WAVES Indonesia:
Women as Primary Disaster Mitigators

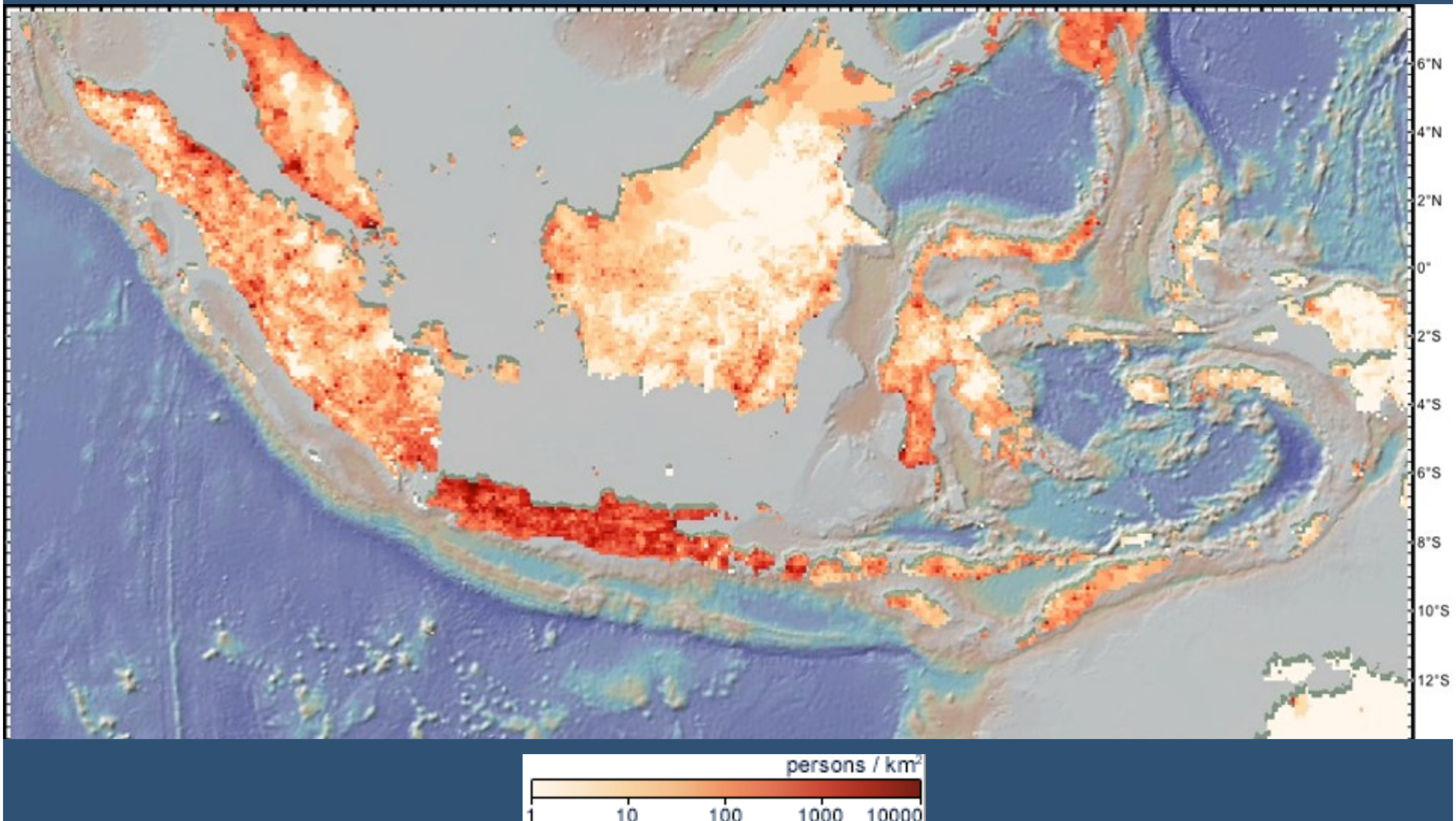
Ron Harris and Waves Team

IN HARM'S WAY

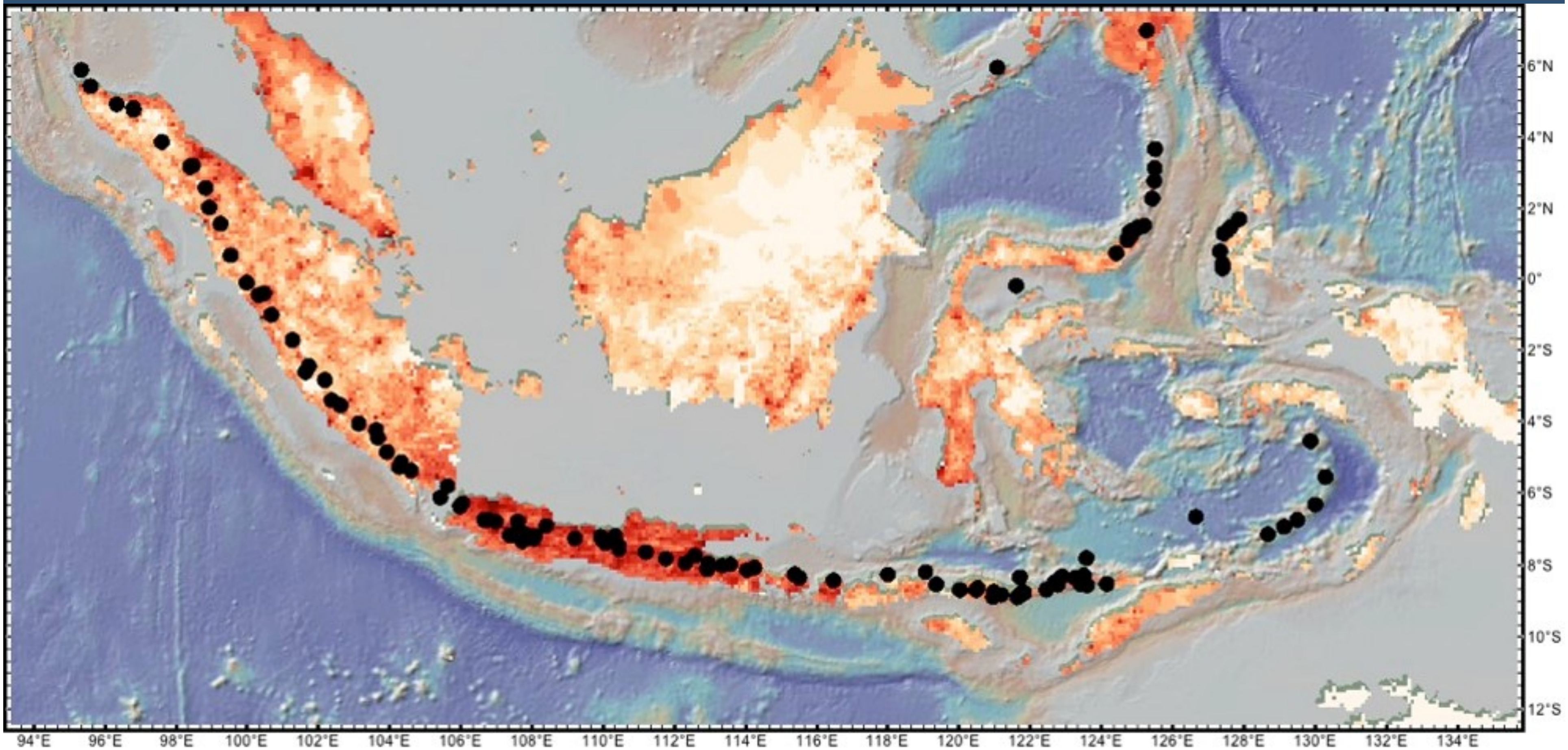
inharmswayhelp.org


not that kind of doctor

Lots of People in Harms Way

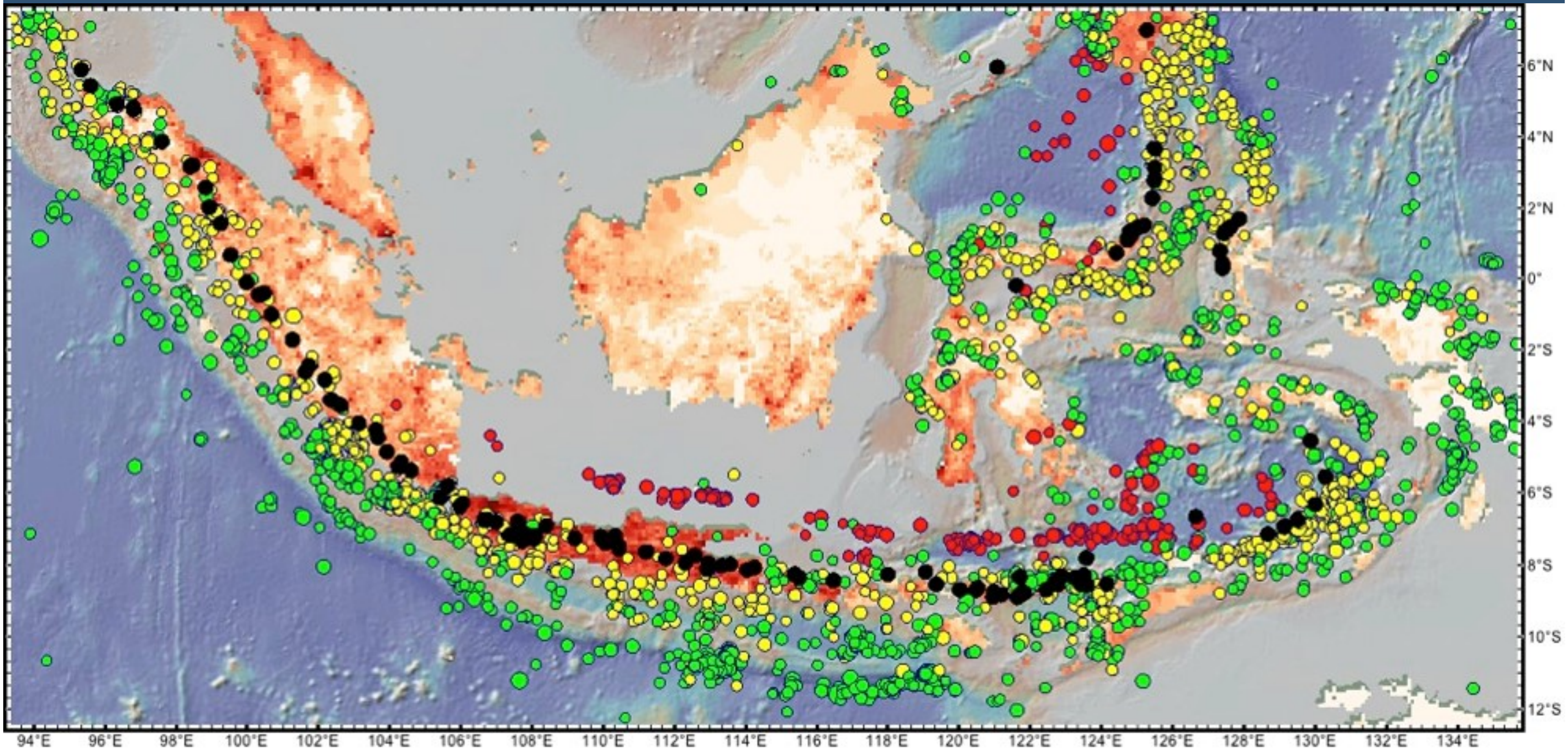


Surrounded by Earth's Most Explosive Volcanoes



Toba, Tambora, Krakatoa, Rinjani, Merapi

Surrounded by Active Faults



Many of Earth's largest earthquakes ever recorded

Indonesia has Historical Records!
Thanks to Dutch Colonists!

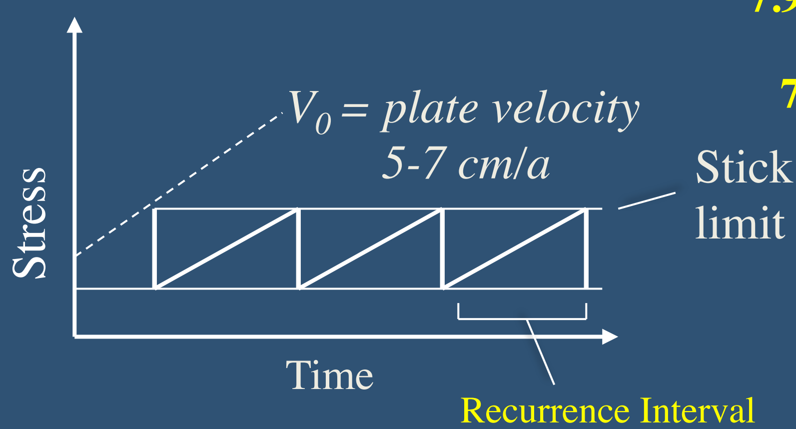
Fig. 55.—INCIDENT DURING THE EARTHQUAKE AT SUMATRA (1861).

1629, August 1. $9^1/_2{}^h$. p. m. Banda-Inseln. Eine halbe Stunde nach Ablauf eines heftigen Erdstosses entstand in der Meer

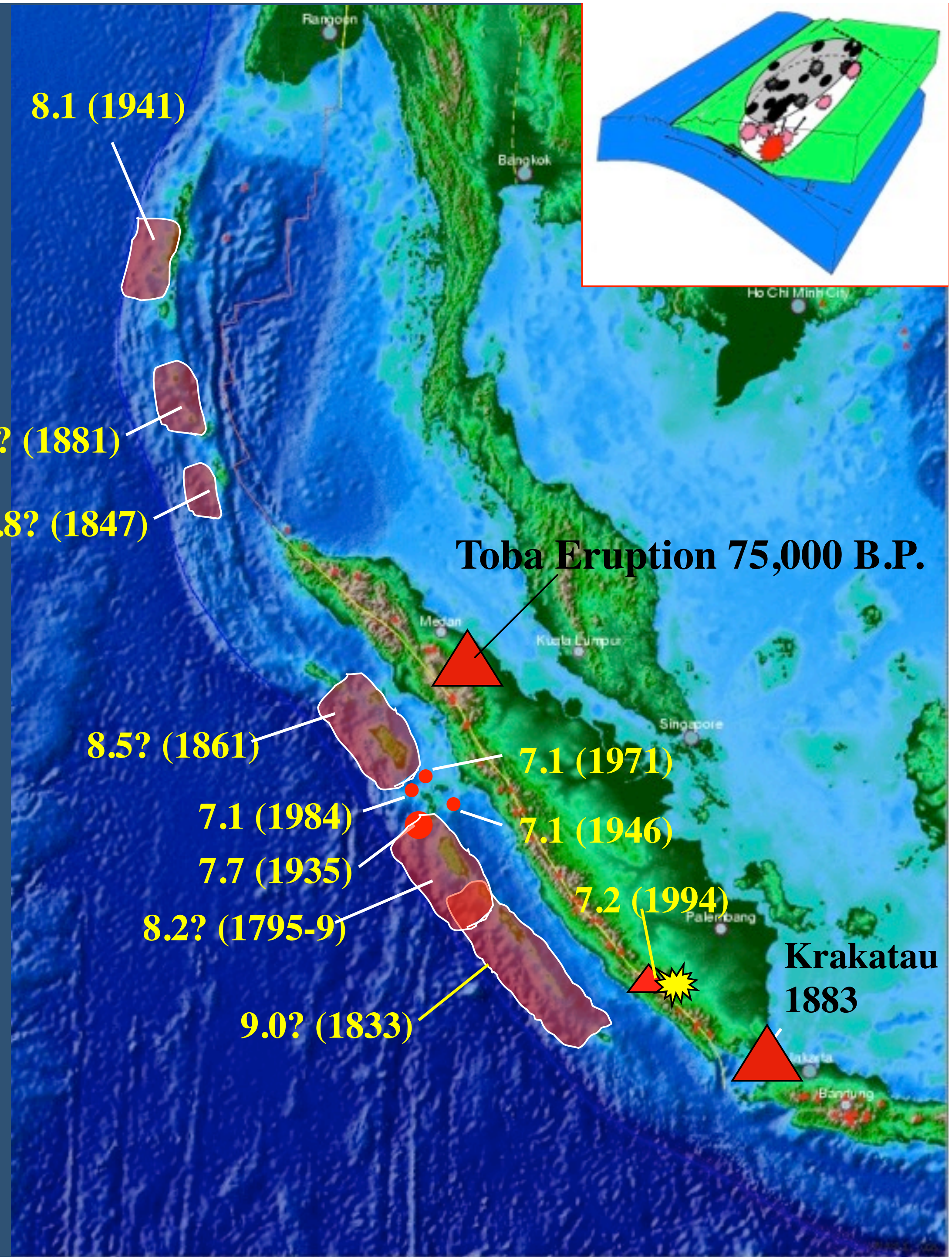
1629, August 1, 9:30 p.m. Banda-Islands.
A half hour after the termination of a violent seismic shock there formed in the sound…a high mountain of water. The wave rolled westward straight against fort Nassau, as well as the village on the beach where it achieved a height of 9 fathoms [15.3m] above the springtide stand. Houses on the beach were swept away, while others were laid to rubble. Eastwards the wave crashed on the island of Lonthor and achieved a height of 13 feet [4.0 m].

1629 August 1, Amboina.
Earthquake occurring at the same time as that on Banda.

What is the History of Earthquakes and Tsunamis in Indonesia



Sumatra ~150-200 yrs. (Mw 7.5-8.5)



Who's Next?

Assessing Vulnerability to Geophysical Hazards in Densely-Populated Regions of Indonesia

by Ron A. Harris, professor of geology, BYU, and C. Prasetyadi, professor of geology, University Pembangunan Nasional, UPN "Veteran," Indonesia

Figure 1
Earthquakes and motion of major tectonic plates of the Indonesian region. Each dot represents an earthquake epicenter during 1970–2000. The color of each event corresponds to earthquake depth: green (0–50 km), yellow (50–100 km), red (>100 km). The distribution of earthquakes defines the location of the major plate boundaries. Arrows correspond to the direction and velocity of plate movement.

Introduction

The densely-populated archipelago of Indonesia has more explosive volcanoes, major earthquakes, and destructive *tsunamis* than any other nation. The disaster potential of these geophysical hazards increases as population, urbanization, and rapid development expand into hazardous regions. Apart from reversing these trends, the disaster potential of recurring hazardous events can be reduced by focusing mitigation efforts on the most vulnerable parts of the country. The results of our collaborative research identify and characterize the regions in Indonesia that are most vulnerable to geophysical hazards, or, in other words, to predict—who's next?

Geophysical Hazards

Most geophysical hazards in Indonesia arise from its unique position in a three-way collision between some of the earth's largest tectonic plates (Figure 1). The movement of these plates is buffered by the nearly continuous release of tectonic strain energy in the form of large earthquakes, explosive volcanic eruptions, and associated tsunami and landslides that claim lives and cause societal and economic disaster. During the nineteenth century alone these hazards caused more than 200,000 fatalities throughout Indonesia (NOAA).

Present Risk

These violent and deadly geophysical disasters resulted because of the sudden release of strain energy that had accumulated for decades and centuries in various parts of the plate collision zone. A similar situation exists today. It has been hundreds of years since many parts of the collision zone have broken free. It is not a question of if, but when. Comparing measurements of how much strain was released during past events with measurements of the present rate of strain accumulation can help predict the most vulnerable regions of the collision zone.

The inevitable and catastrophic release of accumulated plate boundary forces will affect a very different Indonesia than before, one with much more to lose. Population has increased fivefold over the past century to more than 200 million people. The majority of the people are crowded into the island of Java, which has a land area the size of New York and is home to the majority of the nation's wealth. An increasing percentage of the population is concentrated in the sprawling urban centers of Jakarta, Bandung, Surabaya, Semarang, Yoyakarta, and other major cities dangerously exposed to multiple geophysical hazards (Figure 2 on next page).

The economy of Indonesia has expanded rapidly, with an overall growth rate of 7 percent over the past twenty years. During this time, per capita income has increased tenfold and Indonesia has attracted much foreign investment. Yet, little has been done to protect its people, property, and new development from imminent disaster(s). One of the most disturbing trends is that the few small earthquakes and volcanic eruptions of the past few decades have resulted in increasing numbers of fatalities and economic disruption. Development in Indonesia has proceeded with frightening disregard for geophysical hazards.

Seismic Hazards

Earthquakes are the most poorly understood and ... dictable of all natural hazards. During the twentieth ... alone Indonesia had around two hundred major earth... (magnitude 7.5 or greater), more than all of North Am... South America during the same time interval. At leas... these quakes were destructive; the majority jolted den... populated western Indonesia and accounted for as m...

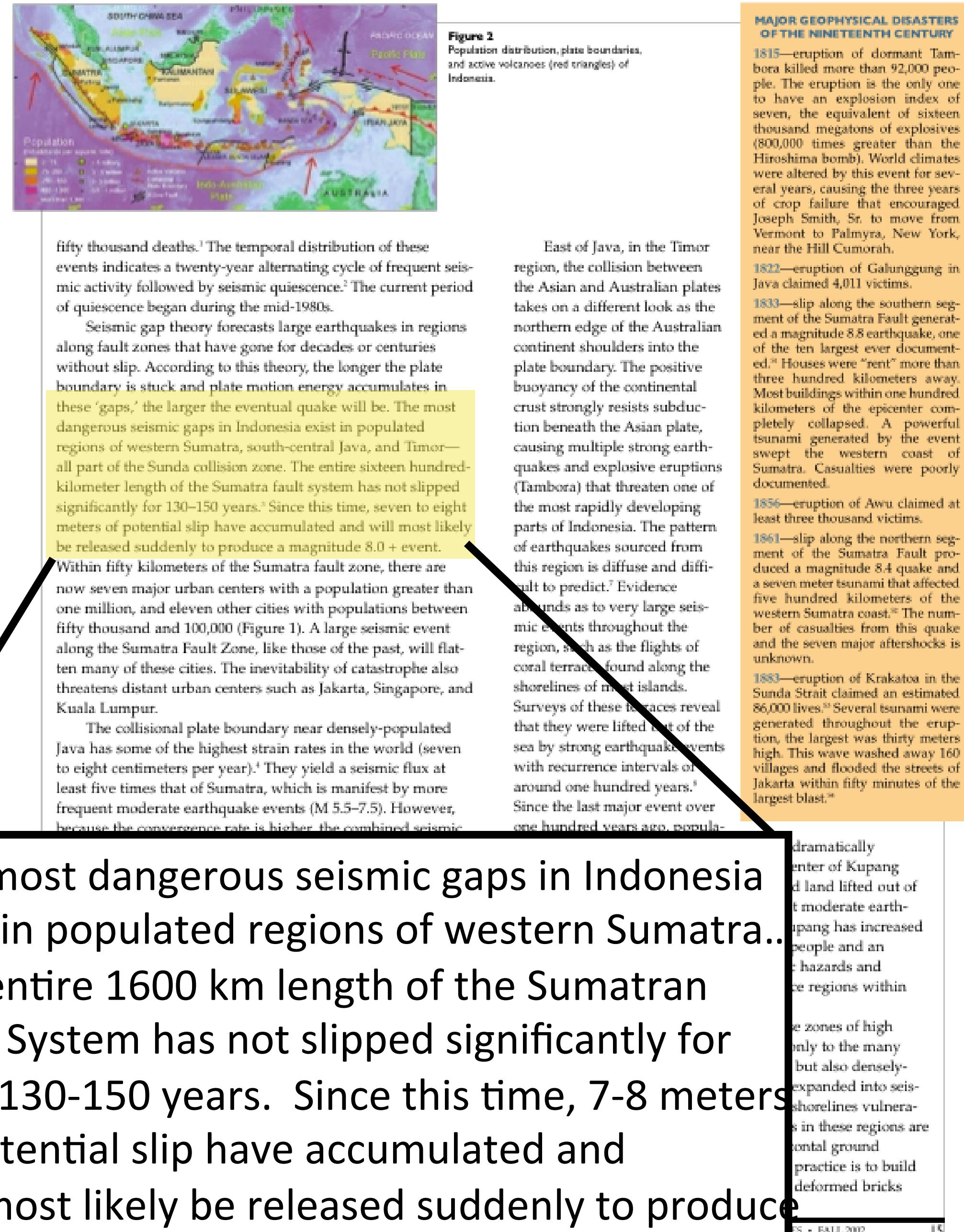


Figure 2
Population distribution, plate boundaries, and active volcanoes (red triangles) of Indonesia.

fifty thousand deaths.[1] The temporal distribution of these events indicates a twenty-year alternating cycle of frequent seismic activity followed by seismic quiescence.[2] The current period of quiescence began during the mid-1980s.

Seismic gap theory forecasts large earthquakes in regions along fault zones that have gone for decades or centuries without slip. According to this theory, the longer the plate boundary is stuck and plate motion energy accumulates in these 'gaps,' the larger the eventual quake will be. The most dangerous seismic gaps in Indonesia exist in populated regions of western Sumatra, south-central Java, and Timor—all part of the Sunda collision zone. The entire sixteen hundred-kilometer length of the Sumatra fault system has not slipped significantly for 130–150 years.[3] Since this time, seven to eight meters of potential slip have accumulated and will most likely be released suddenly to produce a magnitude 8.0 + event. Within fifty kilometers of the Sumatra fault zone, there are now seven major urban centers with a population greater than one million, and eleven other cities with populations between fifty thousand and 100,000 (Figure 1). A large seismic event along the Sumatra Fault Zone, like those of the past, will flatten many of these cities. The inevitability of catastrophe also threatens distant urban centers such as Jakarta, Singapore, and Kuala Lumpur.

The collisional plate boundary near densely-populated Java has some of the highest strain rates in the world (seven to eight centimeters per year).[4] They yield a seismic flux at least five times that of Sumatra, which is manifest by more frequent moderate earthquake events (M 5.5–7.5). However, because the convergence rate is higher, the combined seismic ...

East of Java, in the Timor region, the collision between the Asian and Australian plates takes on a different look as the northern edge of the Australian continent shoulders into the plate boundary. The positive buoyancy of the continental crust strongly resists subduction beneath the Asian plate, causing multiple strong earthquakes and explosive eruptions (Tambora) that threaten one of the most rapidly developing parts of Indonesia. The pattern of earthquakes sourced from this region is diffuse and difficult to predict.[7] Evidence ab... nds as to very large seismic e... nts throughout the region, s... h as the flights of coral terrac... found along the shorelines of m... t islands. Surveys of these t... aces reveal that they were lifted ... t of the sea by strong earthquak... events with recurrence intervals o... around one hundred years.[8] Since the last major event over one hundred years ago, popula...

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... e zones of high ... nly to the many ... but also densely- ... expanded into seis- ... horelines vulnera- ... s in these regions are ... ontal ground ... practice is to build ... deformed bricks

MAJOR GEOPHYSICAL DISASTERS OF THE NINETEENTH CENTURY

1815—eruption of dormant Tambora killed more than 92,000 people. The eruption is the only one to have an explosion index of seven, the equivalent of sixteen thousand megatons of explosives (800,000 times greater than the Hiroshima bomb). World climates were altered by this event for several years, causing the three years of crop failure that encouraged Joseph Smith, Sr. to move from Vermont to Palmyra, New York, near the Hill Cumorah.

1822—eruption of Galunggung in Java claimed 4,011 victims.

1833—slip along the southern segment of the Sumatra Fault generated a magnitude 8.8 earthquake, one of the ten largest ever documented.[10] Houses were "rent" more than three hundred kilometers away. Most buildings within one hundred kilometers of the epicenter completely collapsed. A powerful tsunami generated by the event swept the western coast of Sumatra. Casualties were poorly documented.

1856—eruption of Awu claimed at least three thousand victims.

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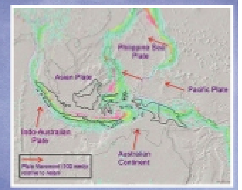
1883—eruption of Krakatoa in the Sunda Strait claimed an estimated 86,000 lives.[13] Several tsunami were generated throughout the eruption, the largest was thirty meters high. This wave washed away 160 villages and flooded the streets of Jakarta within fifty minutes of the largest blast.[14]

Harris and Prasetyadi, 2002, *Bridges*

The most dangerous seismic gaps in Indonesia exist in populated regions of western Sumatra… The entire 1600 km length of the Sumatran Fault System has not slipped significantly for over 130-150 years. Since this time, 7-8 meters of potential slip have accumulated and will most likely be released suddenly to produce a magnitude 8.0 + event!

Who's Next?



Java …has more frequent moderate earthquake events (M 5.5–7.5)…which pose a greater threat due to the more frequent devastation and disruption they inflict. Central Java has the most consistent record of historical earthquakes … We speculate from archeological evidence that it was a large earthquake similar to the one forecast from strain measurements that triggered the large-scale eruption of Merapi volcano in the tenth century C.E., which led to the …transition from Hindu to Islamic culture.

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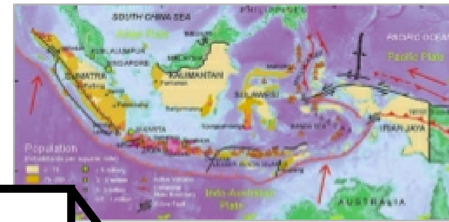

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Poorly-regulated development in these zones of high seismic flux poses a significant threat not only to the many cities with unfavorable site characteristics, but also densely-populated rural regions that have rapidly expanded into seismically unstable hillsides and cities along shorelines vulnerable to tsunami destruction.[5] Most buildings in these regions are incapable of withstanding even mild horizontal ground motions.[10] The most common construction practice is to build unreinforced walls using poorly-fired and deformed bricks

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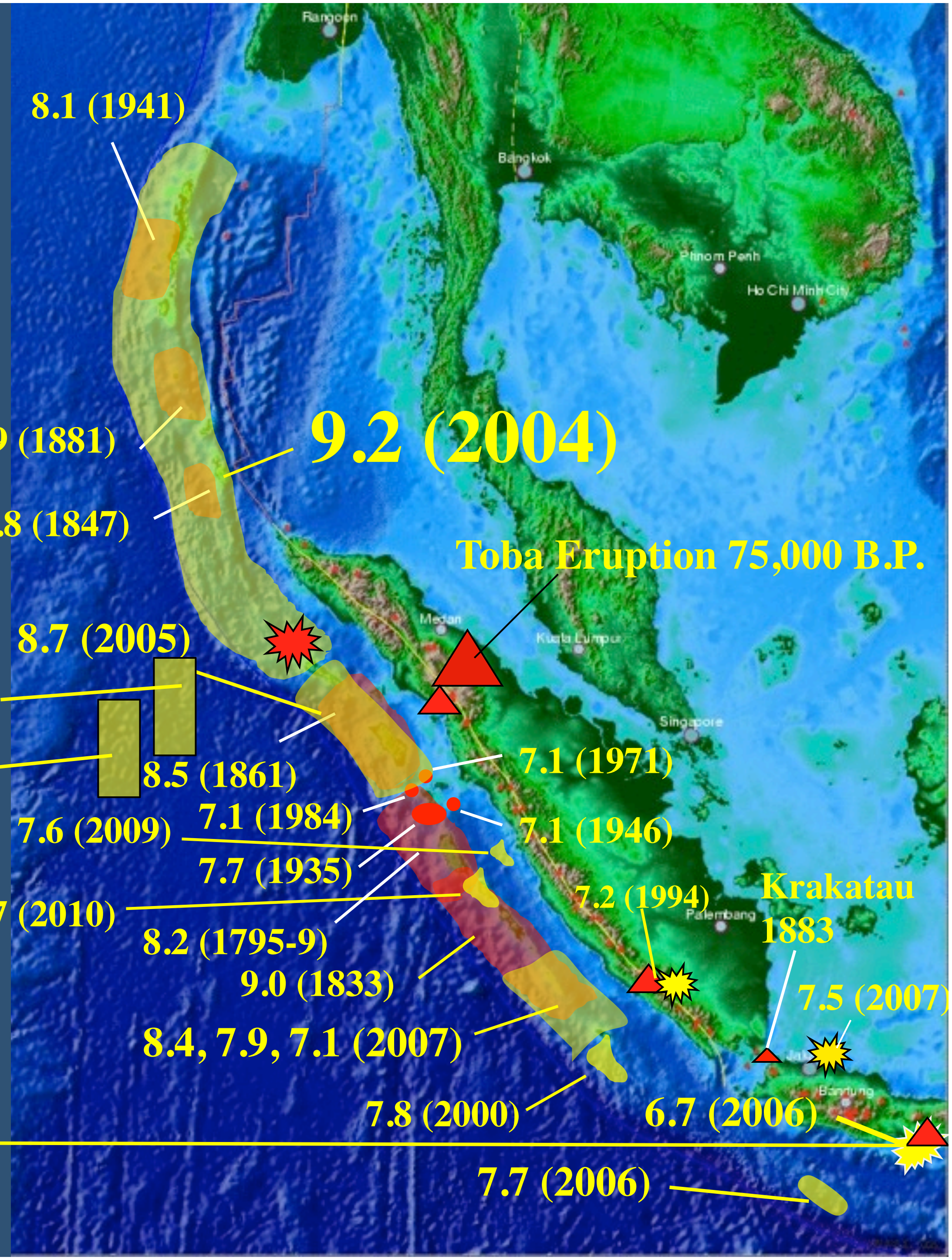
Harris and Prasetyadi, 2002, *Bridges*

What is the History of Earthquakes and Tsunamis in Indonesia

EQ + Tsunami Casualties in Indonesia

- 1500-2000 ≈ 50,000
- 2000-2012 ≈ 280,000

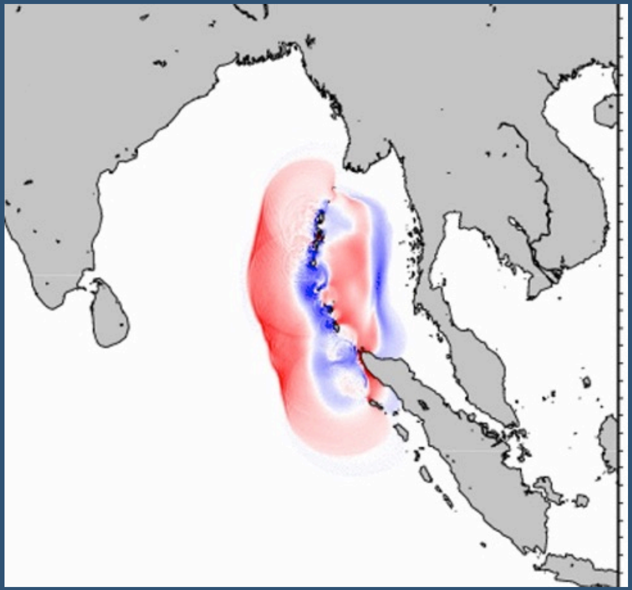


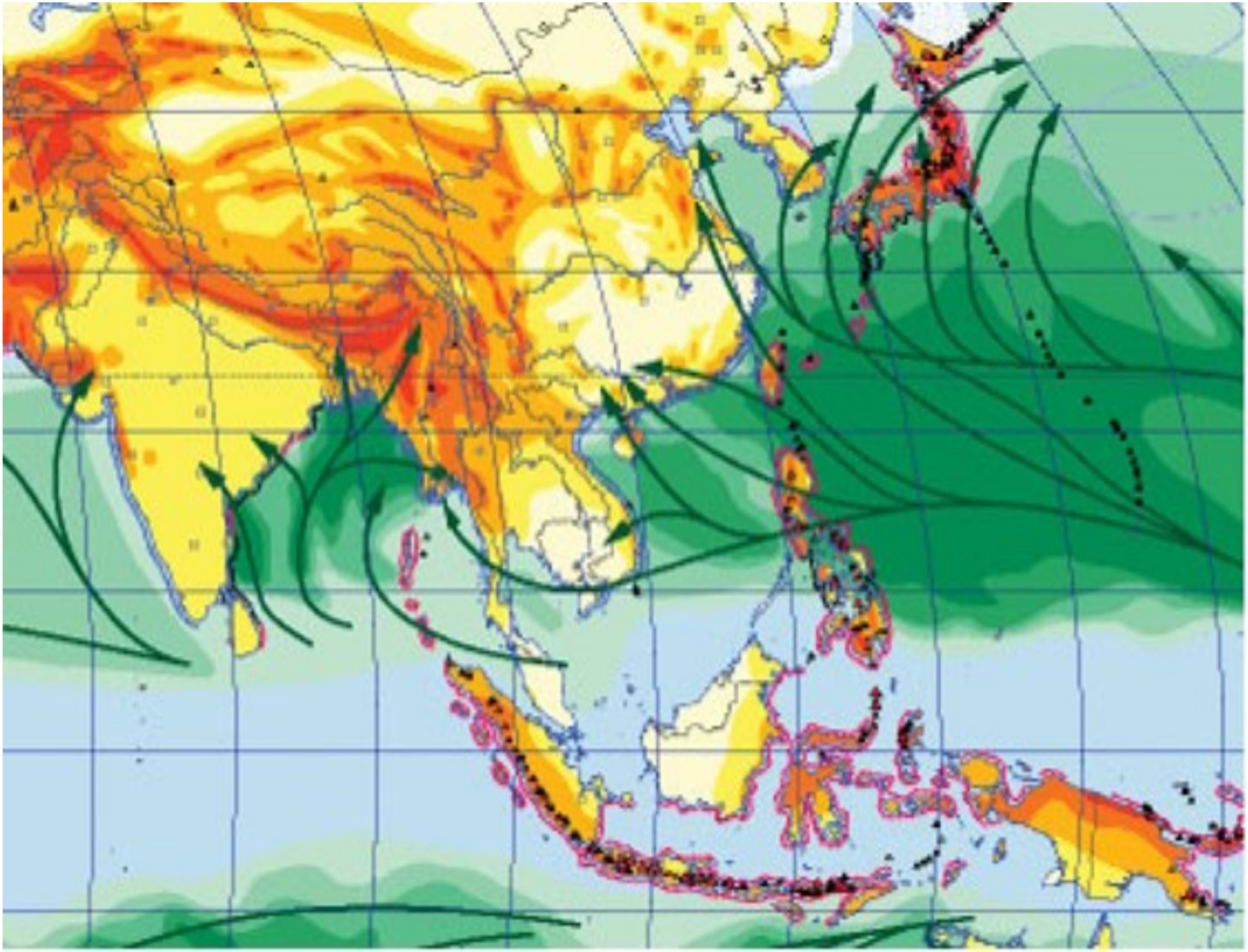
Scientists out performed by a 10 yr. old Girl and "Primitive" Sea Gypsies

Agence France-Presse

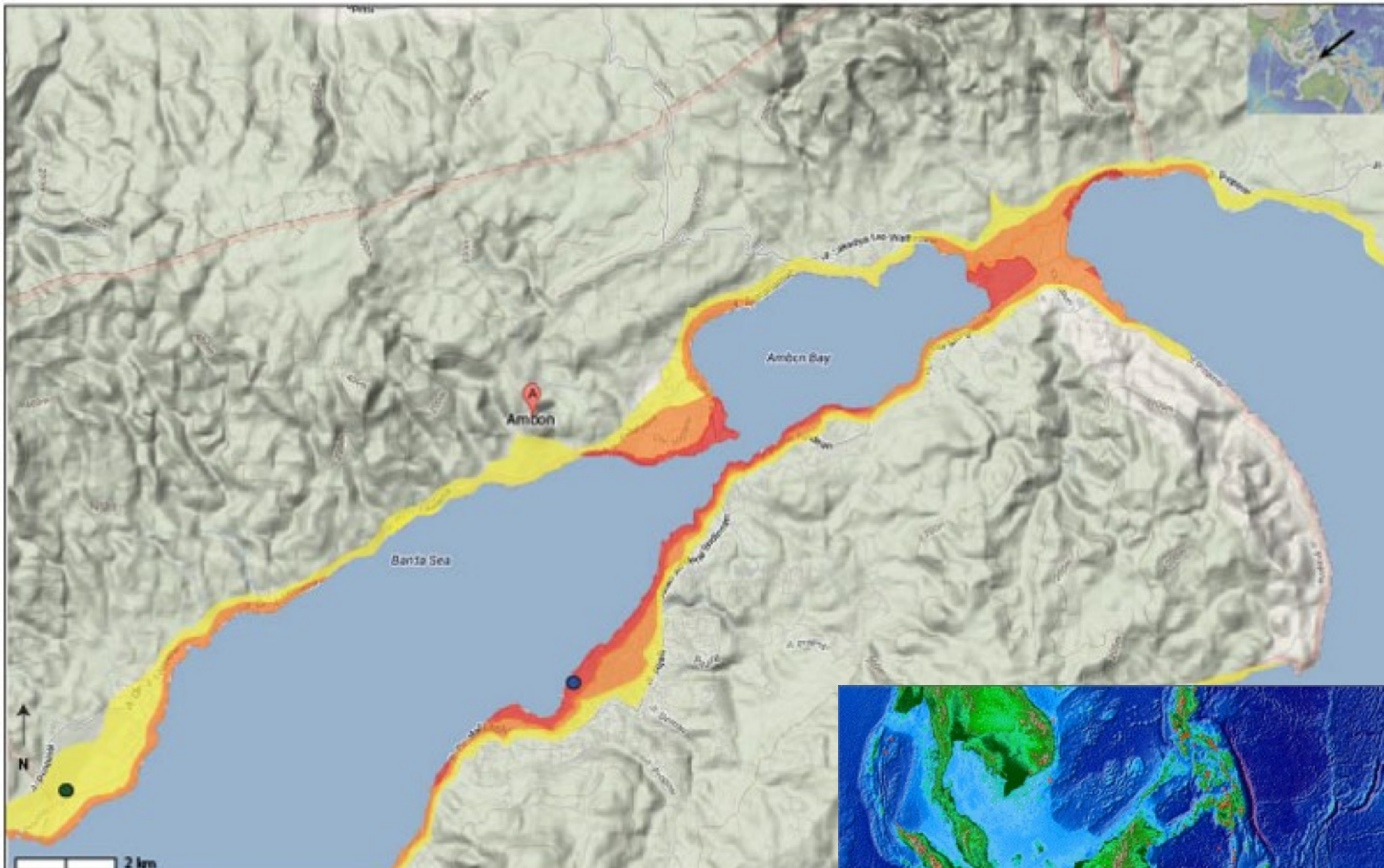
Tourists try to rush to safety before the tsunami hit the Hat Rai Lay Beach in Thailand. The water had

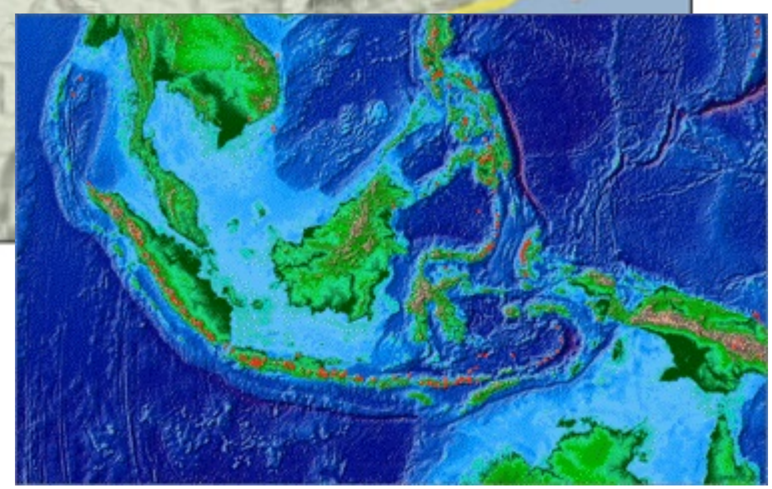
Moken Sea Gypsies warn of
Laboon – wave that eats people





Inundation Map of Ambon City, Indonesia





Legend

- High tsunami flood risk 5m
- Moderate tsunami flood risk 10m
- Low tsunami flood risk 20m
- Airport
- Shipyard

Lima


Lima

- Evacuation plan + signs
- Two evacuation drills

Dam breaks and city has 9 minutes to evacuate

- 428 homes smashed and washed into the sea
- > 2000 persons evacuate, but Only 7 deaths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Prevention: Humans against nature or Humans against Self?

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School community learns about basics of safe construction practices

Wasatch Front: Fix the Bricks!

inharmswayhelp.org

School Bonds Passed to build and renovate schools and study seismic safety in the district's older buildings.

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Questions