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Aquifer Characterization in Cheon-an area by using long-term groundwater-level monitoring data

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Abstract

One-year-long groundwater-level data have been collected from 18 wells in Cheon-an area. The result of barometric efficiency, autocorrelation, cross-correlation and statistical distribution evaluated from the measurement data shows that groundwater -level measurements from observation wells are the principal source of information about aquifer characteristics. Data from WA-2 has high barometric efficiency as well as steady decreasing auto-correlation coefficient, which means nonleaky confined aquifer. Most aquifers in this study show the unconfined properties so that barometric efficiencies are mostly low and the coefficients of cross-correlation between groundwater-level and precipitation are commonly high. This study showed that the long-term groundwater-level monitoring data without artificial stress such as pumping would give accurate information about aquifer characteristics.

key word : long-term groundwater monitoring, aquifer characteristics, barometric efficiency, correlation

1. Introduction

Groundwater systems are dynamic and adjust to short-term and long-term changes in both natural and artificial factors. Climate factors such as barometric pressure and precipitation, and artificial factors including groundwater withdrawal and land use affect groundwater-level fluctuation which implies characteristics of aquifer. Since it is obvious that these stresses make changes on groundwater-level, there have been a number of studies about groundwater recharge rate and aquifer characterization by use of groundwater-level monitoring. The purpose of this study is also aquifer characterization by using one-year-long (2002.7~2003.6) groundwater-level monitoring data from 18 wells in Cheon-an area.

2. Data collection and correction

The study area and observation wells are shown in Figure 1 and the information of wells are

presented in Table 1. Groundwater-level had been measured by pressure type automatic data collecting device, named DIVER so that piezometric influence by atmospheric pressure has been corrected first. Barometric pressure fluctuation data collected from Cheon-an meteoric station had been used for the barometric efficiency, and precipitation data from Cheon-an, Byung-chun, Seong-hwan and Jeong-an meteoric stations had been used for time series analysis. Ten out of eighteen wells are drilled 70 m deep, and eight wells are approximately ranging from 14 to 30 m deep. Aquifers of eighteen wells are classified as shallow aquifers(expressed as alluvium in table 1) and deep aquifers (expressed as fractured rock). Monitoring intervals of groundwater -level were 3 hours which was the same as the one of barometric pressure in Choen-an meteoric station.

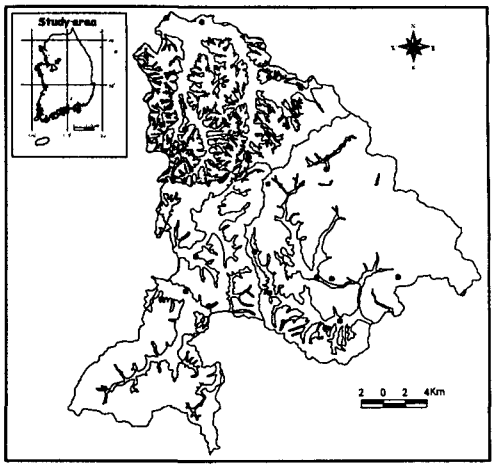

Figure 1. Location of study area

Table 1. Information of wells in study area

well no.	precipitation gaging station	Drilling depth	Aquifer classification	well no.	precipitation gaging station	Drilling depth	Aquifer classification
WA-4*	Byung-chun	70	Frac. Rock	WC-7	Byung-chun	30	Alluvium
WA-3*	Jeong-an	70	Frac. Rock	WC-8	Cheon-an	20.5	Alluvium
WA-6*	Cheon-an	70	Frac. Rock	WC-2	Cheon-an	51.5	Alluvium
WA-9	Byung-chun	70	Frac. Rock	WA-1	Seong-hwan	70	Frac. Rock
WA-7*	Cheon-an	70	Frac. Rock	WC-4	Seong-hwan	16	Alluvium
WC-3	Seong-hwan	25	Alluvium	WA-5*	Seong-hwan	70	Frac. Rock
WC-5	Cheon-an	21.5	Alluvium	WA-8*	Byung-chun	70	Frac. Rock
WC-1	Seong-hwan	26.5	Alluvium	WA-10*	Byung-chun	70	Frac. Rock
WC-6	Byung-chun	14	Alluvium	WA-2*	Seong-hwan	70	Frac. Rock

3. Results

Barometric efficiency:

According to previous studies, barometric pressure fluctuation are important for confined aquifers in general. But only for deep unconfined aquifer, some studies showed that it is also important even for unconfined aquifer. The change of water table by barometric pressure in confined aquifer is totally different from the change in unconfined aquifer; steady and still in confined aquifer, shortly recovered in unconfined aquifer.

Barometric efficiency analysis has been conducted with dry season data which was not affected by other stresses. Figure 3 and 4 show some results of the analysis. As in figures, whatever the aquifer type is, correlation between groundwater change(Δh) and barometric pressure change(Δp) are nearly

same, which means deep aquifers in study area have good connection with upper shallow aquifers. However, the average correlation coefficient of deep aquifers is slightly higher than shallow aquifers. The result of WA-2 and WA-5 classified into fractured rock aquifer show their confined aquifer characteristics very clearly. A notable result among wells classified alluvium is that WC-2 shows quite good correlation between Δh and Δp. It implies that there might be a layer with low permeability in WC-2 area.

Time series analysis: including autocorrelation and cross-correlation

If a series(water-level) is not autocorrelated, it is called independent; the series is without memory; change is happened by stress in short time. In study area, the sites that have high correlation in barometric efficiency have slowly decreasing autocorrelation coefficient; water level data series are with memories; rarely affected by stress(figure 5).

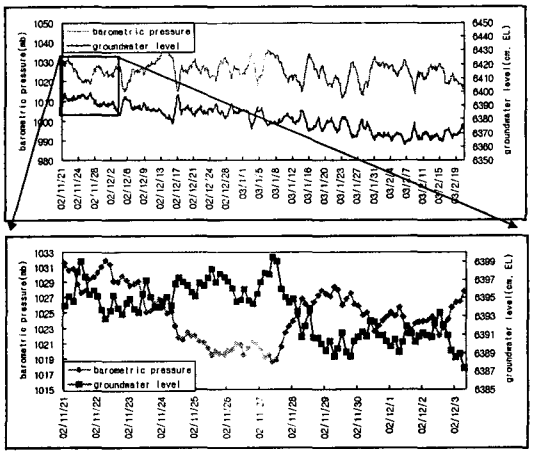

Figure 2. Comparision between Groundwater -level and barometric fluctuation (WA-2)

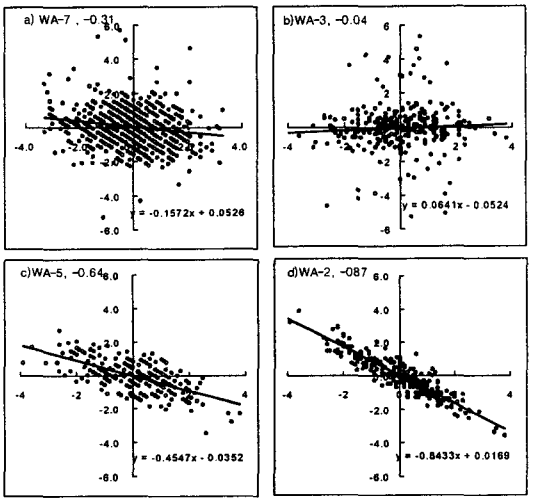

Figure 3. Correlation between Δh (x axix) and Δp (y axix) in deep aqufer (rock)

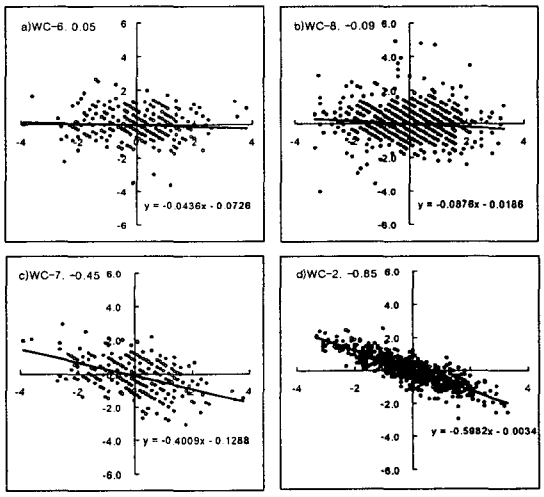

Figure 4. Correlation between Δh (x axix) and Δp (y axix) in shallow aqufer (alluvium)

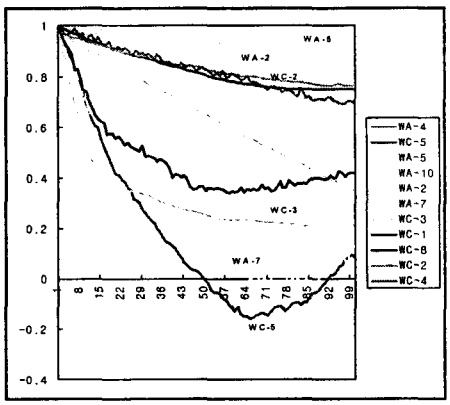

Figure 5. The result of Autocorrelation

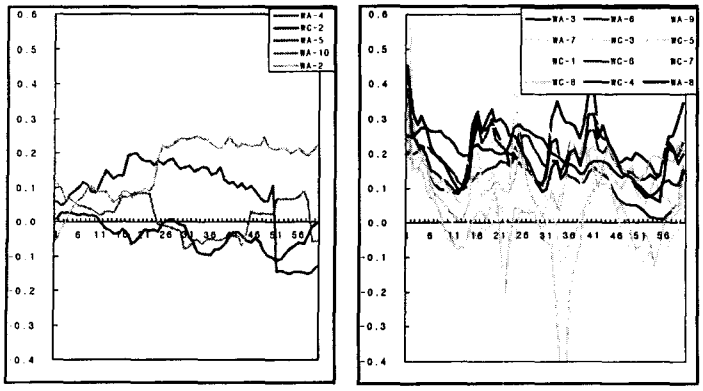

Figure 6. The result of cross-correlation (relatively low; left)

The result of cross-correlation between groundwater-level and precipitation is shown in figure 6. Left graph is a group with low cross-correlation, which means groundwater fluctuation is hardly affected by precipitation.

Sites in this group are also the same sites which have slowly decreasing autocorrelation coefficient. However, right graph is a group showing high cross-correlation at the beginning of series, which means groundwater-level data are shortly affected by precipitation; groundwater lags 1 day behind precipitation at most sites.

Statistical analysis:

Lastly, statistical analysis has been conducted to check the characteristics of aquifers.

The result is plotbox illustrated in figure 7. WA-2 with good barometric efficiency shows that its plotbox pattern in dry season is nearly same as plotbox pattern of barometric pressure. In contrast, the sites with low barometric efficiency and low autocorrelation have absolutely different plotbox patterns from barometric pressure plotbox.

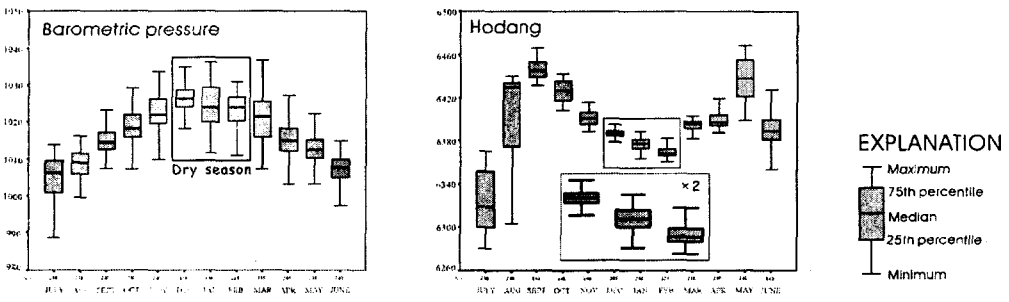

Figure 7. Plotbox of Barometric pressure(left) and WA-2(right)

4. Discussion and conclusion

The measurement data with high barometric efficiency have high autocorrelation coefficient and these aquifer may be confined characteristics. Groundwater-levels in confined aquifers are not sensitive to precipitation but to barometric pressure. Most groundwater-level data except WA-2, WC-2 and WA-5 in this study show the tendency of unconfined aquifer characteristics. Even though 10 out of

18 wells are classified as fractured rock aquifer, it is assumed that most of them are highly fractured with good connection to shallow alluvial aquifer. For the more accurate characterization of aquifers, the longer-term groundwater-level should be monitored.

5. References

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