

VUELCO: Volcanic Unrest in Europe and Latin America
2nd WORKSHOP
“Scientific advice, decision-making, risk communication”
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SESSION 3- “Risk communication: building a risk aware and prepared community”

Talk 4: *Local activities to raise awareness and preparedness in Neapolitan area.*
Edoardo Cosenza, Councillor for Civil Protection of Campania Region, Italy.

The Italian Region of Campania is particularly complex and is historically known as "*Campania Felix*" because it has an outstanding natural beauty, it is rich in thermal mineral water and fertile soil, all positive aspects linked to its volcanic origin.

(SLIDE 2) This map highlights the volcanic areas of Campania, but in reality it is not the map of volcanic zones, but the map of mineral waters in Campania.

Campania has six million inhabitants, more or less like Belgium, but 3 million of them, namely the city of Naples and its province, are concentrated in a small area equal to 9% of the territory, mainly around the Gulf of Naples. Therefore, three million people live in this area and the other 3 million in the rest of the region. This is for ancient climatic and historical reasons. Naples is in fact one of the most ancient cities in Italy and Europe. So, from a civil protection point of view, there is a region to defend, with a huge concentration of people in a very small area and then many other inhabitants spread over a very large territory.

There are 4 volcanic zones: the northernmost is Rocca Monfina, but it is the only non-active volcano. Here are some of the largest manufacturers of Italian mineral waters, very important brands. In this area we can only enjoy the advantages of its volcanic origin, without any disadvantage. The other 3 volcanoes in Campania are Vesuvius, Campi Flegrei and Ischia. Naples is exactly here where it is indicated.

(SLIDE 3 and 4) These are other historical maps that clearly show the volcanic areas, but also the completely different nature of volcanoes. Vesuvius has an eruptive cone with a clearly identifiable central



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crater, whereas the Campi Flegrei have a huge amount of past eruptive vents (as can be seen also very large) and hence volcanoes with potentially very different behavior. (SLIDE 5).

(SLIDE 6) Then there is Ischia, which is a major island, historically inhabited by the Romans, with one of the finest natural harbors in the world. From the picture you can see what a pretty circular mouth the harbor has: it is obviously the caldera of a volcano. The port of Ischia is extraordinary because it is the mouth of a caldera which has only a single breach that allows entry. The last eruption (not the one that gave birth to the port) dates back to 1302, therefore, technically, it is an active volcano.

(SLIDE 7) At Campi Flegrei, the last eruption occurred in historic times: it actually happened in 1538 and generated the Monte Nuovo which you can see in the photo.

(SLIDE 8) This is Mount Vesuvius, whose last eruption occurred during the Second World War, on March 23rd 1944, for which many historical images are available. (SLIDE 9) This is a U.S. soldier next to a B25 airplane half-buried under the ashes of 1944.

(SLIDE 10) As a matter of fact, in addition to this, there is also seismicity in Campania. The region is affected by the Apennine seismic faults, but as you can see there is also a seismogenetic area which crosses into the volcanic area and not by coincidence.

The last Italian earthquake with a magnitude of about 7 (Mw 6.9) occurred in Campania in 1980, resulting in more than 4,000 victims. The recent earthquakes, L'Aquila and Emilia-Romagna, had a magnitude around 6. We know that each degree of magnitude represents a 30-fold increase in energy, therefore the more recent earthquakes have had an energy equal to about one-thirtieth of the earthquake that caused 4,000 victims in Campania. Thus, it was the largest earthquake of the last few decades. The picture shows the seismic zonation for civil engineering purposes, as you can see the colors go in the direction of Naples, therefore this means that the seismic actions on structures to be considered for the Neapolitan area are higher, as this is a consequence of the shape of seismogenetic zone shown. (SLIDE 11)

(SLIDE 12) Back to Mount Vesuvius, the image shows the traces of the deposits of sub-Plinian eruptions. The previous "red zone" was drawn according to the map of the deposits of sub-Plinian eruptions, and it is bounded by the red line in the figure. This red zone did not follow a scientific line of reference, but the administrative boundaries of municipalities. Therefore, the red area included the territory of each municipality that had even a small tract of land involved in previous sub-Plinian eruptions. Thus, you can observe that there was a large extension of the red zone, even in the absence of traces of



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pyroclastic sub-Plinian flow, because the rule was to extend the red zone to the entire municipality. Then the red area of Vesuvius included the entire area of Pompeii, even if there is only a small trace of sub-Plinian eruption. Of course Pompeii is famous for the Plinian eruption, but this plan takes into account only the sub-Plinian eruptions.

(SLIDE 13) The new red zone of Vesuvius is instead based on a slightly different concept of eruptive frequency: through the study of all the Plinian and sub-Plinian eruptions in the last 23,000 years, Gurioli et al (2010) have obtained the various lines that you can see in the picture. The black one is the line which encompasses traces of at least two pyroclastic flows from the seven eruptions studied. On the contrary, if we take into account the trace of only one eruption in the last 23,000 years, we should include a very extensive area of not only Naples, but of the entire Campania region. So it was decided to refer to this scientific black line, which has been validated by the Major Risks Committee and the Department of Civil Protection. Therefore, we refer to a different concept from the previous one.

(SLIDE 14) This is another slide that shows how densely the area is populated. Considering a single eruption we would have definitely gone outside the Neapolitan area, while considering two eruptions we get this black line, which is clearly wider than the previous red zone, yet it is quite similar.

(SLIDE 15) If, starting on the basis of this new scientific line (remember that there was no clear scientific line before), we considered, as before, the entire territory of each municipality, including those with even just a small part falling within the scientific line, we would have obtained an exaggerated extension. For example, it would have been absurd to include the entire municipality of Nola, just because its shape is so elongated, and exclude many other neighboring small towns that showed no trace. We would then have some absurd situations, such as including an extended part of Naples.

Through an agreement between the National Civil Protection and the Campania Region, local communities were involved in the definition of the emergency plan (aspect of sharing and communication certainly important). It was then established that if the Municipal Councils (local political bodies) had approved a clear delineation, outside the reference scientific line, which did not include the entirety of each municipality's administrative extents, the National Civil Protection and us, representing the Region, would have accepted such boundaries. This was a perfect way to allow the communities to democratically participate in the choice, instead of forcing it upon them.



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(SLIDE 16) This way we arrived to this line represented in purple which, as you can see, is very close to the black scientific line, but always outside. This purple line represents the new "red zone" of Mount Vesuvius related to the areas potentially exposed to the risk of pyroclastic flows.

Actually, a more conceptually complex mechanism was implemented; there is also a second red zone, the so-called "red zone 2". A statistical study of the prevailing winds at a certain altitude, together with the statistical knowledge of the vulnerability of the roofs of buildings, has allowed the National Civil Protection to define which municipalities have a high probability of danger of roof collapse due to excessive ash accumulation in case of a sub-Plinian eruption. The orange and red colours in the map indicate a high probability of roof collapse due to accumulation of ash in the case of a sub-Plinian eruption. From the figure we can clearly see how the colors are prevalent towards the east, not toward Naples, in agreement with prevailing winds.

Therefore a new type of red zone was defined, the "red zone 2", which includes entire municipalities and which should be evacuated not because the model leads to a high probability of pyroclastic flow, but because there is a high probability of collapse of the roofs of the buildings.

So, there is a "red zone 1" which is the purple one at risk of pyroclastic flows, and a "red zone 2" which is the area to be evacuated due to the ashes risk. Inside the red zone 1 any type of new construction is forbidden, except for service buildings; thus it is possible to build hospitals, schools, factories, buildings for justice, and all activities that do not involve an increase in urban land use, but offer civil services, whilst any type of new residential building was banned many years ago.

Policies to reduce residential buildings have also been introduced, but they are very difficult to enforce. Actually, for many years we have been witnessing a slow decrease in population, following the expansion recorded in the '50s and '60s. It is really hard to find ways to compel people to move, considering many factors such as the climate, the beauty of the area, fertility; it is really very difficult to carry out a displacement policy.

With this new model, built jointly by the National Civil Protection, the Major Risks Commission and the Campania Region, the inhabitants to evacuate increased from 550,000 to 700,000. However, as I already mentioned, the municipalities were also involved in this decision. They cannot oppose such a decision, because they have participated in the decision making. The final step will take place in a few weeks,



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because it will require (both the National Civil Protection and the Campania Region want it), an act of the National Government, an order of the President of the Council of Ministers.

(SLIDE 17 and 18) These are details of the zonation in the east and in the west area of Vesuvius.

(SLIDE 19) A national act is necessary, because the second step will be the review of the pairing with the other Regions. Each municipality is paired with an Italian Region of reference for evacuation. This pairing must be defined, as demanded by the National Civil Protection and the Campania Region, through an act of Government, stating it in a clear and definitive way.

So the 700,000 inhabitants should be distributed in the various Italian Regions. Of course this is a model that could be extended to other potential emergencies, it is not only valid from Campania towards other Regions. Since 700,000 inhabitants are few if compared to the 56 million inhabitants of Italy, this pairing model among the Regions could be useful to solve other potential national emergencies, not limited to Campania, because it is a way to dilute the population burden. It seems to be a possible model for solving certain types of emergencies in the future which involve large numbers of people.

(SLIDE 20) As a region, it is clear we need to review the entire plan of transport for the evacuation, because we went from 550,000 to 700,000 people.

It would also be advisable to reduce the time for evacuation from 72 to 48 hours, but I do not know if it will be possible. The actions that certainly need to be carried out, in addition to what I just said, are primarily infrastructural.

The old evacuation plan was based on the motorways, very busy roads, marked in green in the figure (marked 1 in the slide). In fact we are still relying on this lower branch, the Naples-Salerno motorway, which we are expanding quite rapidly from two to three lanes in each direction. This is very difficult because the highway crosses urban centers that are densely populated. This will allow an increase of 50% in mobility.

Then we count on this road branch, marked 2 and 3 (in blue and green), closer to Vesuvius (the state road 268 of Vesuvius). Here we have just funded, thanks to European funds, the construction of this small segment marked in red (marked 4 in the slide), which is crucial because it connects the main road to the motorway, closing the ring. Works started a few weeks ago. Simultaneously, national funds financed the doubling in width of some road segments. So in the next few years we will be able to fully count also on this ring road, much closer to Vesuvius, with an increase of 50% here (because we switch from two to



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three lanes) and 100% here (from one to two lanes). We also want to have another very fast passage here, on the outer ring. Again this will be carried out in order to increase evacuation capacity.

(SLIDE 21) Another problem we are confronting with determination is related to the Sarno river. This plain is the Agro Nocerino-Sarnese. The stream is partly natural and partly a man-made. In this basin there are 800 thousand inhabitants. This river slopes with very low grade, so that, even in ordinary conditions, drainage is almost insufficient. We funded, again with European funds, the improvement of this river's hydraulic profile and works should start soon. In particular, the emergency plan will provide for the rapid removal of ash and lapilli from the river in case of eruption. Otherwise the volcanic eruption would also be exacerbated by a serious hydrogeological problem, due to the clogging of the Sarno river. It is an important novelty of the new plan we are considering, because it certainly is a very important aspect.

Once again with European funds, also through an act that will pass in the next few days, we will fund the further extension of the national monitoring network of Vesuvius, Campi Flegrei and Ischia. Therefore, through the European funds assigned to the Campania Region, we will further improve and modernize the monitoring network for deformations, micro-quakes, gas quality, which is already very good.

(SLIDE 22) I must add, however, a number of other things. The picture shows the prevailing wind, wind-related statistics. So, as you can see, the wind blows towards the east. (SLIDE 23) This other map shows the old "yellow zone". So, actually, there is a yellow zone, which is the area that gets evacuated only when, in case of eruption, the wind is going in that direction. Therefore the "red zone 2" is the where the wind is likely to deposit large ash layers, but we must also look at what the wind will actually be like on that day, not just the statistics.

But there is an even more interesting slide (SLIDE 24) that I took from the studies of the Major Risks Commission. This is not the prevailing wind, these are the traces of ash and lapilli left by all known eruptions. The most extensive one represents the "basic pumice deposits" eruption, which is an important eruption. As you can see, the alignments are all more or less towards the east. However, you can see this line towards the south that is single, but it is the last one, the famous Plinian eruption of Pompeii. The wind was going in this direction.

(SLIDE 25) So a consequence of this is the tendency of the region of Campania towards hydrogeological instability. As you can see from the image, the areas most exposed to hydrogeological risk are those oriented downwind (leeward) relative to the historical eruptions of Vesuvius.



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(SLIDE 26) And this is even more direct: these red dots are events that have caused casualties in Campania with dozens of deaths due to landslides. Almost all of them are concentrated towards the south, despite that area not being very densely populated. (SLIDE 27, 28, 29, 30) Looking at the slide: October 24, 1910, 229 deaths provoked by mud slides; March 25 and 28, 1924, 201 victims, October 25, 1954, 310 deaths caused by a mud slide. The last event is the best known: May 5, 1998, 200 victims, the landslide of Sarno. We tend to associate the most dangerous area with the town of Sarno, but this is not the case. The most dangerous area in Campania, I think in Europe, or perhaps in the world, in terms of risk, *i.e.* hazard and vulnerability, is the Amalfi Coast.

In the area of Sarno landslides occur because the winds were directed there during the large majority of other eruptions, but the most dangerous area is the Amalfi coast, because the wind during the Plinian eruption of 79 AD was blowing in that direction. (SLIDE 31) This is the Sarno landslide, that caused over 100 victims; this area has no buildings because they were all dragged down by the mudflow, composed of water mixed with pyroclastic material. Here a hospital was also hit, the town of Quindici was close to Sarno, and this was the latest hydrogeological instability.

As mentioned, mudslides are phenomena closely related to the volcanic eruption of Mount Vesuvius. In fact, 2,000 years in geological terms are equal to zero. So these layers of pyroclastic materials, several meters thick, left 2,000 years ago or so, are highly unstable and can give rise to deadly mudslides.

(SLIDE 32) Recently we had a case in Atrani, a village on the Amalfi Coast, where there was a victim. The beach consisted of ash and pumice from the Plinian eruption of 79 A.D. So now whoever swims on the beach of Atrani, actually walks on the ashes and pumice of that Plinian eruption.

(SLIDE 33) The most sensational data, in my opinion, is the study of the CNR, which shows that over 50% of deaths due to landslide in Italy occurred in October. This is the most dangerous month because the weather is still hot.

(SLIDE 34) But certainly the most amazing data is the percentage of casualties in Italy, which indicates that 25% of deaths due to landslides, since 1900, took place in Campania. That is, Campania, despite having only 10% of the population, has 25% of landslide-related fatalities. This is mainly due to the fact that in Campania a single mudslide has been known to cause up to 300 victims, and the phenomenon is associated with the volcanic problem. This is a problem related to the volcanic risk, more frequent than eruptions and much harder to monitor, because an additional difficulty is that hydrographic basins where



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landslides occur are very small. They are small valleys which can fill up within a few minutes, and therefore heavy summer rains can be enough to fill them. It takes just twenty minutes of rain to fill them and therefore monitoring becomes really hard.

(SLIDE 35) Returning to the volcanic risk, this image shows the "red zone" that will be soon ratified for the Campi Flegrei. It is more extended than before, as it also includes parts of the city of Naples.

(SLIDE 36) So the city of Naples, which is this green area, will be partly in the red zone of Mount Vesuvius (previously it was completely out of it) and partly inside the red zone of Campi Flegrei.

(SLIDE 37) This gives you an idea of how close our friend Vesuvius is.

(SLIDE 38) Of course, this is perhaps the most important case of multi-risk, multi-hazard in the world: the combination of earthquakes, eruptions and subsequent landslides that can possibly happen. It is thus a case of multi-hazard: Vesuvius, Sarno landslides, potential process industry accident due to presence of the port, and, therefore, from this point of view, of great interest.

What else are we doing in addition to what I told you? First, over the new infrastructure axes, we are in talks with the Ministry of Culture for the problem of protecting the enormous cultural heritage that is present in the red zone. In addition to the obvious health problems, the evacuation of hospitals, evacuation of people with disabilities, we are dealing with the problem of the safety of the cultural heritage, which is very important, because a significant part of the regional, Italian and worldwide cultural heritage is situated in the red zone.

(SLIDE 39) Then, with 50 million Euros of EU funds, we are financing new means for the firefighters and for the local civil protection, as well as the computerization of the new technological and monitoring platform of the Campania Region.

(SLIDE 40) With 15 million Euros assigned to the Campania Region (resolution of May 2013) we have funded the emergency plans of all 551 municipalities in Campania. Campania, with 551 municipalities, is below average, because Italy has 8,000 municipalities. We will fund the development of municipal emergency plans where these are inadequate, while if these are already adequate, we will fund further actions, including the dissemination of information in the area. This will bring the civil protection plans to an acceptable level across the Campania Region. But if the emergency plan is already good, funds will be used for other communication activities, dissemination of information, etc.



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(SLIDE 41) These are the guidelines, published in the Bulletin of the Campania Region, which must be followed. This cover, which I'd say is a bit terrifying, reminds us of all that can happen. The bottom left image is not Vesuvius, but it is a ship burning in the harbour, in 1985. So, you see, there is chemical risk, the last earthquake of 1980, Sarno, floods. Although floods would normally be the least of our problems, from the point of view of civil protection, because they usually have a long early-warning: it is hard for floods to cause a large number of victims, while those of Campania cause hundreds of victims, for the reasons previously outlined.

(SLIDE 42) The last activity relates to "territorial garrisons" (hard to translate: "sentinels for territorial defence"). They are comprised of pairs of geologists and environmental engineers (or civil engineers), that each Municipality will have, on a voluntary basis, in the case of early warning alarm. In this way, the mayors, that are the primary authorities on local civil protection, may decide (because in Italy the mayors decide by law), to evacuate or not to evacuate, for a hydrogeological instability, on the basis of information received from experts. Experts who have been trained so far only in a few towns, but we will bring them to all 551 municipalities, with specific courses that will start in a few weeks.

So the whole basis of European funds is used to finance, and we will be able to give the mayor, in the case of early warning, this pair of technical professionals (a geologist and an engineer).

(SLIDE 43) This slide shows the eight areas of early-warning of Campania. The first course will cover the training of technicians for the municipalities in warning area no. 3, because this is the area where all the victims caused by mudslides were concentrated. So we will start with that one, but then we will have solved the majority of the problem, because it is clearly the most hazardous in all Europe with respect to landslides triggered by mudslides.

(SLIDE 44) The last slide shows the events with victims which have been previously discussed. Therefore, by sorting out the problem in this area, we would sort out a large part of the problem.

Sorry if my intervention was too long. Thank you.



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