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# Action A1: Designing integrated Baseline Scenario

Responsible Arpae – Emilia-Romagna

Author: R. Tomozeiu, R. Foraci, A. Valentini. S. Nanni

with the collaboration of Abruzzo and Marche Region

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# Deliverable: Harmonized data set

Creation of a common observational data set of:

1. Meteo-climatology;
2. Hydrology ;
3. Marine data.

Common indices over Emilia-Romagna, Marche and Abruzzo (ER-MA-AB)

1. Climatological indices;
2. Hydrological indices;
3. Marine indices

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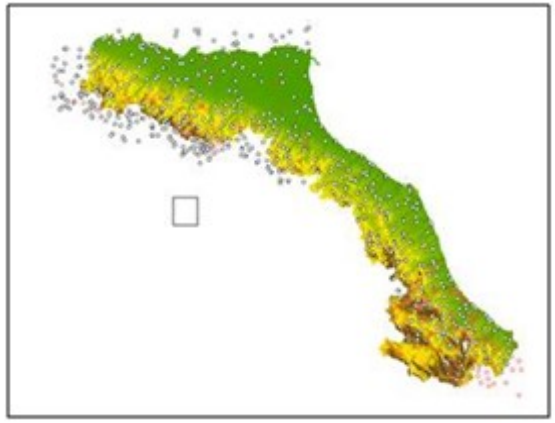
# Meteo-climatology data set (1)

Daily data of precipitation and temperature over the period from 1961-2015 have been analyzed over the whole area covered by the project.

The initial data set was made of 670 rainfall stations: a quality control and the threshold of time series covering at least 80% of the total period reduced the dataset to 280 stations (140 ER, 80 MA, 60 AB).



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# Meteo-climatology data set (2)

A gridded daily analysis at 5x5km resolution has been produced, by applying the Shepard interpolation method in which distances are computed following local topography

As regard daily Tmin and Tmax the data were available from 1951-2015, with a coarse resolution of 0,25°xo0.25°.

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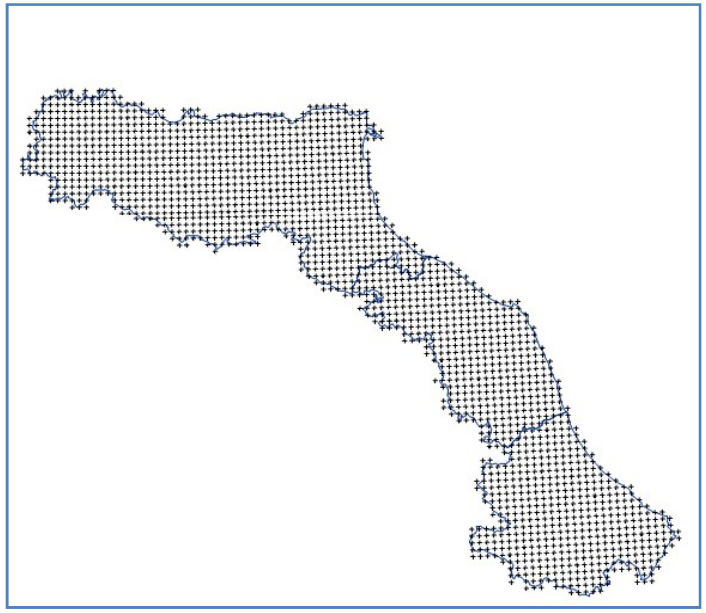
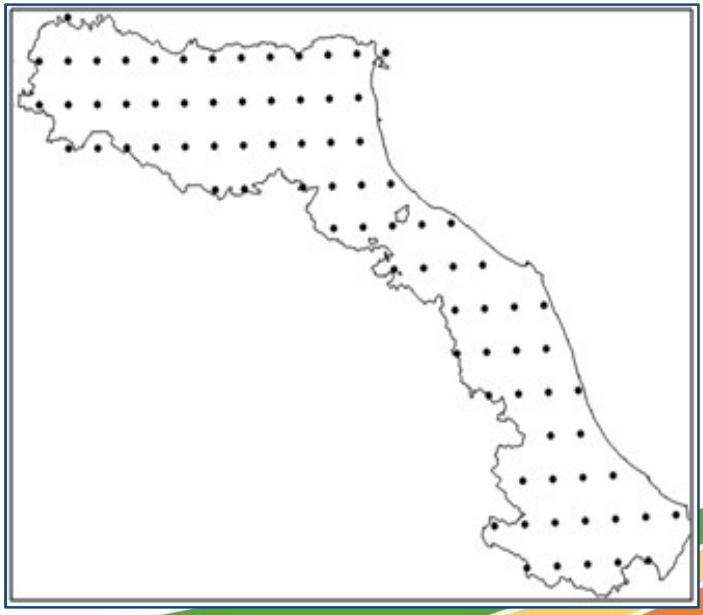
Dati giornalieri sul grigliato

**Precipitazione** (5x5Km)



**Temperatura (27.5x27.5km)**



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## Hydraulic data set

Different  hydrometrc level times series: 35 years ER, 15 years AB and MA

## Marine data set

Only the time series of coastal synoptic stations were available, referred to the period 1960-2016 for the following stations:
 Punta Marina and Rimini (ER), Falconara (MA), Termoli (AB).

Wave data were available only for Cesenatico buoy (ER), period 2007-2016.

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# *Index (acronyms)* - Description

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1

***Amount of precipitation (prcptot)***

-Total amount of precipitation (seasonal/annual).

**2**

***Extreme precipitation (p95thprc)***

-95$^{th}$ percentile of daily precipitation. Only rainy days are used (precipitation is at least 1 mm) (seasonal/annual).

**3**

***Frequency of extreme precipitation (r95p)***

- Number of days when the daily precipitation exceed 95$^{th}$ climatological percentile of daily precipitation. Climatological period= 1971-2000) (seasonal/annual).

**4**

***Frequency of areal intense precipitation (AIP)***

- Number of days in which the areal average daily precipitation exceeds warning threshold (50 mm/day) (seasonal/annual).

**5**

***WET days (cwd)***

- Maximum number of consecutive wet days (the precipitation is at least 1 mm) (seasonal/annual).

**6**

***DRY days (cdd)***

- Maximum number of consecutive dry days (seasonal/annual).

**7**

***Seasonal minimum and maximum temperature (Tminav and Tmaxav)***

- Mean minimum and maximum seasonal values.

**8**

***Heat wave duration (chd95p)***

- Maximum number of consecutive days with maximum temperature > 95$^{th}$ percentile of daily temperature in the base period 1971-2000 (annual).

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The Frequency of Areal Intense Precipitation (AIP) index has been identified by the partners of the project as a relevant index:

AIP describes not only intense events of precipitation but it is also correlated to the vulnerability of the territory.

AIP is computed over the warning areas (macro-areas) of the regions, defined and used by the respective regional operational Functional Centers:

- 8 ER,
- 4 MA,
- 6 AB.

A precipitation threshold of daily 50 mm areal average was chosen as the AIP indicator.

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# Hydrauylic risk index

The main indicator chosen is the exceed of hydrometric level threshold in significant river sections.
It allows to identify the number of flood events occurred and classify their magnitude.

In Italian rivers have been defined two level threshold, called ALERT and ALARM.

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.

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Temperatura minima stagionale

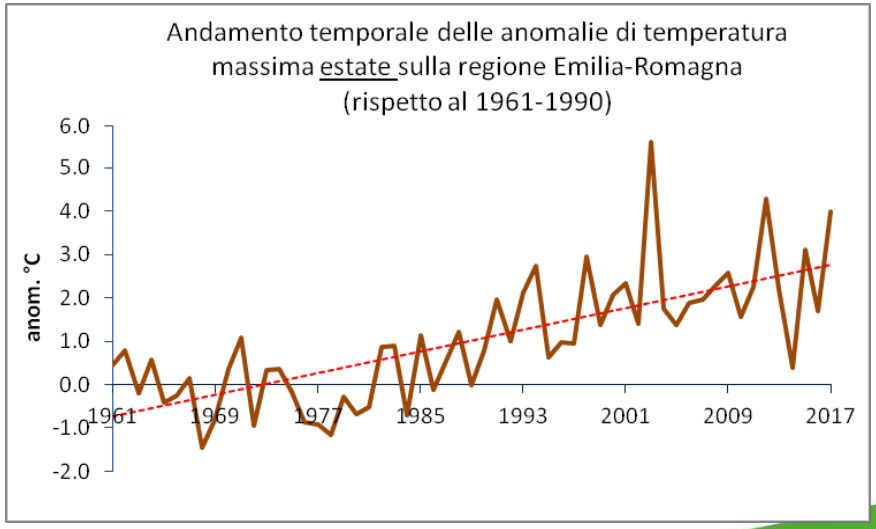
| Stagione | Tendenza (°C/decade) |
|---|---|
| Inverno | 0.2 |
| Primavera | 0.3 |
| Estate | 0.4 |
| Autunno | 0.3 |

Temperatura massima stagionale

| Stagione | Tendenza (°C/decade) |
|---|---|
| Inverno | 0.3 |
| Primavera | 0.4 |
| Estate | 0.6 |
| Autunno | 0.3 |

Nota:

- estate la stagione con segnale molto intenso

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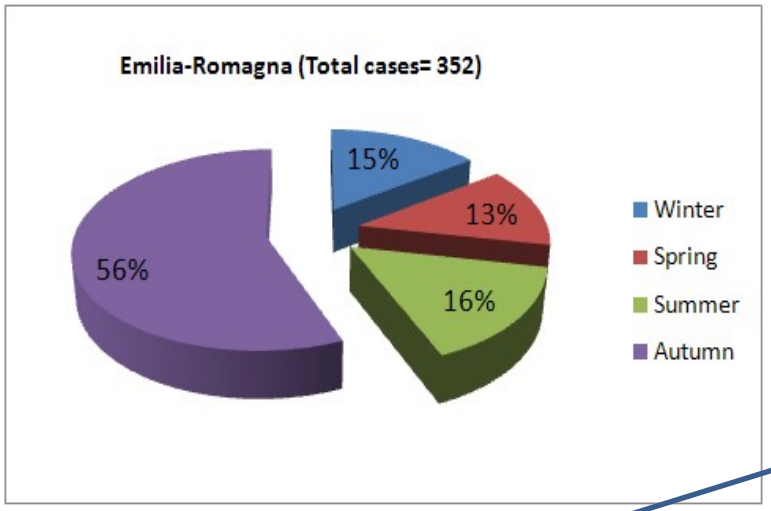
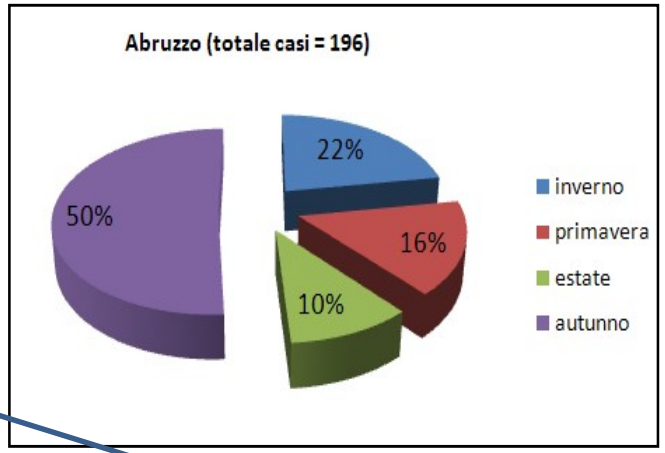
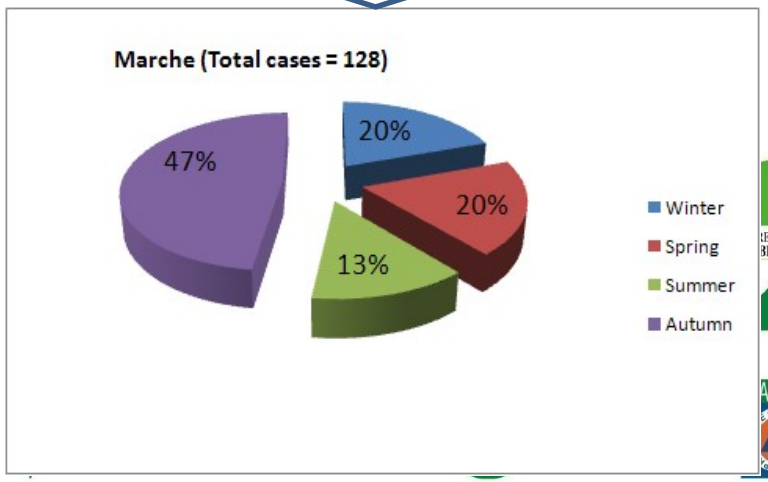



- Maggior parte dei casi in autunno

**Distribuzione stagionale (%) dei numeri di casi con precipitazione maggiore di 50mm/24 ore**

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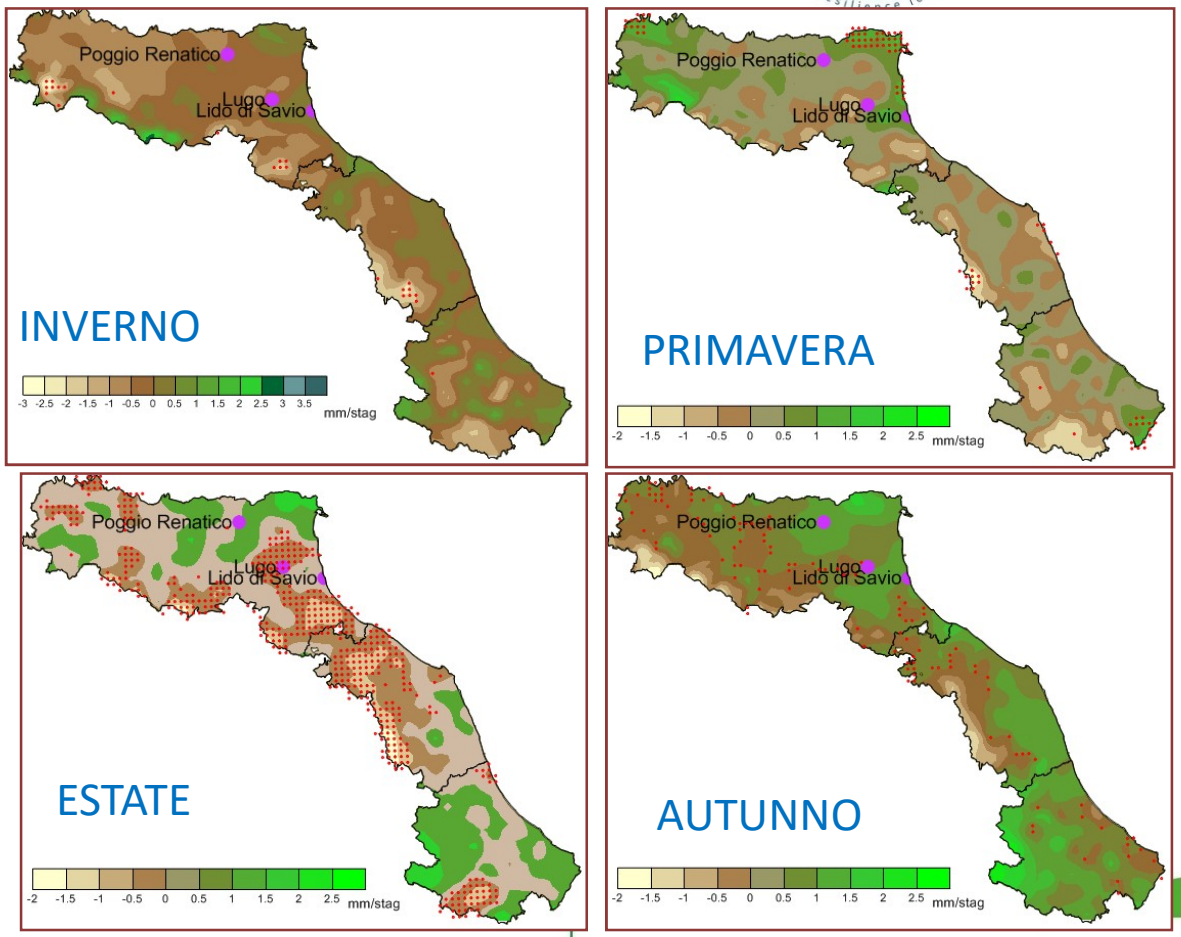


- Leggera diminuzione durante l'estate;
- leggero aumento sopratutto in autunno.

**Verde= tendenze positive;**
**Giallo -Marrone=tendenze negative;**
**Cerchi rossi= tendenze significative al 95%**

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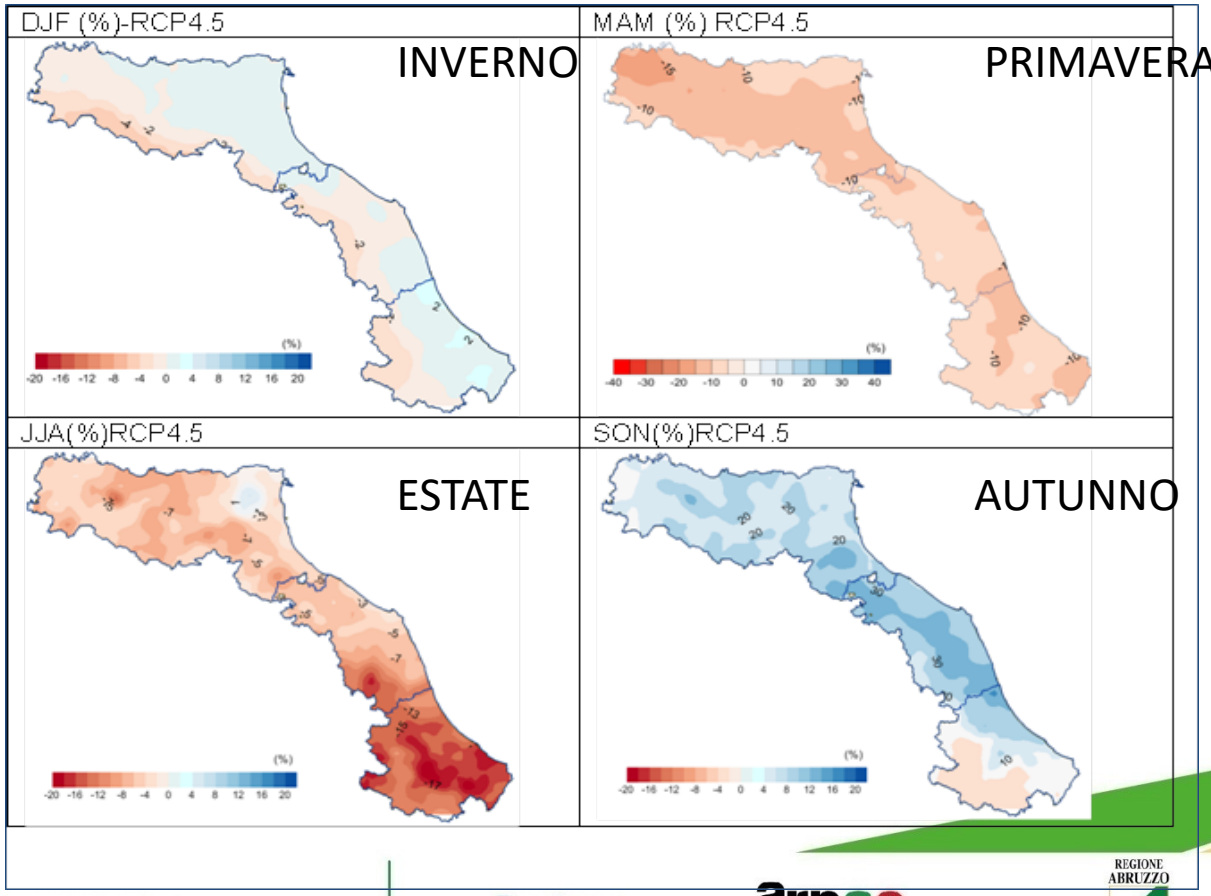
## Cambiamenti nel regimo di precipitazione (%) 2021-2050 vs 1971-2000



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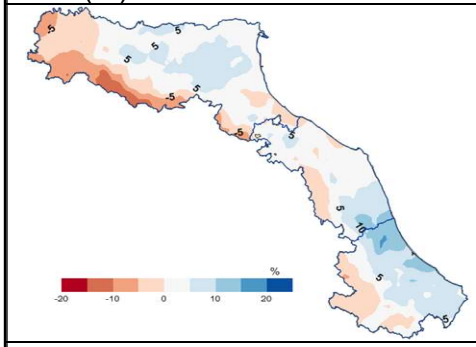
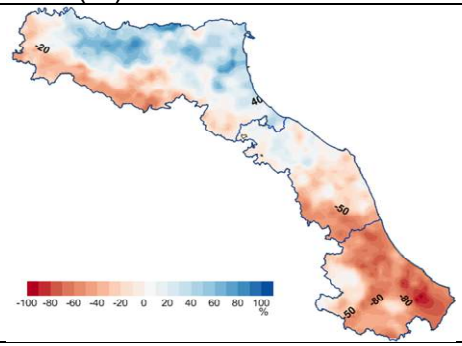
# Frequenza di eventi estremi 2021-2050 v.s. 1971-2000 RCP4.5

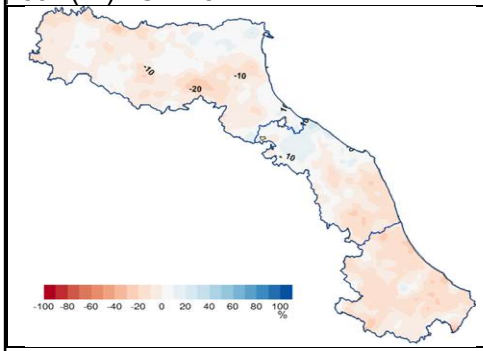
DJF (%)-RCP4.5



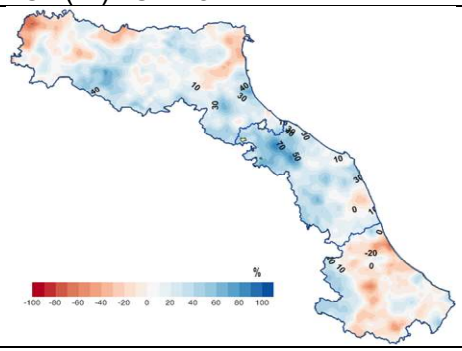
MAM (%) RCP4.5



JJA(%)RCP4.5



SON(%)RCP4.5



- Inverno piccolo aumento (circa 5%) ovunque, ad eccezione delle aree montuose, dove c'è un calo fino al 10%
  Primavera aumento in Emilia-Romagna e calo altrove;
- Estate: segnale poco significativo;
- Autunno aumento del numero di eventi estremi in tutta l'area, fino al 30%

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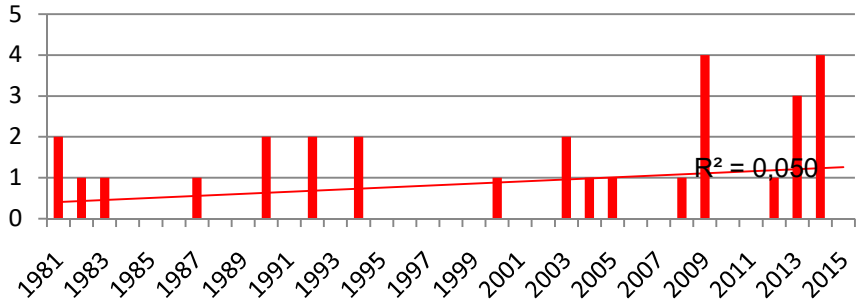
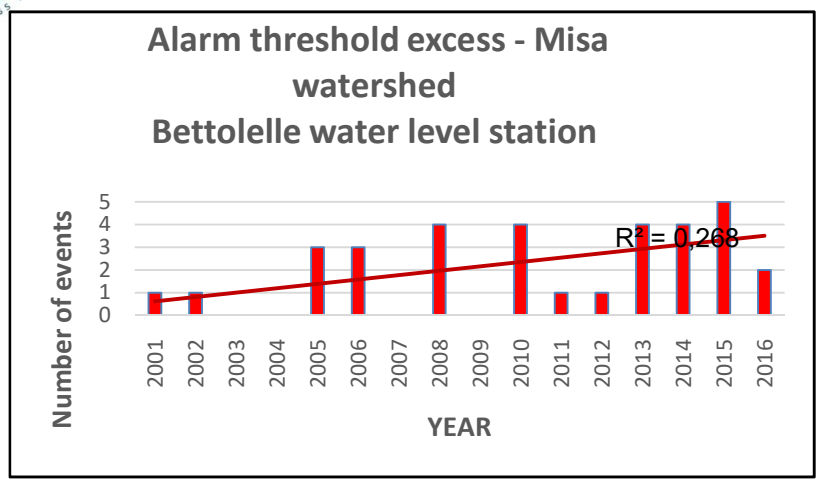
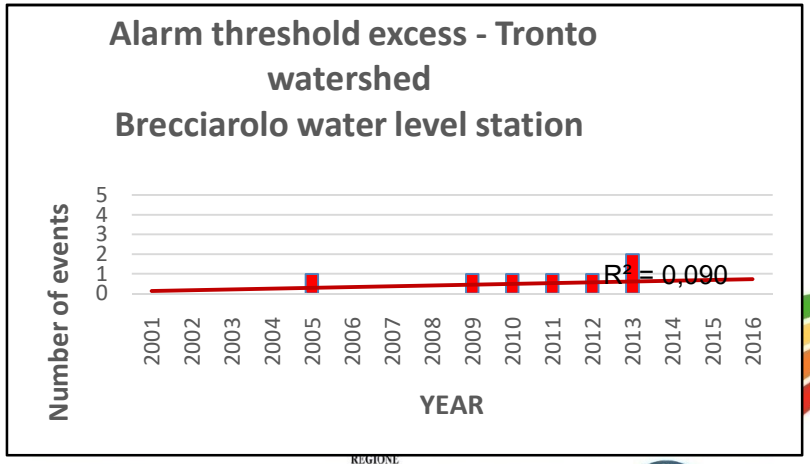
**Alarm threshold exceedance - Reno watershed**
**Casalecchio water level station**




- 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.
-

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# Banche dati utilizzate

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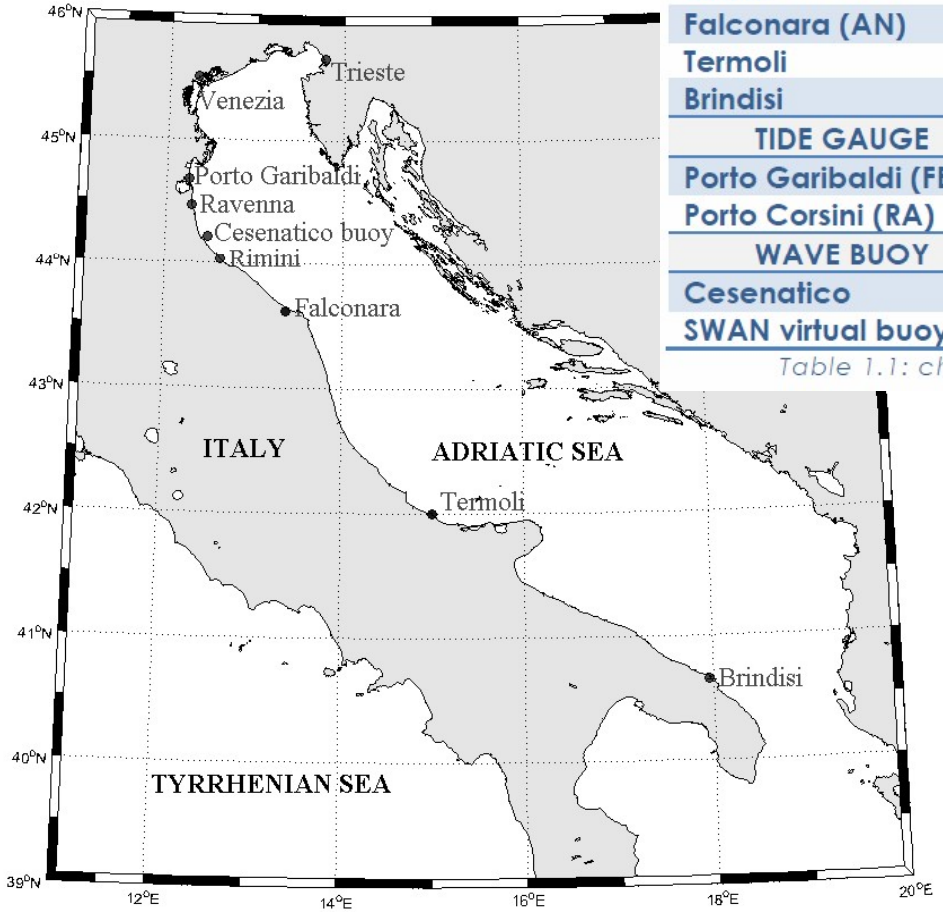
| Station | Latitude N | Longitude E | Water depth (m) | Period of observation |
|---|---|---|---|---|
| **METEO SYNOP** | | | | |
| Trieste | 45° 39' | 13° 47' | - | 1960-2016 |
| Venezia | 45° 30' | 12° 20' | - | 1961-2016 |
| Punta Marina (RA) | 44° 28' | 12° 17' | - | 1960-2016 |
| Rimini | 44° 02' | 12° 37' | - | 1960-2016 |
| Falconara (AN) | 43° 37' | 13° 22' | - | 1960-2016 |
| Termoli | 42° 00' | 15° 00' | - | 1960-2016 |
| Brindisi | 40° 39' | 17° 57' | - | 1960-2016 |
| **TIDE GAUGE** | | | | |
| Porto Garibaldi (FE) | 44° 40.6' | 12° 15' | - | 2009-2016 |
| Porto Corsini (RA) | 44° 29.5' | 12° 17' | - | 1998-2015 |
| **WAVE BUOY** | | | | |
| Cesenatico | 44° 12.9' | 12° 28.5' | 10 | 2007-2016 |
| SWAN virtual buoy | 44° 19.9' | 12° 24' | 10 | 2006-2016 |

*Table 1.1: characteristics of data measurements used in this analysis.*



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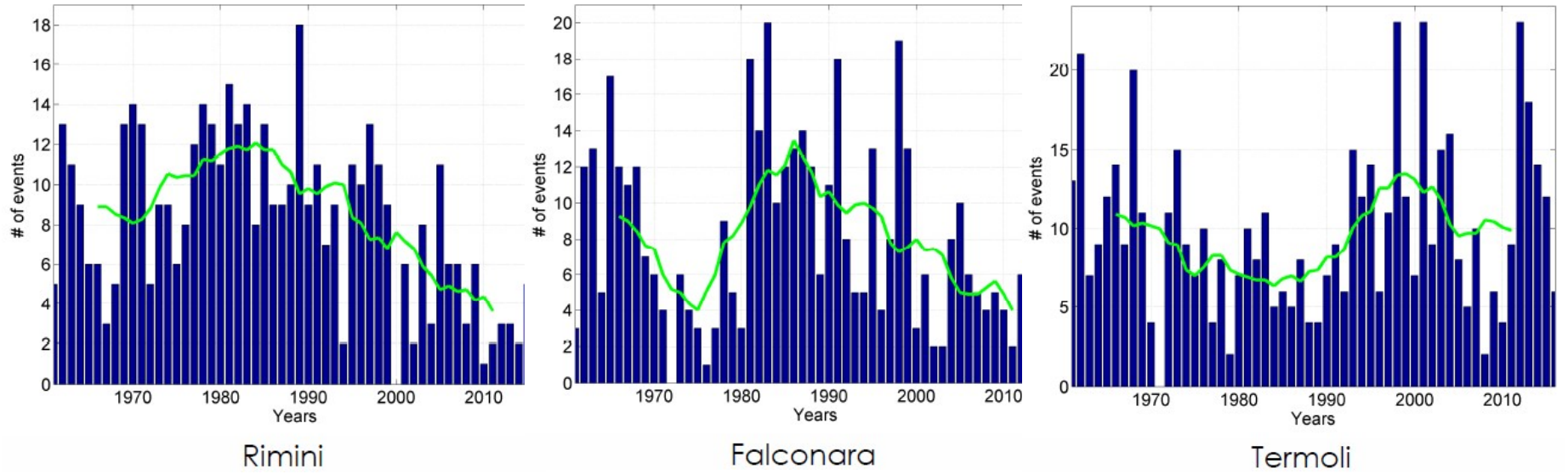
# 1960-2016: analisi vento intenso




**Trend molto differenti tra loro -> non è possibile definire un'informazione univoca per tutte le aree**

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# Subsidenza 2006-2011

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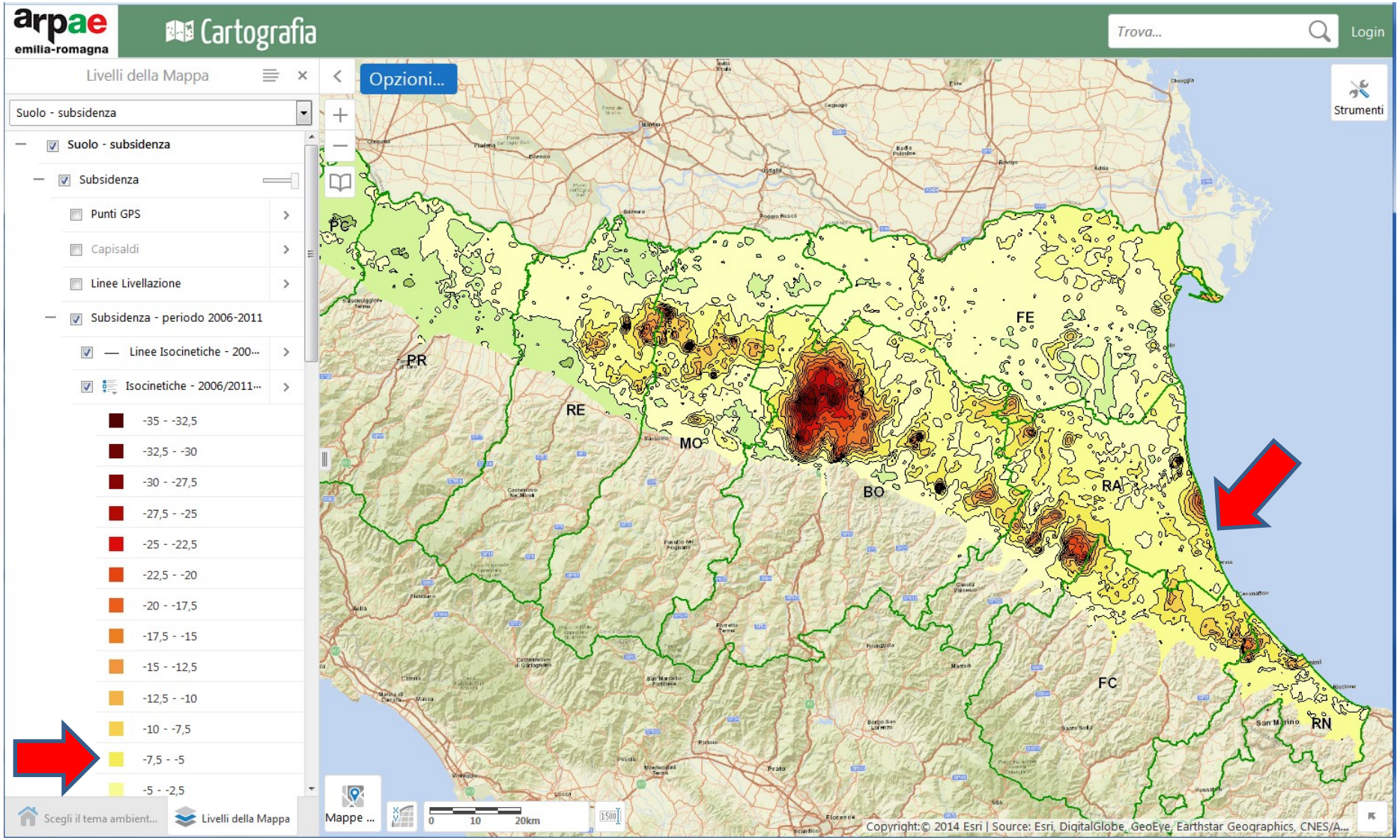

# Livello del mare IPCC →2100

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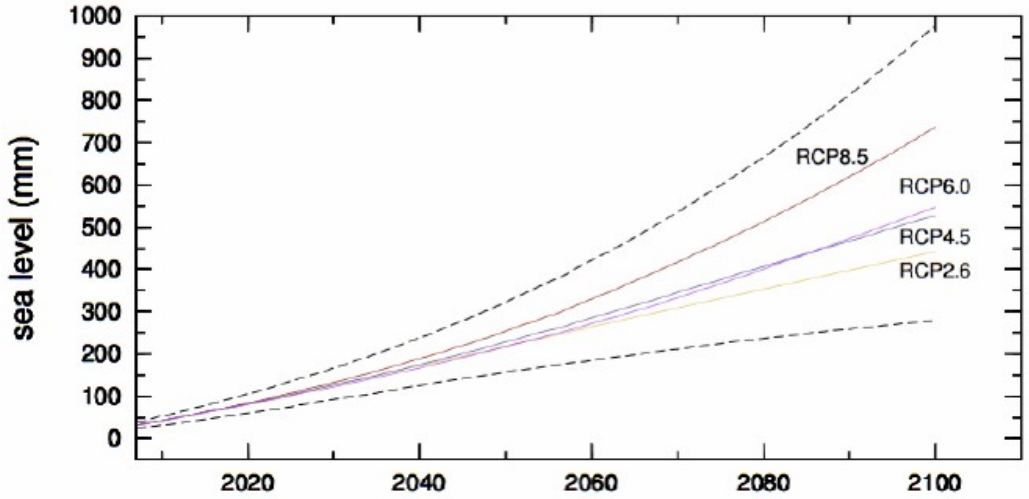


**Figure 4.** Sea-level pathways according to IPCC AR5. Dashed lines show the lower and the upper limits of the projections, corresponding to the upper limit of RCP 8.5 and to the lower limit of the RCP 2.6. Projections are referred to the average sea-level values in the period 1986-2005.

**Table 2.** Sea level predicted during the time interval 2081-2100 with respect to 1986-2005, according to the four IPCC AR5 RCPs. The Adriatic and Mediterranean values are averaged values across these seas. These projections do not include the GIA component of sea-level change.

| RCP | E-R coast<br>m | Adriatic<br>m | Mediterranean<br>m | Global<br>m |
|---|---|---|---|---|
| 2.6 | 0.30 ± 0.07 | 0.31 ± 0.01 | 0.36 ± 0.02 | 0.38 ± 0.15 |
| 4.5 | 0.34 ± 0.09 | 0.37 ± 0.01 | 0.42 ± 0.03 | 0.45 ± 0.16 |
| 6.0 | 0.33 ± 0.08 | 0.36 ± 0.02 | 0.42 ± 0.03 | 0.47 ± 0.16 |
| 8.5 | 0.45 ± 0.12 | 0.48 ± 0.02 | 0.57 ± 0.03 | 0.60 ± 0.19 |

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# Conclusioni –scenari climatici

**Temperature**:

- Probabile aumento delle temperature minime e massime
- Probabile aumento della frequenza delle onde di calore, specialmente in estate;
- Probabile diminuzione delle temperature estreme (minima sotto 0°C) in inverno;

**Precipitazioni**:

- Verosimile calo delle precipitazioni durante la primavera e l'estate e aumento in autunno;
  - segnale più intenso verso fine secolo;
- Verosimile aumento degli eventi estremi di precipitazione.

**Piene fluviali**:

- Verosimile aumento della frequenza degli eventi di piena;
- Verosimile aumento degli eventi estremi durante l'autunno e diminuzione in primavera (minor contributo dello scioglimento della neve).

# Lido di Savio: possibili Scenari di allagamento attuali e futuri (al 2100)

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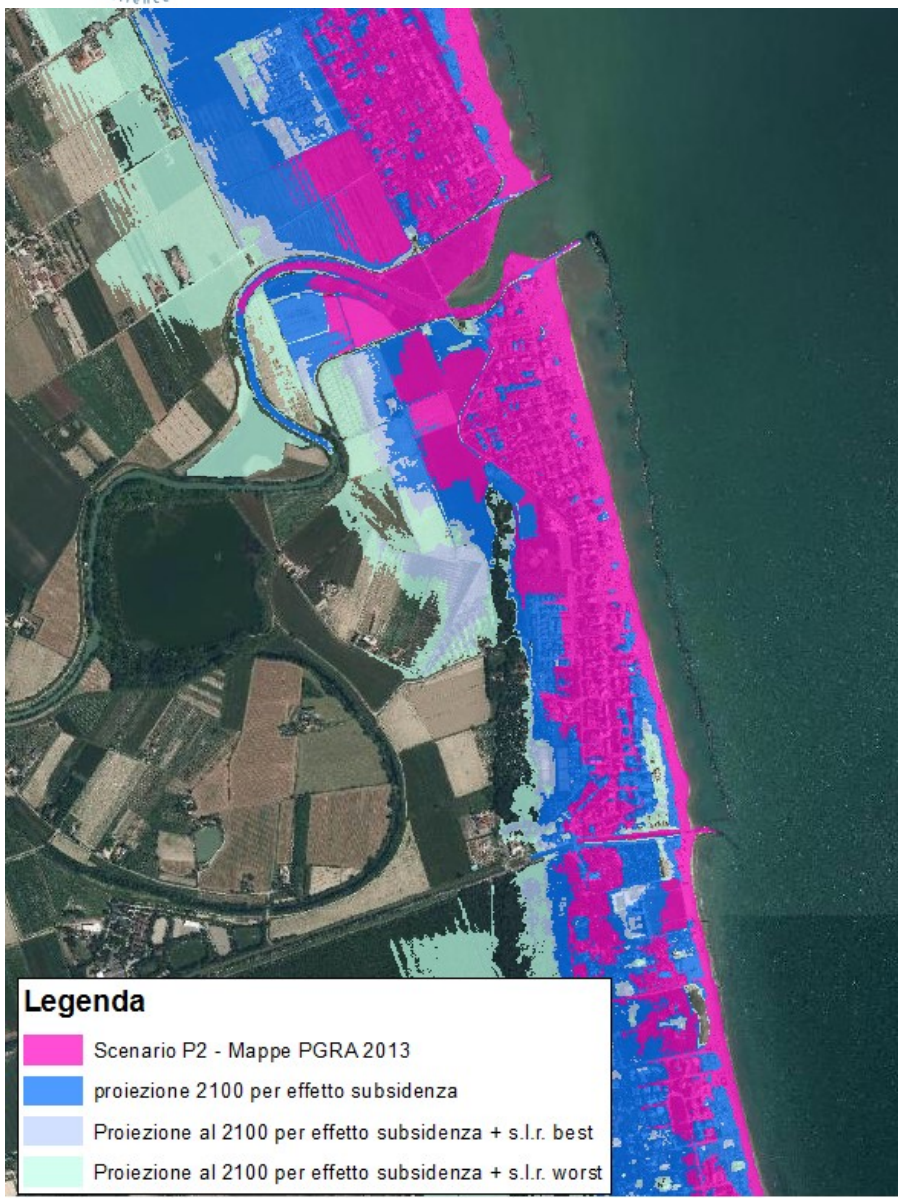


In fucsia sono **rappresentate le aree attualmente allagabili in caso di mareggiata con Tr= 100 anni** (Mappa PGRA – direttiva alluvioni. La mappa non tiene conto della presenza di opere temporanee che attenuano il fenomeno)

Nei toni azzurro sono rappresentate le **aree potenzialmente allagabili al 2100 in caso di mareggiata con Tr= 100 anni** incrementali rispetto alle attuali per:

- Solo effetto della subsidenza (con i tassi 2006-2012)
- Per subsidenza + s.l.r minimo (+23 cm; scenari IPCC – downascaling costa RER)
- Per subsidenza + s.l.r massimo (+55 cm ; scenari IPCC – downascaling costa RER)

Queste simulazioni considerano lo scenario peggiore (o cautelativo) del '**non intervento' con un trend di abbassamento del suolo costante con tassi di subsidenza (2006-2012)**

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