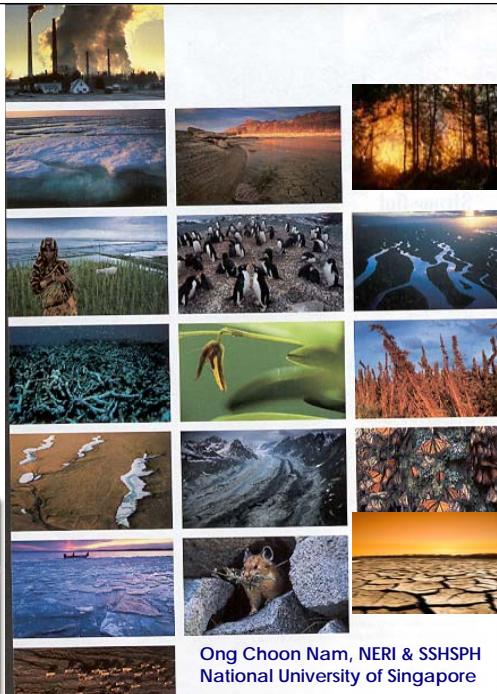


Climate Change & Health

2014 GEK1900

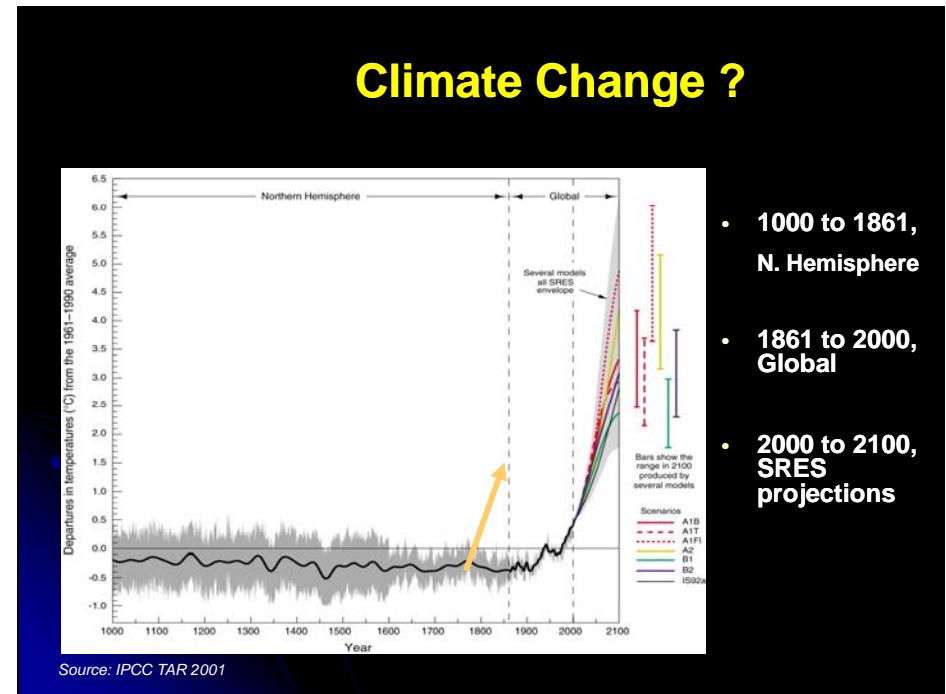
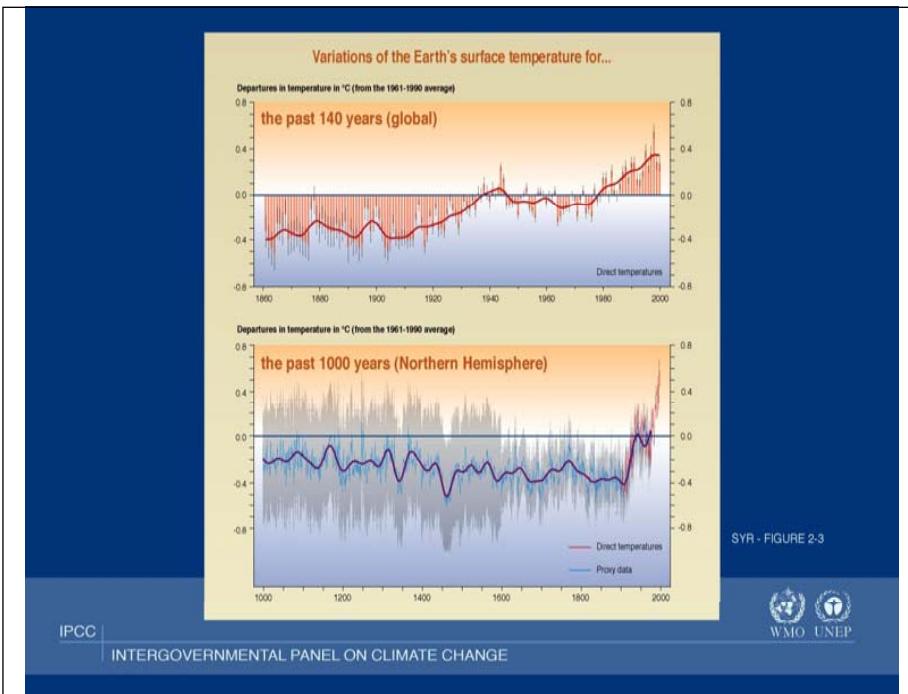


Ong Choon Nam, NERI & SSHSPH
National University of Singapore

Quick Overview

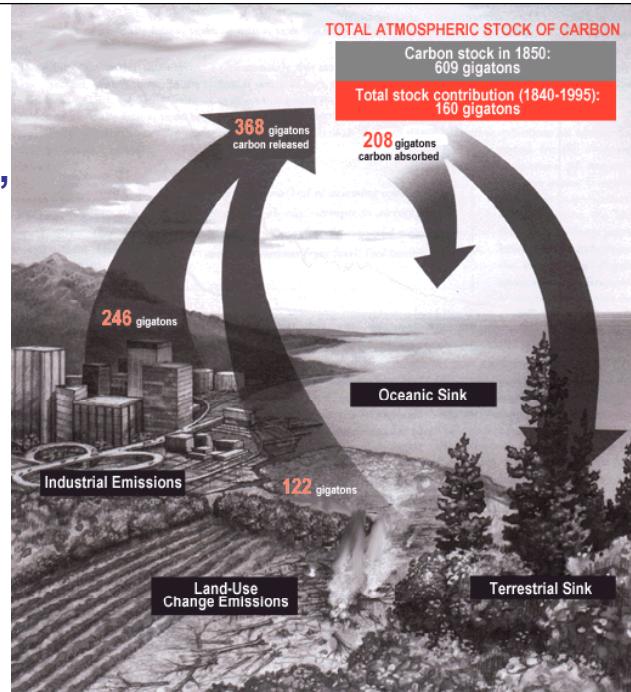


- Definitions
- The Signs and Science of Climate Change
- Impacts of Climate Change
- Public Health Challenge
- South East Asia Rain Forest and Haze

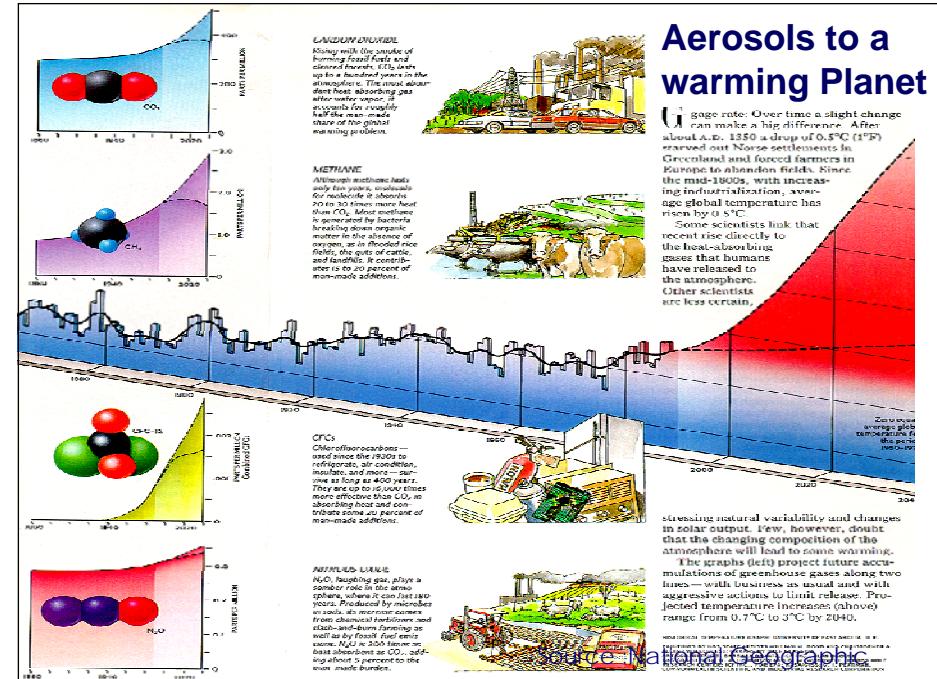


Changes in carbon stocks, 1850-1995

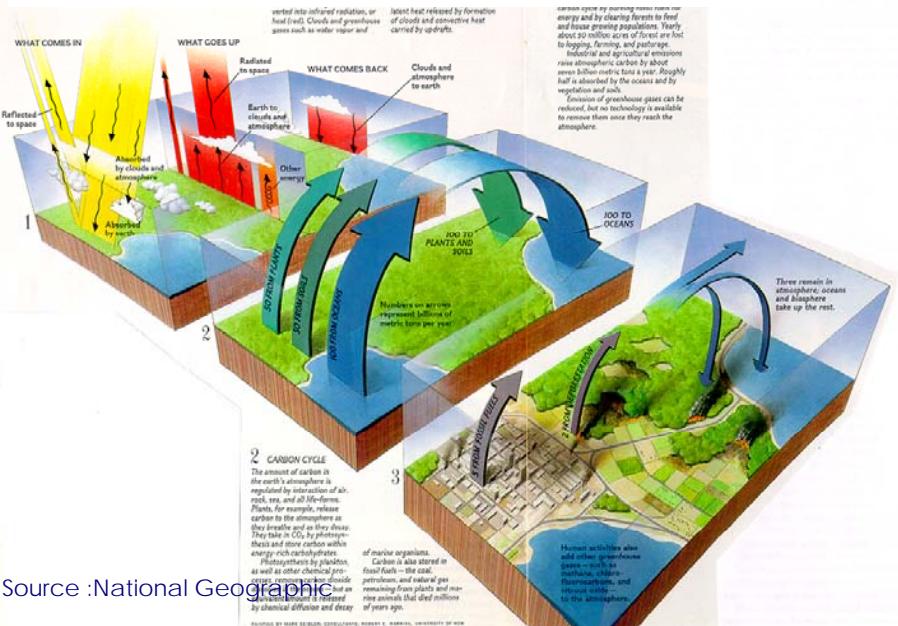
The sum of all carbon releases less carbon absorbed during 1850-1995
(WRI, 1998)



Aerosols to a warming Planet



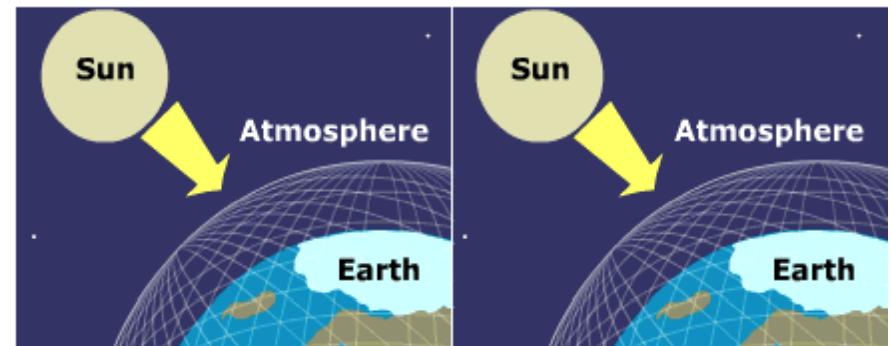
The Green House Effect



Source :National Geographic

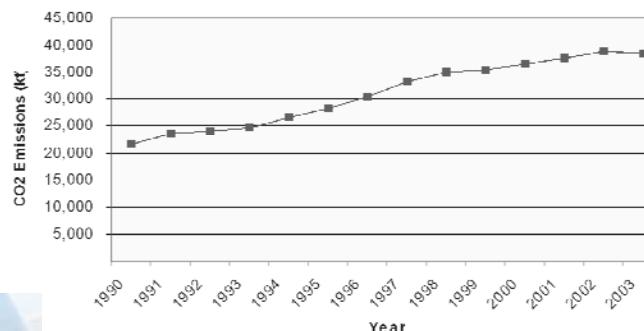
The Greenhouse Effect

Some of the infrared is absorbed and reemitted by the greenhouse gases



Carbon Dioxide Levels (absolute)

Singapore's CO₂ Emissions



Grew 77% between 1990 – 2003
Projected to grow 34% by 2012 over 2003 levels

Source: NEA, Singapore

SCIENCE'S COMPASS



REVIEW: ATMOSPHERE

Aerosols, Climate, and the Hydrological Cycle

V. Ramanathan,^{1*} P. J. Crutzen,^{1,2} J. T. Kiehl,³ D. Rosenfeld⁴

Human activities are releasing tiny particles (aerosols) into the atmosphere. These human-made aerosols enhance scattering and absorption of solar radiation. They also produce brighter clouds that are less efficient at releasing precipitation. These in turn lead to large reductions in the amount of solar heating of the atmosphere, changes in the atmospheric temperature structure, suppression of rainfall, and less efficient removal of pollutants. These aerosol effects can lead to a weaker hydrological cycle, which connects directly to availability and quality of fresh water, a major environmental issue of the 21st century.

One of the most visible impacts of human activities is the brownish haze [see Web fig. 1 for anthropogenic haze just south of Mt. Everest (*I*) that pervades many industrial regions, as well as the rural areas of the tropics and the subtropics that are subjected to heavy biomass burning. Long-range atmospheric transport transforms this haze into a regional-scale aerosol layer (*2, 3*). The optical depth of this haze is about 0.12 (\pm 0.04) [Web table 1 (*I*), Fig. 2B, and (5, 7)]. Anthropogenic sources contribute almost as much as natural sources to the global AOD (Fig. 2, B and C) (2, 6, 7). Anthropogenic aerosols are typically in the submicrometer- to micrometer-size range and are composed of numerous organic and inorganic species (2, 3), falling under four broad categories [Web table 1 (*I*)]: sulfates, carbon

budget? Qualitatively, looking down on Earth from space, anthropogenic activities are making the planet more absorptive and, as a result, darker with time in the IR and brighter in the visible wavelengths. Satellite radiation budget measurements for 1985 to 1990 indicate (9) that the planet absorbed 238 (\pm 2) W m⁻² solar radiation and emitted outgoing long-wave radiation of 235 (\pm 2) W m⁻². The difference of 3 W m⁻² may be real or an artifact due to measurement errors or a combination of both. If we were to instantaneously reduce (as a hypothetical experiment in thought only) the GHGs and aerosols to the preindustrial values, the outgoing long-wave radiation would increase to 237.4 W m⁻² (235 + 2.4), and the absorbed solar radiation would increase to 238.5 to 240.5 W m⁻² (*2, 10*).

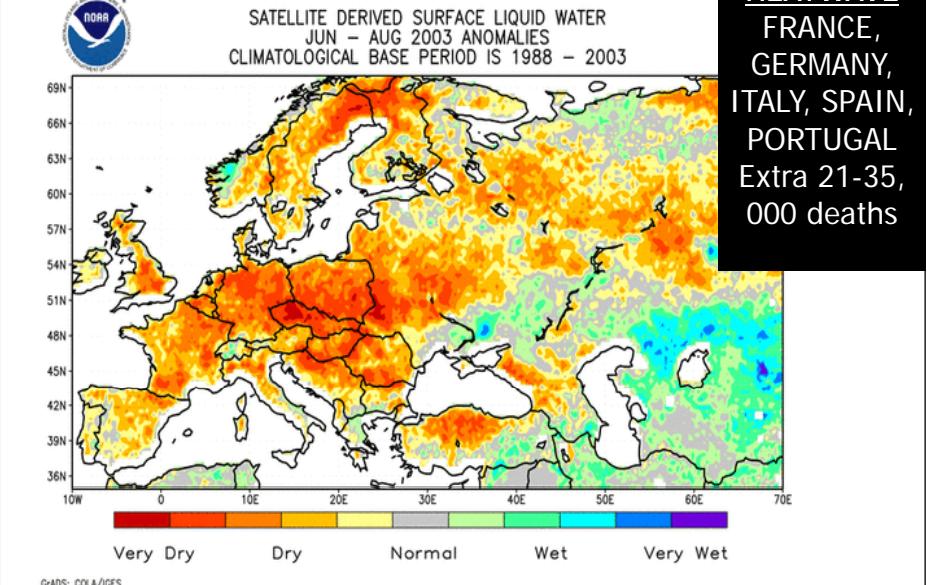
Science 2001, **397**, 241

Aerosols also absorb solar radiation, and this solar absorption within the atmosphere,

Deforestation



SATELLITE DERIVED SURFACE LIQUID WATER
JUN – AUG 2003 ANOMALIES
CLIMATOLOGICAL BASE PERIOD IS 1988 – 2003



Consequences... Direct..

Increase in skin cancer & cataracts

- In Australia and US, melanoma is increasing faster than any other cancers
- lifetime probability of developing melanoma is 1 in 75 (compared to 1:100,000)
- 100 new cases of melanoma diagnosed per day



SECTION Sea level rising

Sea level change

Sea levels have risen about 8 inches since 1900. At just over 2 feet of rise, the world's coastlines would be inundated.

Key data: Mean sea level (global average) ≈ 2 feet

Global sea level has risen about 8 inches since 1900. This is projected to rise another 1.5 feet by 2100.

Many low-lying islands are at further risk of flooding over 4 inches.

Sea level rise projections for the next century:

Year	Sea Level Rise (inches)
2000	0
2020	0.5
2040	1.0
2060	1.5
2080	2.0
2100	2.5

SECTION Ice melting

Arctic sea ice

An image-based analysis shows potential ice cover in 1979 and the ice extent over the Arctic Ocean from edge to edge. Since then the area of coverage has decreased by 9 percent per decade.

SECTION Weather turning wild?

Projected weather and climate changes

Higher global temperatures could fuel more extreme weather. The maps on the right are computer-model projections of the chance that various weather events will be more frequent as warmer world.

Maximum temperatures and more

Higher minimum temperatures and fewer

Higher nighttime temperatures

More droughts

More intense rainfall

More intense hurricanes

SECTION Marine life dying

Coral bleaching

The map shows coral reefs around the world. This map based on satellite data from 2002. The warmest winter temperatures and cold summer extremes are shown in red.

Reef bleaching

A satellite image shows bleaching along the Great Barrier Reef. The reef's length is 1,200 miles long. It is the world's largest reef system, made of coral and 1,500 species of fish—the ocean's equivalent of a tropical forest.

Water temperature anomalies around the world

Reef bleaching threshold

Projected average

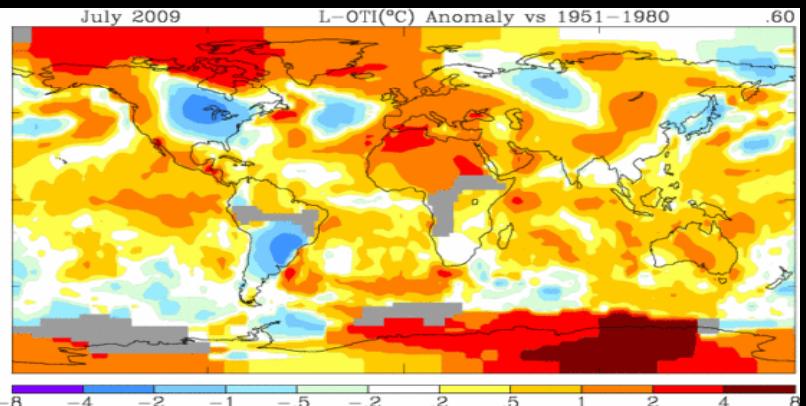
SECTION Coral reefs

Projected average

Reef bleaching threshold

2002 Global reef bleaching

Source :National Geographic



NASA -Wednesday, AUGUST 12, 2009. Second Warmest July on Record Globally.

July 2009 was the second warmest July globally, since records were kept going back well over a hundred years.

The global land-ocean temperature anomaly for July 2009 was +.60C. Only July of 1998 (a strong el nino year) was warmer.

The image above shows the July 2009 anomalies across the globe (warm is red, cool is blue). Clearly the reds and oranges far outweigh the blues.

BBC NEWS | Asia-Pacific | ...

http://news.bbc.co.uk/2/hi/asia-pacific/8194053.stm

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NEWS Watch ONE-MINUTE WORLD NEWS

Last updated at 15:52 GMT, Monday, 10 August 2009 16:52 UK

Taiwan flood sweeps away building

MORE LIKE THIS

Taiwan hotel collapses after typhoon

A hotel in southern Taiwan has collapsed after flood waters from Typhoon Morakot undermined its foundations.

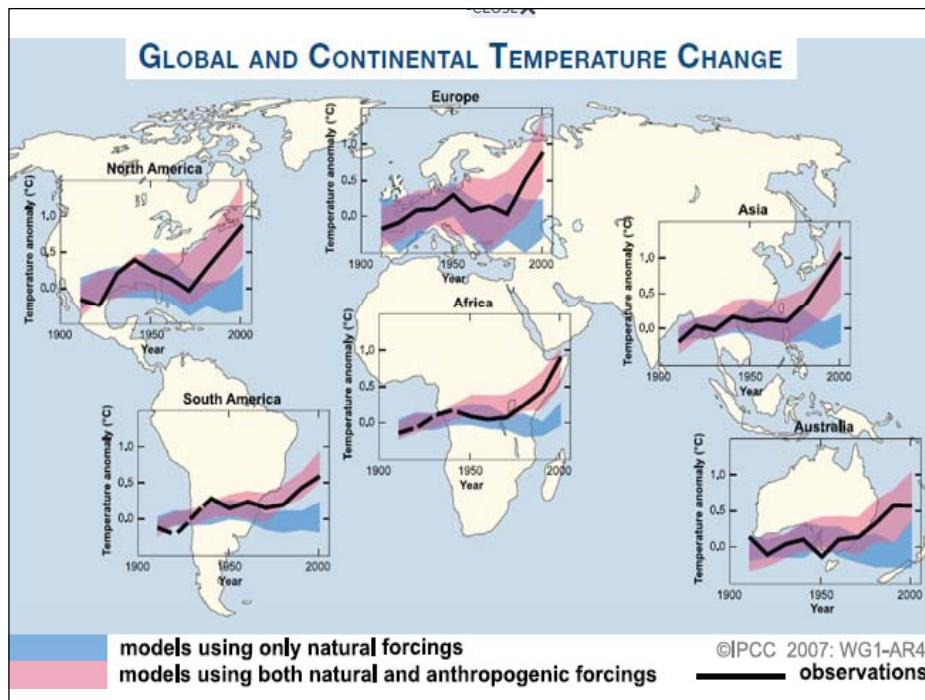
Many missing in Taiwan mudslides

Mudslides have buried a village in southern Taiwan, leaving hundreds of people missing.

EDITOR'S CHOICE

Man rescued from hurricane waves

Watch



Slim 10: Second suit filed
After actress Andie MacDowell's lawsuit, sister of woman who died after taking the slimming pills now takes legal action.
PAGE H2

HOME

THE STRAITS TIMES WEDNESDAY FEBRUARY 23, 2005



Bush fires RAGE

TAMAN SENGKALI Central was blackened yesterday morning when two bush fires blazed for about four hours across two open areas in the 15ha estate.

The laws, which according to residents are unclear, state that no one can burn land within 100m of a building.

One area behind Taman Sengkali Avenue 9 and another field behind the estate were covered in smoke around the site of the first bush fire.

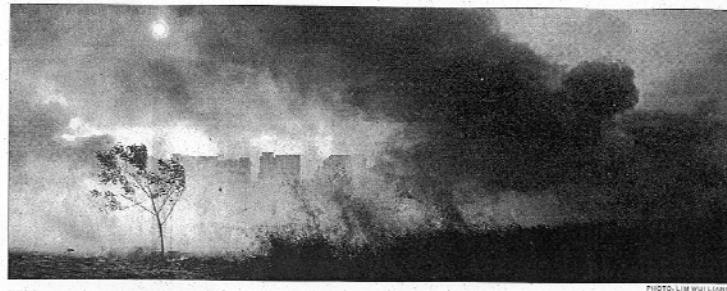
The winds blew the smoke steadily towards the Taman Sengkali mosque in Taman Sengkali.

One 11-year-old boy from the mosque school there had to be taken to the hospital and another to Tan Tock Seng Hospital suffering from respiratory difficulties.

Mosque volunteer Muhammed Hisham, 37, said the mosque had to close for an hour as many people had to keep out the smoke.

"It was suffocating," he said.

Polymer-based disease under control by about 60pc.



Air quality in Singapore worsens

Pollutants index driven up by record number of fires

By CAROLE ANN TAYES Air-Tech Correspondent

All quality has crept up and into the red zone again, with the air index at 300, the highest level of smoginess here since the start of the year.

The National Environment Agency (NEA) — 321 this month alone — has driven up the Pollutants Index (PM), which measures air quality.

Yesterday, it hit the maximum range for the third day in a row, peaking at 300 for parts of 56% of the island. NEA recorded this year had all been in the good range until January 25 at 400.

The air quality index is not expected to affect people's health, but it does increase the difference in air quality.

Dust and polyethylene have remained the main culprits, but haze and sulfur dioxide they account for most of the PM.

According to the latest figures from the National Environment Agency, there was 10 days of haze Monday, bringing the year's total so far to 410, already close to last

year's total of 400.

The National, a fire the size of 10 football fields but Tampons, or 100m by 100m, was the cause of 56% of the haze.

Badly, Singapore PM recorded this year had all been in the good range until January 25 at 400.

While the weather is not expected to affect people's health, it does increase the difference in air quality.

Dust and polyethylene have remained the main culprits, but haze and sulfur dioxide they account for most of the PM.

The air quality index is not expected to affect people's health, but it does increase the difference in air quality.

The good news is the dry spell is expected to ease soon, with showers likely at the end of this month.

According to the NEA, which monitors smog levels in Singapore, the city has seen its highest levels since the start of the year — 167.

The other piece of good news is the open fires of 1997, when the index peaked at 235, is unlikely to return this year.

Although NEA said the weather pattern was similar to the 1997 haze, as expected this year, it is not as bad as last year, because the dry spell and moderate humidity.

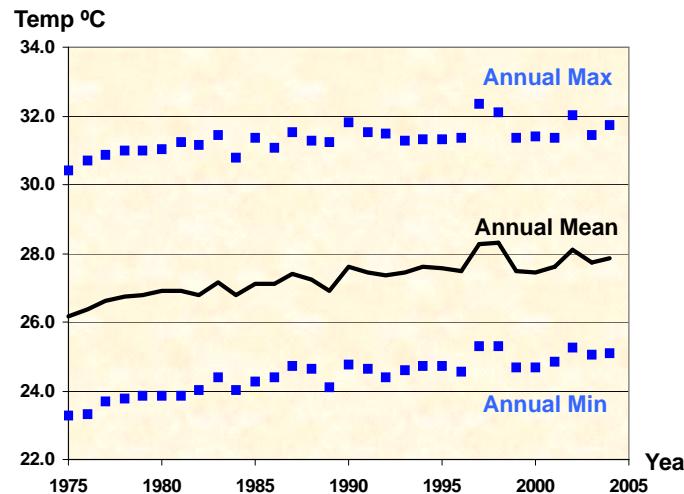
The fifth year of haze in Singapore has been experienced substantially by last June. However, the moderately heavy level, Mr Chia said.

The situation could be a lot worse if the weather pattern could be blighting Singapore in a much drier year.

Source: NEA, Singapore

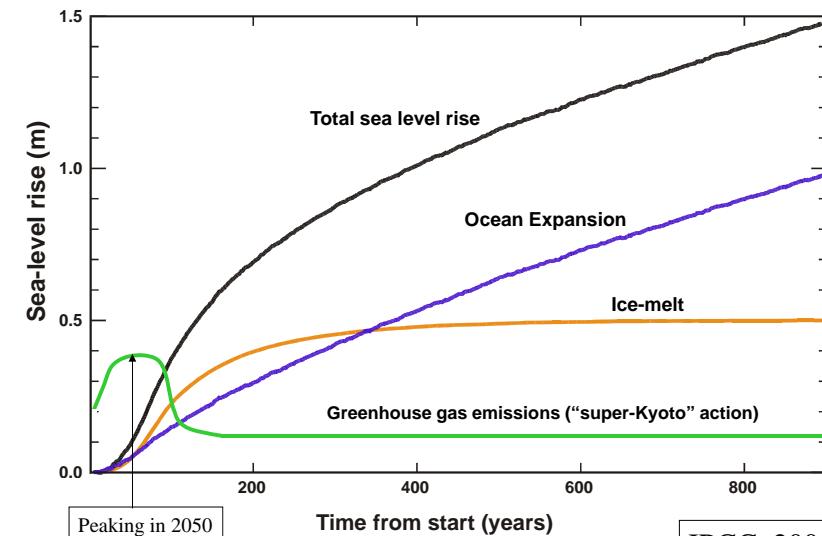
Temperature change in Singapore

Annual mean temp increased **1.8°C** in last 30 years



Source: NEA, Singapore

Sea-Level Rise, over the coming millennium



Climate Change

Some areas will suffer more frequent and severe droughts, and others will face more frequent and severe floods.

Impacts on the world's freshwater resources?



Waterway to work

RUSH hour in Bangkok yesterday was a dicey business as these commuters struggled to get to work along flooded city streets.

Jakarta, Surabaya, Semarang.. will suffer from severe water crisis in the next 10 years breaks on deforestation ... collection and storage of water

cause of frealish weather patterns blamed

The Straits Times
asia Sept. 25, 2002

Searching for drinking water, a boy in the central Java village of Wonogiri finds only an almost-dry lake bed. Many parts of the densely populated island are suffering from the drought blamed on this year's El Niño.

Water shortages putting Jakarta and Java at risk

Flow from public utilities is at a trickle, forcing people to buy water from private firms and even break into pipelines

MARIANNE KLAERKE

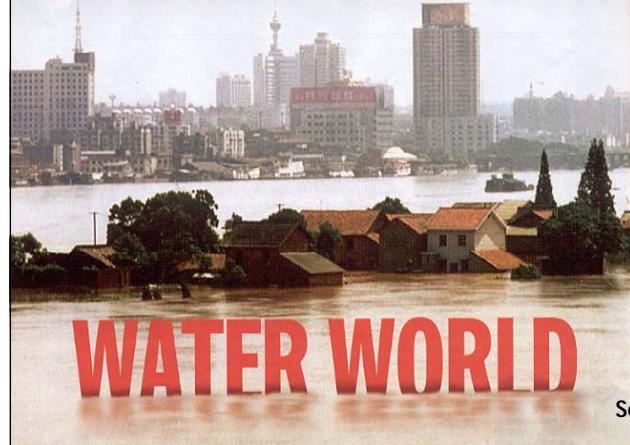
water shortage had reached dangerous levels. Water supplied by public

and Dennis latter policies for the collection and storage of water. The other day, farmers were even breaking gas pipelines to collect water. "I don't know if they can do it," said Mr. Tantardji. "But the lack of water to their fields, especially to those of rice, has been a serious problem. It has caused a lot of damage to agriculture and has led to a decline in rice production."

Mr. Tantardji said that the water shortage had reached dangerous levels. Water supplied by public

PHOTO: AP/WIDEWORLD

August-Sept. 2002, Shanghai, Frankfurt



Central Europe braced for tide of pollution in flood aftermath

Quelle: AP/WIDEWORLD
The flood waters of the River Elbe in central Europe are in retreat, but a new threat has emerged — dioxins, mercury and bacteria in the sludge carried by the waters.

The floodwaters peaked around 16 August, and dredging is now under way in the Czech Republic and eastern Germany to try to remove the debris and toxic waste left in their wake. In the town of Spolana, a chemical plant in Moravia



Flooding at the Spolana chemical plant has caused concern over dioxin and mercury contamination.

But Marian Fernandez, a chemist with the environmental group Greenpeace, says that the buildings used by the 1500 workers at the plant were not properly protected against floods. He adds that the plant has been leaking since the flooding began from gathering samples near the plant, and that the authorities may try to prevent the plant from operating again.

The trend is for a large increase in levels of arsenic and lead, but only for a few hours a day. The time of day is extremely important because the Elbe has a clear line of sight to communications satellites, he says. There is an intermittent contact with spiking concentrations of dioxins and mercury, he claims.

As well as giving 24-hour access to spore results, the link will allow researchers around the world to monitor the situation in real time. The South Pole is popular with physicists because the compressed ice is transparent to gamma rays, which can be used to measure the faint light emitted from neutrino-particle interactions. Astronomers like it because the ice is transparent to infrared radiation — better known as night — for several months of the year, and geologists are interested in the way that radioactive strontium

atoms move through spreading fracture networks in the ice.

"There is no room for panic, but we are scrutinizing the situation," says Axel Hofmann, a medical microbiologist at the Federal Institute for Animal Health and Veterinary Medicine in Leipzig. Thousands of inhabitants of Prague and Dresden have been exposed to the dioxins and mercury released by flooding into the Elbe.

Dioxin contamination of the Elbe may also be due to the industrial pollution from various industries during the communist era (ironically thousands died from the water in Donbas only last month to make it necessary from pollution).

© 2002 Nature Publishing Group

Bottom of the world

WATER WORLD

Source: Nature, Times

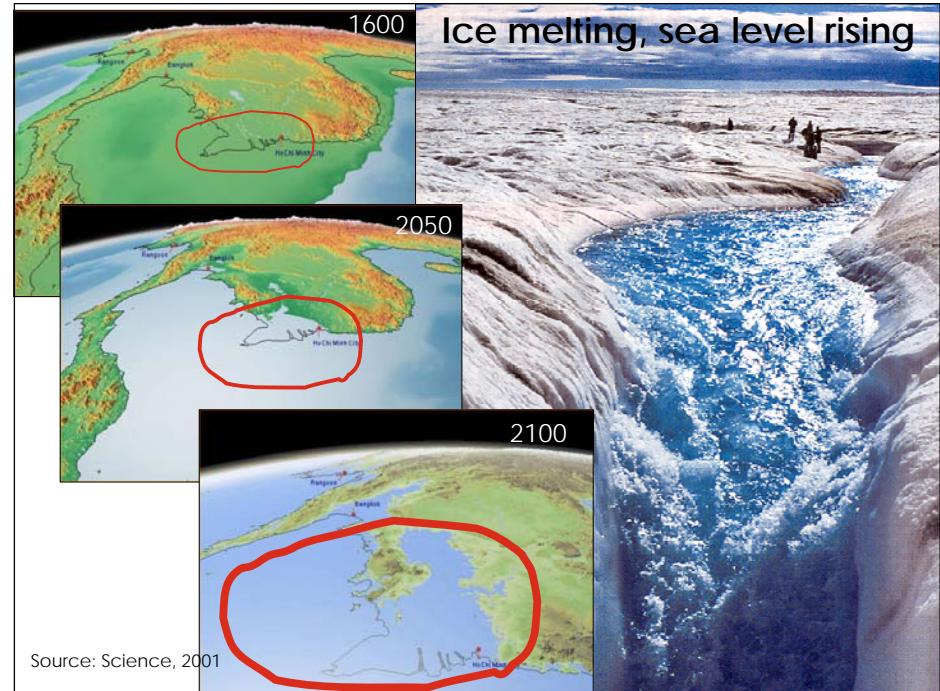
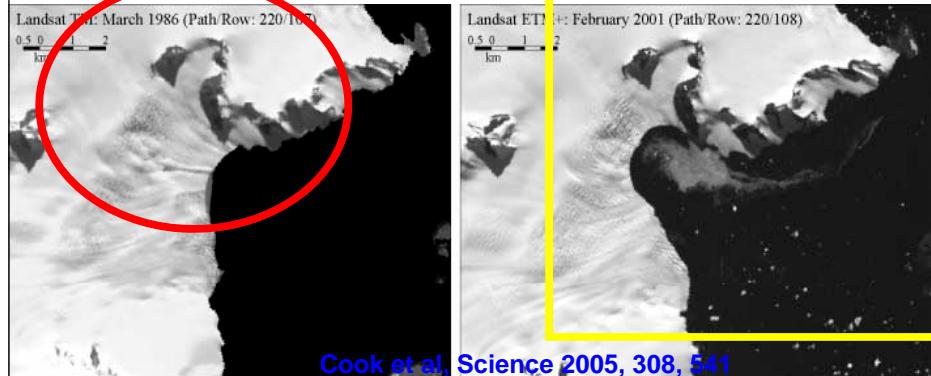
Evidence...



and more...

Melting

1 meter/yr 2000
10 meters/yr 2004



Precipitation Extremes

Average annual precipitation

"Heavy rain events" (>2"/day)

"Very heavy rain events" (>4"/day)

Past century
7%

14%

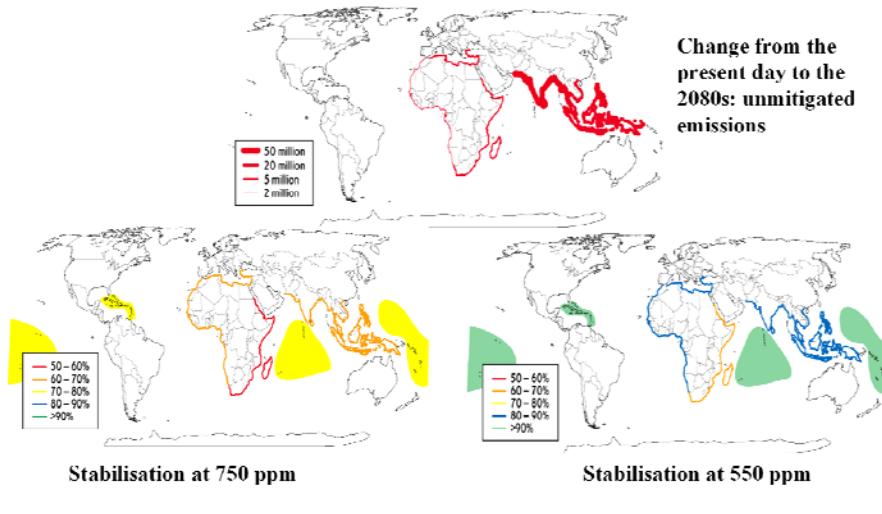
20%

Drought – worst in 500 years

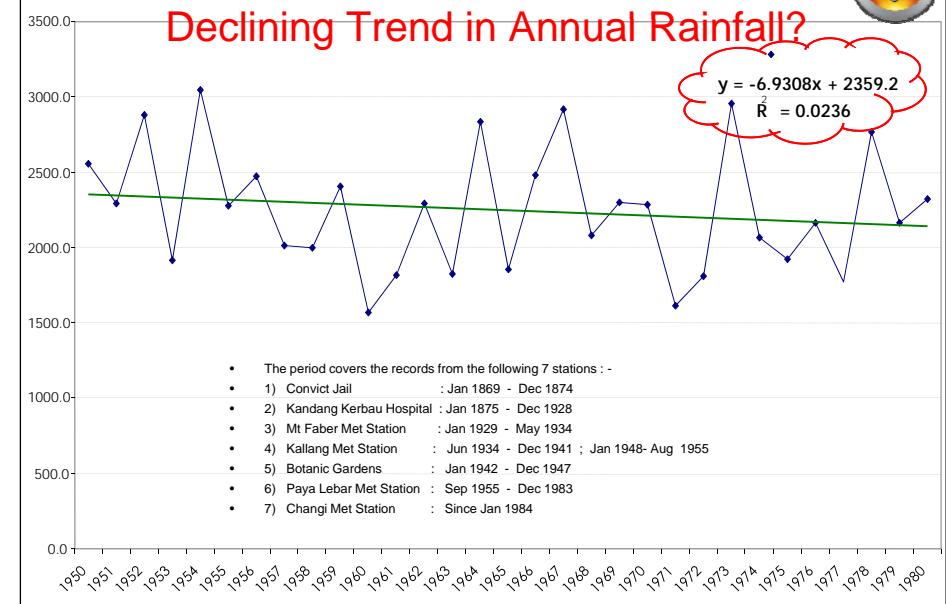
- Groisman et al. 2004



Annual Number of People Flooded



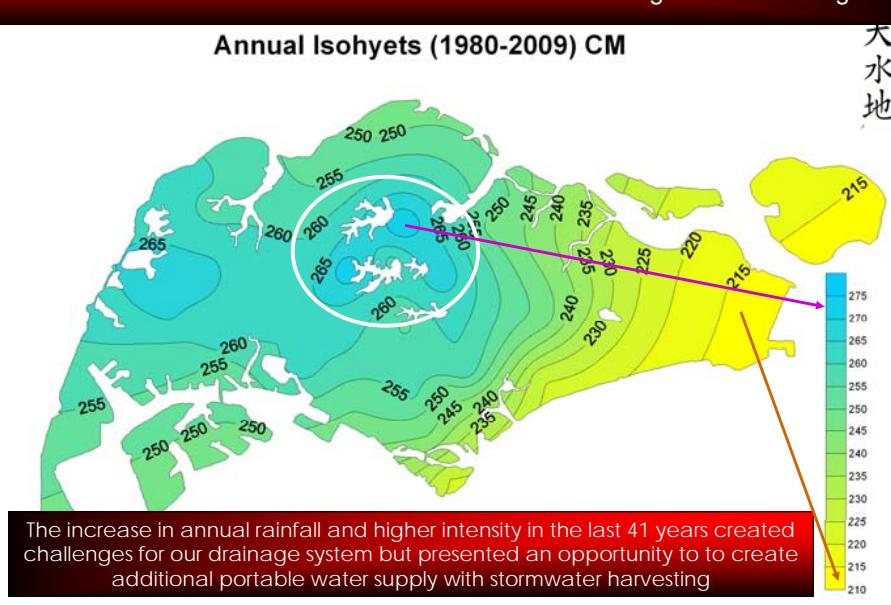
SINGAPORE CLIMATE STATION ANNUAL RAINFALL 1960-2010 SHOWED A DECLINING TREND



Singapore Annual Rainfall Chart 1980 -2009

Annual Rainfall Over Central Catchment is 50 mm Higher Than Changi

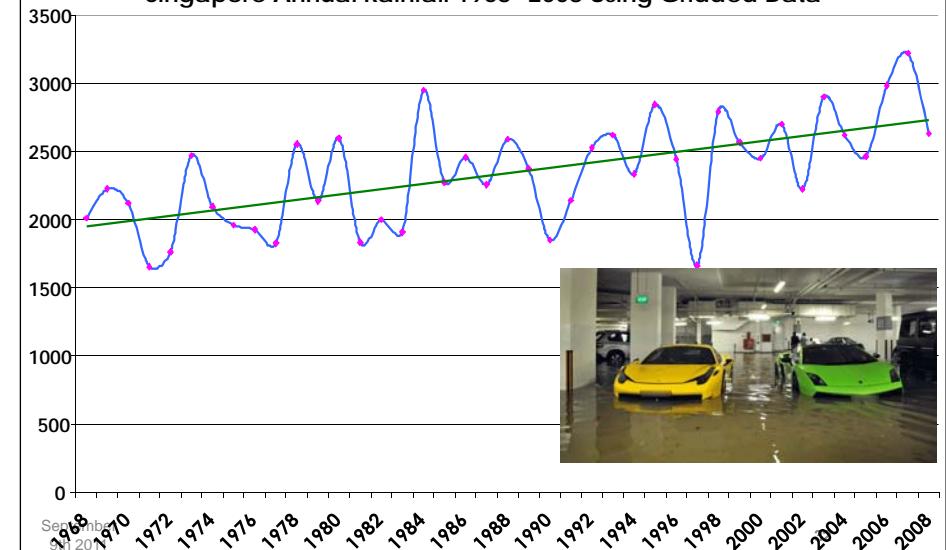
Annual Isohyets (1980-2009) CM

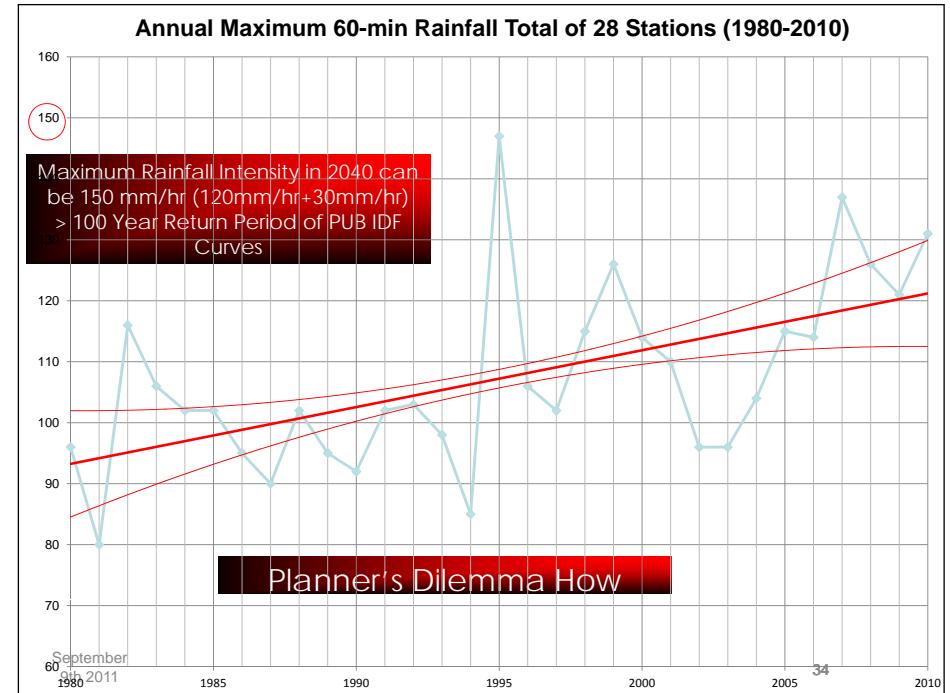
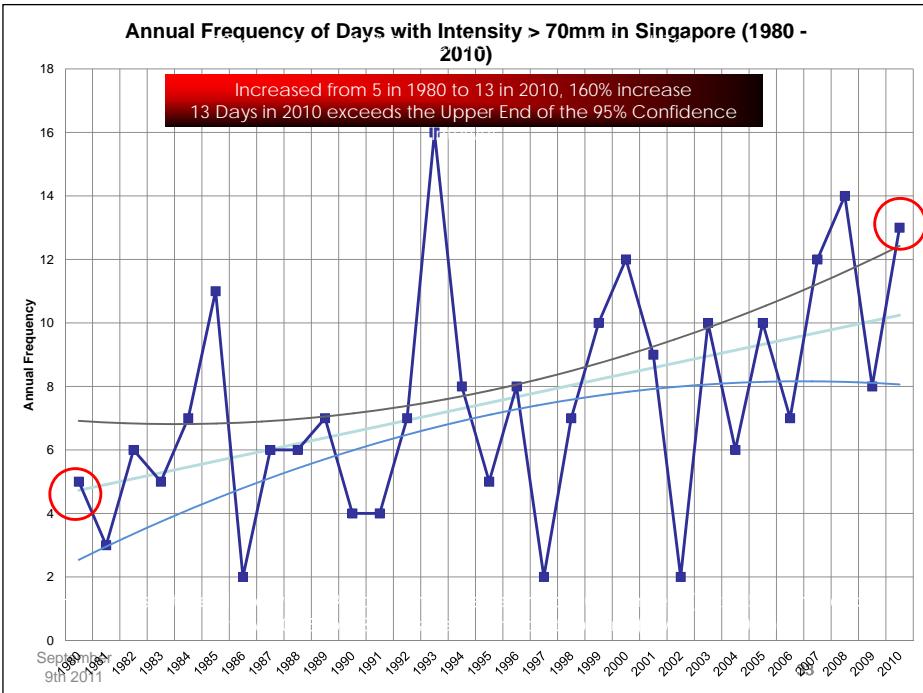


Average Rate of Increase of Annual Rainfall = 15 mm/year in 41 Years
from 1968 to 2008 (31% Increase)

The Increasing Trend is Statistically Significant

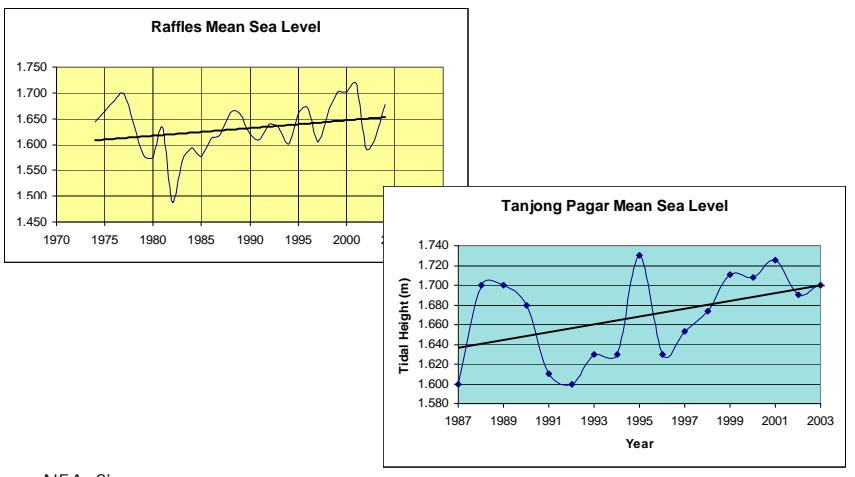
Singapore Annual Rainfall 1968 -2008 Using Gridded Data





Trend in Sea Level

Sea levels showed slight rising trend in last 30 years



Source: NFA, Singapore



Emerging Infectious Diseases

30 "NEW" TO MEDICINE SINCE 1976

HIV/AIDS

E. coli O157:H7

SARS

Legionnaires'

MDRTB & others

H1N1/NDM1

HPS

Nipah virus

Arenaviruses

Vibrio cholerae O139

Ebola

Lyme disease

RESURGENT & REDISTRIBUTING

Malaria, DF, WNV, Leptospirosis,

Cholera, Avian Flu

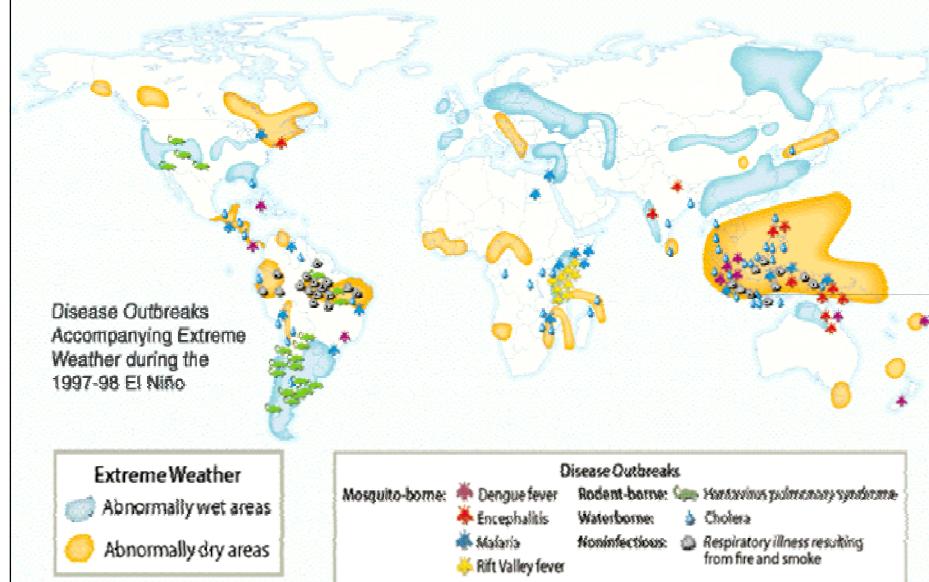


VECTORS

- Mosquitoes
- Ticks
- Rodents
- Bats
- Tsetse Flies
- Fleas
- Lice
- Snails
- Algae



EXTREME WEATHER & DISEASE CLUSTERS



Summary, what have we learned?

CO₂ rise is accelerating: 3ppm/yr, up from 1.5

Tropical oceans are warmer & saltier

Polar and mountain glacial ice is diminishing.

Public Health Challenge



Typhoon IMPACTS ON HEALTH AND DEVELOPMENT



DISEASE CLUSTER

- Malaria (>30,000 cases)
- Dengue fever (>1,000)
- Cholera (>30,000)

Juan Almendares

Global warming; Conducive Environment

- Aedes housed at 79F produced fastest compared to 75 and 72 F reproduced slowest.
- Introduce Culex, Anopheline and Aedes to new regions, multiply faster and bite more in warmer weather.
- Waterborne and other infectious diseases may become more frequent and widespread



LETTER

doi:10.1038/nature12060

The global distribution and burden of dengue

Samir Bhatt¹, Peter W. Gething¹, Oliver J. Brady^{1,2}, Jane P. Messina³, Andrew W. Farlow¹, Catherine L. Moyes¹, John M. Drake^{1,3}, John S. Brownstein⁴, Anne G. Hoen⁵, Osman Sankoh^{6,7,8}, Monica F. Myers¹, Dylan B. George⁹, Thomas Jaenisch¹⁰, G. R. William Wint^{1,11}, Cameron P. Simmons^{12,13}, Thomas W. Scott^{9,14}, Jeremy J. Farrar^{12,13,15} & Simon I. Hay^{1,9}

Dengue is a systemic viral infection transmitted between humans by Aedes mosquitoes¹. For some patients, dengue is a life-threatening illness². There are currently no licensed vaccines or specific therapeutics, and substantial vector control efforts have not stopped its rapid emergence and global spread³. The contemporary worldwide distribution of the risk of dengue virus infection⁴ and its public health burden are poorly known^{2,5}. Here we undertake an exhaustive assembly of known records of dengue occurrence worldwide, and use a formal modelling framework to map the global distribution of dengue risk. We then pair the resulting risk map with detailed longitudinal information from dengue cohort studies and population surfaces to infer the public health burden of dengue in 2010. We predict dengue to be ubiquitous throughout the tropics, with local spatial variations in risk influenced strongly by rainfall, temperature and the degree of urbanization. Using cartographic approaches, we estimate there to be 390 million (95% credible interval 284–528) dengue infections per year, of which 96 million (67–136) manifest apparently (any level of disease severity). This infection total is more than three times the dengue burden estimate of the World Health Organization⁶. Stratification of our estimates by country allows comparison with national dengue reporting, after taking into account the probability of an apparent infection being formally reported. The most notable differences are discussed. These new risk maps and infection estimates provide novel insights into the global, regional and national public health burden imposed by dengue. We anticipate that they will provide a starting point for a wider discussion about the global impact of this disease and will help to guide improvements in disease control strategies using vaccine, drug and vector control methods, and in their

geographical range of endemic transmission⁷. Although the historical expansion of this disease is well documented, the potentially large burden of ill-health attributable to dengue across much of the tropical and subtropical world remains poorly enumerated.

Knowledge of the geographical distribution and burden of dengue is essential for understanding its contribution to global morbidity and mortality burdens, in determining how to allocate optimally the limited resources available for dengue control, and in evaluating the impact of such activities internationally. Additionally, estimates of both apparent and inapparent infection distributions form a key requirement for assessing clinical surveillance and for scoping reliably future vaccine demand and delivery strategies. Previous maps of dengue risk have used various approaches combining historical occurrence records and expert opinion to demarcate areas at endemic risk^{8–12}. More sophisticated risk-mapping techniques have also been implemented^{13,14}, but the empirical evidence base has since been improved, alongside advances in disease modelling approaches. Furthermore, no studies have used a continuous global risk map as the foundation for dengue burden estimation.

The first global estimates of total dengue virus infections were based on an assumed constant annual infection rate among a crude approximation of the population at risk (10% in 1 billion (ref. 5) or 4% in 2 billion (ref. 15)), yielding figures of 80–100 million infections per year worldwide in 1988 (refs 5, 15). As more information was collated on the ratio of dengue infections to fever to dengue haemorrhagic fever and the ratio of deaths to dengue haemorrhagic fever cases, the global figure was revised to 50–100 million infections^{16,17}, although larger estimates of 100–200 million have also been made¹⁸ (Fig. 1). These estimates were intended solely as approximations but, in the absence of better evidence,

Dengue fever

The most serious viral infection transmitted in man by insects, measured in terms of the number of human infections or the number of deaths.

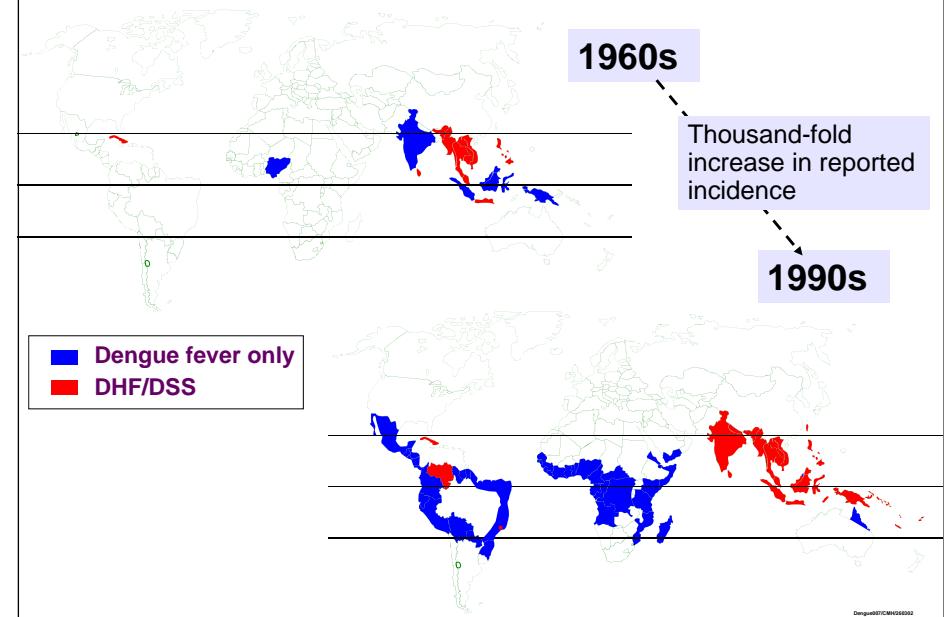
Today Dengue afflicts an estimated 50m - 100m, mainly in urban areas. Asian Tiger Mosquitoes, have been reported as far north as the Netherlands.

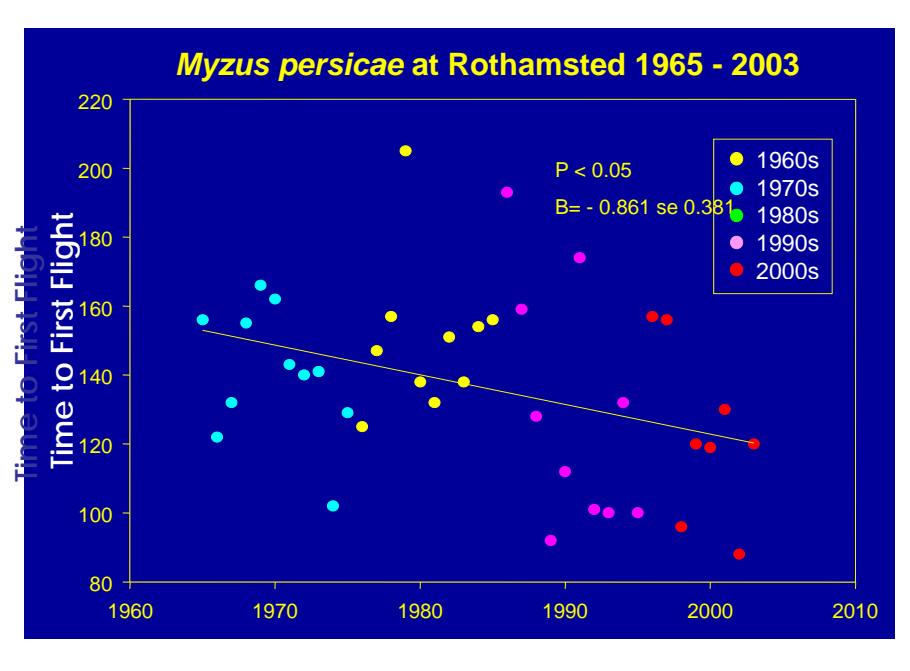


The incidence increased in areas where temperature has increased and spreads to higher elevations. Former limit 1,006 m and now reported above 1,200 m.

Neither a vaccine nor a specific drug treatment is yet available.

Global Dengue Epidemiology



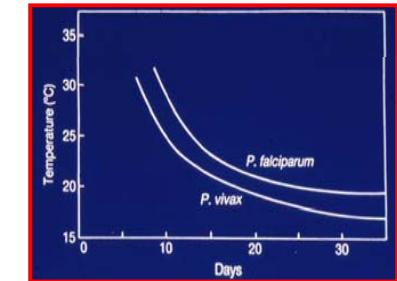
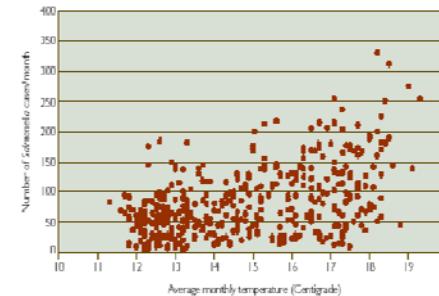


Evidence that global warming has contributed to ID?

1. Cholera and El Nino/Southern Oscillation-Bangladesh
Rodo X. (2002) PNAS

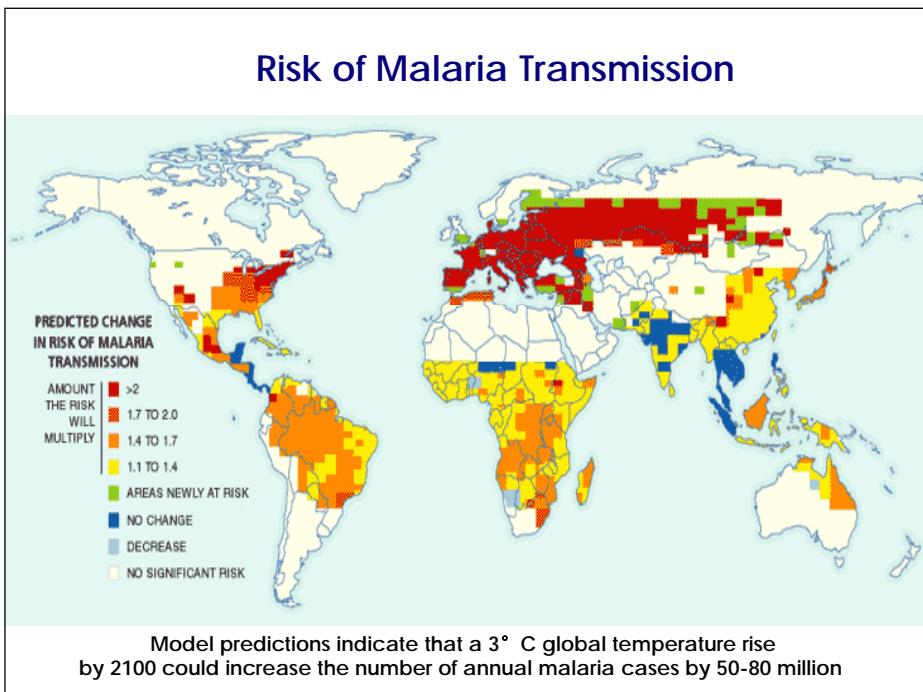
2. Salmonella and temperatures-New Zealand
WHO-Climate Change and Human Health: Risk and Responses.

Figure 4.2 Relationship between mean temperature and monthly reports of Salmonella cases in New Zealand 1965 - 2000



3. Malaria and El Nino/Southern Oscillation-India and Sri Lanka

Bouma M (1996) Tropical Medicine and International Health 1 86-96



Tide pushing shellfishers into red

Harmful algae arrive on New England coast at peak of the season; the bloom 'couldn't come at a worse time'

By Rick Hampson
USA TODAY

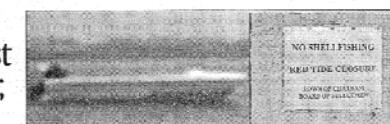
Bruce Keeler was looking down the barrel of his microscope for signs of red tide, but he didn't expect to see the first evidence of New England's worst outbreak in three decades.

The ocean biologist's research vessel was 15 miles off Cape Cod. He had already inspected water samples from two other spots in Massachusetts Bay and found only a few of the toxic algae cells that contaminate shellfish.

Suddenly, the water in a new slide under his microscope was swimming with them.

He started to count the cells, which look like two hard hats pressed together brain to brain, using a hand counter. Click, click, click. A colleague heard the sound and came over.

"We got a lotta cells here," Keeler said. "So many I can't count 'em all." It was time to



Warning: A sign on the Chatham waterfront warns about the infestation.



come in ask, 'How's it goin' with the red tide?' says Mac Hay, owner of three retail fish markets, a wholesale operation and a glorified clam shack on the pier in Wellfleet Harbor on Cape Cod.

"Every day it gets worse," he says of shellfish sales, which normally account for a third of his business. "People aren't going for the stuff we're importing from Canada and Virginia. If you come to Wellfleet, you want Wellfleet oysters."

Stephen Martiniello, director of quality control at Legal Sea Foods, which has 31 restaurants along the Eastern Seaboard, says the company is buying uncontaminated shellfish from Canada, New York and New Jersey. "But if this goes on, price will start to dwindle and price will skyrocket," he says. "It's gonna be tough to get clams."

A blow to business

One attraction to the business of shellfishing is low overhead. In towns such as Chatham, shellfishers work much as they have since colonial times, with nothing more than a rake and a basket.

And they are being hurt by the algal bloom. "This should be the time of year when you start coming out of the hole and make some money," says Pete

May 28 05, Seattle Times

Global Warming - Waterbloom of Cyanobacteria

Widespread genus
Microcystis
produces liver toxins



2007 June, 2nd, ST

PUTRID WATER
“The government said it's safe to drink boiled water. But it has a green film on the surface. How can I drink it?”
A RETIRED WORKER SURNAMED WANG, 65, on the water at Jiangou park in Nanjing, China (left), which has been struck by a rapidly spreading bloom of algae

Residents and media said the emergency steps, which included sending in clouds and bring rain, exposed a long-term failure to prevent the lake, hampered by pollution and rapid urbanisation and economic growth.

In 2005, millions of residents in cities in north-east China had their taps turned off for weeks after a toxic bloom.

The problem was a symptom of widespread environmental destruction threatening water sources, said one commented.

“Along with our country's rapid economic growth, there has been a massive build-up of pollution and docks on the lake,” he said, according to the website of the People's Daily, the official Communist Party newspaper.

“Our country's environmental protection has reached a crisis point,” said Li Yuanchao, the editor-in-chief of Chinese Daily, in an article.

“What's shameful is the municipality's ignorance of drinking water to be a dumping ground,” he said.

The editorial also said the crisis should serve as a warning to the Chinese about the consequences of ignoring the environment in the quest for economic growth.

“The situation is not alone. This disaster should put many more cities on guard,” the editor said.

REUTERS, AGENCE FRANCE PRESSE

CHINA GOES ON OFFENSIVE AFTER FOOD SCARES, PAGE 8

China vows quick action on contaminated lake

But country's long-term failure to protect water sources from pollution criticised

Wuxi

CHINESE officials yesterday vowed to take emergency steps to clean up China's third-largest lake after algae, floating like a green carpet, forced 1.5 million people closer to this city of more than 2.3 million amid a public outcry about pollution.

Lake Taihu in Jiangsu

province has been struck by a rapidly spreading colony of algae which has cut water supplies for nearly 100,000 people.

Convoys of trucks have been bringing bottled water for the town, whose market price has shot by government order to stop people buying tap water.

Algae were formed by

Chinese were formed by algae and algal bloom holders were charging extra for the water — six times as much as usual — for the bottle that contains it, one resident said.

“But it looks like algae

on the surface. How can I drink it?”

The provincial Communist Party chief, Mr Li Yun-chuan, said the lake was improving as officials drew flows from the Yangtze River to dilute the algae in waste, according to a report published by the State Environmental Protection Administration.

Local ecological authorities also managed to induce artificial rainfall

and rivers are threatened by run-off from fertilisers, industrial waste and untreated sewage.

Algae bloom can spread in water rich in nutrients from farm and domestic run-off, which Lake Taihu has in abundance.

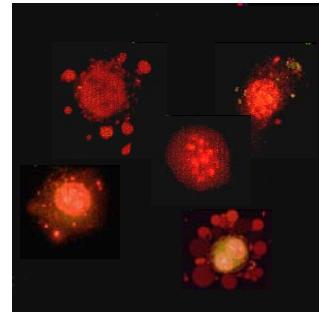
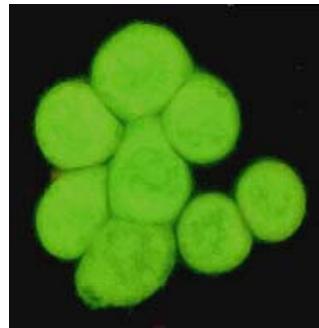
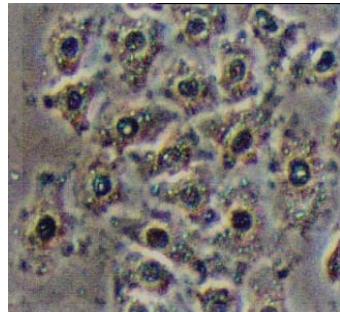
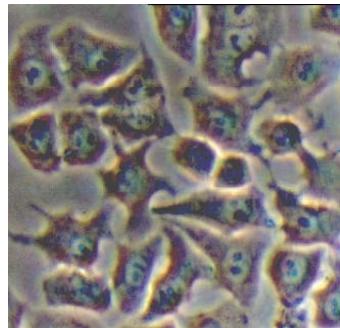
Mr Li acknowledged that the scare exposed deeper failing.

“In future development, we must be determined to clean up Lake Taihu and

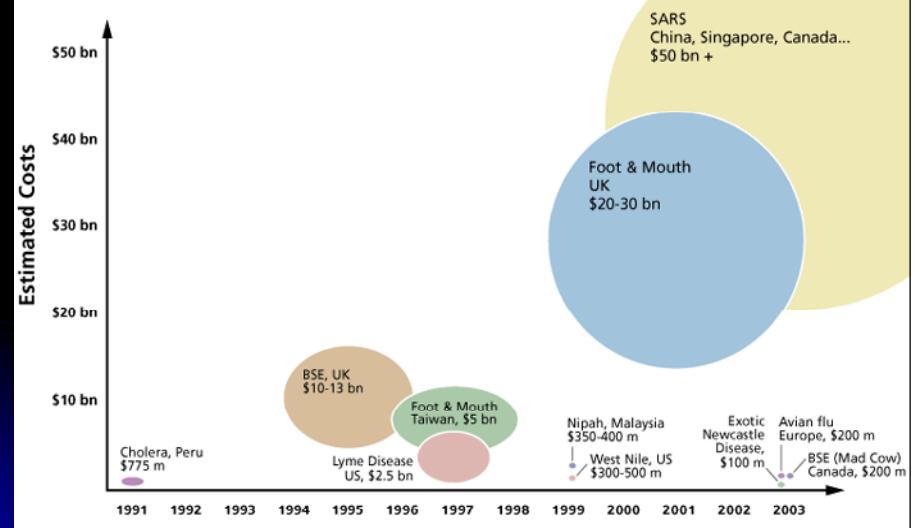
Primary hepatocytes

Liver Cells treated with cyanobacteria microcystin

Ding et al, 2000, Hepatology

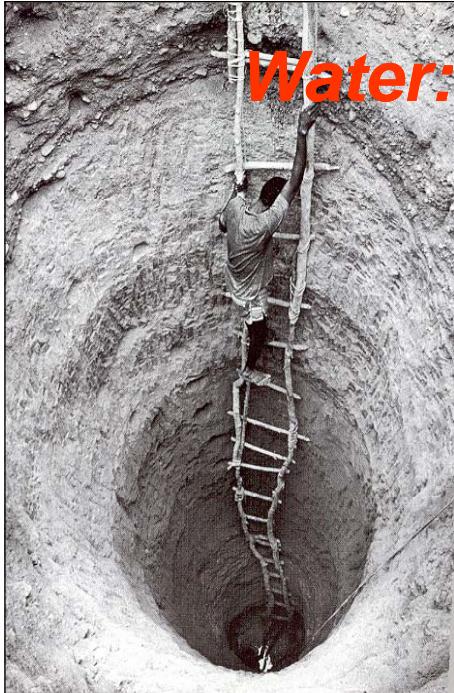


Costs of Emerging Infectious Diseases



Figures are estimates and are presented as relative size. See Table 1 for more details.

BIO ECONOMIC RESEARCH ASSOCIATION, Cambridge, MA



Water: The fuel of international conflict?

Access to water is one of the most fundamental human needs. Yet today, 1.2 billion people in the world still do not have access to clean drinking water.

BusinessWeek

GLOBAL WARMING
Why Business Is Taking It So Seriously
BY JOHN CAREY (P44)

VILLAGERS LEFT...

HIGH & DRY

Economic refugees

Padi farmers staring into empty rice bowl

...AND THE E...

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How does trans-boundary pollution affect climate change and health

(30 min. preparation,
5 min gp presentation)

March 24, 2014

1 in 8 deaths caused by bad air: WHO

GENEVA — Air pollution killed seven million people in 2012, more than Aids, diabetes and road injuries combined.

One in eight deaths globally can be attributed to breathing tainted air, making it the world's largest environmental health risk, the World Health Organisation (WHO) said in a report today, doubling its previous estimates for pollution fatalities.

WHO revised the number as the deadly effects of air contaminants, which extend beyond respiratory problems to heart attacks, strokes and cancer, are now better understood. Low- and middle-income nations in Asia accounted for over 70 per cent of deaths related to air contamination in 2012, the report shows.

The hardest-hit regions, according to WHO, were Southeast Asia, which includes India

and Indonesia, and the Western Pacific, ranging from China and South Korea to Japan and the Philippines.

Together, they accounted for 5.9 million deaths. The toll from outdoor pollution was 3.7 million, with sources ranging from coal heating fires to diesel engines. And 3.3 million deaths were linked to indoor air pollution, mostly from cooking over coal, wood and biomass stoves.

When WHO last released an estimate for deaths related to air pollution, in 2008, the agency had put the figure related to outdoor pollution at 1.3 million, while the number blamed on indoor pollution was 1.9 million.

But a change in research methods makes comparison difficult between the 2008 estimate and the 2012 figures, Dr Neira said.

In the past, for example, WHO did not take into account the overlap between exposure to both forms, and only assessed urban pollution.

WHO said it planned by the end of this year to release a ranking of the world's 1,600 most pol-

luted cities.

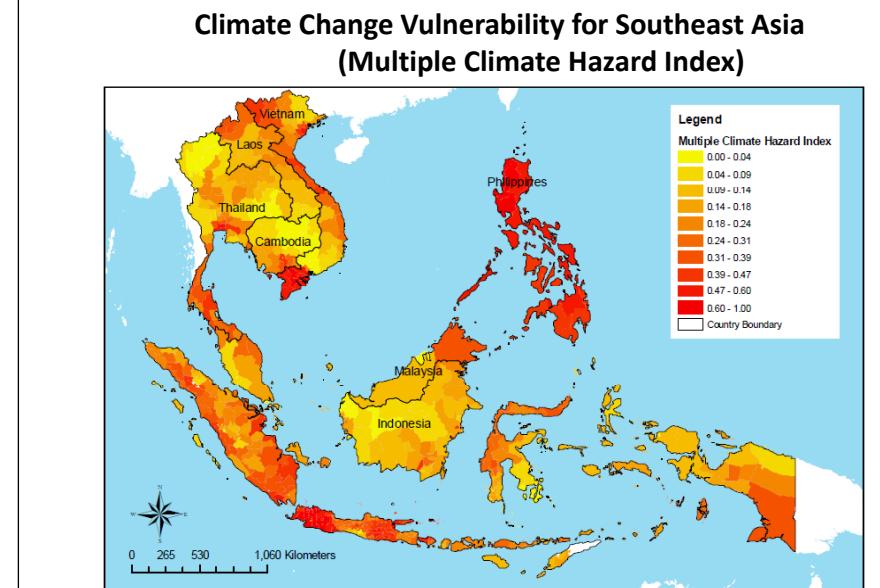
Research suggests outdoor air pollution exposure levels have risen significantly in some parts of the world, particularly in countries with large populations going through rapid industrialisation, such as China and India.

Premature deaths and health problems from air pollution cost China as much as US\$300 billion (\$487 billion) a year, according to a joint report by the World Bank and the Development Research Centre of the State Council, China's Cabinet, released yesterday in Beijing.

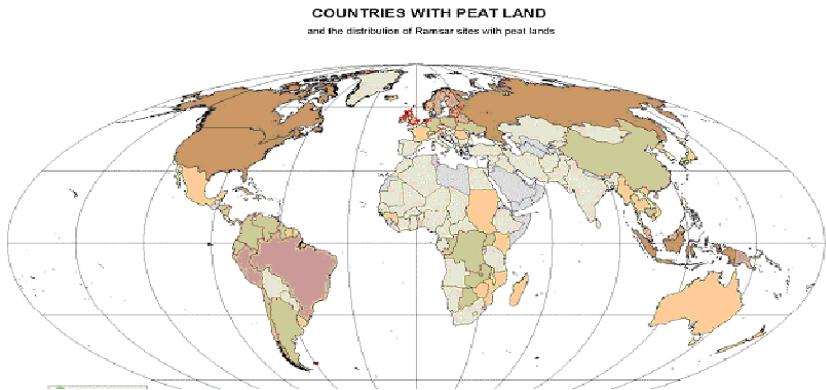
The report, which took 14 months to compile, said that long-term consequences could include birth defects and impaired cognitive function, as young children and infants are severely affected by poor air quality.

BLOOMBERG, AGENCE FRANCE-PRESSE

Forest Fire, Haze, Climate Change and Singapore



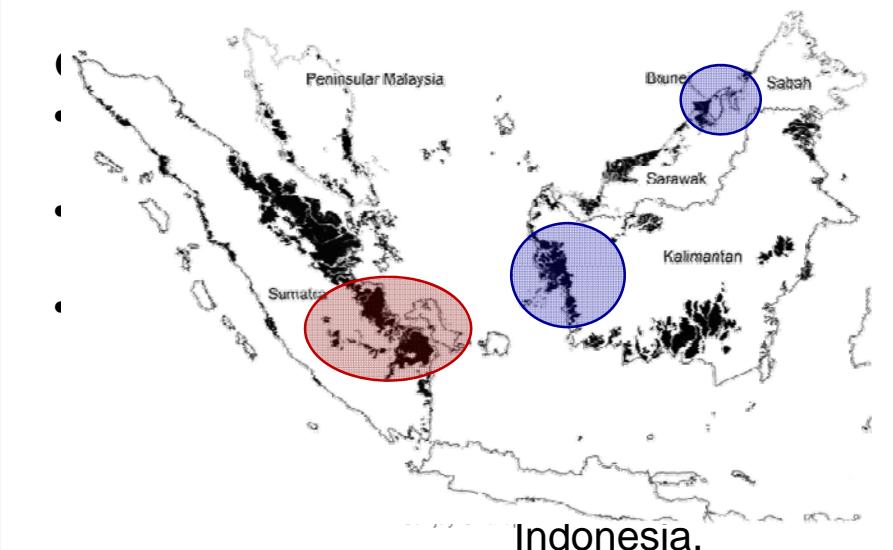
Peatlands around the world



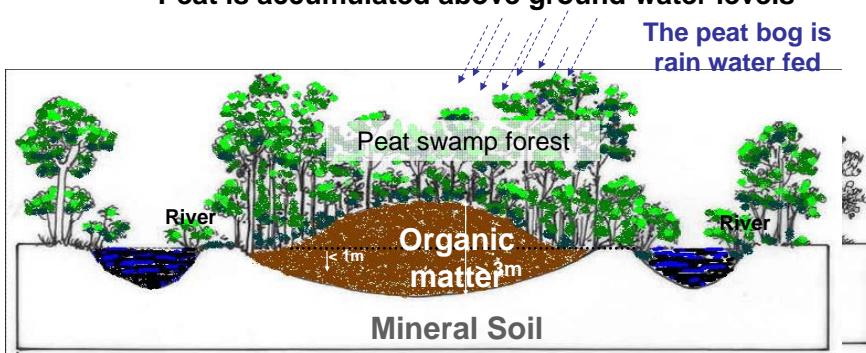
- World wide 400 million ha
- 3% of global land area
- South-east Asia has 6 % of global peatlands

Source: Wetland International

Peatlands: critical water & carbon sinks



- Peat: organic matter accumulated over thousands of years
 - Lowland tropical forest peat bogs are dome-shaped
 - Peat is accumulated above ground water levels



Most of the peatlands are located in the lowlands in the extensive floodplains between rivers of Sumatra, Kalimantan and Papua

Source: Wetland International

Tropical peatlands: unique ecosystems

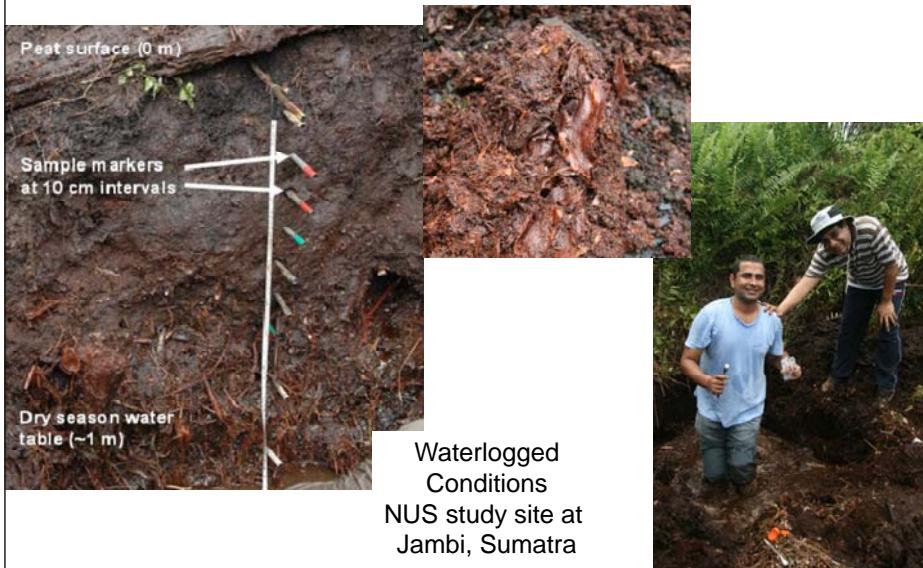
- Peatlands are formed due to accumulation of partially decayed vegetation matter in blocked water – **Carbon sinks**
- **Waterlogged**
- Thick organic soil
- Acidic
- Nutrient-poor
- Support unique **biodiversity**



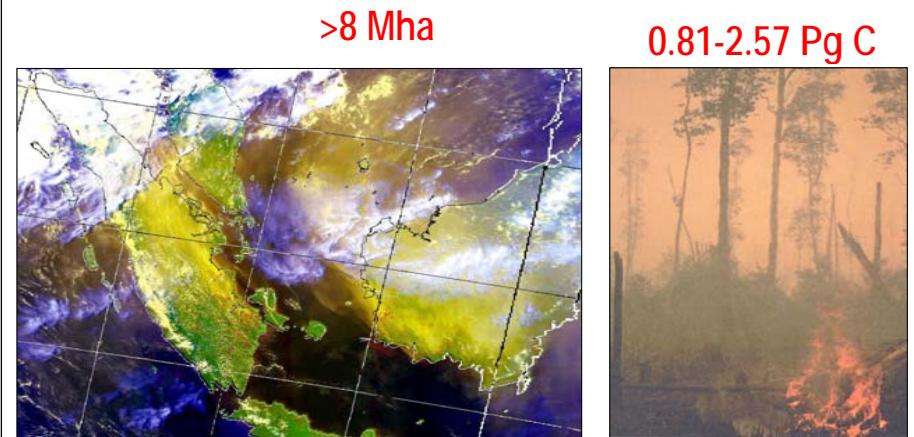
Kalimantan
Mega rice project site

Sanjay Swarup, NERI, NUS

Peat is mainly woody biomass



Fire & Haze from Sumatra and Kalimantan-El Niño 1997-98



Page S et al. 2002

Carbon Released from 1997-98 SE Asia Fires



Emissions

0.81-2.57 Pg C

Equivalent to:

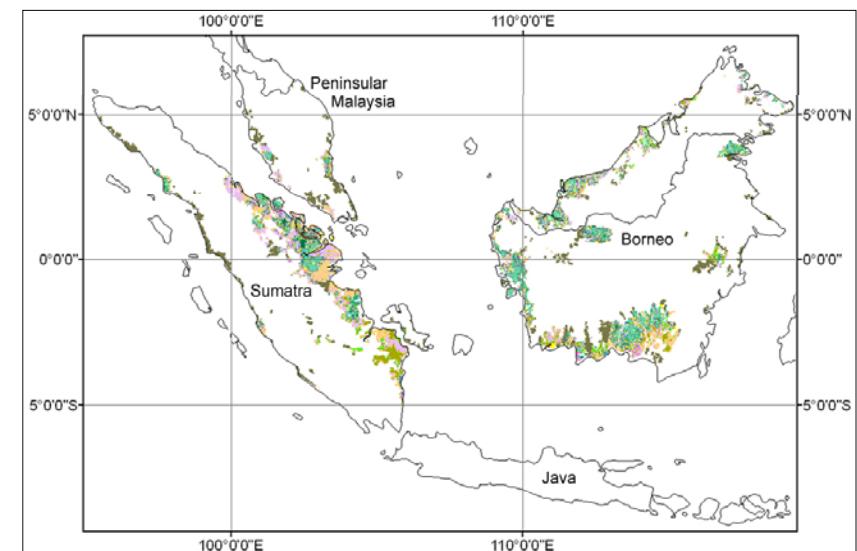
13-40% annual FF
emissions

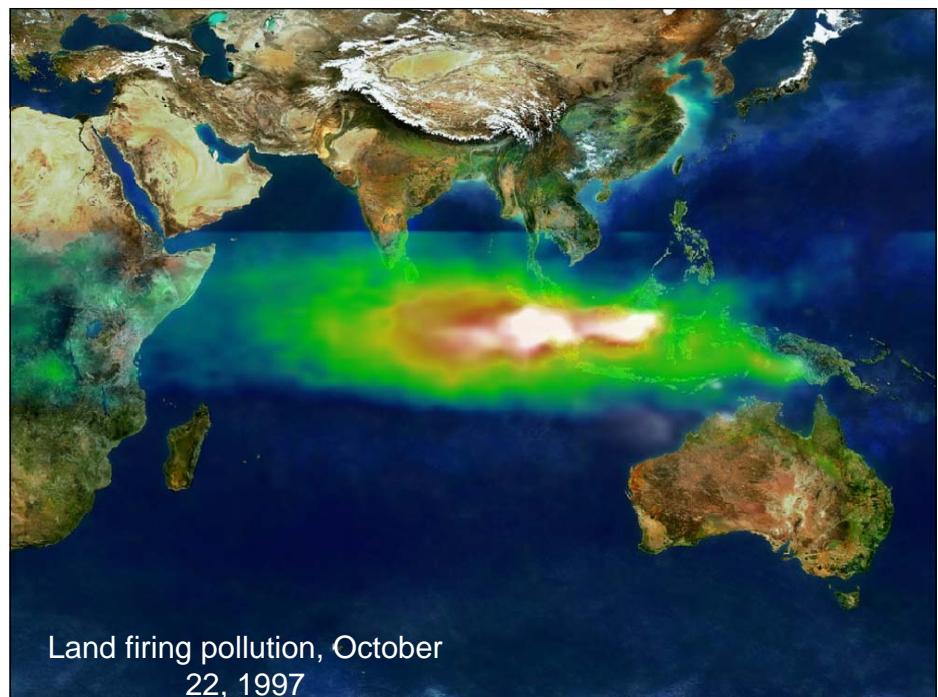
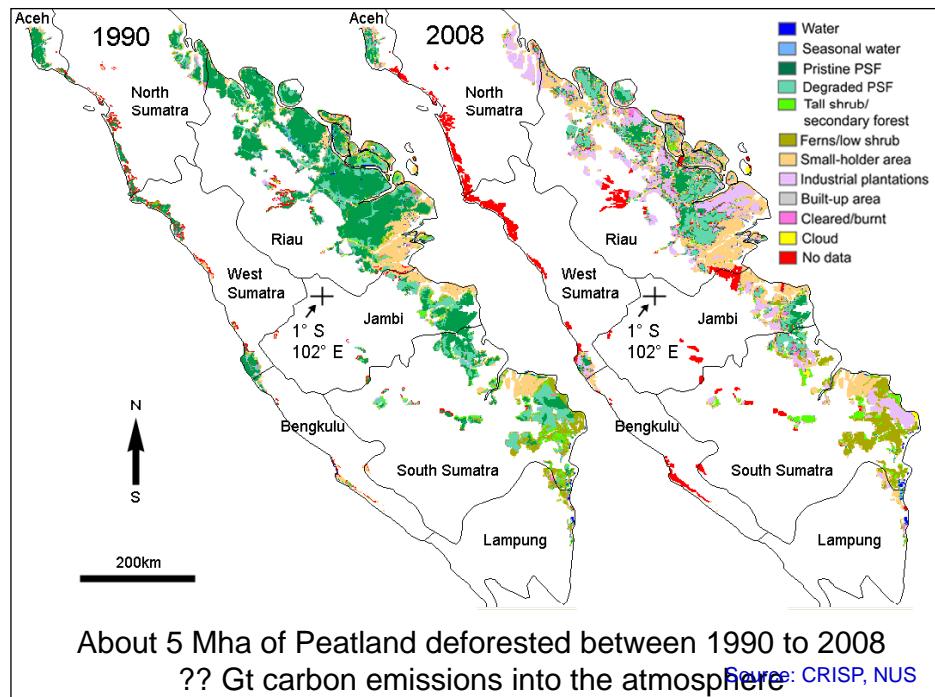
Comparable to:

Net terrestrial Sink
(1-3 Pg C yr⁻¹)

Page S et al.

Land cover map of peatlands (based on 120 SPOT images)





When **DRY**: Peat not only gets oxidized to CO₂ but it also easily burns



Hooijer et al 2011

Sanjay Swarup

Palm oil mills and peat fires emit smoke plumes and aerosols



