European Commission Support to UNESCO through JRC activities

A. Annunziato
Joint Research Centre
European Commission

DG-ECHO Informative Meeting in view of NEAMWAVE-2021

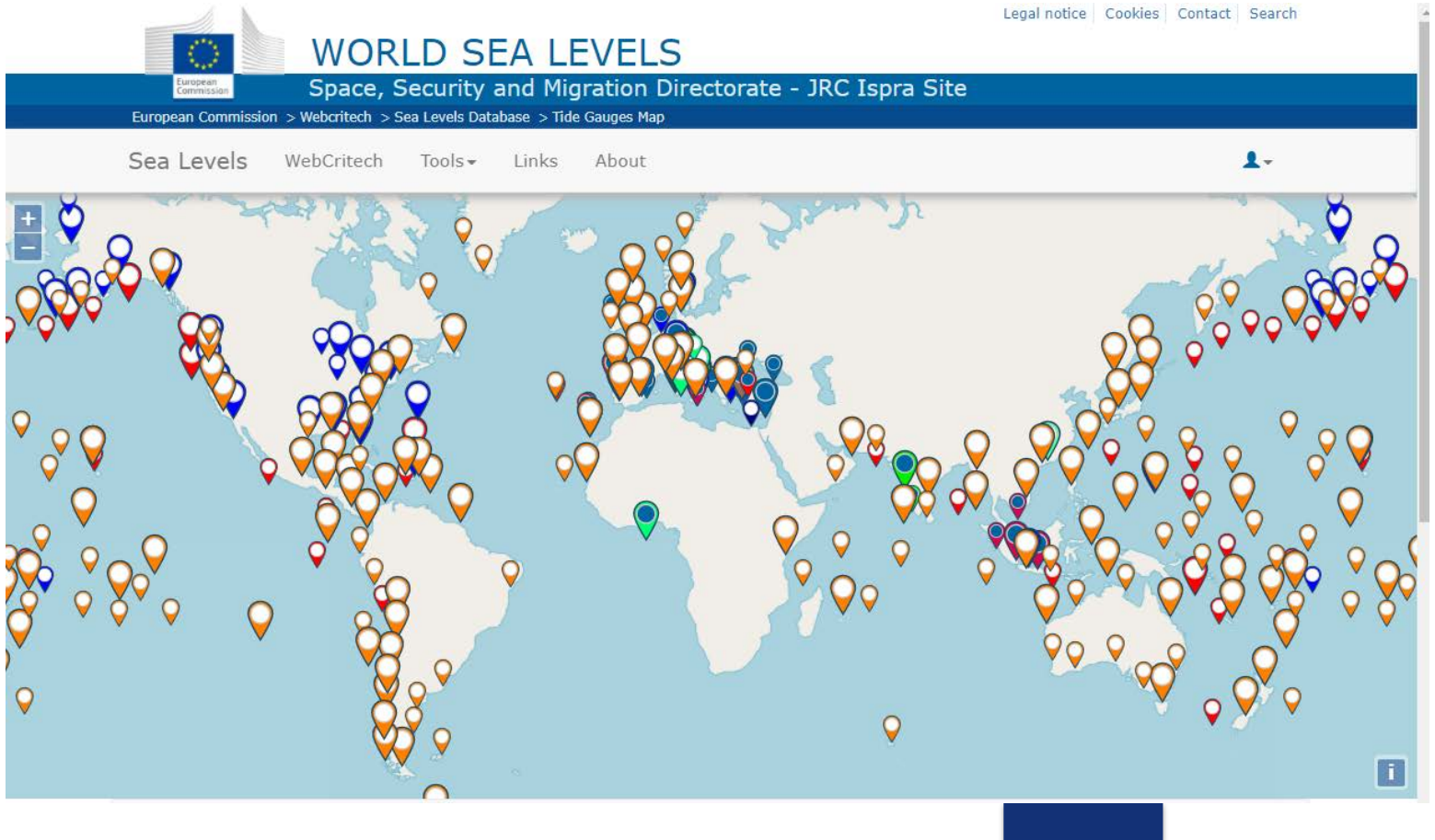
Table of content

Over the years, JRC contributed to UNESCO NEAMTWS activities

- Sea Level Database
- Tsunami Analysis Tool
- IDSL Network
- Tsunami Last Mile Projects
- GDACS Activities with emphasis on NEAMWAVE preparation

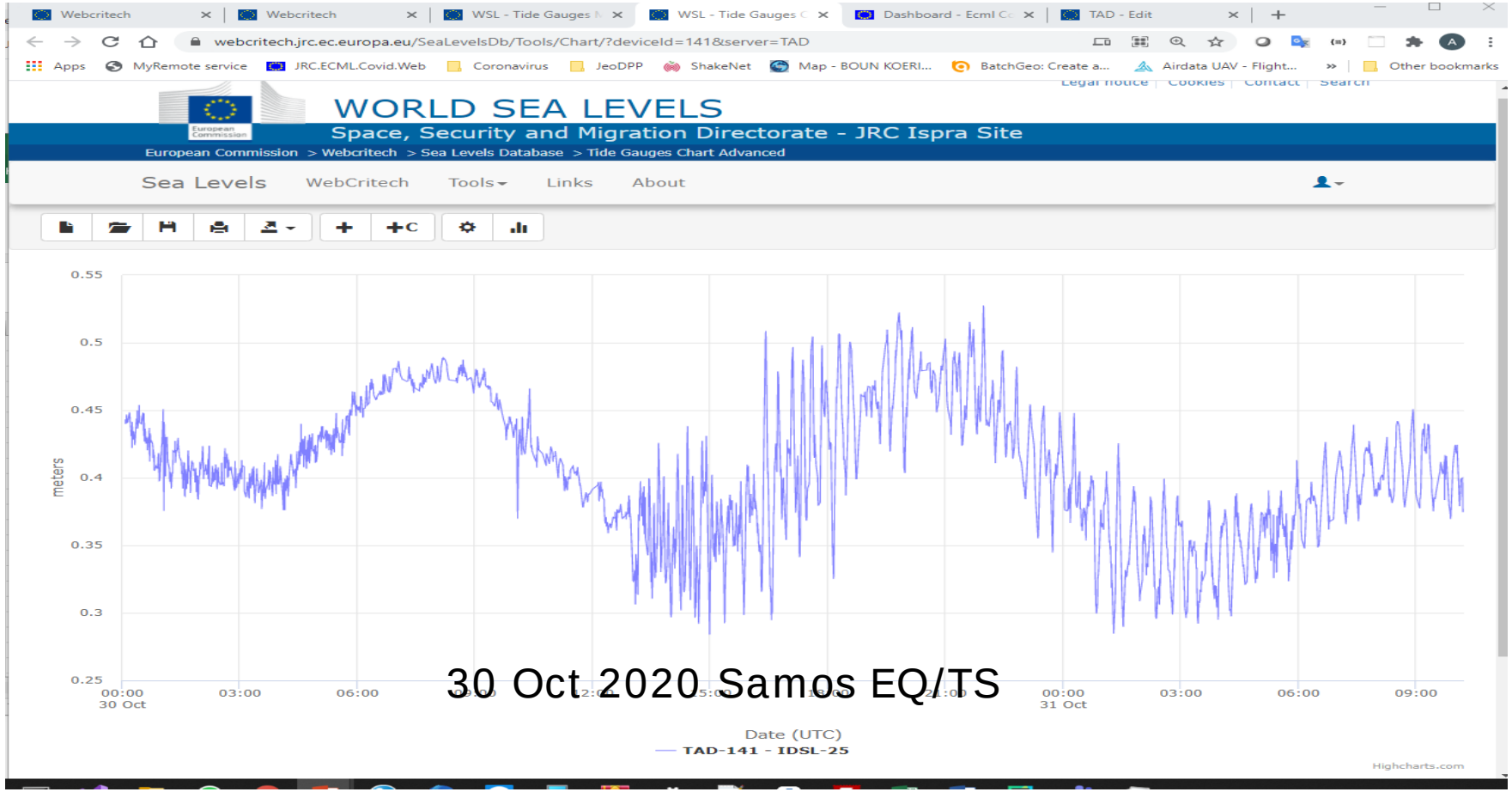
Sea Level Database

- Systematic collection of all sea levels available in real time for Tsunami and Tropical cyclone monitoring
- https://webcritech.jrc.ec.europa.eu/SeaLevelsDb/



- Several data providers
- Estimation of tides in real time
- Detiding (important for Storm surge and Tsunami)

- https://webcritech.jrc.ec.europa.eu/SeaLevelsDb/Tools/Chart/?deviceId=141&server=TAD



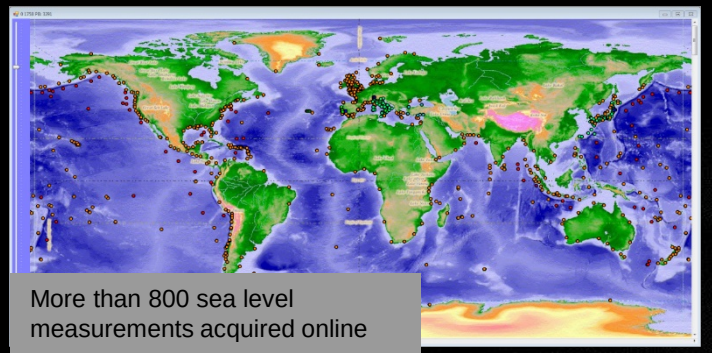
30 Oct 2020 Samos EQ/TS

Tsunami Analysis Tool

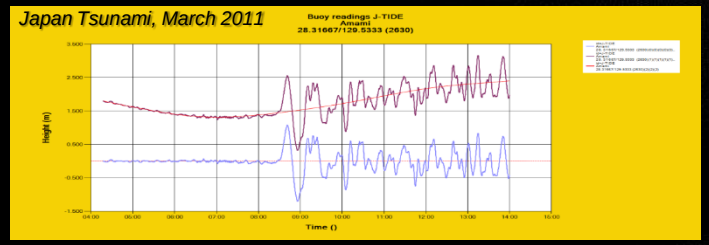
- Software tool to analyse Tsunami in real time and launch calculations
- It allows to generate the Tsunami Service Provider messages
- It is used by:
  - NOA (Operationally as Tsunami Service Provider)
  - KOERI (as backup system as Tsunami Service Provider)
  - IPMA, NIEP, IGN only for research

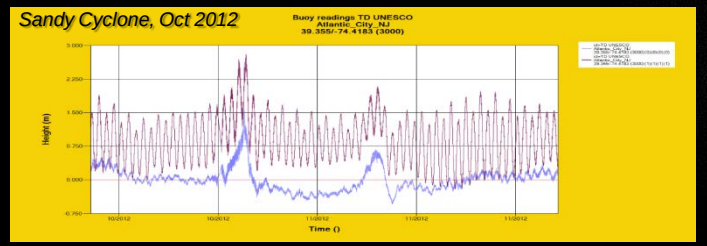
THE JRC DECISION SUPPORT SYSTEM FOR TSUNAMI AND CYCLONES ANALYSIS

Access to Worldwide Sea Level databases, signal processing

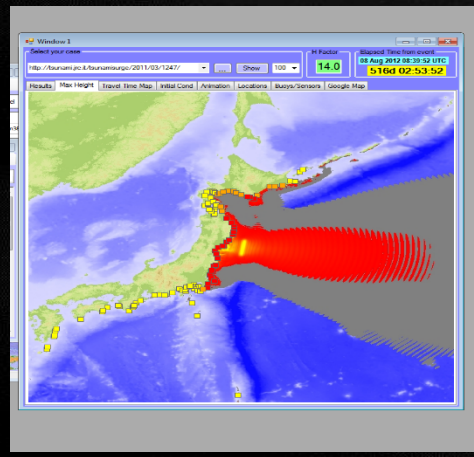


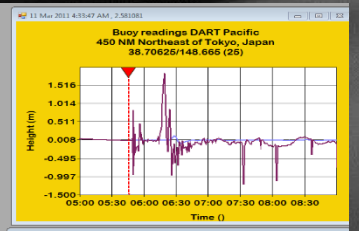
More than 800 sea level measurements acquired online

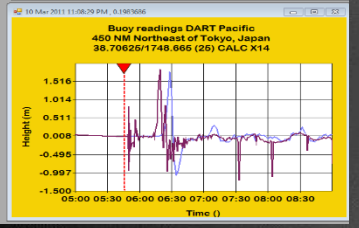




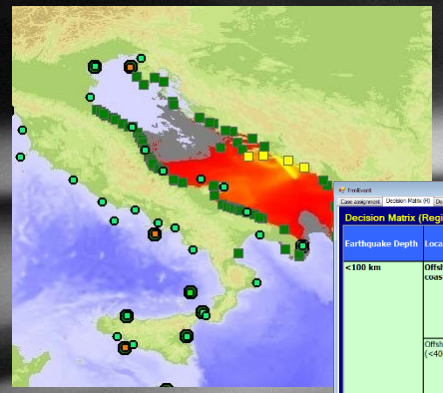
Easy Retrieval and analysis of online or scenario calculations

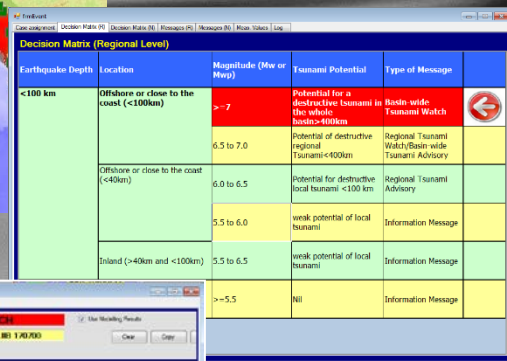


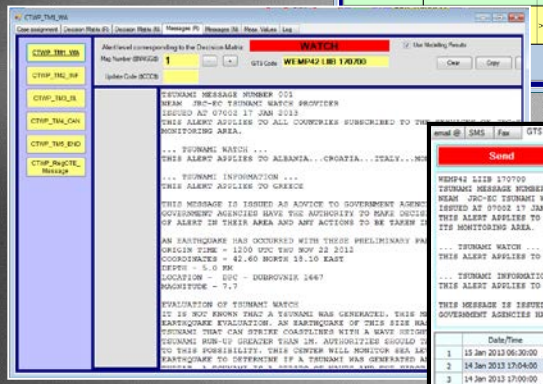


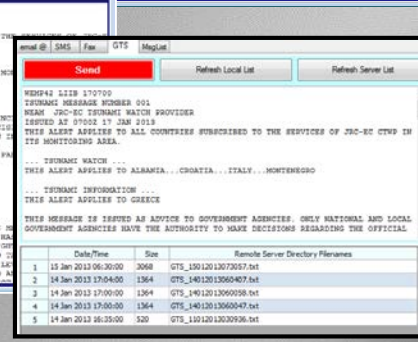


Alert Messages Preparation and Issuing



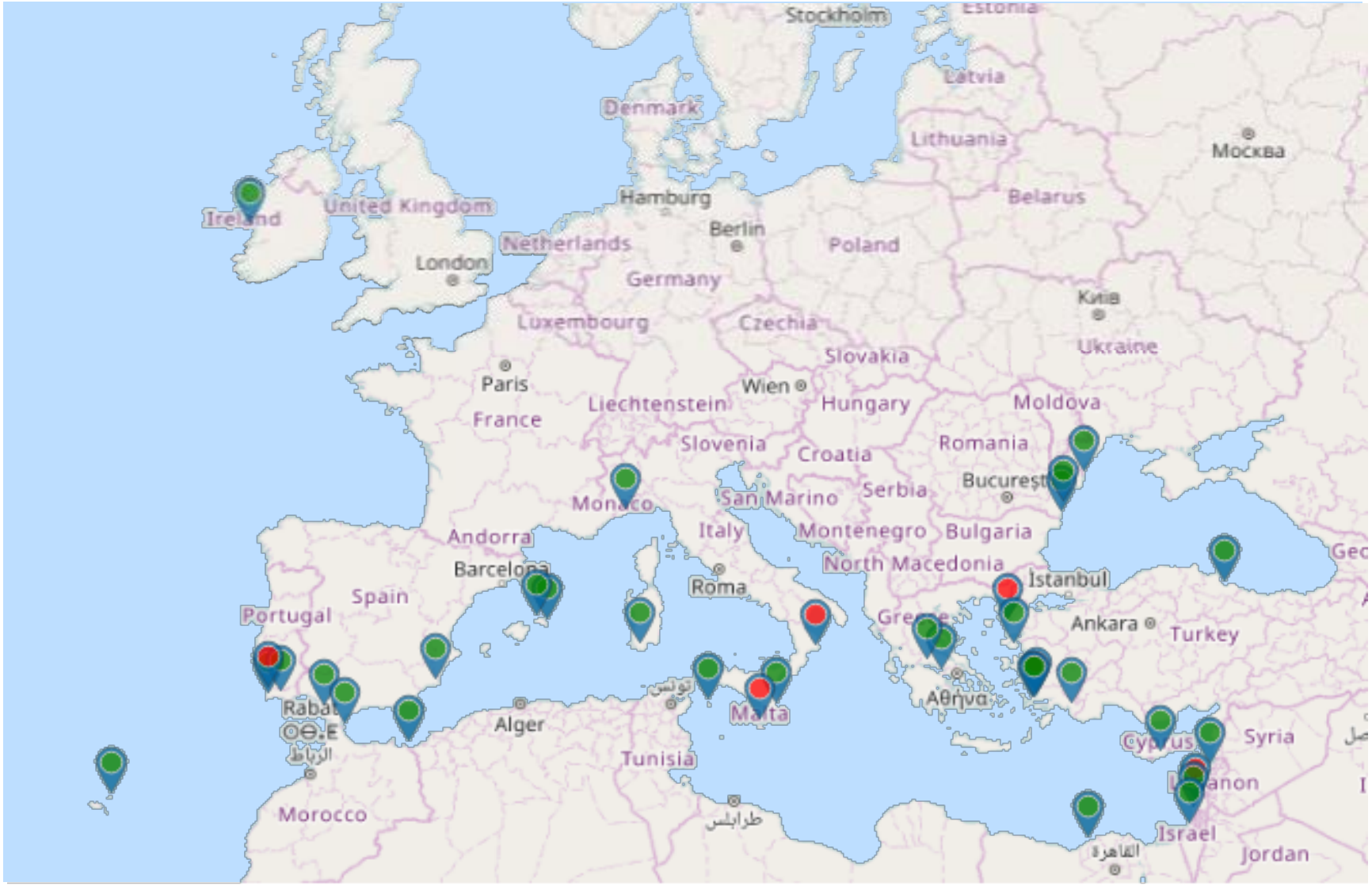






IDSL Status 27th Nov 2019

Problems at: Arrifana (PT), Malta (Sol. Panel), Bozcaada (Device)



Splash screen with all the new installations of 2019

Kos M, IDSL-33

Bodrum, IDSL-17

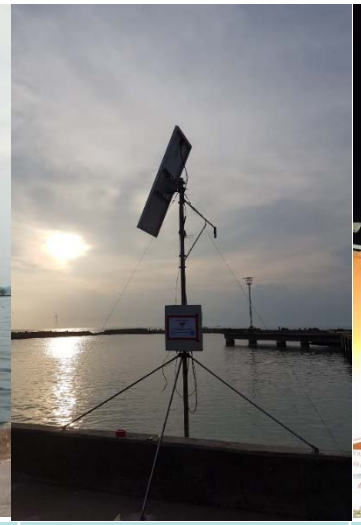
Malta, IDSL-34

Kilronan, IDSL-40

Plomari, IDSL-41

Indonesia >

Sebesi Island, IDSL-301



Marina Jambu, IDSL-301

Sadeng Port, IDSL-306

Pangandaran, IDSL-307

Status of the installations (35 devices)

http://webcritech.jrc.ec.europa.eu/TAD_server/Default.aspx?group=IDSL

Id	Name	Sensor	Location	Country	Provider	Last Value	Last Date	Elapsed Time
IDSL								
64	IDSL-01	RAD	Imperia	Italy (Liguria)	JRC-ISPRA	0.427	27 Nov 2019 05:14:07	4 Sec.
62	IDSL-02	RAD	Saïdia Marina	Morocco (Berkane)	JRC-CNRST	0.546	27 Nov 2019 05:13:50	21 Sec.
70	IDSL-03	RAD	Porto Santo	Portugal (Madeira)	JRC-IPMA	1.725	27 Nov 2019 05:14:10	1 Sec.
77	IDSL-04	RAD	Sagres	Portugal (Algarve)	JRC-IPMA	0.187	27 Nov 2019 05:14:05	6 Sec.
78	IDSL-05	RAD	Albufeira	Portugal (Algarve)	JRC-IPMA	-0.252	27 Nov 2019 05:14:10	1 Sec.
79	IDSL-06	RAD	Cadiz	Spain (Andalucia)	JRC-IGN	1.647	27 Nov 2019 05:14:10	1 Sec.
80	IDSL-07	RAD	Cartagena	Spain (Murcia)	JRC-IGN	0.943	27 Nov 2019 05:14:02	9 Sec.
81	IDSL-08	RAD	Arrifana	Portugal	JRC-IPMA	-4.457	26 Nov 2019 09:22:54	19 Hours
82	IDSL-09	RAD	Marina di Teulada	Italy (Sardegna)	JRC-INGV	0.458	27 Nov 2019 05:14:07	4 Sec.
83	IDSL-10	RAD	Pantelleria	Italy (Sicilia)	JRC-INGV	0.029	27 Nov 2019 05:14:06	5 Sec.
84	IDSL-11	RAD	Portopalo di Capo Passero	Italy (Sicilia)	JRC-INGV	0.365	27 Nov 2019 05:14:10	1 Sec.
85	IDSL-12	RAD	Le Castella	Italy (Calabria)	JRC-INGV	2.543	09 May 2019 21:44:43	201 Days
86	IDSL-13	RAD	Corinth	Greece (Corinthia)	JRC-NOA	0.595	27 Nov 2019 05:14:06	5 Sec.
87	IDSL-14	RAD	Bozcaada	Turkey (Canakkale)	JRC-KOERI	3.445	19 Aug 2019 09:11:38	99 Days
88	IDSL-15	RAD	Fethiye	Turkey (Mugla)	JRC-KOERI	1.574	27 Nov 2019 05:14:04	7 Sec.
89	IDSL-16	RAD	Samsun	Turkey (Eastern Black Sea)	JRC-KOERI	1.099	27 Nov 2019 05:14:09	2 Sec.
90	IDSL-17	RAD	Bodrum	Turkey (Mugla)	JRC-KOERI	0.626	27 Nov 2019 00:51:12	2 Sec.
91	IDSL-18	RAD	Mangalia	Romania	JRC-NIEP	-7.664	27 Nov 2019 05:14:07	4 Sec.
92	IDSL-19	RAD	Constanta	Romania	JRC-NIEP	-7.649	27 Nov 2019 05:14:07	4 Sec.
93	IDSL-20	RAD	Sulina	Romania	JRC-NIEP	-5.000	27 Nov 2019 05:14:06	5 Sec.
94	IDSL-21	RAD	Batroun	Lebanon	JRC-CNRS	4.347	27 Nov 2019 05:14:09	2 Sec.
127	IDSL-23	RAD	Alexandria	Egypt (Egypt)	JRC-NIOF	-3.865	27 Nov 2019 05:14:05	6 Sec.
108	IDSL-24	RAD	Panormos	Greece (Corinthia)	JRC-NOA	0.549	27 Nov 2019 05:14:07	4 Sec.
141	IDSL-25	RAD	Kos	Greece (Kos)	JRC-NOA	0.553	27 Nov 2019 05:14:07	4 Sec.
129	IDSL-26	RAD	Haifa	Israel (Israel)	JRC-IOLR	0.315	27 Nov 2019 02:14:04	2 Sec.
131	IDSL-27	RAD	Hadera	Israel (Israel)	JRC-IOLR	0.404	27 Nov 2019 05:14:07	4 Sec.
137	IDSL-28	RAD	Ashdod	Israel (Israel)	JRC-IOLR	0.681	27 Nov 2019 05:14:05	6 Sec.
124	IDSL-29	RAD	La Mola de Mahon, Minorca	Spain (Islas Baleares)	JRC-IGN	0.233	27 Nov 2019 05:14:08	3 Sec.
125	IDSL-30	RAD	Ciutadella, Menorca	Spain (Islas Baleares)	JRC-IGN	0.244	27 Nov 2019 05:14:07	4 Sec.
126	IDSL-31	RAD	Ceuta	Spain (Ciudad autónoma de Ceuta)	JRC-IGN	0.607	27 Nov 2019 05:14:04	7 Sec.
130	IDSL-32	RAD	Zygi Marina	Cyprus (Cyprus)	JRC-COC	0.904	27 Nov 2019 05:14:08	3 Sec.
532	IDSL-33	RAD	Kos (Marina)	Greece (Greece)	JRC-NOA	0.592	27 Nov 2019 05:14:06	5 Sec.
533	IDSL-34	RAD	Malta	Malta (Malta)	JRC	0.239	15 Nov 2019 12:05:22	2 Sec.
553	IDSL-40	RAD	Kilronan	Ireland (Aran Islands)	JRC	1.873	27 Nov 2019 05:14:06	5 Sec.
554	IDSL-41	RAD	Plomari	Greece (Lesvos Is.)	JRC	0.761	27 Nov 2019 05:14:06	5 Sec.

Sensor to replace

Stolen

Device to replace

Tsunami Last Mile Projects

- Phase 1 – 2017-2019
  - Kos and Bodrum
- Phase 2 – 2019-2021
  - Malta
  - Pandangaran, Indonesia
- Phase 3 – 2021>
  - *Under responsibility of UNESCO/IOC, contract under discussion*

Background

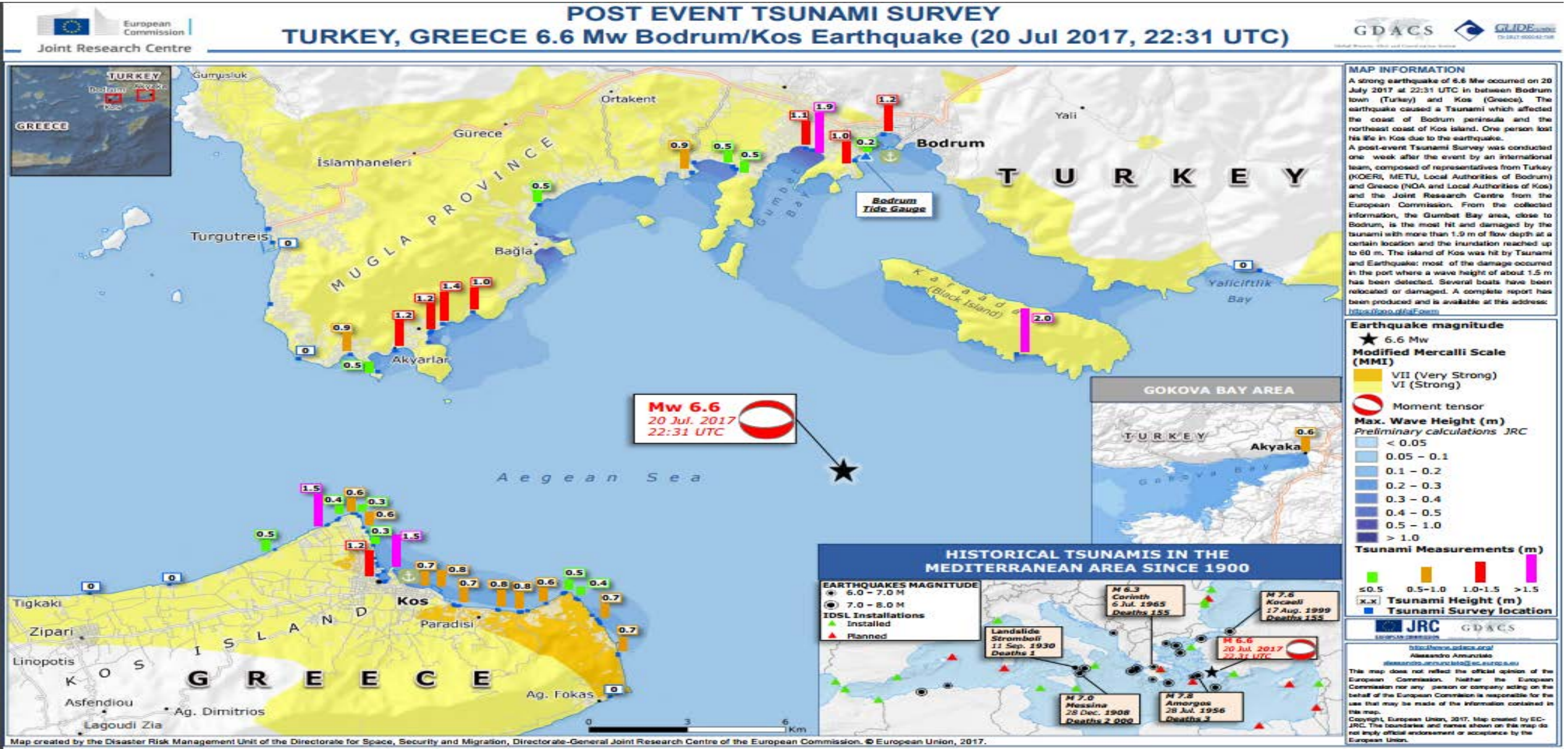
- Large progresses done in the International Community for the monitoring and management of Tsunamis.
- The large difficulty is near field events, in which little or no time is available to give alert to the population
- However, even for far field events, the downstream component of the alerting (**Last Mile**) is still an issue and still work is needed for a proper transfer of the alert to the affected population
- So the objectives of the Last Mile Project, funded by European Commission are:
  - Testing technologies that can help the near field events identification and alerting
  - Testing the dissemination of alerts to the population for near and far field events

European Commission

Joint Research Centre

POST EVENT TSUNAMI SURVEY
TURKEY, GREECE 6.6 Mw Bodrum/Kos Earthquake (20 Jul 2017, 22:31 UTC)

GDACS GLIDE



MAP INFORMATION

A strong earthquake of 6.6 Mw occurred on 20 July 2017 at 22:31 UTC in between Bodrum town (Turkey) and Kos (Greece). The earthquake caused a Tsunami which affected the coast of Bodrum peninsula and the northeast coast of Kos island. One person lost his life in Kos due to the earthquake.

A post-event Tsunami Survey was conducted one week after the event by an international team, composed of representatives from Turkey (KOERI, METU, Local Authorities of Bodrum) and Greece (NOA and Local Authorities of Kos) and the Joint Research Centre from the European Commission. From the collected information, the Gumbet Bay area, close to Bodrum, is the most hit and damaged by the tsunami with more than 1.9 m of flow depth at a certain location and the inundation reached up to 60 m. The island of Kos was hit by Tsunami and Earthquake: most of the damage occurred in the port where a wave height of about 1.5 m has been detected. Several boats have been relocated or damaged. A complete report has been produced and is available at this address:

https://goo.gl/qFoem

Earthquake magnitude

★ 6.6 Mw

Modified Mercalli Scale (MMI)

VII (Very Strong)
VI (Strong)

Moment tensor

Max. Wave Height (m)

Preliminary calculations JRC

< 0.05
0.05 – 0.1
0.1 – 0.2
0.2 – 0.3
0.3 – 0.4
0.4 – 0.5
0.5 – 1.0
> 1.0

Tsunami Measurements (m)

≤0.5 0.5–1.0 1.0–1.5 >1.5

x.x Tsunami Height (m)

Tsunami Survey location

JRC GDACS

http://www.gdacs.org/
Alessandro Amunzio
alessandro.amunzio@ec.europa.eu

How the project was initiated

The two Tsunami in Aegean Sea (Mw 6.3 and Mw 6.6) have demonstrated the limits of the current TEWS for near field Tsunami events

- The wave arrived in Kos at 11 min (measured), about similar time in Bodrum (estimated)
- The alert was issued by the TSPs between 10 and 19 min after the event
- No alert was propagated from the CP to downstream municipalities
- No people has been alerted or informed about the potential Tsunami wave arriving
- The behaviour of the people, during the Tsunami itself, was erratic, intuitive or simply totally unaware of the possible risks

*"Without any alert to the population, the behaviour of people was **erratic, intuitive, if not wrong.***

*We have to think beyond the technical side, also in psycho-sociological terms as well, to the issues to be faced at institutional level when alerting the population on the basis of uncertain information sources, thus identifying those requirements for which future solutions and services could be developed, thus helping to **seriously tackle the last mile of the alert system**"*

From the conclusions of the Aegean Sea Workshop 12-13 Dec 2017

The Last Mile Project

- DG-ECHO, after the Aegean Sea workshop in Ispra (12-13 Dec 2017), decided to fund JRC for the creation of a Tsunami Last Mile Project

- Objectives of the project:
  - Creation of 2 pilot cities where an harmonized set of technological tools are installed to provide Early Warning to the population
  - Execution of a drill that shows the benefits of those new tools
  - Final workshop to show the results of the project

- Timeline: 2 years, 1.1.2018-31.12.2019

Tasks to be performed

- Analyses to be performed:
  - Tsunami sea level
  - Earthquake shaking
- Tsunami Warning System installation (in every pilot location)
  - 2 IDSL
  - 2 seismic accelerometers
  - 2 Tsunami Alerting Panels
  - 1 Long range siren
  - Installation of Tsunami signage
- Execution of a Tsunami drill

Multiple devices for local alerting

Evacuat
e !

Siren

Alerting
Panel

Alert

EQ sensor

Fast Sea Level Measurement

Results

- Bodrum, Turkey
  - Table top exercise (5th Nov 2019)
  - 1 IDSL installed
  - 2 seismic sensors installed
  - No TAD panel
  - No Siren
- Kos, Greece
  - Extended exercise (14th Nov 2019)
  - 2 IDSL installed
  - 2 seismic sensors installed
  - 2 TAD panels installed (see later)
  - 1 Long range siren
  - Katwarn system for alerting

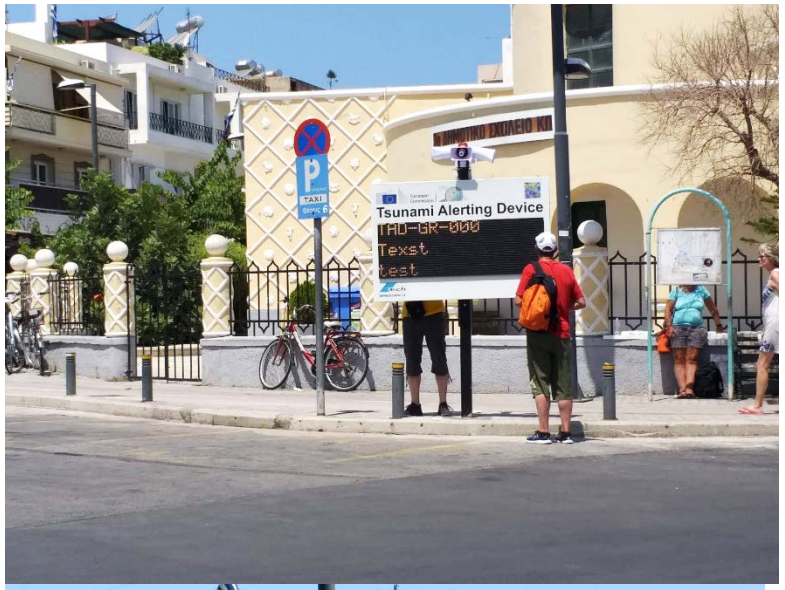
Bodrum Table top exercise

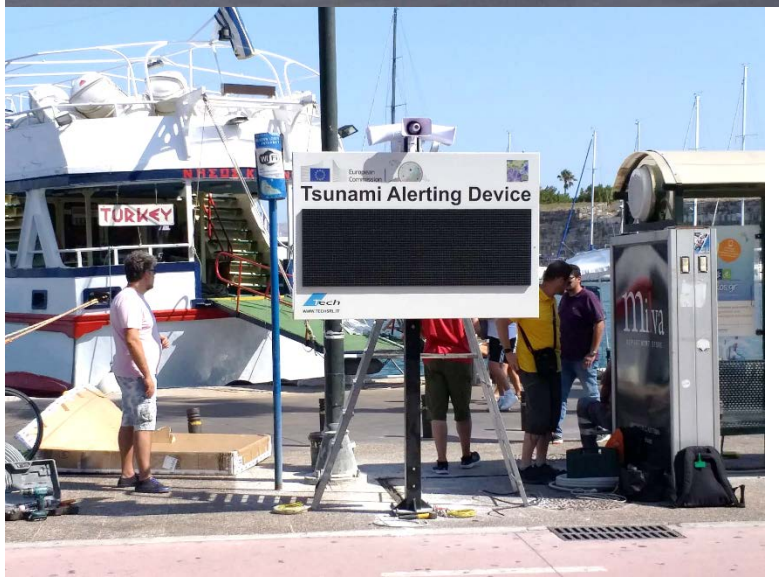
- Table top exercise, Nov 2019
- Inclusion of all the major actors in the Bodrum municipality
- Detailed discussion on the various actions to be performed in the case of a Tsunami alert
- Important lessons learnt
- Installations (2 seismic devices, 1 IDSL)

Installations and Drill in Kos

Last Mile Project devices

- 2 IDSL
- 2 Tsunami Alerting Panels
- 2 Seismic sensors
- 1 Long Range siren



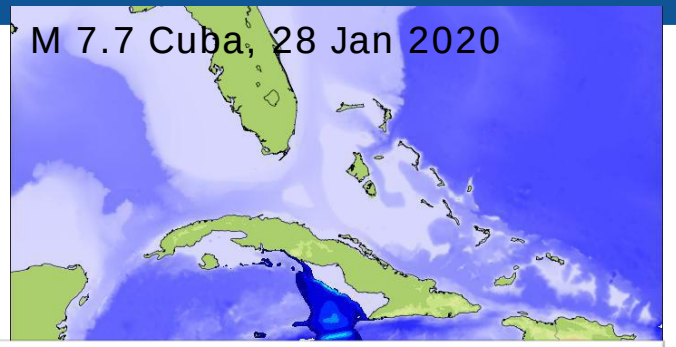


GDACS and Tsunami

- GDACS is following Tsunami events, providing
  - Expected arrival time and sea level height on the coast
  - Official Tsunami Service Provider messages
  - Alert based on simple relations:
    - Expected height >1 m Orange Alert
    - Expected height >3 m Red Alert
- Examples:
  - 30 Oct 2020 Samos Earthquake and Tsunami, **Orange Alert**
    - https://www.gdacs.org/report.aspx?eventtype=EQ&eventid=1241508

Tsunami: estimations progression

- Progression of estimation of sea level height over time, as new information are pr



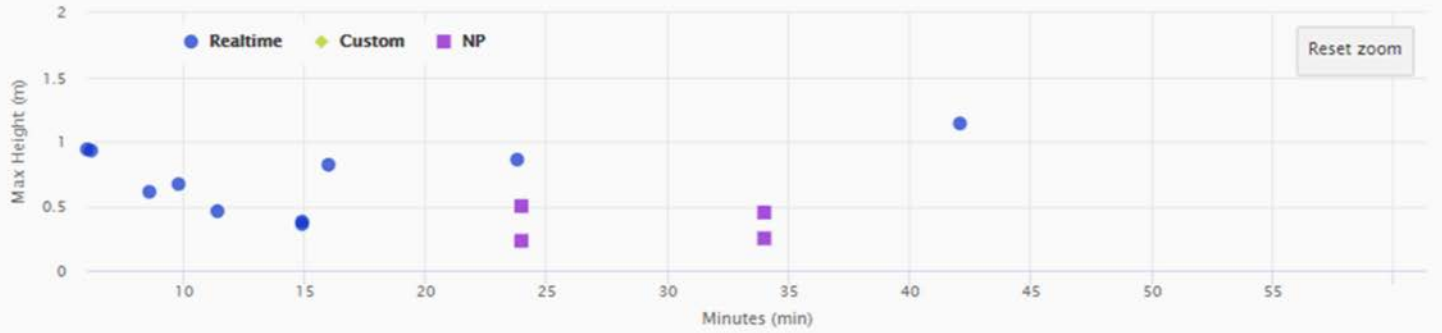
Episode Timeline

ID	Alert	Score	Date
1293009		0.9	28 Jan 2020 19:1
1293011		0.9	28 Jan 2020 19:1
1293023		0.8	28 Jan 2020 19:1
1293801		1.2	28 Jan 2020 19:1

The maximum Tsunami wave height is 1.6

Alert	Date (UTC)
	28-Jan-2020 19:32:14
	28-Jan-2020 20:12:66
	28-Jan-2020 19:22:67
	28-Jan-2020 20:00:97
	28-Jan-2020 19:44:45
	28-Jan-2020 19:44:45
	28-Jan-2020 19:54:68

Timeline tsunami calculations triggered for the event



Type	Delay	Mag	Depth (km)	Lat	Lon	Conditions	MaxHeight (m)
realtime	6 min	7.3	10	19.315	-78.814		0.94
realtime	6 min	7.6	10	19.42	-78.74		0.93
realtime	9 min	7.2	10	19.44	-78.94		0.61
realtime	10 min	7.2	5	19.34	-78.7		0.67
realtime	11 min	7.1	10	19.42	-78.91		0.46
realtime	15 min	7.2	2	19.43	-78.71		0.38
realtime	15 min	7	10	19.37	-79.09		0.36
realtime	16 min	7.4	10	19.37	-78.81		0.82

Click on image to zoom it.

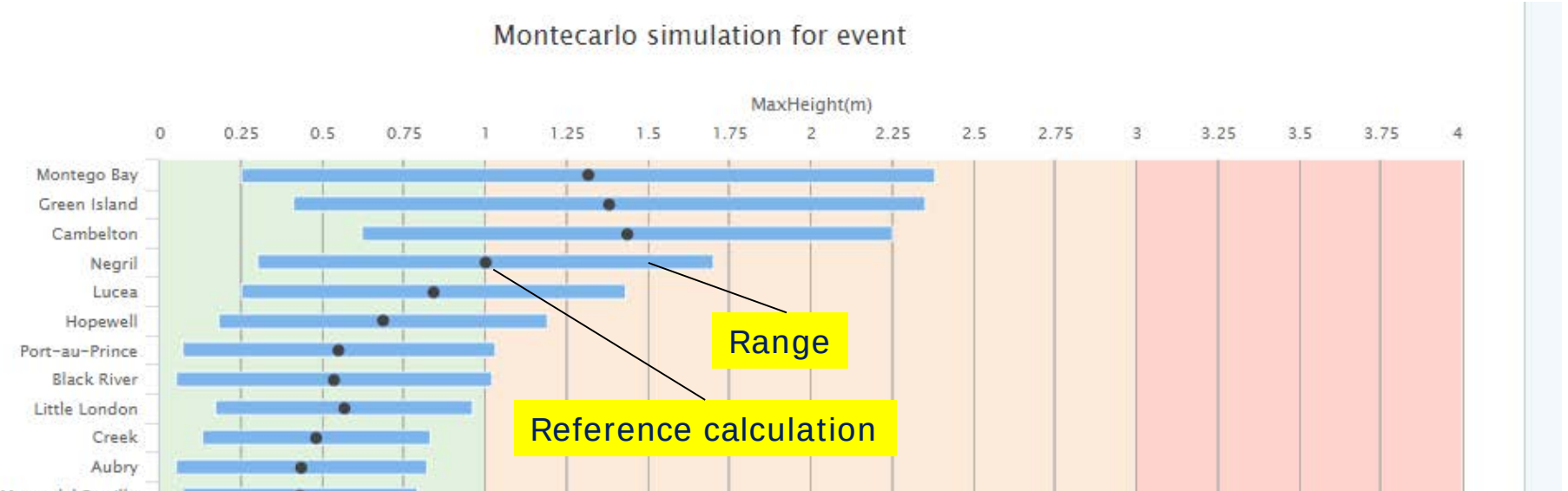
Tsunami: uncertainties quantification

- After 1h from the event calculation of **100** scenarios starting from the reference one by varying arbitrarily the EQ conditions: **location, magnitude, depth and source parameters**

https://www.gdacs.org/Tsunamis/montecarlo.aspx?eventtype=EQ&eventid=1203961&episodeid=1293801&version=1

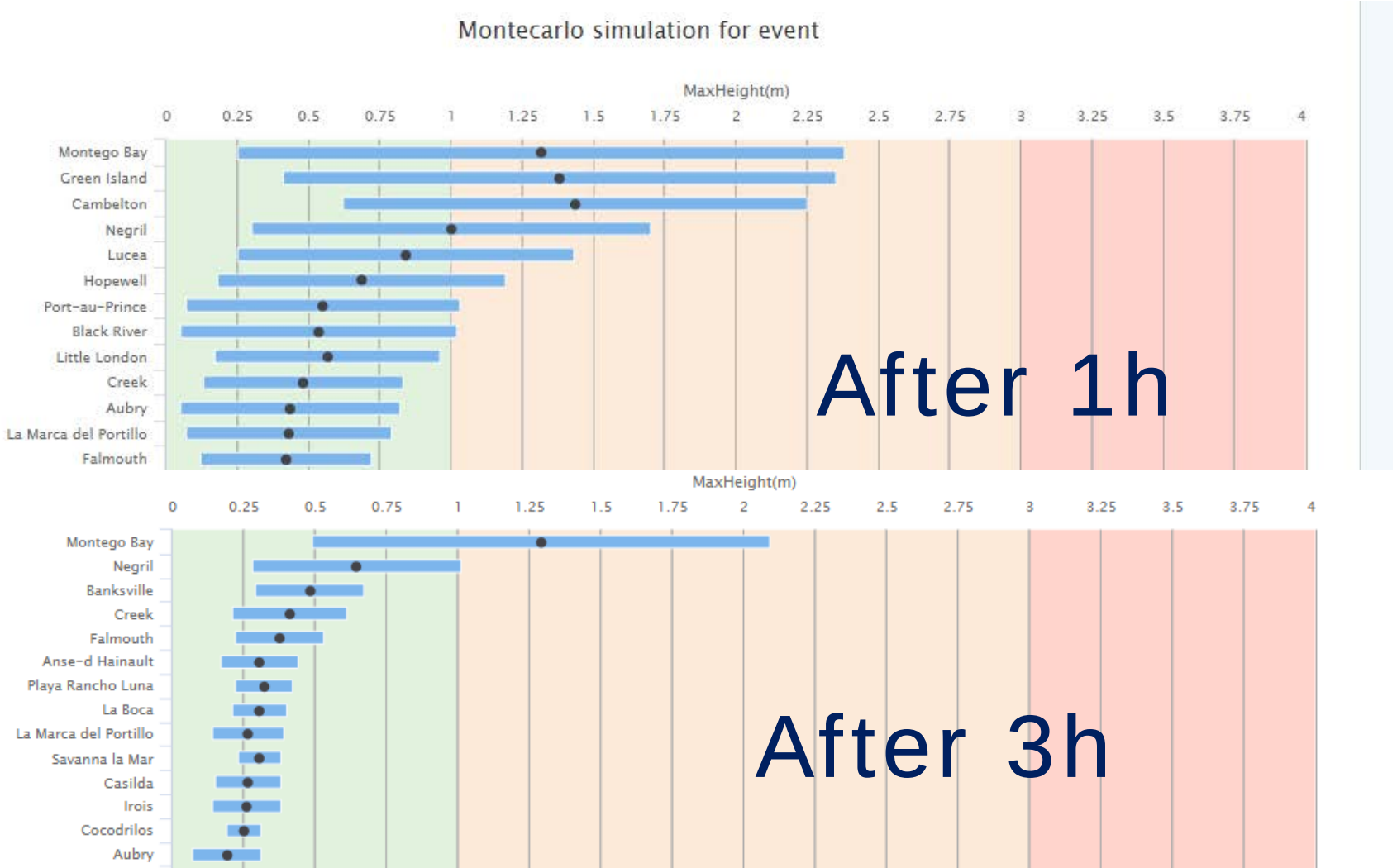
The montecarlo simulation's graph of has been created based on event
M7.7 in Cuba, on 28 Jan 2020 19:10 UTC, and it is available after 1 hour of the event

Parameter	Value	Delta		Parameter	Value	Delta
Magnitude	7.700000	0.250		Strike	259.000000	10.000
Depth	14.800000	10.000		Rake	90.000000	10.000
Latitude	19.421000	0.025		Dip	15.000000	10.000
Longitude	-78.762703	0.025				



Uncertainty analysis

- Calculations repeated after 1, 2 and 3 h with reduced parameters range



GTS Messages visualization

- Extraction of main information from a very long GTS message. The original message is there for reference

Original Message :

```
WECA41 PHEB 282008
TSUCAX

TSUNAMI MESSAGE NUMBER 4
NWS PACIFIC TSUNAMI WARNING CENTER EWA BEACH HI
2004 UTC TUE JAN 28 2020

...TSUNAMI THREAT MESSAGE...


**** NOTICE **** NOTICE **** NOTICE **** NOTICE **** NOTICE *****

 THIS MESSAGE IS ISSUED FOR INFORMATION ONLY IN SUPPORT OF THE
 UNESCO/IOC TSUNAMI AND OTHER COASTAL HAZARDS WARNING SYSTEM FOR
 THE CARIBBEAN AND ADJACENT REGIONS AND IS MEANT FOR NATIONAL
 AUTHORITIES IN EACH COUNTRY OF THAT SYSTEM.

 NATIONAL AUTHORITIES WILL DETERMINE THE APPROPRIATE LEVEL OF
 ALERT FOR EACH COUNTRY AND MAY ISSUE ADDITIONAL OR MORE REFINED
 INFORMATION.

**** NOTICE **** NOTICE **** NOTICE **** NOTICE **** NOTICE *****

NOTE: THERE IS A SIGNAL ON THE GAUGE IN THE CAYMAN ISLANDS BUT
      IT IS SMALL AND POSSIBLY NOT A TSUNAMI BUT ONLY
      BACKGROUND NOISE.  WE WILL CONTINUE TO MONITOR UNTIL
      ADDITIONAL INFORMATION IS RECEIVED TO CONFIRM OR END
      THE TSUNAMI THREAT.


PRELIMINARY EARTHQUAKE PARAMETERS
---------------------------------

  * MAGNITUDE      7.7
  * ORIGIN TIME    1910 UTC JAN 28 2020
  * COORDINATES    19.3 NORTH  78.8 WEST
  * DEPTH          10 KM / 6 MILES
  * LOCATION       CUBA REGION


EVALUATION
----------

  * AN EARTHQUAKE WITH A PRELIMINARY MAGNITUDE OF 7.7 OCCURRED IN
    THE CUBA REGION AT 1910 UTC ON TUESDAY JANUARY 28 2020.

  * TSUNAMI WAVES HAVE BEEN OBSERVED.

  * BASED ON ALL AVAILABLE DATA... HAZARDOUS TSUNAMI WAVES ARE
    FORECAST FOR SOME COASTS.


RECOMMENDED ACTIONS
-------------------

  * GOVERNMENT AGENCIES RESPONSIBLE FOR THREATENED COASTAL AREAS
    SHOULD TAKE ACTION TO INFORM AND INSTRUCT ANY COASTAL
    POPULATIONS AT RISK IN ACCORDANCE WITH THEIR OWN
    EVALUATION... PROCEDURES AND THE LEVEL OF THREAT.

  * PERSONS LOCATED IN THREATENED COASTAL AREAS SHOULD STAY ALERT
    FOR INFORMATION AND FOLLOW INSTRUCTIONS FROM NATIONAL AND
    LOCAL AUTHORITIES.


ESTIMATED TIMES OF ARRIVAL
--------------------------

  * ESTIMATED TIMES OF ARRIVAL -ETA- OF THE INITIAL TSUNAMI WAVE
    FOR PLACES WITHIN THREATENED REGIONS ARE GIVEN BELOW. ACTUAL
    ARRIVAL TIMES MAY DIFFER AND THE INITIAL WAVE MAY NOT BE THE
    LARGEST. A TSUNAMI IS A SERIES OF WAVES AND THE TIME BETWEEN
    WAVES CAN BE FIVE MINUTES TO ONE HOUR.

    LOCATION         REGION             COORDINATES    ETA(UTC)
    ------------------------------------------------------------
    CAYMAN BRAC      CAYMAN ISLANDS     19.7N  79.9W   1921 01/28
    SANTIAGO D CUBA  CUBA               19.9N  75.8W   1933 01/28
    GRAND CAYMAN     CAYMAN ISLANDS     19.3N  81.3W   1937 01/28
    MONTEGO BAY      JAMAICA            18.5N  77.9W   1945 01/28
    CIENFUEGOS       CUBA               22.0N  80.5W   1946 01/28
    KINGSTON         JAMAICA            17.9N  76.9W   2024 01/28
    COZUMEL          MEXICO             20.5N  87.0W   2034 01/28
    PUERTO CORTES    HONDURAS           15.9N  88.0W   2038 01/28
    TRUJILLO         HONDURAS           15.9N  86.0W   2125 01/28
    BELIZE CITY      BELIZE             17.5N  88.2W   2148 01/28
    SANTA CRZ D SUR  CUBA               20.7N  78.0W   2216 01/28
    NUEVA GERONA     CUBA               21.9N  82.8W   2345 01/28


POTENTIAL IMPACTS
-----------------

  * A TSUNAMI IS A SERIES OF WAVES. THE TIME BETWEEN WAVE CRESTS
    CAN VARY FROM 5 MINUTES TO AN HOUR. THE HAZARD MAY PERSIST
    FOR MANY HOURS OR LONGER AFTER THE INITIAL WAVE.
  * IMPACTS CAN VARY SIGNIFICANTLY FROM ONE SECTION OF COAST TO
```

2020-01-28 20:09

Key informations extracted from original GTS message :

Evaluation

- An earthquake with a preliminary magnitude of 7.7 occurred in the CUBA region at 1910 UTC on tuesday JANUARY 28.2020
- TSUNAMI waves have been observed
- Based on all available data hazardous TSUNAMI waves are forecast for some coasts

Threat Forecast

- TSUNAMI waves reaching 0.3 to 1 meters above the tide level are possible for some coasts of BELIZE CUBA HONDURAS MEXICO CAYMAN ISLANDS and JAMAICA
- Actual amplitudes at the coast MAY vary from forecast amplitudes due to uncertainties in the forecast and local features in particular maximum TSUNAMI amplitudes on atolls or small ISLANDS and at locations with fringing or barrier reefs will likely be much smaller than the forecast indicates
- For all other areas covered by this message there is no TSUNAMI threat although small sea level changes MAY occur

Tsunami Observations

- The following are tsunami wave observations from coastal and/or deep-ocean sea level gauges at the indicated locations the maximum tsunami height is measured with respect to the normal tide level

GAUGE LOCATION	LAT	LON	TIME (UTC)	HEIGHT (MT)	WAVE (MIN)
George Town Cy	19.3	-81.4	19: 43	0.11	02

...Other 3 pages

NEAMTWS21 events in GDACS

- Cyprus event (NOA/KOERI):
  - https://www.gdacs.org/report.aspx?eventtype=EQ&eventid=1256376
- Sicily channel event (INGV):
  - https://www.gdacs.org/report.aspx?eventid=1256377&eventtype=EQ
- Gulf of Cadiz event (IPMA)
  - https://www.gdacs.org/report.aspx?eventid=1256378&eventtype=EQ