

aWATERMAPS

***Developing National Water Use Models & Water Loss Program
United States Geological Survey (USGS) & Virginia Tech (VT)***

Every water system leaks. Altogether, billions of gallons of water are lost every day from the U.S. water systems.

Anmol Vishwakarma (CADWR) & Sunil Sinha (VT)



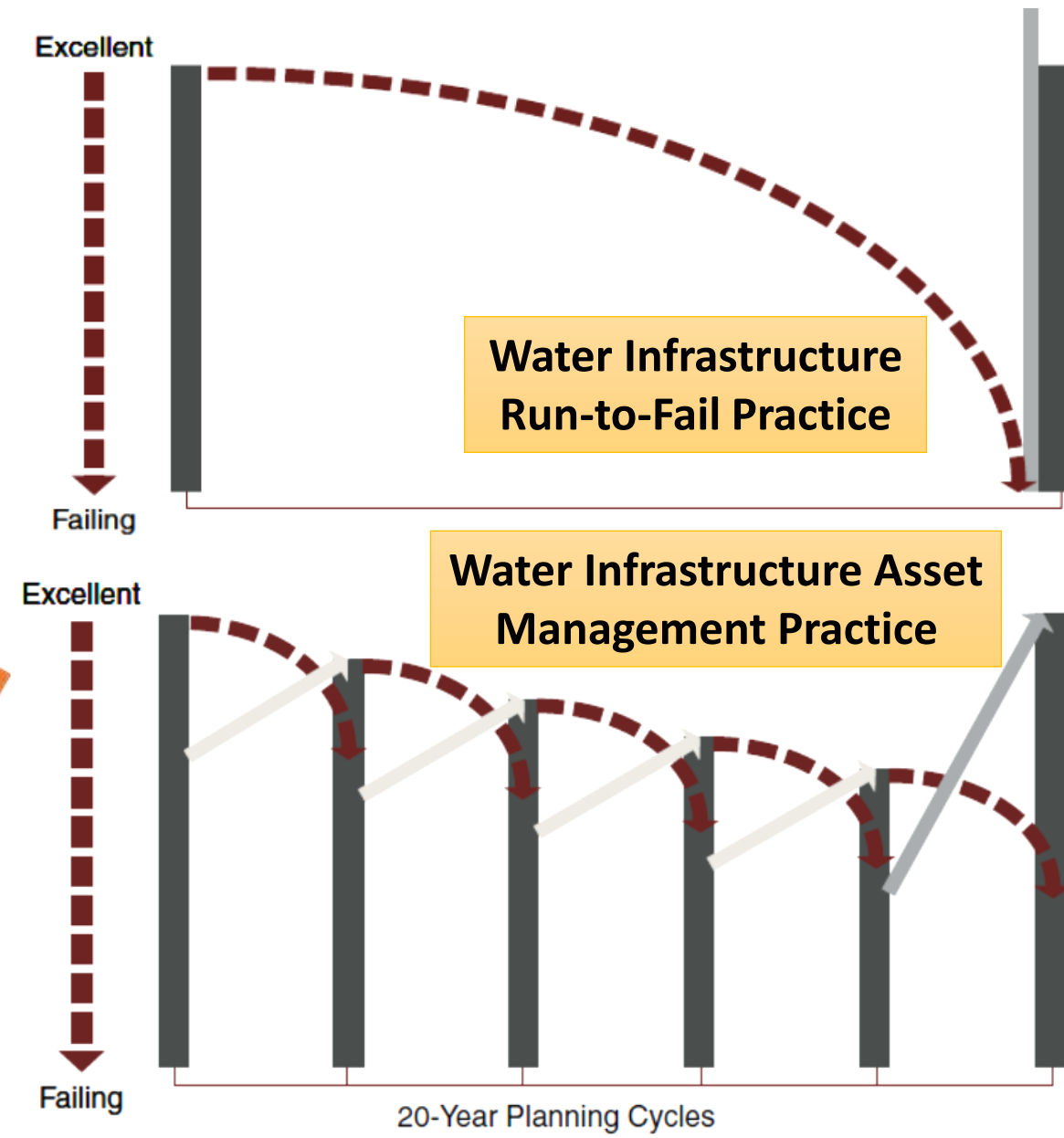
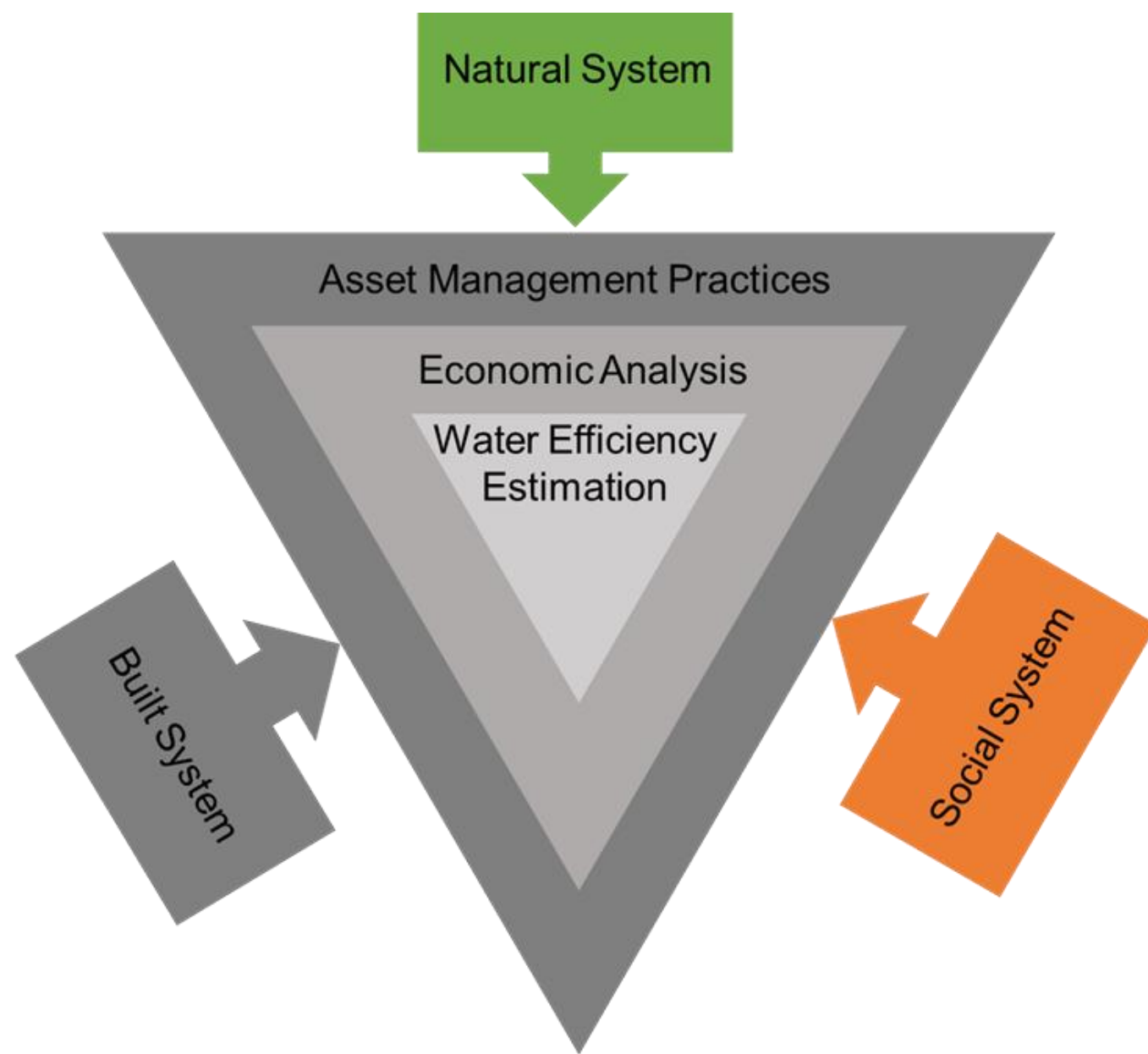
PROBLEM STATEMENT

A collaboration between USGS, ORNL, and VT will bring together the PIPEiD, WATERiD, and historical water use data to develop a series of pilot systems for developing a National Water Efficiency data driven model using machine learning and artificial intelligence.

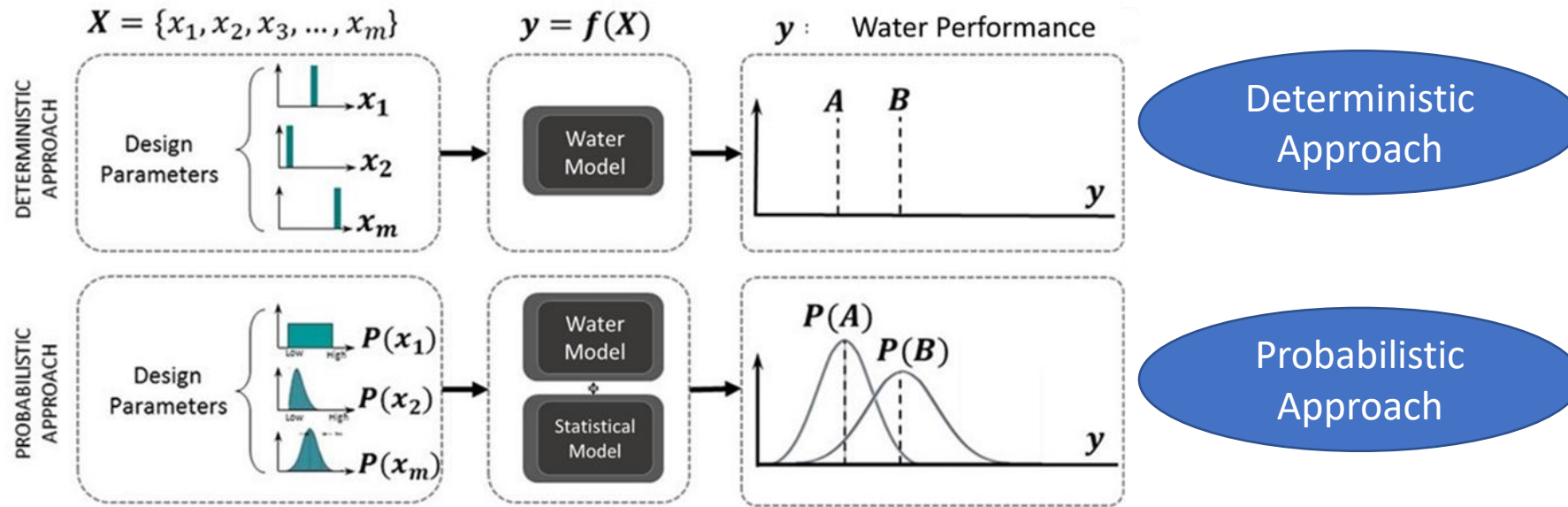
The research provides Nation-wide Estimates of water uses and losses based on scalable, explainable, reliable, and trustworthy models, thereby advancing resilient and sustainable provision of Water in Communities across the Nation.

National compilations of water use is critical to the National Water Census in order to include public supply water use as part of the nine water budget components for the Nation, and to meet the SECURE Water Act requirements.

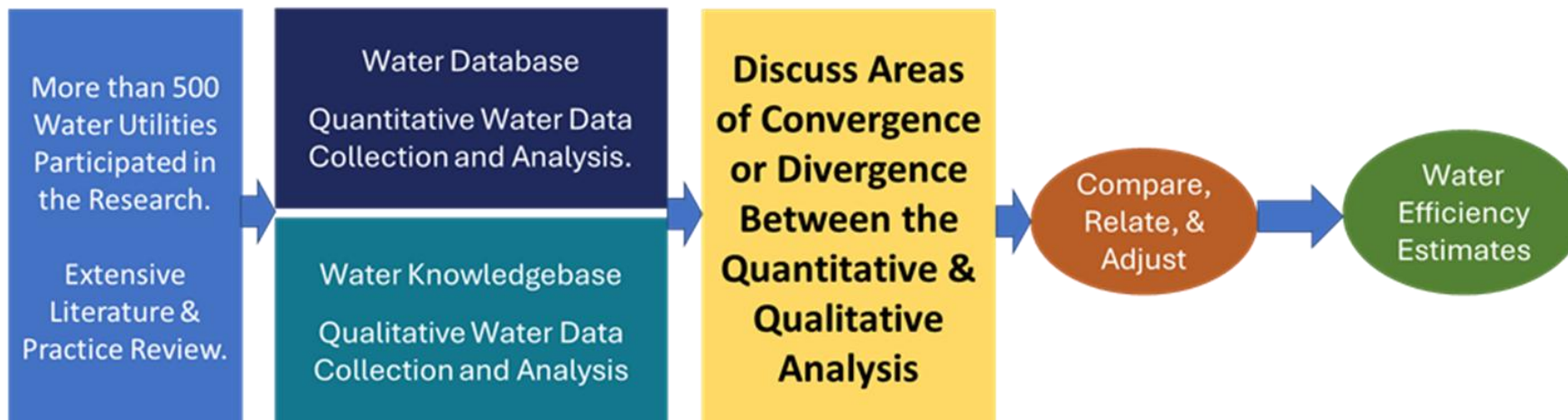
ASSET MANAGEMENT PRACTICES, ECONOMIC, & WATER EFFICIENCY ANALYSES



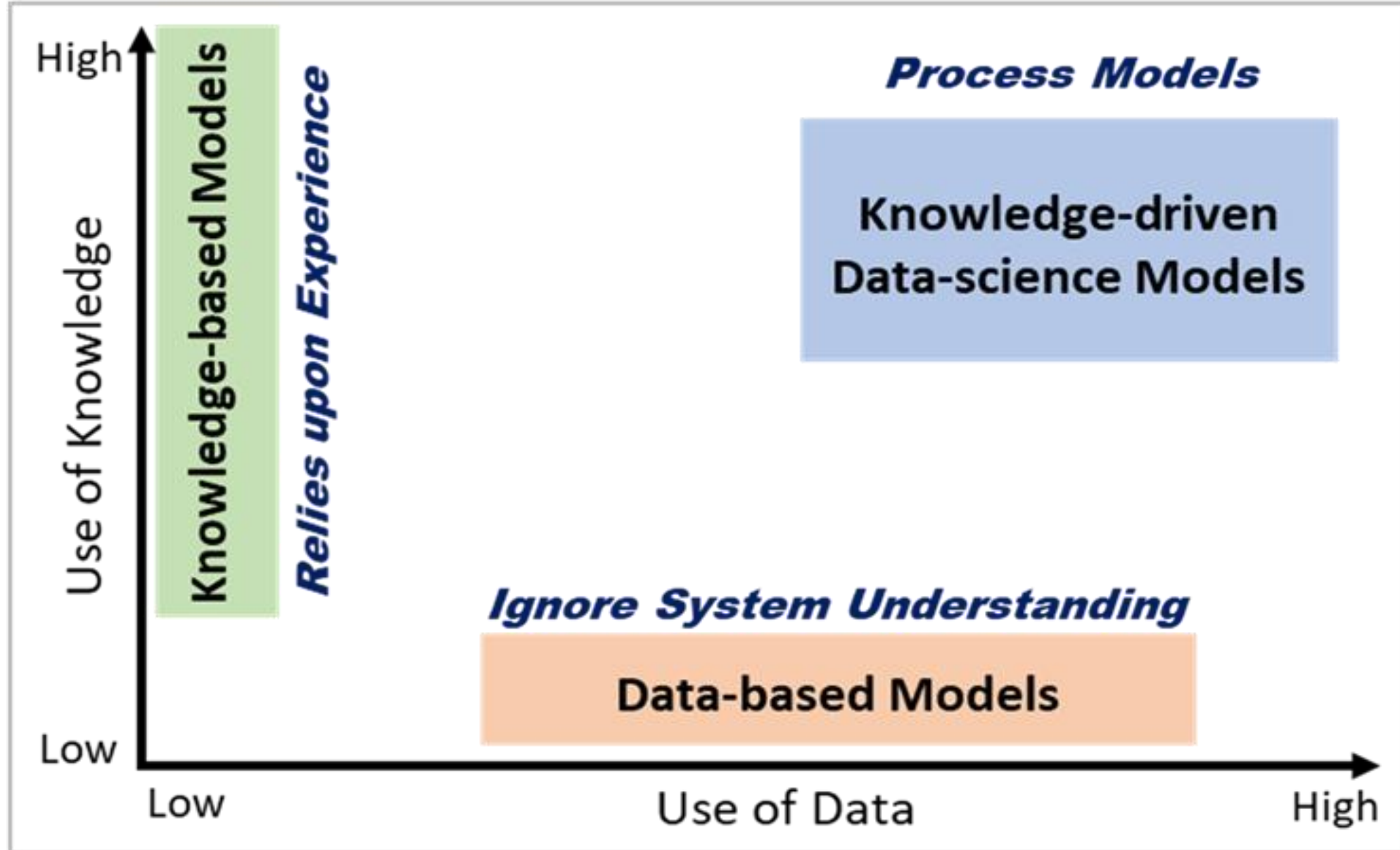
DETERMINISTIC, PROBABILISTIC, AND MIXED-METHOD APPROACHES



Convergent Parallel Mixed Methods Design for Water Efficiency Estimates

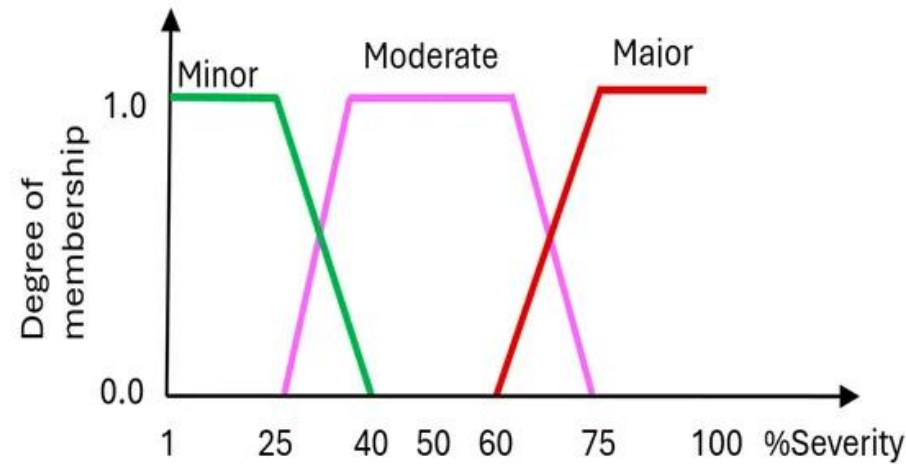


AI/ML KNOWLEDGE-DRIVEN DATA-SCIENCE PROCESS MODELS



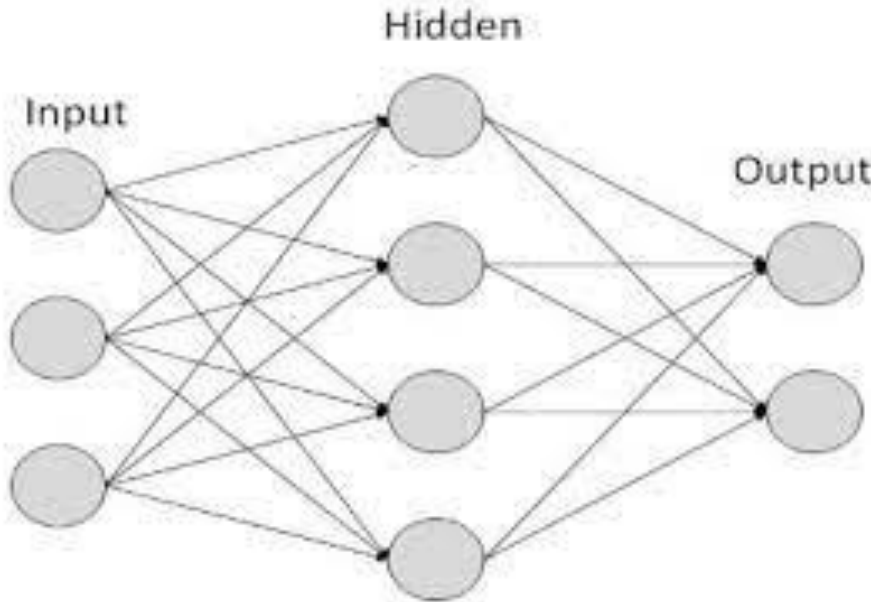
HOLISTIC AI APPLICATION APPROACH

Data Processing



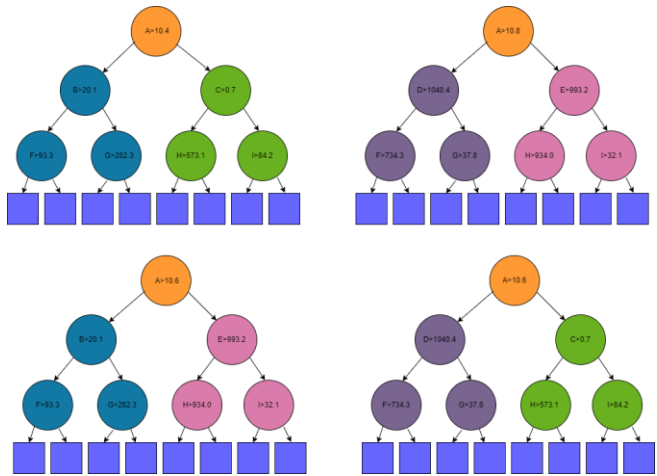
Fuzzy Logic

Data Analytics



Neural Networks

Decision Support



Genetic Algorithm

WATER LOSS DECISION SUPPORT SYSTEMS CHARACTERISTICS

DATA ANALYTICS APPROACH

**Top-Down
Approach**
*System-Level
Analysis*

⊖ TOP-DOWN APPROACH (PRELIMINARY ESTIMATE)

- It often makes it faster to collect and put together the data
- Top down does not require as much data as other strategies
- It offers a big picture look at the water system infrastructure

**Middle-Out
Approach**
*Cohort-Level
Analysis*

⊖ MIDDLE-OUT APPROACH (HYBRID ESTIMATE)

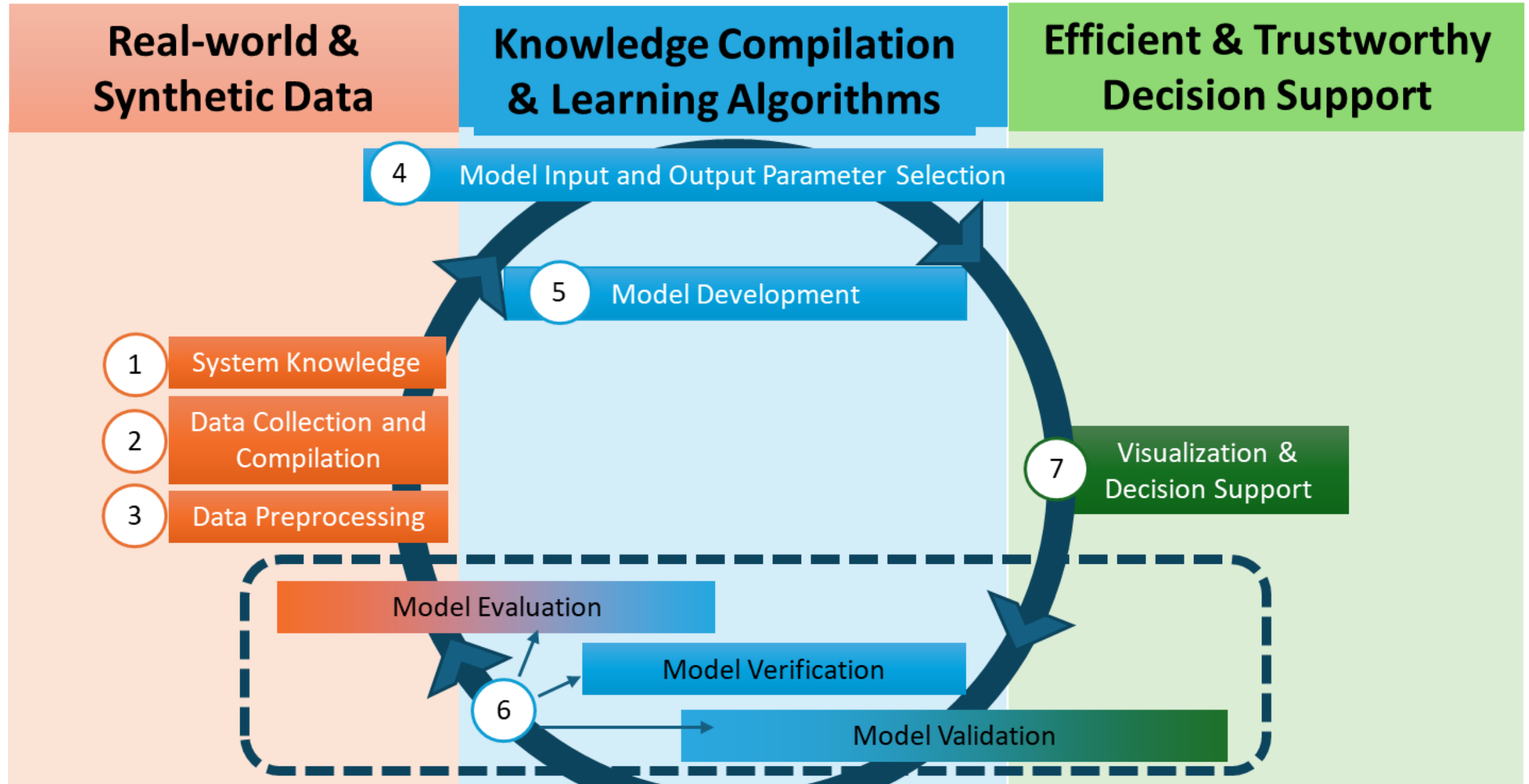
- It offers a more accurate picture than top-down analysis
- It takes into consideration knowledge and other data
- It doesn't take data as much as bottom-up modeling

**Bottom-Up
Approach**
*Component-Level
Analysis*

⊖ BOTTOM-UP APPROACH (DETAILED ESTIMATE)

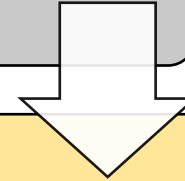
- It offers a more detailed look at the asset levels
- It incorporates data & knowledge from more sources
- Greater understanding of water system performance

TAI: TRUSTWORTHINESS OF ARTIFICIAL INTELLIGENCE APPLICATIONS

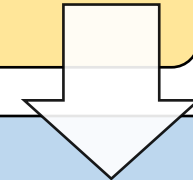


MAJOR STEPS FOR WATER EFFICIENCY ESTIMATION

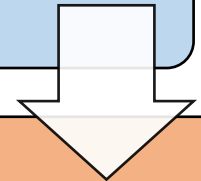
Step 1: Source-To-Tap Flow Diagram



Step 2: Source-To-Tap Data Collection

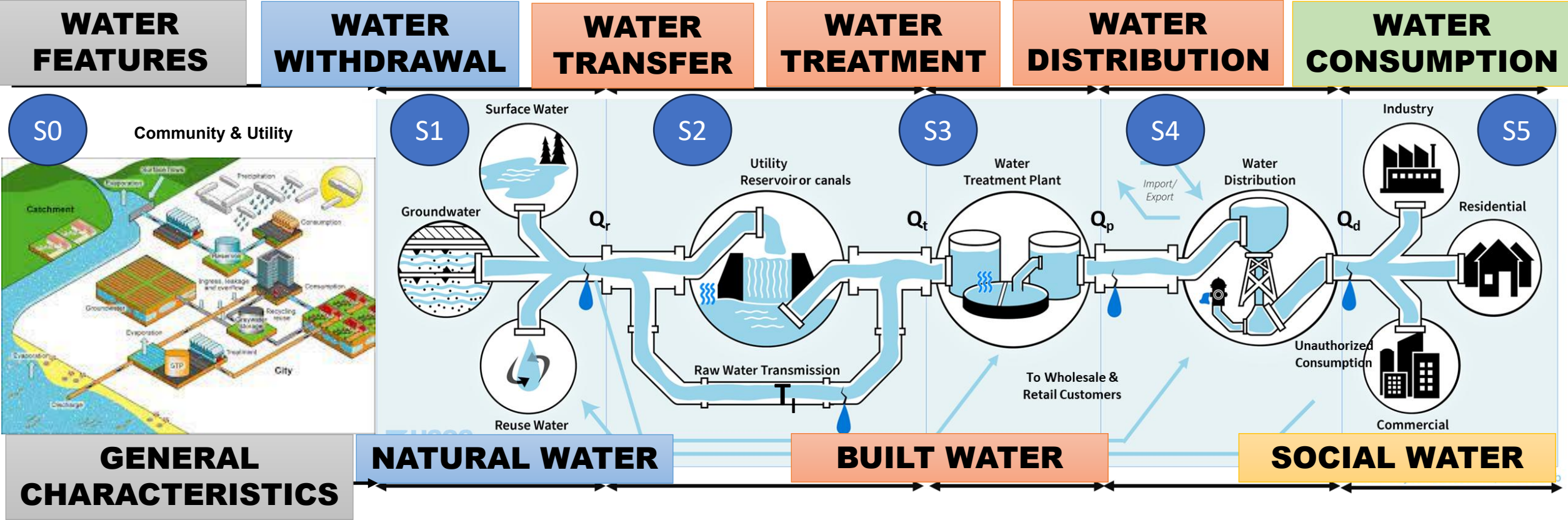


Step 3: Source-To-Tap Performance Analysis



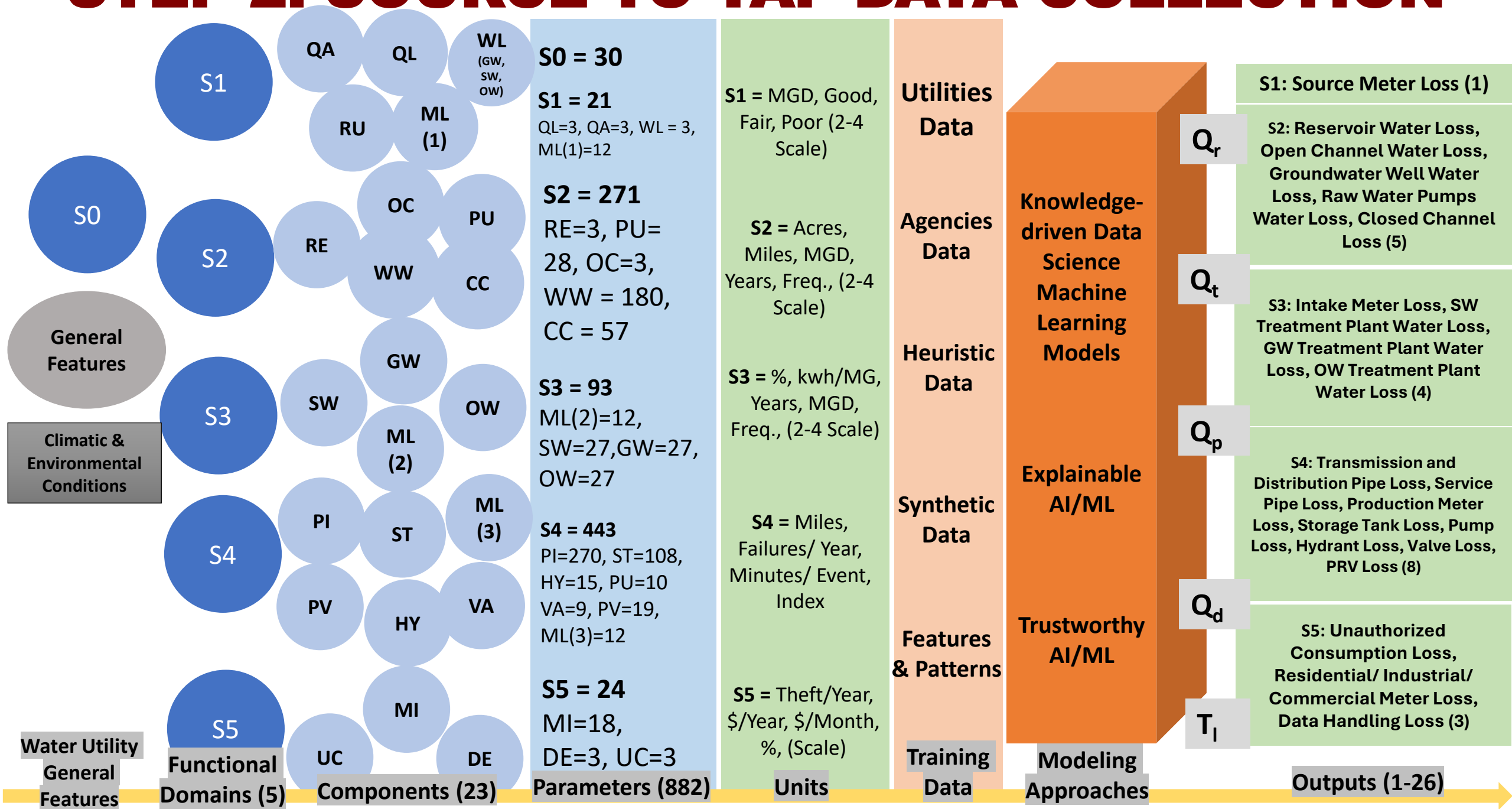
Step 4: Source-To-Tap Water Efficiency

STEP 1: SOURCE-TO-TAP FLOW DIAGRAM

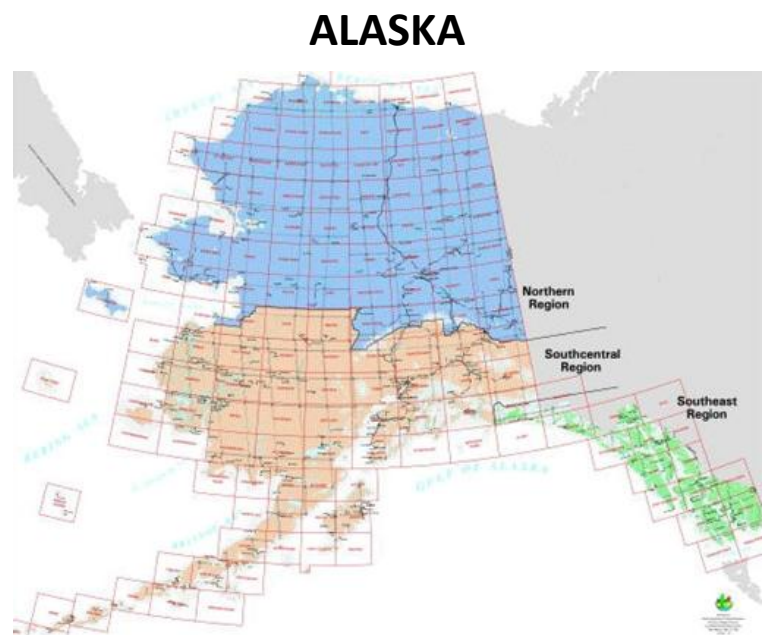
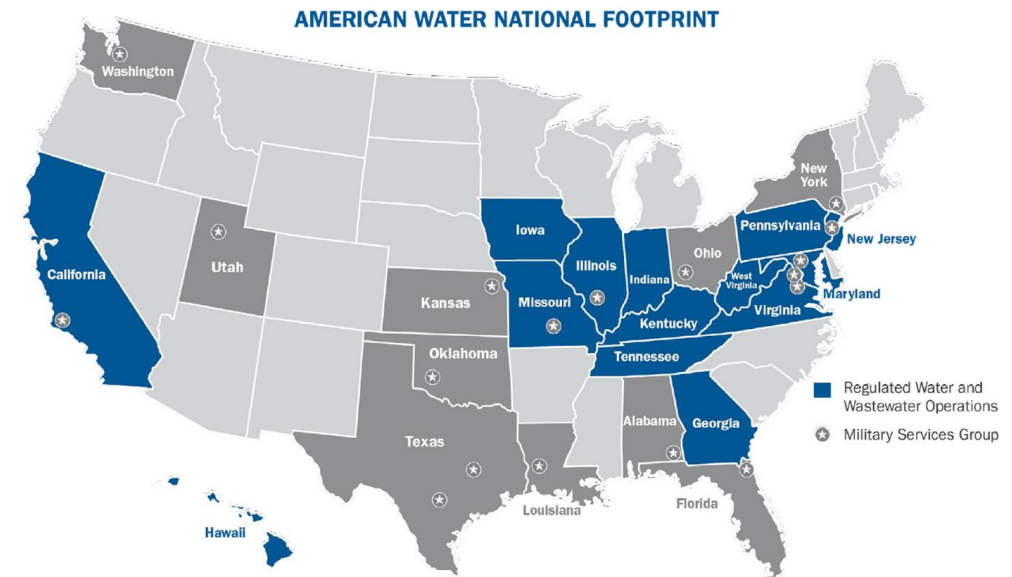
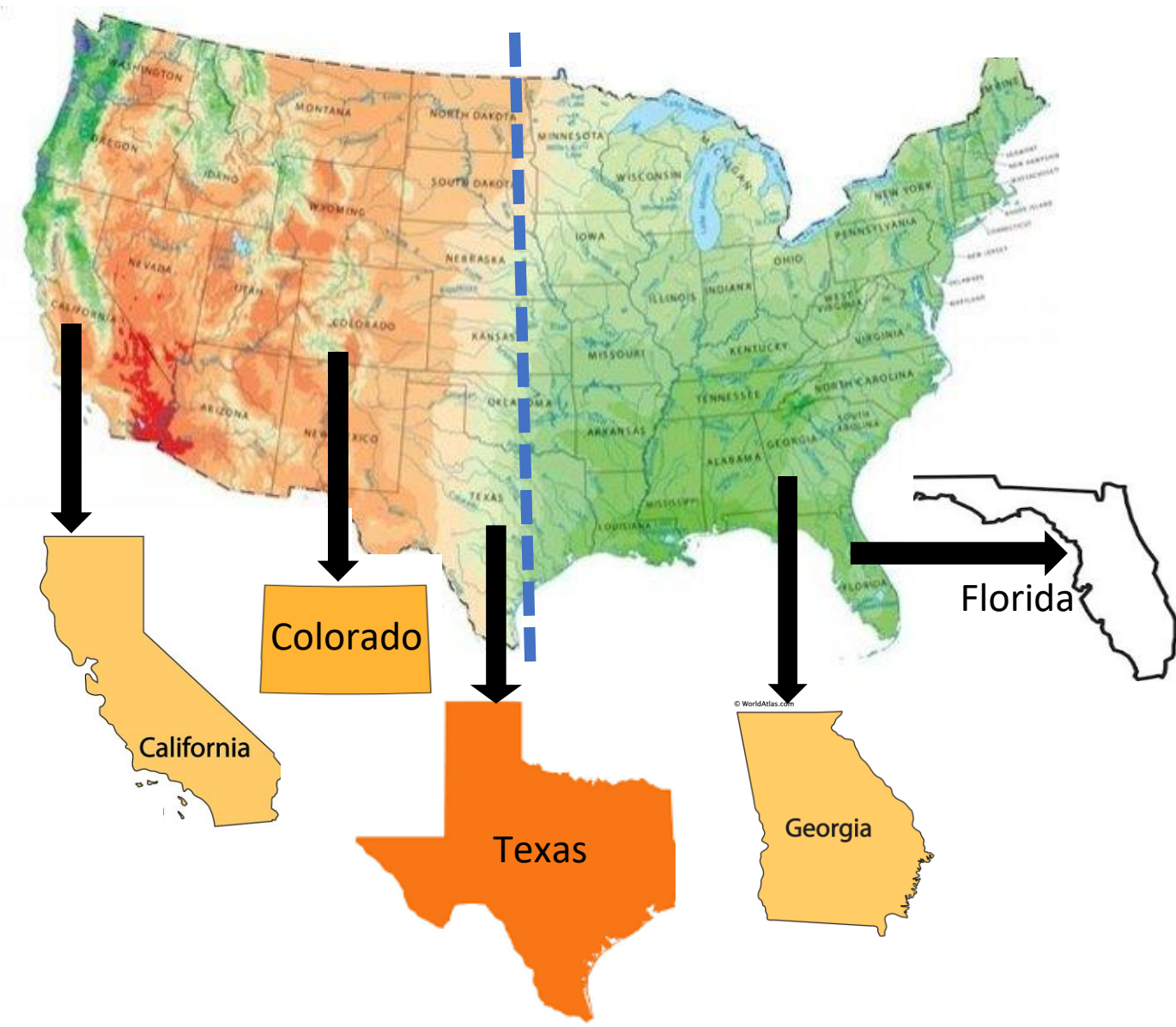


System-of-Systems Understanding

STEP 2: SOURCE-TO-TAP DATA COLLECTION

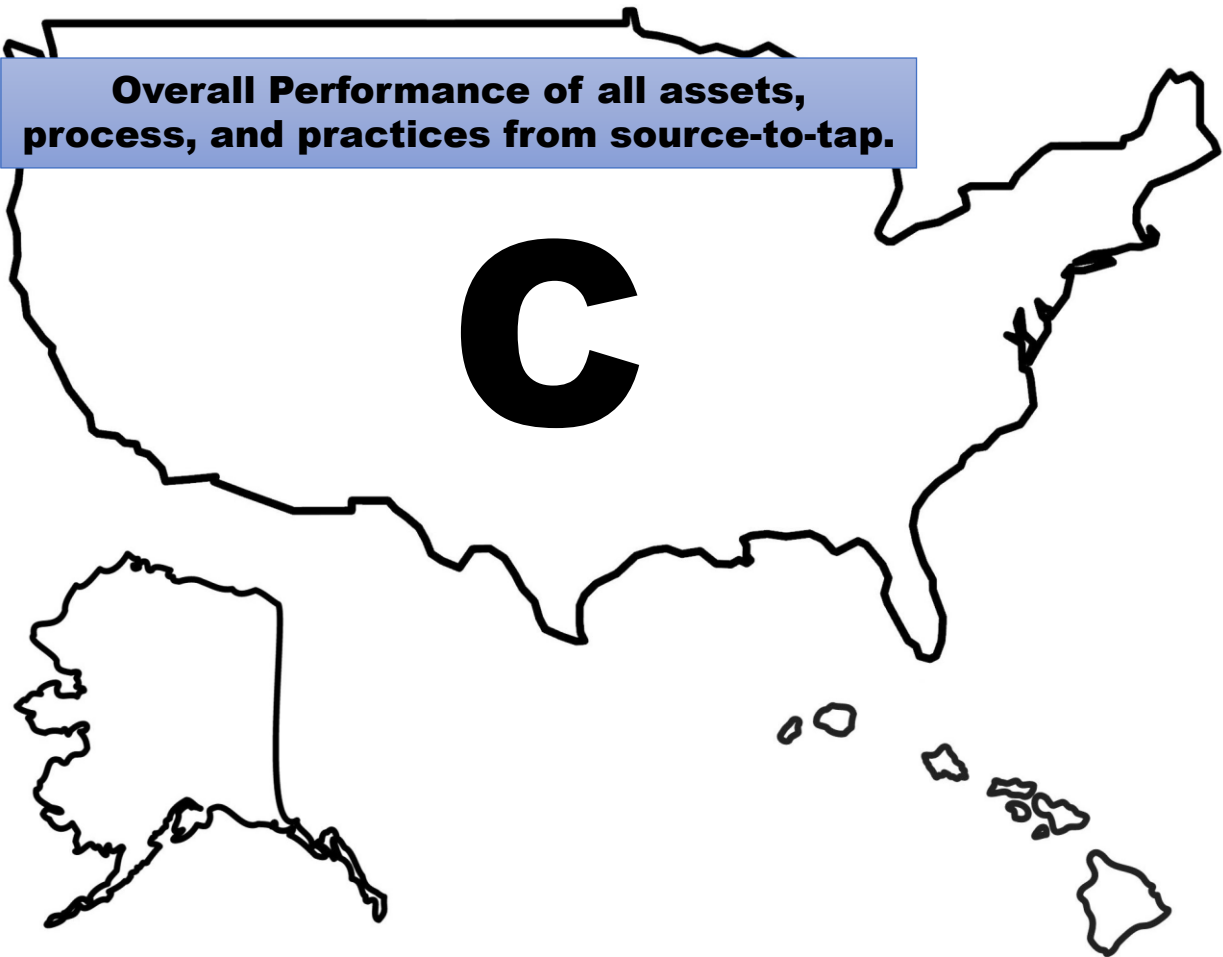


STEP 2: PILOTING APPROACH AND SCALING TO ENTIRE COUNTRY

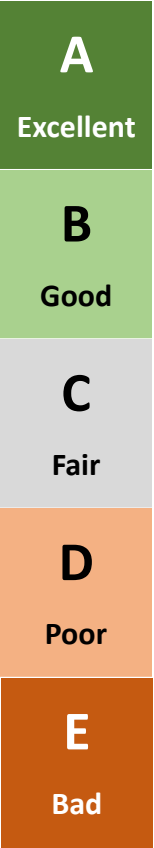


STEP 3: NATIONAL-SCALE WATER SYSTEMS PERFORMANCE RESULTS

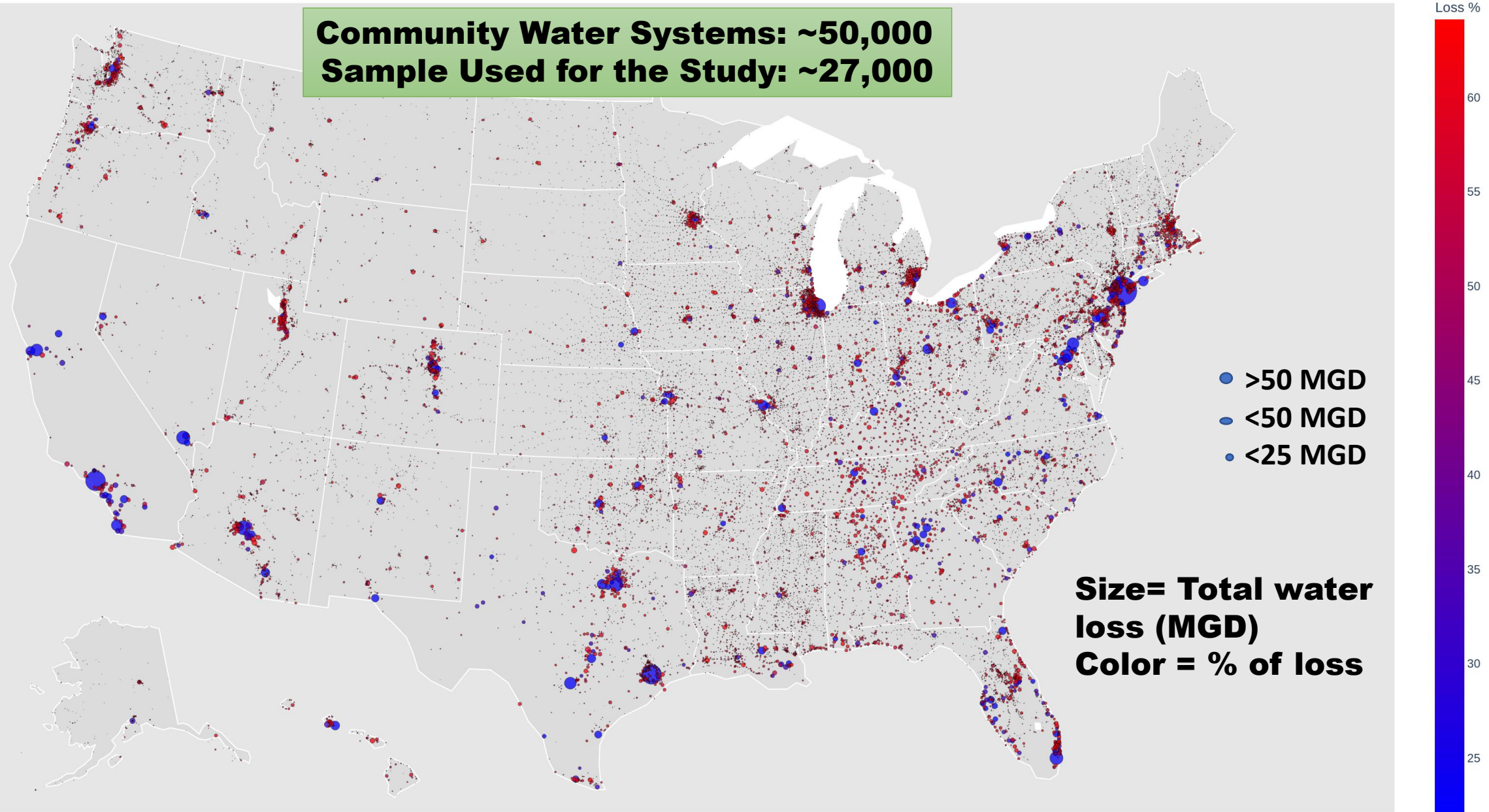
BOTTOM-UP APPROACH



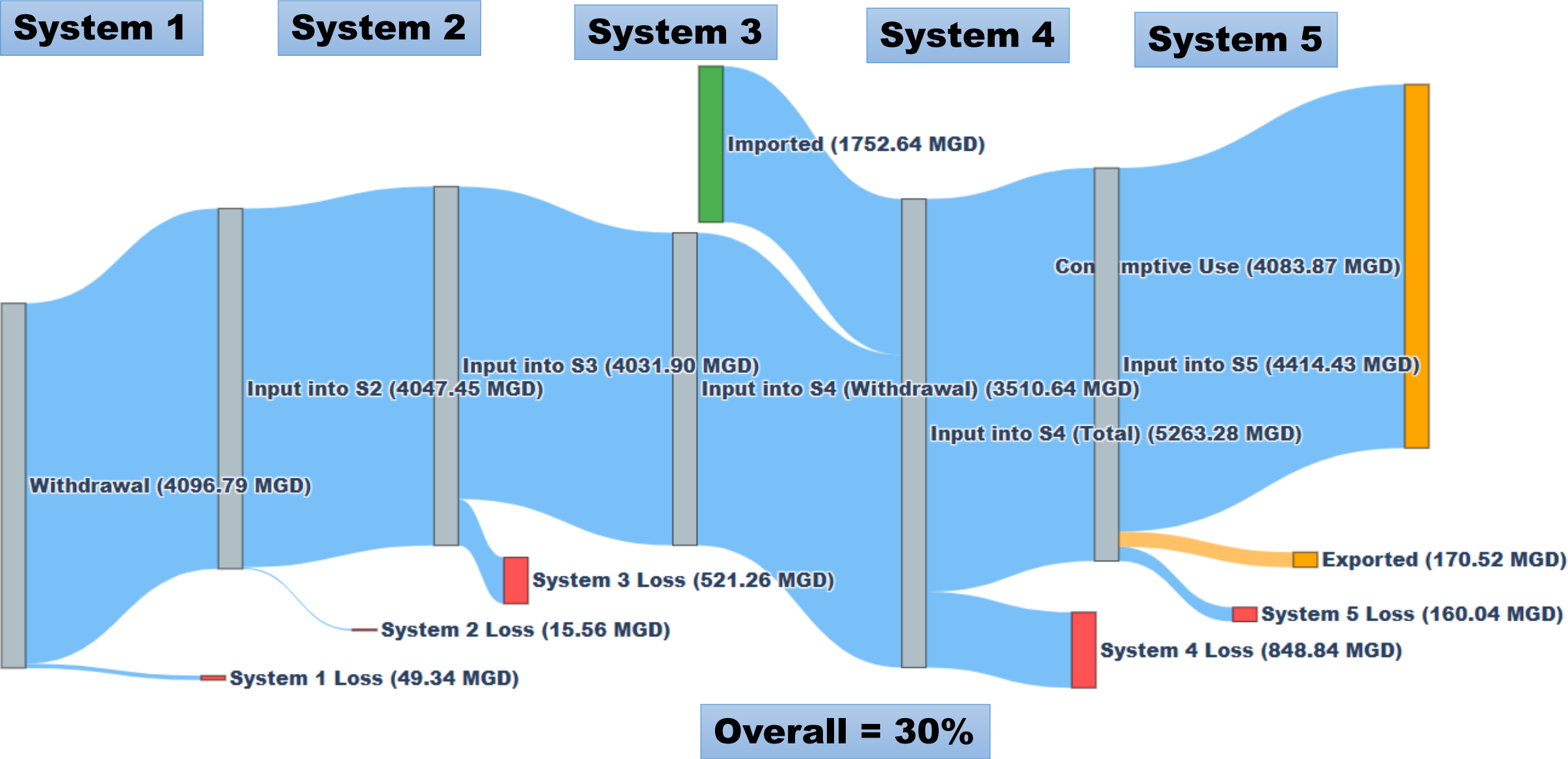
TOP-DOWN APPROACH



STEP 4: NATIONAL-SCALE WATER EFFICIENCY ESTIMATION RESULTS

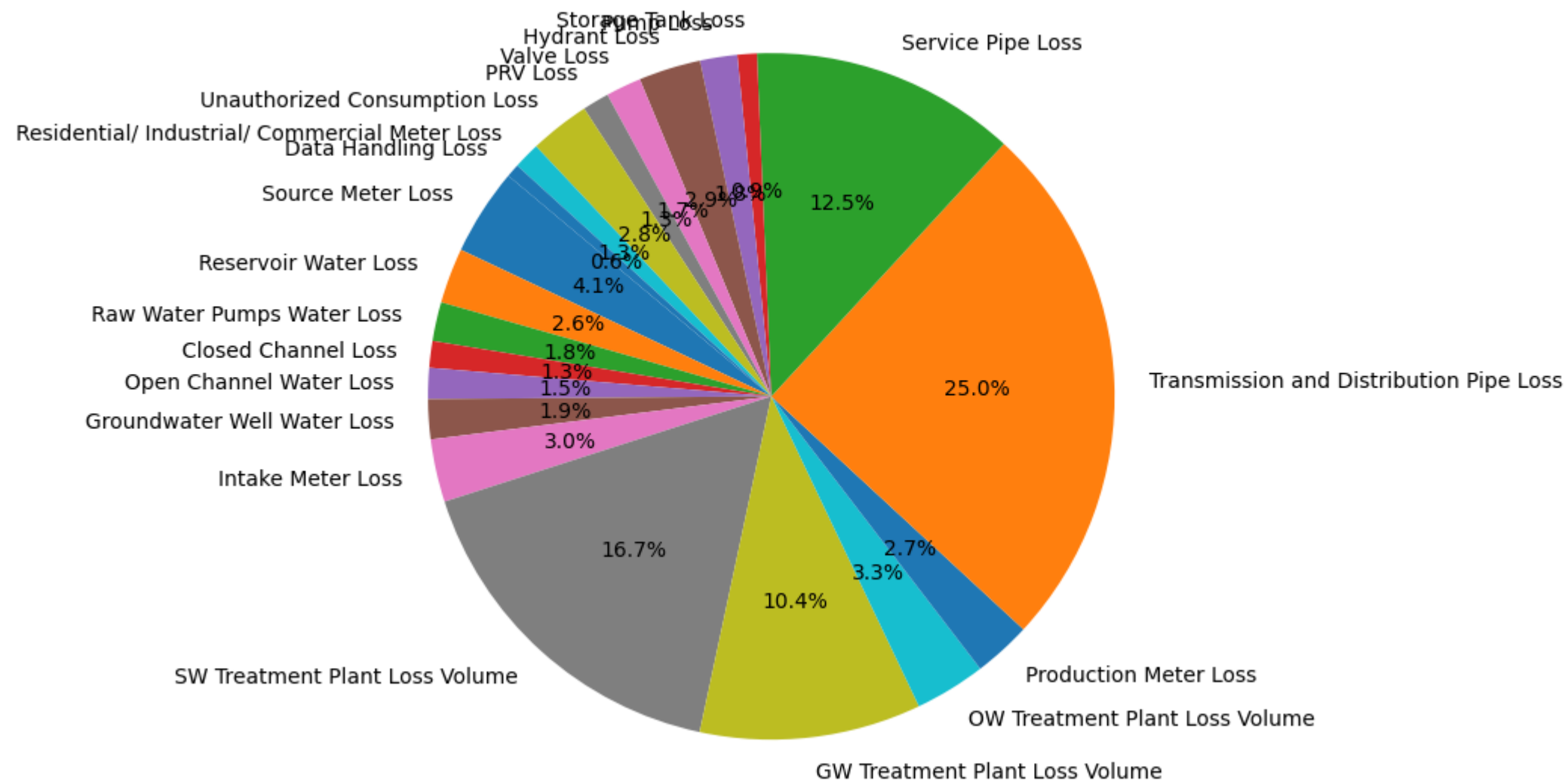


PUBLIC RETAIL SUPPLY WATER EXAMPLE



PUBLIC RETAIL SUPPLY WATER EXAMPLE

California – Share of Total Losses by Component
(based on Withdrawal + Imported – Exported)



BENEFITS FOR WATER SYSTEMS

- **Data integration - intensive patterns require combining and analyzing water data from multiple sources**
- **Long-term patterns require sustained access to resources over a long period to accomplish a well-defined objectives**
- **Better Water Use and Loss Estimate for Water Efficiency**
- **Encourage Standardized Data Collection and Compilation**
- **Predictive Analytics for Water Sustainability & Resilience**
- **Support Asset Management Practices Across the Country**
- **Free Access to National-Scale Water Models & Tools**

Please join the Smart One Water journey!

Questions and Comments

Anmol Vishwakarma, Ph.D.

Sunil K. Sinha, Ph.D. (ssinha@vt.edu)

