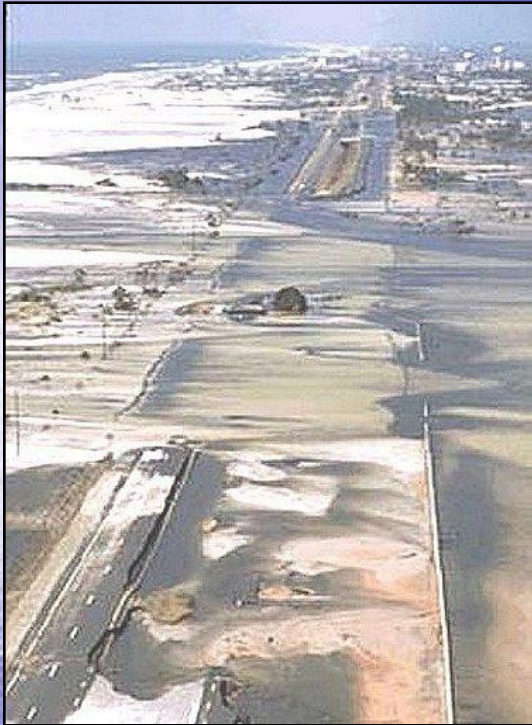


Sea Level Rise Adaptation Options for Local Governments

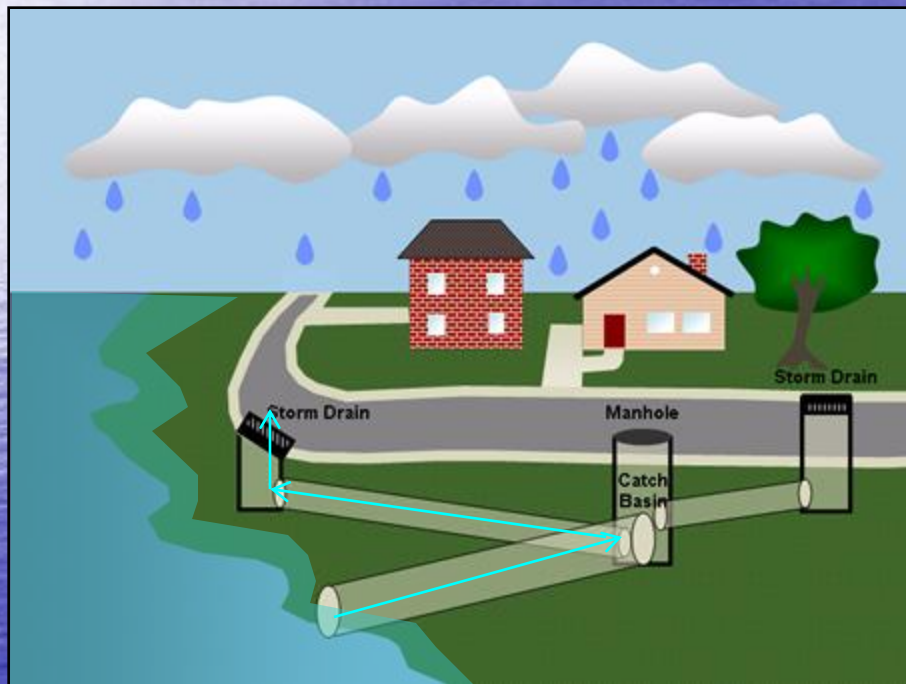
Robert E. Deyle
Department of Urban and Regional
Planning
Florida State University



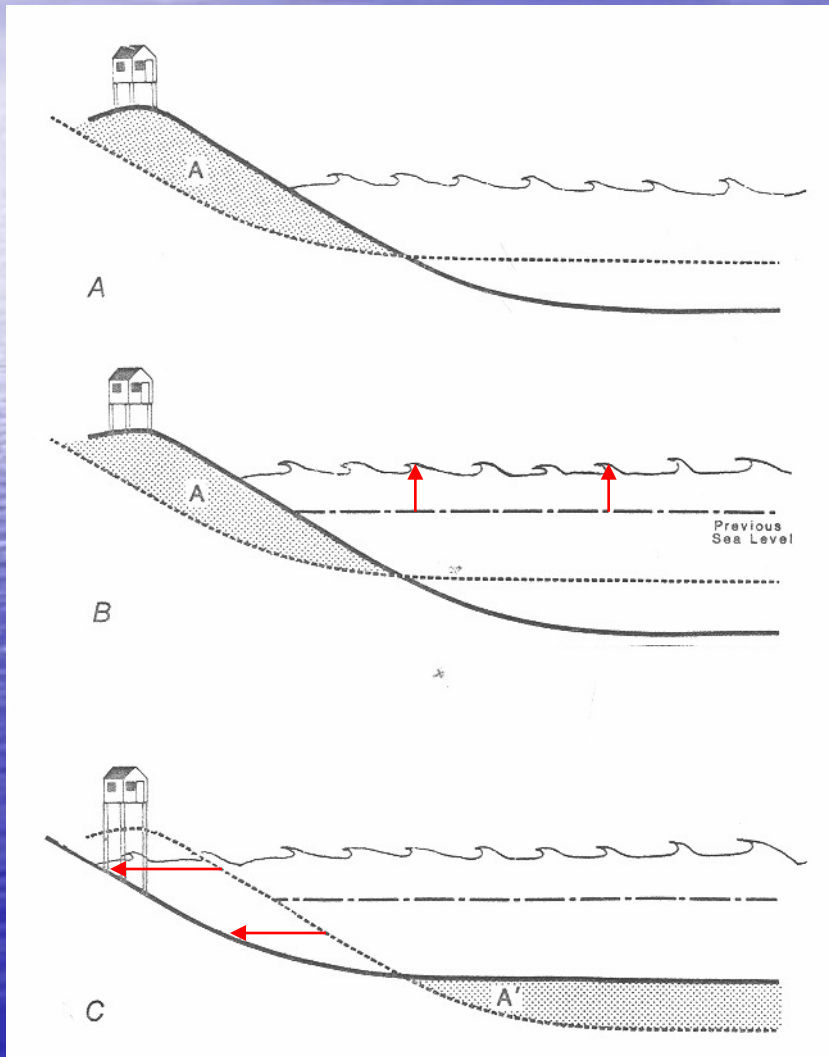
Impacts of Sea Level Rise

1. Inundation and shoreline recession
2. Increased frequency and severity of flooding and associated erosion and scour
3. Saltwater contamination of water supplies
4. Elevated coastal ground water tables

Inundation/Sea Level Rise



Inundation and Shoreline Recession



Bruun Rule

Recession Ratios

- US average: 1:50 to 1:100
- Florida average: 1:1000

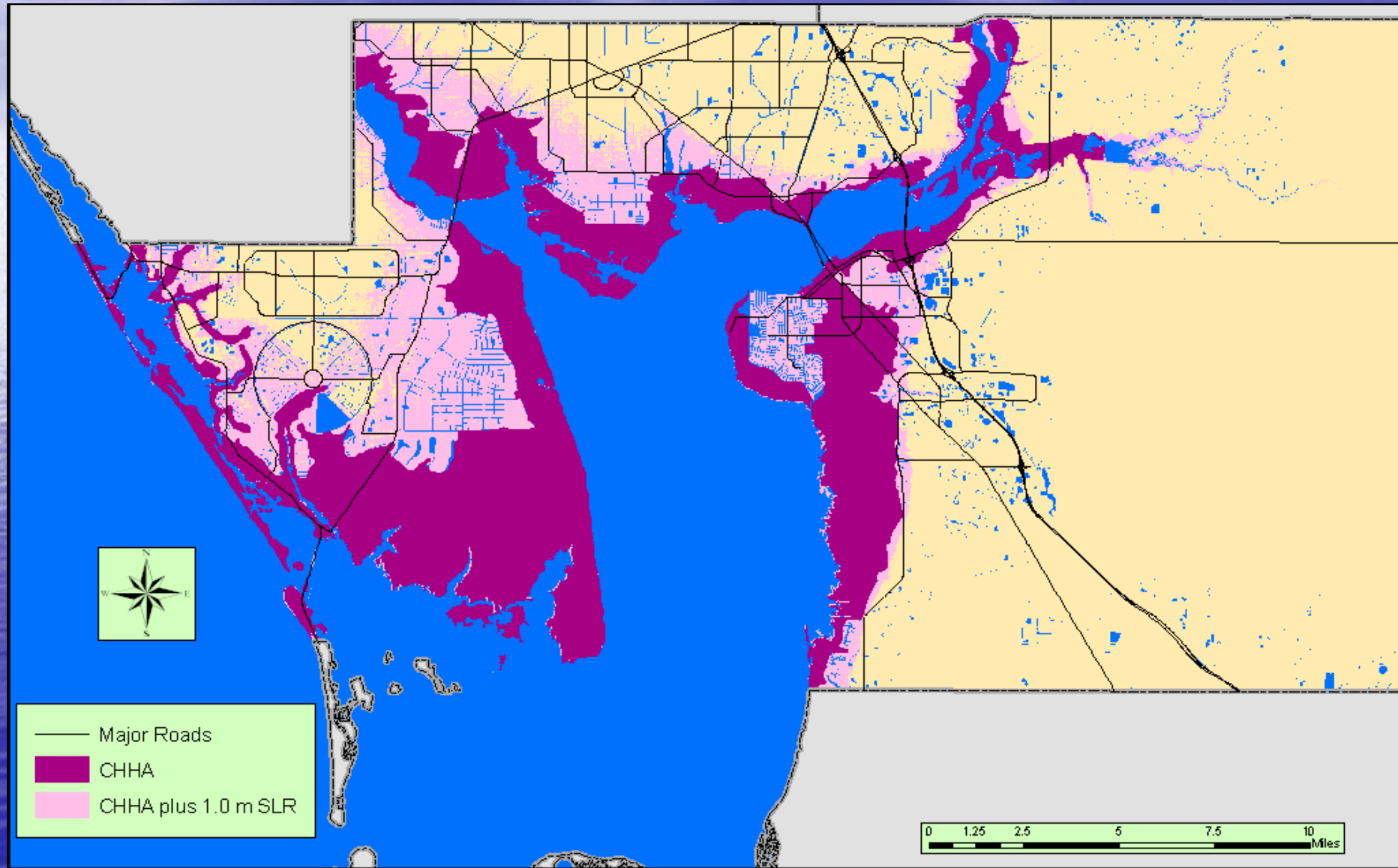
Inundation and Shoreline Recession



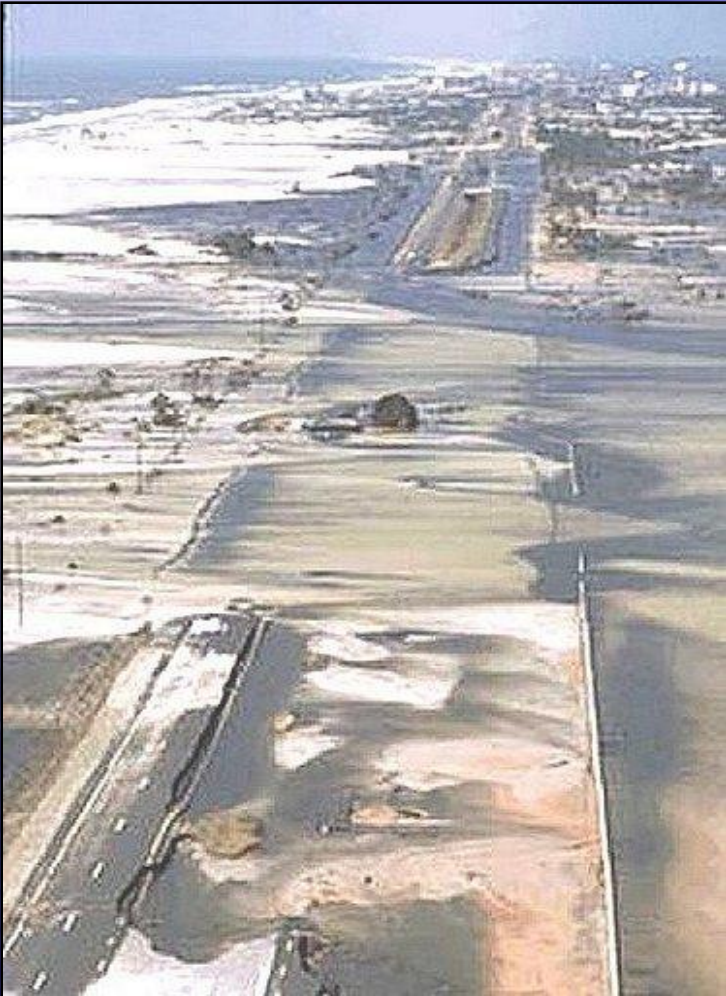
Inundation and Shoreline Recession



Increased Coastal Flooding



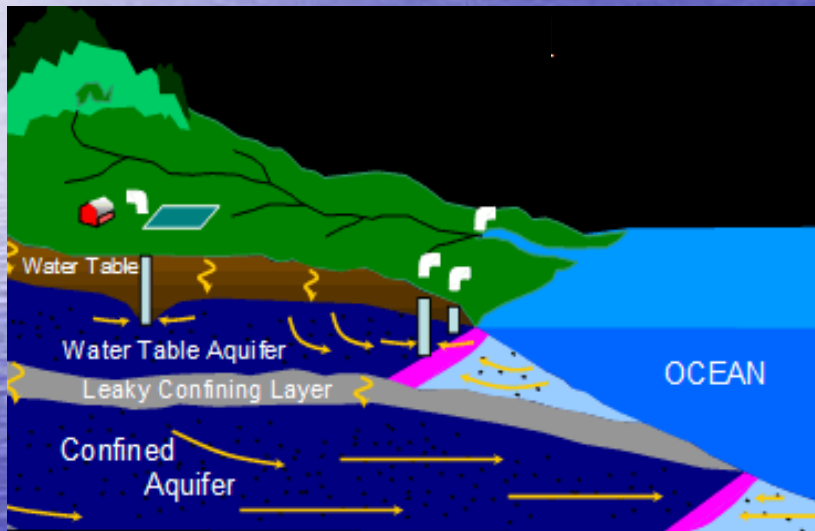
Increased Coastal Flooding



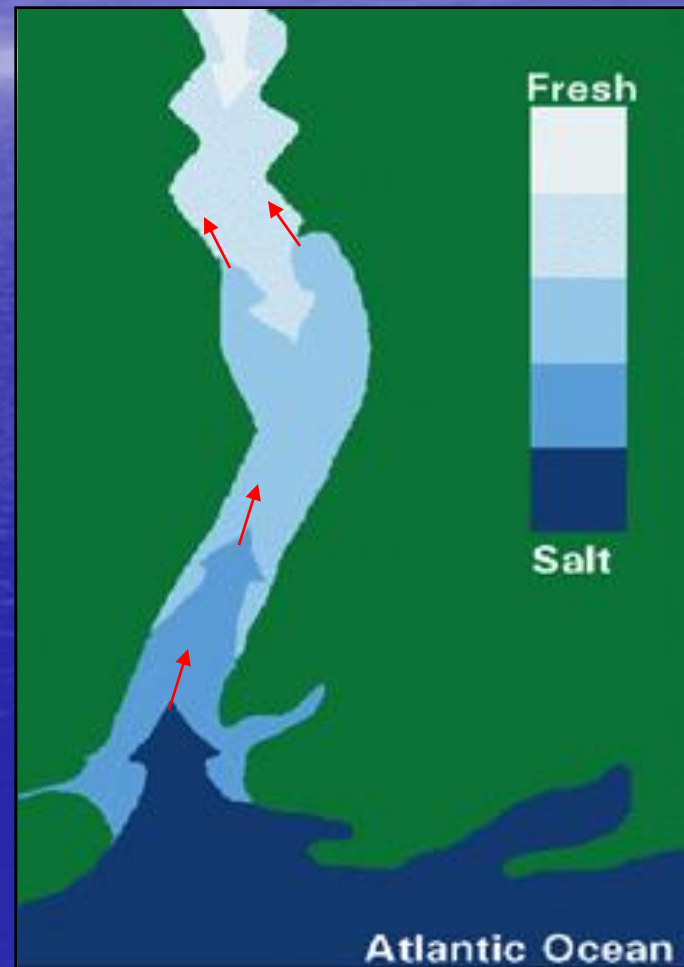
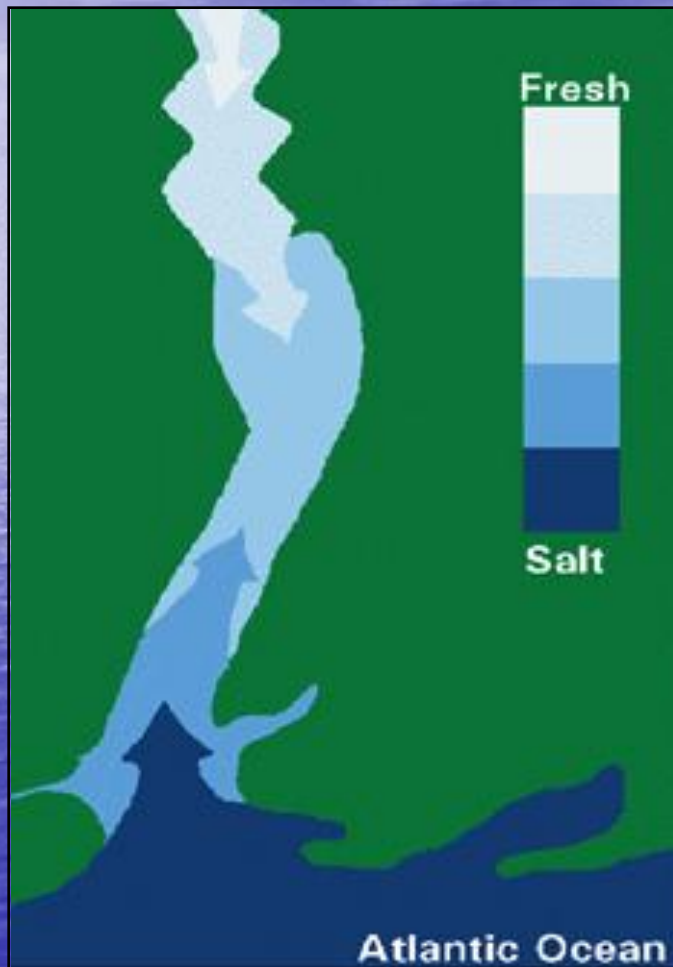
Increased Coastal Flooding and Erosion



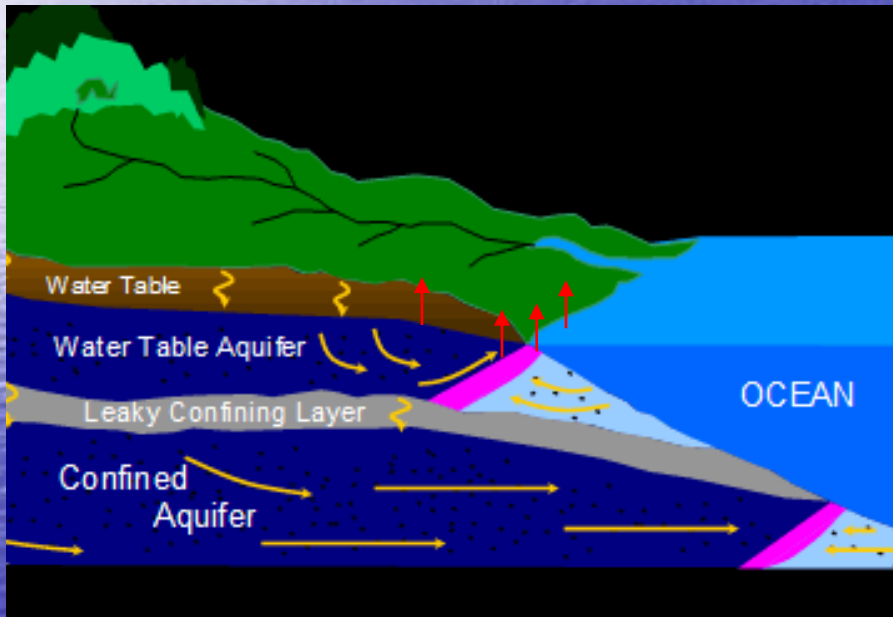
Saltwater Intrusion



Salt Front Advance



Elevated Coastal Water Tables



- Corrosion of buried water and sewer lines
- Ground water infiltration into sanitary and stormwater sewer lines
- Destabilization of buried pipes and road surfaces

Adaptation Approaches

1. Protect: Stand and defend
2. Accommodate: Buy some time
3. Retreat/relocate: Get out of the way

Response Strategies

- Protect
 - Seawalls and bulkheads
 - Beach nourishment
 - Living shorelines
 - Tide gates and saltwater barriers
- Accommodate
 - Flood proof and elevate structures
 - Grade elevation
 - Build bridges higher
 - Prohibit development in projected hazard zones
 - Impose setbacks

Response Strategies

- Retreat/relocate
 - Rolling easements
 - Infrastructure relocation/removal
 - Buy outs
 - Transfer of development rights

Protect: Sea Walls & Bulkheads



- Continued productive use
- Finite design limits
- Beach/shore narrowing
- Prevent beach and wetland migration
- Huge capital costs: \$10-20 million/mi
- Ongoing costs: ~\$1.5 million/mi every 20-25 yrs

Protect: Beach Nourishment



- Continued productive use
- Limited flood protection
- Maintains beach assets
- Allows beach migration
- High capital costs: \$4.3 million/mi
- Ongoing costs: re-nourish every 2-6 years

Protect: Living Shorelines



- Continued productive use
- Modest flood protection
- Habitat restoration or enhancement
- Self-sustaining without armoring
- ~\$2.5 million/mi with armoring
- \$0.25-1.05 million/mi without armoring

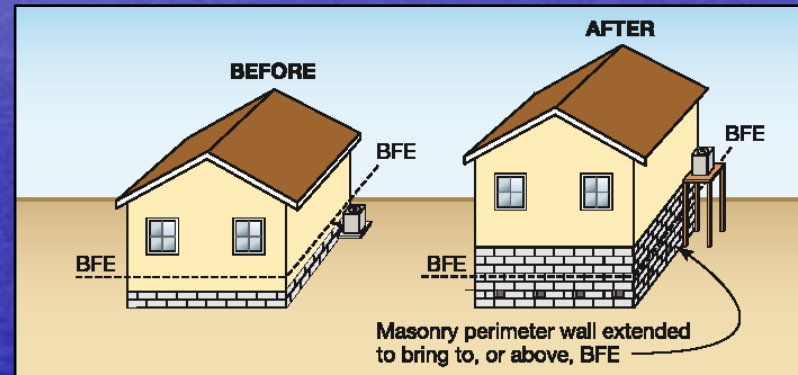
Protect: Tide Gates and Saltwater Barriers



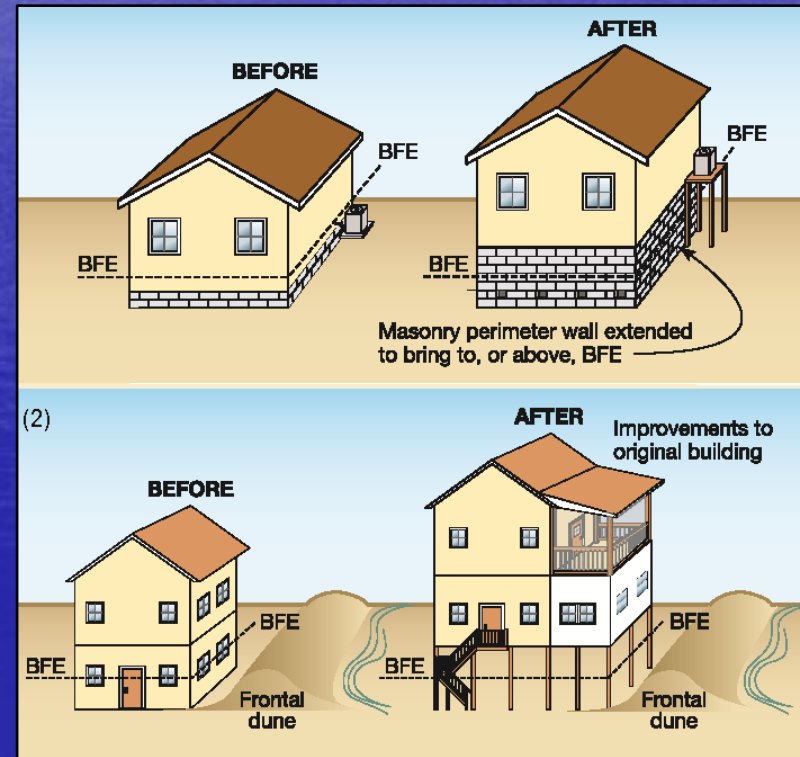
- Tide gates prevent high-tide and storm-tide backflow
- And prevent saltwater inflow into water supply intake pipes
- Large-scale saltwater barriers, e.g. Neches River, Texas



Accommodate: Flood Proof or Elevate



Accommodate: Flood Proof or Elevate



Accommodate: Flood Proof or Elevate



- Continued productive use
- Finite design limits
- Impede beach and wetland migration



Accommodate: Elevate on Open Pilings



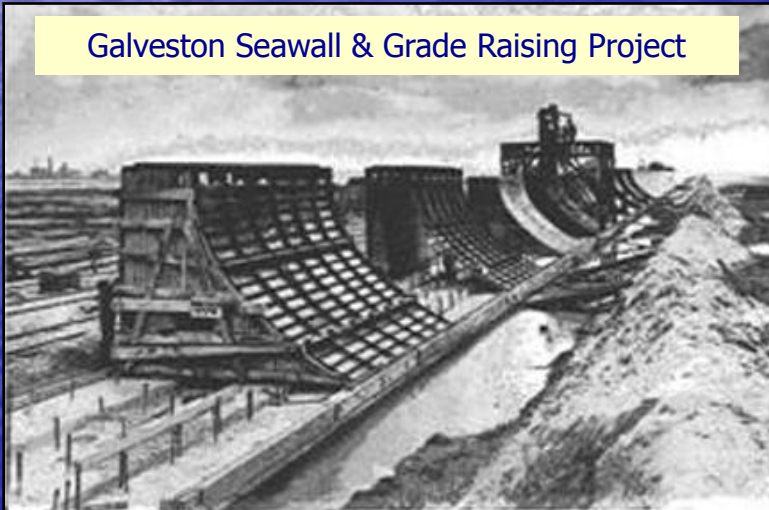
- Allows some beach/wetland migration
- Loss of access → filling (and armoring)
- New construction cost: \$15-\$32/sq ft
- Retrofit cost: \$30-\$100/sq ft

Accommodate/Protect: Grade Elevation

Boston Deer Island Sewage Treatment Plant



Galveston Seawall & Grade Raising Project



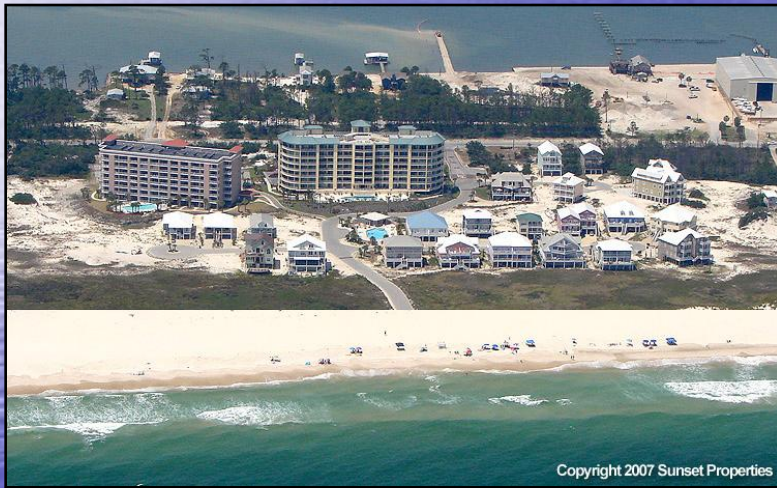
- Beach/shore narrowing
- Prevent beach and wetland migration
- Capital costs >> protection
- Ongoing costs > protection

Accommodate: Build Bridges Higher



- Build to accommodate SLR now
- 75-year design life
- Retrofitting generally(?) not feasible

Accommodate: Development Restrictions



- Prohibit development within projected hazard zones
- Site infrastructure outside of projected hazard zones
- Require setbacks from projected hazard zones

Accommodate: Development Restrictions



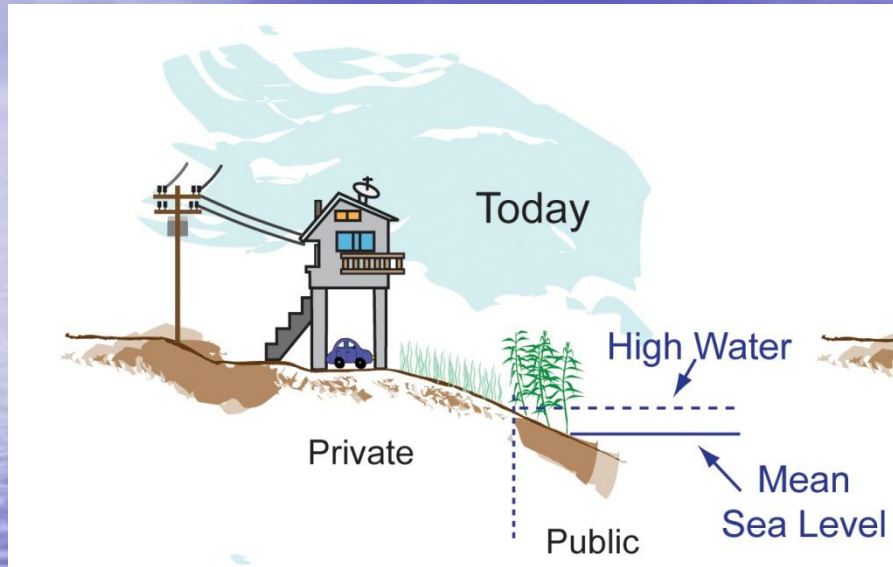
- Finite design limits
- High opportunity costs
- Allows beach/wetland migration

Accommodate: Development Restrictions



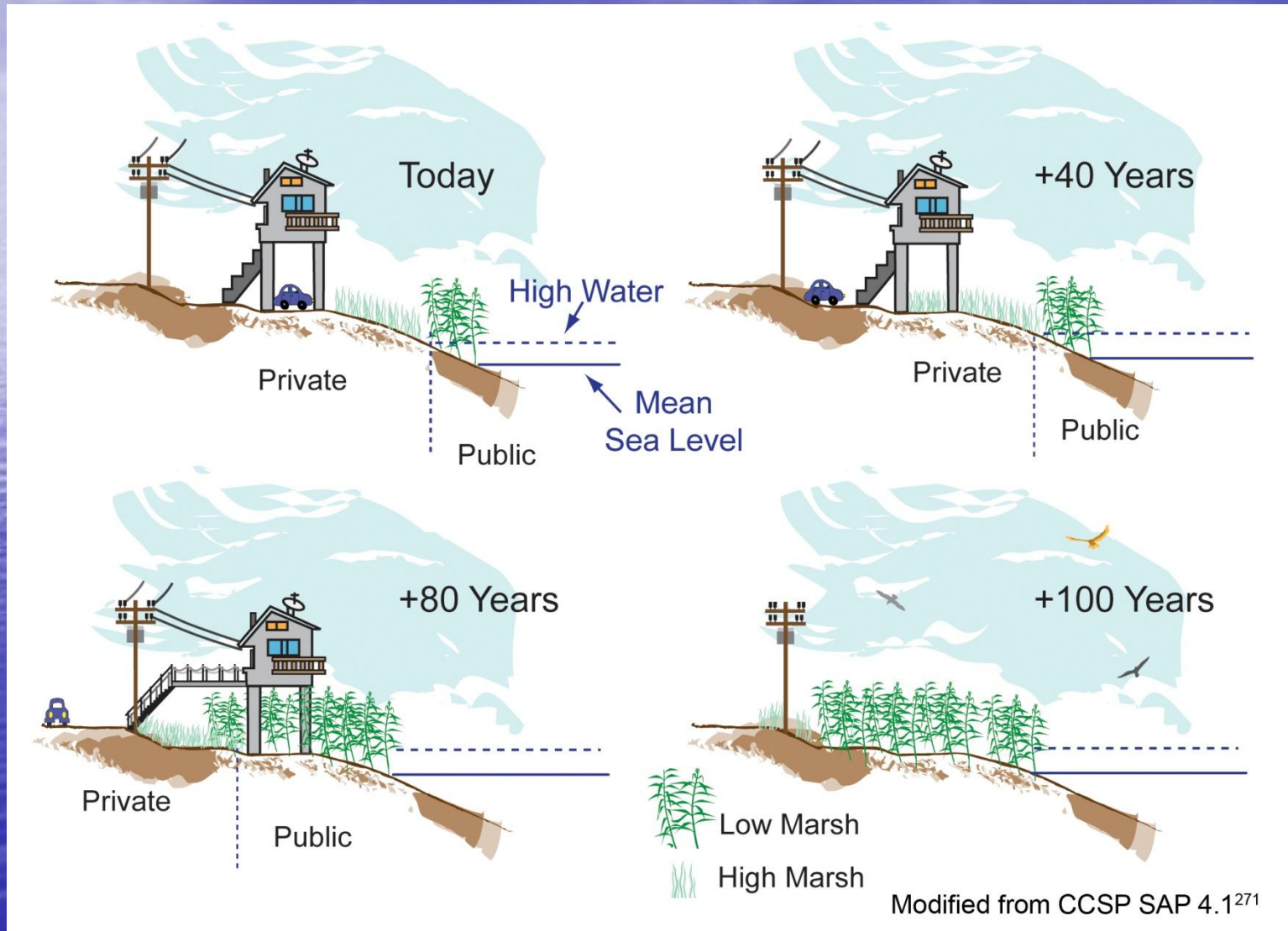
Or NOT!

Retreat: Rolling Easement



- Relocate when MHTL or HHTL reaches threshold position
- Structural protection prohibited

Retreat: Rolling Easement



Retreat: Rolling Easement



- Allows for productive use of uplands
- Infinitely adjustable but . . .
What about infrastructure?
- Maximum beach/wetland migration
- Costs: legal exposure and complexity

Retreat: Infrastructure Relocation/Removal



Retreat: Infrastructure Relocation/Removal

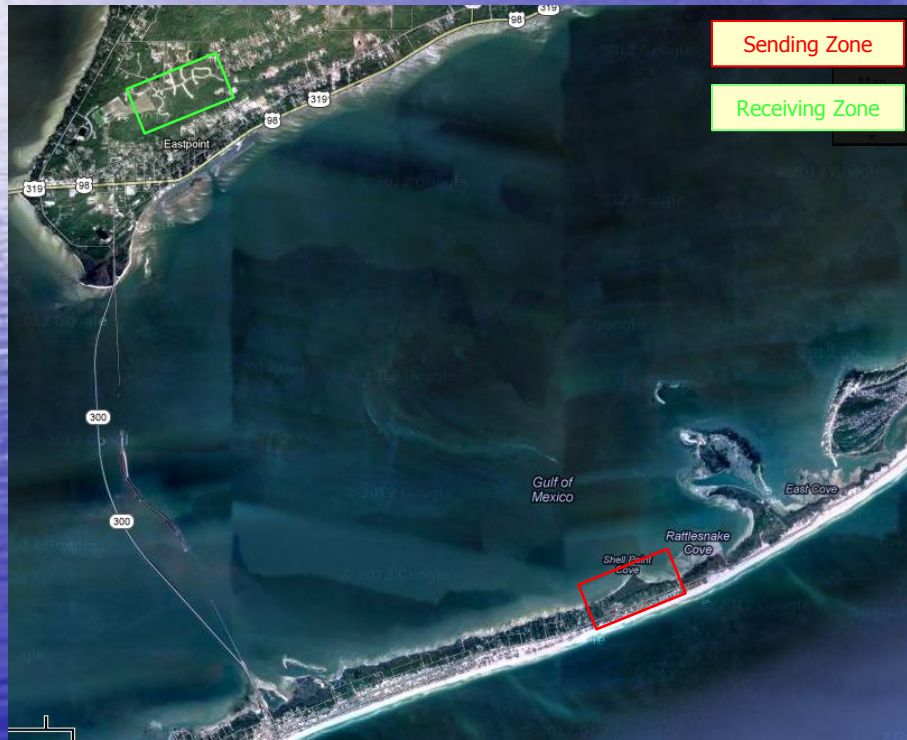


Retreat: Buy Outs



- Allows for productive use of uplands
- Infinitely adjustable
- Maximum beach/wetland migration
- Very high costs

Retreat: Transfer of Development Rights (TDR)



- Retreat area = sending zone
- Higher density development allowed within receiving zone with purchased development rights
- Similar effects as buy outs without the extreme costs

Tradeoffs



- Level and longevity of productive use
- Opportunity costs
- Environmental impacts
- Capital and operating costs
- Legal issues and associated costs