

1. C Program to compute Erosivity of Rainfall Events.

1.1 Purpose

The program finds rainfall events over a xx year period for yy weather stations spread throughout a Region/Country. For example, in our case, the program finds rainfall events over a 22 year period for 79 weather stations spread throughout Switzerland.

It then computes erosivity for all significant events and writes these to output files.

1.2 Event definition

Events are defined as periods having a rainfall total over a 6-hour period exceeding 1.27 mm.

An event will only start at a point where 10-minute rainfall exceeds 0.0 mm.

The end of an event occurs when the rainfall over a 6 hour period falls below 1.27 mm.

Events are flagged as significant if their total rainfall exceeds 12.7mm.

The user defines a temperature threshold, below which precipitation records are not considered when searching for rainfall events.

1.3 Input/output

The program takes as parameters a precipitation list file and a temperature list file.

These are text files containing the names of the meteo data files to process.

The program assumes that there is both a temperature data file and a precipitation data file for each meteo station. It also assumes that the periods covered by the two **match exactly**, and that there are no missing records. It does allow for records to have a no data value of '-'.

The program may run with more than 1 station data. The meteo station data is processed in the order that they appear in the list files. In other words, the program is run in its entirety, and writes event output files, for each weather station in the list files sequentially.

Input data (text) files

10 minute temporal resolution rainfall data recorded in the format:

Station_ID Year Month Day Hour Minute 10-minute_Rainfall_total

1 hour temporal resolution temperature data recorded by Swiss meteorological stations in the format:

Station_ID Year Month Day Hour Temperature

2. Instruction for running the R-factor code

2.1 Preparation of the Precipitation file

Format: stn;time;rre150z0

stn; yyyyMMddHHmm; rre150z0

Stn = station name

y = year

M = month

d = day

H = hour

m = minute

rre150z0 = precipitation (mm) – Sum of 10 min

2. 2 Preparation of the Temperature file

Format: stn; yyyyMMddHHmm;tre200h0

Stn = station name

y = year

M = month

d = day

H = hour

tre200h0 = Temperature (Degrees) – Average of 1 hour


```
C:\WINDOWS\system32\cmd.exe - EROSIIVITY_22YEAR_V7.exe E:\EROSIIVITY\precipFileList...
E:\erosivity>
E:\erosivity>EROSIIVITY_22YEAR_U7.exe E:\EROSIIVITY\precipFileList.txt E:\EROSIUI
TY\TempFileList.txt
Precipitation list file is: E:\EROSIIVITY\precipFileList.txt
Temperature list file is: E:\EROSIIVITY\TempFileList.txt
Enter Temperature threshold
0
```

Please be aware that the program only runs together with hourly temperature data for the same period. In case you want to apply the code for an area with no temperature data and for an area where snowfall is not relevant, you can bypass this condition by creating an artificial temperature file for your site containing e.g. the value 1 covering the same time period.

Example of the Temperature and the Precipitation file are also included in the download package.

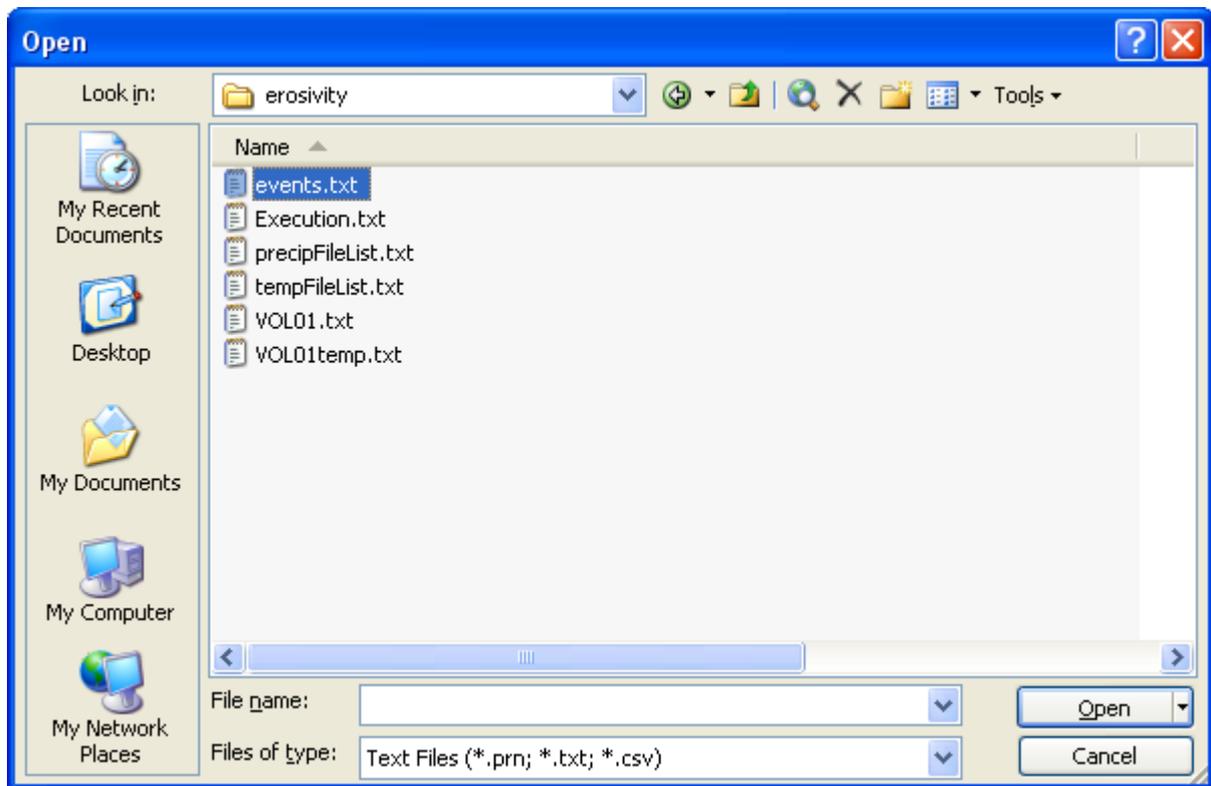
Finally you get the results:

```
C:\WINDOWS\system32\cmd.exe
Enter Temperature threshold
0
There are 52114 records in HER01.txt
There are 8687 records in HER01temp.txt
Temperature threshold = 0.0
Event Count::39
Significant Event Count::9
Execution completed successfully
E:\erosivity>
```

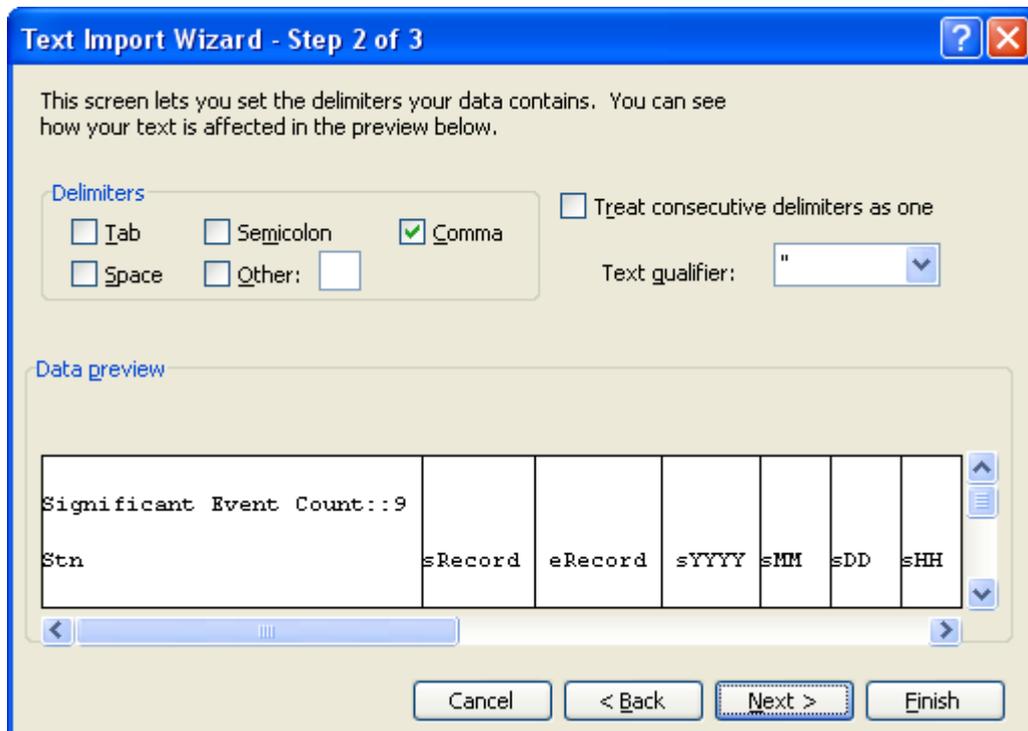
The event.txt file contains all erosive events and you can further process it with Excel for example. The event count summarises all rainfall events. The significant event count only the ones satisfying the criteria for the identification of an erosive event given by Renard et al. (1997): i) the cumulative rainfall of an event should be greater than 12.7 mm, or ii) the event has at least one peak that is greater than 6.35 mm in 15 min.

2. 4 Further process of the Events.txt file.

Open it with a Microsoft Excel Programme:



Attention in the Import Wizard (Select Comma):



You can see the fields of the Excel EVENTS file such as the Total Rain for the Significant Events, the Kinetic Energy, the IE30 and the rainfall erosivity index of a single event.

Stn	sRecord	eRecord	sYYYY	sMM	sDD	sHH	smm	eYYYY	eMM	eDD	eHH	emm	toRain	KE	IE30	R	eValid	Rmonth	mValid
HER	2416	2484	2010	1	17	19	20 02010	1	18	6	40	46.2	10.7	58.8	629.1	1	726	1	
HER	2533	2639	2010	1	16	14	50 02010	1	19	8	30	22.4	3.7	18	66.6	1	-	-	
HER	3011	3079	2010	1	21	22	30 02010	1	22	9	60	14.6	1.7	6.6	9.4	1	-	-	
HER	3305	3329	2010	1	23	23	30 02010	1	24	3	30	12.8	1.9	11.2	20.9	1	-	-	
HER	11524	11566	2010	3	25	1	10 02010	3	25	8	10	13.4	1.6	5.6	9	1	9	1	
HER	39814	39861	2010	10	7	13	10 02010	10	7	21	0	27.4	5.6	29.2	162.3	1	325.9	1	
HER	42710	42778	2010	10	27	15	50 02010	10	28	3	10	26.6	5.6	29.2	163.6	1	-	-	
HER	45116	45171	2010	11	13	9	0 02010	11	13	18	10	30.2	4.9	14.4	70.2	1	70.2	1	
HER	49066	49264	2010	12	10	19	20 02010	12	12	4	20	59	7.4	13.2	98	1	98	1	

sYYYY, sMM, sDD, sHH, smm gives you the starting date and time for an event. eYYYY, eMM, eDD, emm gives you the end of an event. ToRain is the total amount of rain (mm) that occurred in this period, KE the kinetic energy, IE30 the maximum 30min intensity. EValid provides information whether any missing values occurred in during the event, mValid whether there have been missing values in the considered month (the value 1 indicates no missing values).

Output fields:

- "Stn" meteo station name,
- "sRecord" start record number,
- "eRecord" end record number,
- "sYYYY" start year,
- "sMM" start month,
- "sDD" start day,
- "sHH" start hour,
- "smm" start minute,
- "eYYYY" end year,
- "eMM" end month,
- "eDD", end day
- "eHH" end hour,
- "emm", end minute
- "toRain", total precipitation (rainfall)
- "KE", kinetic energy
- "IE30" maximum 30-minute precipitation (rainfall) intensity,
- "R" R-factor,
- "eValid" Event validity. An event is flagged as invalid if it contains more than 4 precipitation records with no data.
- "Rmonth" Monthly R-factor
- "mValid" Month validity. A month is flagged as invalid if it contains more than 36 precipitation records with no data.

3. Function descriptions

Find below the description of each of the functions in case you want to make modifications

```
/*////////////////////////////////////*/
```

main() Function

Checks that command line arguments are correct.

Prompts user for a temperature threshold. Precipitation that falls when the air temperature is below this threshold will not be considered in the computation of rainfall events.

Calls get_all_precip_recs() function

```
////////////////////////////////////*/
```

```
/*////////////////////////////////////*/
```

Function get_all_precip_recs(char *precList, char *tempList)

This is a wrapper function that performs four distinct tasks:

1. Opens the precipitation list file and the temperature list file.

These are text files containing lists of the meteo data files to process.

The program assumes that there is a temperature data file for each precipitation data file.

It also assumes that the periods covered by the two match exactly, and that there are no missing records.

It does allow for records to have a no data value of '-'

2. Identifies from the input data files the number of records.

3. Reads all input rainfall records (one for each 10 minute time interval) into an array of data structures and adds the temperature data (one per hour).

4. Passes these records to the functions that find rainfall events and compute erosivity.

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```
////////////////////////////////////*/
```

```
/*////////////////////////////////////*/
```

Function findEvent(int type)

findEvent() is called twice. The first time, it searches for rainfall events that have > 1.27 mm of rainfall over a 6 hour period. It counts them.

For each event start, findFinish() is called to find the end of the event.

In this way, we can be sure that an event never starts before the end of the previous one.

The event count is used to allocate the required amount of memory for the array of event data structures. The variables in the events data structure are used to compute event erosivity.

The second time findEvent() is called, the events data structure is filled.

An event will only start at a point where rainfall > 0.0 mm

Events are flagged as significant if their total rainfall exceeds 12.7mm.

Records with a temperature less than the user-specified threshold are not considered when searching for rainfall events.

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```
////////////////////////////////////*/
```

```
/*//////////////////////////////////////////////////////////////////  
Function findFinish()  
    Called iteratively from findEvent().  
    Returns the record number of the end of a rainfall event.  
    This is where the rainfall over a 6 hour period falls below 1.27mm  
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//////////////////////////////////////////////////////////////////*/
```

```
/*//////////////////////////////////////////////////////////////////  
Function erosivity()  
    Compute erosivity for each event.  
    Write significant events to output file.  
    The event R-factor and its dependent variables are computed once events have been  
identified satisfying the above criteria and stored in the events data structure. The algorithm is  
described in detail in Section 2 of the acknowledged paper.  
    1. Compute Kinetic energy per event.  
    2. Compute maximum 30-min rainfall intensity per event.  
    3. Compute event rainfall erosivity (R-factor), which is a function of 1 and 2.  
    4. Flag validity of events. i.e. an event is flagged as invalid if it contains more than 4  
precipitation records with no data.  
    5. Compute monthly rainfall erosivity (R-factor), by summing event R-factors for each month  
of the time series.  
    6. Flag validity of months. i.e. a month is flagged as invalid if it contains more than 36  
precipitation records with no data.  
    7. Write an output event file for each meteo station processed, in the format described  
above.  
--  
//////////////////////////////////////////////////////////////////*/
```

4. Acknowledgements

Meusbürger, K., Steel, A., Panagos, P., Montanarella, L., Alewell, C. Spatial and temporal variability of rainfall erosivity factor for Switzerland. *Hydrology and Earth System Sciences*, 16, 167–177, 2012