Supplement

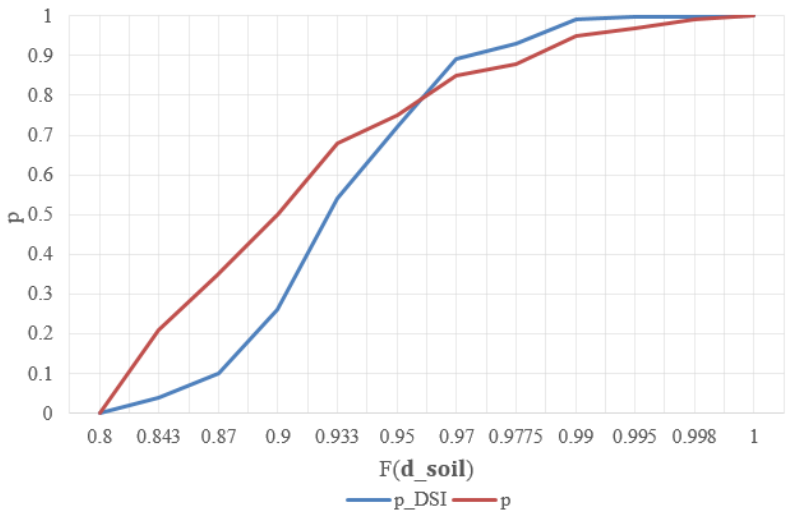

Figure S1. Comparison of p_{soil} with p_DSI values as a function of $F(d_{soil})$ as presented in Table 1

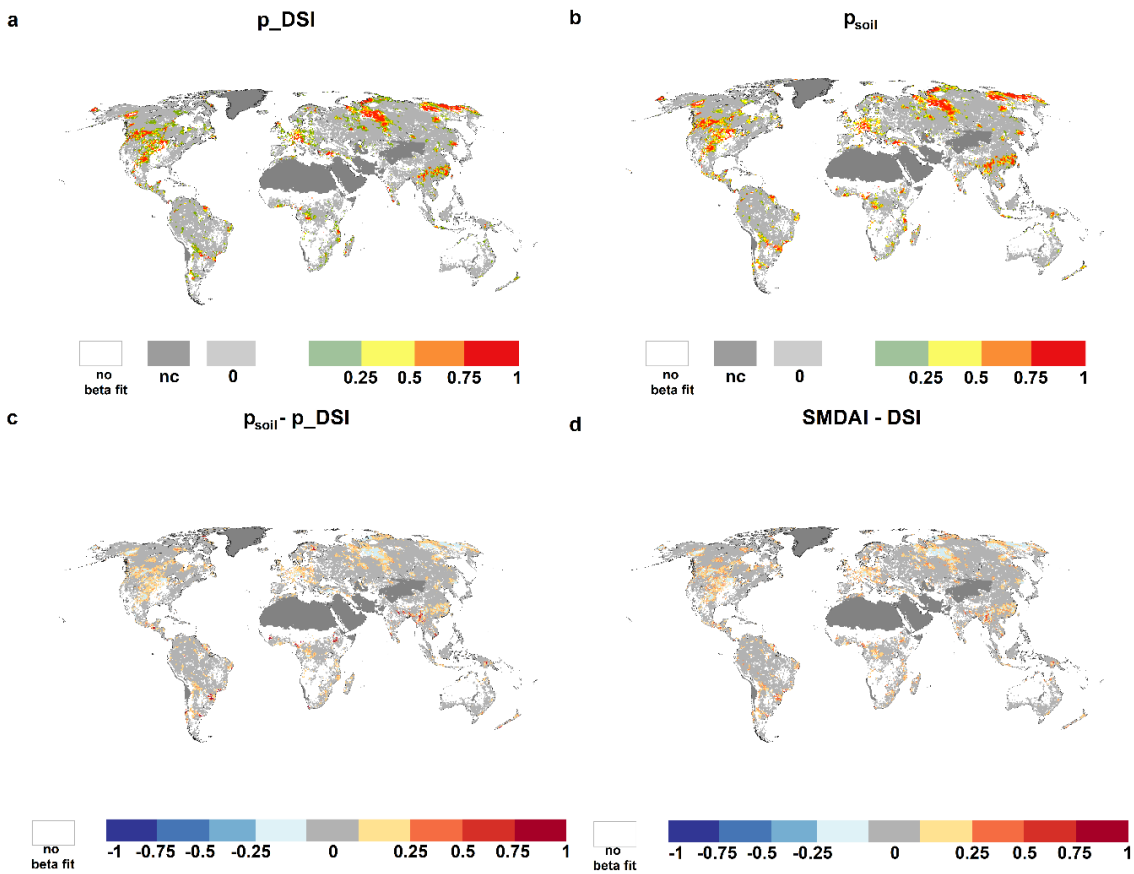

Figure S2. Global maps of p_DSI (a), p_{soil} (b), the difference between p_{soil} and p_DSI (c) and between SMDAI and DSI (d) for August 2003

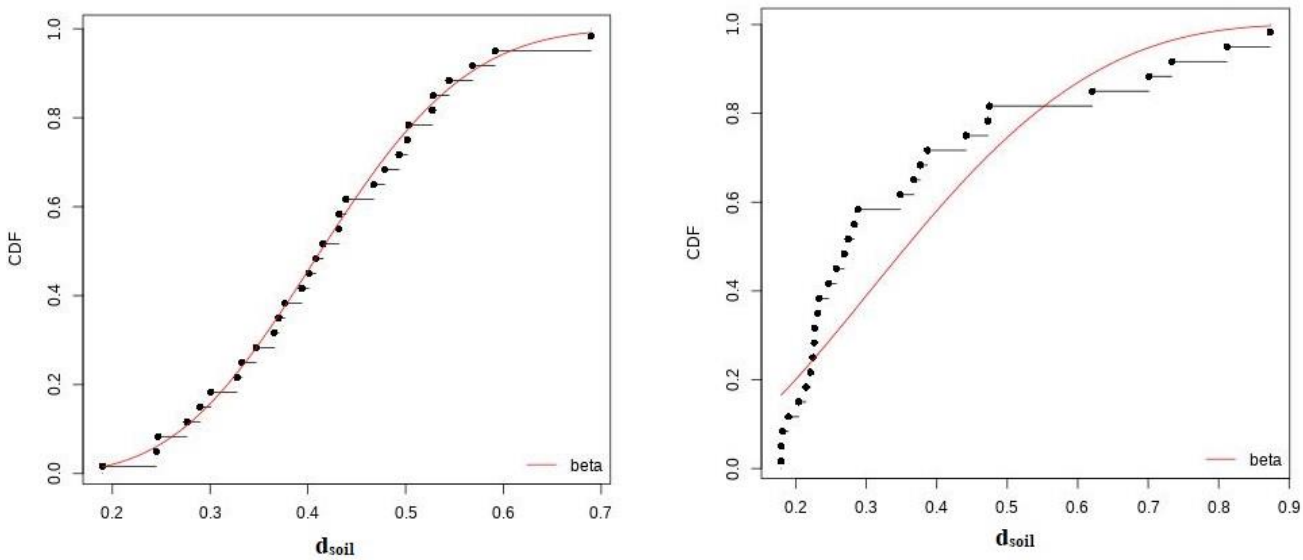

Figure S3. Two examples of CDF plots of all 30 January soil moisture deficits for a cell in the Republic of Congo (27.25E, -10.75N) for which the beta function was accepted (left) and a cell in Russia (31.25E, 56.75N), for which it was rejected (right). In the case of rejection, the ECDF using directly the 30 values (black dots) of $\mathbf{d_{soil}}$ served to determine F. Then, the six (20%) highest values of $\mathbf{d_{soil}}$ are assumed to represent drought conditions.

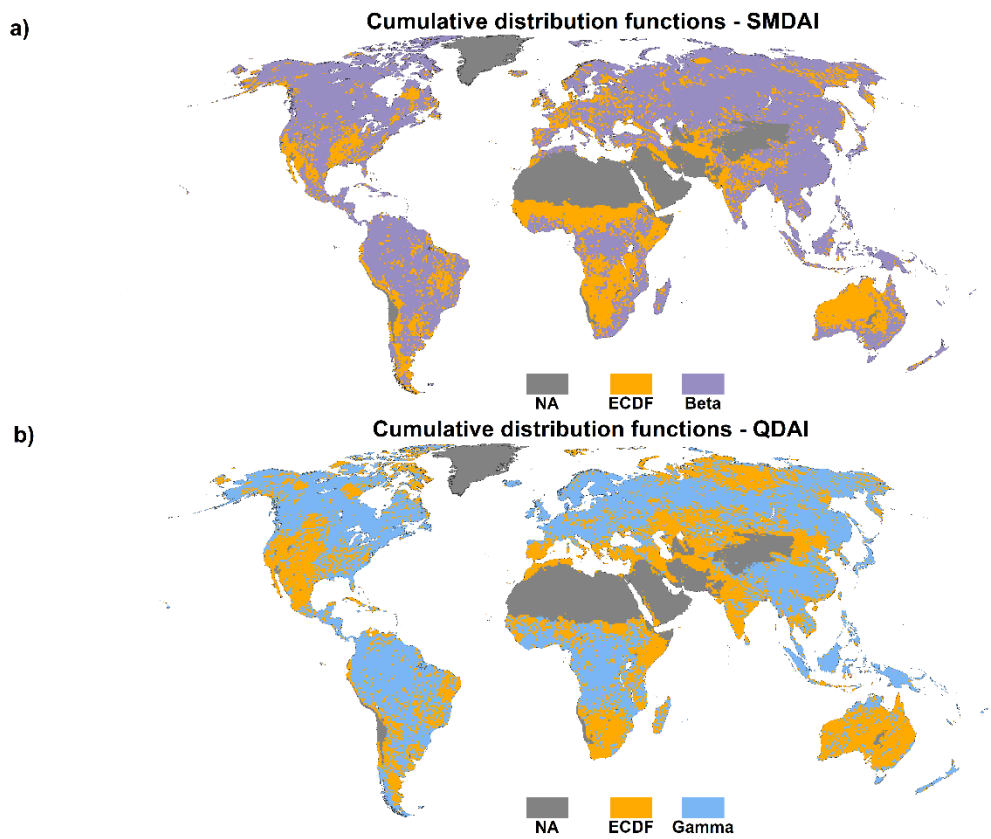

Figure S4. Location of grid cells where, for computing a) SMDAI and b) QDAI, either cumulative distribution functions (beta and gamma, respectively) were fitted or where ECDF was used.

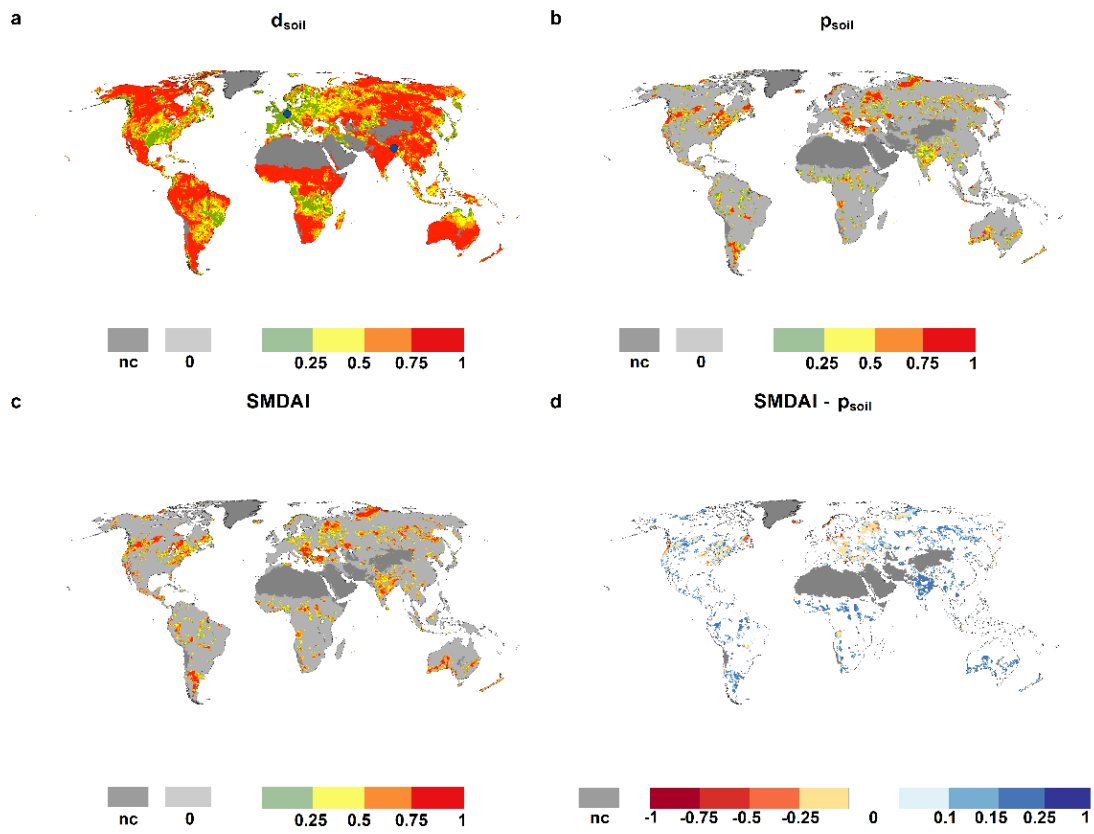

Figure S5. Global maps of d_{soil}, p_{soil}, SMDAI and the difference between SMDAI and p_{soil} for December 1999

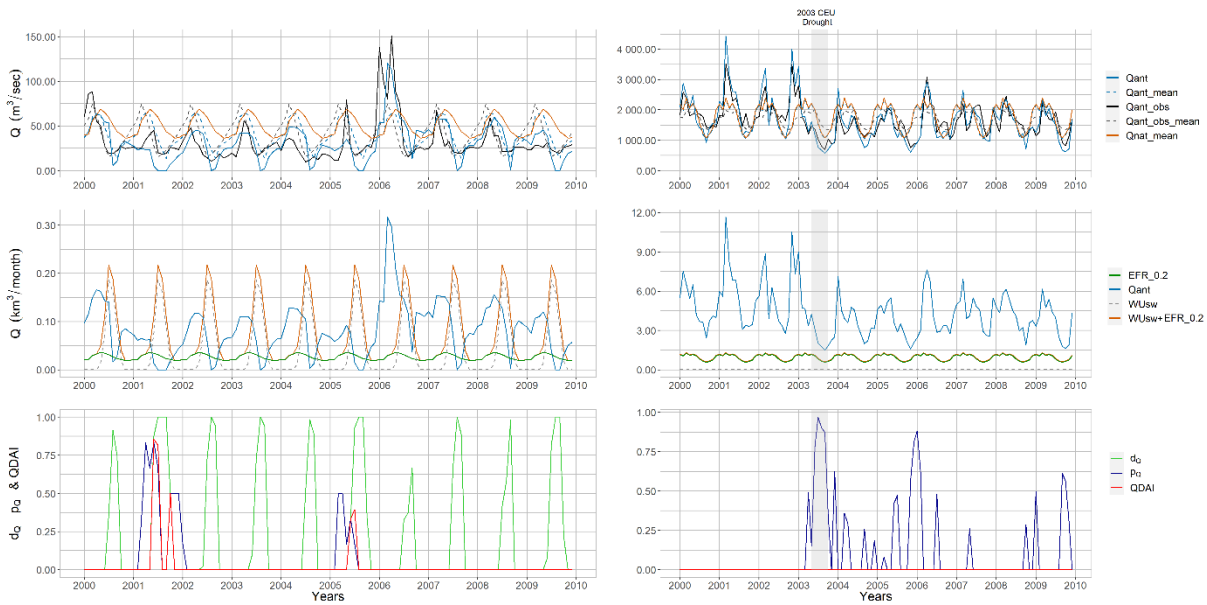

Figure S6. Streamflow drought hazard: example of time series of monthly surface water demand, surface water supply and mean seasonality of surface water supply as well as $\mathbf{d_Q}$, $\mathbf{p_Q}$ and QDAI (bottom) for a cell in the USA (left) and Germany (right) computed with $\mathbf{EFR} = \mathbf{0.2} \cdot \overline{\mathbf{Q_{nat}}}$

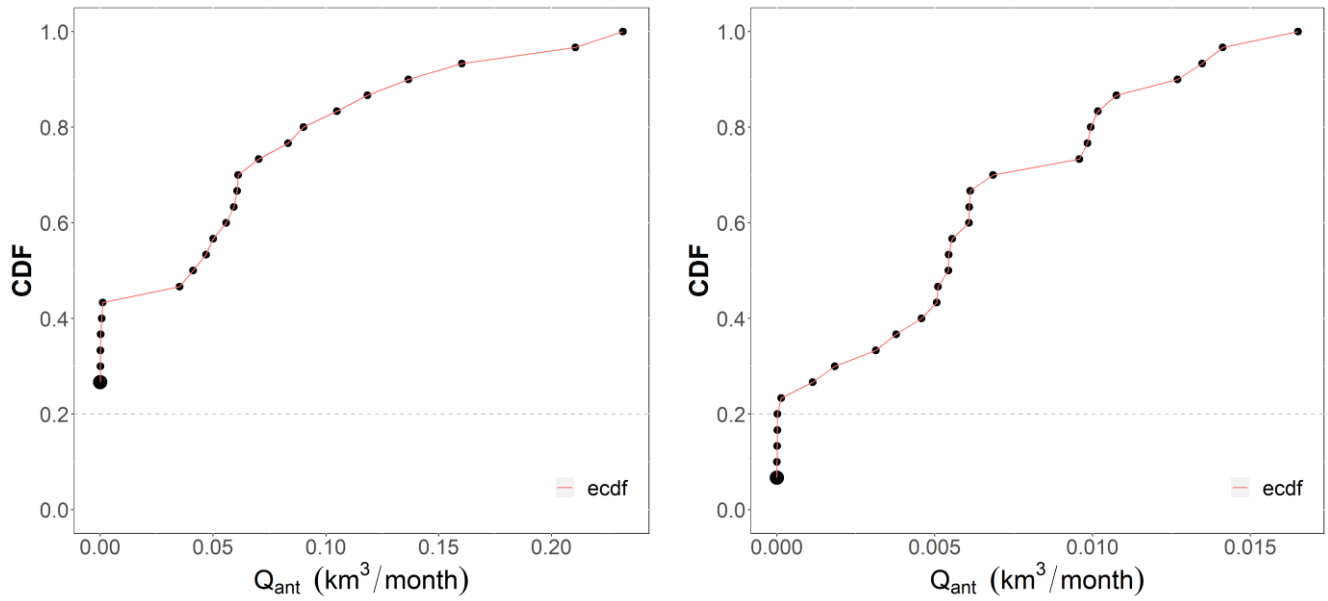

Figure S7. Identification of drought in case of Q_{ant} = 0 for two different examples. Left panel: CDF of 30 October Q_{ant} values for a cell in the southwest of Australia (145.25E, -35.25N) where eight Q_{ant} values (i.e. more than 20% or more than six Q_{ant} values) are equal to zero resulting in a probability of non-exceedance F of 0.267 for all eight Q_{ant} = 0 values, i.e. no drought (pQ= 0) in case of zero streamflow. Right panel CDF of all 30 July Q_{ant} values for a cell in Canada (-111.25E,52.25N) where only two Q_{ant} values (i.e. less than 20% or less than six Q_{ant}values) are equal to zero resulting in F=0.067 for both Q_{ant} = 0 values, i.e. drought (pQ>0) in case of zero streamflow.

The definition of (semi)arid and humid grid cells in WaterGAP 2.2d (Fig. S8) was done based on the ratio of precipitation to potential evapotranspiration. If the ratio is less than 0.75 based on the EWEBMI climate forcing, the grid cell is assumed to be semi(arid). However, all grid cells north of 55°N are defined as humid (Müller Schmied et al., 2021).

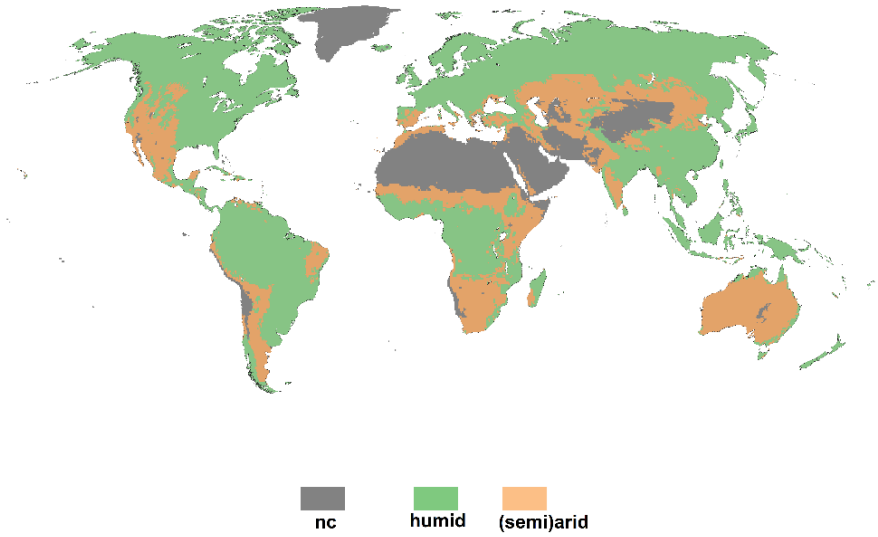

Figure S8. Spatial representation of humid and (semi)arid regions in WaterGAP 2.2d

References

Müller Schmied, H., Cáceres, D., Eisner, S., Flörke, M., Herbert, C., Niemann, C., Peiris, T. A., Popat, E., Portmann, F. T., Reinecke, R., Schumacher, M., Shadkam, S., Telteu, C.-E., Trautmann, T., and Döll, P.: The global water resources and use model WaterGAP v2.2d: model description and evaluation, Geosci. Model Dev., 14, 1037–1079, https://doi.org/10.5194/gmd-14-1037-2021, 2021.