

# Basin-Scale Hydrologic Characterization of La Dore (CAMELS-FR)

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## Abstract

This report characterizes the La Dore basin (CAMELS-FR station K287191001, 795 km<sup>2</sup>) using CAMELS-FR attributes and time series and SRTM DEM. We describe basin physiography (morphometry, stream network, hypsometry), hydroclimate and runoff behavior (daily and monthly P, Q, PET; flow duration curve), and the long-term water balance (1990–2020). Mean annual precipitation is about 1055 mm/yr, runoff 381 mm/yr, and runoff ratio 0.36. Remote-sensing products (IMERG, SMAP) are reserved for future work.

## 1 Introduction

Basin-scale hydrologic characterization supports water resources assessment, flood and low-flow estimation, and understanding of runoff generation. Quantifying physiography, hydroclimate, and water balance in a consistent framework provides a basis for comparison across catchments and for future use of remote-sensing products.

### Project objectives:

- Basin physiography and drainage structure (morphometry, stream network, hypsometry).
- Hydroclimate and runoff behavior from CAMELS-FR time series.
- Water balance (annual and seasonal): precipitation, runoff, PET, residual.

**Study scope.** This report uses the CAMELS-FR dataset and SRTM DEM for one focus basin (La Dore, station K287191001). IMERG and SMAP remote-sensing products are not used in the present analysis; they are reserved for future work (bias assessment, spatial representativeness, storage constraints).

## 2 Study Area

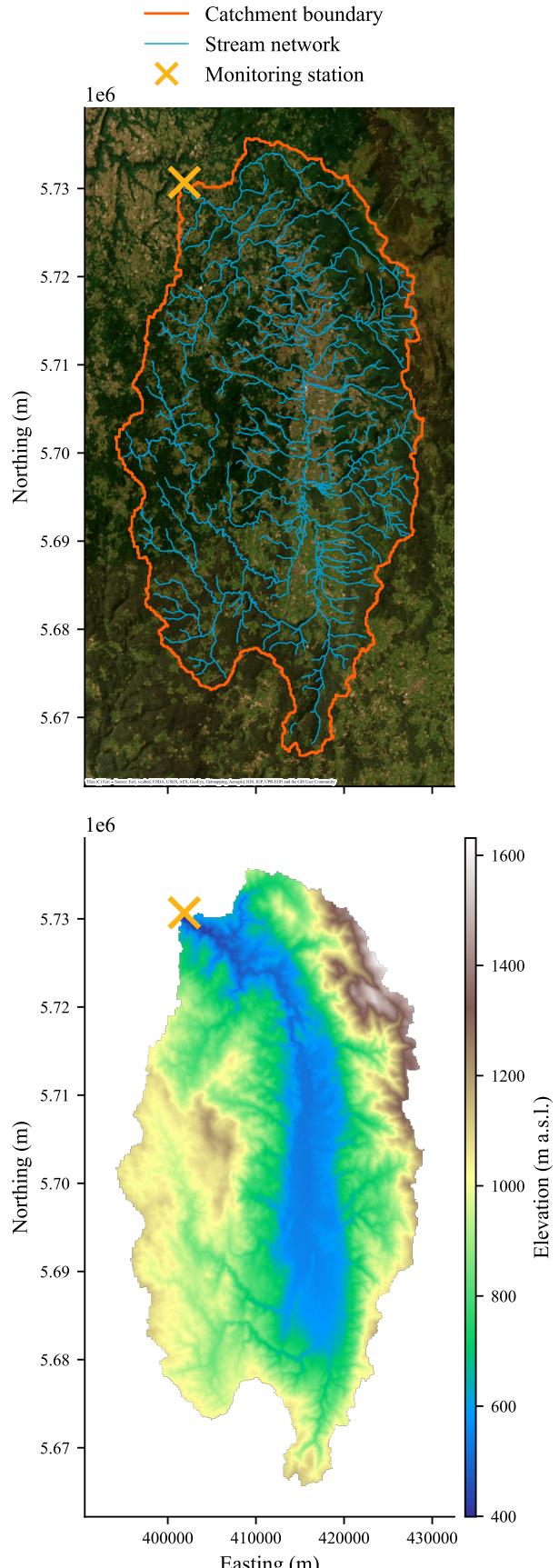
### 2.1 Location and Boundary

The study basin is La Dore at Saint-Gervais-sous-Meymont (station code K287191001), catchment area 795 km<sup>2</sup>, outlet elevation 398 m a.s.l.; it is one of the CAMELS-FR basins with area 500–1000 km<sup>2</sup> (see Appendix A). Figure 1 shows the catchment boundary and gauge outlet on a basemap.

The basin lies in the Massif Central (France); coordinates at the outlet are approximately 3.61°E, 45.69°N (WGS84). The climate is temperate oceanic with continental influence; precipitation and runoff exhibit seasonal variability (winter–spring high flows, summer low flows).

### 2.2 Morphometry and Shape Metrics

Table 1 summarizes basin geometry, elevation, slope, shape, and drainage metrics. The compactness coefficient (1.88) indicates a moderately elongated shape; relief (1232 m) and mean slope (8.5°) reflect the upland character. Drainage density (0.65 km<sup>-1</sup>) is typical of permeable, well-vegetated catchments.



**Figure 1:** Catchment boundary and gauge outlet for station K287191001 (La Dore à Saint-Gervais-sous-Meymont). Area 795 km<sup>2</sup>; outlet elevation 398 m a.s.l. Map displayed in Web Mercator (EPSG:3857).

**Table 1:** Basin physiography and morphometric metrics for La Dore (K287191001).

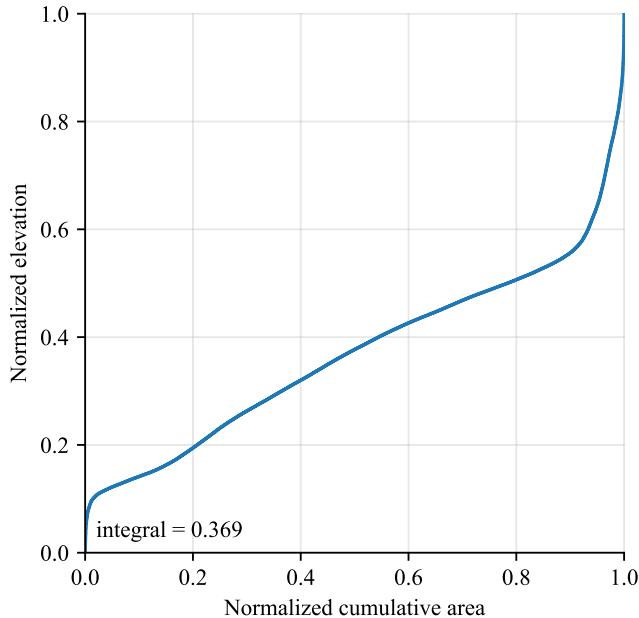
Metric	Value
Area ( $\text{km}^2$ )	795.0
Perimeter (km)	188.2
Basin length (km)	31.8
Main channel length (km)	—
Elevation min (m a.s.l.)	398
Elevation mean (m a.s.l.)	24
Elevation max (m a.s.l.)	1077
Relief (m)	679
Outlet elevation (m a.s.l.)	398
Mean slope (degrees)	8.48
Compactness coefficient	1.88
Circularity ratio	0.28
Drainage density ( $\text{km}^{-1}$ )	0.6548
Max Strahler order	—

### 2.3 Drainage Network Characteristics

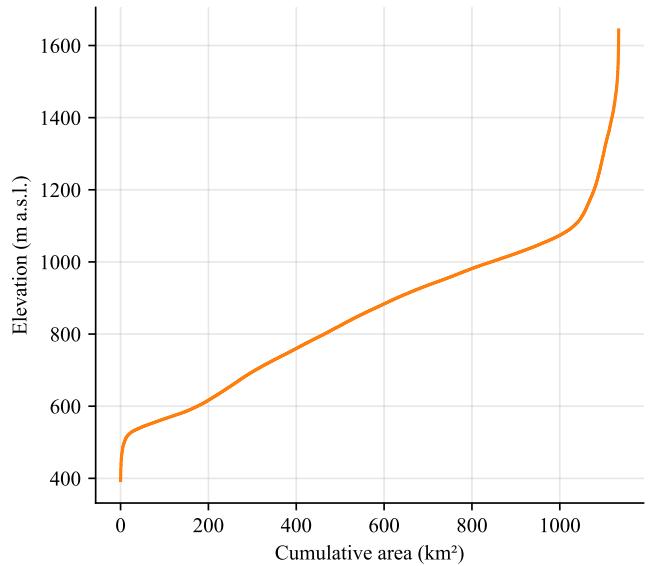
The stream network is overlaid on the basin map (Figure 1). Streams were defined by a flow-accumulation threshold of 200 cells (30 m resolution), yielding a dendritic network consistent with the basin morphology. The main channel was traced from the outlet upstream; its length is reported in Table 1.

### 2.4 Hypsometry and Altimetry

Figure 2 shows the hypsometric curve and Figure 3 the cumulative area–elevation (altimetric) curve. The hypsometric integral is 0.37, indicating a basin with a relatively uniform distribution of area with elevation (neither strongly youth-like nor equilibrium). The altimetric curve shows most of the area between about 400 and 1200 m a.s.l.



**Figure 2:** Hypsometric curve: normalized elevation vs normalized cumulative area.



**Figure 3:** Altimetric curve: cumulative area vs elevation (m a.s.l.).

## 3 Data

### 3.1 CAMELS-FR

Attributes used: station general (`sta_area_snap`, `sta_altitude_snap`), topography (elevation, slope, drainage density, compactness, form factor, etc.). Time series: daily and monthly precipitation (`tsd_prec`, `tsm_prec`), discharge (`tsd_q_mm`, `tsm_q_mm`), potential evapotranspiration Oudin (`tsd_pet_ou`, `tsm_pet_ou`), and temperature (`tsd_temp`, `tsm_temp`). Analysis period: 1990–2020 for water balance and flow duration curve; time-series snippet figure uses 2017–2020. Missing-data policy: days with missing or invalid discharge are dropped; monthly aggregates use only months with at least 90% valid days.

### 3.2 Remote Sensing

SRTM DEM (30 m) is used for terrain and stream network derivation. GPM IMERG and SMAP are available for future extension (precipitation bias, soil moisture); they are not used in this report.

## 4 Methods

### 4.1 GIS and DEM Processing

Basin boundary and outlet are taken from CAMELS-FR geography (catchment boundaries and gauge outlet `.gpkg`). DEM preprocessing: projection to a metric CRS, optional sink filling, flow direction and flow accumulation (D8). Streams are defined by an accumulation threshold (value stated in script and below). Main channel (longest flow path) is delineated from the outlet upstream; Strahler order is assigned to the network.

### 4.2 Computation of Basin Metrics

Compactness coefficient (Gravelius):  $C = P/(2\sqrt{\pi A})$ , with  $P$  perimeter and  $A$  area. Drainage density:  $D_d = \sum L/A$  (total

stream length over area). Hypsometric curve: normalized elevation  $(z - z_{\min})/(z_{\max} - z_{\min})$  vs normalized cumulative area; hypsometric integral is the area under this curve.

### 4.3 Water Balance Framework

Long-term:  $P - Q - \text{PET} \approx \Delta S$ ; over many years  $\Delta S \rightarrow 0$ . Seasonal/monthly: residual  $\Delta S = P - Q - \text{PET}$  (interpreted cautiously as storage change). Runoff ratio  $Q/P$ . Metrics: mean annual  $P, Q, \text{PET}$  (mm/yr), residual, runoff ratio, residual fraction  $(P - Q - \text{PET})/P$ . Monthly climatology: 12-month average of  $P, Q, \text{PET}$ .

### 4.4 Uncertainty and Assumptions

Discharge is from a single gauge and is assumed representative of basin outlet runoff. Precipitation and PET are from the SAFRAN reanalysis and ISBA land-surface model (Météo-France); they are spatially aggregated to the catchment and may not capture local variability. PET (Oudin) is a potential, not actual, evapotranspiration; the residual in the water balance includes storage change and any bias in  $P$  or PET. The basin has non-negligible relief and winter precipitation; snow accumulation and melt can contribute to seasonal storage and are not explicitly separated here.

## 5 Results

### 5.1 Basin Physiography

Table 1 gives the headline metrics. Key numbers: area 795 km<sup>2</sup>, perimeter 188 km, relief 1232 m, mean slope 8.5°, compactness coefficient 1.88, drainage density 0.65 km<sup>-1</sup>. The basin is moderately elongated with substantial relief; the main channel length (about 10 km from DEM) is shorter than the basin length (32 km), consistent with a branched network. Over the analysis period (1990–2020), mean annual precipitation is 1055 mm/yr, runoff 381 mm/yr, and PET (Oudin) 592 mm/yr; the runoff ratio  $Q/P$  is 0.36 and the long-term residual fraction  $(P - Q - \text{PET})/P$  is about 8%.

### 5.2 Hydroclimate and Runoff Behavior

Figure 4 shows discharge, rainfall, and temperature for 2017–2020 with aligned time axis. Figure 5 shows monthly climatology; Figure 6 the flow duration curve.

### 5.3 Water Balance

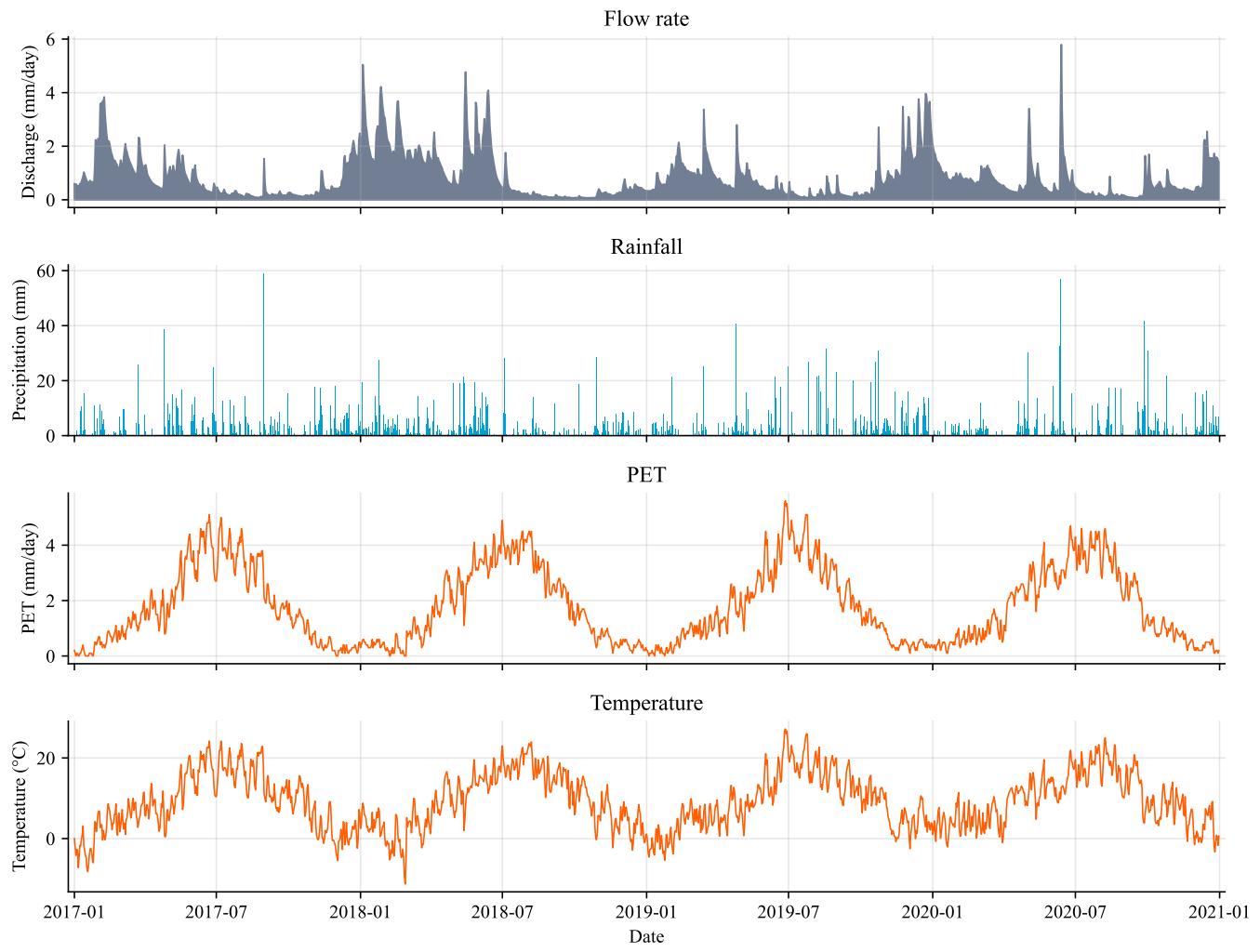
Figure 7 shows annual  $P, Q, \text{PET}$ , and residual by year. Long-term means (1990–2020):  $P \approx 1055 \text{ mm/yr}$ ,  $Q \approx 381 \text{ mm/yr}$ ,  $\text{PET} \approx 592 \text{ mm/yr}$ ; runoff ratio  $Q/P \approx 0.36$ ; residual (storage term)  $\approx 82 \text{ mm/yr}$  ( $\sim 8\%$  of  $P$ ). The positive residual on average is consistent with minor storage accumulation or uncertainty in  $P/\text{PET}$ . Seasonal residuals (from monthly climatology) reflect soil moisture and, in winter, possible snow storage.

## 6 Discussion

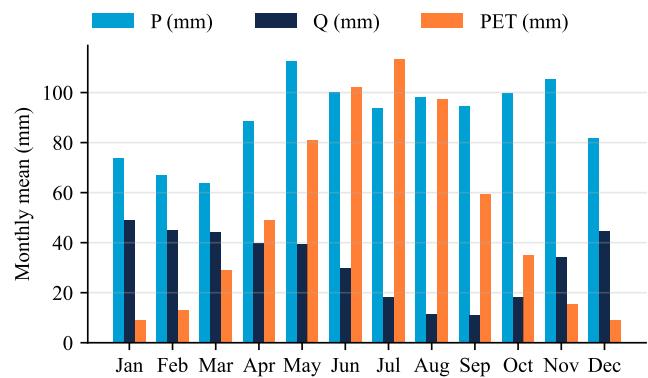
Runoff in La Dore is controlled by seasonal precipitation and PET (higher  $Q$  in winter–spring, lower in summer), by the basin's moderate slopes and drainage density, and by storage (soil moisture, possibly snow). A runoff ratio of 0.36 is within the range typical for temperate, mid-elevation catchments. Limitations include single-gauge discharge, reanalysis-based  $P$  and PET, and the use of PET rather than actual ET. Future work with IMERG could assess precipitation bias and spatial representativeness; SMAP could constrain seasonal storage and improve water-balance closure.

## 7 Conclusion

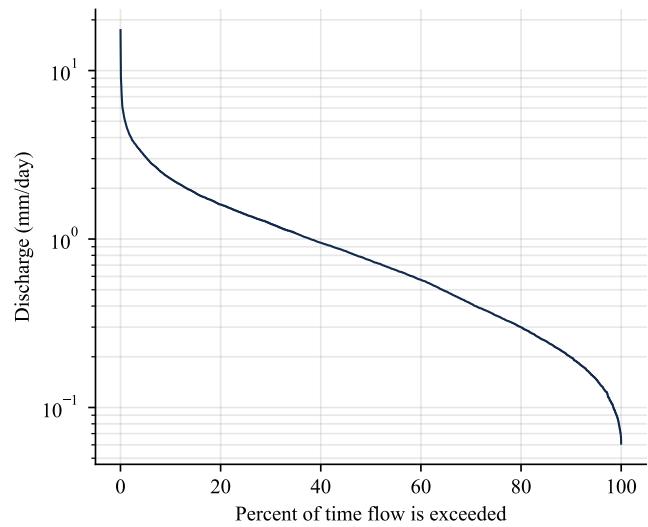
- Basin La Dore (K287191001): 795 km<sup>2</sup>, relief 1232 m, compactness 1.88, drainage density 0.65 km<sup>-1</sup>.
- Hypsometric integral 0.37; stream network and main channel derived from SRTM (threshold 200 cells).
- Analysis period 1990–2020: mean annual  $P \approx 1055 \text{ mm/yr}$ ,  $Q \approx 381 \text{ mm/yr}$ ,  $\text{PET} \approx 592 \text{ mm/yr}$ .
- Runoff ratio  $Q/P \approx 0.36$ ; residual  $\approx 8\%$  of  $P$ .
- Time series (2017–2020), monthly climatology, flow duration curve, and annual water balance are presented.
- Next steps: IMERG bias check, SMAP for storage constraint, and potential use of these data for model calibration or regionalization.



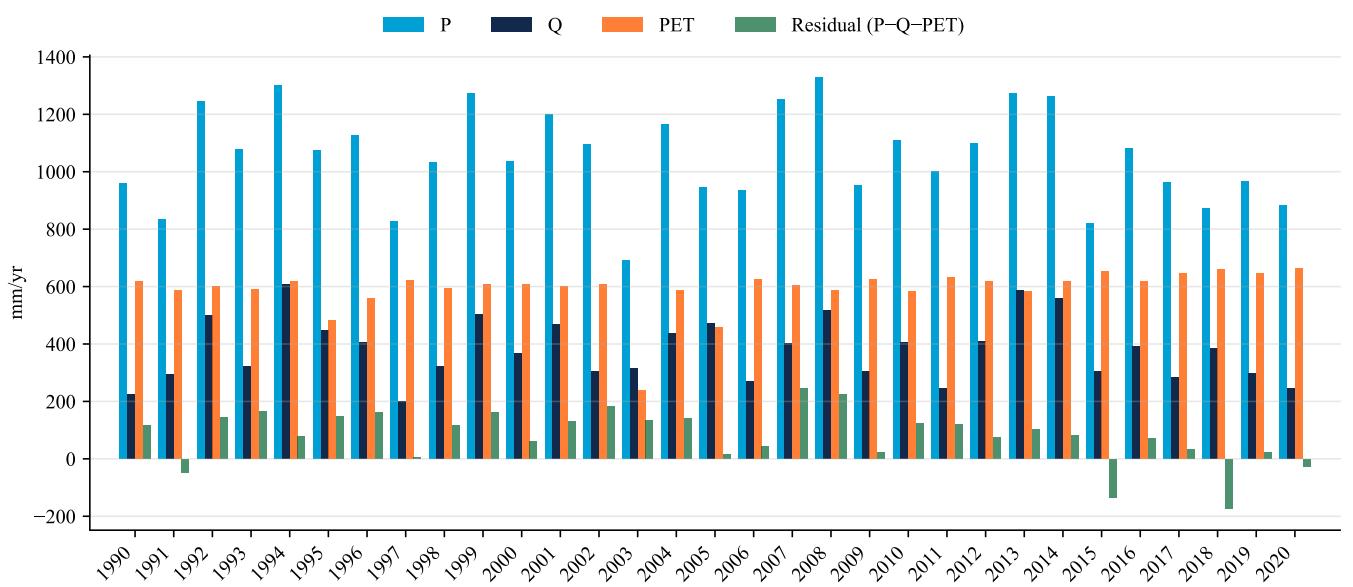
**Figure 4:** Daily time series of flow rate, rainfall, PET, and temperature (2017–2020). Shared time axis.



**Figure 5:** Monthly climatology (1990–2020): 12-month average of precipitation, discharge, and PET.



**Figure 6:** Flow duration curve (daily Q, 1990–2020): percent of time flow is exceeded vs discharge.



**Figure 7:** Annual water balance: precipitation, discharge, PET, and residual (mm/yr) by year.

## A CAMELS-FR basins with catchment area 500–1000 km<sup>2</sup>

The following 77 basins from the CAMELS-FR dataset have catchment area between 500 and 1000 km<sup>2</sup> and an outlet gauge. Station code: Hydroportail `sta_code_h3`. Sorted by catchment area.

**Column definitions.** Outlet alt. is the elevation (m.a.s.l.) of the gauge at the catchment outlet. Mean flow is mean annual runoff (mm/yr). **Agr. (agriculture)** is the percentage of the catchment area classified as agricultural land (CORINE Land Cover 2018, level 1), aggregated to the catchment.

#	Area	Code	Station (river at location)	Period	Out. alt (m)	Mean flow (mm/yr)	Agr. (%)
1	500.1	A975201001	La Nied [Française] à Condé-Northen [Pontigny]	1968-11-01–present	202	227.9	75.9%
2	502.2	A369011001	La Sauer à Beinheim	1964-10-23–present	114	219.4	23.6%
3	506.0	Y503201001	L'Argens à Châteauvert	1971-07-01–present	179	209.2	25.4%
4	508.0	M123304010	La Braye à Sargé-sur-Braye	1990-05-01–present	87	192.8	85.0%
5	512.9	M313301010	La Varenne à Saint-Fraimbault [Moulin Crinais]	1991-06-01–present	112	466.5	86.6%
6	524.3	O234401001	Le Girou à Cépet	1968-09-01–present	120	142.9	92.9%
7	542.5	X043401001	L'Ubaye à Barcelonnette [Abattoir]	1904-01-01–present	1134	577.0	4.5%
8	544.8	O787401001	Le Dourdou [de Conques] à Conques	1974-11-01–present	239	404.9	64.6%
9	548.9	H032103001	L'Ource à Autricourt	1966-12-31–present	196	353.2	43.4%
10	558.8	F415000101	L'Ouanne à Charny	1968-06-01–present	136	200.3	73.2%
11	561.5	L440000101	La Petite Creuse à Genouillac	1967-01-01–present	278	296.5	84.6%
12	562.6	K337301001	La Bouble à Chareil-Cintrat	1966-07-01–present	244	200.8	77.8%
13	568.3	L510181001	La Garonne à Folles [Pont Gibus]	1960-01-01–present	282	433.2	65.1%
14	574.9	K565301001	L'Auron à Bourges - L'Ormeiot	1966-12-19–present	128	184.3	76.3%
15	575.7	J474201001	L'Ellé à Arzano - Ty Nadan [aval pont]	1969-01-01–present	19	525.5	80.3%
16	584.4	O509252002	L'Aveyron à Onet-le-Château	1967-12-31–present	531	332.9	61.6%
17	586.8	V605201001	L'Ouvèze à Vaison-la-Romaine	1971-02-03–present	194	320.6	26.9%
18	589.9	U221502001	Le Dessoubre à Saint-Hippolyte	1955-06-01–present	383	725.2	58.6%
19	593.4	K117321001	L'Arconce à Montceaux-l'Étoile	1969-12-01–present	244	290.2	80.9%
20	599.3	J795301020	Le Don à Guéméné-Penfao - Juzet	1979-12-18–present	10	200.6	89.7%
21	607.6	H640203001	La Vesle à Puisieulx	1983-09-01–present	85	136.4	76.0%
22	609.4	U092402001	La Vingeanne à Oisilly	1970-12-01–present	196	313.3	72.2%
23	616.5	K633252001	La Saône à Brion-sur-Saône	1987-06-01–present	128	224.8	77.9%
24	618.0	H506201001	Le Rognon à Doulaincourt-Saucourt	1968-08-01–present	204	484.6	49.0%
25	622.1	A330010001	La Moder à Schweighouse-sur-Moder [aval]	1966-05-11–present	143	267.1	29.3%
26	626.9	A420063001	La Moselle à Saint-Nabord - Noirgueux	1961-10-30–present	362	1192.1	22.5%
27	628.6	H612201001	L'Aire à Varennes-en-Argonne	1968-08-01–present	155	442.3	73.9%
28	646.8	0001004003	La Garonne à Saint-Béat - HE	1992-01-01–present	507	1093.2	1.0%
29	647.8	H020302002	La Laignes aux Riceys	1983-12-01–present	177	156.1	61.6%
30	662.4	K077322001	Le Lignon à Poncins - Le Bourg	1966-01-01–present	332	365.2	47.9%
31	668.5	A116003002	L'Ill à Didenheim	1973-10-04–present	242	300.7	59.7%
32	673.0	H512234001	L'Ornain à Tronville-en-Barrois	1988-12-01–present	205	379.7	55.3%
33	675.2	Y604201001	Le Var à Entrevaux [Pont-levis]	1920-01-01–present	475	665.4	3.1%
34	677.5	0811351001	Le Célé à Figeac [Merlançon]	1937-01-01–2005-01-01	182	591.4	63.0%
35	684.0	0359402002	Le Dourdou [de Camarès] à Vabres-l'Abbaye - Le Poujol	1987-09-03–present	300	490.2	42.6%
36	686.0	H010002001	La Seine à Plaines-Saint-Lange	1967-08-01–present	180	501.5	54.4%
37	696.4	V177401001	La Bourbre à Tignieu-Jameyzieu	1909-01-01–present	203	338.1	68.0%
38	704.5	U233401001	L'Allan à Fesches-le-Châtel	1986-06-03–present	319	468.4	34.7%
39	722.4	Y028406001	Le Tech à Argelès-sur-Mer - Pont d'Elne	1984-08-30–present	9	359.3	17.5%
40	727.1	A615103001	La Meurthe à Raon-l'Étape	1973-11-01–present	282	604.1	24.2%
41	731.7	M377181010	L'Odon à Châtelais [Marcillé]	1972-09-01–present	29	180.0	93.5%
42	734.9	A907105050	La Sarre à Diedendorf	1970-07-01–present	220	320.0	49.5%

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#	Area	Code	Station (river at location)	Period	Out. alt (m)	Mean flow (mm/yr)	Agr. (%)
43	751.1	H774201001	Le Therain à Beauvais	1967-12-31-present	66	226.9	80.6%
44	772.3	K125181001	L'Arroux à Dracy-Saint-Loup [Surmoulin]	1984-02-01-present	289	253.9	72.4%
45	791.8	Q219252001	La Midouze [Le Midou] à Mont-de-Marsan	1967-01-01-2011-03-14	36	283.3	70.0%
46	792.0	E550572001	L'Authie à Dompierre-sur-Authie	1963-01-01-present	10	308.3	88.1%
47	795.0	K287191001	La Dore à Saint-Gervais-sous-Meymont [Maison du Parc/Giroux-Dore]	1919-01-01-present	398	408.9	34.8%
48	798.1	U464401001	L'Azergues à Lozanne	1964-11-17-present	198	272.3	60.0%
49	809.2	J748301001	La Seiche à Bruz - Carcé	1967-11-21-present	16	181.8	89.7%
50	810.4	H631302001	La Suisse à Orainville	1968-01-15-present	57	159.2	82.4%
51	816.6	M711241010	La Sèvre Nantaise à Tiffauges - Ancienne Station	1967-10-01-present	49	361.0	91.3%
52	832.5	M036151010	L'Huisne à Nogent-le-Rotrou [Pont de bois]	1971-11-17-present	106	237.9	76.0%
53	845.0	U122401001	La Tille à Arceau [Arcelot]	1966-07-01-present	222	267.4	47.6%
54	851.5	F453000101	L'Essonne à Guigneville-sur-Essonne - La Mothe	1974-04-01-present	54	141.5	77.8%
55	852.0	U104401001	L'Ognon à Chassey-lès-Montbozon [Bonnal]	1986-12-09-present	248	618.7	37.7%
56	853.3	L441171001	La Petite Creuse à Fresselines [Puy Rageaud]	1924-01-01-present	222	297.2	84.7%
57	860.7	K518302002	La Tardes à Évaux-les-Bains	1921-01-01-2008-06-01	385	317.7	82.8%
58	868.0	H425042010	L'Avre à Muzy	1971-05-01-present	80	127.5	73.9%
59	876.2	Q028003001	L'Adour à Estirac	1968-10-01-present	165	558.0	43.1%
60	877.3	F416000201	L'Ouanne à Gy-les-Nonains	1968-11-22-present	103	177.1	76.9%
61	881.8	U122402001	La Tille à Cessey-sur-Tille	1962-12-21-present	200	245.1	49.1%
62	882.7	I522101001	La Vire à Saint-Lô [Pont de Gourfaleur]	1969-09-01-present	14	447.8	91.8%
63	884.3	P638251001	L'Auvézère au Change [Aubarède]	1964-01-01-present	97	300.1	64.3%
64	886.3	L620201002	La Claise au Grand-Pressigny [Étableau 1] - Étableau 2	1976-12-31-2019-12-31	57	153.6	61.5%
65	909.5	M005061020	La Sarthe à Saint-Céneri-le-Gérei - Moulin-du-Désert	1977-12-01-present	122	241.1	82.3%
66	917.2	E540031001	La Canche à Brimeux	1962-01-01-present	4	414.6	86.2%
67	929.4	K538302101	L'Aumance à Hérisson - Pont de la Roche	1969-10-01-2008-07-16	181	236.8	88.0%
68	934.2	F467000101	L'Orge à Morsang-sur-Orge	1967-01-01-present	40	130.6	44.3%
69	937.8	U342401001	La Seille à Saint-Usuge	1968-03-01-present	178	458.0	62.5%
70	939.9	P392252001	La Corrèze à Brive-la-Gaillarde - Pont du Buy	1900-01-01-present	107	683.1	43.5%
71	943.2	X045401001	L'Ubaye au Lauzet-Ubaye [Roche-Rousse]	1959-10-01-present	798	674.3	5.2%
72	944.9	0314101001	Le Tarn à Mostuéjouls [La Muse]	1912-12-31-present	398	921.0	10.4%
73	948.1	A543101001	Le Madon à Pulligny	1964-01-01-present	223	333.3	77.0%
74	954.2	P392252002	La Corrèze à Brive-la-Gaillarde - Le Prieur	1918-01-01-2016-02-22	101	662.6	43.1%
75	956.9	H616201001	L'Aire à Chevières	1960-01-01-present	118	430.0	72.0%
76	987.8	U303401001	La Dheune à Palleau	1990-10-01-present	175	231.3	63.1%
77	994.0	K259301001	L'Alagnon à Lempdes-sur-Allagnon	1968-01-01-present	432	378.4	47.6%