

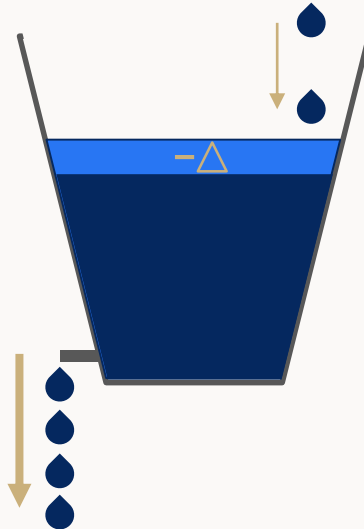


# Water Budget(s)

For the Treasure Valley Aquifer System  
Groundwater Flow Model

$$\text{In} - \text{Out} = \pm\Delta\text{Storage}$$

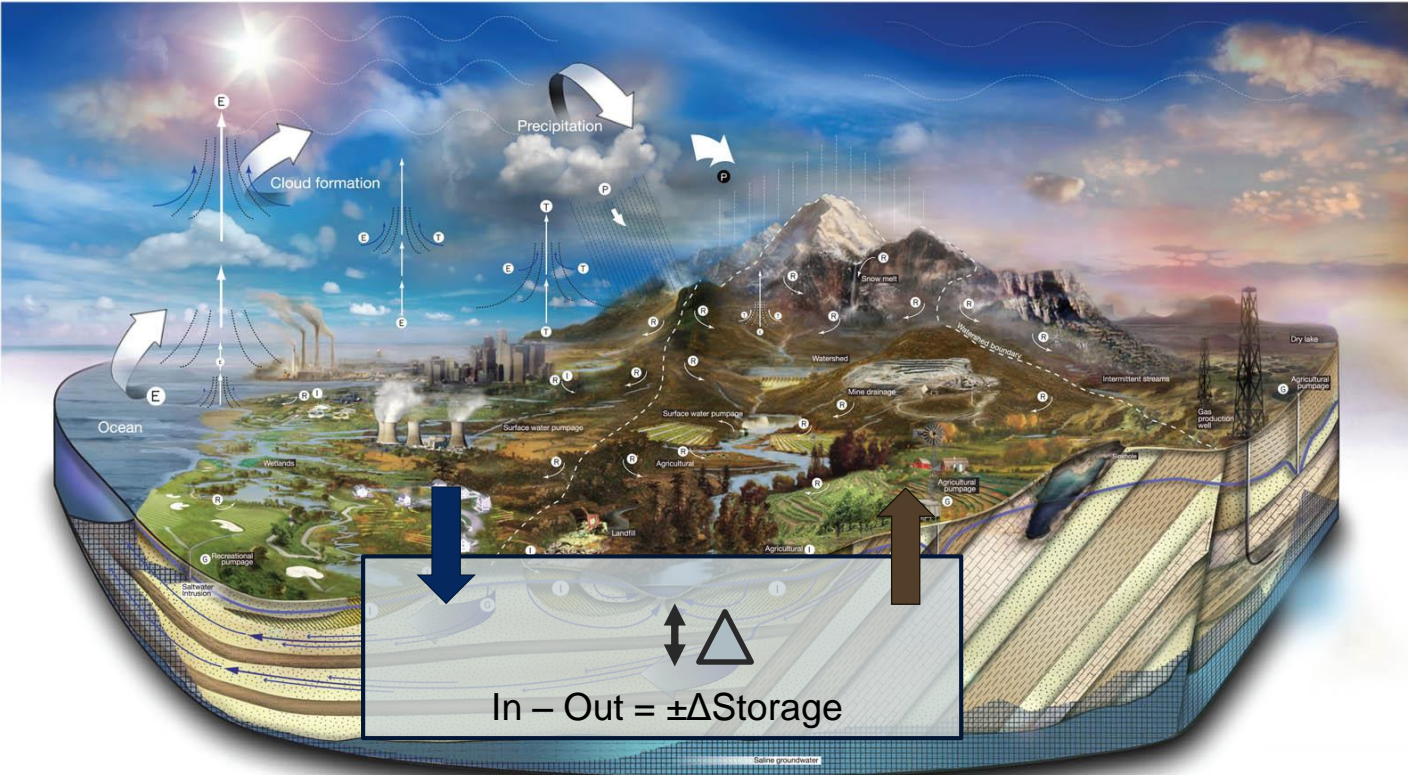
$$\text{In} - \text{Out} = \pm \Delta \text{Storage}$$





Theis, of Albuquerque supply wells going dry:

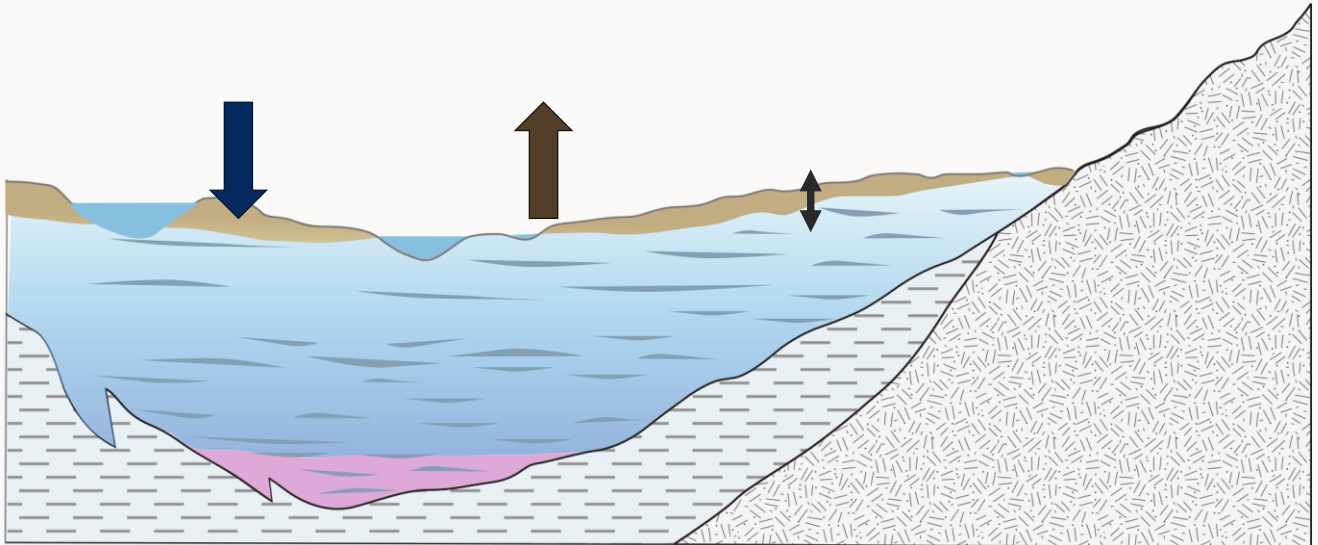
“What happened was that the city got a notice from its bank that its account was overdrawn and when it complained that no one could have foreseen this, only said in effect that it had no bookkeeping system” (Theis, 1953).



EXPLANATION

- Ⓔ Evaporation
- Ⓓ Transpiration
- Ⓕ Precipitation
- Ⓘ Infiltration
- Ⓡ Surface Runoff
- Ⓖ Groundwater

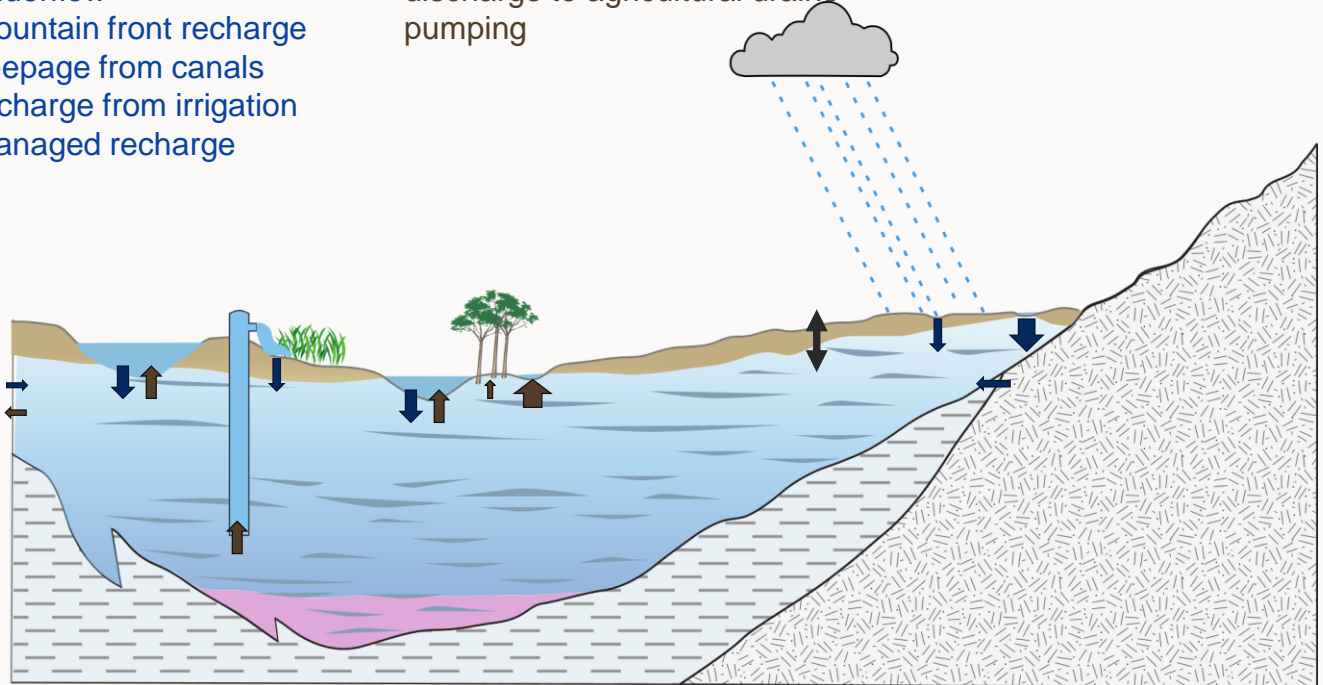
$$\text{In} - \text{Out} = \pm \Delta \text{Storage}$$

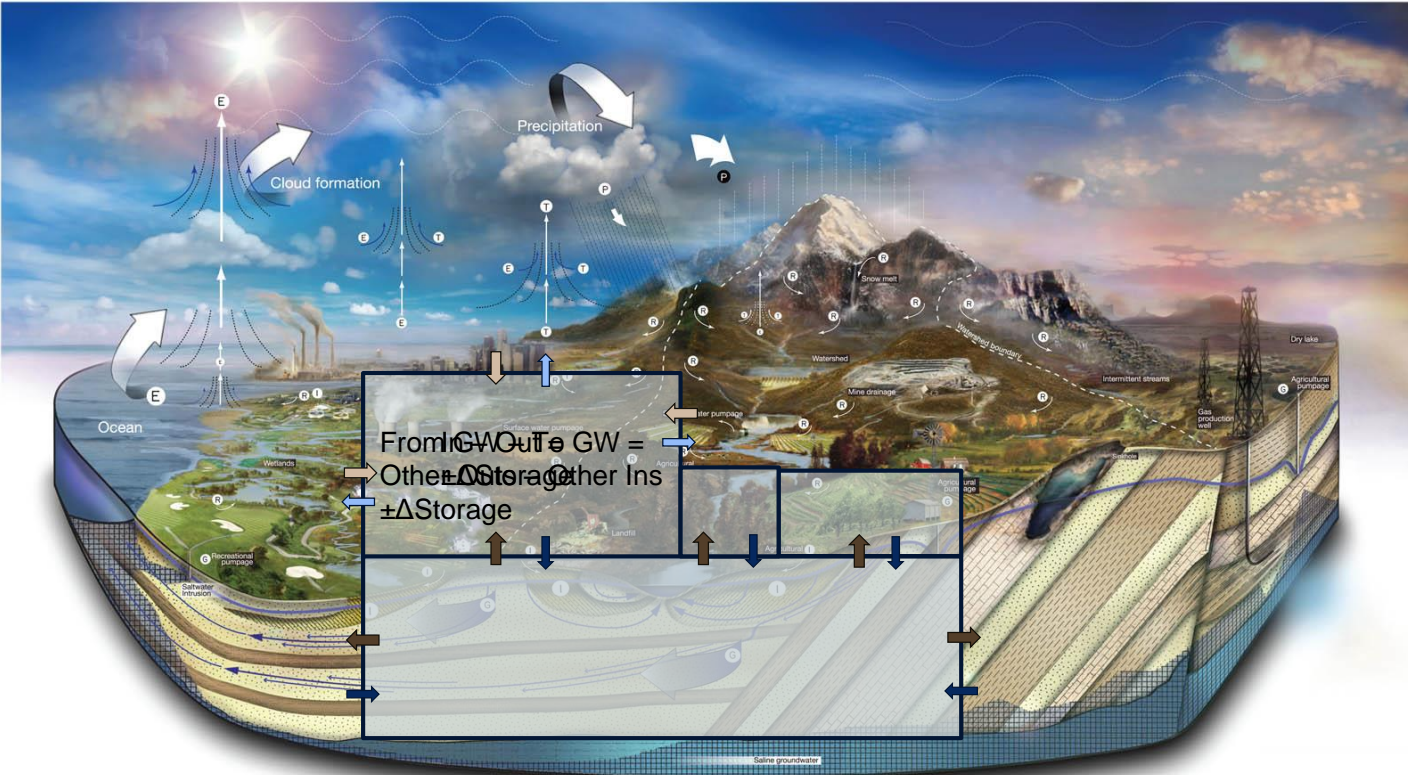


$$\text{In} - \text{Out} = \pm \Delta \text{Storage}$$

recharge from precipitation  
seepage from streams  
seepage from lakes  
underflow  
mountain front recharge  
seepage from canals  
recharge from irrigation  
managed recharge

discharge to streams & springs  
transpiration from phreatophytes  
discharge to lakes & wetlands  
discharge to agricultural drains  
pumping



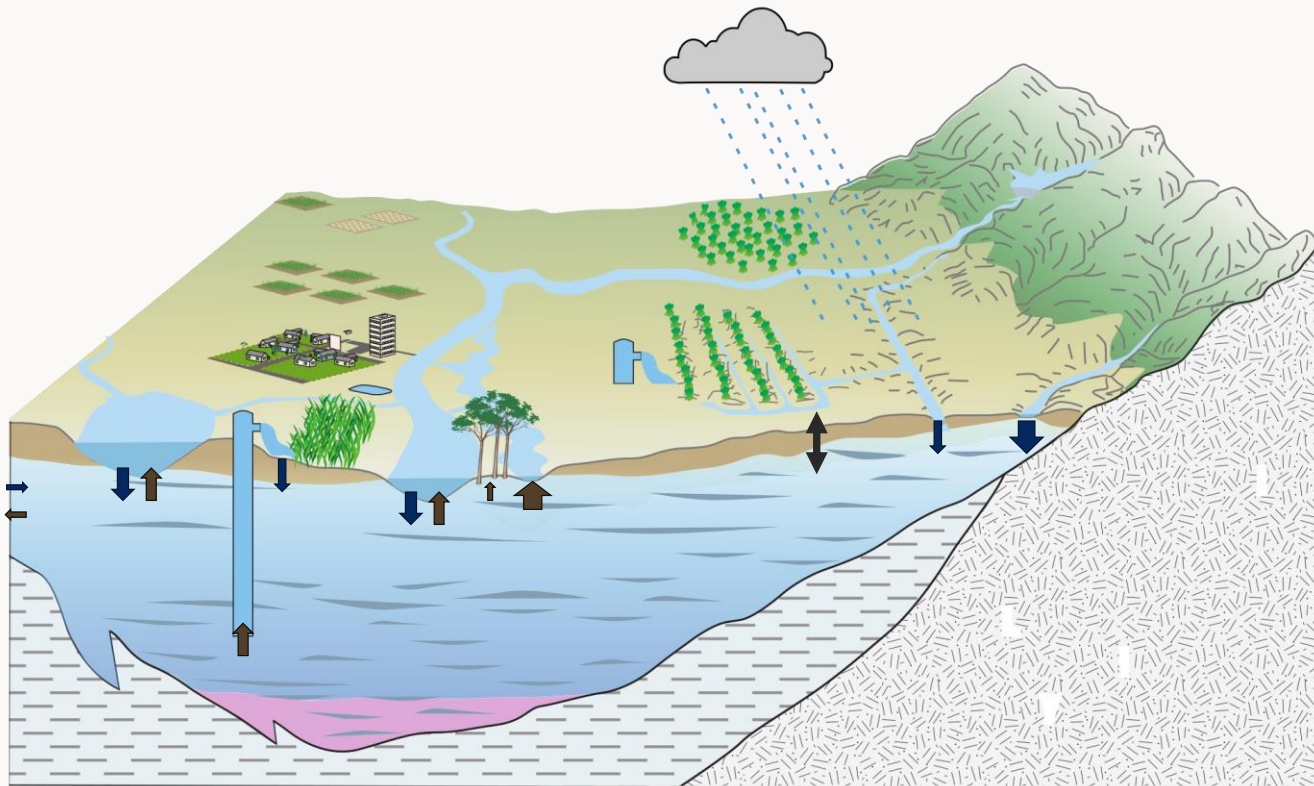


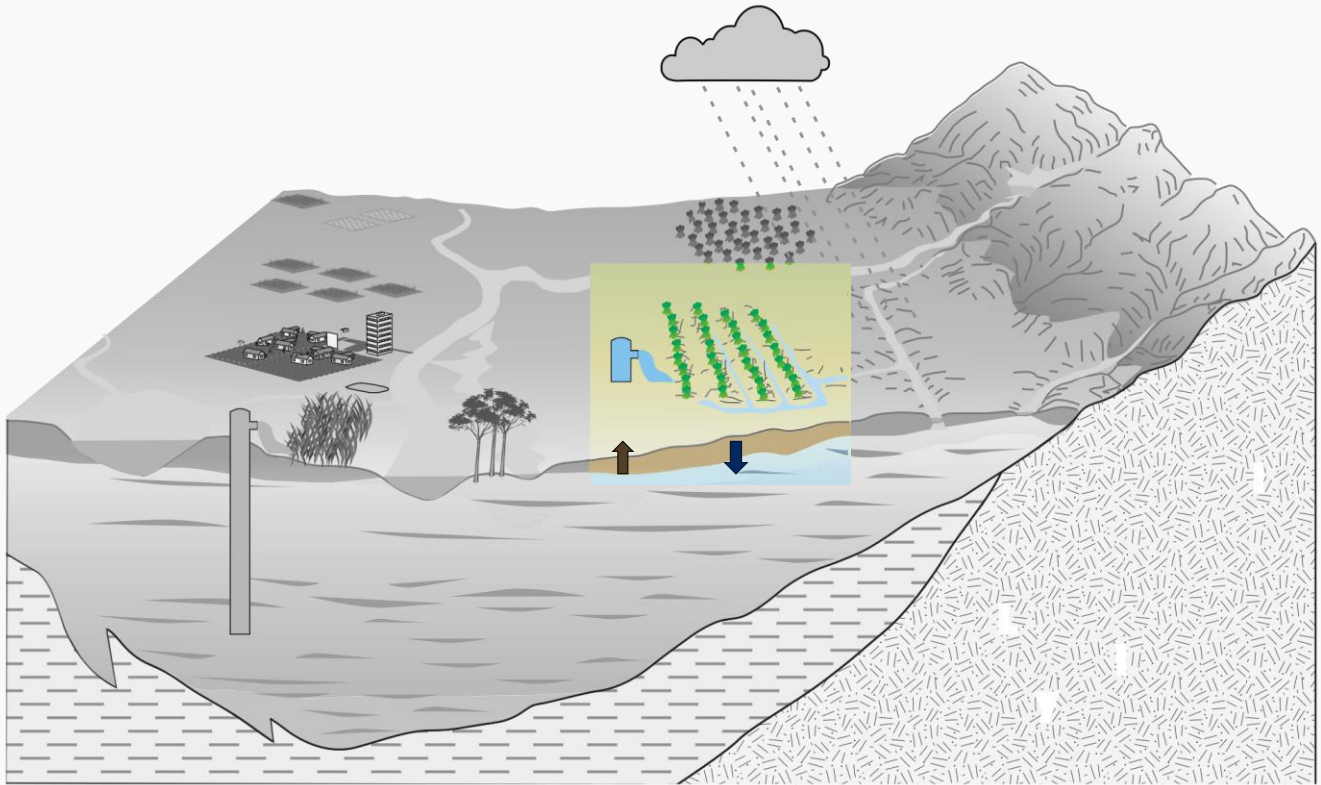
From GW Out = Other Ins ± ΔStorage

EXPLANATION

- Ⓔ Evaporation
- Ⓓ Transpiration
- ⒫ Precipitation
- Ⓘ Infiltration
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- Ⓖ Groundwater





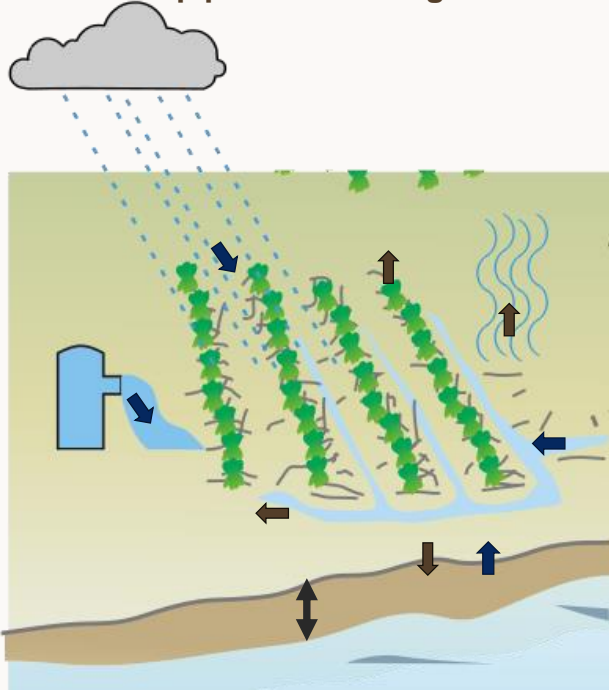


$$\text{In} - \text{Out} = \pm \Delta \text{Storage}$$

precipitation  
 surface water deliveries  
**groundwater deliveries**  
**groundwater uptake**

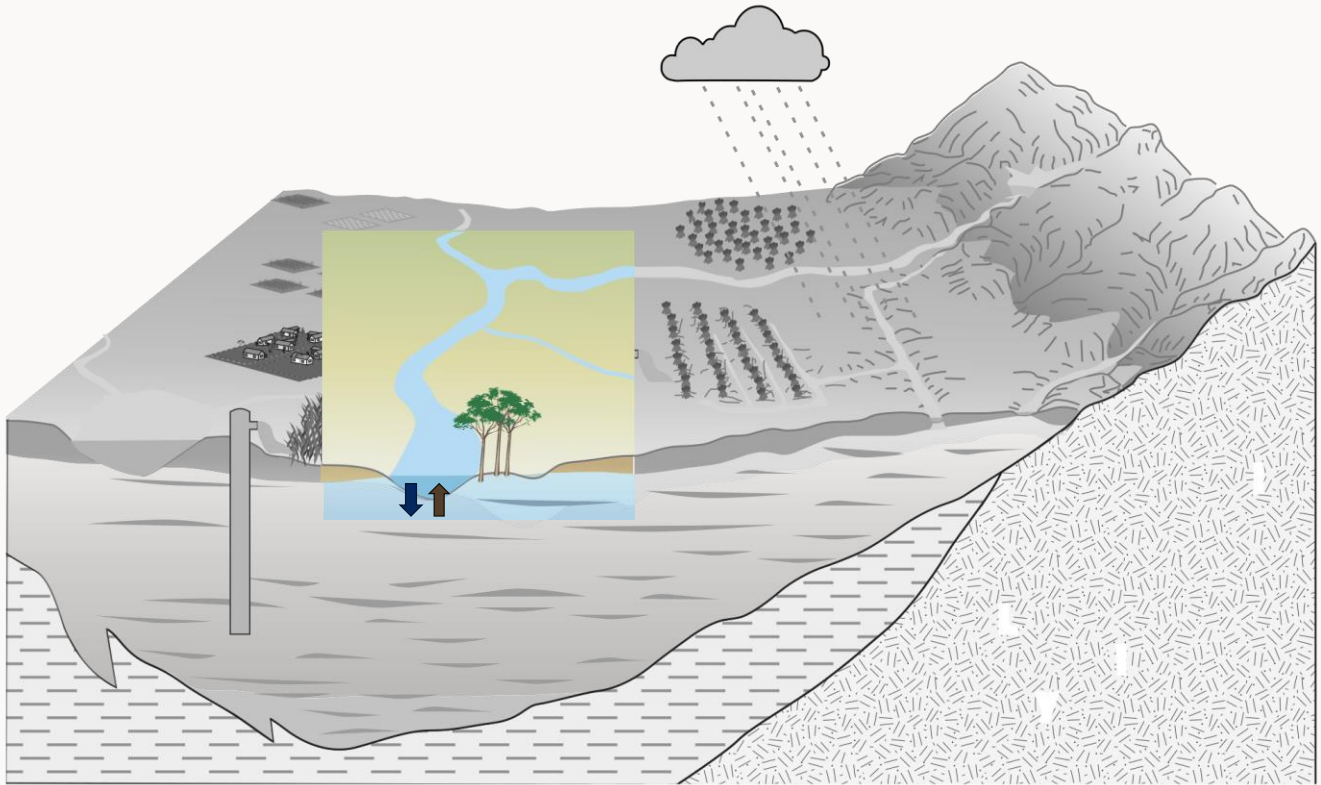
evaporation (irrigation and bare soil)  
 transpiration  
 runoff  
**deep percolation to groundwater**

$\Delta$  soil moisture



**Agricultural Soil**

(modified from Faunt, 2009)

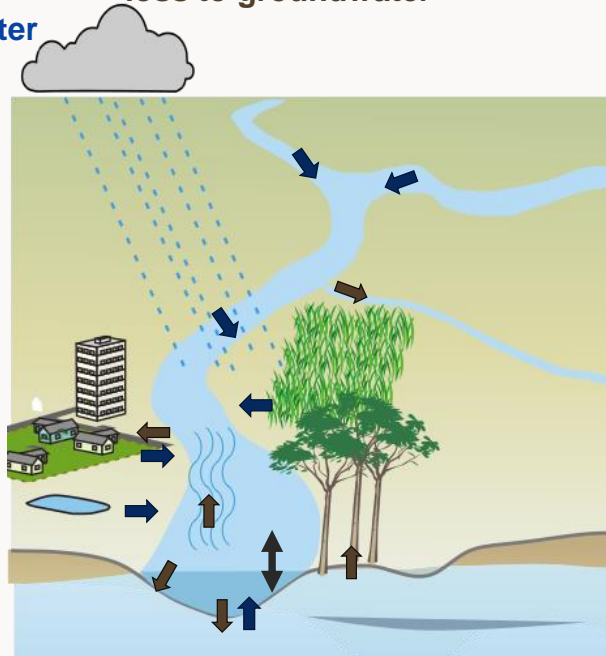


$$\text{In} - \text{Out} = \pm \Delta \text{Storage}$$

upstream inflow  
 tributary inflow  
 runoff (urban, ag, native veg)  
 treated wastewater  
 precipitation  
 gain from groundwater

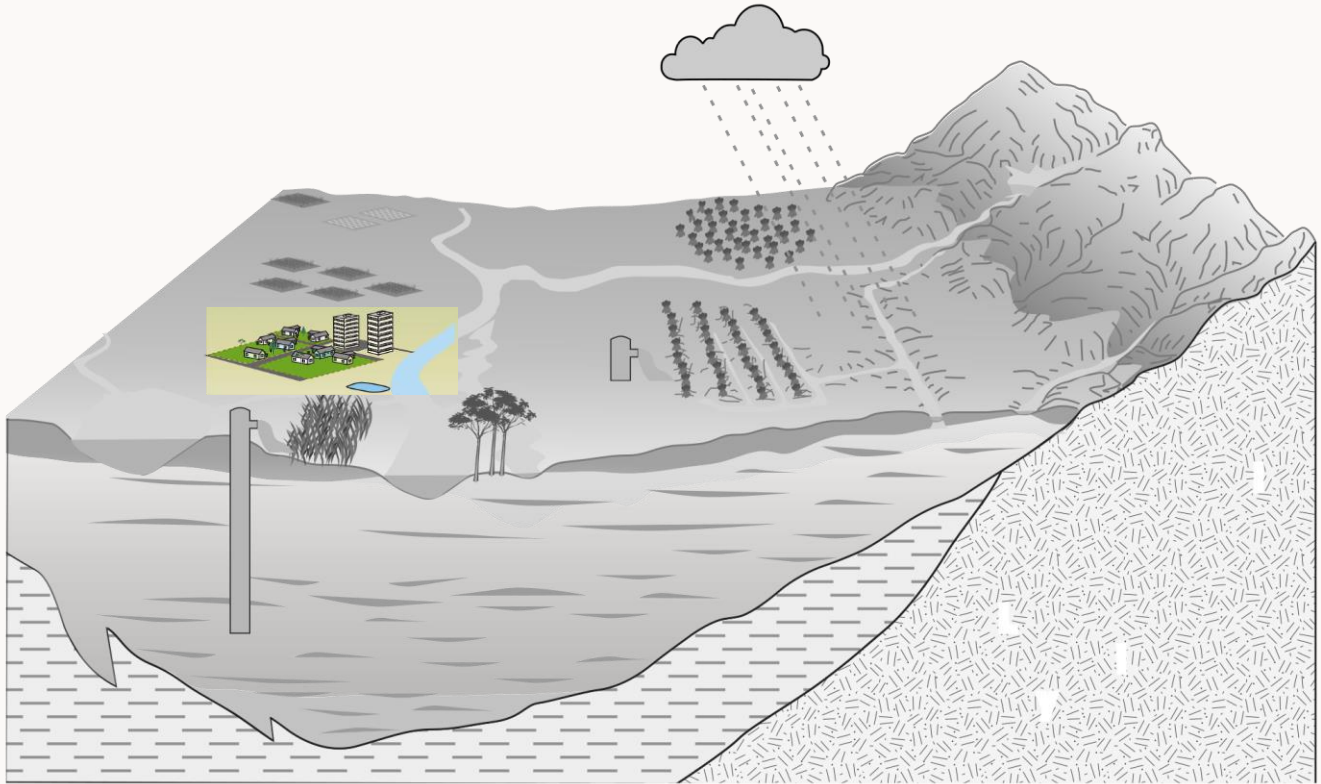
downstream outflow  
 diversions (ag, urban)  
 transpiration from riparian vegetation  
 evaporation  
**loss to groundwater**

$\Delta$  instream volume  
 (negligible)



Rivers

(modified from Faunt, 2009)



$$\text{In} - \text{Out} = \pm \Delta \text{Storage}$$

surface water supplies  
precipitation  
groundwater supplies

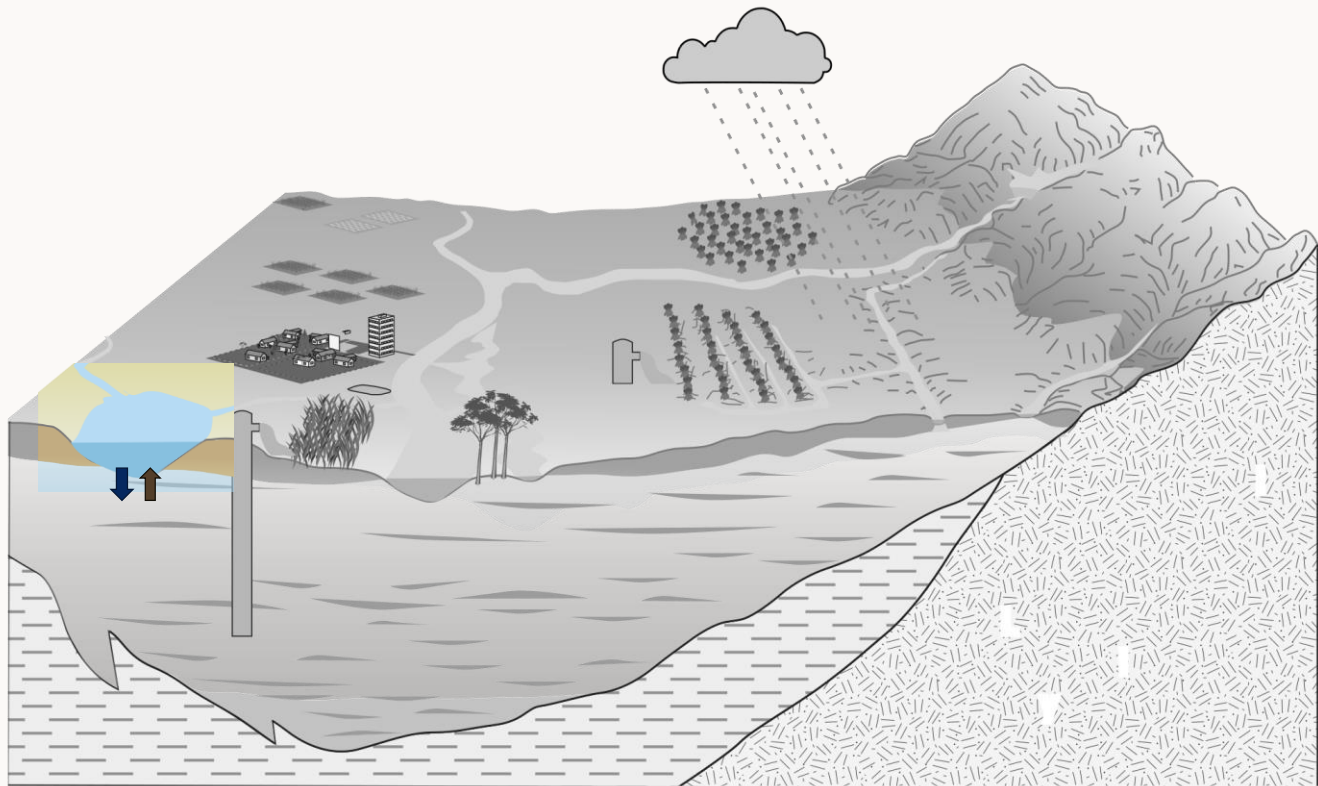
treated wastewater  
evaporation  
transpiration  
runoff  
deep percolation to groundwater

$\Delta$  soil moisture



Urban

(modified from Faunt, 2009)





$$\text{In} - \text{Out} = \pm \Delta \text{Storage}$$

inflow from streams

inflow from canals

inflow from direct precipitation

**inflow from groundwater**

discharge to streams

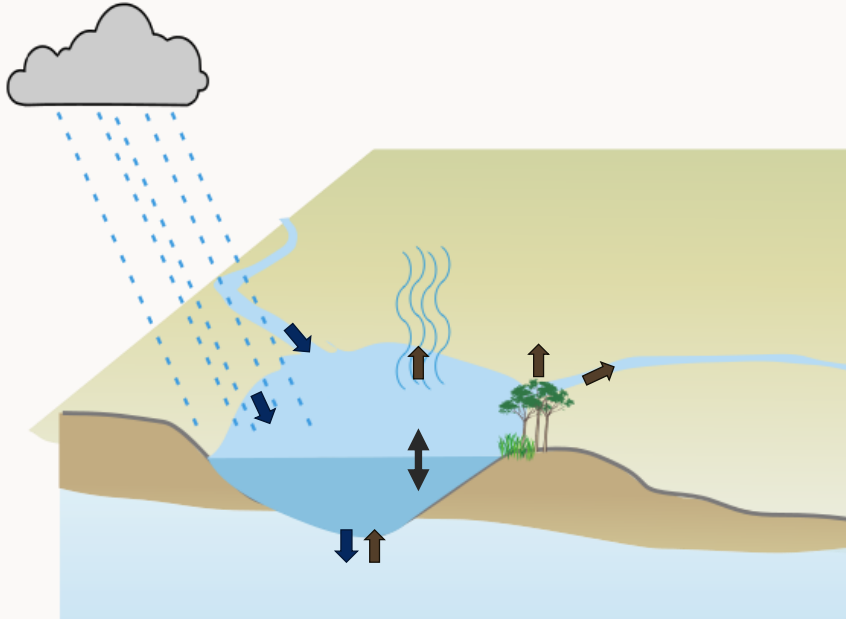
discharge to canals

evaporation

transpiration of lakeside plants

**leakage to groundwater**

$\Delta$  lake volume



**Lakes (Lowell)**

(modified from Faunt, 2009)

# data

## *Ideally, monthly from 1986 - 2015:*

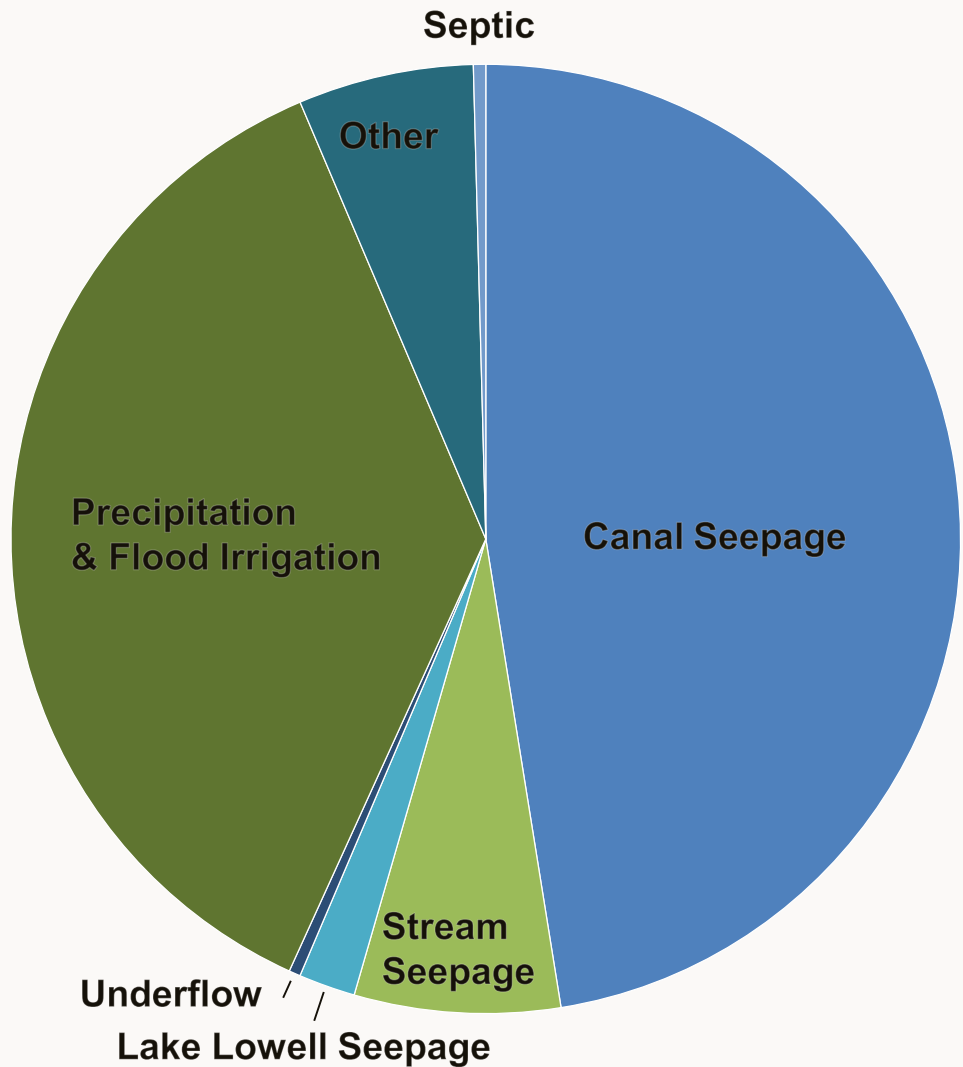
- Boise, Payette, Snake discharge (upstream, downstream, & intermediate)
- tributary/drain discharge
- ET
- precipitation
- diversion locations
- canal diversions
- canal returns
- canal deliveries
- canal seepage estimates
- distribution of deliveries
- land use classification
- irrigation efficiency #s
- municipal, industrial, commercial surface water deliveries
- municipal, industrial, commercial groundwater pumping
- service area populations
- stormwater system info??
- distribution domestic wells
- distribution of domestic septic
- WWTP flows
- Lowell stage
- Lowell inflows
- Lowell outflows
- ...

# Prior Work

Author	Published
Lindgren	1982
Newton	1991
Kjelstrom	1995
Urban	2004
Petrich & Urban	2004
Douglas	2007
Scmidt & others	2008
Pacific Groundwater Group	2008
Sukow	2012
Welhan	2012
Johnson	2013
Tesch	2013

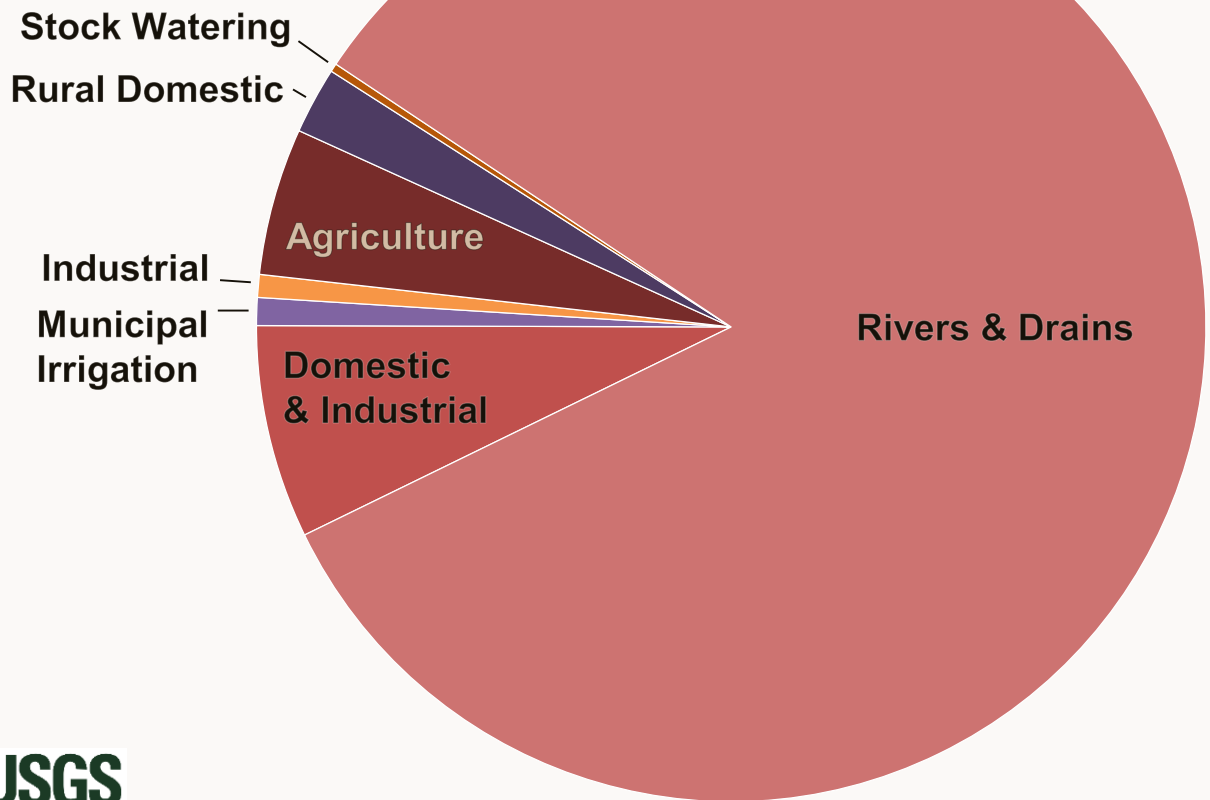
# Inflows

(Urban, 2004)



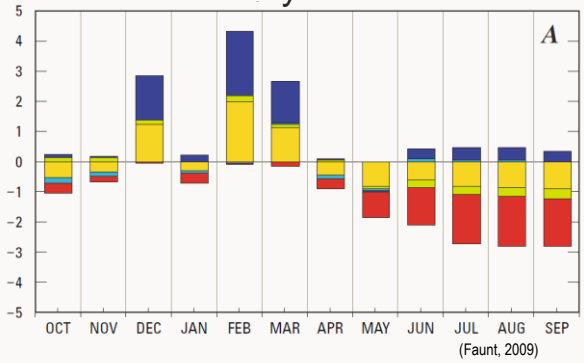
# Outflows

(Urban, 2004)

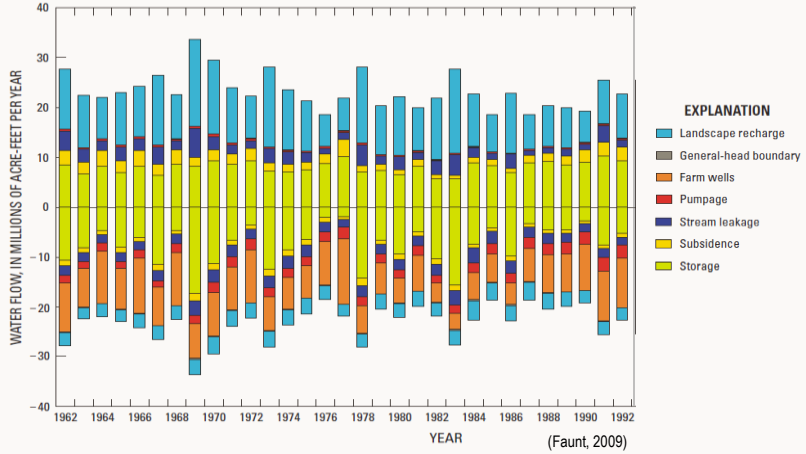


# This time

Time scale and resolution:  
monthly



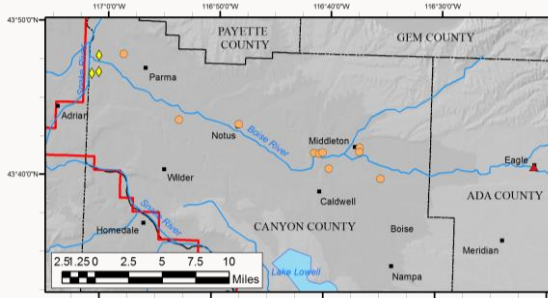
30 years (1986-2015)



# This time

New measurements of important components:

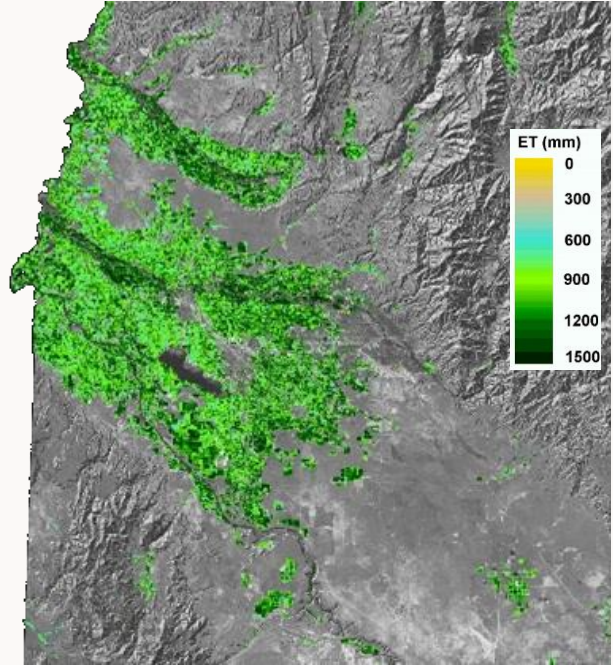
drains



(Bartolina, 2017)



ET



# Summary

Accounting of all water in, out, and in storage

Useful in its own right

Needed for model boundary conditions & calibration

A lot of data will be required