INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

Food to 2030 and beyond: Groundwater & Food Balance in Key Regions

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During the course of this presentation….

We will:

- Discuss some of the key drivers of change in global agriculture to 2030 and beyond
- Discuss key linkages b/w food & (ground)water
- Look at a particular GW scenario for India
- Discuss the implications for global food markets and food security
- Draw conclusions for water and agricultural policy – and importance of further research & better data

Various 'drivers of change' underlie global trends in agricultural market outcomes

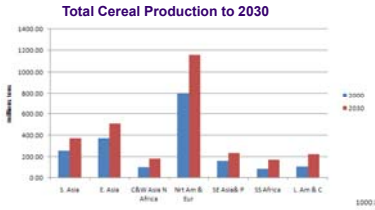
A number of factors at work which determine changing conditions in global food markets

- Socio-economic growth – rising incomes and demands for meat (and the necessary feed grains to supply it)
- Environmental shocks – increasing variability in climate facing agriculture
- Policy drivers
  - Steady decline in cereal stocks
  - Unilateral trade actions (bans & export taxes)
  - Direct effect of energy prices on agriculture & energy policies which have implications for agriculture

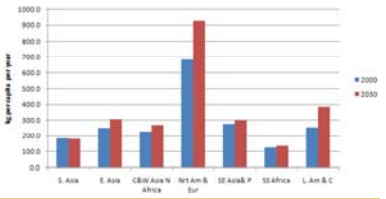
Outlook for cereal production

Continue to depend on key regions to deliver...

Total Cereal Production to 2030



Per Capita Cereal Production to 2030

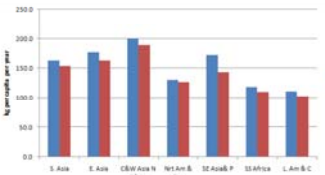


Steady growth in cereals consumption

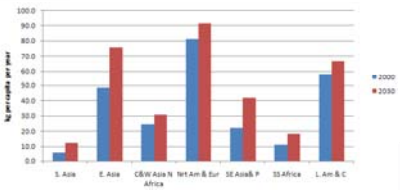
	food consumption		total consumption	
	Growth in Consumption, 2000-2030 (millions mt)	Share of total increase	Growth in Consumption, 2000-2030 (millions mt)	Share of total increase
South Asia	91	40%	117	12%
East Asia	8	4%	200	21%
C&W Asia North Africa	40	17%	101	10%
North America & Europe	7	3%	350	36%
SE Asia& Pacific	13	6%	39	4%
SS Africa	57	25%	79	8%
Latin America & C.	14	6%	74	8%

Regional per cap variation stands out …. especially meat

Per capita Cereal Demand to 2030



Per capita Meat Demand to 2030

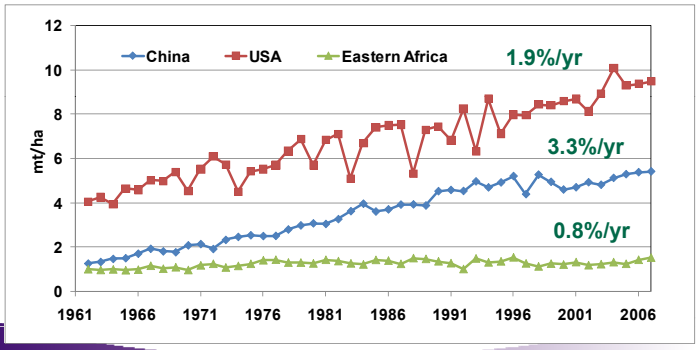


Child malnutrition decreasing in most regions

	Percent of children malnourished (2030)	Total children malnourished 2030 (millions)	Share of all malnourished children (2030)	Change in malnourishment 2000-2030 (millions)
South Asia	37.5	60.5	47%	-15.1
East Asia	3.6	2.8	2%	-7.9
SE Asia& Pacific	22.6	10.9	9%	-2.6
C&W Asia North Africa	10.9	5.2	4%	-1.0
SS Africa	26.6	42.1	33%	10.0
Latin America & C.	11.8	6.0	5%	-1.7
Developing World	23.3	128.2		-18.3

Yield gaps b/w regions reflects productivity gains as well as differing abilities to manage water in agriculture

Example: corn



Agricultural Growth and Water Usage

Environmental challenges for future food

- Growing population and income – lead to increased demand for food, as well as increased pressures on land for non-agricultural uses
- Need to get more food while relying on less expansion in land than before – need to move along the 'intensive' margin
- Also increasing competition from other sectors for water, which is a key input into agriculture
- The challenge of 'more food' from 'less water' is both an objective as well as reflection of reality

Expansion in irrigated area for agriculture

- The expansion of irrigated agriculture has been more rapid in some regions compared to others
- Much depends on the relative natural resource endowments of regions (i.e. available surface & GW)
- Also depends on the climatic conditions and the relative abundance of rainfall at critical points in the growing cycle of staple crops (e.g. North versus South China)
- In the past we've seen much more investment going into expansion of irrigation in Asia compared to Sub-Saharan Africa

Historical growth in irrigated area

Region	1961	1970	1980	1990	1999
	[Thousands of hectares]				
Africa	7,410	8,483	9,491	11,235	12,538
Asia	90,166	109,666	132,377	155,009	192,962
Europe	8324	10,355	13,979	16,744	24,406
North & Central America	17,949	20,938	27,593	28,905	31,395
Oceania	1,079	1,588	1,684	2,113	2,539
South America	4,661	5,673	7,392	9,499	10,326
USSR	9,400	11,100	17,200	20,800	-
Global/World	***138,989***	***167,803***	***209,716***	***244,305***	***274,166***

source: UN, 2005

Key role of India in the global balance

- The agricultural transformation that took place in India over the 1960s & 70s were aided by key Green Revolution technologies – improved seed varieties & intensification of inputs (fertilizer & irrigation)
- This was accompanied by other policies aimed at ensuring local food security (guarantee schemes, stockholding and price stabilization, etc.)
- This allowed India to move from being a country with periodic famines to one in which food security was dramatically improved – even becoming an exporter in some goods
- A sudden shortfall of food, however, could mean a dramatic increase in import demand – with big impacts

Irrigation in India (2003-04)

Region	Total Cultivable Area ('000 ha)	Net Irrigated Area ('000 ha)	Irrigated as % of Total Cultivable
East	13,077	2,416	18.5%
West	76,758	16,862	22.0%
North Central	36,529	18,977	52.0%
North East	6,129	439	7.2%
North West	11,477	7,818	68.1%
South	39,498	8,592	21.8%
All Total	183,468	55,104	30.0%

•Source: CWC, Delhi, India – Water Related Statistics

Irrigation sources in India (2003-04)

Region	Tube Wells	Other Wells	Other Sources	Total All Sources	Share from GW
East	233	98	265	2,416	14%
West	3,865	8,220	893	16,867	72%
North Central	12,898	569	622	18,977	71%
North East	2	2	193	437	1%
North West	4,865	20	183	7,818	62%
South	2,304	2,186	597	8,592	52%
All Total	24,167	11,095	2,753	55,107	

Source: CWC, Delhi, India – Water Related Statistics

Deepening water scarcity in India

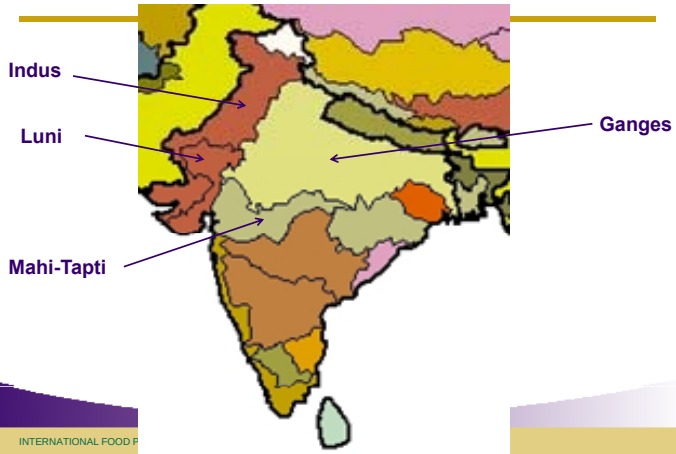
- Increased demand for limited water resources for both agricultural and non-agricultural uses has led to deepening problems of scarcity
- Emerging 'megacities' continue to demand more water resources (both surface & GW sources)
- Options for supply enhancement are running out – need measures to manage the demand side
- Groundwater management is particularly challenging (as it is in many other regions)

Quantitative Experiment: Groundwater Depletion in India & Implications for Global Food Balance

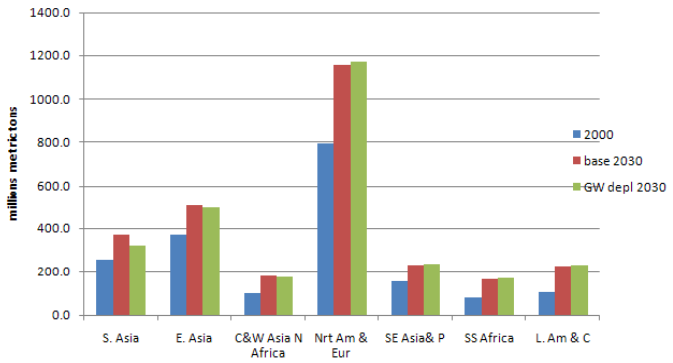
Simple quantitative experiment

- In this experiment, we simulate what would happen if the groundwater availability in northern India (Gujarat, Rajasthan, Haryana, Uttar Pradesh, Madhya Pradesh, Bihar) were to decrease dramatically over 2010-2020
- Essentially having the water available for irrigation (since GW supplies ~50% irrigated area)
- Simulated over the corresponding IMPACT basins (Indus, Ganges, Mahi-Tapti & Luni basins)
- Observe the impact on food production, prices, consumption and malnutrition in India & the world

Key Indian basins targeted in scenario

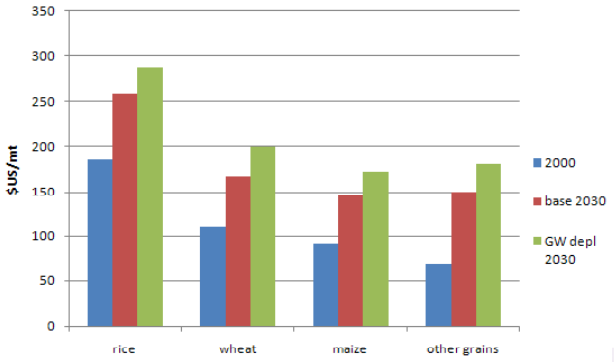


Global cereal production changes

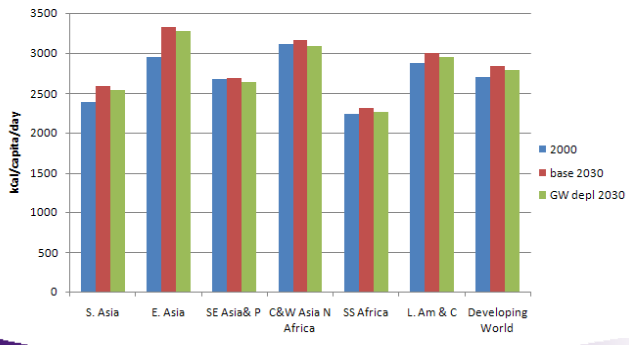


Shifts in global cereal net trade to compensate

Increases in global cereal prices



Global decreases in per capita calorie availability



Negative impacts on child malnutrition globally

Millions of children age 0-5

	baseline		GW depletion
	2000	2030	2030
S. Asia	75.6	60.5	61.4
E. Asia	10.7	2.8	3.2
SE Asia& Pacific	13.5	10.9	11.1
C&W Asia N Africa	6.2	5.2	5.4
SS Africa	32.1	42.1	43.1
L. America & Caribbean	7.7	6.0	6.2
Developing World	146.5	128.2	131.0

Summary

The impact of groundwater declines in northern India have a sizable impact on food production, trade and security in both India and the world

- A more widespread problem in India would be even more dramatic (“Too Big to Fail” !)
- Similar effects would be observed if the North China Plain were subjected to such a scenario
- This is purely illustrative of the importance of India to the global food balance – and the implications of it falling into deficit due to environmental impacts
- This underscores the importance of water for food

Concluding Thoughts

Increasing Need for Efficiency Gains

The ability to supply the needed food, feed and fibre products to satisfy growing global demand requires:

- Consistent levels of high production and exports from key regions of the world – and liberalized trade
- High efficiency in delivering critical agriculture inputs in order to achieve high yields on a consistent basis
- Increasing levels of crop productivity on land under cultivation – and resistance to stresses (pests, salinity)
- Rainfed areas will have to increase in productivity as well, as irrigation expansion potential is limited

Required Actions and Responses

Action needed both at the national and local levels – with coordination between all of them

- National-level action to reform policy regimes governing water to avoid resource collapse – need to evolve from a supply-side focus to manage the demand side better
- Trade policy also needs to be open and flexible to avoid price spikes of 2007-08 created by export bans – requires coordination at the international level
- Local-level monitoring (better data!), enforcement of regulations and implementation of best practices (innovative community management schemes)

Thank You!

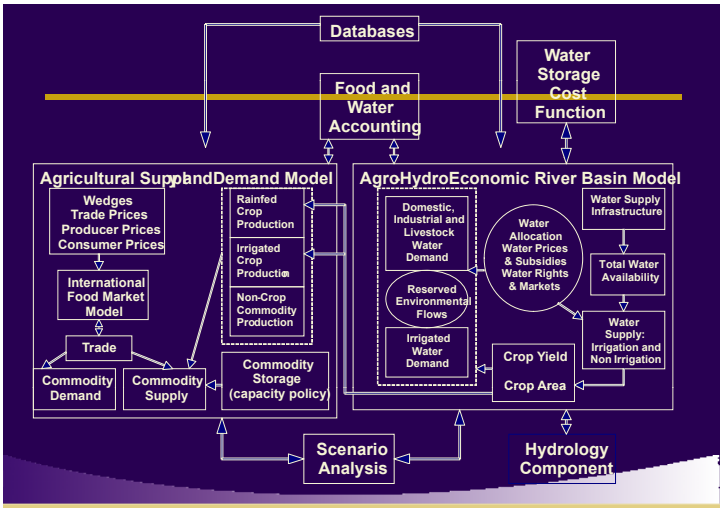
Extra Slides

The IMPACT Model

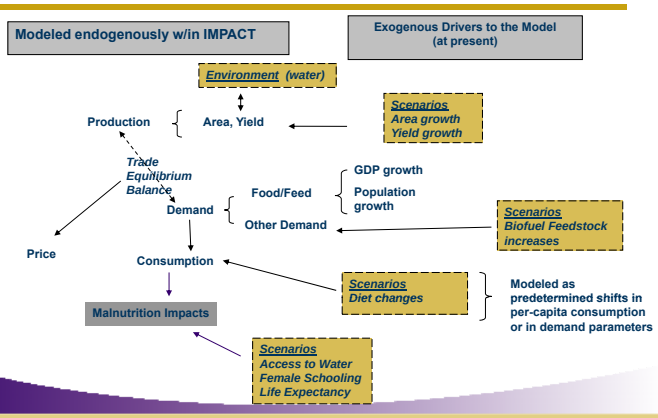
- IMPACT – "International Model for Policy Analysis of Agricultural Commodities and Trade"
- Representation of a global competitive agricultural market for crops and livestock
- Global
  - 115 countries
  - 281 food production units
  - 32 agricultural commodities

IMPACT Basics

- Global, partial-equilibrium, multi-commodity agricultural sector model
- Links country-level supply and demand through global market interaction and prices
- Country-level markets are linked to the rest of the world through trade
- World food prices are determined annually at levels that clear international commodity markets



Entry points for scenarios



32 IMPACT Commodities

- Cereals
  - Wheat, Rice, Maize, Other Coarse Grains + Millet, Sorghum
- Roots & Tubers
  - Potatoes, Sweet Potatoes & Yams, Cassava & Other Roots and Tubers
- Dryland legumes
  - Chickpea, Pigeonpea, Groundnut
- Livestock products
  - Beef, Pork, Sheep & Goat, Poultry, Eggs, Milk
- High-Value
  - Vegetables, (Sub)-Tropical Fruits, Temperate Fruits, Sugar Cane, Sugar Beets and Sweeteners
- Other
  - Soybeans, Meals, Oils
- Non-food
  - Cotton, Biofuel products (ethanol, biodiesel)

Number and Percentage Malnourished Children

Malnourished children are projected as follows:

$$\%\Delta MAL_t = -25.24 * \Delta_{t-1} \ln(PCKCAL) - 71.76\ \Delta_{t-1} LFEXPRAT - 0.22\ \Delta_{t-1} SCH - 0.08\ \Delta_{t-1} WATER$$

$$NMAL_t = \%MAL_t \times POP5_t$$

%MAL = Percent of malnourished children
PCKCAL = Per capita calorie consumption
SCH = Total female enrollment in secondary education as a % of the female age-group
LFEXPRAT = Ratio of female to male life exp. at birth
WATER = Percent of people with access to clean water
NMAL = Number of malnourished children, and
POP5 = Number of children 0 to 5 years old