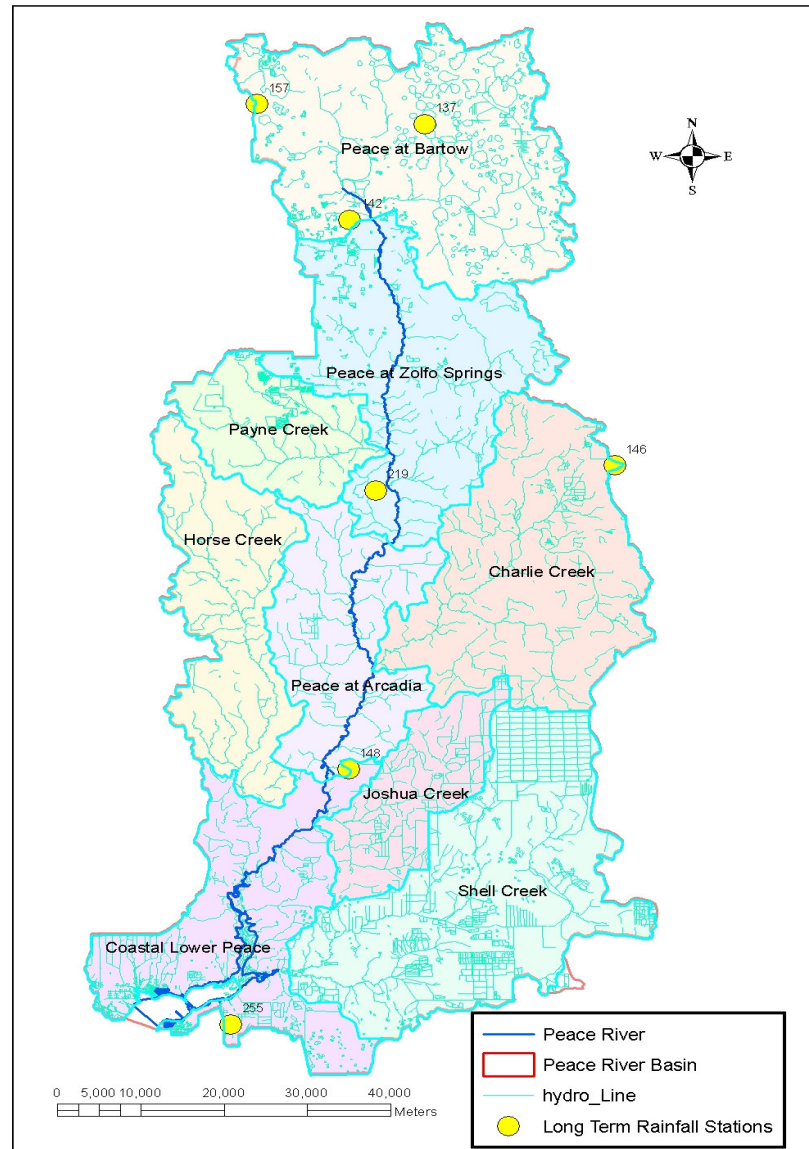
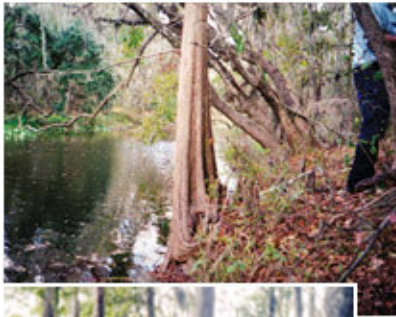


Peace River CIS Water Budgets



What is a water budget?

- An accounting of all the water flows in a watershed
- Useful for understanding hydrologic changes over decades
- Basic equation:

$$P - ET - R - G = \Delta S$$

- P = Rain
- ET = Evapotranspiration
- R = Run off
- G = Groundwater recharge
- ΔS = Change in storage



What are the objectives?

Water budgets should:

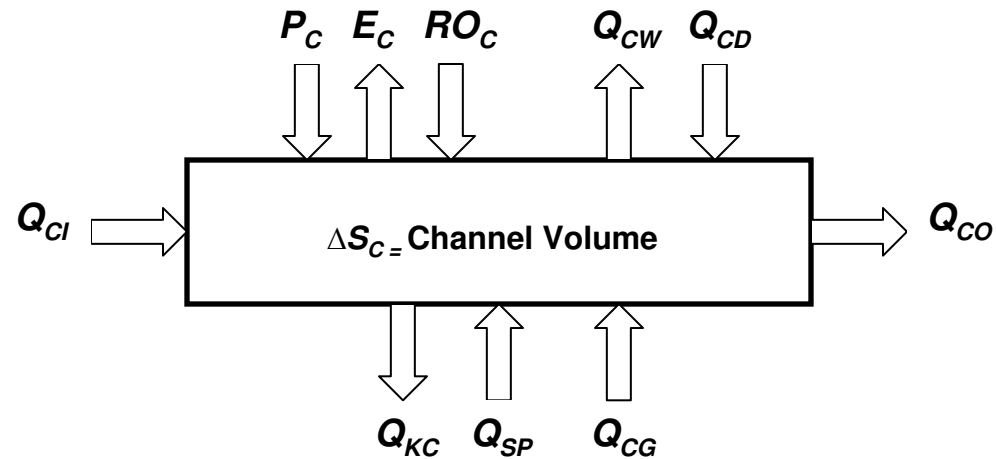
- Quantify hydrologic fluxes on at an order-of-magnitude resolution.
- Lead to understanding the magnitude of natural and anthropogenic fluxes.
- Aid understanding of the natural variations in system hydrology over time.



PRCIS Water Budget Equations

3 Budgets:

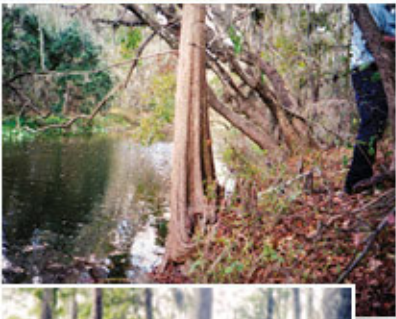
- Channel budget
- Surface budget
- Groundwater budget



Time Periods

Water budgets for four time periods:

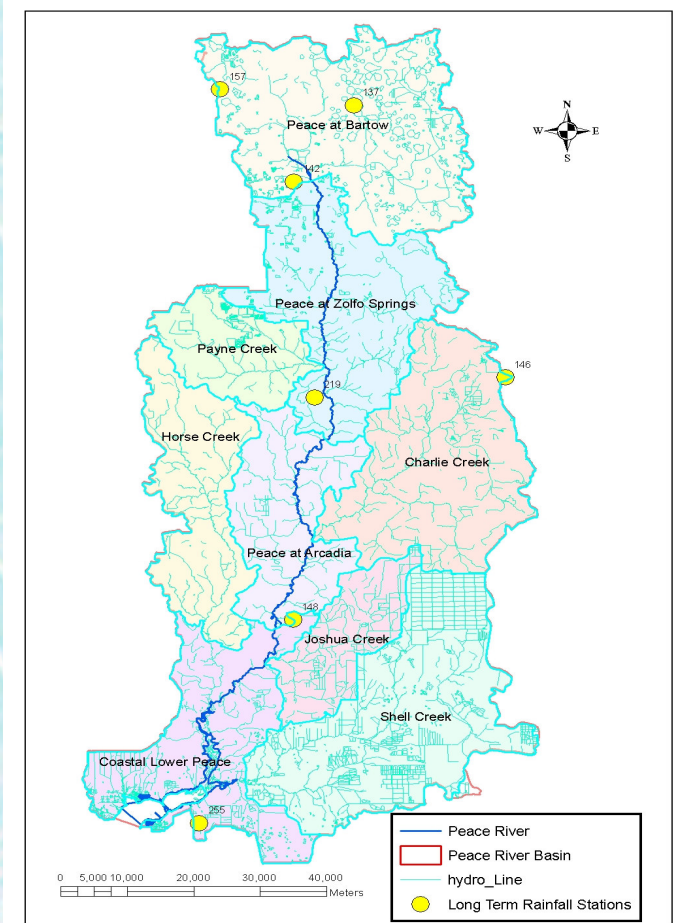
- 1941-1943
 - 1976-1978
 - 1989-1991
 - 1997-1999
-
- 3-year budgets seek to average inter-annual variability
 - 3-year budgets are each associated with a LULC map for that time period



Sub-Basins

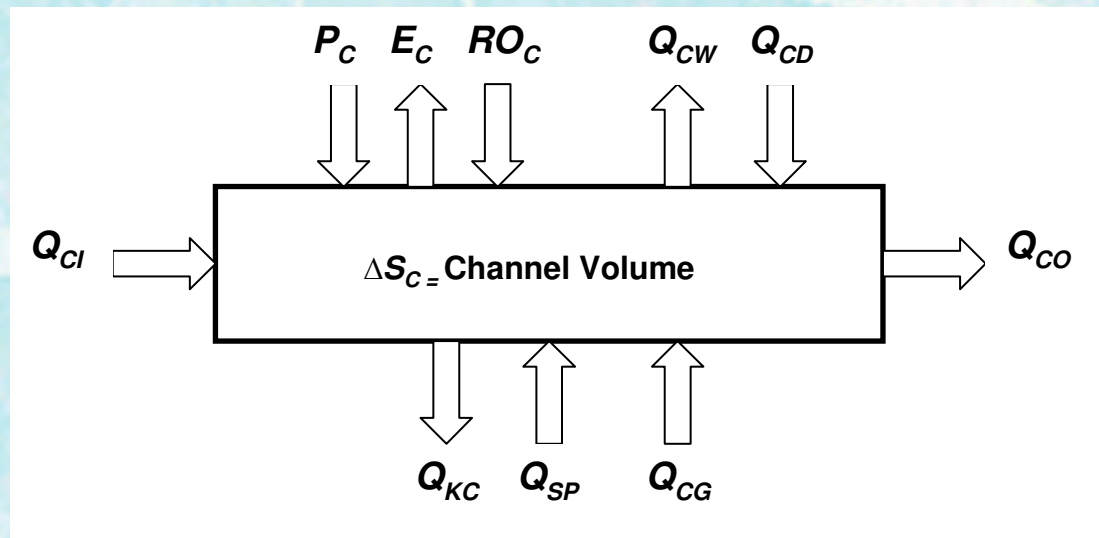
Nine Sub-Basins were selected:

- Peace at Bartow
- Peace at Zolfo Springs
- Peace at Arcadia
- Payne Creek
- Charlie Creek
- Joshua Creek
- Horse Creek
- Shell Creek
- Coastal Lower Peace



Methods

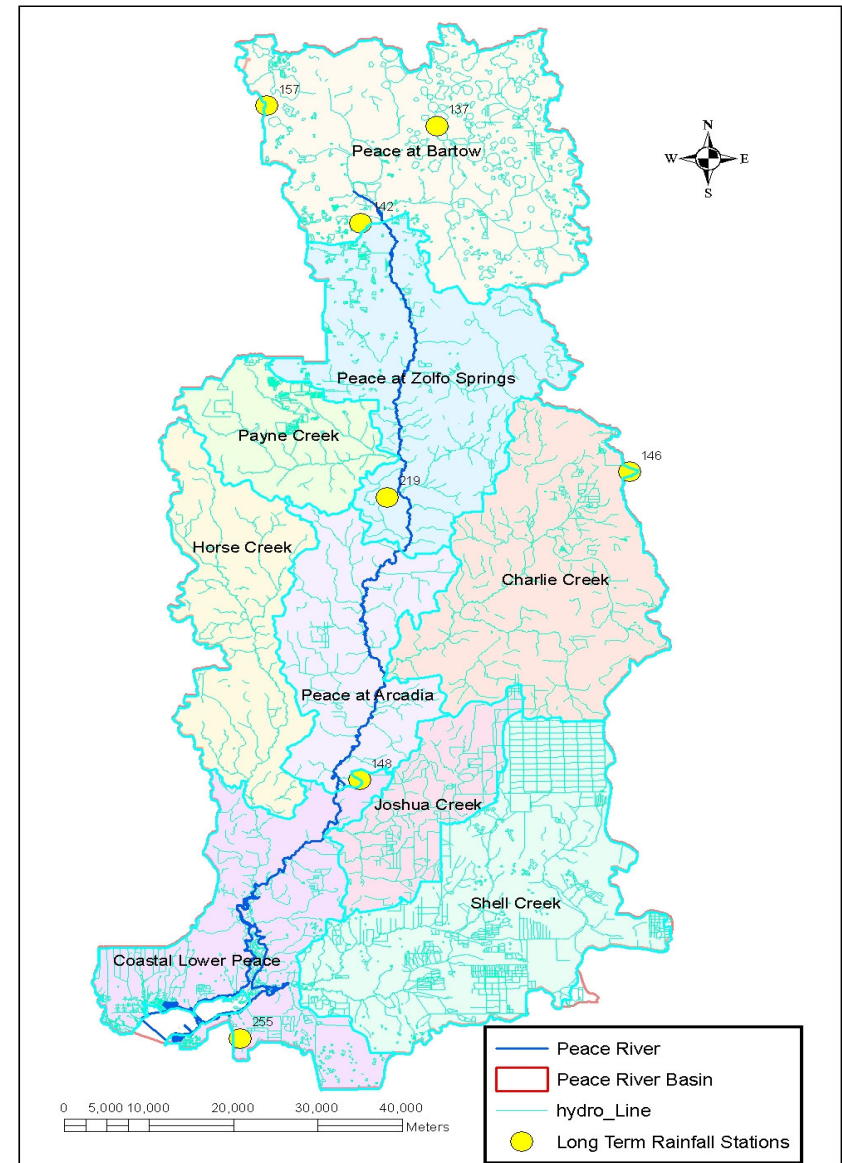
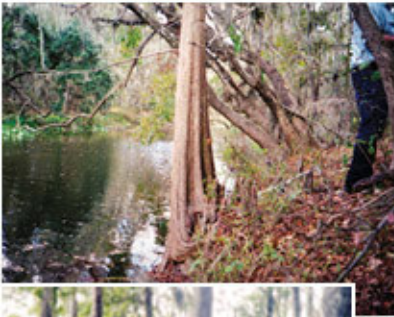
- Each water budget parameter must be directly calculated or estimated as a residual.
- How did we estimate the water budget parameters?



Rainfall Analysis

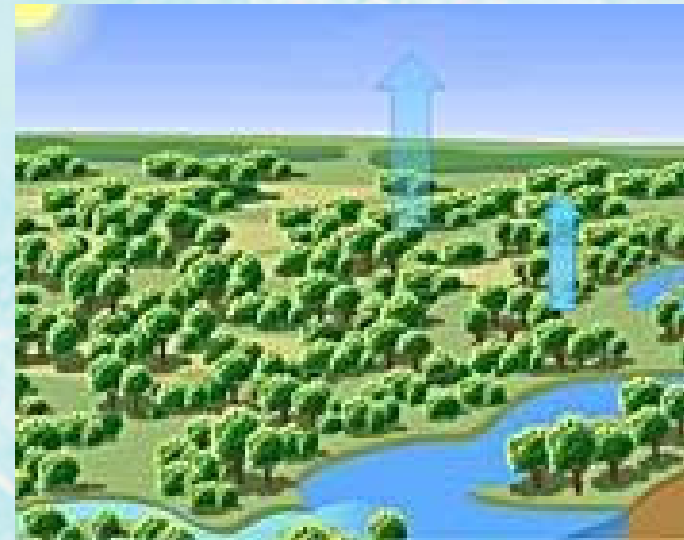
Selected long term rainfall stations:

Station ID	Location
137	Winter Haven
142	Bartow
146	Avon Park
148	Arcadia
157	Lakeland
219	Wauchula
255	Punta Gorda

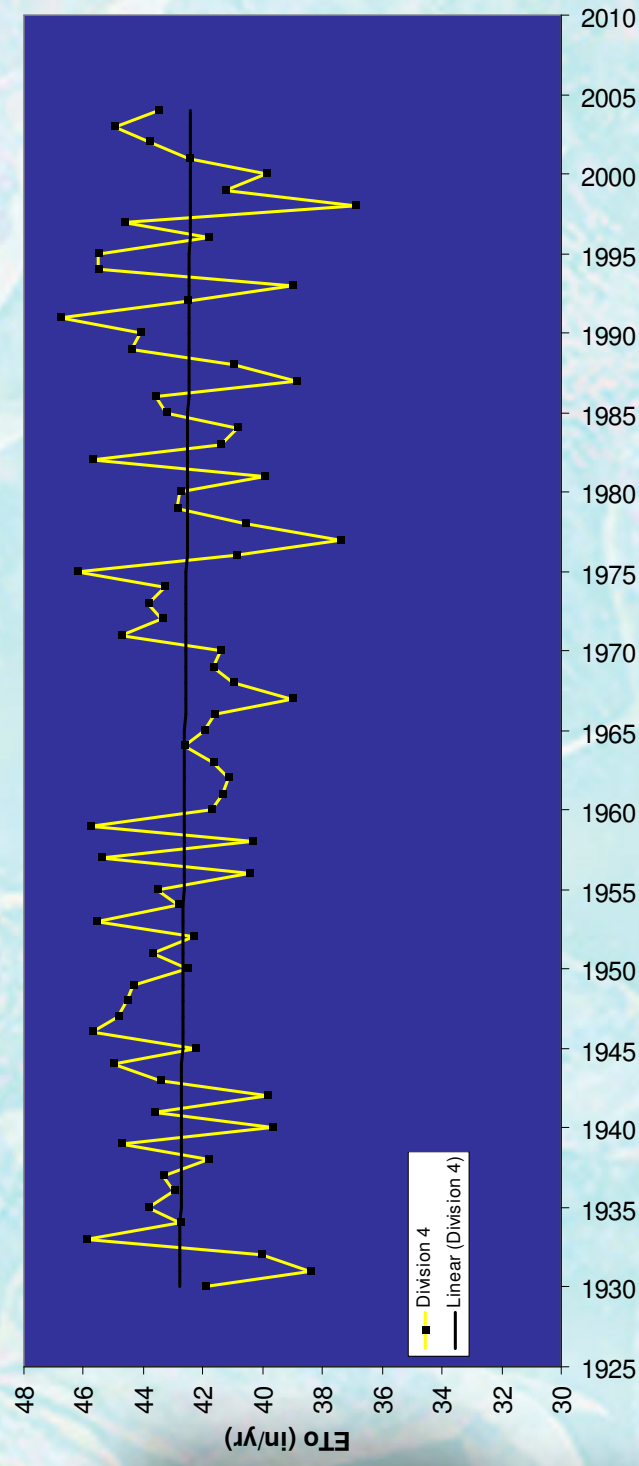


Evapotranspiration Analysis

- **ET**
- **Second largest water budget parameter**
- **Very difficult to estimate**
- **Record of reference ET**
- **Crop coefficients**
- **Yields estimate of actual ET**



Reference ET Record



ET by Land Use and Land Cover

High ET

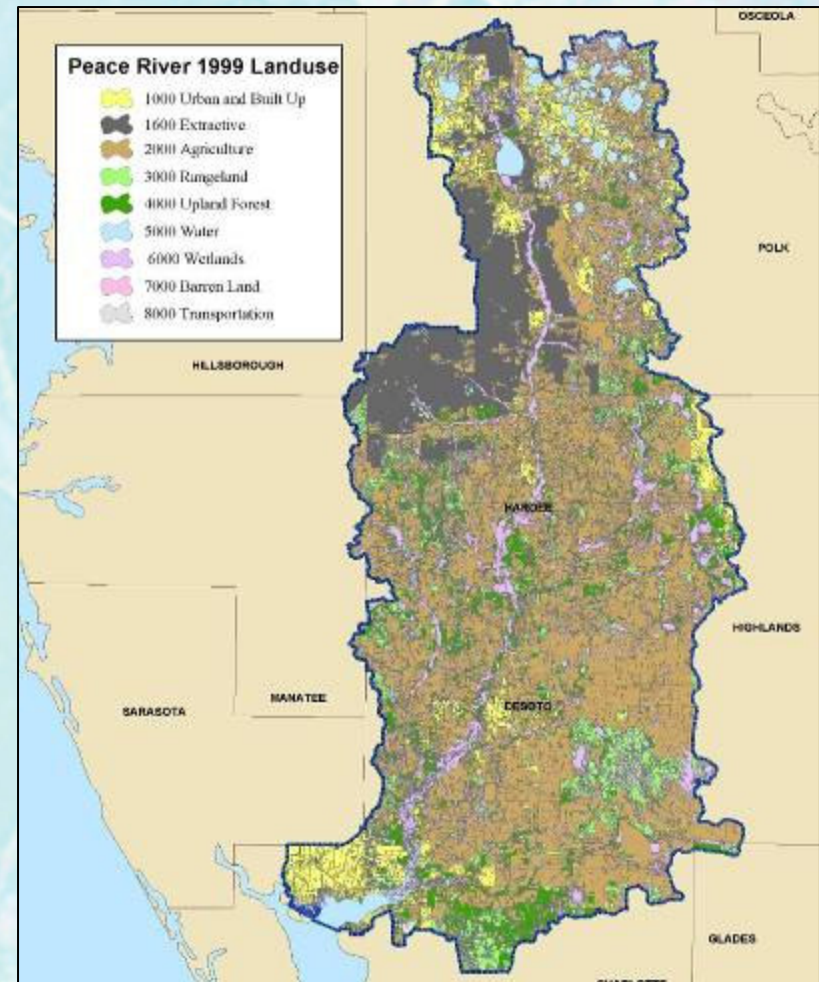
- Open Water
- Irrigated Citrus
- Wetlands

Medium ET

- Native Uplands
- Rangeland
- Low Density Residential

Low ET

- Barren Land
- Dense Urban

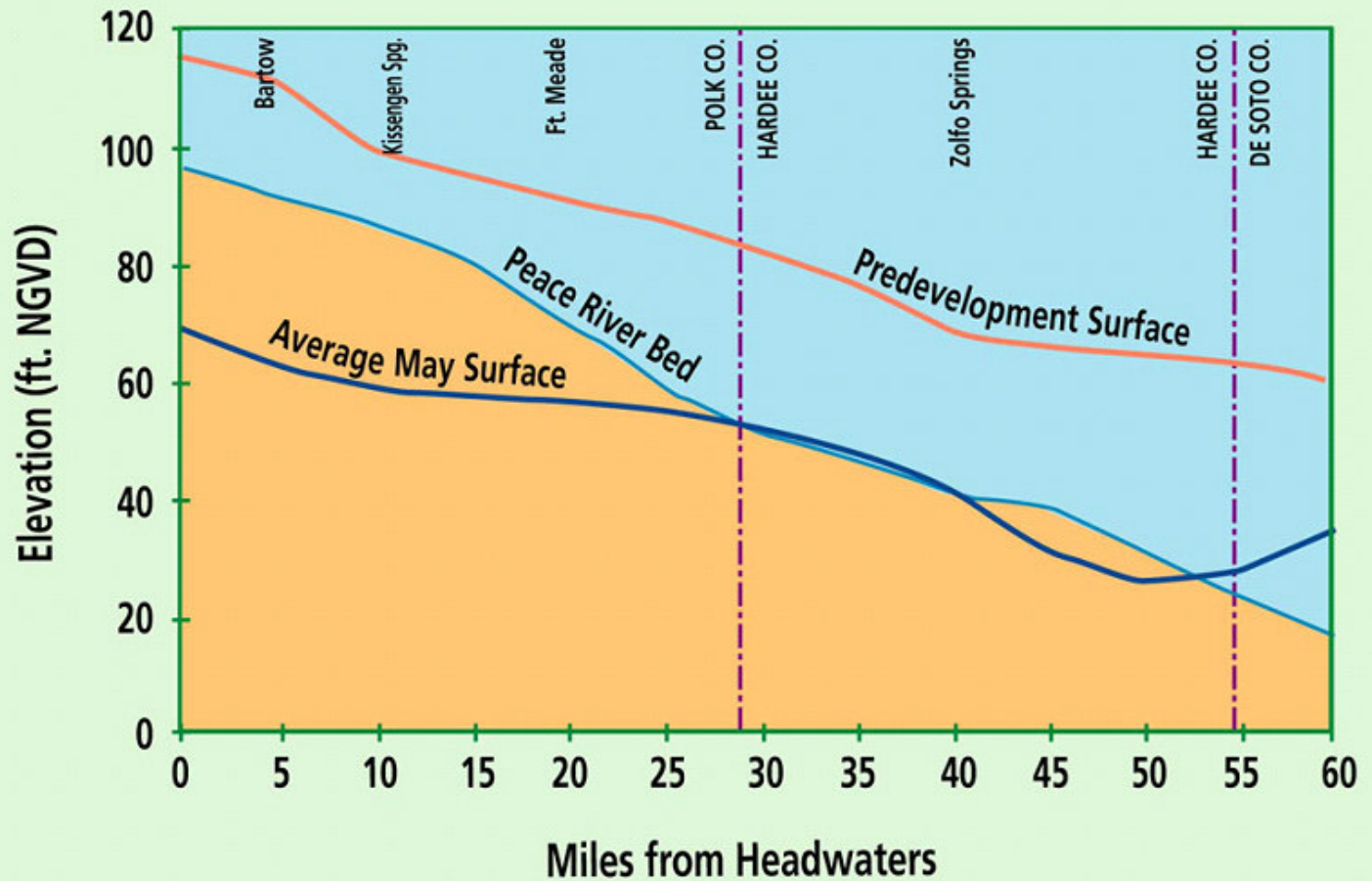


ET Trends

- Long term change in ET across PR Basin appears to be small.
- Annual variation in ET due to weather is large.
- Slight decrease in ET associated with change in land use.
 - High ET land cover are lost and replaced with lower ET LULC.
 - Urbanization
 - Loss of wetlands



Recharge / Discharge Trends



Kissengen Spring

- Flow of approx. 15 to 20 Mgd prior to 1940.
- Flow decreased as head in IAS/UFAS declined due to pumping.
- By 1950's flow was only intermittent.
- Ceased continuous flow after late 1950's.



- Kissengen spring is the “canary in the coal mine” for the onset of losing conditions in Upper Peace River.

Groundwater Budget

**Utilized SWFWMD's
Southern District
Model.**

**Coupled model with
historic estimates for
aquifer conditions
and pumping rates.**

**Results are compiled
into tables and
converted into inch
equivalents.**

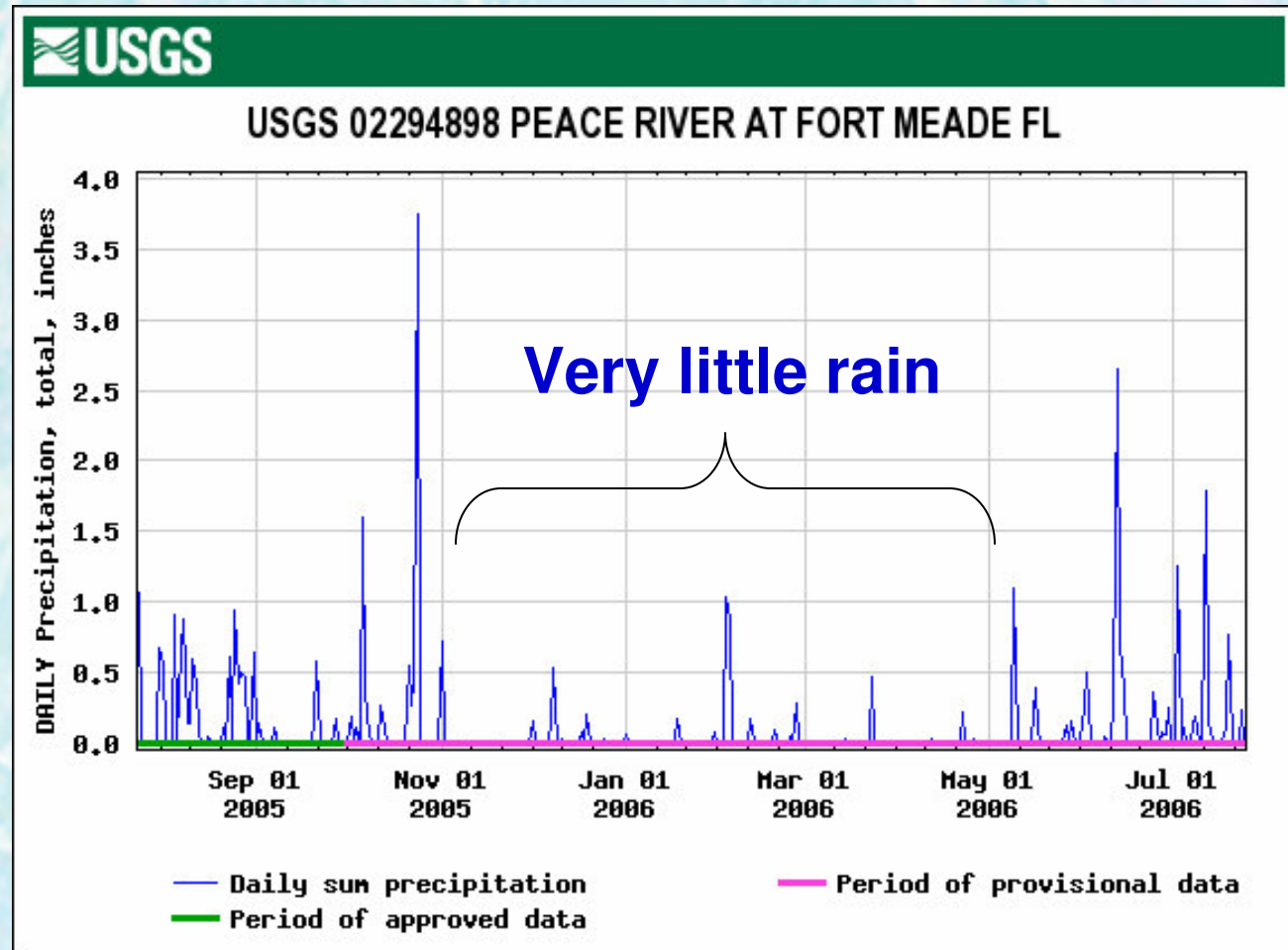
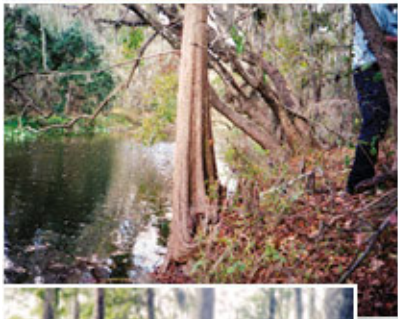


Baseflow

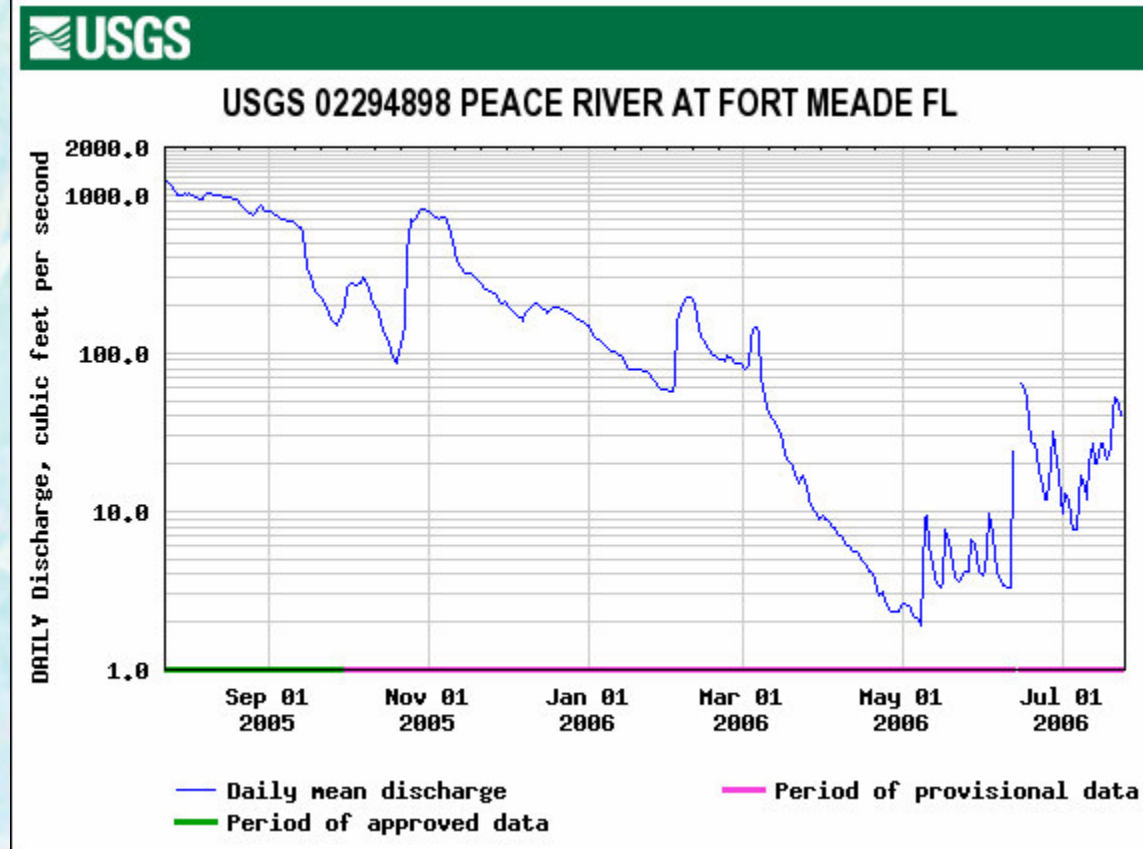
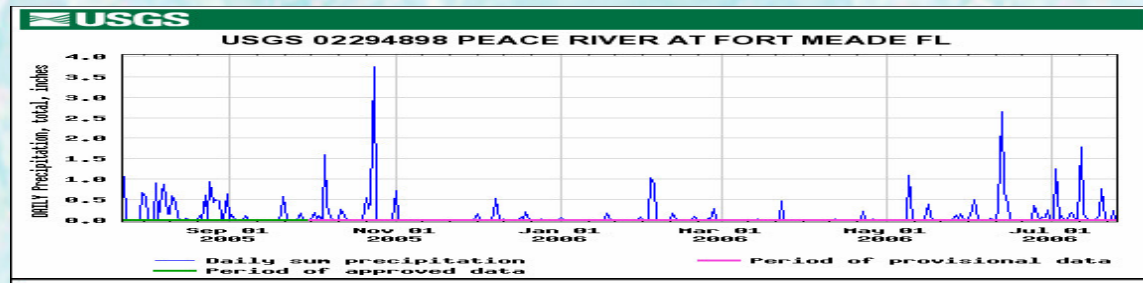
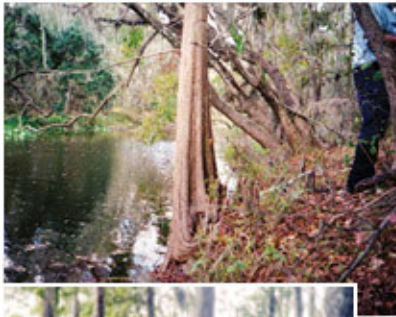
- Defined as the contribution to stream flow from groundwater or other delayed sources



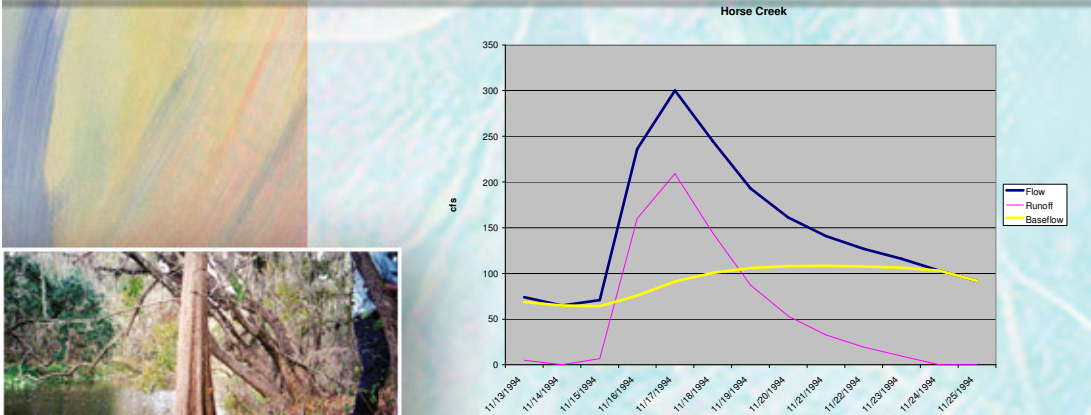
Rain Record at Ft Meade Gauge



Rainfall and Streamflow

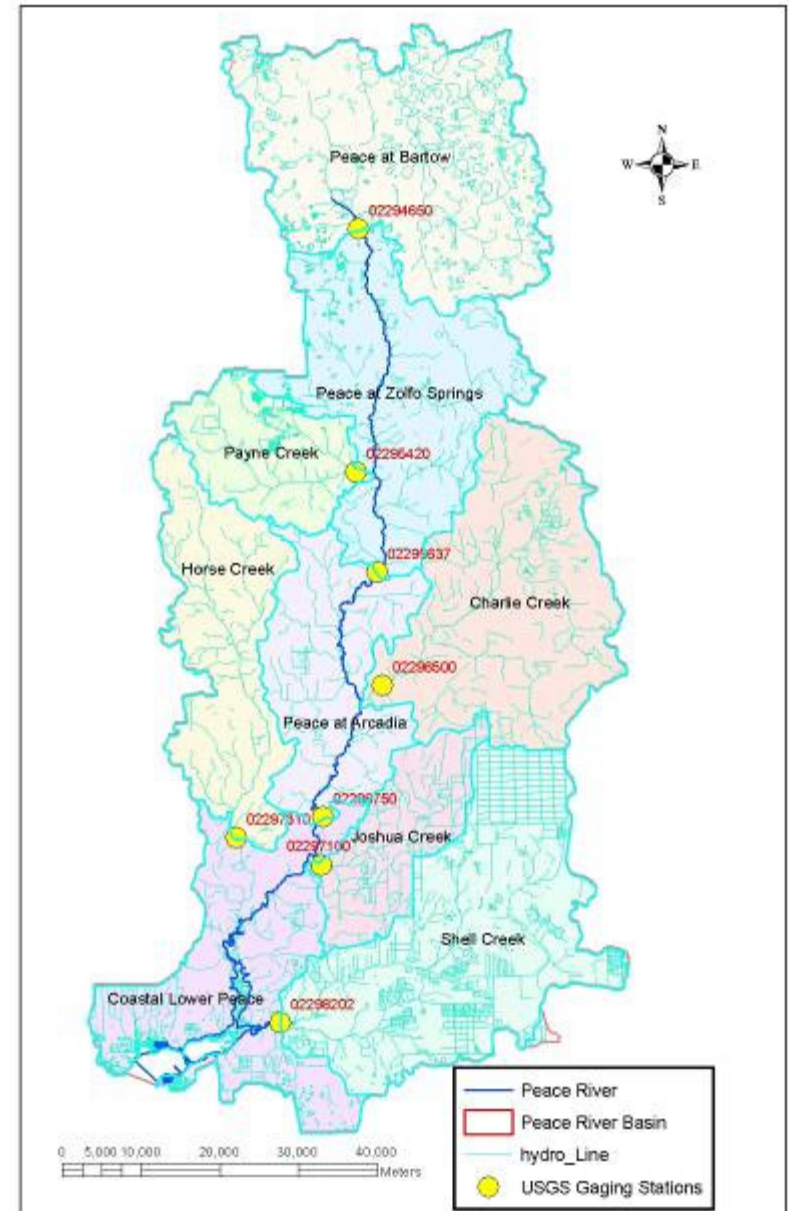


Hydrograph Separation



Selected Flow Gages:

- 2294650 Peace River at Bartow
- 2295637 Peace River at Zolfo Springs
- 2296750 Peace River at Arcadia
- 2295420 Payne Creek
- 2296500 Charlie Creek
- 2297310 Horse Creek
- 2297100 Joshua Creek
- 2298202 Shell Creek



Baseflow Trends*



Decreasing



- Peace at Bartow

Increasing



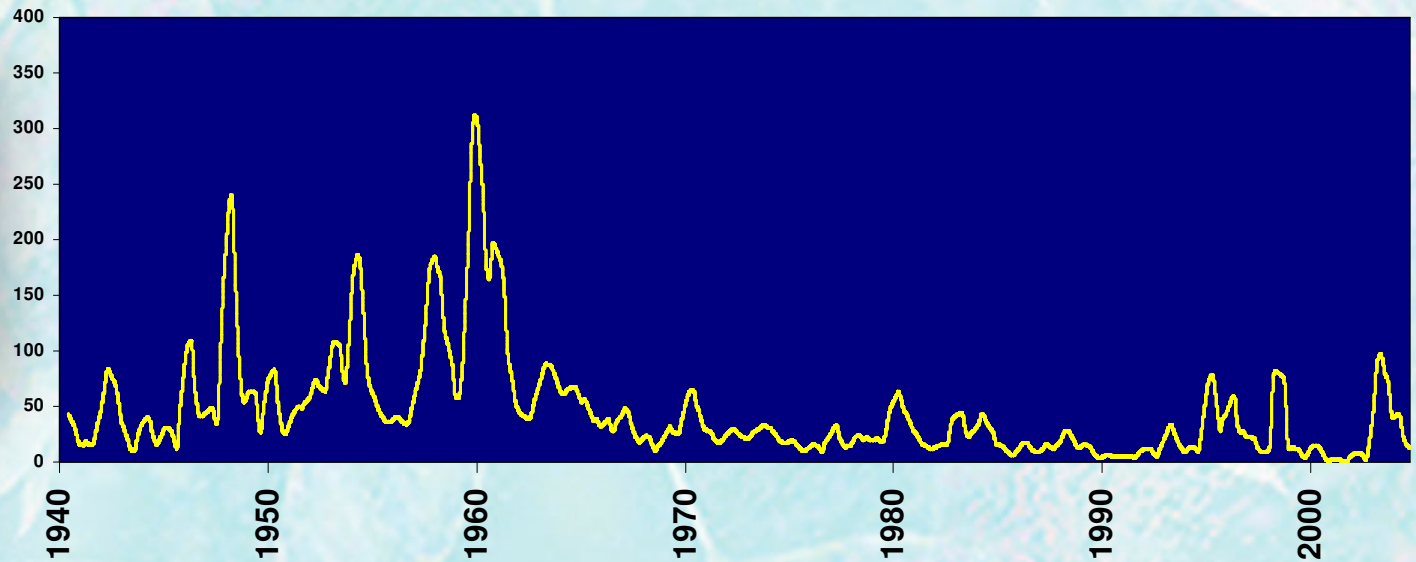
- Joshua Creek

Little Change

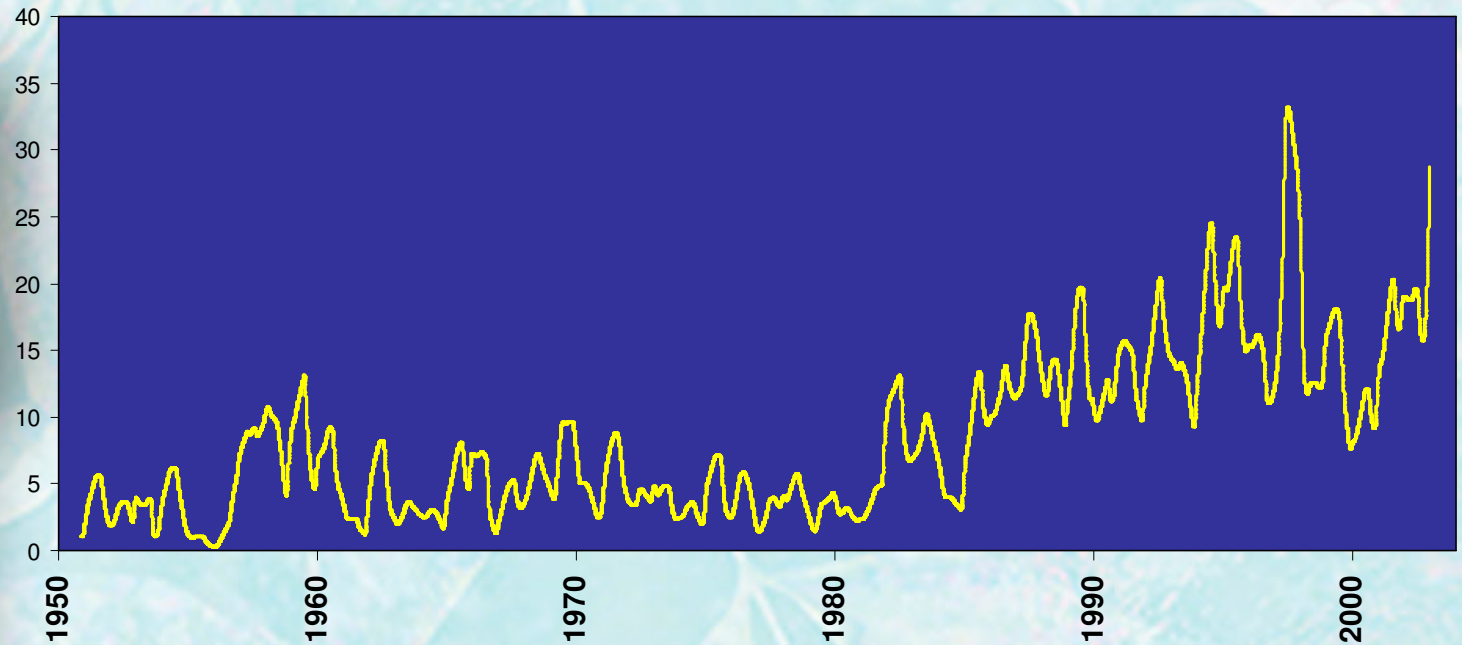
- Peace at Zolfo
- Peace at Arcadia
- Payne Creek
- Charlie Creek
- Horse Creek
- Shell Creek

* For period of record of each gauge

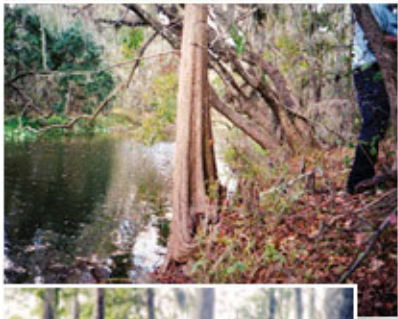
Baseflow at Peace at Bartow



Baseflow at Joshua Creek



Budget Summary at Bartow

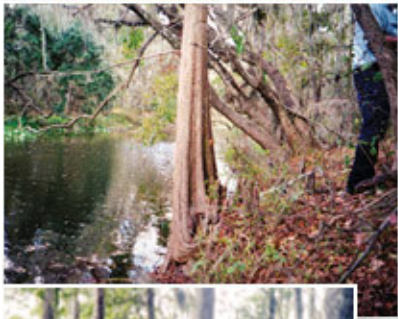


Period	Rain	ET	Flow	Recharge	
41-43	51	37	7 (1)	7	7*
76-79	49	34	3 (1)	12	12*
97-99	54	35	8 (1)	11	11*

All values in inch per year

*Recharge from SWFWMD SD
GW Model

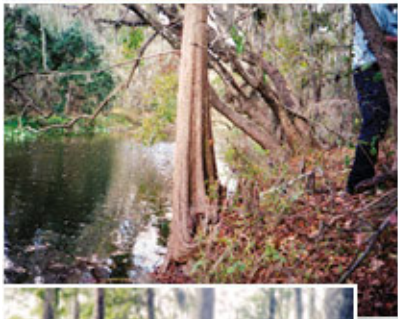
Budget Summary at Arcadia



Period	Rain	ET	Flow	Recharge	
41-43	55	36	14 (1)	6	1*
76-79	45	34	11 (2)	0	1*
97-99	55	37	9 (2)	8	2*

All values in inch per year
*Recharge from SWFWMD SD
GW Model

Budget Summary at Payne

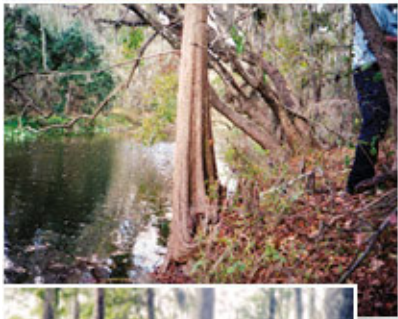


Period	Rain	ET	Flow	Recharge	
89-91	46	37	6 (2)	3	5*
97-99	57	35	13 (3)	9	5*

All values in inch per year

*Recharge from SWFWMD SD
GW Model

Budget Summary at Joshua



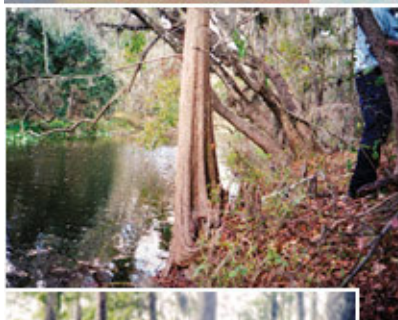
Period	Rain	ET	Flow	Recharge	
76-79	43	34	6 (1)	3	1*
97-99	52	36	12 (2)	4	1*

All values in inch per year

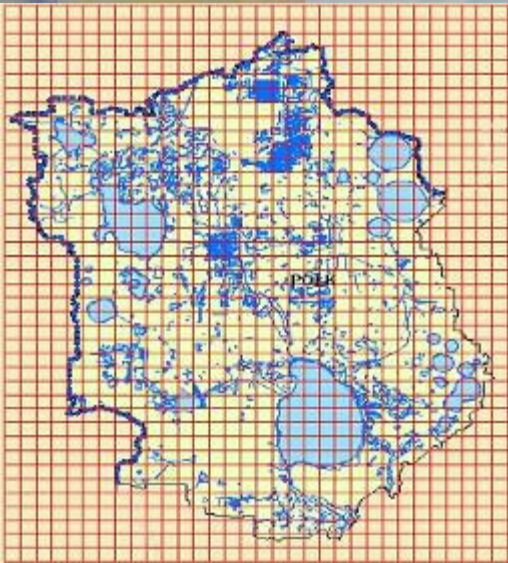
*Recharge from SWFWMD SD
GW Model

Peace River Integrated Modeling Project - PRIM

- **Funded by the SWFWMD**
- **Started in 2004, to be completed in December 2008**
- **Integrated surface-water and groundwater flow model of the Peace River**
- **Calibration for 5 –year period 1998 – 2002, and validation for 1994 - 1997**
- **Better tool for analysis of changes in land-use, climate, and other human impacts.**
- **Prediction – How minimum flows will be affected under various management options**



PRIM Complements the Cumulative Impact Study



Saddle
Creek



PRIM

- Focus on hydrology, not water quality
- Focus on 'recent' (1994 – 2002) conditions vs. multi-decade scale changes
- Building a detailed computer simulation model
- 2500x 2500 ft grid size vs sub-basin scale
- Daily time steps vs. average annual water budgets

Summary

- **Peace River CIS water budget calculations are nearly complete.**
- **Trends and critical issues are identified.**
- **Secondary, focused analysis and reporting to be completed in August.**

