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Authors: Alice Benessia, Bruna De Marchi

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When the earth shakes … and science with it. The management and communication of uncertainty in the L'Aquila earthquake

Alice Benessia[1] and Bruna De Marchi[2]

[1]. Interdisciplinary Research Institute on Sustainability (IRIS) - Università degli Studi di Torino, Torino, Italy
[2]**.** Senter for Vitenskapsteori (SVT), Univeristy of Bergen, Bergen, Norway

Highlights

- We provide an account of the controversy around the earthquake of L'Aquila in 2009
  - We reflect about uncertainty management and communication in mass emergencies
  - We show that uncertainty is not a purely epistemic, independent variable
  - We specify that uncertainty is multidimensional, time and path-dependent
  - We encourage science advisers to consciously engage with all these elements

Abstract

In the spring of 2009, a strong earthquake shook the Italian city of L'Aquila and the region surrounding it. Besides the tragedy of human and material losses, the disaster triggered an unprecedented series of legal consequences. In this paper, we take the L'Aquila case, in all its psychological, social and legal controversies as exemplary for reflecting on how uncertainty can be recognized, treated and communicated in the context of mass emergencies. We examine the inherent path-dependency and multidimensional nature of uncertainty by projecting it along a number of axes, analyzing how the different components evolve and interact with each other. We show that contradictions, controversies and conflicts are bound to arise in the practice of expert advice for public policy as a result of: 1) the improper reduction of the overall situational uncertainty to its scientific component only; 2) the treatment and communication of scientific uncertainty as an independent variable that can be analyzed and computed in isolation from ethical, political and societal concerns. Finally, we provide some suggestions about a more integrated approach to expert advice for public policy.

Keywords: L'Aquila earthquake, L'Aquila trial, uncertainty management and communication, mass emergencies, expert advice.

1. Introduction

On 6 April 2009, a 6.3 moment magnitude (Mw) earthquake devastated L'Aquila, the capital of the Italian region of Abruzzo, and some neighboring municipalities. In total, there were 309 deaths and about 1,600 injured. The numbers of buildings damaged and people evacuated are counted in tens of thousands, and the provisional damage estimate was over 10 billion euros (Global Risk Myiamoto, 2009).

In absolute terms, the magnitude of the shock was not extreme, but the material and human consequences were proportionally acute, given the seismic vulnerability of both the historical center and some of the newer buildings involved. Moreover, the lack of common precautions by some of the residents, such as leaving their homes and spend the night outside after two strong foreshocks in the late evening, increased the number of deaths. In the aftermath of the disaster, some of the survivors attributed the fatal behavior of their relatives to the public reassurance about the imminence of seismic risks given on March 31th, a few days prior to the earthquake, by the then deputy director of the Department of Civil Protection (DPC) in an brief interview broadcasted on prime time national TV. The interview concerned a highly publicized meeting of the Commissione Grandi Rischi[1] (CGR, literally the Major Risks Commission) called in L'Aquila that same day by the head of the DPC, Guido Bertolaso. This was in order to respond to the unsettling effects of the seismic activity that had been affecting the region for many months and dispel the rumors of an impending deadly shock.

As a result of this complaint by some of the survivors, seven people present at the meeting – five scientists and two public officials including the author of the broadcasted interview – were first indicted and then summoned to court into a controversial trial. In October 2012, the so-called "L'Aquila Seven" (Alexander, 2014; see also Gabrielli & Di Bucci, 2015) were sentenced to six years in prison for manslaughter and injuries in connection with the victims of the earthquake. After a second appeal trial, in 2014 the sentence was overturned for all the indicted experts, leaving the former DPC deputy director

[1] The *Commissione Grandi Rischi*, short for *Commissione Nazionale per la Previsione e la Prevenzione dei Grandi Rischi* (National Commission for the Forecast and Prevention of Major Risks) is an advisory body of the DPC, composed of experts in seismic, volcanic, hydrological and other risks. Its activity is consultative, technical, scientific and proactive and includes guidance in the forecast and prevention of various risk situations. It was first established by the law 225 of 24 February 1992, which created the National Service of Civil Protection. Its organisation, functions and composition have been partially modified in October 2011 by a Decree of the Prime Minister Silvio Berlusconi. See http://www.protezionecivile.gov.it/jcms/it/commissione_grandi_rischi.wp (accessed 01/05/2016).

with a suspended conviction[2]. Finally, in November 2015, the Supreme Court confirmed the Appeals' judgment (Corte Suprema di Cassazione, 2015). In the meantime, a large part of the scientific community mainly involved in seismology and earth sciences, both nationally and internationally, expressed its outrage for the indictment, the trial and the conviction: through letters, articles and petitions to the main scientific journals, media and even the then President of Italian Republic, Giorgio Napolitano (Leshner, 2010). The main thesis was that, as earthquakes are fundamentally unpredictable events, no scientist should be held responsible, let alone legally liable, for not having predicted one. In this view, science itself was most improperly and dangerously under trial, evoking some of the most ominous and historically iconic precedents of the Italian Catholic church obscurantism, such as the persecution of Galileo and Giordano Bruno[3] (Clark, 2012; Portanova, 2012). There were some dissenting voices in the scientific community, most notably expressed in another letter addressed to President Napolitano (ISSO, 2012), but didn't resonate widely in the media.

From this brief synthesis of the main events, it is clear that the psychological, social and institutional circumstances in which the L'Aquila earthquake took place are particularly significant in terms of uncertainty management and communication, as they triggered an unprecedented sequence of psychological, material and then legal consequences for the population, and for the scientists and public officials involved in the assessment of the situation and the communication of the risks preceding the main shock (Oreskes, 2015). These circumstances, together with the concurrent heated international debate within and outside of the scientific community, provide strong elements of reflections about the way in which uncertainty is and can be recognized, treated and communicated in the context of mass emergencies, and consequently about the epistemic and normative implications of

[2] Bernardo De Berardinis was sentenced to two years imprisonment for the charges of manslaughter with reference to some of the victims. In the same judgement the sentence was suspended, with no mention in the convict's criminal records (Corte di Appello dell'Aquila, 2014). The verdict was confirmed by the Supreme Court (Corte Suprema di Cassazione, 2015). In October 2010, when not yet indicted but having already received notice of investigation (see section 5), he was appointed as President of ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale - High Institute for Environmental Protection and Research). He still holds the position, after a query of the Court of Auditors about the regularity of the procedure was rejected by the present (Renzi) government in April 2014. See http://www.governo.it/AmministrazioneTrasparente/ControlliRilievi/RilieviCorteConti/rilievo_20140310_DeBernardinis.pdf (accessed 01/05/2016).

[3] On 22 October 2012, the then President of the Tuscany Region, Enrico Rossi, made a public statement of his Facebook page, reported by the media: "The conviction of scientists for having provided an advice, in full conscience, is something that recalls in our minds the obscure times of the convictions to Giordano Bruno and Galileo Galilei". A similar official claim by the then Minister of Environment Corrado Clini was reported in the public press on 24 October 2012 (Zanotti, 2012).

scientific advice for public policy. The main focus of this paper is the exploration and analysis of these elements, based on media coverage and reports, scholarly articles, and in particular legal documents including defendant and witness testimonies (Tribunale di L'Aquila, 2012; Corte di Appello dell'Aquila, 2014; Corte Suprema di Cassazione, 2015).

More specifically, the emergency management we deal with here is not that generated by the earthquake itself, i.e. the handling of the huge and dramatic problems of deaths, injuries, physical destruction, economic loss, social disruption, and psychological distress, which all require an immediate response and a continuous and prolonged attention. Those wounds represent a different chapter in the story of a city and a territory struggling towards physical, economic and socio-psychological recovery (Calandra, 2012; Özerdem & Rufini, 2013). The crisis we consider is the one *preceding* the major earthquake, which can be described as that of a human system under stress generated by a physical phenomenon, in this case seismic tremors, and amplified by rumors and contradictory messages. In synthesis: "a disaster waiting to happen". Moreover, the indictment of "the L'Aquila Seven", the two trials, and the verdicts were based on juridical rules, procedures and criteria, which are not the subject of this paper, even if we do refer also to testimonies and documents from the trials for the reconstruction of the events. What we are interested in is the social representation of uncertainty both of the events leading to the trials and of the trials themselves. We will focus in particular on how the verbal accounts and some of the visual representations provided by the media before the earthquake were shaped by the inputs of those in charge of emergency management and on how these accounts, largely reflected the views of the defendants and their supporters, claiming that the scientific community and science itself were under attack. This paper is not about expert policy advice for emergency management, subject which was discussed by one of the authors elsewhere (De Marchi, 2014). Yet in the concluding remarks, drawing on the L'Aquila and other cases, we will show how scientific experts can conceive or their mandate, tasks, and responsibilities, quite differently.

Finally, through this analysis we provide some broader reflections about the emergence and unfolding of uncertainty within mass emergencies, namely its time and path-dependency and its inherently multidimensional nature. As we will see, when examined in this perspective the trajectory that led to the overall unpreparedness of the citizens, the indictment and the trials to the scientific advisors and public officials in charge, and even the reactions of the scientific community to the trials themselves, becomes the unfortunate result of a sequence of improper reductions of the complex nature of uncertainty to its scientific component only. Moreover, we will argue that, because of this reduction, the epistemic and

normative dimensions of uncertainty – i.e. the (uncertain) facts of science and values of democratic decision-making procedures – became polarized and inevitably and counterproductively clashed into each other, giving rise to what has been improperly described as a conflict between science and the law (Greco, 2015).

2. Before the earthquake: swarms of uncertainty, media operations, and logical fallacies

Earthquakes are usually sudden events, which strike without any preliminary signs, making it impossible to provide any warning or suggest short-term precautionary measures. In this respect, the case of L'Aquila was anomalous, though not unique, as a large number of sporadic low-magnitude tremors (a seismic swarm) had occurred in the four months preceding the main shock. Living in a known seismic area, the residents of the L'Aquila region were not new to the stress and preoccupation generated by these phenomena. However, the psychological tension of the population was further amplified by a number of rumors, always circulating and difficult to control in such circumstances (Wright & Rossi, 1981; Rodriguez et al., 2007). Most importantly, among these rumors a supposed forecast resonated in the region, propagated by a technician named Giampaolo Giuliani, formerly working at a laboratory of the National Research Council (CNR). Based on radon measurements he had performed, Giuliani was convinced that a major earthquake was soon going to happen and also had some hypotheses on where and when, which later proved both wrong (see Jordan et al., 2011, p. 323).

Outraged by Giuliani's conjecture, Guido Bertolaso, the then head of the National Department of Civil Protection, threatened to sue him for diffusing alarming news. In a phone call he made to Daniela Stati, the Abruzzo Region Councillor for Civil Protection, on 30 March 2009[4], he announced a "media operation" (*operazione mediatica*), which would bring to L'Aquila "the leading earthquake experts" (*i luminari del terremoto*) in order "to silence any imbecile and calm down conjectures, preoccupations, etc."[5] (Tribunale di L'Aquila, 2012, pp. 129-130). He also anticipated what he expected the experts to say, i.e. that a seismic swarm was a positive phenomenon in so that it "discharged energy", preventing a deadly shock[6]. In the same occasion, he criticized the press release by the Abruzzo region DPC that literally stated, "No new shocks are foreseen" (Tribunale di

[4] Bertolaso was called as a witness during the first level trial and was asked to explain and comment the disclosed phone call (Tribunale di L'Aquila, 2012, p.127 & pp.150-154). The appellate judges also referred to it in their verdict.

[5] "… in modo da zittire subito qualsiasi imbecille, placare illazioni, preoccupazioni, eccetera".

[6] "… cento scosse servono a liberare energia e non ci sarà mai la scossa quella che fa male".

L'Aquila, 2012, p. 128 & pp. 193-194). With an unusual procedure, he then convened a meeting of the Commissione Grandi Rischi (CGR) to be held in L'Aquila on the following day[7]. As stated in the press release by the DPC, its purpose was to provide the citizens of Abruzzo with all the information on the seismic activity in recent weeks that was available to the scientific community.

At this point in time, Bertolaso's (and the DCP's) framing of the management problem seems to have been mainly in terms of response to public unrest *versus* public safety. Indeed, he confirmed in court that his main concern was to keep people quiet and reassure them that Giuliani's "forecast" had no scientific basis. Possibly, considerations about public safety remained in the background because he believed in the scientific soundness of the "discharge of energy" theory, which - as he also testified in Court – he had mentioned in several public occasions without any scientist ever contradicting him (Tribunale di L'Aquila, 2012, pp. 150-157; Corte d'Appello, 2014, pp. 246-247; see also Ciccozzi, 2014).

The meeting that the head of the DPC convened – and didn't attend - took place on 31st March as planned. No specific measures of protection were suggested to the local authority or the citizens, while, in response to Giuliani's supposed forecast, it was reaffirmed that no scientifically sound method exists to predict earthquakes.

As we have mentioned, also some interviews were given to the local TV news. In one of these, broadcasted nationally after the meeting (but recorded earlier), Bernardo De Bernardinis, then deputy director of the DPC technical-operative sector (*Vice Capo settore tecnico-operativo*), stated that the scientific community assured him that the seismic situation in L'Aquila was normal and actually favorable because of the continuous discharge of energy due to the seismic swarm. This is the same thesis that had been illustrated by Bertolaso in the previously mentioned phone call and confirmed in Court. De Bernardinis also replied positively to the question by a journalist about whether he would recommend people to relax with the help of a glass of local wine, a joke that proved to be a tragic one. There were no disclaimers from the part of the scientists participating in the meeting nor from any other expert or authority, despite the interview was repeatedly broadcasted in the Italian national radio and TV channels, and reported by the press. Later on, in Court, the other defendants claimed that the theory of "the discharge of energy" had no scientific basis, and that they had never defended it (Tribunale di L'Aquila, 2012). During the meeting, the query addressed by Franco Barberi to his colleagues about the scientific status of the

[7] Normally the meetings are convened in Rome by the President of the CGR or his deputy (at the time Giuseppe Zamberletti and Franco Barberi) and are not open to external observers.

"discharge of energy hypothesis" remained unanswered (or rather it was not taken into consideration). It must be added that some inconsistencies appear between the draft minutes of the CGR meeting and the official ones, which were signed a week later, "when the participants met again in L'Aquila, soon after the earthquake" (*quando i partecipanti si rividero a L'Aquila, subito dopo il sisma)* (Tribunale di L'Aquila, 2012, p. 84). Also some of the testimonies of those attending the meeting as observers are inconsistent with those of the defendants and the official accounts (Tribunale di L'Aquila 2012, pp. 97-112).

If we look at the epistemic content of the ambivalent and contradictory message of De Bernardinis – in that context acting *de facto* as the spokesperson of both the DPC and the CGR – we find out that it is essentially based on a logical fallacy, in the name of a supposed rhetorical effectiveness. Giuliani had warned the population about the likelihood of an earthquake, raising the public unrest in an overall delicate seismic and psychological situation. The institutional response focused on eliminating the source of unrest by delegitimizing its author: the experts convened stated (correctly) the general principle that earthquakes are not predictable, whilst they didn't directly address the "discharge of energy theory". Therefore, Giuliani was wrong and, in the words of Bertolaso, "the imbeciles" were "silenced". At this point, De Bernardinis (following Bertolaso's approach) moved one step further and counterbalanced the anxiety generated by a "pseudo-scientist" with the supposed reassurance of "official" science: the seismic swarm became (incorrectly) a positive sign. *Therefore* (logical fallacy), he ended up, paradoxically, predicting a non-earthquake (see also Ciccozzi, 2014). This epistemic loop, generated for normative reasons, was dramatically broken down into pieces by the element of chance, when a few days later the fatal shock actually occurred.

If we now focus on the normative content and look at the way in which the interview was edited, we realize that while De Bernardinis was making his most controversial claim – "the scientific community keeps assuring me that the situation is favorable because of the continuous discharge of energy" – the overlaid images showed geophysicist Enzo Boschi, the then President of the National Institute of Geophysics and Volcanology (INGV) and a prestigious scientific expert of the CGR – examining the data of the seismic swarm (Figure 1). Moreover, even though the interview was released before the experts had convened, the footage collected later, during the meeting, became the visual counterpart of De Bernardinis reassurance. Through this performative use of informational images (Schneider, 2011), the scientific grounds of the public official's statement were implicitly, and most effectively, reinforced. Essentially, in this way, the theory according to which a seismic swarm is a

favorable event appeared to be the actual scientific outcome of the meeting and no denials, corrections or retractions were formulated "in due time" by the participants.

We could of course, as others have done (e.g. Amato et al., 2015), blame the local TV and the media in general for distorting a neutral condition of uncertainty towards a positive one, but we would miss the fact that the meeting itself was conceived by the head of the DPC and performed by the CGR as a "media operation", meaning that the scientific expertise in and on itself was supposed to be displayed for sedating public unrest. In other words, as we will further explore, the local population was invited to see "science speaking truth to power" (Wildavsky, 1979). And in this sense, the media can be sadly praised for efficacy.

3. Multidimensionality and path-dependency: a checklist for uncertainty communication and management

As we have seen, emergency management, in this case that of an impending threat, always requires consideration of a vast array of strictly intertwined matters: political, legal, economic, organizational, social, psychological, moral, ethical, existential, and, of course, scientific. All such matters are full of uncertainties and their linkages produce new and greater uncertainties, which must be addressed by those in charge combining detachment with empathy and understanding for the perspective of those experiencing the threat.

Some two decades ago, one of the authors of this paper with two colleagues undertook a research study under the aegis of the European Commission (EC) Joint Research Centre to explore how key stakeholders in major hazard situations manage and communicate uncertainties (De Marchi et al., 1993; 1996).

The theoretical premise of the study was that "scientific uncertainty", i.e. the incompleteness of scientific inputs (due to whatever reason) does not exhaust the predicament of the decision-maker, whose overall "situational uncertainty" includes also aspects related to the institutional and social framework in which she operates. Fieldwork was conducted in England and in Italy consisting of some 30 interviews with competent authorities, high rank civil protection officials and practitioners, academic researchers, and media people. A very practical result of the study was a checklist divided in two parts. The first one specifying different types of uncertainty, with the further possibility of ranking them according to their relative "salience" (i.e. the level of negative consequences if inappropriate management decisions are taken) and assessing each one according to its level of "severity" (i.e. the perceived level of uncertainty in the actual management problem).

The appraisal of the overall "situational uncertainty" of any given contingency thus results from the examination of the different components of a multi-faced problem (Fig.2). The second part of the checklist is dedicated to communication strategies and highlights a relation between "interpretations" of uncertainty and preferred "policies" (Fig. 3). The checklist was used in several occasions and in various countries, in particular drills and exercises with Civil Protection personnel and managers[8], and proved a useful tool for analysis and discussion of decision making in emergency situations, both constructed for training purposes or experienced in real practice.

Here we use the checklist as a heuristic device in the attempt to provide an analysis and interpretation, from our outsiders' viewpoint, of the rationale underlying the management decisions taken by the top Civil Protection authorities in the days prior to the major seismic event. Our conjecture is that a similar exercise might be performed, though retrospectively by the very actors involved in the management of the crisis to reflect on their own way of reasoning and actions. Of course we cannot know which would be their diagnosis, nor can we identify (and neither could they) what would have been the course of events had they carefully scrutinized all the different types of uncertainty and their implications. Yet, as happened in the cases previously mentioned, some insights might emerge for better addressing new crises.

We will proceed to briefly introduce the checklist, applying it to the current case as a hypothetical exercise

- *Scientific uncertainty* refers to the difficulty of risk assessment or of forecasts based on sound and reliable data. Despite the fact that activities of monitoring, data collection and analysis are very advanced and widespread and produce massive seismic data sets with invaluable information, it is still impossible (and perhaps it will always be) to anticipate the time, location and magnitude of an earthquake. Thus, in this case (as in any similar ones) scientific uncertainty could be recognized as severe. Its salience was high, but possibly underestimated by those in charge, as they thought it sufficient to focus on (and communicate about) the (low) probability of a major shock. Instead, what could have been legitimately expected from them under the circumstances was a complete assessment of the system under stress, including consideration of its most vulnerable components (Blaike et al., 1994). One may argue that in the CGR there were not all the necessary competences for such a complete

[8] Among others, at Mount Macedon disaster training campus (Victoria, Australia) in 2000.

assessment, but in that case one might expect the experts themselves or the authorities to integrate the needed expertise with competent advisors.

- *Societal uncertainty* results from scarce integration of publics and institutions, and overall limited respect for politicians and government agencies. Societal uncertainty so defined is generally salient in Italy, with a generalized lack of trust in the political system (Transparency International, 2014; WJP, 2015). Its salience was possibly not even taken into consideration, but the consequences of the decision taken proved detrimental for social cohesion and increased mistrust in political and scientific institutions from the part of many. Before the earthquake, the words of the CGR were perceived and trusted as those of an independent and knowledgeable scientific body, but after the earthquake, its independence from the political power became questionable. Moreover, opposed factions emerged pro or against its modus operandi, independence and accountability.
- *Institutional uncertainty* refers to inadequate collaboration and/or trust among institutions. It tends to be more salient when a number of bodies, operating at different political and administrative levels, have jurisdiction on the same issue. In the case under investigation the above mentioned episode of the press release issued by the regional civil protection authorities and censured (privately) by the national ones shows that institutional uncertainty was both salient and severe (see Section 2). This problem was definitely diagnosed by Bertolaso, but his strategy of designing "a media operation" that would solve it by giving the final word to a *super partes* independent scientific authority proved inadequate, and actually counterproductive as it generated even more controversy, conflict and mistrust among institutions, including the scientific ones.
- *Proprietary uncertainty* refers to contested rights to know, to warn or to conceal. Under the circumstances its saliency was indisputable, due to the fact that warnings and hypotheses about the seismic swarm were issued from different sources, including some un-accredited (Giuliani in particular) or inadequate ones (the Abruzzo civil protection). Its severity was definitely recognized by the Civil protection authorities, who decided to give the floor to "the leading earthquake experts" to dispel non-scientific rumors (See Section

2). Unfortunately, the events of April 6th proved that there are no "proprietors of certainty" in the case of highly unpredictable physical phenomena.

- *Legal uncertainty* refers to the possibility of future liability for actions or inactions. From the response to the indictment by both those brought to court and most of their colleagues, it seems that it was not even taken into consideration (its salience was *nihil*, so to say). In other words, the experts seem to have conceived their pronouncements as subject to no other scrutiny than the scientific one. To the contrary, "legal uncertainty" proved both salient and severe a posteriori. As we will further explore, it gained central stage in the heated debates that followed the indictment of the "L'Aquila Seven" and resonated in the most diverse forums.
- *Moral uncertainty* is similar to the previous one, but refers to criteria relating to personal and community ethics rather than to juridical norms, and implies the possibility of future guilt or community ostracism for action or inaction. It is of course very difficult to hypothesize the predicament of the actors involved with regard to such type of uncertainty. However, given their public testimonies in court and elsewhere, none of them seem to have considered it either salient or severe, as if the course of action was somehow univocal, clearly established, and unproblematic in that respect.

Moving back to the second part of checklist, which links interpretations of uncertainty with policy choices, it seems that two combinations apply and partially overlap. Apparently, the likelihood (the uncertainty) of the occurrence of a major earthquake was discounted by the competent authorities (and possibly by the experts) while they recognized that the overall situation was full of uncertainty due to social and psychological factors. The strategic choice in terms of communication was one of "confidentiality" at the top of the hierarchy, i.e. within the Department of Civil Protection, and one of "publicity", devised for the local authorities and citizens. Publicity was enacted with the delivery of scientific information in a public event and, most importantly, showing the close collaboration of the DPC and the CGR and their shared concerns for public safety. Indeed, the exchanges between the authorities (and possibly the scientists) were supposed to remain confidential, were it not for the disclosed phone call previously mentioned (See section 2). "Publicity" (by means of a "media operation") was instead chosen as a communication strategy addressed to the residents. Publicity, however, not of scientific uncertainty, but of the

attention to and careful monitoring of the unfolding of the situation from the part of the best scientific experts and the most committed civil servants.

Summing up, we have examined the overall uncertainty regarding mass emergencies by decomposing it along different axes of a multidimensional space. We have defined this multidimensional uncertainty as "situational" and we have explored the salience and the severity of its different components.

If we now look at how situational uncertainty evolves in time, we find out that it is inherently path-dependent, in the sense that every conscious decision and contingent event regarding it, irreversibly determines a new course. In other words, not only uncertainty is multifaceted, but also every component keeps evolving differently over time in response to both chance and intention. Moreover, the dynamics of every component inevitably influences every other. In more general terms, we are in the presence of what has been defined as "emergent complexity" (Funtowicz & Ravetz, 1994).

In light of what we have seen, the L'Aquila case becomes more understandable. The fatally ineffective response of the public institutions to the emergent complexity of the situation, characterized by multiple and intertwined uncertainties, was twofold and inherently contradictory. First, following a modern approach to decision-making, the overall situational uncertainty was reduced to its scientific component only. Second, focusing on public control *versus* public safety (De Marchi, 2014), the situational uncertainty had to be rapidly and drastically lowered, and consequently scientific uncertainty, as the only component at stake, had to be downplayed. Scientists and scientists alone – "*i luminari del terremoto*" i.e. the leading earthquake experts in Bertolaso's words (See section 2) – were entitled to provide the last word of what was happening, dispelling all rumors and, in the expectation of the authorities, providing reassurance to the alarmed population. In terms of "institutional uncertainty" the choice made sense as surveys confirm that trust in scientists tends to be higher than in other institutional actors (EC, 2013; Pellegrini & Saracino, 2015), yet, paradoxically, the scientific component of uncertainty was precisely the only one that could not be justifiably lowered. As we have seen, this epistemic fallacy, founded on specific normative choices – i.e. subscribing to the modern ideal of scientists (alone) "speaking truth to power" (Wildavsky, 1979) and privileging control over safety – ended up collapsing together with the buildings of L'Aquila, on April 6th 2009, along its path-dependent trajectory.

4. After the earthquake: the prosecution of the experts and the trial to the trial

Most regrettably, the consequences of this overall breakdown and reduction of situational uncertainty to its scientific component propagated to the events after the disaster. In essence, the reduction of the perception of risk due to the public reassurance increased the exposure to the actual danger, and logical fallacy became legal liability.

As we have mentioned, the major shock hitting at 03:32:40 a.m. (local time) had been preceded by two others (of M_W 3.9 and 3.5 respectively) in the previous hours. This is key to understand the accusations raised against the seven experts participants to the meeting. Indeed, the relatives of thirty-seven victims killed in the event and five people who were injured submitted a complaint to the L'Aquila prosecutor's office claiming that their loved ones had died (in the former case) and that they themselves had been injured (in the latter), because they had trusted the official reassurance that the situation was "normal" and had consequently neglected the usual precautions (mainly leaving their houses) that they were used to take.

The legal case developed as follows: In June 2010 five scientists and two public officials who had taken part in the meeting of 31 March 2009 received a notification of investigation. On 25 May 2011 they were indicted by the Court of L'Aquila of multiple manslaughter and injuries in relation to the earthquake. The accusation concerned the inadequacy of both the risk assessment and the failure to provide appropriate information, which might have saved some people's lives.

The trial began in L'Aquila on 20 September 2011, and thirteen months later, on 22 October 2012, the Court issued its verdict, supported by 944 pages of argument and documentation filed at the Tribunal registry on 19 January 2013 (Tribunale di L'Aquila, 2012). The judge found the seven defendants guilty in 29 out of the 37 cases of death presented by the plaintiffs and in 4 out of 5 cases of injuries, and acquitted them in 8 and 1 cases respectively. The offenders were sentenced to six years in prison and to pay huge compensations to the victims. They were also permanently barred from holding public office.

The motivation of the verdict was that, on the occasion of the CGR meeting preceding the earthquake, the defendants' assessment of the risks connected to the seismic activity under way had been "approximate, generic and ineffective in relation to the activities and duties of forecast and prevention" (*approssimativa, generica ed inefficace in relazione alle attività e ai doveri di previsione e prevenzione*) (Tribunale di L'Aquila, 2012, p. 2). Also, that the information they had provided to the authorities, the press and the L'Aquila citizens on the

nature, the causes, the dangers and the future developments of the ongoing seismic activity had been "incomplete, inaccurate and contradictory" (*incomplete, imprecise e contraddittorie*) (ibid.). All the defendants appealed against the first instance judgment, whose application was thus suspended, including the ban from public office.

As soon as the notification of investigation to the seven experts was made public (June 2010), i.e. even before their formal indictment, appalled and outraged reactions burst in many quarters. Almost immediately, some colleagues of the defendants started a massive campaign in their support, including letters, petitions, interviews and articles in the mass media and the scientific press (see Pantosti et al., 2010; Nosengo, 2010; Cressey, 2010 among others). The CEO of the AAAS (American Association for the Advancement of Science), Alan Leshner, presented a letter signed by some five thousands scientists to the then President of the Italian Republic, Giorgio Napolitano (Leshner, 2010), totally misrepresenting the charges. In labelling them as "unfair and naïve", the document stated: "the basis for these indictments appears to be that the scientists failed to alert the population of L'Aquila of an impending earthquake. However, there is no way they could have done that credibly". If the actual content of the charges had been checked, the cautious wording ("appears to be") would not have been necessary, but in that case the letter would need to be redrafted. Indeed, the accusation was never of having failed to alert the population, let alone to predict the earthquake, as prosecutors and judges of both the first level trial and the appeal stated over and over in their pleads and verdicts (Tribunale di L'Aquila, 2012; Corte di Appello dell'Aquila, 2014).

While the same superficial thesis appears not only in popular media (Talignani, 2012; Oddifreddi, 2012; Zanotti, 2012), but also in some of the most renowned scientific journals (Nosengo, 2010; Cressey, 2010), a new level of contradiction appears: the result of an empirically inaccurate analysis of the matter at stake emerges paradoxically *within* the scientific community, officially and historically in charge of empirical accuracy. There may be several justifications for framing the issue in such terms, ranging from failure to check the original documents to corporatist interests, to genuine or naïve misunderstanding. Different explanations have been suggested (e.g. Sturloni, 2012; Salvadorini, 2013; Yeo, 2014), and their analysis goes beyond the purpose of this paper.

In our terms, the paradox can be described once again as the outcome of the improper reduction of the overall situational uncertainty, at this point in time regarding the reasons and the development of a trial, to its scientific component. Indeed, if we remove all the normative implications of the public management and communication of uncertainty that

both preceded and followed the CGR meeting, we are left with the purely epistemic and scientifically trivial statement that earthquakes are not predictable: therefore, ethically and professionally accurate scientists could not have treated the implied uncertainty in any other way. In this framework, the logical fallacy of the "media operation" is avoided at its source, thus any possible legal liability. Along the same trajectory, the legal action becomes an indefensible trial to the only salient method for managing the uncertainty of the issue at stake: science itself.

This kind of approach is founded on a set of implicit assumptions that can be clarified through a specific example, involving once again one of the most renowned members of the CGR and the then president of the INGV, Enzo Boschi. One year after the first sentence in which he was convicted with the other six indicted experts, on 27 September 2013, Boschi published a Letter on Science, in which he defended his position by outlining a sharp separation between the merely informative professional task of the scientists, i.e. the INGV, and the exclusive responsibility of "communicating any state of risk" of the decision-makers, i.e. the DPC (Boschi, 2013). According to this separation, the professional and ethical duty of scientists amounted to publish first and later distribute, at the CGR meeting, the Seismic Hazard Map made official in 2003[9]. In Boschi's words: "In publishing an official map, seismologists have done all they currently can to protect society from earthquakes. I can hardly be blamed for the poor quality of buildings or for people's failure to conform to anti-seismic laws – these are responsibilities of other authorities."

Regardless of the actual controversial status of this statement [10], this division of labor between the purely epistemic role of science (the INGV) and the normative responsibility of policy making (the DPC) eludes the crucial role of the institution in between (the CGR). It represents an instance of the demarcation criterion characteristic of both the Modern state and the scientific method, in which facts and values can and have to be effectively separated and autonomously legitimized (Benessia & Funtowicz, 2016). In this Mertonian view (Merton, 1973 [1942], also discussed in Kønig et al., this issue), objective scientific knowledge is produced in epistemic isolation and ethical autonomy from the contingencies of human affairs – the messy world in which disasters actually happen and have to be managed – and it serves policy makers as uncontroversial input for rational decisions to be

[9] See http://zonesismiche.mi.ingv.it/documenti/mappa_opcm3519.pdf (accessed 01/05/2016).
[10] This separation, and Boschi's overall rationale, was contested by a Letter in response, signed by number of journalists, scientists and members of the civil society and never published by Science. See http://www.lettera43.it/upload/files/Reply_Boschi_English%20.pdf (accessed 01/05/2016).

made, in the form of logical deductions for the common good. Uncertainty is then considered within the boundaries of science in its descriptive, epistemic component only, and all its prescriptive, normative implications are left in the hands of the political authority. In other words, scientific uncertainty is an independent variable that can be analyzed and computed in isolation from ethical, political and societal concerns, or, in our terms, independently from the components of the overall situational uncertainty.

According to this perspective, in the L'Aquila case, science (the INGV) provided the objectively uncertain truth (the updated seismic map of Italy) to the power in charge (the DPC), but this latter failed to rationally manage it for the common good (i.e. to minimize the losses). Attributing to the scientists involved the moral responsibility and even the legal liability of this failure amounts to improperly and even violently collapsing the Mertonian isolation of science, thus threatening the very progress of science itself. The immediate, uncritical outrage of the scientific establishment and the reference to Galileo's trial as the symbol of an improper invasion of the realm of science emerge from this approach.

Scientific uncertainty, as introduced here, is not an independent variable, a neutral statistical input emerging from some isolated scientific truth-spot (Gyerin, 2002), but it is inherently correlated with the stakes implied and embedded in a path-dependent non-linear trajectory, constantly evolving over time. If we look at the L'Aquila case through this post-normal perspective (Funtowicz & Ravetz, 1993), we realize that the CGR meeting was organized as the stakes started to grow. This in order to stabilize the rising situational uncertainty and to re-establish a dual system of public control provided by scientific objective truth on the one side, and legitimated political authority on the other. This system had been shaken by the unverified claims of a "pseudo-scientist" and the uncontrolled rumors spreading within the local population. In other words, as we have seen, a public display of power was needed in order to demarcate, i.e. to define and legitimize the threatened authority of both science and governance. In all this, the focus ineffectively and then tragically remained on salvaging a loss of authority, instead of protecting the citizens of the L'Aquila region.

5. Concluding remarks

Although not the subject of this paper, it is impossible to ignore the institutional and social implications of the legal story, which goes far beyond the L'Aquila case and will very likely condition the future relation between policy and scientific expertise in Italy and

possibly elsewhere. As already mentioned, as early as 2011 a Prime Minister decree partially modified the norms regulating the organization and functions of the CGR[11].
Yet the role of expert advice in emergency management is being and will continue to be discussed beyond the L'Aquila case and beyond civil protection policies.

The fact that the management of the emergency became the object of a trial no doubt contributed to focus all attention on legal uncertainty (and liability) (DPC and CIMA, 2013). This situation was further magnified by the misrepresentation of the reasons for the indictment and the first verdict, which were circulated with the purpose of attracting attention to the case and possibly generating solidarity for the defendants and the professional milieus they belonged to. As we have seen the "scientific community" split - though unevenly in terms of numbers and resources - between supporters and detractors of the seven defendants (and later some of them), occasionally even indulging in personal attacks. To distinguish selfish, instrumental intentions (be them individual or collective) from genuine persuasion is not easy, neither is it the purpose of this paper. Yet the whole case is a further proof of the impossibility, to separate "hard facts" from "soft values" in science for policy.

The bitter confrontation of opposing pleas of innocence or guilt left little room for the discussion of other types of uncertainty, which would deserve a deeper scrutiny. Thus, the much-needed collective analysis of the crisis from the part of those involved in its management, and more generally the authorities responsible for civil protection is still missing. An investigation of what went wrong (apart from the earthquake itself), and why, should not evade criticism and self-criticism. Whilst it is indisputable that the occurrence of a major shock couldn't be predicted (nor excluded), other doubts remain. Was there any miscalculation or misplaced focus of attention; any undetected intra- or inter-organizational problem; any unchallenged personal or professional hubris; any hierarchical constraint or compliance which – if timely and properly addressed – might have prevented (some of) the crisis' dramatic shortcomings?

These questions can and should be addressed through a broader reflection about the role of expert policy advice in the management of emergencies. In the context that we have considered, the expertise to be provided by the CGR – in theory the designated interface between science and decision-making – has been reductively equated to the technical delivery of the most updated and reliable scientific research, with all its implied uncertainty (Boschi 2013). As we have seen, the consequences of this reduction have been catastrophic,

[11] See footnote n.1

in political, social, psychological and even scientific terms. Indeed, as any state-of-the-art scientific knowledge, be it more or less certain, becomes relevant for making complex and urgent decisions, the lack of a critic and reflexive attitude about the context, the aims and the values implied in that knowledge causes the emergence of contradictions, conflicts and most of all possible failures in terms of citizens' safety.

At the geographical and theoretical antipodes of this conception, Sir Peter Gluckman, the Chief Science Adviser to the Prime Minister of New Zealand, provides a different perspective about the challenges of expert policy advice. In his words: "science advice is not generally a matter of dealing with the easy issues that need technical solutions. Rather it is largely sought in dealing with sensitive matters of high public concern and inevitably associated with uncertainty and considerable scientific and political complexity" (Gluckman, 2014, p. 4). In his view, science advisers should become mediators of their own knowledge, not bound to fully subscribe to the framing of the problem suggested by those who convene them, and capable of acknowledging the situational uncertainty implied in the knowledge they deliver: its dynamic evolution over time, inherent limitations, normative assumptions and implications. Moreover, they should possibly provide indications on which other types of knowledge and expertise might be helpful for attaining a broader and more accurate perspective of what the problem at hand is and how it should be managed. Not surprisingly, such self-awareness and critical approach are not common among experts because, as Fjelland puts it: "It is not part of professional training to learn about the limits of the models and methods of a field" (Fjelland, 2002, p .165). He adds that the consequent "tunnel vision of experts is at least as great a problem as the ignorance of non-experts" (Fjelland, 2002, p. 167).

Definitely, the advice necessary in the days preceding the (unpredictable) L'Aquila earthquake was not about an easy issue requiring technical solutions. The policy problem that had to be addressed was to enhance the safety of the exposed population, taking into consideration the complexity of the situation, including the seismic swarm, the state of the built environment, the local culture and traditions, the psychological stress of the residents, and their understandable need for reassurance. Such complexity and its management cannot possibly be reduced to a problem of controlling rumors interfering with sound scientific information. Though a real problem, and a possible disturbance for "public order", the issue of defending the authority of science and the legitimacy of public policy from the interference of unmediated pseudo-science is neither the main nor the only challenge when dealing with public safety. Even more interestingly, from what we have seen, the issue itself

emerges and becomes central only when the complexity of the stakes implied are improperly reduced to a matter of science "speaking truth to power" (Wildavksy, 1979). If enough democratic room is allowed for the overall situational uncertainty to openly unfold and be collectively managed, then the need to maintain public order is inevitably overcome by the one to ensure public safety.

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References

Alexander, D.E. **(**2014). Communicating Earthquake Risk to the Public: The Trial of the "L'Aquila Seven". *Natural Hazards, 72(2),* 1159–1173. DOI 10.1007/s11069-014-1062-2

Amato, A., Cerase, A., & Galadini, F. (Eds.) (2015). *Terremoto, comunicazione, diritto: riflessioni sul processo alla Commissione Grandi Rischi*. Milano: Franco Angeli.

Benessia, A., & Funtowicz, S. (2016). Never late, never lost and never unprepared. In A. Benessia, S. Funtowicz, Â. Guimarães Pereira, J. Ravetz, A. Saltelli, R. Strand & J.P. van der Sluijs, *The Rightful Place of Science: Science of the Verge* (pp. 71-114). Tempe AZ : Consortium for Science Policy and Outcomes.

Blaikie, P., Cannon, T., Davis, I., & Wisner, B. (1994). *At Risk: Natural hazards, people's vulnerability, and disasters*. London: Routledge.

Boschi, E. (2013). L'Aquila's aftershocks shake scientists. *Science*, *341(6153),* 1452.

Calandra, L.M. (Ed.) (2012). *Territorio e democrazia. Un laboratorio di geografia sociale nel doposisma aquilano*. L'Aquila: L'Una.

Ciccozzi, A. (2014). Il terremoto dell'Aquila e il processo alla Commissione Grandi Rischi: note antropologiche. In: A.L. Palmisano (Ed.) *Antropologia applicata* (pp. 123-176). Lecce: Pensa.

Clark, S. (2012). From Galileo to the L'Aquila earthquake: Italian science on trial. *The Guardian*, October 24, 2012.

Corte di Appello dell'Aquila (2014). Sentenza n. 3317 pronunciata in data 10/11/2014 depositata in data 06/02/2015. See http://www.scribd.com/doc/255215279/Grandi-Rischi (accessed 01/05/32016).

Corte Suprema di Cassazione (2015). Cassazione Penale, sezione IV, 25 marzo 2016 (udienza 19 novembre 2015), n.12748. See http://www.giurisprudenzapenale.com/wp-content/uploads/2016/04/terremoto-sentenza.pdf (accessed 01/05/2016).

Cressey, D. 2010, Seismologists on trial triggers scientific debate. Nature NewsBlog. 01 July 2010. http://blogs.nature.com/news/2010/07/_seismologists_on_trial_trigge.html (accessed 01/05/2016).

De Marchi, B. (1995). Uncertainty in Environmental Emergencies: A Diagnostic Tool. *Journal of Contingencies and Crisis Management 3(2)*, 103-112.

De Marchi, B. (2014). Scientific advice and the case of the L'Aquila earthquake. *Diskussionforum, Technikfolgenabschätzung – Theorie und Praxis 23. Jg., Heft 3*, November 2014, 90-94. (TATuP, Technology Assessment – Theory and Practice). See http://www.tatup-journal.de/downloads/2014/tatup143_dema14a.pdf (accessed 01/05/2016).

De Marchi, B., Funtowicz, S., & Ravetz, J.R. (1993). *The Management of Uncertainty in the Communication of Major Hazards*. Report EUR 15268 EN. Office for Official Publications of the European Communities, Luxembourg.

De Marchi, B., Funtowicz, S., & Ravetz, J.R. (1996). Seveso a paradoxical classic disaster. In Mitchell, J.K, (Ed.) *The Long Road to Recovery: Community Responses to Industrial Disaster* (pp 86-120). Tokyo, New York, Paris: United Nations University Press.

DPC & CIMA – Dipartimento Protezione Civile & Fondazione CIMA (2013). *Protezione civile e responsabilità. Chi valuta, chi decide, chi giudica.* Pisa: Edizioni ETS.

EC – European Commission (2013). *Responsible Research and Innovation (RRI), Science and Technology Report*, Special Eurobarometer 401. See http://ec.europa.eu/public_opinion/archives/ebs/ebs_401_en.pdf (accessed 01/05/2015).

Fjelland, R. (2002). Facing the Problem of Uncertainty. *Journal of Agricultural and Environmental Ethics, 15*, 155-169.

Funtowicz, S., & Ravetz, J. (1993). Science for the post-normal age. *Futures, 25(7)*, 735-755.

Funtowicz, S., & Ravetz, J. (1994). Emergent Complex Systems. *Futures, 26(6)*, 568-582.

Gabrielli, F., & Di Bucci, D. (2015). Comment on "Communicating Earthquake Risk to the Public: The Trial of the 'L'Aquila Seven'" by David E. Alexander. *Natural Hazards, 75(1)*, 999-1003.

Gieryn, T. F. (2002). Three truth-spots. *Journal of the History of the Behavioral Sciences, 38(2)*, 113–132.

Global Risk Myiamoto (2009). *L'Aquila Italy M6.3 earthquake, Earthquake Field Investigation Report, 6 April*. See http://miyamotointernational.com/wp-content/uploads/Italy-EQ-Report.pdf (accessed 01/05/2016).

Gluckman, P. (2014). Evidence Based Policy: A Quixotic Challenge? Address Given at the Invitation of the Science Policy Research Unit, University of Sussex, Brighton, UK, January 21st, 2014; See http://www.pmcsa.org.nz/wp-content/uploads/Sussex_Jan-21_2014_Evidence-in-Policy_SPRU.pdf (accessed 01/05/2016).

Greco P. (2015). All'erta. RadioTreScienza 22/06/2015. http://www.radio3.rai.it/dl/portaleRadio/media/ContentItem-ae47077e-60d7-4df6-916a-1d7080a4654a.html (accessed 01/05/2016).

ISSO (international Seismic Safety Organization) (2012). Letter to President Giorgio Napolitano, N0ovember 8th 2012. See http://www.cngeologi.it/wp-content/uploads/2012/10/CoverletterandStatementISSO1.pdf (accessed 01/05/2016).

Jordan, T.H., Chen, Y-T., Gasparini, P., Madariaga, R., Main, I., Marzocchi, W., Papadopoulos, G., Sobolev, G., Yamaoka, K., & Jochen Zschau, J. (2011). Operational Earthquake Forecasting – State of Knowledge and Guidelines for Utilization. Report by the International Commission on Earthquake Forecasting for Civil Protection. *Annals of Geophysics, 54(4),* 314–391. DOI:10.4401/ag-5350.

Leshner ,A. I. (2010). Letter to the President of the Italian Republic. American Association for the Advancement of Science (AAAS), June 30th 2010. See http://www.aaas.org/sites/default/files/migrate/uploads/0630italy_letter.pdf (accessed 01/05/2016).

Merton R.K. (1973) [1942]. The Normative Structure of Science. In: R.K. Merton, *The Sociology of Science: Theoretical and Empirical Investigations* (pp 267-278). Chicago: University of Chicago Press.

Nosengo, N. (2010). Italy puts seismology in the dock. *Nature 465*, (24 June), 992.

Odifreddi, P. (2012). Scienza o onniscienza? la Repubblica, 23 ottobre 2012. http://odifreddi.blogautore.repubblica.it/2012/10/23/scienza-o-onniscienza (accessed 01/05/2016).

Oreskes, N. (2015). How earth science has become a social science. *Historical Social Research, 40(2),* 246-270.

Özerdem, A., & Rufini, G. (2013). L'Aquila's reconstruction challenges: Has Italy learned from its previous earthquake disasters? *Disasters 37(1),* 119–143.

Pantosti, D., et al. (2010). Open Letter to the President of the Italian Republic Giorgio Napolitano, Istituto Nazionale di Geofisica e Vulcanologia, July 3rd 2010. http://shakingearth.blogspot.it/2010/07/open-letter-to-president-of-republic-of.html (accessed 01/05/2016).

Pellegrini, G., & Saracino, B. (Eds.) (2015). *Annuario Scienza Tecnologia e Società 2015*. Rapporto Obseva. Bologna: il Mulino.

Portanova, M. (2012). Grandi rischi, la scienza non c'entra. I sismologi "condannati" dalla politica. *Il Fatto Quotidiano,* 23 Ottobre 2012.

Rodriguez, H., Quarantelli, E.L., & Dynes, R.R. (Eds.) (2007). *Handbook of Disaster Research*. New York: Springer.

Salvadorini, R. (2013). L'Aquila: processo alla scienza o alla negligenza? 12 Luglio 2013. http://www.scienzainrete.it/contenuto/articolo/ranieri-salvadorini/laquila-processo-alla-scienza-o-alla-negligenza/giugno-2013 (accessed 01/05/2016).

Schneider, B. (2011). Image politics: picturing uncertainty. The role of images in climatology and climate policy. In G. Gramelsberger & J. Feichter (Eds.), *Climate Change and Policy* (pp. 191-209). Berlin Heidelberg: Springer-Verlag.

Sturloni, G. (2012). A lesson from L'Aquila: The risks of science (mis)communication. Jcom. *11 (4)* 2012 E. See http://jcom.sissa.it/sites/default/files/documents/Jcom1104%282012%29E_en.pdf (accessed 01/05/2016).

Talignani, G. (2012). Terremoto L'Aquila, condanna a membri Grandi Rischi: il geologo Mario Tozzi 'Follia senza senso. Ora condannino anche le galline'. *Huffington Post*, 22 ottobre 2012. http://www.huffingtonpost.it/ 2012/10/22/terremoto-laquila-condanna-tozzi_n_2001850.html (accessed 01/05/2016).

Transparency International (2014). http://www.transparency.org/cpi2014/ (accessed 01/05/2016)

Tribunale di L'Aquila, Sezione penale (2012). Motivazione Sentenza n. 380 del 22/10/2012, Depositata il 19/01/2013. See http://www.magistraturademocratica.it/mdem/qg/doc/Tribunale_di_LAquila_sentenza_condanna_Grandi_Rischi_terremoto.pdf (accessed 01/05/2016).

Yeo, M. (2014) fault lines at the interface of science and policy; Interpretative responses to the trial of scientists in L'Aquila. *Earth-Science Review* 139, 406-419.

Wildavsky, A. (1979). *Speaking truth to power*. Boston: Little Brown and Co.

WJP (World Justice Project) (2015). http://worldjusticeproject.org/rule-of-law-index (accessed 01/05/2016).

Wright, J., & Rossi, P. (Eds.) (1981). *Social science and natural hazards*. Cambridge, MA: Abt Books.

Zanotti, R. (2012). Terremoto, Clini contro la sentenza: 'Ricorda la condanna di Galileo'. La Stampa, 24 ottobre 2012. http://www.lastampa.it/2012/10/24/italia/cronache/terremoto-clini-contro-la-sentenza-ricorda-la-condanna-di-galileo-q4oW81hza256PwMQNY5D1N/pagina.html (accessed 01/05/2016).

FIGURES

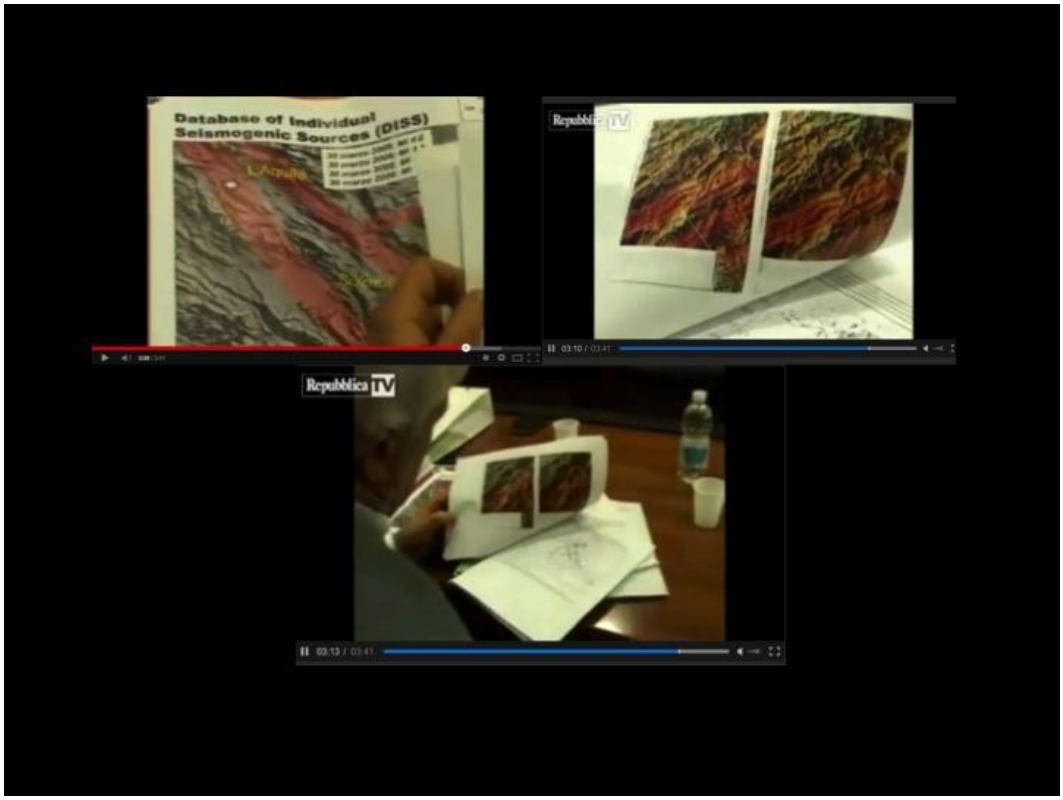

Figure 1. Still shots from the broadcasted interview to Bernardino De Bernardinis, extracted from https://www.youtube.com/watch?v=kLIMHe0NnW8

Ranking of Salience		**Level of severity**		
		H	M	L
|__|	Scientific	|_____|	|_____|	|_____|
|__|	Legal	|_____|	|_____|	|_____|
|__|	Moral	|_____|	|_____|	|_____|
|__|	Societal	|_____|	|_____|	|_____|
|__|	Institutional	|_____|	|_____|	|_____|
|__|	Proprietary	|_____|	|_____|	|_____|
	Situational	|_____|	|_____|	|_____|

Figure 2. Uncertainty Checklist. Part one: Assessment of uncertainties

Interpretations	**Policies**
Denial	Secrecy
Discounting	Confidentiality
Recognition	Publicity
Amplification	Sharing

Figure 3. Uncertainty Checklist. Part two: Communication strategies