

# Package ‘Tides’

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**Version** 2.1.1

**Title** Quasi-Periodic Time Series Characteristics

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**Description** Calculate Characteristics of Quasi-Periodic Time Series, e.g. Estuarine Water Levels.

**License** GPL

**LazyData** yes

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**NeedsCompilation** no

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Tides-package

*Characteristics of water level time series in intertidal systems.*

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### Description

The tides package contains routines to calculate ecologically relevant characteristics of observed tides in intertidal systems.

### Details

Package: Tides  
Type: Package  
Version: 2.1.1  
License: GNU Public License 2 or above

### Author(s)

Tom Cox (maintainer, <tom.cox@uantwerp.be>), Lennert Schepers (contributor, <lennert.schepers@uantwerp.be>)

### See Also

[TidalCharacteristics](#): the aggregate function returning several characteristics of the tides

### Examples

```
## Not run:  
##  
  
## End(Not run)
```

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extrema

*Extrema*

---

### Description

Calculate maxima and minima of quasi periodic time series. The function works good when the time series is 'smooth enough'. The function will fail when multiple local extrema exist, with a magnitude similar to the extremum extremorum and in an interval larger than  $[t-T2, t+T2]$  around the extremum extremorum at time  $t$ . When this is the case, this might be solved by adding extra wrappers around the function.

**Usage**

```
extrema(h, h0, T2 = 5*60*60, hoffset = 0, filtconst = 1)
```

**Arguments**

|           |                                                                                                           |
|-----------|-----------------------------------------------------------------------------------------------------------|
| h         | Water level time series. Data frame with time and h column                                                |
| h0        | Reference level, either single valued vector with dimension corresponding to h                            |
| T2        | 'Lower' bound on half the quasi period, but higher than expected stagnant phase; default = 5h             |
| hoffset   | Offset level, to prevent spurious maxima generation due to small fluctuations                             |
| filtconst | Filtering constant for smoothing the time series with <code>filter(x, rep(1/filtconst, filtconst))</code> |

**Value**

a list containing:

|    |                                                                                                                                            |
|----|--------------------------------------------------------------------------------------------------------------------------------------------|
| HL | Data frame with time, water level and reference level of the extrema. Column HL denotes H(igh) (=maximum) or L(ow) (=minimum) water levels |
| h  | Original water level data frame with additional columns HL, denoting H(igh) or L(ow) water phase and N(umber) of tidal cycle.              |

**Author(s)**

Tom Cox <tom.cox@untwerpbe>

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gapsts

*Gaps in time series*


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**Description**

Determine gaps (time intervals bigger than a certain maximum dtMax) in a time series

**Usage**

```
gapsts(ts, dtMax, unit = "mins", shiftbegin=FALSE)
```

**Arguments**

|            |                                                                                                                                                                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ts         | Array of times, not necessarily of class POSIXt. Time sequences with differences of subsequent values < dtMax are considered a continuous series. Time differences > dtMax are considered gaps between two consecutive series.                                                            |
| dtMax      | Maximum time interval that is not considered as a gap.                                                                                                                                                                                                                                    |
| unit       | Unit of dtMax. only used when ts is of class POSIXt                                                                                                                                                                                                                                       |
| shiftbegin | IF TRUE, the beginning of the gap is estimated at the time of the presumed (but not available) next sample, with the sampling rate derived from the time step between fore-last and last measurement before the gap. If FALSE the gap is assumed to begin at the time of the last sample. |

**Value**

Data frame with the initial time, end time and time difference (unit = unit) of each interval > dtMax

**Author(s)**

Tom Cox <tom.cox@uantwerp.be> & Lennert Schepers <lennert.schepers@uantwerp.be>

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|    |                             |
|----|-----------------------------|
| IF | <i>Inundation frequency</i> |
|----|-----------------------------|

---

**Description**

Calculate inundation frequency at height h0 from series of high water levels H

**Usage**

```
IF(H, h0, N = length(H[,1]))
```

**Arguments**

|    |                                                                                                                   |
|----|-------------------------------------------------------------------------------------------------------------------|
| H  | High water levels. Data Frame with column h                                                                       |
| h0 | Reference level for which IF has to be calculated                                                                 |
| N  | number of cycles in time series, equals the number of high water levels when these are complete (= default value) |

**Value**

Inundation frequency [%] at reference level h0

**Author(s)**

Tom Cox <tom.cox@uantwerp.be>

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|    |                        |
|----|------------------------|
| IT | <i>Inundation time</i> |
|----|------------------------|

---

**Description**

Calculate inundation times, i.e. time intervals for which water level  $h > h_0$ . Care must be taken when there are gaps (long time periods for which there is no data) in the time series. Either the erroneous values have to be removed manually, or a wrapper making use of the function `gapsts` can be used.

**Usage**

```
IT(h, h0, hoffset = 0, dtMax = 15, unit = "mins")
```

**Arguments**

|                      |                                                                                                                                                  |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>h</code>       | Water level time series. data frame with time and h column                                                                                       |
| <code>h0</code>      | Reference level, either single valued or vector with same length as h                                                                            |
| <code>hoffset</code> | Offset level to cope with small fluctuations due to rain, ripples. $h \leq h0 + hoffset$ is considered dry; $h > h0 + hoffset$ is considered wet |
| <code>dtMax</code>   | Maximum time interval in continuous water level series. Larger time intervals are considered gaps                                                |
| <code>unit</code>    | Unit of dtMax.                                                                                                                                   |

**Value**

a list containing:

|                 |                                                                                             |
|-----------------|---------------------------------------------------------------------------------------------|
| <code>IT</code> | Data frame with start time (t1), end time (t2) and duration (dt, unit = unit) of inundation |
| <code>DT</code> | Data frame with start time (t1), end time (t2) and duration (dt, unit = unit) of dry time   |

**Author(s)**

Tom Cox <tom.cox@uantwerp.be>

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plot.Tides

*Simple plot of Tides*

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**Description**

Plot water levels, calculated high and low water, and reference level of a Tides-object

**Usage**

```
## S3 method for class 'Tides'
plot(x,...)
```

**Arguments**

|                  |                                                          |
|------------------|----------------------------------------------------------|
| <code>x</code>   | Tides object (e.g. the result of TidalCharacteristics()) |
| <code>...</code> | Other arguments to be passed to plot()                   |

**Details**

Produces a very simple plot of a Tides object, containing water levels, calculated high and low water, and reference level of a Tides-object. Useful for diagnostic purposes.

**Author(s)**

Tom Cox <tom.cox@uantwerp.be>

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|                          |                                                  |
|--------------------------|--------------------------------------------------|
| <code>print.Tides</code> | <i>Print summary information of Tides-object</i> |
|--------------------------|--------------------------------------------------|

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### Description

Print summary information of Tides-object

### Usage

```
## S3 method for class 'Tides'
print(x, ...)
```

### Arguments

|                  |                                                                        |
|------------------|------------------------------------------------------------------------|
| <code>x</code>   | Tides object (e.g. the result of <code>TidalCharacteristics()</code> ) |
| <code>...</code> | Other arguments to be passed to <code>print()</code>                   |

### Details

Print inundation frequency, average inundation height, average inundation time, average dry time and number of tidal cycles in time series.

### Author(s)

Tom Cox <tom.cox@uantwerp.be>, Lennert Schepers <lennert.schepers@uantwerp.be>

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|                         |                                   |
|-------------------------|-----------------------------------|
| <code>RemoveGaps</code> | <i>Remove gaps from intervals</i> |
|-------------------------|-----------------------------------|

---

### Description

Check whether a set of intervals (ivals) contains gaps (given as a second set of intervals). If so, either remove or split the original intervals.

### Usage

```
RemoveGaps(gaps, ivals, method = c("All", "Split"))
```

### Arguments

|                     |                                                                                                                                                                                          |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>gaps</code>   | Dataframe generated with <a href="#">gapsts</a> containing gaps in waterlevel time series                                                                                                |
| <code>ivals</code>  | Data frame of intervals that have to be corrected for gaps (typically dry times DTS or inundation times ITs)                                                                             |
| <code>method</code> | Method to remove gaps. "All": every interval containing (part of) a gap is removed. "Split": intervals are split into smaller intervals before and after the gap. "None" nothing is done |

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|               |                                         |
|---------------|-----------------------------------------|
| summary.Tides | <i>Summary of tidal characteristics</i> |
|---------------|-----------------------------------------|

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**Description**

Outputs list of summary statistics of a Tides oobject

**Usage**

```
## S3 method for class 'Tides'
summary(object, ...)
```

**Arguments**

|        |                                                                         |
|--------|-------------------------------------------------------------------------|
| object | Tides object (e.g. the result of <a href="#">TidalCharacteristics</a> ) |
| ...    | Not used (Added for S3 method compatibility)                            |

**Value**

A list containing:

|            |                                                                                                                                                       |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| IFsum:     | Inundation frequency: see IF(). The proportion of high water tides higher than h0. A warning will be displayed when the inundation frequency is 100%. |
| nIndsum:   | Inundations during time span, when the waterlevel > h0.                                                                                               |
| IHsum:     | Average inundation height. A warning will be displayed when the inundation frequency is 100%.                                                         |
| IHcsum:    | Average inundation height (per cycle).                                                                                                                |
| Tunitssum: | time units                                                                                                                                            |
| ITsum:     | Average inundation time, in Tunitssum A warning will be displayed when h0 is never inundated                                                          |
| ITCsum:    | Average inundation time (per cycle), in Tunitssum                                                                                                     |
| ITMsum:    | Maximal inundation time, in Tunitssum                                                                                                                 |
| DTsum:     | Average dry time, in Tunitssum                                                                                                                        |
| DTCsum:    | Average dry time (per cycle), in Tunitssum                                                                                                            |
| DTMsum:    | Maximal dry time, in Tunitssum                                                                                                                        |
| MHWsum:    | Average high water. Note that the calculated HW and LW are always >= h0!                                                                              |
| MLWsum:    | Average low water. Note that the calculated HW and LW are always >= h0!                                                                               |
| TRsum:     | Average tidal range. Note that the calculated HW and LW are always >= h0!                                                                             |
| nTCsum:    | number of (tidal) cycles                                                                                                                              |
| nTCFsum:   | number of full tidal cycles (used to measure averages per cycle)                                                                                      |
| nGsum:     | number of gaps                                                                                                                                        |
| GTsum:     | total gaps time in mins                                                                                                                               |

|             |                                                                                                                         |
|-------------|-------------------------------------------------------------------------------------------------------------------------|
| nTSSum:     | number of continuous timeseries                                                                                         |
| TTNoGapsum: | total continuous timeseries time (without gaps, also tidal phases before and after gap are not included)                |
| ITTsum:     | total inundation time (without gaps, and also tidal phases before and after gap are not included)                       |
| DTTsum:     | total dry time (without gaps, and also tidal phases before and after gap are not included)                              |
| IPsum:      | proportion of total time inundated (without gaps, and also tidal phases before and after gap are not included)          |
| DPsum:      | DTTsum/TSSum # proportion of total time dry (without gaps, and also tidal phases before and after gap are not included) |

**Author(s)**

Lennert Schepers <Lennert.Schepers@uantwerp.be>, Tom Cox <tom.cox@uantwerp.be>

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TidalCharacteristics    *Calculate tidal characteristics*

---

**Description**

Calculates the characteristics of observed tidal water levels. Wrapper of the functions [extrema](#), [IT](#) and [IF](#). Also works on time series with gaps.

**Usage**

```
TidalCharacteristics(
  h,
  h0 = h$h0,
  T2 = 5 * 60 * 60,
  hoffset = 0,
  filtconst = 1,
  dtMax = 15,
  unit = "mins",
  Tavg = 12.4 * 60,
  removegaps = c("All", "Split", "None")
)
```

**Arguments**

|    |                                                                                               |
|----|-----------------------------------------------------------------------------------------------|
| h  | Water level time series. data frame with time and h column                                    |
| h0 | Reference level, either single valued or vector with dimension corresponding to h             |
| T2 | 'Lower' bound on half the quasi period, but higher than expected stagnant phase; default = 5h |

|            |                                                                                                          |
|------------|----------------------------------------------------------------------------------------------------------|
| hoffset    | Offset level, to prevent spurious maxima generation due to small fluctuations                            |
| filtconst  | Filtering constant for smoothing the time series                                                         |
| dtMax      | Maximum accepted time interval in a continuous series. Bigger time intervals are considered to be gaps   |
| unit       | Unit of dtMax, Tavg                                                                                      |
| Tavg       | Average period of time series                                                                            |
| removegaps | Method to remove gaps in time series from inundation times and dry times. See <a href="#">RemoveGaps</a> |

**Value**

An object of class Tides, i.e. a list containing:

|      |                                                                   |
|------|-------------------------------------------------------------------|
| HL   | Data frame with extrema                                           |
| h    | original water level data frame with additional attributes        |
| gaps | a data frame containing start and end times of gaps in the series |
| IF   | inundation frequency of the reference level                       |
| ITs  | inundation times at the reference level                           |
| DTs  | dry times at the reference level                                  |
| h0   | reference level                                                   |
| N    | Total number of cycles in time span                               |

**Author(s)**

Tom Cox <tom.cox@uantwerp.be>, Lennert Schepers <lennert.schepers@uantwerp.be>

**See Also**

[extrema](#), [IT](#), [plot.Tides](#)

**Examples**

```
TC <- TidalCharacteristics(waterlevels, filtconst=10, hoffset=1)
TC
plot(TC)
summary(TC)
```

---

|             |                                                                                                                       |
|-------------|-----------------------------------------------------------------------------------------------------------------------|
| waterlevels | <i>Observed water levels of the tides in the Lippenbroek Flood Control Area with controled reduced tide (FCA-CRT)</i> |
|-------------|-----------------------------------------------------------------------------------------------------------------------|

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**Description**

This data set gives the observed water levels (in mTAW, the Belgian reference for water levels) the Lippenbroek Flood Control Area with controled reduced tide (FCA-CRT) between 2007-03-01 and 2007-04-01

**Usage**

waterlevels

**Format**

A data frame containing observation time, the observed water level  $h$  (mTAW) and the elevation  $h_0$  of the observation site

**References**

Cox et al (2006) *Flood control areas as an opportunity to restore estuarine habitat*. Ecological engineering 28:55-36  
Maris et al (2007) *Tuning the tide: creating ecological conditions for tidal marsh development in a controlled inundation area*. Hydrobiologia 588: 31-43

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