Summary of Cluster Group Meeting Water in the Landscape, SIWI, 2017-12-08

The SIWI/SWH coordinator of the Cluster Group, Anna Tengberg, opened the meeting and welcomed all participants and presenters. The theme for the meeting was "Forests and Water" and the four keynote presentations are summarised below together with key conclusions and recommendations from the meeting.

David Ellison, Swedish Agricultural University (SLU): Forest, water, recycling ratios and hydrologic space

The Blue Nile basin is used as an example to illustrate the theme of the presentation. Atmospheric moisture in Ethiopia comes from the West African rainforest where increased deforestation leads to reduction in rainfall in Ethiopia, some predict as much as 25% reduction. The following concepts were introduced:

Concept of hydrological cycle - It is necessary to think outside the basin to see where the water comes from and how water is transported across continental and terrestrial surfaces.

Concept of hydrological space – Recycling ratios: what share comes from recycled conventional evapotranspiration? It feeds an important share of terrestrial precipitation. On average, forests provide more evapotranspiration (atmospheric moisture) than other land cover surfaces.

Is more forest equal to more water? Forests only consume water – this is the demand-side view of forest-water relationships that only sees the catchment, and not outside it – a larger framework is needed. There are not many that support the supply side, i.e. that forests produce water. A model has been developed to predict how forests change precipitation in the catchment, and it shows that spatial organisation matters and that it matters where you plant forest.

When are forests potentially a good thing?

- Upwind coast
- Locations not water stressed
- High altitude and cloud forest regions

Consequences of removing forest?

- Reducing forest cover may get more water to downstream users
- But this may have the consequence of reducing evapotranspiration (ET) output from the basin
- Some downwind communities could suffer significantly by losing an important share of their water.

In conclusion, forests both consume and produce water. The large-scale spatial organisation and connectivity of land-use practices and forest cover must be cautiously and carefully considered when addressing issues of forest cover, water availability and the hydrological cycle.

Ulrik Ilstedt, SLU, Dept. of Forest Ecology and Management: What is the impact of tree density? Are forests producers or consumers of water?

There is a long history of argument over the role of tree cover in the hydrological cycle. Contrasting views include: forests are like sponges; forests create more water, forestation reduces water yields, etc. Watershed studies of deforestation and afforestation have shown that differences in evapotranspiration (ET) give streamflow effects. However, most studies have been biased and have not included sufficient number of sites in the tropics and none on degraded land.

Extra infiltration associated with afforested land may outweigh the extra evaporation. There is 2-5 times higher infiltration with trees, also with agroforestry, and soil infiltration is better close to trees. We cannot only look at the catchment, but need to see the whole landscape, under trees, small and large gaps between trees (also including surface runoff and groundwater recharge) to understand and find the optimal tree cover

When it comes to soil-water drainage, there is not much water under a tree, as the tree is consuming it, but water increases with increasing distance from the tree. Trees are good for water:

- Roots and macro fauna lead to more preferential flows
- Water can more easily infiltrate surface and unsaturated soil depths, potentially reducing soil surface evaporation
- More infiltration results in less surface runoff

Too many trees can consume excessive amounts of water, but we need to find the optimum tree cover, which is related to soil improvement, pruning, small gaps, species with low water use, livestock control and tree age (older trees).

Jan Lannér, Swedish Forest Agency: Helge å Model Forest

The Model Forest (MF) concept originates in Canada and was developed to handle conflicts between logging companies and First Nations. It was launched at the 1992 Earth Summit and today there are about 60 Model Forests distributed over four continents, of which three are in Sweden. The MF concept combines the landscape approach with partnerships and sustainability considerations.

The key issues in Helge å in southern Sweden include:

- Brownification – there is an impact on fish, what can be done?
- Streams – restauration of habitats
- Rural development – develop attractions based on natural and cultural values
- Green infrastructure – oak woodland along the river Helge
- Tree species and woods in the future forest landscape
- Peri-urban nature and participatory planning – are gaining experience together with HIBAB development company and SLU on how to involve users in the management of urban nature
- Knowledge building and mediation – development and communication of new knowledge

A toolbox is needed to address the problems as well as conflicts in the landscape.

The Helge å MF uses a multi-level governance model to address several of the Sustainable Development Goals (SDGs). The MF six principles include (1) partnerships; (2) landscape approach; (3) commitment to sustainability; (4) transparent, consensus-based and inclusive governance; (5) programme activities reflective of stakeholder needs; and (6) knowledge sharing, capacity building and networking. Remaining challenges include financial sustainability and to build a resilient social network to ensure the future of Helge å MF.

Nora Berrahmouni, UN Food and Agricultural Organization (FAO) – Working Group on Dryland Forests and Agrosilvopastoral Systems

Globally, the drylands cover 41.5% of the land surface and are the home of 2 billion people. With climate change, the drylands are expected to expand with 11-23%. Current challenges include:

- Overpressure on resources – forests in drylands are becoming ever more important, but are under increasing pressure

- Desertification that exacerbates migration and conflicts
- Climate change that induces long drought spells
- Undervaluation of drylands
- Lack of attention and lack of investment in drylands
- Insufficient information about drylands

The FAO Committee on Forestry (COFO) recommended in 2014 to "develop a global assessment of the extent and status of dryland forests, rangelands and agrosilvopastoral systems". This led to the Rome promise 2015 and the launch of a Global Dryland Assessment that include many partners from different institutions, organisations, companies and Google Earth. A paper has been published in Science on the extent on forest in dryland biomes that reported on 400 million ha of forest land that has never been mapped and reported before.

Priority measures in drylands are large-scale restoration, also along value-chains. FAO is involved in the Great Green Wall (GGW) that is Africa's response to climate change and zero hunger. It is not a wall of trees, but a mosaic of sustainable land management practices. FAO´s as well as the SDG objectives are common with those of the GGW. The goal is to restore 10 million ha of land per year. Communities and their preferences are at the heart of forest and landscape restoration and the focus is not only on trees, but on feed, medicines, food, fuel, etc. Moreover, water is at the centre of restoration in drylands.

The FAO Working Group on Dryland Forests and Agrosilvopastoral systems include members from 27 different countries and 52 experts. There are also observers from international organisations and institutions. The first meeting will take place in April 2018 and there is a need to mobilise financial resources as well as wider technical expertise.

Conclusions from the discussion

- The cluster group welcomed the new participants from the food sector and concluded that it is important to consider water in the wider landscape, not only in the production or value-chain.
- The relationship between forest and water depends on the context and there is a need to integrate trade-offs between e.g. timber/other uses/livelihoods, etc., and different stakeholders and different topics need to be connected, and forests is one of the topics.
- We also need to widen the geographical perspective from watersheds to whole continents and cross-regional perspectives, and also consider the time-spectra – trees are lost fast, but new gains of trees and forests take more time
- It is sometimes better to focus on trees than forests, and on how best to benefit from trees, taking into consideration different species, age of trees, spacing/density, etc.
- An additional perspective is diversification of species and use of local varieties, to use, for example, less thirsty crops or trees that are adapted to the local context.
- Existing conceptual frameworks do not serve us well and we need to find another way of approaching the issue of water and forests.
- The FAO Working Group on Dryland Forests and Agrosilvopastoral Systems could be linked to the Call for an Africa Water Revolution that SIWI is involved in. The Swedish resource base could be use to provide inputs to FAO.
- When identifying opportunities for restoration, we should not only focus on degradation, but try to identify opportunities instead. However, all landscapes are degraded in some way.

- Finally, there is also a need to have a stronger focus on stakeholders and the end-users. We need to bring in a more stakeholder focused and practical perspective in the work of the cluster group in the future.

Upcoming meetings of the Cluster Group

The next meeting of the Cluster Group will be on the theme Climate Change and Landscapes and will take place on 9 February 2018. A detailed programme and invitation to the meeting will be sent out in the beginning of January.

The series of thematic meetings of the Cluster Group are summarised below and more information can be found in both Swedish and English at:

http://www.swedishwaterhouse.se/sv/klustergrupper/vatten-i-landskapet/

The Cluster Group
Water in the Landscape

Forests and Water

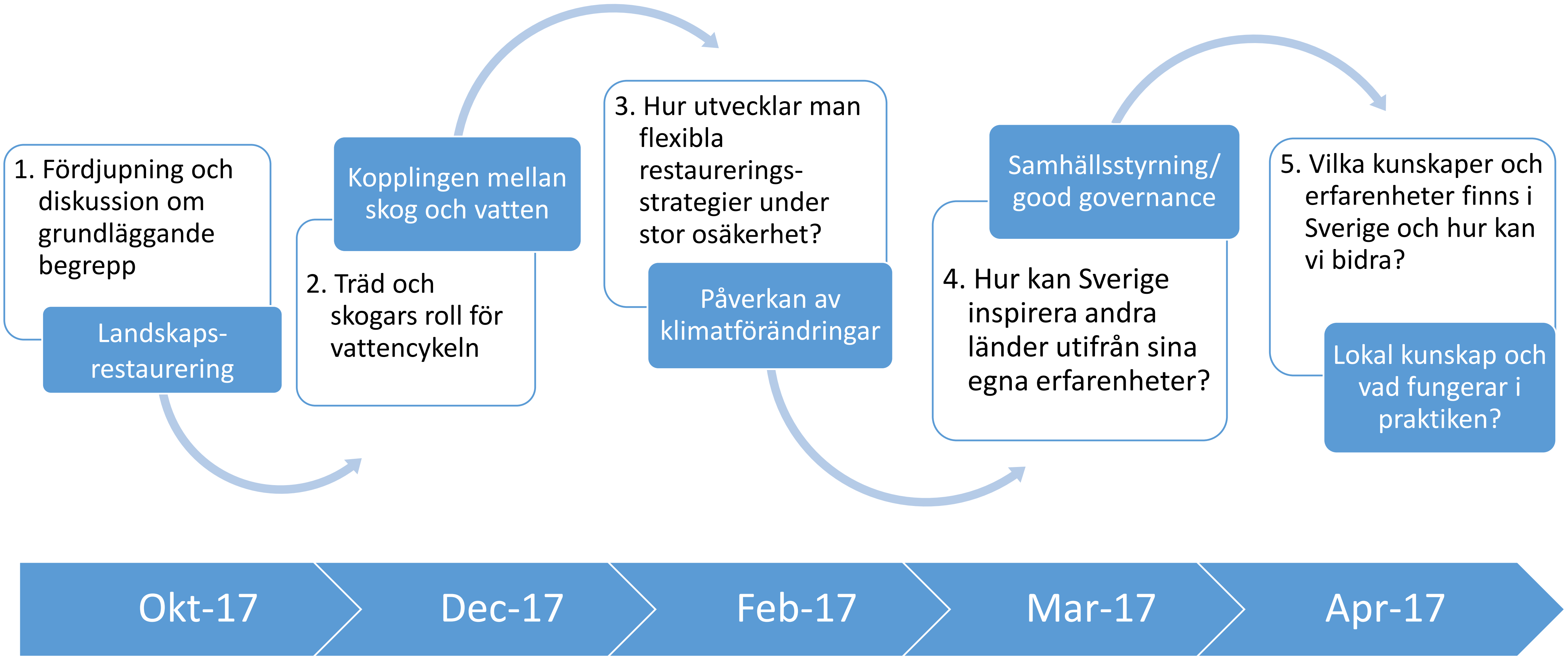
Anna Tengberg
SWH/SIWI

SIWI

Sustainable use of water for productive and multifunctional landscapes

- To promote water in the international conversation on landscape approaches and restoration
- Strengthening / expanding Swedish and International networks on water-related natural resource management

Teman hösten 2017/våren 2018



Developments since last meeting

- Summary and blog about the last meeting
- Presentation of the Cluster Group at HAV/SWaM 8 Nov
- Participation in the Swedish Water Days in Halmstad 14-15 Nov – theme green infrastructure
- Suggestion to organise Landscape Forum together with KSLA next year
- New Sida-funded SIWI project in Ethiopia with landscape restoration component (as well as IWRM and Textile) – training & capacity building

Conclusions so far…..

Capacity building

Educational systems - We need to include not only technical expertise, but also tools for behavioral change and social aspects that are closely linked to landscape restoration.

There is a lot to learn from countries in the South, where water issues and especially the lack of water has been given more attention than in Sweden.

SIWI SWEDISH WATER HOUSE

Integration of water in landscape approaches

- **Forest versus agriculture -** Shift from watershed focus to nexus
- **Competition for water** - see the landscape as the system boundary and that activities upstream affect water flows/access downstream.
- **Multifunctional and productive landscapes** are the goal, and sustainable water management is the means to achieve that.

Governance

- **Need to focus on governance** from a water perspective and to get forest and land owners interested in the way water moves, and to see the complexity and the whole landscape.
- **Governance strategies.** The risk is that water is not given top priority when it comes to landscape approaches.
- **Need to include the people who own the question**

SIWI

Today’s Programme

9.30-9.40	Welcome and opening of the meeting *Introduction of participants*	Anna Tengberg, SIWI/SWH
9.40-11.10	Key Notes:	
9.40-10.05	Explanation of concepts, such as Evaporation/Landscape wetting/Moisture feedback/Biotic pump/Aerial rivers – what do they mean for the hydrological cycle?	David Ellison, SLU (The Swedish Agricultural University)
10.05-10.30	Are forests net producers or consumers of water, what is the impact of tree density?	Ulrik Ilstedt, SLU
10.30-10.55	Swedish case study – Helge å Model Forest	Jan Lannér, Skogsstyrelsen (The Swedish Forest Agency)
10.55-11.10	Introduction of FAO’s Working Group on Dryland Forest and Agrosilvopastoral Systems	Nora Berrahmouni, Forestry Policy and Resources Division (FOA), FAO
11.10-12.00	Coffe break and group discussions	
12.00-12.20	Presentation of group discussions	Group rapporteurs
12.20-12.30	Conclusions and next meeting	Anna Tengberg, SIWI/SWH

Introduction of Participants

Today's questions for discussion

1. How could the complex relationship between forest and water best be summarised and what are the key factors to consider? What is the role of land degradation?

2. Which are the key agro-ecological zones where this relationship is critical and where improved management of forests and trees in the landscape can contribute most to improved water quantity and quality?

SIWI

Next meeting

- Theme – climate change
- Speakers – SMHI, County Board of Västra Götaland, AGWA?
- Date

SIWI

Water in the Landscape

Engage in our network @ swedishwaterhouse.se

Thank you!

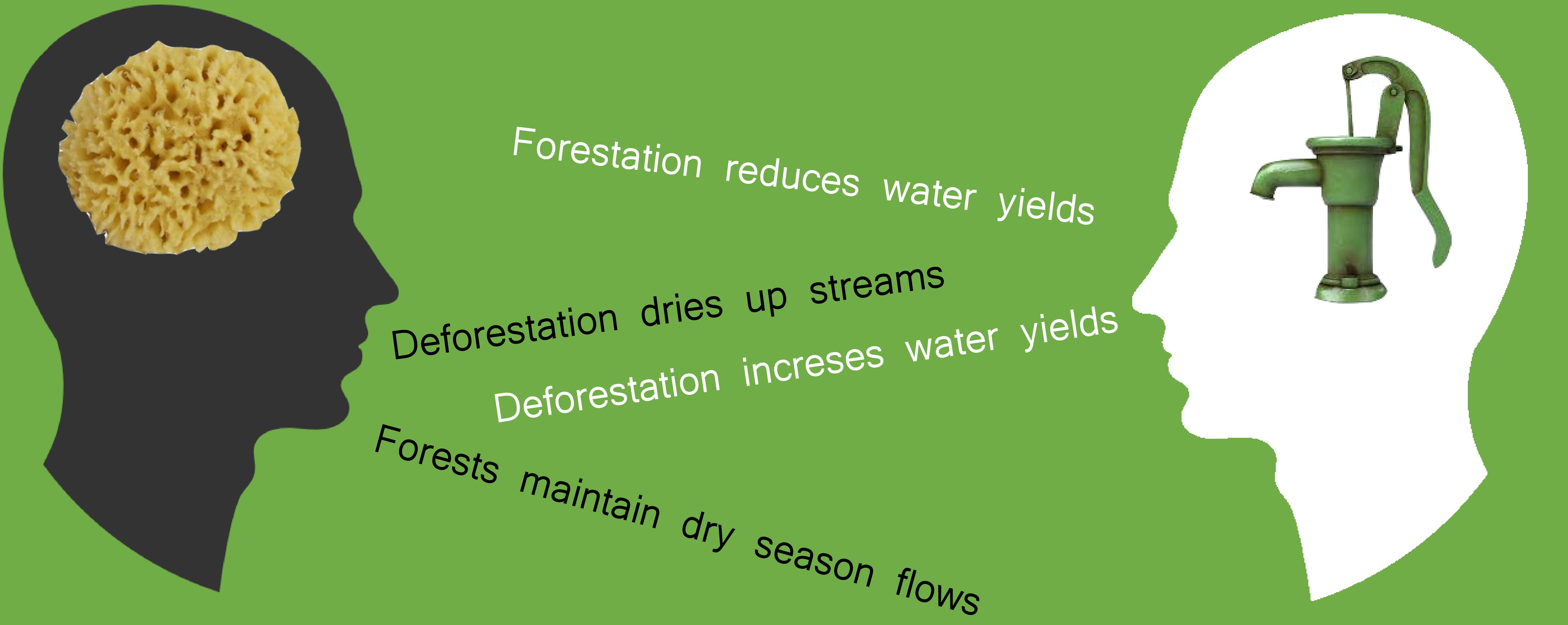
SIWI SWEDISH WATER HOUSE

Are forests net producers or consumers of water, What is the impact of tree density?

Ulrik Ilstedt, Dept. of Forest Ecology and Management

SLU

CONTRASTING VIEWS ON (DE)FORESTATION AND WATER YIELDS



(illustration: Aida Bargués -Tobella)

“REDD …contribute towards gradual restoration and sustainance of water flows…averting the looming water stress in East Africa.”

Kimbowa et al. 2011. REDD Net

Trading Water for Carbon with Biological Carbon Sequestration
Robert B. Jackson, *et al.*
Science **310**, 1944 (2005);

"It doesn't matter where you are in the world,
when you grow trees on croplands,
you use more water...

...reduce the water available for drinking and irrigation,
and harm local aquatic ecosystems."

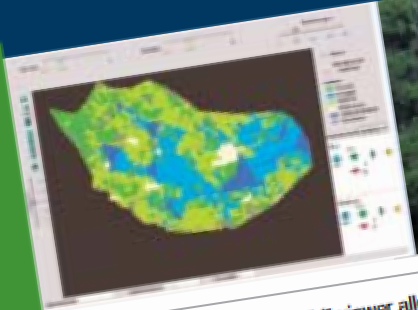
Nature News, 22 Dec 2005

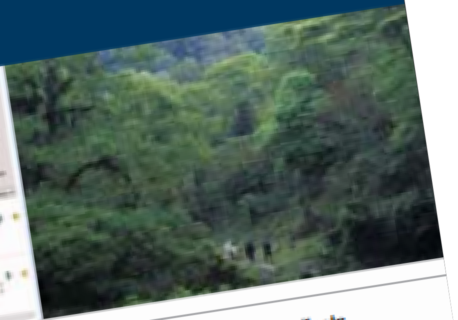
Research into Use: Policy Brief No. 3

Research Into Use

Forests, flows and water harvesting: replacing myths in watershed management

Watershed-development projects have often been based on a set of common misbeliefs. This has all too often led to less water for those who need it most. Instead, evidence-based, pro-poor and integrated land and water management policies are needed. New tools are available to help.





Above: The EXCLAIM[2] viewer allows easy assessment of the effects that changes in rainfall, water harvesting and land use have on groundwater and surface water flows.

Common water-related myths exposed

Better ways of measuring water, better models and powerful new geographic information systems (GIS) have exposed some fatal flaws in 'conventional wisdom'. It is a myth, for example, that trees always improve water availability by increasing local rainfall and runoff'.

Other common myths are that water harvesting is totally benign, and that drops in flows from catchments are always caused by a decrease in rainfall. Capturing and using more water upstream through terracing fields, planting trees and ... water-storage structures is often actually the cause.

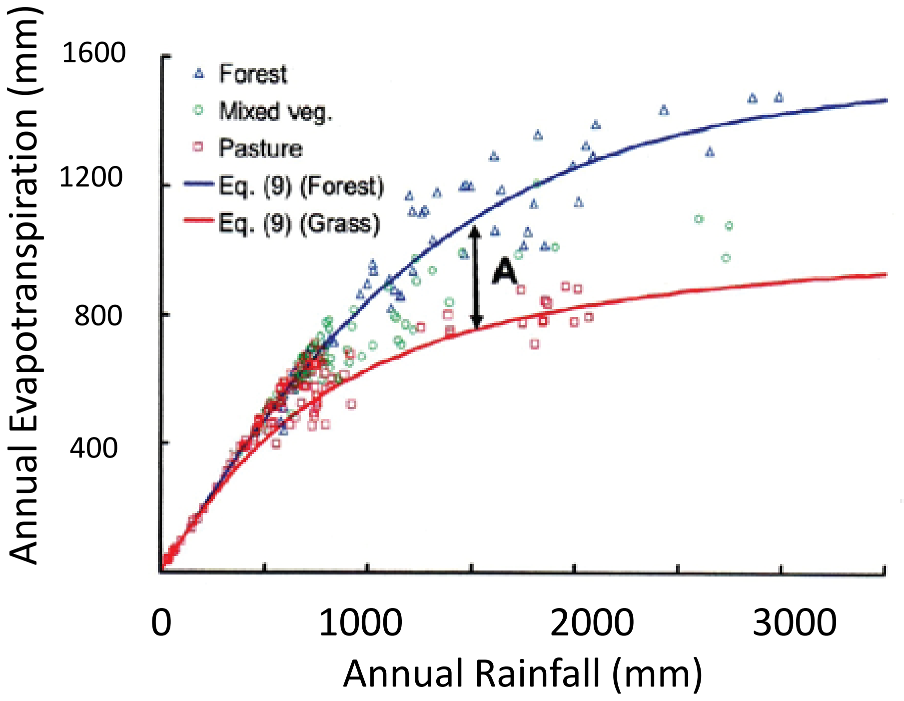
What can policy makers do?

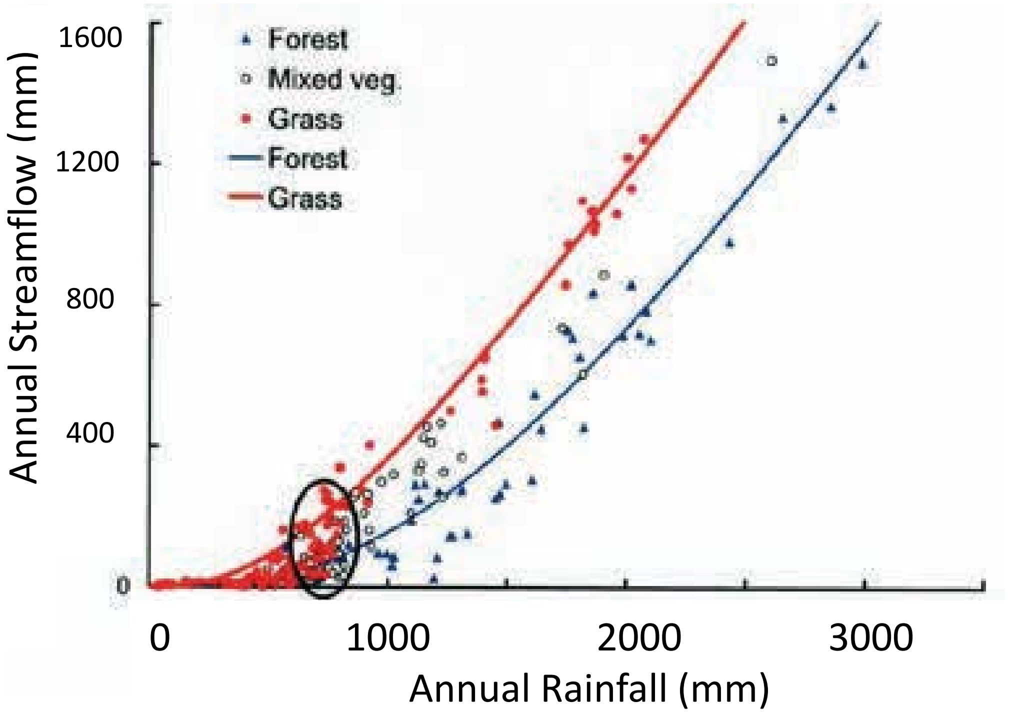
Policy makers need to:

- Recognise that many firmly held beliefs about forests providing and protecting water supplies are simply not correct
- Recognise that watershed-development projects involving tree-planting and water-harvesting often do not benefit the environment or alleviate poverty
- Base new catchment projects and land and water policy firmly on scientific evidence that shows that they will bring benefits
- Take advantage of the new models and user-friendly ... decision-making on water and ...

Differences in ET give Streamflow effects

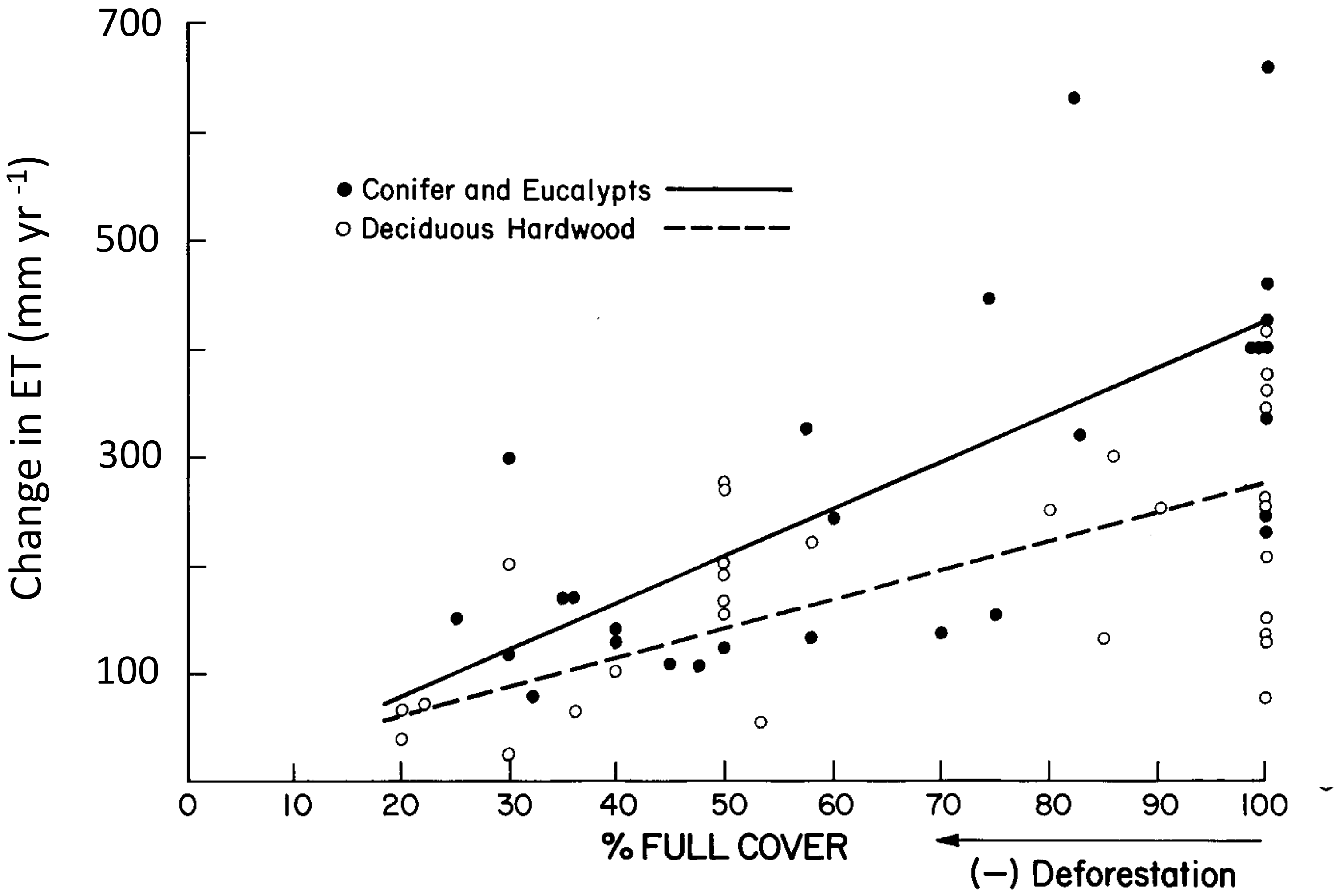
Streamflow = Rainfall - ET





(Zhang 2005)

Watershed studies



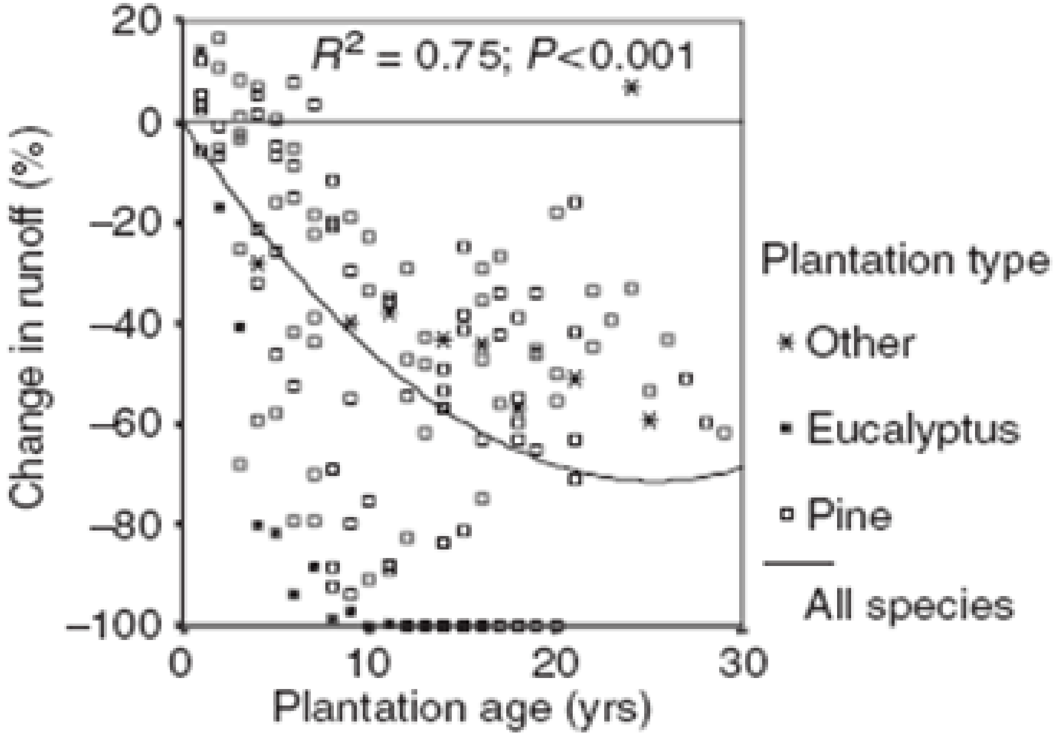
(After Bosch and Hewlett 1982)

Trading Water for Carbon with Biological Carbon Sequestration
Robert B. Jackson, *et al.*
Science **310**, 1944 (2005);

506 afforestation observations 'globally'

- Annual stream flow decrease 33-44%
- Proportionally worse at dry sites
- Larger reductions in dry season

Grasslands



FAO Forestry Paper 155

"…there is no question that even partial forest removal increases downstream water yields. " (Hamilton 2008)

“**<u>Forests reduce dry-season flows…</u>**

as much as or more than they reduce annual water yields. “

Calder et al 2007 (http://www.fao.org/docrep/010/a1598e/a1598e02.htm)

It is theoretically possible that in degraded agricultural catchments the extra infiltration associated with afforested land might outweigh the extra evaporation loss from forests…

…increased rather than reduced dry-season flows

– but this has rarely been seen.”

Calder et al 2007 (http://www.fao.org/docrep/010/a1598e/a1598e02.htm)

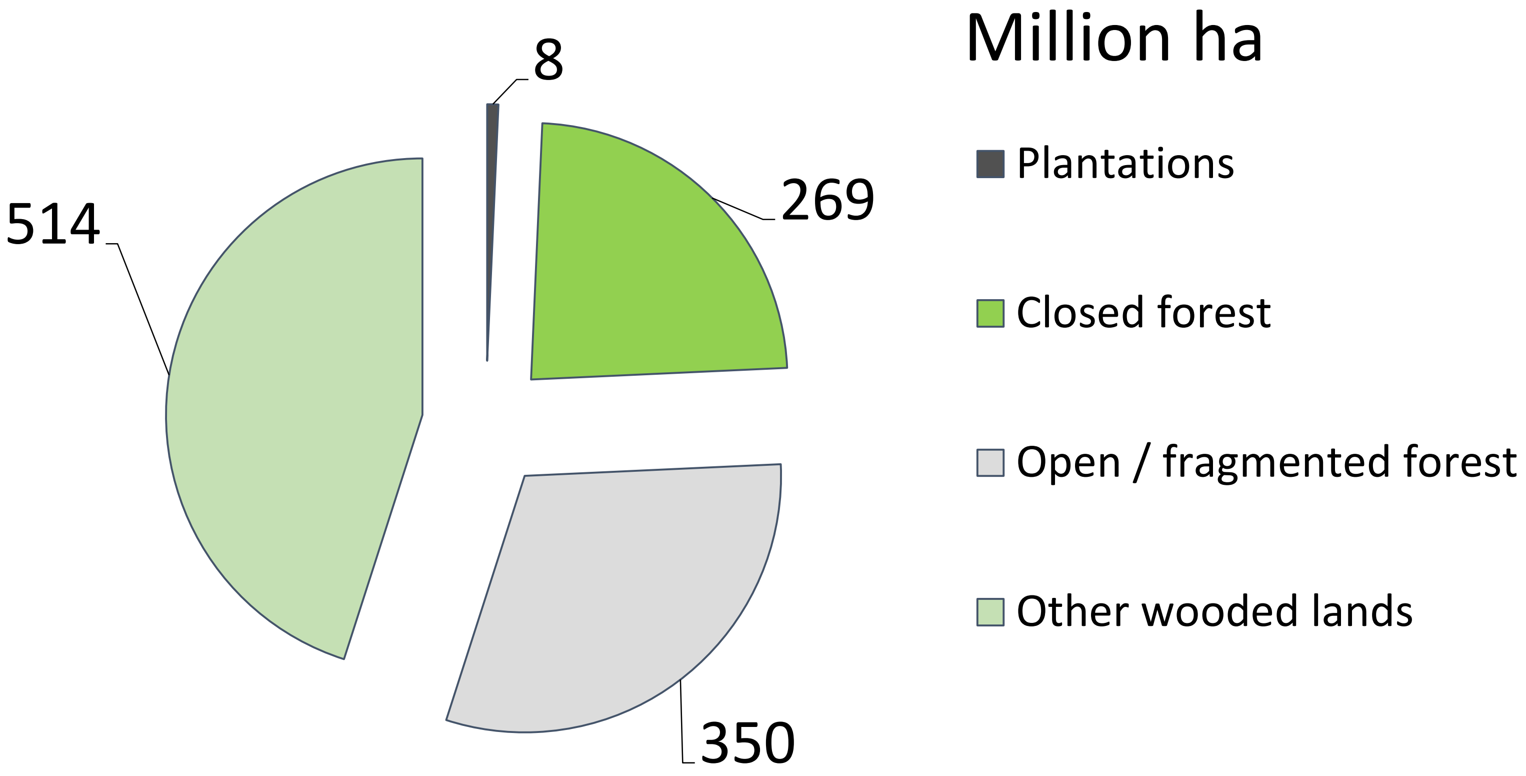
506 observations 'globally' BUT….

(Jackson et al 2005; Ilstedt et al 2007; Malmer et al. 2010)

- Only 17 locations and 3 locations in the tropics
- *None on degraded sites*
- None in the dryer tropics (<1000 mm/yr)
- All but three planted with *Eucalyptus* or *Pinus*

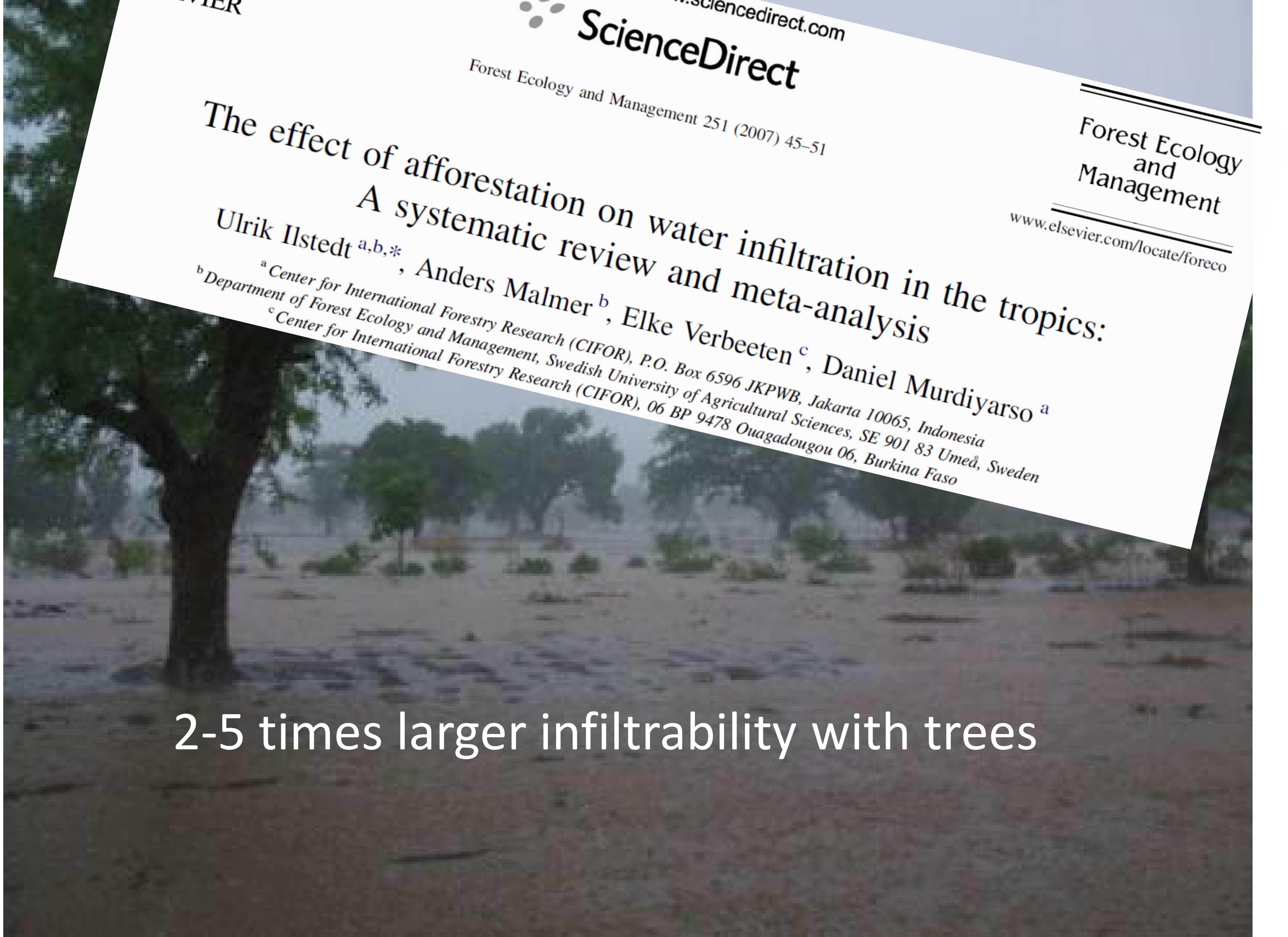
Zhang, L. & Zhao, F. 2009

Closed vs. open forest - Africa



Shvidenko et al. 2005

…extra infiltration associated with afforested land might outweigh the extra evaporation…



ScienceDirect

Forest Ecology and Management 251 (2007) 45–51

Forest Ecology and Management

www.elsevier.com/locate/foreco

The effect of afforestation on water infiltration in the tropics: A systematic review and meta-analysis

Ulrik Ilstedt [a,b,*], Anders Malmer [b], Elke Verbeeten [c], Daniel Murdiyarso [a]

[a] Center for International Forestry Research (CIFOR), P.O. Box 6596 JKPWB, Jakarta 10065, Indonesia

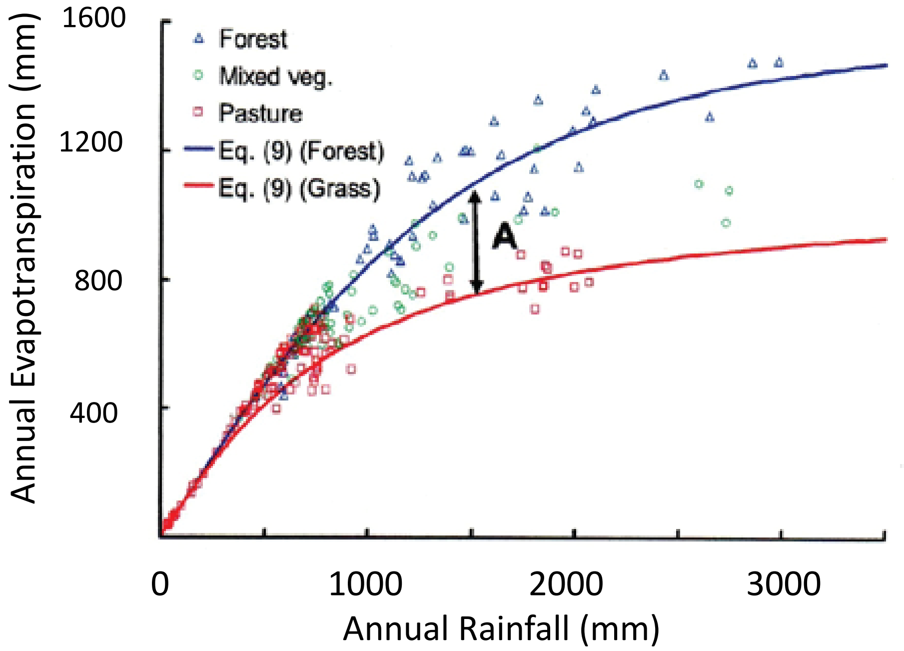
[b] Department of Forest Ecology and Management, Swedish University of Agricultural Sciences, SE 901 83 Umeå, Sweden

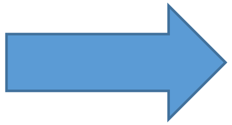
[c] Center for International Forestry Research (CIFOR), 06 BP 9478 Ouagadougou 06, Burkina Faso

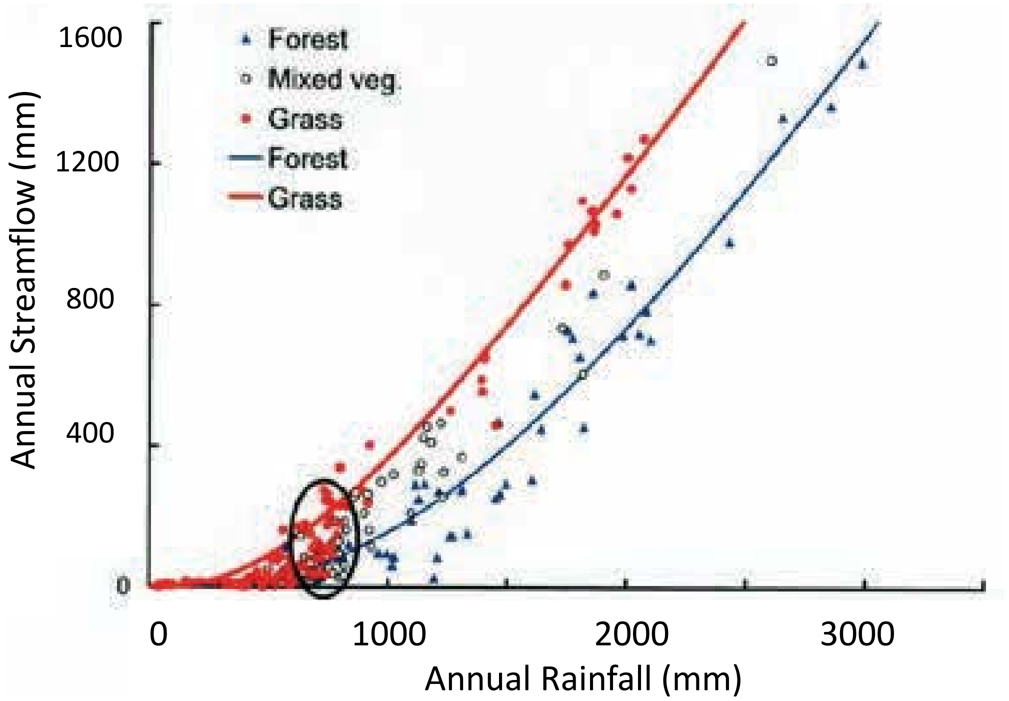
2-5 times larger infiltrability with trees

Soil infiltration capacity Burkina Faso

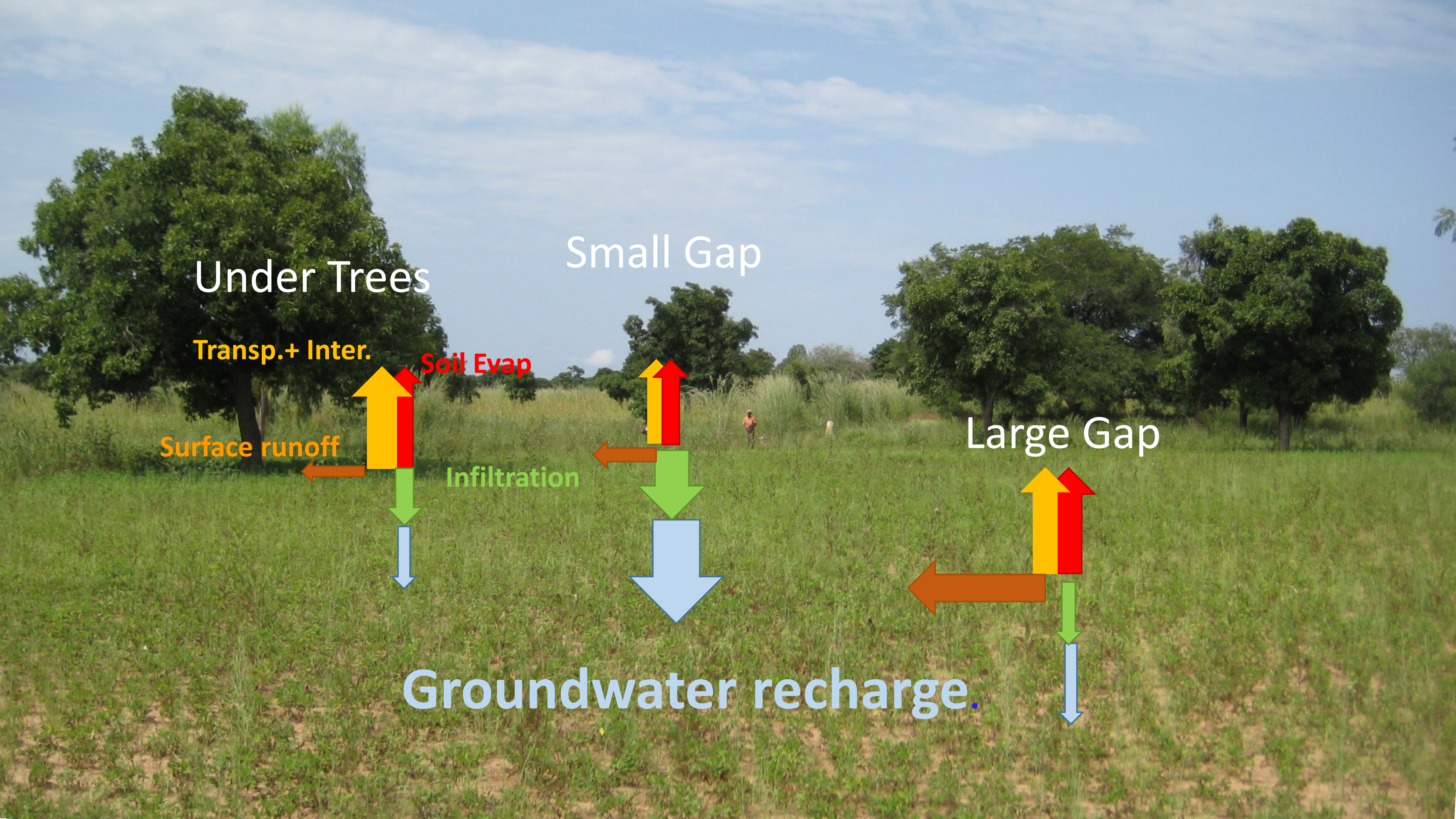
Difference in ET smaller at 500-1200 mm







(Zhang 2005)

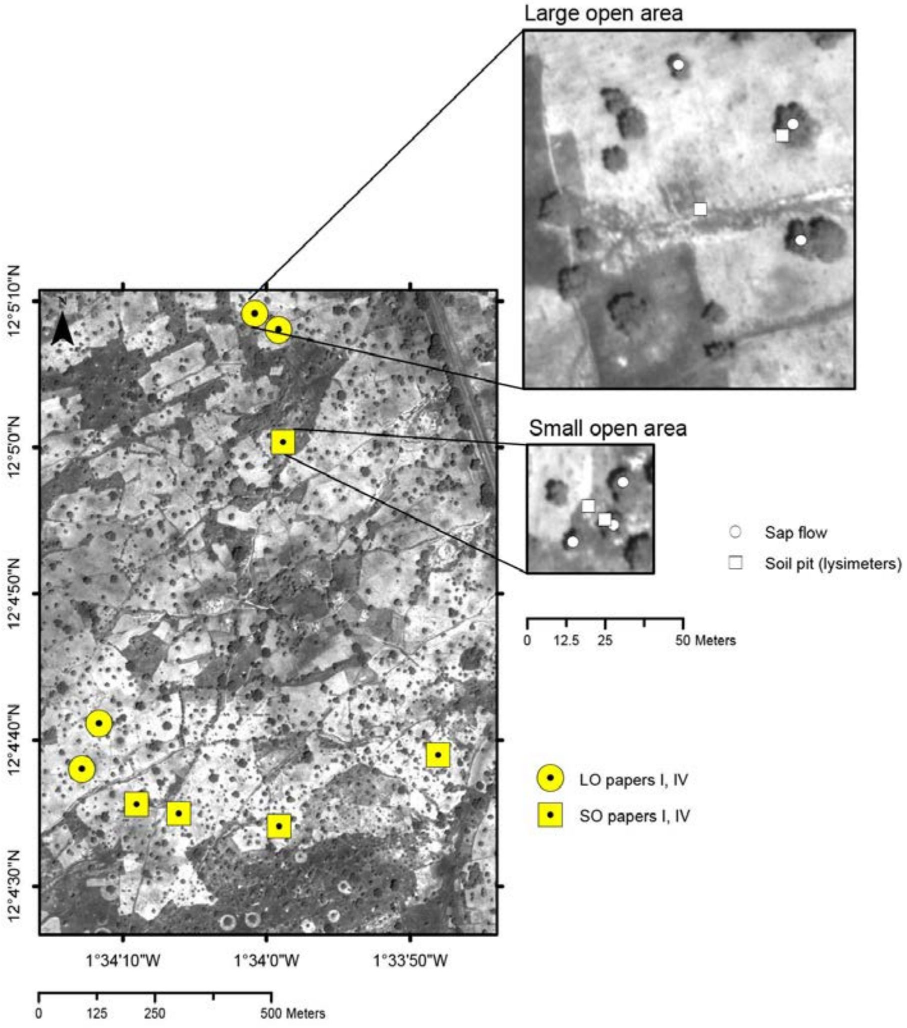

Under Trees
Small Gap
Large Gap
Transp.+ Inter.
Soil Evap
Surface runoff
Infiltration
Groundwater recharge.

The agroforestry parklands of Saponé, Burkina Faso

Photo: Maria Ölund

Photo: Maria Ölund

Measurements in a agroforestry parkland



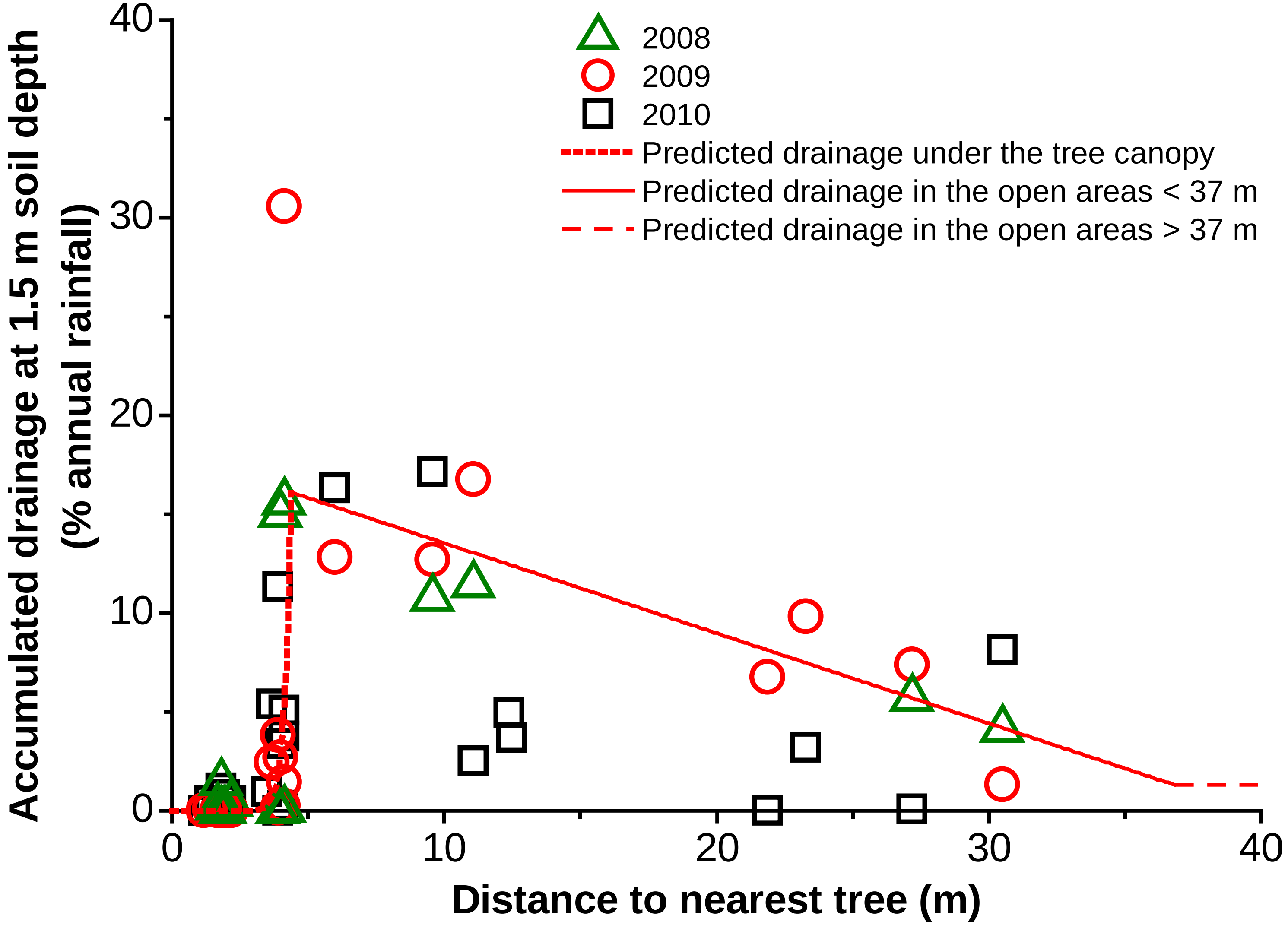
Soil pits under tree – open

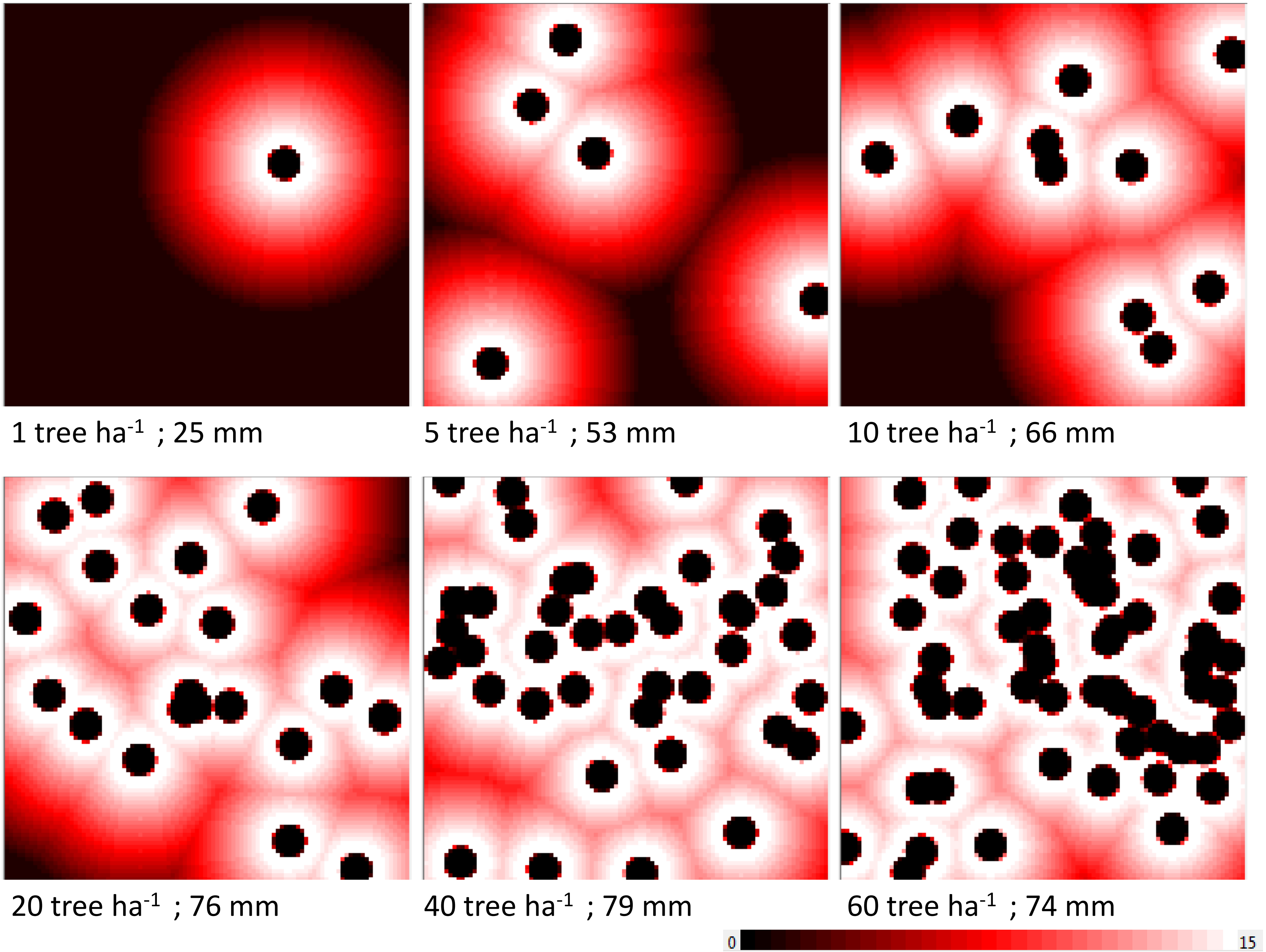
Soil pit with lysimeters

Passive fiberglass wick lysimeter

Sap flow measurements– HRM

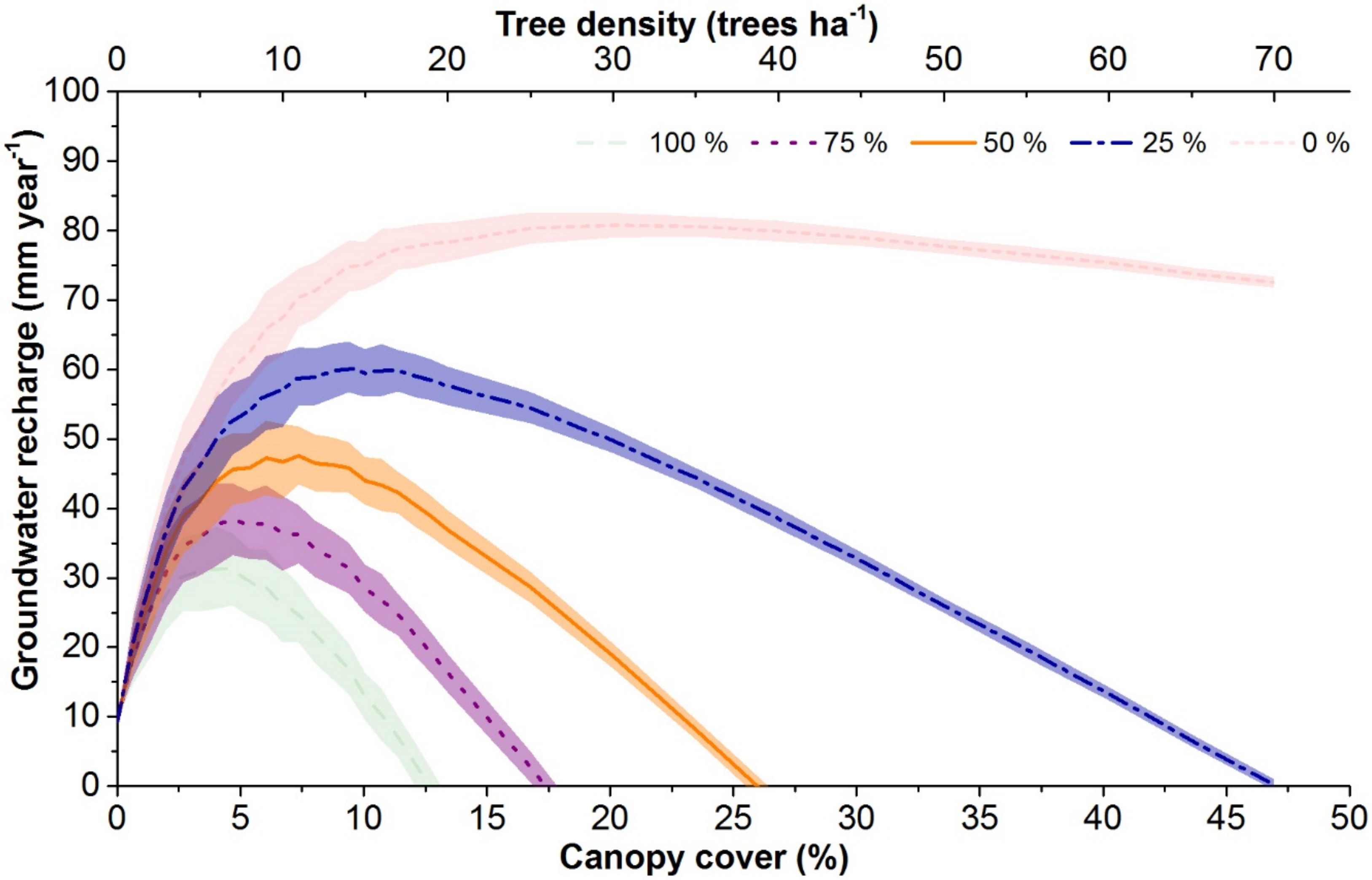
SOIL WATER DRAINAGE AT 1.5 m DEPTH





1 tree ha-1 ; 25 mm
5 tree ha-1 ; 53 mm
10 tree ha-1 ; 66 mm
20 tree ha-1 ; 76 mm
40 tree ha-1 ; 79 mm
60 tree ha-1 ; 74 mm
0
15

MODELED GROUNDWATER RECHARGE

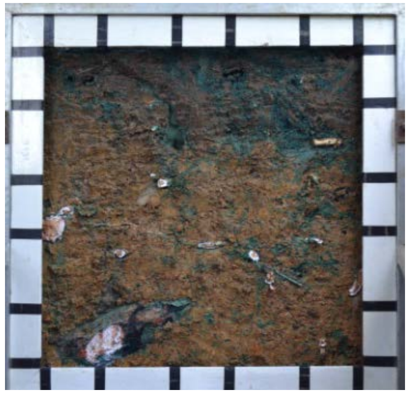


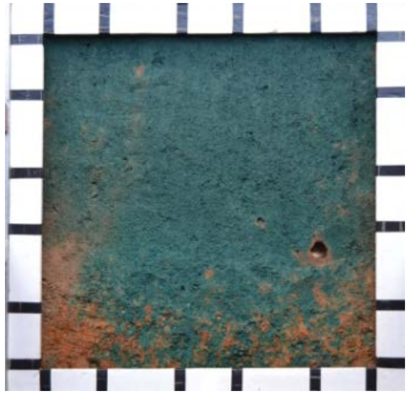
Degree of preferential flow

Brilliant Blue dye

Photographing soil sections

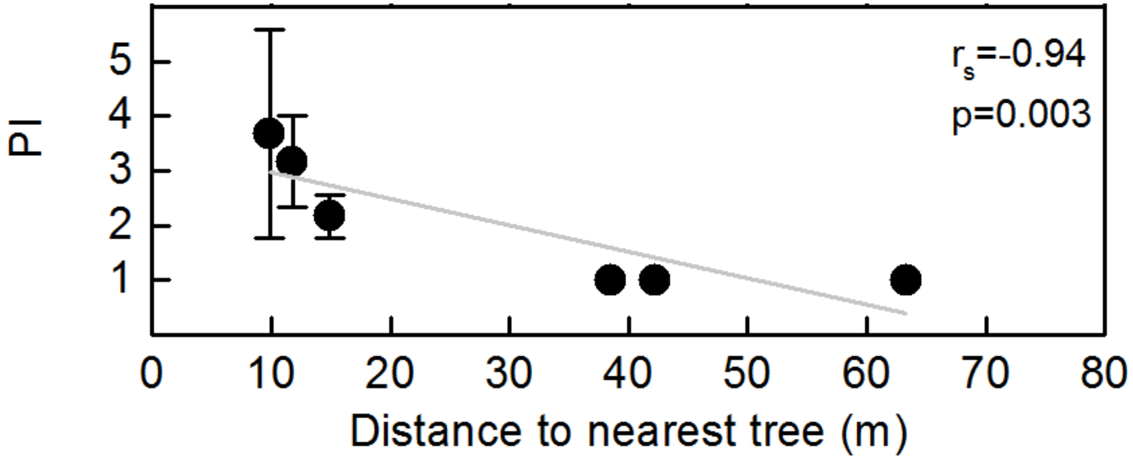
Soil sections

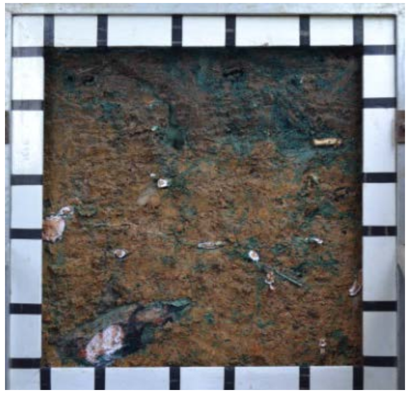


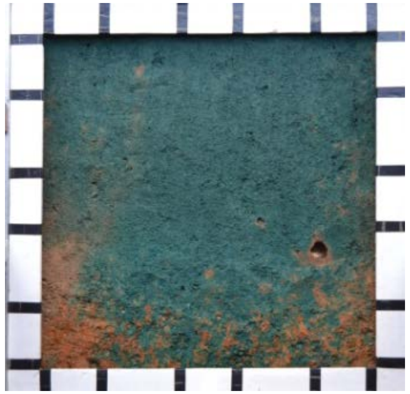


THE EFFECT OF TREES EXTENDS BEYOND THE CANOPY EDGE

Degree of preferential flow







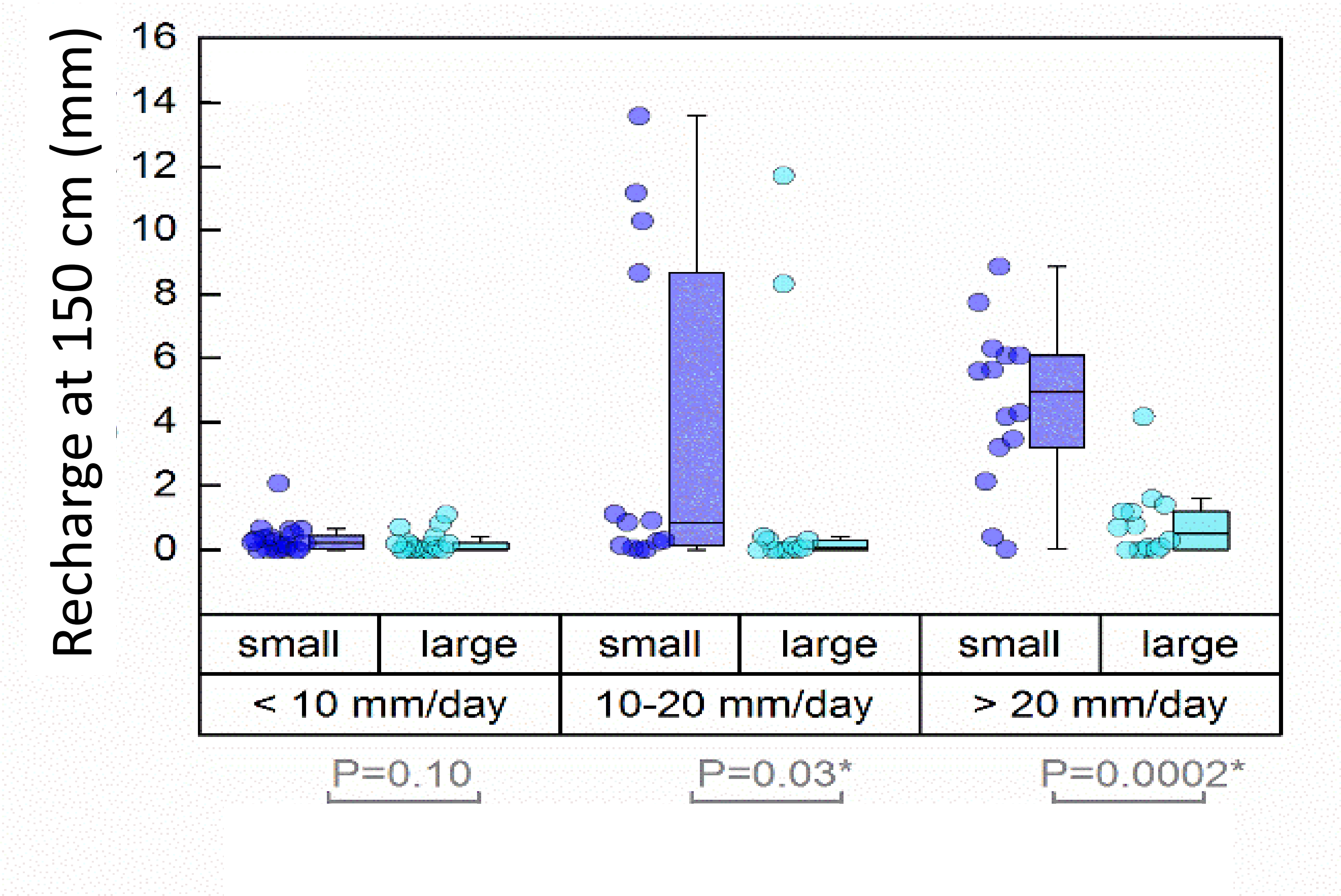
Vitellaria paradoxa (Shea tree) roots

Trees give water the VIP line

-Roots and macro fauna	→ More preferential flow
-Water by-pass surface soil	→ Escape soil evaporation
-Less surface run-off	→ More infiltration

Implications for climate change:

At high rain intensity recharge x13 higher in small gaps



OPPORTUNITY:
INCREASING GROUNDWATER THROUGH TREE MANAGEMENT

TREE SPATIAL DISTRIBUTION

TREE SPECIES

TREE SIZE & AGE

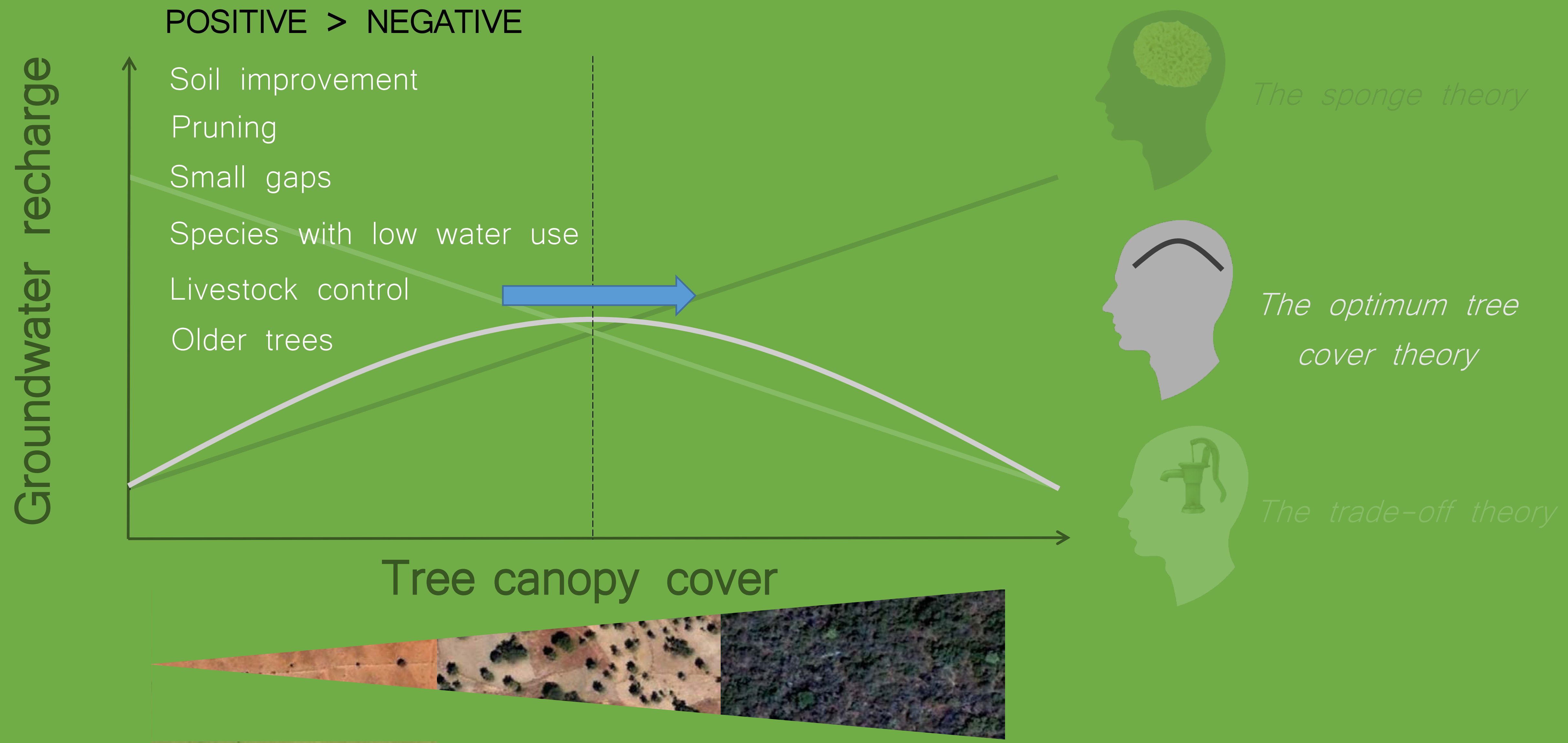
TREE PRUNING

LIVESTOCK CONTROL

TREE WATER USE & INTERCEPTION

SOIL HYDRAULIC PROPERTIES

THE OPTIMUM TREE COVER THEORY



THANK YOU!

Team: Aida Bargués-Tobella, Jules Bayala, Niles J. Hasselquist, Ulrik Ilstedt, Hjalmar Laudon, Anders Malmer, Gert Nyberg, Hugues Romeo Bazié, Josias Sanoui, Douglas Shiel, Elke Verbeeten

Sida

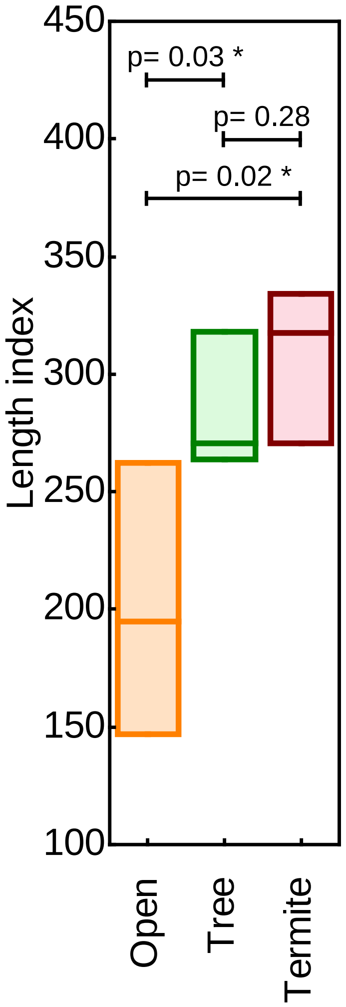
Vetenskapsrådet


From degraded land to agroforest
https://vimeo.com/channels/agendagotsch/videos

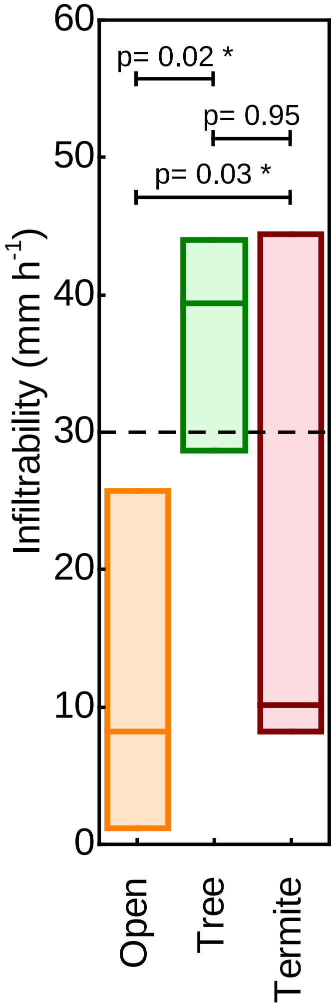
Soil infiltration capacity Burkina

TREES vs. OPEN

Degree of preferential flow

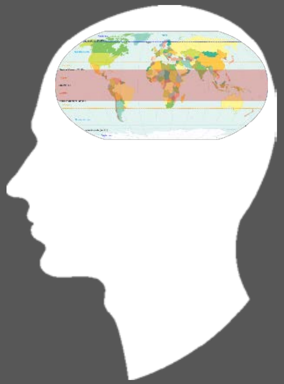


Infiltrability



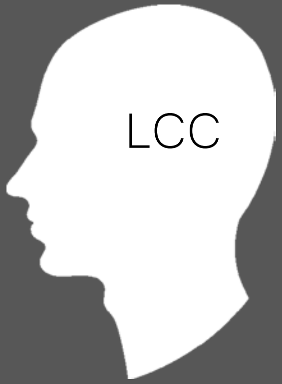
LIMITATIONS of the scientific evidence

Bias to humid temperate areas



No intermediate tree covers

No soil degradation

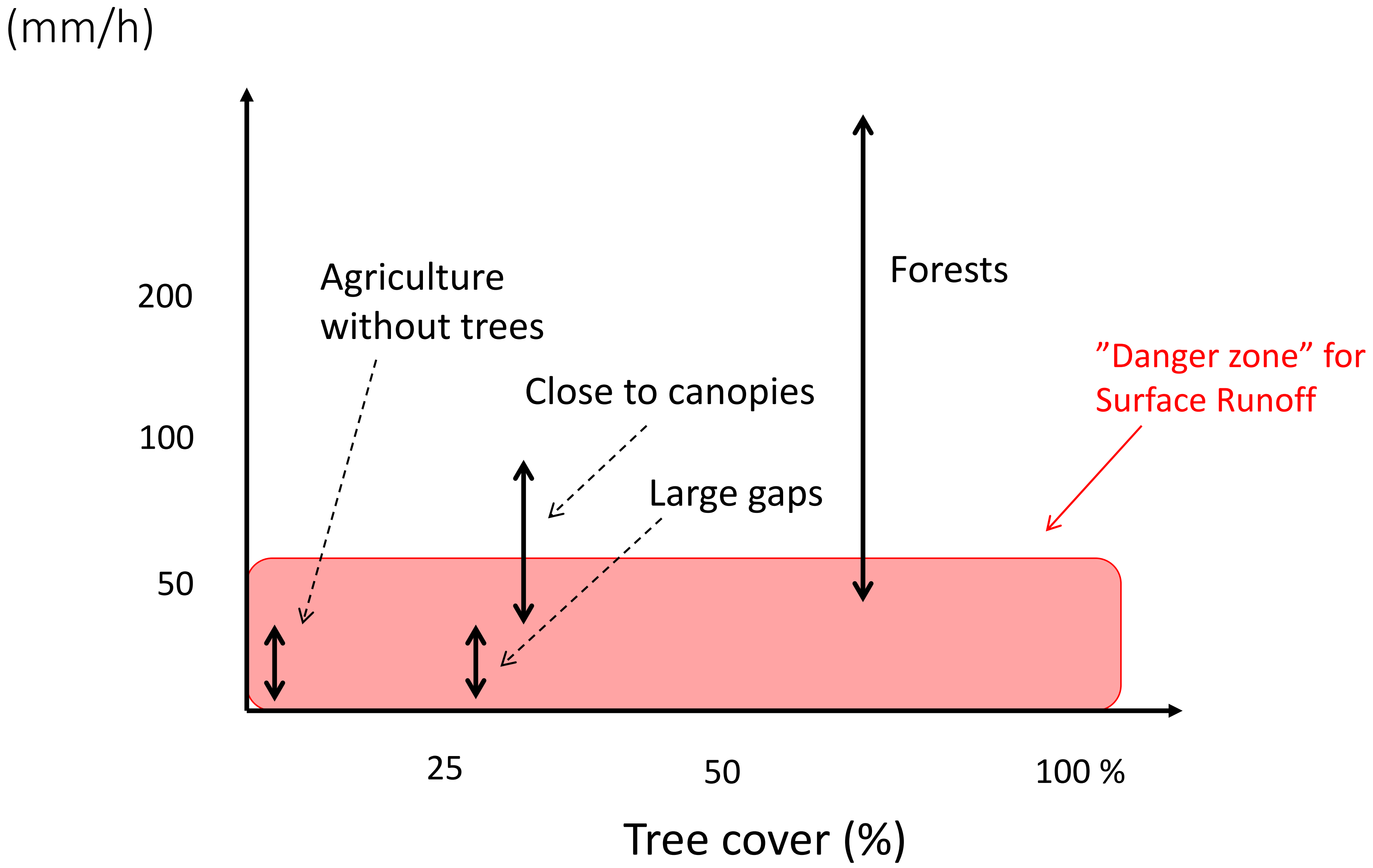


Few long term studies

Fast growing species

(e.g. Malmer et al 2008)

Infiltrability and tree cover (Alfi-/Ultisols)



SCIENTIFIC REPORTS

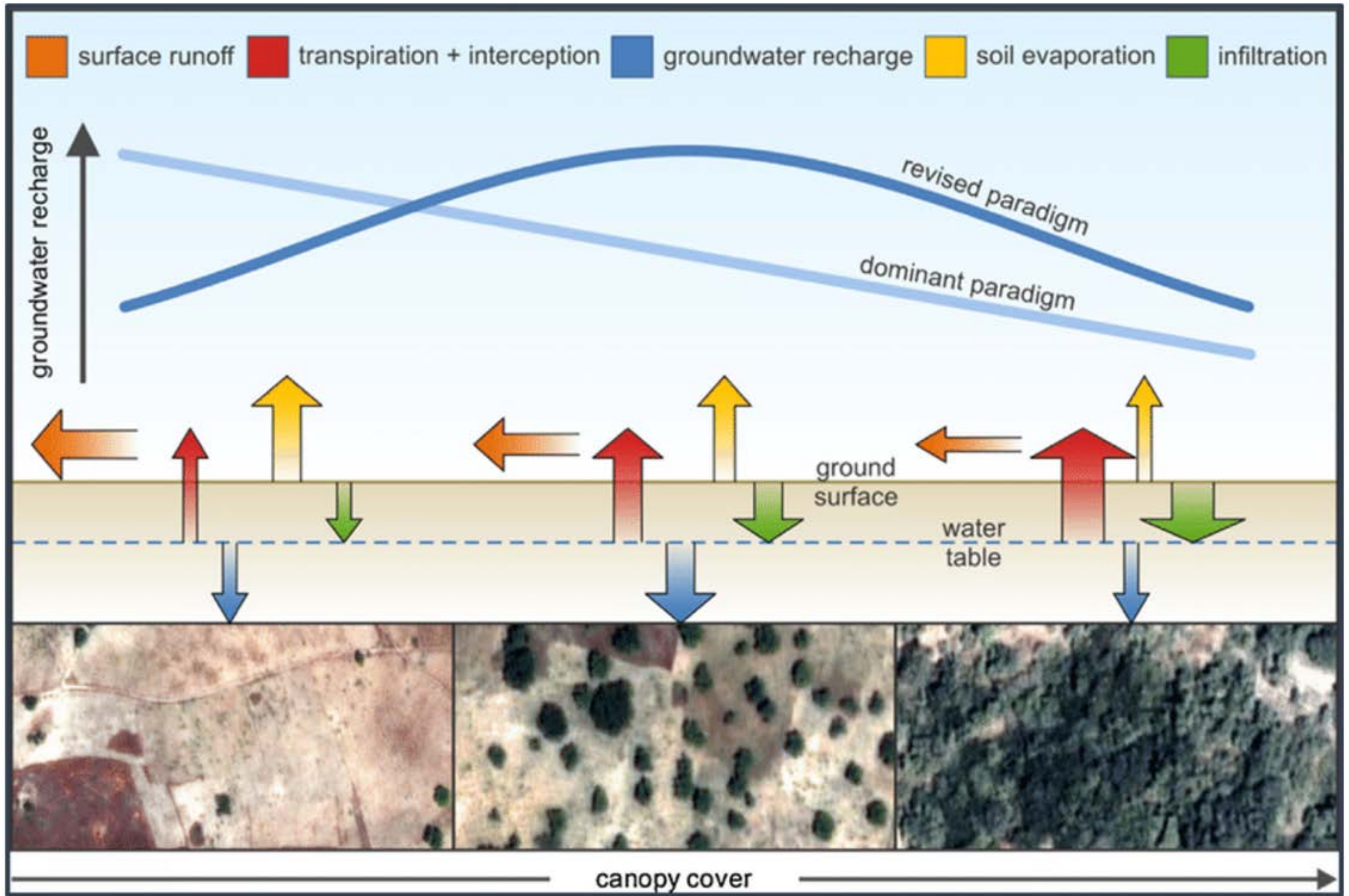
https://www.nature.com/articles/srep21930

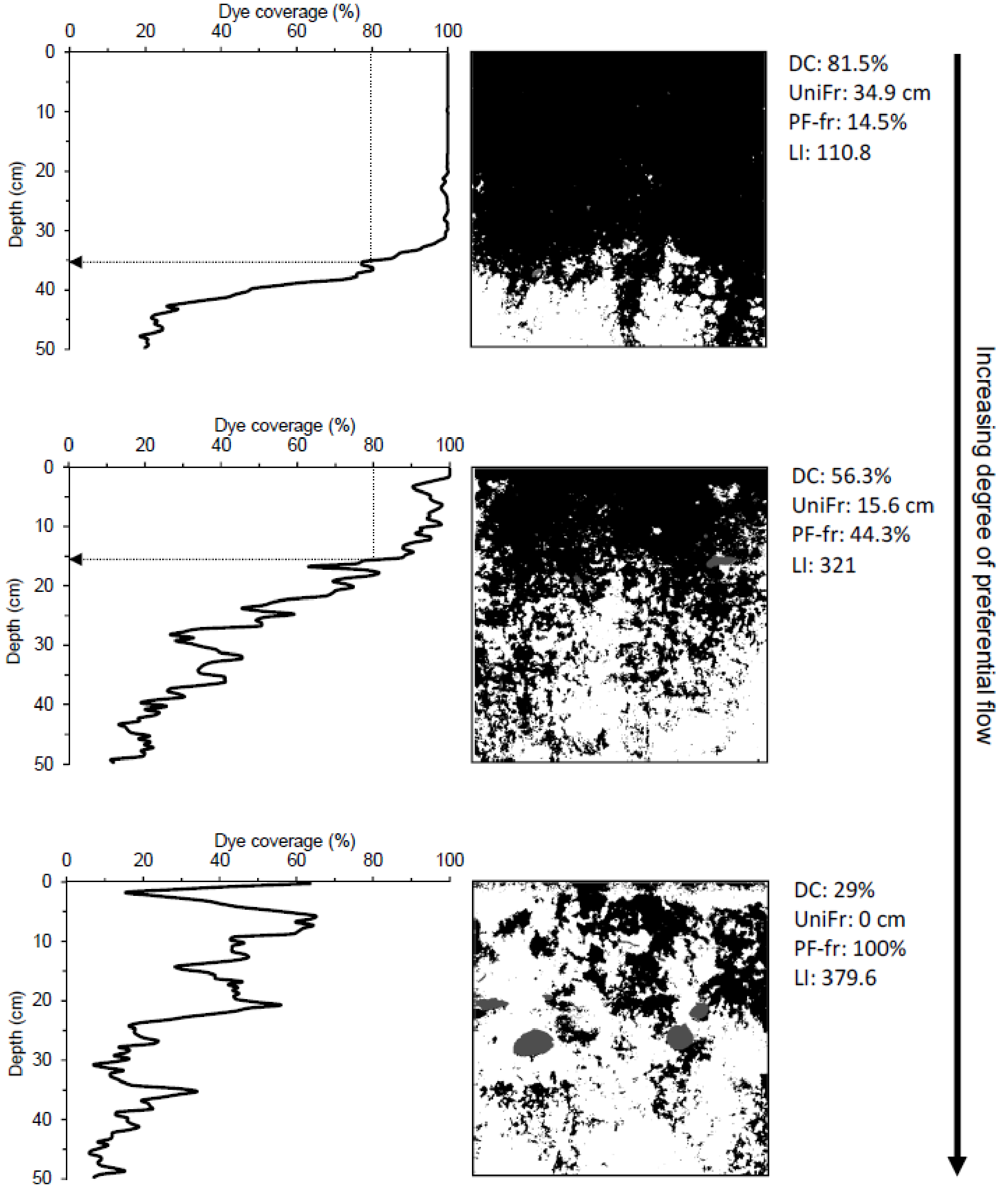
OPEN

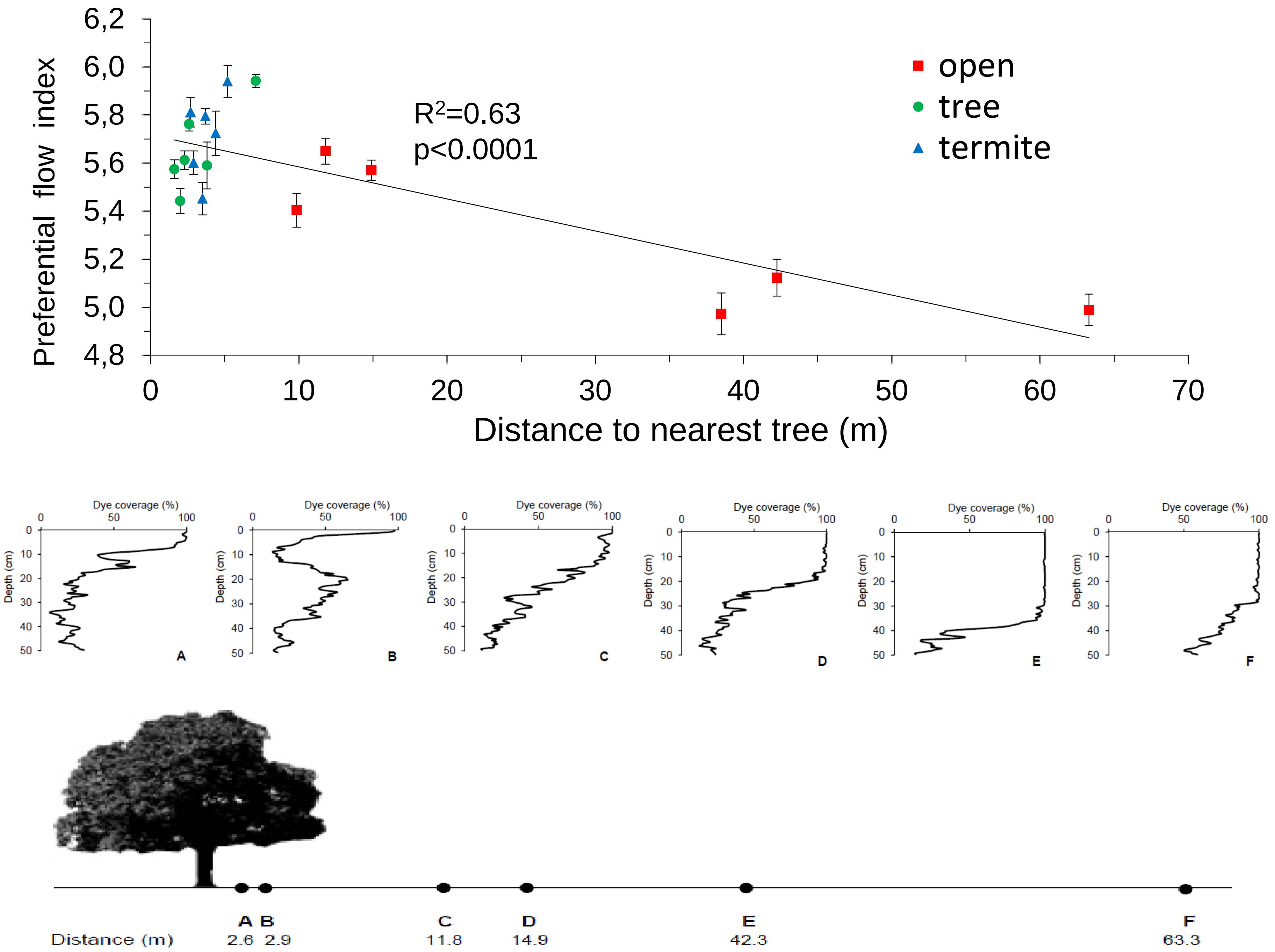
Intermediate tree cover can maximize groundwater recharge in the seasonally dry tropics

Received: 23 February 2015
Accepted: 03 February 2016

U. Ilstedt[1,*], A. Bargués Tobella[1,*], H. R. Bazié[2,3], J. Bayala[4], E. Verbeeten[5], G. Nyberg[1,11], J. Sanou[2], L. Benegas[1,6], D. Murdiyarso[7,8], H. Laudon[1], D. Sheil[8,9,10] & A. Malmer[1]

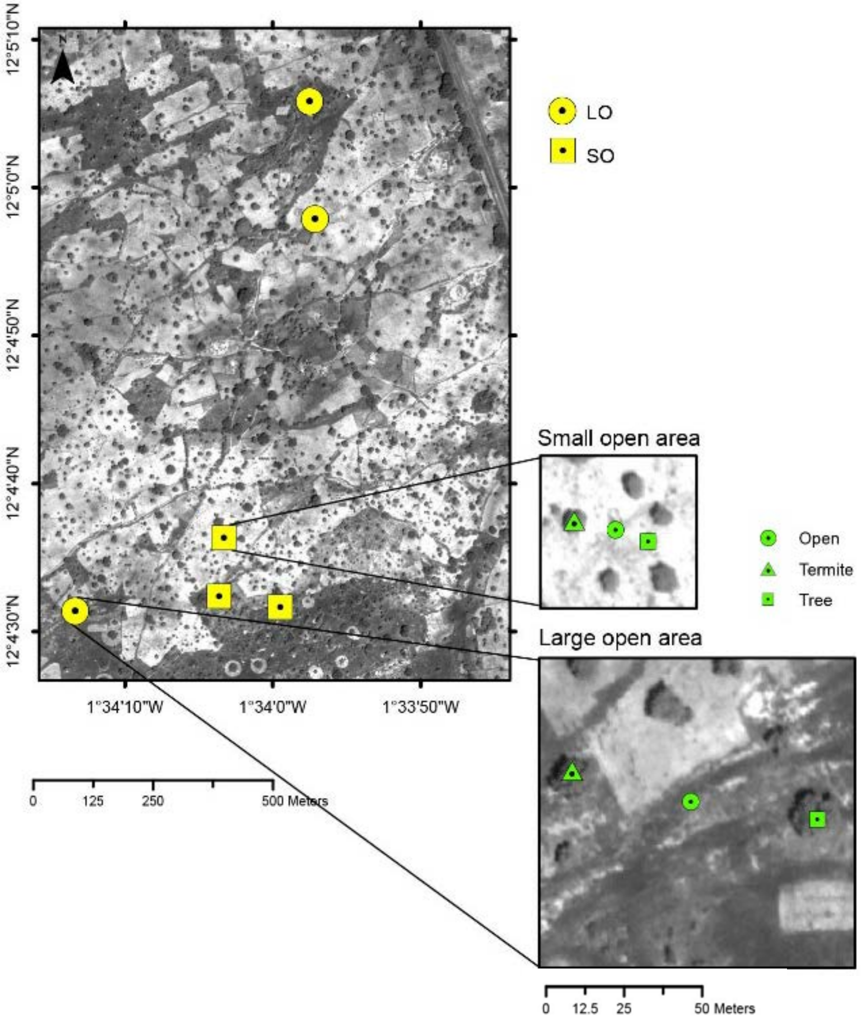



Dye coverage (%)
Depth (cm)
DC: 81.5%
UniFr: 34.9 cm
PF-fr: 14.5%
LI: 110.8
DC: 56.3%
UniFr: 15.6 cm
PF-fr: 44.3%
LI: 321
DC: 29%
UniFr: 0 cm
PF-fr: 100%
LI: 379.6
Increasing degree of preferential flow


Preferential flow index
Distance to nearest tree (m)
R2=0.63
p<0.0001
open
tree
termite
Dye coverage (%)
Depth (cm)
A
B
C
D
E
F
Distance (m)
2.6
2.9
11.8
14.9
42.3
63.3

PAPER II

- Soil infiltrability and degree of preferential flow
- Large vs. small open areas
- Tree – open – tree+termite

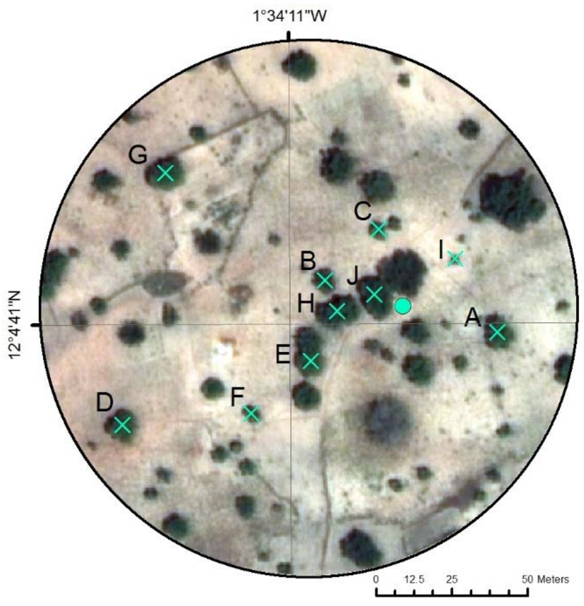


Soil infiltrability measurements: Drip-type Amsterdam rainfall simulator

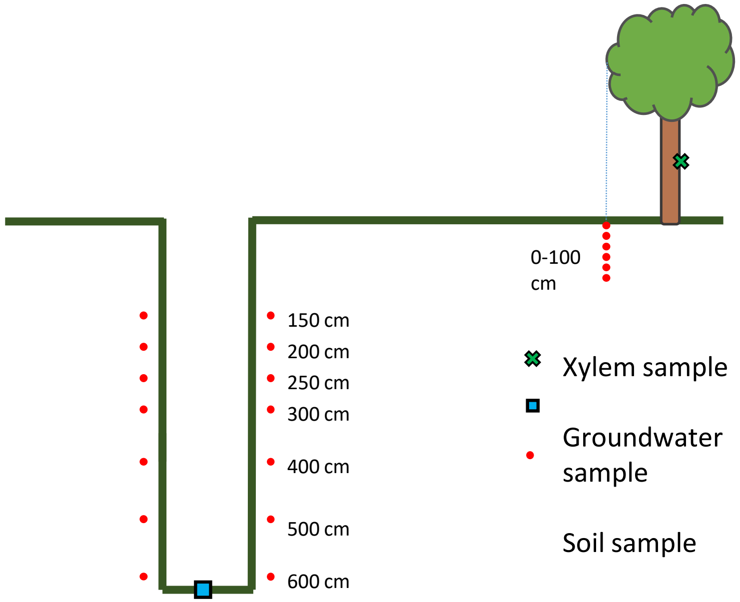
PAPER III

- Tree (*Vitellaria* paradoxa) water source partitioning experiment
- Water stable isotopes (^{18}O and D) of tree xylem, soil water and groundwater

Sampling: 10 trees and 1 well



Sampling: soil, xylem and groundwater

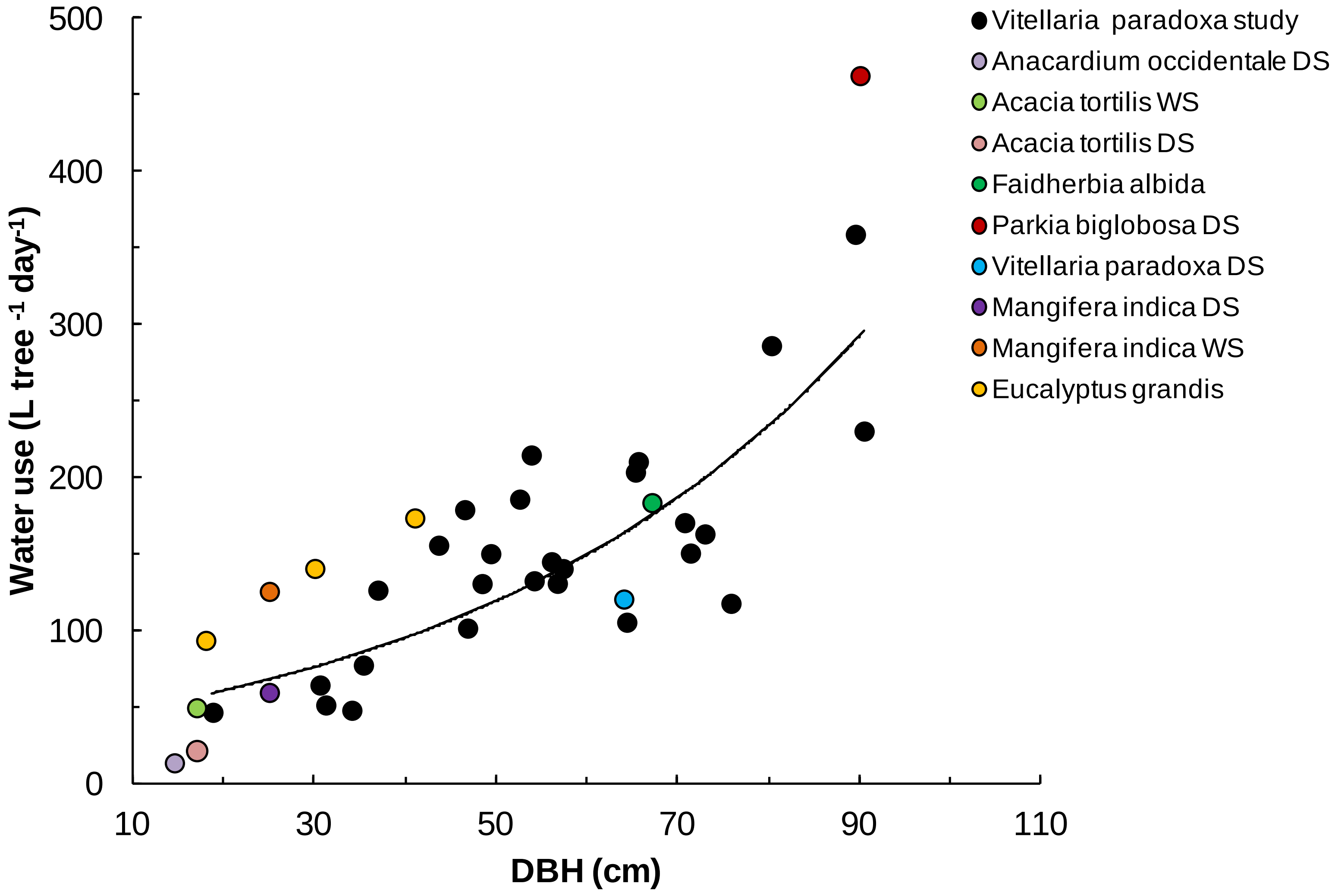


Extraction of wood cores

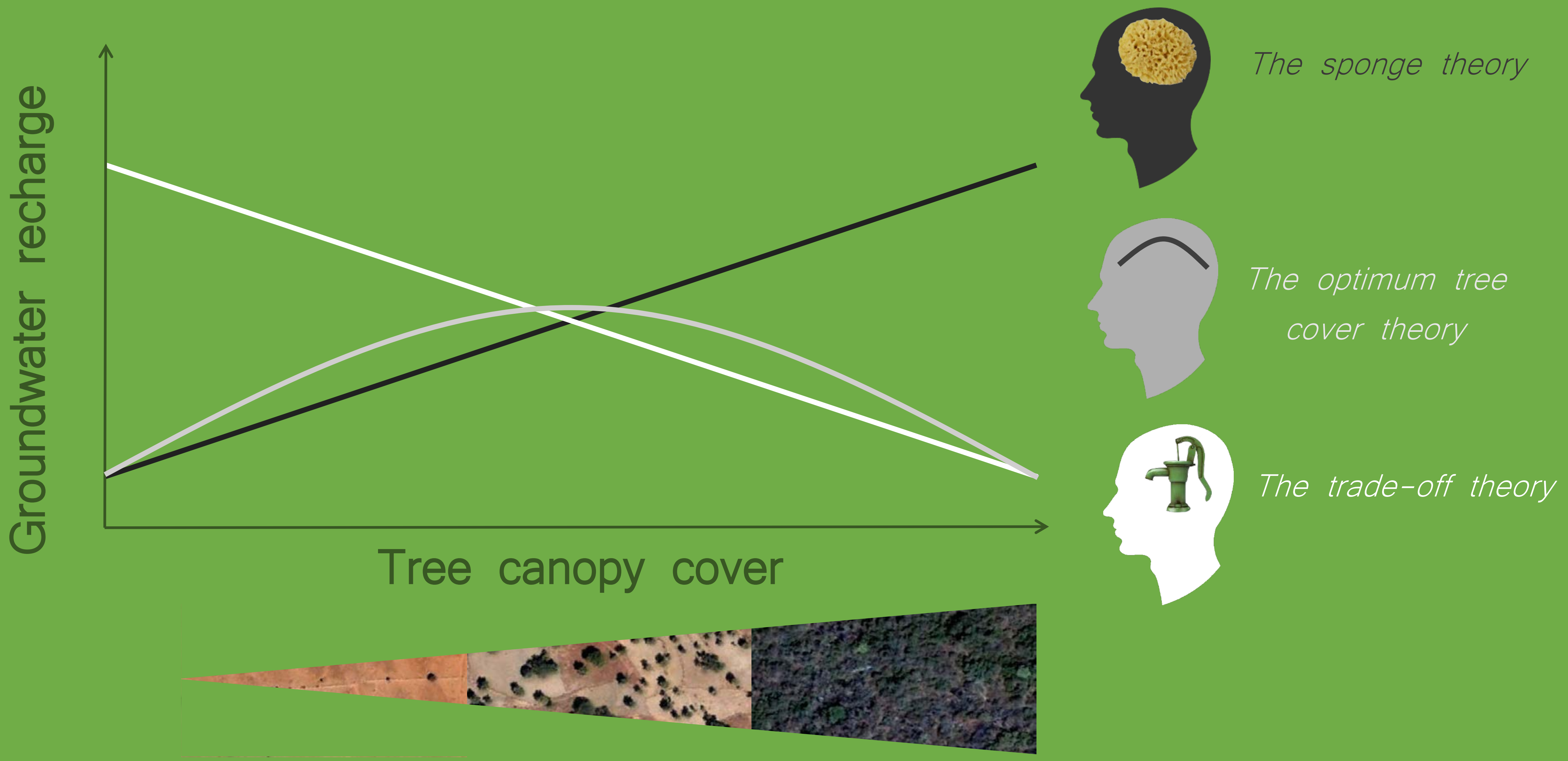
Well


Global dryland forests
1 327 million ha
> 10% tree-cover

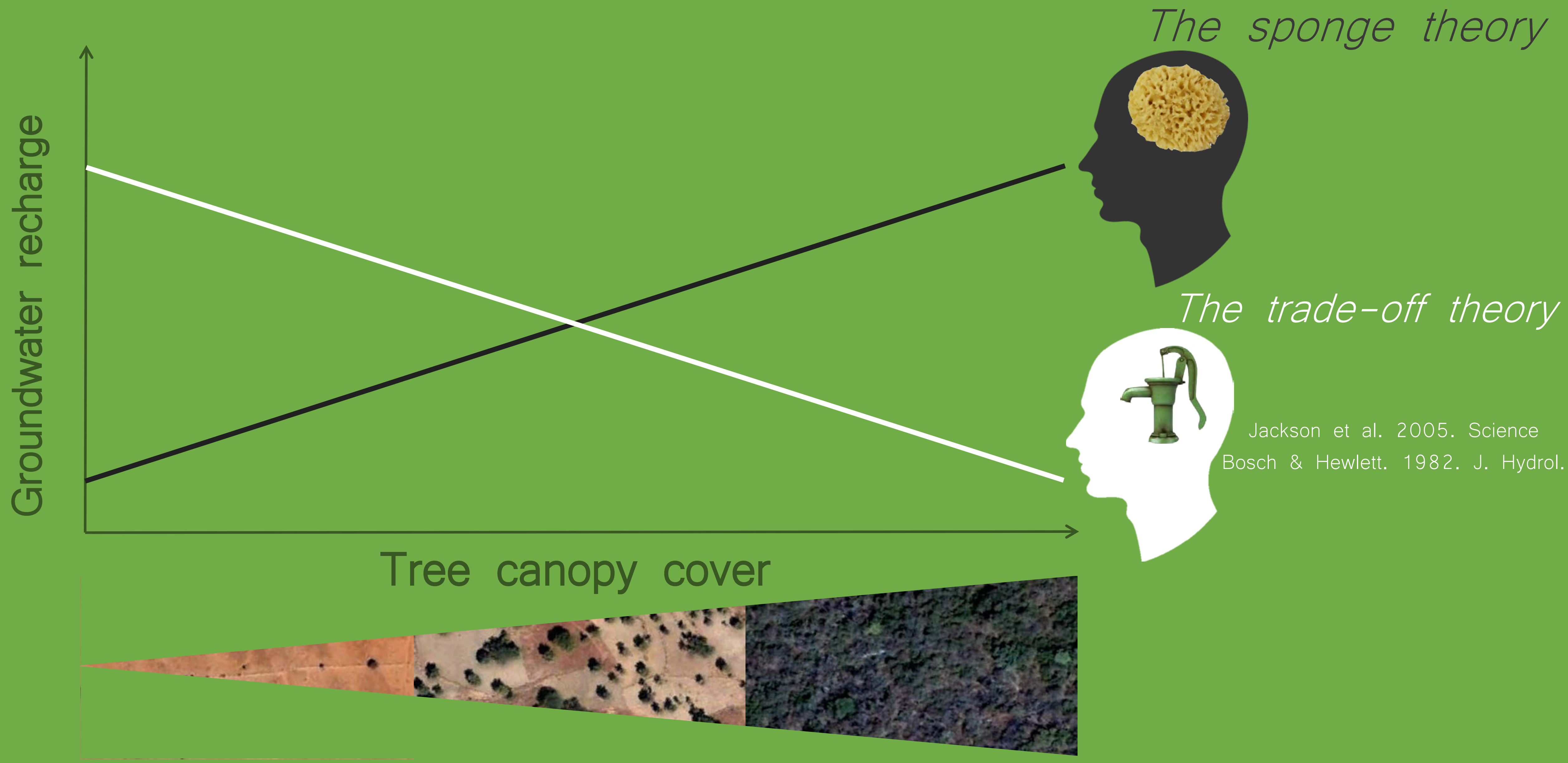
Tree transpiration semi-arid tropics



Conclusion: More trees can improve groundwater recharge

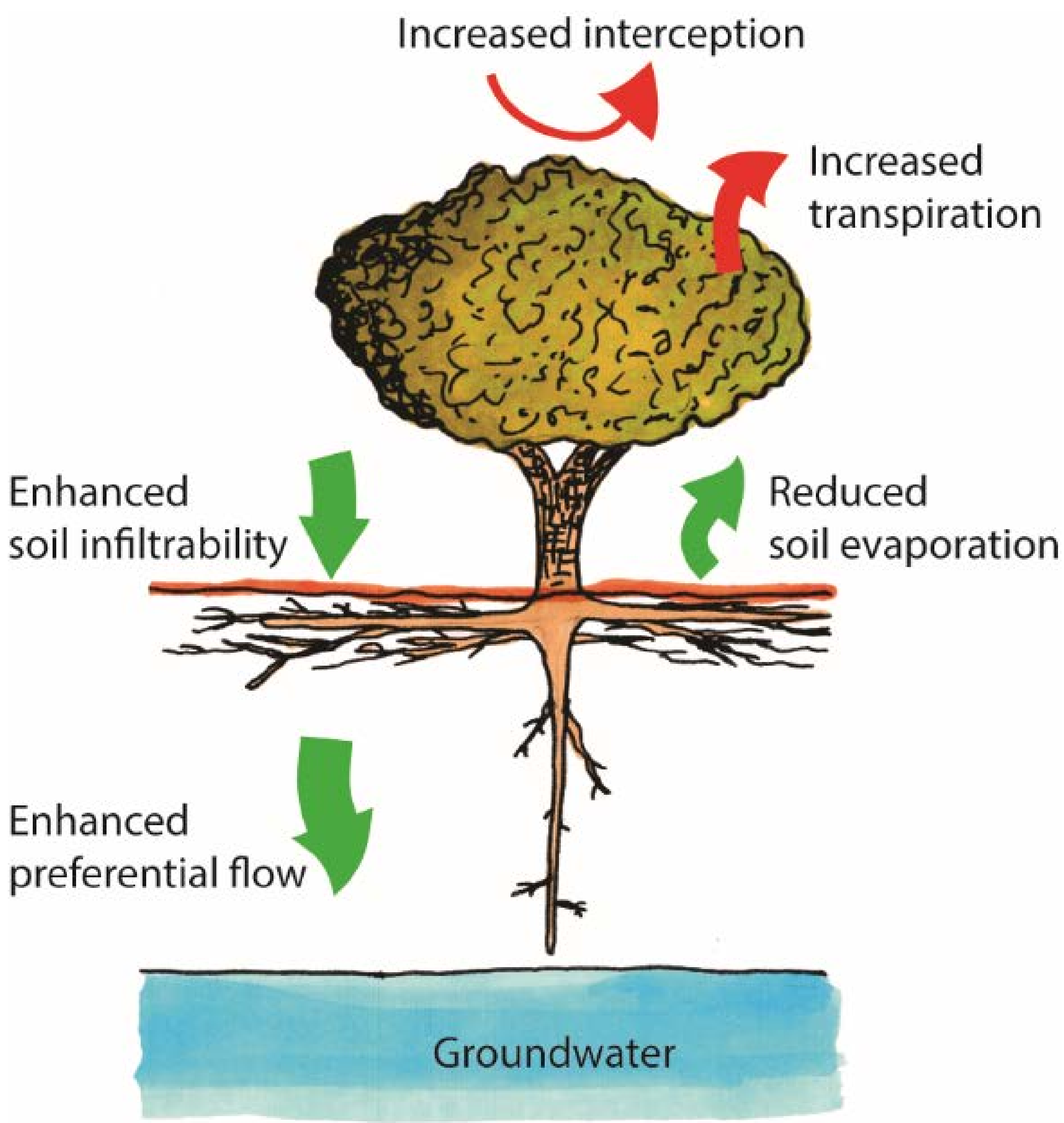


CONTRASTING VIEWS ON (DE)FORESTATION AND WATER YIELDS



Jackson et al. 2005. Science
Bosch & Hewlett. 1982. J. Hydrol.

Trees **can** have both POSITIVE and NEGATIVE effects on groundwater recharge



Forests, Water, Recycling Ratios and Hydrologic Space

DAVID ELLISON

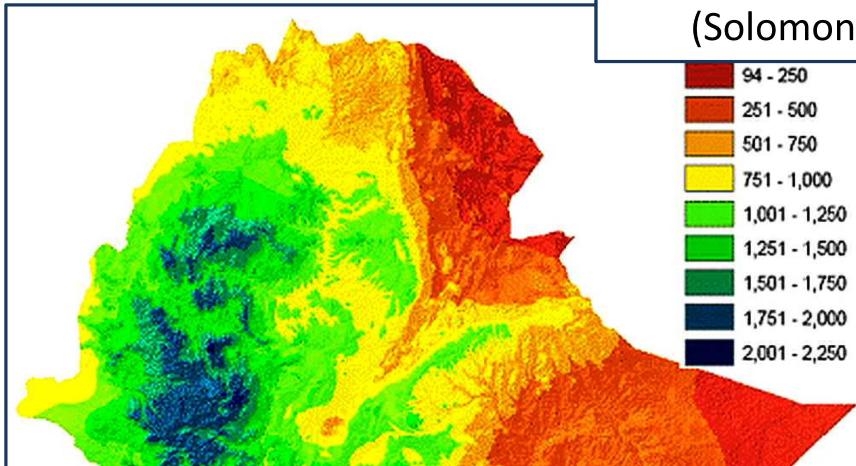
SIWI, STOCKHOLM
DEC. 8TH, 2017

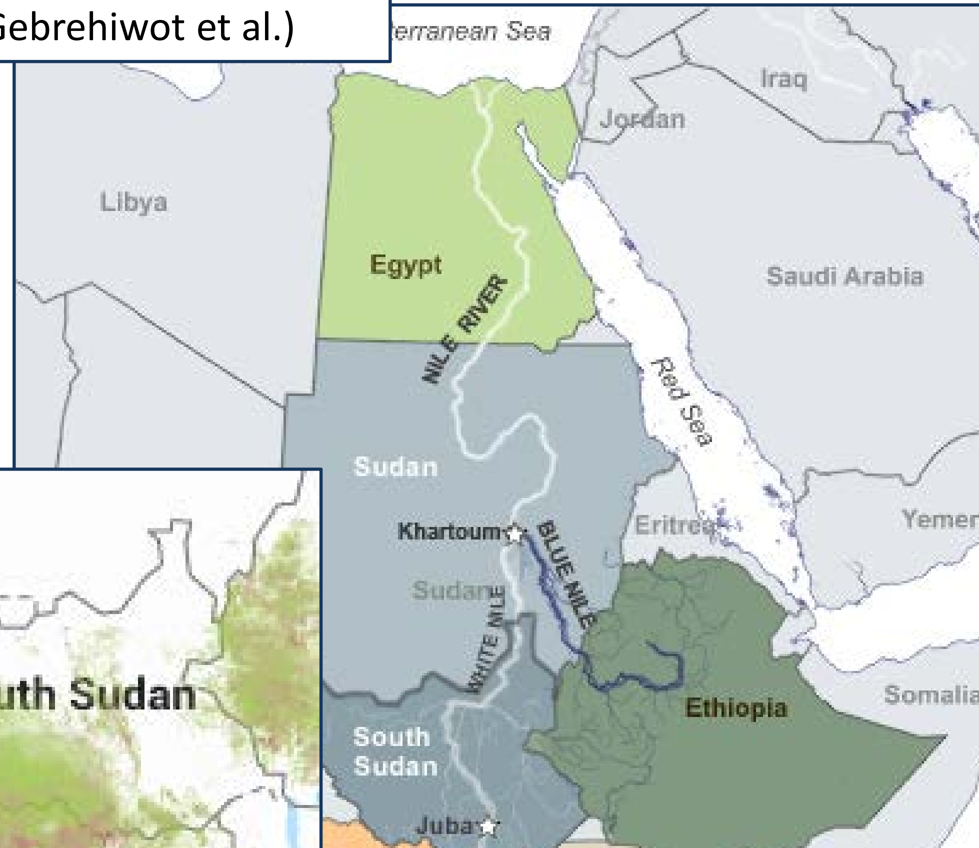
Co-Authors: Claudia Teutschbein, Xiaohua Wei, Martyn Futter,
Ype van der Velde, Thomas Grabs, Hjalmar Laudon, Kevin Bishop

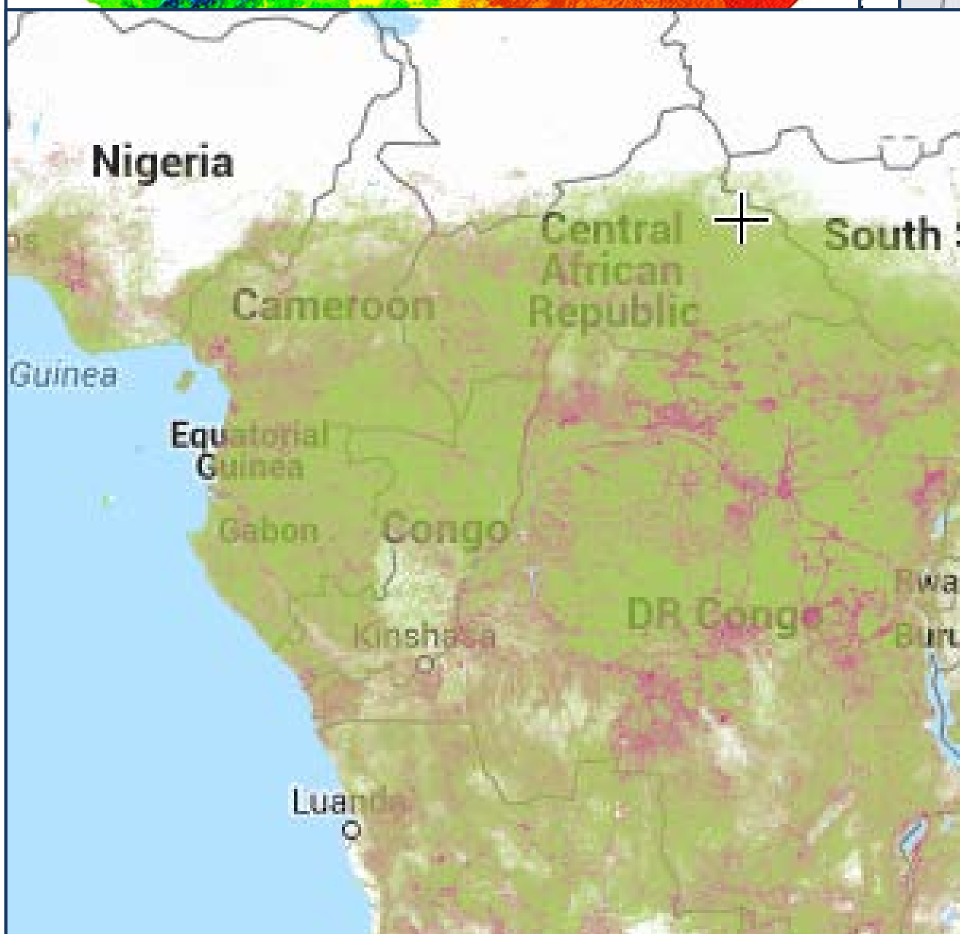
IUFRO GFEP Report on Forests and Water

GEC Publication

(Solomon Gebrehiwot et al.)

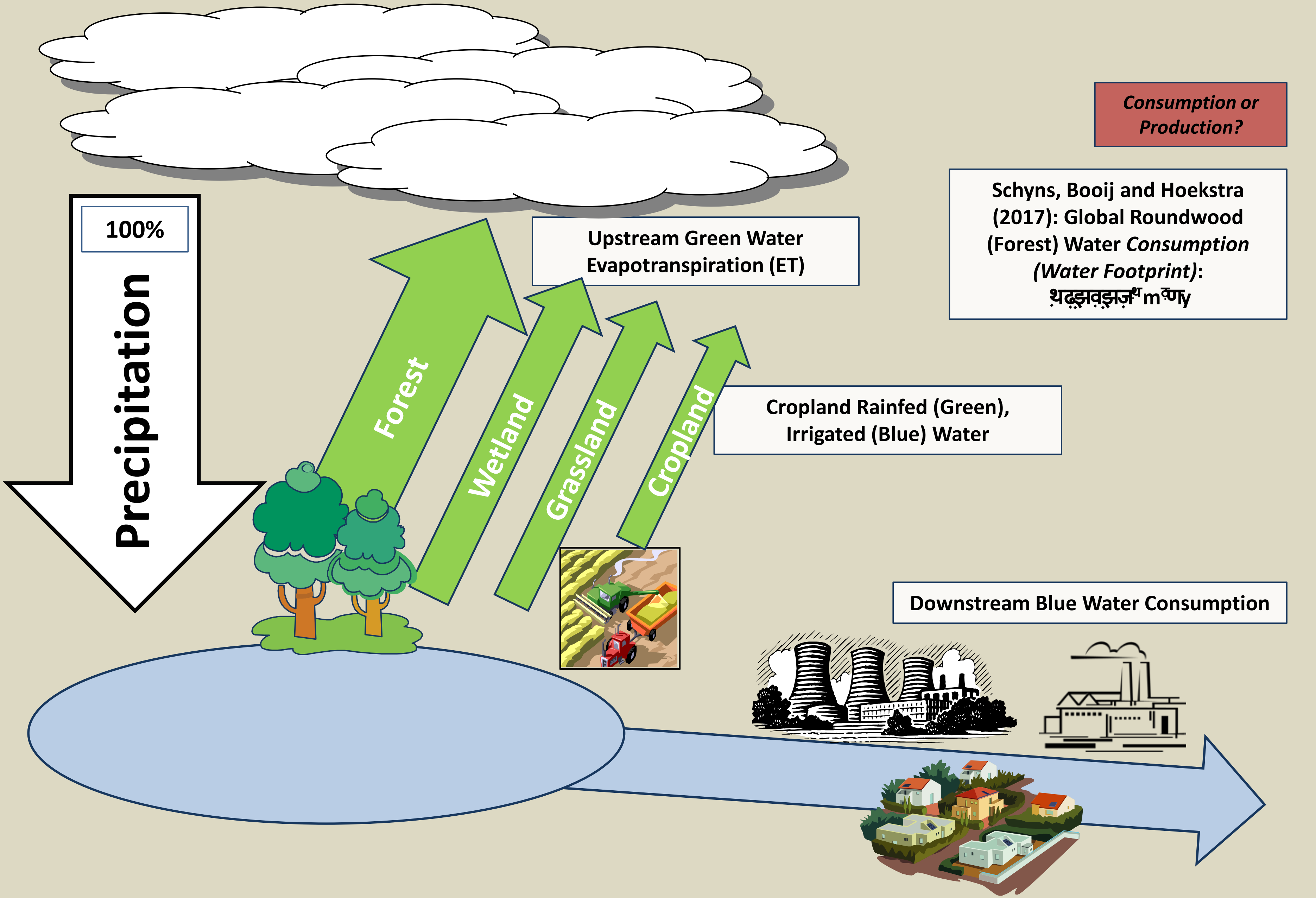






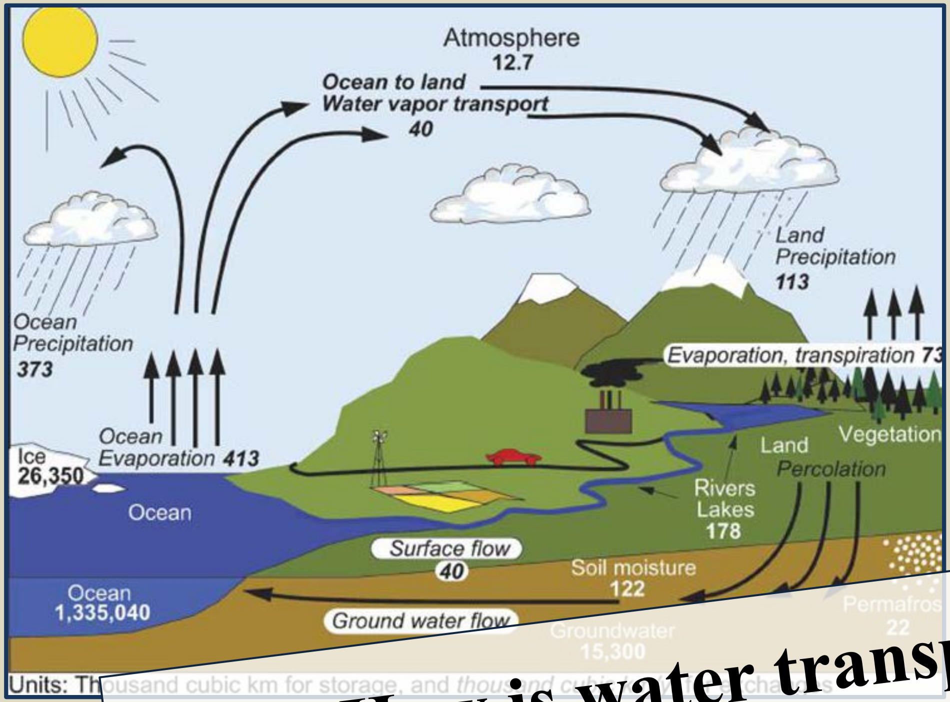
- Viste and Sorteberg (2013) suggest a large share of the atmospheric moisture that feeds the precipitation in the Blue Nile Basin originates from the West African Rainforests
- There is an increasing amount of deforestation in this area
- Some project as much as a 25% reduction in rainfall in the Ethiopian Highlands with continued deforestation

How C-Basin Centric are We?

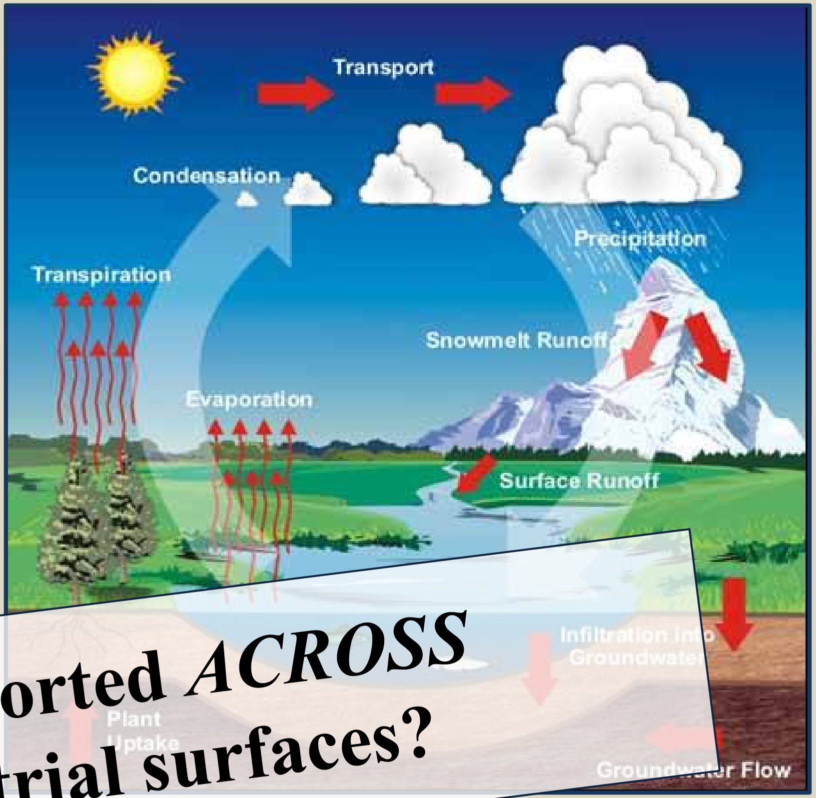


Concepts of the Hydrologic Cycle

Is this enough?

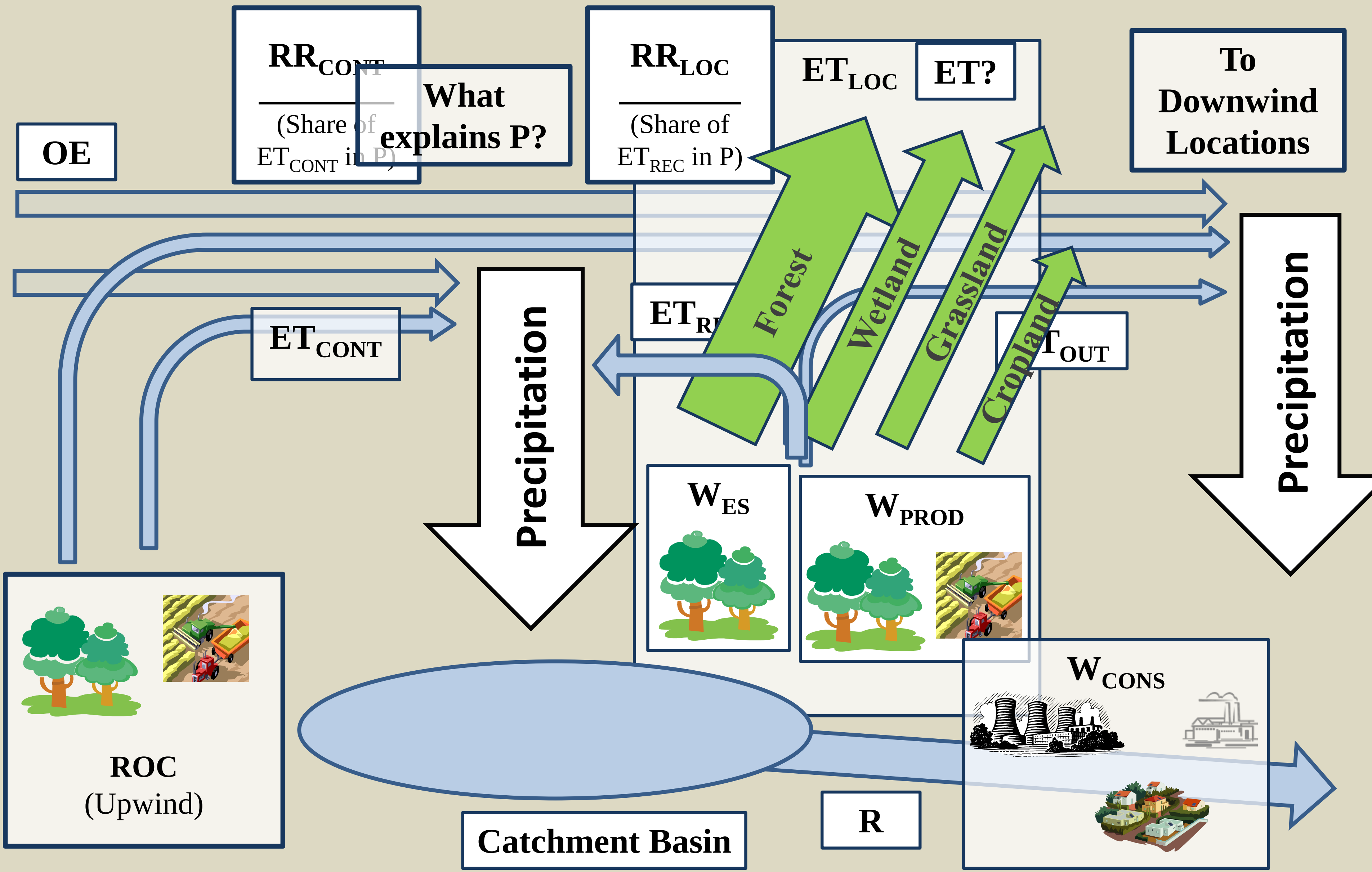


Is this enough?



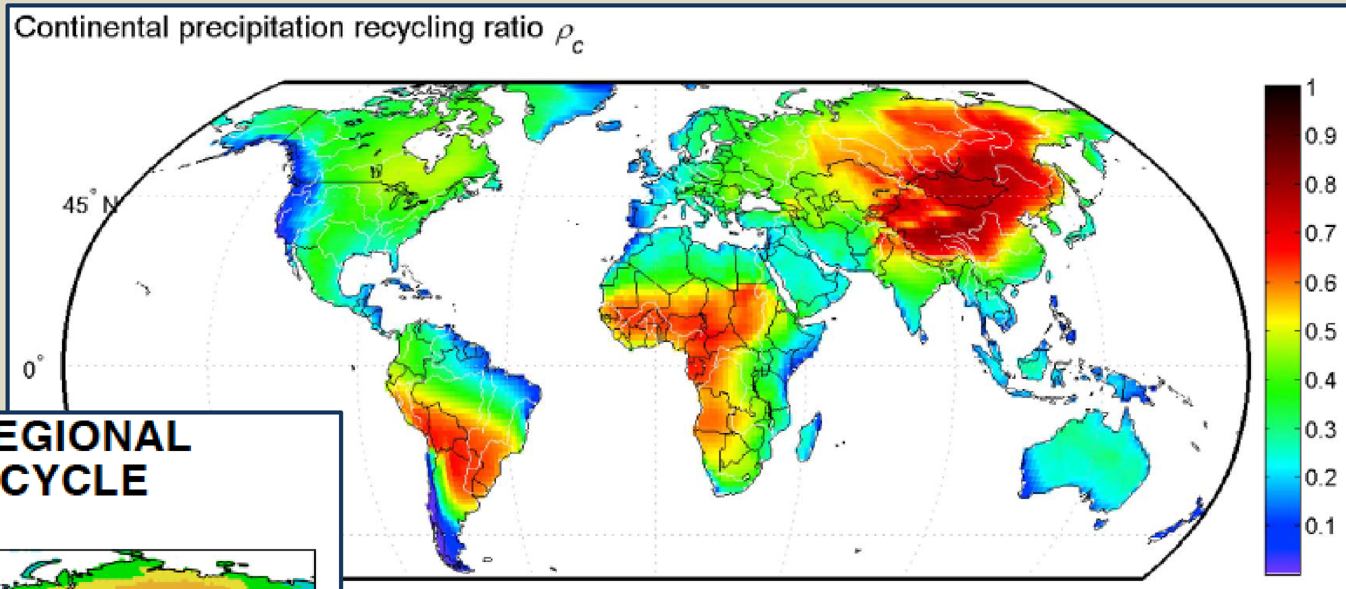
How is water transported *ACROSS* continental, terrestrial surfaces?

P-recycling and the Concept of Hydrologic Space



The Share of Terrestrial ET in Continental Rainfall

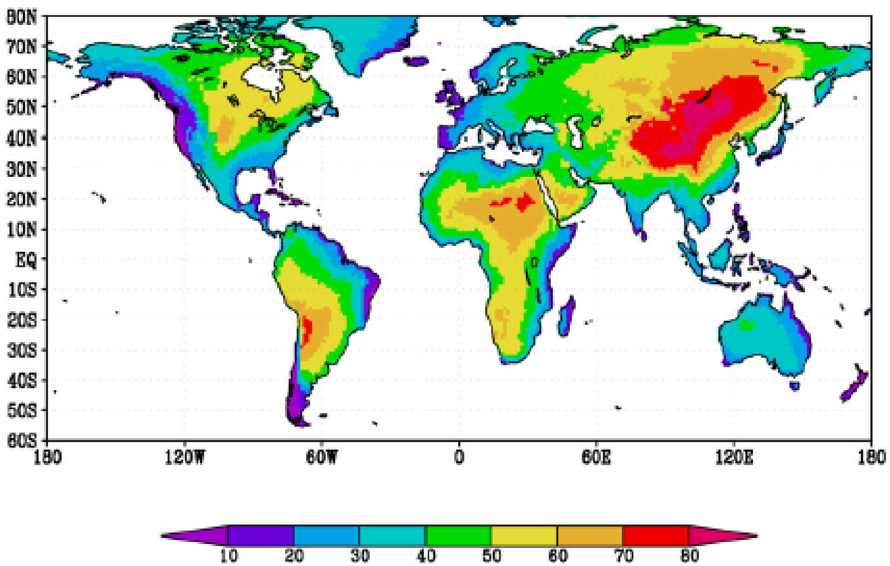
Continental evapotranspiration feeds an important share of terrestrial Precipitation



Average continental precipitation recycling ratio ρ_c (1999–2008).

(Van der Ent et al., 2010)

ANALYZING THE REGIONAL HYDROLOGICAL CYCLE



Percentage of precipitation over land that originated as continental evaporation, annually averaged over 15 years of simulation. (Bosilovich et al., 2002)

- On average, ***Forests*** provide ***more evapotranspiration (atmospheric moisture)*** for cross-continental transport than other land cover surfaces.
- Land ***further away from upwind coasts*** is typically ***MORE dependent*** than other lands.
- ***Land-atmosphere interactions*** matter for the distribution of water across terrestrial and continental surfaces.

More Forests = More Water?

PLOS | ONE

RESEARCH ARTICLE

Impacts of forest restoration on water yield: A systematic review

Solange Filoso[1]*, Maíra Ometto Bezerra[1,2,3], Katherine C. B. Weiss[2], Margaret A. Palmer[1,2,3]

1 Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, Solomons, Maryland, United States of America, 2 National Socio-Environmental Synthesis Center, University of Maryland, Annapolis, Maryland, United States of America, 3 Department of Entomology, University of Maryland, College Park, Maryland, United States of America

* filoso@umces.edu

Abstract

Background

Enhancing water provision services is a common target in forest restoration projects worldwide due to growing concerns over freshwater scarcity. However, whether or not forest cover expansion or restoration can improve water provision services is still unclear and highly disputed.

Purpose

The goal of this review is to provide a balanced and impartial assessment of the impacts of forest restoration and forest cover expansion on water yields as informed by the scientific literature. Potential sources of bias on the results of papers published are also examined.

Data sources

English, Spanish and Portuguese peer-review articles in Agricola, CAB Abstracts, ISI Web of Science, JSTOR, Google Scholar, and SciELO. Databases were searched through 2015.

Search terms

Intervention terms included forest restoration, regeneration/regrowth, forest second-growth, forestation/afforestation, and forestry. Target terms included water yield/quantity, streamflow, discharge, channel runoff, and annual flow.

Study selection and eligibility criteria

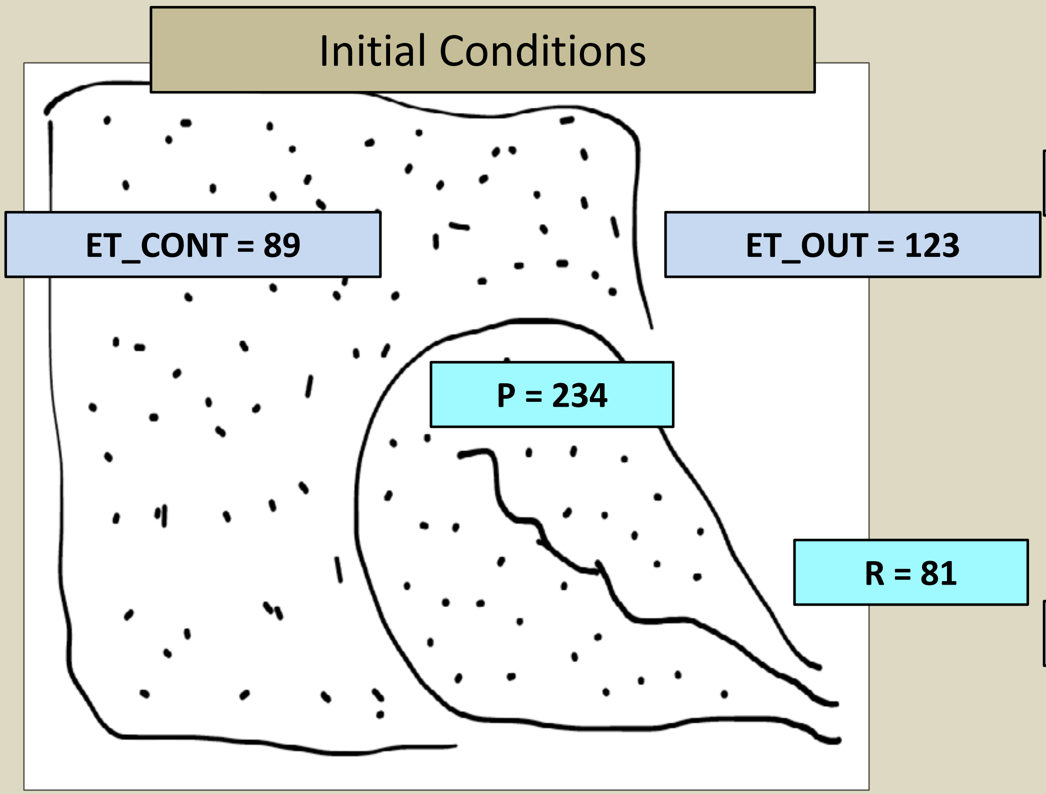
Articles were pre-selected based on key words in the title, abstract or text. Eligible articles

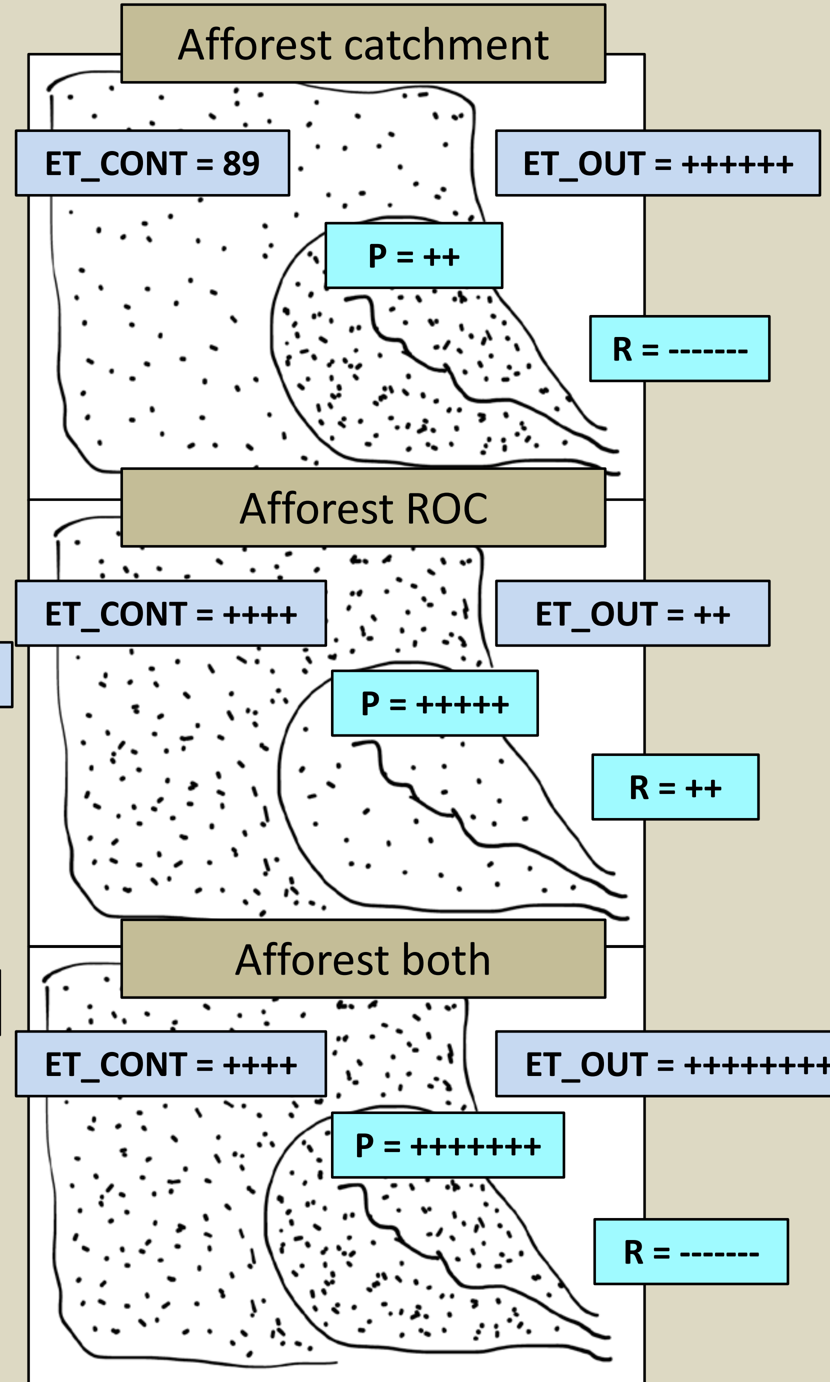
Current Objections to the Supply-side Model?

- This is a demand-side, c-basin centric approach and looks only at evidence based on larger catchment scales!
- Most of the studies that criticize the supply-side view of forest-water relationship tend to take this demand-side approach.
- Meta-Analysis, but does not consider the supply-side literature!
- There are NOT many published criticisms of the supply-side approach that address its merits.
- The Filoso et al findings are not surprising and are similar to what the supply-side literature would also predict.

Deforestation and Afforestation Scenarios

(50%-150% Change in ET Regime, JJA)





When are More Forests Potentially a Good Thing?

4-5 HydroSpace Management Scenarios in Chapter 6:

- Add forest and vegetation cover, for example, to upwind coasts where evapotranspiration is likely to primarily affect water that would otherwise flow into the ocean

- Add additional forest in locations where the water supply is relatively abundant. Not all locations are water stressed! (E.g. flood management, etc.)

- High altitude, montane and cloud forest regions are of particular importance. Situated at the “receiving end” of forest-water hydrologic cycle, with the potential to directly extract moisture out of the atmosphere, many montane and cloud forests contribute disproportionately to downstream runoff.

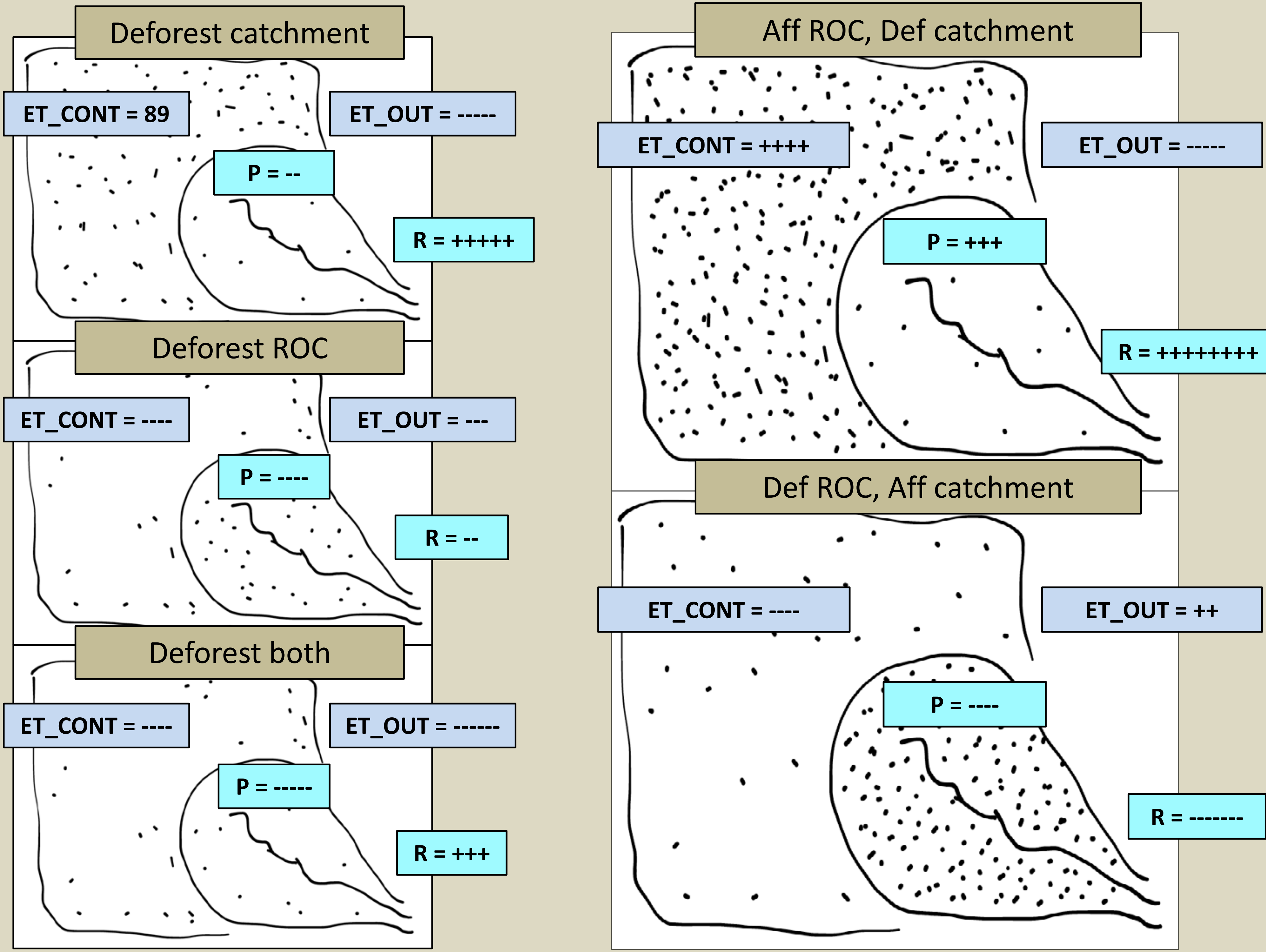
- Are there limits to the degree to which one can indiscriminately remove forest and tree cover from terrestrial surfaces? Ilstedt et al in fact argue there is some as yet not clearly defined level of “optimal tree density/cover” that maximizes groundwater recharge, while minimizing the potential for producing evapotranspiration.

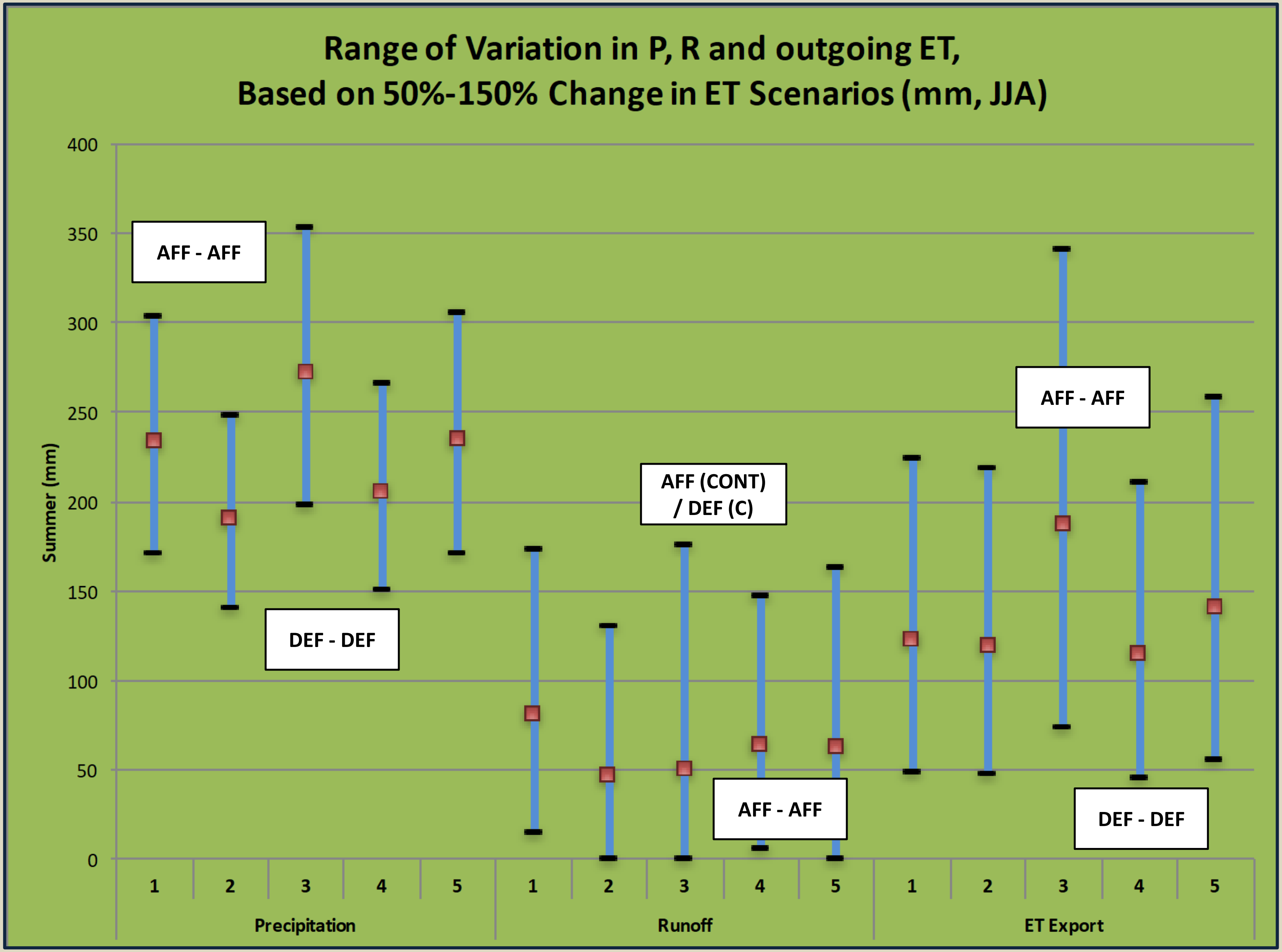
- Not all places in the world are experiencing increasing temperatures and declining rainfall. Some, e.g. the Boreal region, are experiencing rising rainfall. This ultimately makes trees and forests more attractive.

What are the Consequences of Removing too much Forest?

What are the downsides of forest removal and its extreme case, deforestation?

- There may be unfortunate consequences attached to too much removal of forests
- Given rising temperatures and declining rainfall, one forest management strategy suggests reducing forest density (to maintain downstream water supplies)
- This may have the consequence of reducing ET output from the basin. Iterated across up- and downwind space, this will have an increasingly powerful impact on rainfall in locations that are more dependent upon p-recycling. (*Deforestation*)
- At the end of this chain, some downwind communities could suffer significantly by losing an important share of their water.


Deforest catchment
ET_CONT = 89
ET_OUT = -----
P = --
R = +++++
Deforest ROC
ET_CONT = ----
ET_OUT = ---
P = ----
R = --
Deforest both
ET_CONT = ----
ET_OUT = ------
P = -----
R = +++
Aff ROC, Def catchment
ET_CONT = ++++
ET_OUT = -----
P = +++
R = ++++++++
Def ROC, Aff catchment
ET_CONT = ----
ET_OUT = ++
P = ----
R = -------


Range of Variation in P, R and outgoing ET,
Based on 50%-150% Change in ET Scenarios (mm, JJA)
Summer (mm)
400
350
300
250
200
150
100
50
0
AFF - AFF
DEF - DEF
AFF (CONT)
/ DEF (C)
AFF - AFF
AFF - AFF
DEF - DEF
1
2
3
4
5
1
2
3
4
5
1
2
3
4
5
Precipitation
Runoff
ET Export

Forests, Water and Hydrologic Space:

What do C-Basin Centric Models, like the Water Footprint Miss?

Land use practices have the effect of either ***appropriating*** or ***re-distributing*** water

- ➢ Reducing forests (and vegetation) can ***appropriate water*** for downstream uses
  - But ***downwind communities*** may pay the price of this appropriation
- ➢ Increasing forest (and vegetation) cover can ***redistribute water*** for downwind uses
  - But ***downstream communities*** may pay the price through reduced local water availability

The large scale ***spatial organization*** of ***land use practices*** and ***forest cover*** must be cautiously and carefully considered when addressing issues of forest cover, water availability and the hydrologic cycle.

Addressing factors that help explain ***atmospheric moisture availability*** is key to being able to explain water resource availability.

A focus ONLY on the c-basin is risky, especially in today's world of rising temperatures and declining rainfall.

- ➢ The Water Footprint model, as well as most catchment basin water management strategies, appear to fall into this trap.
- ➢ It is impossible to think of forest water use only as either ***consumption*** or ***production***, since it is clearly both

Forests, Water and Hydrologic Space: Some Conclusions

Forest cover plays an important role in the global hydrologic cycle.

Increasing forest cover can lead to ***increasing precipitation and runoff*** (and vice-versa).

The global impact of increasing forest cover does not rule out local ***demand-side impacts***. (Forests use water. ***Tradeoffs*** are possible, but so are ***win-wins***).

Forest-based ecosystems provide an ***ecosystem service*** that extends well beyond their ability to produce biomass, carbon sequestration, etc. This role must be nurtured. (ET, cooling, precipitation triggers, infiltration & groundwater recharge).

C-basin interconnectivity is the key to understanding how water is transported across terrestrial surfaces.

The ***supply of water*** available on continental/terrestrial surfaces varies depending on the impact of ***land use practices*** and the ***role of connectivity*** across hydrologic space.

The ***transboundary*** and perhaps the ***transregional*** concept of ***Hydrologic Space*** should be placed at the core of water and land use management planning strategies. Time for paradigm change.

SLU
Swedish University of Agricultural Sciences

Future Forests
Sustainable strategies under uncertainty and risk

Thanks for Listening!

Comments Welcome (EllisonDL@Gmail.com)

WeForest
Making Earth Cooler

IUFRO

A Simplified Estimation Model

Initial Values

GIVEN		CALCULATED	
P_0	234.70	$ET_{LOC,0}$=	171.80
R_0	62.90	$ET_{REC,0}$=	30.51
$\beta_{CONT,0}$	0.38	$ET_{OUT,0}$	141.29
$\beta_{LOC,0}$	0.13	$ET_{CONT,0}$	89.19
$\beta_{OE,0}$	0.49	$OE_{CONT,0}$	115.00
		$rc_0=R_0/P_0$	0.27
		ec_0	0.82

values that can be modified

Case 1: afforest/deforest catchment

λ_{LOC} (Reduction factor for ET_{LOC}):	50%
$ET_{LOC,1}$	**85.90**
$ET_{REC,1}$	15.26
$ET_{OUT,1}$	**70.64**
$ET_{CONT,1}$	89.19
$OE_{CONT,1}$	115.00
P_1	**219.44**
R_1	**133.54**
rc_1	0.61
ec_1	0.82

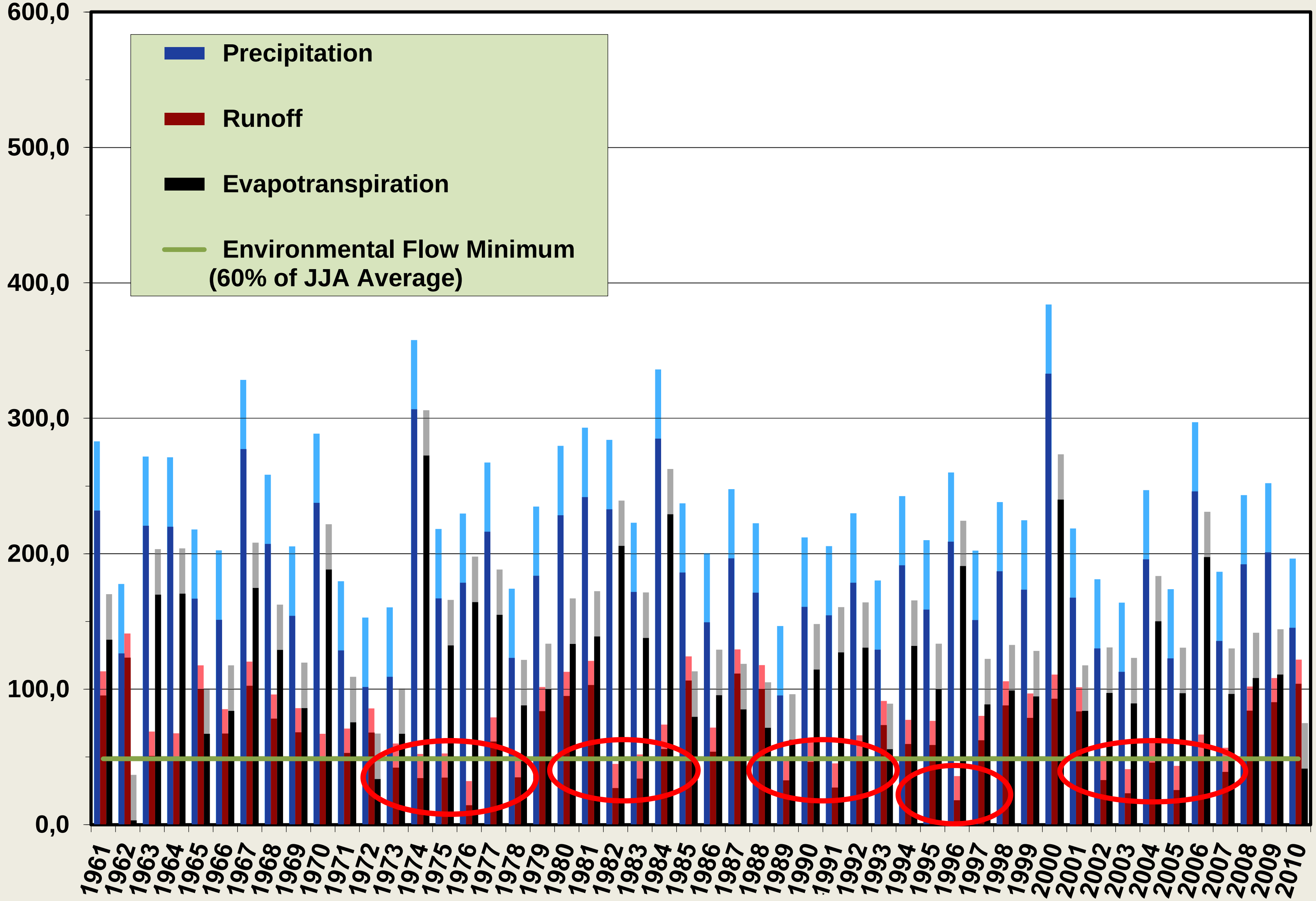
Case 2: afforest/deforest ROC

Reduction factor for ET_{CONT}:	50%
$ET_{CONT,1}$	44.59
$OE_{CONT,1}$	115.00
rc_1	0.27
ec_1	0.82
P_1	**183.44**
R_1	**49.16**
$ET_{LOC,1}$	**134.28**
$ET_{OUT,1}$	**110.43**
$ET_{REC,1}$	23.85

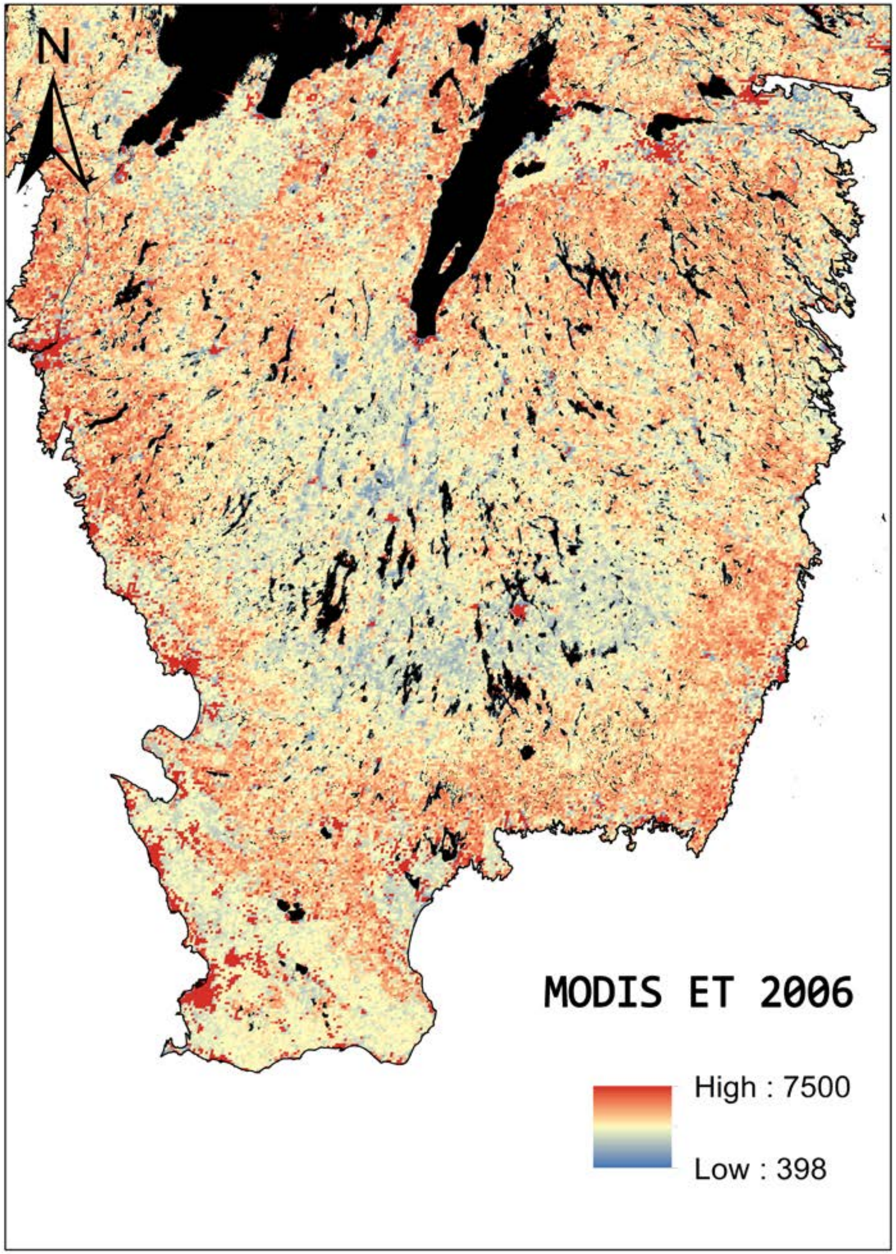
Case 3: afforest/deforest both

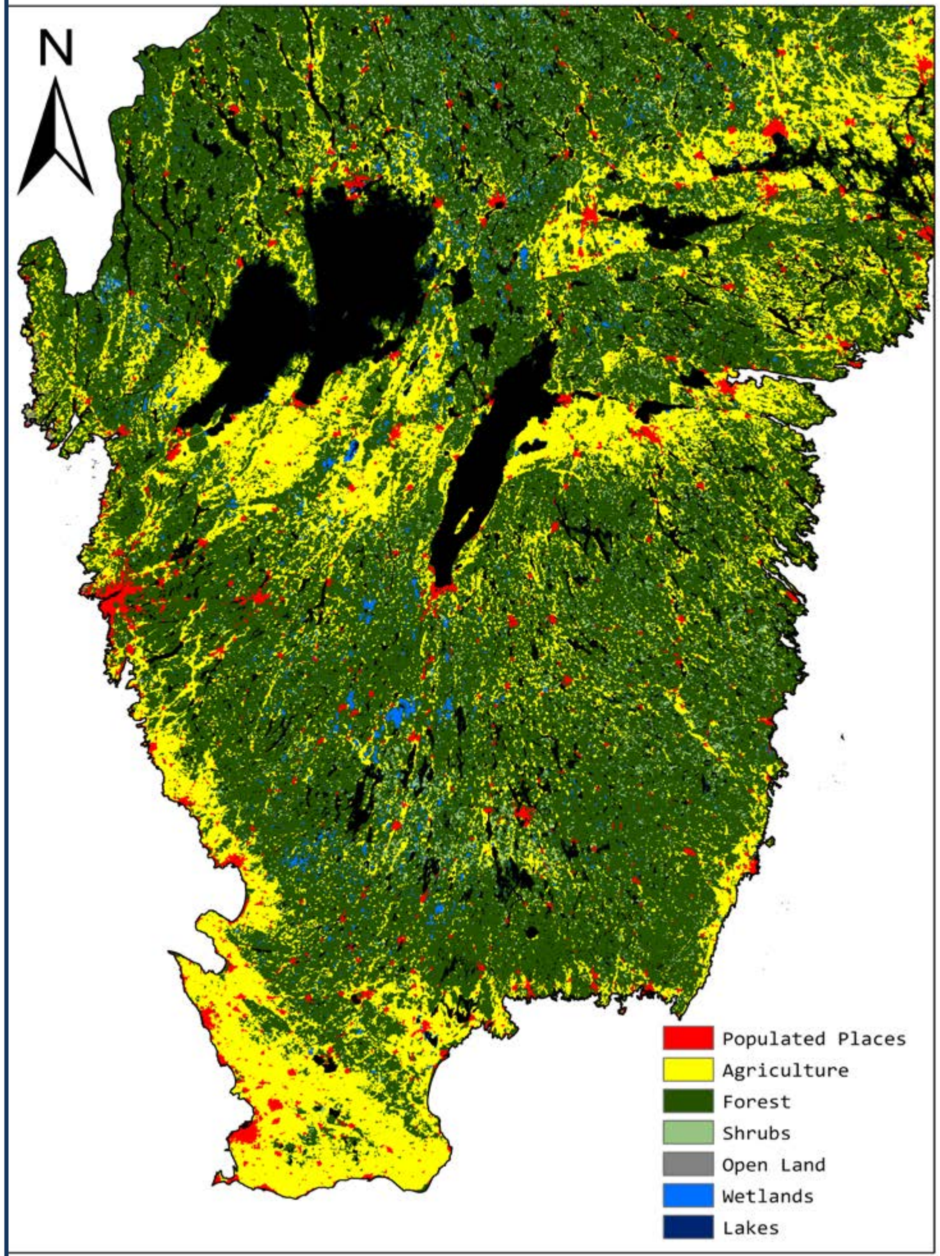
λ_{LOC} (Reduction factor for ET_{LOC}):	50%	Reduction factor for ET_{CONT}:	50%
$ET_{LOC,1}$	**85.90**	$ET_{CONT,1}$	44.59
$ET_{REC,1}$	15.26	$OE_{CONT,1}$	115.00
$ET_{OUT,1}$	**70.64**	rc_1	0.61
$ET_{CONT,1}$	89.19	ec_1	0.82
$OE_{CONT,1}$	115.00	**P_2**	**171.52**
P_1	**219.44**	**R_2**	**104.38**
R_1	**133.54**	**$ET_{LOC,2}$**	**67.14**
rc_1	0.61	**$ET_{OUT,2}$**	**55.22**
ec_1	0.82	$ET_{REC,2}$	11.92

Estimated Impact of Deforesting Continent (50% of Status Quo ET): Summertime P, R and ET (JJA/mm): Sample Catchment Basin

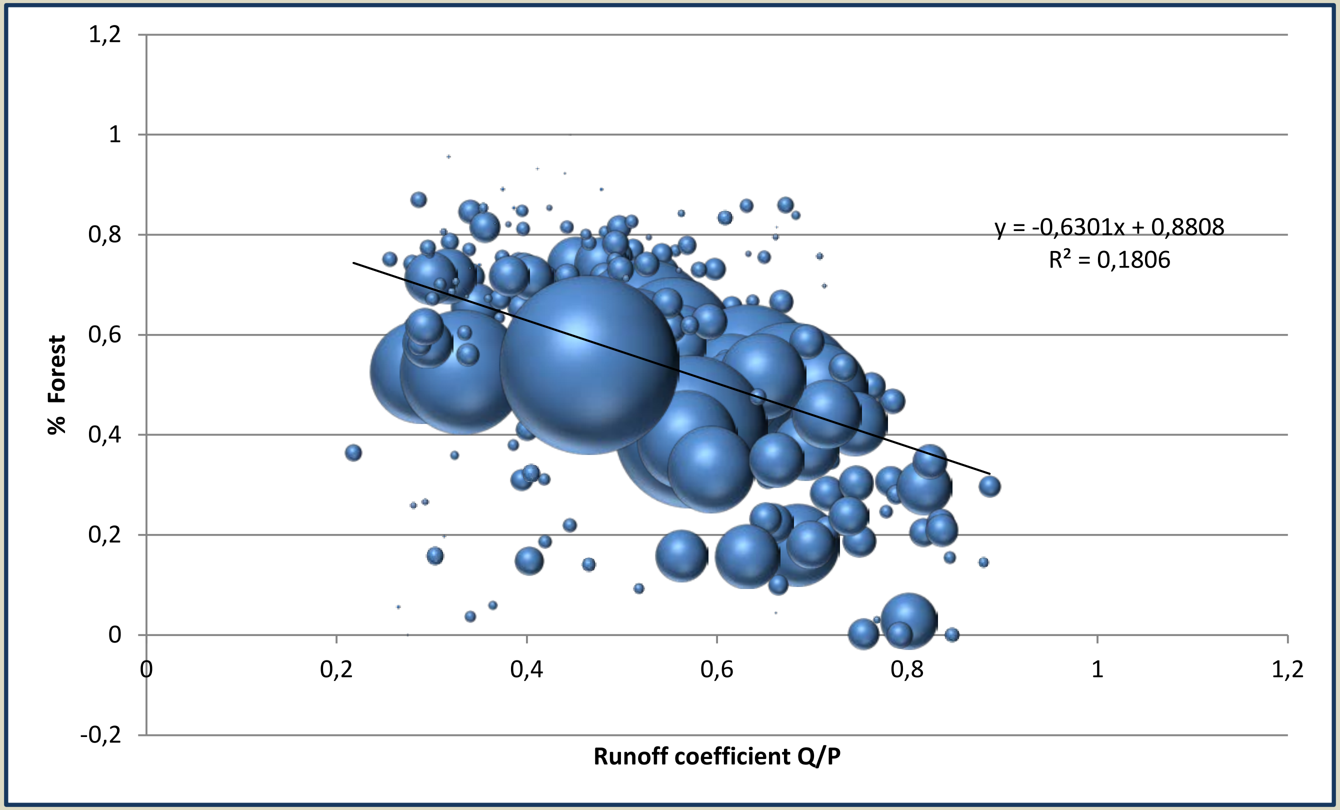


Forests vs. Agriculture and ET Production

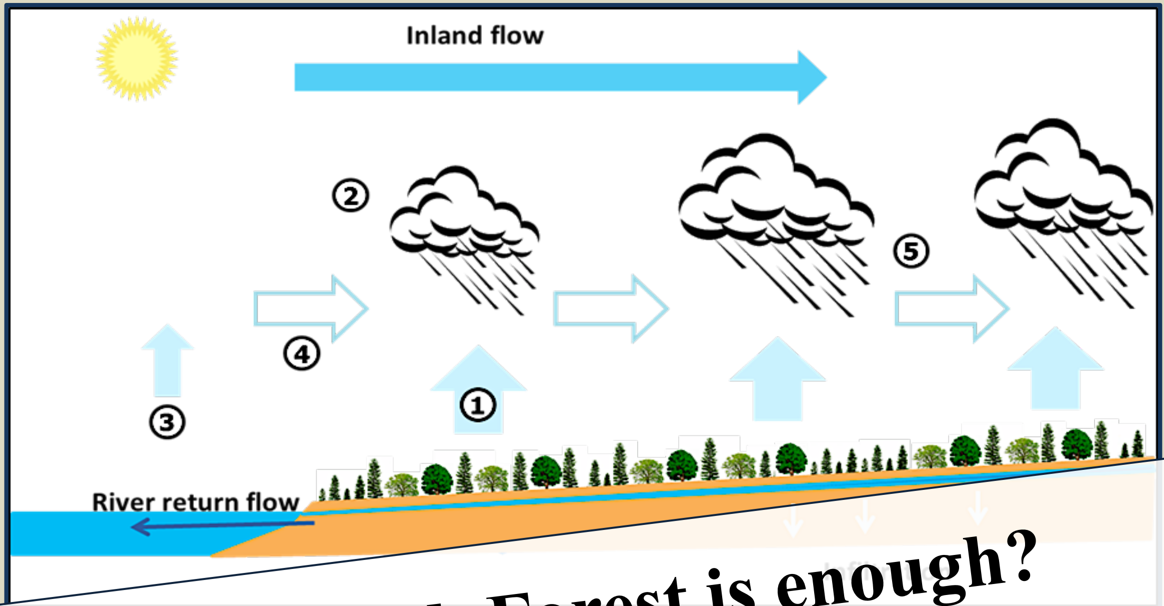




Impact of Variation in Forest Cover on Runoff Coefficient

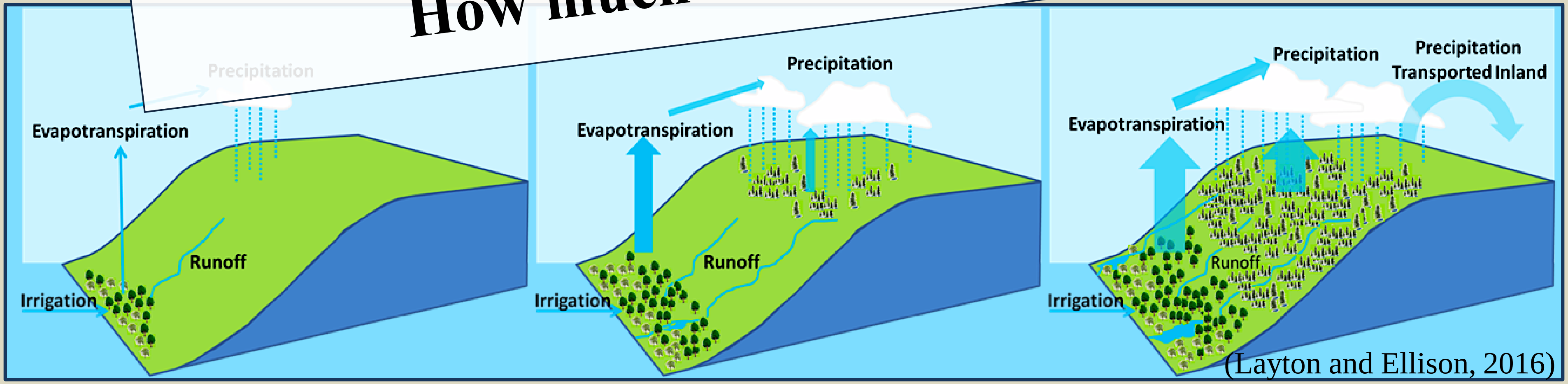


Biotic Pump and Continuous Forest Cover



(Makarieva et al, various)

How much Forest is enough?



(Layton and Ellison, 2016)

Virtuous cycle of increased Precipitation, ET and Forest Growth

Jan Lannér

Swedish Forest Agency

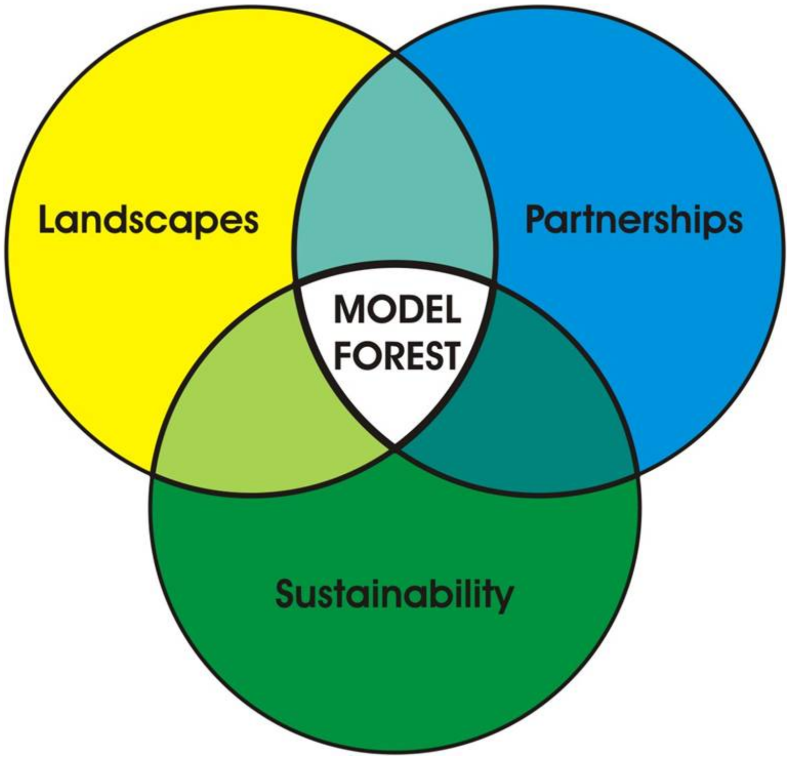
Coordinator Helge å Model Forest (HMF)

SKOGSSTYRELSEN

International Model Forest Network

Helge å Model Forest

The Concept Model Forest – Model landscapes for sustainable development



Helgeå Model Forest

International Model Forest Network

Background in Canada

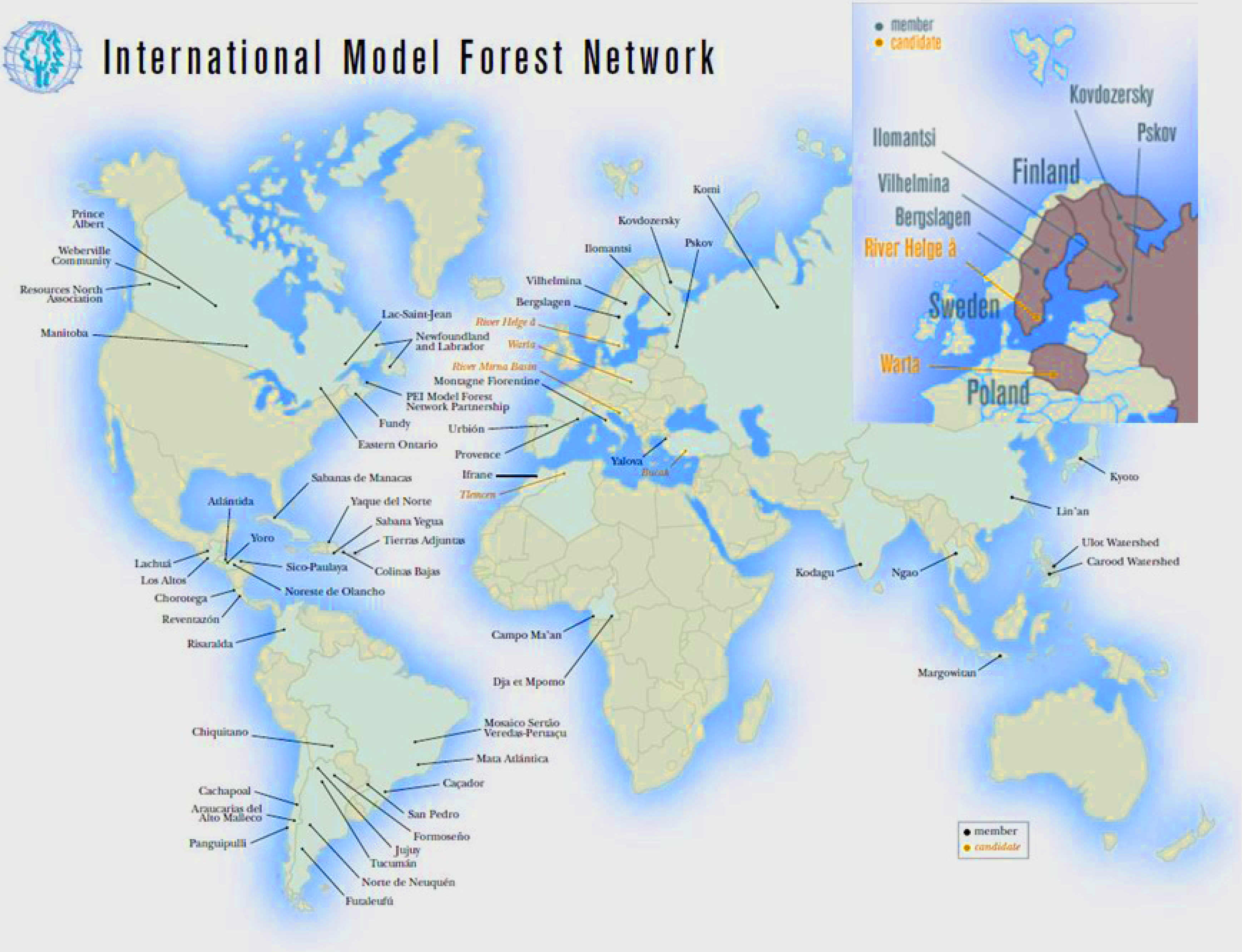
- Handle conflicts between logging companies and First Nations
- At the 1992 Earth Summit in Rio de Janeiro, the Prime Minister of Canada made a commitment to extend the concept of Model Forests internationally.

- Today about 60 MF distributed on four continents
- In Sweden three MF members of IMFN

Helgeå Model Forest

International Model Forest Network

International Model Forest Network



Helgeå
Model Forest

3 Countys
14 municipalities
Helgeå river basin 4,725 km^2

Originally initiated in 2006 by persons at
-the Biosphere Reserve Vattenriket
- Södra a economic forest association
-the Swedish Forest Agency

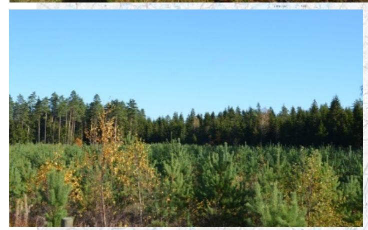
Helgeå
Model
Forest

The Landscape
Helge Å watershed and water system

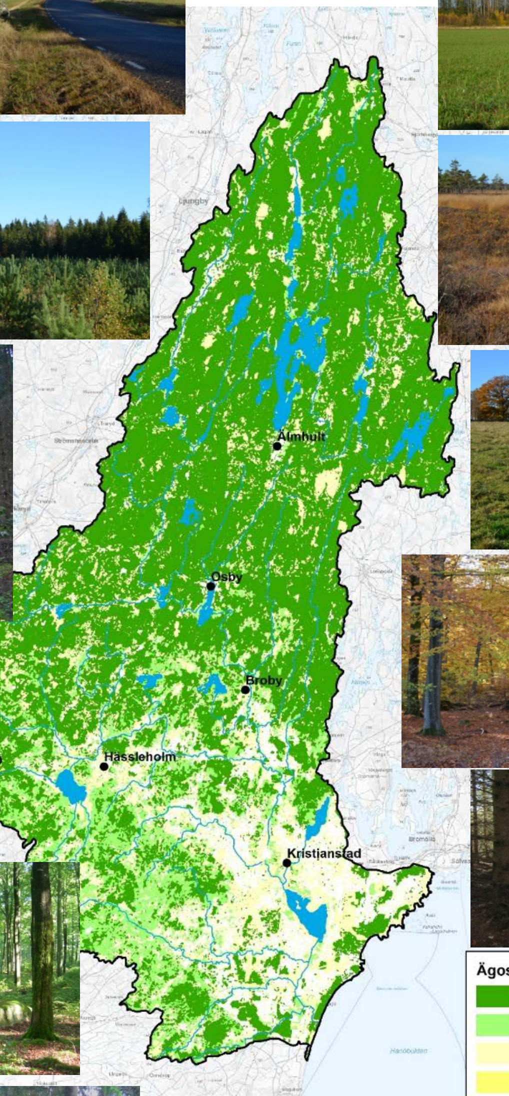
Helgeå
Model
Forest

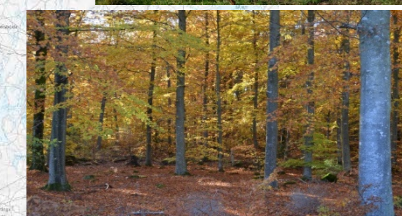
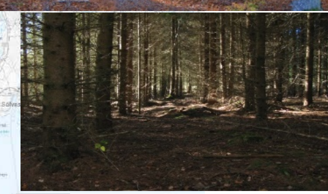
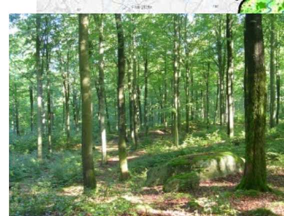
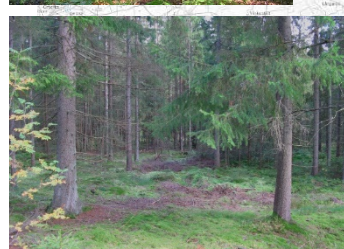
The Landscape
Helge Å watershed
Vegetation





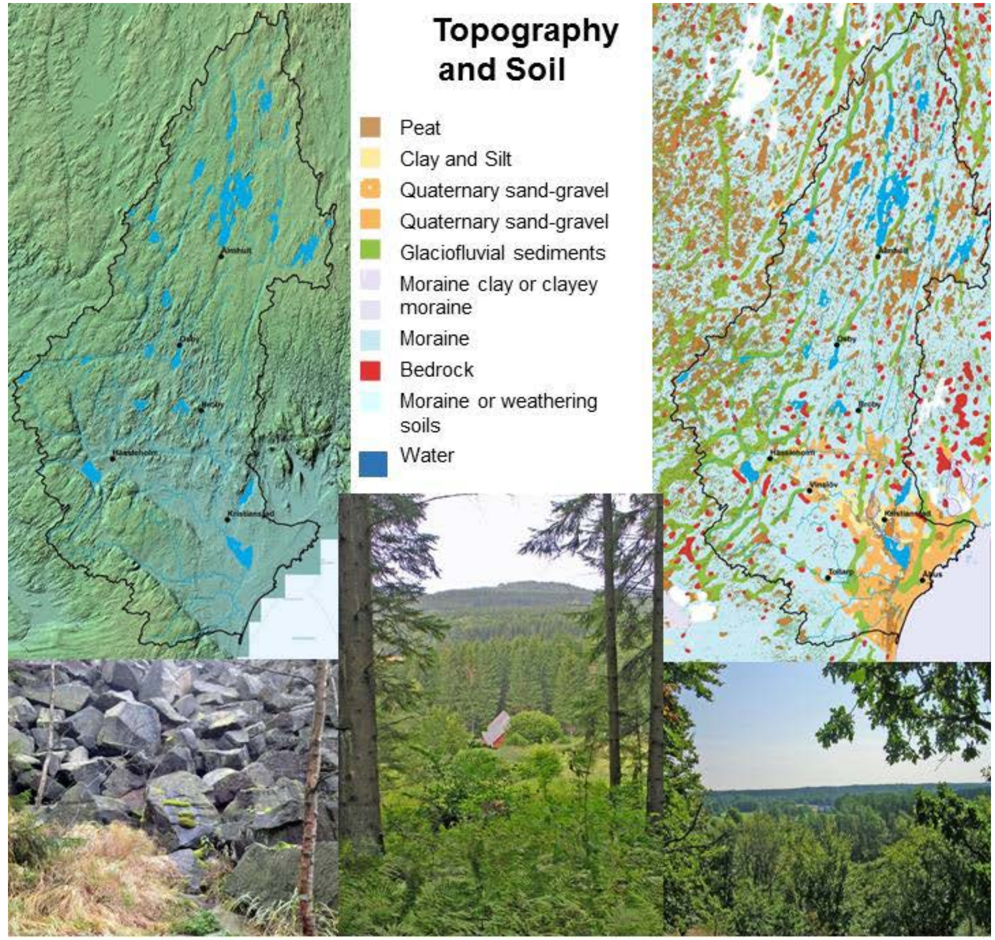





Helgeå
Model
Forest

The Landscape
Helge Å watershed and water system



Helgeå
Model
Forest

Model Forest Helgeå - a river basin approach to sustainable landscape management

Seven Key issues are:

- Brownification – what can be done?
- Streams - restauration of habitats
- Rural development – people living in the countryside is the a key factor to achive MF goals
- Green infrastructure for values of hardwood forest
- Tree species and woods in the future forest landscape
- Peri-urban nature and participatory planning
- Knowledge-building and mediation

Helgeå Model Forest

The brownification process what can be done? – Key Issue raised by Vattenriket and Möckelns Fish conservation association.
In 2018 carry through a conference at KSLA and Vattenriket with SEI, LU, Sydvatten and other partners.

In collaboration with Lund University try to develop a toolbox for action in the forest that can affect the brownification processes.

Running water
- Water Flow and restoration measures

Identify suitable objects in Helgeån tributaries and work for minimum water flow of drained stream stretches

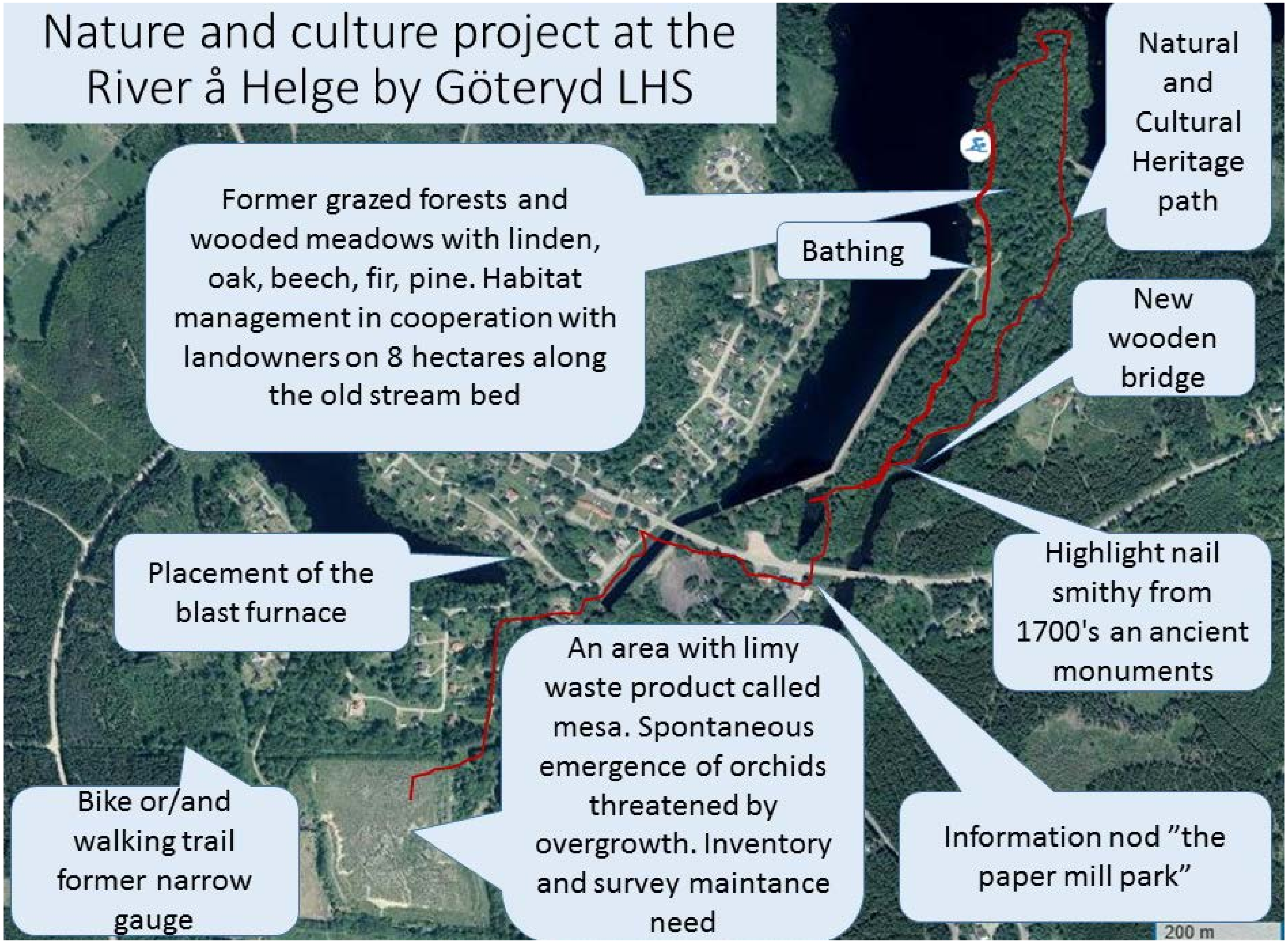
In spring 2018 field excursion with stakeholders about habitat restoration.
Working with riparian zone management through EU project WAMBAF.

Landsbygdsutveckling - levande landsbygd avgörande för att uppnå målen

LONA-application with Älmhult municipality and one athletic and three local Heritage associations

Project meeting places at Helgeå. Develop urban nature and attractions based on natural and cultural values.

Key Issue Rural Development



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Helge å Model Forest

SKOGSSTYRELSEN

Oak woodland along the River Helge

With information to landowners work for the existing values are managed and on a landscape level - ie green infrastructure

Urban nature and participatory planning

Along with development company HIBAB in the municipality Hässleholm and with the support of SLU Alnarp gain experience in how to involve users in the management of urban nature

Knowledge building and mediation

Together with researchers initiate or contribute to that new knowledge are developed and communicate the research front

>Wambaf – EU-Interreg
>Bundles of ecosystem services – SRC
>Miracle – EU-BONUS project on sustainable ecosystem services in a changing climate

Multi level Governance and HMF

The European Commission has developed a **Green Infrastructure Strategy**.

- In Sweden implemented by RAGI (Regional action plans for green infrastructure) where Helge å MF is appointed as collaboration platform by the County Administrative board of Kronoberg and working directly with the County board in Skåne and two of our key issues: streaming water and hardwood values

Helge å Model Forest

European Commission

Green Infrastructure

ENVIRONMENT

Multi level Governance and HMF

- Our work in the partnership overlap several of the goals of Agenda 2030 as
- **Partnership** Target 17.16 and 17.17 on multi-stakeholder partnerships,
- **Goal Human settlements** 11.3 enhance inclusive le human settlement planning and management …. *11.7* provide universal access to safe, inclusive and accessible,
- **Goal 6. Clean Water** Ensure availability and sustainable management of water … 6.5 implement integrated water resources management at all levels … 6.6 … restore water related ecosystems, including … forests, wetlands,
- **Goal Life on Land 15.1** … ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands,

Helge å
Model
Forest

SUSTAINABLE DEVELOPMENT GOALS
17 GOALS TO TRANSFORM OUR WORLD

x

Multi level Governance and HMF

- In a EU-project got the opportunity the develop present demo-sites concerning drainage issues and management of riparian zones

- WAMBAF stands for Water management in Baltic Forests and aims to reduce nutrient and mercury export from forestry to streams, lakes and the Baltic Sea.

x

The Future

- Pay back time - Searching funding to make concrete actions
- Broaden the network - challenge is age and gender!
- Try to build a resilient social network to ensure the future of Helge å Model Forest

SKOGSSTYRELSEN

Helge å Model Forest

Partners and stakeholders

- The Forestry collage of the municipality of Osby
- The Water Board of Helgeå
- The Swedish Forest Agency
- The Economic association of forest owner Södra
- The municipality of Älmhult
- Local heritage associations of Göteryd, Pjätteryd och Hallaryd
- Interested landowners and specialists
- The Biosphere Reserve Vattenriket
- Fish conservation associations in Helgeå catchment area
- The Rural Economy and Agricultural Society of the Scania
- HIBAB that manages and develops commercial premises and natural areas in the municipality of Hässleholm
- The department of landscape Architecture, planning and management at the Swedish University of Agricultural Sciences
- Kristianstad University, the Landscape Science program
- SLU - the Southern Swedish Forest Research Centre
- The University of Lund – Department of Biology, Aquatic Ecology research group

The six Principles of Model Forest

§ 1 Partnership – forms a neutral forum that welcomes voluntary participation of stakeholders

§ 2 Landscape – large scale fully working, urban to rural

§ 3 Commitment to Sustainability - environmental, social and economic

§ 4 Governance – transparent, consensus-based and inclusive

§ 5 Program of Activities – **reflective** of stakeholder needs, values and issues in accordance with national policies

§ 6 Knowledge sharing, Capacity building and Networking – to engage in sustainable management of natural resources

Helgeå
Model
Forest

Present state of art

- Functional steering and an excutive committe
- Partners - established and presumtive
- Three established demonstrations sites
- Governance – created a NGO
- Since winter 2016 a full member of IMFN
- In full swing to transform the plan for 2016 into concrete actions and activities

Helgeå
Model
Forest

Forest landscape future species and woodlands

Creating a platform for discussions about wildlife management and tree species possibility of natural regeneration from production and diversity perspective

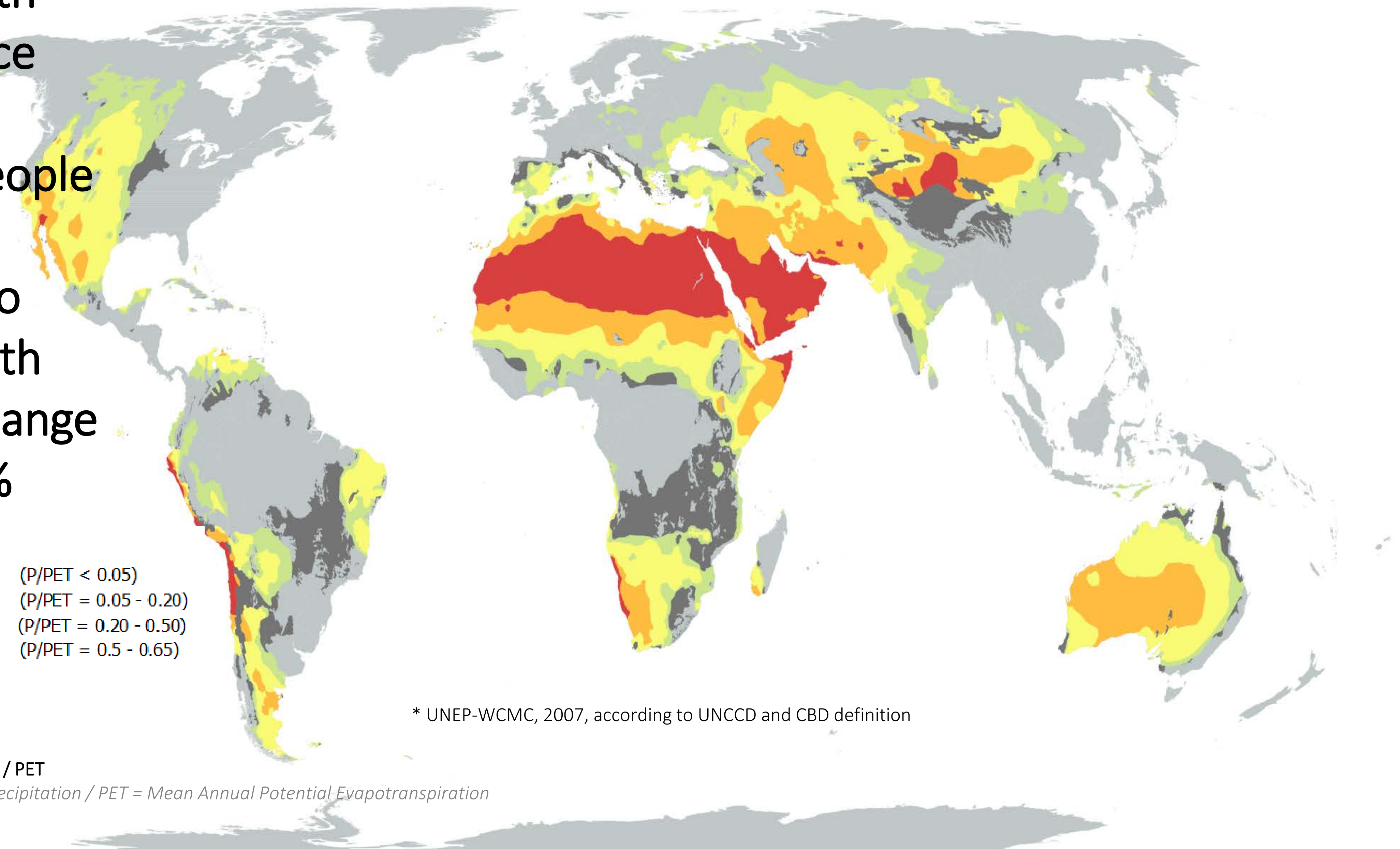
Working Group on Dryland forests and agrosilvopastoral systems:

Global agenda to contribute to SDGs implementation on the ground

Nora Berrahmouni
Forestry officer (Drylands), FAO
Nora.berrahmouni@fao.org

Global Drylands

- 41.5 % Earth land surface
- 2 billion people
- expected to expand with Climate Change to 11 - 23%



* UNEP-WCMC, 2007, according to UNCCD and CBD definition

Aridity Index (AI) = P / PET

P = Mean Annual Precipitation / PET = Mean Annual Potential Evapotranspiration

Dryland Forests : current issues

- Overpressure on resources
- Desertification in drylands exacerbates migration & Conflicts
- Climate Change induces long drought spells
- Undervalued
- Lack of attention & lack of investment
- Insufficient information

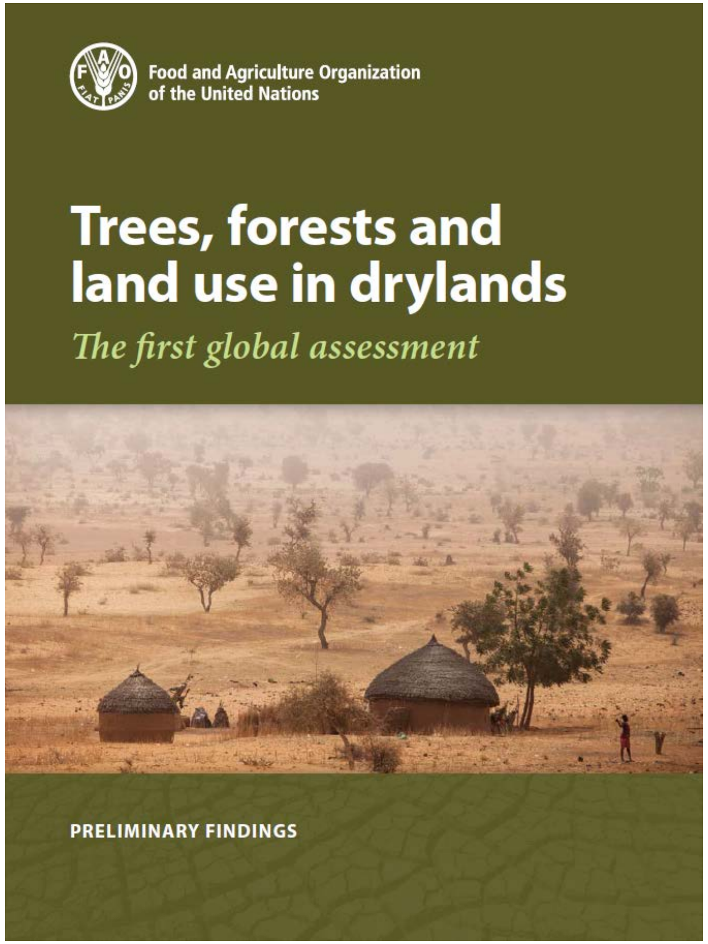
Dryland Forests on FAO agenda

- **COFO 2014 recommendation**

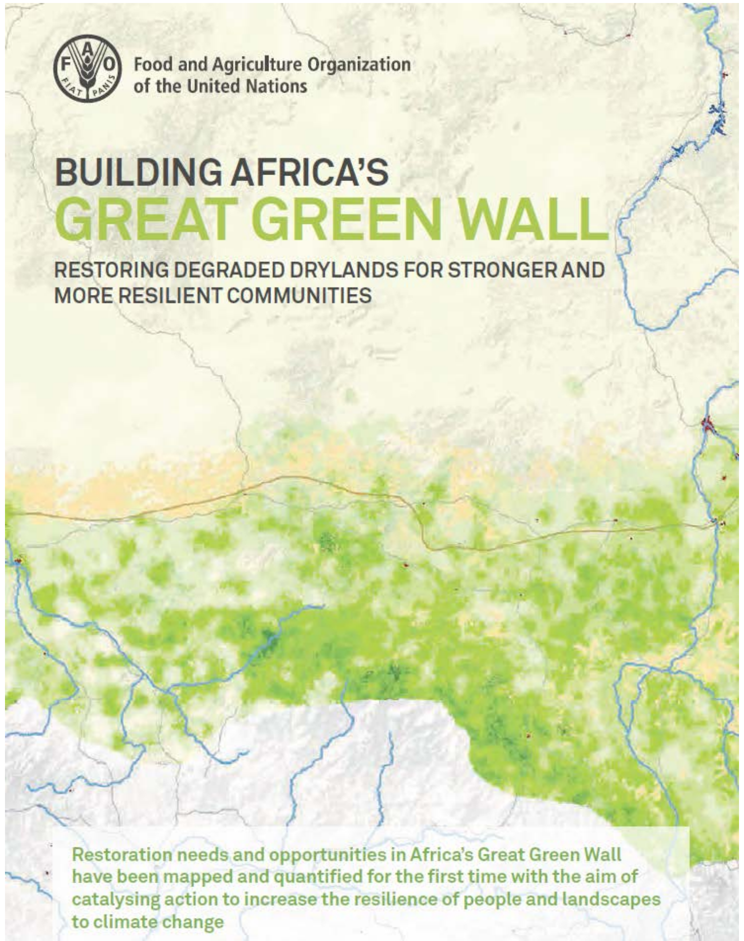
"Develop a **global assessment** of the extent and status of dryland forests, rangelands and agrosilvopastoral systems"

Global Drylands Assessment : Partners

PUBLICATIONS

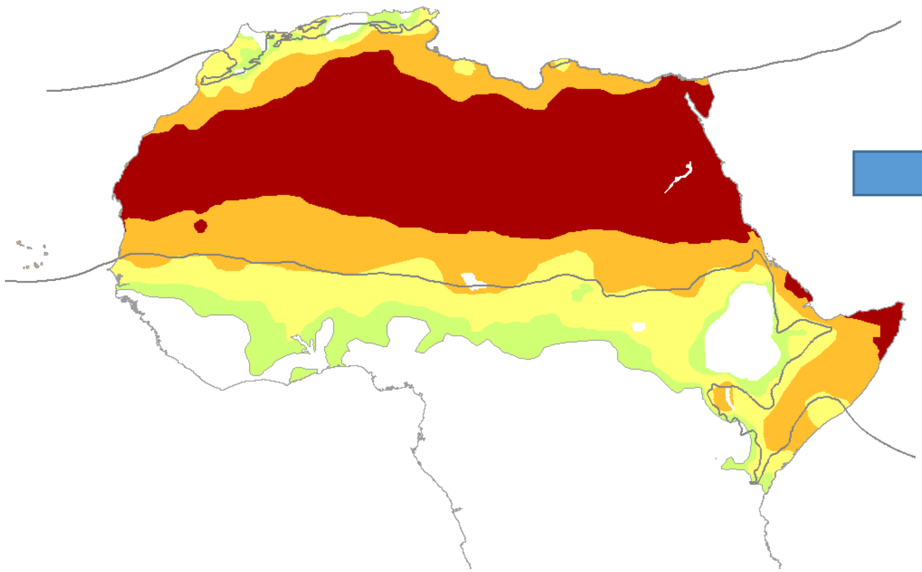


http://www.fao.org/3/a-i5905e.pdf



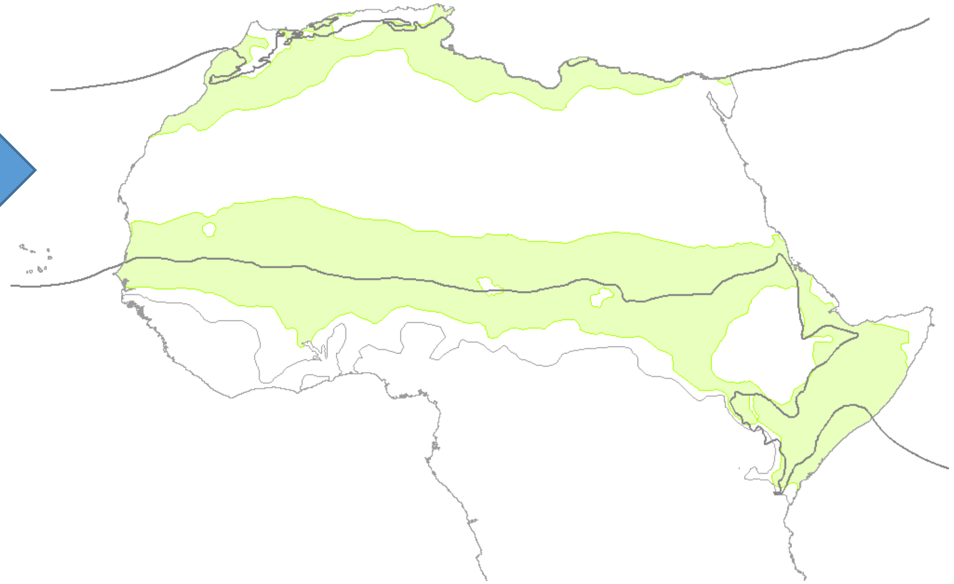
Great Green Wall
Africa's Response to Climate Change and Zero Hunger

Drylands by Aridity Index from UNEP-WCMC 2007, rev 2014



Hyperarid
Arid
Semiarid
Dry subhumid

Core GGW area



Core GGW area
400 mm precipitation limit

1.6 billion ha of drylands
in North Africa, Sahel and Horn
- 55% of Africa land area
- 11% world land area

0.8 billion ha in core GGW area

GGW overall goal

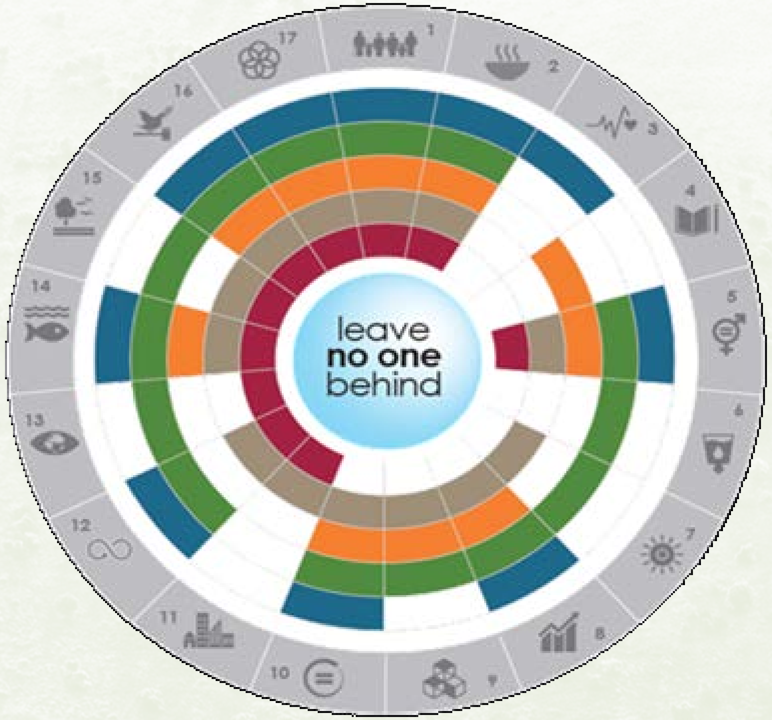
Adopted harmonized regional strategy for implementation of the "Great Green Wall Initiative of the Sahara and the Sahel". 2013.

- **Address increasing challenges**
  - ⇒food insecurity, poverty, forced migration
  - ⇒climate change, desertification, biodiversity loss

- **Improve resilience** of human and natural systems : **Large Scale Restoration**
  - Intervention priority as one of the key solutions
  - Along value chains : **from land and seed to end products & ecosystem services**

Food and Agriculture Organization
of the United Nations

FAO and SDG objectives common with those of Africa’s Great Green Wall



1. Help eliminate hunger, food insecurity and malnutrition
2. Make agriculture, forestry and fisheries more productive and sustainable
3. Reduce rural poverty
4. Enable inclusive and efficient agricultural and food systems
5. Increase the resilience of livelihoods to threats and crises

FAO tools and global products

- Partnerships
- Market value chains
- Land & Water
- Resilience
- Capacity development
- Communications & Visibility
- Farmer Field Schools

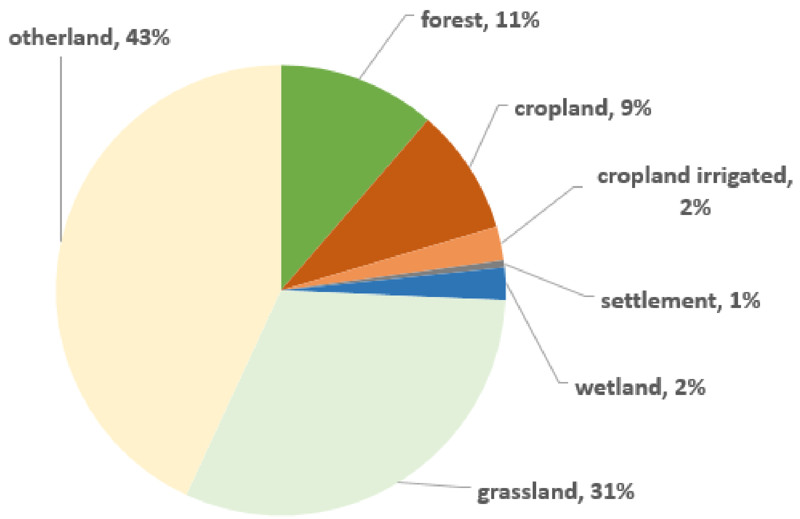
GGWSSI
great green wall
for the sahara
and the sahel
initiative

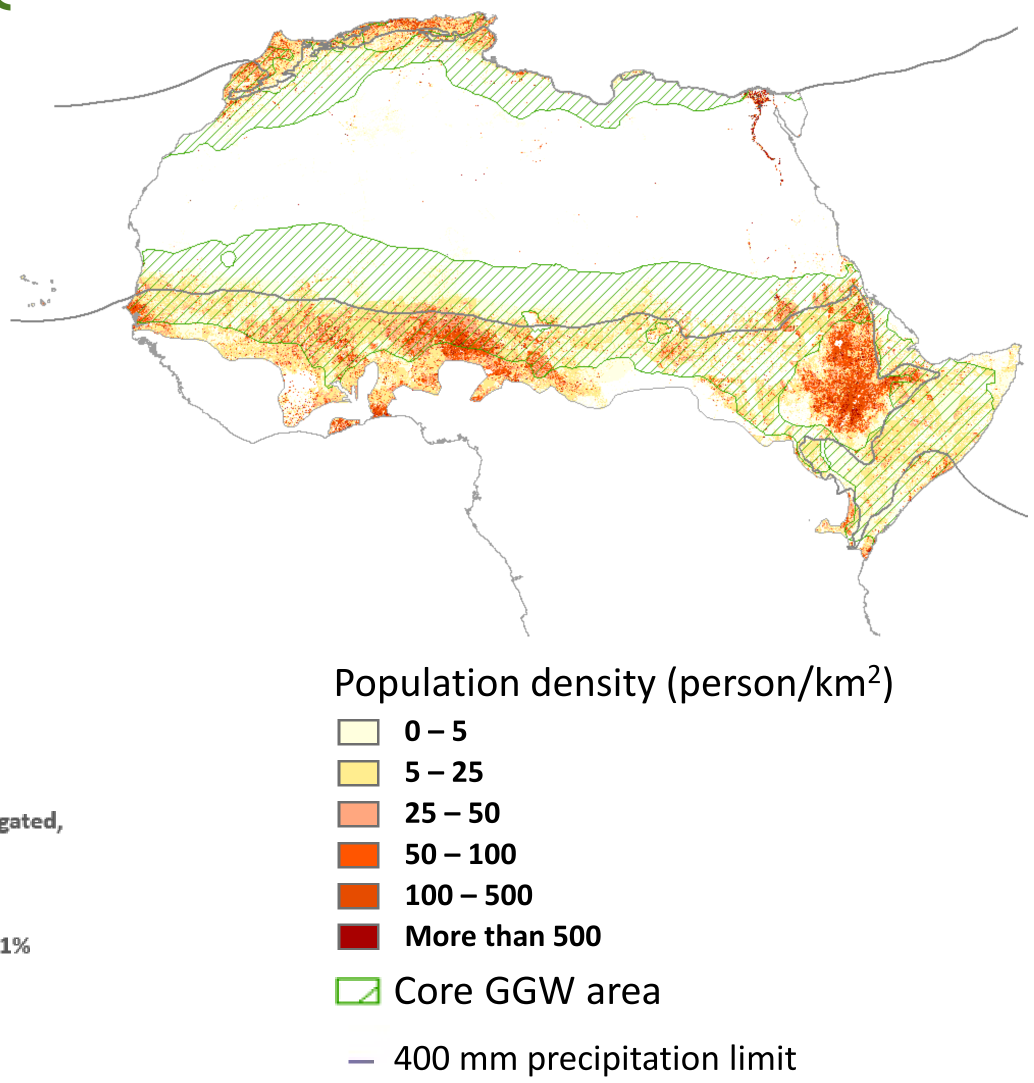
- Information
- Resource mobilization
- Policy guidance
- Sust. Landscape Management Restoration
- Climate-Smart Agriculture
- Assessment & Monitoring

Comparative advantage
FAO HQ & decentralized offices (regional, sub-regional and country level)

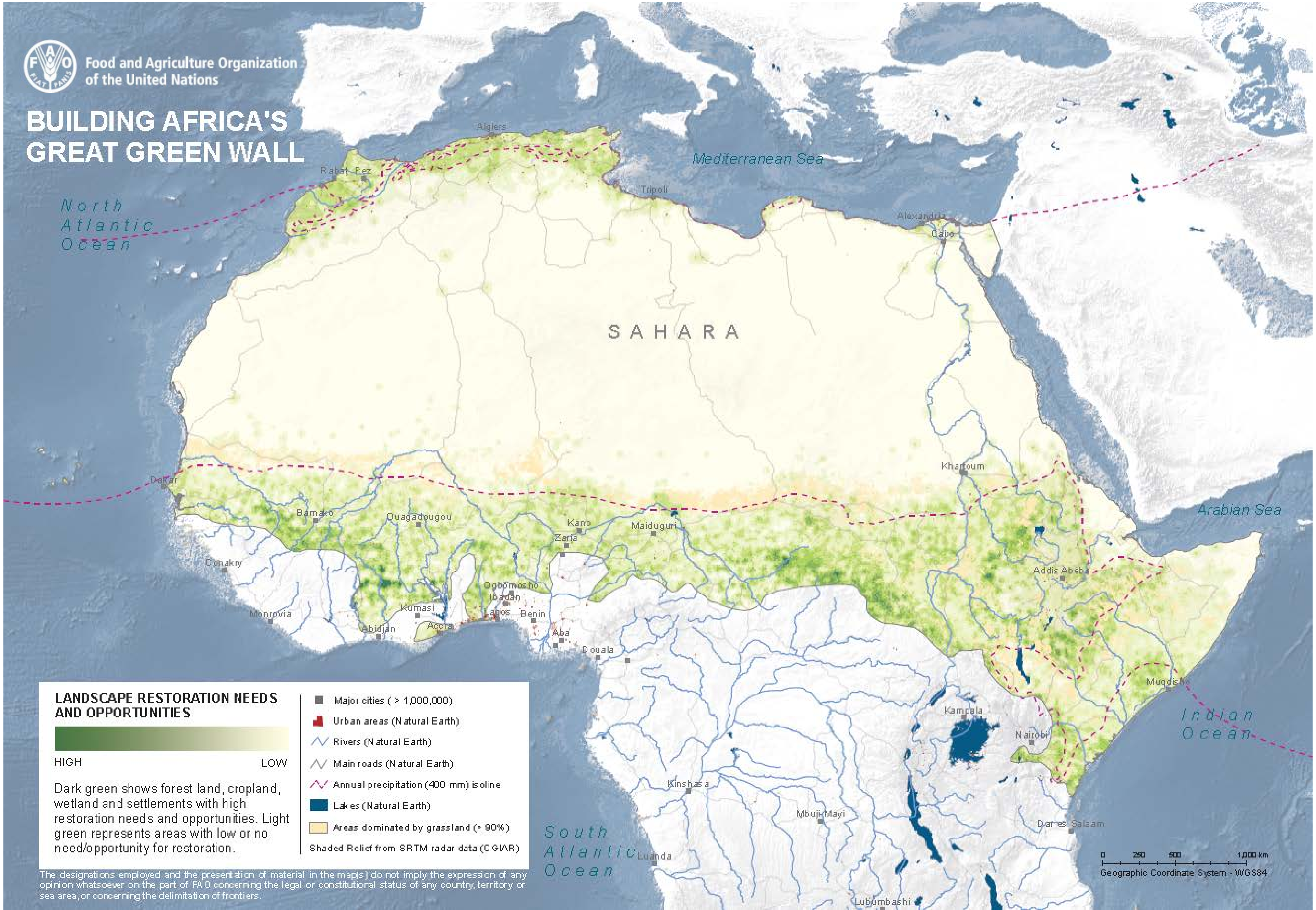
Population & Land use

- Overall GGW : **500 million people**
- Core GGW : **near 50%**
- **Land use distribution** in the core GGW area (0.8 billion ha)





GGW Restoration opportunities map based on the most ambitious scenario



Great Green Wall

How big is it?

Opportunity area - scenario

- High 21% - 166 million ha
- Medium 16% - 128 million ha
- Low 8% - 66 million ha

Scenario Sustainable Development Goals (SDG) – 2030

Range of restoration need: 10 million ha/ year

Food and Agriculture Organization
of the United Nations

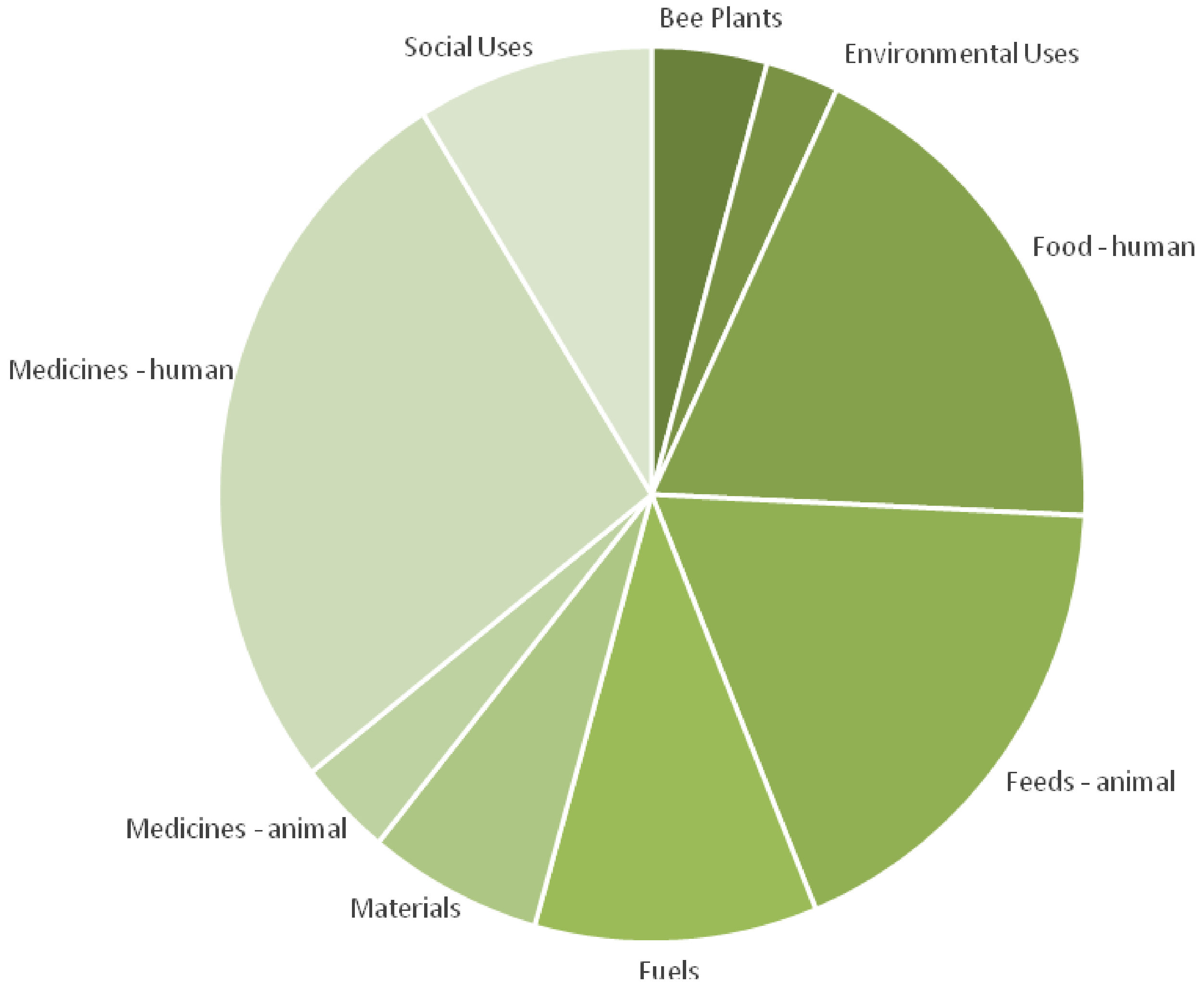
Restoration approach

- **Direct beneficiaries**: Rural communities
- **Research and mobilisation of seeds** of native species
- **Operations on the ground**

Communities at the heart of Forest and Landscape Restoration (FLR) in GGW/ drylands

- **Consult** with communities and assess their **commitment, motivation** and **needs**
- **Understand** local **needs** and **requirements** for restoration
- **Gather** detailed information **on species, their uses and preferences, objective(s) and site(s) for restoration**

Communities' preferences for restoration species & objectives



Examples of native species for large-scale restoration

Species (taxa)	Life form	Species (taxa)	Life form
Alysicarpus ovalifolius	grass	*Acacia nilotica*	woody
Andropogon gayanus	grass	*Acacia senegal*	woody
Andropogon pseudapricus	grass	*Acacia seyal*	woody
Aristida mustabilis	grass	*Acacia tortilis*	woody
Brachiaria ramosa	grass	*Adansonia digitata*	woody
Cenchrus biflorus	grass	*Adenum obesum*	woody
Chloris pilosa	grass	*Balanites aegyptiaca*	woody
Chrozophoro senegalensis	grass	*Bauhinia rufescens*	woody
Crotalaria macrocalyx	grass	*Combretum glutinosum*	woody
Cymbopogon giganteus	grass	*Combretum micranthum*	woody
Cymbopogon schoenamthus	grass	*Dalbergia melanoxylun*	woody
Dactyloctenium aegyptium	grass	*Faidherbia albida*	woody
Digitaria exilis	grass	*Grewia bicolor*	woody
Eragrostis tremula	grass	*Guiera senegalensis*	woody
Leptadenia hastate	grass	*Lannea microcarpa*	woody
Panicum laetum	grass	*Parkia biglobosa*	woody
Pennisetum pedicellatum	grass	*Piliostigma reticulatum*	woody
Schoenefeldia gracilis	grass	*Prosopis africana*	woody
Senna occidentalis	grass	*Pterocarpus lucens*	woody
Senna tora	grass	*Sclerocarya birrea*	woody
Stylosantes amata	grass	*Sterculia setigera*	woody
Waltheria indica	grass	*Tamarindus indica*	woody
Zornia glochidiata	grass	*Ziziphus mauritiana*	woody

Improvements on land preparation : WATER!

Land preparation for large-scale restoration in GGW

Manual

(100 people 1 ha / day)

Appropriate technology

(10-15 ha / day)

FAO is investing in Delfino units for Burkina Faso and Niger




improvements on seeds and seedlings

Planting inoculated seeds and seedlings associated with symbiotic micro-organisms in order to boost their vigour, their growth and/or their production

1- Rhizobium (bacteria) for nitrogen fixation through roots nodules (mostly in legumes, pulses – e.g. Acacia)

2- Mycorrhiza (fungi) living on plants roots in a mutual benefit relationship (95% of tropical plants)

Applied to Large Scale Restoration in GGW

- Seed coating for direct sowing
- Inoculating seedlings in nurseries
- Injecting inocula in planted seedlings on the ground

Resilience on the ground

A mix of minimum **10 species / ha**

Combining annuals and perannials

(direct sowing & planting)

improvements on seeds and seedlings

Planting inoculated seeds through direct sowing
(June) and nursery seedlings (July)

Supporting non timber forest products value chains

(with direct link to restoration in drylands)

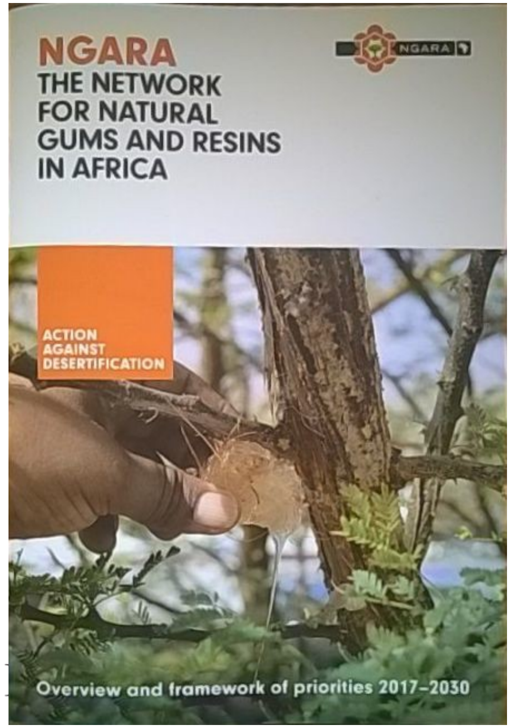
1) Balanites oil production

10% of species planted are *Balanites aegyptiaca* (natural stands, edible oil, soap, cosmetic)

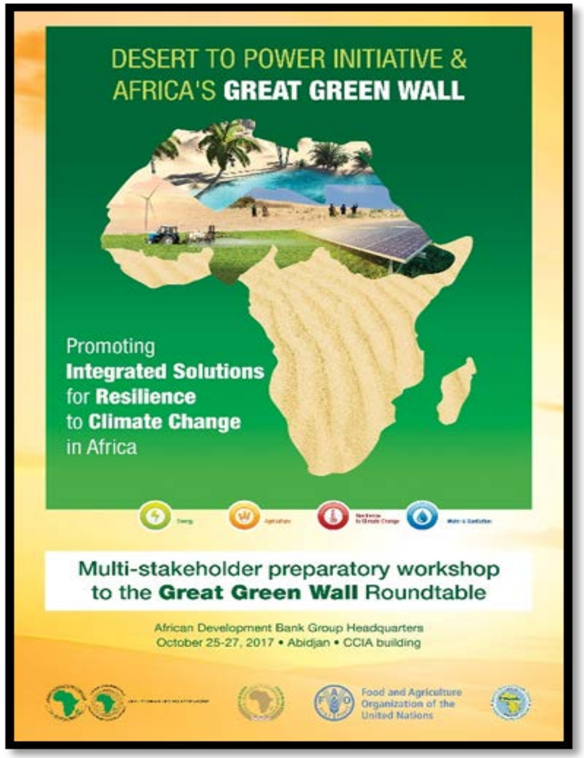
2) Beekeeping and Honey production

as for food and nutrition and importantly for crop/seed production (pollination)

3) NGARA – the network for natural gums and resins in Africa, as 25% of species planted are commercial gum producing species (*Acacia senegal, A. seyal*, etc,)



EXPANDING THE GGW
CONCEPT AND APPROACH



Desert to Power Initiative – African Development Bank & Africa's Great Green Wall

Launching workshop for the Great Green Wall for the SADC Region

Dryland Forests on FAO agenda : how to contribute ?

COFO 2016 : Working Group on Dryland Forests & Agrosilvopastoral systems with a mandate:

- **Review and report on status and trends**
- **Sharing Knowledge** on monitoring, sustainable management & restoration (FLR)
- **Collaboration** & **scaling up** good practices
- **Advice** in support of implementation of **SDGs** and other decisions

Membership and how to contribute?

- **FAO** : Secretariat for the Working Group
- **Members:** all drylands and non dryland member countries : experts from multiple disciplines
- So far 52 experts (members) from **27 countries**
- 1st meeting to be organized in April/May 2018 : operationalization of the Working Group
- Financial resources and wider technical expertise needed
- **Observers**: from international organizations and institutions


www.fao.org/dryland-forestry
www.fao.org/in-action/action-against -desertification