International Workshop
Erosion, Transport, and Deposition of Sediments
Bern April 28-30, 2008

Soil Erosion Modeling & Control in Brazil: Past, Present, and Future

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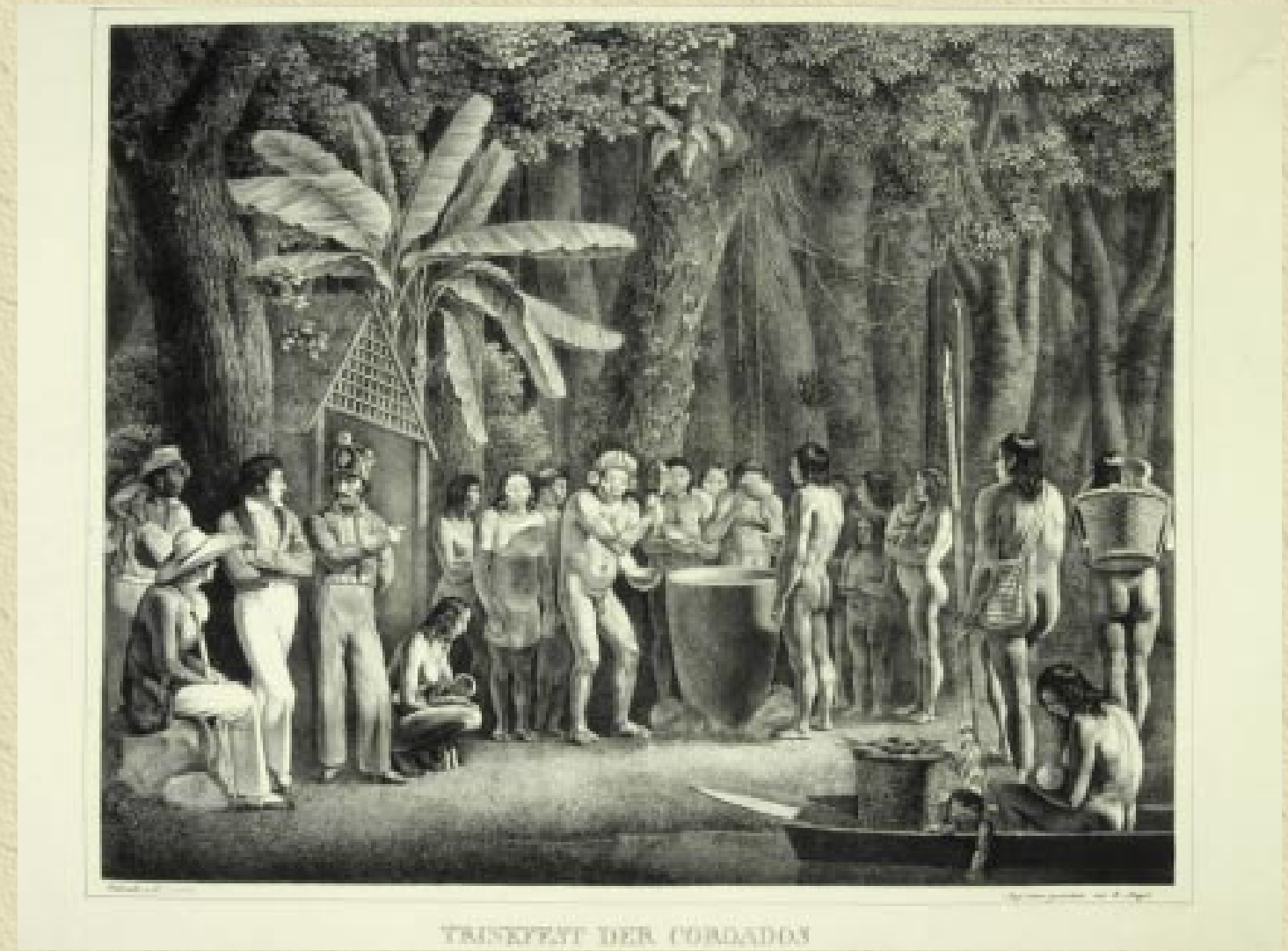
Outline

1. Erosion & Sedimentation in Brazil: Lessons from the Past
2. Assessment of the present: Erosion & sedimentation modeling & control
3. Vision of the future: Can we achieve sustainability?
4. Conclusions

1. Lessons from the Past

- Brazil's economy relied strongly on agriculture & mining
- The lush native forest was considered an "enemy" to be conquered
- Little concern existed about soil protection & conservation
- As a result, severe erosion & sedimentation occurred



Spix & von Martius (1820)

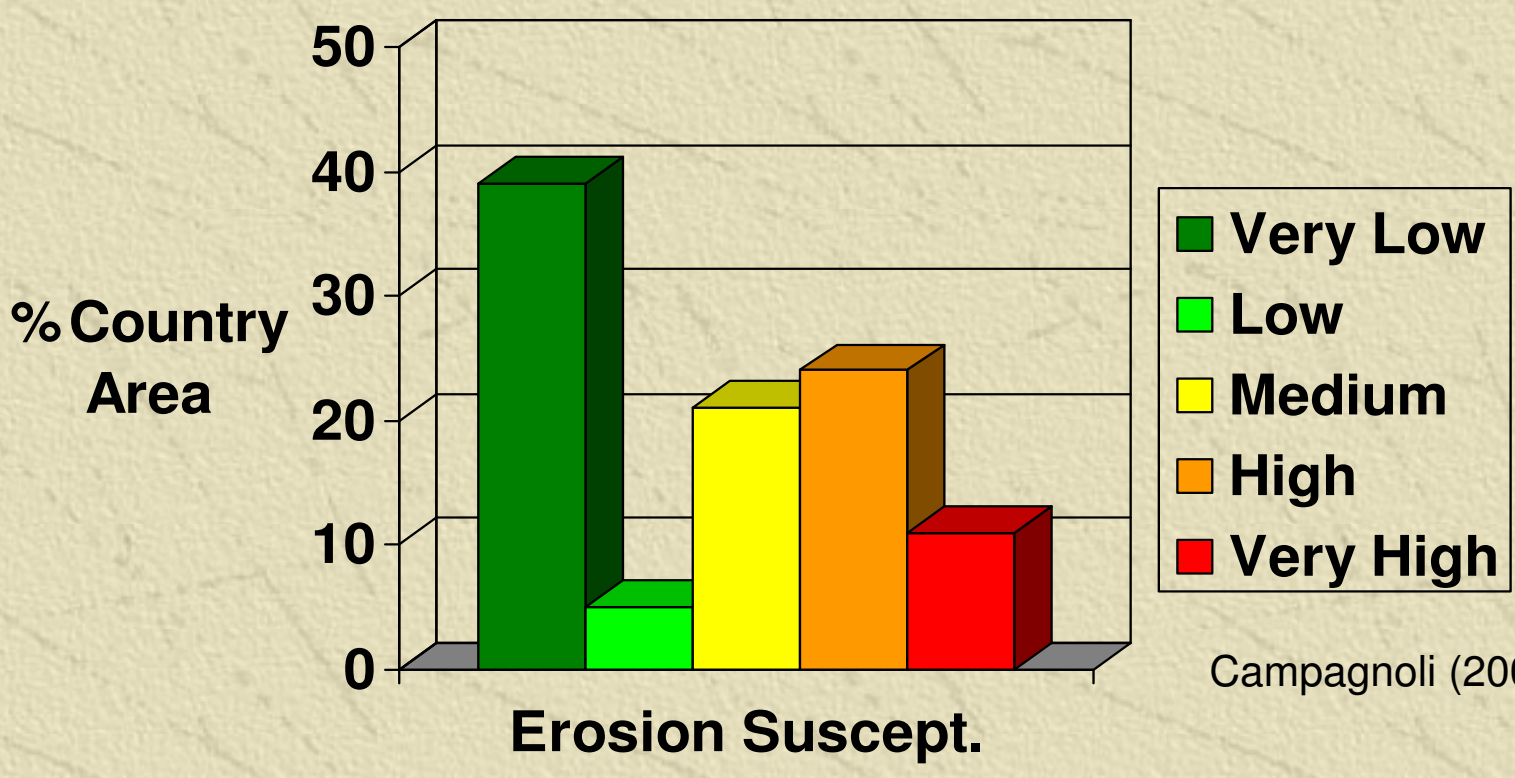
2. Assessment of the Present

- 28% of Brazil's territory is under crop & pastureland (2,4 M km^2)
- Under conventional systems, erosion rates exceed 20 tons per hectare per year
- Soil loss tolerance is 10 t /ha yr
- As a result, over 2 billion tons of sediment silt up rivers & lakes
- Off-site costs: US$ 1 billion/yr
- Impacts threaten sustainability

Assessment of Erosion Susceptibility

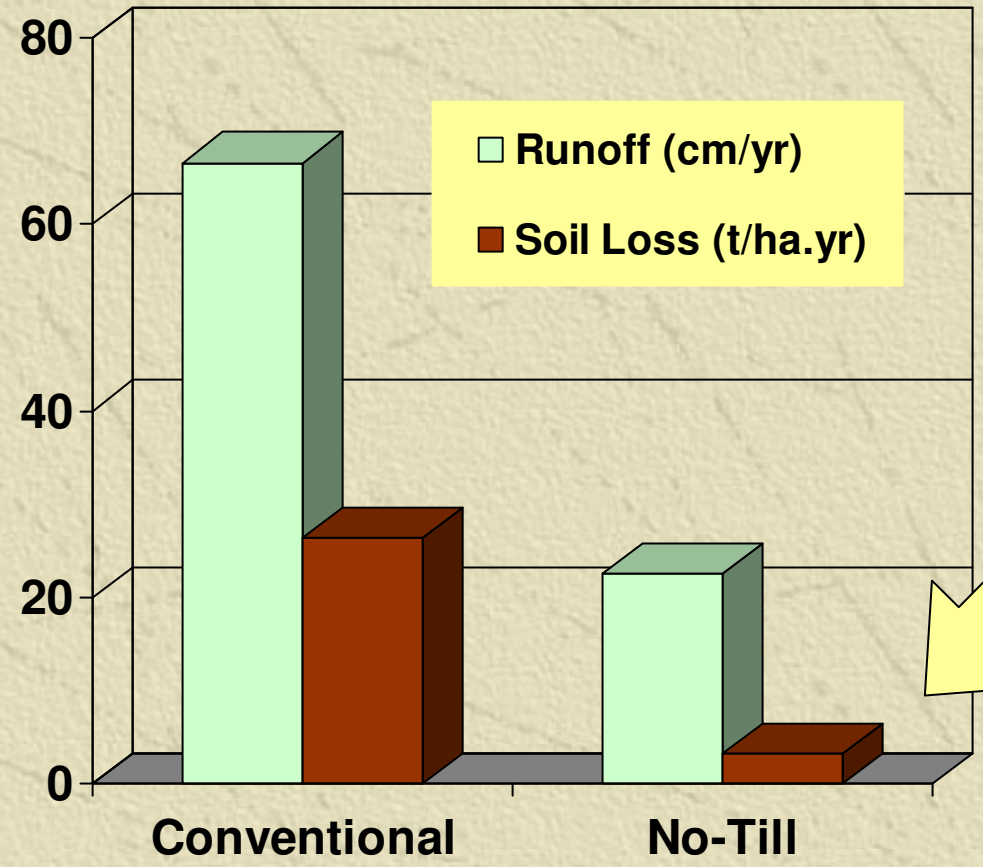
Sigla	Região Hidrográfica
A	Amazônica
B	Tocantins
C	Atl. Nc Ocidental
D	Parnaíba
E	Atl. Nc Oriental
F	São Francisco
G	Atl. Leste
H	Atl. Sudeste
I	Atl. Sul
J	Uruguai
L	Paraná
M	Paraguai

Assessment of Erosion Susceptibility



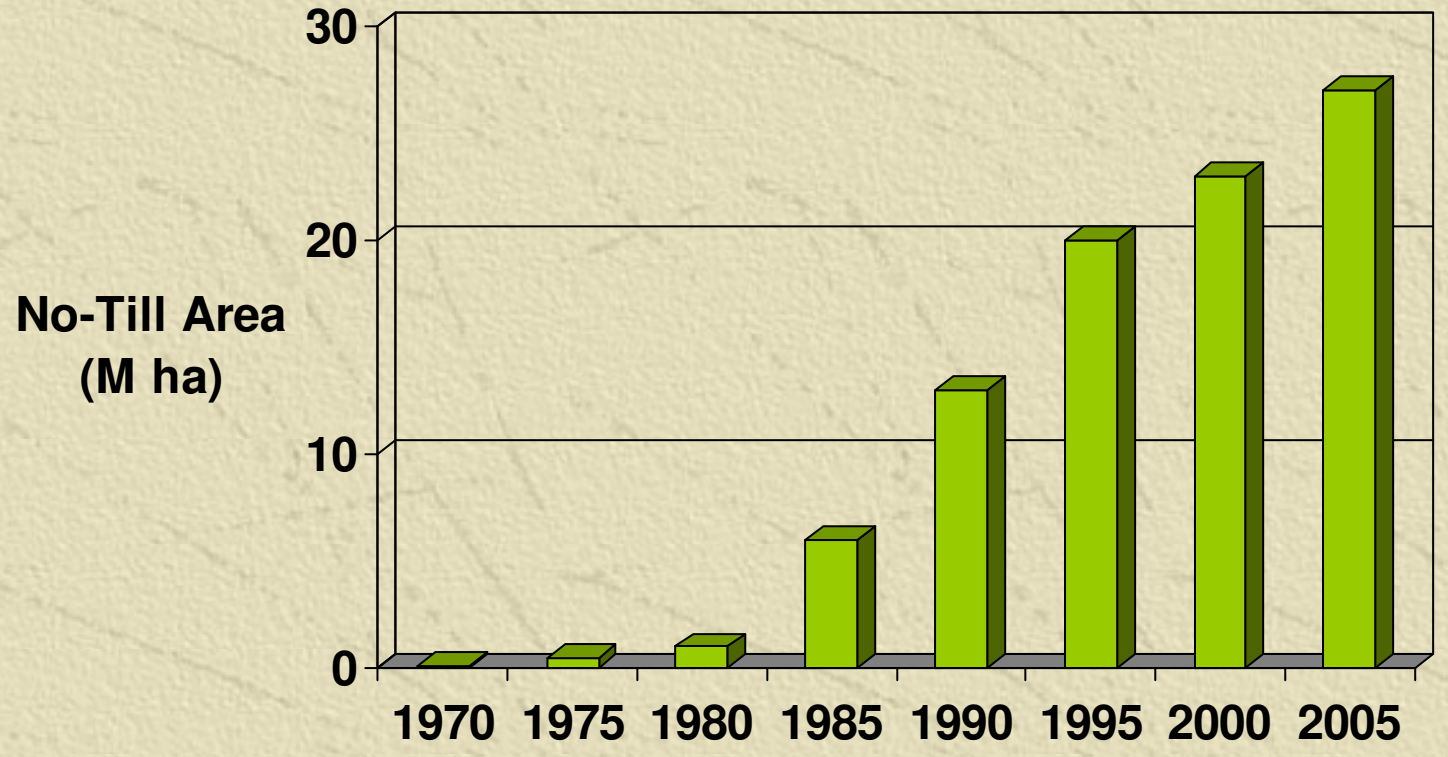
Campagnoli (2005)

Soil Mgt. vs. Erosion: Conventional x No-Till



Merten et al (1993)

Soil Mgt. vs. Erosion:
Growth of No-Till in Brazil



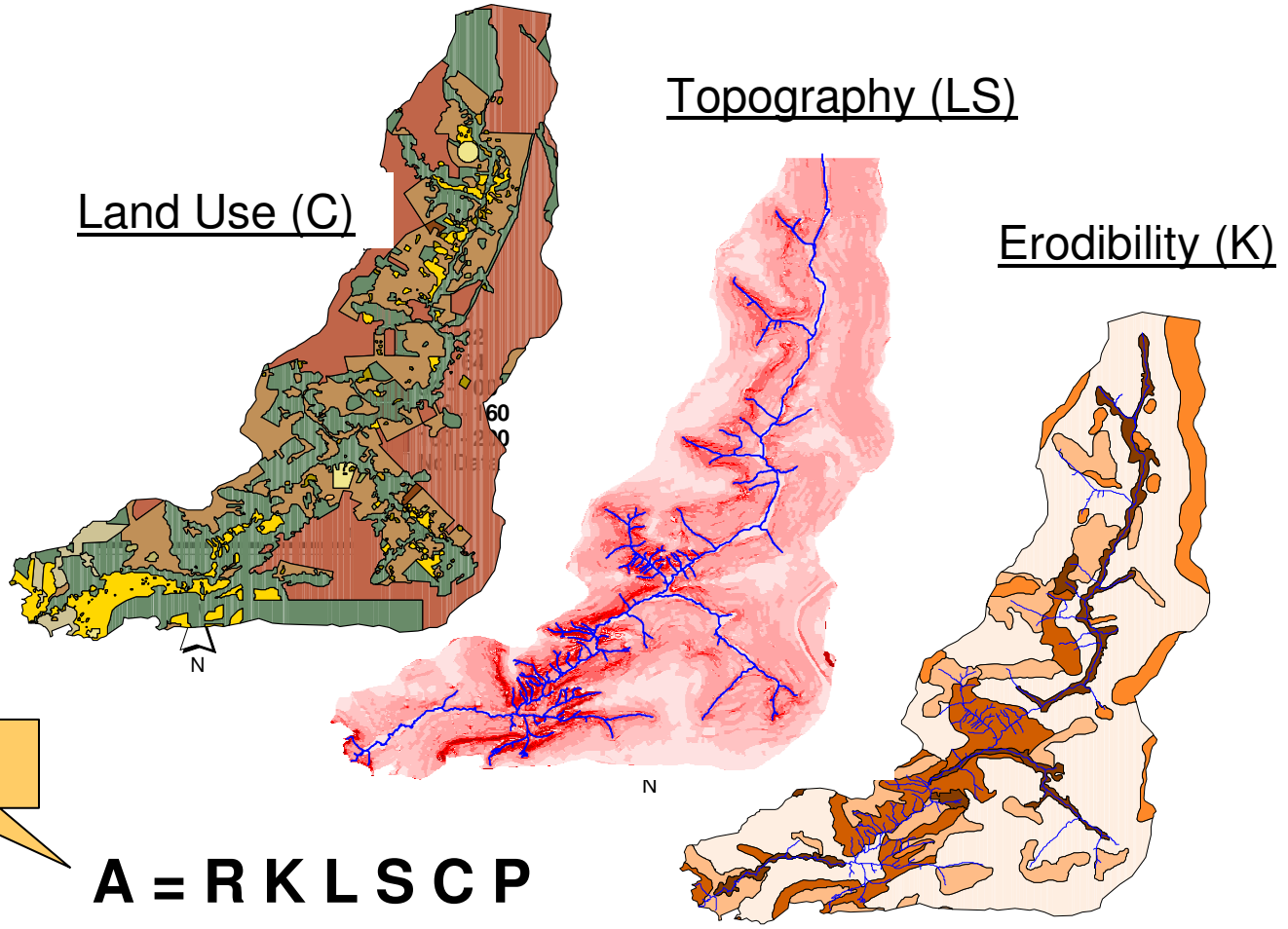
FBPDP (2006)

Erosion Modeling & Land-use Planning

Land Use (C)

Topography (LS)

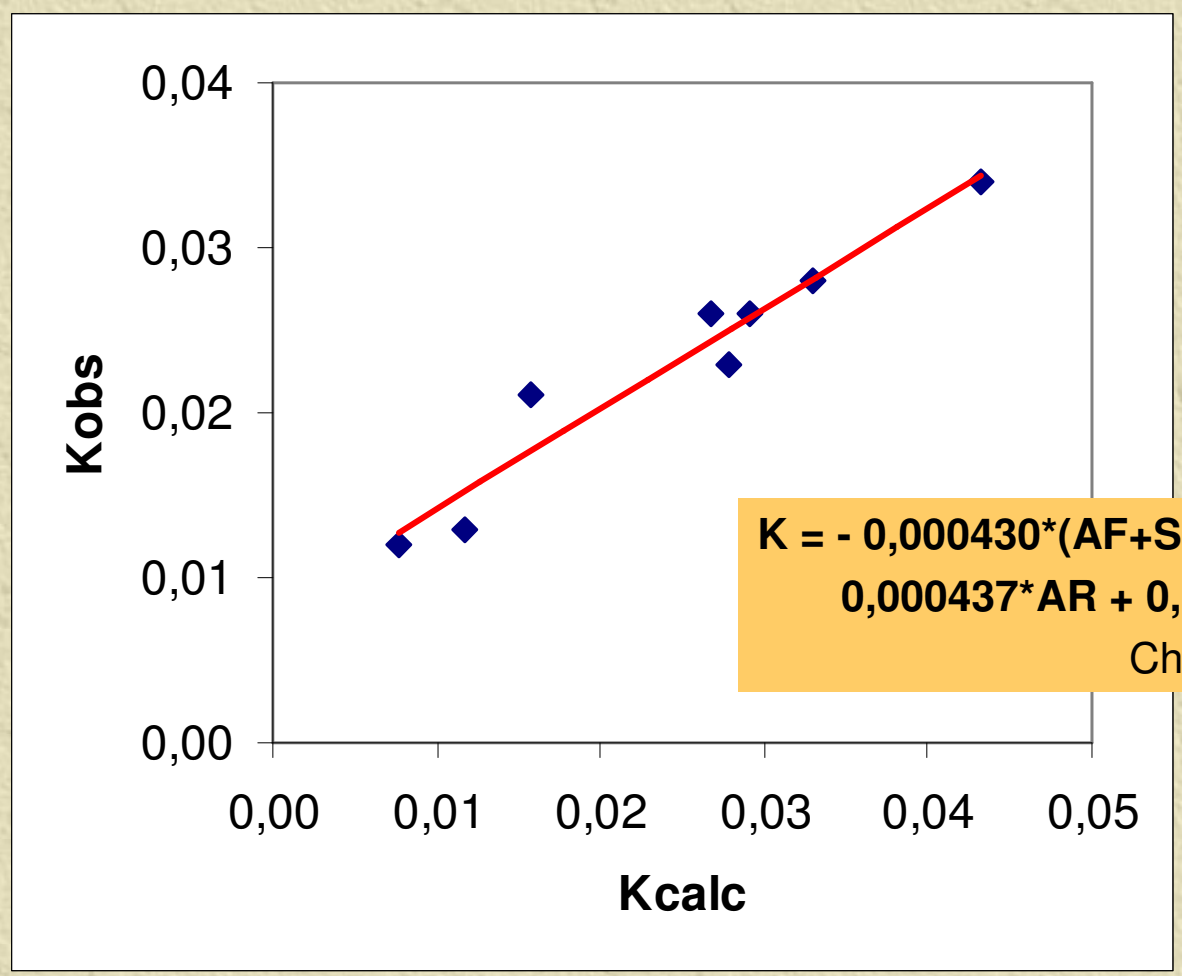
Erodibility (K)



A < T

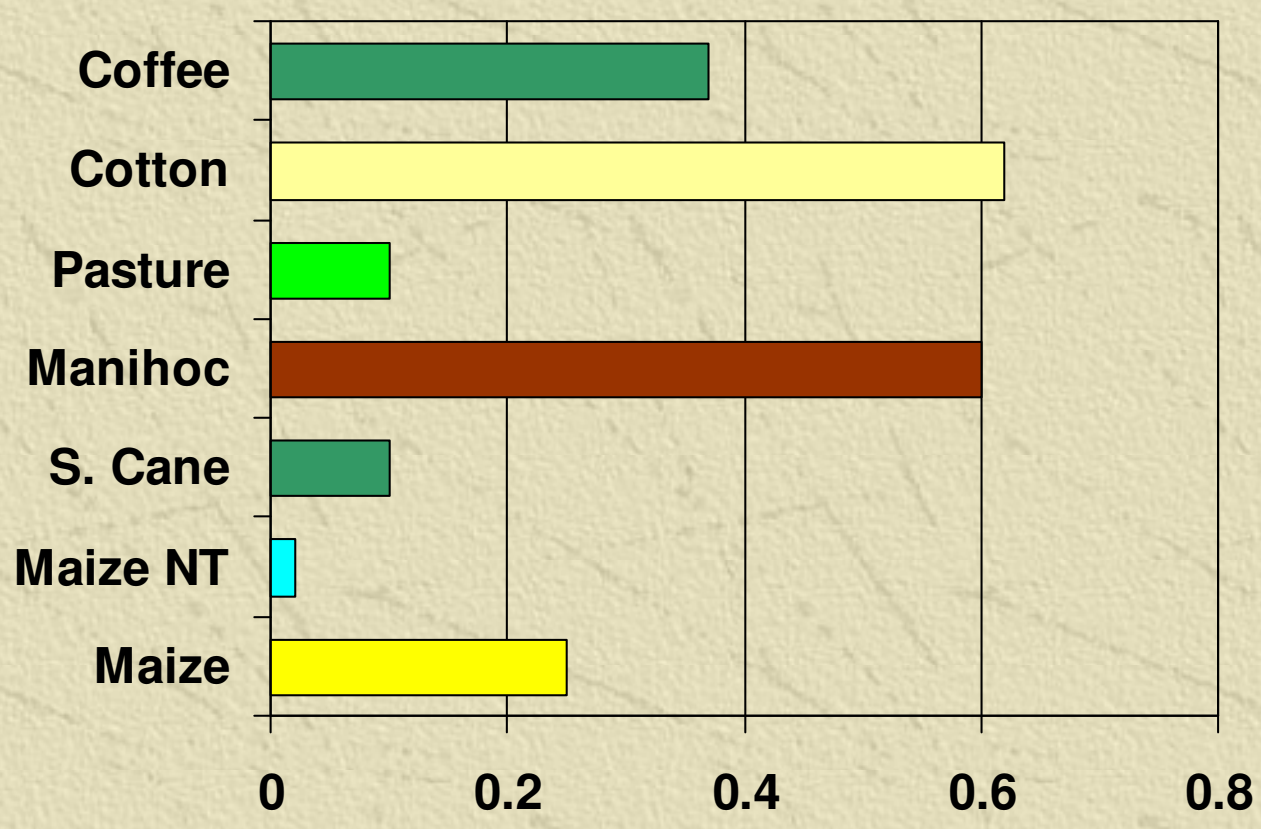
A = R K L S C P

Erosion Modeling Challenges:
USLE's K for Brazil



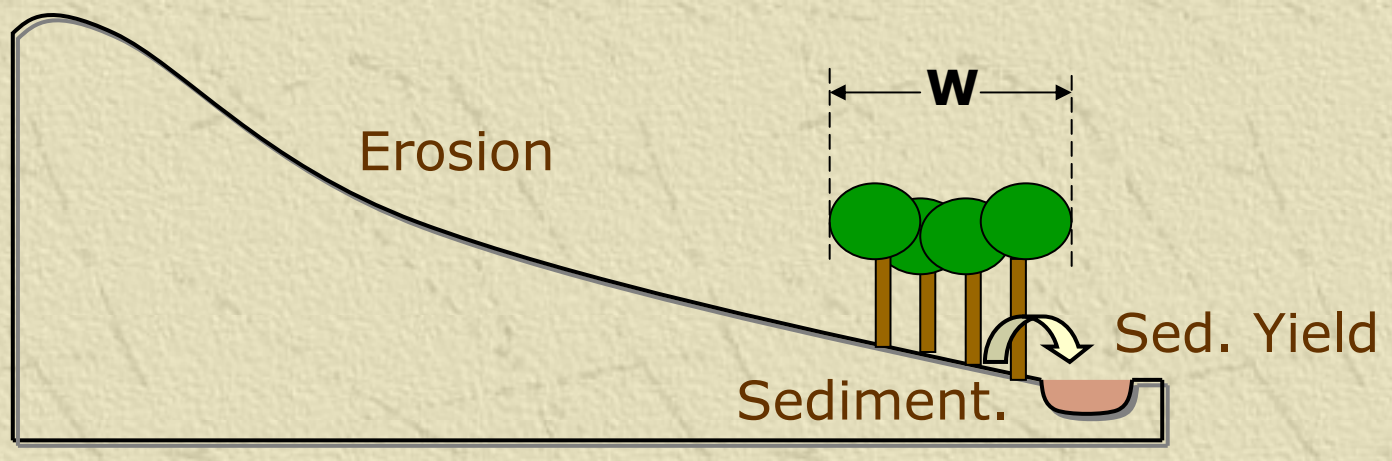
K = - 0,000430*(AF+SIL)/CO +
0,000437*AR + 0,000862*SIL
Chaves (1994)

Erosion Modeling Challenges: USLE's C for Brazil



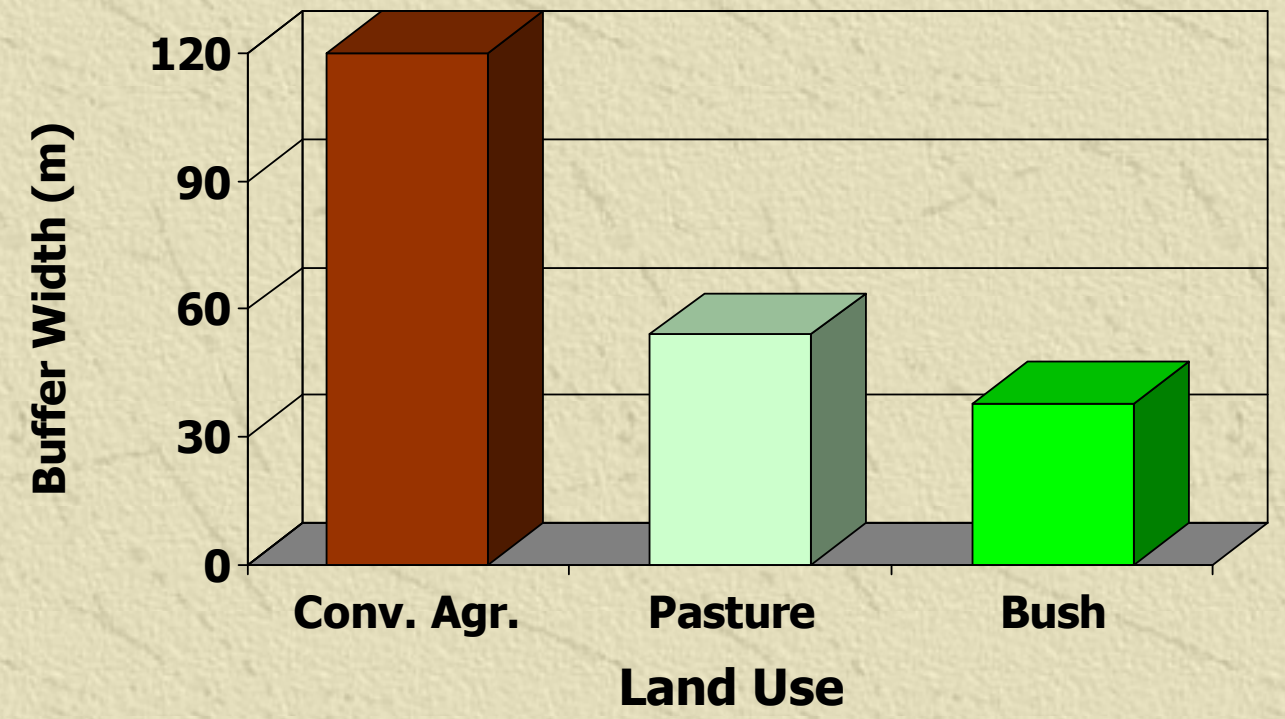
(Various authors)

Erosion Modeling Challenges:
Designing Buffer Strips with WEPP



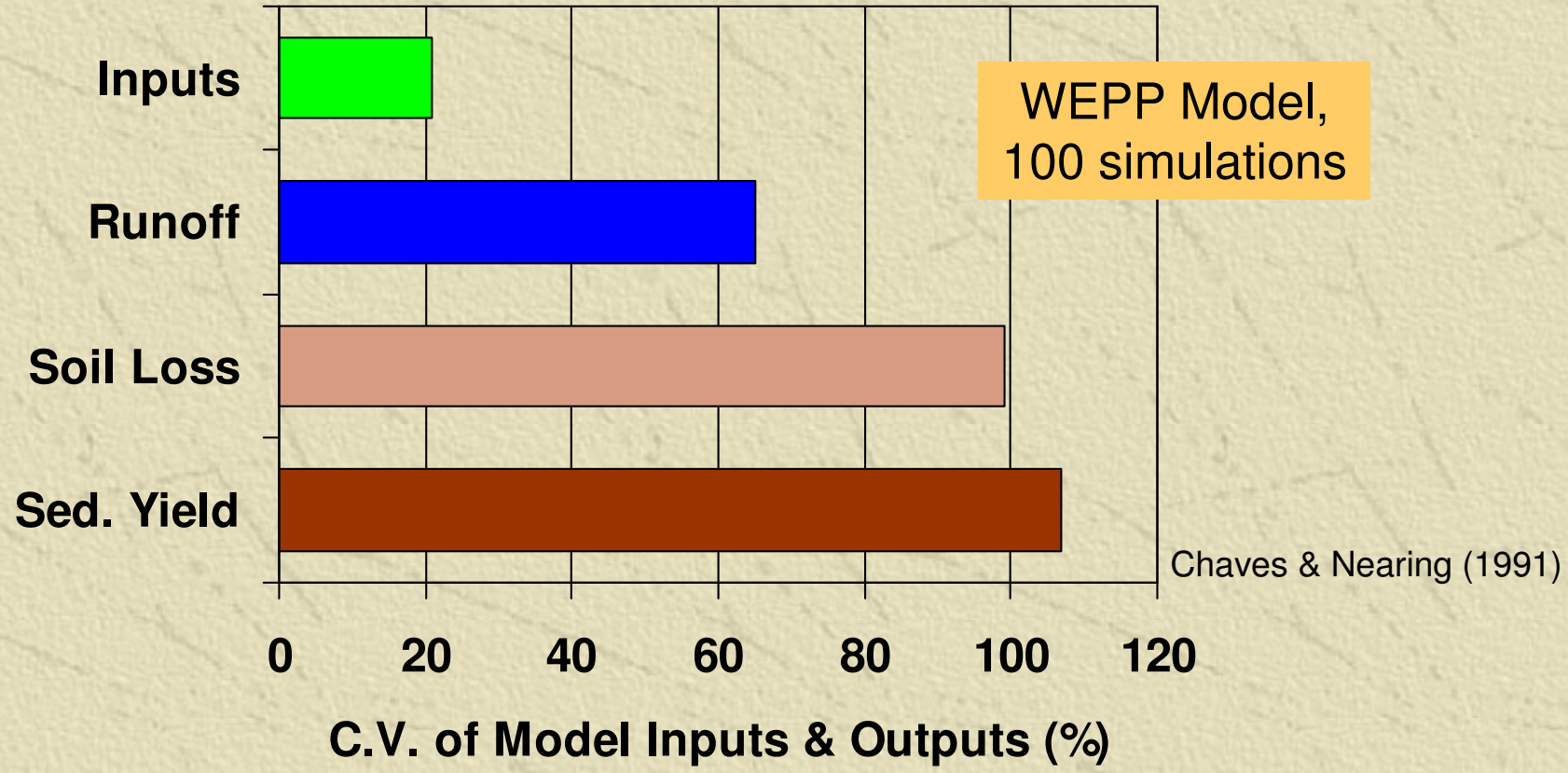
What is the width W of buffer strip capable of reducing 90% of sed. yield?

Erosion Modeling Challenges:
Designing Buffer Strips with WEPP



Chaves (1996)

Erosion Modeling Challenges: Uncertainty in Erosion & Sedimentation Modeling



Erosion Modeling Challenges: Uncertainty in Erosion & Sedimentation Modeling

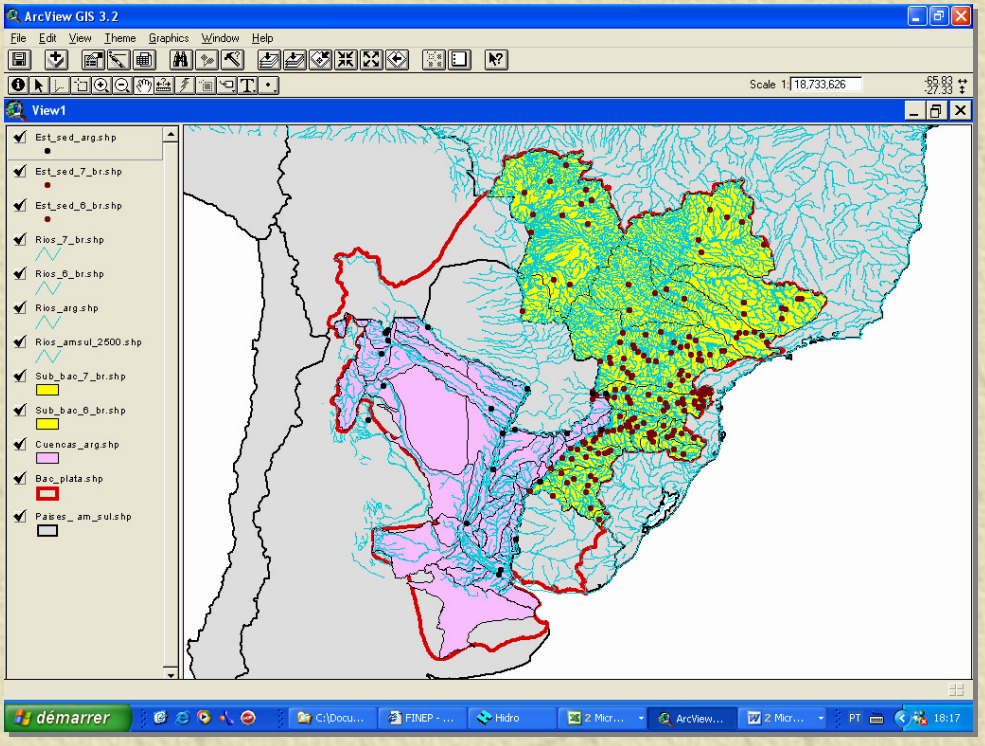
WEPP Rill Erosion Component:

$$\frac{\partial Q_s(x)}{\partial x} = K_r(\tau - \tau_c)\left(1 - \frac{Q_s(x)}{T_c(x)}\right)$$

Boolean structure

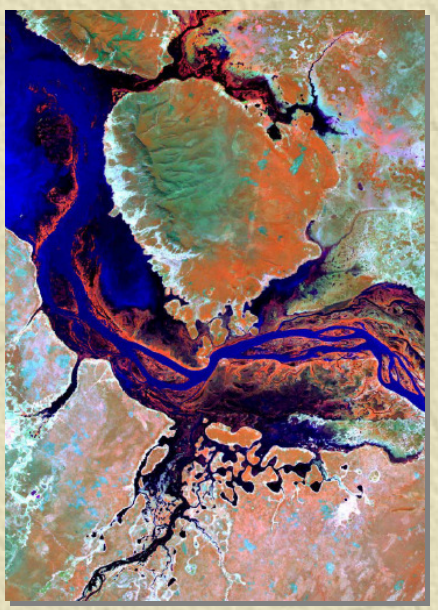
Erosion Modeling Challenges: Improving Sediment Database & Analysis

UNESCO-ISI HidroPlata-Sed



- 5 Countries
- Over 100 stations
- User-friendly
- Data integration is difficult

3. Vision of the Future



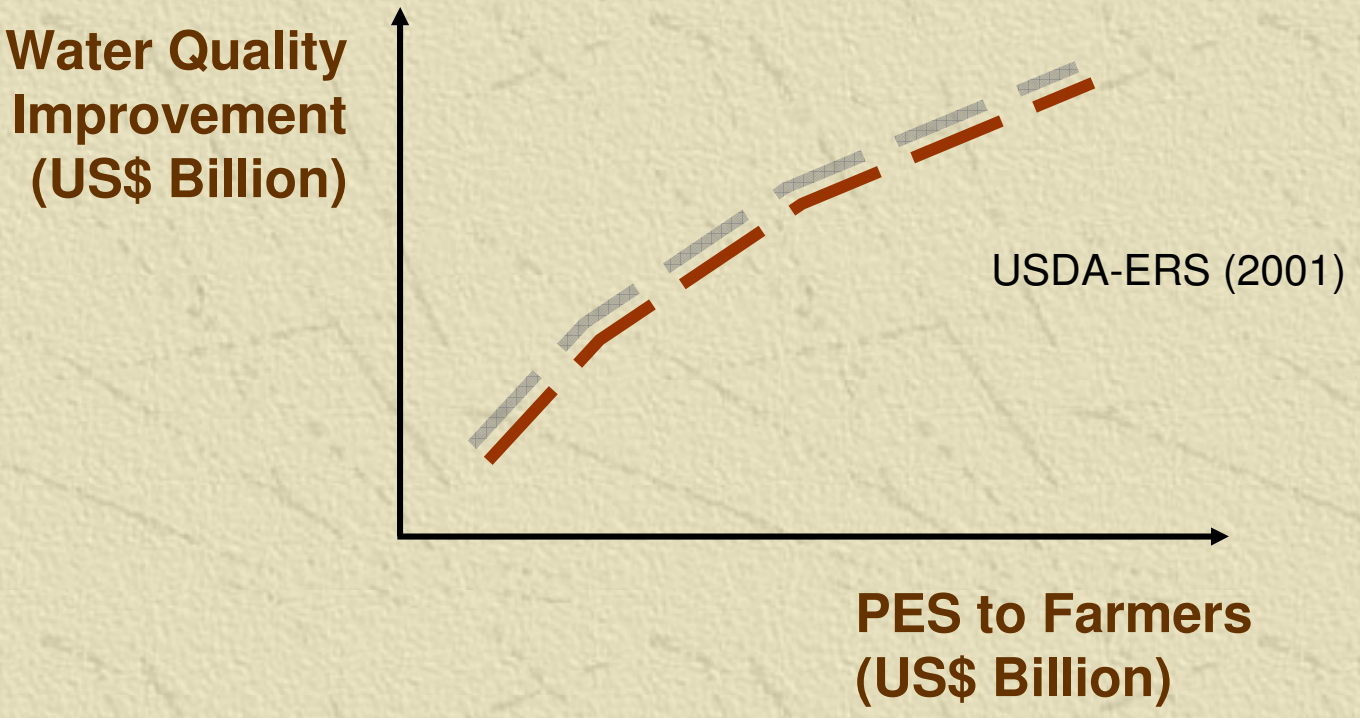
- Agriculture & hydropower will be increasingly more important in Brazil
- Farmers face market & financial burdens
- Reservoirs are being silted up
- How do we tie both ends?
- How do we tackle model complexity?

Payments for Environmental Services

- BMPs such as no-till farming, reforestation, terracing, & gully control reduce erosion & sedimentation
- Their effectiveness can be estimated by modeling
- Farmers could be financially compensated based on practice performance

Payments for Environmental Services -PES

Benefits to water users & environment



Water Provider Program

ANA
AGÊNCIA NACIONAL DE ÁGUAS

Estimating Environmental Additionality:

$$\frac{A_1}{A_0} = \frac{\cancel{R_1 K_1 L_1 S_1} C_1 P_1}{\cancel{R_0 K_0 L_0 S_0} C_0 P_0} \Rightarrow \frac{A_1}{A_0} = \frac{C_1 P_1}{C_0 P_0}$$

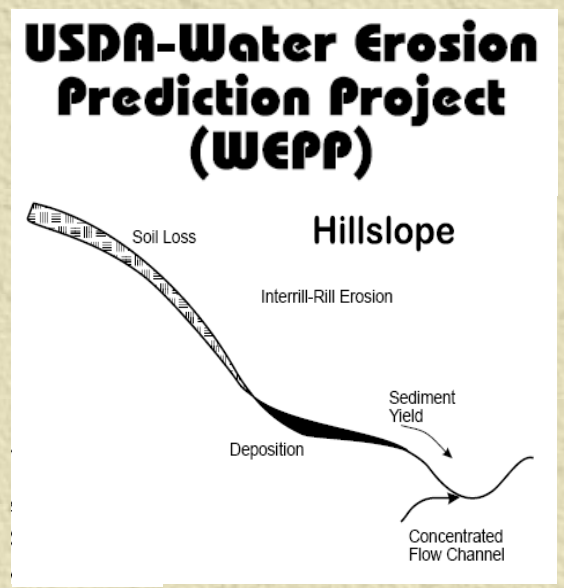
Erosion Reduction:

$$E_r\,(\%) = 100\,[1 - (C_1 P_1 / C_0 P_0)]$$

Model Complexity & Developing Countries

- Recent models are complex, with many input variables & parameters
- Data are frequently not available in developing countries
- Is it possible to emulate models and to bridge this gap?

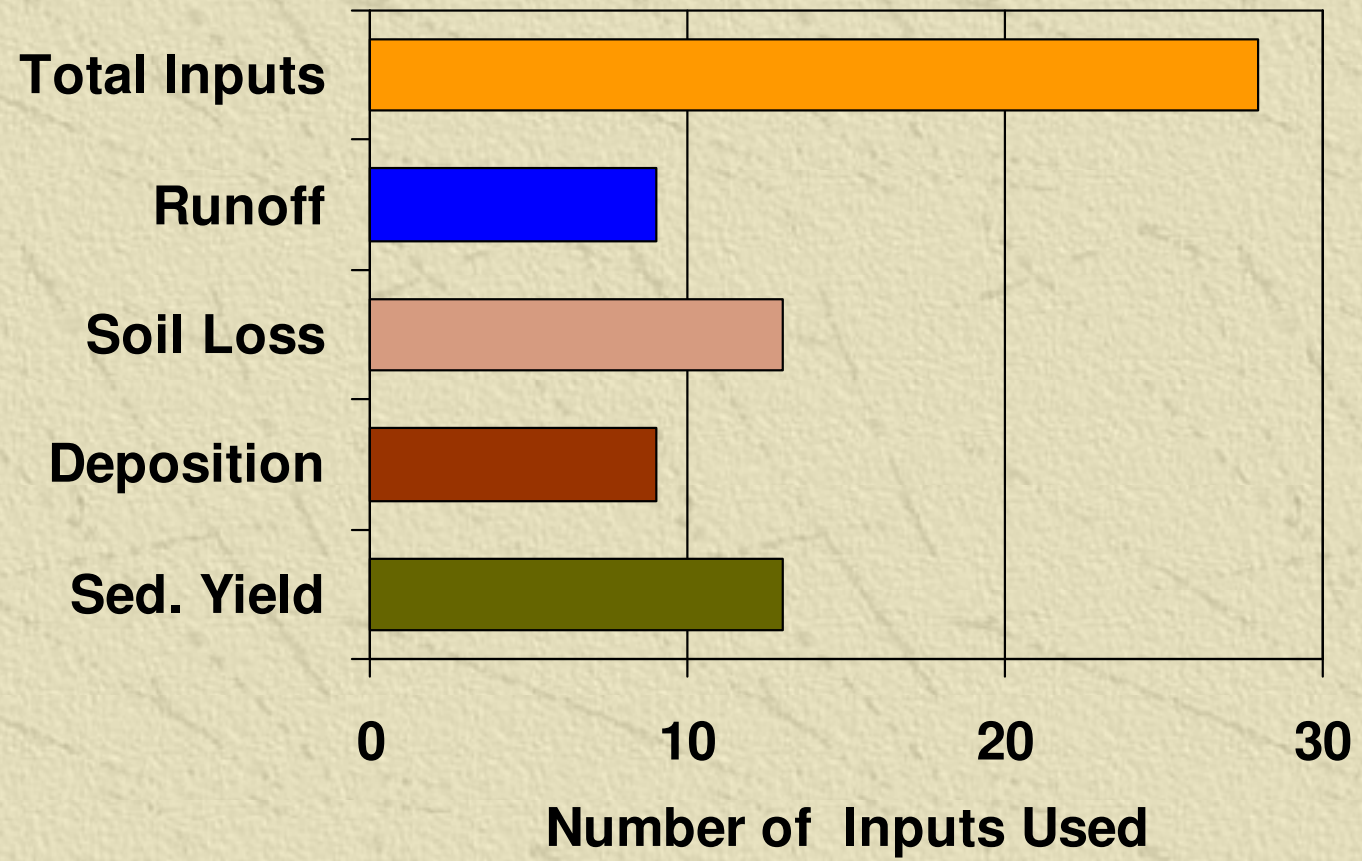
Emulating WEPP with Neural Networks (SONN)



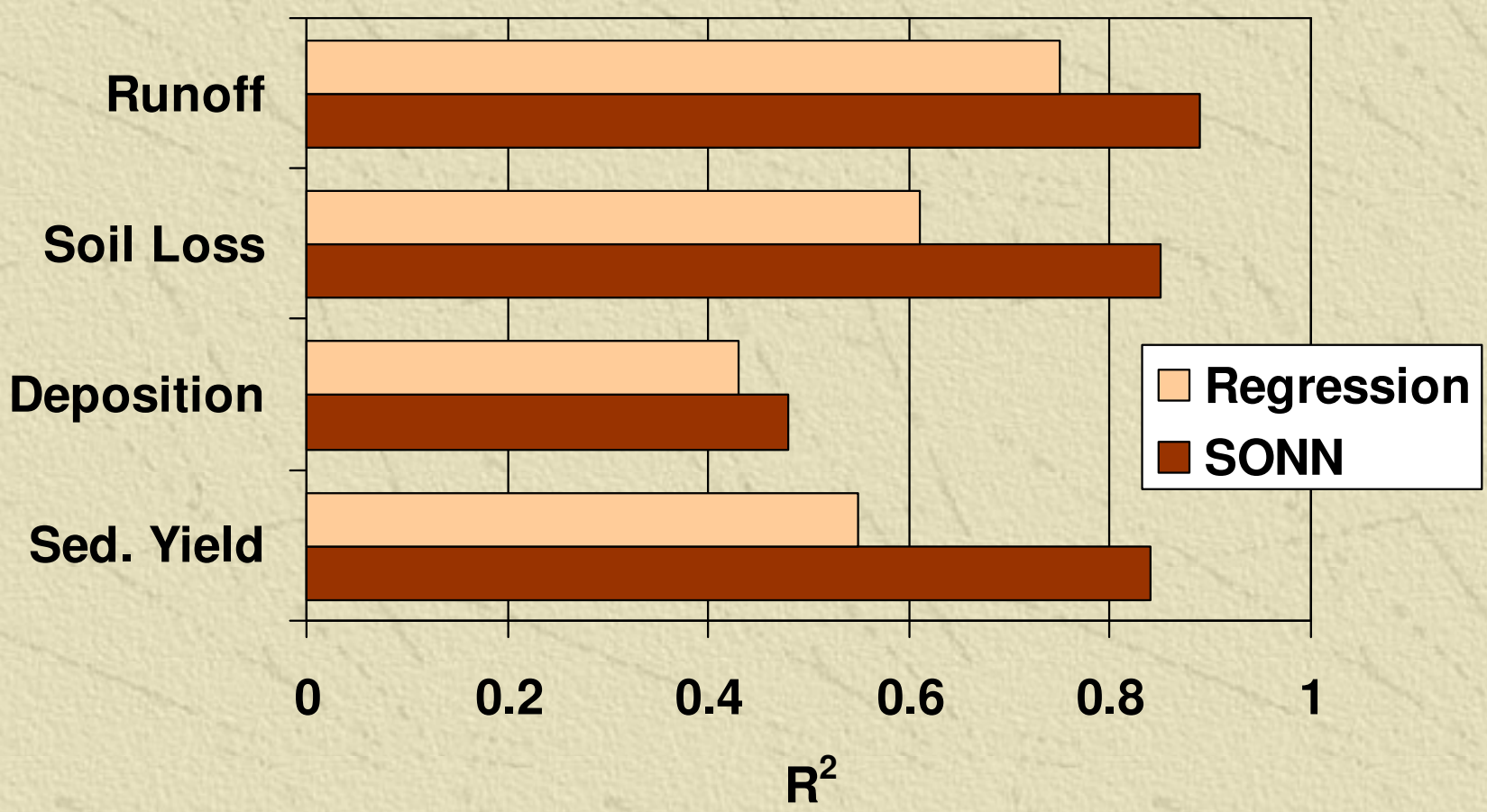
- Inputs: 28 variables & parameters
- Simulations: 1.500
- SONN nodes: Kolmogorov-Gabor polynomials

$$y = a_0 + a_1x_1 + a_2x_2 + a_3x_1x_2 + a_4x_1^2 + a_5x_1^2x_2 + \ldots$$

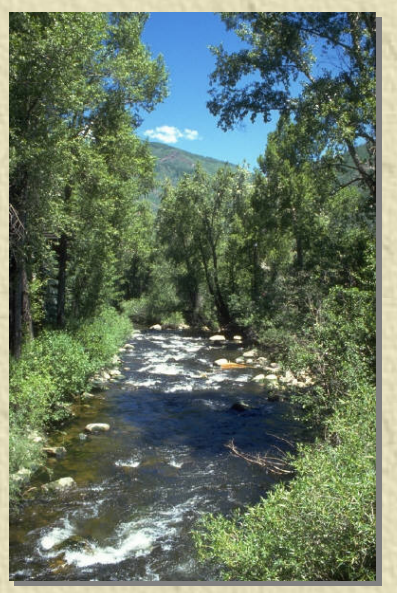
Emulating WEPP w/ Neural Networks (SONN)



Emulating WEPP w/ Neural Networks (SONN)



4. Conclusions



- Erosion & sedimentation are important issues in Brazil
- Situation is improving with BMPs
- To be more effective, PES shall be considered in integrated basin planning
- Complexity & insufficient data hinder model application in the tropics
- Models can be simplified by suitable algorithms

Soils are nothing but rocks in their way to the Ocean.

M.L. Jackson