PRIMES

“Preventing flooding risks by making resilient communities”

Action A1: Designing integrated baseline scenarios

Report B1: Summary of data and state of the art about hydraulic risk observed in the three Regions

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1. Introduction

The present report of Action A1 overviews trends of hydraulic risk over the territory of the three regions participating to the project: Emilia-Romagna, Marche and Abruzzo (ER-MA-AB), to evaluate the effects of climate change and variability over the above regions.

The first step of the action is the construction of a common observed data set of hydrological indices, with focus on extremes. Although the time series analyzed are quite short for the case studies selected for Marche and Abruzzo regions (15 years), longer from Emilia Romagna region (35 years), the focus on extreme events showed an increase in frequency and magnitude during the last five years.

2. Indices selected to define the hydraulic risk framework of ER-MA-AB

The main indicator chosen to describe the state of the art about observed hydraulic risk is the exceed of hydrometric level threshold in significant river sections. This indicator allows to identify the number of flood events occurred during the analyzed time period, and classify their magnitude. In Italian rivers have been defined a system of two level threshold, to identify hydraulic risks for civil protection system, called alert and alarm threshold.

Alert threshold indicates a flood that invades flood plains, but is still confined into river areas or embankments. Alarm threshold indicates a flood that reaches few meters from the top of the embankments, or from bridges, causing damages in the nearest areas.

The chosen river sections have characteristics of stability during time, so that we can consider hydrometric level congruent with flow discharge in the same section, making water levels comparable during the analysis period. For example Casalecchio Chiusa on Reno river, and Codrignano on Santerno river, are characterized from transversal dams, used since ancient time to derive river water into artificial canals.

2. Case studies and available data set

2.1. Emilia Romagna case studies and data set

The case studies chosen in the Primes Project are Reno river basin and its tributary Santerno, both in the east region, extending from Appennini mountains to Adriatic sea, but different for extension. The two river sections chosen are just at mountain river closure, and have characteristics of stability during time.

Reno mountain basin at Casalecchio Chiusa river section has an extension of 1056 kmq, while Santerno river at Codrignano has an extension of 346 kmq, their position on territory can be seen in the pictures below. The analysis period is 35 years long, from 1981 to 2015, during which have been registered 155 flood events over alert threshold in Reno river and 111 events in Santerno river.

2.2. Marche case studies and data set

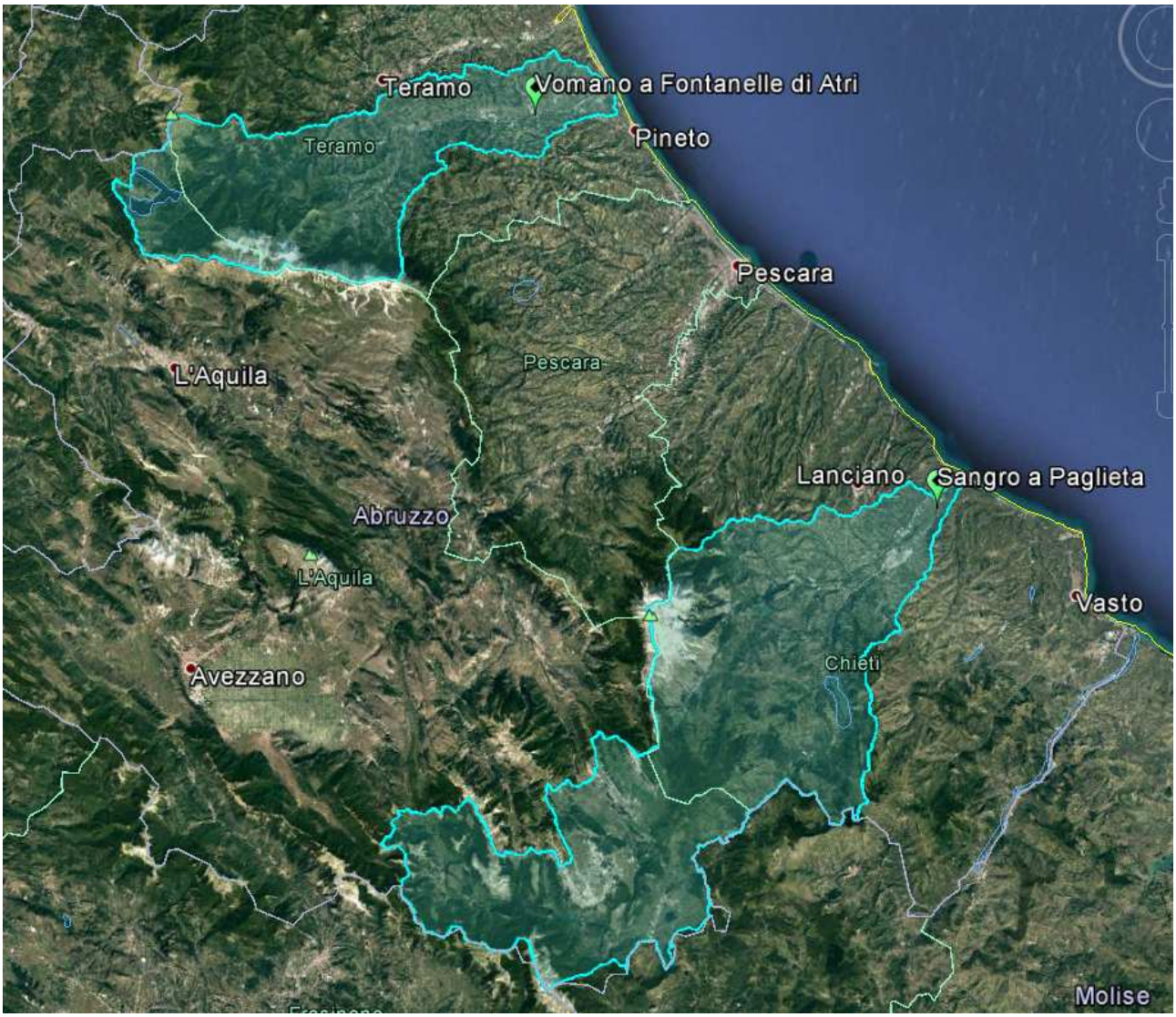
The case studies chosen are Tronto and Misa river basins, both extending from Appennini mountains to Adriatic sea, but different for extension. The two river sections chosen have characteristics of stability during time, in particular Bettolelle on Misa river is interesting because is located just at the door of Senigallia city, while Brecciarolo river is located over Ascoli Piceno city.

The Tronto basin at Brecciarolo river section has an extension of 958.9 kmq, while Misa river at Bettolelle has an extension of 333.6 kmq, their position on territory can be seen in the pictures below. The analysis period is 16 years long, from 2001 to 2016, during which have been registered 18 flood events over alert threshold in Tronto river and 51 events in Misa river.

2.3. Abruzzo case studies and data set

The case studies chosen are Vomano and Sangro river basins, both extending from Appennini mountains to Adriatic sea, but different for extension. The two river sections don't have evident characteristics of stability during time, because of the presence of dams upstream the two rivers: for this reason in November 2013 alert and alarm thresholds have been changed to better represent the hydraulic risks.

The Sangro basin at Paglieta river section, far 5,4 km from the mouth in Adriatic sea, has an extension of 1478 kmq, while Vomano river at Fontanelle di Atri has an extension of 706 kmq, far 11,2 km from the mouth; their position on territory can be seen in the pictures below. The analysis period is 16 years long, from 2001 to 2016, during which have been registered 16 flood events over alert threshold in Sangro river and 15 events in Vomano river.



3. Data Analysis

In the selected river basins have been analyzed the time distribution of registered flood events during years and during seasons in different years.

In the following graphics are represented the number of flood exceeding alert threshold during the analysis period: although the Emilia Romagna one is longer than others regions period, in all basins we can recognize a general increase of number events in the last five years, in a context of general progressive increase, as can be seen from the trendline.

In particular for Emilia Romagna region 2013 and 2014 have the most flood number, until more than double of the other years in Reno river. In Marche region 2014 has the most flood number for Misa basin, in the north part of the region, while for Tronto basin, in the south part, the most flood number have been registered in 2015, just as in the two basins of Abruzzo region.

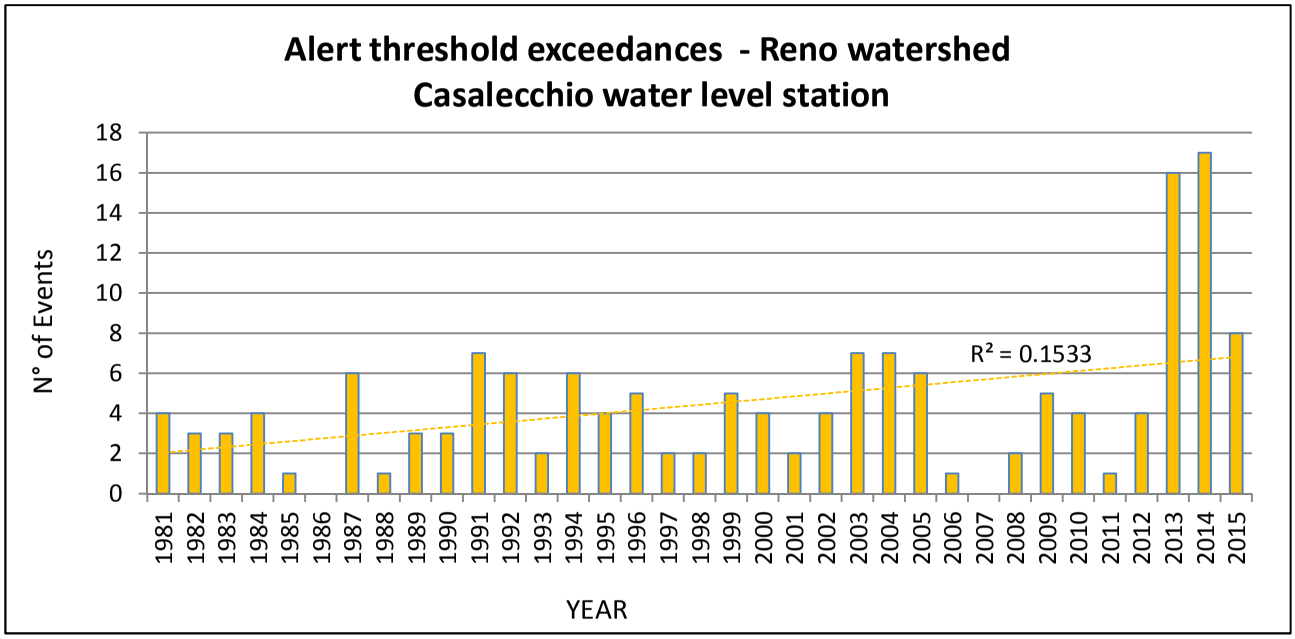
This trend is confirmed from the graphs that showed the number of floods exceeding alarm threshold in all the basins: an increasing trend can be recognized in all the basins, moreover the northest ones, as Reno at Casalecchio, Santerno a Codrignano and Misa a Bettollelle. In Tronto, vomano e Sangro rivers can’t be recognise an increasing of number for the most intensive flood events.

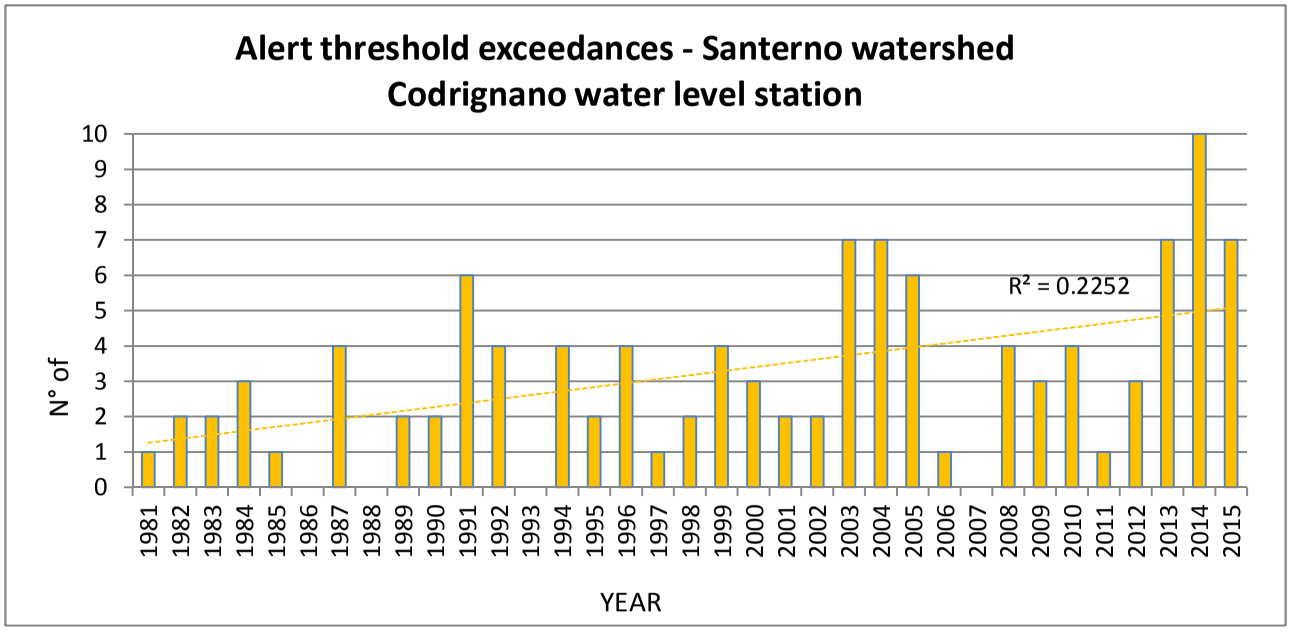
The distribution of major number of flood during years, illustrated in the six last graphs, shows that in Emilia-Romagna region flood events are concentrated in the autumn months, in particular November and December. In the basins of Marche e Abruzzo instead, the most number of flood events are concentrated in March and April. This is probably due to the specific climatologic reasons of the different regions.

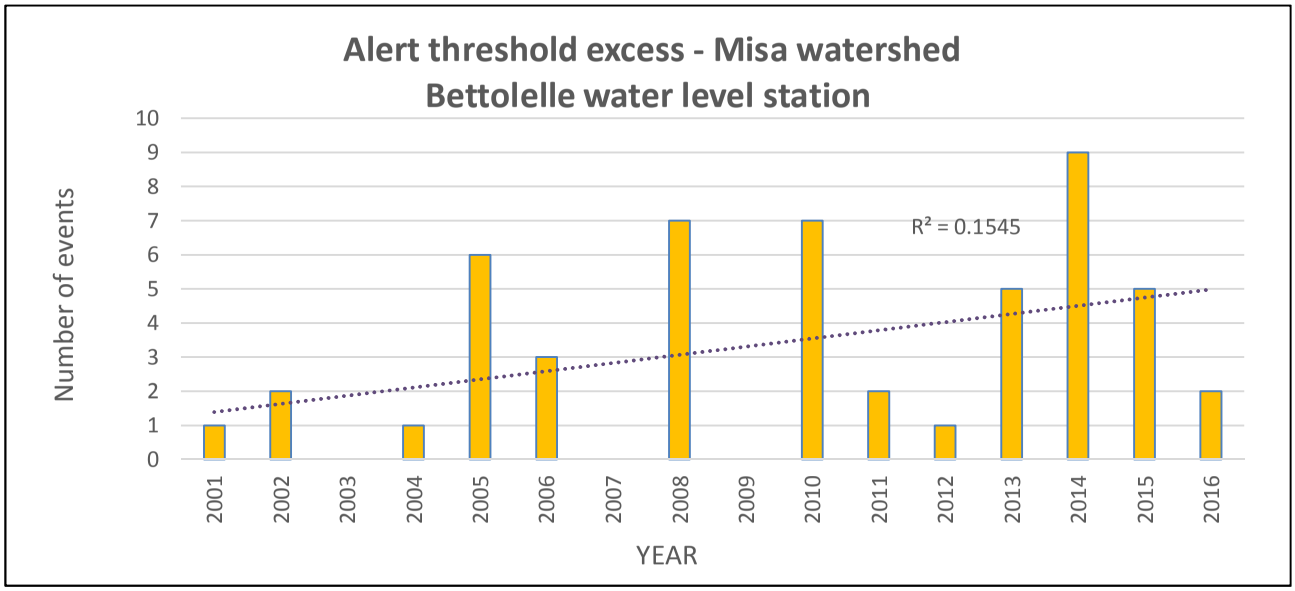
4. Conclusions

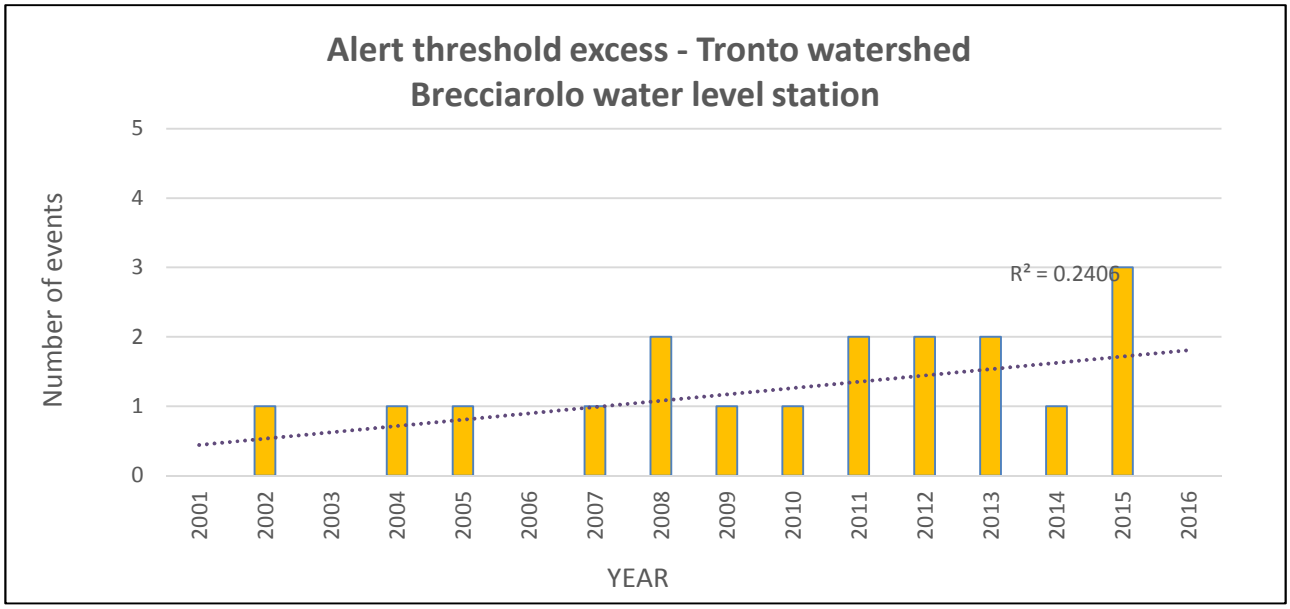
Analysing the number of floods occurred in the case studies basins, two for each reasons, different in area, it seems evident that, the number of events are increasing in time, especially in the last five years and in Emilia Romagna region (about twice), both for small and largest basins.

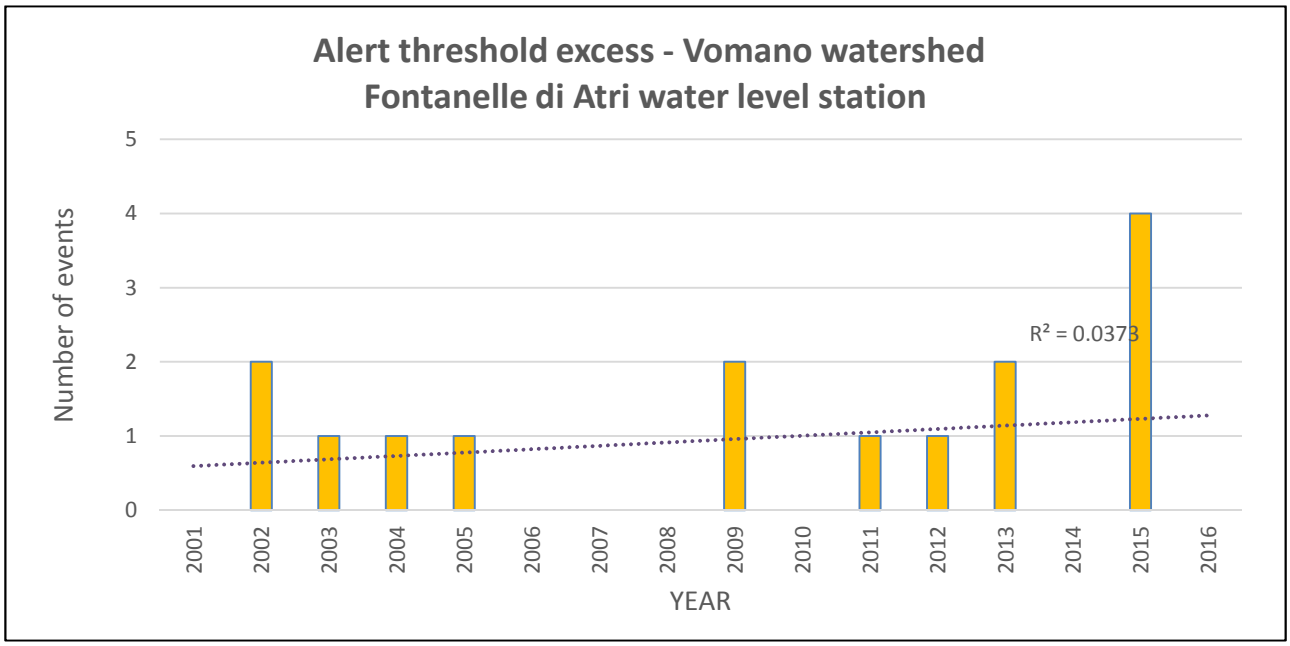
The year distribution events instead confirm that in the last years the major number of floods are concentrated in Autumn and Spring, in lines with climatologic behaviour.

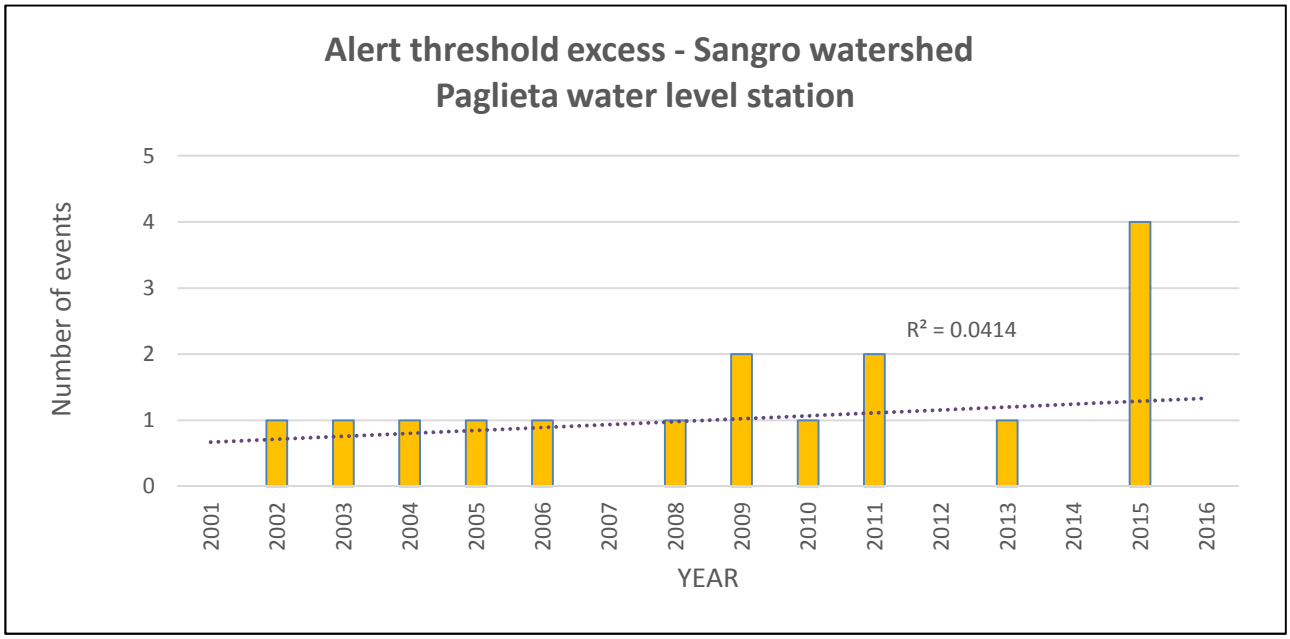

Alert threshold exceedances - Reno watershed
Casalecchio water level station
N° of Events
YEAR
R² = 0.1533

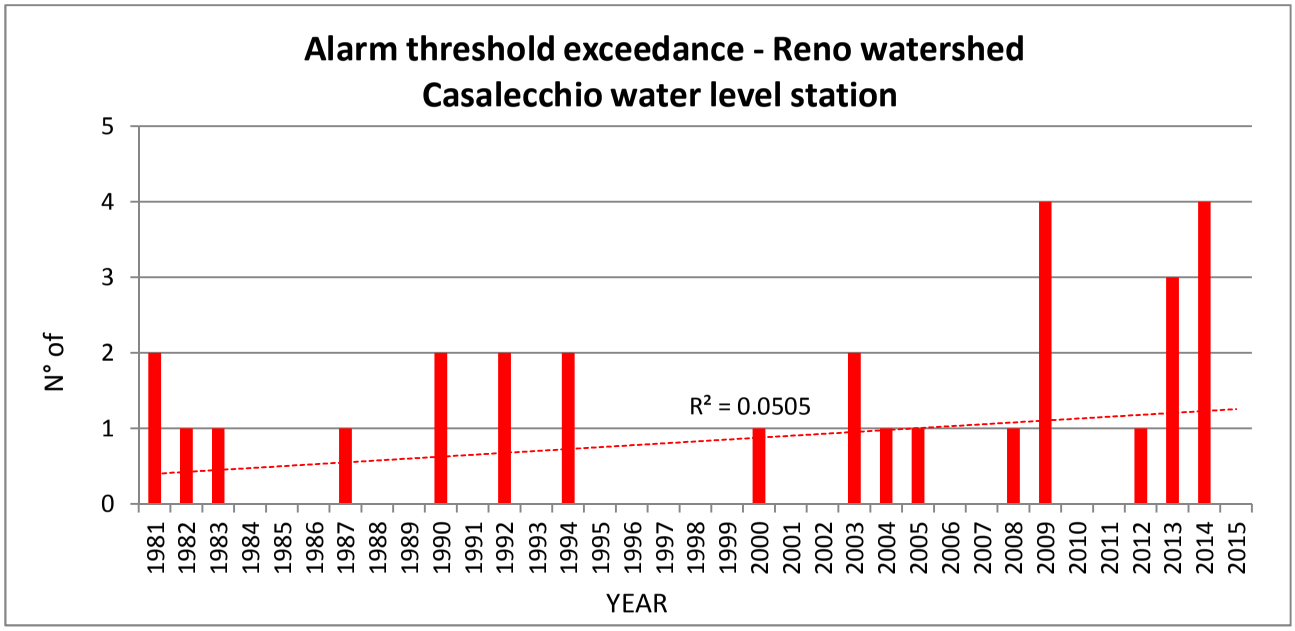

Alert threshold exceedances - Santerno watershed
Codrignano water level station
N° of
YEAR
R² = 0.2252

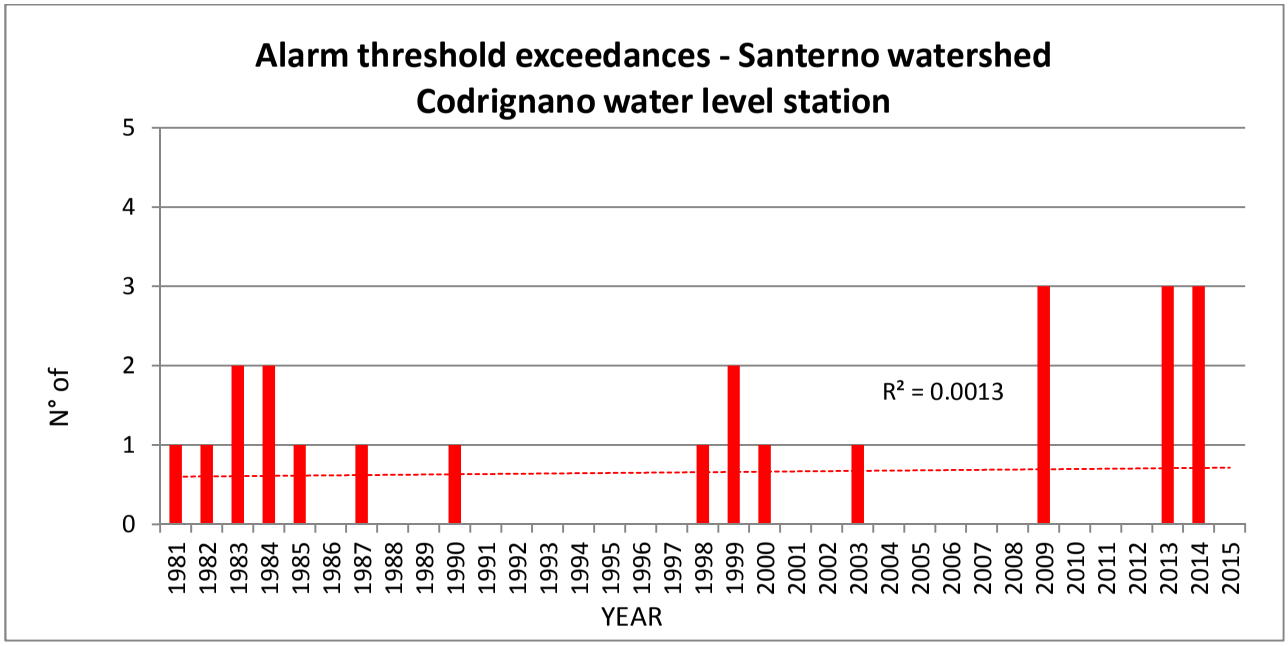

Alert threshold excess - Misa watershed
Bettolelle water level station
Number of events
YEAR
R² = 0.1545

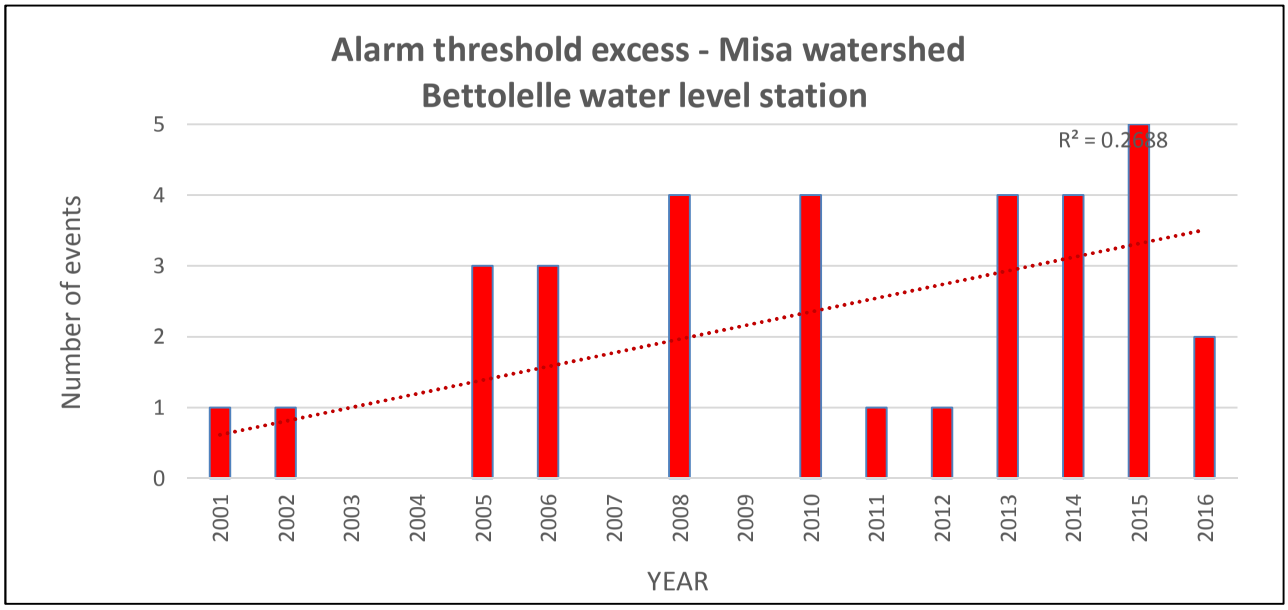

Alert threshold excess - Tronto watershed
Brecciarolo water level station
Number of events
5
4
3
2
1
0
R² = 0.2406
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
YEAR

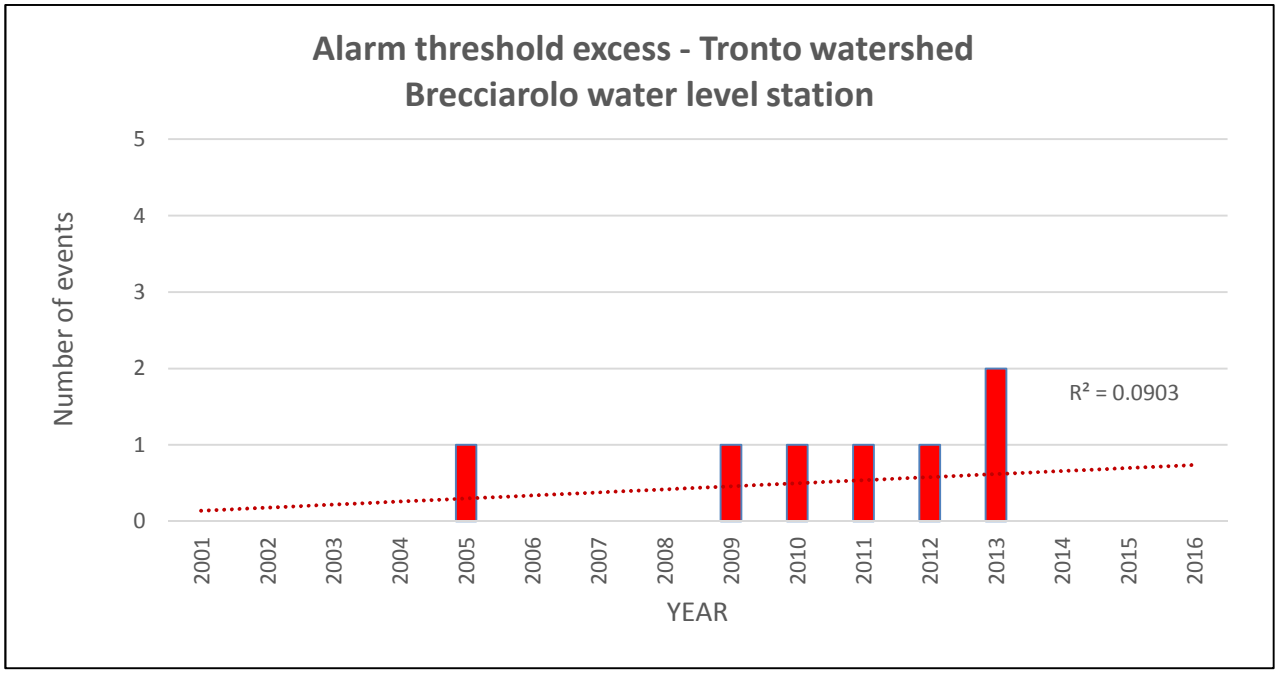

Alert threshold excess - Vomano watershed
Fontanelle di Atri water level station
Number of events
5
4
3
2
1
0
R² = 0.0373
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
YEAR

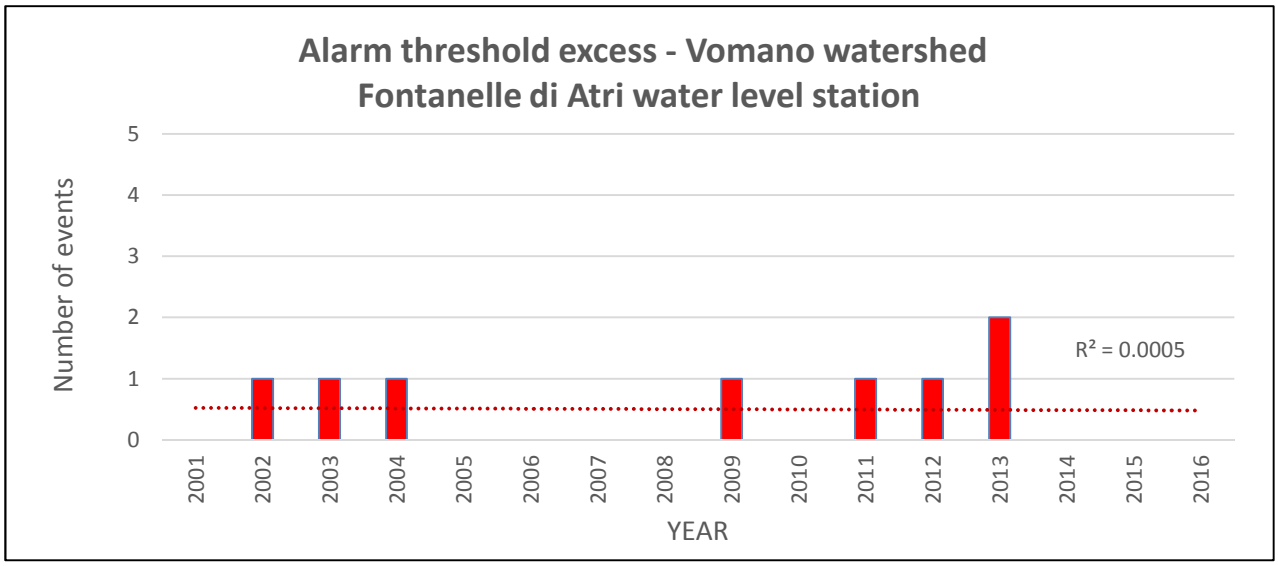

Alert threshold excess - Sangro watershed
Paglieta water level station
Number of events
5
4
3
2
1
0
R² = 0.0414
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
YEAR

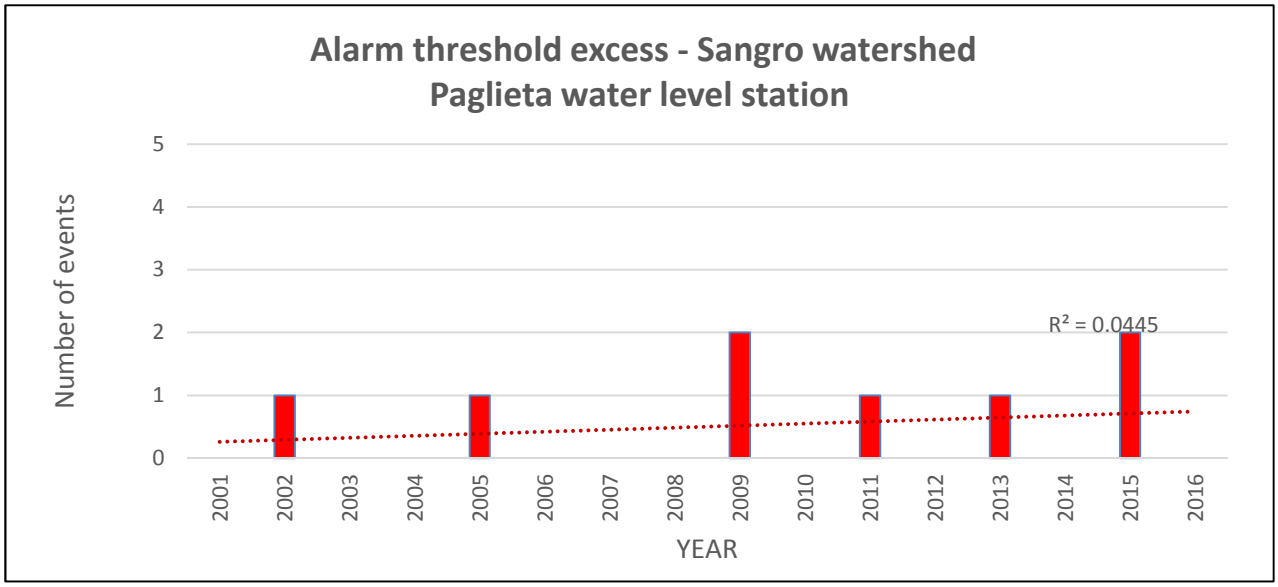

Alarm threshold exceedance - Reno watershed
Casalecchio water level station
N° of
YEAR
R² = 0.0505

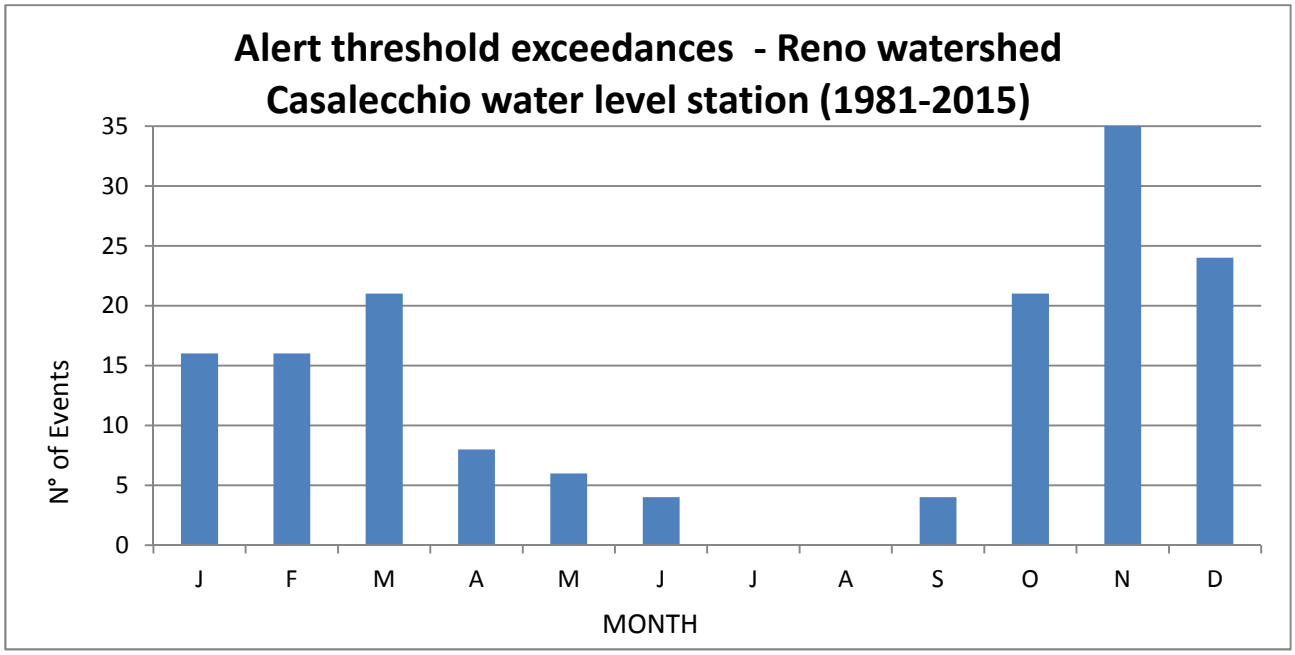

Alarm threshold exceedances - Santerno watershed
Codrignano water level station
N° of
YEAR
R² = 0.0013

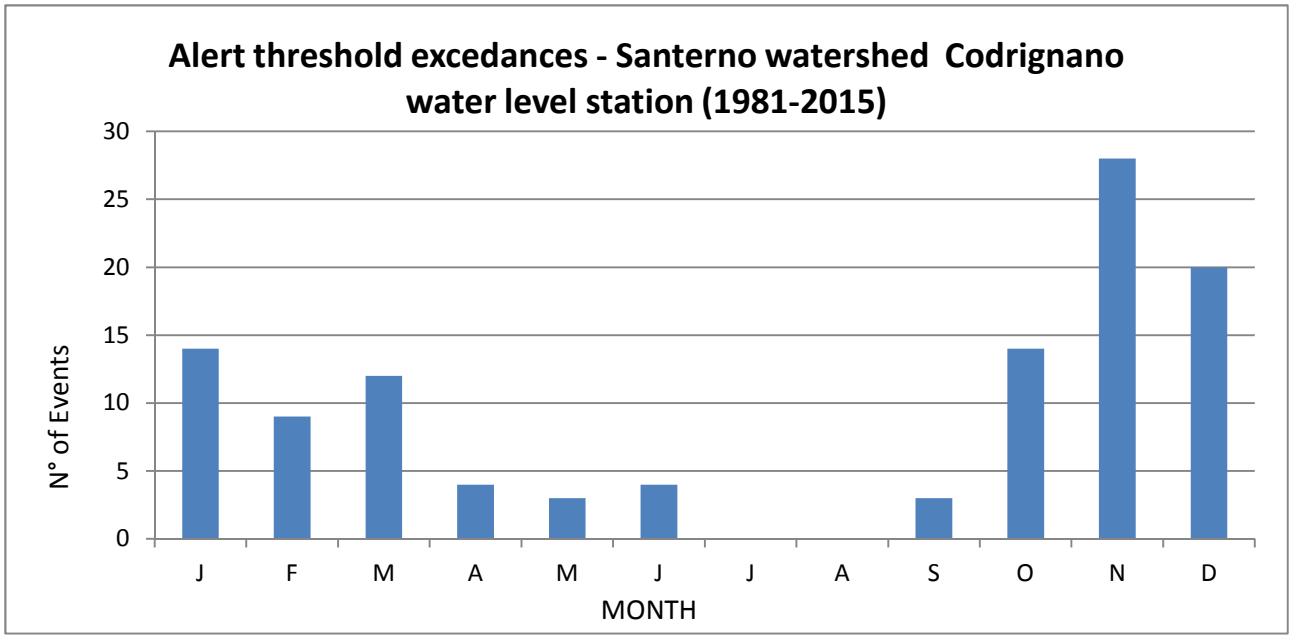

Alarm threshold excess - Misa watershed
Bettolelle water level station
Number of events
YEAR
R² = 0.2688

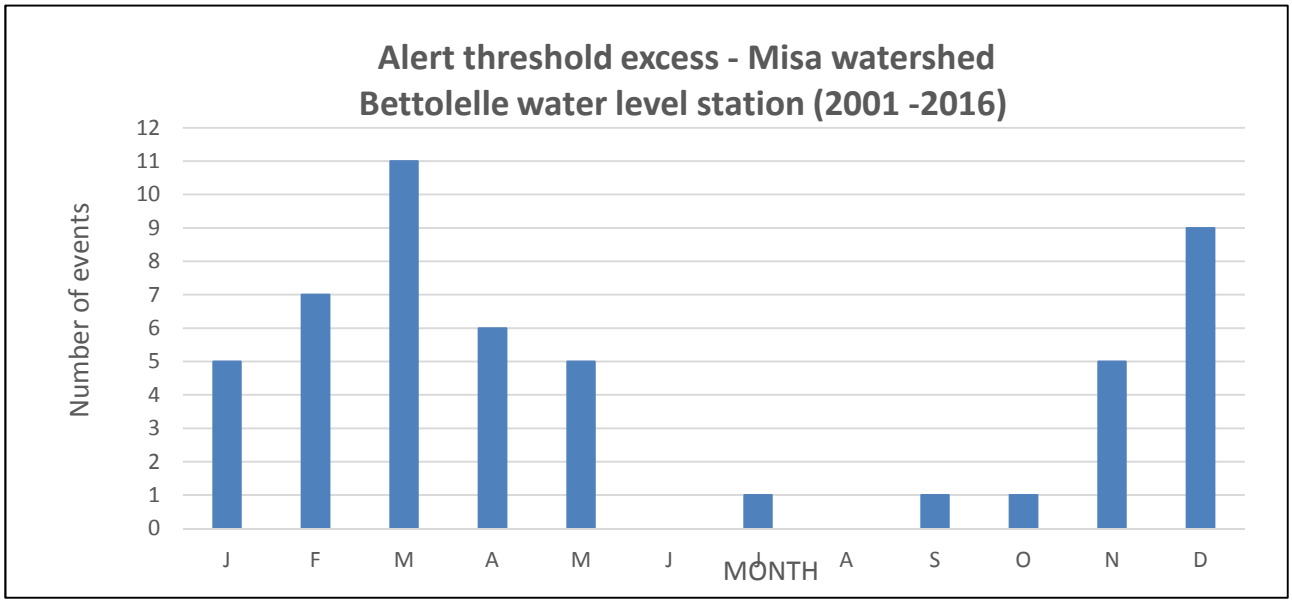

Alarm threshold excess - Tronto watershed
Brecciarolo water level station
Number of events
5
4
3
2
1
0
R² = 0.0903
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
YEAR

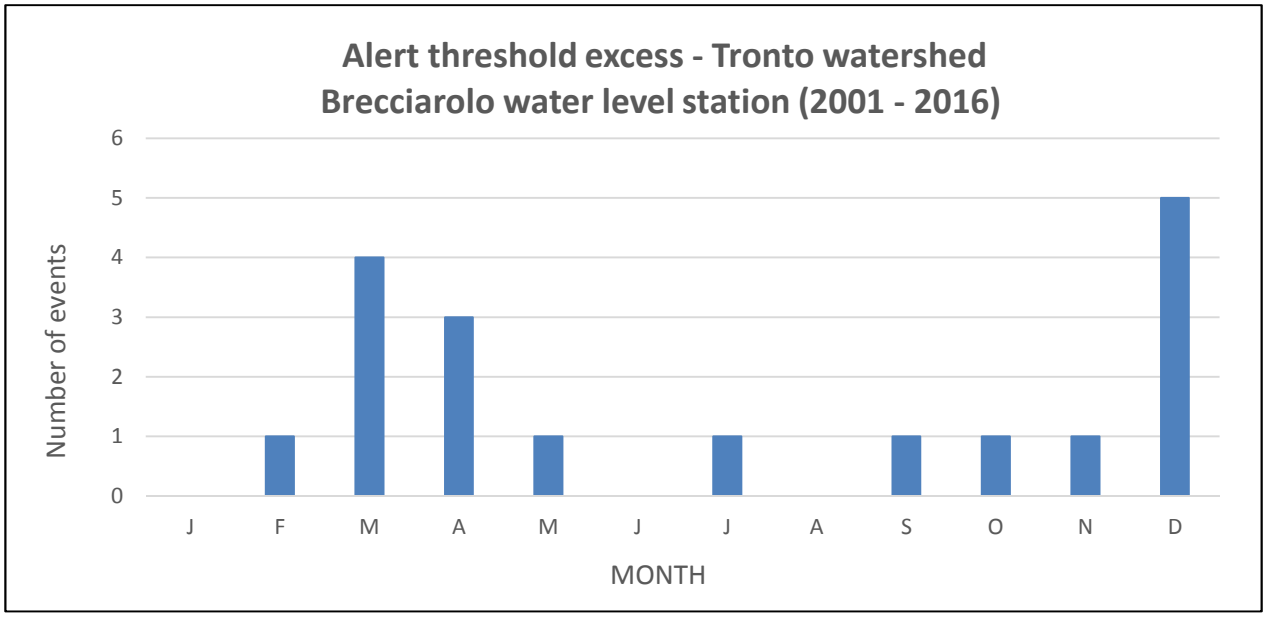

Alarm threshold excess - Vomano watershed
Fontanelle di Atri water level station
Number of events
5
4
3
2
1
0
R² = 0.0005
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
YEAR

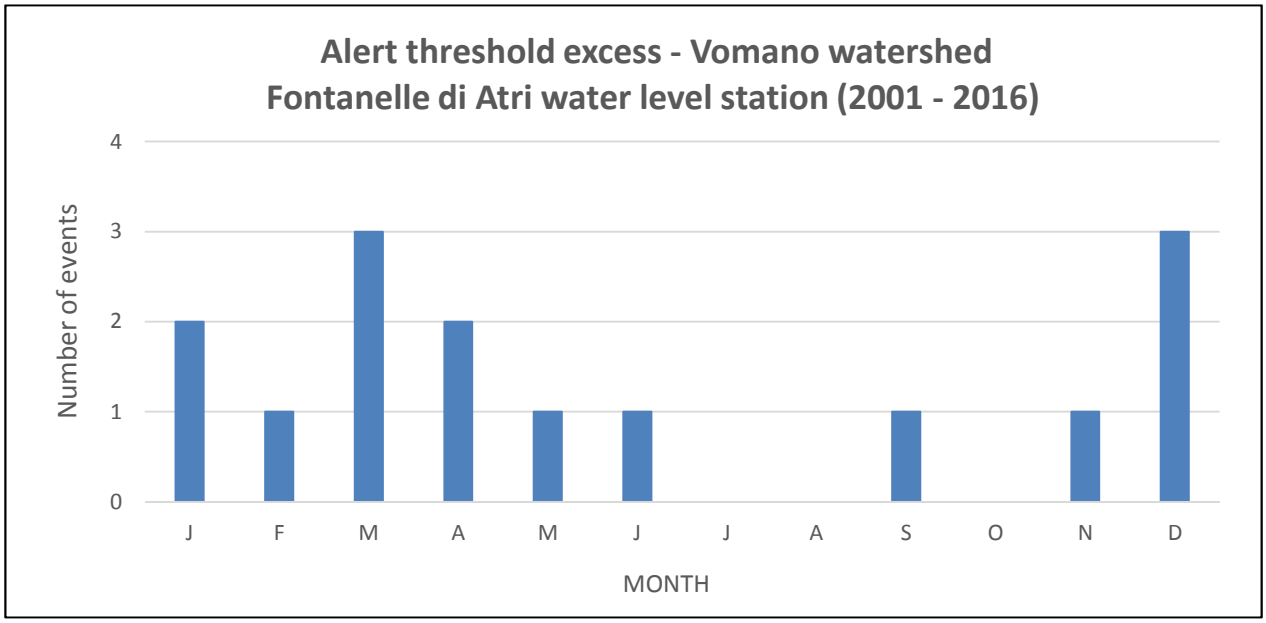

Alarm threshold excess - Sangro watershed
Paglieta water level station
Number of events
5
4
3
2
1
0
R² = 0.0445
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
YEAR

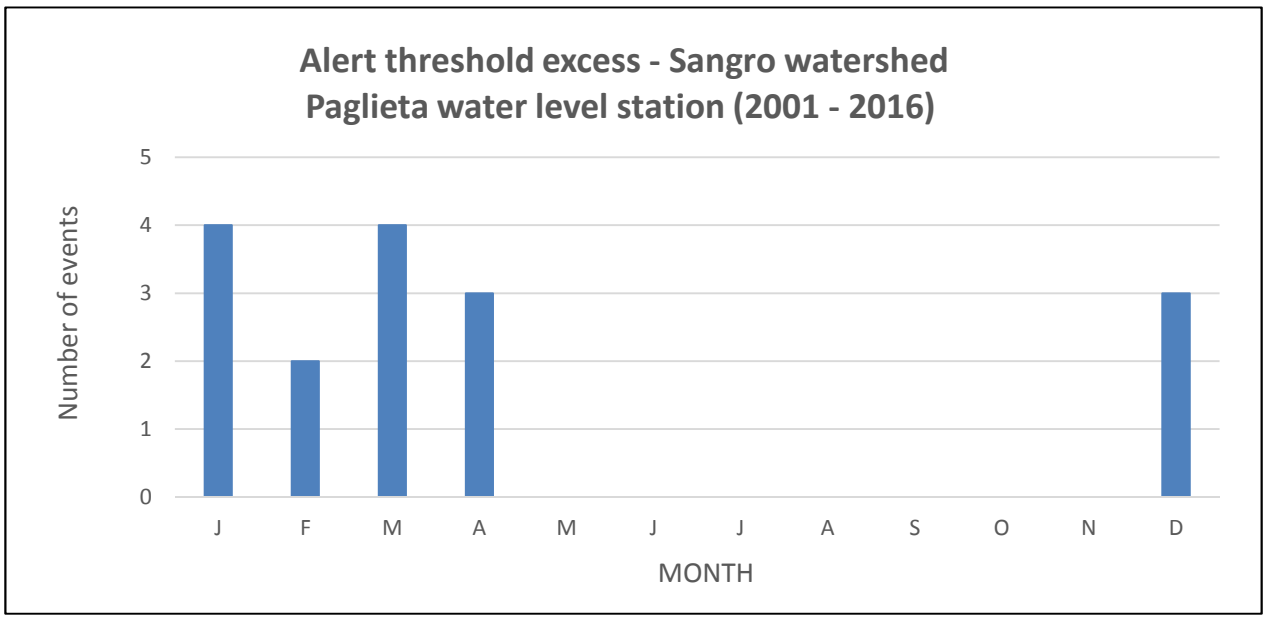

Alert threshold exceedances - Reno watershed
Casalecchio water level station (1981-2015)
N° of Events
35
30
25
20
15
10
5
0
J F M A M J J A S O N D
MONTH


Alert threshold excedances - Santerno watershed Codrignano
water level station (1981-2015)
N° of Events
30
25
20
15
10
5
0
J F M A M J J A S O N D
MONTH


Alert threshold excess - Misa watershed
Bettolelle water level station (2001 -2016)
Number of events
12
11
10
9
8
7
6
5
4
3
2
1
0
J F M A M J J A S O N D
MONTH


Alert threshold excess - Tronto watershed
Brecciarolo water level station (2001 - 2016)
Number of events
0
1
2
3
4
5
6
J
F
M
A
M
J
J
A
S
O
N
D
MONTH


Alert threshold excess - Vomano watershed
Fontanelle di Atri water level station (2001 - 2016)
Number of events
0
1
2
3
4
J
F
M
A
M
J
J
A
S
O
N
D
MONTH


Alert threshold excess - Sangro watershed
Paglieta water level station (2001 - 2016)
Number of events
0
1
2
3
4
5
J
F
M
A
M
J
J
A
S
O
N
D
MONTH