Spectral Analysis of the Groundwater Levels in a Suburban versus an Urban Region. An Example from Suffolk and Queens Counties in Long Island, NY

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1. Introduction

The supplied water in Long Island, NY originates from the underground reserves available throughout the island. Factors such as the installation of sanitary, storm-sewer systems, and large scale groundwater pumpage have been affecting the amount of water in the reserves since the area first began being developed. Suffolk, although founded around the same time as Queens, lead to be a largely undeveloped area with a smaller population where residents have their own well, many of which are still active today.

Figure 1: Study area and USGS data collection sites (404416073491802, 405743072425701 for Queens and Suffolk county respectively) are projected on a satellite image produced in Google Earth. The dashed line represents the groundwater divide of the watershed in Long Island, NY (Franke & McClymonds, 1972).

These two areas have been studied in order to monitor the periodicity of groundwater in each location (Figure 1). We have used data retrieved from the United States Geological Survey (USGS) monitoring stations for the water depth levels in order to analyze the long-term correlation between the groundwater in Queens and Suffolk County and their related periodicities.

2. Methodology

The data sets of daily groundwater levels were collected from USGS, ranging from March 3, 2014, to February 26, 2019. Groundwater measurements were retrieved from two USGS stations located in Queens and Suffolk County. The data was imported and analyzed in KoNstanz Information MinEr (KNIME) to evaluate any possible missing values and applied different data analytics techniques. The groundwater data were then detrended to convert the groundwater time series in a stationary time series in order to study the different periodicities at both locations. Applied the spectral analysis method, we determine the main periodicities for both groundwater time series. The spectral analysis has been conducted in R software using the time series analysis package (TSA package in R; Chan and Ripley, 2018) for the groundwater levels in Queens and Suffolk. Groundwater time series analysis was performed by detrending the time series, and further separation of the various time scale components (long, seasonal, and short term component). With this information, we can determine the groundwater period in urban Queens versus suburban Suffolk county.

3. Results-Conclusions

The spectral analysis of the groundwater from the two USGS stations for the time period of 2015 through 2019 has shown two main periods of 256 days and 142 days for Queens station, and two main periods of 320 days and 160 days for Suffolk station (Table 1). The spectral density peaks and related periods are shown in the plot of periodogram (Figure 2).

Queens

Frequency (cycles/time unit)	Spectral	Period (days)
0.00391	0.00016	256
0.00703	0.00015	142

Suffolk

Frequency (cycles/time unit)	Spectral	Period (days)
0.00625	0.00028	160
0.00312	0.00028	320

Table 1: For the time period of 2015-2019, the spectral density, related frequency (cycles/time unit), and periods are presented for Suffolk county USGS station 405743072425701 and Queens county USGS station 404416073491802.

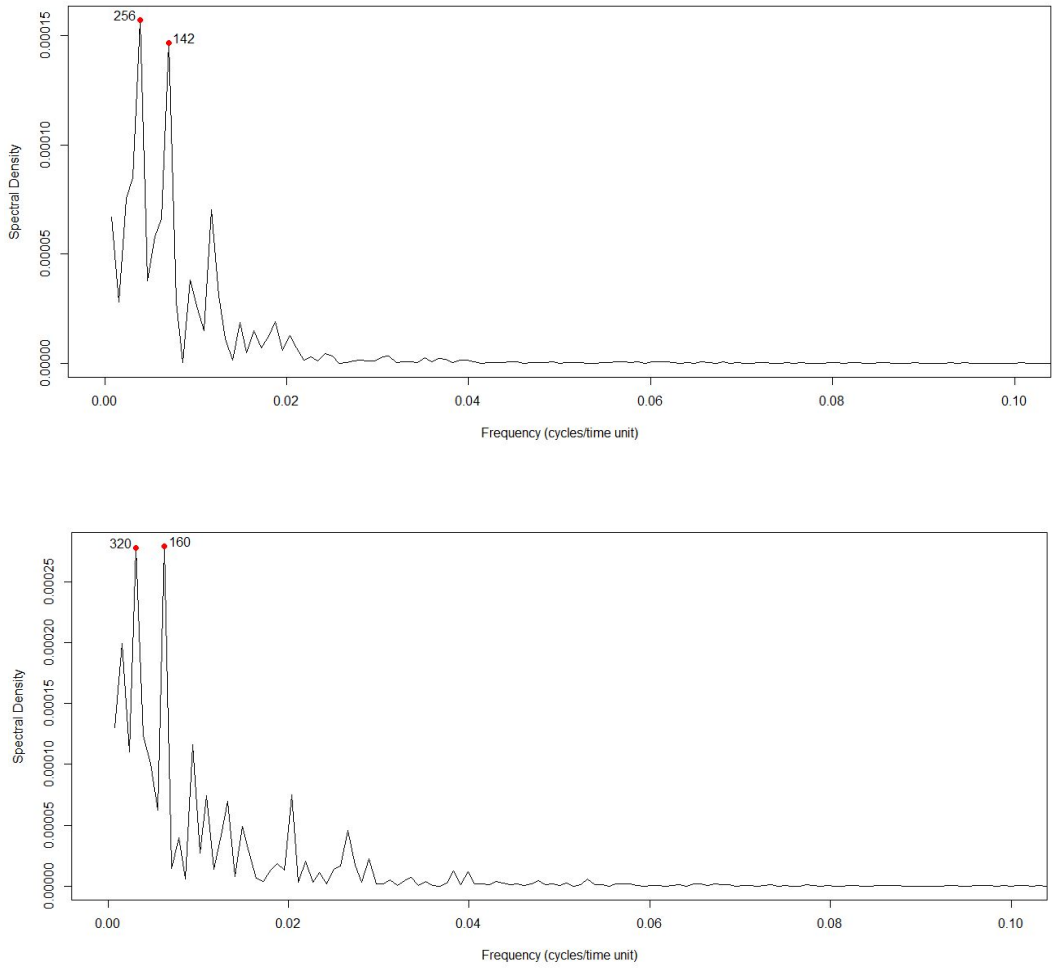

Figure 2: Periodograms showing the major cycles of groundwater for Queens (upper) and Suffolk region (lower). Periodicities (in days) are showing with a red bullet on each corresponding spectral density peak.

4. References

Chan K.S. and Ripley B., 2018, TSA: Time Series Analysis. R package version 1.2. https://CRAN.R-project.org/package=TSA

Franke, O.L., McClymonds, N.E., 1972, Summary of the hydrologic situation on Long Island, New York, as a guide to water-management alternatives: U.S. Geological Survey Professional Paper 627-F, 59p.

"Groundwater Levels for the Nation.", 2014, *USGS*, U.S. Department of the Interior, nwis.waterdata.usgs.gov/usa/nwis/gwlevels/?site_no=404504073444401.

"National Water Information System: Mapper." *Water Resources of the United States*, maps.waterdata.usgs.gov/mapper/index.html.

"National Water Information System: Mapper." *USGS*, U.S. Department of the Interior, maps.waterdata.usgs.gov/mapper/index.html.
"New York Active Water Level Network." *USGS*, U.S. Department of the Interior, groundwaterwatch.usgs.gov/statemaps/GA.html.
"NWIS Site Information for the USA: Site Inventory ." *USGS*, U.S. Department of the Interior, waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=404416073491802.