Crossing the Threshold of a Higher Order
Urban Groundwater Level Forecast

Dr. Jaber Almedeij
Introduction

- Groundwater level increase constitutes a common problem in residential areas.
- It is believed that the source for this water is human-induced recharge activities.
- Evaluating directly the source of groundwater recharge might not be practically possible.
- Climatological parameters may be used to find in an indirect manner any causative relationship.
Objectives

- To examine the correlation of groundwater level data with both temperature and rainfall data.
- To examine the cyclic structure of the three data sets in the frequency domain using the periodogram technique.
- To provide an attempt for modeling and forecasting groundwater level variation in residential areas.
HL-1A

The graph shows the water level over time for HL-1A with the y-axis representing water level (m) and the x-axis representing time (months). The black dotted line represents the observation data, while the red dashed line represents the fitted trend. The graph covers the period from 1993 to 2002.
\[ \bar{\bar{j}} = \frac{1}{N} \sum_{v=1}^{N} j_{v,\tau} \quad \tau = 1, \ldots, 12 \]

\( j \) = seasonal time series
\( \bar{\bar{j}} \) = seasonal mean
\( N \) = total number of years
Monthly-averaged temperature

Detrended water level

Monthly-totaled rainfall
Data characteristics of monitoring wells

<table>
<thead>
<tr>
<th>Well no.</th>
<th>Duration (year)</th>
<th>aWater Level (m)</th>
<th>r_T</th>
<th>r_R</th>
<th>Periodicity (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BN-1A</td>
<td>1992-2001</td>
<td>8.42-12.23</td>
<td>0.35</td>
<td>-0.29</td>
<td>12, 20, 30</td>
</tr>
<tr>
<td>JB-1A</td>
<td>1993-2002</td>
<td>4.52-6.08</td>
<td>0.26</td>
<td>-0.37</td>
<td>12, 17</td>
</tr>
<tr>
<td>JB-2B</td>
<td>1993-2002</td>
<td>1.92-2.56</td>
<td>0.43</td>
<td>-0.58</td>
<td>12</td>
</tr>
<tr>
<td>HL-1A</td>
<td>1993-2002</td>
<td>3.76-5.60</td>
<td>0.37</td>
<td>-0.44</td>
<td>12, 27</td>
</tr>
<tr>
<td>NZ-1A</td>
<td>1992-2000</td>
<td>2.68-4.07</td>
<td>0.36</td>
<td>-0.43</td>
<td>12, 18</td>
</tr>
<tr>
<td>NZ-1B</td>
<td>1993-2000</td>
<td>2.68-4.07</td>
<td>0.34</td>
<td>-0.43</td>
<td>12, 19</td>
</tr>
</tbody>
</table>

^aBelow ground surface
\[ h(t) = y(t) + s(t) + \varepsilon(t) \]

\[ y(t) = \begin{cases} 
0.0158t - 5.3091, & \text{if } t < 48 \\
0.0122t - 5.7302, & \text{if } 48 \leq t < 80 \\
0.0045t - 4.4914, & \text{if } t \geq 80 
\end{cases} \]

\[ s(t) = 0.11067 \cos\left( \frac{2\pi}{12} t + 1.526 \right) - 0.086376 \cos\left( \frac{2\pi}{27} t - 0.64181 \right) \]
MAE = 0.105 m

\[
MAE = \frac{1}{N} \sum_{i=1}^{N} |h_{i, \text{observed}} - h_{i, \text{calculated}}|
\]

MAE = 0.097 m
Conclusions

- The examined data of groundwater level is correlated with temperature and rainfall.
- The periodogram technique can provide means for modeling and forecasting the variation pattern of groundwater level data.