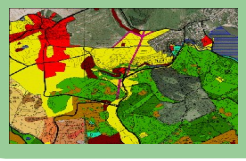
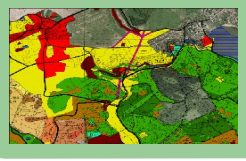


AnnAGNPS

Annualized **AG**ricultural **N**on-**P**oint **S**ource
Pollurant Loading Model

Pavel Vranka, Masaryk University in Brno

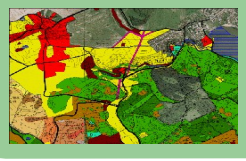


Erosion

Erosion can be expresed as: *E=f(C, S, T, SS, M)*

E = erosion
C = climate
S = soil properties
T = topography
SS = soil surface conditions
M = human activities

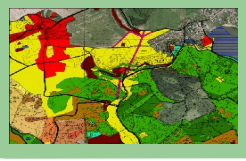
(Renard and Foster, 1983)



Pollutant transport

Pollutant transport in the watershed is function of:

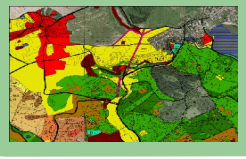
- amount of nutrients and pollutants
- surface runoff and infiltration
- soil conditions
- adsorption of pollutants on sediment
- transport of sediment partices etc.



AnnAGNPS

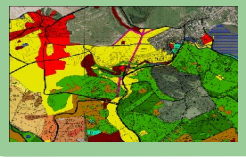
- **Ann**ualized **Ag**ricultural **N**on-**P**oint **S**ource Pollution computer model.
- Developed by:
  - USDA Agriculture Research Service, National Sedimentation Laboratory, Oxford, MS and
  - USDA Natural Resources Conservation Service, National Water and Climate Center, Beltsville, MD.
- Surface runoff pollutant loading (PL) computer model.
- Replacement for single-event AGNPS 5.0.
- Download from:

  http://www.ars.usda.gov/Research/docs.htm?docid=5199



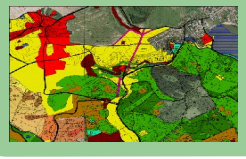
AnnAGNPS - overview

- simulates quantities of surface water, sediment, nutrients, and pesticides leaving the land areas (cells) and their subsequent travel through the watershed,
- continuous simulation – calculations aro done on a daily step,
- the watershed is subdivided into homogenous land areas (cells) with respect to soil type, land use, and land managemen,
- runoff quantities are based on runoff curve number,
- sediment is determined using RUSLE,
- includes special components to handle concentrated sources of nutrients (feedlots and point sources), concentrated sediment sources (gullies), and added water (irrigation).



AnnAGNPS overview

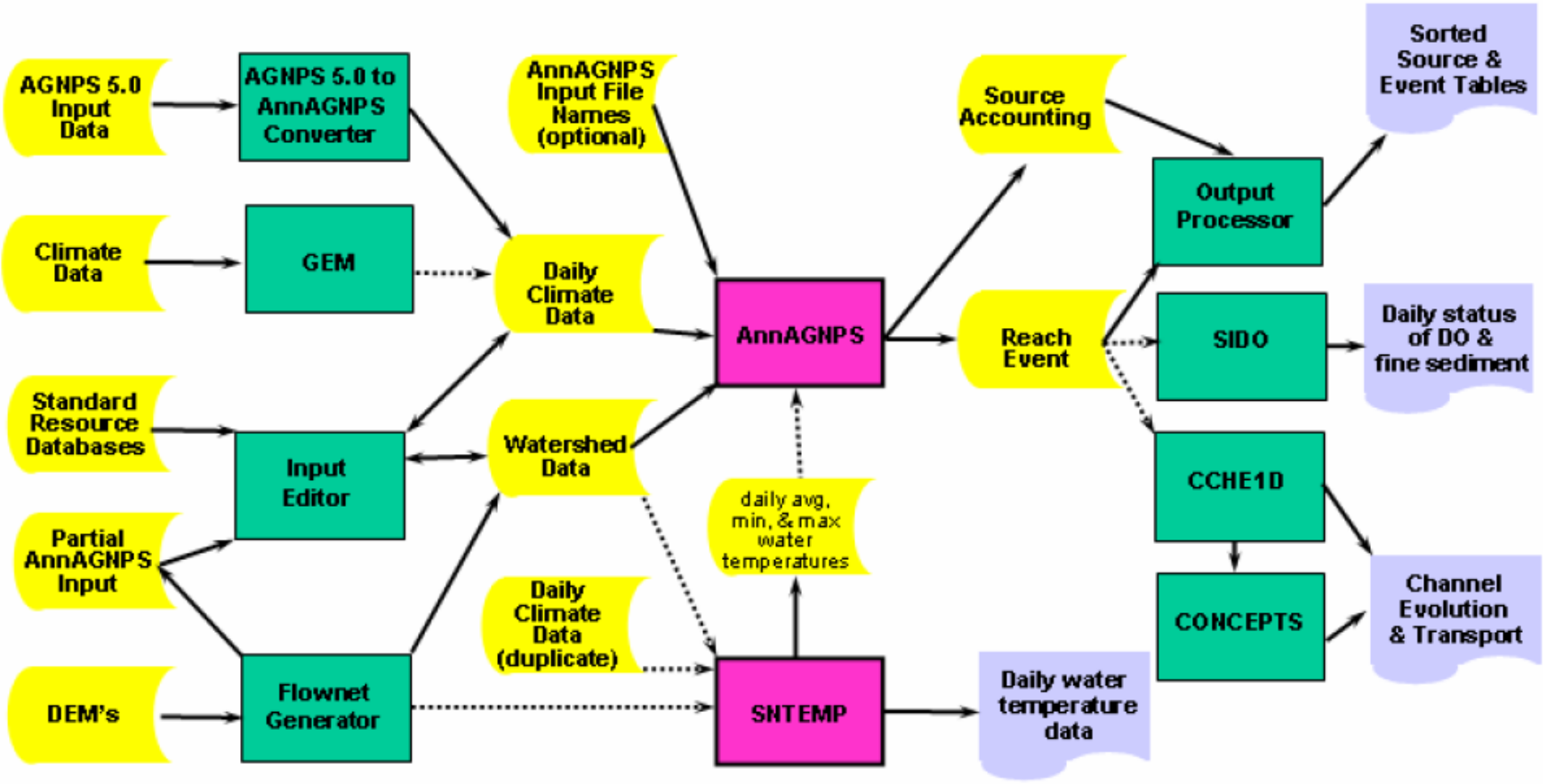
- partitions soluble nutrients and pesticides between surface runoff and infiltration, and determine sediment-transported nutrients and pesticides,
- sediment is subdivided into particle size classes, that are routed separetly in the stream reaches,
- estimates of bed–and–bank, gully, and sheet–and–rill erosion in each of the particle sizes,
- multiple watershed source locations can be identified, each with its own set of output parameters.

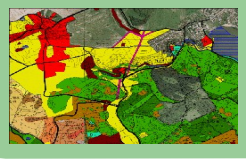


AnnAGNPS uses and applications

- evaluates non-point source pollution from agricultural watersheds,
- can compare the effects of implementing various conservation alternatives over time within the watershed,
- can evaluate alternative cropping and tillage systems, fertilizer, pesticide, and irrigation application rates, point source loads and feedlot management,
- predicts water quality and erosion on a cell, reach, and watershed basis,
- divides pollutant transport into soluble pollutants and sediment-attached pollutants,
- simulates the amount of soluble nutrients and chemical oxygen demand present in feedlot runoff,
- etc.

AnnAGNPS structure





RUSLE - Revised Universal Soil Loss Equation

$$A = R * K * LS * C * P$$

where:

A = estimated **average soil loss** in tons per acre per year

R = **rainfall-runoff erosivity** factor – the average annual summation of erosion index (EI) values in a normal year's rain. EI is a measure of the erosion force of specific rainfall.

K = **soil erodibility** factor – represents both susceptibility of soil to erosion and the rate of runoff.

LS = L is the **slope length** faktor and S is the **slope steepness** factor. They are usualy considered together and represent the effect of the topography.

C = **cover-management** factor. It represents the effects of plants, soil cover, soil biomass, and soil disturbing activities on erosion.

P = **support practice** factor. It is the ratio of soil loss with support practices (contouring and/or stripcropping) to that with straight row farming up-and-down slope.

Erosion and sediment yield

Erosion:

- the process of soil transport
- the amount of transported material

Sediment yield is the amount of the sediment transported *out* of the channel section summed for time specific time period (such as a storm event, month, crop stage etc.)

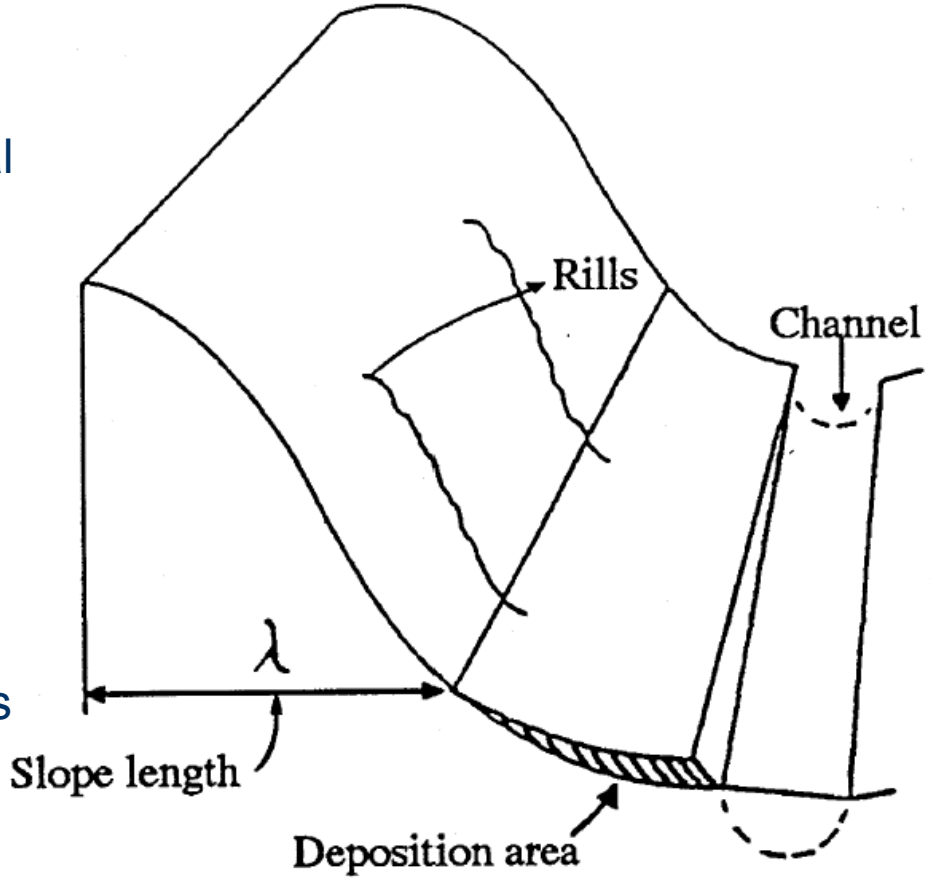
$SY = E - D$

where:

SY = sediment yield

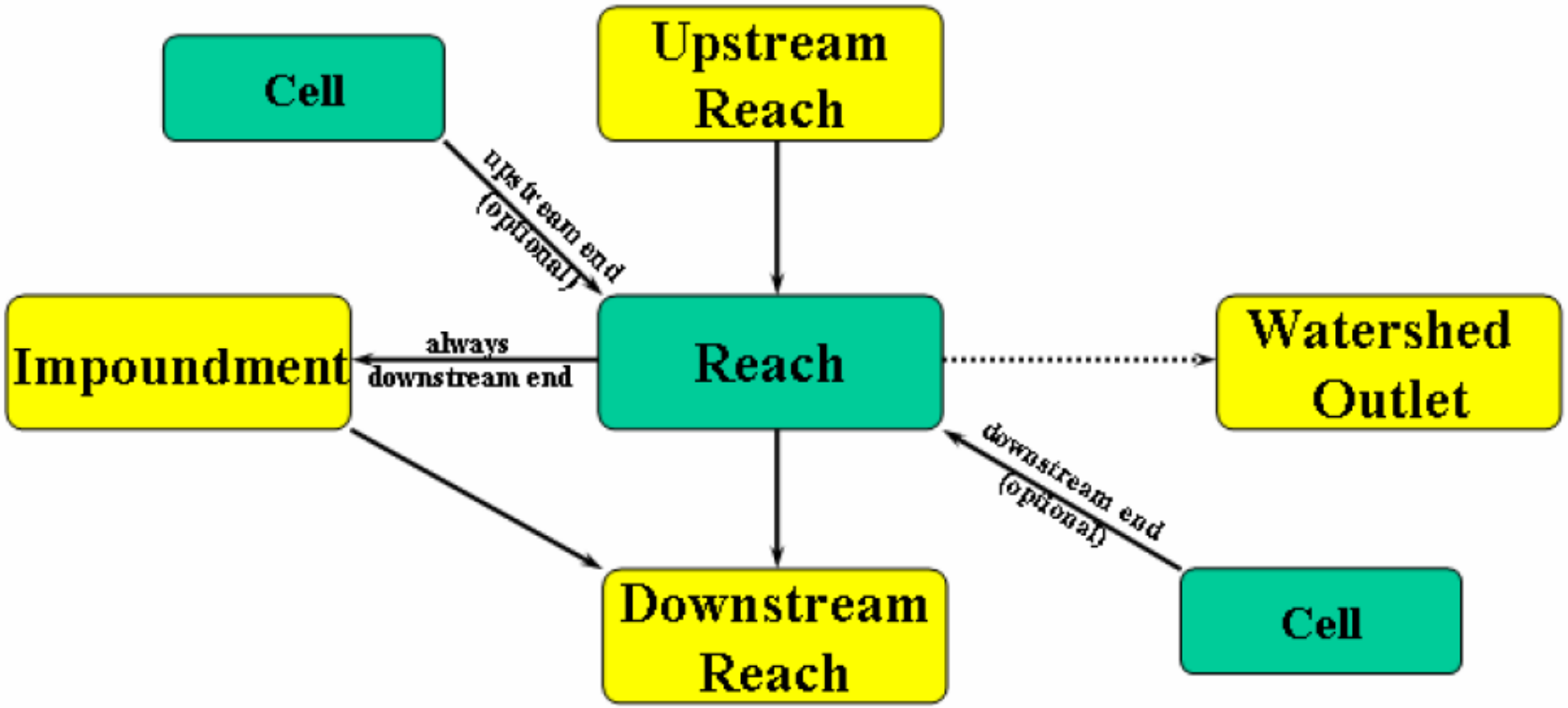
E = erosion from slopes and channels

D = *sediment deposited before it reaches the point of interest („outlet“)*



Pavel Vranka, Masaryk University in Brno

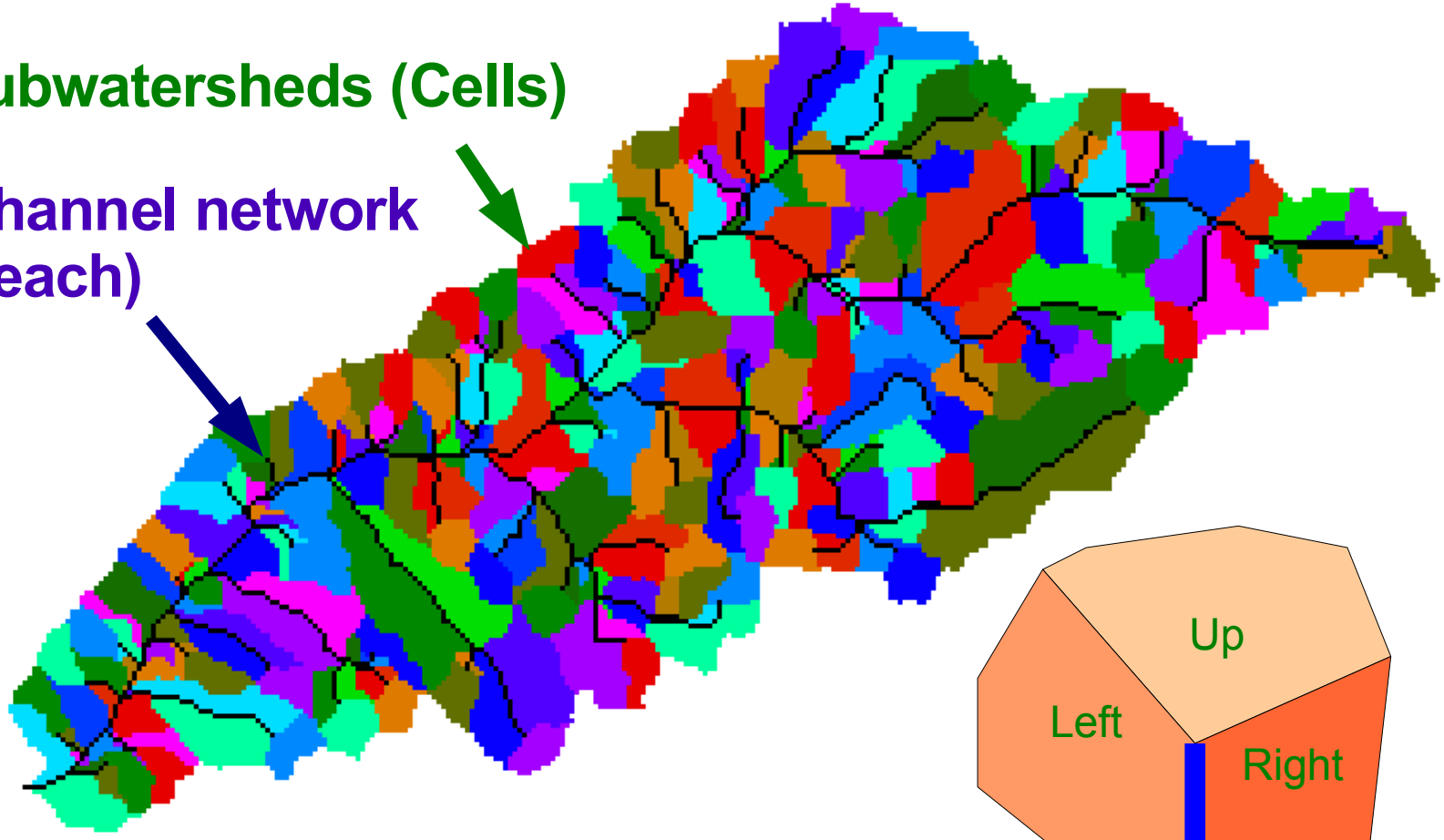
AnnAGNPS runoff event processes

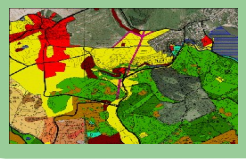


Watershed description

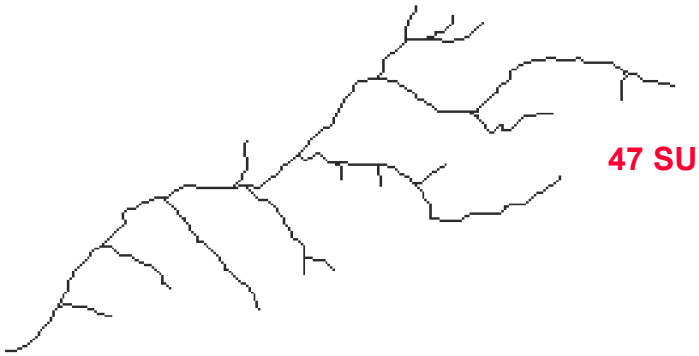
Subwatersheds (Cells)

Channel network (reach)

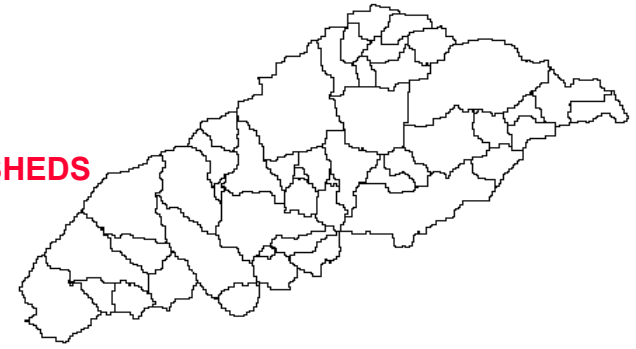


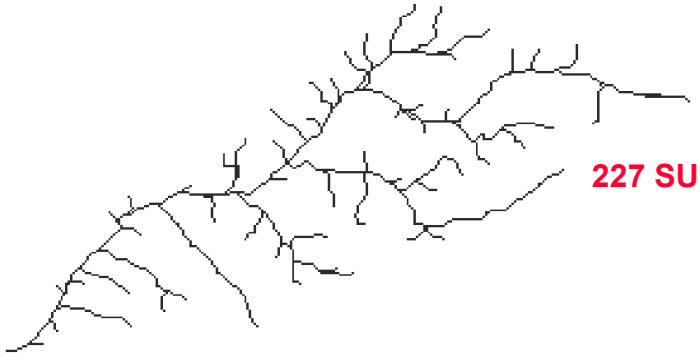


Channel network and watersheds



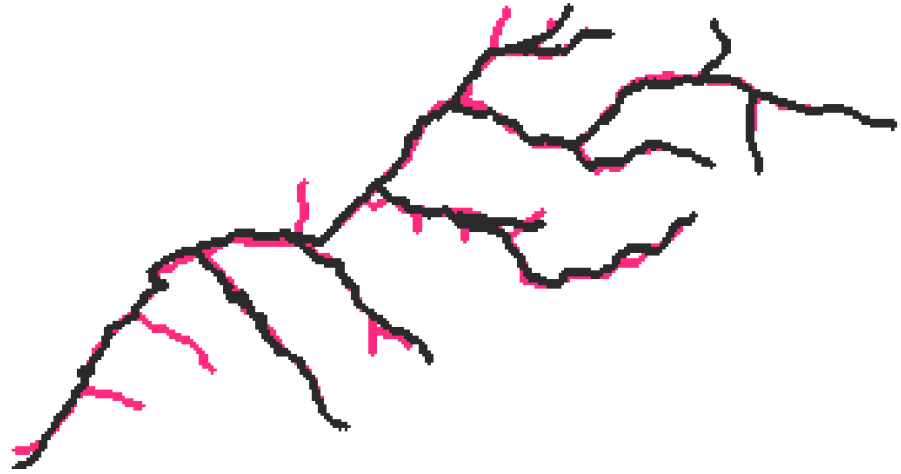
47 SUBWATERSHEDS



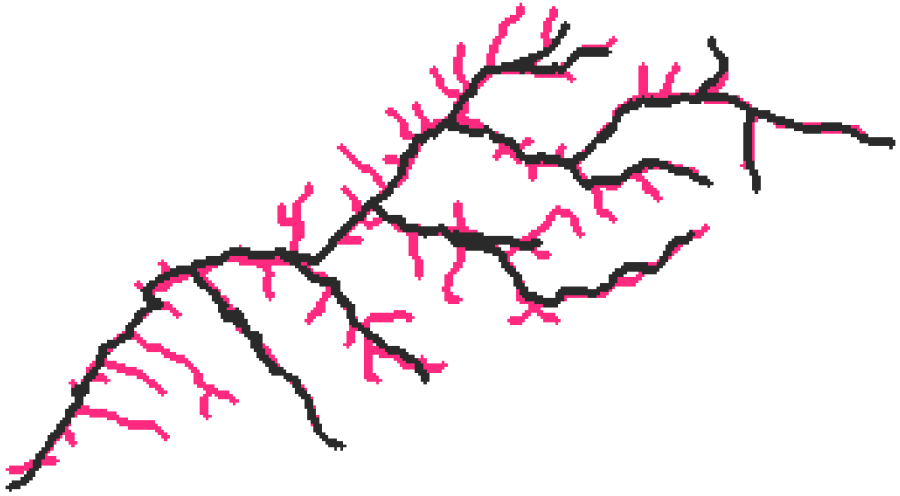


227 SUBWATERSHEDS

Digitized and generated stream network

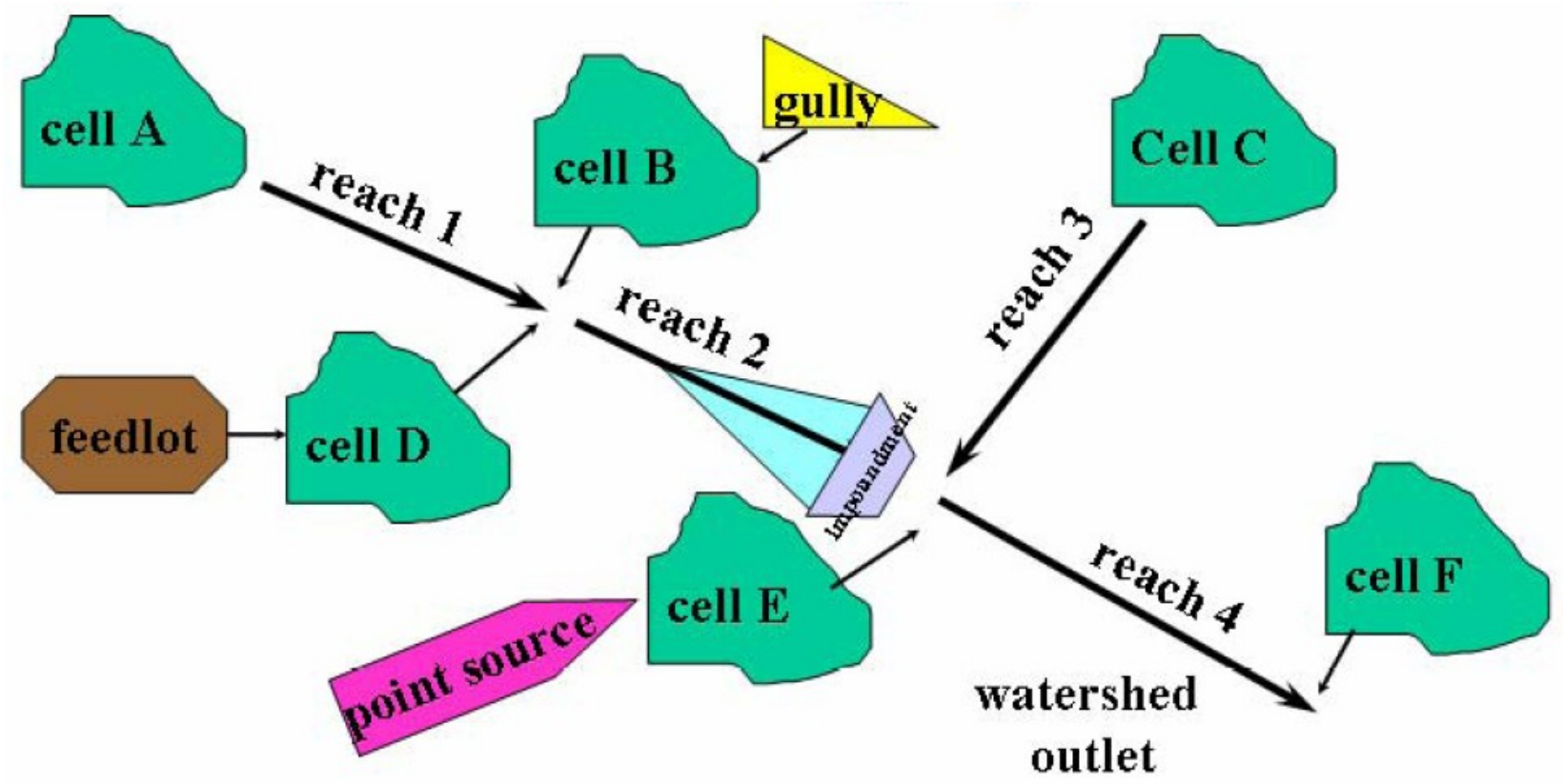


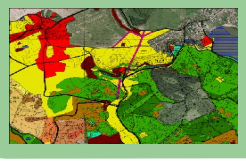
GENERATED STREAM NETWORK ASSOCIATED WITH 47 SUBWATERSHEDS



GENERATED STREAM NETWORK ASSOCIATED WITH 168 SUBWATERSHEDS

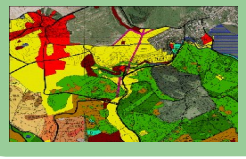
AnnAGNPS major processes





Cell processes

Weather – air temperatures and relative humidity.
Precipitation – rainfall, snowmelt and irrigation runoff.
Soil moisture – precipitation, infiltration, percolation and evapotranspiration.
Management operations – crops, rotation, fertilizer etc.
Irrigation – amount of added water.
Winter routines – snowpack, melt and frozen ground.
Curve number – antecedent moisture condition (current soil moisture).
Sediment yield – RUSLE or USLE.
Pesticides – application and decay; adsorbates and solutes.
Nutrients – application and decay; adsorbates and solutes.
Foliage – relative growth, nutrients and pesticides.
Soil surface – residue, nutrients and pesticides.
Soil profile – moisture, frozen layers, residue, nutrients and pesticides.
Operations – next operation and rotation year.



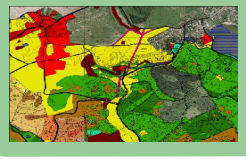
Reach processes

Water – rainfall, snowmelt, irrigation and point sources.

Sediment Yield – by particle size-class and source.

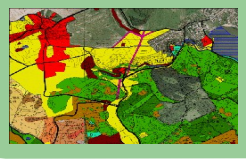
Chemicals – nutrients, pesticides and organic carbon.

Impoundments – sediment deposition



AnnAGNPS limitations

- All runoff and associated sediment, nutrient, and pesticide loads for a single day are routed to the watershed outlet before the next day simulation.
- There is no tracking of nutrients and pesticides attached to sediment deposited in stream reaches from one day to the next.
- Point sources are limited to constant loading rates (water and nutrients) for entire simulation period.



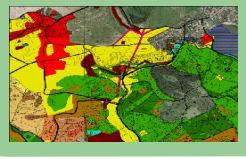
Input data

Input files used by AnnAGNPS:

- AnnAGNPS input file names – optional (if this file does not exist then "AnnAGNPS.inp" and "DayClim.inp" are used)
- AnnAGNPS input
- Daily Climate

AnnAGNPS.inp

- contains all of the data that is watershed specific for an AnnAGNPS simulation
- has more than 30 data categories in relational structure
- data are based on:
  - topography,
  - soil attributes,
  - landuse,
  - agriculture management,
  - crop plant characteristic etc



Annualized **Ag**ricultural **N**on-**P**oint **S**ource Pollutant Loading Model

Initial data

- AnnAGNPS ID
- Watershed Data
- Simulation Period Data
- Winter Dates
- Output Options Data

Cell related data

- Cell Data

Reach realted data

- Reach Data
- Reach Geometry Coefficients (built-in)
- Reach Geometry Coefficients (user-defined in input)

Point source data

- Classic Gully Data
- Ephemeral Gully Data
- Landslide Data
- Field Pond Data
- Feedlot Data
- Feedlot Management Data
- Impoundment Data

Other data

- Soil Data
- Runoff CurveNumber Data
- Tile Drain Data
- Contour Data
- Crop Data
- Strip Crop Data
- Non-Crop Data

Acquaculture data

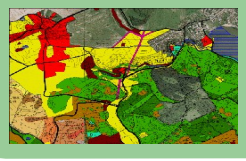
- Aquaculture Pond Data
- Aquaculture Pond Management Schedule Data

Field management data

- Management Field Data
- Management Operation Data
- Management Schedule Data
- Management Sequence Data
- Irrigation Application Data

Fertilizer and pesticide data

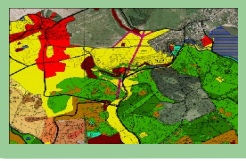
- Fertilizer Application Data
- Fertilizer Reference Data
- Pesticide Application Data
- Pesticide Reference Data
- Point Source Data



Input data

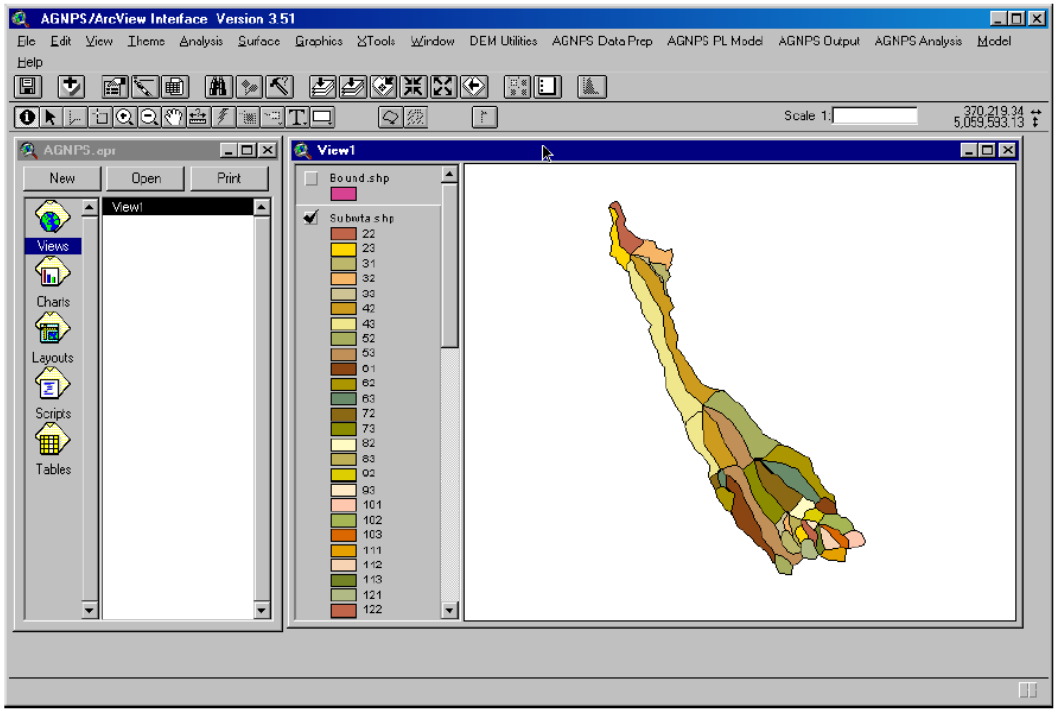
DayClim.inp

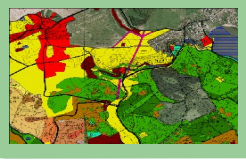
- general data
  - climate station – name, latitude, longitude, elevation
  - temperature change
  - precipitation nitrogen
  - seasonal storm types
  - elevation difference and elevation rain factor
- daily data
  - maximum and minimum air temperature
  - precipitation
  - dew point temperature
  - sky cover
  - wind speed and direction
  - solar radiation
  - daily storm type



Integration with GIS

- Data input preparation – DEM processing, soil and field data integration etc.
- Output presentation
- GRASS
- IDRISI
- ArcView etc.





Thank you for your attention

Pavel Vranka
vranka@seznam.cz

Masaryk University
T-MAPY s.r.o.