

# Updated method of automatic assessment based on macroseismic data collected online at the Portuguese Seismological Service

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**IPMA**

Instituto  
Português  
do Mar e da  
Atmosfera

## IPMA's web questionnaire 2006-2019

### IPMA Web questionnaire purposes:

- The primary purpose of the macroseismic questionnaire and its automatic evaluation implementation is to provide macroseismic information to the civil protection authorities, immediately after felt earthquakes with impact on the population.
- Secondly, it is a efficient method to collect macroseismic information that will be deployed on catalogues, after revision.

For nearly 13 years, between 2006 and 2019, the Portuguese seismic service used a first web questionnaire to collected macroseismic information based on voluntary collaboration of Internet users that report their experiences after felt earthquakes.

During this period, thousands of responses (~17800) were received and analyzed, after the occurrence of almost five hundreds earthquakes that were felt in Azores archipelago, Madeira archipelago and Portugal mainland.



## IPMA's web questionnaire 2006-2019

- The results of the questionnaire were fully integrated with the seismic processing routine of Portuguese seismological service, providing quantitative and qualitative information about seismic intensities.
- For that, an algorithm and a computer application written in C programming language was developed to analyze the reported effects and convert them into degrees of seismic intensity.
- Nevertheless some items of the entire process, needed to be corrected, expanded, and/or clarified.
- Although the good performance, the stability and the coherence with other methods (manual collection and ShakeMap), the process had some limitations, and some aspects had to be improved specially what concerns with hardware support, damages on buildings and indicators for intensities exceeding V.

At the end of 2019, after a revision of the questionnaire and the algorithm, a major upgrade of the method was implemented.



## The new IPMA's web questionnaire

The new version of the questionnaire was created using LimeSurvey (GmbH, Hamburg, Germany, <http://www.limesurvey.org>), a free and open source survey tool.

The software LimeSurvey XAMPP package includes:

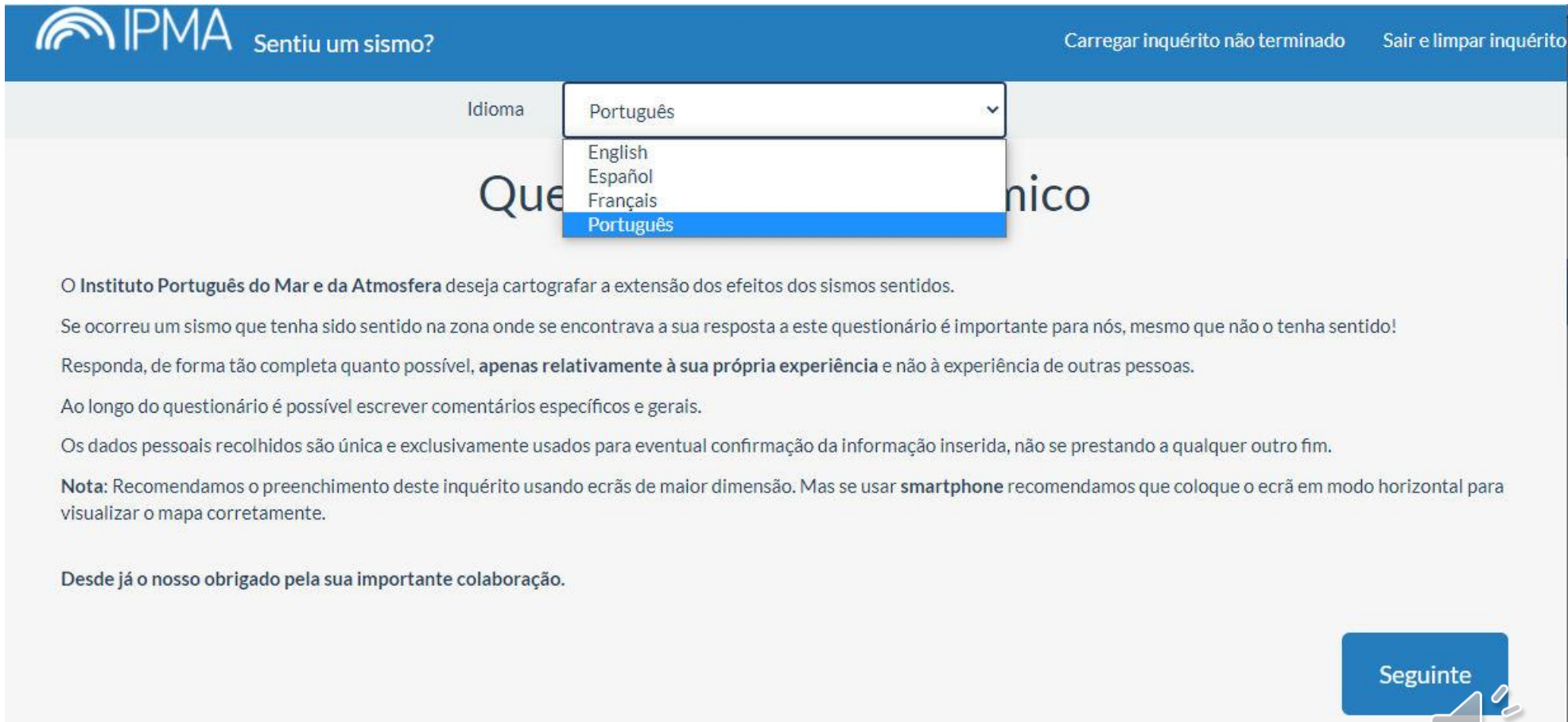
- Apache Server,
- MySQL database,
- interpreters for scripts written in the Hypertext Preprocessor (PHP) and Perl programming languages, and
- several other modules as OpenSSL and phpMyAdmin.



## The new IPMA's web questionnaire

New features includes:

1) Multiple languages implemented (English, French, Portuguese and Spanish);



IPMA Sentiu um sismo? Carregar inquérito não terminado Sair e limpar inquérito

Idioma: Português (dropdown menu showing: English, Español, Français, Português)

**Que** **nico**

O Instituto Português do Mar e da Atmosfera deseja cartografar a extensão dos efeitos dos sismos sentidos.

Se ocorreu um sismo que tenha sido sentido na zona onde se encontrava a sua resposta a este questionário é importante para nós, mesmo que não o tenha sentido!

Responda, de forma tão completa quanto possível, apenas relativamente à sua própria experiência e não à experiência de outras pessoas.

Ao longo do questionário é possível escrever comentários específicos e gerais.

Os dados pessoais recolhidos são única e exclusivamente usados para eventual confirmação da informação inserida, não se prestando a qualquer outro fim.

**Nota:** Recomendamos o preenchimento deste inquérito usando ecrãs de maior dimensão. Mas se usar **smartphone** recomendamos que coloque o ecrã em modo horizontal para visualizar o mapa corretamente.

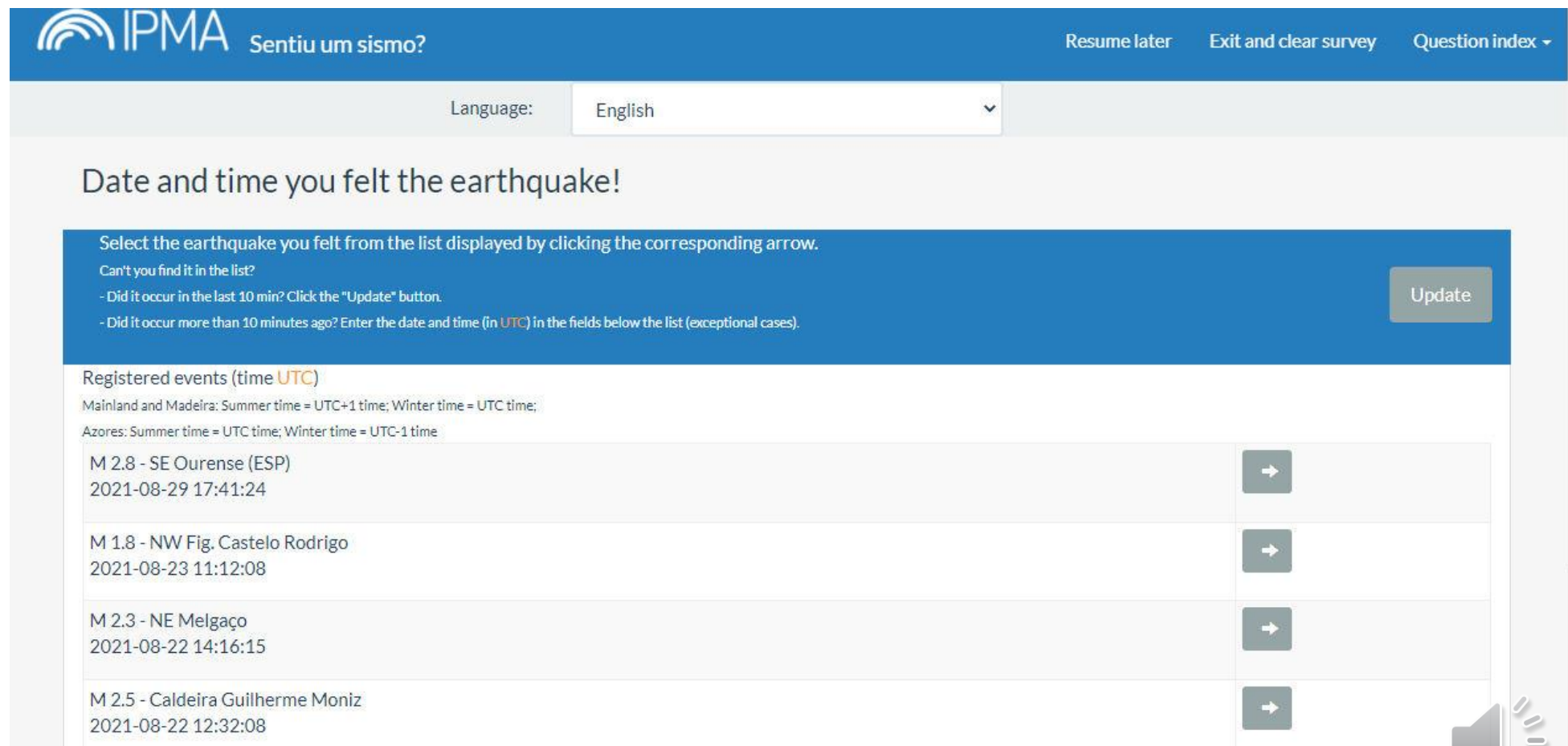
Desde já o nosso obrigado pela sua importante colaboração.

Seguinte

## The new IPMA's web questionnaire

New features includes:

2) A list of last earthquakes that may have been felt in the Portugal region, that allows selection of the felt earthquake;



**IPMA** Sentiu um sismo?

Language: English

Resume later Exit and clear survey Question index

### Date and time you felt the earthquake!

Select the earthquake you felt from the list displayed by clicking the corresponding arrow.  
 Can't you find it in the list?  
 - Did it occur in the last 10 min? Click the "Update" button.  
 - Did it occur more than 10 minutes ago? Enter the date and time (in UTC) in the fields below the list (exceptional cases).

Update

Registered events (time UTC)

Mainland and Madeira: Summer time = UTC+1 time; Winter time = UTC time;  
 Azores: Summer time = UTC time; Winter time = UTC-1 time

M 2.8 - SE Ourense (ESP) 2021-08-29 17:41:24	→
M 1.8 - NW Fig. Castelo Rodrigo 2021-08-23 11:12:08	→
M 2.3 - NE Melgaço 2021-08-22 14:16:15	→
M 2.5 - Caldeira Guilherme Moniz 2021-08-22 12:32:08	→

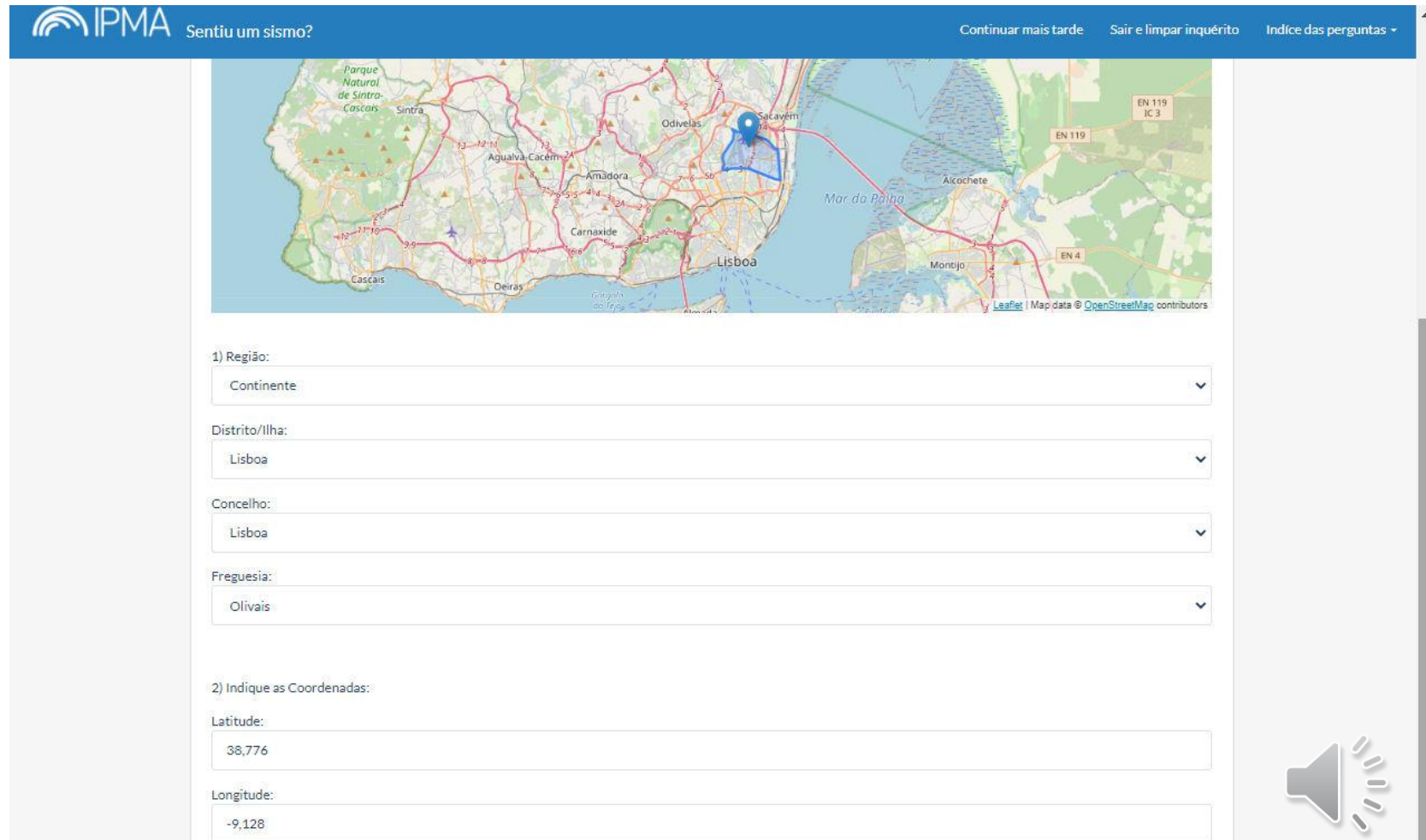



## The new IPMA's web questionnaire

New features includes:

3) A redesigned process to indicate the geographic location of the observer

- interactive map with zoom,
- a drop-down menu with the Portugal administrative regions (region, district, county and parish), or
- text boxes to fill with the coordinates;




 Sentiu um sismo?

[Continuar mais tarde](#)
[Sair e limpar inquérito](#)
[Índice das perguntas](#)

Parque Natural de Sintra-Cascais Sintra Odivelas Sacavém EN 119 IC 3  
 Agualva-Cacém Amadora EN 119  
 Cascais Deiras Lisboa EN 4  
 Carnaxide Montijo Aicochete Mar do Póvoa

1) Região:  
 Continente

Distrito/Ilha:  
 Lisboa

Concelho:  
 Lisboa

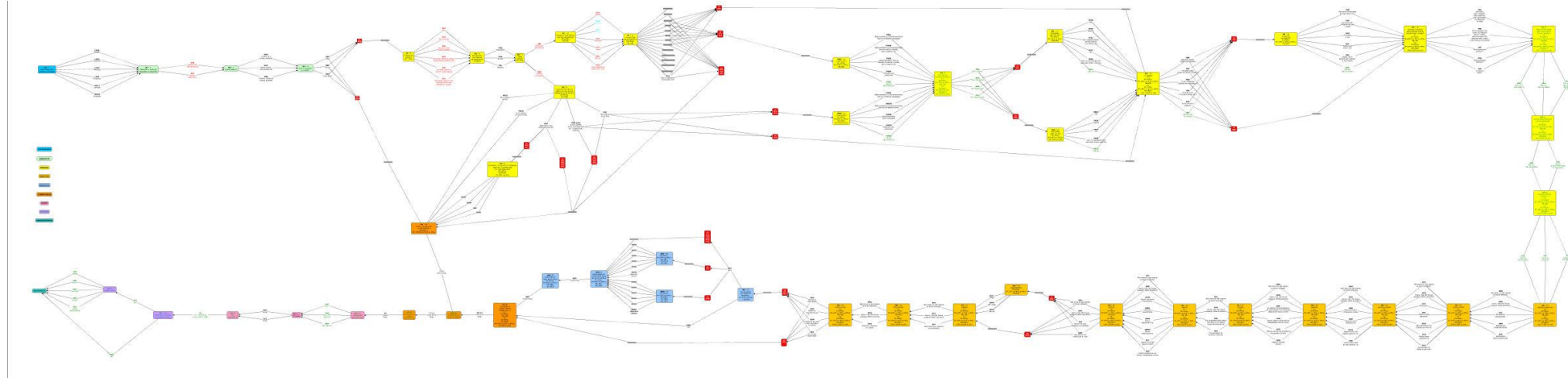
Freguesia:  
 Olivais

2) Indique as Coordenadas:  
 Latitude:  
 38,776  
 Longitude:  
 -9,128

## The new IPMA's web questionnaire

New features includes:

4) A redesigned interactive schema of questions following the EMS-98 scale, using branch logic, with conditions implemented related to some questions and their answers, in order to display some questions if some conditions are met;

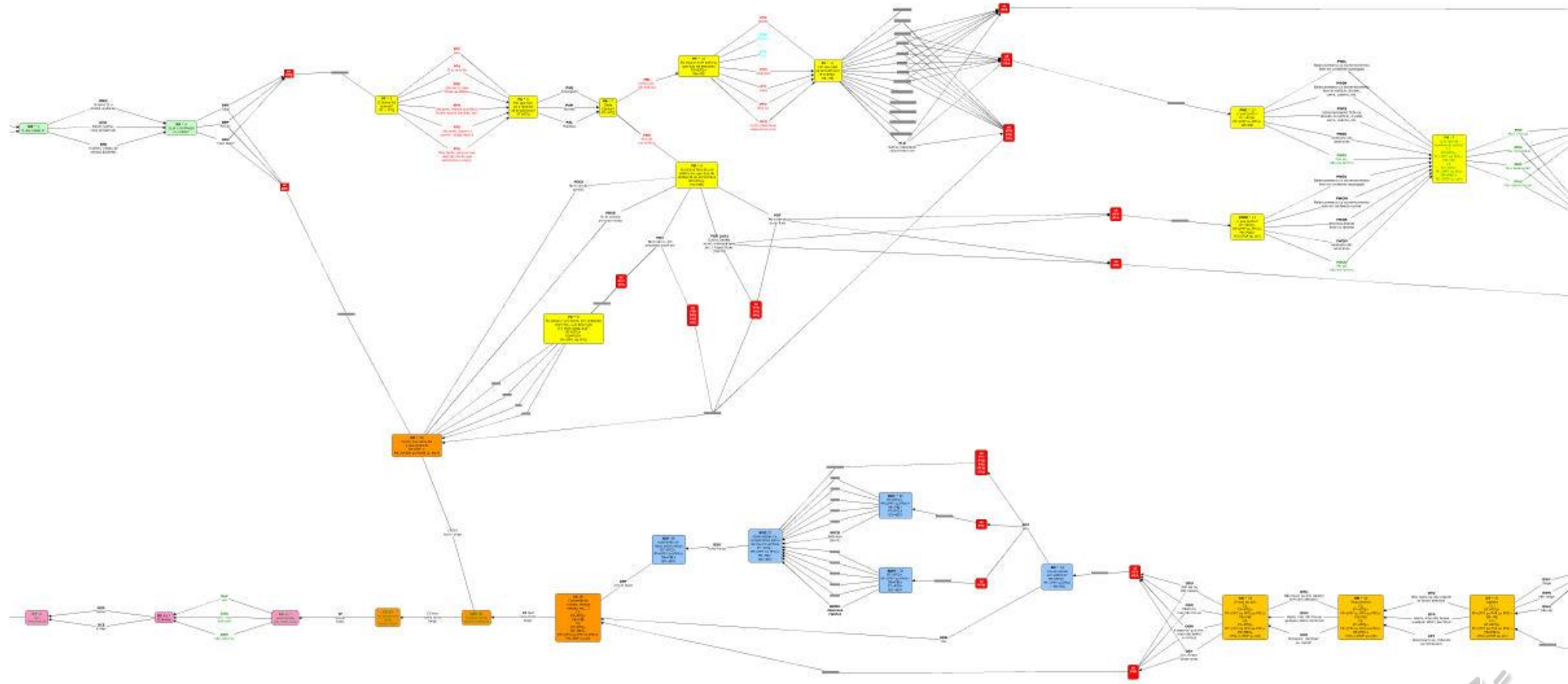




## The new IPMA's web questionnaire

New features includes:

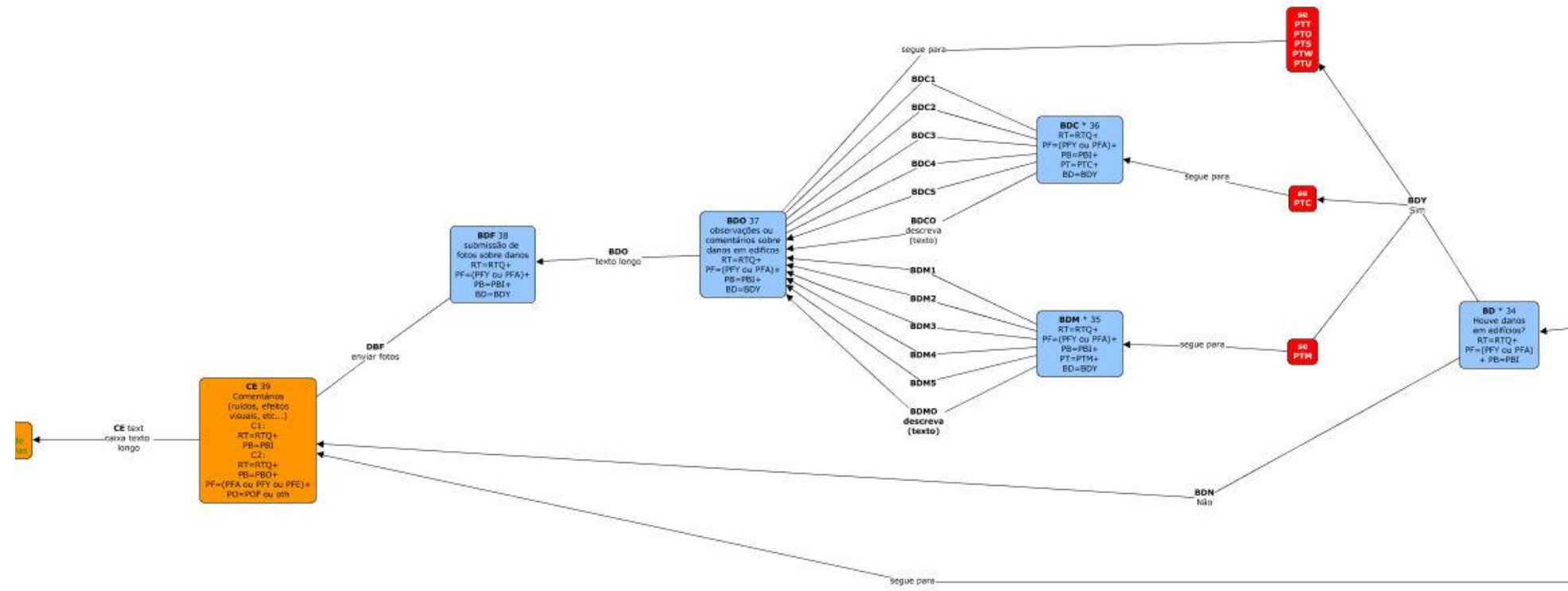
4) A redesigned interactive schema of questions following the EMS-98 scale, using branch logic, with conditions implemented related to some questions and their answers, in order to display some questions if some conditions are met;



## The new IPMA's web questionnaire

New features includes:

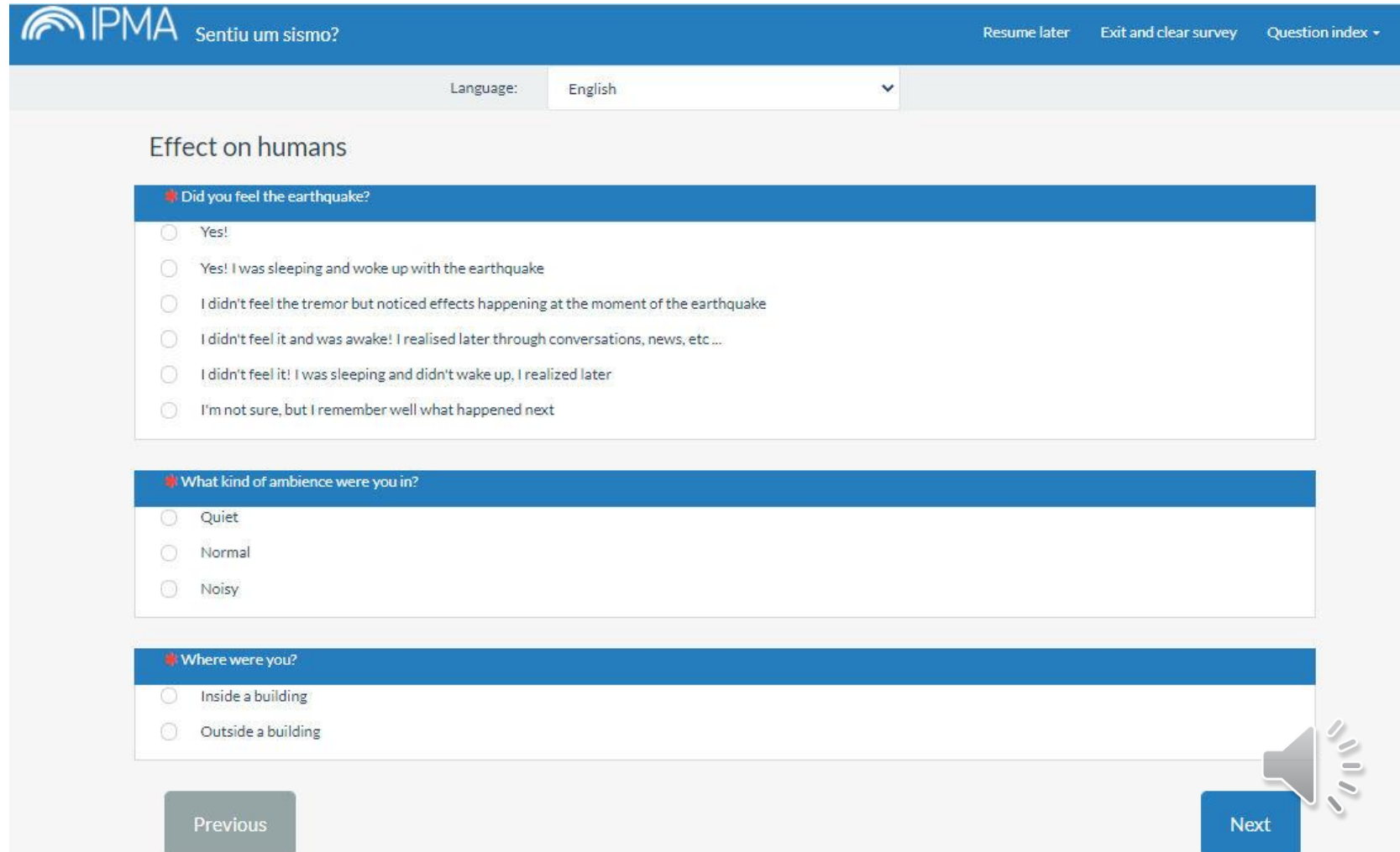
4) A redesigned interactive schema of questions following the EMS-98 scale, using branch logic, with conditions implemented related to some questions and their answers, in order to display some questions if some conditions are met;



## The new IPMA's web questionnaire

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IPMA Sentiu um sismo? [Resume later](#) [Exit and clear survey](#) [Question index](#)

Language: English

### Effect on humans

Did you feel the earthquake?
 

- Yes!
- Yes! I was sleeping and woke up with the earthquake
- I didn't feel the tremor but noticed effects happening at the moment of the earthquake
- I didn't feel it and was awake! I realised later through conversations, news, etc ...
- I didn't feel it! I was sleeping and didn't wake up, I realized later
- I'm not sure, but I remember well what happened next

What kind of ambience were you in?
 

- Quiet
- Normal
- Noisy

Where were you?
 

- Inside a building
- Outside a building

[Previous](#) [Next](#)



## The new IPMA's web questionnaire

New features includes:

4) A redesigned interactive schema of questions following the EMS-98 scale, using branch logic, with conditions implemented related to some questions and their answers, in order to display some questions if some conditions are met;

### Effect on objects and nature

#### \* Hanging objects?

- There were none or I did not notice if they were affected
- There were, but there was no noticeable effect
- Swing slightly
- Swing moderately
- Swing considerably



#### Liquides?

- Il n'y avait pas ou je n'ai pas regardé si ont été affectés
- Il y avait, mais il n'y avait pas d'effets visibles
- Ils ont oscillé et dans certains cas projetés hors des récipients
- Les récipients, les réservoirs et les piscines se sont débordés.



#### \* ¿Vajilla (platos, vasos, tazas, copas, etc...)?

- No había o no me di cuenta si fueron afectados
- Había, pero no hubo ningún efecto perceptible
- Tintinearón
- Hicieron ruido apreciable
- Alguna vajilla se rompió
- Mucha vajilla se rompió
- Casi toda la vajilla se rompió

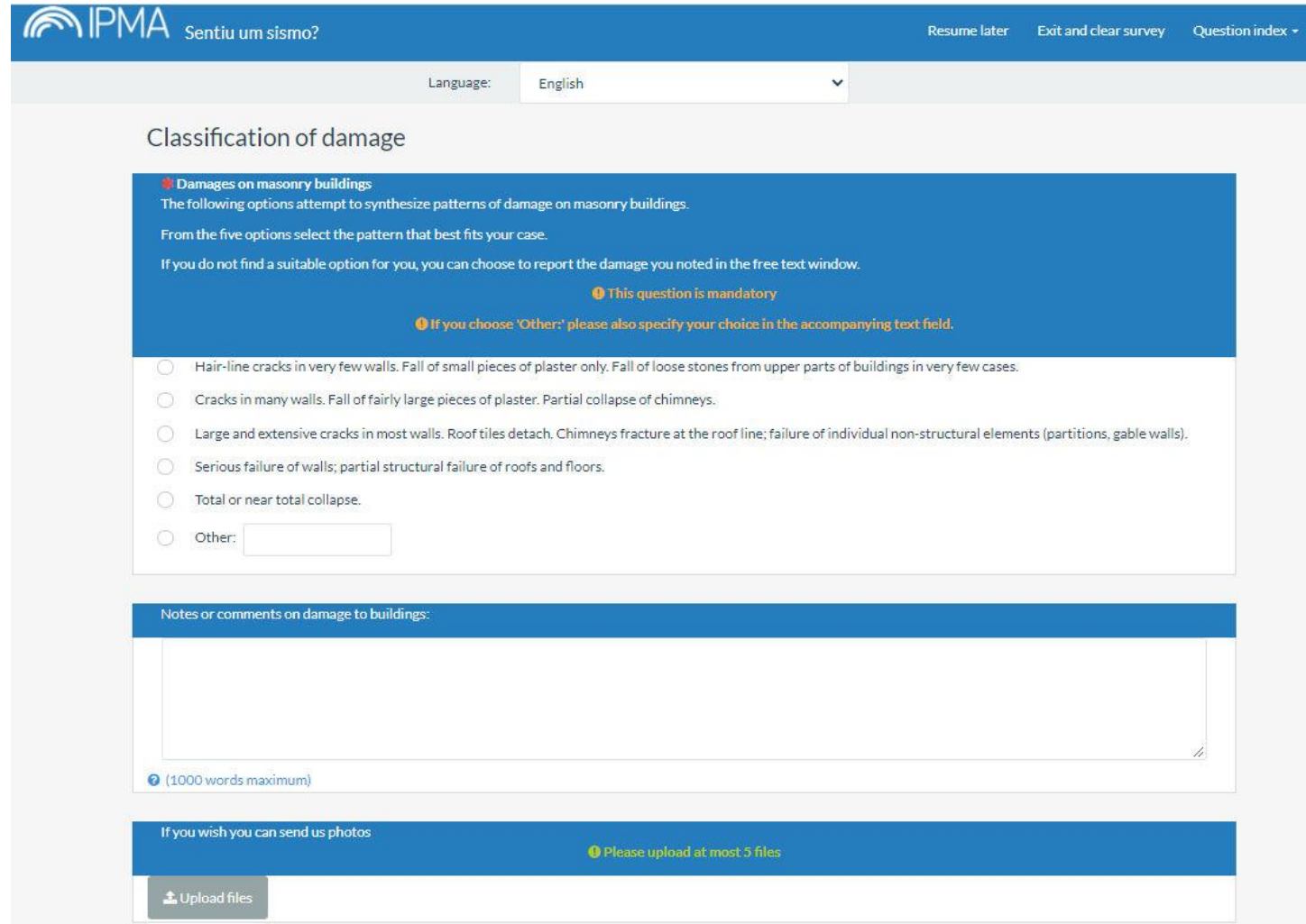


## The new IPMA's web questionnaire

New features includes:

5) More questions and details were included, including:

- a completely new group of questions related to damages on buildings,
- questions related to effects felt in offshore boats, and
- possibility to send photos;



The screenshot shows the IPMA web questionnaire interface. At the top, there is a blue header with the IPMA logo and the text "Sentiu um sismo?". On the right side of the header, there are links for "Resume later", "Exit and clear survey", and "Question index". Below the header, there is a language selection dropdown menu set to "English".

The main content area is titled "Classification of damage". It features a blue box with the following text:
 

- Damages on masonry buildings**
- The following options attempt to synthesize patterns of damage on masonry buildings.
- From the five options select the pattern that best fits your case.
- If you do not find a suitable option for you, you can choose to report the damage you noted in the free text window.
- This question is mandatory**
- If you choose 'Other,' please also specify your choice in the accompanying text field.**

Below this blue box, there are five radio button options:
 

- Hair-line cracks in very few walls. Fall of small pieces of plaster only. Fall of loose stones from upper parts of buildings in very few cases.
- Cracks in many walls. Fall of fairly large pieces of plaster. Partial collapse of chimneys.
- Large and extensive cracks in most walls. Roof tiles detach. Chimneys fracture at the roof line; failure of individual non-structural elements (partitions, gable walls).
- Serious failure of walls; partial structural failure of roofs and floors.
- Total or near total collapse.
- Other:

Below the radio buttons, there is a section titled "Notes or comments on damage to buildings:" with a large text input area. At the bottom of this section, it says "(1000 words maximum)".

At the bottom of the form, there is a section titled "If you wish you can send us photos" with a note "Please upload at most 5 files" and an "Upload files" button.



## The new IPMA's web questionnaire

New features includes:

5) A code was incorporated to convert the questions and answers into another form that is the same in the different languages;

Examples of codification about People:

**PF**elt **PF**Yes **PF**No **PF**But

**PB**uilding **PB**Iinside **PB**Ooutside

**PT**ype of building **PT**Masonry **PT**Concrete **PT**Wood **PT**Steel + C

**PW**hat was felt Inside **PW**ILight **PW**IModerate **PW**IStrong **PW**IDifferent

**PW**hat was felt Outside **PW**OLight **PW**OModerate **PW**OStrong **PW**ODifferent

**PD**uration Comments on duration (### in seconds)

**PR**eaction **PR**No fright (almost) **PR**Some fright **PR**Moderate fright

**PR**Big fright **PR**X-treme fright + C

**PS**leep **PS**Conscient **PS**Awake **PS**Sleep

**PA**mbience **PA**Quiet **PA**Normal **PA**Loud



## The new IPMA's web questionnaire

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Examples of codification about **Objects** and Nature:

- O**Suspended **OS**Don't know **OS**No effect **OS**Light 3 **OS**Moderate 4 **OS**X-treme 5
- O**China **OC**Don't know **OC**No effect **OC**Rattle – tilintar 4 **OC**Clatter – chocalhar 5  
**OC**Break – few may break 6 **OC**Many break 7 **OC**X-treme, most break >=8
- O**Doors and Windows **OD**Don't know **OD**No effect **OD**Rattle (estremeceram 4  
**OD**Swing panes open and shut 5 **OD**Windows panes break - few 5  
**OD**Xtreme windows panes break - many >=6
- O**Objects **OO**Don't know **OO**No effect **OO**Top heavy and small objects may fall or shift 5  
**OO**Stable objects may fall 6 **OO**Fall from shelves in large numbers 7  
**OO**Big objects fall to the ground 8
- O**Liquids **OL**Don't know **OL**No effect **OL**Oscillate and may spill 5  
**OL**Splash from containers, tanks, pools 7
- O**Furniture **OF**Don't know **OF**No effect **OF**ShakeFew 4 **OF**ShakeMany 5  
**OF**MoveFew (shift) 6 **OF**MoveMany (shift) 7  
**OF**Top heavy, may be overturned 7 **OF**Overturned 8



## The new IPMA's web questionnaire

New features includes:

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Examples of codification about **B**uildings:

**B**Damages **BD**No **BD**Yes

**B**D Masonry (with figure) **BDM**1 **BDM**2 **BDM**3 **BDM**4 **BDM**5

**B**D Concrete (with figure) **BDC**1 **BDC**2 **BDC**3 **BDC**4 **BDC**5

**B**D Others **C**omments on others



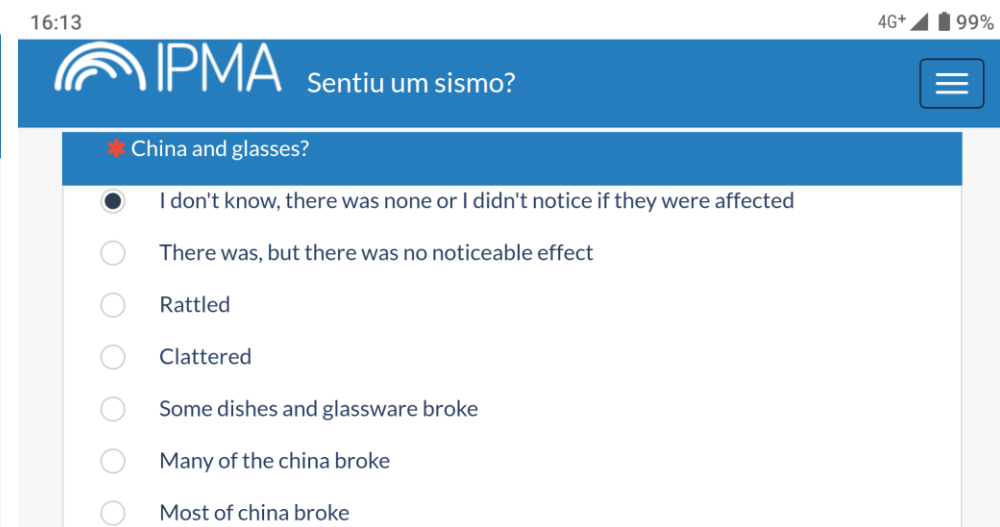
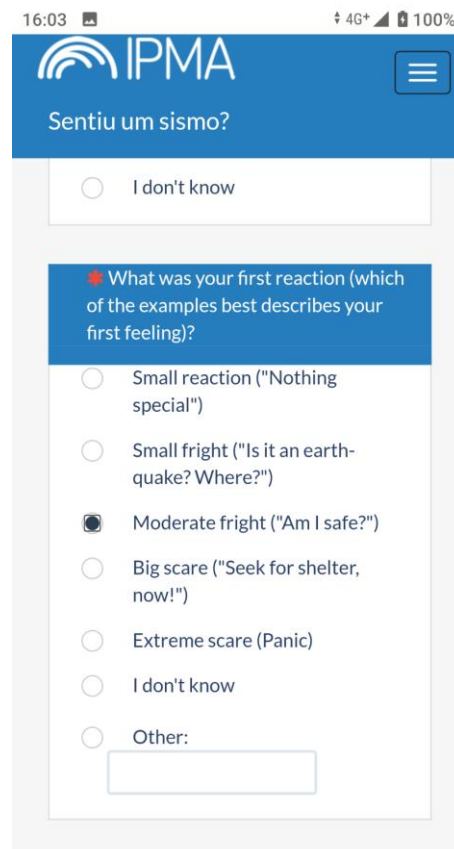
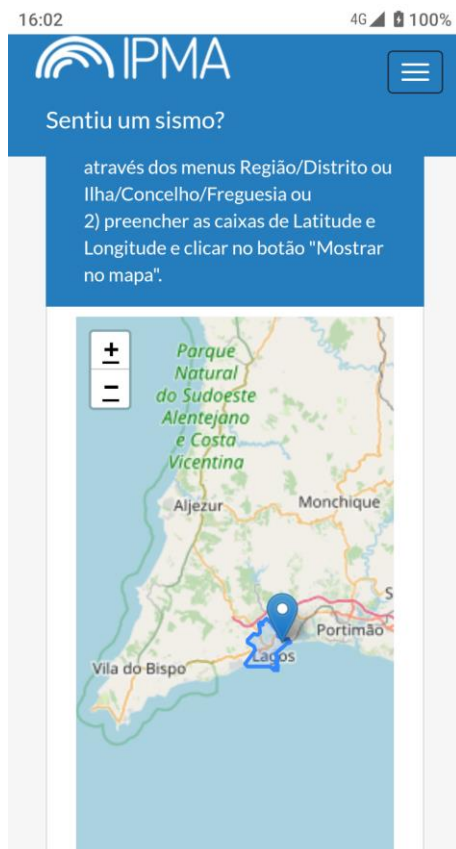




## The new IPMA's web questionnaire

New features includes:

5) Possibility to be displayed in PC or/and mobile devices (smartphones and tablets) regardless of the operating system.



## The new IPMA's web questionnaire

The questionnaire has now 5 main groups of questions related to:

- time and date of observation,
- geographic location of observer,
- effects on people,
- effects on objects and nature,
- building damages and
- has the possibility to collect some different kinds of comments on the earthquake, in free text.

The algorithm and the WebMInt program were adapted and upgraded according to the new features of the questionnaire and some other improvements were made. For instance, analyses question by question the responses associated with the same location (still in test), some quality control strategies implemented were refined, and several results according to different statistical approaches are obtained to gather information for further discussion.

The main steps of the algorithm are:

- read and filter data,
- conversion of answers to numbers,
- analysis of answers,
- summary by Macroseismic Data Point (MDP), and
- writing results.



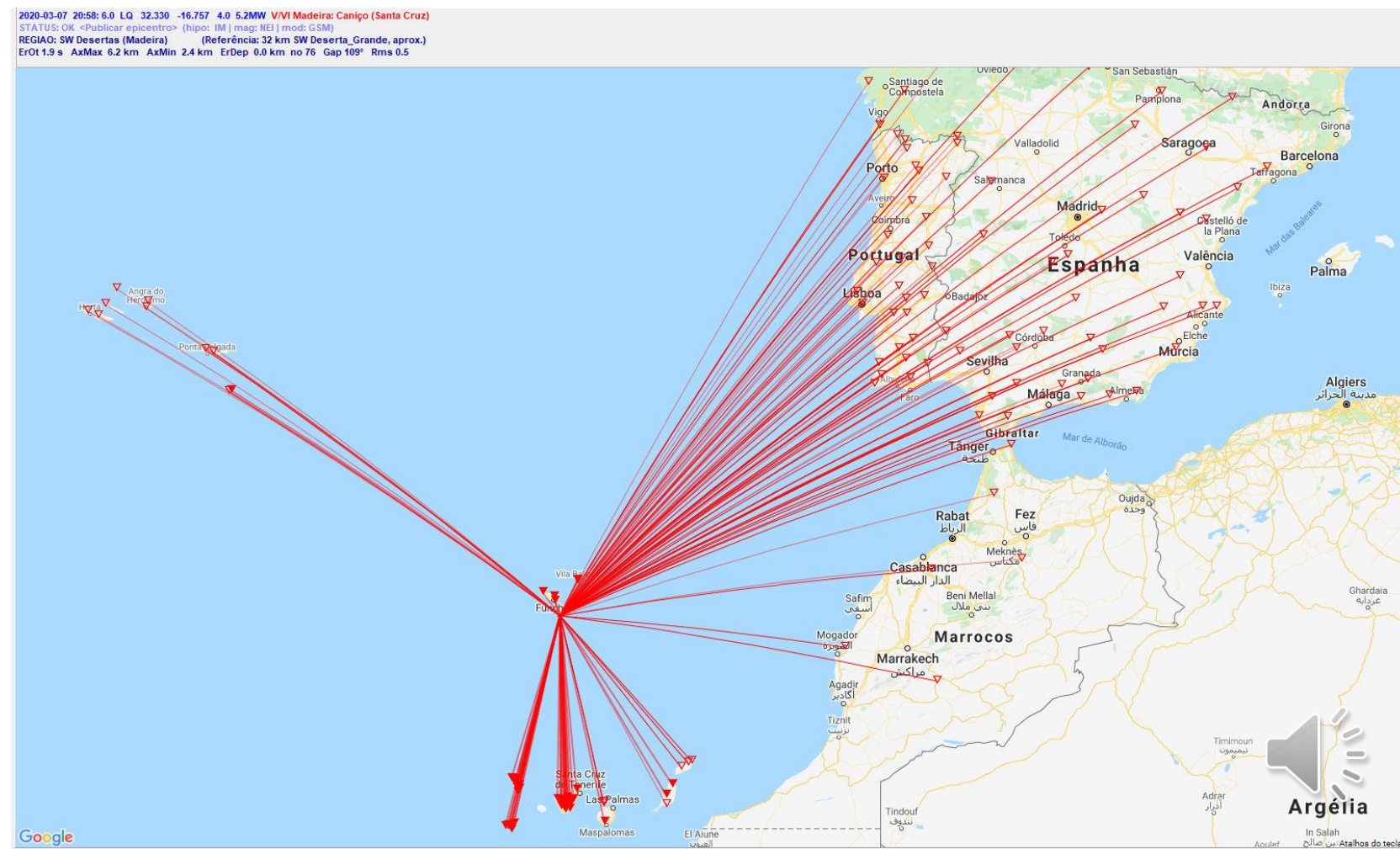


## The new IPMA's web questionnaire

The WebMInt program interacts with other tools of the operational seismic center (figure 1), in particular with:

- the earthquake analysis software SEISAN (Havskov J., and Ottemoler L., 2005),
- the program W\_Emap (Carrilho F., 2005), and
- the software ShakeMap (Wald et al., 2005).

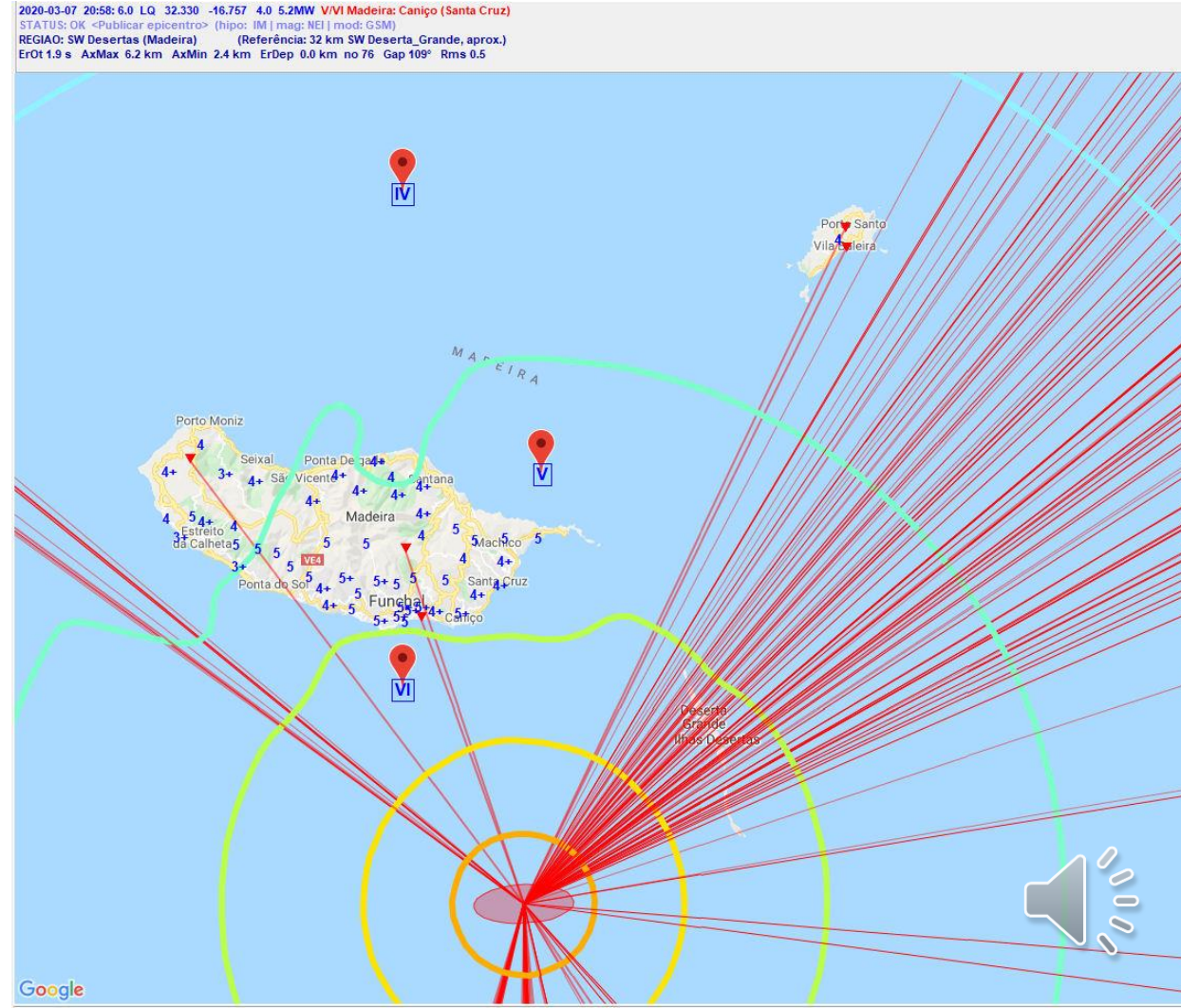
Example: March 7, 2020 Mw 5.2 Madeira Is. Earthquake



## The new IPMA's web questionnaire

Example: March 7, 2020 Mw 5.2  
Madeira Is. earthquake

The IPMA's seismic operational program W\_Emap plots MDP's intensities, as well, theoretical and observed isoseismals.



## The new IPMA's web questionnaire

Example: March 7, 2020 Mw 5.2  
Madeira Is. earthquake

The IPMA's seismic operational program W\_Emap allows interactions with MPD's data and manual validation.

w\_emap - resultados dos inquéritos (fonte: LIMESURVEY)

2020-03-07 20:58: 6.0 LQ 32.330 -16.757 4.0 5.2MW							Registado	
Distrito/Concelho/Freguesia	Int	Q	NinqV	Dist	IntT	IntR	S	
Ilha Da Madeira/Funchal/Imaculado Coração de Maria	4.5	B	32	40	5.5	5.5	V	
Ilha Da Madeira/Santa Cruz/Camacha	5.0	B	19	41	5.5	5.0	A	
Ilha Da Madeira/Câmara de Lobos/Câmara de Lobos	5.0	C	46	42	5.5	5.0	A	
Ilha Da Madeira/Machico/Água de Pena	4.5	C	14	43	5.5	4.5	A	
Ilha Da Madeira/Funchal/São Roque	4.5	C	30	43	5.5	5.0	V	
Ilha Da Madeira/Funchal/Monte	5.0	B	34	43	5.5	5.0	A	
Ilha Da Madeira/Câmara de Lobos/Estreito de Câmara de Lobos	5.0	C	21	44	5.0	5.0	A	
Ilha Da Madeira/Funchal/Santo António	5.0	C	151	44	5.0	5.5	V	
Ilha Da Madeira/Machico/Canical	4.5	B	5	45	5.0	5.0	V	
Ilha Da Madeira/Machico/Machico	5.0	C	31	45	5.0	5.0	A	
Ilha Da Madeira/Câmara de Lobos/Jardim da Serra	5.5	B	7	46	5.0	5.5	A	
Ilha Da Madeira/Ribeira Brava/Campanário	4.5	B	17	46	5.0	4.5	A	
Ilha Da Madeira/Machico/Porto da Cruz	4.5	C	8	47	5.0	5.0	V	
Ilha Da Madeira/Ribeira Brava/Ribeira Brava	5.0	B	39	49	5.0	5.0	A	
Ilha Da Madeira/Santana/Faial	4.5	B	6	50	5.0	4.5	A	
Ilha Da Madeira/Ribeira Brava/Serra de Água	5.0	C	10	51	5.0	5.0	A	
Ilha Da Madeira/Ponta Do Sol/Ponta do Sol	4.5	C	21	53	5.0	5.0	V	
Ilha Da Madeira/Santana/Santana	4.5	C	22	53	5.0	4.5	A	
Ilha Da Madeira/Ponta Do Sol/Canhas	5.0	C	10	55	5.0	5.0	A	
Ilha Da Madeira/São Vicente/Boa Ventura	4.5	B	5	55	5.0	4.5	A	
Ilha Da Madeira/Santana/São Jorge	4.0	C	5	55	5.0	4.0	A	
Ilha Da Madeira/São Vicente/São Vicente	4.5	C	17	56	5.0	4.5	A	
Ilha Da Madeira/Calheta/Arco da Calheta	5.0	B	7	57	5.0	5.0	A	
Ilha Da Madeira/São Vicente/Ponta Delgada	4.5	C	7	58	5.0	4.5	A	
Ilha Da Madeira/Calheta/Calheta	4.0	C	10	59	5.0	4.0	A	
Ilha De Porto Santo/Porto Santo/Porto Santo	4.0	C	24	91	4.0	4.0	A	

Filtros  
 Inst  Qual ABC  NinqV/min 5

35 freguesias / 1214 inquéritos válidos / <Primeiros inquéritos + associados>

Abrir em CSV

Registar

Sair

## The new IPMA's web questionnaire

Example: March 7, 2020 Mw 5.2 Madeira Is. earthquake

The IPMA's seismic operational program W\_Emap allows interactions with MPD's data and manual validation.

w\_emap - resultados dos inquéritos (fonte: LIMESURVEY)

2020-03-07 20:58: 6.0 LQ 32.330 -16.757 4.0 5.2MW							Registado	
Distrito/Concelho/Freguesia	Int	Q	NinqV	Dist	IntT	IntR	S	
Ilha Da Madeira/Santa Cruz/Canico	5.0	C	174	37	5.5	5.5	V	
Ilha Da Madeira/Funchal/Funchal (Sé)	5.0	C	26	38	5.5	5.0	A	
Ilha Da Madeira/Santa Cruz/Gaula	4.5	B	22	39	5.5	4.5	A	
Ilha Da Madeira/Funchal/Funchal (São Pedro)	4.5	C	56	39	5.5	5.5	V	
Ilha Da Madeira/Funchal/Funchal (Santa Maria Maior)	5.0	C	63	39	5.5	5.5	V	
Ilha Da Madeira/Funchal/Funchal (Santa Luzia)	5.0	B	30	39	5.5	5.5	V	
Ilha Da Madeira/Funchal/São Martinho	5.0	A	206	39	5.5	5.5	V	
Ilha Da Madeira/Santa Cruz/Santa Cruz	4.5	B	20	40	5.5	4.5	A	
Ilha Da Madeira/Funchal/Imaculado Coração de Maria	4.5	B	32	40	5.5	5.5	V	
Ilha Da Madeira/Câmara de Lobos/Câmara de Lobos	5.0	C	46	42	5.5	5.0	A	
Ilha Da Madeira/Funchal/São Roque	4.5	C	30	43	5.5	5.0	V	
Ilha Da Madeira/Funchal/Monte	5.0	B	34	43	5.5	5.0	A	
Ilha Da Madeira/Câmara de Lobos/Estreito de Câmara de Lobos	5.0	C	21	44	5.0	5.0	A	
Ilha Da Madeira/Funchal/Santo António	5.0	C	151	44	5.0	5.5	V	
Ilha Da Madeira/Machico/Machico	5.0	C	31	45	5.0	5.0	A	
Ilha Da Madeira/Ribeira Brava/Ribeira Brava	5.0	B	39	49	5.0	5.0	A	
Ilha Da Madeira/Ponta Do Sol/Ponta do Sol	4.5	C	21	53	5.0	5.0	V	
Ilha Da Madeira/Santana/Santana	4.5	C	22	53	5.0	4.5	A	
Ilha De Porto Santo/Porto Santo/Porto Santo	4.0	C	24	91	4.0	4.0	A	

Filtros Inst  Qual ABC  NinqV/min 20

19 freguesias / 1048 inquéritos válidos / <Primeiros inquéritos + associados>

Inquéritos Totais - Estatísticas

## The new IPMA's web questionnaire

Example: March 7, 2020 Mw 5.2  
Madeira Is. earthquake

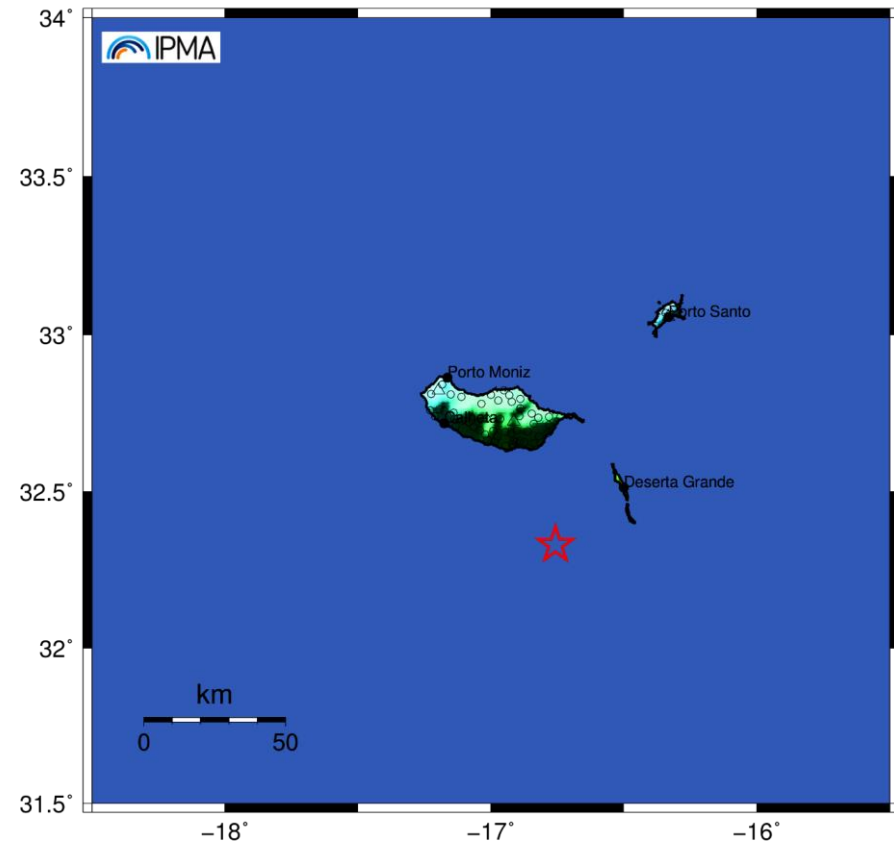
The ShakeMap program incorporate also MDP's data (see report stationlist.txt)

```

# Earthquake 2020030720580502: 03/07/2020 20:58:06 GMT, M=5.2, Lat: 32.3300,
Lon: -16.7570, Depth: 4km, Bias: mmi=0.00 pga=0.00 pgv=0.00
# Columns: Station Code, latitude, longitude, regression dist (km),
intensity, network code, Channel 1 Code, PGV (cm/sec), PGA (%g), PSA 0.3 sec
(%g), PSA 1.0 sec (%g), PSA 3.0 sec (%g), Channel 2 Code, PGV (cm/sec), PGA
(%g), PSA 0.3 sec (%g), PSA 1.0 sec (%g), PSA 3.0 sec (%g), Channel 3 Code,
PGV (cm/sec), PGA (%g), PSA 0.3 sec (%g), PSA 1.0 sec (%g), PSA 3.0 sec (%g)

PMPST, 33.0788, -16.3333, 91.3, 3.3, IMP, HHE, 0.1618, 0.6510, , , , HHN,
0.2365, 0.7235, , ,
I310101, 32.7317, -17.1366, 56.6, 5.0, MMI, DERIVED, nan, nan, nan, nan, nan
I310102, 32.7521, -17.1397, 58.6, 4.0, MMI, DERIVED, nan, nan, nan, nan, nan
I310103, 32.7568, -17.1760, 61.1, 4.5, MMI, DERIVED, nan, nan, nan, nan, nan
I310105, 32.7395, -17.2099, 61.8, 3.5, MMI, DERIVED, nan, nan, nan, nan, nan
I310106, 32.7596, -17.2284, 64.6, 4.0, MMI, DERIVED, nan, nan, nan, nan, nan
I310107, 32.8115, -17.2251, 68.7, 4.5, MMI, DERIVED, nan, nan, nan, nan, nan
I310108, 32.7624, -17.1941, 62.7, 5.0, MMI, DERIVED, nan, nan, nan, nan, nan
  
```

Portugal – IPMA ShakeMap : SW Desertas (Madeira)  
MAR 7 2020 08:58:06 PM GMT M 5.2 N32.33 W16.76 Depth: 4.0km ID:2020030720580502



VIBRAÇÃO PERCEPTÍVEL	N/ sent	Fraco	Moderado	Forte	Bast/ Forte	Mto Forte	Ruinoso	Desastroso	Extremo
DANOS POTENCIAIS	n/a	n/a	n/a	Mto ligeiro	Ligeiro	Moderado	Mod./Forte	Forte	Mto Forte
PGA(%g)	<0.05	0.3	1.6	5.0	8.8	15	27	47	>83
PGV(cm/s)	<0.07	0.4	1.9	5.8	11	22	43	83	>160
INTENSIDADE INSTRUMENTAL	I	II-III	IV	V	VI	VII	VIII	IX	X+

Scale based upon IM-(Atkinson & Kaka; 2007) & (Wald, et al.; 1999)

## The new IPMA's web questionnaire

Since October 16, 2019, there were more than 20,000 hits that resulted in 7200 validated responses. During this period there were 35 earthquakes felt on the mainland, 2 in the Madeira archipelago and 76 in the Azores archipelago.

### Next steps:

- all aspects concerning quality must be reviewed in detail,
- the MDP assessment of seismic intensity by questions needs to be further tested,
- the use of orthogonal grids should be introduced as well as other approaches that can overcome the limitations of the DCF concept as they are MDP's based on administrative criteria that vary in time, and
- there is a lack of secure criteria for quantifying the terms "few", "many" and "most" of the EMS-98.





## The new IPMA's web questionnaire

This entire process, always evolving, as it is in use, responds efficiently, on the one hand, to operational emergencies and, on the other, to the volume of data that is collected.

However, it remains necessary to stay focused on the basic concepts of seismic intensity as they are applied in EMS-98 and ensure that these are well translated into the algorithms and that the best tools of mathematics and statistics are used since data scarcity and geographical sparsity of observations are significant problems when dealing with macroseismic studies.

