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THE DEADLY AVALANCHE OF RIGOPIANO (ITALY): EVIDENCES OF A CONSTRUCTED LOCAL SCALE DISASTER

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Abstract

In a context of enhancing development, namely using natural resources and amenities to attract investments and create jobs, local interests can undervalue the natural risks. Our work demonstrates how local decisions and private, and political issues can interplay increasing risks and converge in creating a small-scale disaster. On January 18th 2017, an avalanche of size 5 (200,000 m^3) buried under 4 meters of snow the Rigopiano Hotel, in the National Park of Gran Sasso and Maiella, in Italy. In this four-star resort, 38 people were blocked inside when the avalanche hit. Two people, who fortuitously escaped the avalanche because they were outside the hotel, contacted the Operational Center for Emergency. Rescue activities started after some hours of misunderstanding about alarm truthfulness. After some days of frantic efforts, carried out 24h/24 by up to 330 people, 9 people were pulled out alive and in good conditions, whereas 29 victims were pulled from wreckage. Our research demonstrates how the coincidence of structural and contingent factors of natural and human origin converged into a disaster. Even though the resort was built on a very hazardous and unsafe location, and the high level of avalanche danger on that day, the loss of lives could have been avoided by timely evacuating the people. The final result is tightly related to weak risk awareness of local authorities, which only saw in the resort a job tank.

Keywords: avalanche, disaster, emergency management, risk awareness

Resumo

Numa perspetiva de desenvolvimento, o uso de recursos naturais e amenidades para atrair investimentos e criar empregos, pode subestimar os riscos naturais existentes. Neste trabalho demonstra-se como decisões locais e aspetos privados e políticos podem interagir aumentando os riscos e criando condições para a ocorrência de desastres à escala local. Em 18 de janeiro de 2017, uma avalancha de categoria 5 (200 000 m^3) soterrou sob 4 metros de neve o Hotel Rigopiano, no Parque Nacional de Gran Sasso e Maiella, em Itália. Neste hotel de quatro estrelas, 38 pessoas ficaram bloqueadas no interior quando a avalanche o atingiu. Duas pessoas, que escaparam da avalancha, porque se encontravam no exterior do hotel, contactaram o Centro Operacional de Emergência. As atividades de resgate começaram após algumas horas de mal-entendidos sobre a veracidade do alarme. Depois de alguns dias de esforços frenéticos, realizados 24h / 24h que envolveram até 330 indivíduos, 9 pessoas foram retiradas vivas e em boas condições, enquanto 29 corpos sem vida foram retirados dos escombros. Este trabalho mostra como a conjugação de vários fatores estruturais e conjunturais de origem natural e humana convergiram para criar um desastre. Embora o resort tenha sido construído num local de elevada suscetibilidade às avalanchas e o perigo fosse muito elevado nesse dia, a perda de vidas poderia ter sido evitada, se o hotel tivesse sido evacuado. Este desastre demonstra a reduzida perceção do risco por parte das autoridades locais, que valorizaram mais a capacidade de o hotel criar postos de trabalho e riqueza para a região.

Palavras-chave: avalanche, desastre, gestão de emergência,

1. Introduction

It is commonly accepted that a *"natural"* disaster is more a consequence of socio-economic than natural factors, occurring in the interface between an extreme physical phenomenon and a vulnerable population (O'Keefe et al., 1976). "*Nature can strike with punishing force, but human attitudes and actions determine the outcome*" (Cooper, 2013: p. 13). The case we present is a manual example of unnatural disaster, where deaths and damages mainly result from human acts of omission and commission. In this paper, firstly we describe the event, giving a detailed narration of facts and circumstances; secondly, we define it as a socially constructed event. The main source of information was newspapers; at our knowledge, no scientific paper has up to now examined the event which was noticed but, after a mediatic rush, is almost removed from collective memory. On its first anniversary, the Italian press almost ignored the episode.

2. The event and the site: chronicle of a disaster

2.1. The avalanche

Around 5pm, on 18th of January 2017, a major avalanche occurred in the tourist destination of Rigopiano, municipality of Farindola, in eastern part of the Gran Sasso d'Italia and Maiella National Park, (Abruzzo Region, in Southern Italy). The avalanche was type 5 according to the European Destructive Size Scale (Moner et al., 2013), described as "*very large avalanche, able to devastate the landscape, with a catastrophic destructive potential*" (Avalanche bulletin and snow situation, n.d.).

Italian authorities estimated that the avalanche had a front of detachment of 500 m and a length of 250 m. The snow slab was 2.50 m thick, with a total volume of 200,000-300,000 m^3. In the runout zone, at the end of a narrow steep defile that channeled snow, after about 1,220 m of run (Photo 1), the avalanche struck the luxury four-star resort Hotel Rigopiano, creating a 4m thick heap of snow and debris, which literally buried the hotel with 40 people (29 guests and 11 staff personnel). The weight of snow reached 120,000 tons as the snow and ice pressing down on the building became heavier. The dynamic force of snow partially brought down the roof and, shifted the building 10 m off its foundations, killing 29 people and injuring 9 others.

The avalanche of Rigopiano is estimated as the deadliest in Italy since the White Friday sequence of avalanches that struck the Italian Alps in December 1916, during I World War (270 fatalities only on 13th of December, 10,000 in subsequent weeks, mainly caused by avalanches deliberately triggered for strategic purposes; Brugnara et al., 2016; Gilli, 2016), and among the deadliest ones in Europe, after the Galtür avalanche in 1999, in Austria (30 fatalities) (Ansey, 2016; Corno, 2016).

2.2. Rigopiano Hotel: from a seasonal mountain refuge to a four stars resort

After II World War, a simple seasonal mountain refuge in masonry was built in the area by Italian Alpine Club (CAI) (Photo 2A). It was transformed in a summer hotel in 1967, successively it was sold to a private.

Photo 1 - The ruins of the Hotel Rigopiano at the end of the defile where avalanche run down, between slopes covered by beech forest (*Fagus sylvatica* L.) (Source: Photo by H.Bradshow, mySA http://www.mysanantonio.com/news/us-world/world/article/New-photos-reveal-aftermath-of-Italy-avalanche-10940249.php)

In 2007, in the occasion of important works of extension and renovation, this original hut was incorporated in the new structure of a luxurious four-stars hotel (43 rooms, spa, open and inner swimming pool, sauna), nestled in the beech forests near Farindola (Photo 2B).

The remote, idyllic nature of Hotel Rigopiano and its seclusion was part of hotel's charm, equally popular and appreciated by the national and international jet-set as a golden refuge at high altitude, where more than ski, guests appreciated the heated pool and the spa. The resort's heated pool meant guests could bathe outdoors, even during heavy snow flurry, enjoying a high-altitude pleasure bath. The spa and a locally sourced restaurant completed guests' experience. The hotel was 75 km from the sea (Pescara) and not far from the highway Pescara-Rome, thus attracting people and offering them the beauty of snowy winters, mild summers, and the colored charm of autumn canopies, in the 3-4 hours isochrones from Rome, Naples, Ancona and Bari.

Photo 2A - The seasonal C.A.I. (Club Alpino Italiano) mountain refuge at the end of the '50s (Source: www.quotidiano.net/cronaca/foto/rigopiano-foto-storiche-1.2845586); 2B - The luxurious four-stars hotel before the disaster; the old building was incorporated but maintained its identity (Source: www.direttanews24.com/il-processo-sullhotel-rigopiano-da-casolare-a-resort-di-lusso-politici-arrestati-per-corruzione-e-poi-assolti/)

3. Factors which interplayed for the disaster

3.1. Hotel Rigopiano risk location

The location of the hotel was certainly unique and attractive, but rather risky, at the end of a long and narrow defile, under rather steep slopes. In the aftermath of the event, it was put in evidence that Hotel Rigopiano was built on the debris of the alluvial fan of an avalanche from 1936, which had taken the same track through the narrow defile beneath the bare mountain flanks of Monte Tremoggia (Fig. 1A, B). It is clearly registered by the aerial photos of IGM (Military Geographic Institute) (Photo 3) that show that prior to

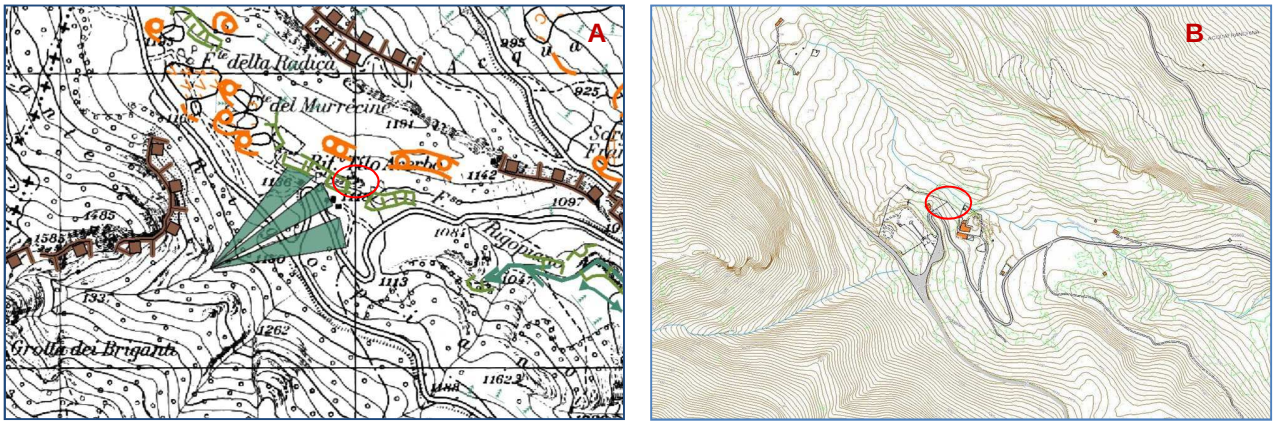

Figure. 1A - Geomorphologic map (scale 1:25,000) with the alluvial fan. The hotel location is highlighted in red (Source: http://geoportale.regione.abruzzo.it/Cartanet/catalogo/difesa-suolo-geologia/carta-geomorfologica-dei-bacini-idrografici-1989-91-conoidi); 1B - Detail of topographic relief.
(Source:www.repubblica.it/cronaca/2017/01/23/news/rigopiano_valanga_forum_h2o_abruzzo-156682455/#gallery-slider=156684484)

Photo 3 - Aerial photo (1945) by IGM (Istituto Geografico Militare) showing the bare strip which corresponds to the 1936 avalanche; it is indicated by the small white dot (Source: www.repubblica.it/cronaca/2017/01/23/news/rigoiano_valanga_forum_h2o_abruzzo-156682455/#gallery-slider=156684484)

1945 a similar event had denudated the defile, thus confirming an active geomorphologic activity in the area (www.repubblica.it/cronaca/2017/01/26/foto/rigopiano_forum_h2o-156964271/1/#1).

The historical map of avalanches, available in the geoportal of Abruzzo Region (http://geoportale.regione.abruzzo.it/Cartanet/viewer?sharedViewId=1442483504478), reports 793 avalanches which occurred in the Region, in the period 1957-2013 (http://geoportale.regione.abruzzo.it/Cartanet/catalogo/protezione-civile/carta-storica-delle-valanghe-eventi-puntuali-2010-2013) (Fig.2). None of them anyhow, directly or indirectly impacted the hotel.

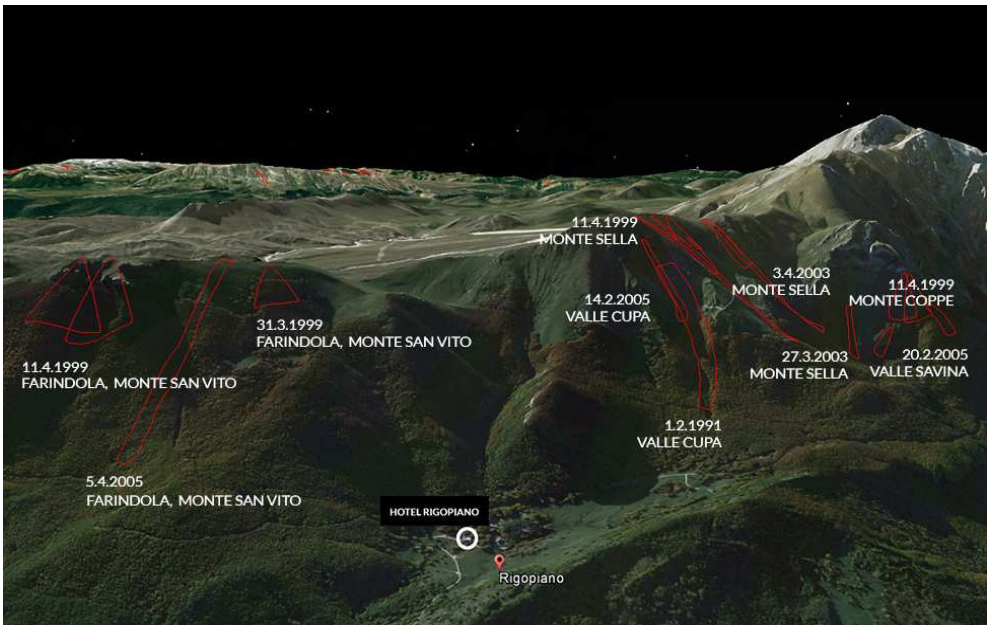

Figure 2 - Location of the avalanches (1957-2013) closest to the area of Rigopiano (Source:http://www.repubblica.it/cronaca/2017/01/23/news/abruzzo_la_mappa_di_tutte_le_valanghe_

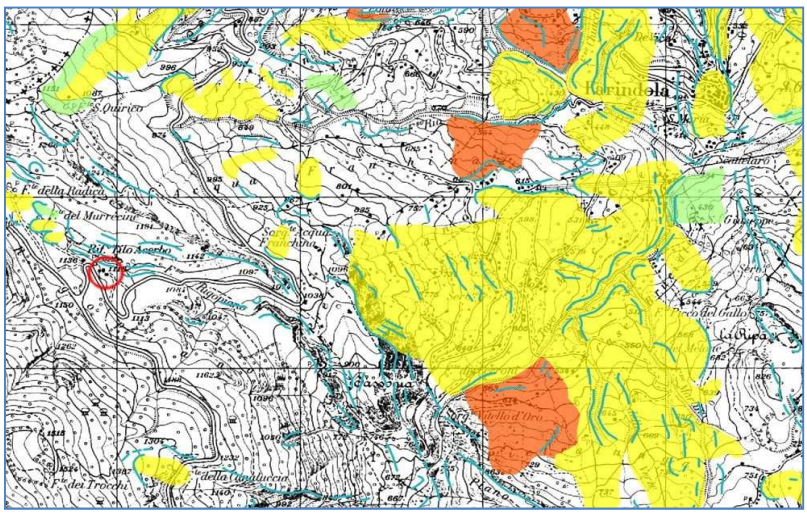

Figure 3 - Map of landslide danger; colors are related to three degrees of danger (Source: http://autoritabacini.regione.abruzzo.it/index.php/carta-delle-pericolosita-pai). The Hotel location is indicated by the red circle.

In 1999, a member of the Municipal Avalanche Commission of Farindola had already repeatedly warned about a possible avalanche risk in the area of Rigopiano, also reminding previous avalanche events. In the area landslide danger is also documented but no mention of it is reported for the hotel site (Fig. 3).

3.2. Avalanche risk and exceptional snowfall

The area is among the snowiest in Italy, due to the *Adriatic Sea Effect Snow* (ASES): when cold Bora/Bura Eastern and North-Eastern winds advect cold, dry air across the warm Adriatic Sea, it picks up water vapor and deposits it as snow on the leeward shore of the peninsula or on the eastern sides of Apennine Abruzzo mountains (*stau* effect) (Barile, 2010). In such area, record snowfalls are registered. On 5th of March 2015, Capracotta (about 100 km SE of Rigopiano) got 256 cm in 18 hours, setting the all-time world mark for most snow in 24 hours (Almasy, 2015; Caridi, 2015).

From the beginning of December 2016, the snow piles up was recorded at 3 m atop the summit of mountains close to the hotel Rigopiano, and in the early weeks of 2017, particularly heavy snowfall created conditions ripe for avalanches in Abruzzo.

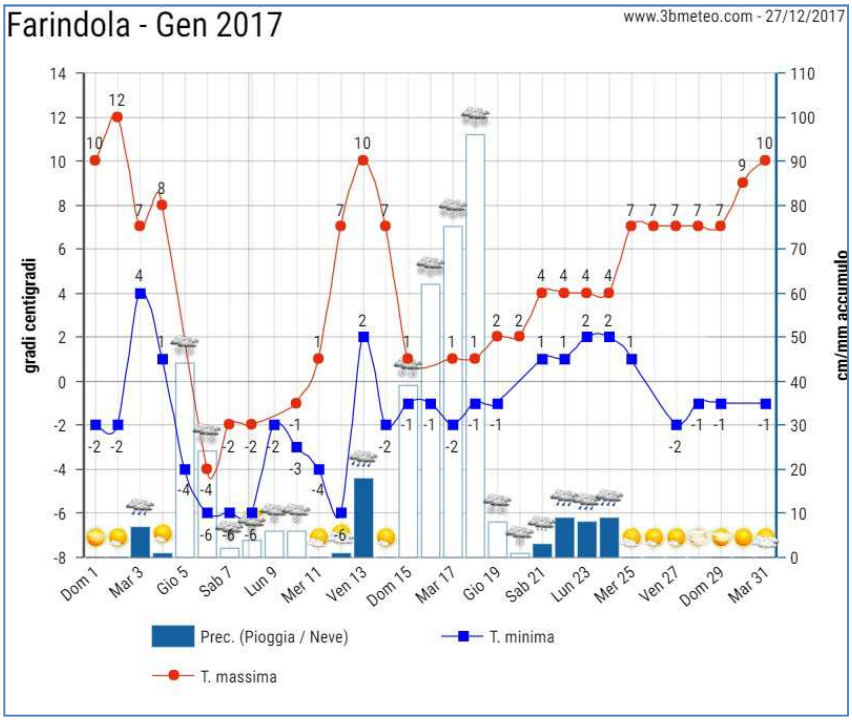

Figure 4 - Weather conditions in the municipality of Farindola in January 2017 (Source: www.3Bmeteo.com)

Avalanche conditions in Rigopiano area resulted from abundant snowfall from 5th to 11th of January 2017, followed by relatively milder and rainy days which favored snow melting and formation of a crust (layer of hard-compacted snow resulting from a melt-freeze process or wind). Weather conditions graphs of Farindola in the days of tragedy (Fig. 4) depict the alternation of snow falls and rainy or hotter intervals, followed by temperature well below zero during the night. Snow pack analysis made after the avalanche

(Farabollini, 2017) put in evidence a basal snowpack 70 cm high of old snow, on which about 130 cm of fresh fallen snow had accumulated. Between the two packs a thin layer of *graupel* (snow pellets, granular snow;) ((Nurzynska et al., 2013). The combination of density and low viscosity makes fresh layers of graupel unstable on slopes, and layers of 20 - 30 cm favor high dangerous slab avalanches acting as a lubricant. Thus, the upper recent and abundant snowfall did not find the necessary cohesion to adhere to the previous snowpack accumulation, and avalanche started when thickness of snowpack reached a critical value. For January 18th the avalanche danger for the area was 4 (High) in the scale up to 5 on the EAWS -European Avalanche Warning Services, with the same value of January 17th, descripted as "*poorly bonded snowpack on most steep slopes*" (Meteomont, 2017).

The danger value 4 should have advised the precautionary evacuation of the hotel. On the contrary, the previous day guests were even helped by local rangers of Pescara Provincial Authority to reach it, during a snowstorm. Guests were attracted by seasonal discount rates. Barely 24 hours earlier, the manager of the hotel had tweeted: "*A dream Tuesday (…) The snow is giving us spectacular scenery*!" (www.theguardian.com/world/2017/jan/21/family-dug-out-of-italian-avalanche-after-24-hours).

3.3. Earthquakes

From 24th of August 2016 Central Italy was rattled by a prolonged seismic sequence of high intensity. Until the end of 2017 about 42,000 tremors, of which 3,400 with Mw ≥ 2.5 were registered in the area, not so far from Rigopiano (INGV, 2017).

In the day of the event (18th of January) a ML[1] 5.3 (Mw 5.1) earthquake struck 25 km northwest of L'Aquila (about 14 km, direct distance, from Hotel Rigopiano to L'Aquila) at 10.25 am local time. A stronger, ML 5.4 (Mw 5.5) tremor hit the same epicentral area at 11:14 am local time. A third earthquake of ML 5.3 (Mw 5.4) struck at 11:25 am. At 2:33 pm local time, the fourth tremor of ML 5.1 (Mw 5.0) (INGV, 2017).

The sizeable tremors were immediately supposed to have triggered the avalanche that swept into the Hotel Rigopiano (Amos, 2017). Arguably, they were a useful element to minimize the underestimation of avalanche danger. Some weeks after the event, one of the Tribunal experts, textually affirmed that "*There does not appear to be any correlation between the seismic sequence and the avalanche events. Also, all the other avalanches that were detached that day are linked more to the characteristics of the snowfall than to the earthquake*" (De Leonardis, 2017). This statement is based on the rather long interval between the last earthquake (at 2:33 pm) and the avalanche (around 5 pm), not consistent with the relationship of causality and effect between the two phenomena, which should be almost contemporary. In fact, large earthquakes can trigger avalanches, but the quakes and avalanches usually happen simultaneously or within moments of one another (Podolskiy et al. 2010; Pérez-Guillén et al., 2010), not after hours. Although, it is not known the influence of the seismic swarm in the instability of the snow mass.

[1] ML or Local Magnitude is commonly referred to as Richter magnitude; Mw is moment magnitude based on the concept of seismic moment (USGS Earthquake Glossary https://earthquake.usgs.gov/learn/glossary/?term=magnitude).

3.4. Roads conditions and impossibility of evacuation

Due to large amount of accumulated snow, the road to reach the hotel was blocked by about 2 m of snow and fallen trees, not permitting guests and personnel to leave the hotel without the intervention of a powerful “turbine-style” snow blower.

A similar event of heavy snow fall had already happened in March 2015, but without relevant problems except some days of complete isolation. The hotel had been unreachable by land, with reduced energy autonomy, and guests unable to leave. On that occasion some medicines and basic necessities for infants were sent by helicopter. The event did not receive any attention by mass-media, but it certainly was a portent of a potential greater disaster to come.

After the series of earthquakes occurred in the morning of January 18th 2017, all the hotel guests, terrified by the tremors and by the uninterrupted and impressive snow accumulation, had already checked out and were gathered, with heavy cloths and baggage, on the ground floor of the hotel; they were awaiting for a turbine snow blower to arrive at 3 pm to open up the road and let them down the mountain. The snow plough serving the area was stuck in a garage for repairs after it broke down following intense work, and its repair costs were not yet afforded by Provincial Authority. Thus, the hotel had summoned another snow blower. Its arrival had been successively reported to 7pm of January 18th 2017, but unfortunately, the avalanche arrived earlier.

Irony of fate, after the disaster it was realized that a powerful snow blower was available and operating at no more than 22 km from Farindola. In about three hours it could have been dispatched to Rigopiano and avoid the disaster (Mensurati & Tonacci, 2017), but nobody intervened to modify its activity plans. According to the Italian press, behind the tragedy there would have been a sort of relief on request for "recommended" at the expense of those who really needed it. Politicians and favoritism dictated the priority of the road cleaning interventions (www.ilgiornaleditalia.org/news/cronaca/892910/Rogopiano--a-dettare-la-priorita.html). Telephone intercepts have highlighted the inability of the Prefecture to manage the snow emergency and the patronage optics in the distribution of aid and in the use of snow ploughs (www.repubblica.it/cronaca/2017/11/25/news/rigopiano_intercettazione_choc_tra_d_incecco_e_di_blasio-182114291/).

At 1:57 pm of January 18th an email signed by the hotel’s sole director (http://www.repubblica.it/cronaca/2017/01/22/foto/rigopiano_la_mail_inviata_dall_hotel_alle_autorita_-156632970/1/#1) was sent to local authorities expressing concern for the hotel guests due to their panicky nature following the earthquakes in the morning and uninterrupted snow fall. The email mentioned about a "*worrisome situation*" and that "*clients were terrified*" because they were stranded and couldn't leave "*due to blocked roads*", asking “*to intervene*”. It also added that many hotel guests were planning on spending the night in their cars, out in the open (Roberts, 2017). This email produced no tangible and relevant consequences.

3.5. Italian authorities' slow response

There was criticism over the amount of time it took emergency services to respond to the disaster. In the days after the tragedy accounts emerged of hotel guests messaging rescuers and friends for help, with at least one attempt at raising the alarm rebuffed for several hours.

At the time of avalanche, there were 38 people inside the hotel and 2 outside for a simple errand; immediately after the event, one of them, after having tried at 5:10 pm to launch alarm to emergency phone number, called his boss launching the alarm of disaster and desperately asking for help.

His boss immediately called the regional emergency coordination center, but officials assured him that the hotel director two or three hours before had assured them by telephone (unfortunately, not on site from the hotel, but from Pescara, without seeing the situation) that everything was fine, so vilifying the early alarm. Survivor's boss insisted that his employee frantically tried to call other emergency numbers but no one took him seriously. He kept insisting and called other emergency numbers until someone finally took him seriously and a rescue column was mobilized at 8 pm of January 18th 2017.

4. Emergency response

4.1. Rescue operations

Given the accumulation of snow on the road, the rescue column was obliged to stop at about 9 km from the hotel, and it took some eight hours for a scouting patrol of 12 rescuers to reach the site, by ski, because the road was impassable. The patrol rescuers, belonging to Italian Fiscal Guard and some volunteers, struggled to reach the hotel walking through a snowstorm all night. They were forced to ski and shovel their way in more than 2 m of snow for about 9 km to reach the site of tragedy and arrived at 4:30 am of January 19th. They found the two survivors in state of hypothermia, but no movement or cries for help from beneath the wreckage was heard (www.repubblica.it/cronaca/2017/01/20/news/_io_in_quell_inferno_per_primo_dopouna_notte_nella_tempesta_che_rabbia_non_poter_fare_nulla_-156427567/).

Photo 4 - Rescue in action on the wreckage of the hotel (Source: Corpo Nazionale Vigili del Fuoco).

The first rescue workers reached the area by helicopter and ski in the early hours of 19th January, but it was midday before a snow blower and excavation equipment managed to pass the snow-clogged road leading to the hotel. A temporary command post was set up in the nearby snow-bound village of Penne, 10km far (The Telegraph News, 2017). Amid treacherous weather conditions and high risk of a new avalanche, frantic rescue activities were carried out in the search of survivors (Photo 4).

From 19th to 28th of January, rescuers arrived to the number of 330 people, working 24h/24h. They belonged to National Fire Corps (Corpo Nazionale Vigili del Fuoco), Carabinieri, CNSAS (Alpine and Speleological National Rescue Corps), Alpine troops (Army), Fiscal Guard, Emergency Services. For the organization of such impressive number of people and means the Incident Command System procedure was adopted. Urban Search and Rescue (USAR) specialized personnel was used by National Fire Corps (Verna 2017). Rescuers tried to reach survivors through a specifically planned research adopting TAS (Topografia Applicata al Soccorso, Rescue Applied Topography), using maps of the hotel, adopting sniffing dogs, earphones, new technologies such as RECCO®SAR (rapid searches technology for missing people and find buried avalanche victims), HUAWEI mobile communications infrastructure, military devices to detect mobiles, steam probes and “snakes” (flexible TV probes). More than 100,000 tons of ice and debris were moved by rescue workers. Rescue operations had an unheard degree of complexity and difficulty beyond any other possible comparison, including risk of new avalanches.

Nine survivors trapped in the wreckage of the hotel were found alive in good conditions and rescued until January 20th. They had heavy clothes, ski caps to cover themselves, and survived thanks to an air pocket in the kitchen, which permitted to remain away from the snow and cold, inside the structure, staying together and having water to avoid dehydration. That's why their hypothermia wasn't severe. All the other people died and the last two victims were extracted on 25th of January; on 26th the end of rescue operation was declared. The balance of disasters was 29 fatalities, 11 survivors, of which 9 extracted from the rubble and 2 found out of the structure. Also 3 puppies were extracted alive.

Post-mortem examinations on victims found that most died from physical trauma when the structure collapsed, though some showed both signs of hypothermia and body compression with acute respiratory and circulatory failure. Ten out of the eleven people rescued received minor injuries related to hypothermia, the eleventh person also received an irreversible compression injury to his upper arm. Thus, most of the victims died on impact, making less relevant questions of whether rescuers could have reached the site faster. For hypothermia, only intervention within 2 hours from the event could have saved people entrapped inside the hotel (Petris, 2017).

4.2. Activity of investigation

Activity of investigation by Pescara Court about causes of disaster started within a few days from the event, and in November 2017 Italian prosecutors have already put 23 people under formal investigation over the avalanche, about possible violations in authorizing the hotel’s construction in a risky area, whether the hotel should have been evacuated, and if authorities were slow to respond to rescue pleas (www.therepublic.com/2017/11/23/eu-italy-avalanche-probe/).

5. A socially constructed local scale disaster: discussion of evidences

The disaster of the Hotel Rigopiano puts in evidence a "chain of causation" (Blaikie at al., 2003) where structural factors and conditions (i.e. historically present and not time related) and contingent ones (i.e. of recent appearance in the disaster scenario or in the time where the avalanche occurred) interplayed. The most obvious and evident pattern of causality can be identified in an ordinary sequence of events, starting with the decision to build the hotel in a hazardous situation, followed by a sequence of factors and conditions listed in Table 1.

An explanation to the decision to localize the hotel in a risky and unsafe condition can be offered by the concept of *amenity risks* (Berger et al. 2008; Kousky et al. 2006; Willis et al., 2011). Many times, the risks are known, but people located in areas susceptible to natural hazards to secure other benefits related with the valuable amenity of the location. The choice of an unsafe and risky location can be also explained by the oblivion of past facts: several years after an event, people may underestimate the likelihood of a similar occurrence in the future, so discounting risks, and overestimate their safety (Berger et al. 2008). Cognitive perception calls "*optimism bias"* the tendency to overestimate the likelihood of positive events, and underestimate the likelihood of negative ones (Sharot, 2011). More simply, the imprudent belief that "*It won't happen to me*" explains many risky behaviors.

The historical avalanche and landslides occurrence in Abruzzo records should advice the assessment and management of this risk, as disciplined by the Regional Law 47/92 of Region Abruzzo, which makes

Table 1 - Structural and contingent causes involved in the construction of the Rigopiano's disaster

	Factors and conditions	Actions/inactions	Effects
Structural	Records of historical avalanche and landslides occurrence in the area	Undervaluation of risk	Hotel hazardous location
	Failure to apply the Regional Law 47/92 about avalanche risk, lack of avalanche maps and regional plan of defense	No prevention and mitigation measures	Susceptibility to avalanche risk
	Missing activity of the Municipal Avalanche Committee in Farindola	No mitigation measures	Missing initiatives of evacuation
	Change of hotel activity from seasonal to all-year open and made attractive as beauty farm	Undervaluation of risk	Increased proneness to avalanche risk
	Attraction exerted by infrastructures	Emphasis on scenario with minimization of risk	Hotel sold-out in critical periods
	Frequent heavy snowfall in the area	Accumulation of snow	Avalanche risk
Contingent	Recklessness of Provincial Authority	Delay in repairing snow plough serving the area of disaster	Impossibility to open up roads blocked by snow
	No availability of snow plough in the hotel	Undervaluation of risk	Access blocked by snowfall
	Exceptional snowfall in the days before the avalanche	Increased attractiveness	Resort publicized in social media
	Accumulation of snow, scarcely coherent and instable; high avalanche risk (degree 4 out of 5)	No order of evacuation of the hotel had been done by Prefect or Mayor	Increased vulnerability of people blocked in the hotel
	Snow ploughs insufficient to open up roads	Roads blocked	Impossibility to evacuate
	Impossibility to circulate on roads blocked by snow accumulation	First rescue patrol reached the tragedy site by sky	Late arrival on site of disaster
	Intervention requested by hotel's sole director because of snow and panic generated by earthquakes	No response	Increased vulnerability of people blocked in the hotel
	General power system outage in all the province	Difficulty of communication	Difficulty to receive and transmit messages
	Multiple simultaneous emergencies (earthquake, snowfall, power outage, displaced people)	Collapse of public institutions	Failure in copying with emergencies
	Prefect's office not taking seriously calls for help; misunderstanding in checking the veracity of the situation	Delay in the organization	Late departure of rescue

compulsory, for first category avalanche risk areas (permanent and not evitable risk), ineligibility for building development or, for already existing structures, restriction of use (Art. 8) (Regione Abruzzo, 1992).

The first regional "map of avalanche danger localization" (Art. 2 of Regional Law 47/92) has been formally adopted for the territory of "Massiccio del Gran Sasso d'Italia settore occidentale" only on February 28th 2017, more than one month after the disaster (Regione Abruzzo, 2017). It is still missing the successive "map of the local avalanche risk" (Art. 5 of Regional Law 47/92). As a consequence, the regional avalanche plan has not yet been executed because of the lack of the maps and will be executed within the year 2018. Result of non-timely redaction of maps was the failure to adopt restrictive measures (Art. 11) which can consist in the immediate suspension of any use of works and areas, conditioning their restoration to preventive realization of suitable defense interventions.

The Art. 17 of the Regional Law 47/92 governs the establishment of a special Municipal Avalanche Prevention Commission in any municipality which includes territories where avalanche risk is present. The opinion of the said Commission, except in cases of urgency, is mandatory for the issuance (by the Mayor) of orders relating to the unavailability and evacuation of a building with imminent avalanche danger (Art. 15) and to limitations of traffic in the areas subject to avalanches risk (Art. 16). In 1999, the Municipal Avalanche Commission of Farindola warned about a possible avalanche risk in the area of Rigopiano. Surprisingly (or not??) the Commission was canceled in 2005, just before the works of extension and renovation, which transformed the simple seasonal hotel (open April-October) in the luxury four-star all-season Hotel Rigopiano, pride for the small municipality of Farindola (1,486 inhabitants, in 2017; http://www.tuttitalia.it/abruzzo/44-farindola) and its job tank. This detail adds to the debate if hotel's owners obtained the building license under the blackmail of job opportunities, as some newspapers argued (Amurri, 2017).

The incapacity of local authorities to cope with multiple emergencies is evident in the lack of preparedness and readiness to act in the situation of exceptional snowfall and persistent seismic activity. The lack of foresight by authorities in dealing with potential situations of high snowfall of January 2017 is expressed by the lack of an adequate number of strategically located equipment (snow ploughs, turbine type snow ploughs) which made difficult to keep roads clean, and by the reduced number of snow ploughs active in the area of Farindola. It was also aggravated by the hidden conflicts between authorities concerning priorities in the dispatch and use of snow ploughs and worst, by the patronage optics in the distribution and use of them, and in the difficulty of communications in case of disasters.

In the specific case of Rigopiano, the difficulty of communication was evident in the personal decision to reject a call asking for help, without validating the request, and in the failure by the authorities in considering the request of evacuation sent by the hotel which was practically ignored. Communication is a pivotal element in the management of emergencies, which demands the validation of the veracity of the information not as a personal initiative, but using the official contact or an emergency contact. This procedure is not possible for individual requests, but only in cases where the affected assets are non-individual like as hotels, hospitals, and schools. It is also necessary a follow up, because the natural and human conditions have high variability and can suddenly change.

For a full understanding how several but "small" conditions and decisions conjugate to create the disaster of Rigopiano, we present a Causal Loop Diagram (CLD) (Fig. 5), where links between all factors and

situations are clearly exposed. The intervention in one of the factors and conditions could affect the final outcome. The majority of components are related to human activities or behaviors, which overwhelm the only natural component (an exceptional snowfall in the snowiest area of the country), showing that "*Disaster is also a function of human volition. Disaster reflects choices we make. Our choices play a role not only in engendering disaster risk where none would otherwise exist, but also in exacerbating the impact of the otherwise natural forces we associate with disaster*" Cooper (2013, p. 11).

6. Conclusion

Exceptional snow falls and avalanches are a recurrent and expectable presence in the area. Their occurrence is documented by maps and inventories, and people memory and local documents help in defining such potential risk. For this, the avalanche on 18th of January 2017, cannot be considered an extraordinary or unexpected event. This means that could have been timely forecast, also given the warning by EAWS, and should have imposed the immediate evacuation of the hotel.

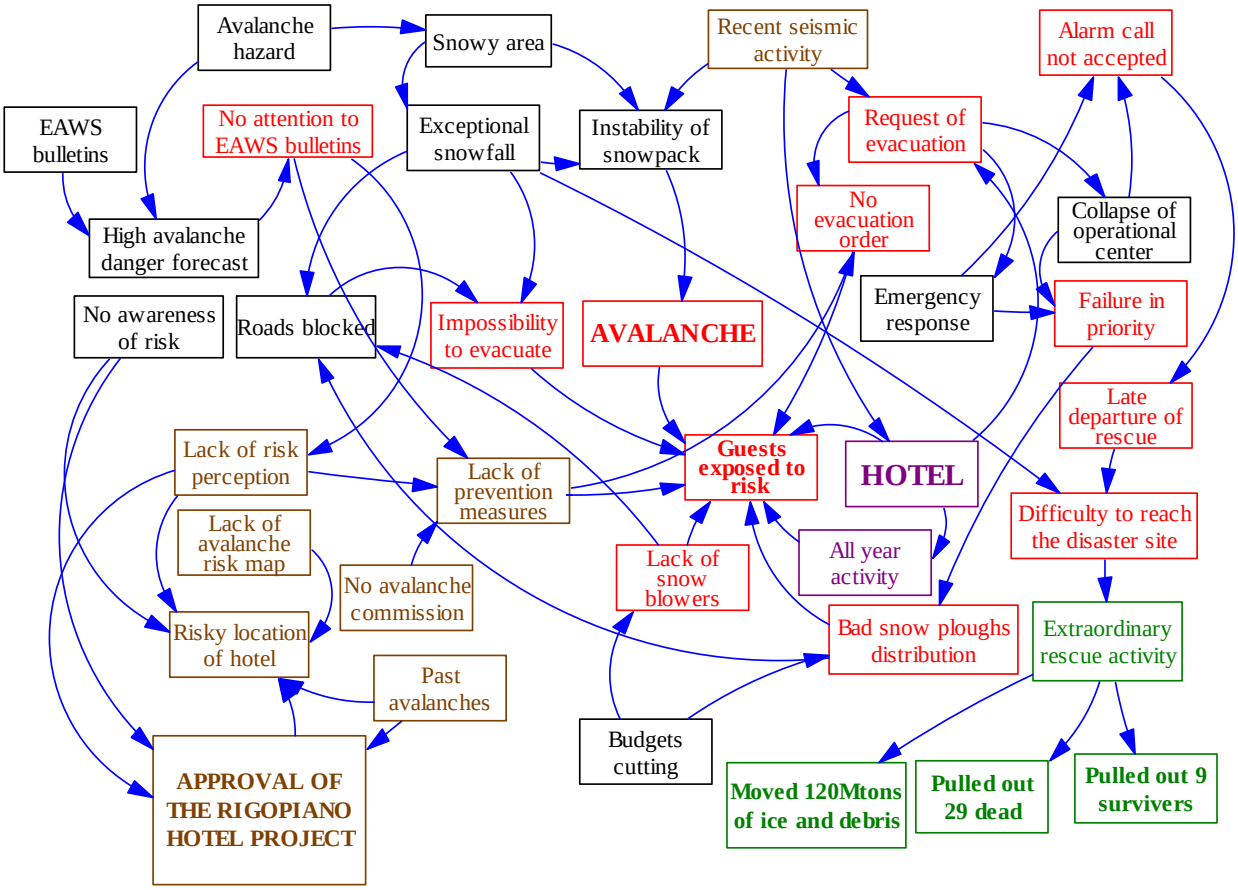

Figure 5 - The Causal Loop Diagram (CLD) depicting processes, conditions and factors and their interplay in determining the disaster. Red colour marks the more critical contingent ones that induced disaster occurrence.

The disaster of Hotel Rigopiano thus results from the interplay among behaviors, omissions, decisions and commitments. Not by chance Prosecutors in nearby Court of Pescara have opened a probe into the hotel disaster about three main points: i) if there were violations in authorizing the Hotel's construction in an avalanche-prone area; ii) if the hotel should have been evacuated; iii) and whether authorities were slow to respond to rescue pleas by hotel's direction. The 23 suspects are being investigated for negligence, imprudence, and recklessness. Possible charges for some of them could include manslaughter. This indirectly confirms that in the collective perception the disaster is considered an unnatural one, a social construct. Avalanche, like any other natural hazards, underline in a fiercely tragic way all that has not been done before. That the neglect of men is uncovered by natural disasters is a detail even if many use it to justify their faults (Cavalli, 2017).

In the case of Rigopiano Hotel, nature initiated the avalanche but the disaster resulted from a sum of negligent and unaware initiatives and omissions, which started with the permission to build the resort, the incapacity to manage the risk, and promptly respond during the emergence.

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