HAZARDS AND RISKS ALONG COASTS (34)

I Main Topics

A Hazard recognition

B Hazard characterization

C Risk evaluation (analysis)

D Risk assessment

E Local engineering approaches

F Closing comments

II Hazard recognition

A Hazards peculiar to coasts

1 Coastal erosion

2 Coastal deposition

3 Hurricanes

4 Tsunamis

II Hazard recognition

B Hazards accentuated at coasts
- 1 Flooding from relative sea level change
- 2 Quick clays (where young sediments are uplifted)
- 3 Seismic shaking (because of proximity to subduction zones)

III Hazard characterization

A Possible characterization targets
- 1 Waves and currents
- 2 Wind
- 3 Weather
- 4 Climate
- 5 Sediment (sources, sinks, fluxes)
- 6 Topography/bathymetry
- 7 Sea-level change
- 8 Climate change
- 9 Ecosystems
- 10 Effects of human activity

III Hazard characterization

A Characterization methods (focus here is on coastal erosion)

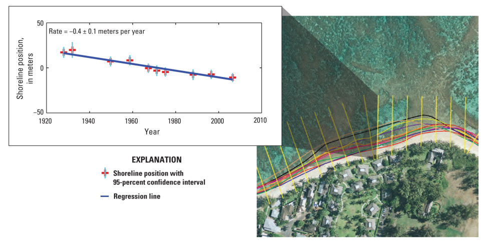
1 Geologic record

2 Historical review (e.g., UK)

3 Aerial photography

4 Ground surveys (fieldwork)

Shoreline position change at a transect on on Oahu



http://pubs.usgs.gov/of/2011/1051/pdf/ofr2011-1051_report_508.pdf

III Hazard characterization

5 LIDAR and GIS (need for teamwork) http://www.google.com/

https://www.youtube.com/watch?v=S4d5oofMujg

III Hazard characterization

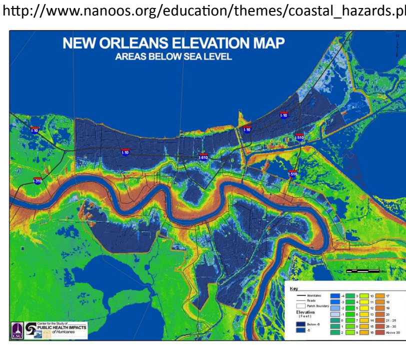
6 Drone surveys (45-minute survey time here)

https://www.youtube.com/watch?v=f-JF7cEM004

IV Risk evaluation (analysis)

A Risk = (Probability of loss)(Cost of loss)
B Loss probability depends on weather and climate
C Requires identifying what is at risk
  1 Cities
  2 Harbors/piers
  3 Property
  4 Buildings
  5 Pipelines (e.g., oil, sewage) and cables
  6 Floating structures (e.g., drill rigs)
  7 Seawalls, jetties, breakwaters, groins, rip rap
  8 Habitat/fisheries
D Requires identifying appropriate time scale

http://www.nanoos.org/education/themes/coastal_hazards.php

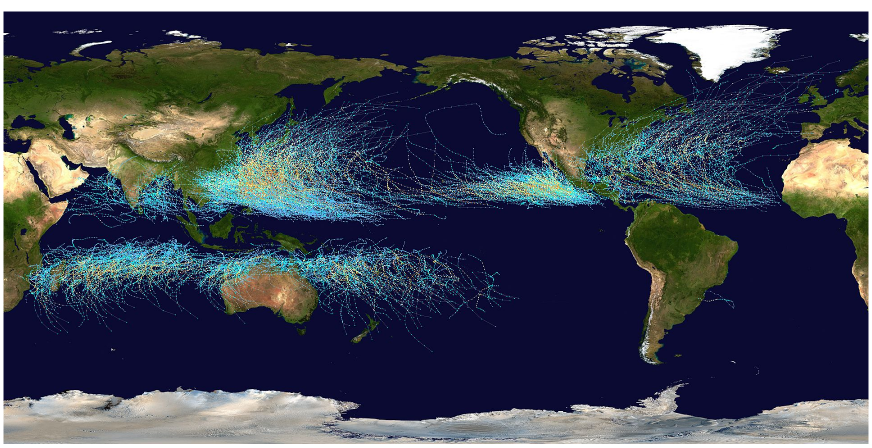


http://people.uwec.edu/jolhm/eh3/group7/Picture1.jpg

D 10 Costliest Atlantic Hurricanes

Hurricane	Damage (Billions)	Deaths	Year	Peak classification	Areas affected
Katrina	$125.00	1,833	2005	5	The Bahamas, U.S. Gulf Coast
Sandy	$71.40	286	2012	3	The Caribbean, U.S. East Coast, Eastern Canada
Ike	$37.50	195	2008	4	Greater Antilles, Texas, Louisiana, Midwestern U.S.
Wilma	$29.30	23	2005	5	Greater Antilles, Central America, Florida
Andrew	$26.50	65	1992	5	The Bahamas, Florida, U.S. Gulf Coast
Ivan	$23.30	124	2004	5	The Caribbean, Venezuela, U.S. Gulf Coast
Irene	$16.60	56	2011	3	The Caribbean, U.S. East Coast, Eastern Canada
Charley	$15.10	40	2004	4	Jamaica, Cayman Islands, Cuba, Florida, The Carolinas
Rita	$12.00	62	2005	5	Cuba, U.S. Gulf Coast
Frances	$9.85	49	2004	4	The Caribbean, Eastern U.S., Ontario

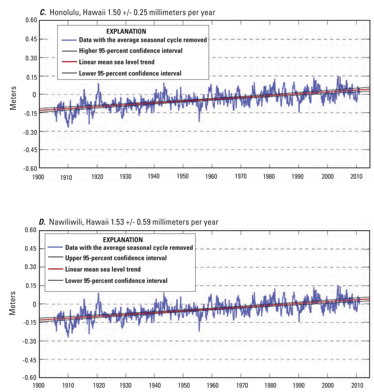
E Tracks of all tropical cyclones, 1985–2005 (Risks are widespread, but not uniform)



http://en.wikipedia.org/wiki/Tropical_cyclone

F Analytical methods

1 Numerical models



USGS_ofr2011-1051_report_508-20_Fig_6CD.jpg

2 Physical models
(e.g., wave tank experiments)

https://www.youtube.com/watch?v=N9hQJd5vNWY

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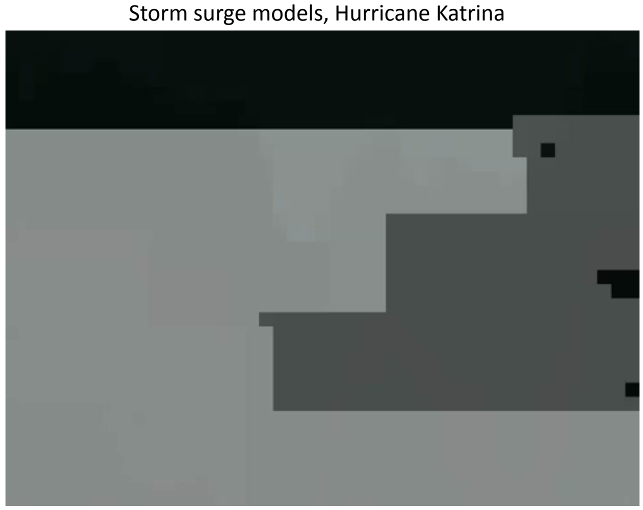
F Analytical methods
3 Physically-based computer models

Storm surge models, Hurricane Katrina



https://www.youtube.com/watch?v=S3j87m7wAik

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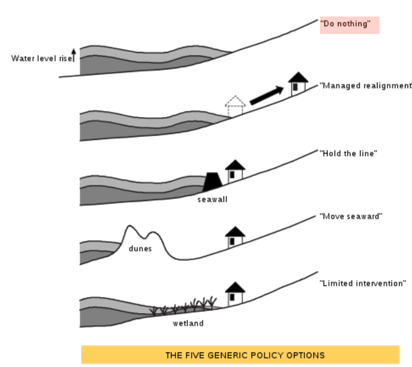
IV Risk Assessment
Is the level of risk acceptable?

A Yes
  1 Can be based on a thorough analysis
  2 Can be based on an analysis that ignores infrequent, high-energy events
  3 Can be a default answer
  4 Can involve coastal management options

B No
  1 Do not build (esp. where waves focus)
  2 Exercise coastal management options if risk can be made acceptable

IV Risk Assessment
C Coastal management options

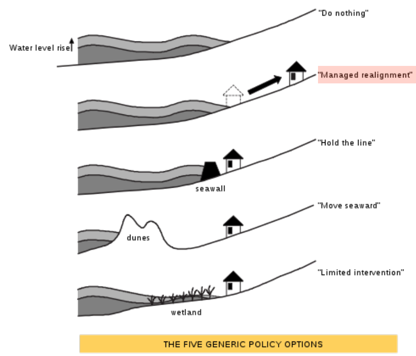
1 "Do nothing"
  a Commonly politically difficult
  b Can designate "forfeited land" as open space
  c Key costs
    i Forfeited land
    ii Loss of infrastructure
    iii Tax base
  d Can change assessed land value to offset tax base loss (e.g., Encinitas, CA)



http://en.wikipedia.org/wiki/Coastal_management

IV Risk Assessment
C Coastal management options

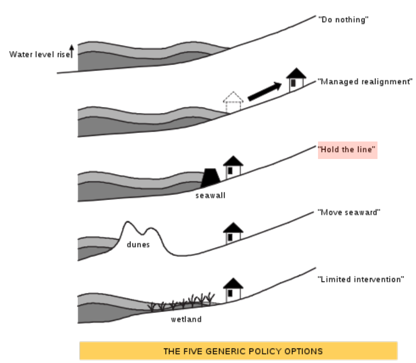
2 Managed retreat or realignment,
- a Plan for retreat
- b Adopt engineering solutions that account for natural processes
- c Identify where to construct new defenses
- d Can be cost-effective
- e Key costs
  - i Loss of land
  - ii Purchase cost of land



http://en.wikipedia.org/wiki/Coastal_management

IV Risk Assessment
C Coastal management options

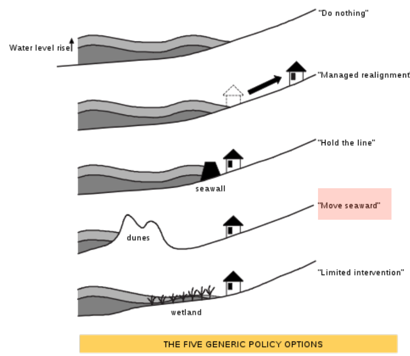
3 "Hold the line"
- a Traditional
- b Protects shoreline, commonly at expense of beach
- c Usually involves "hard" engineering (e.g., seawalls)
- d Can involve "soft" engineering (e.g., sand replenishment)



http://en.wikipedia.org/wiki/Coastal_management

IV Risk Assessment
C Coastal management options

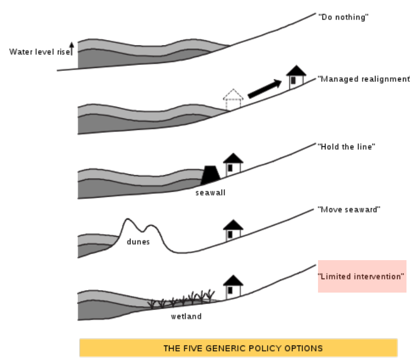
4 Move seawards
- a Construct new seaward defenses
- b can create land of high value
- c Usually involves "hard" engineering
- d Can involve "soft" engineering (e.g., sand replenishment)
- E Perturbs system; can create new problems



http://en.wikipedia.org/wiki/Coastal_management

IV Risk Assessment
C Coastal management options

5 Limited intervention
- a Raise coastal land
- b Build vertically
- c Can involve "hard" and soft" engineering



http://en.wikipedia.org/wiki/Coastal_management

IV Risk assessment

D Insurance

1 Coastal erosion insurance(?)

Not covered by National Flood Insurance Program

1 Hurricane insurance

A Available in Hawaii

B Augmentable by flood insurance (to cover flooding during hurricane)

2 Tsunami insurance(?)

3 Coastal sedimentation insurance(?)

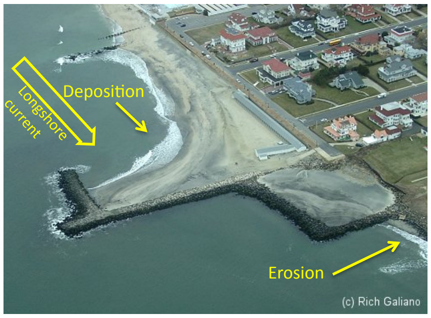
http://ageconsearch.umn.edu/bitstream/21818/1/sp00ke01.pdf

V Local engineering approaches

A Groins

1 Groins: barriers or walls perpendicular to the sea
2 Commonly used to create or maintain beaches
3 Deposition on side facing longshore current
4 Erosion on side in lee of longshore current
5 Do not protect against storm-driven waves
6 Generally cost-effective
7 Low maintenance
8 Excessive emplacement of groins can diminish sediment flux "downdrift" and result in erosion

View to the SSW of the groin at Allenhurst, New Jersey



http://njscuba.net/biology/misc_coast.php

B Jetties

1 Jetty: a structure that projects from the land out into water
   a Piers
   b Wharfs
   c Docks
   d Breakwaters
2 Can disrupt longshore currents (like groins)
3 Harbor jetties intended to maintain a deep channel
   a Channel erosion if jetty pairs spaced too closely
   b Channel deposition if jetty pairs spaced too widely

Jetties constructed of dolos at Humboldt Bay harbor

http://en.wikipedia.org/wiki/Jetty

C Breakwaters

1 Breakwater: Offshore structure that alters waves and filters the energy of waves and tides
2 Waves break offshore and lose erosive power inside breakwater
3 Diminished wave action behind breakwaters can lead to sediment deposition

Breakwater at Sidmouth, Devon, UK

http://www.southwestcoastalgroup.org/cc_defence_offshorebreakwaters.html

D Seawalls

1 Structure intended to protect land behind seawall
2 Straight seawalls
   a Can receive simultaneous large wave impact
   b Subject to wave damage
   c Reflect waves
   d Can induce scouring by stationary clapotic waves
3 Curved seawalls dissipate energy more effectively
4 Commonly result in beach loss

Sea wall at Saint-Jean-de-Luz, France

http://commons.wikimedia.org/wiki/File:Sea_wall_at_Saint_Jean_de_Luz.jpg

E Rock armor (Riprap)

- Boulders placed along the shore
- Used in areas prone to erosion to absorb the wave energy and hold beach material.
- Does not hinder longshore drift
- Rock armour has a limited lifespan, it is not effective in storm conditions, and it reduces the recreational value of a beach.
- Can be lost by undermining of underlying sand
- The cost is around £3000 per metre, depending on the type of rocks used.

Riprap along San Francisco Bay

http://en.wikipedia.org/wiki/Riprap

F Interlocking structures:

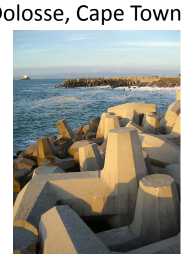
Alternatives to monolithic walls and riprap

1. Resist waves and dissipate wave energy better than walls
2. Resist foundering resulting from erosion of underlying sand
3. Tetrapods
4. Dolosse

Tetrapods

http://en.wikipedia.org/wiki/Tetrapod_(structure)

Dolosse, Cape Town



http://en.wikipedia.org/wiki/Dolos

Tetrapods, Yokosuka

http://www.japanfocus.org/-Stephen-Hesse/2481

G Gabions

1 Gabion: retaining wall of stone-filled wire cages
2 Can be angled ("battered"), stepped, and stacked vertically
3 Advantages over riprap
  a Modularity/can be stacked in various shapes
  b Resistant to transport by water
4 Advantages over monolithic structures
  a Flexibility
  b Dissipation of wave energy
  c Drainage
5 Strength can increase with time by sedimentation and vegetation
6 Life expectancy
  a Depends on wire, not stone
  b PVC-coated galvanized gabions: ~60 yrs
7 Also for debris flow retardation

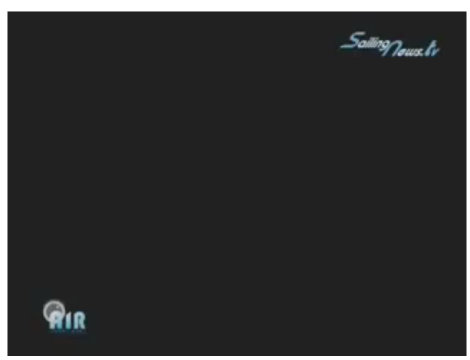
Battered gabion, Solvakia

Stepped gabion

http://en.wikipedia.org/wiki/Gabion

VI Closing comments

A Ocean stores enormous amounts of heat energy
B Coastal system are dynamic
C Time frame important
D Static engineering solutions are not permanent
E "Should do" vs. "can do"
F Monitoring should accompany engineering and policy choices



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- Rip currents
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