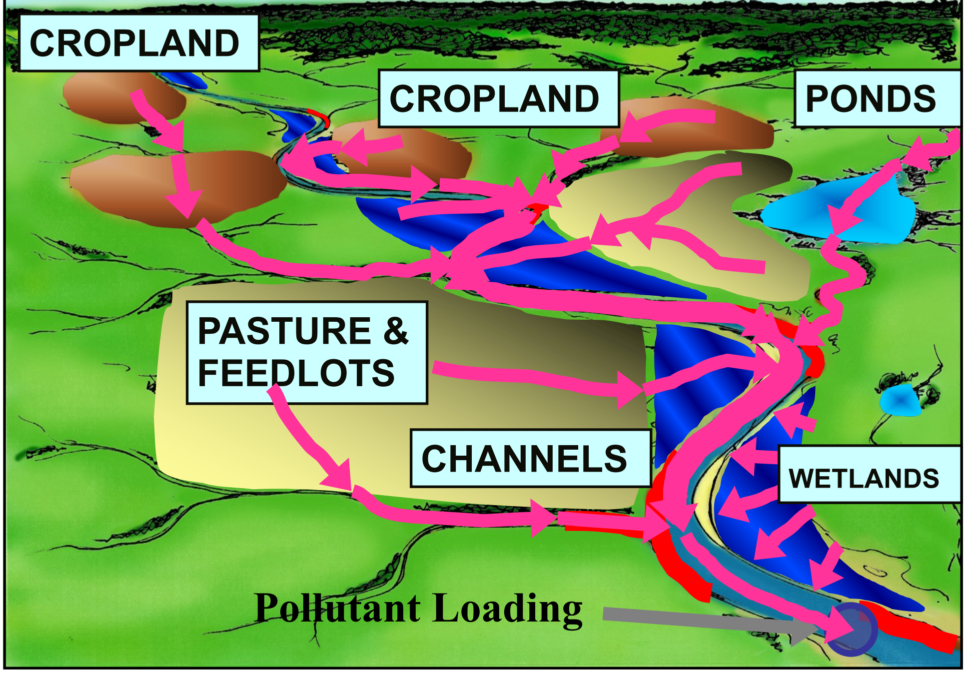
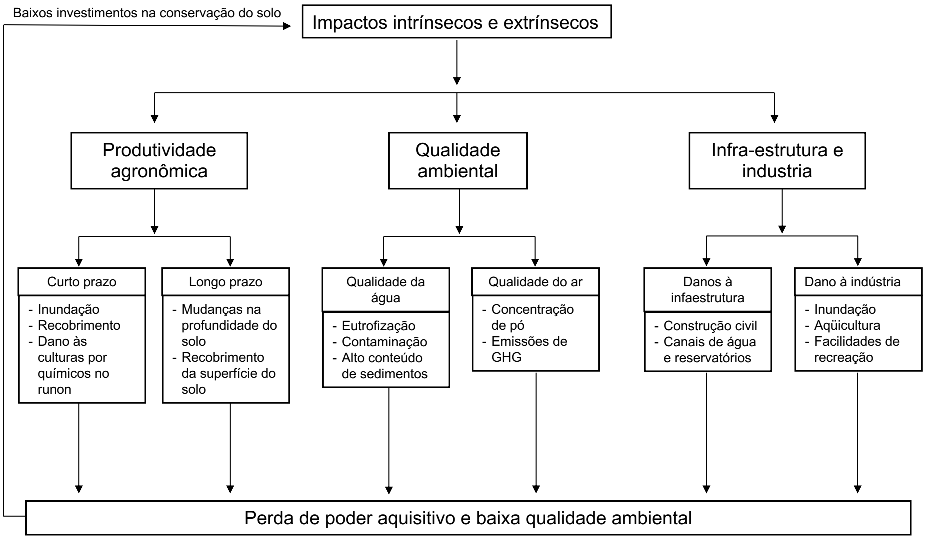
Impactos da erosão do solo

Prof Miguel Cooper
Depto de Ciência do Solo
ESALQ/USP
E-mail: mcooper@usp.br

Where do the Pollutants Come From ?





Baixos investimentos na conservação do solo

Impactos intrínsecos e extrínsecos

Produtividade agronômica

Qualidade ambiental

Infra-estrutura e industria

Curto prazo
- Inundação
- Recobrimento
- Dano às culturas por químicos no runon

Longo prazo
- Mudanças na profundidade do solo
- Recobrimento da superfície do solo

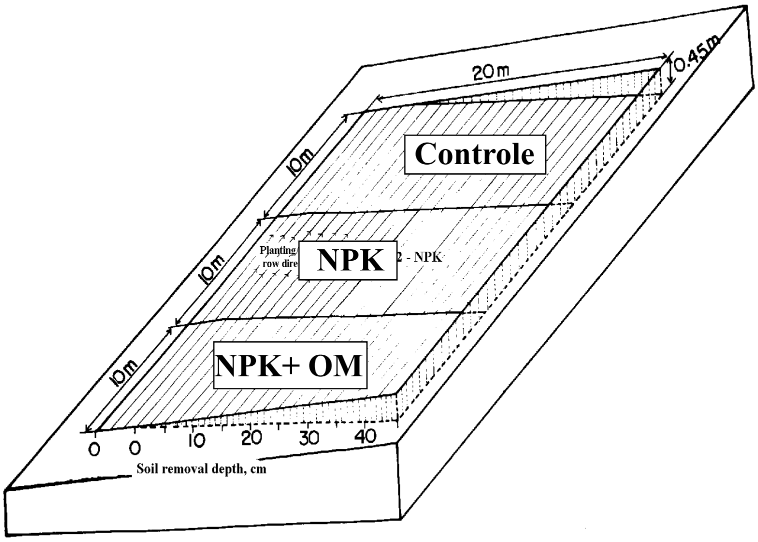
Qualidade da água
- Eutrofização
- Contaminação
- Alto conteúdo de sedimentos

Qualidade do ar
- Concentração de pó
- Emissões de GHG

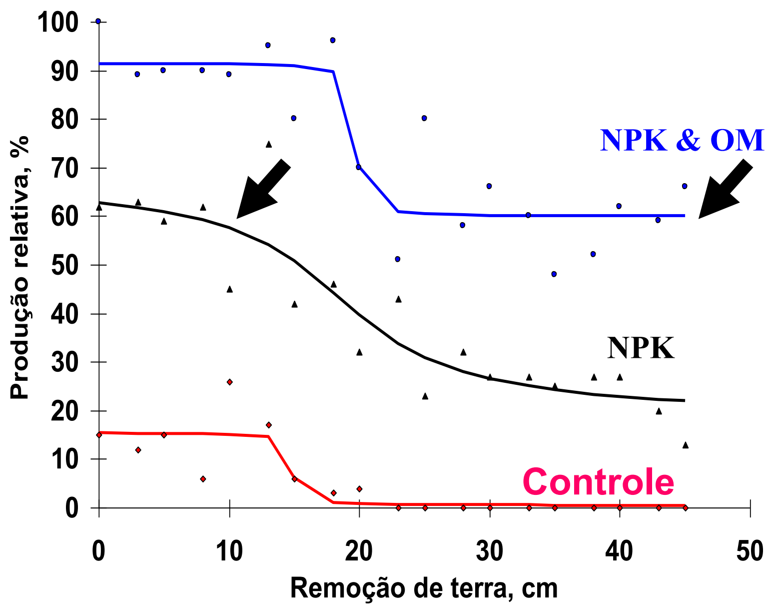
Danos à infaestrutura
- Construção civil
- Canais de água e reservatórios

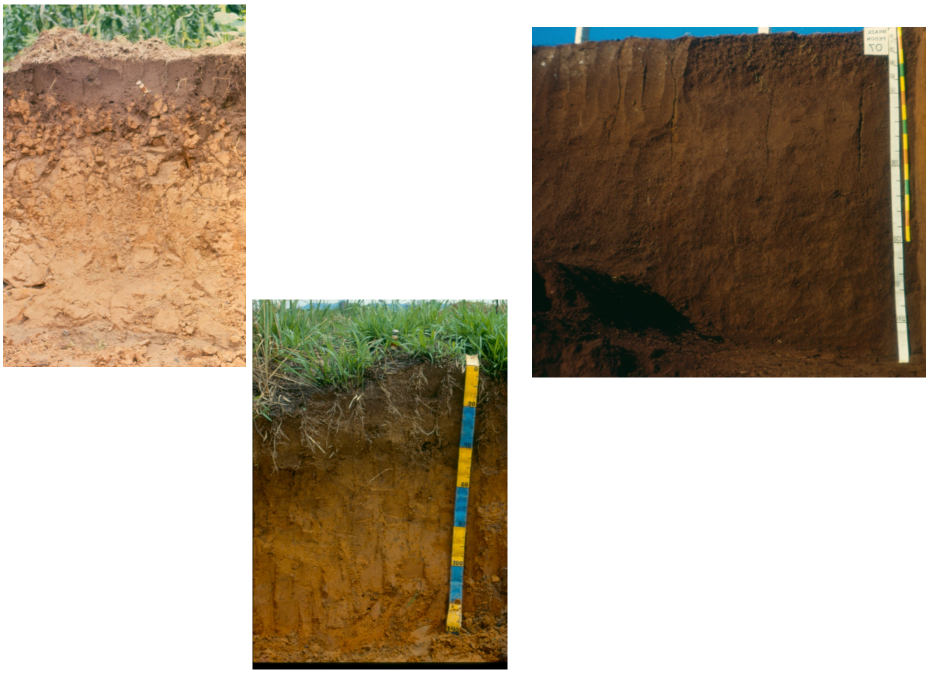
Dano à indústria
- Inundação
- Aqüicultura
- Facilidades de recreação

Perda de poder aquisitivo e baixa qualidade ambiental

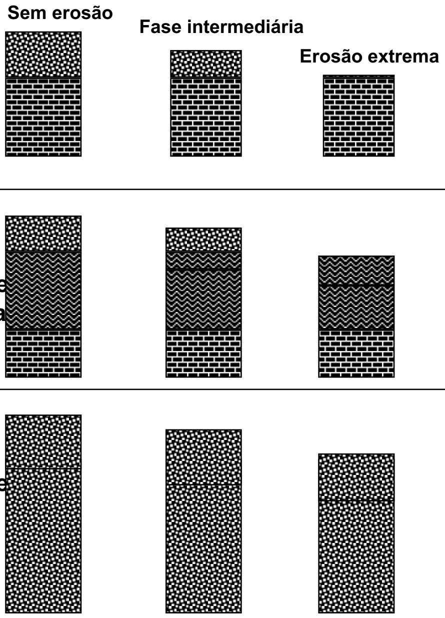


Erosão simulada vs. produtividade do milho





Classes de solos em função da relação erosão vs. produtividade



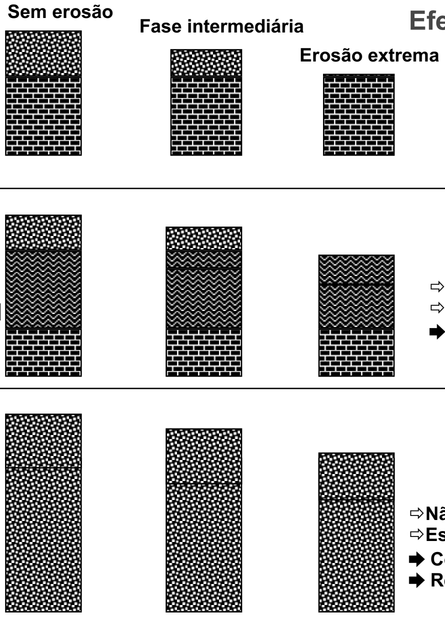
Tipo de Solo

Solos rasos

Solos com gradiente estrutural ou textura

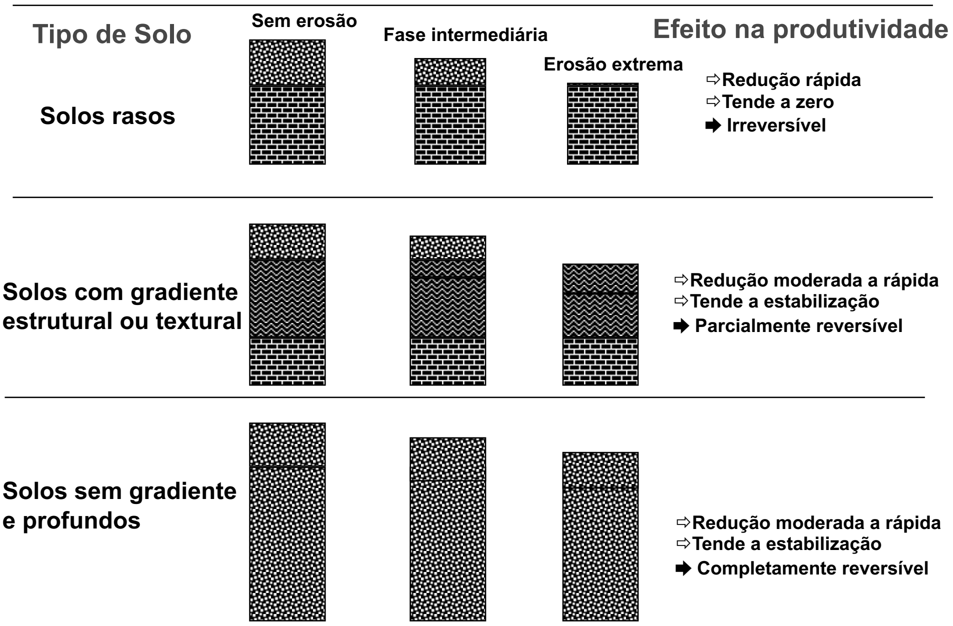
Solos sem gradiente e profundos

Alta utilização de insumos



Tipo de Solo	Efeito na produtividade
Solos rasos	⇨Redução rápida ⇨Tende a zero ➡ Irreversível
Solos com gradiente estrutural ou textural	⇨Redução moderada ⇨Tende a estabilização ➡ Parcialmente reversível
Solos sem gradiente e profundos	⇨Não há redução ou moderada ⇨Estabiliza ➡ Completamente reversível ➡ Recuperação completa do solo

Baixa utilização de insumos



Tipo de Solo	Sem erosão	Fase intermediária	Erosão extrema	Efeito na produtividade
Solos rasos				⇨Redução rápida ⇨Tende a zero ➧ Irreversível
Solos com gradiente estrutural ou textural				⇨Redução moderada a rápida ⇨Tende a estabilização ➧ Parcialmente reversível
Solos sem gradiente e profundos				⇨Redução moderada a rápida ⇨Tende a estabilização ➧ Completamente reversível

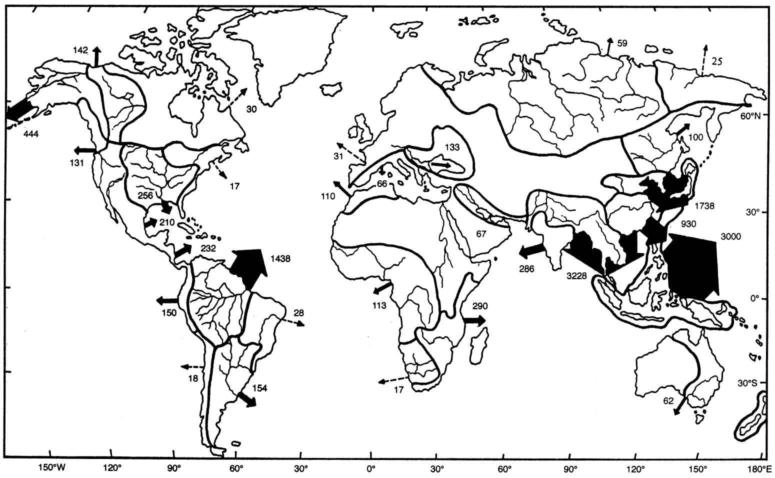
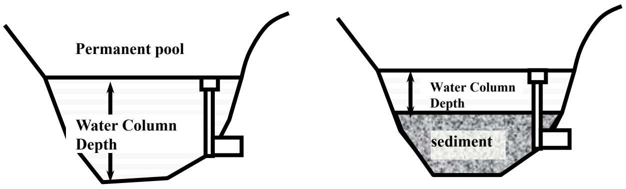


Fig. 11.1. Annual discharge of suspended sediment from various drainage basins of the world. Width of the arrows corresponds to relative discharge; numbers refer to average annual input in millions of tons. Source: Milliman and Meade (1983).



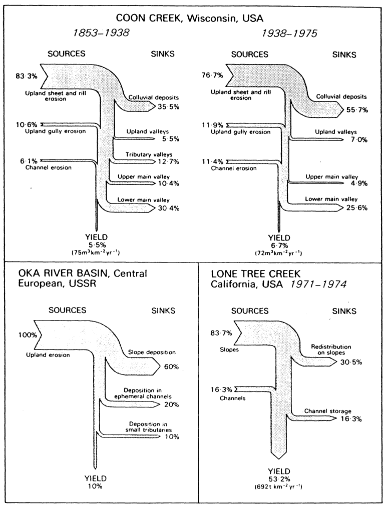


Figure 3.14 Tentative sediment budgets for Coon Creek, Wisconsin (360 km^2), 1853–1938 and 1938–1975; Lone Tree Creek, California (1.74 km^2); and the Oka River, USSR. Based on data presented by Trimble (*100*), Lehre (*54*), and Zaslavsky (*125*).

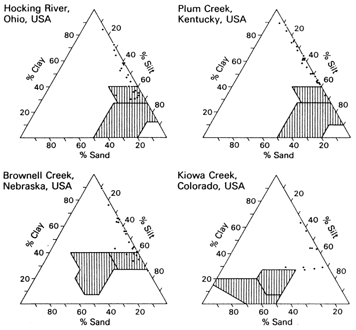
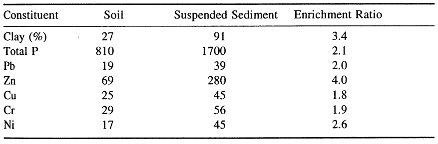


Figure 3.10 Comparison of the particle size composition of suspended sediment and soils in four U.S. drainage basins. Textural classes of the dominant soils are denoted by shaded zones on the trilinear plots. Based on data from Flint (*35*), Anttila (*5*), and Mundorff (*66,67*).

Table 3.5 Enrichment of clay and pollutants in suspended sediment transported by a headwater tributary of the Menomonee River, Wisconsin, US [based on Novotny et al. (*70*)].



Constituent	Soil	Suspended Sediment	Enrichment Ratio
Clay (%)	27	91	3.4
Total P	810	1700	2.1
Pb	19	39	2.0
Zn	69	280	4.0
Cu	25	45	1.8
Cr	29	56	1.9
Ni	17	45	2.6

All chemical elements expressed in parts per million.

Young et al. (1986)

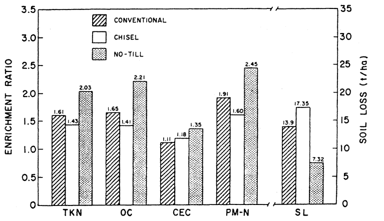


Fig. 2—Soil losses and enrichment ratios from three tillage practices on row crops on Russell silt loam. Values above the bars are enrichment ratios or soil loss.

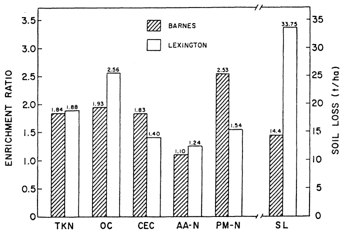


Fig. 3—Comparison of soil losses and enrichment ratios from fallow plots of Barnes loam (Minnesota) and Lexington silt loam (Mississippi). Values above the bars are enrichment ratios or soil loss.

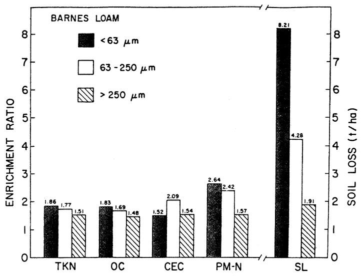


Fig. 5—Soil losses and enrichment ratios of various size classes of eroded aggregates on a Barnes loam. Values above the bars are enrichment ratios or soil loss.

MO + microrganismos + $O_2 \rightarrow CO_2 + H_2O$ + mais microrganismos

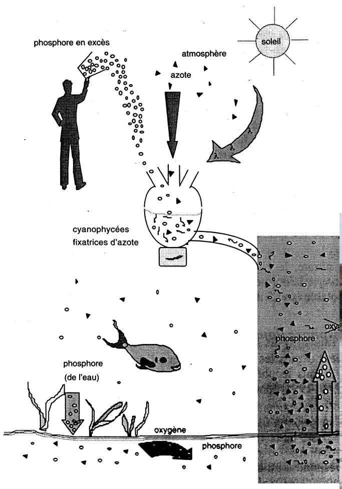


Figure 8.7 – Rôle du phosphore dans l'eutrophisation
(d'après Barroin La Recherche 1991).

Crescimento de algas e vegetação aquática

Depleção de oxigênio dissolvido

Aumento da turbidez

Degradação da qualidade da água

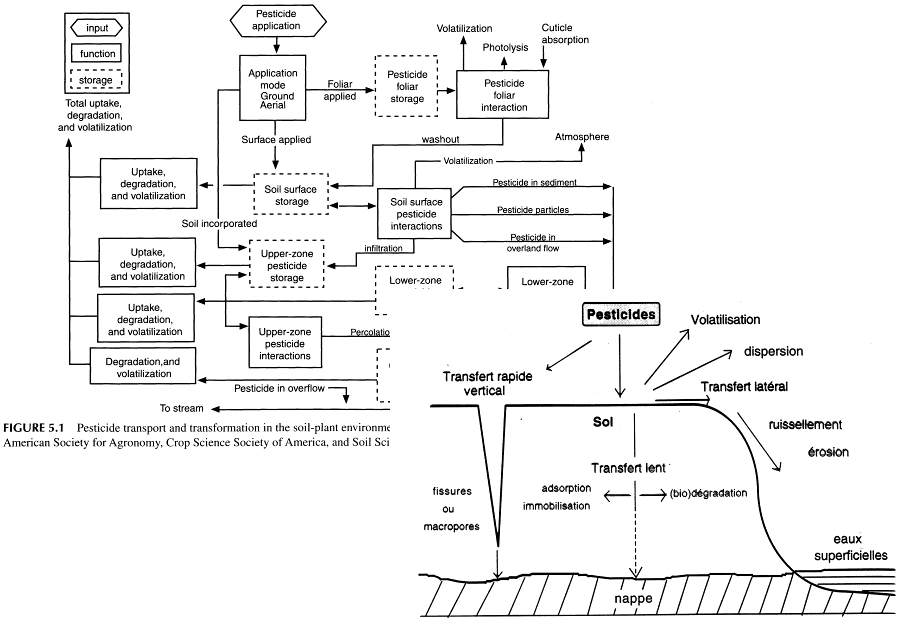


FIGURE 5.1 Pesticide transport and transformation in the soil-plant environme
American Society for Agronomy, Crop Science Society of America, and Soil Sci

FIGURE 9.1 – Devenir des pesticides dans les sols.

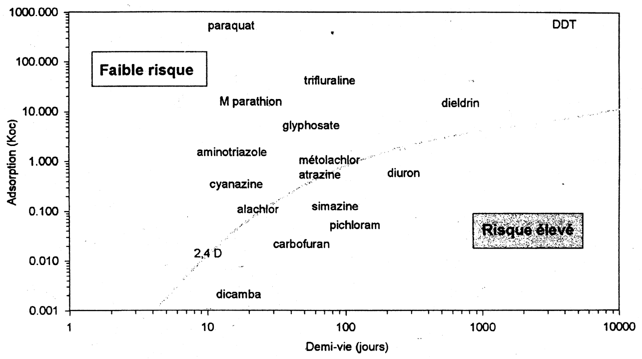


FIGURE 9.3 – Évaluation des risques de pollution par lixiviation des pesticides en fonction de leur demi-vie et de leurs coefficients d'adsorption (Barriuso et al. *1991).*

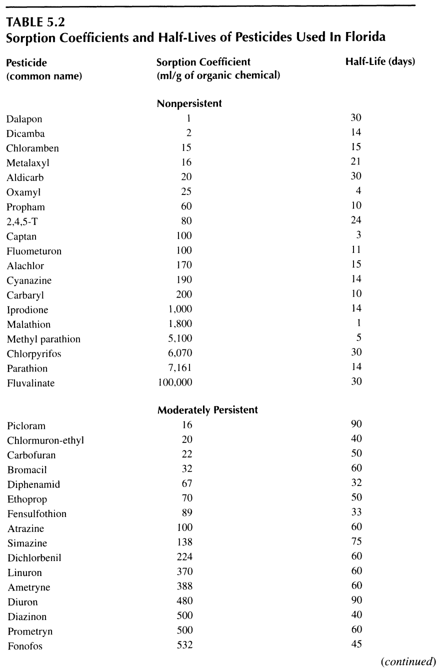


TABLE 5.2
Sorption Coefficients and Half-Lives of Pesticides Used In Florida

Pesticide (common name)	Sorption Coefficient (ml/g of organic chemical)	Half-Life (days)
	Nonpersistent	
Dalapon	1	30
Dicamba	2	14
Chloramben	15	15
Metalaxyl	16	21
Aldicarb	20	30
Oxamyl	25	4
Propham	60	10
2,4,5-T	80	24
Captan	100	3
Fluometuron	100	11
Alachlor	170	15
Cyanazine	190	14
Carbaryl	200	10
Iprodione	1,000	14
Malathion	1,800	1
Methyl parathion	5,100	5
Chlorpyrifos	6,070	30
Parathion	7,161	14
Fluvalinate	100,000	30
	Moderately Persistent	
Picloram	16	90
Chlormuron-ethyl	20	40
Carbofuran	22	50
Bromacil	32	60
Diphenamid	67	32
Ethoprop	70	50
Fensulfothion	89	33
Atrazine	100	60
Simazine	138	75
Dichlorbenil	224	60
Linuron	370	60
Ametryne	388	60
Diuron	480	90
Diazinon	500	40
Prometryn	500	60
Fonofos	532	45

(*continued*)

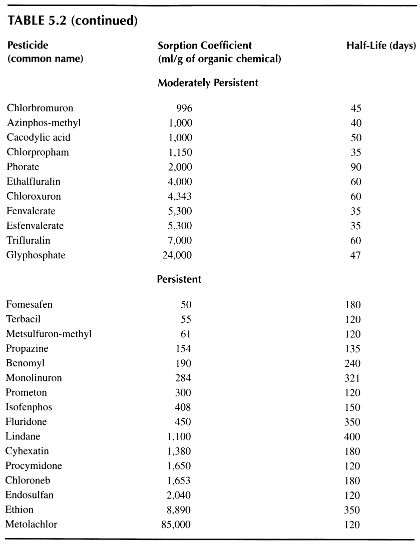


TABLE 5.2 (continued)

Pesticide (common name)	Sorption Coefficient (ml/g of organic chemical)	Half-Life (days)
	Moderately Persistent	
Chlorbromuron	996	45
Azinphos-methyl	1,000	40
Cacodylic acid	1,000	50
Chlorpropham	1,150	35
Phorate	2,000	90
Ethalfluralin	4,000	60
Chloroxuron	4,343	60
Fenvalerate	5,300	35
Esfenvalerate	5,300	35
Trifluralin	7,000	60
Glyphosphate	24,000	47
	Persistent	
Fomesafen	50	180
Terbacil	55	120
Metsulfuron-methyl	61	120
Propazine	154	135
Benomyl	190	240
Monolinuron	284	321
Prometon	300	120
Isofenphos	408	150
Fluridone	450	350
Lindane	1,100	400
Cyhexatin	1,380	180
Procymidone	1,650	120
Chloroneb	1,653	180
Endosulfan	2,040	120
Ethion	8,890	350
Metolachlor	85,000	120

Custos dos impactos intrínsecos e extrínsecos da erosão do solo

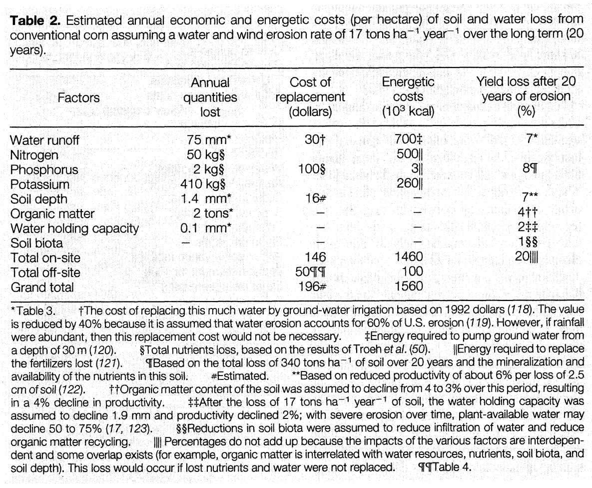


Table 2. Estimated annual economic and energetic costs (per hectare) of soil and water loss from conventional corn assuming a water and wind erosion rate of 17 tons ha^{-1} $year^{-1}$ over the long term (20 years).

Factors	Annual quantities lost	Cost of replacement (dollars)	Energetic costs (10^3 kcal)	Yield loss after 20 years of erosion (%)
Water runoff	75 mm*	30†	700‡	7*
Nitrogen	50 kg§		500‖	
Phosphorus	2 kg§	100§	3‖	8¶
Potassium	410 kg§		260‖	
Soil depth	1.4 mm*	16#	–	7**
Organic matter	2 tons*	–	–	4††
Water holding capacity	0.1 mm*	–	–	2‡‡
Soil biota	–	–	–	1§§
Total on-site		146	1460	20‖‖
Total off-site		50¶¶	100	
Grand total		196#	1560	

*Table 3. †The cost of replacing this much water by ground-water irrigation based on 1992 dollars (*118*). The value is reduced by 40% because it is assumed that water erosion accounts for 60% of U.S. erosion (*119*). However, if rainfall were abundant, then this replacement cost would not be necessary. ‡Energy required to pump ground water from a depth of 30 m (*120*). §Total nutrients loss, based on the results of Troeh *et al.* (*50*). ‖Energy required to replace the fertilizers lost (*121*). ¶Based on the total loss of 340 tons ha^{-1} of soil over 20 years and the mineralization and availability of the nutrients in this soil. #Estimated. **Based on reduced productivity of about 6% per loss of 2.5 cm of soil (*122*). ††Organic matter content of the soil was assumed to decline from 4 to 3% over this period, resulting in a 4% decline in productivity. ‡‡After the loss of 17 tons ha^{-1} $year^{-1}$ of soil, the water holding capacity was assumed to decline 1.9 mm and productivity declined 2%; with severe erosion over time, plant-available water may decline 50 to 75% (*17, 123*). §§Reductions in soil biota were assumed to reduce infiltration of water and reduce organic matter recycling. ‖‖ Percentages do not add up because the impacts of the various factors are interdependent and some overlap exists (for example, organic matter is interrelated with water resources, nutrients, soil biota, and soil depth). This loss would occur if lost nutrients and water were not replaced. ¶¶Table 4.

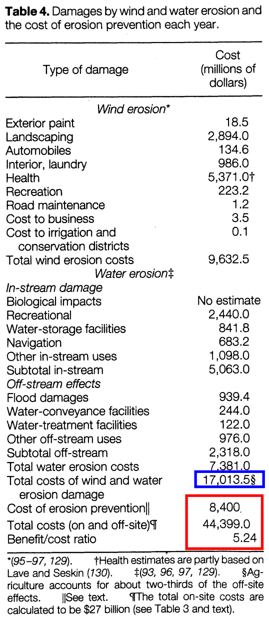


Table 4. Damages by wind and water erosion and the cost of erosion prevention each year.

Type of damage	Cost (millions of dollars)
*Wind erosion**	
Exterior paint	18.5
Landscaping	2,894.0
Automobiles	134.6
Interior, laundry	986.0
Health	5,371.0†
Recreation	223.2
Road maintenance	1.2
Cost to business	3.5
Cost to irrigation and conservation districts	0.1
Total wind erosion costs	9,632.5
Water erosion‡	
In-stream damage	
Biological impacts	No estimate
Recreational	2,440.0
Water-storage facilities	841.8
Navigation	683.2
Other in-stream uses	1,098.0
Subtotal in-stream	5,063.0
Off-stream effects	
Flood damages	939.4
Water-conveyance facilities	244.0
Water-treatment facilities	122.0
Other off-stream uses	976.0
Subtotal off-stream	2,318.0
Total water erosion costs	7,381.0
Total costs of wind and water erosion damage	17,013.5§
Cost of erosion prevention‖	8,400
Total costs (on and off-site)¶	44,399.0
Benefit/cost ratio	5.24

*(*95–97, 129*). †Health estimates are partly based on Lave and Seskin (*130*). ‡(*93, 96, 97, 129*). §Agriculture accounts for about two-thirds of the off-site effects. ‖See text. ¶The total on-site costs are calculated to be $27 billion (see Table 3 and text).

USA → perda de $4x10^9$ Mg de solo e $130x10^9$ Mg de água. ano^{-1}→ U$S 27 bilhões (20 bilhões para reposição de nutrientes, 7 bilhões para perda de água e solo)

Pimentel et al. (1995)

Riparian Buffer System

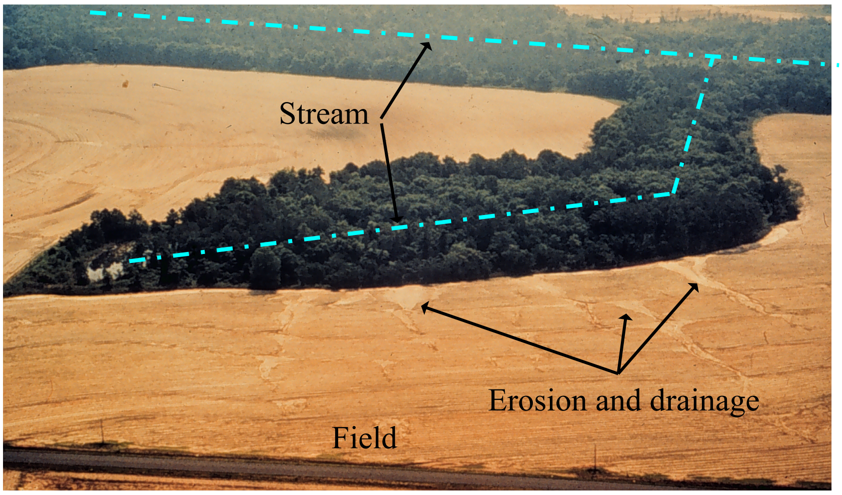
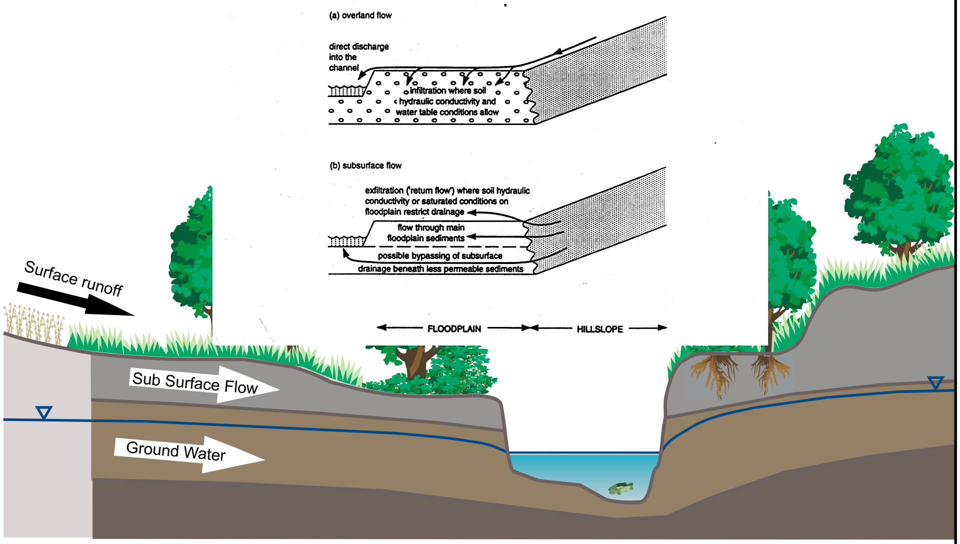
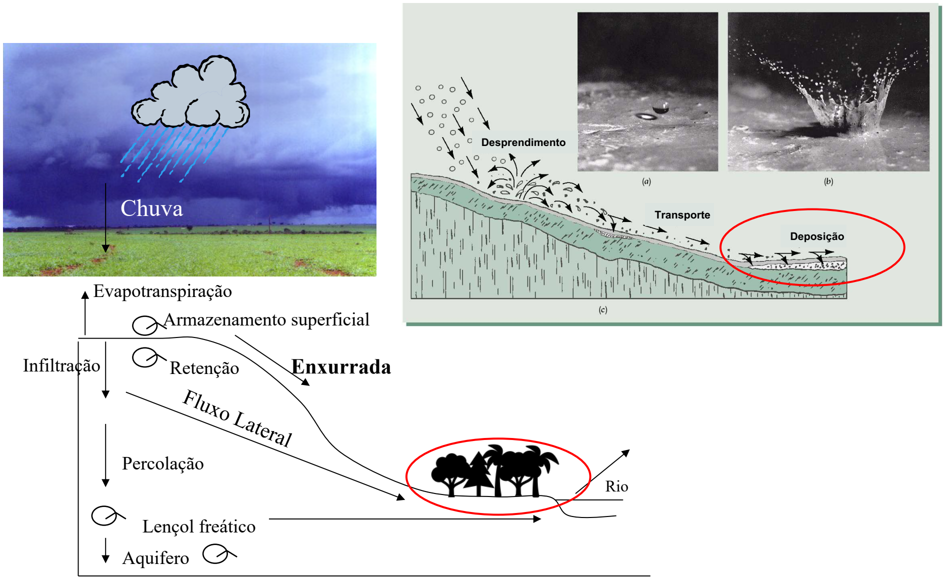


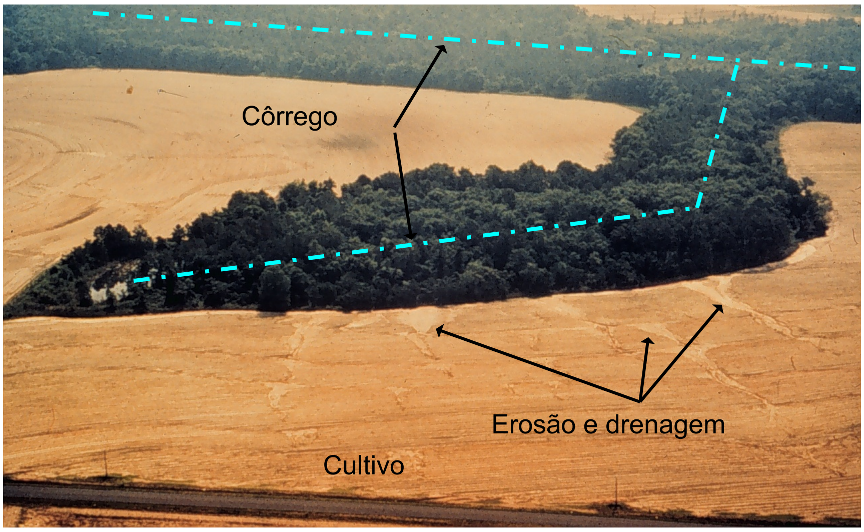
Figure 6. Summary of main flow paths by which hillslope discharge moves through a floodplain to reach the channel: (a) for surface water inputs from upslope; (b) for subsurface water inputs from upslope.



Deposição e interceptação de sedimentos

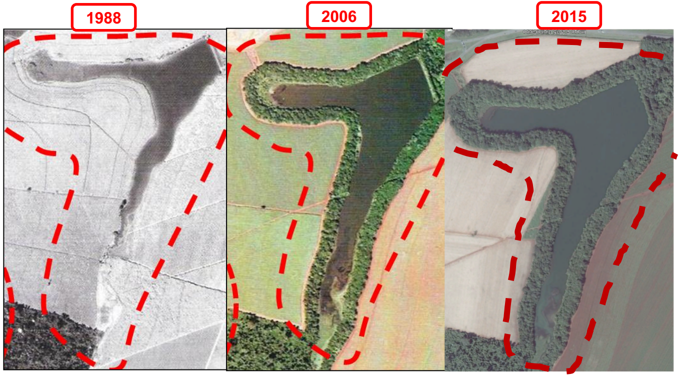


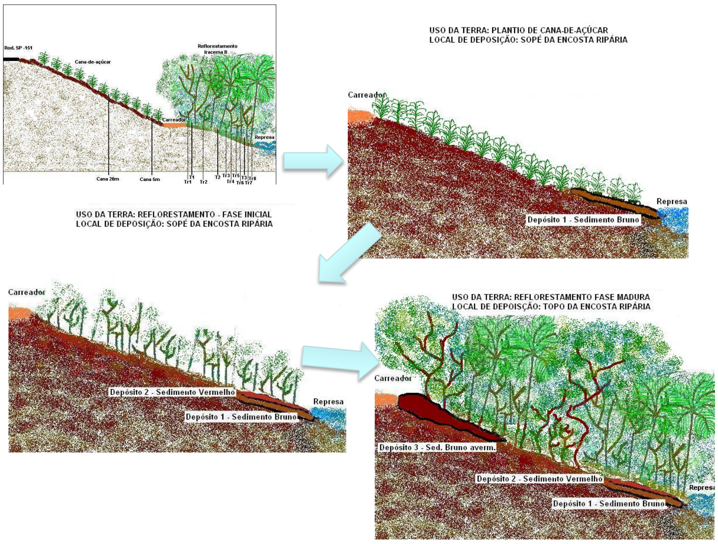
Sistema Ripário



Momoli & Cooper 2007, 2011 e 2016

RESTAURAÇÃO DA MATA CILIAR NA REPRESA DE ABASTECIMENTO PÚBLICO DE IRACEMÁPOLIS



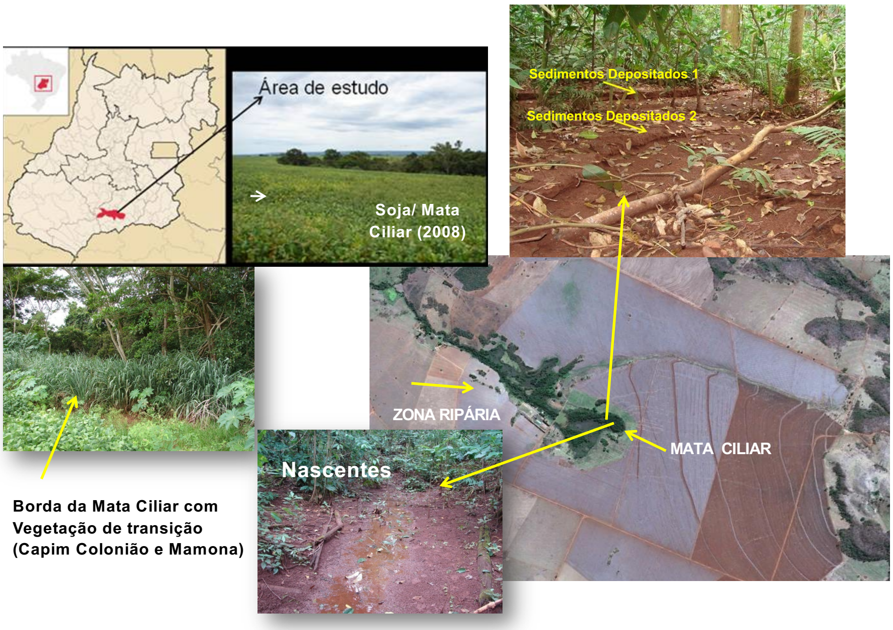


USO DA TERRA: PLANTIO DE CANA-DE-AÇÚCAR
LOCAL DE DEPOSIÇÃO: SOPÉ DA ENCOSTA RIPÁRIA

USO DA TERRA: REFLORESTAMENTO - FASE INICIAL
LOCAL DE DEPOSIÇÃO: SOPÉ DA ENCOSTA RIPÁRIA

USO DA TERRA: REFLORESTAMENTO FASE MADURA
LOCAL DE DEPOISÇÃO: TOPO DA ENCOSTA RIPÁRIA

Bacia Hidrográfica Rio Meia Ponte – Goiatuba, GO

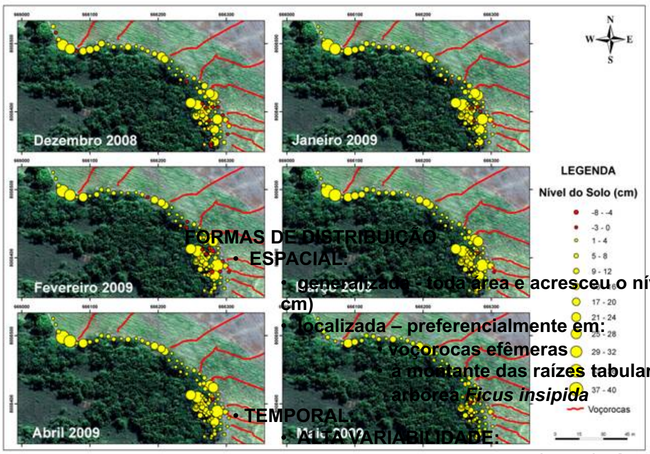


Borda da Mata Ciliar com
Vegetação de transição
(Capim Colonião e Mamona)

Monitoramento dos sedimentos

Estacas ou Pinos de erosão

DISTRIBUIÇÃO ESPAÇO-TEMPORAL SEDIMENTOS



- altos valores de deposição em vários pontos
- valores acima de 30 cm
- erosão em todos os meses (- 6cm Fevereiro)

FORMAS DE DISTRIBUIÇÃO
- **ESPACIAL:**
  - **generalizada - toda área e acresceu o nível do solo (m=12 cm)**
  - **localizada – preferencialmente em:**
    - **voçorocas efêmeras**
    - **à montante das raízes tabulares, p. ex. da espécie arbórea *Ficus insipida***
- **TEMPORAL:**
  - **ALTA VARIABILIDADE:**

> sedimentação verão 2008/2009 (> índices pluviométricos + solo descoberto)

> erosão verão 2009/2010

29

AGNPS: A nonpoint-source pollution model for evaluating agricultural watersheds

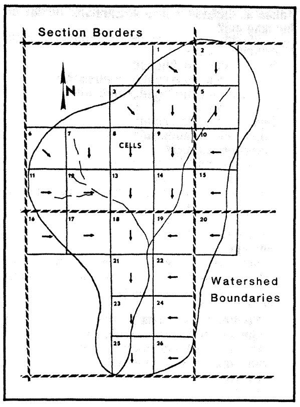


Figure 1. Sample watershed showing subdivision into cells.

Table 1. Input data file.

Column Number	*Data*
	Watershed Input
1	Watershed identification
2	Cell area (acres)
3	Total number of cells
4	Precipitation (inches)
5	Energy-intensity value
	Cell Parameter
1	Cell number
2	Number of the cell into which it drains
3	SCS curve number
4	Average land slope (%)
5	Slope shape factor (uniform, convex, or concave)
6	Average field slope length (feet)
7	Average channel slope (%)
8	Average channel side slope (%)
9	Mannings roughness coefficient for the channel
10	Soil erodibility factor (K) from USLE
11	Cropping factor (C) from USLE
12	Practice factor (P) from USLE
13	Surface condition constant (factor based on land use)
14	Aspect (one of 8 possible directions indicating the principal drainage direction from the cell)
15	Soil texture (sand, silt, clay, peat)
16	Fertilization level (zero, low, medium, high)
17	Incorporation factor (% fertilizer left in top 1 cm of soil)
18	Point source indicator (indicates existence of a point source input within a cell)
19	Gully source level (estimate of amount, tons, or gulley erosion in a cell)
20	Chemical oxygen demand factor
21	Impoundment factor (indicating presence of an impoundment terrace system within the cell)
22	Channel indicator (indicating existence of a defined channel within a cell)

Table 2. Output at the watershed outlet or for any cell.

Hydrology Output
- Runoff volume (inches)
- Peak runoff rate (cubic feet/second)
- Fraction of runoff generated within the cell

Sediment Output
- Sediment yield (tons)
- Sediment concentration (ppm)
- Sediment particle size distribution
- Upland erosion (tons/acres)
- Amount of deposition (%)
- Sediment generated within the cell (tons)
- Enrichment ratios by particle size
- Delivery ratios by particle size

Chemical Output
- Nitrogen
  - Sediment associated mass (pounds/acre)
  - Concentration of soluble material (ppm)
  - Mass of soluble material (pounds/acre)
- Phosphorus
  - Sediment associated mass (pounds/acre)
  - Concentration of soluble material (ppm)
  - Mass of soluble material (pounds/acre)
- Chemical Oxygen Demand
  - Concentration (ppm)
  - Mass (pounds/acre)

30

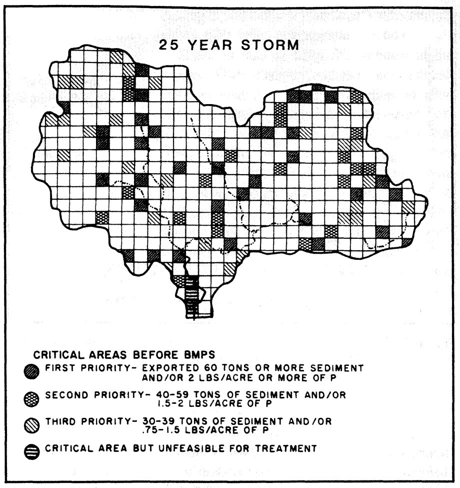


Figure 6. Estimated discharge of sediment and phosphorus by cells in Salmonson Creek watershed, Big Stone County, Minnesota.

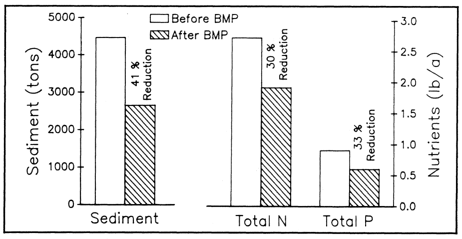


Figure 7. Estimated sediment and nutrient yields from a 25-year, 24-hour storm before and after implementation of best management practices.

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