Estimating Recharge in Indian Wells Valley

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Desert Recharge

- There's a precipitation threshold for recharge
- Non linear relationship of recharge with precipitation
- It doesn't recharge every year
Outline

• Model description
• Example of recharge estimates and application to groundwater flow model at Borrego
• Recharge at Indian Wells Valley
• Potential path forward
Analysis tool: Basin Characterization Model

A grid-based water balance model

- Uses gridded climate data downscaled to fine spatial scales (historical and future)
- Incorporates detailed soil properties and estimates of bedrock permeability
- Calculates spatially distributed water supply as recharge and runoff
- Calculates climatic water deficit as estimate of demand
Potential evapotranspiration

Precipitation

Average annual (mm/year)

- High: 1994
- Low: 250

Average annual (mm/year)

- 43.5 - 50
- 50 - 75
- 75 - 100
- 100 - 125
- 125 - 150
- 150 - 175
- 175 - 200
- 200 - 300
- 300 - 400
- 400 - 500

Potential evapotranspiration

Precipitation
Within West Borrego watershed boundary
Approx 10% of runoff becomes recharge
(~460 ac-ft or 4,000 ac-ft total recharge)
Uncalibrated regional model

<table>
<thead>
<tr>
<th>Average annual</th>
<th>m³</th>
<th>ac-ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Runoff</td>
<td>5.6 million</td>
<td>4,590</td>
</tr>
<tr>
<td>Recharge</td>
<td>4.2 million</td>
<td>3,370</td>
</tr>
</tbody>
</table>
Updates to Calculations

- Most of the Borrego basin is surrounded by granites that provide intermittent runoff from the small subbasins on the western side of the basin.
- The quantification of this runoff was based on the streamflow record from Borrego Palm Creek.
Recharge Model Calibration to Streamflow
Updates to Calculations

- Using the calibration developed for this subbasin, time series estimates of monthly streamflow for all small tributary subbasins were developed for 1940-2007.
Example of time series at Anza-Borrego
Recharge

2002

(mm/year)

0 - 10
10 - 20
20 - 50
50 - 100
100 - 200
200 - 300
300 - 400
400 - 500
Recharge

2007

(mm/year)

- 0 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
Recharge

2008

(mm/year)

- 0 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
Recharge 2009 (mm/year)

- 0 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
Recharge + 10% Runoff (mm/yr)

- 0.5
- 0.5 - 1
- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 20
- 20 - 40
- 40 - 70
- 70 - 100
- 100 - 130

Closed basins
Percent of Total Basin Recharge into Groundwater Basin

- 0
- 0 – 0.4
- 0.4 – 0.7
- 0.7 – 1
- 1 – 1.7
- 1.7 – 2.8
- 2.8 – 3.2
- 3.2 – 4
- 4 – 5.8
- 5.8 – 8.3
Relative Contribution of Recharge to Groundwater Basin

High : 1
Low : -1
Recharge Summary and Path Forward

- Water balance modeling can be used to characterize hydrologic conditions, including recharge, in the Indian Wells basin.
- Characterize climate and changes in climate for the region.
- Refine distributed recharge estimates using remotely sensed actual evapotranspiration to constrain the water balance and model calibration to streamflow.
- Depending on available data, additional considerations to refine estimates:
  - age-dating, chemical signatures, source areas
  - well responses
  - long term trends, subsidence
- Characterize projected changes in climate, demand, and recharge for the region.
Potential Modeling Work

• To understand how much water makes it through the unsaturated zone and to the aquifer and how it is distributed requires a groundwater model.

• Advances in characterizing subsurface conditions: Borrego example (utilized BCM).

• Workflow/Budget

• Timeline
Physical aspects of the landscape can now be used directly in models.
Spatial and temporal water use is calculated.
Water level declines are determined.
Land Subsidence Evaluation

• Elevations for all 25 benchmarks are stable (< 6") compared to elevations derived from leveling measurements in 1978 (23 benchmarks) or 1969 (2 benchmarks)
• InSAR shows a maximum of 0.6 inches in 4 recent years
• NOT CURRENTLY AN ISSUE OF CONCERN IN BORREGO

Max. change (ft) in 40 years
14JRH  -0.329 ft
Hydrogeologic Characterization: subsurface permeability and storage
Groundwater budget changes with historical climate variability
Predictive simulations for management

- **Scenarios**
  - No action 50 years
  - Growth scenarios
  - Example water usage reduction to reach sustainability
  - Climate change scenarios

![Diagram of water levels and aquifers](image)

- More sustainable usage
- Continued use at current rate
Basic groundwater budget for Borrego

**Preliminary Groundwater Budget (acre-feet per year)**

<table>
<thead>
<tr>
<th>IN</th>
<th>No Development</th>
<th>2010</th>
<th>No Change Scenario</th>
<th>Example Sustainable</th>
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</thead>
<tbody>
<tr>
<td>Natural Recharge</td>
<td>5,395</td>
<td>2,812</td>
<td>5,395</td>
<td>5,395</td>
</tr>
<tr>
<td>Flow out southern end</td>
<td>518</td>
<td>517</td>
<td>515</td>
<td>515</td>
</tr>
<tr>
<td>Natural ET</td>
<td>5,355</td>
<td>453</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Wells</td>
<td>17,410</td>
<td>18,821</td>
<td>5,148</td>
<td></td>
</tr>
<tr>
<td>Storage Change</td>
<td>-478</td>
<td>-15,568</td>
<td>-14,141</td>
<td>-478</td>
</tr>
</tbody>
</table>

Period has slight decrease in storage
Scenarios: storage changes over time

Continued use at same rate

More sustainable usage
Potential Modeling Work

- **Workflow/Budget**
  - Define IWV needs and conditions
  - Update existing model with additional characterization, BCM recharge, and current climate
  - Add scenarios/optimization?
  - About $500K (depending on funding sources, up to 25% from USGS)

- **Timeline (3 yrs)** –
  - Quarterly reports
  - Update model and incorporate BCM – year 1
    - Provide preliminary model
  - Develop optimization and scenarios testing – 1.5 years
    - Meetings: showing/testing model
  - Report documenting model end of 3 years
    - Journal article/USGS report?