AGNPS Model

Introduction

AGNPS(*Agricultural Non-Point Source Pollution Model* **)** is an event-based model that simulates surface runoff, sediment, and nutrient transport primarily from agricultural watersheds. The nutrients considered include nitrogen (N) and phosphorous (P), both essential plant nutrients and major contributors to surface water pollution. Basic model components include hydrology, erosion, and sediment and chemical transport. In addition, the model considers point sources of water, sediment, nutrients, and chemical oxygen demand (COD) from animal feedlots, and springs. Water impoundments, such as tile-outlet terraces, also are considered as depositional areas of sediment and sediment-associated nutrients.

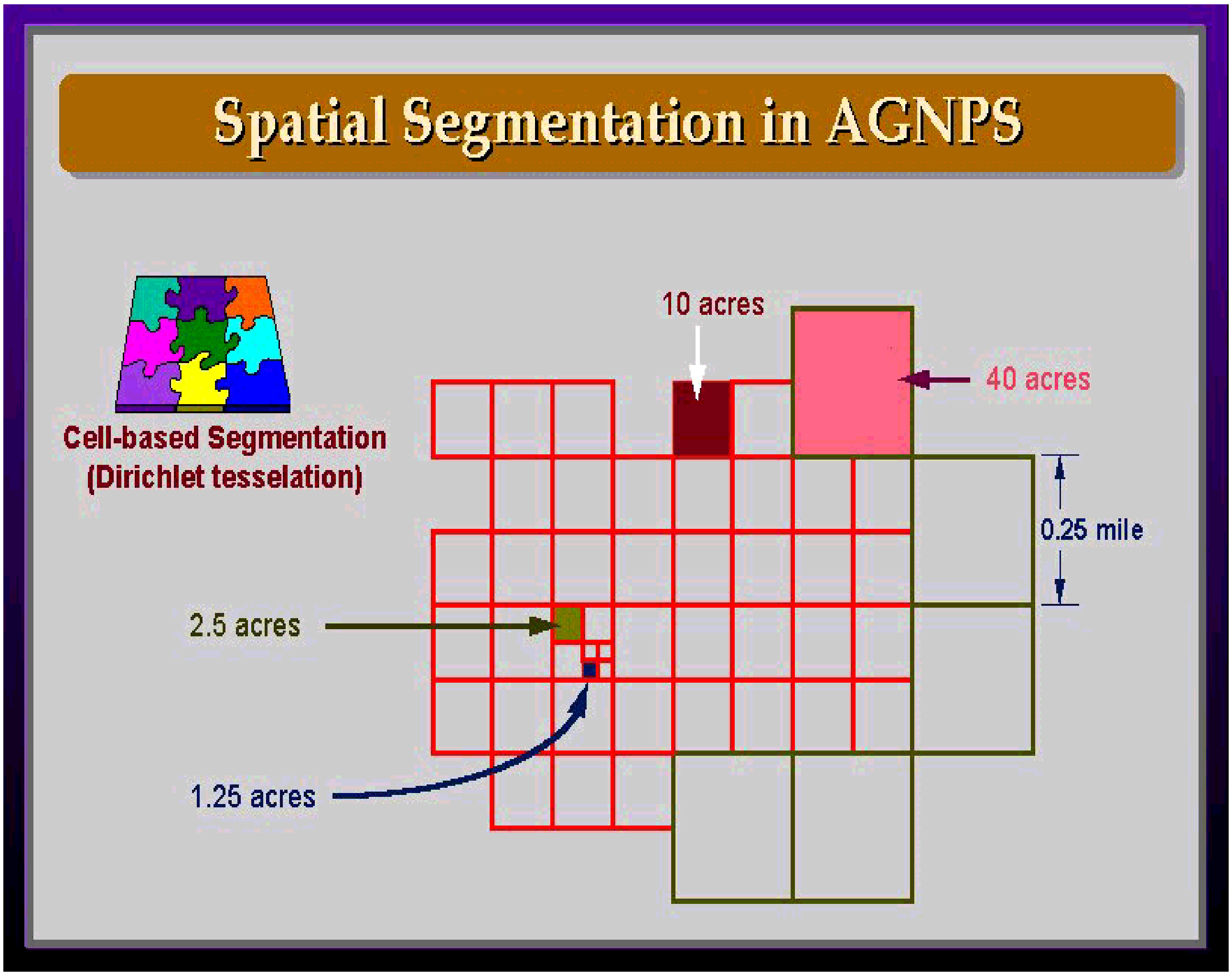
The model has the ability to output water quality characteristics at intermediate points throughout the watershed network. This capability is based on the model's implementation of the 'cell'. Cells are uniformly square areas subdividing the watershed, and all watershed characteristics and inputs are expressed at the cell level.

Model components use equations and methodologies that have been well established and are extensively used by agencies such as the USDA Soil Conservation Service. Runoff volume and peak flow rate are estimated using the SCS runoff curve number method. Peak runoff rate for each cell is estimated using an empirical relationship proposed by Smith and Williams (1980) and which is also used in CREAMS (Frere et al., 1980). Upland erosion and sediment transport is estimated using a modified form of the Universal Soil Loss Equation, USLE (Wischmeier and Smith, 1978). Sediment is routed from cell to cell through the watershed to the outlet using a sediment transport and depositional relationship described by Foster et al. (1981) which is based on a steady-state continuity equation. Chemical transport is calculated based on the relationships adapted from CREAMS and a feedlot evaluation model (Young et al., 1982). Feedlots are treated as point sources and chemical contributions are estimated using the feedlot pollution model developed by Young et al. Other point-source inputs of water and nutrients, such as springs, and wastewater treatment plant discharges are accounted for by inputting incoming flow rates and concentrations of nutrients to the cells where they occur.

Conceptualization of Model

The model operates on a geographic cell basis (Dirichlet tesselation) that is used to represent upland and channel conditions. Dirichlet tesselation is a process of splitting up and grouping a study area into cells or tiles, also known as Thiessen or Voronoi polygons. Cells are uniformly square areas subdividing the watersheds, allowing analyses at any point within the watershed. Potential pollutants are routed through cells from the watershed divide to the outlet in a stepwise manner so that flow at any point between cells can be examined. All watershed characteristics and inputs are expressed at the cell level.

A single cell or a data unit can be at resolutions of 2.5 acres to 40 acres. Smaller cell sizes such as 10 acres are recommended for watersheds less than 2000 acres. For watershed exceeding 2000 acres, cell sizes of 40 acres is normally used to pixelize the watershed. In a 40-acre main unit cell segmentation scheme, different and smaller cell sizes than 40-acre can also be used to meet the further resolution needs for complex topography or smaller-than-40-acre watershed characteristic unit. Figure 2 shows the cell-based segmentation scheme for a watershed. Accuracy of results can be increased by reducing the cell size, but this increases the time and labor required to run the model. Conversely, enlarging the cell size reduces time and labor, but the savings must be balanced against the loss of accuracy resulting from treating larger areas as homogeneous units.



The computations in AGNPS occur in three stages based on twenty three items of information per cell. Initial calculations for all cells in the watershed are made in the first stage. These calculations include estimates for upland erosion, overland runoff volume, time until overland flow becomes concentrated, level of soluble pollutants leaving the watershed via overland runoff, sediment and runoff leaving impoundment-terrace systems, and pollutants coming from point source inputs such as feedlots.

The second stage calculates the runoff volume leaving the cells containing impoundments and the sediment yields for primary cells. A primary cell is one that no other cell drains into. The sediment from these and other cells is broken down into five particle-size classes: clay, silt, small aggregates, large aggregates, and sand.

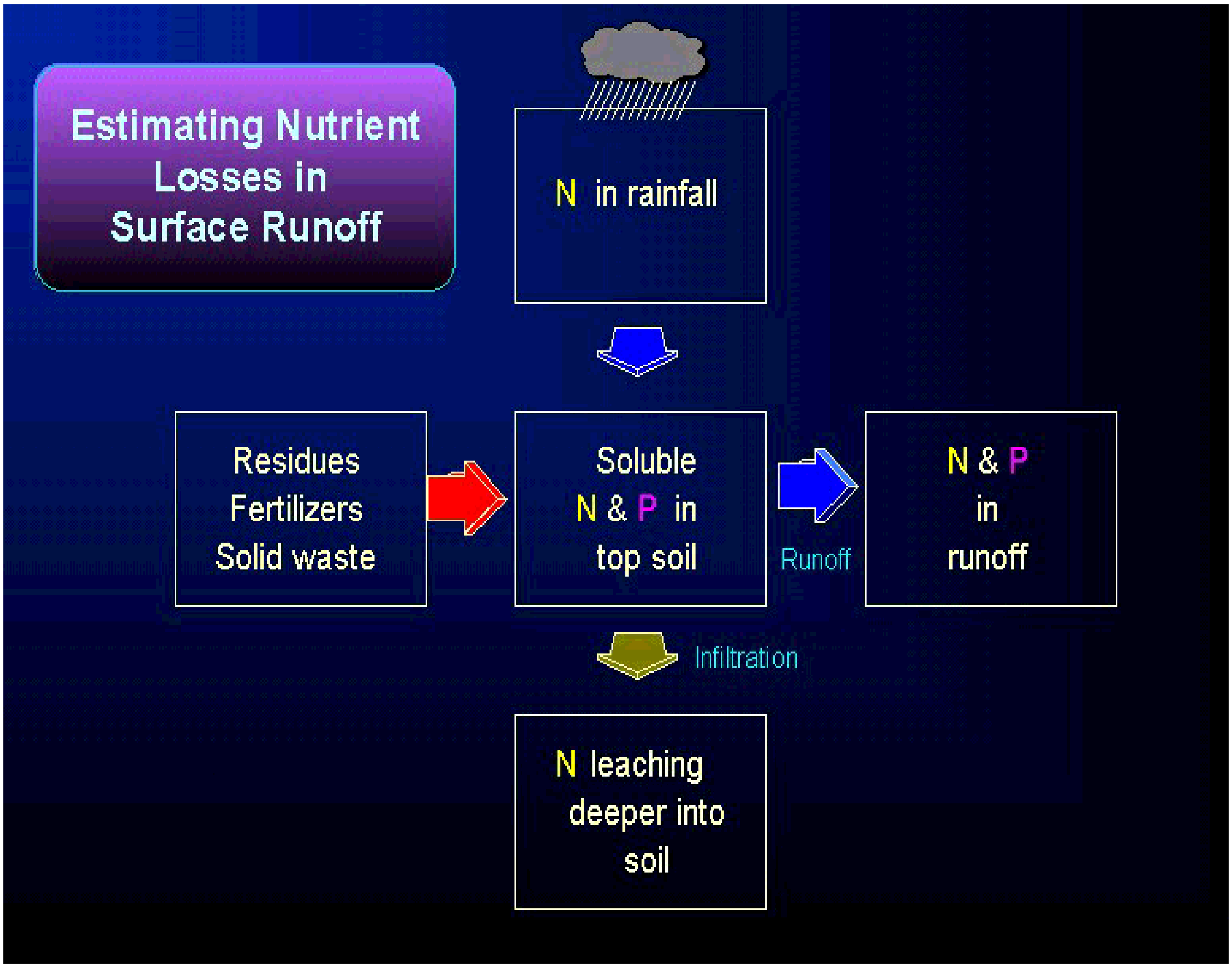
The sediment and nutrients are routed through the rest of the watershed in stage three. Calculations are made to establish the concentrated flow rates, to derive the channel transport capacity, and to calculate the actual sediment and nutrient flow rates.

Nutrient Transport

The pollutant transport part of the model estimates transport of nitrogen, phosphorous and chemical oxygen demand (COD) throughout the watershed. The pollutant transport portion is subdivided into one part handling soluble pollutants and another part handling sediment-attached pollutants. Pollutant transport for soluble nitrogen and phosphorus is calculated using a relationship adapted from CREAMS (Frere et al., 1980) and a feedlot evaluation model by Young et al (1982). Soluble nitrogen and phosphorus in runoff waters represent the effects of rainfall, fertilization, solid waste and leaching from the soil in each cell. The nutrient yield associated with the sediment is calculated using the total sediment yield from each cell and by relationships proposed in the CREAMS nutrient submodel (Frere et al., 1980).

The contributions of soluble nitrogen and phosphorous from each of the cells are calculated first and routed into the channel. Once soluble nutrients reach concentrated flow, they are assumed to remain as constants. That is, the amount arriving in the overland flow from any particular cell is simply added to what is already present in the channel, with no losses of soluble nutrients in the channel allowed.

Figure shown below illustrates the concepts used in the nutrient portion of the model with regard to soluble forms of nitrogen and phosphorous in runoff waters. As the figure shows, the soluble nitrogen and phosphorous calculations account for the effects of rainfall, fertilization, and leaching.



AGNPS Input Parameters

1. cell number (from)
2. receiving cell number (to)
3. SCS curve number
4. land slope
5. land slope shape factor
6. field slope length
7. channel slope
8. channel sideslope
9. Manning's roughness coefficient
10. soil erodibility factor
11. cover and management factor
12. support practice factor
13. surface condition constant
14. aspect (direction of drainage)
15. soil texture
16. fertilization level
17. fertilization availability factor
18. point source indicator
19. gully source level

20. chemical oxygen demand (COD) factor
21. impoundment factor
22. channel indicator

AGNPS Output at the Watershed Outlet or for Whole Watershed

Output values for the whole watershed

1. watershed description
2. area (acres)
3. area of each cell (acres)
4. characteristic storm precipitation (inches)
5. storm energy-intensity (EI) value

Output values at the watershed outlet

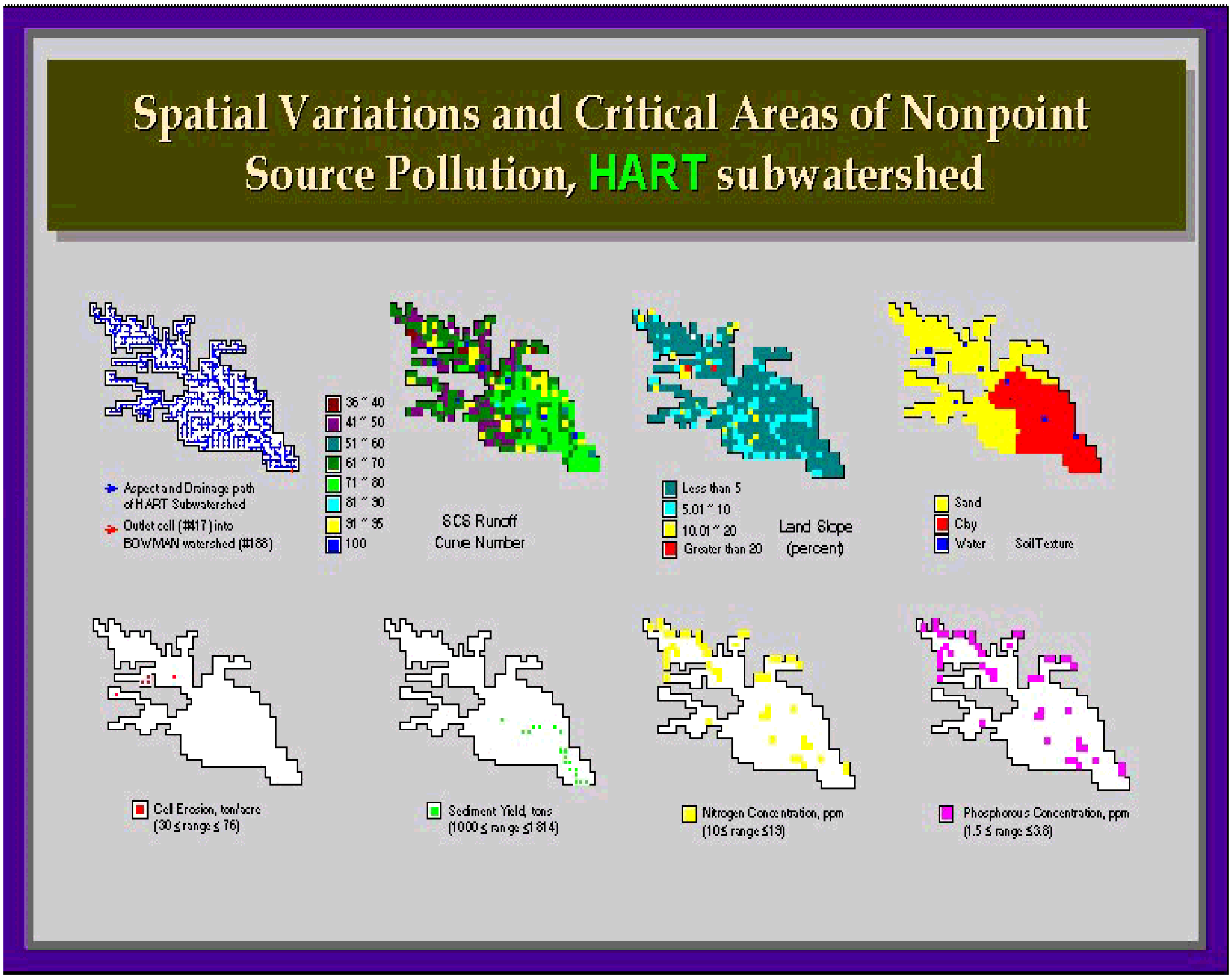
Hydrology

1. runoff volume (inches)
2. peak runoff rate (cfs)
3. fraction of runoff generated within the cell
4. Sediment (by particle size and in total)
5. sediment yield (tons)
6. sediment concentration (ppm)
7. sediment particle size distribution
8. upland erosion (tons/acre)
9. channel erosion (tons/acre)
10. amount of deposition (%)
11. sediment generated within the cell (tons)
12. enrichment ratio
13. delivery ratio

Nutrient

1. Nitrogen
2. sediment associated mass (lbs/acre)
3. concentration of soluble material (ppm)
4. mass of soluble material in runoff (lbs/acre)
5. Phosphorous
6. sediment associated mass (lbs/acre)
7. concentration of soluble material (ppm)
8. mass of soluble material in runoff (lbs/acre)
9. Chemical Oxygen Demand
10. concentration (ppm)
11. mass (lbs/acre)

Example of AGNPS output is shown below.



Originated from **USDA-ARS**
Current version is **5.00**
Released in **May 1995**

Following AGNPS model files (program and user manaual) are downloadable for MS-DOS system.

- **AGNPS model system (program and user manaual)** (2.45 MB)

There’s also AGNPS model files (program and sample I/O data) for Unix (compiled for CEE Unix Lab’s Solaris 2.5) are downloadable to your **Unix**, NOT for MS-DOS system.

- **AGNPS model files (program and sample I/O data) for Unix (Solaris 2.5)** (agnps500.solaris_2.5.tar.gz, 0.10 MB)
