Looking at Water-Energy Nexus via Reservoirs : An Integrated Approach of Algorithms, Modeling and Decision Making

Tiantian Yang, Ph.D.
Assistant Professor
School of Civil Engineering and Environmental Science
University of Oklahoma

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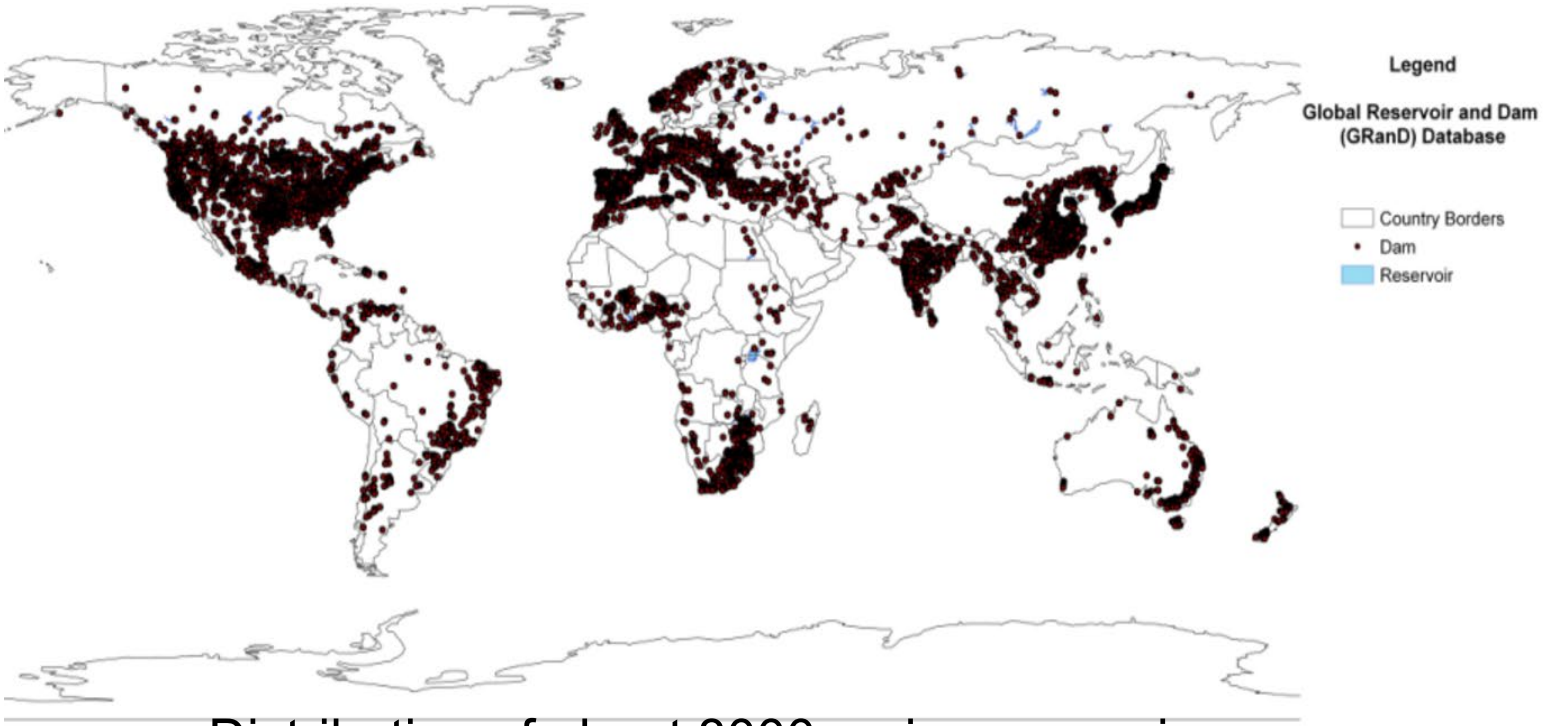
Reservoirs: Global Scale



Distribution of about 8000 major reservoirs from NASA's (GranD) Dataset

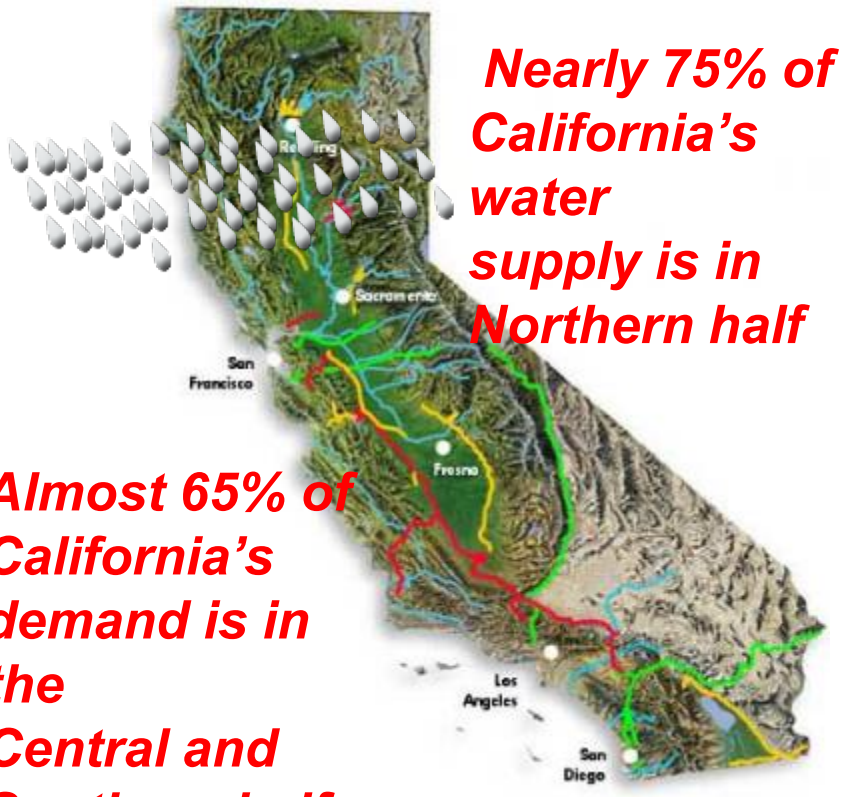
Source: http://atlas.gwsp.org/ And NASA

- *There are about **515,149 reservoirs in the globe***
- *Developing Country: **Build** more and more dams for many purposes*
- *Developed Country: More efficiently **operation and management***

Source: https://www.currentresults.com/Environment-Facts/number-reservoirs-in-world.php

Reservoirs: State / Inter-basin Level

- Reservoirs are vital infrastructures for Inter-basin, Water Transferring Project



Nearly 75% of California's water supply is in Northern half

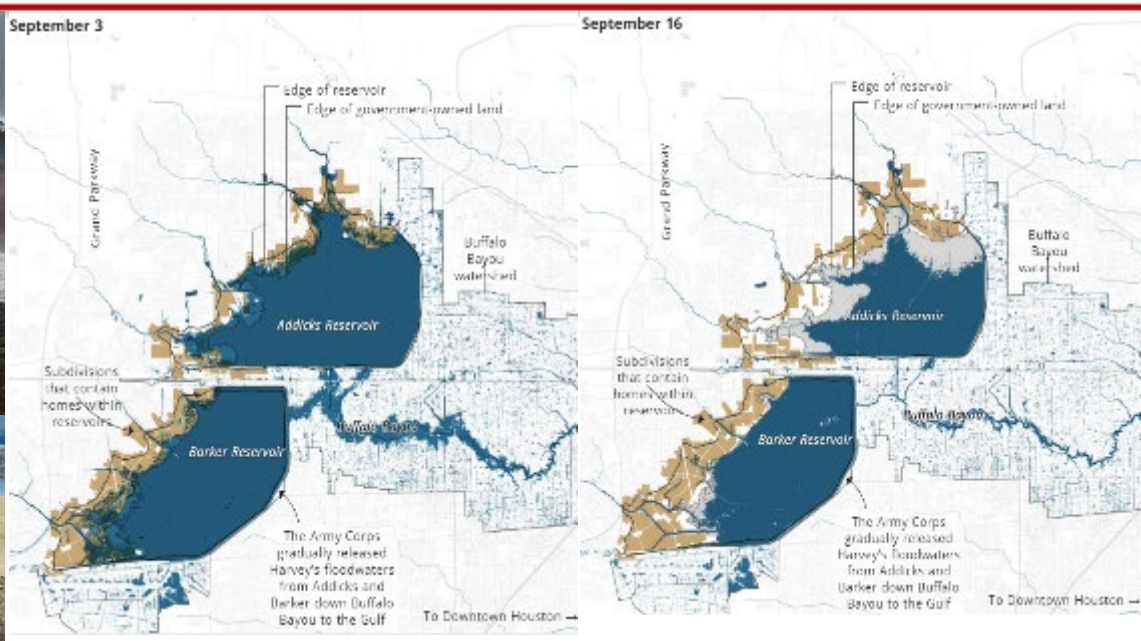
Almost 65% of California's demand is in the Central and Southern half

Nearly 35% of the entire population (> 1 billion) of China is at the mega cities (Beijing and Tianjin) at the northern part. However, 80% of water supply is from the southern and eastern coastal areas.

Reservoirs: Regional Level

Source: California DWR

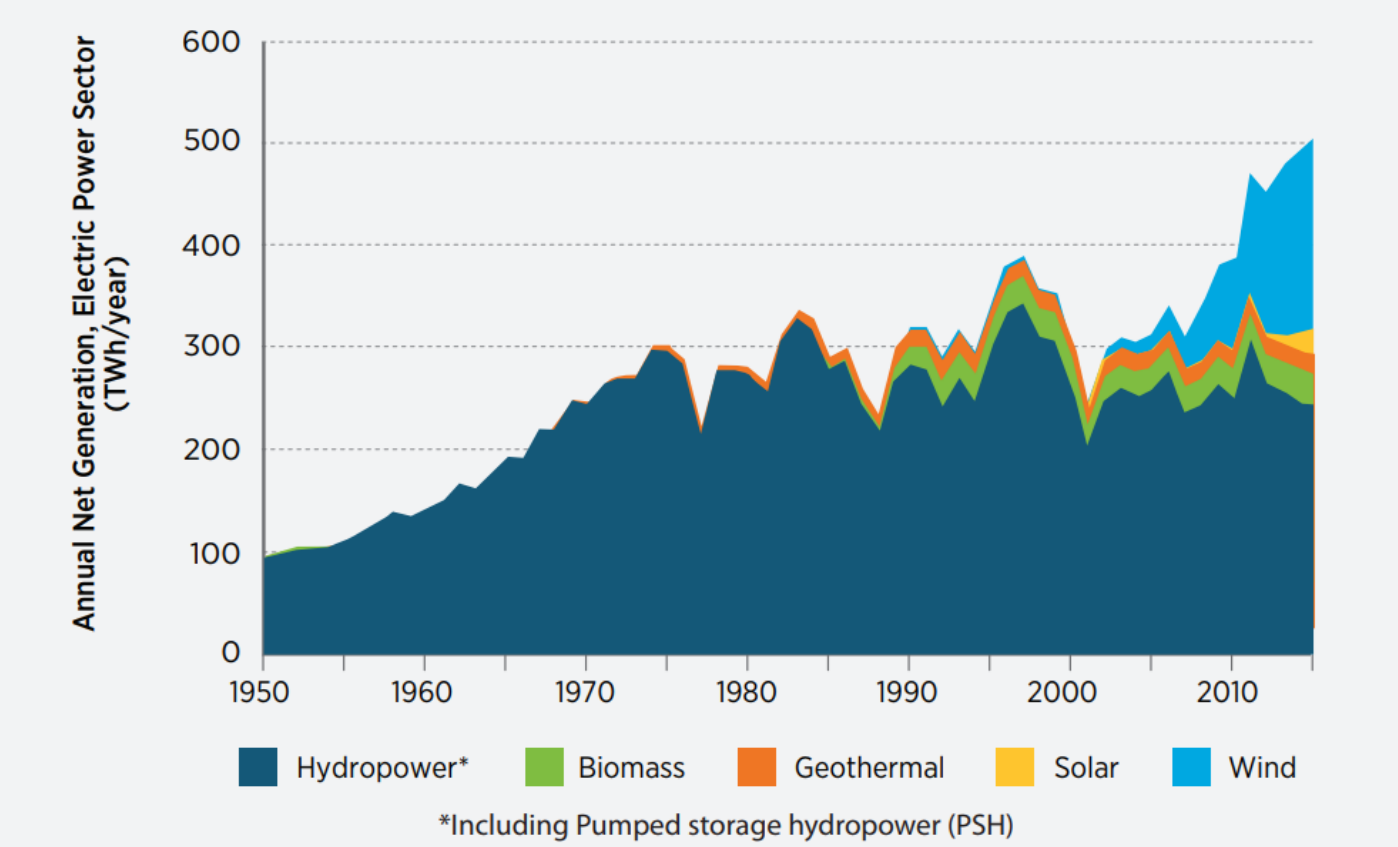
Water cascaded down the emergency spillway of Oroville Dam, triggering the evacuation of more than 180,000 people downstream of Lake Oroville on February 11, 2017.



Source: texastribune.org

During Harvey, when more floodwater accumulated behind the dams than ever before, about 8000 of those homes flooded.
Before Harvey, the neighborhoods inside the reservoirs had been some of the most desirable places to live in Houston.

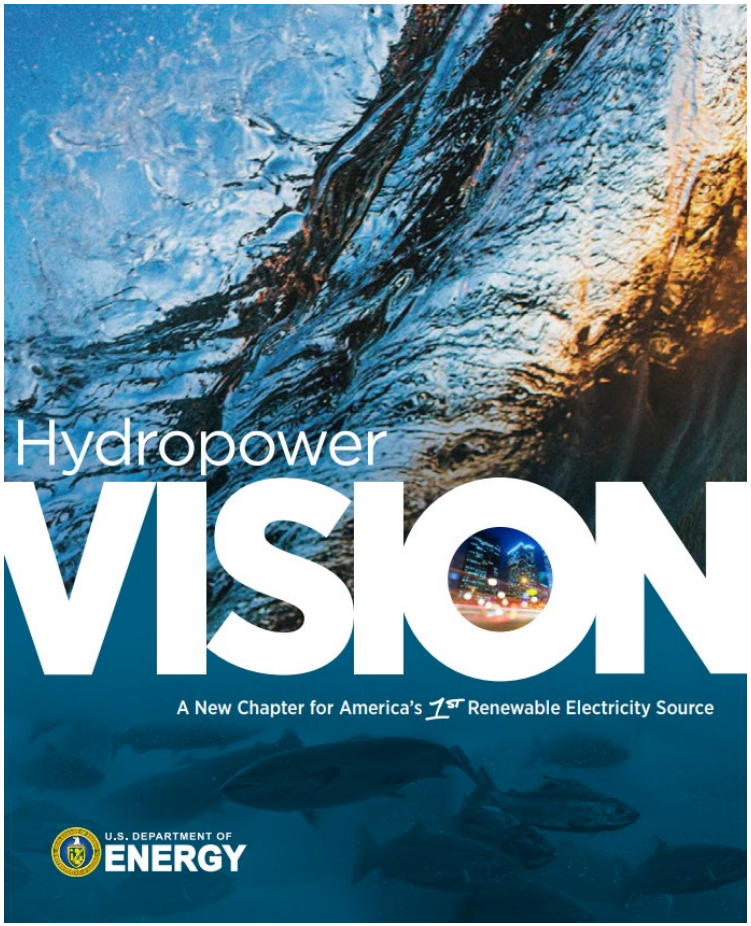
Hydropower: Fact from Data



Annual U.S. renewable electricity net generation (terawatt-hours per year), electric power sector, 1950–2015 (Source: DOE Energy Information Administration 2016)

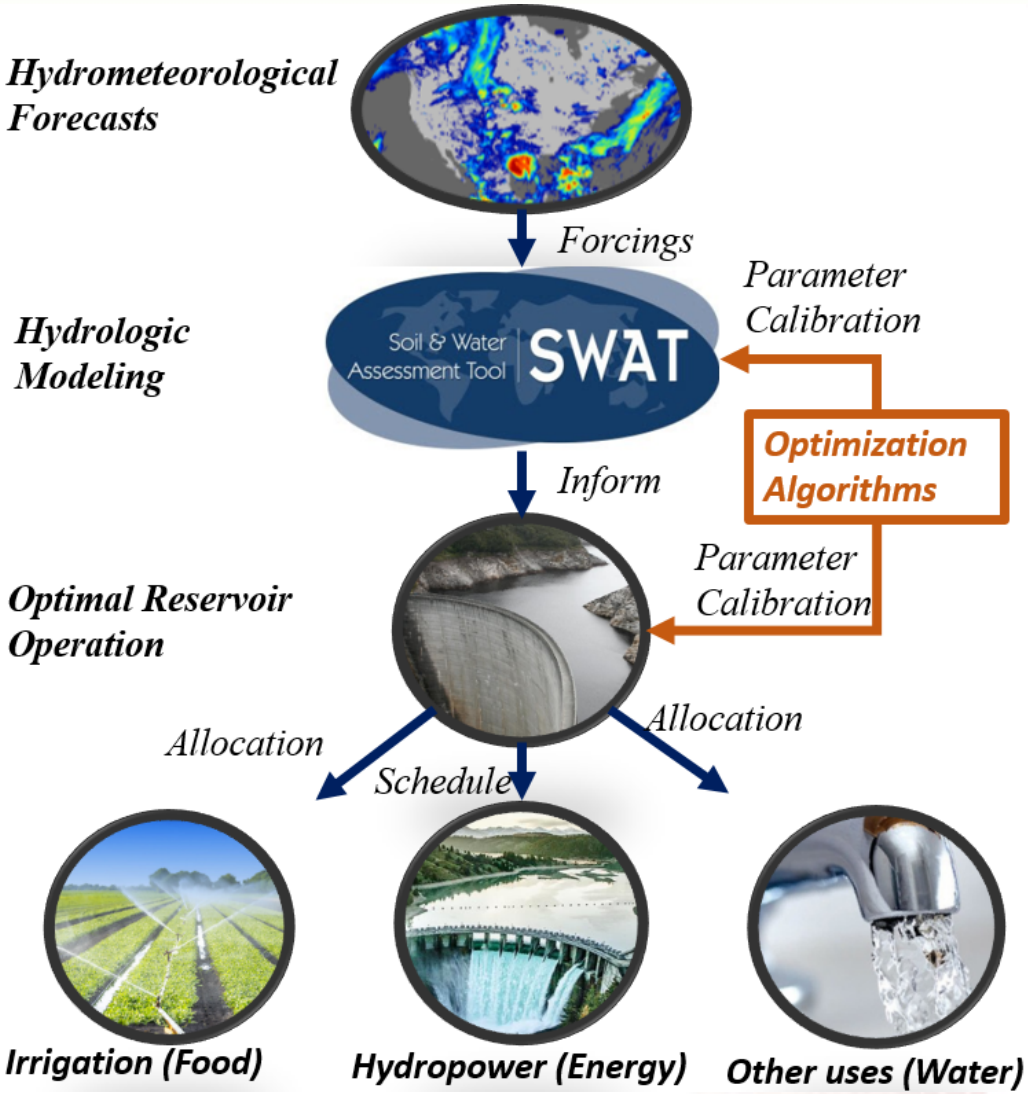
Vision From DOE: Hydropower

The *Hydropower Vision* report is grounded on three equally important foundational pillars arrived at through extensive stakeholder input.

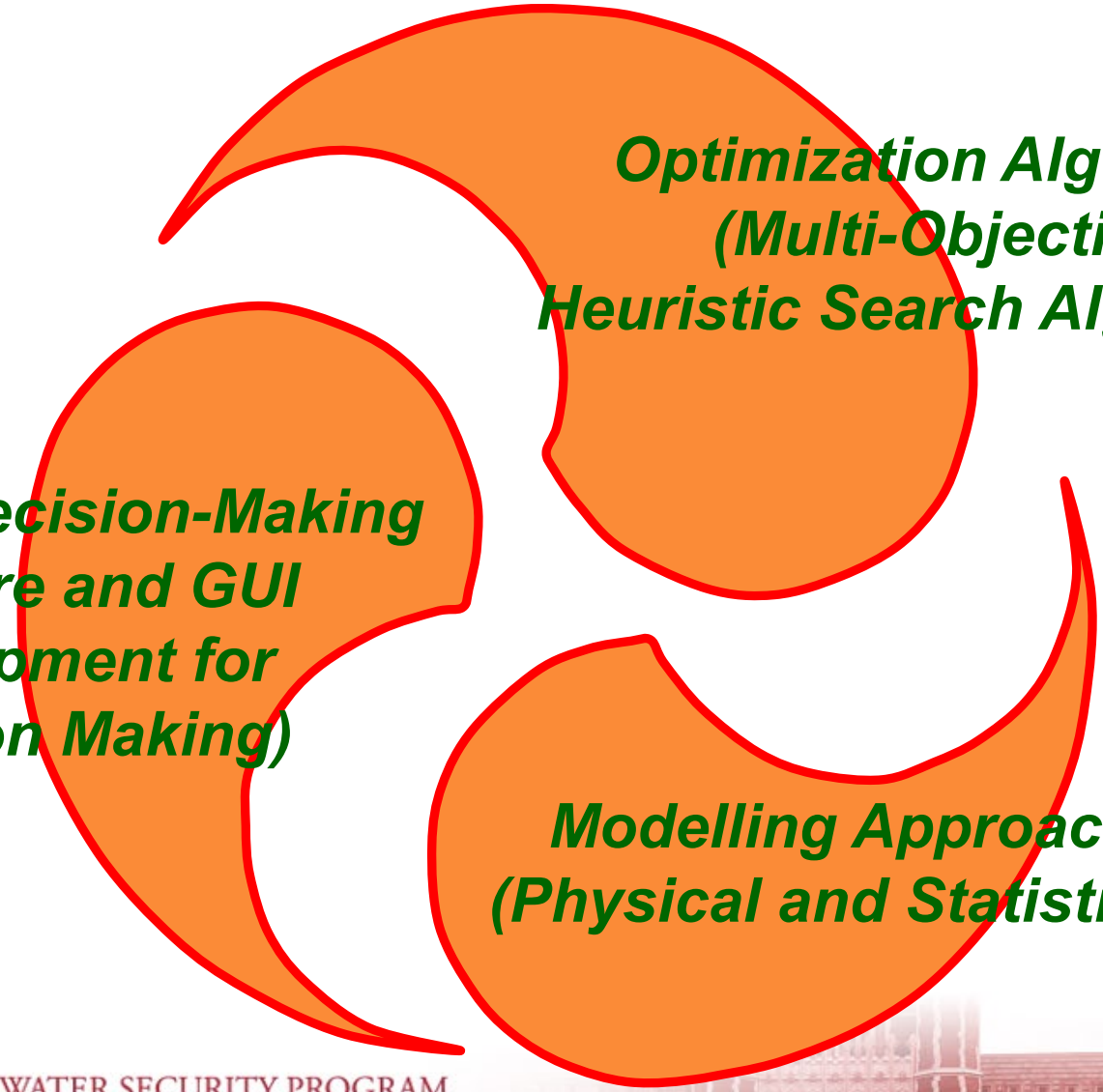


Credit: DOE - Water and Wind Power Office Manager, Hoyt Battey
U.S. Dept. of Energy Science Review Meeting, Washington DC. 2017
Hydropower Vision Report (https://www.energy.gov/eere/water/downloads/hydropower-vision-report-full-report)

Reservoirs: A direct linkage to Water Energy and food



Integrate Approach: to advance Algorithms, Modelling Capabilities, and make them useful for Decision-Making and Users.



Multi-Functional Reservoir Requires Multi-Objective Optimization

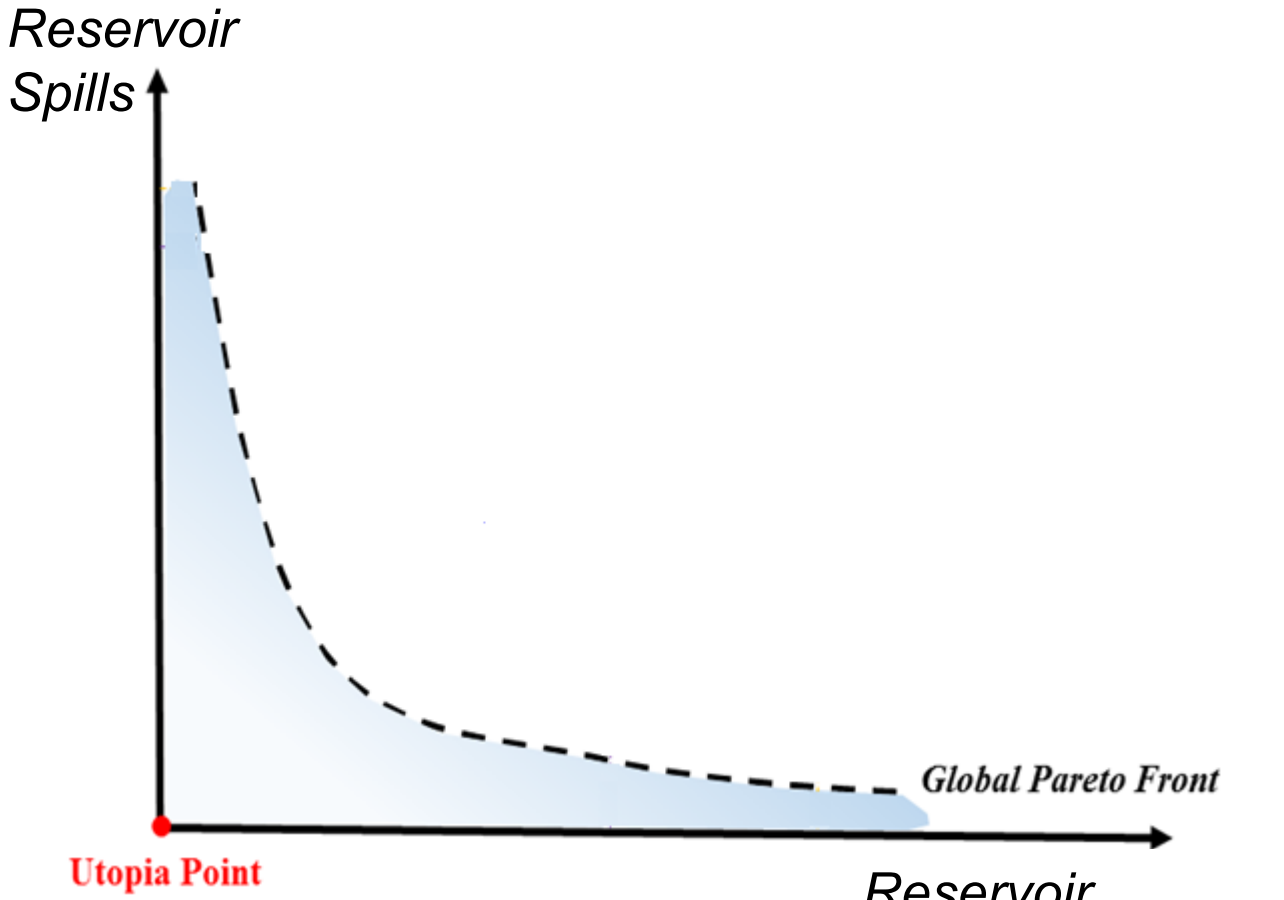


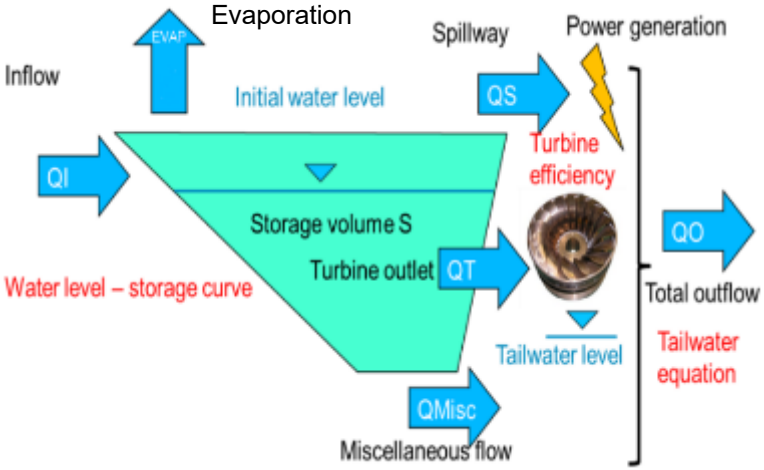
Figure. Concept of Trade-offs

Hydropower Turbine Releases

Spillways- Once water is spilled, it cannot be recovered for hydropower

Physical and Statistical Modeling

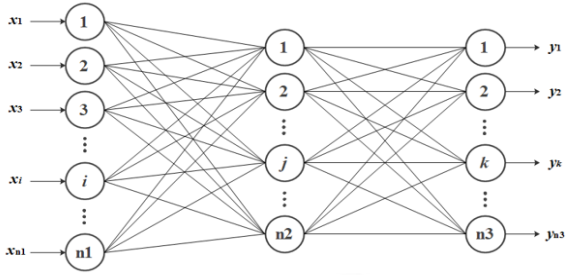
Modeling Approach

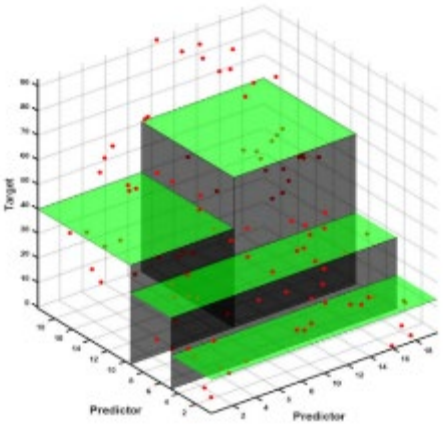


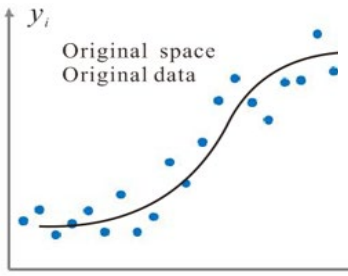
Physical-Based Modeling

v.s.

Artificial Intelligence & Data Mining







Federal Columbia River Power System

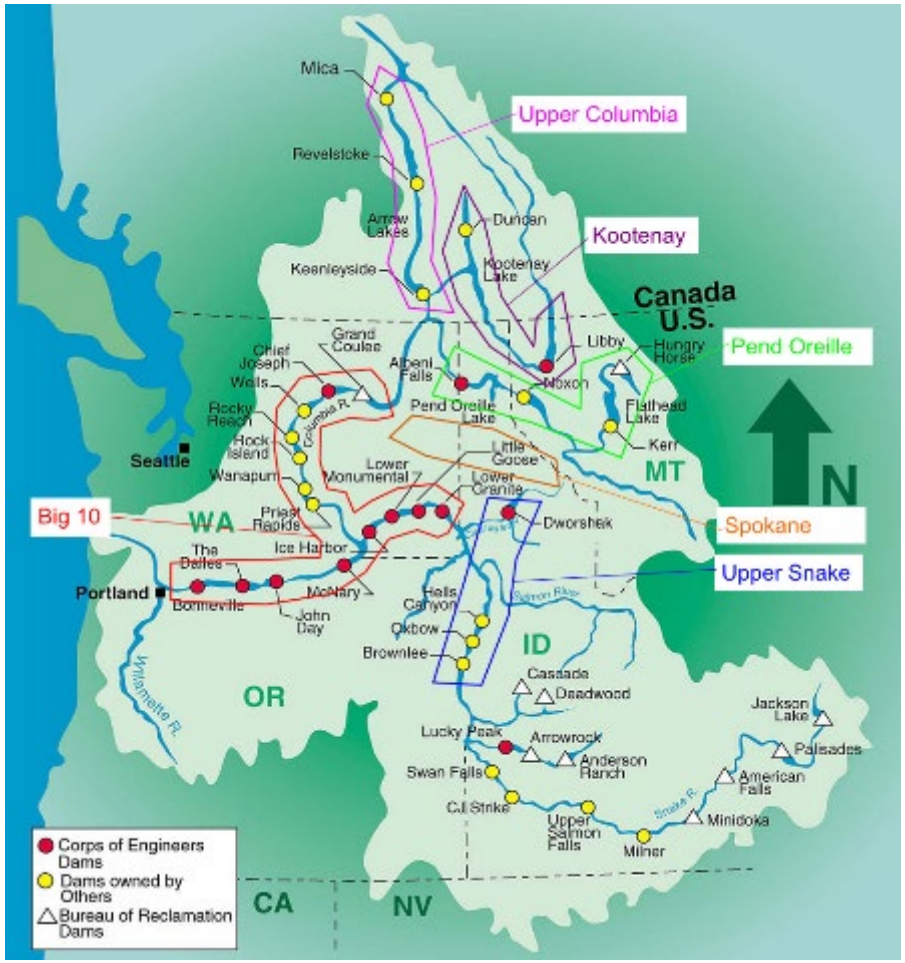
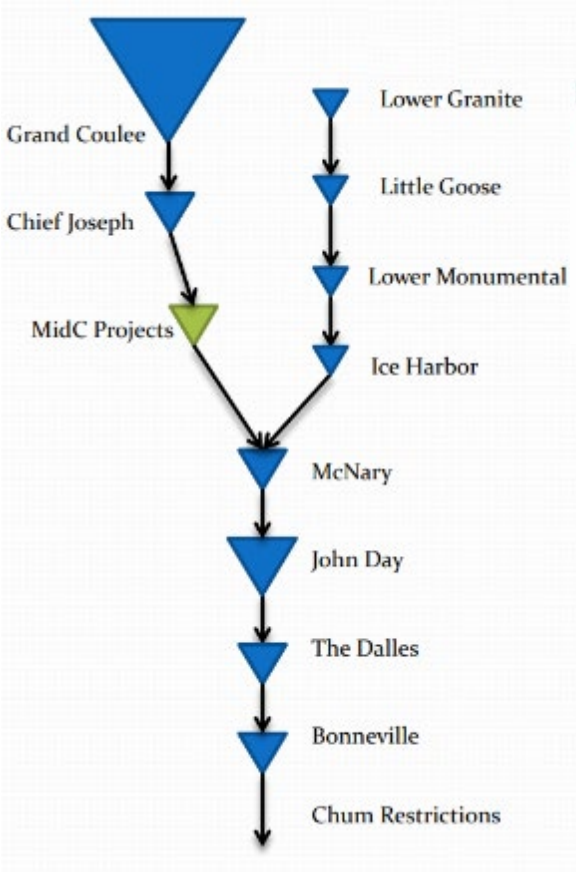


Figure. Modeling area and the models for the sub-basins (background map taken from Bonneville Power Administration, 2013, SOW)



BONNEVILLE POWER ADMINISTRATION

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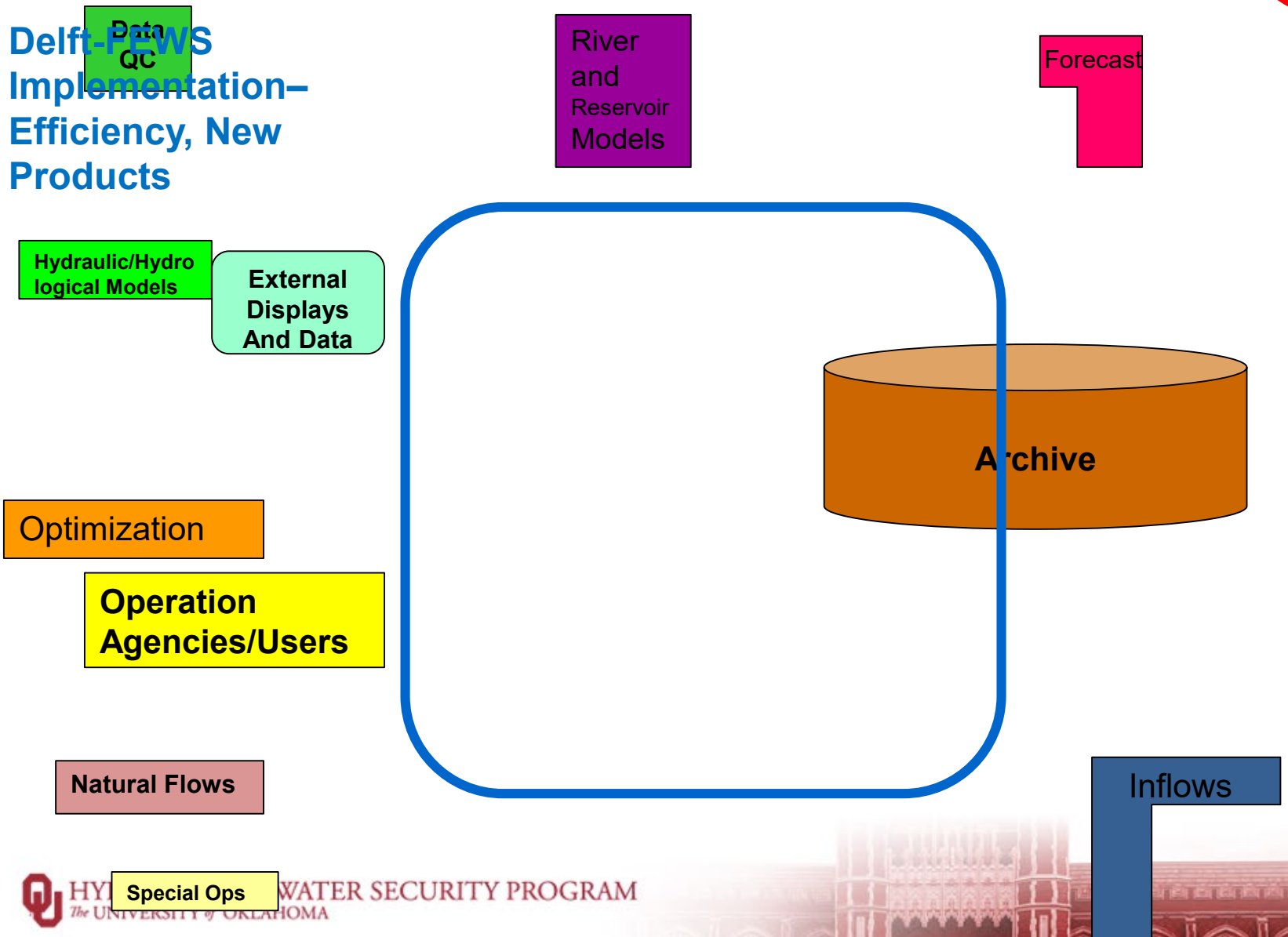
- BPA's Role
  - Markets the power produced from the federal dams within the constraints and requirements for other river purposes

System Integration for Decision Making

Decision-Making

Delft-FEWS Implementation– Efficiency, New Products



Summary

- *All kinds of **optimization algorithms, tools, and models** have been developed in the field of hydrology and water resources.*

- *It is particularly important to ensure that newly-invented technologies and advances can be **transferred as quickly as possible to relevant external stakeholders, and operation agencies.***

- *It is needed to **build a foundation of knowledge, technologies, human capabilities, and relationships that position the universities and research institutes** to continue to thrive in a future with constrained energy and water resources in a changing global climate.*