Geohazards in the Urban Environment

Michael Sheridan

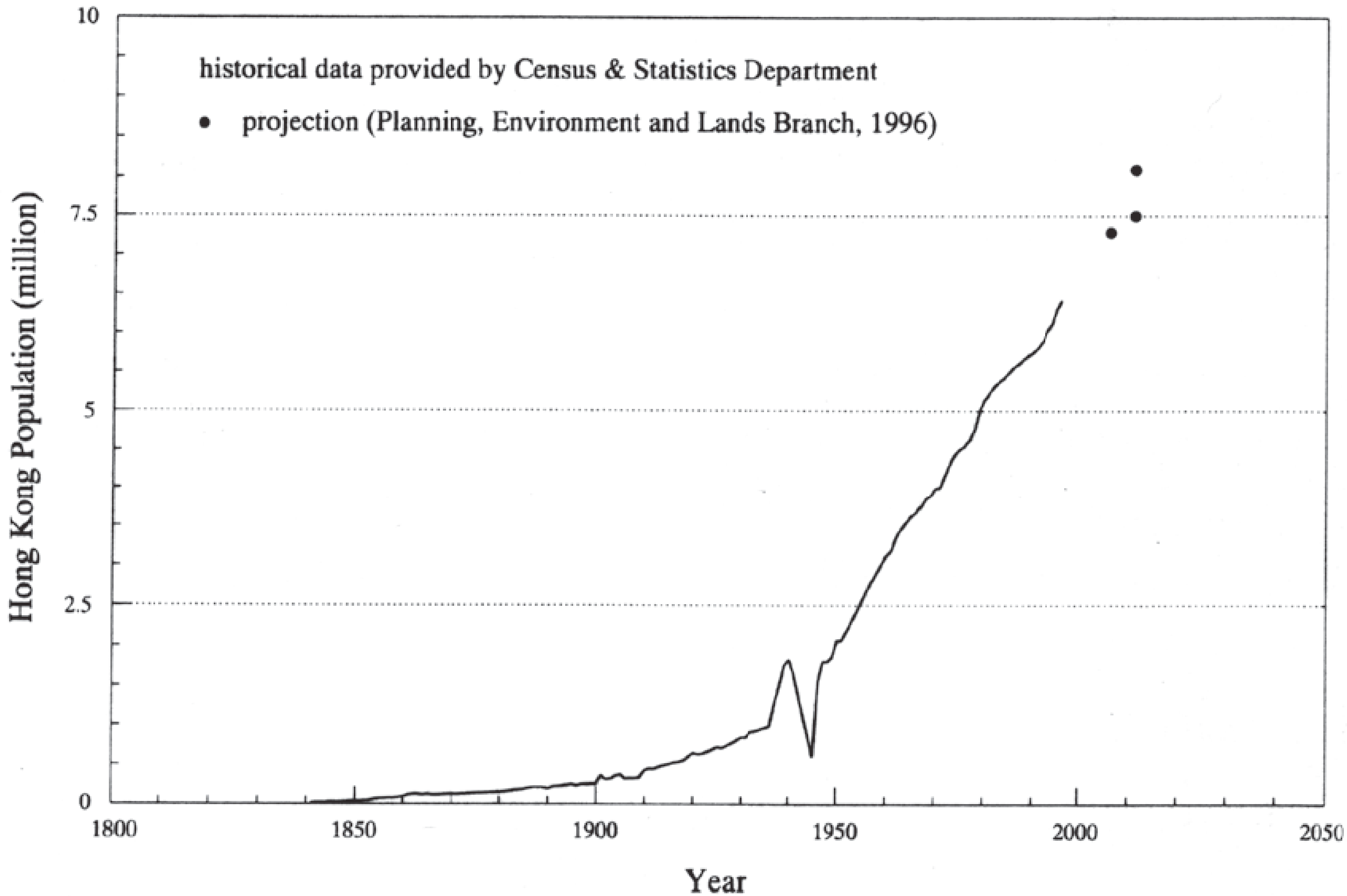
Director, Center for Geohazards Studies

University at Buffalo

Why the Urban Environment?

- High population density
- Rapid growth and change
- Important lifelines and facilities
- Resilience can be compromised

Hong Kong Population



Argument for Cities and Coastal areas

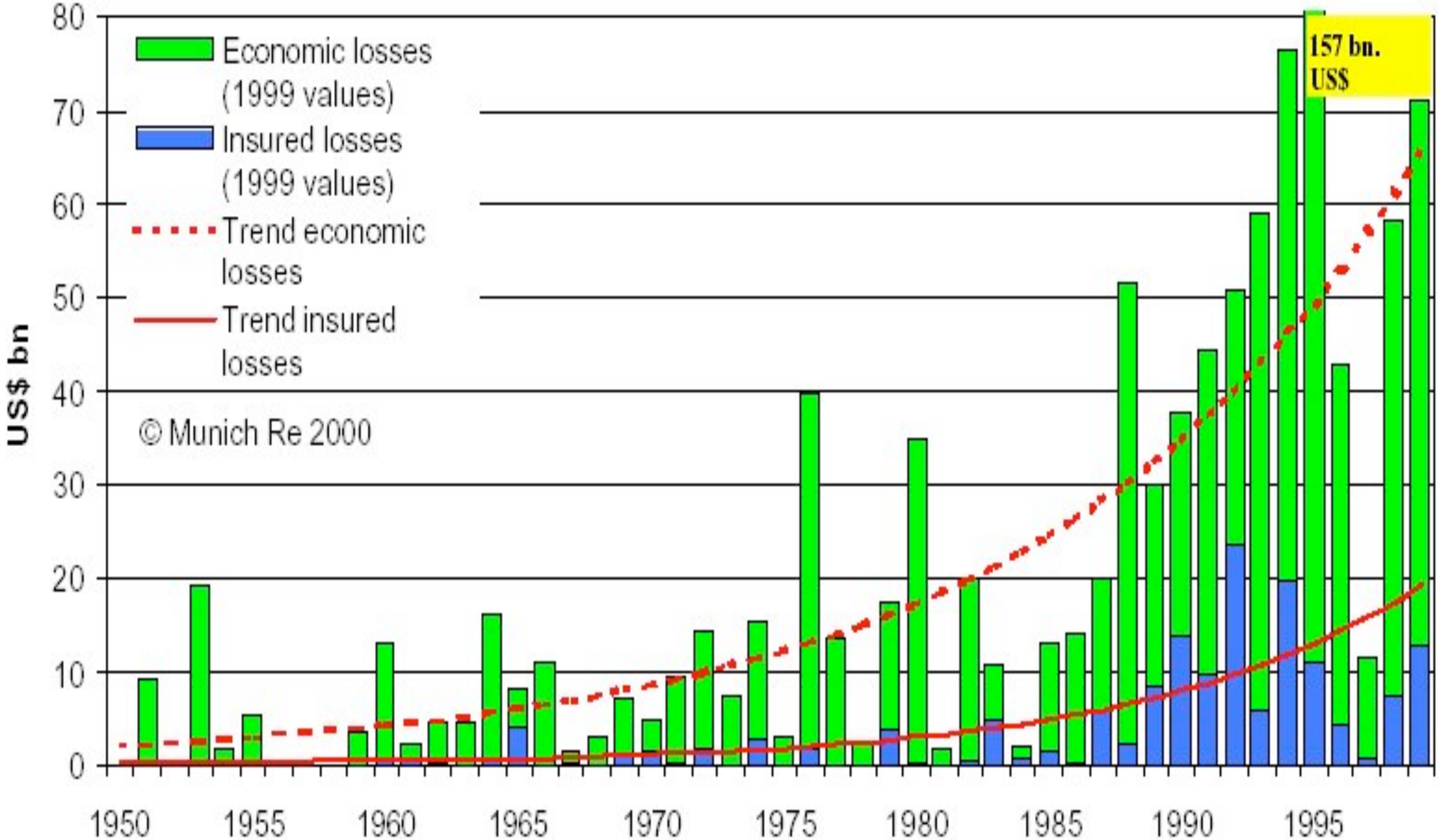
United Nations (ESCAP) Urges decision makers:

- To take geological factors into account
- To improve the quality of land-use planning
- Reduce effects of natural hazards posed by:
  - Earthquakes, volcanism, ground subsidence and flooding.

This is particularly urgent for

- The coastal lowlands of the region,
  - Habitat to an estimated 1.7 billion people,
- And more so for the urban centers,
  - Most of which are located in the coastal zone.

Economic and insured losses with trends



NatCat*SERVICE*

David Godshalk, (2003), *Urban Hazard Mitigation: Creating Resilient Cities*, Natural Hazards Review

Worldwide 7000 natural disasters, 25,000 deaths, $36 billion economic loss, 11.5 insured loss

Building disaster resilience

Some Geohazards to Consider

- Landslides
- Mudflows
- Earthquakes
- Volcanic eruptions
- Severe storms
- River floods
- *Hazardous waste*

Possible class activities

- Understand the causes of Geohazards
- Actively review many case studies
- Interact with classmates to debate issues
- Hear presentations from several experts
- Prepare different types of presentations:
  - Oral PowerPoint slide show
  - Professional style posters
  - Short written reports
  - Debate style arguments

Sheridan course “Preventing Natural Disasters”

http://www.eng.buffalo.edu/~mfs/lecnotes/lecnotes528.html

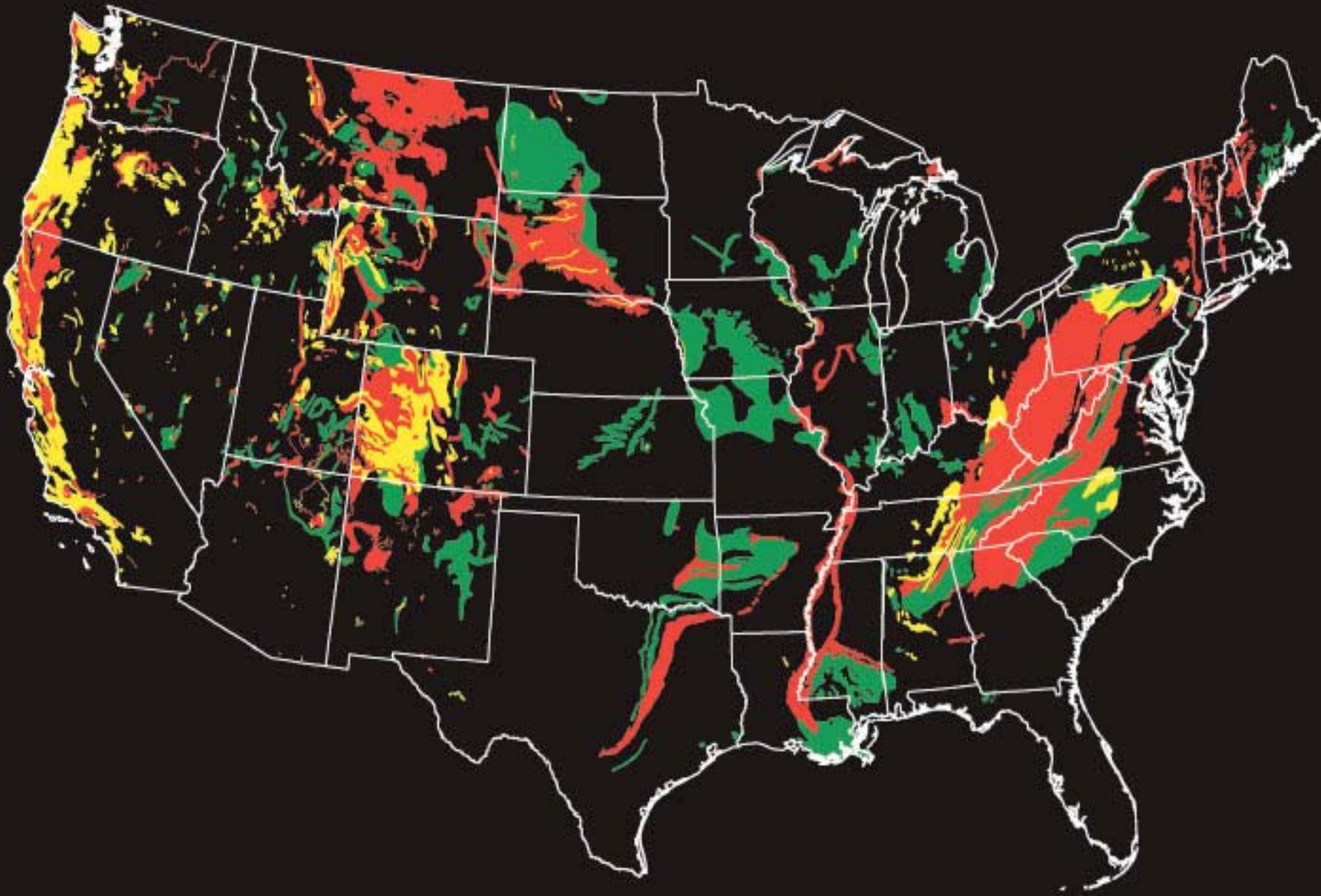
Questions About Hazards

- What causes it?
- Where will it happen?
- When will it happen?
- How big will it be?
- What can we do?

More Questions

- Does it give a warning?
- How long will it last?
- Where are the dangerous areas?
- Where are the safer areas?
- How can loss be managed?

Landslide potential of the USA



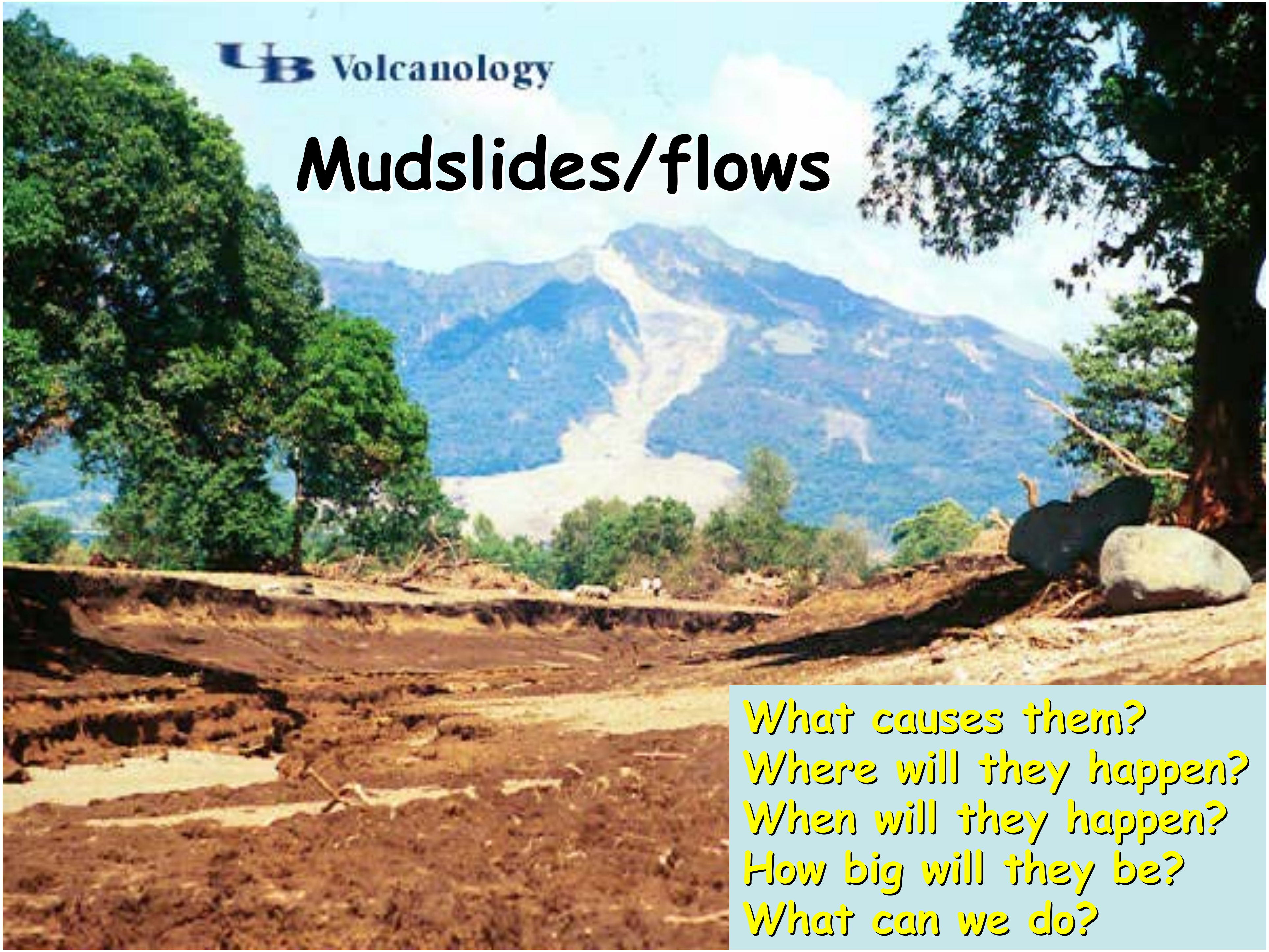
Hong Kong


Hong Kong


El Salvador

2007 Indonesia Landslide

2007 Indonesia Landslide


UB Volcanology
Mudslides/flows
What causes them?
Where will they happen?
When will they happen?
How big will they be?
What can we do?

Casita Disaster, 1988

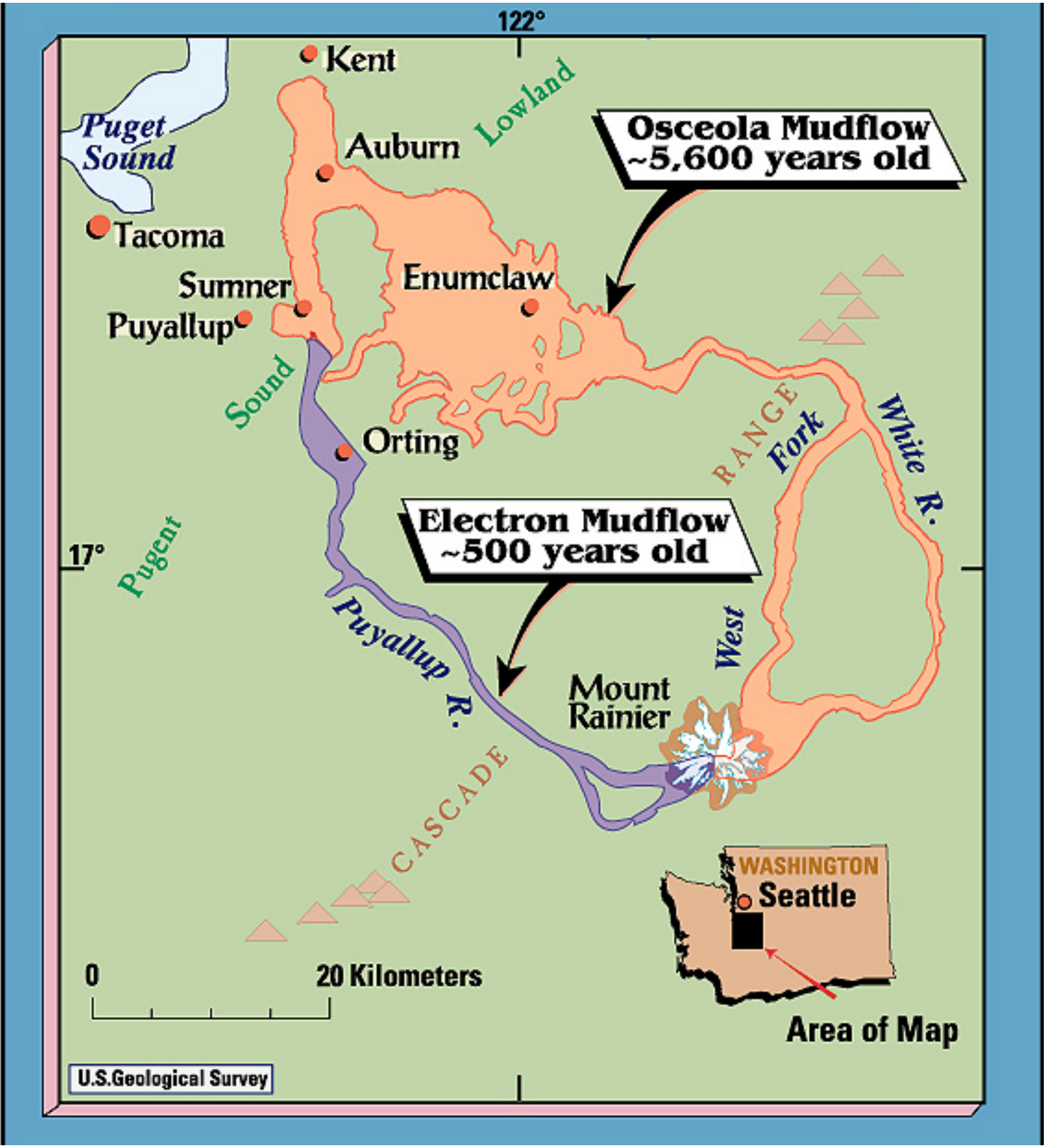
- Volcano not previously studied
- No published hazard map
- Inactive volcano
- Mudslides in the past
- No mitigation plan
- Country politically fragmented

- **2.5-3 mins to reach towns of El Porvenir and Rolando Rodriguez.**
- **1km wide, 4.5m deep flow stripped the dense forest leaving only 1 surviving house.**
- **Subsequent flood affected Pan Am Highway**

- Two medium-sized towns destroyed
- Between 1560 and 1680 people died
- Hundreds more displaced
- Destroyed several settlements
- Disrupted the Pan American Highway

Nevado del Ruiz Disaster in 1985 killed 28,000 people by a volcanic mudflow

Mount Rainier Mudflows



Sidoarjo, Indonesia Toxic mud, May 2006


HORIZONS Lahar WebCam
2007-03-18 GMT-12 12:17:12
FS REC DY

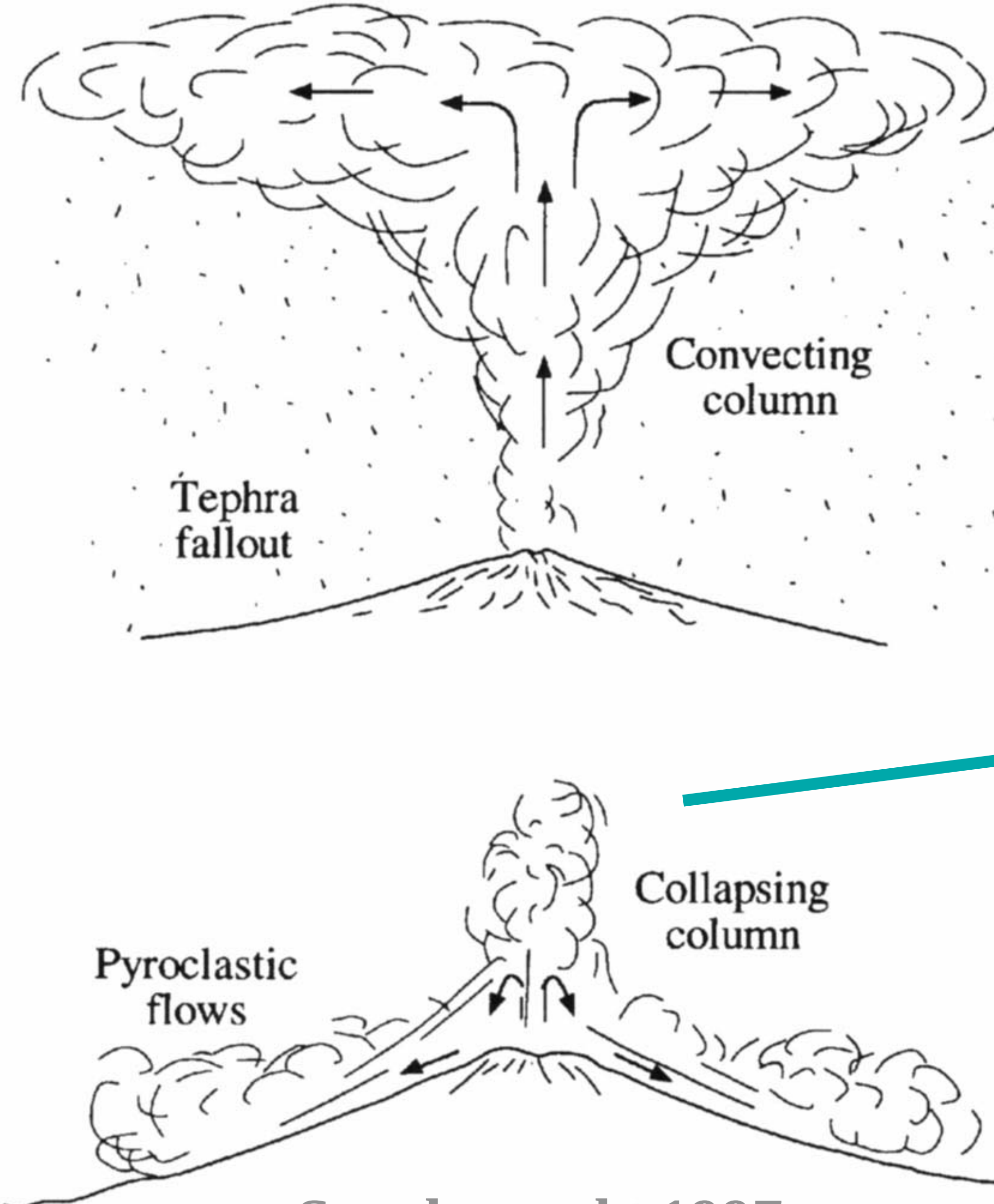

Volcanoes
What causes them?
Where will they happen?
When will they happen?
How big will they be?
What can we do?

Methodology

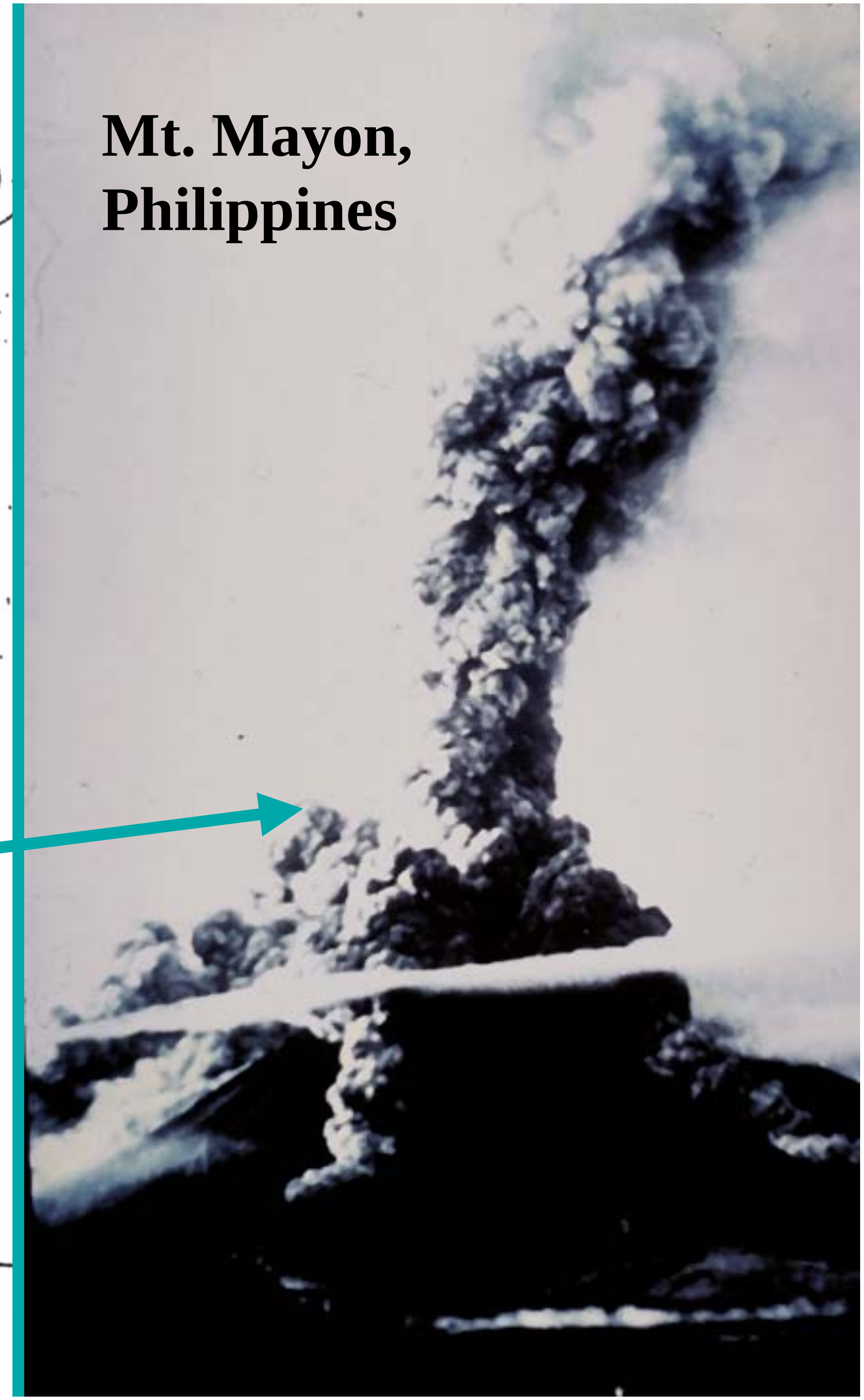
- Determine the geological hazards presented by the volcano
- Estimate the size/frequency relationships of various events
- Make hazard maps to distinguish dangerous and safe areas
- Work with the civil protection agencies and scientific research groups of the respective countries

There are Many Types of Volcanic Hazards

- Volcanic gas
- Lava flows & domes
- Ash fallout
- Pyroclastic flows
- Debris flows & floods
- Debris avalanches



Sparks et al., 1997



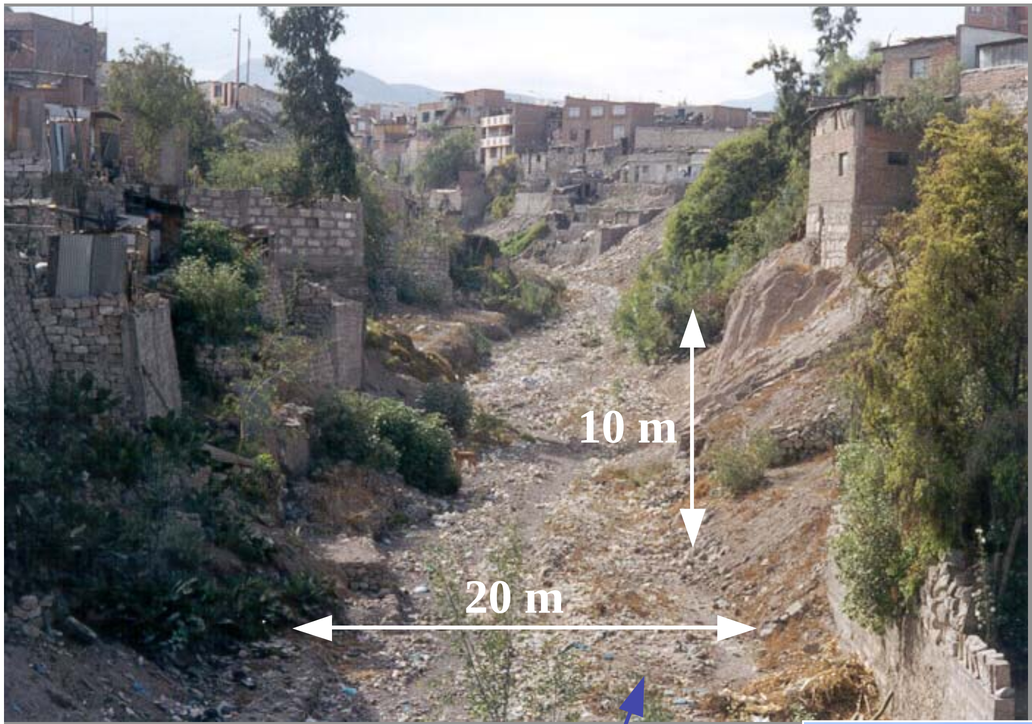
Reventador, Ecuador

Volcanic Ash Closed Airports

Mudflows Cut Oil Pipelines

Mudflows Cut Highways

Volcanoes of the Central Andes, El Misti

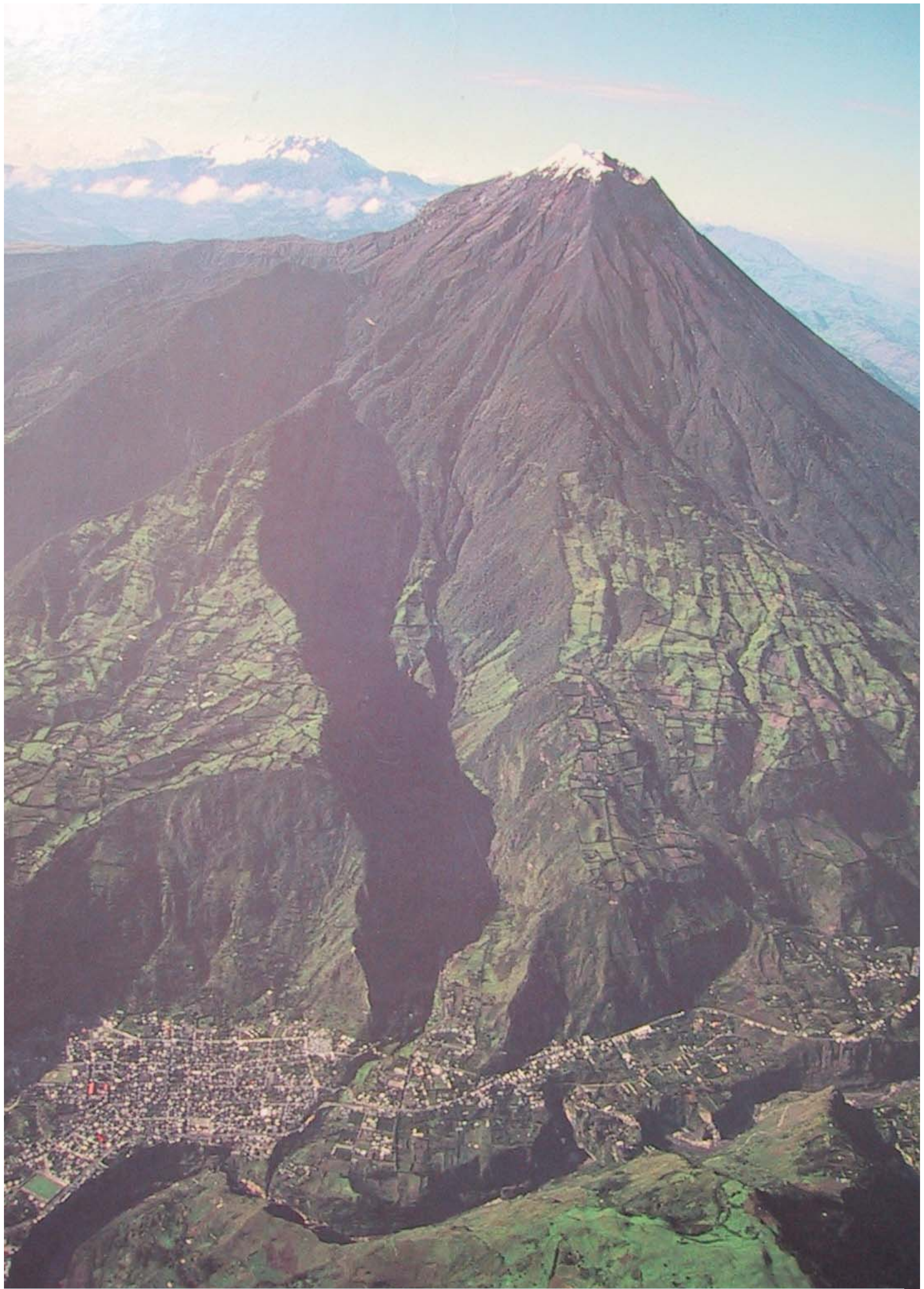


La quebrada San Lazaro

à 11 – 13 km du sommet,

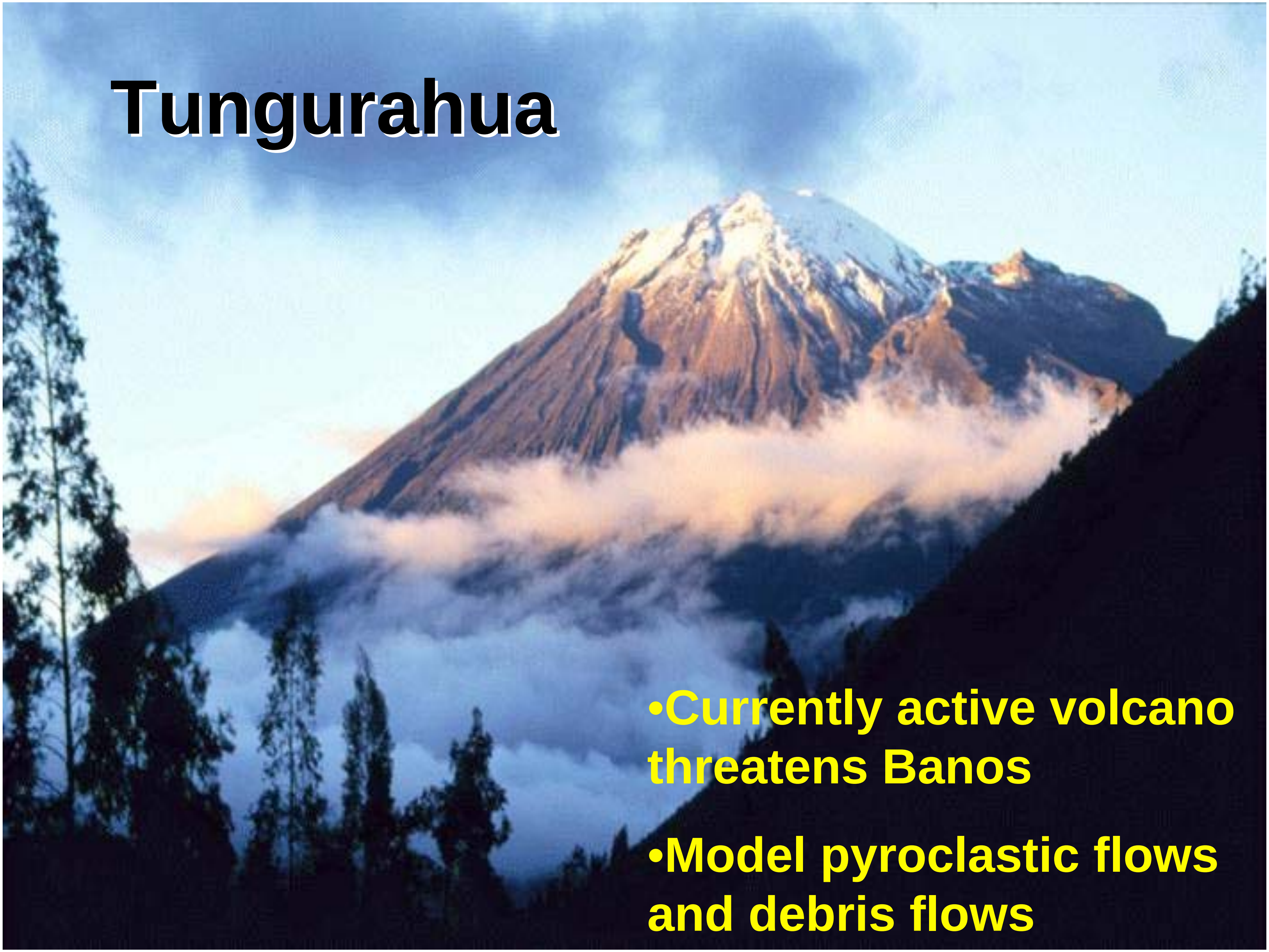
à l'amont de la ville.

Dépôts pyroclastiques et lahariques récents



Tungurahua, Ecuador

Tungurahua

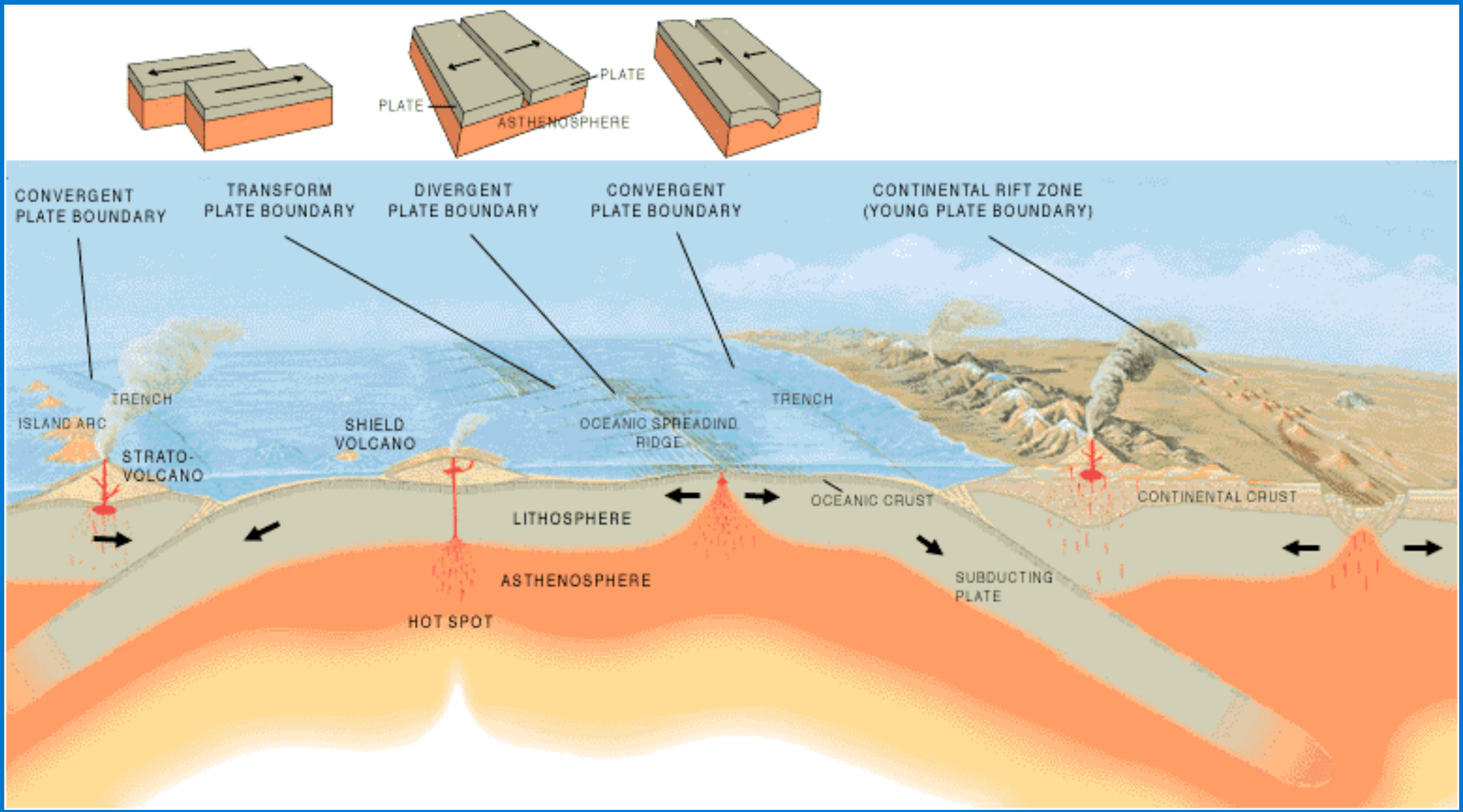


- Currently active volcano threatens Banos
- Model pyroclastic flows and debris flows

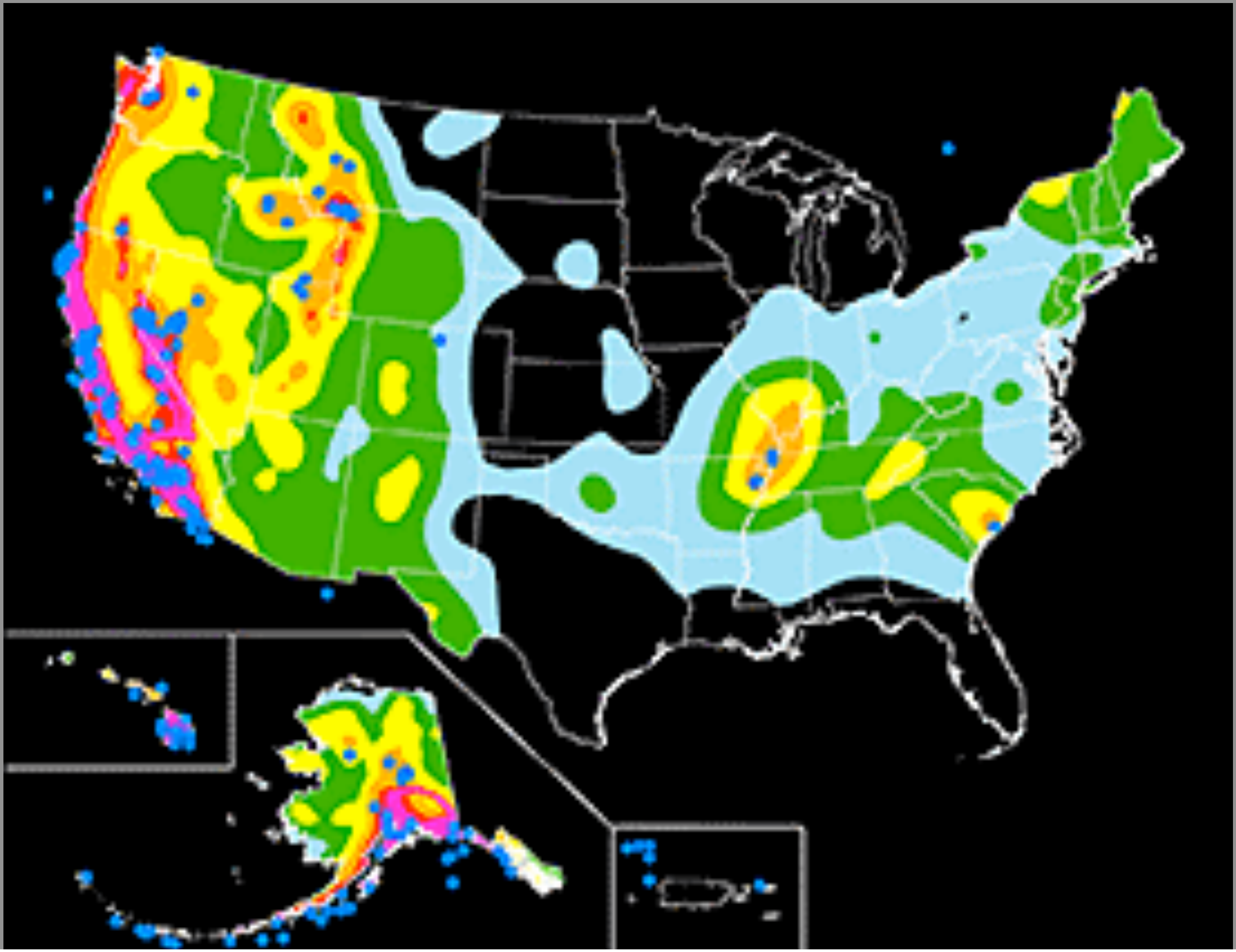
Earthquakes

- What causes them?
- Where will they happen?
- When will they happen?
- How big will they be?
- What can we do?

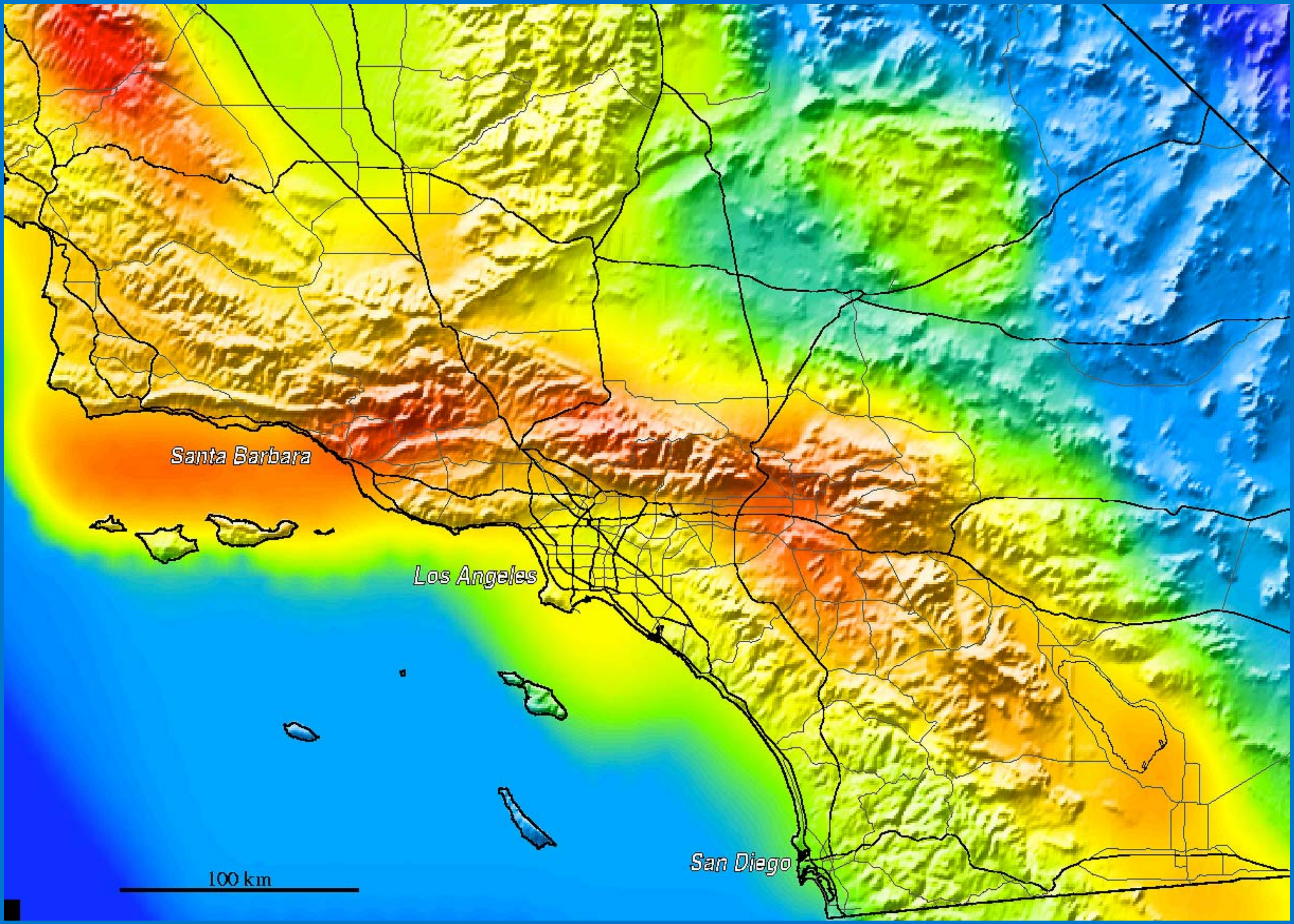
Plate motions are the main cause



USA Shaking hazards - USGS

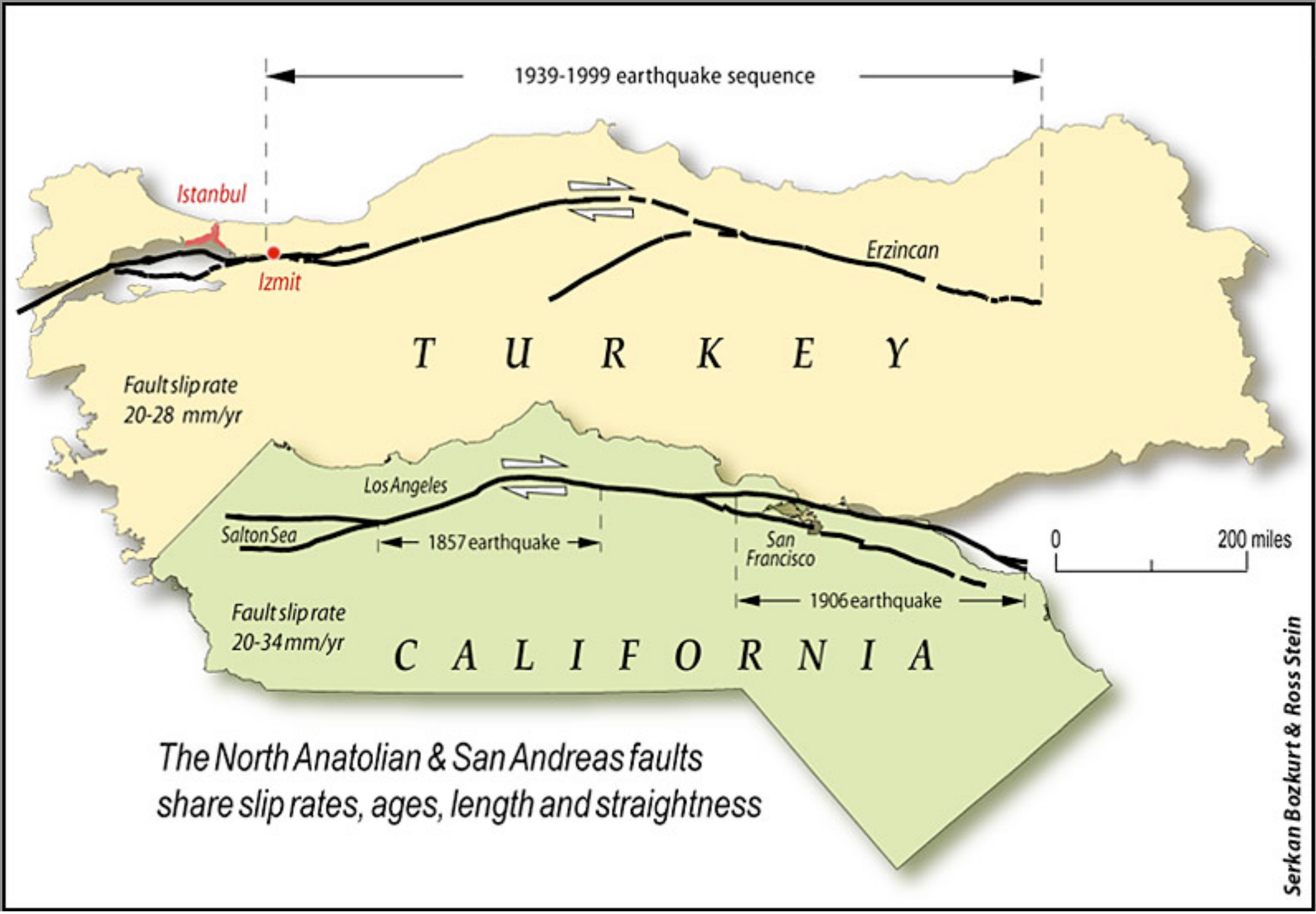


Shaking Hazard in Southern California



USGS

Comparison of San Andreas and Anatolian Faults



Earthquake at Izmit, Turkey

1906 San Francisco Earthquake Photograph by Arnold Genthe shows Sacramento Street

Photograph, taken by George Lawrence from a series of kites five weeks after the great earthquake of April 18, 1906

Peru Earthquake, 2007

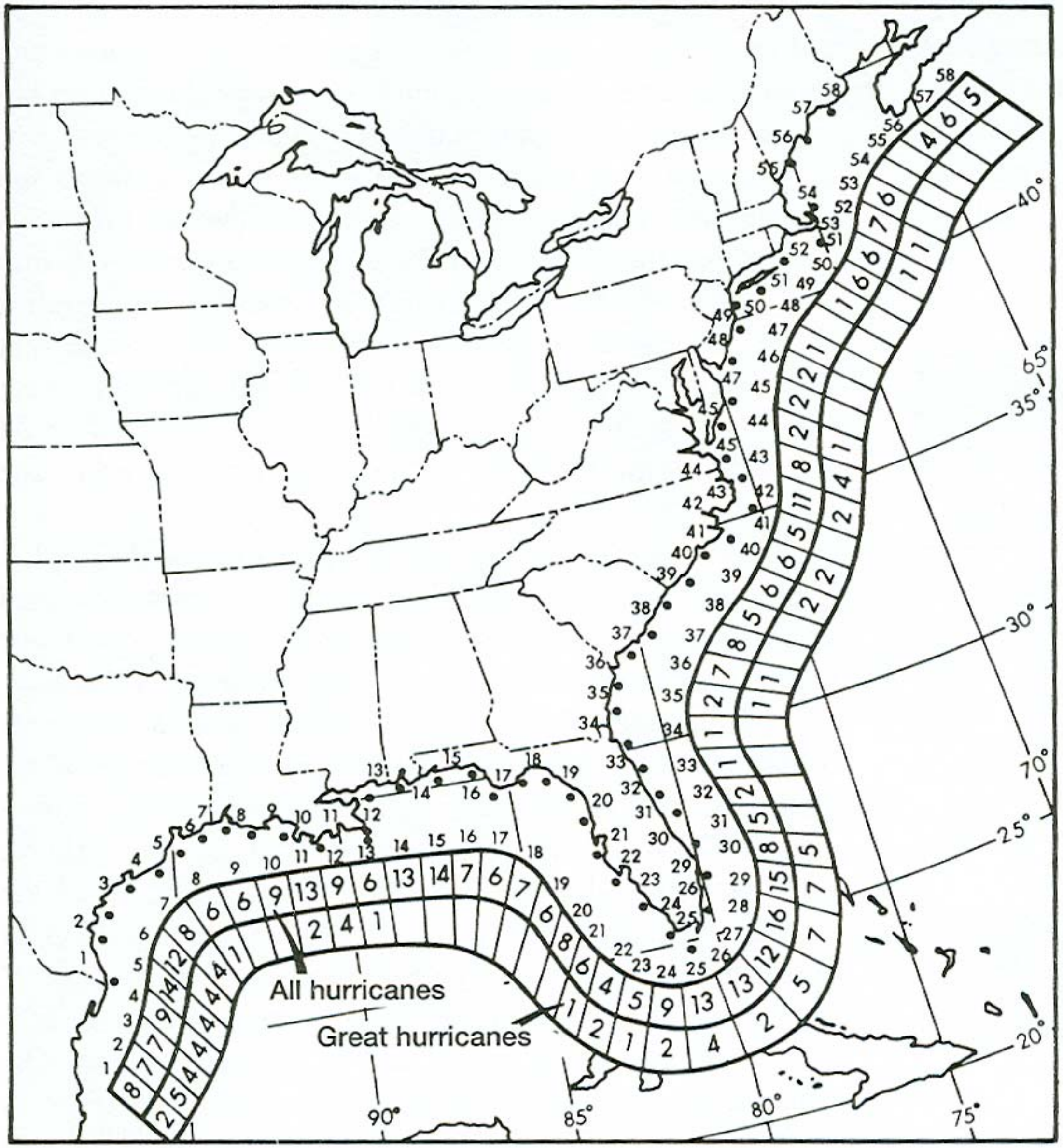


Figure 11.6 Percent probability that a hurricane (74 mph or faster) or a great hurricane (125 mph or faster) will occur in a given year along 80-km (50-mi)-long segments of the U.S. coastline.

After Simpson and Lawrence, 1971.

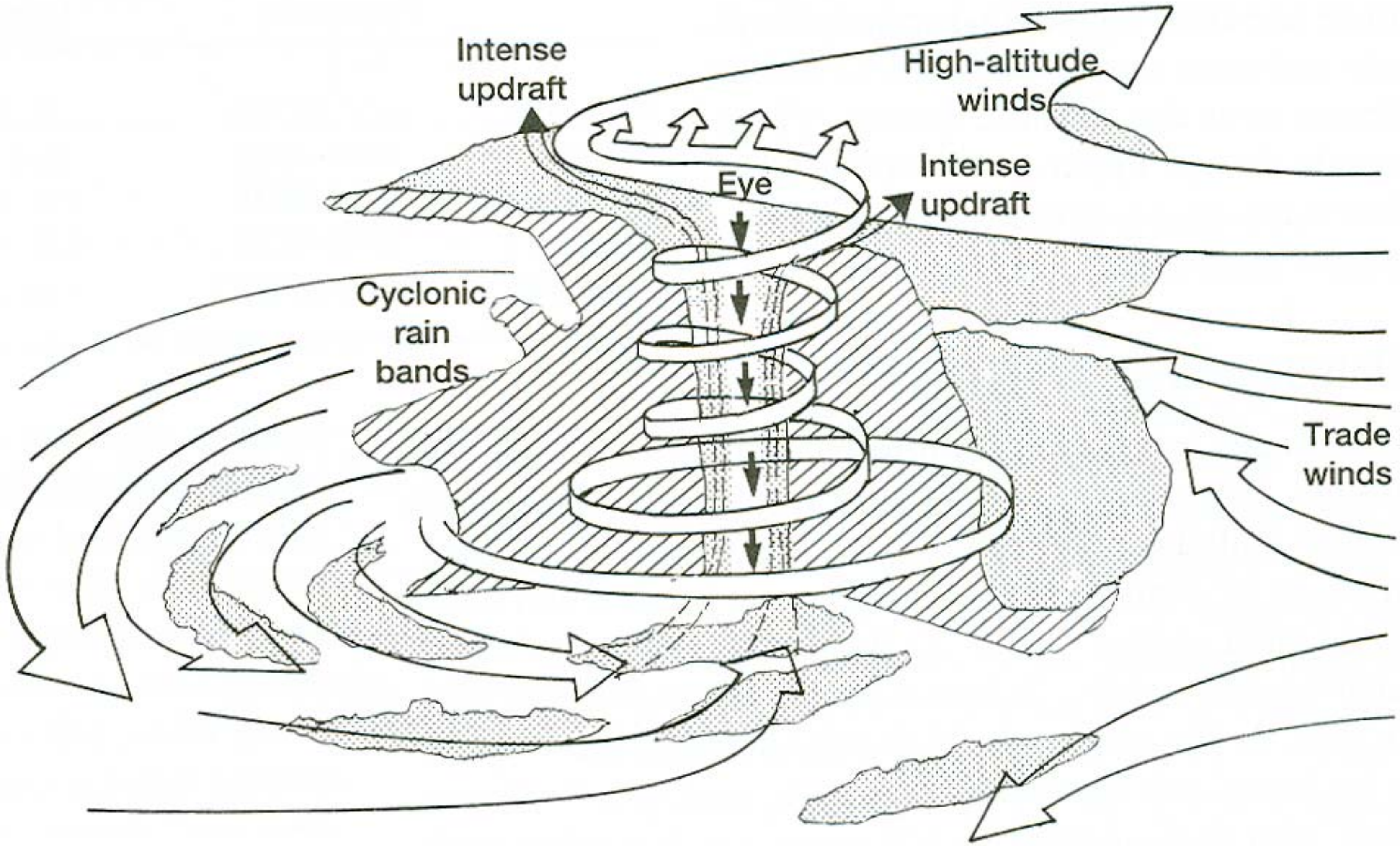


Figure 11.4 Schematic drawing through a hurricane. Low-altitude trade winds feed moisture and heat to the eye. Updrafts rise rapidly up the core (eye) wall and are helped away by high-altitude winds.

Source: U.S. Department of Commerce, 1971.

Two men wade through floodwaters on Canal Street two weeks after Hurricane Katrina tore open New Orleans' levees, flooding about 80 percent of the city and neighboring parishes. ***Photograph by Michael Lewis***

Hurricane Felix, Nicaragua
Gustavo Amador / EPA

Floods

- What causes them?
- Where will they happen?
- When will they happen?
- How big will they be?
- What can we do?

Floodplains and Fans

- Represent the storage of sediment (sand and gravel) deposited by rivers
  - Within bank deposition due to channel migration
  - Over bank deposition at times of high water
- Recurrence interval for bank full flow (flooding) is 1.5 years on the average.
- This suggests that the river morphology is adjusted to accommodate channel flow most of the time but the floodplain is developed to handle the larger flows on the remainder of the time

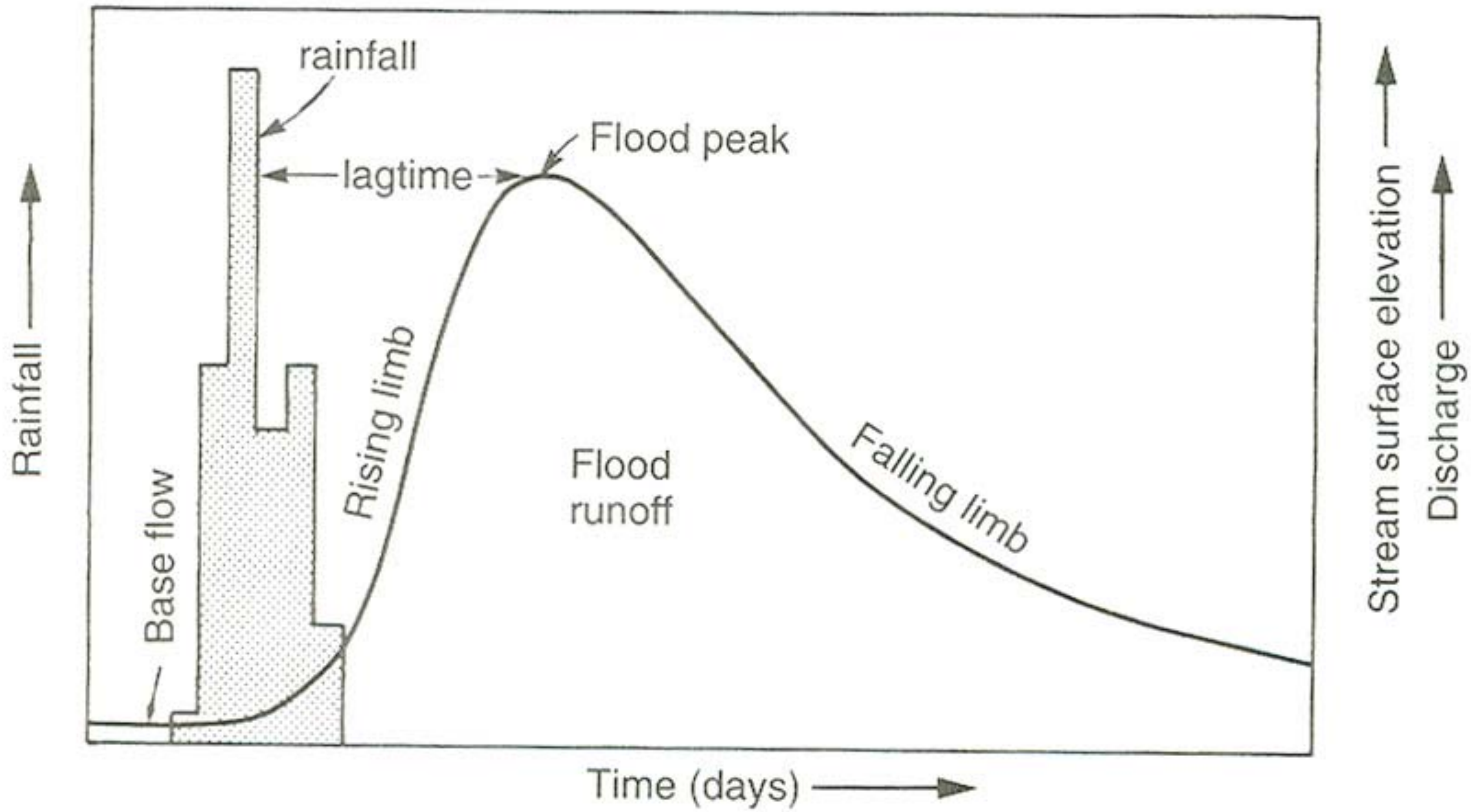


Figure 12.18 A hydrograph charts flood runoff. Commonly, stream flow rapidly increases from surface runoff, as shown by a steep rising limb reaching a peak flow. From the peak, discharge decreases slowly as infiltrated rain flows underground and feeds the stream.


M.J.KENNEDY.
HARD & SOFT COAL.
WOOD & BALED HAY.

Johnstown Flood