



# **NATURAL HAZARDS: MITIGATING THE IMPACTS**

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# OUTLINE OF PRESENTATION

- Why is the Philippines hazard prone?
- Some of the major geologically-related catastrophes in Philippine history
- DENR-MGB's Geohazard Assessment and Mapping Program
  - Objective of the Program
  - Activities involved in geohazard mapping
  - Geohazard maps
  - Where are we now?



# Natural Hazards

**Panaon, So. Leyte**



**Real, Quezon**



**St. Bernard, So. Leyte**



**Why are we  
hazard-prone?**





# THE CIRCUM-PACIFIC BELT OF FIRE



## Why are we hazard-prone?

- Numerous active Faults and Trenches
- Numerous volcanic belts and active volcanoes
- Generally mountainous terrane and steep slopes
- Numerous typhoons and extended rainy seasons/periods
- Strong and shifting wave currents

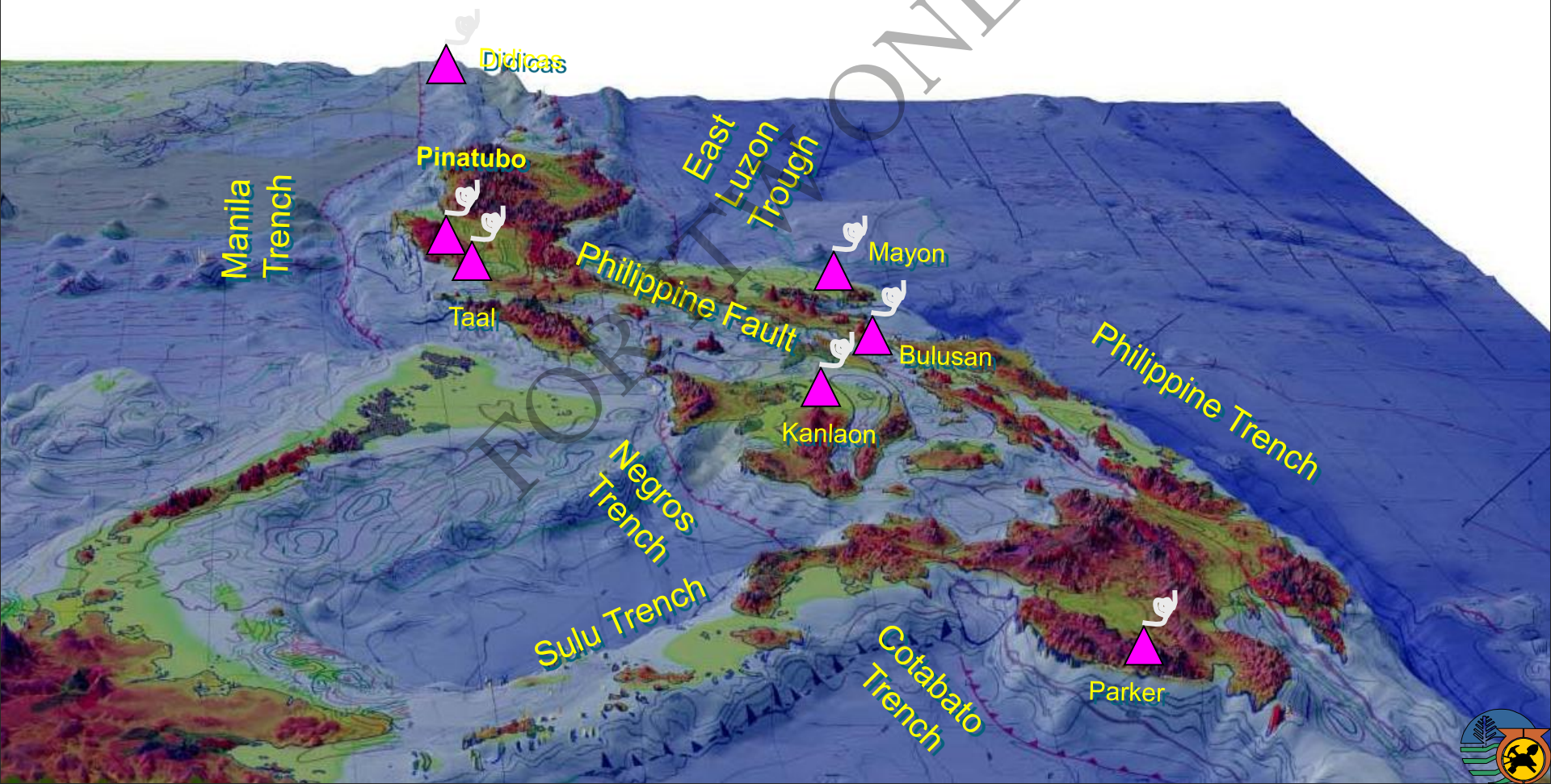
## Exacerbated by....

- **Silted rivers and, in urban areas, clogged waterways**
- **Deforested and denuded forests**
- **POOR SITE SELECTION OF SETTLEMENT SITES!**

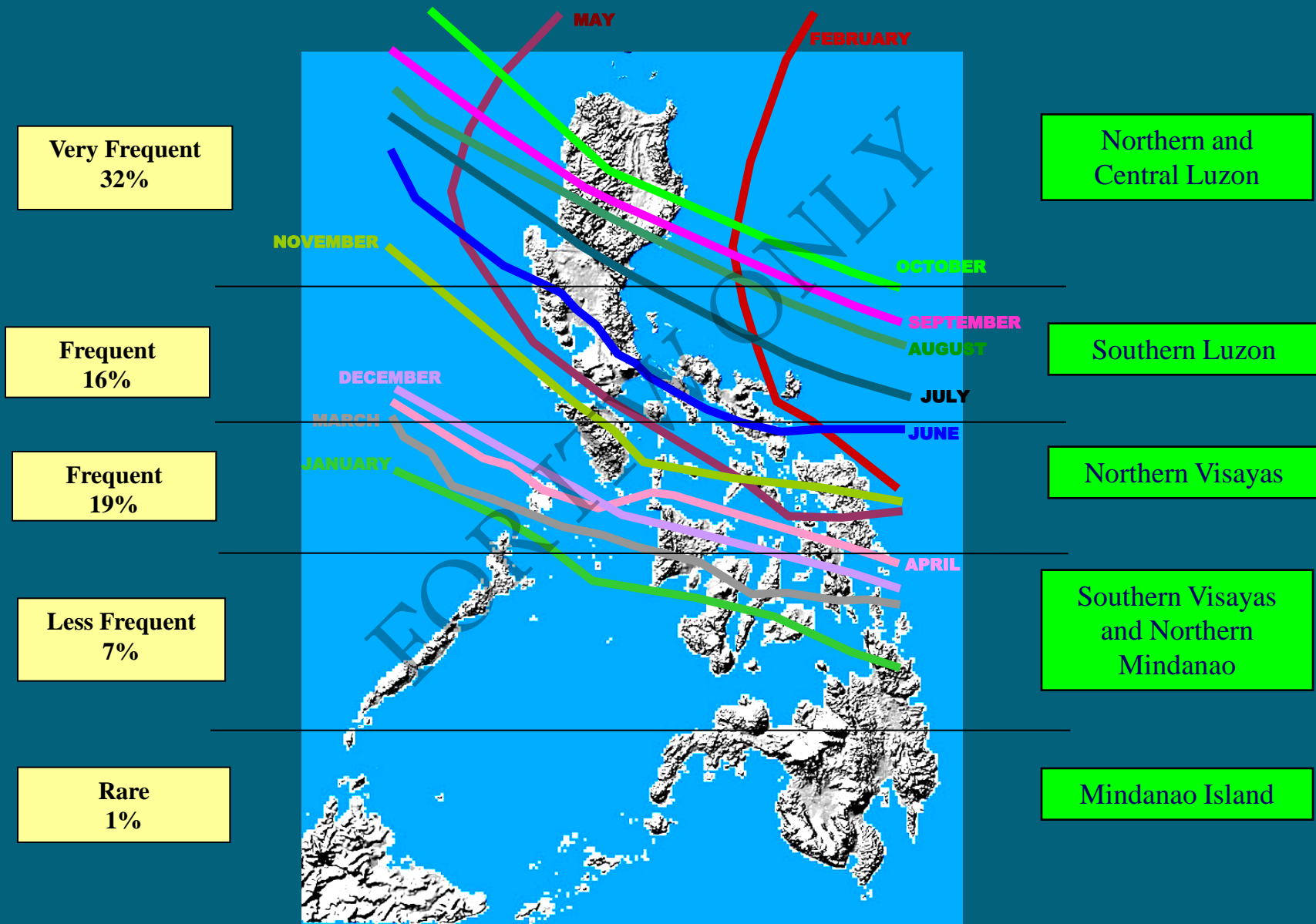




# Philippine Tectonics and Geologic Hazards



# Representative Typhoon Tracks





# N. Luzon EQ 16 July 1990 Ms 7.8

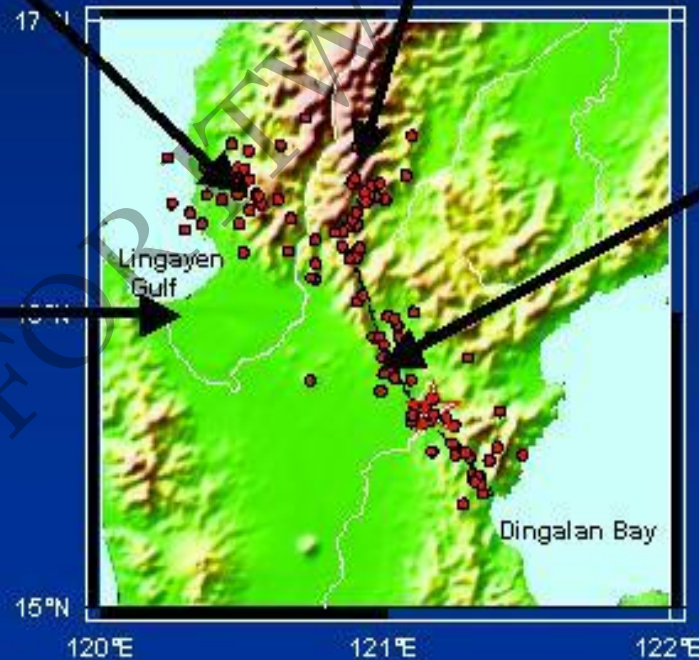
Baguio City  
Intense Ground Acceleration



Dalton Pass  
HD = 3.6 m



Dagupan City  
Liquefaction



Imugan River  
HD = 4.0 m



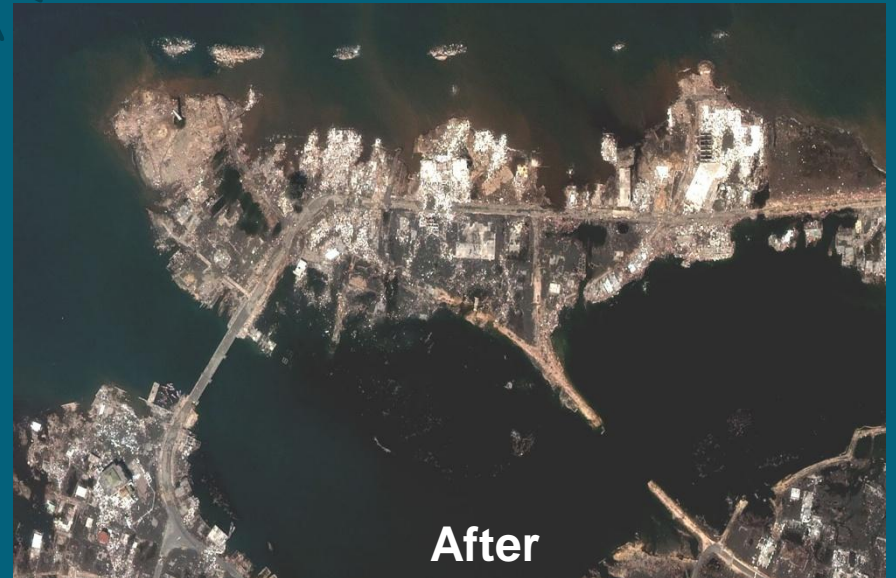
# Tsunami



Coastal areas of Maguindanao Province was submerged by the tsunamis.



Before



After

Indonesia 2005.





# Volcanic Hazards

## 1) Tephra Fall

LAHAR  
Bamban,  
Tarlac



Mt. Pinatubo Eruption  
1991

Ashfall  
Clark Air Base



September 1991





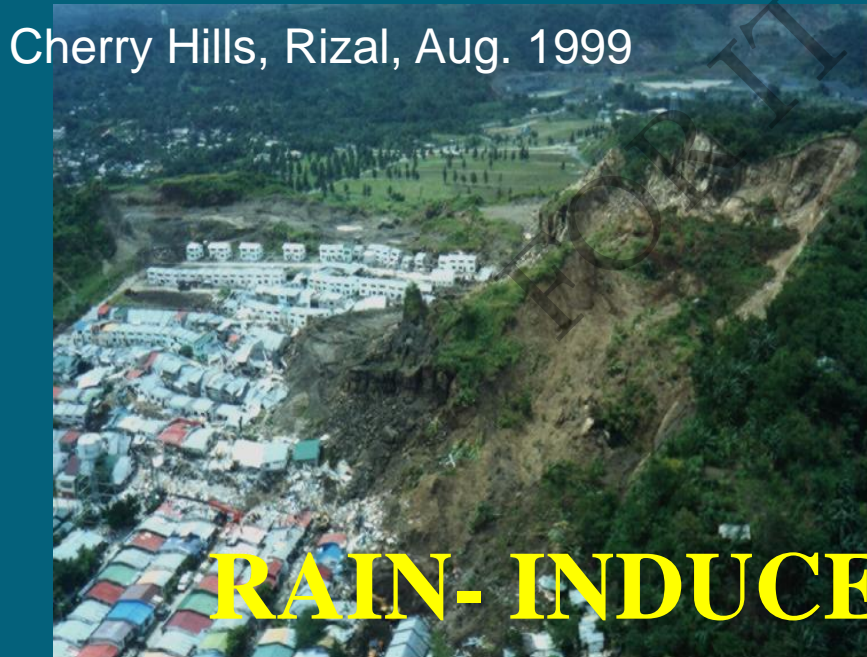


**LAHAR**  
**Legazpi City, Albay**  
**December 2006**





Jagna, Bohol, Jul  
2005



Cherry Hills, Rizal, Aug. 1999



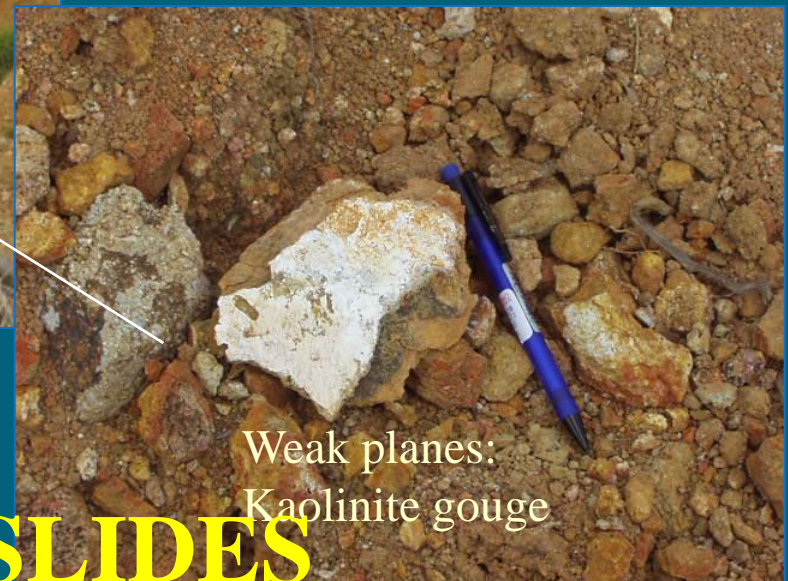
Maria Aurora, Aurora,  
Dec 2004

# RAIN- INDUCED LANDSLIDES





**Panaon, Leyte 2003**



Weak planes:  
Kaolinite gouge

**RAIN- INDUCED LANDSLIDES**



# Various Topographies





# FLOODING



Pangasinan, May 18, 2008  
(Reuters)



Santa Cruz, Laguna, October 31, 2009  
(Reuters)



Actual flooding in Brgy. Carael, Botolan  
due to Typhoon Kilo (2000)



Flooding in Pulilan, Bulacan, Nov. 2004



# OTHER NATURAL HAZARDS

- **EARTHQUAKES** – due to fault movements, volcanic eruptions, landslides
- **LANDSLIDES** – landslides due to fault movements, earthquakes, excavations and rain-induced landslides
- **LIQUEFACTION** – fast settling of porous grounds due to earthquakes
- **SUBSIDENCE/SINKING** – due to dissolution of underground caves or rocks
- **COASTAL EROSION** – due to wave currents, loosening of grounds due to earthquakes, underground excavation



# **The DENR – MGB Geohazard Mapping and Assessment Programme**

2006-5-7 10:00

University of Tokyo-Geotech Team



# **GEOHAZARD MAPPING AND ASSESSMENT PROGRAM: A GOVERNMENT PRIORITY**

## **THE PROGRAM**

- **An ongoing priority undertaking of the DENR-Mines and Geosciences Bureau (MGB)**
- **One of the major undertakings under the 10-point Agenda of President Arroyo**
- **A critical component of the national government's disaster management program**

## PROGRAM OBJECTIVE

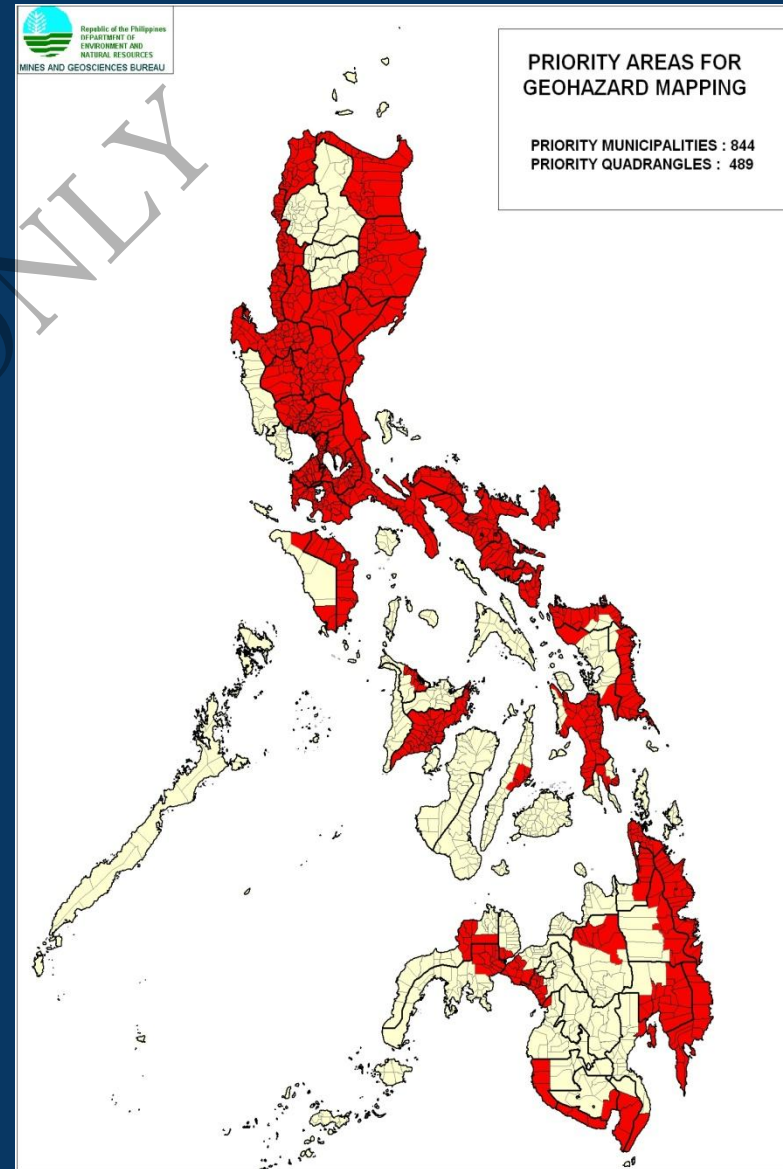
- To identify areas in the country that are susceptible or prone to various geologic hazards and provide the vital information to various stakeholders in order to lessen or mitigate the impacts of these events.



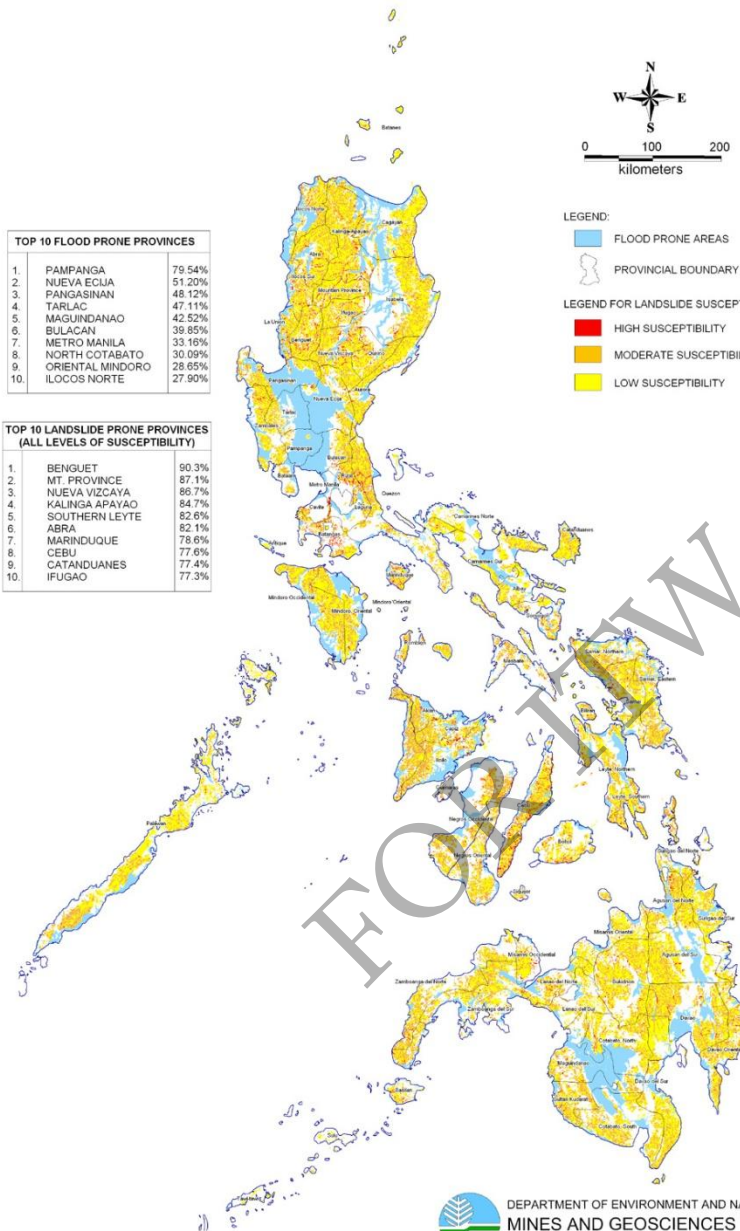


## BASIS FOR PRIORITIZATION

- Densely populated areas
- Highly developed areas
- Areas of rapid growth or programmed for development
- High incidence of geohazards



## LANDSLIDE AND FLOOD PRONE AREAS IN THE PHILIPPINES



# THE MOST SUSCEPTIBLE

### TOP 10 FLOOD PRONE PROVINCES

1.	PAMPANGA	79.54%
2.	NUEVA ECIJA	51.20%
3.	PANGASINAN	48.12%
4.	TARLAC	47.11%
5.	MAGUINDANAO	42.52%
6.	BULACAN	39.85%
7.	METRO MANILA	33.16%
8.	NORTH COTABATO	30.09%
9.	ORIENTAL MINDORO	28.65%
10.	ILOCOS NORTE	27.90%

### TOP 10 LANDSLIDE PRONE PROVINCES (ALL LEVELS OF SUSCEPTIBILITY)

1.	BENGUET	90.3%
2.	MT. PROVINCE	87.1%
3.	NUEVA VIZCAYA	86.7%
4.	KALINGA APAYAO	84.7%
5.	SOUTHERN LEYTE	82.6%
6.	ABRA	82.1%
7.	MARINDUQUE	78.6%
8.	CEBU	77.6%
9.	CATANDUANES	77.4%
10.	IFUGAO	77.3%



# **Five Major Components of the Geohazards Mapping Program**

- 1. Capability Building**
- 2. Data Acquisition, Generation and Integration**
- 3. Field Survey**
- 4. Generation of Hazard Maps**
- 5. Information and Education Campaign (IEC)**

# STEPS IN GEOHAZARD MAPPING

## 1. Research work and map interpretation/analysis





# STEPS IN GEOHAZARD MAPPING

## 2. Aerial photo interpretation



# STEPS IN GEOHAZARD MAPPING

## 3. Field mapping, verification, sampling and laboratory analysis



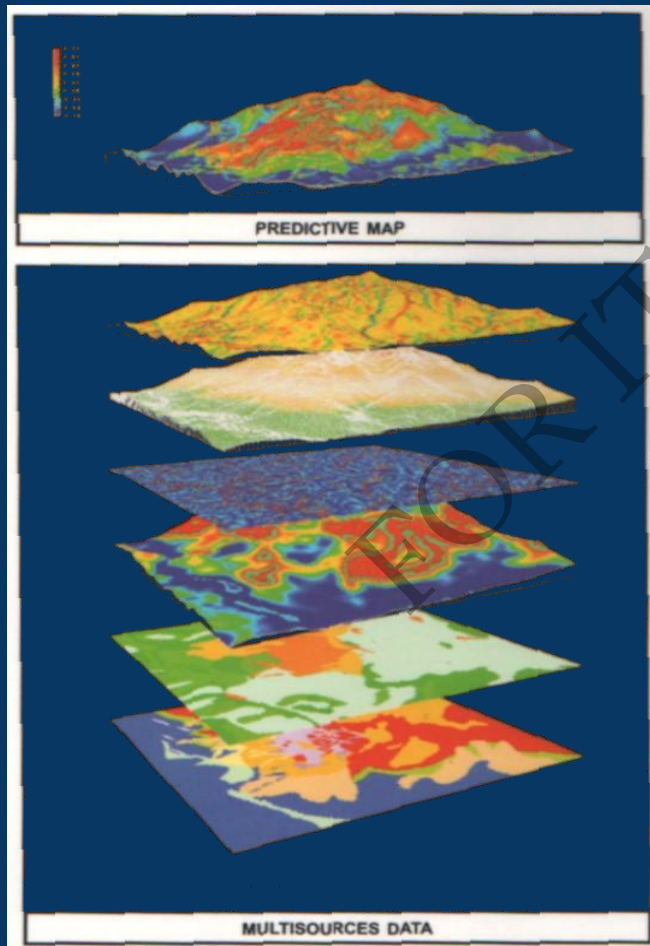
**Field geologic, geotechnical and hydrogeologic mapping:**

- most important part of hazard mapping
- most expensive and time consuming

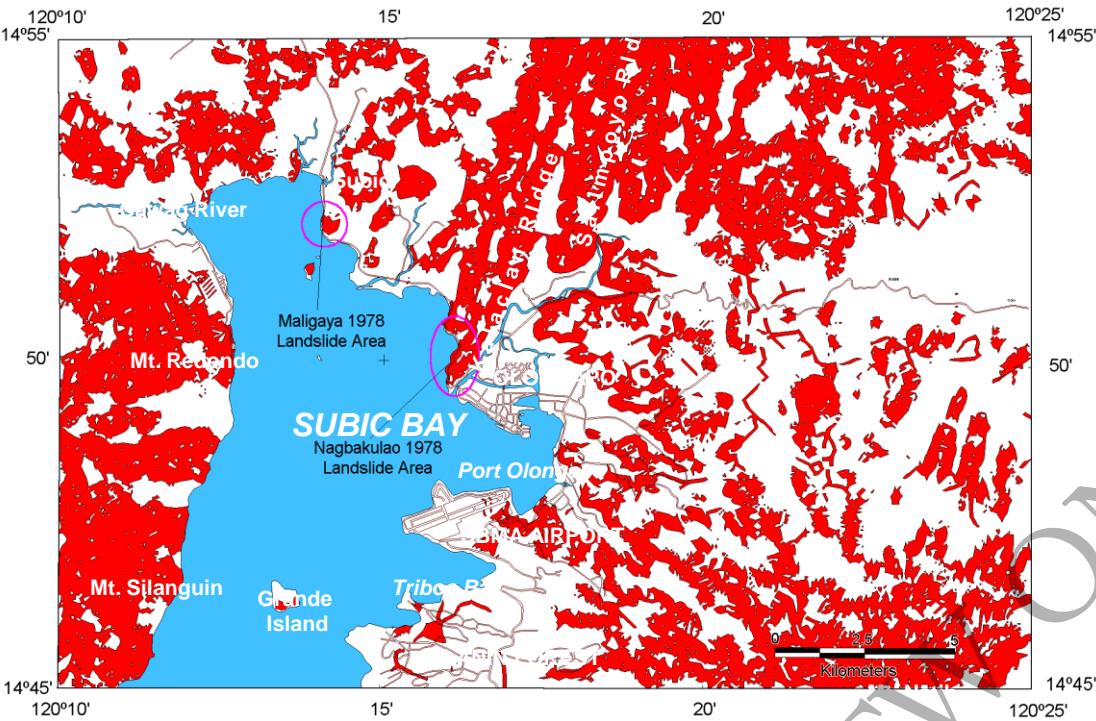


# STEPS IN GEOHAZARD MAPPING

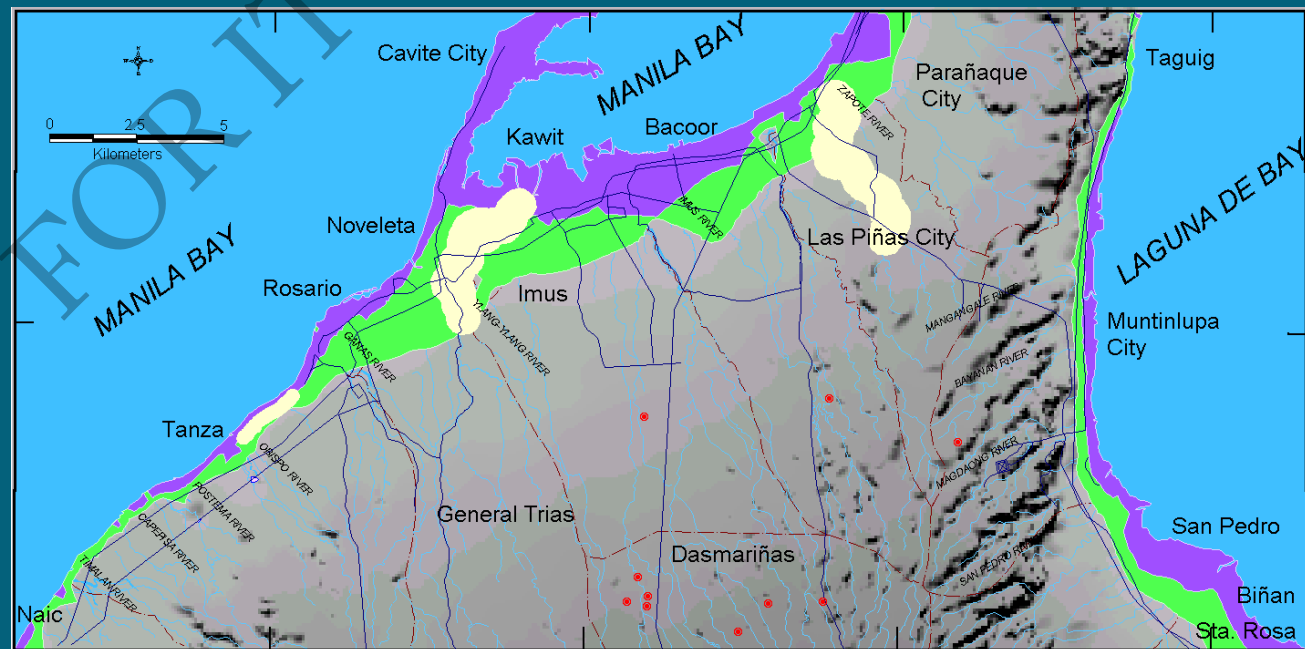
4. Data integration and processing
5. Map preparation and report writing



## Subic – Olongapo Landslide Susceptibility Map

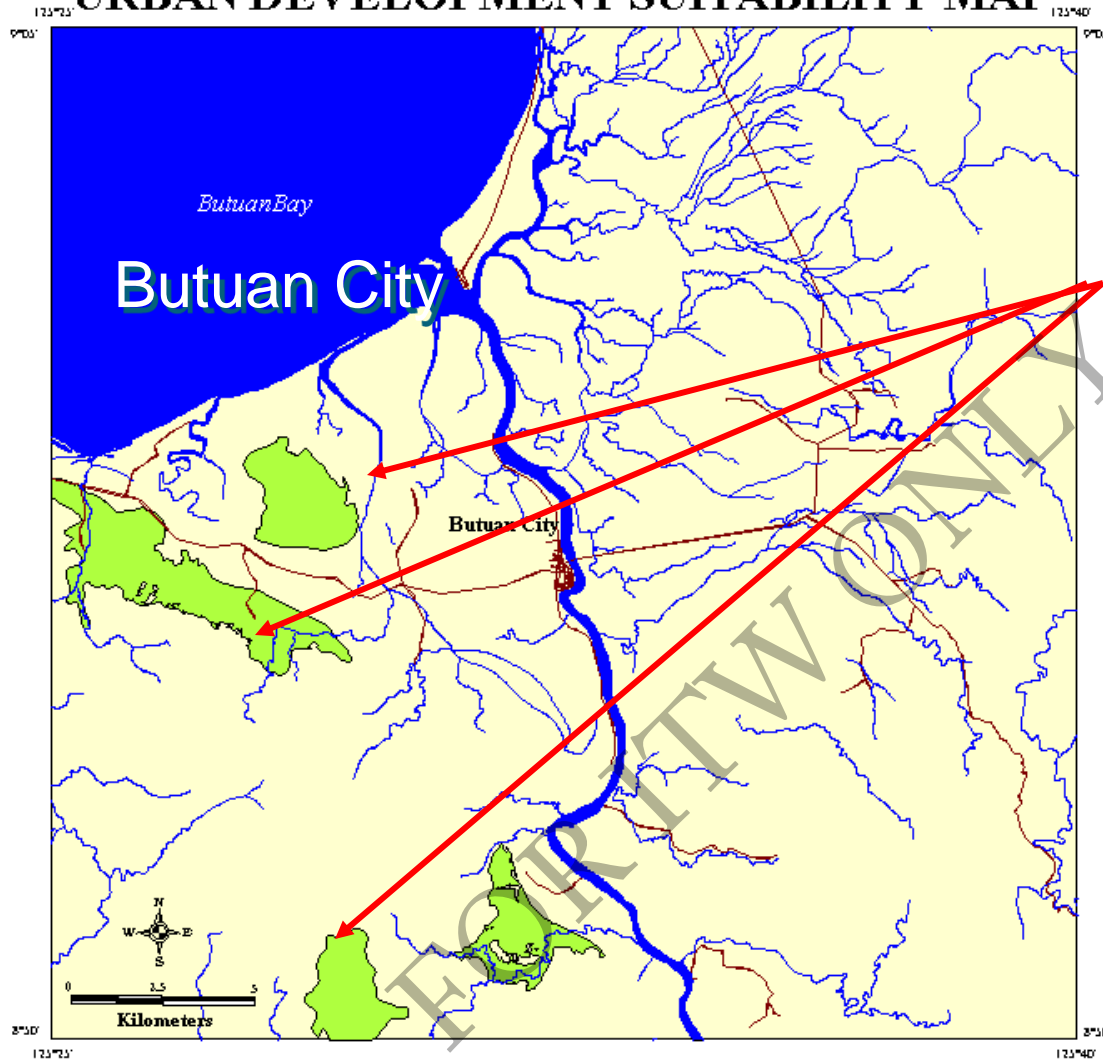


## Cavite – San Pedro Flood Susceptibility Map









# URBAN DEVELOPMENT SUITABILITY MAP

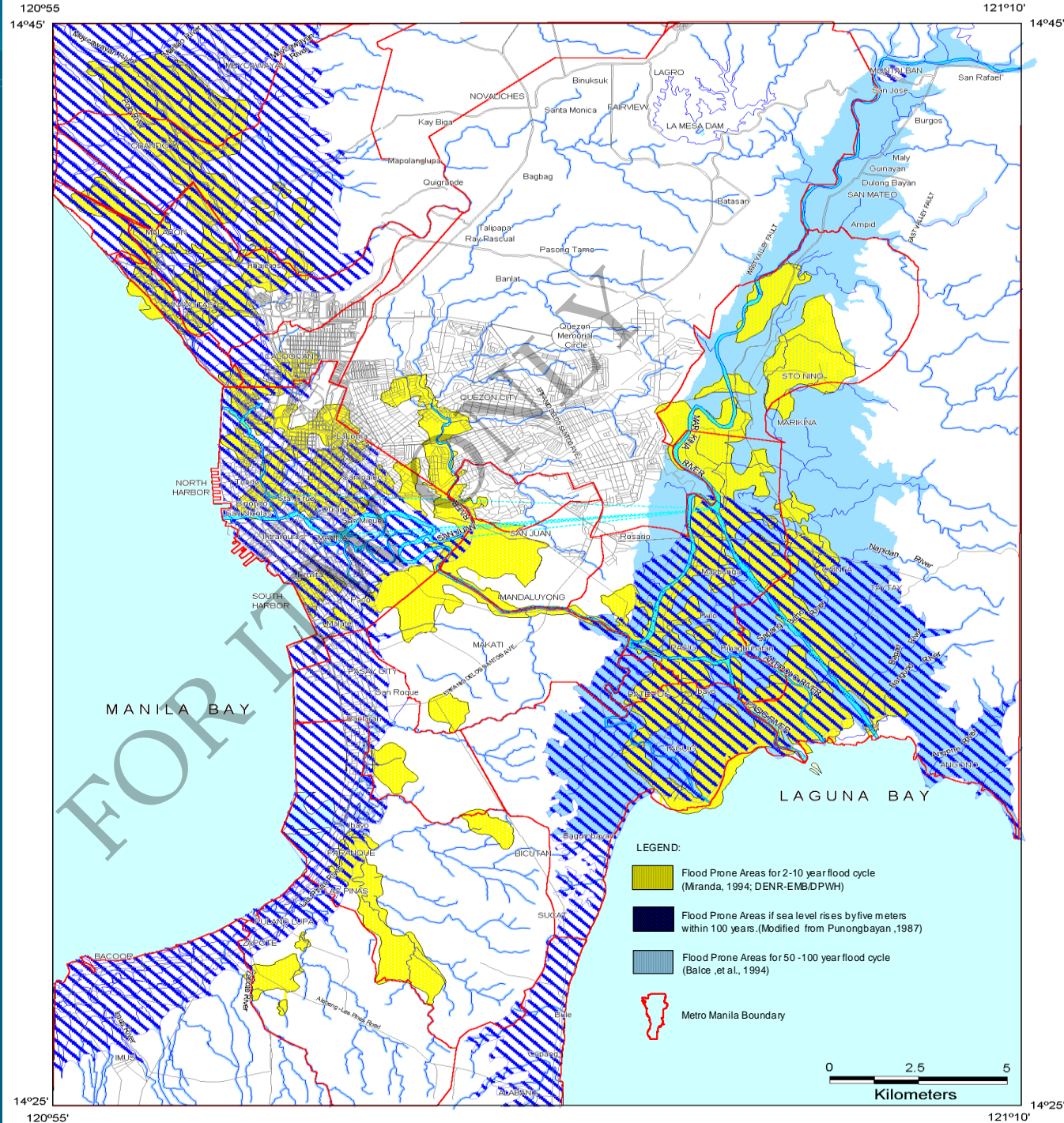


## LEGEND:

-  Suitable for Urban Development
-  Unsuitable for Urban Development
-  River
-  Road

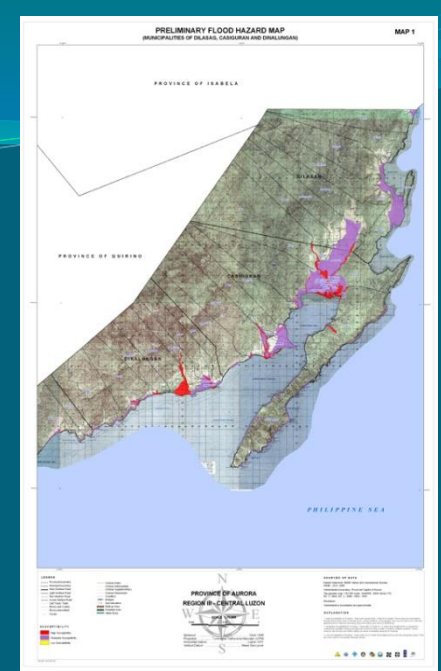
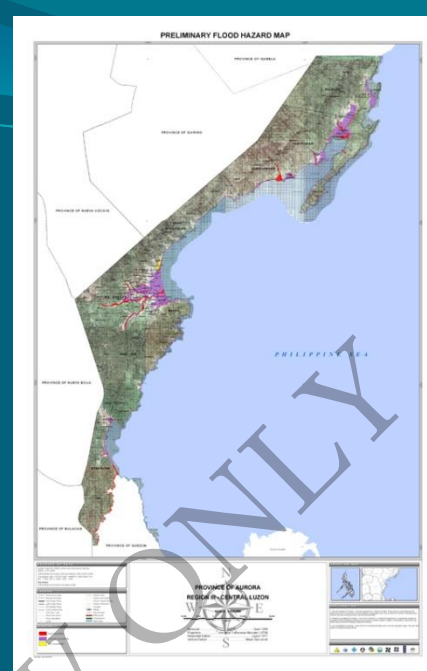
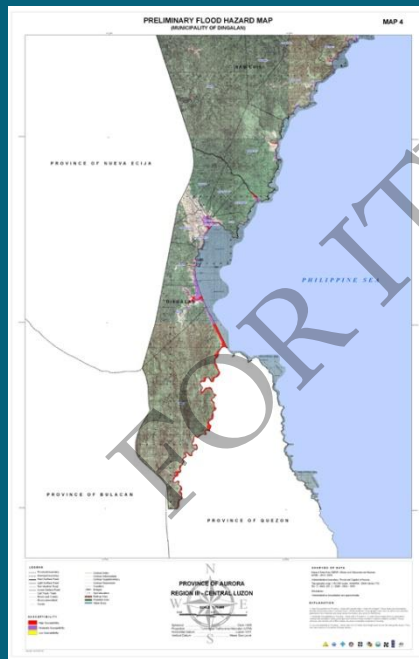
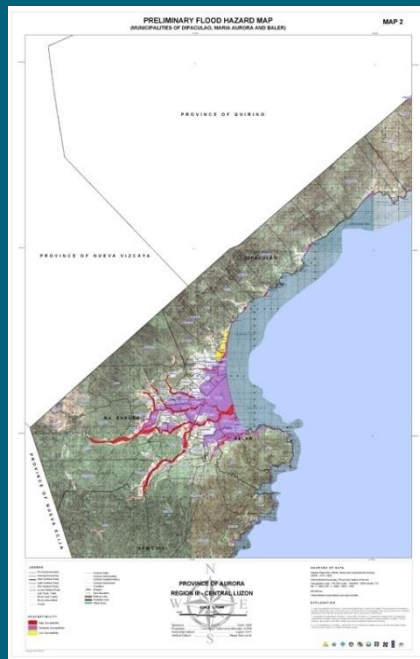
“relocation sites free from flooding, landslides and low seismic hazards”

# Flood-prone areas of Metro Manila





# Flood Susceptibility Maps of the Province of Aurora



## LEGEND



**-HIGH SUSCEPTIBILITY**  
( > 1.00 m. Depth of floodwaters)



**-MODERATE SUSCEPTIBILITY**  
( 0.51 – 1.00 m. Depth of floodwaters)

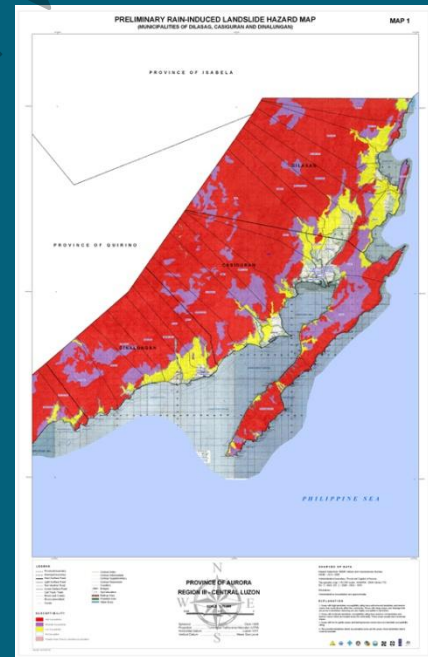
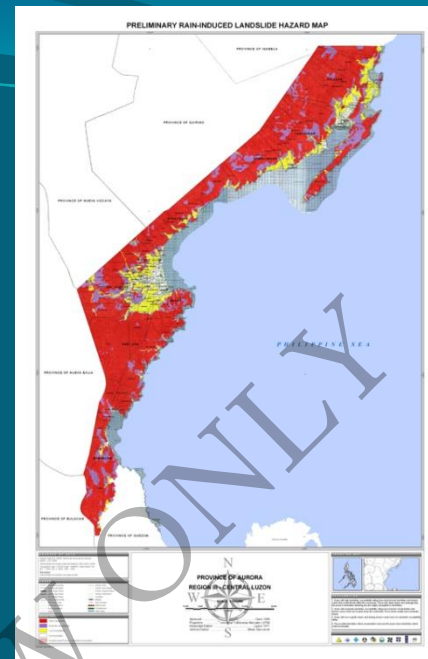
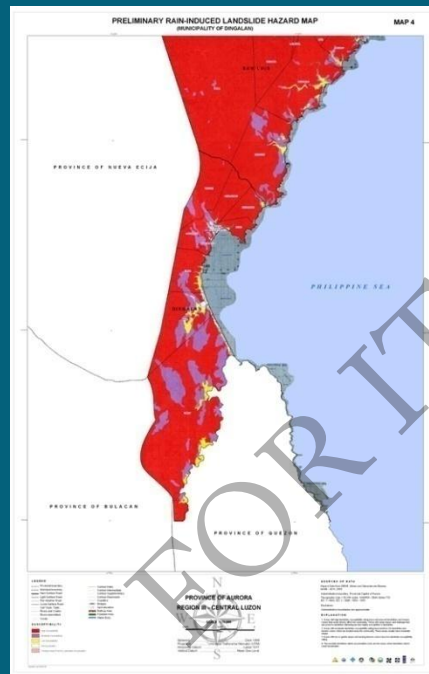
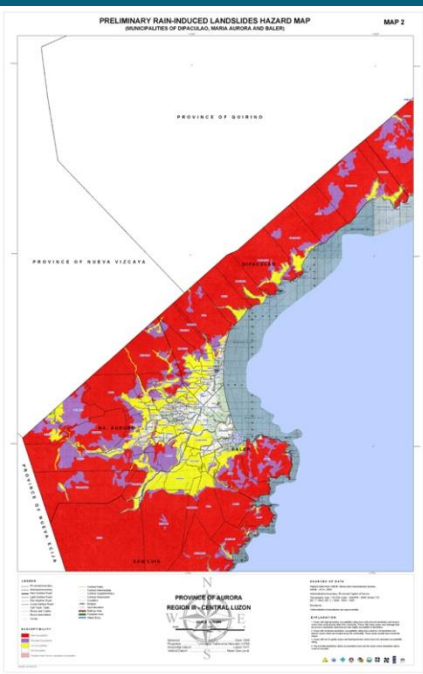


**-LOW SUSCEPTIBILITY**  
( 0 – 0.50 m. Depth of floodwaters)



**NOT PRONE TO FLOODING**

# Rain-Induced Landslide Susceptibility Maps of the Province of Aurora

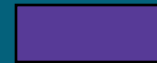


## Explanation

### Rain-Induced Landslide Classification



High Susceptibility



Moderate Susceptibility



Low Susceptibility



Possible Landslide Debris Accumulation Zone



# WHERE ARE WE NOW?

- Provinces in Region 3 with available Rain-Induced Landslide and Flood Susceptibility Maps in 1:50,000 scale

1. Aurora
2. Pampanga
3. Zambales
4. Bulacan (partial)
5. Nueva Ecija (partial)
6. Bataan (partial)
7. Tarlac (partial)



Debris flow in Arayat, Pampanga, Sept. 2009

## BEYOND MAPPING: GETTING PEOPLE INVOLVED

Exit conferences in critical barangays are held during the conduct of the geohazard assessment pinpointing geohazard prone areas in each barangay being assessed





## BEYOND MAPPING: MAKING PEOPLE EQUIPPED THROUGH

Successful province-wide information and education campaigns in the Province of Aurora , Pampanga and Zambales together with the partner agencies such as PHIVOLCS, PAGASA, NAMRIA and OCD-NDCC.

Provision of geohazard maps and posters, videos and pamphlets to various LGUs, educational institutions, government agencies

Resource Person in various training programs of LGUs, institutions and government agencies



## **Dissemination of MGB Maps**



**Barangay Officials  
City and Municipal Mayors  
Governors  
Congressmen  
Regional Land Use  
Committees  
Internet  
For sale in CD media**



***Thank you  
very much***