The L'Aquila trial: are we prepared to face the next earthquake?

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with the contribution of

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Why this seminar?

• The implications of L’Aquila trial are widespread within and outside the international scientific community

Ex. RESIF meeting in Yenne in Oct 2013: the L’Aquila trial is mentioned regarding the necessity of disclaimer for use of seismic software and data

• France (1):
  – low seismic hazard but nuclear power plants
  – cooperation with high risk countries
Why this seminar?

- France (2):
  - M 5 Barcelonnette April 7, 2014
Séisme : faut-il redouter le pire ?

Les spécialistes se veulent rassurants : le séisme de lundi soir n’en announces pas forcément un plus gros. En sismologie, tout est affaire de statistiques...

5.2, dû lieu en 1909 dans la région de Lambesc (Bouches-du-Rhône) et a fait 46 victimes. « Ça ne veut pas dire que le prochain gros séisme se déroulera dans 200 ans et au même endroit. Il n’aura d’ailleurs sûrement pas lieu dans la région de Salon-de-Provence », poursuit le spécialiste. Toujours selon les statistiques, les tremblements de terre atteignant une magnitude 7 se dérouleraient tous les 3 000 ans.
Séisme en Provence : "La région va connaître des répliques"

Va-t-il y avoir des répliques ?
M.M. : Oui, elles peuvent aller jusqu'à une magnitude de 4,5. L'arc alpin est actif depuis l'Italie jusqu'en Autriche en passant par la Haute-Provence.

La population alpine peut-elle craindre un gros tremblement de terre ?
M.M. : L'activité sismique est importante mais, de part les études menées depuis un siècle et demi, les déformations engendrées par les secousses ne suffisent pas à créer un danger majeur, des dégâts lourds.
Prequel
Prequel

2009
January-March
• Long sequence (max Ml=2.9)
• Predictors claimed to anticipate earthquakes

March 30
Ml 4.0 earthquake

March 31
CGR meeting

April 5
20:48 Ml 3.9
22:39 Ml 3.5

April 6
Mw 6.3 earthquake
Prequel - The seismic sequence

From January 2009 a seismic sequence began near the L’Aquila area and near the town of Sulmona (max ML 2.9)
Prequel - The seismic sequence

- Predictors claimed to anticipate earthquakes

March 30th
ML 4.0
ML 2.9
Prequel - The seismic sequence

- Predictors claimed to anticipate earthquakes

- Press release by the responsible of Civil Protection for Abruzzo Region (Stati): *No earthquakes of any magnitude are predicted... Anything else is false*...
Prequel - The seismic sequence

- Predictors claimed to anticipate earthquakes
- Press release by the responsible of Civil Protection for Abruzzo Region (Stati): *No earthquakes of any magnitude are predicted... Anything else is false...*

- The Head of Italian Civil Protection Bertolaso calls Stati

*Never say this!... We will correct it... Tomorrow I’ll send you my vice De Bernardinis and the experts ... It is a mediatic operation ... they will say it is a normal activity, better 100 M4 earthquakes releasing the energy, than a big one, that hurts...* (from a famous phone tapping)
Prequel - March 31, 2009

• CGR meeting
The High Risk Commission (CGR) is an advisory board of Civil Protection Department (DPC). It was convened in L’Aquila to evaluate two questions:

1 - To make an objective evaluation of the ongoing seismicity also in terms of what can be forecasted
2 - discuss and provide indications on the alarms that people is suffering
Prequel - March 31, 2009

• **CGR meeting**
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1. To make an objective evaluation of the ongoing seismicity also in terms of what can be forecasted
2. Discuss and provide indications on the alarms that people is suffering

• **Before** the meeting, De Bernardinis (Vice head of DPC) in a local TV interview says: *the scientific community tells us there is no danger, there is an ongoing discharge of energy... The situation looks favorable...*
March 31, 2009

- The meeting is held in an unusual **open setting**, with many local authorities: the L’Aquila Mayor (Cialente), the responsible of Civil Protection for Abruzzo Region (Stati), etc.
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Experts were **neither alarmist nor reassuring:**

- large earthquakes are not predictable deterministically
- a large event in the short-term is “unlikely” but not impossible
- L’Aquila is one of the most hazardous areas in Italy

No minutes of the 31/3 meeting were delivered before April 6
March 31, 2009

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After the meeting
• De Bernardinis and Stati hold a press conference with no seismologists
• No audio recording of the conference is available. No press release.
April 1 to 5, 2009

- Local newspapers report the sentence of De Bernardinis *(the discharge of energy is positive)*, *forgetting* it was said before the meeting

*Il Messaggero, April 1*

«Do not expect aftershocks of large magnitude»
April 1 to 5, 2009

• Local newspapers report the sentence of De Bernardinis (the discharge of energy is positive), forgetting it was said before the meeting.

• Titles and articles focus on the swarm, reporting numbers and magnitudes of earthquakes, and listing rules of conduct in case of earthquakes.

Il Centro, April 4

Evacuation exercises in schools
flyers with advices are distributed in some school

Il Messaggero, April 3

Cialente confirms an emergency plan absolutely reassuring
Earthquake, back to normality
The 15th of April scholars of De Amicis should go back to their school
The Earth is still shaking

Earthquake, requested state of emergency

Today schools are open. The police is looking for false allert predictors

• L’Aquila mayor Cialente asks for the state of emergency
• No other M>3 event occurs until the night of April 5-April 6
The April 6, 2009, L’Aquila earthquake

March 30th
MI 4.0

April 6, 01:32
Mw 6.3
(309 casualties)

April 5 (20:48-22:39)
MI 3.9, 3.5
The trial

• For 29 casualties (out of 34) the Prosecutors accused the **7 experts** who participated to the CGR:

  **4 scientists** belonged to the CGR

  **2 Civil Protection Directors**

  - Franco Barberi (President)
  - Enzo Boschi (member)
  - Gian Michele Calvi (member)
  - Claudio Eva (member)

  - Bernardo De Bernardinis (Vice head of DPC)
  - Mauro Dolce (director DPC Risk mitigation office)
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1 is an INGV seismologist

Giulio Selvaggi (Director of the INGV Earthquake Centre)

Giulio Selvaggi was invited to report on the seismic swarm
According to the defense, and even the prosecutor's office, Bertolaso did not attend the meeting, it is not a seismologist and therefore should be exonerated.
The verdict  
(Oct. 2012, first degree of judgment)

CONVICTION for multiple manslaughter and multiple serious injuries for 29 victims as consequence of the March 31, 2009 CGR meeting:

• 6 years in prison (*)
• Perpetual interdiction from public offices and legal interdiction during the enforcement of the sentence (*)
• Compensation to the families of the victims (€ 8ml)

(*) conviction suspended until final judgment
The verdict

MOTIVATION

a) Approximate risk assessment, generic and ineffective in relation to the activities and duties of prediction and prevention...

b) Incomplete, imprecise and contradictory information on the nature, causes, hazard and future developments of the seismic activity...

...inducing people not to leave their houses as they were used to do by family tradition

(the behavior of the defendants caused the death of the victims → causal connection)
The verdict

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Approximate risk assessment?

- scientific arguments are used to show that the CGR has underestimated the indicators that could define a higher probability of occurrence of an impending earthquake
Underestimated Risk Indicators

L’istruttoria dibattimentale consente di affermare con certezza che la scossa di terremoto del 6.4.09 (fatto sopravvenuto) si è posta su una linea di sviluppo della condotta colpevole ampiamente prevedibile, come dimostrano:

- la conoscenza da parte degli imputati dei dati riferiti alla storia sismica di L’Aquila ed in particolare della ripetizione in epoca storica di forti terremoti preceduti da sciami sismici;
- il particolare andamento dello sciae sismico iniziato nel 2008, connotato da scosse progressivamente crescenti per numero ed intensità, focalizzate alla medesima profondità ed in un medesimo ipocentro;
- la conoscenza delle Mappe di pericolosità che individuano L’Aquila come una di quelle a più elevata pericolosità sismica;
- gli studi probabilistici di BOSCHI che, per la zona di L’Aquila, come una di quelle a più elevata probabilità di occorrenza di un terremoto di magnitudo pari o maggiore 5.5 o a 5.9, con valori tra i più alti di tutto il territorio nazionale; addirittura con giudizio di certezza, probabilità (P) pari a 1, nell’arco del ventennio 1995 – 2015, secondo lo studio “L’individuazione preventiva dei luoghi in cui potrebbero verificarsi gravi terremoti nell’immediato futuro” pubblicato negli USA, nell’ottobre 1995, dal prof. BOSCHI Enzo.

- Seismic history of L’Aquila
- the recurrence of large earthquakes preceded by swarms
- The hazard map
- Other probabilistic studies
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✓ la conoscenza da parte degli imputati dei dati riferiti alla storia sismica di L’Aquila ed in particolare della ripetizione in epoca storica di forti terremoti proceduti da sciami sismici;
✓ il particolare andamento dello sciacme sismico da scosse progressivamente crescenti per numero e magnitudo alla medesima profondità ed in un medesimo ipocentro;
✓ la conoscenza delle Mappe di pericolosità che indicavano la città di L’Aquila come una di quelle a più elevata pericolosità sismica;
✓ gli studi probabilistici di BOSCHI Enzo e SELVAGGI Giulio che indicavano la zona di L’Aquila come una di quelle a più elevata probabilità di occorrenza di un terremoto di magnitudo pari o maggiore 5.5 o a 5.9, con valori tra i più alti di tutto il territorio nazionale; addirittura con giudizio di certezza, probabilità (P) pari a 1, nell’arco del ventennio 1995 – 2015, secondo lo studio “L’individuazione preventiva dei luoghi in cui potrebbero verificarsi gravi terremoti nell’immediato futuro” pubblicato negli USA, nell’ottobre 1995, dal prof. BOSCHI Enzo.
1- Historical seismicity

• The largest events occurred in 1315, 1349, 1461, 1703

(from the report discussed in the CGR meeting)
Historical seismicity and hazard

2- The seismic hazard map of Italy (2004)

• L’Aquila has been classified as high hazard since 1915
• since 2006 is used for the classification of Municipalities
• since 2008 is used for the building code

(from the report discussed in the CGR meeting)
Peculiar time evolution of the sequence?

Cumulative number and magnitude of earthquakes within 30 km from L’Aquila

2008
5 Jan-31 Dec
Peculiar time evolution of the sequence?

Cumulative number and magnitude of earthquakes within 30 km from L’Aquila

2008
5 Jan-31 Dec

2009
1 Jan – 6 April
Peculiar time evolution of the sequence?

2008-2010

- at least 127 sequences occurred in Italy (70% of the seismicity)
- background seismicity (remaining 30%)
- only 1 destructive earthquake (L’Aquila Mw 6.3)

1950-2006

- 77% (of 26) M5.5+ have NOT been anticipated by M4+ (within 3 days and 10 km)
- 0.8% (of 742) M4+ were followed by M5.5+ (Marzocchi and Zhuang, 2008)
The verdict

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Message in/out the CGR meeting

IN
✓ Earthquakes are not predictable
✓ A strong earthquake in the next days is unlikely (but not impossible)
✓ The only activity of seismic risk reduction consists in reducing the buildings vulnerability
Message in/out the CGR meeting

**IN**
- Earthquakes are not predictable
- A strong earthquake in the next days is unlikely (but not impossible)
- The only activity of seismic risk reduction consists in reducing the buildings vulnerability

**OUT - the understood message**
- The earthquake will not happen
- The situation is normal (favorable)
Implications in Italy

1- Reducing vulnerability or not

2- Nobody wants to take responsibility

3- Research (ex. short-term forecast, earthquake precursors)

4- It can happen again
1-Reducing vulnerability or not?

The argument that the activity of seismic risk reduction consists only in strengthening buildings and improving their ability to resist to earthquakes seems to be as obvious as useless ... because it provides an indication that in practice is not feasible... The Italian municipalities require ... such a huge financial resource that it is effectively unavailable ... it is not seriously feasible to reduce seismic risk by improving building standards”
1-Reducing vulnerability or not?

• 9 million of people living in high hazard region (central-southern Italy)
1-Reducing vulnerability or not?

• When building code is not enforced

Wrong retrofitting of old building

Inadequate strength of concrete pillars

Damages from the L’Aquila April 6th 2009 Mw 6.3 earthquake
2- Responsibility: the case of Garfagnana (Tuscany)

1. Ml 4.8 on Jan 25 (2013), followed by Ml 3.2 on Jan 30: INGV report states that other shocks are likely
2- Responsibility: the case of Garfagnana (Tuscany)

1. MI 4.8 on Jan 25 (2013), followed by MI 3.2 on Jan 30: INGV report states that other shocks are likely

2. After several hours, the INGV report is transmitted as it is to Regione Toscana and to the municipalities

“Following the communication received from the Prime Minister office, we suggest to leave your house and stay outside”
...for 1 night!
3 – Research: “forecasting” the mainshock

- short-term forecast - 24h probability for a M5.5+ (made retrospectively)

April 5, morning: 0.01%
April 6, before the Mw 6.3: 0.05%

Marzocchi, pers. com.
3 - Research: “forecasting” the mainshock

- short-term forecast - 24h probability for a M5.5+

April 5, morning: 0.01%

April 6, before the Mw 6.3: 0.05%

Is it useful for civil protection purposes (buildings, nuclear power plants)?
How do we explain it to media and public?

Marzocchi, pers. com.
4- It can happen again

A (long) seismic sequence + Unprepared public authorities

• one of the main problem is the lack of preparation and awareness

• seismologists are the weakest actors in the chain of responsibility, especially when the attention is moved to the short term (huge cultural problem)
Some example

ML 2.3 (March 5, 2014)

March 6 – The NEWS

“Earthquake, do not worry”
Some example

MI 2.3 (March 5, 2014)

March 6 – The NEWS

**Corriere di Viterbo**

**Scossa a Monterano** Il sismologo: “Nessun movimento di faglie”

“Terremoto, non c’è da preoccuparsi”

**Monte Romano** Scossa di magnitudo 2.3 martedì

Il sismologo Amato: “La zona dell’epicentro non ci preoccupa”

La terra trema

“Ma niente paura”

March 7 – The DENIAL (démentis)

**Corriere di Viterbo**

Il sismologo Amato interviene sul terremoto di martedì a Monte Romano

“Il problema è la vulnerabilità dei centri storici
Non mi sento di rassicurare nessuno”

Monte Romano: Terremoto, come quella in quel piccolo terremoto dell’altra

“The problem is the vulnerability of historic centers. I would not reassure anyone”
Since 2010: thousand of earthquakes (max MI 4)

2014: hundreds of earthquakes (max MI 3.3)
Some example

Discharge of energy

March 26, 2014

«Le scosse possono aumentare di frequenza e non di intensità»
Il professor Stefano Santini analizza i dati

Il Messaggero (April 1, 2009)

«Do not expect aftershocks of large magnitude»

«Shocks may increase in numbers but not in intensity»
Some example

**Discharge of energy**

The L’Aquila Trial
Il Processo a L’Aquila

“Scarico di energia” e i terremoti a Gubbio

La sequenza sismica in Umbria e lo “scarico” di energia
DISCUSSION

food for thought
1\textsuperscript{st} thought

- To be involved or not: do we have the choice?

- To say or not to say: a no-win no-win affair
2\textsuperscript{nd} thought

- Are we always sure about our role in official commissions?
  Ex: L’Aquila case

- What and how to communicate the hazard
  Ex: loose of reliability in case of false alarms (“People didn’t want to leave their houses the second time”)

- Uncertainties of the natural phenomena & roles
Uncertainties of the natural phenomena & roles

“Decision window”

Eruption level

Steady state of mild eruption

Back to normal

Back to normal

Eruption

1

Intensidad de los parámetros de monitoreo

Tiempo

1
3rd thought

- Direct interaction with the population (not always effective/possible)

- Can we be effective in communicating the hazard? Ex: Use of scientific words with different meaning in usual language ("normal seismic sequence") ➔ we should develop expertise in risk-communication

- Independent variables: political games, economical pressures (induced seismicity)
The L'Aquila trial

Second degree of judgment will start next Fall ... this is not the END!
The L’Aquila Trial
Il Processo a L’Aquila

About

This is an initiative of the INGV working group for the information management on the L’Aquila trial (decreto INGV n. 641 del 19/12/2012). The goal is to collect and describe the documentation concerning the trial, an event which has had and still has a major impact on the interaction between the scientific community and civil society both in Italy and abroad. Our thoughts go once again to the earthquake victims and their relatives: we know that no sentence could ever act to compensate for the loved ones, lost in this disaster.

INGV working group for the information on the L’Aquila trial