Deliverable D5.2

Current communication pathways for seismic information in Italy, Switzerland and Iceland

Deliverable information	
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Introduction

In order to improve communications, it's important to understand the existing communication chains in place. These chains usually form an interconnected web, with many different types of actors, components, products and audiences participating and interacting at each stage. At each point (following Laswell (1948)), we can ask ourselves:

WHO communicates WHAT, in WHAT FORM, TO WHOM, to WHAT EFFECT?

The component 'to what effect' is the 'aim' of the communication process at that point, and defines the outcomes we might measure to see if our communication is 'successful'. For those aiming to send a message or change behaviour with their communications (e.g. a communicator issuing an earthquake early warning message or a rapid loss assessment report), one outcome might be how many people took the action to 'duck, cover and hold on', or whether emergency resources were proportionally distributed relative to the size of impact in each location affected. For those aiming more to inform an audience (e.g. via a seismic hazard map or operational earthquake forecast), the outcome is more likely to be how well did people understand the information that was communicated to them, and do they feel more informed having received it.

If we are to improve the outcomes of our communications, it is key to understand and characterise those factors that feed into each outcome, and this is where the earlier stages of Laswell's model come in; the who, what, what form and to whom.

The 'who' might be individuals or groups that are wide ranging in nature - politicians, community leaders, emergency services, infrastructure managers, business owners and so on.

The 'what' is the actual content of the communication itself i.e. what is the number, the fact or the broader message being communicated.

'What form' pertains both to the format of the communication itself (e.g. is it a passage of text, a graph, a narrative, a map etc.) and the medium via which the communication travels (e.g. tv, radio, app, push notification).

Finally, 'to whom' refers to the receivers of the information, the audiences. Again, these can be diverse and numerous, from individual members of the public to high level decision makers within government, and may vary in their level of knowledge, expertise, numeracy, literacy and accessibility to various media. When considering these audiences, it is also key to understand their relationship to the information being communicated (which for seismic information may be highly sensitive for some), and the relationship they have with the communicator (is the relationship one of trust, for example).

This document is based on interviews with those in various organisations within the communication chain in Italy, Switzerland and Iceland. It aims to provide a clear and detailed characterisation of the communication process for seismic information in each country. We hope it therefore provides a resource for those wishing to better understand the communication process for various types of seismic information across these three countries and allow them to identify areas where improvements can be made.

Current communication pathways for seismic information in Italy

National organisation

Italy is a country with a population of 60 million. It was established as a democratic republic in 1948 consisting of legislative, executive, and judicial subdivisions. In Italy the head of the Italian state is the President of the Italian Republic, who is guarantor of the Constitution. According to the constitution, the President of the Council of Ministers of the Italian Republic (the Prime Minister) is responsible for directing the general policy of the government. They promote and coordinate the activity of ministers, and maintain the unity of political and administrative direction.

Administratively, Italy is composed of a total of 21 regions and autonomous provinces. Each region contains more provinces, which, in turn, are composed of many municipalities. The only region not divided into provinces is the region of Valle d'Aosta.

Sicilia, Sardegna, Valle d'Aosta, Friuli-Venezia Giulia and Trentino-alto Adige are regions that benefit from a special status, approved by the parliament via a constitutional act; while Trento and Bolzano, within the region of Trentino-alto Adige, are autonomous provinces, according to the Paris Agreement and to article 16 of the Italian Constitution.

Provinces of Italy (grey borders), within Regions (solid borders)

Figure 1: Administrative map of Italy

Seismic hazard in Italy

As a country, Italy is considered to be at high seismic hazard: according to the records of the national seismic centre, Istituto Nazionale di Geofisica e Vulcanologia (INGV), 13 earthquakes greater than magnitude 5.5 have occurred in the country since 1985.

Seismically, the country is divided into 4 zones (according to the National Civil Protection Department official homepage):

- Zone 1: High seismicity (PGA > 0.25 g)
- Zone 2: Medium-high seismicity (PGA 0.15 - 0.25 g)
- Zone 3: Medium-low seismicity (PGA 0.05 – 0.15 g)
- Zone 4: Low seismicity (PGA < 0.05 g)

Strong earthquakes, however rare, are possible in all zones.

The 4 seismic zones were derived by the Probabilistic Seismic Hazard Assessment (PSHA) map (Modello di pericolosità sismica MPS04-S1).

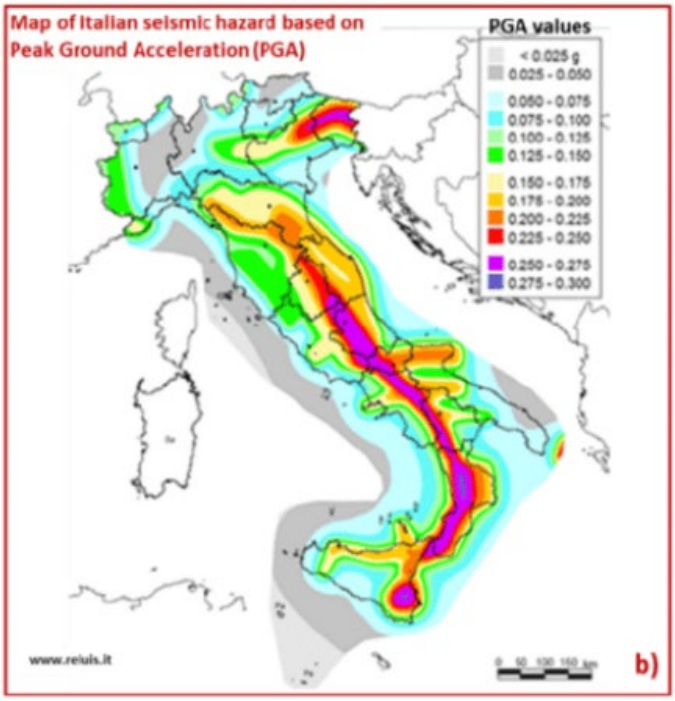


Figure 2: Seismic hazard map of Italy

The Italian National Civil Protection Department

The Italian National Civil Protection Department is the operational arm of the Prime Minister of Italy that is responsible for protecting the people and structures of the country from natural and man-made disasters. It is a major part of the country's civil security system and as such plays a crucial role in seismic risk management. It includes the police force, fire brigade, armed forces, the Italian Red Cross, the National Health Service, various voluntary organisations, and scientific research committees (as well as the ministries of health, economy, transport, agriculture, cultural heritage, defence etc). Civil protection also has operations below the national level of organisation, at regional, provincial and municipal (local) level.

Civil protection is organised as a «System» that embraces the "Augustus method". This means that the organisation is decentralised, but functions in a systemic way such that it is operationally flexible and ready to adapt to various scenarios and interventions. All the departments at each level of organisation are characterized by the same tools and use the same terminology, so that all members can understand each other in any department they are located. Civil protection operates according to the principle of subsidiarity. This means that, regardless of the severity of the emergency, the higher levels of organisation, such as the regional and national levels, cannot assume the responsibility of the lower levels, however they can collaborate and support them. For example, representatives of the region in which the emergency occurs do not assume the responsibility of the affected municipality, but they can help the local mayor in handling the situation.

Figure 3 depicts the organisational structure of the National Civil Protection Department, whilst Figure 4 gives a top-line overview of its responsibilities.

The **Great Risk Commission** is an independent technical advisory body that serves as a connecting link between the National Civil Protection Department and the scientific community. In case of emergency, the Great Risk Commission can be consulted; they provide technical and scientific advice and suggest how to improve the capacity of assessment, forecast and prevention of different risks.

Hereafter, references to civil protection in the Italian section of the document refer to the National Civil Protection Department, unless otherwise specified.

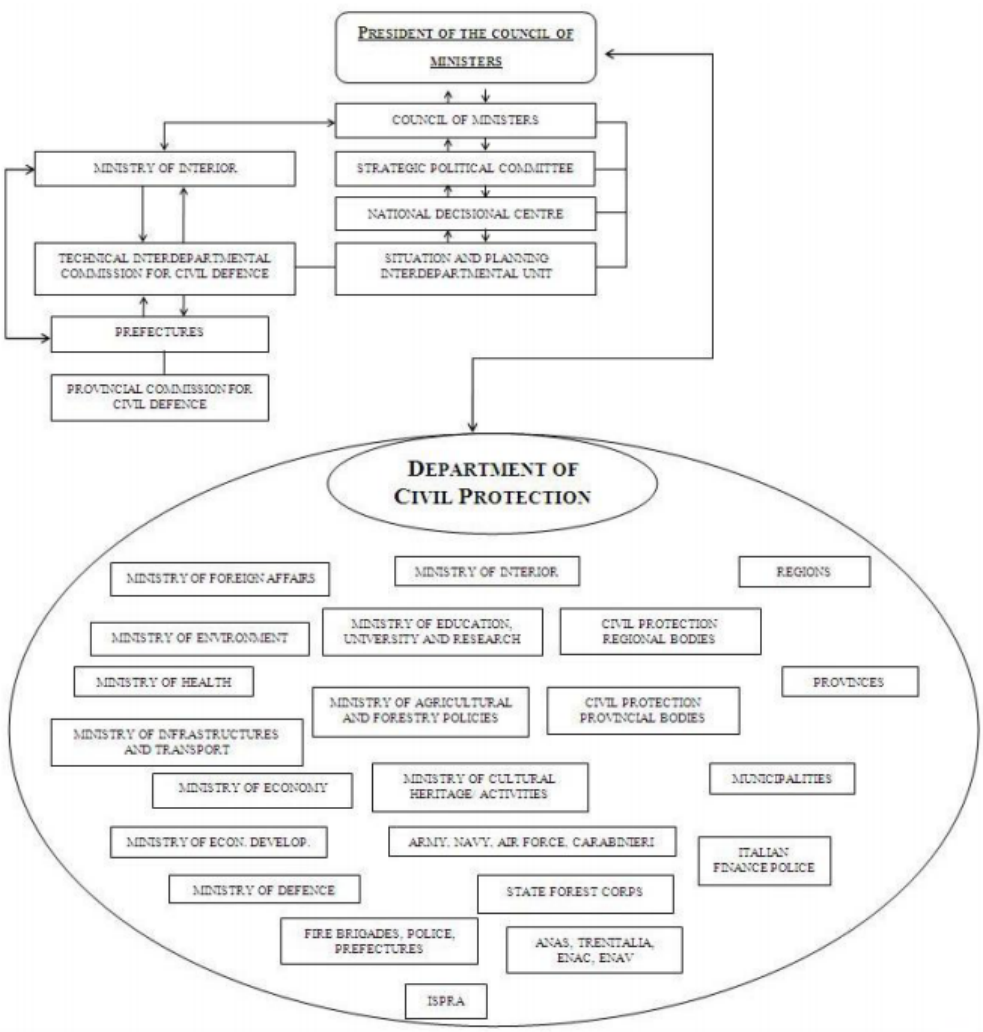


Figure 3: Organisational structure of the Italian Civil Protection system. Source: The Italian Civil Security system by Di Camillo et al. https://www.iai.it/sites/default/files/iairp_11.pdf

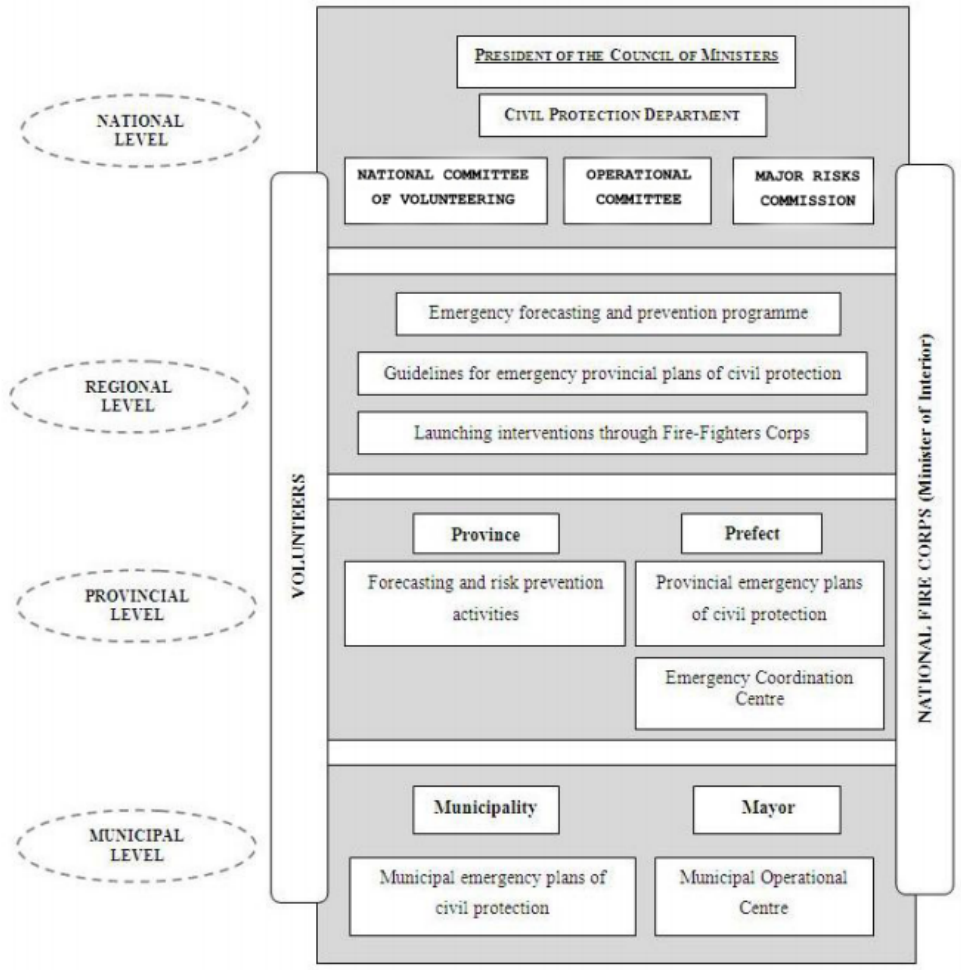


Figure 4: Simplified schematic of the responsibilities of the Italian Civil Protection system. SOURCE: The Italian Civil Security system by Di Camillo et al. https://www.iai.it/sites/default/files/iairp_11.pdf

Who produces seismic information?

The following institutions are two of the major producers of seismic information in Italy:

- **INGV**, the National Institute of Geophysics and Volcanology, studies both geological and volcanological phenomena, and manages the national seismic network (RSN). It operates more than 500 stations located across Italy and abroad. The INGV have a seismic surveillance room in Rome which carries out monitoring activities 24h, 365 days per year through a cycle of three daily shifts (8.00 - 14.00; 13.45 - 23.15; 22.45 - 8.15). According to the agreement between the department of civil protection and the INGV, four staff are on each rota. Two of these are either seismologists or in charge of the analysis of the seismic data, one is in charge of the Tsunami Alert Centre (CAT), and one is a technician in charge of the acquisition systems, the Short Waves (SW) procedures, and the network failures. The INGV produces hazard maps (e.g. Figure 9) and is responsible for reporting all data about a seismic event (e.g. magnitude, location). The INGV also produces operational earthquake forecasts (OEF). (http://www.ingv.it/it/)

- **Eucentre** is a non-profit private law foundation that is concerned with research, training and delivering services in the seismic engineering field. It provides a publicly available website called sicuro+ (https://www.sicuropiu.it/index.xhtml) where it publishes seismic hazard and risk maps. In the event of an earthquake, it provides risk scenarios, similar to Rapid Impact Assessments, but displaying information in full detail, to its centre of competence, the National civil protection department. (https://www.eucentre.it/)

INGV and Eucentre communicate the seismic information they produce to the National Civil Protection department. Within this department, there are three further, internal sources of seismic information:

- A monitoring network called the **National Accelerometric Network** that includes 650 monitoring stations, although only some of these stations provide data in real time. These stations provide the instrumental intensity, maximum registered acceleration (horizontal/vertical), velocity, and movement of each seismic motion detected. The National Accelerometric Network produces information within around 2-5 minutes of a seismic event.

- The **National Seismic Observatory**, which includes 200 recording systems on buildings and bridges that produce information regarding structural damage within 2-15 minutes after an event.

- A room operating 24 hours a day called the National Operational Room (**Sala Situazione Italia**). It aims to identify emergency situations and alert the representatives of all the operational structures of the national civil protection, for example fire brigade, army, police, Red Cross. (http://www.protezionecivile.gov.it/attivita-rischi/schede-tecniche/dettaglio/-/asset_publisher/default/content/sistema-nella-sala-situazione-italia)

Figure 5 provides a schematic overview of the interactions between these different organisations and data sources. Further details on what information is being communicated and to whom is detailed in the next section.

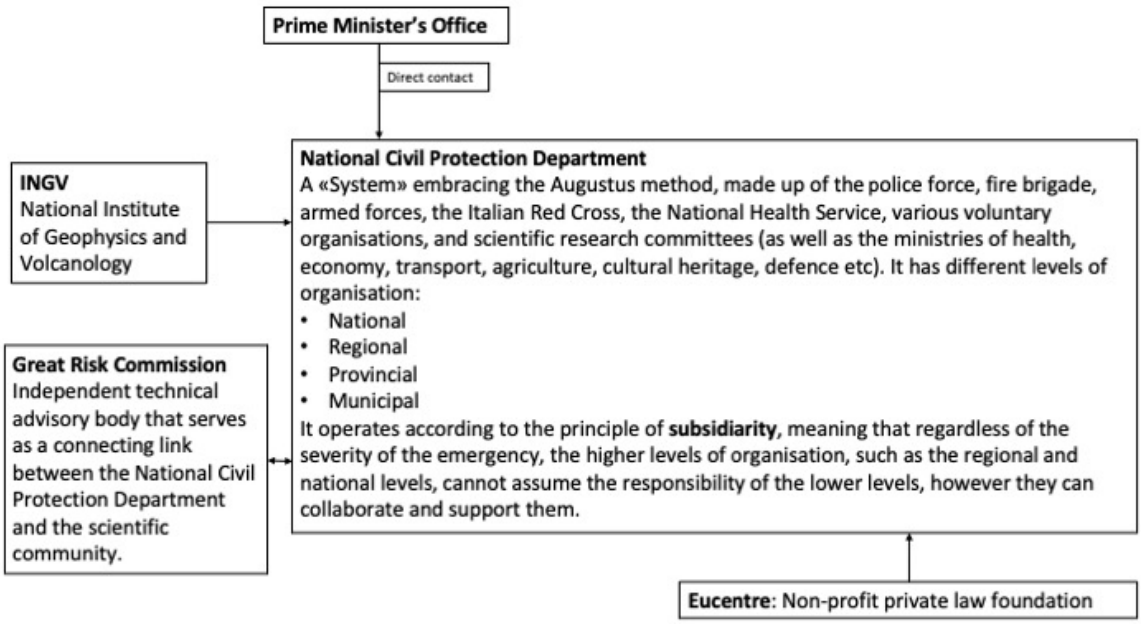


Figure 5: The Italian institutions passing seismic information to the National Civil Protection department for emergency response

There are various other producers of seismic data, for example:

- **GEM**, the Global Earthquake Model foundation, based in Pavia, Italy, delivers products providing information about earthquakes such as a global earthquake hazard map, global earthquake risk map, global exposure map, global recovery map, global economic vulnerability map, global earthquake social vulnerability map. These are made publicly available on their website (https://www.globalquakemodel.org/gem). GEM communicate their data and interpretation to the National Civil Protection department as academic reports.

To whom do the information producers communicate the information to? In what format? How often?

INGV

The INGV can communicate information about seismic activity but cannot provide any advice or recommendations on responses to such information. They communicate information differently depending on specific magnitude thresholds as well as on the audience.

INGV to the National Civil Protection

INGV sends regular information to Civil Protection as follows:

- **A weekly bulletin** sent every Monday detailing the trend in Italy's seismic activity and the operating state of the seismic network.
- **A quarterly bulletin** detailing the ongoing seismic sequences. This includes details such as the earthquake distribution in a particular area, a map, and a box with a long-term model of hazard. As well as detailing ongoing seismic sequences, the bulletin also contains **Operational Earthquake Forecasts** (OEF). These forecasts report the weekly probability of an earthquake at and above five different thresholds: magnitude (MI) 4+, magnitude 5.5+, and modified intensity (MMI) VI+, VII+, and VIII+. The information reported is not an alert, but an estimate of the possibility of future ground shaking caused by earthquakes. This information is also forwarded to the Great Risk Commission (see definition earlier).

During active earthquake sequences, a monthly bulletin is sent, describing the sequence in the location concerned. However, for some seismic sequences, the frequency of updates differs, generally being agreed between INGV and National Civil Protection depending on the magnitude of the main event, on the aftershock rate etc.

For any earthquakes over magnitude 3.0, SMS text messages and emails are also sent, although individual members of the Civil Protection department can choose to receive messages based on different magnitude thresholds.

- Three SMS messages detailing information about the earthquake are sent at 2, 5, and 15 minutes after the event (see Figure 6).

- After an earthquake occurs, measurement data from the event comes in dynamically from a variety of seismographs. As such, data issued in the early SMS messages in the 2-, 5- and 15-minute sequence may change in subsequent messages, as more data is received. Each SMS message thus includes a rating of the quality of the data (Q) underlying the information communicated that indicates the extent to which the INGV expect the information to change. This rating is based on three components, each given a quality rating from high (A) to lower quality (e.g. C), generating a three-letter data quality code. The first letter refers to the residuals of the localization, namely the gap between the calculated times and the observed ones; the second letter indicates both the azimuthal gap of the network that records the earthquake event (the smaller this is, the more accurately the hypocentre is determined) and the distance between the epicentre and the first station (where the closer the station is to the epicentre, the more reliable the reading). The third letter refers to the quality of the estimation of the magnitude. The highest quality overall code is AAA which means that the message contents is unlikely to change in subsequent SMS messages (although an AAA rating is rare). Codes less than AAA indicate that the data quality is lower and thus that information in subsequent SMS messages may change as more data are gathered.

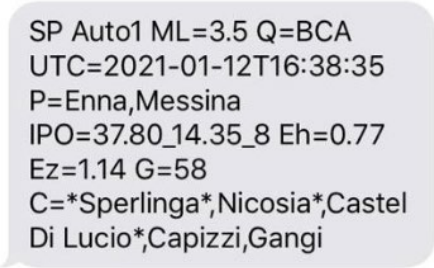


Figure 6: Example SMS sent from INGV after a seismic event in Italy.

ML: magnitude; Q: data quality; UTC: universal time coordinated; T: time; P: provinces; IPO: hypocentre; Eh: standard error on the epicentral location calculated in km; EZ: c/s for the estimate of the hypocentral depth; G: azimuthal gap; C: municipalities

- An email is sent with the same information as in the SMS messages along with a text explanation and a map.

For earthquakes greater than magnitude 4, the INGV seismic surveillance room in Rome produces a quick first automatic report to send to Civil Protection within 1 hour, while within a few hours it produces and sends a second, handcrafted report to Civil Protection with the following information:

- The earthquake registered, its Moment magnitude (Mw) and its location.
- Uncertainty around this information and the reasons why there is uncertainty (e.g. the depth of the hypocentre is not quickly measurable, for which an example of a sentence reporting such uncertainty would be “assessments show that the values of depth between 9 and 20km produce a fit of observations practically equivalent. To determine conclusively the depth will require more detailed analysis.”).
- The difference between the current earthquakes and others in the same location that have occurred in the past (from the year 1000 to the present day).
- The difference between the current earthquakes and past earthquakes that occurred in different locations.
- The seismic characteristics of the affected area e.g. location of faults
- Maps, as shown in Table 1

Figure 7 summarises the different communications between INGV and the National Civil Protection Department.

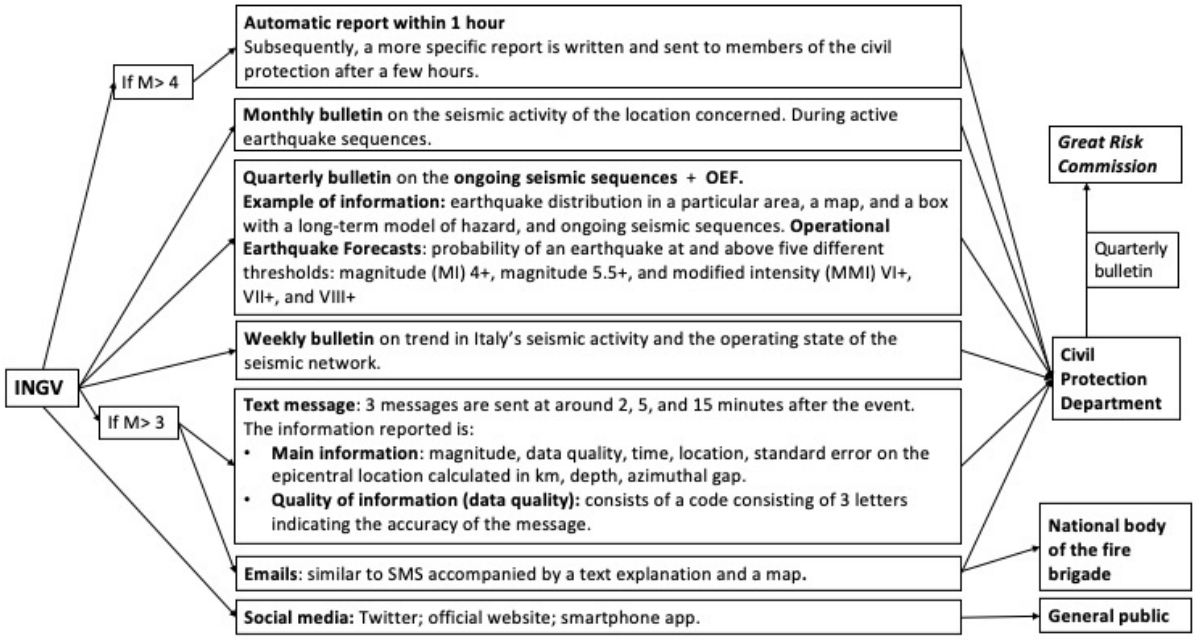


Figure 7: INGV's communication pathways in Italy

Table 1: Examples of information in the second, handcrafted reports the INGV sends to the civil protection in the event of an earthquake over magnitude 4

Mappa evento sismico

Localizzazione epicentrale dell'evento di coordinate lat=41.878, lon=14.875 e profondita' 9km.
(Image URL_001: http://bit.ly/2MSpMDE)

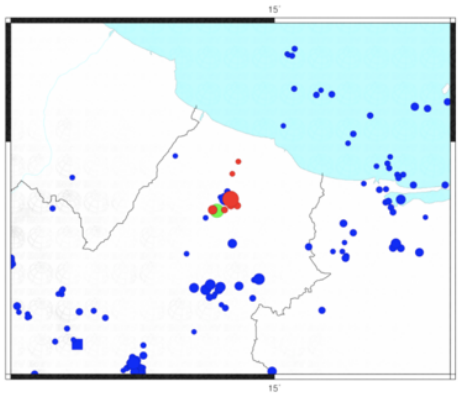
Magnitudo 5.1 – 4 km SE Montecilfone (CB)
2018–08–16 18:19:04 (UTC)

Map seismic event
Epicentral localization of the event having coordinate lat=41.878, lon=14.875 and depth 9km
(Image URL_001: http://bit.ly/2MSpMDE)
Magnitude 5.1 - 4 km SE Montecilfone (CB)
2018-08-16 18:19;04 (UTC)

Mappa sismicita' della regione

Mappa della sismicita' nella regione avente coordinate lat_min=41.503, lon_min=14.25, lat_max=42.253 e lon_max=15.5 con gli epicentri dei terremoti da M>=2.4.
(Image URL_001: http://bit.ly/2w4PBsM)

Mappa della Sismicità dal 01–01–2007 al 16–08–2018



Magnitudo Richter da 2.4 a 5.1.
Profondità da 1.1 a 335.3 km.
Numero di eventi: 155.

Profondità
< 30
> 30

Eventi
Oggi
1 giorni fa
2 giorni fa
precedenti

Magnitudo
7
5
3
1

Map seismicity of the region
Map of the seismicity of the region having coordinate min_lat=41.501 min_long=14.25, max_lat=42.253 and max_long=15.5 with earthquakes' epicenters from M>=2.4.
(Image URL_001: http://bit.ly/2w4PBsM)

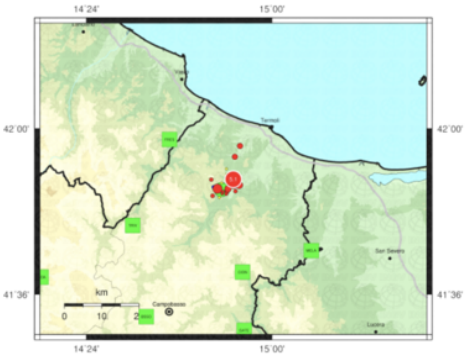
Map of the seismicity from 01-01-2007 to 16-08-2018

Richter magnitude from 2.4 to 5.1.	Depth	Events	Magnitude
Depth from 1.1 to 335.3 km.	< 30	Today	7
Number of events: 155	> 30	1 day ago	5
		2 days ago	3
		Previous	1

Mappa sequenza sismica

Epicentri dei terremoti nella regione avente coordinate lat_min=41.503, lon_min=14.25, lat_max=42.253 e lon_max=15.5 dal 2018-08-09 alle 19:44:30 UTC ad oggi (2018-08-16 alle 19:44:30 UTC).
(Image URL_001: http://bit.ly/2w93tSZ)

Mappa Epicentrale della Sequenza Sismica
per il periodo 09–08–2018 : 16–08–2018



Aggiornata al 2018–08–16,19:44:30 UTC, numero di eventi 38

	Oggi	Ieri	2gg fa	Precedenti
MI < 3.0	14	13	5	1
3.0 <= MI < 4.0	3	0	0	0
4.0 <= MI < 5.0	0	0	1	0
MI >= 5.0	1	0	0	0

Stato della rete
Funzionante Parzialmente funzionante Guasta

(http://iside.rm.ingv.it)

Map seismic sequence

Earthquakes' epicenters in the region having coordinates min_lat=41.503, min_long=14.25, max_lat=42.253 and max_long=15.5 from 2018-08-09 at 19:44:30 UTC to date (2018-08-16 at 19:44:30 UTC)
(Image URL_001: http://bit.ly/2w93tSZ)

Epicentral map of the seismic sequence for the period 09-08-2018 : 16-08-2018

Updated to 2018-08-16, 19:44:30 UTC, number of events 38

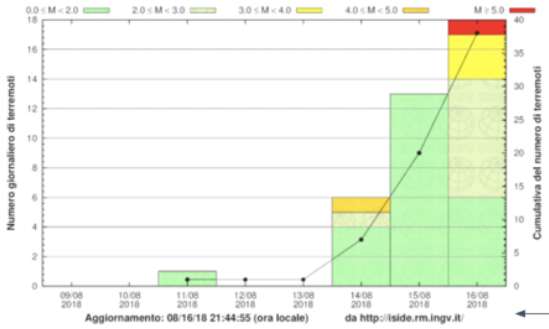
	Today	Yesterday	2 days ago	Previous
MI < 3.0	14	13	5	1
3.0 <= MI < 4.0	3	0	0	0
4.0 <= MI < 5.0	0	0	1	0
MI >= 5.0	1	0	0	0

State of the detectors:

Working	Partially working	Not working

Istogramma sequenza sismica e cumulata eventi

Istogramma dei terremoti e cumulata degli eventi sismici nella regione avente coordinate lat_min=41.503, lon_min=14.25, lat_max=42.253 e lon_max=15.5.
(Image URL_001: http://bit.ly/2wcXn49)



Histogram seismic sequence and cumulated events

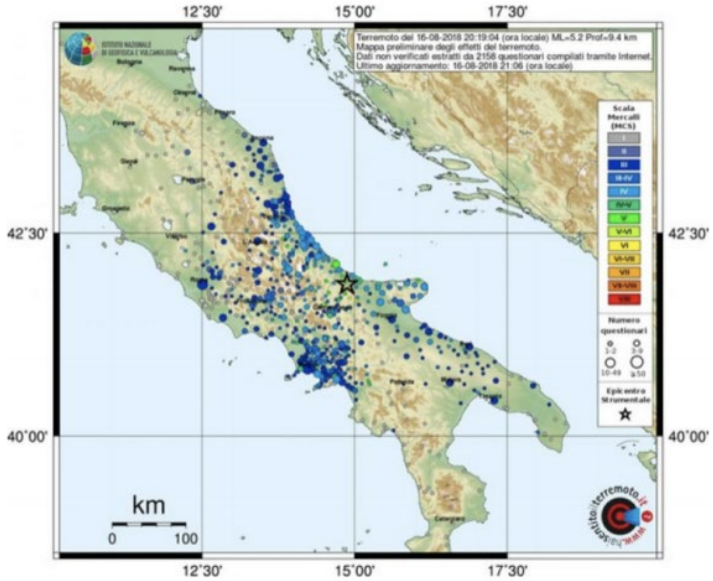
Histogram of the earthquakes and of the cumulated seismic events within the region having coordinates min_lat=41.503, min_long=14.25, max_lat=42.253 and max_long=15.5.
(Image URL_001: http://bit.ly/2w93tSZ)

Left Y: daily number of earthquakes;
Right Y: cumulated number of earthquakes
X: time in days

Update: 08/16/18 21:44:55 (local time) from HTTP://iside.rm.ingv.it/

Mappa di risentimento

Mappa di risentimento (dati non verificati).
(Image URL_001: http://bit.ly/2MviybP)



Resentment map

Resentment map (not verified data)
((Image URL_001: http://bit.ly/2w93tSZ)

On the legend there is the Mercalli scale the intensity is reported.

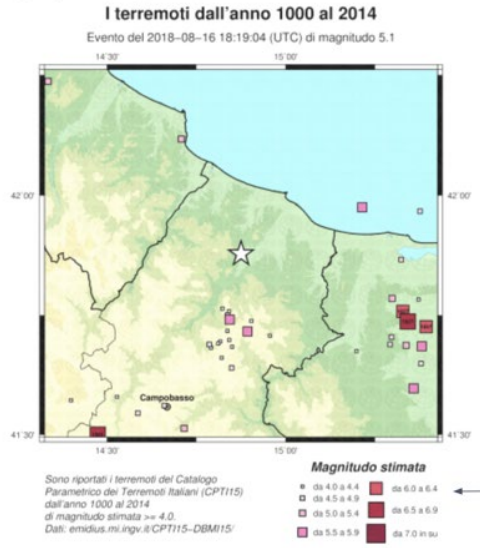
Mappa sismicita' storica di dettaglio

Terremoti storici nella regione avente coordinate lat_min=41.128, lon_min=13.625, lat_max=42.628 e lon_max=16.125 con magnitudo minima 4.0, (CPTI15, http://emidius.mi.ingv.it/CPTI15-DBMI15/).
(Image URL_001: http://bit.ly/2w93vu5)

Map historic seismicity of detail

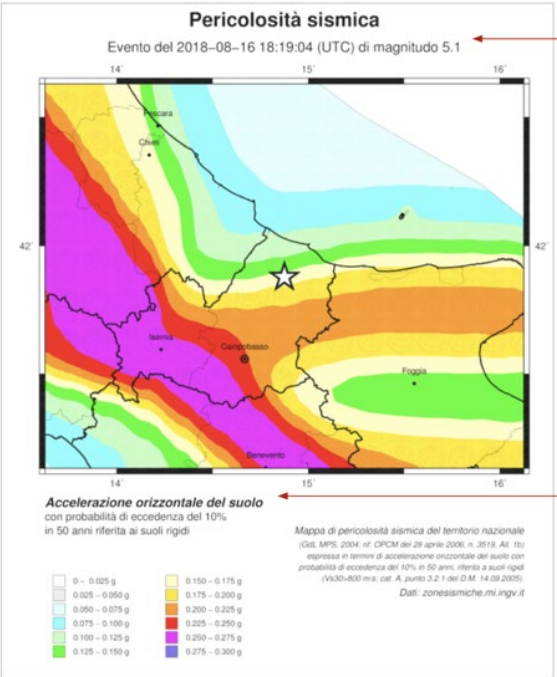
historic earthquakes in the region having coordinates min_lat=41.501 min_long=14.25, max_lat=42.253 and max_long=15.5 with minimum magnitude 4.0 (CPTI15, http://emidius.mi.ingv.it/CPTI15-DBMI15/)
(Image URL_001: http://bit.ly/2w93vu5)

The earthquakes from 1000 to 2014
Event of 2018-08-16 18:19:04 (UTC) of magnitude 5.1



The earthquakes of the Parametric Catalogue of the Italian Earthquakes (CPTI15) are reported from 1000 to 2014 of estimated magnitude >= 4.0.
Data: emidius.mi.ingv.it/CPTI15-DBMI15/

Estimated magnitude	
from 4.0 to 4.4	from 6.0 to 6.4
from 4.5 to 4.9	from 6.5 to 6.9
from 5.0 to 5.4	from 7.0 above
from 5.5 to 5.9	



Seismic hazard
M 5.1 Earthquake happened in 2018

Horizontal soil acceleration
With 10% likelihood of exceedance within the next 50 years referring to rigid soil

Tabella sismicita' storica di dettaglio

Terremoti storici nella regione avente coordinate lat_min=41.128, lon_min=13.625, lat_max=42.628 e lon_max=16.125 con magnitudo minima 4.0, (CPTI15, http://emidius.mi.ingv.it/CPTI15-DBMI15/).

Tempo Origine (UTC)	Lat.	Lon.	Mw	Area Epicentrale
2014-12-24 11:40:11	41.707	14.956	4.3	Molise
2014-01-20 07:12:40	41.367	14.452	4.4	Matese
2013-12-29 19:49:49	41.384	14.44	4.0	Matese
2013-12-29 17:08:43	41.395	14.434	5.2	Matese
2012-09-27 01:08:23	41.176	14.92	4.4	Beneventano
2010-09-17 12:20:18	41.472	15.623	4.3	Tavoliere delle Puglie
2009-08-06 15:36:44	41.648	13.669	4.2	Sorano
2008-03-19 14:38:58	41.898	15.858	4.2	Gargano
2008-02-20 08:06:19	41.582	13.78	4.3	Valle del Liri
2007-10-18 23:25:46	41.695	14.817	4.0	Molise
2007-07-22 17:26:04	41.905	13.671	4.1	Marsica
2006-10-04 17:34:21	42.074	15.746	4.3	Adriatico centrale
2006-05-29 02:20:06	41.801	15.903	4.6	Gargano
2003-12-30 05:31:38	41.64	14.849	4.5	Molise
2003-06-01 15:45:18	41.661	14.821	4.4	Molise
2002-12-02 20:52:59	41.684	14.85	4.1	Molise
2002-11-12 09:27:49	41.689	14.786	4.6	Molise
2002-11-04 03:26:31	41.764	14.823	4.3	Molise
2002-11-04 00:35:47	41.75	14.837	4.5	Molise
2002-11-02 23:28:00	41.738	14.904	4.2	Molise
2002-11-02 06:21:45	41.691	14.811	4.0	Molise
2002-11-02 02:37:01	41.758	14.841	4.0	Molise
2002-11-01 22:44:00	41.682	14.791	4.0	Molise
2002-11-01 17:21:31	41.737	14.841	4.5	Molise
2002-11-01 15:19:54	41.717	14.837	4.1	Molise
2002-11-01 15:09:02	41.741	14.843	5.7	Molise
2002-10-31 13:03:48	41.698	14.842	4.2	Molise
2002-10-31 10:32:59	41.716	14.893	5.7	Molise
2001-07-02 10:04:43	41.783	15.372	4.3	Tavoliere delle Puglie
2000-08-30 13:45:17	42.139	15.535	4.2	Isole Tremiti
1998-09-22 23:23:39	41.792	15.808	4.3	Gargano
1997-04-22 03:12:04	41.401	14.635	4.1	Sannio-Matese
1997-03-19 23:10:50	41.392	14.63	4.5	Sannio-Matese
1996-11-10 23:23:11	41.675	15.198	4.4	Tavoliere delle Puglie
1995-10-05 23:51:50	41.779	15.859	4.0	Gargano
1995-09-30 10:14:34	41.79	15.971	5.2	Gargano
1992-11-05 13:34:28	41.702	15.778	4.3	Gargano
1992-07-16 05:38:54	42.311	14.208	4.2	Chietino
1992-02-18 03:30:10	42.39	14.208	4.1	Chietino
1990-04-22 09:45:05	41.214	14.752	4.0	Sannio
1990-02-13 09:15:29	42.195	15.575	4.2	Isole Tremiti
1990-02-01 06:24:14	42.14	15.649	4.4	Isole Tremiti
1989-10-06 17:38:26	42.118	15.681	4.6	Isole Tremiti
1989-10-05 11:09:17	42.077	15.576	4.3	Isole Tremiti
1989-08-22 14:28:57	42.011	15.485	4.1	Isole Tremiti
1989-03-11 21:05:00	41.762	15.642	4.3	Gargano
1988-08-24 23:05:57	42.024	15.505	4.1	Isole Tremiti
1986-01-18 08:32:44	41.535	14.218	4.1	Isernino
1985-10-27 11:45:28	41.705	15.854	4.1	Gargano
1985-03-14 23:03:51	41.592	14.211	4.4	Isernino
Totale eventi: 263 - Visualizzati: 50				

Table historic seismicity in detail
Historic earthquakes in the region having coordinate min_lat=41.128, min_long=13.625, max_lat+42.628 and max-long=16.125 with minimum magnitude 4.0 (CPTI15, link)

Table columns:
1. date and time
2. Latitude
3. Longitude
4. Moment magnitude
5. Epicentral area

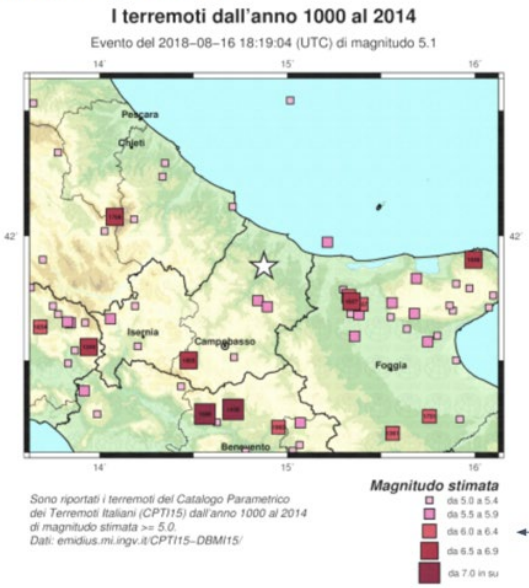
Mappa sismicita' storica

Terremoti storici nella regione avente coordinate lat_min=41.128, lon_min=13.625, lat_max=42.628 e lon_max=16.125 con magnitudo minima 5.0, (CPTI15, http://emidius.mi.ingv.it/CPTI15-DBMI15/).
(Image URL_001: http://bit.ly/2w8P3T2)

Map historic seismicity of detail

Historic earthquakes in the region having coordinates min_lat=41.501 min_long=14.25, max_lat=42.253 and max_long=15.5 with minimum magnitude 5.0 (CPTI15, http://emidius.mi.ingv.it/CPTI15-DBMI15/)
(Image URL_001: http://bit.ly/2w93vu5)

The earthquakes from 1000 to 2014
Event of 2018-08-16 18:19:04 (UTC) of magnitude 5.1



The earthquakes of the Parametric Catalogue of the Italian Earthquakes (CPTI15) are reported from 1000 to 2014 of estimated magnitude >= 5.0.
Data: emidius.mi.ingv.it/CPTI15-DBMI15/

Estimated magnitude
from 5.0 to 5.4
from 5.5 to 5.9
from 6.0 to 6.4
from 6.5 to 6.9
from 7.0 above

INGV to National Fire and Rescue Service

INGV shares their own reports of all seismic events of a magnitude greater than 3 (e.g. using digital cartography via WebGis) and the reports of the civil protection with the National Fire and Rescue Service. These reports detail the magnitude, location, and vulnerability - in terms of the number of inhabitants concerned and more detailed information about the buildings involved. If an earthquake lower than magnitude 3 occurs and it is felt by the population, provincial or municipal civil protection may manage the emergency instead.

INGV to the general public

Various channels are used by the INGV to communicate to the general public (http://istituto.ingv.it/images/Convenzioni_DPC/convenzione_dpc_ingv_a_%202020_2021_fg_con_pda_allegati_23dic2019pdf_SS.pdf) for example:

- Social media: in the case of a felt earthquake, information deemed reliable is posted on a variety of social media platforms such as Twitter, Facebook, YouTube and various blogs. An automatic message is released 2 minutes after the shaking to ensure the media (e.g., ANSA (National Associated Press Agency) and TG 24 (Italian TV channel)) cite this official information in their initial reports. A revised message is then sent 10 or 15 minutes after the earthquake event (see Appendix). The first message delivered is provisional and reports the minimum and maximum magnitude of the earthquake with a 95% probability i.e. there is a 95% chance that the true earthquake magnitude will be between the maximum and the minimum values of the magnitude reported. The second message reports the exact magnitude. According to some studies carried out, the number of retweets of the first, automatic tweet is greater than of the revised ones (Amato et al., 2020).

- Website: the INGV website publishes a long-term section called STORY MAPS, where different dashboards report various earthquake related statistics (e.g. past earthquakes that have occurred over various timeframes; the values of ground acceleration that have a 10% likelihood of being exceeded within the next 50 years). See Appendix for example screen shots. It also publishes shake maps (e.g. Figure 8 and hazard maps (e.g. Figure 9), that are designed to report the likelihood of experiencing earthquake ground shaking that exceeds a pre-set threshold within a specific geographical area and timeframe. Finally, it has a banner running at the top of the page when a crisis event occurs, and important information needs to be communicated (http://ismd.mi.ingv.it/notes-hazard.php).

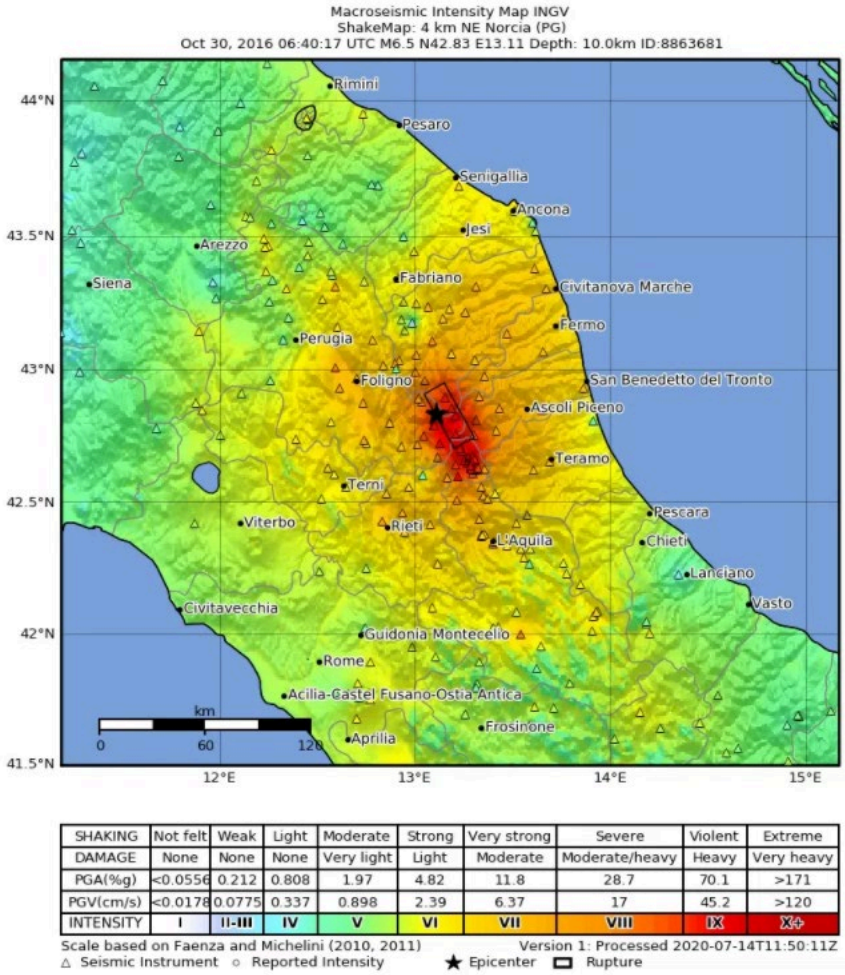


Figure 8: ShakeMap provided by the INGV https://ingvterremoti.com/2021/05/25/il-nuovo-sito-delle-mappe-dello-scuotimento-sismico-shakemaps/

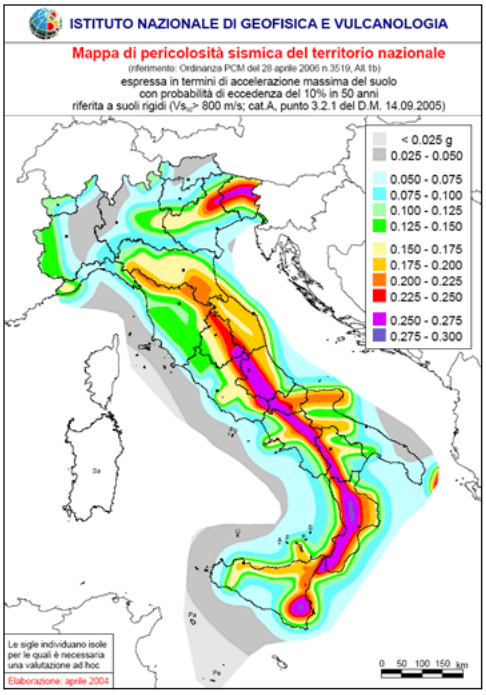


Figure 9: Seismic hazard map provided by the INGV. Source: http://zonesismiche.mi.ingv.it/

- Apps: INGV has smartphone apps for both IOS and Android running, presently under renovation. See Appendix for example screen shots.

- Press release: In the event of an earthquake, a press release is prepared. This includes a list of people prepared to speak to the press. The press releases tend to be structured in a bullet point format so that the press is given guidance as to which topics to cover (e.g. the geographic area where the event happened, the seismic history of the area, what is likely to happen next, a recommendation to use the seismic hazard map).

Civil Protection and INGV educational activities

During times where there is no major seismic activity, the INGV collaborates with different levels of civil protection (e.g. national, regional, local etc) to organise different activities and provide resources, including:

- A continuous training/information programme to schools through visits at INGV headquarters.
- Responses to data requests via the production and sharing of documentation, and the convening of meetings or ad hoc work groups.

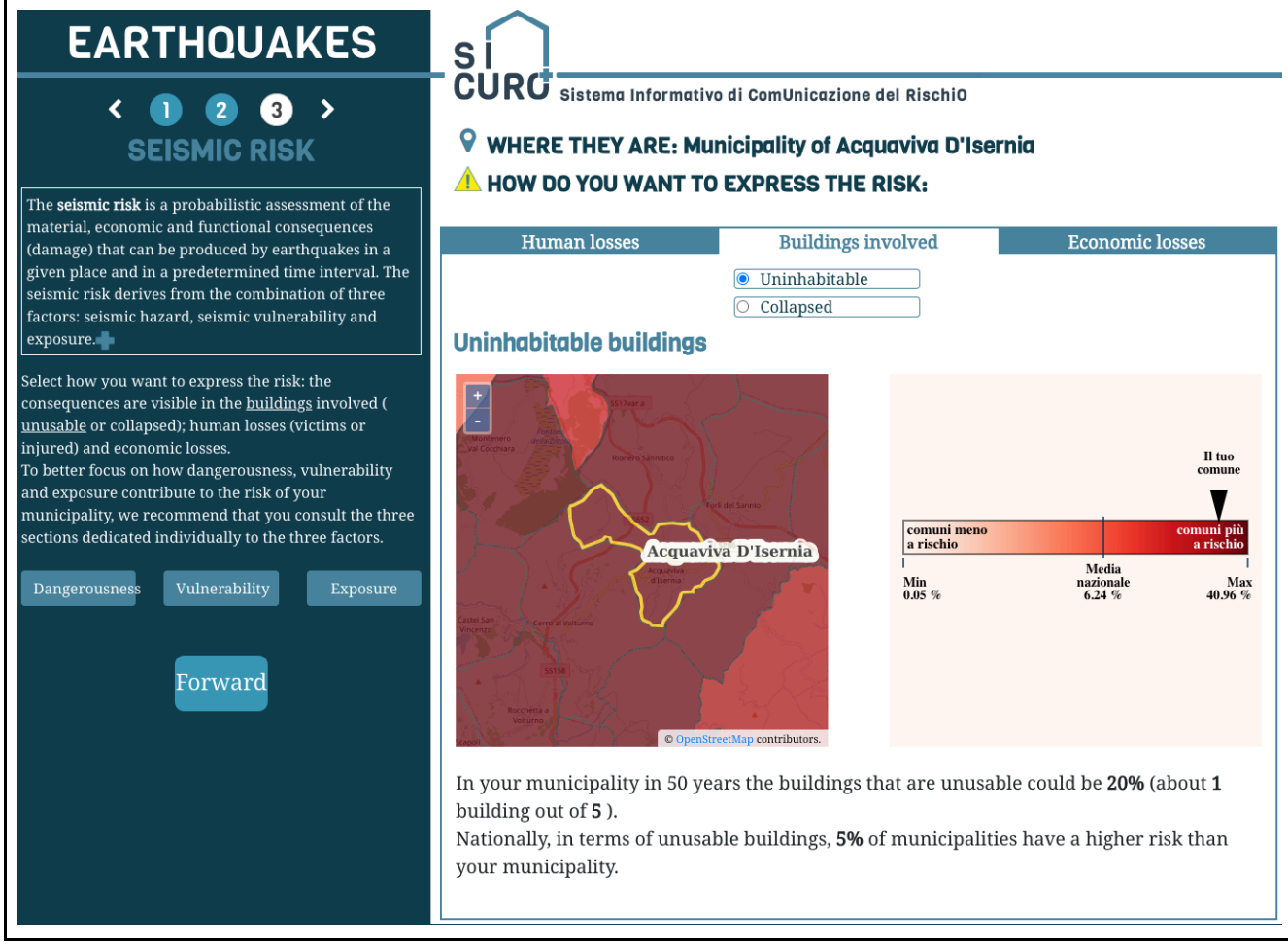
Note that there is no regular training offered to journalists in how to interpret or report seismic events.

The Eucentre

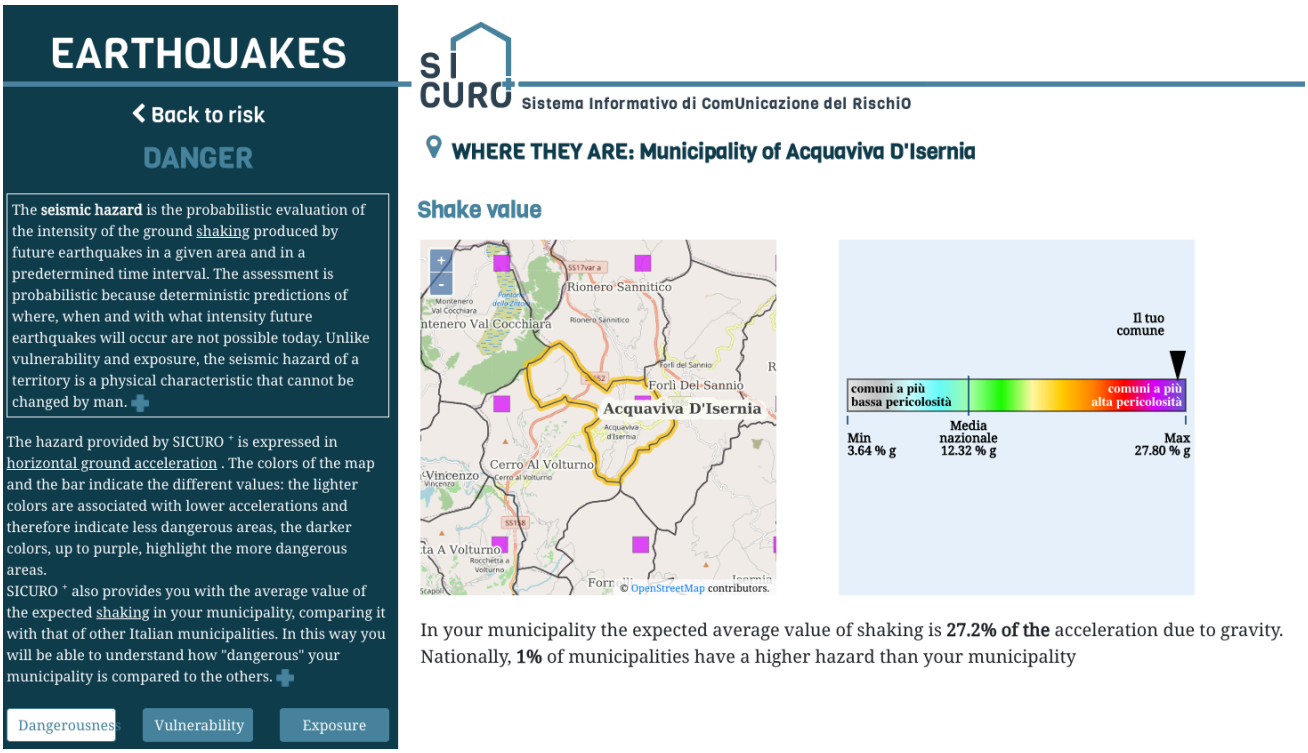
The Eucentre, in collaboration with the civil protection, provides risk and hazard maps to the general public on its website Sicuro+ (https://www.sicuropiu.it/index.html), comparing the seismic activity in different regions (including both the seismic hazard and the vulnerability of the buildings and population) (see Table 2). This website is always publicly available, not only in the case of earthquake swarms.

Table 2: Sicuro.it website from Eucentre in collaboration with the Civil Protection

Seismic risk

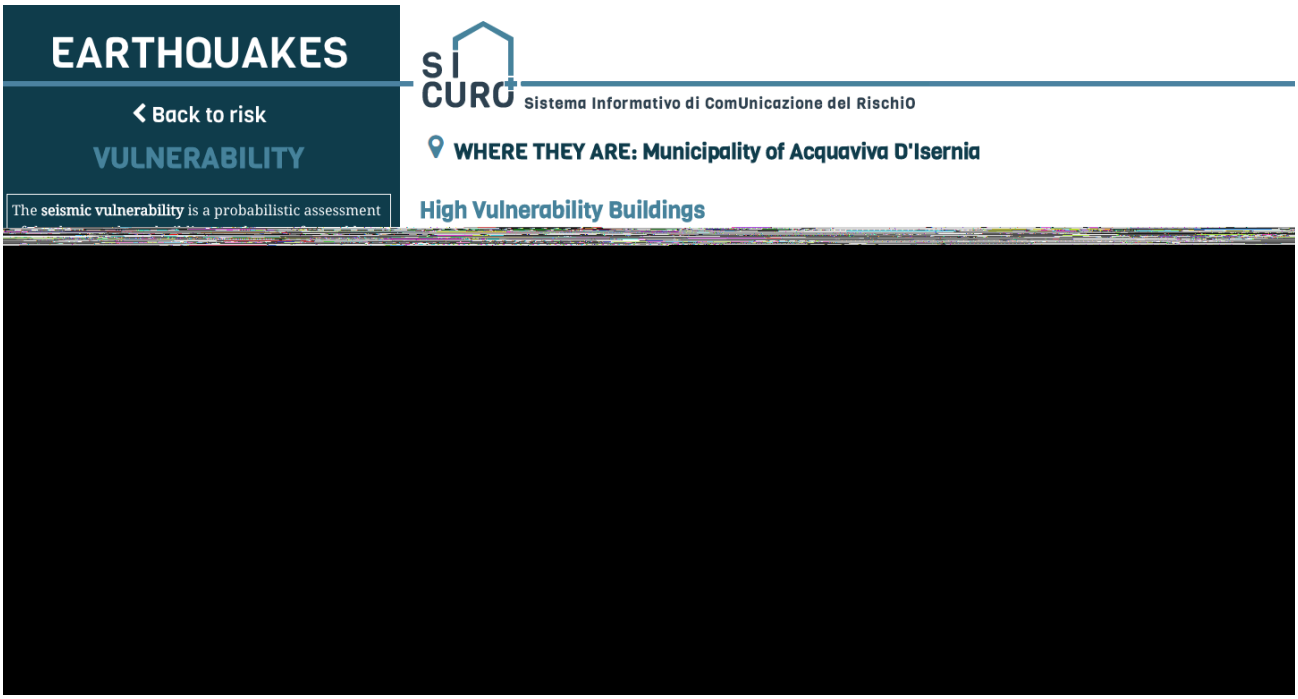


Seismic hazard



In your municipality the expected average value of shaking is **27.2% of the** acceleration due to gravity. Nationally, **1%** of municipalities have a higher hazard than your municipality

Seismic vulnerability



Seismic exposure

Infrastructure managers

Managers of infrastructure are the people in charge of the operation and maintenance of building systems and services. Their role is to ensure a safe, secure and legal work environment. As such, they require information on seismic hazard in order to perform this role successfully.

In the location where building infrastructure is planned, a localised study has to be carried out that involves certain actions e.g. geotechnical testing to study the specific characteristics of the ground at that location, and the relative seismic amplification. Some testing is carried out in the field, some in the laboratory.

If building work is planned on an already existing building, the current seismic vulnerability verification is carried out, or other checks are performed. This process involves a search of the original drawing of the buildings (found in various places, for example the “genio civile” - administrative storage centre) and can be combined with field investigations. The original documentation related to the building should include all the names of the people involved in the building planning, such as the static designer, the static director of work and the test overseer (a structural expert who is different from the other professionals). This allows individual accountability for adherence to design regulations.

Infrastructure managers receive seismic information when undertaking construction work. Their information comes from:

- INGV, from whom information on expected ground acceleration and seismic hazard zone classification (see earlier) for the location can be obtained. This allows the infrastructure managers to calculate further parameters.
- The municipality within which the building work will be conducted, who draw up a management plan of the territory where seismic, geological and hydrogeological details are shown. This information about the characteristics of the ground can be provided on request to infrastructure managers when building is planned.

What happens during an earthquake emergency?

Although there are no pre-set magnitude thresholds that activate particular levels of response, if an earthquake of magnitude 6 or above occurs, the national level of response is very likely to be activated. In the event of any damaging earthquake, the Prime Minister decrees a State of Emergency, where they can appoint special commissioners who are government officials who deal with the specific assignment according to Act. 5 of Law 225/1992.

When an earthquake first occurs, the mayor of the associated municipality is responsible for the initial handling of the situation. Straight after the event, the provincial and regional Civil Protection typically contact the mayor via phone (or via radio if a phone call is not possible). If, after a visual assessment, the municipal mayor feels they do not have enough resources to handle the emergency on their own, they ask for help from the provincial, regional and/or national level. If necessary, assistance is requested at the European level. There is no delegation of responsibilities however; the municipal mayor remains in charge of all their duties but becomes supported by other roles within the Civil Protection. All institutions involved in the emergency situation (e.g. the Red Cross, the fire brigade, volunteers) are hierarchically organised so that the national level gets information from the various regions rather than from each and every one of the 7903 Italian municipalities. Thus, the national level interacts with the regional level, and the regional level with the municipal level, but there is no direct interaction between the national and municipal levels.

For emergencies that a municipality requires assistance with, there are several different phases that occur:

1. Gathering of the National Operational Technical Committee (OC)

Initially, the National Operational Technical Committee of the Italian National Civil Protection Department is set up. The committee manages the coordination of emergency response activities at the national level. Internally, it gathers national representatives from the armed forces, the fire department, police forces, the Italian Red Cross, the National Health Service, voluntary organisations, technical and scientific agencies (e.g. INGV and the Italian Institute for Environmental Protection and Research (ISPRA)), infrastructure network managers, mobile phone service providers etc, who can make decisions (e.g. financial) without the need to consult someone else. A video conference is conducted between this committee and the corresponding representatives of each region and the autonomous provinces of Trento and Bolzano. It is chaired by the Head of the National Civil Protection Department and located within the National Operational Room in Rome, which converts into a crisis cell equipped with technical and communication systems to provide assistance for meetings.

Alongside the National Operational Technical Committee, further committees are activated at lower levels, such as (in descending order of size):

- The Operational Regional Centre (COR): operates at the regional level.
- The Rescue Coordination Centre (CCS): operates at the provincial level.
- Mixed Rescue Coordination Centre (COM): operates at the municipal level.
- The Operational Town Centre (COC): headed by the town mayor.

All the communications within the committee occur via phone call and SMS, with a radio channel backup. The provincial-level Rescue Coordination Centre alerts the regional-level Operational Regional Centre of an earthquake occurrence, who then alert the National

Operational Technical Committee via phone calls or radio. They also use software called SUPREME that collects all this information for accountability purposes.

The National Operational Technical Committee also receive information from:

- Regional representatives of different rescue teams.
- Social media - e.g. public pages on Twitter, Telegram.
- INGV.
- Other members of the Department of Civil Protection.
- Information from satellites when available.
- Images from helicopters and drones to help understand the topography, which will affect rescue efforts.
- People's calls reporting the earthquake, which helps them to see where the affected areas are located.
- Images from "You Report", a system of cameras located around cities for real-time monitoring. It is possible to connect directly to the cameras on buildings.

2. First response from the fire brigade

Meanwhile the fire brigade enters the affected area, as by law it has a duty to determine whether the area is safe for others or not. The fire brigade can deny access to buildings if it deems them not safe for rescue work. Firemen on duty must keep their phone switched on at all times to be able to respond in case an emergency occurs. The responsible manager in the fire brigade, who is usually an engineer, takes a helicopter tour to report the situation and estimate the resources required for the fire brigade to operate. This information is provided to the National Civil Protection Department on request.

3. Task force sent to the epicentre

While the National Operational Technical Committee is assembling, a small task force (including members of the armed forces, police forces, Red Cross, volunteer associations and psychologists for emergencies who are proximal to the location of the event) is sent directly into the field with radio and satellite phones. This enables direct contact with people within the affected area. Information is reported back to the National Operational Technical Committee.

4. Assessment of need for resources

Once it has made contact with the affected region and ascertained the need for resources, the National Operational Technical Committee informs the various Italian regions and autonomous provinces via video conference. The Department of Trento, an autonomous province, sends a further, separate official communication to the affected region via email, to ask whether they can help with supply (e.g. water, tents, food), means of transport, and human resources. Later on, they call to make sure the email has been received.

5. Rescue teams in the field

Once the need for resources has been assessed, further members of the task force of armed forces, police forces, Red Cross, volunteer associations and psychologists are activated and travel to the epicentre.

Within the team supplied by each volunteer association, one becomes the nominated manager. Once they reach the affected area, the manager of each team makes their way to the Operational Town Centre (COC) and provides the COC with the names and contact details of all the members/volunteers in their group. Volunteers tend to go directly to the COC, however if unforeseeable problems arise, they may go to different locations e.g. the Operational Regional Centre (COR), and in all these places the procedure is the same. All follow the orders given to them by those in Civil Protection who are running the COC, and team managers report to their association presidents via calls.

6. Command and Control centre (DICOMAC) creation

The National Operational Technical Committee remains in video conference until the DICOMAC gets created, usually within two days of the emergency. The DICOMAC is the centre of Command and Control that directs the rescue activities. It is built in an area close to the affected location but with lower risk, and becomes the new headquarters of the National Operational Technical Committee where members gather and can coordinate all activities, e.g. rescue activities, communications. However, there is no official communication strand for operational earthquake forecasting and the likelihood of aftershocks. Sometimes the Prime Minister attends meetings at the DICOMAC.

7. Campsite life

A campsite is set up for those displaced by the emergency. Every day the head of the campsite, who tends to be a person most of the citizens trust and who has received special training, gathers together with the various field representatives (e.g. of the armed forces, Red Cross etc) to discuss what has happened, what is ongoing, and future actions. Within the campsite, members of the Civil Protection communicate with one another via loudspeakers, radio transmitters, normal phones and word of mouth. The loudspeaker tends to be used in case of a missing person, an important meeting, or if activities are being set.

Each volunteer in the field has a tablet and an extra battery provided by the Civil Protection Department, so that they can write reports and place them within a shared folder visible internally by all members of their volunteer association.

8. Recovery phase

After the emergency has been dealt with, the recovery phase takes place. In this phase, standing temporary or permanent living modules called MAPs, are built, and people are asked whether they prefer to stay in these MAPS or to go to available hotels. The details of people accommodated in both the hotels and the campsite are held in software called “DESIGNA”.

9. End of emergency status

The emergency status ends when the Prime Minister releases the Decree of Emergency ending.

Alongside the emergency response detailed above, four technical groups are activated and deal with different activities according to an agreement between the Department of Civil Protection and the INGV:

- SISMIKO: installs a temporary seismic network to better monitor the seismic activity around the epicentre.
- EMERSITO: studies the site effects due to local geology.
- EMERGEO: detects the geological effects of an earthquake.
- QUEST: undertakes macro seismic inspections.

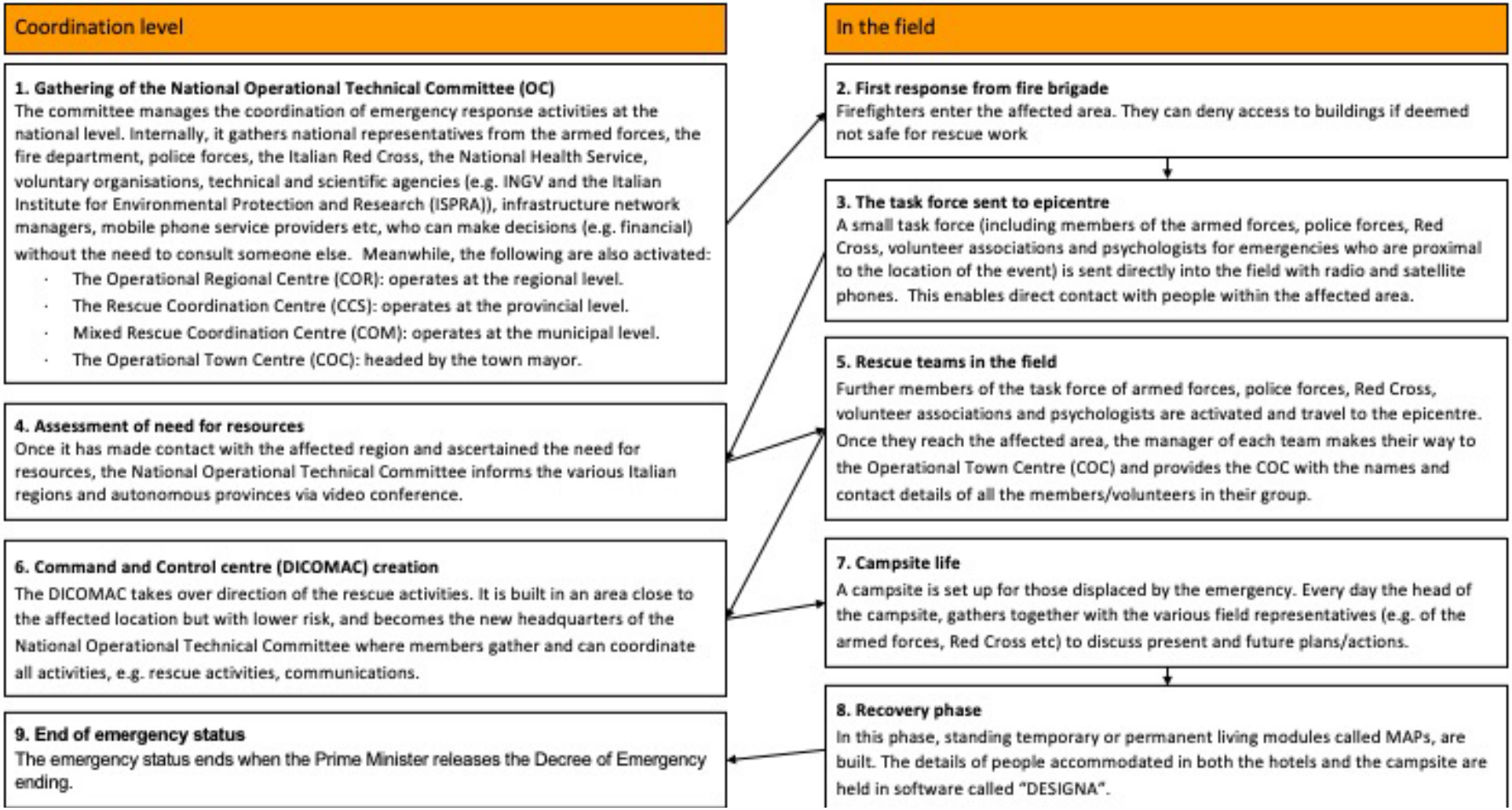


Figure 19: The Italian communications network in the event of a seismic event

Amatrice – A case study of communication during a seismic emergency

Interview with a volunteer about his experiences in the field after the 2016 earthquake in Amatrice.

03:36 The earthquake happens.

03:38 INGV sent me the first message with the M 6.2 and depth 4 km and the epicentre. I woke up, I called my director and the operative room. The second message said M 6 and depth 8 km and the epicentre, and the third message confirmed the 2nd one. Within 15 mins the scenario was clear and we knew we would have to work on it for years.

The director asked me to leave and to do assessments to check the number of injuries to organize the number of resources needed. Everything happened very quickly, and everything was agitated because you realize that you have to handle something. These are particular moments during which, as during all emergencies, you set aside all plans, it is a matter of interpersonal relationships. I had met a person and I called this person who I knew was there (...) It is more difficult to organize training activities than to get ready for the real emergency, as the emergency leaves you a broader scope, especially in the first days. No one will be asking you why you have bought 100 bottles of water because they are of help. While the training has set paths, in an emergency, you have the situation that dictates the timing, you have to use the possibilities that the sequence of events gives you, moment by moment.

My director called me after 30 minutes and told me to go and do this assessment. So, I left and I arrived in Amatrice with a colleague of mine I met in Rieti. He was not an expert. Our first mission was to contact the colleagues of the department to help the Mayor to settle the Operative Centre of the Municipality that has to handle the emergency. Going there, we passed along the main street with all the aftershocks and people rescuing victims, both dead and alive. We met the Mayor and others, we collected the first contacts and we did the first meetings. The first thing I had to do was to find a place to put the first victims that met certain requirements: cold, so that the bodies were preserved; clean, as the relatives arrive to identify them; accessible, for example to the magistrate and various Consulate officers.

So I found this place and I entered the meeting room, but I was told that it is not feasible anymore because the number of victims had doubled. You have to develop very strong relationships, then you do your assessments to better understand. Such assessment is visual and it is done in a possible scenario answering questions like - How many people live in that place, how many should be evacuated, how many are leaving, how many want to remain. The evaluation is rough. It is based on my feelings and experience. The assessment has to be done very quickly because the most important thing is that people have a place to eat and sleep within 24 hours. This is based on need, not on a rule.

Then we called the director and we told him to stop the Regional Mobile Column [i.e. police force, volunteers etc] arriving in Rieti because it was chaos, and it was useless to bring so many people. This was a rule that didn't work because the volunteers, although so helpful, didn't follow our order and they still came and this created even more chaos. Not all the streets were accessible because the bridges were unstable so we had just one accessible way. We also had another Municipality in Lazio where there was an earthquake.

We gave the first meal at 2 p.m. in the afternoon. You have to calculate from 6 a.m. till 2 a.m., you have to organize a kitchen for 300 people. The first thing you have to do is to set up a tent and while the people go out from their tents to eat, clean themselves, check their houses, you need to pack up the tent, put the under-tent and then set up the tent again.

Then, within the first 3 days, you have to set up all the further things such as walkways, electric cables, air conditioners, heaters. Then little by little, you make people part of the process because they will have to live there for some months, so you ask them to give names to the street, to do tables together with volunteers to give them a sense of belonging, to make them active, and then you start preparing a social area to provide wifi, charge phones, provide PlayStation. The more the days pass, the more you have to organize the camp. All the volunteers arrive from places far away so you need to wait for the volunteers.

Current communication pathways for seismic information in Switzerland

National organisation

Switzerland is a federal republic of about 8.5 million people, covering around 41,000km^2 and composed of 26 cantons, with federal authorities based in Bern. The government is a federal semi-direct democracy under a multi-party assembly-independent directorial republic, with seven federal councils. The three largest cities are Zurich, Geneva and Basel. Furthermore, Switzerland has four national languages, i.e. German (~62.8%), French (~22.9%), Italian (~8.2%) and Romansh (~0.5%).

In Switzerland, earthquakes are the natural hazard with the greatest potential for damage. With a monitoring network consisting of more than 200 seismometers, the Swiss Seismological Service (SED) at ETH Zurich records 1,000 to 1,500 earthquakes per year, about 10 to 20 of which are actually felt by Swiss citizens. There is roughly a 1% probability of a damaging earthquake with a magnitude 6 or higher within the next year. The last earthquake of that strength occurred near Sierre in the canton of Valais in 1946. The strongest recorded earthquake in Switzerland occurred near Basel in 1356 with a magnitude of about 6.6. In general, Valais is the region with the highest hazard, followed by Basel, Grisons, the St. Gallen Rhine Valley, Central Switzerland and the rest of Switzerland (Figure 20).

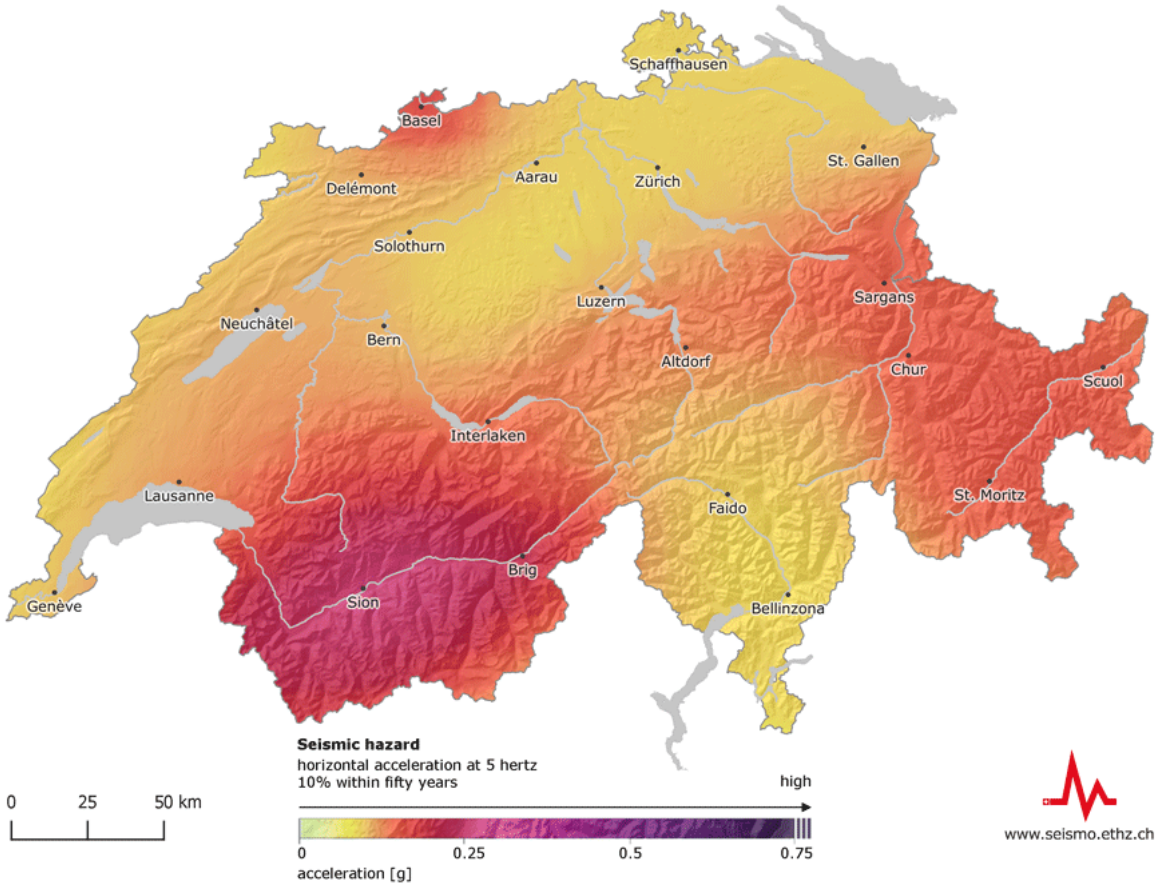


Figure 20: Long-term seismic hazard in Switzerland
[Source: http://seismo.ethz.ch/en/knowledge/seismic-hazard-switzerland/]

Earthquake-resistant construction offers the best protection against the consequences of serious seismic activity. In Switzerland, construction, i.e. building codes with applicable standards, is governed by the cantonal legislation. In addition, the cantonal and municipal authorities have emergency plans in place to react to severe earthquakes. On the national level too, the Federal Office for Civil Protection (FOCP) has defined emergency procedures which get activated depending on the severity of the quake. Furthermore, the FOCP, the police and firefighters are allowed to give behavioural instructions. The SED, as a federal institution, has the mandate to inform the various stakeholders and the public and to provide advice.

Who makes decisions regarding actions to be taken in the light of seismic information?

The SED, as the responsible national authority, suggests the thresholds for different communications. Generally, earthquakes are of interest when they are at a level that can be felt or cause damages. Therefore, the information thresholds are organized around these two main interests. First information is always distributed automatically to inform the different stakeholders as fast as possible. Only thereafter is the information verified in detail by an expert and additional information provided if needed. The federal authorities can only provide recommendations and advice. It is up to the cantonal and communal authorities to issue orders e.g. to evacuate an area.

The SED also takes seat in the "Bundesstab", a crisis management group consisting of permanent members (i.e., governmental group) and - depending on the nature of the crisis - additional specialists e.g. seismologists. In this group important decisions on a national level are made and information is shared.

Who generates seismic information?

The SED provides a long-term hazard map and rapid information after earthquakes. The SED is currently also working on a Swiss Seismic Risk Model which will be publicly released in 2022. The SED has ongoing research activities in the following domains: Earthquake Early Warning and Operational Earthquake Forecasting.

Over 200 seismic monitoring stations operated by the SED monitor the seismic activity in Switzerland and its neighbouring countries in real-time. The stations are spread all over the country and installed at various sites like caves, tunnels and boreholes. The processing centre in Zurich acquires data recorded in Switzerland from the Swiss National Network (CHNet) consisting of both the Swiss Digital Seismic Network (SDSNet) and the Swiss Strong Motion Network (SSMNet). Furthermore, the SED operates also temporary networks in order to monitor increased natural seismic activity, do aftershock deployments, monitor geothermal exploration, support research and educational projects (e.g. AlpArray and seismo@school), or industry projects by third-party assignment.

The SED monitors ground shaking 24/7 days a week. Within approximately 90 seconds after an earthquake, details about the time, location, magnitude, and possible effects are published on the SED website and on the twitter channel in three national languages (German, Italian and French) and English (Figure 21). In addition, above certain thresholds (see below), national and cantonal authorities as well as the media, are informed by email, SMS or pager.

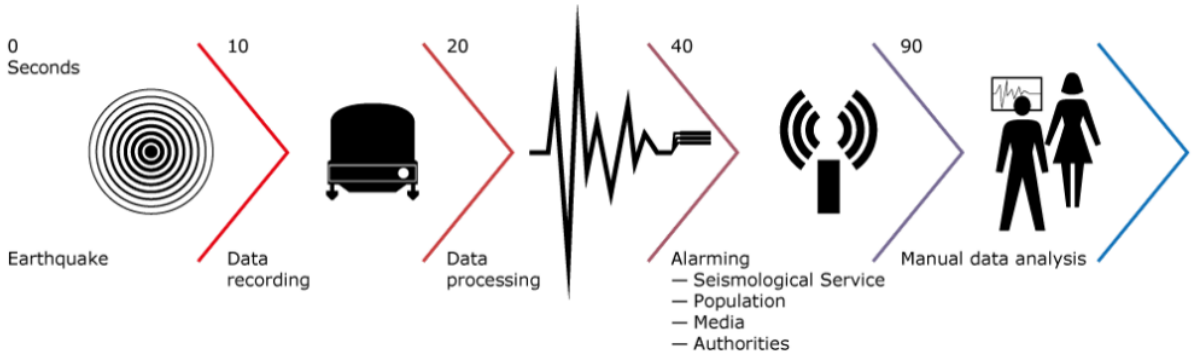


Figure 21: Time-dependent alerting system in Switzerland

In addition to real-time data, the SED also provides information about on-going projects related to earthquakes, provides general behavioural recommendations on what to do before, during and after an earthquake, material for schools and data and models, and offers training courses (e.g. Certificate of Advanced Studies “CAS”).

To whom does the SED communicate directly?

The SED automatically reports any potentially felt earthquakes (M>2.5) directly …
… to the National Emergency Operations Center (NEOC) at the Federal Office for Civil Protection (FOCP),
… the cantonal authorities,
… specific institutions (e.g. Swiss federal railways),
… the Common Information Platform for natural hazards (GIN) for experts,
… the National Hazard Portal operated by the Federal Office of Meteorology and Climatology MeteoSwiss,
… the Swiss weather App operated by MeteoSwiss,
… the media,
… and the general public.

This information is transmitted to the SED’s 24-hour on-call service by pager, e-mail, and SMS. This service is also available to the authorities and the media for further information about current earthquakes. Background information is published on the SED website.

As part of the Swiss Rescue Chain, the SED also informs the Swiss Humanitarian Aid Unit (SHA) about any earthquakes that cause major damage worldwide. The SHA then conducts further investigations and decides whether or not to dispatch a rescue team with search dogs to the disaster area.

How often?

One can differentiate between information that is always available on the SED website (e.g., long-term hazard map, behavioural recommendations, description of the origins of earthquakes) and information that is communicated after an earthquake occurred (e.g., notifications, shakemaps).

Regarding the dynamic information after an earthquake, we summarized the announcement products as well as the used channels and the reached stakeholders in Figure 22. Additionally, the threshold for the announcements communicated to specific stakeholders or disseminated through specific communication channels are indicated with the colours green to red. A green path is activated for all events and the orange pathways for example are activated from magnitude 3 onwards. The thresholds were chosen because from magnitude 2.5 the earthquakes are potentially felt and thus the public asks for information. From a magnitude 3 onwards events are most likely felt and events with a magnitude of 5.5 or higher are very likely to cause severe damage.

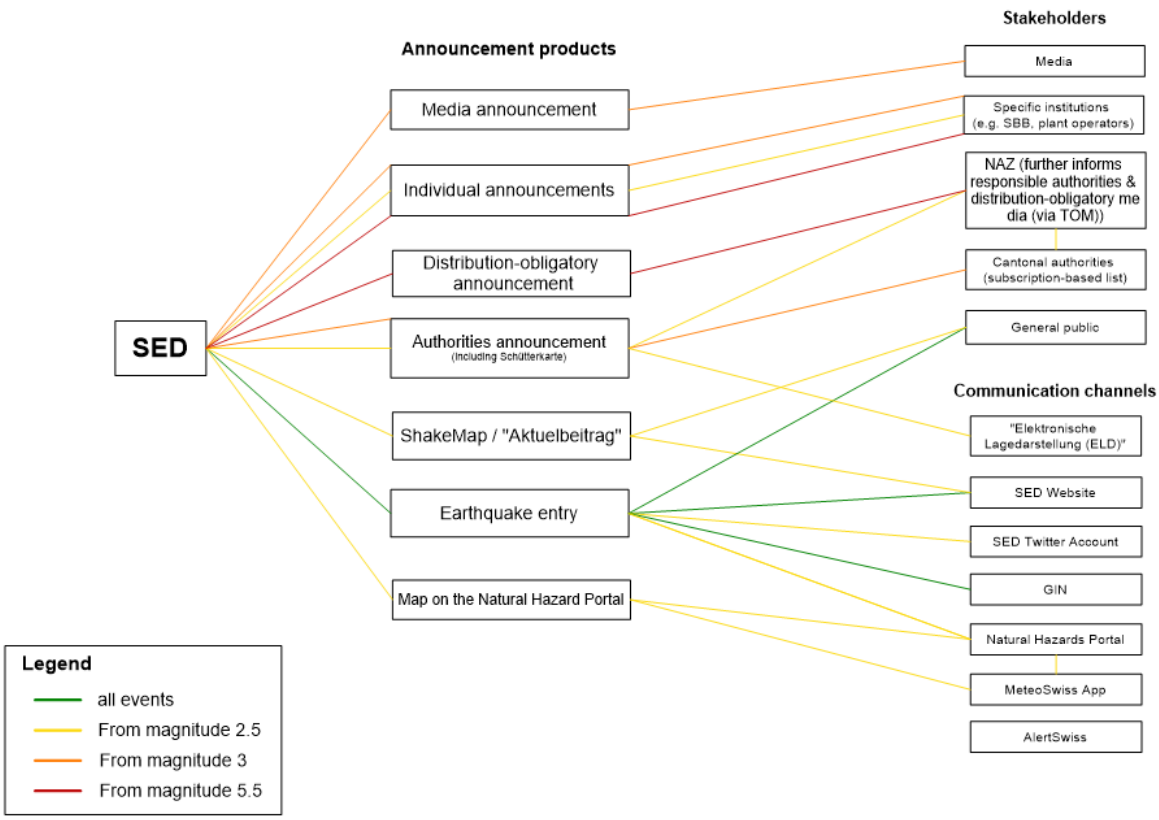


Figure 22: Products, stakeholders and communication channels differentiated according to the magnitude of the earthquake

In what format?

The static information about earthquakes is always available on the SED website. The general information about earthquakes (e.g., origin, historical events, behavioural recommendations) are additionally available on the national multi-hazard platforms (Natural Hazard Portal and AlertSwiss). On the SED website, there is also information about the on-going and already finished research projects, the seismic situation in Europe and worldwide, material for teachers and students andQ&A pages. The information thereby is often a combination of different formats namely a visualization, an explanation text and also tables. Moreover, for certain issues there are also videos for non-experts available (see an example in Figure 23). In addition, the SED has an open data policy, which means that the collected data is available openly and in a format that is commonly used (i.e., FAIR - findable, accessible, interoperable, reusable).

Impacts of Earthquakes

How clearly an earthquake is felt depends not only on its strength, but also on the depth of its seismic focus (hypocentre) and on the local subsoil.

Earthquakes in soft ground (e.g. in valley sediments, lake deposits) are felt more than earthquakes in rocky subsoil. The type of subsoil in the locality also affects the resulting damage: earthquake waves in sediment-filled valleys (like the Rhone Valley) are 10 times stronger than in solid bedrock and cause correspondingly greater damage. As a rule, the more solid the subsoil beneath a building is, the less damage earthquake waves can cause.

Watch the video to see how the waves in a simulated earthquake in the Rhone Valley spread and how long they remain 'trapped' in the valley floor.

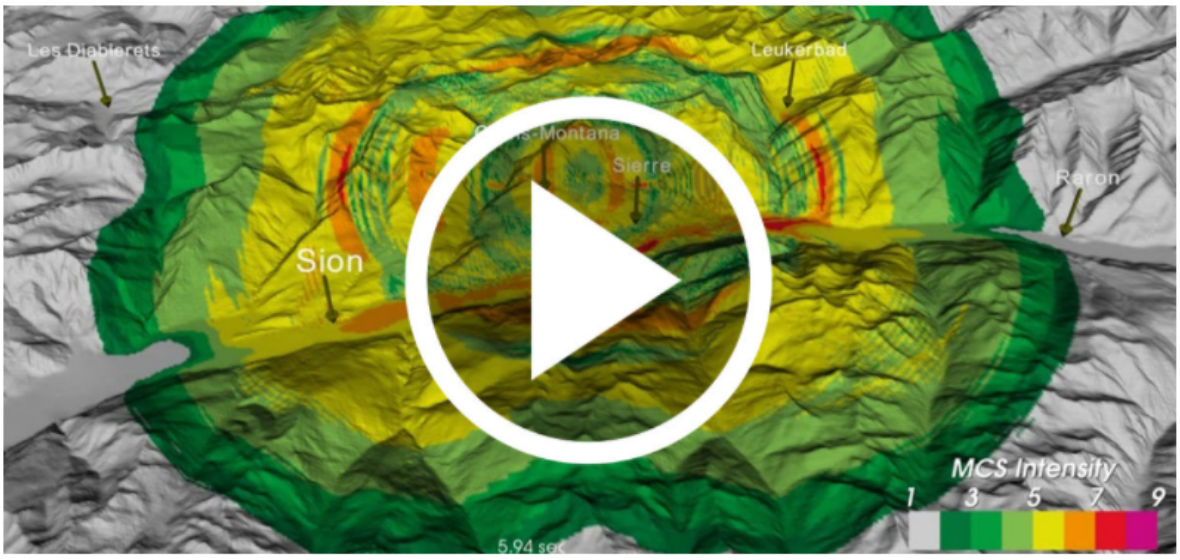
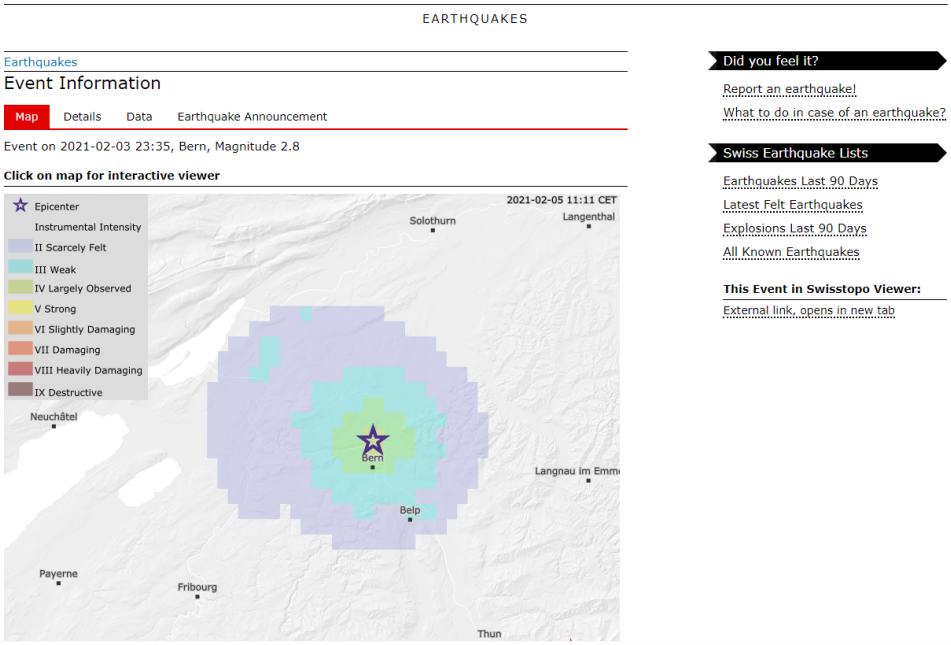


Figure 23: Example of general information that is permanently available on the SED website. [http://seismo.ethz.ch/en/knowledge/things-to-know/impacts/]

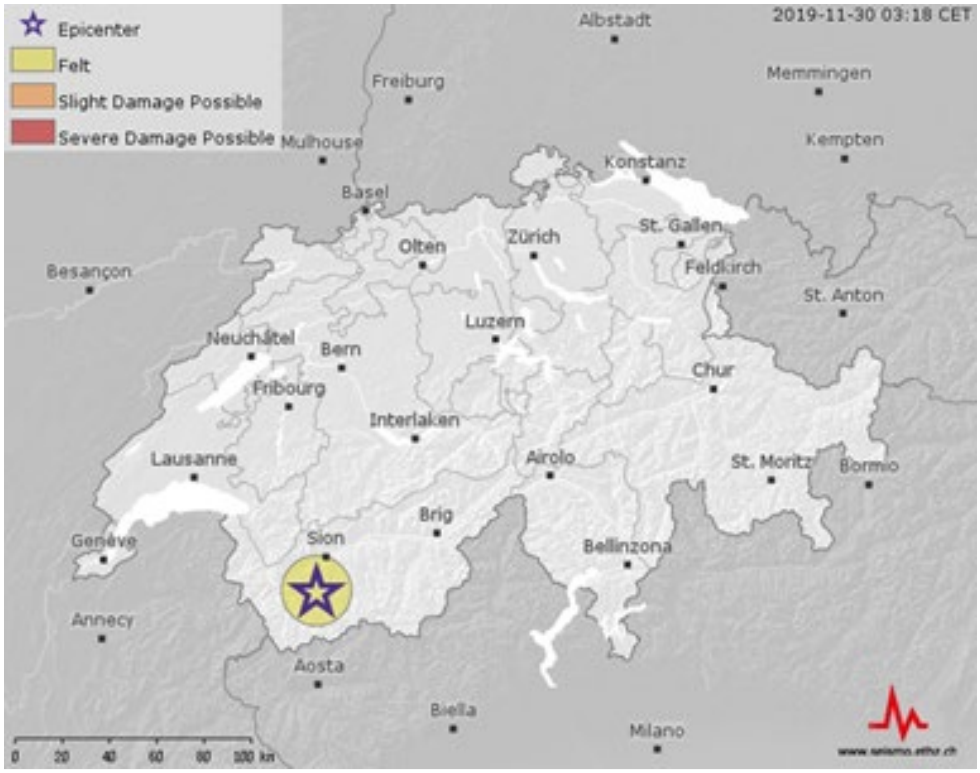
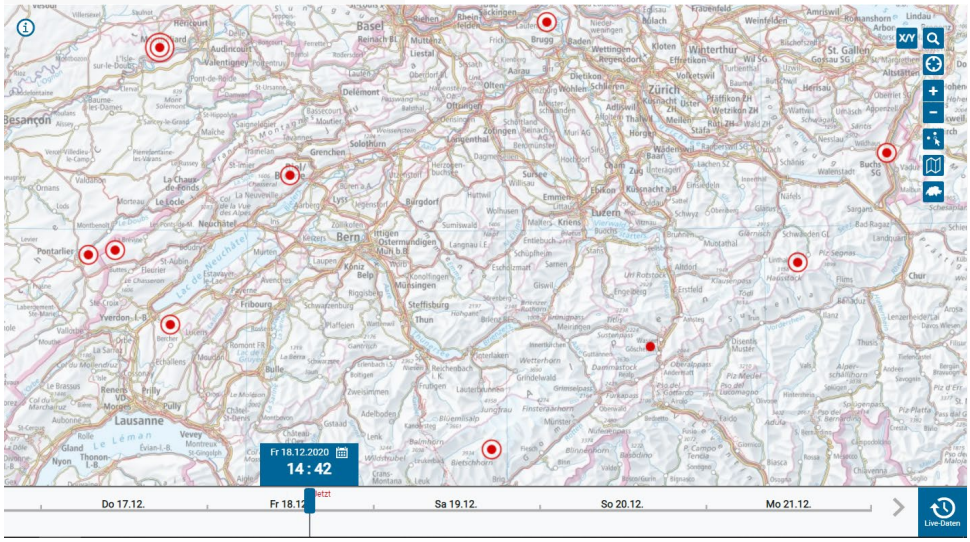
Regarding the information after an event, we list exemplary announcements in Table 3 and described under which circumstances (i.e., thresholds) the different stakeholders receive them.

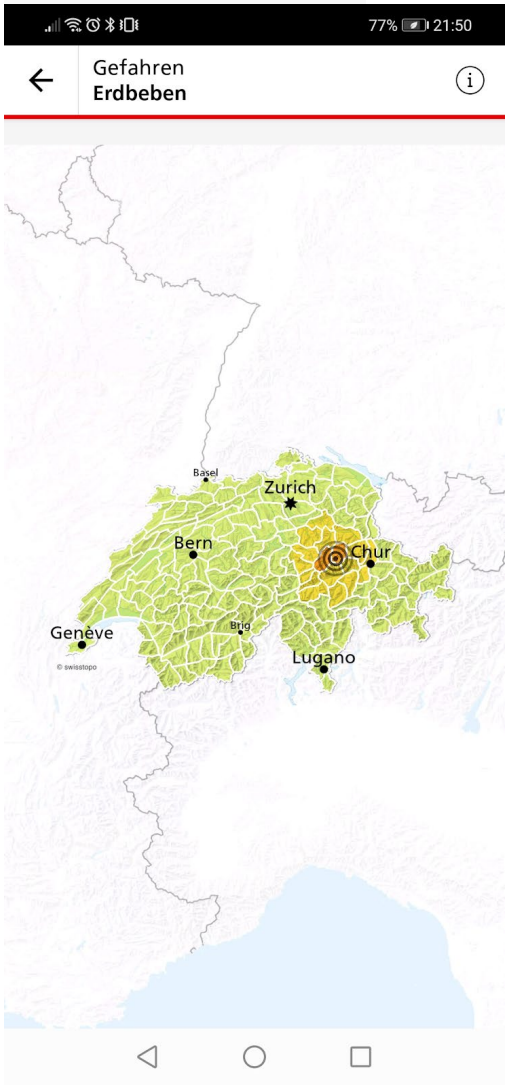
Table 3: Example earthquake announcements for Switzerland after an earthquake

Earthquake entry on the SED website [in all three national languages and English, here in German and English]	The event information on the website consists of a map, detailed information listed in a table, the underlying data and a written earthquake announcement. The map is available in static format or as an interactive map viewer. In addition, there is a link which redirects readers to the home page of the SED-website where for special or large earthquakes, and for events with more than 20 felt reports, an article is published, explaining the geological circumstances. ----------

	
Tweets on the SED Twitter Account [templates in English]	Tweets are sent automatically for earthquakes with magnitudes of 2.5 and above. They contain information about the magnitude, the location and the possible impacts of an earthquake. Additionally, a sentence indicating that aftershocks are possible is added for earthquakes with a magnitude higher than 4.7. In case of a false alert, a corrective tweet is sent (as a reply to the initial tweet). ---------- Intensity ≥VIII/approx. >5.4 [TIME] earthquake with a magnitude of about [XX] near [SANTA MARIA IM MÜNSTERTAL]. Major damage likely. Strong aftershocks possible. www.seismo.ethz.ch Intensity VI or VII/approx. ≥4.7 to ≤5.4 [TIME] earthquake with a magnitude of about [XX] near [SANTA MARIA IM MÜNSTERTAL]. Local damage likely. Strong aftershocks possible. www.seismo.ethz.ch Intensity V/approx. >4 to <4.7 [TIME] earthquake with a magnitude of about [XX] near [SANTA MARIA IM MÜNSTERTAL]. Felt across a wide area. Minor damage likely. www.seismo.ethz.ch Intensity IV/approx. ≥3.5 to ≤4 [TIME] earthquake with a magnitude of about [XX] near [SANTA MARIA IM MÜNSTERTAL]. Felt locally. No damage likely. www.seismo.ethz.ch Intensity III/approx. 2.5 to <3.5 [TIME] earthquake of a magnitude of about [XX] near [SANTA MARIA IM MÜNSTERTAL]. May be perceptible. No damage likely. www.seismo.ethz.ch

Authority and media announcement [in German, French and Italian]	The earthquake announcements are sent via email to authorities and media and published on the website. For media and authorities, a phone number and email address is included, which allows them to get more information if needed [removed from the announcement below because the number is confidential]. In addition, a simple map with the epicentre of the earthquake is part of the announcement. The example below is announcement number 1, which was not yet verified by a seismologist, highlighted with the number 1 at the top and a sentence in the last paragraph. ---------- ********** Meldung / Announcement / Annuncio / Annonce Nr: 1 für dieses Ereignis / concernant cet événement / per questo evento / for this event ********** ERDBEBENMELDUNG des Schweizerischen Erdbebendienstes an der ETH Zürich Der Schweizerische Erdbebendienst an der ETH Zürich hat im Kanton Wallis, ungefähr 6 km östlich von Verbier ein Erdbeben registriert. Das Beben ereignete sich am 30. November 2019 um 03:14:45 Uhr (Lokalzeit) mit einer Magnitude von etwa 3.0 auf der Richterskala. Dieses Erdbeben dürfte in der Nähe des Epizentrums deutlich verspürt worden sein. Schäden sind bei einem Erdbeben dieser Stärke in der Regel nicht zu erwarten. ========== Weitere Informationen finden Sie unter www.seismo.ethz.ch. Medien können sich für weiterführende Fragen an media@sed.ethz.ch wenden. Achtung: Diese Angaben wurden automatisch berechnet und noch nicht von einem Seismologen / einer Seismologin überprüft.

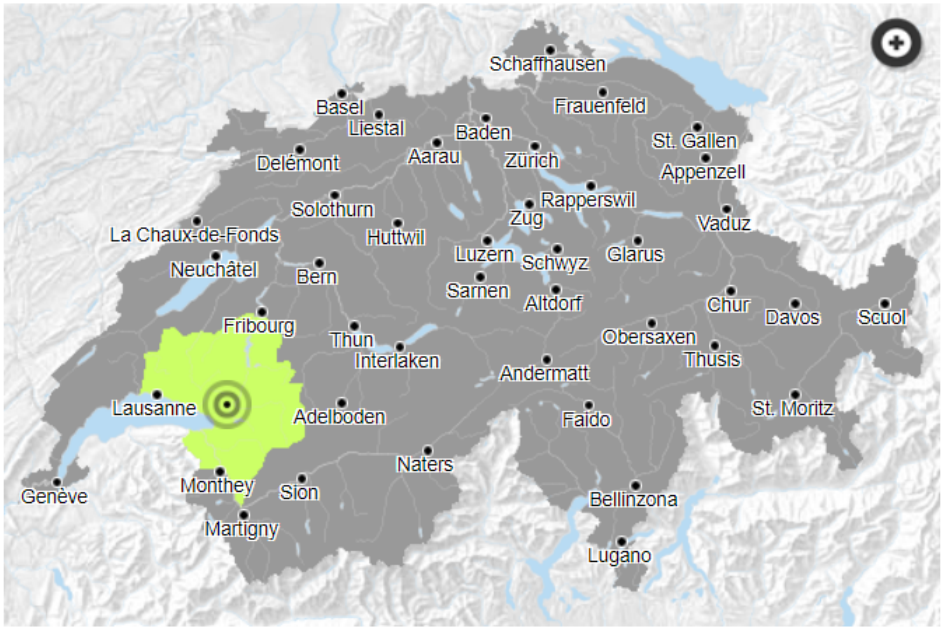
	
GIN	The Common Information Platform for Natural Hazards (GIN) is a platform for federal natural-hazard agencies to share their natural-hazard products with federal, cantonal and municipal experts in the field. The products shared include measurement and monitoring data, forecasts, warnings, models and bulletins. By clicking on an earthquake event a window with more detailed information opens (e.g. magnitude, location, hazard level, link to the SED website). ---------- 
MeteoSwiss app	Potentially felt earthquakes (M>2.5) are also displayed on the MeteoSwiss App. The categorisation is harmonized for all natural hazards in Switzerland, existing of the following five categories: “no or minor danger, moderate danger, considerable danger, higher danger, very high danger”.

	In times with no earthquake of a magnitude of 2.5 or higher within the last 72 hours, the map is grey. By clicking on the event a window opens with further information (location, time, impacts) and links to the “Did you feel it” report form, the Swiss Seismological Website and the Natural Hazard Portal’s sub-page with the behavioural recommendations. ---------- 
Natural Hazard Portal	Potentially felt earthquakes (M>2.5) are also displayed on the Natural Hazard Portal (NHP). The categorisation is harmonized for all natural hazards in Switzerland, existing of the following five categories: “no or minor danger, moderate danger, considerable danger, higher danger, very high danger”. In times with no earthquake of a magnitude of 2.5 or higher within the last 72 hours, the map is grey. By clicking on the event a window opens with further information (location, time, impacts) and links to the “Did you feel it” report form, the Swiss Seismological Website and the Natural Hazard Portal’s sub-page with the behavioural recommendations. ----------

Aktuelle Erdbeben

Aktualisiert am: 19.03.2020, 05:36

Ortsname / PLZ | Ort suchen



Aktuelle Erdbeben für die ganze Schweiz (1 Meldung)

ausblenden

Erdbeben: Keine oder geringe Gefahr, Stufe 1

18.03.2020, 02:54 Erdbeben der Stärke 2.6 bei Montbovon FR. In dieser Warnregion möglicherweise spürbar. Keine Schäden zu erwarten.

Betroffene Regionen

Aigle - Leysin, Basse-Gruyère, Bex - Villars, Glâne, Gros-de-Vaud, Jogne - Haute-Gruyere, Lausanne - Lavaux, Oron – Haute-Broye, Pays-d'Enhaut, Préalpes vaudoises, Saanen-Gsteig, Vouvry

Erläuterung der Gefahrenstufe
Verhaltensempfehlung

EMSC App/Website	International service providing information about earthquakes worldwide. About 5’000 Swiss people have downloaded the EMSC app and for earthquakes larger than magnitude 3, 20 users in average fill in a felt report.

Specifying the information that is available also before or some minutes/days after the event:

Information for the public

	Pre-event	Up to 5min Rapid earthquake information	After 5min After the event/ During the aftershocks	After several days/ weeks Recovery	
All earthquakes	**Events** - Information events - Workshops - School visits - etc.	1) Earthquake entry	1) Earthquake entry (adjusted by a seismologist if needed)	1) Background report	products
		1) SED Website	1) SED Website	1) SED website	channels
From magnitude 2.5	**Content on the website** - Description of the hazard - Current research projects - Historical context - Description of danger levels - Behavioural recommendations - Material for teachers - Hazard maps - Information about the earthquakes occurred. - etc.	2) Earthquake entry 3) ShakeMap 4) Bulletin map & short text 5) Bulletin map 6) Authorities announcement	2) "Aktuelbeitrag" (2-6h) 3) Updated earthquake information products (listed in the blue column)		products
		2) SED Twitter Account 3) SED Website 4) Natural Hazard Portal 5) MeteoSwiss 6) NAZ	2) SED Website 3) Same channels as in the blue column		channels
From magnitude 3.0	**Channels** - SED Website - Natural Hazards Portal - GIN - Media (TV, newspaper etc.) - AlertSwiss (hazard description, behavioural recommendations etc.) - MeteoSwiss (map only)	7) Media announcement 8) Direct authorities announcement (subscription based)	3) Media reports (e.g., interviews)		products
		7) Media (subscription based) 8) Subscription-based list	3) Various media		channels
Form magnitude 5.5		9) Distribution-obligatory media	3) Press conference		products
		9) Distribution-obligatory me dia (TV, radio)	3) Different channels		channels

Figure 24: Information issued to the public depending on the magnitude thresholds

The current chains of communication in the event of an earthquake

During a seismic emergency in Switzerland, the SED automatically informs the responsible entities, namely the National Emergency Operations Centre (NEOC), which is part of the FOCP. Their task is then to inform the relevant cantonal and federal authorities, the operators of telecommunications, energy and traffic networks as well as the international organisations and situation centres of neighbouring states and mobilize the needed emergency services. The NEOC can be reached round the clock 365 days a year. Every message is assessed by a standby team ("Pikett") that takes preliminary measures and calls the first echelons. In the case of a severe emergency, 30 employees, with prior training in various fields, are ready within one hour so that key positions can be staffed rapidly. In the case of less severe emergencies, the NEOC forms core teams consisting of needed specialists from different joint functional areas. These core teams continuously monitor the situation, coordinate the operations and inform the population.

Furthermore, in case of a severe earthquake with high damage potential, damages on critical infrastructure and the potential of secondary hazards a "Bundesstab" (crisis management board) is activated. The NEOC is in continuous exchange with this crisis management board. The crisis management board is responsible for: i) ensuring the flow of information and the coordination with the federal and cantonal offices, the operators of critical infrastructures and the responsible authorities abroad; ii) assessing the current situation; iii) providing the Federal Council and the responsible federal department or office which have to take decisions; and iv) coordinating expert knowledge at federal level and the deployment of national and international resources. At the SED, there is a video conference room that is always reserved for an emergency situation, where the directors of the SED can stay in contact with the other members of the crisis management board and report and update them on the situation (e.g. estimated losses, expected aftershocks, earthquake activities).

In addition, for longer period emergencies, the NEOC can call in a militia-based military unit, namely the Federal NEOC Military Staff. This unit consists of well trained, qualified specialists who are ready for deployment within four to six hours of an incident. Three times a year, they have a training week to remain familiar with the procedures and systems.

Diagram of the communication pathways within the country for seismic information

In Figure 25, we summarize the communication pathways from the SED to the different stakeholders. As visible, it is a complex network wherefore consistent information flow must be guaranteed.

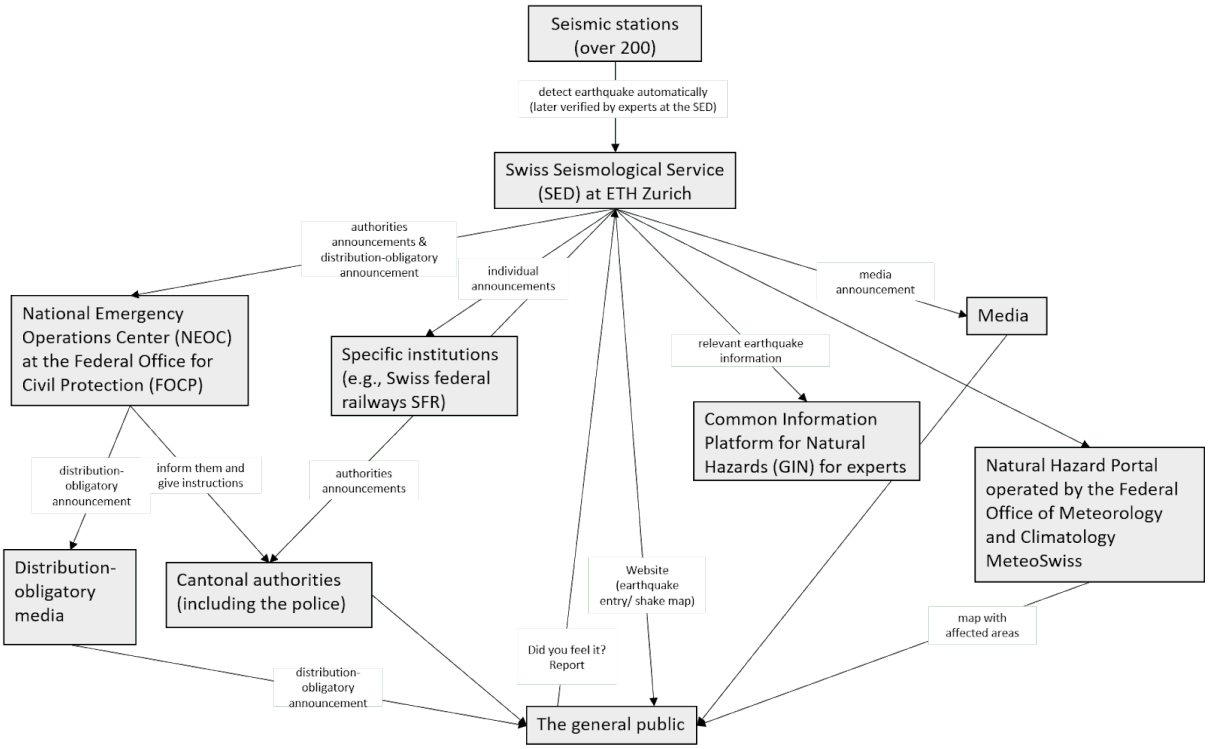


Figure 25: Communication pathways for seismic information in Switzerland

Who requires seismic information and from whom do they seek the information?

Audiences	From whom do they seek information?	How often	In what format?
The public	In general, people in Switzerland still most often use TV or Radio to seek daily information. However, the younger participants tends to use more often the smartphone or computer to read general news/information. Depending on the size of an earthquake, media reports are published regionally or nationwide. Through the interviews last year with the public, we identified that the majority of the Swiss people read the articles about earthquakes especially about the severe ones that happened in other countries. Only rarely and often as part of a specific project (e.g. geothermal energy), the public receives an information brochure about possible earthquakes. And, only people who attended high school covered the topic “earthquake” at school. However, more general aspects such as the origin of earthquakes. Furthermore, in some villages in Valais there are also drills at school. But the majority of the public has never received any kind of	Most people do not seek information in normal times. However, when there was a felt earthquake or during an earthquake sequence, they often check the latest news or read the newspaper. In addition, they access the website of the SED (webpage access correlates with the occurrence of earthquakes). In addition, the earthquake map on the MeteoSwiss-App is consulted when an earthquake occurred.	Based on interviews we conducted with the public in Switzerland and our general assessments we have the following insights. The general public demands for information on the general hazard situation (preferably a map) and behavioural recommendations. Especially after an earthquake, not only general information about the earthquake (e.g. severity and affected area) but also recommendations on what to do next are needed. However, the public only wants earthquake information in times of increased seismicity, i.e. when the probability of a severe earthquake increases in comparison to the normal situation. EEW was appreciated but the feasibility and need in Switzerland was questioned. Regarding the format, most of them stated that their preferences of how the news is presented depends on the topic. In general, most of them first read the headlines then look at the graphs and if they are interested in the topic, they start reading the text. To get the

	earthquake information. If they receive information, they would like to receive it from the cantonal or national authority (preferably the SED) as they trust them. However, they stressed that they may just check the latest news. The public can also fill out "Did you feel an earthquake?" report which helps the SED to assess the impacts of an earthquake.		relevant information quickly they prefer a qualitative graph for general news information but with a short explanation text. In particular, for timely developments curve diagrams are useful (reference to COVID infection rates).
Cantonal authorities	The cantonal authorities either receive information about an earthquake occurred directly by email from the SED or via an online platform operated by the civil protection office. Other kinds of information that is not event-specific (e.g. new building codes, release of a new model) is shared by various means including seminars, brochure, web information etc. The cantonal authorities also seek information for their disaster management planning, especially in the cantons with moderate-high risk.	See thresholds and frequency of information receipt in the Figure 22.	See format of the information communicated in Table 3.
National civil protection agency (FOCP)	In case of an earthquake, they receive the information automatically from the SED and further distribute it via their own channels (ELD, VULPUS) to other		

	national and cantonal authorities. They also coordinate the recovery phase and stay in continuous contact with the seismologists at the SED.		
Emergency managers	The emergency managers are informed by the national or cantonal authorities.		
Specific stakeholders	The operators of critical infrastructure (e.g. nuclear power plant, transportation infrastructure) need the hazard maps to estimate the impacts of an earthquake. In addition, they also have the opportunity to receive rapid information from the SED, which allows them, for example, to decide whether to shut down the plant or not.		
Media	For earthquakes from a magnitude of 3, all media who are on the media list receive an automatic earthquake announcement with the relevant information. For earthquakes with a magnitude of 5.5 or more, all media receiving public support are obligated to share the respective earthquake announcements as soon as possible (broadcasts in progress must therefore be interrupted). In addition, they often seek information after a felt earthquake or when		

	an earthquake-related project was initiated.		
Engineers, architects	The need norms for building earthquake resistant buildings or renovating old buildings. In Switzerland, there are five seismic zones SIA 261 which defines which minimal standard buildings should have (https://map.geo.admin.ch/?lang=en&topic=ech&bgLayer=ch.swisstopo.pixelkarte-farbe&layers=ch.bafu.gefahren-gefaehrdungszonen&layers_opacity=0.75&zoom=0.8348795752618031&E=2646601.14&N=1188505.57). In Valais, there is a pool of 100 experts which can check damaged building and make the first damage assessment after a severe earthquake.	Can always access this information.	Maps, written text, norms

How would they like to receive that information?

From the feedback the communication team at the SED receives, it can be concluded that the different stakeholders are satisfied with the information they currently received/receive. However, there is an on-going project together with the other Swiss natural hazard institutions with the aim to assess the future needs and expectations of the different stakeholders. Taking also into account technological progresses and the improvement of the communication means.

Moreover, as earthquakes in Switzerland only occur rarely and people want to receive push notification on multi-hazard apps, a group at the SED explores how this could best be implemented. Which information do they need? How can a map displaying all current hazards be designed avoiding information overflow?

Furthermore, experts are working on a Swiss Seismic Risk Model. This model should not only provide the stakeholders with the long-term risk of an earthquake but also rapid impact information after an event. This information will help them to assess the damages and potential losses already a few hours after an event. Of course, field assessment is still needed but it can help as a decision tool where to send the emergency services first.

And lastly, there is an EEW pilot project on-going for Switzerland. Seismologists and technicians are testing the performance of the system and the related challenges and uncertainties. The communication team in parallel tests how the EEW messages should be communicated to the public in a way that they are supported in taking immediate actions and look for further information after the shaking.

What training/co-production of communication has taken place or is planned?

The SED gives lectures and organizes fieldwork courses for students and guests at the Earth Science department at ETH Zurich, offers a Certificate of Advanced Studies (CAS) for engineers, architects and other experts and also organizes information events for specific audiences (e.g. insurance companies, cantonal and municipalities). Through an exhibition and public events, the general public is also informed about earthquakes and recommended responses and mitigations.

In collaboration with the other natural hazard institutions and the civil protection agency in Switzerland, the SED also provides data for the multi-hazard platforms accessed by the public, specialists and the authorities. To this end, the SED closely collaborates with the other natural hazard institutions (e.g. working groups).
Challenges among the communication pathway
There are various challenges which have to be considered:

- The federal structures make it difficult to take fast decisions:
    - As the cantonal and communal authorities are the ones issuing orders, it might be that neighbouring region, which are similarly affected, take different decisions, e.g. one prompts the public to evacuate their buildings and others might want them to stay inside.
- For the SED it is not always easy to approach the “right” people within a canton. The automatic alerts are received by the alarm centres, but additional advice should be shared with other cantonal representatives, e.g. the cantonal geologists.
- Switzerland is a multilingual country and thus have to provide information in the three national languages (German, French, Italian) as well as English.

- Operating a multi-channel communication system goes in hand with several challenges: (i) ensuring that consistent information is published; (ii) collaborating with the different authorities and stakeholders involved; and (iii) fulfilling users' need, i.e. which information should be immediately communicated and which information can be accessed later on.

International private agencies (e.g. Google) are driving and advancing technological developments and it is challenging for the authorities operating information/warning platforms to continuously update and advance them.

Current Communication Pathways for Seismic Information in Iceland

National Organization

Iceland is an island country with around 500,000 inhabitants scattered across the territory. It is a representative democracy and a parliamentary republic, and is highly geologically active.

Iceland is divided into 9 police districts - areas bounded by black lines in Figure 19 - and there are a total of 72 municipalities. 21 civil defence committees are active in 9 districts of the country - the coloured areas in Figure 26 (many municipalities have merged into one committee).

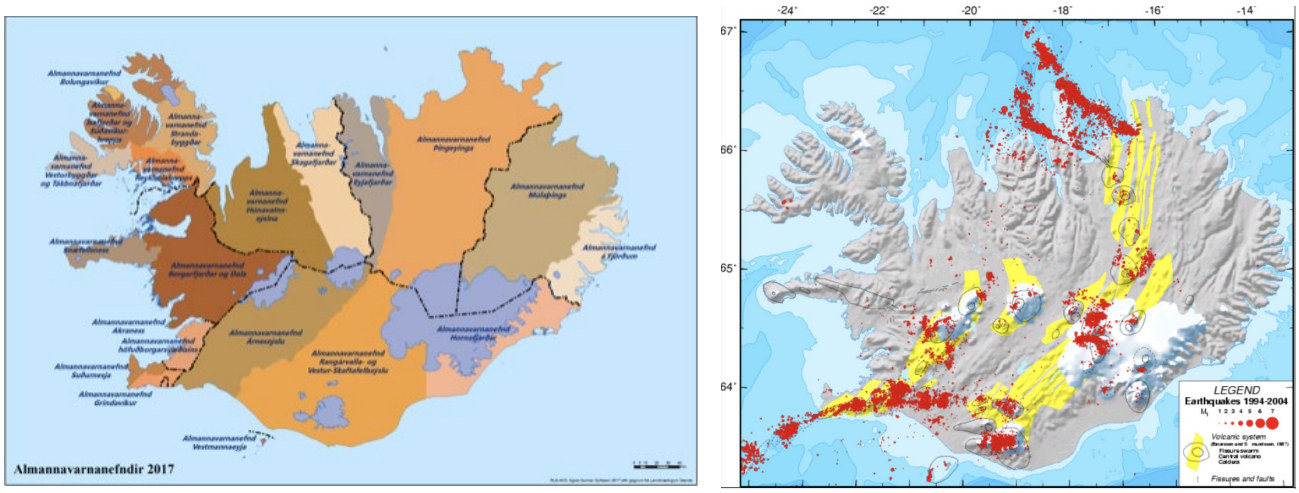


Figure 26: Administrative and geological maps of Iceland. Sources: https://www.almannavarnir.is/almannavarnir/almannavarnarnefndir/ & Gunnar B. Guðmundsson 2005

The civil defence acts as a system: when there is an emergency, the National level has the responsibility to coordinate and inform the lower levels. Thus, the National level tends to be activated in case of great emergency, in case the local level does not have enough resources to face the catastrophe on its own.

The civil defence system organisation is shown in Figure 27, but is highly flexible and does not follow a strict hierarchical structure. All the associations (e.g. Red Cross, fire brigade, and volunteers) have representatives at both the National and Municipal level, making the communication chain process smoother and faster.

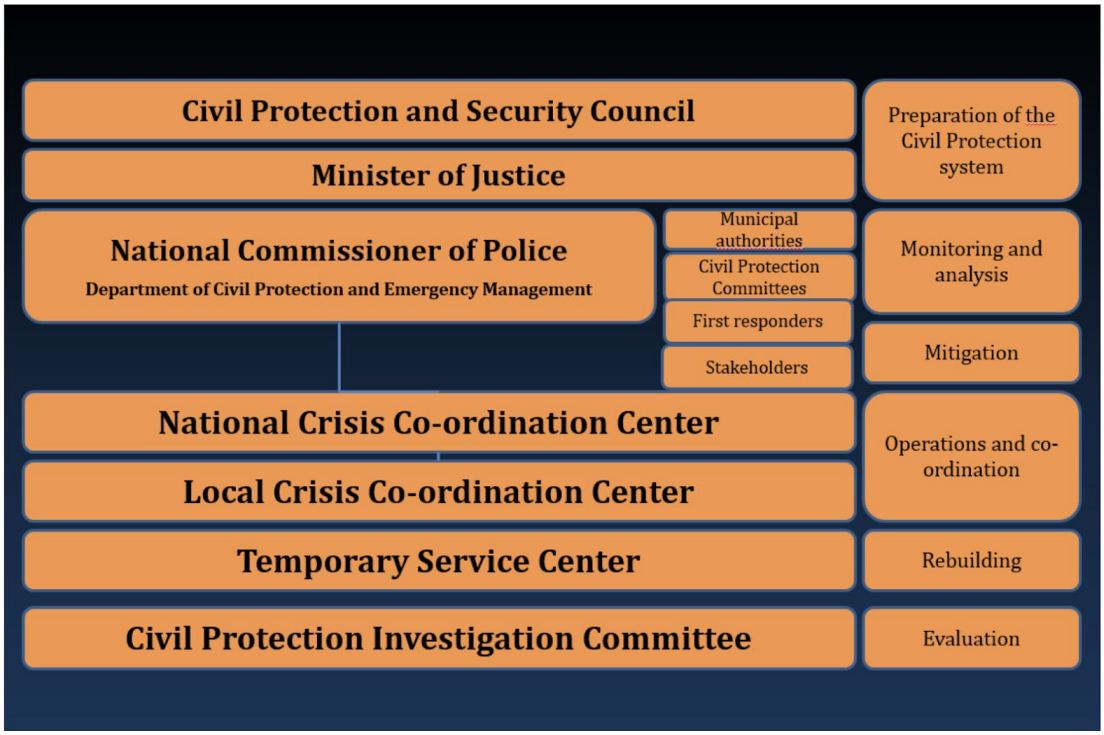


Figure 27:The Icelandic Civil Protection system. Source: https://www.almannavarnir.is/english/about-the-department-of-civil-protection-and-emergency-management/

Who makes decisions regarding actions to be taken in the light of seismic hazard information?

Long term seismic hazard maps are used in planning decision. Construction requires adherence to building codes, informed by the seismic hazards.

Medium-term hazard planning also takes place. At least once a year, or more frequently if needed, scientific board meetings are organised by The Department of Civil Protection and Emergency Management of the National Commissioner of the Icelandic Police. The aim of these meetings is to discuss the seismic activity in the country and go over the status of the most active volcanoes in Iceland and volcanoes that are showing increased activity beyond background levels. Scientists can suggest that such meetings take place if measurements indicate precursors of large earthquakes and/or volcanic eruptions. The scientific board meetings are a platform to discuss precursors and different aspects of possible scenarios in short and long term and give advice to the Civil Protection, police and other stakeholders. If volcanic eruption is imminent the scientific board meetings are held very frequently, even daily. There is a role within the police who regularly daily monitors the earthquake movements, and information also comes in from drones and fixed cameras. There are usually weekly emails to the scientific board members to give updates about seismic activities in certain areas. E.g. possibility of earthquakes within a few days.

There are no pre-set thresholds that activate an emergency plan; however, there is a national contingency plan where all the procedures are explained. This is pre-set every three years and after each event. The plan is prepared at the municipal level, within the Civil Protection Committee, alongside the emergency units (e.g. fire departments, police, hospitals, Red Cross of the area concerned). It is generally publicly accessible with only a few parts confidential.

The contingency plan is divided into sections that cover the following issues:

1. The definition of three phases – uncertainty phase; alert phase; emergency phase.
2. Hazards - what kinds of disaster could be expected.
3. Activities that need to take place e.g. The Red Cross opens the evacuee shelter.
4. Who and how to activate the plan. In most cases the emergency services will send out SMS messages to the first responder that is linked to the plan. This chapter also implies who has the authority to decide in what state to activate the plan.
5. Layout control (this chapter is almost the same in all plans).
6. Lays out the geographical areas that are to be used in the plan. Where people would gather together responders, injured personnel, bystanders, and so on.
7. Is often used for something extra regarding event of accident (some special situations that may change the cores of the operation)
8. Checklist to check the activities already done and the ones to give.

While designing the contingency plan, the Icelandic Meteorological Office might use the risk matrix shown in Figure 28.

Almost Ceratin 5	5	10	15	20	25
Likely 4	4	8	12	16	20
Moderate 3	3	6	9	12	15
Unlikely 2	2	4	6	8	10
Rare 1	1	2	3	4	5
likelihood/con-sequences	Insignificant (1)	Minor (2)	Major (3)	Critical (4)	Extreme (5)

Figure 28: The Icelandic National Risk Assessment risk matrix. Source: https://www.almannavarnir.is/wp-content/uploads/2016/10/NATIONAL-RISK-ASSESSMENT-FOR-ICELAND_.pdf

Who generates seismic information?

The Icelandic Meteorological Office produces seismic information that is available on the Meteorological Office website in different formats. This combines their own data with data from the University of Iceland.

To whom do they communicate directly? In what format? How often?

The Icelandic Meteorological Office (IMO) shares information with the following actors:

The **general public** who

- Read the IMO website at any time (see Figure 30, Figure 32).
- Receive public announcements in the event of enhanced seismic activity.
- Receive an emergency text message in the event of an earthquake if they are close to it, including the location of the earthquake. They are usually also given advice to reach the fire station.
- Receive information via social media which can include video and images where available (see Figure 31).
- Can attend meetings and conferences given by seismologists.

The **Police** (who are head of civil protection and in charge of public advice on what to do in an emergency or raised risk situation).

The **media** also tends to look at the Icelandic Meteorological Office website – predominantly because they are used to it for communication of the weather, which means they can simultaneously look at the earthquake information. The information released shows the magnitude, location, date and the municipalities next to the epicentre with further information about the earthquake such as whether the Icelandic Meteorological Office got phone calls from people and who felt it. The media tends to show the data they get from the official sources and because some information (e.g. magnitude) can change they make sure to insert the disclaimer on the top of their media website with a link to current data, and tell people whether the data in the article are confirmed and what the source was. For example, see Figure 29.

Usually multiple stories around the same event are quickly published and give the ongoing updated data. When the Meteorological Office does not update for technical issues, the journalists call the scientists directly for updates, publishing the information provided by him/her and inserting their name as the source.

If journalists have any particular questions, they can call a specific number asking the scientists directly. If the website is not available a small story is sent out about the fact that an earthquake has been felt in a specific time and location, and sometimes posted on social media by the Meteorological Office. Since it is a rather small community, most of the exchanges happen informally by phone call. Some members of the media have the phone number contact of someone working within the seismic department of the Meteorological Office or in the University of Iceland or the Icelandic Meteorological Office.

Everything played on a rider in the south west of the country

Kristin Ólafsdóttir and Sunna Kristín Hilmarsdóttir write October 20, 2020 13:47

The recording of the tremor is about five miles for the west geothermal area at the Seltún in Reykjanes.

A very large earthquake became about five miles west of the geothermal area at the Seltúni in Reykjanes at 13:43 today. According to information from the Living room, the tremor measured 5.6 to size. About fifty aftershocks have occurred in the area as a result, and they are increasing.

You can keep track of the latest news from the tremor in the shift at the bottom of the story.

Figure 29: Example of media coverage of seismic activity in Iceland

Besides the Icelandic Meteorological Office, the National Security Board within the National Commissioner of Police also provides the media with information to release to the public in the event of a raised risk or a damaging event. Examples of such information are actions to put in place, what could happen next, how the situation is thought to be coordinated, thus whether any support is provided e.g. the Red Cross is coming to the area and the source of such information.

People in Iceland tend to read geological information fairly frequently because natural events represent such a great part of their daily lives. People seem to receive more details from the scientists who provide further information about past earthquakes.

Furthermore, a section named “life fit of information” is posted on the media websites, gathering ‘what to do’-information from all the possible sources. Most people previously had all the information on the procedures to follow in case of hazards given from the National Security Board on their phone book, however now such a book is less and less used and people do not have such information anymore.

Change of alert level

The media is informed of change in colours/alerts either by the Civil Protection department or by the Icelandic Meteorological Office via email, its website, or a press conference.

Information communicated about the change of alert tends to be similar to the information published on the official websites describing to the public the meaning of the alert. During an earthquake sequence, the media try to specify what is going on with the scientists' support, e.g. they count and release the number of earthquakes occurring and the number of earthquakes above a certain magnitude e.g. 3 and communicate the magnitude of the greatest earthquake.

Whole country - earthquakes during the last 48 hours
(Preliminary results)

Map | Table

Earthquake count:
- Magnitude less than 1 in all: 53
- Magnitude 1 to 2 in all: 21
- Magnitude 2 to 3 in all: 2
- Magnitude more than 3 in all: 0
- Total: 76

Earthquakes shown: All earthquakes Opna

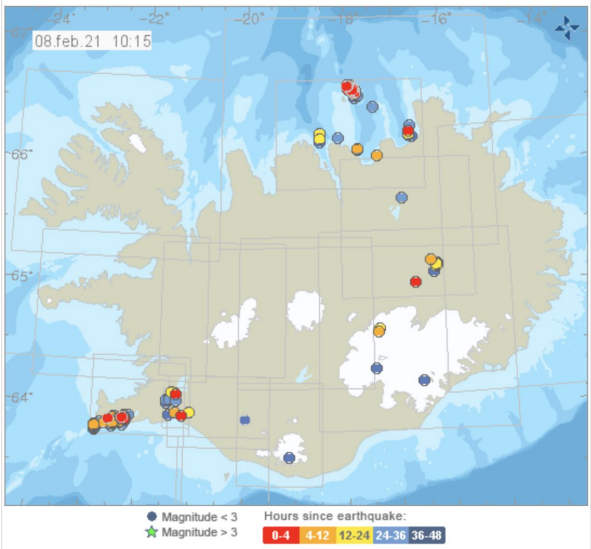
Earthquake table

Date	Time	Latitude	Longitude	Depth	Magnitude	Quality	Location
Thursday 21.01.2021	08:42:06	63.858	-22.602	5.7 km	0.8	99.0	8.1 km WNW of Grindavík
Thursday 21.01.2021	08:30:47	63.870	-22.307	4.3 km	0.9	99.0	4.0 km SSW of Fagradalsfjall
Thursday 21.01.2021	08:15:31	63.899	-22.322	5.7 km	0.7	99.0	2.4 km W of Fagradalsfjall
Thursday 21.01.2021	08:13:19	63.975	-21.605	7.9 km	1.0	99.0	2.3 km ESE of Bláfjallaskáli
Thursday 21.01.2021	07:39:26	63.867	-22.316	3.7 km	0.7	99.0	4.4 km SSW of Fagradalsfjall
Thursday 21.01.2021	06:15:34	63.883	-22.457	4.5 km	1.2	99.0	4.9 km N of Grindavík
Thursday 21.01.2021	05:21:11	64.607	-20.574	3.7 km	1.7	99.0	17.4 km SE of Húsafell
Thursday 21.01.2021	04:40:14	63.845	-22.675	3.9 km	0.8	99.0	5.2 km NNE of Reykjanestá
Thursday 21.01.2021	04:35:54	66.230	-18.552	10.0 km	1.4	99.0	14.3 km WNW of Gjögurtá
Thursday 21.01.2021	02:32:06	65.905	-17.996	9.4 km	0.9	99.0	9.7 km ESE of Grenivík
Thursday 21.01.2021	00:09:12	63.873	-22.310	4.2 km	0.9	99.0	3.7 km SSW of Fagradalsfjall

Whole country - earthquakes during the last 48 hours
(Preliminary results)

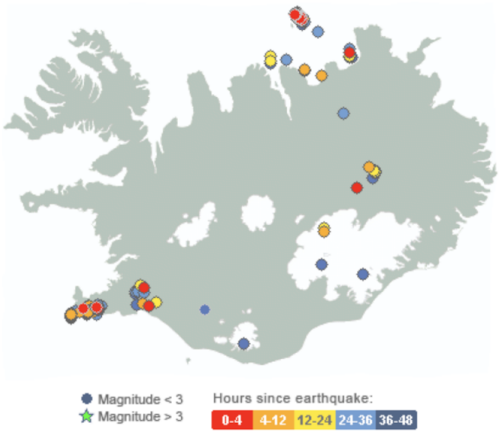
Map | Table

Earthquake location 08 Feb 10:15 GMT



Weather forecast | Weather observations | Earthquakes | Hydrology | Avalanches

Earthquakes during last 48 hours. at 08 Feb 10:10 GMT
Preliminary results



Biggest earthquakes during the last 48 hours

Size	Time	Quality	Location
3.3	06 Feb 15:45:28	46.1	179.6 km WSW of Eldeyjarboði
2.4	06 Feb 15:46:02	Checked	3.1 km W of Reykjanestá
2.3	06 Feb 17:13:07	Checked	2.9 km WNW of Reykjanestá
2.2	06 Feb 16:17:54	Checked	13.0 km NNE of Grímsey
2.0	07 Feb 15:22:29	Checked	2.9 km SSW of Herðubreiðarlindir
1.9	06 Feb 17:16:23	Checked	3.0 km WNW of Reykjanestá

Week overview 25 January - 31 January

Around 1000 earthquakes were detected by the IMO¿s SIL seismic network this week, almost twice as many as the previous week when around 560 earthquakes were detected. The increased activity during the week is due to earthquake swarm on Reykjanes peninsula where 720 earthquakes were detected, and in the central highlands. The largest earthquake of the week was a M2.9 on January 27th at 13:06 on the Þórisjökull glacier in a short earthquake swarm that began at 09:30 and lasted until midnight January 27th. Few earthquakes over M2.0 followed the largest earthquake. Conciderable activity was in Vatnajökull glacier during the week, especially in Bárðarbunga volcano, where an earthquake of M2.4 was detected and eight earthquakes were detected near Grímsvötn, the largest one M2.4 on January 29th. Two earthquakes of M2,3 were detected near Hamarinn.One minor earthquake was detected east of Hekla volcano and three in Öræfajökull volcano.

More

Time and magnitude of earthquake 08 Feb 10:15 GMT

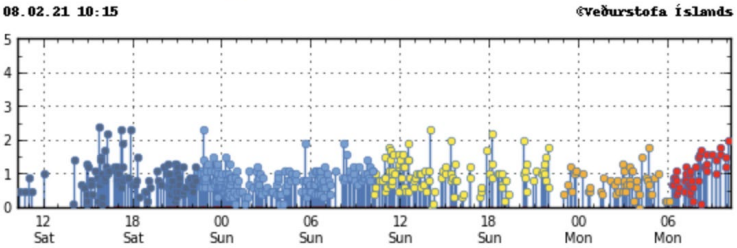


Figure 30: The Iceland Meteorological Office representations of earthquakes over a 48hr period, from their public website. For more see Supplementary Figure 15 and Supplementary Figure 16

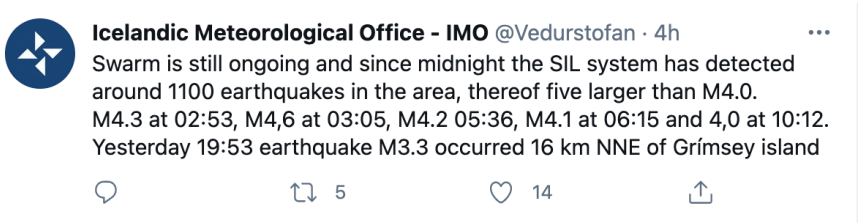


Figure 31: Tweets from the Iceland Meteorological Office

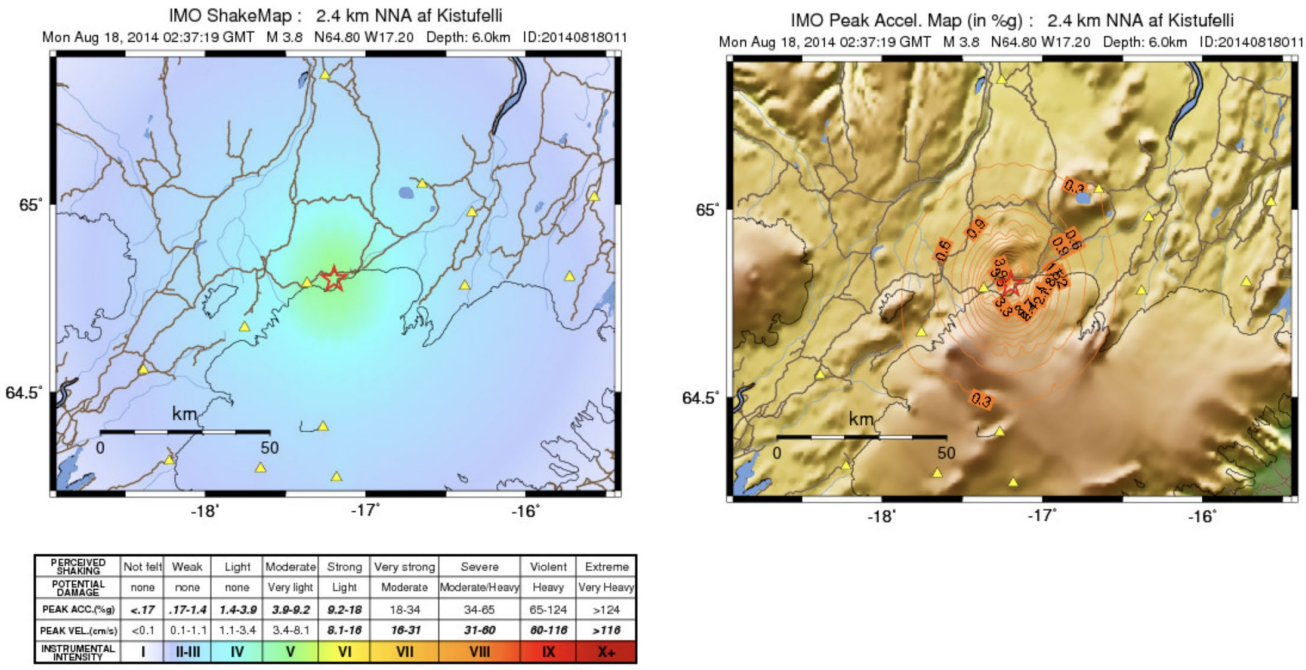


Figure 32: Iceland Meteorological Office ShakeMaps from their public-facing website, showing instrumental intensity (Source: http://hraun.vedur.is/ja/alert/shake/20140818011/intensity.html)

Who is activated in an earthquake emergency?

The Icelandic system works according to the NIMS (Incident Command System). When an earthquake happens the responsibility of the civil protection operations is given to the chief of police in the relevant police district and if that person is not available, to the higher level, to the National police, which lead the operation from the centre in Reykjavik.

Main actors involved:

- **Security Council**: meeting where ministers and directors of key government agencies in security and civil defence, representatives of the Landsbjörg Accident Prevention Association, the Icelandic Red Cross, the Association of Icelandic Municipalities and a coordinated emergency response gather together every now and then, chaired by the Prime Minister.
- **Minister of Justice**: representing the head of Civil Protection in Iceland.
- **National Commissioner of the Icelandic police/Department of Civil protection and Emergency Management (INCP/DCPEM) role** covers the exchange between districts e.g. municipal authorities, first responders, civil Protection Committees (a few representatives for each region), government agencies.
    - Each of the 21 Civil Protection committees includes the mayor of the Municipality, Local Commissioner of police, a partner from the Red Cross as well as from the Rescue teams. Each committee covers more than a municipality. They ensure that contingency plans are made, and risk assessment is fulfilled, thus they serve a more preventive function rather than a reactive one.
    - Besides the committee, a smaller group consisting of the mayor, the chief of the police and the manager of the local civil protection also gathers and reports to the civil protection committee. Such meetings tend to be convened when an emergency happens. Usually, the information brought up during this meeting is reported by the civil protection manager to the local level and by the chief of police to the national level.

- **National Crisis Coordination Centre**: a station that covers the whole country, based in Reykjavik. It acts as a backup in case of crisis. It covers the exchanges within districts and receives information from the Icelandic Meteorological Office, from the public who are calling the 112 emergency services number and from the first responders already on the hit field. It can be activated both during the uncertainty phase and the emergency phase. It depends on how the earthquakes happen and the time frame available before the event.
- **Local Crisis Coordination Centre**: this centre coordinates *operations* when a major event happens, while the National Crisis Coordination Centre serves as a *strategic* coordinator. Both are called to contribute to the formulation of the response and evacuation plan, and depending on the scale of the emergency, may call upon help from:
    - Chief of the local police
    - Member of the relevant Civil Protection committee
    - Fire department
    - Regional search & rescue (Landsbjorg volunteers)
    - Healthcare institutions (Heilbrigoisstofnun)
    - Local branches of Red Cross (Rauoi Kross)
    - Representatives of volunteers in the area

- **The Temporary Service Centre** is activated in the event of a crisis and run by the National Civil Protection Committee, with the Commissioner of Police in charge. People gather and guidance is given to deal with the ongoing event and post-event. For example, specialists, contractors, engineers from “The House and Construction Authority”; members of “Icelandic Catastrophe Insurance”; a local priest if a memorial service is needed; members of the Red Cross, government, psychologists etc are gathered at this physical centre so that people do not need to reach different officers spread across a geographical area. This Centre might co-located with the Local Crisis Coordination Centre and can remain open for a few days or weeks depending on the damages. The Red Cross fulfils some of the duties that the civil protection department has, such as running the daily activities carried out within the Temporary Service Centre. The Red Cross identifies needs, so that the relevant services can be provided, e.g. financial support for people so that they can restore their basic needs. The Centre stays open as long as is necessary.
- **The Civil Protection Investigation Committee** goes over everything that happens in any crisis to develop a better strategic plan. This might take a few months and is conducted alongside the Temporary Service Centre and the Crisis Coordination Centres. All of them work interdependently.

The current chain of communication in the event of an earthquake

In the event of a raised hazard level, the University of Iceland and the Icelandic Meteorological Office coordinate together and send either emails or calls (only if the situation is considered highly dangerous) the Crisis Coordination Centres. In case of earthquakes, usually the Local Crisis Coordination Centre meets people or puts out information on social media channels to increase awareness of what people should do in case of a seismic event. Meanwhile the Local Crisis Coordination Centre keeps in contact with scientists, regional and local civil protection during regular in person or online meetings. If small seismic waves keep on happening, awareness among health carers, policemen and other professionals is increased.

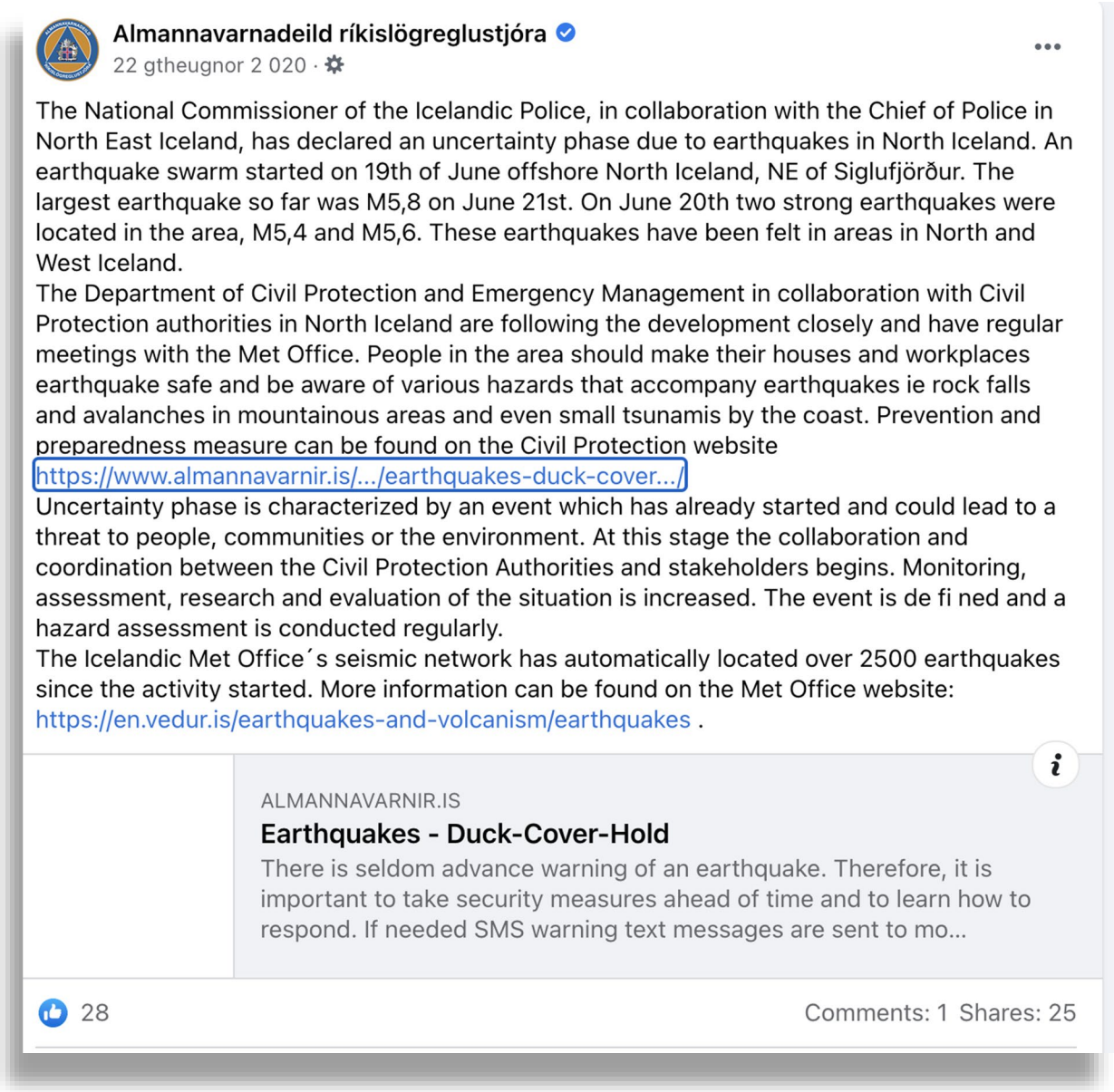
Meanwhile people are warned via social media and in person meetings that tend to gather a maximum of around 300 people so that everyone feels free to stand up and speak up, asking questions and sharing their hypotheses. A red alert level is activated only if a large earthquake has already occurred, as that entails evacuation.

Even if the community where the earthquake happens is small, the regional level is alerted because small communities are more likely to need external help and resources to deal with any crisis.

As outlined in the national contingency plans, there are three phases to any emergency. In a seismic event, these involve the following communications:

- **Uncertainty phase**: The Icelandic Meteorological Service sends a notification to the National Commissioner of Police informing them of the surge of seismic activity in specific areas. Such information tends to be shared via text message by the National commissioner of police to all the responding agencies involved in the contingency plan e.g. the Red Cross and Search and Rescue teams.
- **Alert phase:** This phase implies the likelihood of an event has increased to a high threshold and tends not happen in terms of earthquakes since their likelihood rarely reaches a high enough level before an event. This phase is more used in cases of avalanches or landslides.
- **Emergency/distress phase:** This phase is declared once an event has occurred and so is the commonest phase in terms of earthquakes. It involves the same communications as in the Uncertainty phase.

Once an uncertainty phase is declared by the National Commissioner of Police, who has been notified by the Icelandic Meteorological Service of an increase in seismic activity, SMS messages to all the emergency agencies are sent out. This includes information about a) the urgency, which refers to the speed the ambulances should take, that can be F1 (high risk, meaning that life is at risk); F2 (moderate urgency); F3 (low urgency, meaning that you can finish your cup of coffee); F4 (no emergency); b) specification of the emergency phase; c) location of the emergency; d) a colour code referring to the magnitude of the event; e) the identification of the code of the radio frequency to be used to communicate with the other actors involved in the contingency plan. There are some criteria that set when the text message should be sent out. The uncertainty phase is declared publicly as well (see Figure 33)



Almannavarnadeild ríkislögreglustjóra
22 gtheugnor 2 020 ·

The National Commissioner of the Icelandic Police, in collaboration with the Chief of Police in North East Iceland, has declared an uncertainty phase due to earthquakes in North Iceland. An earthquake swarm started on 19th of June offshore North Iceland, NE of Siglufjörður. The largest earthquake so far was M5,8 on June 21st. On June 20th two strong earthquakes were located in the area, M5,4 and M5,6. These earthquakes have been felt in areas in North and West Iceland.
The Department of Civil Protection and Emergency Management in collaboration with Civil Protection authorities in North Iceland are following the development closely and have regular meetings with the Met Office. People in the area should make their houses and workplaces earthquake safe and be aware of various hazards that accompany earthquakes ie rock falls and avalanches in mountainous areas and even small tsunamis by the coast. Prevention and preparedness measure can be found on the Civil Protection website
https://www.almannavarnir.is/.../earthquakes-duck-cover.../
Uncertainty phase is characterized by an event which has already started and could lead to a threat to people, communities or the environment. At this stage the collaboration and coordination between the Civil Protection Authorities and stakeholders begins. Monitoring, assessment, research and evaluation of the situation is increased. The event is de fi ned and a hazard assessment is conducted regularly.
The Icelandic Met Office´s seismic network has automatically located over 2500 earthquakes since the activity started. More information can be found on the Met Office website:
https://en.vedur.is/earthquakes-and-volcanism/earthquakes .

ALMANNAVARNIR.IS
Earthquakes - Duck-Cover-Hold
There is seldom advance warning of an earthquake. Therefore, it is important to take security measures ahead of time and to learn how to respond. If needed SMS warning text messages are sent to mo...

28 Comments: 1 Shares: 25

Figure 33: Declaration of 'uncertainty phase' by the police due to heightened seismic activity in Iceland

If an event has happened, the Mayors of the relevant Municipalities receive an email from the National Civil Protection, a call from the National radio, and a message from the emergency services.

- **Call:** Five minutes after the event, with no scientific assessment – just a general message of something having occurred.
- **Email:** From Civil Protection/Defence to the Mayors of the relevant Municipalities e.g. “Hello everybody, the n peninsula, there has been an ongoing event. About 8 hundred earthquakes have been recorded. There is an earthquake sequence. It started x and now over n numbers of earthquakes have been recorded. The biggest one was about 5. The biggest earthquakes in the area might occur so we will be remaining on the uncertainty stage of the civil protection scale. There are 5 different scales, uncertainty stages. At the beginning of September, we will be having another meeting.”
- **A text message** from the emergency services that depends on the situation.

Within Civil Protection:

- The first message is from emergency services sent to the Crisis Coordination Centre and the first responders;
- Radio channel VHF and the TETRA system are set up - the conversations in place on the radio channel are logged into the system by people listening to the communication;
- Internet and other systems are set up e.g., the aviation system; geographical information system (GIS).

After these messages, the recipients should already know what to do based on the contingency plan. For instance, the national representative of the Red Cross rapidly reaches the National Crisis Coordination Centre, while the local level representatives go to the Local Crisis Coordination Centre, and the volunteers might go directly into the field.

When the earthquake has happened, the emergency team (local coordination centre, policemen, health carers) go into the field and inspect buildings, get estimates of new possible earthquakes, check what people need and explain what the plan to others.

As a channel of communication, they use TETRA, a radio system characterised by different channels, such as the police channel, the power company channel, a channel where they can talk all together etc. Within the Crisis Coordination Centres, members can see a map and all the locations of the cars, fire tracks, ambulances and the rescue teams as they make use of the TETRA system, because it sends the location of the user. Members of the police have access to a program where they can mark out an area on the map where the buildings have been damaged.

The emergency management unit within the Civil Protection office in Reykjavìc calls a meeting (often virtual) where the Police Commissioner debriefs the fire chief of each town, and the Mayors.

Red Cross

The Red Cross is responsible for disaster management, first aid, and ambulance service (the Red Cross provides vehicles whereas the government pays the salary of the staff). It tends to be responsible for setting the following centres:

- Temporary mortuaries
- Centres for casualties
- Centres for survivors
- Centres for evacuees
- Centres for relatives and friends
- Centres for the provision of food
- Service and Welfare Centres

These centres are usually located in buildings that serve as temporary services to help the population. The buildings should be approved by the local committee as they should respect certain criteria e.g. big size, well known, have a kitchen, have a good connection with a main

road, and have a big parking area. Usually the buildings that might serve as temporary services in case of calamities are already listed, however if this is not the case, they must be approved before being set up.

Sources of communication:

- Red Cross emails
- Walkie talky where people use only one frequency channel
- Everyone use google maps
- Facebook to get information

ICE-SAR

ICE-SAR is the Icelandic Association for Search and Rescue service, which has around 800 volunteers and part time employees.

Fire brigade & Ambulance service

Members of the fire brigade are all full time paid employees and are 24h. After any minor earthquake, fire workers try to secure people and buildings and, if there is enough time, to work together with members of the Search and Rescue teams specialised in structural engineering to strengthen buildings.

If a major earthquake happens, fire workers rescue people from the ruins, are responsible for calling the ambulance service, protect people from building collapses, evacuate, and secure each area.

Volunteer Associations

Within a range of Associations there are volunteers who support the other members of the civil protection, e.g. fire brigade, Red Cross, and might be specialized in different areas such as structural engineers.

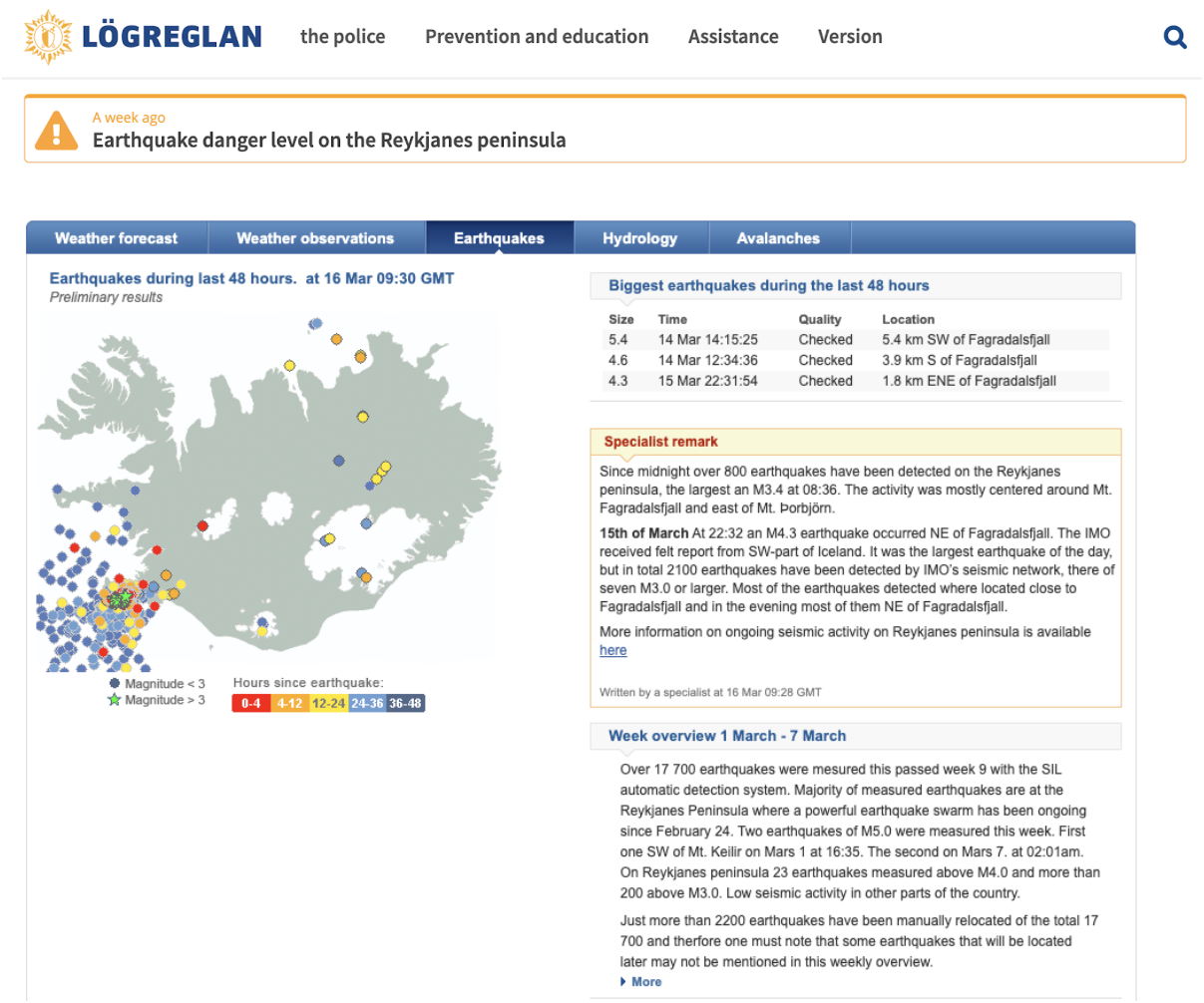
The police

The **national police** as well as the **local police** are responsible for public communication which is done via its website and via social media (see Figure 34).

This is done in the case both of a raised risk as well as in the aftermath of an event. The general public is involved from the beginning of the planning side, so that people's attention is gained, and they get engaged. The police give the following information:

- Risk and what it means;
- Information about the geology of the territory;
- Introduction of the plan;
- Advice on how to react e.g. take pictures down from the wall.

Mostly they want to meet people to get to know each other, to answer their questions and develop mutual trust. People are informed by radio, TV, media websites e.g. visir.is, Twitter, Facebook.



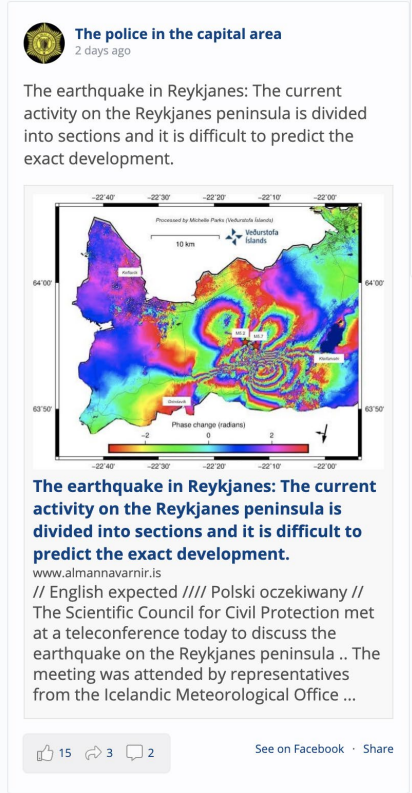


Figure 34: Icelandic police information during an earthquake swarm - on their website (top) and Facebook page (bottom)

The Civil Protection

The Civil Protection then shares publicly information about the geological situation as well as the location of fracture surfaces (see Figure 35).

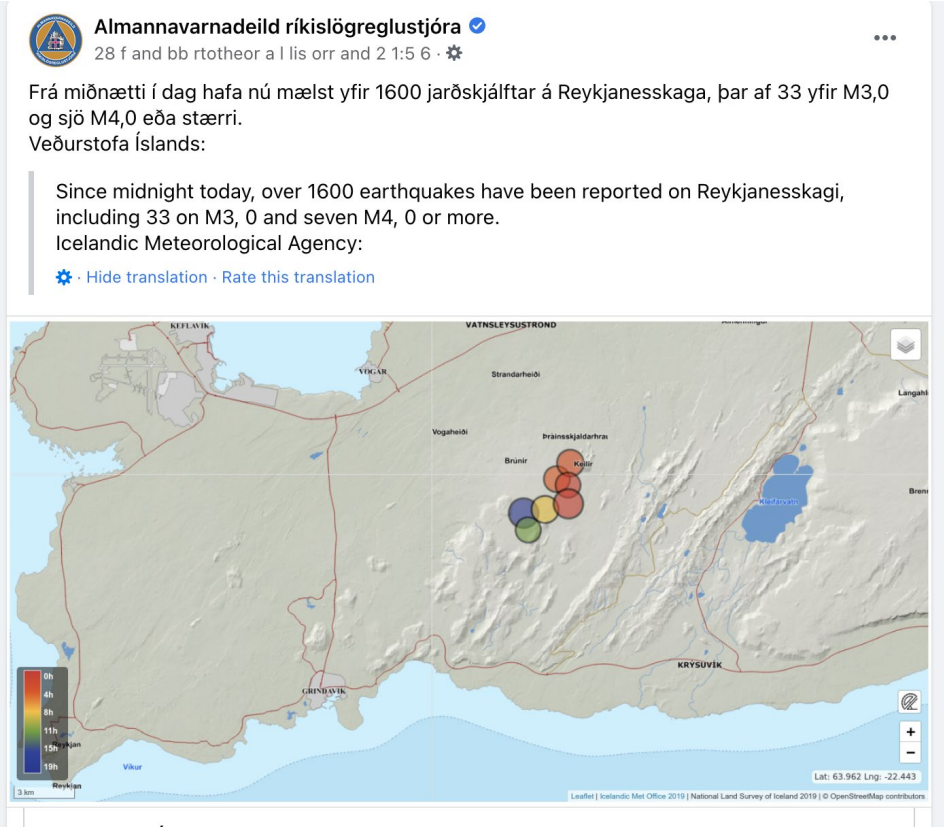


Figure 35: Example of Civil Protection's communication in Iceland, reporting the Meteorological Office's data on earthquake activity. Source: https://www.almannavarnir.is/natturuva/jardskjalftar/varnir-gegn-jardskjalfta/

The media

The media's sources of information might be

- The Meteorological Office
- The Police and Civil Protection
- The Mayor of the Municipality by phone call
- People living in the affected area via calls e.g. schools headmasters, storeowners, social media groups

Journalists' key information that they seek after any event is:

- the epicentre (to understand if it is close to a municipality that needs to take measures

- the magnitude (to understand the size of it)

- the time (to check whether there are more than one earthquake occurring and thus, an earthquake swarm is happening).

Plus:

- is the earthquake a sign of something bubbling underneath?

- is there the possibility of a volcanic eruption coming in the aftermath of an earthquake?

- is the possibility of another earthquake as strong as the one just happened?

These questions are asked of the scientists, who always answer that there is no evidence to declare any upcoming volcanic eruptions or earthquakes. Thus, journalists tend to post a disclaimer saying that the earthquake does not seem to be a sign of an eruption, however no one can be sure that an eruption might not be happening, thus a close monitoring is ongoing.

SAReye Software platform used to share information within the Icelandic civil protection

Each and every response has its own system, however when there is a crisis and the Crisis Coordination Centre is activated, a unique web-based software platform to which everyone has access is used. This system has been in operation for 7 years and has been activated for over 8 thousand operations and it is constantly updated based on the ongoing end-users' perspectives. It is based on the contingency plan and can be used on a daily basis or whenever a crisis occurs. The main end-users are:

- First responders
  - Icelandic Red Cross
  - ICE/SAR Search and Rescue
- Icelandic Public Safety Authority
  - Reykjavik Fire Brigade
  - National Hospital of Iceland
  - Icelandic Aviation Authority
  - Icelandic Road Authority
  - Ambulance Services
  - Icelandic National and Regional Police
- End-users for the Critical Infrastructure
  - National Electricity Grid Operator: ICEGRID
  - National Hydro Production Company: Landsvitkjun

All first responders are trained to use this software platform. A mantra used is "a system that you use during a crisis is the system that you use on a daily basis as you tend to grab onto the system you are most familiar with".

Usually on a daily basis the platform is used for equipment payments, setting meetings, training activities while during the crisis by the first responders such as ICE-SAR.

Responders share the common operating picture.

The platform is used at three operational levels:

- Boots on the ground. People in the field enter information about the impact of the hazard on the site to collate information.
- Tactical level e.g. district level
- Coordination, where the Crisis Coordination Centre is. This allows tasks to be assigned to people on the ground: on the basis of the information collated e.g. the number of injuries and locations of damaged buildings. The tasks are classified by priority and then allocated to the teams.

The Operation Dashboard is divided into five sections:

1. Operation logs, keeping track of all events
2. Group Management
3. Task Management
4. Operation Map
5. Information window

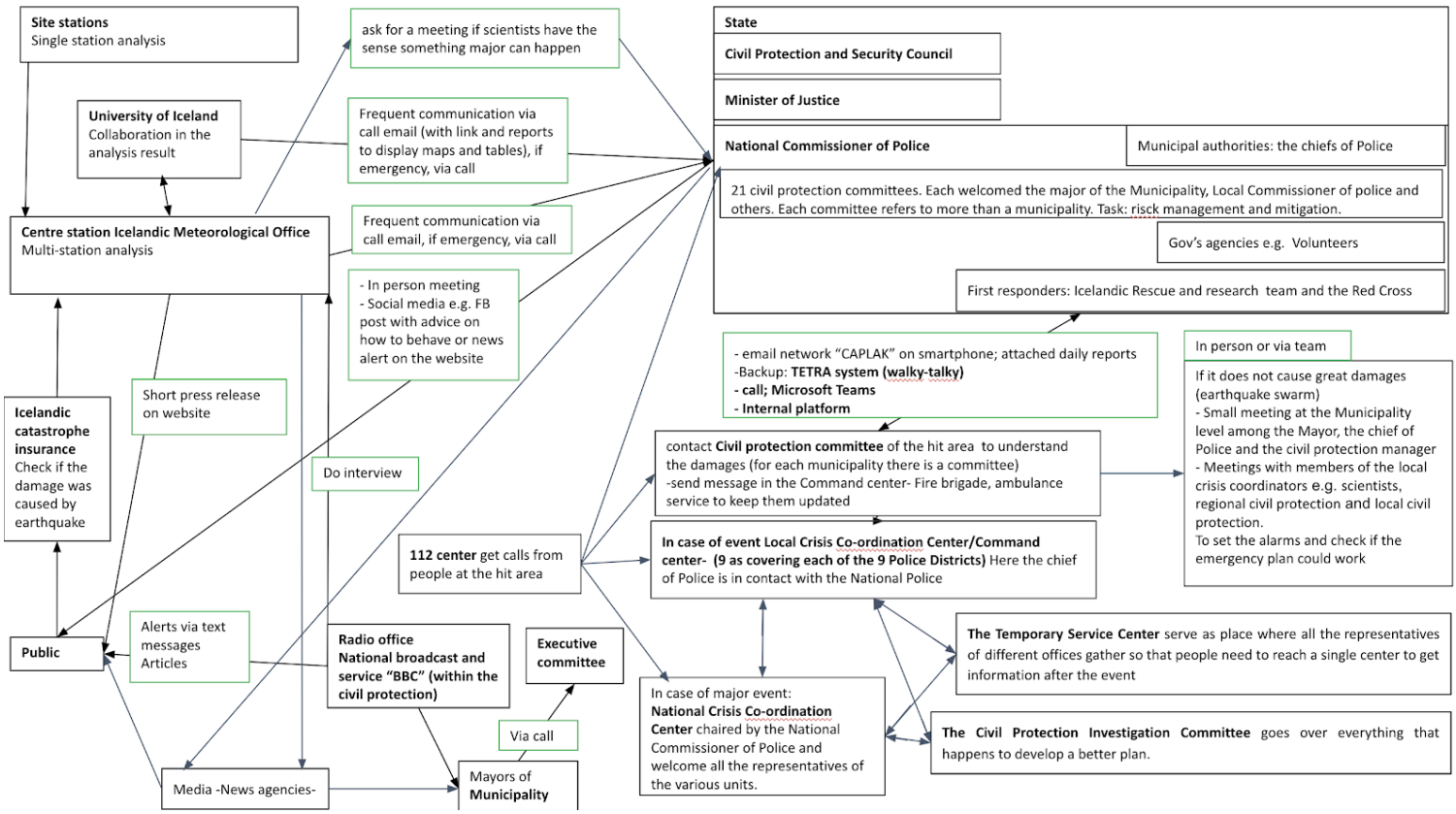
Users can see:

- Description of each task
- A priority for each task: Priority 1 means that it needs doing within 15 minutes and if it is not fulfilled within that time, the notification becomes red or a notification is sent to those assigned the task to tell them it is overdue; Priority 3 means that it needs to be dealt with within 1 hour
- Time for each task to be fulfilled
- Automatic overview of the tasks a user hasn't yet completed, with a user-chosen timeframe for visualising their tasks.

- Estimated Magnitude and epicentre (usually provided by the Meteorological Office).
- The teams that have been dispatched.
- Known damages e.g. what is known so far; amount of injuries; collapsed buildings; loss of electricity, given by the electricity company; destruction of a road, given by the road authorities; the phone companies would give information to a coalition that would communicate their information.

Users cannot choose what notifications to receive because they are tailored towards the different teams involved during the contingency plan.

Diagram of the communication pathways within the country for seismic information



What training/co-production of communication has taken place or is planned?

Exercises to rehearse the handling of earthquakes are done at least once a year, however earthquake exercises are perceived quite hard to simulate, thus they are usually held on a desk where different strategies and the steps are hypothesised and followed. There is no other co-ordinated communication of seismic information.

Conclusions

The systems of communication of seismic information in these three countries is, naturally, complex. In all cases there is a main provider of seismic information (INGV in Italy, SED in Switzerland and IMO in Iceland), but also additional information being supplied by others (e.g. from the EUCentre).

The dissemination and use of long term hazard maps is relatively straightforward, as these tend to be made publicly available, and are also used by those involved in construction planning and regulation.

The complexities come with short-term and dynamic information.

In none of the countries has a regular seismic forecast service been highly developed in the way that weather forecasts have, although the Icelandic Meteorological Office comes closest to this – perhaps because of the co-habitation of the seismic and weather hazard information within the same Office, and perhaps because of the more regular occurrence of seismic events in the country.

In all the countries the main seismic information producers can inform others about earthquake information, but in Italy and Iceland they cannot release information on how to behave - that is the responsibility of civil protection alone. In Italy this rule is strictest as the INGV, the main producer, cannot even suggest protective behaviours. This role is fulfilled by the Italian Civil Protection alone, no doubt at least in part influenced by the fall-out from the L'Aquila earthquake of 2009. In Switzerland, however, the main producer of seismic information, SED, is allowed to give both information and behavioural recommendations. These differences in divisions of responsibility are important and will inevitably be reflected in the types of communications in each country.

In Iceland, the communication networks about immediate seismic activity are the simplest, likely due to the smaller size of the country and population, but also potentially because the population is relatively used to seismic activity and have a higher baseline knowledge about the underlying geological processes. This means that the information provided by seismologists can go relatively directly both to the general public and to decision-makers without specialist seismological training.

The Italian system tends to rely on automatic reports, emails, text messages or weekly bulletins over specific platforms. This information is in a specific and precise format, which could ensure that it is comprehensible, although no tests of how well it is understood by the recipients are reported. This information is also kept much more closely within the authorities, with very little reporting to the general public and little to no interest from the media. This could be a cultural difference based on a lesser level of geological knowledge and interest in the public (since Italy is less seismically active than Iceland), and also the result of fewer direct connections between the media and the relevant scientists. There could also be nervousness about seismological reporting since the L'Aquila earthquake.

In Switzerland there is a highly co-ordinated system of seismic detection and automated notification of information, including the media, with careful plans of what to do in the event of an earthquake. However, the public is generally not given training or information on how to prepare for or react in the event of an earthquake – probably because of the low level of seismic activity in the country as a whole – and so communications in the event of a raised risk need to be more specific than if the population were well-drilled in how to respond.

In all countries there is a plan for a co-ordinated response to an earthquake once it has happened and there are greater similarities between the systems: the most local level has the responsibility and the higher levels, e.g. regional and national, support with appropriate resources. Again, Iceland is perhaps the most co-ordinated, in this case perhaps because of the regularity of events and perhaps also because of the small size of the country and so the lesser need for hierarchical controls.

Looking at what lessons can be learned from these three existing networks of communications, and the gaps they reveal it seems that the closer relationships between the media, the scientific community and the police and civil protection found in Iceland probably all help with the communication channels – although with their informal networks there is the danger of miscommunication, particularly if the more informal Icelandic system were simply scaled up in countries such as Switzerland and Italy. In Italy and Switzerland there are higher barriers to such direct communication than in Iceland. Work will need to be done specifically with the media and those who communicate directly with the public when developing seismic communication materials, to ensure that these key communicators understand the geological principles and can therefore help interpret the information provided by seismologists for a public audience with a lower baseline level of understanding than is found in Iceland.

Appendix

Italy

Financial incentives for anti-seismic adaptations in Italy

LE DETRAZIONI IRPEF E IRES PER GLI INTERVENTI ANTISISMICI (SISMABONUS)			
PERCENTUALI di detrazione	**50%**	**70%**, per le singole unità immobiliari, se si passa a **una classe** di rischio inferiore **75%**, per gli edifici condominiali, se si passa a **una classe** di rischio inferiore	**80%**, per le singole unità immobiliari, se si passa a **due classi** di rischio inferiore **85%**, per gli edifici condominiali, se si passa a **due classi** di rischio inferiori
IMPORTO MASSIMO delle spese	**96.000** euro per unità immobiliare per ciascun anno		
	96.000 euro moltiplicato per il numero delle unità immobiliari di ciascun edificio, per gli interventi sulle parti comuni di edifici condominiali		
RIPARTIZIONE della detrazione	**5** quote annuali		
IMMOBILI INTERESSATI	qualsiasi immobile a uso abitativo (non solo l'abitazione principale) e immobili adibiti ad attività produttive l'immobile deve trovarsi in una delle **zone sismiche 1**, **2** e **3**		

Supplementary table 1: example of financial incentives for seismic retrofitting in Italy

English translation of supplementary table 1

Deductions IRFPEF and IRES for antiseismic interventions (SISMABONUS)			
Percentages of deduction	50%	**70%**, for single home unites, if there is a switch to **an** inferior risk **category** **75%**, for condominium buildings, if there is a switch to **an** inferior risk **category**	**80%** for single home units, if there is a switch to **2** inferior risk **categories** **85%** for condominium buildings, if there is a switch to **2** inferior risk **categories**
Maximum amount of the costs	**96.000** euros for home unit for each year		
	96.000 euros multiplied by the number of home units of each building, by the interventions on the common parts of condominium buildings		
Distribution of deduction	**5** annual dues		
Properties concerned	Any property for housing (not only the main house) and properties used as productive activities The property must be located in **seismic zone 1, 2,** and **3**		

LA DETRAZIONE PER L'ACQUISTO DI UN'UNITÀ IMMOBILIARE ANTISISMICA (in vigore dal 2017)	
PERCENTUALI di detrazione	**75%** del prezzo di acquisto (se si passa a una classe di rischio inferiore)
	85% del prezzo di acquisto (se si passa a due classi di rischio inferiori)
IMPORTO MASSIMO su cui calcolare la detrazione	**96.000 euro** per ogni unità immobiliare
RIPARTIZIONE della detrazione	**5** quote annuali
LE CONDIZIONI	• gli immobili interessati sono quelli che si trovano nei Comuni ricadenti in una zona classificata "a rischio sismico 1" (anche "2" e "3", a seguito della disposizione introdotta dal Dl n. 34/2019) • devono far parte di edifici demoliti e ricostruiti per ridurre il rischio sismico, anche con variazione volumetrica rispetto al vecchio edificio • i lavori devono essere stati effettuati da imprese di costruzione e ristrutturazione immobiliare che entro 18 mesi dal termine dei lavori vendono l'immobile

Supplementary table 2: Example of deduction for the purchase of an anti-seismic home unit

English translation for supplementary table 2

The deduction for the purchase of an anti-seismic home unit (In force since 2017)	
Percentages of deduction	**75%** of the purchase prize (if there is a switch to an inferior risk category)
	85% of the purchase prize (if there is a switch to 2 inferior risk categories)
Maximum amount on which calculate the deduction	**96.000 euros** for each home unit
Distribution of the deduction	**5** annual dues
Conditions	• The property concerned are those located in the municipalities in an area categorised as "at seismic risk 1" (also "2" and "3", following the provision introduced from Dl n. 34/2019) • The demolished buildings and the ones rebuilt to reduce the seismic risk are included, also with volumetric variation compared to the old building • The works must be performed from construction companies and enterprise restructuring that sell the property by 18 months from the end of the works.

Press releases by the Civil Protection in Italy communicating earthquakes information

PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

COMUNICATO STAMPA

TERREMOTO: MAGNITUDO 4.4 IN PROVINCIA DI VERONA

Dalle verifiche non risultano danni e feriti.

A seguito dell'evento sismico registrato dall'Istituto Nazionale di Geofisica e Vulcanologia in provincia di Verona alle ore 15:36 con magnitudo ML 4.4, la Sala Situazione Italia del Dipartimento della Protezione Civile è in contatto con le strutture locali del Servizio nazionale della protezione civile. Dalle verifiche non risultano danni e feriti.

L'evento sismico – con epicentro localizzato tra i comuni di Salizzole, Isola della Scala ed Erbè, in provincia di Verona – risulta avvertito dalla popolazione.

Roma, 29 dicembre 2020

Supplementary figure 1: An example series of three press releases sent out by Italian Civil Protection after an earthquake: firstly, when investigations are ongoing.

English translation of supplementary figure 1:

"In the aftermath of the seismic event recorded by the National Institute of Geophysics and Volcanology in the province of Verona at 3.36 pm with magnitude ML 4.4, the National Operational Room of the Civil protection is in contact with the local structures of the National Service of the Civil Protection. According to the verifications, there are neither damages nor injuries.
The seismic event- with epicentre located among Salizzone, Isola della Scala and Erbè, in the province of Verona- was felt by the population."

PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

COMUNICATO STAMPA

Terremoto: magnitudo 4.6 in provincia di Ragusa
In corso le verifiche da parte della Sala Situazione Italia

A seguito dell'evento sismico registrato dall'Istituto Nazionale di Geofisica e Vulcanologia in provincia di Ragusa alle ore 21.27 con magnitudo ML 4.6, sono in corso le verifiche da parte della Sala Situazione Italia del Dipartimento della Protezione Civile in contatto con le strutture locali del Servizio nazionale della Protezione Civile.

L'evento sismico – con epicentro localizzato tra i comuni di Vittoria, Acate e Santa Croce Camerina in provincia di Ragusa– risulta avvertito dalla popolazione. Dalle prime verifiche non risultano danni e feriti.

Roma, 22 dicembre 2020

Supplementary figure 2: An example series of three press releases sent out by Italian Civil Protection after an earthquake: secondly reporting damages detected (none, in this instance)

English translation of supplementary figure 2

"In the aftermath of the seismic event recorded by the National Institute of Geophysics and Volcanology in province of Ragusa at 9.27 p.m. with magnitude ML 4.6, chechs are ongoing from the National Operational Room of the Civil protection in contact with the local structures of the National Service of the Civil Protection.

The seismic event- with epicenter located among Salizzone, Isola della Scala and Erbè, in the province of Verona- was felt by the population. From the first verification there are neither damages nor injuries."

PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

COMUNICATO STAMPA

SEQUENZA SISMICA IN PROVINCIA DI FORLÌ-CESENA

Prosegue lo sciame sismico nella zona del Montefeltro, in provincia di Forlì-Cesena. Questa mattina si sono verificati due terremoti di M 4.0 e 3.9, i più forti della sequenza in atto. Le località più prossime all'epicentro sono i comuni di Santa Sofia, Premilcuore e Galeata.

Dal 24 maggio nella zona adiacente al Montefeltro, in provincia di Forlì-Cesena, si rileva un'intensa attività sismica. L'area interessata dalla sequenza è di circa 70 km quadrati compresa tra i comuni di Bagno di Romagna, Santa Sofia, Sarsina e Verghereto. Tutti i terremoti registrati hanno ipocentri abbastanza superficiali, che si concentrano intorno a 8-9 km di profondità, e per questa ragione molti di essi sono stati avvertiti dalla popolazione.

Dal 24 maggio la Rete Sismica Nazionale dell'INGV - Istituto Nazionale di Geofisica e Vulcanologia ha registrato più di 860 scosse. Il terremoto più forte, di magnitudo 4.0, è avvenuto oggi alle 8:53 (ora italiana). In totale, sono stati 16 gli eventi di magnitudo tra 3.0 e 4.0, più di 60 gli eventi di magnitudo tra 2.0 e 2.9, tutti gli altri di magnitudo inferiore a 2.

Lo studio di una sequenza sismica, come quella in corso nel Montefeltro, non consente di fare ipotesi sulla possibilità che si verifichi o meno una scossa più forte. Ad oggi, infatti, non ci sono metodi riconosciuti dalla scienza per prevedere il tempo ed il luogo esatti in cui avverrà un terremoto. La prevenzione resta la migliore difesa dai terremoti e l'unico modo per ridurne le conseguenze.

Supplementary figure 3: An example series of three press releases sent out by Italian Civil Protection after an earthquake: thirdly, when an earthquake swarm is occurring

English translation of supplementary figure 3

"The earthquake swarm proceeds in the area of Montefeltro, in the province of Forli-Cesena. This morning two earthquakes of M 4.0 and 3.9 have occurred. The strongest of this sequence. The locations nearest the epicentre are the municipalities of Santa Sofia and Galeata.

From 24 May in the area next to Montefelto, in the province of Forli-Cesena, an intense seismic activity was detected. The area concerned with the sequence is around 70 km2 between Bagno di Romagna, Santa Sofia, Sarsina and Verghereto. All the recorded earthquakes have hypocentres rather superficial, that are 8-9 km deep, and for this reason most of them have been felt by the population.

From the 24, May the National seismic Network of the INGV- National Institute of Geophysics and Volcanology has detected more than 860 shakes. The strongest earthquake, of 4.0 magnitude, occurred today at 8.53 am (Italian time). In total, 16 have been the events of magnitude between 3.0 and 4.0, more than 60 the events between magnitude 2.0 and 2.9, all the others of a minor magnitude.

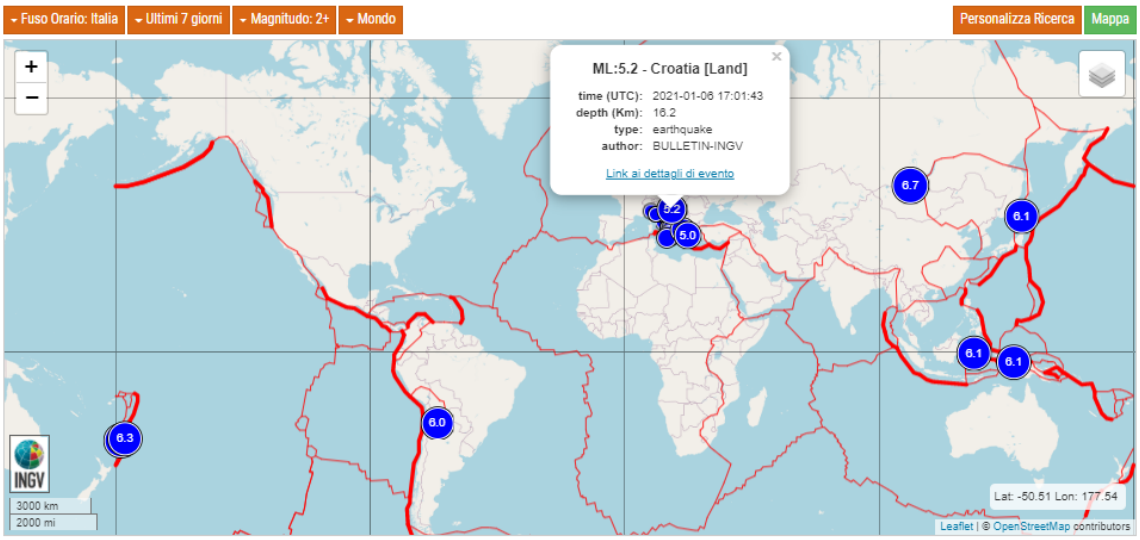
The study of a seismic sequence, as the one occurring in Montefeltro, does not allow us to hypothesize the probability of a future earthquake. At present, indeed, there are no methods recognised by the scientific community to forecast the exact time and location where an earthquake will happen. Prevention remains the best defence from earthquakes and the only way to reduce its consequences."

Supplementary figure 4: Examples of INGV provisional communication to the public (on Facebook) in the event of an earthquake

Translation of supplementary figure 4*:*
"(PROVISIONAL ESTIMATE) #earthquake Mag between 3.2 and 3.7, time 5.38 pm IT on 12-01-2021, prov/area Enna"

Supplementary figure 5: Examples of INGV revised communication to the public (on Facebook) in the event of an earthquake

English translation of supplementary figure 5:
"(REVISED DATA) #earthquake Mw 6.1 time 7:17pm IT on 12-01-2012, Irian Jaya, Indonesia (Land: Indonesia) Depth=20 km [link]"

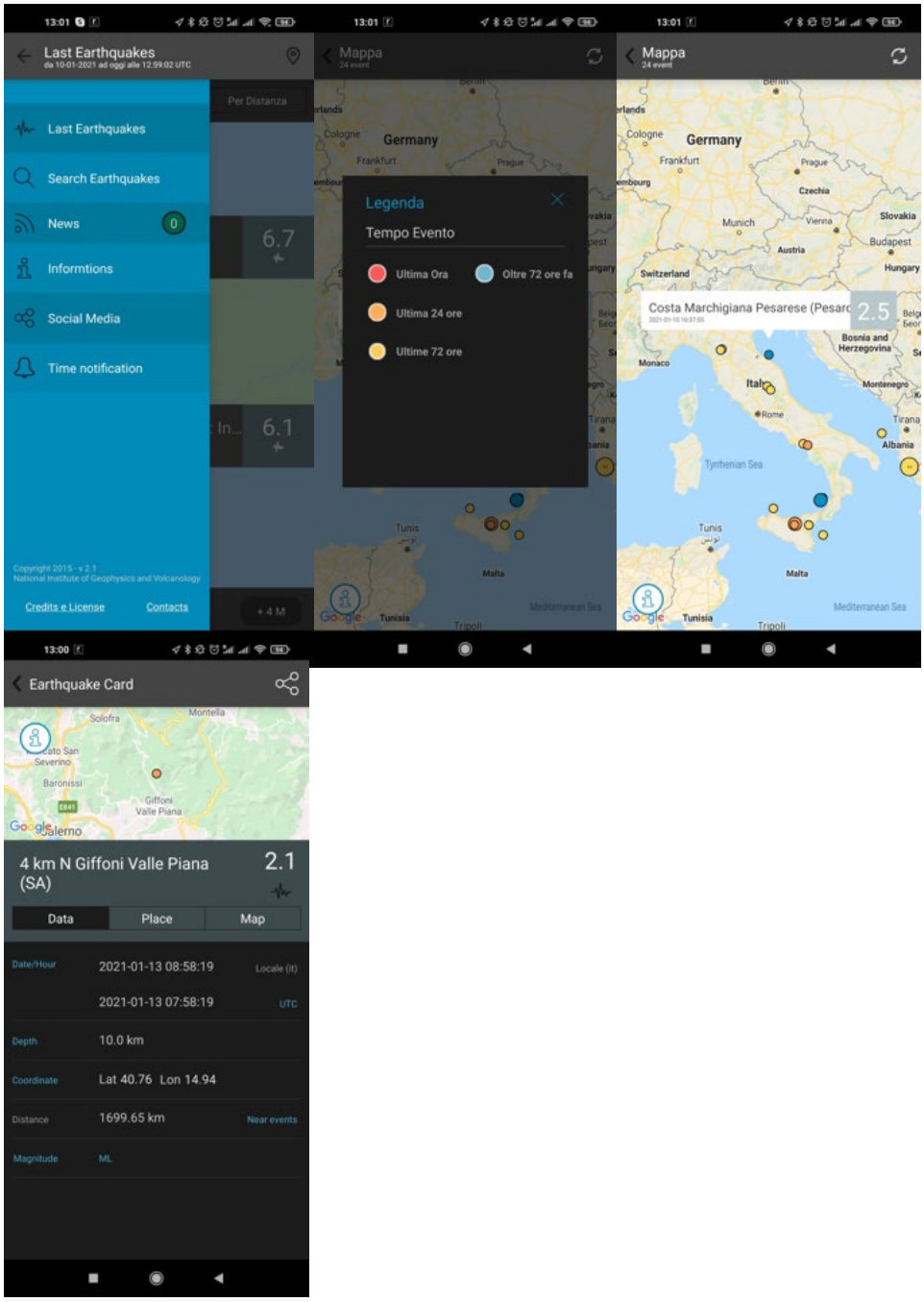


Visualizzati terremoti da 1 a 30 dei 42 trovati (Ordinamento Tempo Decrescente)

Esporta lista (UTC)

Data e Ora (Italia)	Magnitudo	Zona	Profondità	Latitudine	Longitudine
2021-01-13 08:58:19	ML 2.1	4 km N Giffoni Valle Piana (SA)	10	40.76	14.94
2021-01-13 08:18:17	ML 2.3	6 km W Sperlinga (EN)	24	37.77	14.29
2021-01-12 23:10:00	**mb 5.0**	**Greece**	20	38.41	21.96
2021-01-12 19:35:01	ML 2.4	7 km N Sperlinga (EN)	6	37.83	14.35
2021-01-12 19:17:36	**Mwp 6.1**	**Irian Jaya, Indonesia [Land: Indonesia]**	20	-3.07	136.95
2021-01-12 17:38:35	Mw 3.5	4 km NW Sperlinga (EN)	9	37.80	14.33
2021-01-12 16:18:06	ML 2.7	Costa Calabra sud occidentale (Catanzaro, Vibo Valentia, Reggio di Calabria)	161	38.79	15.69
2021-01-12 11:39:34	ML 2.0	Costa Siciliana centro settentrionale (Palermo)	37	38.39	13.26
2021-01-12 09:55:26	ML 2.3	4 km SW Sestola (MO)	57	44.21	10.73
2021-01-12 08:26:32	**ML 4.3**	**Confine Grecia Albania (GRECIA, ALBANIA)**	17	39.96	19.94

Supplementary figure 6: Screen shot reporting example of list of earthquakes from the INGV public-facing website



Supplementary figure 7: screenshots from the INGV smartphone application. It reports earthquakes that have happened in the past 1 hour, 24 hours, 72 hours and beyond on a map where the dots are clickable to have information on the past seismic event.

Italian National Civil Protection campaigns on social media

Supplementary figure 8: actions in case of earthquake

English translation of Supplementary figure 8

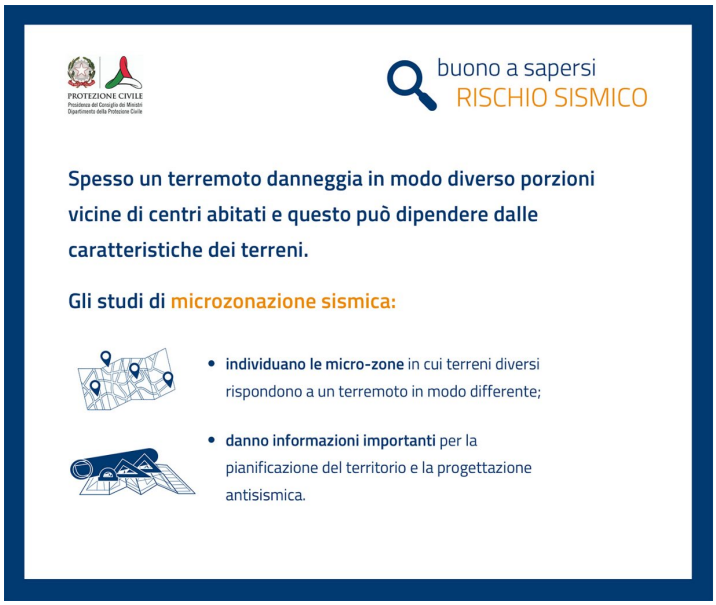
"In case of earthquake

- Shelter near a load-bearing wall, under a beam or under a bed or a resistant table
- Do not rush out: wait for the end of the shaking and wear your shoes
- Avoid the lift and be careful to the stairs: they could be damaged
- Keep far from buildings, threes, light streets, power lines
- If you are in a earthquake risk area, get away from the beach and reach an elevated place
- Be careful also after the shaking; there is the risk of gas leaks, landslides, bridge failures"

Supplementary figure 9: Explanation of the Richter scale

English translation of Supplementary figure 9
"Good to Know" campaign

“Richter magnitude, also called local magnitude, is the most known among the different scales to measure earthquakes.
It estimates the energy release, based on the oscillations recorded by the seismometers, and not the perceived intensity at that point.
It is available already a few minutes after the shaking because it is based on instrumental data and not on the damage assessment.
It does not depend on the location the tools are located.”



Supplementary figure 10: explanation of the reason why people perceive an earthquake in different ways. It depends on the micro zonation

English translation
“Often an earthquake damages in different ways close portions of residential areas and this can depend on the land characteristics.

The studies on seismic micro zonation:
Identify the micro-zones where different lands react to an earthquake in a different way.
Give important information for the land use planning as well as the anti seismic planning”

Supplementary figure 11: the images debunk the myths showing the false version alongside the true one

English translation

"True/False" debunking campaign

"**False**: all the earthquakes cause damage.

True: the damages of an earthquake depend on various factors, among which the intensity of the shaking and the vulnerability of the buildings."

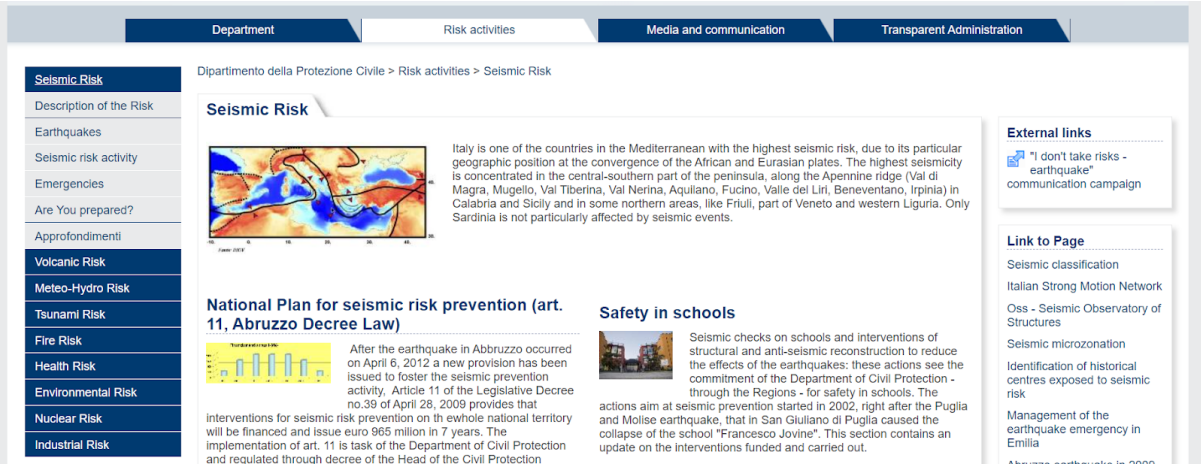
"**False**: the magnitude of the earthquakes is adjusted by the State to avoid compensatory damages.

True: the compensation for damages caused by an earthquake does not depend on the magnitude, but on the entity of the damage and on the parameters set for the reconstruction."

"**False**: It is possible to forecast when and where the next earthquake will occur.

True: It is not possible to forecast exactly where, when and with what strength an earthquake will occur and we are not able to determine how long the seismic sequence will last. However, we know which are the riskiest areas and that it is important to get informed on how the buildings are built and on their consequent seismic vulnerability."

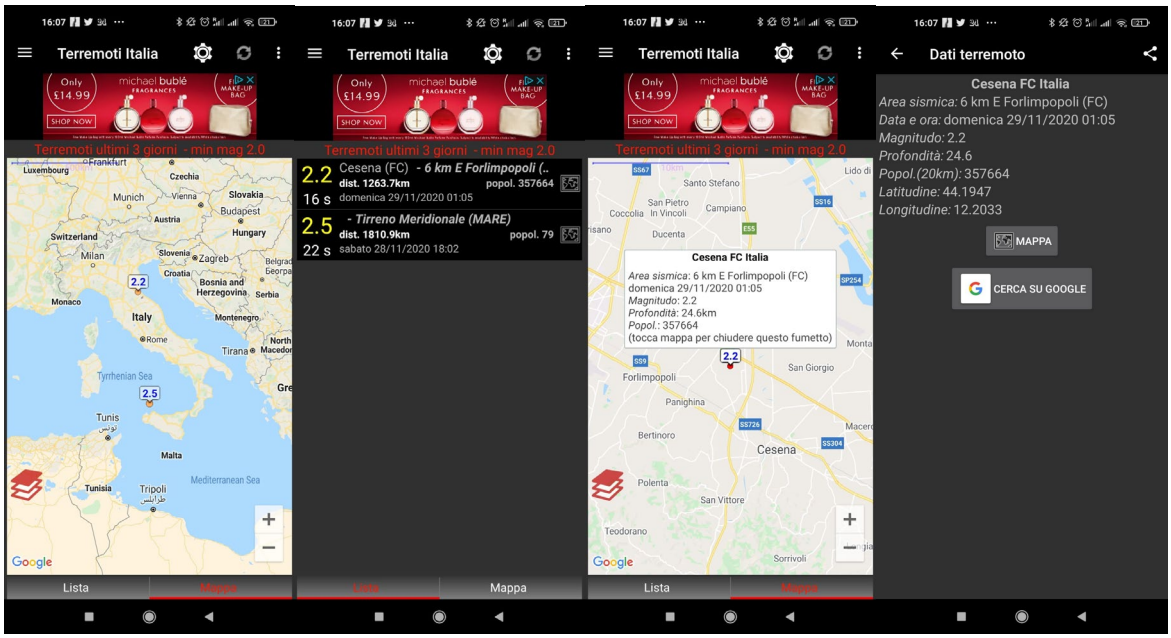
Italian National Civil Protection's public-facing website about seismic risk



Supplementary figure 12: brief explanation of Italian general seismic risk

Examples of smartphone applications spread and largely used from volunteers in Italy

Several smartphone applications are used by the civil protection in different regions, provinces and even Municipalities with different aims, such as to keep track of the earthquakes occurring, or to display the civil protection plan.
PIVEC volunteers have smartphone app called «terremoti Italia»:

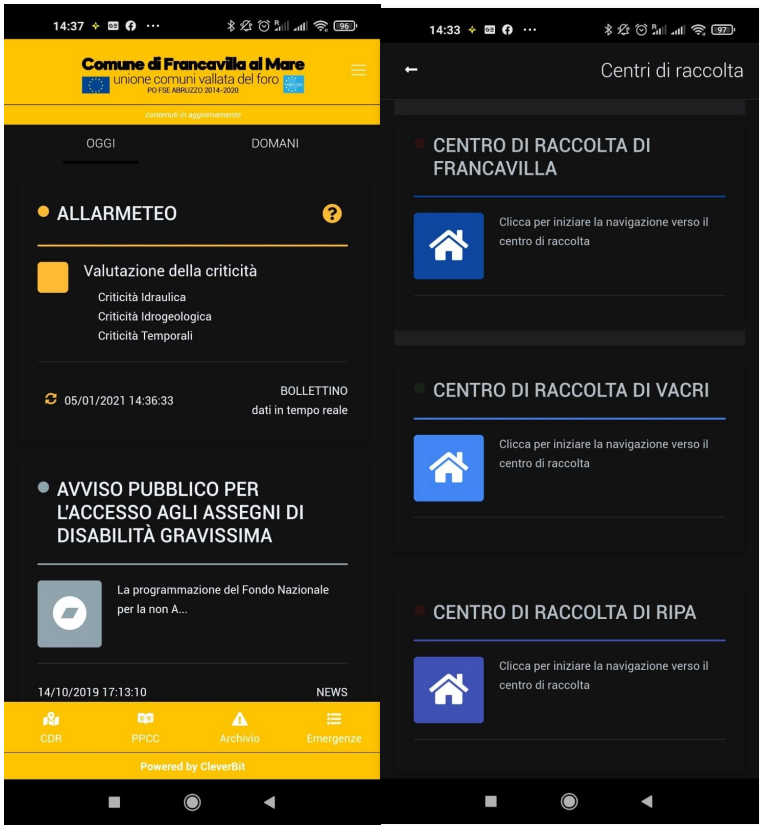


Supplementary figure 13: images of the smartphone application called "terremoti Italia"

Local municipalities

Although some municipalities have multi-hazard apps, whilst their design-structure is sometimes practical and easy to use, the content is almost absent. The app called “Comune di Francavilla al Mare” is an example.

Municipality app for Francavilla al Mare in Abruzzo - a high hazard region:

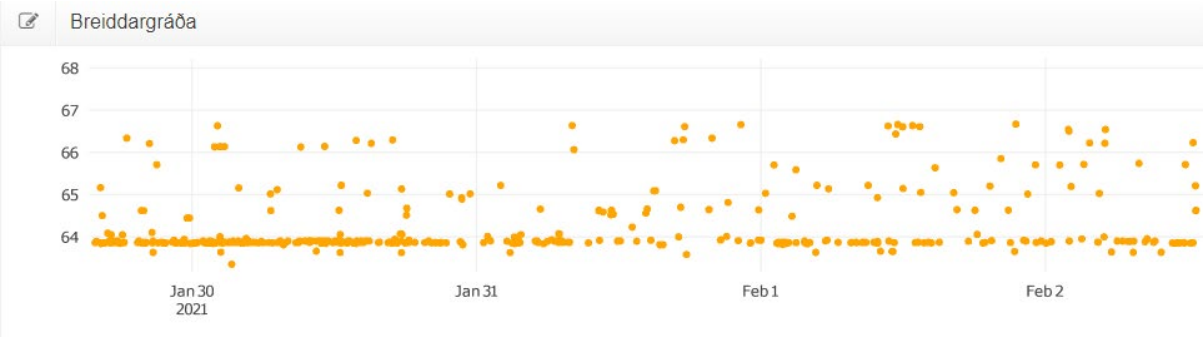


Supplementary figure 14: images of the smartphone application called "Comune di Francavilla al Mare"

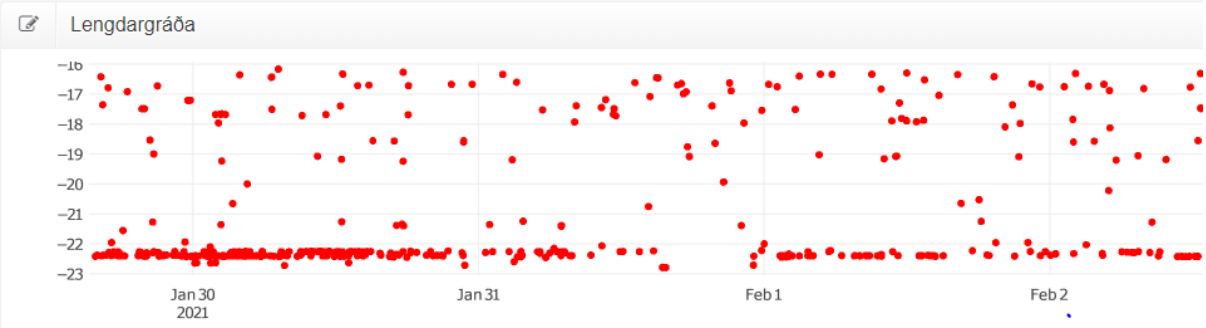
Iceland

Icelandic seismic information reported by the Icelandic Meteorological Office

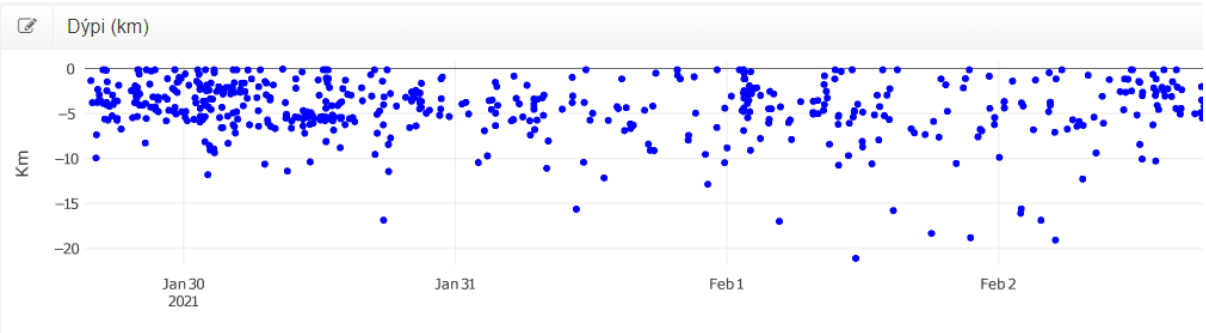
Latitude



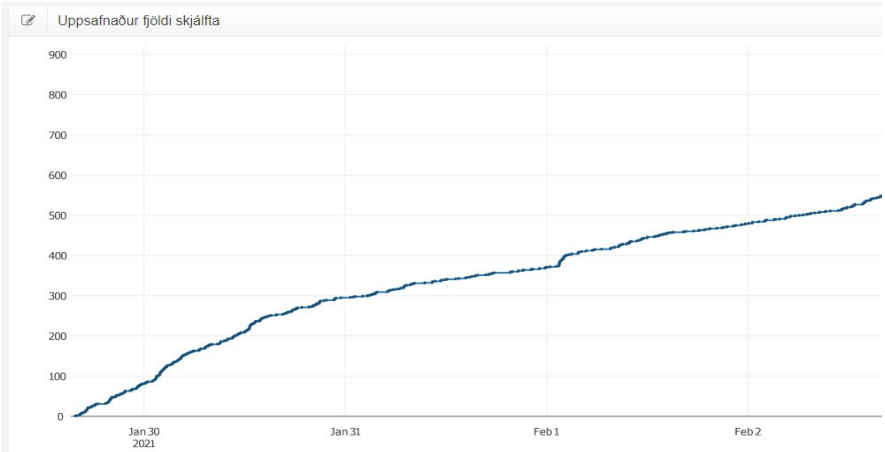
Longitude



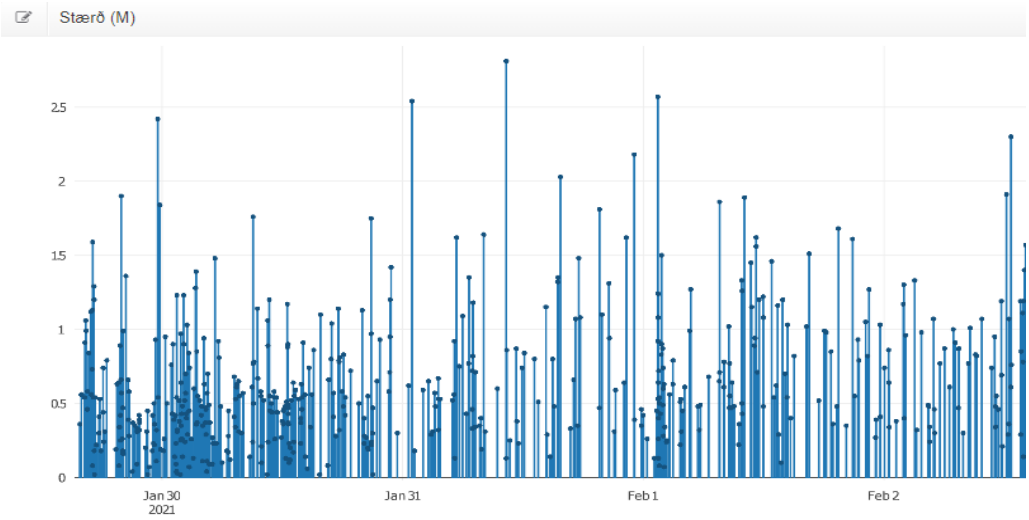
Depth



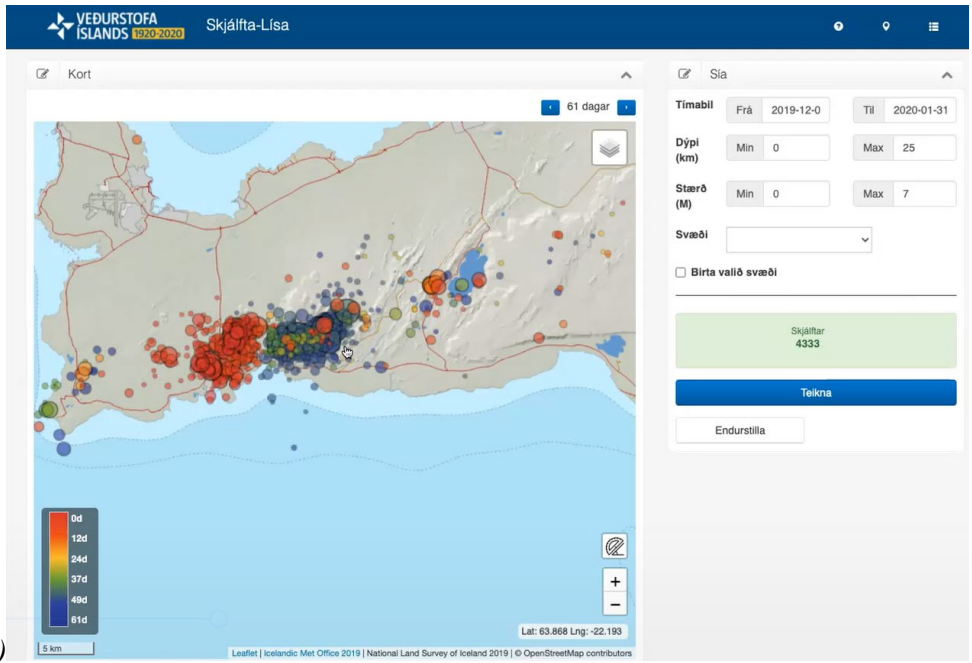
Supplementary Figure 15: Iceland Meteorological Office's representation of recent seismic activity. Source: Lists of earthquakes and their properties: https://skjalftalisa.vedur.is/#/page/graph_quakes2 .



a)

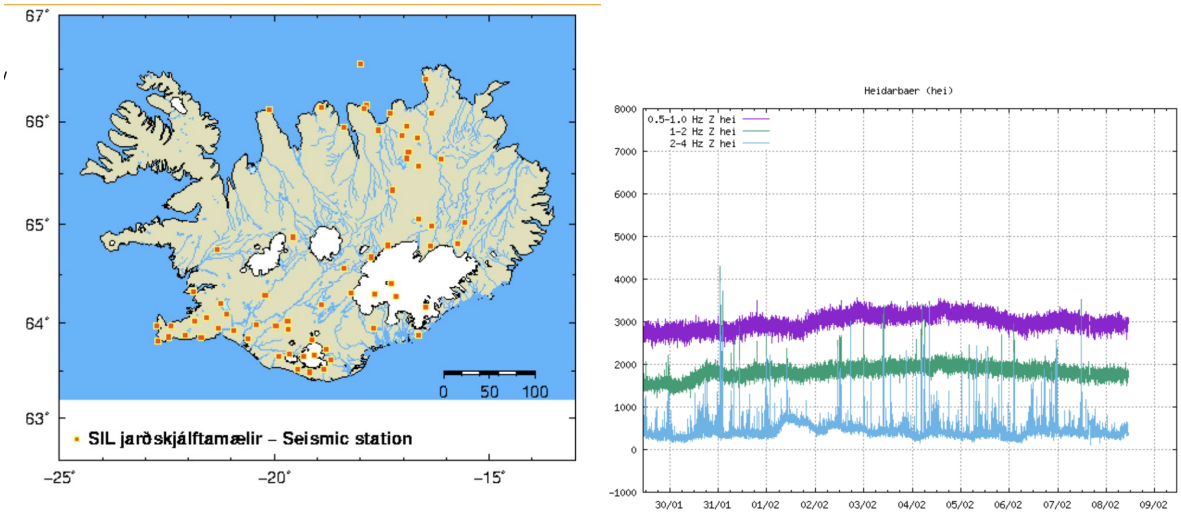


b)

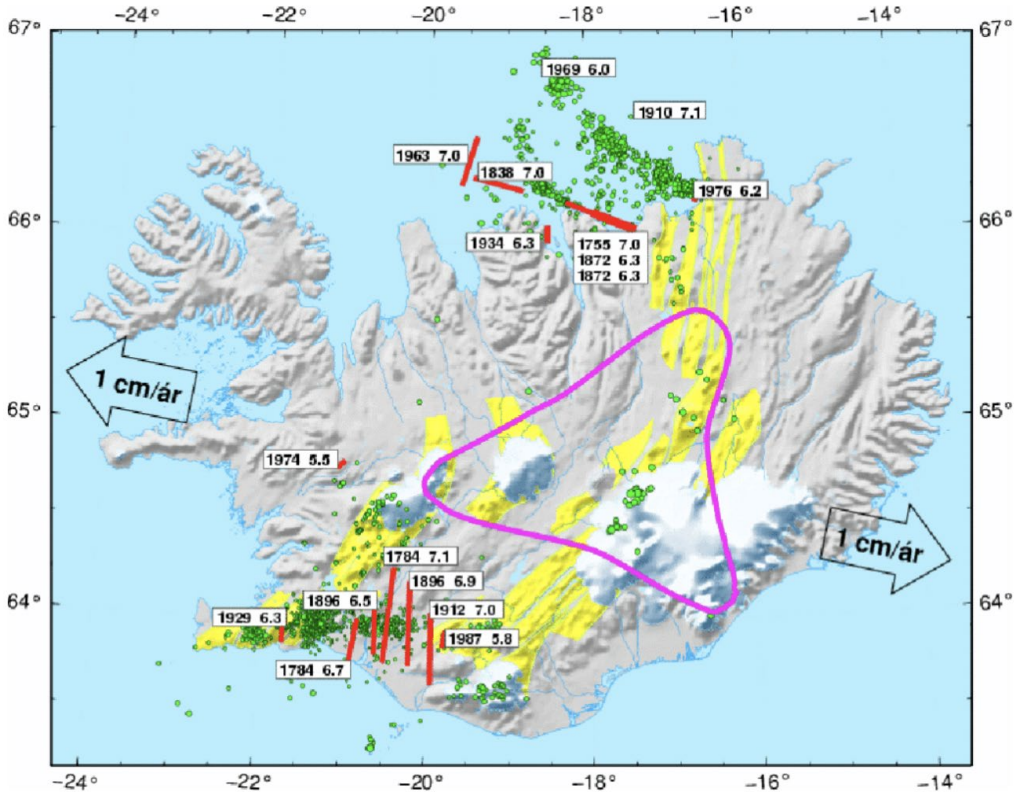


c)

Supplementary Figure 16: Icelandic Meteorological Office's representations of recent earthquakes on their public website: a) accumulated number of events, b) Magnitudes of events, c) location of recent events (colour shows time since event)

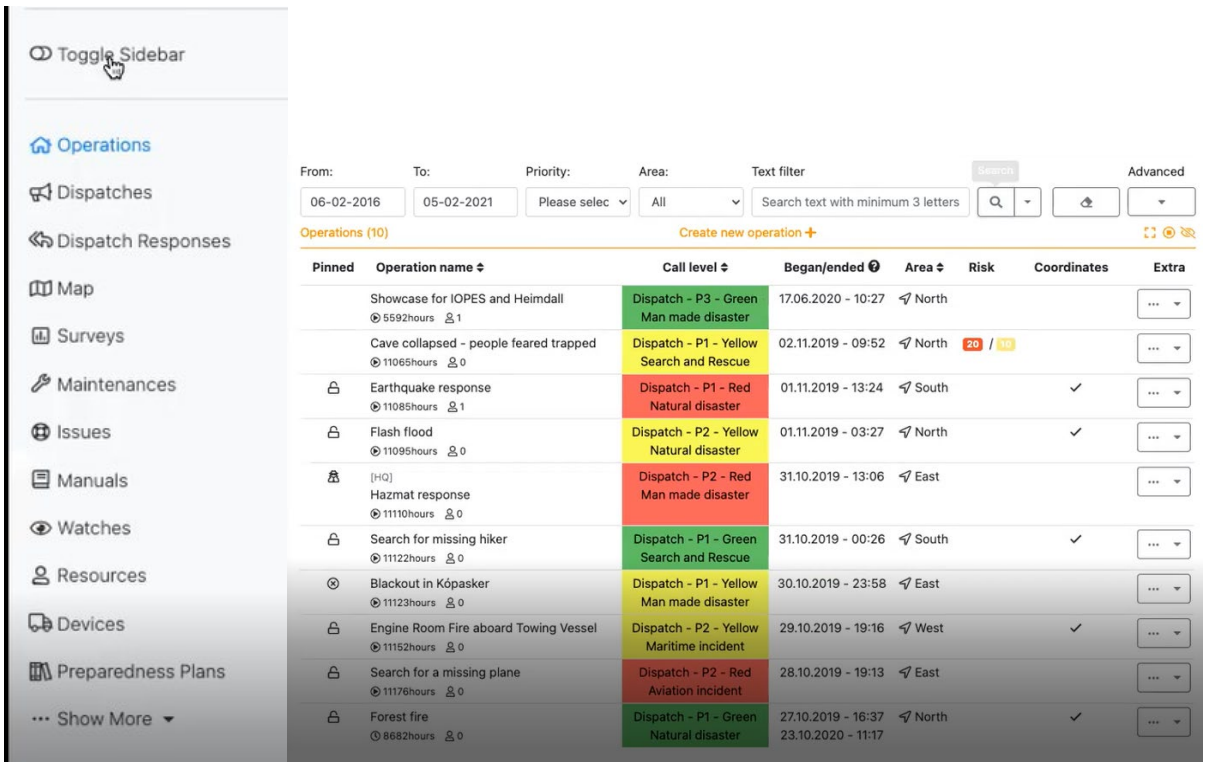


Supplementary figure 17: the red squares represent seismometers of the IMO. Clicking on them, graphs with the average vertical motion of a seismometer per minute at three different frequency ranges (Hz) pop up. To the website: http://hraun.vedur.is/ja/oroi/allarsort.html



Supplementary figure 18: Size of some large earthquakes in Iceland and the direction of the fracture surface (R. Stefansson, G. Guðmundsson et al. 2000) Source: https://www.almannavarnir.is/natturuva/jardskjalftar/

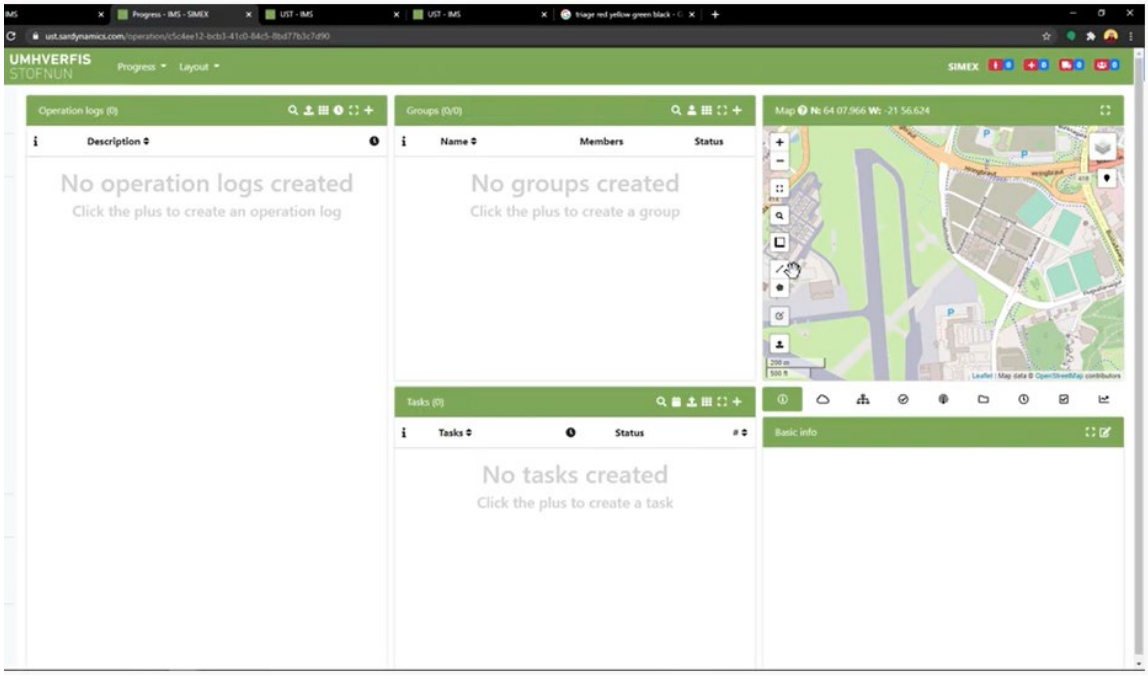
Below are screenshots of the SAReye platform used by the Icelandic Civil Protection, with explanation.



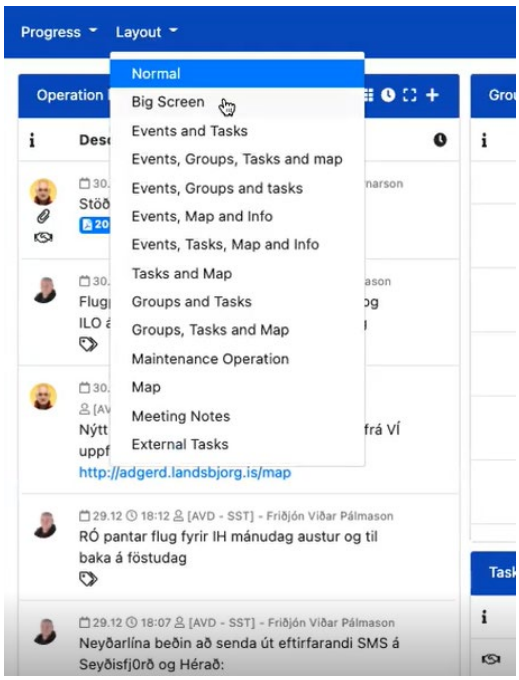
Supplementary figure 19: Dashboard for the Operations together with a navigation bar on the left side made by Icons, but clicking on the first icon, the wording associated with every icon can be displayed on SAReye platform

In supplementary figure 19 the page shows to create a new operation or open an existing one. In the former case the operation is given a priority (P1, P2, P3), geographical coordinates, people who can access the operation and people who can see the existence of the operation and the type of operation e.g., aviation incident, natural disaster. The colour refers to the resources put in place by the emergency units to handle the emergency. For each operation the number of hours the operation is going on is written below the operation name.

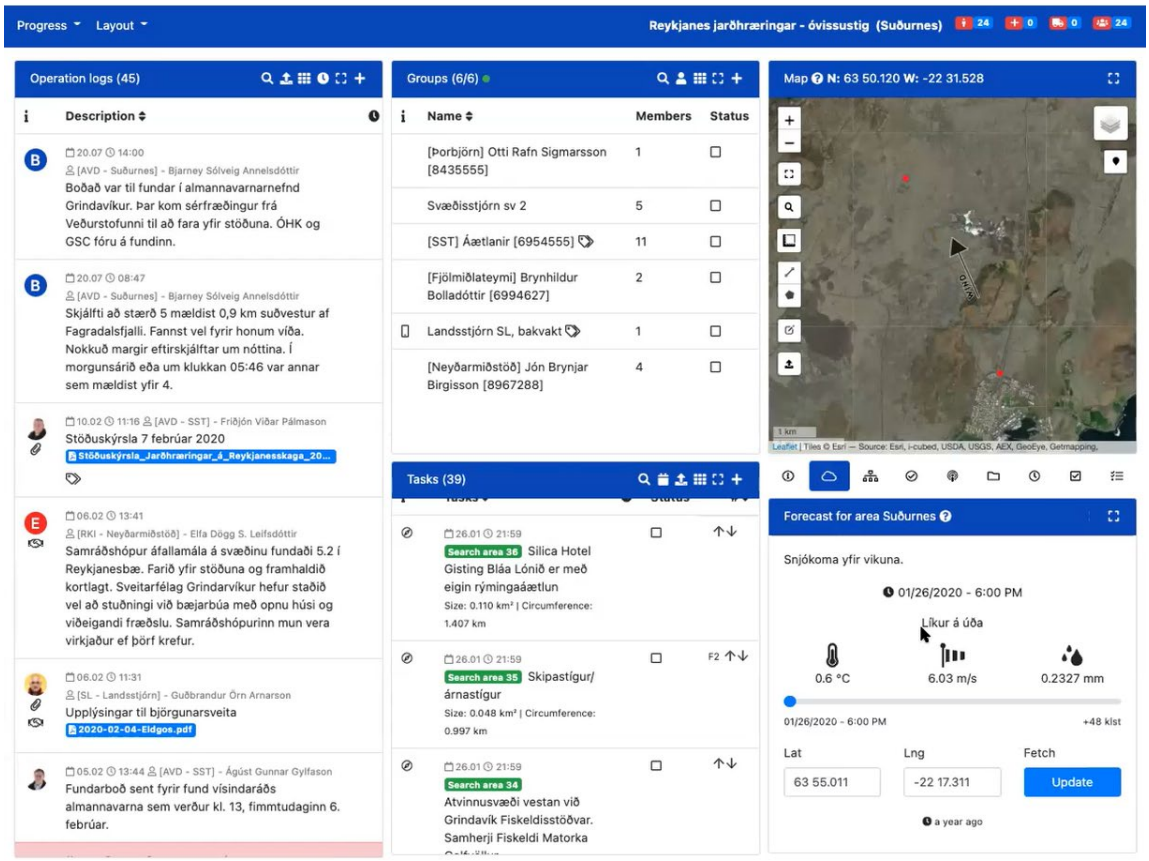
While in supplementary figure 20, if creating a new operation, the page looks empty and the person can add new operation logs, groups/independent people, tasks together with its priority, and add location on the map.



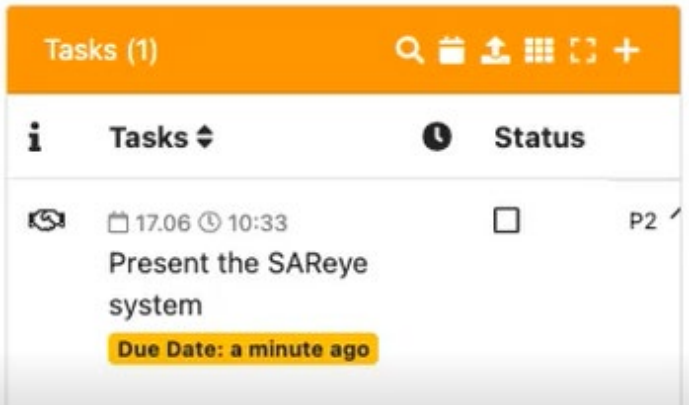
Supplementary figure 20: Dashboard for the Operations not yet filled in on SAReye platform



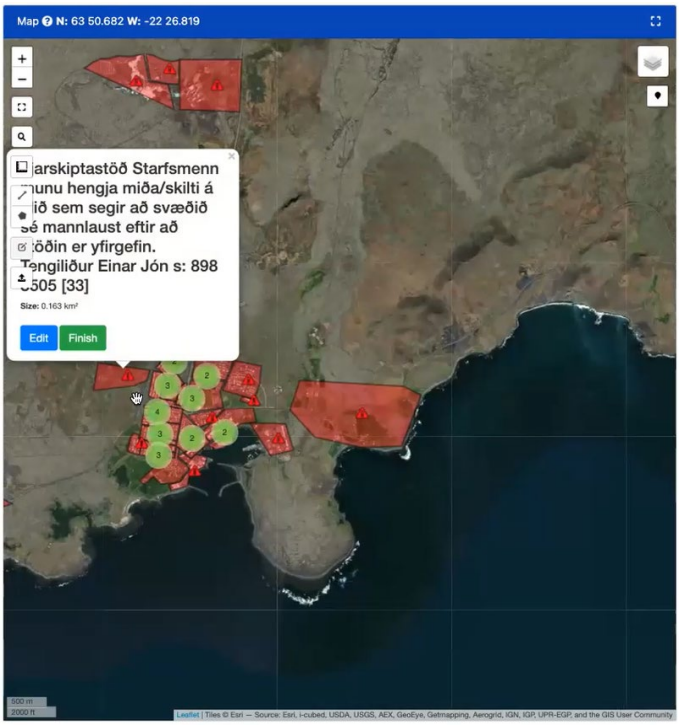
Supplementary figure 21: screenshot showing the different layout among which to choose on SAReye platform



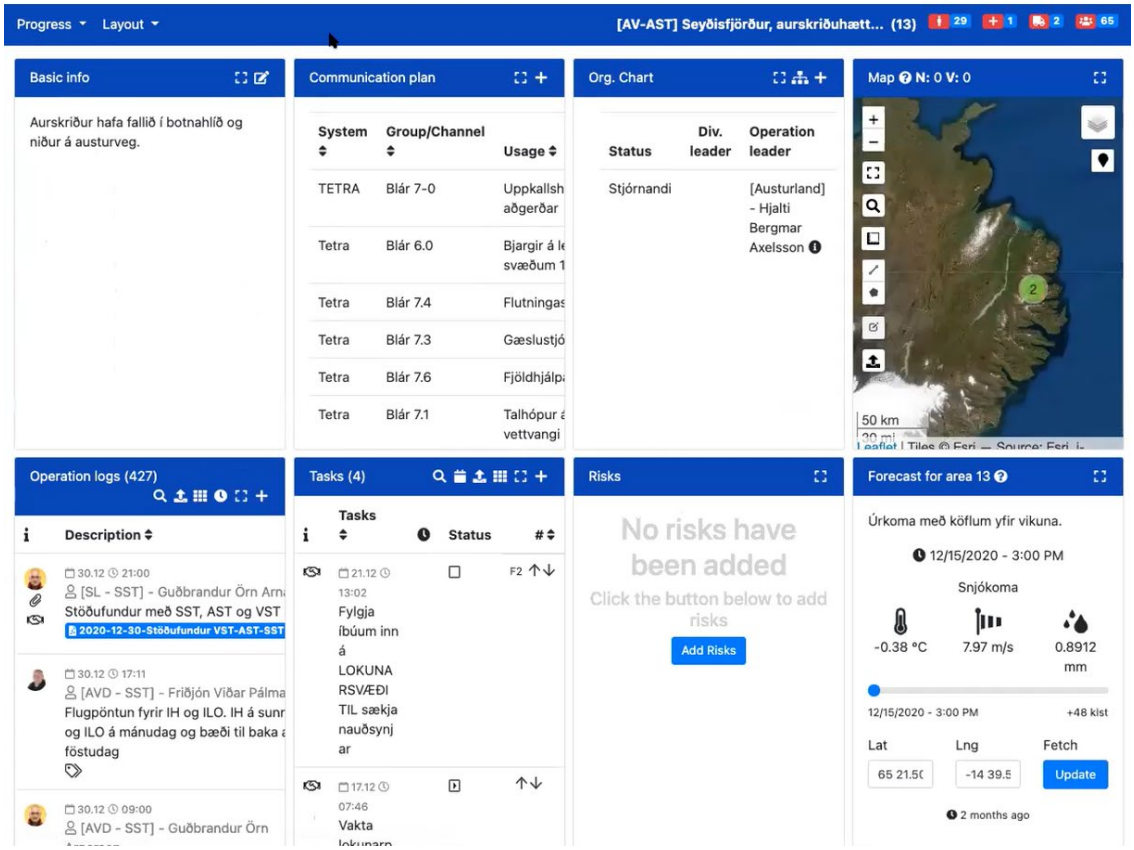
Supplementary figure 22: example of normal layout on SAReye platform



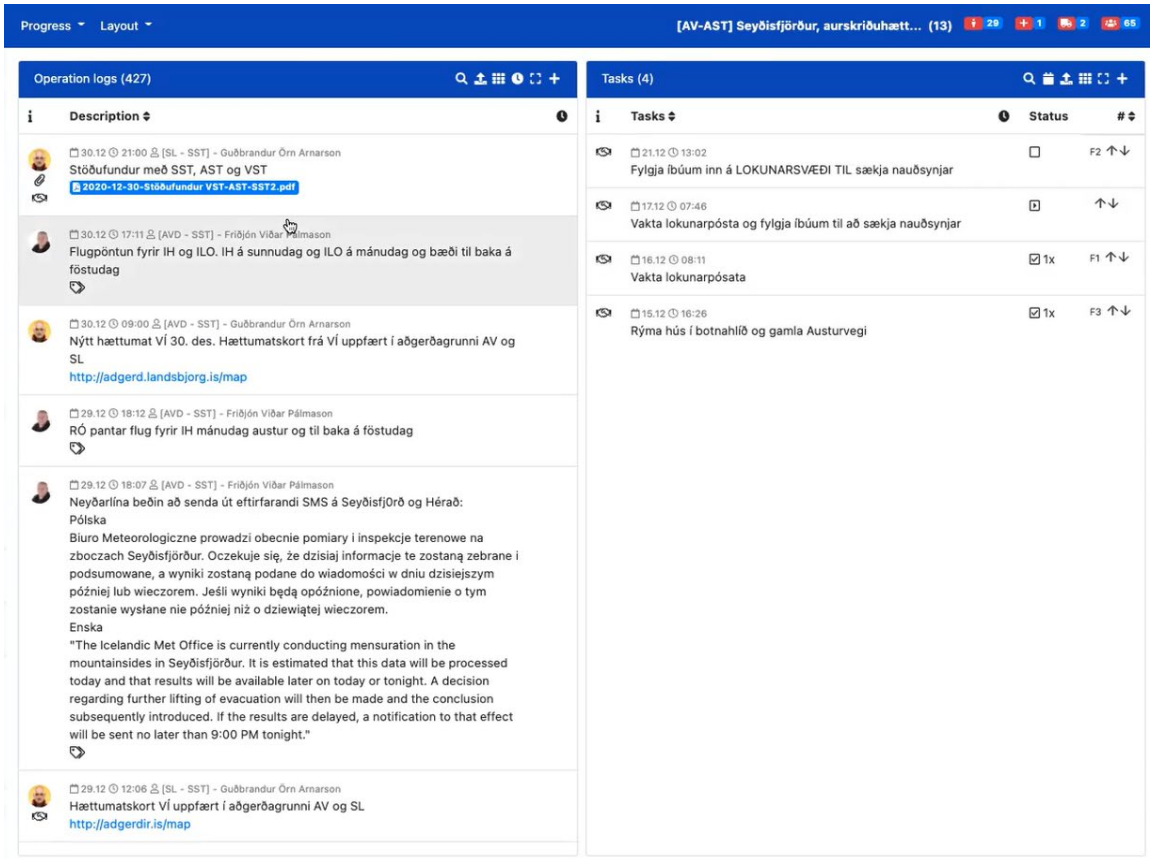
Supplementary figure 23: time by which the task assigned should be due on SAReye platform



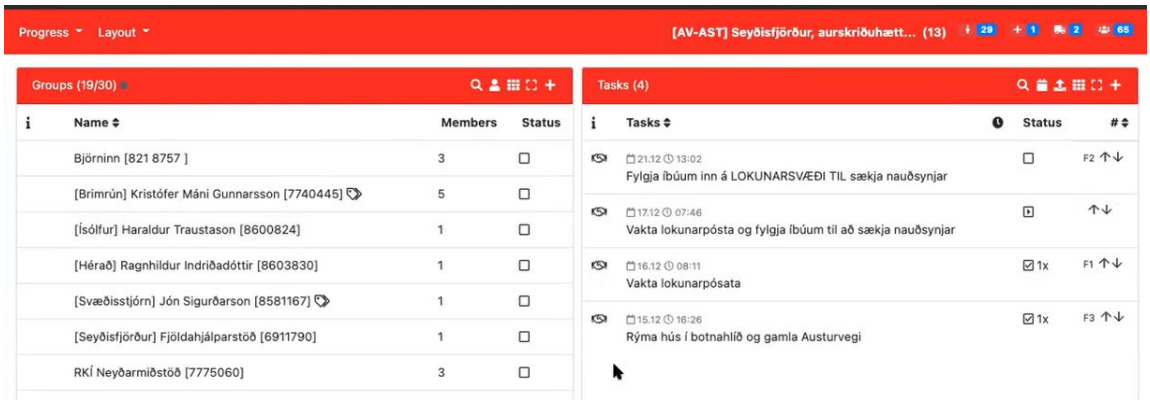
Supplementary figure 24: Each triangle is referred to a task and the numbers refer to the numbers of tasks, when only the map and the task are shown. When clicking on a triangle a message pops up describing the task itself on SAReye platform



Supplementary figure 25: big screen layout

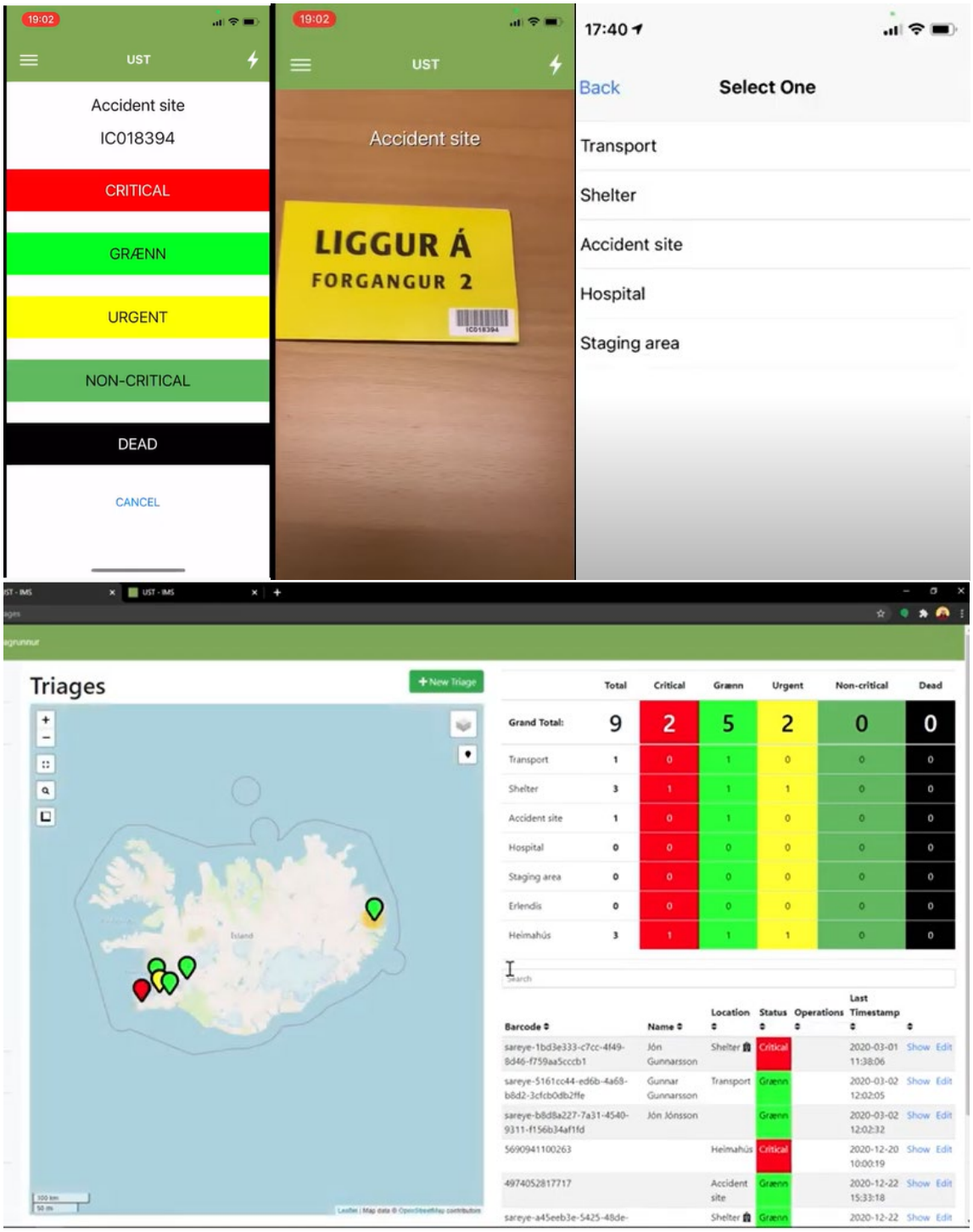


Supplementary figure 26: Operations and tasks layout on SAReye platform

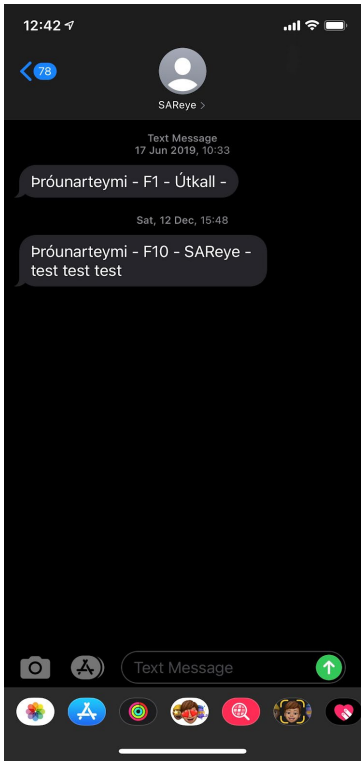


Supplementary figure 27: group and map layout on SAReye platform

Supplementary figure 28: triage option

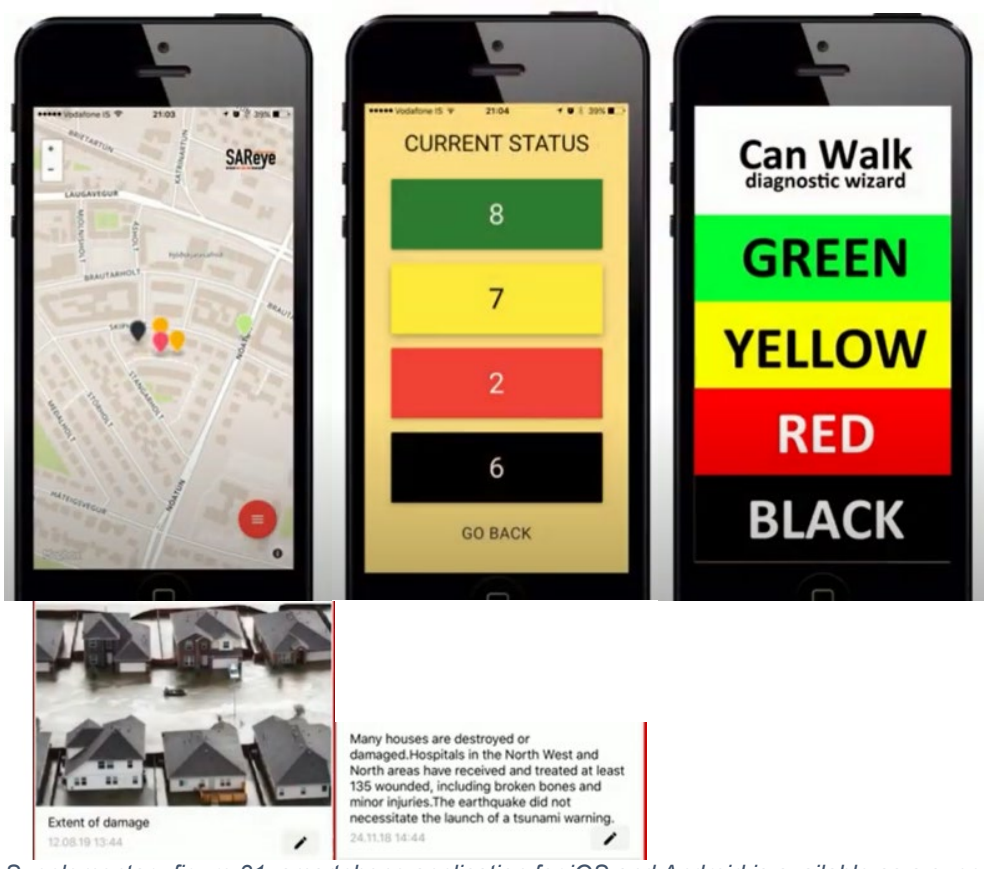


Supplementary figure 29: the barcodes are associated with each injured person. Indeed, the emergency responder going on the ground leaves the barcode to the person involved in the event on SAReye platform



Supplementary figure 30: text message sent when a task is added: "Name of the team" - F1 urgency - SAReye - call out" on SAReye platform

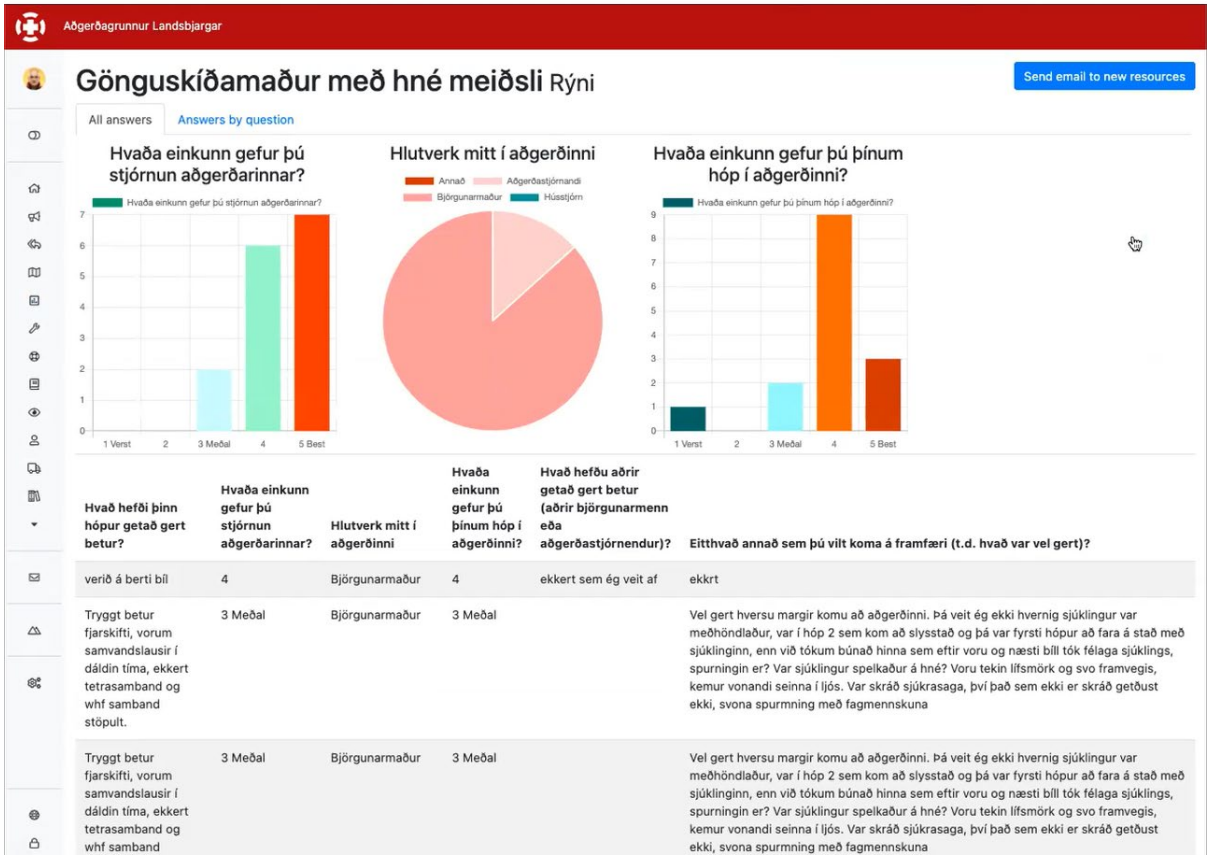
Smartphone application version of the platform



Supplementary figure 31: smartphone application for iOS and Android is available as a support for people on the field since formatted for phones and tablets on SAReye platform

Teams in the field can upload damage pictures to share a common operational overview and can estimate scope, thus providing prioritization in case of major events.

Interactive and static reports are written, and automatic reports are sent to unit leaders.



Supplementary figure 32: example of dynamic report, which is a survey administered to people involved in the emergency plan who answer anonymously so that an overview on how the event went is given on SAReye platform

English translation of supplementary figure 32

The results are displayed both in a graphical format as shown on the top of the figure above or in a table as visualised on the bottom of the figure.

The questions are:

- What grade do you give to the manager of the operation? Answer options: terrible; ok; good; great.
- What was my role in the operation? Instances of answers: regular rescue; incident manager.
- What grade do you give to your group in the operation? Answer options: terrible; ok; good; great.

On the table the columns refer respectively to:

- What could your group have done better?
- What grade do you give to the manager of the operation?

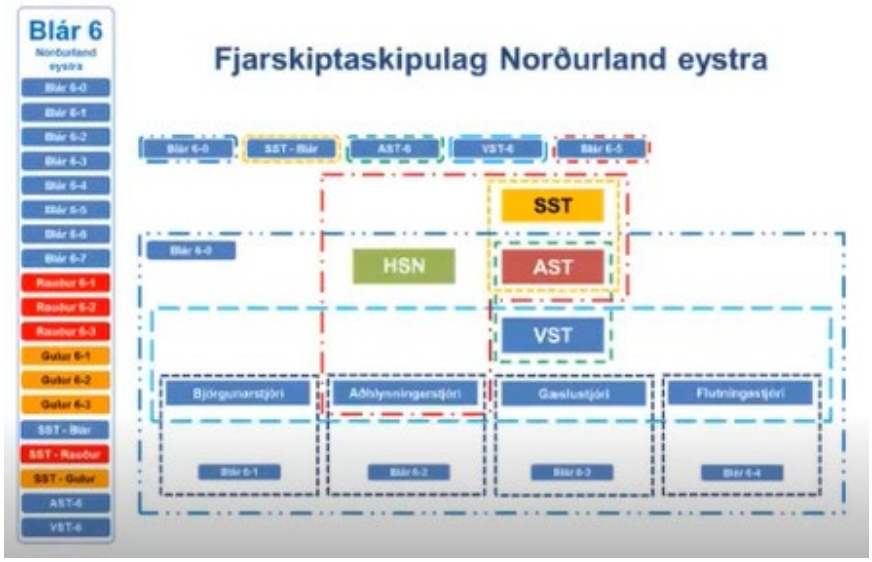
- What was my role in the operation?
- What grade do you give to your group in the operation?
- What could others have done better?
- Is there something else you would like to tell us about?

Such reports help people to get better for further emergencies.

Further options are:

Supplementary figure 33: trackers: the devices, i.e., car and ambulances are tracked during the emergency on SAReye platform

Mean of communication used by the Icelandic civil Protection: TETRA system



Supplementary figure 34: tetra system. The coloured rectangles correspond to the channels used by each unit of the Icelandic Civil Protection

Wear good protective clothing Wear good
shoes and protective clothing if broken glass on the floor or debris falls.

The emergency **box** Get to the emergency box, if available or needed.

Accidents - Injuries
Check if anyone has been injured and if help is needed, contact the Emergency Line at **1-1-2.**

Information .
Try to find information about the earthquake, its extent and source on the Meteorological Office's website and follow the civil protection recommendations in the media. Social media is quick to respond.

The phone does not work
If telephone assistance is not available, the scene of the accident must be marked with a white wave. The telephone is a safety device and when an emergency situation has arisen, the load on the network can lead to those who need help not being able to get in touch. Instead of making calls, send an **SMS** instead of making a call, to let your loved ones know about you, to reduce network load. It can also be a good idea to have a charging bank, rechargeable batteries and chargers to use in a car to charge electrical appliances (telephones and computers) in the absence of electricity, which is often accompanied by earthquakes.

Elevators
Do not use elevators in high-rise buildings where there is a risk of them being skewed. Have elevators inspected following earthquakes.

Drinking water
Do not drink tap water until it is ensured that it has not been polluted during the earthquake. Notifications come from civil defense.

Water leak -
Electricity Turn off the water inlet if the leak is uncontrollable and turn off the main switch in the electrical panel if the house is damaged.

Fire - fire food
Check if there is a fire and do not use an open light or fire if there is a risk of flammable material spilling.

Evacuation
Take things in **stride and try not focus too much** on the problem. Many accidents occur when people run into trouble after an earthquake. It is good to be well dressed if you need to leave the house, especially in winter. See Evacuation - Evacuation.

Collection point
Go to a pre-determined outdoor collection point and consult with your family before taking the next step.

The car is often the first shelter
Remember that a car is often the first heated shelter available if housing has been damaged and there is a public radio. Drive with the utmost care and note that roads and bridges can be damaged in earthquakes. Remember first aid centers in schools.

Radio - announcements
Listen to announcements and news in the media. Follow any instructions that may be given. It is good to have a radio with a long wave if FM transmitters fall out.

Fallen power lines
Never touch fallen power lines.

Neighbor
Help Check if your neighbors need help. If you know of elderly or disabled people in the immediate area, it is important to consider them. Remember that if many people are injured, help may be delayed.

REMEMBER:
In an emergency, the phone is a safety device and should only be used in an emergency. Keep calls as short as possible or send an SMS!

Supplementary figure 35: Actions to take after an earthquake provided by the Icelandic Civil Protection's official website. Source: ***https://www.almannavarnir.is/natturuva/jardskjalftar/eftir-jardskjalfta/***

When there is an earthquake, it is good to have thought about how best to react.

First, it is necessary to keep calm, kneel, cover your head and stay. Many earthquakes in the wake of earthquakes occur when people run around or out of buildings. If you run around in a hurry, the chances of getting hit by shelves or walls and the like increase, and it is often difficult to keep your balance. Glass fragments can be on the floors as well as countless objects that can cause an accident if stepped on carelessly, and this could be counted on for a long time.

Below are 5 common questions regarding the response Kneel - Shelter - Hold and answers to them.

Question 1: Why kneel, hide and hold?

Answer: The good thing about kneeling, hiding and holding is, firstly, that it protects against falling objects that can come from above. / she's in.

Question 2: What is the reason for going under the table, not everyone can do it. For example, those who have reduced mobility and can not easily get up from a chair without help, let alone go under the next table?

Answer: People must evaluate their reactions in terms of their abilities and the environment. Trying to get under the table can actually injure people with reduced mobility. Going under the table, however, further protects against catching flying / falling objects that can cause accidents. Those who have the opportunity to go under the table, kneel there, cover their heads and stay, they are protected as much as possible indoors. Those who can not defend themselves in this way, however, have to dig down (in a bed or chair) and cover their heads with their hands.

Question 3: But going to the door? People who have reacted in this way and gone to the door, have actually got the door in their face, because the door fits back and forth in the earthquake. Why go to the door if there is a risk of injury from getting in the door?

Answer: By positioning yourself in a doorway in the event of an earthquake, the person in question protects themselves against falling objects from two directions, it keeps the escape route open if a door hole is distorted in the earthquake, because if there is a door and the door opening is skewed, it is uncertain whether it is possible to get out. The only drawback to positioning yourself in a doorway is that a door can start slamming to and fro and therefore land on the person standing in the doorway. If this route is chosen during an earthquake, it is necessary to be aware that the door may slam. It is important that the door opening is in a load-bearing wall, as light walls often provide little protection. Note that in new houses, door openings are often not particularly reinforced and there is usually a door that can swing. Take the utmost care and ensure an escape route after the earthquake.

Question 4: I fully understand the reason for going to the "corner of the load-bearing walls", as the load-bearing structure of the house is probably the best there. However, I have no idea where the load-bearing walls are in my home or at work. How do I find out?

Answer: Look at the drawings of your house. If you are in doubt about how to read out the drawing, seek expert help from, for example, a master builder or the construction representative of the town / municipality in question. Information on load-bearing walls in the workplace must be obtained from the employer.

Question 5: What about the house itself. How can I be sure that it will withstand earthquakes?

Answer: It is a good idea to get a building representative to take out the building with regard to the load-bearing capacity of earthquakes, especially in older buildings. Recent buildings in Iceland are taken out by a building representative, cf. Planning Act no. 123/2010 and should therefore meet all the requirements made for house construction.

Parts of a building can fall off in an earthquake. Therefore, avoid being in places where there is a risk of such.

Kneeling - Hiding - Holding.
The reaction to staying calm, kneeling, hiding and holding is not a guarantee of not being injured in the aftermath of an earthquake. There is a need for more, such as making the environment so that things, furniture and other loose objects move as little as possible in the event of an earthquake. Its role is twofold. On the one hand, it reduces the likelihood of physical damage caused by falling objects, and on the other hand, it also reduces the likelihood of damage to furniture during earthquakes.

It is not enough to carry out prevention in their home. It also needs to be done at all family residences and workplaces. Companies and institutions are responsible for ensuring that safety in the workplace is in accordance with the relevant rules. Employers need to be alert to the dangers that may lurk in the environment. Staff also need to be vigilant about this. "Who is the carpenter of his fortune" applies here.

Supplementary figure 36: answers to main questions on earthquakes suggested by the Icelandic Civil Protection's official website. Source: https://www.almannavarnir.is/natturuva/jardskjalftar/krjupa-skyla-halda/

It is important that residents in known earthquake areas take measures to reduce earthquake damage. There are several ways to do this.

Furniture
Attach cabinets, shelves and heavy items to the floor or wall. Always keep the wheels on the furniture in the locked position. If there is no locking on the wheels, place a frame around the wheels to prevent the furniture from starting in an earthquake. Remember, however, that a frame or lock on wheels does not prevent furniture from tipping over. Attach light ornaments with teacher gum.

Loose objects and ornaments
Do not place heavy objects high on shelves or walls without securing them securely. Teacher chewing gum can be used to ensure that lighter objects do not move during an earthquake. Heavy tableware and items are best stored in lower cabinets, preferably closed.

Heaters and heaters
Attach heaters and heaters. Familiarize yourself with the location and closure of the water intake and electrical panel. Secure the radiator. Leaks can cause significant damage if the water is not blocked immediately. The same applies to the finishing of washing machines and dishwashers.

Photos, chandeliers
Attach photos and chandeliers to closed loops.

Cabinet doors
Store heavy tableware in lower cabinets / drawers and place safety locks / child locks on cabinet doors to prevent their contents from falling out.

Sleeping places
Prevent cupboards, paintings, fragments and heavy objects from falling on sleeping places. Avoid having space by large windows and loaded partitions.

Ceilings and floors
Well-hung suspended ceilings and raised floors.

Windows
Cover windows or apply safety film to windows to prevent the breakage of broken glass in the event of a broken window. Do not leave bed under windows if there is a risk of earthquakes.

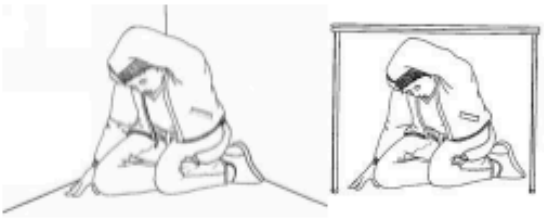
Insurance
Compensation The Icelandic Natural Disaster **Insurance** on real estate is based on fire insurance, which is compulsory insurance.
It is important that contents insurance, which is voluntary insurance, is as close as possible to the real value of the contents so that damage can be fully compensated.

Radio and announcements
Listen to announcements and instructions given on the radio. It is good to have a radio with a long wave if FM transmitters fall out. Then you can listen to the car radio.

Phones
Mobile phones are sufficient if electricity is cut off for a long time. Then it can be good to have a charger to have in the car or a charging bank to charge a mobile phone. Send SMS to your loved ones instead of calling (especially after a major earthquake) to reduce network load in disasters.

In earthquake zones, the effects of earthquakes can be reduced by earthquake drills to be better prepared for major earthquakes:

- **KJÚPA - SHIELD - HOLD - is a series of words** that should be memorized.



Out in the corner of the load-bearing wall or kneel under a table, cover your head and hold on.

- Find places at home, at work or at school where it is safe to be in the event of an earthquake.
- Remember that it is possible to assemble emergency equipment in an "emergency box" that everyone in the home knows about. It can store first aid kits, flashlights, radios, matches, candles, batteries and various special needs of household members that are difficult to do without.
- A video about the family's preparedness for Selfoss due to earthquakes can be found under the educational material here on the website.

Supplementary figure 37: actions to undertake to protect and prepare in case of earthquake provided by the Icelandic Civil Protection's official website. Source: https://www.almannavarnir.is/natturuva/jardskjalftar/varnir-gegn-jardskjalfta/

Earthquake response

Civil protection > Civil war and risk > Earthquakes > Earthquake response

If you are indoors when an earthquake starts - do not run .

• Keep still, there will be many accidents when the race starts

• Go under a table or bed, cover your head and neck, stick to solid furniture

• Kneel in a corner against a load-bearing wall or in a doorway against a load-bearing wall. Take the utmost care and look for an escape route after the earthquake.

• If you wake up to an earthquake, cover your head and face with a pillow

• Stay away from windows - they may break

• Let your loved ones know about you via SMS when the earthquake stops

If you are outdoors when you feel an earthquake - do not run inside

• Stay outdoors - try to find shelter to *kneel, shelter, hold*

• Try to avoid buildings that may collapse

• Rock falls, landslides and avalanches can fall from slopes and mountains

• Power lines are dangerous if worn - be careful not to touch them

• Try to get to an open area where buildings do not restrict

- Depart from the beach if you are in an area where there is a risk of a tidal wave

If you are driving when you feel an earthquake :

• Park the vehicle and stop. Roads and bridges can be damaged in earthquakes

• Fasten your seat belts

• Keep quiet if you are in a car where it can protect you from fractures and debris that can be exposed in an earthquake - listen to the radio, this is where the first information about the earthquake usually comes from.

Supplementary figure 38: actions to undertake after the earthquake, provided by the Icelandic Civil Protection's official website. Source: https://www.almannavarnir.is/natturuva/jardskjalftar/vidbrogd-vid-jardskjalfta/