Comparison of Pre- and Post-Irrigation Stream Flow
Flint River at Newton

Exceedance

Flow rate (cfs)

Jan 1, 1939-Sep 30, 1950; Oct 1, 1956-Sep 30, 1975
Jan 1, 1976-Sep 30, 2004
Comparison of Pre- and Post Irrigation Stream Flow
Ichawaynochaway Creek nr. Milford

Sep 1, 1905-Dec 31, 1975
Jan 1, 1976-Sep 30, 2004
Comparison of Pre- and Post- Irrigation Stream Flow
Spring Creek nr. Iron City

Flow rate (cfs) vs. Exceedance

- Jun 11, 1937-Apr 30, 1971
- Dec 20, 1976-Sep 30, 2004
Region 7 Monthly Rainfall

Month

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Monthly Rainfall (inches)

Pre-irrigation

Post irrigation

+11
Overview of Modeling Process

AWP data
New Hydrol. Data

Precipitation
hydrology
watershed
water use

Transient
MODFE
Model

HSPF
Model

In-stream
flows

Groundwater
flow to streams
(+ or -)
Calibration and Validation of A Hydrological Model for Spring Creek and Ichawaynochaway Sub-basin Using the EPA BASINS/HSPF Modeling Tool

06/26/05
GA EPD
**Objective**

- To develop a hydrological model for Spring Creek and Ichawaynochaway sub-basin:
  - to simulate stream flow in any place of interest based on the rainfall data.
  - to provide unimpaired flows for basin-wide model.
STANFORD WATERSHED MODEL

Potential ET
Precipitation
Temperature
Radiation
Wind,Dewpoint

Snowmelt

Actual ET

CEPSC*
Interception Storage

INFILT*
Direct Infiltration

LZSN*
Lower Zone Storage

LZETP*
Deep or Inactive Groundwater

INTFW*
Interflow

UZSN*
Upper Zone Storage

Deep or Inactive Groundwater

AGWETP*
Groundwater Storage

AGWRC*

Overland Flow

LSUR*
SLSUR*
NSUR*

To Stream

ET - Evapotranspiration
* Parameters

Order taken to meet ET demand

Input
Output
Storage
Decision
Process

Input
Output
Storage
Decision
Process
Flow Chart for HSPF Model Development Process

Data Preparation

Model Assembling

Model Calibration

Model Verification & Validation

Model Application (Scenario Analysis)

Geographic (soid&landuse) data
River hydraulic data
Meteorological data
Topographical Data
Historical Withdrawal & Return
GW –SW interaction
Hydrological Data (observed flow)
The Spring Creek & Ichawaynochaway in Flint River Basin
Gage Stations in Spring Creek
Weather Stations Near Spring Creek
Data – Spring Creek

- **Meteorological data**
  - Three stations at: Edison, Colquitt and Blakely

- **Hydrological & hydraulic data**
  - Four gage stations, but only gage near Iron City with long record
  - Channel geometry, DEM, river network
  - Stage-discharge-storage relationships of channels

- **Watershed data**
  - Landuse
  - Soil property
Data Sources

- **Meteorological data**
  - GA State Climate Office and NOAA

- **Hydrological & hydraulic data**
  - Gage stations, (USGS)
  - Channel geometry, DEM, river network (USGS)
  - Stage-discharge-storage relationships of channels (USGS)
  - (Note: hydraulic data was generated by BASINS Tool and may not be accurate)

- **Watershed data**
  - Landuse (USGS, generated in 1980s)
  - Soil data (USGS)

- **Calibrated data: determined by calibration**
Model Calibration – Spring Creek

- **Calibration period:**
  From 1955 - 1970

- **Calibration Indices**

<table>
<thead>
<tr>
<th>Calibration Period</th>
<th>Correlation Coefficient</th>
<th>Coeff. of Determination</th>
<th>Nash-Sutcliffe Coefficient</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1/1955 – 12/31/1970</td>
<td>0.85</td>
<td>0.73</td>
<td>0.72</td>
<td>Spring near Iron City</td>
</tr>
</tbody>
</table>
Model Calibration – Spring Creek
(Comparison of observed and simulated flow duration)
Model Calibration – Spring Creek
Year 1956 (Dry)
Model Calibration – Spring Creek
Year 1956 (Dry)
Model Calibration – Spring Creek
Year 1965 (Wet)
Model Calibration – Spring Creek
Year 1965 (Wet)
Model Calibration – Spring Creek Year 1968 (Drought)
Model Validation — Spring Creek

- Validation period:
  From 1982 - 1995
Model Validation — Spring Creek

- Withdrawal consideration

- **Surface water withdrawal:**
  
  10% withdrawal for first-order stream, 90% withdrawal for other streams

- **Ground water withdrawal effect:**
  
  not considered in this validation due to lack of GW effect info.
## Validation Indices for Spring Creek

<table>
<thead>
<tr>
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<th>Correlation Coefficient</th>
<th>Coeff. of Determination</th>
<th>Nash-Sutcliffe Coefficient</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/1/1982 – 12/31/1995</td>
<td>0.87</td>
<td>0.75</td>
<td>0.68</td>
<td>Spring at Iron</td>
</tr>
</tbody>
</table>
Model Validation - Spring Creek
(Comparison of Flow Duration Curve)
Model Calibration – Spring Creek
(Comparison of observed and simulated flow duration)
Model Validation – Spring Creek Year 1986 (Drought)
Model Validation – Spring Creek
Year 1986 (Drought)
Model Validation – Spring Creek Year 1988 (Dry)
Model Validation – Spring Creek
Year 1988 (Dry)
Model Validation – Spring Creek
Year 1989 (Wet)
Model Validation – Spring Creek
Year 1989 (Wet)
Results Analysis – Spring Creek

- Pre-irrigation calibration: duration curves match very well except low end (>98%) with higher simulated flow.
- Post-irrigation validation: simulated flows are slightly lower in both higher and lower ends.
- Improvement of low flow for pre or post irrigation period will make result of other period worse.
- Comparison of observed and simulated flows indicates general good match of two flow series
- Low flows match satisfactorily.
Ichawaynochaway Cr.
Meteorological Records
Watershed Delineation
Model Calibration - Ichawaynochaway

- Achieving high value indices (CC = 0.88; COD = 0.78; and NS = 0.77).
- Duration curve of simulation matched that of observation reasonably well.
- Magnitude and timing of low flow seemed acceptable.
Duration Curve

Analysis Plot for at ICH. CR.
Model Calibration – Ichwaynochaway
Year 1956 (Dry)
Model Calibration – Ichwaynochaway
Year 1965 (Wet)
Model Calibration – Ichwaynochaway
Year 1968 (Drought)
Model Validation - Ichawaynochway

- Achieving similar indices (CC = 0.89; COD = 0.79; and NS = 0.78).
- Duration curve of simulation matched that of observation reasonably well except for the very low end.
- Magnitude and timing of low flow seemed acceptable.
Duration Curve - Ichawaynochaway

- OBSERVED FLOW (Unknown)
- SIMULATE FLOW (cfs)

Analysis Plot for at ICH. CR.
Model Validation – Ichwaynochaway
Year 1986 (Drought)
Model Validation – Ichwaynochaway
Year 1988 (Dry)
Model Validation – Ichwaynochaway
Year 1989 (Wet)
Uncertainty Analysis

- Met Data limitation
- Accuracy of GW impact
- Accuracy of river parameters
- Accuracy of landuse and topography
- Accuracy and limitation of Gage station

Decreasing Impact
Conclusion

- Both the Spring Creek and Ichawaynochaway Creek surface water model calibrations and validations are acceptably accurate except in the lowest 2-5% of the stream flow range.
- In both basins, the modeled agricultural irrigation withdrawals during the validation period lower the simulated stream flow rates compared to the observed flow records in the lowest 2% of the flow range.
- The inclusion of groundwater withdrawal effects in the models is likely to significantly further lower the simulated flow rate in the lowest 2-5% of the flow range in Spring Creek, perhaps reaching 0 cfs in years other than 2001.
- The models are believed to be suitable for all conditions except the lowest 2-5% of the stream flow range. However, for the extreme drought conditions, uncertainties in data input and hydrologic and hydrogeologic processes will likely require additional evaluation for resource management decisions, especially for the smaller tributaries and stream reaches.