

smires – Calculating Hydrological Metrics for Univariate Time Series

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useR!2017
BRUSSELS



Happy families are all alike; ...

– Leo Tolstoi, Anna Karenina

Hydrological/ecological metrics are all alike.



Science and Management
of Intermittent Rivers
and Ephemeral Streams

Working Group 1: *Prevalence, distribution and trends of IRES*

The R package smires

- Provides a framework for computing hydro-/ecological metrics.
- Contains sample datasets of every participating European country.
- Is aimed at unexperienced useRs.
- Has only a few requirements on input data.
- Can work with binary data (flow, no-flow).

`https://github.com/mundl/smires`

Functions

Preprocessing

<code>is.intermittent()</code>	checks for intermittency
<code>validate()</code>	validates input time series

Computing Metrics

<code>metric()</code>	continuous time series
<code>smires()</code>	binary time series, e.g. for intermittent rivers

Low level functions

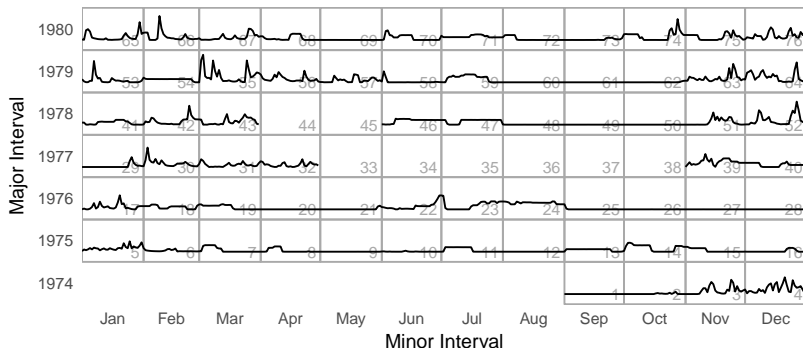
<code>group_by_interval()</code>	assigns indices and groups
<code>find_events()</code>	derives a binary time series

Metrics for continuous time series

E.g. mean annual maximum discharge

```
> metric(balder,  
+       fun_major = max, fun_total = mean,  
+       plot = T, drop = T, outvar = "mean.annual.max")
```

mean.annual.max
5.438429

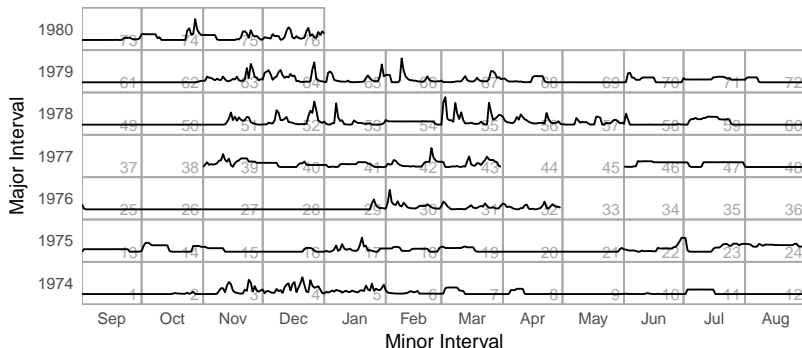


Metrics for continuous time series

E.g. mean annual maximum discharge, hydrological year starting in September

```
> metric(balder, major = 244,  
+       fun_major = max, fun_total = mean,  
+       plot = T, drop = T, outvar = "mean.annual.max")
```

```
mean.annual.max  
5.696429
```



Metrics for continuous time series

E.g. maximum annual discharge, hydrological year starting in September

```
> metric(balder, major = 244, fun_major = max)
```

```
# A tibble: 7 x 2
```

```
  major variable
```

```
  <ord>      <dbl>
```

```
1  1974      4.720
```

```
2  1975      3.955
```

```
3  1976      5.471
```

```
4  1977      5.334
```

```
5  1978      7.757
```

```
6  1979      6.753
```

```
7  1980      5.885
```

Metrics for binary time series

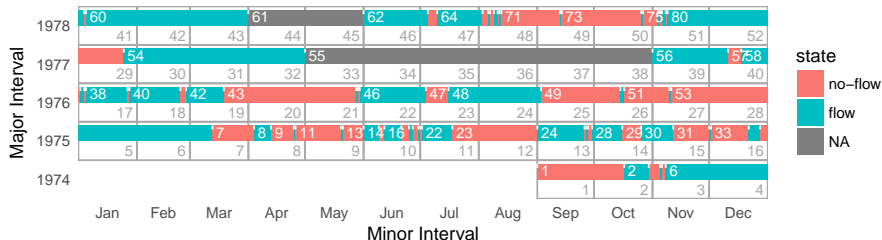
Threshold is 1 l/s

```
> smires(balder, plot = T) %>% head(3)
```

```
# A tibble: 3 x 9
```

	event	state	start	end	group	duration	major	minor	variable
	<ord>	<fctr>	<date>	<date>	<dbl>	<time>	<ord>	<ord>	<time>
1	1	no-flow	1974-09-01	1974-10-17	1	46 days	1974	Sep	46 days
2	2	flow	1974-10-17	1974-10-30	2	13 days	1974	Oct	13 days
3	3	no-flow	1974-10-30	1974-11-05	2	6 days	1974	Oct	6 days

Stream-Flow Permanence (threshold = 0.001)



Metrics for binary time series

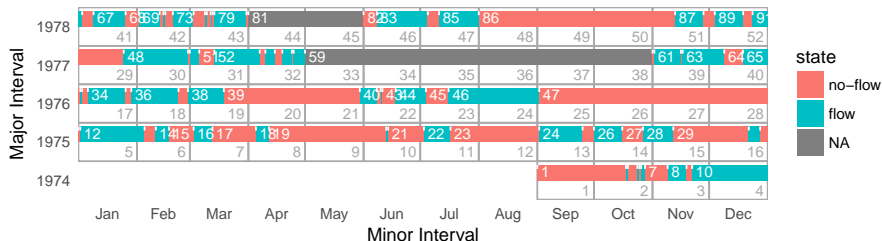
Threshold is 20 l/s

```
> smires(balder, threshold = 0.2, plot = T) %>% head(3)
```

```
# A tibble: 3 x 9
```

	event	state	start	end	group	duration	major	minor	variable
	<ord>	<fctr>	<date>	<date>	<dbl>	<time>	<ord>	<ord>	<time>
1	1	no-flow	1974-09-01	1974-10-18	1	47 days	1974	Sep	47 days
2	2	flow	1974-10-18	1974-10-19	2	1 days	1974	Oct	1 day
3	3	no-flow	1974-10-19	1974-10-24	2	5 days	1974	Oct	5 days

Stream-Flow Permanence (threshold = 0.2)



Metrics for binary time series

Mean annual maximum duration of events

```
> rm(balder)
```

```
> smires(balder,  
+       fun_major = max,  
+       drop_na = "major")
```

```
# A tibble: 10 x 3
```

	major	state	variable
	<ord>	<fctr>	<time>
1	1974	no-flow	46 days
2	1974	flow	125 days
3	1975	no-flow	45 days
4	1975	flow	25 days
5	1976	no-flow	76 days
6	1976	flow	49 days
7	1979	no-flow	20 days
8	1979	flow	214 days
9	1980	no-flow	12 days
10	1980	flow	46 days

```
> smires(balder,  
+       fun_major = max,  
+       fun_total = mean,  
+       drop_na = "major")
```

```
# A tibble: 2 x 2
```

	state	variable
	<fctr>	<time>
1	no-flow	39.8 days
2	flow	91.8 days

Metrics for binary time series

Low level functions

```
> # Appending the group and interval indices
> grouped <- group_by_interval(balder)
> head(grouped, 3)
```

```
# A tibble: 3 x 6
```

	time <date>	discharge <dbl>	major <ord>	minor <ord>	group <dbl>	hday <dbl>
1	1974-09-01	0	1974	Sep	1	244
2	1974-09-02	0	1974	Sep	1	245
3	1974-09-03	0	1974	Sep	1	246

```
> # Detecting events
> find_events(grouped, rule = "start") %>% head(3)
```

```
# A tibble: 3 x 8
```

	event <ord>	state <fctr>	start <date>	end <date>	group <dbl>	duration <time>	major <ord>	minor <ord>
1	1	no-flow	1974-09-01	1974-10-17	1	46 days	1974	Sep
2	2	flow	1974-10-17	1974-10-30	2	13 days	1974	Oct
3	3	no-flow	1974-10-30	1974-11-05	2	6 days	1974	Oct

Varying the minor interval: Seasonal analysis

```
> seasons <- c(spring = 60, summer = 152,  
+              autumn = 244, winter = 335)  
  
> smires(balder, minor = seasons, fun_minor = max)  
  
# A tibble: 8 x 3  
  minor    state variable  
  <ord>   <fctr>   <time>  
1 spring no-flow   70 days  
2 spring   flow   96 days  
3 summer no-flow   45 days  
4 summer   flow   49 days  
5 autumn no-flow   76 days  
6 autumn   flow  214 days  
7 winter no-flow   20 days  
8 winter   flow   96 days
```

Summary

- The package **smires** provides a framework to compute metrics of univariate time series.
- Either continuous or binary time series.
- Free choice of the aggregation period (calendar years, hydrological years, months, seasons, ...).
- Free choice of the aggregation function.
- github: <https://github.com/mundl/smires>

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