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Groundwater fluctuations during a debris flow event in western Norway – triggered by rain and snowmelt

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Air temperatures recorded at the weather station at Anestølen in 2013 (Fig. S1)

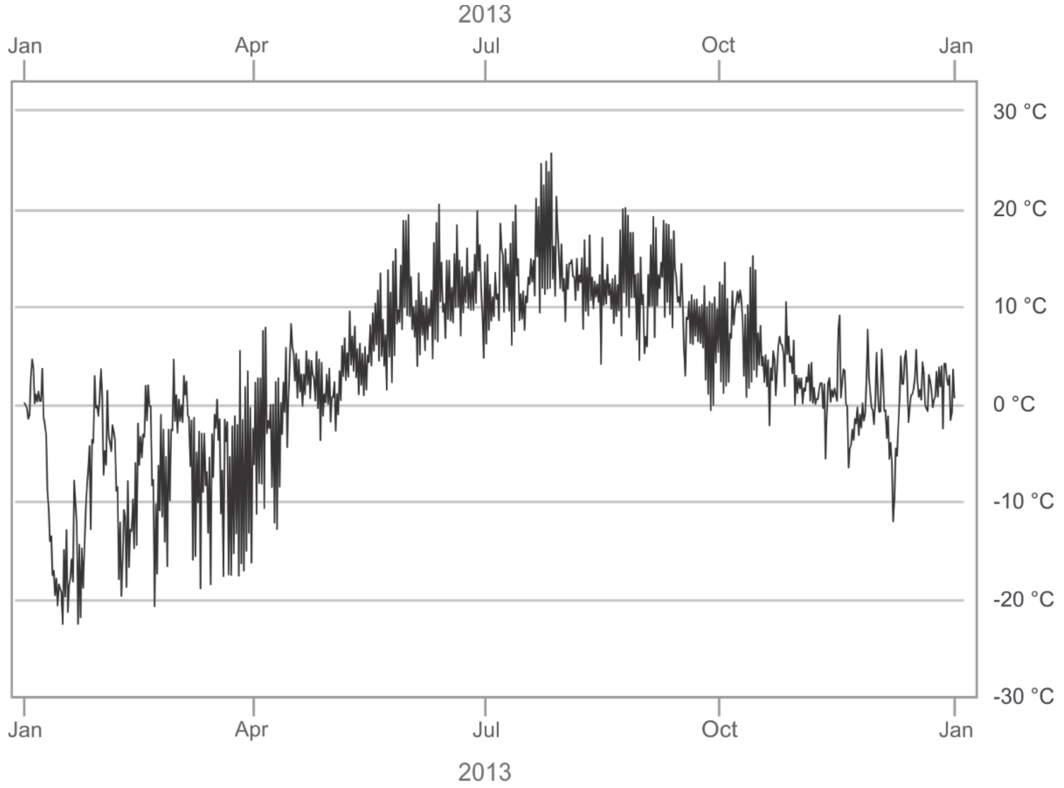

Figure S1: Air temperature measured at the weather station 77.24.0. Data downloaded from http://sildre.nve.no.

Photos of the debris flow in 2013 at Anestølen (Figs. S2-S5)

Figure S2: The debris flow deposits covered the road and continued into the lake. Photographed in the morning of 16 November 2013 by Vidar Leirdal.

Figure S3: The debris flow photographed in the morning of 16 November 2013 by Vidar Leirdal.

Figure S4: The debris flow photographed in the morning of 17 November 2013 (Stein Bondevik).

Figure S5: The debris flow ended in the lake and built out a delta. Photographed in the morning of 17 November 2013 (Stein Bondevik).

Groundwater and groundwater temperatures at the weather station in 2013 (Fig. S6)

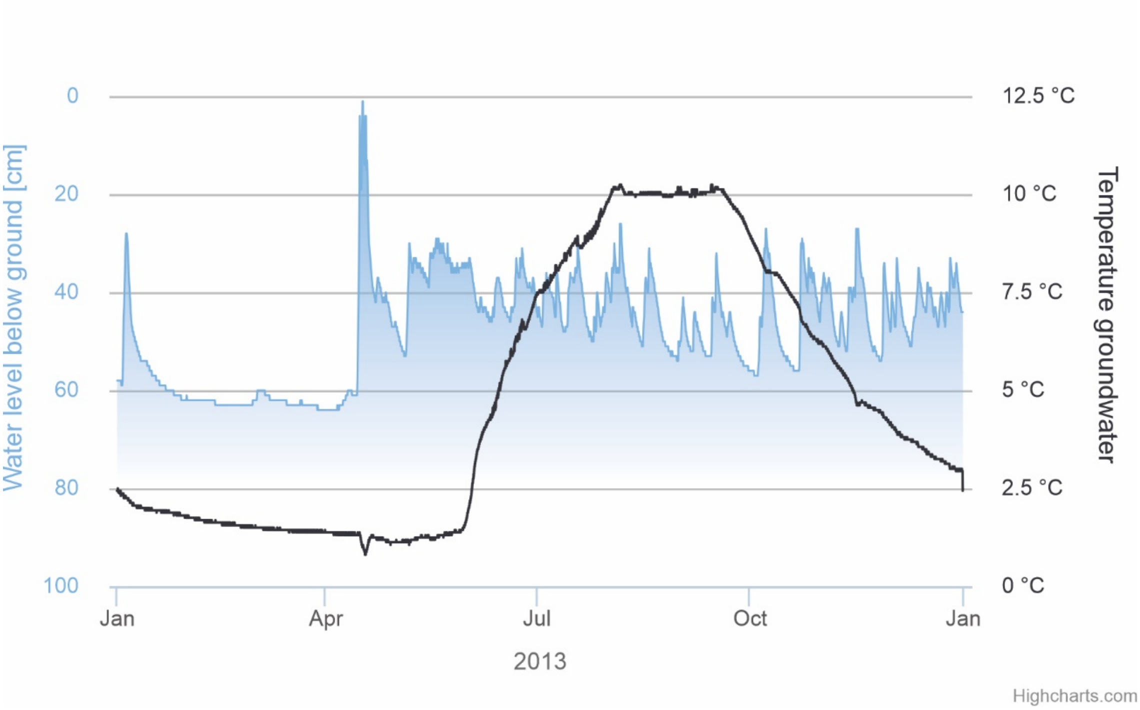

Figure S6: The diagram shows groundwater level (blue curve) and groundwater temperature (black curve) from the weather station in the valley bottom in 2013. The highest peak of the groundwater level is 15–18 April when the water level reached 25 cm higher than the sensor measures during fully saturated conditions at other times of the year. We think the water is ponded on the surface at this time because the soil is (partly) frozen. When the soil has thawed completely, the water level drops (e.g. Daniel and Staricka, 2000).

Groundwater and groundwater temperatures upslope, and precipitation, in 2012 (Fig. S7)

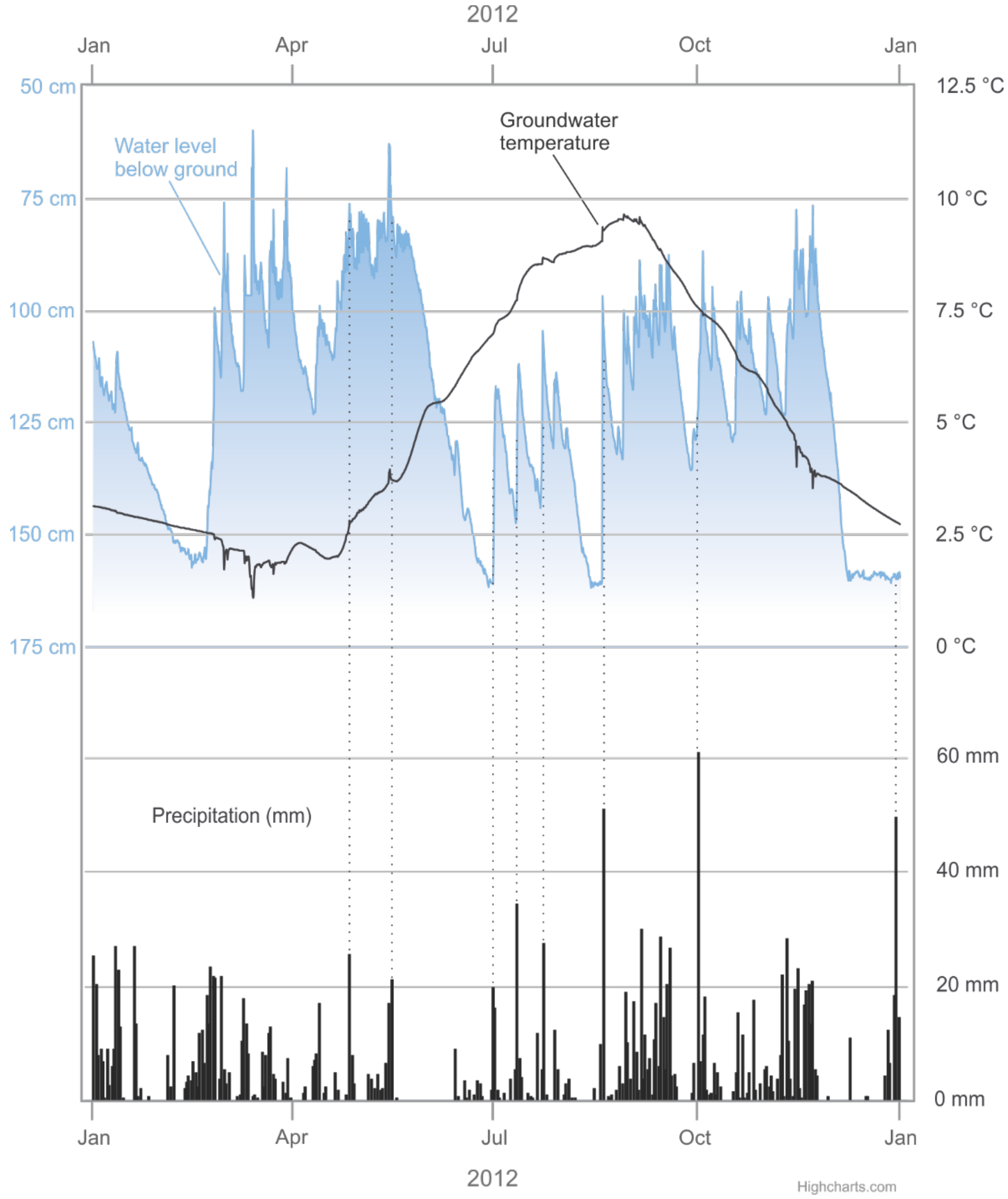

Figure S7: The upper diagram shows groundwater level (blue curve) and groundwater temperature (black curve) from the borehole upslope in 2012. The lower diagram shows 24h precipitation at the weather station at Selseng, station no. 55700, http://eklima.met.no.

Groundwater and groundwater temperatures upslope, and precipitation, in 2011 (Fig. S8)

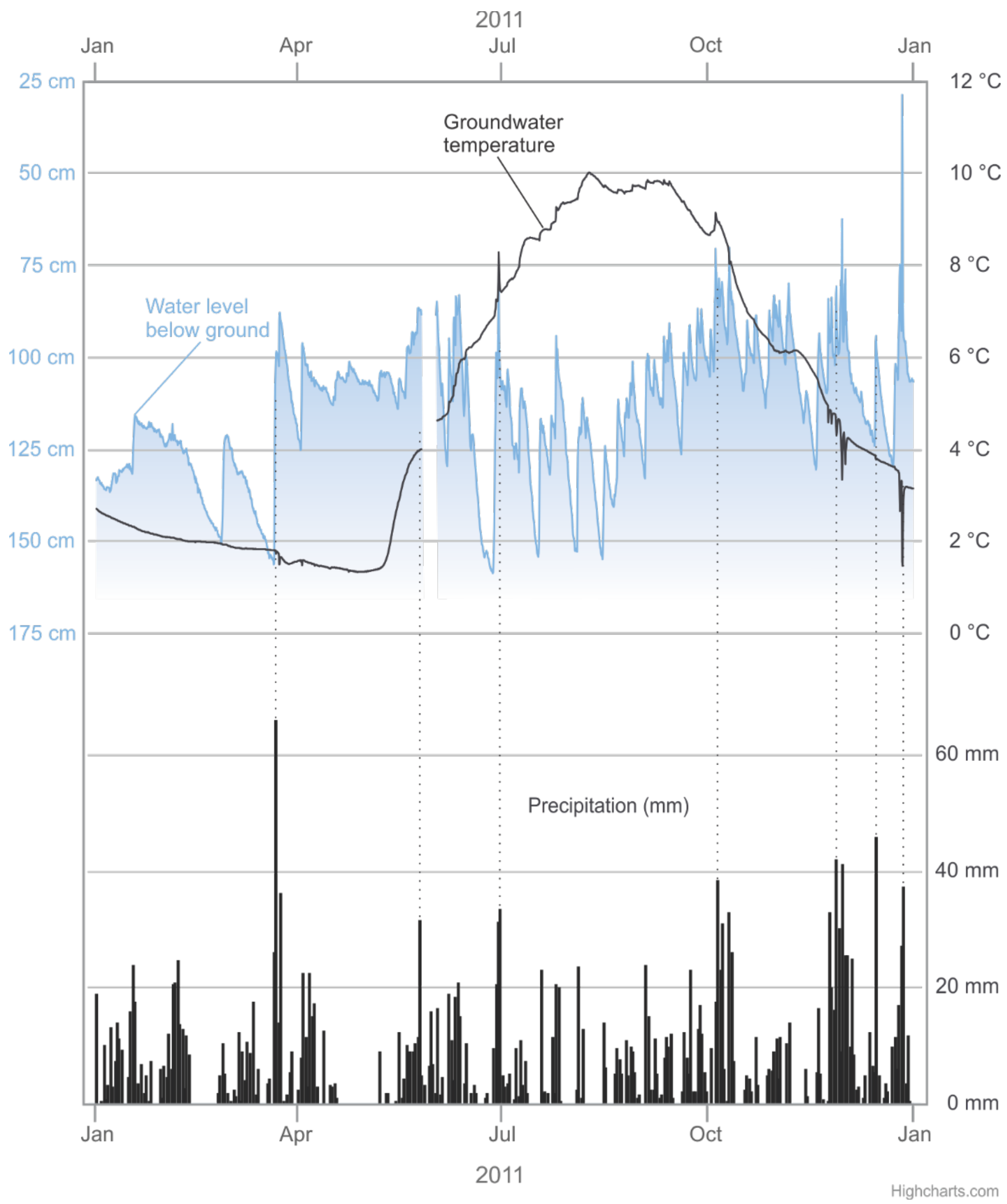

Figure S8: The upper diagram shows groundwater level (blue curve) and groundwater temperature (black curve) from the borehole upslope in 2011. The lower diagram shows 24h precipitation at the weather station at Selseng, station no. 55700, http://eklima.met.no. The most pronounced peak is on 26 December, when groundwater reached 28 cm during storm Dagmar. No data between 26 May and 1 June.

Groundwater and groundwater temperatures upslope, and precipitation, in 2010 (Fig. S9)

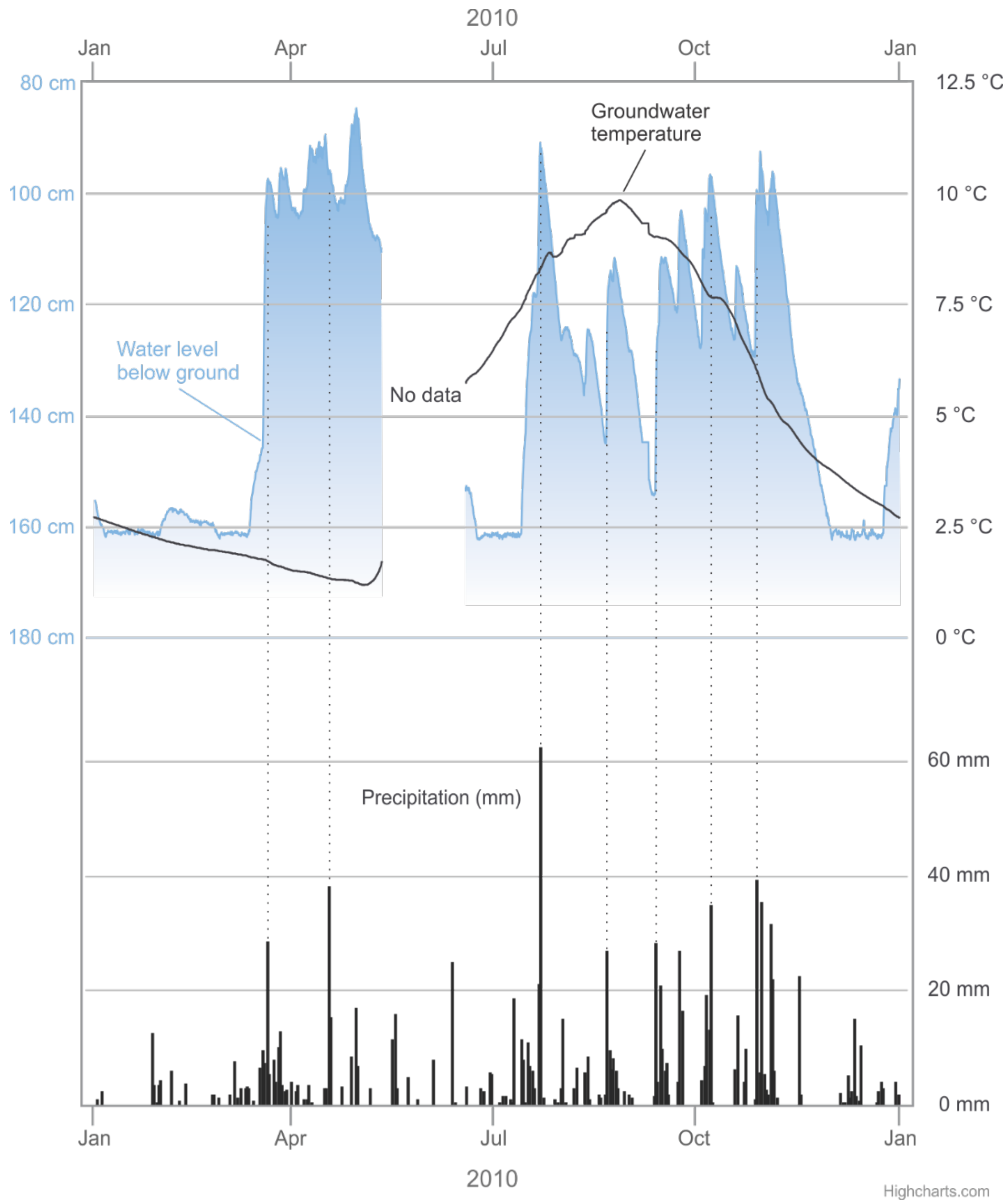

Figure S9: The upper diagram shows groundwater level (blue curve) and groundwater temperature (black curve) from the borehole upslope in 2010. The lower diagram shows 24h precipitation at the weather station at Selseng, station no. 55700, http://eklima.met.no. No data between 11 May and 17 June.

Rates of change of groundwater level in borehole upslope in 2012 (Fig. S10)

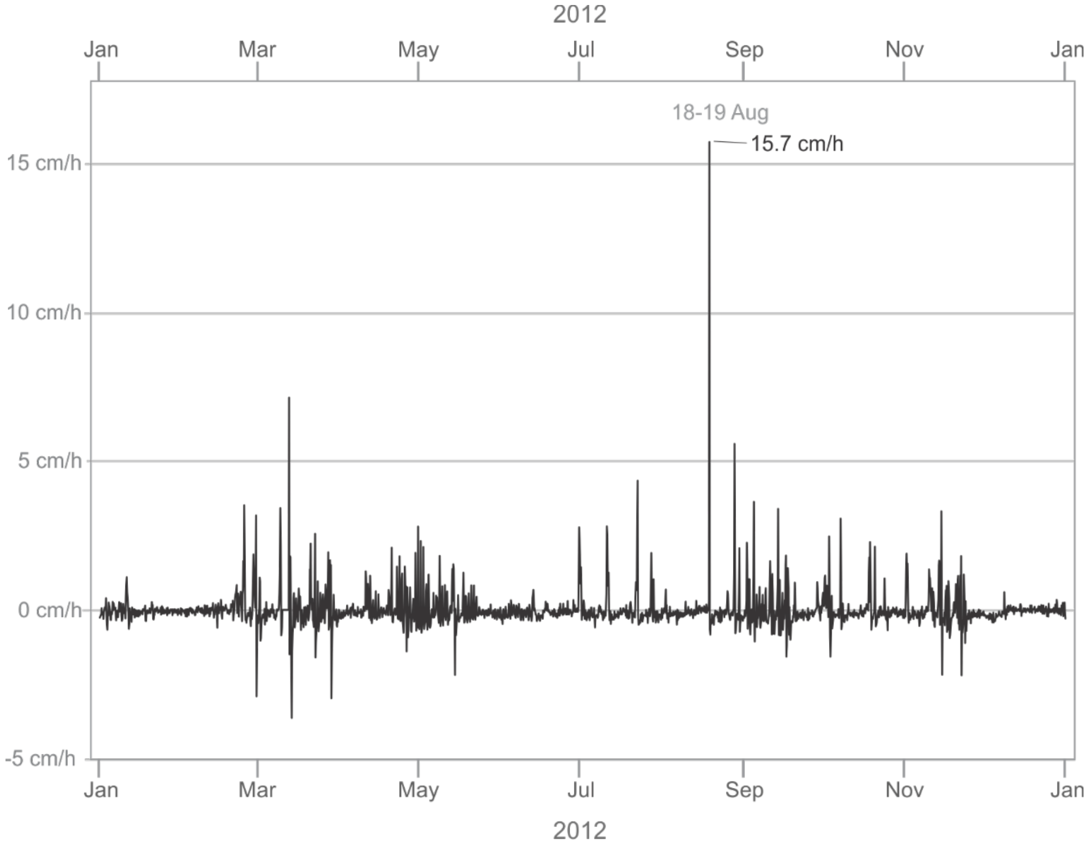

Figure S10: Rates of change of groundwater level in 2012 in the borehole upslope. The largest recorded rate was on 18–19 August, 15.7 cm/h.

Rates of change of groundwater level in borehole upslope in 2011 (Fig. S11)

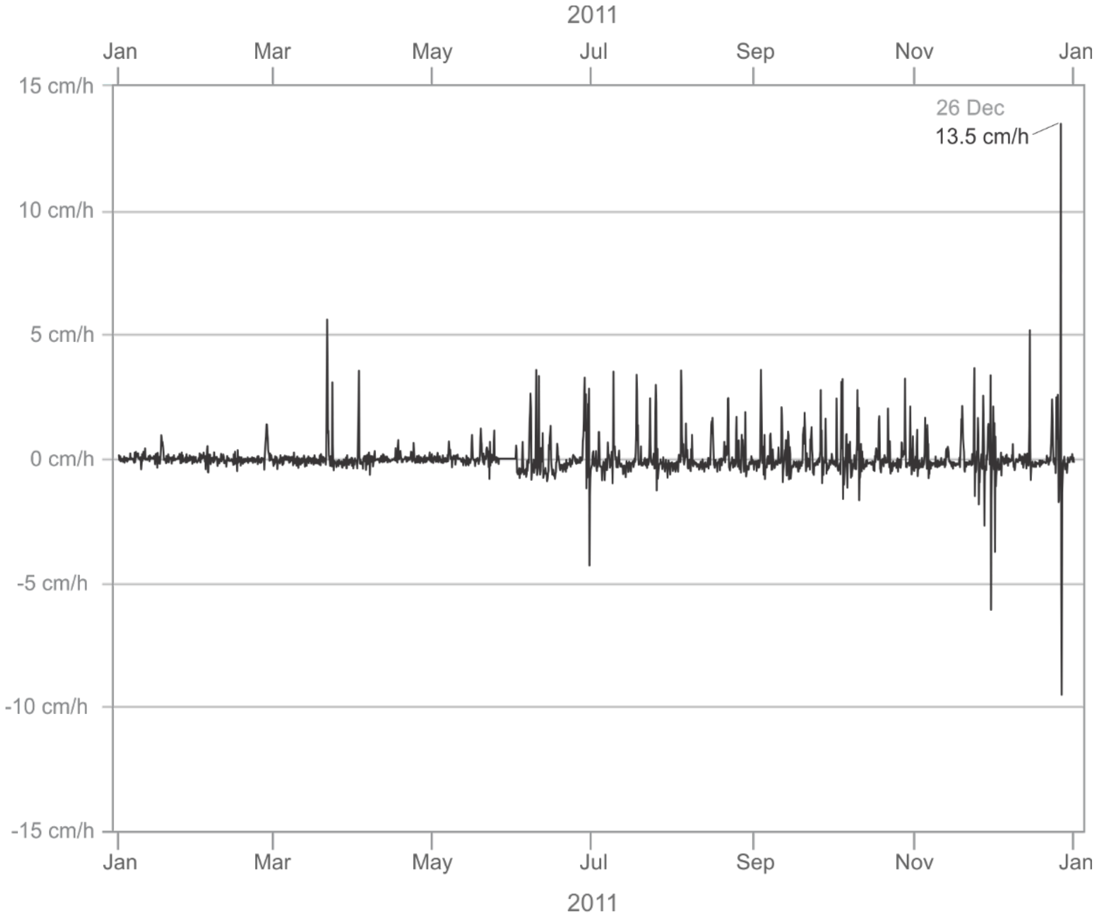

Figure S11. Rates of change of groundwater level in 2011 in the borehole upslope. The highest rate this year was 13.5 cm/h recorded during storm Dagmar on 26 December.

Rates of change of groundwater level in borehole upslope in 2010 (Fig. S12)

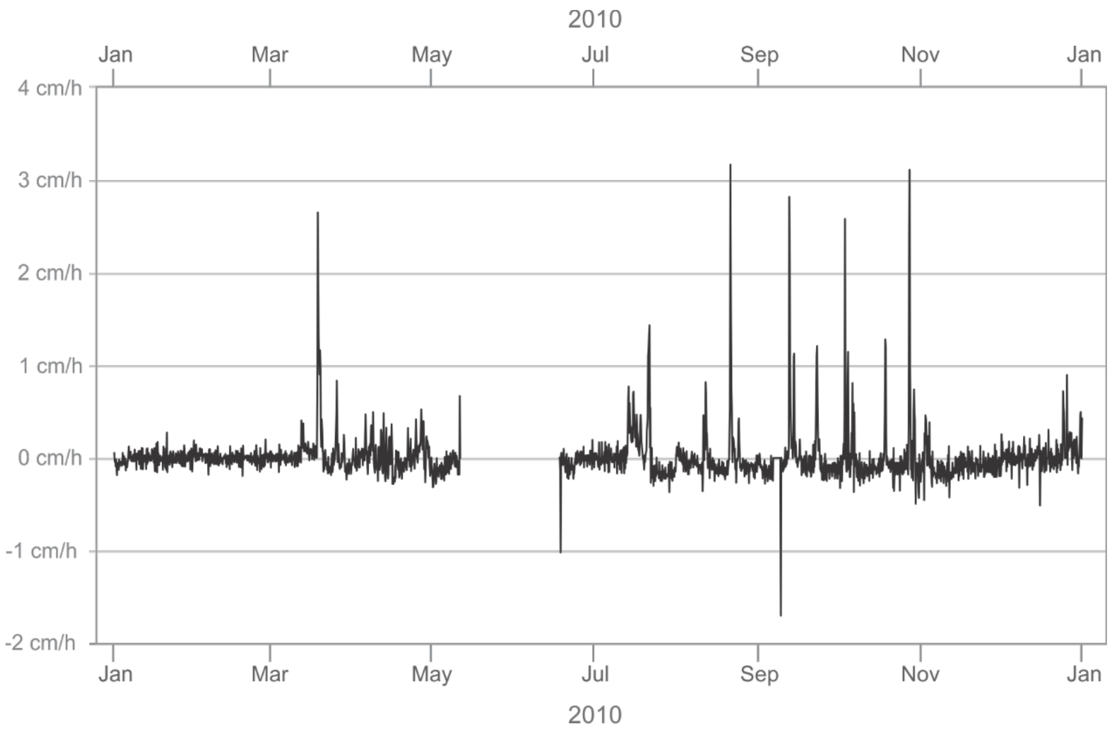

Figure S12: Rates of change of groundwater level in 2010 in the borehole upslope. The highest rate recorded was 3.2 cm/h.

References

Daniel, J., Staricka, J., 2000. Frozen soil impact on ground water-surface water interaction. Journal of the American water resources association 36, 151-160.