Everglades Rainfall Driven Operations

The Evolution of a New Paradigm for Operating the South Florida System

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Presentation Outline

- I’ve heard of Rainfall Driven Operations (RDO) before.

- **RDO in “Model Land” – EAA Reservoir Case Study**
  - Based on the output of the Natural System Model (NSM)
  - Used in simulations with the South Florida Water Management Model (SFWMM or 2x2)
  - Even in model land it’s complicated
  - Policy objectives result in adjustments to RDO targets

- **RDO in the “Real World” – Making Progress**
  - Stage based RDO formula development

- **Next Steps / Ongoing work – Stay tuned, more to come…**
The goal of the Everglades Rainfall Driven Operations (RDO) project is to provide a set of operational protocols for a current or projected future system infrastructure that are aimed at achieving pre-drainage conditions in a post-drainage, managed hydrologic system.
Background
RDO vs. Regulatory Releases

- Regulation schedules tend to discharge water to downstream areas based on a primarily flood control paradigm. (PUSH)

- Typically, they are calendar-based so they capture seasonal variability, but not year to year variability.
RDO utilizes stage-based performance relative to desired targets at a series of selected gauges in the natural area to move water through the South Florida system. (PULL and PUSH)

Stage targets are initially based on NSM depth added to current topography.

Methodology responds to variability in climate, so both seasonal and year to year variability is observed.
Some planning efforts make use of an operation known as “RDO Lite”.

This refers to a flow-based formula (Ali 2004) that predicts NSM-like flow volumes across Tamiami Trail.

The flow-based formula is used to derive the environmental component of the WCA-3A regulation schedule, but does not change the schedule itself.

Full RDO utilizes stage targets to dictate flows throughout the system and replaces regulation schedules.
EAA Reservoir Case Study

Conceptual Model of the A-1 EAA Reservoir in the SFWMN NAI1

- LOK releases thru Miami Canal
- NNR releases thru NNR Canal
- Miami basin runoff
- NNR basin runoff
- Ag deliveries to NNR Basin
- Ag deliveries to Miami Basin
- Environmental deliveries to the south

Footprint of the EAA Reservoirs in the SFWMN grid

- A-1 North Footprint: 9,600 acres
- A-1 North Volume: 115,200 ac-ft
- A-1 South Footprint: 6,400 acres
- A-1 South Volume: 76,800 ac-ft
- Total Volume: 192,000 ac-ft
- Max Depth: 12.0 ft

There is no direct connection from the proposed EAA reservoirs to compartments B and C (expanded STA’s) in the IOR.
EAA Reservoir Case Study
Example RDO Transformations

Export Offset

Date
Hydrograph
Offset 1
Offset 2

Truncation

Max
Min

New Target
Hydrograph
Typically, a series of modifications to RDO targets (initially NSM depth) are required in order to achieve desired outcomes.

This is due to a number of considerations including:

- Balancing the competing objectives of the natural system
- Limitations of downstream infrastructure
- Performance constraints related to water quality or endangered species.

As part of the CERP planning process, RDO schemes are utilized in both current and future modeling scenarios, further complicating matters.
EAA Reservoir Case Study - Results

Seasonal Shift in STA3/4 Outflows due to EAA A-1 Reservoir Project

Average Monthly STA3/4 Outflow (kac-ft)

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
EAA Reservoir Case Study – Results
Inflows to Everglades National Park

Average Annual Overland Flow across Transects 17 & 18 (1965–2000)
Southward flows in Northern ENP (south of Tamiami Trail – west & east of L-67 extension)

<table>
<thead>
<tr>
<th>Transect 17</th>
<th>Transect 18</th>
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<tbody>
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Real World RDO - Challenges

- Exploratory data analysis
  - What data is needed to do real time RDO?
- Determining the target to attempt to reach
  - NSM depths are not available real-time.
  - How do policy objectives and “model land” translate into operational protocols?
- Identifying the flow regime that will produce desired targets
  - Inverse modeling techniques
  - Field validation
Selecting Rainfall and ET stations
Real World RDO – New Rainfall Driven Formula

$$\hat{St}_t = \left( \sum_{i=1}^{n} Tansig \left( \sum_{k=1}^{19} \omega_{k,i} \ast \sum_{j=1}^{114} (x_{i,j} \ast p_{j,k}) + \alpha_i \right) \ast \theta_1 + \beta \right) \ast \sigma_q + \mu_q$$

- $\omega_{k,i}$ is the (k,i) element of hidden layer weight matrix $\Omega$
- $\alpha_i$ is the $i^{th}$ element of the hidden layer bias vector $\alpha$
- $\theta_i$ is the $i^{th}$ entry of output layer weight vector $\Theta$
- $\beta$: The output layer bias vector term
- $Tansig$: Hyperbolic tangent sigmoid transfer function
- $n$: Number of hidden layer nodes (14 in this case)
- $\mu_q$: Historical global mean vector of stage target time series of the modeling data set.
- $\sigma_q$: Historical global standard deviation vector of stage target time series of the modeling data set.

Structured as a Nonlinear autoregressive network with exogenous inputs (utilizes a Feedforward Levenberg-Marquardt backpropagation)
New Rainfall Driven Formula - Results

Overall RDF Vs. NSM restoration targets
Averaged across the 5 trigger locations.
### Overall Statistics for Global Prediction (ft.)

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<th>NWC3A</th>
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Real World RDO – Next Steps

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