# Mount Pinatubo – a case study of a multihazard network


Annie Winson[1], Melanie Duncan[1], Luz Ramos Cabrera[1], Ma. Mylene Martinez-Villegas[2]

1 British Geological Survey 2 Philippine Institute of Volcanology and Seismology


## Mount Pinatubo

Pinatubo is located in central Luzon, the largest island in the Philippines. Previously relatively unknown, Pinatubo was the site of one of the largest eruptions in the 20th century.

After a brief period of unrest (c.3 months) the climactic phase of the eruption began at 05:55 on the 15th of June, 1991. This was the first eruption of its size (VEI 6) to have been monitored in the pre-, syn- and post-eruptive phases and has therefore been the focus of much study.

In this project we propose to review all hazards that impacted this region between 1990 and 2022, define any multihazard relationships and develop techniques for visualising this spatially and temporarily diverse data.

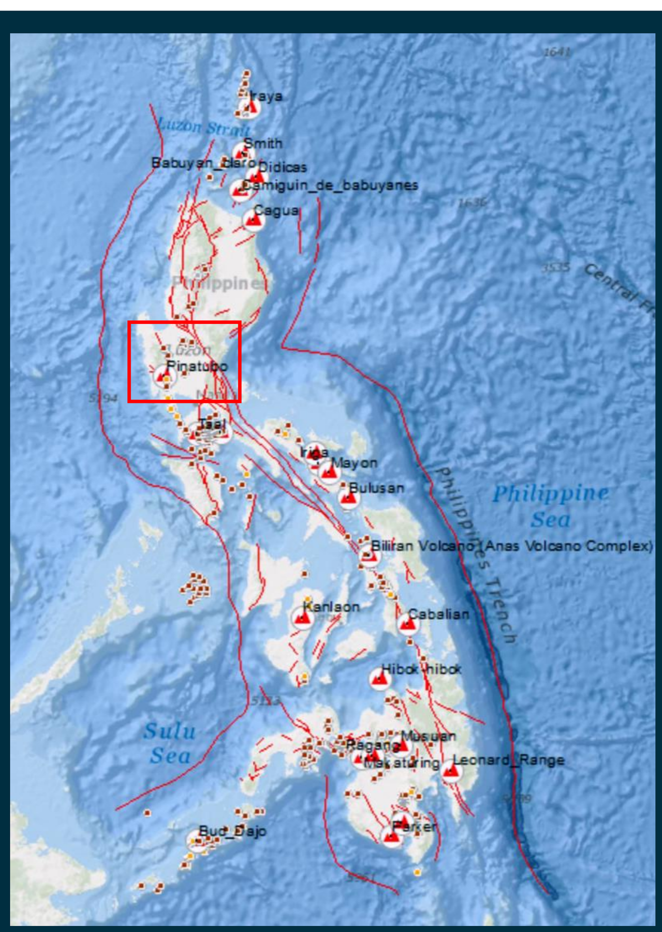

*Figure 1: Location of Pinatubo and project study area*

## Project aims

The Philippines location on the edge of the Pacific makes it a nexus for tectonic and climatic hazards and a real-world example of the possible complexities surrounding multi-hazard assessment, risk management and governance. This inherently multi-hazardous environment and the well documented events over the last few decades provide an opportunity to characterise multi-hazards over temporal and spatial scales beyond those previously considered.

- Assess multi-hazard systems / networks in the Philippines through a case study approach (Pinatubo)
- Develop a framework for the use of case studies in Geovisionary, specifically that align with Hazard Hunter PH

## Pinatubo Multihazard Network

A review of available academic and grey literature as well as information provided by those who were involved in the original response, has so far resulted in the creation of a database with over 300 hazard events .

Fig 2 shows selected examples of these hazards, grouped by type and mapped into a network representing the types of multihazard connections and how they evolve through time.

What is clear from this initially mapping of events is:

- Multi-hazard events associated with the 1991 eruption continue until 2002 – when the breaching of the Maraunot notch cause the crater lake to overspill. The crater lake was formed following the climatic phase of the eruption which created a collapse caldera following the evacuation of 5km$^3$ of magma from the subsurface.
- We are able to identify independent hazards as well as triggering, compound, change condition and cascading multi-hazard relationships all of which form part of a wider multi-hazard network in Luzon.
- Visualising these networks is complex. We therefore need to develop techniques of communicating these interactions clearly.

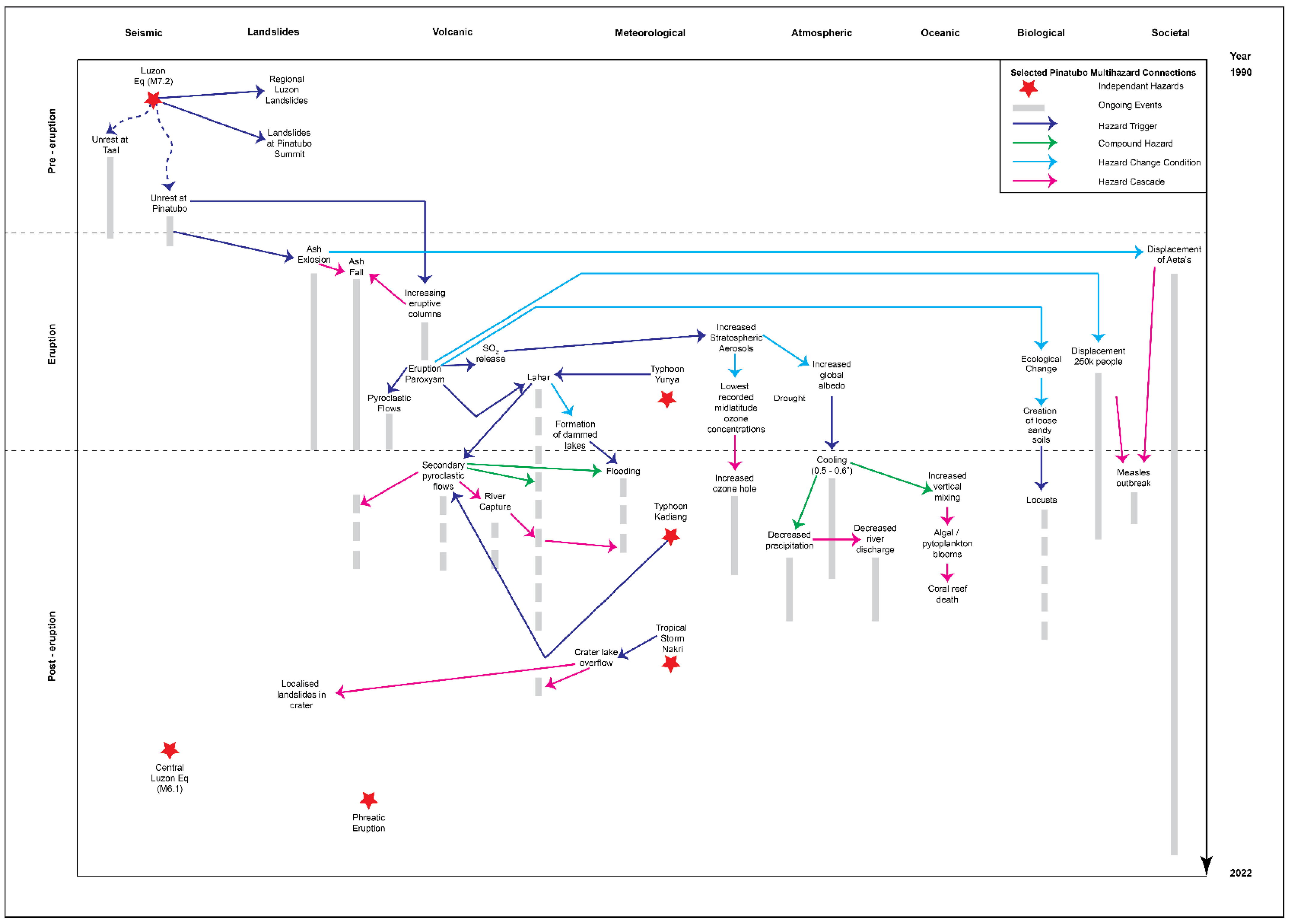


*Figure 2: A schematic representation of selected multi-hazards and their relationships in this study.*

## Bacolor Case study

The town of Bacolor is sited 36km to the SE of the summit of Pinatubo, along the eastern bank of the Pasig-Potrero river.

When areas closer to the summit were evacuated in 1991, many people relocated to towns such as Bacolor. Indeed during the main phase of the eruption Bacolor received only a small amount of ash fall and was out of reach of lahars generated between 1991 and October 1993.

On the 6th of October 1993 however, a secondary pyroclastic flow shifted sediments and blocked the upper reaches of the Sacobia river, disconnecting it from its lower basin – a process known as river capture. As a consequence of this lahars found a new path into the Pasig – Potrero river increasing the lahar potential there.

On the 23rd of September 1994 a breakout of a sediment dammed lake higher up in the catchment caused an erosive lahar to form which dropped the channel bed by 50m and caused the inundation Bacolor by lahars.

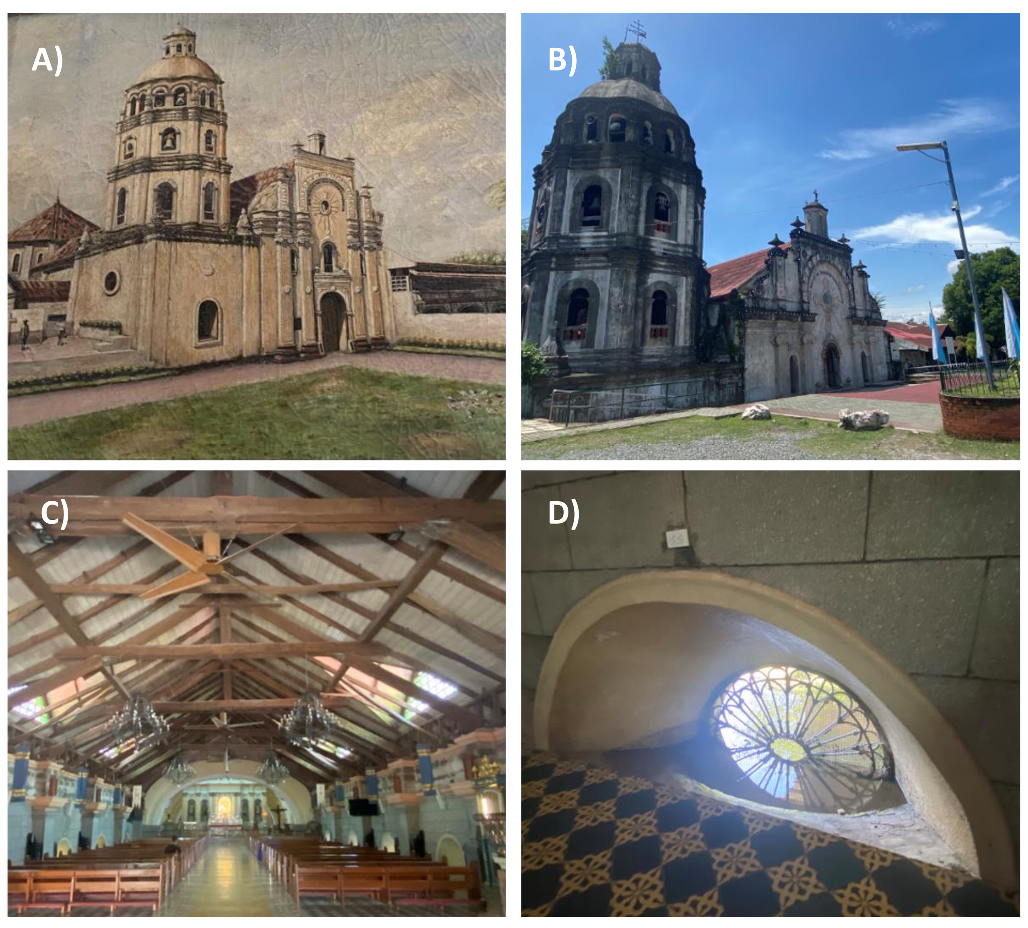


*Figure 3: The church at Bacolor shows the impacts of a series of lahars. A) is a painting showing the original building, note the window above the main entrance in the photograph B) (taken in 2022) the land surface has changed so that this window is now the doorway into the church. Images from inside show: C) the now seemingly low ceiling of the building and D) windows at ground level. Lahars generated in rainy seasons between 1993 and 1997, as well as larger lahar events due to the failure of dammed lakes and engineered dike structures further up the catchment, buried much of the town with only a few original buildings still in use in an adapted form.*

## 3D Visualisation

The BGS and PHIVOLCS both use the Geovisionary 3D software and so using this platform this project will develop guidance for integrating data from past events.

These products will be compatible with the Hazard Hunter PH project and so in future could be used to help communicate hazard to communities at risk by demonstrating lessons from past events.

As a first step we are integrating historic imagery (Fig 4) and published maps to look at changes through time.

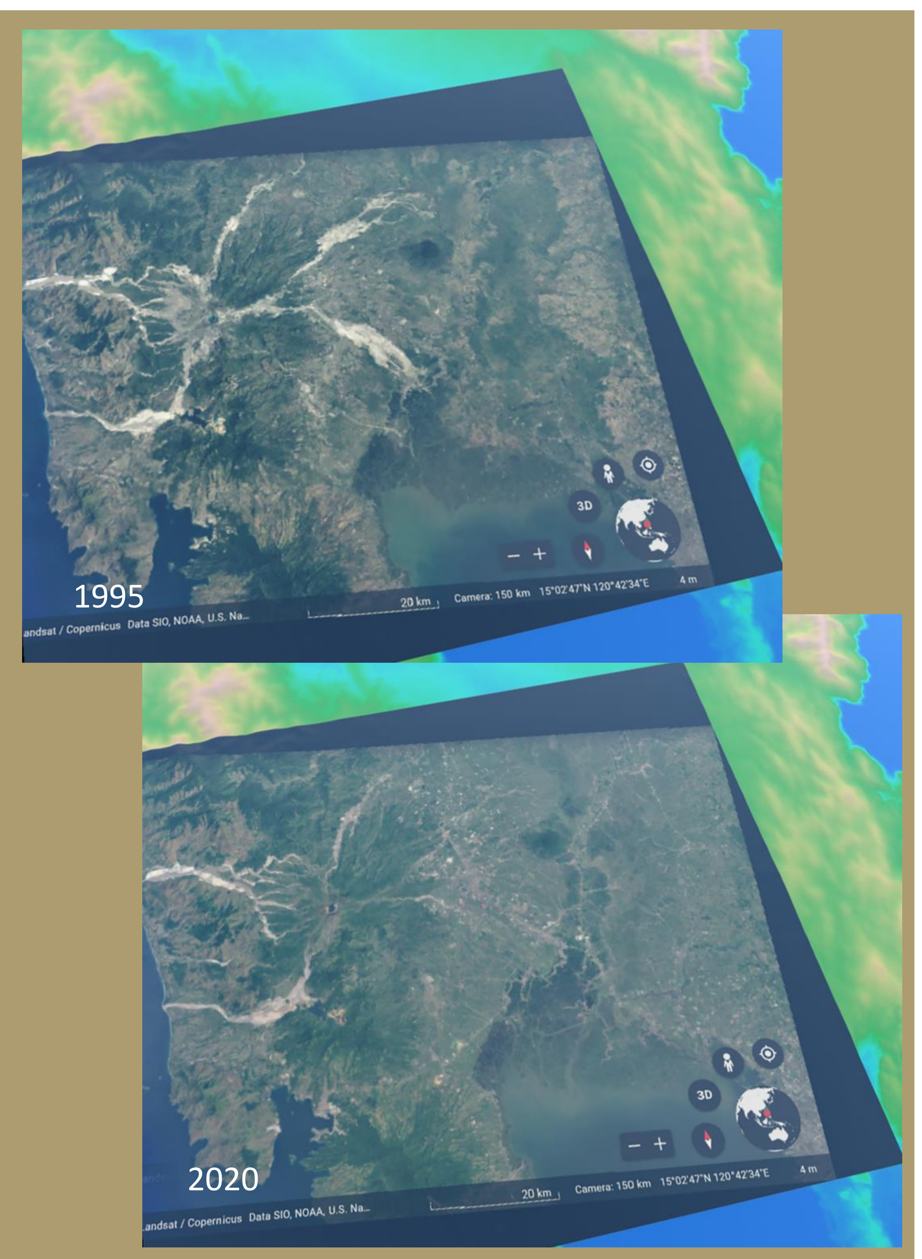


*Figure 4: Historic Imagery overlaid in Geovisionary environment shows the difference between lahar deposits in 1995 and 2020.*


ANNIE WINSON - anwin@bgs.ac.uk


www.bgs.ac.uk