Differentiating Runoff Contributing Areas for Effective Water Quality Management

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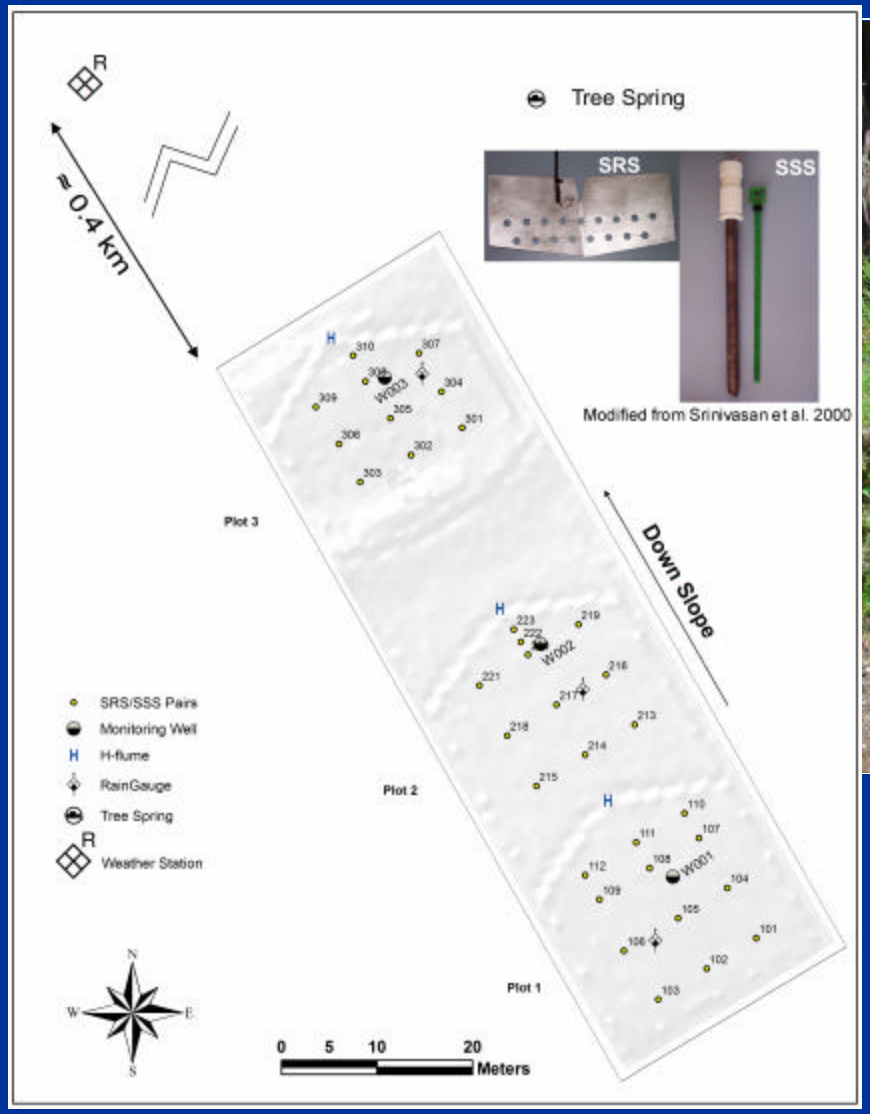
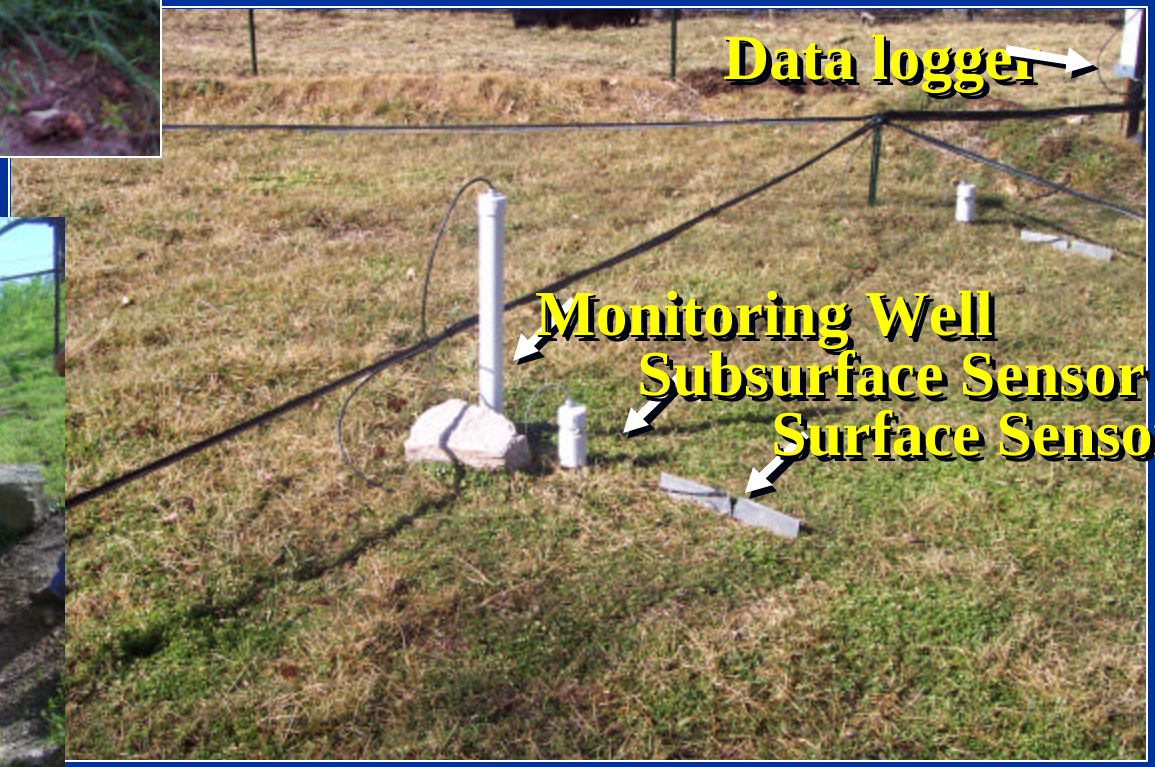
Objectives

- Develop and test a field-scale methodology to measure the location of different runoff contributing areas from pastureland.
- Relate spatial variability of field runoff to hydrologic, topographic, and soil characteristics.

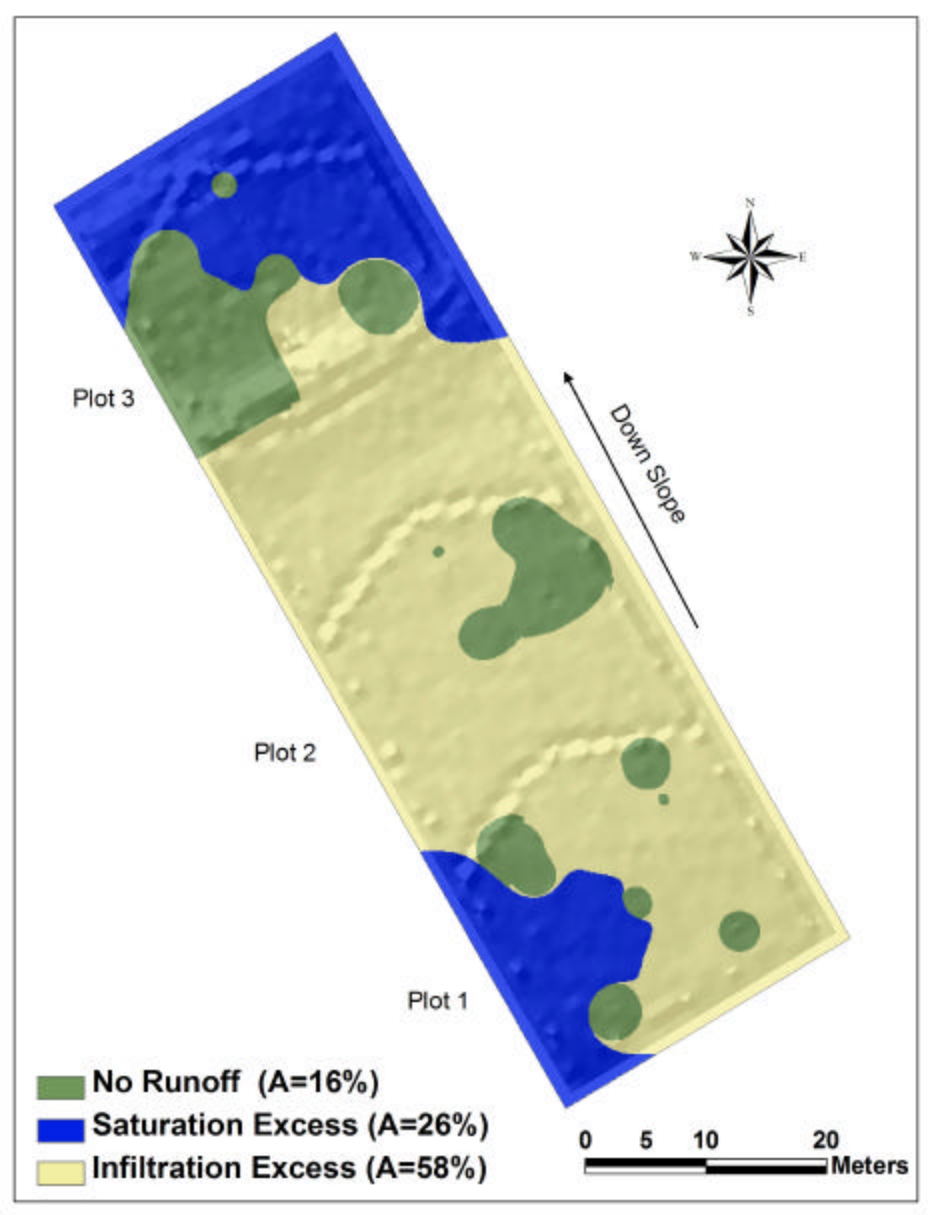
Methods: Field Layout & Instrumentation



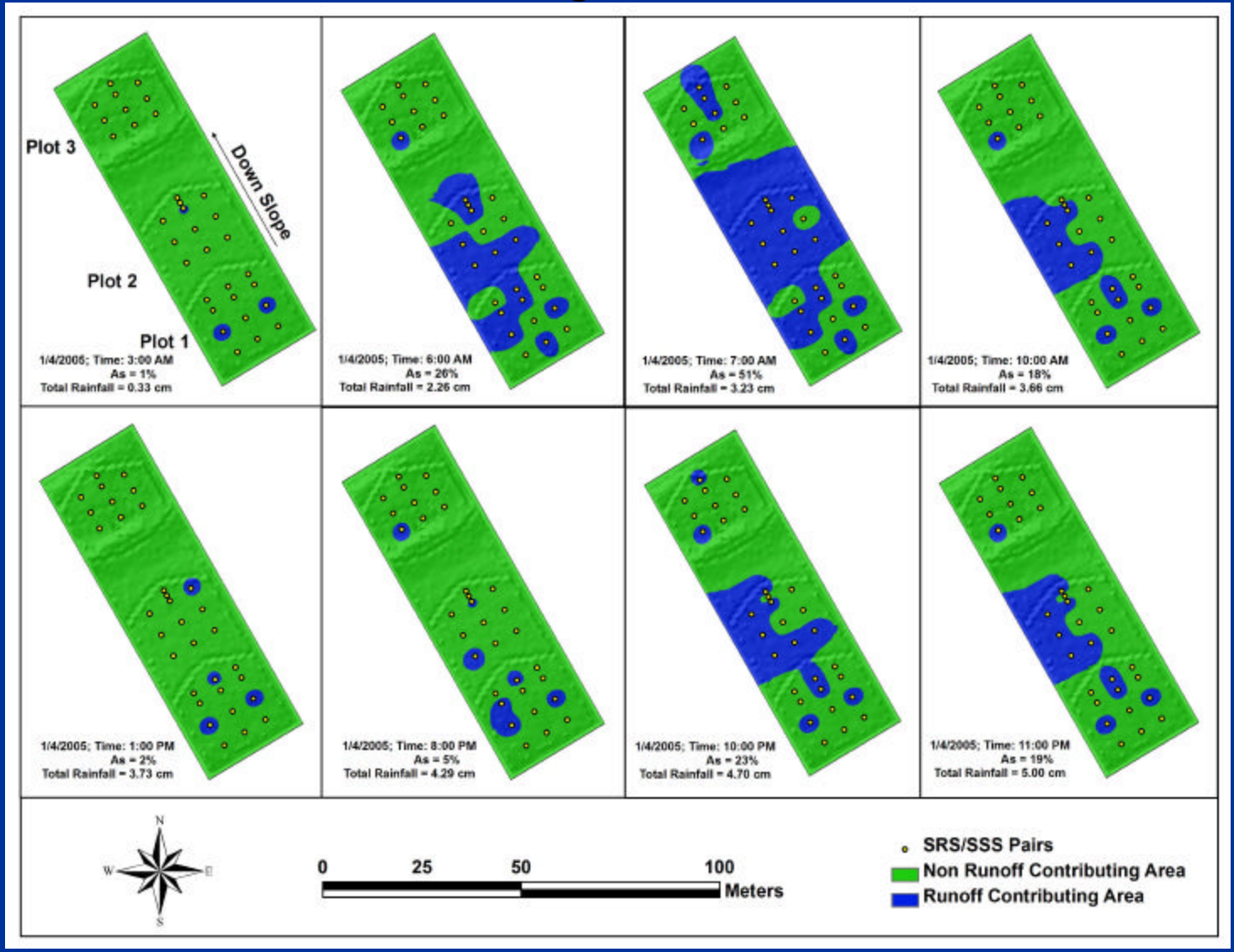
*Instruments logged at 5- minute intervals since April, 2004.


Data logger
Monitoring Well
Subsurface Sensor
Surface Sensor

Results: Runoff mechanisms



Runoff Contributing Areas
January 1-5, 2005



Modeling – Topographic Index Model

- Topographic Index (TI) :

$$TI = \ln\left(\frac{a}{\tan B}\right)$$

a = upslope contributing area

tan B = slope

  - Higher areas of TI indicate areas most likely to contribute to saturation excess runoff
  - Normalized TI with largest TI value

Beven and Kirkby, 1979

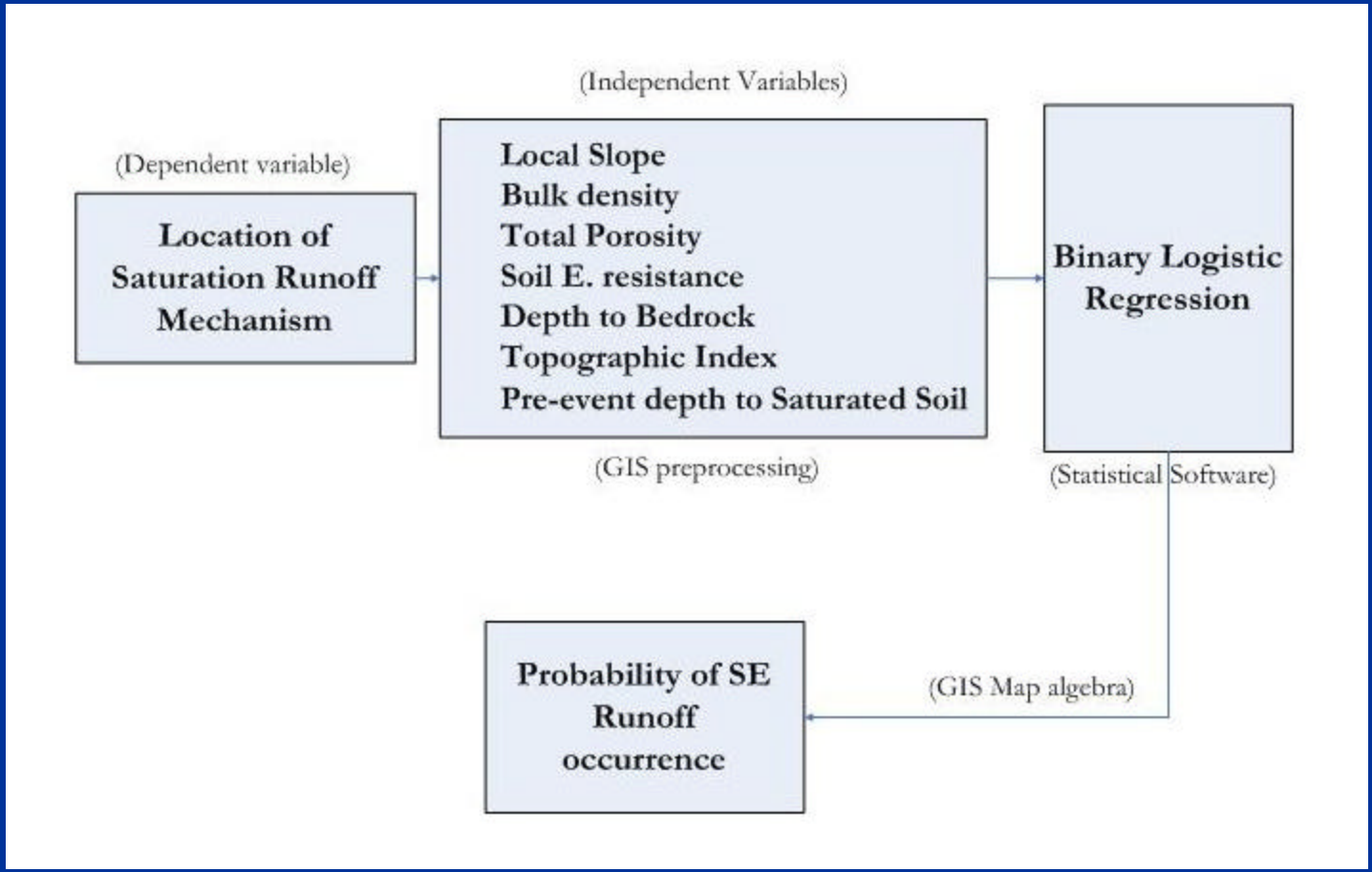
Modeling – Likelihood Indicator Model

- Binary Logistic Regression

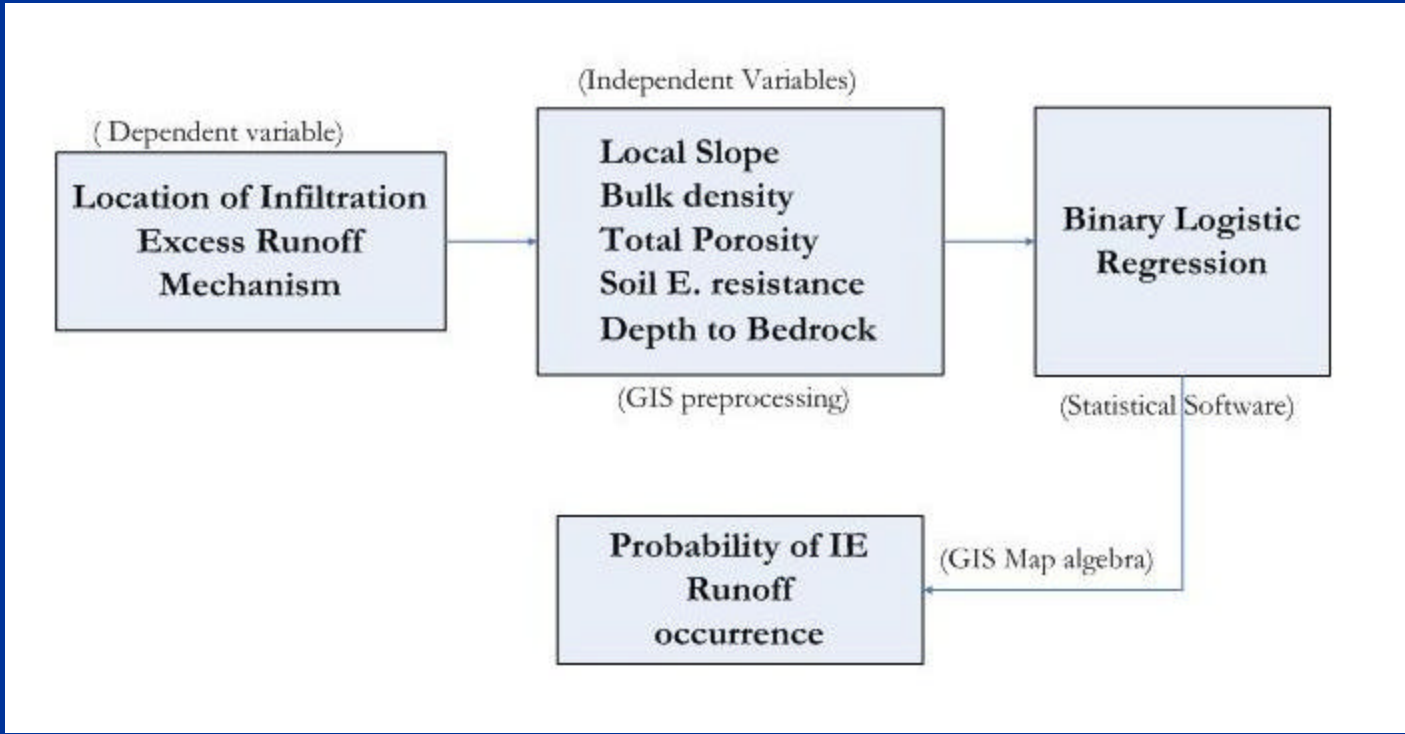
$$Logit(p) = \ln\left(\frac{p}{1-p}\right) = a + b_1X_1 + b_2X_2 + \ldots.. + b_iX_i$$

  - where p is the probability of occurrence particular runoff mechanism, a is intercept, $ß_i$ is coefficient of variable X_i

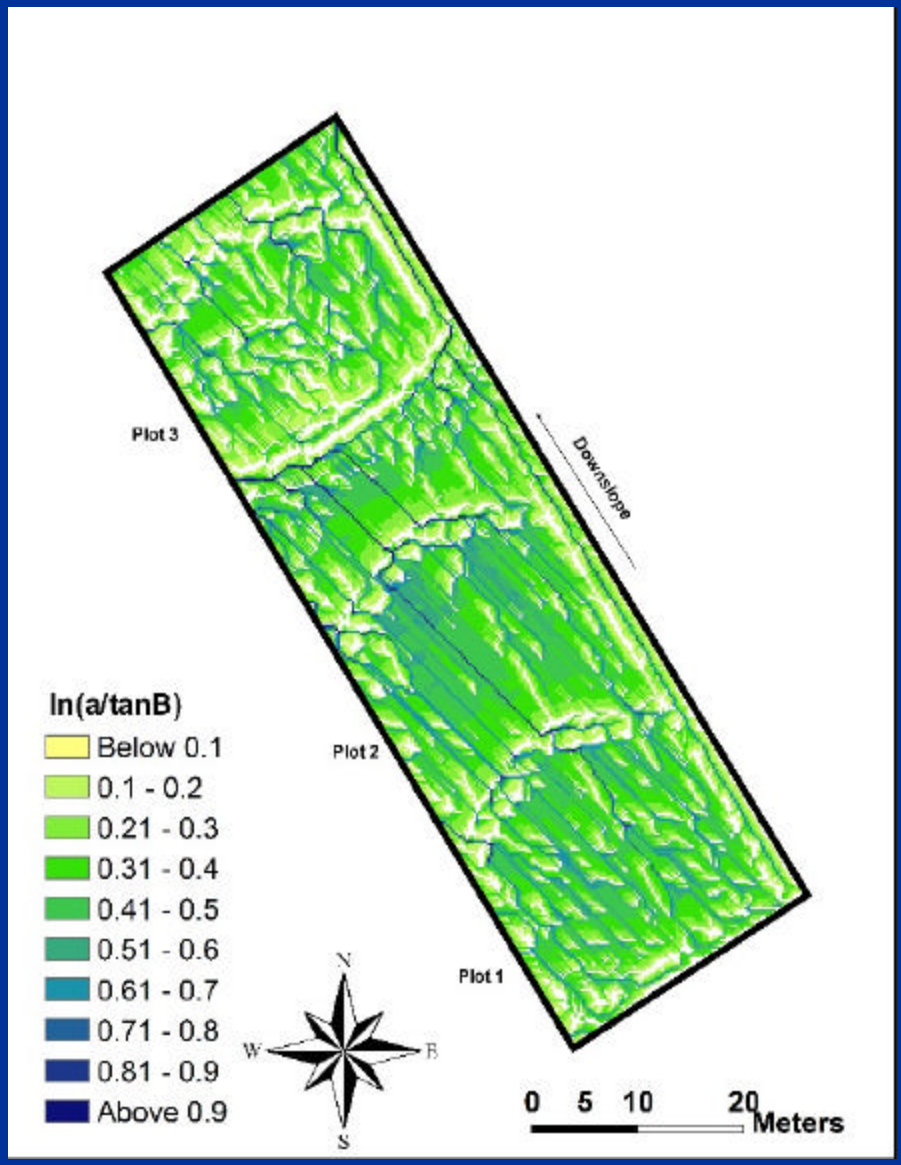
Saturation Excess Runoff Model



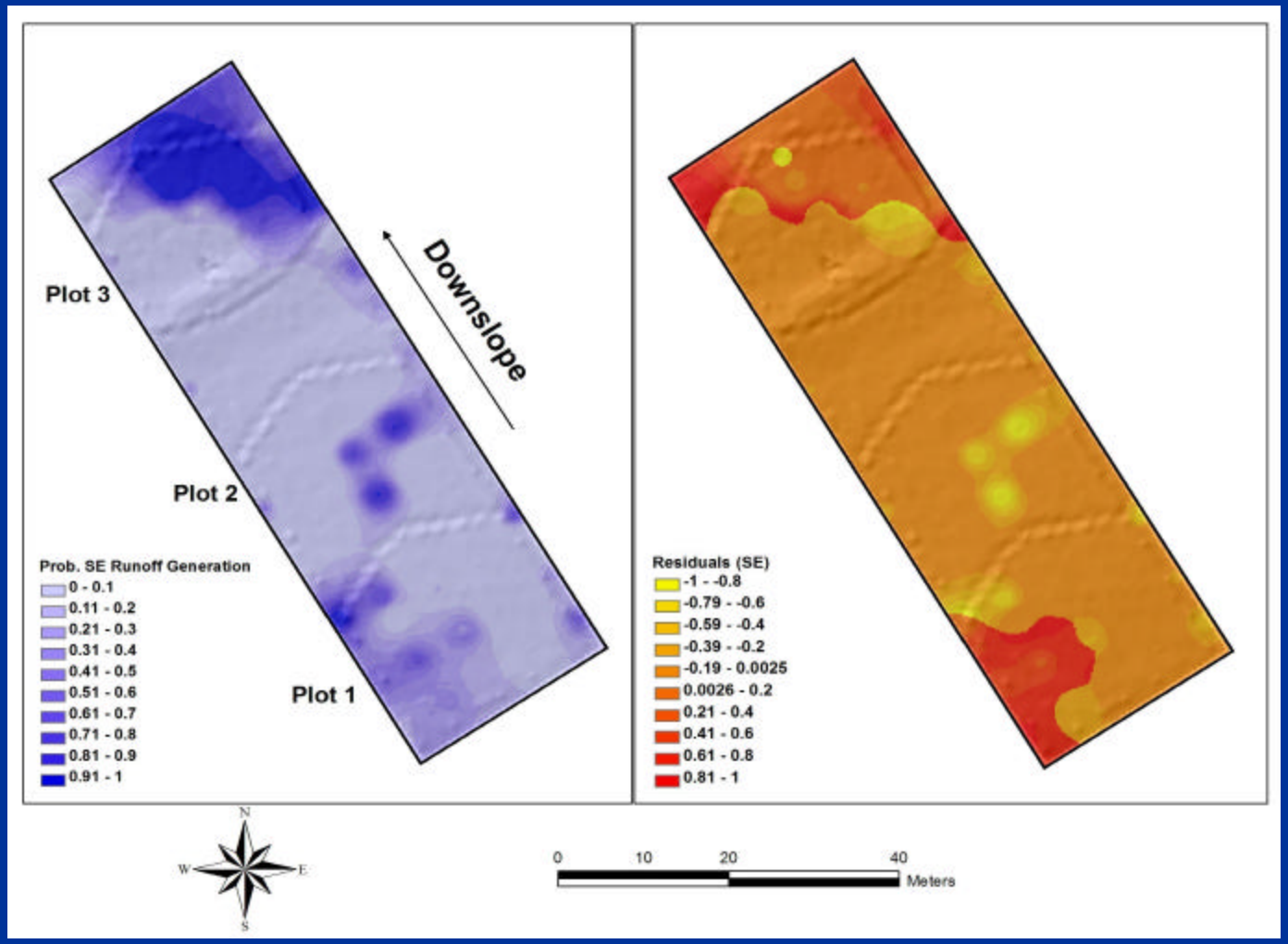
Infiltration Excess Runoff Model



Results : Topographic Index Model

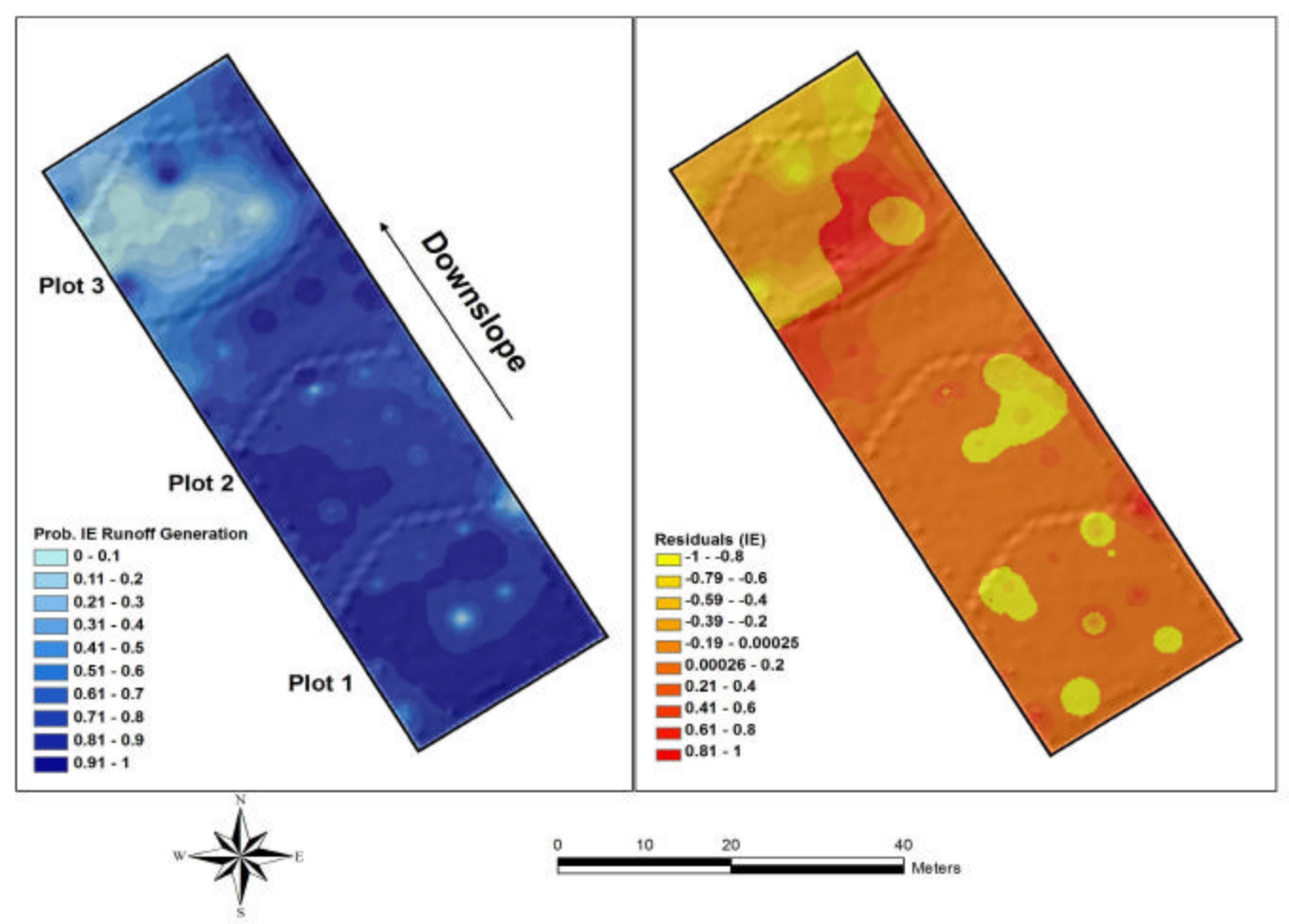


Results : Likelihood Indicator Model- Saturation Excess Runoff



SE Loc = 113.0303 – 35.8356*Bulk D – 79.8503*Total P-0.09545*DepthB-0.62634*Pre-eventW

Results : Likelihood Indicator Model- Infiltration Excess Runoff



IE Loc = 149.9021 – 65.5912*Bulk D – 141.6018*Total P+0.05452*DepthB-0.0042*ERes

Model Accuracies

Model	Rsquare (U)*	Average Accuracy (%)	Overall Accuracy (%)
Topographic Index Model	-	53	**87****
SE Likelihood Indicator Model	0.48	81	87
IE Likelihood Indicator Model	0.26	78	81

** Mostly due to non saturation excess runoff areas being predicted correctly.

Summary & Conclusions

- Sensors indicate that both infiltration excess and saturation excess runoff occur on these fields.
- Overall, surface runoff was generated from well-defined and identifiable areas within the field.
- GIS based binary logistic regression models were developed to predict locations of runoff source areas within a field in the SEW. Both saturation excess and infiltration excess models gave satistfactory results.
- TOPMODEL's topographic index (TI) does not seem to provide reasonable estimates of runoff source areas in the field with significant infiltration excess runoff.

Broader Impacts of the Project

- One M.S. student (Mansour Leh).
- The site developed provided training for more than 200 undergraduate and graduate students through other research project, field visits, and hydro days (geology camp).
- Approximately 300 scientists and engineers have visited the site and obtained information about this project.
- State agencies, such as Arkansas Natural Resources Commission, are considering to incorporate results in making animal manure management decisions.