FOOD SECURITY IN A WARMER WORLD
Wheat, viticulture, livestock and fisheries

How a changing climate will affect our lives

JIM SALINGER (ed.)
Outline

• Our changing climate
• Food – cropping: wheat and wine;
• Pastures and livestock;
• Fisheries;
• Concluding remarks

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Administrator, United Nations Development Programme

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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.
Our changing climate

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

A mediaeval warm period

Rapid warming

Colder in different places at different times
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
- Hurricane Katrina
- Kobe earthquake
- Trends for each category

© NewScientist
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.
Some regions are likely to face significant water management challenges – especially subtropics and low mid-latitudes, Mediterranean, southern half of Australia; Increase in heavy rainfall events leading to floods, and largest impacts will be felt by poor with limited resources to adapt.
Based on many studies covering a wide range of regions and crops, negative impacts of climate change on crop yields have been more common than positive impacts;

Many marine species have shifted their geographic ranges, seasonal activities, migration patterns, abundances, and species interactions in response to ongoing climate change;

All aspects of food security are potentially affected by climate change, including food access, utilization, and price stability.
For the major crops in tropical and temperate regions, climate change without adaptation is projected to negatively impact production for local temperature increases of 2°C or more.

IPCC AR5
Food: Wheat

• Wheat is the world’s most important cereal crop;
• 70 percent is used for food, 19% is for animal feed;
• Annual per person average wheat consumption is 68 kg, rice 57 kg;
• Yield and productivity growth now being outpaced by population growth.
Food: Wheat

- Without adaptation, wheat yields decline with warming, and the rate of decay increase;
- An increase of 4°C reduces yields 50% without adaptation;
- With adaptation decline is 30%.
Food: Wheat

Adapting wheat systems to a warming world

- On-farm management alterations to deal with small changes in climate (e.g. integration of livestock), transformation change (major change in farming system, or similar farming system in a new location);
- Zero tillage for increase in irrigation efficiency;
- Planting crops to avoid high temperatures;
- Use conventional and modern plant breeding to improve the climate and the environmental response;
- Selection of varieties that can cope with higher temperatures and increased drought.
Food: Wine

Grapevine Climate/Maturity Groupings

<table>
<thead>
<tr>
<th>Cool</th>
<th>Intermediate</th>
<th>Warm</th>
<th>Hot</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-15°C</td>
<td>15-17°C</td>
<td>17-19°C</td>
<td>19-21°C</td>
</tr>
</tbody>
</table>

- Wine production limited to 13 – 21°C growing season;
- Outside this range wine growth possible, but quality poor;
- A climate sensitive crop grown over a narrow geographic range;
- Warming (~1°C) has produced higher alcohol content but lower quality;
- Harvests are now occurring a month earlier.
Food: Wine

- Map of growing season average temperatures (NH Apr–Oct, SH Oct–Apr) from observations (tan) and model runs for the A1B emission scenario (red line);
- Current areas of wine growing are shaded in black;
- Wine production an early warning system for all food crops of climate change.
Food: Pastures

- Grasslands comprise 26% of the global land area and 70% of the agricultural area;
- Over 800 million rely on grasslands for their lives, largely through livestock;
- Grasslands are a low cost source of food for ruminants;
- Contributes to human food consumption on land unsuited for other agriculture.
Food: Pastures

- Pasture production may increase under moderate change in high rainfall, cool temperature areas;
- Moderate warming produces little change in lower rainfall temperate regions;
- With more warming and in lower rainfall areas yield lowers production quite dramatically.
Food: Pastures

- Natural or low input adaptation options limited but include:
  - building soil carbon
  - using varieties with deeper rooting systems to extract more soil moisture and more heat tolerance;
  - matching stocking rates and reproduction to carrying capacity of grassland;
  - shift from C3 to C4 grasses;
  - continue plant breeding.

- Intensive systems include
  - changing grasses;
  - water management;
  - use of legumes;
  - fertilizer.
Livestock contribute 13% of global calories, 28% of protein: numbers have increased 5-25% in the 2000s;
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

• Heatwaves and drought have highest impacts on production;
• Traditional cattle breeding is for rapid growth, high egg or milk production – these animals are less able to lose heat;
• With warming thermal stress will affect productivity if selected for this trait;
• Breeding livestock and feeding for reduced thermal stress;
• Maximising forage and low protein/high fibre diets, rather than energy-dense diets to reduce animal heat production;
• Warming is likely to increase bacterial, fungal and vector (insect) borne diseases.
Food: Livestock

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.

Removing livestock from the vast rangeland systems will not help food security;

Livestock is part of the future global food equation.
Food: Fisheries

- 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.


Warmer Temperatures increase Recruitment

Warmer Temperatures decrease Recruitment
Due to projected climate change by the mid 21st century and beyond, global marine-species redistribution and marine biodiversity reduction in sensitive regions will challenge the sustained provision of fisheries productivity and other ecosystem services.

IPCC AR5
For medium- to high-emission scenarios, ocean acidification poses substantial risks to marine ecosystems, from phytoplankton to animals. 

IPCC AR5
Food: Fisheries

Change in maximum catch potential (2051-2060 compared to 2001-2010, SRES A1B)

< -50 %  -21 - -50 %  -6 - -20 %  -1 - -5 %  no data  0 - 4 %  5 - 19 %  20 - 49 %  50 - 100 %  > 100 %

IPCC AR5
Food: Fisheries

Sensitivity of national economies to impacts of climate on fisheries
Food: Fisheries

Adaptive capacity of national economies to impacts of climate on fisheries
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).

Marine Pollution Bulletin

journals homepage: www.elsevier.com/locate/marpolbul
“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

Food security in a warmer world requires:

• Adaptation of cropping systems to climate change as part of good risk management;
• Viticulture needs to prepare for change;
• Management of grasslands will be crucial to matching carrying capacity to climate;
• Developed world must fund win-win ways to improve livestock; production for a warmer world with less emissions;
• Imperative to ensure sustainable marine fisheries for regional food security.