Characteristics of real time variations of freshwater-saltwater interface using a new monitoring method at Jeju island, South Korea

Yongcheol Kim[1], Heesung Yoon[1] and Gipyo Kim[2]
[1] Korea Institute of Geoscience and Mineral Resources (KIGAM), South Korea
[2] Jeju Water Resources Headquarter, South Korea

ABSTRACT
In the present study, a new method using an interface-floating device to monitor the time series change of the freshwater-saltwater interface is developed and has been applied Handong-1, a sea water intrusion monitoring station of Jeju island, South Korea. The cross-correlation analysis using 21-days time series data in August, 2013, shows that the lag times of the freshwater level and the interface compared to tide were calculated to be 80 minutes and 195 minutes, respectively. Monitoring data from September to November indicates that the groundwater and interface level fluctuations are highly affected by the tide level. The interface level shows the rising tendency reducing the size of the freshwater lens. The floating device can be applied to sea water intrusion warning system if it is combined with a wireless submersible distance measuring device and remote communication technology.

INTRODUCTION
Most of the coastal monitoring wells are equipped with a single sensor at specific depth for water pressure, temperature and/or electrical conductivity. However, single depth method can give us only the information that the freshwater-saltwater interface is up or down from the sensor. Multi-depth method which is equipped with several sensors at different depth can be used to monitor the interface. The method, however, has blind zone between the sensors and economic problems to get high resolution vertical profile data. Geophysical logging can be used to monitor the interface, but it gives us a vertical location of the interface only at a specific time instead of time series data.
In the present study, a new method using an interface-floating device to monitor the time series change of the freshwater-saltwater interface is developed and has been applied Handong-1, a sea water intrusion monitoring station of Jeju island, South .

METHODS
A new method using a interface-floating device to monitor the time series change of the freshwater-saltwater interface is developed. The floating device can move up and down along with movement of the interface because it has intermediate density between freshwater and saltwater. Although in case that there is more or less wide transition zone, it can give us a real time location of the upper or lower boundary or a certain density within the transition zone. It has been applied to Handong-1, a sea water intrusion monitoring station of Jeju island, South Korea with a depth-fixed pressure sensor. Figure 1 shows the location of Handong-1, tide level monitoring station and weather station.

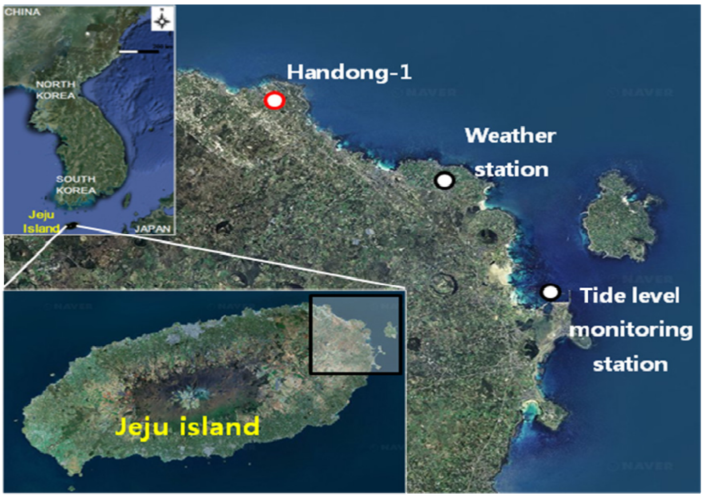

Figure 1. Location of study site

RESULTS AND DISCUSSIONS

The device was a success in obtaining time series data of the groundwater and interface levels (Figure 2).

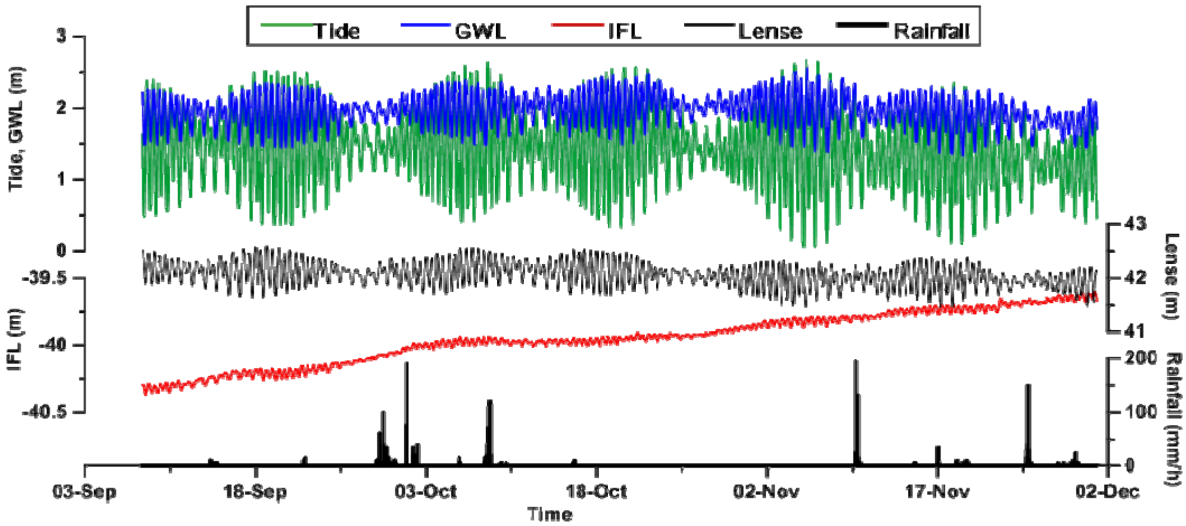

Figure 2. Time series data of groundwater and interface levels

Based on the 21-days time series data in August, 2013, it is found out that maximum amplitude of the freshwater level and the interface are damped down to 1.1m and 0.14m, respectively, compared to tide of which maximum amplitude was 2.6m. The lag times of the freshwater level and the interface compared to tide were calculated to be 80 minutes and 195 minutes, respectively. According to vertical EC profiles obtained from 32 times well logging from April 2001 to August 2011, the average depth of the upper and lower boundary is -34.6m and -44.8m from the mean sea level, respectively. The upper and lower boundary of the transition zone has EC values of about 2,000µS/cm and ranging 47,000 to 51,000µS/cm, respectively. The device was estimated to move up and down following the brackish water of about 8,000μS/cm in this site.

Monitoring data from September to November indicates that the groundwater and interface level fluctuations are highly affected by the tide level (Figure 2). The interface level shows the rising tendency reducing the size of the freshwater lens. A long-term data will be obtained and analyzed to find out the effect of rainfall on interface fluctuations and the cause of upward trend of the interface level.

The floating device can be applied to sea water intrusion warning system if it is combined with a wireless submersible distance measuring device and remote communication technology.

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Contact Information: Yongcheol Kim, Korea Institute of Geoscience and Mineral Resources, 124 Gwahang-no, Yuseong-gu, Daejeon 305-350, Korea, Email: yckim@kigam.re.kr