices and some of their potential impacts on the beach environment are categorized in Table 12.8.

Of particular concern is the device's performance during storms. During storm conditions, even the most robust infrastructure is threatened with damage and the debris from these coastal devices is often left strewn along the coast. This debris creates dangerous conditions for everyone, from beachcombers to swimmers.

The pollution problem related to these structures is dependent upon original water quality. If a device creates standing or very slow moving water and the local

Table 12.8 A tabulation of the likely impacts of the ‘alternative’ devices surveyed

Device	Harms beach access	Erosion of downdrift beaches	Erosion of fronting beaches	Potential hazard to water-based recreation	Impact on water quality	Impact on turtle nesting	Impact on beach fauna and flora	Impairs aesthetics
In the water								
Artificial Surfing Reef		X		X				X
Atlas Shoreline Protection System	X	X		X	X	X	X	X
Beach Cones		X		X	X	X		
Beach Prisms		X		X	X	X		X
Beach Protector Tire Mat	X	X		X	X	X	X	X
Beachsaver Reef		X		X	X	X	X	X
Biorock		X			X		X	
Burns Beach Erosion Device		X		X	X	X		
Cegrass		X		X	X	X		
Coil System		X		X	X			
Flow & Erosion Control System (FECS)		X		X		X	X	X
Menger Submerged Reef		X		X	X	X	X	
MOTO		X						
PEP Reef		X		X	X	X	X	X

Device	Harms beach access	Erosion of downdrift beaches	Erosion of fronting beaches	Potential hazard to water-based recreation	Impact on water quality	Impact on turtle nesting	Impact on fauna and flora	Impairs aesthetics
On the beach								
Beachbuilder Technique	X			X		X	X	X
Biodune Sand Gel			X				X	
Brush Fence		X		X	X			X

(continued)

Table 12.8 (continued)

Device	Harms beach access	Erosion of downdrift beaches	Erosion of fronting beaches	Potential hazard to water-based recreation	Impact on water quality	Impact on turtle nesting	Impact on fauna and flora	Impairs aesthetics
Dune Guard			X					X
Fabric Fence			X					X
Geo-Textile Low Profile Stabilization System	X	X		X		X	X	X
HDSI	X					X	X	X
High Energy Return Wall		X	X	X				X
Holmberg Undercurrent Stabilizer		X	X	X	X	X	X	X
L Wall Bulkhead	X	X	X	X		X	X	X
Marine Bin Walls		X	X	X				X
Nicolon Geotube			X					X
Parker Sand Web	X	X						X

Device	Harms beach access	Erosion of downdrift beaches	Erosion of fronting beaches	Potential hazard to water-based recreation	Impact on water quality	Impact on turtle nesting	Impact on shellfish resource	Impairs aesthetics
On the beach								
Pressure Equalizing Modules (PEM)	X	X		X		X	X	X
Ravens Retaining Wall		X	X	X				X
Sealogs (ramps)	X	X	X			X		X
Shoreline Construction Corp. groin		X	X	X	X			
Soukup Rubber Tire Revetment			X	X	X			X
Stabeach	X	X		X		X	X	X

(continued)

Table 12.8 (continued)

Device	Harms beach access	Erosion of downdrift beaches	Erosion of fronting beaches	Potential hazard to water-based recreation	Impact on water quality	Impact on turtle nesting	Impact on shellfish resource	Impairs aesthetics
Stabilito		X	X					X
Stabler Disks	X			X		X		
Subsurface Dune Restoration System			X					
Subsurface Dune Stabilization		X	X			X	X	X
Triton Marine Mattress			X					X
T-wall Groins	X	X	X	X		X	X	X
Wave Buster		X	X	X				X
Z-wall		X	X	X				X

Device	Harms beach access	Erosion of downdrift beaches	Erosion of fronting beaches	Potential hazard to water-based recreation	Impact on water quality	Impact on turtle nesting	Impact on fauna and flora	Impairs aesthetics
In the water								
Reef Ball		X		X	X		X	
Reef Mitigation Gardens		X						
Seabox	X	X	X	X	X	X	X	X
Sealift		X		X	X	X	X	X
Seascape		X		X	X	X		
Shoreprotector		X		X	X	X		
Surge Breaker		X		X	X	X		
Temple Beach System		X	X	X	X	X	X	X
Waveblock		X		X	X			
Waveshield		X		X				X
Wave Wedge		X		X	X	X		

water is already polluted, additional pollution may result. This is a possible impact of all breakwaters. Since most erosion control involves holding sand in place or causing it to deposit, essentially all devices will create downdrift sand loss. Damage to fauna and flora includes harming the biota of the sand, the plants and animals that live within beach sand and are an essential part of the whole ecosystem.

Although objective analysis of the performance of alternative devices is typically lacking, some impression of the performance of a few is presented below. These are based upon firstly, results from the State of Florida’s monitoring program and secondly from an analysis of secondary sources which we present for artificial surfing reefs and beach drainage systems.

12.5 Florida Monitoring Program

In light of the profusion of new technologies being offered, the State of Florida passed a law in 1989 to encourage development of new methods of shoreline stabilization and to test them along its shores. The law (Sec. 29, 89–175 – Rule 62B-41.0075) was intended to encourage development of new and innovative approaches to deal with the widespread erosion problems of the state whose economy depends heavily on beaches and associated tourism. Before this program on innovative erosion control technology was created, state officials had no basis on which to assess the performance of proposed devices, and no established basis for ascertaining the performance of a device once in the water. As is the case elsewhere, they were at the mercy of the companies that proposed such devices.

The Florida Department of Environmental Protection summarized the state’s experience with innovative technology in a historical overview that included pre-1989 experience (Woodruff 2006). The results of that analysis are summarised below.

12.5.1 Artificial Seaweed

Installations: Three, from 1983 to 1984. All were declared to be ineffective. The required monitoring in two cases was too short or not carried out at all.

Problems: Problems included an inadequate anchoring system, buoyancy loss by individual fronds, and unknown environmental impact.

12.5.2 Net Groins

Installations: Four, in 1987, 2000, 2001 and 2005. Third party reviews showed that success criteria were not met and there was significant downdrift beach loss.

Problems: Significant hazard potential for swimmers, surfers and jet skis because of possible entanglement with nets.

12.5.3 Beach Scraping

Installation: Three, in 1985 (2) and 2004, were considered ineffective or inconclusive. In this category are a variety of mostly post-storm scraping approaches. One ineffective approach involved **Beach Builder Screws**, large augers intended to bring sand ashore from beyond low tide (Florida Department of Environmental Protection 2008).

Problems: Beach scraping is not permitted except with an emergency permit. It can be a form of beach erosion, with possible impact on dunes.

12.5.4 Beach Dewatering

Installations: One installation, 1985 – StaBeach System.

Problems: Beach was stable but inadequate information to determine effect of installation.

12.5.5 Physical Structures (Geotextile Groins)

Installations: 1. **Protect Tube II**, 1989: beach remained stable 2 years; 2. **Longard Tubes**, 1992: performed well but tubes damaged and settled; 3. **Undercurrent Stabilizers**, 1984: no beneficial effects.

Problems: Long-term groin effects expected, plus concern about inhibition of turtle nesting.

12.5.6 Proprietary Reef Structures or Thin Line Submerged Breakwaters

Installations: **P.E.P. Reef** (Palm Beach, FL), **Beach Saver** (Avalon, NJ), **Beach Beam** (Maryland), **Beach Prism** (Bennetts Point, MD), **Campbell Module** (Sea Island, GA). All are concrete, segmented, prefabricated offshore breakwaters with more-or-less triangular cross sections.

Installations: **P.E.P. Reef** – 2 installations: 1. Palm Beach, 1993, installation removed after 2 years; reef segments used to make groins for nourished beach retention. 2. Vero Beach, 1996, minimal effect.

Problems: Relatively little impact on beach volume; swimmer hazard; Palm Beach structure had enhanced seaward sand loss.

The Florida analysis is unique in having made an objective assessment of the field performance of several 'alternative' devices. As can be seen from the analysis, none was regarded as an unqualified success.

12.6 Case Studies

Probably the highest profile 'alternative' devices at the present time are artificial surfing reefs and beach dewatering systems. Both approaches have seen numerous installations worldwide and sufficient material exists to compare the manufacturers' claims with practical experience and public opinion. In the following section we review the application of both technologies and the outcomes as perceived by the public. These are then compared to the manufacturers' claims.

12.6.1 Artificial Surfing Reefs

A US patent for artificial surfing reefs (ASRs) was first filed in 1991 and granted in 1993. Early installations for surfing reefs include Cable Station, Western Australia (Bancroft 1999) and Pratte's Reef, California (2000). Subsequent structures have been built in Queensland (Australia), New Zealand, England and India using a variety of designs and materials. Most of the available literature on artificial surfing reefs derives from the manufacturers and designers themselves (e.g., Black (1998); Hutt and Mead (1998); Hutt et al. (1998); Mead and Black 1999; Black 2001; Mead et al. 2010) and much is aspirational and theoretical in character, reporting the outcomes of modelling studies and describing the *expected* outcomes. A few studies, however, do describe monitoring of artificial surfing reefs for a short period after installation. The authors of many of those studies also have interests in the construction of artificial surfing reefs. For example, Bancroft (1999) assessed the Cable Station reef as "working to design specifications and is performing as well, or better than, was predicted," but few reports have described the results of monitoring of ASRs over several years. In several cases this is because they have not been completed to specification, thus hampering analysis of their performance. The 4-year monitoring study reported by Jackson et al. (2005) for Narrowneck Reef (Gold Coast, Queensland) was inconclusive regarding the influence of the reef on shoreline position and surfing but did prompt a number of design changes during and after installation, as unexpected physical changes in the seabed occurred. A subsequent report on 7 years' monitoring (Jackson et al. 2007) was much more emphatic in concluding that the reef had been a success in retaining the nourished beach, in providing a substrate for development of a diverse marine community and improved surfing conditions. The report did conclude that there were only a few occasions when the ideal swell simulated by modeling had been reproduced in the field.

An artificial surfing reef at El Segundo, California, was constructed to compensate for a surf break that was destroyed by construction of a 900-foot groin by the Chevron oil company in 1984. The Surfrider Foundation was given a 10-year permit in which to make an artificial surfing reef work or take it out. That point was reached in 2008 when it was acknowledged that the efforts had failed. A spokesperson for Surfrider, the proponents of the scheme, stated eventually that "For eight plus years, Pratte's Reef was as useless as useless gets". The sandbags that formed the artificial reef were removed from the seabed in 2008 (http://www.surfline.com/surf-news/after-years-of-unspectacular-closeouts-prattes-reef-is-removed-from-el-segundo-sandbagged_19261/photos).

The rationale behind installation of artificial surfing reefs often refers to them as multipurpose, offshore and adjustable (e.g. Black 2001), and several potential benefits are commonly cited to justify their installation. The priority and importance of each of these benefits, however, appear to evolve according to the way the installation pans out. Turner et al. (2000), for example, described the Gold Coast reef's aims as primarily to stabilise and enhance the beach by promoting beach widening and, secondly, to enhance local surfing conditions. The diverse marine environment created by the reef was identified subsequently as a significant value (Jackson et al. 2005).

Studies of long-term effects of artificial surfing reefs are difficult to find. However, a number of commentaries on artificial surfing reef performance in the WWW and press indicate that such structures often fail to satisfy expectations that existed at the time of their construction. The Mount Maunganui artificial surfing reef in New Zealand was partly installed in October 2006 (http://www.mountreef.co.nz/MountReef/4th-Oct-2006-Mount-Reef-Delivers!_IDL=10_IDT=464_ID=2290_.html). In August 2007, it still had a "further 30% of bag filling to go." One of the large geocontainers ruptured during 2006 and was replaced in 2008. It was reported in 2009 that work was continuing to "push the reef closer to the design specs" (http://www.mountreef.co.nz/) and in July 2010, the work was ongoing: "There was also a problem with one of the containers that make up the reef – which was not properly sealed by the construction crew – and thus part of the reef is actually missing." (http://www.surfermag.com/features/rinconmtreef-opedwhenry/). Subsequently, in March 2011, another surf magazine deemed the reef "a costly mistake" and reported the local council's concerns over failure to achieve completion of the structure (http://surf.transworld.net/1000127318/news/nz-artificial-reef-a-costly-mistake/). A number of reports claimed that the artificial surfing reef was being ignored by local surfers (http://www.bayofplentytimes.co.nz/local/news/surf-reef-branded-a-dangerous-flop/3947426/).

The artificial surfing reef in Boscombe, England, was constructed as part of a scheme to regenerate the seaside resort. It was opened in November 2009, reportedly a year behind schedule and at twice the estimated cost. It was subsequently declared unsafe and was closed to the public in April 2011 (http://news.bbc.co.uk/1/hi/england/dorset/8673078.stm). This closure was blamed on substantial changes to the reef structure and fears that dangerous currents could be produced. In addition, low tides left the reef exposed out of the water. Press reports commented that the reef was being used by an average of three surfers a day. In its defense, a local councilor was quoted on the BBC as saying: "We're disappointed that the reef isn't performing better at this stage but it is innovative marine engineering. I'm not surprised that it needs some optimising."

It appears from the global experience of artificial surfing reefs that few, if any, meet their desired outcomes (Jackson and Corbett 2007). There are calls for a number to be removed as has already happened to Pratte's Reef. Problems with installation, safety issues associated with unanticipated currents, danger of entanglement in torn webbing (http://www.bayofplentytimes.co.nz/local/news/surf-reef-branded-a-dangerous-flop/3947426/), and surfing waves not living up to expectations are widely cited. Jackson et al. (2007) also point to unrealistically high expectations driven by media hype. Based on their experience of the Pratte's Reef in California, the Surfrider Foundation no longer accepts artificial surfing reefs as a form of mitigation for loss of natural surf breaks (http://www.surfline.com/surf-news/after-years-of-unspectacular-closeouts-prattes-reef-is-removed-from-el-segundo-sandbagged_19261/photos). Steinvorth (2010) argues that installation of artificial surfing reefs in areas that already have good surf breaks is inappropriate. Despite the mixed opinions of surfers regarding the outcomes of such installations and the difficulties in construction, however, new artificial surfing reefs continue to be planned and constructed worldwide.

An assessment of six artificial surfing reefs (Jackson et al. 2007) showed that only four had been completed and of these, three produced acceptable surfing conditions. An alternative assessment published on a surfing website gave a contrasting qualitative ranking of six operational (or formerly operational) ASRs on an A to F scale (Table 12.9) with no reef scoring better than a C-minus.

12.6.2 Beach Drainage Systems

Turner and Leatherman (1997) and Curtis and Davis (1998) reviewed the history of beach dewatering work up to that date. Machemehl et al. (1975) appear to have been the first to propose beach dewatering for coastal stabilization, based on flume experiments, and the first field test was conducted by Chappel et al. (1979) in Australia. The first patent of a beach drainage system was registered by the Danish Geotechnical Institute in 1985 (Vesterby 1991, 1994), and full-scale tests were conducted in Denmark between 1985 and 1991 at Thorsminde (Turner and Leatherman 1997). However, as late as 2005 Bruun concluded that beach drainage systems should still be regarded as experimental, a sentiment since echoed by

Table 12.9 Qualitative ranking of performance of artificial surfing reefs and their cost. http://oceanswavesbeaches.surfrider.org/do-artificial-reefs-work-vol-4-track-record

Name	Installation	Cost	Rating (surfability)
Burkitts Reef, Bargara, Australia	1997	AU$5000	D
Cable Station, Western Australia	1999	AU$2 million	C-
Narrowneck, Gold Coast, Australia	2000		C-
Pratte's Reef, El Segundo, California	2001	US$300,000 installation US$300,000 removal	F
Mount Maunganui, New Zealand	2005 (not yet completed)	NZ$1.5 million	D/F (but incomplete)
Opunake, Taranaki, New Zealand	2005 (not yet completed)	£935,000	Incomplete
Boscombe, England	2008 (not yet completed)	£3 million	Incomplete

Ciavola et al. (2009). Like artificial surfing reefs, beach drainage schemes are sometimes promoted as multi-functional. The system at Ravenna, Italy, for example, was primarily installed to provide water supply into reservoirs (Ciavola et al. 2009), while Curtis and Davis (1998) report on the ecological implications of such an installation in Massachusetts. Ciavola et al. (2009, p. 7317) contend that "too often this solution is presented to the coastal manager without an impartial view of the possible failure of the interventions." Nonetheless Goler (2004) reported that 33 BD (Beach Drainage) systems had been installed around the world since 1981 in Denmark, USA, UK, Japan, Spain, Sweden, France, Italy, and Malaysia, with four more under construction or approved for installation at that time.

The several monitoring studies of beach drainage systems report variable but usually inconclusive results. Chappel et al. (1979) were unable to quantify the influence of dewatering on the morphological response of a high energy beach in Australia. In a 6-year experiment at Thorsminde, Denmark, accumulation in the drained zone of 30 m^3/m of shoreline within the first year was followed by stability for a further 2 years. The beach then eroded, but possibly at a lower rate than adjacent sections of the coast. Infrequent surveys and the occurrence of a 1:100 year storm during the survey period precluded any definitive conclusions being reached on the prototype installation (Turner and Leatherman 1997). A similar conclusion was reached by Dean (1989) who found it was not possible to separate natural beach changes from those induced by a dewatering system (STABEACH) installed in Florida in 1988. Bowman et al.'s (2007) 1-year study at Alassio, Italy, concluded that the beach drainage system did not promote beach accretion. Ciavola et al. (2009) monitored a beach drainage system near Ravenna, Italy, over a 3-year period, noting a progressive accretion trend with seasonal variability that was impossible to separate from the natural behaviour of the beach. They did note that the system did not provide a definitive solution to coastal erosion. Vicinanza et al. (2010) found no positive effects of a system installed at Chiaiolella Beach, Italy. They also reported consistent volume loss from the beach during a mild storm and damage to the system during the storm. They particularly drew attention (p753) to the "inadequacy of the dewatering system as coastal protection under high wave conditions." Curtis and Davis (1998) reported that a system installed on Florida's Gulf coast was rendered inoperable by a series of storms.

12.7 Discussion

The abundance of proposed alternative devices is an outgrowth of a number of societal issues that include:

- Intense development along ocean shorelines that are eroding.
- The reasonable expectation that erosion problems will increase as sea level rises.
- The high cost of traditional shoreline erosion response (an especially large burden for small communities).
- The demand for lower cost devices to halt erosion.
- The demand for less environmentally damaging approaches to erosion response.

Alternative shoreline stabilization device is a term applied to a category of coastal engineering structures that differ from the "standard" widely used structures. Thus, by definition, 'alternative' structures have not found wide application. These devices use distinctive materials or are emplaced in particular configurations along a shoreline that render them different from standard approaches.

Usually, however, the principles of shoreline stabilization are the same for the alternative devices as for the more widely used ones. That is, most of the devices can be said to fall into the categories of seawall, groin, or offshore breakwater, which in some fashion or other aim to trap/retain sand or reduce wave impact, the two main tasks of all shoreline erosion control devices.

Introducing any structure into a dynamic physical environment like a beach will likely promote changes in that environment. Since a beach's success and persistence is linked to its ability to adapt to changing circumstances, any structure is likely to impede that process. Beaches operate under a range of wave energy conditions to which they respond by changing shape as sediment is moved within the beach system. Such changes are commonly cyclic and beaches usually recover after storms, but not always. Those that are suffering long-term erosion are driven by either a sediment deficit or rising relative sea level, neither of which is addressed by any type of shoreline stabilization device at any meaningful timescale.

The stabilization approaches listed here have the usual impact problems, foremost of which is that engineering devices that hold the eroding shoreline in place inevitably will result in a narrowed and sometimes completely lost beach. Most of our listings, however, have either never been emplaced or have been emplaced in very few locations. Thus the experience base for these alternative structures is very sparse. In addition, monitoring, if carried out at all, has mostly been done by the manufacturers, the Florida and Puget Sound programs being major exceptions to the rule. Monitoring is typically over short time periods, and apparent successes that are promoted by the manufacturer are often undone by subsequent events such as storms. All too often, however, unexpected storms or unusual field conditions are given and accepted as a reason for failure. Storms can be expected to be the main cause of failure of all coastal engineering structures, and the alternative devices are no exception. Few literature descriptions specifically address this problem.

An interesting issue is the widespread implicit and sometimes explicit assumption in the manufacturers' descriptions of these devices that they can find use on almost any shoreline – an extension of the one-device-fits-all mentality. Of course a device that may appear to succeed on one beach may not on another. Differences in parameters, such as sand supply, sand size, wave energy and storm frequency and intensity, can be responsible for differing responses of stabilization devices.

Evaluation of success of shoreline stabilization structures is fraught with a number of hazards including over-optimistic interpretations and too-short time frames. A device should be in place for a minimum of 5 years before a reasonable evaluation of how close the device came to achieving its stated original goals can be made. At Pratte's Reef, a 10 year period was used to make such an assessment. Acknowledgement of failure is often a progressive phase in the emplacement of alternative devices. For example, the lack of success is often blamed on unexpected conditions. Most commonly this means a storm, but other commonly cited issues include poor installation. The secondary goals of the device then begin to be promoted. For example, the artificial surfing reef on Australia's Gold Coast was promoted by the press as a surfing reef. When it clearly began to fail as the sandbags shifted, the reef's purpose as an offshore breakwater was stressed by its developers. Later emphasis was placed on its function as a habitat for benthic marine organisms. Other breakwaters that failed in their original reason for being have also been labelled as important habitats. This phase of shifting goalposts often enables the purchaser and supplier to enter a prolonged period during which the public slowly forgets the device's original purpose, and the costs involved are forgotten.

Coastal managers who must make the decision as to erosion response may find it difficult to get beyond the manufacturer's claims. One approach is to seek objective evaluation of the success or failure of the same or a similar device at another location. This is problematic, however, because no two beaches are identical in terms of the processes, and success at one location does not assure a similar experience at another. We contend that the best approach if these devices are to be used is to view them as experiments and be prepared to remove them if the experiment fails. A community should have a clear statement of expectations from the contractor. Monitoring of success or failure should be done by independent parties and not by the company that installed the project.

A major issue with these devices is that they address the symptoms rather than the underlying cause of the shoreline problem. A case in point is ongoing experiments on the delta of the Chao Phraya at Bangkok. There, delta subsidence, sea level rise, damming of rivers and reduction of sediment supply to the delta, and removal of mangroves with their sediment trapping ability have contributed to annual shoreline

Fig. 12.2 Pilot emplacement of patented shoreline stabilization devices at Chao Phraya Delta involving wave baffles made of concrete

recession rates of 25 m/year for more than 40 years (Vongvisessomjai 1992). In that context a patented system of wave baffles comprising concrete pillars arranged in three lines (Fig. 12.2) has been proposed as a solution to the erosion problem and a pilot scheme has been instigated. The scheme does not address any of the underlying problems and yet, such is the need for a solution and the strength of advocacy by the developers that pilot schemes have been supported.

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