Sea State CCI
User Consultation Meeting #2
Online meeting

Wind waves and coastal risk in Emilia Romagna Region: monitoring and forecasting

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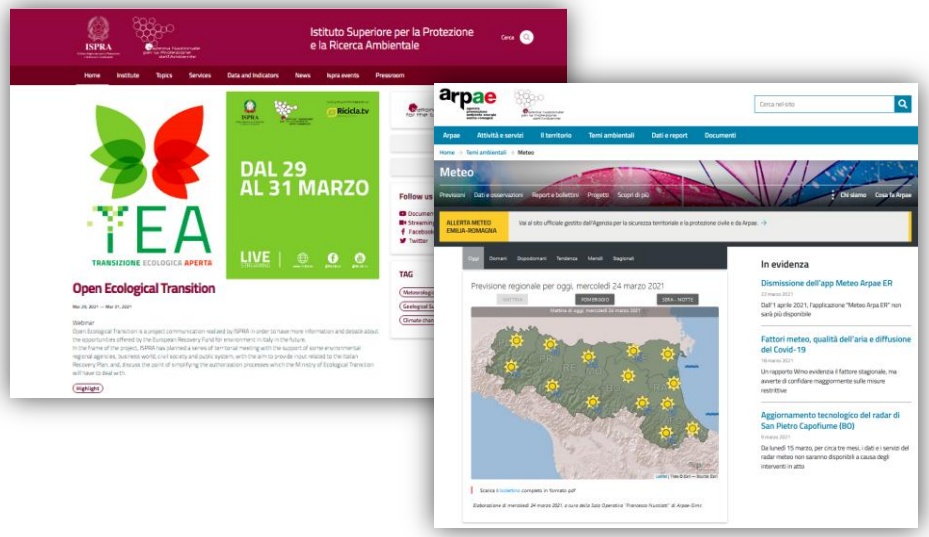
ARPAE-SIMC & ISPRA

ISPRA (Italian National Institute for Environmental Protection and Research) **is the National authority** for national issues regarding protection, enhancement and improvement of the environment with a wide expertise in marine and coastal areas:

- **real time monitoring of meteo-marine parameters** through **three** networks, the
  - **national tide gauge network (RMN)**
  - **North Adriatic and Venice Lagoon tide gauges network (RMLV)**
  - **Wave Measurement Network (RON)**
- **operational forecasting system** with a special focus on storm surges in the North Adriatic Sea and the Venice Lagoon
- technical and scientific activities concerning climate change and adaptation
- national environmental databases, environmental data, **statistics, information, reports**

ISPRA coordinates the National System of Environment Protection Agencies (SNPA) ensuring the exchange of information and expertise on environmental monitoring, control and inspections, connecting scientific knowledge communities with environmental administrators and policy makers at national and local level.

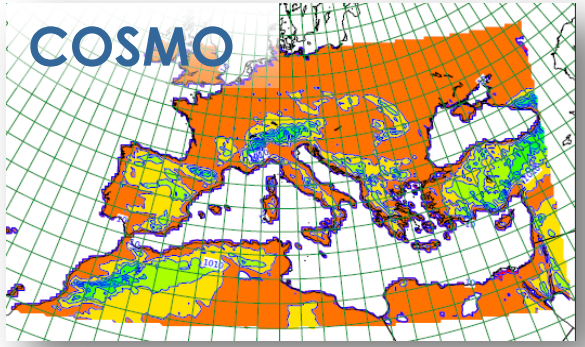


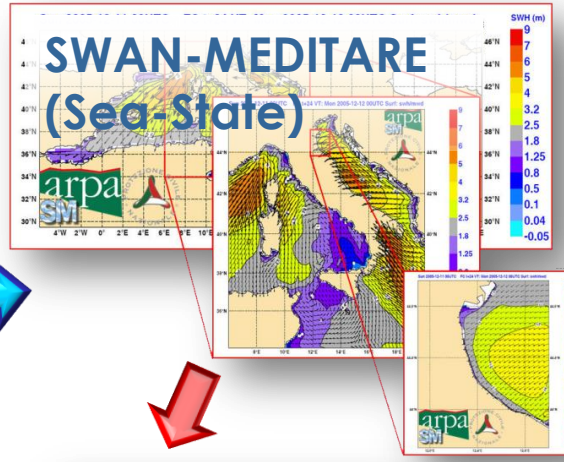
The **Hydro-Meteo-Climate Service of Arpae (Arpae-SIMC)** is the met service in Emilia-Romagna and **Support Centre** for the Civil Protection Agency as well as **Centre of Competence** for the Italian National Civil Protection system.

Arpae-SIMC carries out in situ measurements, forecasts and evaluations regarding meteorological and marine climate and waves forecasts and specific applications for bathing water quality studies, coastal risk and oil-spills.

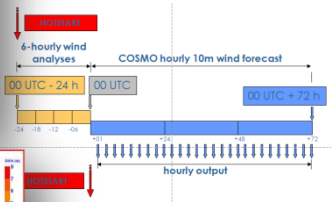
METEO-MARINE-COASTAL OPERATIONAL CHAIN @ ARPAE

COSMO-5M
+72h 2.2 km h.r.
COSMO-2I
+48h, 2.2 km h.r.
COSMO-2I EPS
+48h 2.2 km 20 membs
COSMO-2I RUC
+18h every 3h



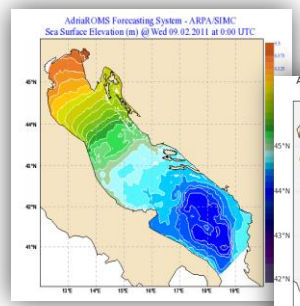


SWAN model
COSMO-5M
+72h 25-7-0.5 km h.r.



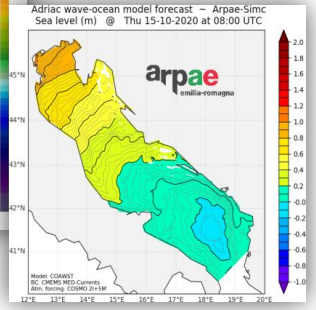
AdriaROMS (ROMS)
COSMO-5M
+72h 2km h.r.
20 σ-layers
4 harmonics
BCs from CMEMS-MFS

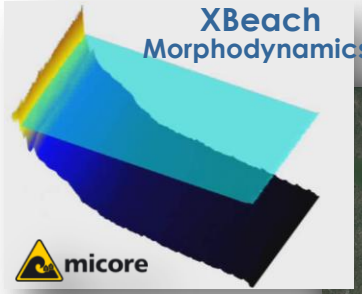
Adriac (COAWST)
COSMO-2I+5M
+72h 1km h.r.
30 σ-layers
8 harmonics
BCs from CMEMS-MFS



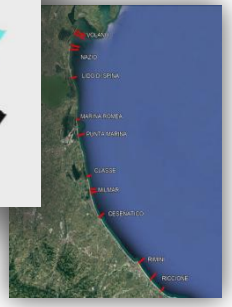
AdriaROMS
circulation

Adriac
waves&circulation



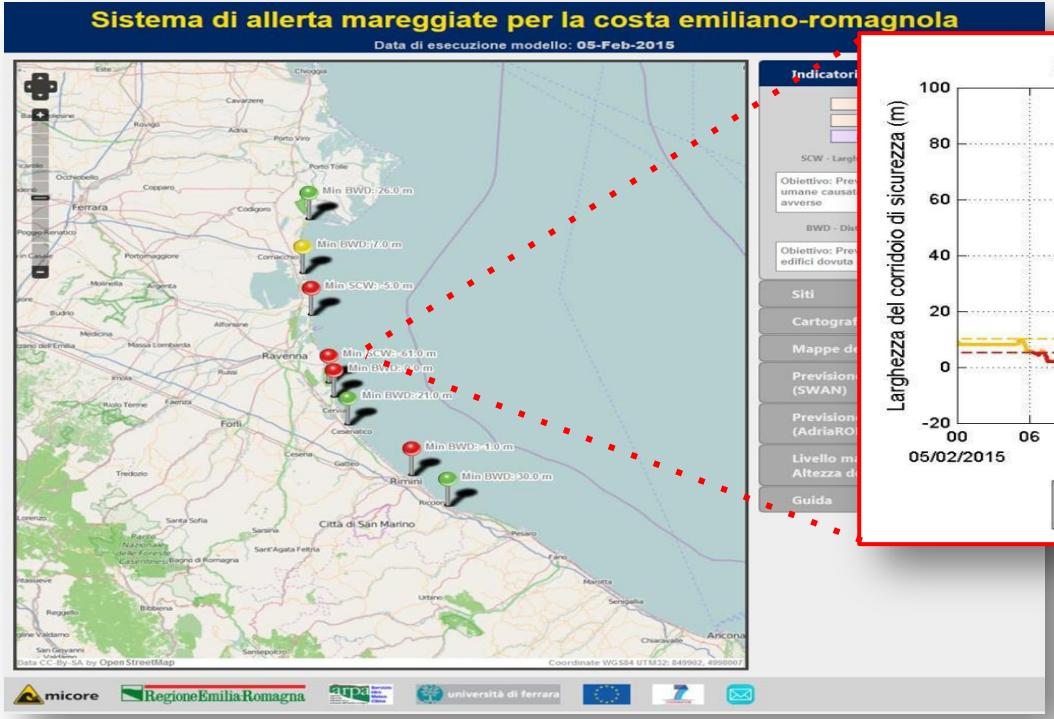


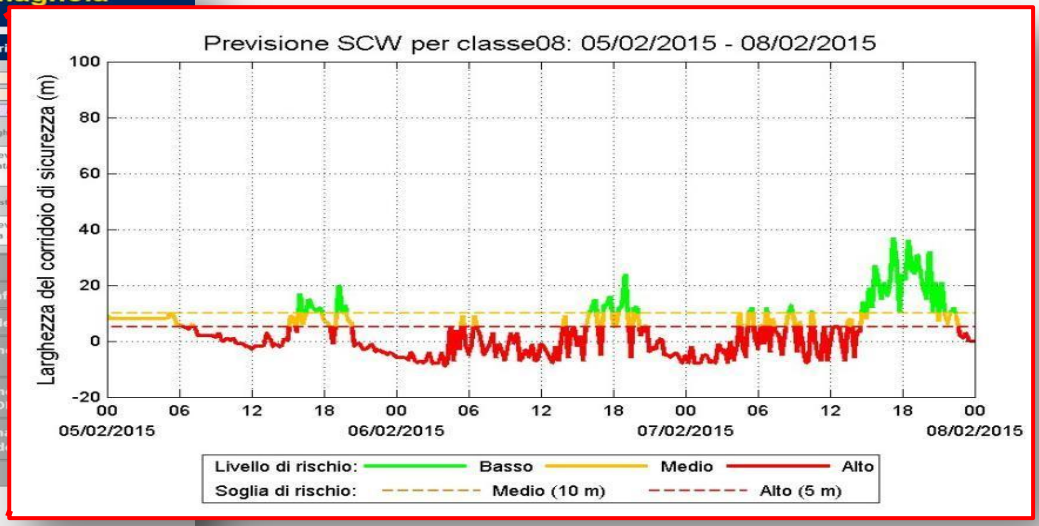
XBeach
Morphodynamics

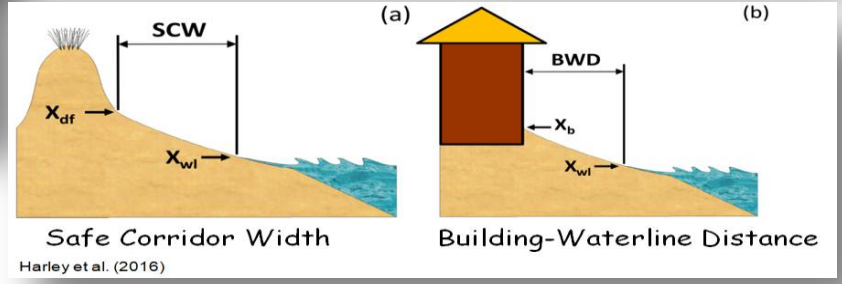


XBeach model
16 regional transect
2 Storm Impact Indicators

REGIONAL WEB-GIS
GEO.REGIONE.EMILIA-ROMAGNA.IT/SCHEDE/EWS







DECISION SUPPORT SYSTEM FOR COASTAL HAZARDS

Met Service
Arpae-SIMC

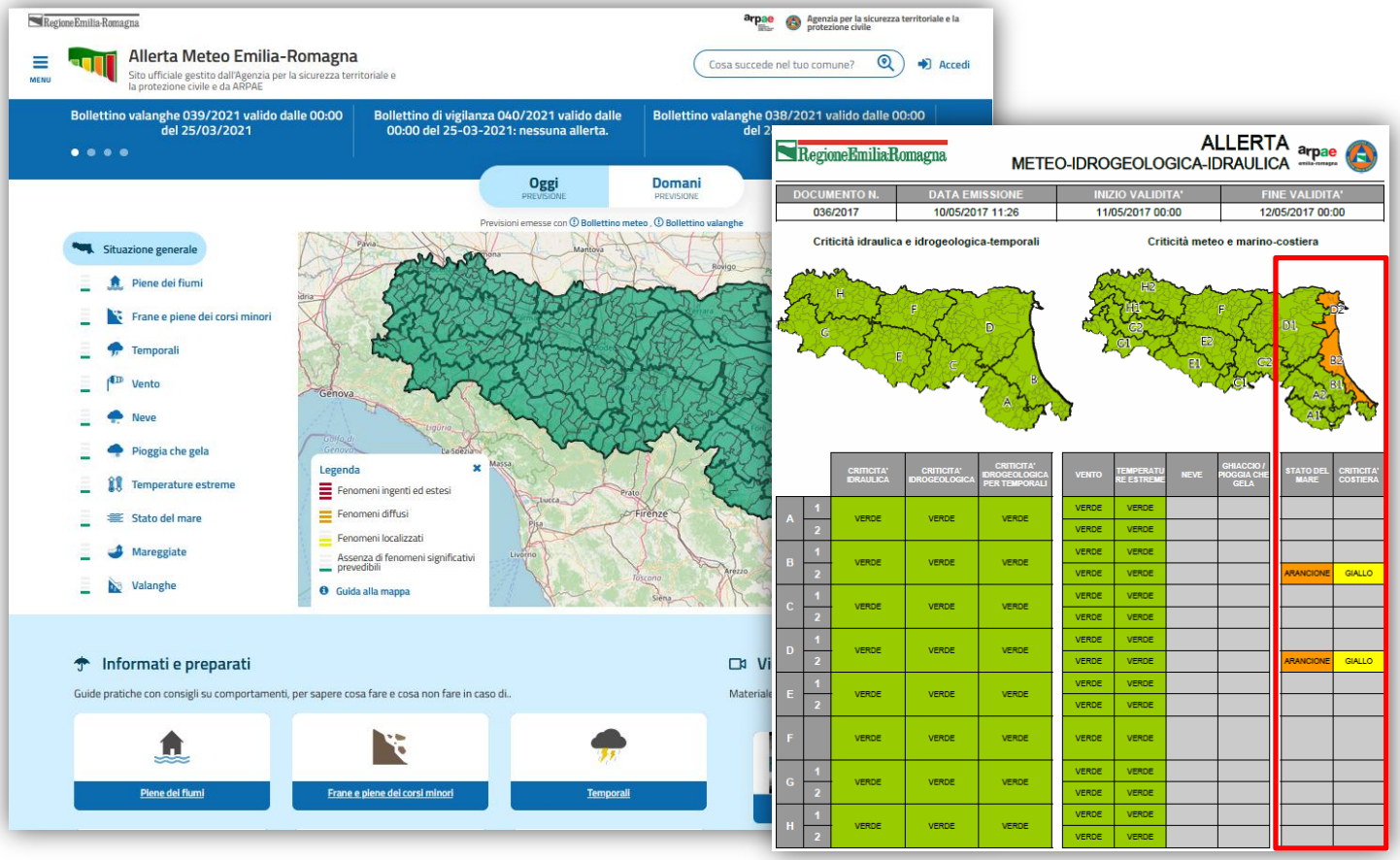
Meteo-marine forecasts and monitoring

Thresholds exceeding :
SWAN-MEDITARE + AdriaROMS/Adriac
Indicators analysis and inpacts/risk evaluation:
XBeach

Regional Civil protection BRIEFING

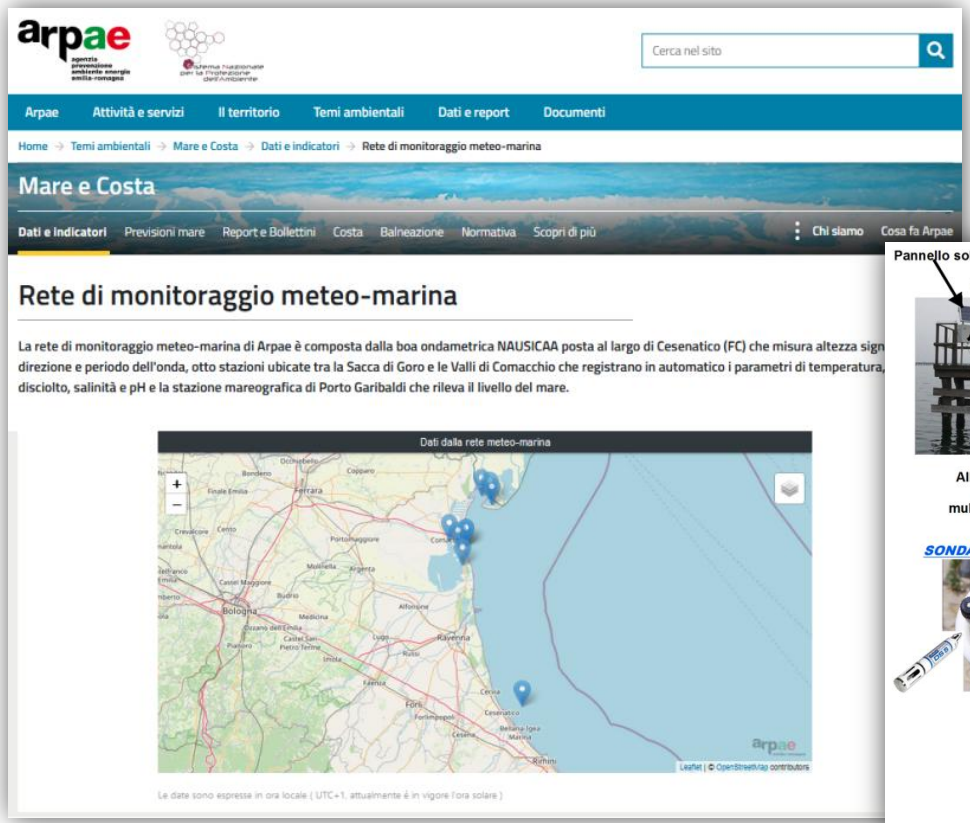
Meteorological Service (Arpae-SIMC)
Geological survey (SGSS)
Civil Protection (ARSTePC)

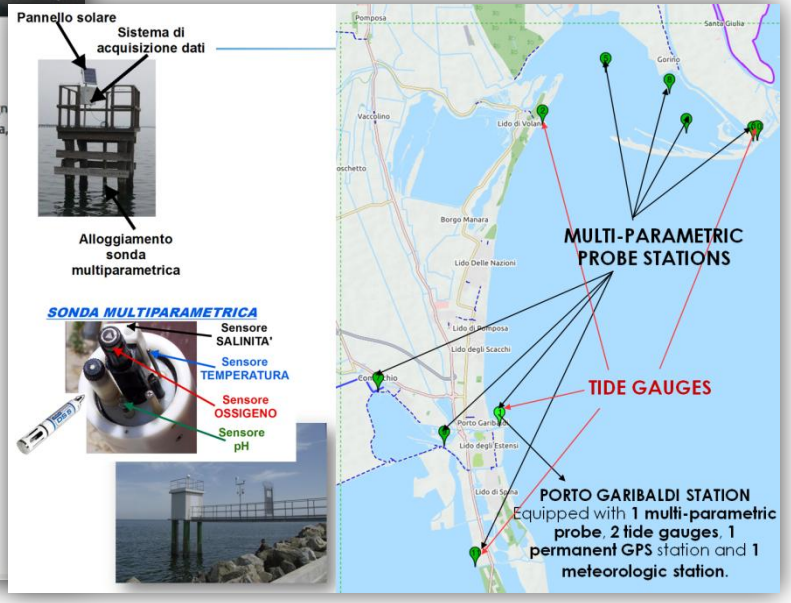
HTTPS://ALLERTAMETEO.REGIONE.EMILIA-ROMAGNA.IT/



ARPAE SIMC – MARINE-COASTAL MONITORING NETWORK

HTTPS://WWW.ARPAE.IT/IT/TEMI-AMBIENTALI/MARE/DATI-E-INDICATORI/RETE-DI-MONITORAGGIO-METEO-MARINA





NAUSICAA WAVE BUOY – SINCE MAY 2007

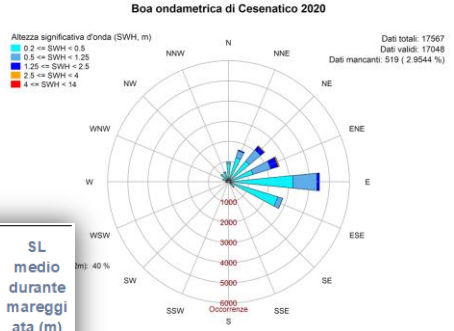
Datawell WAVERIDER MKIII
Transmission: HF and GSM, GPS
Power supply: Hybrid Power System (solar energy combined with primary cells)

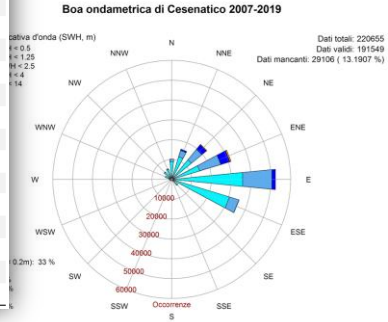
Plots available on the Arpae website:
https://www.arpae.it/it/temi-ambientali/mare/dati-e-indicatori/dati-boa-ondametrica

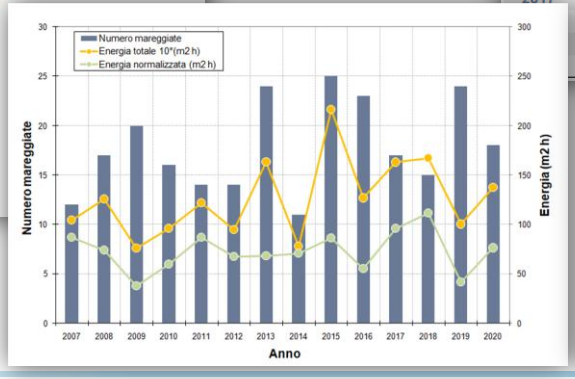
Data available on the Arpae web service
https://simc.arpae.it/dext3r/

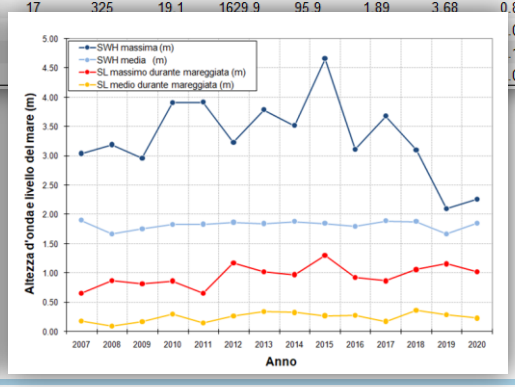
Data e ora (GMT)	Durata (h)	Energia totale (m^2 h)	Classe mareggiata	Direzione durante max SWH (°N)	SWH massima (m)	SWH media (m)	SL massimo (m)	SL medio (m)	SL durante SWH max (m)
1/19/2020 21:30	24	61.2	2	61	1.73	1.58	0.33	-0.02	0.22
2/5/2020 15:30	18	83.3	2	44	2.54	2.10	0.39	-0.02	-0.20
3/15/2020 5:30	5.5	12.9	1	70	1.55	1.47	0.03	-0.08	-0.07
3/22/2020 5:30	31.5	111.1	2	59	2.45	1.83	0.30	-0.03	-0.21
3/24/2020 1:30	76	360.4	3	44	2.84	2.15	0.40	0.04	-0.04
3/30/2020 13:00	20	62.1	2	48	2.24	1.72	0.39	0.09	0.26
3/31/2020 23:00	10	28.9	1	61	1.88	1.65	0.24	0.08	0.18
4/14/2020 14:00	15.5	57.7							
5/6/2020 10:00	2	7.0							
5/20/2020 16:00	3	9.1							
7/7/2020 3:00	8.5	53.4							
9/26/2020 5:30	3	10.3							
11/17/2020 0:00	11.5	32.7							
11/20/2020 5:30	46	270.6							
12/1/2020 22:30	15	64.3							
12/5/2020 10:30	33	85.6							
12/26/2020 14:30	14	53.3							
12/28/2020 8:30	4	10.0							

Anno	Numero mareggiate	Durata totale (h)	Durata media (h)	Energia totale (m^2 h)	Energia normalizzata (m^2 h)	SWH media (m)	SWH massima (m)	SL massimo durante mareggiata (m)	SL medio durante mareggiata (m)
2007	12	277	23.1	1042.9	86.9	1.90	3.04	0.66	0.18
2008	17	363.5	21.4	1255.8	73.9	1.67	3.19	0.87	0.09
2009	20	211.5	10.6	759.3	38.0	1.75	2.96	0.82	0.17
2010	16	250	15.6	959.9	60.0	1.83	3.91	0.87	0.30
2011	14	311	22.2	1219.8	87.1	1.83	3.92	0.66	0.15
2012	14	237	16.9	947.3	67.7	1.86	3.23	1.18	0.27
2013	24	381.5	15.9	1632.9	68.0	1.84	3.79	1.02	0.35
2014	11	181.5	16.5	780.7	71.0	1.88	3.52	0.98	0.33
2015	25	496	19.8	2162.7	86.5	1.85	4.66	1.31	0.27
2016	23	343	14.9	1268.0	55.1	1.80	3.11	0.93	0.28
2017	17	325	19.1	1629.9	95.9	1.89	3.68	0.87	0.18
								0.06	0.37
								0.16	0.29
								0.03	0.23









CLASSE MAREGGIATA	ENERGIA TOTALE (m2 h)
I-debole	E < = 58.4
II-moderata	58.4 < E < = 127.9
III-significativa	127.9 < E < = 389.7
IV-severa	389.7 < E < = 706.9
V-estrema	E > 706.9

arpae agenzia prevenzione ambiente energia emilia-romagna
ISPRA Istituto Superiore per la Protezione e la Ricerca Ambientale
Sistema Nazionale per la Protezione dell'Ambiente

Sea State CCI : User Consultation Meeting #2 – 25 March 2021

Valentini – Morucci – Unguendoli - Biolchi

EXTREME EVENTS

WAVES -> 2007-2019

ANNUAL MAXIMA & GENERALIZED EXTREME VALUES (GEV)

Generalized Extreme Values (GEV)

The Generalized Extreme Values model could be fitted for the annual maxima and it is specified by the following parameters: the scale parameters and the shape one similarly to the GPD approach. Depending on the shape parameters it could be obtained a Gumbel, a Frechet or a Weibull. The limit of this approach is that using annual maxima it reduces the amount of extreme measurements to be fitted. However also in this case it has been possible to evaluate return period and the related return level.

EXTREME EVENTS

WAVES -> 2007-2019

ANNUAL MAXIMA & GENERALIZED EXTREME VALUES (GEV)

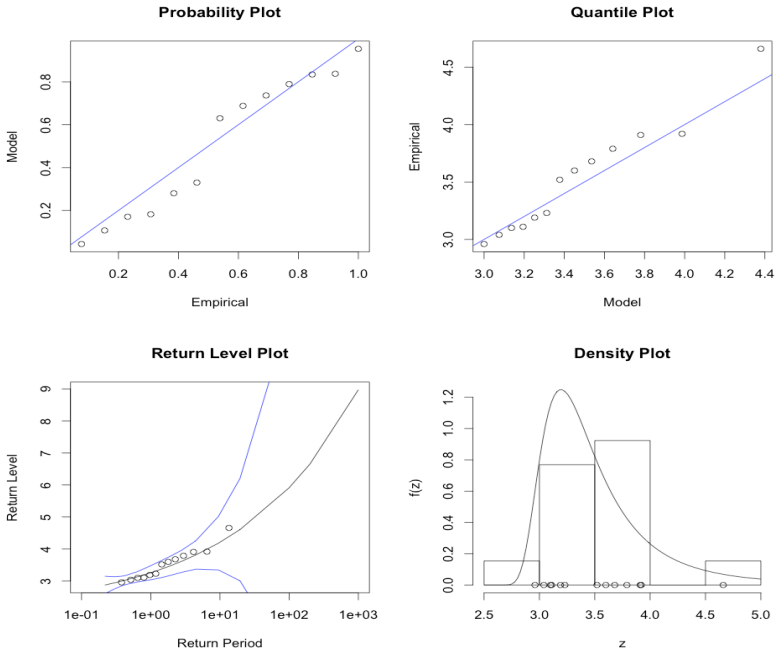
$$\mathrm{P}(Y < y) = \mathrm{GEV}(y; \xi, \mu, \sigma) = \exp(-[1 + \xi(y - \mu)/\sigma]_+^{-1/\xi}).$$

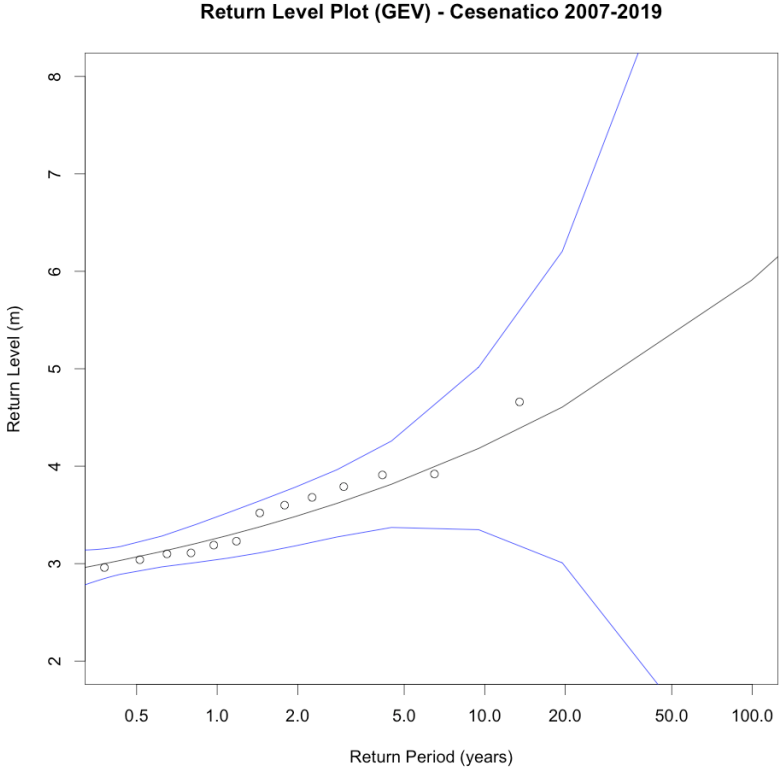
The key parameter is ξ, the shape parameter, and μ, σ are location and scale parameters respectively.
Depending on ξ the GEV could converge to a Gumbel, a Frechet or a Weibull distribution

EXTREME EVENTS

WAVES -> 2007-2019

ANNUAL MAXIMA & GENERALIZED EXTREME VALUES (GEV)





EXTREME EVENTS

WAVES -> 2007-2019

PEAK OVER THRESHOLD (POT) & GENERALIZED PARETO DISTRIBUTION (GPD)

The Generalized Pareto Distribution model could be fitted for the observed extreme data with considering the following assumptions:

- data are considered as **exceedances from a specific threshold** (1.5 m in ER)
- a sequence of **independent and identically distributed events** (12 hours)

In order to achieve these assumptions the Peak Over threshold approach has been applied. In this method the threshold needs:

- to be neither too high **to get enough observations**
- not too low **not to take into account non-extreme values**

Once declustered maxima, the Generalized Pareto Distribution can be fitted (Pugh, D., 2004) using a maximum likelihood estimation of the distribution parameters such as the scale parameter, the shape parameters (that gives information on qualitative behaviour of the distribution) and the location one. Finally it has been possible to evaluate the return period and the related return level.

EXTREME EVENTS

WAVES -> 2007-2019

PEAK OVER THRESHOLD (POT) & GENERALIZED PARETO DISTRIBUTION (GPD)

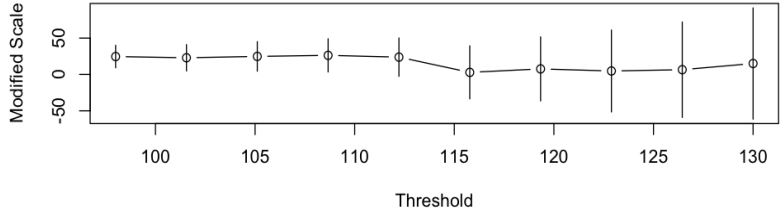
$$\Pr(Y > y + u | Y > u) \approx \mathrm{G}(y; u, \xi, \sigma) = [1 + \xi y/\sigma]_+^{-1/\xi}, \quad \text{for } y > 0. \qquad (1)$$

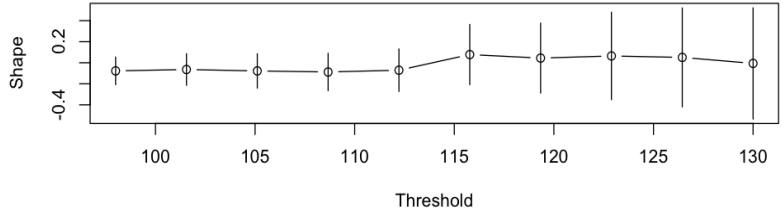
Here the distribution function $1 - \mathrm{G}$ is the GPD, and the scale parameter σ depends on the threshold u. The shape parameter ξ is the same parameter which appears in the GEV, and therefore controls the weight of the tail. The symbol $\approx$ indicates an approximation. As u increases, the approximation improves, and then, for $y > u$, large u, we get:

$$\Pr(Y \leq y) \approx 1 - \lambda_u [1 + \xi(y - u)/\sigma]_+^{-1/\xi} \qquad (2)$$

where:

$$\lambda_u = \Pr(Y > u).$$

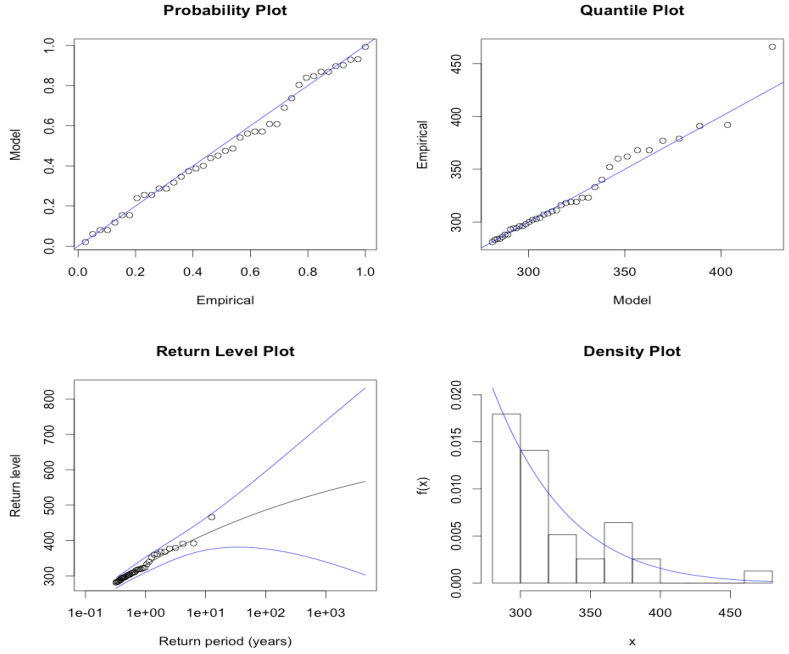


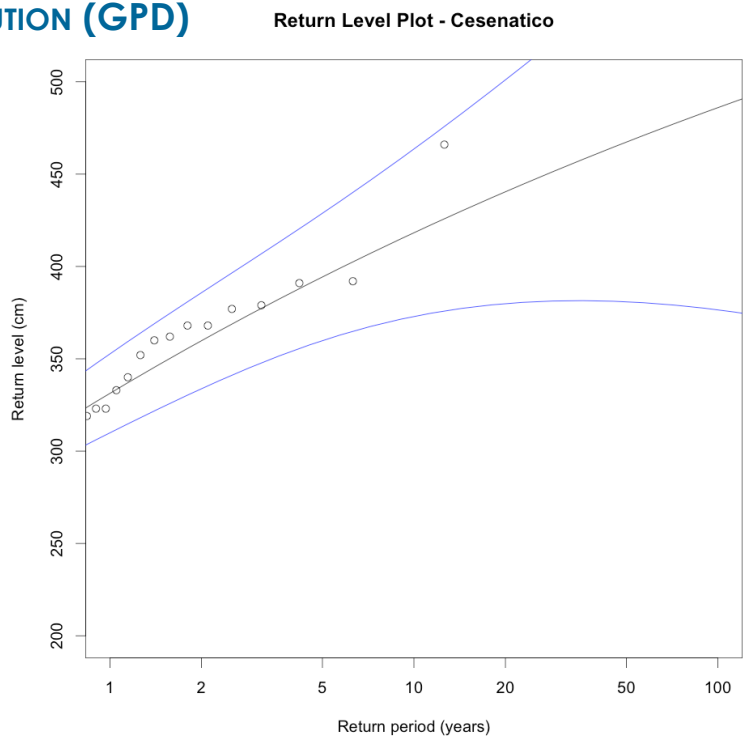


EXTREME EVENTS

WAVES -> 2007-2019

PEAK OVER THRESHOLD (POT) & GENERALIZED PARETO DISTRIBUTION (GPD)



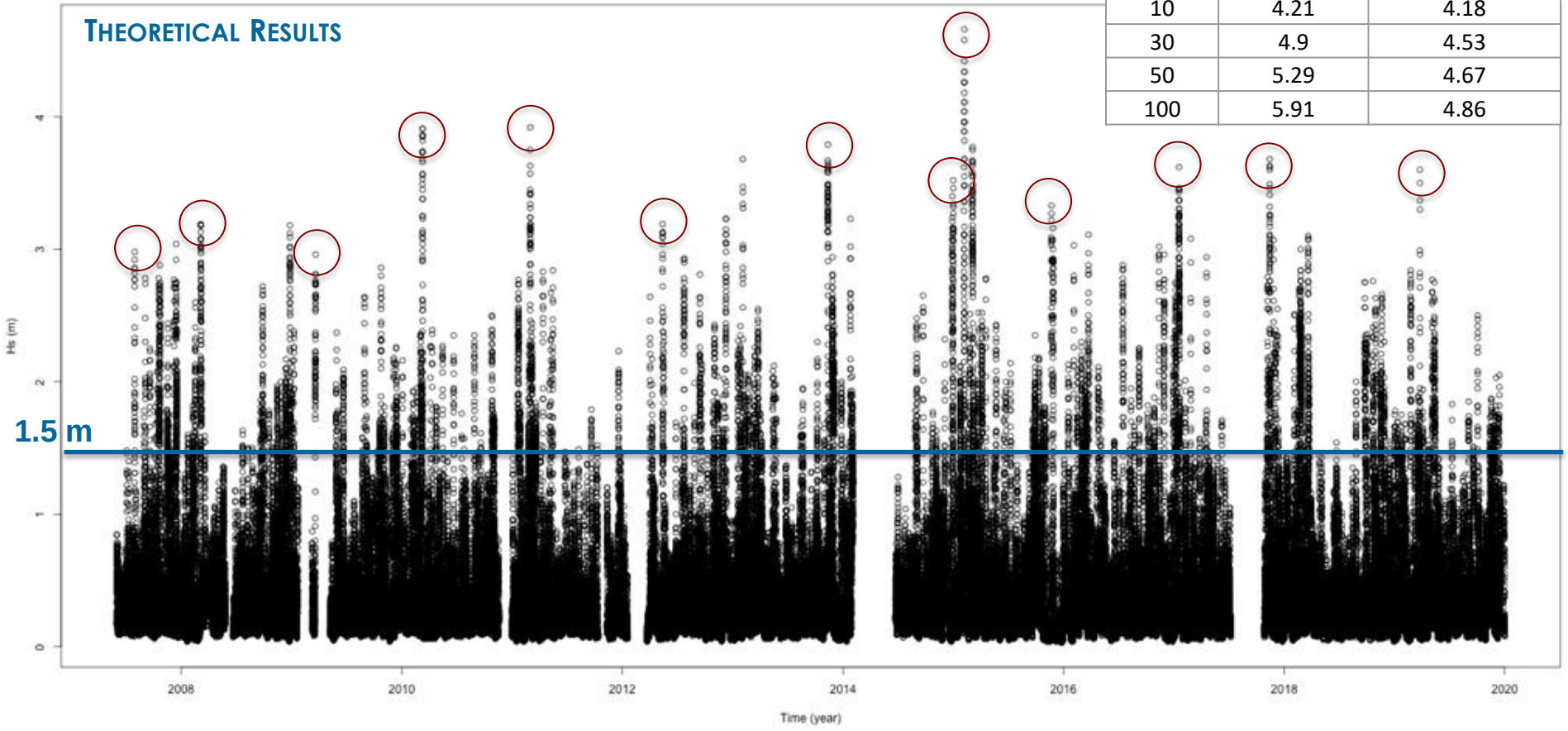


EXTREME EVENTS

WAVES -> 2007-2019

THEORETICAL RESULTS

YEAR	GEV Ret. Lev. (m)	POT-GPD Ret. Lev. (m)
1	3.26	3.31
5	3.86	3.94
10	4.21	4.18
30	4.9	4.53
50	5.29	4.67
100	5.91	4.86



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User Consultation Meeting #2
Online meeting

Thank you!