Depletion of Interconnected Surface Water

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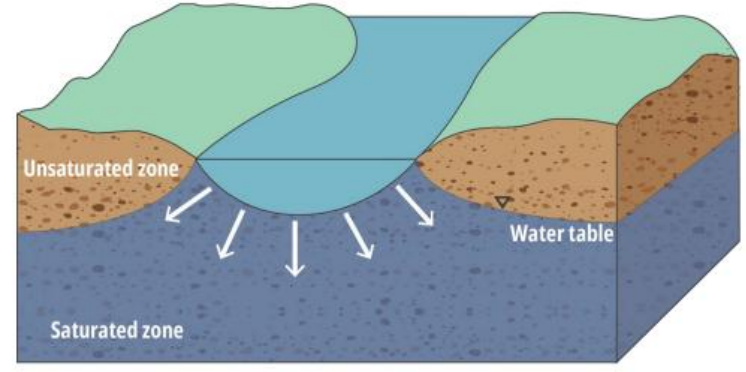
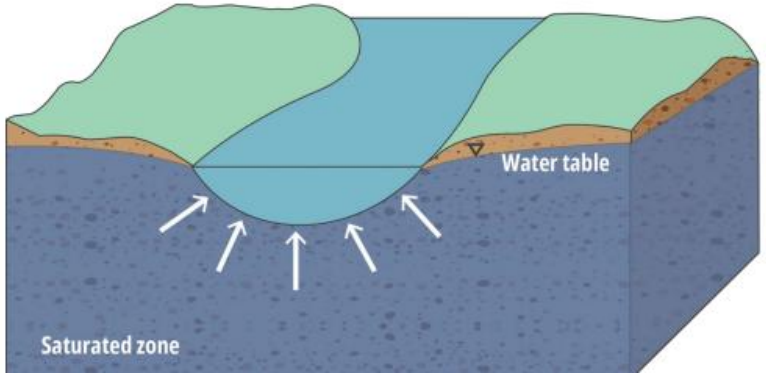
What is interconnected surface water?

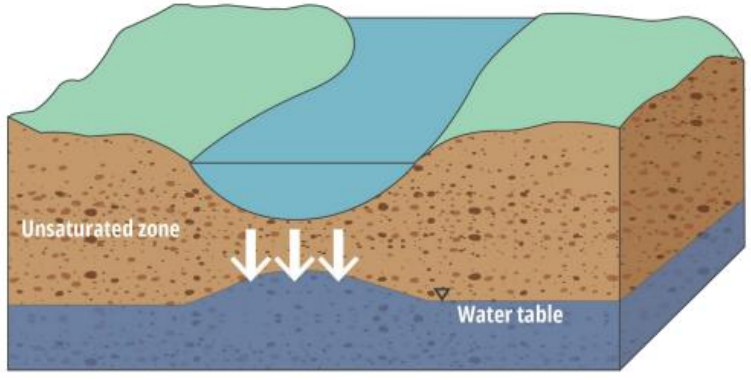
GSP Regulations: *Surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.*

<u>Interconnected</u>
The quantity of flow between the surface water and the groundwater system is a function of the groundwater elevation



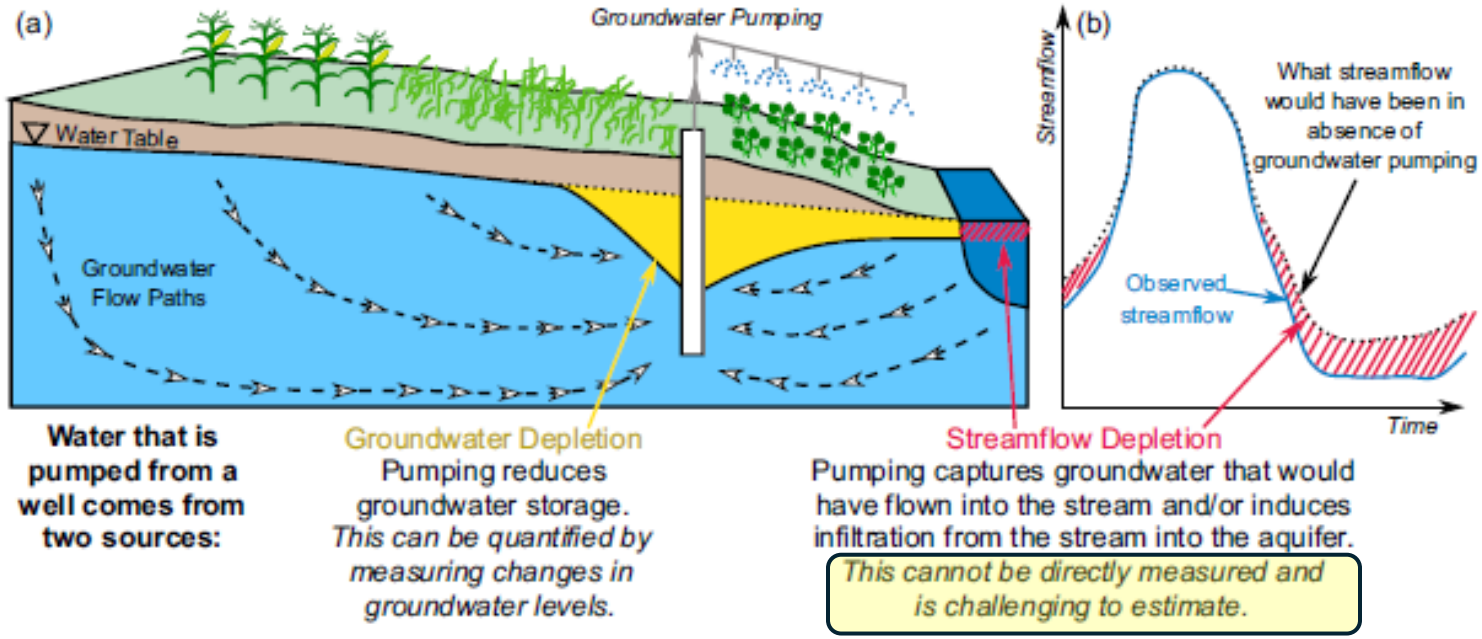


<u>Not Interconnected</u>
The quantity of flow between the surface water and the groundwater system **<u>is not</u>** a function of the groundwater elevation



What is depletion of ISW (in the context of SMGA)?

- Reduction in flow or stage of a surface water body caused by groundwater use



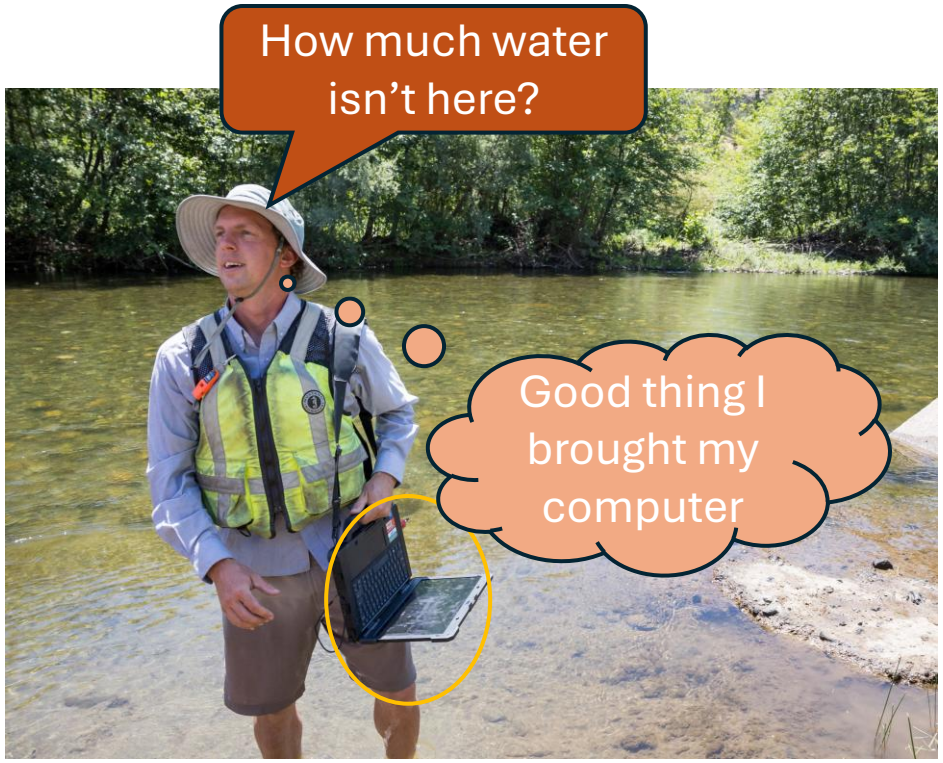


Image source: Zipper, S.C., W.H. Farmer, A. Brookfield, H. Ajami, H.W. Reeves, C. Wardropper, J.C. Hammond, T. Gleeson, and J.M. Deines. 2022. "Quantifying Streamflow Depletion from Groundwater Pumping: A Practical Review of Past and Emerging Approaches for Water Management." Journal of the American Water Resources Association 58 (2): 289–312. https://doi.org/10.1111/1752-1688.12998. [Open Access]

Other challenges

- Timing
  - Lag times can range from days to decades
- Location
  - Not always just the nearest surface water body

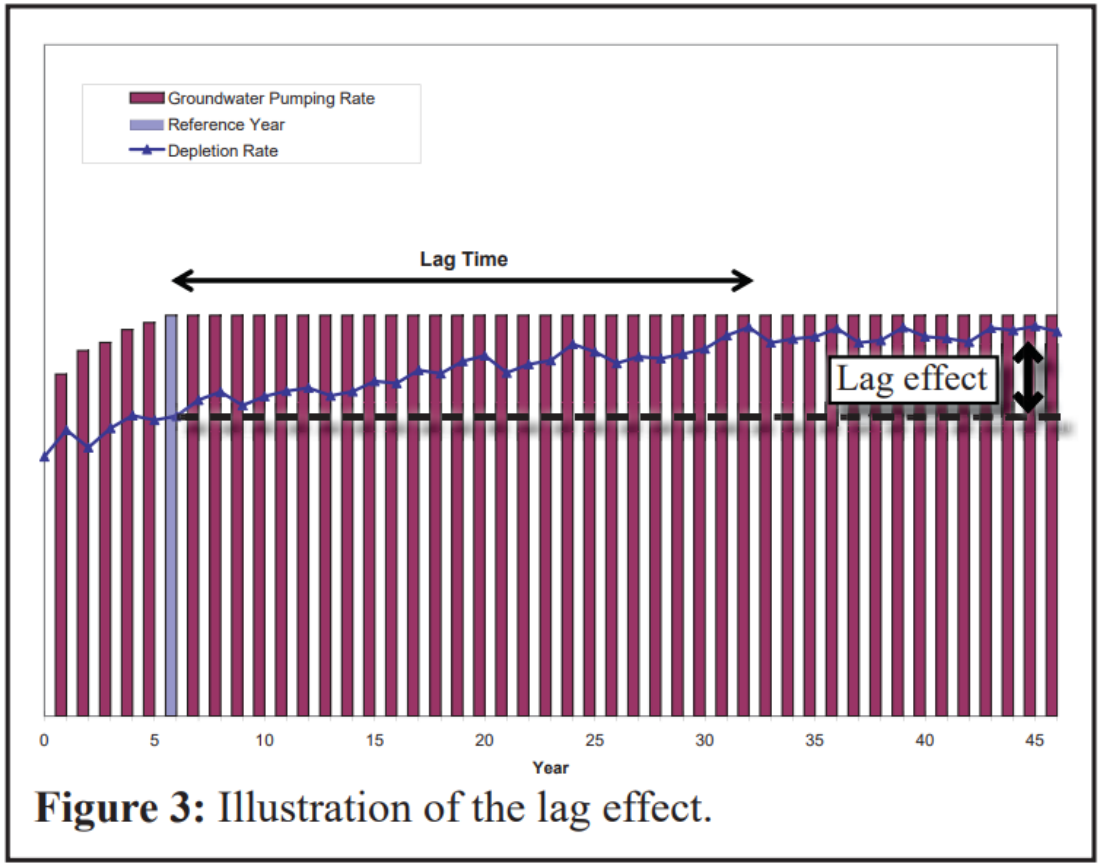


Figure 3: Illustration of the lag effect.

Image source: Schneider, J. 2010. Number 5, Water Matters Newsletter, "Stream Depletion and Groundwater Pumping Part Two: The Timing of Groundwater Depletions", Nebraska Department of Natural Resources.
https://dnr.nebraska.gov/sites/dnr.nebraska.gov/files/doc/water-planning/water-matters/WaterMatters_No5.pdf

DWR Papers and Upcoming Guidance

Technical Papers

Guidance Document

Under Development

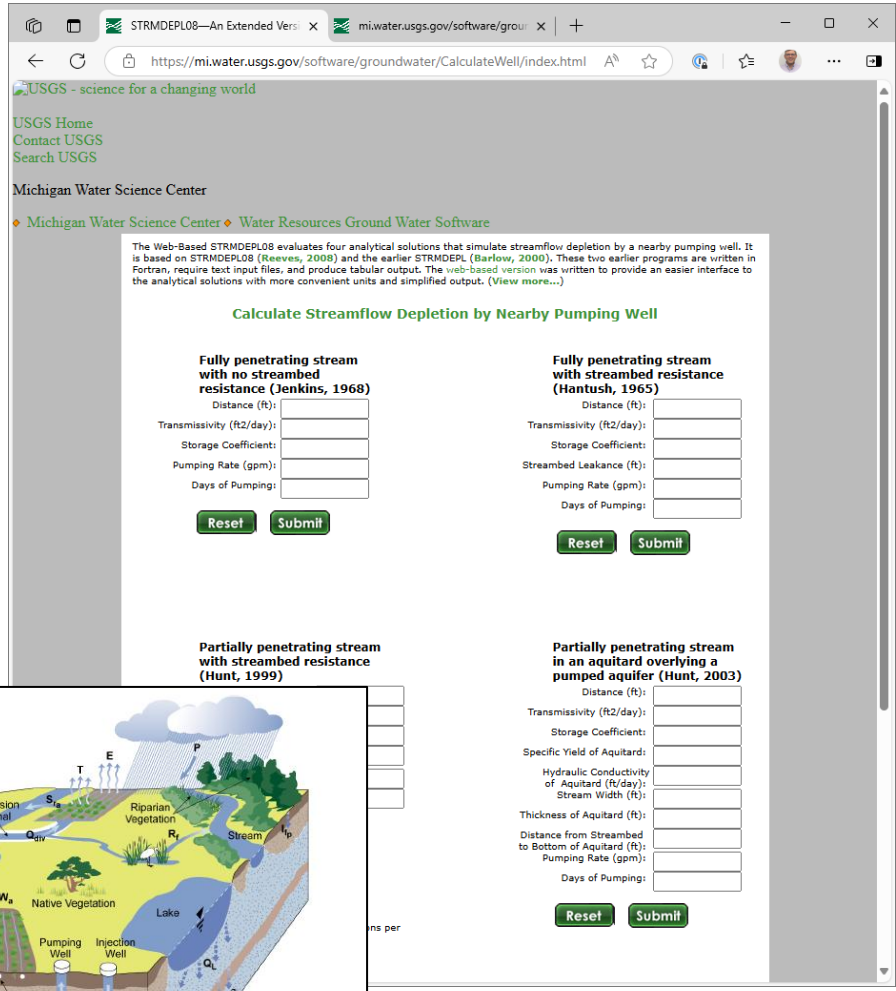
- https://water.ca.gov/Programs/Groundwater-Management/SGMA-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents
- https://www.youtube.com/watch?v=HQbPod1Kr2o

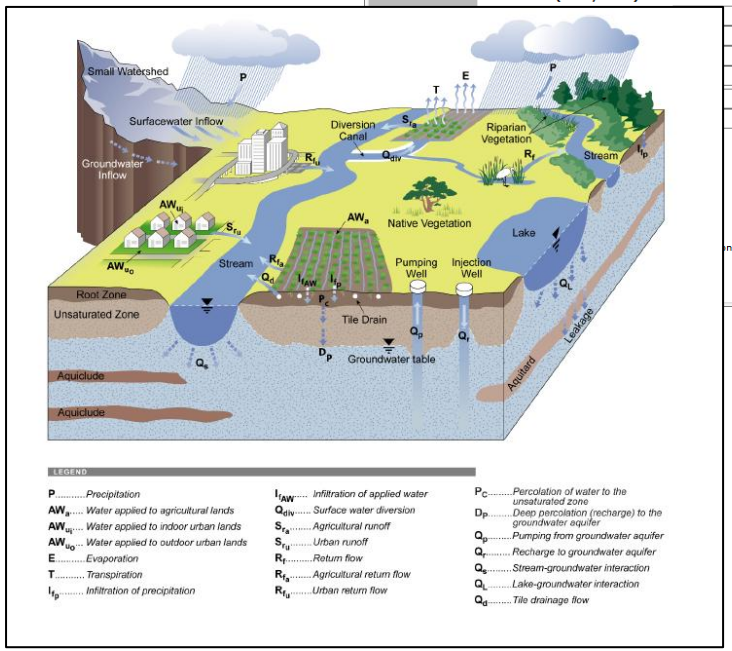
Requirements

- In a nutshell:
  - Locate ISW systems, determine the quantity and timing of depletions of those systems caused by groundwater use (pumping)
  - Consider beneficial uses of surface water and determine the level of depletion (quantity, location, timing) that would cause a significant and unreasonable effect
  - Manage and monitor groundwater conditions to demonstrate that the significant and unreasonable effects are not occurring

Estimating ISW depletion

- Key information needs
  - Pumping
    - Quantity
    - Spacing, relative to surface water
  - Aquifer properties
  - How well are those known?
- Typically, either numerical modeling, analytical methods, or statistical methods





Estimating ISW depletion

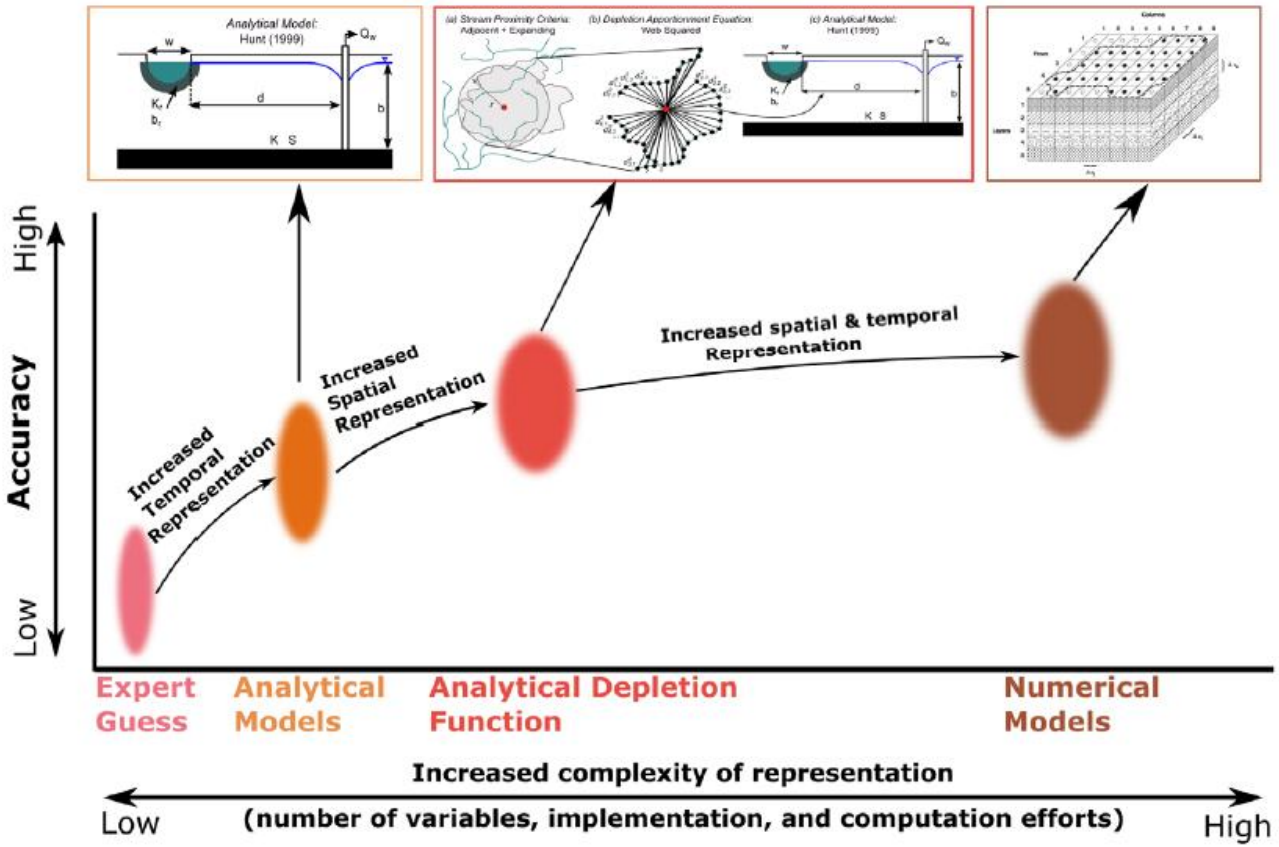
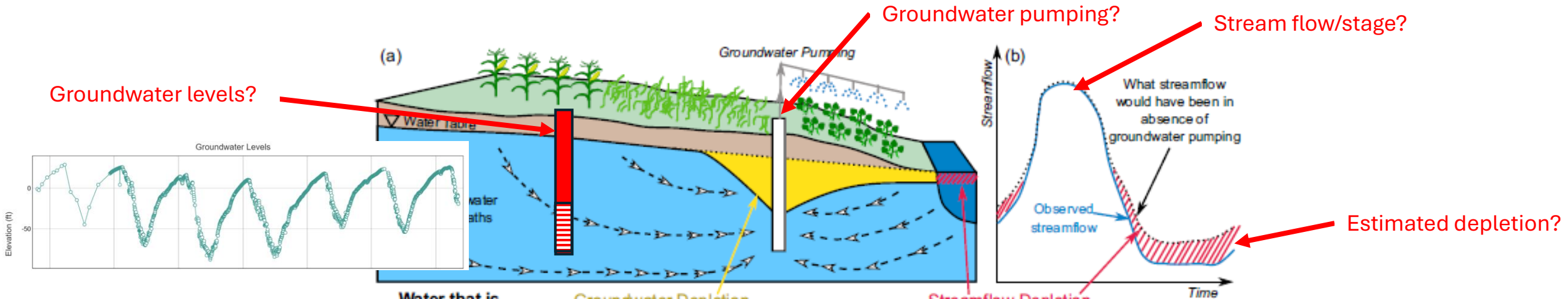


Figure 2. Diagram showing methods and accuracy in assessing streamflow depletion in conjunctive water management. Accuracy in this figure refers to the method that can estimate the streamflow depletion best in real-world settings with multiple streams. Inset figures are reproduced with permission from Zipper et al. (2019b) and Harbaugh (2005).

Image source: Li, Q., T. Gleeson, S.C. Zipper, and B. Kerr. 2022. "Too Many Streams and Not Enough Time or Money? Analytical Depletion Functions for Streamflow Depletion Estimates." Groundwater vol 60, issue 1. https://doi.org/10.1111/gwat.13124

Management Metrics (and Monitoring)

- Depletion cannot be measured, only estimated, yet GSP implementation is focused on measurable outcomes (MTs, MOs, etc.) – what can we do?
  - Frequently updated estimates of depletion – not discouraged but may not always be the best solution (time, cost, etc.)
  - Proxy – measurable phenomena significantly correlated to depletion
    - Will measurements of [insert proxy metric] be a good indicator of depletion caused by groundwater use and /or the effects on beneficial users of surface water?



Conclusions

- Quantifying ISW depletion can be challenging
- Technical professionals have an important role
  - Advising on the types of questions that different approaches are well suited to answer (and not answer)
  - Communicating concepts that are complex and not always intuitive
  - Advising on new data collection and analysis