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WATER AND CLIMATE CHANGE ADAPTATION: THE KEY TO INCREASING AGRICULTURAL PRODUCTIVITY AND POVERTY ALLEVIATION

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ABSTRACT

Climate change (CC) associated with excessive CO_2 emissions (IPCC 2007) will have a profound impact on the natural resources base that agriculture is dependent upon. Climate models generally anticipate an increase in global average precipitation, though the spatial and temporal changes are still debated. The impacts of CC on water – through rainfall, snowfall, soil moisture, river flow and groundwater recharge – will directly translate into impacts on food, livelihoods and ecosystems. With predicted increases in the global populations, rising incomes and changing dietary patterns, demand for food will double over the next 50-80 years – the timeframe when most of the CC impact will be felt. In order to keep up with this demand 60 to 90% more water will need to be consumed by agriculture (Fraiture *et al*., 2007). This raises significant concerns in that currently 20% of the world's population lives in areas where agriculture is affected by water scarcity that will undoubtedly be exacerbated by CC.

Agriculture consumes more than 3000 l of water per person per day to meet current food demand. Approximately 80% of this water is directly met by rainfall and 20% is diverted from rivers, lakes and groundwater. It is estimated that 60% of all agricultural production is derived from rainfed systems, while 40% is generated from irrigated areas. Besides quantity, quality and the timing of water supply through rain or irrigation is equally important and will be significantly affected by CC.

The expected effects of CC on rainfed agriculture vary regionally. In arid and semi-arid areas the absolute amount of rain is expected to decrease but variability will likely increase substantially. This may lead to more short term droughts and crop losses that will further limit crop choice. In monsoon areas the amount and intensity of rain is projected to increase. Flooding in paddy areas may increase which may prove to be beneficial because of increased water supply and fertile silt deposits. Many irrigation schemes, particularly the smaller village level ones, divert water directly from streams and rivers without water storage facilities. These so-called run-of-the-river schemes are particularly vulnerable to changes in river flow in quantity and timing. Changes in rainfall quantities and intensity will affect natural groundwater recharge and therefore the millions of smallholders depending on the groundwater economy in South Asia Many CC mitigation measures have often unforeseen water implications. Biofuels, promoted because they are nearly carbon neutral, in comparison to fossil fuels, could add to pressure on water resources in areas where water is already scarce. In China and India ambitious plans to boost biofuel production are being promotes, however, given the already over-exploited surface and groundwater resources it is unlikely that both countries can expand the irrigated production of maize and sugarcane for ethanol production without affecting sustainable water use and food crop production.

Improved management of water resources will be a requirement in adapting to present and future climate variability. The main premise of previous IWMI research has been that by better understanding and coping with *existing* climate variability, society will develop resilience to CC. Wise water management can increase productivity, create higher rural incomes and smooth water supply shocks, thus reducing fluctuations in production and associated risks. Improved water management is an appropriate way to reduce poor people's vulnerability by reducing water related risks and creating buffers against often unforeseen changes in precipitation and water availability (Fraiture *et al*., 2007). A key element in adaption to CC is building resilience through better water management. In this respect IWMI advocates five key responses.

There is a need to think more creatively with respect to water storage. An obvious response to variability in supply is to store water when it is abundant for use during dry periods. Water storage improves the ability of rural poor to cope with climate shocks by increasing agricultural productivity (and hence income) and by decreasing fluctuations (and hence risks). There are many proven

approaches to enhancing water storage, ranging from small on-farm ponds to large reservoirs, groundwater recharge and storage, water harvesting and soil water conservation capture that may include *in situ* storage associated with conservation tillage.

Improvement of land and water productivity is important both as CC adaptation and mitigation strategy. Improving water productivity by deriving more value from water through higher yields, crop diversification, integrating livestock and fisheries is an important means to improve rural incomes, alleviate poverty and reduce risks by diversifying income sources. At the global scale, improved productivity assists in reducing greenhouse gas (GHG). Land and soil degradation are a major constraint to increasing water productivity on much of the world's arable lands. The needed productivity increases will have to be achieved through enhancing current production systems, most of which have undergone varying degrees of degradation. Soil amendments and farming practices to enhance the productivity of rainfed production systems have resulted in dramatic increases in water productivity, increased soil water and nutrient holding capacity and notable declines in sediment discharge to water bodies.

A key issue in water management and allocation is the management of trans-boundary rivers i.e. rivers that flow across international boundaries. Managing these rivers requires cooperation between countries, a process complicated by both flow variability and potential impacts of CC. Current and future inter- and intra-basin water transfers often insufficiently incorporate climate variability and CC. Planning water transfers without taking adequate consideration of the likely impacts of climate change can reduce the performance of such major investments. Clearly, adjustments in water allocation will require both knowledge of water flows, as well as social and institutional governance mechanisms will be a key area of research associated with adaptation to CC.

Adaptation research closely links with identification of institutional frameworks required to support effective development and use of water, options to build ecosystem resilience to support long term agriculture and options to build societal resilience in response to CC (such as drought early warning systems, insurance schemes and the transition of some people out of farming). Establishing targeted safety nets for farmers who are unable to adjust quickly enough, providing credible insurance against catastrophic asset losses and facilitating rapid recovery will be crucial, given the expected CC impacts.

It is also acknowledged that there will be challenges. These challenges include understanding the impacts of anticipated increased investments in water storage on the environment and long-term feasibility of large scale interventions; downscaling CC predictions to basin level particularly in ungauged situations; and the impacts of mitigation measures on water availability and use.

KEYWORDS
Water resources, climate change, adaption.

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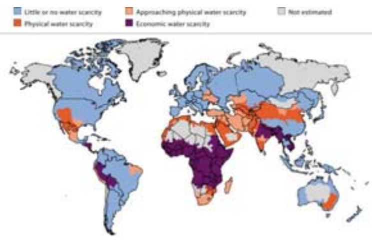
We Live in a Water Scarce World – and it is going to get worse with Climate Change!

- As much as 60% of the global population may suffer different forms of water scarcity by the year 2025
- Water resources, both in terms of quantity and quality, will be critically influenced (compromised) by human activities



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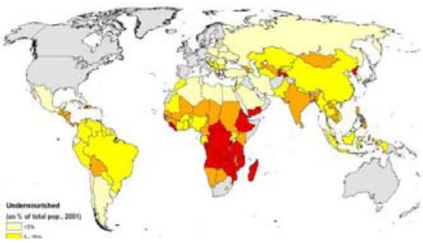
Hunger and Water Scarcity go together.

- Most hungry and poor people live where water challenges pose a constraint to food production
- In the semi-arid and arid tropics, 840 million people are malnourished



Climate Change is adding a further dimension to the food and water nexus

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The Question to be Asked

Do we have enough water resources to grow enough food to meet future demand for food and biofuels in the context of **climate change**?

No!

unless ….

We change the way we think and act on water issues.

RESPONDING TO CLIMATE CHANGE

IS ABOUT MANAGING WATER RESOURCES.

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Presentation Outline

- ✓Water Issues.
- ✓Adaptation.
- ✓ Concluding Remarks.

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Water Issues

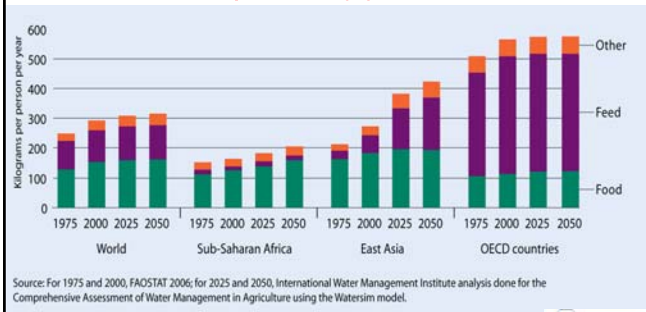
Diets and Water

Between 2,000 and 5,000 liters per person per day – depending on type and amount of food eaten and how it is produced

Developed ← → ***Developing***

Food demand will double over the next 50 years because of dietary changes and population growth

Water requirements (ET) will double – without water productivity gains!



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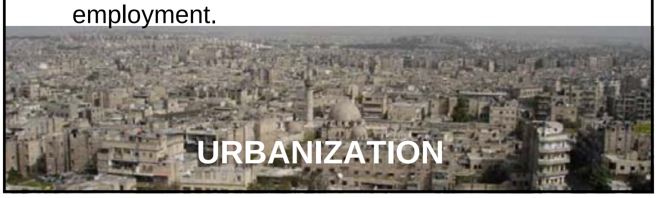
Water Issues

- Increased demand for water for cities.
- Reallocation of water from agriculture to cities.
- Cities generate more wastewater – an important potential source for agriculture.
- Voting dynamics shift.
- Cities offer jobs – competition for rural employment.



Energy and Water

- Competition between sectors: Agriculture and hydropower (could be an opportunity).
- Water for biofuels – competing with water for food?
- Higher energy prices – higher fertilizer prices.
- Desalinization less attractive.

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CC Impacts on Water for Agriculture

- Reduced glacier melt in spring affecting some 17 % of the world's population, irrigation in Indus, Amudarya and Syrdarya and other basins.
- 70% of the world's irrigation is fed from the Himalayan Hindu Kush.
- There are already changes in groundwater recharge affecting irrigation in India and China.
- Changes in timing and magnitude of river flows affecting irrigation schemes diverting directly from rivers and storage requirements.

Adaptations means RETHINKING STORAGE

- Explore a wide range of options in water storage:
  - Large scale reservoirs, small village ponds, groundwater storage, water harvesting (i.e. soil moisture storage).
  - Lining canals and storage structures.
- There will be a need for diversity of storage options within a basin and there management.
- New hydropower developments focusing on electrification of rural areas (i.e. Africa and Southeast Asia) and as a cleaner energy source offers opportunities for "smarter" ways of irrigation.

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- Multiple-use systems – integrating domestic water, irrigation, fisheries, livestock – to provide income, nutrition and health benefits, improved water productivity and environmental services.

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Increasing Water Productivity of Irrigated and Rainfed Production Systems

- **Physical Water** Productivity – more crop per drop
  - To reduce future water needs
- **Economic Water** Productivity – more value per drop
  - For more income, nutrition, value of ecosystem services.

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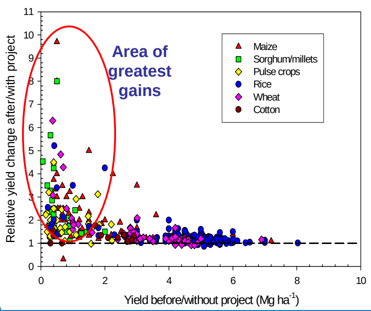
Global assessment of 'Bright' spots – cause for optimism in adaptation



Comprehensive study of 286 cases in 57 countries where individuals and communities that have adopted simple, non-exploitive, innovations to their production systems that have increased incomes and enhanced food security at the household level.

Bright spots influenced: **10.9 million households** covering **31.6 million hectares**.

Pretty et al., 2006; Noble et al, 2006; 2008; ul Hassam et al., 2005.

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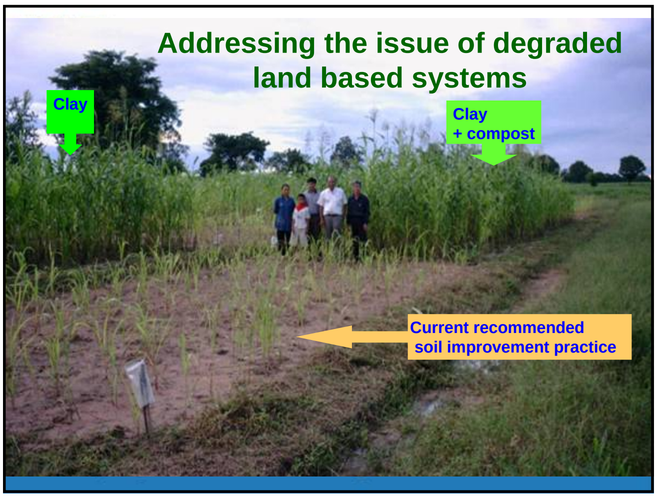

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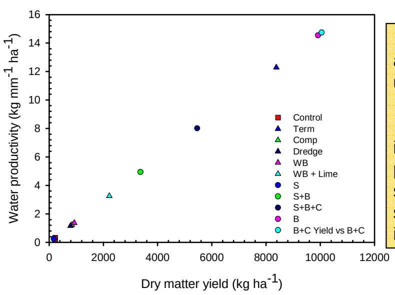
Water productivity – synergistic effect of soil productivity.



- ➢Synergistic effect of **soil** and **water** productivity under **rainfed** conditions.
- ➢Addressing land based issues that enhance the productivity of degraded systems will have significant positive implications.

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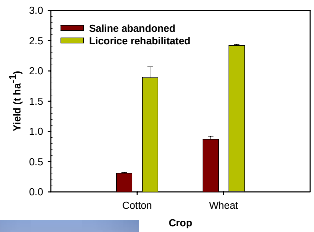
Addressing degraded irrigation production systems

Central Asia 30 000 ha go out of production annually from salinity.

Reverting saline lands back into agricultural production is an important strategy.

Example – cost effective bioremediation through salt tolerant licorice results in improved hydraulic conductivity and lowering of water table.



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Adapt yesterday's irrigation to tomorrow's needs

Rethink and revitalize irrigation in the face of CC:

- Improved and new technologies for water application.
- There is a need to move beyond PIM: Are there other institutional models that are more efficient and effective?
- Recognize the important role of groundwater and pumps – need for rural electrification.
- Take a basin view to find real water savings. This requires effective and functional institutions.

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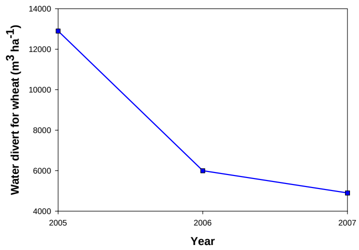
Improving farmer based irrigation institutions

Empowering farmers to manage irrigation systems.

Changing approaches to irrigation planning and water allocation.

In Kyrgyzstan organizing farmers and canal managers can yield significant increases in water productivity.

Water divert for wheat production reduced by > 50%.



Institutional changes are an imperative in adapting to climate change

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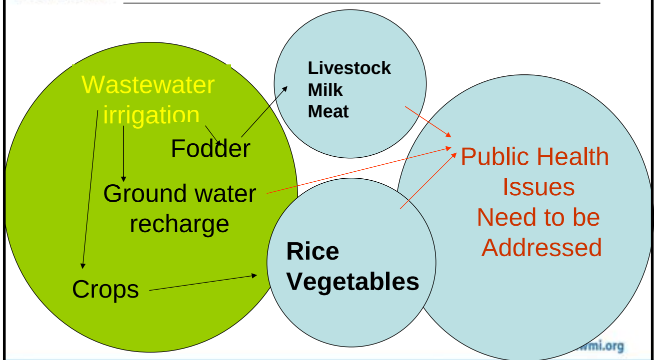
View Waste Water as a Valuable Resource



Need to manage this resource in a sustainable manner

Concluding Remarks

- Water and land resources management are the key to addressing adaptation (and mitigation) to climate change.
- There is no longer the luxury of lateral expansion of the agricultural sector in Asia.
- Need to improve productivity of current degraded land systems.
- Adoption of adaptation strategies has a cost. Who pays?
- We should not loose sight of the fact that the poor and marginalized are the most vulnerable to the impacts of climate change.

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Thank you

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