Oportunidades y potencial de los mercados de servicios ambientales a nivel regional e global

Erick C.M. Fernandes
Banco Mundial
efernandes@worldbank.org

El Pago por Servicios Ambientales (PSA)

- Un mecanismo de compensacion
- Proveedores de servicios ambientales y beneficiarios de tales servicios
- Proveedores reciben un pago
  - Directa
  - Contractual
  - Condicionada (provision segura y continua del servicio)

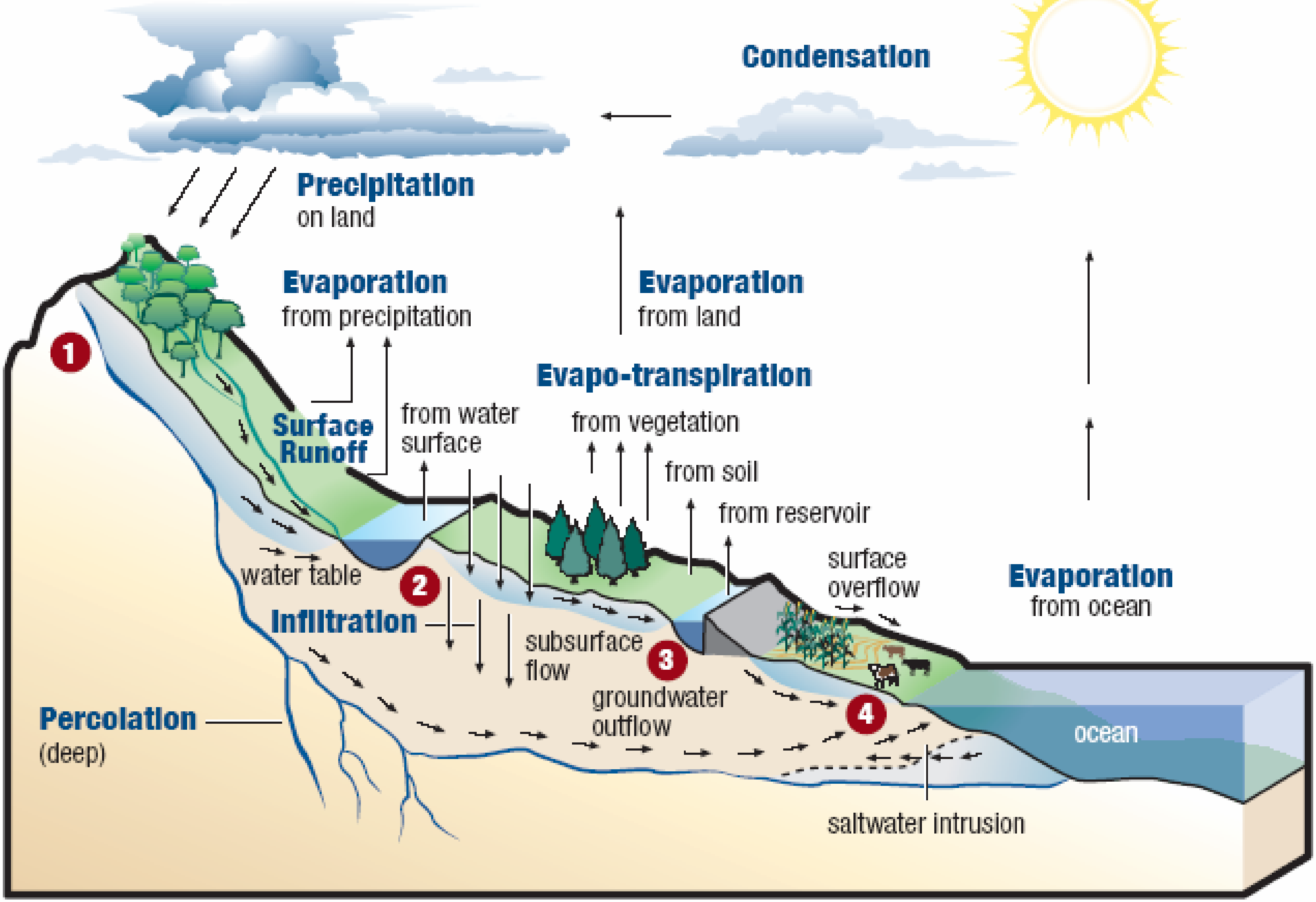
Tipos de PSA

- **Clima**
  - Secuestro y almacenamiento de carbono
  - Para los tropicos – MDL/CDM (biomasa aerea, carbono en el suelo?)
- **Biodiversidad**
  - Corredores biologicos
  - Belleza escenica
- **Agua**
  - Proteccion de cuencas hidrograficas
  - Quantidad e calidad de aqua

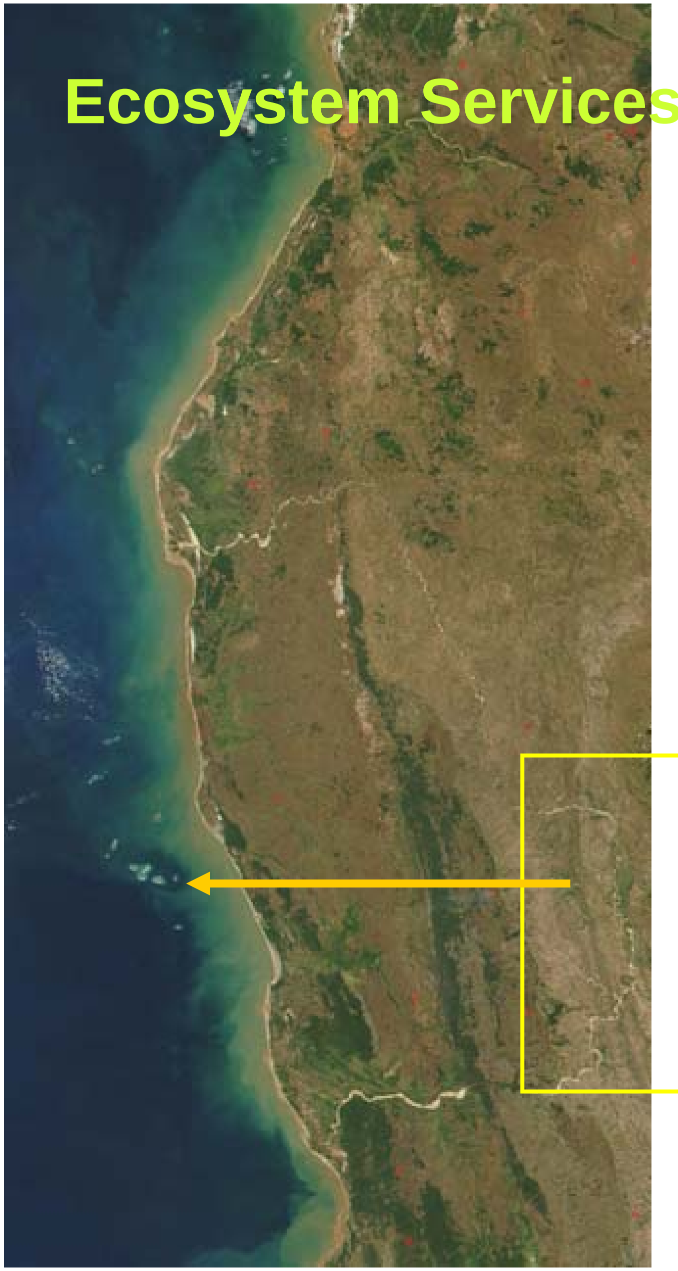
PSA Mitigacion de Pobreza?

- Importancia local, regional, global
- Cuencas, bacias,
- Por campesinos, los pagos por SA podrian aumentar sus ingresos. Sin embargo, <u>no es automatica</u>
  - Provision segura y continua del servicio
  - Posesion o derecho de uso de la tierra
  - Alto costo de transaccion tratar con muchos pequenos propietarios….

The Hydrological Cycle

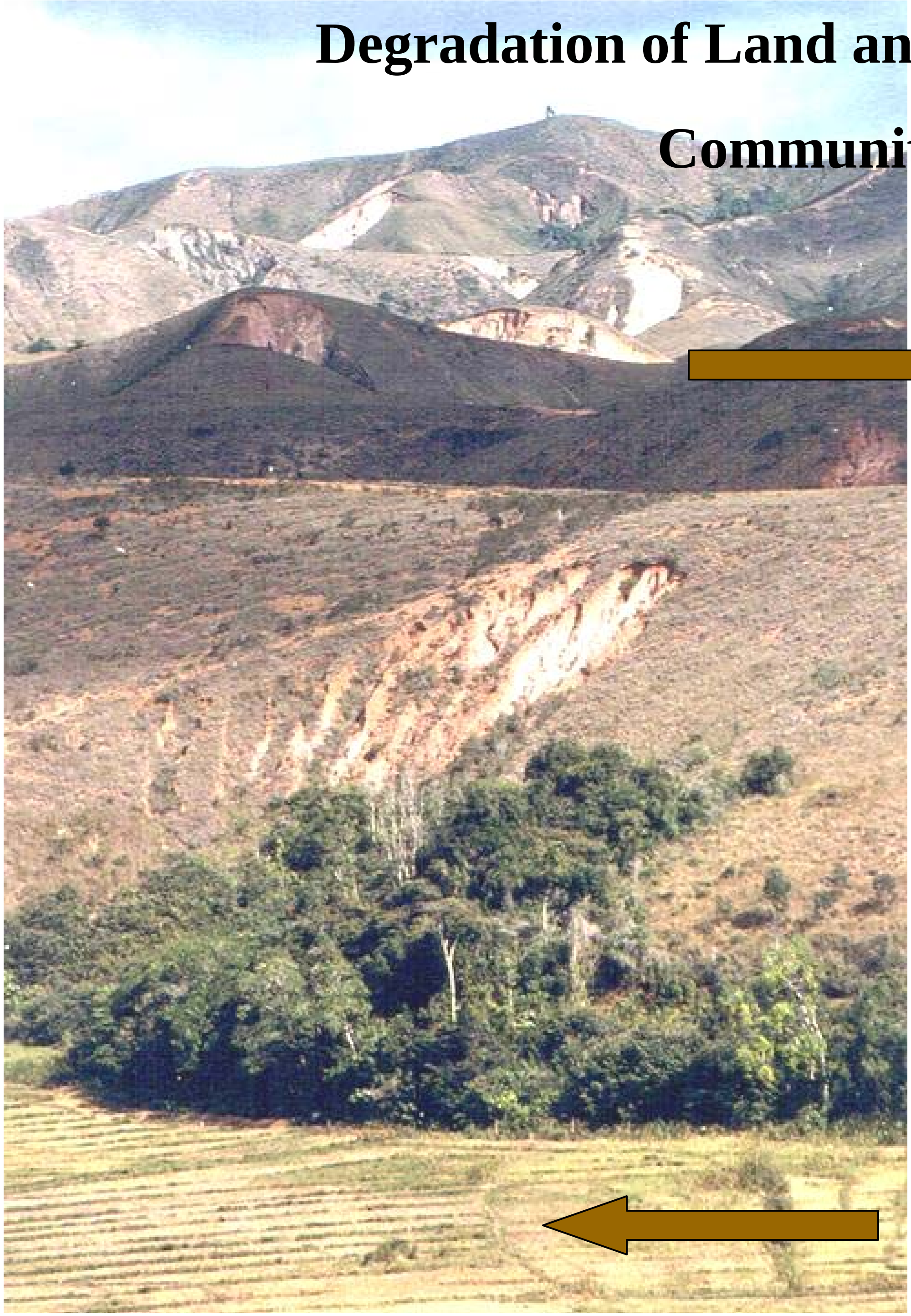


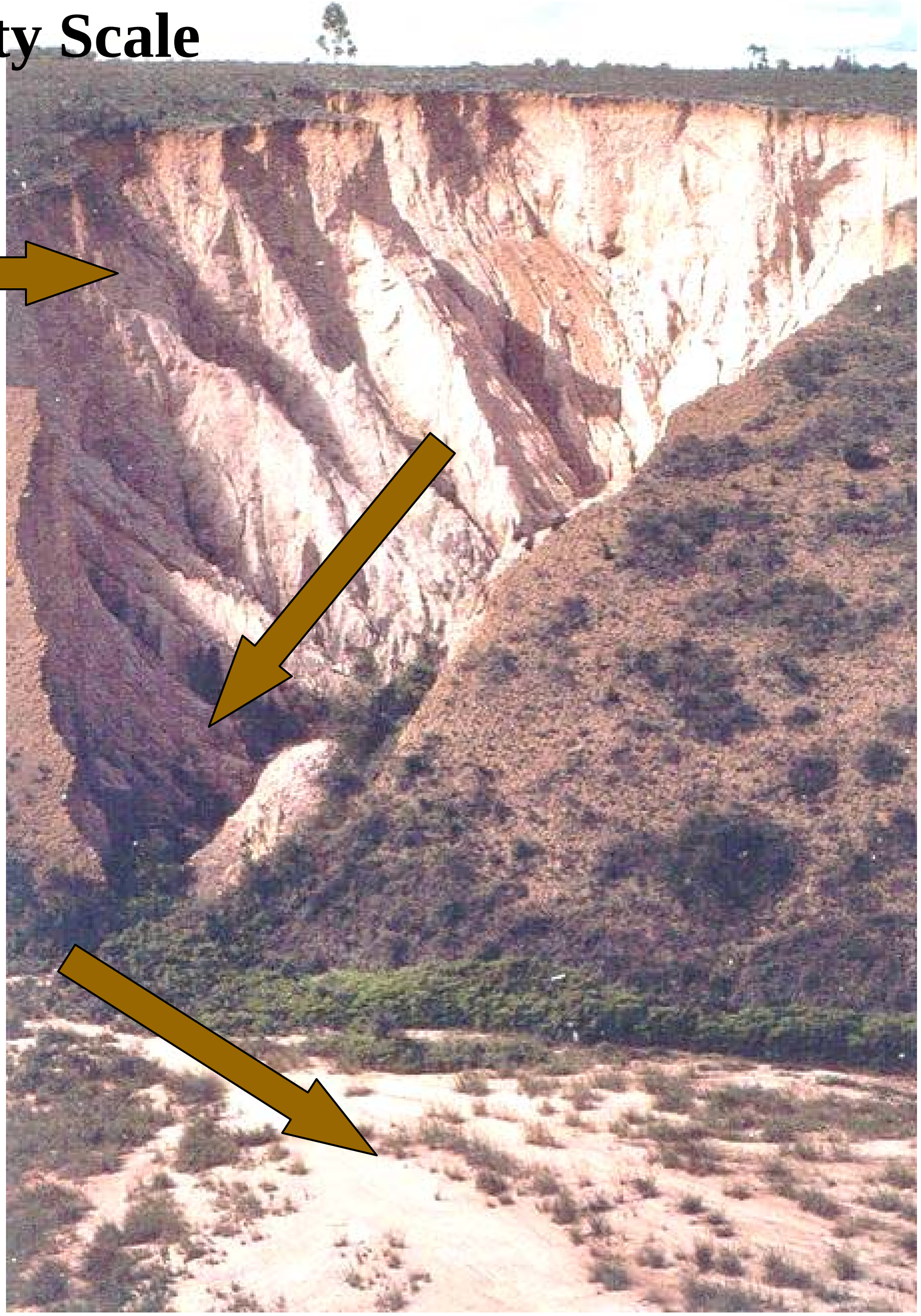
Ecosystem Services from Mountain Top to Coastal Lands



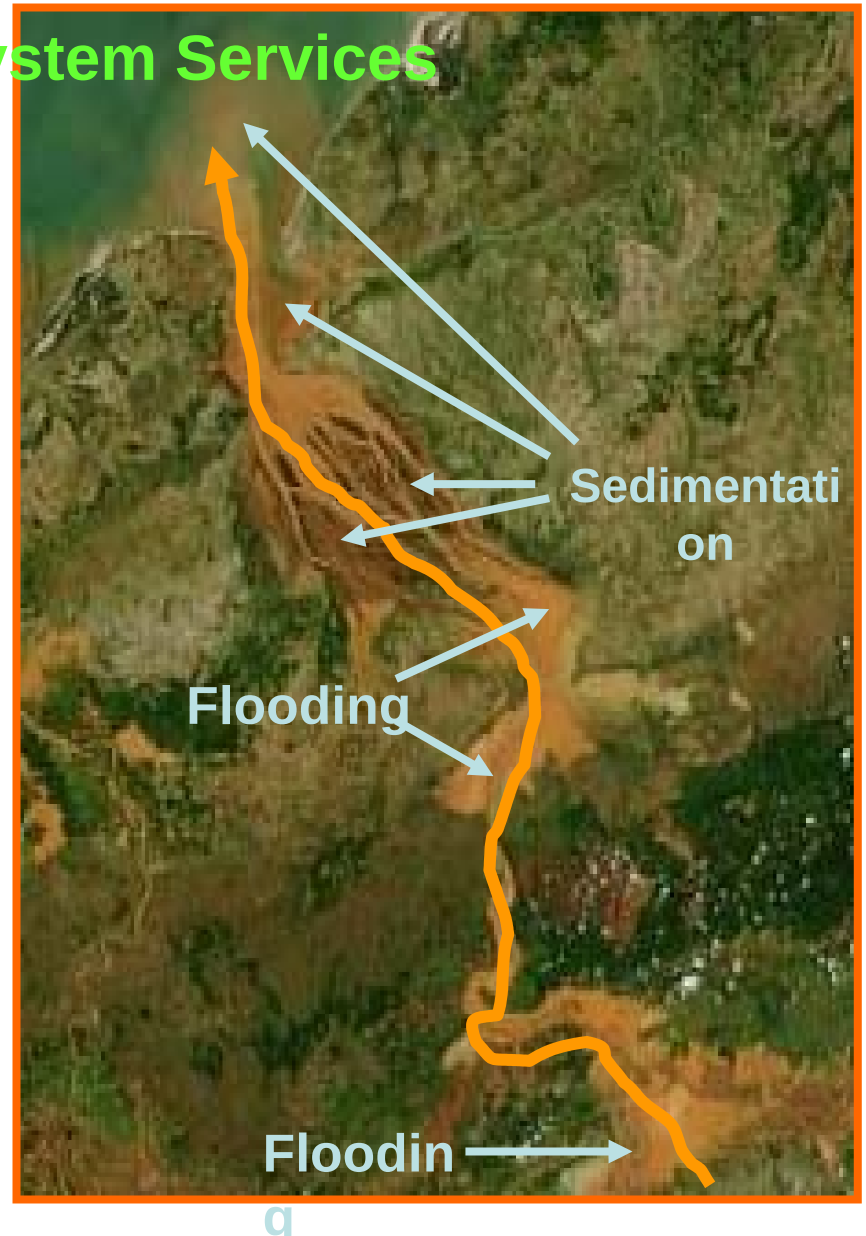
Degradation of Land and Ecosystem Services

Community Scale





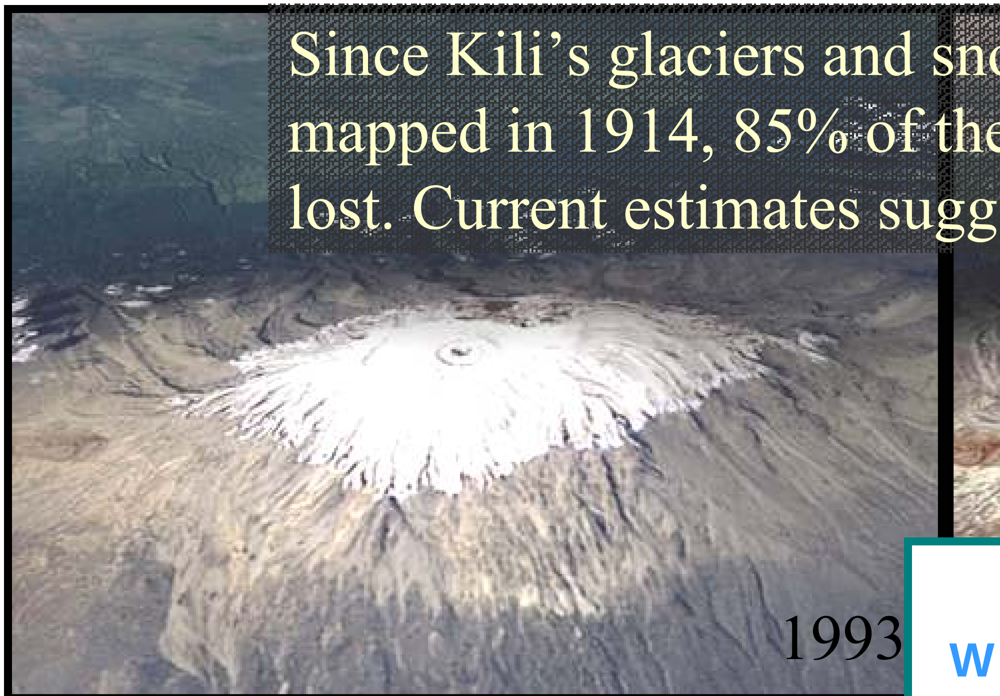
Madagascar
Degradation of Land and Ecosystem Services
Landscape Scale




Madagascar: Traditional Land Management options for improved production and ecosystem services
Pit to capture Crop Residues + Manure
Beginning of Cropping Season – pit empty
End of Cropping season – pit full
Nitrogen -rich compost back to fields
Terraces to control water & nutrient fluxes

Climate Change as a driver
environmental services at

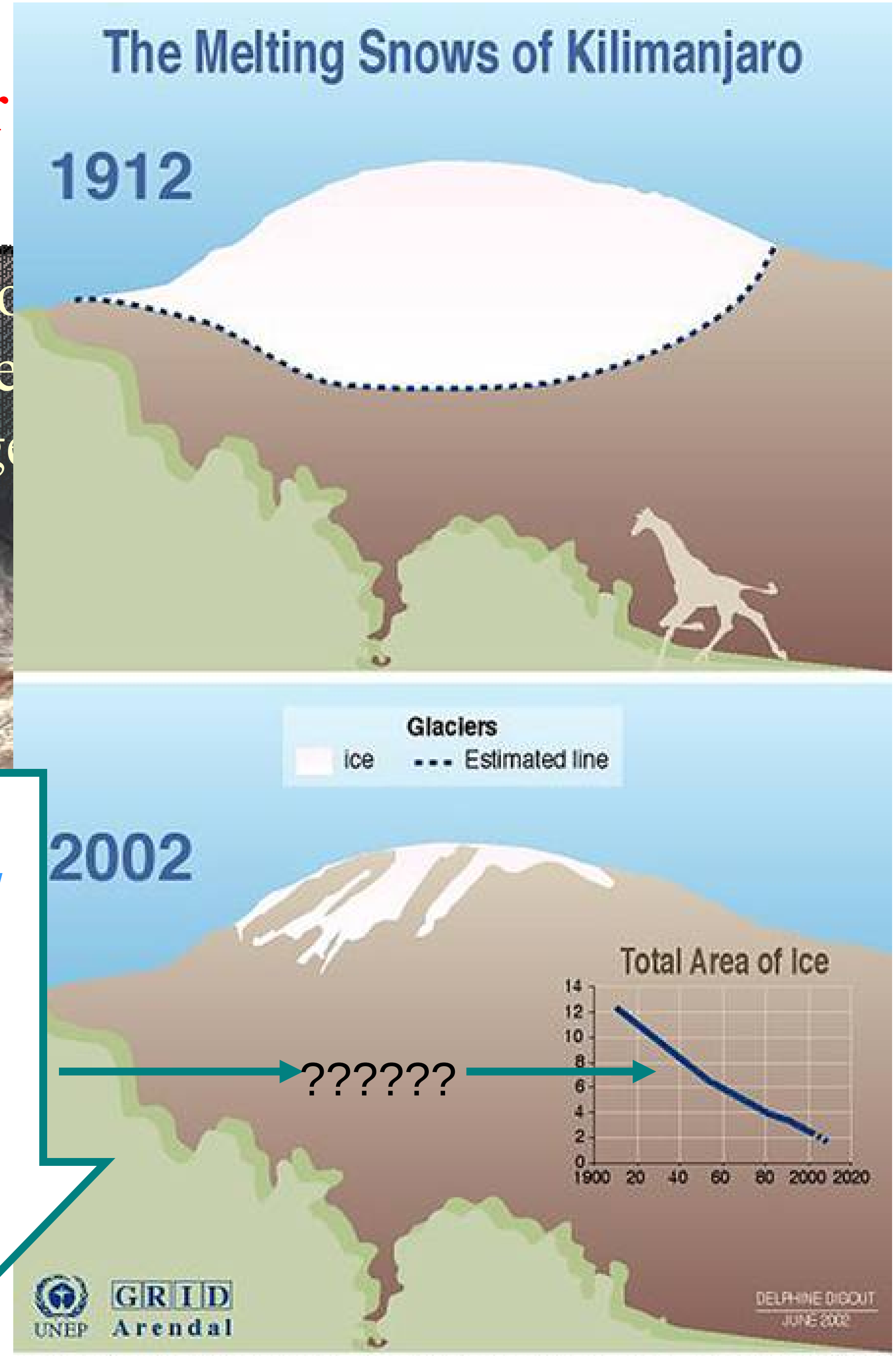
Since Kili's glaciers and sno
mapped in 1914, 85% of the
lost. Current estimates sugge



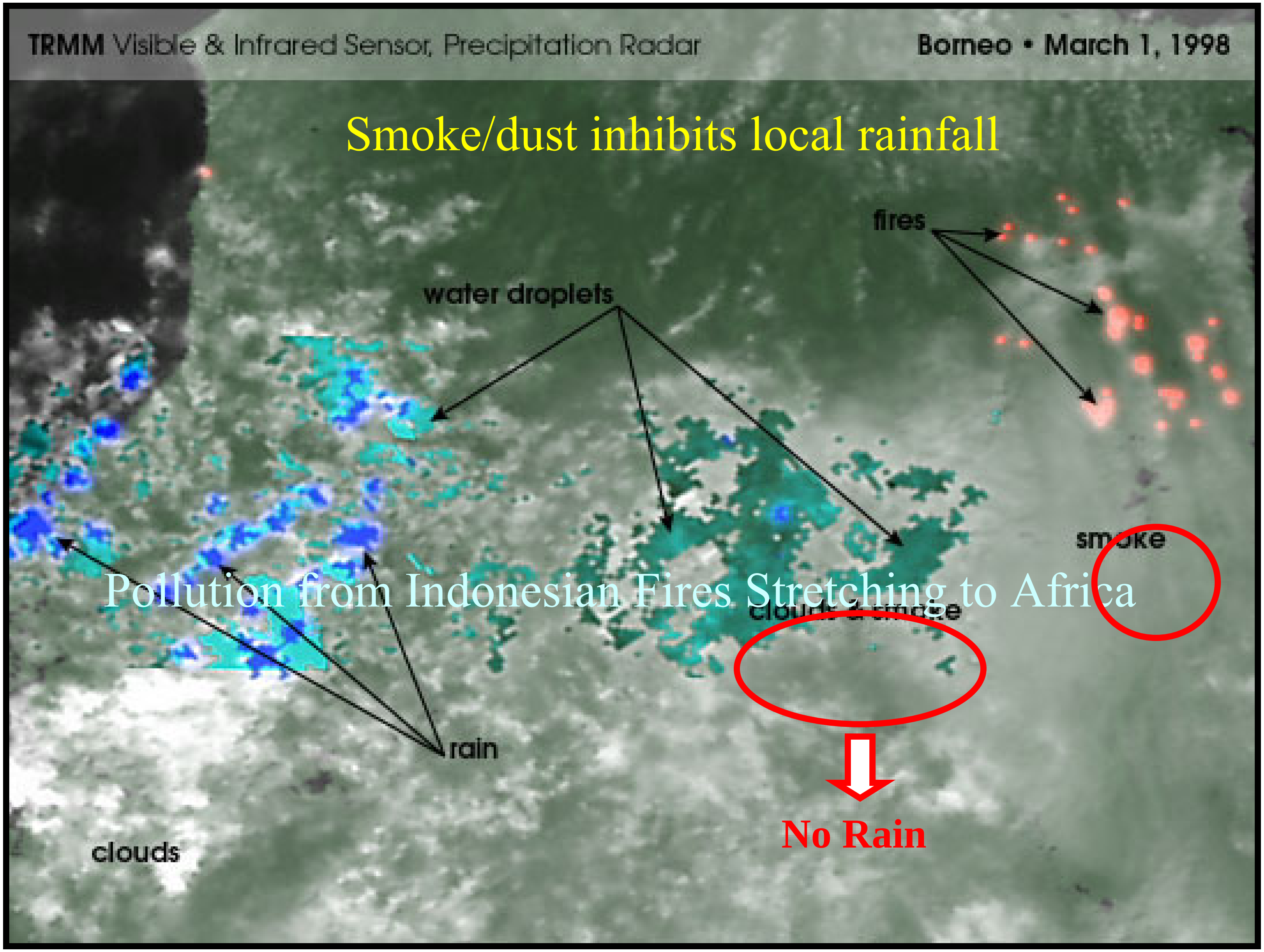
1993

WATER

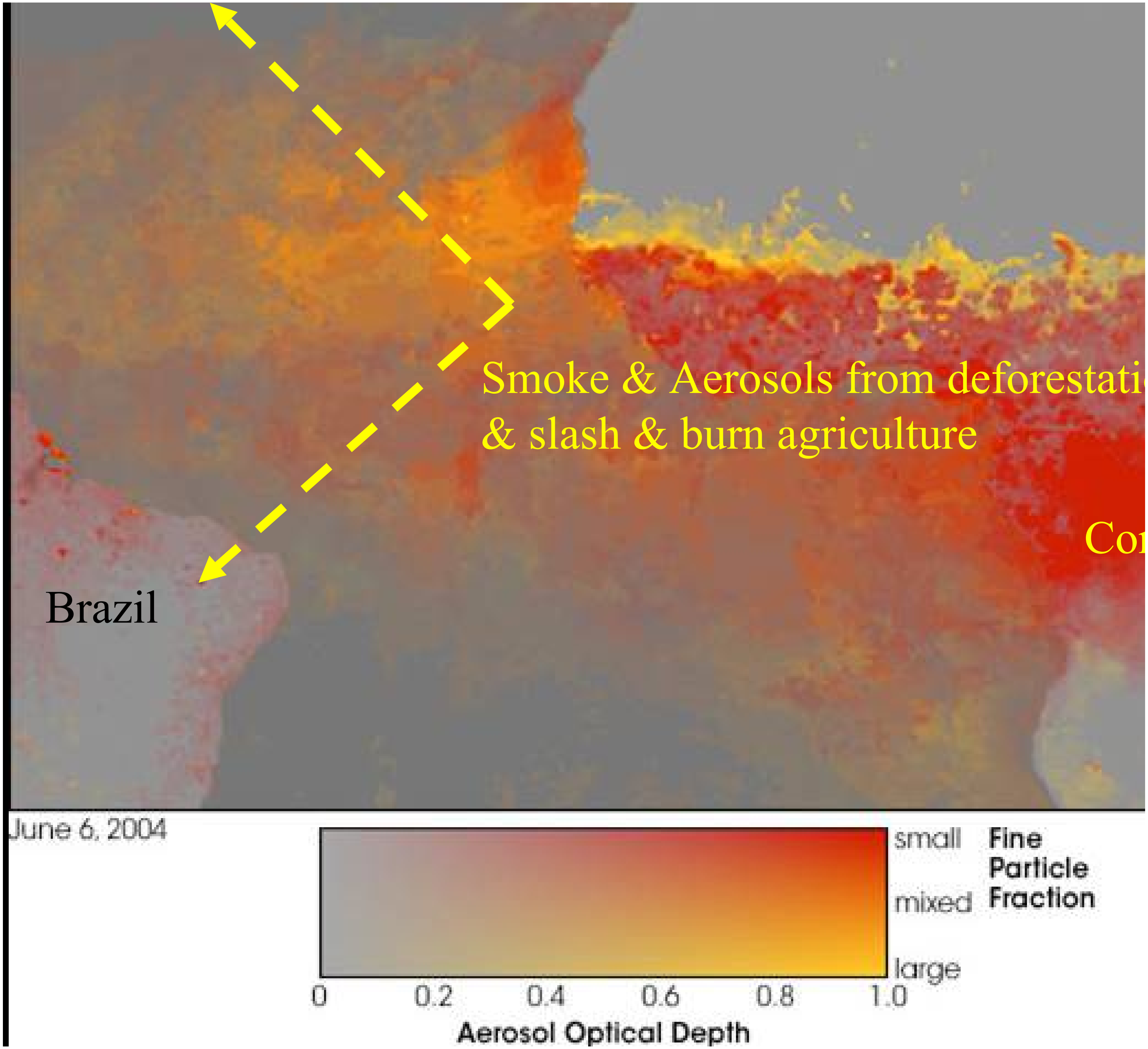
??????

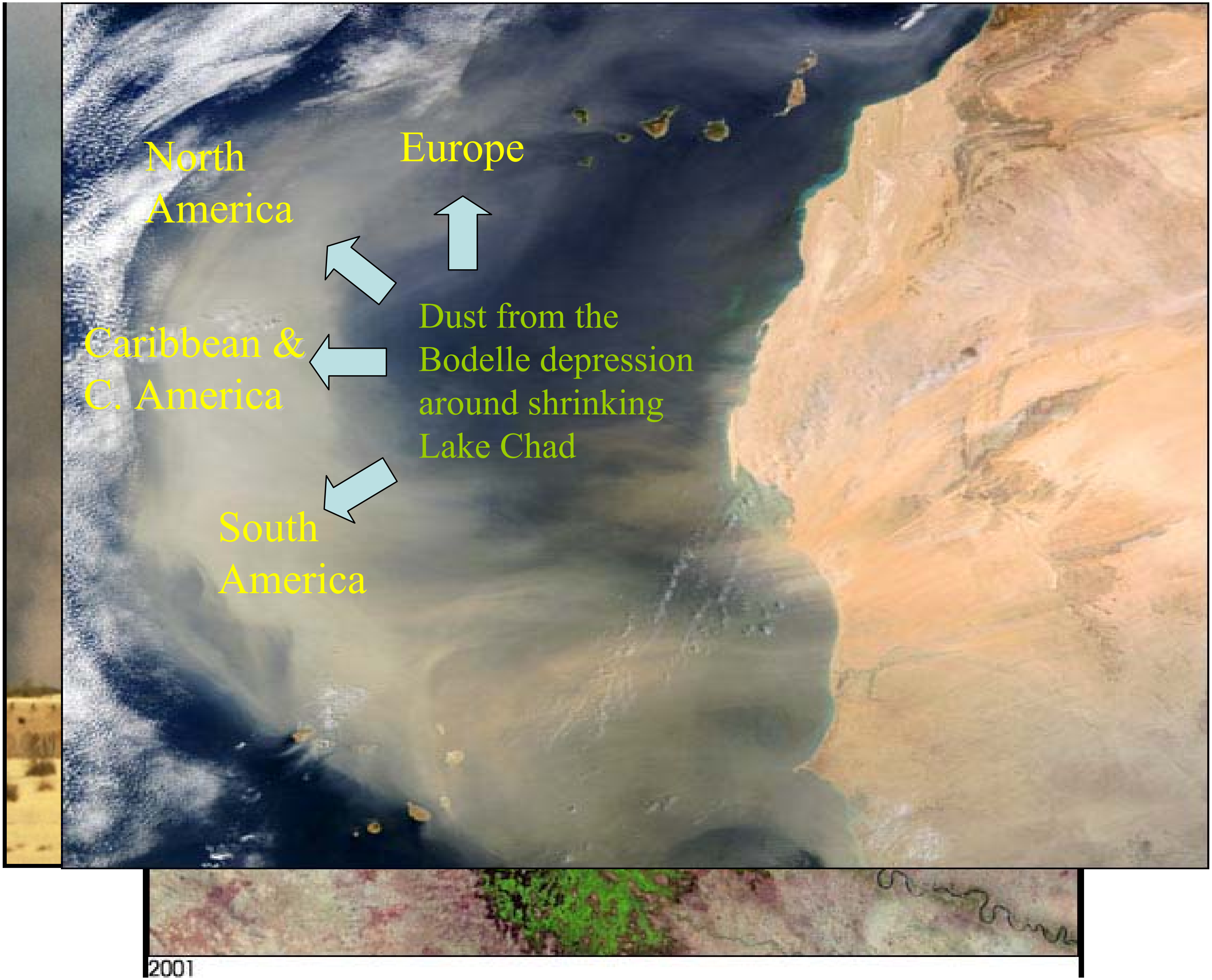


Sources: Meeting of the American Association for the Advancement of Science (AAAS), February 2001 ; Earthobservatory.nasa.gov.

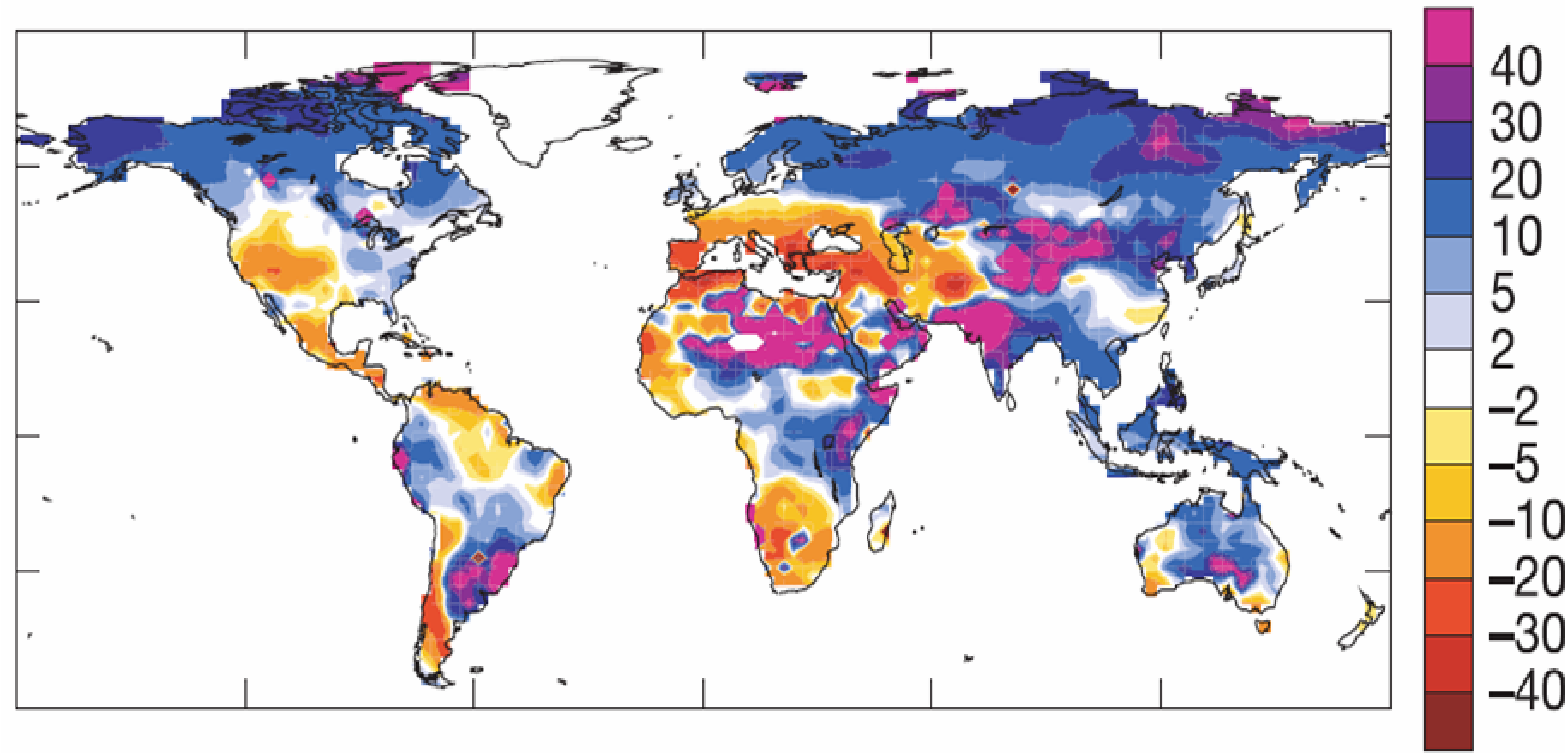


TRMM Visible & Infrared Sensor, Precipitation Radar
Borneo • March 1, 1998
Smoke/dust inhibits local rainfall
fires
water droplets
smoke
Pollution from Indonesian Fires Stretching to Africa
rain
No Rain
clouds


Smoke & Aerosols from deforestati
& slash & burn agriculture
Co
Brazil
June 6, 2004
small
mixed
large
Fine
Particle
Fraction
0
0.2
0.4
0.6
0.8
1.0
Aerosol Optical Depth

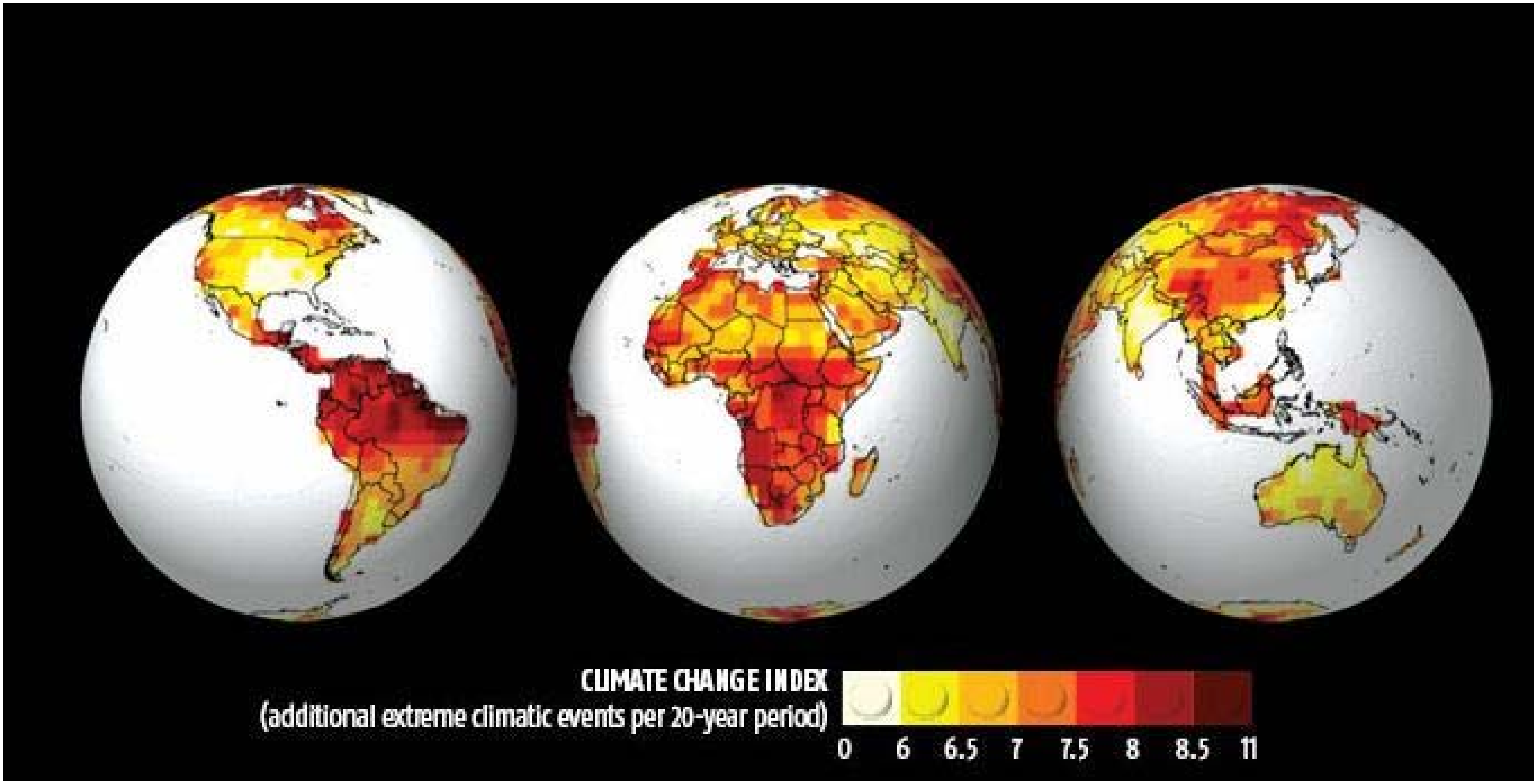

North America
Europe
Caribbean & C. America
Dust from the Bodelle depression around shrinking Lake Chad
South America
2001

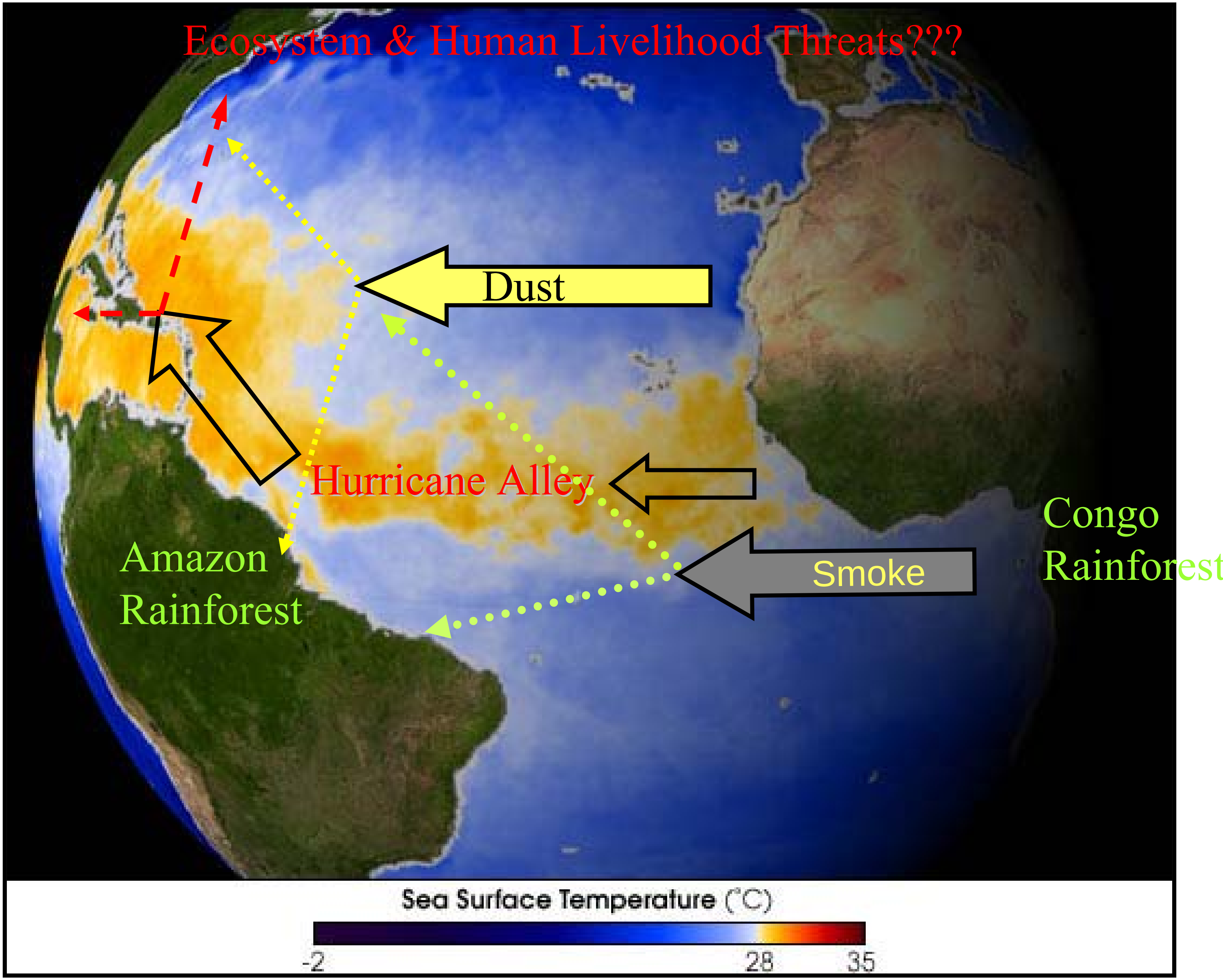
% change in runoff by 2050



- Many of the major “food-bowls” of the world are projected to become significantly drier
- Globally there will be more precipitation
- Higher temperatures will tend to reduce run off
- A few important areas drier (Mediterranean, southern South America, northern Brazil, west and south Africa)

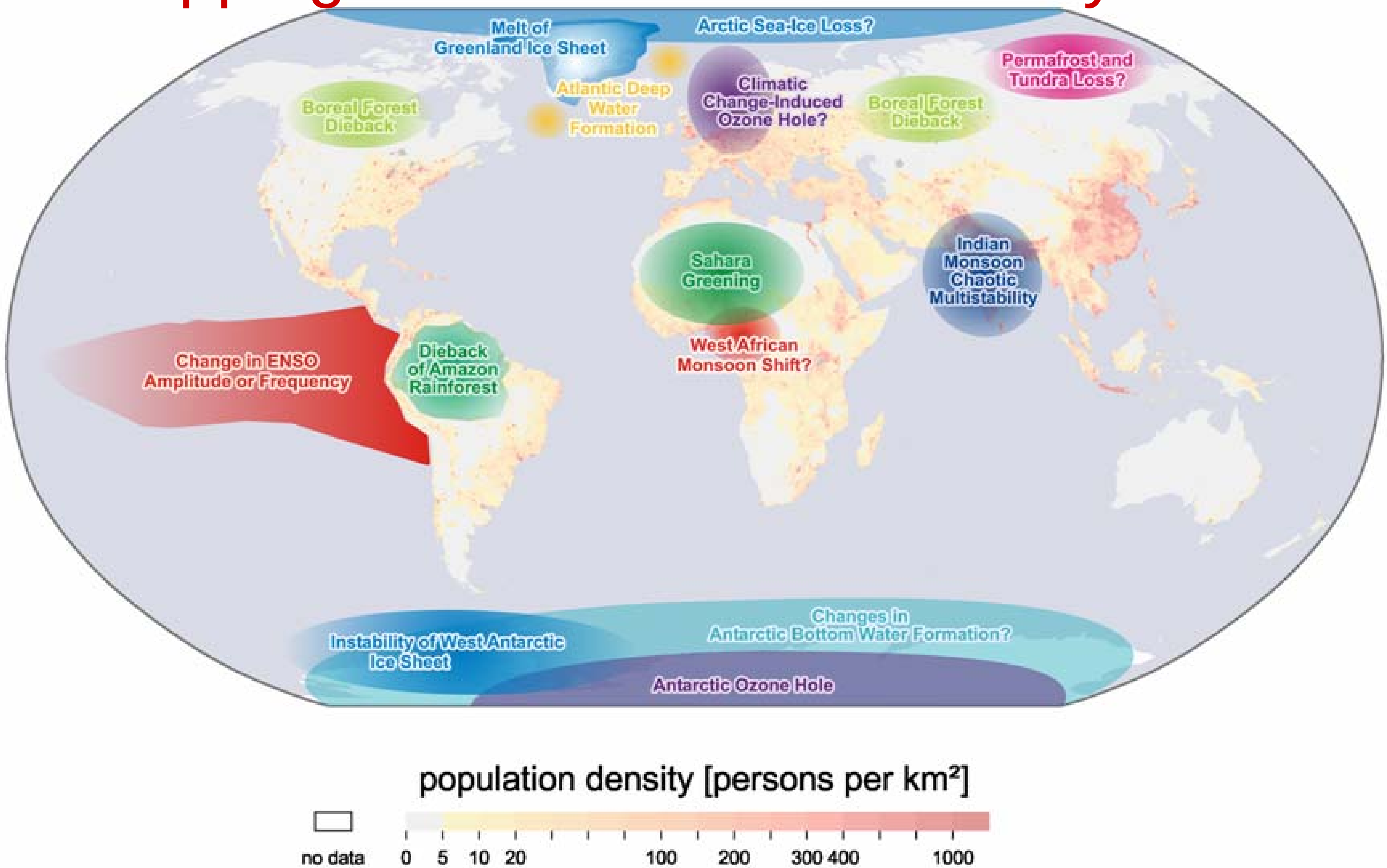
Projected Change in Frequency of Extreme Events in next 20 years





Ecosystem & Human Livelihood Threats???
Dust
Hurricane Alley
Amazon Rainforest
Congo Rainforest
Smoke
Sea Surface Temperature (°C)
-2
28
35

Tipping Elements in the Earth System



Source: Lenton, Held, Kriegler, Hall, Lucht, Rahmstorf, Schellnhuber, subm. to NATURE)

Progs. Banco Mundial

- GEF-MDL
- Carbon Funds (PCF, Biocarbon..) $50-80 million
- Reduced Deforestation and Degradation (Global Forest Alliance, Forest Carbon Partnership Facility + REDD) $50-200 million
- DFID Transformation Fund – clean energy, adaptation + mitigation ($1 billion)

Community and Research Experiences for Natural Resource Management and Improved Livelihoods

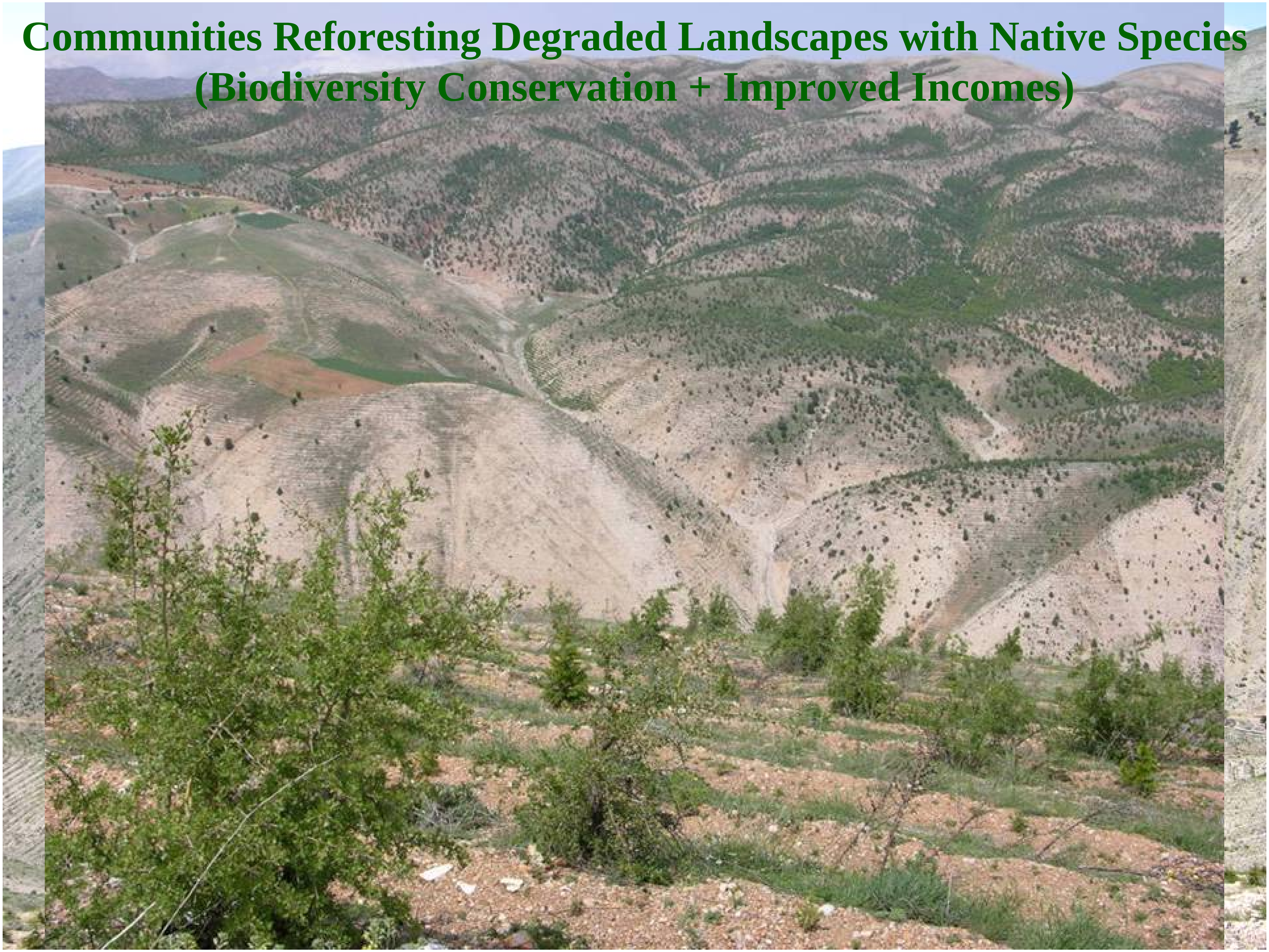
Loess Plateau, China

Community-Based Watershed Rehabilitation
Eastern Anatolia, Turkey

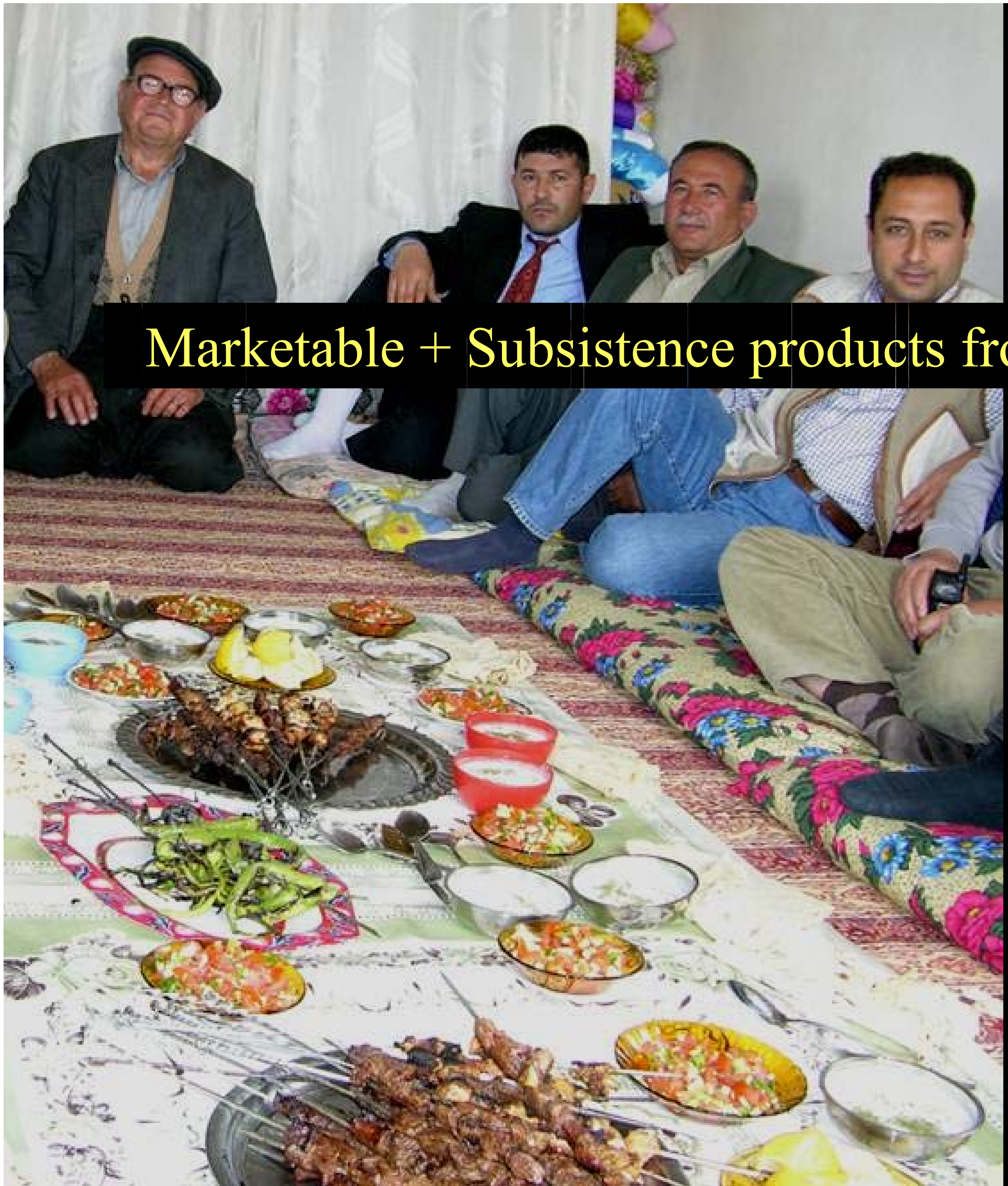
Traditional Grazing

- Access to common grazing land
- Impact on regeneration of local forests/woodland
- Community-driven watershed planning and management to ensure sustainability of rehabilitation impacts

Communities Reforesting Degraded Landscapes with Native Species (Biodiversity Conservation + Improved Incomes)



nd Flows



Marketable + Subsistence products from native species

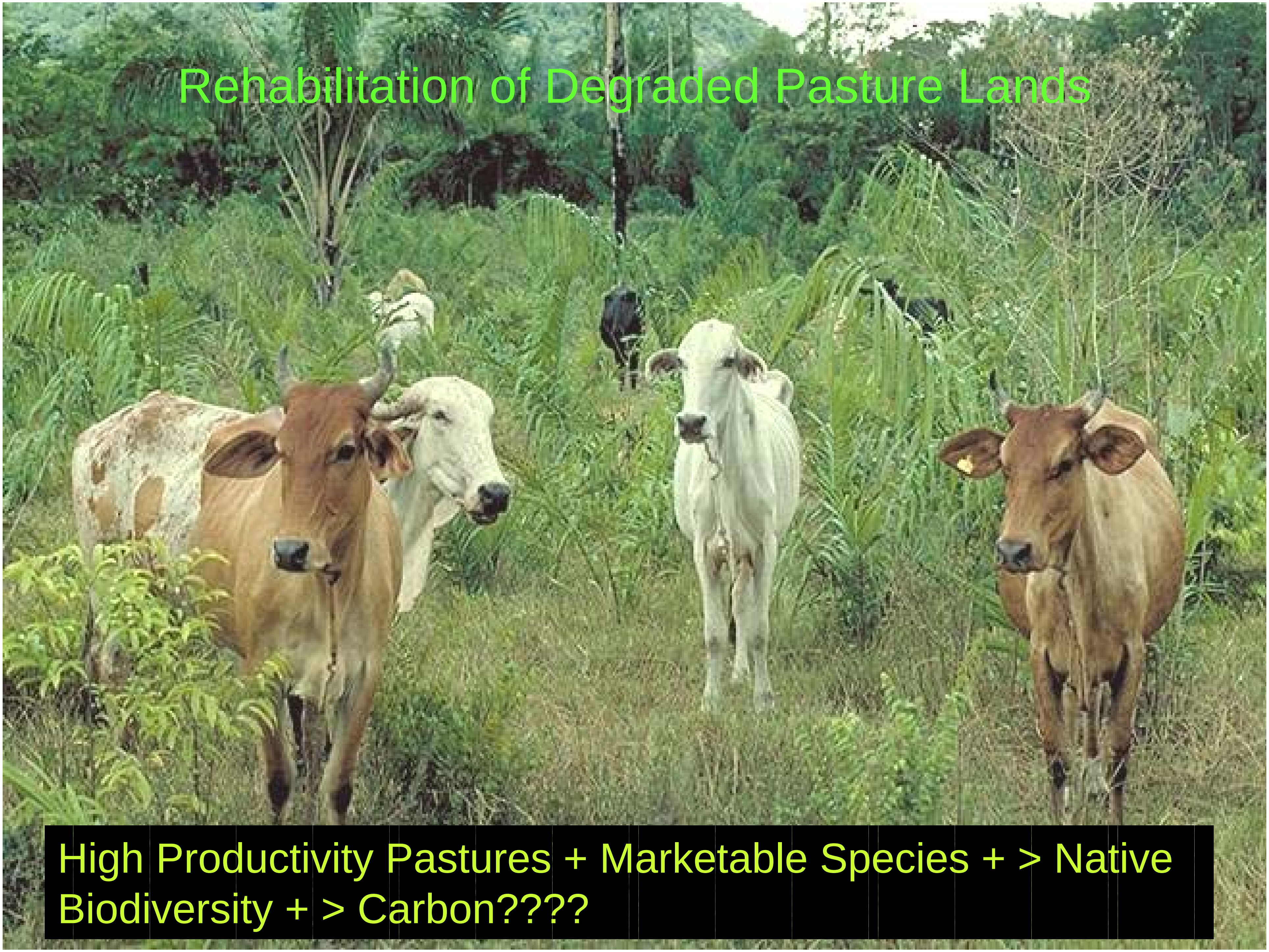
Community Management of Grazing & Watershed Protection

Rehabilitation of Sodic Lands - UP, India

Deforestation and Land Degradation:

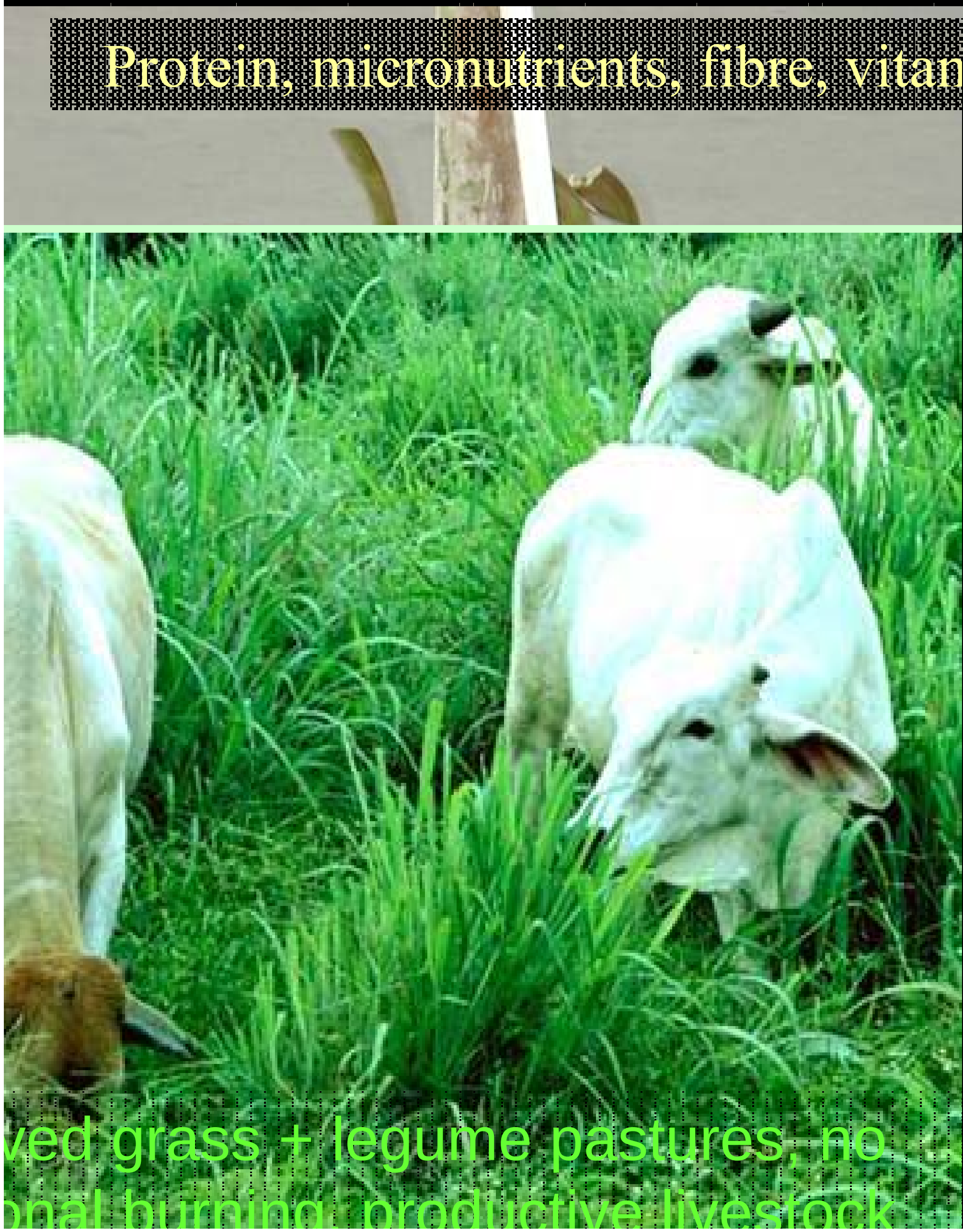
E

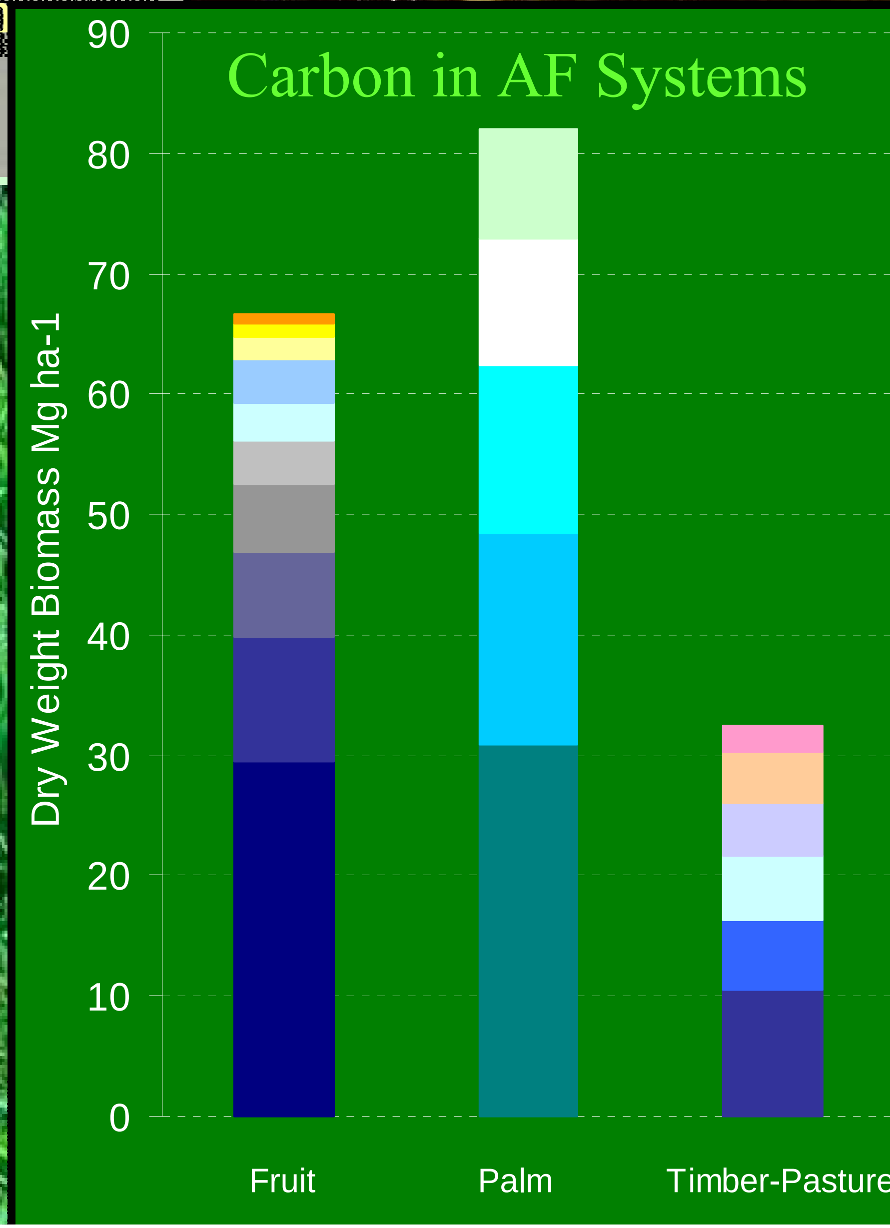
Rehabilitation of Degraded Pasture Lands



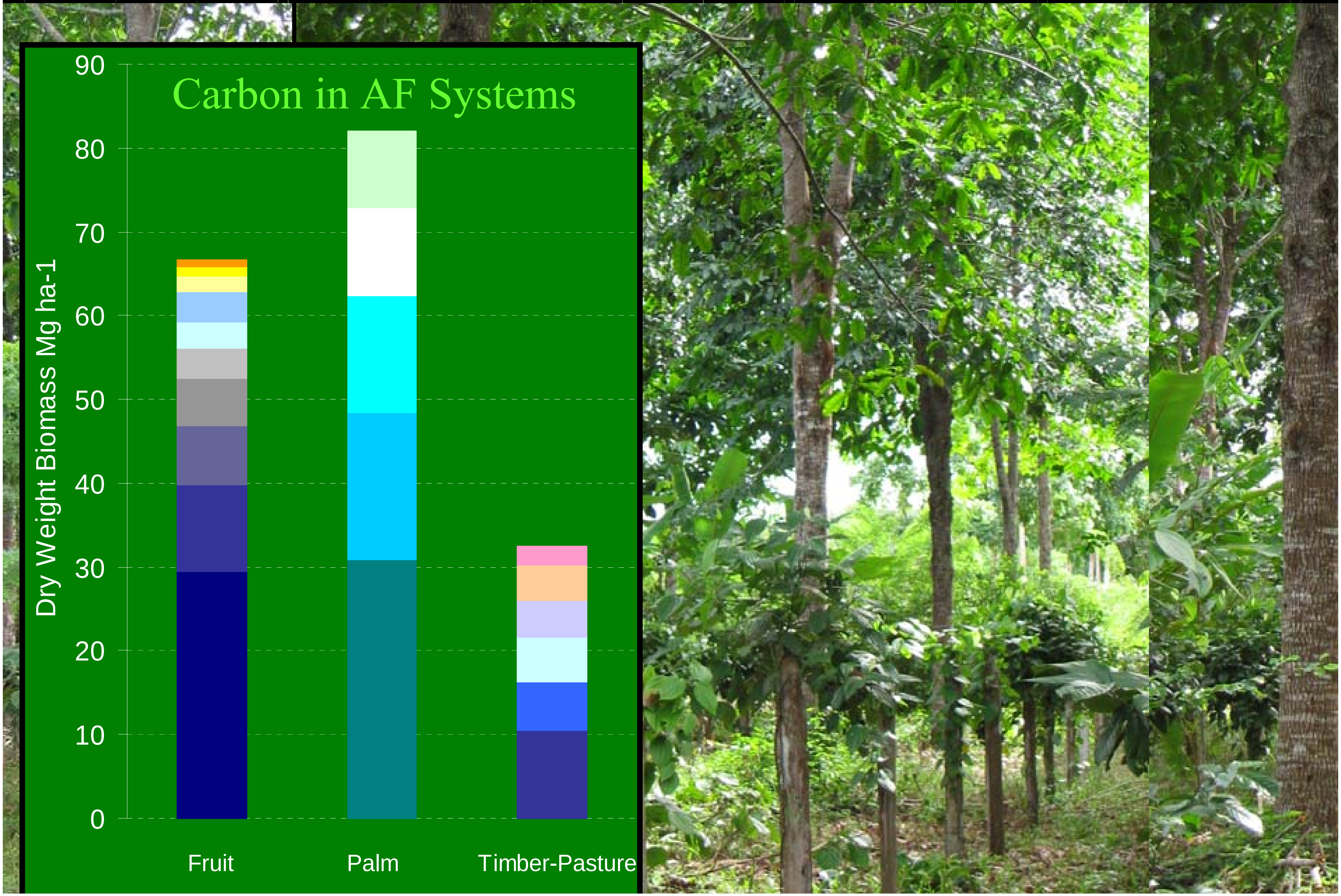
High Productivity Pastures + Marketable Species + > Native Biodiversity + > Carbon????

10-year-old Agroforestry System for livestock + marketable native fruits + high value timber on formerly degraded pastures in the Amazon





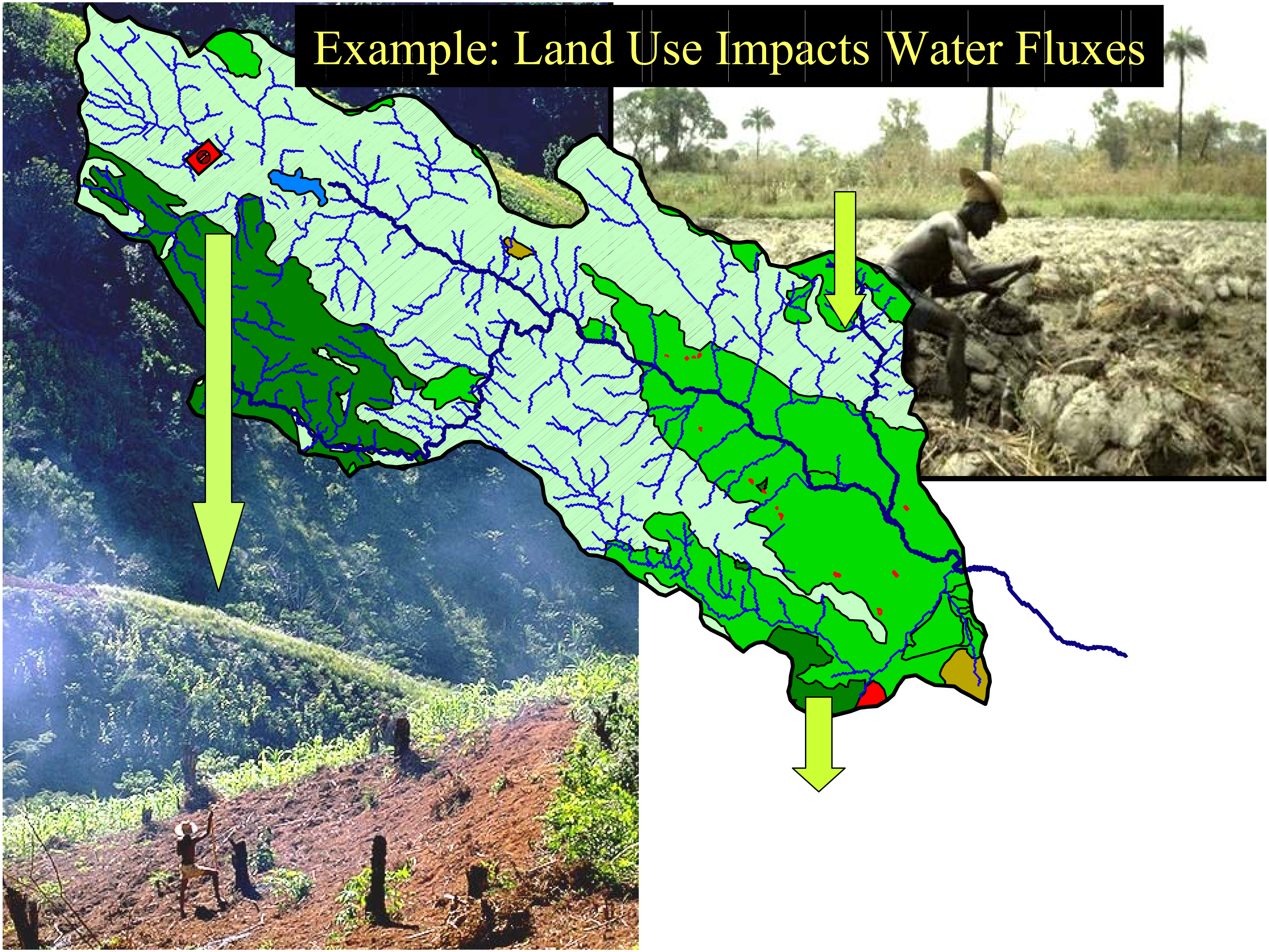
10-year-old Agroforestry System for marketable native fruits, nuts, high value spices + carbon on formerly degraded pastures in the Amazon



Tools for Evaluating Multisectoral Impacts on Environmental Services

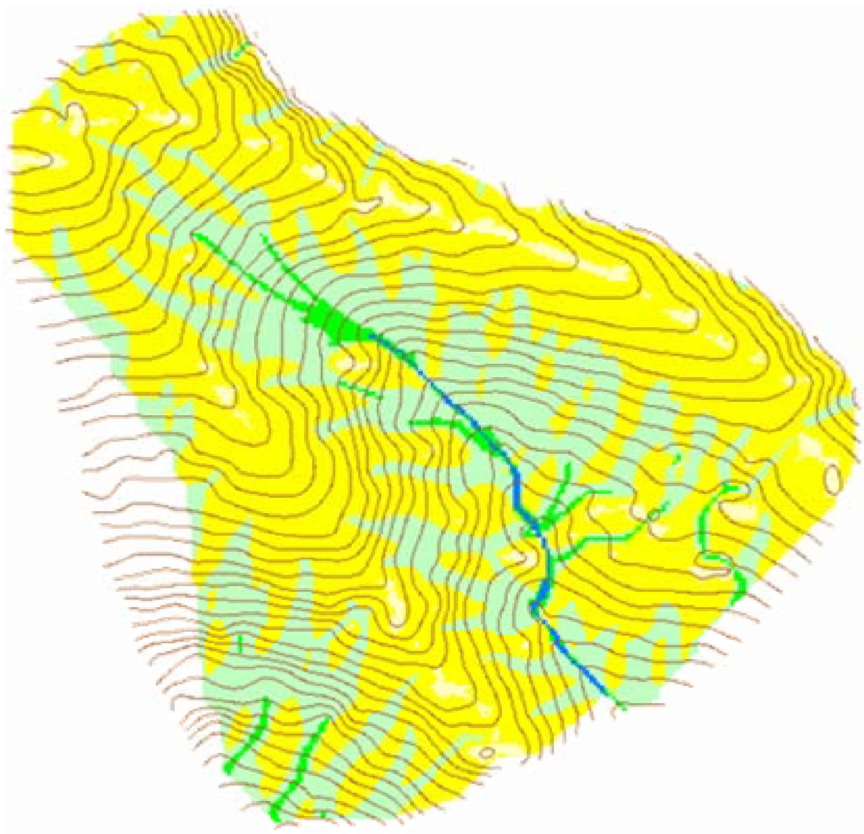
- Watershed and landscape assessment approaches (Digital elevation models, remote sensing & land cover assessments, dynamic basin & watershed models)
- Coupling scenarios to state of the art climate change estimates
- Use outputs of above approaches to inform all stakeholders (accessible Decision Support Systems, Discussions and input from civil society, Discussions of required policy changes)

Example: Land Use Impacts Water Fluxes



Terrain Analysis method

Example map of contributing area



Wetness index:

$$\omega = \ln\left[A_s / \tan\beta\right]$$

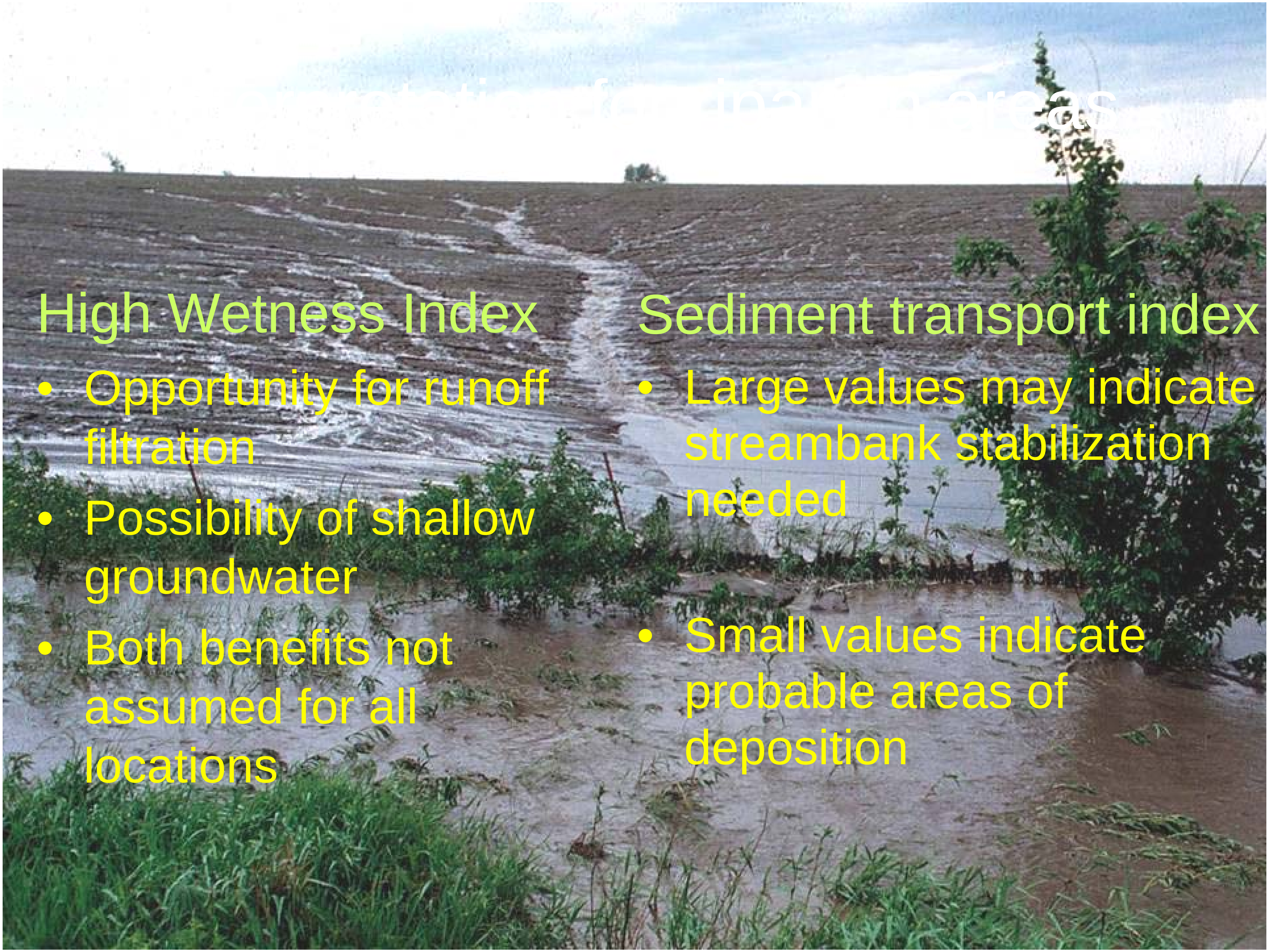
Sediment transport index:

$$\tau = \left(\frac{A_s}{22}\right)^{0.6} \left(\frac{\sin\beta}{0.09}\right)^{1.3}$$

A_s = contributing area

β = slope

Moore et al. 1991, 1992



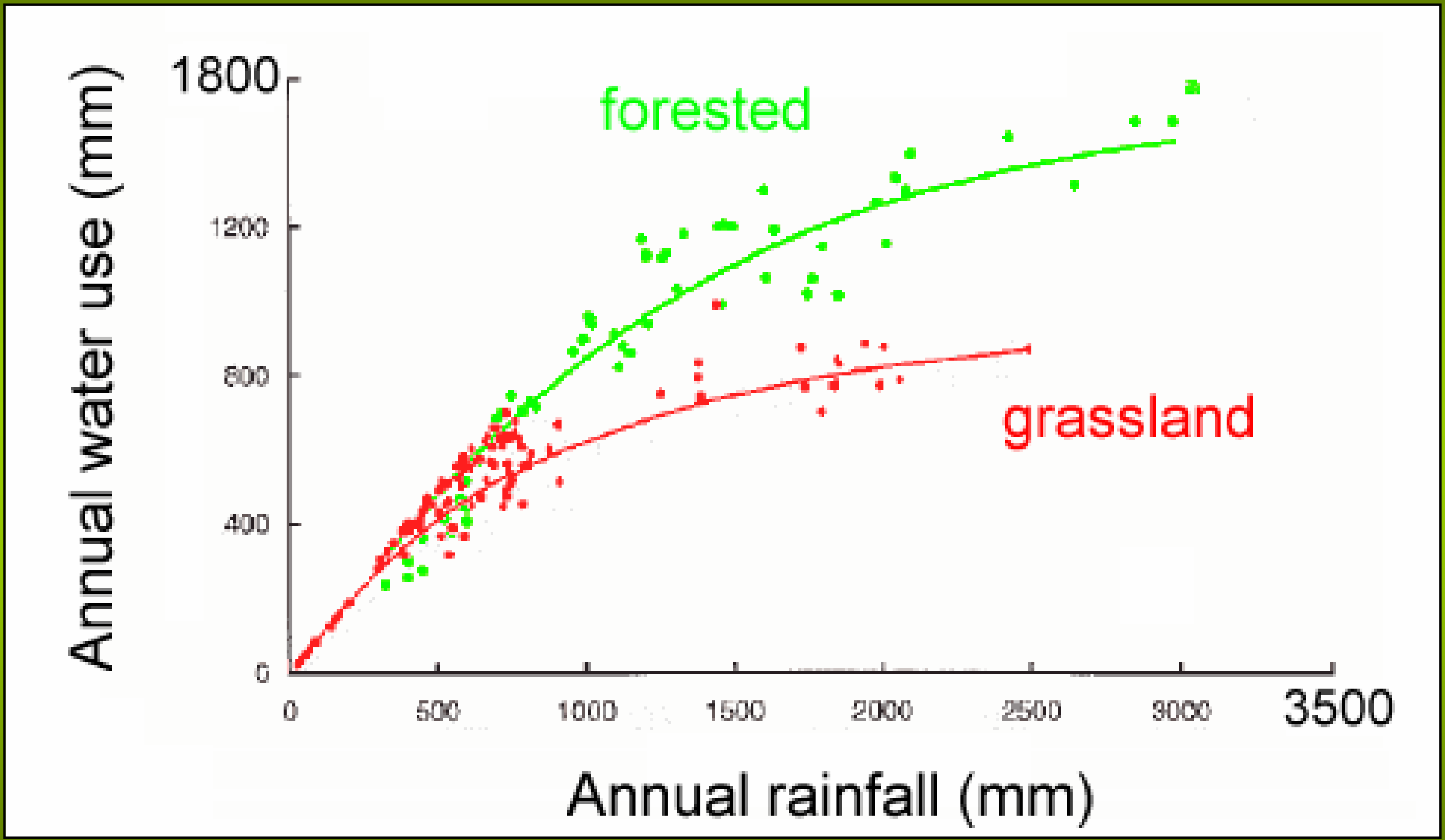
High Wetness Index

- Opportunity for runoff filtration
- Possibility of shallow groundwater
- Both benefits not assumed for all locations

Sediment transport index

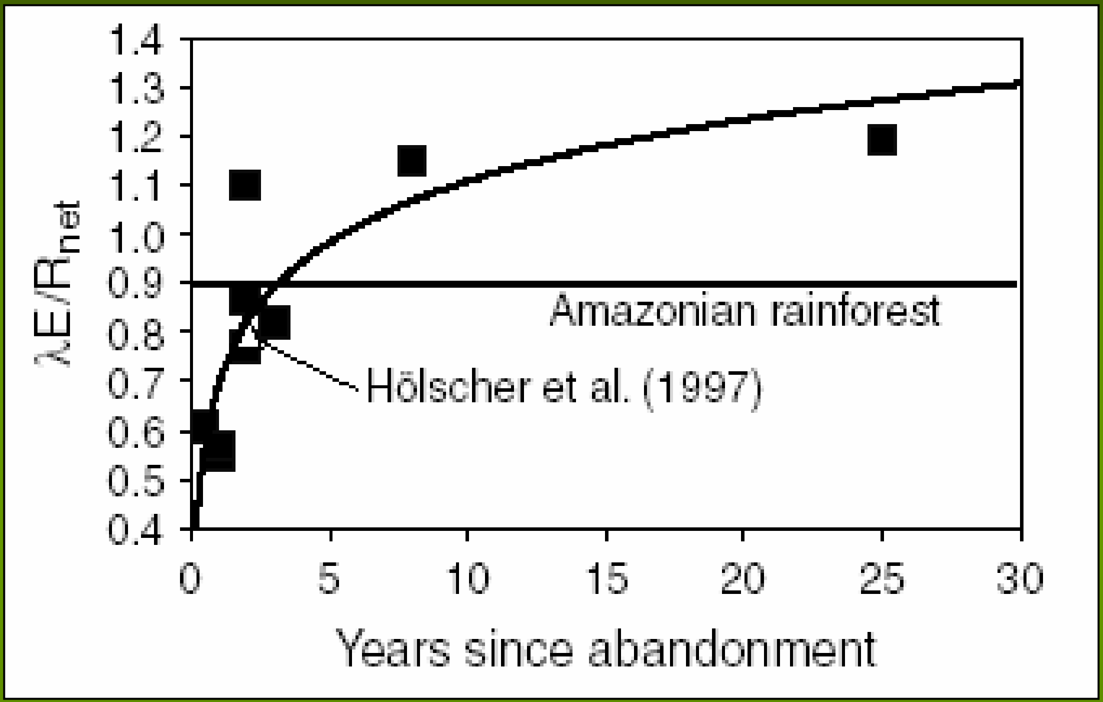
- Large values may indicate streambank stabilization needed
- Small values indicate probable areas of deposition

Water Use – Plantation Forests v Grasslands



(Source: Zhang et al., 2001)

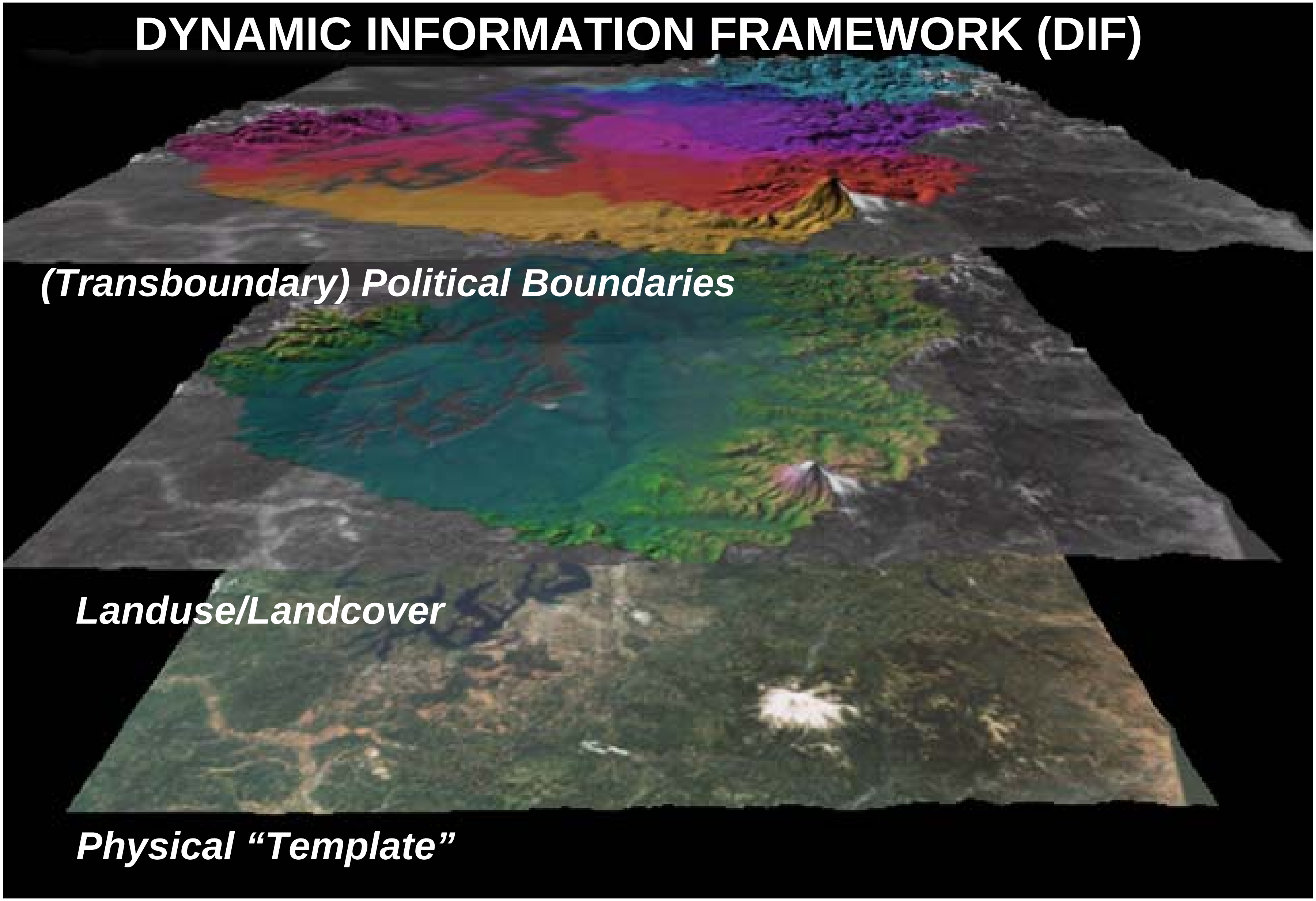
Enhanced water use during rapid regrowth - 2



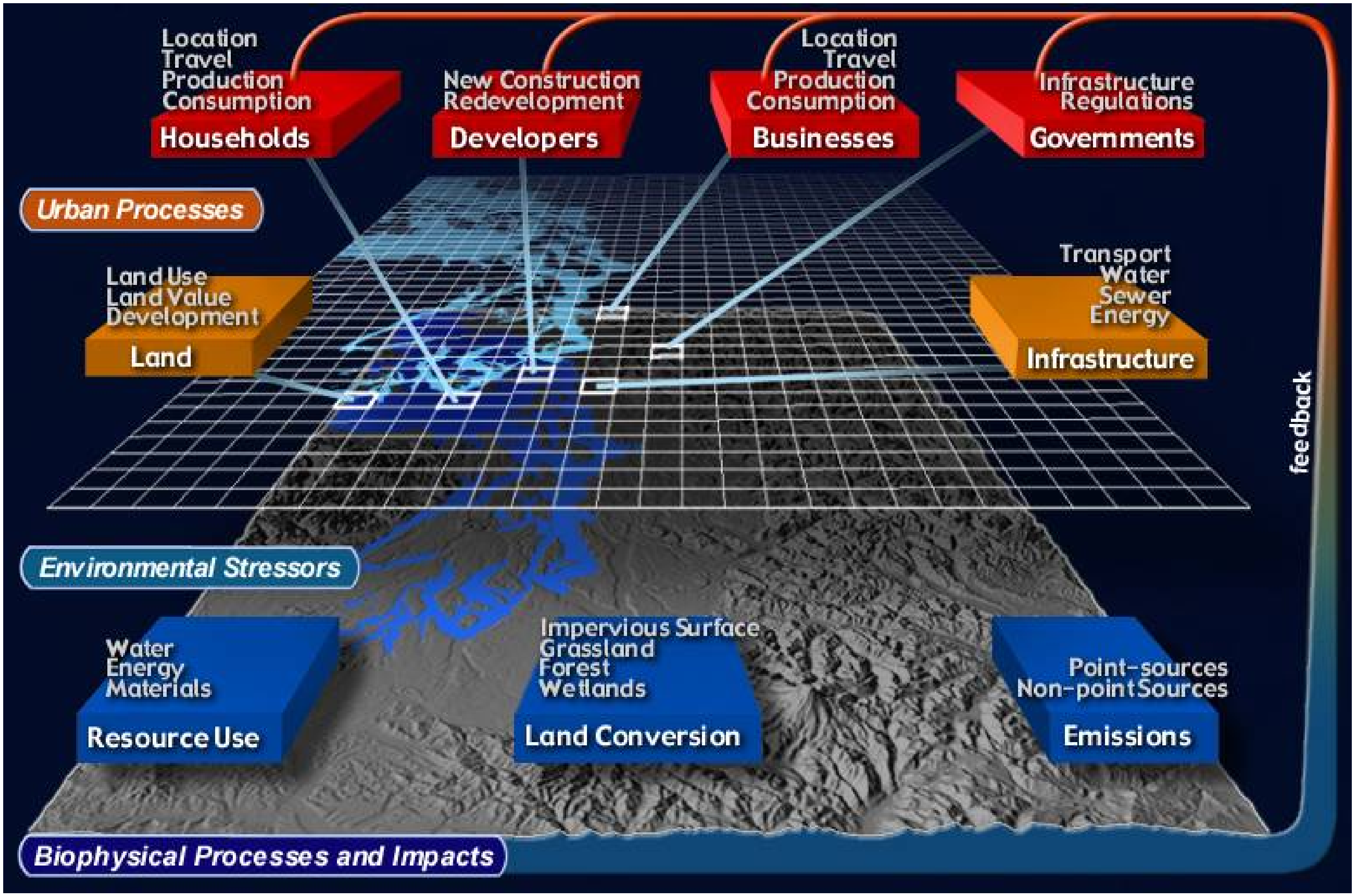
- Water use of secondary growth exceeds that of old-growth tropical rain forest within 3 - 5 years (Amazonia).
- Maximum difference in water use 350-400 mm / year? Duration of higher evaporation 50 years?

Source: Bruijnzeel citing Giambelluca (2002)

Geospatial Organization of Information & Data (Socio-political, biophysical)



Multisectoral, Geospatially-Referenced Baseline Data



Example of a "DIF" for Harmonizing Watershed Functions for Multiple Users

•Process of creating the model provides an integration of data from multiple sources (of interest to many)

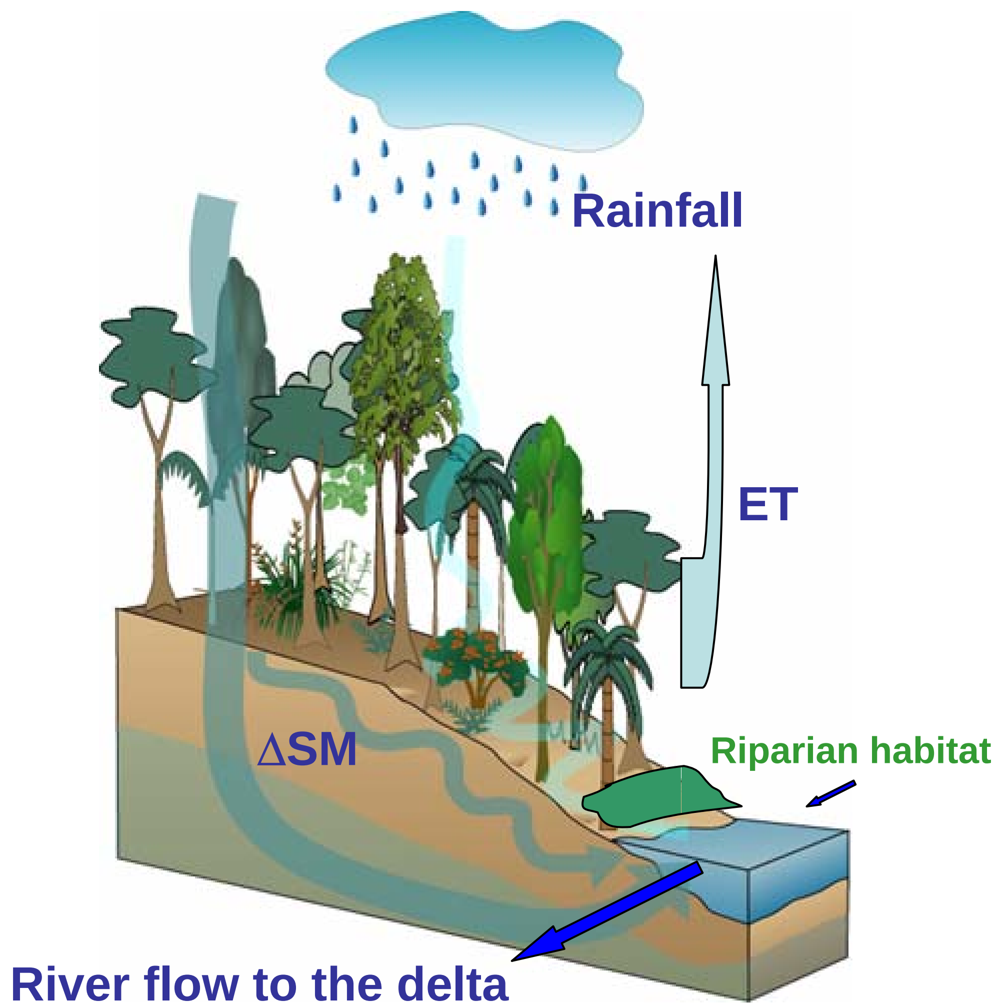
Provides a means for ~intelligent interpolation for sparse data. Also, provides the basis for cross-scale/upscaling analyses.

Provides an instrument for a (quantitative) analysis of complex interdependent problems

•Provides a foundation for "scenarios"

Climate – Landsurface – Water Cycle (1)

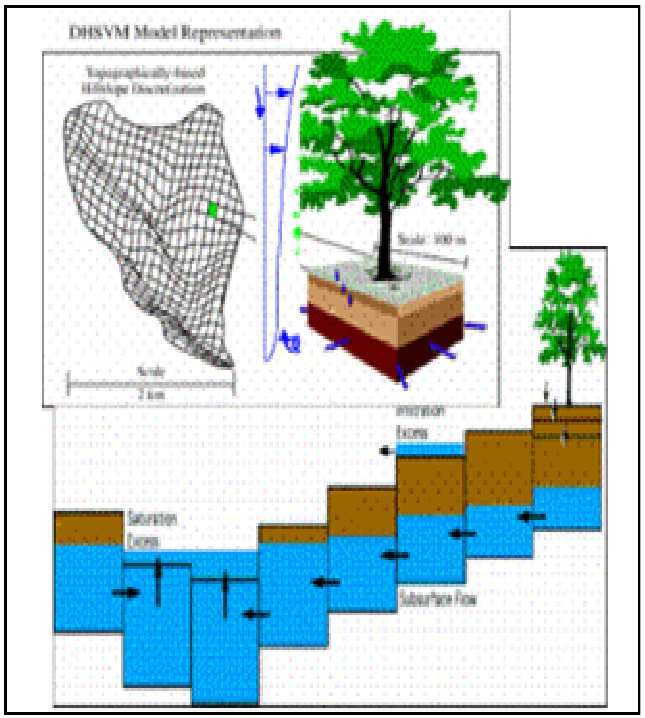
Q (river flow) = P (rainfall) - ET (evapotranspiration) + ΔSM (soil moisture)



Bring it to life: geospatially-explicit, process-based Landscape-Hydrology Models

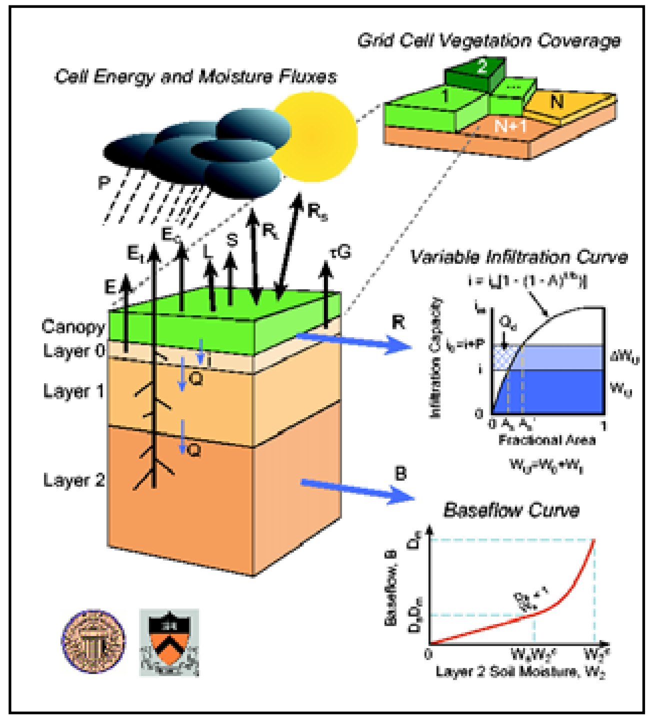
Small-Scale

e.g., DHSVM (Distributed Hydrology Soil Vegetation Model) Micro/Mesoscale Landscape/Hydrologic Model (high to moderate resolution)



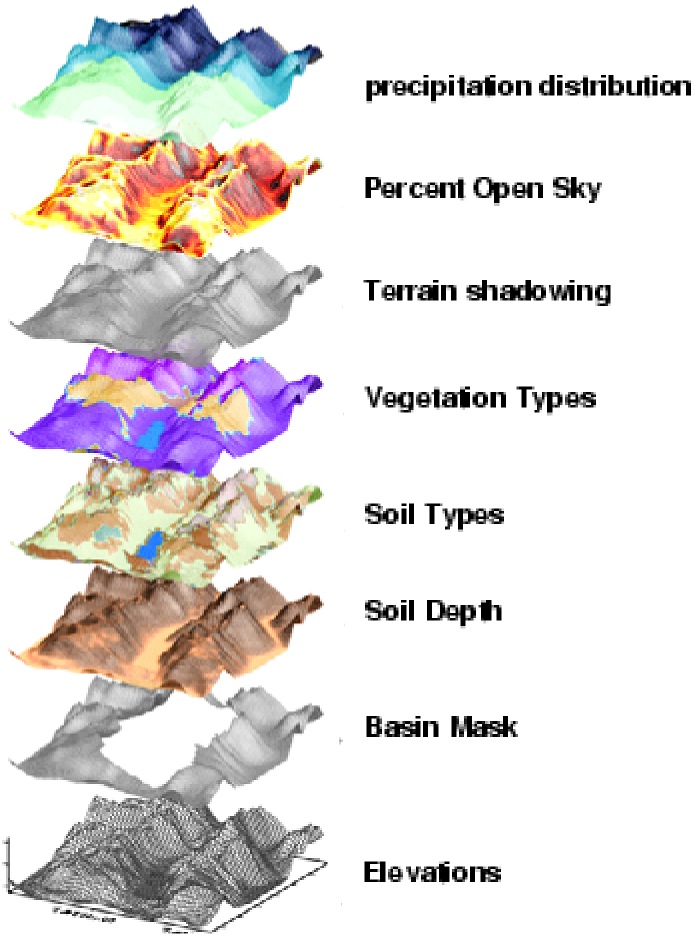
Large Scale

e.g. VIC (Variable Infiltration Capacity) Meso/Macroscale Landscape/Hydrologic Model. (moderate to large-scale resolution)

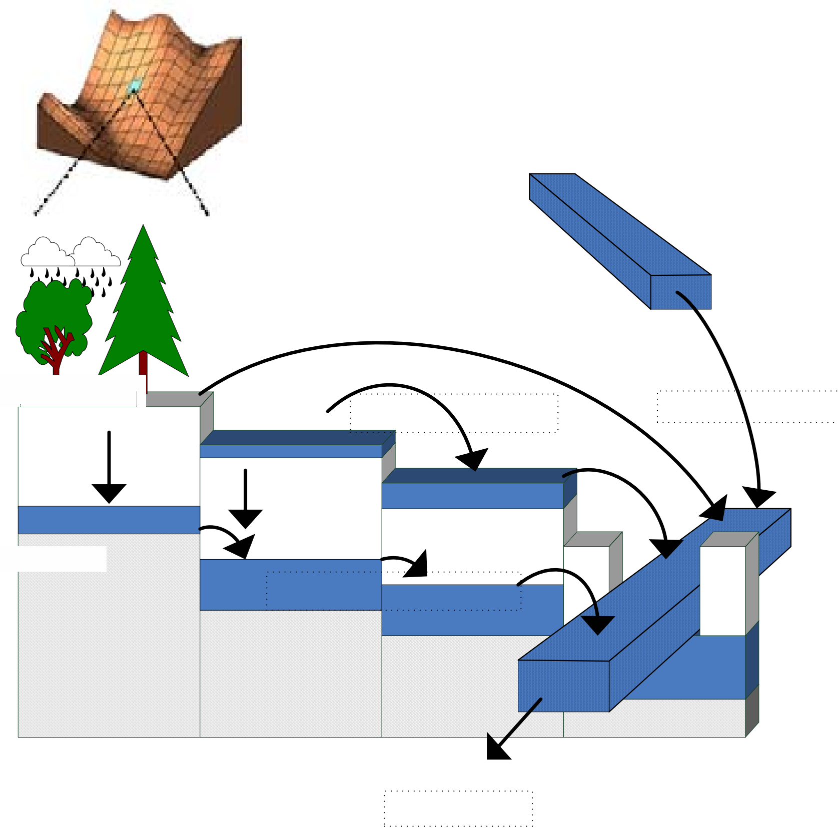


Climate – Landsurface – Water Cycle (2)

Climate and landscape structure

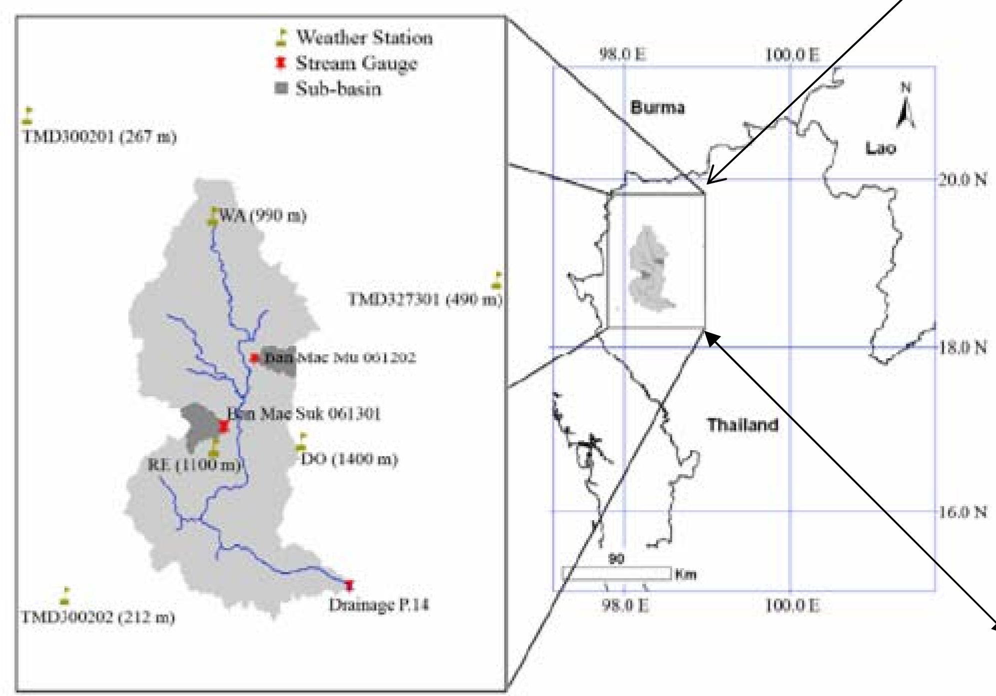


Water and “stuff” movement



Effects of landuse change on the hydrologic regime of The Mae Chaem river basin, NW Thailand

*Thanapakpawin et al (in press) J. of Hydrology**

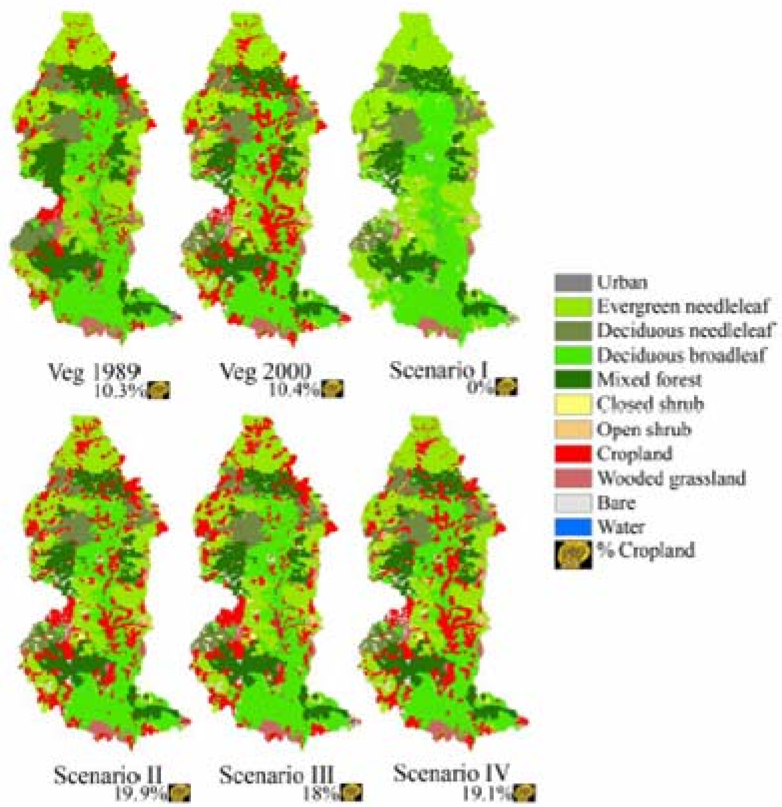


4000 km²/Sparse Data

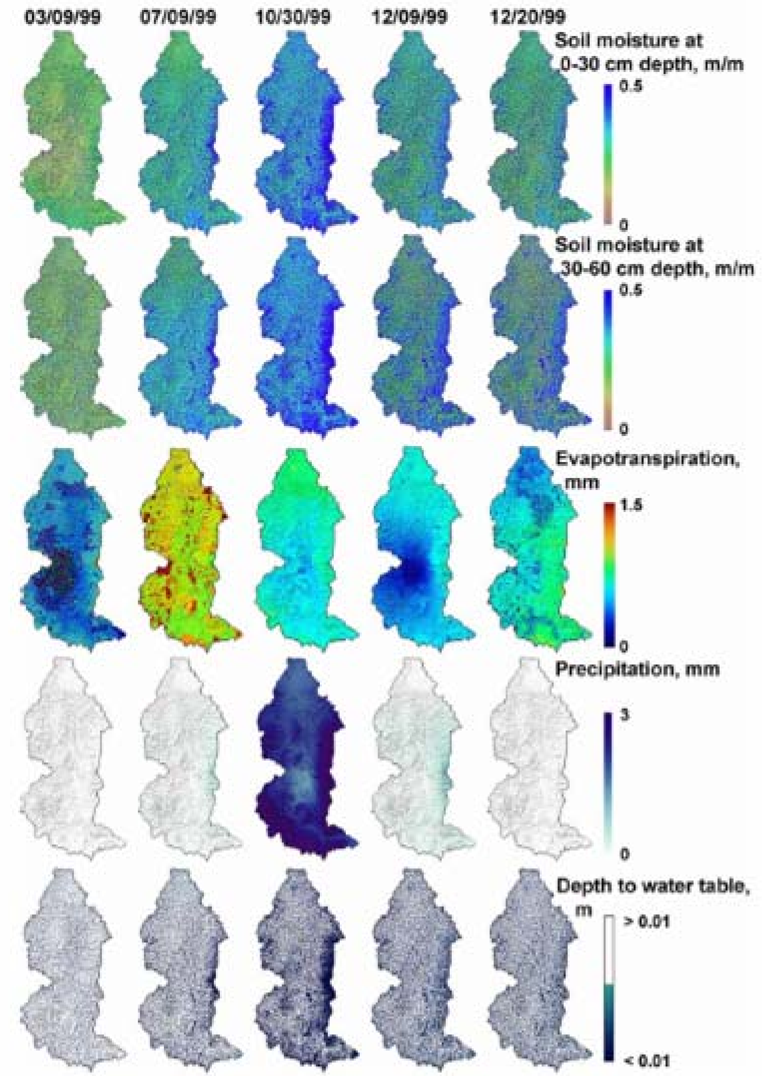
***NSF, BNPP Functional Value of Biodiversity**

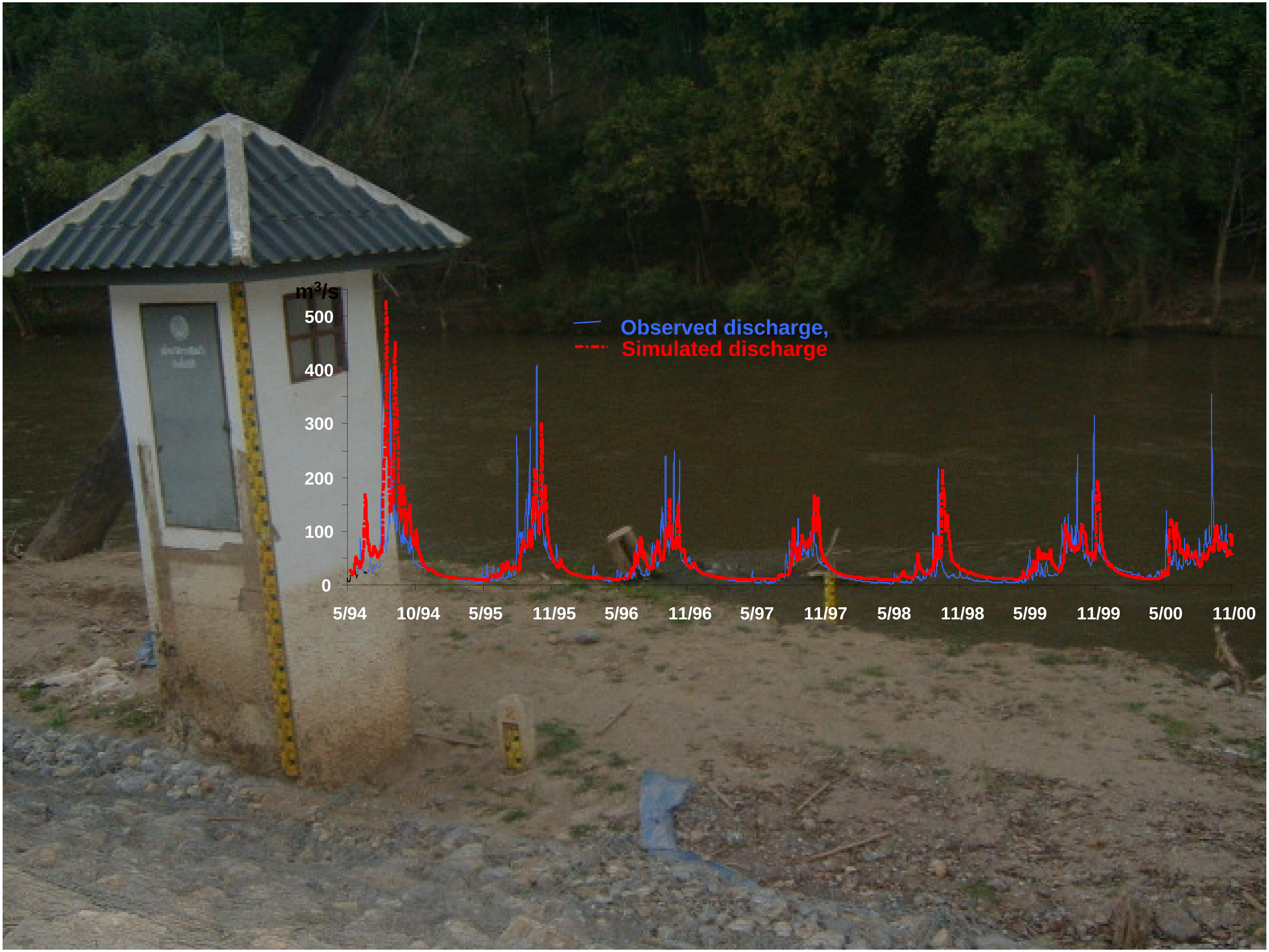
Derive Land Cover Scenario Impacts on Hydroshed Functions

Landcover Scenarios



Underlying Dynamic Changes

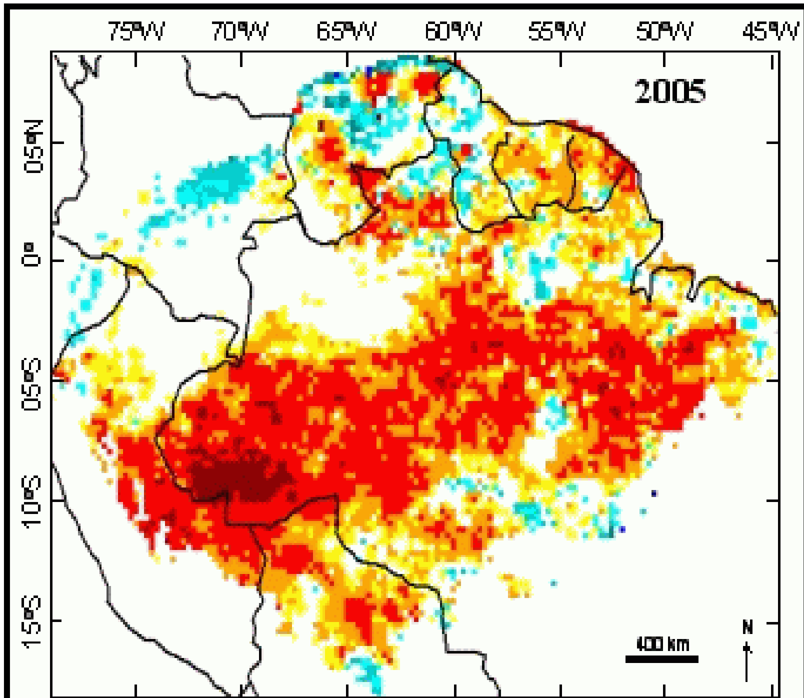



m3/s
500
400
300
200
100
0
Observed discharge,
Simulated discharge
5/94
10/94
5/95
11/95
5/96
11/96
5/97
11/97
5/98
11/98
5/99
11/99
5/00
11/00

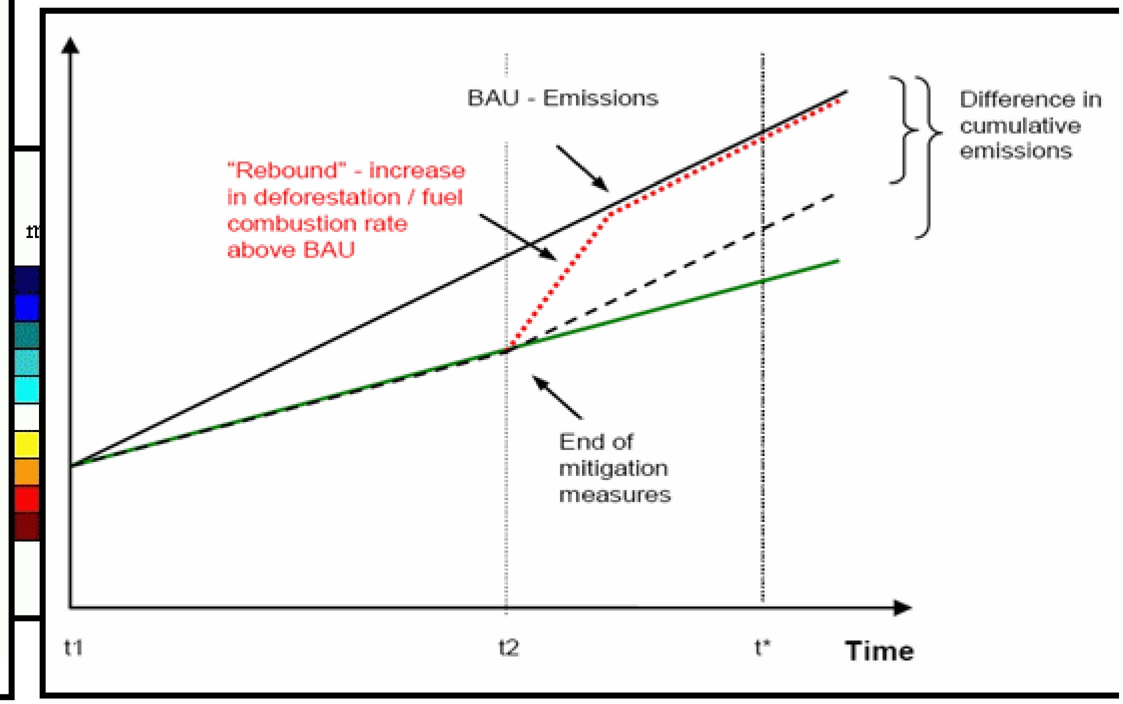
Simulating Land Cover Change Impacts on Hydrology

Landcover scenarios		Average hydrologic components (1995 – 2000)			
		Annual yield, mm (m^3/s)	High flow, m^3/s^a	Low flow, m^3/s	Annual evapotranspiration, mm
Veg 2000	I	215 (26.2)	54.7	7.6	762
	NI	249 (30.5)	58.6	12.0	727
Scenario I	NI	223 (27.2)	53.3	11.1	752
Scenario II	I	202 (24.7)	53.6	5.8	781
	NI	261 (31.8)	61.2	12.5	715
Scenario III	I	220 (25.6)	56.8	7.0	759
	NI	269 (32.8)	63.1	12.7	707
Scenario IV	I	193 (23.6)	51.6	5.6	786
	NI	251 (30.7)	59.1	12.2	724

Risk of Non-permanence of Environmental Services



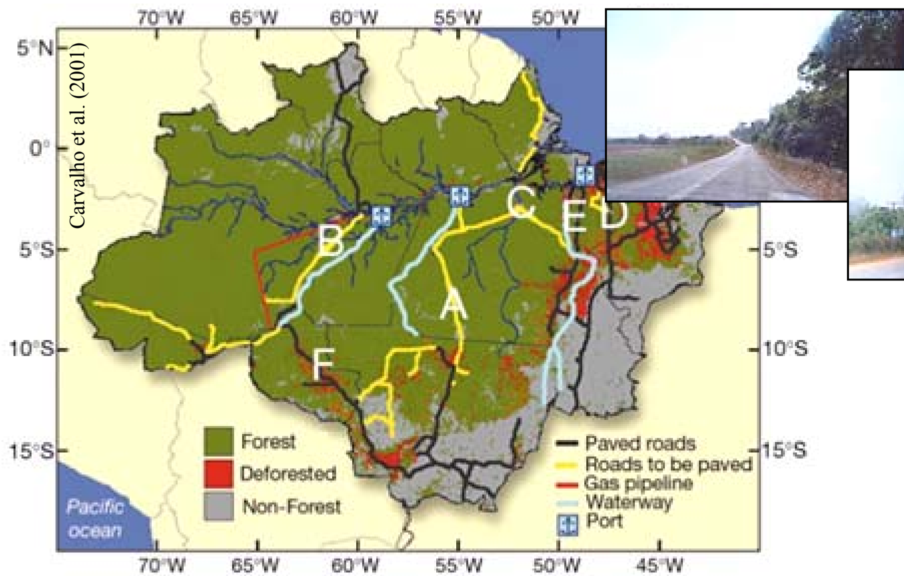
Aragao (2007)



Climatic risk Feedbacks and tipping points - droughts, fires

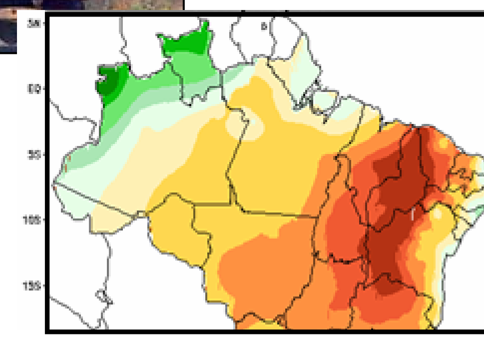
Anthropogenic risk: "Rebound" after temporary deforestation prevention

Risk of Non-permanence of Environmental Services
Infrastructure and Land Use Changes



Land use

Dry season



At year-decade time scales, the majority of fires in Amazonia occur during the dry season as a result of land use

Source: Nobre, C. 2007

Prepare for the Future?
Goal should be to ensure resilience of landscapes for local, livelihoods AND local, regional and global environmental services.
Source: Dr. Virgílio Viana
The Drought of Amazonia in 2005!!