

Interactive comment on “Recent trends in groundwater levels in a highly seasonal hydrological system: the Ganges-Brahmaputra-Meghna Delta” by M. Shamsudduha et al.

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Reply to comments on "Recent trends in groundwater levels in a highly seasonal hydrological system: the Ganges-Brahmaputra-Meghna Delta by Shamsudduha et al."

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Reply to reviewer's comments:

We thank the anonymous reviewer for helpful comments and suggestions for extend-
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ing our current analysis of recent (1985-2005) trends in groundwater levels in the Ganges-Brahmaputra-Meghna Delta to assessments of the relationships between rainfall, groundwater abstraction and sea-level rise on groundwater levels following methods (HARTT: Hydrograph Analysis - Rainfall and Time Trend) as recommended in Ferdowsian and Pannell (2001; 2009). These suggestions complement the current analysis (Shamsudduha et al., 2009) which applies a newly compiled dataset of weekly groundwater-level monitoring records from a network of 1267 stations to investigate directly changes in groundwater storage in the Ganges-Brahmaputra-Meghna Delta. Our work demonstrates a clear link between abstraction and trends in groundwater levels but there may be other contributing factors such as rainfall variability. The recommendations of the anonymous reviewer will be considered in our on-going research together with a range of techniques such as cross-correlations (Lee et al., 2006) and new datasets that include high-frequency (every half hour) observations of rainfall and groundwater levels and estimates of groundwater abstraction for irrigation throughout Bangladesh.

We further thank the anonymous reviewer for drawing attention to the fact that trends in groundwater levels may not be linear. Indeed, we present an example of a non-linear trend in a borehole hydrograph (see Fig. 3a in Shamsudduha et al., 2009). In our analysis, we apply a Seasonal-Trend decomposition procedure based on Loess (STL) (Cleveland et al., 1990) to resolve seasonality from the time series and detect non-linear trends in groundwater-level observations. Moreover, the STL decomposition used in our work makes no assumptions of linearity, and indeed we state explicitly in Section 3.4 that one of the aims of these analyses is "detection of non-linear patterns in long-term trends that cannot be assessed through linear trend analyses". Furthermore, there are many possible ways of carrying out temporal trend analysis of which the HARTT method (Ferdowsian and Pannell, 2001) is just one of them.

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