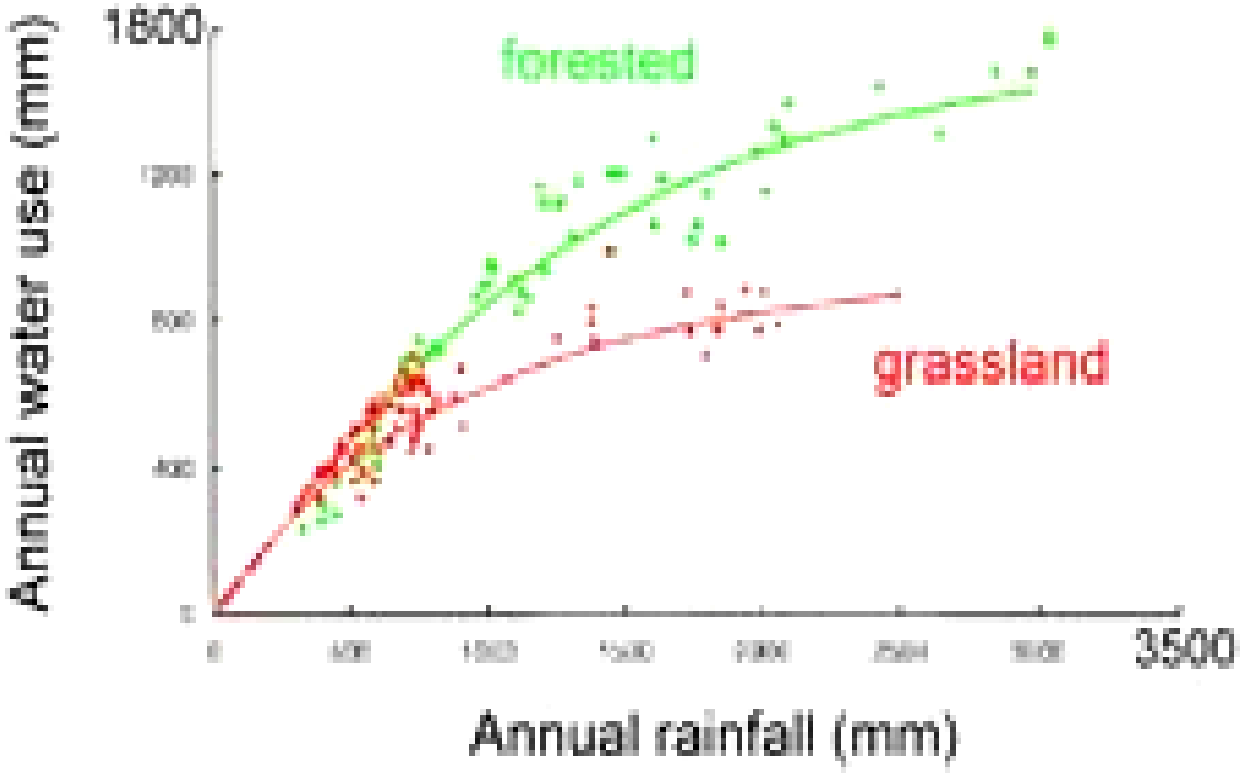
Water Co-Benefits of REDD+

Bernhard Mohns
RECOFTC, Bangkok

Hydrological benefits of (tropical) forests severely questioned of late…

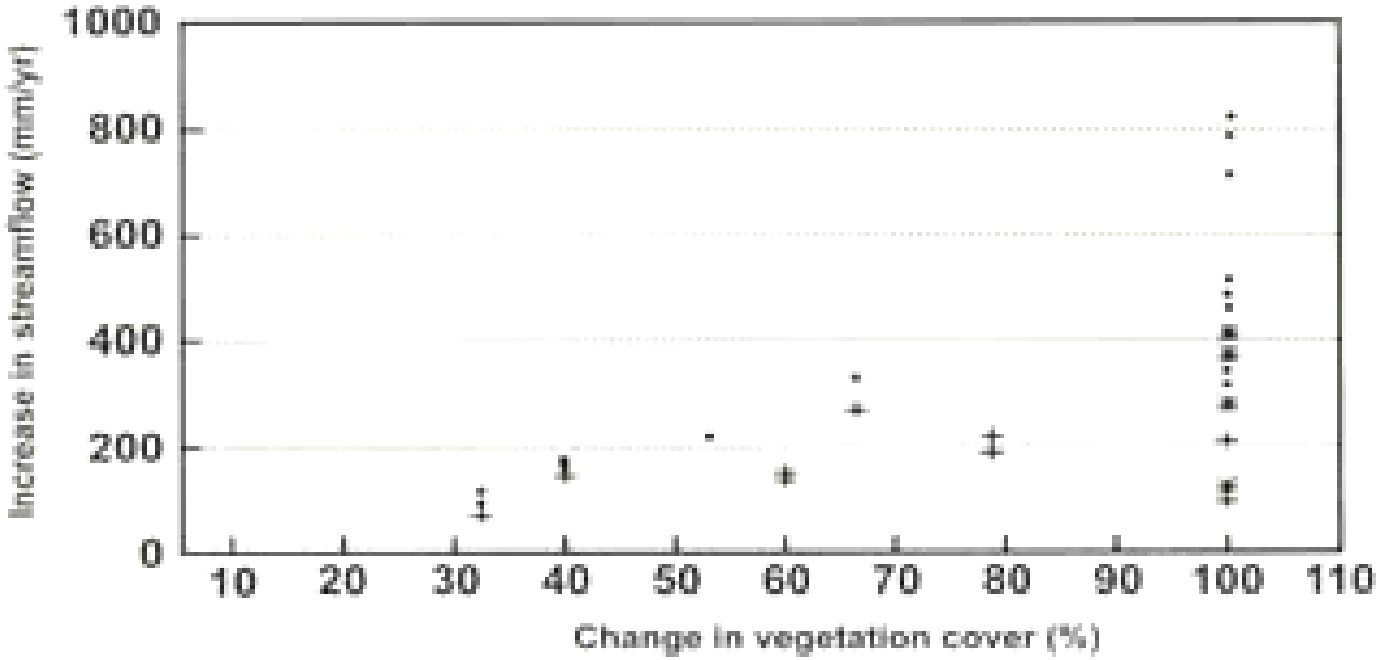
- ‘Public’ perceptions tend to ever estimate positive hydrological role of ‘forests’ .
- ‘Scientific’ findings tend to emphasize high water use of trees but sometimes downplay or ignore positive aspects such as infiltration and soil protection.
- Distinctions between old-growth, 2ndary growth, and (exotic) plantations largely ignored: *not all forests are equal!*

Does forest increase water yield?



- **Forests almost always use more water than shorter vegetations like grass or crops, due to greater aerodynamic roughness, larger leaf area and deeper roots…**

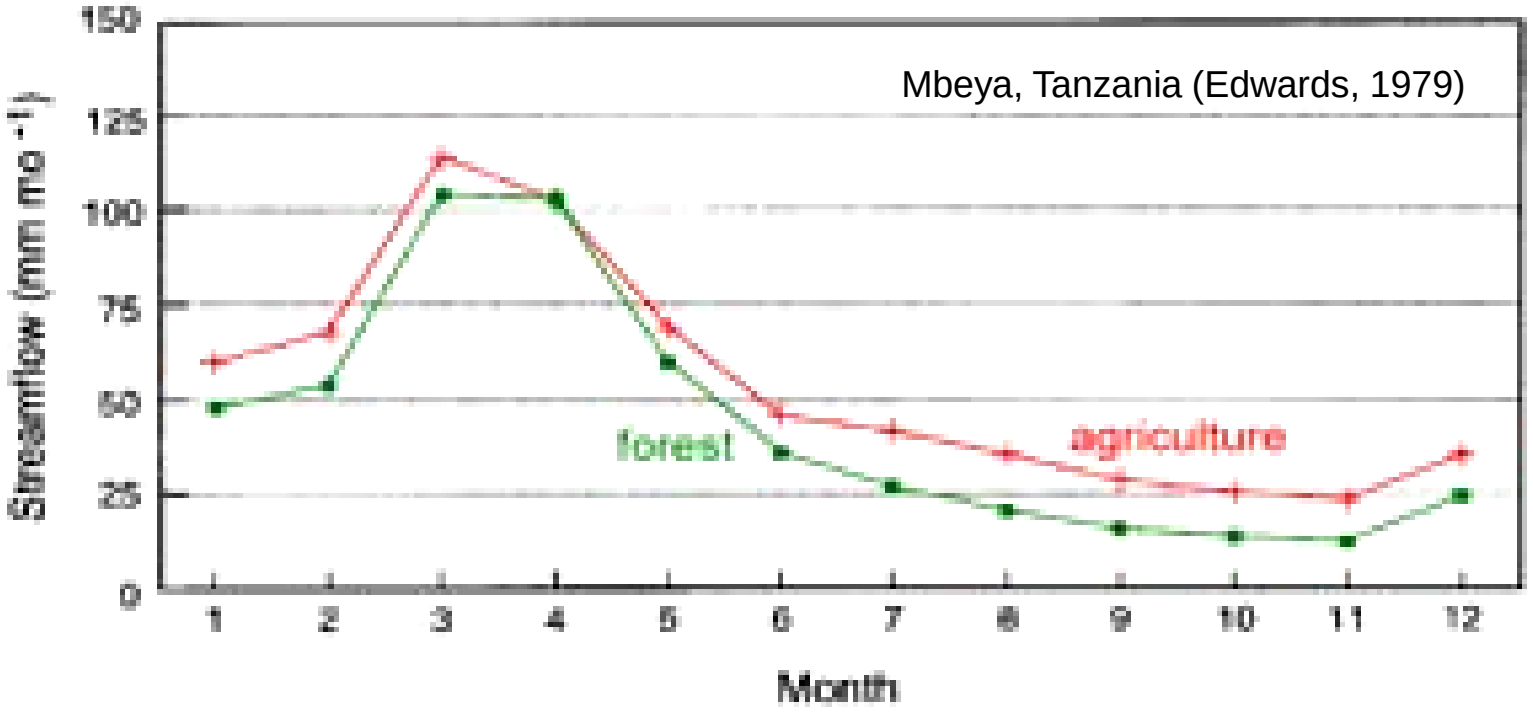
Tropical paired catchment experiments: Less forest = more streamflow *per year*…



Source: Bruijnzeel (1993)

***Annual* flow totals increase proportionally with degree of forest removal (situation for initial 3 years).**
***Final effect depending on post-forest land use*.**

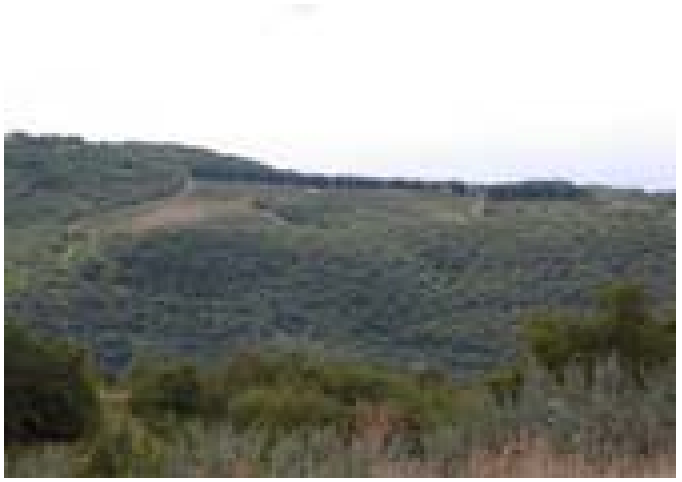
Tropical deforestation and *low flows*: Maintaining infiltration increases all flows



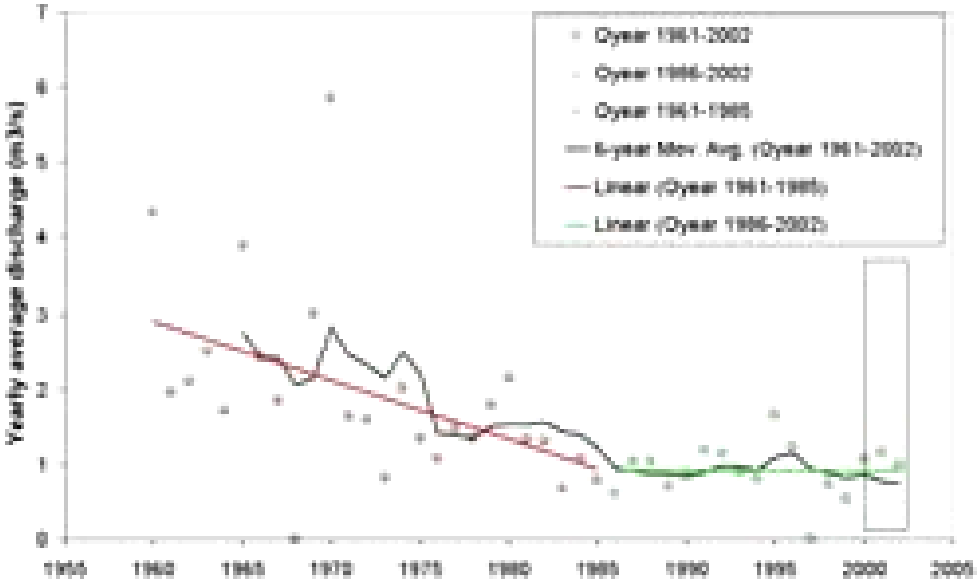
- **Without soil degradation**: deforestation leads to ***increases*** in dry season flows due to lower water use of crops...

Natural reforestation in Mediterranean Slovenia reduces overall streamflow

1960s. 20% forest

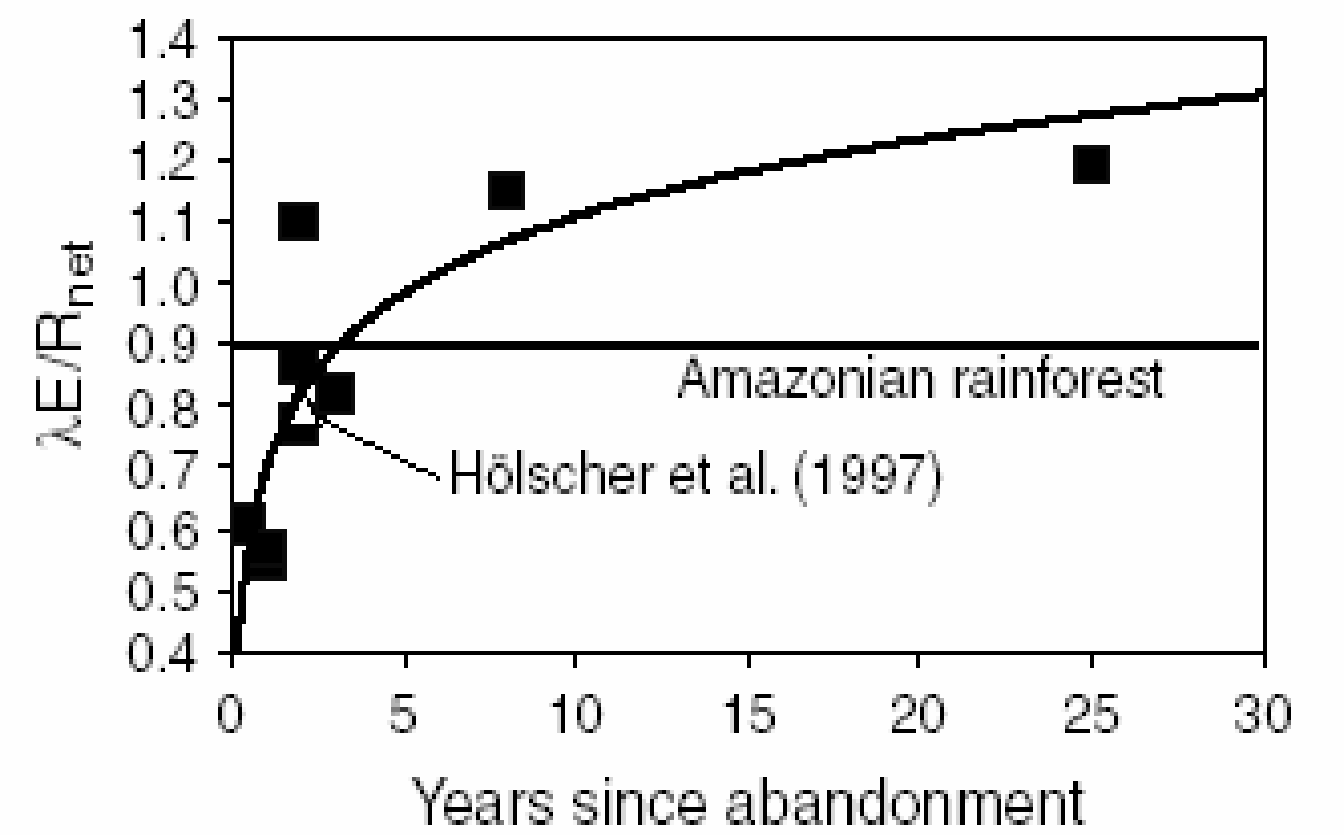


2000, 65% forest



Average discharge halved but stabilised after ca. 40 years.

Restoring tropical biomass also has its price



- **Water use of secondary growth exceeds that of old-growth tropical rain forest within 3 - 5 years (Amazonia).**
- **Maximum difference in water use 350-400 mm / year? Duration of higher evaporation 50 years?**

Can low flows be restored by tree planting? *NOT* by afforesting non-degraded soils!

Where ***infiltration*** does not change much after planting, changes in streamflow will simply reflect **increased water use by trees…**

Thus, ***large reductions*** **in flows** recorded (*up to 700 mm/yr*) after foresting natural or fire- climax grasslands…

Massive reductions in flow after foresting fire-climax grassland in Fiji with exotic pines

- Soils not degraded physically prior to reforestation => no gain in infiltration capacity.
- Massive reductions in water yield after forestation. Strong effect on low flows.
- Water use related to larger *Leaf Area Index of trees* , While Grassland dormant in dry season trees continue to grow.

Can low flows be restored by tree planting? Wood production comes at the cost of water…

- Vigorous **evergreen plantations** (***Eucalypt***, Pines, ***Acacias***) **use up to 450 – 750 mm/year** of extra water compared to grass or annual crops in the seasonal tropics.

- ***Deciduous trees (Teak)*** use less water than evergreens but soils often ***prone to erosion*** unless good shrub and litter layer


Teak, Cebu


Prescribed burning in teak, East Java

TABLE 9
Values of water use in the United States of America, by sector

	Value of water use in 1994 US$/acre-foot of water			
	Average	Median	Minimum	Maximum
In situ				
Waste disposal	3	1	0	12
Recreational/ habitat	48	5	0	2 642
Navigation	146	10	0	483
Hydropower	25	21	1	113
Withdrawal				
Irrigation	75	40	0	1 228
Industrial	282	132	28	802
Thermal power	34	29	9	63
Domestic	194	97	37	573

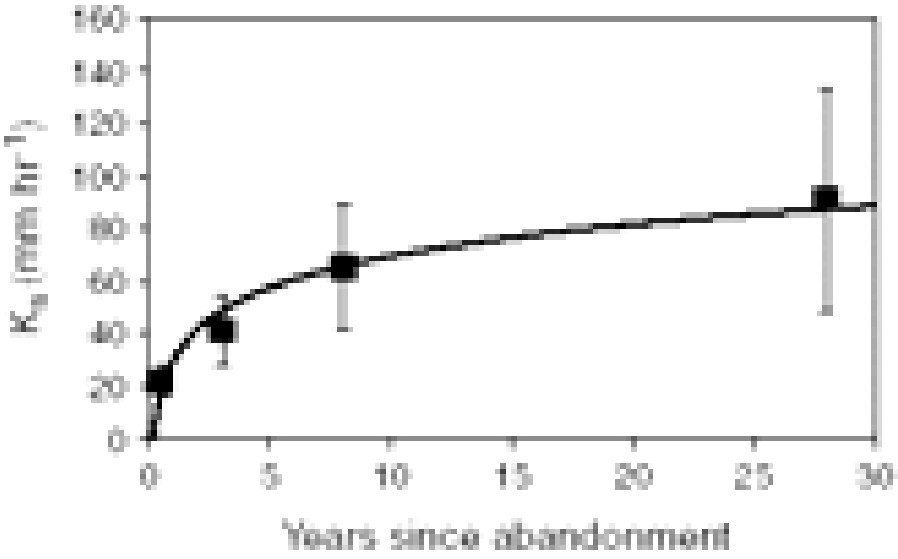
Source: Frederick, VandenBerg and Hanson (1997).

Can low flows be restored by forestation


Poor litter development, Java

Only if extra water use ΔET by trees is compensated by improved infiltration ΔI.


Controlled fire, India



- Rebuilding of infiltration capacity poorly documented (slow/fast?).
- Repeated disturbance fatal…

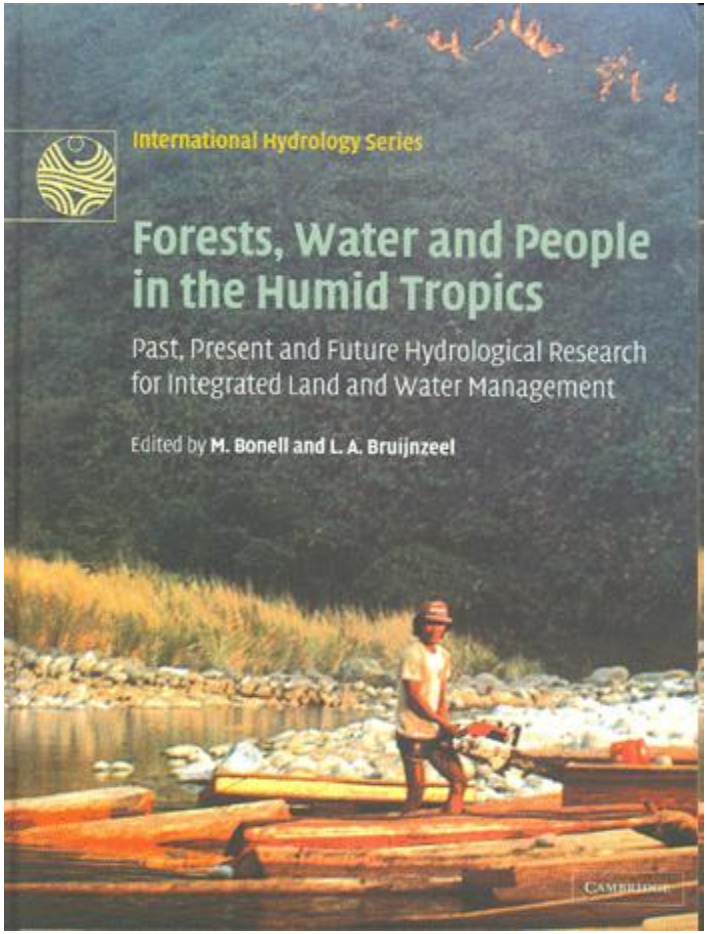
Reforestation and low flows: summary

- Forestation reduces dry season flows, except where infiltration and recharge are improved sufficiently to compensate higher water use.
- Very large reductions in overland flow / storm runoff and erosion have been demonstrated after restoring severely degraded land (~ or > ΔET).
- Positive effect on low flows requires high infiltration rates, sufficient soil depth and a highly degraded initial situation
- Conservation crops (cover crops and grasses) more effective due to lower water use

Forestation and low flows: Knowledge gaps and outlook

- ***Identify situations where forestation leads to reduced or improved low flows: study of tree water use, hill slope hydrological intractions.***
- ***Consider all hydrological effects, e.g. in Payments for Environmental Services schemes (for conservation, restoration, poverty alleviation).***

This book should be in the hands of any forest and water resources policy maker !!!!!!!



- Invited expert chapters
- Theory vs. practice
- 3 kg and 1000 pages of information for $300 …