# Evaluating Evidence for Deep Infiltration and Recharge Below Playas and Drainage Channels in Dryland Environments

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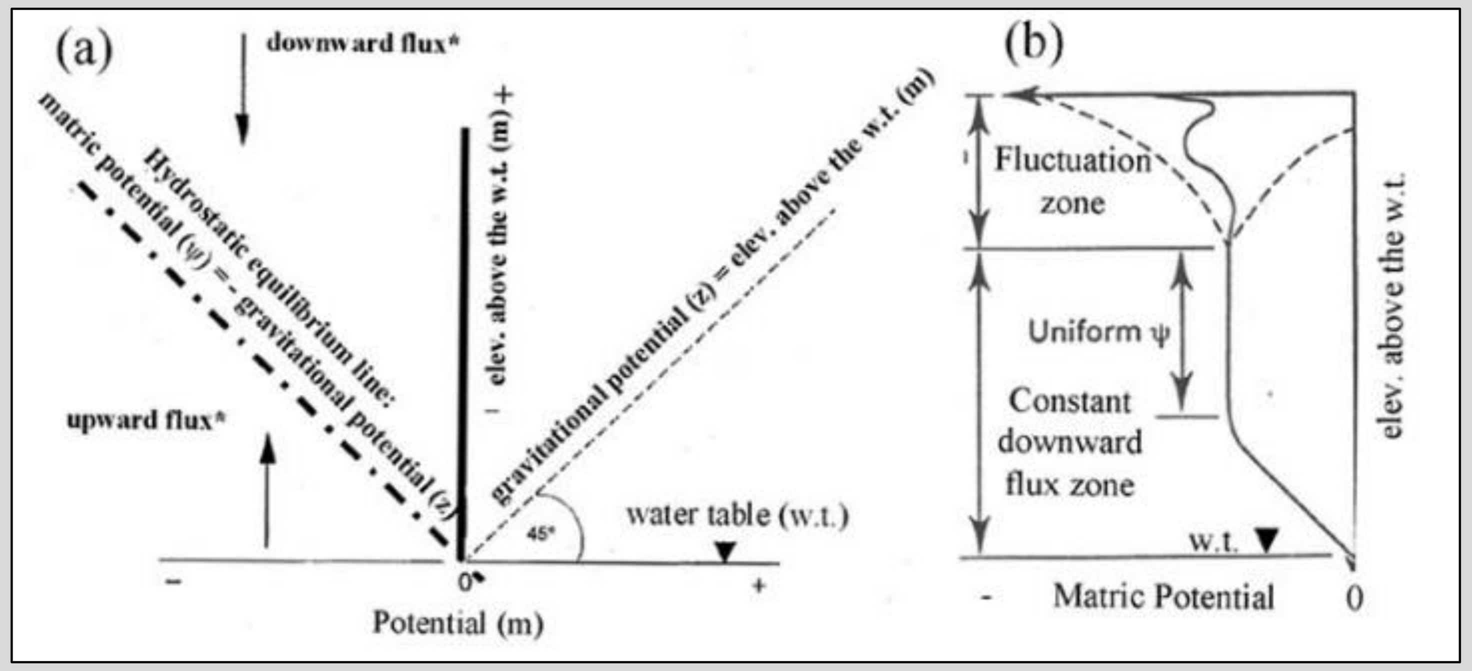
## Introduction

- Increasing population is cause for an increasing reliance on groundwater resources (Gaur et al., 2018; Qader et al., 2021).
- Playas, vital in wetter regions, store water and support ecosystems, but are challenging to quantify recharge due to variable unsaturated zone processes.
- Past research indicates recharge occurs only along mountain fronts and blocks, with none persisting in valley. It is assumed that no basin-ward recharge occurs (Walvoord et al., 2002; Scanlon, 1991). However, recent data has challenged these assumptions, proposing deep infiltration beneath playas and channels during large storm events (Duniway et al., 2018).




*(a) Conventional Hydrostatic equilibrium model from the National Research Council [1995] Ward Valley report. (b) Unit gradient model from Nimmo et al. [1994]. Plot shown right displays Cl- concentrations with depth at sites shown on the plot (Walvoord et al. 2002).*

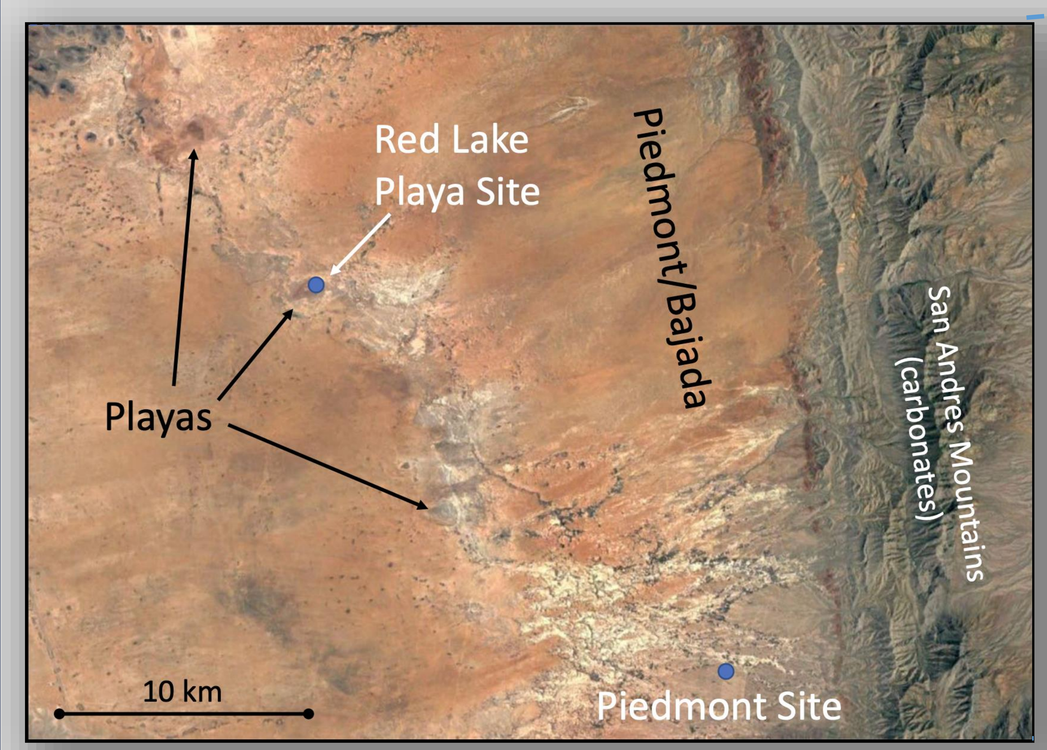
- This thesis aims to evaluate deep infiltration beneath a desert playa at the J-LTER in southeast, New Mexico, focusing on soil properties and geochemical analysis.

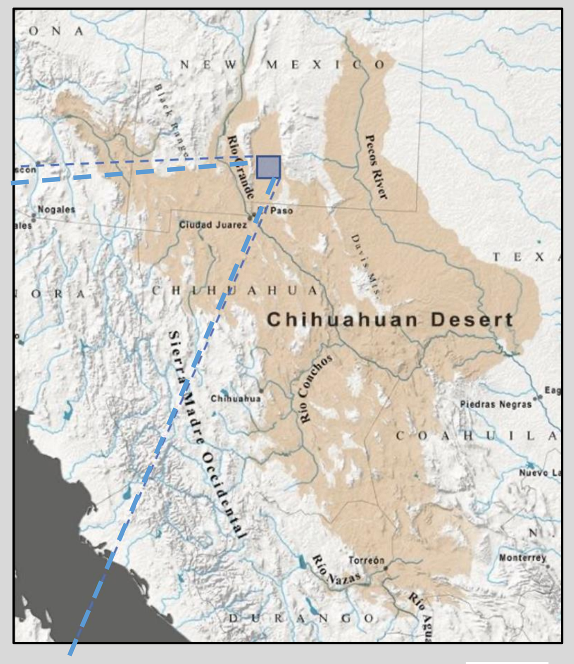
## Study Goals

- Help to improve understanding of recharge beneath desert playas by evaluating evidence for deep infiltration.
- Investigate the role of geologic factors in moisture dynamics.
- Examine moisture flux dynamics with physical samples to identify if DASH model is appropriate in study area, or if recharge might be occurring in this playa location.
- Expand upon existing models and theories of vadose zone hydrology.
- Inform future regional groundwater studies the potential necessity to closely examine playas and drainage channels as significant sources for aquifer recharge.

## Study Area

DCZN-2A-31R-1




*Map credit: Mark Engle*

- **Jornada J-LTER: Las Cruces, New Mexico**
  - Situated in the Chihuahuan desert.
  - Characterized by a desert climate with mean annual precipitation of 9.72 inches (247 mm) and high evaporation rates.
  - Used for integrated studies focusing on soil water dynamics, vegetation response to hydrological and atmospheric changes, and other factors sensitive to climate change.

## Methodology

•**Drilling and Sample Collection:**
- Utilized hollow stem auger and sonic drilling rig for borehole drilling at various depths.
- Collected soil cuttings and core samples from multiple sites, including shallow and deep playa locations and a piedmont-bajada site.

•**Soil Property Analysis:**
- Conducted analysis of hydrogeological properties such as matric potential, bulk density, porosity, and gravimetric/volumetric water content.
- Employed Decagon WP4C for measuring soil-water potential, utilizing a dewpoint sensor to determine relative humidity.
- Used a pipe ring method to measure bulk density and determine volumetric water content based on the relationship between bulk density and particle density.

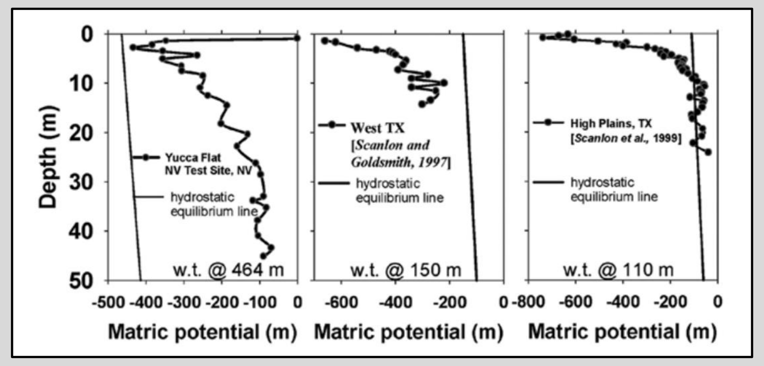
•**Chemical Analysis:**
- Analyzed chloride and nitrate concentrations in soil samples to track water movement and potential recharge pathways.
- Followed established procedures for chemical extraction and analysis, including extraction of soil samples with de-ionized water and subsequent analysis using ion chromatography.

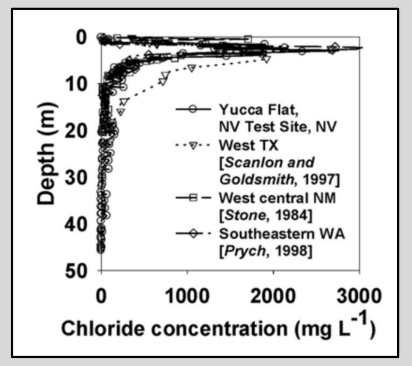
•**Sample Handling and Preservation:**
- Stored soil samples in appropriate containers to minimize moisture loss and preserve sample integrity.
- Followed standard protocols for sample collection, storage, and transport to ensure accurate analysis of soil properties and chemical concentrations.

•**Data Interpretation:**
- Interpreted soil property data to understand moisture flux patterns and recharge dynamics in arid environments.
- Integrated chemical analysis results with hydrogeological data to identify potential pathways for deep infiltration and recharge below basin-ward dryland surfaces.

•**Quality Control:**
- Implemented quality control measures to ensure accuracy and reliability of data, including calibration of instruments and standardized sampling protocols.
- Conducted cross-validation of results and comparison with established models to validate findings and ensure consistency.

## Past and Preliminary Data



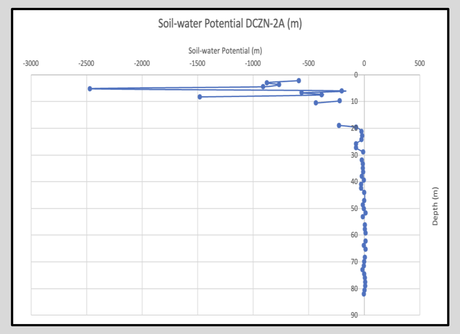



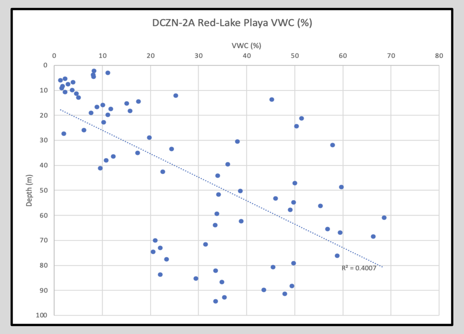

*Standard matric potential curves with depth (Walvoord et al., 2002)*

- Typical Ψ curve with depth showing extremely negative at surface and increasing with depth.
- Cl⁻ bulge typically observed in arid soils due to evaporation and root-zone flux.

**Red-Lake Playa site:**

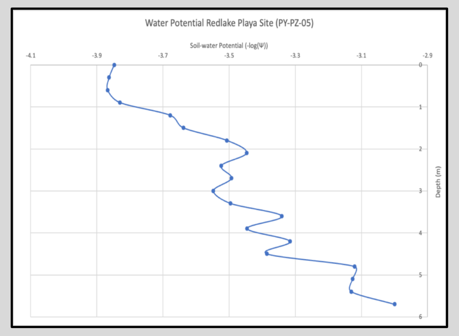
Deep Core: DCZN-2A

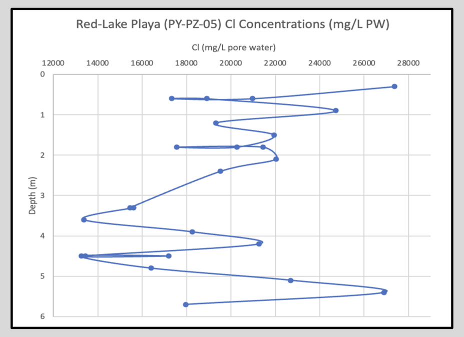


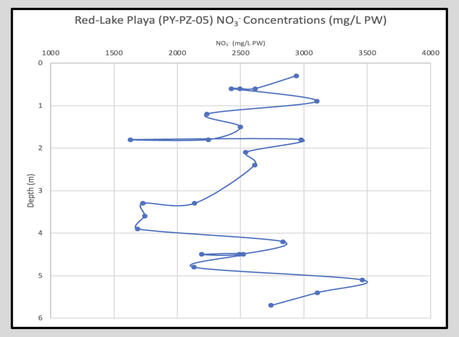


**Datasets needed:*
- *VWC shallow cores*
- *$NO_3$ and $Cl^-$ deep core*
- *Channel ("grassy pit") P to VWC conversions*
- *Completion of IC data for "grassy pit"*
- *Completion of WP4C on deep core*

Shallow Core: PY-PZ-05

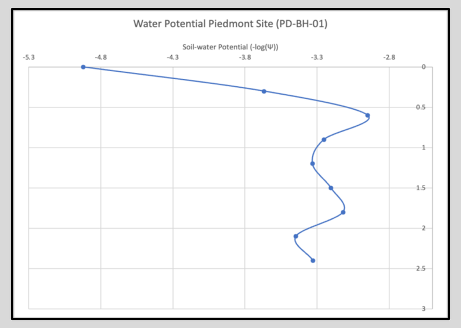


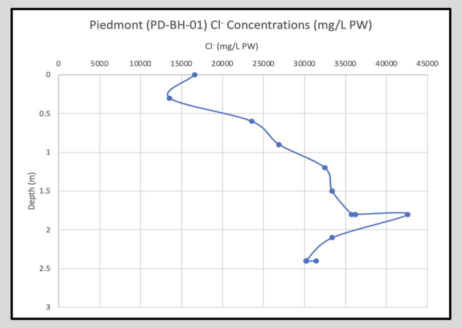


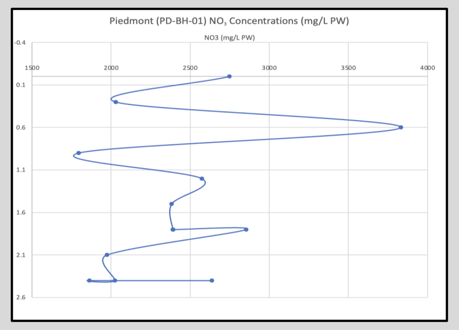



**Piedmont Site:**

Shallow Core: PD-BH-01







## Discussion

- Validity of recharge mechanisms: implications for understanding groundwater recharge in arid and semi-arid regions.
- Methodological considerations: drilling techniques, sample collection, analysis methods: strengths and limitations for reliability.
- Future research directions and investigations: thermal vapor flux, perched aquifer studies.

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