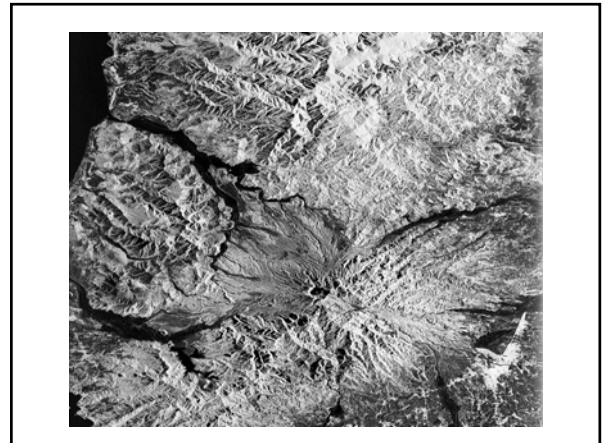
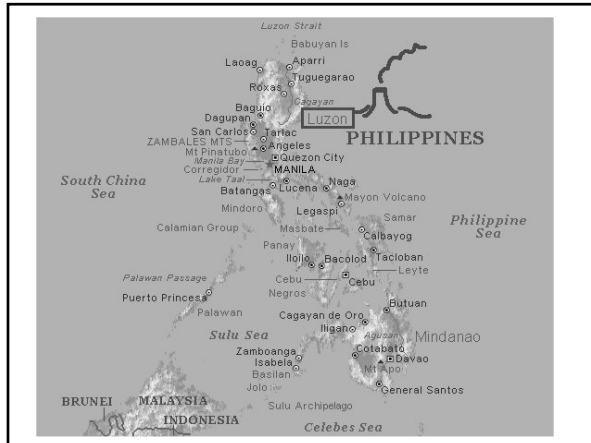
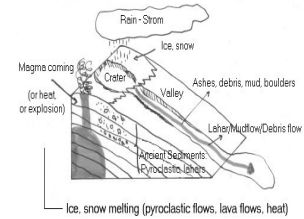


Mt. Pinatubo Lahars 1991

Contributing Factors of the Pinatubo Lahars

- Volcanic deposits
- Steep Valleys and Channels
- Heavy Rainfall



Social Aspects

- Our records indicate that the villages around Pinatubo were not aware it was a volcano prior to 1991 eruption
- 30,000 people lived on the volcano flanks, and 500,000 on the sloping alluvial fans
- Agricultural people reside
- Spiritual connection to the mountain

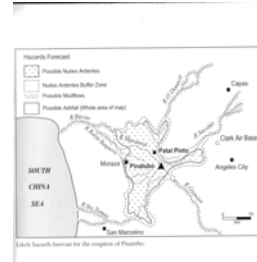
Precursors/Preparation

- March 15, 1991 earthquakes
- April 2 Series of small explosions
- April 5 PHIVOLCS came and installed portable seismographs
- 30-180 high-frequency earthquakes a day
- USGS joined PHIVOLCS and installed more seismographs
- Residents 10 km around summit evacuated

Background Assessment

- Began Geological interpretation of area
 - Voluminous material 20 km circumference
 - Evidence of repeated lahars
 - Lahars inundated large parts of low-gradient alluvial fans
 - Last eruptions dated 500, 3,000, and 5500 years ago

- Hazard map created
- Acquainted civil defense and military about possible eruption/hazards
- Educated using Krafft videos



Precursors Continue

- Deformation of Pinatubo
- Dome formed and grew until June 11
- Vertical eruptions June 12-14
- Pyroclastic flow deposit Marañon Valley
- Extended evacuation again to 30 km
120,000 ppl
- June 10 14,500 evacuated Clark Air Base

Unfortunate Circumstance

- June 15 Violent eruption
- Also Typhoon Yunya is approaching just north of Pinatubo
- 5-6 km³ volcanic material deposited extending 12-16 km from the summit
- Pre-existing valleys have ash deposits as high as 200 m

And it Begins

- 1.5 m blocks common
- Discharge peak 1000 m³/s
- Pasig-Potrero, Marañon, O'Donnell, Sacabia, Gumain, Sta. Tomas, Bucao
- Inundated several villages



Prediction

vs.

Actual



- Pinatubo eruption was a plinian eruption, occurs once every 100 years
- Because of the continual lahar activity pinatubo lahars are considered the worst in human history

Lahars Alert System

- PHIVOLCS formulated a 3 level alert system
- Level 1- Rain is falling in Pinatubo area
- Level 2- intense rain has fallen for 30 minutes
- Level 3 – mudflows have been observed
- Official Civil Defense send warnings to hierarchy of officials who used radios, loud speakers, sirens, church bells or gunshots
- At first people doubted warnings

Education

- Educational warnings were dispersed to public
 - Brochures
 - Videos
 - Maps of threatened areas
 - Seminars and posters used to describe what to do after warnings issued
 - People Encouraged to build permanent hummocks

Resettlements

- Resettlements established for homeless
- Had inadequate water supply and waste management
- Aetas 30,000 ppl isolated tribe lived on flanks of volcano
- Proved inadequate for Aetas
- 349 died within 12 weeks
- Total 537 dead by December 1991

Damage 1991

- Infrastructure loss; \$374 million
- Refugee camps; \$69 million
- Mudflow control; \$150 million
- 8,000 homes, 700 schools
- 42 % of croplands
- 100 people dead

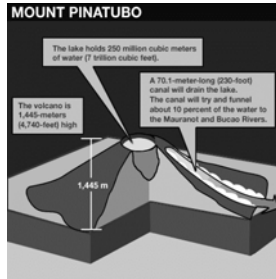


Difficult Recovery

- Oct. 1993 159 evacuation centers accommodating 55,000 people
- Rebuilt public buildings and roads before building homes in relocated villages

Long term affects

- Agriculture has shifted to early season crops
- Making of permanent flat-top hummocks
- Draining of the crater lake



Evaluation

- Considering only 3 months to prepare they did pretty good
- Improve alert system
- Improve resettlement conditions

Questions ?