Czech University of Life Sciences in Prague

Land Management and Soil and Water Resources

The solution for future World security and an access to food

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(with support of information from Dr. Chartres, IWMI, Prof. Feddes, WUR, and Prof. Loiskandl, BOKU)

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Landscapes, Water, Soil in general

- **Securing our future – the chalenge:**
- **to apply sustainable management of our common resources,**
- **to ensure adequate food for all,**
- **to enable sufficient income and living conditions.**

A broad and comprehensive sustainability innovation is needed, one that comprises bigger thinking and more responsible acting.

As complex solution as possible is needed !!

MAIN KEY QUESTIONS

1. How do we make our soil and water more productive in the face of increasing demand for food and limited water resources?
2. How can we manage soil and water quality to minimize risks to agriculture and environment
3. How much water do we have and will we have it available?
4. How we can support human health and an sustainable environment?
5. How do we help to establish better governance to facilitate equitable, productive and sustainable use of soil and water resources among all users?

International Framework – CGIAR a video

- a consorcium of 15 international agric. research centres, financed by a trust, that is managed by the World Bank.
- a global research partnership for a food-secure future. CGIAR science is dedicated to reducing poverty, enhancing food and nutrition security, and improving natural resources and ecosystem services.
- The 15 CGIAR centres (one of those is IWMI) collaborate with hundreds of partners, including:
  - national and regional research institutes, academia
  - civil society organizations, development organizations
  - and the private sector.

Motto:

- "Water issues have never been as acute as they are today. Climate change, urbanization, population growth, hydropower development and a host of others are having a major impact on water availability and how we, as a research-for development organization, must respond." (IWMI director-general Jeremy Bird, Strategy of IWMI 2014 - 2018)
- The CGIAR Research Program on Water, Land and Ecosystems combines the resources of 11 CGIAR centers and numerous international, regional and national partners to provide an integrated approach to natural resource management research.
- This program is led by the International Water Management Institute (IWMI).

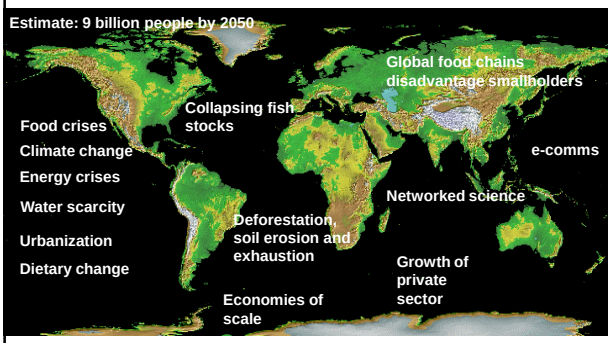
International Water Management Institute

- Non-profit, scientific research organization

- focusing on the sustainable use of water and land resources in developing countries.
- works in partnership with governments, civil society and the private sector to develop scalable agricultural water management solutions that have a real impact on poverty reduction, food security and ecosystem health.
- headquartered in Colombo, Sri Lanka, with regional offices across Asia and Africa.



The world is changing fast



increasing challenges – increasing opportunities

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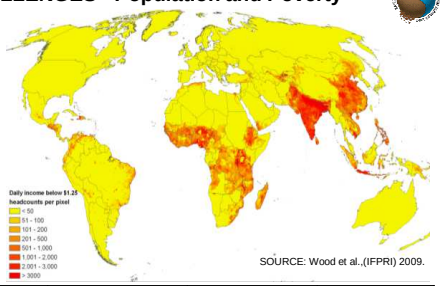
GRAND CHALLENGES - Population and Poverty

Population growth, dietary change and poverty and malnutrition will be key drivers with respect to agriculture



SOURCE: Wood et al.,(IFPRI) 2009.

	Population (millions) 2009	Population (millions) 2050	Growth
Africa	1010	1998	98%
Asia	4121	5231	27%
Europe	732	691	- 5%
Latin America and Caribbean	582	729	25%

The Paradox and the Challenge

Feeding another

2.5 billion people with

less water for

agriculture than we

have now by the year 2050!

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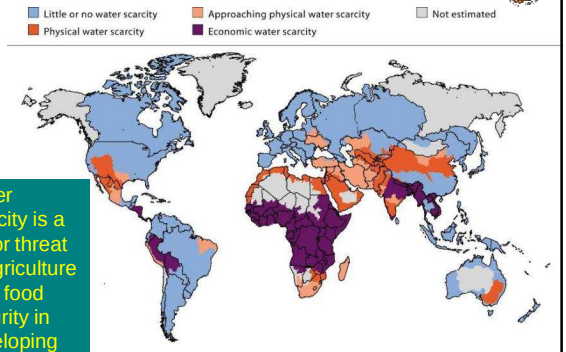
GRAND CHALLENGES – Water Scarcity



Water scarcity is a major threat to agriculture and food security in developing countries

SOURCE: Chartres, IWMI, 2010

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(Ethiopia, 2006)

WHAT ARE THE KEY DRIVERS OF WATER SCARCITY?

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Key Drivers of Water Scarcity

- 1.Population growth (6.7 billion now to 9 billion by 2050)
- 2.Dietary changes
- 3.Urbanization
- 4.Globalization
- 5.Climate Change
- 6.Biofuels - competing for land and water
- 7.Hydropower - competing for land and water

SOURCE: Chartres, IWMI, 2010

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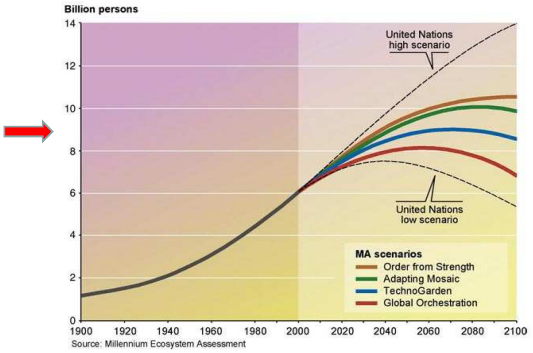
1.Population growth



(6.7 billion now to 9 billion by 2050 , source the UN)

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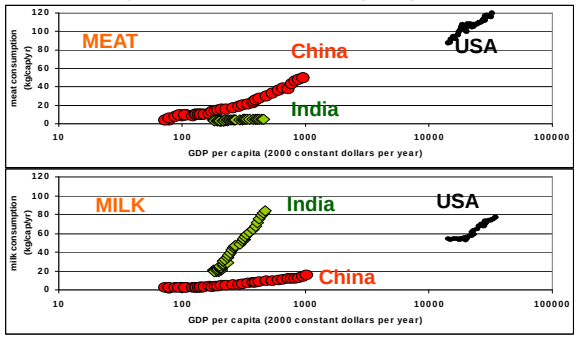
2. Dietary changes

(Income versus Consumption)



SOURCE: Chartres, IWMI, 2010

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3. Urbanisation

Continent	1970	Est. for 2025
W. Europe	76.4%	83.2%
E. Europe	53.5%	72.0%
South Asia	21.3%	55.0%
Africa	22.5%	50.3%

Source: Musil (1999)

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4. Globalisation

- A set of processes which embodies a transformation in the spatial organization of social relations and transactions, generating transcontinental or interregional flows and networks of activity, interaction and power.

- It is characterized by four types of change:
  - *stretching* of social, political and economic activities across political frontiers, regions and continents.
  - *intensification*, or the growing magnitude, of interconnectedness and flows of trade, investment, finance, migration, culture, etc.
  - *interconnectedness* can be linked to a speeding up of global interactions and processes
  - *growing extensity, intensity and velocity* of global interactions

Source: Held (2015)

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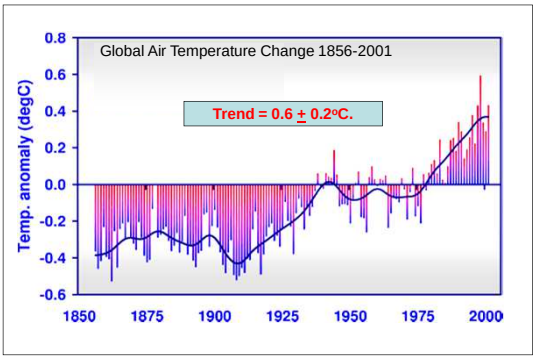
5. Climate Change



SOURCE: Feddes, 2009

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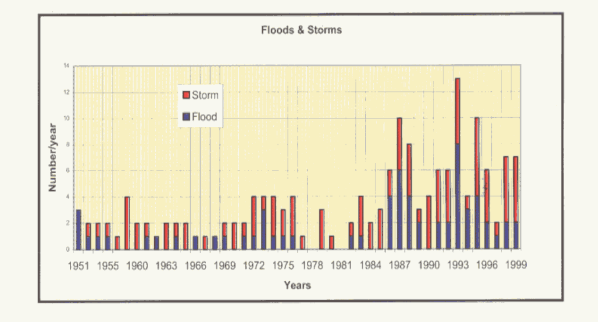
Number of global natural disasters caused by floods and storms.



SOURCE: Feddes, 2009

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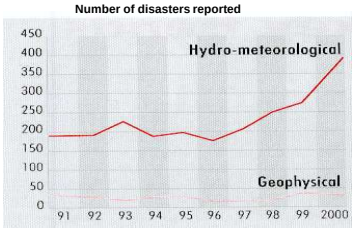
Water and disasters

Extreme weather events are becoming more common



SOURCE of graph: Feddes, 2009

Floods (Prague 2002)

Droughts (Ethiopia 2006)

Storms (Asia 2010)

Thank you for attention

6. Biofuels – need of water

Water use per liter of biofuel production

	Litres of ET	Litres of Irrigation water
China	3800	2500
India	4100	3500
US	1750	300
Brazil	2250	200

Bio-fuels may not necessarily increase net water usage, but they will compete with food crops for available water!!

SOURCE: Chartres, IWMI, 2010

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7. Hydropower

- Hydropower may use water being released at times unsuitable for subsequent agricultural use

- New constructed reservoires will change a landscapes, micro-climate, natural sedimentation of the transported soil particles,……
- New - the reservoires may pose unique malaria threat due to climate change!!!

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IMPACTS OF CHANGE ON WATER DEMAND AND AVAILABILITY BY 2050

- Dietary change will simply increase the demand for cereals to feed animals = water needed
- Non-agriculture water demand estimated to go from 25% (902 km^3) to 42% (1963 km^3) of global withdrawals by 2050. This comprises domestic, manufacturing and thermo-cooling.
- Bio-fuels may play a negative role in competing with food crops for available water
- Hydropower may see water being released at times unsuitable for subsequent agricultural use, changing the local natural conditions of the landscape
- Climate change could see 30% decline in available water resources in worst hit areas

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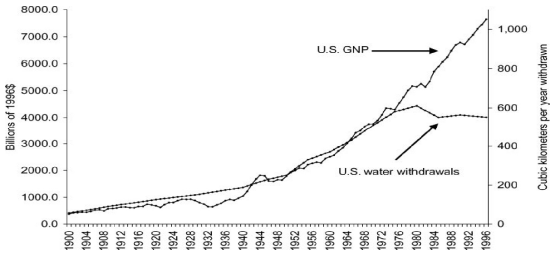
Potential to address the water gap exists



U.S. GNP (1996 dollars) and total water withdrawals in the U.S. U.S. water use rose consistently with GDP up until the 1980s when the two curves split apart. Total water use in the United States is now actually well below its peak level, because the economic productivity of water use in the U.S. has improved.

SOURCE: Gleick, 2003

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A concept of Virtual water

Virtual water = the volume of fresh water depletion or pollution during the manufacturing of a product, considering the entire production chain.

→**Water footprint =** a further development of this approach. It is a multi-dimensional indicator of the direct and indirect freshwater use in the manufacture or use of a product. Thus it is possible to calculate the total water consumption of a single person or a country.

Example (Austria)

- Average Water footprint: **1598 m³/ year and capita**
- Part of the water footprint that arises outside of Austria: **68,4 %**
- Global average water footprint: **1385 m³/ year and capita**

SOURCE: Loiskandl (2014)

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Virtual water
– Green – Blue – Grey water

Green water: Part of the precipitation that flows or not replenishes the groundwater storage, but is temporarily left on soil or plant surfaces → Available for the plants (soil moisture through precipitation)

Blue water: Surface water and groundwater volume

Grey water: freshwater volume required to purify the polluted water according to the existing quality standards

SOURCE: Loiskandl (2014)

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MORE FOOD AND WATER DO WE NEED?

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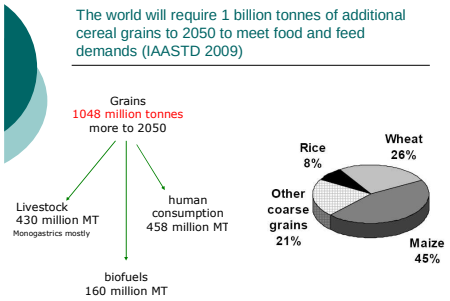
2050 Food and Feed Demand

The world will require 1 billion tonnes of additional cereal grains to 2050 to meet food and feed demands (IAASTD 2009)



A positive is that straw from these crops will help meet the growing fodder demand as rangelands and fodder crops come under pressure from expansion of cereal cropping

SOURCE: Chartres, IWMI, 2010 and IAASTD 2009

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Food for Thought

- *Based on a 2500 cal/day diet water demand under business as usual will increase to approximately 13,000 km³ by 2050* [1]
- *Rainfed agriculture occupies about 80% of cropland and produces 60% of cereal grains.* [1]
- *Irrigation provides 40% of world cereal supply and 46% of the gross value of agricultural production.*[1]
- *Farmers in mixed crop-livestock systems produce about half of the world's food.* [2]

SOURCES:

[1] Comp. Assess. Water Management in Agriculture (2007)

[2] Herrero et al. (2010)

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SO HOW DO WE RESPOND TO THE CHALLENGE?

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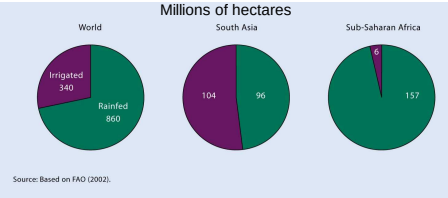
Two problems are growing the required food via irrigation

1. *Availability of land in Asia (particularly S. Asia)*



2. *Water availability* — Limited unutilized blue water resources in Asia, but more available water is in parts of sub-Saharan Africa

SOURCE: Chartres, IWMI, 2010

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Rainfed agriculture has to be a big part of the solution

- Whilst there is clearly capacity to expand irrigation in Africa and South America, this will not be as easy in Asia given land availability issues
- Given the problems of large dams we have to look to dryland/rainfed farming to increase its productivity, particularly in Asia, but also in Africa and South America
- There is land available to increase rainfed cropping particularly in Africa and Latin America, but it is often marginal in quality
- Productivity increases in Rainfed Systems are critical

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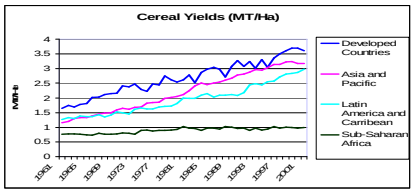
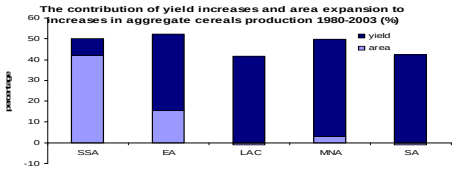
Why has Africa missed out?

- Agricultural productivity in Sub Saharan Africa is low & stagnant
- Production growth so far has been achieved mainly via land expansion





- SSA=Sub-Saharan Africa, EA=Europe+Central Asia, LAC=Latin America+Carribean, MNA= Middle East+NorthAfrica, SA=South Asia

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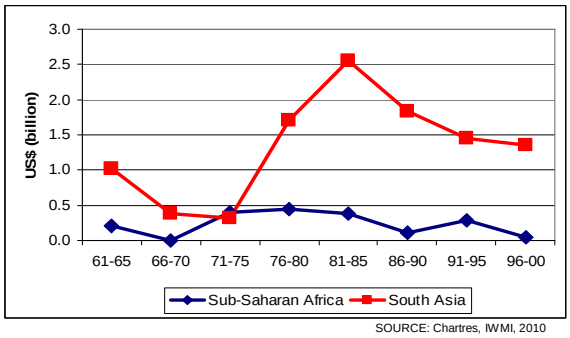
A comparison of Investments in irrigation and drainage in Asia and Africa



SOURCE: Chartres, IWMI, 2010

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Africa – a great potential of growth

Units: Millions of hectars

Region	Area currently cropped (irrigated plus rainfall)	Total area suitable for rainfed production
Sub-Saharan Africa	228	1,031
Middle East and North Africa	86	99
Central Asia and E. Europe	265	497
South Asia	207	220
East Asia	232	366
Latin America	203	1,066
Developed countries	387	874

SOURCE: FAO, 2002

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What are the challenges for landscapes, soil and water research and teaching?

Key issues in the World:

- Landscapes, Soil and Water research is not integrated ➡ integration
- Majority of policy makers still unaware of impending water crisis and its enormous impact on food production ➡ changing an opinion
- Energy and fertilisers costs - fertilizer scarcity due to costs of it and fuel costs ➡ changing politic/economic situation

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- Continuing land and water degradation, an increase of pollution ➡ sustainable development
- Dealing with complex socio-economic factors including market access, finance availability and feminization of agriculture

➡ **education**, fighting corruption, social, political and economic development

- Dealing with population health problems (AIDS, malaria, parasites,….) ➡ health care, landscape improvement

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VITAL GOAL - FOOD

Doubling production with no significant increase in land area, water use or environmental degradation

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Conclusions

- **Food and feed production need to double by 2050.**
- **Under "*business as usual*" scenarios this will require twice as much water**
- **Significant productivity gains are feasible in the developing world and are absolutely necessary**
- **Both Rainfed and Irrigated Systems have to increase their productivity**
- **There is no unique solution; rather suites of solutions based on geography, technology and socio-economics**
- **R&D based on a more integrative paradigm has a major role to play in achieving the required outcomes**

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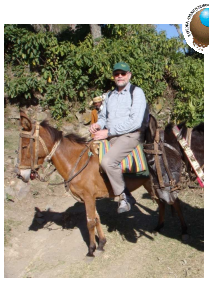

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