#### A Framework of Multi-objective Optimization for Monthly Water Resources Allocation from Multiple Supply Sources

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- Long-term water master planning (10-20 years)
- Annual (1 to 5 years), budgeting and member government rate advice
- Seasonal source allocation
  - -Source allocation, seasonal outlook
  - Agency wide cross functional team
- Weekly Operational Decision Support
  - -Optimized Regional Operations Plan (OROP): optimizes wellfield pumpage to maximize environmental value
  - -Weekly coordination among departments of the agency

## Tampa Bay Water Models: Seasonal Flow Outlook



### Tampa Bay Water Models: Seasonal Demand Forecasts

### Weather observations & Forecasts

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#### **TAMPA** BAY Simplified TBW water supply system





### Input and output of the Model

#### Stream flow projections

#### Regional demand projections



#### Monthly water production from different supply sources

### MOEA-assisted Seasonal Allocation: Retrospective analysis

### Objectives of the Seasonal Allocation Model

### <u>Minimize:</u>

- deviation from annual budget (in mgd)
- total cost of water production (in relative monetary values)
- Under-Utilization of groundwater use
- Over-Utilization of groundwater use

Examples of Operating Constraints:

• Keep reservoir storage full at the end of water year



surface water treatment operation efficiency

## Configuration of the model: Framework



### Configuration of the model: Interaction between PAM and BORG



PAM fixed variables – MOEA/Borg decision variables (groundwater production from two major supply sources)



PAM decision variables – allocation from other sources

### Setup PAM in AMPL as Simulation

- ➢PAM problem 24-month source allocation to satisfy monthly demands for a given water availability (to be withdrawn from TBC and Alafia river)
- >PAM objective as optimizing preferential operation via penalty functions
- >PAM constraints operating rules, facility capacity, water distribution balance, etc.
- PAM equality constraints evaluation of multi-objectives for MOEA/Borg



### Retrospective analysis using MOEA

- Water year 2017 with an extreme dry spring
  Retrospective forecast of demand and flow at beginning of each month
- ≻Define data set by 'RunDate" for each month
- Interim criteria to select one Pareto solution per realization

Overarching question: For each month in WY2017, how much improvement in source allocation if MOEA was used?



#### Results of MOEA for Tampa Bay Water's Seasonal Source Allocation: Model run October 2016



TAMPA

#### Results of MOEA for Tampa Bay Water's Seasonal Source Allocation: Pareto optimal solutions



TAMPA BAY WATER

#### Results of MOEA: Filtering of Pareto Solutions



#### Comparison between heuristic-planning and MOEA-assisted planning: operational differences





#### Comparison between heuristic-planning and MOEA-assisted planning: objective differences





18

### MOEA-assisted Seasonal Allocation: Real-time Implementation

Real-time implementation of MOEAassisted source allocation

Different inputs of the model run, e.g., seasonal demand forecasts and water availability forecasts, prepared at the beginning of the month

≻Model run: ~6 hours

≻Postprocessing: test use of Power BI



### Real-time implementation of MOEAassisted source allocation: postprocessing





Application of MOEA Results: Challenges

Distilling the huge amount of output information to determine final decisions on allocation

Communicating uncertainty/risk

How to incorporate feedback to inform decision processes





### Conclusions

Collaborative research among Water Research Foundation, Universities and Water Utilities helps to develop tailed decision tools (WRF project #4941)

>MOEA provides a framework for Tampa Bay Water to formulate its seasonal source allocation in a rigid model



> Challenges exists in using enormous amount of information to develop on-ground decisions

# Questions

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