Oct 28th, 10:00 AM - 12:00 PM

Sea Level Rise: Impacts, Adaptation and Information Gaps

Jeffrey R. Kivett
South Florida Water Management District

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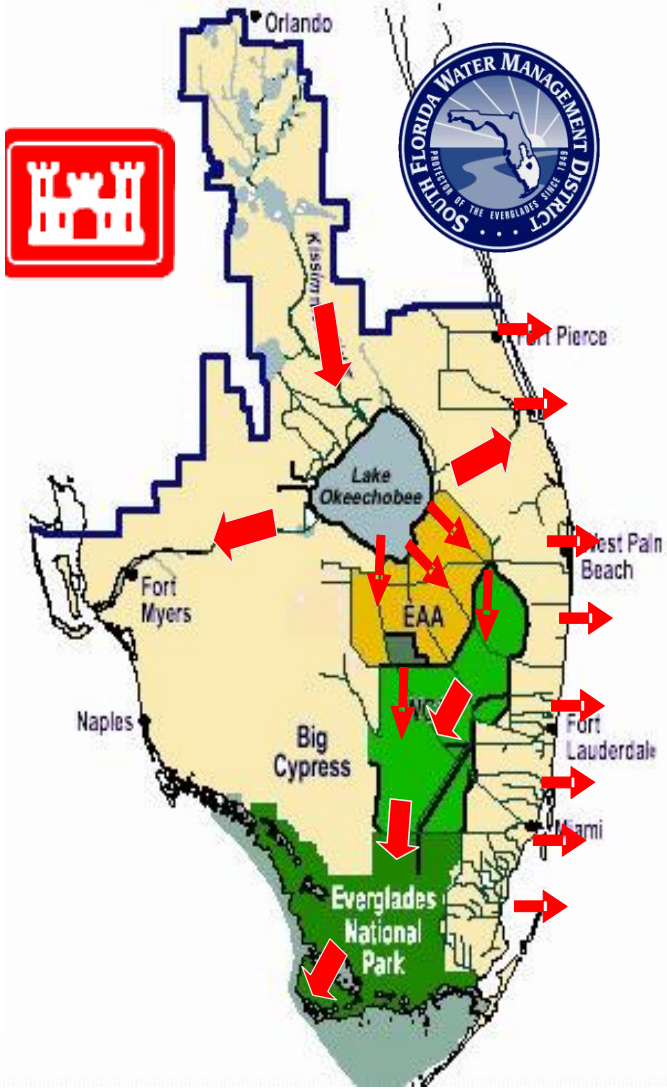
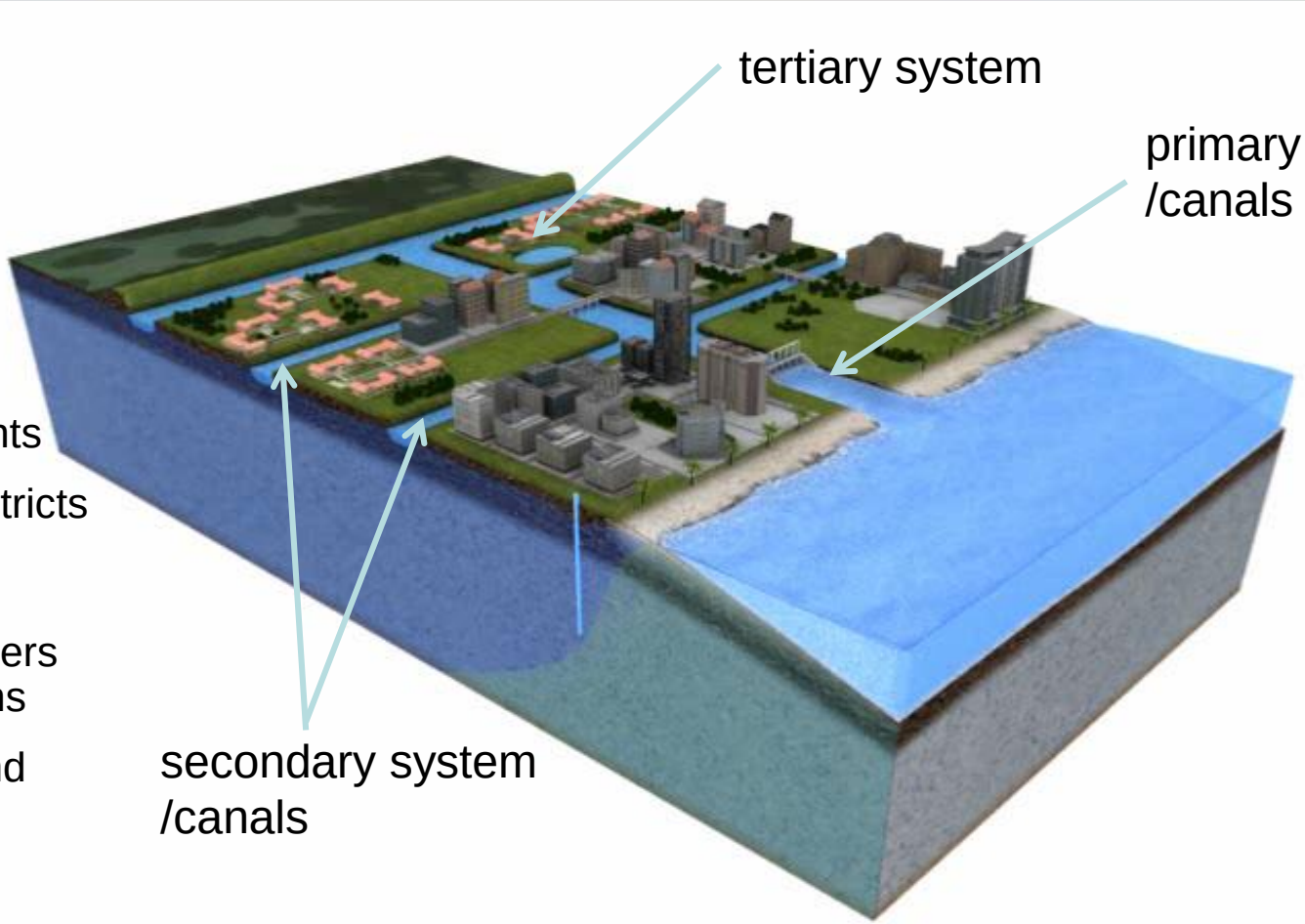
Central and Southern Florida Project for Flood Control and Other Purposes

- Authorized in 1948
- Designed for multiple purposes
  - Flood Control; Water Supply; Navigation; Prevention of Saltwater Intrusion; Protection of Fish & Wildlife
- Constructed by the U.S. Army Corps of Engineers between 1950 and 1970
- Operated by the South Florida Water Management District



Three-Tiered System

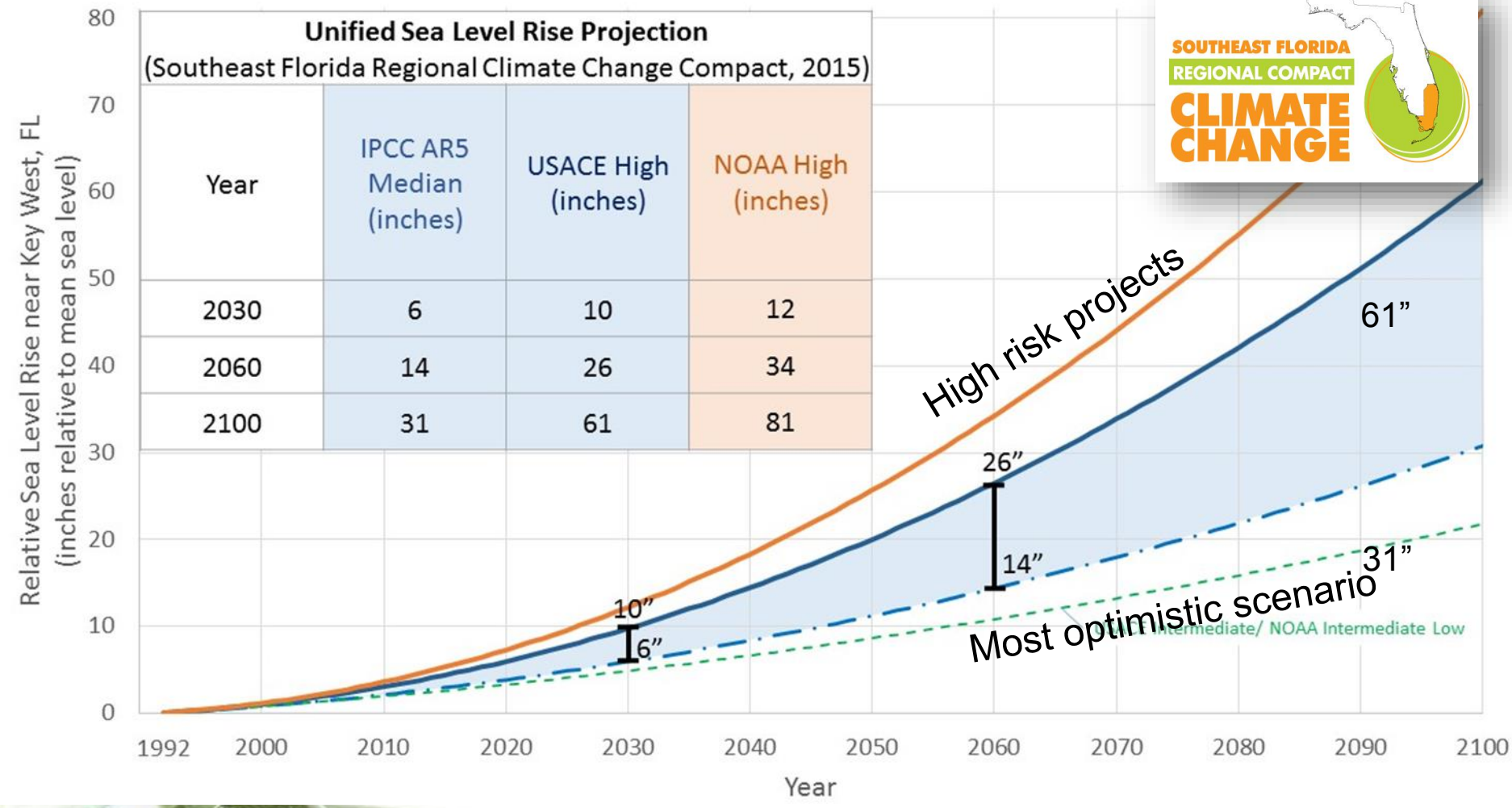
- Primary
  - USACE
  - SFWMD
- Secondary
  - Local Governments
  - Special Districts
- Tertiary
  - Home Owners Associations
  - Private Land Owners



Regional Sea Level Projections (update to 2011 projections)

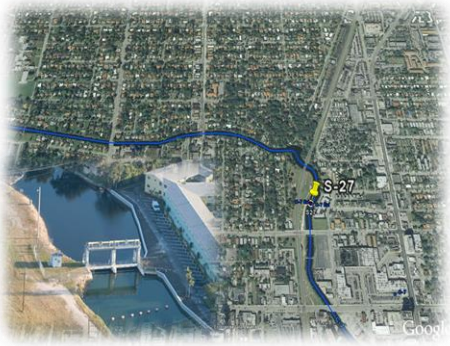
Unified Sea Level Rise Projection
(Southeast Florida Regional Climate Change Compact, 2015)

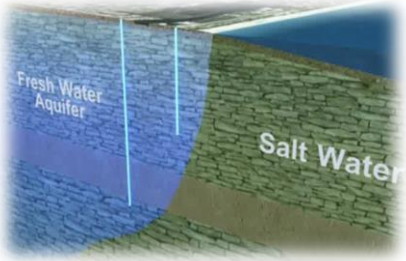
Year	IPCC AR5 Median (inches)	USACE High (inches)	NOAA High (inches)
2030	6	10	12
2060	14	26	34
2100	31	61	81



SOUTHEAST FLORIDA REGIONAL COMPACT CLIMATE CHANGE

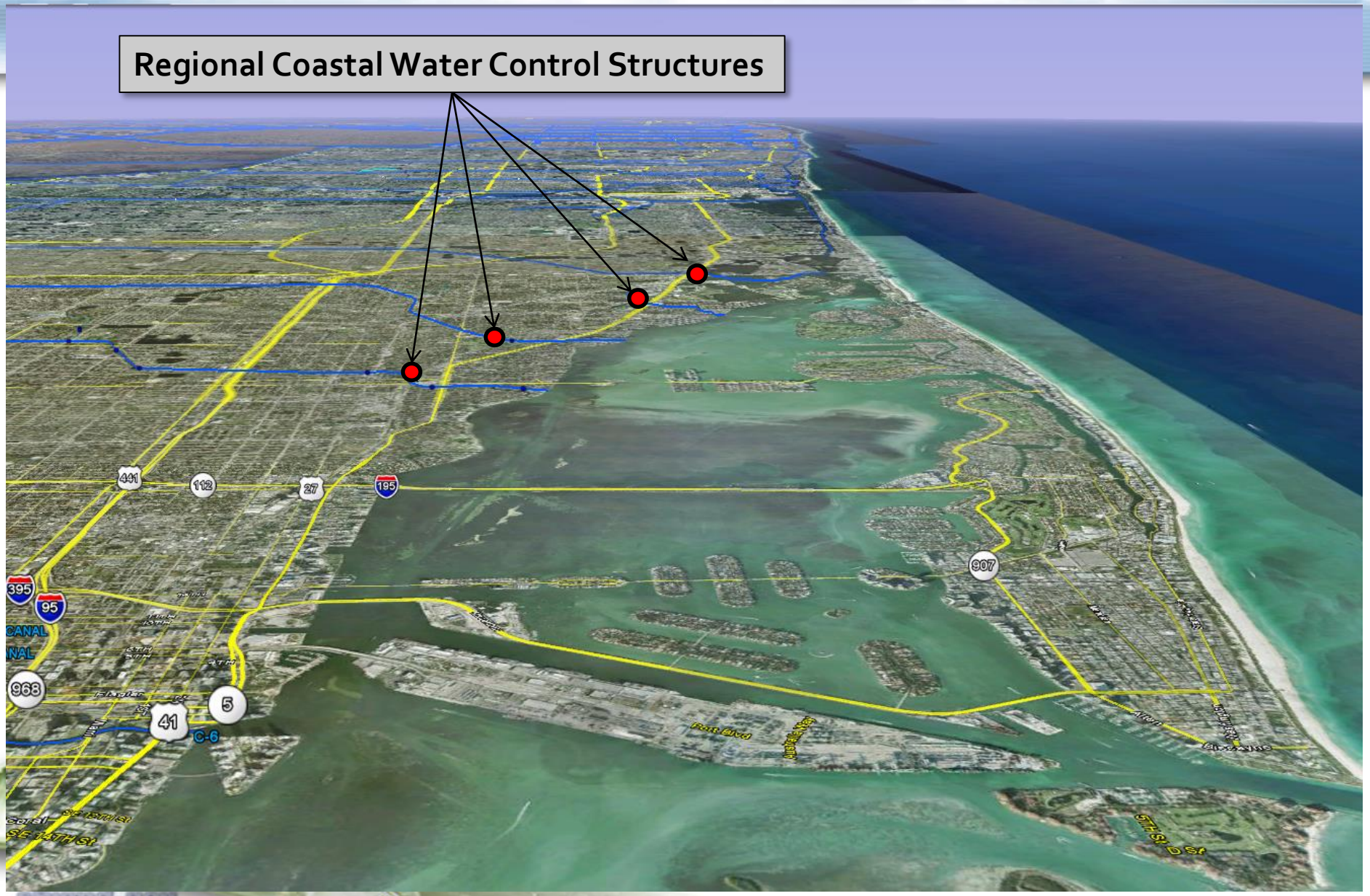
Potential Impacts on Water Management from Rising Sea Level

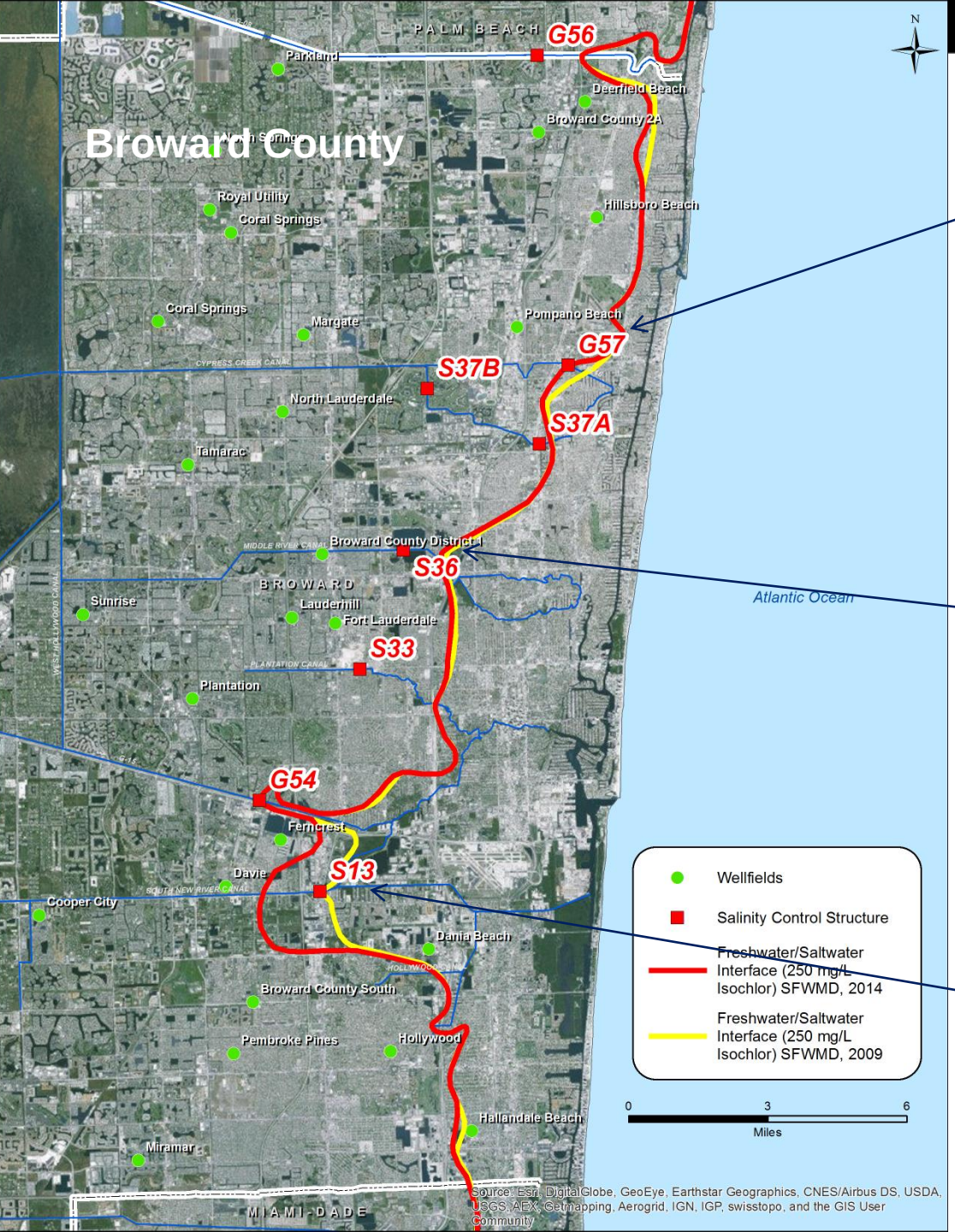


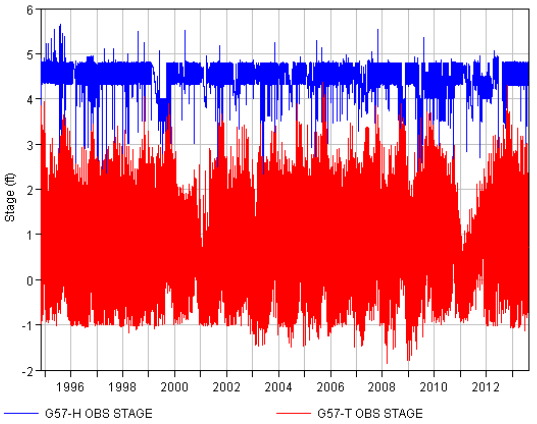


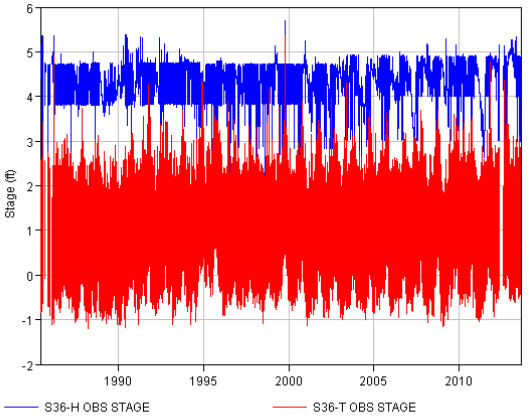
- Flood protection (flooding, storm surge, hurricanes, coastal structures, groundwater)
- Drinking water supply (saltwater intrusion, freshwater wells)
- Natural environment (southern Everglades, coastal wetlands)

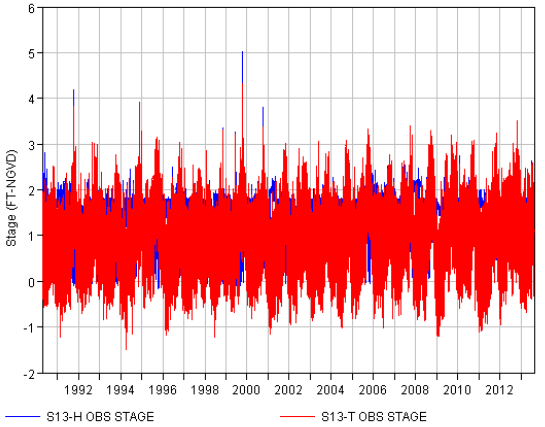
Coastal Water Control Structures




Broward County
PALM BEACH
BROWARD
MIAMI-DADE
Atlantic Ocean
G56
G57
S37B
S37A
S36
S33
G54
S13
Parkland
Deerfield Beach
Broward County 2A
Royal Utility
Coral Springs
Hillsboro Beach
Margate
Pompano Beach
North Lauderdale
Tamarac
Broward County District I
Sunrise
Lauderhill
Fort Lauderdale
Plantation
Ferncrest
Davie
Cooper City
Dania Beach
Broward County South
Pembroke Pines
Hollywood
Hallandale Beach
Miramar
CYPRESS CREEK CANAL
MIDDLE RIVER CANAL
PLANTATION CANAL
SOUTH NEW RIVER CANAL
HOLLYWOOD CANAL
WEST HOLLYWOOD CANAL
N
Wellfields
Salinity Control Structure
Freshwater/Saltwater Interface (250 mg/L Isochlor) SFWMD, 2014
Freshwater/Saltwater Interface (250 mg/L Isochlor) SFWMD, 2009
0
3
6
Miles
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

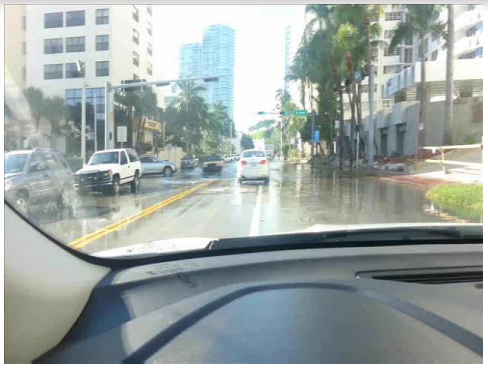

Stage (ft)
6
5
4
3
2
1
0
-1
-2
1996
1998
2000
2002
2004
2006
2008
2010
2012
G57-H OBS STAGE
G57-T OBS STAGE

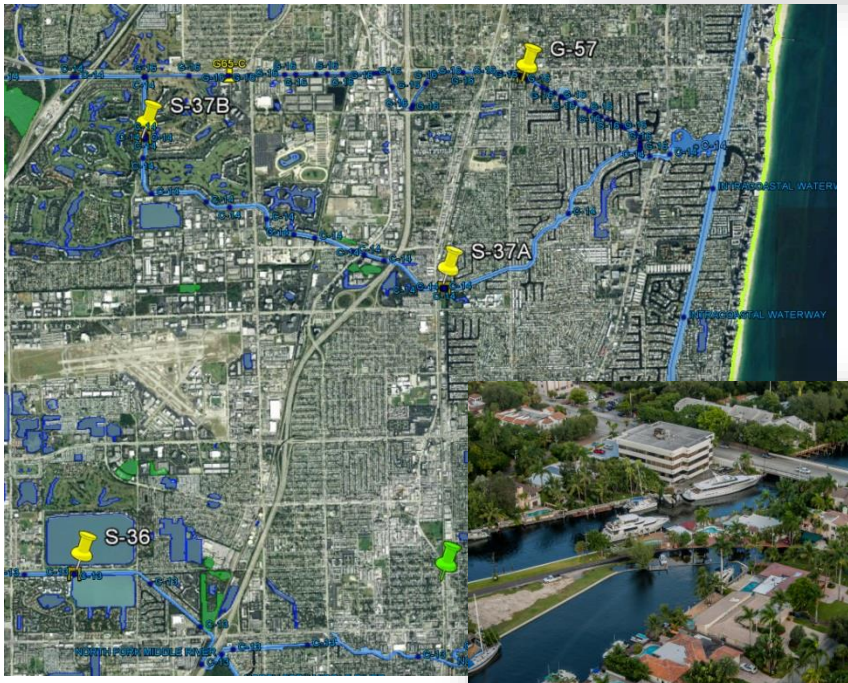

Stage (ft)
6
5
4
3
2
1
0
-1
-2
1990
1995
2000
2005
2010
S36-H OBS STAGE
S36-T OBS STAGE


Stage (FT-NGVD)
6
5
4
3
2
1
0
-1
-2
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
S13-H OBS STAGE
S13-T OBS STAGE

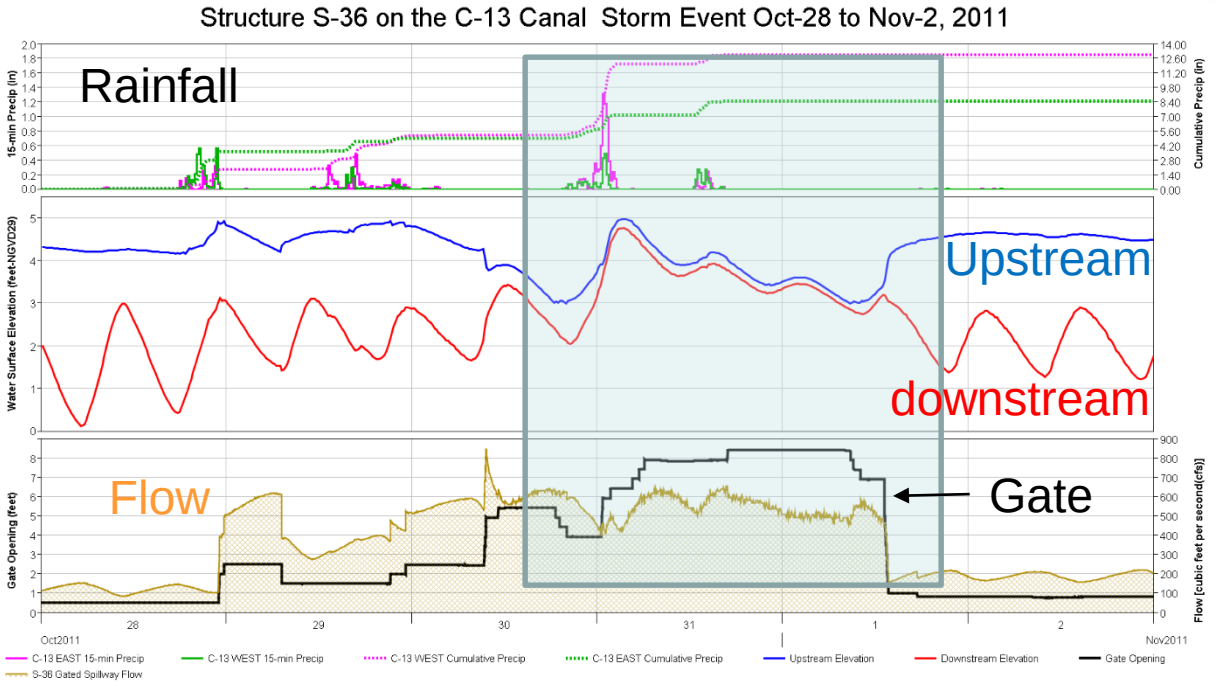
Flood Protection: Areas of Concern

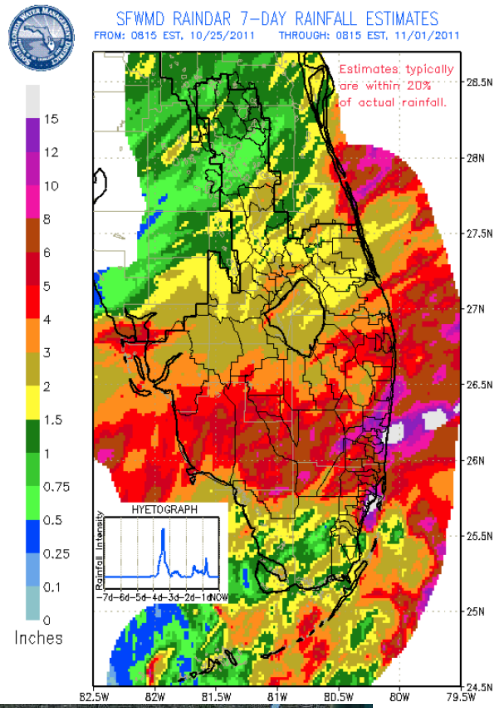
- Island communities (tidal flooding)
- Areas downstream of primary coastal structures
- Areas served by coastal structures (western communities)





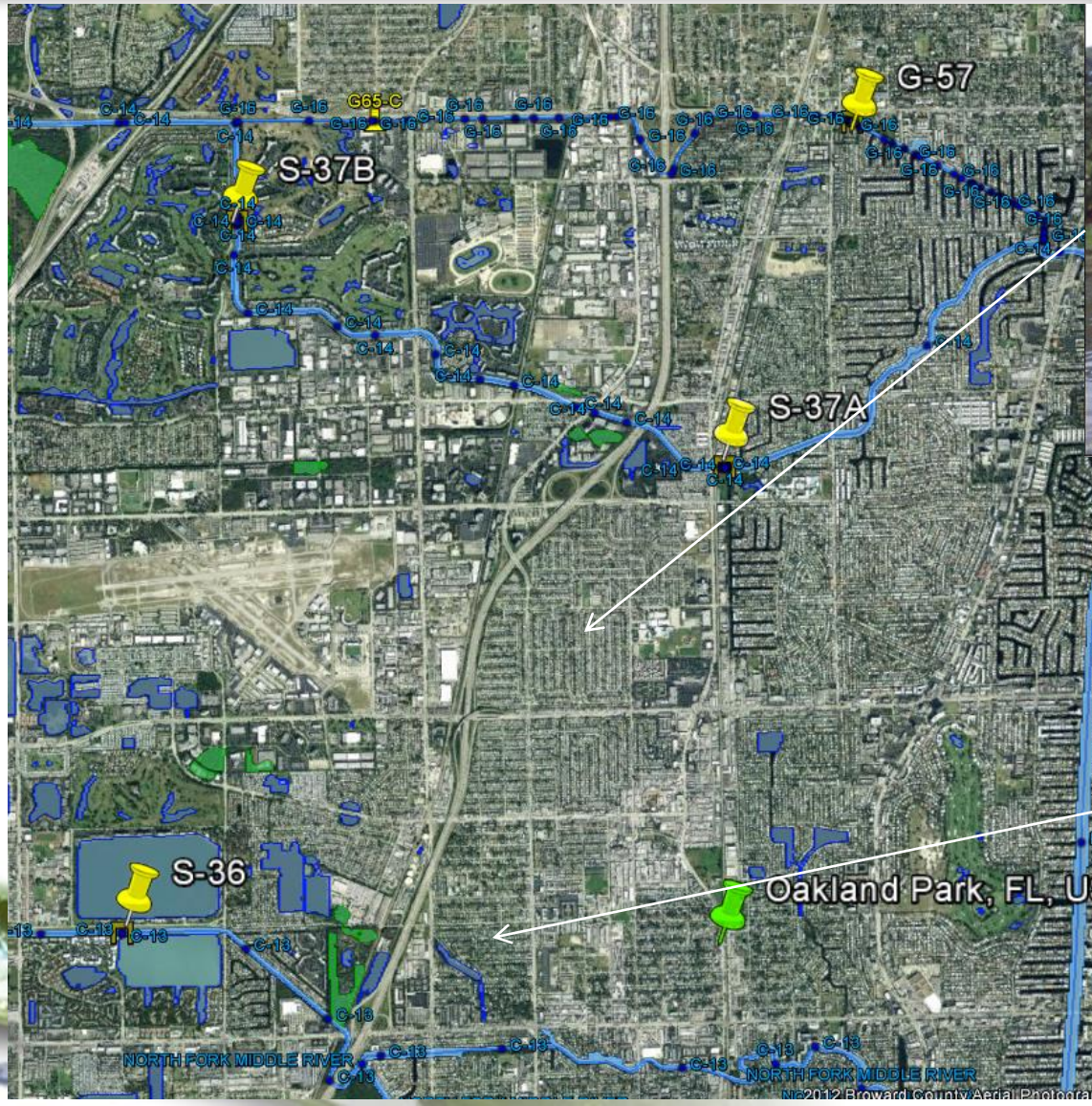
Example: Storm of October 28-31, 2011, C-13 Basin, S-36 Structure



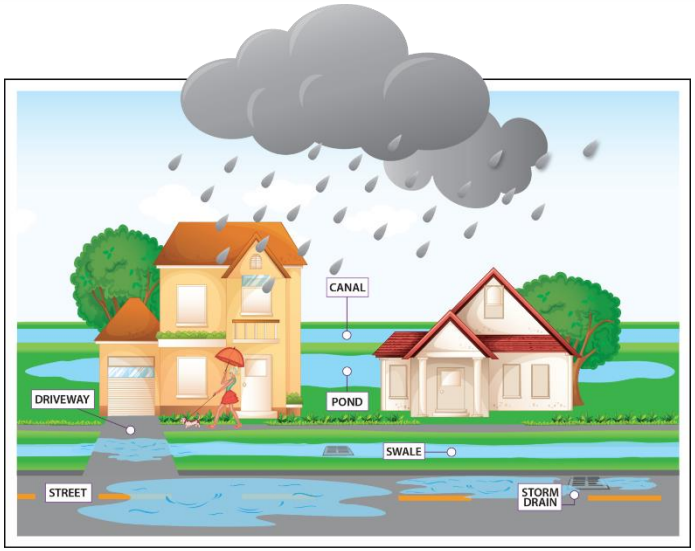


- Oakland Park area is an urbanized area east of the S-36 structure.
- October 28-31, 2011, storm resulted in flooding some communities

Flood in communities in Oakland Park area during the October 2011 storm

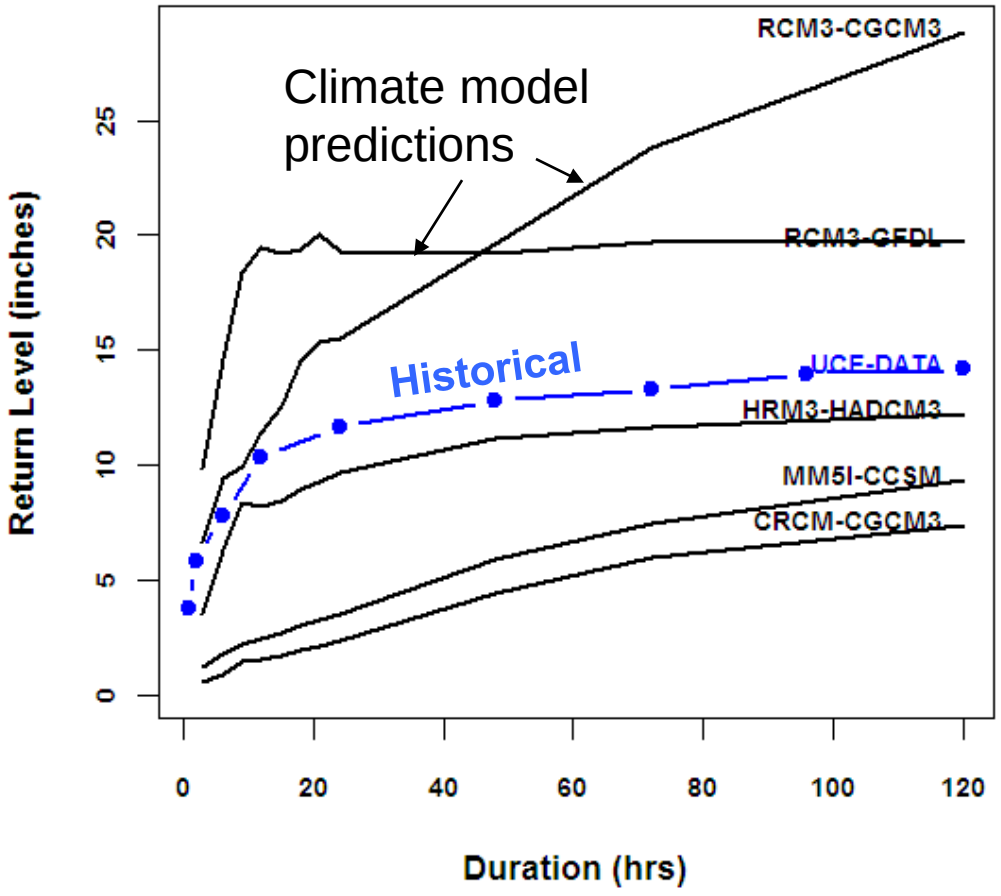


Potential changes in Rainfall Extremes : Do we have “actionable science”?

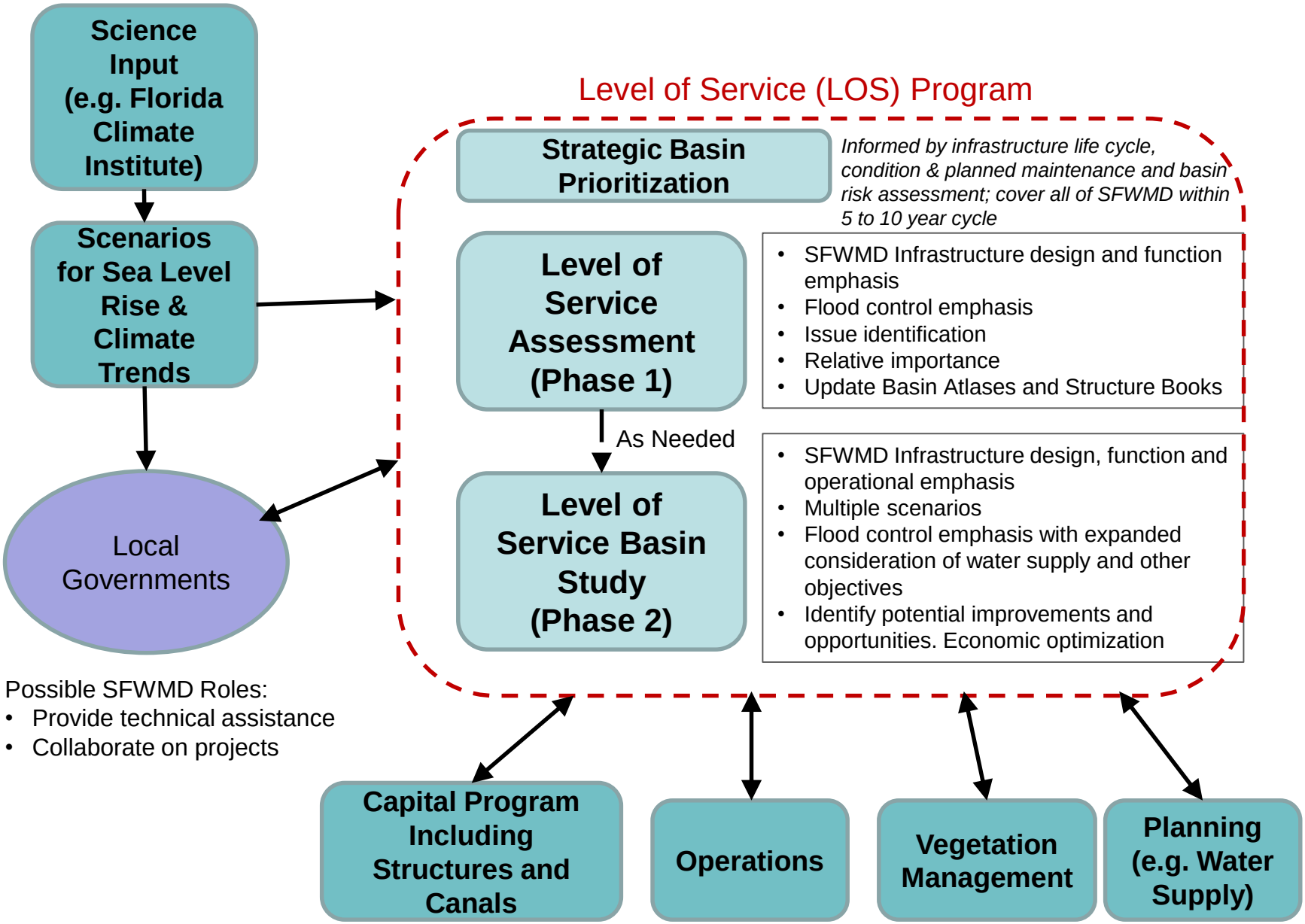


Uncertainty due to significant model spread (General Circulation Model & Regional Climate Model Combinations)

50-Year Location: West Palm Beach International Airport



SFWMD Level of Service Program Overview



Adaptation

Everglades restoration

impoundments and pumps

green infrastructure

revised stormwater permitting criteria

pre-storm drawdown

wellfield relocation/ interconnect/alternative water supply (reuse)

water conservation

water storage

forward pumps

seawalls/natural barriers

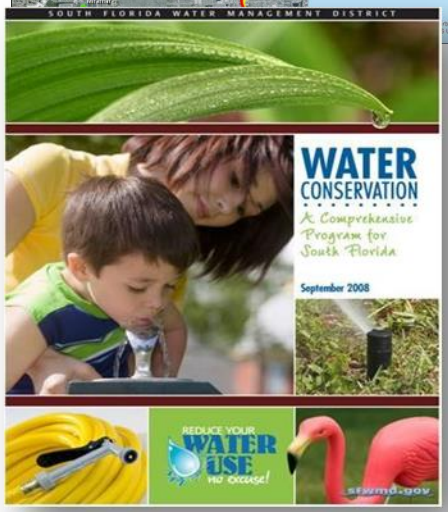
Information Gaps

- Resolution of climate models is not adequate to capture hydro-meteorology of Florida peninsula (grid is too coarse)
- Skills of models for regional climate information may not be adequate, yet. More work is needed to verify and improve the methods/models. Future magnitude of extreme rainfall is uncertain.
- Need to work together on a “unified set of climate scenarios” for Florida (perhaps through collaboration with the academic community)
- Extremes sea levels under various sea level rise scenarios are needed

Questions

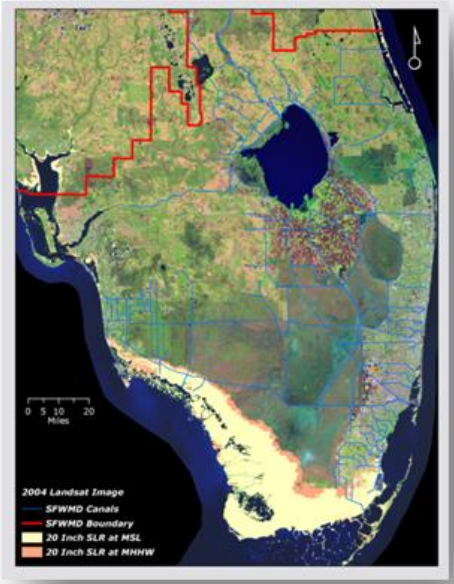
Backup slides

Water Supply Impacts & Adaptation

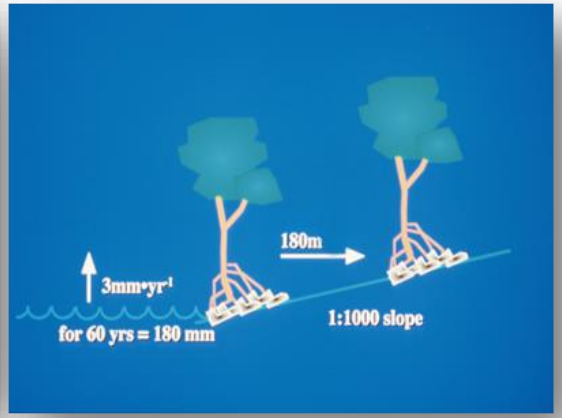


- Potential acceleration of saltwater intrusion towards coast wellfields
  - Mapping of saltwater fronts (2009 and 2014 complete). Five year updates
  - Work with Utilities of Concern and Utilities at Risk on adaptation
- Added emphasis on Water Conservation, Use of reclaimed waste water, and alternative water supply
- Inclusion of sea level rise and potential changes in rainfall into water supply planning

Natural Systems-Impacts & Adaptation



- Concerns: Inundation, peat collapse, and migration of mangroves in the southern Everglades
- Added emphasis on Everglades Restoration as an adaptation to sea level rise
- Multiagency study on mechanisms of peat collapse-with FIU, ENP, funded by Florida Sea Grant
- Studies to determine mangrove peat deposition)
- Monitoring of Southern Coastal Habitats



Using Climate Change Information
(Lessons from California's Experience!)

General Circulation Models (GCMs)

Observed Climate Data

Simulation of Late 20th Century

21st Century Climate Projections

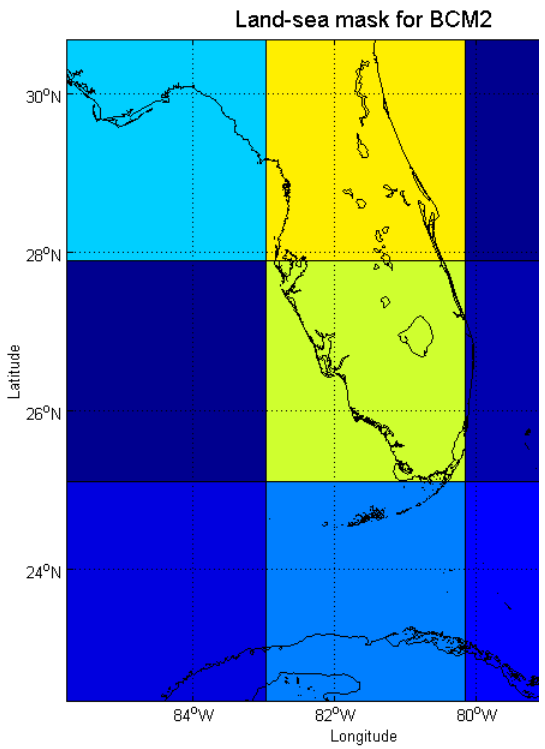
Downscale (Statistical & Dynamical) global information to regional information

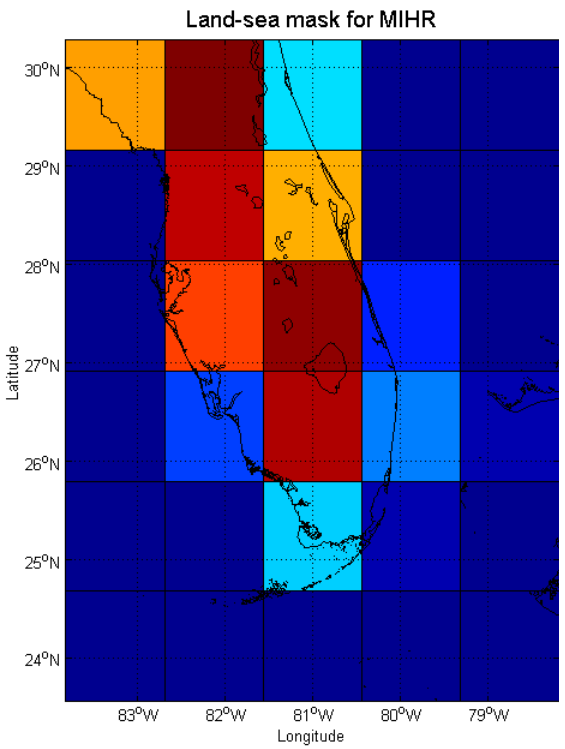
Is there evidence that climate is changing in Florida?

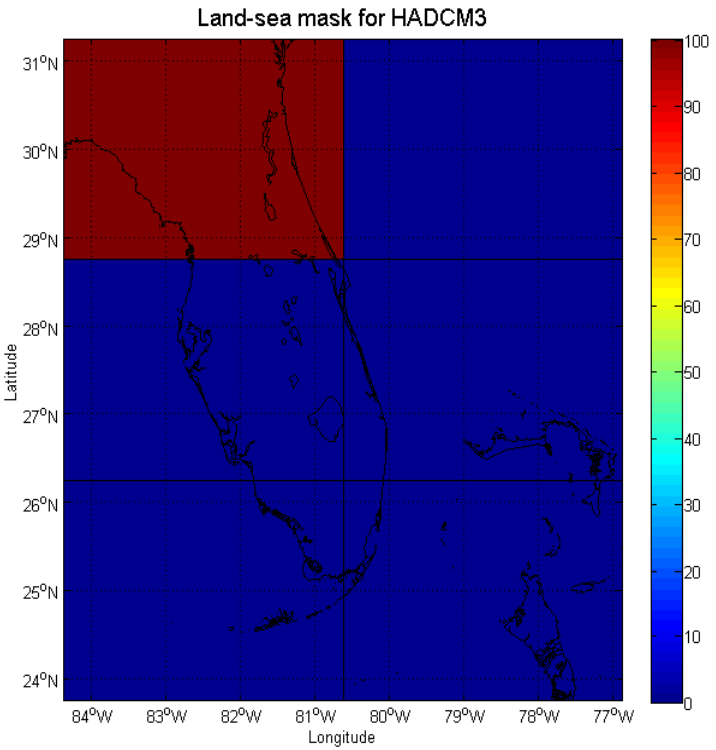
How well are south Florida's climate and teleconnections represented by climate models?

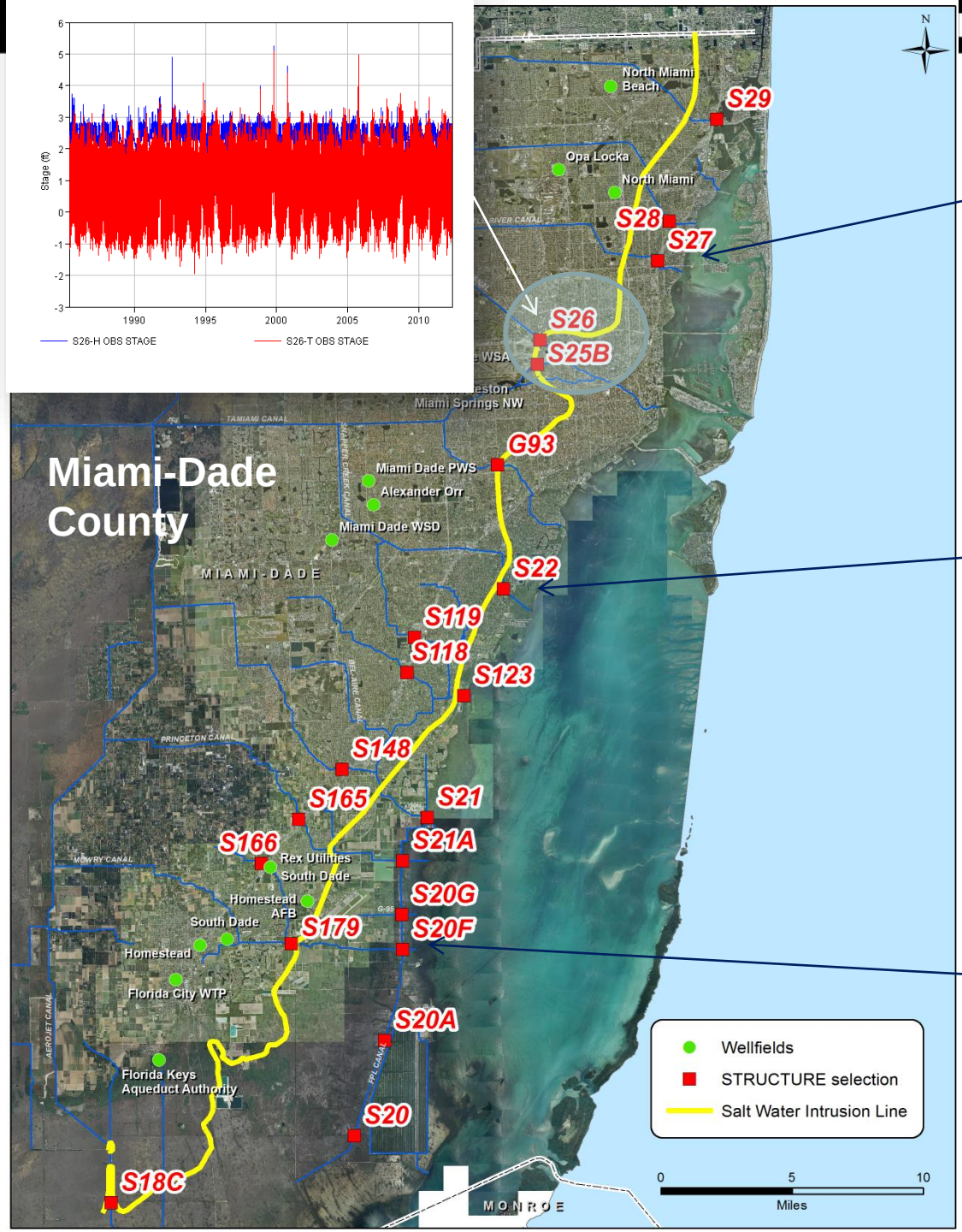
How do climate projections affect water resources management?

GCM Resolution in Florida

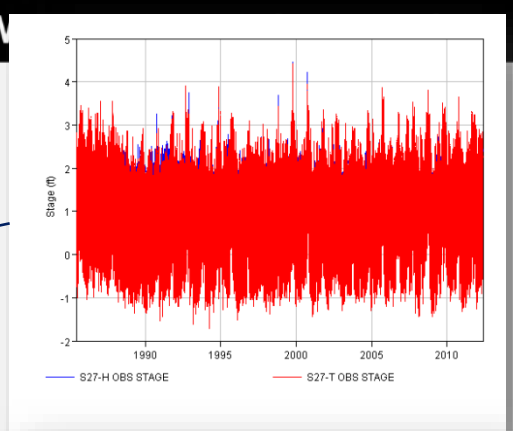


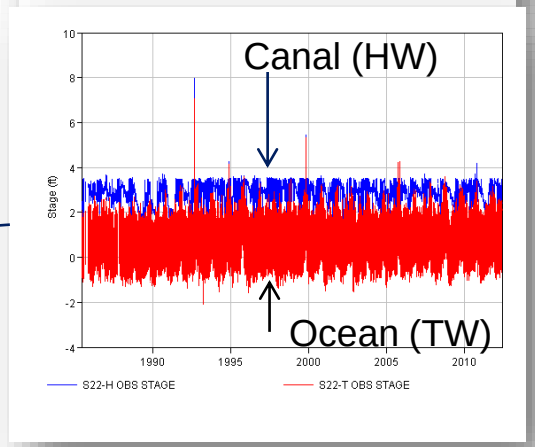


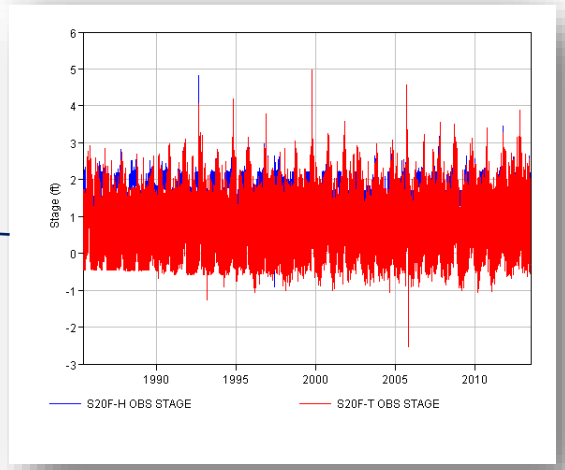



Miami-Dade County
North Miami Beach
Opa Locka
North Miami
Miami Springs NW
Miami Dade PWS
Alexander Orr
Miami Dade WSD
MIAMI-DADE
Rex Utilities
South Dade
Homestead AFB
South Dade
Homestead
Florida City WTP
Florida Keys Aqueduct Authority
MONROE
S29
S28
S27
S26
S25B
G93
S22
S119
S118
S123
S148
S165
S21
S21A
S166
S20G
S179
S20F
S20A
S20
S18C
Wellfields
STRUCTURE selection
Salt Water Intrusion Line
0
5
10
Miles
N

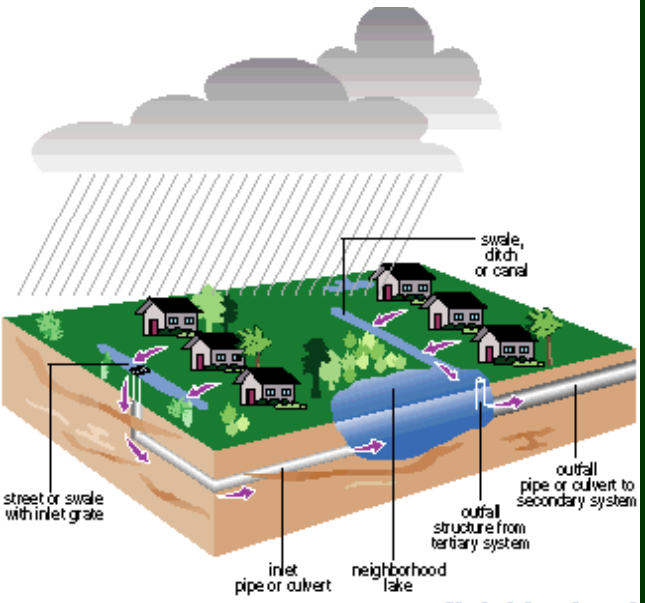
Stage (ft)
S26-H OBS STAGE
S26-T OBS STAGE


Stage (ft)
S27-H OBS STAGE
S27-T OBS STAGE


Canal (HW)
Ocean (TW)
Stage (ft)
S22-H OBS STAGE
S22-T OBS STAGE


Stage (ft)
S20F-H OBS STAGE
S20F-T OBS STAGE

Neighborhood System *(Tertiary)*

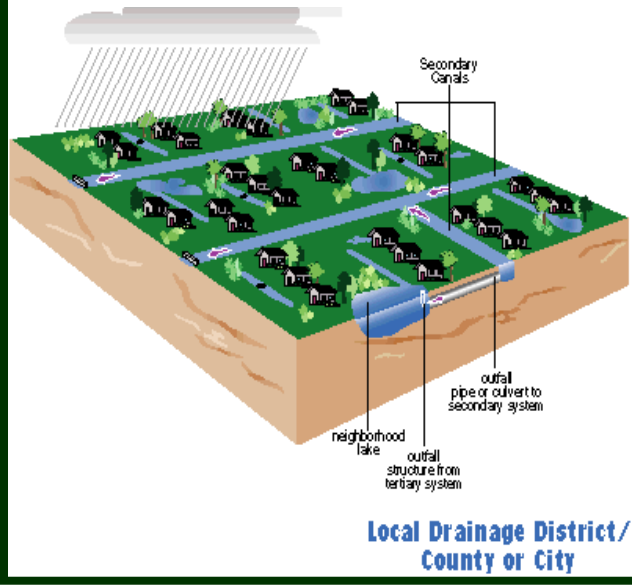


…Tertiary to Secondary…

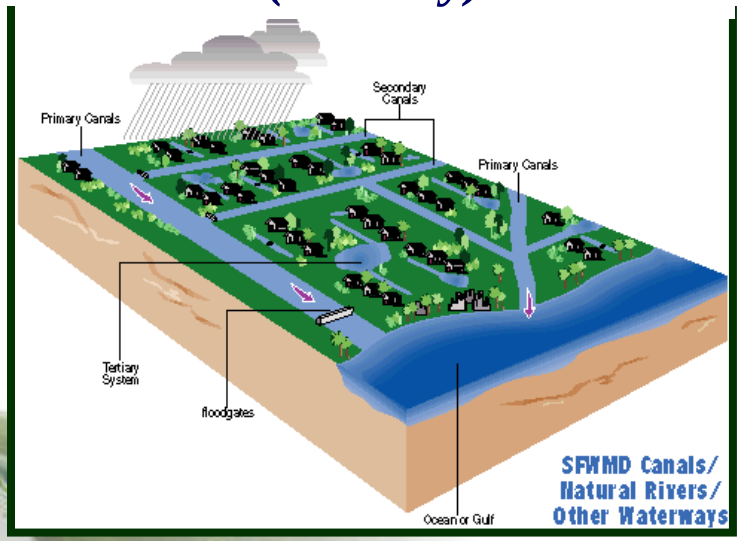
Secondary to Primary…

Primary to Ocean or Everglades

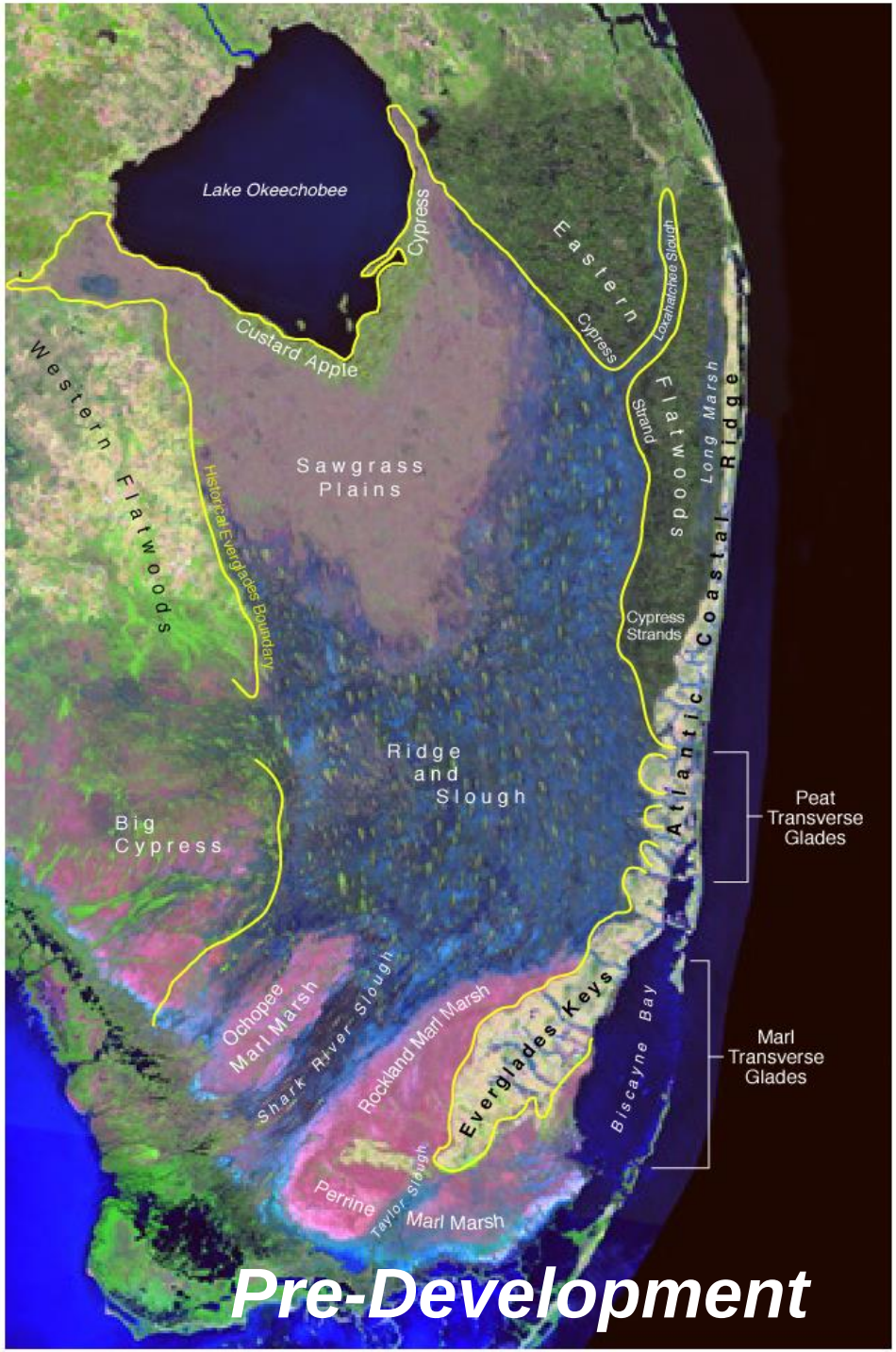
Local Drainage District *(Secondary)*

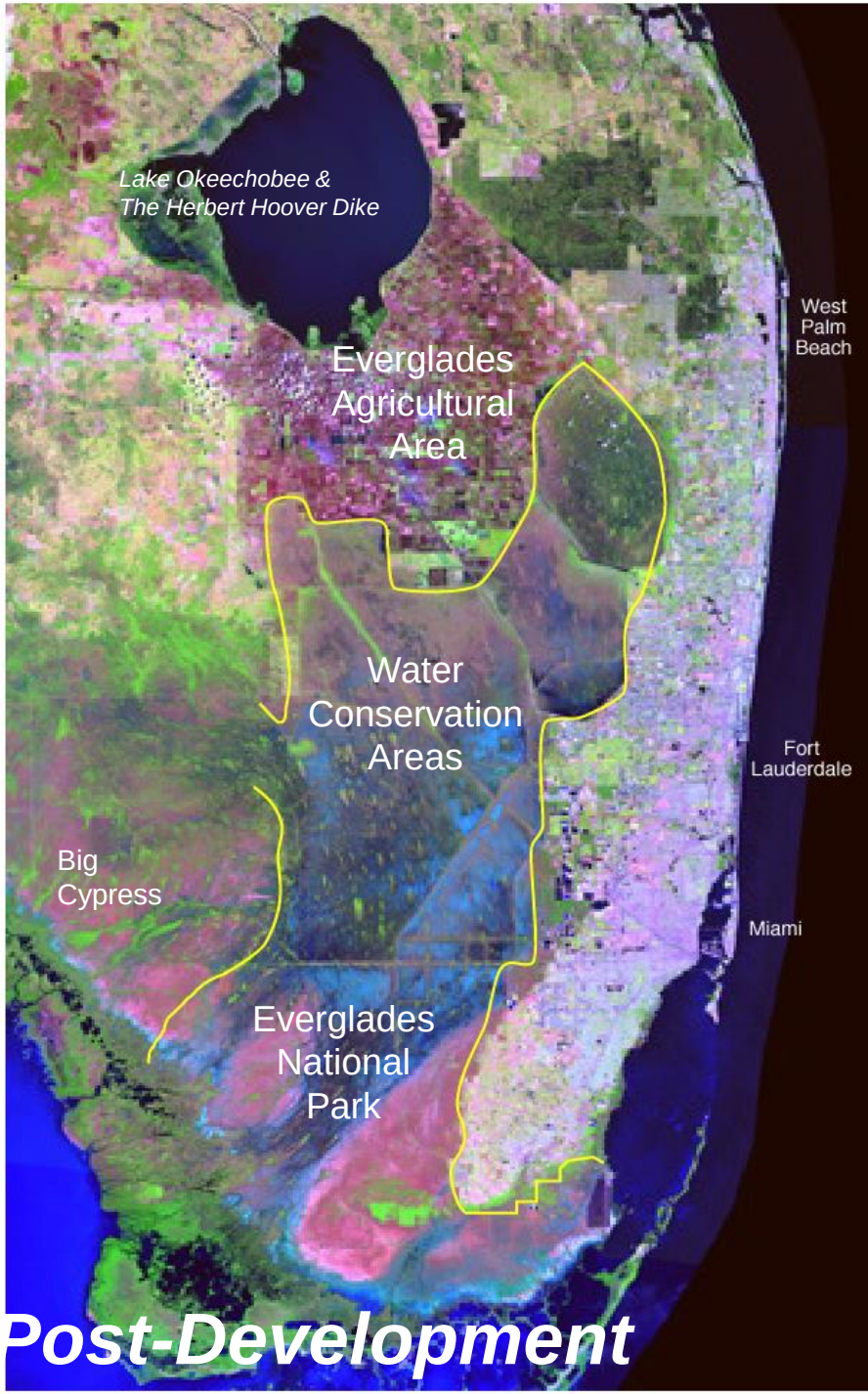


SFWMD Canals *(Primary)*



Every drainage system flows into a larger system


Lake Okeechobee
Cypress
Eastern
Cypress
Loxahatchee Slough
Custard Apple
Western Flatwoods
Historical Everglades Boundary
Sawgrass Plains
Flatwoods
Strand
Long Marsh
Ridge
Cypress Strands
Atlantic Coastal
Ridge and Slough
Peat Transverse Glades
Big Cypress
Ochopee Marl Marsh
Shark River Slough
Rockland Marl Marsh
Everglades Keys
Biscayne Bay
Marl Transverse Glades
Perrine
Taylor Slough
Marl Marsh
Pre-Development


Lake Okeechobee &
The Herbert Hoover Dike
West Palm Beach
Everglades Agricultural Area
Water Conservation Areas
Fort Lauderdale
Big Cypress
Miami
Everglades National Park
Post-Development

C&SF System: 1950s Planning Assumptions versus now!