Water for food - Water for energy: biofuels at the water-energy-food nexus

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WATER RESEARCH COMMISSION

UNIVERSITY OF KWAZULU-NATAL
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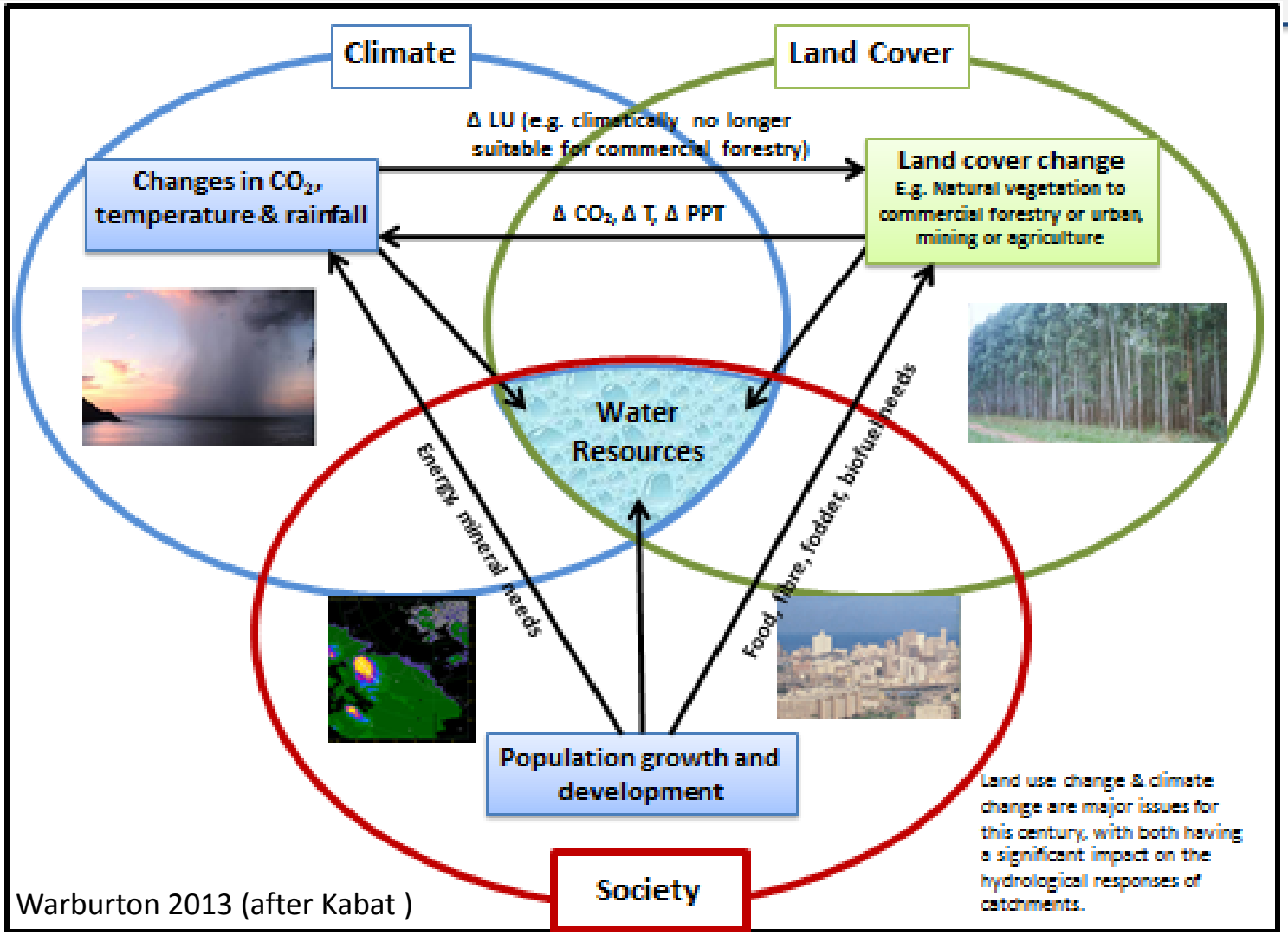
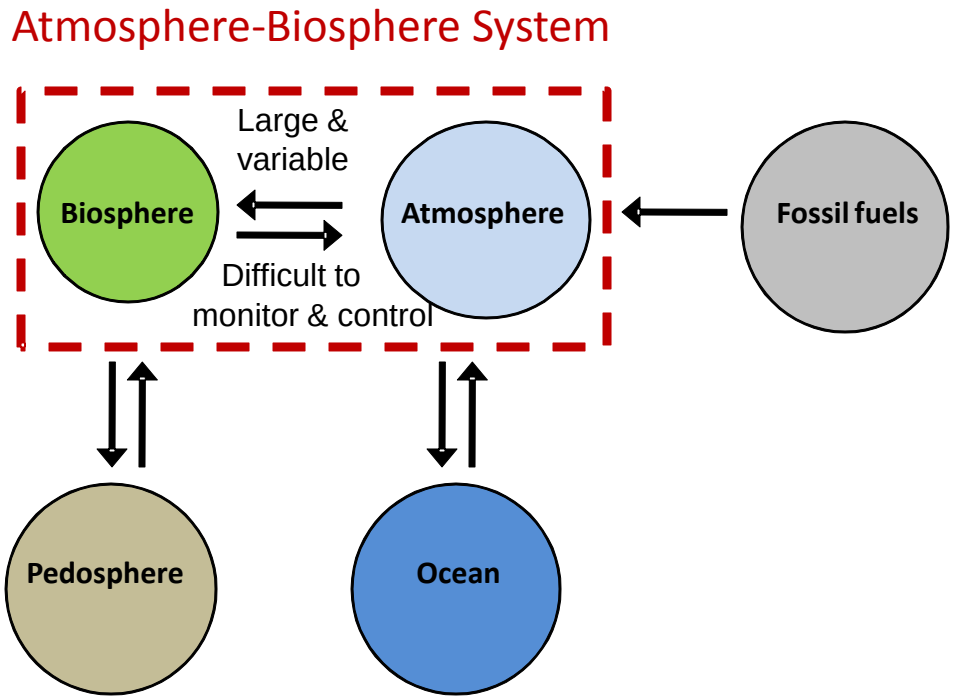
Water Research Commission Symposium 2013

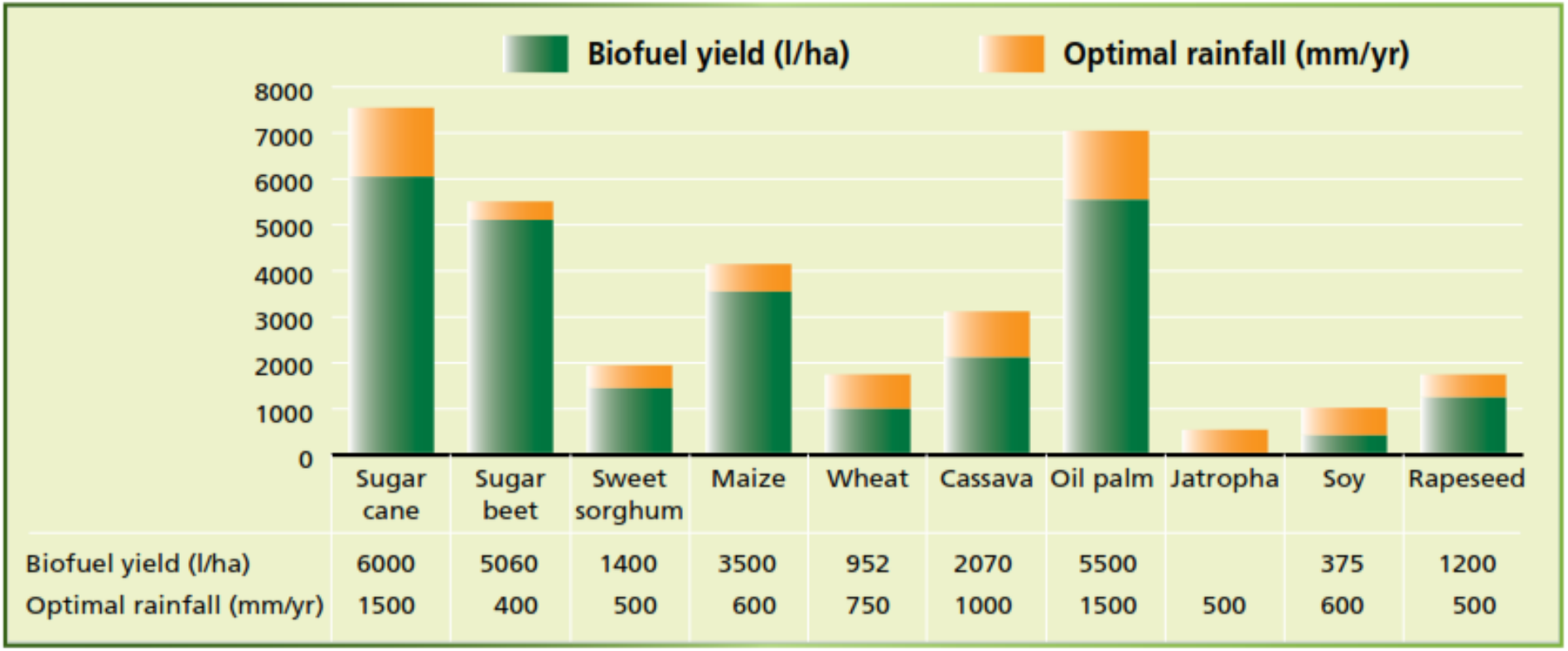
LOCAL SOLUTIONS - GLOBAL IMPACT



Warburton 2013 (after Kabat)

Biofuel – a way of limiting the injection of fossil carbon into the highly dynamic and strongly coupled atmosphere-biosphere system?

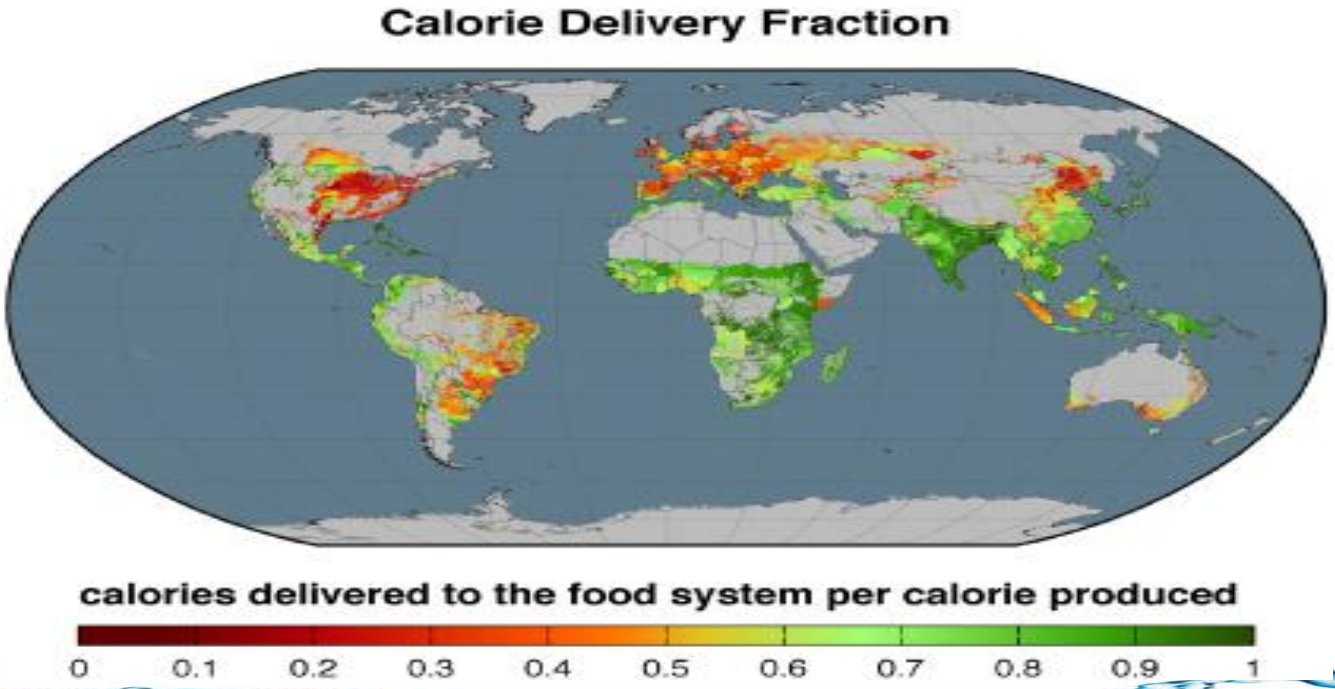




	Sugar cane	Sugar beet	Sweet sorghum	Maize	Wheat	Cassava	Oil palm	Jatropha	Soy	Rapeseed
Biofuel yield (l/ha)	6000	5060	1400	3500	952	2070	5500		375	1200
Optimal rainfall (mm/yr)	1500	400	500	600	750	1000	1500	500	600	500

Energy from Crops

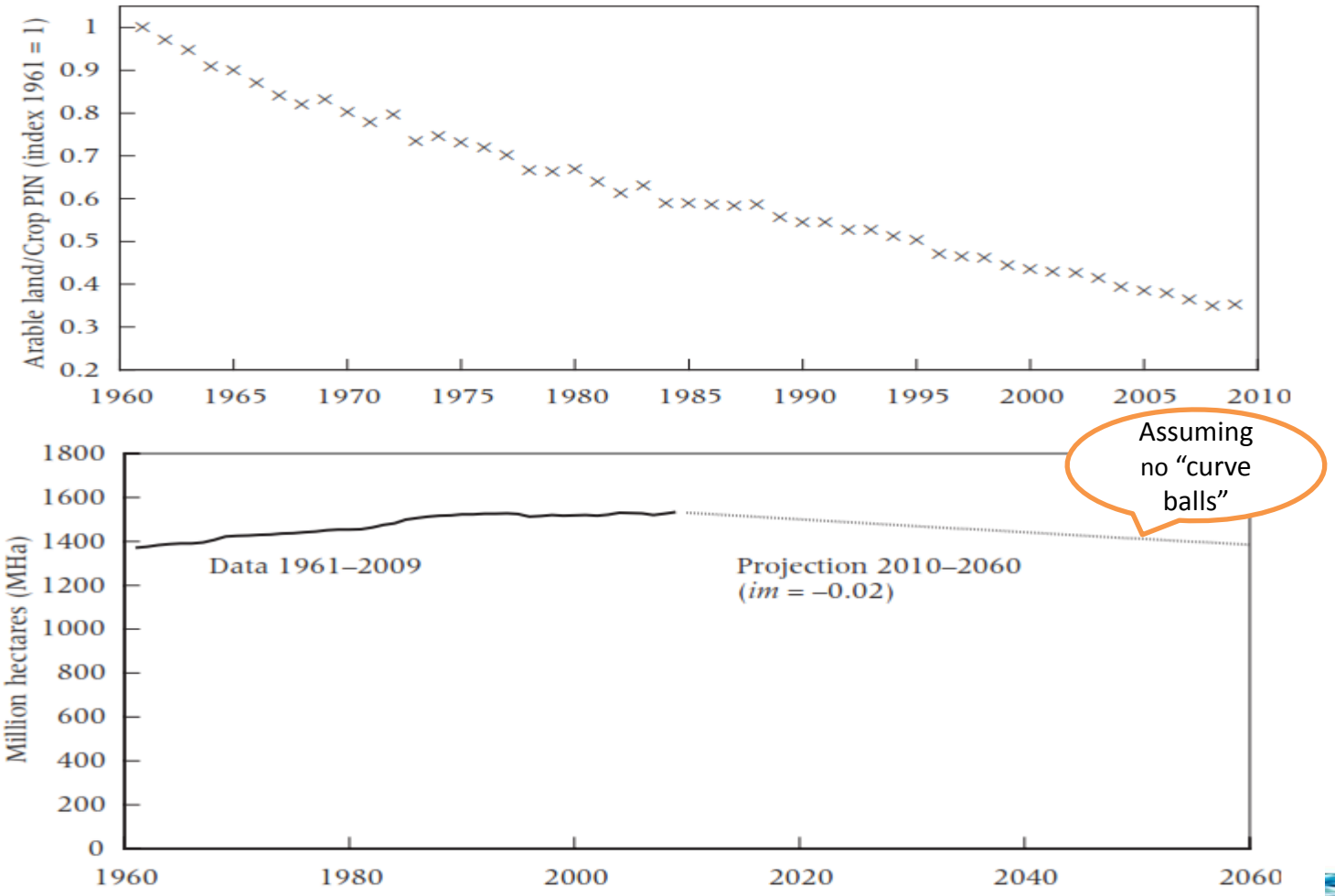
- 36% of the calories produced by the world's crops used for animal feed (1:3 conversion)
- 2000-2010: Human-edible calories used for biofuel production increased from 1% to 4%
- Food security through shifts in consumption and production



Cassidy et al Environ. Res. Lett. 8 (2013)

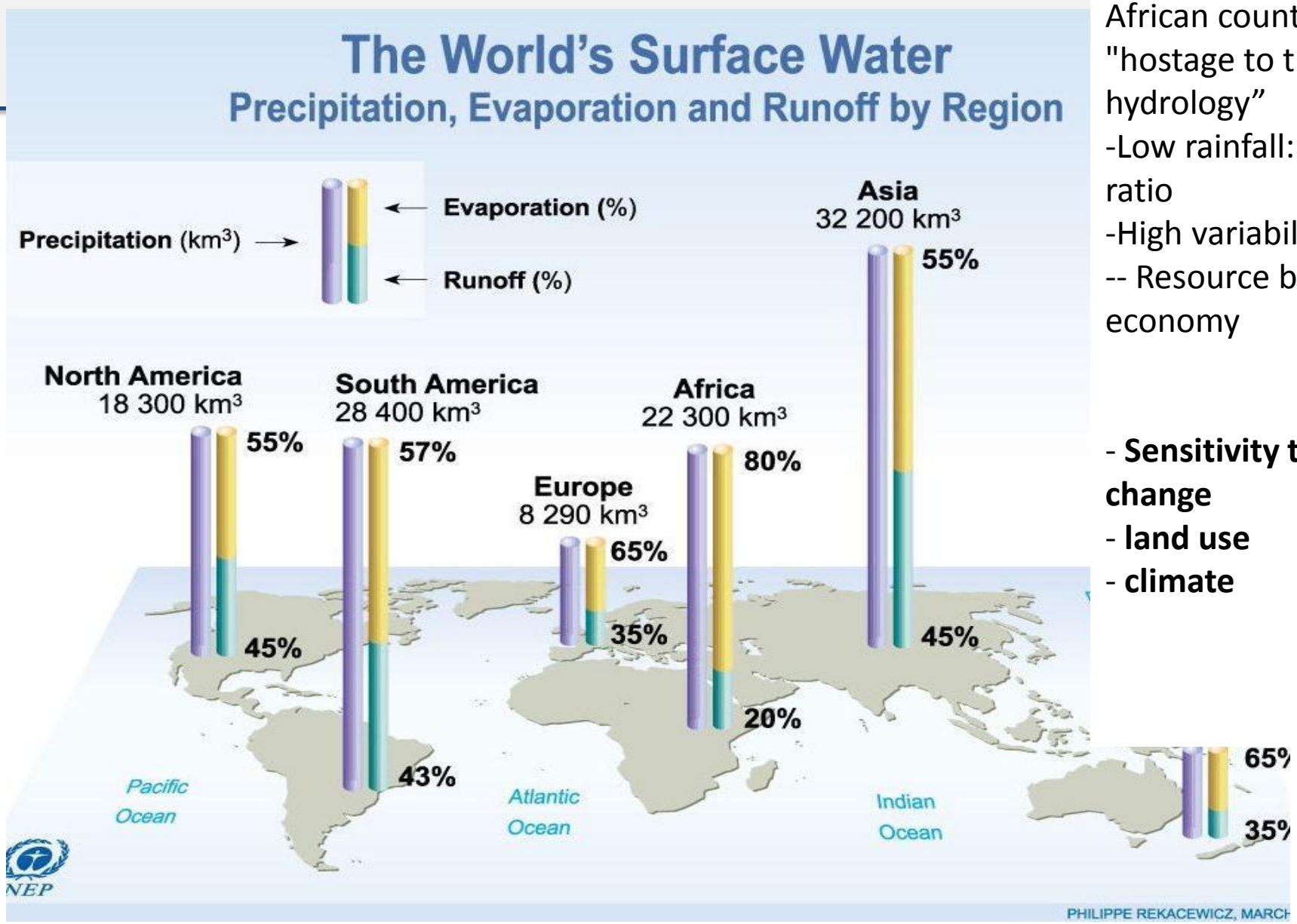
Higher productivity

Equivalent crop productivity in 2009 required 35% of the land needed in 1961



Ausebel et al 2013

- Opportunities to increase yield, reduce land for crop production, or grow other (non-food) crops.
- Global averages vs local context



African countries "hostage to their hydrology"

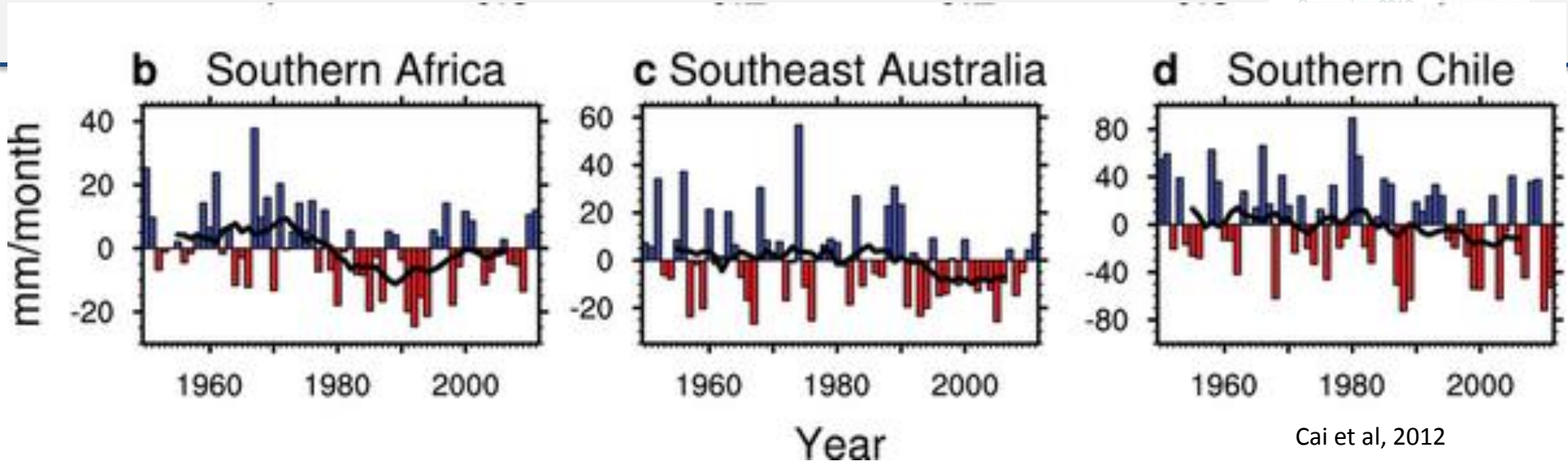
-Low rainfall: runoff ratio

-High variability

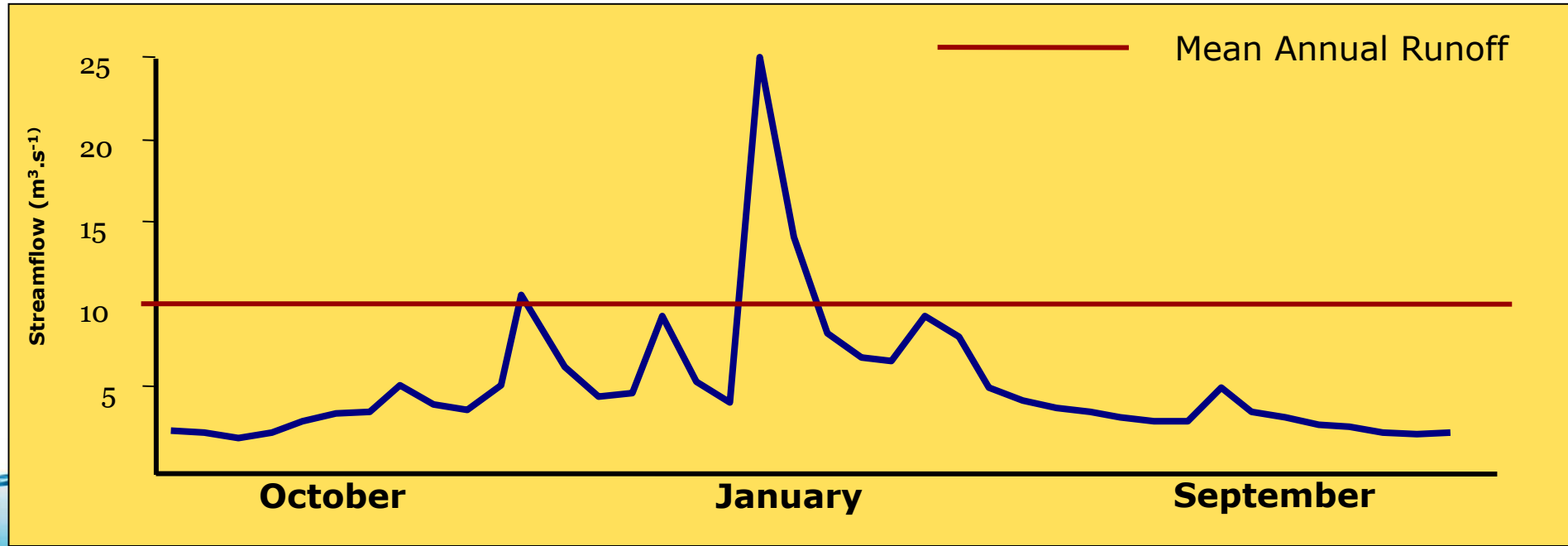
-- Resource based economy

- **Sensitivity to change**
- **land use**
- **climate**

The Mean is Meaningless

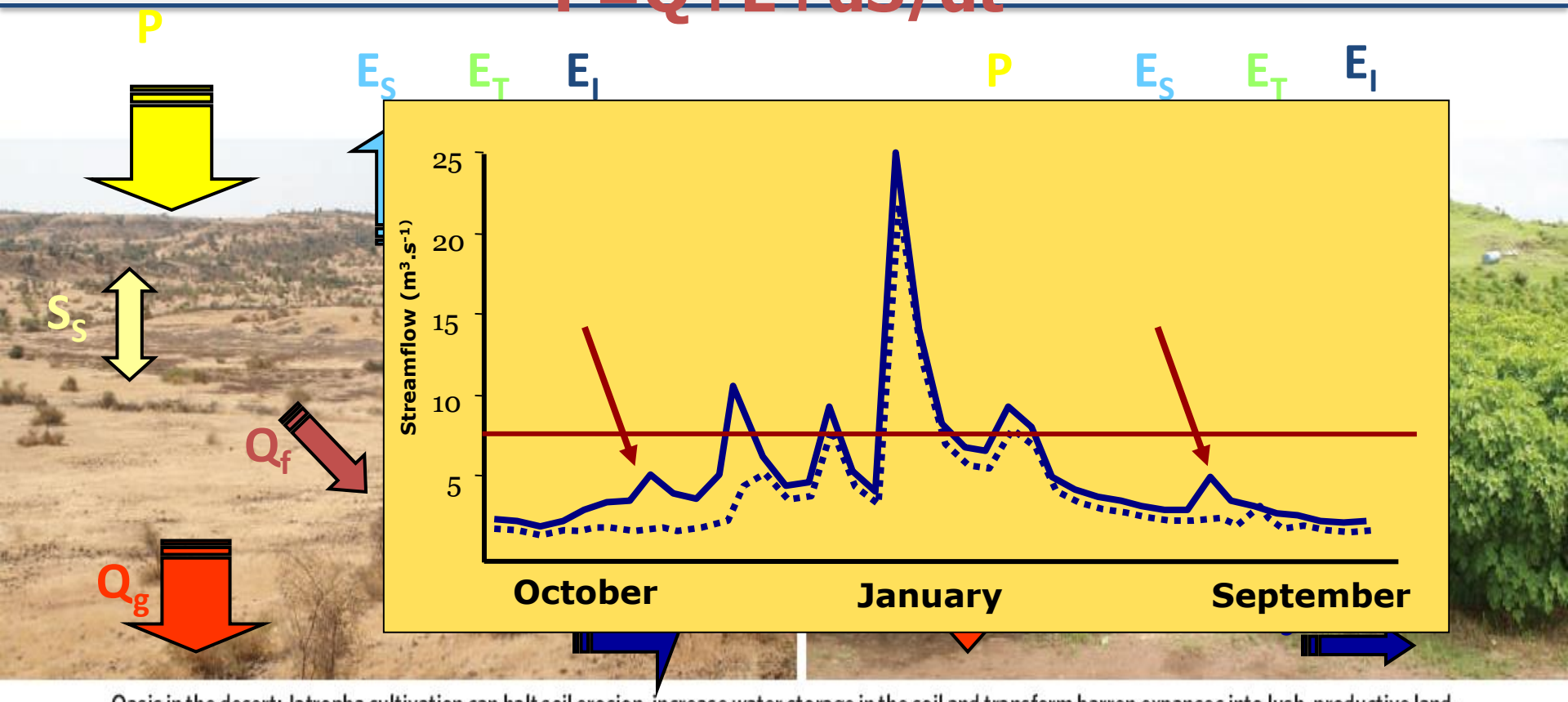


Cai et al, 2012



Impacts of bioenergy production on hydrological processes

$$P=Q+E+dS/dt$$



Oasis in the desert: Jatropha cultivation can halt soil erosion, increase water storage in the soil and transform barren expanses into lush, productive land.

Short-term dynamics (e.g. interception, flood generation) *vs.* long-term dynamics (e.g. groundwater recharge, base flow)

Picture from Fairless, 2007. *Nature* with annotation by Stefan Uhlenbrook

Biofuels in South Africa

The National Biofuels Industrial Strategy of South Africa (NBIS)

Department of Minerals and Energy (DME, 2007)

2% penetration of biofuel within five years (conservative)

- 400 million litres per year by 2013
- Van Maltitz = 310 000Ha

Biofuel crop production

- Alleviate rural poverty
- Provide economic development

Policy Approaches from South Africa

- No food crops for biofuels
- No potential invasive plants
- No irrigation of biofuels
- If **dryland** water use is significant – water use license

Biofuels in South Africa

Specified energy crops to be considered (NBIS)

- Sugarcane
- Sugarbeet
- Soybeans
- Canola
- Sunflower

Energy crops that are excluded

- Jatropha (alien invasiveness; moratorium)
- Maize (food security issues)

Irrigation of biofuel crops not supported

- Industrial water tariff applied

South Africa's National Water Act

- **Principle 18**
  - Since many **land uses** have a significant **impact** upon the water cycle, the regulation of land use shall, where appropriate, be used as an instrument to manage water resources within the broader integrated framework of land use management
- Unique in law internationally
- Are bioenergy crops SFRA's?
- Optimal growing areas?

WRC Project No: K5/1874
Water use of cropping systems adapted to bio-climatic regions in South Africa and suitable for biofuel production

To determine the water use of crops/trees for biofuel production in selected high and low potential bio-climatic regions of South Africa.

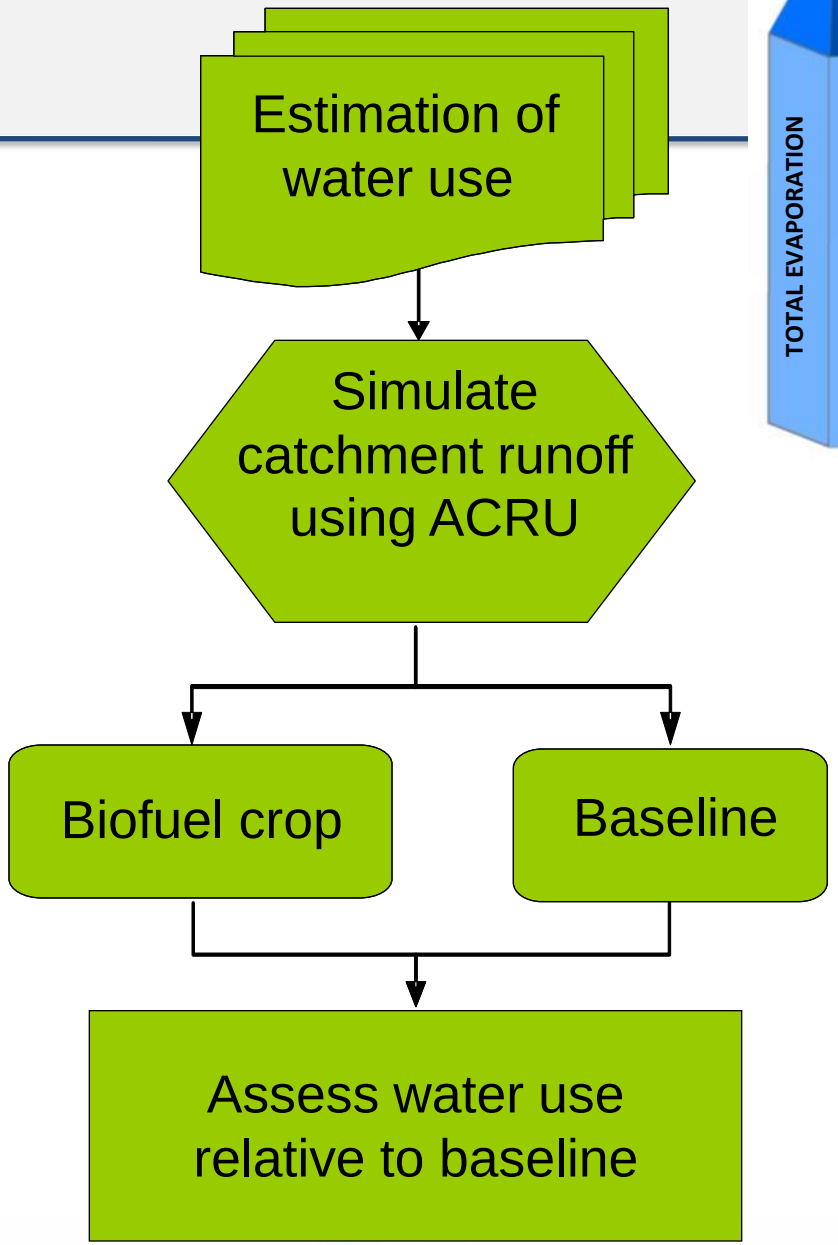
- Identify and describe bio-climatic regions suitable for crop/tree systems for biofuel production
- To specify and prioritize currently grown and potential alternative first and second generation crops and cropping systems including both annual and perennial crops/trees
- Assess the impact of land use changes on the water balance
- Provide training opportunities

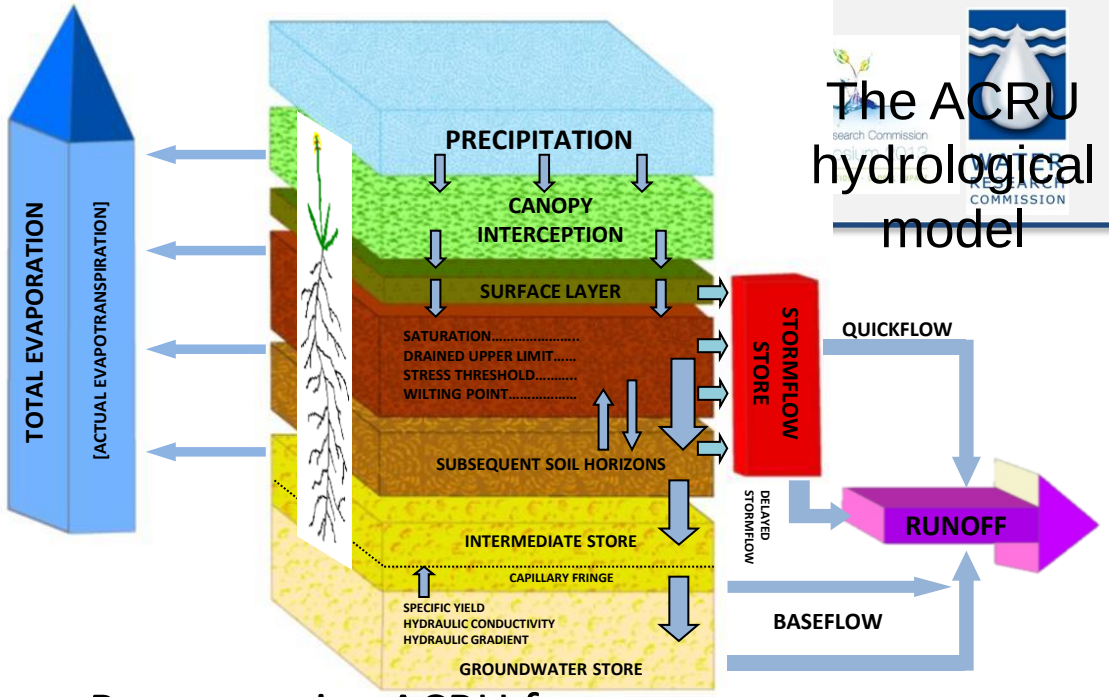
UKZN led team in collaboration with CSIR, Univ of Pretoria and SASRI

Measuring Feedstock Water Use

Grain Sorghum (Ukulinga)

The ACRU hydrological model





Parameterise ACRU for:

- Baseline conditions (natural vegetation)
- Each biofuel crop

Crop Yield and Water Use modelling

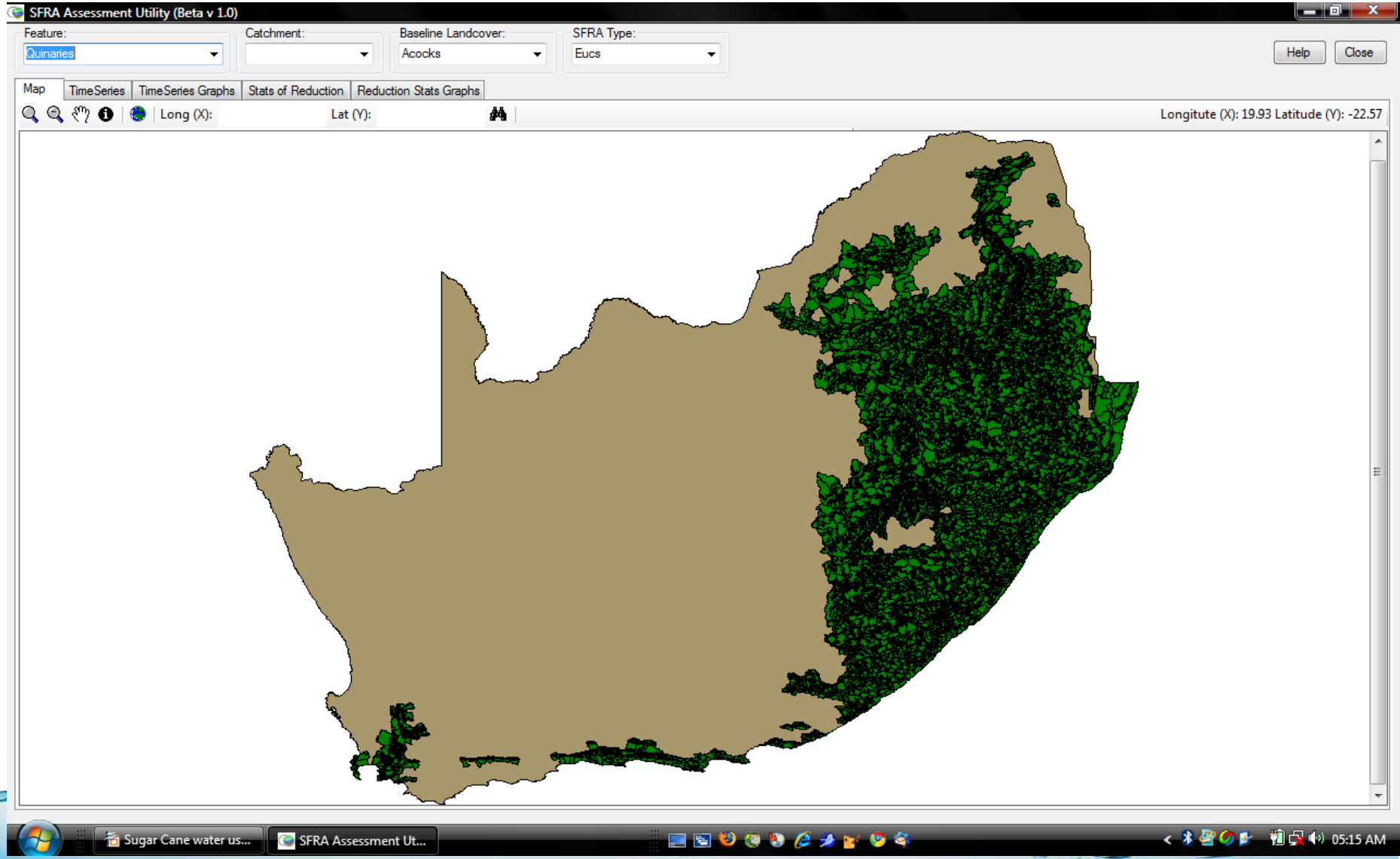
Simulate catchment annual runoff for:

- Baseline conditions (MAR_{base})
- Each biofuel crop (MAR_{crop})

Estimated water use = $MAR_{base} - MAR_{crop}$

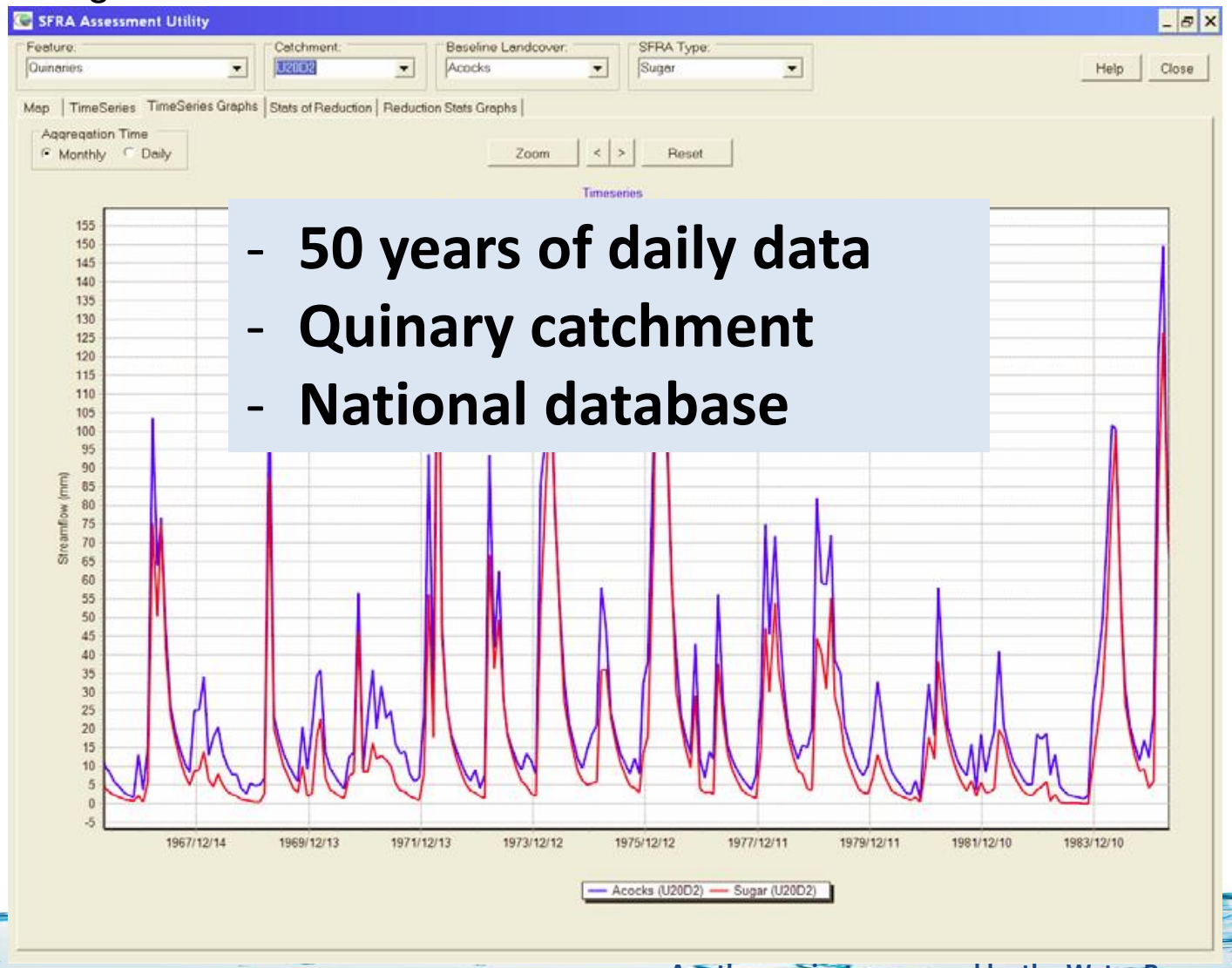
- Monthly and annual basis

SFRA Assessment Utility



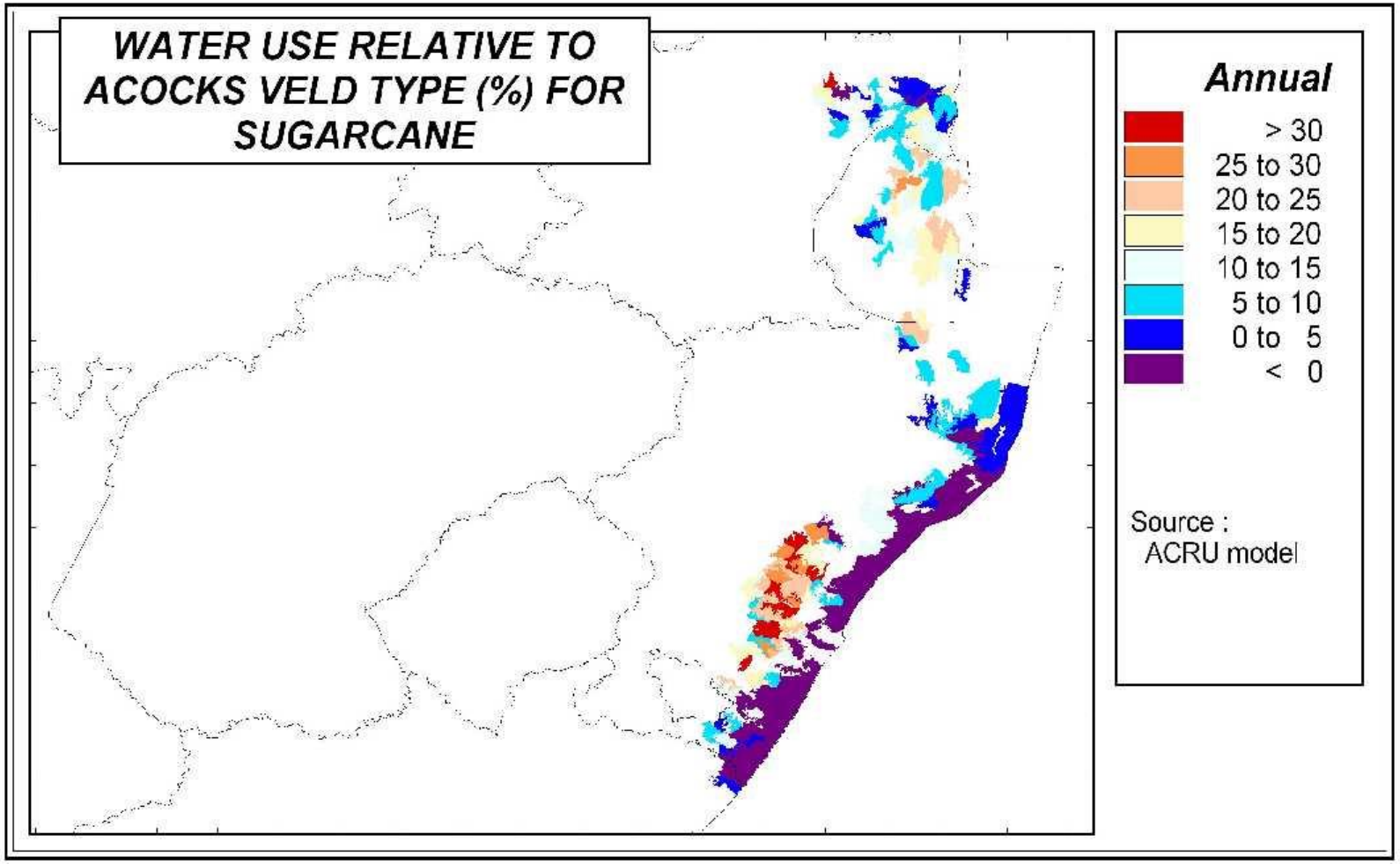
Streamflow Analysis

KZN Midlands Sugar Cane



- **50 years of daily data**
- **Quinary catchment**
- **National database**

Sugar Cane “Water Use”



Impact of Land Use on Streamflow

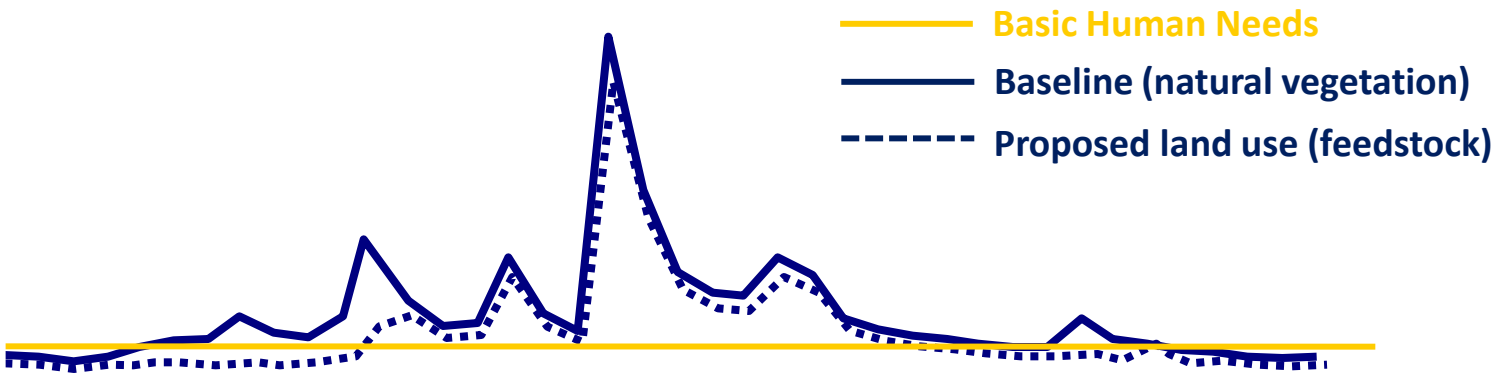
Does the reduction in stream flow compromise water required for:

- Basic human needs, or
- Environmental flows?

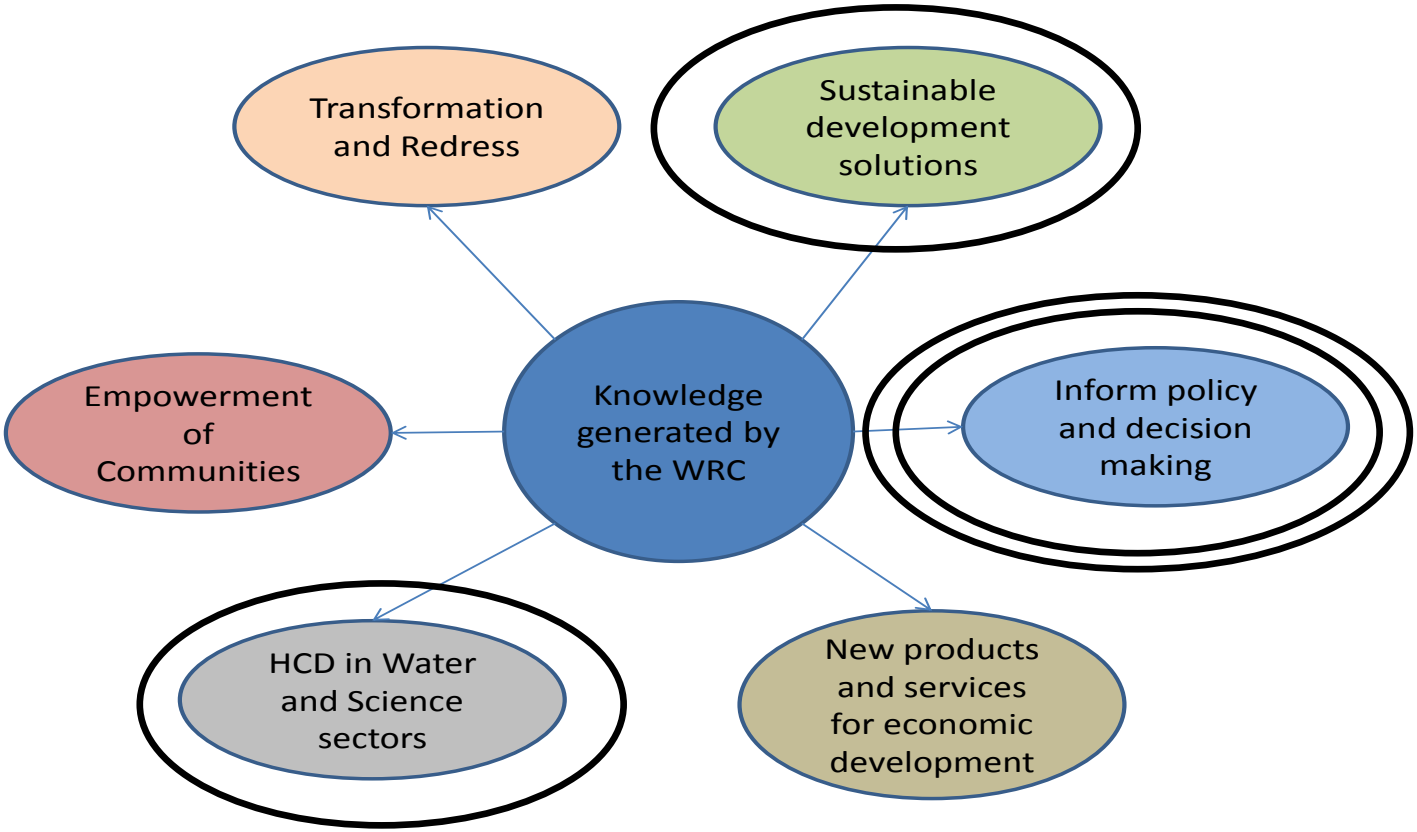
If so, declare the land use a Stream Flow Reduction Activity (SFRA):

- DWA controls where and how much can be planted

Tool for sustainable management of land and water



Impact


Transformation and Redress
Sustainable development solutions
Empowerment of Communities
Knowledge generated by the WRC
Inform policy and decision making
HCD in Water and Science sectors
New products and services for economic development

Perspectives

- Ill Informed Innovation
  - Cradock Biofuels
  - Several Foreign Investments
  - Hydrological Heist
- Non-food crops
  - Locking land in jatropha vs flexibility of annual crops
- Jargon
  - Beyond the theory and language “words like “nexus” are almost guaranteed to send politicians and captains of industry to sleep” – David Tickner WWF