Lessons from Statewide Hydro-economic Modeling:
Adventures with CALVIN

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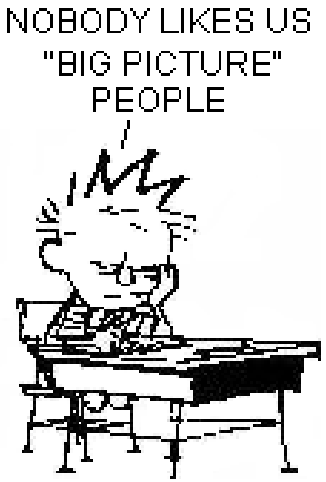

http://cee.engr.ucdavis.edu/faculty/lund/CALVIN/

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More Thanks

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$till More Thank$

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Henry Vaux's connections

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CEC – Guido Franco

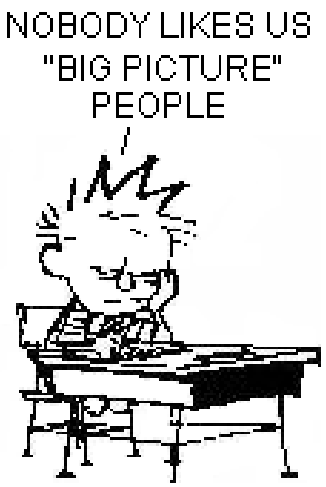
USBR

CALEPA – Ricardo Martinez

PPIC

TNC

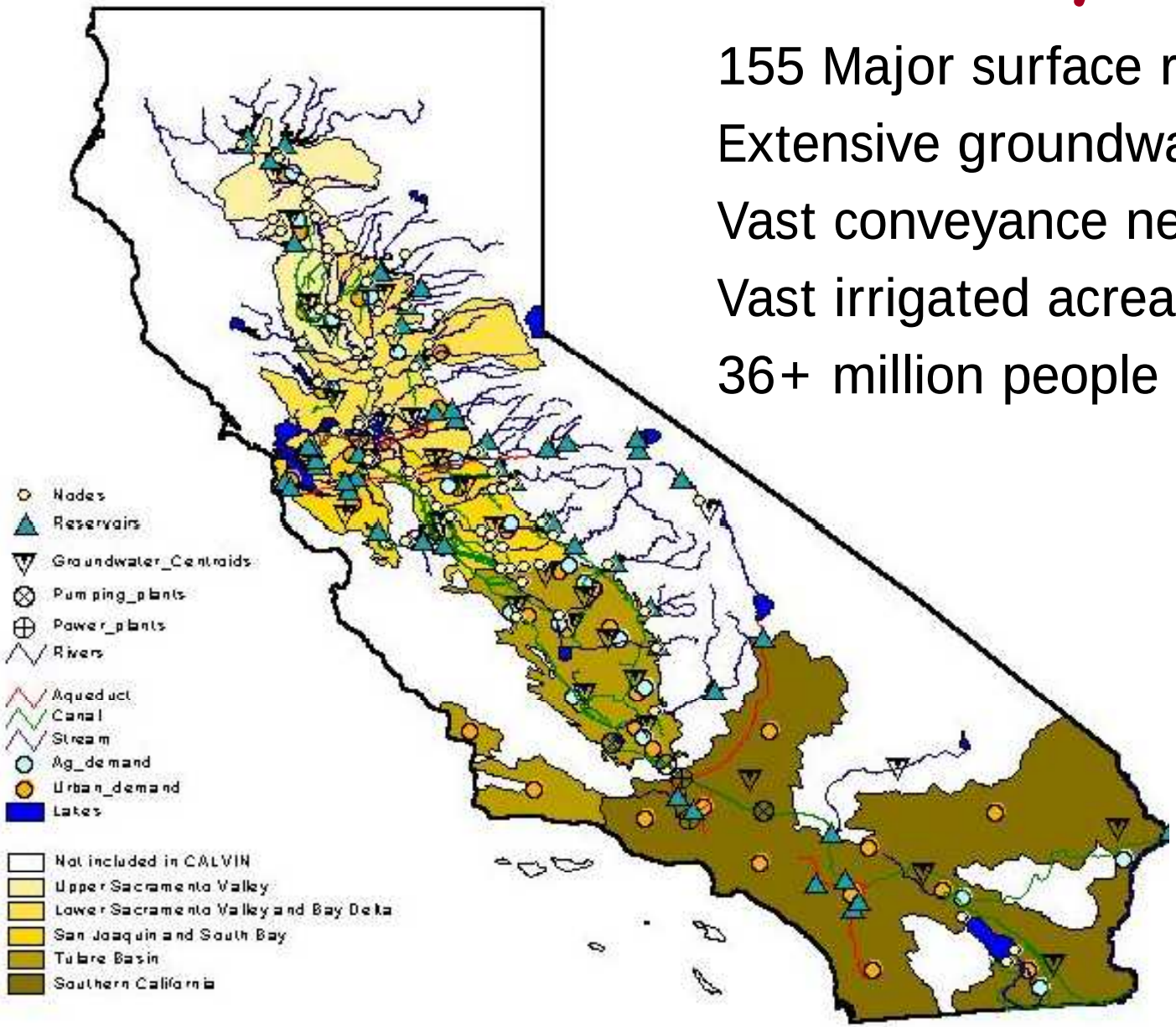
What is CALVIN?



- Entire inter-tied California water system
- Surface <u>and</u> groundwater systems
- Supply <u>and</u> demand management options
- Economics-driven engineering <u>optimization</u> model
  - Economic Values for Agricultural, Urban, & Hydropower Uses
  - Constraints for Environmental Uses and Flows
- Prescribes monthly system operation over a 72-year representative hydrology

Forces quantitative understanding of integrated water and economic system

California's Water System



155 Major surface reservoirs

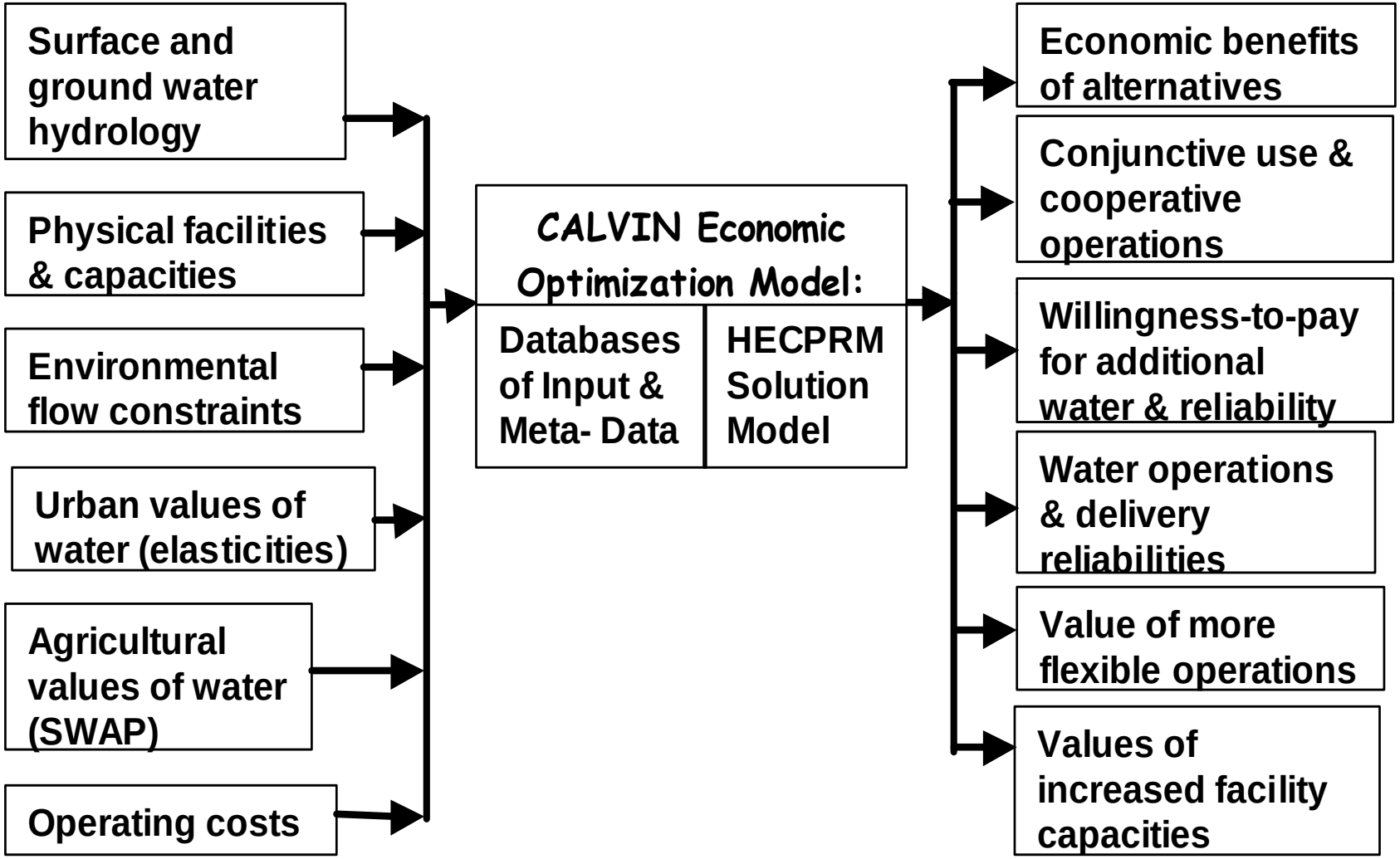
Extensive groundwater

Vast conveyance network

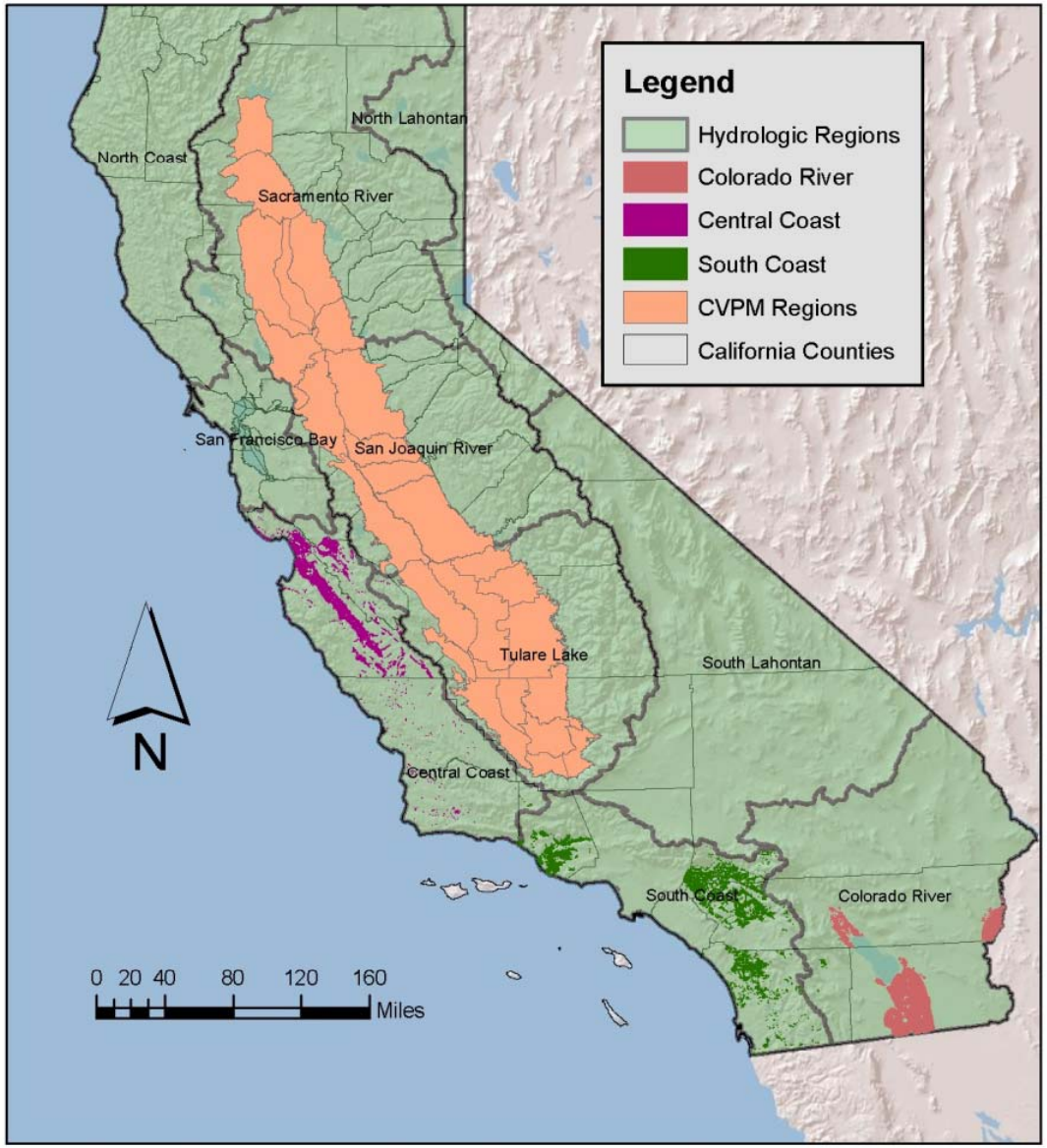
Vast irrigated acreage

36+ million people

Data Flow for the CALVIN Model



Agricultural Water Values (SWAP)



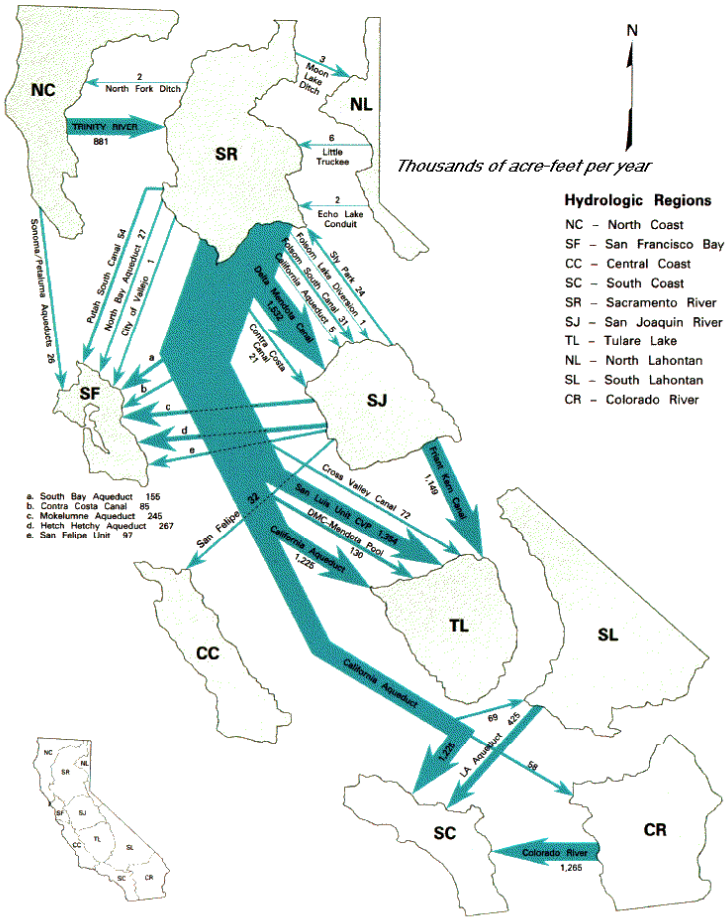
Local & Statewide Activities

Local Activities:

- Groundwater use and recharge
- Surface reservoir operations
- Local water markets and exchanges
- Water use efficiency improvements
- Wastewater reuse
- Desalination

Statewide Activities:

- Inter-regional water conveyance
- Surface reservoir operations
- Water conservation incentives
- Groundwater banking and recharge
- Water market support and conveyance
- Wastewater reuse subsidies



Integrating mix of responses is important – portfolio planning.

Purposes of CALVIN

Economic-engineering optimization of regional and California-wide water supply

User targets:

- Research
- Student education
- Educate California water modeling community:
  - Databases and documentation
  - Large-scale optimization
  - Integrated water management & portfolio planning
  - Integrating economics and engineering
  - Trouble-making?

Some CALVIN Study Results

Application	References
Integrated water management, water markets, capacity expansion	Draper et al. (2003); Jenkins et al.(2001; 2004)
Conjunctive use and Southern California	Pulido et al.(2004); Newlin et al. (2002)
Perfect and Limited Foresight	Draper 2001
Hetch Hetchy restoration	Null (2004); Null and Lund (2006)
Climate Change, wet and dry	Lund et al. (2003); Tanaka et al.(2006; 2008); Medellin et al.(2008a; 2009); Connell (2009)
Severe sustained drought impacts and adaptation (paleodrought)	Harou et al. (In Press)
Colorado River delta and Baja California water management	Medellin-Azuara et al.(2006; 2007; 2008b; 2009)
Ending overdraft in the Tulare Basin	Harou and Lund (2008)
Cosumnes River restoration and Sacramento area water planning	Hersh-Burdick (2008)
Reducing Delta exports and increasing Delta outflows	Tanaka and Lund (2003); Tanaka et al.(2006; 2008); Lund et al.(2007; 2008; in press)

Does CALVIN work?

- Intertie between Contra Costa and East Bay (CCWD-EBMUD)
- Water markets and transfers
  - Imperial Irrigation District and the South Coast
  - State Water Project and Castaic-Antelope
  - Sacramento Valley
- Conjunctive use is active
- Small value of expanded storage

Limitations

- Chapter 5 of 2001 report, on web
- Data problems
- Limits of network flow formulation
- Too smart: perfect hydrologic foresight
- Lack of companion simulation model
- Never finished (interface, data, software, …)

Model Development Lessons

- Build around a few desired features – Attempting everything leads to nothing
- Have an integrated & workable technical plan
- Organize input data in databases
- Document in databases
- Better data quality & documentation is needed
- Scientific information is often inconvenient for current policy discussions

Water Management Lessons

- Hydro-economic modeling is possible, and improves understanding and policy insights.
- Physical and economic flexibility exists
- Not water shortage, but a shortage of cheap water
- The Sacramento - San Joaquin Delta is the weakest link in the network

Water Management Lessons

- Portfolio solutions tend to be cost effective and robust
- Water markets, conservation, groundwater banking, & reuse
- Expansions of selected conveyance and aquifer recharges are beneficial
- Higher expectations for quantitative information are reasonable
- More adventures to come!