#Istayhome and guarantee Seismic Surveillance and Tsunami Warning during the COVID-19 emergency in Italy

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Abstract

The continuity of monitoring operations at national earthquake centers during crisis is an important challenge. In 2020 due to the COVID-19 health emergency monitoring centers all over the world faced new, unexpected problems. In Italy, the Istituto Nazionale di Geofisica e Vulcanologia has the duty to perform earthquake and volcano monitoring, seismic surveillance and tsunami alerting, and maintaining effective communication with the National Civil Protection agency and the public. During the lockdown, that started on March 9 2020, INGV set up a series of sanitary and organizational measures and improved the technological infrastructures in the Control room in Rome for remote use of software for seismic network monitoring, seismic surveillance and tsunami alerting. Our main goal was to protect the researchers and technicians on duty as much as possible and develop the remote use of software tools necessary to perform service activities when needed in order to limit the presence in the Control room to the essential.

In the first month of lockdown we implemented the organizational controls, the health aids and the tools for remote surveillance and alerting, and gave online training courses for about 100 shift-workers. At the end of March 2020, most of the technicians, researchers and tsunami experts on duty were able to access the new monitoring tools from home. During these months, the shifts in the Control room were done in person and we performed remote seismic surveillance and tsunami alerting only during the weekly disinfections of the Control room and at the beginning of each week. The tools developed during the COVID health emergency are going to be useful in the future especially in the case of other emergencies including the occurrence of a strong earthquake.

Introduction

Since the beginning of March 2020, to prevent the spread of COronaVIrus Disease 2019 (COVID-19), scientific institutes monitoring natural phenomena all over the world had to reorganize the way scientists and technicians work, in particular improving their tools to work remotely. It is worth noting that routine monitoring of Earth processes must continue during the lockdown (Wendel J., 2020). Ensuring continuity of monitoring operations during the COVID-19 emergency and in general during crises is a priority, in particular for national earthquakes monitoring centers, critical facilities that must maintain continuity of operations throughout crises.

Starting March 8th, 2020, the Italian Government announced quarantine measures intended to contain the outbreak of COVID-19: Italy started the lockdown while coronavirus cases were rising. Consequently, in research institutes such as the Istituto Nazionale di Geofisica e Vulcanologia (INGV), most of the employers, researches and technicians started operating remotely. This working method is particularly suitable for INGV since most of the employees are equipped with the technologies necessary to implement their work from home, thus following the mandate "I STAY HOME *(“#IORestoacasa”*= #IStayhome) during the health emergency Covid-19" dictated by the Italian Prime Minister. From the first days of the lockdown, INGV technicians of the IT Service Centre (Centro Servizi Informativi) put efforts towards facilitating access to office facilities for researchers and employees working from home through VPN (Virtual Private Network). At the end of July 2020, while we are writing, working remotely is still the norm for INGV personnel involved in research and administrational activities and will continue until the middle of September.

Earthquakes do not stop during pandemics and therefore the INGV continues during the COVID-19 emergency to monitor Italy with the usual accuracy locating about 7000 earthquakes from March to the end of July 2020 (see Data and Resources). The goal for the leaders of the Seismic Surveillance and of the Tsunami Warning is to provide an accurate service and communication to the Civil Protection and to the public and, at the same time, to protect the staff on duty by adopting protection measurements and by providing infrastructures that allow remote use of all the software tools for surveillance and alert.

Only the INGV employees involved in these crucial services are allowed to access the INGV Control room in Rome. In this facility, the INGV staff performs, as part of the National Civil Protection System, the Seismic Surveillance and Tsunami Warning services. In Catania and Naples there are two other Control rooms (Figure 1). These control centers are devoted to volcanic surveillance of Etna and Vesuvius, respectively, plus all other Italian active volcanoes.

The Control room in Rome was designed and organized to ensure efficiency and redundancy for the timely communication of seismic events occurring all over the Italian national territory and surrounding regions, as well as for potential tsunamis in the Mediterranean area. The services are provided by four specialized shift-workers working 24h/7d: two seismologists, a technician for data acquisition and a tsunami expert to issue the alert in the event of a tsunami wave (Michelini et al., 2016; Amato, 2020). The operators are equipped with multi-screen workstations and a set of telephone lines, as well as a radio device to be used in emergency situations. Although communications also take place through other channels such as e-mail, SMS, Twitter and Web services, the physical presence in the Control room is considered crucial and consequently it has been allowed during the pandemic. Prior to the pandemic, all work was done physically from the office, and employees on duty could only work in presence in the Control room.

In the following, we describe the setup for logistics and improvements to the infrastructure at the Control room in Rome in response to COVID-19. Our main goal is to protect the shift-workers on duty as much as possible and to reduce the presence in the Control room to the essential personnel, by enabling remote use of software tools necessary to perform service activities.

It is worth noting that in March-May 2020 the activities in the field were almost suspended, so seismic stations, sea-level sensors and other monitoring stations malfunctioning would not have been repaired with the same rapidity as before. However, the Italian seismic network utilizes more than four hundred stations belonging to several networks for fast characterization of earthquakes (Michelini et al., 2016) thus allowing sufficient redundancy and efficiency during the lockdown period. The rate of malfunctioning stations was not significantly higher than usual, moreover at the end of May field activities were allowed again, with the necessary care.

Sanitary and Organizational measures

Since the beginning of the COVID-19 emergency, the INGV has implemented a series of measures, both of sanitary and organizational nature, aimed at safeguarding shift-workers in the Control room and reducing risks of infection in the event of a colleague's illness.

In particular, the Control room area, including two other rooms and the service rooms (kitchen and bathrooms) for the shift-workers, has been isolated from the rest of the Institute (Figure 2) and has been disinfected with specific medical devices at the beginning of the emergency and again every week by an external certified company. Disinfection (Figure 3) is carried out with atomizers/nebulizers that allow the uniform distribution of the disinfectant product on larger surfaces such as: chairs, armchairs and benches furniture and shelves, computers and monitors and paving of critical areas. The air conditioning system filters are also sanitized every week. Surfaces, telephones, and computers are manually cleaned by the cleaning company working at INGV. All operators are equipped with masks and disposable gloves. Sprays for surface disinfection and a disinfectant gel dispenser are available in the Control room.

In March at the beginning of the lockdown a list of people that participate in the critical services for Civil Protection, i.e. shifts for surveillance and alerts, was prepared; they are allowed access to the office for the time they are on duty.

The shift-workers have been separated into three distinct teams: each team operates in one week shifts and never interacts with the staff of the other teams. This guarantees the containment of the infections in the unfortunate event that one of the shift-workers should contract the COVID-19, and limits the number of people to be quarantined if needed.

Moreover, the four people on duty were placed in three different rooms to enlarge the physical distance between operators: a seismologist and the tsunami expert are in the Control room while the second seismologist and the technician are in two adjacent rooms (Figure 2).

Remote use of software for seismic network monitoring, seismic surveillance and tsunami alert

To meet the possible need to temporarily abandon the Control room, the researchers and the IT technical staff of INGV decided to implement new tools to work remotely. These actions provide organizational arrangements that are suitable for keeping staff from contagion as much as possible, without neglecting institutional duties.

In order to ensure remote operation for monitoring seismic stations and to allow review of seismic events, the software used for seismic surveillance (Mazza et al., 2012) and for tsunami alerting (Bernardi et al., 2015) has been installed on several virtual servers and accounts, which can be accessed via Remote Desktop Protocol (RDP) or Virtual Network Computing (VNC) (Richardson et al., 1998). The virtual servers are replicated on a second infrastructure to ensure a safe backup.

To monitor the state of health of the seismic stations and their data acquisition flow, the following software are used: SeisFace (Pintore et al., 2012), SeisNetWatch (Hellman et al., 2001; Figure 4), Swarm (Figure 5) and SeisGram2k (see Data and Resources).

The automatic detection of earthquakes and locations are based on Earthworm (Johnson et al., 1995; see Data and Resources). In addition, through the use of Mole (Quintiliani and Pintore, 2013), permanent storage of seismic event parameters is possible within a MySQL database.

The software SisPick (Bono, 2008) interacts with the MySQL database and it is used by seismologists for reviewing automatic locations, to view seismograms, pick the arrival times of seismic waves and calculate the hypocenter and magnitude of the earthquakes. This software is accessible in remote desktop thanks to virtualization and reproduction of the seismologist workstation.

The Early-est system (Bernardi et al., 2015) is used to detect seismic tsunamigenic events worldwide and the Tsunami Warning Service is managed through the JET software (Bono et al., 2019; Figure 6) which is also virtualized and is available through a VNC connection to the experts who operate from their homes.

Discussion and conclusions

Thanks to the commitment of computer technicians and scientists, innovative and effective solutions were developed to enable the use of monitoring, surveillance and alerting software from home. Afterwards, online training courses were organized for all shift-workers. The courses were scheduled over a total of 10 hours to ensure that each of the colleagues with a personal internet connection might be able to contribute to the services. In three days, around 100 people attended the courses. At the end of March 2020 most of the personnel on duty and experts on call were able to access the monitoring tools from home; the human capital for these important services is the most valuable element for ensuring the continuity of the monitoring and communication to Civil Protection and to the public.

Every Monday morning when the shift team changes, as well as on Friday afternoons during disinfection of the Control room, a remote team temporarily takes over the surveillance and alert duties. Three or more people from home participate in a Google Meet (Figure 7): the staff present in the Control room can talk and meet with colleagues connected remotely providing the necessary updates on the seismicity and on the status of the monitoring system and setting the call forwarding of one of the telephones in the Control room to the technician connected from home. After this handover, the shift-workers leave the Control room and the surveillance and alert is temporarily guaranteed remotely. In the Google Meet connection the technician presents to all the participants the status of the network and the seismic waveform received in real time. In a few cases during the remote monitoring official communications to the Civil Protection were performed following the official protocol (first information of earthquake occurrence after 2 minutes, preliminary automatic hypocentral parameters and magnitude after 5 minutes and final location in 10 to 30 minutes; Michelini et al., 2016).

Moreover, from May to August 2020 a remote shift experimentation was carried out by four technicians and four seismologists. It is important to remotely test the tools in a real 9 hours shift. The experiment was in general a success with a few cases of short interruptions in the network connectivity.

On July 28 2020 the Italian Government extended the state of emergency to October 15th 2020. In the last days of July 2020, the lockdown measures were quite relaxed due to the low number of new COVID-19 cases; in the middle of September INGV is partially opening the offices providing the necessary health aids to the personnel; hopefully the situation will slowly go back to normal.

To date, at INGV, none of the employees involved in the surveillance and alerting services have been infected, but if reducing the number of colleagues in the Control room would be necessary due to coronavirus cases rising in Italy or to the illness of one INGV person, we are fully able to guarantee the services continuity remotely.

Having remote capabilities helps us to be less concerned that we cannot ensure the continuity of essential services during a crisis. The challenges faced during these months taught us two main things: (1) the importance of having flexible tools for the services and (2) the importance of a Control room isolated from the rest of the offices. We will surely keep these two changes once the pandemic is over.

The tools developed to carry out remote surveillance and warning are going to be useful when the COVID-19 emergency is over, especially in the case of a seismic emergency. In fact, after a strong earthquake and during a seismic sequence, expert seismologists can now collaborate remotely with the people in the Control room and if there is the need to increase the number of seismologists locating earthquakes, it can now be done remotely using the new tools strengthening surveillance and alerting services.

Data and Resources

Italian earthquake locations and magnitude are stored in the database: Italian Seismological Instrumental and Parametric Database (ISIDe); ISIDe Working Group. (2007). https://doi.org/10.13127/ISIDE; http://terremoti.ingv.it

Software to visualize seismic signals: SeisGram2k (http://alomax.free.fr/seisgram/SeisGram2K.html).

Software to evaluate automatic earthquake locations and magnitude: Earthworm (http://www.earthwormcentral.org/)

Software to monitor the transmission health of the stations of the National Seismic Network: SeisNetWatch software (https://isti.com/products/seisnetwatch/).

Software to view the real time continuous seismograms recorded at stations of the national seismic network: Swarm: https://volcanoes.usgs.gov/software/swarm/index.shtml).

Software to evaluate manual earthquake locations and magnitude: SisPick: (http://sispick.ingv.it/)

Online meetings are done using Google Meet connection (https://meet.google.com/)

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Figure Captions

Figure 1. The INGV Control rooms. Central picture: Rome Control room which provides Seismic, Surveillance and Tsunami Alert services. Picture on the left: Naples volcanic Control room. Picture on the right Catania volcanic Control rooms.

Figure 2. Plan of the Control room and of the area isolated from the rest of the INGV offices, the red lines are barriers built to isolate the area; one of the seismologist and the technicians who use to stay in the Control room (together with the tsunami expert and the other seismologist) moved to the Aki meeting room and the room next to it to enlarge the physical distance between shift-workers.

Figure 3. Disinfection of the Control Room at INGV in Rome.

Figure 4. Map of transmission health of the stations of the National Seismic Network using the *SeisNetWatch* software (see Data and Resources). The technician on duty can manage this activity remotely via VNC access (*Virtual Network Computing*).

Figure 5. Remote reproduction of the video wall of the Control room, showing in real time the continuous seismograms recorded at some tens of stations of the national seismic network (see Data and Resources)

Figure 6. *JET:* The graphical interface for tsunami warning service available through VNC.

Figure 7. *Google Meet connection (see Data and Resources) where seismologists and technicians in their houses connect to the monitoring room to perform the remote seismic surveillance and tsunami alert during the disinfection of the control room.*