Is hydrology a natural science?

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Introduction

1. Socio-hydrology
2. Hydrology serving and shaping society
3. Hydrology of coupled human-water systems – examples from Africa
4. Towards a xxxxxxxxxreflexive hydrology

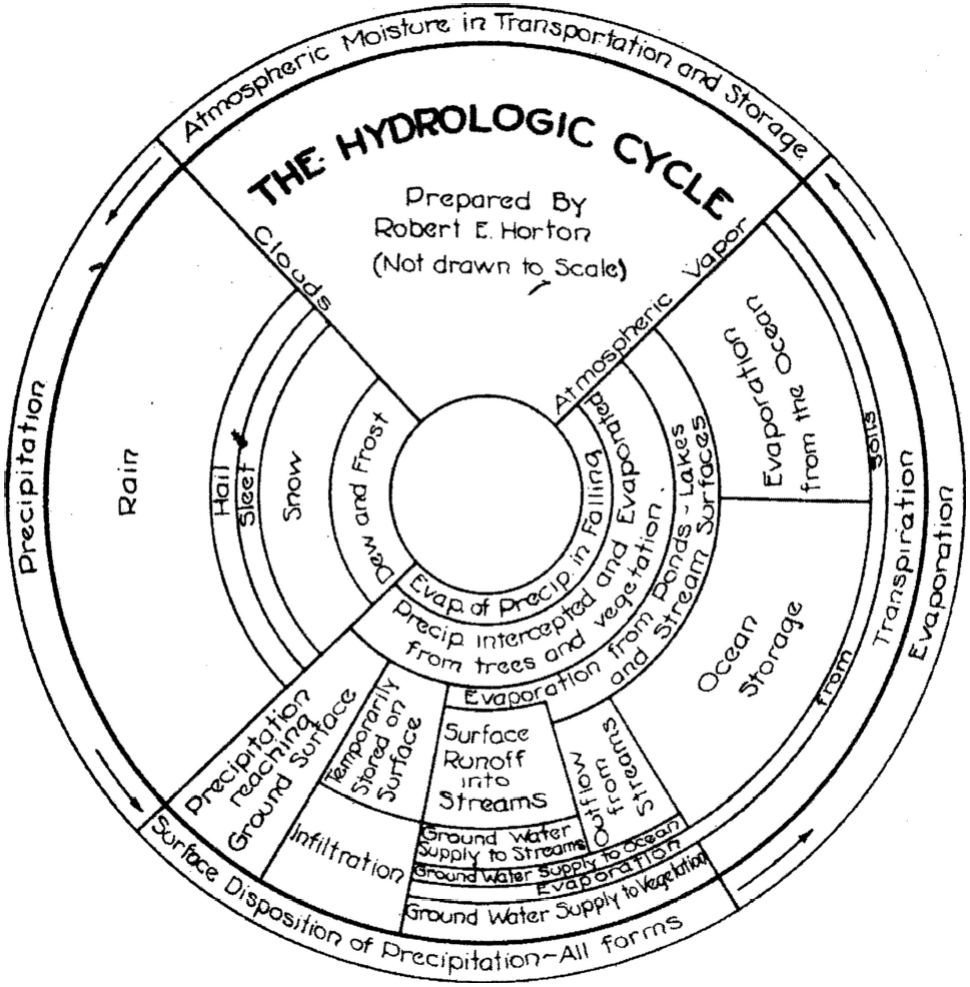
Is hydrology a natural science?

Introduction

Defining hydrology

"tracing and explaining the processes and phenomena of the hydrologic cycle, or the course of *natural* circulation of water in, on and over the Earth's surface"

Horton 1931, p. 192,
cited in Linton, 2008, p. 635



Is hydrology a natural science?

1 Socio-hydrology

INVITED COMMENTARY

HP TODAY

HYDROLOGICAL PROCESSES
Hydrol. Process. **26,** 1270–1276 (2012)
Published online 24 January 2012 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/hyp.8426

Socio-hydrology: A new science of people and water

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[2] *Department of Civil and Environmental Engineering, University of Technology Sydney, Broadway, NSW 2007, Australia*
[3] *Department of Water Management, Faculty of Civil Engineering and*

Humans have changed the way the world works. Now they have to change the way they think about it, too. **The Economist, May 26, 2011**

THE COUPLED HUMAN-WATER SYSTEM

Dateline November 2010, Murrumbidgee River Basin, Australia: Irrigators are up in arms over proposed government plans to cut their water allocations and return flows back to the basin's rivers to support the environment and restore lost biodiversity. *The Australian* of November 04, 2010 reported on the community backlash, including the resort to 'book burning' to highlight their plight. Community backlash and 'book burning' notwithstanding, the reality is that this conflict had been brewing for decades. Now, wind back the clock 100 years to the early 20th century. Up

1 Socio-hydrology

aims at "understanding the dynamics and co-evolution of coupled human-water systems”

"socio-hydrology treats people as endogenous of the water cycle"

(Sivapalan et al., 2012)

- I find the above propositions interesting but also problematic

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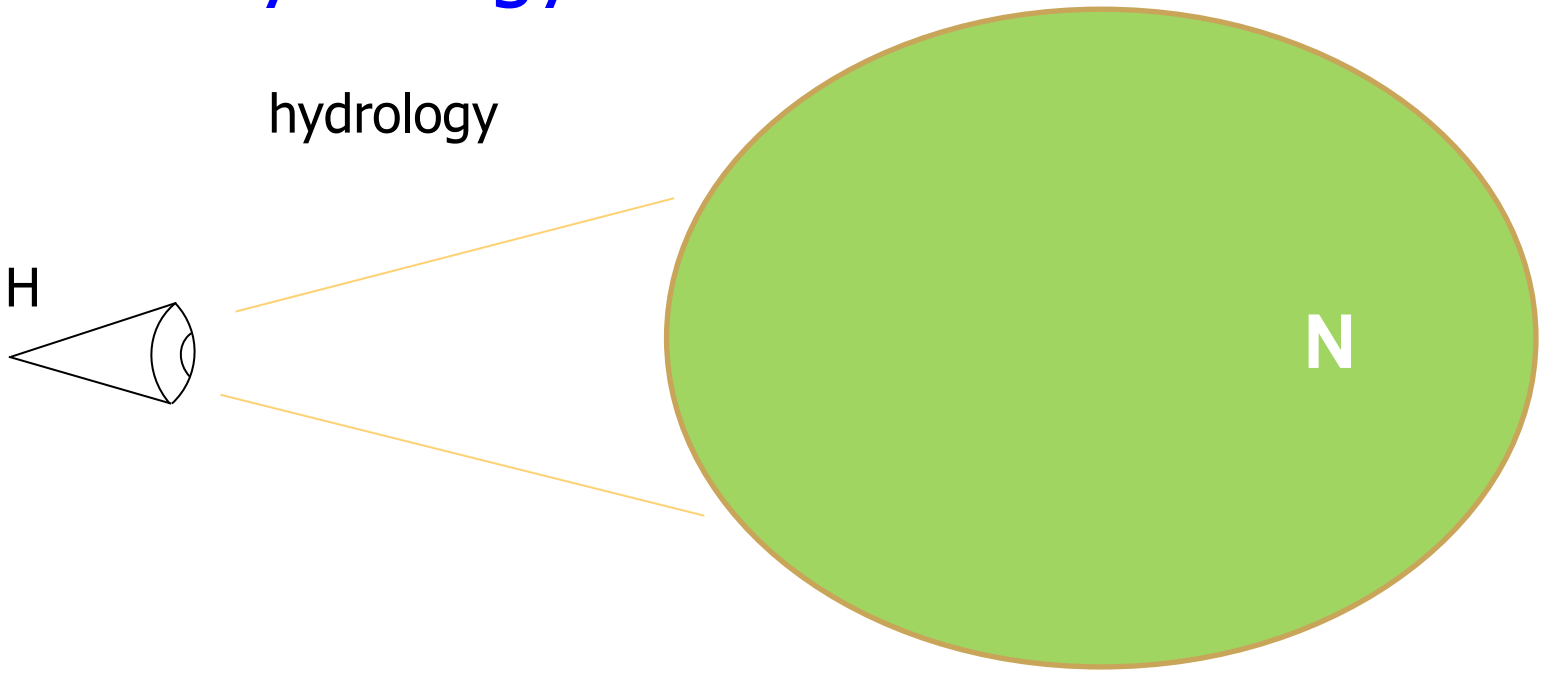
1 Socio-hydrology



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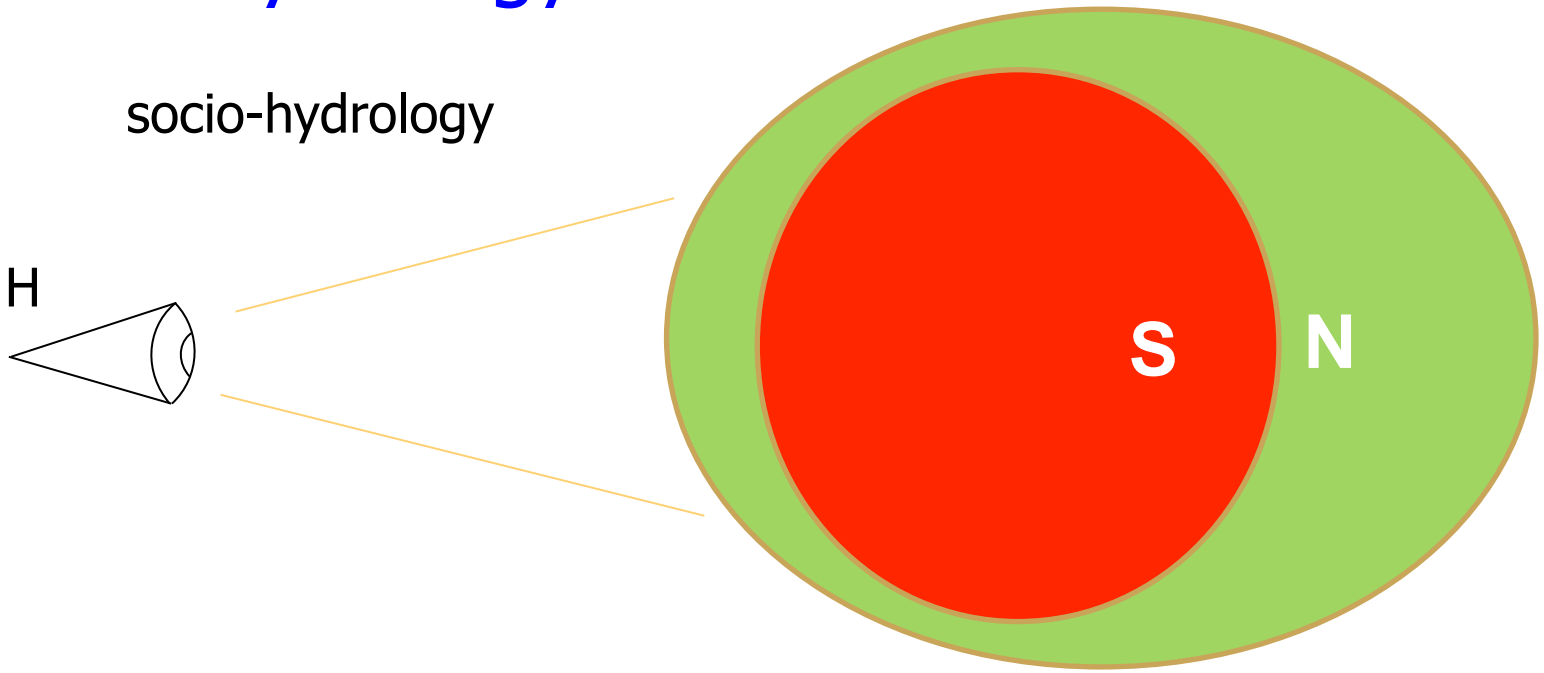

Is hydrology a natural science?

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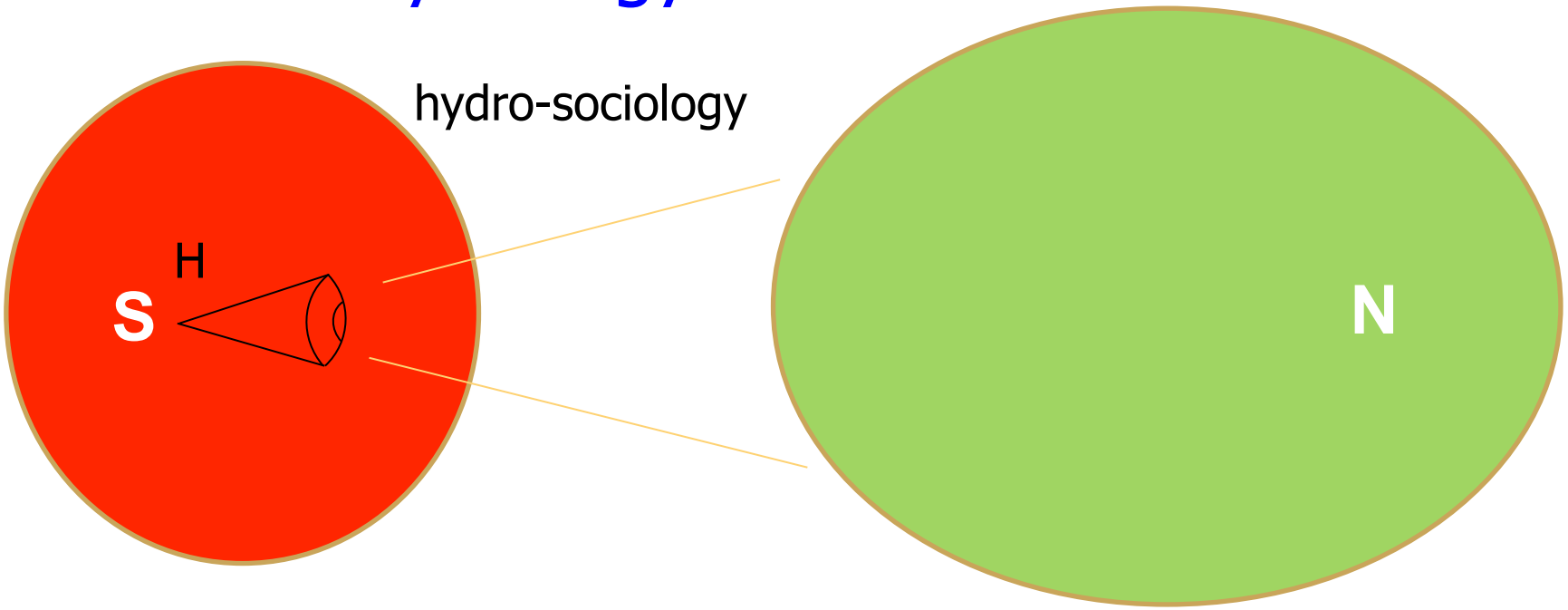

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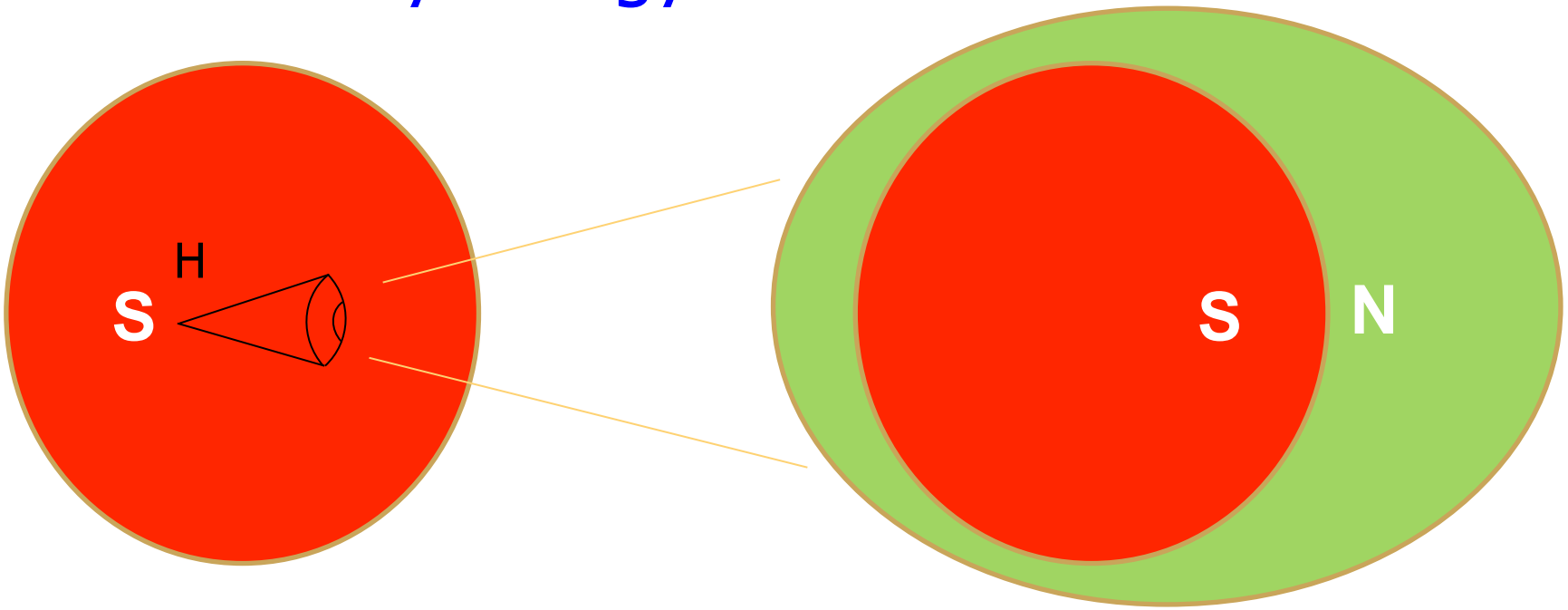

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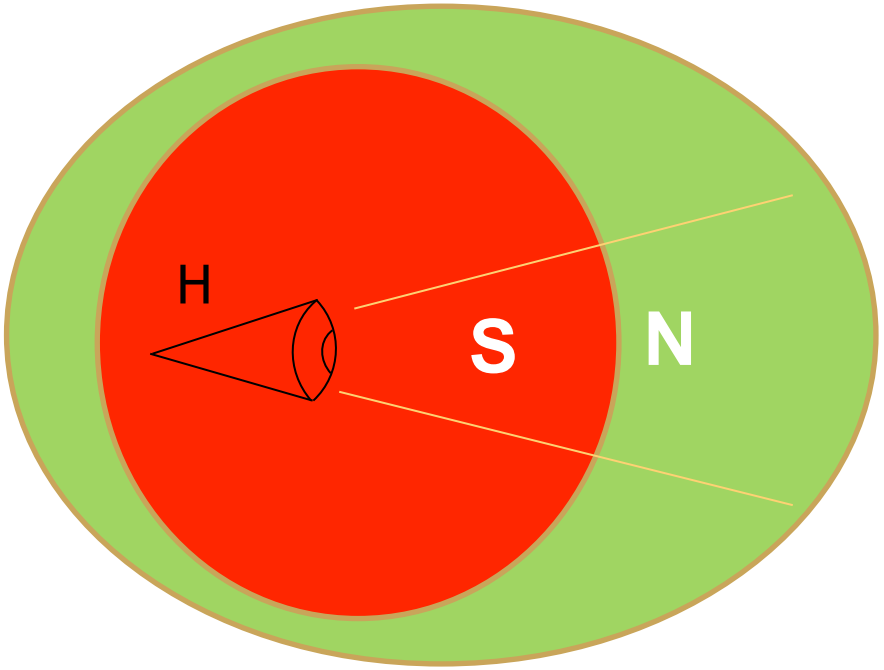
1 Socio-hydrology

constructivist



1 Socio-hydrology

aims at "understanding the dynamics and co-evolution of coupled human-water systems"

"socio-hydrology treats people as endogenous of the water cycle"

(Sivapalan et al., 2012)

- I find the above propositions interesting but also problematic
- Seems to imply that hydrology has *not* been integral part of society
- Socio-hydrology should make explicit the role of hydrological knowledge and hydrological consciousness in society.
- Socio-hydrology *vs.* "Hydro-sociology"
- My own interest: I see a possibility to contribute to hydrology, as I have studied coupled human-water systems since 1984

2 Hydrology serving and shaping society

Nilometer (3000? BC - 1000 AD)

Hero of Alexandria ("the first engineer") (c. 10–70 AD)

Leonardo Da Vinci (1452-1519), the first experimental hydrologist

Antoine Chézy (1718-1798)

Thomas James Mulvaney (1822-1892)

Gaspard Darcy (1803-1858)

Robert Manning (1816-1897)

S.B. Hooghoudt (1901-1953)

2 Hydrology serving and shaping society

Nilometer (3000? BC - 1000 AD)

These first river gauges were used to plan the start of the irrigation season, and to tax the irrigators.

These Nilometers thus served the status quo.

2 Hydrology serving and shaping society

Hero of Alexandria ("the first engineer")
(c. 10–70 AD)

Source: Wikipedia

measured the discharge of a spring correctly for the first time

this information was important for the design of water works and the supply of water to the city of Alexandria

he also wrote about the discharge of syphons used for irrigating lands bordering the desert

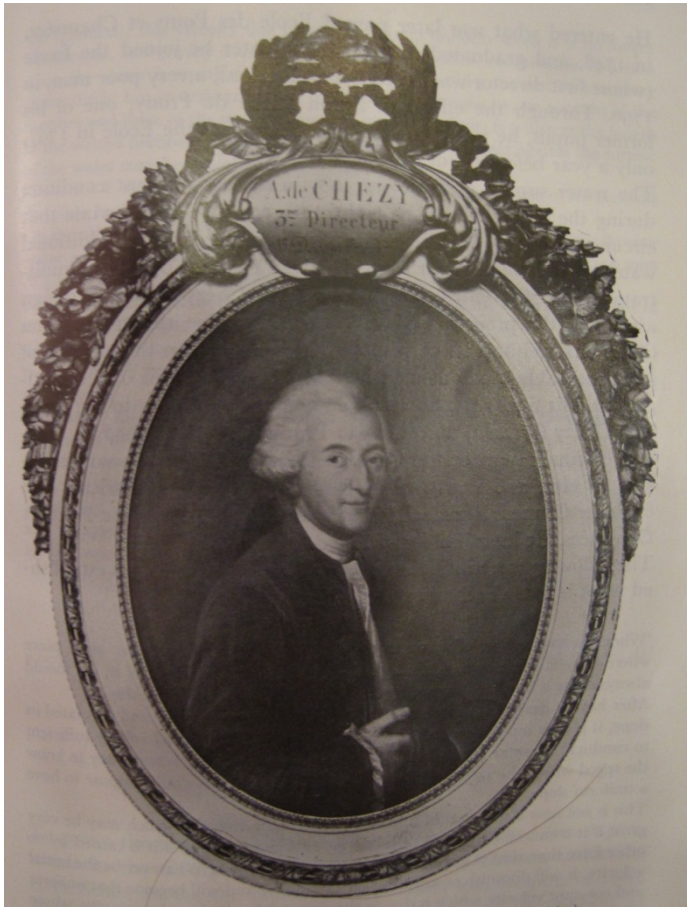
(Biswas, 1970: 87-88)

2 Hydrology serving and shaping society

Antoine Chézy (1718-1798)

needed to design a new canal to bring additional water to Paris, and developed a formula to calculate discharge

(Biswas 1970, p. 262-267)



2 Hydrology serving and shaping society

Thomas James Mulvaney (1822-1892)

developed the "rational method" (1850) to calculate the storm discharge from a drainage area in Ireland, in order to design drainage canals

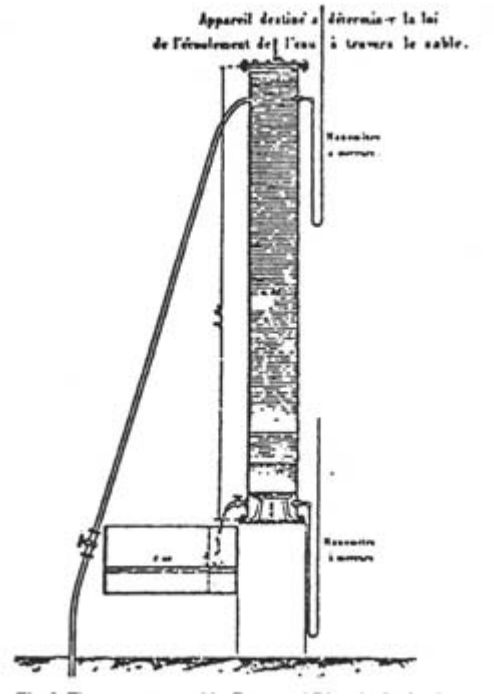
(Biswas 1970, p. 301-302)

2 Hydrology serving and shaping society

Gaspard Darcy (1803-1858)

in his 1856 report on the water supply system of Dyon described in quantitative terms the purification of water by filtration through sand and developed an equation that is considered the theoretical foundation of groundwater hydrology

(Biswas 1970, p. 308)



2 Hydrology serving and shaping society

In 1857 the General Royal Agricultural Association in The Netherlands called for a competition whereby a reward would be given to the person who in designing a sub-surface drainage system for agricultural lands applied the then known scientific rules in the most effective manner.

The absence of an adequate groundwater flow theory that could model Dutch circumstances was considered problematic.

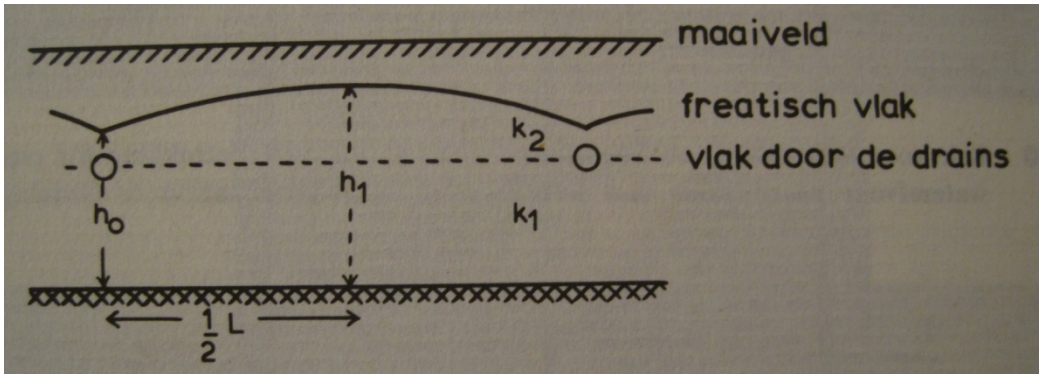
Apparently no satisfactory solution was submitted

(De Vries, 1982: 18-19)

2 Hydrology serving and shaping society

S.B. Hooghoudt (1901-1953)

published in 1940 a formula to calculate the spacing of and size of underground drainage pipes for a two-layered soil profile with different permeability.



(De Vries, 1982, p. 92 & 86)

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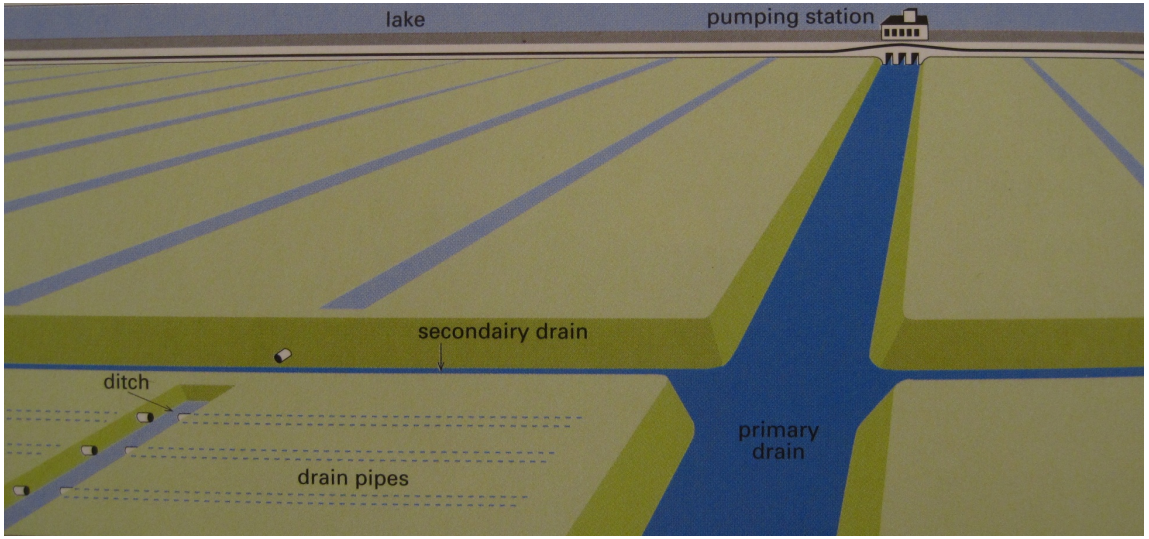
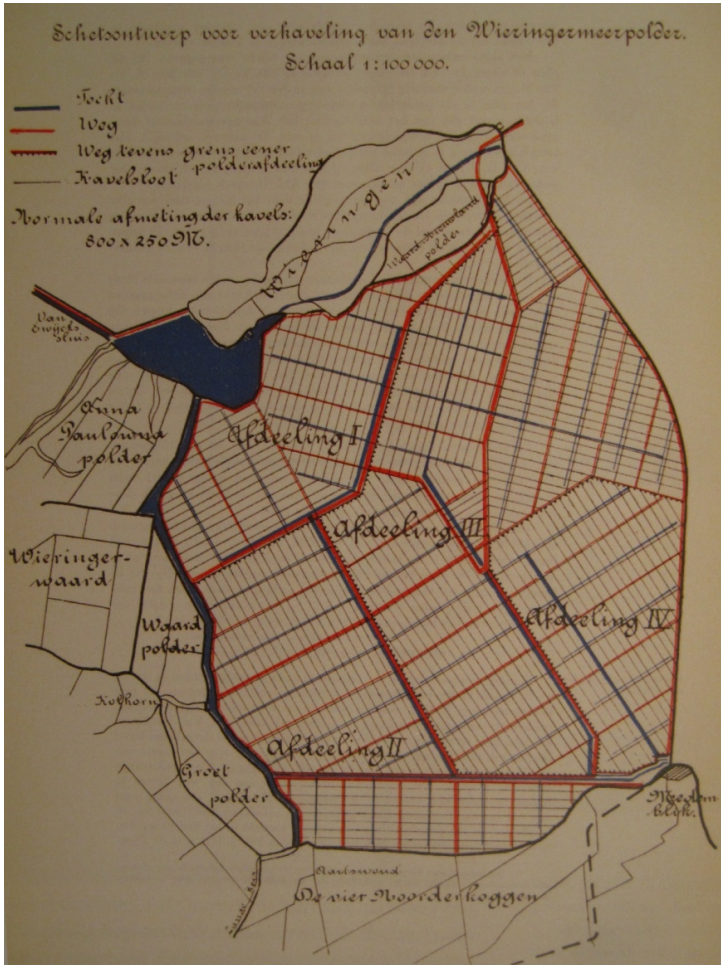
2 Hydrology serving and shaping society

S.B. Hooghoudt (1901-1953)





2 Hydrology serving and shaping society

Conclusion: hydrology was instrumental in shaping society.
This knowledge helped to transform the landscape - and thus also the very hydrology it had helped to describe and analyse!

The history of hydrological research describes
"how the human "art" calls upon "nature", which it has violated, for assistance to mitigate the consequences"
(R. Hooykaas in De Vries, 1982, p.ii)

This in fact describes a process of co-evolution
between society and hydrology

3 Coupled human-water systems - Africa

Even in Africa coupled human-water systems have fundamentally changed the hydrology. And the increasing hydrological knowledge the societies

If this is the case in Africa, how much will this be true for many other parts of the world that have been even more intensively modified by man.

3 Coupled human-water systems - Africa

Zambezi: a modified flow regime

Incomati: what is the natural hydrology

Lake Victoria: tb controversy over declining lake levels

Makanya, Tanzania: hydrograph reveals institutional information

Basse Casamance, Senegal: ricepolders

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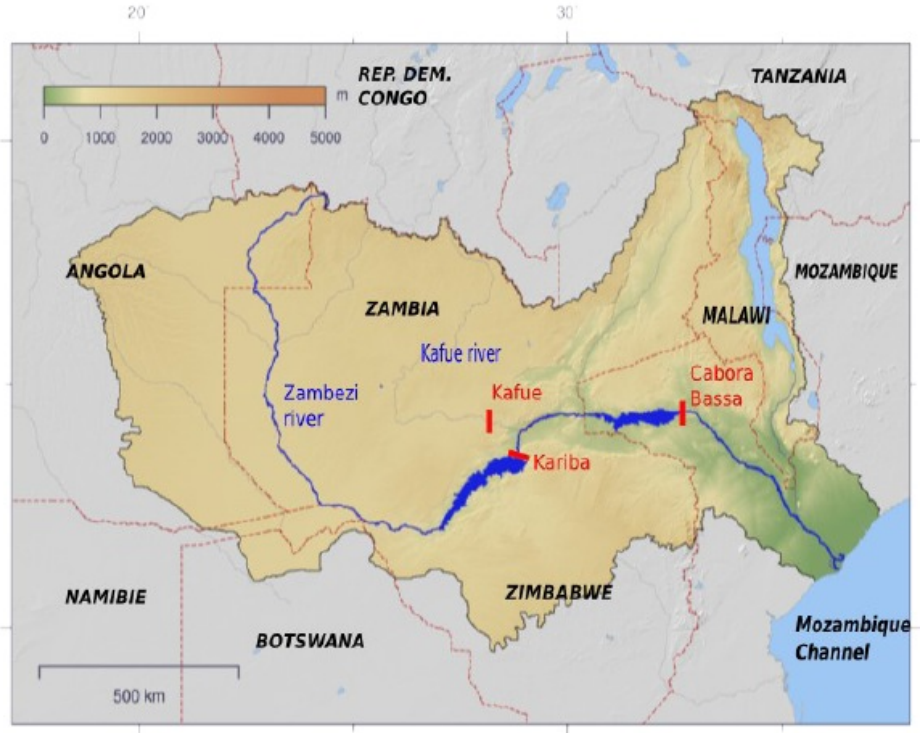
3 Coupled human-water systems - Africa

Zambezi Basin



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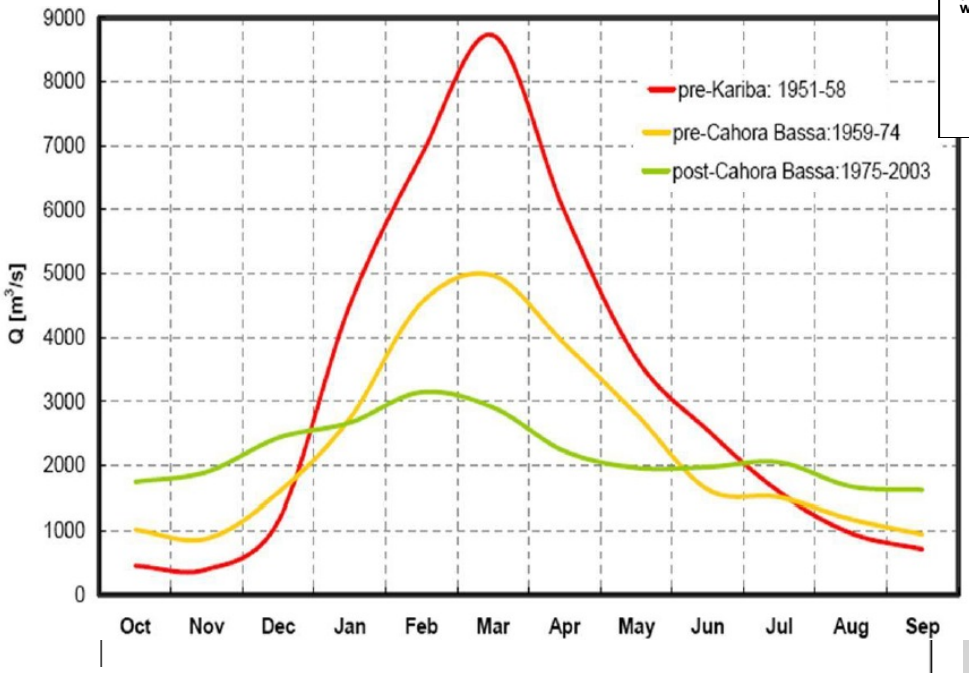
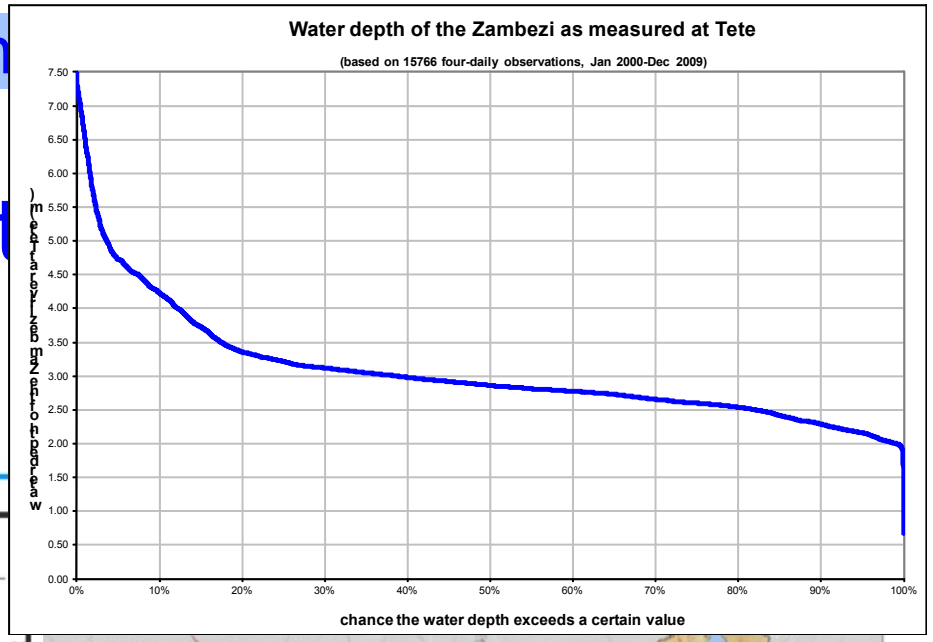
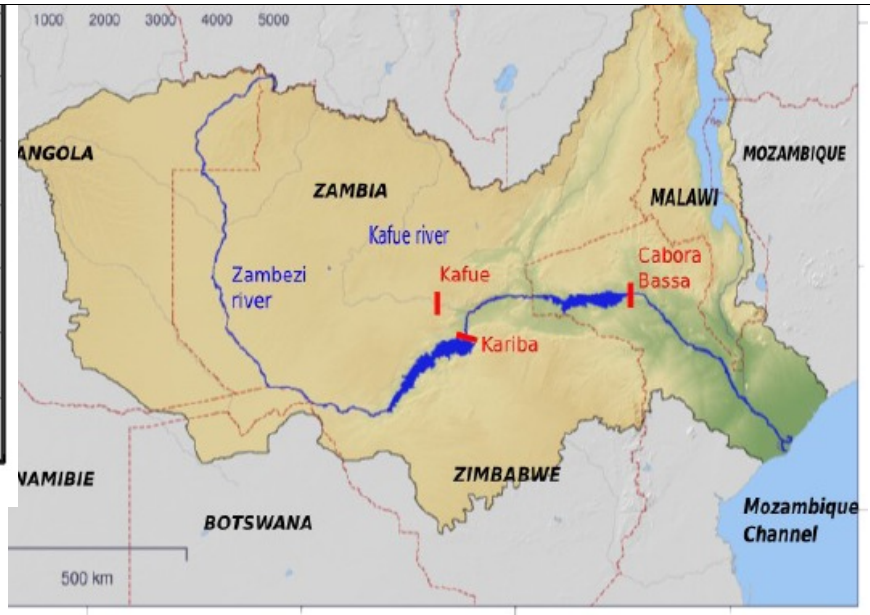
3 Coupled human-wat

Zambezi Basin



Monthly average discharge at Tete, Mozambique (Source: Ronco et al., 2010)





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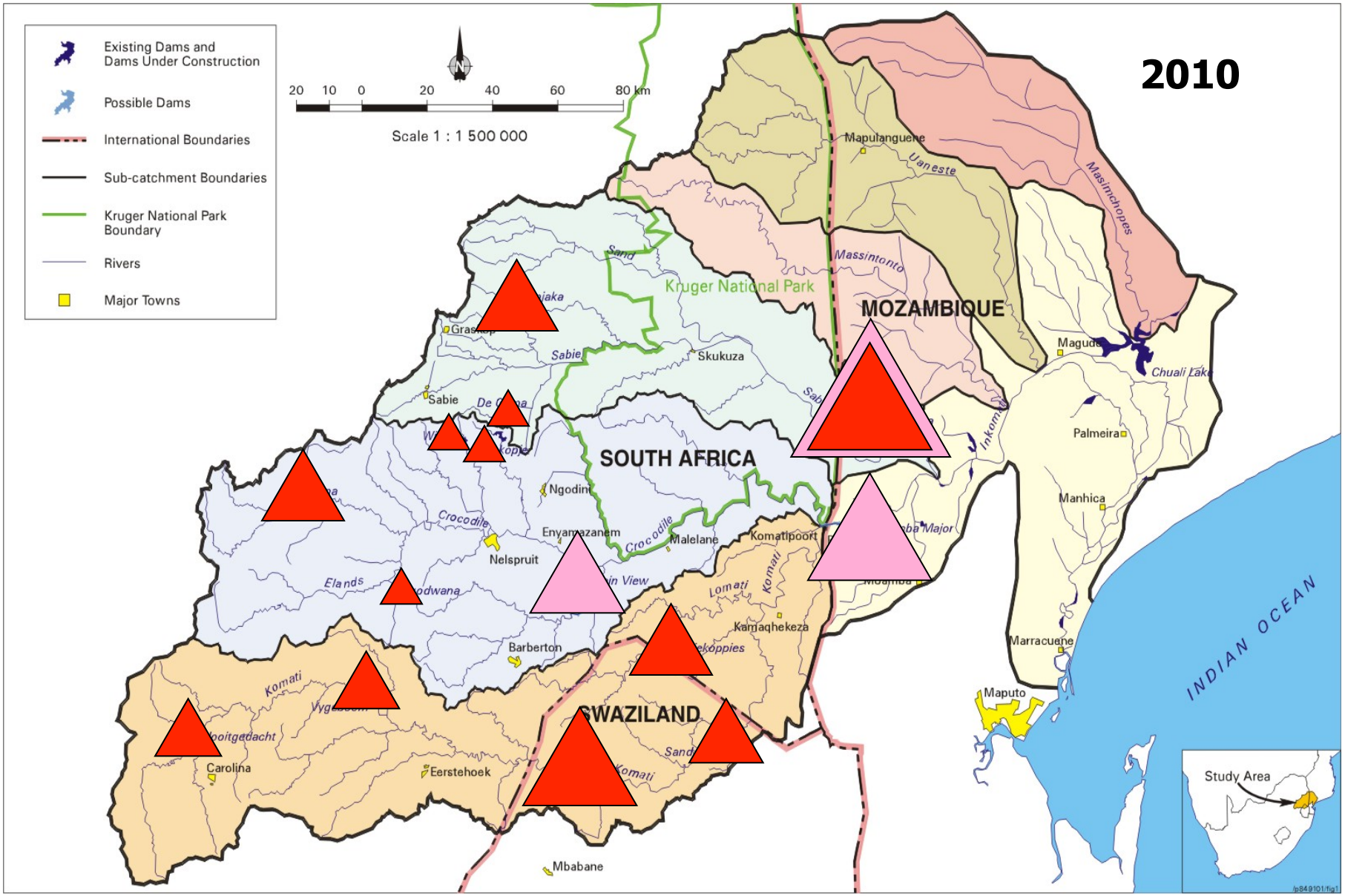

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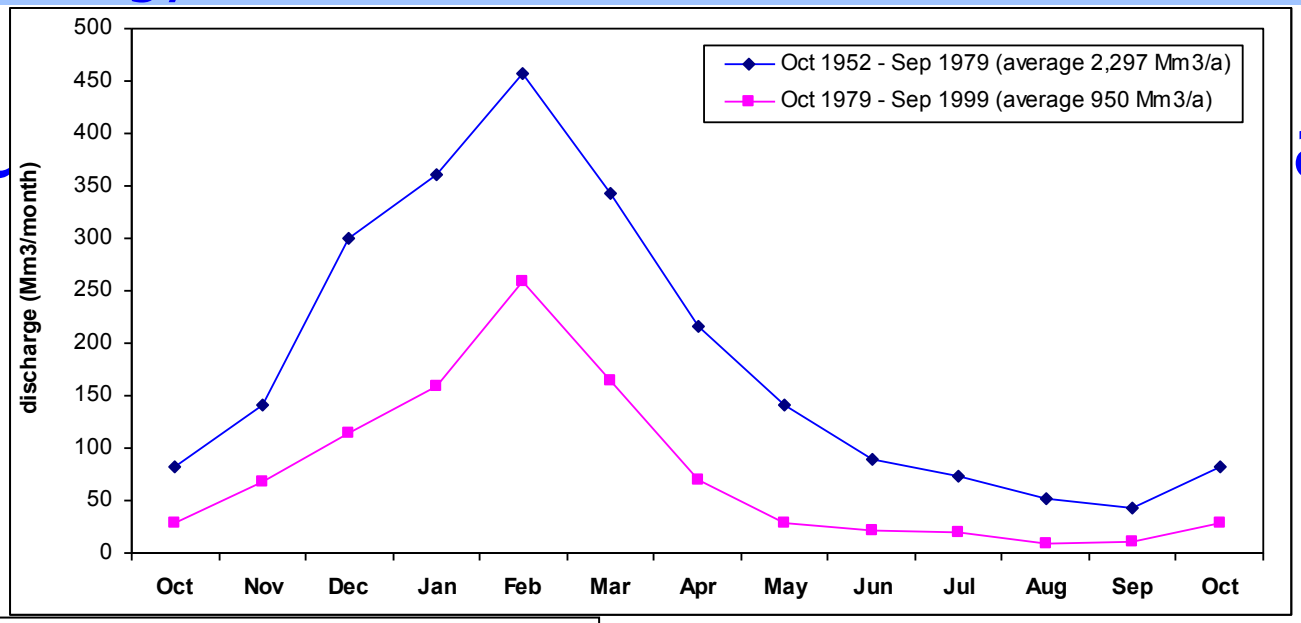

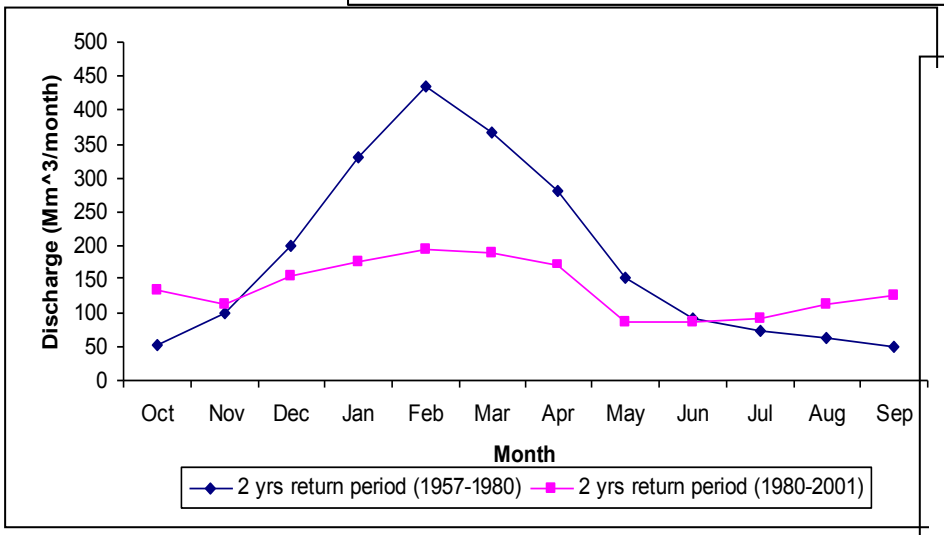

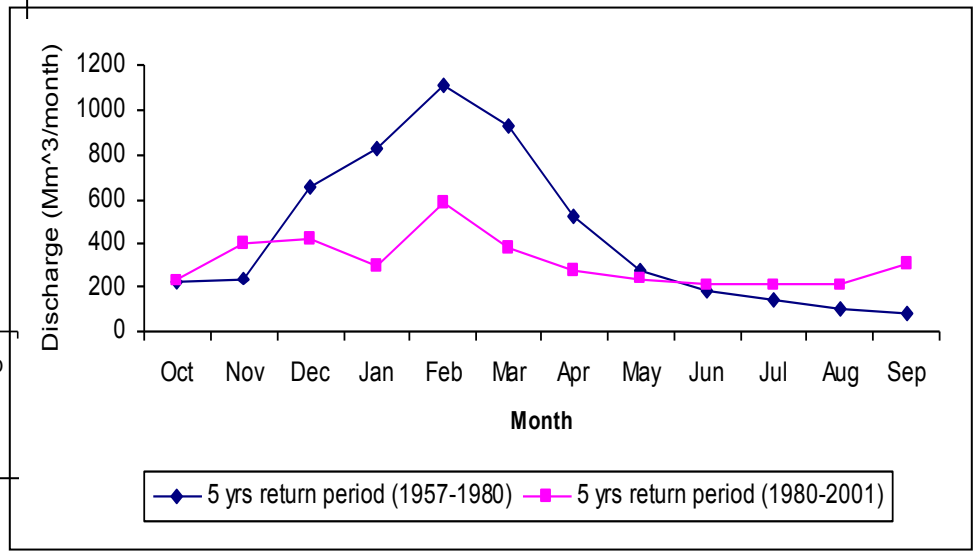

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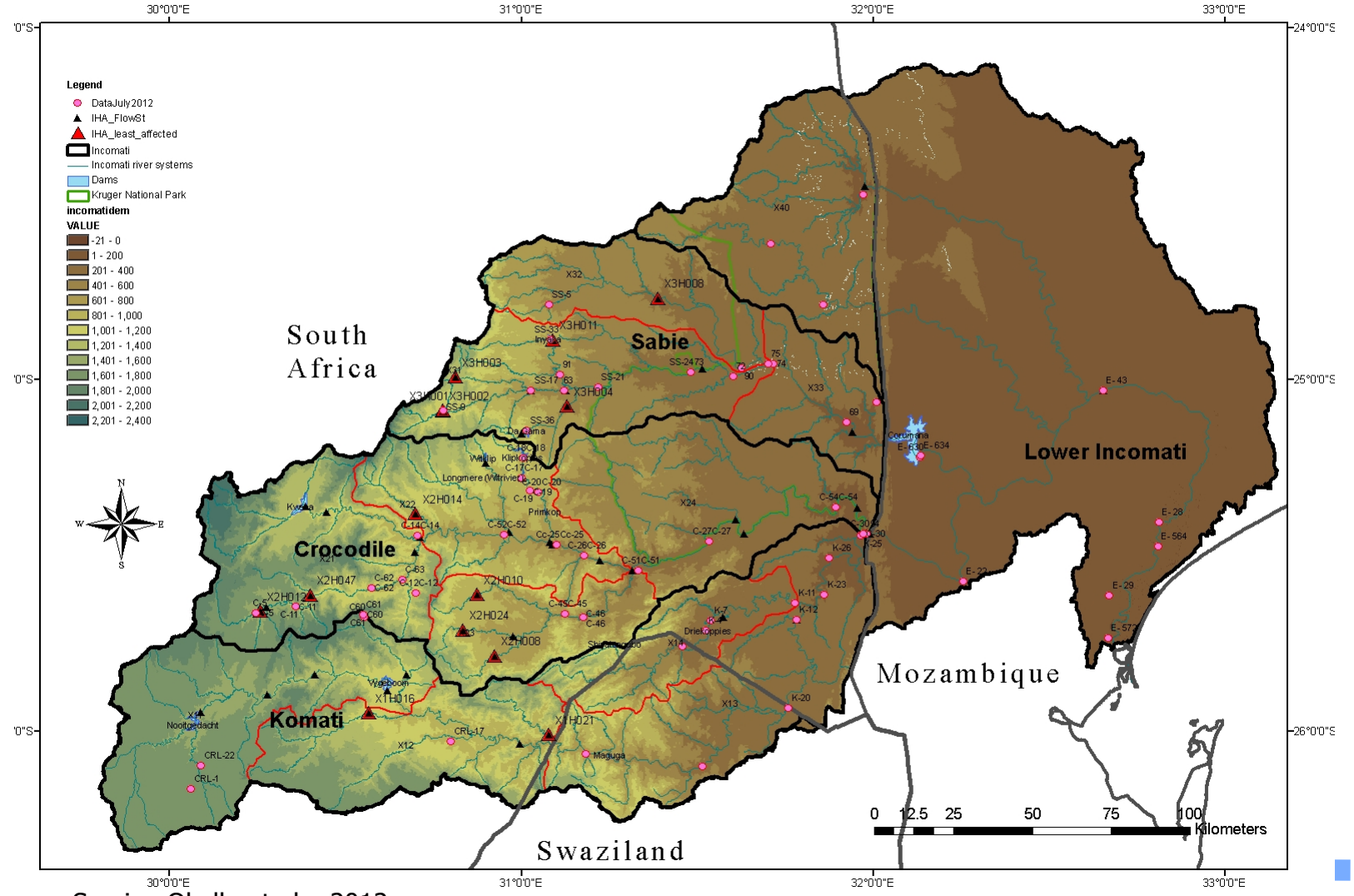
3 Coupled human-water systems - Africa



Saraiva-Okello et al.., 2012

UNESCO-IHE
Institute for Water Education

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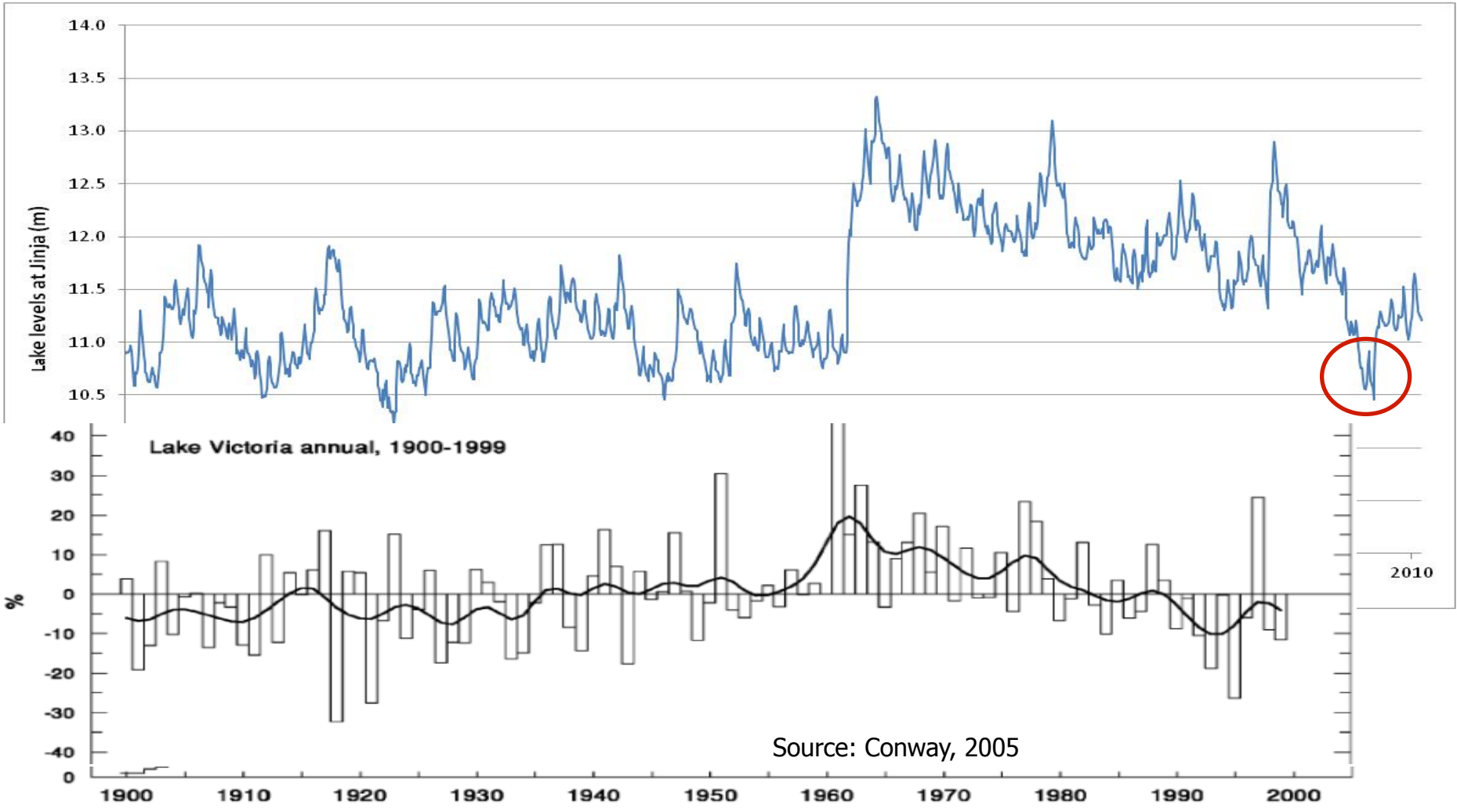

Source: Conway, 2005

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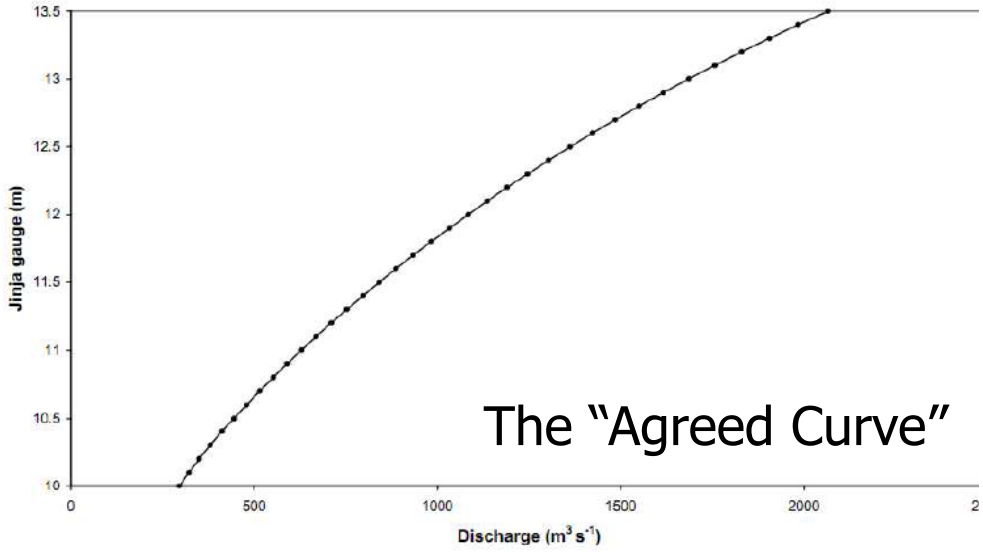
3 Coupled human-water systems - Africa

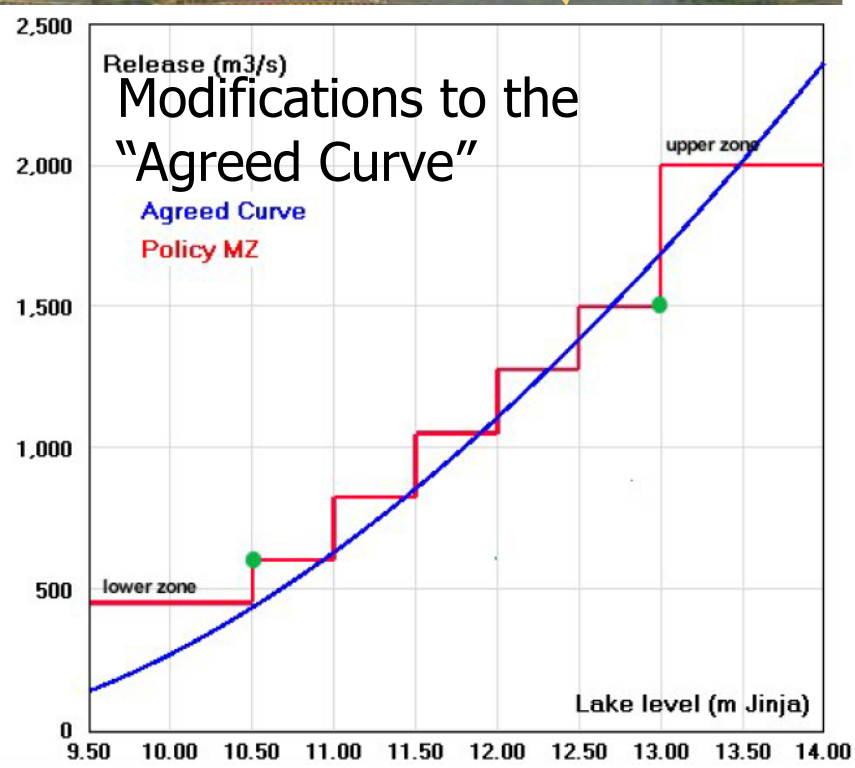
Owen Falls (Nalubaale) Dam (1954; 200 MW)

Kiira Dam
(2000; 180 MW)



The "Agreed Curve"

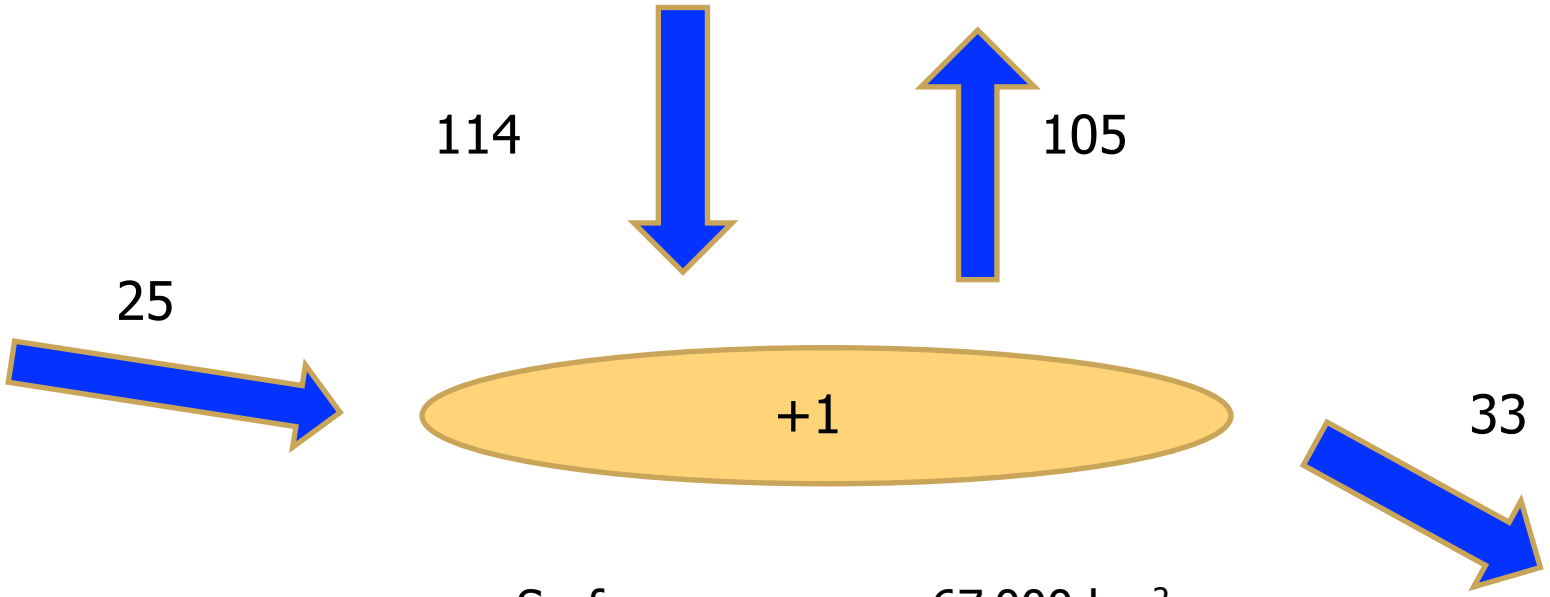
(Source: Sutcliffe and Petersen, 2007)



(LVBCS, 2012)

3 Coupled human-water systems - Africa

Water Balance Lake Victoria , 1950-2000 (km^3/yr)

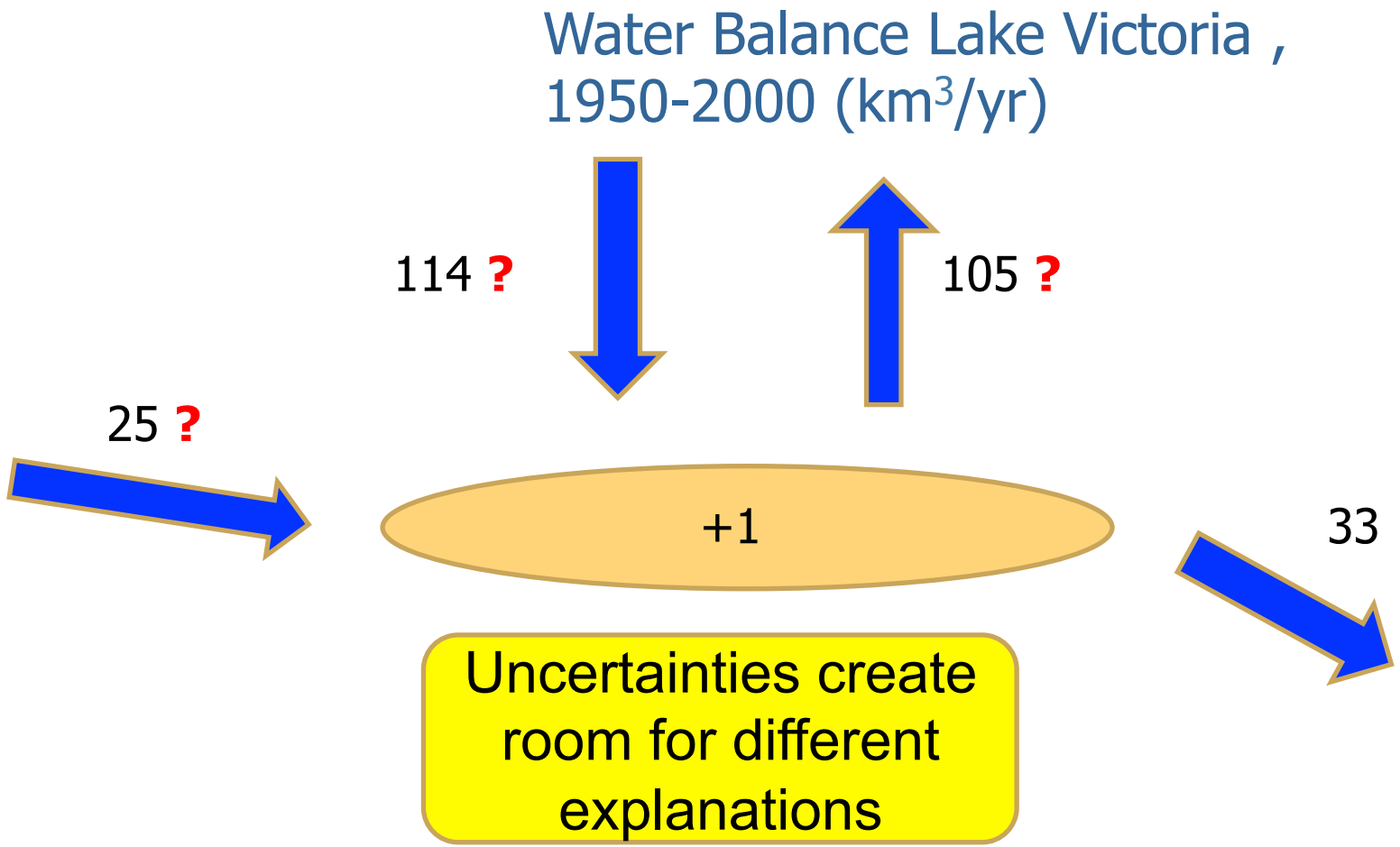


Surface area: 67,000 km^2

Volume: 2,750 km^3

Source: adapted from LVEMP I Hydrology and Meteorology Report (2005)

3 Coupled human-water systems - Africa



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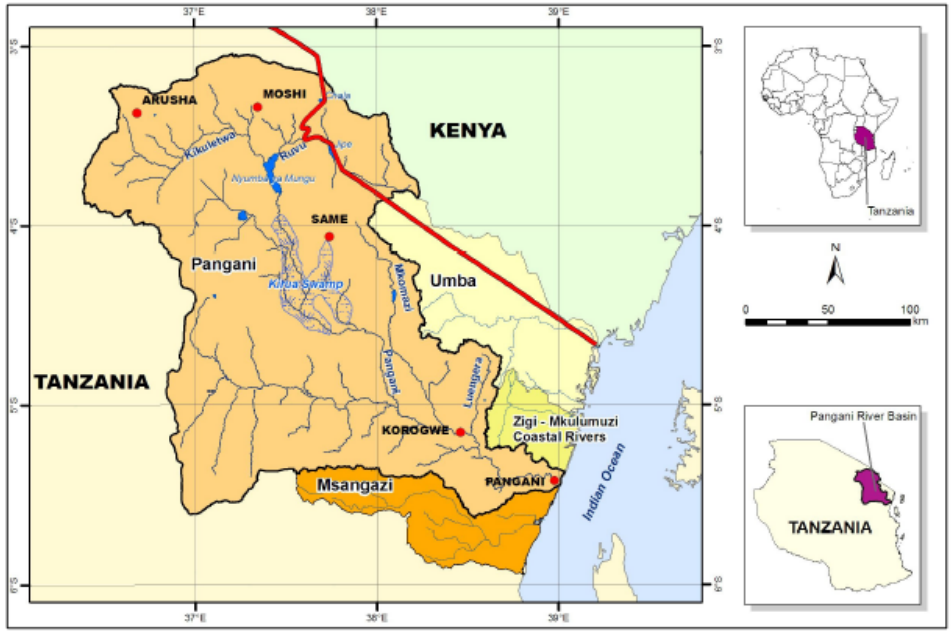
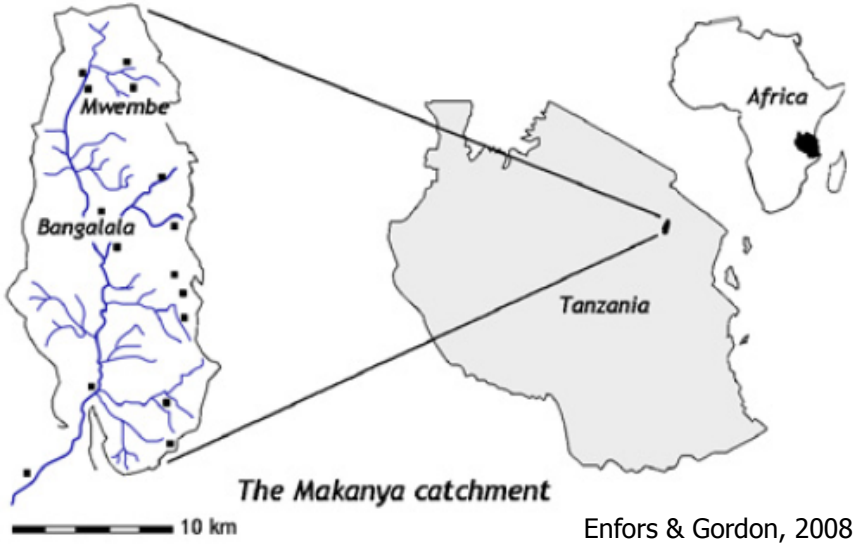
3 Coupled human-water systems - Africa

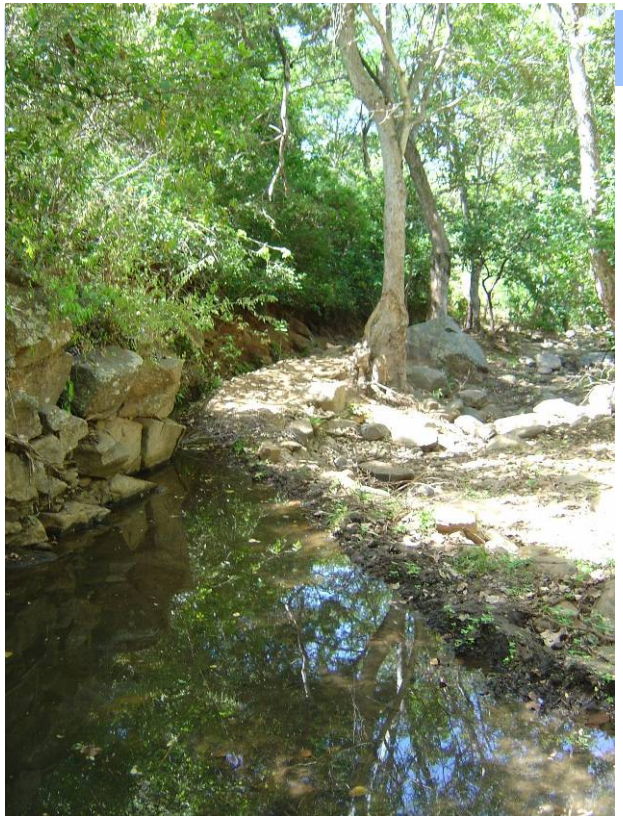
Irrigation canals in the
Pangani basin, Tanzania



Source: PWBO/IUCN, 2008



Enfors & Gordon, 2008



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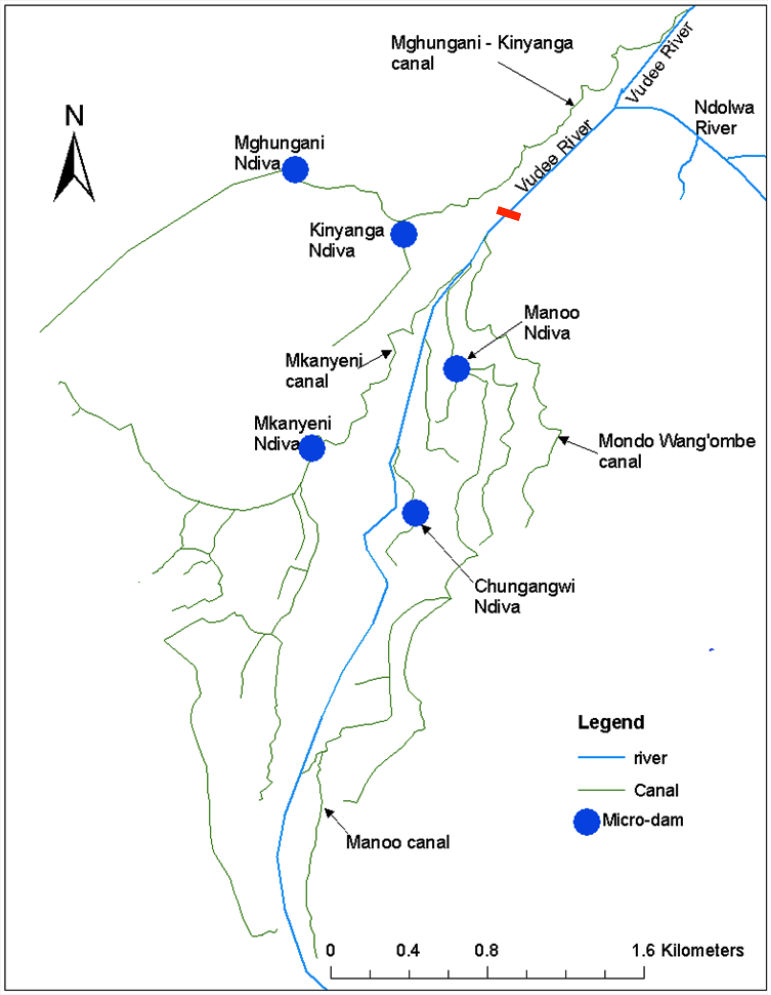
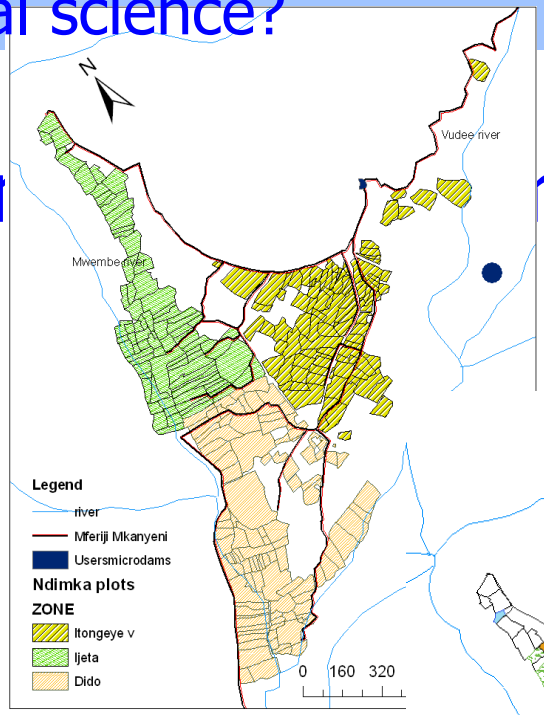
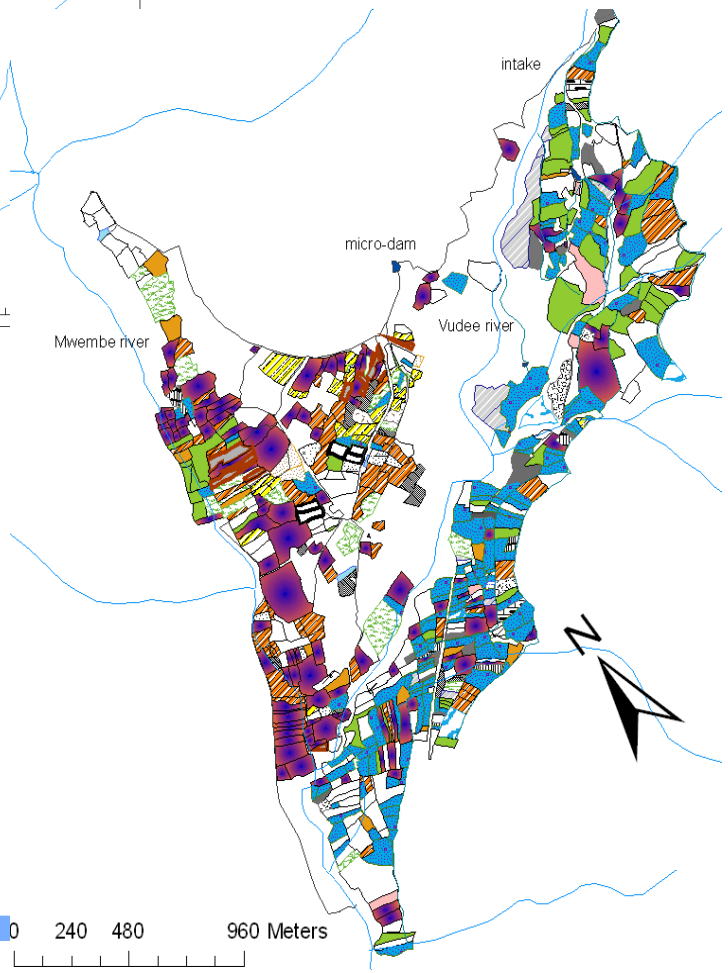
3 Coupled human ... ns - Africa



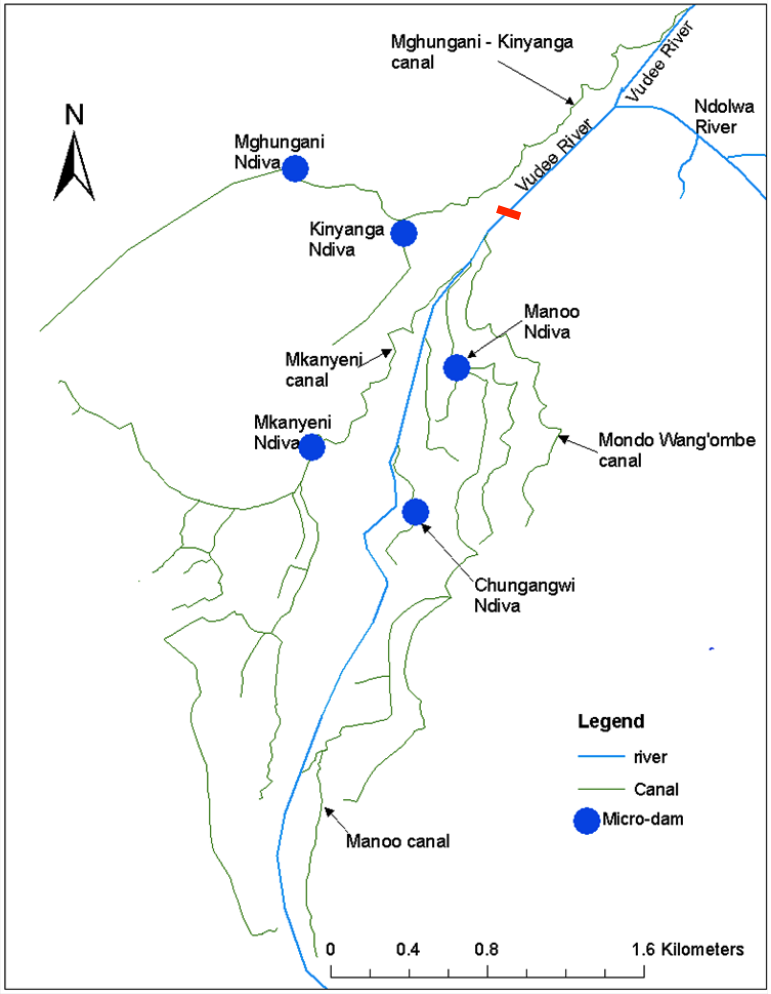




Komakech et al., 2012

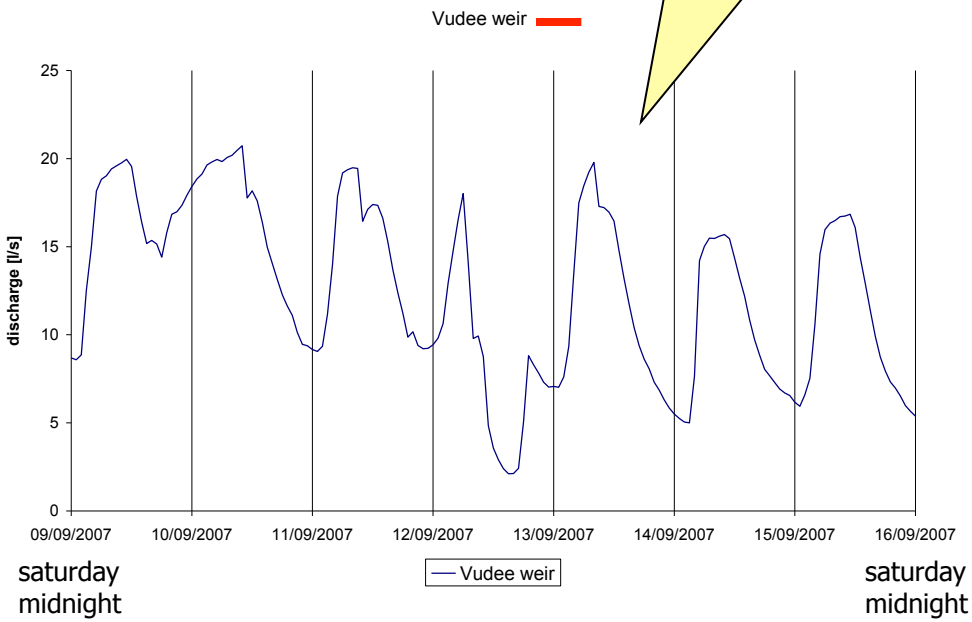
Is hydrology a natural science?

3 Coupled human-water systems - Africa



Komakech et al., 2012

Evidence of the presence of a river institution



Mul et al., 2010

Africa

Rice polders in Basse Casamance

ems - Africa


Image © 2007 DigitalGlobe
© 2007 Europa Technologies
Image © 2007 TerraMetrics
Pointer 12°36'43.04" N 16°40'31.77" W elev 10 ft
Streaming 100%


Kabounkoute
Niomoune
Image © 2007 DigitalGlobe
© 2007 Europa Technologies
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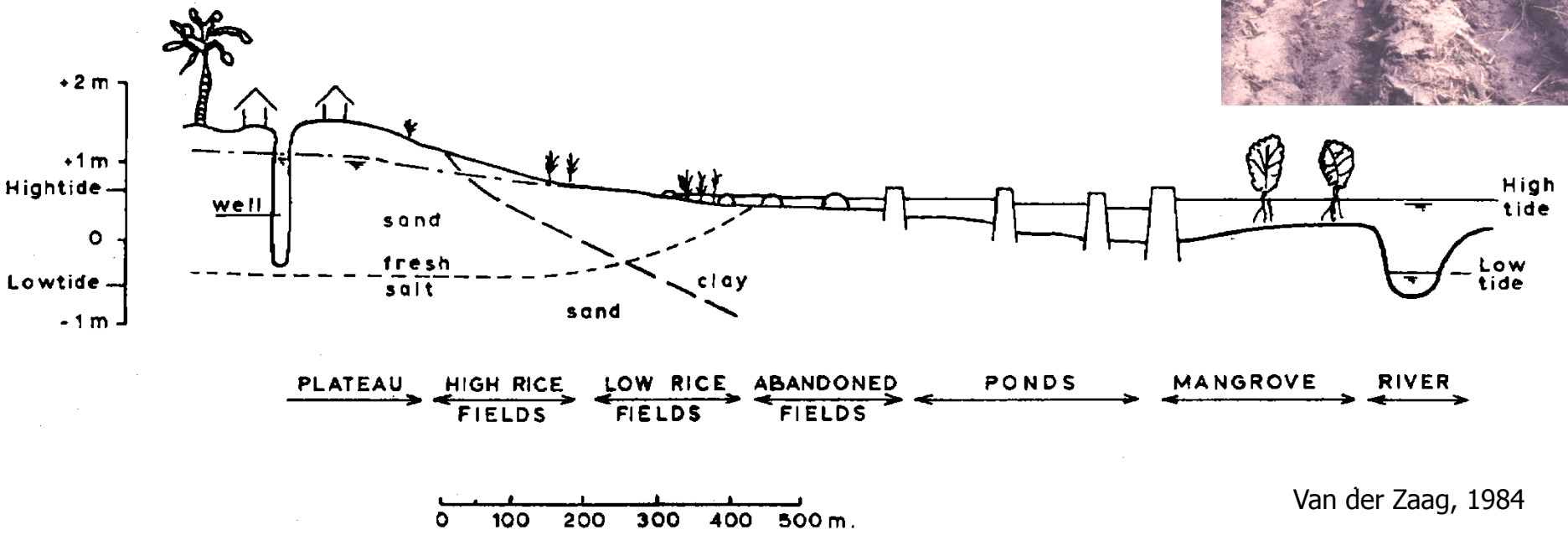
science?

-water systems - Africa



Van der Zaag, 1984

3 Coupled human-water systems - Africa

Zambezi: a modified flow regime

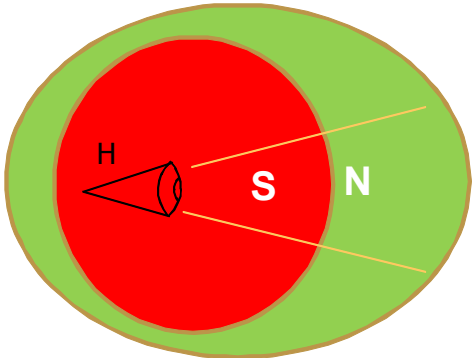
Incomati: what is the natural hydrology

Lake Victoria: tb controversy over declining lake levels

Makanya, Tanzania: hydrograph reveals institutional information

Basse Casamance, Senegal: ricepolders

4 Towards a new (reflexive?) hydrology (i)



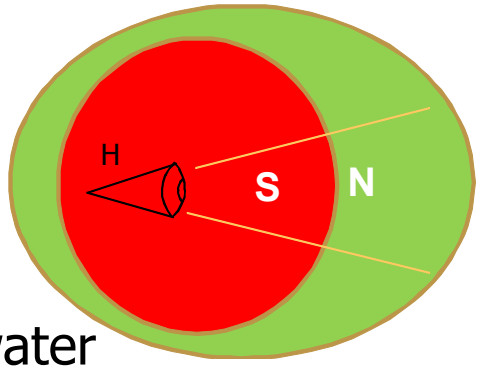
Everywhere and throughout history we have with limited knowledge intervened in the water cycle. As a consequence societies could develop. But nature always talks back, requiring us to refine our water knowledge and adjust our interventions.

Water management is dialectic, “in which each successful response gives rise to new challenges” (Briscoe, 2010)

This dynamic may be a kind of "double hermeneutics" (Giddens); "The ‘findings’ of the ... sciences (may) ... enter constitutively into the world they describe” (Giddens, 1987: 20).

This refers to active feedbacks and to an increasing level of self-consciousness that may be consdered an essential feature of the anthropocene.

4 Towards a new (reflexive?) hydrology (ii)

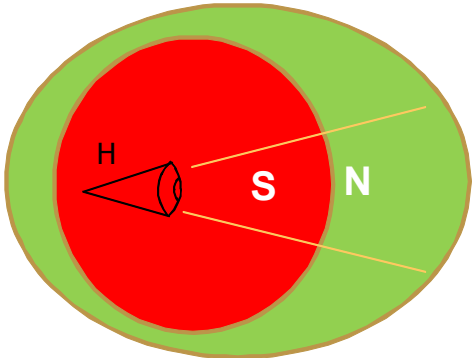


The double hermeneutics aspect of coupled human-water systems requires a new hydrology that takes account of the fact that such coupled systems co-evolve, and that can describe and analyse how water knowledge is used by humans and how it informs not only policies but also the behaviour of individuals

Optimality: in coupled human-water systems optimality will most likely to be a normative concept, as it implies value judgments, namely how to weigh (or commensurate) social, economic and ecological criteria, and which may be difficult to "universalise"

Co-evolution: in coupled human-water systems co-evolution will most likely lead to an increased awareness among humans of their interdependence on each other and on the environmental systems

4 Towards a new (reflexive?) hydrology (iii)



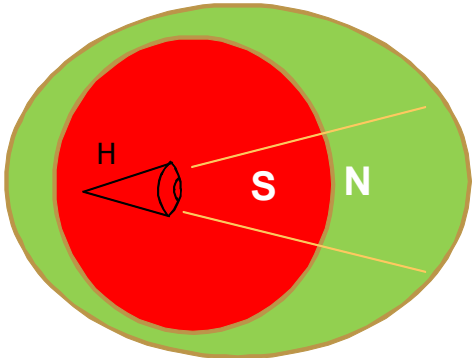
We need social science concepts to enrich this new hydrology, and we need hydrological concepts to enrich sociology and human geography.

Possible starting points to overcome the huge rifts that exist between the natural and social sciences:

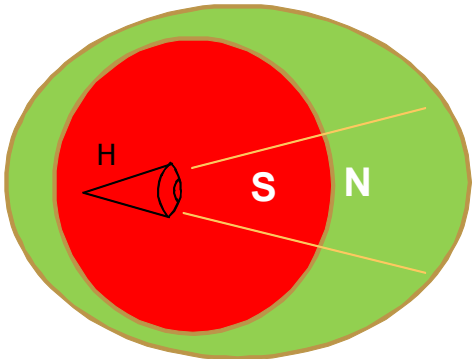
- to attribute (or allow) agency not only to humans but also to non-humans, i.e. the concept of symmetry (Latour)
- to accept that coupled human-water systems have soft and hard parts that interact
- to postulate a political objective, e.g. to strive for sustainable water systems
- to embrace an empirical and experimental approach

So is hydrology a natural science?

Yes, it is just as natural as humans are!



Is hydrology a natural science?



"Remember when you speak about water to show first the experience and then the interpretation"

Leonardo Da Vinci

(ca. 1500, Codex Paris H
cited in Pfister et al., 2009, p.17).