University of Massachusetts Amherst

HYDROGEOLOGY

University of Massachusetts Amherst

Direct Lithium Extraction at the Salar de Atacama

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SOSTENIBILIDAD DE LA INDUSTRIA DEL LITIO:

Monitoreo y desafíos ambientales ante el cambio climático

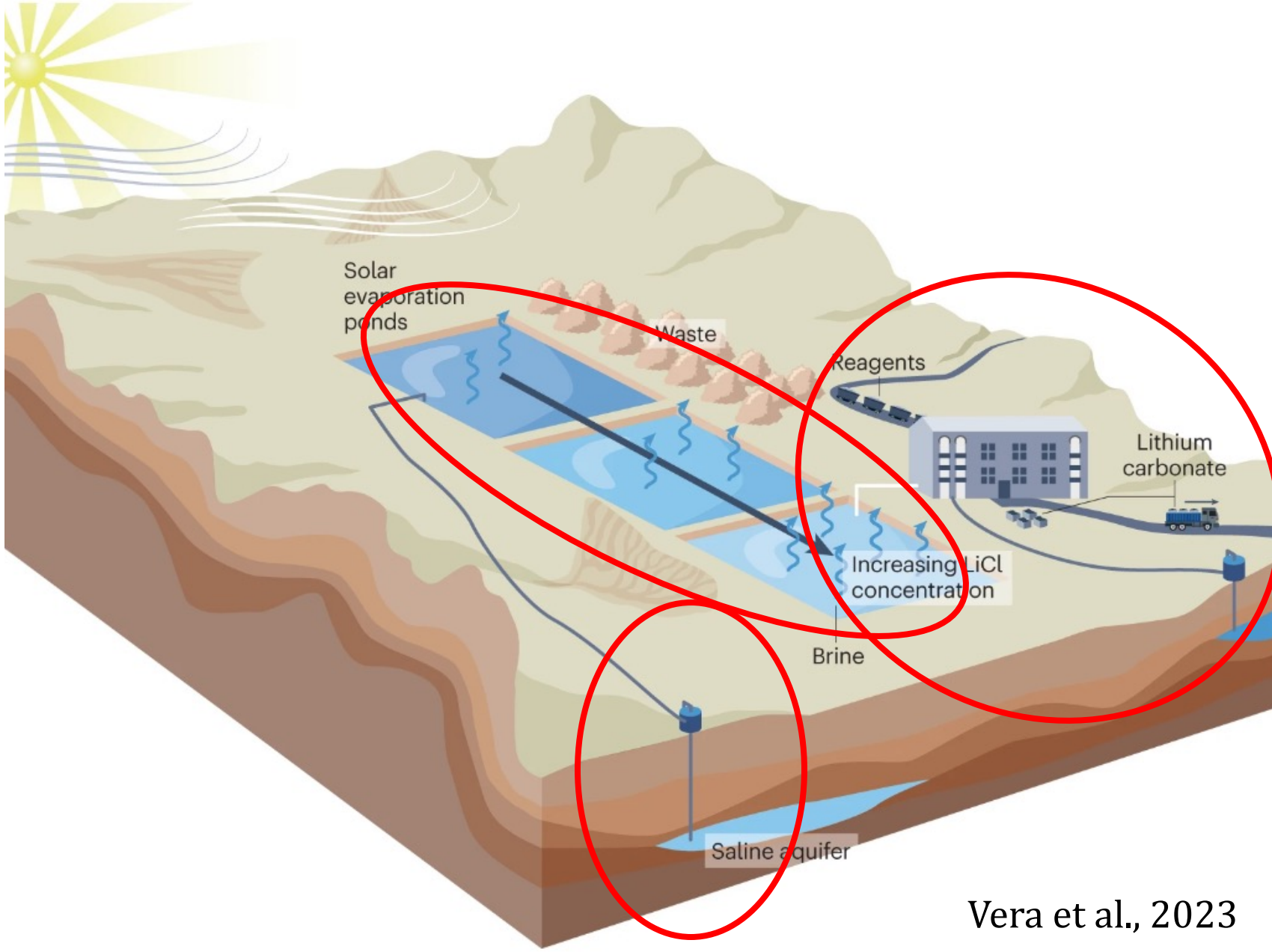
Santiago
15/03/2024

01 Direct Lithium Extraction vs. Evaporative Technologies

Photo by Nicole Blin

Evaporative Technology

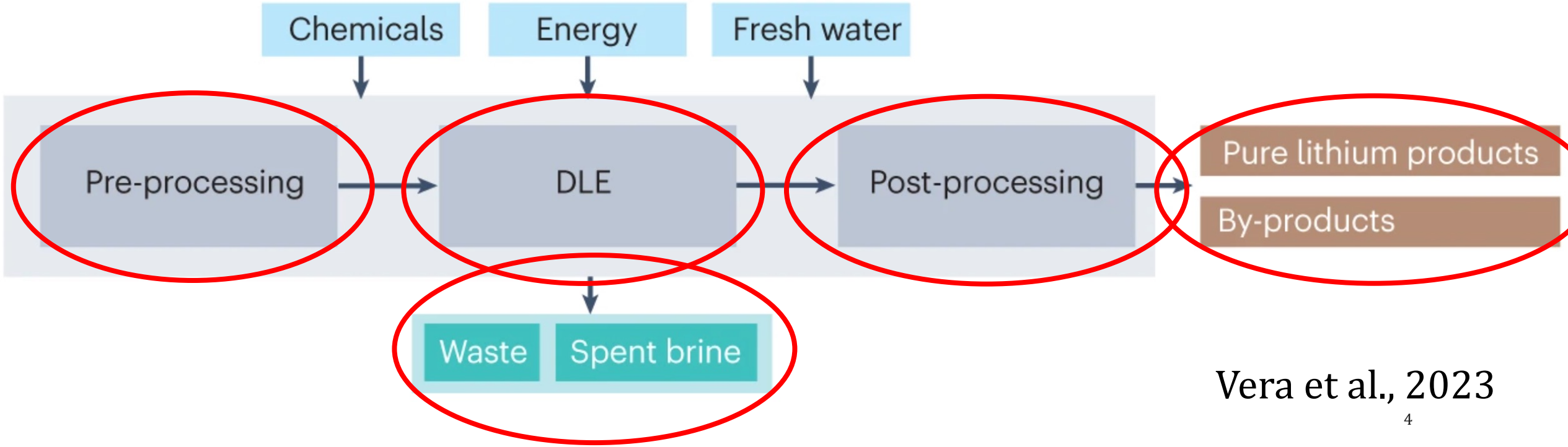
1. Brine and freshwater pumping
2. Solar evaporation in ponds
3. Secondary processing with additional freshwater
4. Final lithium product



Vera et al., 2023

Direct Lithium Extraction (DLE)

1. Brine pumping and pre-processing (sometimes evaporation ponds)
2. DLE process with freshwater
3. Spent brine reinjection
4. Post-processing with additional freshwater
5. Final lithium product



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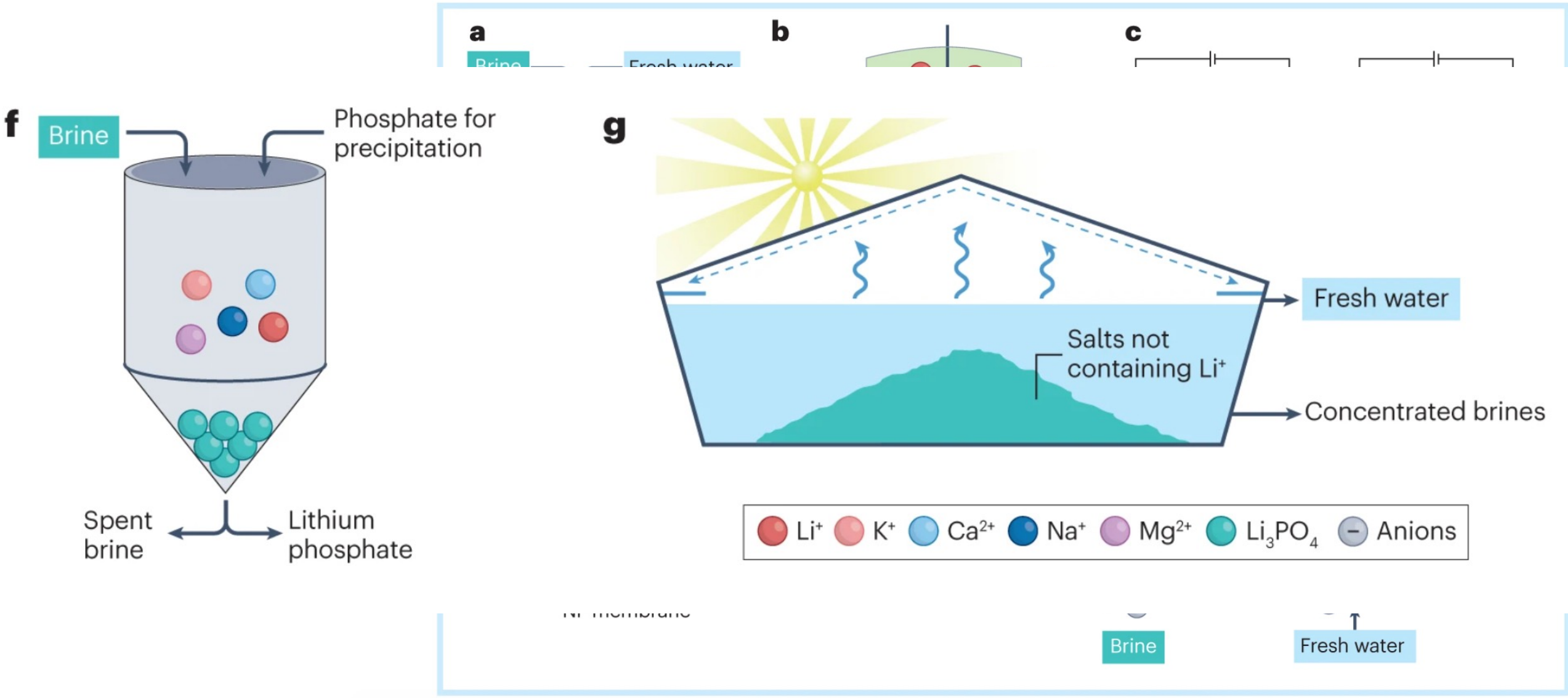
Direct Lithium Extraction Methods



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Brine Reinjection and Major Challenges

Major challenges of brine recycling (reinjection)

- Hydrogeology and understanding impacts of injection on hydrological behavior
- Brine geochemical reactions
- Seismicity and subsidence

Best practices

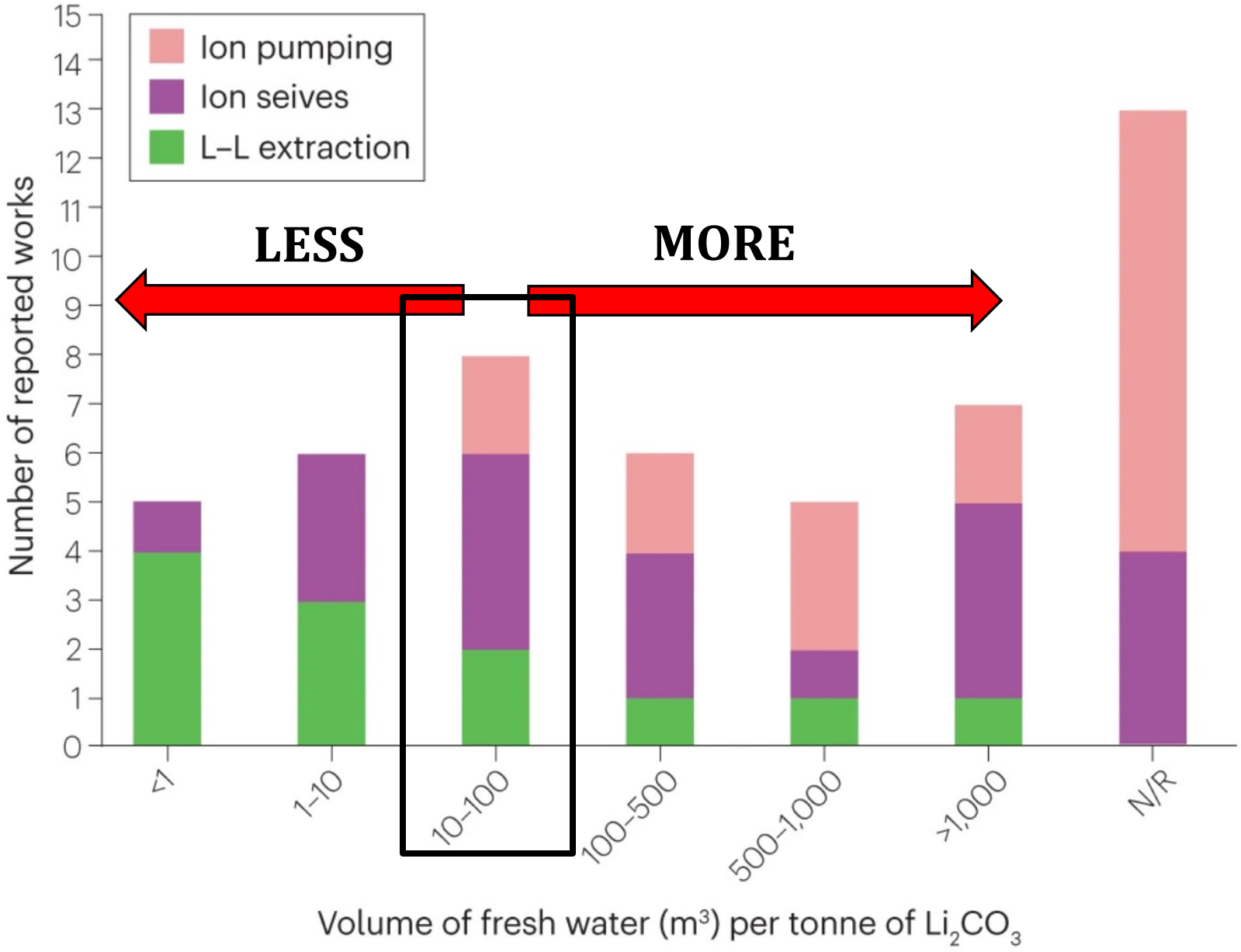
- Extensive exploration (drilling and geophysics)
- Geochemical sampling and modeling
- Develop numerical groundwater flow model with proposed well sites
- Comprehensive evaluation of well design

Reinjection Challenges at the Salar de Atacama

1. Severe lack of freshwater – cannot increase freshwater use
2. Chemistry of brine reinjection
   - Will chemical reactions change permeability?
3. Hydrogeology
   - Lack of deep permeable aquifers
   - Uncertainty in nucleus stratigraphy – important for hydrologic response
   - Dominated by evaporites – more challenging than siliciclastic aquifers

Freshwater use per tonne lithium carbonate

- Evaporative technology uses **23-50 m^3 per tonne** freshwater
- Current full-scale DLE uses **71 m^3 per tonne** freshwater
- Other test-scale DLE processes use MORE and LESS freshwater



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02 Water Availability and Freshwater Use

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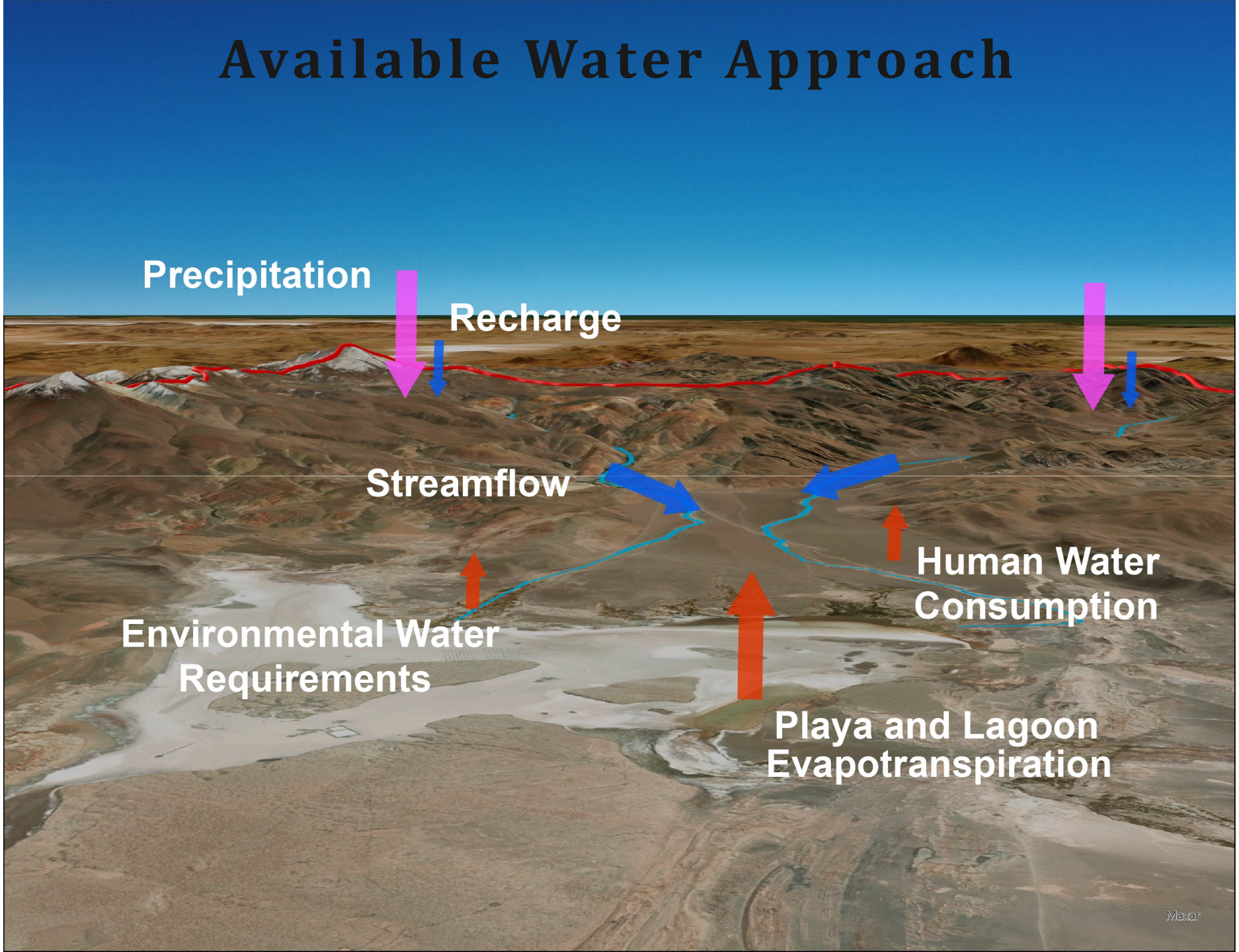
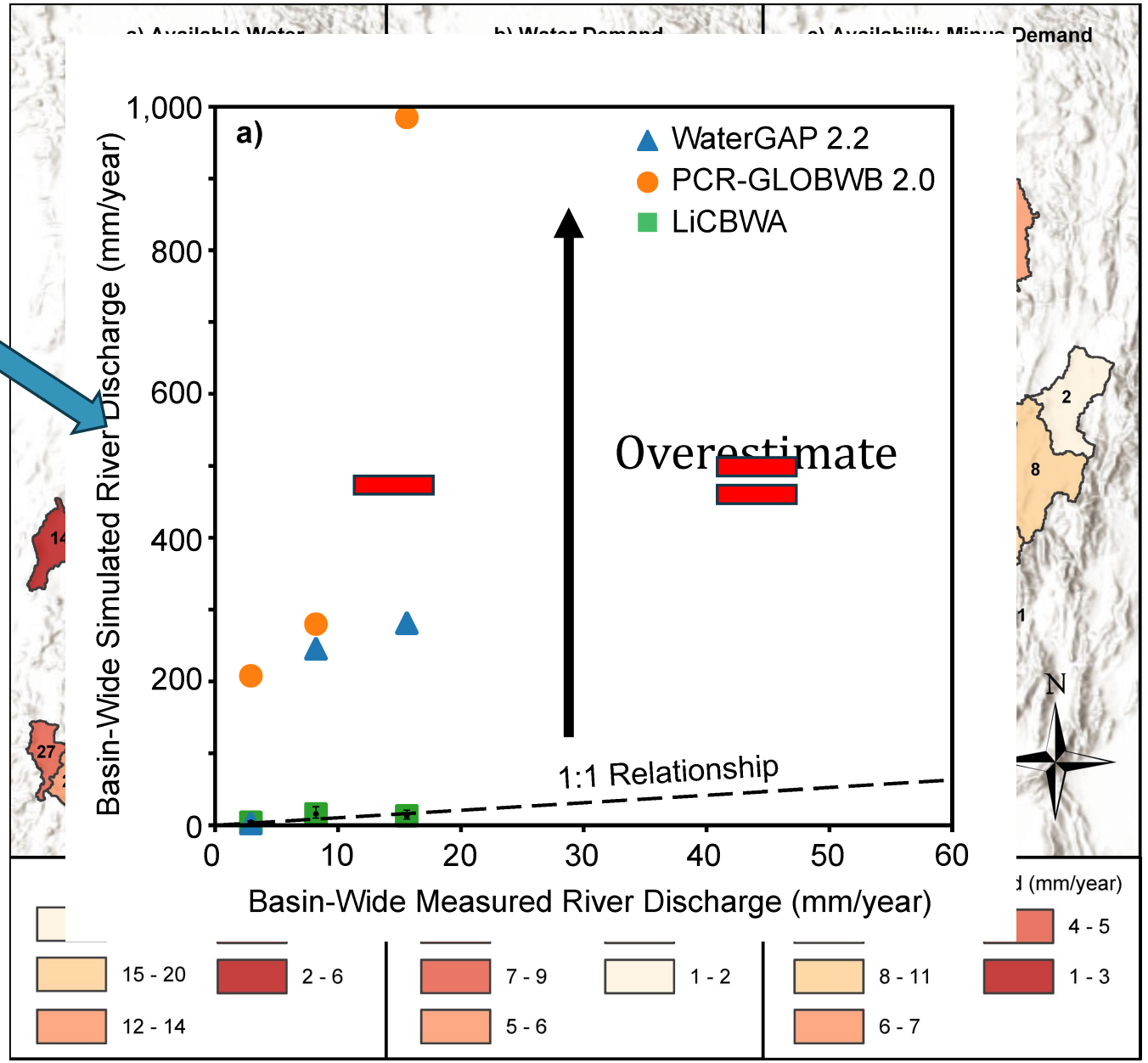
Available Water Approach



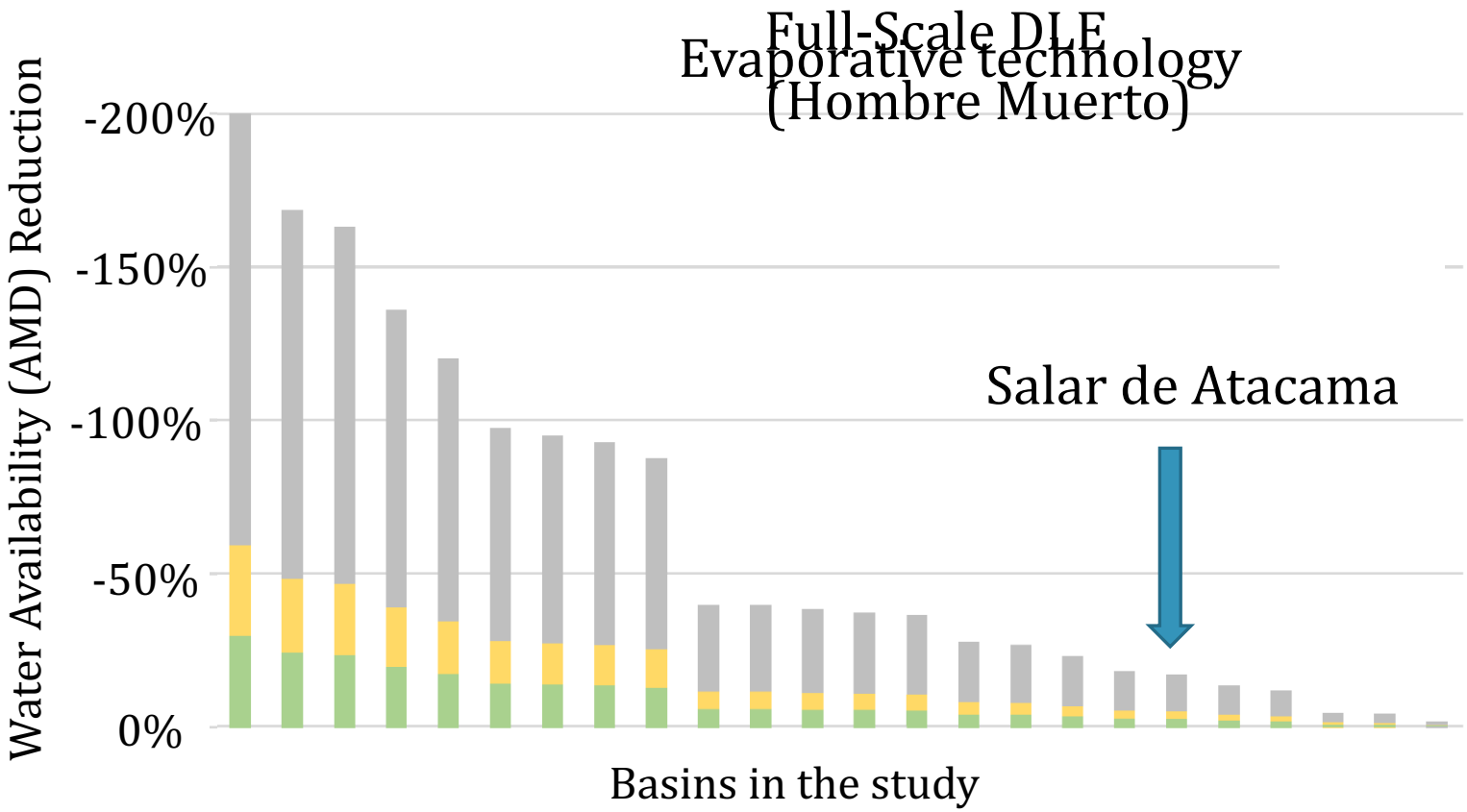
Availability Minus Demand Results

- Calculated basin-scale water availability in the context of freshwater allocations and sustainability
- Commonly used global hydrologic models greatly overpredict streamflow
- Understanding streamflow and groundwater will play large role in mining impacts



How does freshwater availability decrease with lithium mining?

- Calculated AMD when incorporating freshwater use associated with producing 10, 20, and 70 ktpa LCE
- Freshwater consumption from Li mining will preferentially impact drier, smaller basins
- Assuming the current full-scale DLE technology, DLE reduces water availability by 2x evaporative technologies



Key Takeaways

1. Hydrologic impact of DLE depends on specific DLE method (current full-scale DLE uses 2x more freshwater)
2. Challenges regarding DLE and brine reinjection at the Salar de Atacama must be addressed
3. Precipitation and water availability is overestimated in global hydrologic models in the Lithium Triangle
4. Accurate water budgets are critical to quantify impacts of lithium mining and direct lithium extraction