GEOLOGIC HAZARDS AND DISASTER REDUCTION EFFORTS IN THE PHILIPPINES

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Natural Hazards

Natural phenomena that pose potential threat or cause negative impact to man and property

1. Geologic

Earthquakes
Volcanic eruptions
Mass movements
(ex.Landslides, mudflows)
Tsunamis

2. Hydro-meteorologic

Typhoons
Rains
Floods
Drought

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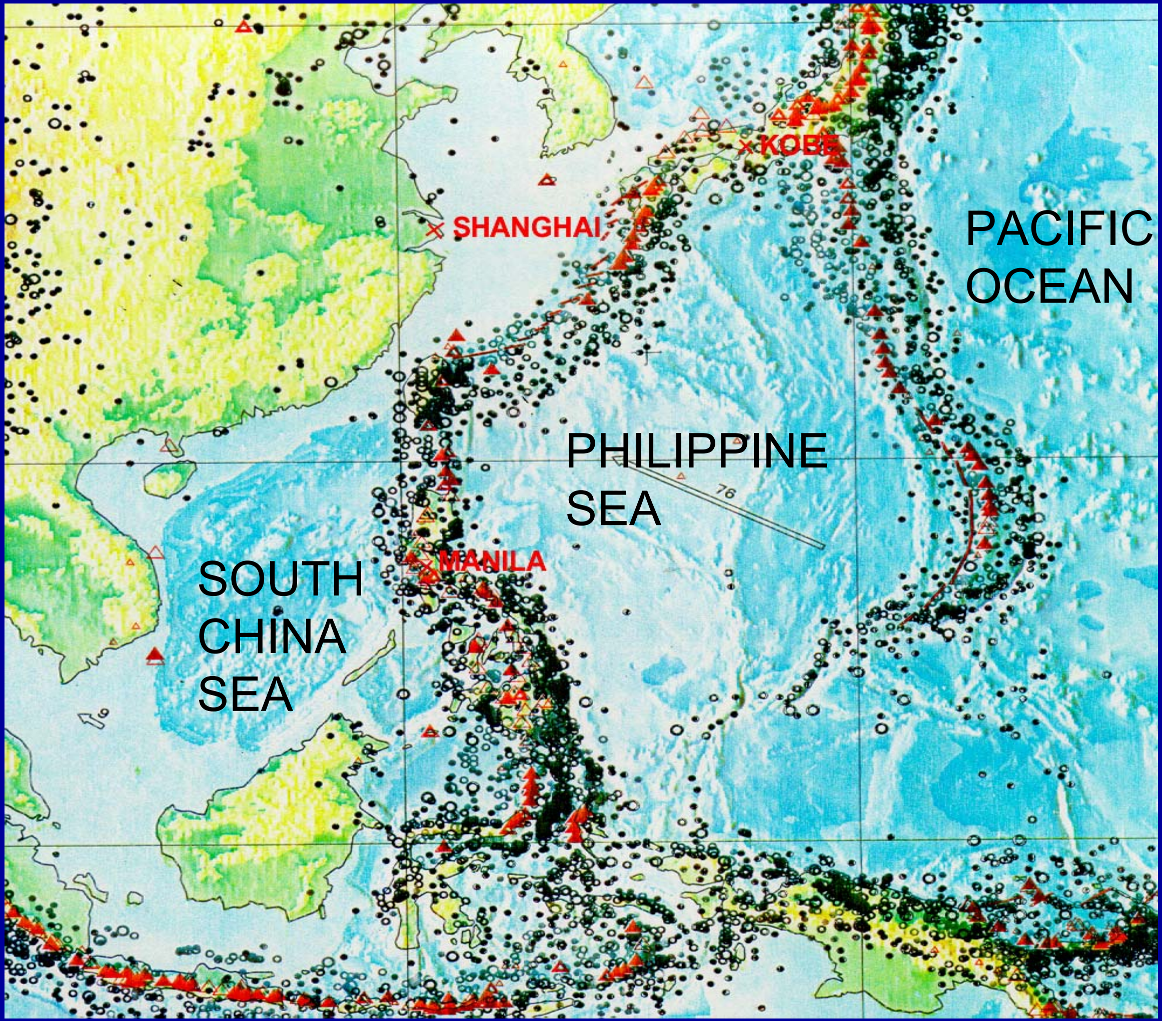
THE PHILIPPINES: A HAZARD PRONE COUNTRY



INACTIVE VOLCANO

ACTIVEVOLCANO

EARTHQUAKE EPICENTER

The geographic and geologic setting of the Philippines make it prone to various hazards, including:

- typhoon/rain-related
- volcano-related
- earthquake-related
- tsunami

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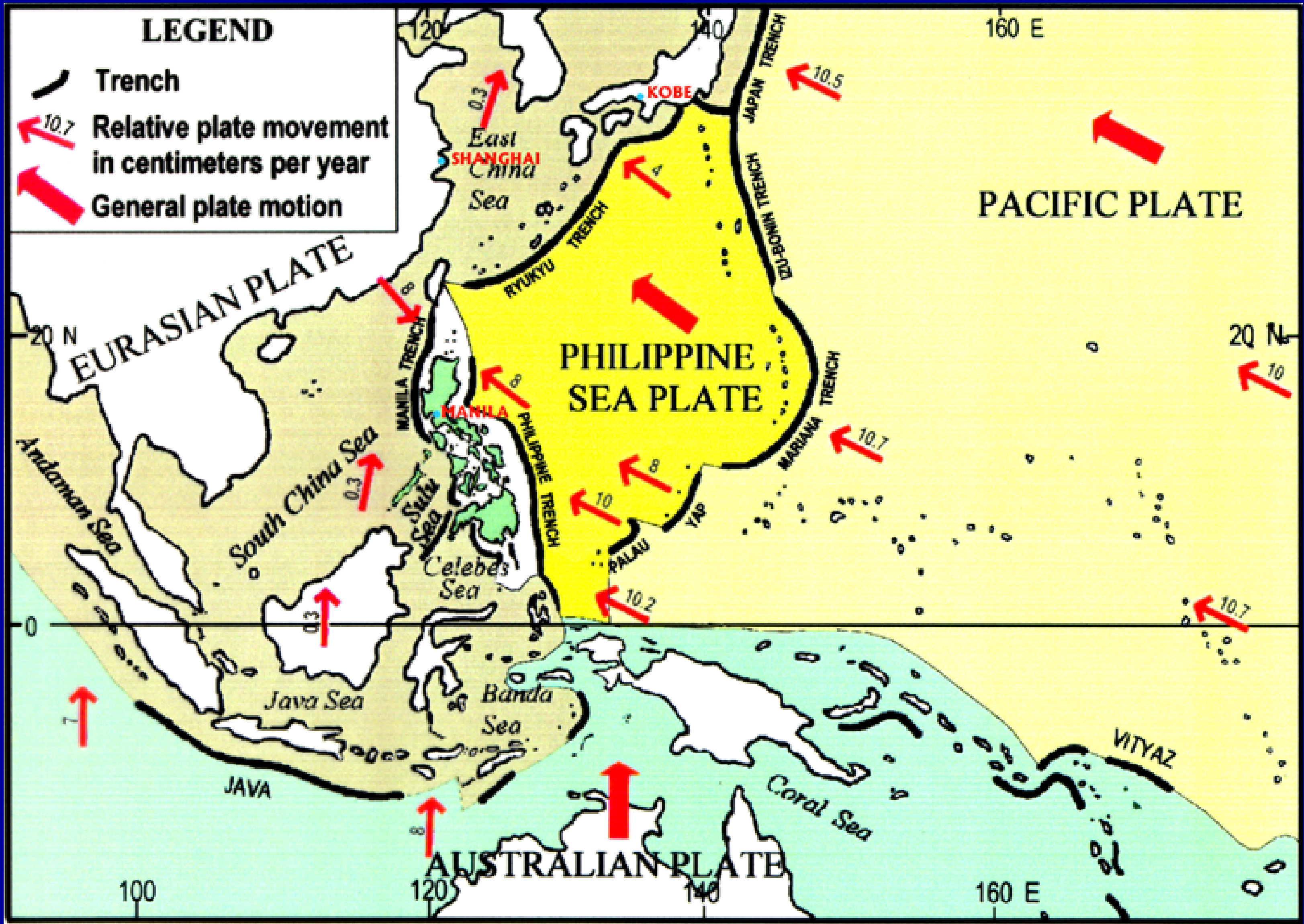
Different plates approaching the Philippines



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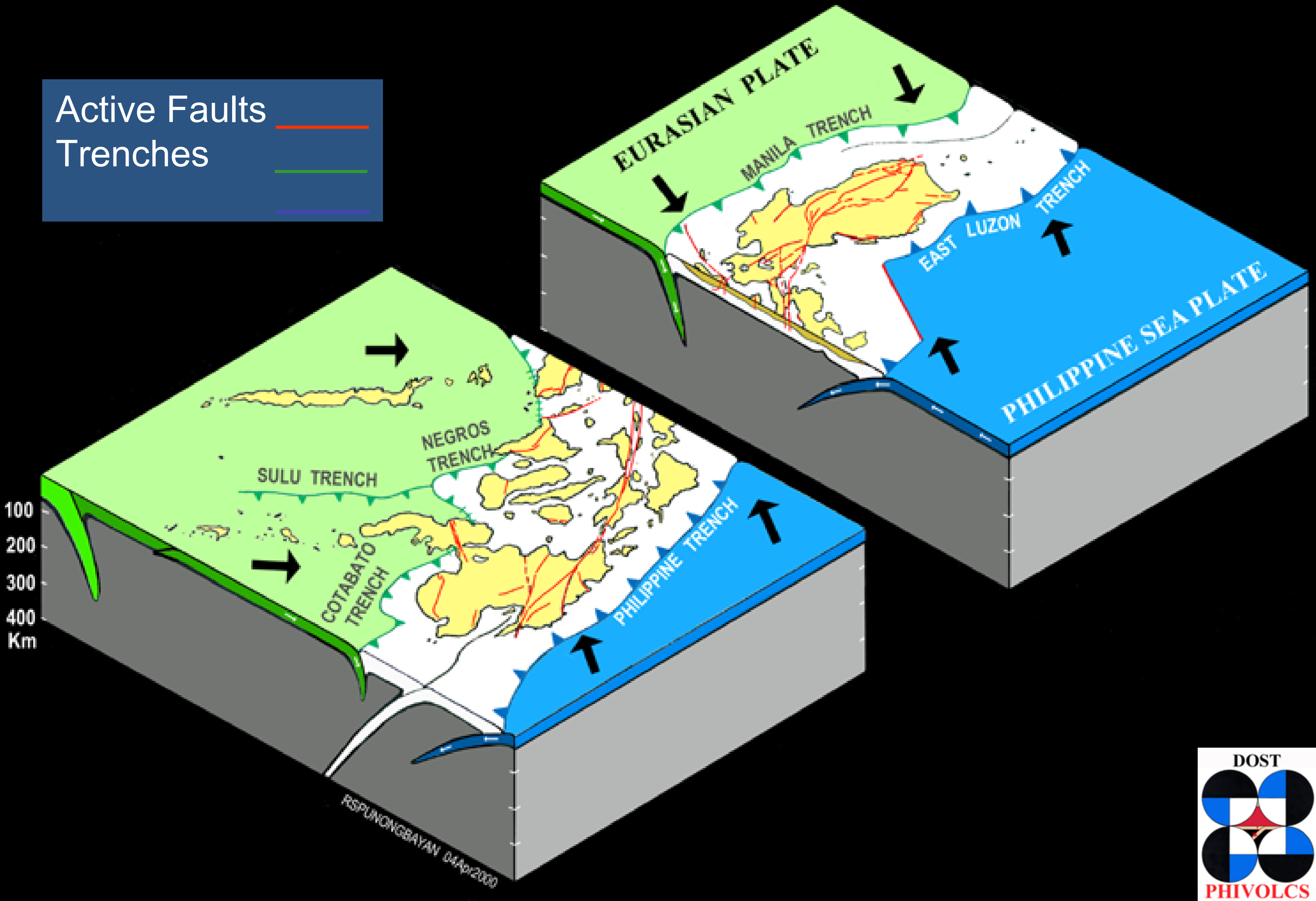
Earthquake Generators in the Philippines



EARTHQUAKES

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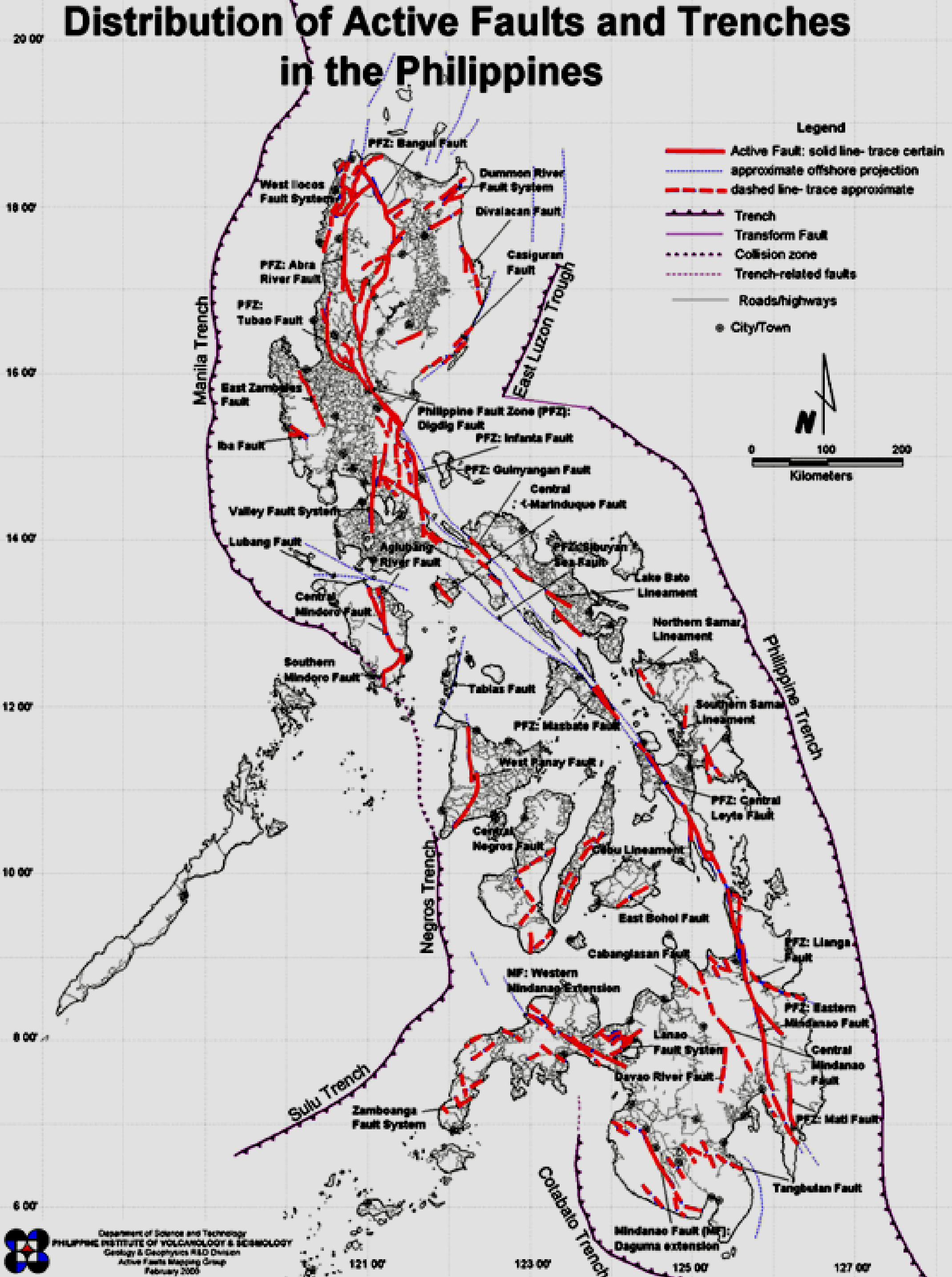

Earthquake Generators in the Philippines: *Active Faults* and *Trenches*

An ACTIVE FAULT is defined as a fault, which has moved within the last 10,000 years.

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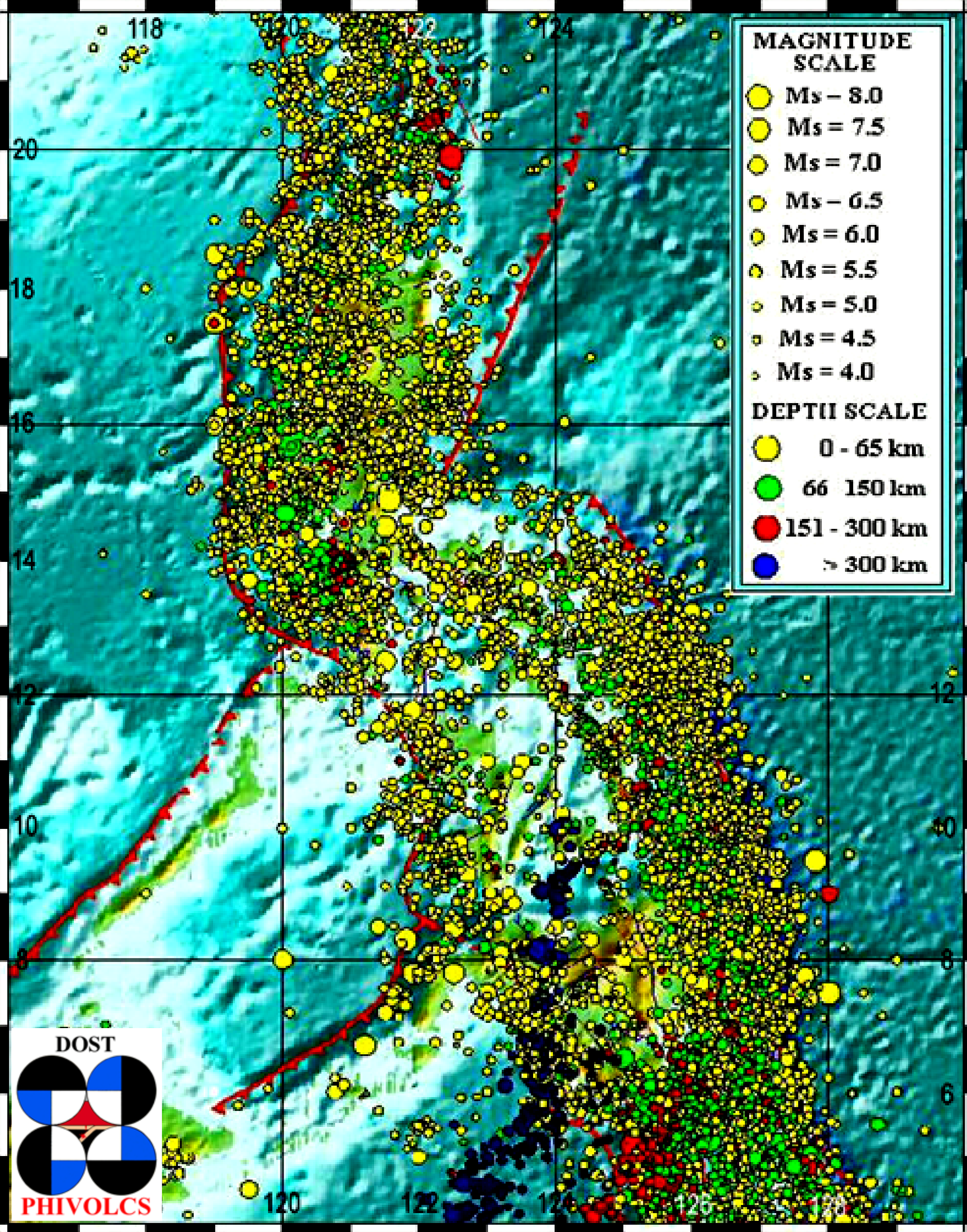

EARTHQUAKES IN THE PHILIPPINES

(1608-2002)

Magnitude 4 or greater

~ an average of 20 earthquakes recorded per day

~100-150 felt per year

~90 destructive earthquakes for past 400 years

~ 40 tsunamis for past 400 years

Recent examples of devastating earthquakes in Asia

1990, Luzon, Philippines	M7.8	1,280 dead	
1990, western Iran	M7.7	40,000 dead	
1991, northern India	M7.0	2,000 dead	
1992, Flores, Indonesia	M7.5	2,500 dead	(with tsunami)
1993, India	M6.2	9,748 dead	
1995, Kobe, Japan	M6.9	5,502 dead	
1997, northern Iran	M7.5	1,560 dead	4,460 injured
1998, Afghanistan	M6.1	2,323 dead	
1998, Afghanistan	M6.9	4,000 dead	
1999, Izmit, Turkey	M7.6	17,118 dead	50,000 injured
1999, Taiwan	M7.7	2,297 dead	8,700 injured
2001, Bhuj, India	M7.7	20,023 dead	167,000 injured
2003, Bam, Iran	M6.6	26,200 dead	30,000 injured
2004, Sumatra, Indonesia	M9.0	283,000 dead	(with tsunami)
2005, Pakistan	M7.6	80,361 dead	
2006, Java, Indonesia	M6.3	~ 5,800 dead	

Earthquake threat is high in populated or commercialized/industrialized cities

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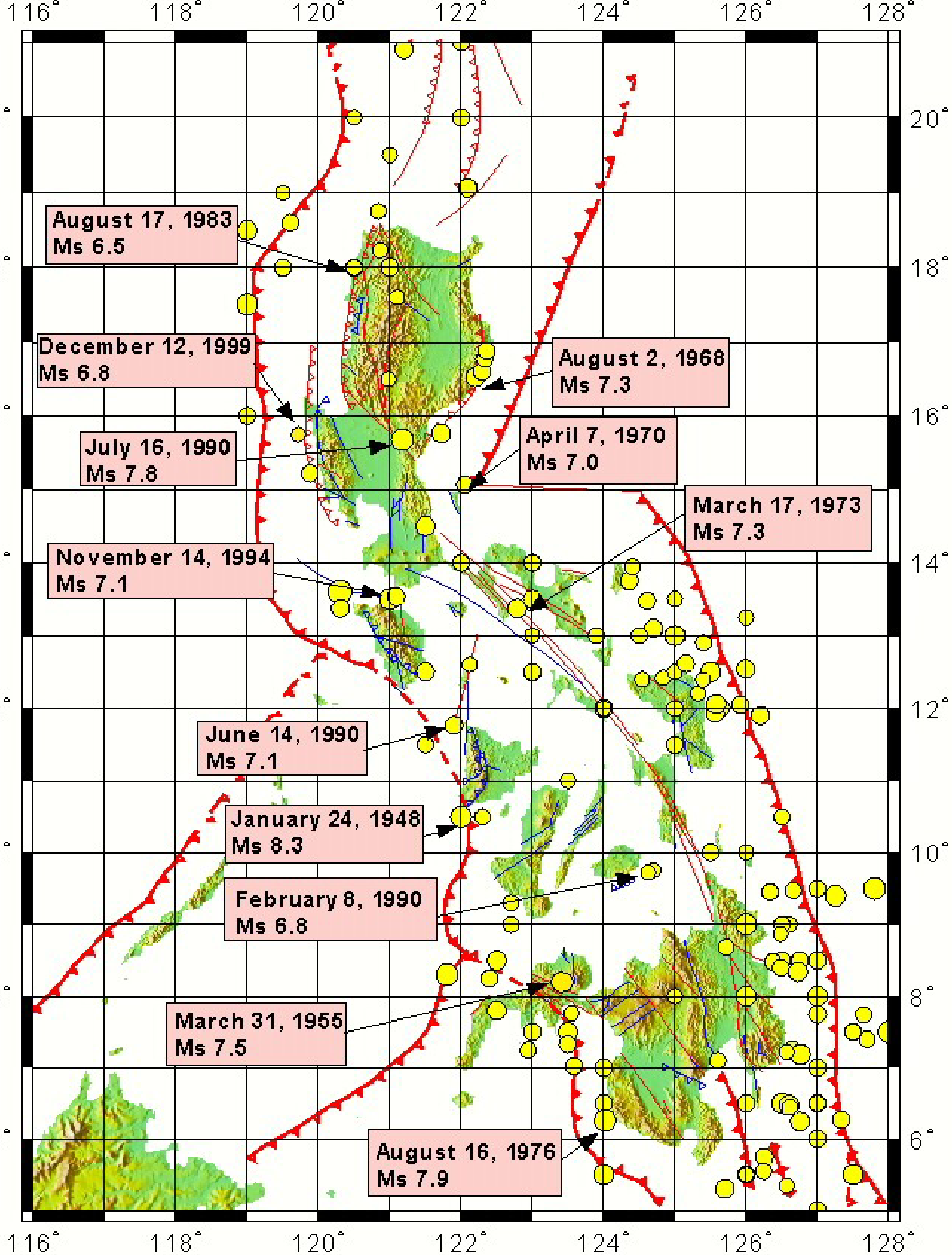

Most Damaging Earthquakes from 1900 to 1999
(compiled by Bautista, 1999)

DESTRUTIVE EARTHQUAKES OF THE PHILIPPINES

01 Apr 1955 Lanao (291 dead/713 injured)

02 Aug 1968 Casiguran (270/600)

07 Apr 1970 Baler (15/200)

17 Aug 1976 Moro Gulf (3,739/8,000)

16 July 1990 Luzon (1,283/2,786)

15 November 1994 Mindoro (78)

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1990 M7.8
Northern Luzon Earthquake

Death – 1,283

Injuries – 2,786

Families affected – 227,918

Direct Damage – PhP 12.226 billion
(US$ 244 million)

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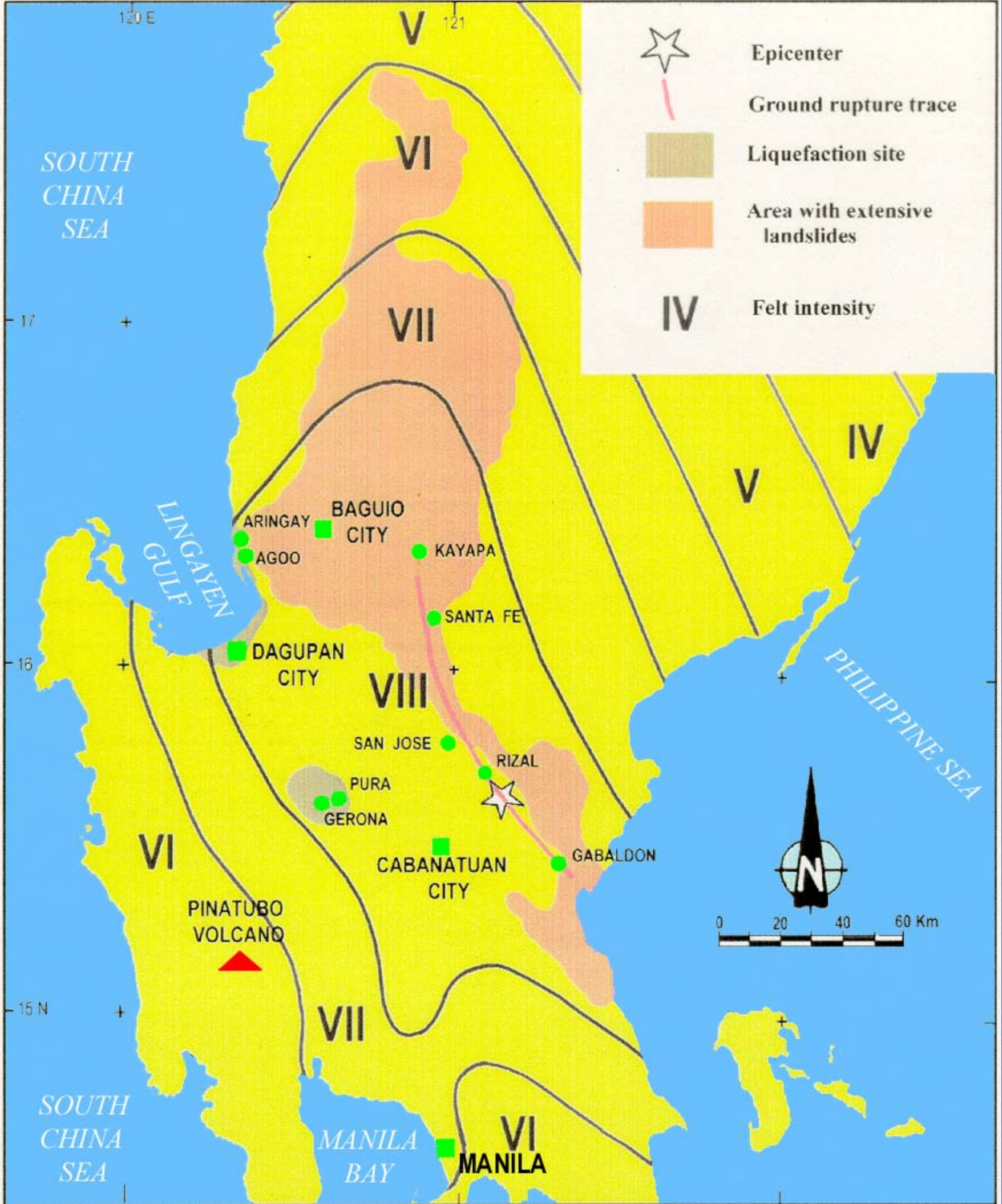

IMPACTS OF THE 16 JULY 1990 M7.8 NORTHERN LUZON EARTHQUAKE

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Ground rupture
(125 km long)

Fault →

← Fault

Pilapils (rice paddy dikes) in Imugan, Nueva Vizcaya displaced left-laterally by the ground rupture of the 1990 Luzon Earthquake.

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Collapse of Buildings

July 16 1990 Luzon Earthquake

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Liquefaction

Dagupan City, Pangasinan - July 16 1990 Luzon Earthquake

Landslides

Earthquake triggered, Luzon, 1990

TSUNAMIS

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Tsunami

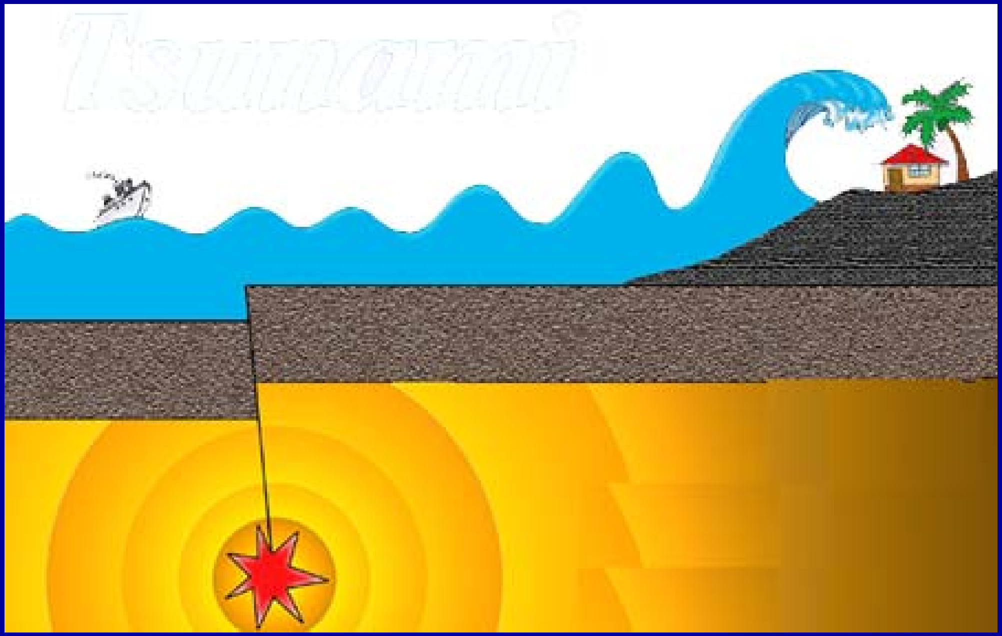
Large sea waves resulting from the disturbance of seawater by:

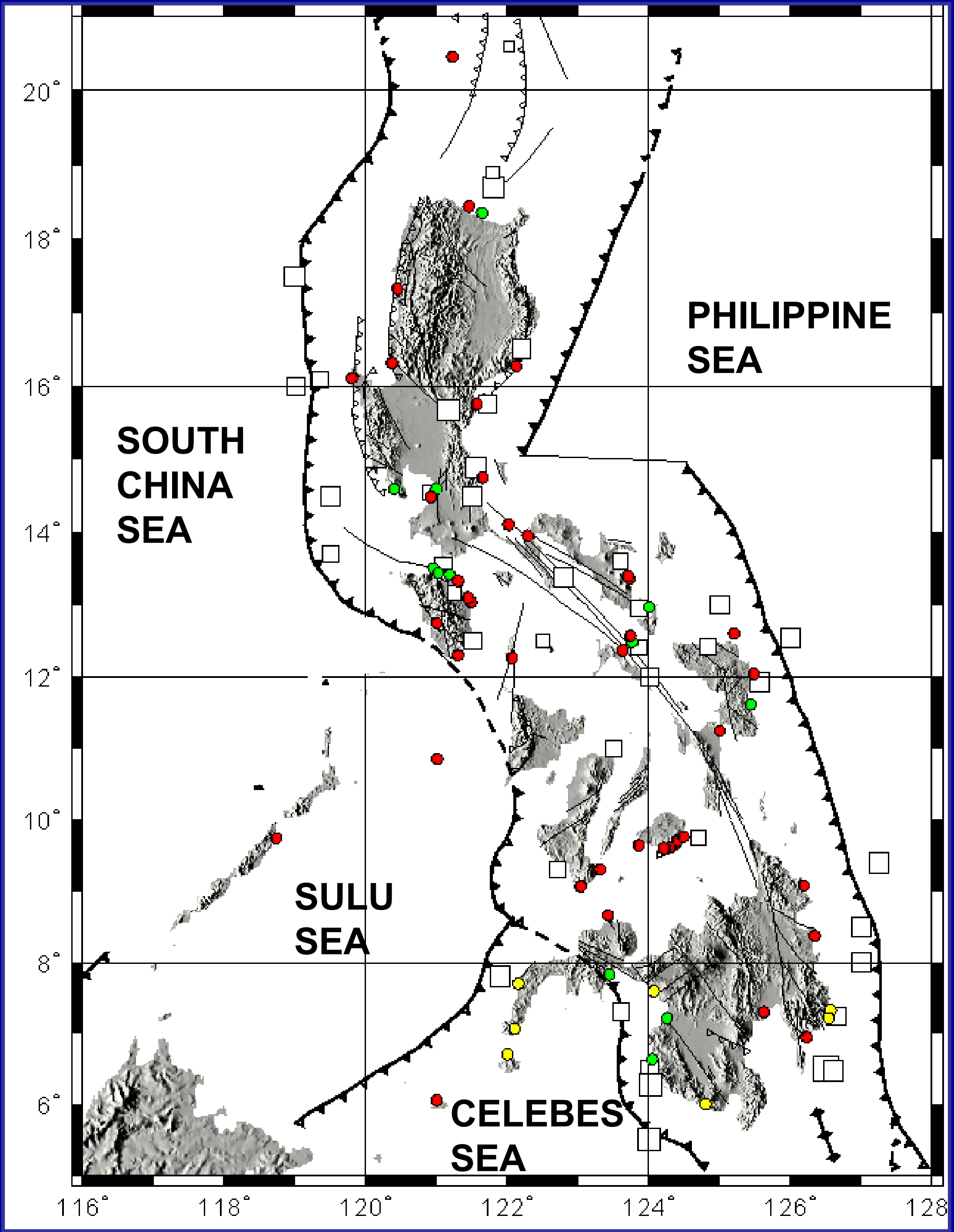
1) commonly by vertical displacement of the ocean floor associated with a strong and shallow earthquake

2) Submarine volcanic explosions

3) Landslides

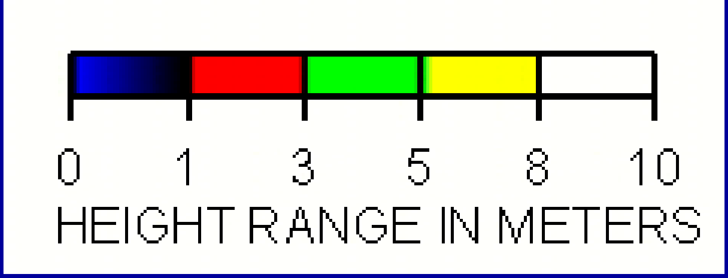
4) Meteor impact





Tsunami-Affected Areas in the Philippines

(~40 tsunamis for past 400 yrs)



- Epicenter of tsunamigenic earthquake

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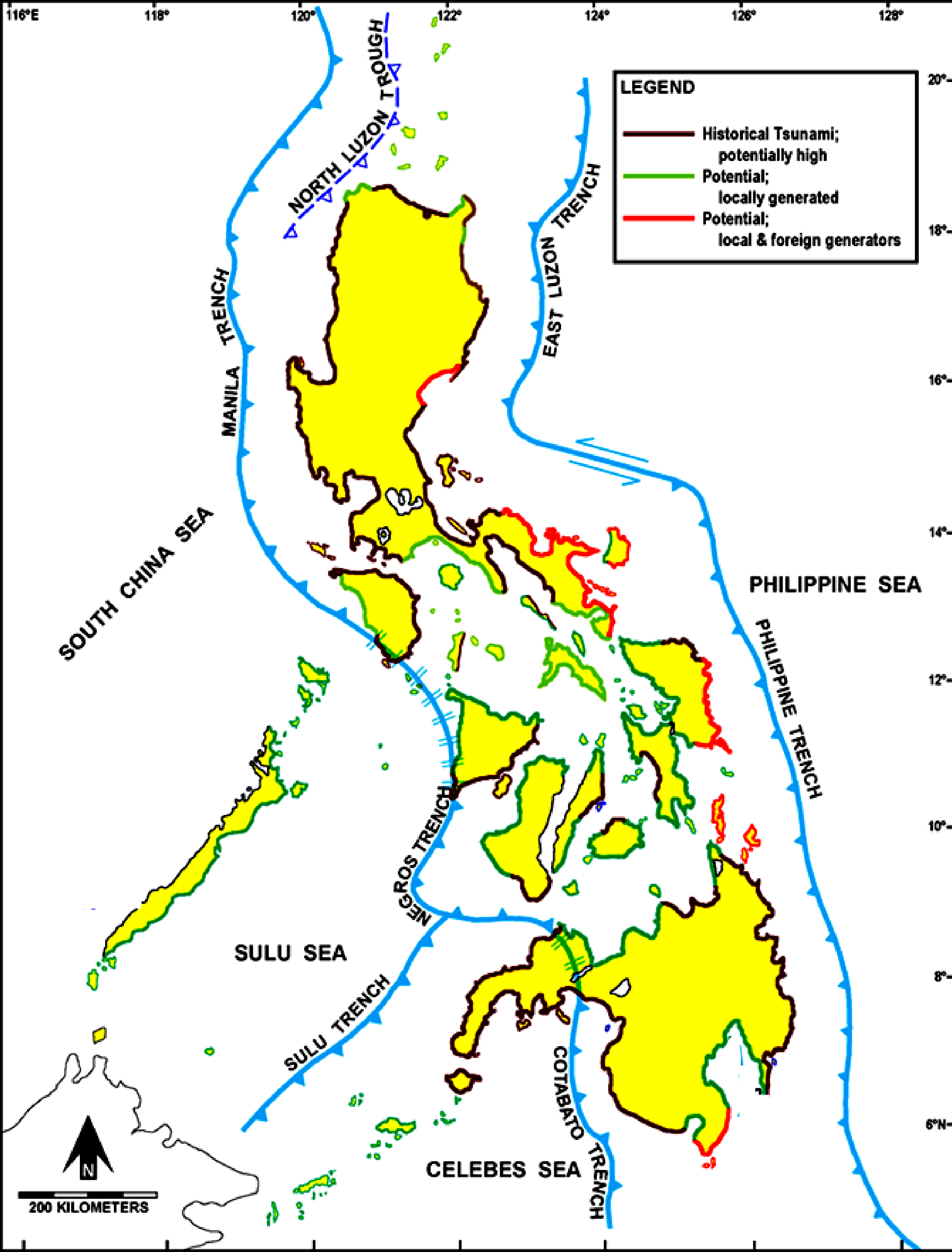

Tsunami Prone Areas in the Philippines

(to be further refined with new modeling results and detailed field investigation)

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1976 M7.9
Moro Gulf Earthquake and Tsunami

Death – 3,700

Injuries – 8,000

Families affected – 12,000

Direct Damage – PhP 276 million
(US$ 5.5 million)

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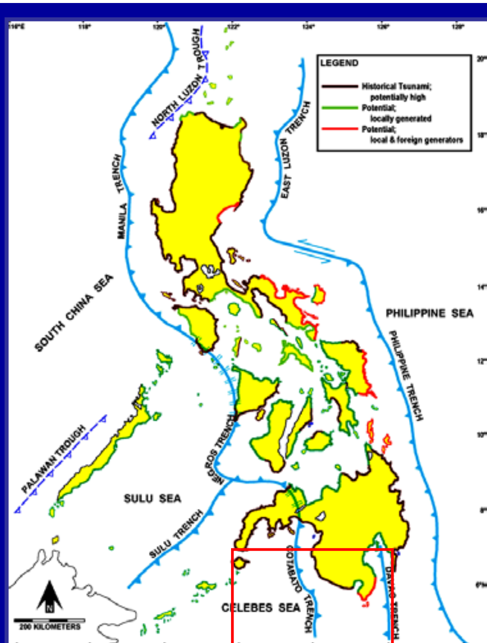
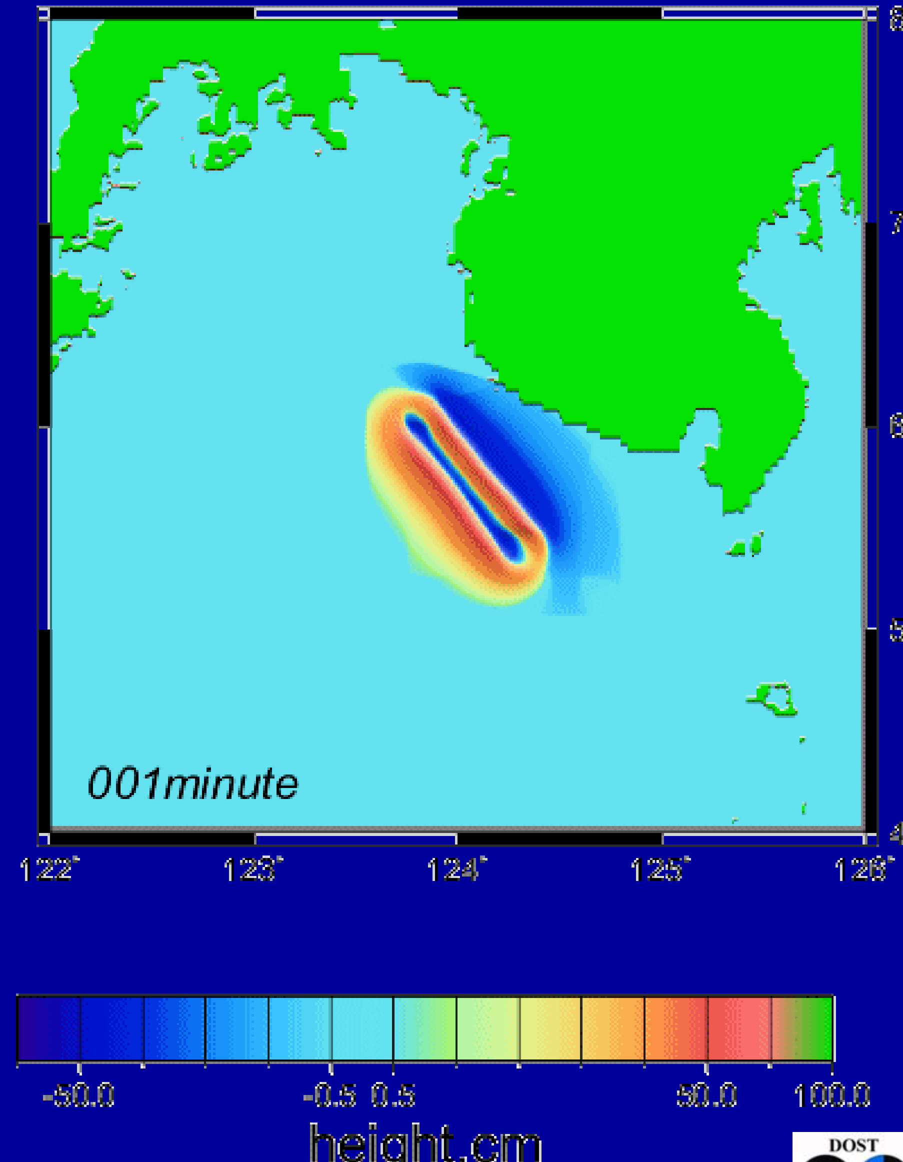
August 1976 Moro Gulf Earthquake & Tsunami

(M7.9, < 33 km)





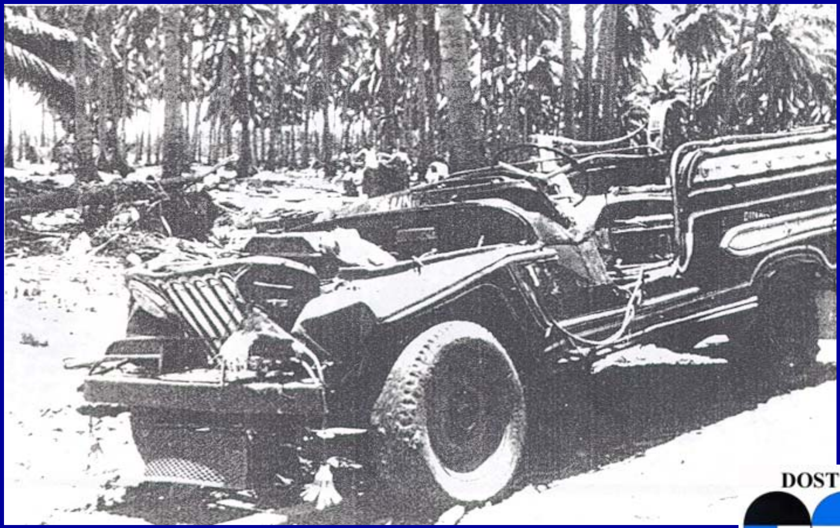
- First waves reported within 2-5 minutes of the main shock
- Series of waves (~3- 7 waves reported), 1-5 minutes apart

Tsunami Impacts: 1976 Moro Gulf Earthquake

Inundated villages

Damaged houses & buildings

Transported bancas



Crushed vehicles

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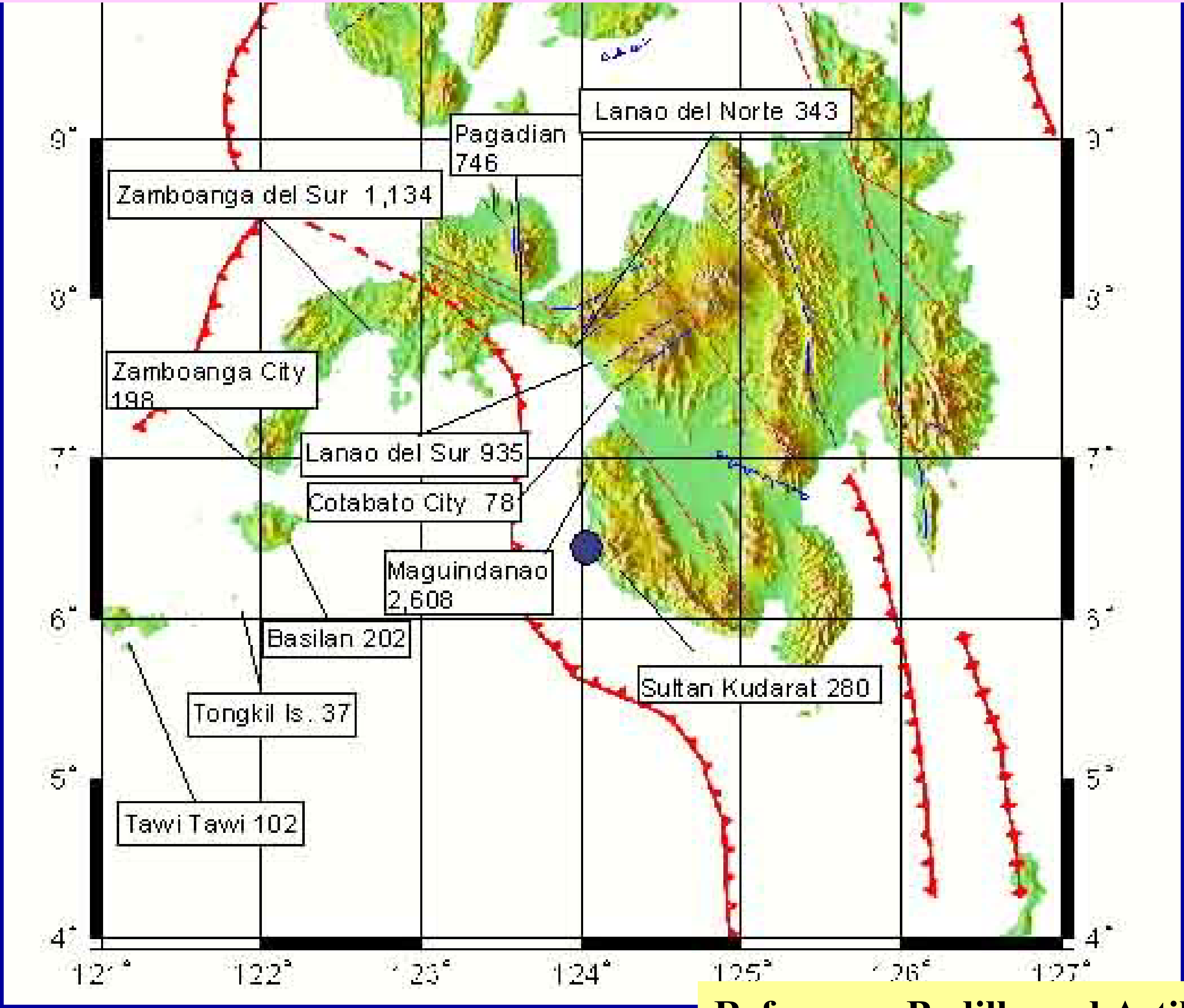
The 1976 August 17 Moro Gulf Earthquake and Tsunami: Number of Casualties



From L. Bautista (PHIVOLCS-DOST)

Reference: Badillo and Astilla, 1978

TYPES OF TSUNAMI

Type	Source	Lead time earthquake to tsunami	Warning mechanism
LOCAL	trench or fault in Philippine region, usually less than 200 km from shoreline	2 – 20 minutes	Community-based *must rely on natural signs such as moderate to intense shaking in coastal area, rapid sea level retreat or rise, unusual sound*
DISTANT *Regional or Trans-Pacific*	trench or fault outside the Philippine region (*ex. Japan, Hawaii, Chile*)	1 – 24 hours	International Centers* ⇒PHIVOLCS ⇒NDCC * *Pacific Tsunami Warning Center, NW Pacific Tsunami Advisory Center*)

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Tsunami Risk Reduction

Knowing Hazard

- Understanding tsunami
- Maximum tsunami height
- Minimum arrival time
- Duration
- Inundation area (Tsunami hazard mapping)

Knowing Vulnerability

- History of tsunami disaster
- Land use management
- Loss estimation of human lives and property

Knowing Measures

- Public education (School curricula, information materials, tri-media, markers, signages, museums)
- Identification of evacuation routes and sites
- Conduct of earthquake and tsunami drills
- Capacity building on emergency management
- Tsunami warning National and community-based
- Mitigation

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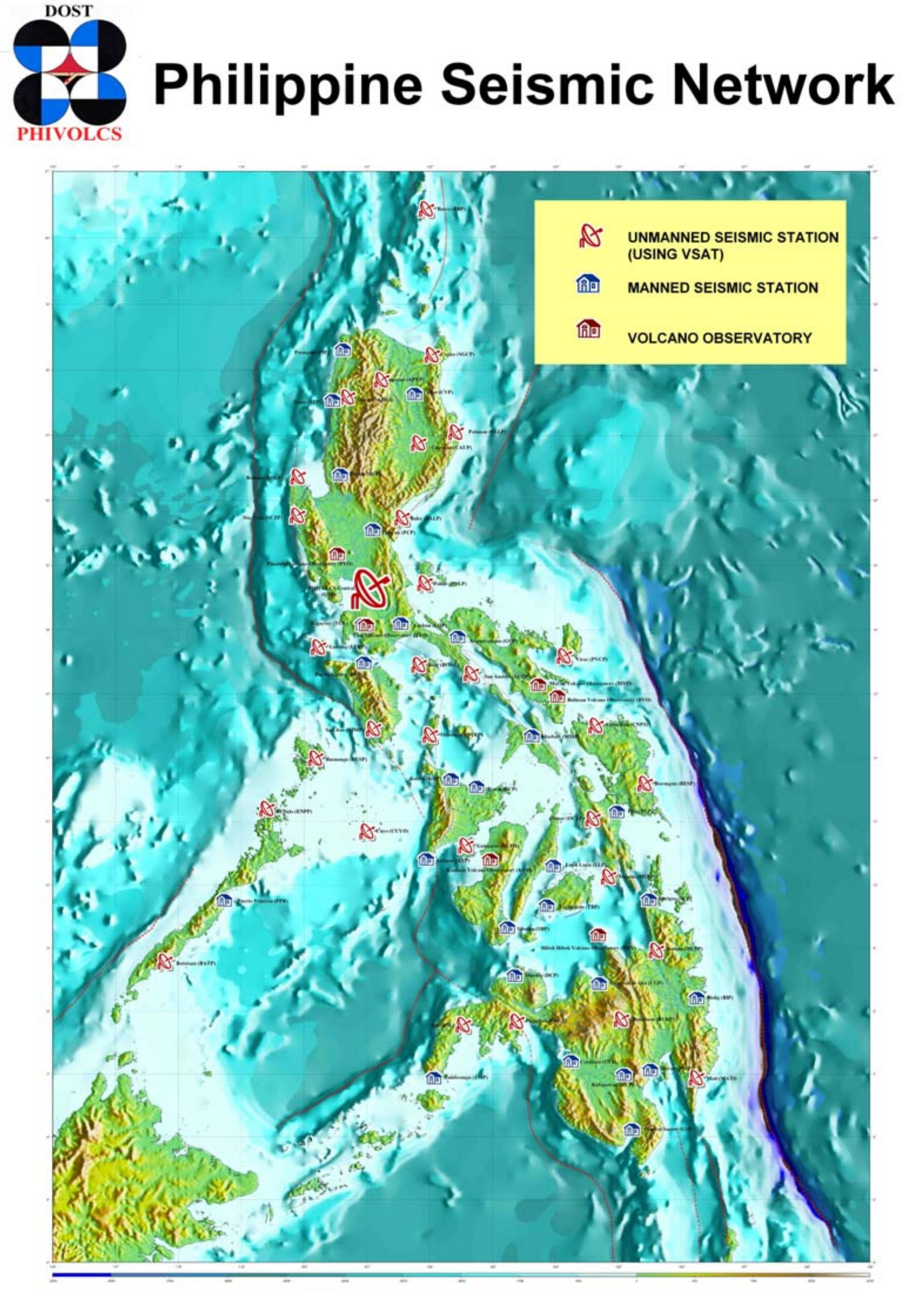

Philippine Seismic Monitoring Network

- 29 satellite-telemetered stations with near-real time data transmission
- 35 manned stations equipped with SSB radios and telephones for non-real time data transmission

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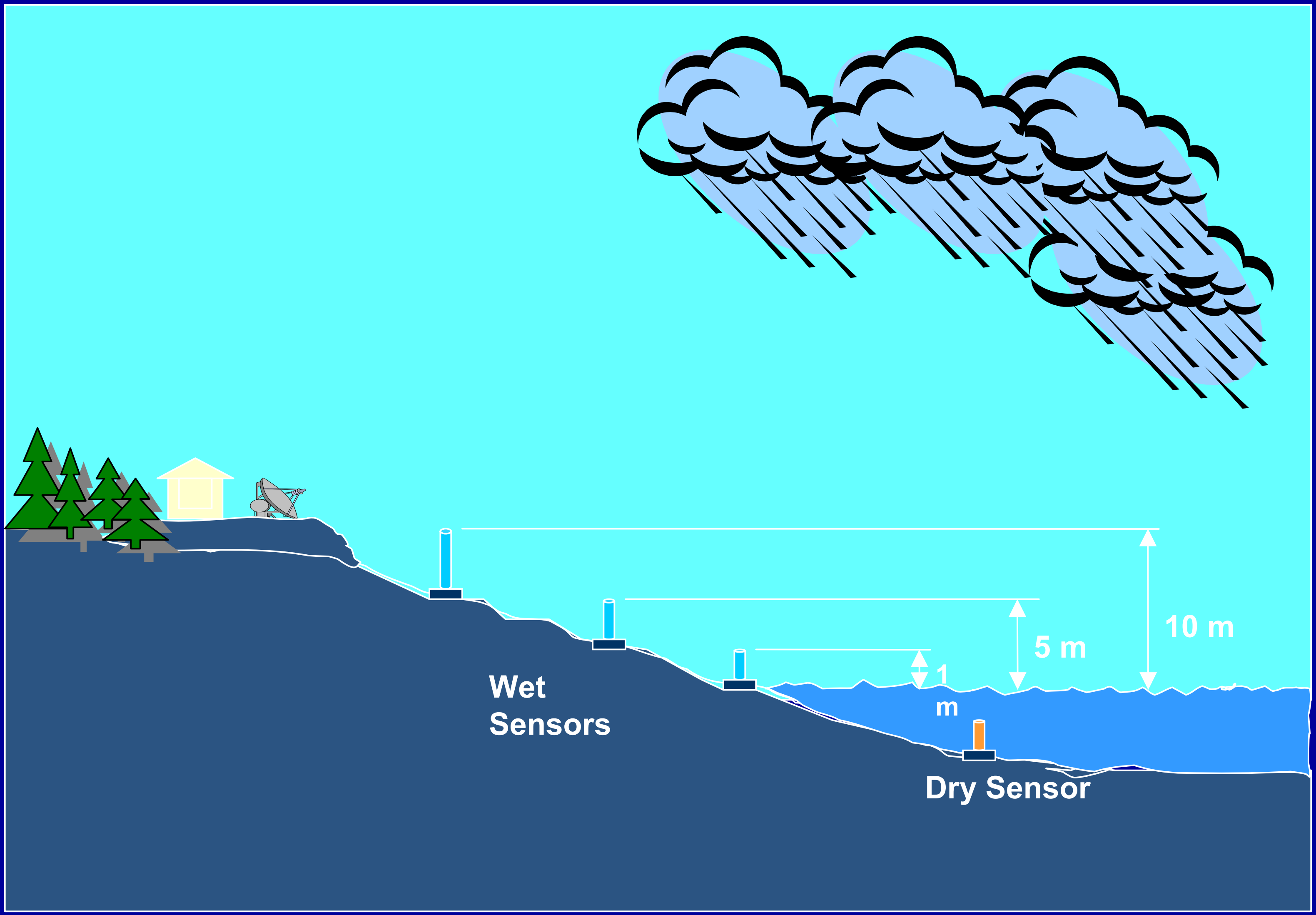
Establishment of Local Tsunami Warning Systems

(Deployment of Tsunami Sensors in Lubang Island, near Mindoro)



VOLCANIC ERUPTIONS

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Volcanoes of the Philippines

- 300 volcanoes
- 22 considered active *(with eruption witnessed by man or latest eruption <10000 years)*

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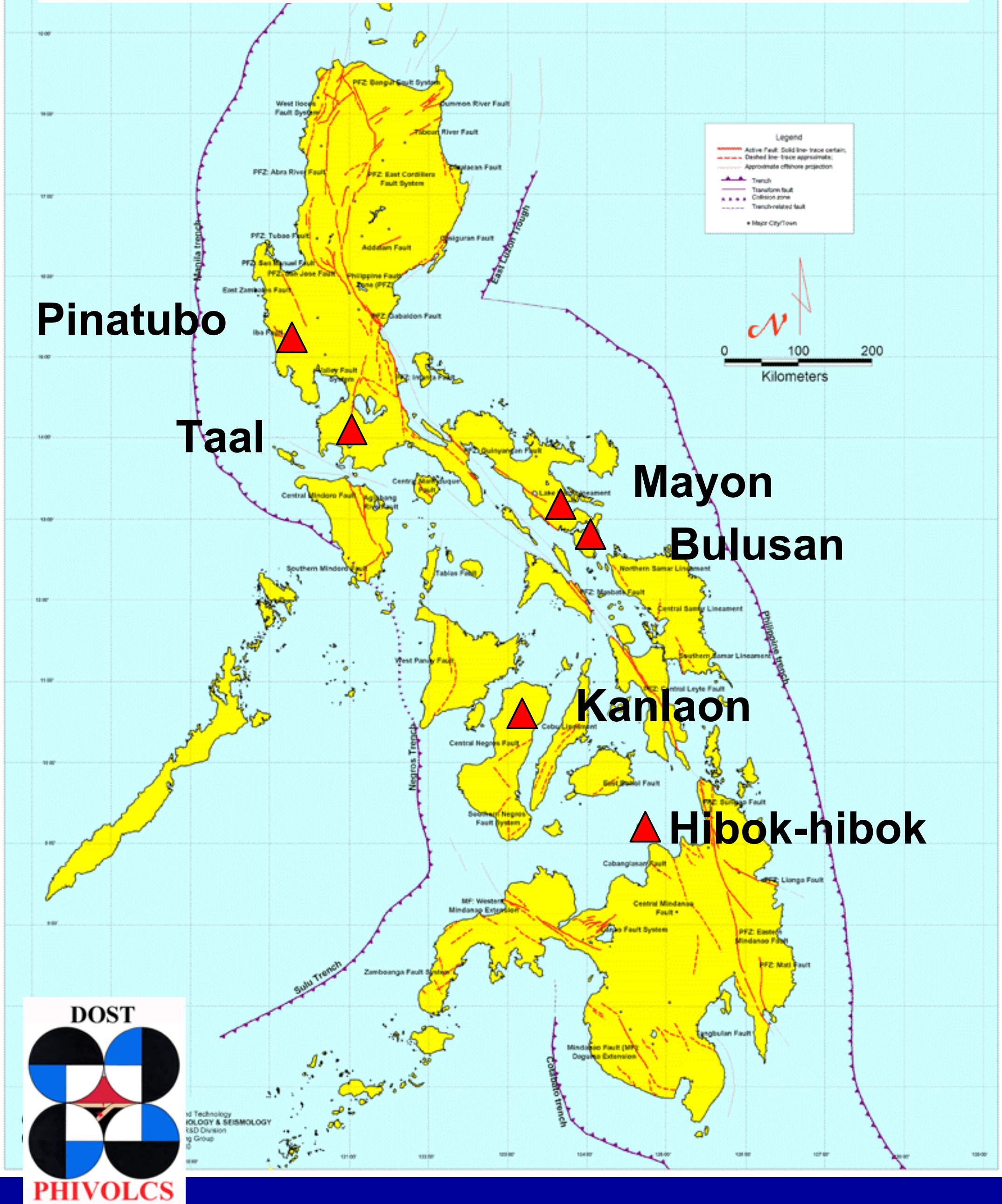
Volcano Monitoring in the Philippines

MONITORED VOLCANOES



* 6 Volcano Observatories (Pinatubo, Taal, Mayon, Bulusan, Kanlaon, Hibok-hibok)

- Seismic
- Visual
- Geochemical
- Hydrological
- Ground deformation

* Central Office staff - survey-type activities (e.g., hazards mapping)

* Data from observatories sent at least twice daily to Central Office

1991 Pinatubo Eruption

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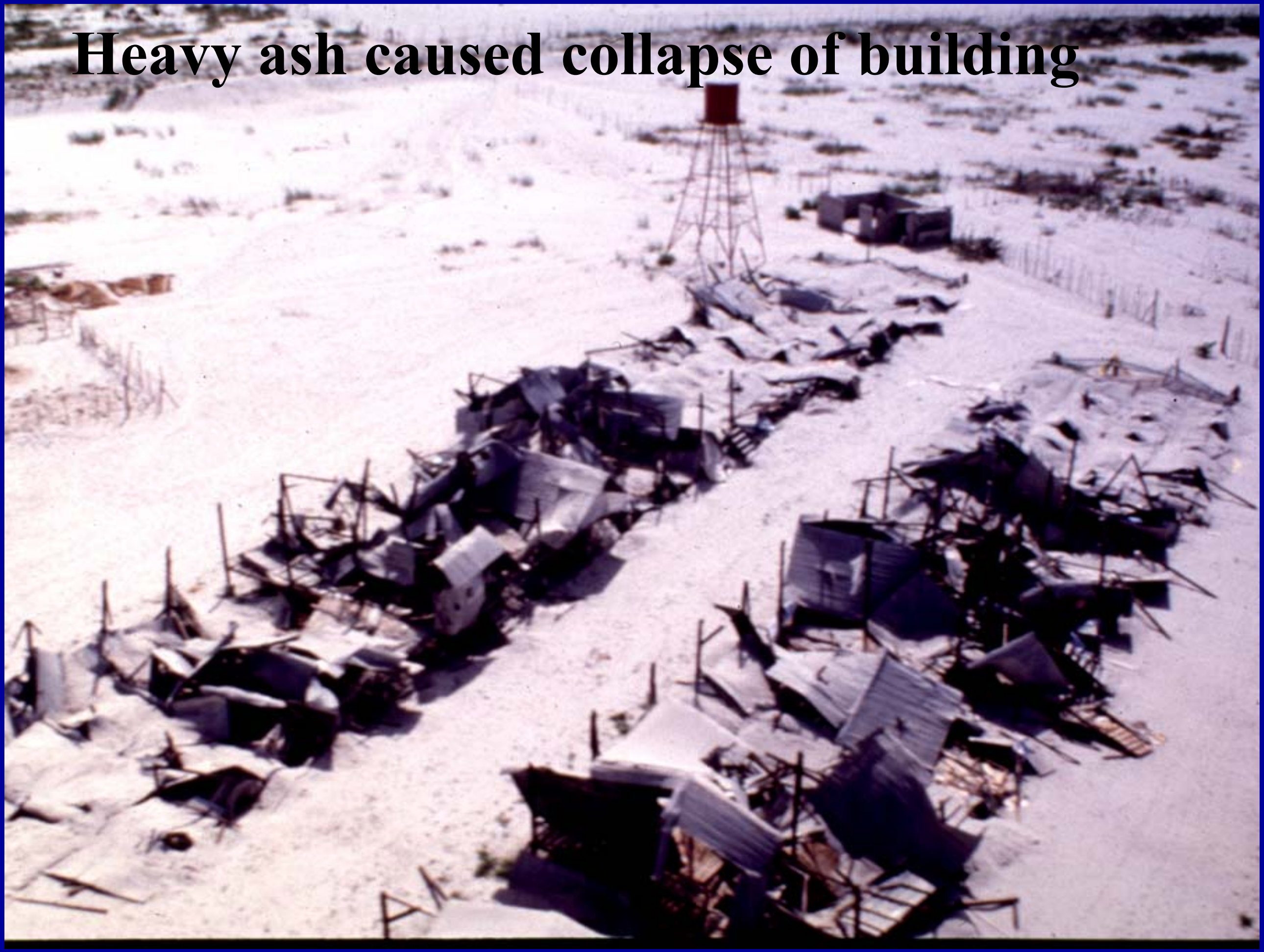
Ashfall



~ 4 km^3 of airfall deposits were dispersed

Pyroclastic Flow

~ 5 km^3 of pyroclastic flow materials deposited on slope

Filling of river valleys with pyroclastic flow deposits (1991 Eruption of Pinatubo Volcano)

Lahars (Volcanic mudflows)

- Flow of water and eroded volcanic materials, with sediments between 20 to 80% by volume

- Lahar a longer lasting hazard years after the eruption of Pinatubo

Impact of the 1991 Pinatubo Eruption

-More than a million people were affected

-Caused deaths of less than 300

-Burried forest and agricultural land, destroyed infrastructure, and blanketed most of Southeast Asia with ash

- Caused damage US$420 M worth of properties, infrastructure, agricultural crops and forest land

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Volcanic Activities of Four Volcanoes in 2006 (Bulusan, Kanlaon, Mayon and Taal)

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BULUSAN VOLCANO, SORSOGON

Ash explosion, 31 May 2006

Ash explosion, 23 October 2006

Exhibited steam and ash explosions from March to June 2006, October and December 2006

Current Status: Alert Level 1

PUBLIC ADVISED NOT TO VENTURE INSIDE THE 4 KM RADIUS PERMANENT DANGER ZONE

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KANLAON VOLCANO, NEGROS ISLAND

Exhibited steam and ash (phreatic) explosions/emissions in June, 2006

Current Status: Alert Level 0

PUBLIC ADVISED NOT TO VENTURE INSIDE THE 4 KM RADIUS PERMANENT DANGER ZONE

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MAYON VOLCANO, ALBAY

Current status: Alert Level 1

Public advised not to be in 7-km Extended Danger Zone (EDZ) at the southeast sector of the volcano and in the 6-km Permanent Danger Zone in other areas of the volcano.

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Mayon Volcano, 2006

Lava flow at southeastern sector from 14 July to September 2006

Mayon Volcano, 2006

Intermittent mild explosions in August to September 2006 accompanying lava flow

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TAAL VOLCANO, BATANGAS

Above normal earthquakes recorded; increasing temperature and acidity of main crater lake

Current Status: Alert Level 1

PUBLIC ADVISED NOT TO VENTURE INSIDE THE MAIN CRATER OF TAAL VOLCANO

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MASS MOVEMENTS

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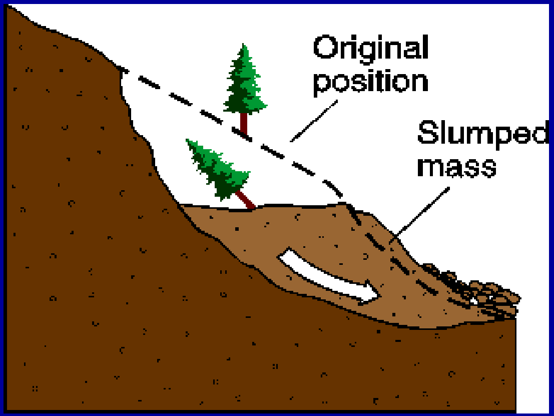
Typical types of mass movement

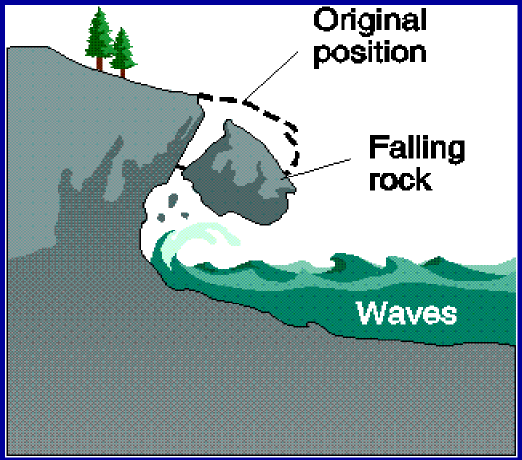
(based on velocity, kind of materials and behaviour of movement)

Creep

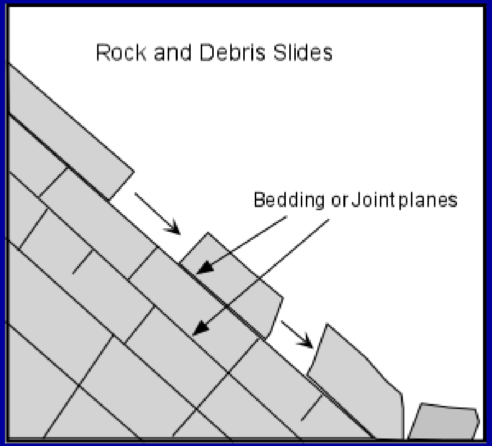
Slump



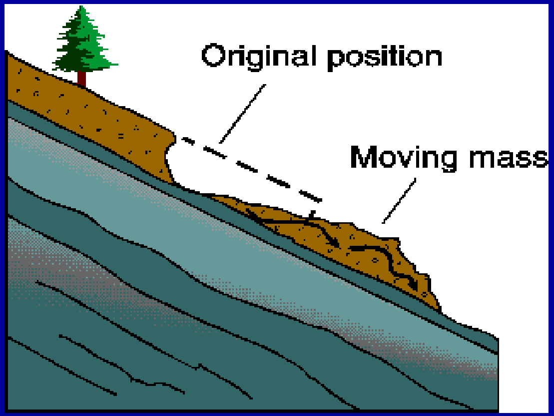
Fall



Slide



Debris Flow



Landslide in Real and Infanta, Quezon (2004)

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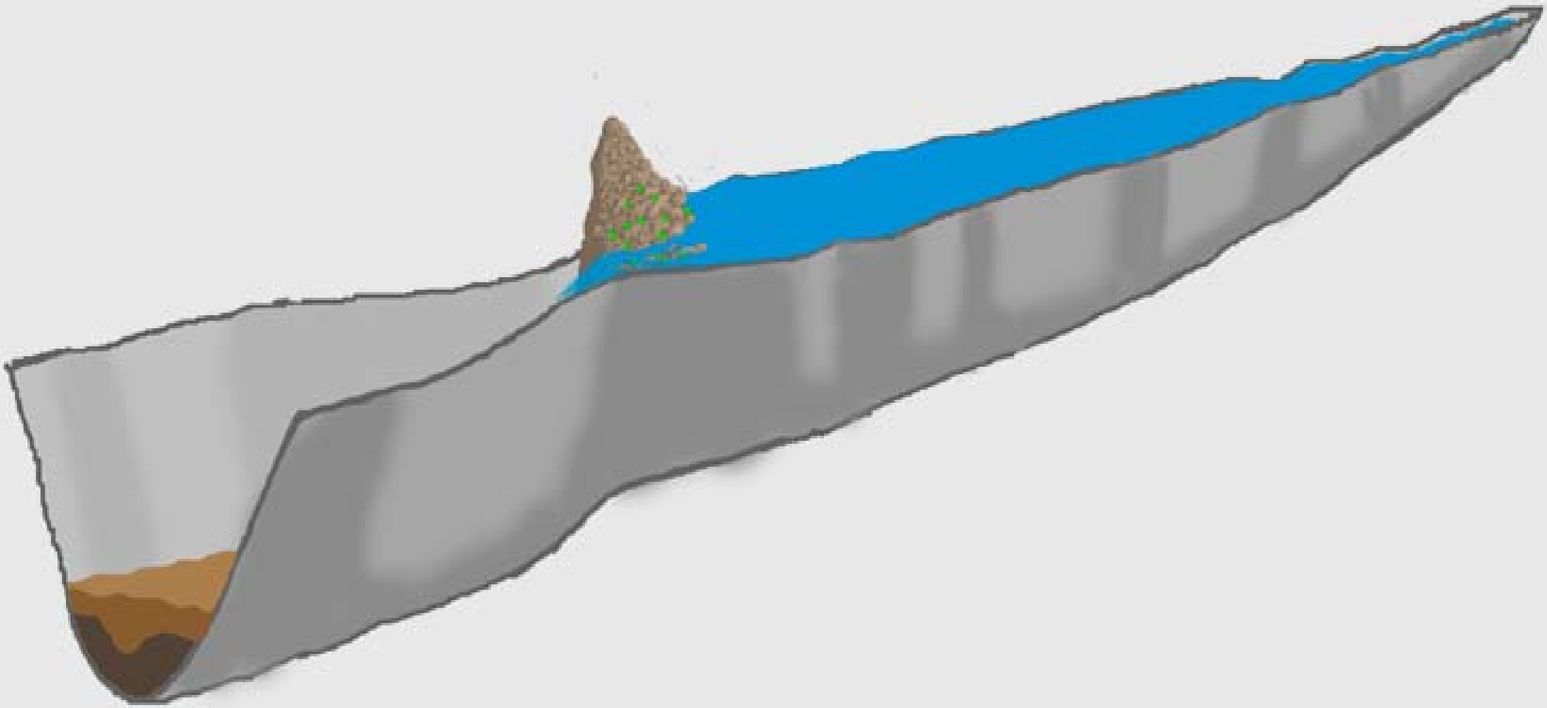
Landslide in Real and Infanta, Quezon (2004)

A chaotic pile of tree trunks, branches and roots in Infanta

OVERTOPPING OF LANDSLIDE DAM LEADING TO ITS FAILURE



Flashflood formation mechanism

Flood and mudflow damages at Infanta, Quezon

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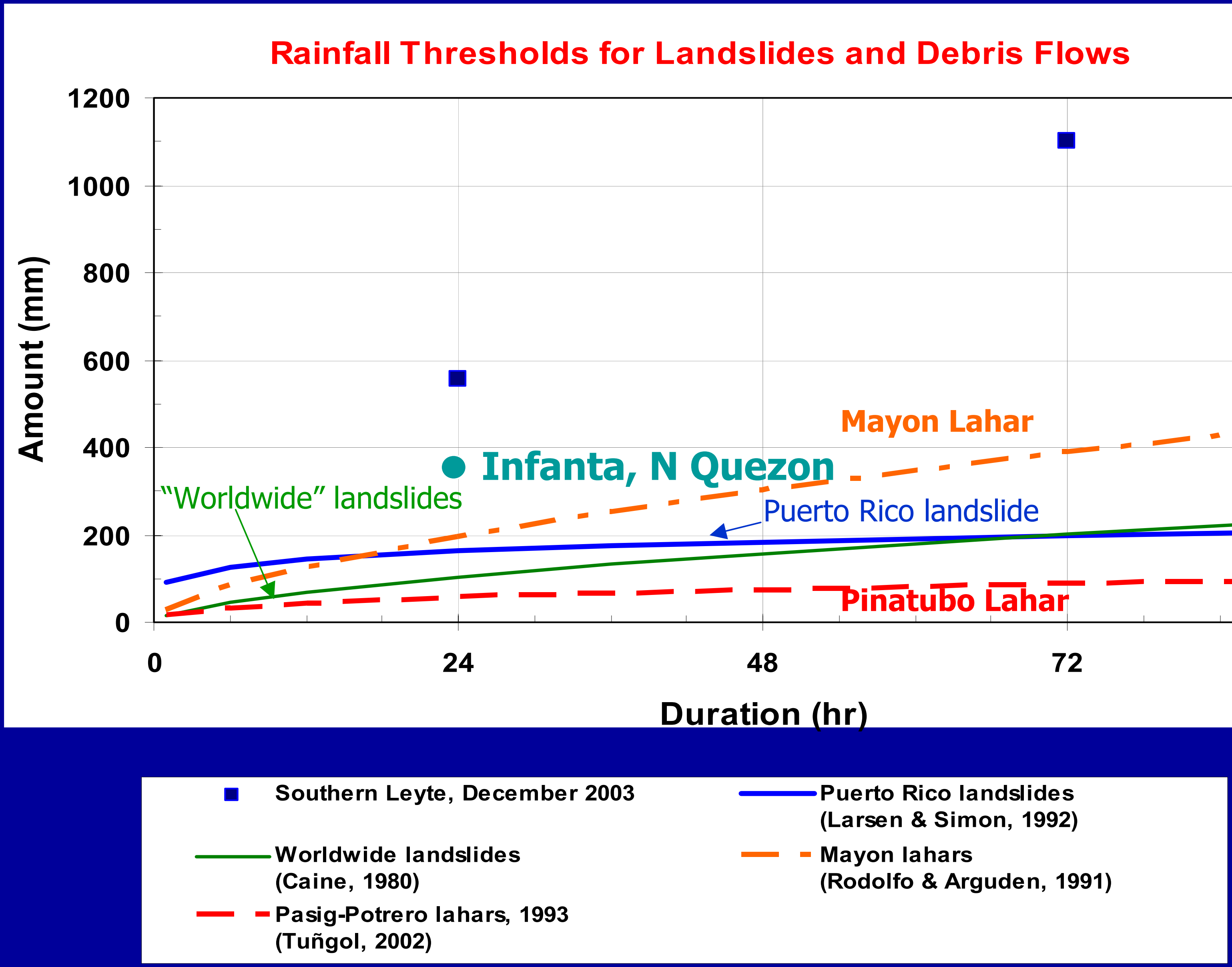
Rainfall Northern Quezon (2004) Landslides more than 3 times the typical rainfall threshold for landslides



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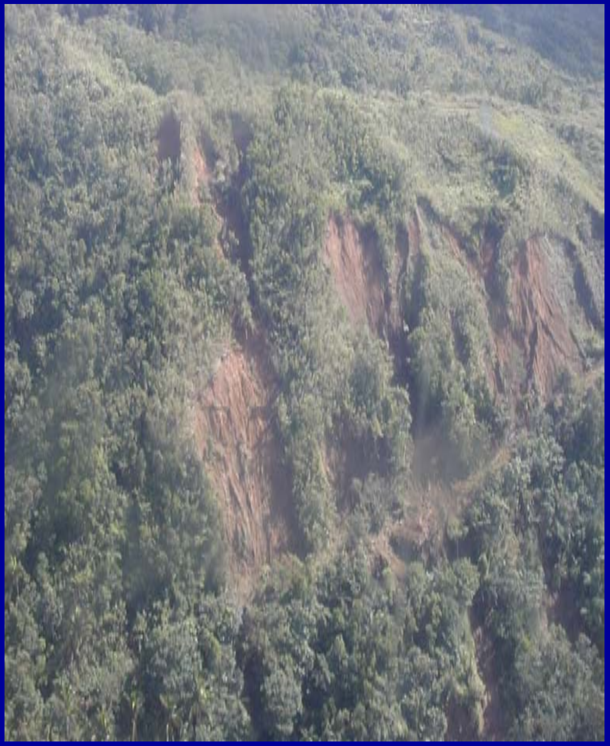
WHAT WAS THE CAUSE of NORTHERN QUEZON 2004 LANDSLIDES?

Excessive rainfall resulted into the over-saturation of thick soil in steep slopes



Very high rainfall + Thick soil + Steep slope = Landslides

Landslides -> -> Debris Flow/Flashflood → Population Centers

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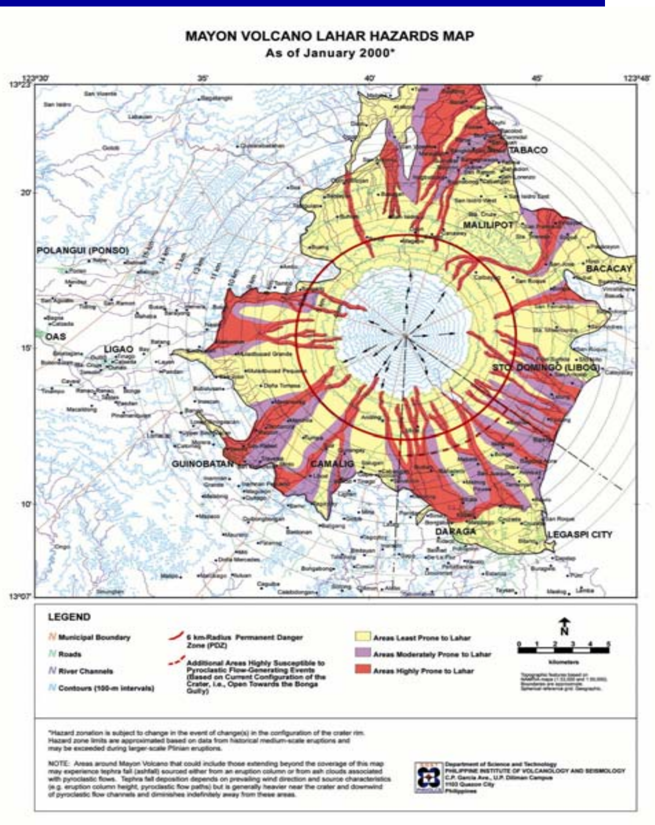
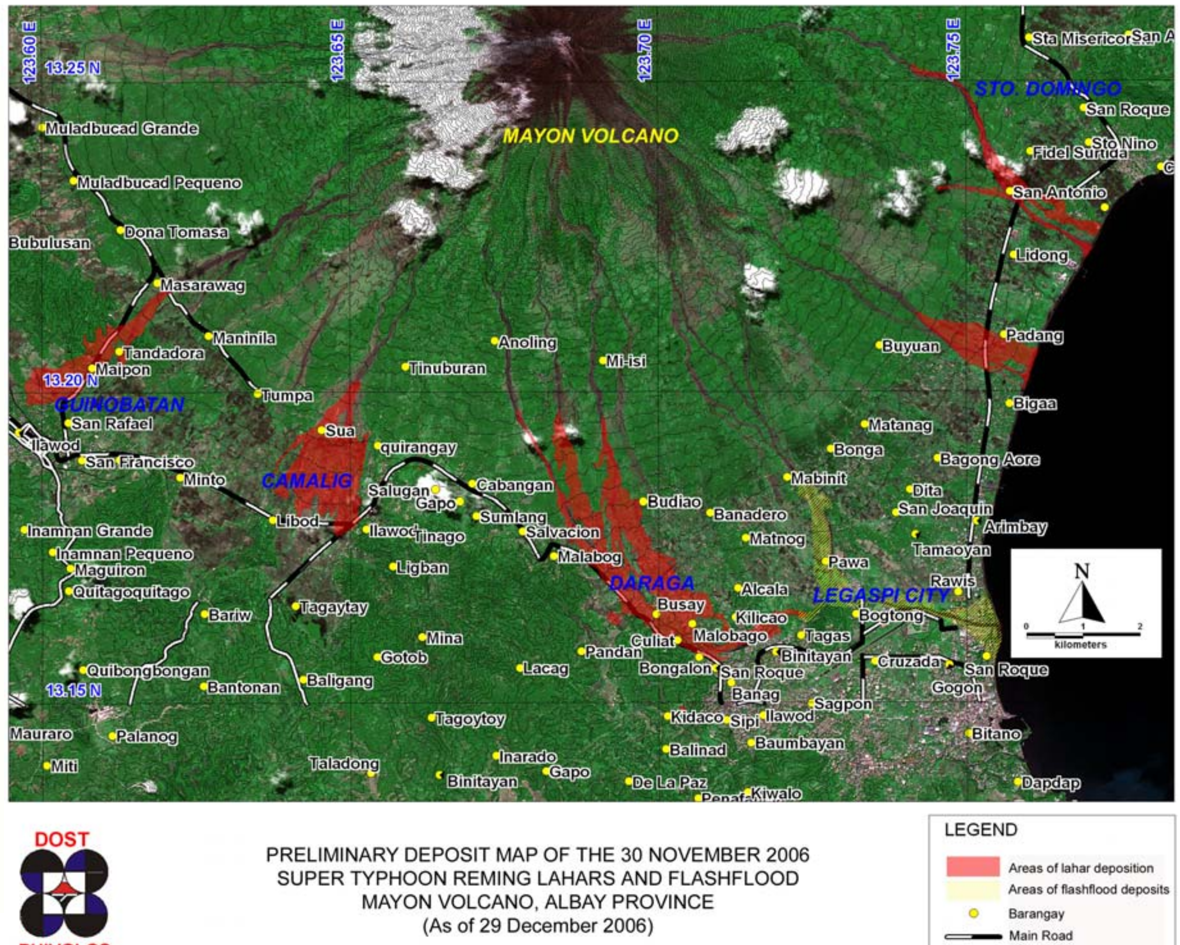
Mayon Volcano, 2006 Lahar and Flashfloods



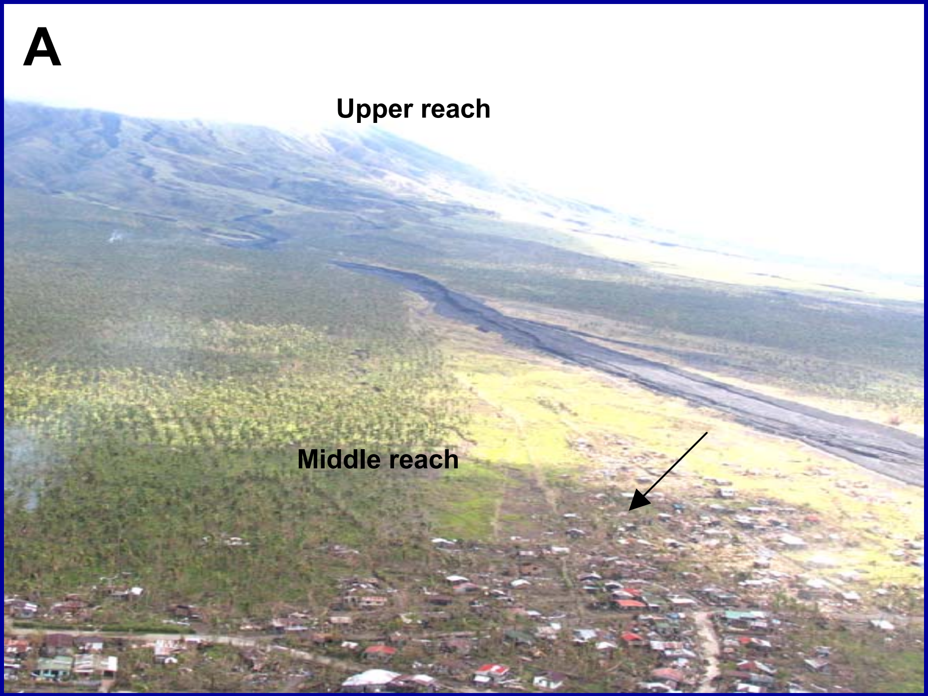
Lahar Hazards Map
PHIVOLCS-DOST



Data Source: PHIVOLCS Field Data
SPOT 5, June 2006 (NAMRIA), ALOS (JAXA)

From delos Reyes et al, 2007 (PHIVOLCS-DOST)

Mayon Volcano, 2006 Lahar and Flashfloods



From delos Reyes et al, 2007 (PHIVOLCS-DOST)

A. Erosion of 10-20 meters along the upper reach and about 2 meter deposition and subsequent 10 meter erosion along the middle reach of Masarawag Channel. Potential avulsion may threaten residents of Brgy. Masarawag. B. Two to four meter lahar deposition devastated the barangays of Tandarora, Maipon, and San Rafael in the Municipality of Guinobatan, Albay.

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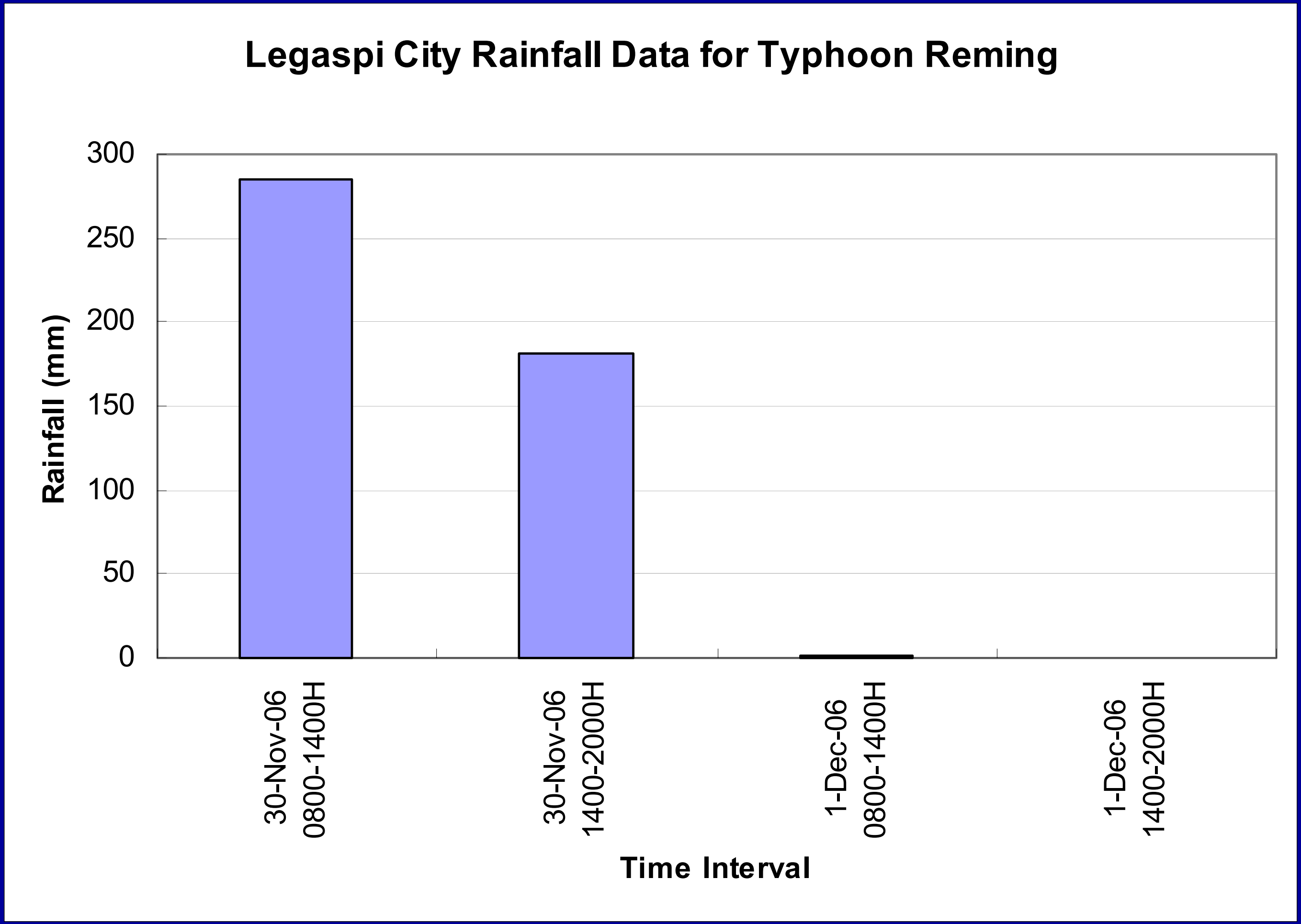
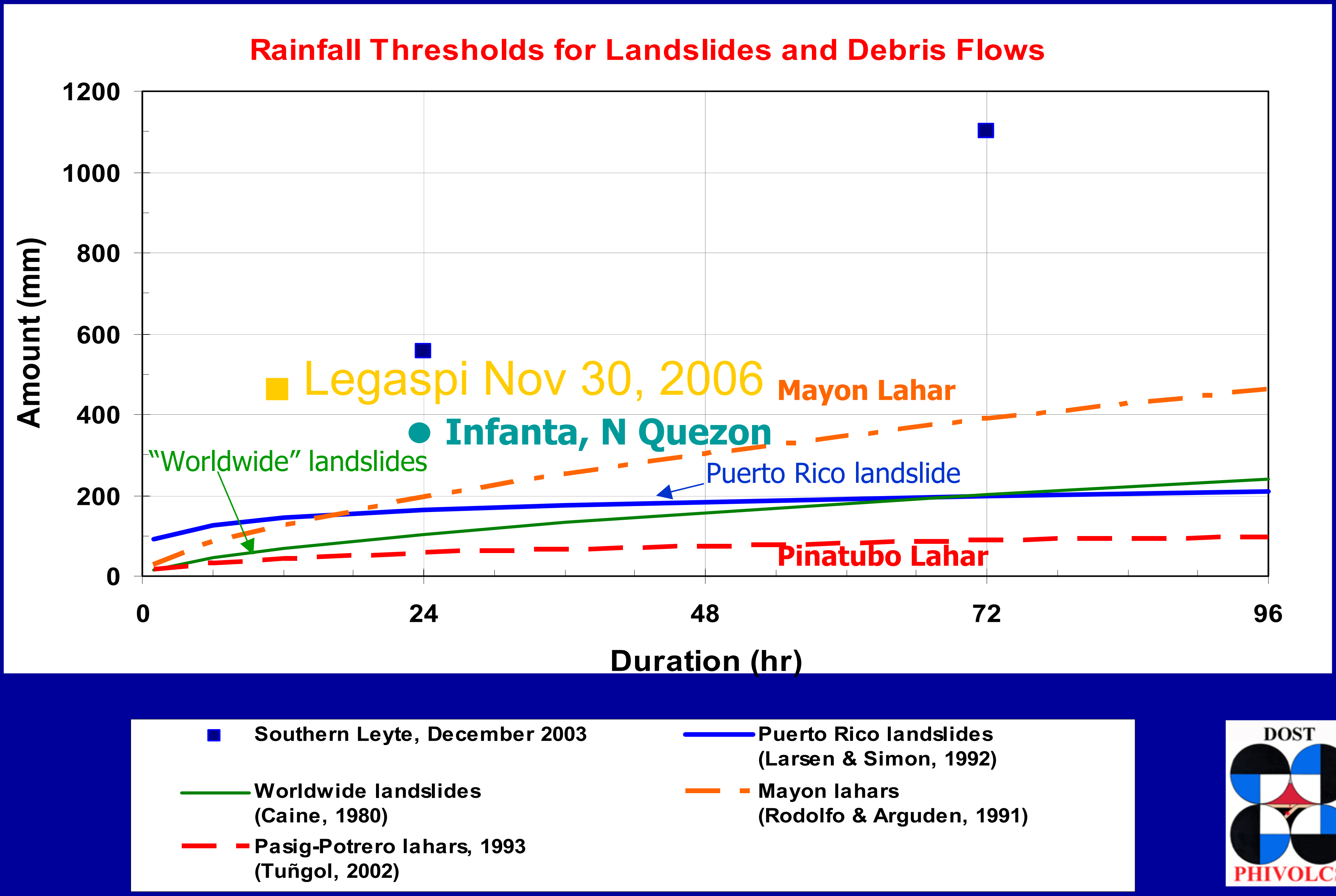


From delos Reyes et al, 2007 (PHIVOLCS-DOST)

Rainfall recorded by the Legaspi City PAGASA Station during the passage of *Super Typhoon Reming*. The six-hour rainfall from 8:00 AM to 2:00 PM of 30 November 2006 was 285 mm. Total rainfall from 2:00-8:00 PM on the same day was 181mm.

Rainfall in Legaspi (Mayon Volcano) 4 times the typical rainfall threshold for debris flows



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READY (Hazards Mapping and Assessment for Effective Community-Based Disaster Risk Management)

and

GOP (Government of the Philippines) **Projects on Disaster Risk Management (DRM)**

READY Project

- A four-year project (June 2006-May 2010)
- Multi-hazard, multi-agency, community-based strategy

- Executing Agency: Office of Civil Defense (OCD)
  Responsible Agencies:
  PHIVOLCS, PAGASA, MGB-DENR, NAMRIA
  Main Implementor:
  Collective Strengthening of Community Awareness for Natural Disasters (CSCAND) as NDCC Sub-Committee on Disaster Preparedness

- With United Nations Development Programme (UNDP) as the implementing agency of donors (ex. UN, AusAID)

READY Project

- The project will cover 27 provinces and has three (3) main components:

1. Multi-hazard identification and disaster risk assessment

   (1:50,000 to 1:10,000 for floods, rain-triggered landslide, storm surge, ground shaking, ground rupture, earthquake-triggered landslide, tsunami)

2. Community-based disaster preparedness

   Information, Education and Communication

   Community based Early Warning Systems

3. Initiate the mainstreaming of risk reduction into the local development planning process

The GOP Project Activities

2006

1. Aerial Photography/Base Map Production *(NAMRIA)*
2. Equipment Acquisition *(MGB,PAGASA,PHIVOLCS)*
3. Manual Preparation *(NDCC,MGB,PAGASA,PHIVOLCS)*
4. Capacity Building *(MGB,PAGASA,PHIVOLCS, NDCC)*
   Pangasinan (50K); Dagupan City (10k)
   Cebu (50K); Metro Cebu (10k)
   Sarangani (50K); General Santos City (10K)

2007

1. Aerial Photography and Topo base mapping (continued)
2. Capacity Building (continued)

2008

1. Remaining 13 Provinces (possibly until 2009)

SOME NEEDS FOR DISASTER PREPAREDNESS AND WARNING

- Images for Hazard Mapping and Risk Assessment, Monitoring
- Post-disaster images for impact assessment, response and rehabilitation planning, hazards evaluation: review primary hazards and identify subsequent (secondary) hazards
- Estimate of rainfall prior to arrival in an area
- Good communication link with communities at risk, among researchers and disaster management practitioners

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