Integrated remote and in situ analysis of a playa lake groundwater system in northern Chile

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Hydrogeology of Arid Environments
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- Precipitation: 78.8 mm/yr
  (88% occurring during summer)
- Evapotranspiration: 1630 mm/yr
- Mean Temperature: 5.8 °C
- Elevation: 3700 masl
- Salar Size:
  - Ascotán: 243 km²
  - Carcote: 108 km²
Why do we care?
Keller and Soto, 1998
What has been the extent of the climatic and anthropogenic influence on this groundwater system over time?

1) Characterize regional and local behavior using remote sensing.
2) Relate the spatiotemporal variation to climate and/or anthropogenic forcings.
3) Supplement with in situ and hydrochemistry data.
4) Assess implications for future water resource management.
Salar Water Budget

$$\Delta V = (P + I_{GW} + I_{SW}) - (ET + O_{GW} + O_{SW})$$

**ET >> P**

Simple water budget for salars:  
$$\Delta V = (I_{GW}) - (ET + O_{GW})$$

$\Delta V =$ change in volume  
$P =$ precipitation (rain/snow)  
$I_{SW} =$ surface water inputs  
$I_{GW} =$ groundwater inputs  
$ET =$ evapotranspiration  
$O_{SW} =$ surface water outputs  
$O_{GW} =$ groundwater outputs

Remote sensing gives us $\Delta A$, which can be related to the groundwater system!
Satellite Data

- 14 scenes during 1985-2011
- Landsat 4-5 TM and 7 ETM+ from the USGS Archive.
- Supervised Classification in ERDAS Imagine 2011

Hydrochemistry

- pH
- Conductivity (µS/cm)
- Temperature (°C)
- Water depth (m)
- Cl/Br (mg/l)

-(Risacher et al., 2003)
• Houston (2006) study linked precipitation in the region to ENSO cycles
• Link between increased GW contributions to the salars, precipitation, and La Niña
Regional application: **Pastos Grandes** as a **recharge** zone for Ascotán?

\[ y = 5.1249x - 10.402 \]
\[ R^2 = 0.7074 \]
Current groundwater abstraction is located in the southern portion of Ascotan. Has this affected springs to the north?
Integrate remote sensing observations with hydrochemistry analysis.

- Water temperature, conductivity, and pH gave no clear indication of regional versus local flow.
- Cl/Br ratios provide the best indication for spatial relationships.
- Possible inverse Ghyben-Herzberg flow in the north, causing the recycling of brines.
Conclusions

1) Remote sensing allowed for antecedent analysis and large scale observation of regional recharge behavior.

2) Total surface water extent has fluctuated with a clear response to pumping initiation, but also appears to be dominated by precipitation.

3) Integration of hydrochemistry data, namely Cl/Br ratios, provided evidence for disconnect between north and south Ascotán
Future water resource management to take into account:

- Ocean circulation cycles
- Climate change
- New mine projects
- Cost-benefit analysis of water importation

Next steps:

1) Build systems dynamics models.
2) Compare across multiple salar sites in Chile
3) Incorporate into cyberinfrastructure to support cross-disciplinary and longitudinal studies.
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Questions?
References


