Monsoon-driven Total Head and Temperature Variations at the GW-SW Interface

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1. Introduction:

Extreme precipitation events associated with a monsoon-type climate can strongly influence the hydrologic dynamics of an entire watershed with implications for groundwater (GW) and surface water (SW) exchange. The rapid basin-wide change in flow patterns controls the spatial and temporal variability of downstream surface GW-SW exchange. The focus of this study is to investigate how extreme storm events affect the dynamics of river-aquifer exchange on the reach-scale in a small catchment in South Korea where the hydrologic dynamics are mainly driven by the monsoon-type climate.

2. Investigation Area

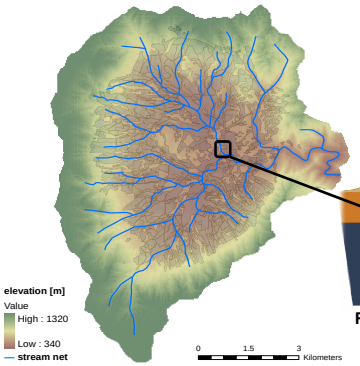

Fig.1: The **Haean Catchment** is located in the North East of South Korea and a subcatchment of the watershed of Lake Soyang. The lake serves as a major drinking water supply for the metropolitan area of Seoul. Hence, the supply of clean water from the Haean Catchment is impartant and therefore, it is crucial to understand GW-SW exchange processes.

3. Methods

1. Piezometer Transect

- hydraulic gradient monitoring via piezometer transect, nested wells and stage records
- wells were installed perpendicular to the stream
- all piezometers are equipped with pressure transducers

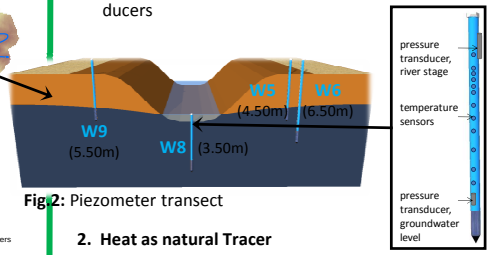

Fig.2: Piezometer transect

2. Heat as natural Tracer

- piezometer W8 is equipped with 14 single channel temperarature thermistors as well as with two pressure transducers for determining hydraulic gradients (see Fig. 2)
- data loggers recorded the temperature and head response at 15 min intervals

4. Results

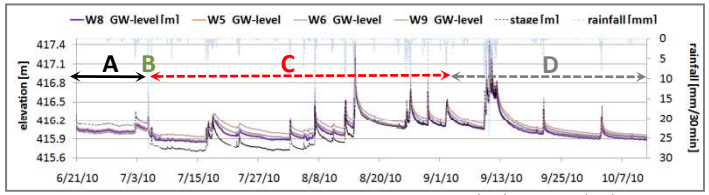

Fig.3: Measured stage and groundwater level fluctuations (06/16/2010 – 10/14/2010)

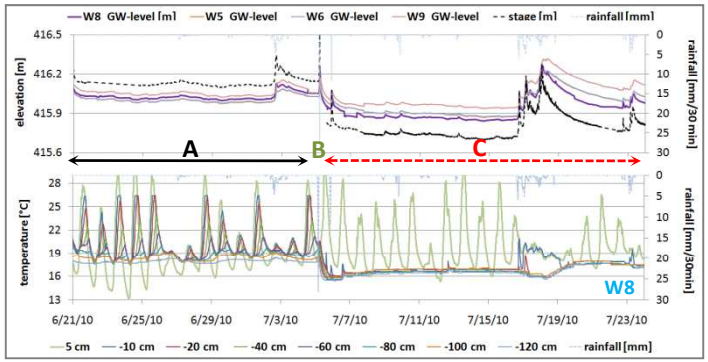

Fig.4: 06/21/10 – 07/21/10 **a)** hydraulic gradient and **b)** temperature monitoring (W8)

A. **16th of June - 5th of July:**
primarily **losing SW conditions**

- vertical hydraulic gradient (stage-W8): **0.0428** (average value 16th June till the 5th of July)
- durnal fluctuation till ca. 100 cm depth clearly visible (W8)

B. **5th of July:** monsoonal storm event, duration: ca. 70 min, precipitation amount: 15 mm

→ **storm event changed the streambed elevation within 70 min (see Fig. 6)**
→ for example at piezometer W8 the riverbed was ca. 30 cm deeper

C. **5th of July - 5th of Sept.:**
primarily **gaining conditions**

- vertical hydraulic gradient (stage-W8): **- 0.0467** (average value till the 5th of Sept.)
- already no diurnal fluctuations in 10 cm depth (W8)

→ **comparable slow streambed elevation changes (see Fig. 6)**

D. **5th of Sept. - 14th of October:**
primarily **losing SW conditions**

- vertical hydraulic gradient (stage-W8): **0.0147** (average value 5th of Sept. till 14th of October)

5. Outlook

A) In order to **determine the water exchange fluxes** based on the observed temperatures the finite-difference numerical code **VS2DH**, a partially coupled model of fluid and heat flow model, will be used for flow and heat transport modeling.

B) **Implications for biogeochemical processes:** In future work we will investigate how reversals in exchange fluxes may influence nutrient transformations at the GW-SW interface and hence nutrient export from the Haean Catchment.

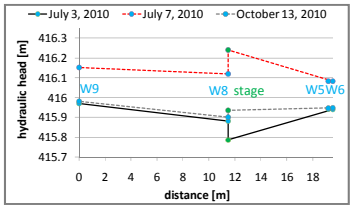

Fig.5: Hydraulic heads at different dates

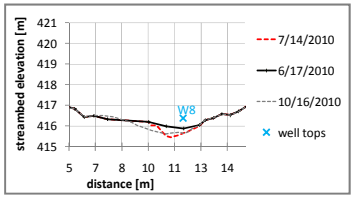

Fig.6: Measured streambed elevation changes

6. Summary and Conclusions:

Our field data indicate that the river reach exhibits primarily losing surface water conditions throughout most of the year. After the extreme precipitation event of the 5th of July 2010, gaining groundwater conditions at the river reach were evident, almost until the end of the Monsoon season. Noticeable is how quickly the hydraulic gradient responded to streambed elevation changes caused by high flow velocities and the corresponding high streambed loadings. In conclusion, the presented results indicate that event-based changes in streambed elevation can be an important control of river-aquifer exchange.

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