# Impacts of Intensive Potato Production on Water Yield and Sediment Load: Black Brook Experimental Watershed: 1992-2002

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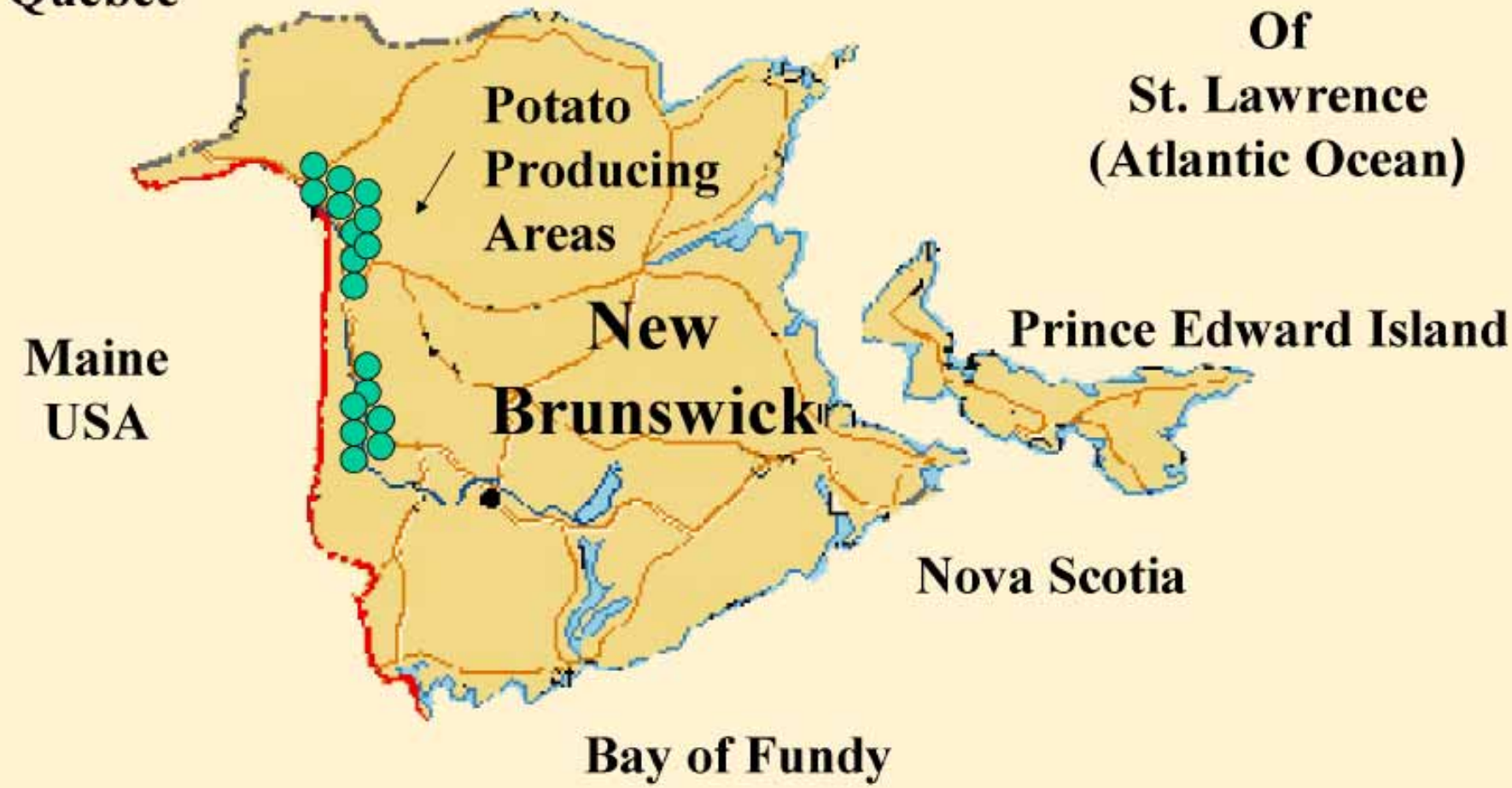
Quebec
Gulf
Of
St. Lawrence
(Atlantic Ocean)
Potato
Producing
Areas
New
Brunswick
Prince Edward Island
Maine
USA
Nova Scotia
Bay of Fundy

- 20,000 ha of potato grown annually in New Brunswick
- 30-40 % of total provincial farm cash receipts
- Value added products

Shallow Soils

Sloping Topography

Major Rain Storms

Intensive Management


Pollution

## runoff with sediment, nutrients & pesticides enters streams - water quality impacts

# 20+ Years of Soil Erosion Research in Potato Production in New Brunswick

**On-farm**

- **Rainfall simulator plots (1m x 1m);**
- **Permanent runoff-erosion plots (10m x 30m);**
- **Paired drainage basins (2-5 ha);**
- **Other field scale experiments (Buffer strip, Nutriment management, etc.)**

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**Off-farm**

- **Experimental watersheds (15 and 340 $km^2$)**

# Objectives:

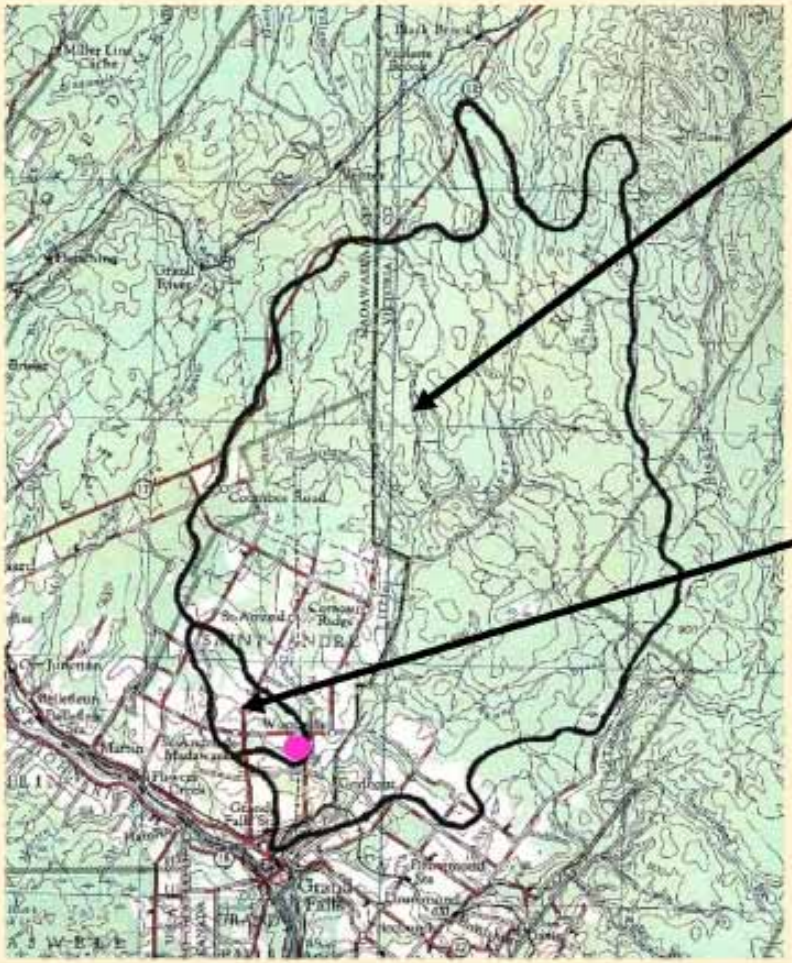
- **Impacts of intensive potato production on:**
  - **Runoff and soil erosion**
  - **Soil quality in terms of productivity**
  - **Water quality in terms of discharge, sediment and nutrient loading**

- **Beneficial Management Practices on:**
  - **Runoff and soil losses**
  - **Soil quality**
  - **Water quality**

# Collaborators

- **Environment Canada**
- **NB Department of Agriculture, Fisheries and Aquaculture**
- **NB Department of Environment and Local Government**
- **Eastern Canada Soil and Water Conservation Centre**
- **University of New Brunswick (biology, engineering, forestry)**
- **Various farm agencies and associations**
  - **Potatoes New Brunswick**
  - **NB Soil and Crop Improvement Association**
- **Individual farmer/producers**

# Experimental watersheds



**Little River Watershed (est. 2000)**:

Size : 380 km$^2$

Land use:

Agriculture – 15%

Forestry – 85%

**Black Brook Watershed (est. 1992):**

Size : 15 km$^2$

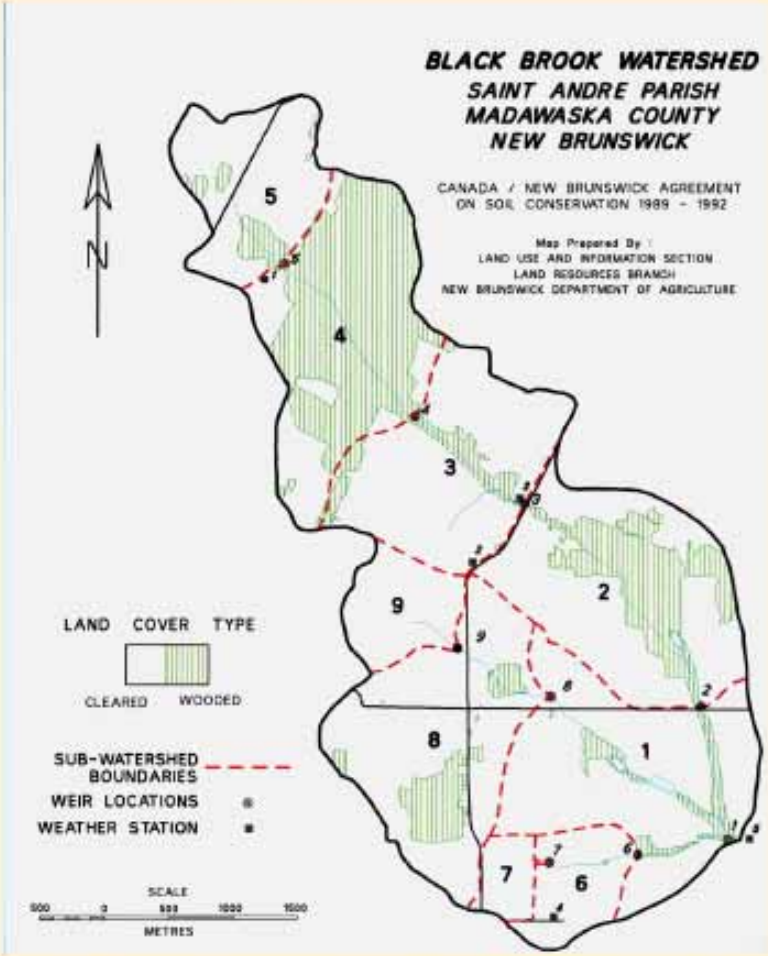
Land use:

Agriculture – 64%

Forestry – 36%

● Monitoring station

# Experimental watersheds – Black Brook




Size = 1450 ha
(7.5 km long x 3.5 km wide)

Slope:
- Upper -- 1- 6%
- Central – 4-9%
- lower – 5-16%

Detailed soil survey data 1:10,000

5 Automated weather stations

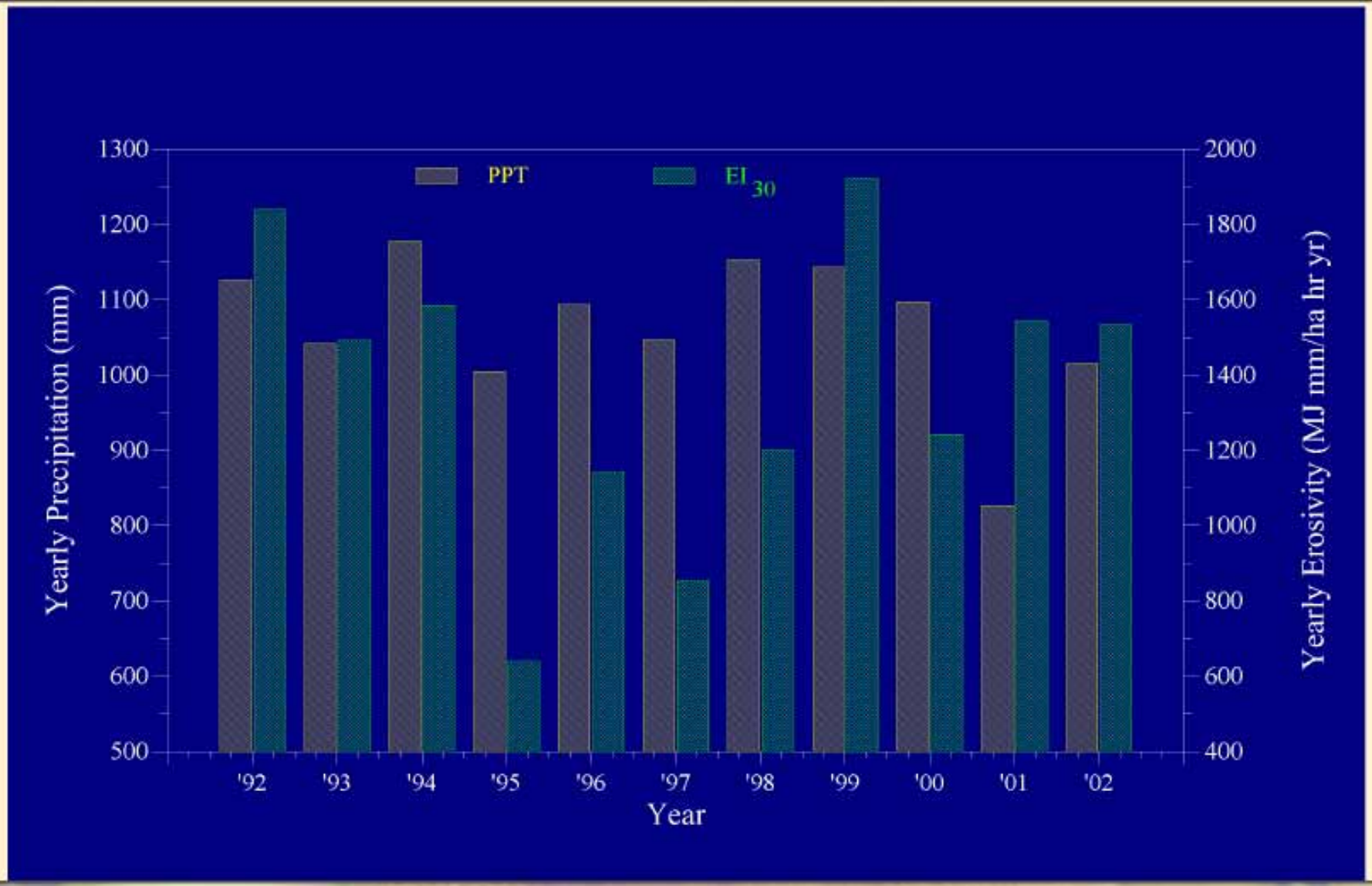
Land use (survey):
- Potatoes – 38%
- Grain – 15%
- Pasture – 6%
- Forage – 4%
- Peas – 1%
- Non-agric. – 36%

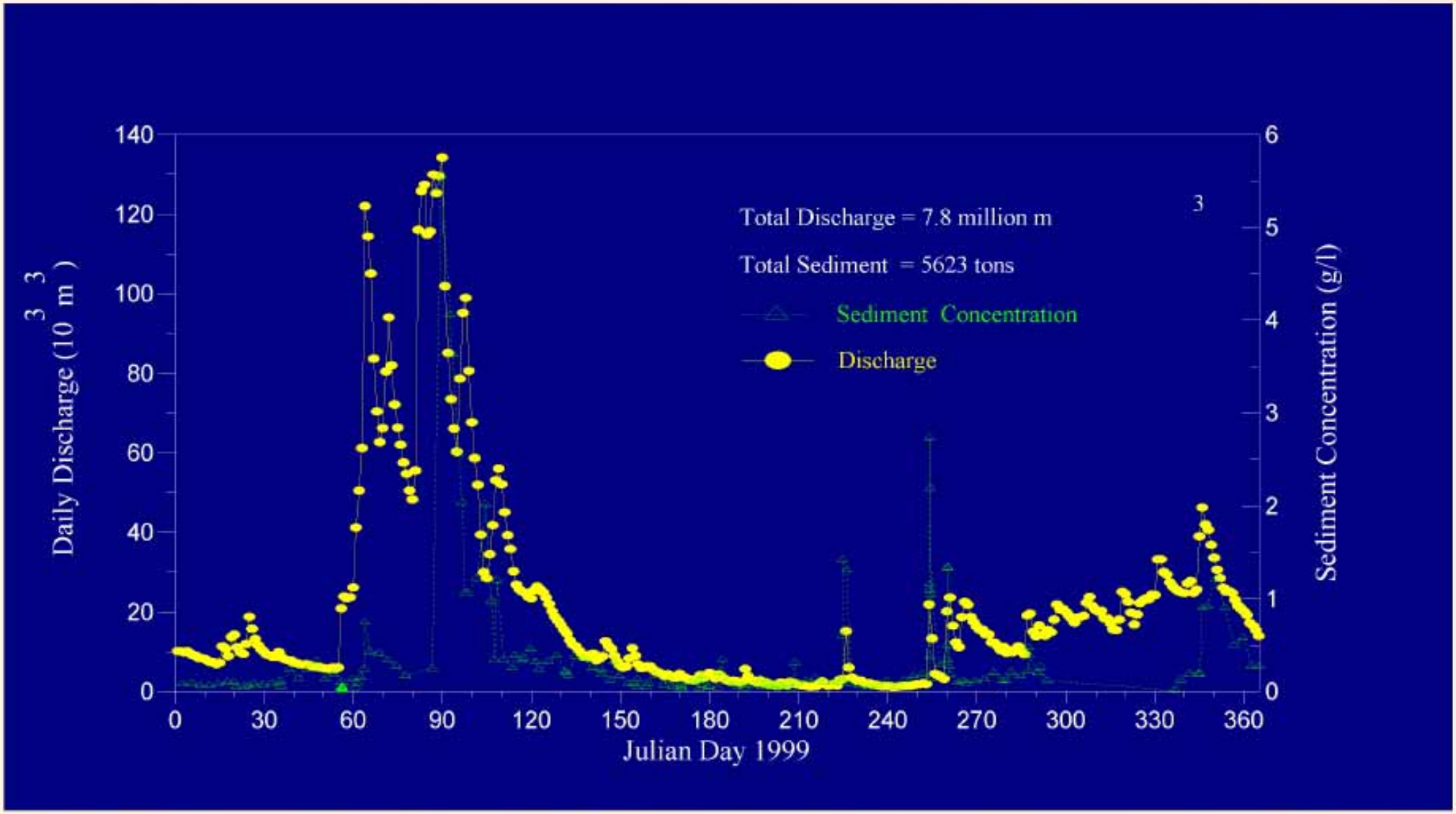
Divided into 8 sub-basins for surface water monitoring

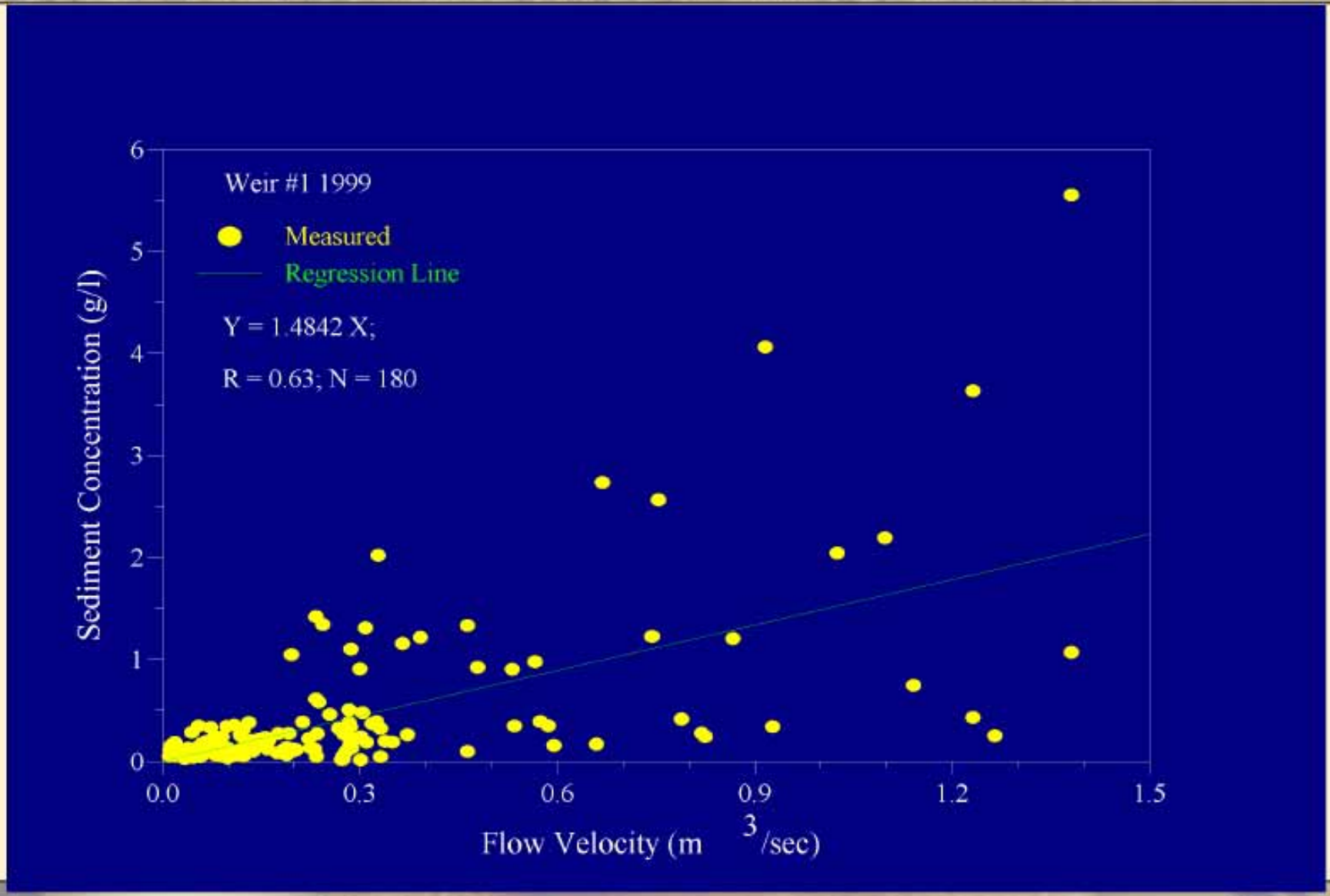
# Black Brook Experimental Watershed

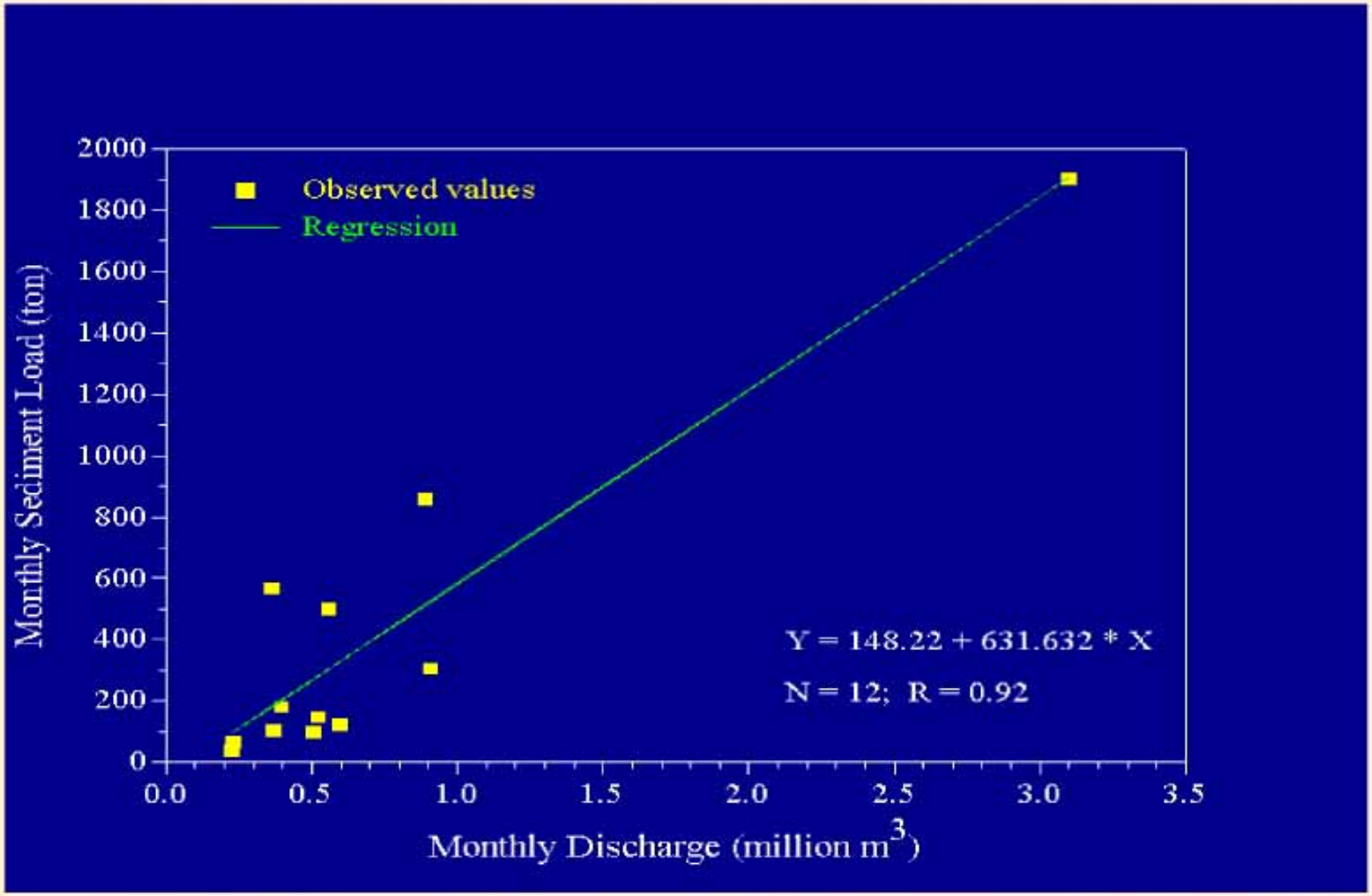
Surface water monitoring sites

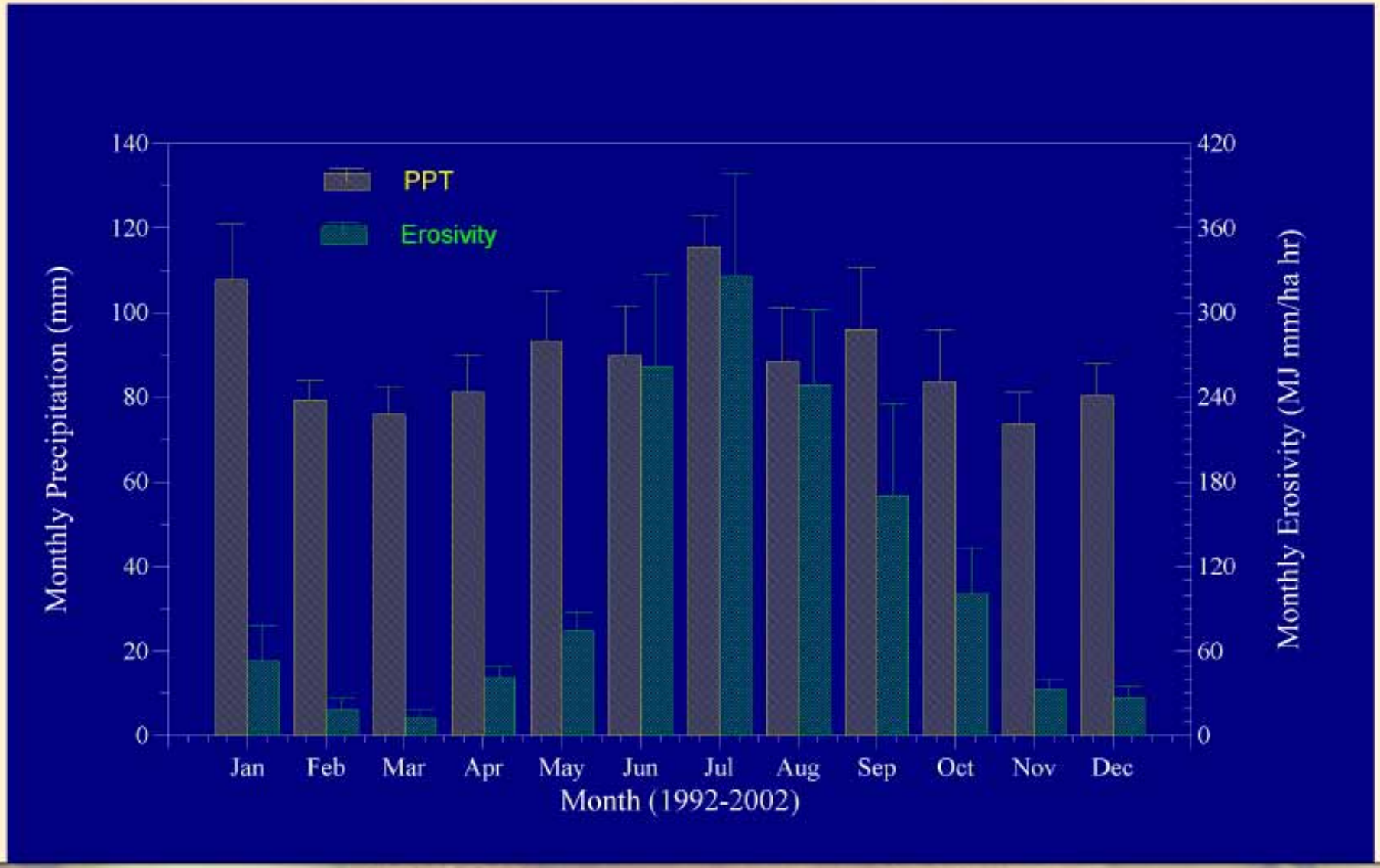
Automated stage height recording and water sampling for flow, pH, conductivity, sediment loading, N, P, K, Ca, Mg

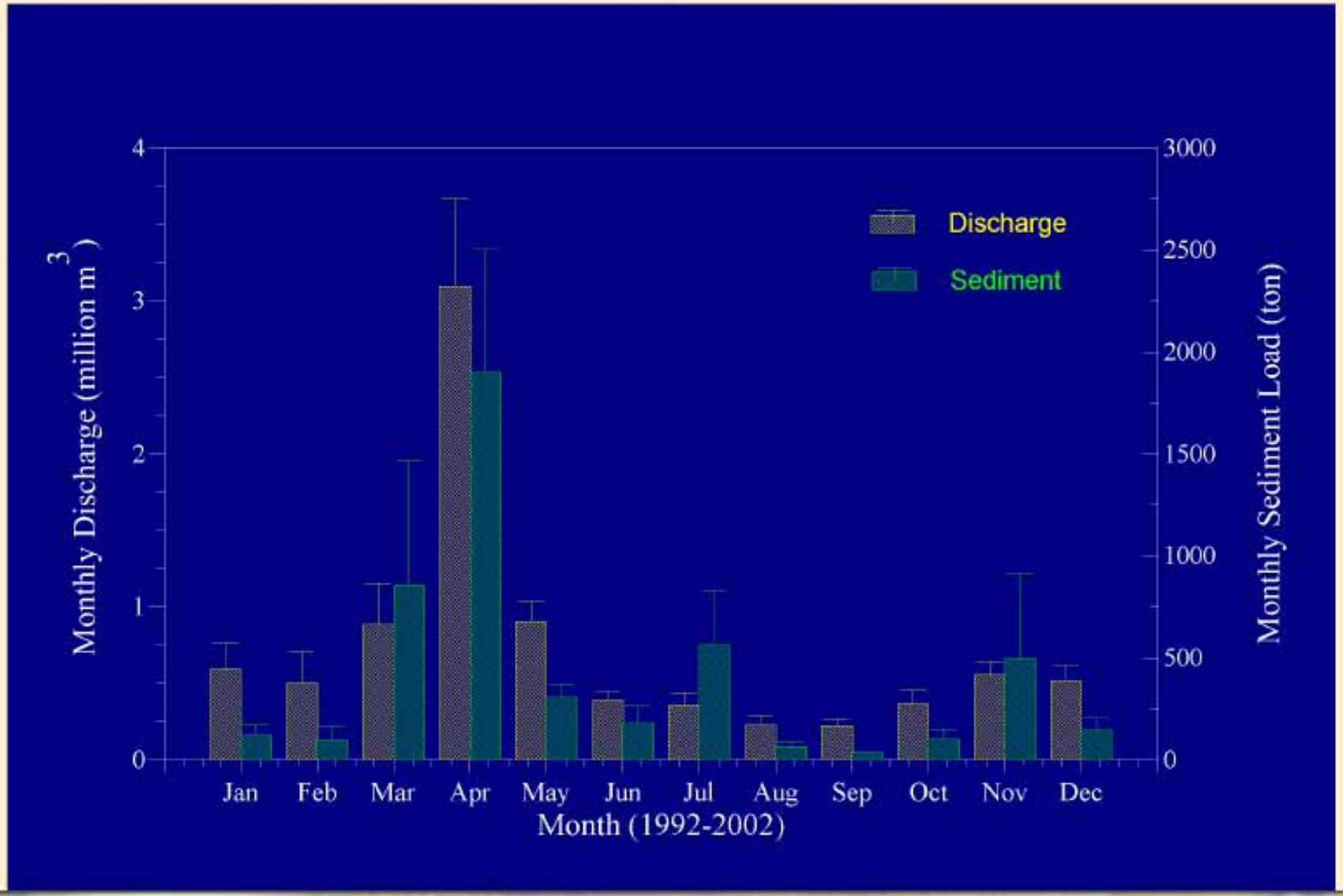

PPT
EI 30
Yearly Precipitation (mm)
Yearly Erosivity (MJ mm/ha hr yr)
Year
1300
1200
1100
1000
900
800
700
600
500
2000
1800
1600
1400
1200
1000
800
600
400
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
'02

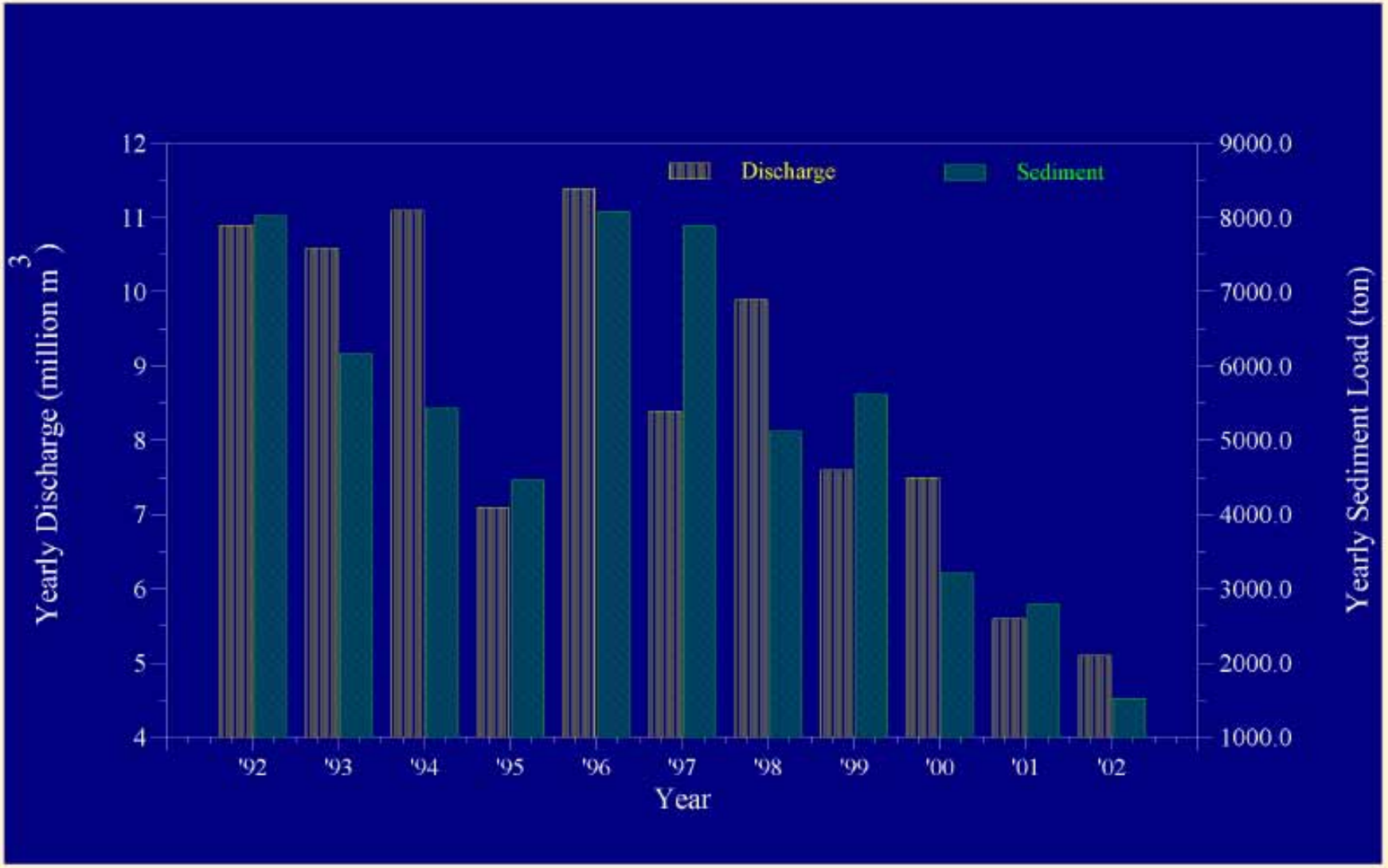

Total Discharge = 7.8 million m3
Total Sediment = 5623 tons
Sediment Concentration
Discharge
Daily Discharge (10 m3 s-1)
Sediment Concentration (g/l)
Julian Day 1999
0
20
40
60
80
100
120
140
0
1
2
3
4
5
6
0
30
60
90
120
150
180
210
240
270
300
330
360


Weir #1 1999
Measured
Regression Line
Y = 1.4842 X;
R = 0.63; N = 180
Sediment Concentration (g/l)
Flow Velocity (m 3/sec)
0
1
2
3
4
5
6
0.0
0.3
0.6
0.9
1.2
1.5


Observed values
Regression
Monthly Sediment Load (ton)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Monthly Discharge (million m3)
Y = 148.22 + 631.632 * X
N = 12; R = 0.92


PPT
Erosivity
Monthly Precipitation (mm)
Monthly Erosivity (MJ mm/ha hr)
140
120
100
80
60
40
20
0
420
360
300
240
180
120
60
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month (1992-2002)


Monthly Discharge (million m3)
Monthly Sediment Load (ton)
Discharge
Sediment
0
1
2
3
4
0
500
1000
1500
2000
2500
3000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month (1992-2002)


Discharge
Sediment
Yearly Discharge (million m3)
Yearly Sediment Load (ton)
Year
12
11
10
9
8
7
6
5
4
9000.0
8000.0
7000.0
6000.0
5000.0
4000.0
3000.0
2000.0
1000.0
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
'02

# BMPs to prevent erosion and runoff

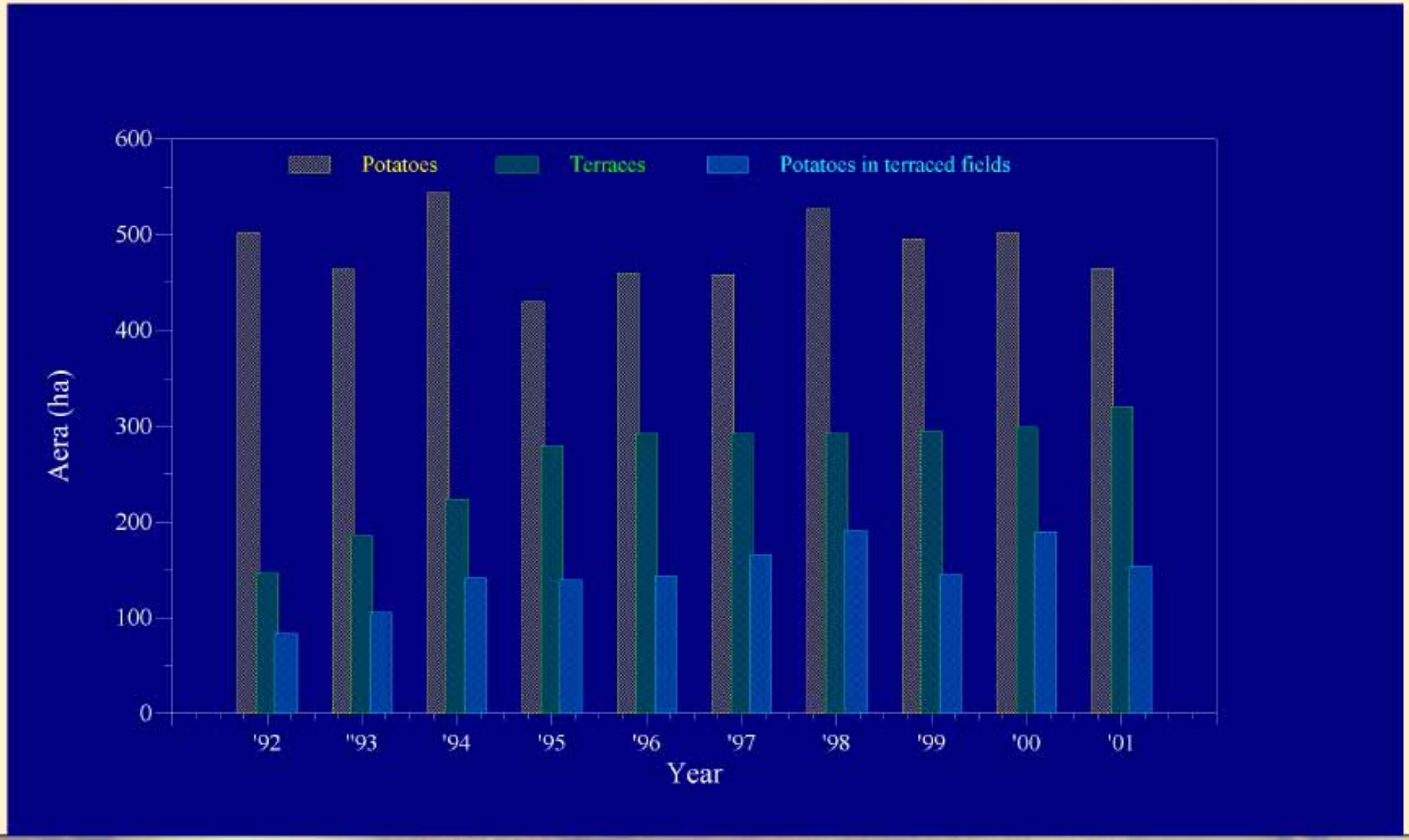
1. Crop Rotation
2. Under-seeding cereals with a forage crop
3. Winter cover crops
4. Conservation tillage
5. Green manures

## BMPs to prevent erosion & runoff



6. Contour ploughing
7. Cross-slope & contour cropping
8. Runoff control (terraces, grassed waterways)
9. Sub-surface drainage, subsoiling & 4x4 tractors
10. Straw cover, soil amendment



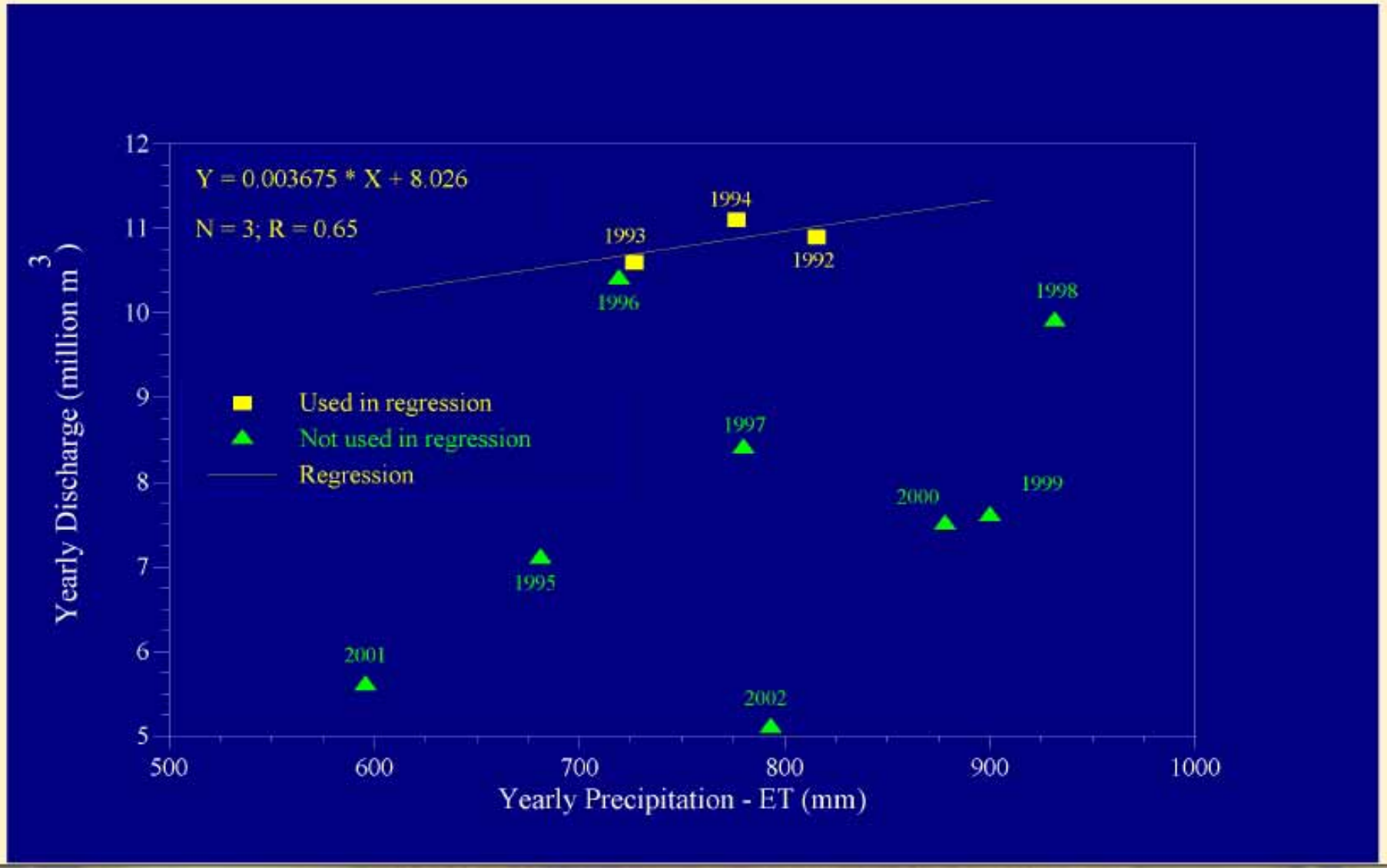


Potatoes
Terraces
Potatoes in terraced fields
Aera (ha)
600
500
400
300
200
100
0
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
Year

# Area of fields protected by terraces/grassed waterways:

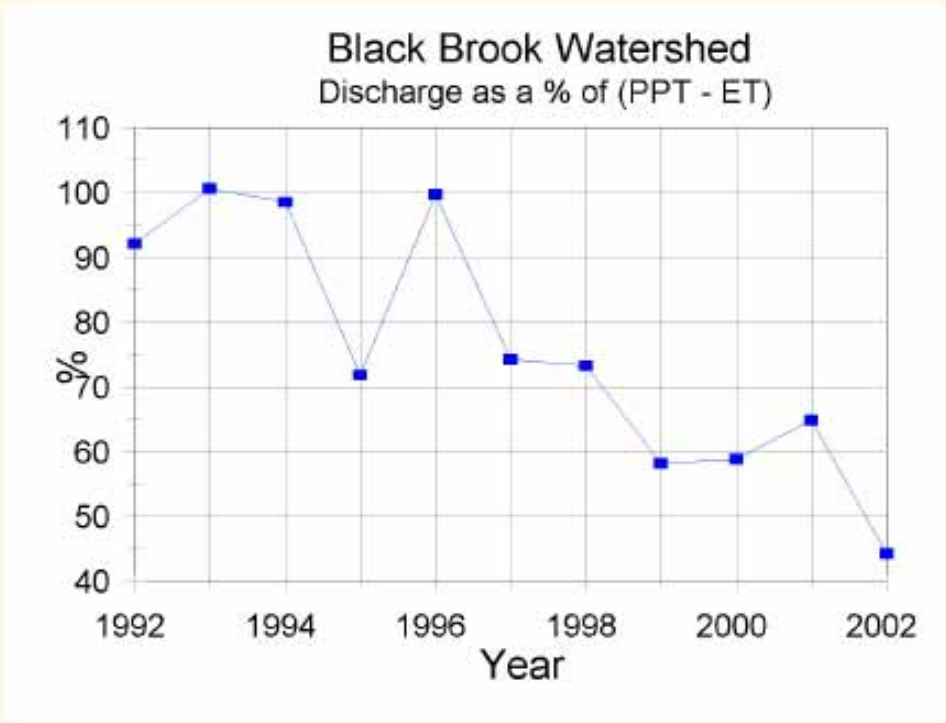
**1992 - 147 ha (16% of farm land)**

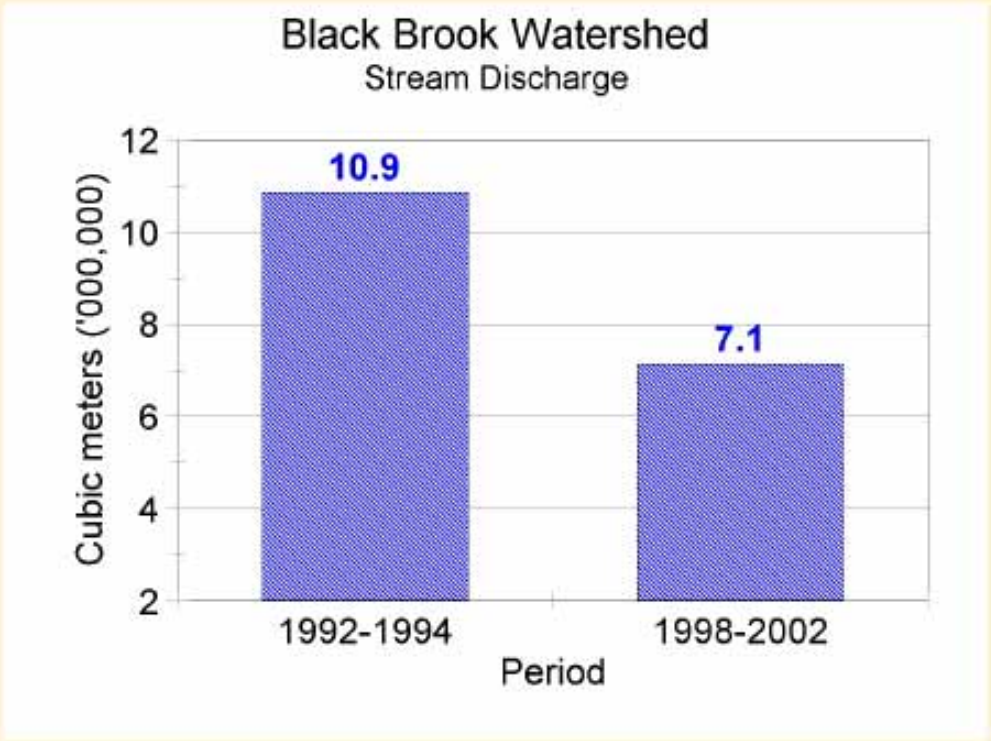
↓

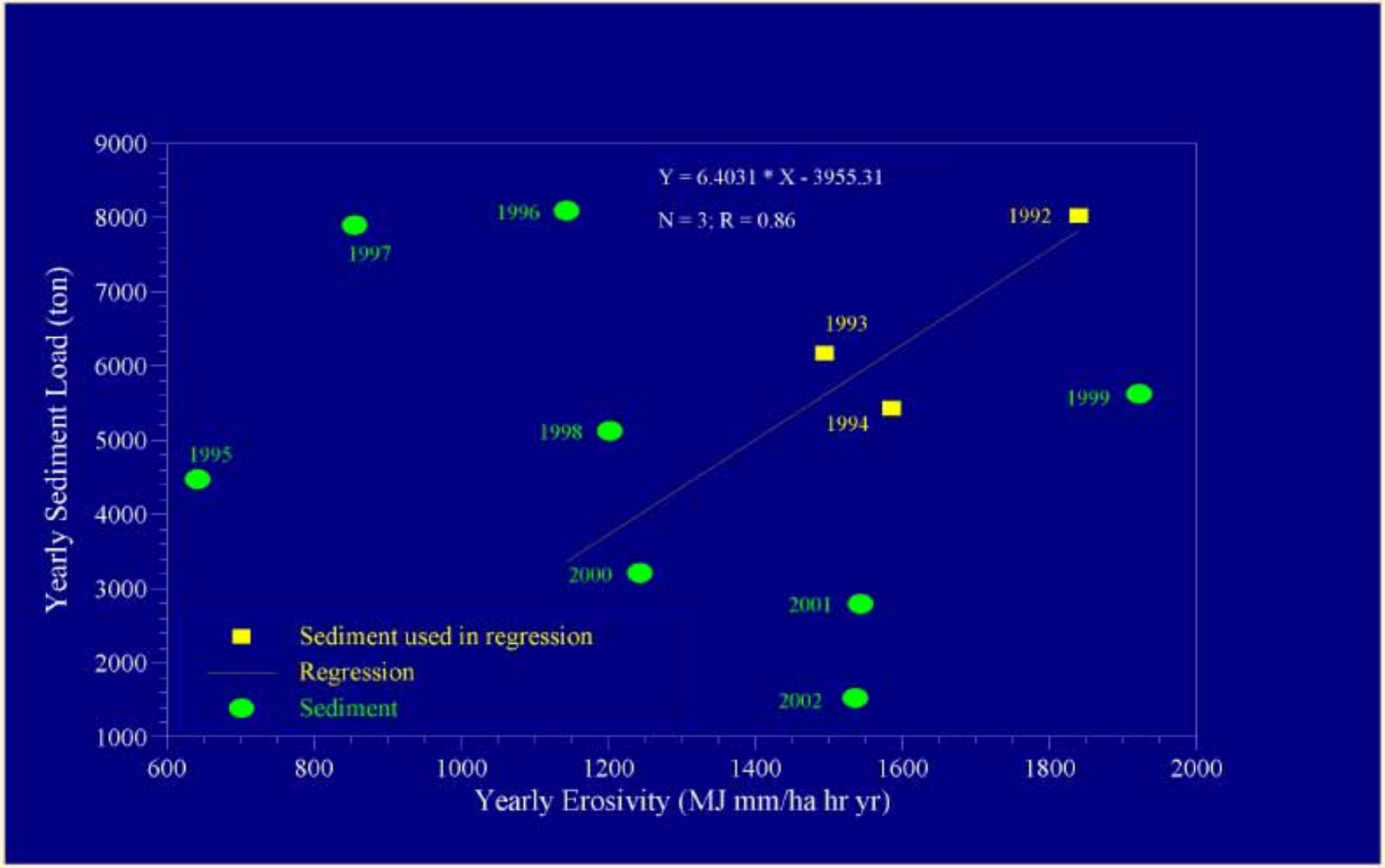
**2003 - 321 ha (35% of farm land)**


Y = 0.003675 * X + 8.026
N = 3; R = 0.65
Used in regression
Not used in regression
Regression
1994
1993
1992
1996
1998
1997
2000
1999
1995
2001
2002
Yearly Discharge (million m3)
Yearly Precipitation - ET (mm)
12
11
10
9
8
7
6
5
500
600
700
800
900
1000

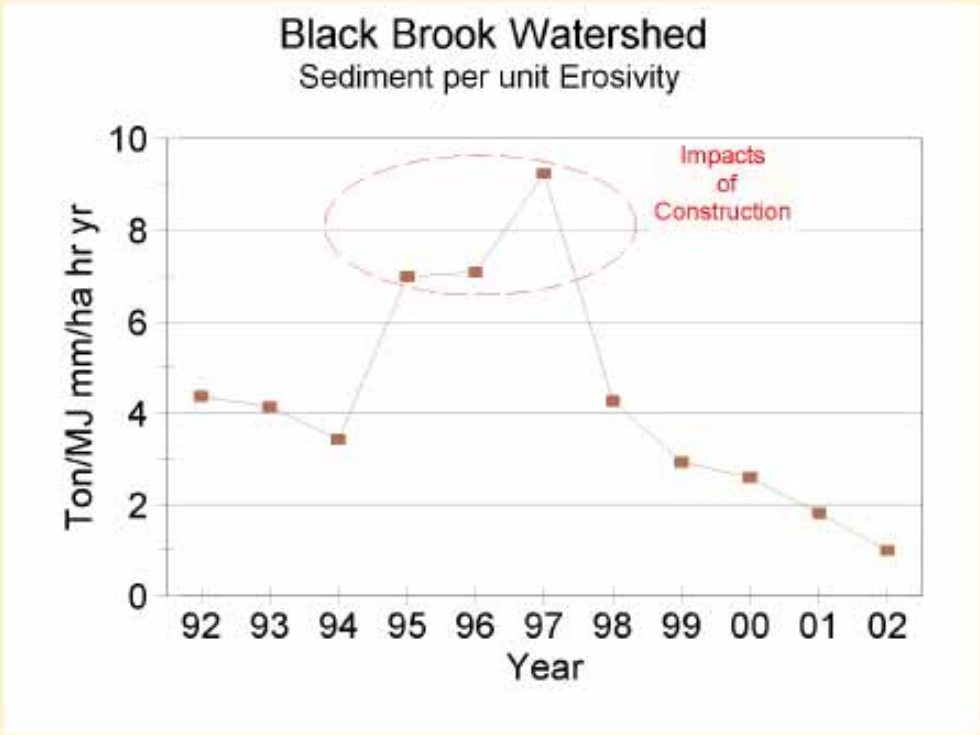
# IMPACTS of TERRACING

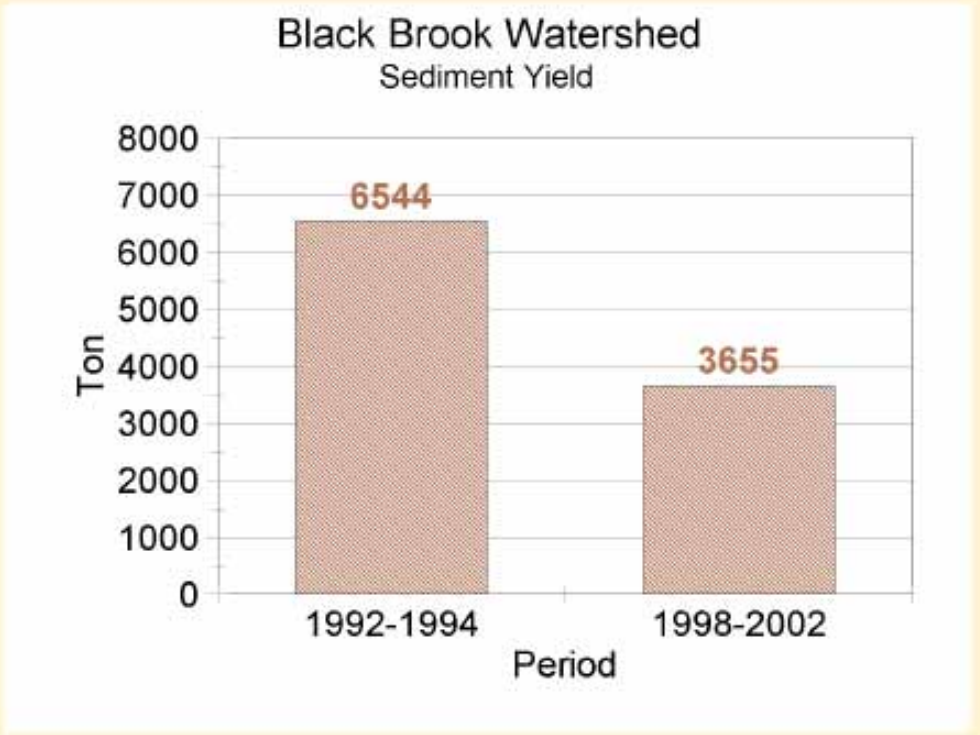



Y = 6.4031 * X - 3955.31
N = 3; R = 0.86
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
Sediment used in regression
Regression
Sediment
Yearly Sediment Load (ton)
9000
8000
7000
6000
5000
4000
3000
2000
1000
600
800
1000
1200
1400
1600
1800
2000
Yearly Erosivity (MJ mm/ha hr yr)

# IMPACTS of TERRACING



# THE QUESTION

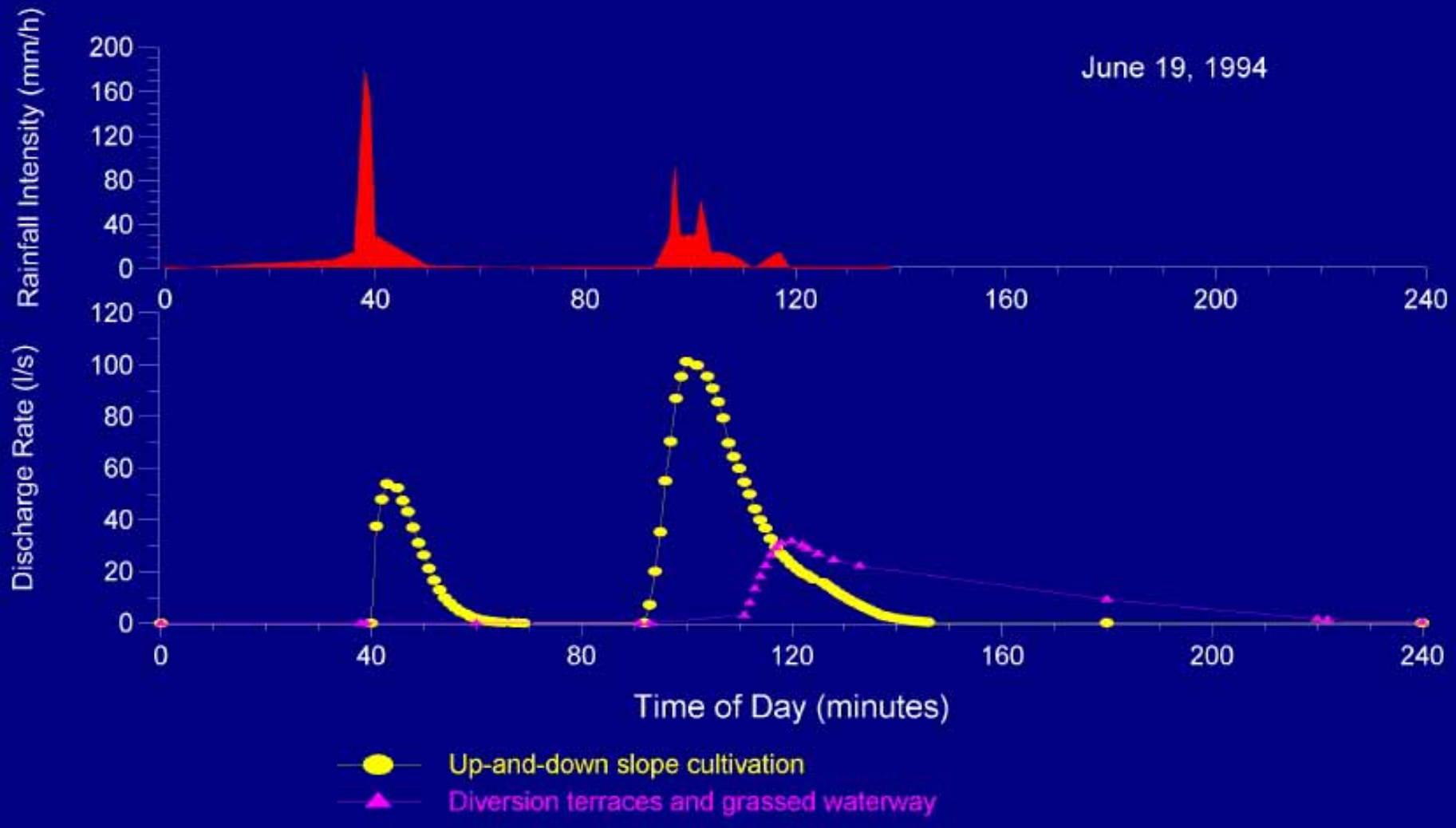
**We're keeping the soil in place by keeping the water on site, so what's happening to the groundwater ???**

**Nutrient Management! Nutrient Management! Nutrient Management!**

# Conclusions

- Without proper conservation system, accelerated soil erosion and surface water contamination are of major concerns under intensive potato production;
- Suspended sediment concentration increased with increasing flow velocity with r=0.63 or 40% of variation in sediment concentration may be accounted by flow velocity;
- Monthly discharge is well correlated with monthly sediment load with r=0.92 or 85 % of variations in monthly sediment load may be explained by variations in monthly discharge;
- Under a watershed scale study, over 50% of discharge and 80% of sediment load occurred during snow melt period in March and April, whereas under 80% of runoff and 8% of soil losses happened during the non-cropping season (November to April, inclusive) under a field scale study;
- Terraces/grassed waterways systems are effective measures to reduce discharge and sediment load from watersheds intensive potato production. Full potential of these systems to reduce soil loss was not reached until 3-4 years after construction.

# Thank You


June 19, 1994
Rainfall Intensity (mm/h)
200
160
120
80
40
0
0
40
80
120
160
200
240
Discharge Rate (l/s)
120
100
80
60
40
20
0
0
40
80
120
160
200
240
Time of Day (minutes)
Up-and-down slope cultivation
Diversion terraces and grassed waterway

# ANNUAL SOIL LOSS

**Tolerable Soil Loss = 6 T/Ha/Yr**