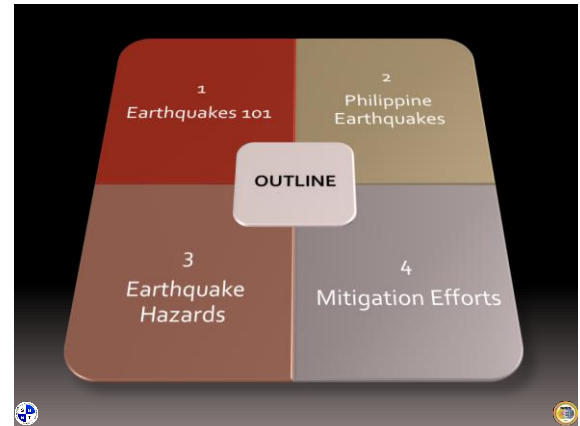


THE EARTHQUAKE THREAT IN THE PHILIPPINES

MARIO AURELIO, PH.D.
STRUCTURAL GEOLOGY AND TECTONICS LABORATORY
NATIONAL INSTITUTE OF GEOLOGICAL SCIENCES
UNIVERSITY OF THE PHILIPPINES
DIUMAN, QUEZON CITY

INTERNATIONAL SYMPOSIUM ON SEISMIC RETROFIT OF UNREINFORCED MASONRY HERITAGE CHURCHES IN THE PHILIPPINES
NATIONAL MUSEUM, MANILA, PHILIPPINES
13-14 JANUARY 2016

ICOMOS PHILIPPINES



EARTHQUAKES 101

rupture surface
hypocenter
fault plane
fault line
epicenter
hypocenter

Source: USGS

ACTIVE FAULTS, EARTHQUAKES, SEISMIC WAVES

EARTHQUAKES 101

P-Wave
S-Wave
Surface Wave

Baguio Cathedral School
M7.2 EQ, 15 Oct. 2013

Sagayan Municipal Hall, School
M7.2 EQ, 15 Oct. 2013

THE CULPRIT – SURFACE WAVES

EARTHQUAKES 101

PLATE TECTONICS

The earth's crust is broken into pieces (oceanic and continental plates) that move dynamically about each other

Translational
Divergent
Convergent

HOW IT WORKS – WHY FAULTS MOVE

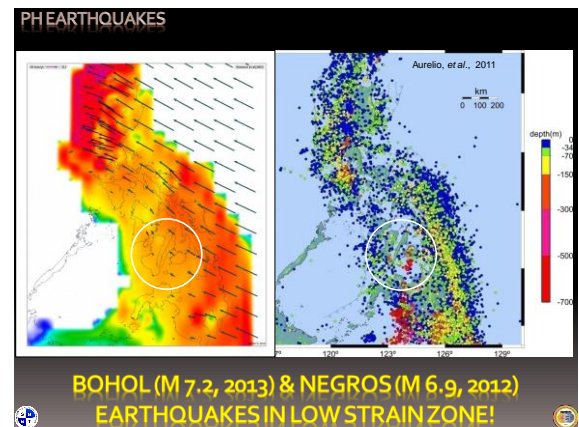
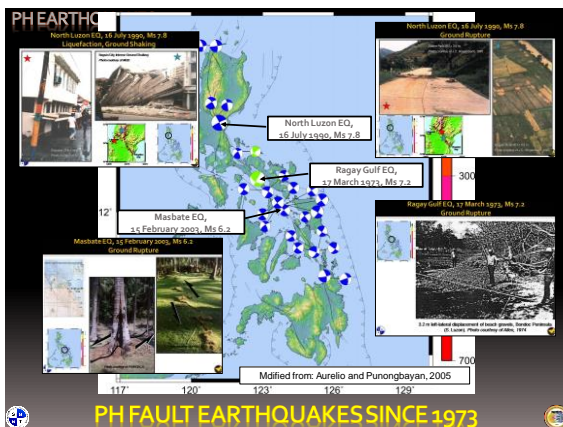
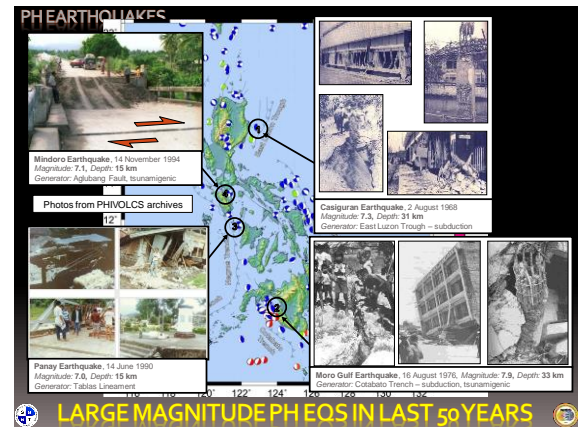
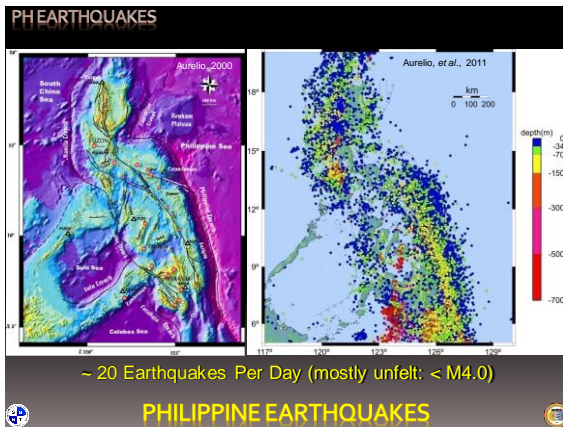
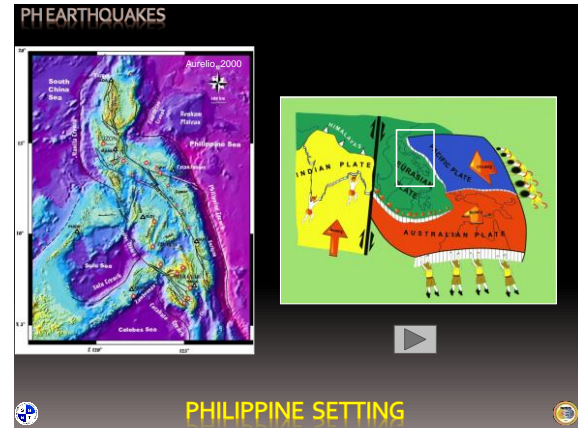
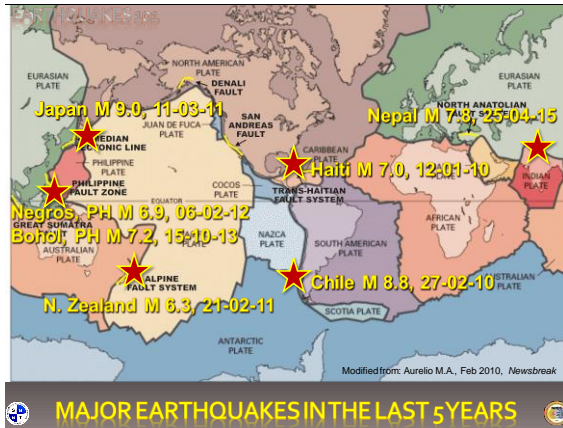
EARTHQUAKES 101

Circum-Pacific Ring of Fire

Major fault systems shown include: DENALI FAULT, SAN ANDREAS FAULT, JUAN DE FUCA PLATE, PHILIPPINE FAULT ZONE, GREAT SUGRAFA FAULT, ALPINE FAULT SYSTEM, NORTH ANATOLIAN FAULT SYSTEM, ARABIAN PLATE, AFRICAN PLATE, AUSTRALIAN PLATE, SCOTIA PLATE, and ANTARCTIC PLATE.

Aurelio M.A., Feb. 2010, Newsbreak

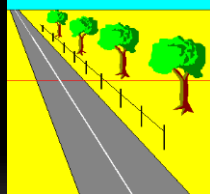
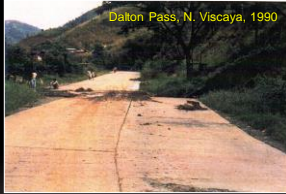
TECTONIC PLATES & PACIFIC EARTHQUAKES



EARTHQUAKE HAZARDS

N. Luzon Earthquake
16 July 1990, M 7.8

Theory



GROUND RUPTURE

EARTHQUAKE HAZARDS



Kobe Skyrail, 1995
Magnitude 7.6



Hyatt Regency Hotel, Baguio, 1990
Magnitude 7.8

GROUND SHAKING

EARTHQUAKE HAZARDS



M7.2 Bohol Earthquake, 15 October 2013



Earthquake-resistant wooden house vs collapsed concrete house

GROUND SHAKING

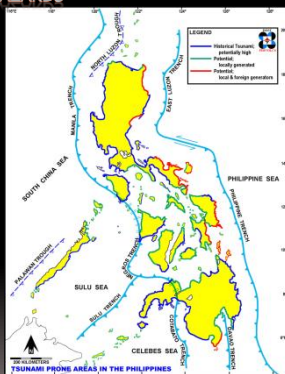
EARTHQUAKE HAZARDS



Earthquake-resistant traditional "nipa hut" built only a few tens of meters away from the ground rupture of the North Bohol Fault, practically undamaged by the Mag 7.2 Bohol Earthquake

GROUND SHAKING

EARTHQUAKE HAZARDS



TSUNAMI

EARTHQUAKE HAZARDS



Jimalalud Bridge, Negros, Feb 2012, M6.9



Abatan Bridge, Bohol, Oct 2013, M7.2



Dagupan City, PH, 1990, M7.8

LIQUEFACTION

EARTHQUAKE HAZARDS



Overturned house at the toe of the Pitogo Landslide, induced by the M6.9 Negros Earthquake of February 2012 – 3 dead (Bgy. McKinley, Guhungan Town)

LANDSLIDES

EARTHQUAKE HAZARDS



Road displaced vertically by about 20 m, resulting from a landslide induced by the M6.9 Negros Earthquake of February 2012 (Bgy. McKinley, Guhungan Town)

LANDSLIDES

EARTHQUAKE HAZARDS

15 October 2014, Magnitude 7.2 Bohol Earthquake



House engulfed by tension crack at landslide crown (or a suspected sinkhole?). Bagtik, Catigbian

LANDSLIDES

EARTHQUAKE HAZARDS

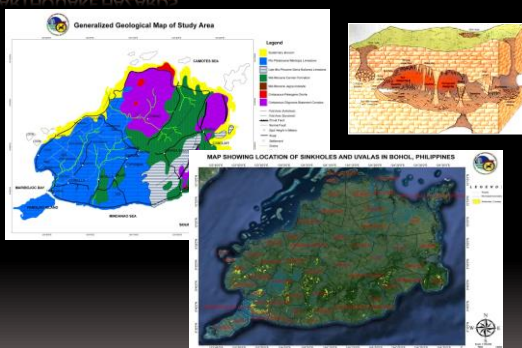
15 October 2014, Magnitude 7.2 Bohol Earthquake



"Caramelized chocolate" hill in Sagbayan (close to epicentral location) – landslides in sinkhole areas

LANDSLIDES

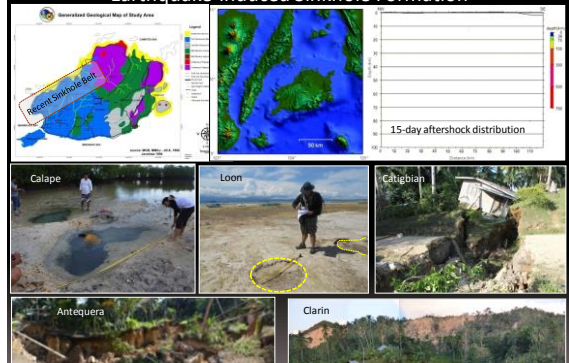
EARTHQUAKE HAZARDS



Total number of sinkholes in Bohol based from topo maps and RS images: 1,187 (as of December 2013)

SINKHOLES

Earthquake-induced Sinkhole Formation



SINKHOLES

