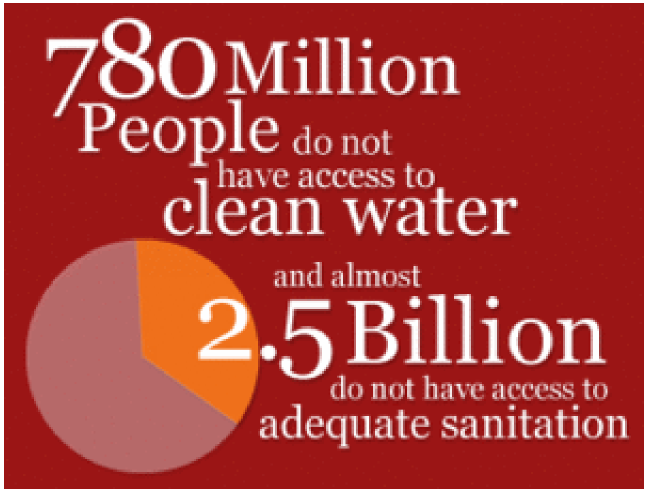
Bienvenue !!
Welcome
Willkommen

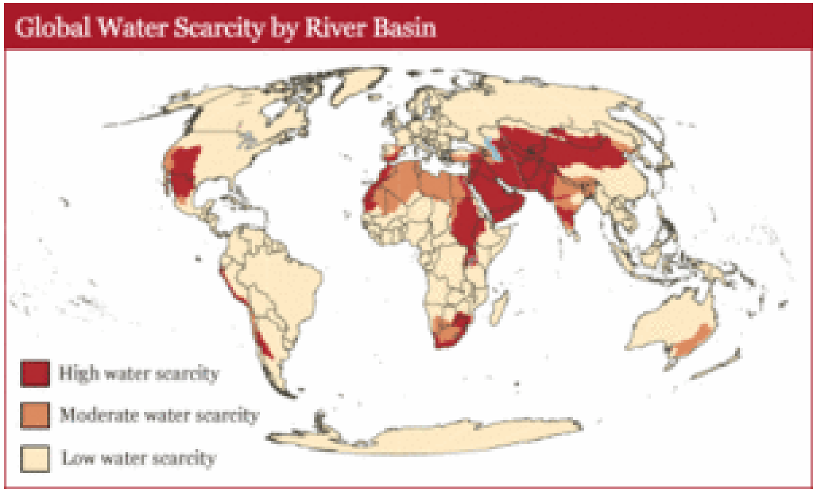
Recent SWAT Developments and Future Directions

Why are we here?

2013 - UN International Year of Water Cooperation

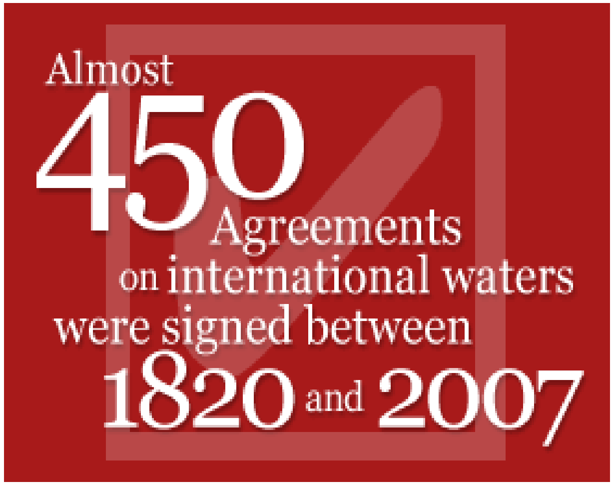
- Increasing Demand for Water – decreasing availability
- 6-8 Million People Die Annually from water related disasters and diseases
- 3.5 planets Earth would be needed to sustain a global population with the current European/N. American lifestyle
- Next 40 years – population growth of 2-3 billion and increase in food demand of 70%
- Agriculture accounts for 70% of freshwater withdrawals

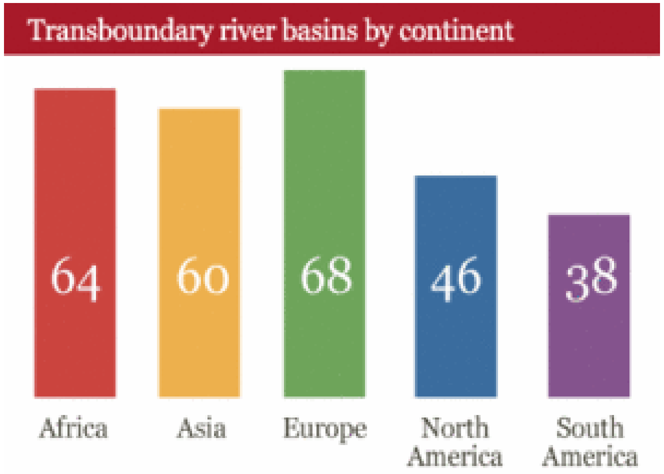




Why are we here?

- 148 countries have international basins within their territory
- 276 transboundary river basins in the world (46% of world)
- 90% of wastewater in developing countries flows untreated
- 80% of water worldwide is not collected or treated





Why are we here?

- SWAT and other water resource models can provide science-based decision support for water management, land use and management, climate change, food production, and bio-energy production.
- Our work is having tremendous impact on global water resources management.

2006 Soil and Water Assessment Tool

Model Developer's Workshop

October 3 - 6 2006

Potsdam Institute for Climate Impact Research
Potsdam, Germany
Valentina Krysanova and Fred Hattermann

TOPICS:

(1) Landscape Processes (riparian, floodplain, overland routing and sediment),

(2) Channel Processes (sediments and pollutants),

(3) Nutrients, Carbon, and Bacteria (uplands),

(4) Plant Growth,

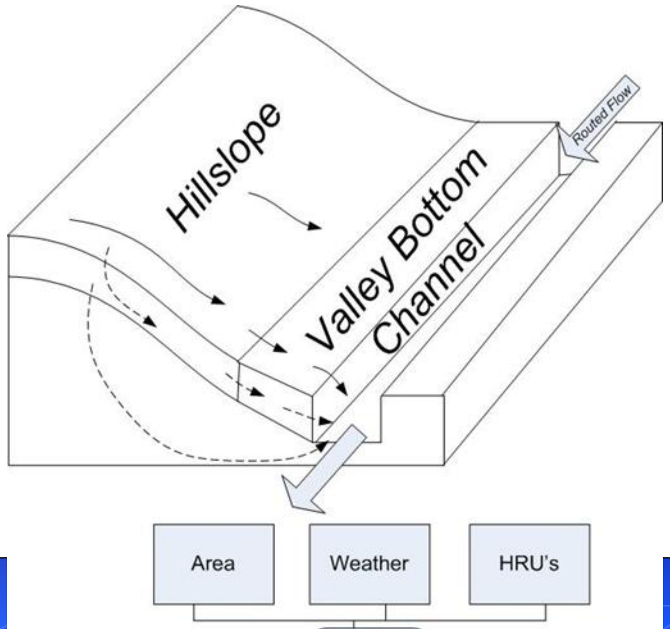
(5) Version Control and Modular Systems, and

(6) Tools (GIS, climate interpolation, crop generator, autocalibration & uncertainty).

- **Special Issue: Hydrological Sciences Journal 53(5)**

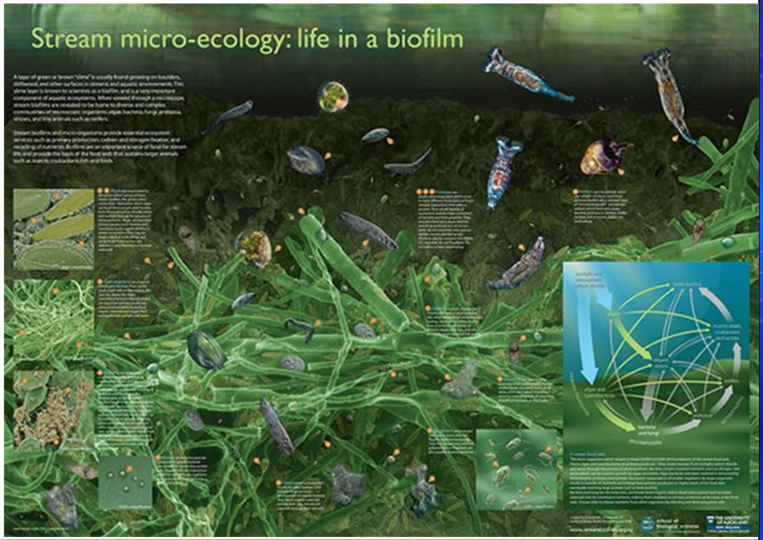
(1) Landscape processes

- Two papers (Arnold et al., 2010, Bosch et al., 2010) published on landscape routing (Riesel (TX) and Gibbs farm (GA)
- Landscape routing still under development
- Nadia Bonuma (Bonuma et al., 2013) included sediment transport capacity approach and used landscape routing (Brazil)
- Hendrik Rathjens, Martin Volk, Jeff Arnold develop grid version that include landscape routing (Little River Basin (GA))



(2) Channel processes

- Improved channel sediment routing (Balaji and Peter Allen)
- More realistic bed and bank erosion, bed and wash load, and improved flood plain deposition
- Improved BOD and dissolved oxygen (still using the modified QUAL2E approach
- Biofilm module – Sabine and Jose



(3) Nutrients, carbon and bacteria

- C-FARM (Kemanian et al., 2010) and CENTURY (Zhang et al., 2013) included in SWAT for carbon dynamics
- Improved soil phosphorus routines
- Improved and validated tile nitrate routines
- Bacteria – refined and validated, in-stream component developed

(4) Plant Growth

- Plant growth – parameterized forest and energy plants – Jim Kiniry is leading
- Plant competition (water, light, and nutrients)
- Modified plant growth algorithm for the tropics (Michael Strauch and Martin Volk)
- Reworked management operation scheduling – minor mgt file changes but more robust
- Real time soil moisture and plant status – Jaehak Jeong

(5) Version control and modular systems

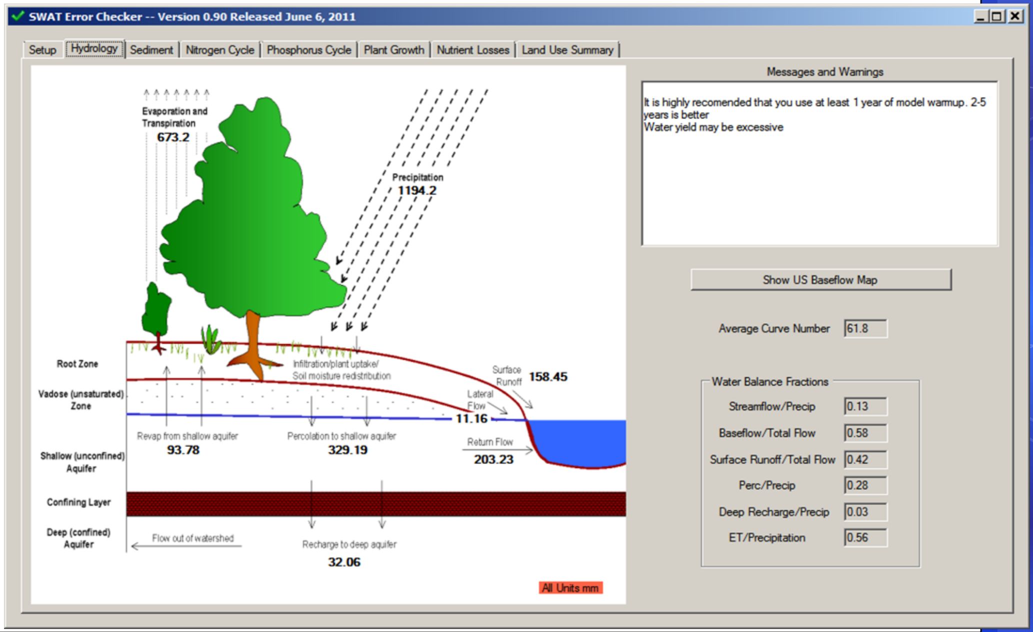
- Version control – Nancy uses on daily basis
  1) Backup versions and notes
  2) Filemerge
  3) CoLab-access trunk and other versions

- Modular code – JRW Library of modules
  Efficient platform for development
  Provide spatial and temporal framework
  Facilitate parallelization

(6) Tools (GIS, climate interpolation, crop generator, autocalibration & uncertainty)

- ArcSWAT and MapWindows continued development
- Web-based interfaces – HAWQS, eRAMS, BASHYT
- Web-based spatial BMP tools - Mazdak
- SWAT-CUP- Karim
- SWAT Check-

  Mike White



2013 Soil and Water Assessment Tool

Model Developer's Workshop

July 11-12, 2013

Paul Sabatier Université, Toulouse, France

Sabine and Jose

TOPICS:

(1) Landscape Processes (riparian, floodplain, overland routing and sediment)

(2) River/landscape Continuum AND In-Stream processes, Flood plains, riparian, stream aquifers (spatial, flow sediments, nutrients and biology) + emergent contaminants (antibiotics, hormones, metals, pesticides)).

(3) Plant Growth, competition, crop management

(4) New technology (web based/training, Super computers, GIS, sensitivity, autocalibration, optimization, uncertainty analysis).

(1) Landscape Processes

Martin Volk, Nicola Fohrer, David Bosch, Hendrik Rathjens, Louis Thibodeaux, Xuesong Zhang

- Gridded landscape version at Tifton. Dynamic wetness index.
- Vertical profile transport of emerging contaminants
- Improved Lowland processes – tile and groundwater
- Century carbon validation

(2) River Landscape Continuum and In-Stream Processes

Peter Allen, Jose Miguel Sanchez Perez, Mike White, Sabine Sauvage, Balaji

- Channel erosion, transport/deposition, pool/riffle
- Floodplain and riparian processes
- Particulate and dissolved organic carbon - biofilm
- Contaminant transfer – in-stream Kd
- Finite element groundwater model and MODFLOW link
- Rice paddy irrigation

(3) Plant growth and crop management

Phil Gassman, Indrajeet Chaubey, Claire Baffaut, Michael Strauch, Jeff Arnold

- Updating crop parameters into single database
- Plant competition validation and development of agroforestry module
- Bioenergy crop improvements and stover removal
- Tropical conditions modifications
- Realistic planting and applications as a function of heat unit and time distribution

(4) New Technology

Karim Abbaspour, Jaehak Jeong, Srini

- Objective function constraints
- Model structure uncertainty
- Sensitivity analysis routines
- Continue modularization
- Incorporate remotely sensed ET

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OUTCOMES/SUGGESTIONS:

(1) Web-Site for Developers

(2) Archive test data sets

(3) Easy access to version code

(4) Developer's manual and workshops

JRW Library

- What it is:

- A Library of Modules to: 1) honor Jimmy who developed many of the core processes all the models are built on and 2) move away from “proprietary ownership” to a truly global library supported and maintained at Temple.

- What it is not:

- Not a building
- A software system that “magically” disaggregates models and automatically builds models

- What it is:

- A library of modules OF the developers, BY the developers and FOR the developers

JRW Library

- What it can do:
- Provide a platform for efficient model development – eliminates need to “rework” similar modules into multiple models
- Provide a spatial and temporal framework for model development
- Facilitate parallelization
- Ultimately, it will help define input databases
- Empower Developers!

JRW Library

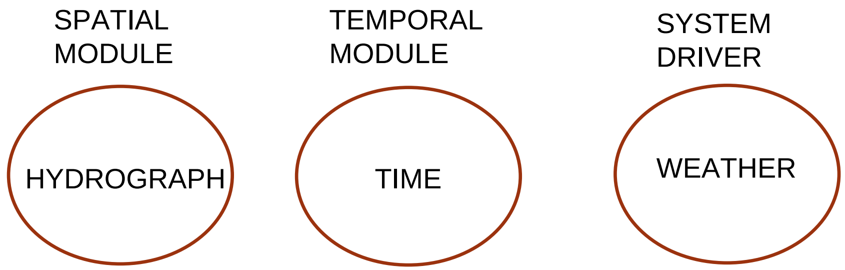
- Why has the SWAT modeling effort been successful?
- True team effort
- Stable developers base (Jimmy has anchored for 50 years)
- Philosophy – Open and Empower
- Empower Users – Interfaces, Web site, Manuals, Training, Calibration Tools, Tools to Analyze Output, Data Development, Web Support Groups, Regional Groups
- Empower Developers – JRW Library, Developer's manual and training, coordinated global effort, Developer's Workshops (Potsdam '06 and Toulouse '13)

JRW Library

SPATIAL OBJECTS (Modules)..

SPECIAL OBJECTS (Modules)

DATA SHARED BETWEEN SPATIAL OBJECTS:



HRU OBJECTS (Modules)

HRU MODULES:

- PLANT GROWTH
- SOIL WATER ROUTING
- SURFACE RUNOFF
- MGT OPERATIONS
- EROSION
- NUTRIENTS
- PESTICIDES
- ET
- PATHOGENS
- SEPTIC SYSTEMS
- SOIL TEMP
- STRUCTURAL MGT PRACTICES
- CARBON
- SURFACE STORAGE
- OTHERS

JRW Library

DATA STRUCTURES (HRU)

INPUT DATA STRUCTURES:

- WEATHER
- TOPO HYD
- SOIL
- LAND USE
- MGT OPERATIONS
- STRUCTURAL OPERATIONS
- SUBSURF DRAINAGE
- SEPTICS
- SOIL TEST
- PLANT COMMUNITY
- PESTICIDES
- SNOW
- ATMOSPHERIC DEPOSITION
- FERTILIZER
- URBAN
- TILLAGE
- PLANT PARAMETERS

OUTPUT DATA STRUCTURES:

- HYDROGRAPH
- HRU SUBBASIN BASIN
- CHANNEL
- RESERVOIR

Future Development

1. Continued testing and module additions to the JRW Library. Documentation and on-line training.
2. Movement of nitrate, soluble phosphorus and pesticides across the landscape. Landscape→River interactions
3. Biofilm and improved in-stream kinetics
4. Validation of large scale simulations (national and continental scale)
5. Web-based tools for running the model and scenario analysis

Merci !!
Thank You
Danke

Recent SWAT Developments and Future Directions

JRW Library

```
type plant_community_db
        character(len=4) :: name
        integer :: plants_com
        type (plant_init_db), dimension(:), allocatable :: pl
 end type plant_community_db
type (plant_community_db), dimension(:), allocatable :: pcomdb
```

```
read (113,*) pcomdb(icom)%pl(ipl)
```

```
type plant
     character(len=4) :: cpnm          !n/a       |4 letter crop name
     integer :: idplt = 0              !none      |land cover code from plant.dat
     real :: cht = 0                   !m         |canopy height
     integer :: gro = 0                !none      |land cover status code
     real :: laimx_pop = 0.
     real :: idorm = 0.                !none      |dormancy status code
     real :: phuacc = 0.               !frac      |frac of plant heat unit acc
     real :: lai = 0.                  !m**2/m**2   |leaf area index
     real :: bioms = 0.                !kg/ha       |land cover/crop biomass
     real :: plnn = 0.                 !kg N/ha   |amt of nit in plant biom
     real :: plnp  = 0.                !kg P/ha   |amt of phos in plant biom
     real :: plet = 0.                 !mm H2O |act ET simduring life of plant
     real :: plpet = 0.                !mm H2O |potl ET sim during life of plant
     real :: laimxfr = 0.
     real :: hvstiadj = 0.             !(kg/ha)/(kg/ha)  |opt harvest index
     real :: olai = 0.
     real :: rwt = 0.                  !none       |frac of tot plant biomass in roots
     real :: strsw = 1.                !none       |frac of pot plant growth achieved
     real :: strsa = 1.
     real :: strsn = 1.                !none       |frac of pot plant growth-ni stress
     real :: strsp = 1.                !none       |frac of potl plant growth-p stress
     real :: pop_com = 0.              !none
     integer :: curyr_mat = 0.
     real :: fr_n = 0.                 !none       |frac of plant biom that is nit
     real :: fr_p = 0.                 !none       |frac of plant biom that is phos
 end type plant
```

```
Plant community datafile
2          Number of communities in data file
 TRGR  2
frse  8  1  1400.  1.0   100.  0.1  500.  25.   1.    evergreen forest
ryeg 44  1  1400.  0.5   200.  0.15  60.   0.   1.    rye grass ground cover
 TUNL  7    Tunnel plant community with 7 plants
sonu  113  1  3400.  1.0    50.  0.1    8.   0.   1.    sonu  Sorghastrum nutans
bocu  114  1  3400.  1.0    50.  0.1    8.   0.   1.    bocu  Bouteloua curtipendula
soca  115  1  3400.  1.0    50.  0.1    8.   0.   1.    soca  Solidago canadensis
scsc  116  1  3400.  1.0    50.  0.1    8.   0.   1.    scsc  Schizachyrium scoparius
tral  117  1  3400.  1.0    50.  0.1    8.   0.   1.    tral  Tridens albescens
saaz  118  1  3400.  1.0    50.  0.1    8.   0.   1.    saaz  Salvia azurea
deil  119  1  3400.  1.0    50.  0.1    8.   0.   1.    deil  Desmanthus illinoiensis
```

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SWAT & SWIM

33 participants:

Australia, Canada, France, Germany, India, Italy, Netherlands, Spain, Switzerland, UK, USA

P I K

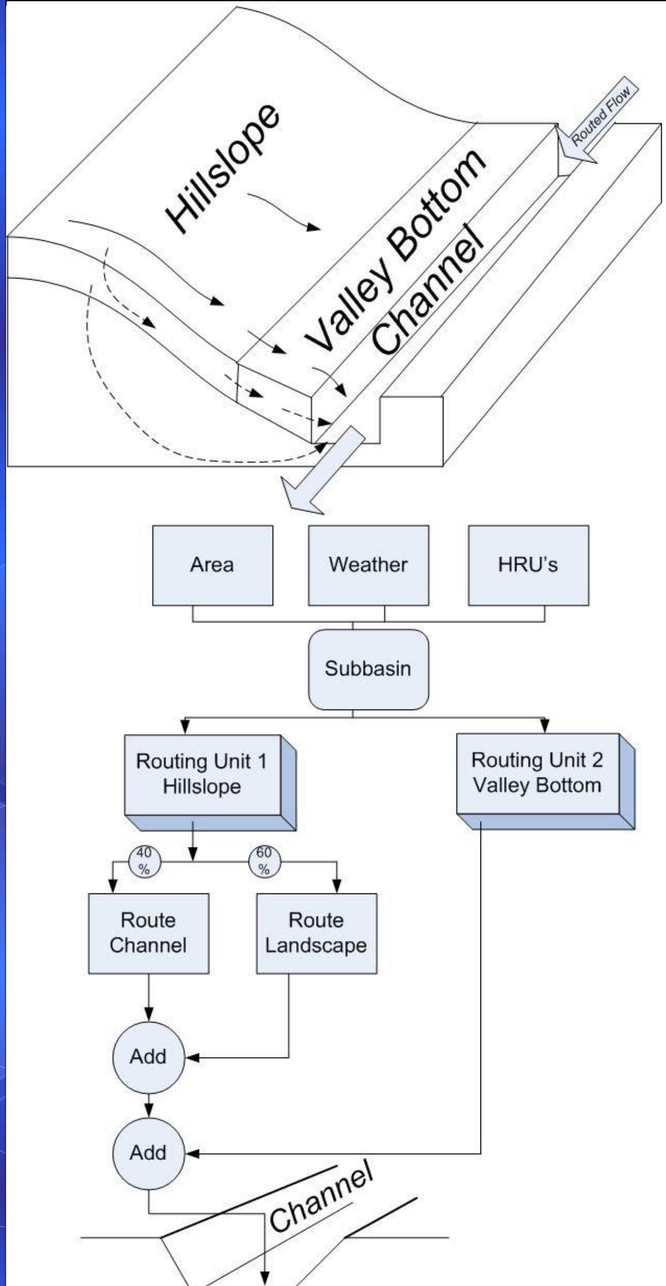
USDA

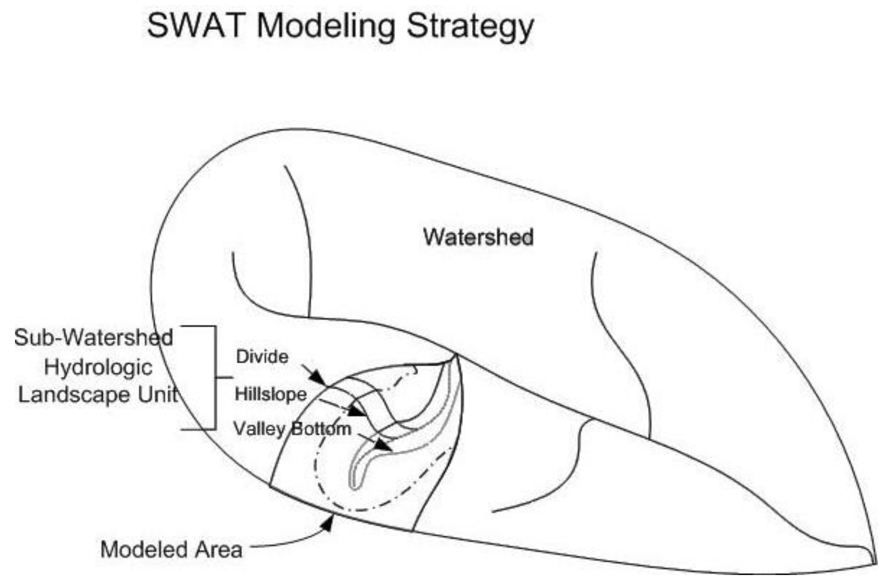
ars Agricultural Research Service

IAHS AISH

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

Recent Development





- Channel can be added across the valley bottom
- Multiple HRUs in the hill slope and valley bottom can be used
- Multiple "subwatersheds" with representative hill slopes can be used within a subbasin.

Draft: *Peter Allen, Jeff Arnold, Martin Volk, 2012*