A Rational Reconstruction of the L'Aquila Case. How non-denial turns into acceptance[*]

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Abstract

[503] In 2009, an earthquake struck the city L'Aquila, causing more than 300 deaths and leading to a trial which lasted almost four years and—though cleared in the appeal—in which scientists were sentenced to imprisonment for failing to adequately assist in public decision-making. In this paper, the particular role of scientists in risk assessment communication is investigated. The arguments put forward in the trial of this case are rationally reconstructed, evaluated, and our results are compared with other analyses of this case.

Keywords: L'Aquila 2009 earthquake, public inclusion, expert-laypeople communication, risk communication

1 Introduction

The scientific enterprise consists of processes of theory building and justification, but also a great deal of it is about communicating scientific results in different contexts. Some of these contexts are completely science internal, e.g., when a scientist discusses her results at a conference with her colleagues. And some of them are so-called *hybrid forums* (cf. Callon, Lascoumes, and Barthe 2001, p.18), e.g., when a scientist communicates scientific findings to policy-makers or the public.

Not only with respect to the latter, but particularly in such hybrid forums scientists face several communication challenges, such as the challenge of appropriately demarcating between what stems from their scientific expertise and what has its origins in private opinions, but also challenges of gaining knowledge-authority which is also traceable for non-experts. Such complexes of topics related to hybrid forums have been widely discussed in social epistemology, as, e.g., by Goldman (1999, p.108):

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> "To combat [...] possible scepticism [of laypeople against expert], a speaker might enhance her credibility by issuing "signals" of observational competence. She might accompany her report with a display of certification, such as a professional degree or license. She might wear a professional uniform (a physician's white coat, for instance), or use professional jargon that signals technical expertise."

But also in philosophy of science such discussions about hybrid forums have a long tradition, spanning from, e.g., the logical positivists' socio-politically motivated demand of general testability of scientific theses, basically testable also by the broad public:

> "A physicist must, in principle, be able to satisfy the demand of the talented writer who insisted that: 'One ought to be able to make the outlines of any rigorously scientific thesis comprehensible in his own terms to a hackney-coach-driver."' (cf. Neurath 1932, translation in Ayer 1959, p.200)

to more recent discussions about the value-neutrality or value-ladenness of science, e.g., that the assumption that scientists play no particular role in hybrid forums ... [504]

> "[...] overlooks the authority science and scientists have in our culture and the important role scientists play in practical decision-making. [...] To claim that scientists ought not consider the predictable consequences of error (or inductive risk) is to argue that scientists are somehow not morally responsible for their actions as scientists." (cf. Douglas 2000, p.563)

In this paper we aim to underpin the challenge of laypeople-expert communication in hybrid forums by help of a detailed case study of the so-called *L'Aquila 2009 earthquake*, where after an earthquake struck the city L'Aquila and caused more than 300 deaths in 2009, a four years lasting trial was conducted in which scientists were sentenced to imprisonment for failing to adequately assist in public decision-making. Although the sentences of the scientists were cleared in an appeal, this caused a political earthquake in the scientific community. It also led to opposing assessments of more popular reconstructions of the case, where some voices stressed more the scientists' failing to some degree—e.g. Ropeik (2012) in the *Scientific American*—and others put more focus on negative consequences of charging scientists for failures not directly related to their scientific expertise—e.g. Hall (2011) in *Nature*.

The L'Aquila trial became one of the most talked about events in science; one problem of the discussion of this case is that there was and still is much misconception of it. As Alexander (2014) argues, much of the international reaction to the trial was misguided because it was based on incomplete information about the proceedings. In order to account for this, there are still investigations arising (for the most recent cf. Alexander 2018). Our investigation aims at further elucidating this case by bringing in a new discussion of

material of the trial(s)—e.g. files of the judges and prosecutors—which was previously not investigated in detail. Furthermore, we will see that in this material shortcomings in science communication play an important role, for which reason our investigation focusses on challenges related to the communicative structure of the case. This naturally connects our investigation to the above-mentioned debate on value-neutrality of science, because in this debate the discussion of value-neutral/-laden *acceptance* of scientific hypotheses is increasingly replaced by a discussion of value-neutral/-laden *assertion* of scientific hypotheses (cf. Douglas 2009, chpt.5; and John 2015, p.81).

There are several expositions, which focus on communication-structural problems of this case. So, e.g., Woodman (2013) elaborates on it as a case study of science communication. Lane (2014, sect.V) discusses challenges of *institutional design* regarding the panel which was convicted for failing to provide adequate information about the probabilistic risk of an earthquake as well as an estimation of the possible degree of damage, though, according to Lane (2014), nobody in the panel was qualified for these tasks. DeVasto (2016) backs up her proposal of reconfiguring decision-making procedures by help of an investigation of the L'Aquila case. And, finally, DeVasto, Graham, and Zamparutti (2016) provide a detailed deliberation- and communication-oriented analysis of the case. Our analysis is in this vein and has a similar conclusion, namely that at an important point of the communication situation non-denial turned into (i.e. was interpreted as) acceptance. However, as we will see by help of employing material provided by the judges and the prosecution of the trial, their claims about the importance of particular scientific hypotheses under consideration need to be modified and the main problem was not, as they claim, due to miscommunication between the scientists and authorities, but more relevantly due to miscommunication between scientists, authorities, and laypeople/the public.

The structure of the paper is as follows: In section 2, we describe the case under study, namely the circumstances of the L'Aquila 2009 earthquake, as well as the different communication situations concerning experts, authority, and laypeople/the public. In section 3, we present details of a particular communication situation, namely that between experts and the authority. In section 4, we describe the analysis of the case of DeVasto, Graham, and Zamparutti (2016). In section 5, we provide our analysis of the case, which is based on a detailed study of the minutes and justification of the trials. There we also show how non-denial turned in a fatal way to acceptance. Finally, we briefly conclude in section 6. [505]

2 The L'Aquila 2009 Earthquake

In this section, we present relevant key facts of the L'Aquila case and cluster them into different types of communication situations. The background of this trial is a swarm of earthquakes in the Abruzzi region, especially close to and in the main city L'Aquila in the centre of Italy. The seismic activity started in Oc-

tober 2008 with earthquakes of increasing intensity. In the time from January until March 2009 Giampaolo Giuliani, a technician, announced unofficial earthquake predictions which caused insecurity in the local population of L'Aquila. In order to calm down the situation, Giuliani was forbidden to make such public announcements on March 30. Also, on this day, an earthquake caused minor damage in L'Aquila and increased insecurity in the local population, for which reason a meeting of deputies of Italy's civil protection department (*DPC: Dipartimento Protezione Civile*) and the so-called *high-risk commission* (*CGR: Commissione Grandi Rischi*) was scheduled for the next day. On March 31, Bernardo De Bernardinis, vice head of the DPC, gave an interview to *TV UNO*, stating that there was no danger. Afterwards, the meeting of the high-risk commission and the DPC started. Participating scientists were: Franco Barberi (vice-president of the CGR), Enzo Boschi (member of the CGR and president of the "National Institute for Geophysics and Volcanology" *INGV: Instituto Nazionale di Geofisica e Vulcanologia*), Michele Calvi (member of the CGR), Claudio Eva (member of the CGR), and Giulio Selvaggi (director of the Earthquake Centre of the INGV). Designated from the public authority (DPC) was, among others, De Bernardinis. Boschi later called the circumstances of this meeting "completely out of the ordinary" (cf. Hall 2011, p.267). We will provide the key-points of the meeting below, when we prepare the ground for an exact analysis of the situation. After the meeting, there was a press conference about the results with Massimo Cialente, back then major of L'Aquila, Daniela Stati, head of the "Civil Protection for the Abruzzo Region", De Bernardinis (DPC), and Barberi (CGR)—the only scientist, volcanologist, at the podium (however, also he did not talk to the public). During this conference, De Bernardinis repeated his reassurance and made claims about the tremors' function of discharging energy. After the press conference, the locals were, according to the judge of the first trial, reassured that the increased seismic activity is no indicator of a big earthquake. On April 6, a quake with magnitude 6.3 struck L'Aquila and caused 309 deaths.

Given this short description of the earthquake and its circumstances, we see that regarding the communication structure four parties are of interest: the public, authorities as, e.g., De Bernardinis (DPC), non-scientific predictors/"non-scientists", in particular Giuliani, and scientists, in particular the five later on convicted scientists of CGR and the national geophysics and volcanology institute. For simplicity of expression, we subsume in the following the authorities under DPC and the five scientists to CGR, although this is not entirely accurate, e.g., not regarding Selvaggi.

Now, given these four "collectives", there are 15 possible combinations of communication within and between them. Most of them are also instantiated in the case. So, e.g., communication between the "non-scientist" Giuliani and the public increased insecurity, communication within the public perpetuated it, etc. Whether there was direct communication between the "non-scientist" and the scientists is not recorded (as we will see below, there was at least indirect communication in the sense that the scientists discussed a hypothesis of Giuliani). Also, no communication situation between the scientists and the public is recorded. Out of this 15—partly instantiated—possibilities, three will

be of particular interest in our analysis, namely communication between the authorities and scientists, between authorities and the public, and between authorities, scientists, and the public. We summarise these three types of communication as follows:

Label	**Communication**	**Exemplar**
DPC-PUBLIC	authorities and public	De Bernardinis interview to *TV UNO* before this meeting
DPC-CGR	authorities and scientists	the DPC and CGR meeting before the press conference
DPC-CGR-PUBLIC	authorities, scientists, and public	The press conference with three authorities and one scientist (Barberi from CGR)

Since we are interested in the role of scientists involved in the case, we will focus on the two mainly relevant communication situations where CGR is involved, namely the meeting of authorities [506] and scientists (DPC-CGR) on March 31, 2009, and the press conference afterwards (DPC-CGR-PUBLIC). We will see, however, that the communication situation of type DPC-PUBLIC also plays an important role in the end.

3 The Meeting of Authorities and Scientists (DPC-CGR)

The meeting of the authorities (DPC) and the scientists (CGR) was convened by the vice president of DPC, De Bernardinis, and took place on March 31, 2009, 18:30-19:30. The results of the meeting can be briefly summarised by the geoscientists' statements that large earthquakes are not predictable, that L'Aquila is one of the most hazardous areas in Italy, and that a large event in the short term is unlikely but not impossible. Regarding the authorities, the scientific experts gave the advice to increase the standards for constructing buildings. In order to prepare the ground for a detailed analysis, we provide here the key-phrases of the minutes (Commissione Grandi Rischi 2009, translation taken from (INGV 2012)):

KP1 "*Altero Leone (Regional Civil Protection)*: informs that people claiming with a megaphone in the street for an imminent earthquake has been identified by the police [they speak of Giuliani here]."

KP2 "*Boschi*: The recurrence period of large earthquakes in Abruzzi is very long. There is a low probability of a large earthquake in the short term, as the 1703 earthquake [with $ML = 6.7$], but this cannot be excluded in a definitive way."

KP3 "*Selvaggi*: He shows the INGV technical documentation. The swarm started in October 2008, in L'Aquila."

KP4 "*Barberi*: I am here as Vice President of the High-Risk Commission as the President is absent. I, therefore, take charge of this meeting. The commission must 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 information for the concerned public

As regards to the first point, I agree on how extremely difficult any temporal forecast on the evolution of seismic phenomena is. We can refer to the historical seismicity, from which we learn the high seismicity of Abruzzo. We know the Abruzzo is a high seismic region. In the past there have been seismic sequences similar to those we are observing today. What can you say? I heard the head of civil protection declare to media, although he is not a geophysicist, that when there are seismic sequences there is a discharge of energy and there is more probability that the large shock will not arrive. What can you say?"

KP5 "*Eva*: [...] In recent times there have not been large earthquakes but numerous swarms that have not preceded large earthquakes (like in Garfagnana). Obviously, as L'Aquila is a seismic zone, we cannot make a statement that there will not be large earthquakes."

KP6 "*Boschi* (showing a hazard map and the seismic zonation): [...] L'Aquila in the seismic zonation is at the second class and it has a high hazard. Earthquakes cannot be forecasted, but they can be mitigated and so it should be appropriate to make prevention (resistant buildings). This statement should be included in the drafting "Decreto Casa"."

KP7 "*Barberi*: [...] Swarms tend to have the same magnitudes and it is highly unlikely that in the same swarm there is an increase of the magnitude."

KP8 "*Stati* (Head of Regional Civil Protection): I would like to ask a question. Today, distinguished experts explained to us what could happen. We, I and the Major, must also give political answers to people through the media. We would like to know if we have to believe those people that go around creating alarmism [again, speaking of Giuliani]."

KP9 "*Barberi*: There is also someone that would claim forecasts with a gas sensor [speaking of Giuliani again]. This could be useful in the future but surely not today. [...] On the contrary, it is [507] worth to say that any forecast has no scientific base. [...] We now tell to the Civil Protection and to the Regional Administration that the only protection today is to increase prevention activities (reinforce building) and planning."

KP10 "*Stati*: Thanks for your statements, they allow me to reassure the population through a press conference."

It is important to note that Giuliani's predictions mentioned above are referred to and rejected in this meeting by a scientist, namely Barberi, in KP9 (authorities implicitly refer to Giuliani in KP1 and KP8). It seems that Giuliani's activities evoked in representatives of the DPC the idea of using this meeting as "media movement". The need for taking care of unauthorized alarmists is obvious: As *The Guardian* reports:

> "By [... March 28, 2009 ...] Giuliani was detecting a greater threat to the south-east, towards the city of Sulmona, 50km from L'Aquila. Its mayor was contacted, he took the alert seriously, and sent loudspeaker vans around to warn the populace (an event wrongly associated with L'Aquila in British press reports), which duly provoked a panic. This is what worried [...] Bertolaso and the authorities, leading them to issue the gag order which was served to Giuliani on 30 March." (cf. Dollar 2010)

Even more harm would have been done if the people of Sulmona were evacuated to L'Aquila until April 6 in accordance with Giuliani's predictions.

With this key phrases at hand, we will have now a look on how DeVasto, Graham, and Zamparutti (2016) analyse the case.

4 DeVasto, Graham, and Zamparutti (2016)' Functional Stasis Analysis

DeVasto, Graham, and Zamparutti (2016) analyse parts of the communication in this case. Particularly, they think that the DPC-CGR meeting had structural problems, because, as the authors think, not only the DPC, but also the scientists intended to discredit Giuliani's prediction: "the participants at the [commission] went into the meeting intending to immediately shut up any imbecile" (cf. p.155). DeVasto, Graham, and Zamparutti (2016)' approach is to apply so-called *functional stasis analysis* to identify the primary breakdown in the deliberation of the risk commission that led to the reassurance claim during the press conference.

We do not need to go into detail of stasis theory in order to sketch DeVasto, Graham, and Zamparutti (2016)' analysis. However, in order to get some grip on their approach and its context, we give a very brief description of it: Stasis theory stems from rhetoric and is about a pre-writing invention process of deliberation. It traces back to Hermagoras' and Aristotle's work and was particularly further developed by Roman rhetoricians, such as Cicero. The main idea of stasis theory is that in order to account for a problem, one best works through four stasis questions in order to gain knowledge of the issue at hand. The four questions are about (i) facts: *conjecture*, (ii) the nature of the issue: *definition*, (iii) values: *quality*, and (iv) action: *policy*. E.g., the so-called *six journalistic questions* (who?, what?, where? when? why? how?) are related to these stasis questions (the latter two are related to values and action; the former four

to facts and the nature of the issue), but also many other question-schemes as, e.g., in legal contexts, etc., can be considered as such a form of analysis. The idea of stasis analysis is that such an analysis ends by achieving stasis, which means that the parties involved in a dialogue about a given issue have reached consensus on (or agreed upon) the information and conclusions in one or more of the stases.

When considering the four stases, one sees that such an analysis approaches an issue from a descriptive (roughly: regarding matters of fact), particularly (i), but also normative (roughly: regarding matters of concern), particularly (iii), perspective. Being aware of the very different natures of these two perspectives and the role of scientists therein, it is important to keep these stases and results thereof separated. However, there is a phenomenon of so-called *overflow* where unexpected problems rise due to important unforeseen effects: "All, specialists included, think they have clearly [508] defined the parameters of the proposed solutions [...] and are convinced they have *clearly identified the groups concerned and their expectations. And then disconcerting events occur*" (cf. Callon, Lascoumes, and Barthe 2001, p.28, our analysis). In cases of overflow a (e.g. technical) matter ceases to remain in its proper (e.g. technical) sphere.

Traditional stasis invention (as a tool for finding the right questions) or analysis (as a tool for decomposing a phenomenon into relevant sub-components) in the form we outlined above is typically performed in a strict sequential, e.g., in the order *fact* then *definition* then *value* then *action*, or strict hierarchical, e.g., when distinguishing lower level stases (*fact* and *definition*) from higher-level stases (*value* and *action*), way (cf. DeVasto, Graham, and Zamparutti 2016, pp.136f). Since overflow is about mixing up spheres, hierarchies, and orders, classical stasis analysis needs to be modified in order to account also for overflow. The modification with which DeVasto, Graham, and Zamparutti (2016) work is *functional stasis analysis*, which does not presuppose a fixed order of - or hierarchy between the stases, but allows also for "nesting". In this respect, three functions of discourse are distinguished (cf. DeVasto, Graham, and Zamparutti 2016, p.143): *nesting* itself in the sense that positing a stasis question enforces positing another (a nested) one; *resolution* in the sense that a stasis question is answered; and so-called *buttressing*, which is about an interaction between nesting and resolution in the sense that a resolution for a nested stasis is considered to be a precondition for the resolution of the stasis in which it is nested.

Now, according to DeVasto, Graham, and Zamparutti (2016), in the L'Aquila case overflow took place and caused a fatal misunderstanding. The, for the case, relevant instance of overflow became manifest when "discussants risk[ed] eliding the necessary hybridity [of a forum] and [started] treating matters of concern as matters of fact" (cf. DeVasto, Graham, and Zamparutti 2016, p.138). According to DeVasto, Graham, and Zamparutti (2016)' analysis, particularly the DPC-CGR meeting was influenced by such an overflow due to a gap between the "public requests for information and the available evidence" (DeVasto, Graham, and Zamparutti 2016, p.140). In order to argue for this, they provide the nested-structure of the different stases of the DPC-CGR meet-

ing (for details cf. particularly pp.146,152,154,156) and divide the meeting into four phases (cf. pp.148ff):

1. A phase of data delivery by the scientists—this phase concerns the stases fact and nature of the issue in question.
   In our clustering, this amounts to KP2–KP3 and KP5–KP7.

2. A phase where scientists attempted to hand off their information to the government officials who would then define the action, i.e. scientists trying to discern between matters of concern (roughly: values) and matters of fact.
   In our clustering, this happens in KP4.

3. A phase dealing with Giuliani's prediction, namely when Stati (implicitly) asked how to cope with it. This is about the stasis of action.
   It concerns our KP1, but particularly KP8.

4. And a phase where the scientists' statements about uncertainty was transformed by the policymakers to a message of reassurance due to an interpretive conflict: The policymakers took the scientists' uncertainty and hesitancy about predicting an earthquake as a signal of unlikelihood.
   This concerns particularly KP10.

According to DeVasto, Graham, and Zamparutti (2016), what caused the illegitimate values/fact-overflow in this case was the, by Giuliani triggered, public demand for instructions on what to do and the small available data in order to draw any specific conclusions:

> "The overflow that transforms this case from a matter of fact into a matter of concern lies at the intersection between public requests for information and the available evidence. Indeed, a truism of research in STP [science and technology policy studies] is that public requests for information in the face of uncertain situations will exceed the available scientific evidence." (p.140)

[509] Again, for the details of their functional stasis analysis, we refer the reader to DeVasto, Graham, and Zamparutti (2016, pp.148–157). However, on the schematic level we can say that their analysis aims at bringing to the fore that due to the gap between public/DPC demands and evidence available to CGR, the *buttressing*-interaction between *nested* stases and *resolutions* failed and brought about misunderstandings in resolving the problems under consideration. In the L'Aquila case, the fatal structure is that "scientists' 'objective' statements cannot necessarily be divided from value, as much as they may try to do so" (cf. DeVasto, Graham, and Zamparutti 2016, p.157).

We think that their analysis of the first three phases is correct and our KP-clustering and the KPs are in favour of their analysis. However, their analysis of the fourth phase, namely that policymakers and the scientists talked past each other, is only weakly grounded, namely in KP10. Clearly, that there was

no refutation on part of the scientists of such a reassurance conclusion can be explained well by assuming that they talked past each other. Nevertheless, e.g., KP2 and KP5 of the minutes seem to suggest that the scientists were quite explicit about what they thought could be concluded from their claims and what not, and it is hard to see how this could have been missed by the authorities. For this reason, we want to remain undetermined regarding this phase. Rather, we will provide a different analysis based on the argumentation in the trial. As we will see soon, at surface we come to the same result, namely that some form of non-denial turned into acceptance. However, whereas according to DeVasto, Graham, and Zamparutti (2016)' analysis, uncertainty and hesitancy on part of the scientists (non-denial) was interpreted as a signal of unlikelihood (acceptance) by the authorities, we argue that non-denial on part of the scientists led to acceptance by the public. So, whereas DeVasto, Graham, and Zamparutti (2016)' thesis is mainly about the problem of non-denial in a communication situation of type DPC-CGR, our thesis is about the problem of non-denial in a communication situation of type DPC-CGR-PUBLIC.

5 How Non-Denial Turns Into Acceptance: The Argumentation in the Trial

In what follows, we try to study the role of the scientists in different communication settings as discussed in the trial. Let us begin with a brief overview of the trial, before we delve into more details: The first trial started in September 2011. In this trial, two authorities and five geoscientists taking part in the meeting (the *L'Aquila Seven*—cf. Alexander 2014) were convicted of manslaughter, sentenced to imprisonment and fined. According to the main accusation, the geoscientists in particular did not provide accurate information about the earthquake and failed to assess the risk correctly, for this reason the deputies' reassurances were unjustified and wrong. In an appeal, starting in October 2014, the sentence was cleared. Only one deputy of the authority was blamed for failing to provide adequate information to the locals. This sentence was confirmed in the final trial of November 2015.

Let us come to more details now: Sixteen months after the first trial against the *L'Aquila Seven* began, Judge Marco Billi ended the trial with sentencing them to six years in jail, disqualifying them from public offices, and demanding them to pay compensation of 8Mio EUR (cf. Billi 2013, sect.10). By this, he even surpassed the claim of the prosecution. In his justification (motivazione), he provides the following reasons for this verdict (cf. Billi 2013, p.750, my translation):

> "The activity of forecasting, prevention and *risk analysis was carried out in a superficial, approximate, and generic way*, with apodictic and self-referential statements, *totally ineffective with respect to the duties imposed by law*. The lack of analysis of seismic risk covers not only the failure to consider some single factor, but the underestimation

> of multiple risk indicators and the correlation between these indicators. [...] *The direct communication, favoured by the authoritativeness of the source, has amplified the effectiveness of the reassuring message, producing devastating effects on precautionary habits traditionally followed by the victims*."

What is meant here with 'underestimation of multiple risk indicators' is, according to Billi, the geoscientists' failure to take earthquake forecasts into account. One such forecast referred to by Billi is a paper of Boschi, Gasperini, and Mulargia (1995) (cf. Billi 2013, p.283). Billi's critique in mentioning this paper was mainly about an inadequate assessment of the probability of an [510] earthquake to take place. However, the paper of Boschi, Gasperini, and Mulargia (1995) is about long-term development of earthquakes and provides only long-term forecasts. What would have been needed for legitimising Billi's critical assessment would have been short-term predictions. But it is generally accepted in the geosciences—and also by Billi—that justified short-term predictions are impossible (at least up to now) and that the best one can do in such a situation is to refer to a seismic hazard map (cf., e.g., Stein and Wysession 2003, sect.1.2.5; Holzer 2005). Also, the appeal argued this way and so the conviction of performing an inadequate analysis of the seismic situation by the geoscientists was cleared by the appeal court on basis of the decision that Billi's critique of the geoscientists' probability estimations is inadequate.

However, more important for us is the other reason he mentioned in his justification, namely that the "*direct communication [of the scientists], favoured by the authoritativeness of the source, has amplified the effectiveness of the reassuring message*" (cf. Billi 2013, p.750, my translations). So, what about the conviction of inadequate communication of the geoscientists? In the L'Aquila case, according to Billi, an explicit distinction between scientific expertise and non-scientific estimation was not clear at all. The consequences of the scientists' analysis in form of the statements by the DPC/De Bernardinis, namely the reassurance, were considered by the public as well as in the verdict of Billi as part of the scientists' claims and by this led to a mixing up of the two domains in public opinion. Also, although only one of the members of the CGR was present at the press conference, namely Barberi (who was not talking to the public), Billi judged that all members of the CGR were equally involved in this case of inadequate communication with the public, likewise as the members of the DPC (De Bernardinis among others) were, because in public opinion they acted as a group.

However, this interpretation was not shared by the appeal court, which started in October 2014 (cf. Rosen 2014), and came already one month later to the decision that only in De Bernardinis' case a link between the expert's words and the actions of some of the victims which lead to their death/injuries could be proven. In the appeal trial, the prosecution argued that De Bernardinis' reassurance with the help of "scientific facts" hinges mainly on the *discharge hypothesis*. For simpler reference, let us introduce it explicitly as:

(h) Swarms lead to an ongoing discharge of energy and by this decrease the

probability of a big quake—which is an earthquake with $ML \geq 5.5$. or in the words of De Bernardinis:

> "The scientific community continues to tell me that the situation is in fact favourable because there is an ongoing discharge of energy." (Picuti 2012, p.47, translation by me)

Now, if we consider a decision just based on hypothesis h and the ongoing swarms from October 2008 until March 2009 with the bigger eruptions on March 30, 2009, i.e. the context that there was an ongoing discharge by an increasing number of small earthquakes, then h may be simplified to the claim that there will be no earthquake. This was the conclusion De Bernardinis drew when he reassured people to stay in their homes. However, he had no reason to conclude so, given the high costs at stake—this is intuitively clear, but follows also from ordinary decision theory by help of a parametrisation according to the sums regarding the damage mentioned in the verdict of Billy: Given the costs at stake, De Bernardinis would have needed to be much more sure about h than he actually reasonably could have been.

This concerns the role of the authorities (DPC). But how about the role of scientists (CGR) in this respect? According to the drafts of the minutes, Barberi asked the participants and especially his colleagues whether h is correct (cf. KP4). Eva answered that as a matter of fact in L'Aquila there had been numerous swarms not followed by a large earthquake, which would be in favour of h. But he also added immediately that L'Aquila is a very seismically active zone for which no predictions about large quakes can be made (cf. KP5). Later on, Barberi mentioned that swarms tend to have similar magnitudes and that it is highly unlikely that one of the quakes within a swarm has significantly [511] increased magnitude (cf. KP7). Again, this claim of Barberi would be in favour of h conditioned on the assumption that all earthquakes in the sequence under consideration are part of the same swarm. It seems that in the appeal the prosecution pointed mainly to this fact that there was no clear "No" regarding h from the scientist's side (both in the DPC-CGR meeting as well as in the DPC-CGR-PUBLIC situation) and that this might have been relevant for blocking De Bernardinis reassurance claims (note that DeVasto, Graham, and Zamparutti 2016, p.157, interpret the case differently when implicitly referring to h only with respect to the interview of De Bernardinis prior to the meeting and considering h to be "a completely falsified claim that had not come from the CGR discussion").

De Bernardinis' reassurance by h seems to be the main factor which has had a strong impact on the locals:

> "That message, whatever its source, seems to have resonated deeply with the local population. 'You could almost hear a sigh of relief go through the town,' says Simona Giannangeli, a lawyer who represented some of the families of the eight University of L'Aquila

> students who died when a dormitory collapsed. '*It was repeated almost like a mantra: the more tremors, the less danger*.' 'That phrase,' in the opinion of one L'Aquila resident, 'was deadly for a lot of people here.' " (cf. Hall 2011, p.268)

Also, the qualitative investigation by Pietrucci (2016) points in this direction and the relevance of h in the press conference *after* the meeting: She provides interviews with relatives of people dying in course of the earthquake. All interviewed people changed their habit due to the reassurance by De Bernardinis. As also DeVasto, Graham, and Zamparutti (2016, p.140) highlight, "traditionally, the practice was to leave the house and spend the night outside sleeping in cars or staying up in the piazza. Now, more and more people stay inside and watch television, listening to broadcasts from authorities." That in the case of L'Aquila the energy discharge hypothesis h and it being used in the press conference of March 31, 2009, 19:30, *after* the meeting, with the authorities Cialente (major of L'Aquila), De Bernardinis (DPC) and Stati, as well as the scientist Barberi (CGR) taking part was of utmost relevance, can be seen, e.g., in the fact that four out of the five interviews provided by Pietrucci (2016) cite particularly the hypothesis on energy release for them being reassured. So, it seems to be that particularly in this communication situation of type DPC-CGR-PUBLIC the lack of denial on part of Barberi was interpreted as *acceptance*. In this sense, although the scientists of the commission took great care of avoiding any form of plainly *accepting* or *refuting* seismic hypotheses during the meeting and also in the press conference, the setting brought it about that they were interpreted by the public (and perhaps also by the authorities—this is the thesis of DeVasto, Graham, and Zamparutti 2016) to *assert* such hypotheses.

In general, one might conclude that, although some of the geoscientists' claims may be regarded as partly confirming h, one also has to recognize their repeatedly pointing to the fact that L'Aquila is within a highly active seismic hazard zone and that short-term predictions are impossible. This was also the conclusion of the cassation prosecutor in the final trial: "Giuseppina Fodaroni, whose role was to analyze the legal validity of the appeals court's judgment, took a very different view [and] claimed, the message from the other experts during the meeting—that the chance of a major quake had neither increased nor decreased—was 'neutral' and therefore not reassuring" (cf. Cartlidge 2015).

In a nutshell: In the first trial, the judge convicted the scientists of failing to provide adequate probabilistic information, and of mixing up value neutral judgements (roughly, matters of fact in the sense that subjective values play no role in these judgements) with value laden judgements (roughly, matters of concern in the sense that subjective values play a rule in the judgements) in *accepting* and *asserting* hypotheses unconditionally. In the appeal, the first conviction (inadequate probability estimates) was quickly ruled out, as well as the claim of unconditional *acceptance*. However, the problem of unclear *assertion* was still intensively debated and focused on by the prosecution, although in the end also this conviction was annulled. The decision was confirmed in a final trial in 2015. [512]

6 Conclusion

We investigated in detail the key facts of the L'Aquila 2009 case. In the first verdict, the scientists and representatives of the authorities were found guilty on two main counts, namely in failing to provide an adequate estimation of the situation (wrong probabilities), and in biased communication with the public. Our analysis suggests that the first count is unjustified since its justification contains a mixing up of short- and long-term probability forecasts in geoscience. Whereas the former would have been needed for the decision procedure as stated by the judge of the first trial, the scientists always made clear that they can provide only the latter. A particularly relevant hypothesis, namely that of energy discharging via swarms which would indicate possibilities of refined short-term forecasts, was not explicitly rejected by the scientists, but the degree of confirmation needed for such a hypothesis in order to be interpreted as a categorical advice is clearly not to be found in the discussion between the scientists and the representatives of the authorities. We also saw that due to a misinterpretation of the communication structure by the public as well as the involved scientists, the scientists' non-denial of false or unproven hypotheses as, e.g., the one just mentioned, misled the public to read a non-denial as acceptance. This reconstruction is also in the line of argumentation of the appeal court who cleared the first verdict and restricted the second count only to a failure of communication by the representative of the authorities.

It seems to be one of the main lessons of the six years lasting L'Aquila 2009–2015 case that scientists concerned with topics that are closely related to public interest have to make more of an effort in figuring out their role in such a situation and make the boundaries of applying their results more explicit.

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