Taal Volcano and air quality – what's the link?

Written and published by Clean Air Asia, with review from Dr. Gerry Bagtasa of the UP Institute of Environmental Science and Meteorology

June 28th was marked with news, speculations, and worries about the Taal Volcano activity and the smog not only in the vicinity of Taal but also in Metro Manila. With hazy skies, people turned to social media and wondered if what they see is due to emissions coming from the volcano. Media picked it up and had reports of volcanic smog or 'vog' in Metro Manila.

A day after (June 29th), DOST USec and OIC Dr. Renato Solidum, Jr. of PHIVOLCS clarified that what is being seen in Metro Manila is air pollution from daily activities, and that emissions from Taal Volcano were transported in a different direction than Metro Manila. Today (June 30th), PHIVOLCS explained that more data has shown that sulfur dioxide (SO_2) from Taal has indeed reached Metro Manila and other surrounding areas.

This is how science works – new and additional data can change or further strengthen previous conclusions. And given these changes, what should we understand about air quality and emission sources, such as Taal Volcano?

Air quality is the condition of the atmosphere with respect to the presence of pollutants or substances that can possibly pose harm to the environment and to people. The pollutant type, chemical composition, size, concentration, and exposure level determine the extent of impacts. The more polluted the air, the poorer the air quality. In worst cases, air pollution is seen and felt – but just because you don't see it does not mean it's not there.

Air pollution levels are influenced by three main things – (1) emission sources, (2) meteorology or weather conditions, and (3) chemistry. Yes, all of them. The dominance of each varies under different circumstances, but all play a crucial part.

Emission sources are all activities (and processes) that emit pollutants that can be in gas, liquid, or solid particle form. Pollutants that degrade air quality and drive climate change can be natural (such as Taal Volcano), or man-made (transportation, industries, etc.) - which is the main source of pollutants that degrade air quality and drive climate change. The more sources there are, usually, the more pollutants to manage.

Meteorology is concerned with atmospheric processes and phenomena – wind speed, wind direction, temperature, pressure, rainfall, solar radiation, humidity, to name a few. These conditions can disperse, trap, and transport pollutants at varying rates depending on intensity.

Chemistry is equally crucial because the atmosphere is a big pot of chemical reactions. Pollutants in the air are so reactive, which means in a few hours (sometimes longer, depending on the pollutant) – they can either disappear (disintegrate), transform, or create more pollutants!

Now back to Taal Volcano and air quality.

All these three factors played a role. The emission source in question is Taal Volcano due to its sulfur dioxide (SO_2) emissions, but let's not forget that there are other sources of SO_2 emissions such as

factories, power plants, and vehicle fuel combustion. The nearer the area is to the source, the higher the level of SO_2, hence the initial health advisory is for residents near the volcano.

The farther from the source, the higher the chances of lower SO_2 concentration (imagine spraying perfume from one corner of the room, and the smell fades away at the other end). The height or altitude of emission release also plays a role. This is because the wind also disperses (or dilutes) the pollutant, possibly to a point that it's not detectable anymore in far areas. How far is far? It depends on the amount of SO_2 released, the intensity of meteorological conditions (more perfume sprays would take longer to fade out), and other factors such as geography.

To visualize this, here's a model run by Dr. Gerry Bagtasa to show SO_2 movement from Taal Volcano.

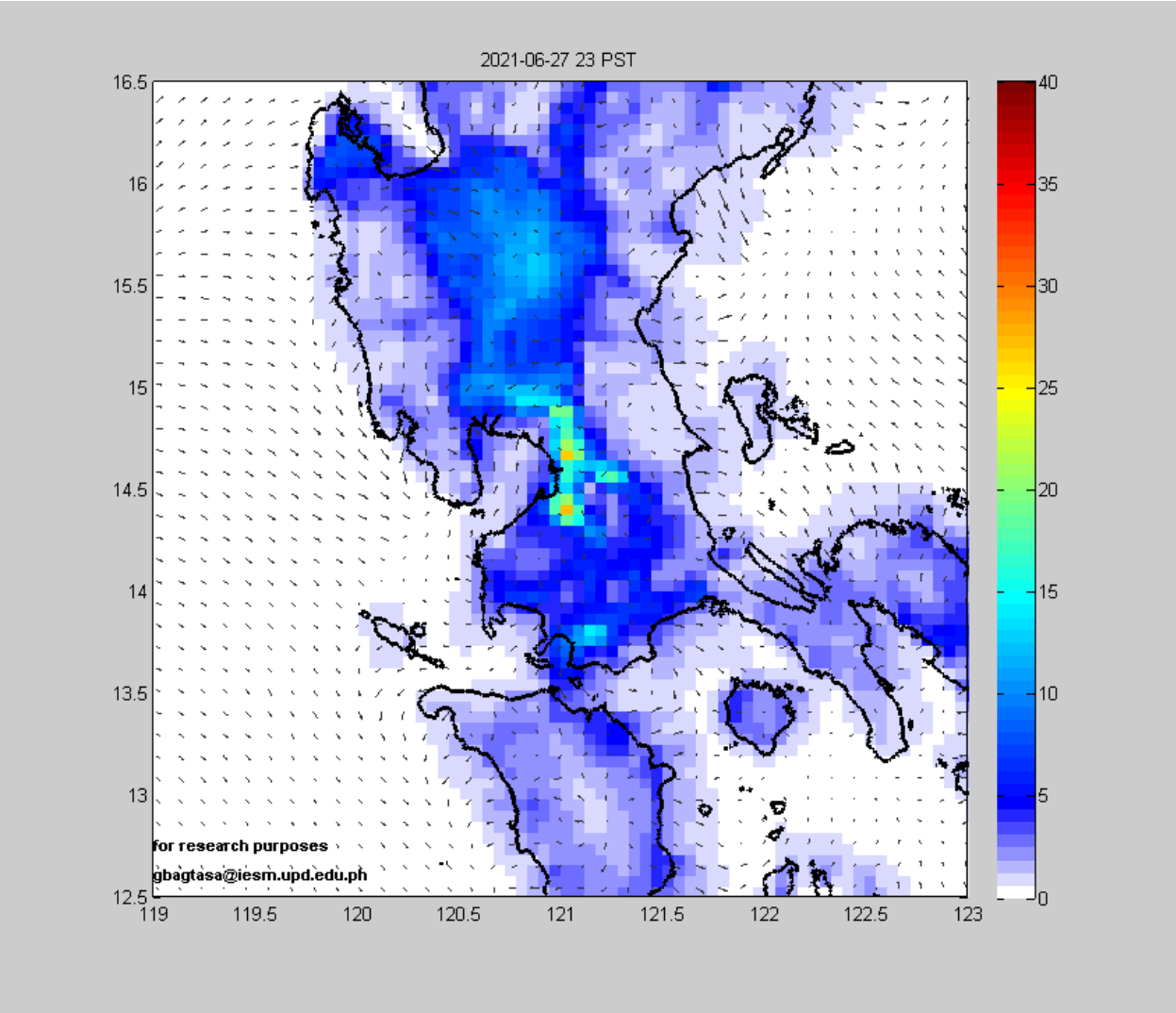

Figure 1. WRF-Chem model simulation of the transport of PM derived from sulfur dioxide emissions from Taal Volcano on June 28, 2021 from (Jun 28 0PST-Jun29 18PST) at surface level (modeled by Dr. Gerry Bagtasa of UP Institute of Environmental Science and Meteorology)

What's so special with running a model? A model calculates pollution movement while considering ALL of the factors and the complexities of the interactions in the atmosphere in 3-dimensions. Take note that

movement of gas, liquid, or solid pollutants do not happen in a straight line. The model provides a clearer visualization of what happened to the pollutant from the point of emission.

The tricky part though, is the chemistry. As reported by the City of Manila, $PM_{2.5}$ (particles with size less than 2.5 micrometers and can go directly to the lungs) also peaked on June 28 in various sites in the city. Is there a possible link?

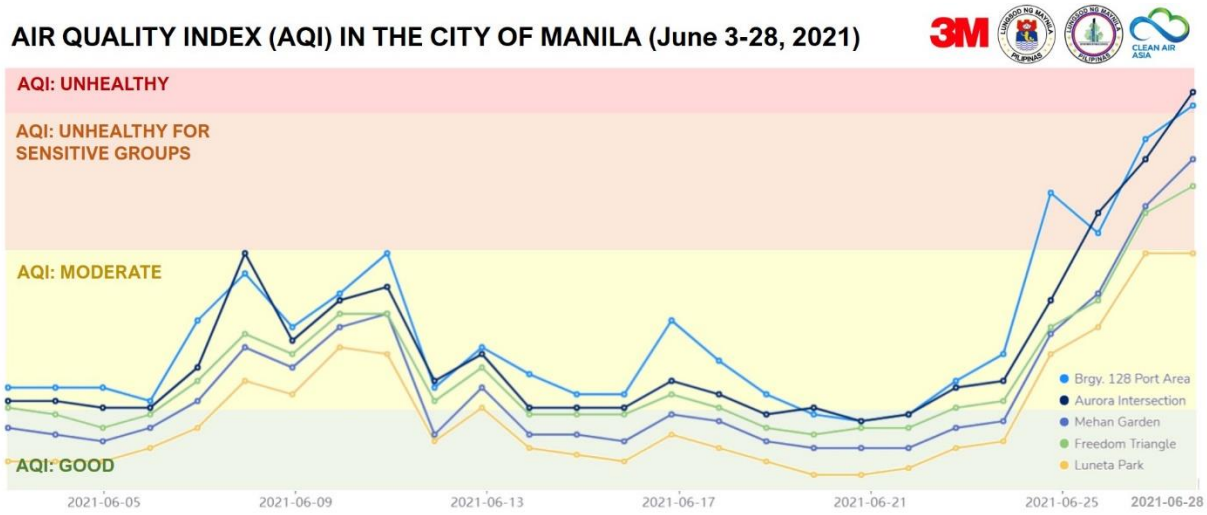

Figure 2. Daily $PM_{2.5}$ air quality index (AQI) in five location in City of Manila from June 3-28, 2021 (image first published in the DPS Manila June 29, 2021 Facebook post)

Most likely, yes. By the time sulfur dioxide from Taal Volcano 'moves' towards other parts of the country, it has already been transformed to sulfates – which is a precursor (or an 'ingredient') for 'secondary' particle formation. This means that aside from particle emissions directly emitted by sources ('primary'), more particles were created indirectly from chemical reactions in the air which can lead to higher $PM_{2.5}$ values.

While more laboratory analyses and data crunching must be done, it is clear that among the three determinants of air pollution, we can only control EMISSION SOURCES. The mere presence of natural sources should further push us to immediately act on controlling sources that we have control over. Air quality management informed by sound science is key.

Just as emissions from Taal Volcano are linked to air pollution in Metro Manila and other places, all sources of information and data must also be linked to provide clearer communication to the public. While we cannot control the pollution from Taal Volcano, we have control over our actions which cause pollution. It is incumbent upon us to prevent or reduce our polluting activities.

About Clean Air Asia:

Clean Air Asia is an international non-governmental organization that leads the regional mission for better air quality and healthier, more livable cities in Asia. For more information about our work, please visit www.cleanairasia.org.

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