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## **Global Challenges: The Future of Food, Energy and Water Security**

**National Science and Technology Development Agency**  
Thailand Science Park

**Professor John Beddington**

Chief Scientific Adviser to HM Government and Head of the Government  
Office for Science

30<sup>th</sup> September 2009



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## **The role of the Chief Scientific Adviser to HM Government**

- Report to the Prime Minister and Cabinet
- Responsible for the quality of all engineering and scientific advice across the whole of Government
- Lead a network of departmental Chief Scientific Advisors
- Head of the Science and Engineering Profession in the Civil Service
- Supported by the *Government Office for Science* who have a cross-Government challenge and support role





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## Global challenges in the 21<sup>st</sup> Century



↑ Urbanisation



↑ Population



Food security



Alleviating poverty



↑ Energy demand



Climate Change



↑ Water demand



Counter-terrorism



WMD proliferation



Infectious diseases



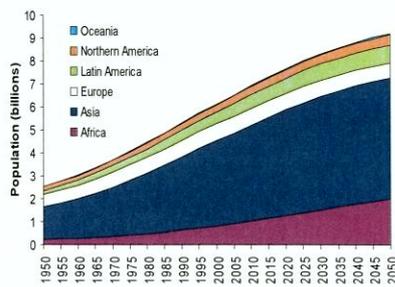
Biodiversity



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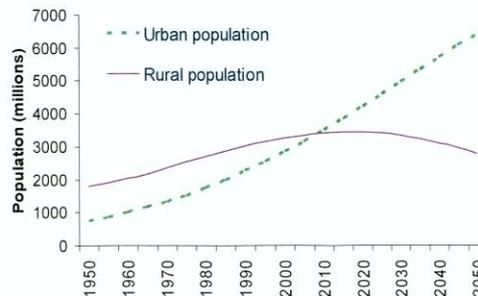
## Increases in global population and urbanisation

World population by region



Source: United Nations, World Population Prospects: The 2006 Revision (medium scenario)

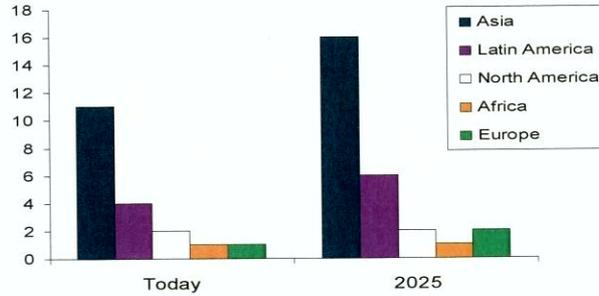
Urban and rural populations of the world (at mid-year) 1950 - 2050



Source: United Nations, World Urbanization Prospects: 2008 (revision)



## Increasing number of Mega Cities

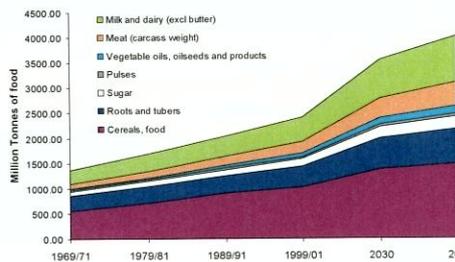


Source: FAO / World Bank



## Increased demand for food and energy

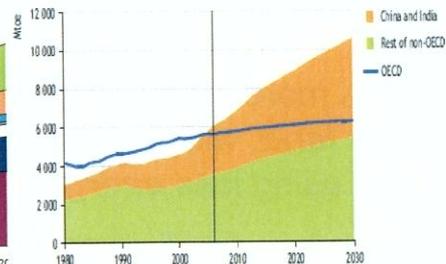
### World food requirements



World food production must rise by **50 % by 2030** to meet increasing demand

(Source: UN 2008)

### World primary energy demand by region

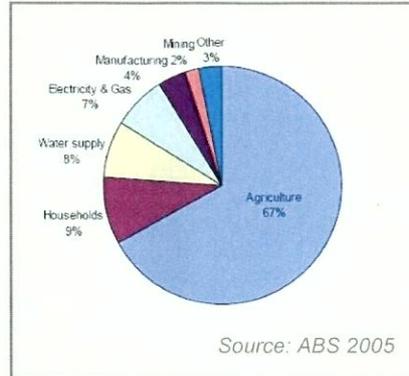
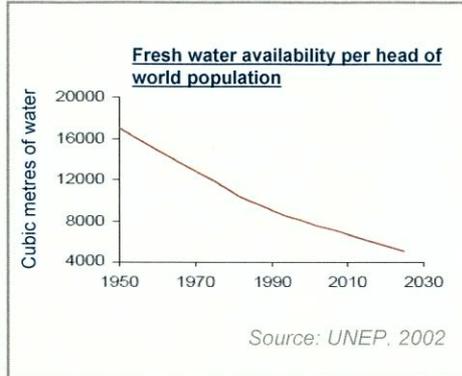


Total world energy demands are predicted to increase by approx. **50% by 2030**

(Source: IEA 2008: Reference Scenario)



## Availability of fresh water



“The challenge of securing safe and plentiful water for all is one of the most daunting challenges faced by the world”

Source: Ban Ki-moon, 2008

Total world water demands are predicted to increase by **over 30% by 2030**

Source: IFRPI



## A challenge?

### Need:

50% more production on less **land**, with less **water** and using less **energy**

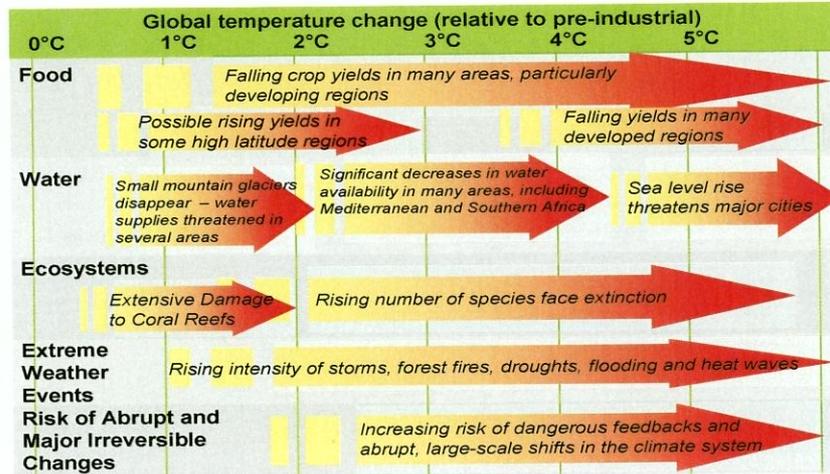
.....by 2030





# Climate Change impacts

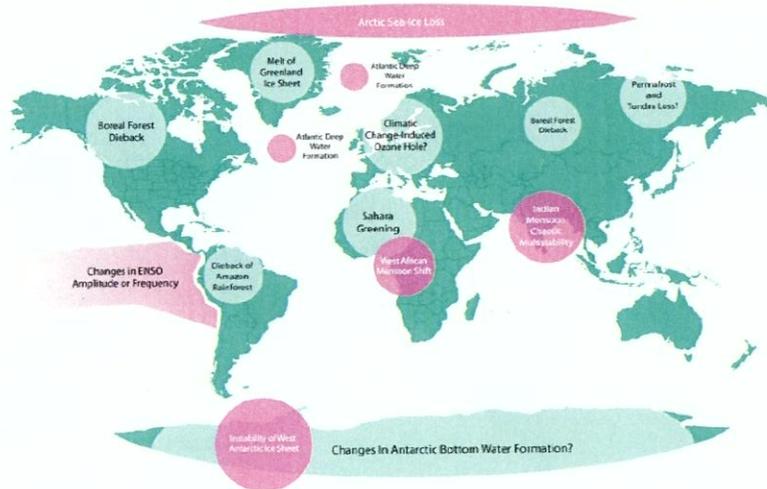
## Projected impacts of climate change



Source: IPCC Report, 2007



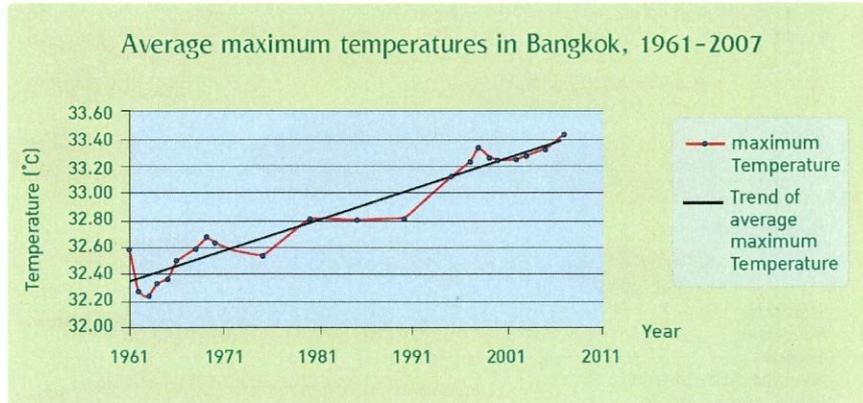
# Some of the global consequences of climate change



Source: Synthesis Report, Climate Change Summit, Copenhagen March 2009



## Climate Change in Bangkok



Source Bangkok Assessment Report on Climate Change (2009)



## The consequences: Global coastal vulnerability

Growing coastal vulnerability of mega-deltas



Source: IPCC AR4, 2007



Human activities also increase flood risk

### Top 5 sinking river deltas

Chao Phraya	Thailand
Colorado	Mexico
Krishna	India
Nile	Egypt
Pearl	China

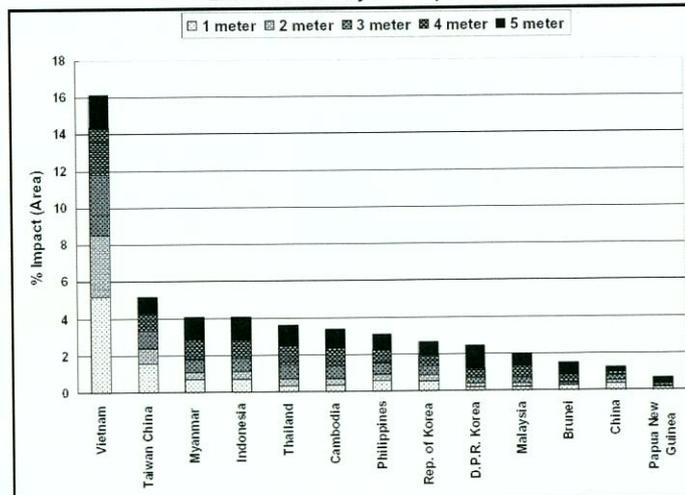


*“parts of the [Chao Phraya] delta have sunk relative to sea level by 15cm”*

Source: Syvitski et. al., Nature Geosciences, 2009



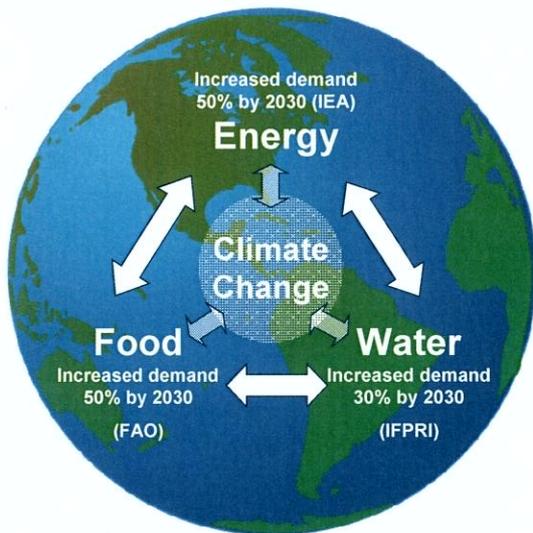
East Asia: Country area impacted



Source: World Bank 2007



## The Perfect Storm?



1. Can 9 billion people be fed equitably, healthily and sustainably?
2. Can we cope with the future demands on water?
3. Can we provide enough energy to supply the growing population coming out of poverty?
4. Can we do this whilst mitigating and adapting to climate change?
5. How does science and engineering help in preventing and adapting to this perfect storm scenario?



## If we do nothing – Conflicts over food?

**NEWS** BBC NEWS CHANNEL

News Front Page Refresh updated at 04:21 GMT, Saturday, 5 April 2008 05:21 UK

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### Food riots turn deadly in Haiti

At least four people were killed and 20 wounded when demonstrations against rising food prices turned into riots in southern Haiti, officials say.

Reports say scores of people went on the rampage in the town of Les Cayes, blocking roads, looting shops and shooting at UN peacekeepers.

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**Food riots erupt near Bangladesh capital, army called in**

Dhaka (PTI): Thousands of textile workers protesting against soaring food prices on Saturday clashed with the police and went on a rampage attacking vehicles and shops, prompting authorities to call in the military in the outskirts of the Bangladesh capital.

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### Food crisis threatens security, says UN chief

- Warning of instability and backlash for economies
- Progress on development goals could be wiped out

Alexandra Topping  
The Guardian, Monday 21 April 2008  
Article history

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### Already we have riots, hoarding, panic: the sign of things to come?

Can Monitor World Business Editor

Dear Central, click here to read Times Online's environment blog

The spectre of food shortages is casting a shadow across the globe, causing riots in Africa, consumer protests in Europe and panic in food-importing countries. In a world of increasing affluence, the hoarding of rice and wheat has begun. The President of the Philippines made an unprecedented call last week to the Vietnamese Prime Minister, requesting that he promise to supply a quantity of rice.

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## Conflicts over water?

### The dam that divides Ethiopians

Divisive dam Video map 'Water wars' Lake at risk Slides



By Peter Grestia  
BBC News, Ethiopia

Most people in Ethiopia's lower Omo River Valley continue to exist much as they have done for hundreds of years with virtually no concession to the 21st Century, with one disturbing exception: automatic weapons.

Almost every male carries a Kalashnikov or an M-16 assault rifle, and what might in the past have been a fairly innocuous dispute over grazing or water-rights between different groups, now frequently escalates into bloody warfare.

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### India is stealing water of life, says Pakistan

Thousands of Punjab farmers suffer as river Chenab runs dry

By Andrew Buncombe and Omar Waraich in Warirabad

Thursday, 26 March 2009

Crucial, coveted and increasingly scarce, water has become the latest issue to stoke tensions between India and Pakistan, with farmers in Pakistan's breadbasket accusing Delhi of reducing one of the subcontinent's most important rivers to little more than a trickle.

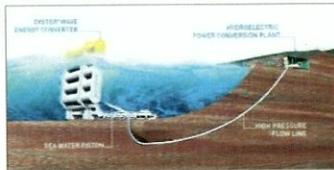
A group of more than 20 different UN bodies warned earlier this month that the world may be perilously close to its first water war. "Water is linked to the crises of climate change, energy and food supplies and prices,



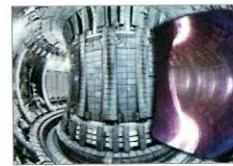

## Science and engineering solutions: energy



'Zero energy' Tobacco Company Building  
Gaungzhou, China



"Oyster" wave energy converter



Fusion at JET (Joint European Torus) in Oxfordshire, UK

There are many other solutions, for example:

- Hydrogen
- Solar photovoltaic
- Wave
- Energy efficiency engineering
- Wind
- Geothermal
- Natural Gas Hydrate
- Biomass (gas and liquid fuel)



## Science and engineering solutions: water security

Demand primarily driven by:



Domestic



Agriculture



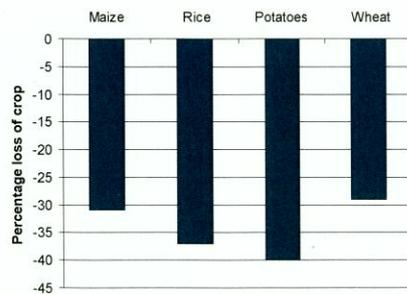
Manufacturing and  
energy supply

Each requires a different type of solution, for example:

- Improving agricultural water use efficiency e.g. drought resistance crops, drip irrigation system
- Recycling domestic grey water from houses
- Nanotechnology to increase the availability of fresh water
- Solutions for water storage, for example reservoirs



## Science and engineering solutions: food security



*Current losses due to pests and diseases worldwide*

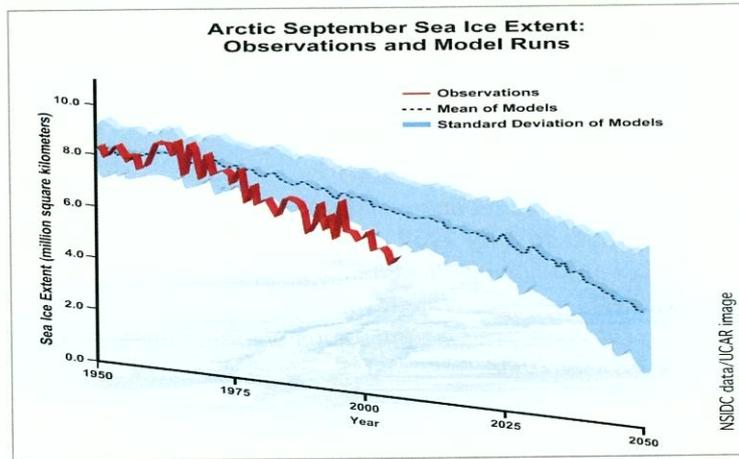


*Plants grow in an oasis next to the desert in Dunhuang, Gansu province*

- Genomics to provide targeted and predictive non-GM plant breeding (e.g. for yield, sustainability, quality)
- Work on crop improvement e.g. increased disease resistance
- GM may also provide future solutions, notably for improved drought and saline tolerance; and resistance to pests and disease



# The situation may be worse than predicted



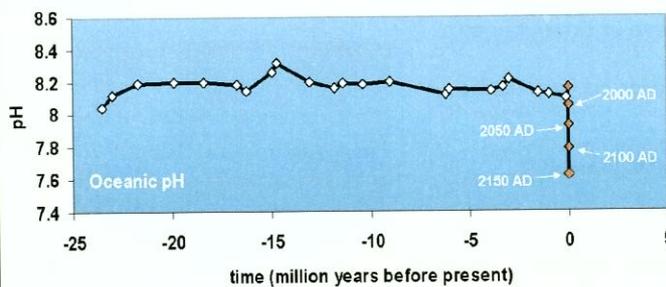
Arctic, near-ice free by 2030?  
 (Source: Wang and Overland, 2009)

Source: National Snow and Ice Data Center (NSIDC), 2007



# Ocean acidification

## Changes in pH over the last 25 million years



Oceans are an important reservoir for CO<sub>2</sub> with ~30% of CO<sub>2</sub> produced from fossil fuel burning & land-use change taken up by oceans  
 (Sabine et al 2004)

- Oceans will become: warmer; more acidic; less diverse; and over exploited
- The impact on ocean food webs, ecosystems and biogeochemical cycles could be very serious

Source: Blackford & Gilbert 2007, Caldeira & Wickett 2003



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## Science and engineering is driving UK Climate Change policy

The Climate Change Committee has made a number of recommendations which have been welcomed by the UK Government:

- *The UK should reduce emissions of greenhouse gases by at least **80% by 2050**, as a fair contribution to a global action on climate change*
- *The UK should reduce emissions of greenhouse gases by **34% by 2020***
- *Once a global deal is reached, the target should increase to **42% by 2020***



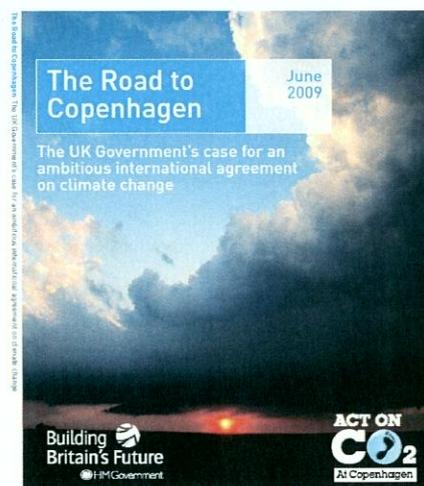
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## Key issues for the Copenhagen climate change summit

What we need to achieve in Copenhagen:

- Action by every country to cut green house gas emissions
- Using the Carbon Market to support emissions reductions
- Using technology to tackle climate change
- Tackling Deforestation
- Supporting countries in adapting to climate change
- Put in place the finance mechanism for action
- Reforming International Institutions





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## Thai climate change action (1)

The Bangkok Assessment on Climate Change (2009) suggested climate change adaptation measures. Some examples:

Climate change impact	Community infrastructure operations	Business and commercial	Residential health and general population
General long-term rising temperatures	<ul style="list-style-type: none"> <li>• Urban design</li> <li>• Tree planting</li> <li>• Water conservation</li> <li>• Insect and pest controls</li> </ul>	<ul style="list-style-type: none"> <li>• Reduced "heat island" effect using green spaces</li> <li>• Agricultural techniques</li> </ul>	<ul style="list-style-type: none"> <li>• Better insulation</li> <li>• Design for efficient cooling</li> <li>• Pest, insect controls</li> <li>• Water conservation</li> </ul>
Increased frequency and intensity of short-duration heavy rain	<ul style="list-style-type: none"> <li>• Increase the size of storm drains, culverts, bridge opening etc</li> <li>• Increase water absorbing capacity of urban landscape</li> </ul>	<ul style="list-style-type: none"> <li>• Increase water-absorbing capacity of large paved areas</li> </ul>	<ul style="list-style-type: none"> <li>• Ensure that storm sewers are clear of debris</li> <li>• Increase attention paid to landscape design for reducing rapid run-off</li> </ul>



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## Thai climate change action (2) Rice production in Thailand

### Addressing Methane Production

- Use low-methane rice cultivars
- Use direct seeding to reduce the period of methane formation
- Use soil aeration in conjunction with water management
- Reduce use of organic matter as fertilizer
- Use mineral fertilizers
- Use methane production inhibitors





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## **International scientific collaboration is essential to solve the major global problems**

The UK is committed to working with  
Thailand on key areas of science:



- Infectious disease
- Bioelectronics / nanotechnology
- Life Sciences / healthcare
- Climate Change and renewable energy technology

### **UK-Thailand Partners in Science Joint Statement**

is a clear indication of this commitment