

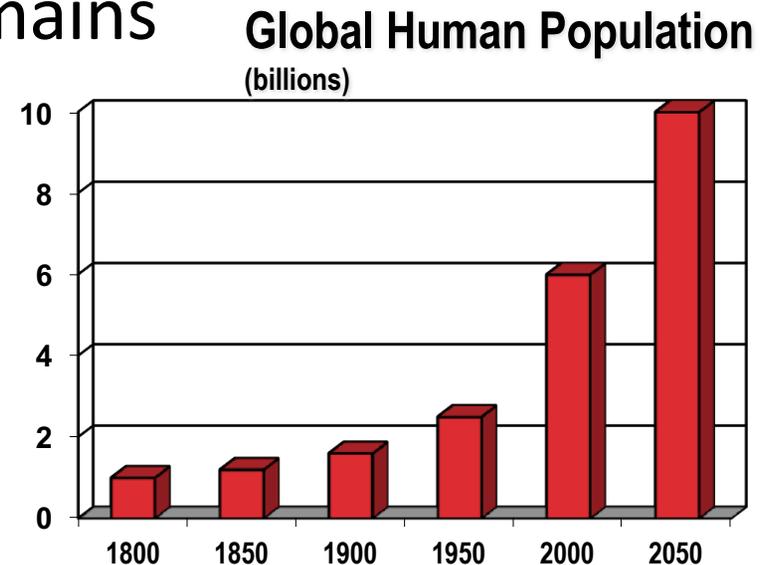
The Water-Climate Nexus and Food Security in the Americas

Michael Clegg

University of California, Irvine

The Global Challenge

- Global population is projected to increase by about 30% between now and 2050
- Global food demand is projected to increase by as much as 70% between now and 2050
- Environmental degradation remains a major threat.
 - Deforestation
 - Loss of soils
 - Water
 - Climate change



Some Data On Food Production

- Cereals
 - Today the world produces 2.1 billion tons
 - 2050 projected to reach 3 billion tons
 - Uncertainty in projections owing to future demand for biofuels
 - FAO projects food demand will increase by about 70% by 2050
 - This is without considering the impacts of climate change.

*FAO High Level Expert Forum. "How to Feed the World by 2050".

The Americas

- Extends more than 14,000 km from the Arctic to the Antarctic.
 - It covers almost every conceivable environment from arctic tundra to tropical forest to montane regions and extensive deserts.
 - About 28% of the land area of the earth is included within the Americas, while the region hosts only about 13.5% of the human population.
- About 9% of the land area of Latin America and the Caribbean is arable and almost 38% is agricultural.
- About 16.9% of US land was arable in 2014 having declined from about 19.7% fifty years ago (about 44.6% is agricultural), while Canada's arable land has increased from 4.5% fifty years ago to 5.1% in 2014
- Most urbanized region of world with > 80% of population living in urban settings
- Current human population about 950 million, projected to about 1.2 billion by 2050

The Current Role of the Americas in Food Security

- Latin America is the largest net food exporter in the world.
 - yet 18 countries in Latin America are net food importers
 - The Caribbean imports about 60% of its food supply.
- North America is the second largest net exporter.
- Aquaculture is a major industry in countries such as Canada, Chile, Mexico, Peru, Argentina, and Ecuador.
- Marine resources are important for many countries of Americas, but are threatened



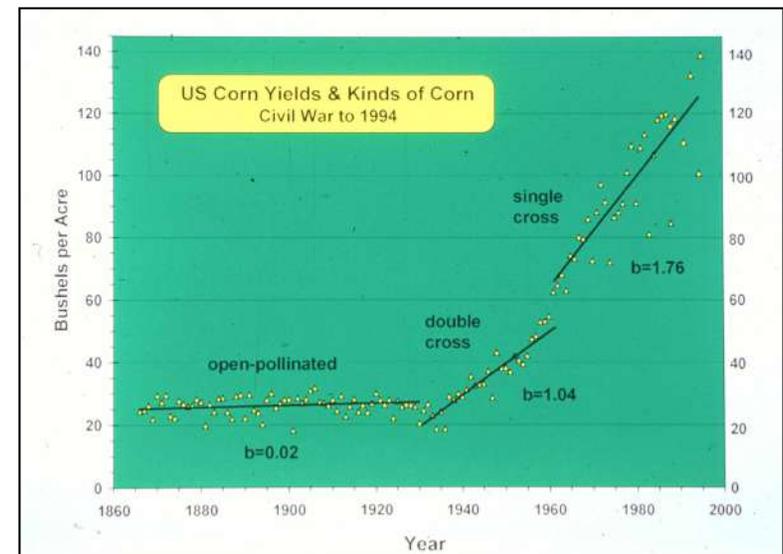
Food Security Facts

- More than 85% of all Biotech and GM crops are currently planted in the Americas.
 - These have provided substantial environmental benefits through reduced herbicide use, low or non-tillage practices, increased productivity per unit land area and reduced Greenhouse Gas (GHG) emissions.
- The region of the Americas has major potential for growth in food production.



More...

- Progress in the Americas over the last quarter century has been impressive owing to advances in science, technology & innovation (STI).
 - STI have played a major role in improvements linked to the Millennium Development Goals (MDGs).
 - STI will continue to play a key role in achieving the Sustainable Development Goals (SDGs) by 2030.
 - Progress will depend, in part on greater regional and global cooperation in STI, and partly on the development of more uniform policy frameworks.



Water Challenges - Americas

- Poor water quality and inefficient water management are among the greatest environmental challenges for the Americas.
- The Americas are rich in water resources, but STI based improvements for water management, especially with respect to optimizing irrigation efficiency, are essential to meeting the food producing potential of the region.
- Water quality is increasingly degraded by unwanted contaminants.
 - Includes pathogens, fertilizers, pesticides, decomposed plant material, suspended sediment, and other contaminants such as fuels and solvents.
 - Run off into streams and lakes causes turbidity that is harmful to fish and adds materials that, over time, reduces the volume of lakes and reservoirs.
Eutrophication of surface waters due to agricultural inputs like phosphorous and nitrogen is a continuing problem.



More challenges

The region of Latin America continues to suffer **massive deforestation** and associated environmental degradation. The largest net losses (3.6 million hectares/yr) were recorded between 2005 and 2010 and occurred in South America.

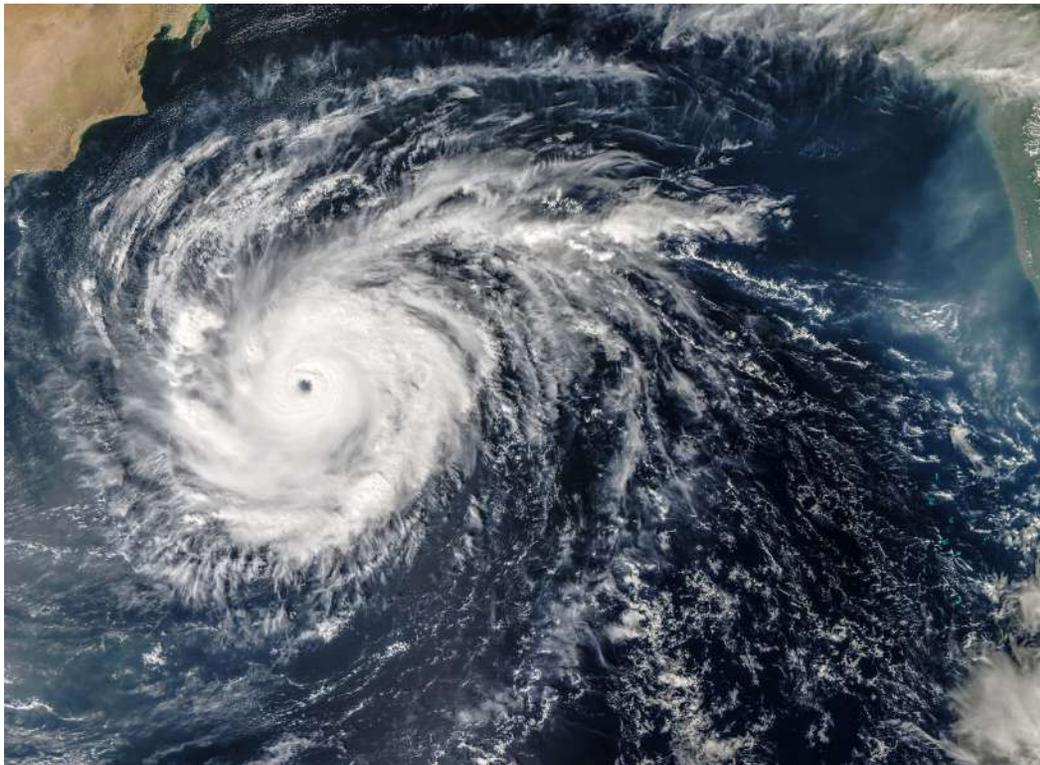
The challenge for the Americas will be to retain the ability to feed and adequately nourish itself while also making a substantial contribution to the food supplies available to the rest of the world.

Where will the food come from?

- Arable land increase for agricultural production by about 5%.
- Higher yields and increased cropping intensity will account for about 80% in developing countries.
 - But on average crop yield increases will be about half (0.8%/yr) of historical levels (1.7%/yr)
 - Cereal yield growth rates will slow to about 0.7%/yr.
- Expansion of irrigation by about 28% (in developing countries).
- Water withdrawals will increase by about 11% (286 cubic km).
 - Pressures on renewable water resources from irrigation will remain severe.

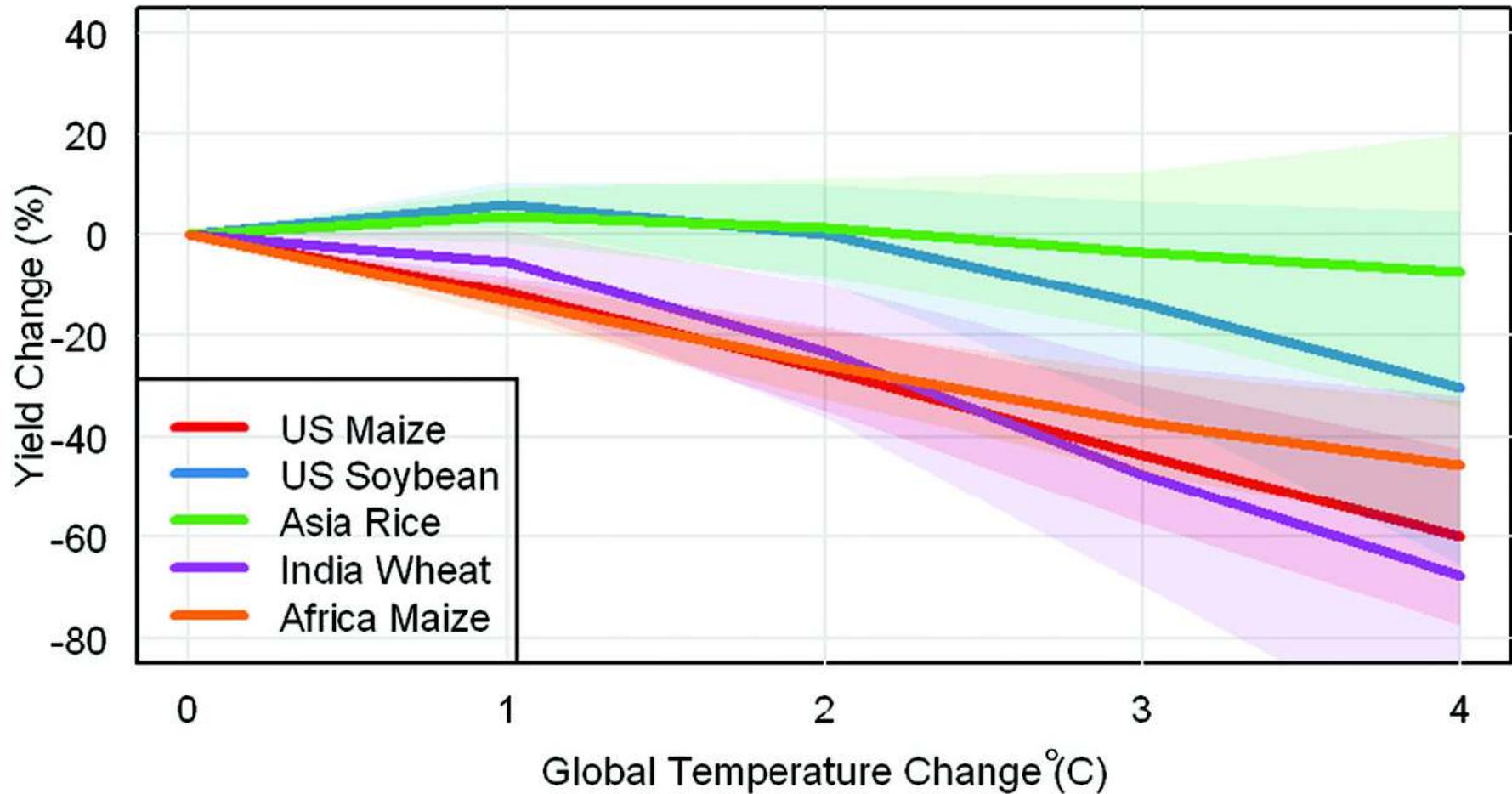
*FAO High Level Expert Forum. "How to Feed the World by 2050".

Modern Agriculture is a Major Contributor to Climate Change



Extreme
events will
become
more
frequent

Loss of crop yields per degree warming



Contributions to GHGs from Agriculture

- Highest source of non-CO₂ GHGs (e.g. methane) –
 - Livestock and emissions from agricultural soils account for about 70% of Ag emissions.
 - Other major sources are:
 - Rice paddy cultivation
 - Biomass burning
 - Manure management
- About 10-12% of total GHG emissions are from Agriculture
- If forestry is included this doubles to about 24%*

*According to the IPCC fifth assessment (AR5) report.

Opportunities to reduce agricultural emissions

- Demand side
 - Reducing waste and loss in food.
 - Encouraging diet changes.
 - Reduce over consumption where applicable.
- Supply side
 - Management changes in land and livestock.
 - Terrestrial carbon stocks can be increased by sequestration in soils and biomass.
 - Substitution of fossil fuels by biomass providing certain conditions are met.

General Considerations

- In most cases CO₂ has a stimulating effect on plant growth, but ozone reduces growth. Elevated ozone levels suppress global production of crops, causing estimated losses of 10% for wheat and soybean.
- Terrestrial ecosystems provide a variety of vital services for agricultural production that will be undermined by climate change.
 - nutrient cycling,
 - waste decomposition,
 - seed dispersal.
- Complex systems
 - interactions between CO₂, ozone, mean temperature rise, temperature extremes, reduced water availability and changes to the nitrogen cycle.
- **Disruptions in these systems will have unpredictable, but largely negative outcomes.**

*Cameron, E. 2014. Key Findings from the Intergovernmental Panel on Climate Change Fifth Assessment Report. University of Cambridge.

Impacts of Climate Change on North America

- Marked increase in crop losses attributed to climate-related events such as drought, extreme heat, and storms has been observed across North America
- Among studies that do not consider adaptation, overall yields of major crops in North America are projected to decline modestly by mid-century and more steeply by 2100
 - two factors stand out: exceedance of temperature thresholds and water availability
- Some specific impacts
 - Projected temperature increases would reduce corn, soy, and cotton yields by 2020, with declines ranging from 30 to 82% by 2099 depending on crop and scenario
 - Projected large declines in land suitability for California viticulture by 2050
 - The northeastern and southeastern USA have been identified as “vulnerability hotspots” for corn and wheat production, respectively, by 2045 with vulnerability worsening thereafter
 - Central North America is identified as among the globe’s regions of highest risk of heat stress by 2070

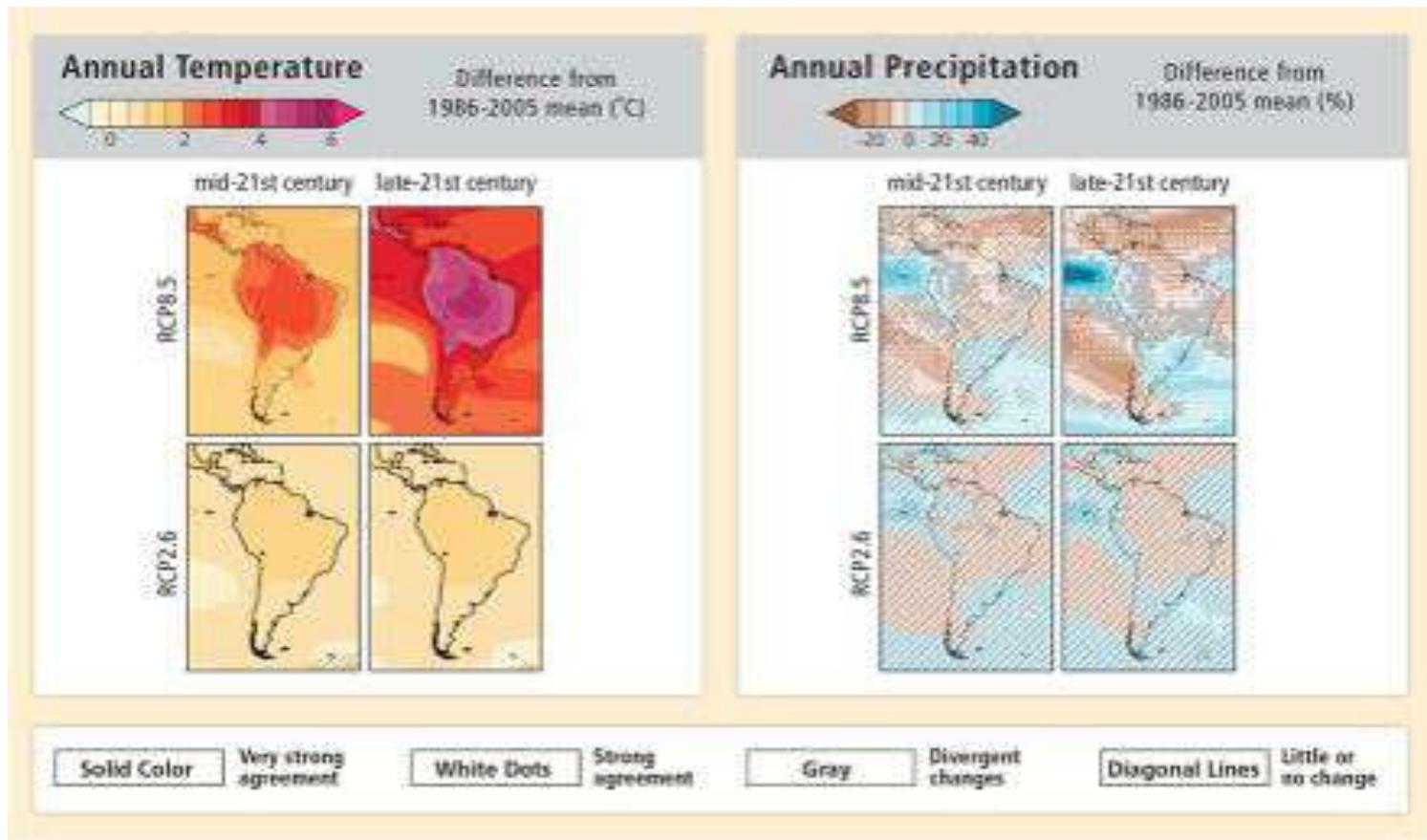
Impacts of Climate Change on Mexico

- Land classified suitable for rain-fed corn is projected to decrease from 6.2% currently to between 3 and 4.3% by 2050
- Precipitation declines of 0 to 30% are projected over Mexico by 2040 with the most acute declines in northwestern Mexico, the primary region of irrigated grain farming
- Indigenous peoples are highly vulnerable due to high reliance on subsistence

IPCC, North America (2014)

Temperature and rainfall projections LAC countries

Projected changes in annual average temperature and precipitation. CMIP5 multi-model mean projections of annual average temperature changes (left panel) and average percent change in annual mean precipitation (right panel) for 2046-2065 and 2081-2100 under two model scenarios.



Regional Impacts LAC Countries

- Probable impacts on North American and South American Monsoon seasons will affect rain fed agriculture and surface water availability
- Impacts in regions near equator are projected to be large
- Current agricultural systems with high levels of production and inputs are unsustainable

Regional Impacts- Sub Saharan Africa

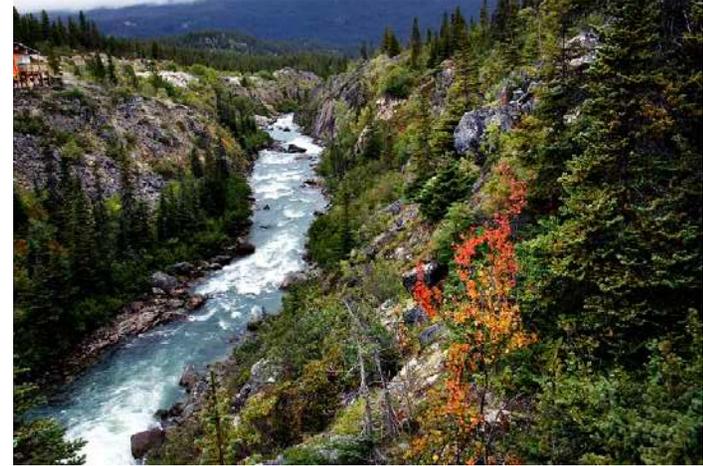
- Climate change is expected to reduce land productivity by 14-27% by 2080.
- About 40% of current production lost owing to poor transport and other factors.

Regional Impacts- Asia

- GHG emissions from agriculture are highest in Asia.
- Climate change will cause reductions in productivity of 18-32% by 2080.
- Negative impacts on rice and other crops.

Impacts on Water

- Climate change is projected to reduce renewable surface water and groundwater resources significantly in most dry subtropical regions.
- Each degree of warming is expected to decrease renewable water resources by at least 20% for an additional 7% of the global population



Impacts on Water Resources- North America

- Projected change in climate will reduce soil moisture and water availability in the US West/Southwest, the Western Prairies in Canada, and central and northern Mexico
- The US Great Plains is identified as one of four global future vulnerability hotspots for water availability from the 2030s and beyond, where anticipated water withdrawals would exceed 40% of freshwater resources

Risks

- “Adaptive capacity is projected to be exceeded if temperature increases by 3°C or more, especially in regions close to the equator.”
- “Climate-related risks interact with existing environmental stressors such as biodiversity loss, soil erosion, and water contamination, together with social stressors such as inequality, poverty, gender discrimination, and lack of institutional capacity.”
 - These interactions compound risks to agricultural production and food security.

*Cameron, E. 2014. Key Findings from the Intergovernmental Panel on Climate Change Fifth Assessment Report. University of Cambridge.

Societal and economic impacts related to agriculture

- Extreme climatic events, such as heat waves, droughts, floods, and wildfires are certain to negatively affect food production.
- Price volatility induced by extreme climate events will enhance investment uncertainty
 - Broad and deep implications for the agricultural sector and global food security.
 - Impacts are largest for the poor.
- Large scale migration of populations.
- Political instability.

Adapting to climate change: Reducing vulnerabilities to emerging and future impacts

- Response options depend on accurate predictions of future impacts
 - Breed heat tolerant crops – but this takes time and investment capital.
 - Control development in areas threatened by sea level rise or flooding
 - Improve efficiencies of water use
- Avoid climate scenarios that impose unacceptable social and economic costs

Conclusions

- The food-water-climate system is a strongly interacting system with multiple feed back loops
 - Link between deforestation and agriculture
 - Link between water management, irrigation and food yields per unit arable land
 - Expansion of pests and diseases with climate change
- Time lags are important and may serve to destabilize the system
- Role of policy and international cooperation is crucial

Thank you

