Surface-subsurface interaction analysis and the influence of precipitation spatial variability on a lowland mesoscale catchment

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Supplementary material

Table S1: calibration weights for each variable

Discharge location	Weights	Evapotranspiration locations	Weights
Outlet	0.4	CCP, PAS, LPOA, NIAL	0.1
At Middle	0.3	DUF, CF, MF, NG, IM	0.05
At Border	0.3		
Groundwater location	**Weights**		
GWL Points	0.08		

CCP - Complex cultivation Pattern
PAS - Pastures
APOA- Land principally occupied by agriculture
DUF - Discontinuous urban fabric
NIAL - Non-irrigated arable land
NG - Natural grassland
IM - Inland marshes
MF - Mixed forest
CF - Conifer forest

Table S2: Model component and parameters for sensitivity analysis

Component	Parameter
Channel Flow	• Manning's roughness coefficient (M) • Leakage Coefficient
Saturated Zone	• Horizontal hydraulic conductivity • Vertical hydraulic conductivity • Specific yield • Specific storage
Drainage	• Time Constant

Table S3: Model validation parameters and data source

Parameter	Details
Precipitation	2017-2018: Dutch part: Radar Data Belgium part: IDW interpolated data 2019-2021: Complete radar data (Meteobase, n.d.)
Reference Evapotranspiration	Gilze-Rijen Weather station (Time series)
Observed streamflow's	Waterschap Brabantse Delta
Groundwater levels	Waterschap Brabantse Delta & Dinoloket (Data and information on the Dutch subsurface)

Table S4: Model performance results for streamflow, GWL, and actual evapotranspiration for the calibration period (2010-2016) and validation period (2017-2021)

Name	Calibrated Model		Validated Model	
	R	NSE	R	NSE
Streamflow's				
At Outlet	0.90	0.78	0.89	0.71
In the middle	0.78	0.61	0.84	0.65
At Belgium Boarder	0.76	0.57	0.84	0.62
Groundwater				
5219	0.79	-0.08	0.93	0.85
5332	0.82	0.38	0.83	0.29
5170	0.92	0.83	0.85	0.71
5165	0.81	0.43	0.71	0.41
B50COO77	0.92	0.57	0.87	0.30
B50C0079	0.91	0.52	0.86	0.63
B50C0078	0.81	0.56	0.86	0.53
B49F0231	0.61	0.33	-	-
B50A0234	0.88	0.40	-	-
1-0344	0.65	0.34	0.70	0.28
1-0347	0.96	-0.23	0.92	-0.40
1-0342	0.74	0.45	0.76	0.36

1-0170	0.89	0.79	0.55	-0.10

Name	**Calibrated Model**		**Validated Model**	
	R	**NSE**	**R**	**NSE**
Evapotranspiration				
CCP(20,31)	0.85	0.71	0.84	0.69
CCP(38,57)	0.87	0.72	0.82	0.67
DUF(42,61	0.88	0.54	0.71	0.27
DUF(18,18)	0.88	0.73	0.85	0.68
PAS(20,27)	0.84	0.68	0.83	0.66
PAS(33,12)	0.86	0.70	0.82	0.64
CCP(27,11)	0.89	0.36	0.86	0.14
APOA(18,34)	0.83	0.66	0.82	0.59
NIAL(17,27)	0.84	0.66	0.85	0.68
ACF(14,42)	0.66	0.18	0.60	0.08
MF(26,43)	0.85	0.12	0.82	-0.22
NG(27,45)	0.82	0.55	0.79	0.42
IM(18,10)	0.83	0.62	0.82	0.62

CCP – Complex cultivation pattern
DUF – Discontinuous urban fabric
NIAL - Non-irrigated arable land
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MF- Mixed forest
PAS - Pastures

Table S5: Detailed catchment water balance for the calibrated and validated period (2010-2021)

Water balance component (mm)	**Calibrated (2010-2016)**	**Validated (2017-2021)**
Precipitation	6149	4000
Evapotranspiration	3518	2554
Overland flow to river	240	99
Infiltration	2596	1504
Base flow to river	192	99
SZ drains to river	1421	610
UZ Storage change	-96	-108

SZ storage change	255	250

Table S6: Detailed catchment water balance for the wet and dry hydrological years

Water balance component (mm)	Wet Hydrological Year- (2010)	Dry Hydrological Year- (2018)
Precipitation	923	757
Evapotranspiration	476	531
Overland flow to river	25	25
Infiltration	379	241
Base flow to river	21	21
SZ drains to river	148	146
UZ Storage change	53	-28
SZ storage change	111	-41

Table S7: Detailed catchment water balance with different precipitation representation

Water balance component (mm)	Theisen Polygon	Inverse Distance Weighting	Radar
Precipitation	6239	6243	6149
Evapotranspiration	3538	3548	3518
Overland flow to river	253	249	240
Infiltration	2656	2654	2596
Base flow to river	191	191	192
SZ drains to river	1474	1471	1421
UZ Storage change	-95	-95	-96
SZ storage change	256	256	255

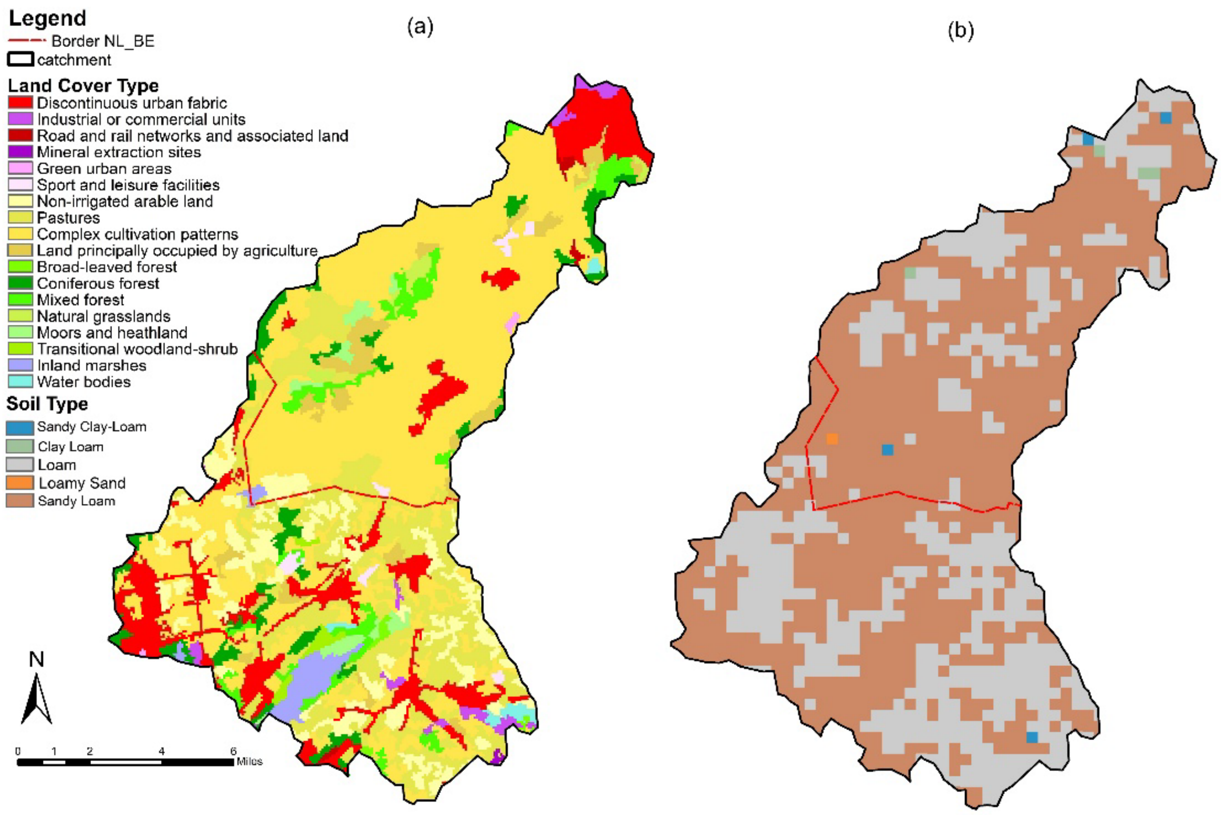

Figure S1: (a) Corine Land Use type (Copernicus, 2018) (b) Soil Type ESDAC (Ballabio, et al., 2016)

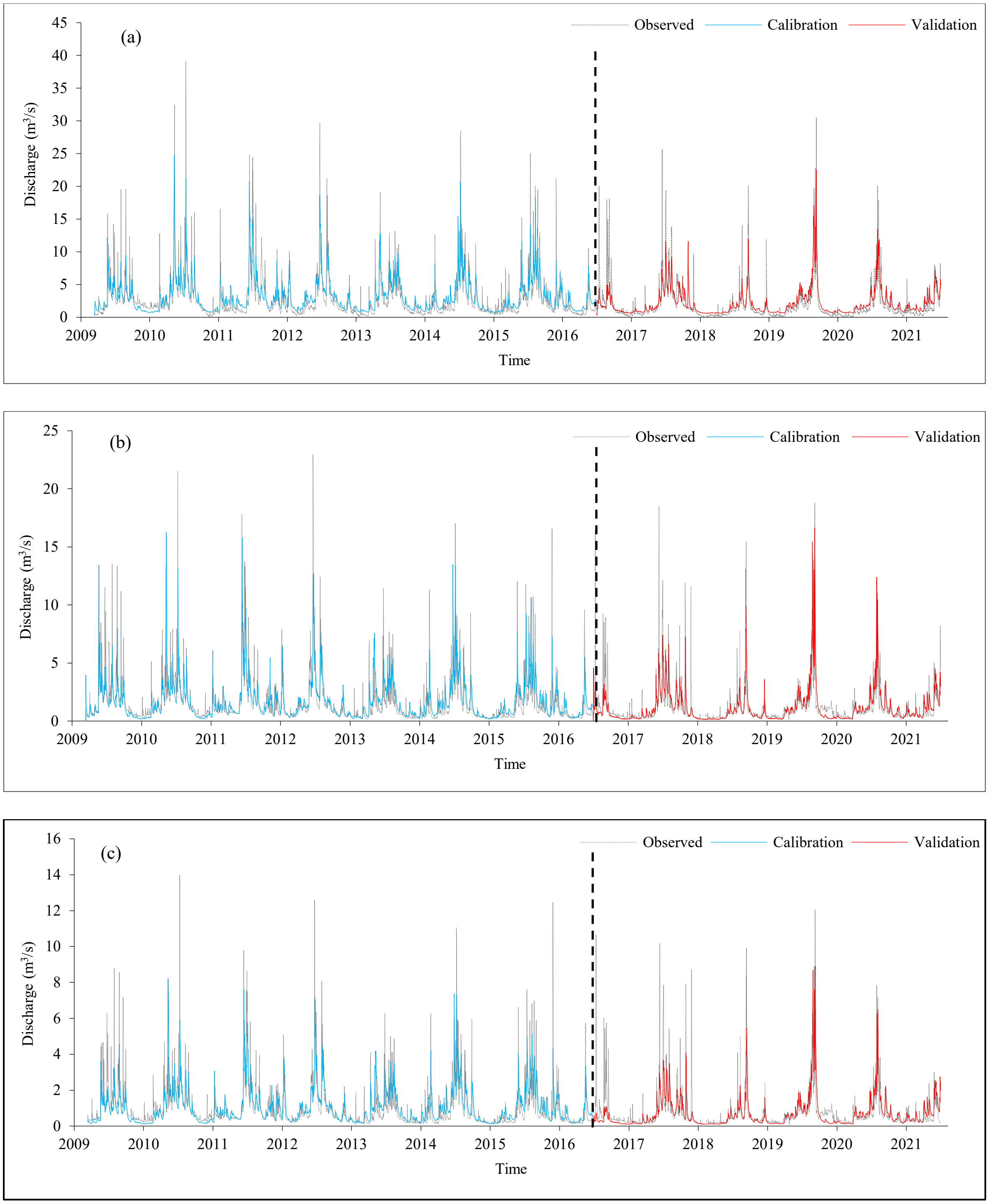

Figure S2: Streamflow's variation for calibration and validation period at (a) Outlet (b) Middle (c) At Border

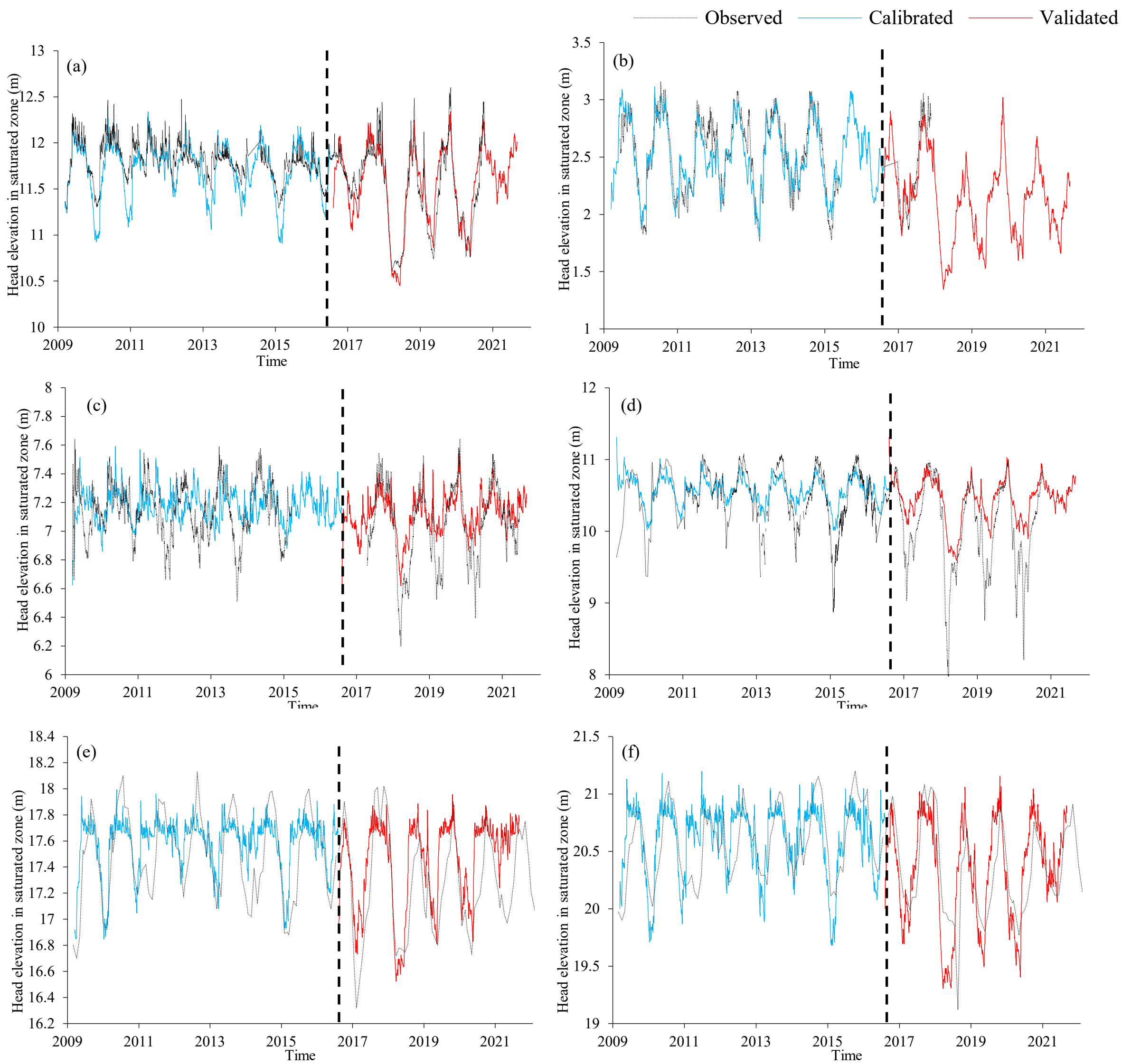

Figure S3: Groundwater level variation for calibration and validation period at (a) 5219 (b) 5170 (c) B50COO78 (d) B50COO77 (e) 1-0342 (f) 1-0344