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Natural Hazards

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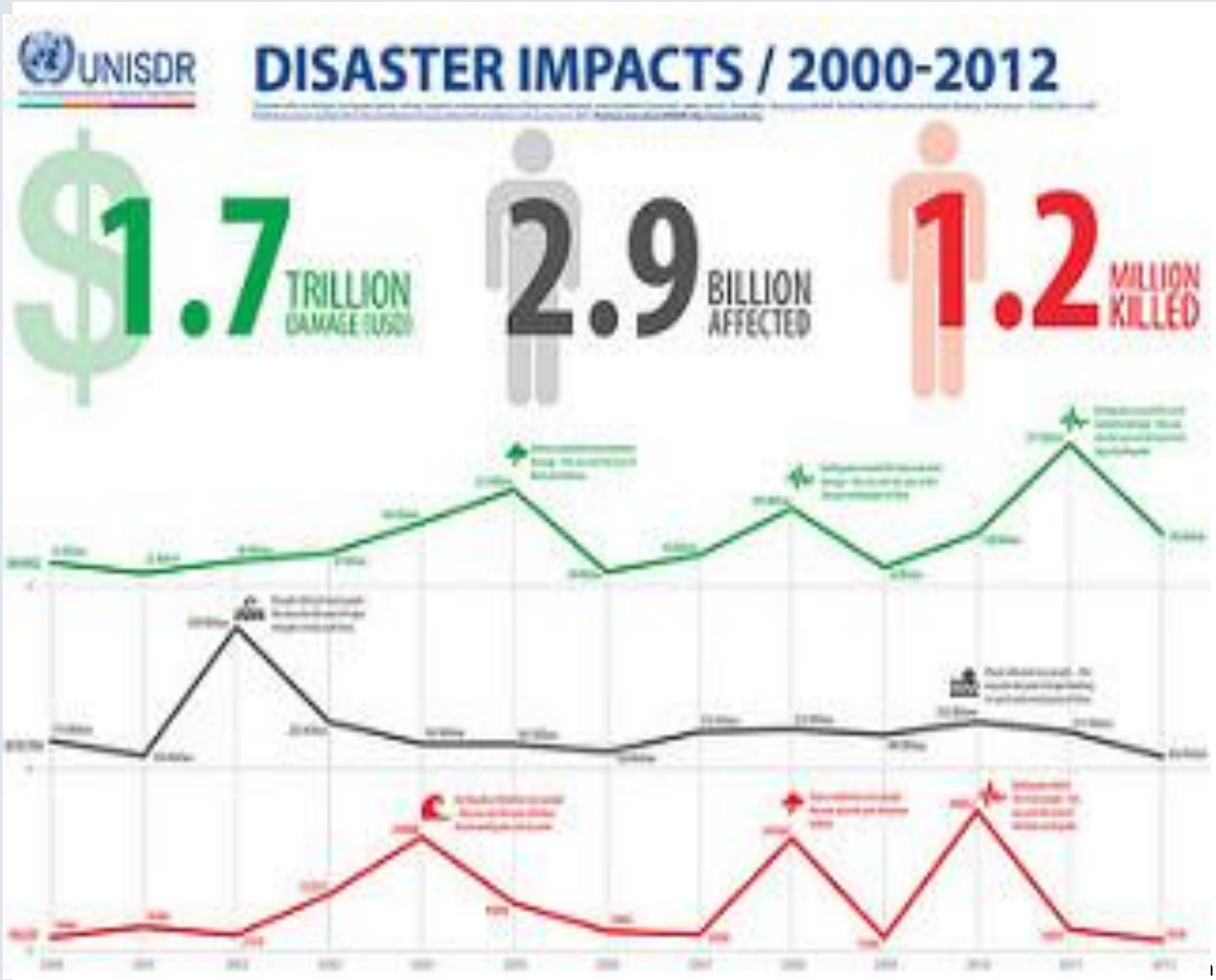

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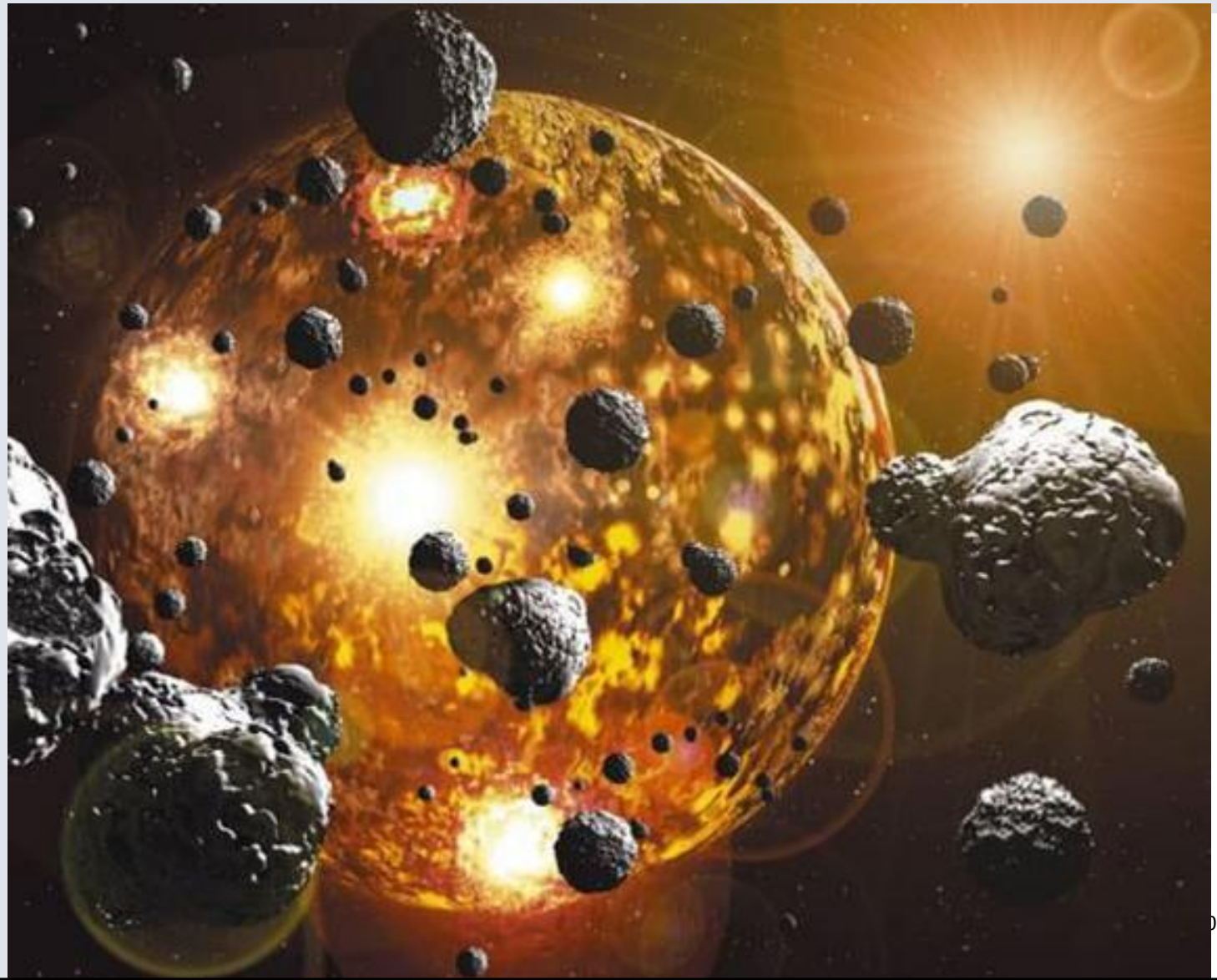

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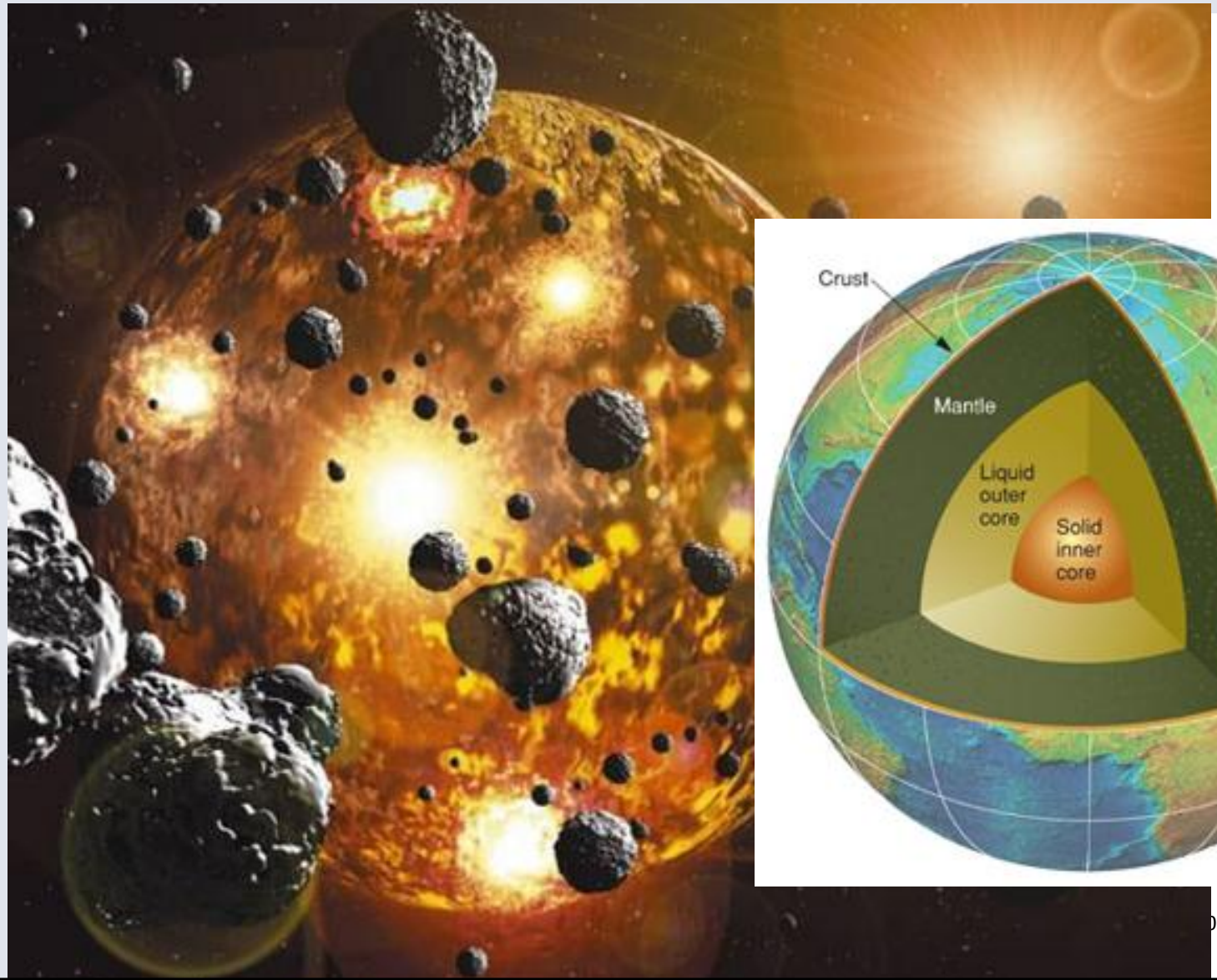

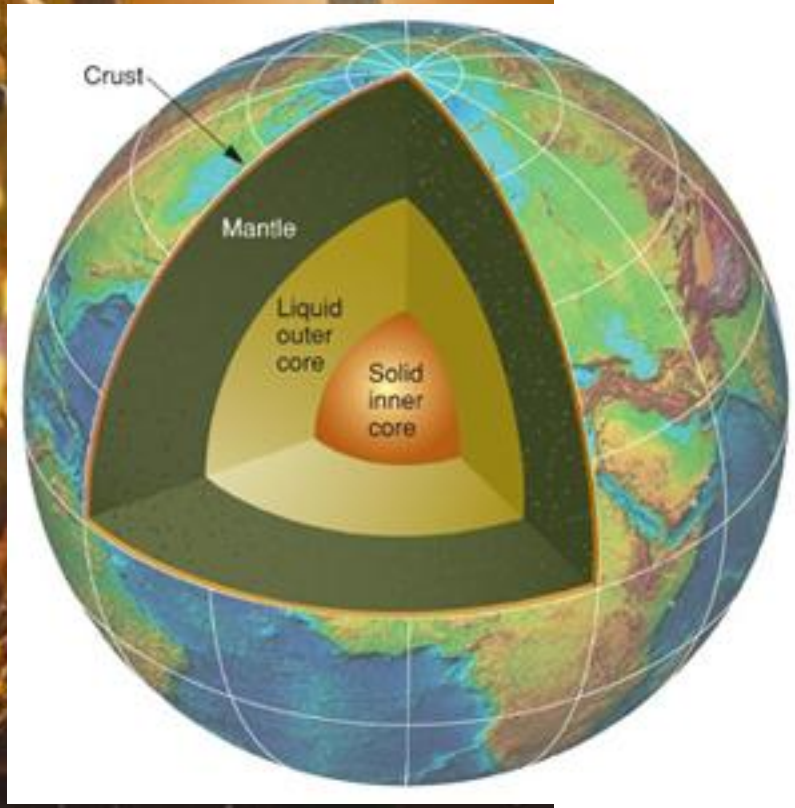

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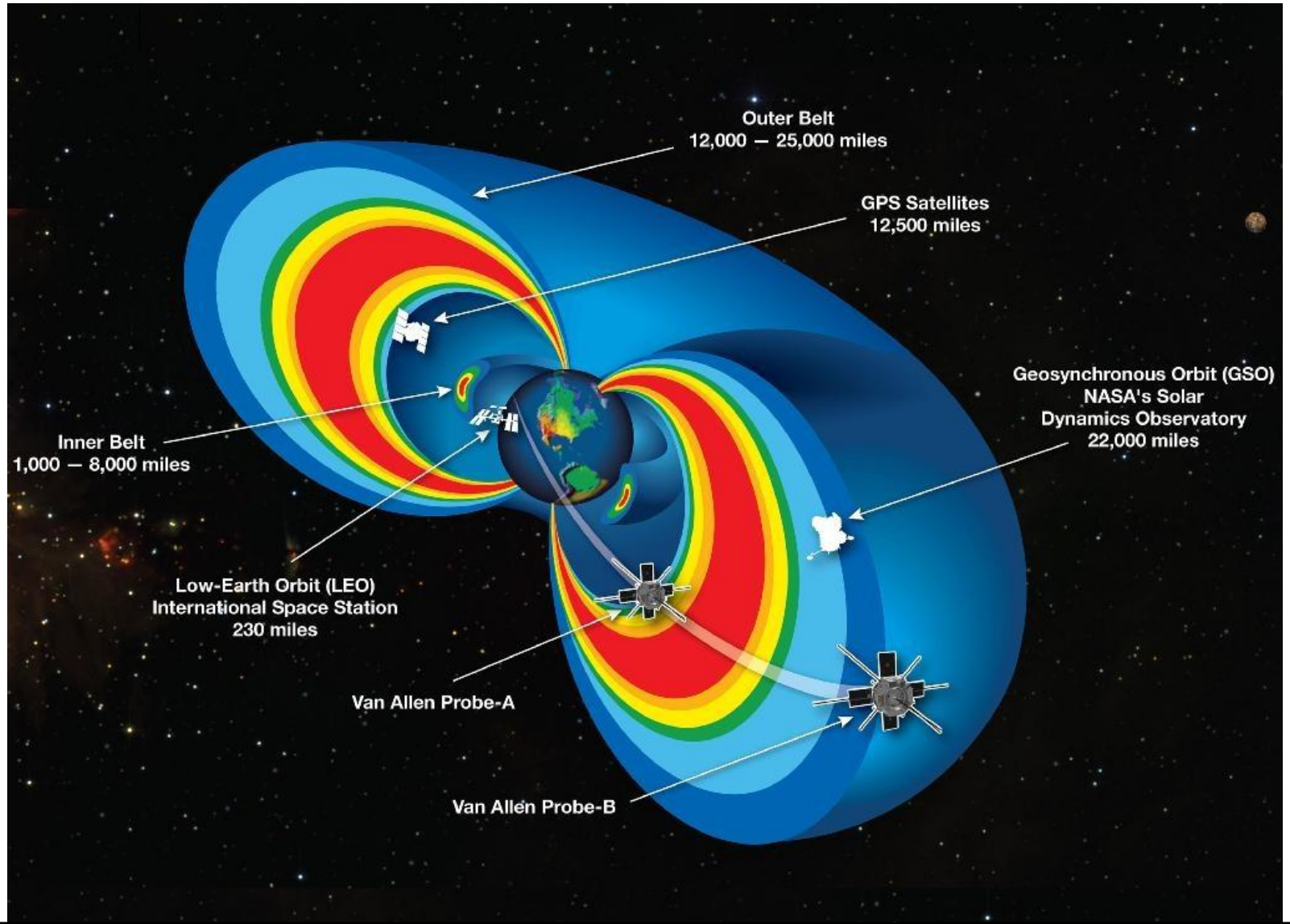

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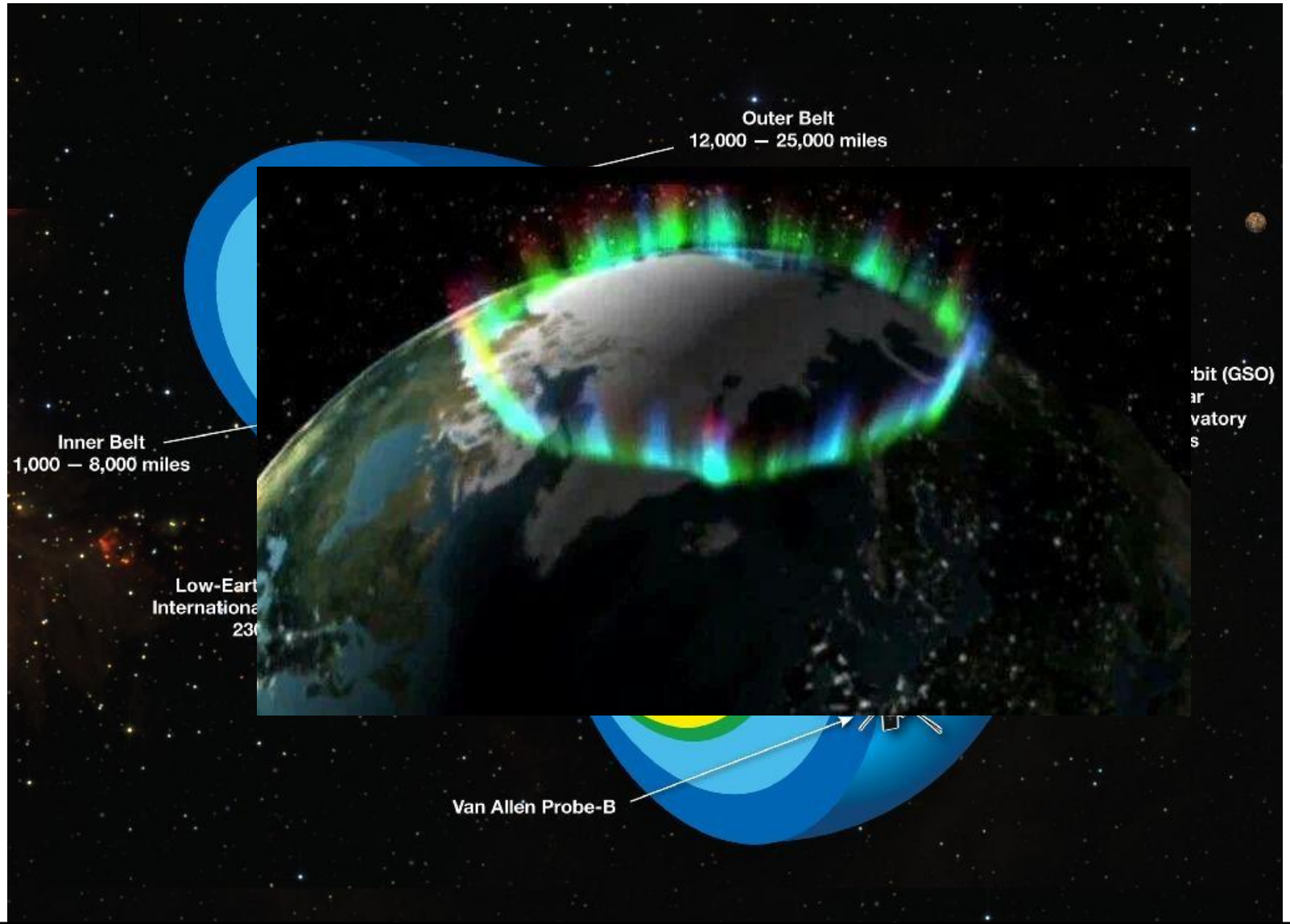

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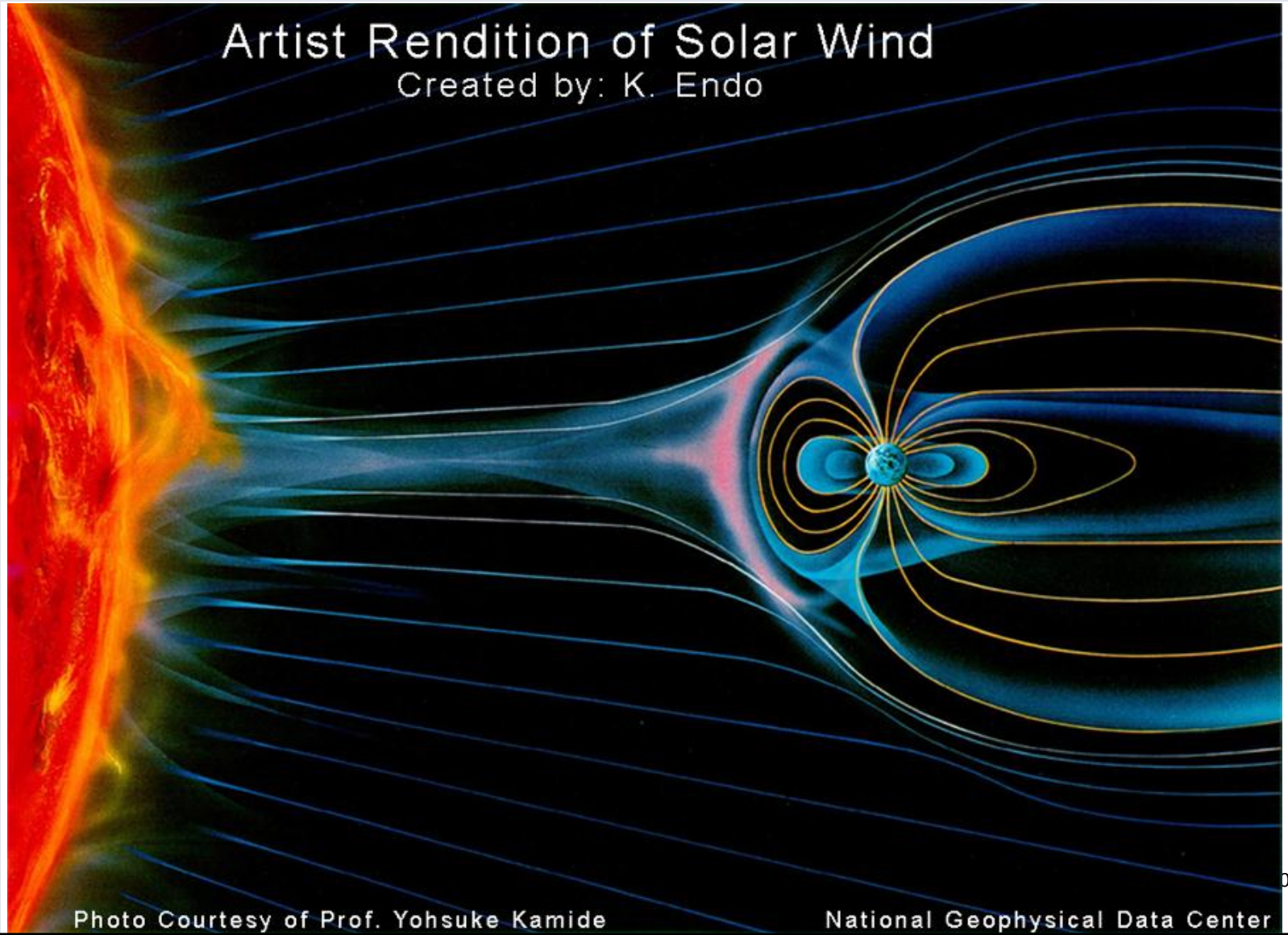

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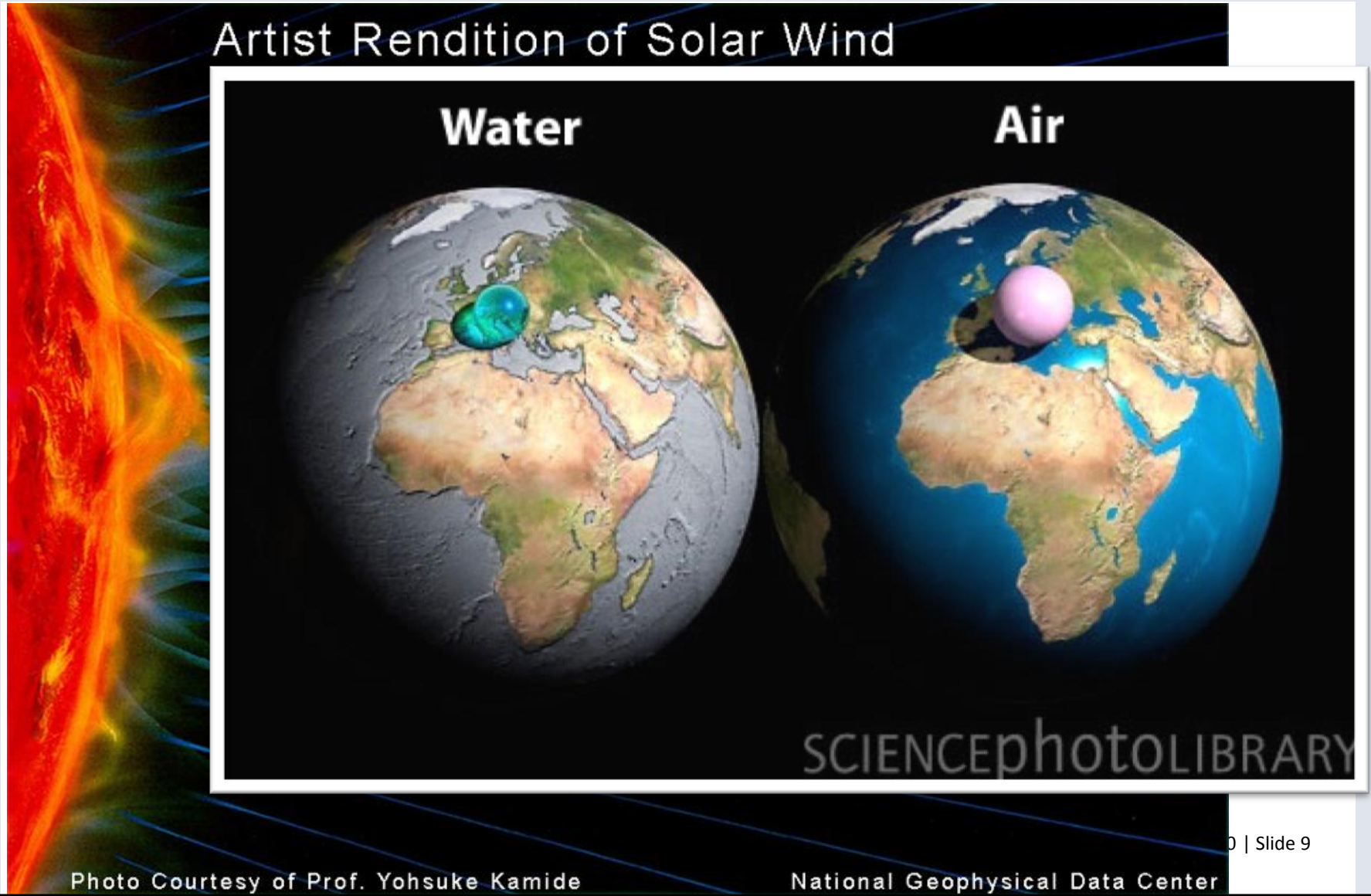

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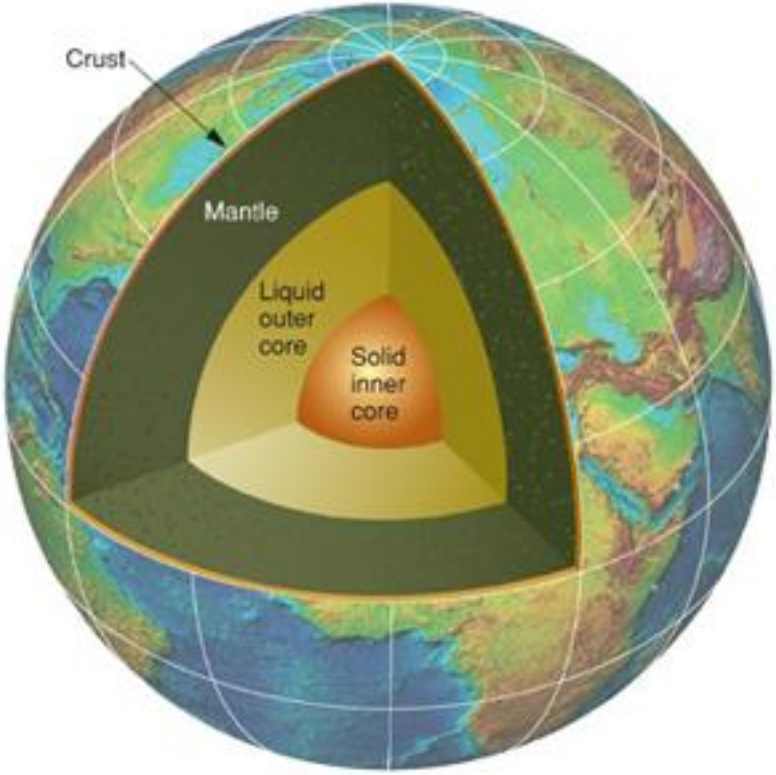
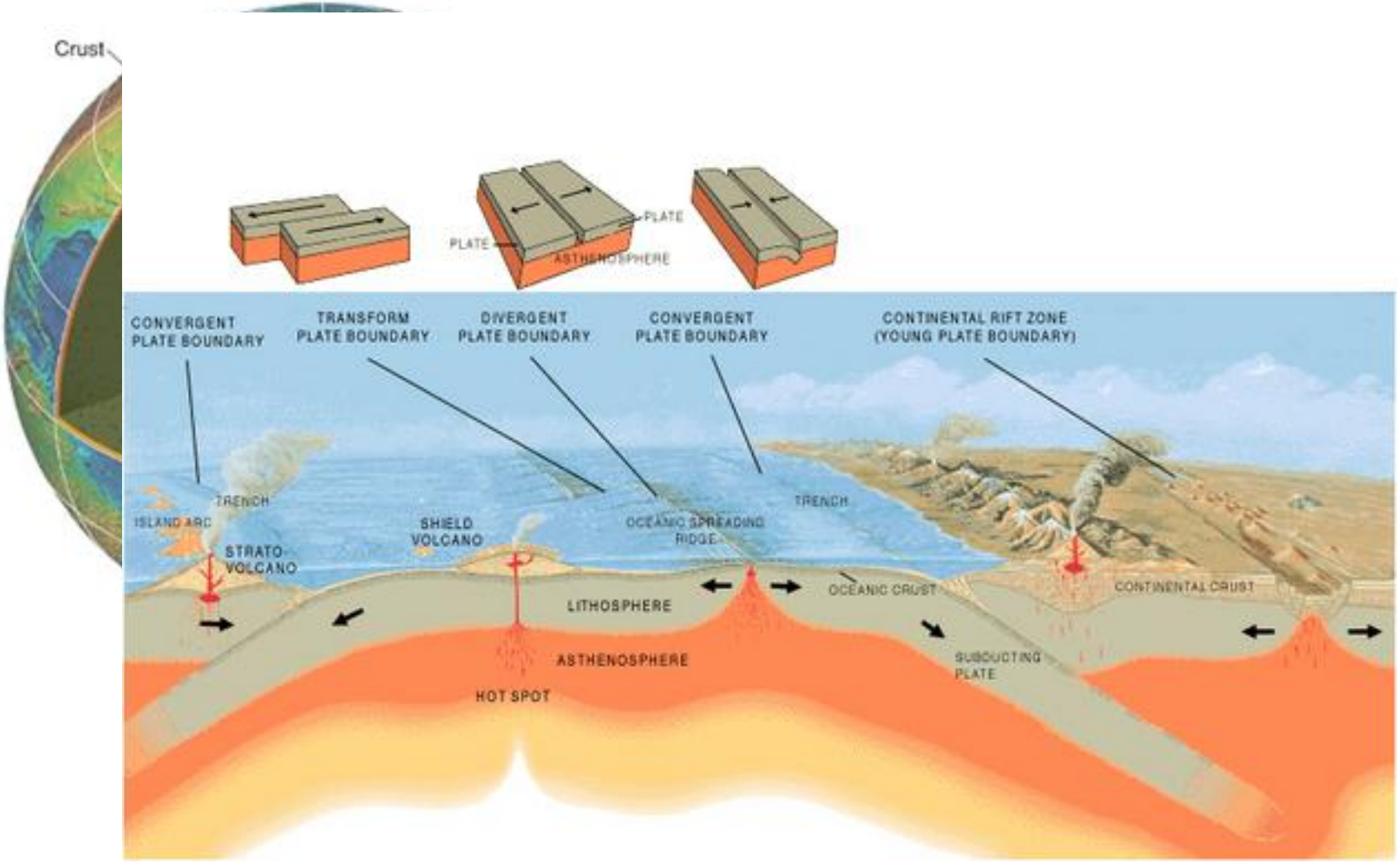

Crust
Mantle
Liquid outer core
Solid inner core


Crust
PLATE
PLATE
ASTHENOSPHERE
CONVERGENT PLATE BOUNDARY
TRANSFORM PLATE BOUNDARY
DIVERGENT PLATE BOUNDARY
CONVERGENT PLATE BOUNDARY
CONTINENTAL RIFT ZONE (YOUNG PLATE BOUNDARY)
TRENCH
ISLAND ARC
STRATO-VOLCANO
SHIELD VOLCANO
OCEANIC SPREADING RIDGE
TRENCH
LITHOSPHERE
OCEANIC CRUST
CONTINENTAL CRUST
ASTHENOSPHERE
SUBDUCTING PLATE
HOT SPOT

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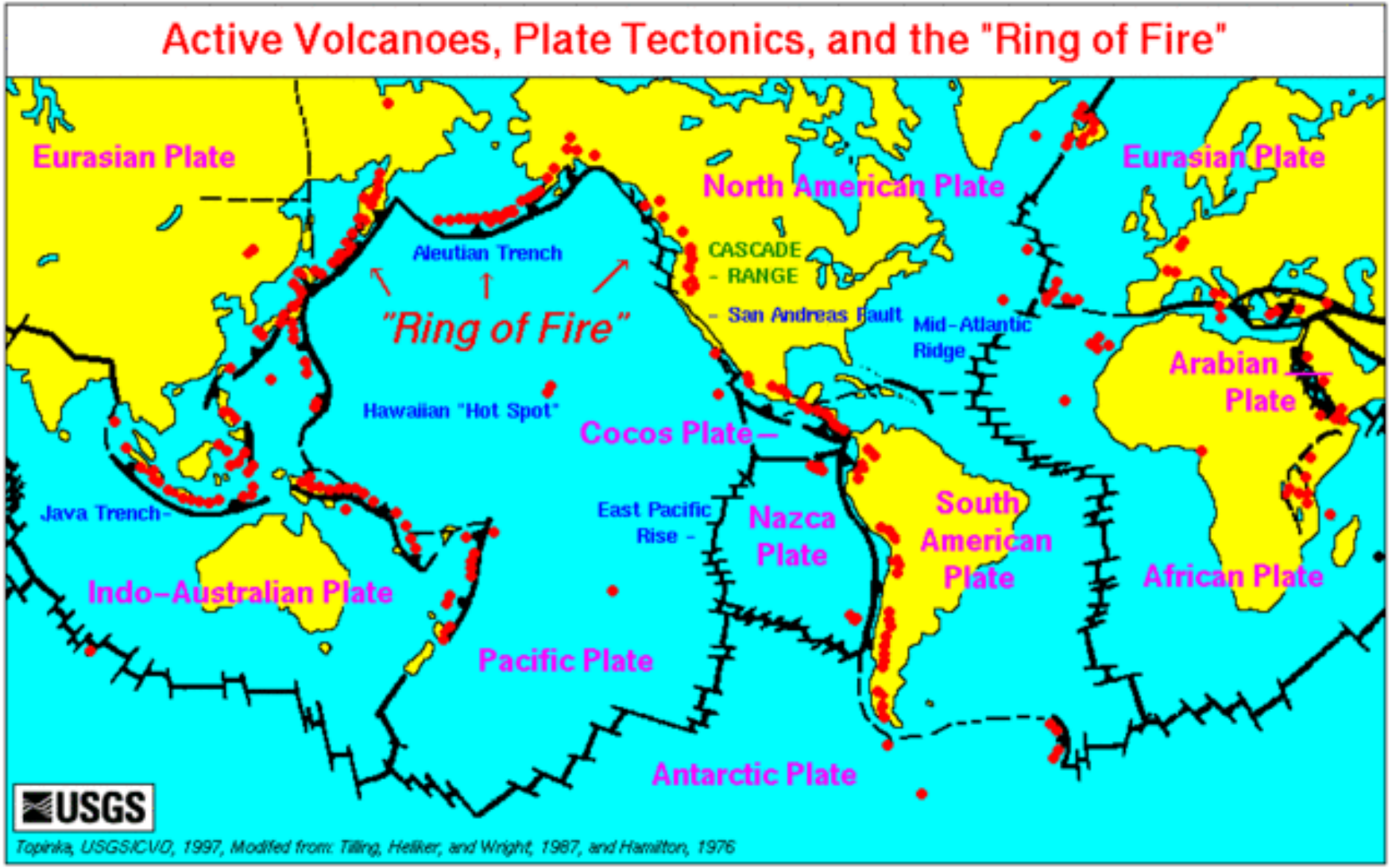

Earthquake

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Earthquake

Earthquake

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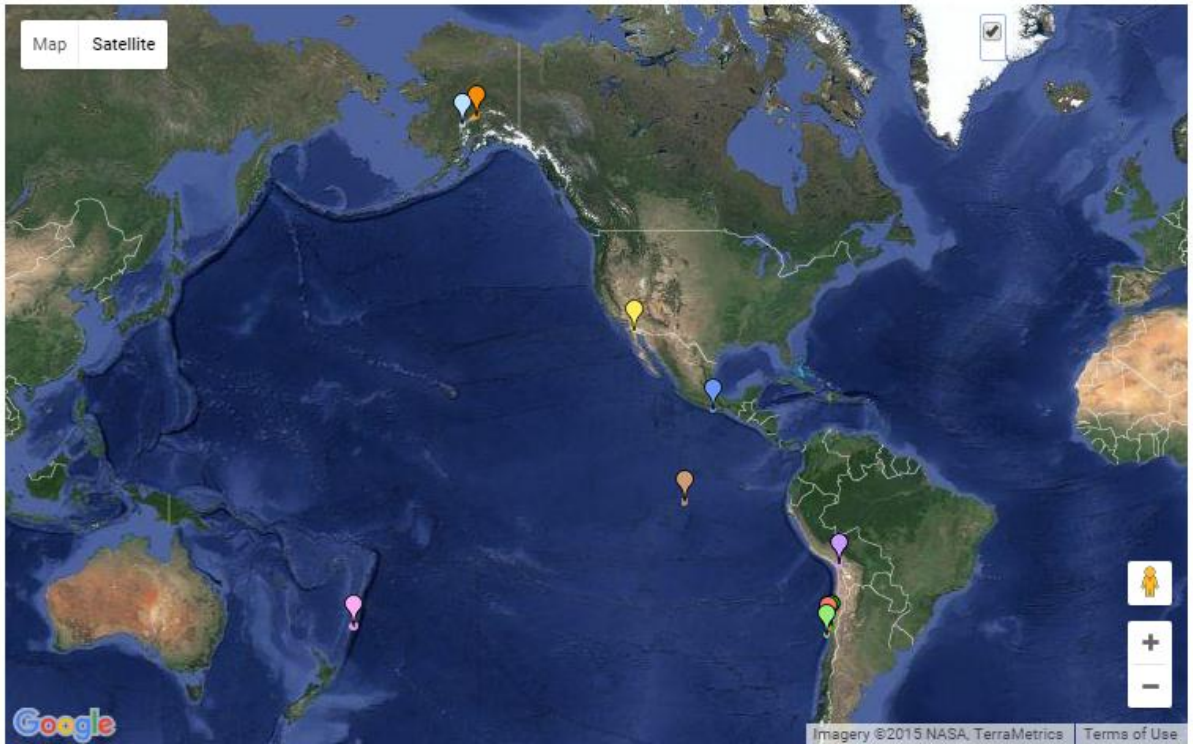
earthquaketrack.com

Today's Biggest Earthquakes

All recent earthquakes »

Earthquakes over 3.0 M within the last 24 hours



- about 5 hours ago 3.5 magnitude, 113 km depth
  Central Alaska
- about 7 hours ago 3.4 magnitude, 15 km depth
  Guadalupe Victoria, Baja California, Mexico
- about 8 hours ago 4.2 magnitude, 10 km depth
  Illapel, Coquimbo, Chile
- about 13 hours ago 4.7 magnitude, 7 km depth
  Coquimbo, Coquimbo, Chile
- about 14 hours ago 4.2 magnitude, 58 km depth
  Pinotepa Nacional, Oaxaca, Mexico
- about 15 hours ago 4.9 magnitude, 123 km depth
  Tacna, Tacna, Peru
- about 17 hours ago 5.0 magnitude, 32 km depth
  Kermadec Islands, New Zealand
- about 17 hours ago 3.3 magnitude, 15 km depth
  Central Alaska
- about 18 hours ago 4.9 magnitude, 10 km depth
  Central East Pacific Rise
- about 18 hours ago 4.2 magnitude, 12 km depth
  Coquimbo, Coquimbo, Chile

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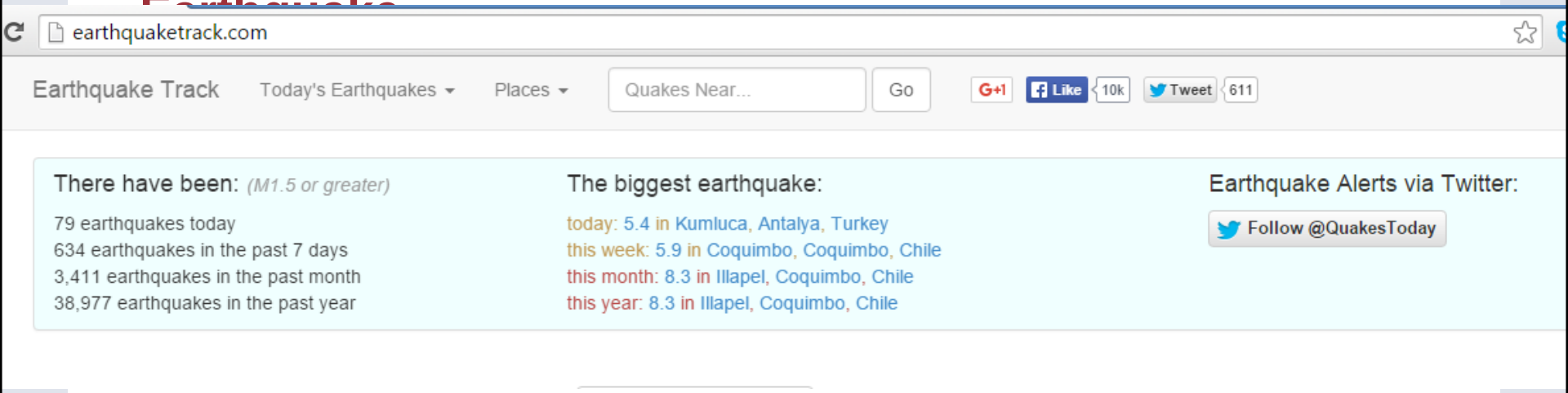
Earthquake



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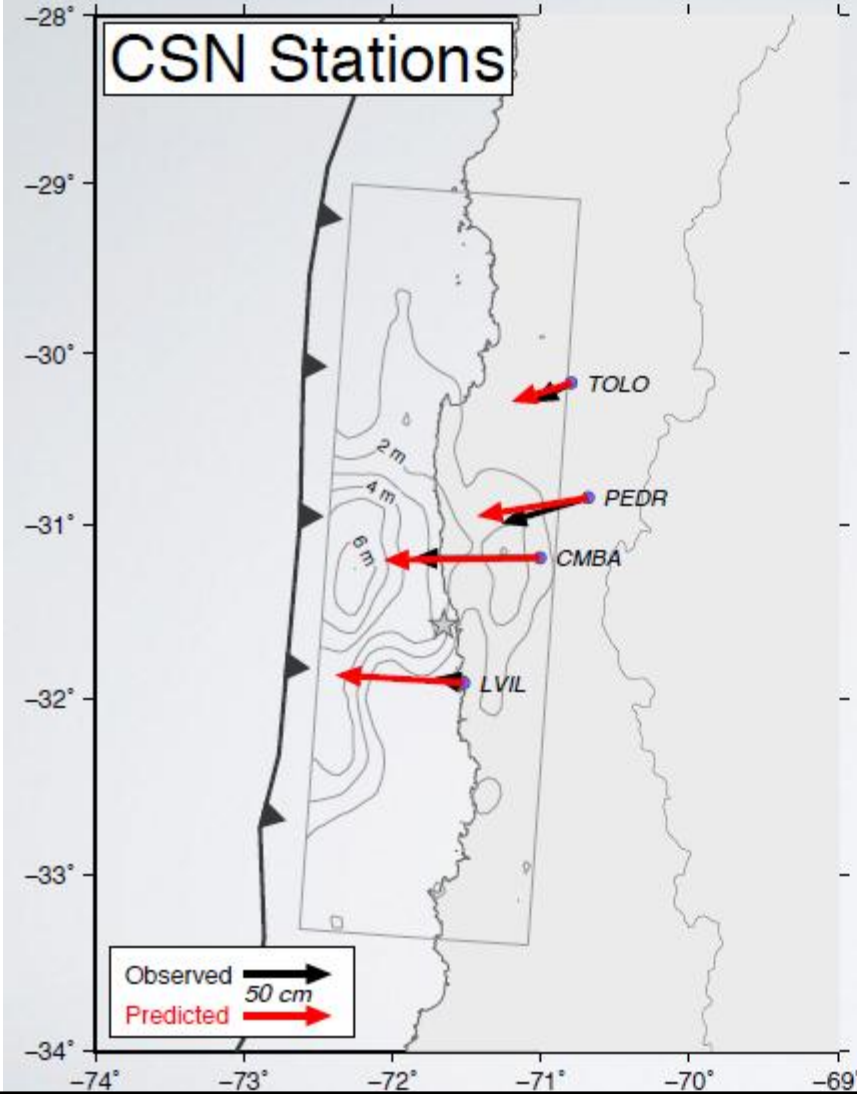

Predicted vs Observed Horizontal GPS Displacements

- Predicted horizontal displacement from teleseismic finite fault model
- Red arrows indicate predicted horizontal displacement from finite fault model
- Black arrows indicate horizontal displacements observed at GPS stations

Data Source:
University of Chile
http://www.csn.uchile.cl/desplazamientos-del-terremoto-de-illapel-2015/

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Earthquakes in Australia

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Earthquakes in Australia

Location	Year	Magnitude
Meeberrie WA	1941	7.2
Adelaide	1954	5.5
Newcastle	1989	5.6

Earthquakes in Australia

	Magnitude
	7.2
	5.5
	5.6

Earthquakes in Australia

Earthquakes in Australia

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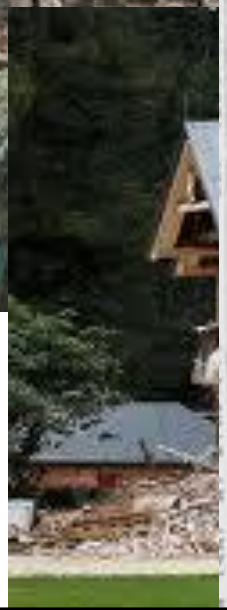
Earthquakes i



'Quake Link With H-Bomb "Possible"

It was possible, but extremely unlikely, that Adelaide's earthquake on March 1 was "triggered-off" by the hydrogen bomb explosion at Bikini on the same day, the Professor of Physics at the University of Adelaide (Professor L. G. H. Huxley) said yesterday.

"I do not think the bomb was powerful enough to have had any effect at this distance," he said.

Professor Huxley was commenting on a theory advanced by several people who telephoned "The Advertiser" yesterday following an announcement that the hydrogen bomb explosion on March 1 was 600 times greater than that which tore Hiroshima apart.

Professor Huxley said he understood that no earthquakes had occurred elsewhere in the world on March 1 and that no 'quakes had been reported after previous atomic explosions.

Adelaide's 'quake was more likely to have been triggered off by local gravitational effects of the moon or changes in barometric pressure.

Both of these influences could produce changes in the earth's crust.

However, if it could be established that the bomb were exploded shortly before 6 a.m. (Bikini time), the possibility that the explosion triggered-off the 'quake should be examined.

The shock of an H-bomb explosion at this time would have reached Adelaide at approximately the moment the earthquake began.

Professor Huxley's calculation allowed one hour for the shock to travel 3,600 miles from Bikini to Adelaide.

WASHINGTON, March 19. — The "hydrogen device" exploded by the US in the Pacific on March 1 left an area of total destruction about 12 miles in diameter, it was reported yesterday.

The estimate was made by Representative James Van Zandt, a Republican member of the Joint Congressional Atomic Energy Committee.

Washington and some of its fringe communities would have been destroyed if the US capital had been the target, he said.

The March 1 explosion "might be dwarfed by later tests," he added.

Mr. Van Zandt confirmed earlier reports from Congressional sources that the March 1 explosion had the destructive punch of from 12m. to 14m. tons of TNT.

LONDON, March 19.— The Washington correspondent of the "Manchester Guardian," reporting that later explosions in the present series of tests are expected to be even bigger, quotes Congressional officials as saying that one device may have a blast equal to that of 45m. to 50m. tons of TNT.

"The explosion of this bomb is planned for the second half of April," he adds.

"American scientists say they could make one with a blast equal to 100m. tons of TNT."

Tuna Fear

TOKIO, Mar. 19.—A US-Japanese team of six radiation specialists has begun treating 23 Japanese from the Kakuryu Maru who were showered with radio-active debris from the March 1 explosion.

The Japanese Kyodo newsagency quotes spokesmen for the fishing industry as saying it has been dealt a "near fatal blow" by the discovery that some fish from the Fukuryu Maru had been sold.

Tuna went begging in the market yesterday.

Several more Japanese fishing boats made radio-active by hydrogen explosion put into port today.

BOY PINIONED 2 HOURS BY RABBIT TRAPS

PERTH, March 19.

With his ankle and wrist pinioned by two rabbit traps a four-year-old boy spent two painful hours in the bush last night, before his searching father released him.

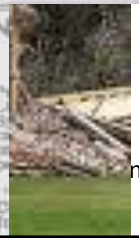
He was Raymond Quirk, who lives eight miles from Collie.

The boy was playing with other children when he stepped on a set trap, which snapped shut on his ankle.

Falling forward, his hand set off another trap which closed around his wrist pinning him to the ground.

His frightened playmates ran away but did not tell anyone what had happened.

The father began searching for his son when he failed to return home.



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Construction for Earthquakes

Tsunami


BANGLADESH
INDIA
MYANMAR
(BURMA)
THAILAND
SRI
LANKA
MALAYSIA
MALDIVES
SOMALIA
KENYA
INDONESIA
TANZANIA
SEYCHELLES
Indian
Ocean
MADAGASCAR
SOUTH
AFRICA

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Tsunami

Tsunami

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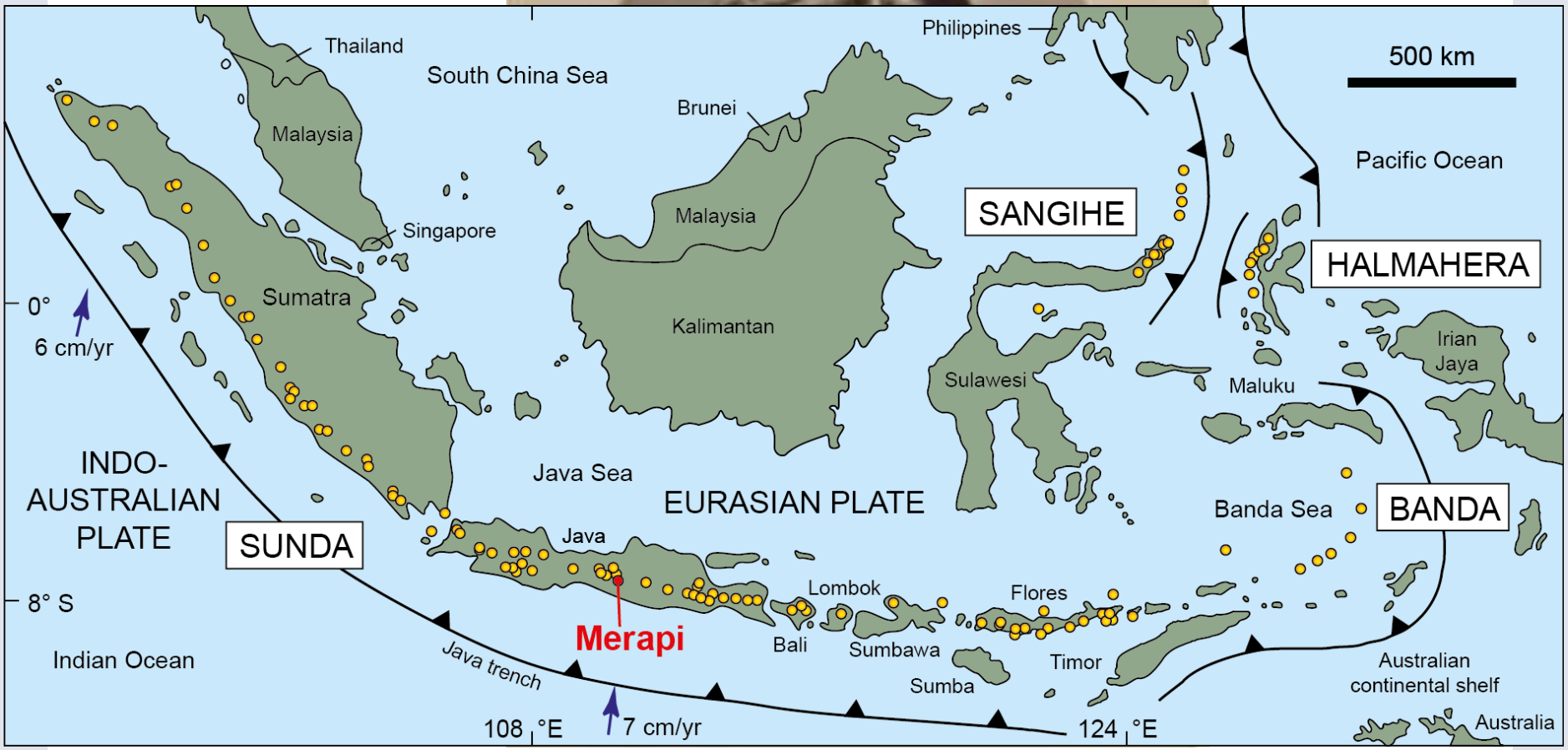

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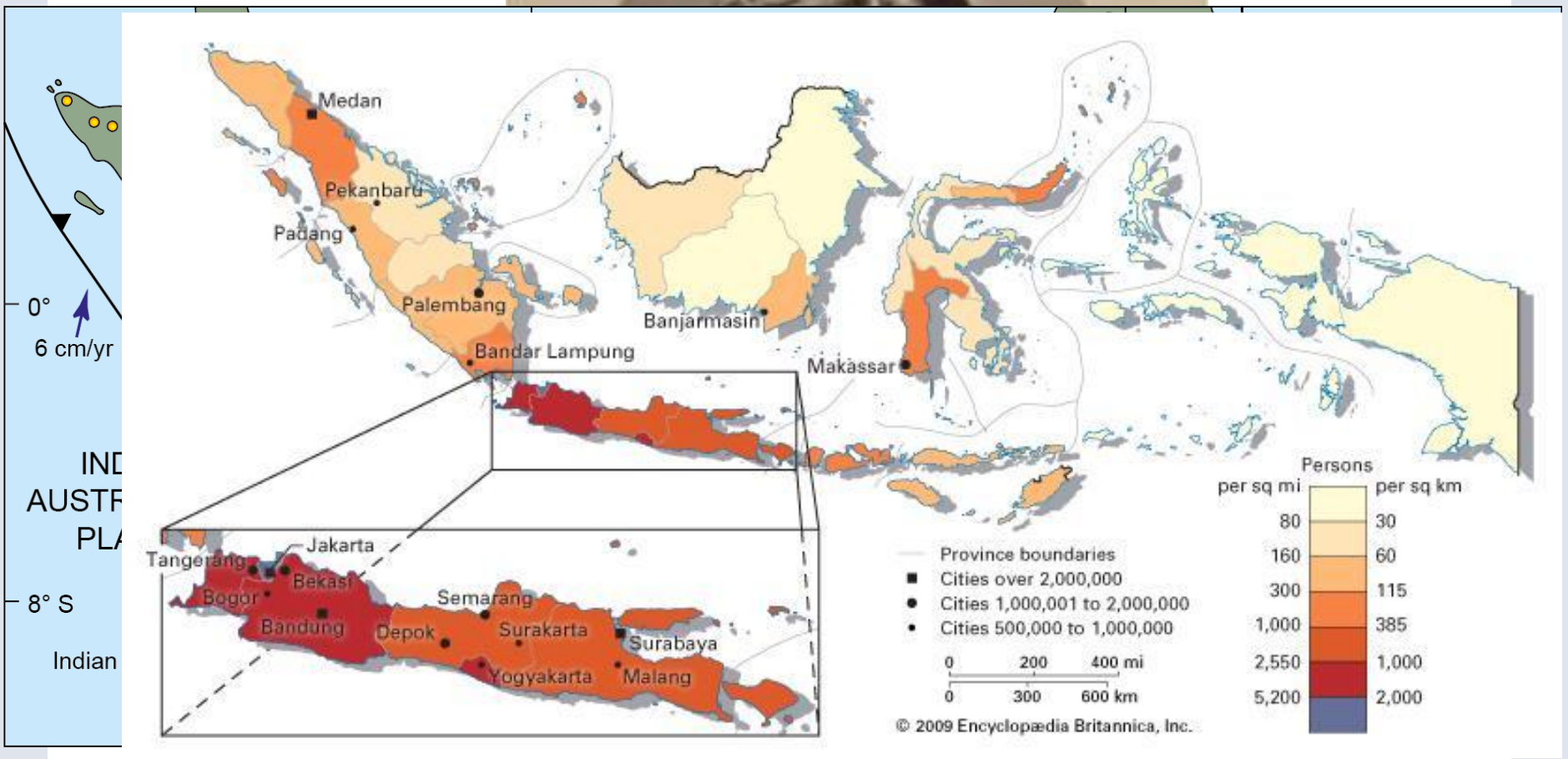

Volcanic Eruption

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Volcanic Eruption

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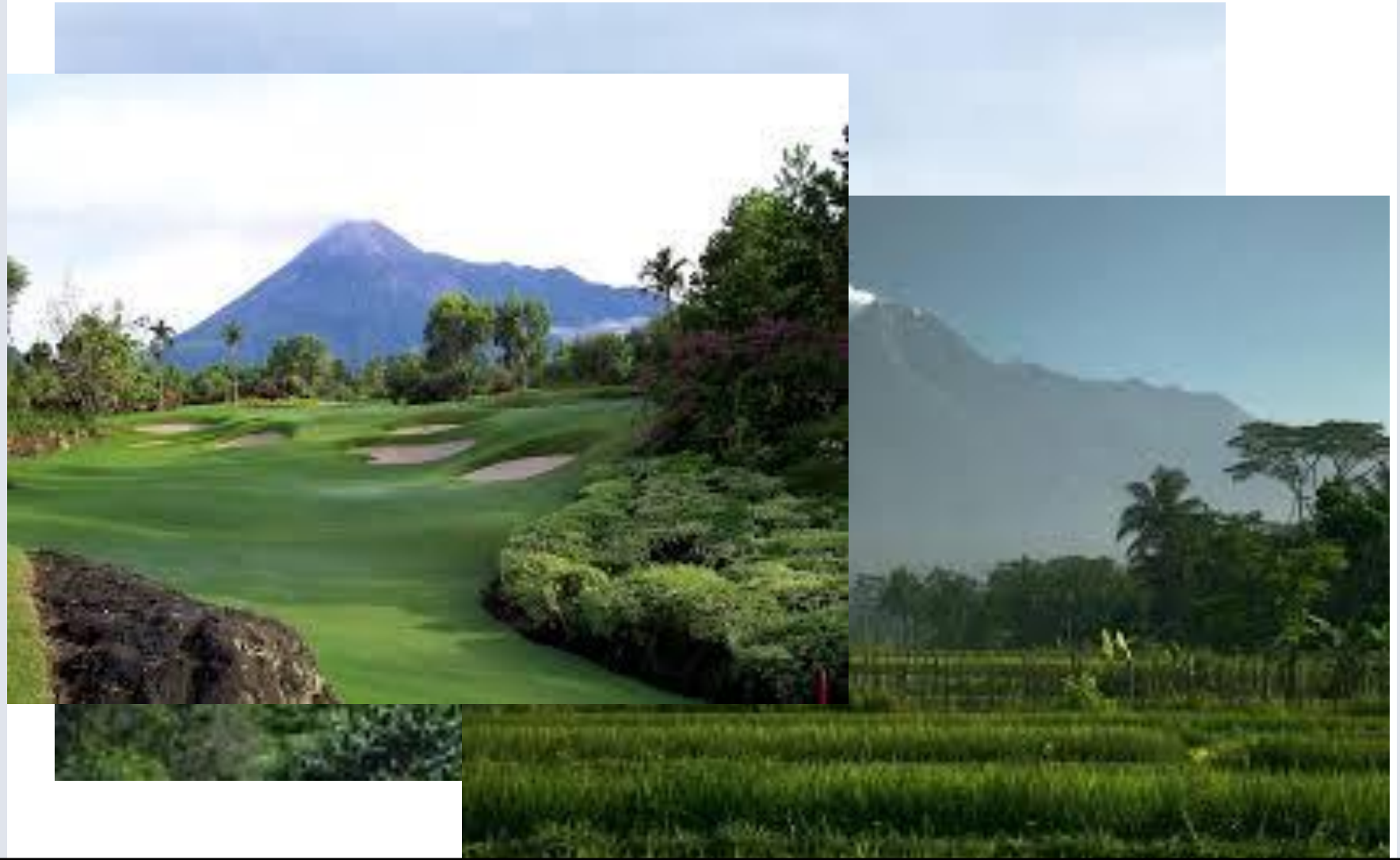
Volcanic Eruption



Volcanic Eruption

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Volcanic Eruption

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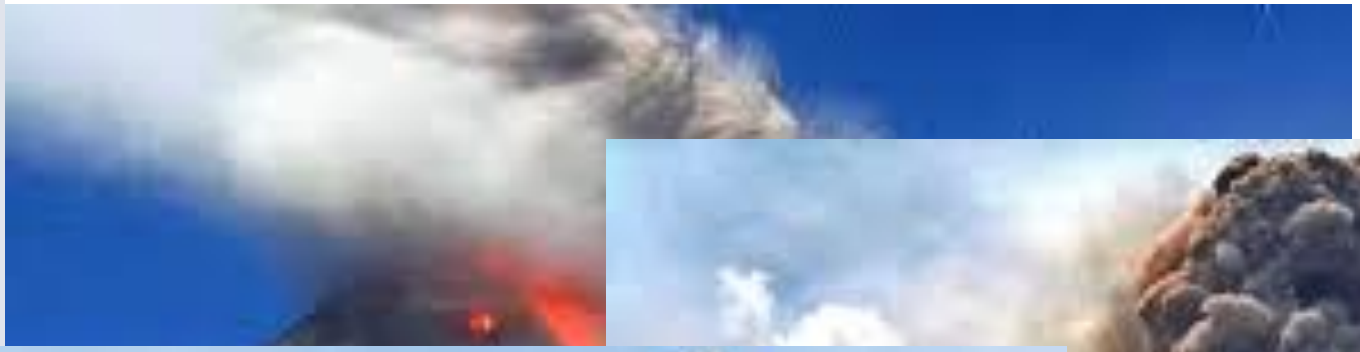
Volcanic Eruption

Volcanic Eruption

Volcanic Eruption

Volcanic Eruption



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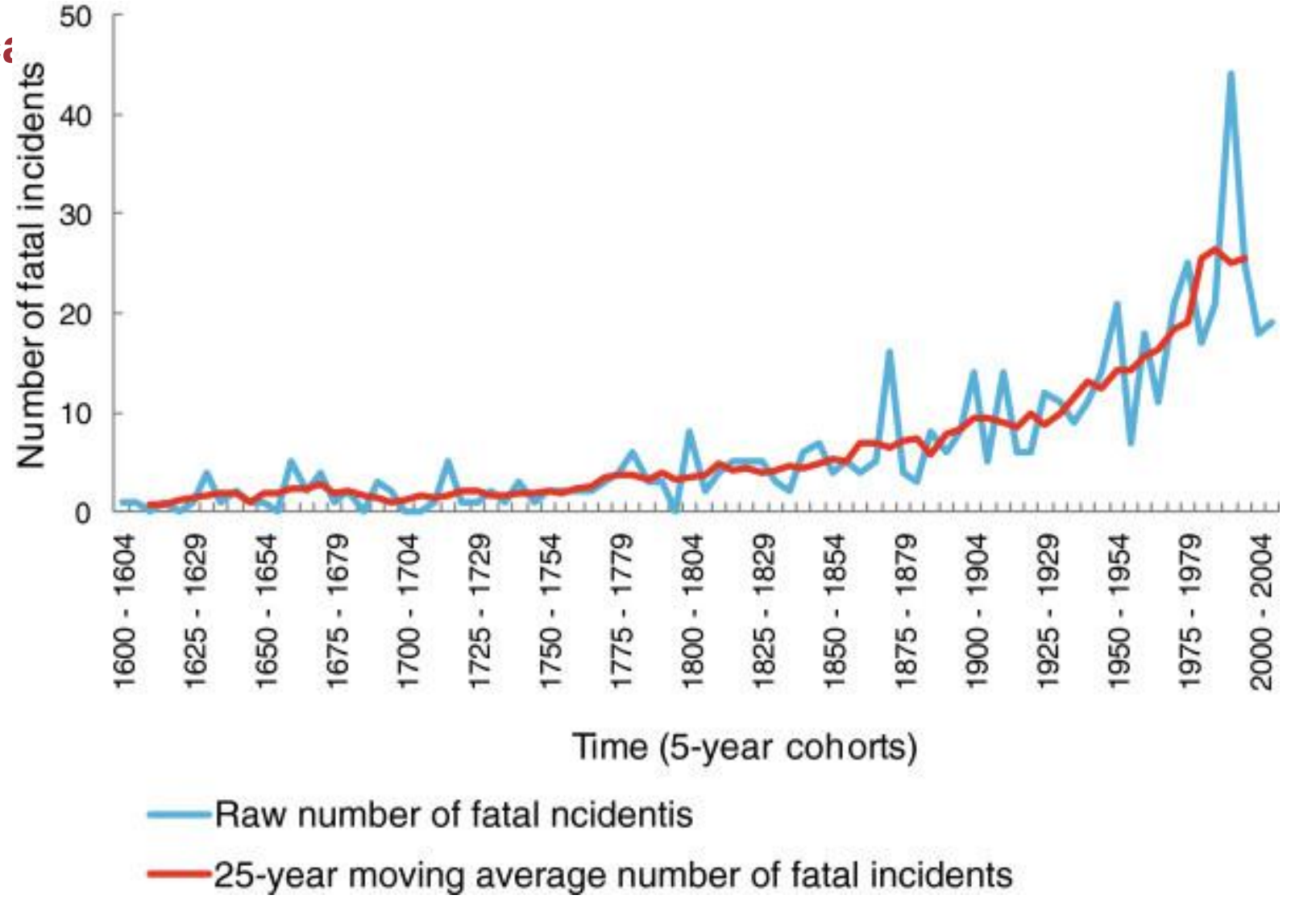
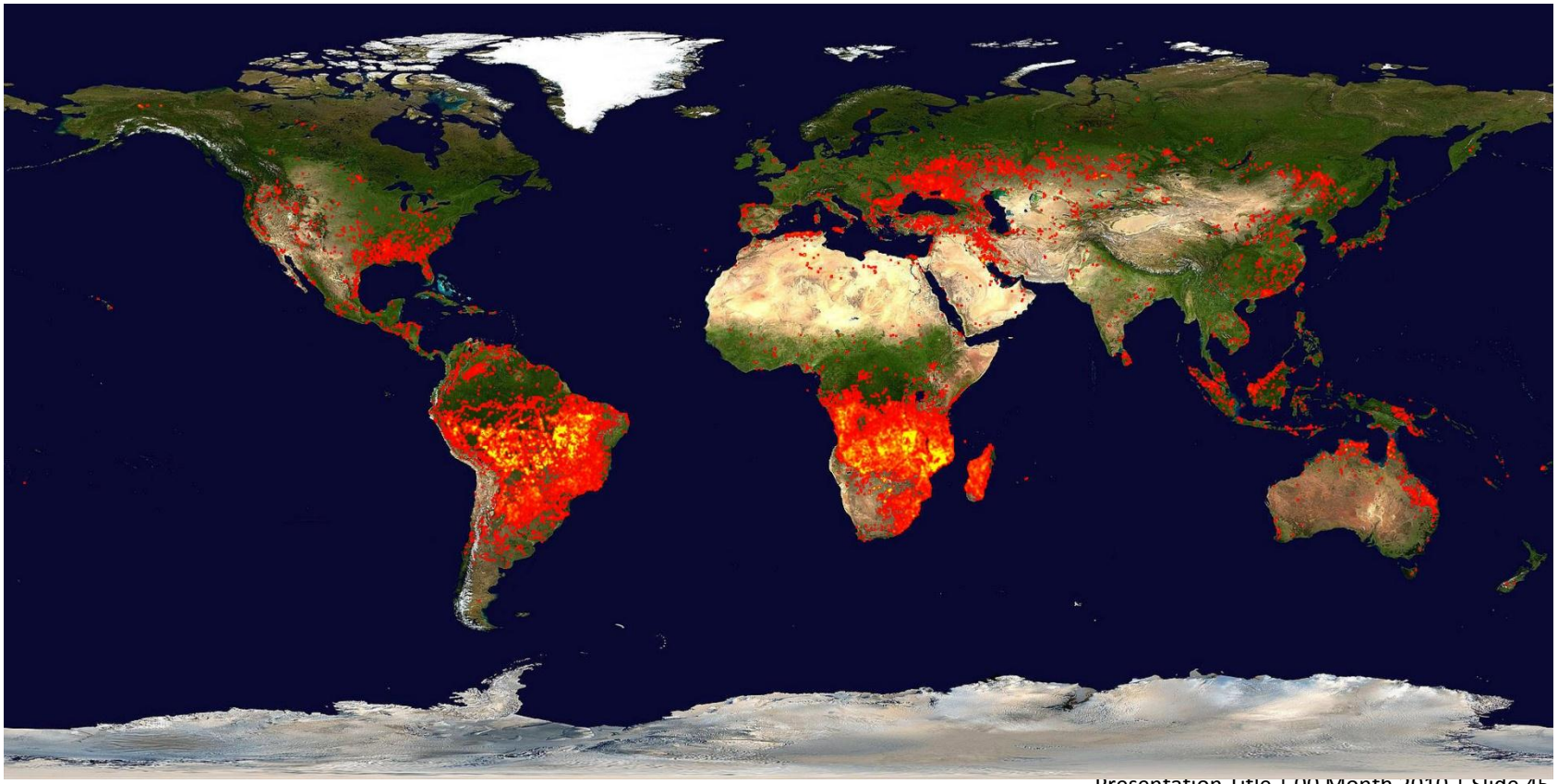
Volca



Natural Context of Fire



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Natural Context of Fire

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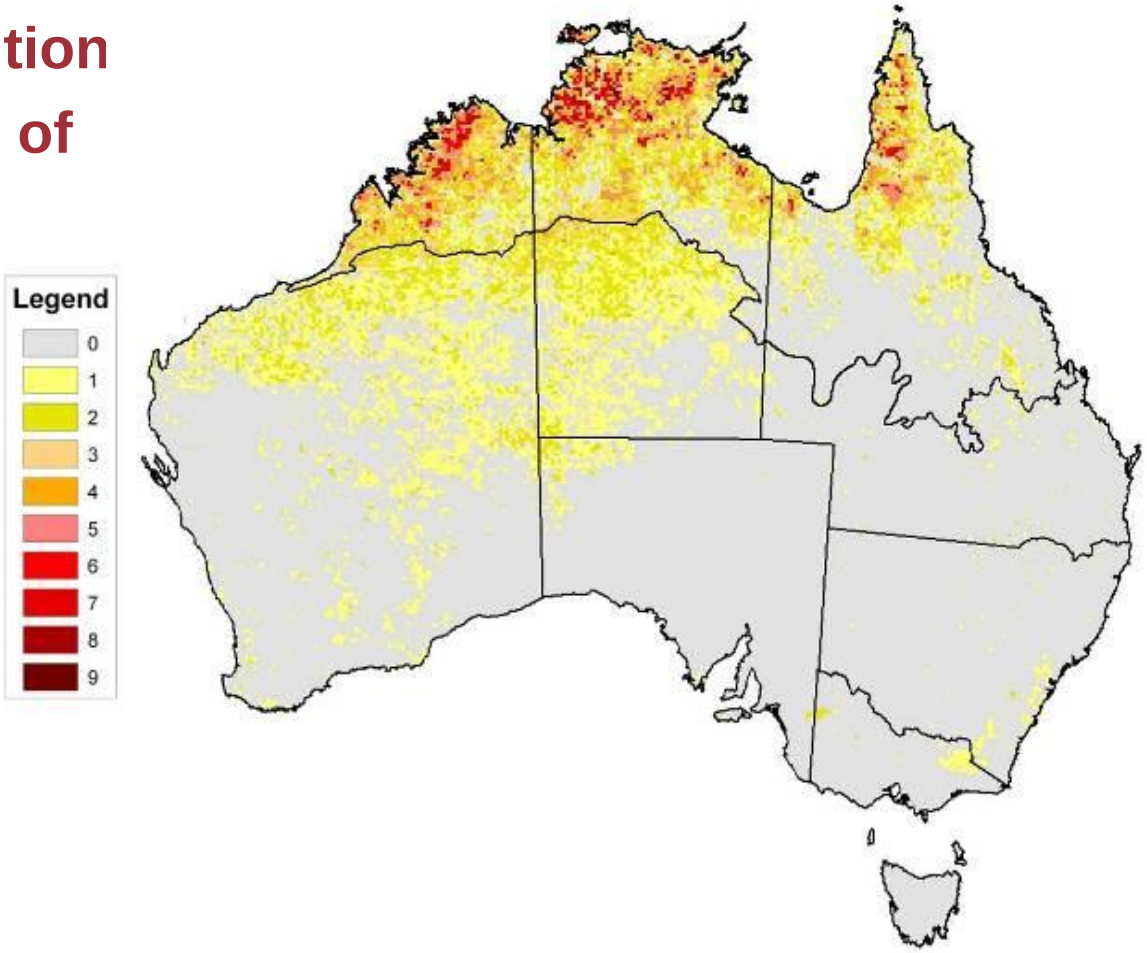
Actual fire distribution

Based on 10 years of satellite

data



Cultural Context of Fire

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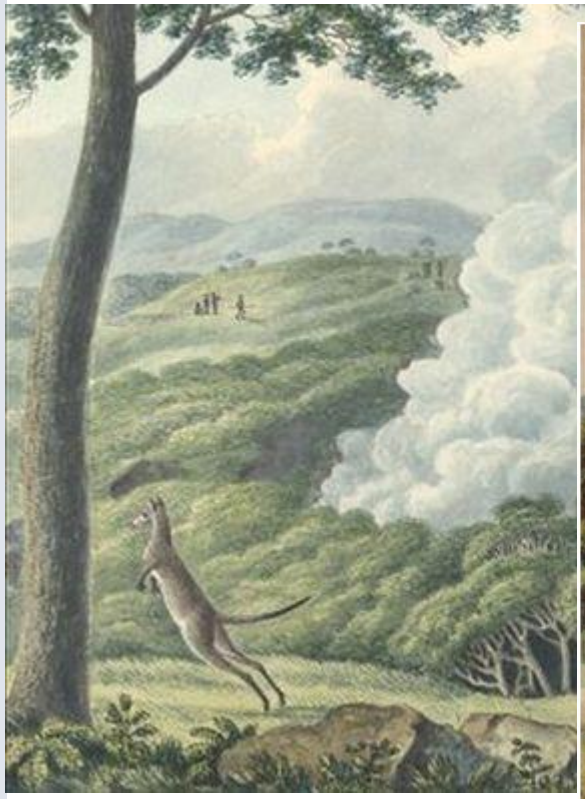
Cultural Context of Fire



Cultural Context of Fire

Prior to 1788 fire was not a hazard:

The secret of fire in our traditional knowledge is that it is a thing that brings the land alive again. So we do not necessarily see fire as bad and destructive...But it is not a thing to play with unless people understand the nature of fire.

Dean Yibarbuk and Peter Cooke, *Savanna Burning—Understanding and Using Fire in Northern Australia* , Tropical Savannas CRC, 2001

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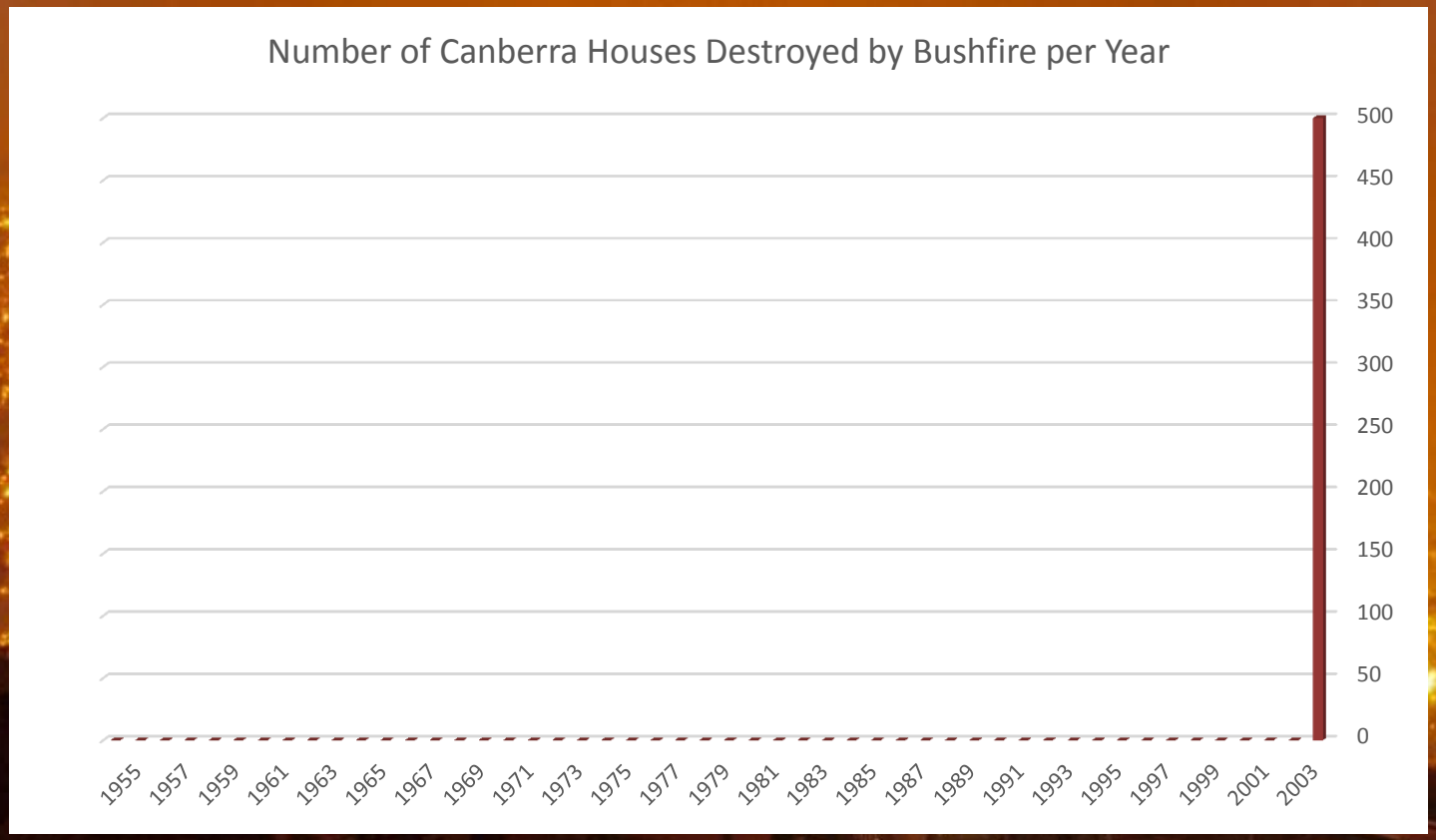


Fire management by RESPONSE

Floods

Floods

Some Causes of Flooding in Bangladesh

1. Monsoon Climate
Brings very heavy rain and snow
Soils are leached and heavy
runoff results in soil erosion

2. Spring Snow-Melt
Results in soil erosion and a
rapid increase in River Discharge

3. Deforestation in Headwater Areas
due to increasing population in Nepal & Tibet.
Trees cleared for fuel and grazing land.
Less Evapotranspiration, more runoff and
faster soil erosion. Landslides also occur.

Tibet

River Brahmaputra

4. Rivers Silt-up due to to increased soil
erosion. This raises the river bed and
reduces the capacity of the channel
resulting in increased likelihood of
flooding.

Bangladesh

Nepal

India

River Ganges

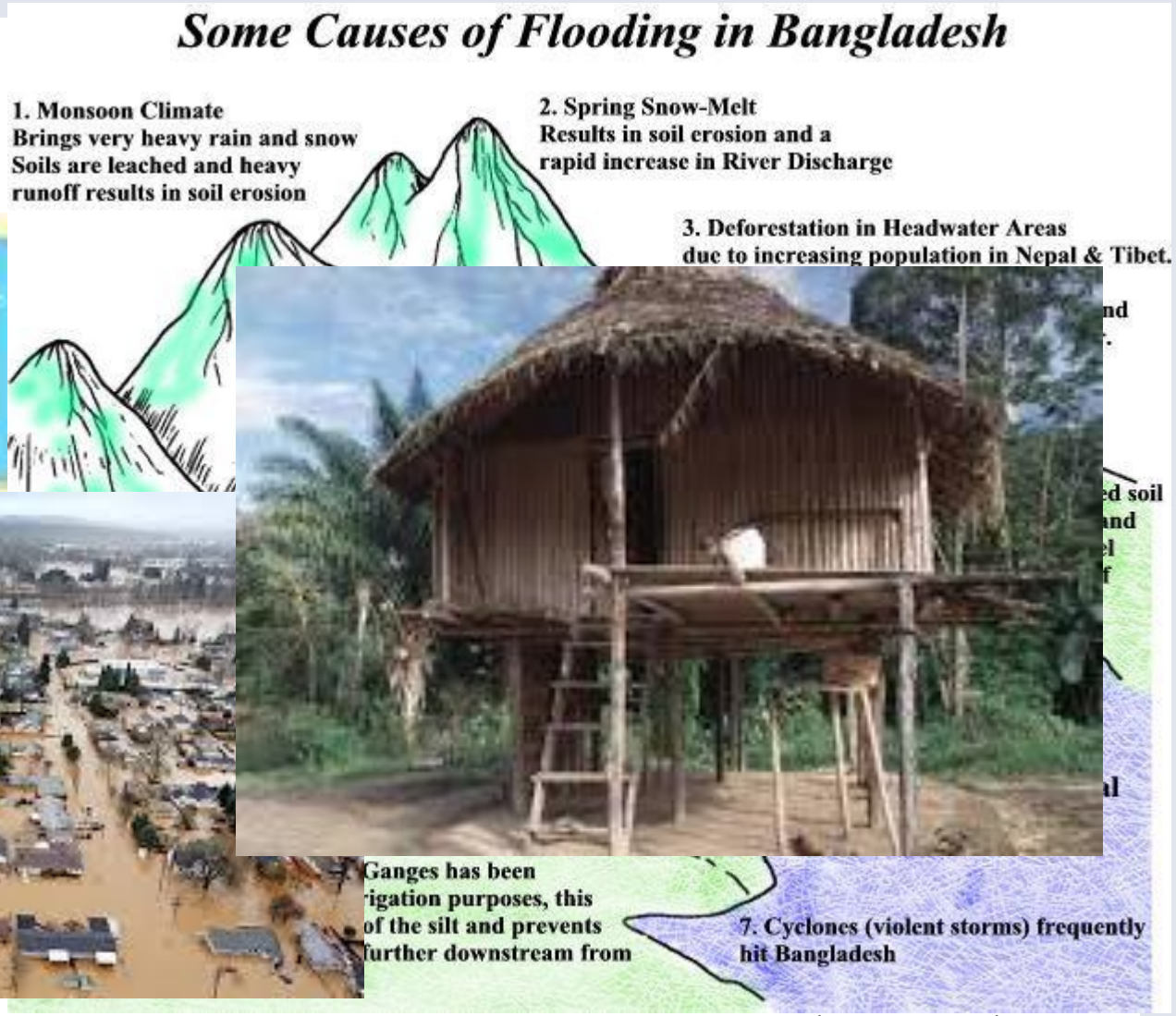
5. 80% of Bangladesh lies on a huge
floodplain and delta, most of which is
only 1m above sea level.

Bay of Bengal

6.Much of the Ganges has been
diverted for irrigation purposes, this
removes some of the silt and prevents
the floodplain further downstream from
being built up.

7. Cyclones (violent storms) frequently
hit Bangladesh

Floods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further downstream from
7. Cyclones (violent storms) frequently
hit Bangladesh

Cost of disasters in Australia

Table 1.1 **Deadliest natural disasters in Australia, 1970–2013**

Rank	*Event*	*Fatalities*
1	2009 Black Saturday bushfires	173
2	1983 Ash Wednesday bushfires	75
3	1974 Cyclone Tracy	71
4	2010–11 Queensland floods	33
5	1997 Thredbo landslide	18

Source: AEMI (2014).

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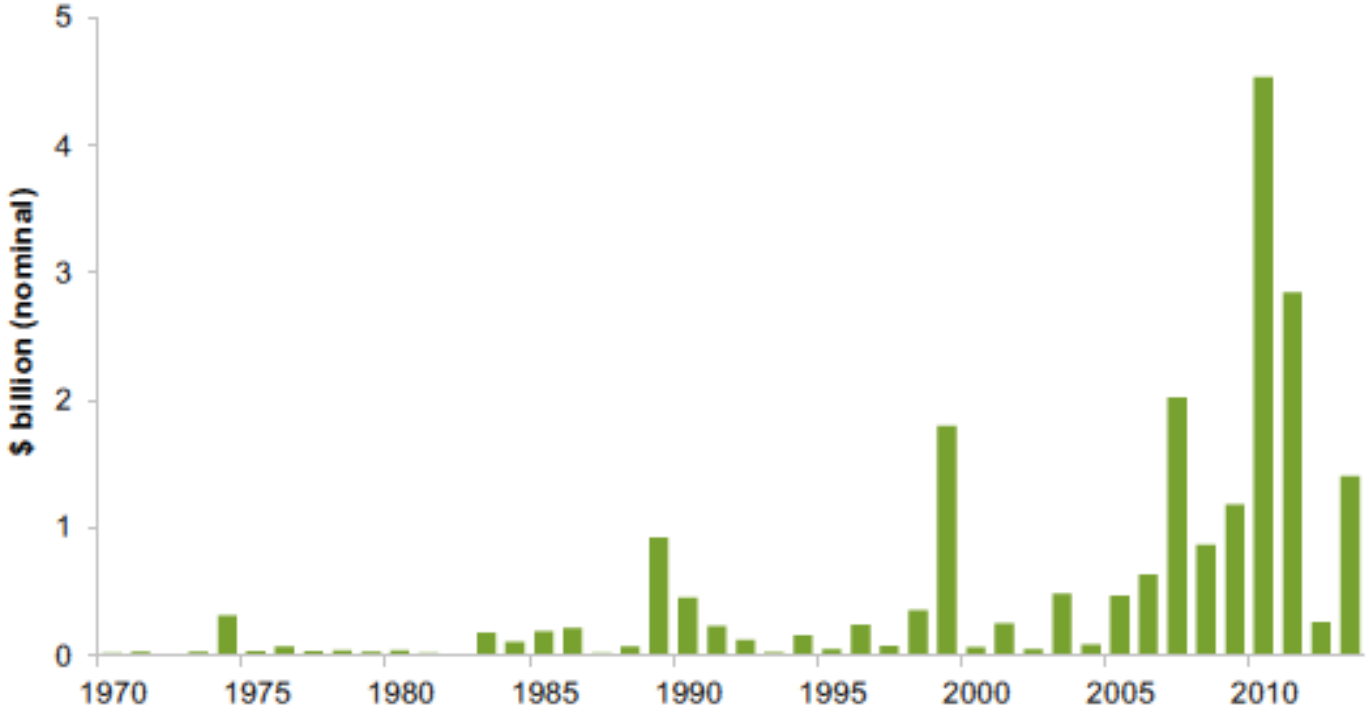
Cost of disasters in Australia

Figure 1.2 **The insurance losses of natural disasters, 1970–2013**



Data source: ICA (2014e).

Cost of disasters in Australia

Table 1.2 **Insurance losses by natural hazard, 1970–2013[a]**

$ million (2011 dollars)

Event type	*NSW*	*Vic*	*Qld*	*SA*	*WA*	*Tas*	*NT*	*ACT*	***Total***
Bushfire	527	1 650	–	189	96	100	–	440	**3 002**
Cyclone	36	–	3 329	–	486	–	1 529	–	**5 379**
Flood	965	400	3 630	–	24	51	123	–	**5 192**
Storm	2 747	2 439	1 376	47	1 232	34	–	–	**7 874**
Hail	4 856	294	949	92	0	86	–	–	**6 277**
Earthquake	1 657	–	–	–	15	–	–	–	**1 671**
Total	**10 788**	**4 783**	**9 283**	**327**	**1 852**	**271**	**1 652**	**440**	**29 395**
Per cent	*36.7*	*16.3*	*31.6*	*1.1*	*6.3*	*0.9*	*5.6*	*1.5*	*100.0*

[a] Where events were recorded as impacting multiple states, costs have been divided evenly across those states. – Nil or rounded to zero.

Data sources: ICA (2014e); Productivity Commission estimates.

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Cost of disasters in Australia

Table 1.3 **The five costliest natural disasters in Australia, 1970–2013**

Various forms of insurance losses

Rank	*Nominal cost*		*Deflated cost*		*Normalised cost*	
	Event	$b	Event	2011$b	Event	2011$b
1	2010–11 Queensland floods	2.4	2010–11 Queensland floods	2.5	1999 Sydney hailstorm	4.3
2	1999 Sydney hailstorm	1.7	1999 Sydney hailstorm	2.5	1974 Cyclone Tracy	4.1
3	2007 Newcastle and Hunter Valley storm	1.5	2007 Newcastle and Hunter Valley storm	1.7	1989 Newcastle earthquake	3.2
4	2011 Cyclone Yasi	1.4	1989 Newcastle earthquake	1.6	1974 Cyclone Wanda and Brisbane flood	2.6
5	2009 Black Saturday bushfires	1.1	1974 Cyclone Tracy	1.4	2010–11 Queensland floods	2.4

Sources: ICA (2014e); Productivity Commission estimates.

Cost of disasters in Australia

Estimated economic costs of the 2009 Black Saturday bushfires

Item	*Cost ($m)*
Direct costs	
General insurance payouts	1 200
Loss and damage to public infrastructure	77
Value of destroyed timber, replanting and salvage costs	658
Asset damage and other costs incurred by Telstra and Melbourne Water	25
Indirect costs	
Costs associated with the Victorian Bushfire Reconstruction and Recovery Authority	1 081
Cost of 2009 Victorian Bushfires Royal Commission	90
Intangible costs	
Loss of life	645
Other costs	
Supplementary funding from the Victorian Government	593
Total	**4 369**

Source: VBRC (2010b).

Expenditure on disasters in Australia

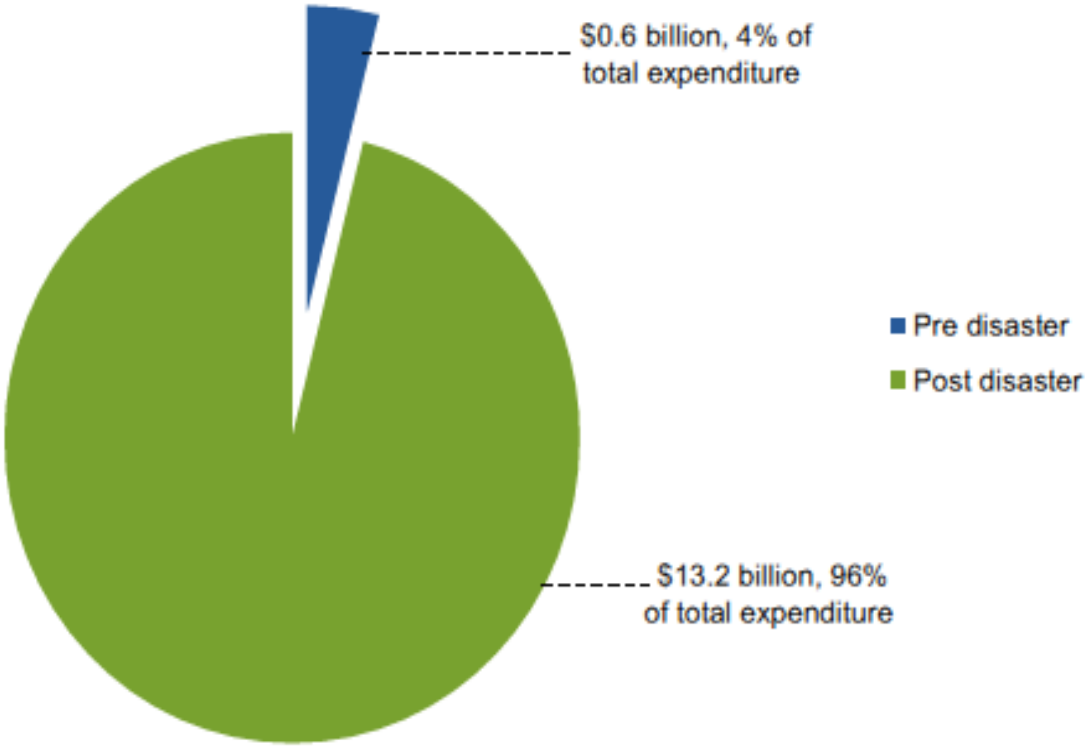
- Anti-terror expenditure from 2001 to 2011 >$21 Billion (ASPI)

Table 1.4 **Estimated Australian Government pre-disaster expenditure**
2002-03 to 2014-15

Financial year	*NPANDR/SPPs*[a]	*NEMP*	*Other*[b]	***Total***
	$m	$m	$m	$m
2002-03	18.4	–	8.0	**26.4**
2003-04	10.2	–	10.2	**20.4**
2004-05	15.5	–	12.4	**27.9**
2005-06	30.9	–	20.0	**50.9**
2006-07	24.0	–	17.7	**41.7**
2007-08	30.2	–	17.4	**47.6**
2008-09	36.9	–	15.6	**52.5**
2009-10	34.1	3.6	15.0	**52.7**
2010-11	26.4	3.6	13.0	**43.0**
2011-12	30.0	3.6	13.0	**46.6**
2012-13	24.0	3.8	16.0	**43.8**
2013-14	17.6	3.6	16.0	**37.2**
2014-15	39.2	3.7	22.0	**64.9**
Total	**337.4**	**21.9**	**196.3**	**555.6**

Expenditure on disasters in Australia

Figure 1.7 **Estimated Australian Government expenditure pre and post disaster, 2002-03 to 2014-15**



Data source: Productivity Commission estimates.

Disaster Decision Making

- Research in the last 15 – 20 years indicates that there is almost universal failure to make good decisions in the face of infrequent natural hazards. This is largely due to hard-wired elements of human cognition...

Cognitive bias

- Kahneman, D 2011 “Thinking, fast and Slow
- Framing
- Availability heuristic
- Unreasonable Optimism
- Outcome expectancy
- Shifting blame / responsibility
- Persistent failure to grasp probability

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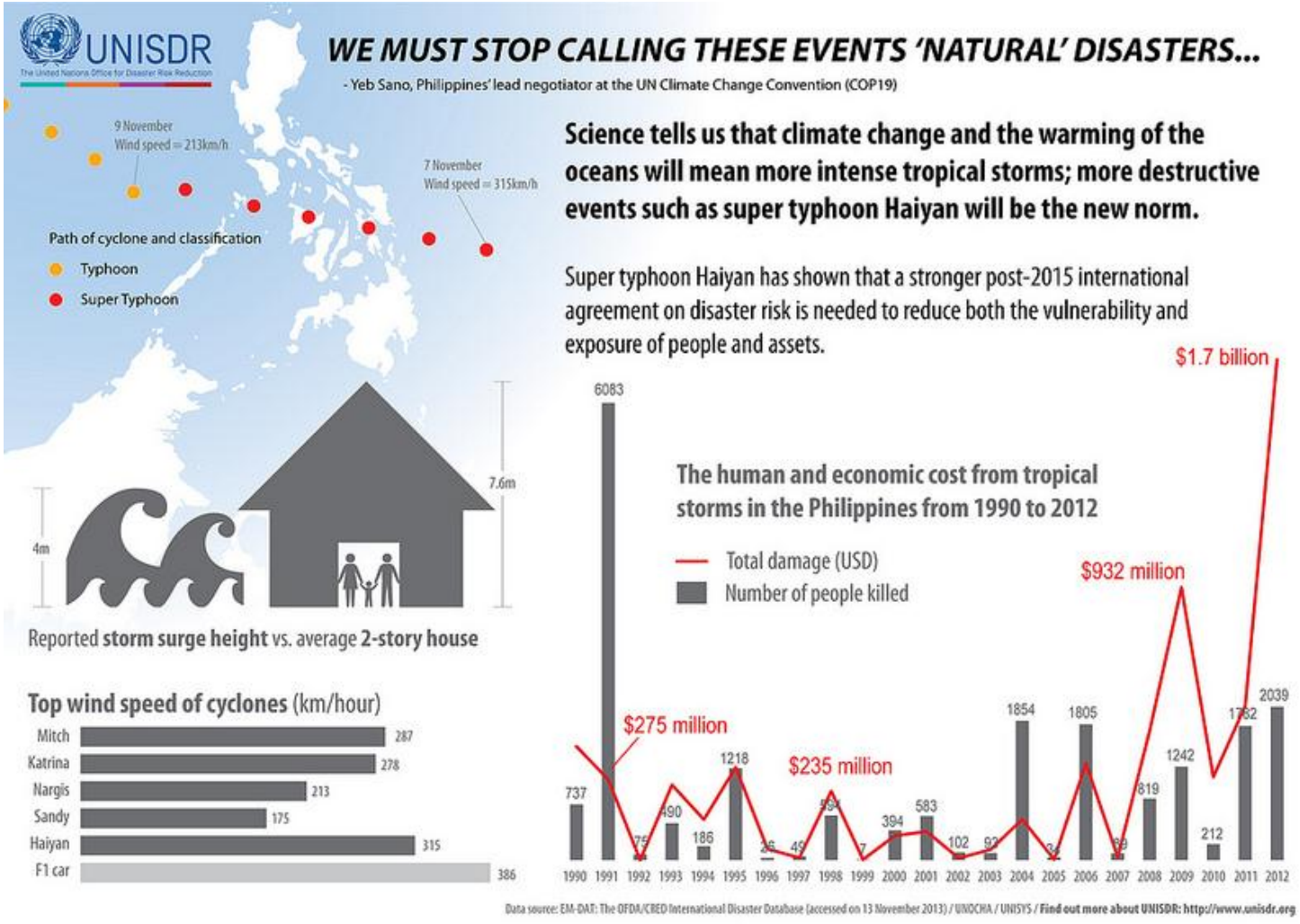
Conclusions:



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Conclusions: