

Museum of Vesuvius Observatory

Final Project

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I choose the Museum of Vesuvius Observatory, from Chapter 27, pgs. 342-348 (Wyss & Peppoloni, 2015) as the case study for the final project.

The Vesuvius Observatory was founded in 1845 officially while Vesuvius was displaying semi-persistent activity (Wyss & Peppoloni, 2015). The metro area of Naples, Italy sitting at the base of Mount Vesuvius has more than two million residents today (Macrotrends.net, 2023) who could be affected by the kind of catastrophic volcanic release that leveled Pompeii in 79 AD.

Mount Vesuvius itself is not the only volcano in the area. The Vesuvius Observatory also monitors two additional volcanic zones: the Campi Flegrei caldera and Ischia island (Wyss & Peppoloni, 2015). Researchers there monitor volcanic and seismic activity, preserve artifacts, and attempt to forecast eruptions. Besides the scientific research going on, the Museum also tries to provide outreach to the community. In addition to doing tours of the collections for visitors, they also sponsor education programs for the general public. Most visitors to the Museum are Italians with only 12% coming from other countries. A large number of visitors are students. Among the Italians, most visitors are from the region surrounding Naples (Wyss & Peppoloni, 2015).

The Observatory portion of the museum is important because it continues to monitor the volcano and collect data that may help to warn the public about the potential for a future eruption. The Museum portion is also important as it serves to educate the public, mostly in the form of school-age museum tours, about the potential hazards of living near a volcano and how to mitigate those dangers. The museum staff also work with legislators as experts to help them plan for possible emergencies related to an eruption. They can also help to communicate with the public in any emergency about where the greatest risk is, the likelihood of increased activity, and where to go in the event of an eruption.

The Italian legal system has placed the mandate for the Museum in a precarious position in the last two decades. In 2012, an Italian court convicted several geologists and sentenced them to prison for six years for failing to predict an earthquake in 2009, despite there being no way to predict earthquakes that is considered scientifically reliable (Associated Press, 2012). In light of these events, it would seem reasonable for scientists at the Museum to be concerned that if they, too, fail to foresee the future, that they, too, might suffer a similar fate. How then does one ethically warn the public about the possibility of a volcanic eruption? If one over-predicts to be cautious, then the public may initially panic, which can be disruptive and expensive, or they may adopt a boy-who-cried-wolf response and be unprepared when the prediction finally proves true. Or, do they use appropriate caution, and then end up in prison for not being clairvoyant? Mount Vesuvius is far from the only geologically active part of Italy, and so they are not the only organization that faces such ethical challenges.

It's clear from such a verdict, however, that additional means of informing the public about the scientific process and what it can and cannot do realistically is essential, and public outreach on these matters must become a priority. We have seen a similar lack of understanding among the public around climate change. One might imagine in some locations that moneyed interests, such as real estate interests, might not want the public fully informed about the dangers something similar to Vesuvius might be as it could lower real estate prices, in either the long or short term. They might be able to bring political pressure to bear on scientists to under-report the dangers, or lead the public to dismiss such dangers as unlikely despite the evidence.

The Museum and Observatory are in a unique position since they are located directly on the volcano (the observatory obviously must be to collect data). This can present potential hazards even without an eruption as access can be limited during part of the year due to weather.

Being at altitude can also present certain challenges for access both for visitors and museum staff. This can also make it difficult to expand the location to house additional resources or to expand the museum, not to mention its potential immediate danger in the event of an eruption. One might consider it ethically questionable to place more staff in danger than is absolutely necessary. A possible alternative might be to expand the museum in another location further down the slope in a safe location for visitors and general staff, and have shuttle tours of location with more proximity to the volcano during periods where it is safe to do so. Of course, building a new facility at another site will also present challenges related to impact on the surrounding community and potential environmental concerns.

Museum experts must play a role in working with emergency managers to foresee possible consequences of both large and small eruptions so that they can plan for a potential disaster, as well as other government bodies that may be involved in risk mitigation such as designing better building codes. Communicating with other such facilities around the world could also lead to best practices being shared being regions with higher and lower risk profiles to better calibrate appropriate and consistent strategies for communicating to both the public and political leadership.

Observatories near active volcanoes, including Mount Vesuvius, are crucial for monitoring volcanic activity and predicting potential eruptions. These observatories house instruments such as seismometers, gas analyzers, and thermal imaging devices to track changes in the volcano's behavior. The data collected helps scientists understand the volcano's activity and assess potential risks to surrounding communities (Wyss & Peppoloni, 2015).

Living near Mount Vesuvius presents several potential challenges that the work of the Museum/Observatory hopes to address, particularly during the most active phases of the volcano.

The primary concern is the risk of volcanic eruptions. Vesuvius is historically famous for wiping out cities like Pompeii and Herculaneum with devastating consequences for the residents. The efforts of the Observatory are to monitor those risks in the hope of warning the public if a similar danger were to become likely. Eruptions can take several different forms with different risk profiles such as lava flows, pyroclastic flows, ashfall, gas emissions and seismic activity. Most of these types of activities can be deadly to people. The Museum plays a vital role in communicating those risks and developing evacuation plans for the region. They also make policy recommendations about use restrictions to reduce the threat of human casualties (Wyss & Peppoloni, 2015). Of course, with millions of people living at the base of an active volcano, those warnings may not be enough (Macrotrends.net, 2023).

The Museum and Observatory help to mitigate environmental risks from the volcano through a number of programs. One primary focus of the Museum is public awareness and education. Most of the visitors to the museum are Italian school-age children, with a lesser number of tourists, so many of their programs are designed with this cohort in mind. They also provide programs for the community. The Observatory focuses on monitoring of seismic activity and air quality to provide early warnings of increased activity to the community (De Lucia, et al., 2010).

In addition to the monitoring and public engagement activities, experts from the Museum Observatory work with policy makers on land use planning, infrastructure resilience, evacuation route and shelters, emergency response preparedness and emergency communication systems, so that the region is prepared in case Vesuvius becomes more active and an event seems imminent. The staff also collaborate with international organizations to share research data, preparedness

strategies and communication techniques to improve methods locally and share best practices (De Lucia, et al., 2010).

Human activities in the area have little effect on Vesuvius itself, but they can impact the environment in other ways. Urbanization can impact things like infrastructure and land use, air quality and water consumption. These, in turn, can impact agricultural practices and deforestation, as well as increasing waste generation. Tourism is a big part of the region because of the rich history there. That can have an impact on the environment, but also on planning for an event because they will not be familiar with evacuation strategies in the same way local communities can be prepared for it (Ente Parco Nazionale del Vesuvio, 2023).

The human-environmental coupled system plays a critical role in shaping the planning and response to volcanic activity near Mount Vesuvius. This system involves the intricate interactions between human societies and the natural environment, and it evolves over time based on various factors. Population changes play a key role both in impact on the environment and in response to any potential threat. Evacuating millions of people from an urban center is much more challenging than a small agricultural population. That risk grows as the population continues to grow. Infrastructure to support such a population and its evacuation must be developed to accommodate its needs. Models must take into account the potential impact of urban environments on geological stresses that could contribute to an eruption. Economic factors have to be considered: what are the costs associated with living in a geologically hazardous environment, both in the short and long term. The incorporation of technological advances must be supported to improve warning systems. Policies need to be developed regionally, nationally and internationally to cope with the consequences of such an event. Adaptive planning considers the dynamic nature of the human-environmental coupled system. It involves regularly updating

risk assessments, refining evacuation plans, incorporating new technologies, and engaging with communities to ensure a resilient and effective response to volcanic activity near Vesuvius. The ability to adapt and evolve strategies over time is essential for mitigating the impact of volcanic hazards on human communities and the surrounding environment (Wyss & Peppoloni, 2015).

There are many potential trade-offs for living in the vicinity of an active volcano like Vesuvius. For one, there is a rich cultural heritage nearby, such as Naples, Pompeii and Herculaneum, and the general scenic beauty, despite the risks of a volcanic eruption that is irregularly spaced, difficult to predict and uncommon. The rich history also brings tourism and economic opportunities, but in the light of the geologic hazards, preservation of that heritage can be challenging. Land use can be a challenge to balance between hazards of lava flows risks, rich soil, and zoning restrictions. Scientific research should be carried out to learn and mitigate risk, but this is safety risk for scientists as well as the local public. It's also important to make residents aware of the risks, but also carefully balance public perception of that risk. Too little concern can lead to complacency, while too much may list to economic costs and population decline from fear (Ente Parco Nazionale del Vesuvio, 2023). Local authorities play a crucial role in implementing effective risk mitigation measures, emergency preparedness, and land-use planning to minimize the potential negative impacts of volcanic activity on the communities in the region.

To resolve these trade-offs in an ethical way, the Mount Vesuvius Museum Observatory can assist in the implementation of several strategies. One is to assist with an enhanced early warning system to provide timely information about volcanic activity so that residents can stay informed as the situation changes. Risk must be communicated transparently so that everyone understands their risks. The community must be engaged and be allowed to participate in

planning for a response. The local cultural sites should also have plans to preserve the site in the face of such risks. Communities in the region should develop risk-resilient infrastructure to prioritize the safety of residents in the event of an emergency. The public should be educated about the hazards and what to do in the event of an emergency. Evacuation plans should be inclusive and take into account diverse needs in an emergency including the young, the sick, the poor and the elderly. Continuous risk assessment should be employed along with adaptive strategies for dealing with new information. Collaboration with regional partners and international organizations can enhance the ability to prepare for any potential disaster (Ente Parco Nazionale del Vesuvio, 2023).

In order to best inform the public about geoscience risks associated with living near Mount Vesuvius, various stakeholders would need a comprehensive understanding of various factors related to volcanic risk, community well-being, cultural heritage, and sustainable development. The Observatory exists to gather scientific data about historical volcanic activity, eruption patterns, and current geological conditions, as well as monitoring current conditions such as seismic activity, gas emissions and ground deformation that could indicate a future eruption (Ente Parco Nazionale del Vesuvio, 2023).

In addition to understanding the behaviour of the volcano, they would need to understand how that impacted human elements, such as population dynamics including distribution and density, as well as infrastructure and critical assets including emergency services. They would also need to understand sites of cultural and historical significance and any strategic plans for protecting those assets. Land use and urban planning strategies would need to be developed that consider volcanic risk, and emergency response plans such as evacuation routes and emergency shelters would need to be put in place in the event of an eruption (Wyss & Peppoloni, 2015).

Public awareness and education plans would need to be put into place to guide local citizens on what to do if eruptions of various types were to become likely, or to actually occur. Resiliency plans for dealing with the environmental and economic impact of an eruption. The needs of the community would need to be assessed through careful study, but also through community surveys that can take the needs of various communities into account. Ethical guidelines for decision-making would need to be in place so that a course of action doesn't have to be made at the last minute (De Lucia, et al., 2010).

Technological advancements should be sought out and incorporated into any plan, such as early warning systems, and the potential risks associated with any new technologies should be considered in advance of their use. Developing collaborations with other national and international organizations such as research institutions can improve access to information, communication strategies and resources to aid in the event of an eruption. Regular updates and continuous monitoring are crucial to adapt strategies over time based on evolving conditions and knowledge (Wyss & Peppoloni, 2015).

Geoscience and geospatial analyses play a crucial role in communicating critical information regarding hazards associated with living near Mount Vesuvius. Geologic mapping of areas that might be most likely to be prone to lahar flows and pyroclastic flows would aid in communicating where the greatest ground hazards are. Seismic hazard maps can aid lawmakers and builders in developing appropriate regulations for areas at highest risk of earthquake damage that might be associated with an eruption. Gas emission monitoring can both help to predict a future eruption, but gas emissions themselves can also be hazardous. Understanding how gas is dispersed by wind and weather can inform the public about where evacuations might need to take place even without a strong eruption. Ground deformation and landslide susceptibility can

also be mapped so that evacuation routes are not disrupted (Ente Parco Nazionale del Vesuvio, 2023).

Evacuation routes can be affected by many of these factors. Geospatial network analysis can aid in optimizing evacuation routes based on terrain, existing roads and potential hazards. Accessibility maps can be developed to ensure that vulnerable populations are able to evacuate. Integration of multiple data sources is important in developing the most comprehensive maps, and routes can be communicated to the public through maps, but also apps, and clear signage on evacuation routes (Ente Parco Nazionale del Vesuvio, 2023).

Hazard maps can be compared with land use maps and cultural heritage site maps to help develop plans to protect sites important to the community. Resources should be inventoried and protection strategies developed. Community risk perception can be mapped from survey responses, which can, in turn, be used to better communicate to those people that feel the most vulnerable (De Lucia, et al., 2010).

In order to communicate hazards, maps could be posted at rest stops along major evacuation routes in multiple languages indicating the highest risk areas and where to go in case of emergency. Phone apps could be developed and offered to residents for free that could alert them of potential hazards and reminding them of how to prepare and where to go in case of an event. In combination with geospatial mapping, they could be provided with the information that was most relevant to their present location. When risks increase owing to ongoing monitoring, news channels can be provided with updated risk assessments, and experts made available to communicate with the public.

When planning for the risks of living near Mount Vesuvius, various trade-offs have to be considered. The list below is not exhaustive, but are some examples to consider.

- Preserving Cultural Heritage vs. Safety – restrictions to sites like Pompeii may need to be implemented during an increase in volcanic activity.
- Community Cohesion vs. Evacuation – coordinating evacuations should consider the benefit of preserving local ties.
- Residential Proximity vs. Safety and Urban development vs. Hazard mitigation – given the size of the population living around Vesuvius, access to urban amenities might have to be traded off against the potential for increased property damage. There is a trade-off between short-term economic gains and long-term interest in safety.
- Attachment to place vs. Evacuation – a common problem we see in the US with hurricane evacuations.
- Land Use Opportunities vs. Zoning restrictions – volcanic soil can be quite fertile, but could also be a sign of higher risk areas that might need to be limited for development.
- Economic prosperity vs. Risk exposure and Economic opportunity vs. Infrastructure resilience – capitalizing on tourism might limit willingness to invest in hazard infrastructure, and hazards could restrict areas that might otherwise be developed.
- Public awareness vs. economic impact – investing in public awareness programs about volcanic risk could have a negative impact on tourism and business.

The choices in this list are not meant to be black-and-white choices, but rather an optimization problem where the community works together to enhance the overall benefits as

much as possible, by considering realistic short- and long-term term planning (Wyss & Peppoloni, 2015).

In addition to considering the various trade-offs, a number of management and organizational constraints can impact communication strategies. Among these are time constraints in that the need for communication is crucial during a volcanic event. Clear protocols should be established in advance so that information can be easily disseminated. Resources will also be inherently limited for both financial and human resources, so that essential needs must be prioritized. There may also be benefits to pooling resources. Interdisciplinary collaboration is essential. This means not only among scientists of different disciplines, but also between scientists and the community leaders. Regular communication lines should be developed along with training programs to ensure information is communicated quickly and accurately to everyone who needs it. Public awareness programs need to take into account of level of knowledge the average citizen has and speak to that level so that they can be understood. Community outreach and education should be continuous. Technology infrastructure such as communication networks, access (or lack of it) to the internet and other methods should be utilized, but communication should not only rely on these methods. Using radio and other methods that are more difficult to disrupt in an emergency should also be available. Because of tourism in the area, non-native speakers of Italian will be in the area, so efforts need to be made to account for communicating in the midst of an emergency. Regulatory and legal constraints in both Italy and in the EU should be considered when making plans. Community engagement should be an ongoing process. Evacuation planning and logistics should be developed, including regular drills, clear routes and agency coordination. Risk perception should also be addressed

among vulnerable communities (Wyss & Peppoloni, 2015). Any plans developed should be regularly reassessed as hazard risk changes.

Italy belongs to the European Union (EU) and so both national and EU laws and regulations apply to planning for an eruption at Mount Vesuvius. In general, EU laws and regulations provide a broader framework, including some minimum standards, within which Italian law operated. These laws and regulations fall into several broad categories. These include: land use and zoning regulation, environmental protections, emergency preparedness, cultural heritage protection, public safety regulations, risk communication and public engagement regulations, insurance and liability regulations, research and monitoring funding, and cross-border collaboration. Any hazard response should take into account the specific regulations to which the region is subject (Organisation for Economic Co-operation and Development, 2010).

Beyond laws and regulations, ethical considerations should also be considered. These include equity and social justice, community involvement in decision-making, cultural preservation and respect, transparency in communication, accountability and responsibility, precautionary principle, intergenerational equity, adaptive management, human rights and dignity, and international collaboration (Wyss & Peppoloni, 2015). Balancing these ethical considerations is essential for fostering resilience, community engagement, and sustainable development in the face of volcanic hazards.

Ethically and effectively managing hazards near Mount Vesuvius involves a strategic and multidisciplinary approach. National and European regulations should be adhered to, as well as taking into account unique geological, cultural and social contexts of the region. A number of techniques could be applied to achieve these goals. A comprehensive risk assessment could aid in

prioritizing potential hazards. Involving communities in the decision-making process put more emphasis on risk perception and community knowledge. Transparent communication fosters trust and empowers individuals. Interdisciplinary collaboration ensures a comprehensive understanding of the complexity of the problem and enable diverse contributions to the solution. Develop plans for preserving cultural heritage sites and artifacts. Investing in monitoring and early warning systems and education and training programs are a key role performed by the Mount Vesuvius Observatory and Museum. Infrastructure resilience and retrofitting can ensure that the community can withstand potential impacts. Continuous monitoring and adaptive management are committed to continuous improvement to respond to evolving risks. Sharing resources and international collaboration help the region stretch limited resources (Wyss & Peppoloni, 2015). These methods allow the community to balance risks with other considerations.

The proposal here would be to expand the museum in a new location in a place that is more accessible to visitors during more parts of the year at a lower elevation. This would provide several benefits both to museum staff and the public. First, greater accessibility during more of the year would allow the museum to increase their public outreach and host more visitors, as well as allowing them to expand their facilities to accommodate more staff and exhibits. A location further down the slope would be a safer location to store artifacts and provide more evacuation time in the case of a volcanic event. Monitoring of the volcano (the observatory component) could be maintained at the original site with greater access to the volcano directly by those who need it, and tours of the observatory could be shuttled in as weather and other factors allowed. However, moving the majority of the staff for all or part of their workday downslope to a safer location would reduce risks for both staff and the visiting public.

Some potential concerns that would need to be addressed are the specific location where the museum is to be expanded. Neighborhoods that host a museum and the attendant traffic will need to be able to accommodate that increase in traffic so that it does not cause too much disruption for those that already live in the area of the proposed site. A hazard assessment will have to be conducted of the site to ensure that it will be resilient in the face of a volcanic event, so that experts on staff can continue to work and coordinate with local officials in a safe location. Geologic maps of the area would have to be studied to select the most resilient location that still has relatively easy access to the original monitoring station. The community would also have to consider other infrastructure adjustments to accommodate emergency coordination taking place at the site.

Government stakeholders might be reluctant to spend money, but the greater public access, and for themselves as well, could be a benefit they might be willing to get on board with. Emergency planning facilities could be incorporated into a site at a lower elevation, with better road access, that could consist of a staging area for rescues would increase the level of resiliency of the region. A larger staging area would also permit additional monitoring stations to be set up in the area that could be monitored largely remotely if the appropriate infrastructure is in place. Such stations could be set up at multiple locations, even more difficult to access ones that could provide additional data and make it less likely that all of them would be disabled in an eruption unless it was particularly catastrophic. This would permit the ongoing collection of data without interruption.

A museum location that is more accessible to the public could also host additional outreach events and be a greater presence in the community all year round. The access can build trust with government officials and the public and, hopefully, make the public more likely to

heed warnings if they are made. Perhaps the museum could be clustered with other development projects such as expanded public transportation, commercial shops and parks to further encourage community engagement.

To build community consensus, a number of important steps could be taken. A community survey could be conducted to help choose a location for the museum that would most welcome the project. The museum staff could communicate with the staff of other museums with a similar purpose to understand their perspectives on the kinds of facilities that work best to achieve the project goals. Geoscientists on staff and university researchers could contribute geological hazard maps, and address potential environmental concerns, to help plan required infrastructure and select monitoring locations. Partnerships could be developed to provide research support and student internships to facilitate training of future experts. All stakeholders could be consulted regarding what other types of facilities could be co-located to help serve the community and reduce overall cost of the project.

Once plans begin to be designed, outreach should continue with community organizations, legislators and emergency planners, and other stakeholder until the facilities are complete and after the new museum location is open. A professional communicator should most likely be employed who can be a central source of information and help the experts put their knowledge into a form that is best suited to the audience they are speaking to.

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