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Outline

- Our changing climate;
- What nature is telling us: glaciers, sea level, coral reefs and wildlife;
- Food – wine, livestock and fisheries;
- Health;
- Risks, media and ethical issues.
Our changing climate

- Ice age earth at 20,000 years ago 5°C less than today.

From IPCC 2007
Our changing climate

A medieval warm period

- Little Ice Age a time of cooler climate lasting 250 years;
- Temperatures have warmed 1°C from 1850.

Rapid warming

Colder in different places at different times

http://www.cru.uea.ac.uk/cru/info/warming/
Our changing climate

Natural disasters are more frequent than 30 years ago - and are costing us more.

- Earthquake, tsunami, volcano
- Extreme temperature, drought, fire
- Flood, mass water movements
- Storms

Global losses $bn

- Japan & New Zealand earthquakes
- Kobe earthquake
- Hurricane Katrina

Trends for each category

Drought March 2013
Our changing climate

Concentrations of the greenhouse gas carbon dioxide in the air are approaching 400 parts per million (ppm) - the first time in **human history:** the highest back to 3-5 million years.
Projected Change in Global Mean Temperature

We are at a Y-Junction for the future

Rapid development of new technology and halving greenhouse gas emissions by 2050.

Increasing use of fossil fuels.
Glacier length records were at a maximum from 1700-1900;

Glaciers show massive retreat 1900 – 1950 then slowed.
Reconstructions indicate temperatures -0.5°C cooler pre 20th century;
Glacier trends show a warming of 0.5°C from the 1910s to 1940s, with a small cooling of 0.1°C to 1975, then warming.
Since the later 1950s, glaciers have thinned a massive 14 metres in water equivalent.
What nature says: Glaciers

Ice volume changes for the Southern Alps in water equivalents (km³). 30% reduction 1976 - 2012: 55 to 38 km³. 1890s 100 to 170 km³.
The Mid-Pliocene (about 3.3 to 3.0 Ma) is the most recent time in Earth’s history when mean global temperatures were substantially warmer for a sustained period, at about 2 to 3°C above 1971-2000;

- Atmospheric CO₂ concentrations estimated to be between 360 to 400 ppm);
- Sea level were in the order of 10 metres above modern levels.
Sea level has been fairly stable over the last few millennia;
- It has risen 250 mm since 1880 and the rate is increasing.
What nature says: Sea level

- Loss of mass of glaciers contributes to sea level rise;
- The other large contribution is from ocean thermal expansion – where oceans spread out as they warm;
- Surprisingly dam construction resulting in water capture has reduced sea level rise;
- Extraction of groundwater now offsets this;
- Largest uncertainty comes from melting of Greenland and Antarctic ice sheets.
What nature says: Sea level

- Sea level is expected to rise between 50 - 120 cm by 2100, then continue;
- Humanity is faced with three adaptations:
  - retreat: abandoning coasts or islands;
  - accommodate: changing infrastructure, plan appropriate use of coastal zones, storm-surge shelters;
  - protect: extending barriers or dykes.
What nature says: Coral reefs

- Small changes in sea temperature and chemistry are driving mass death of reef-building corals;
- Mass bleaching has been increasingly affecting corals around the world;
- This was driven in 1998 by an unusually warm El Nino event in the tropical Pacific;
What nature says: Coral reefs

- The steady rise of carbon will acidify the oceans making corals unable to build their skeletons;
- If these changes continue, coral reefs will be ecologically extinct in the latter part of this century.
What nature says: Wildlife

- Phenology shifts: earlier arrival in spring, earlier eggs;
- Other behavioural changes.

Short Distance Migrants Arriving Earlier Than Cuckoo
What nature says: Wildlife

1900

>7,800 ft

2004

>9,500 ft

Pika

http://www.youtube.com/watch?v=dsKmUoDyQEU

Range shifts:

• Polewards;
• Upwards in elevation;

BUT

• Human civilization often interferes with the new ranges.
What nature says: Wildlife

- Current extinction rate is ~1 in 10 species over 1000 years
- IPCC Assessment Report 4:
  - Up 2°C = ~400,000 species extinctions;
  - Up 4°C = ~1 Million species extinctions.
High temperature tolerance traits appear constrained and less variable than low temperature tolerance traits;

Many species are already at their genetic limits of high temperature tolerance.
What nature says: Insects

Nature: Extinct Family of Insects Couldn't Cope with Climate Change

- Insects may adapt to new climate, and sometimes extent their range to stay in the current climatic envelope;
- Populations may shift;
- Some go extinct;
- As the world cooled, the insect Eorpidae may not have been able to cope with the change as effectively as other types of plants and animals 50 million years ago.
What nature says: Insects

- Many insects are pests of crops and forests;
- Pine bark beetle has been causing die off of pines in North America with warmer winters;
- With warming there is a movement of temperature suitability to higher latitudes and elevations;
- Areas increase of a high potential for bark beetle outbreaks and associated tree mortality in the coming century.
Food: Wine

Grapevine Climate/Maturity Groupings

- Wine production limited to 13 – 21°C growing season;
- Outside this range wine growth is possible, but quality poor;
- Warming to date has produced higher alcohol and quality;
- Harvests are now occurring a month earlier.
Map of growing season average temperatures (northern hemisphere Apr–Oct, southern hemisphere Oct–Apr) from observations and model runs from the Community Climate System Model. Current areas of wine growing are shaded in black. Future projections are from the A1B emission scenario.
Livestock contribute 13% of global calories, 28% of protein;
World demand set to increase by 72% by 2050, with 85% coming from developing countries;
Humans can not digest grass: ruminant livestock most efficient means of producing food on extensive grasslands.
Food: Livestock

- Traditional cattle breeding is for rapid growth, high egg or milk production – these animals are less able to lose heat;
- Livestock that have a higher resistance to heat have lower productivity;
- With warming thermal stress will affect productivity to select for this trait;
- Maximising forage, rather than energy-dense diets reduce animal heat production.

- Warming is likely to increase bacterial, fungal and vector (insect) borne diseases.

Bos taurus

Bos indicus

LIVING IN A WARMER WORLD
Options for reducing methane and nitrous oxide emissions include:

- Dietary supplements;
- Balancing energy to protein ratios
- Nitrate inhibitors to grass;
- Breeding for improved efficiency and reduced methane emissions;
- Adjusting microbes in animals & soil;
- Vaccination.
Fish account for 15% of global food protein;
Fish are moving poleward, phenology changing with warming;
Climate warming only one of several pressures on fisheries.
Food: Fisheries

The relationship between recruitment anomaly and sea surface temperature (SST) anomaly in °C for various cod stocks.

Food: Fisheries

Reducing fishing pressure: A triple win, no regrets strategy

- More resilient populations and ecosystems (enhances adaptation);
- Lower use of fuel (mitigation of GHG emission);
- Higher yields (most stocks overfished).

Editorial

Tackling the old familiar problems of pollution, habitat alteration and overfishing will help with adapting to climate change
**Health - Heatwaves**

<table>
<thead>
<tr>
<th>Country</th>
<th>Date</th>
<th>Number Killed</th>
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<tbody>
<tr>
<td>Russia, Heat wave</td>
<td>June - August 2010</td>
<td>55736</td>
</tr>
<tr>
<td>Italy, Heat wave</td>
<td>July, 2003</td>
<td>20089</td>
</tr>
<tr>
<td>France, Heat wave</td>
<td>August, 2003</td>
<td>19490</td>
</tr>
<tr>
<td>Spain, Heat wave</td>
<td>August, 2003</td>
<td>15090</td>
</tr>
<tr>
<td>Germany, Heat wave</td>
<td>August, 2003</td>
<td>9355</td>
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<tr>
<td>Portugal, Heat wave</td>
<td>August, 2003</td>
<td>2696</td>
</tr>
<tr>
<td>India, Heat wave</td>
<td>May, 1998</td>
<td>2541</td>
</tr>
<tr>
<td>France, Heat wave</td>
<td>July, 2006</td>
<td>1388</td>
</tr>
<tr>
<td>United States, Heat wave</td>
<td>June, 1980</td>
<td>1260</td>
</tr>
<tr>
<td>India, Heat wave</td>
<td>May-June, 2003</td>
<td>1210</td>
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- Heatwaves are silent killers – they have notable impacts on illness and deaths;
- The Russian & European heatwave events of 2010 & 2003 broke the 500-year-long seasonal record over 50% of Europe;
- By 2100 1 in 20 year annual hottest day will increase will become a 1 in 2 year event;
- What are unusual heatwaves now (e.g. European 2003 heatwave) will be 'normal for summer by 2100.
# Health - Diseases

<table>
<thead>
<tr>
<th>Very high confidence</th>
<th>Negative impact</th>
<th>Positive impact</th>
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<tbody>
<tr>
<td>Malaria: contraction and expansion, changes in transmission season</td>
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<thead>
<tr>
<th>High confidence</th>
<th>Negative impact</th>
<th>Positive impact</th>
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<tbody>
<tr>
<td>Increase in malnutrition</td>
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<tr>
<td>Increase in the number of people suffering from deaths, disease and injuries from extreme weather events</td>
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<tr>
<td>Increase in the frequency of cardio-respiratory diseases from changes in air quality</td>
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<td>Change in the range of infectious disease vectors</td>
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<td>Reduction of cold-related deaths</td>
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<tr>
<th>Medium confidence</th>
<th>Negative impact</th>
<th>Positive impact</th>
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<tbody>
<tr>
<td>Increase in the burden of diarrhoeal diseases</td>
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IPCC 2007
Health - Diseases

Dengue distribution 2050

B Climate and GDP both change ~ 120 million people more at risk;

C Climate change only ~ 280 million people more at risk.
Media

Risk theorist Ulrich Beck has identified the social world’s tendency, when faced with environmental risk, to engage in ‘organized irresponsibility’.

With climate change, policy makers and the news media framed the issue as a matter of international political negotiations over emission reductions. Direct physical risks to national populations, environments and economies were ignored.
Ethical issues

- Historical liability highest for US, Europe;
- Emerging economies now ramping up;
- Ethical responsibility to future generations;
- Most challenging is burden sharing;
- Major democracies have so far failed to take domestic actions to fulfil global responsibilities;
- Run the risk of a huge environmental debt of the quality of life on earth.
Ethical issues
Risk and climate change

The Key and Abbott’s administration attitude towards climate policy
Risk and climate change

Sleeping giants
“In my personal value frame, it is already a few decades too late for having implemented some policy measures against such risks.....

beyond a few degrees Celsius of warming —it is likely that many ‘dangerous’ thresholds will be exceeded.....

uncertainty is no longer a responsible justification for delay. ”

Stephen H Schneider