Food Security and Water Scarcity Challenges

Colin Chartres and Aditya Sood

Director General and Research Scientist, International Water Management Institute, Colombo, Sri Lanka
Demography, GDP and Water Withdrawals 1900 - 2000

- Population increase about 3.6 times
- Water withdrawals increased 6.8 times
- GDP increased 19 times, about 3% per year (constant prices, IMF)
Population hot spots

Population increase 2000-10

Key increases/decrease in 1000s
Water and land per person decreasing

- Land area (ha) per person
- Water availability 1000m³ per person
**Water scarcity**

**Physical scarcity:**
Water resources development approaching or exceeding sustainable limits

**Economic Scarcity:**
Water resources can meet needs; but human, institutional and financial capital lacking to actually harness and use these resources

Global Potato Cultivation

Potato yields, in tons per hectare:
- Above 30
- 25.1 - 30
- 20.1 - 25
- 15.1 - 20
- 10.1 - 15
- 5.1 - 10
- 0 - 5

Each dot represents one thousand hectares.

From World potato Atlas - CIP
Eastern Asia:
Physical Features and Potato Cultivation

Each dot estimates 5,000 hectares.

Altitude, in Meters Above Sea Level:
- Below 500
- 500 - 1,000
- 1,000 - 1,500
- 1,500 - 2,000
- 2,000 - 2,500
- 2,500 - 3,000
- 3,000 - 3,500
- 3,500 - 4,000
- 4,000 - 4,500
- Above 4,500
Drivers of Food and Water scarcity

The **major drivers** of water scarcity and food security:

- Population growth (7.0 b today to 9.0 b in 2050)
- Dietary change
- Urbanisation
- Globalisation
- Biofuel production
- Climate Change
Consumption and income 1961-2000

These trends are continuing

**Meat**
- China
- India
- USA

**Milk**
- India
- China
- USA
Issue identification
Water supply vs. demand gaps

Base-case demand, supply, and gaps for the regional case studies

- **India**
  - Aggregate 2030 demand: 1,498 Billion m³
  - Demand growth: 100% = 2.8%
  - 2030 supply: 744 Billion m³
  - Aggregate gap % of demand: 50%

- **China¹**
  - Aggregate 2030 demand: 818 Billion m³
  - Demand growth: 1.6%
  - 2030 supply: 619 Billion m³
  - Aggregate gap % of demand: 25%

- **São Paulo state¹**
  - Aggregate 2030 demand: 20 Billion m³
  - Demand growth: 1.4%
  - 2030 supply: 19 Billion m³
  - Aggregate gap % of demand: 14%

- **South Africa²**
  - Aggregate 2030 demand: 18 Billion m³
  - Demand growth: 1.1%
  - 2030 supply: 15 Billion m³
  - Aggregate gap % of demand: 17%

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1. Gap greater than demand-supply difference due to mismatch between supply and demand at basin level
2. South Africa agricultural demand includes a 3% contribution from afforestation

SOURCE: 2030 Water Resources Group
Drivers paint a pessimistic picture even without climate change

- Food production to increase by 70% by 2050 (World Food Summit, Rome)
- Additional water required under BaU up to 6000 km³ (Comprehensive Assessment 2007)
- Climate Change may reduce potential yields in Sub-Saharan Africa and South Africa by 30% by 2030 (Lobell et al, Science, 2008)
- Temperature increase may reduce yields of corn, soya beans and cotton by 30 – 46% in the US in a century (Schlenker & Roberts, PNAS, 2009)
Scenarios considered

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Pop growth %</th>
<th>GDP growth %</th>
<th>Per cap. GDP growth %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business as Usual</td>
<td>50.2</td>
<td>365.7</td>
<td>253.4</td>
</tr>
<tr>
<td>Optimistic</td>
<td>30.7</td>
<td>444.3</td>
<td>397.4</td>
</tr>
<tr>
<td>Pessimistic</td>
<td>71.0</td>
<td>164.5</td>
<td>74.5</td>
</tr>
</tbody>
</table>

- Used WATERSIM model which has 2 modules;
  - water supply and demand and
  - food supply and demand
- The model was run for 125 river basins and 115 economic areas
- We looked at scenarios where trade was enhanced over 2010 levels
A new economic world map
Slowing of population growth

Population Change - OPT scenario (2010 to 2050)

Legend
- Increase
- Decrease
- No Change
Increases in commodity demand

**Potatoes**

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>13.23</td>
</tr>
<tr>
<td>2030</td>
<td>22.13</td>
</tr>
<tr>
<td>2040</td>
<td>31.66</td>
</tr>
<tr>
<td>2050</td>
<td>39.42</td>
</tr>
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</table>
The increase in the prices of crops leads to innovation and higher motivation for improving the yields of the crops.

Based on the WATERSIM model run, the yields for the main crops increase from 16 to 20 percent for BAU scenario.

<table>
<thead>
<tr>
<th>Year</th>
<th>Potato Price Increase %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>56.78</td>
</tr>
<tr>
<td>2030</td>
<td>93.02</td>
</tr>
<tr>
<td>2040</td>
<td>148.81</td>
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<tr>
<td>2050</td>
<td>228.74</td>
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</table>
Consumptive water demand (regions) 2010 – 2050
BAU, Optimistic and Pessimistic

Consumptive Water Demand - BAU

Consumptive Water Demand - OPT

Consumptive Water Demand - PES
Consumptive water demand (sector) 2010 – 2050
BAU, Optimistic and Pessimistic

Consumptive Sectoral Water Demand
- BAU

Consumptive Sectoral Water Demand
- OPT

Consumptive Sectoral Water Demand
- PES

Legend:
- DomDmd
- IndDmd
- LvstkDmd
- IrriDmd.
Global Water Withdrawals: historical and projected (after Peter Gleick)
Trade helps reduce total water demand

**Consumptive Sectoral Water Demand**

- **OPT**

  Approx. Year 2000 water withdrawals

<table>
<thead>
<tr>
<th>Year</th>
<th>DomDmd</th>
<th>IndDmd</th>
<th>LvstkDmd</th>
<th>IrriDmd</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>1000</td>
<td>2000</td>
<td>3000</td>
<td>4000</td>
</tr>
<tr>
<td>2020</td>
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<tr>
<td>2050</td>
<td>5000</td>
<td>10000</td>
<td>15000</td>
<td>20000</td>
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Trade at 2010 levels

*But note that demand potentially exceeds supply*
So where will extra production come from?

Enhanced Trade

Rainfed agriculture has to expand in area/become more productive

Trade at 2010 levels
Different climate change scenarios show no clear trend in the total rainfall; Potential evapotranspiration (PET), which is dependent upon the temperature, increases, with much sharper increase after 2040. By 2050, for the irrigated area, the gap between PET and effective rainfall will be about **17% higher** than the baseline for the A2 climate change scenario where as it will be about **14% higher** for B1 climate change scenario. This will put extra stress on demand for irrigation water.
The Global Paradox and Challenge

Feeding c.2 billion more people with less water for agriculture than we have now in an era of climate change

So what are the solutions?
REDUCE WASTE

• At point of production
  ➢ particularly in developing world due to inadequate storage, transport & market access
• At point of consumption
  ➢ In 2010 we threw away 179 kg/cap, year
• Demand side issues, food intake
  ➢ Reducing losses and waste by 50% - equivalent to a rise in output of 15 – 25%
  ➢ 50% reduction of losses & waste: potential water savings of 1,350 km³
ENCOURAGE TRADE

- Grow water hungry crops in water rich areas

From Water Footprint Network
INCREASE PRODUCTIVITY

- more crop per drop
- In irrigated and rainfed systems

 Courtesy Simon Cook
Reducing losses and waste by 50% - equivalent to a rise in output of 15 – 25%
50% reduction of losses & waste: potential water savings of 1,350 km$^3$
Then we can reduce water demand by 000s of km$^3$.

Based on WaterSim analysis for the Comprehensive Assessment of Water Management in Agriculture.

Comprehensive Assessment Scenario: Policies for productivity gains, upgrading rainfed areas, revitalized irrigation & trade.
What does all this mean for potato farmers?

- Demand for food and water continues to rise
- Competition for agricultural water will become greater almost everywhere
- Cultivation areas may have to shift due to heat and water stress issues associated with climate change
- Water “price” may increase
- The modeling assumes that increasing demand and prices will trigger productivity increases and greater efficiency
- Sustainable intensification of agriculture has to occur
- More use of treated water?
Thank You