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Practitioner Interview

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As part of an effort to better understand how water resources systems knowledge is used in practice and how to improve water resources systems curricula, Jayantha Obeysekera, chief modeler at South Florida Water Management District, was interviewed by David Watkins and Ali Mirchi on November 10th, 2015. The interview started at 2:00 PM EDT and took about an hour.

BACKGROUND QUESTIONS

1. **What is your current job title?**
Chief Modeler at the South Florida Water Management District (SFWMD)

2. **For how many years have you worked in your job?**
Since 1987. Worked in various positions at SFWMD

3. **What formal training have you had in systems analysis?**
Bachelor's degree in Civil Engineering from University of Sri Lanka, M. Eng. from University of Roorkee, India, and Ph.D. in Civil Engineering from Colorado State University with specialization in water resources.

4. **If your professional activities have included systems analysis, for how many years have you performed these activities?**
Nearly 30 years

QUESTIONS ABOUT USE OF SYSTEMS ANALYSIS ON THE JOB

5. **Describe your job. What is/are your roles/activities in your job?**
Leads modeling efforts (e.g., modeling of Kissimmee River Restoration, and the Everglades Restoration) at SFWMD's Hydrologic & Environmental Systems Modeling department. He was responsible for establishing a large group of multi-disciplinary modelers with over 60 members covering the disciplines of hydrology, hydrodynamics, water quality and environmental restoration.

6. **What work projects have used systems analysis techniques to identify/evaluate/select a design or decision alternative?**

A couple of examples. Optimization of Lake Okeechobee (LO) operations by regulation or rule curve development. There were complementary and competing objectives, including flood protection, ecosystem, and estuaries. Used multi-objective optimization but not as a formal approach. A lot of Monte Carlo simulations of different rule curves were done. Purpose was to pick one rule curve that balances different objectives. Used climate outlooks. Looked at tradeoffs and incorporated climate outlook.

7. **What systems analysis techniques, software, and/or tools were used?**

Developed in-house software, South Florida Water management Model or the 2X2 model to simulate LO inflow, outflow, water supply, flood protection, etc. We used dynamic programming to look at reservoir sizing in some watersheds. Another example is Regional Simulation Model (RSM) in which we incorporated linear programming (LP) for optimization within a time step (not a period of record optimization).

8. **Have any projects coupled optimization algorithms with external simulation models, simulated system equations within the optimization framework, or used an optimization algorithm available within a simulation model? If yes, what kinds of simplifications were required in the solution approach?**

In the LO case, we coupled simulation and optimization for trade-off analysis. We use genetic algorithm linked to optimization and we also use LP optimization at every time step. Simplifications: Linearize and define boundary conditions. In PRMS we use piecewise linear functions. Simplifications are necessary when interacting with stakeholders. This is what I have realized in the last 10-15 years. Optimization models are tools for consensus. So, if you have multiple stakeholders that do not concur on trade-offs, we run simplified optimization models to build consensus and help them understand the tradeoffs. It is an iterative process -- we go to stakeholder meetings and we have interactions, and then the modelers simplify the model to respond to stakeholders. Simple trade-off analysis was done in Excel using a simplified tool that allowed them to run hundreds of scenarios to generate trade-off curves that people understood.

9. **What uncertainty analyses have been used to evaluate designs or decision alternatives? If yes, what assumptions were required? What difficulties (if any) were there in communicating results of the uncertainty analysis to decision-makers?**

Stakeholders don't like uncertainty. We have used formal uncertainty analysis in model calibrations using PEST. We have somebody who is an expert on that. Started out with using GW modeling to account for uncertainties in hydraulic conductivity, etc. So PEST allows you to optimize uncertain parameters to calibrate the model. Just finished a study in Miami-Dade County in which we used PEST to optimize the calibration of HEC-RAS. Monte-Carlo is standard practice. We also do scenario analysis or predictive uncertainty analysis. In statistical modeling we use standard uncertainty analysis like delta-method, Jacobian or other advanced methods like bootstrapping or maximum likelihood. Another example is position analysis, i.e., what are the probabilities of LO level being at a certain level in the future. That's a tool we have been successfully using to communicate with our governing board (probability plots). For prediction of hurricane tracks, Hurricane Center provides a cone of uncertainty, and people are familiar with that. We have done multiple workshops on uncertainty (Pete Loucks and Jery Stedinger have held workshops). Challenge is to put uncertainty bounds on different alternatives and how to incorporate that into decision making. Sea level rise inundation maps is another area where we successfully used uncertainty analysis. The method provides color-codes of possible inundation areas, showing where are the areas that will be inundated and where are the areas where inundation can happen. When all parameters are uncertain and it's difficult to come up with probability plots we use deep uncertainty methods.

We use ensemble sub-samples of system states under climate outlooks, for example to focus on El Nino years. Purpose is to see what could happen in these years. We have also begun to use methods for "deep uncertainty," when probabilities (climate change, SLR) cannot be specified.

10. Have projects applied multi-objective decision methods to select a final design or decision alternative? If yes, how was a preferred alternative selected from a set of tradeoffs?

We haven't applied formal multi-criteria decision methods that are in textbooks, but we do conduct explicit analysis of trade-offs. We have used spider plots, where the smaller the polygons the better the alternative is, so this is a graphical approach. In the LO example, some formal trade-off analysis may have been used, like Pareto Frontiers. We run simulations and we come up with large sets of performance metrics and that shows tradeoffs for different objectives, and stakeholders provide feedback.

USE OF SYSTEMS ANALYSIS IN THE PROFESSION

11. What role should systems analysis play in professional practice? How can the profession more effectively use systems analysis in the future?
We have great theory on systems analysis, but on the whole, we are not teaching students to use theory in practice. Should use case studies to show how systems analysis is used in practice. The other thing is that systems analysts should know how to incorporate uncertainty explicitly in the analysis. Also, tools often don't have the capability to simulate the complexity of the system and you have to simplify, e.g., non-linear optimization is not used a lot. And there are a lot of great tools out there for this. An example is I-Model which uses neural networks along with signal processing toolbox to come up with optimal operation rules for LO.

a. What encourages or limits the use of systems analysis in the water resources engineering profession?
Hindrance or stumbling blocks are that people don't have a good sense of how the techniques work. Presenting the output in ways people can understand is also a challenge. People are more inclined to look at trade-offs, but reluctant to give weights. Understanding trade-offs is the first step to compromise, sometimes. Comprehending formal optimization can be a challenge, and advanced methods may not be suitable for typical stakeholders.

12. What systems analysis skills and techniques should universities teach to prepare new practitioners to successfully join the profession?

You teach OR pretty well but predictive uncertainty may be an area that should be taught more. Global sensitivity analysis is another thing. Also, the method of combined simulation-optimization. More practical examples help students learn how these things are applied. Real-world examples are needed.

REFERRAL

13.   Can you recommend a colleague we should also interview? What is their contact info? Would you be willing to put us in contact with them?

Dr. Dan Sheer and Dr. Pete Loucks,