Abstract

This presentation will set the scene in explaining how water and energy are interdependent while underscoring the significance of this nexus and the resulting tradeoffs. For example, the way that energy and drinkable water are produced can result in very different ecological footprints. The speaker will argue that the sustainable generation of water and energy will be dependent on how the nexus is internalized.

SETTING THE SCENE: THE VIRTUAL WATER CONCEPT AND THE WATER/FOOD/TRADE/ENERGY NEXUS

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SN3 - Água / Alimnetos /Energia / Climat Nexus

PAP006586

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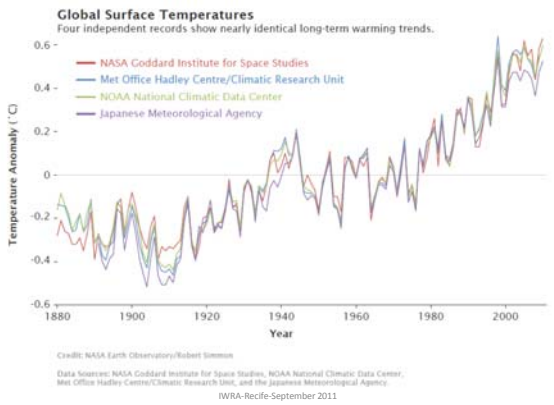
Purpose

To explain how water and energy are interdependent

To underscore the significance of the water-energy-climate change nexus and the resulting tradeoffs.

To argue that the sustainable generation of water and energy will be dependent on how the nexus is internalized.



The water-energy-climate change security nexus
is poorly understood.

It's prominence has lagged the public profile of the global warming discourse.

There is a suite of

***G**lobal **U**ncertainties about **E**nvironmental and **E**conomic **S**ecurity and **S**ustainability*

GUESS

Two centuries of the Industrialisation of

Agriculture, Manufacturing, Services and of Trade

has done wonderful things for **SOCIETY**

Two centuries of the Industrialisation of

Agriculture, Manufacturing, Services and of Trade

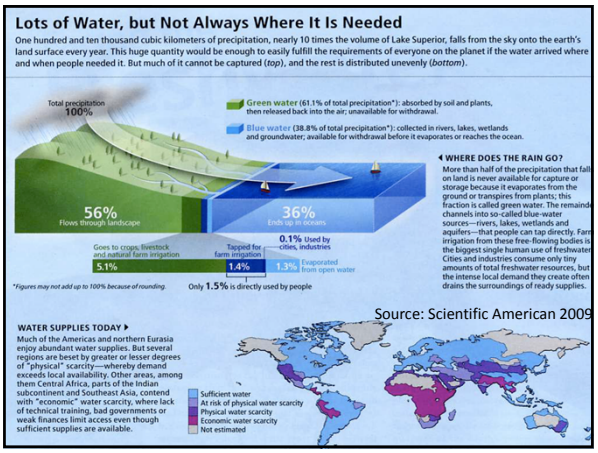
has done wonderful things for **SOCIETY**

but has had very serious impacts

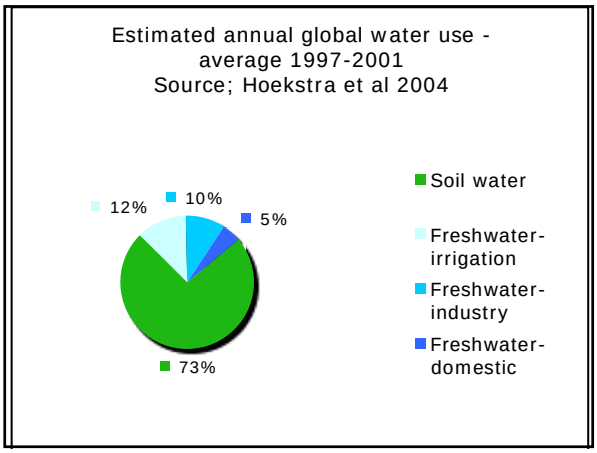
on the **GLOBAL NATURAL RESOURCES** of

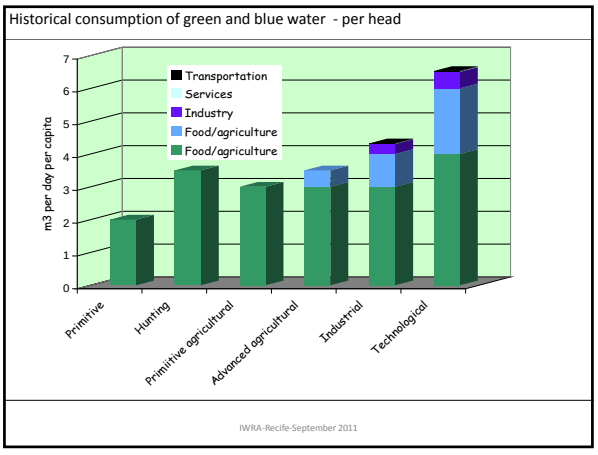
Land, Energy, Water and the Atmosphere.

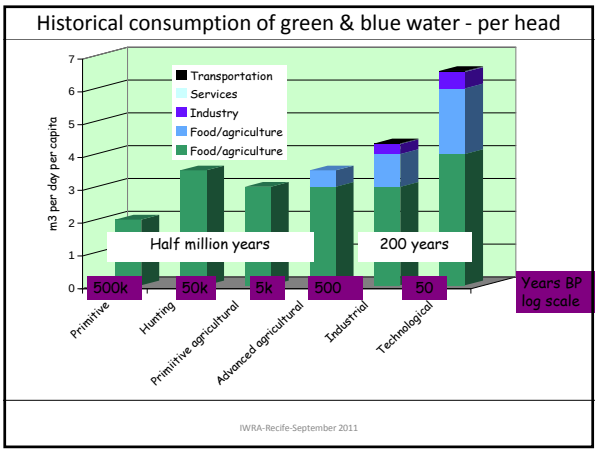
Water



Source: Scientific American 2009

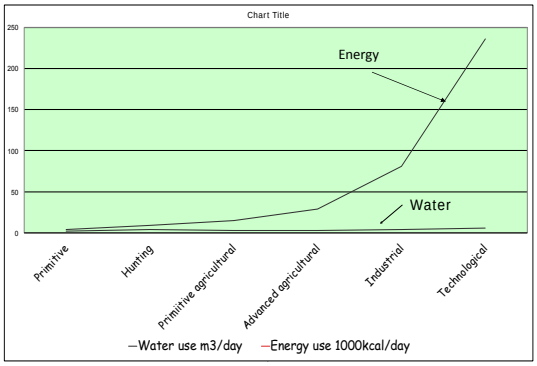






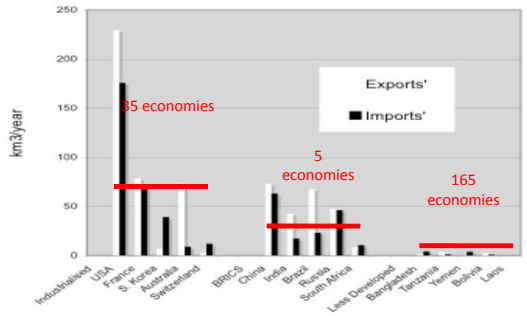
Comparison of historical consumption

of energy [1000kcal/day] and water capita [m3/day]



Regional virtual water balances and net interregional virtual water flows related to the trade in agricultural products.
Period: 1997-2001.
Only the biggest net flows (>10 Gm3/yr) are shown.

Virtual water 'exports' and 'imports' - some industrialsed, BRICS and less developed economies - 1997-2001 - cubic kilometres per year



Virtual water content for selected products

[m^3/ton]

(Zimmer D., and D. Renault, 2003)

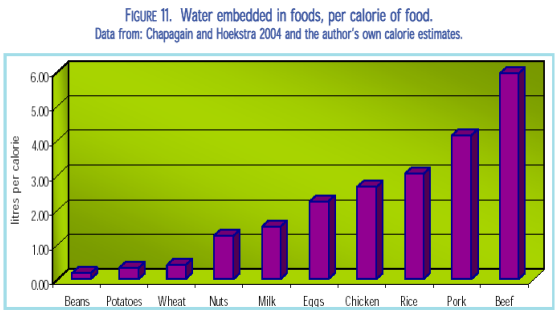
Beef	13 500
Pork	4 600
Poultry	4 100
Soybean	2 750
Eggs	2 700
Rice	1 400
Wheat	1 160
Milk	790

Virtual water content of diets

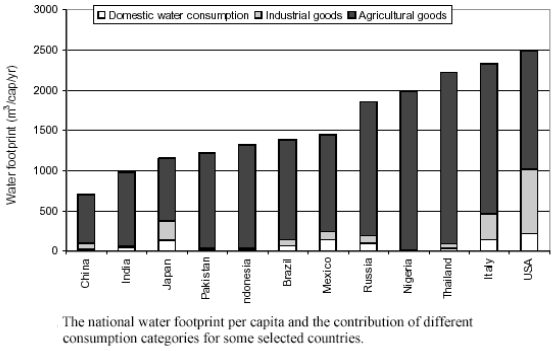
[m3/person/day]

(D. Renault, W.W. Wallender, 2000)

Diet 0 (reference USA)	5.4
Diet 1 25% reduction animal product	4.6
Diet 2 poultry replaces 50% beef	4.8
Diet 3 vegetal products replaces 50% red meat	4.4
Diet 4 50% reduction of animal products	3.4
Diet 5 vegetarian	2.6
Diet 6 Survival	1.0

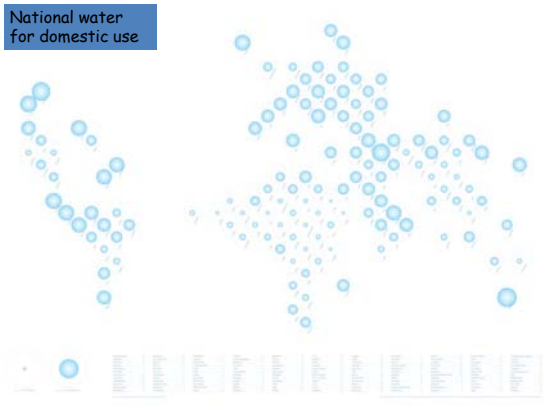


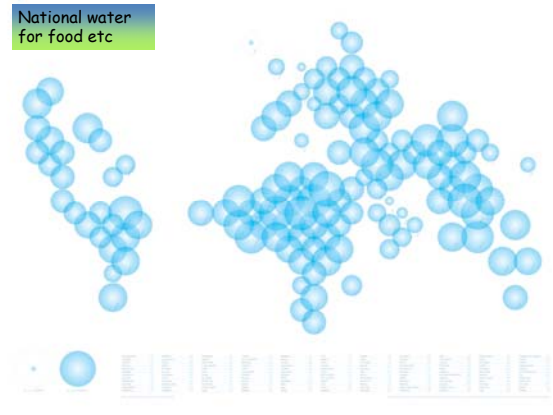
Hoekstra et al



The national water footprint per capita and the contribution of different consumption categories for some selected countries.

Hoekstra et al





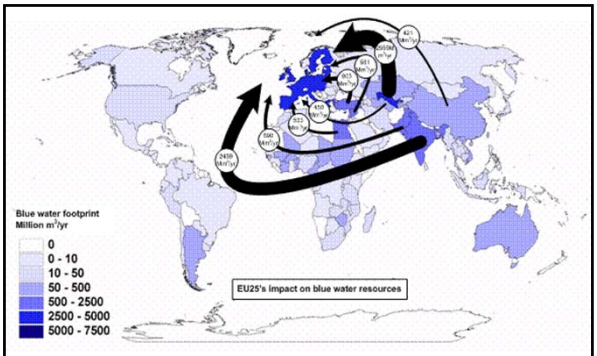
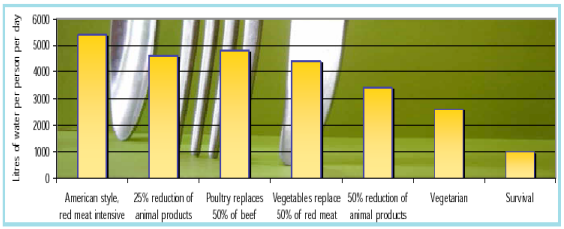
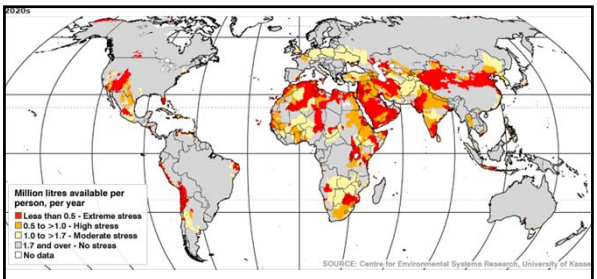


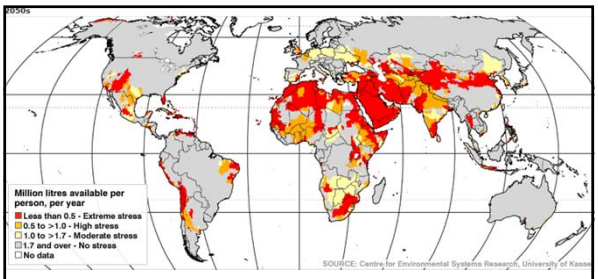
FIGURE 10. Water intensity comparison of various diets. After: Renault and Wallender 2000.



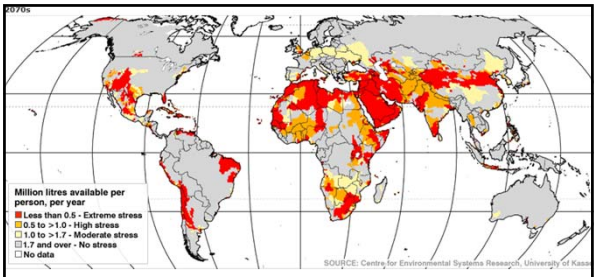
Hoekstra et al



2020s



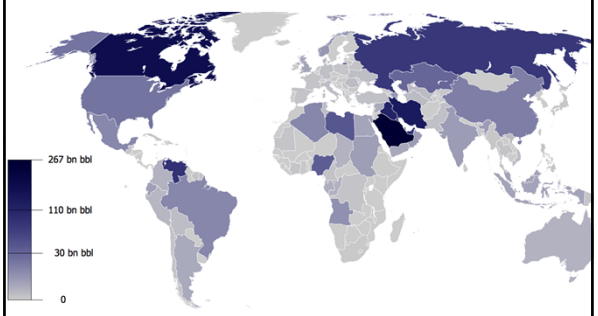
2050s

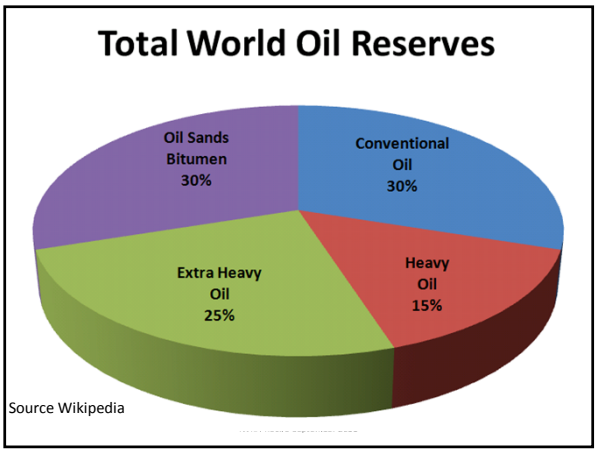


2070s

Energy - Oil

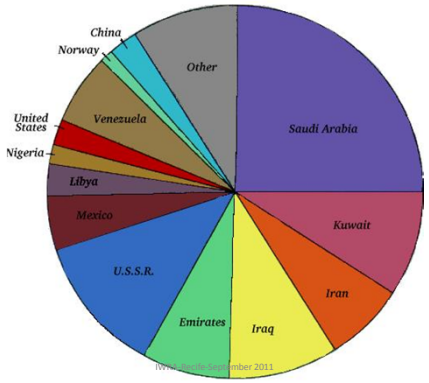
Global oil reserves Source Wikipedia



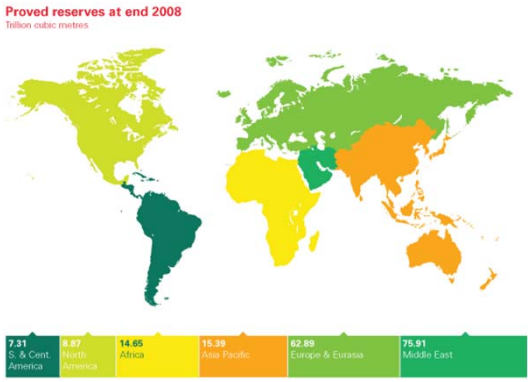


Source Wikipedia

Crude oil reserves



Natural gas – proved reserves 2008



The processes, synergies and outcomes of the use of

water and energy

have *not* been as well theorised as the small nexus.

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water and energy

have *not* been as well theorised as the small nexus.

Nor has an analytical framework been developed

to capture the *big nexus*

of water-food-trade-energy-climate change.

The small nexus

The small nexus

The big nexus

The small nexus

The big nexus

The mega nexus

The small nexus
Water – Food - Trade

The big nexus
Water-Food-Trade-Energy-CC

The mega nexus
Water-Food-Trade-Energy-CC-Finance

Awareness of the ***energy/carbon-climate change element of the nexus*** has risen rapidly in the past three decades helped by concepts such as **carbon footprints.**

The ***water-food-trade element of the nexus*** has, over the same period been well conceptualised with ideas such as **embedded water and water footprints.**

It is only in the past decade, however, that the links between the **industrialised and agricultural use of water and energy** across the international political economy has been debated.

Major players in the world economy **– big-oil, big-auto, big-ag, big-food and trading** – have engaged

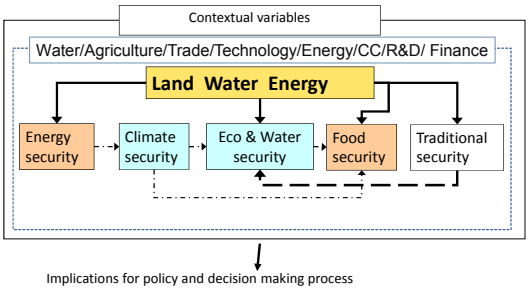
Widening of the security discourse

- Until the end of the Cold War, security was about sovereignty using hard economic and military power
- Securitization was a process with few components:
  - Threats and threatened
  - Actors
  - Audience
- Environmental issues became security issues and we have the mega nexus
- The outcome: many competing securities and a much wider agenda

The main securities

Security type	Group of environmental securities	Storyline	Means for achieving security
Water ….Land Food	Reliable supply	Accessibility to food	Sustainable intensification Local production & trade. Behavior.
Energy	Reliable supply	Availability and sustainability	Local & global resources & trade
Climate	Life support system	Climate that enables life	CO2 reduction
Ecology	Life support system	Ecology v. food production & polluting Industriy	Environmental protection – sustainable consump-tion, diet & reduced waste
Traditional	Not environmental	Protection of the nation	Strong security capacity

A framework



New political challenges for politicians

- **Securities compete** for limited resources.
- Decisions based not only on cost-benefit are **now very politicized.**
- Politicians and decision makers need to reconcile **between conflicting securities and new uncertainties**

New political challenges for experienced politicians

- **Securities compete** over same resources.
- Decisions based not only on cost-benefit are **now very politicized.**
- Politicians and decision makers need to reconcile **between conflicting securities and new uncertainties**
- **Politicians were invented to cope with uncertainty.**
- **Scientists like probability not uncertainty**

Challenges

- How can the competing discourses be reconciled?

- Who owns what, who does what, who controls what and who gets what?

- In FOOD security it is the private sector – locally and internationally

- In ENERGY security it was the private sector. It is no longer.

Differences – Energy & water sectors

Energy and water are different

	Energy	Water
The resource	Many non-renewables & renewables	Almost all renewable
Management & impacts		
Who owns?	Sovereign states & Private sector	Private sector
Who operates?	NOCs & Private sector	Private sector
Who trades?	Mainly Private sector	Private sector
Who controls?	States & Private sector	Private sector
Who gets?	States & Private sector	Private sector
	Energy	**Water**

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	Energy	**Water**

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Energy and water are problematic in the nexus

Sometimes expensive – Sometimes scarce

	Energy	Water
Energy for water security	Pumping water - 19% of energy consumption in California, 30% in some Indian states	
Water for energy		Cooling thermal
		Cooling nuclear
		Tar sands extraction
	Energy	**Water**

Energy can manufacture water

Water can generate energy

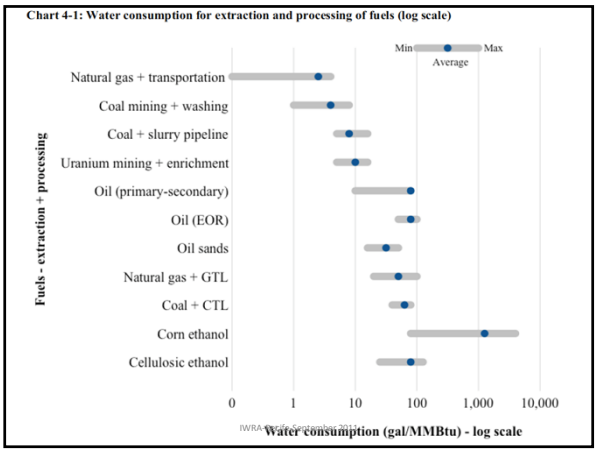
Not much is clean yet

	Energy	Water
Technologies	***Energy***	***Water***
	Desalination dirty	>>>> Water
	Desalination clean	>>>> Water
	Electricity clean ≤≤≤≤	Hydro
	Oil substitute clean but big water footprint ≤≤≤≤	Biofuels – 1st generation
	Oil substitute clean <<<	Biofuels – 2nd & 3rd generation
		Atmosphere and Solar
	Electricity clean ≤≤≤≤	Wind
	Electricity clean ≤≤≤≤	Solar thermal
	Electricity clean ≤≤≤≤	Solar voltaic

Table 7. Average water footprint for fossil energy carriers, electricity from active solar space heat, electricity form wind energy, biomass produced in the Netherlands, Brazil, the United States and Zimbabwe (m^3/GJ).

Primary energy carriers	Average water footprint (m^3/GJ)
Wind energy	0.00
Natural gas	0.04
Nuclear energy	0.09
Coal	0.16
Solar thermal energy	0.30
Crude oil	1.06
Biomass the Netherlands (average)	24.16
Biomass US (average)	58.16
Biomass Brazil(average)	61.20
Biomass Zimbabwe (average)	142.62
Biomass (average the Netherlands, US, Brazil, Zimbabwe)	71.54

Water footprint of bioenergy & other primary energy carriers, Gerben-Leenes, P. W.., Hoekstra, A. Y., Van Der Mer, Th., 2008, Report 29, Delft: IHE



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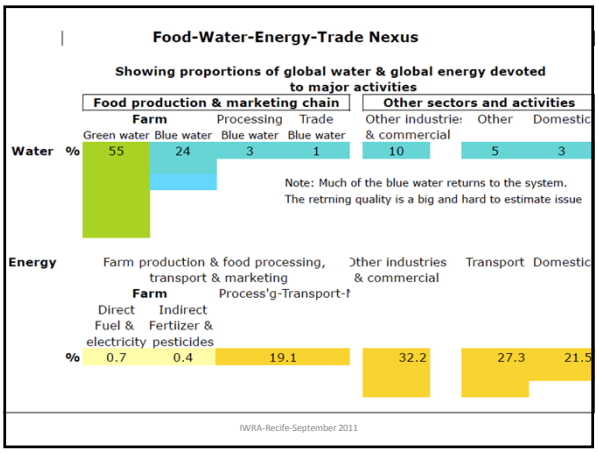
Example of trade-offs

Water footprint of bioenergy & other primary energy carriers, Gerben-Leenes, P. W.., Hoekstra, A. Y., Van Der Mer, Th., 2008, Report 29, Delft: IHE

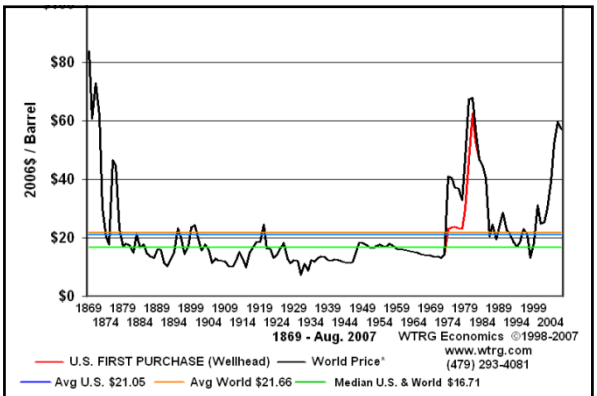


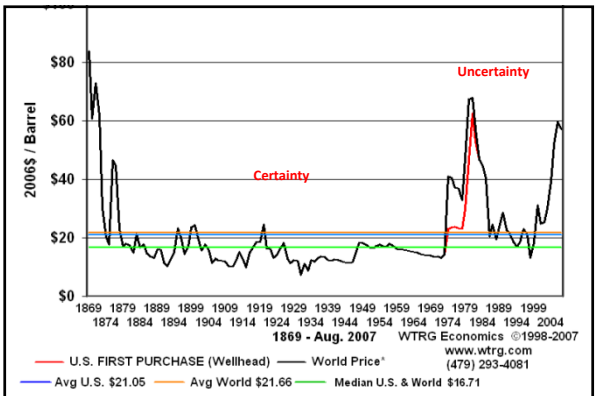
Uncertainty

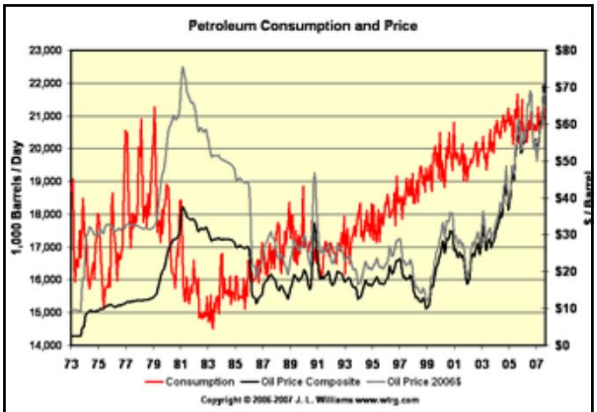
is always part of

security and security politics

Prices and price spikes







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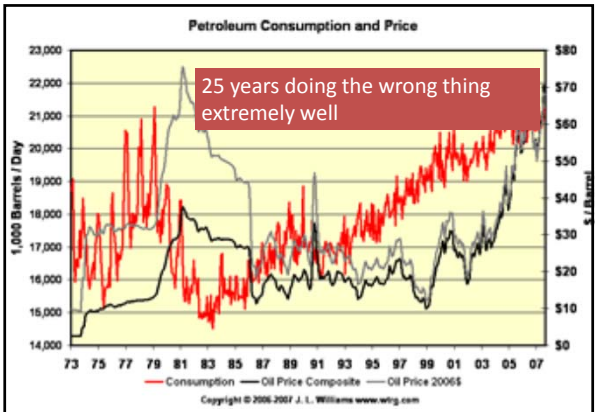

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Food and food price spikes

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Wheat prices on the other hand
have been falling for 1000 years
- agro [fertilizers & plant breeding etc] and other technological effects on yield plus transport,
main increases came since 1945.
[UK wheat yields/ha - 1800 1t, 1900 2t, 1950 3t, 1990 9t]

There have been **price spikes** in the periods of wars and other crises - such as the UK adjusting
to global pressures from US production 1830s
Also after the energy price spike in 1980
and in 1995 when the WTO was launched.
And we have a price spikes now apparently
also associated with the oil price
and other commodity price surges.

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Price spikes are important

They are moments when attention is focused of providers, politicians, the media and consumers

We are in the middle of such a window of opportunity now.

The biggest one in my life so far and the most scary because of GLOBAL WARMING AND PEAK OIL

Key messages

1 **Sustainable intensification** essential – roles for science, technology and improved farming

2 **Farmers** must deliver **high yields and stewardship**

3 **Energy sources must be cleaned up**

4 **Trade underpins** energy, water & environmental security

5 **Trade** must be **fair**

Key messages - 2

6 **Consumers** are key – must eat sensibly &waste less

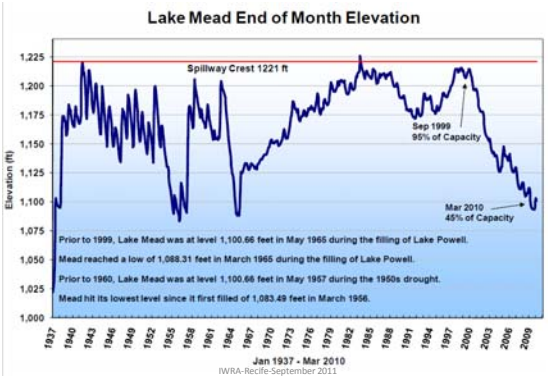
7 **Socio-economic development** is key

8 **Private sector** is key

9 **Research and innovation is key**

9 **Sound investment** is key

10 **Understanding the mega-nexus is key**



Thank you

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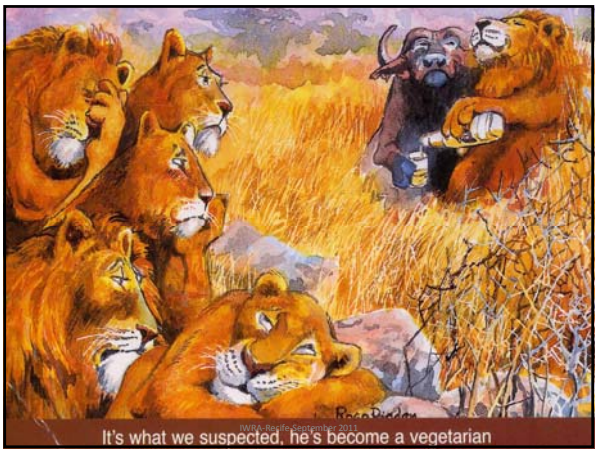

Cross Currents:
Bringing Together Different Perspectives

Water

- Climate change is a key driver of water systems.
- Current focus is water sufficiency and climate change **adaptation**.
- Energy dimension provides new insights into **mitigation** potential in the water sector.

Energy

- Energy systems drive climate change
- Current focus is energy sufficiency and climate change **mitigation**.
- Water dimension provides new insights into how climate **adaptation** will affect energy systems.

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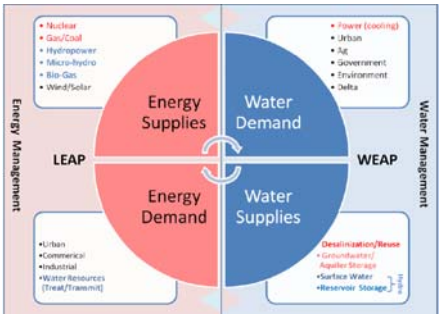
Integrated model development



Water Evaluation And Planning System.

- Integrated watershed hydrology and water planning.
- www.weap21.org

Long range Energy Alternatives Planning System.

- Integrated Energy Planning and GHG Mitigation Assessment.
- www.energycommunity.org

Tools for Modeling Energy-Water Connections

- General purpose model building, data management and scenario analysis tools.
- Environmental engineering perspective on long-term resource allocation problems.
- Integrated analysis across demand and supply.
- Transparent, flexible and user-friendly with low initial data requirements.
- Common code and modeling language.
- Available at no charge to non-profit, academic and governmental institutions based in developing countries.

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