Hydrological drought propagation analysis of the transboundary Lauter River (France/Germany) in this century using SWAT

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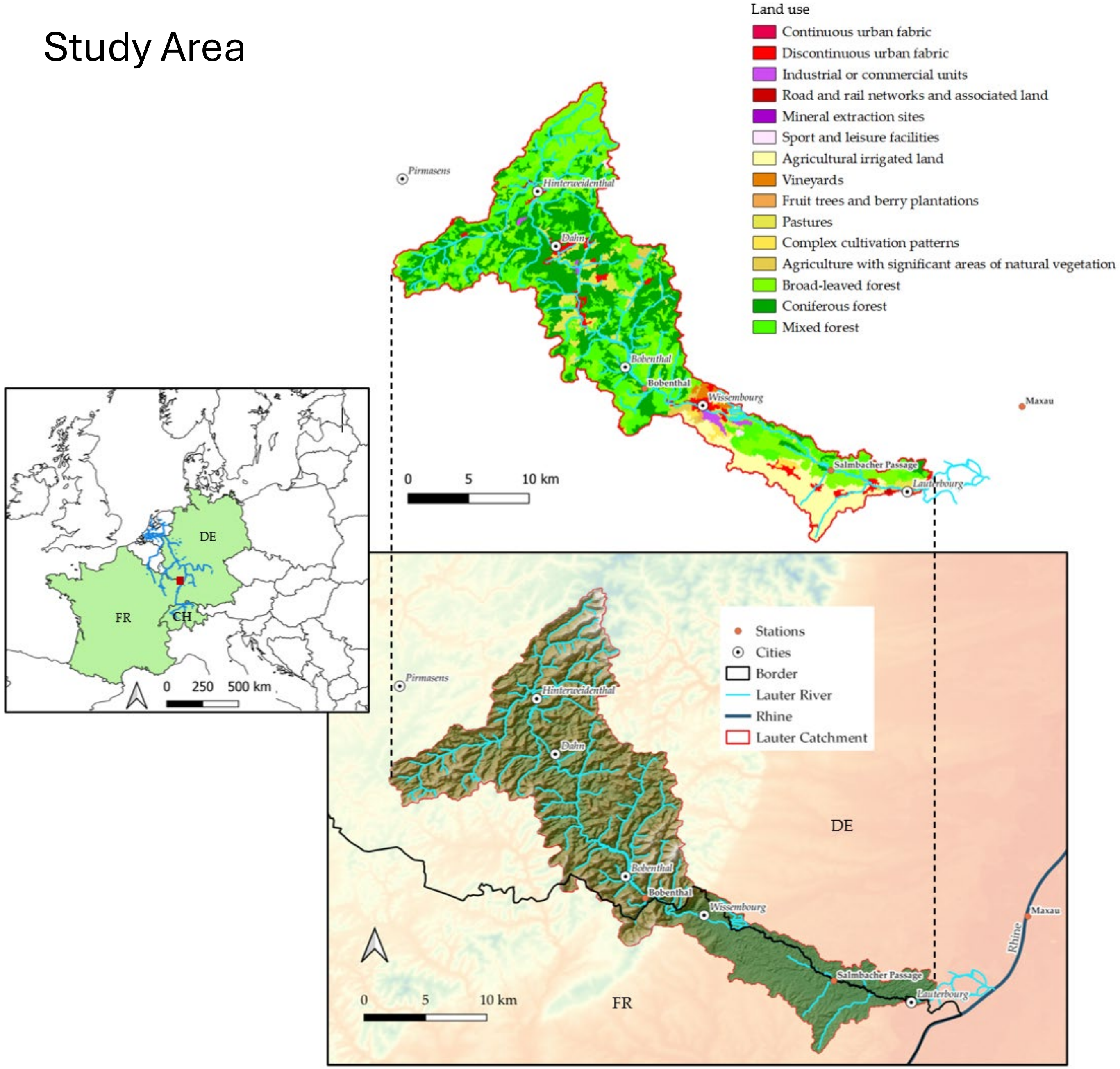
URM 7362

Study Area



Lauter Catchment Description	
Area:	375.8 km^2
Elevation range:	107-609.3 m
Length of the mainstream:	74.6 km
Slope of the mainstream:	0.25%
Discharge (MQ):	2.31 m^3/s (Bobenthal, 1956-2023)
Discharge (MQ):	3.27 m^3/s (Salmbacher Passage, 1961-2021)
Particularities:	- Sandstone mitigating both high water peaks and low flow periods - Historical wood-rafting pond series

Overview of the project

Klimawandel- und Landnutzungszenarien

Scenarios de changement climatique et d'utilisation des sols

Artenvielfalt und Rückzugsgebiete

Diversité des espèces et zones réfuges

Wasserquantität und -qualität

Quantité et qualité de l'eau

Wissensdialog, Vernetzung, Umsetzung

Dialogue scientifique, misen en réseau, mise en œuvre

Study Area

Historical management

- how the ancient wood-rafting ponds influence the hydro-regime



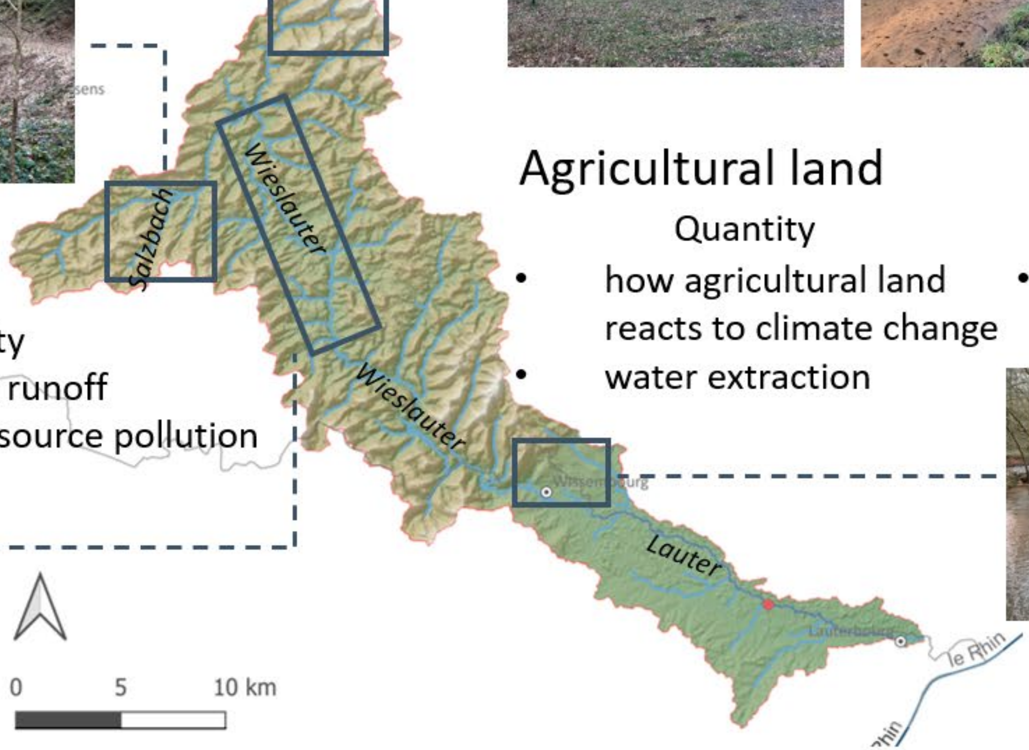
Urban area

Quantity

- how urban area reacts to climate change
- water extraction
- hydro-stations

Quality

- urban runoff
- point source pollution

Protection zone

- how pristine zones react to climate change


Agricultural land

Quantity

- how agricultural land reacts to climate change
- water extraction

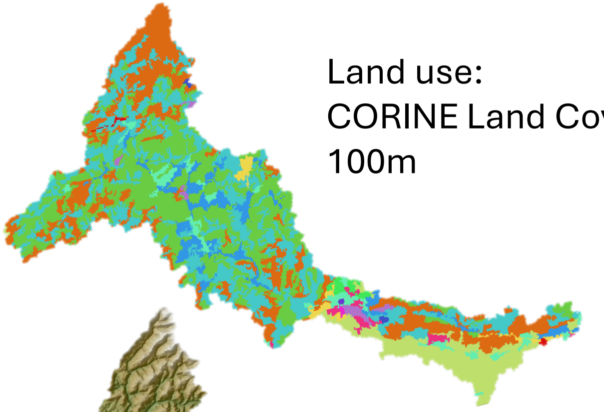
Quality

- non-point source pollution

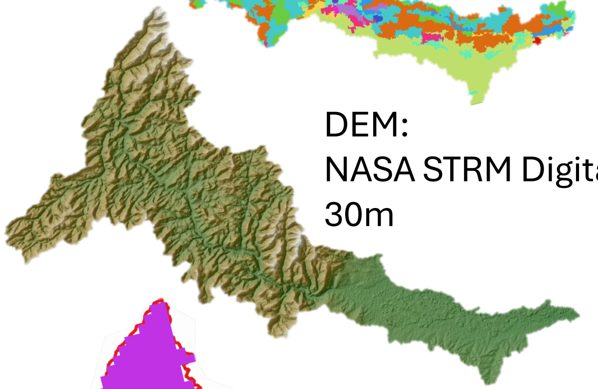
Great appreciation to everyone of the group of Dept. of Hydrology and Water Resources Management of University of Kiel for all the helps!

SWAT Model

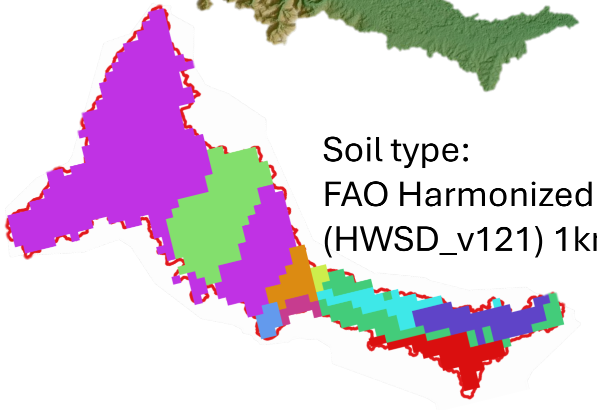
Climate data:
CLIMATE COMPETENCE CENTRE of Rhineland-Palatinate based on DWD data, in a 1000 m by 1000 m resolution



Land use:
CORINE Land Cover 2018 Raster
100m

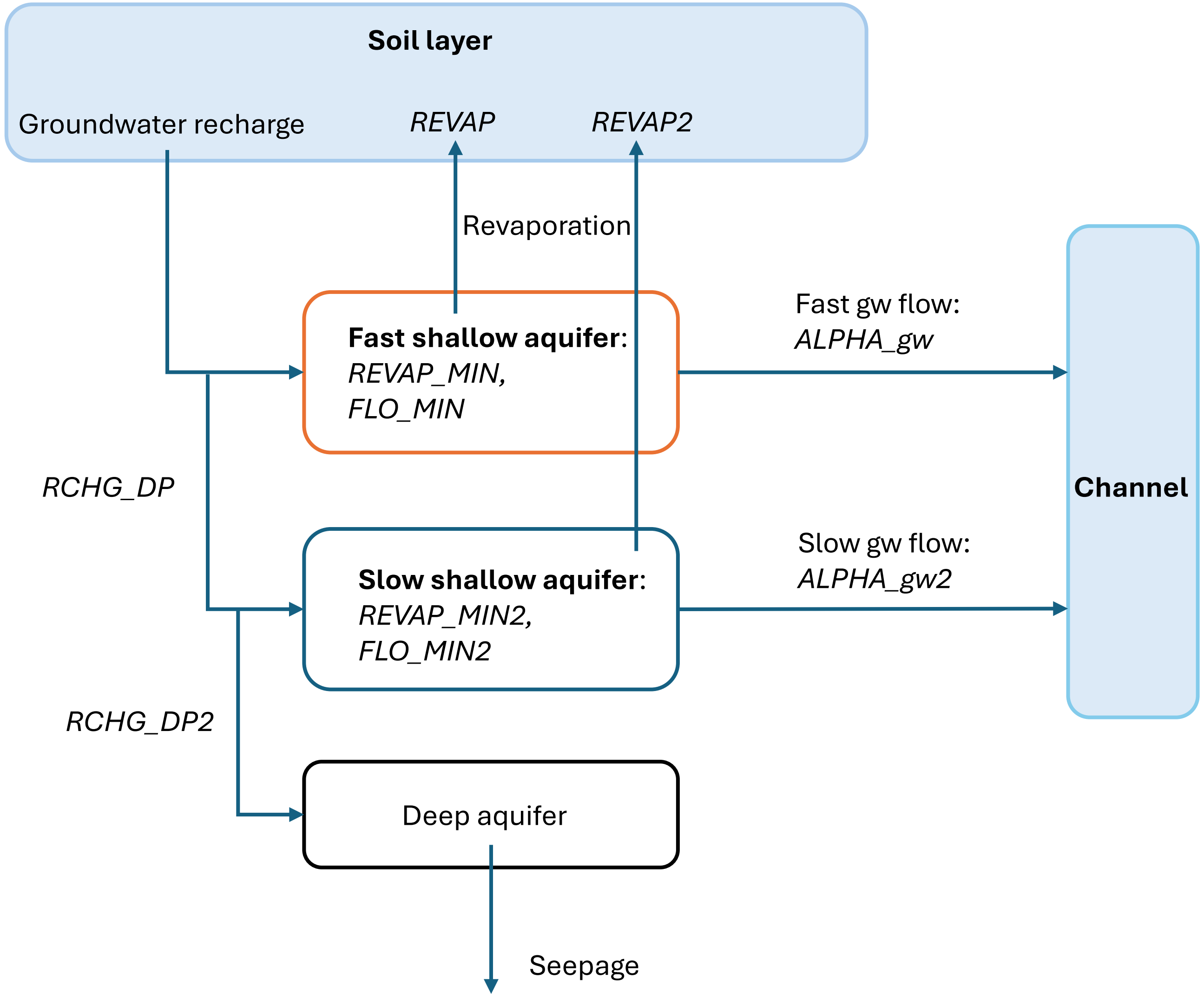


DEM:
NASA STRM Digital Elevation
30m



Soil type:
FAO Harmonized World Soil Database
(HWSD_v121) 1km

Double aquifer layers



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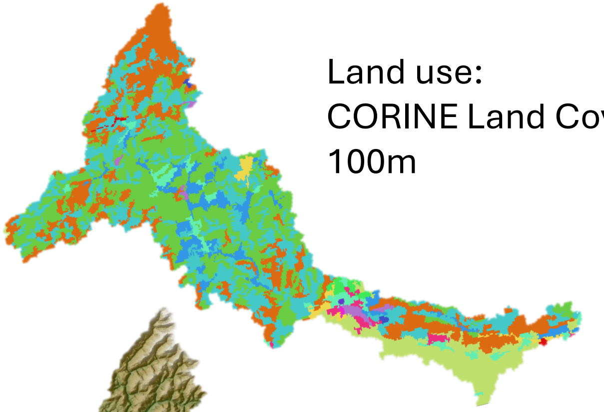

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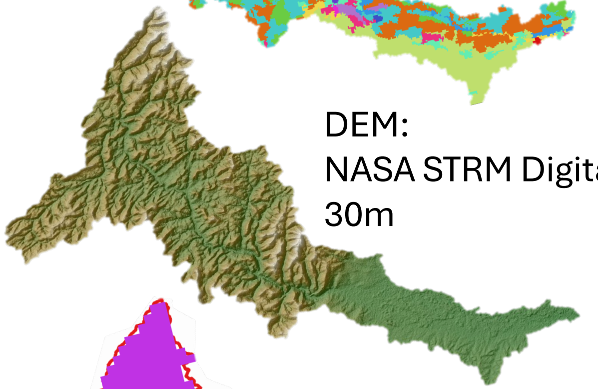
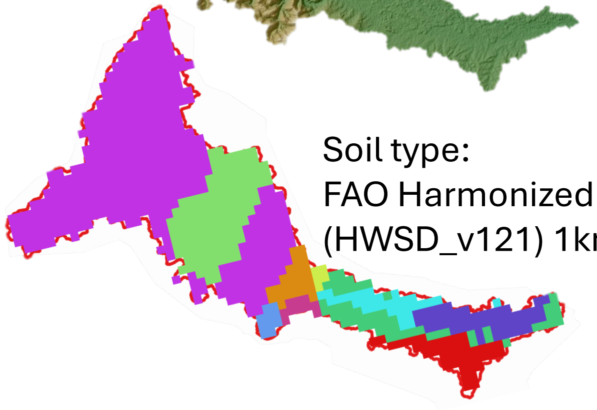
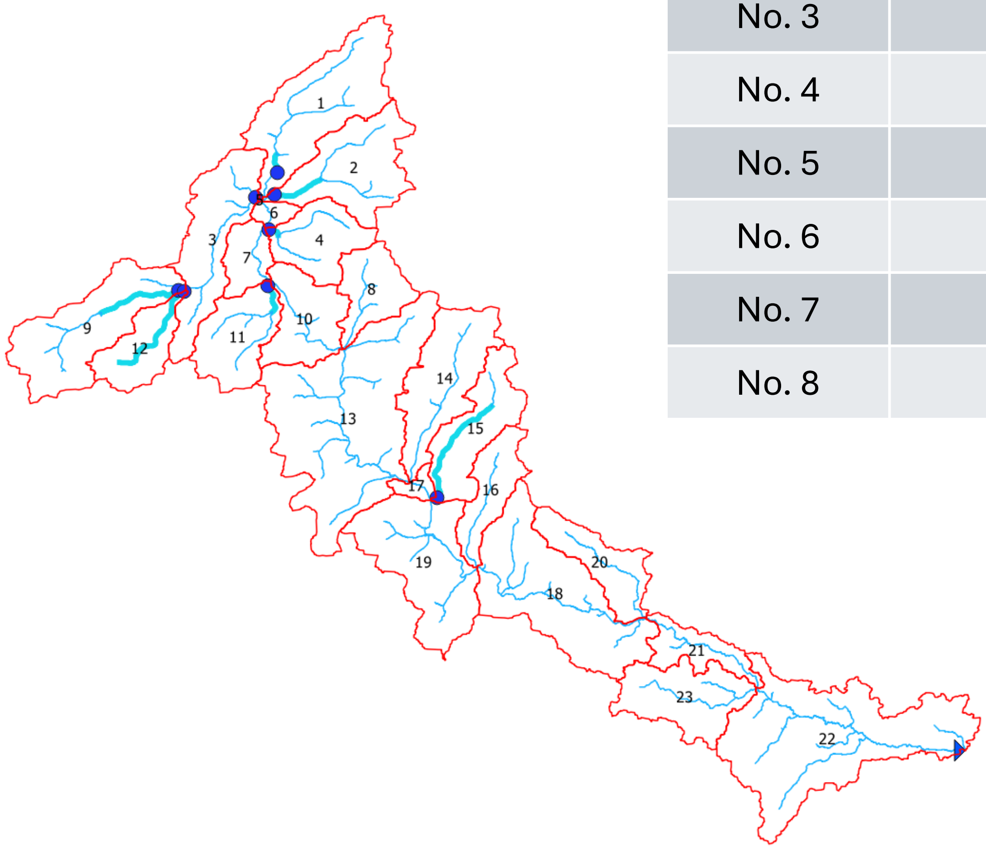


DEM:
NASA STRM Digital Elevation 30m



Soil type:
FAO Harmonized World Soil Database (HWSD_v121) 1km

Ponds



Pond	Subcatchment	Area (m^2)
No. 1	1	6144.72
No. 2	2	11487.1
No. 3	3	16046.57
No. 4	4	34385.83
No. 5	9	11702.09
No. 6	11	53820.72
No. 7	12	13665.01
No. 8	15	101735.1

SWAT Model

Aquifer parameters

- Shallow aquifer

Parameter	Value
alpha_bf	0.9
revap	0.02
rchg_dp	0.8
flo_min	0.5
revap_min	5

- Deep aquifer

Parameter	Value
alpha_bf	0.1
revap	0.02
rchg_dp	0.05
flo_min	8
revap_min	10

Other parameters

- Upstream

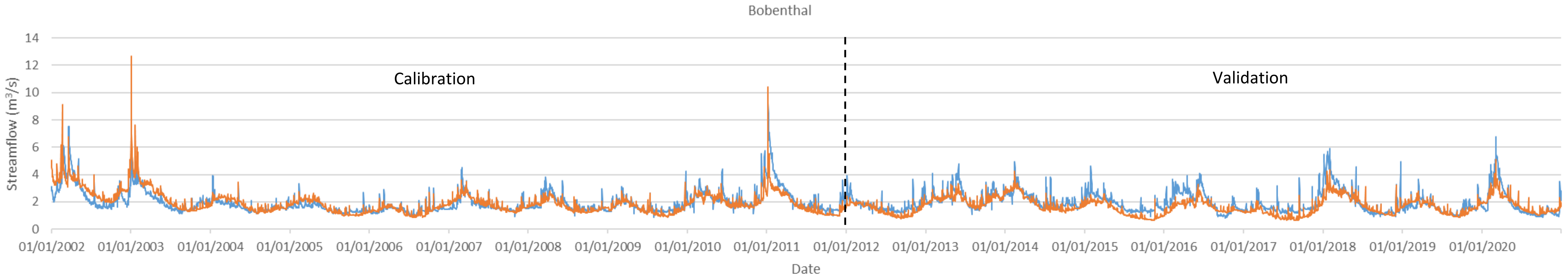
Parameter	Change	Value
cn2	pctchg	-16.291
cn3_swf	absval	0.999
lat_ttime	absval	179.983
lat_len	absval	62.237
perco	absval	0.267
esco	absval	0.971
epco	absval	0.109
surlag	absval	7.418
canmx	pctchg	8.401
latq_co	absval	0.335
awc	absval	0.012
slope	pctchg	-10.467
z	pctchg	5.354
k	pctchg	-17.814

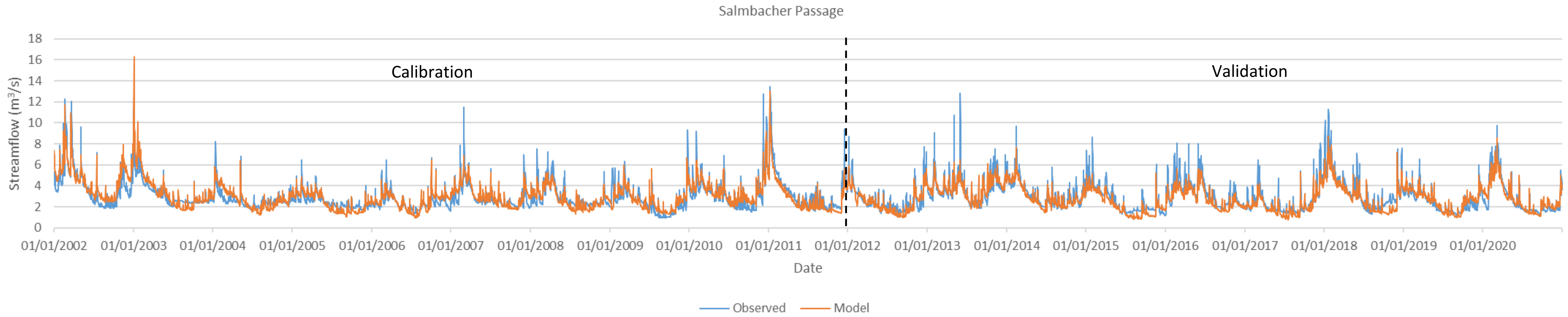
- Downstream

Parameter	Change	Value
cn2	pctchg	-14.545
cn3_swf	absval	0.998
lat_ttime	absval	1.340
lat_len	absval	4.451
perco	absval	0.009
esco	absval	0.043
epco	absval	0.993
surlag	absval	0.101
canmx	pctchg	-2.429
latq_co	absval	0.740
awc	absval	0.016
slope	pctchg	2.321
z	pctchg	-19.876
k	pctchg	-45.329

Results

	NSE		R^2		PBIAS	
	Calibration	Validation	Calibration	Validation	Calibration	Validation
Bobenthal	0.61	0.52	0.64	0.66	1.49	14.75
Salmbacher Passage	0.69	0.72	0.71	0.76	-1.72	8.33



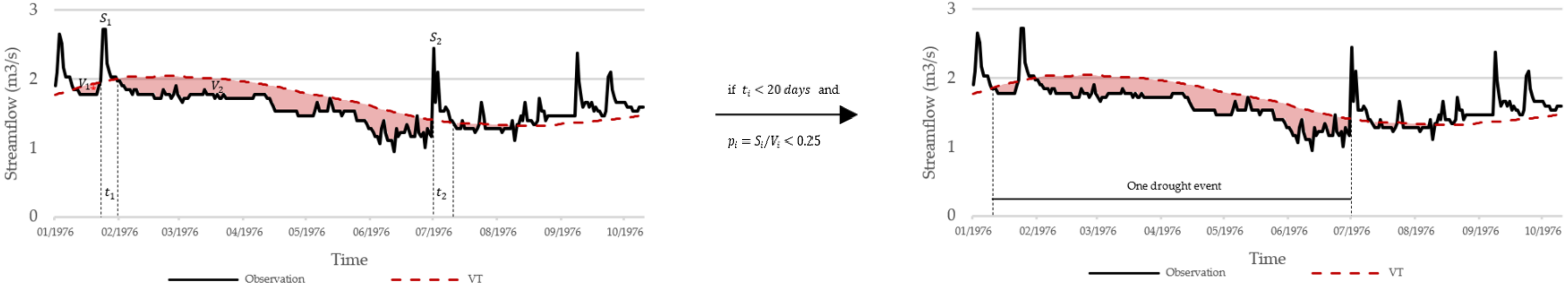


Discussion

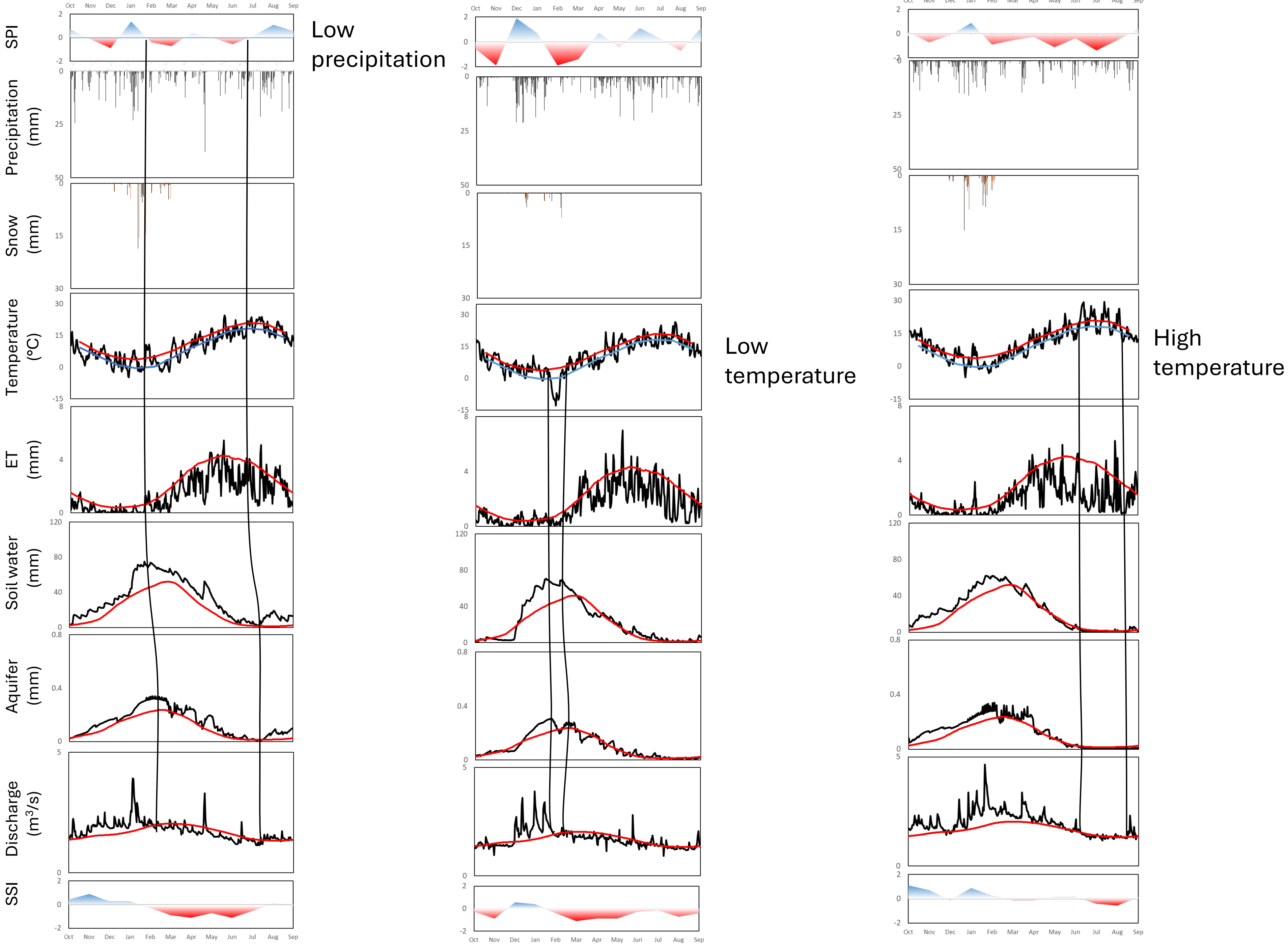
Questions to answer:

- Differences of the drought period characteristics between upstream and downstream
- How hydrological drought propagates from upstream to downstream

Hydrological drought period definition:



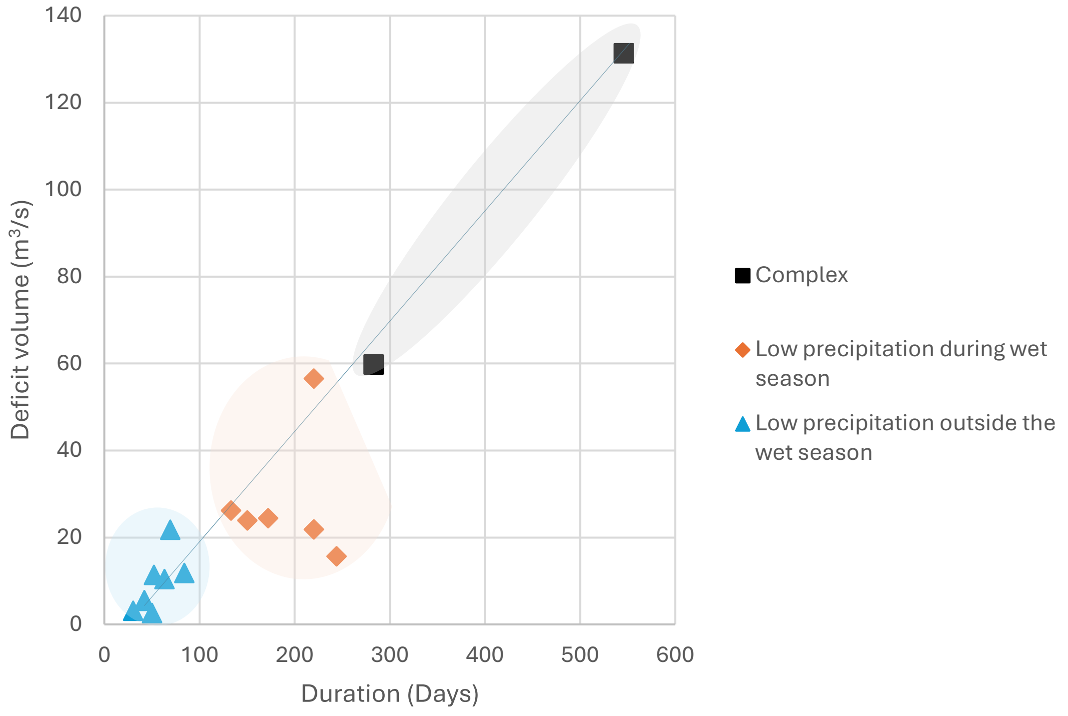
Drought type



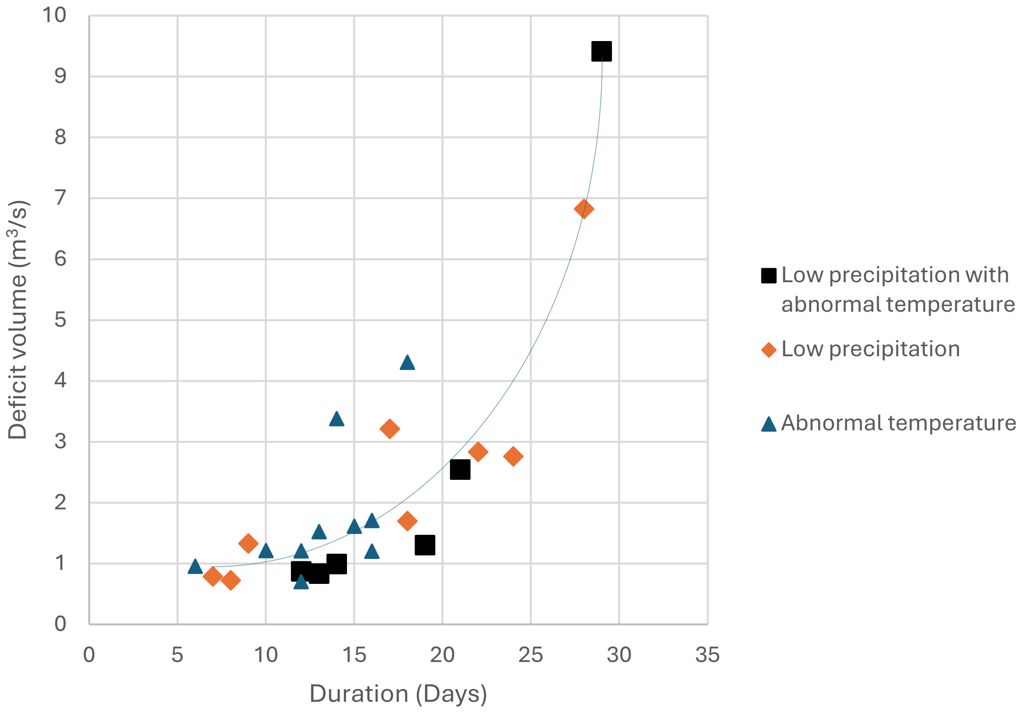
Characteristics of each drought type from upstream to downstream

Bobenthal Station (Upstream)

a) Drought period longer than 30 days



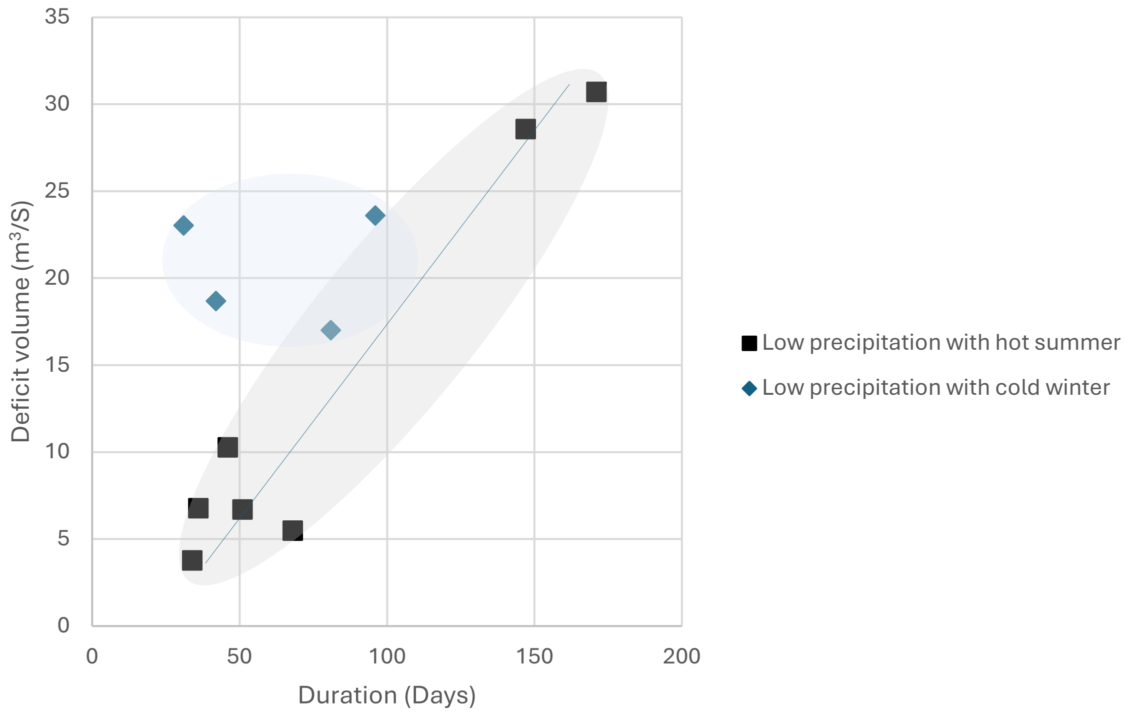
b) Drought period shorter than 30 days



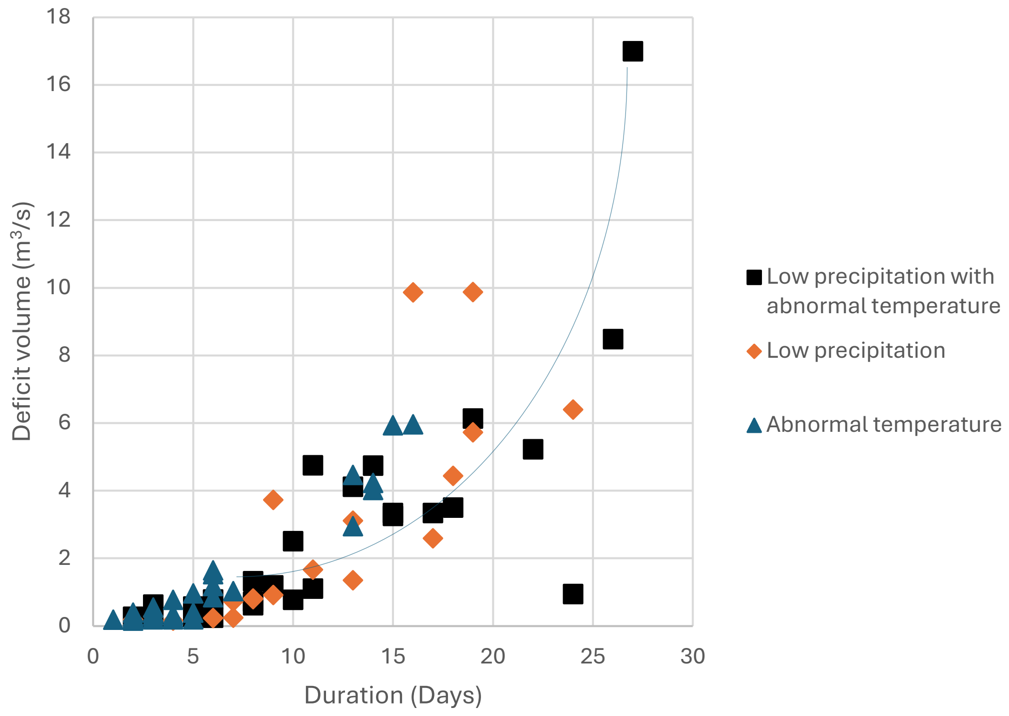
Characteristics of each drought type from upstream to downstream

Salmbacher Passage Station (Downstream)

a) Drought period longer than 30 days



b) Drought period shorter than 30 days



How hydrological drought propagates

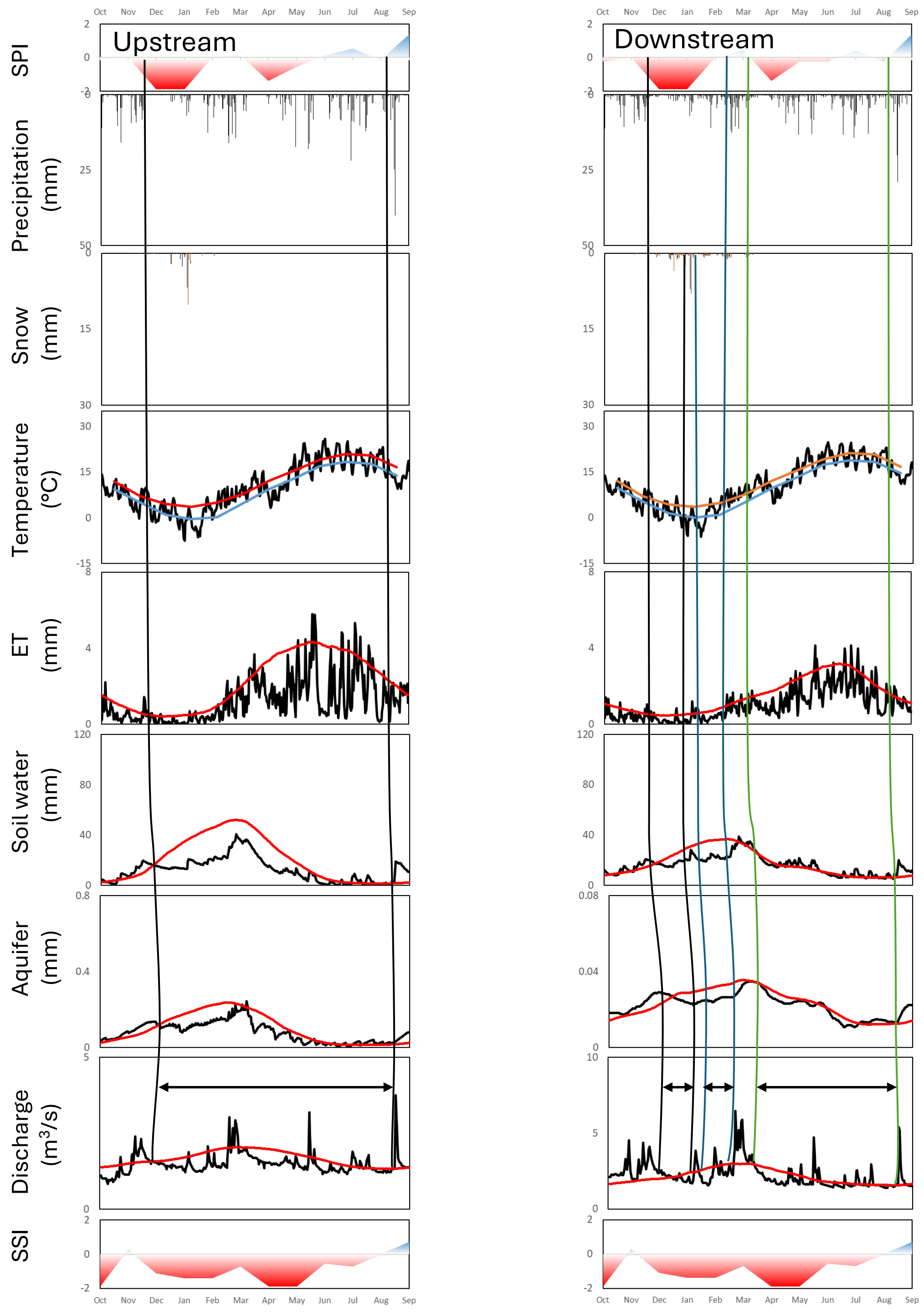
Hydrological drought events in the water year 2017

- Bobenthal station

No.	Start date	End date	Duration
1	2016-12-03	2017-09-12	283 days

- Salmbacher Passage station

No.	Start date	End date	Duration
1	2016-12-16	2017-01-11	26 days
2	2017-01-16	2017-02-27	42 days
3	2017-03-24	2017-09-11	171 days



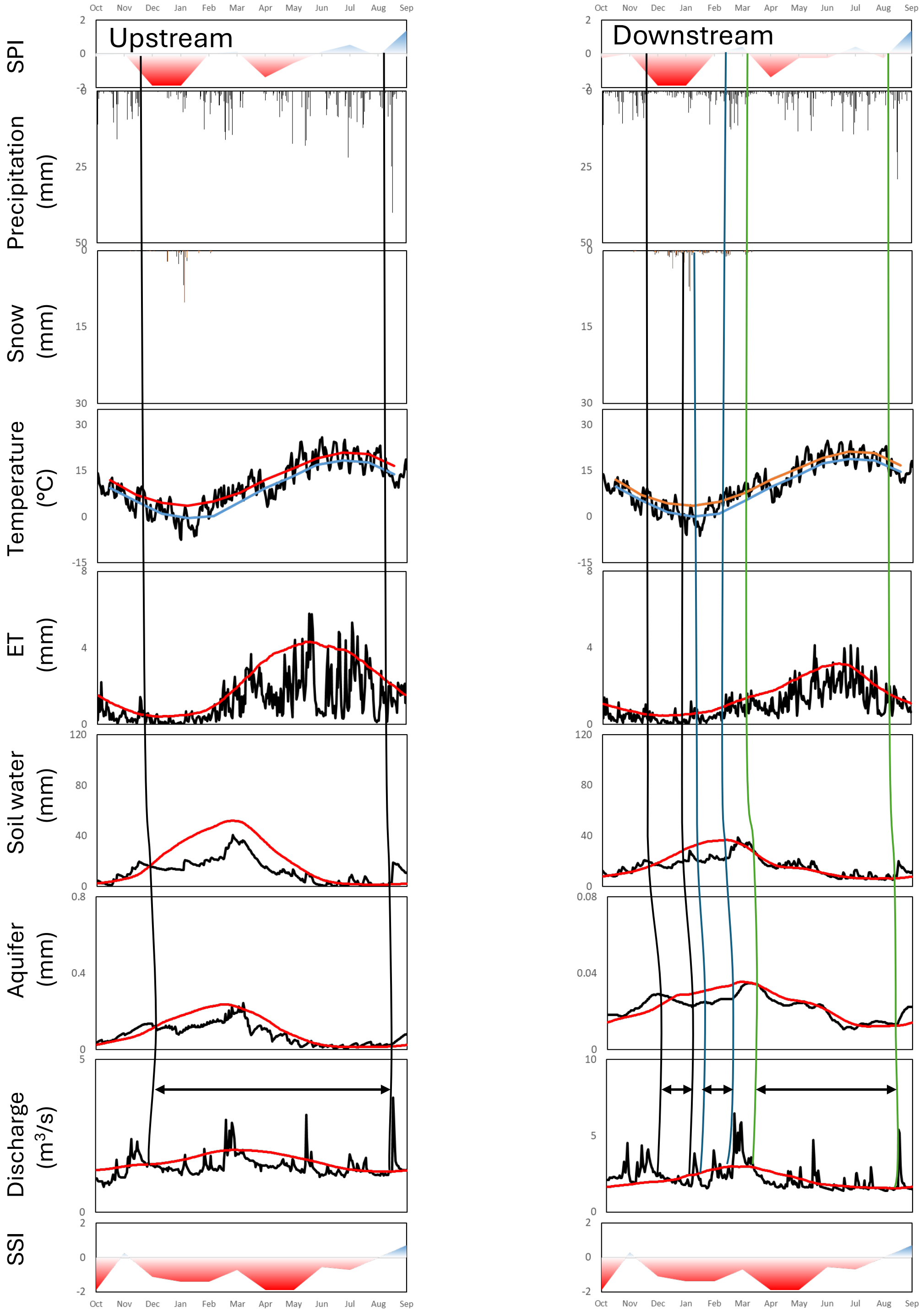
How hydrological drought propagates

Hydrological drought events in the water year 2017

- Hydrological drought period began around **2 weeks later at downstream than upstream**

- Highly active **surface water and groundwater exchange** at upstream and **higher ET** make upstream more prone to precipitation deficit, which resulted in **longer hydrological drought period** and **slower recovery** than downstream

- Order for each component revealed drought signal:
  1) Upstream, soil water -> discharge -> aquifer
  2) Downstream, soil water -> aquifer -> discharge



Thank you for your attentions!