Supplementary Material

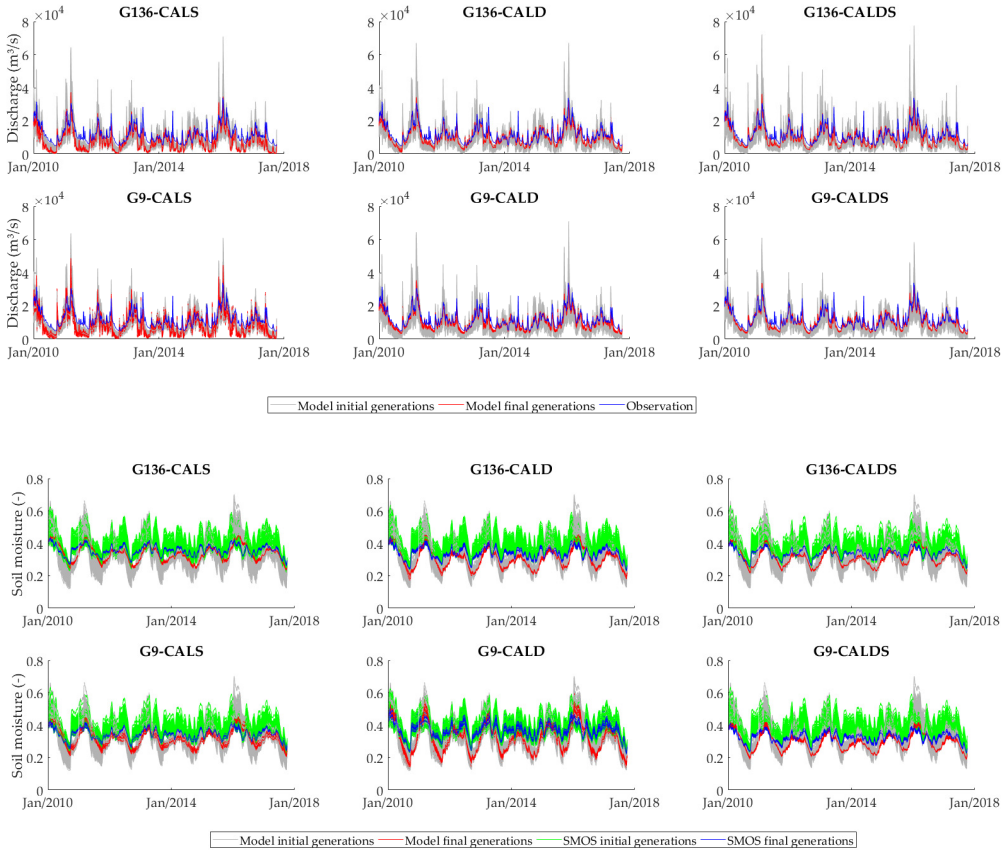

Figure S1. Time series of discharge (upper panel) and soil moisture (bottom panel) for the initial and final calibration generations, for the location of Itaipu dam close to the basin outlet. The calibration with all 136 gauges (G136) and 9 selected gauges (G9) are presented. CALD refers to calibration with discharge only, CALS to calibration with soil moisture only, and CALDS to the joint calibration with both. Given the rescale of SMOS data to the MGB model min/max values, SMOS initial and final generations are different and plotted as green and blue lines, respectively.

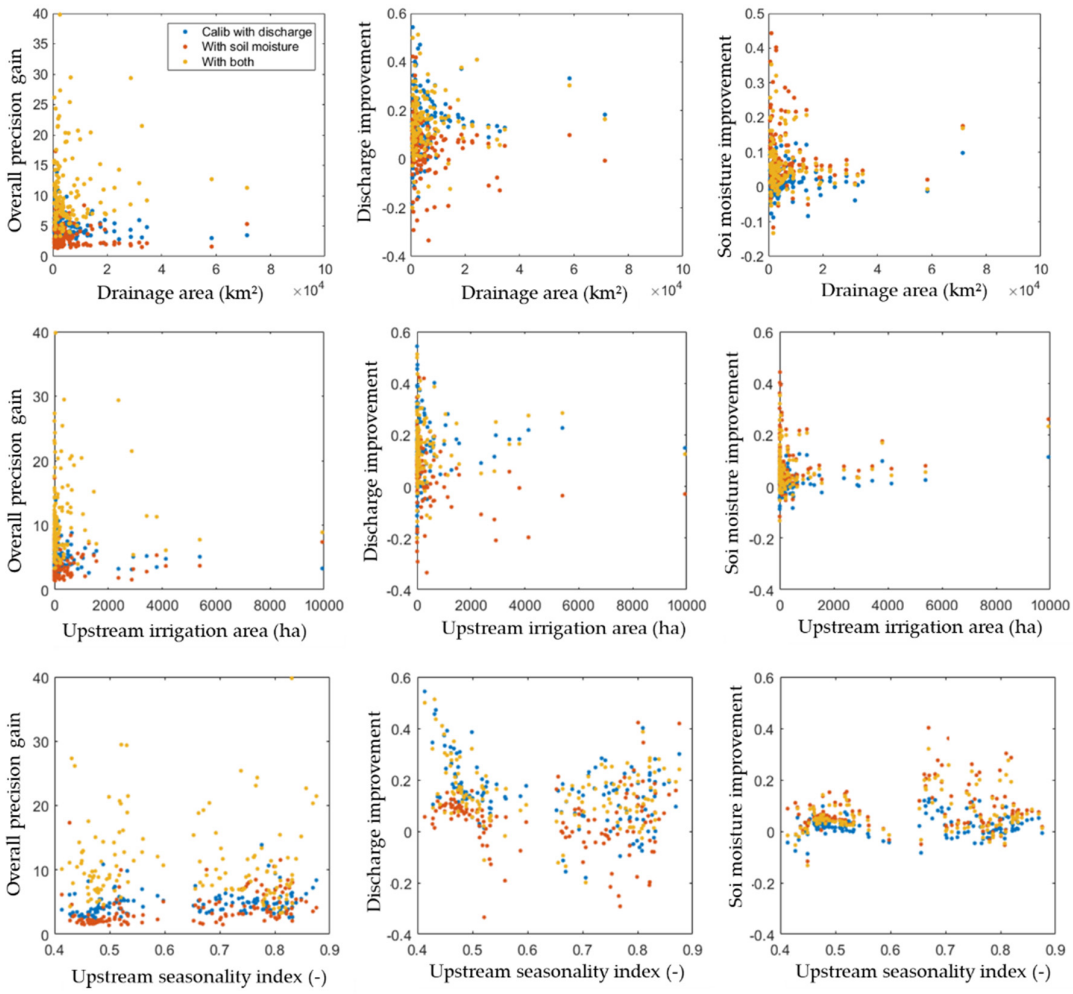

Figure S2. Relation between drainage area (first row), upstream irrigation areas (second row) and precipitation seasonality index (third row) with overall precision, and accuracy improvement for discharge and soil moisture. Results presented for the scenario of calibration with 136 gauges. In the first row, the maximum drainage area is truncated at 10.000 km² to improve visualization of most gauges.

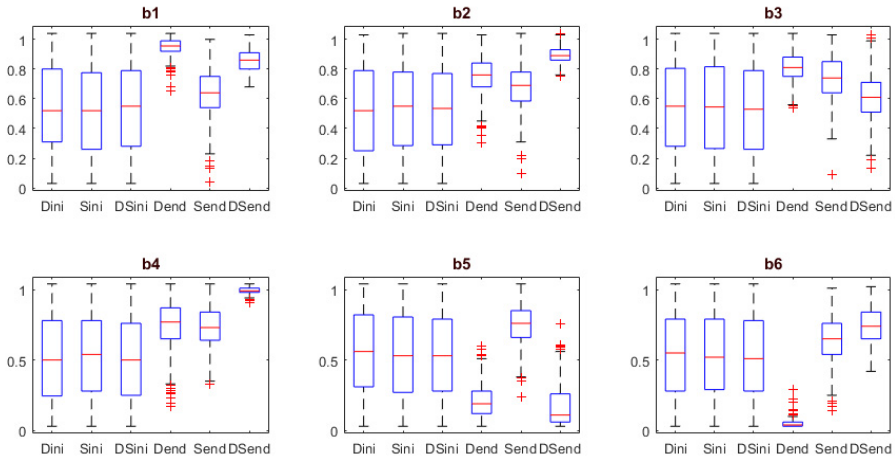

Figure S3. Initial (ini) and optimized (end) values for the b parameter (unit: adimensional) for the three calibration scenarios (discharge only (D); soil moisture only (S); and calibration with both (DS)) and six HRU's: (1) Forest with shallow soils; (2) Forest with deep soils; (3) Agriculture with shallow soils; (4) Agriculture with deep soils; (5) Grasslands with shallow soils; and (6) Grasslands with deep soils. "b" is the shape parameter of the ARNO model, which defines the sensitivity of runoff generation on saturated areas.

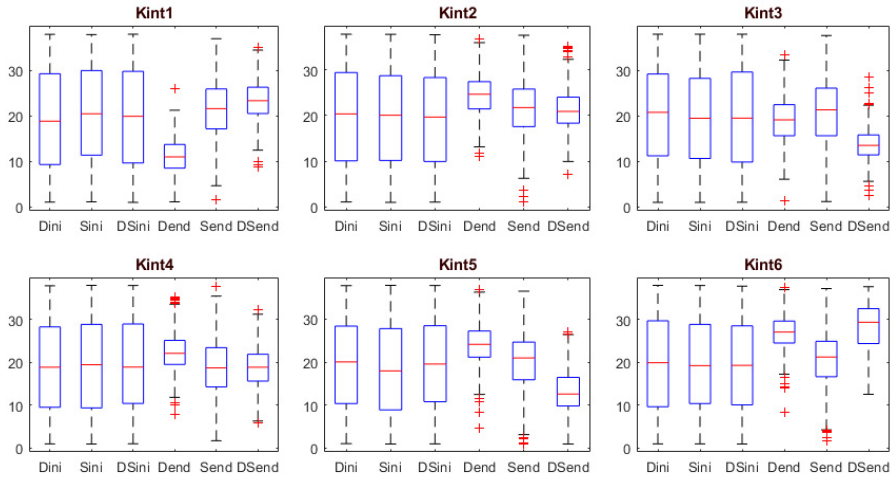

Figure S4. Initial (ini) and optimized (end) values for the Kint parameter (unit in mm.day^{-1}) for the three calibration scenarios (discharge only (D); soil moisture only (S); and calibration with both (DS)) and six HRU's: (1) Forest with shallow soils; (2) Forest with deep soils; (3) Agriculture with shallow soils; (4) Agriculture with deep soils; (5) Grasslands with shallow soils; and (6) Grasslands with deep soils. This parameter refers to the subsurface flow (i.e., it is a proxy of soil conductivity).

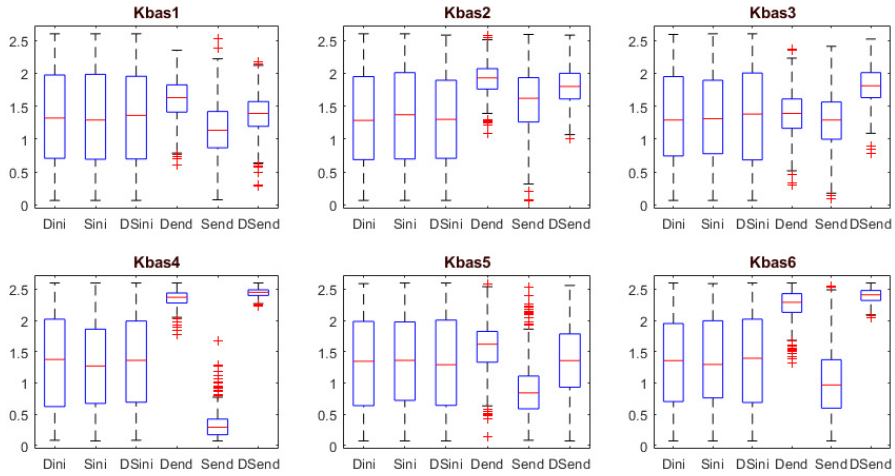

Figure S5. Initial (ini) and optimized (end) values for the Kbas parameter (unit in mm.day^{-1}) for the three calibration scenarios (discharge only (D); soil moisture only (S); and calibration with both (DS)) and six HRU's: (1) Forest with shallow soils; (2) Forest with deep soils; (3) Agriculture with shallow soils; (4) Agriculture with deep soils; (5) Grasslands with shallow soils; and (6) Grasslands with deep soils. This parameter refers to the groundwater flow (i.e., it is a proxy of groundwater conductivity).

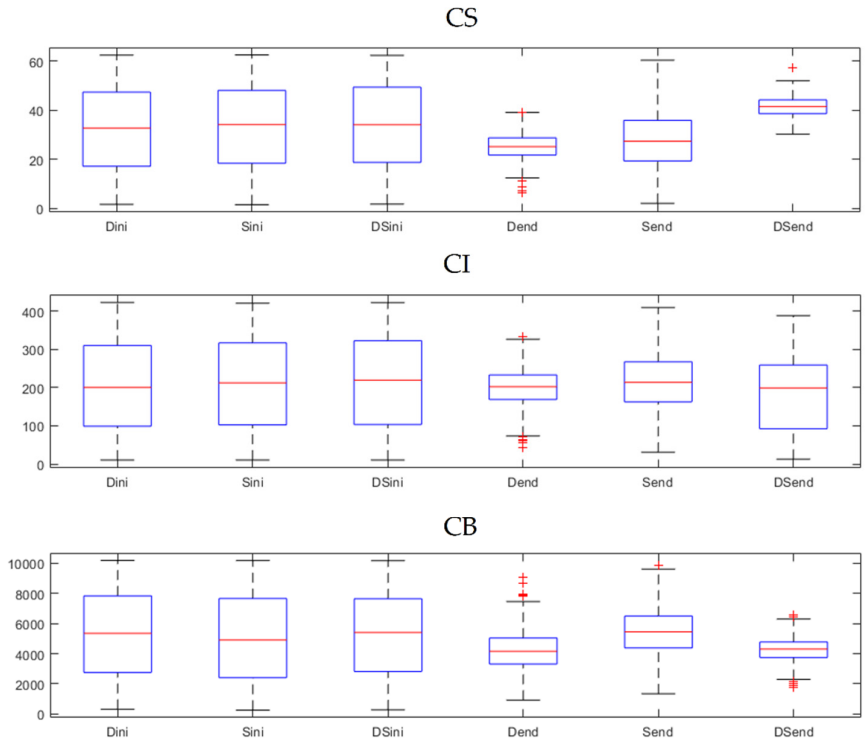

Figure S6. Initial (ini) and optimized (end) values for the CS, CI and CB parameters (unit in days) for the three calibration scenarios (discharge only (D); soil moisture only (S); and calibration with both (DS)). These parameters refer to the outflow of the three linear reservoirs (i.e., MGB hillslope routing): surface reservoir (CS), intermediate (CI) and baseflow (CB).

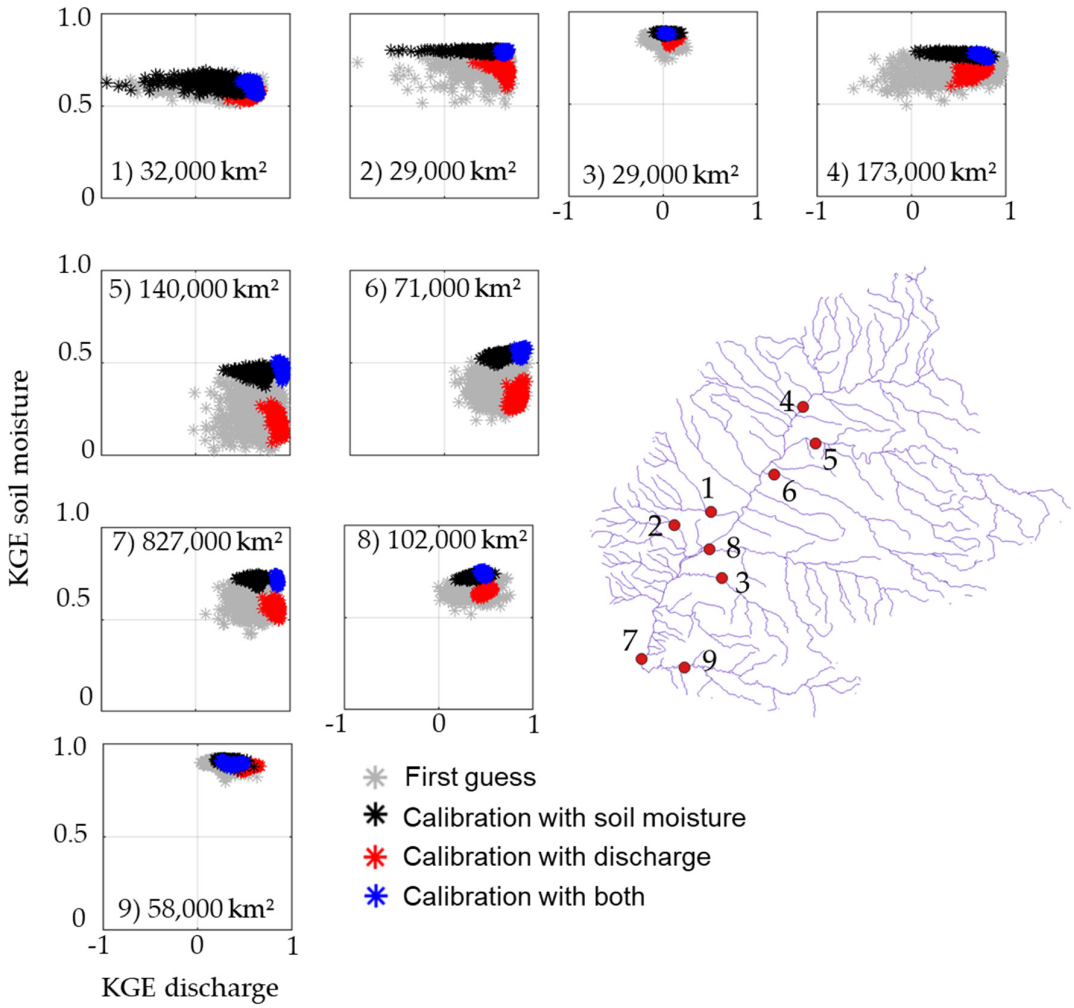

Figure S7. Soil moisture and discharge KGE values for the nine gauge locations used for the 9-only calibration scenario; results for the 9-only scenario.

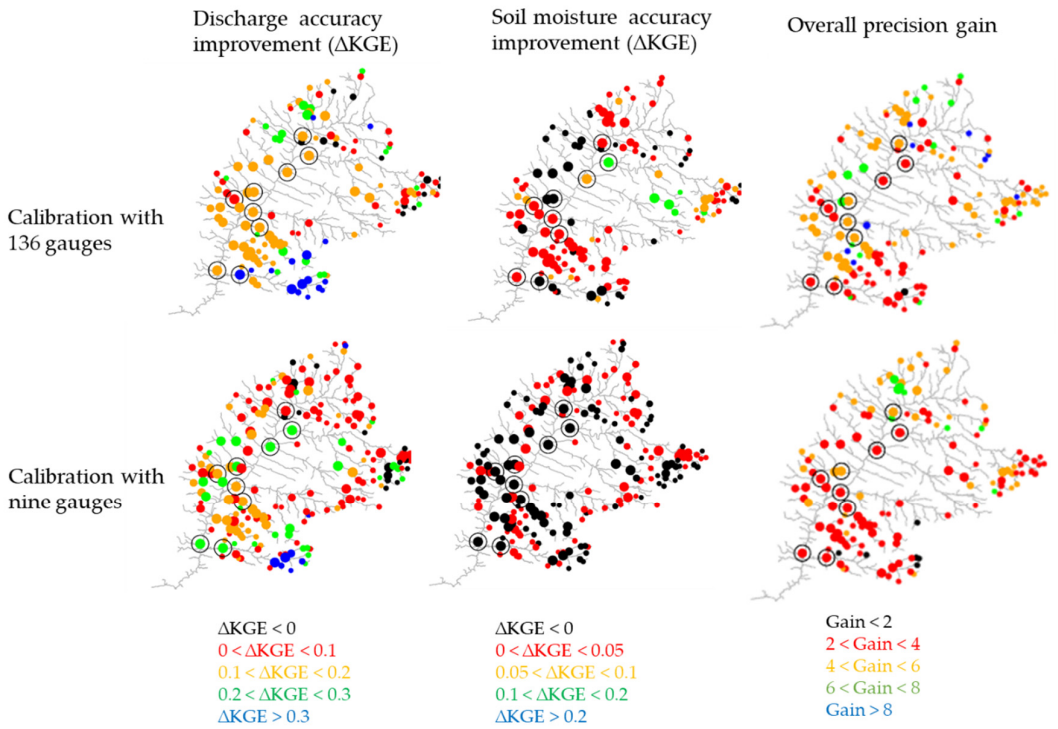

Figure S8. Spatial assessment of discharge and soil moisture accuracy improvement (ΔKGE) and overall precision gain, when calibrating with nine and 136 gauges (including the nine ones). Results are presented for the calibration scenario with discharge only (CAL-D). The circle size refers to the gauge drainage area, and the black open circles are the location of the nine gauges.

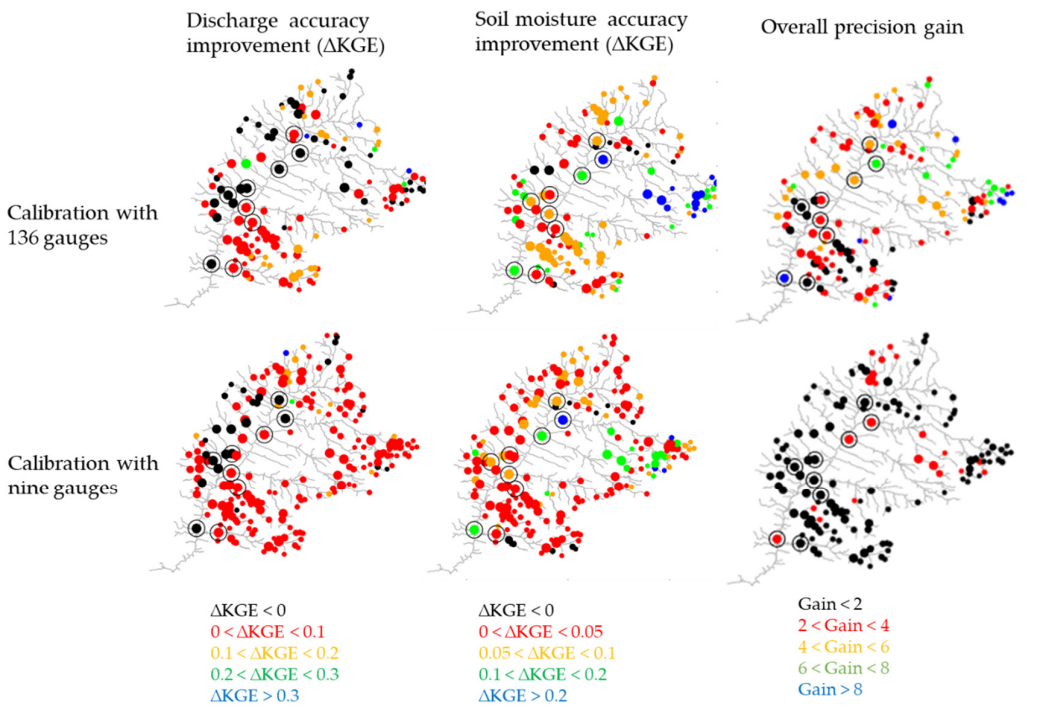

Figure S9. Spatial assessment of discharge and soil moisture accuracy improvement (ΔKGE) and overall precision gain, when calibrating with nine and 136 gauges (including the nine ones).

Results are presented for the calibration scenario with soil moisture only (CAL-S). The circle size refers to the gauge drainage area, and the black open circles are the location of the nine gauges.