Hydrologic Systems Services (HSS) as a Framework for Groundwater Evaluation and Management

Jennifer Pensky[1,2], Andrew T. Fisher[1,2]

Earth and Planetary Sciences, University of California, Santa Cruz

University of California Water Security and Sustainability Research Initiative (UC Water)

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16th BIENNIAL SYMPOSIUM ON MANAGED AQUIFER RECHARGE

UCSC Hydrogeology
THE UNIVERSITY OF CALIFORNIA 1868
"Endeavor to persevere..."

Presentation Outline

- New requirements for CA (SGMA, 2014)
- The Ecosystem Services (ESS) framework
- Application of ESS framework to water resources
- The need for Hydrologic Systems Services (HSS)
- Examples of HSS, for surface water and groundwater
- Implications of a HSS framework for water management

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How can we quantify and assess the magnitude of these consequences?

Hydrologic systems have value…

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"Once the land was enriched by yearly rains, which were not lost, as they are now, by flowing from the bare land into the sea.

The soil was deep, it absorbed and kept the water in the loamy soil, and the water that soaked into the hills fed springs and running streams everywhere.

Now the abandoned shrines at spots where formerly there were springs attest that our description of the land is true."

Plato's Dialogues (427–327 B.C.E.)

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- Emerged in technical literature in mid-20th century
- Became firmly established in scientific research studies in the 1980s, complementary to expanded environmental regulation

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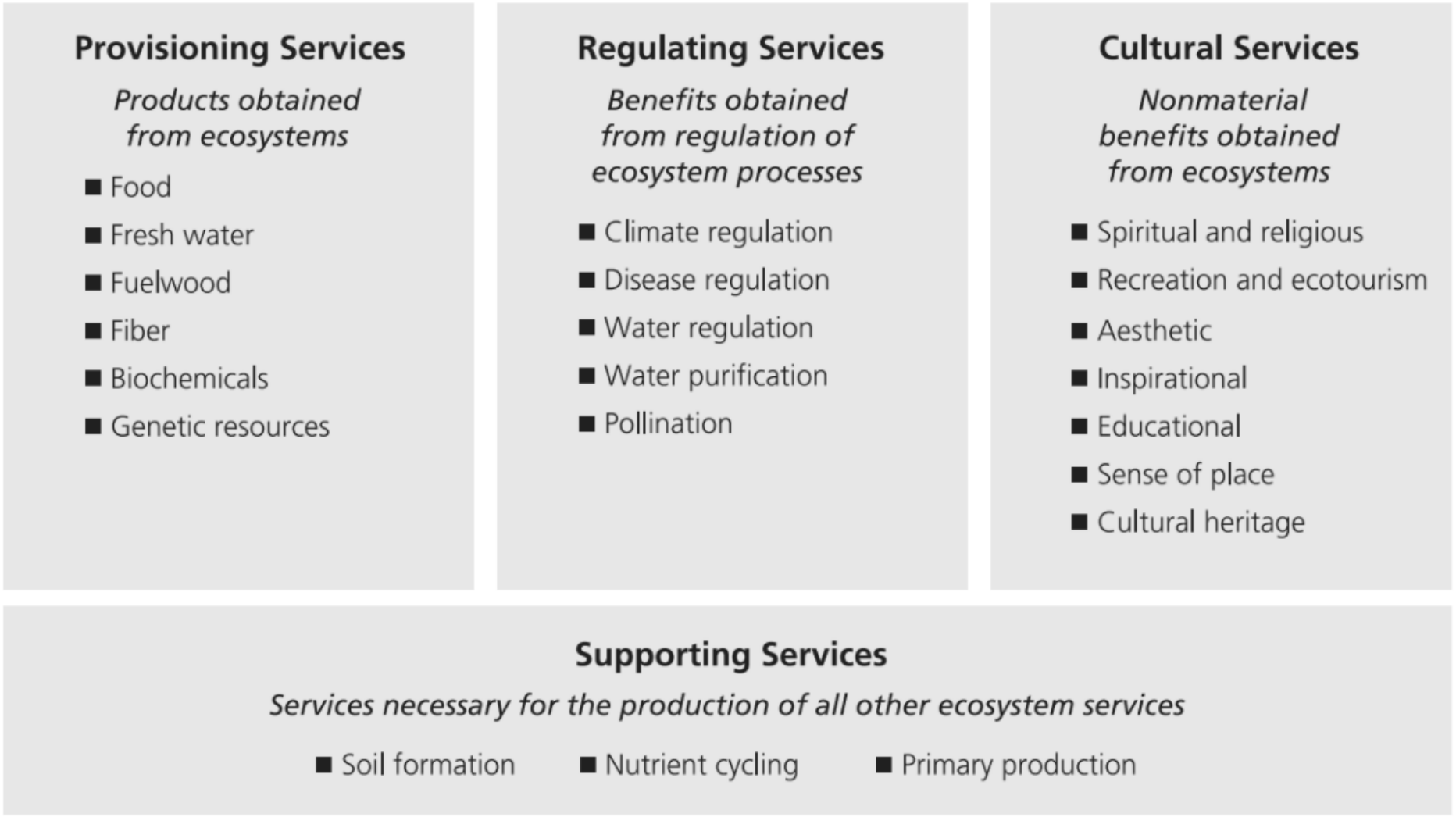

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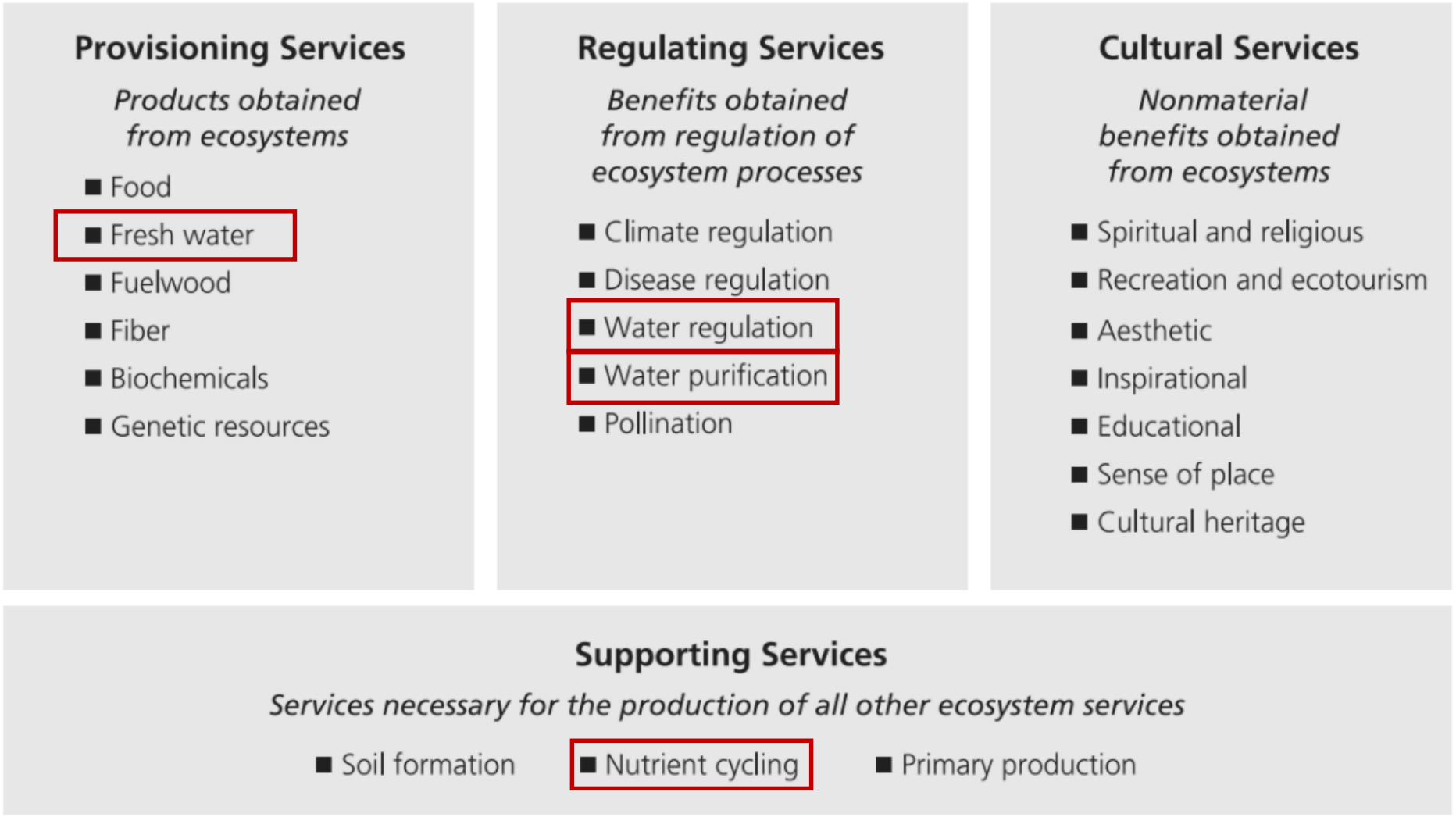
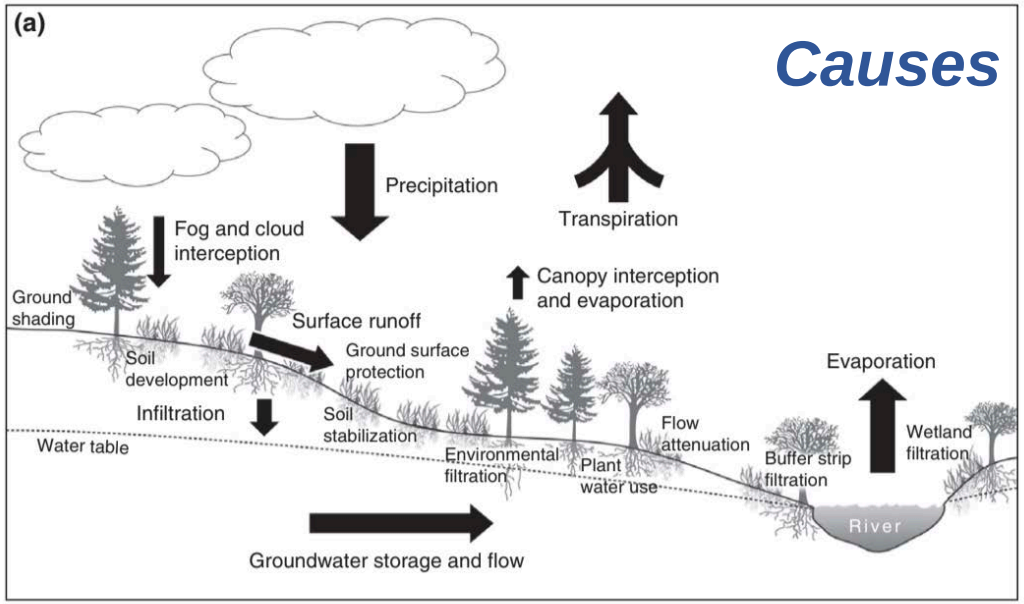
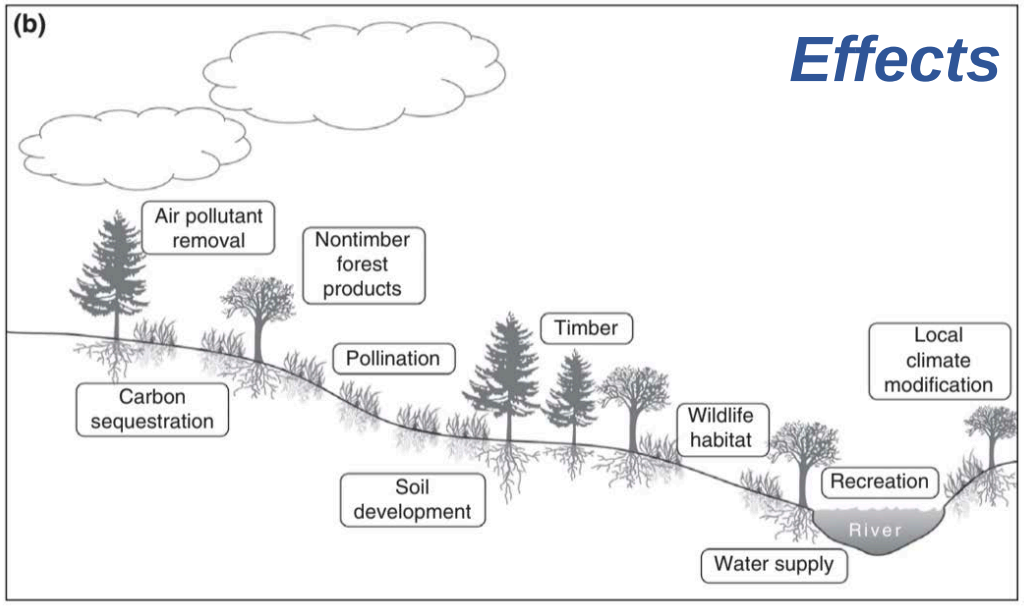


Hydrologic Ecosystem Services

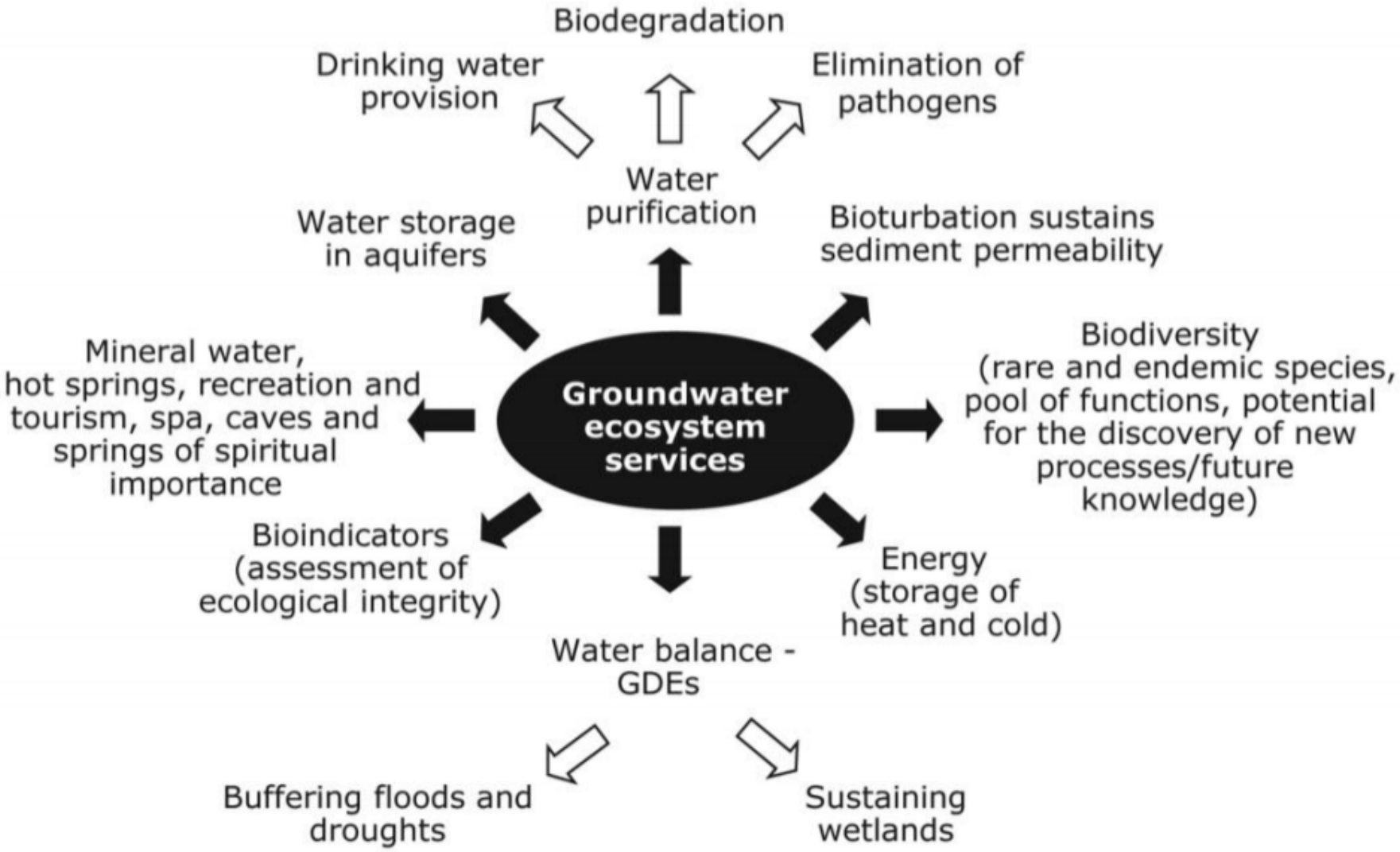




- "…*the subset of terrestrial ecosystem services related to water…*"
- "…hydrologic services arise from addressing the way people are affected by ecohydrologic processes."
- Implies that ecosystem benefits are a consequence of hydrologic flows, not the flows themselves

Brauman (2015)

Groundwater Ecosystem Services



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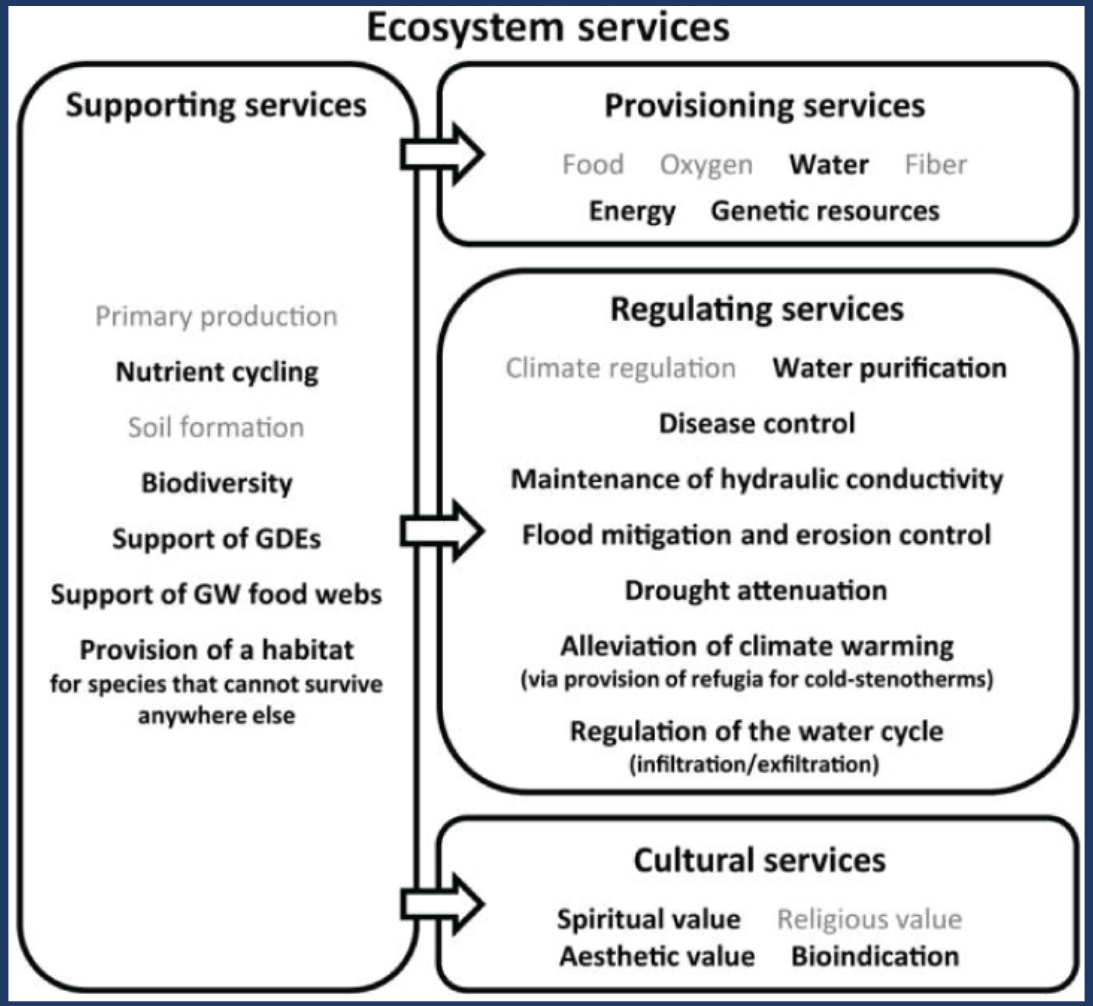

- GW fits into ESS framework…
- …but still an emphasis on human benefits
- Notes that GW can include subsurface ecosystems and support surface ecosystems

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ESS Applied to Water Resource Management

- **New York City water supply – 1990s**
  - Water quality of Catskill Reservoir was declining due to changes in land use and runoff inputs
  - City applied ESS framework: invested in preserving the watersheds in lieu of developing expensive filtration system

www.nyc.gov

ESS Applied to Water Resource Management

- **<u>Groundwater recharge in Kona, HI – 2015</u>**
  - Evaluated how upland land use changes would impact groundwater recharge on the leeward, dry side of the island
  - Utilized hydrologic models and interviews with stakeholders to connect biophysical function to human well-being

Hydrologic Ecosystem Services and Water Resource Management

- ESS emphasizes services provided ***by ecosystems*** for the ***benefit of human welfare***
- There is a basis for applying the ESS framework to hydrologic systems (including groundwater systems)
  - Generally requires showing an explicit and quantifiable connection, storage and/or flow → benefit

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  - Generally requires showing an explicit and quantifiable connection, storage and/or flow → benefit
- As a result, ***there is a gap:***
  - Many hydrologic systems, and especially groundwater systems, are highly variable in space and time (heterogeneous, dynamic), and operate at multiple spatial and temporal scales.
  - This limits recognition of storage and flows that are ***intrinsic benefits.*** This risks harm to important hydrologic systems. ***We need to fix this.***

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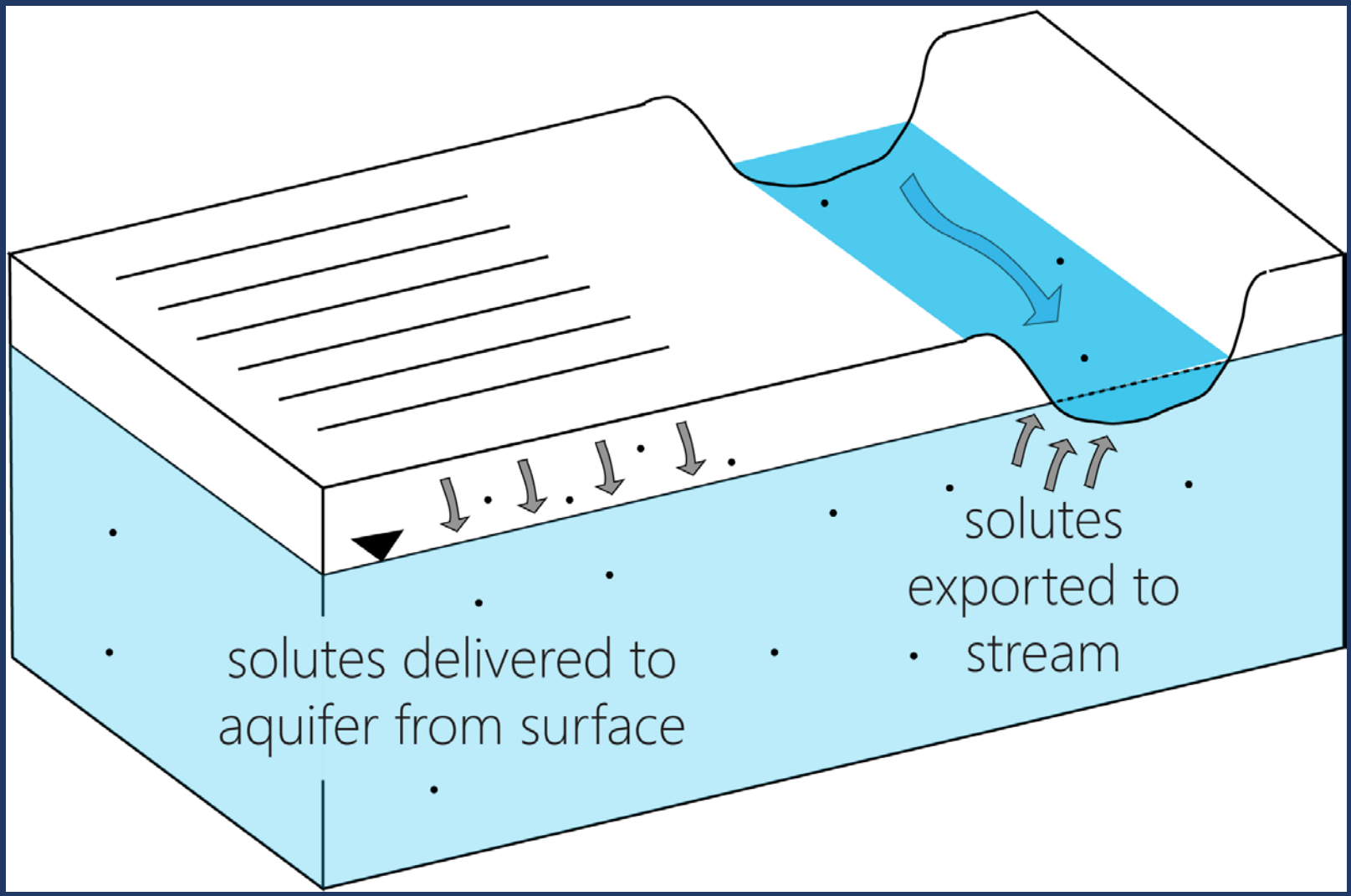
- HSS can include things that humans do to improve hydrologic function (***humans benefit hydrology***)
- Many HSS are ***quantifiable*** through direct observation or modeling, but may be several steps removed from measurable human benefit. Understood from decades of technical research to be ***hydrologically valuable***

Surface water – groundwater system: *pre*-development



Graphic by S. Beganskas, UCSC

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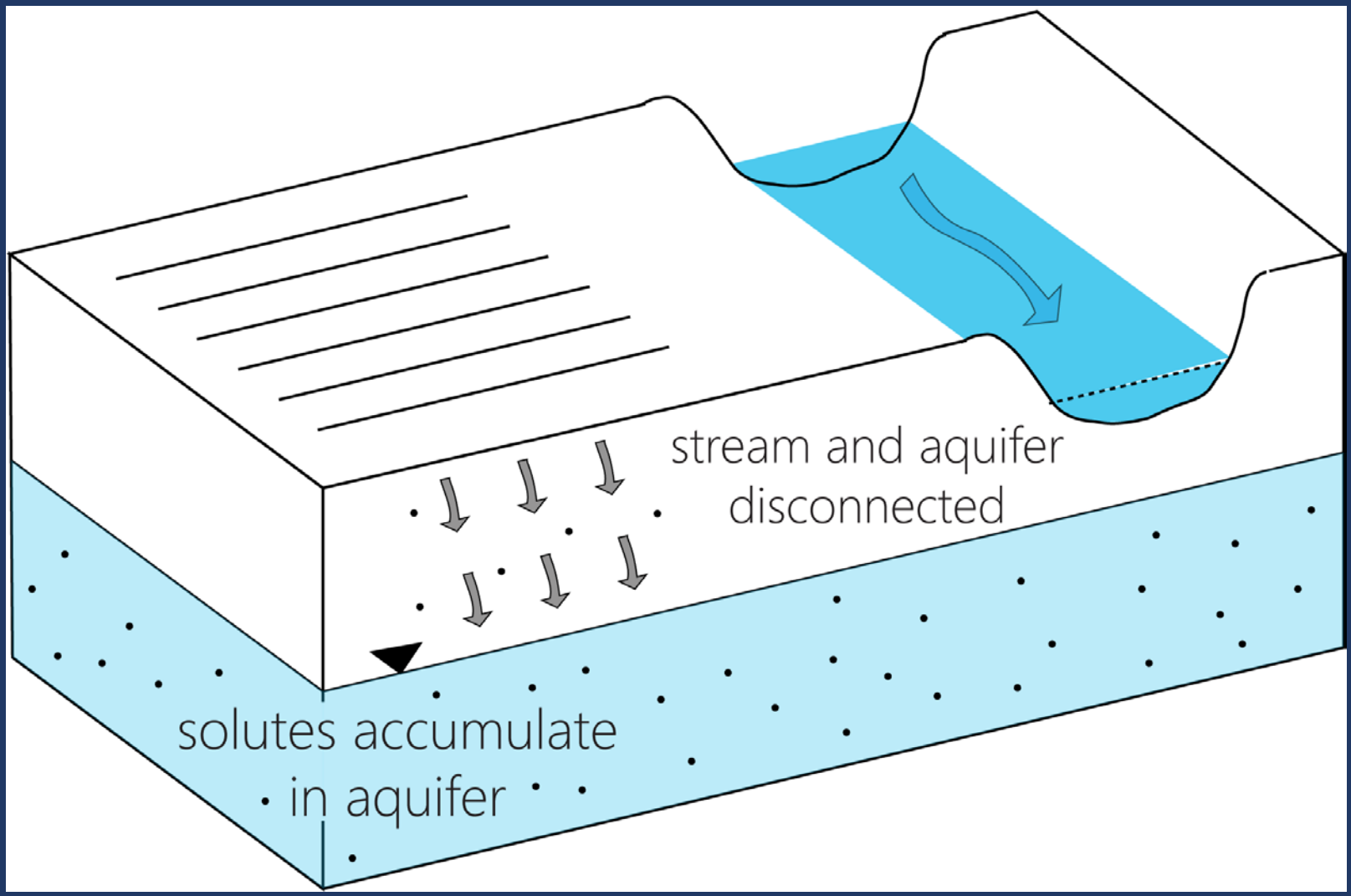

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- Recognizing benefits allows development and encouragement of innovative incentive programs
- Suggests interesting studies (field, lab, computer) for better understanding HSS/ESS and GW in general

Thank You!

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Questions?