EARTH 270 – DISASTERS AND NATURAL HAZARDS (v. 2018)

Kensennuma City, Miyagi Prefecture , Japan, March 2011

PROFESSOR S.G. EVANS, PhD, PEng (Room 303, Earth Science and Chemistry (ESC) Building)

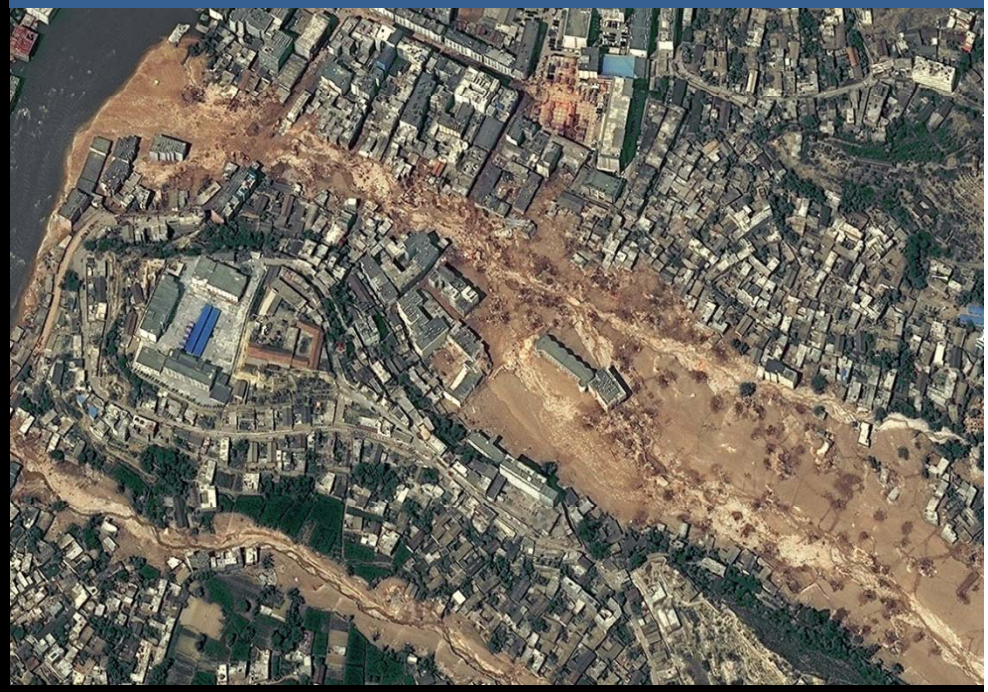
UNIVERSITY OF WATERLOO

EARTH 270 – DISASTERS AND NATURAL HAZARDS

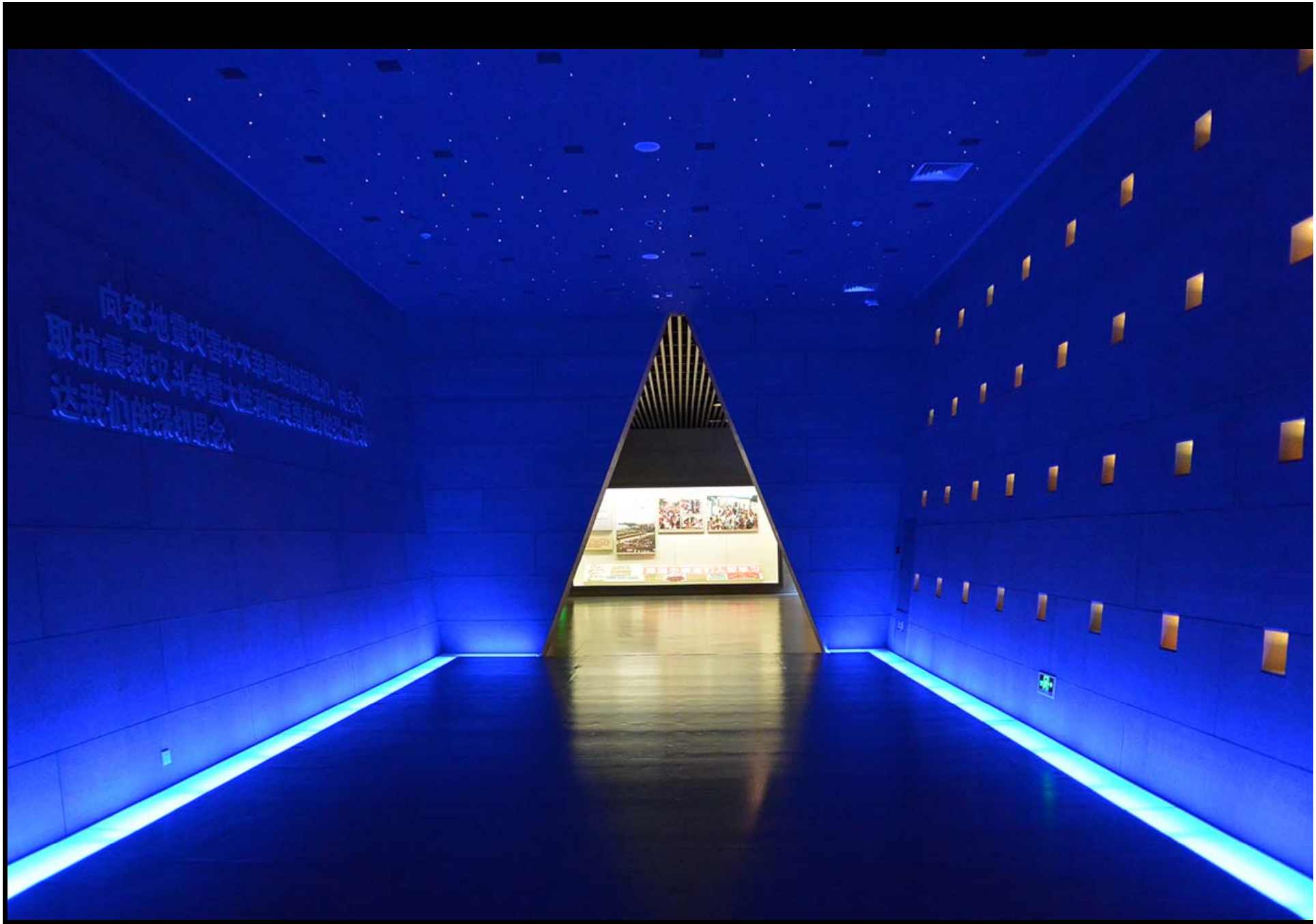
The course examines the physical causes and effects of disasters that result from natural hazards including earthquakes, tsunamis, volcanic activity, landslides, glacier–related processes, hurricanes, tornadoes, extreme weather, river and coastal flooding, wildfire, surface subsidence, asteroid impacts, and space weather. Illustrated by case histories, the course will analyse the factors that lead to disasters. The effect of climate change, human activity, and population growth on the magnitude and frequency of disasters will be explored. The course will introduce the basic principles of GeoRisk management and its applications in natural hazards engineering, emergency management, in the development of mitigation strategies and in the finance/re-insurance industries. For each natural hazard examined, methods and strategies of mitigation will be explored. The course is global in scope.

Hurricane Matthew Storm Surge, Haiti, October 2016

Zhouqu Landslide, Gansu Province, China, August 2010



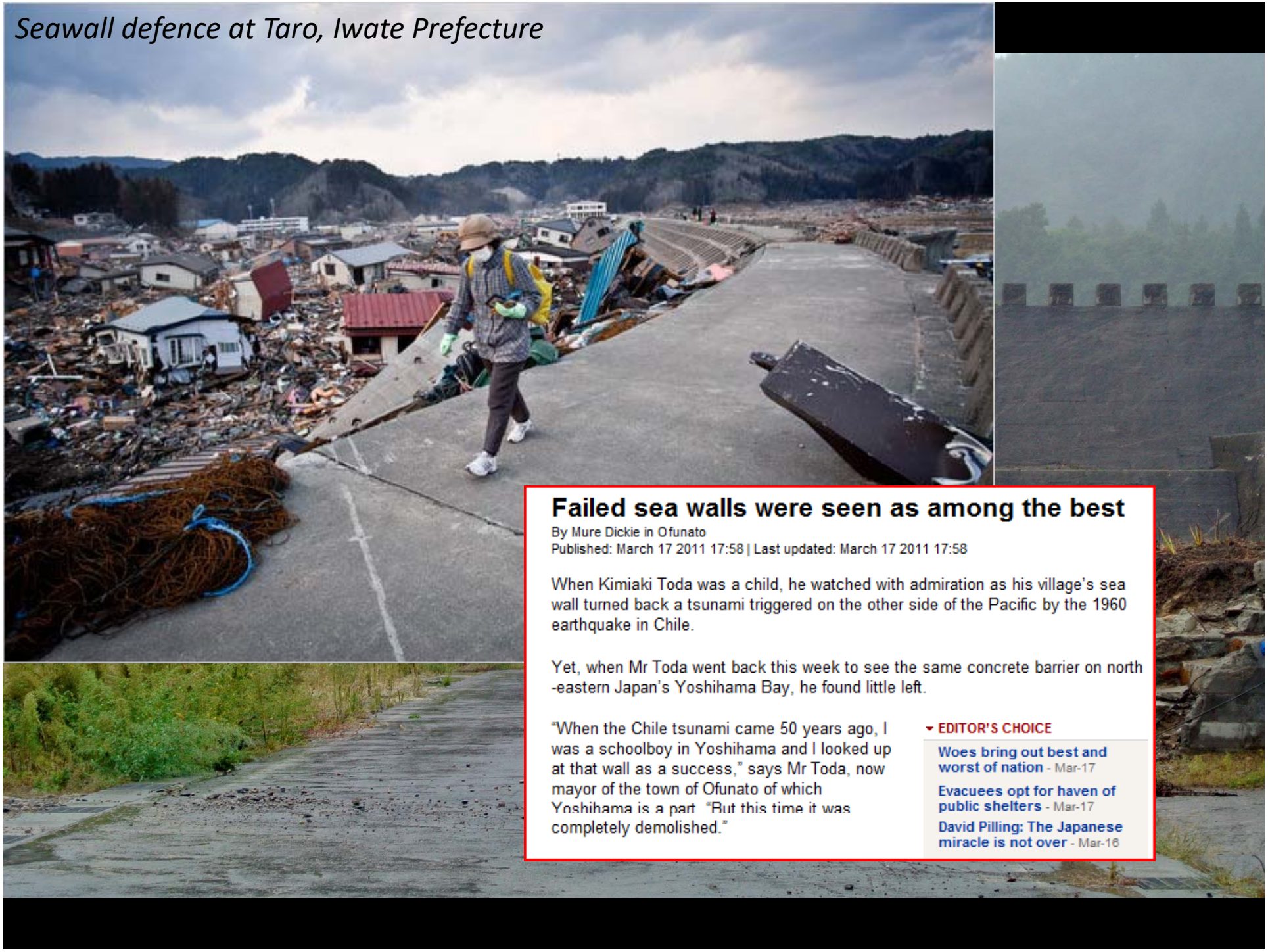
RUINED MULTISTORY BUILDING, BEICHUAN COUNTY, SICHUAN [WENCHUAN EARTHQUAKE 2008 – M 7.9]



MEMORIAL HALL TO VICTIMS (87,419) OF 2008 WENCHUAN EARTHQUAKE, BEICHUAN COUNTY

Kensennuma City, Miyagi Prefecture, Japan, September 26, 2012

Seawall defence at Taro, Iwate Prefecture



Failed sea walls were seen as among the best

By Mure Dickie in Ofunato
Published: March 17 2011 17:58 | Last updated: March 17 2011 17:58

When Kimiaki Toda was a child, he watched with admiration as his village's sea wall turned back a tsunami triggered on the other side of the Pacific by the 1960 earthquake in Chile.

Yet, when Mr Toda went back this week to see the same concrete barrier on north-eastern Japan's Yoshihama Bay, he found little left.

"When the Chile tsunami came 50 years ago, I was a schoolboy in Yoshihama and I looked up at that wall as a success," says Mr Toda, now mayor of the town of Ofunato of which Yoshihama is a part. "But this time it was completely demolished."

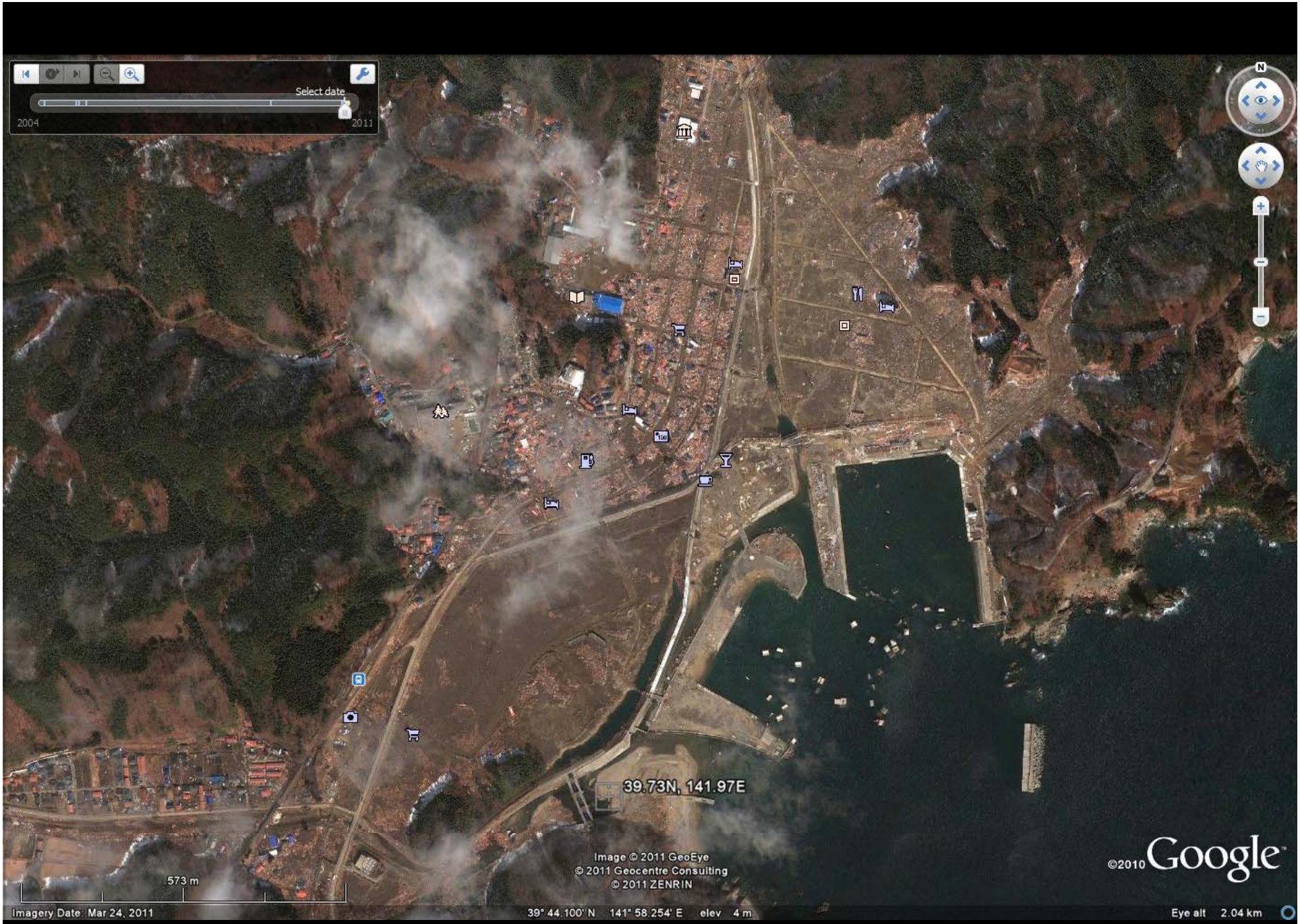
EDITOR'S CHOICE

Woes bring out best and worst of nation - Mar-17

Evacuees opt for haven of public shelters - Mar-17

David Pilling: The Japanese miracle is not over - Mar-16

Taro machi, Iwate Prefecture,July 2009



Taro machi, Iwate Prefecture, after the tsunami in March 2011

Seawall defence at Taro, Iwate Prefecture

Seawall defence at Taro, Iwate Prefecture

Philippines in 'national calamity'

The Philippine President Benigno Aquino declares a state of national calamity following Friday's devastating typhoon which has killed thousands of people.

- BBC reports from destroyed Cebu
- George Alagiah: Inside aid centre

Photos before and after the storm

Messages sent to loved ones

In pictures: Philippines reels

Survivors' stories

Cyclone Phailin (Oct 2013) : Cyclone Shelter at Gokhorkuda (Ganjam District, Odisha State, India)

MANHATTAN POPULATION DENSITY

Residential (night time) – 44,743 p/km2 [built on land]

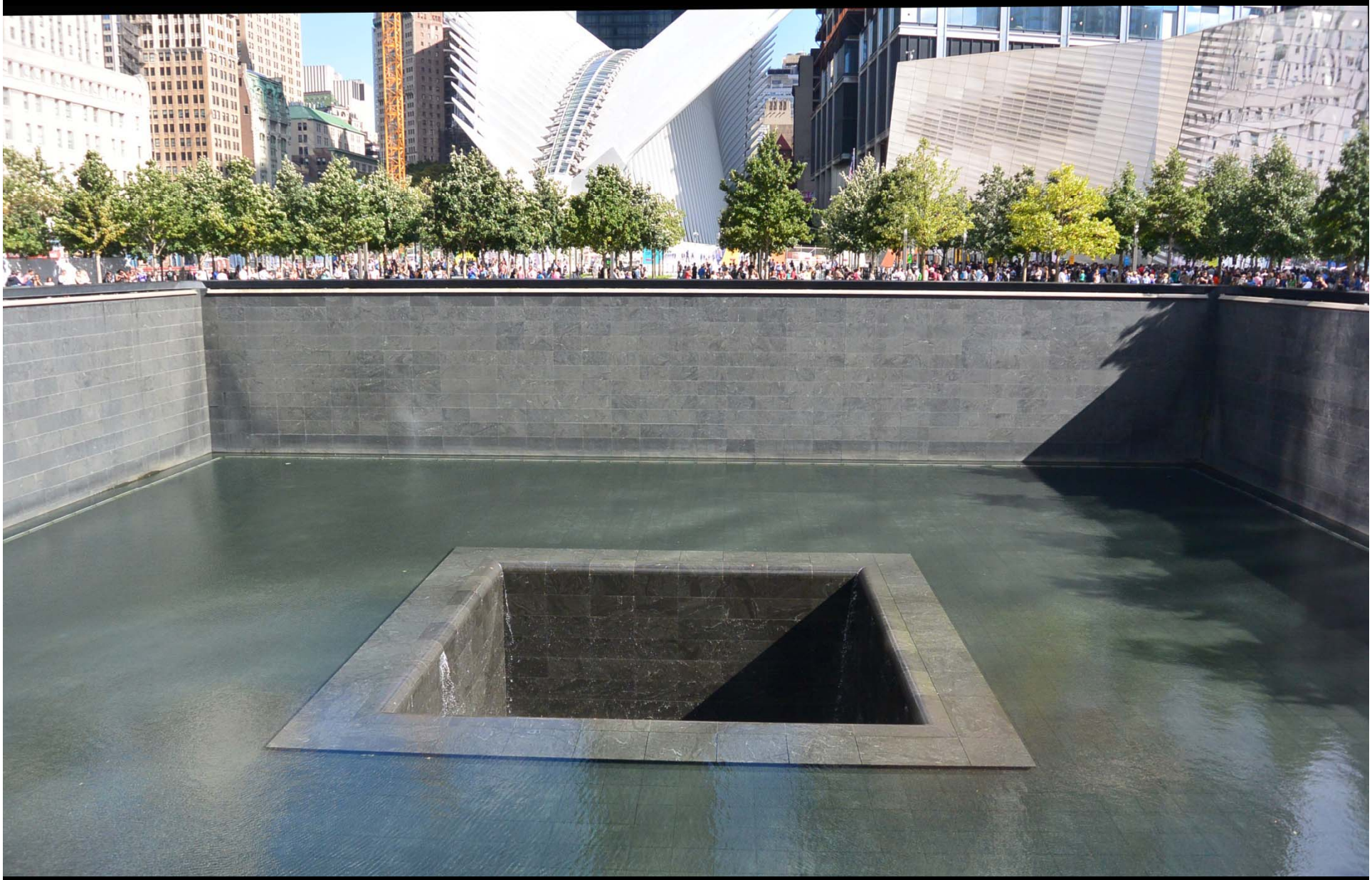
Work day (day time) – 107,308 p/km2 [built on land]

Work day density = 2.4 x Residential density

Individual skyscraper population density (WTC 1 – 2,172,852 p/km2; WTC 2 – 2,084,961 p/km2)

Individual super-tall building (432 Park Avenue [820 m2] 100 condos – 350,000 p/km2)

9/11 ATTACKS ON WORLD TRADE CENTRE



TOWER FOOTPRINT = 4,096 m2

https://c1.staticflickr.com/1/48/127765052_5f90570da6_b.jpg

ONE WORLD TRADE CENTER [September 15, 2015]

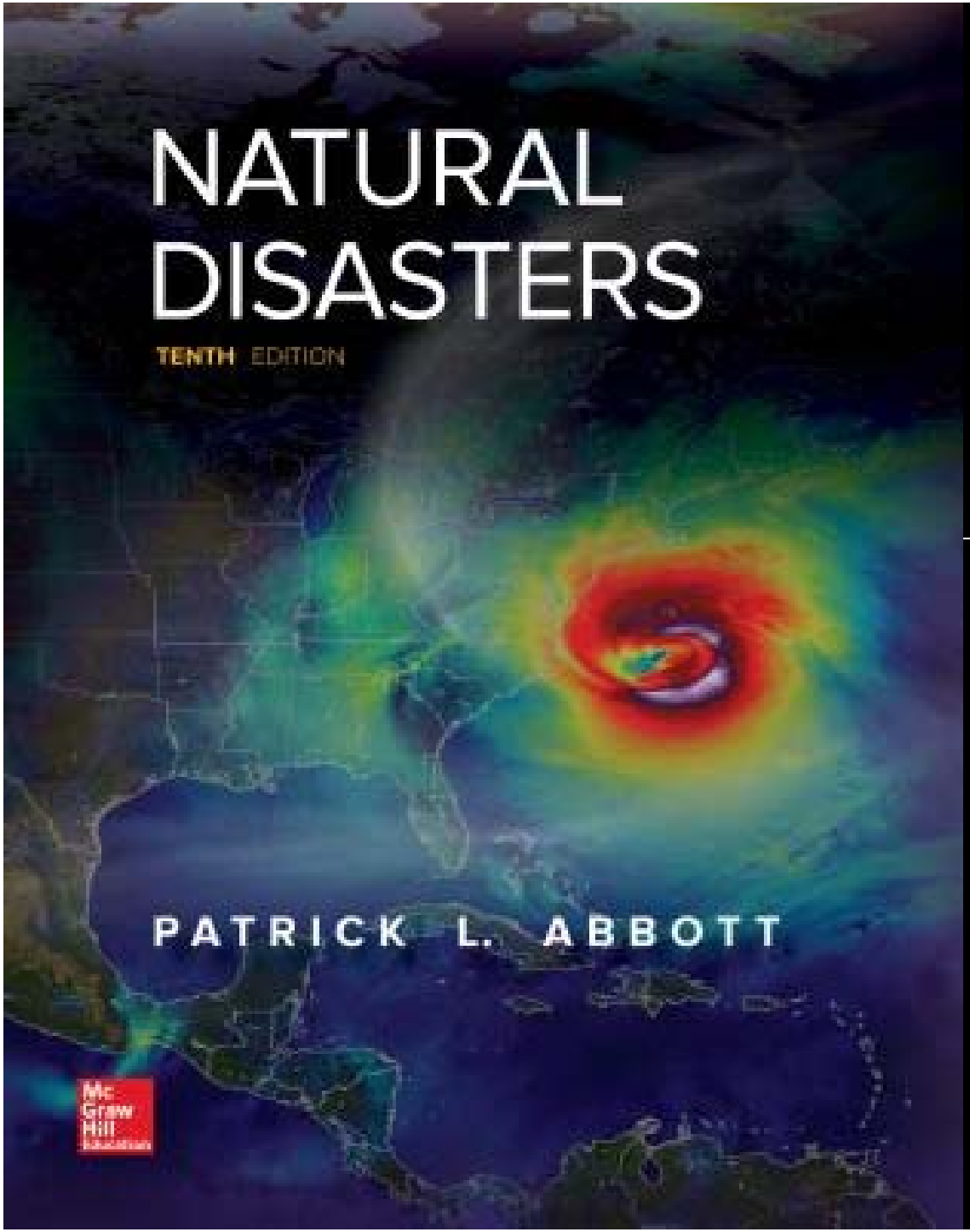
NATURAL DISASTERS AND RISK

WHY STUDY THIS SUBJECT?

1. Basic humanitarian reasons to reduce death and suffering
2. To reduce financial losses and economic impacts
3. Understand process for Hazard Assessment
4. Knowledge for Warning Systems
5. Knowledge for Preparedness
6. Knowledge for the Design of Post-Disaster Response Strategy
7. Knowledge for the Design of Resistance Strategies (e.g., Building Codes)

2008 Sichuan Earthquake, China; damage in Beichuan

PROFESSIONAL CAREERS (e.g., geoscience; finance and re-insurance; humanitarian organisations; regional, national and global government; civil engineering; emergency response); P.Eng./P. Geo



Natural Disasters (Tenth Edition)

By Patrick L. Abbott (*San Diego State University)*

Mc Graw Hill

Published by McGraw-Hill 2016

- Topics and lectures will more-or-less follow the sequence and content of book chapters
- Canadian content will be added where appropriate
- Additional topics will be *Glacial Hazards; Hazards, Disasters , and Climate Change, Solar Flares, Ontario Hazards,* and a series of lectures on *Risk/GeoRisk* (including Hazard Assessment)

EARTH 270 – DISASTERS AND NATURAL HAZARDS (v. 2018)

MARKS :
FINAL EXAM (50%), MID-TERM (25%), DISASTER REPORT (25%)
ATTENDANCE BONUS – MAXIMUM 2.5%

2007 Cyclone Sidr, Bangladesh

- 12 x 150 minute lectures
- Last lecture on **March 29, 2018**
- Mid-term exam in first lecture period on Thursday, **February 15, 2018 (1830-1920 h)**
- Disaster report to be handed in at the beginning of last class on **March 29, 2018**
- Disaster reports are individual projects
- Disaster reports summarise and analyse an assigned historical/recent disaster event

DISASTER PROJECTS (25% OF MARK)

1988	Armenia	Earthquake
1966	Arno River, Italy (Florence)	Floods
1915	Avezzano (Italy)	Earthquake
1970	Bangladesh	Tropical Cyclone
1991	Bangladesh	Tropical Cyclone
2007	Bangladesh	Tropical Cyclone (Sidr)
1998	Casita (Nicaragua)	Landslide
1999	Chi Chi (Taiwan)	Earthquake and Landslides
1960	Chile	Earthquake
1920	China (Kansu)	Earthquake and landslides
1976	China (Tangshan)	Earthquake
1931	China (Tangshan)	Flood
1996	China (Yangtze)	Floods
1985	Colombia	Volcanic eruption and mudflow
2002	E. Europe	Floods
1987	Ecuador	Earthquake and landslides

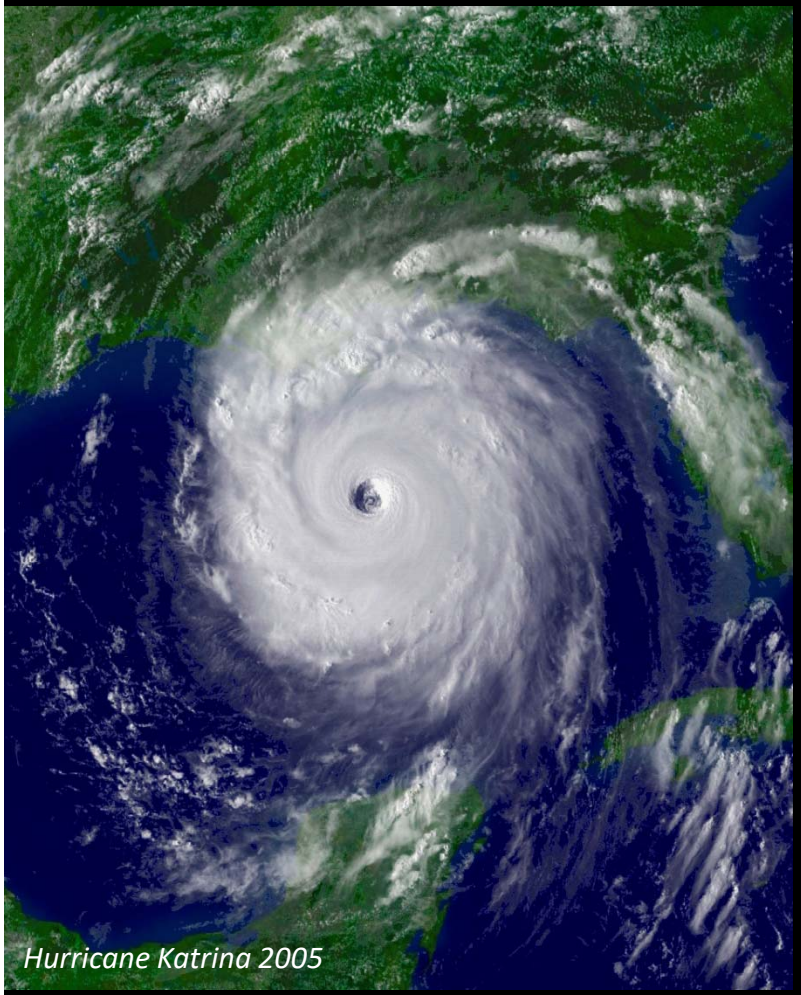
SAMPLE OF DISASTER REPORT LIST

STUDENTS CANNOT PASS (OR GAIN CREDIT FOR MARKS IN) EARTH 270 WITHOUT SUBMITTING A DISASTER REPORT ON MARCH 29, 2018

270 Learning Environment Protocol

OFFICE HOURS: TUESDAY
10:30 AM – 12:00 PM

WHAT IS A NATURAL HAZARD ?



Hurricane Katrina 2005

Landslides in the Philippines

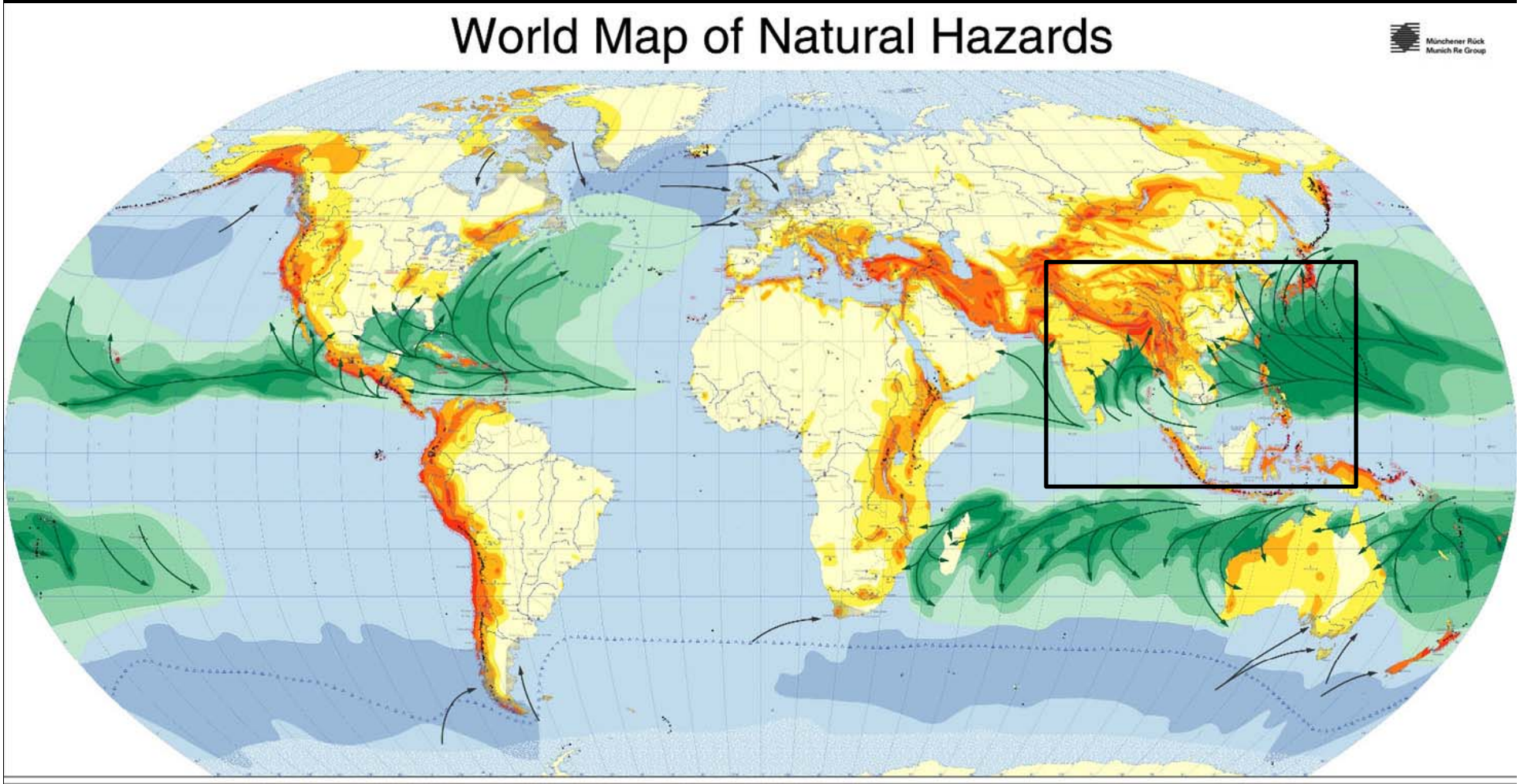
"THE OCCURRENCE OF A POTENTIALLY HARMFUL EVENT RESULTING FROM THE OCCURRENCE OF EXTREME NATURAL GEOLOGIC, CLIMATIC, HYDROLOGICAL , OR EXTRA-TERRESTRIAL PROCESSES"

WHAT IS A NATURAL DISASTER ?

"A NATURAL DISASTER OCCURS WHEN THE OCCURRENCE OF AN EXTREME NATURAL HAZARD PROCESS RESULTS IN SUDDEN AND SUBSTANTIAL LOSSES INVOLVING EITHER LOSS OF LIFE AND/OR ECONOMIC LOSSES ABOVE A DEFINED THRESHOLD"

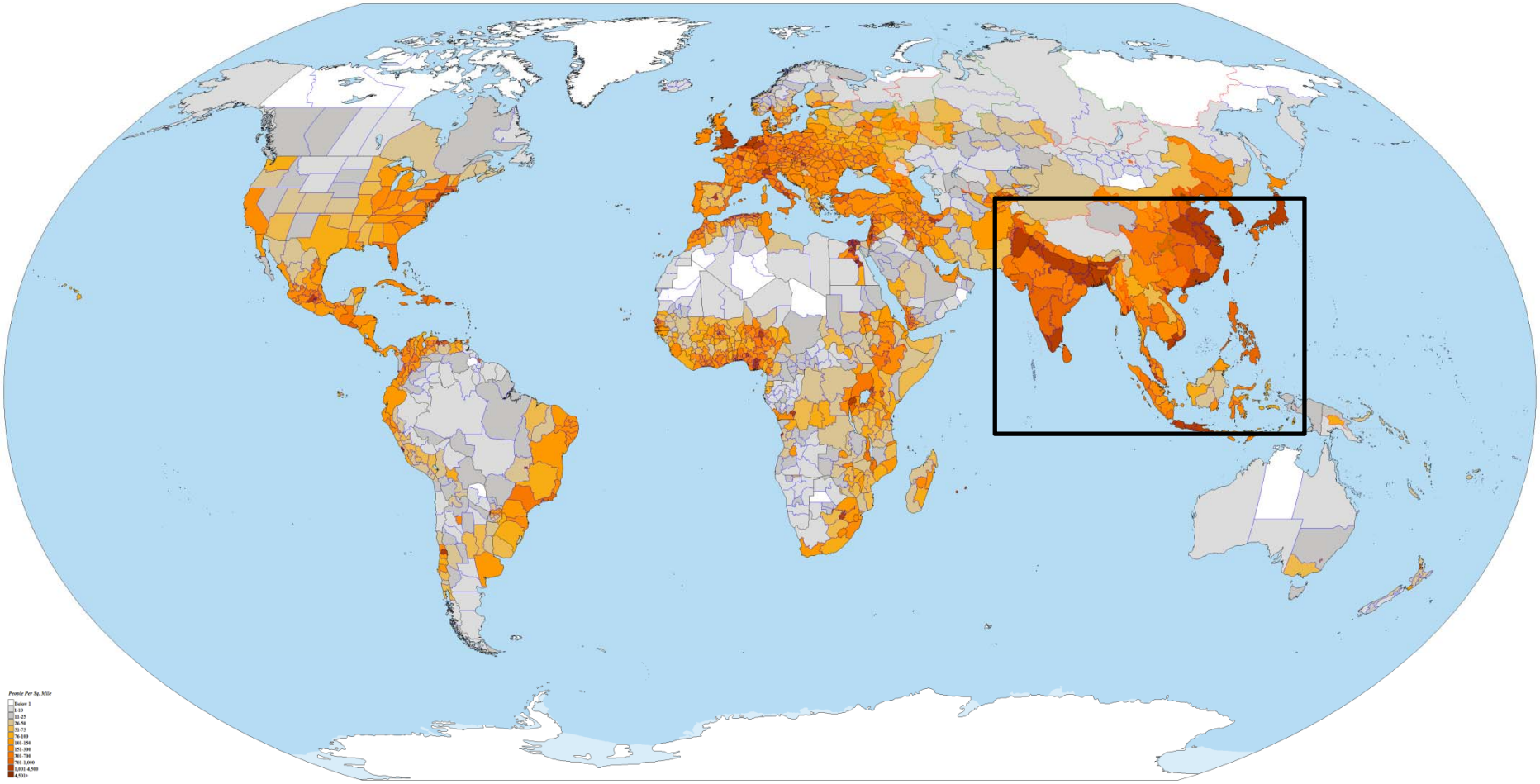
[ECONOMIC LOSSES MAY INCLUDE DIRECT COSTS OF IMMEDIATE DAMAGE, INSURED LOSSES, LONG-TERM COSTS OF DISRUPTION, RECOVERY COSTS, etc.]

WORLD MAP OF NATURAL HAZARDS DEVELOPED BY THE MUNICH RE-INSURANCE COMPANY

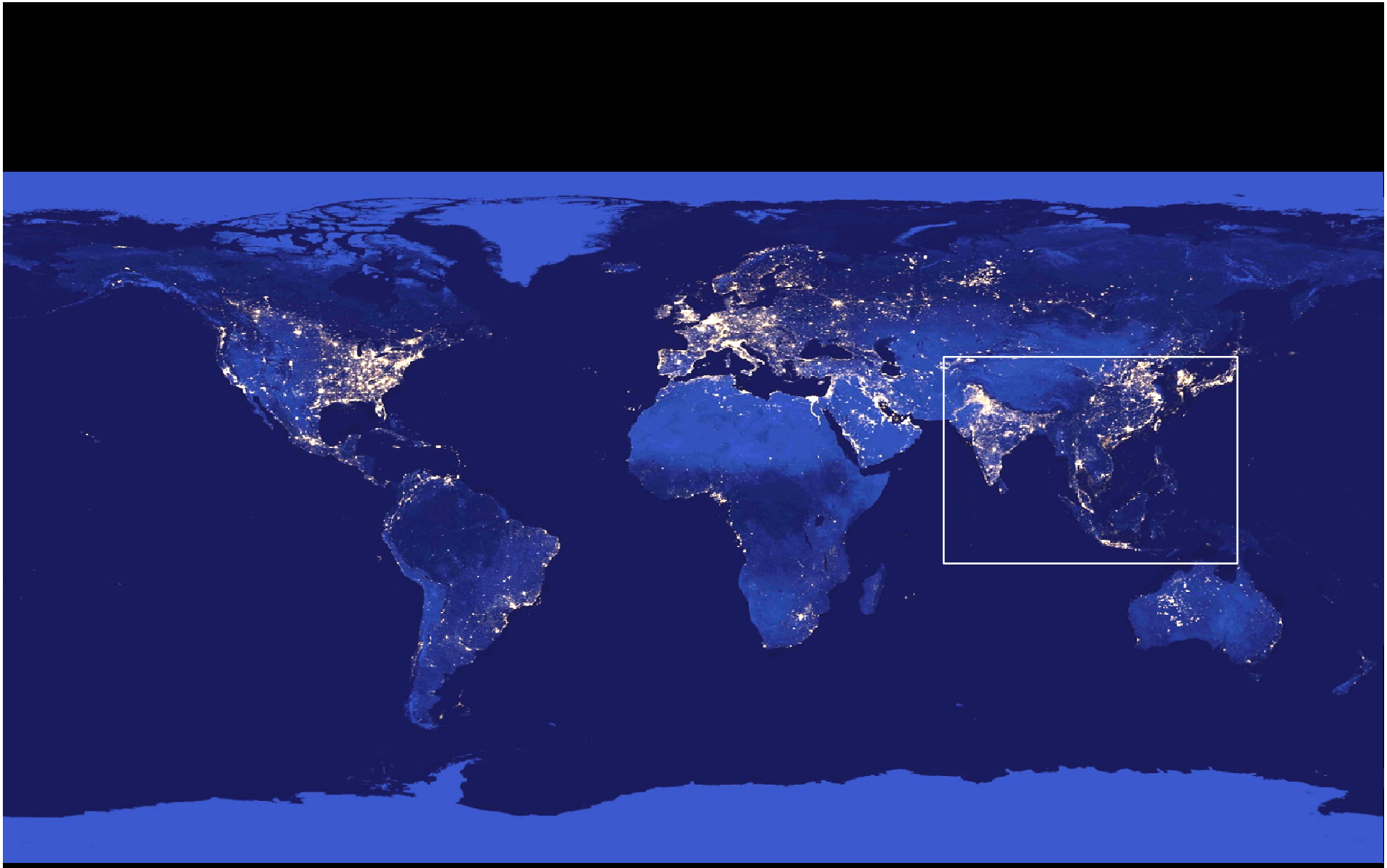


A world map of the distribution of natural hazard processes independent of human activity and distribution of population

POPULATION DENSITY OF THE WORLD (persons/sq km) - 2012

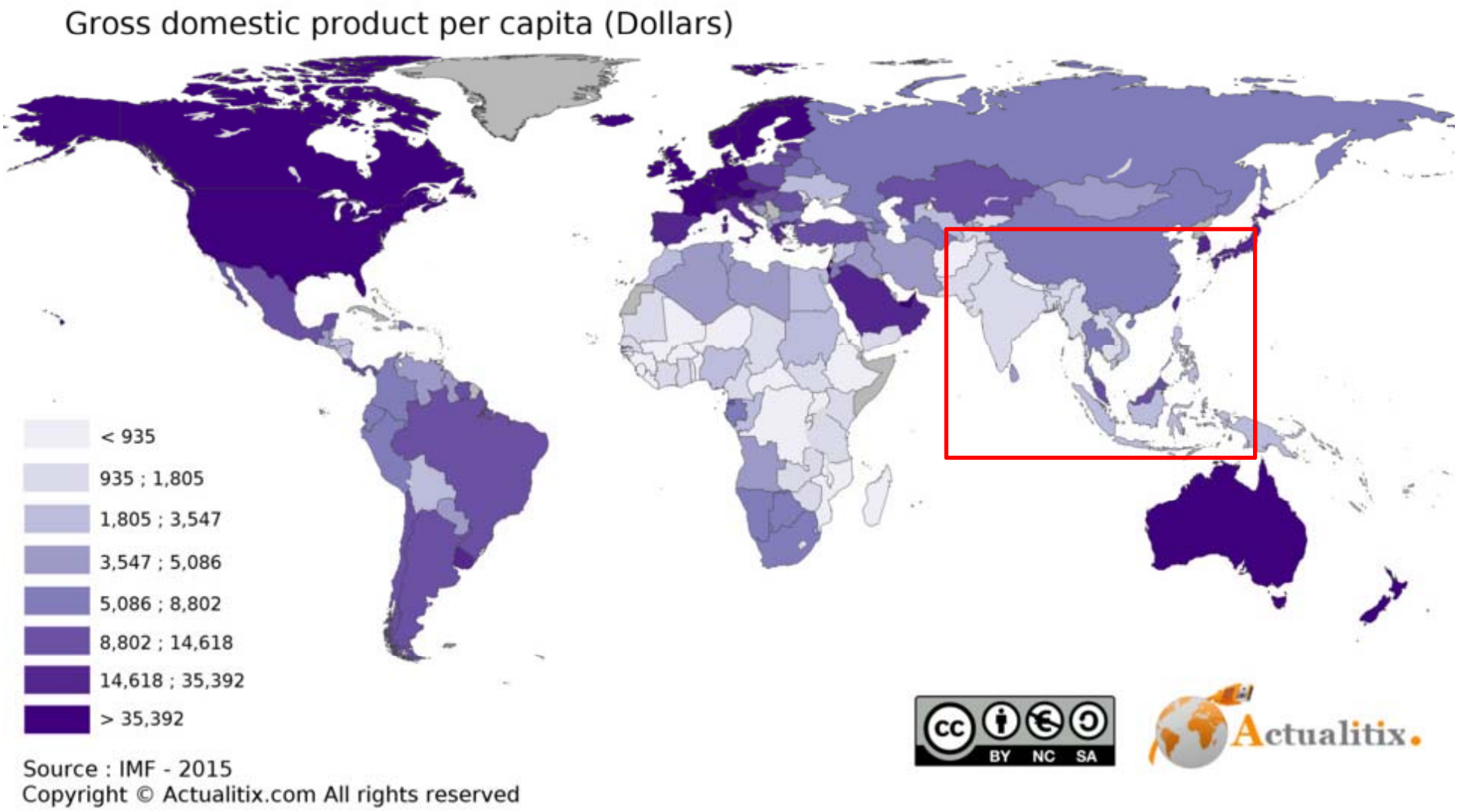


WHERE PEOPLE ARE – WHERE PEOPLE ARE NOT



The Earth at Night – the Black Marble Image from NASA's Suomi NPP satellite (composite April-October 2012)

GDP MAP OF THE WORLD ($US/CAPITA) - 2016



WHERE HIGH ECONOMIC VALUE OF ASSETS ARE LOCATED (e.g. 2016 DATA - NORWAY $71,497; CANADA $42,157; PERU $6,049; PHILIPPINES $2,951; BANGLADESH $1,358; HAITI $739)

IMF RANKING OF GDP/CAPITA - 2016

	Country Name	2016
1	Luxembourg	$100,573.14
2	Switzerland	$ 79,890.52
3	Macao SAR, China	$ 73,186.96
4	Norway	$ 70,911.76
5	Ireland	$ 63,861.92
6	Iceland	$ 59,976.94
7	Qatar	$ 59,324.34
8	United States	$ 57,638.16
9	Denmark	$ 53,549.70
10	Singapore	$ 52,962.49
11	Sweden	$ 51,949.27
12	Australia	$ 49,927.82
13	San Marino	$ 47,908.56
14	Netherlands	$ 45,669.81
15	Austria	$ 44,676.35
16	Hong Kong SAR, China	$ 43,681.42
17	Finland	$ 43,402.86
18	Canada	$ 42,157.93
19	Germany	$ 42,069.60
20	Belgium	$ 41,236.27
21	United Kingdom	$ 40,341.41
22	New Zealand	$ 39,416.36
23	Japan	$ 38,900.57
24	United Arab Emirates	$ 37,622.21
25	Israel	$ 37,175.74
26	Andorra	$ 36,988.62
27	France	$ 36,854.97
28	Guam	$ 35,562.57
29	Italy	$ 30,674.84
30	Bahamas, The	$ 28,785.48
31	Korea, Rep.	$ 27,538.81

EXPECTED ANNUAL MORTALITY RISK FOR MULTIPLE NATURAL HAZARDS 2020-2030 (Shi et al., 2016)

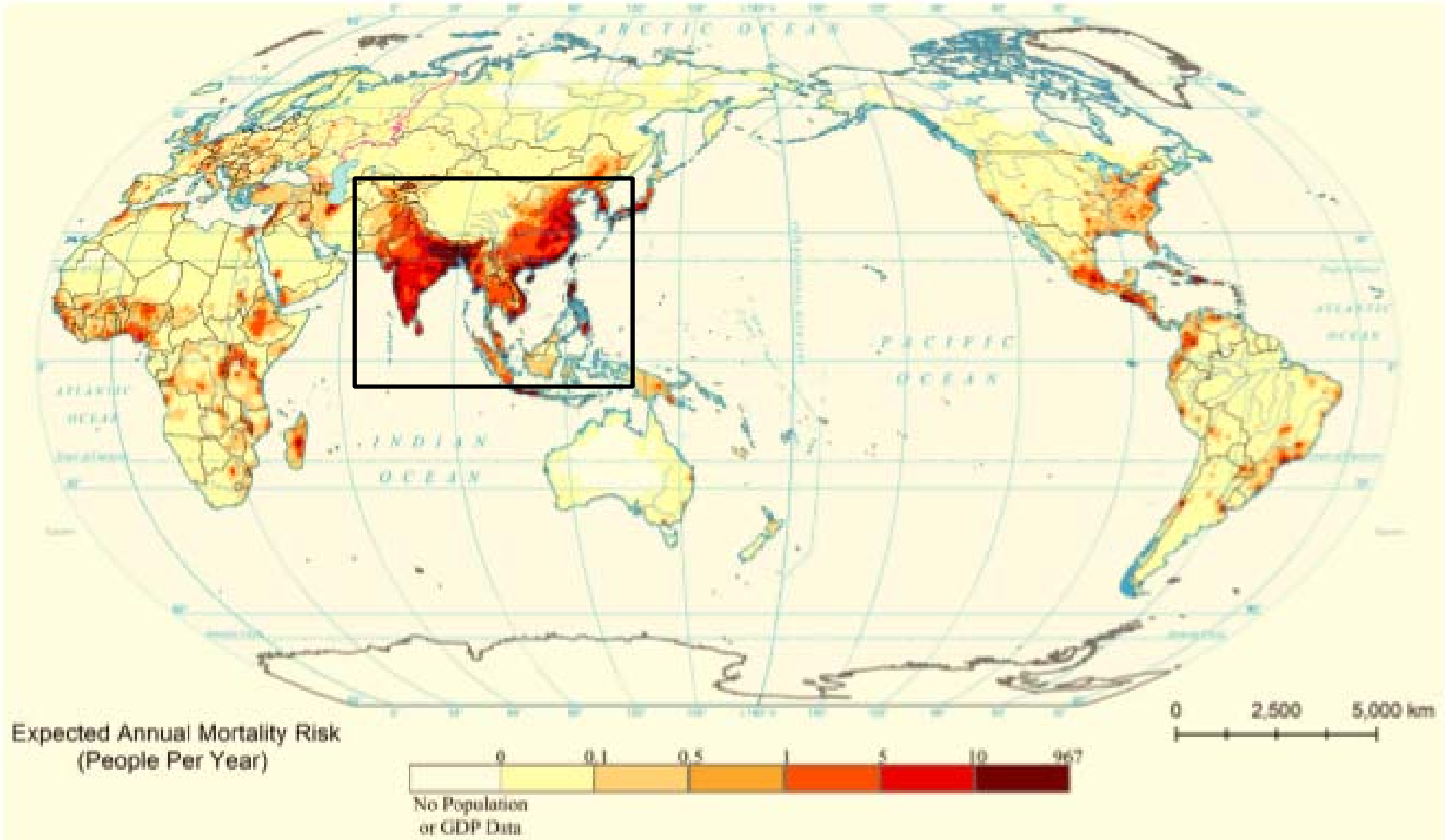
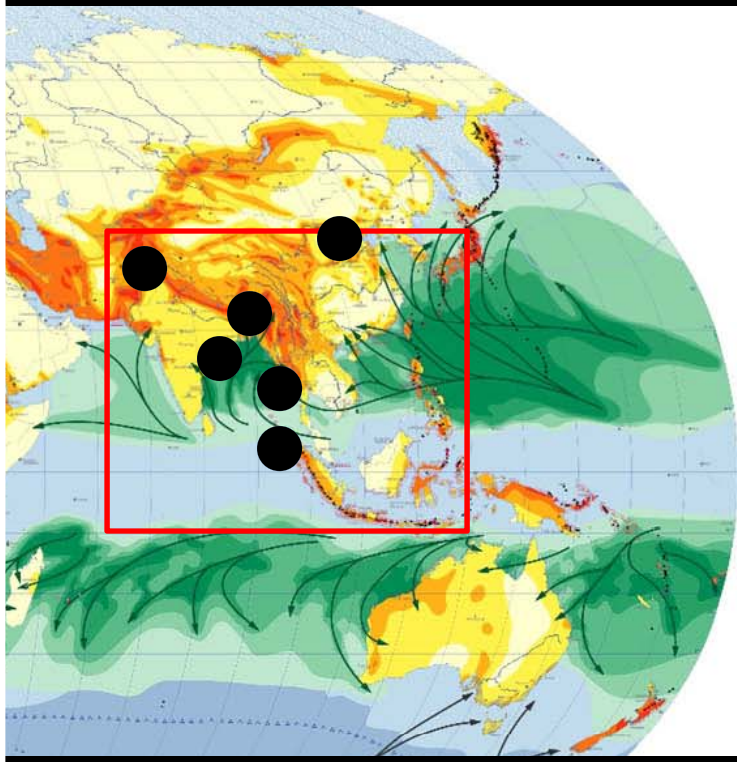


Fig. 3 Global expected annual mortality risk for multiple natural hazards (2020–2030) (0.5° × 0.5°)

Damage due to storm surge, Cyclone Gorky, Bangladesh, 1991

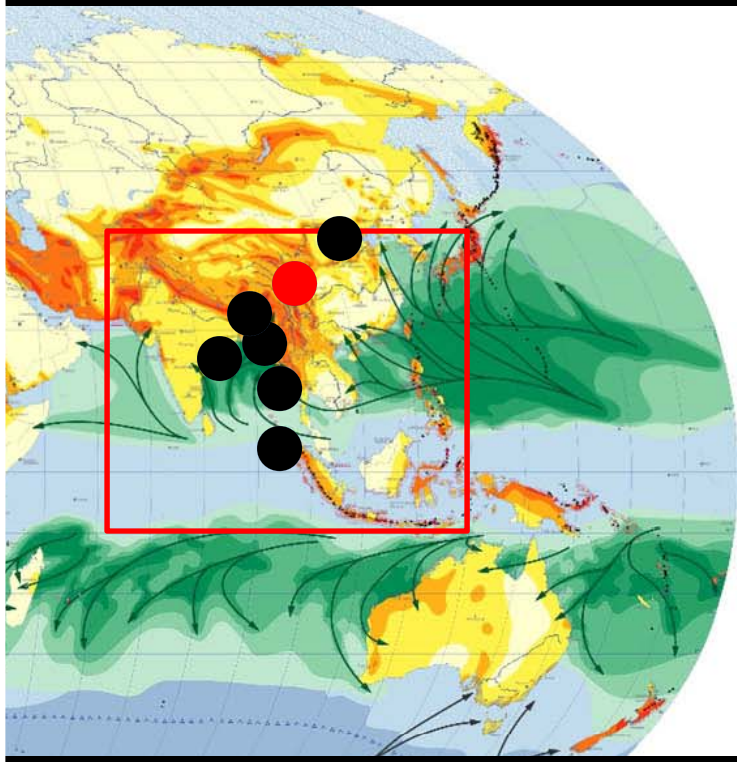
	DATE	HAZARD	COUNTRY	DEATHS
1	1970/11/14	Hurricane (Cyclone Bhola)	Bangladesh	400,000
2	1976/07/28	Earthquake (Tangshan Earthquake)	China	255,000
3	2004/12/26	Earthquake & Tsunami	South Asia	246,000
4	1991/04/30	Hurricane (Cyclone Gorky)	Bangladesh	140,000
5	2005/10/08	Earthquake	Pakistan	88,000



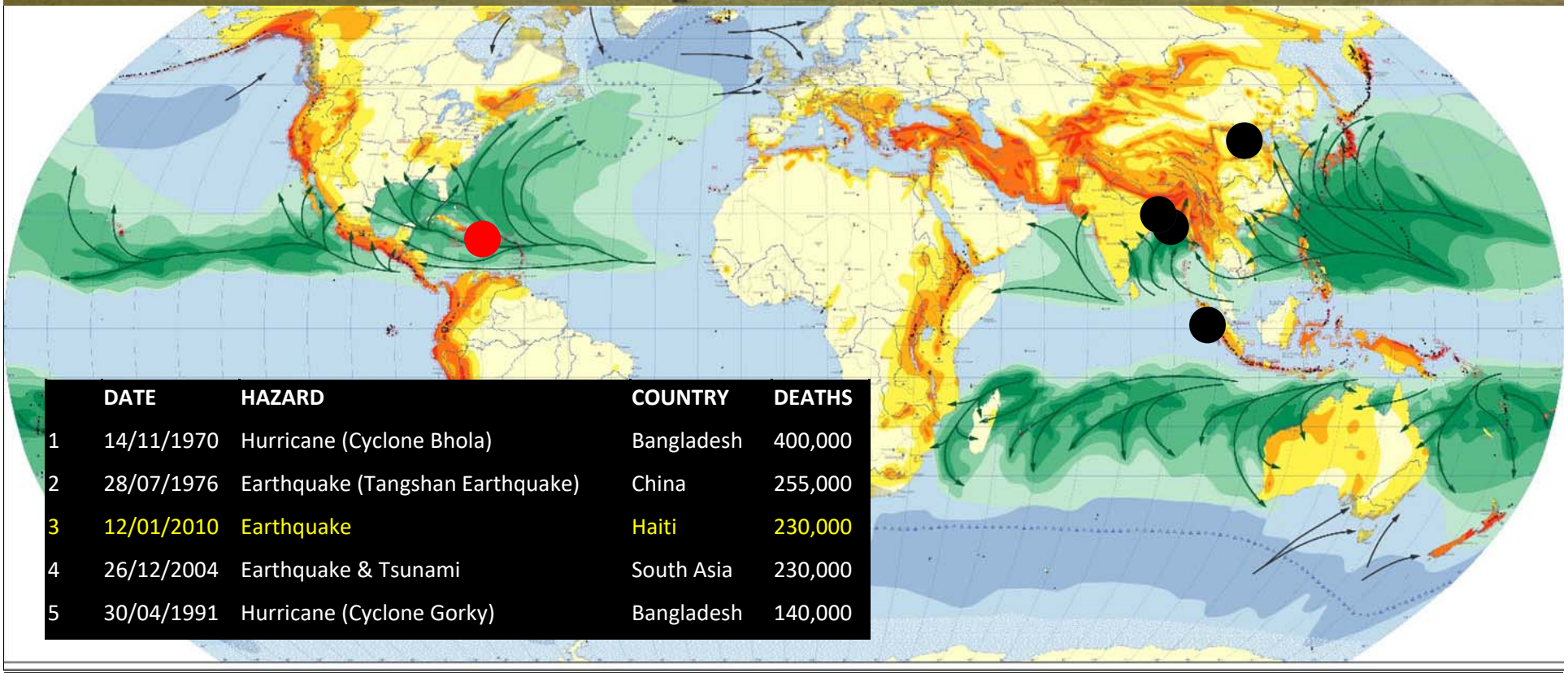
GLOBAL DISASTERS WITH HIGHEST DEATH TOLLS SINCE 1970

Cyclone Nargis, Irrawaddy Delta, May 2008

	DATE	HAZARD	COUNTRY	DEATHS
1	1970/11/14	Hurricane (Cyclone Bhola)	Bangladesh	400,000
2	1976/07/28	Earthquake (Tangshan Earthquake)	China	255,000
3	2004/12/26	Earthquake & Tsunami	South Asia	246,000
4	1991/04/30	Hurricane (Cyclone Gorky)	Bangladesh	140,000
5	2008/05/2-5	Hurricane (Cyclone Nargis)	Myanmar	134,500

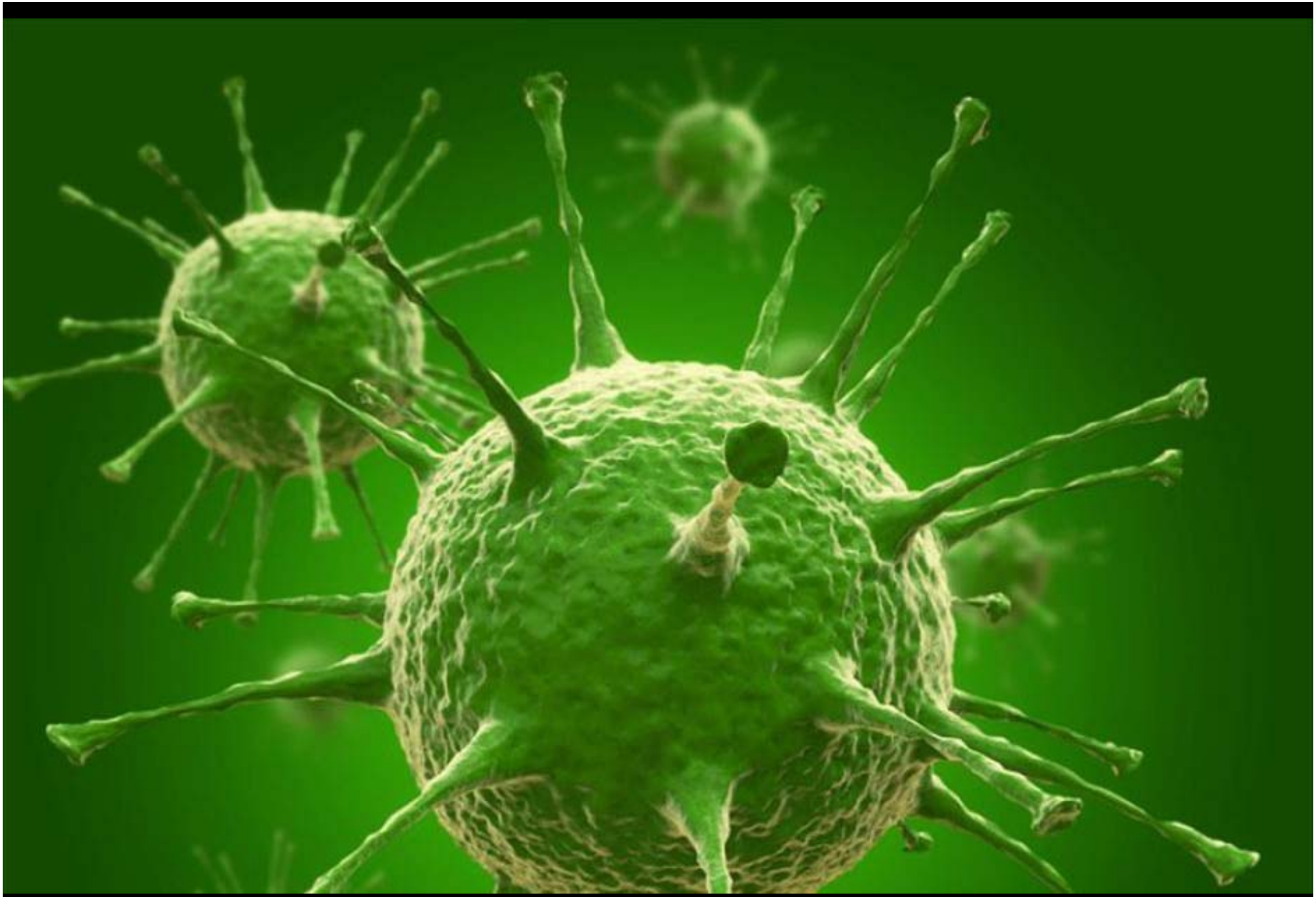


GLOBAL DISASTERS WITH HIGHEST DEATH TOLLS SINCE 1970



	DATE	HAZARD	COUNTRY	DEATHS
1	14/11/1970	Hurricane (Cyclone Bhola)	Bangladesh	400,000
2	28/07/1976	Earthquake (Tangshan Earthquake)	China	255,000
3	12/01/2010	Earthquake	Haiti	230,000
4	26/12/2004	Earthquake & Tsunami	South Asia	230,000
5	30/04/1991	Hurricane (Cyclone Gorky)	Bangladesh	140,000

GLOBAL DISASTERS WITH HIGHEST DEATH TOLLS SINCE 1970



THE INFLUENZA VIRUS – DEATHS FROM PANDEMICS?

THE IRISH FAMINE 1845-1851 ; ABOUT 1 MILLION DEATHS – A NATURAL DISASTER ?

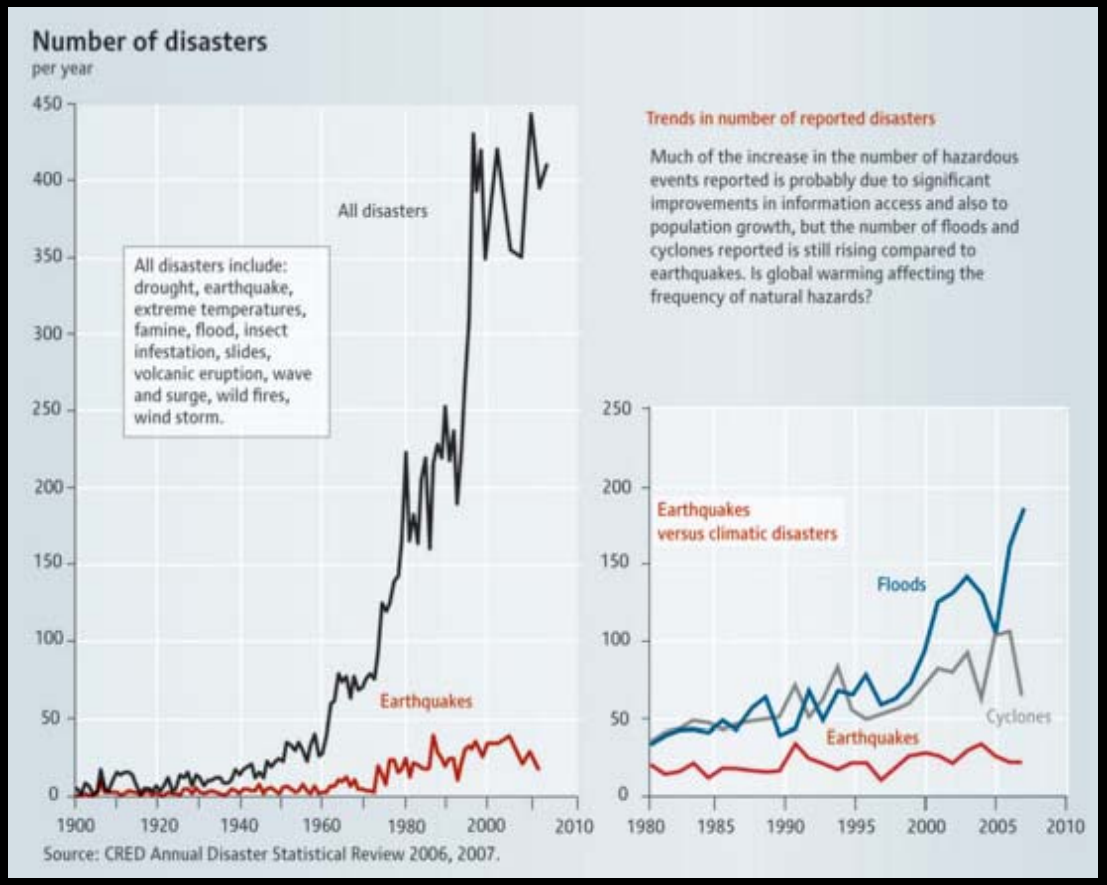
ECONOMIC LO$$E$ - 3 MAJOR COMPONENTS

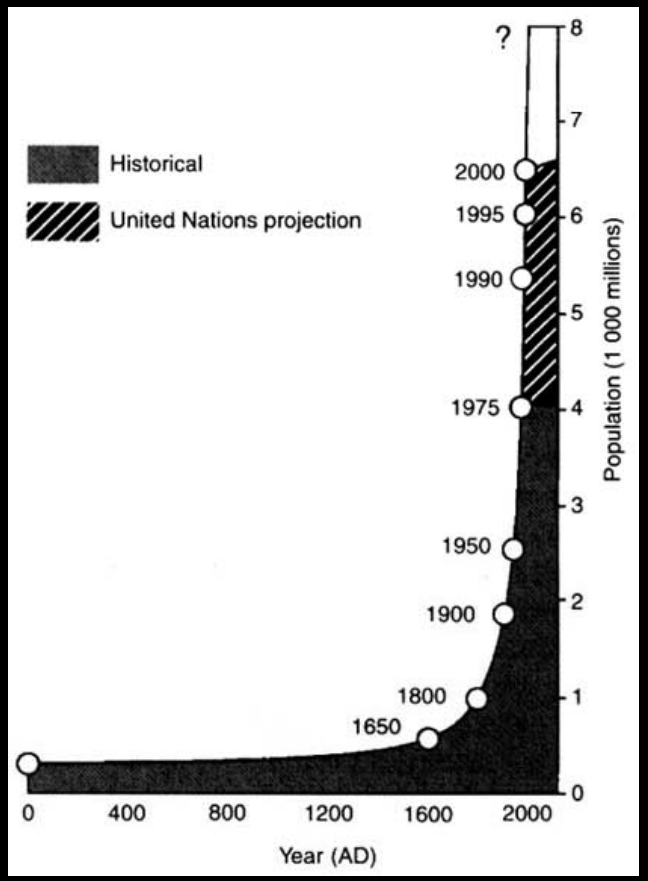
1. **DIRECT LOSSES** – actual replacement value of damaged/destroyed property/infrastructure
2. **INSURED LOSSES** – insurance claims paid out to policy holders to cover a percentage of damage in 1
3. **INDIRECT LOSSES** – additional/downstream costs (e.g., economic disruption, loss of production, medical and emergency services, rebuilding)

TOTAL ECONOMIC LO$$E$ = (1-2)+2+3

2017 REVIEW

INCREASE IN NATURAL DISASTERS VERY EVIDENT FROM DATABASES





5 KEY QUESTIONS INCLUDE;

1. How are disasters defined? What threshold is used?
2. What is role of increasing global and regional population (increasing exposure) ?
3. What is role of climate change in changing magnitude and frequency of atmospheric and hydrologic hazards (increasing hazard ?) ?
4. What is role of increasing value of damaged assets (increase in insurable losses) ? The issue of loss monetization ?
5. What is role of increased reporting ?

Are Natural Hazards and Disaster Losses in the U.S. Increasing?

PAGES 381, 388–389

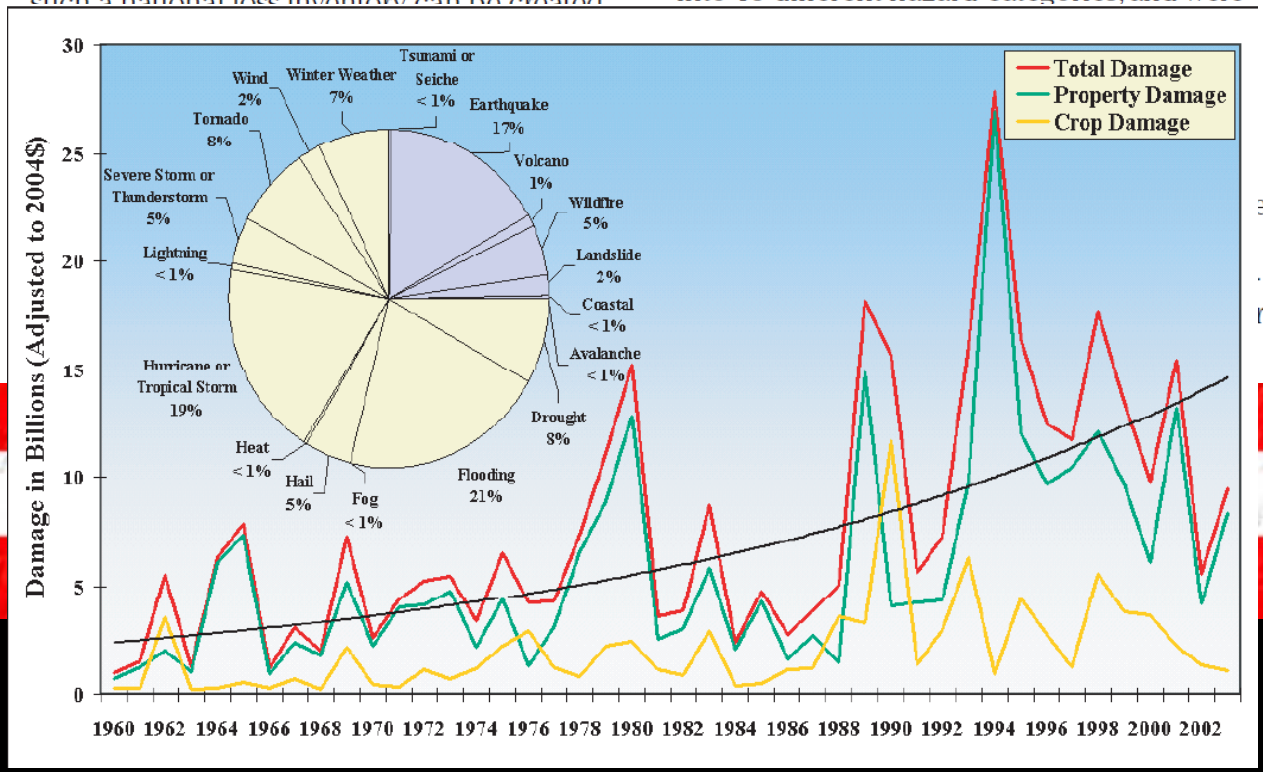
More than 35 major Presidential disaster declarations, including those for Hurricanes Katrina and Rita, already have been declared across the United States in 2005. This is a harbinger of another costly year for natural disasters.

While losses from the 2004 hurricane season are still being tallied, estimates suggest that each Florida hurricane last year was responsible for more than $5 billion in damages (http://www.ncdc.gov/oa/reports/billionz.html). This year (2005) may prove to be the costliest ever. To see whether the years 2004–

these storm records do not represent all natural hazards. Another concern is how losses are defined and measured. With concerted effort, such a national loss inventory can be created

colleagues at the Hazards Research Lab at the University of South Carolina. The database, presently covering 1960–2003 (updates are made every six months), was collated from a variety of governmental sources including the U.S. Geological Survey (USGS) and the NCDC.

Events were selected for the database if they caused more than $50,000 in property and/or crop losses. The events then were classified into 18 different hazard categories, and were



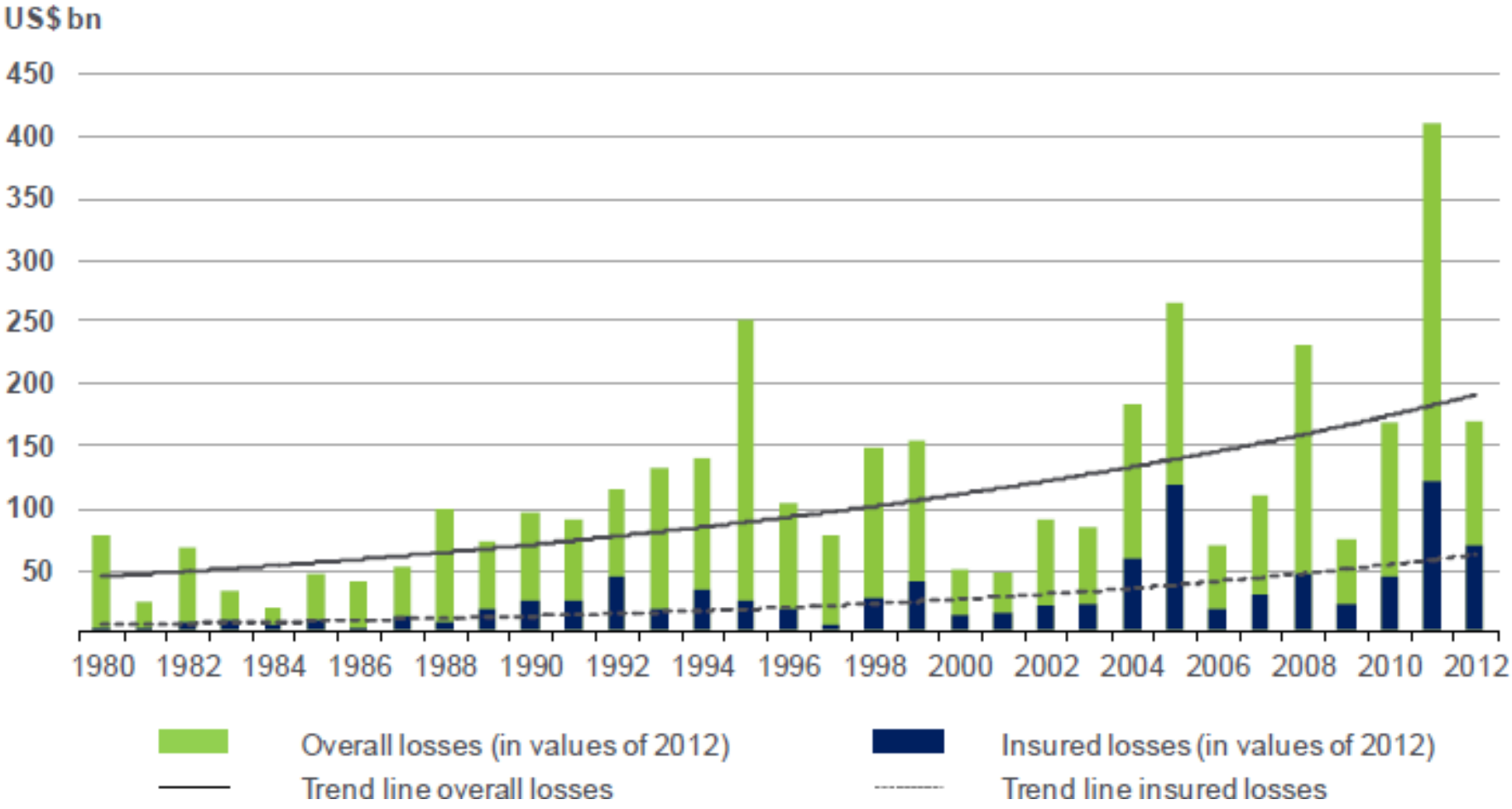
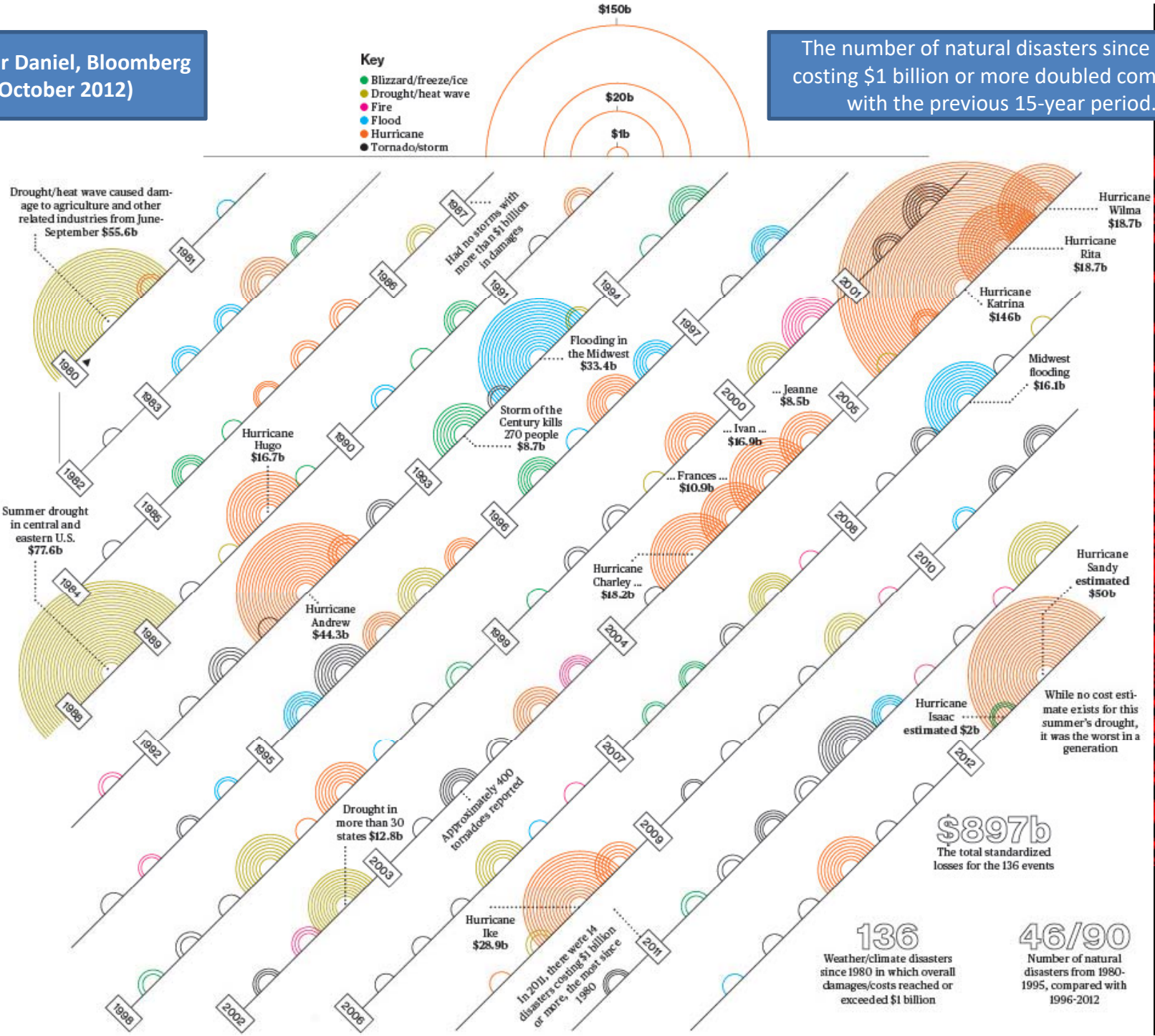
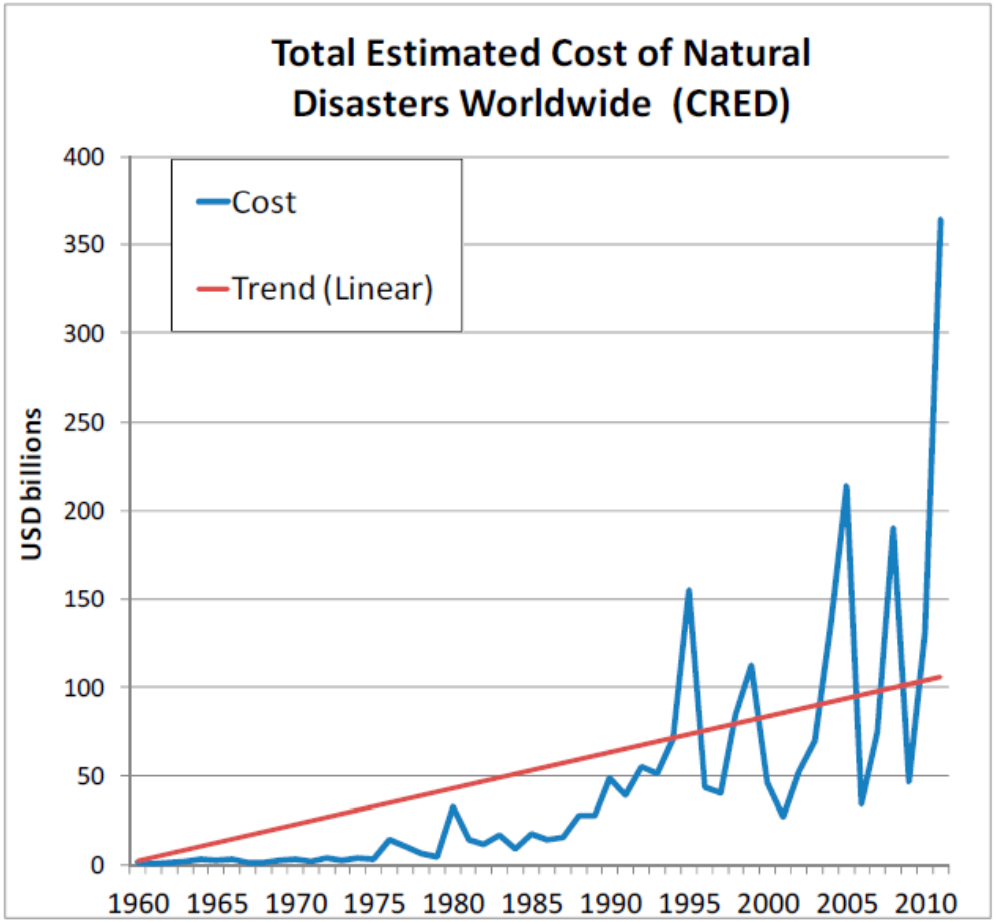


Fig. 1 *Natural catastrophes worldwide 1980-2012: In the past 30 years, there has been a significant increase in direct overall losses and insured losses; Source: Munich Re NatCatSERVICE*

Jennifer Daniel, Bloomberg (October 2012)

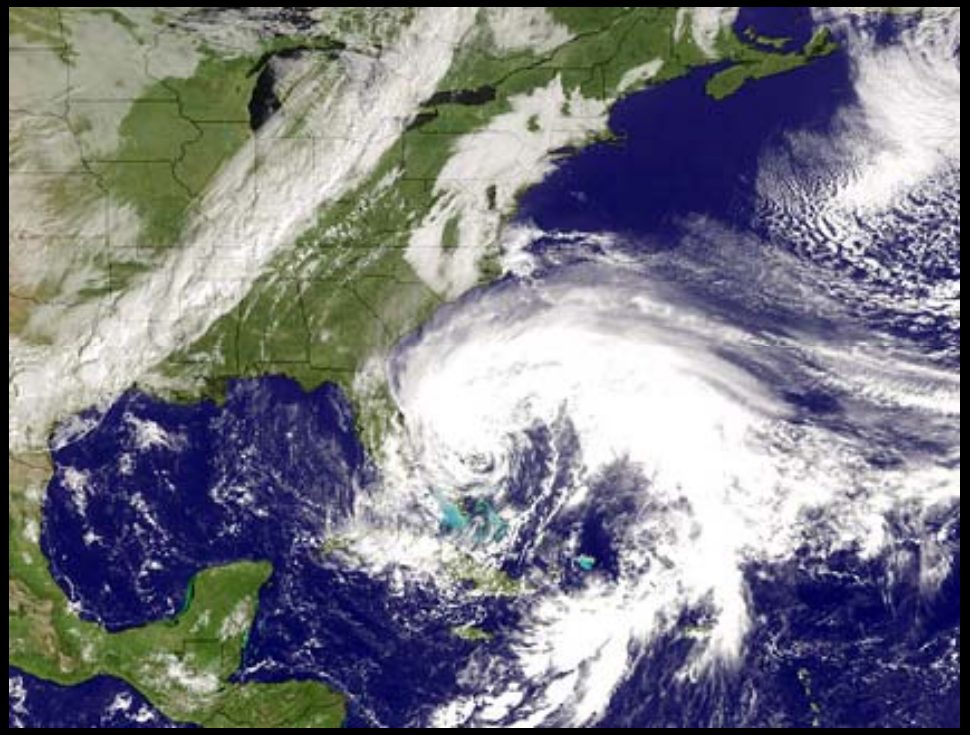
The number of natural disasters since 1996 costing $1 billion or more doubled compared with the previous 15-year period.

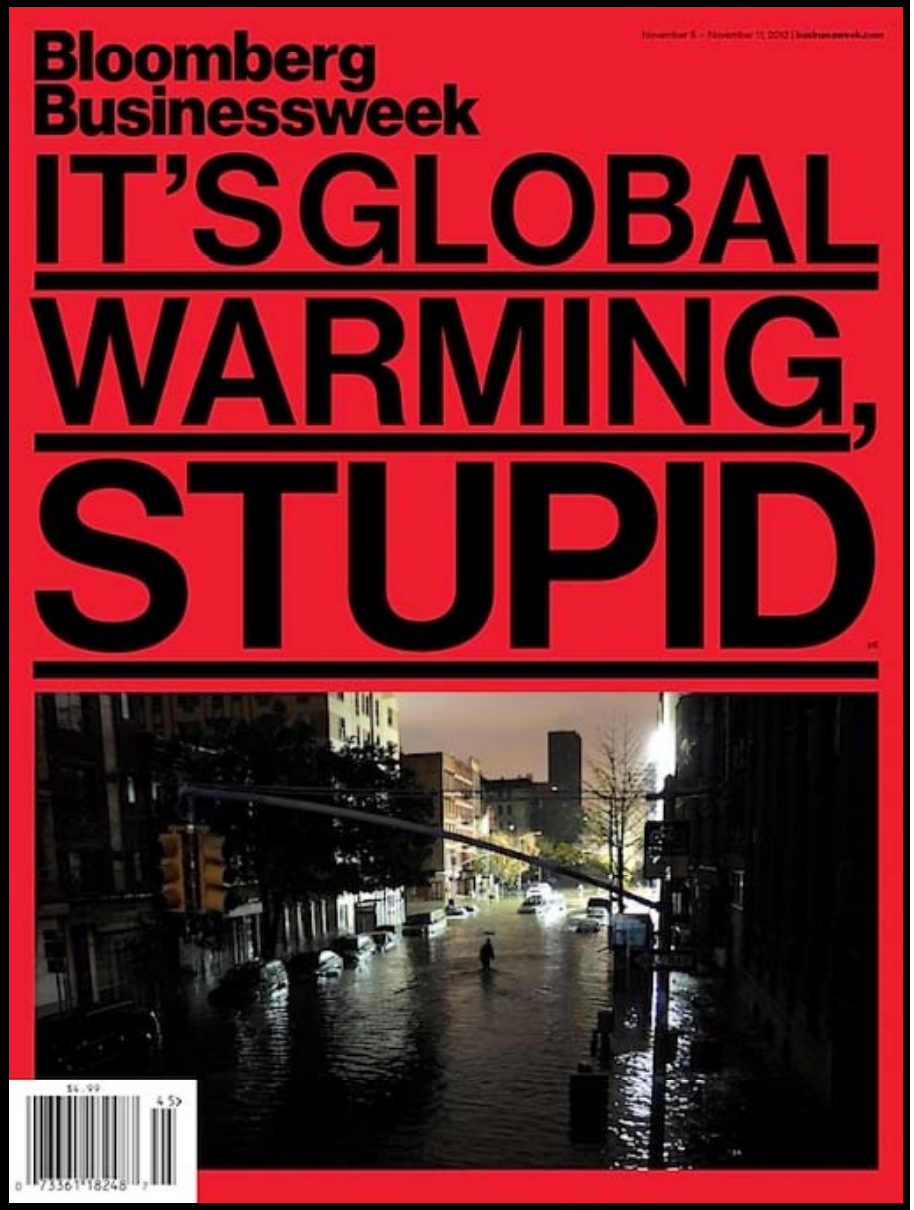




	Haiti	Japan	Kenya	NZ	Pakistan	Samoa	St. Lucia
Disaster	Earthquake	Earthquake Tsunami	Drought	Earthquake	Floods	Tsunami	Hurricane
Cost US$ bn	$8 bn	$213 bn	$0.8 bn	$24 bn	$10 bn	$0.08 bn	$0.43 bn
% GDP	120%	3.6%	1.9%	10%	5%	15%	43%
No. affected	4.3 mn	0.4 mn	4.3 mn	0.3 mn	18 mn	5400	3,000
% pop	43.0%	0.3%	10.6%	6.9%	10.0%	3.0%	1.7%

RELATIONSHIP BETWEEN CLIMATE CHANGE AND EXTREME HAZARDS (DISASTERS?)





Global warming at a standstill, new Met Office figures show

The Met Office has downgraded its forecast for global warming to suggest that by 2017 temperatures will have remained about the same for two decades.

It is thought that factors such as ocean current patterns may be behind the slowdown Photo: REUTERS

By John-Paul Ford Rojas
11:59AM GMT 08 Jan 2013

Print this article

HAVE DISASTER LOSSES INCREASED DUE TO ANTHROPOGENIC CLIMATE CHANGE?

BY LAURENS M. BOUWER

Table 1. Normalization studies of disaster loss records.

Hazard	Location	Period	Normalization	Normalized loss	Reference
Bushfire	Australia	1925–2009	Dwellings	No trend	Crompton et al. (2010)
Earthquake	United States	1900–2005	Wealth, population	No trend	Vranes and Pielke (2009)
Flood	United States	1926–2000	Wealth, population	No trend	Downton et al. (2005)
Flood	China	1950–2001	GDP	Increase since 1987	Fengqing et al. (2005)
Flood	Europe	1970–2006	Wealth, population	No trend	Barredo (2009)
Flood	Korea	1971–2005	Population	Increase since 1971	Chang et al. (2009)
Flood and landslide	Switzerland	1972–2007	None	No trend	Hilker et al. (2009)
Hail	United States	1951–2006	Property, insurance market values	Increase since 1992	Changnon (2009a)
Windstorm	United States	1952–2006	Property, insurance market values	Increase since 1952	Changnon (2009b)
Windstorm	Europe	1970–2008	Wealth, population	No trend	Barredo (2010)
Thunderstorm	United States	1949–98	Insurance coverage, population	Increase since 1974	Changnon (2001)
Tornado	United States	1890–1999	Wealth	No trend	Brooks and Doswell (2001)
Tornado	United States	1900–2000	None	No trend	Boruff et al. (2003)

Far Rockaway, New York (in the wake of Superstorm Sandy, October 2012)


earth 270

RMS


TŌHOKU EARTHQUAKE AND TSUNAMI
東北地方太平洋沖地震
MARCH 2011
A magnitude 9.0 undersea megathrust earthquake struck off the coast of Japan, 154 kilometers from the Fukushima Daiichi Nuclear Power Plant. The plant was automatically shut down following the earthquake and backup generators started the cooling process. 41 minutes later, powerful tsunami waves reached the plant at heights of up to 14 meters. A seawall was designed to protect the plant from a worst-case tsunami of 6 meters. The waves inundated the Fukushima facility, disabling the backup generators. What is your view of the risk within a resilient risk management framework?
READ MORE>>
= 2 METERS

SECOND EDITION

WITH A NEW SECTION: "ON ROBUSTNESS & FRAGILITY"

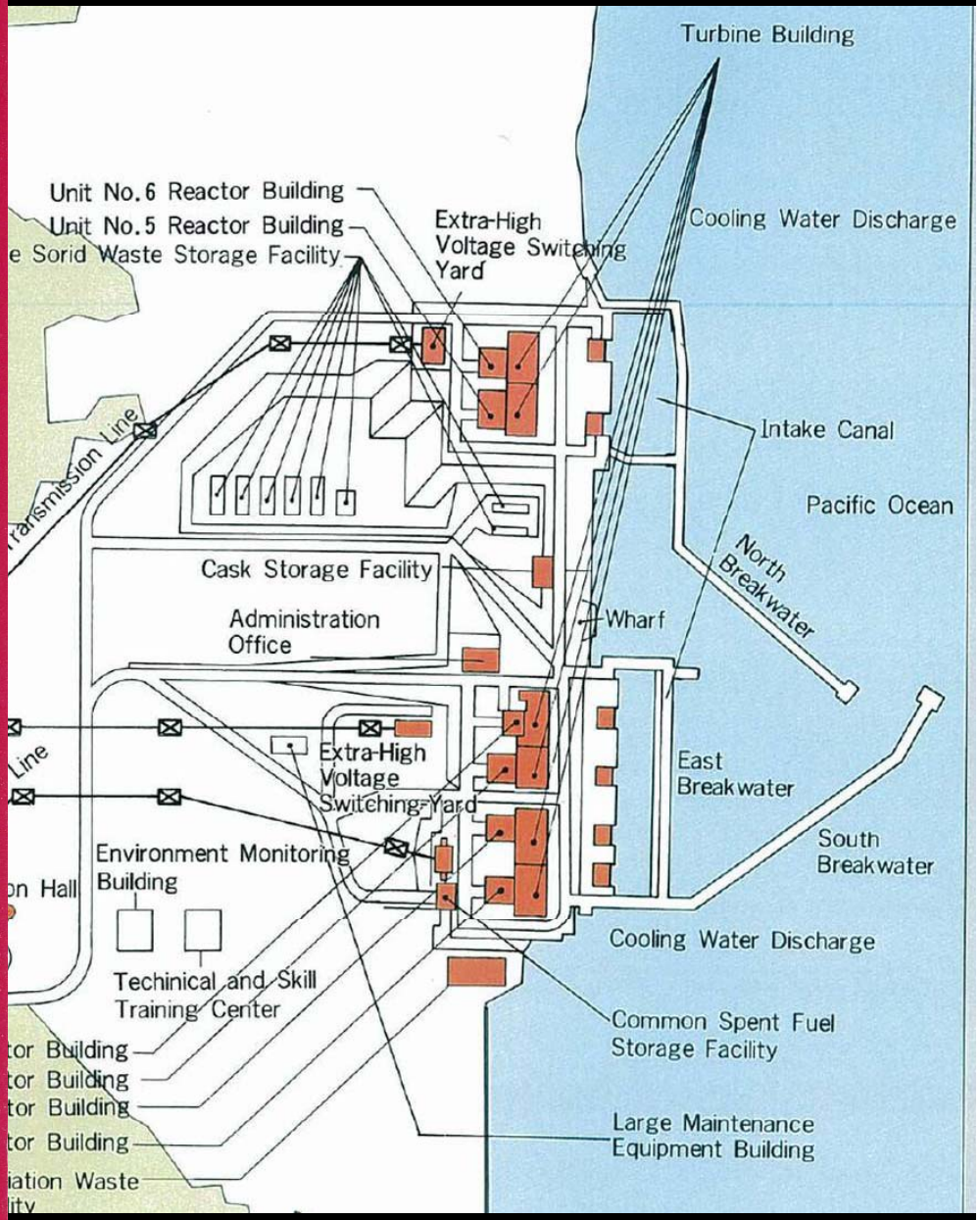
NEW YORK TIMES BESTSELLER

THE BLACK SWAN

The Impact of the HIGHLY IMPROBABLE

"The most prophetic voice of all."
—*GQ*

Nassim Nicholas Taleb



NATURAL HAZARDS OF CONCERN IN EARTH 270 (v. 2018)

HAZARD GROUP	HAZARD TYPE
GEOHAZARDS	**EARTHQUAKES** **TSUNAMI** **VOLCANOES** **LANDSLIDES** SURFACE COLLAPSE
ATMOSPHERIC HAZARDS	**HURRICANES (TROPICAL CYCLONES, TYPHOONS)** **TORNADOES** DROUGHT HEAT WAVE WILDFIRE
HYDROLOGIC HAZARDS	**GLACIER HAZARDS** **FLOODS (RIVER AND COASTAL)**
ULTIMATE HAZARDS	**ASTEROID IMPACTS (ARMAGEDDON)** **SOLAR FLARES (SPACE WEATHER)**

MANY HAZARDS DEVELOP MULTIPLE THREATS (e.g. Earthquake-triggered landslides; Earthquake-triggered tsunami; Floods caused by Hurricane heavy rainfall; Storm surges caused by Hurricanes). SOME HAZARDS ARE HYBRID HAZARDS (e.g., tsunamis, landslides, flooding)