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Assessment of hydrological pathways in East African montane catchments under different land use

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Table S1. Limits of quantitation for trace element analysis. The samples were analysed in three batches (Set 1–3).

Trace element	Justus Liebig University Giessen		University of Hohenheim
	Set 1 (*n* = 61)	Set 2 (*n* = 61)	Set 3 (*n* = 231)
Li	0.050 µg L^{-1}	0.050 µg L^{-1}	0.25 µg L^{-1}
Na	15.00 µg L^{-1}	30.00 µg L^{-1}	0.10 mg L^{-1}
Mg	25.00 µg L^{-1}	10.00 µg L^{-1}	0.10 mg L^{-1}
Al	1.000 µg L^{-1}	1.000 µg L^{-1}	0.10 mg L^{-1}
Si	50.00 µg L^{-1}	25.00 µg L^{-1}	0.10 mg L^{-1}
K	10.00 µg L^{-1}	10.00 µg L^{-1}	0.10 mg L^{-1}
Ca	100.0 µg L^{-1}	100.0 µg L^{-1}	0.10 mg L^{-1}
Cr	0.010 µg L^{-1}	0.010 µg L^{-1}	0.25 µg L^{-1}
Fe	0.500 µg L^{-1}	0.500 µg L^{-1}	0.25 µg L^{-1}
Cu	0.100 µg L^{-1}	0.050 µg L^{-1}	0.25 µg L^{-1}
Zn	0.100 µg L^{-1}	0.100 µg L^{-1}	0.25 µg L^{-1}
Rb	0.010 µg L^{-1}	0.050 µg L^{-1}	0.25 µg L^{-1}
Sr	0.100 µg L^{-1}	0.100 µg L^{-1}	0.25 µg L^{-1}
Y	0.010 µg L^{-1}	0.010 µg L^{-1}	0.25 µg L^{-1}
Ba	0.100 µg L^{-1}	0.500 µg L^{-1}	0.25 µg L^{-1}
Ce	0.010 µg L^{-1}	0.010 µg L^{-1}	0.25 µg L^{-1}
La	0.010 µg L^{-1}	0.010 µg L^{-1}	0.25 µg L^{-1}
Nd	0.010 µg L^{-1}	0.010 µg L^{-1}	0.25 µg L^{-1}

Table S2. Relative root mean square error (RRMSE) for end member models with up to four dimensions, based on measured and projected solute concentrations in stream water in the three sub-catchments (NF, SHA, TTP) and the main catchment (OUT).

Dimension	Li	Rb	Sr	Ba	Na	Mg	K
	%	%	%	%	%	%	%
Natural forest (NF)							
1D	0.0358	0.0161	0.0154	0.0218	0.0237	0.0136	0.0136
2D	0.0210	0.0161	0.0154	0.0152	0.0168	0.0105	0.0095
3D	0.0066	0.0147	0.0099	0.0075	0.0120	0.0088	0.0094
4D	0.0055	0.0075	0.0069	0.0074	0.0054	0.0069	0.0085
Smallholder agriculture (SHA)							
1D	0.0457	0.0121	0.0292	0.0335	0.0387	0.0215	0.0195
2D	0.0216	0.0216	0.0145	0.0334	0.0305	0.0136	0.0167
3D	0.0216	0.0120	0.0139	0.0089	0.0271	0.0088	0.0106
4D	0.0036	0.0119	0.0126	0.0039	0.0059	0.0075	0.0106
Tea and tree plantations (TTP)							
1D	0.0397	0.0117	0.0187	0.1243	0.0236	0.0119	0.0119
2D	0.0391	0.0115	0.0181	0.0206	0.0205	0.0099	0.0093
3D	0.0037	0.0109	0.0163	0.0162	0.0205	0.0087	0.0071
4D	0.0012	0.0091	0.0111	0.0043	0.0044	0.0086	0.0063
Main catchment (OUT)							
1D	0.0322	0.0152	0.0235	0.0719	0.0162	0.0174	0.0194
2D	0.0321	0.0150	0.0231	0.0094	0.0136	0.0119	0.0179
3D	0.0115	0.0148	0.0170	0.0046	0.0134	0.0104	0.0179
4D	0.0027	0.0087	0.0096	0.0039	0.0125	0.0101	0.0060

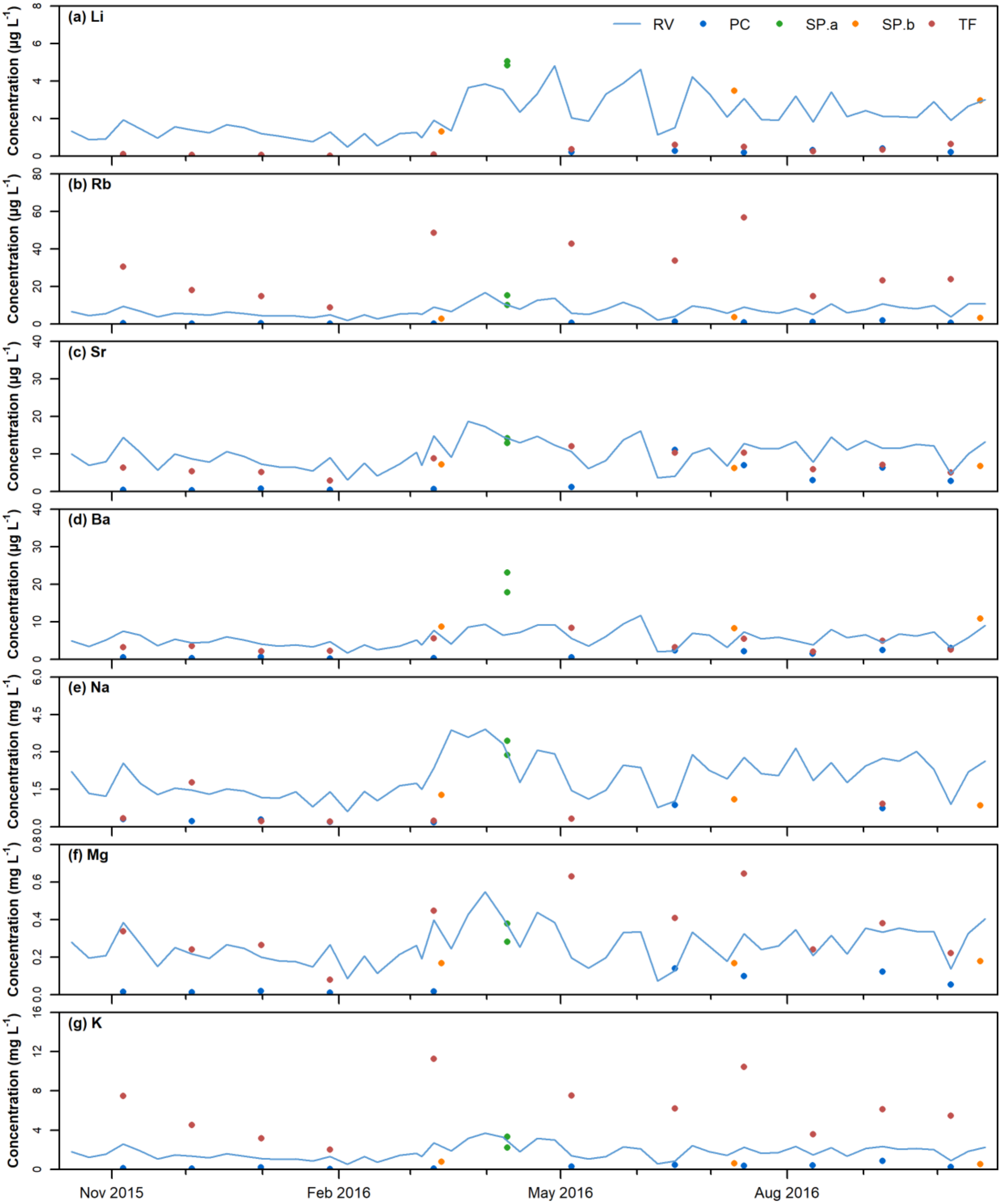

Figure S1. Time series of solute concentrations in stream water (RV) and sampled end members (PC = precipitation, SP.a = spring, SP.b = spring, TF = throughfall) in the natural forest (NF) sub-catchment between 15 October 2015 and 21 October 2016 in the South-West Mau, Kenya.

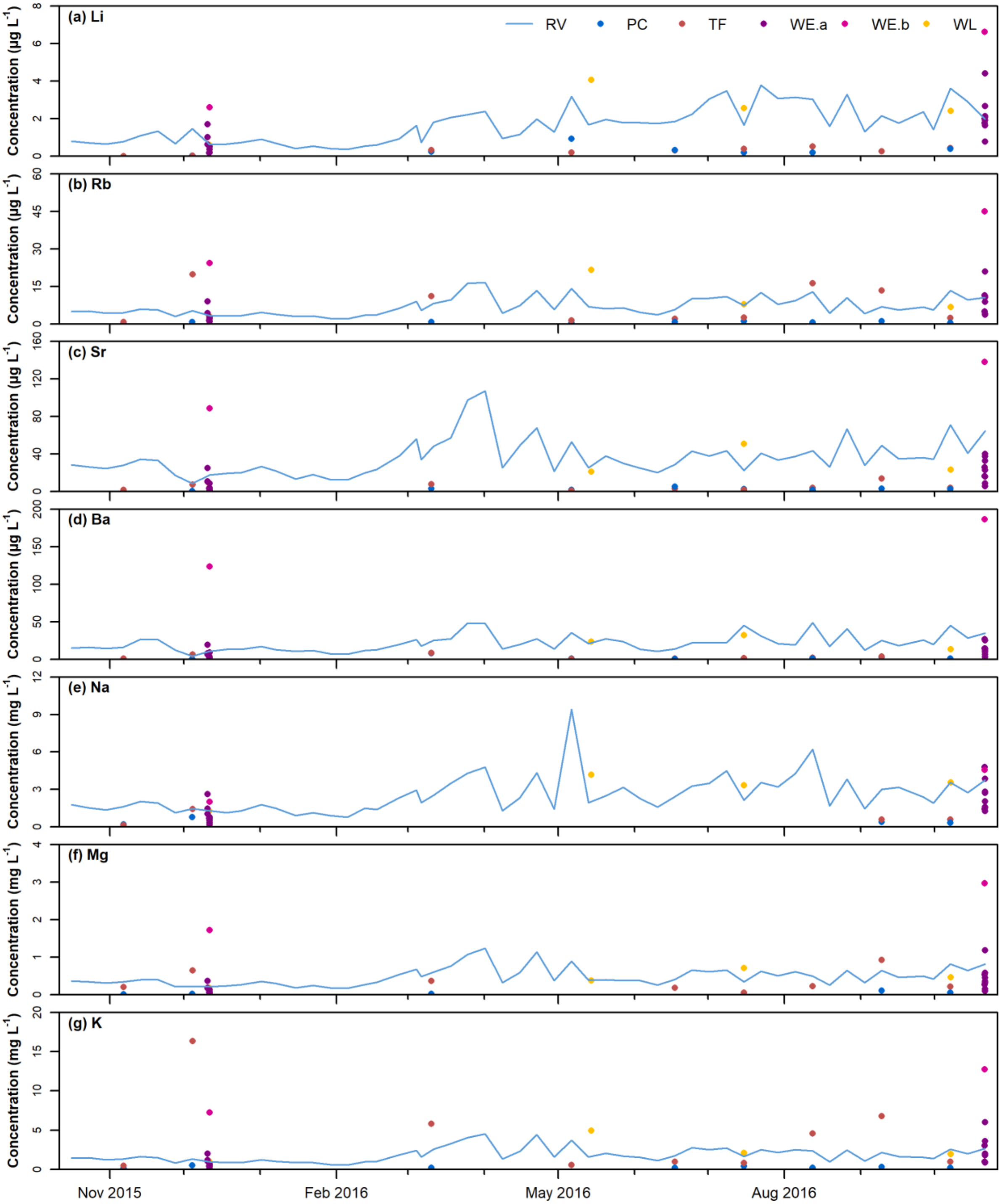

Figure S2. Time series of solute concentrations in stream water (RV) and sampled end members (PC = precipitation, TF = throughfall, WE.a = shallow well, WE.b = shallow well, WL = wetland) in the smallholder agriculture (SHA) sub-catchment between 15 October 2015 and 21 October 2016 in the South-West Mau, Kenya.

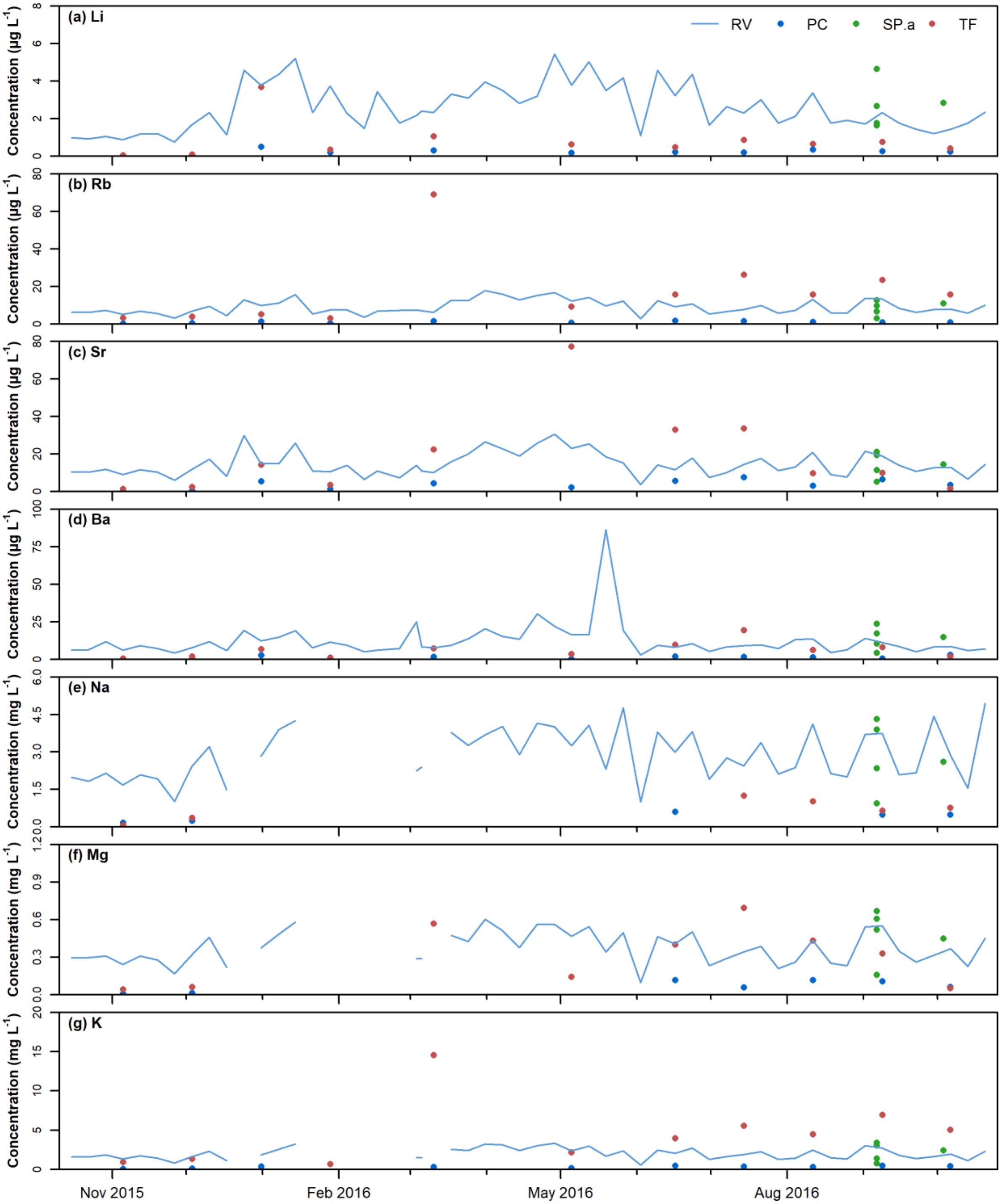

Figure S3. Time series of solute concentrations in stream water (RV) and sampled end members (PC = precipitation, SP.a = spring, TF = throughfall) in the tea and tree plantation (TTP) sub-catchment between 15 October 2015 and 21 October 2016 in the South-West Mau, Kenya.

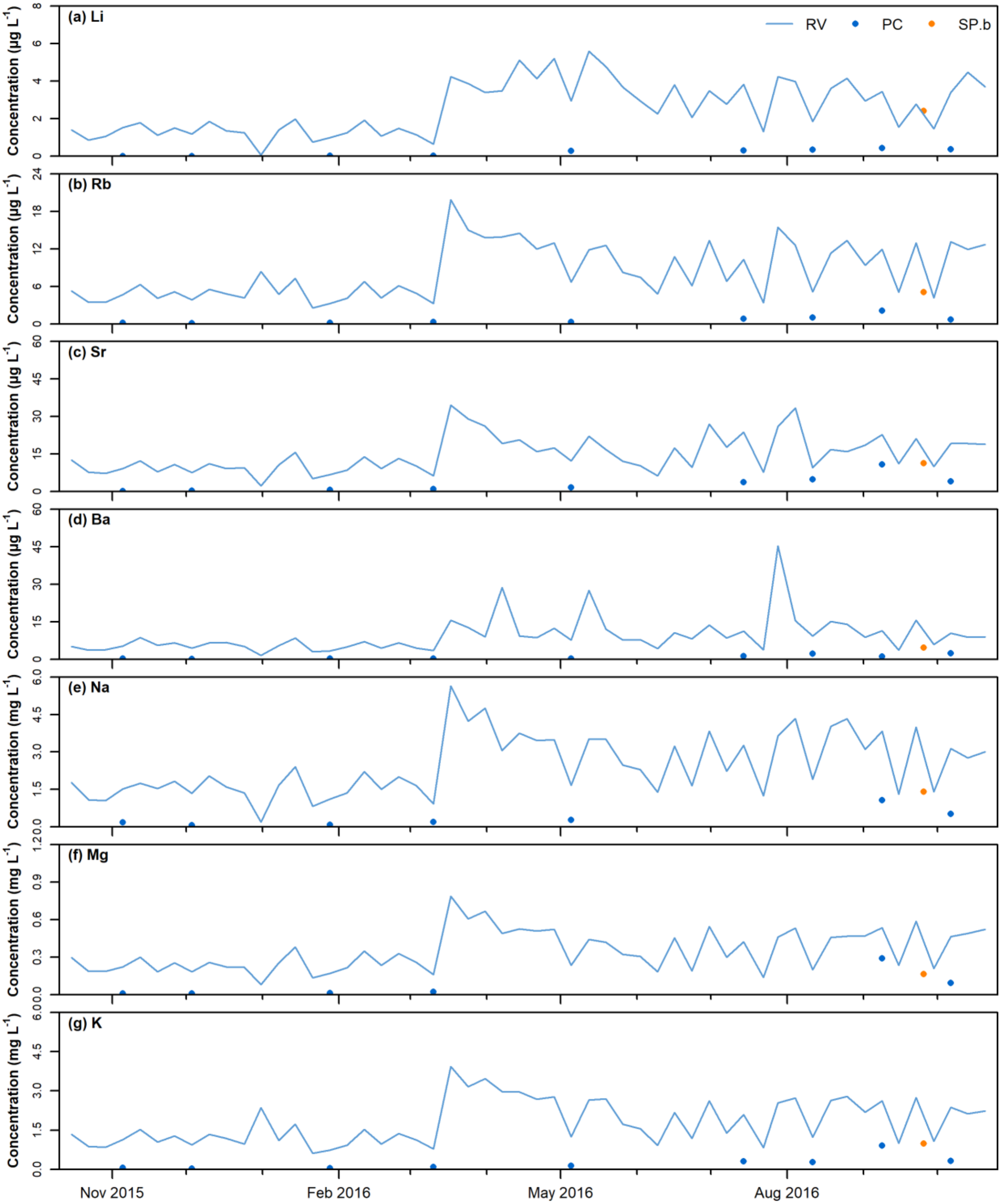

Figure S4. Time series of solute concentrations in stream water (RV) and sampled end members (PC = precipitation, SP.b = spring) in the main catchment (OUT) between 15 October 2015 and 21 October 2016 in the South-West Mau, Kenya.

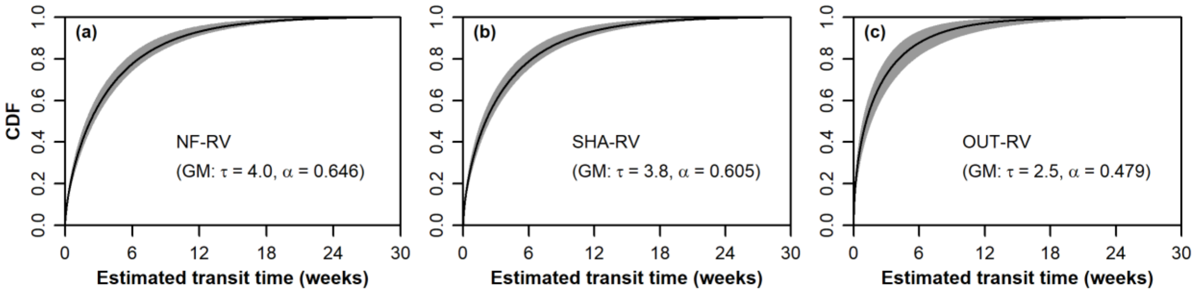

Figure S5. Transit time distributions as cumulative density functions of modelled results for the gamma model (GM) for stream water in (a) natural forest (NF-RV) and (b) smallholder agriculture (SHA-RV) sub-catchments and (c) the main catchment (OUT-RV). In each plot, the grey shaded area corresponds to the range of possible shapes of the distribution function, according to generalised likelihood uncertainty estimation (GLUE), while the black line corresponds to the best modelled distribution function. Values in parentheses correspond to the distribution function parameters of the best fitted result.

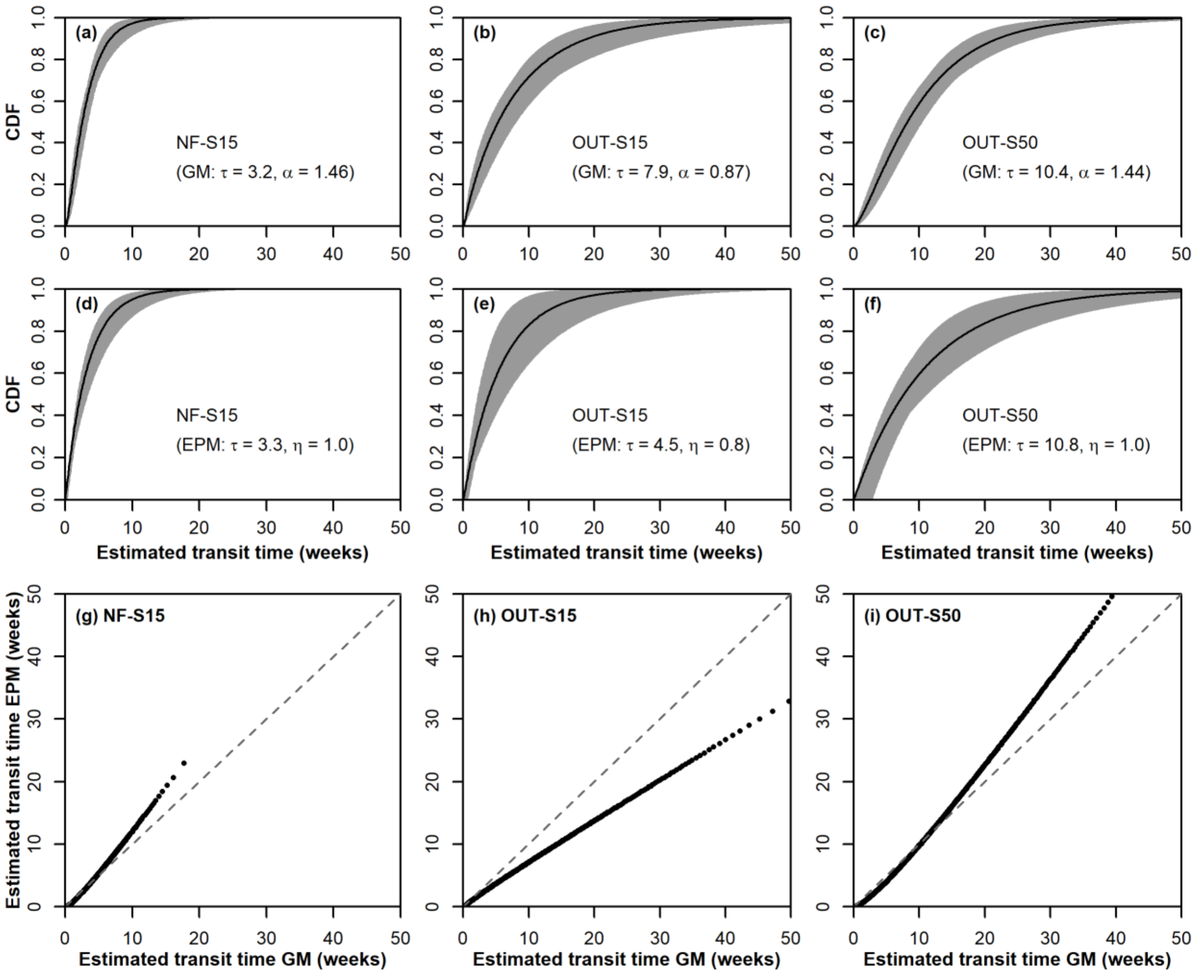

Figure S6. Transit time distributions as cumulative density functions of modelled results for (a–c) the gamma model (GM) and (d–f) the exponential piston flow model (EPM) for mobile soil water at 15 cm depth in the natural forest sub-catchment (NF-S15) and the main catchment (OUT-S15), and at 50 cm depth in the main catchment (OUT-S50). In each plot, the grey shaded area corresponds to the range of possible shapes of the distribution function, according to generalised likelihood uncertainty estimation (GLUE), while the black line corresponds to the best modelled distribution function. Values in parentheses correspond to the distribution function parameters of the best fitted result. (g–i) Comparison of best fitted transit time distribution generated by both models through quantile plots per site. The dashed line is the reference line (same distribution).

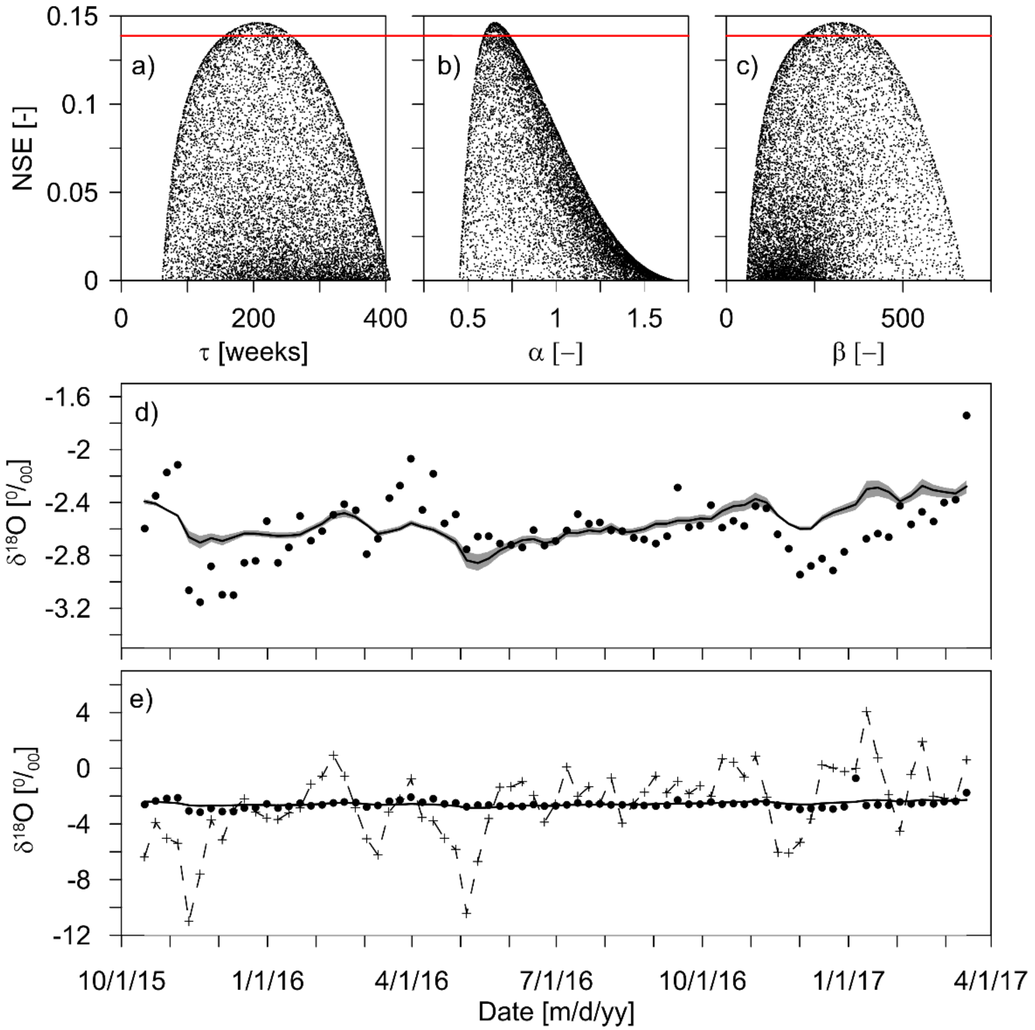

Figure S7. Uncertainty ranges for stream water (RV) in the natural forest (NF) sub-catchment using a gamma (GM) distribution function: (a), (b) and (c) show the modelled parameter uncertainties of 10 000 simulations and the feasible range of behavioural solutions taking a lower limit of 5 % from the best solution. Black filled circles in (d) and (e) represent the observed data; the black line and the shaded area represent the best possible solution and its range of variation according to the 5–95 % confidence limits of the behavioural solutions shown in (a); and the grey dashed line with crosses in (e) represents the weekly rainfall variation as an input function for the model.

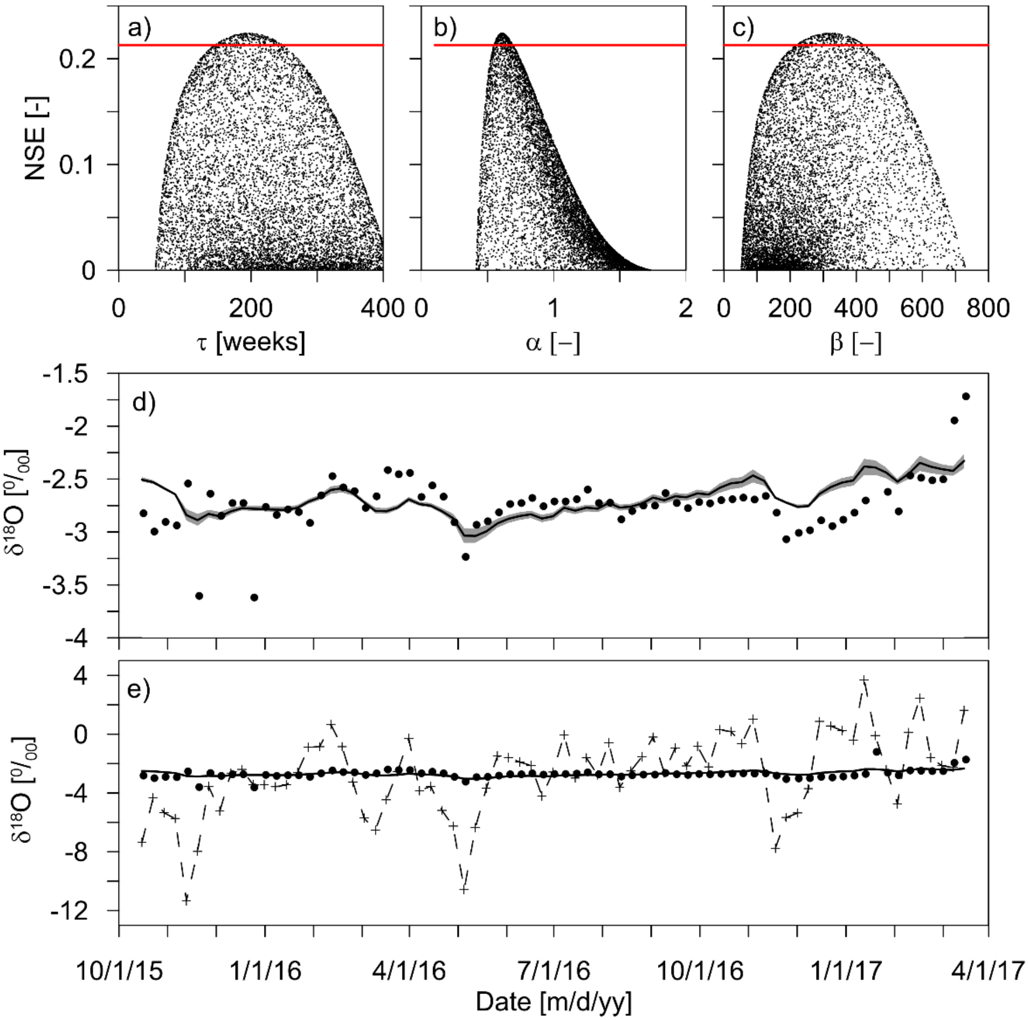

Figure S8. Uncertainty ranges for stream water (RV) in the smallholder agriculture (SHA) sub-catchment using a gamma (GM) distribution function: (a), (b) and (c) show the modelled parameter uncertainties of 10 000 simulations and the feasible range of behavioural solutions taking a lower limit of 5 % from the best solution. Black filled circles in (d) and (e) represent the observed data; the black line and the shaded area represent the best possible solution and its range of variation according to the 5–95 % confidence limits of the behavioural solutions shown in (a); and the grey dashed line with crosses in (e) represents the weekly rainfall variation as an input function for the model.

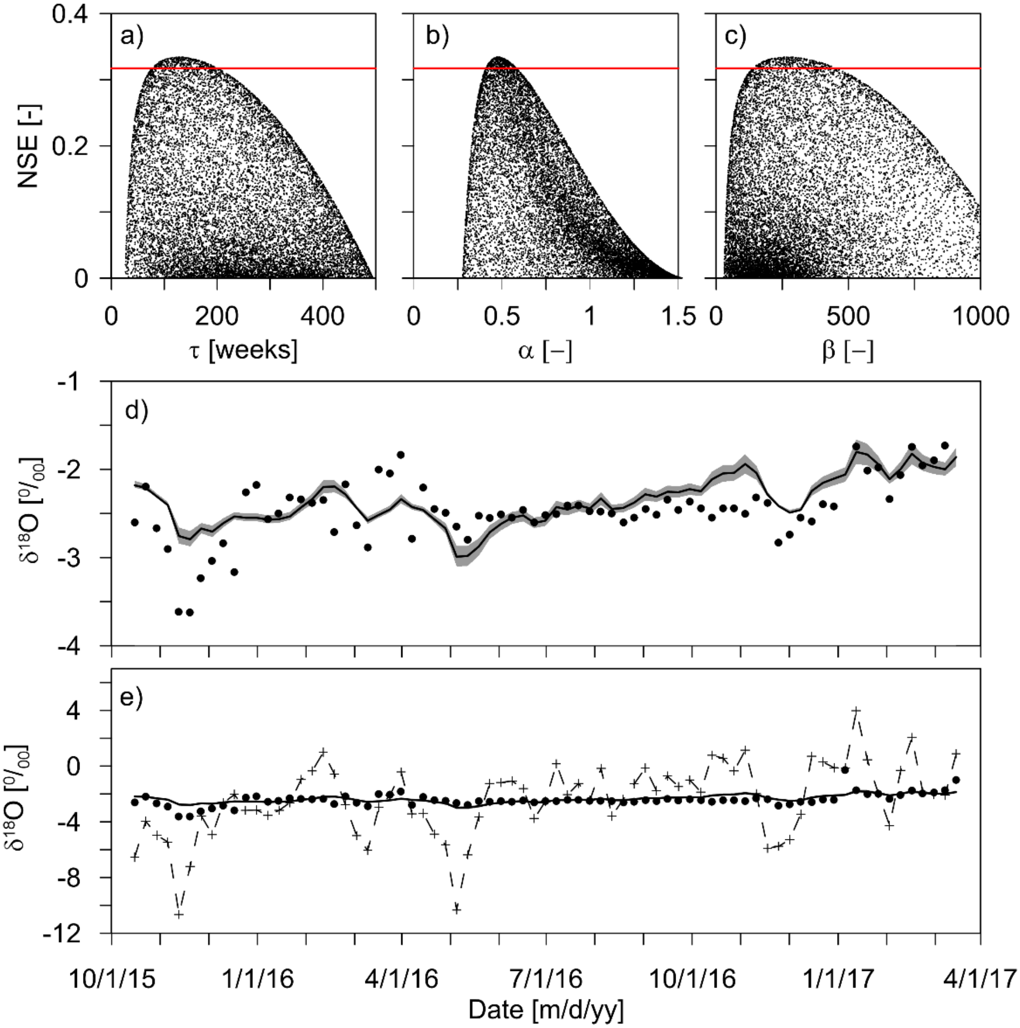

Figure S9. Uncertainty ranges for stream water (RV) in the main catchment (OUT) using a gamma (GM) distribution function: (a), (b) and (c) show the modelled parameter uncertainties of 10 000 simulations and the feasible range of behavioural solutions taking a lower limit of 5 % from the best solution. Black filled circles in (d) and (e) represent the observed data; the black line and the shaded area represent the best possible solution and its range of variation according to the 5–95 % confidence limits of the behavioural solutions shown in (a); and the grey dashed line with crosses in (e) represents the weekly rainfall variation as an input function for the model.

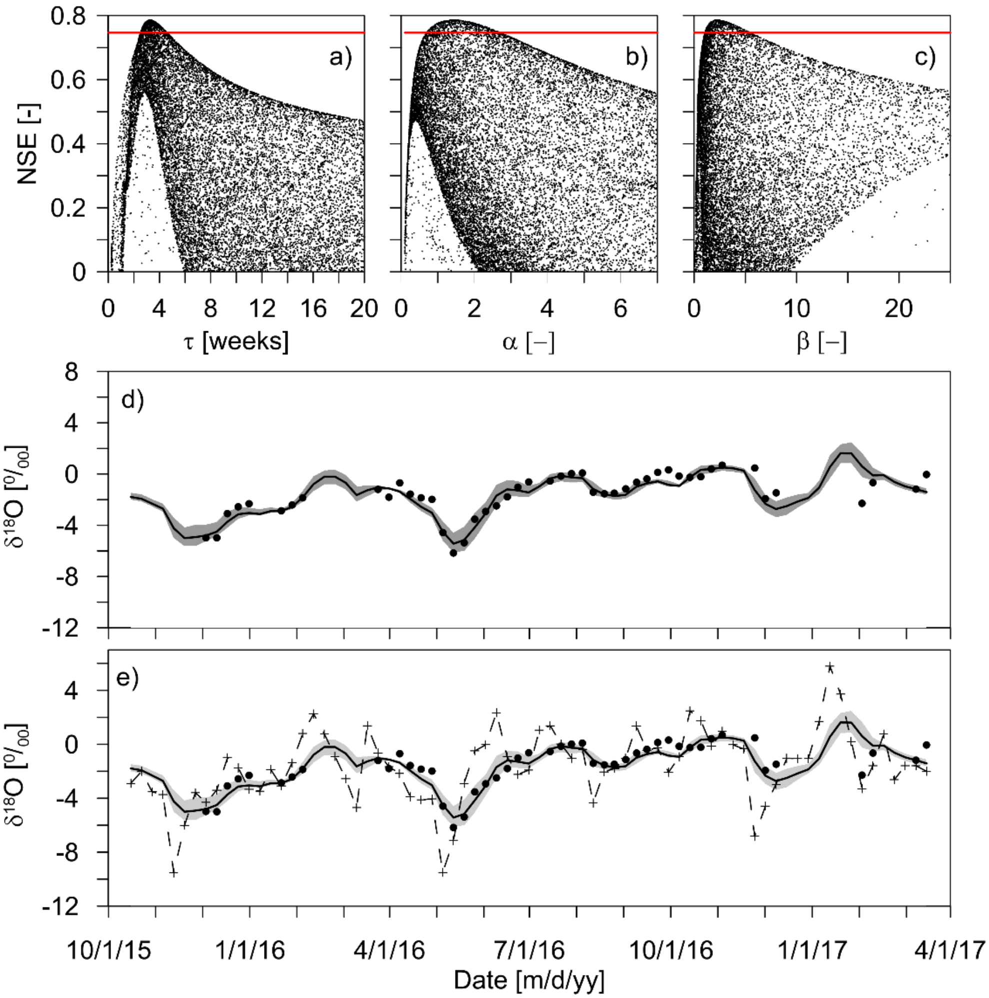

Figure S10. Uncertainty ranges for mobile soil water at 15 cm depth (S15) in the natural forest (NF) sub-catchment using a gamma (GM) distribution function: (a), (b) and (c) show the modelled parameter uncertainties of 10 000 simulations and the feasible range of behavioural solutions taking a lower limit of 5 % from the best solution. Black filled circles in (d) and (e) represent the observed data; the black line and the shaded area represent the best possible solution and its range of variation according to the 5–95 % confidence limits of the behavioural solutions shown in (a); and the grey dashed line with crosses in (e) represents the weekly rainfall variation as an input function for the model.

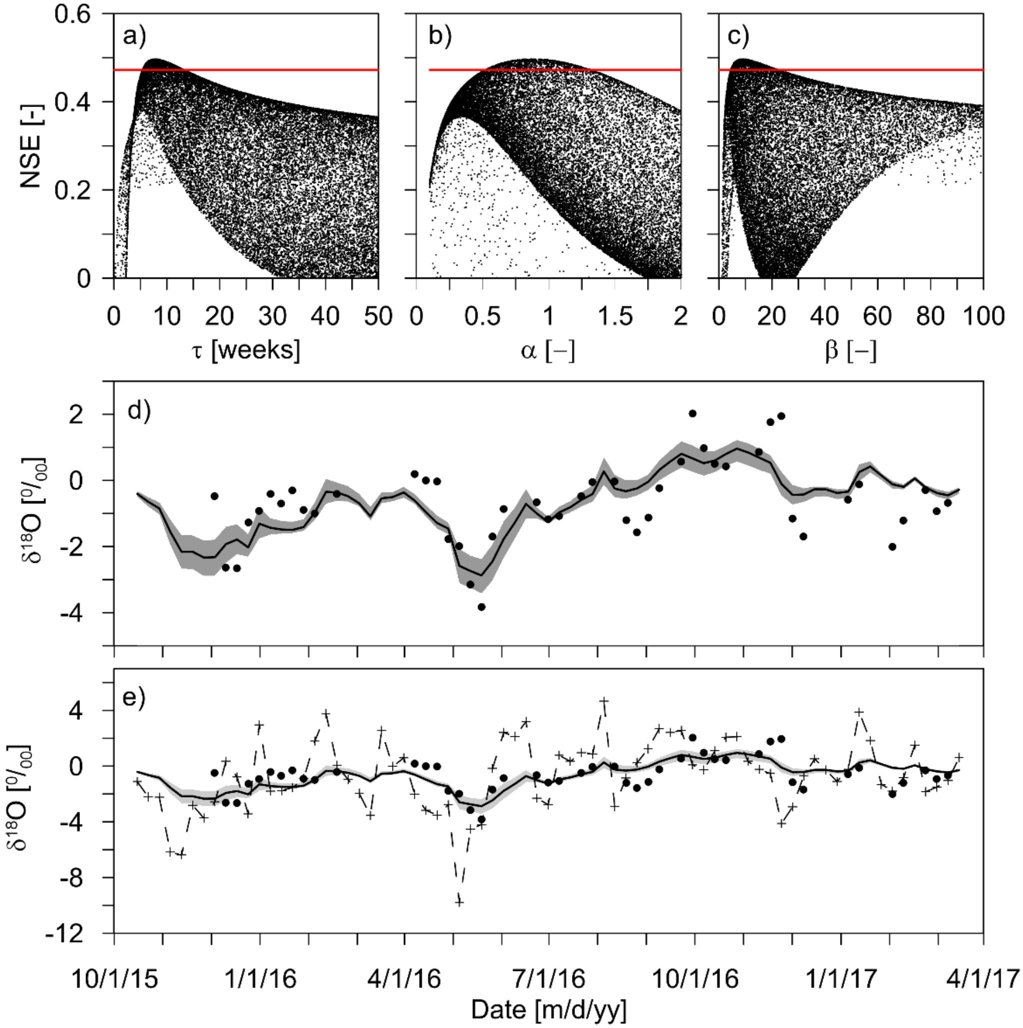

Figure S11. Uncertainty ranges for mobile soil water at 15 cm depth (S15) in the main catchment (OUT) using a gamma (GM) distribution function: (a), (b) and (c) show the modelled parameter uncertainties of 10 000 simulations and the feasible range of behavioural solutions taking a lower limit of 5 % from the best solution. Black filled circles in (d) and (e) represent the observed data; the black line and the shaded area represent the best possible solution and its range of variation according to the 5–95 % confidence limits of the behavioural solutions shown in (a); and the grey dashed line with crosses in (e) represents the weekly rainfall variation as an input function for the model.

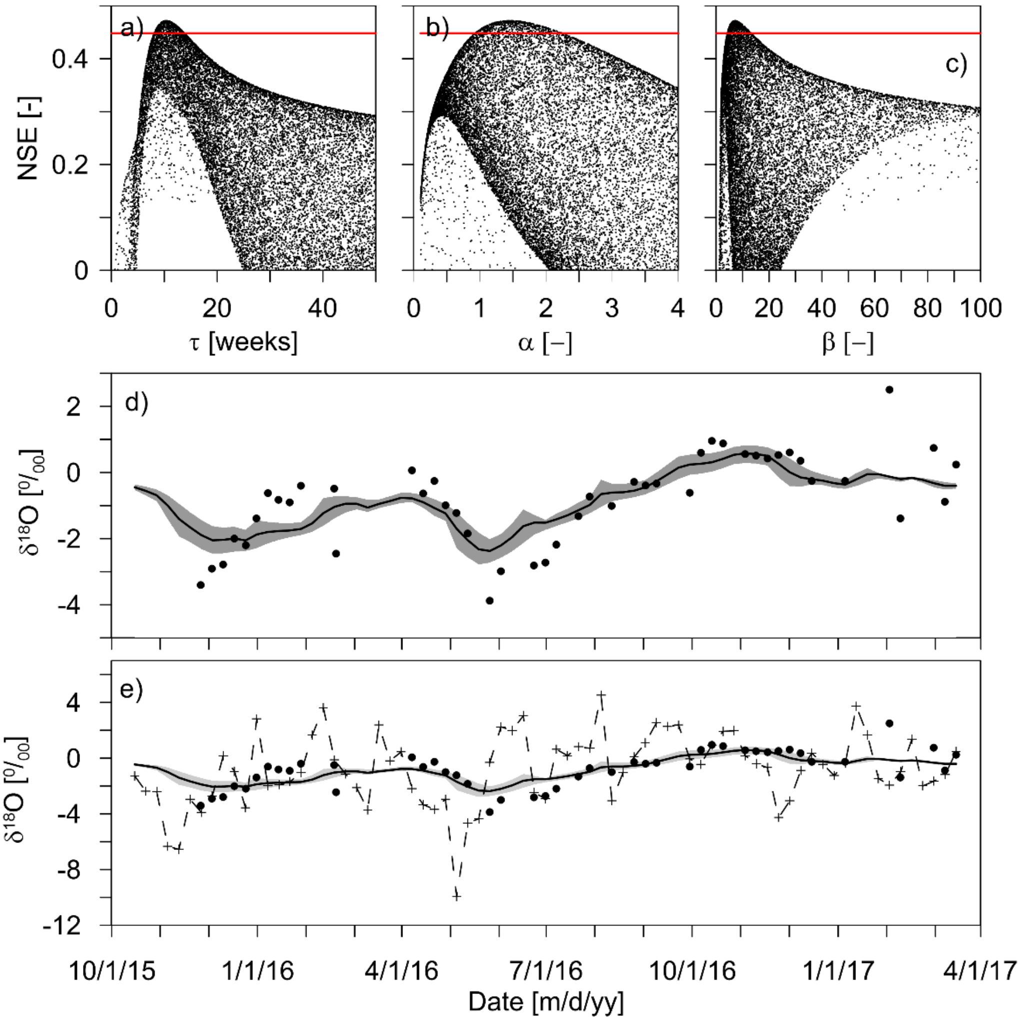

Figure S12. Uncertainty ranges for mobile soil water at 50 cm depth (S50) in the main catchment (OUT) using a gamma (GM) distribution function: (a), (b) and (c) show the modelled parameter uncertainties of 10 000 simulations and the feasible range of behavioural solutions taking a lower limit of 5 % from the best solution. Black filled circles in (d) and (e) represent the observed data; the black line and the shaded area represent the best possible solution and its range of variation according to the 5–95 % confidence limits of the behavioural solutions shown in (a); and the grey dashed line with crosses in (e) represents the weekly rainfall variation as an input function for the model.

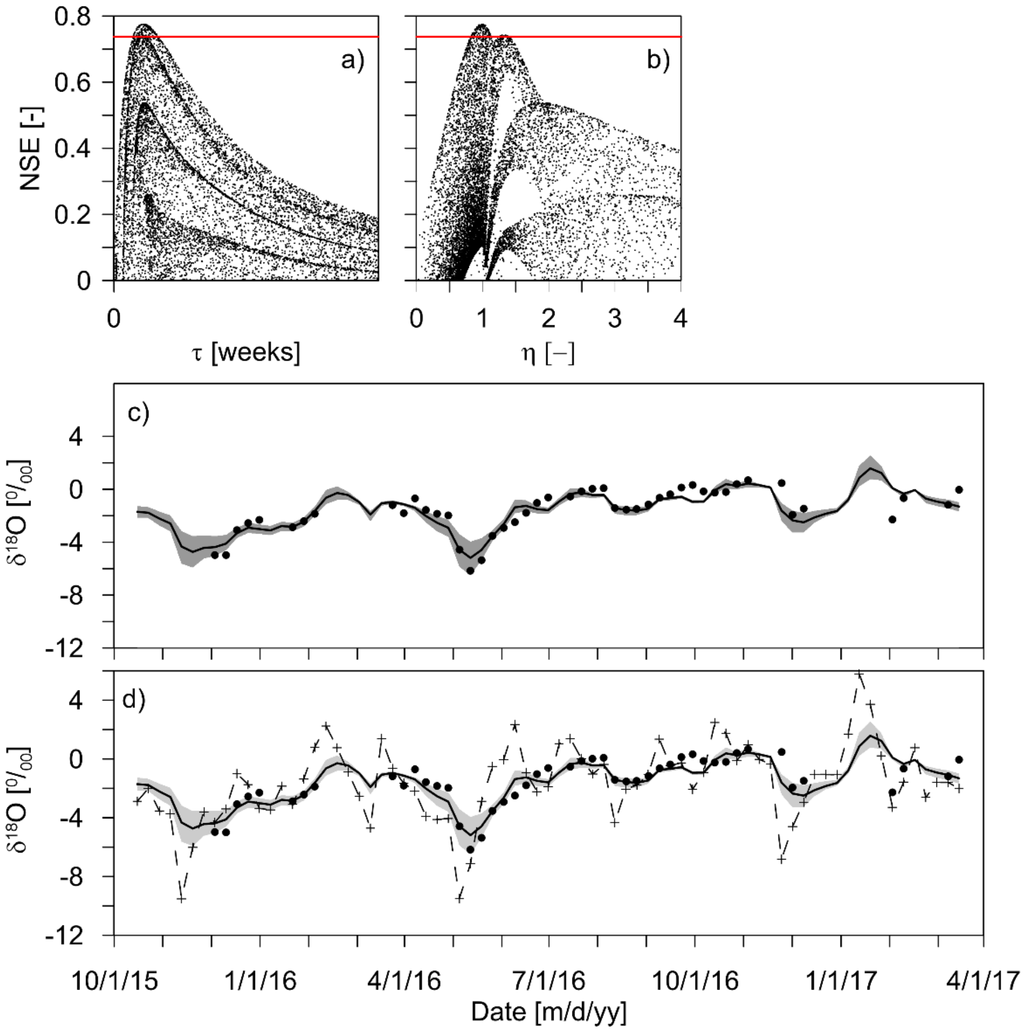

Figure S13. Uncertainty ranges for mobile soil water at 15 cm depth (S15) in the natural forest (NF) sub-catchment using an exponential piston flow (EPM) distribution function: (a) and (b) show the modelled parameter uncertainties of 10 000 simulations and the feasible range of behavioural solutions taking a lower limit of 5 % from the best solution. Black filled circles in (c) and (d) represent the observed data; the black line and the shaded area represent the best possible solution and its range of variation according to the 5–95 % confidence limits of the behavioural solutions shown in (a); and the grey dashed line with crosses in (d) represents the weekly rainfall variation as an input function for the model.

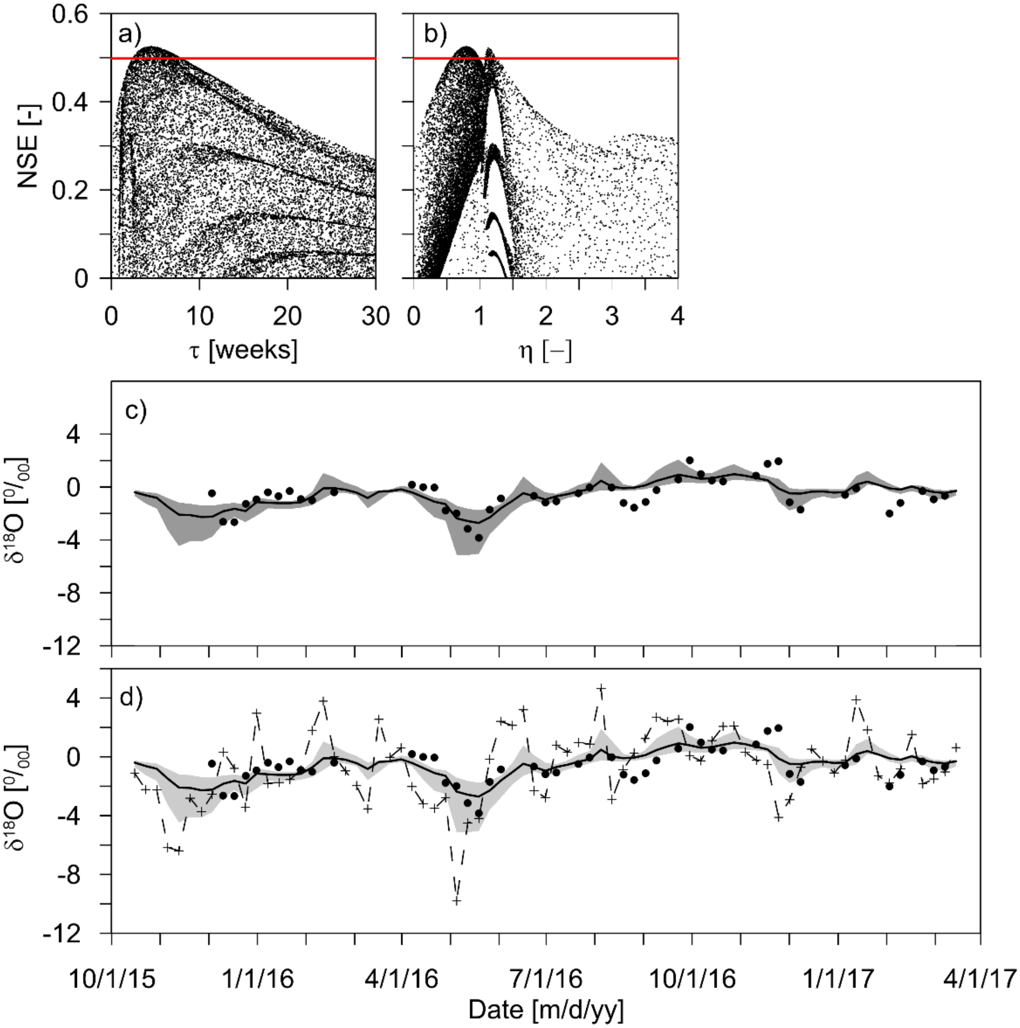

Figure S14. Uncertainty ranges for mobile soil water at 15 cm depth (S15) in the main catchment (OUT) using an exponential piston flow (EPM) distribution function: (a) and (b) show the modelled parameter uncertainties of 10 000 simulations and the feasible range of behavioural solutions taking a lower limit of 5 % from the best solution. Black filled circles in (c) and (d) represent the observed data; the black line and the shaded area represent the best possible solution and its range of variation according to the 5–95 % confidence limits of the behavioural solutions shown in (a); and the grey dashed line with crosses in (d) represents the weekly rainfall variation as an input function for the model.

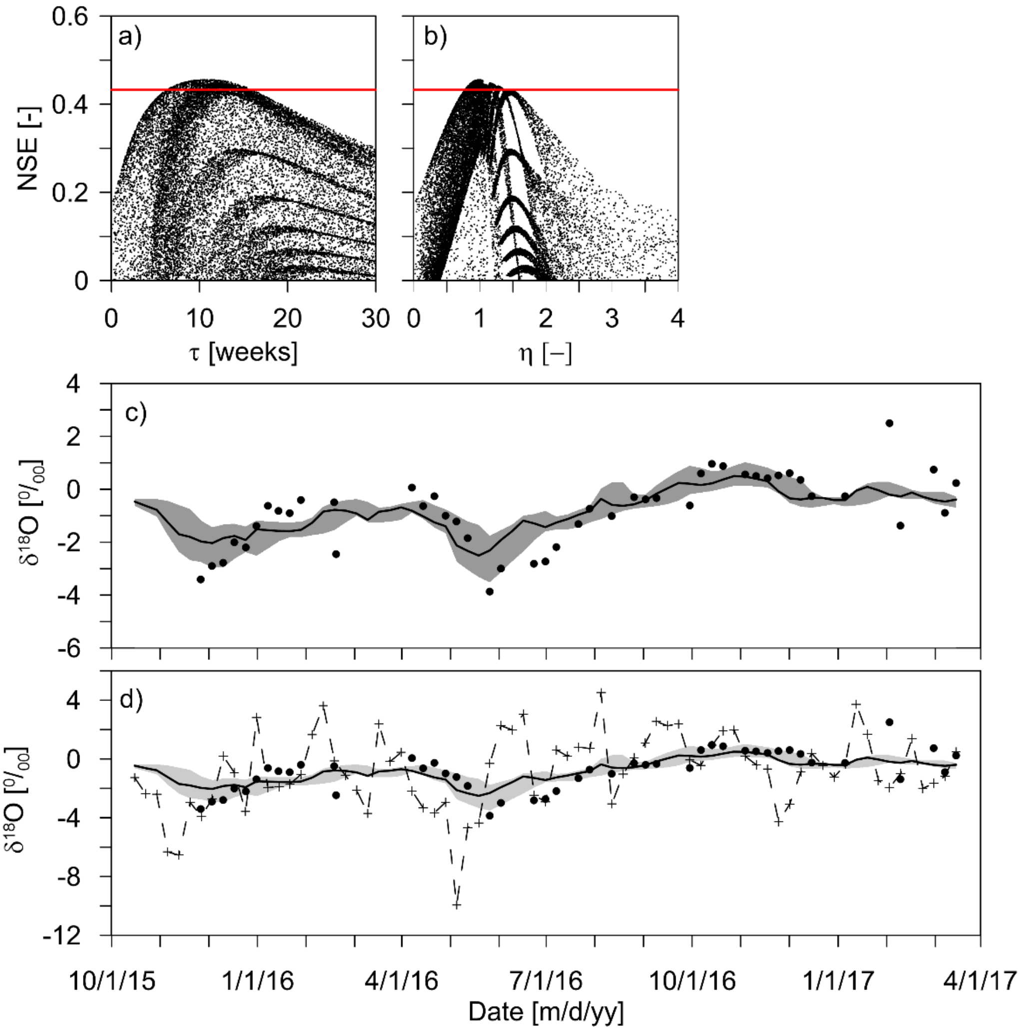

Figure S15. Uncertainty ranges for mobile soil water at 50 cm depth (S50) in the main catchment (OUT) using an exponential piston flow (EPM) distribution function: (a) and (b) show the modelled parameter uncertainties of 10 000 simulations and the feasible range of behavioural solutions taking a lower limit of 5 % from the best solution. Black filled circles in (c) and (d) represent the observed data; the black line and the shaded area represent the best possible solution and its range of variation according to the 5–95 % confidence limits of the behavioural solutions shown in (a); and the grey dashed line with crosses in (d) represents the weekly rainfall variation as an input function for the model.