Soils as a water resource : Some thoughts on managing soils for productive landscapes to meet development challenges

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Objective: finding examples of accelerated landscape transformations and associated investments needs in developing contexts

- **Water, soils, global boundaries & demand**

- **Can we manage for multiple benefits?**
  Some examples of transforming landscapes

- **Raising demands on research: states, processes and realistic expectations and better informed investments**





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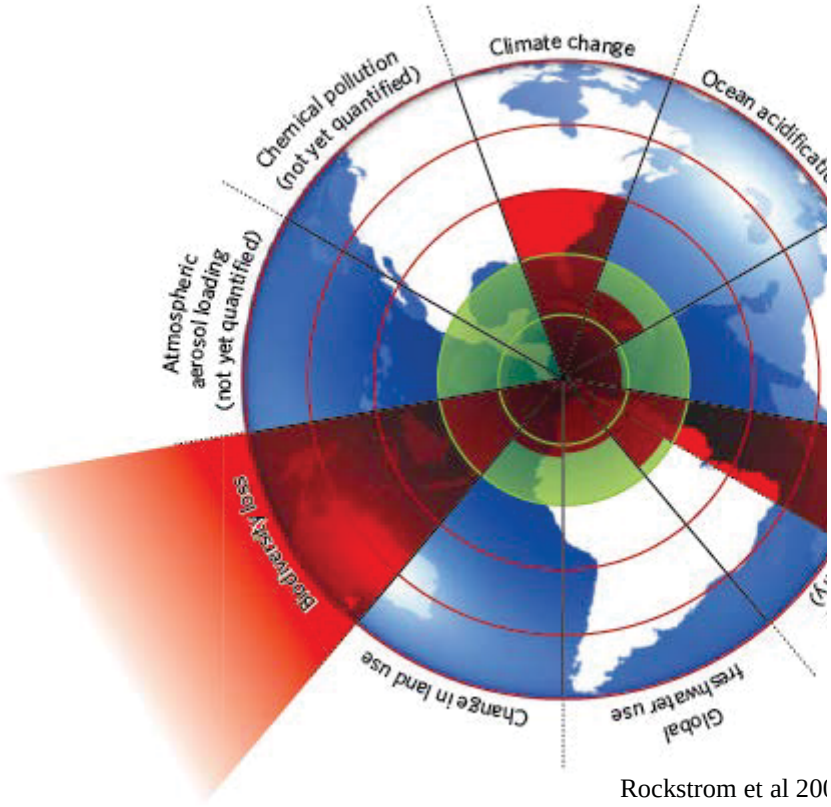
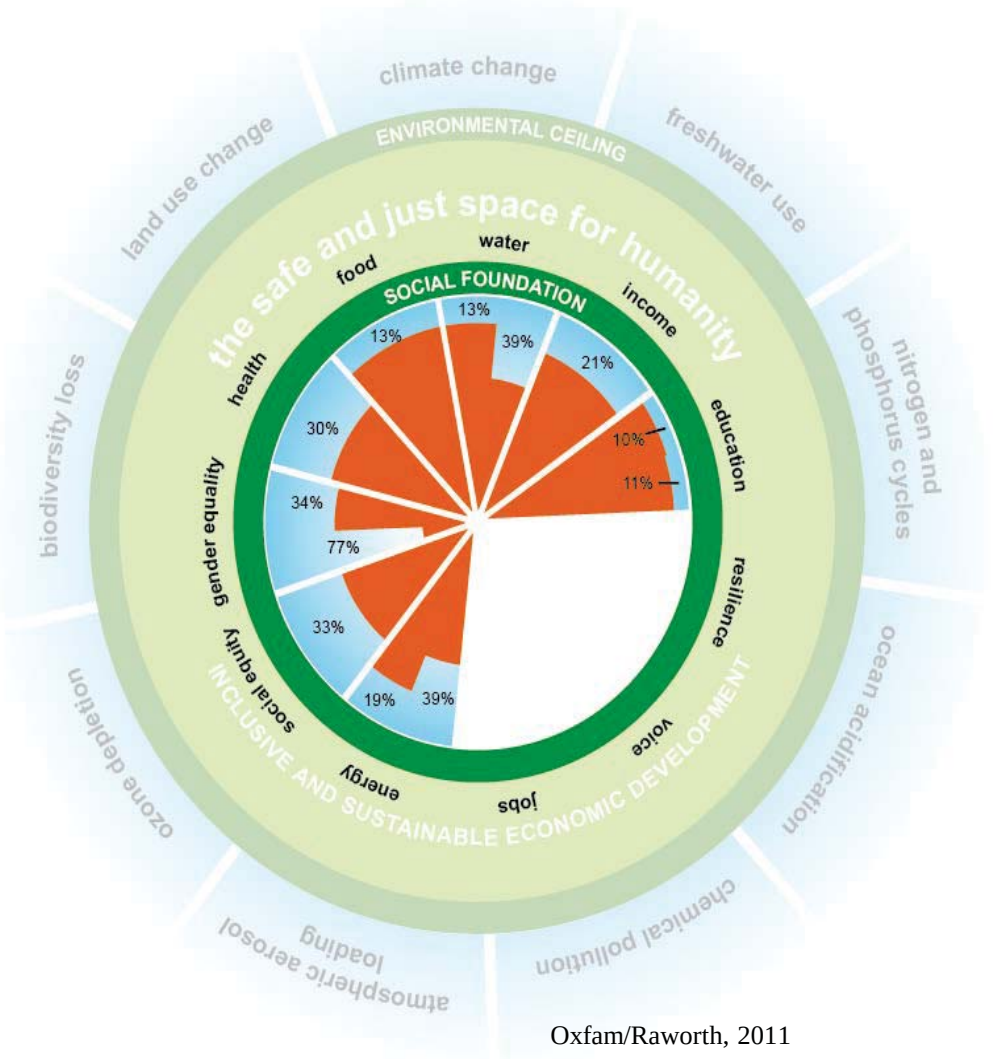
Limits and boundaries at global scale



Rockstrom et al 20(



Oxfam/Raworth, 2011

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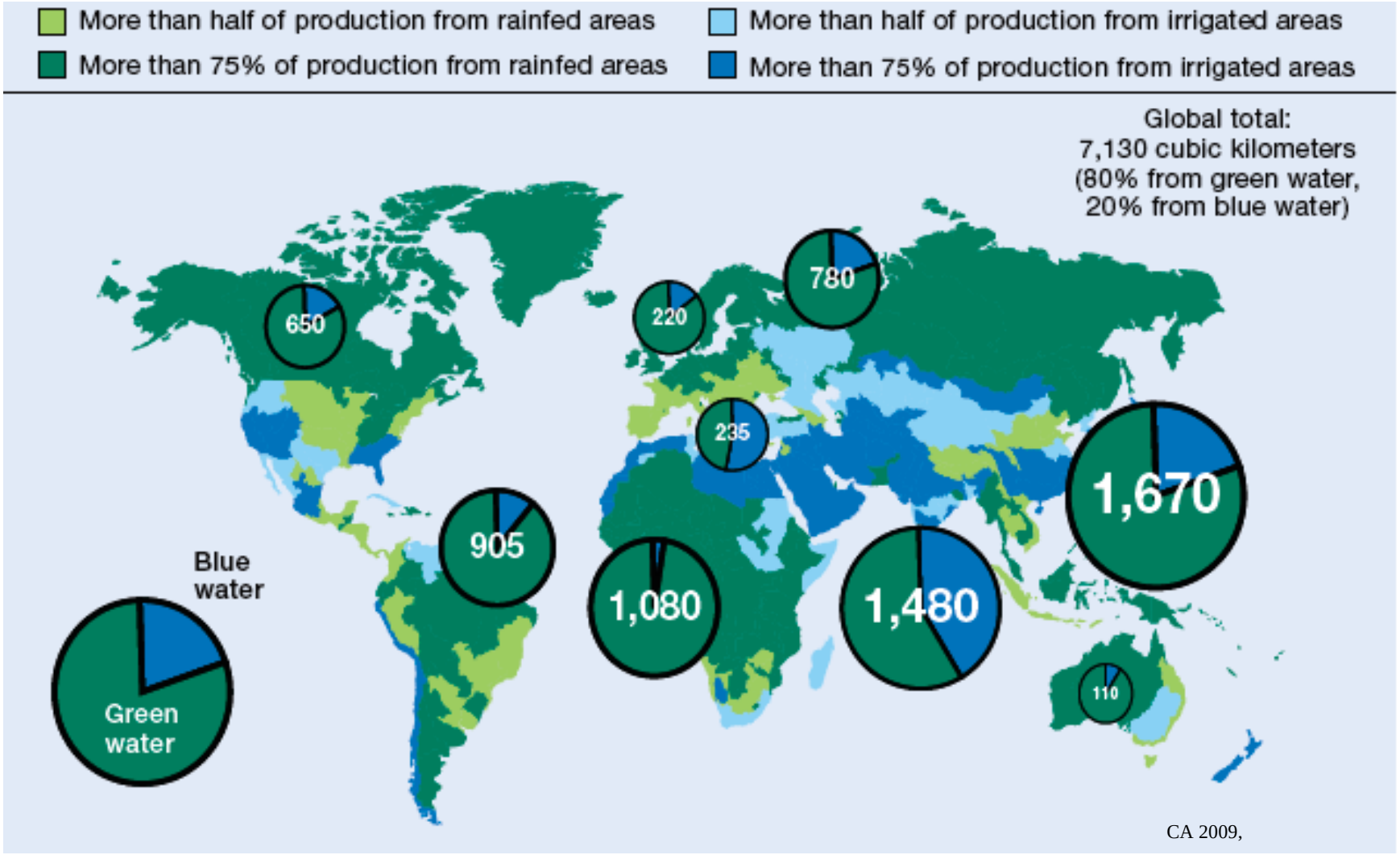
Green and blue water dependency



CA 2009,

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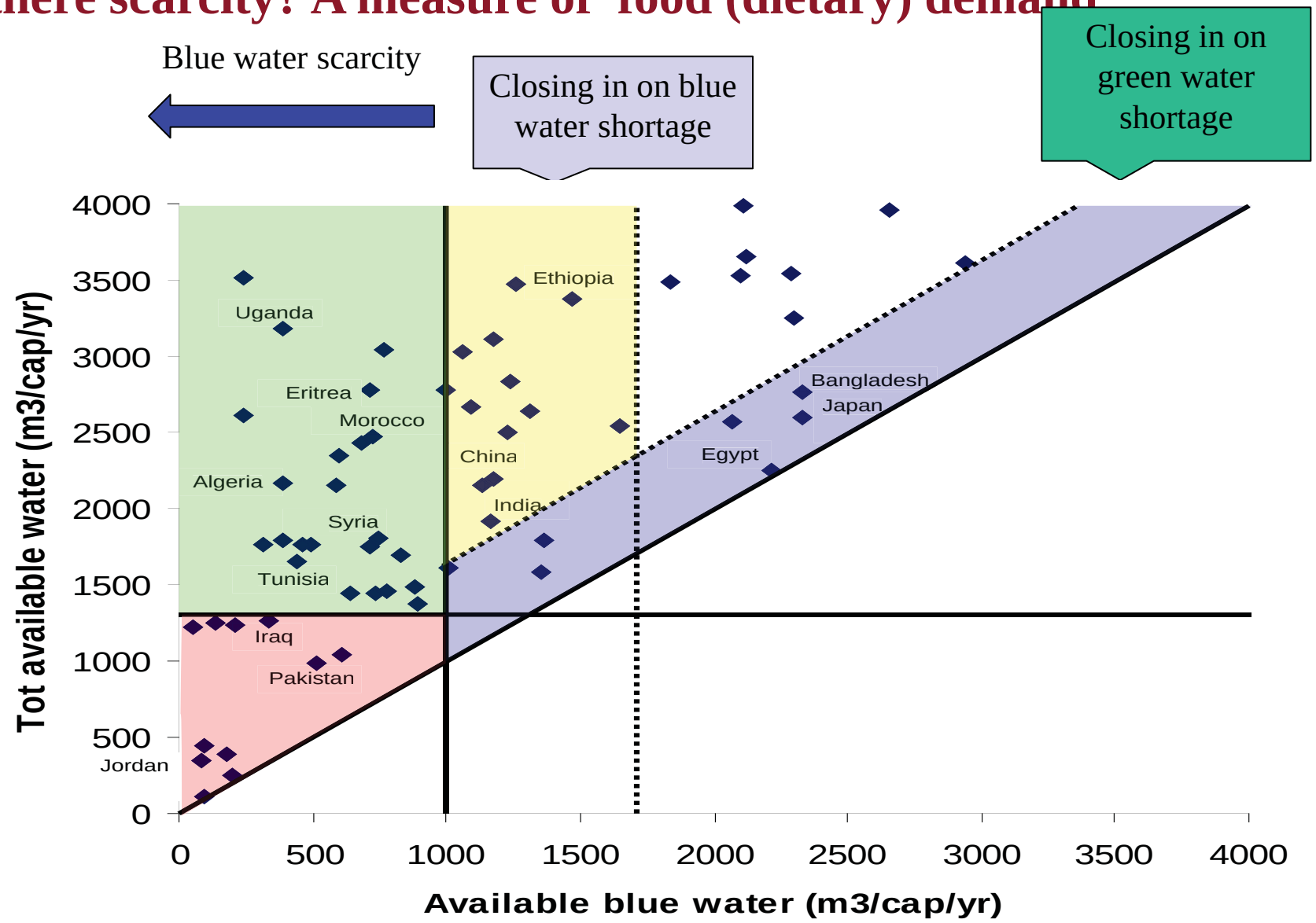
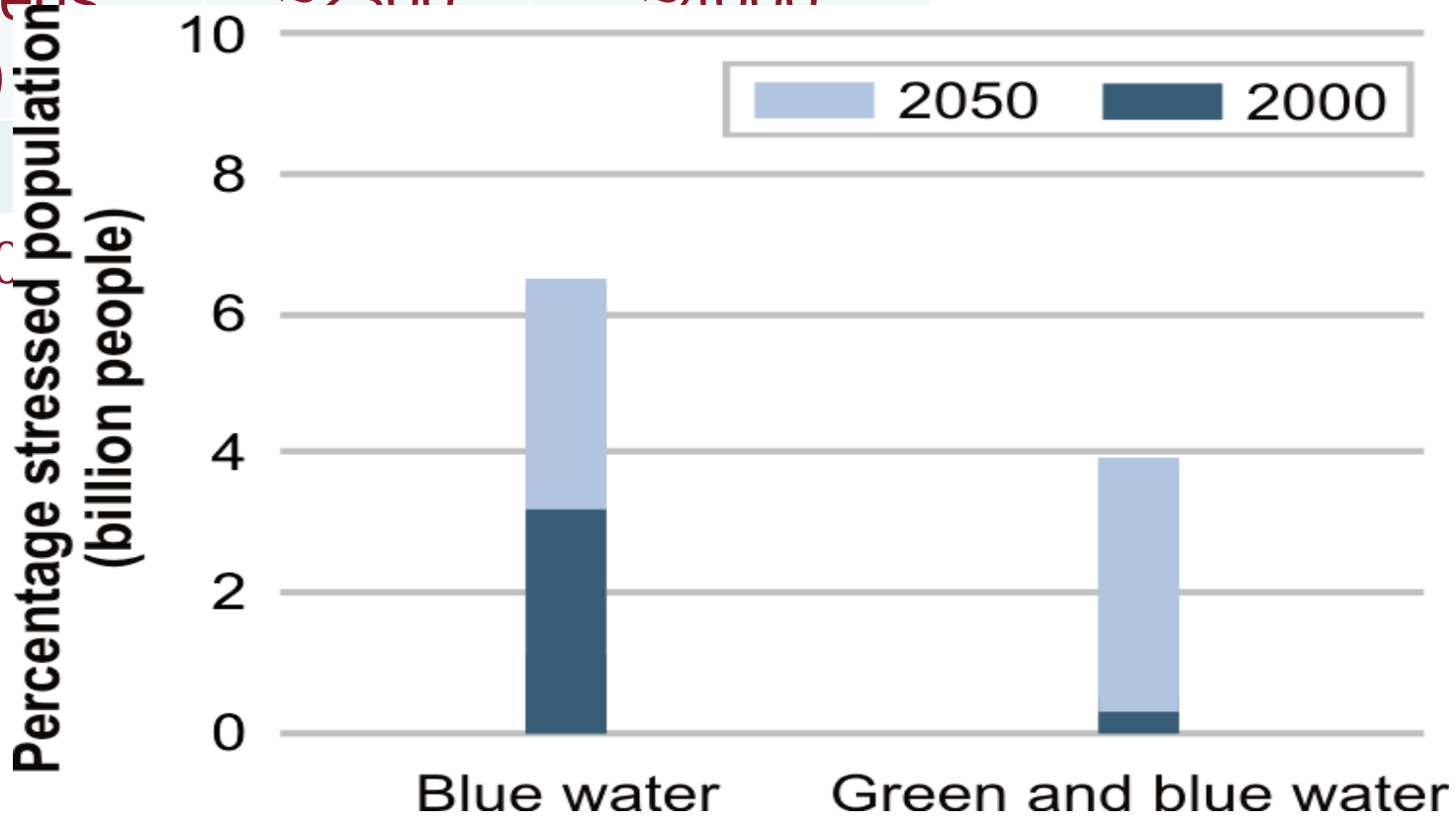
Is there scarcity? A measure of food (dietary) demand



Aggregate ~future crop water needs (2050)

	HIGH WP	LOW WP
Current Use	~7000	
Future needs (2050)	~2300	~4000
Total		

Future of 900



Rockstrom et al 2010

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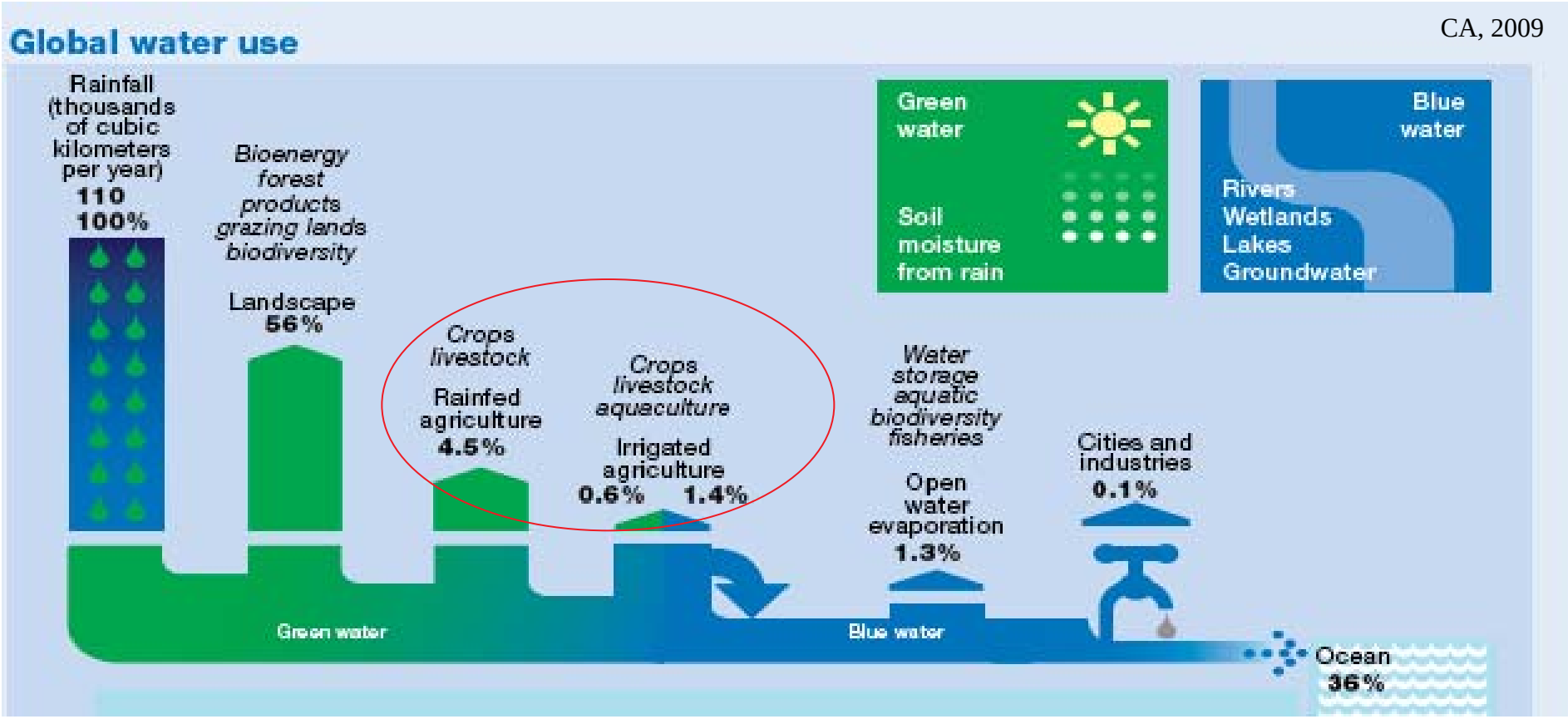
Water crisis? The facts….

Water for drinking : very little!!

Water for food, fodder fibre

Water for ecosystem services to sustain human livelihoods and economies

CA, 2009



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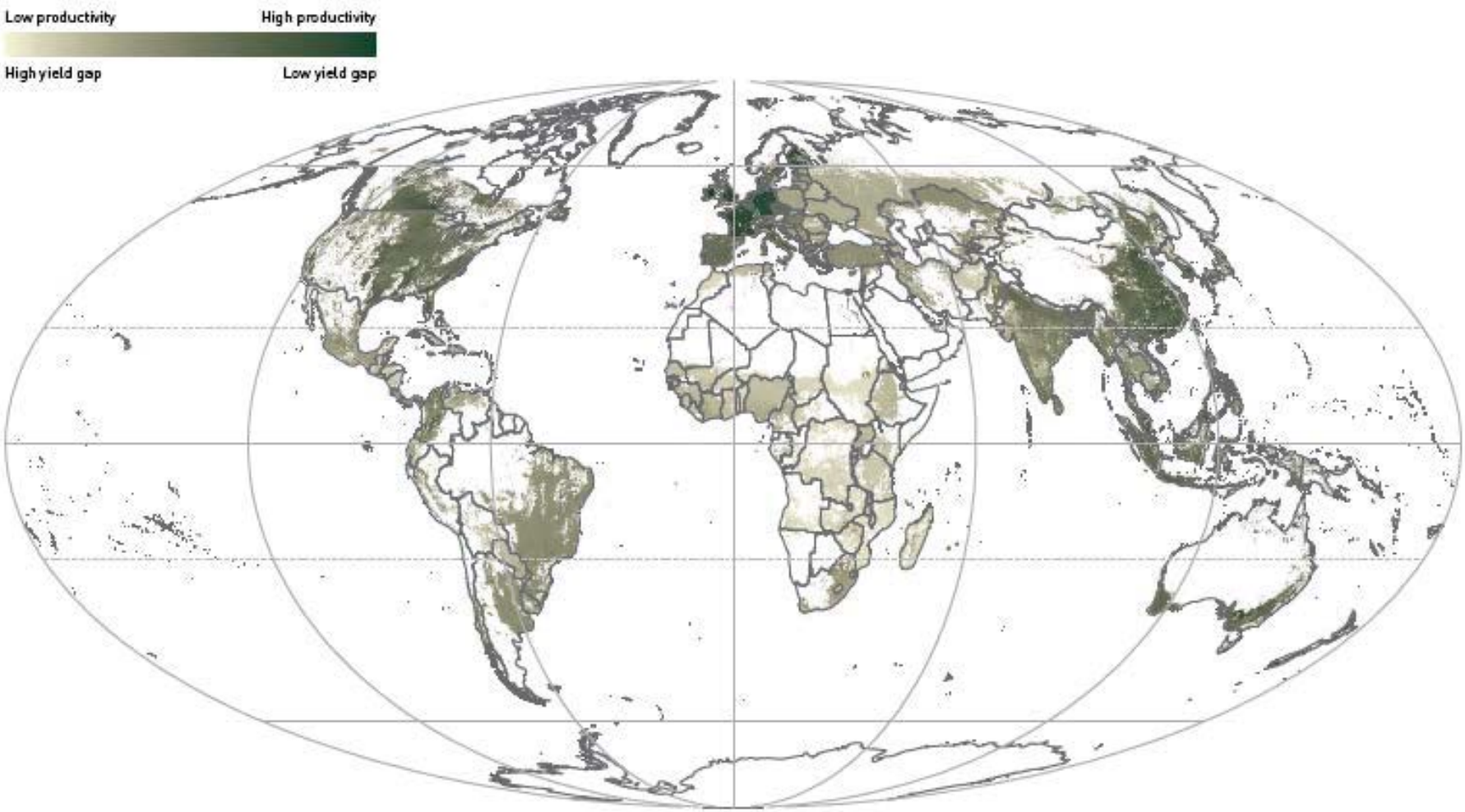
FAO SOLAW 2012

YIELD GAP FOR A COMBINATION OF MAJOR CROPS



- **Water, soils, boundaries & demand**

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  Some examples of transforming landscapes

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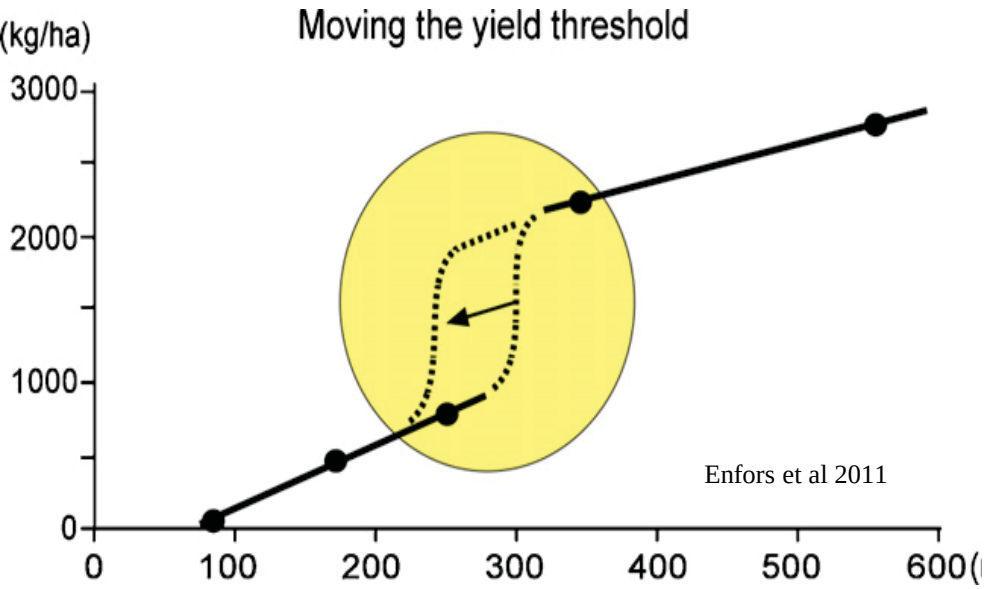
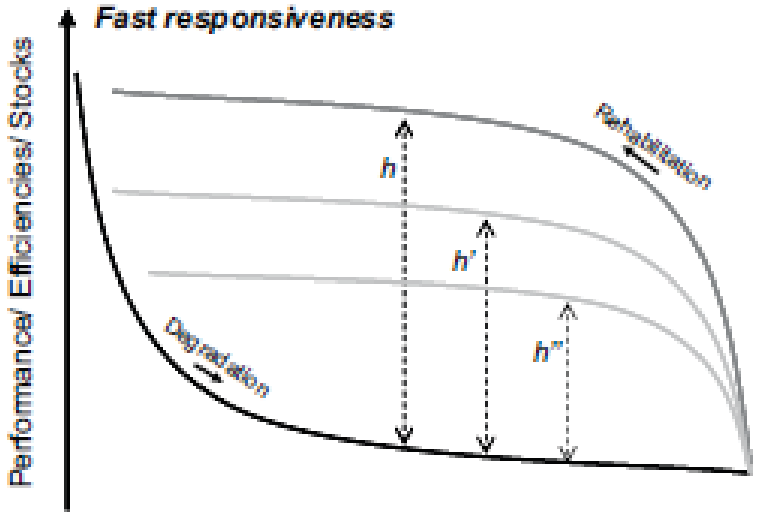
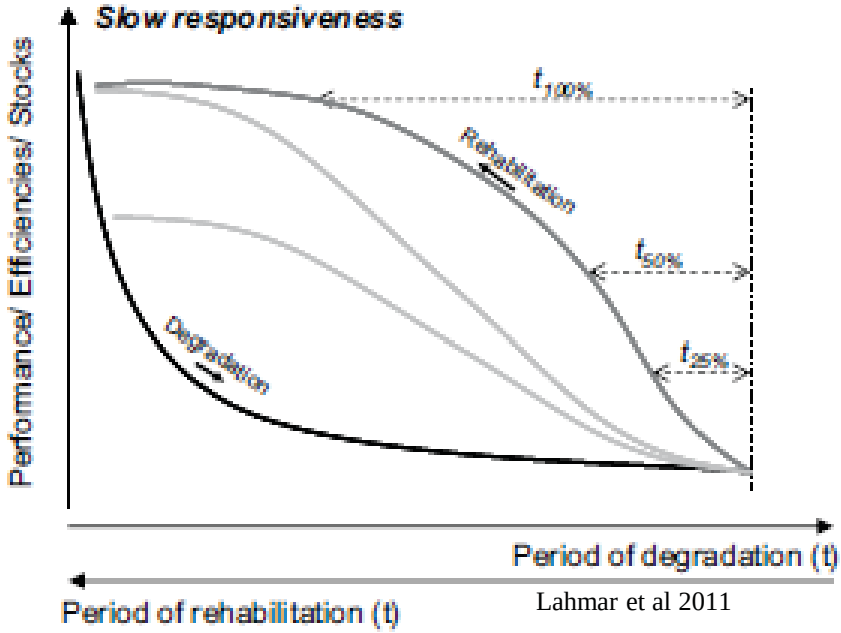
Threshold features can work to advantage addressing soil-water continuum,
but *multiple* levers needs addressing *simultaneously*



Enfors et al 2011





Lahmar et al 2011

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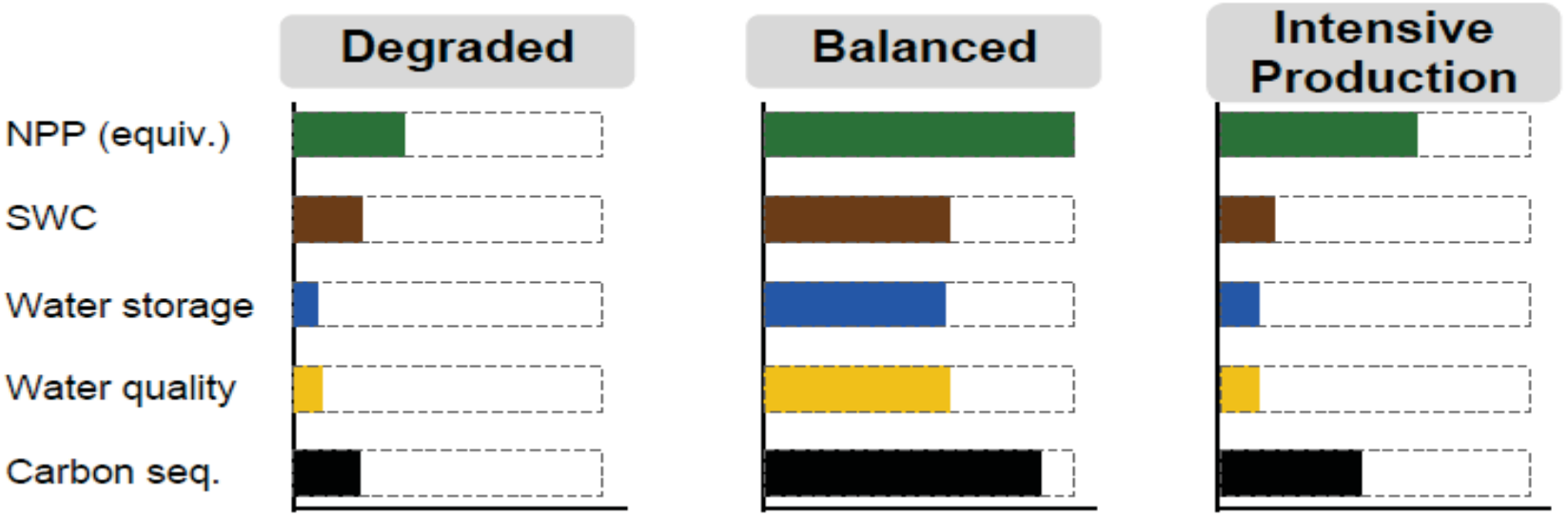
States and processes of productive landscapes



Degraded system with low agricultural and ESS productivity, poor soil water capacity, lack of natural water storage, reduced water quality, and lack of carbon sequestration.

Intermediate system with high agricultural and ESS productivity, good soil water capacity, robust natural water storage, improved water quality, and high carbon sequestration.

High yield system with emphasis on high yield agricultural but at the cost ESS productivity. Reduced soil water capacity, lack of natural water storage, reduced water quality, and lack of carbon sequestration because ESS systems marginalized for high yield agriculture.

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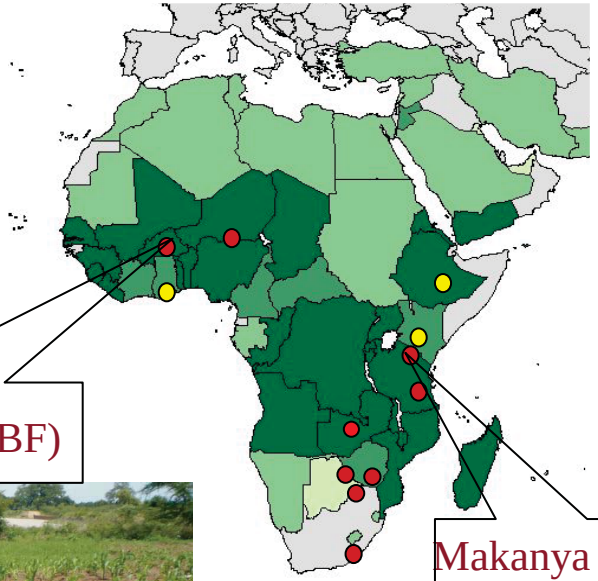
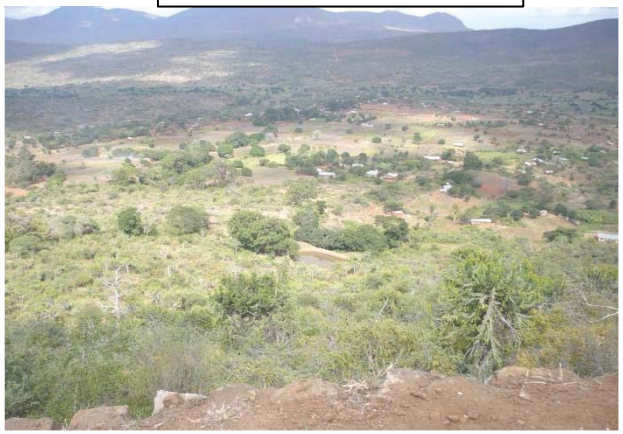
3 examples of transforming landscapes



Nariarle (INERA/ BF)

Makanya (SUA/TZ)



Kothapally/Osman Sagan (ICRISAT/IND)

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Example Kothapally micro watersheds/Osman Sagan Basin

From degraded to productive micro watershed in 15 years

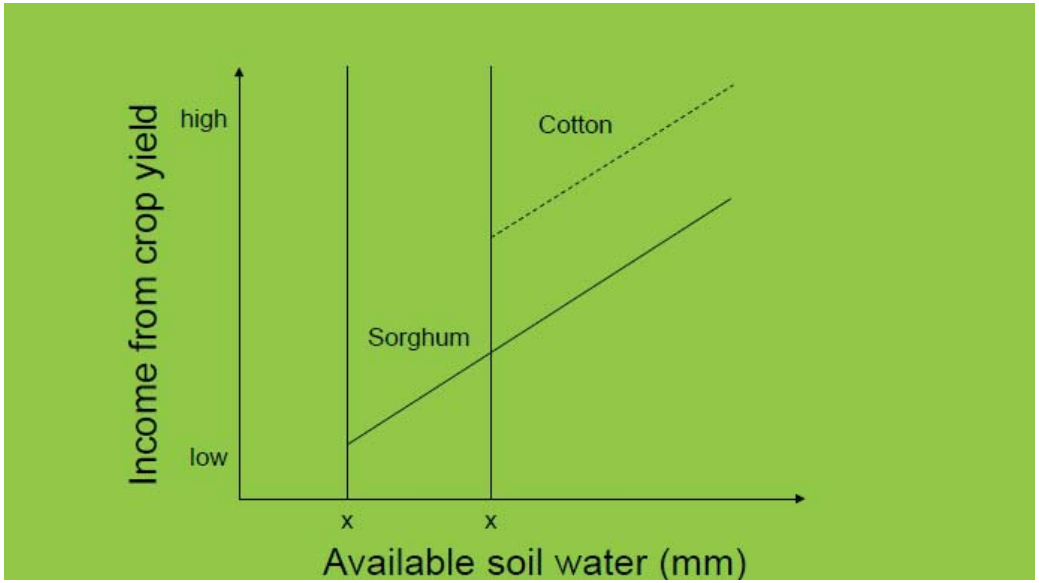
- Tropical semi-arid 4.7 km^2, less than 1 m soil depth
- 90% rainfed /30-40% irrigation during dry season
- Completely under SWC , infiltration strategies with shallow wells (storage)

Livelihood & environmental benefit

- 1.5-2 crop seasons/ year= more biomass
- high value=income
- Less sediment loss

Livelihood & environmental cost

- Reduce outflow from 19% to 10%
- More reduced during dry years



Garg et al, 2011; forthcoming
Barron forthcoming
Karlberg et al forthcoming

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Example Kothapally micro watersheds/Osman Sagan Basin

Taken to scale Osman Sagan (1 000 km^2) : Ex situ & Max Int
severely reduce water inflow (-3%), but also sediment by 30-50%
Farmers income benefit outweigh urban reservoir water costs

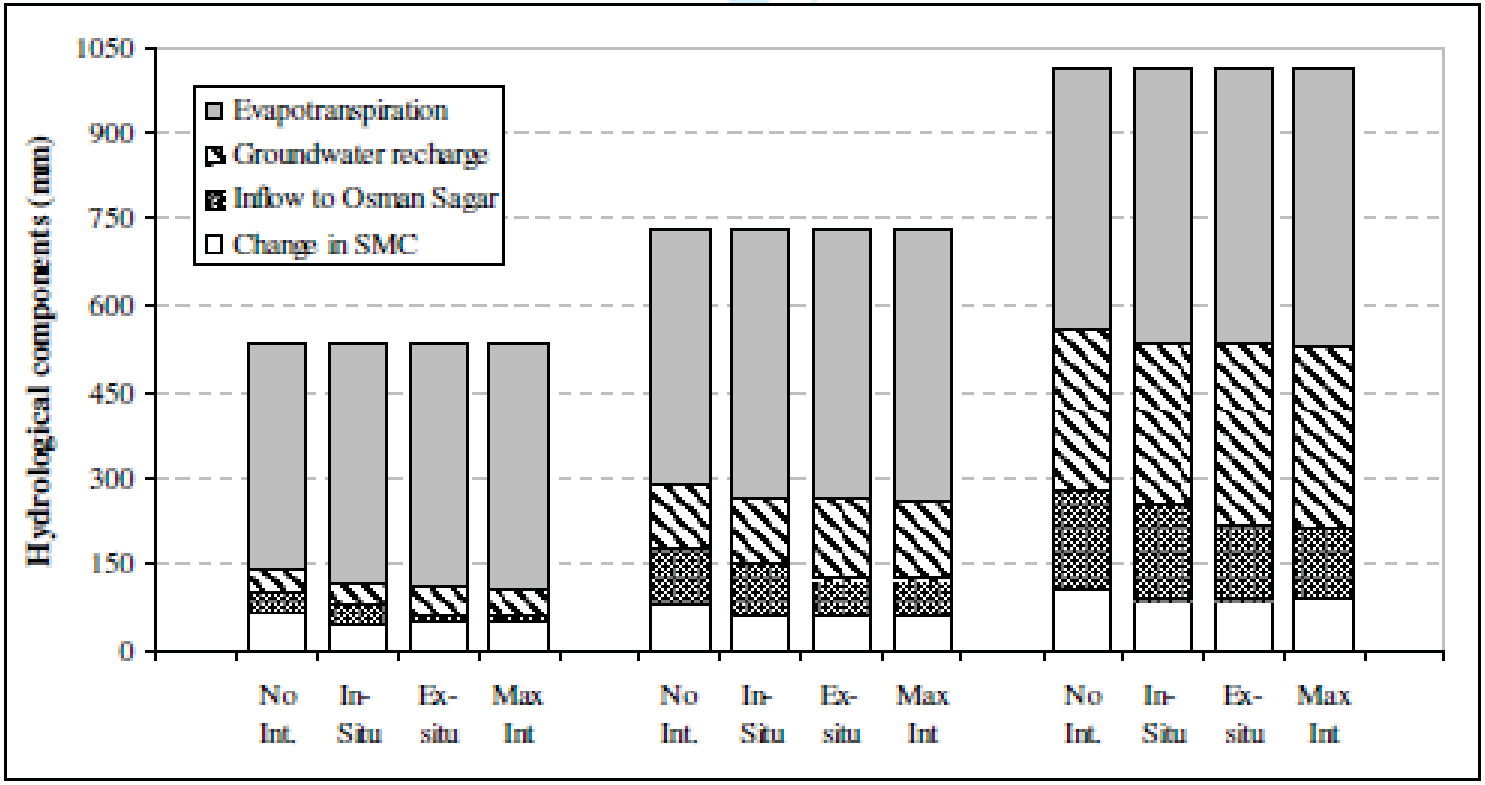

Figure 3b: Water balance of the Osman Sagar catchment area under four water management scenarios in dry, normal and wet years (data from 1978 to 2008)

Garg et al forthcoming

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Example Nariarle watershed (BF)

From degraded to productive ? watershed in 30 years

- Tropical semi-arid 1000 km^2, deep soils
- Peri-uban
- 70% rainfed /1-2% irrigation during wet & dry season
- under some SWC , plus small reservoirs with storage 2% of annual rainfall for multiple use
- Seasonal rainfall decrease

Livelihood & environmental benefit

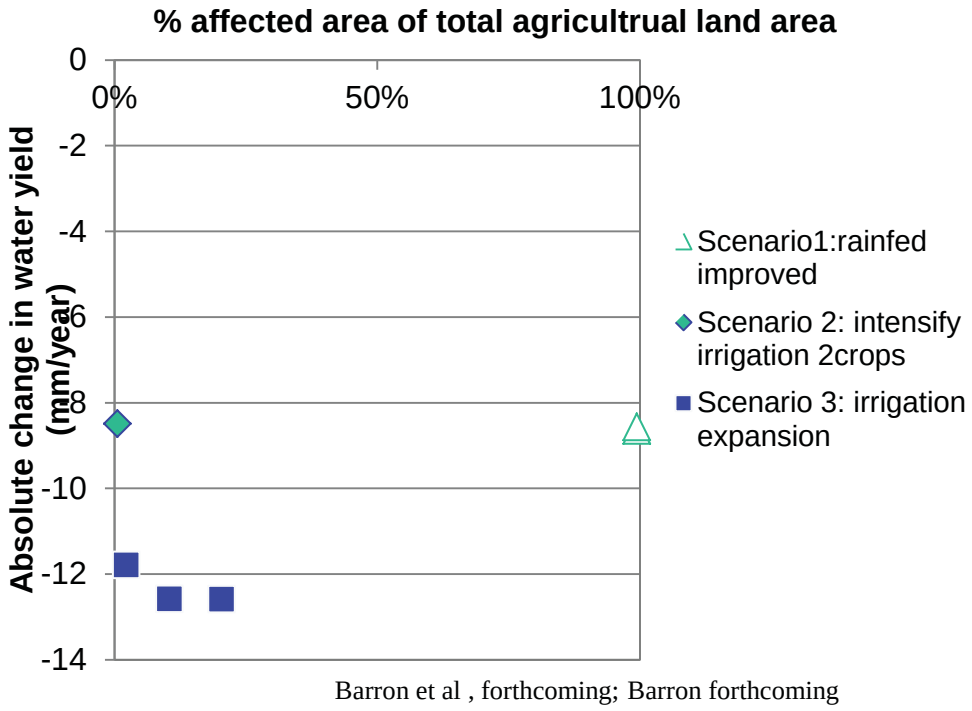
- 1 rainfed + 1-2 irrigated crop seasons/ year
- high value irrigated crop=income
- Sustain more people (+10% in 10 yrs)

Livelihood & environmental cost

- Reduce outflow during dry season
- Water quality
- Management of structures

Unrealised potential:

- Improve current low yield rainfed 3-4times



Barron et al , forthcoming; Barron forthcoming

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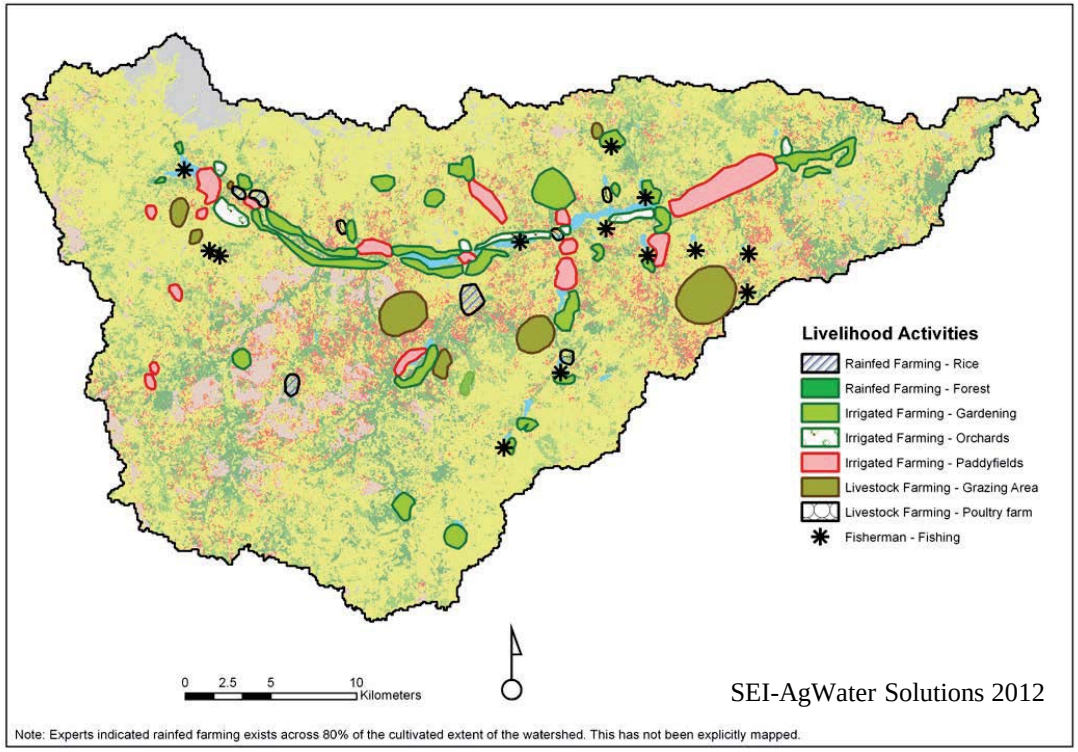
Example Nariarle watershed (BF)

Livelihood activities according to local experts



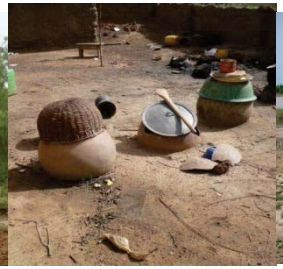
Livelihood & environmental cost

- Reduce outflow during dry season
- Water quality
- Management of structures
- Inequity

Unrealised potential:

- Improve current low yield rainfed 3-4 times

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Example Makanya watershed (TZ)

From degraded to more degraded watershed in 30 years

- Tropical semi-arid 320 km^2, varied soils
- 55% rainfed ,?% spate irrigation during wet & dry season
- under some SWC ,
- Seasonal dryspell increase

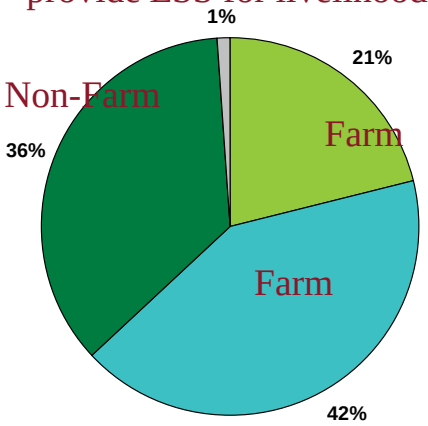
Livelihood & environmental benefit

- Sustain more people (+200% in 50 years)

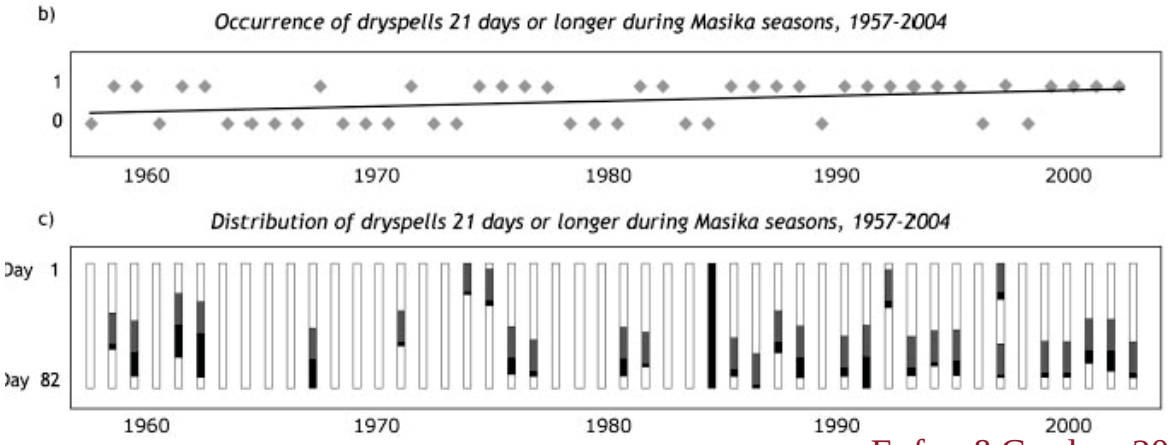
Livelihood & environmental cost

- No flow in landscape
- Over-use of spate irrigation
- Deteriorating ESS

1) Dependency on water to provide ESS for livelihood



2) Availability of water and change



Enfors&Gordon, 2007

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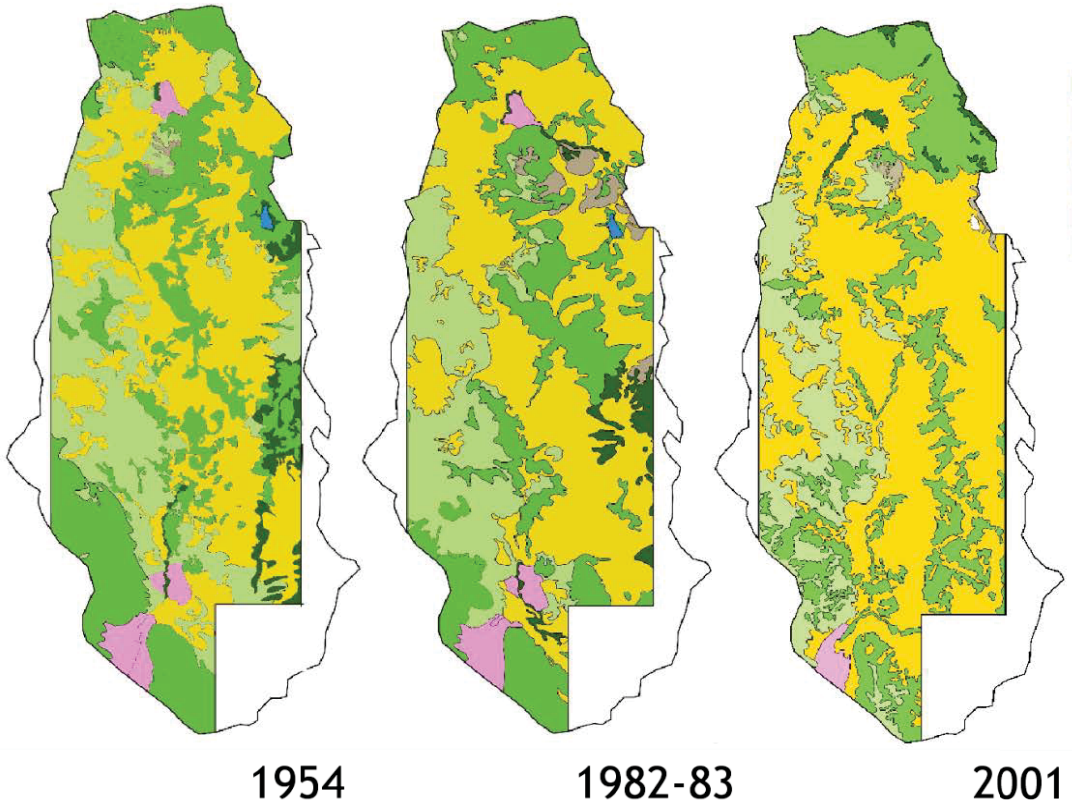
Example Makanya watershed (TZ)

Unrealised potential:

- Improve current low yield rainfed 3-4 times, - yet not adopted/resilient to change

Land cover in the Makanya catchment



	1954	1982-3	2001
Agricultural land	37%	44%	55%
Sparse bushland	23%	21%	18%
Bushland	34%	27%	23%
Forest	4%	3%	2%
Sisal estate	3%	3%	1%
Bare mountain	0%	2%	1%

Loss of ecosystem services when agriculture expand

Loss of livelihood support system

Downward spiral undermining development opportunities

Enfors& Gordon, 2007;Enfors et al 2009

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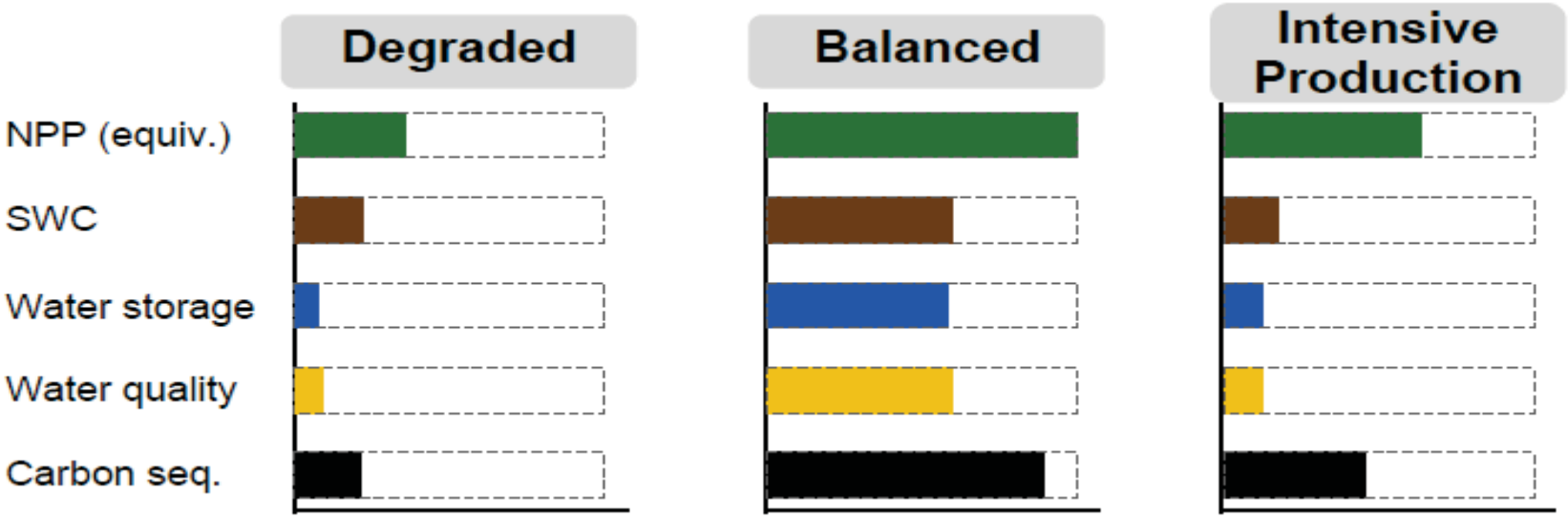
Summary productive landscape examples



Kothapally (IND)	Pre 2000		Post 2000
Nariarle	Pre 1960		?? 2010
Makanya	Today , pre 1990		

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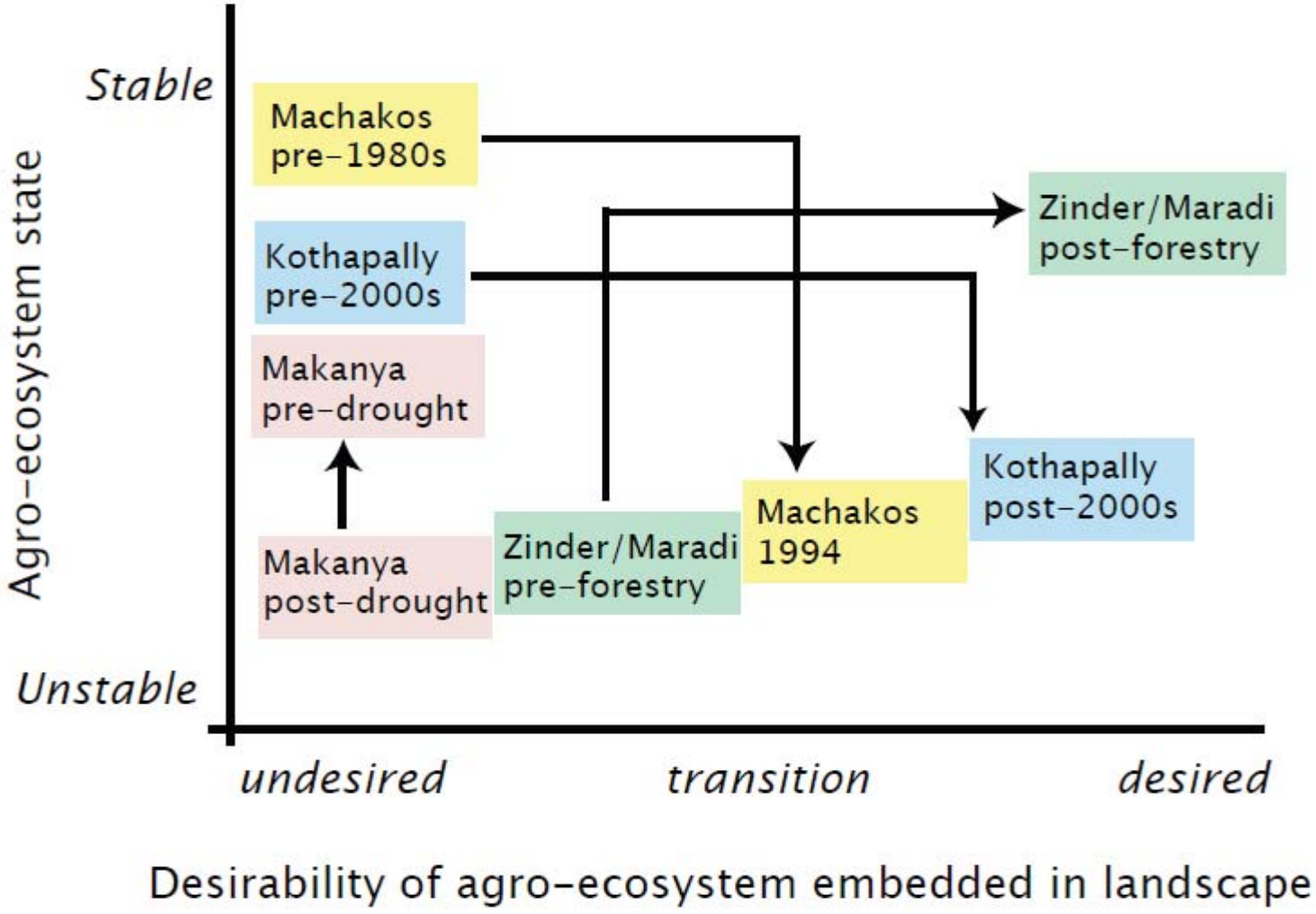
Transforming landscapes with soil and water



Barron & Keys, 2011

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- Water, soils, boundaries & demand

- Can we manage for multiple benefits?
  Some examples of transforming landscapes

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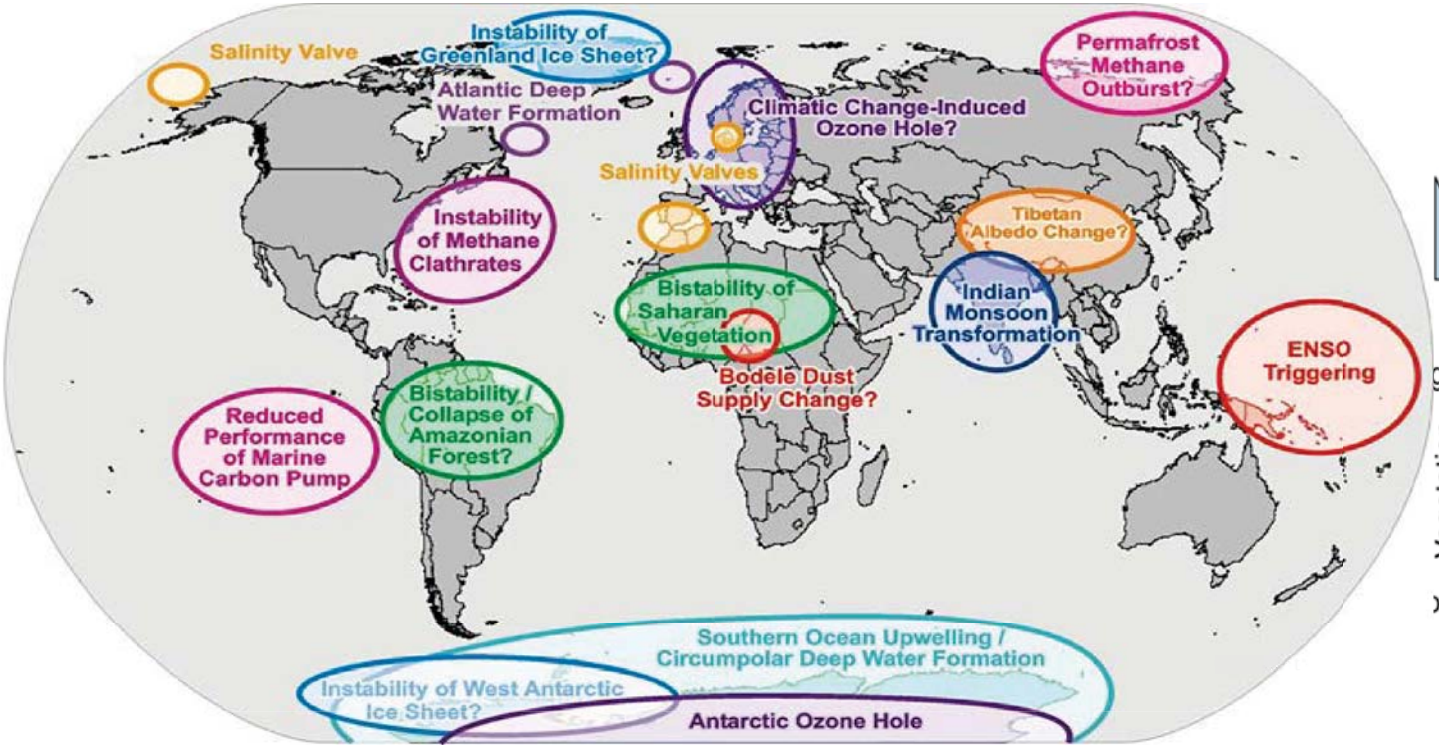
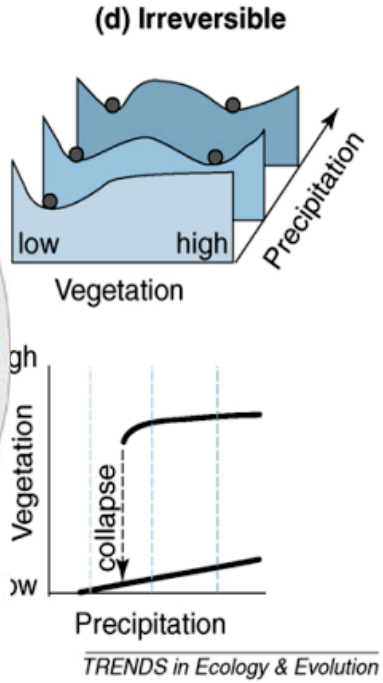
Processes and uncertainty

We know various systems , -including social-ecological system can rapidly change and lose its ‘systems characteristics’: many are soil and water -related





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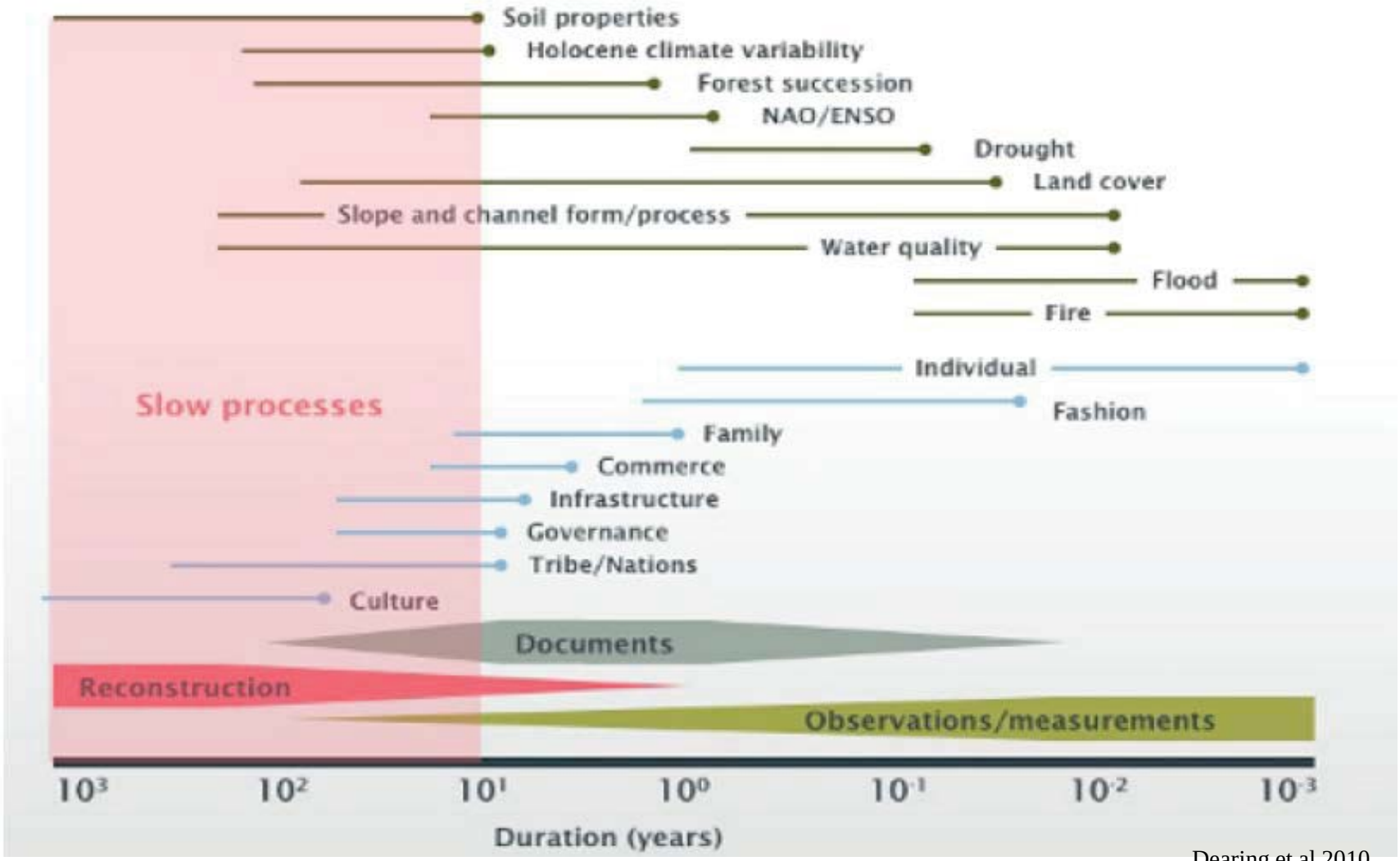
Mis match of processes and scales and the matter of urgency



Dearing et al 2010

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Turbulent future, accelerating trends in the anthropocene: there are good examples

1) **Multiple levers simultaneously**: Healthy soils, water , nutrient , energy and people can transform landscapes,- not one factor alone
2) Globally there is enough food, land, water and knowledge to make a start
3) Energy (labour?) and nutrients and land are more critical?

But a window of opportunity?

- Global recognition of issues
- Re-investment in agriculture
- Progressing adoption of addressing water and land
- Examples of economic incentives for good management
- …….
- BETTER DATA!!

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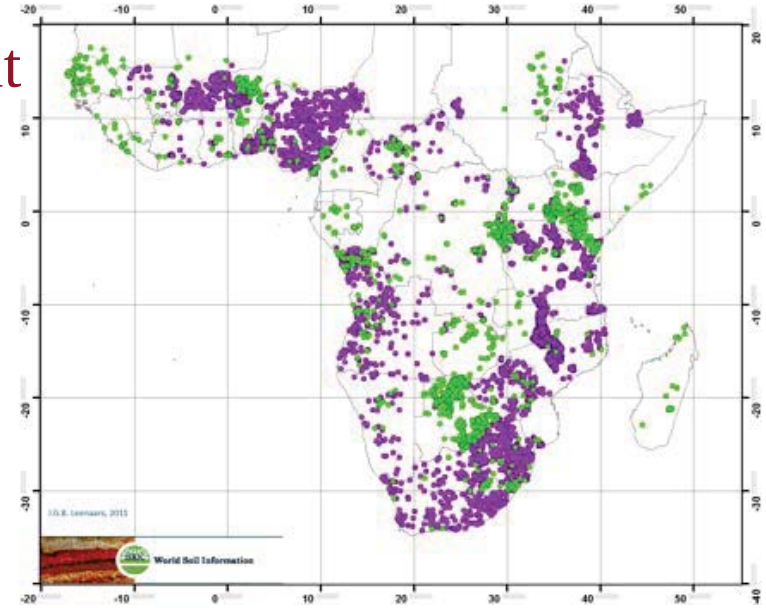
BETTER DATA: Good news & remaining gaps

- Africa Soil Map (19 200 samples), but not-so-strong water attributes
- Africa Soils data base (ISRIC) 12 000 geo-ref profiles released 2012



Possible gaps:

- soil biological attributes: critical for nutrients, GHG & SOM and hence water flows, uptake and e.g. water productivity
- Methods & tools for water partitioning and flows in soils in transformed landscapes

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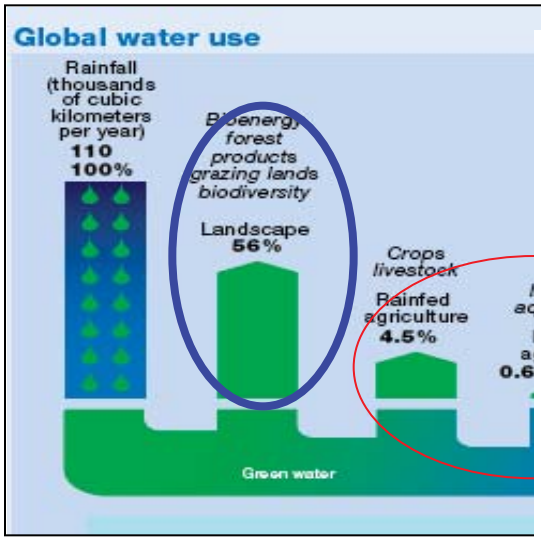
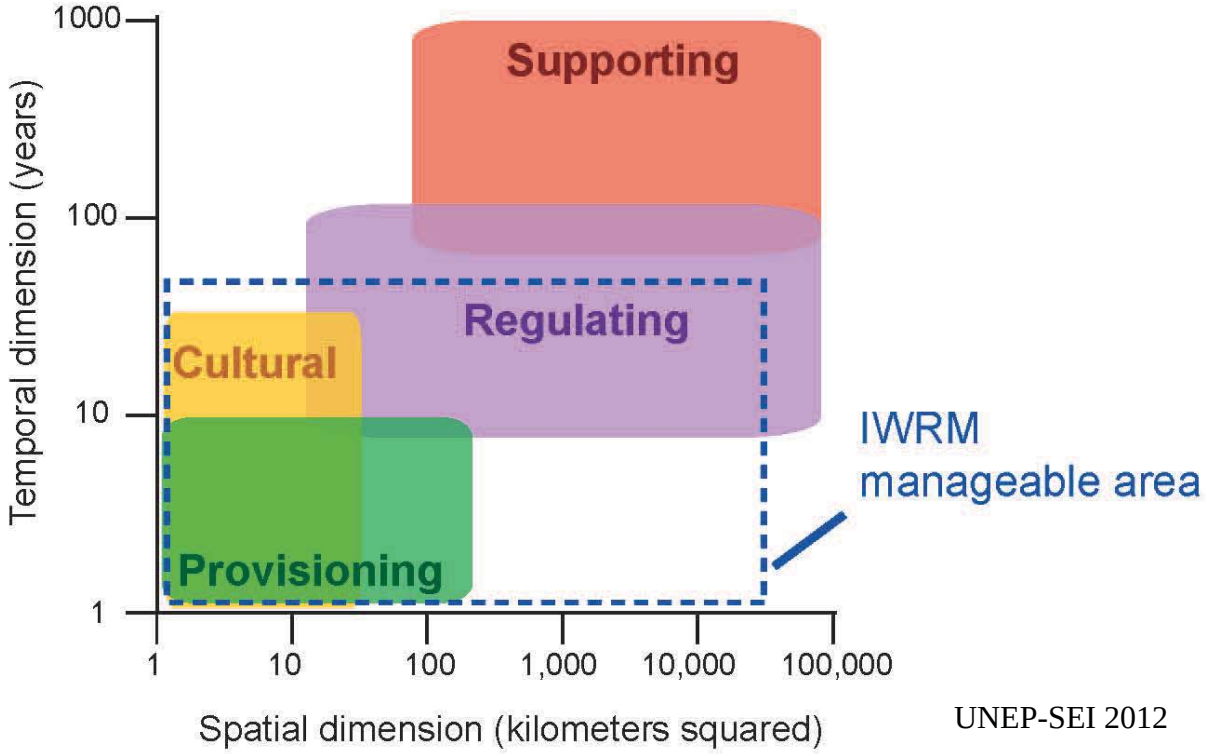
So far , we value soils for water and for food ..

but maintaining/enhancing soils in good health for regulation and supporting services is imperative to retain water and transform landscapes,, - not just agricultural land





UNEP-SEI 2012

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Managing soils to manage water:
Soil and water management entry point but other factors to realise potential

	Degraded	Balanced	High intensity
Kothapally (IND)	Pre 2000		Post 2000
Nariarle (BF)	Pre 1960		?? 2010
Makanya (TZ)	Today , pre 1990		

Critical levers to realise and accelerate benefits of managing soils for water

- SUBSTANTIAL INVESTMENTS!!
- Supply of affordable and available labour/energy, nutrients, water
- Market: for produce, supply , for ESS
- Knowledge: changing farming is knowledge intensive

Need viable 'business models' account for wider set of costs and benefits in rainfed agriculture: when public-when private investments relevant?

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Thank you!



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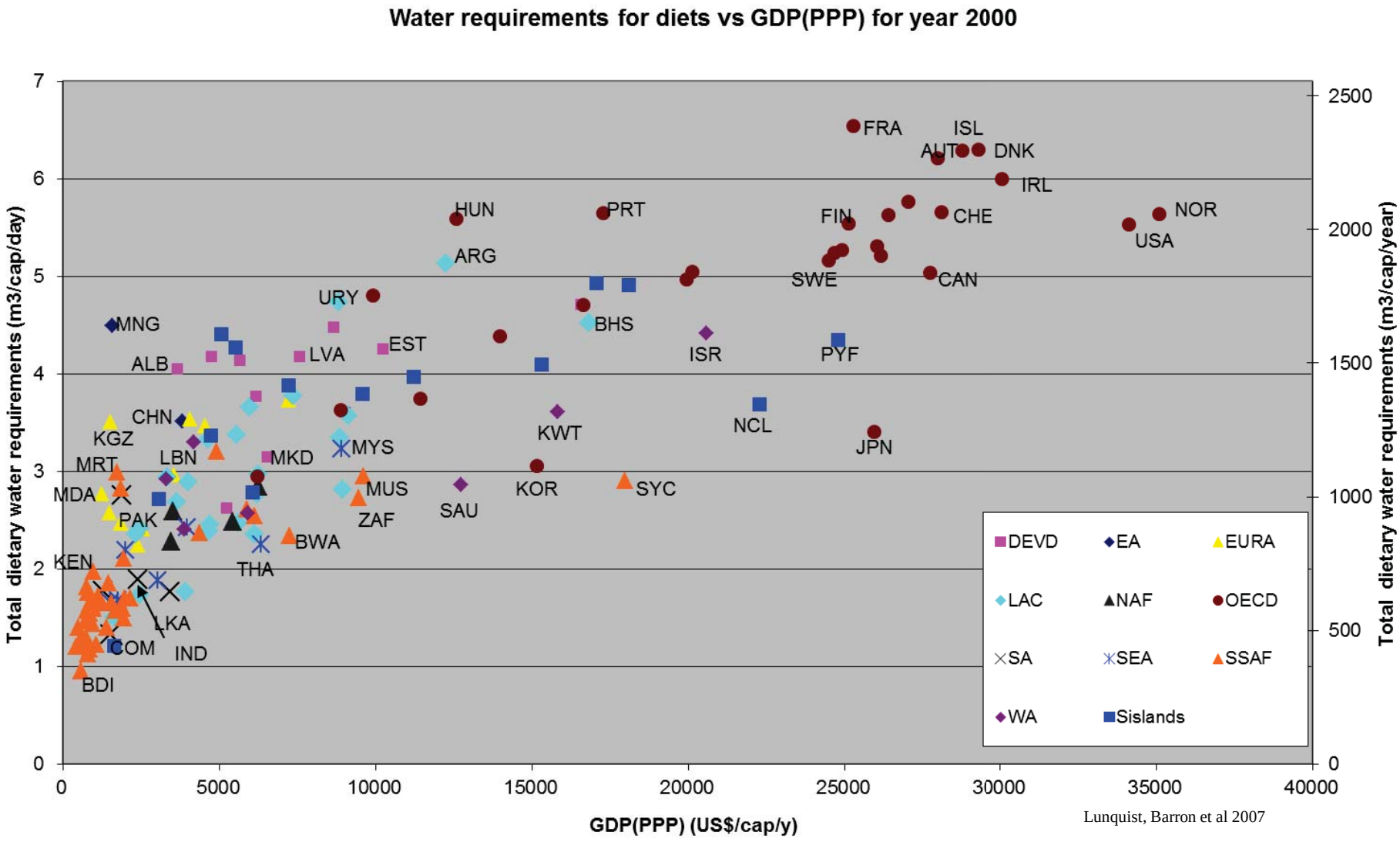
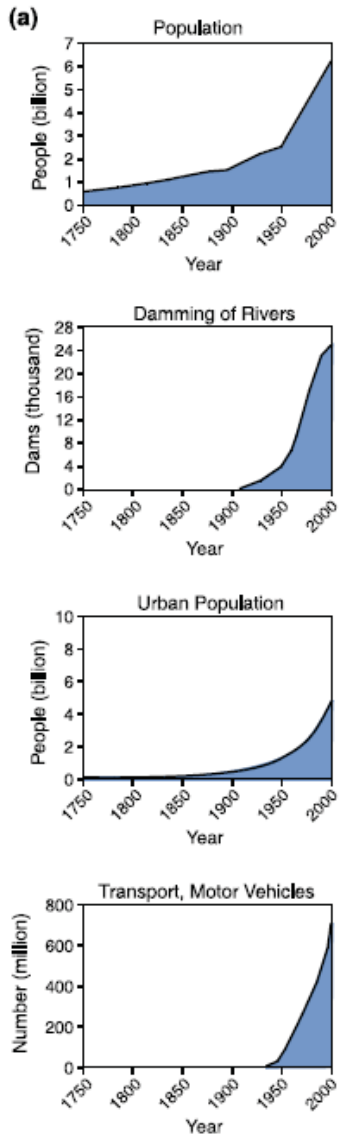
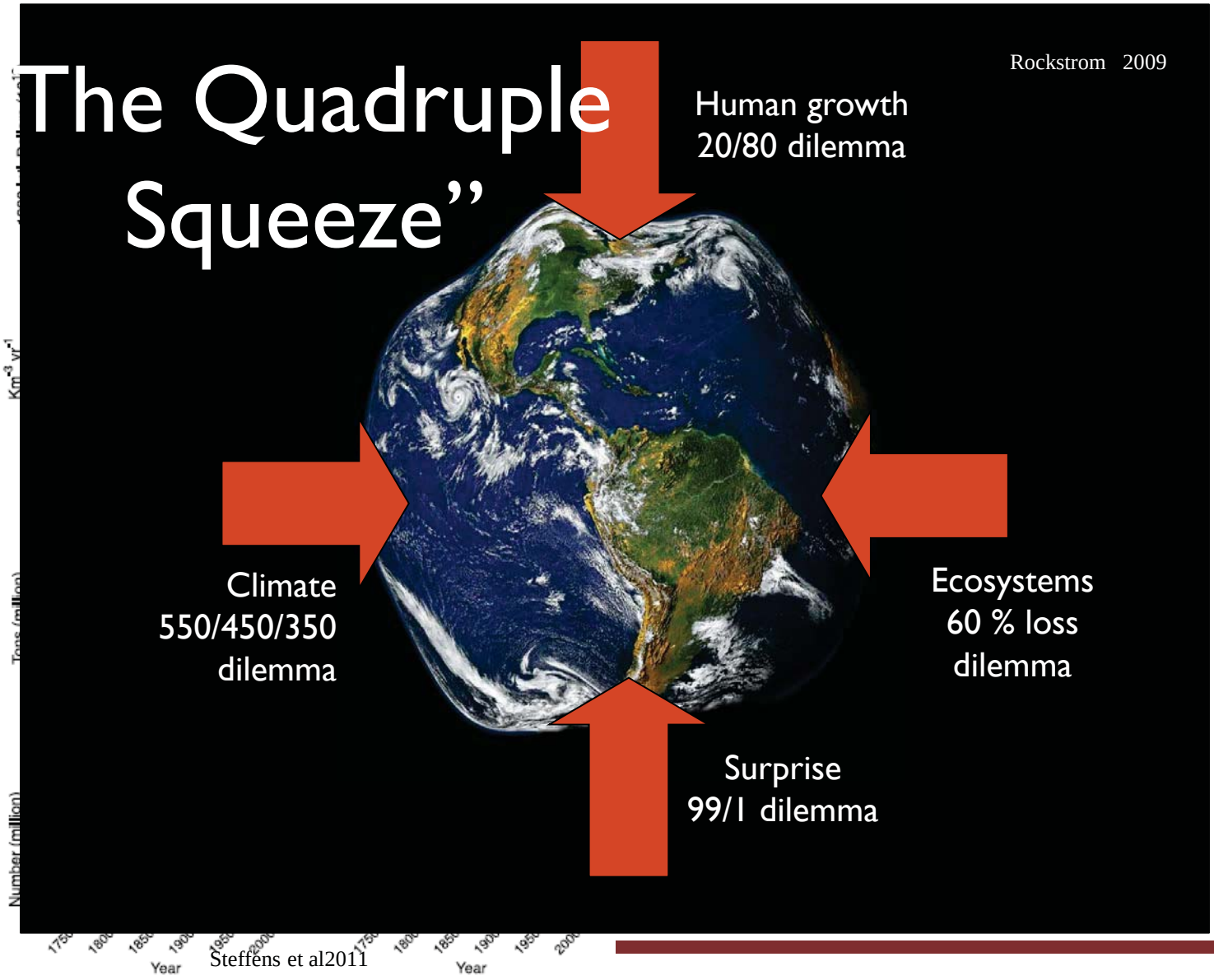


Lunquist, Barron et al 2007

Why should we bother? The anthropocene dilemma





Steffens et al2011

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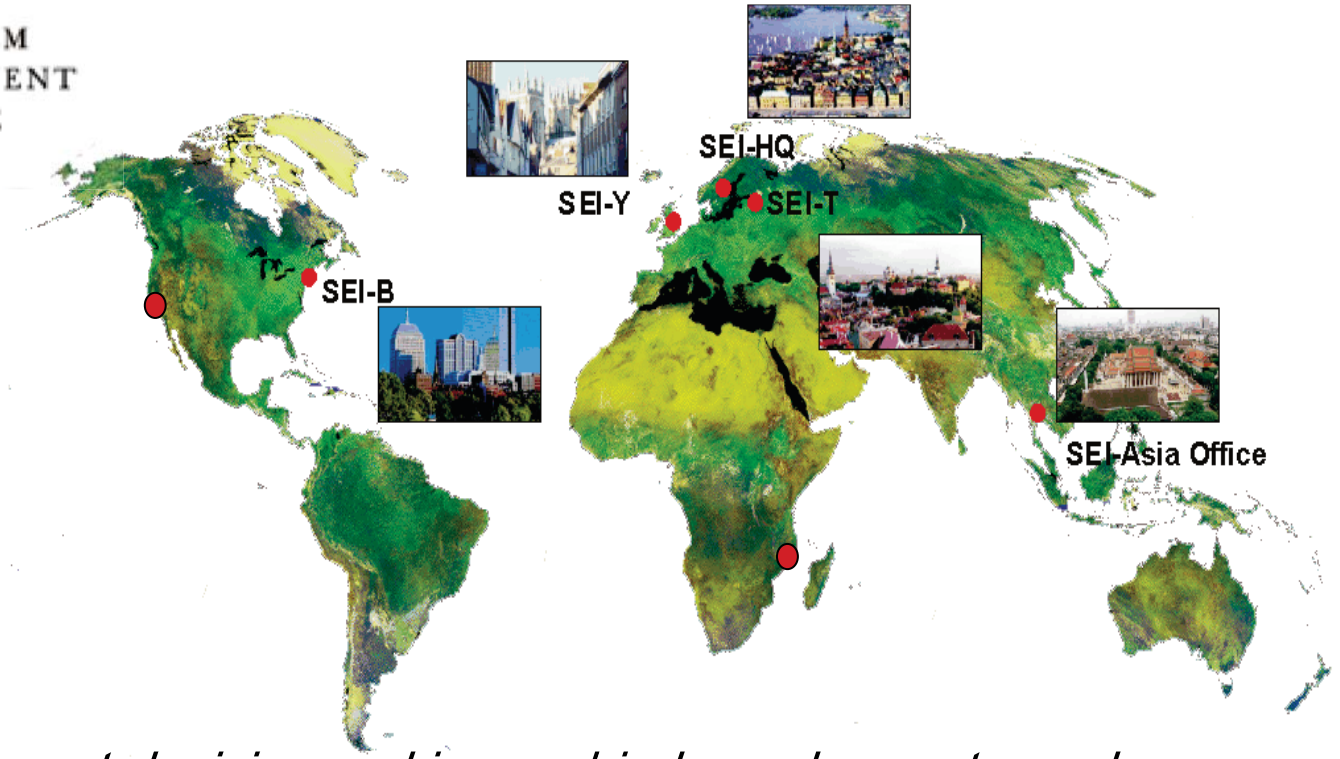

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SEI is an independent, international research institute specializing in sustainable development and environment issues for policy and decision making

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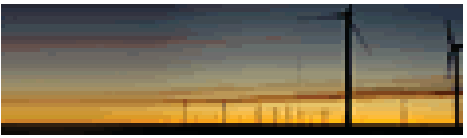
4 themes:



Reducing climate risks

Collaboration platforms for climate change adaptation ; Economics of climate policy Equitable approaches to mitigation and adaptation; Analytical frameworks on climate change

Managing environmental systems

Modelling carbon and water cycles; Integrating air pollution and climate change; Sustainable urbanisation; Energy and land-use planning; Sustainable biofuels and bionergy; Food security, health and biodiversity

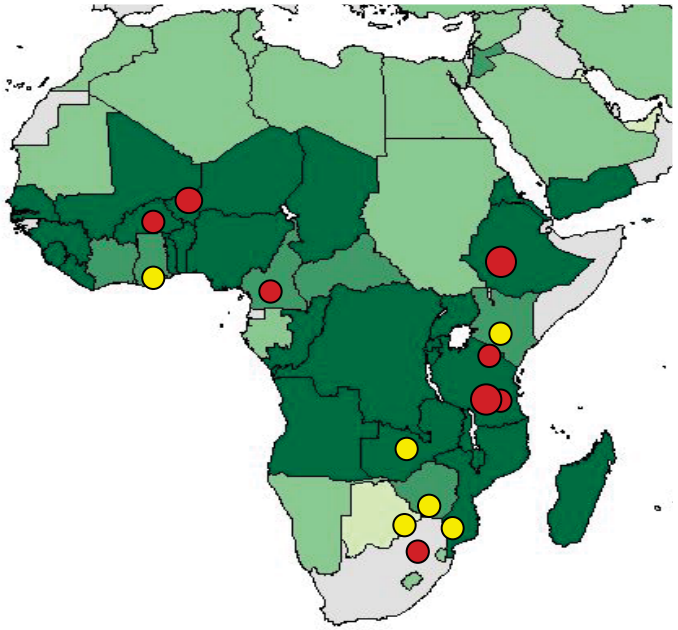
Transforming vulnerable communities

Vulnerability approach to livelihood development; Strategic assessments for transformation; Avoiding socio-ecological traps

Rethinking development

Global assessments; New economics for sustainable development; Partnership in developing countries; Sustainable consumption and production; Analytical tools and scenarios; Planetary boundaries; SEI China Cluster

Current and past relevant projects in ecosystems, freshwater and development



Direct on-going

Indirect and/or recent

• **AWM Solutions project** (2009-2011): IWMI, FAO, IFPRI, IDE INERA, Univ. Sokoine

• **Challenge Programme Water for Food Volta V1 and Limpopo L1Nile basin N3 (**2010-2013):

•Climate change and economics in Kenya and Tanzania

•CIFOR work valuing forest & NFTP

• **Climate Change, and water flows in watershed in transition (IPS 2010-2011)**

• **Local livelihoods and reliance on ecosystem services (IPS 2009-2010)**

<u>In collaboration with Stockholm Resilience Centre/Stockholm University:</u>

• **SRC Sahel re-greening: transformation in climate change** 2009, 2010-2013

• **SRC : EU FP7 Whater: Rainwater harvesting revisited:** 2011-2014

Modes of operation:

- From research to policy : strong research and evidence based

- Partnership : local to global

- Facilitating and hosting

- **Stockholm Resilience Centre** (SRC) with Stockholm University and KVA Beijer

- **ECOSANRES** Ecological Sanitation Research

- **BIO-EARN** East African Regional Programme and Research Network for Biotechnology, Biosafety and Biotechnology Policy Development

- **APINA** Air Pollution Information Network in Africa