Characterization of seasonal effects on the specific capacity of rope-pump wells in a fractured rock-aquifer in Nicaragua

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Outline

- Problem Statement
- Research Objectives
- Study Area
- Methodology
- Results
- Conclusions
Problem Statement

• Practically no information exists on the productivity of rural wells in developing countries.

• Policy makers have no information to base decisions or to develop water management plans.

• The lack of technical and economic resources prevents the collection of performance and monitoring data.
Research Objectives

Design and test a method to characterize the productivity of existing rope-pump wells in rural areas of developing countries.

Monitor seasonal changes in SWLs and specific capacities of rope-pump wells in an area that experiences distinct rainy and dry seasons.
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Regional Geology

Tpc - Coyol Group
Fractured ignimbrites, tuff, andesite, basalt

Source: INETER
Rope-pump well
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Testing and Monitoring Approaches

- Monthly manual pump tests in triplicate at 3 wells
- Each test conducted to attain pumping, equilibrium, and recovery phases
- A conventional step-drawdown test performed in one well
Pump test regime

- Pump 60 – 90 gal
- Approximate rate of 5 gpm
- Allow well to recover for an hour or more
- Triplicate tests
Well 2: 1/11/07

Elapsed Time (sec) vs. Drawdown (ft)

- Pumping
- Equilibrium drawdown
- Recuperation

Legend:
- Test 1 levelogger
- Test 2 levelogger
- Test 3 levelogger
- Test 3 sounder
- Test 2 sounder
- Test 1 sounder
Equilibrium drawdown
Data analysis method
Pump and recovery curves
Data analysis methods

Cooper-Jacob Approximation in “Conventional” Units:

\[
\frac{Q}{S} = \frac{T}{264 \log \frac{0.3Tt}{r^2S}}
\]
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Change in static water level

Static Water Levels (Dec '06 - Oct '07)

Average dry season drop = 6 ft

Time

Well 1
Well 2
Well 3
Well 4

10/22/06 12/11/06 1/30/07 3/21/07 5/10/07 6/29/07 8/18/07 10/7/07 11/26/07

DRY
RAINY
### Specific Capacity Changes

#### Data Table

<table>
<thead>
<tr>
<th>Well</th>
<th>Change SWL (ft)</th>
<th>Change SWL (% available water column)*</th>
<th>% Change Specific Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.6</td>
<td>4 %</td>
<td>15 %</td>
</tr>
<tr>
<td>2</td>
<td>4.4</td>
<td>2.5 %</td>
<td>26 %</td>
</tr>
<tr>
<td>3</td>
<td>6.3</td>
<td>3.5 %</td>
<td>--</td>
</tr>
<tr>
<td>4</td>
<td>7.9</td>
<td>4.8 %</td>
<td>81 %</td>
</tr>
</tbody>
</table>

*Assuming 200' well

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**Diagram Description:**

The graph shows the specific capacity (attained from recovery data) vs. SWL for three wells: Well 1, Well 2, and Well 4. The x-axis represents the feet below SWL in December 06, ranging from -1.0 to 9.0. The y-axis represents the specific capacity, with values ranging from 0.0 to 2.0. Each well's data points are marked with different colors: Well 1 with red squares, Well 2 with blue diamonds, and Well 4 with green triangles. Error bars indicate the variability in specific capacity measurements.
Analysis method comparison

Spec. cap values calculated from:
- equilibrium approx
- recovery curve
- pump curve
Conventional pump test comparison

Well 4

Spec. cap values calculated from manual tests:
- equilibrium approx
- recovery curve
- pump curve

Spec. cap values calculated from conventional test:
- equilibrium approx
- recovery curve
- pump curve
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Conclusions (1 of 2)

On method:

- Manual test pump rate low, but results are representative of well behavior at high rates (in this case 7 times higher).

- Recovery data easiest to collect and yields accurate specific capacity values.

- Overestimated specific capacity of wells as determined by equilibrium drawdown method maybe caused by lack of understanding of geology.

- Modifications to well for manual pump test minor, economical.
Conclusions (2 of 2)

On seasonal effects:

- Current water demands not affected by seasonal change in the static water level.

- Method determined that max capacity of wells to be at least 10X greater than what rope pump well delivers.

- Observed changes in productivity with even slight changes in SWL.
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