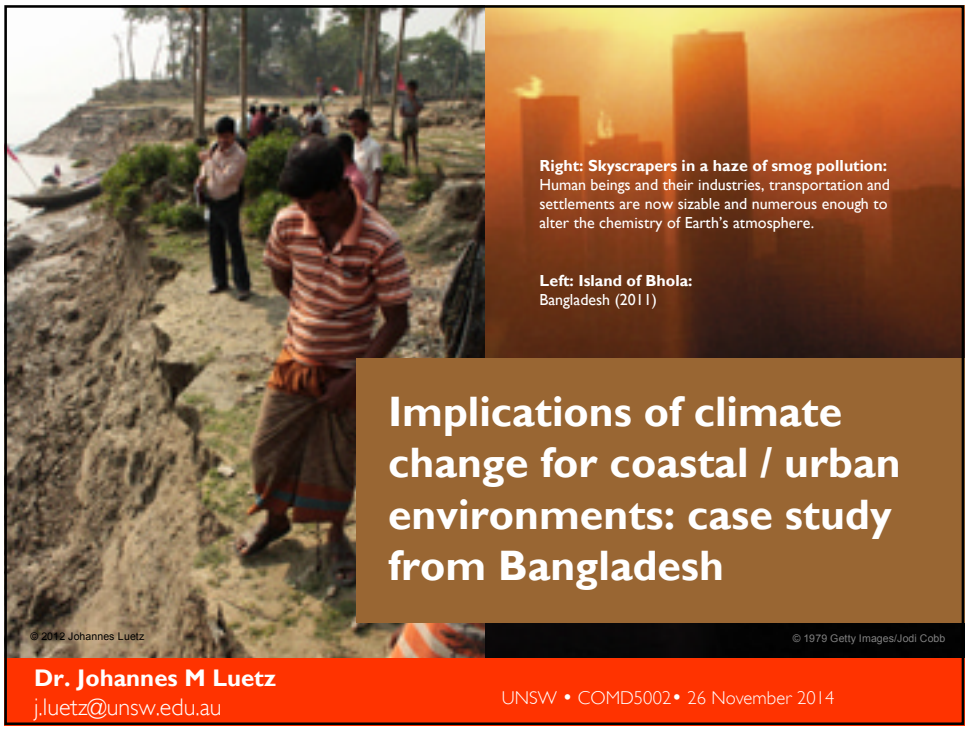
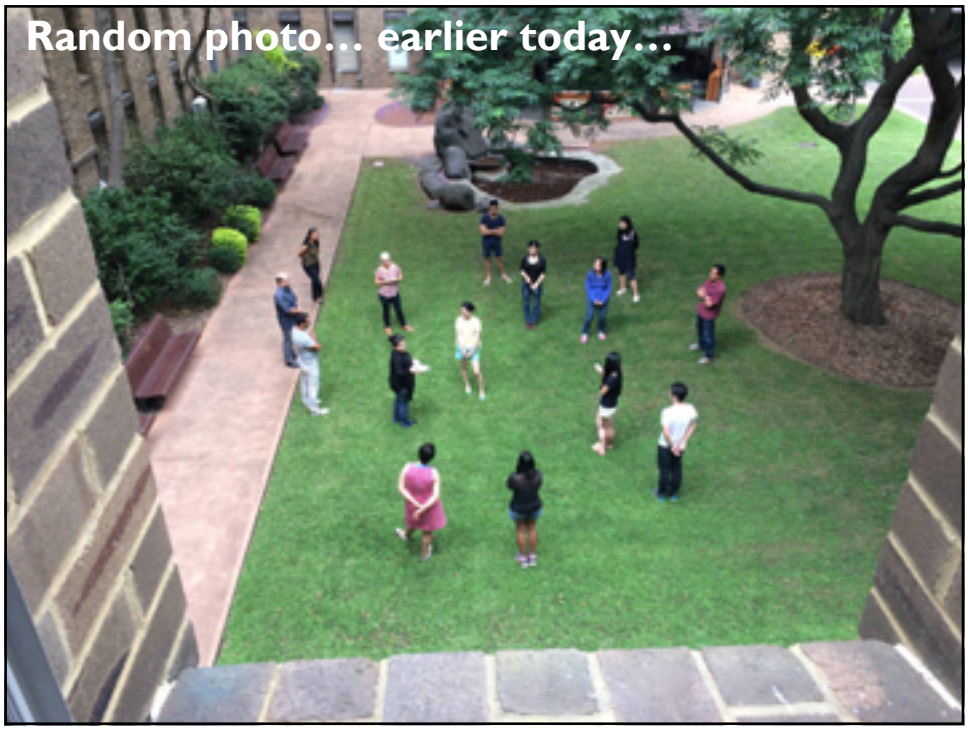

Right: Skyscrapers in a haze of smog pollution:
Human beings and their industries, transportation and settlements are now sizable and numerous enough to alter the chemistry of Earth's atmosphere.
Left: Island of Bhola:
Bangladesh (2011)
Implications of climate change for coastal / urban environments: case study from Bangladesh
© 2012 Johannes Luetz
© 1979 Getty Images/Jodi Cobb
Dr. Johannes M Luetz
j.luetz@unsw.edu.au
UNSW • COMD5002 • 26 November 2014


Random photo… earlier today…

Readings

- **McGranahan, G., Balk, D., & Anderson, B., (2007)** The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones. *Environment & Urbanization*, International Institute for Environment and Development (IIED). Vol 19. No 1. Pages 17-37.
- **Nicholls, Robert J. (2006)** Storm Surges in Coastal Areas. Chapter 3. Pages 79-108. (In: Arnold, Margaret; Robert S. Chen, Uwe Deichmann, Maxx Dilley, Arthur L. Lerner-Lam, Randolph E. Pullen, Zoe Trohanis (eds., 2006) Natural Disaster Hotspots: Case Studies. Disaster Risk Management Series No 6. The World Bank. 2006. Washington) Available 13 Jun 2014 @ http://siteresources.worldbank.org/INTDISMGMT/Resources/0821363328.pdf

Intro: Research Background

PLANET **PREPARE**

2008 World Vision Preparedness Study

P rotect Development
R esearch Priorities
E mpower Communities
P artner And Network
A dvocate Justice And Change
R einforce Disaster Defences
E ducate Children

http://wvasiapacific.org/downloads/publications/PlanetPrepare_LowRes.pdf

Intro (2008)

Matsungan, Papua New Guinea: Island Chief John Kela (right) standing on what he says was formerly dry ground. Photo: Johannes Luetz

Intro (2008)

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Intro (2010)

Intro (2008)

Group of environmental or climate change related forced migrants who abandoned their coastal village "because of rising sea levels."

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planetprepare@gmail.com

Intro (2008)

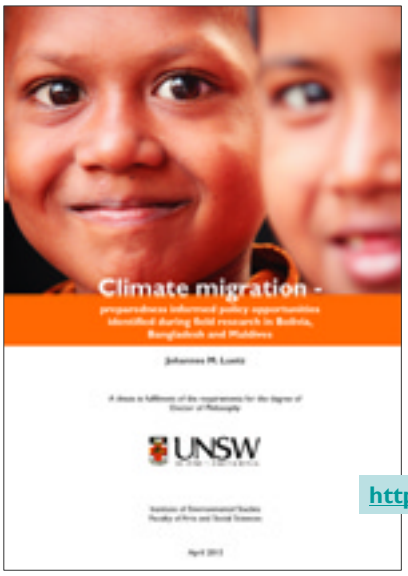
Albert Nai: "The bush is better than the beach!"
(At his new home with two of his grandchildren)

PhD Research

http://youtu.be/KBq2jNrD-yg OR
http://tv.unsw.edu.au/video/bolivia-leaving-the-land

j.luetz@unsw.edu.au //
planetprepare@gmail.com

PhD Thesis



I can promise you:

I have more materials than we have time... feel free to interrupt, ask questions, engage.

http://handle.unsw.edu.au/1959.4/52944

Lecture structure

1. **Climate science, selected impacts, longevity of CO_2 in the atmosphere**
2. Case Study: Bangladesh and the Low Elevation Coastal Zone (LECZ)
3. Discussion – Intersections

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Photo from Apollo 17, taken as the crew was traveling toward the moon.

This picture was taken in 1972, during the last Apollo mission. It is the last photo of Earth taken from halfway between Earth and the moon. It is unique because the entire circle of the earth is revealed; the photo helps us think about our planet in its entirety.

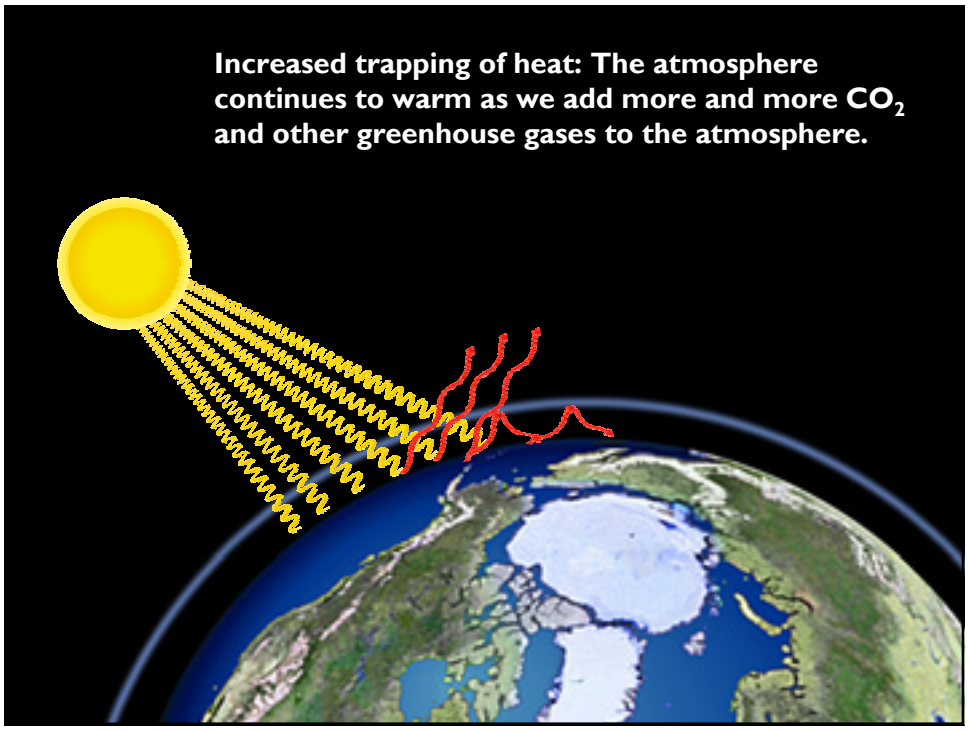
Source: NASA

Sun shining over Earth's horizon: This image shows the troposphere and the stratosphere, the two lowermost layers of the atmosphere.

If you look up on a nice day, the sky looks vast and limitless. From the angle in this photo, however, you can see that the lower layers of the atmosphere are actually quite thin. Carl Sagan (1934-1996), a renowned teacher and astronomer, said about the troposphere, "If you had a globe covered with a coat of varnish, the thickness of that varnish would be about the same as the thickness of the Earth's atmosphere compared to the Earth itself." This view makes it easier to understand that the atmosphere is vulnerable to the vast amounts of pollution we emit.

Source: NASA


http://ipcc.ch/publications_and_data/publications_and_data_reports.shtml
Smokestacks spewing greenhouse gases, including water vapor: Many people assume that Earth is too vast to harm through human activity, or that the planet can recover quickly from environmental harm. But multiple lines of evidence point to carbon pollution as the cause of recent climate warming, and indicate that warming has already had an impact on physical and biological systems around the world.
© Getty Images/Steve Cole

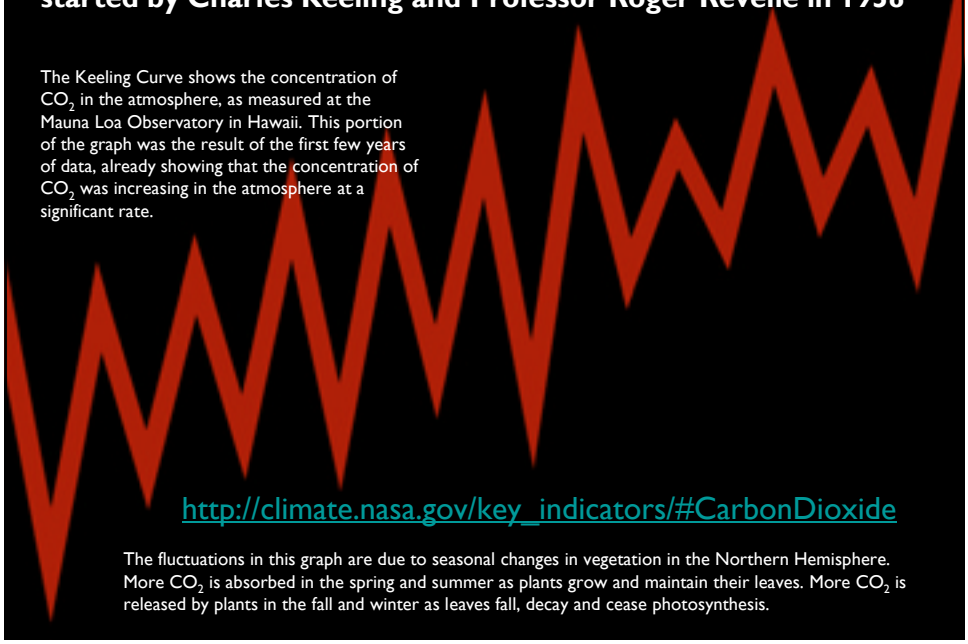

Increased trapping of heat: The atmosphere continues to warm as we add more and more CO_2 and other greenhouse gases to the atmosphere.


© European Pressphoto Agency/Everett Kennedy Brown
Smoke billowing up from a factory in the industrial port area Chiba Prefecture, Japan
The Intergovernmental Panel on Climate Change (IPCC) and other scientific organizations around the world have concluded that it is extremely unlikely that observed changes in Earth's temperature have been caused by natural variability.


Where Do Greenhouse Gases Come From?
THAWING PERMAFROST
AIR TRANSPORT
COAL MINING
COAL PLANTS
OIL PRODUCTION
CROP BURNING
INDUSTRIAL PROCESSES
FERTILISATION
FOREST BURNING
INDUSTRIAL AGRICULTURE
LAND TRANSPORTATION
LANDFILLS

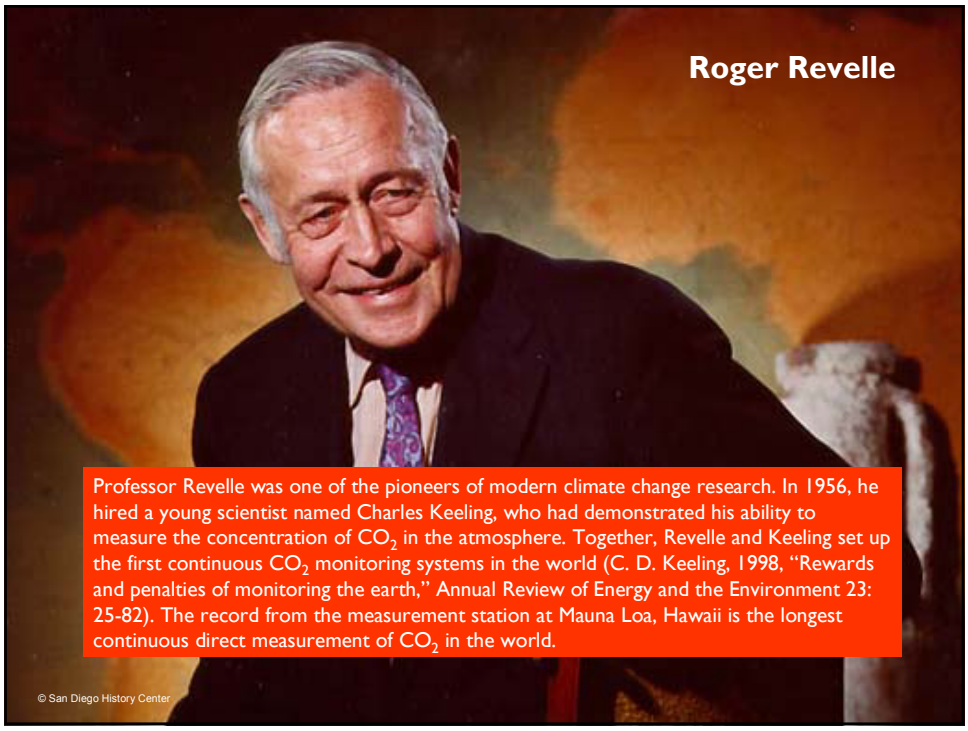
Small portion of the Keeling Curve, produced by a study started by Charles Keeling and Professor Roger Revelle in 1958

The Keeling Curve shows the concentration of CO_2 in the atmosphere, as measured at the Mauna Loa Observatory in Hawaii. This portion of the graph was the result of the first few years of data, already showing that the concentration of CO_2 was increasing in the atmosphere at a significant rate.

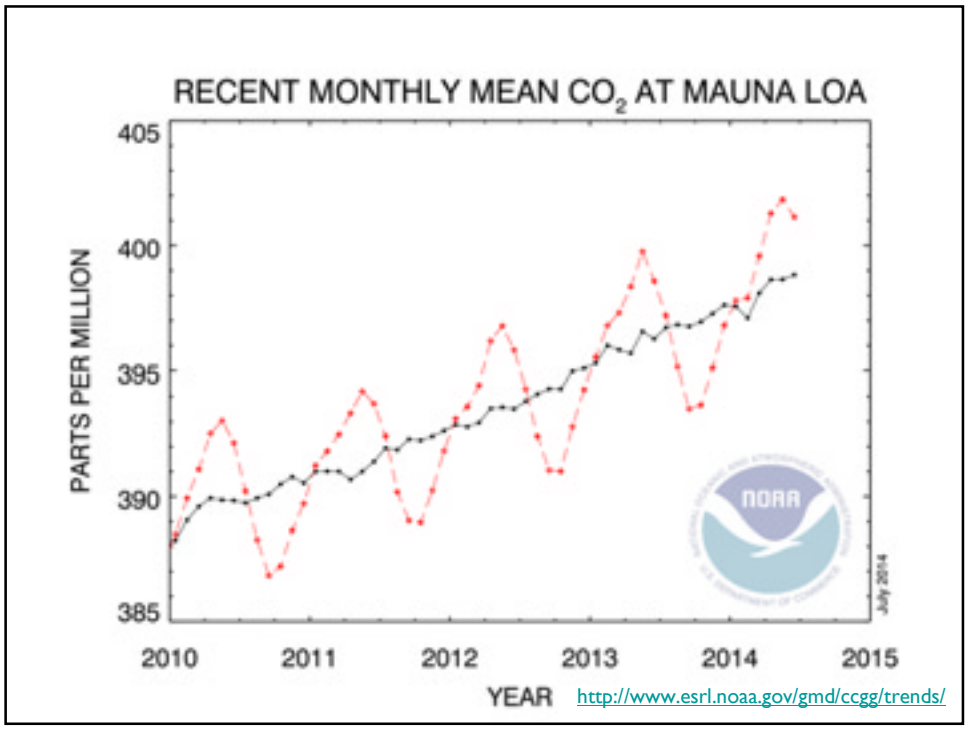


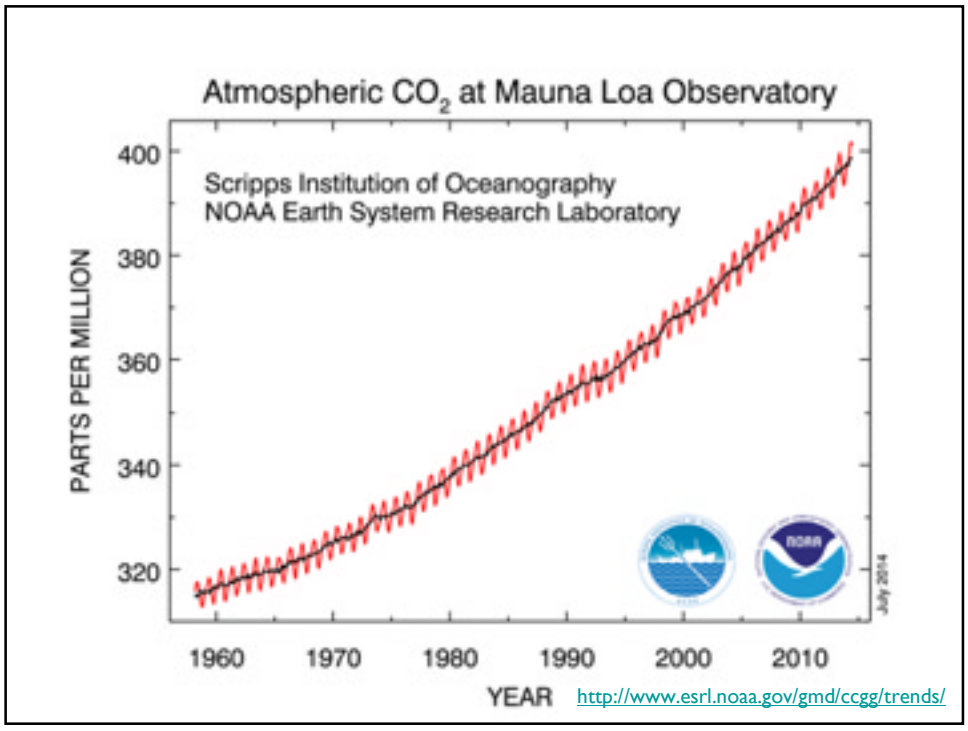
http://climate.nasa.gov/key_indicators/#CarbonDioxide

The fluctuations in this graph are due to seasonal changes in vegetation in the Northern Hemisphere. More CO_2 is absorbed in the spring and summer as plants grow and maintain their leaves. More CO_2 is released by plants in the fall and winter as leaves fall, decay and cease photosynthesis.



Professor Revelle was one of the pioneers of modern climate change research. In 1956, he hired a young scientist named Charles Keeling, who had demonstrated his ability to measure the concentration of CO_2 in the atmosphere. Together, Revelle and Keeling set up the first continuous CO_2 monitoring systems in the world (C. D. Keeling, 1998, "Rewards and penalties of monitoring the earth," Annual Review of Energy and the Environment 23: 25-82). The record from the measurement station at Mauna Loa, Hawaii is the longest continuous direct measurement of CO_2 in the world.


RECENT MONTHLY MEAN CO_2 AT MAUNA LOA
PARTS PER MILLION
405
400
395
390
385
2010
2011
2012
2013
2014
2015
YEAR
http://www.esrl.noaa.gov/gmd/ccgg/trends/


Atmospheric CO_2 at Mauna Loa Observatory
Scripps Institution of Oceanography
NOAA Earth System Research Laboratory
PARTS PER MILLION
400
380
360
340
320
1960
1970
1980
1990
2000
2010
YEAR
http://www.esrl.noaa.gov/gmd/ccgg/trends/

Climate Change

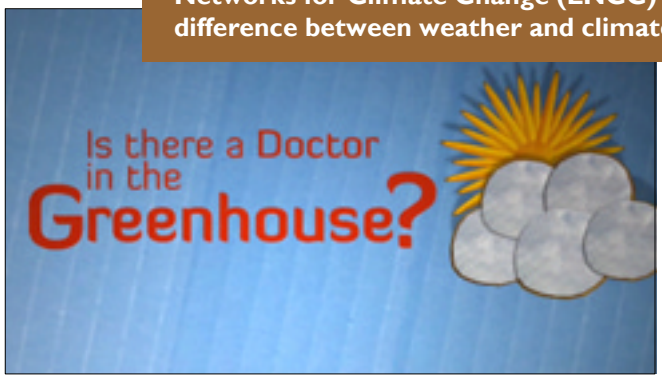
Climate Change:

"Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the United Nations Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes. See also Climate variability; Detection and Attribution."

—Intergovernmental Panel on Climate Change, 2007: Fourth Assessment Report; Synthesis Report, p. 78.

Weather ≠ Climate

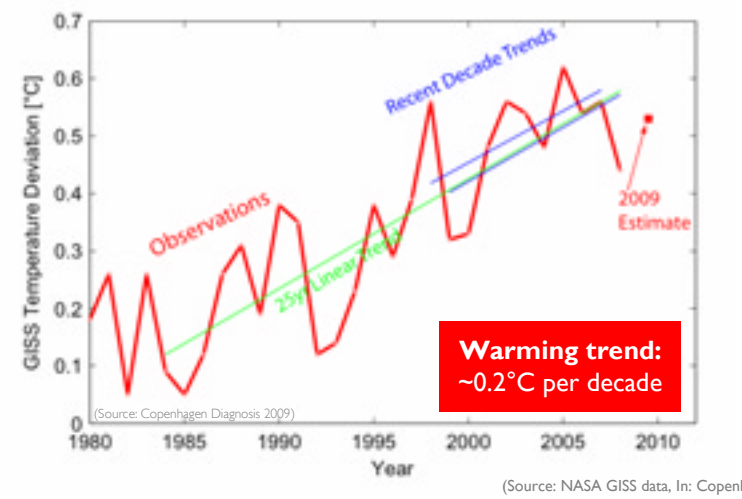
UNSW-produced video scripted for Leadership Networks for Climate Change (LNCC) highlights difference between weather and climate



http://tv.unsw.edu.au/04E68CE0-08D5-11E1-832C0050568336DC

Decadal Scale Warming

Global temperature change 1980-2009



Warming trend:
~0.2°C per decade

(Source: NASA GISS data, In: Copenhagen Diagnosis 2009)

Stopping Distance

UNSW-produced video scripted for Leadership Networks for Climate Change (LNCC) explains that climate change cannot be stopped overnight; early action is therefore urgent.

http://tv.unsw.edu.au/video/hit-the-brakes

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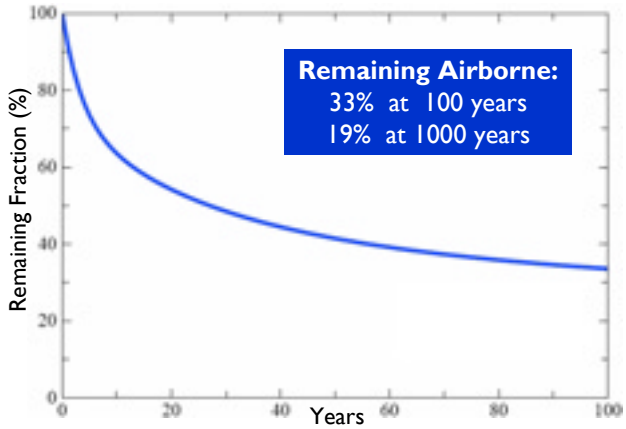
planetprepare@gmail.com

Stopping distance

Longevity of CO_2

Slow decay of fossil fuel CO_2 emissions



The fraction of CO_2 remaining in the air, after emission by fossil fuel burning, declines rapidly at first, but 1/3 remains in the air after a century and 1/5 after a millennium.

(Hansen, J, 2007, *Atmos. Chem. Phys.* **7**, 2287-2312).

Longevity of CO_2

Example calculation:
Canada trip (2010)
Boeing 767-300

1t Jet Fuel Burned
= 3.157t CO_2 Emissions

(Photo: Adrian Pingstone)

Longevity of CO_2

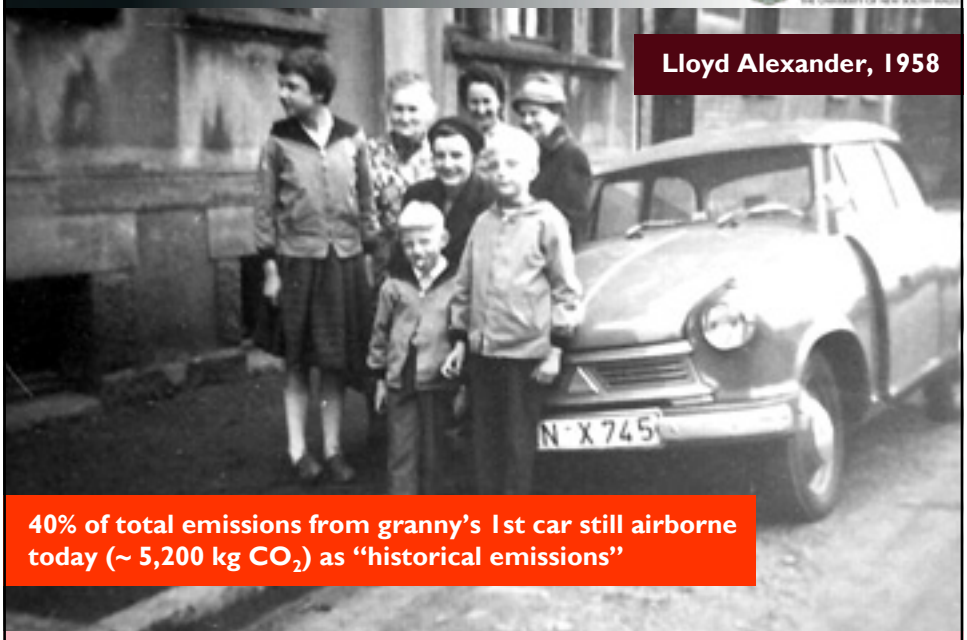
Top of Atmosphere as seen from space at 335km altitude
(Photo: NASA Earth Observatory)

Per-capita emissions for
Canada trip in 2010: 1.4t CO_2
(2110: 460kg, 3010: 260kg)

* 2.7 (Radiative Forcing Index, RFI) = ~ 3.8t CO_2

Historical Emissions

Historical Emissions



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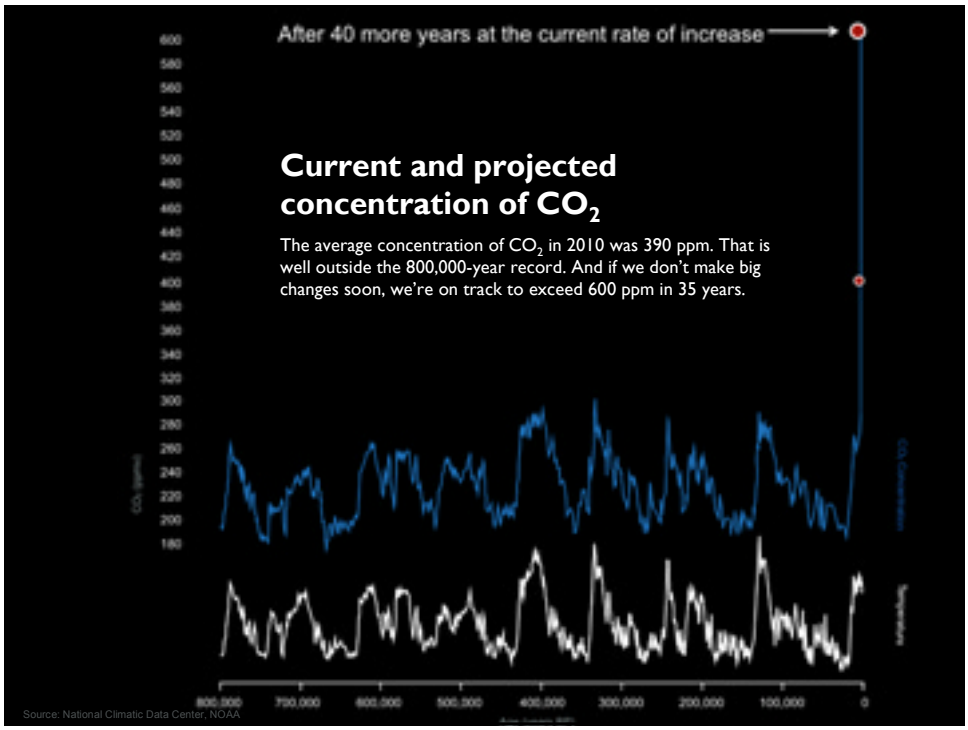
Historical Emissions

Cumulative CO_2 Emissions 1850-2006

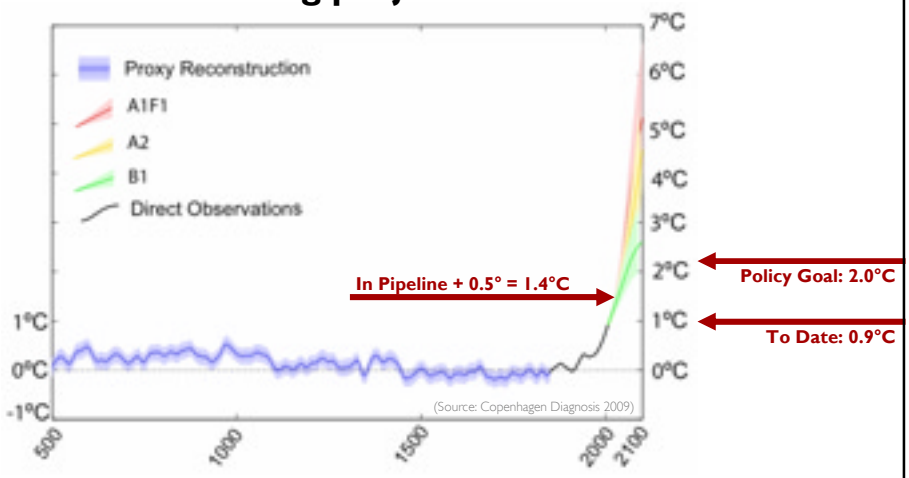
Rank	Country	Mt CO_2e	% of World Total
1	United States of America	333,747.8	29.00%
2	European Union (27)	305,750.1	26.57%
3	China	99,204.2	8.62%
4	Russian Federation	93,081.6	8.09%
5	Germany	[80,377.0]	[6.99%]
6	United Kingdom	[68,235.8]	[5.93%]
7	Japan	44,535.2	3.87%
8	France	[32,278.6]	[2.81%]
9	India	27,433.6	2.38%
10	Canada	25,133.1	2.18%
Top 10	**Cumulative Total**	**928,886**	**80.71%**

CAIT, World Resources Institute
CAIT GHG data are derived from CDIAC, EDGAR, EIA, EPA, Houghton, IEA, and WB.

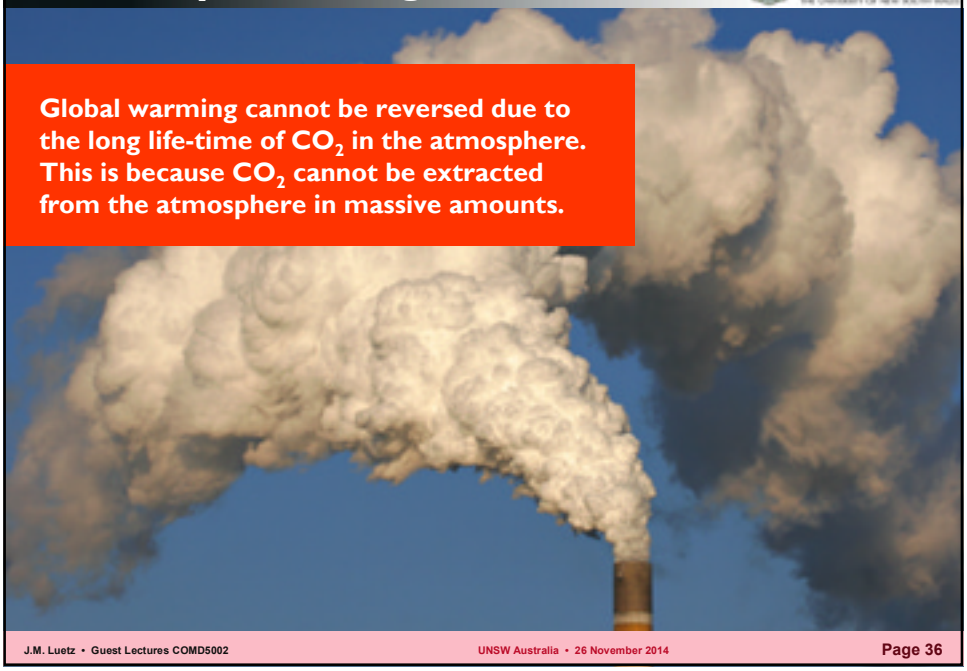


Climate System Inertia

Reconstructed, observed and future warming projections



One-Way Warming



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The energy trapped by man-made global warming pollution is now "…equivalent to exploding

400,000

Hiroshima atomic bombs per day 365 days per year."

James Hansen
Former Director, NASA Goddard Institute for Space Studies

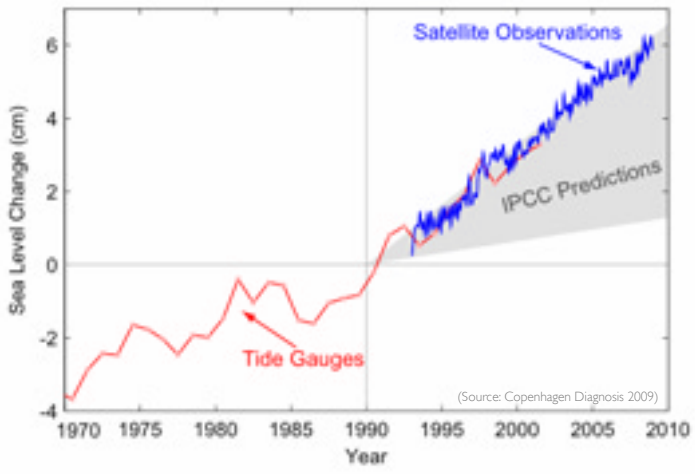
Sea Level Rise

UNSW

Sea Level Rise

Past Sea Level Rise

Global sea level change 1970-2010



SLR by 2100: 1-2m

Last 15 years: 5cm SLR ~ 80% faster than IPCC

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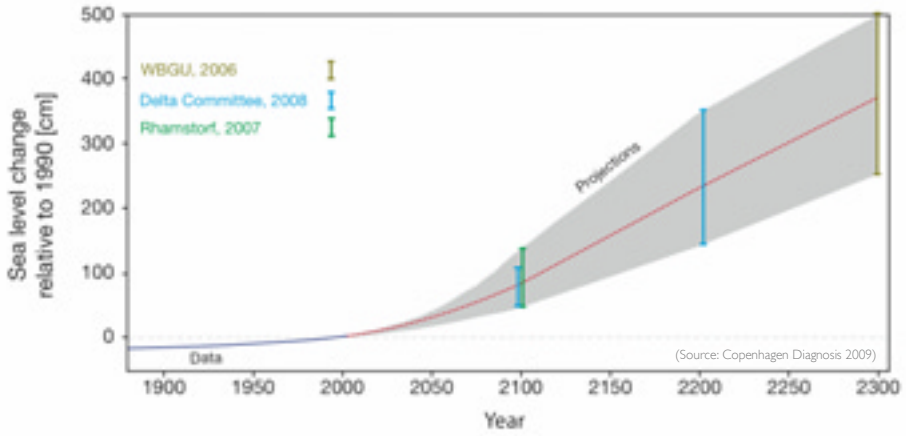
planetprepare@gmail.com

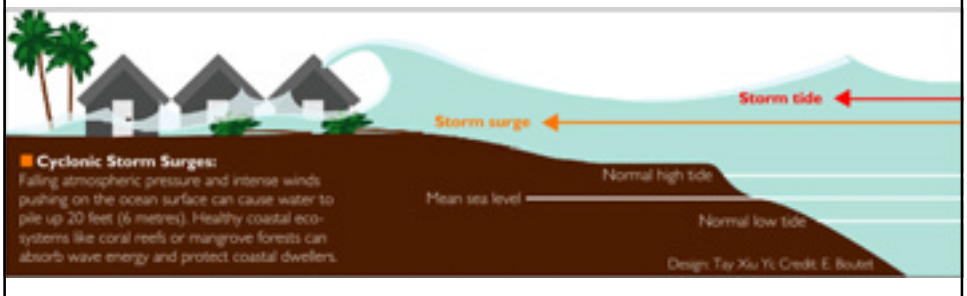
Projected Sea Level Rise

SLR by 2300: up to 5m

Future sea-level projections

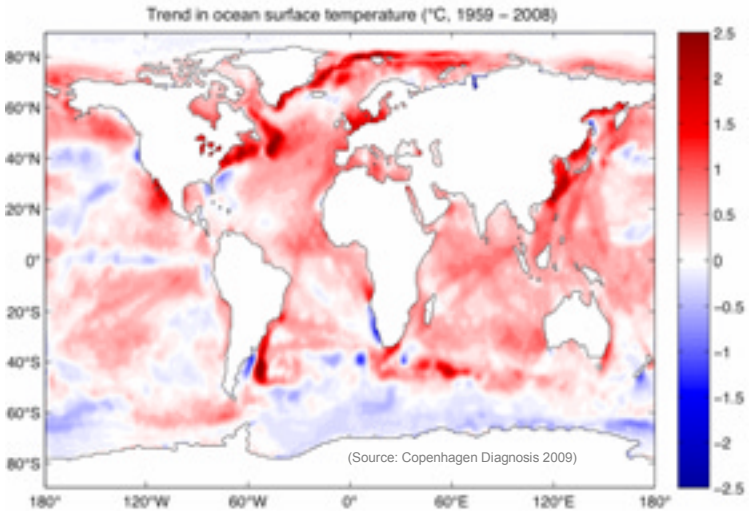


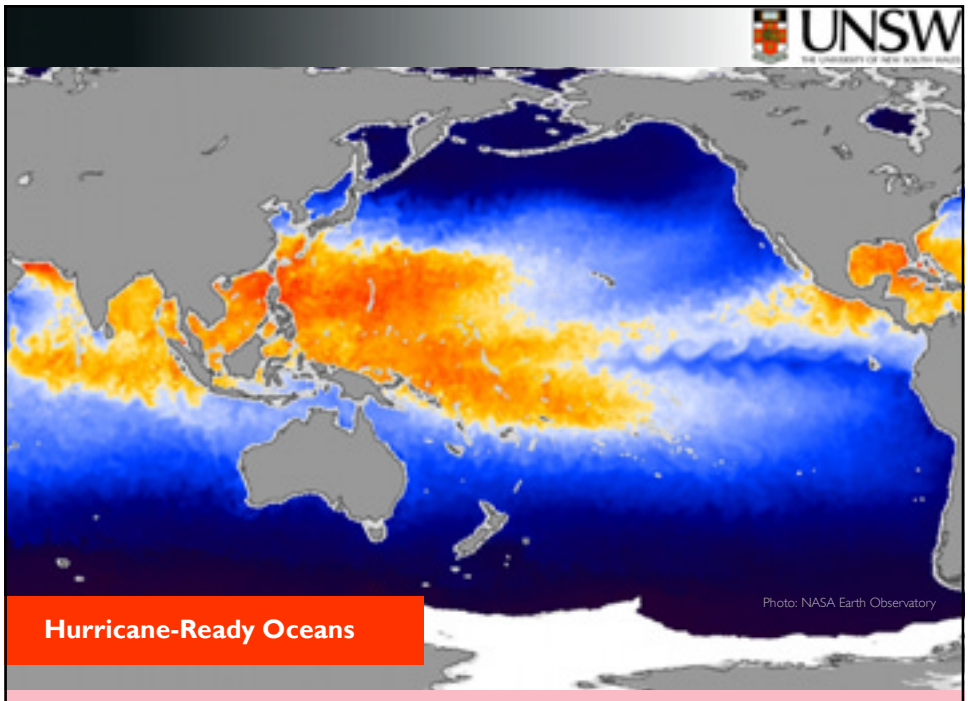
Storm surges

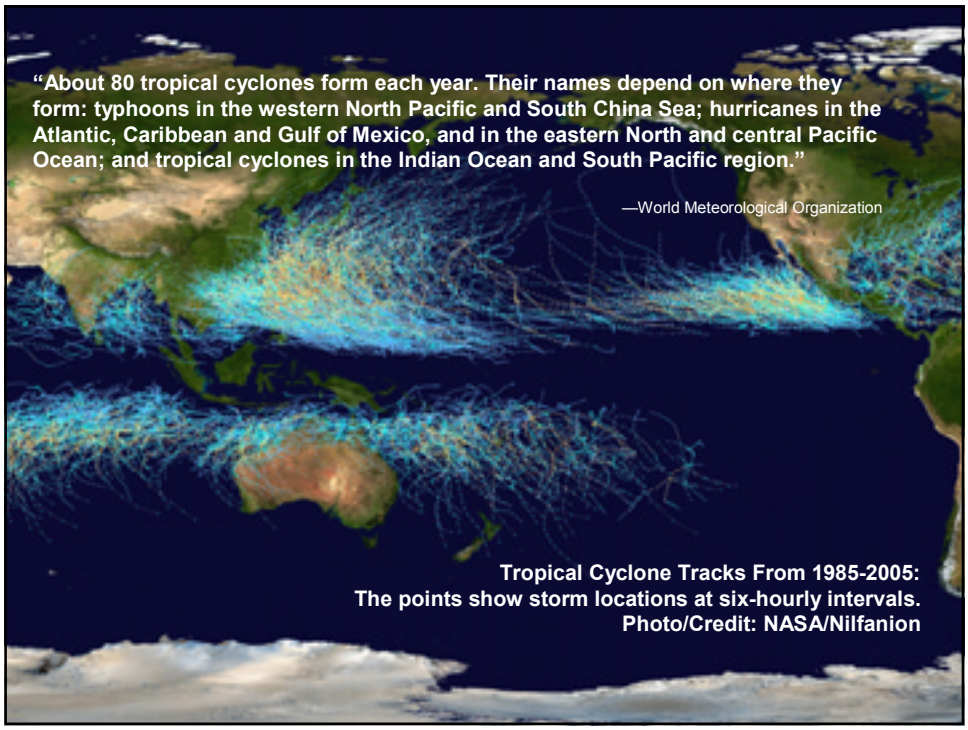


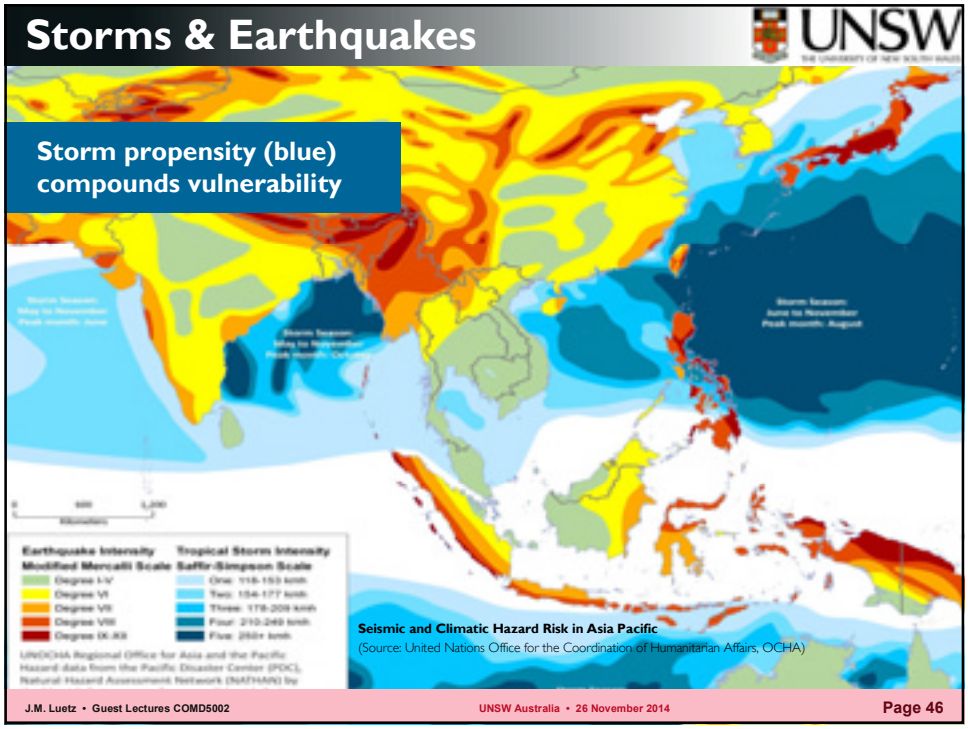
Warming Oceans

Ocean heat uptake 50% higher than previous calculations






"About 80 tropical cyclones form each year. Their names depend on where they form: typhoons in the western North Pacific and South China Sea; hurricanes in the Atlantic, Caribbean and Gulf of Mexico, and in the eastern North and central Pacific Ocean; and tropical cyclones in the Indian Ocean and South Pacific region."
—World Meteorological Organization
Tropical Cyclone Tracks From 1985-2005:
The points show storm locations at six-hourly intervals.
Photo/Credit: NASA/Nilfanion


Storms & Earthquakes
UNSW
Storm propensity (blue) compounds vulnerability
Seismic and Climatic Hazard Risk in Asia Pacific
(Source: United Nations Office for the Coordination of Humanitarian Affairs, OCHA)
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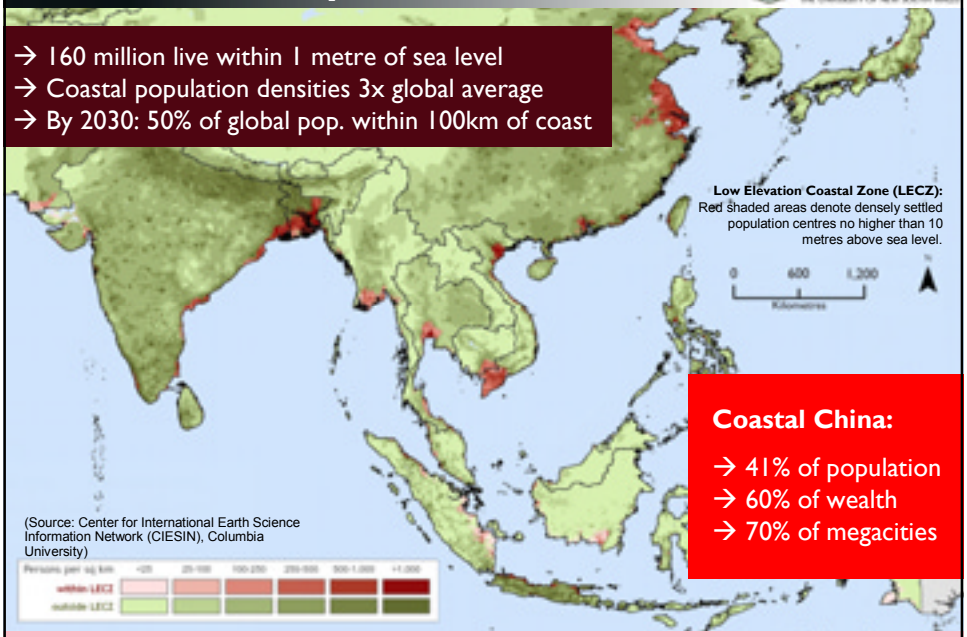
UNSW Australia • 26 November 2014
Page 46

Lecture structure

1. Climate science, selected impacts, longevity of CO_2 in the atmosphere
2. **Case Study: Bangladesh and the Low Elevation Coastal Zone (LECZ)**
3. Discussion – Intersections

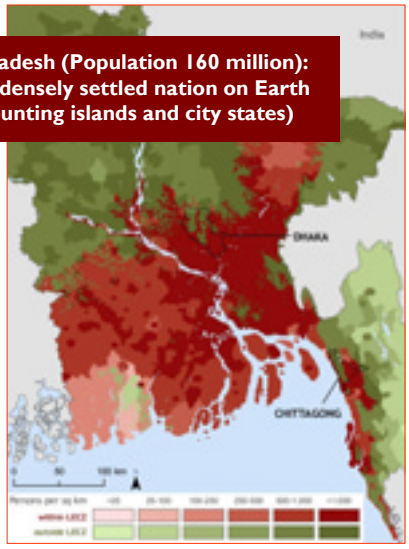
Coastal Development

→ 160 million live within 1 metre of sea level
→ Coastal population densities 3x global average
→ By 2030: 50% of global pop. within 100km of coast



Coastal China:
→ 41% of population
→ 60% of wealth
→ 70% of megacities

Coastal Dwellers



Bangladesh (Population 160 million): most densely settled nation on Earth (discounting islands and city states)

Low Elevation Coastal Zone (LECZ): Dark red shaded areas denote densely settled population centres no higher than 10 metres above sea level.

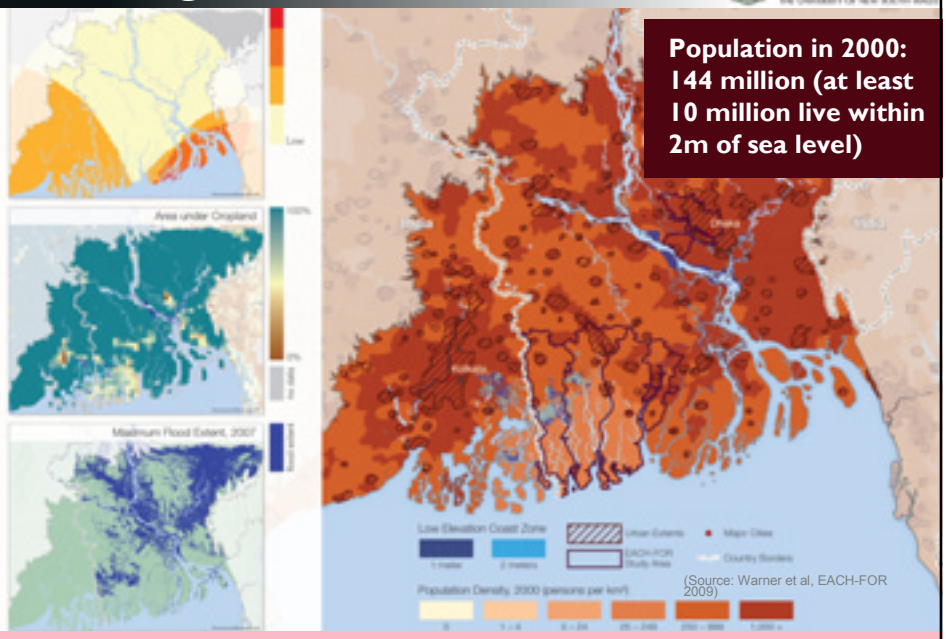
Graphic: Centre for International Earth Science Information Network (CIESIN), Columbia University

Deltaic regions

Figure 3.3: Selected hot spots in the world indicating the "[r]elative vulnerability of coastal deltas as shown by the indicative population potentially displaced by current sea-level trends to 2050 (Extreme = >1 million; High = 1 million to 50,000; Medium = 50,000 to 5,000; following Ericson et al., 2006)." (Nicholls et al 2007, p. 327)

Source: Nicholls et al 2007, p. 327; cf. slide 13, below.
Map quoted from http://www.ipcc.ch/graphics/ar4-wg2/jpg/fig-6-6.jpg (last accessed 10 Oct 2013); http://www.ipcc.ch/pdf/presentations/briefing-geneva-2007-05/climate-changes-impact-coastal.pdf

The Ganges Delta



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Page 52

Intro (2008)

Mohammad Shamsuddoha: "Bhola – Bangladesh's biggest island – is eroding. From a size of 6,400km^2 in the 1960s, Bhola is now only half its original size."

(General Secretary Equity & Justice Working Group)

Intro (2008)

Abdul Mannan: "The place where I was born lies 5 kilometres out in the sea. I've already moved my home and family four times." Community elder Abdul Mannan (centre) points out signs of erosion.

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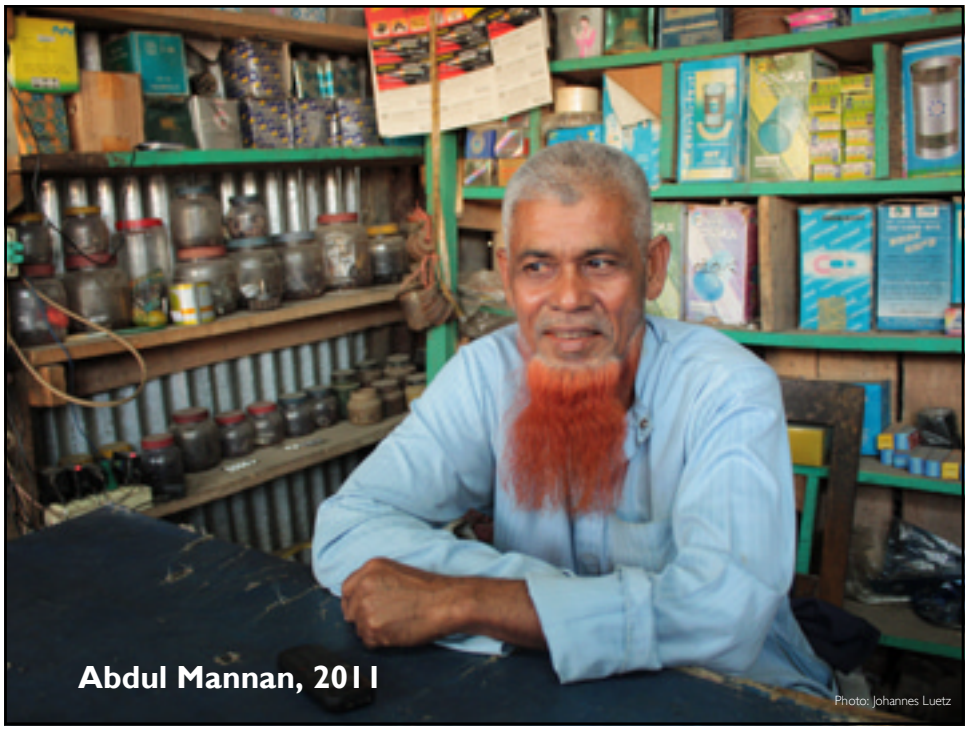
Intro (2008)

Abdul Mannan: "People are constantly moving back. This family left last week. Only the toilet pit is left."

Bhola Island, Bangladesh

Tajumuddin, Bhola, Bangladesh: (Photo: Johannes Luetz)



Abdul Mannan, 2011

Photo: Johannes Luetz

Bridge to "nowhere" (2011)

Show field research video footage:

File name "Bangladesh 1":
55:00 (1min) – Bridge to "nowhere"

(Photo: Johannes Luetz)

Photo: Johannes Luetz

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planetprepare@gmail.com

Google

Bhola (2011)

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planetprepare@gmail.com

Dhaka (2011)

Show field research video footage:

File name "Bangladesh 5":
46:00 (1min) – Dhaka tenants, settlements
59:00 (30sec) – Bhola-CEGIS (6km@61min)
00:00 (3min) – INDIA 1: erosion/ accretion

Md. Faruk, migrant from Bhola Island interviewed at Dhaka slum

(Photo: Johannes Luetz)

Lecture structure

1. Climate science, selected impacts, longevity of CO_2 in the atmosphere
2. Case Study: Bangladesh and the Low Elevation Coastal Zone (LECZ)
3. **Discussion – Intersections**

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Discussion – Intersections

- Why is climate change fundamentally a human rights issue?
- Which rights are in jeopardy?
- Whose rights need protecting?
- Who is responsible? (past / future)
- What are pertinent challenges?

Good News

Global warming can be completely stopped. The temperature at which global warming will finally stop depends mainly on the total amount of CO_2 released into the atmosphere since industrialisation.

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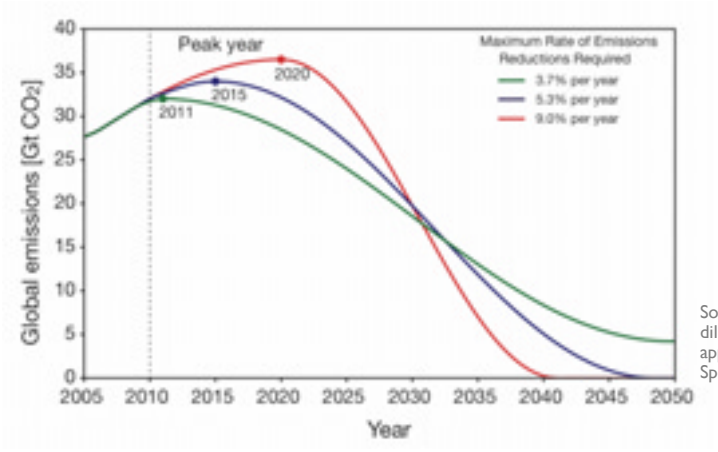
The Challenge

Global decarbonisation

Exemplary emissions pathways which remain within 750Gt and leave a 67% chance of limiting global warming to 2°C



Solving the climate dilemma: The budget approach; WBGU Special Report 2009

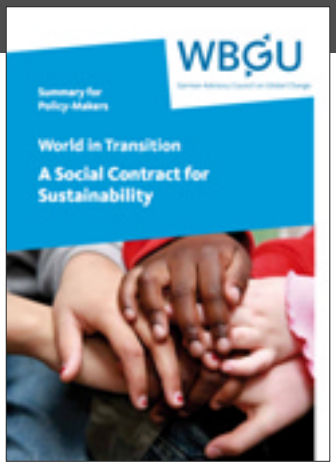
"Great Transformation"

Mitigation

World in Transition: Social Contract for Sustainability

Flagship Report 2011

http://www.wbgu.de/en/home



Op-ed

http://www.theguardian.com/commentisfree/2014/oct/14/island-nations-shouldnt-be-left-to-drown-from-climate-change

Policy recommendations

→ PREPAREDNESS **MATTERS**

- Create and safeguard livelihoods *before* these are compromised beyond reasonable hopes of recovery
- Plan macro-managed migrations wherever there is reasonable doubt that communities can persist in perpetuity in situ, and importantly, *before* environmental or climatic changes overwhelm communal coping capacities, trigger ad hoc evacuations, impede benign migration scenarios, or create unnecessary duress for migrants and/or hosts.
- Prepare rural migrants for urban realities *before* these are encountered
- Conserve natural and forest resources *before* they irrecoverably disappear (along with their diverse protective ecosystem services)
- Equip migrants to know their rights *before* these are transgressed
- Appraise financial and social costs of migration *before* these are incurred
- Protect host and guest communities from unfamiliar diseases *before* these are contracted
- Foster ethnocultural equity *before* transmigration forecloses options for harmonious integration and multicultural or multicommunal coexistence

Policy recommendations (cont.)

- Invest in free and compulsory education for all *before* options are foreclosed and the hopes of a whole generation eclipsed (along with promising options for in situ and ex situ adaptation to climate change)
- Coordinate migration and mainstream services *before* slum conditions deteriorate beyond all reasonable prospects for human displacement with dignity, and importantly, before conditions degenerate beyond all hopes for remediation
- Meet the aspirational ambitions of migrants through upscaling of services in pre-selected future-proof locations *before* urbanisation commences, continues or even accelerates into environmentally fragile or unsustainable locations
- Implement awareness campaigns and community integration initiatives *before* unnecessary conflict and social problems evolve
- Establish a stronger state presence and more accountable government institutions in urban slums *before* parallel structures develop or expand in "state-absent" areas (eg, mastaans or "musclemen" controlling local level availability of rental space, land, amenities, etc and exacting exorbitant fees for the same); guarantee rights fulfilment through law enforcement with consequences
- Anticipate labour market requirements and create jobs *before* labour supplies supersede labour demands

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Q&A

Thank You!

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