Water Budget – Utility, Reliability, and Uncertainty

California Water and Environmental Modeling Forum

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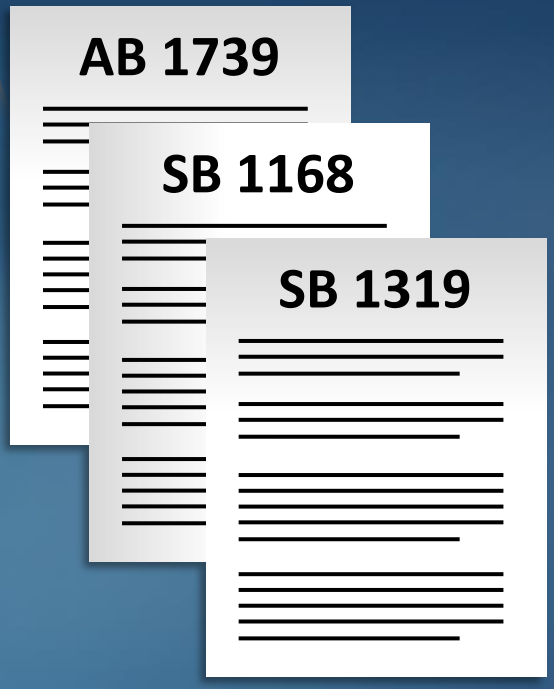
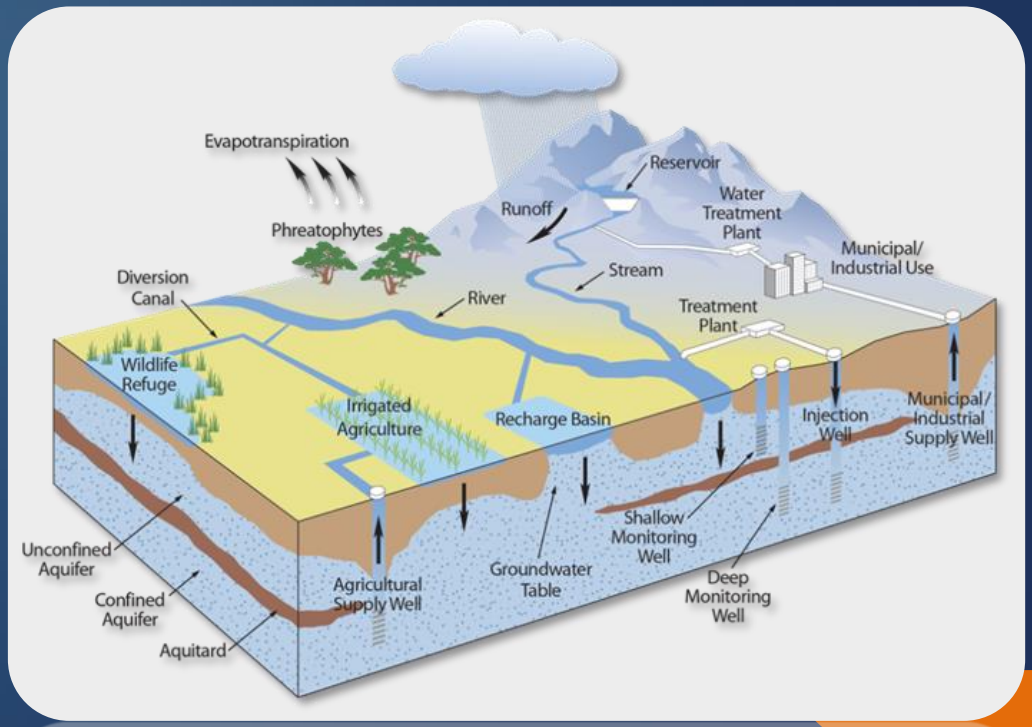
CA Department of Water Resources

What is water budget?



" ***Water budget*** means an accounting of the **total groundwater and surface water entering** and leaving a basin including the changes in the amount of water stored."



Utility of Water Budget

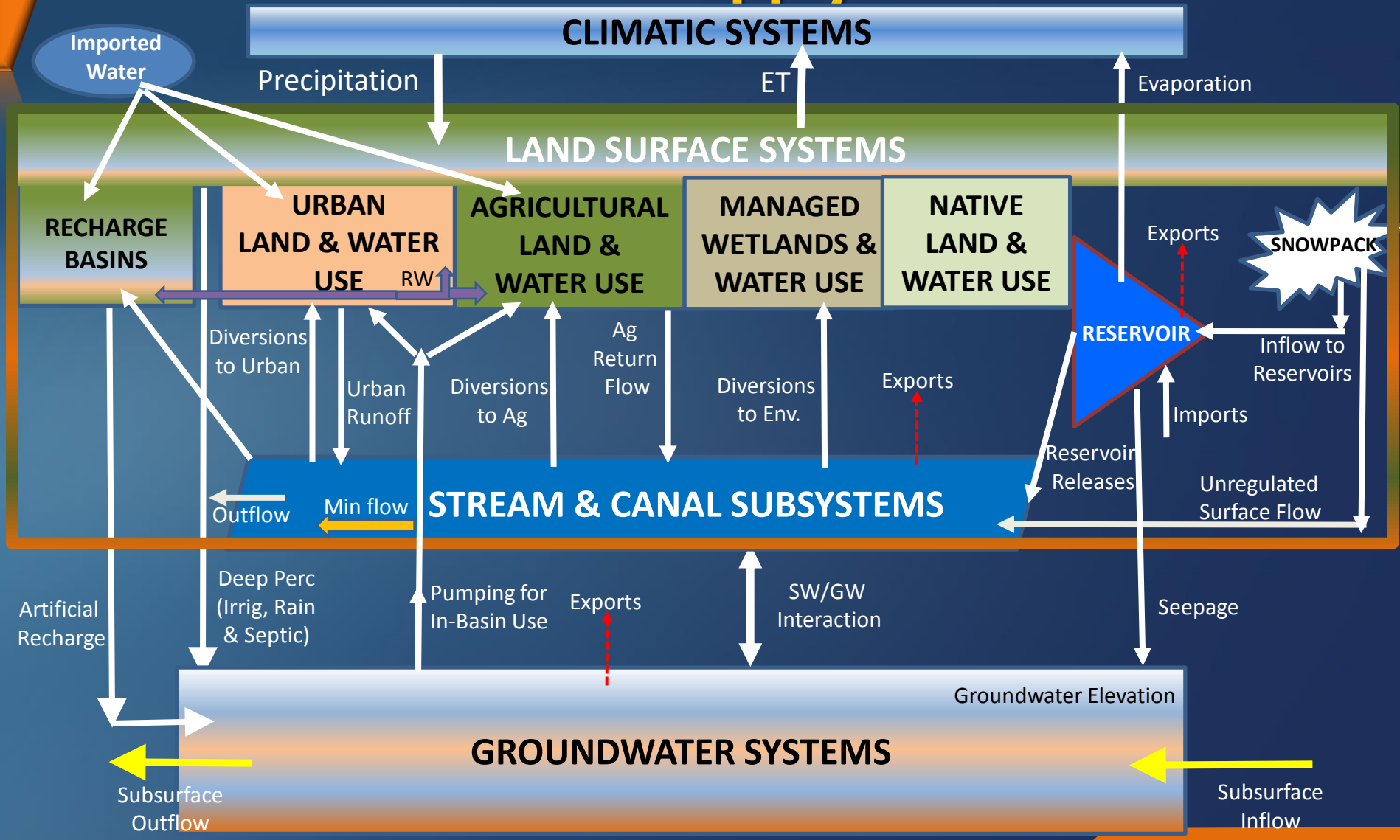
- Allows tracking of all water supply sources and water demands sinks in a geographic area to reduce undesirable results, drought vulnerability, and risks to people, economy, and environment.
- Gives a complete picture about water inflows and outflows in a watershed and groundwater basin.
- Can advance sustainability of California's watersheds and groundwater basins through development, understanding, and implementation of sustainable total water budgets.
- Required by sustainable groundwater management act (SGMA).

Utility of Water Budget

- An understanding of water budgets and underlying hydrologic processes provides a foundation for effective water resource and environmental planning and management.
- Provides a basis for assessing how a natural or human induced change in one part of the hydrologic cycle may affect other aspects of the cycle.
- Can be used for watershed management and planning, such as, assess effects of land-use changes.
- Aid in assessing how changes to one water budget component affect other components.
- Water budgets of soil zones help management of agricultural lands.

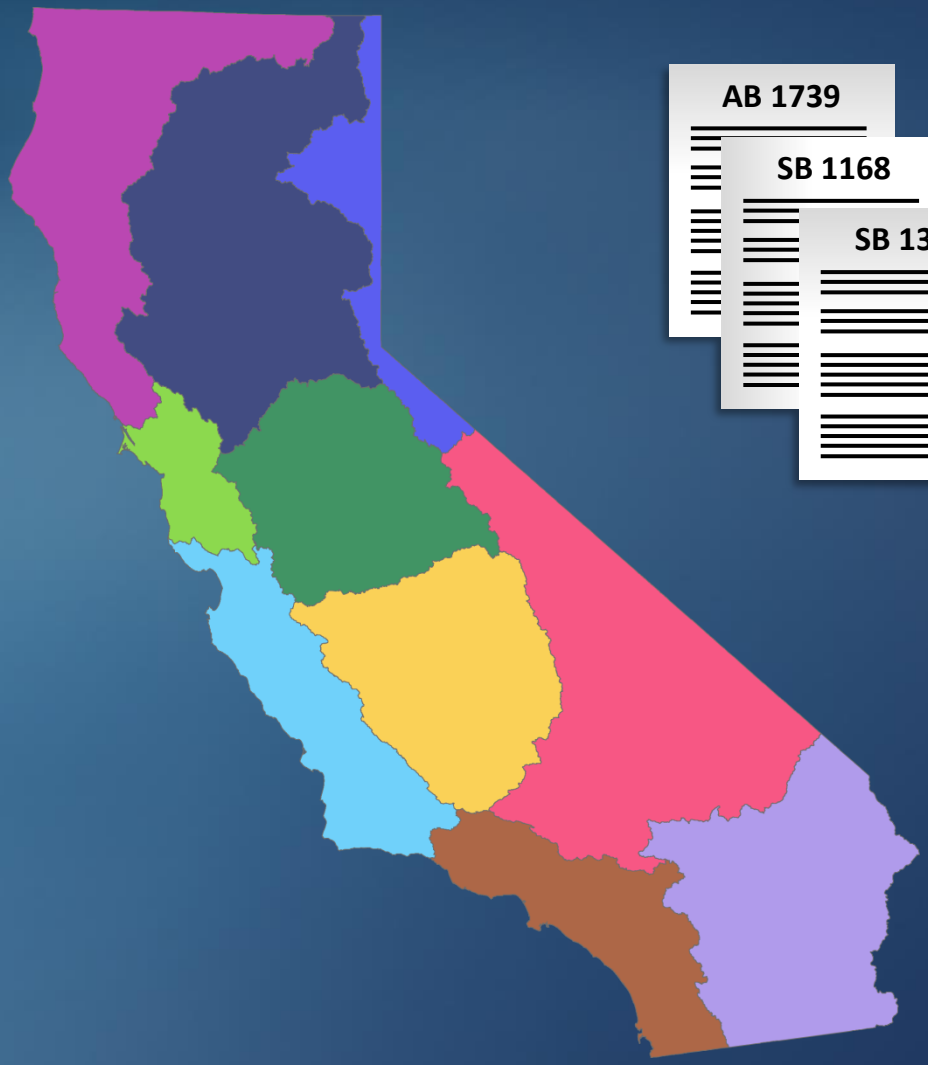
Utility of Water Budget

Track sources of supply and demand



Utility of Water Budget

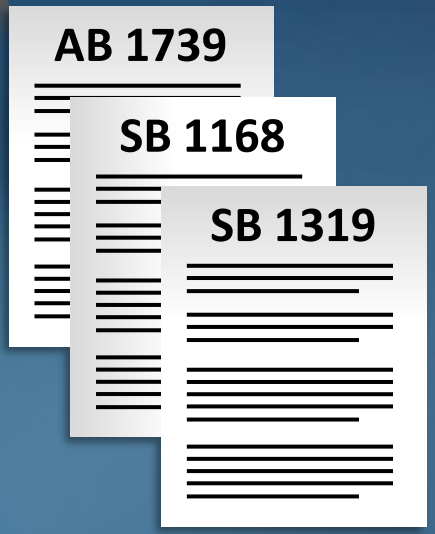
Watershed based water budget for SGMA implementation by DWR will allow roll-up of local water budget efforts



"The department shall periodically review the groundwater sustainability plans… **to evaluate** whether a plan conforms with Sections 10727.2 and 10727.4 [*components of GSP*] and is likely to achieve the sustainability goal"

Utility of Water Budget

SGMA mandates consistency



"Groundwater sustainability agencies intending to develop and implement multiple groundwater sustainability plans pursuant to paragraph (3) of subdivision (b) of Section 10727 shall coordinate with other agencies preparing a groundwater sustainability plan within the basin to ensure that the plans utilize the same data and methodologies for the following assumptions in developing the plan"

- Groundwater elevation data
- Groundwater extraction data
- Surface water supply
- Total water use

- Change in groundwater storage
- **Water budget**
- Sustainable yield

Water Budget
Reliability and Uncertainty

- Water budgets can vary greatly in complexity and so can the analytical tools/models that are developed to simulate them.
- A simple model may provide a rough estimate of water budget but is unlikely to provide insight into the processes that drive water movement within an area.
- A more complex model may provide that insight but at substantially greater expense in data, tools, and capacity building.
- Uncertainty arises from the natural variability in hydrology, geology, climate, and land use and inaccuracies in data and tools.
- That uncertainty is compounded by misalignment between boundaries of an water budget area with hydrologic boundaries, as is often the case with jurisdictional boundaries of local governments and agencies.

Water Budget
Reliability and Uncertainty

- Uncertainty comes from both natural variability of the hydrologic cycle and errors associated with data and tools.
- Uncertainty comes from temporal variability in storage and fluxes largely tied to diurnal, seasonal, and long-term trends in weather/climate.
- Land use is the most critical factor affecting water exchange among the atmosphere, land surface and the subsurface/groundwater system. Replacement of native vegetation with agricultural crops and urban lands leads to changes in patterns of infiltration, evapotranspiration, and groundwater recharge, and consequently, in water budget.

Water Budget
Reliability and Uncertainty

- Data
- Tools
- Capacity

Water Budget
Reliability and Uncertainty

- **Data:** Are sufficient and reliable data available to calculate or estimate a water budget?

Water Budget
Reliability and Uncertainty

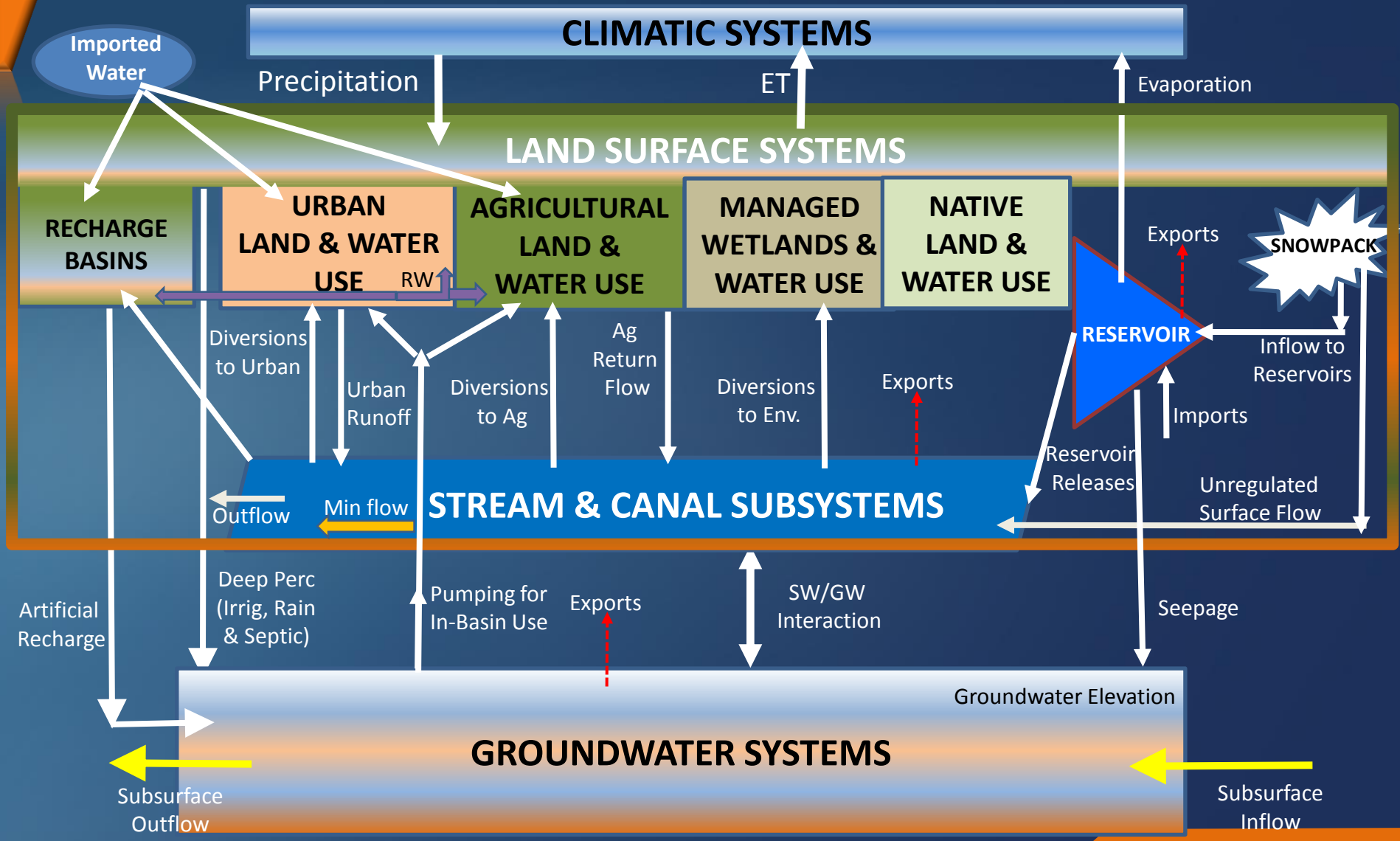
- **Tools:** Are robust, defensible, credible analytical tools available to calculate a water budget?

Water Budget
Reliability and Uncertainty

- **Capacity:** Do GSAs have the organizational capacity and the required level of expertise to conduct necessary water budget calculations/modeling?

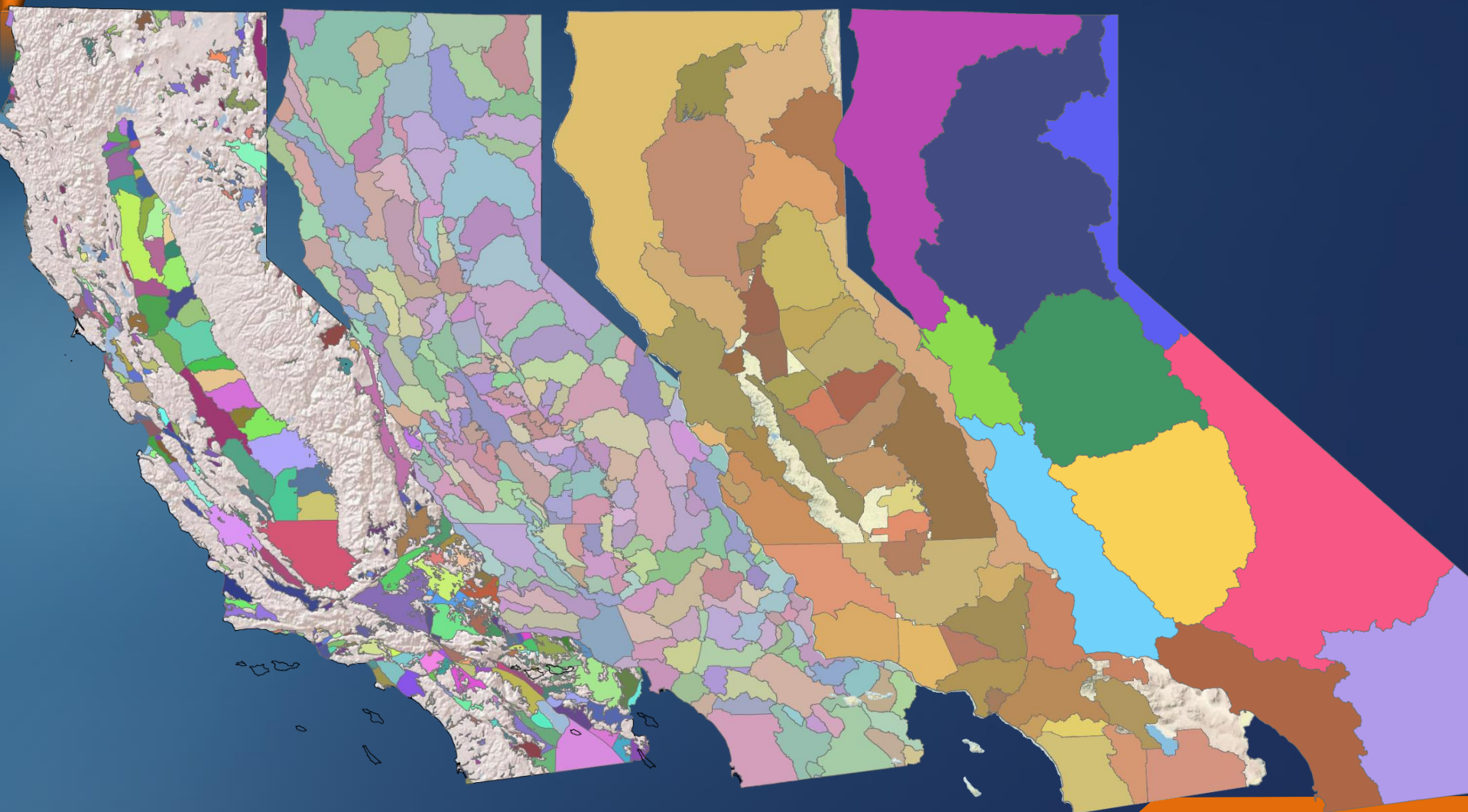
Reliability/Uncertainty = f (Data Complexity)

Every "In" and "Out" arrow/every storage element is a data carrier



Reliability/Uncertainty = f (Spatial Complexity)

Varieties of geographic scales to consider



Reliability/Uncertainty = f (Temporal Complexity)

What time periods and time steps to consider?

- Annual, monthly, or daily time step
- Average annual
- Representative hydrologic period
- Long-term (10-50 years with extreme hydrologic year types)
- Dry/critical years

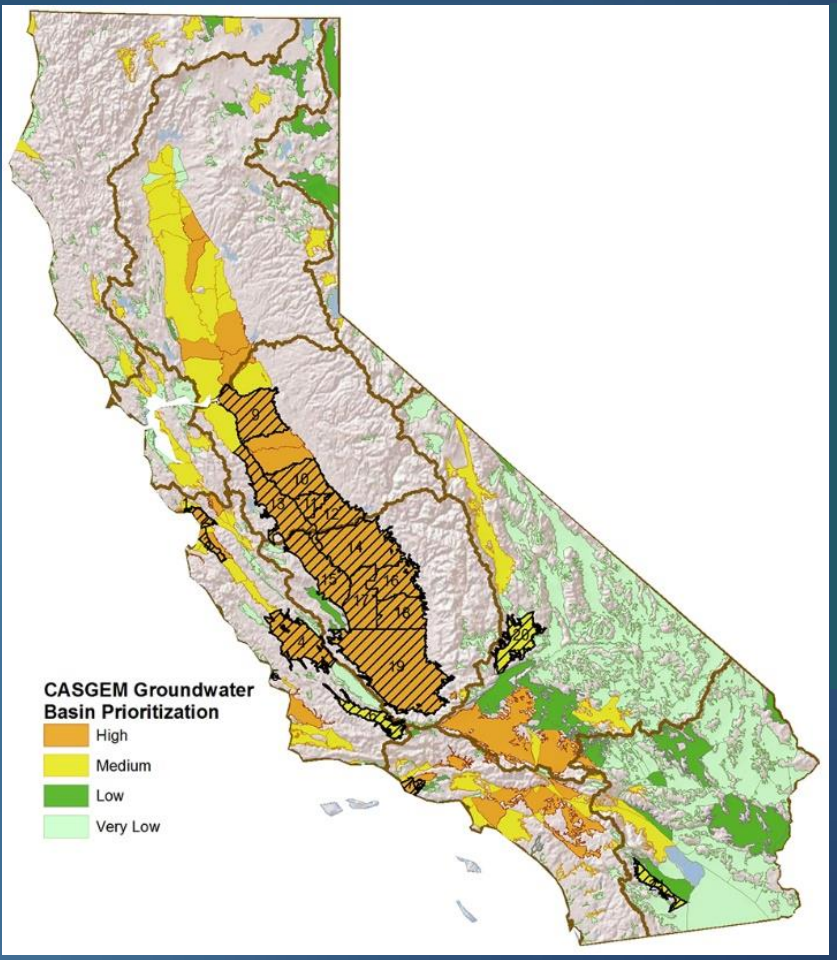
Reliability/Uncertainty = f (Technical Complexity)

Many complex issues to consider

- Geologic representation of the system
- Groundwater recharge rates quantification = f (climate, geology, soils, land use practices, depth to the water table)
- Aquifer hydraulic conductivity/other parameters estimation
- Stream aquifer interactions
- Boundary conditions (interbasin flows)
- Travel time of stored water
- Salt water intrusion
- Land subsidence
- Water quality impacts on supply variability

Reliability/Uncertainty = f (Regulatory Time Constraint)

Initial set of GSPs for Critically Overdrafted Basins will be a major test



- 10-20 GSPs will be submitted by January 2020
- These GSPs will be complex
- Accurate data and defensible water budgets are necessary to avoid unnecessary challenges

Reliability/Uncertainty = f (SGMA Consistency Requirement)

"Groundwater sustainability agencies …
shall coordinate with other agencies preparing a groundwater sustainability plan within the basin to ensure that the plans utilize the same data and methodologies for the following assumptions in developing the plan"

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Reliability/Uncertainty = f (Challenge of Common Vocabulary)

- Same agency, different programs, different terminologies
- Different agencies, different terminologies
- Different models, different terms
- Different agreements, different terms
- Different assumptions, different meanings

Data Dictionary

Water Budget: Reliability/Uncertainty

Summary: Issues to consider

- What data are necessary for a water budget?
- How frequently data are needed?
- What spatial scales to consider?
- How will different scales be consistent?
- Does a water budget include future estimates?
- How is climate change addressed in a water budget?
- How do we attain a consistent and defensible water budget framework?
- Time and space scales of measurement and estimation methods should match the needs of the water budget.
- Developing detailed water budget requires a substantial commitment of funding and manpower.

Thank you!

- Questions?

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