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Harbors & Beach Erosion

Manistee Michigan 1993 DLH Photo by Marge Beaver

The Historic Growth and Loss of Beaches

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The Historic Growth and Recent Loss of Beaches and Deltas

First and foremost, a proven environmentally sound and sustainable method of mitigating the un-natural erosion to beaches and coastal wetlands described in this document already exists. Over 58 years of actual field data and technical refinements confirms the success of this alternate method to stop sand and beach loss. The method uses natural beach building processes to harness the power of nature forces to mitigate and reverse the man made destructive erosion cycle and process now in place. The value of the reversal is a continuous expansion of natural beaches to insure a healthy protective coastal system. The important message is that, in almost every case, this negative cycle of destruction can be mitigated and reversed by restoring natural regenerative beach building processes.

Continuous man-made changes have negatively altered the flow dynamics of coastal zones and watersheds changing them into unnatural erosion processes that are responsible for the destructive and ever increasing rates of erosion to beaches, land and waterways. It is important to understand that natural processes build beaches and that man is responsible for destroying them.

Today the loss of beaches, dunes, and bluffs through man-induced erosion has similar underlying causes that can be traced back to relatively recent human activity. This fairly contemporary phenomenon coincides with engineered alterations of land formations, the nearshore and coastal waterways. In doing so, these engineering projects have negatively affected the natural accretion, or natural sand deposit process, that builds healthy beaches. The erosion seen today does not result from natural ecological and environmental factors, but from the shift in the normal gravitational processes caused by these engineered changes

Geologists' research documents the expansion seaward of land formations such as beaches and deltas since the last Ice Age as a result of natural erosion and accretion processes Geology of Michigan (1970 Dorr & Eschman). The TEXT BOOK of GEOLOGY (1864, James D Dana.LL.D.) describes how gravity and other forces combined to transport soil from upper and offshore land surfaces to create and continuously expand coastal formations. This fact is in sharp contrast to the recent massive amounts of beach, delta and shoreline destruction. Other references to this phenomenum include; (Principles of Geomorphology 1954 W.D. Thornbury), (Geomorphology 1919 D.W.Johnson), (American Journal of Science 1943

U.S.Grant), (Geology 1931-32 Lewis agreed to the findings of De Beaumont 1845), (Ge ographical Essays 1909 Davis).

"A geological example of this is Egypt, the 'gift of the Nile'." Similarly, it can be said that Louisiana is a gift of the Mississippi growing continuously since the end of the last Ice Age. In 1875, however, James Buchanan Eads an engineer was paid $10 million by the US Congess to design and install a self-dredging device below New Orleans that deepened the river to a constant 30 feet. He accomplished this by increasing the flow rate of the river, which began to excavate the soils from the deltoid into the offshore waters of the Gulf of Mexico. As a result of that change the Mississippi River Delta stopped expanding. Since then, Louisiana has lost thousands of square miles of its once expanding land and watersheds. According to the records of Humphreys & Abbot (1864) the delta was annually receiving 268 million cubic yards of sediment that created about 25 square miles of new land. Louisiana is now reported to be losing that much or more annually. By doubling this figure it equates to annual soil losses of a half billion cubic yards. The loss in the last 130 years is about 70 billion cubic yards of irreplaceable soil or 700 billion dollars figured at $10 per cubic yard. The eroded and lost material would cover 260 square miles and raise the level of the land 268 feet. The damage and loss to Louisiana is continuing to escalate the river depth south of New Orleans now reported to be 45 feet. The cost of restoring the Mississippi watershed, delta and other lost resources is not calculable: the starting point in dollars would be in the trillions. The losses will continue to escalate and not stop until man-made causes are mitigated. What is happening to Louisiana and New Orleans is only a small part of a global pattern of destruction that is quickly eradicating the final elements that support earth's present forms of life.

Nature's way is to create elevated land formations called beaches and deltas to control the flow rate of water within river sheds, to provide protection and safety, to retain and assist the distribution of soils, to maintain water tables, provide aquatic habitat and purify water, filtrate out and isolate contaminants, recycle organic matter and etc. Whenever land gradients become steeper, gravity increases the flow rate of water, which then escalates soil erosion. Doubling the flow velocity of water increases its' soil carrying force 64 times, (1864, James D Dana LL.D)

The cause of beach erosion is displayed, in an aerial photo taken in the sixties, of a beach losing its sand due to the self-dredging design of the federal harbor located at Frankfort, Michigan. The same textbook also used aerial photos to show how beaches, deltas and dunes along the Great Lakes had been in a state of expansion since the end of the last ice age. The photos were used to present a geologic perspective of how natural accretion processes had enclosed bays along Lake Michigan shores with ever widening beaches and sand spits then sealing them in with additional sand dune formations and forests to create inland lakes.

Offshore breakwaters deflect sand and inner parallel walls accelerate water current through channels to flush out sand (Geology of Michigan Textbook 1970)."

The first beach erosion occurred in the Great Lakes when a navigational harbor was constructed within a deltoid region along the southern shores of Lake Michigan. According to geologists, no obstructions interrupted the continuous net southerly transport to a drift terminus along the Indiana coast. "Jetties built in 1830 to defend the mouth of the Chicago River formed the first barriers to littoral transport, and substantial downdrift erosion developed. Additional coastal structures that form both total and partial barriers to littoral transport have segmented the original single-littoral cell (*see* note) into a series of 6 primary cells (bounded by total barriers) and 18 secondary cells (bounded by partial cells). As a result, the supply of littoral sediment from the Illinois coast that once nourished the Indiana coast has been eliminated. A comparison of beach and nearshore bathymetric profiles collected over the past 15 to 20 years document a thinning of littoral-sediment prisms along the Illinois coast caused by insufficient sediment influx to compensate for that lost to downdrift and offshore transport" (Chrzastowski and Trask, 1994) (Abstract from 1994 GSA Meetings). NOTE: Cells are a term now used by coastal authorities to describe shore areas located between man made harbors, inlets and etc.

The report seems to be quite accurate except for the misconception about jetties. They are not designed to protect river mouths, however, they do serve to protect ships while entering and mooring within harbors during turbulent weather. Old piers had stones placed on top to protect ships by breaking up waves. Later in 1930, more stone was placed under the piers to create walls to convert them into jetties. "Constructions extending into the lake, particularly piers protecting harbor entrances, divert currents for several miles to either side of them" (Michigan Natural Resources Magazine 1983).

Ludington Harbor July 1993

DLH Photo by Marge Beaver

The primary problem with harbors, inlets and jetties are that they cause erosion and land subsidence. Their intent is to serve navigation and commerce while their design is directed at maintaining deep water in sandy shallow areas in the near shore. Counter designs that would negate shoreline loss are not part of this design. These designs are quite effective in removing sand. However in so doing, they also erode, remove and transport soils from adjoining beaches, dunes, bluffs and watersheds to lower elevations offshore and divert sand that would normally deposit and amass to expand coastal beaches, river wetlands, deltas and other areas. "Points, breakwaters, and piers all influence the circulation pattern and alter the direction of the currents flowing along the shore. In general, these obstructions determine the position of one side of the circulation cell. In places where a relatively straight beach is terminated on the downcurrent side by points or other obstructions, a pronounced rip current extends seaward. During periods of large waves having a diagonal approach to the shore, these rip currents can be traced seaward for 1 mile or more (McGraw Hill Encyclopedia)."

Standard shore-protection measures are not working. The current field data shows that the standard (theoretical) model studies are flawed, in that they do not accurately represent the short, medium and long term effects to the installations. The standard shore-protection design manuals, such as the Shore Protection Manual, are based on laboratory tests with fixed beds.

- Standard revetment designs are optimized to use the minimum possible volumes of stone.
- Standard groin design assumes that the beach material is stable against shore-normal transport.
- Sheet pile seawall design is based on an assumed lakebed elevation.

None of these designs mentioned above incorporate adequate reserve, either functionally or structurally, against undermining. Undermining is the removal of base material under a structure. “Revetment toes are undermined, causing settlement of the entire structure and loss of backfill. Lakebed deepening destabilizes beaches and causes them to migrate away from the water’s edge, rendering groins ineffective. Sheet pile walls collapse suddenly whenever the penetration becomes inadequate. The lethal effects of lakebed down cutting on shore protection structures tell us that such structures are inherently futile and can be useful for buying a few more years of upland lifetime at the expense of beach loss.” “Lakebed Down Cutting and its Effects on Shore Protection Structures", Charles Johnson, COE. (Abstract for GSA Meetings, 1994).

Arcadia Harbor, Mi

New Buffalo, Mi.

July 2005 Oct. 1984 DLH Photos by Marge Beaver

Land subsidence and net deficiencies in coastal sand budgets is a direct result of a man made erosion process. Land levels along shorelines drop as their sand and soils are transported offshore. As shorelines become sand depleted, sea defenses and erosion control structures become dysfunctional and prone to destruction by ever larger waves and erosive energy. It should be noted that nature or shoreline residents are not the cause of beach erosion but the victims of man made erosion processes

While attention has been heavily focused on water levels moving up and down a few feet, land levels have been plummeting during storm events. Dunes several hundred feet tall simply disappear during short duration storms. Other shorelines with high bluffs are losing thirty to seventy feet of their embankments within hours during short term storms. Sleeping Bear Dunes, a federal park located north of Frankfort, is a prime example of this problem. In 1995, within minutes, a huge section of the park's dune system totaling more than a million cubic yards of soil and trees was carried en masse and lost offshore leaving only a vacated deep hole in the shoreline. A 1997 US Geological Survey team located the displaced dune with trees still intact in deep water over a mile offshore.

More than 35 million cubic feet of sand disappeared beneath the waters of Lake Michigan in a huge coastal landslide at Sleeping Bear Point in 1995. This composite image shows both the onshore and offshore areas removed from the point in that slide. In 1997, U.S. Geological Survey scientists found a thick blanket of debris from the slide extending more than 2 miles offshore, much farther than expected. Underwater video of the deeper part of the slide showed trees protruding from the sand (inset photo). These trees had been growing on the bluff at Sleeping Bear Point and were swept into deep water with the slide.

To those vested with navigational interests, deep water has always been more desirable than shallows. Since 1830, over a thousand similar changes have taken place just along the shorelines of the Great Lakes. Land that was once inside "metes and bounds" and land locked is now lying submerged offshore. Figures on the amount of land that has been lost are not available. The government, without compensation, claims all lost land if they decide it has subsided below ordinary high water marks or in the Great Lakes the International Great Lakes Datum Line (IGLD). For Lake Michigan and Huron this fixed elevation line is approximately 580 feet above sea level.

Government agencies have maintained that beach erosion is natural and pre-existing before navigational changes. This is proven to be false by these documents. The unnecessary loss of these resources has had a devastating impact on the economy and health of all those who are, or have been, dependent upon the Great Lakes and its fresh water basins.

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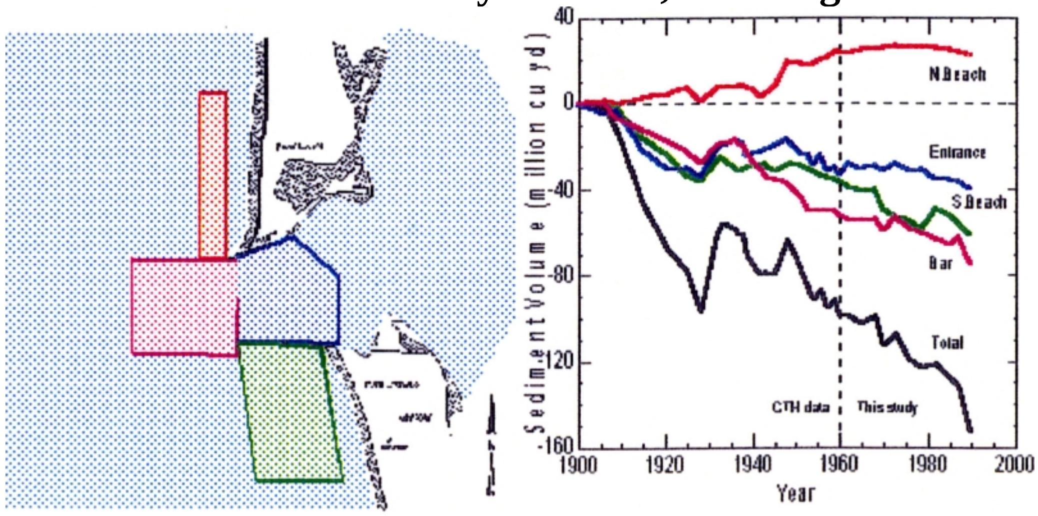
Large changes in the distribution of sediment near the entrance to Grays Harbor, Washington have occurred since the long rock jetties were built to confine flow. Spits to the north and south of the entrance have grown, the entrance channel has deepened, and the outer bar has eroded and moved offshore" (US Army Corp of Engineers Committee on Tidal Hydraulics, 1967 Burch, T.L., and Sherwood, C.R). The same report further stated, "Overall, more than 150 million cubic yards of sediment has been lost from the four areas around the entrance to Grays Harbor since 1900").

Historical Bathymetric Changes Near the Entrance to Grays Harbor, Washington



The erosional loss of 150 million cubic yards of sand at the location of the harbor, though serious, represents only a small part of a much larger picture: "the loss of billions of cubic yards of sand from the adjoining shores". This loss has had a major impact on beaches and other land formations along the Pacific Coast, but has not been included in this study. However, it does mention that erosional losses in some areas have reached 60 feet annually and there is a problem with a self-enlarging sinkhole near the harbor mouth. These two problems are related and indicate an out of control situation that will continue to create more coastal erosion and land subsidence unless stopped and mitigated. This is not a localized problem; the United States alone has thousands of channels, harbors, and inlets where natural protective beaches, deltas and watersheds have been destroyed. Compounding this problem are increasing numbers of ever-larger ships that require deeper channels and harbors. There are better alternatives than adapting land for ships such as offshore harbors and smaller packet ships designed for commercial transport in coastal waters.

Another example of how bad these problems have become is what happened to a healthy, expanding shoreline at Cape Canaveral, Florida. In 1951, the shore was altered with a 14-mile inlet channel and harbor. Prior to this change, the coastline to the south enjoyed an extraordinary shallow nearshore, wide beaches and dunes. A 1994 USACE study --using surveys from the 1800's-- found this coast to be steadily expanding seaward "by natural accretion" at two or more feet per year with its offshore shoal depths decreasing. The 1951 dredging of the 27 feet deep inlet immediately reversed this expansion along forty-one miles of the coast to the south to erosion with an average loss rate of fifteen feet per year (Dean, 1987). The beach also lost the 2 feet of new beach expected annually through natural accretion. After the initial two years of dredging the 41 by 14 miles section of shore not only lost 34 feet of dry beach it lost billions of cubic yards of sand from its' offshore bottoms leaving a 574 square mile depression. The change created a continuous erosion process and left a net deficiency in the Atlantic's coastal sand budget. Unnatural erosion has been removing new and pre-existing sand from this area of beaches ever since this change. This is only one of many inlets established and maintained along the Atlantic seaboard that have displaced protective beaches and deltas. The lost land formations formerly protected shores from soil erosion, land subsidence and sea level rise while during storms they collected new sand supplies from offshore to extend coastal beaches seaward.

A man-made global crisis has developed over the last one hundred years. Around the world, similar land altering measures and their continued use has allowed for these abnormal, deficit producing processes to reach powerful and increasingly destructive proportions. Solutions to this human-induced cycle of destruction are available. These must be implemented immediately, before the escalating negative effects become irreversible and the catastrophic collapse of our coastal resources occurs.