The increasing groundwater usage in the Indus Basin of Pakistan has caused and causes salinity problems endangering food security and livelihoods on the long run. The use of the aquifer in like situations is so intense and dynamic that the scarce data is insufficient to support calibration of a regional model. The groundwater levels are only a snapshot in this highly dynamic environment, both within a year and as from year to year due to ever more wells being installed. The boundary conditions have ceased due to the groundwater drawdown and water table is freely soaring and highly dependent on local dynamics. On the other hand, the predevelopment situation is much more stable. The past groundwater system was far more continuous on the scale of the doab than the current one, where numerous artificial water divides are ubiquitous due to extractions and irrigation, including leaking canals and return flow and altered river stages/discharges. The more contiguous behavior of the virgin groundwater system allows calibrating regional aquifer parameters, which are now impossible to filter out of the current data, due to the spatial variability of the aquifer parameters in combination with the irregular infiltration and extraction due to combined irrigation and groundwater effects. We prove in the present work that a model calibrated under the predevelopment situation provides more reliable predictions as compared to one calibrated under the present situation.