RIPGIS-NET: An ArcGIS Custom Application for the RIP-ET Package in MODFLOW

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2008 ESRI International User Conference, San Diego, CA

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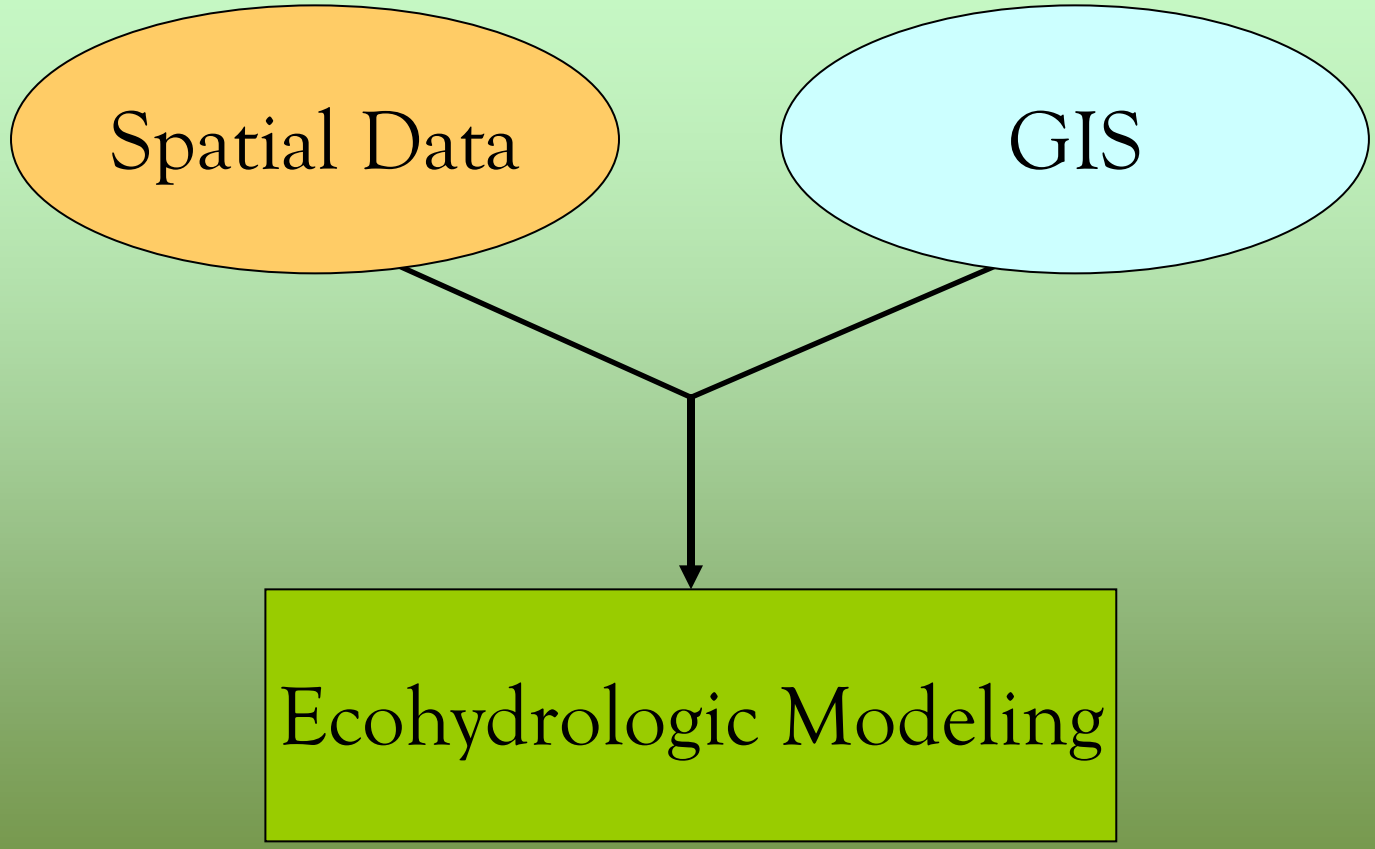
TUCSON ARIZONA



Developing Custom Applications

Overview

- MODFLOW groundwater model

- Riparian Evapotranspiration (RIP-ET) Package in MODFLOW and data inputs

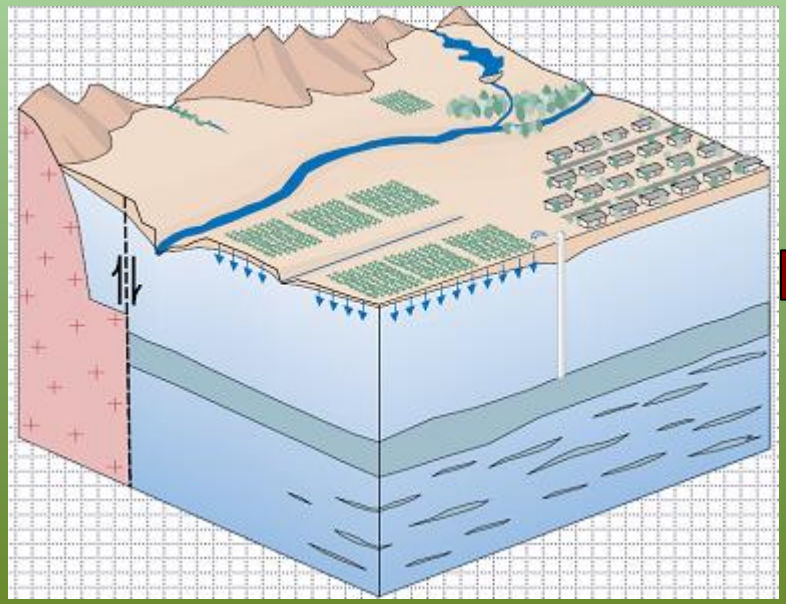
Development of RIPGIS-NET tool:

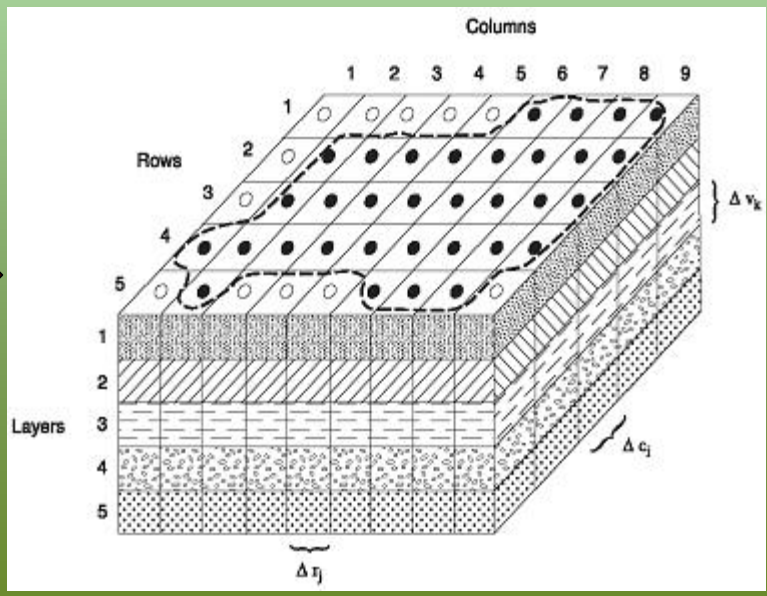
- Preprocessor- Data input for RIP-ET
- Postprocessor-Visualize MODFLOW and RIP-ET results

Environmental System Research Institute (ESRI)

USGS-MODFLOW

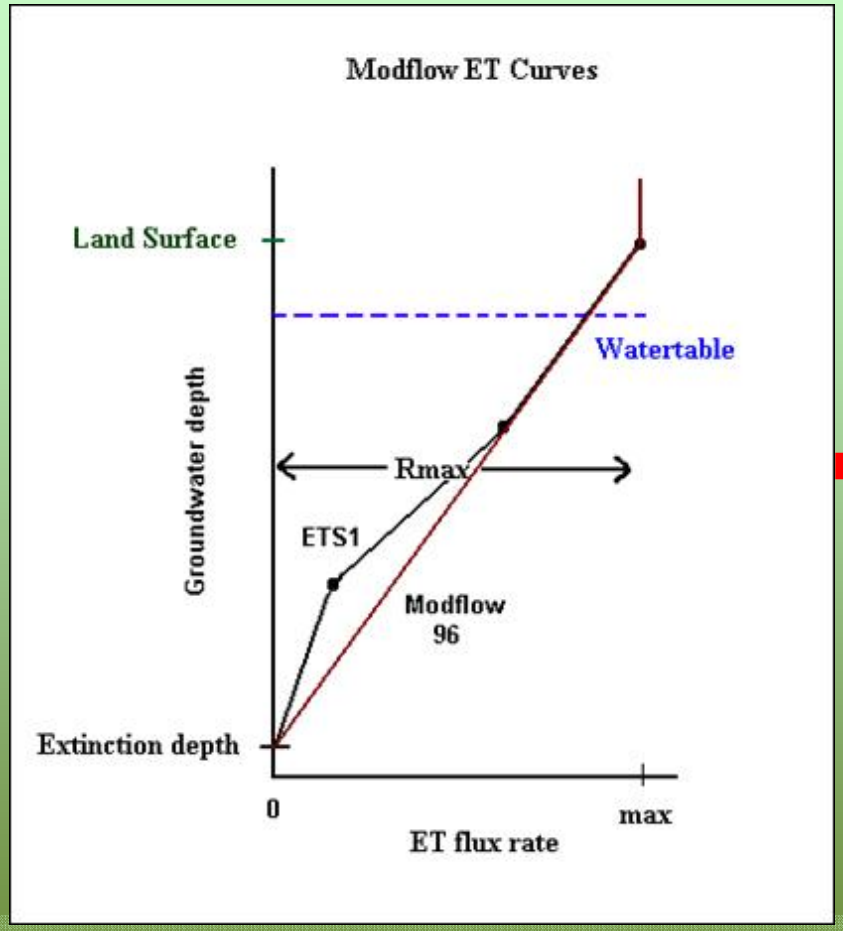
- MODFLOW is a computer program that numerically solves the three-dimensional ground-water flow equation for a porous medium by using a finite-difference method.

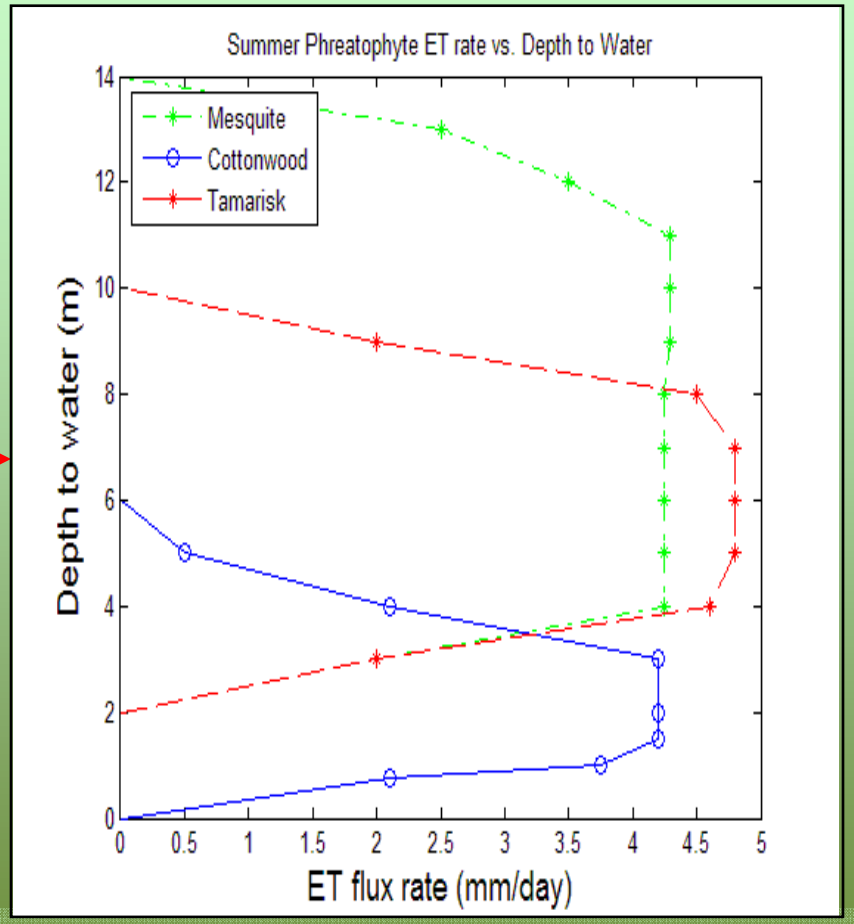




Harbaugh,2005

Riparian ET in MODFLOW





Traditional MODFLOW ET package

RIP-ET package (Baird & Maddock, 2005)

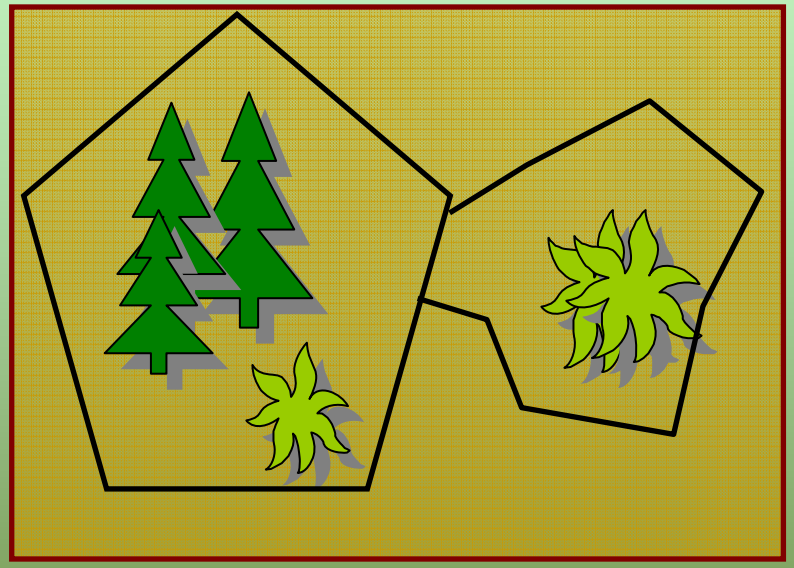
RIP-ET Package

- Simulates ET using a set of eco-physiologically based ET curves.
- Reduction in ET due to anoxia
- Provides explicit link between groundwater and riparian/wetland habitat conditions
- Decouples evaporation from transpiration

RIP-ET Inputs

Plant coverage information is organized by polygons with an approximately uniform land surface elevation throughout.

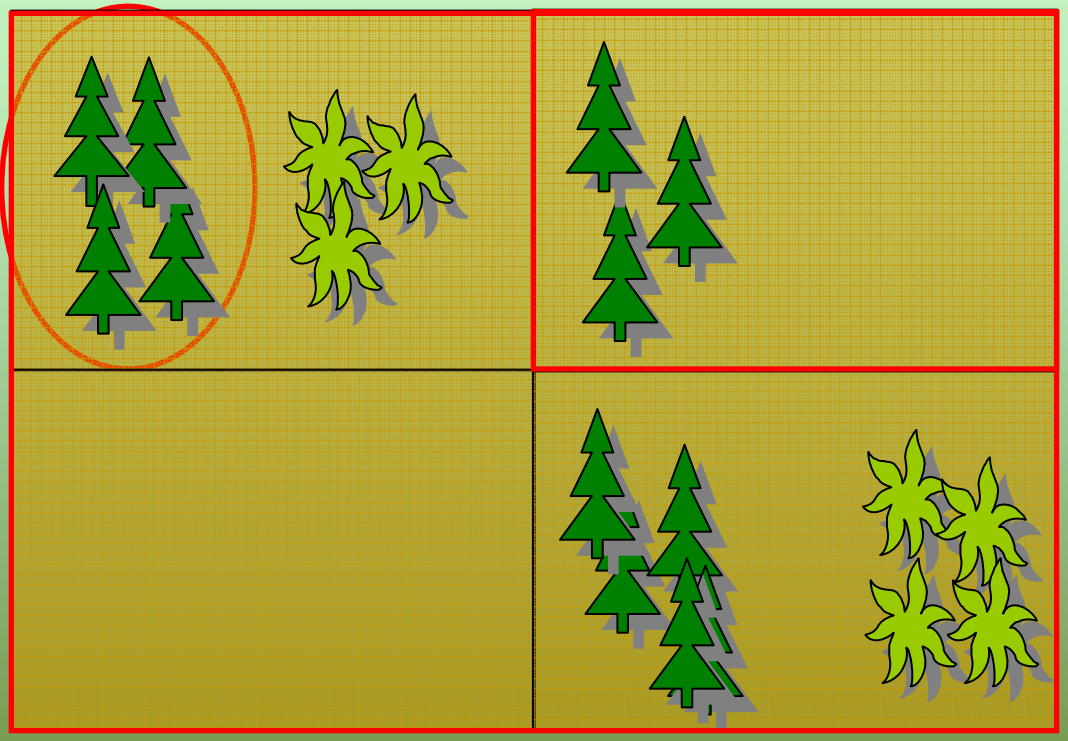
- Plant functional subgroup (PFSG) ET curve file
- Polygon fractional area of a cell
- Fractional areal coverage of each PFSG in a polygon
- Average surface elevation for each riparian polygon



MODFLOW cell

Multiple riparian habitats within model cell
Elevation for each polygon within a cell

RIP-ET Output



- ET for each PFSG in a cell
- Total ET for each cell
- ET for the entire region

RIPGIS-NET

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and
Thomas Maddock III

SAHRA

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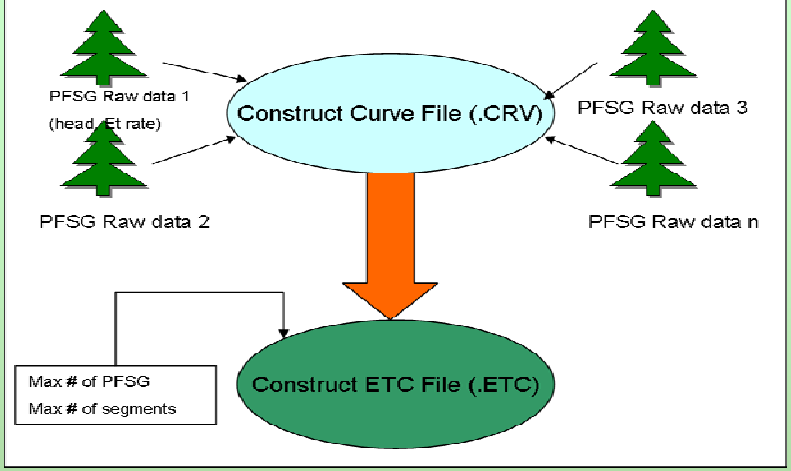
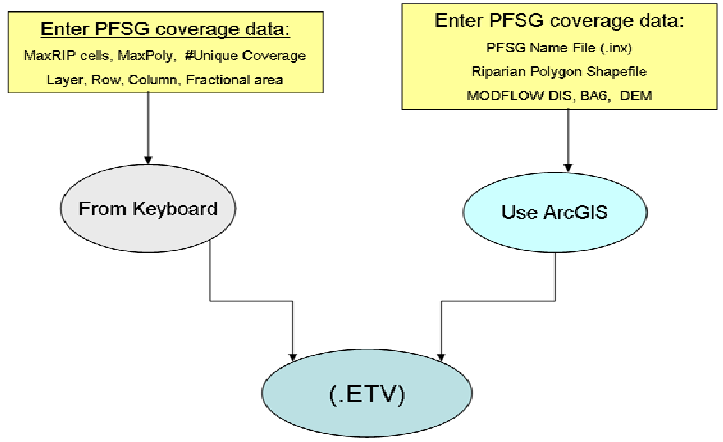
ArcMap

ESRI

Construct ET Curves File (.ETC)



Construct ET Fractional Coverage File (.ETV)



Construct ET Output Control File (.ETO)

Input:

IRIPCB Flag

IRIPCB1 Flag

Number of seasons

Number of years or cycles

Order of Coverage

Construct ETO File (.ETO)

Build MODFLOW RIP-ET File (.ET)

Input:

(.ETC)

(.ETV)

Construct RIP-ET File (.ET)

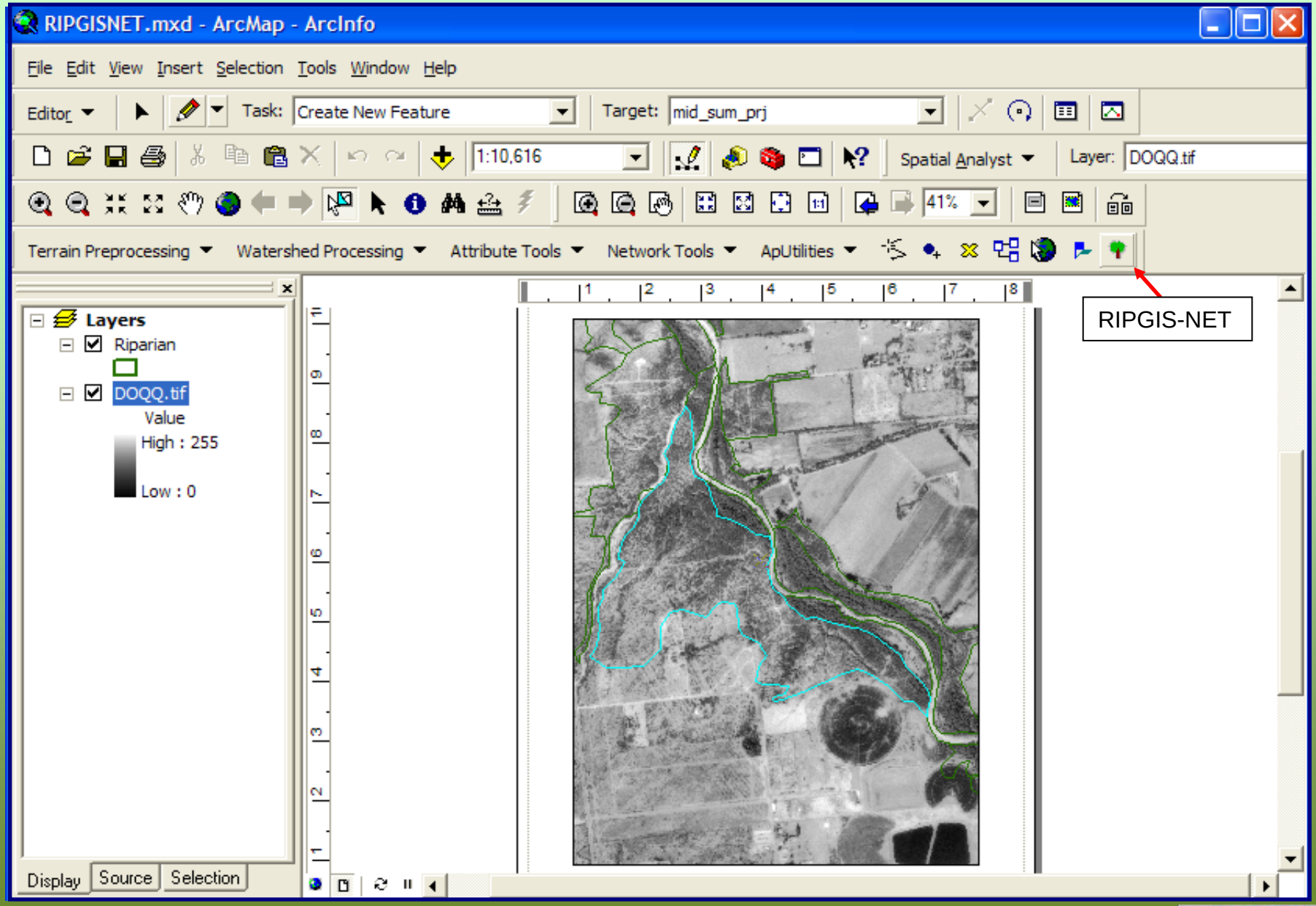
Run MODFLOW

Visualize MODFLOW Output

Draw head maps

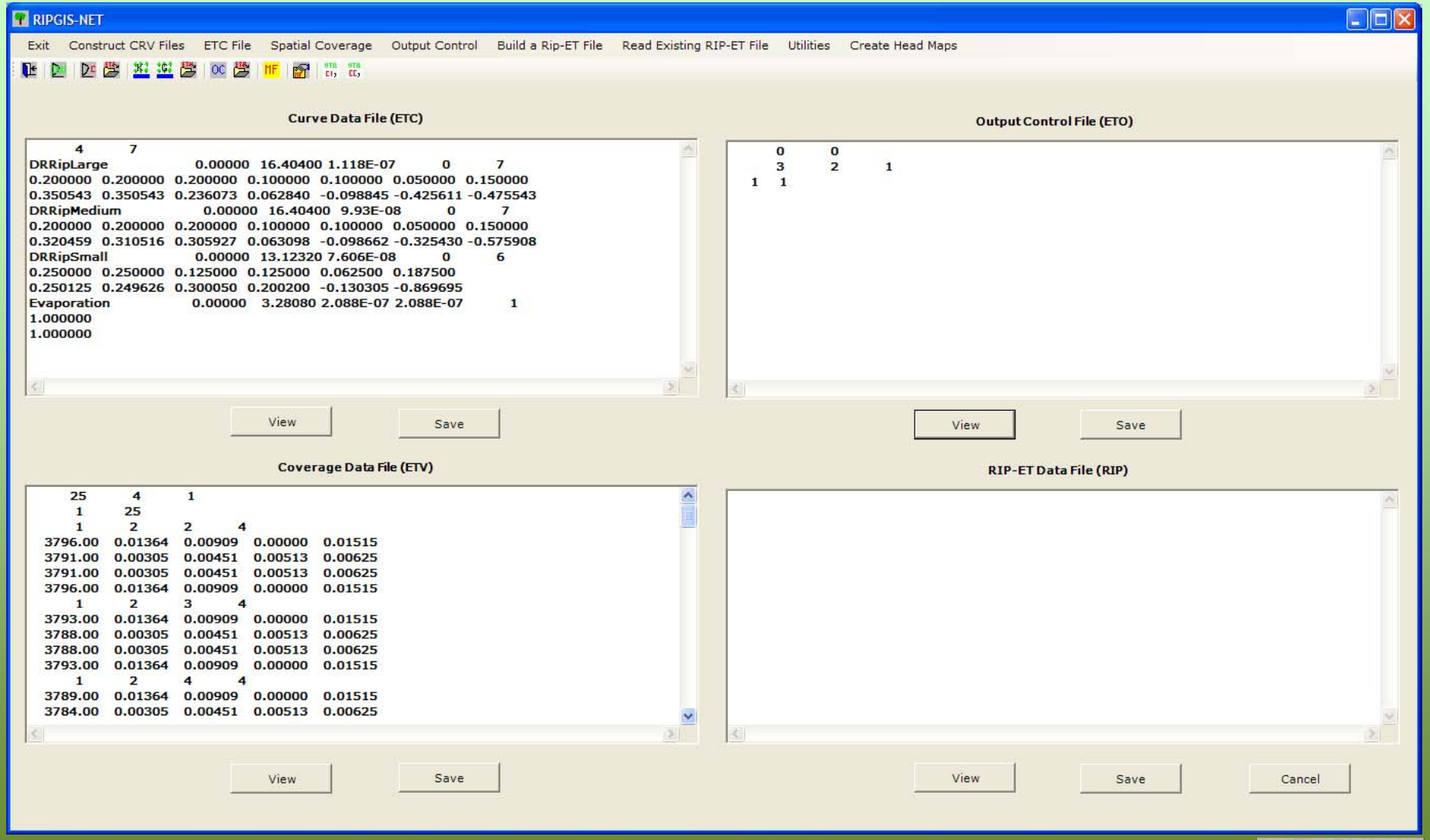
Draw depth to water map

Draw PFSG depth to water


RIPGISNET.mxd - ArcMap - ArcInfo
File Edit View Insert Selection Tools Window Help
Editor
Task: Create New Feature
Target: mid_sum_prj
1:10,616
Spatial Analyst
Layer: DOQQ.tif
41%
Terrain Preprocessing
Watershed Processing
Attribute Tools
Network Tools
ApUtilities
RIPGIS-NET
Layers
Riparian
DOQQ.tif
Value
High : 255
Low : 0
Display
Source
Selection

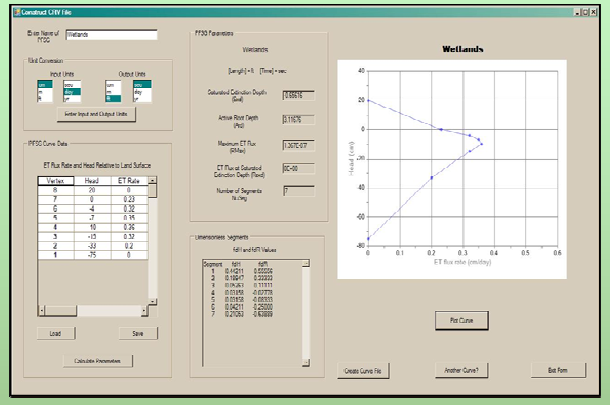

RIPGIS-NET

Main Program



RIPGIS-NET

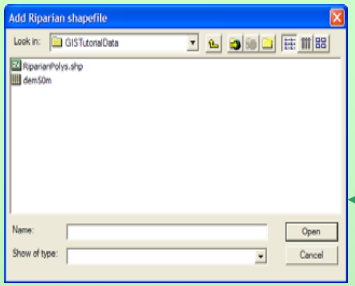
Construct Curve File

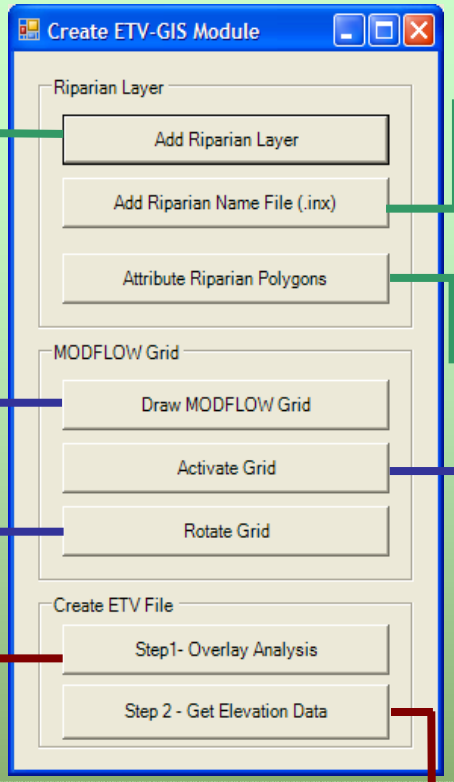


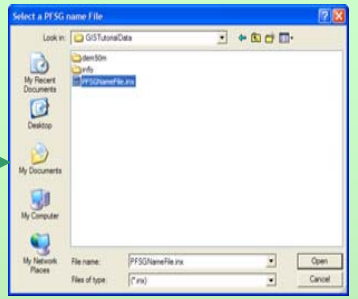
Construct Fractional Coverage File

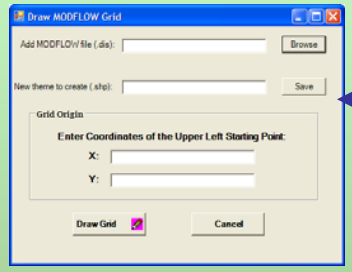
RIPGIS-NET which is developed in Visual Basic .NET 2005, is a GIS processor for the RIPET package.

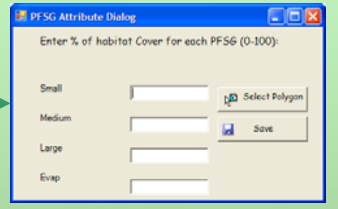
Two input files are generated by RIPGIS-NET: plant functional group curve file and fractional coverage file that has the % of each plant functional group in each polygon plus average elevation.

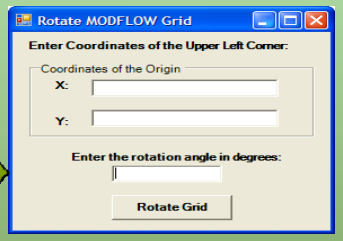


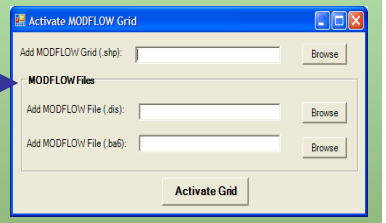


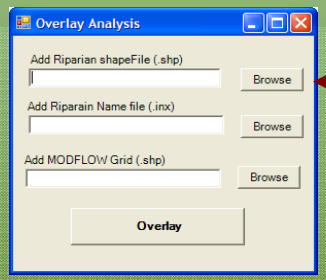


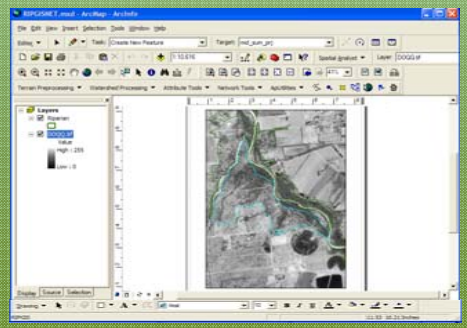


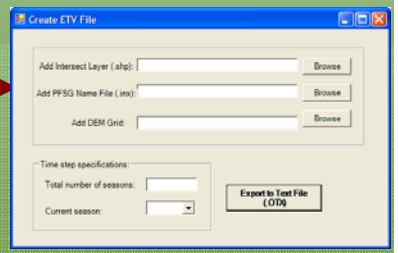




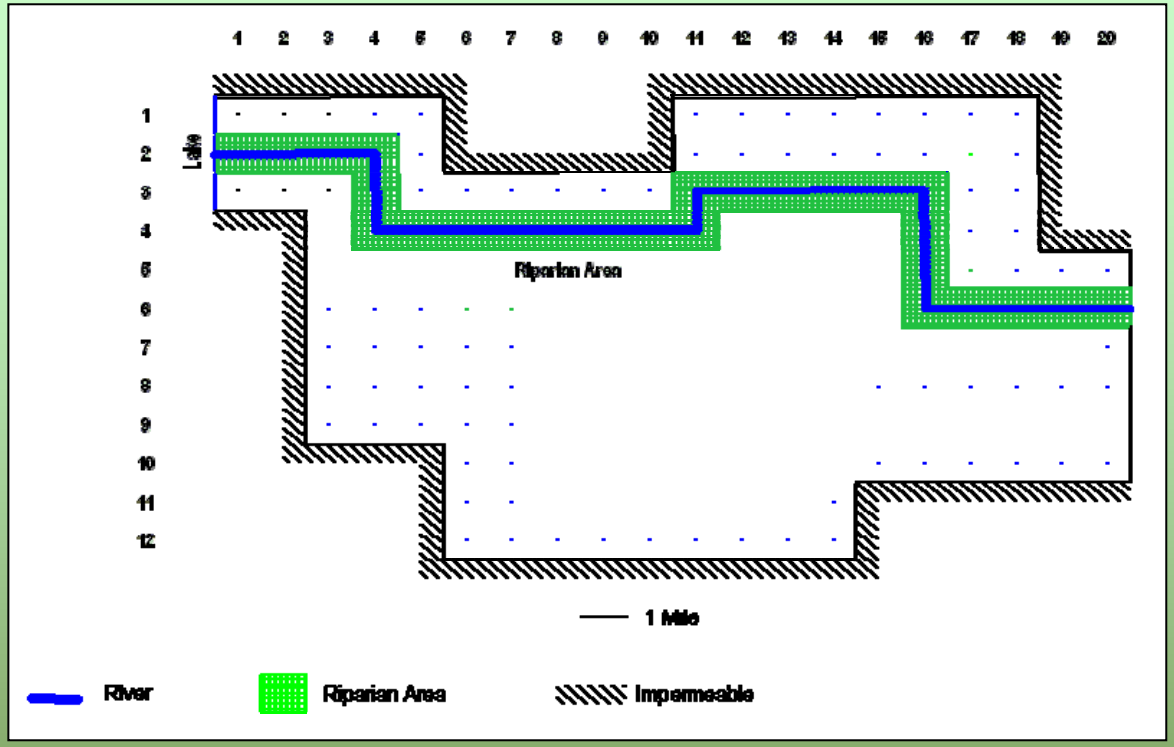


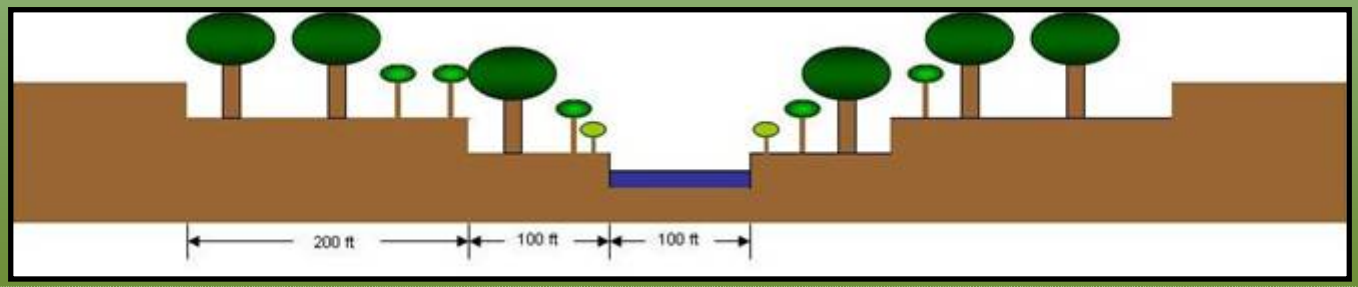






Example- Dry Alkaline Valley

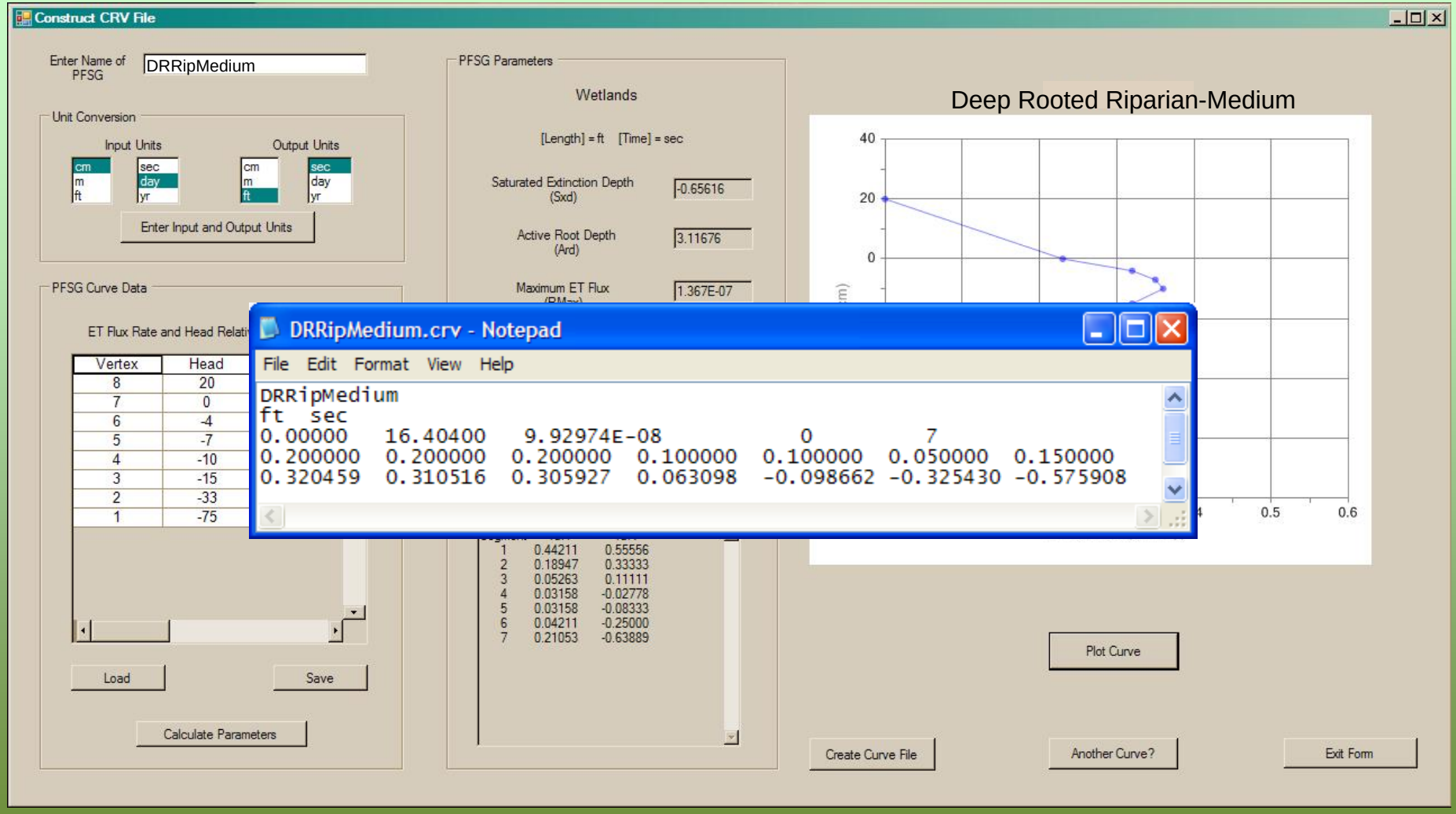




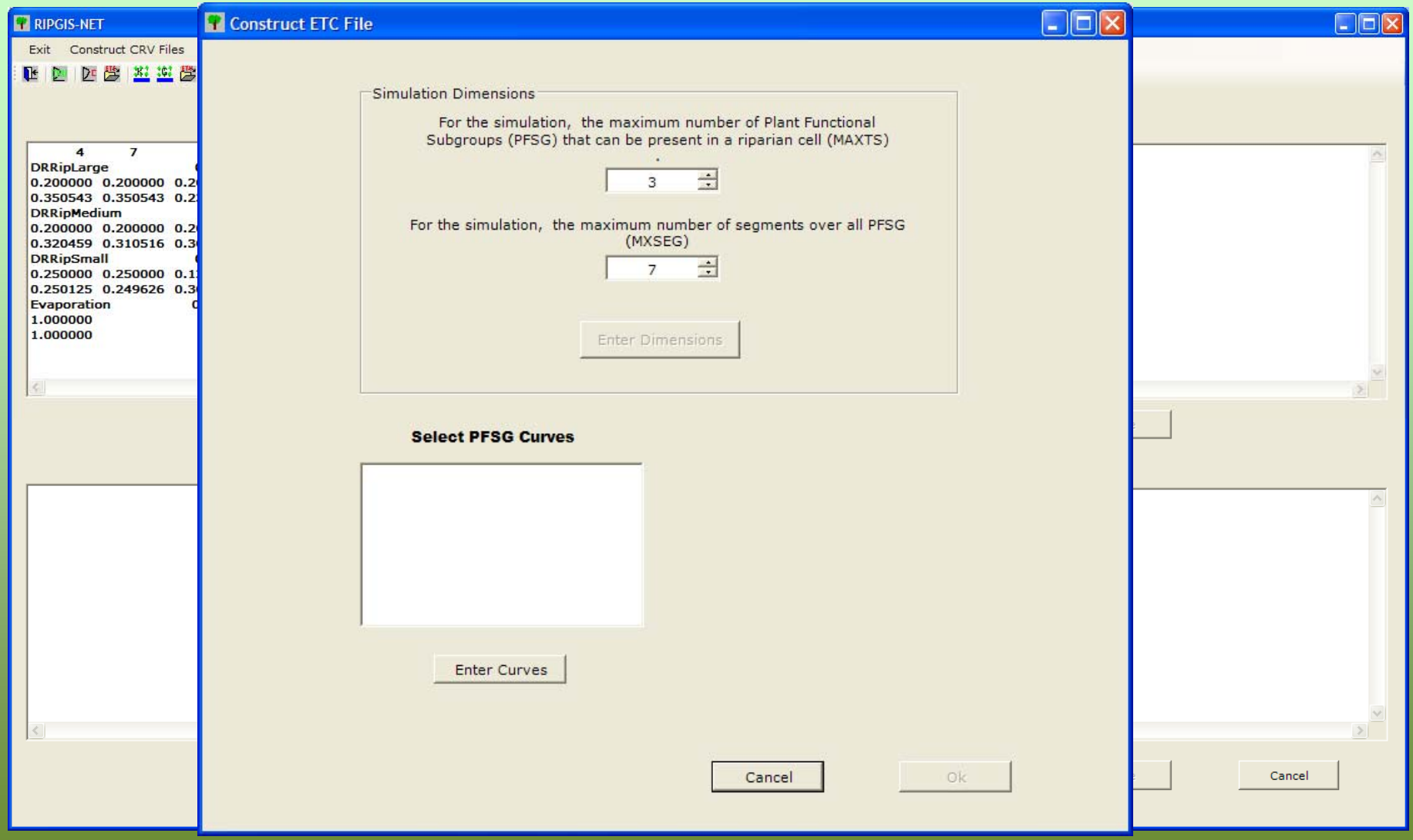
Cross-section of Dry Alkaline Valley riparian area

With small, medium, and large deep-rooted riparian vegetation

Construct Curve File (.crv)



Construct ETC File (.etc)



Construct ETV File (.etv) - Keyboard

http://images.inmagine.com/img/glowimages/gwis022/gwil14111.jpg

RIPGIS-NET

Exit | Construct CRV Files | ETC File | Spatial Coverage | Output Control | Build a Rip-ET File | Read Existing RIP-ET File | Utilities | Create Head Maps

- Keyboard ETV
- ARC-GIS ETV
- Read Esisting ETV

Coverage Dimensions

Cell Information

Unique Cover Number 1

Maximum Number of Cells for This Cover 25

Cell

Cell Number (i)

Location

Layer

Row

Column

Number of Polygons

Cell Coverage Data

Unique Coverage Number 1

Polygon

Load MODFLOW DIS File | Browse

MODFLOW Cell Number 0

Cell Area

Cell Number (i) 1

Polygon Number (j) 1

Enter Polygon Area

Enter fPA

Land Surface Elevation for Polygon (HSurf)

PFSG

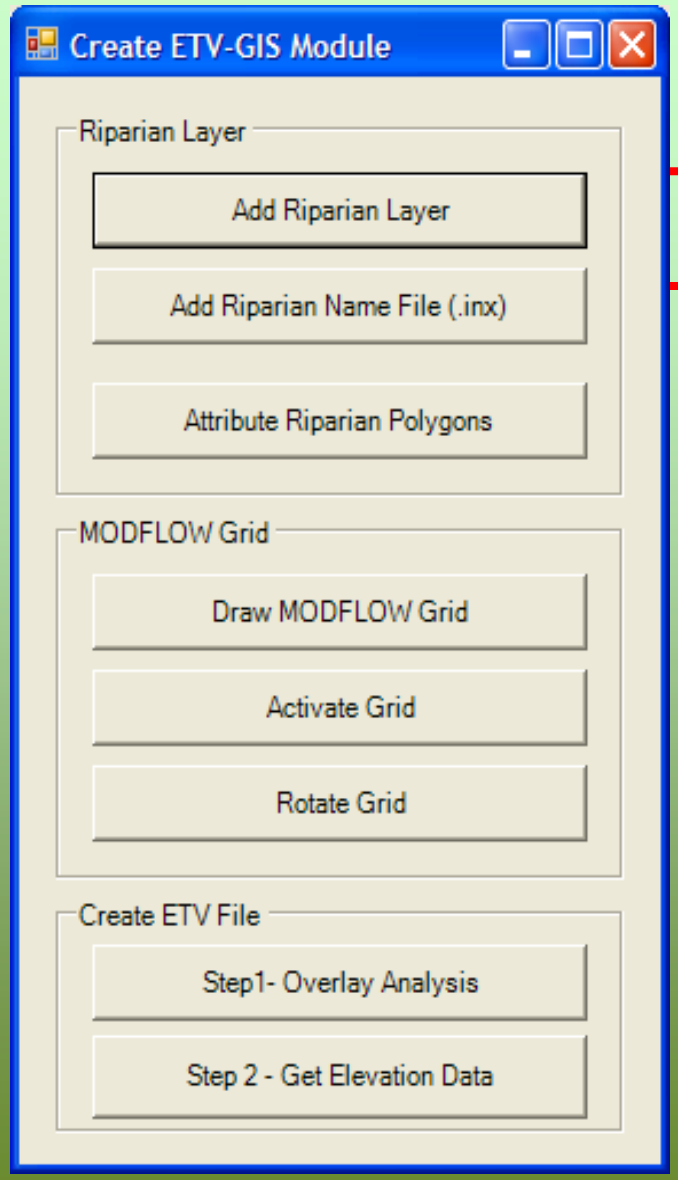
Enter Percent Polygon Area Covered with Canopy or Bare Ground (all PFSG) %

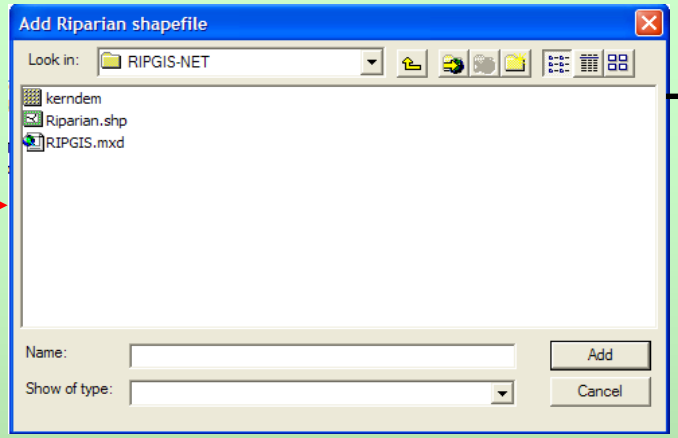
Land Surface Elevation and P

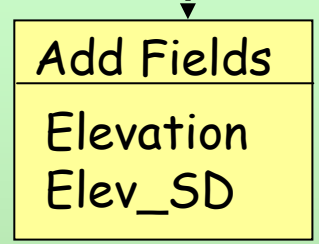
Cell #	Poly #	HSurf	DRRipLarge	DRI

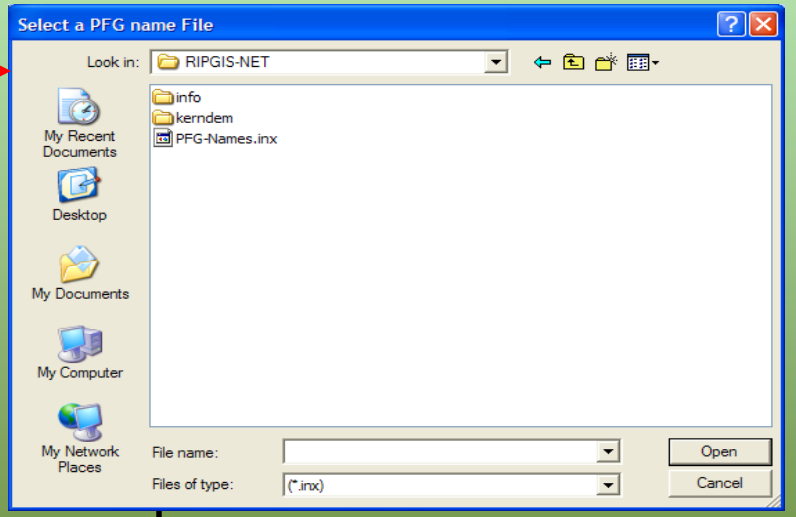
Import from Excel | Store as Variable | Export to Excel | Cancel | Ok

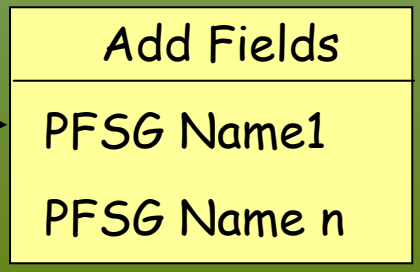
```
25      4       1
 1     25
 1      2       2       4
3796.00 0.01364 0.00909 0.00000 0.01515
3791.00 0.00305 0.00451 0.00513 0.00625
3791.00 0.00305 0.00451 0.00513 0.00625
3796.00 0.01364 0.00909 0.00000 0.01515
 1      2       3       4
3793.00 0.01364 0.00909 0.00000 0.01515
3788.00 0.00305 0.00451 0.00513 0.00625
3788.00 0.00305 0.00451 0.00513 0.00625
3793.00 0.01364 0.00909 0.00000 0.01515
 1      2       4       4
3789.00 0.01364 0.00909 0.00000 0.01515
3784.00 0.00305 0.00451 0.00513 0.00625
```


Create ETV-GIS Module
Riparian Layer
Add Riparian Layer
Add Riparian Name File (.inx)
Attribute Riparian Polygons
MODFLOW Grid
Draw MODFLOW Grid
Activate Grid
Rotate Grid
Create ETV File
Step1- Overlay Analysis
Step 2 - Get Elevation Data


Add Riparian shapefile
Look in:
RIPGIS-NET
kerndem
Riparian.shp
RIPGIS.mxd
Name:
Show of type:
Add
Cancel


Add Fields
Elevation
Elev_SD

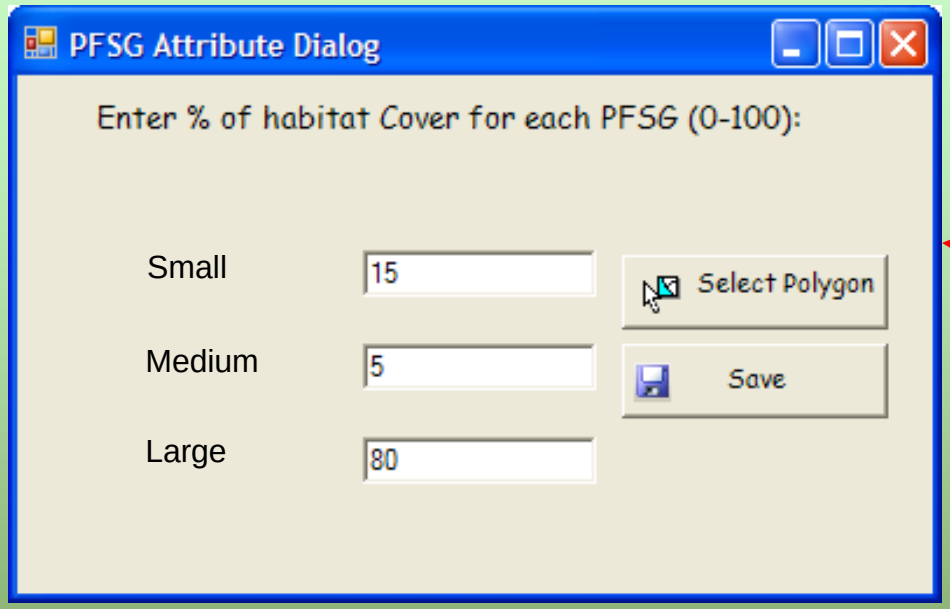

Select a PFG name File
Look in:
RIPGIS-NET
My Recent Documents
Desktop
My Documents
My Computer
My Network Places
info
kerndem
PFG-Names.inx
File name:
Files of type:
(*.inx)
Open
Cancel

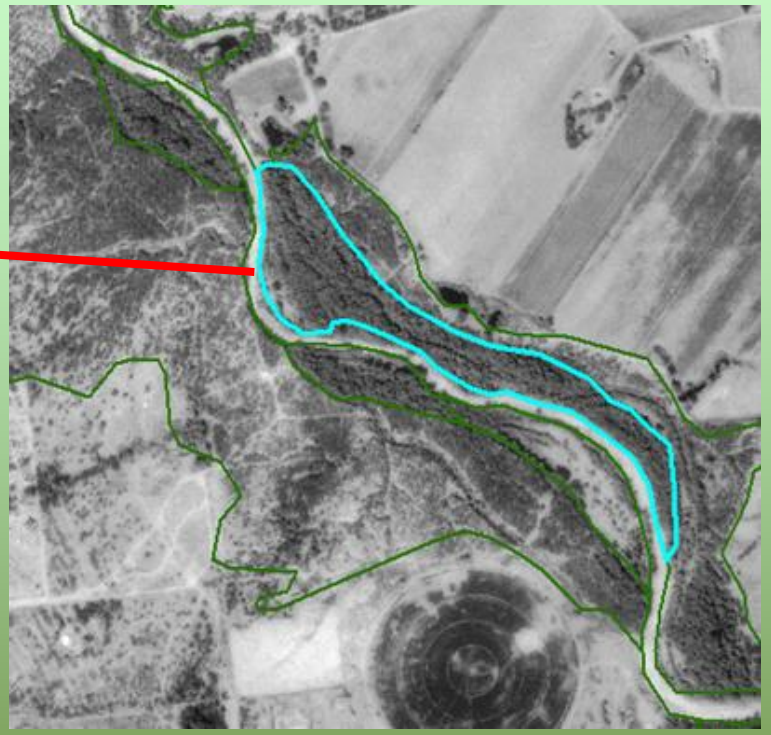

Add Fields
PFSG Name1
PFSG Name n


ESRI

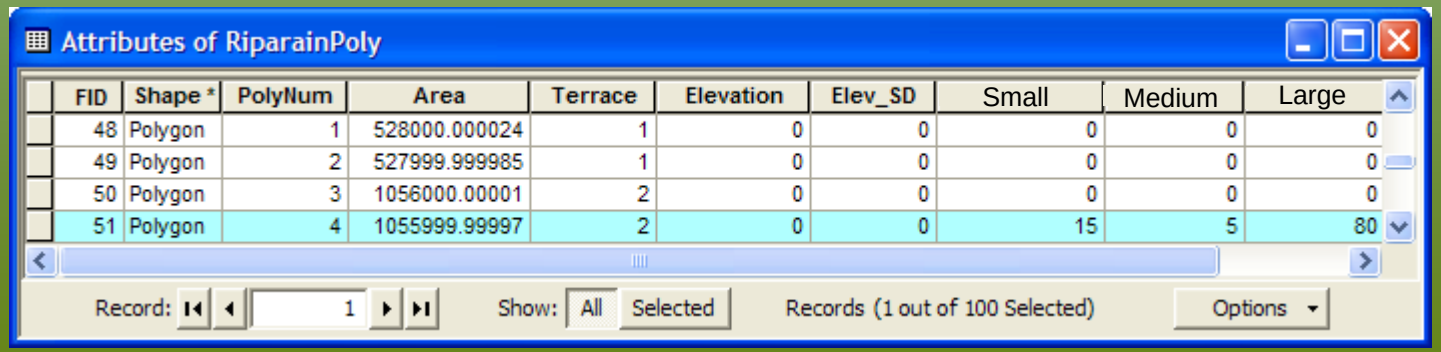

RIPGIS-NET

Attribute Riparian polygons

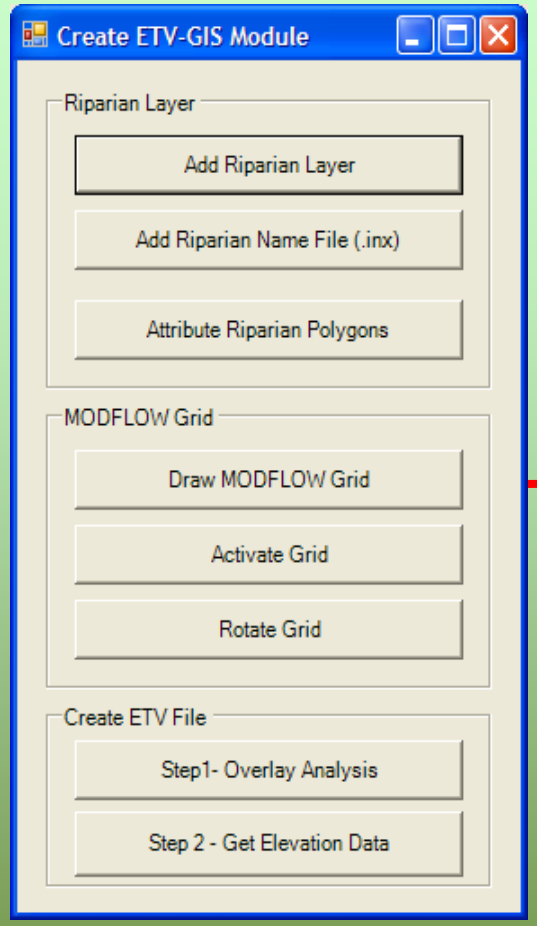


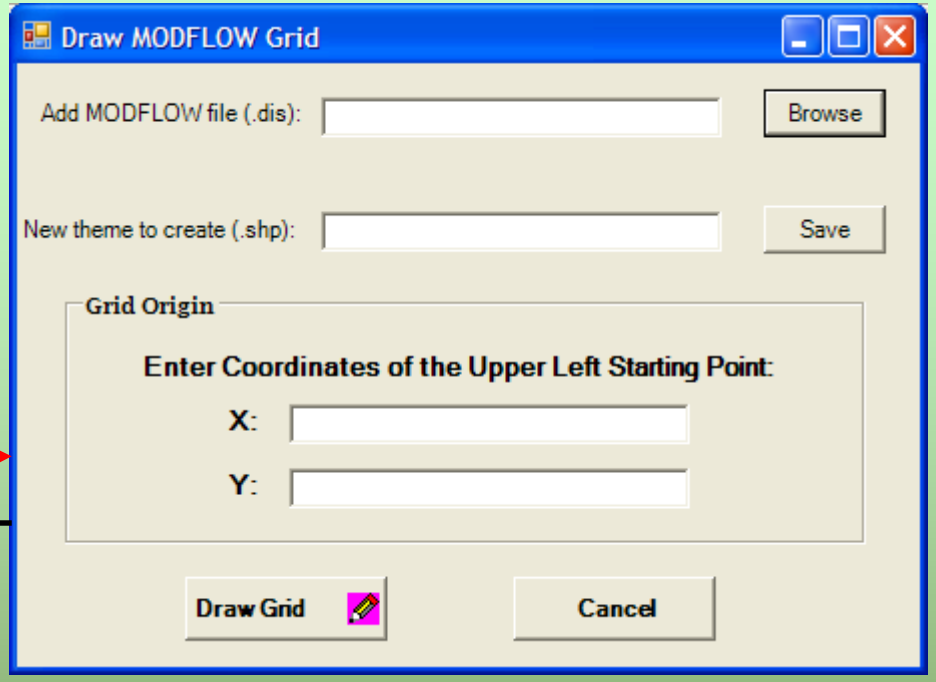


Form is scalable at runtime



MODFLOW Grid





Add Fields

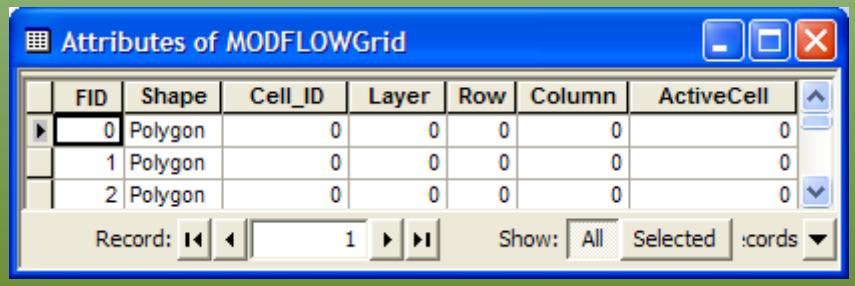
Cell_ID

Layer

Row

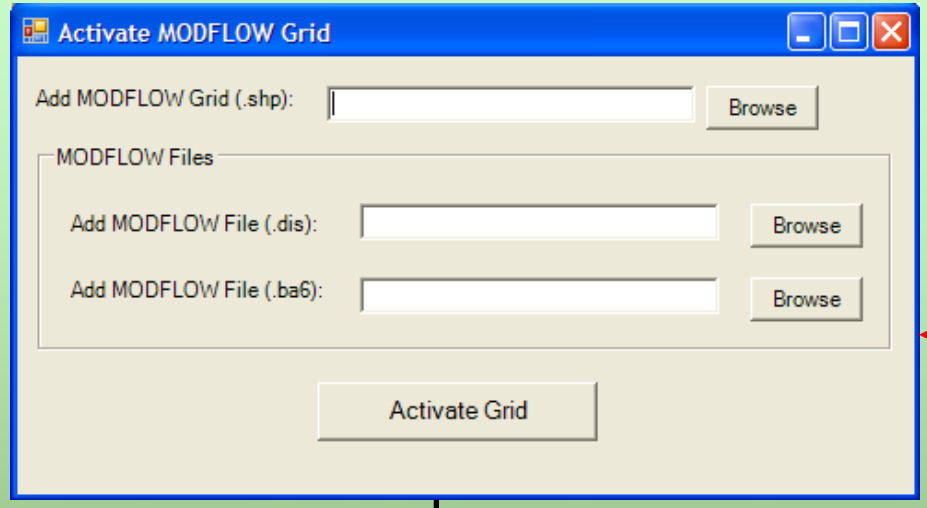
Column

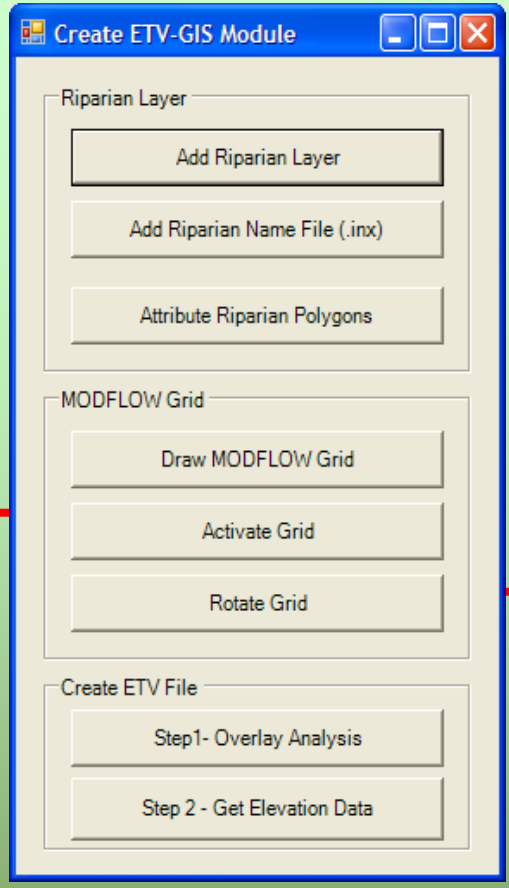
ActiveCell

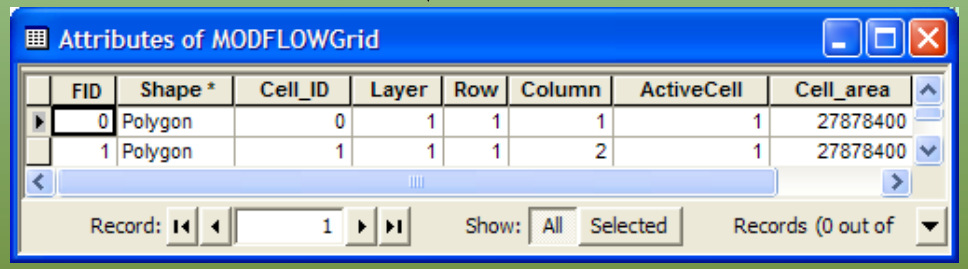


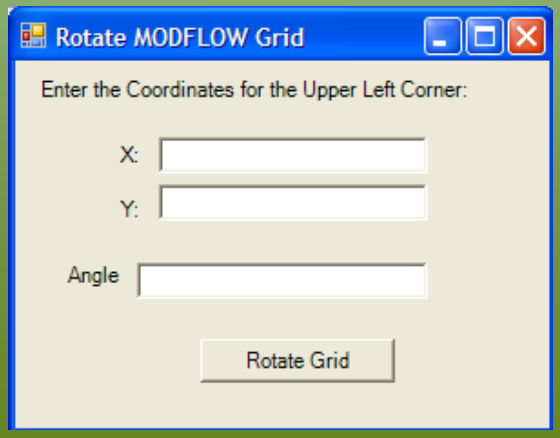
Reads: NRow, NCol, DelR,DelC

Activate MODFLOW Grid

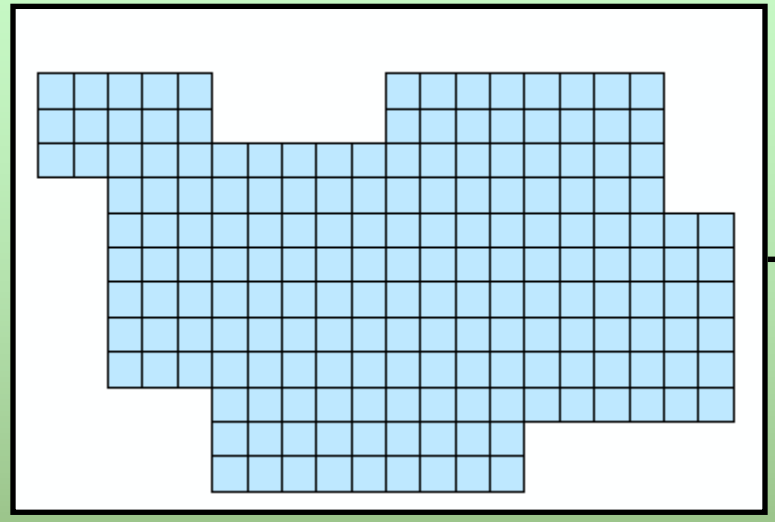








Dry Alkaline Valley MODFLOW Grid



Attributes of MODGrid

FID	Shape *	Cell_ID	Layer	Row	Column	ActiveCell	Cell_area
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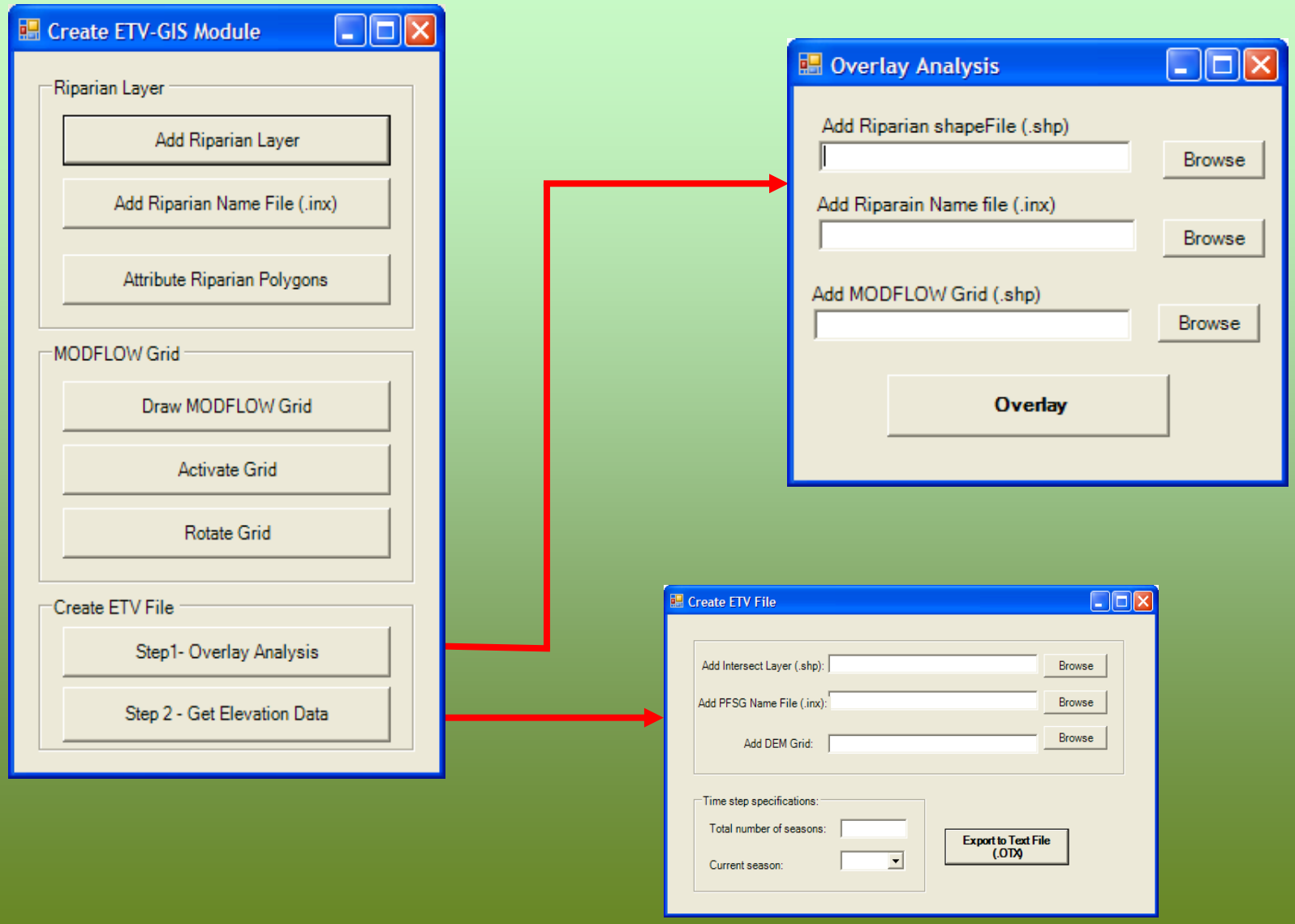
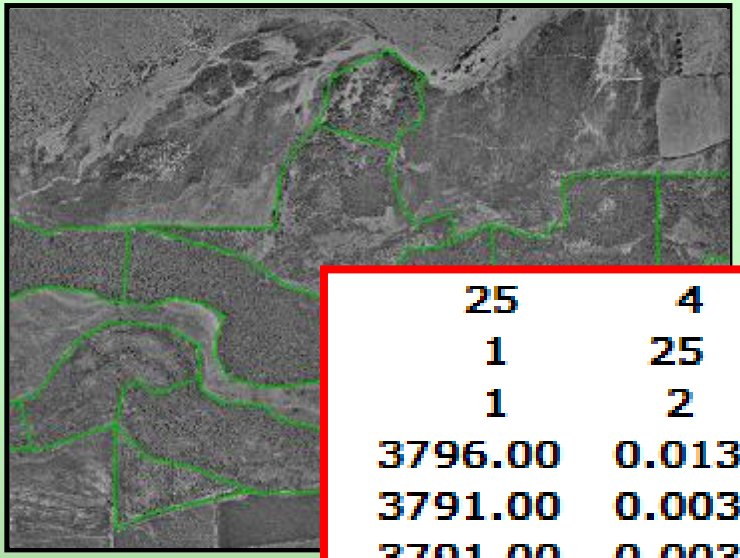
1	Polygon	1	1	1	2	1	27878400
2	Polygon	2	1	1	3	1	27878400
3	Polygon	3	1	1	4	1	27878400
4	Polygon	4	1	1	5	1	27878400
5	Polygon	10	1	1	11	1	27878400

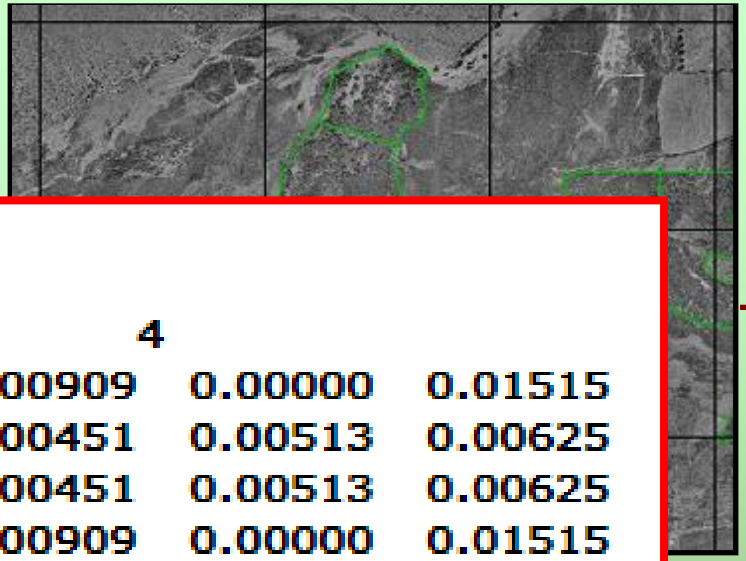
Record: 1 Show: All Selected Records (0 out of

Create ETV File



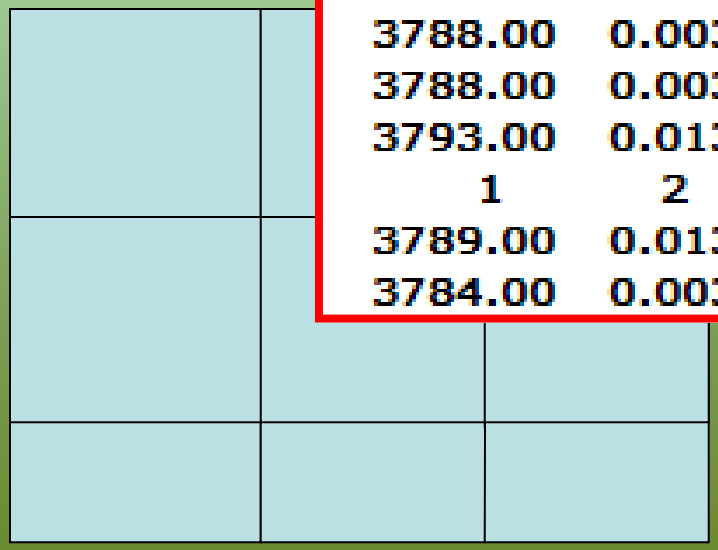
RIPGIS-NET





Riparia

25	4	1		
1	25			
1	2	2	4	
3796.00	0.01364	0.00909	0.00000	0.01515
3791.00	0.00305	0.00451	0.00513	0.00625
3791.00	0.00305	0.00451	0.00513	0.00625
3796.00	0.01364	0.00909	0.00000	0.01515
1	2	3	4	
3793.00	0.01364	0.00909	0.00000	0.01515
3788.00	0.00305	0.00451	0.00513	0.00625
3788.00	0.00305	0.00451	0.00513	0.00625
3793.00	0.01364	0.00909	0.00000	0.01515
1	2	4	4	
3789.00	0.01364	0.00909	0.00000	0.01515
3784.00	0.00305	0.00451	0.00513	0.00625

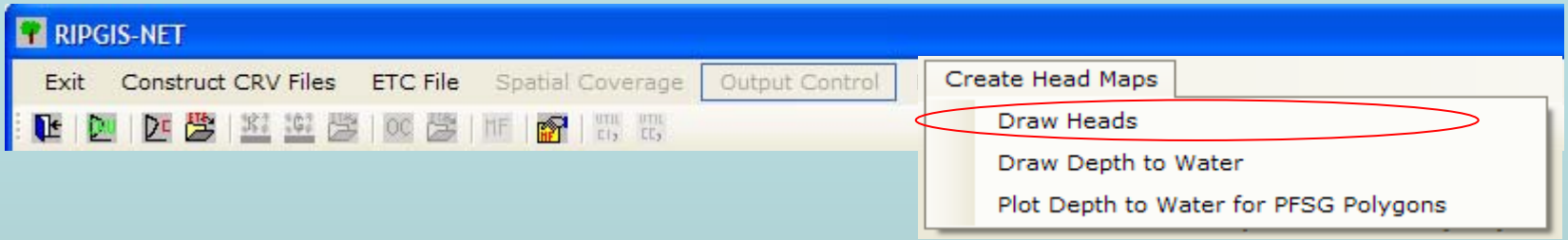


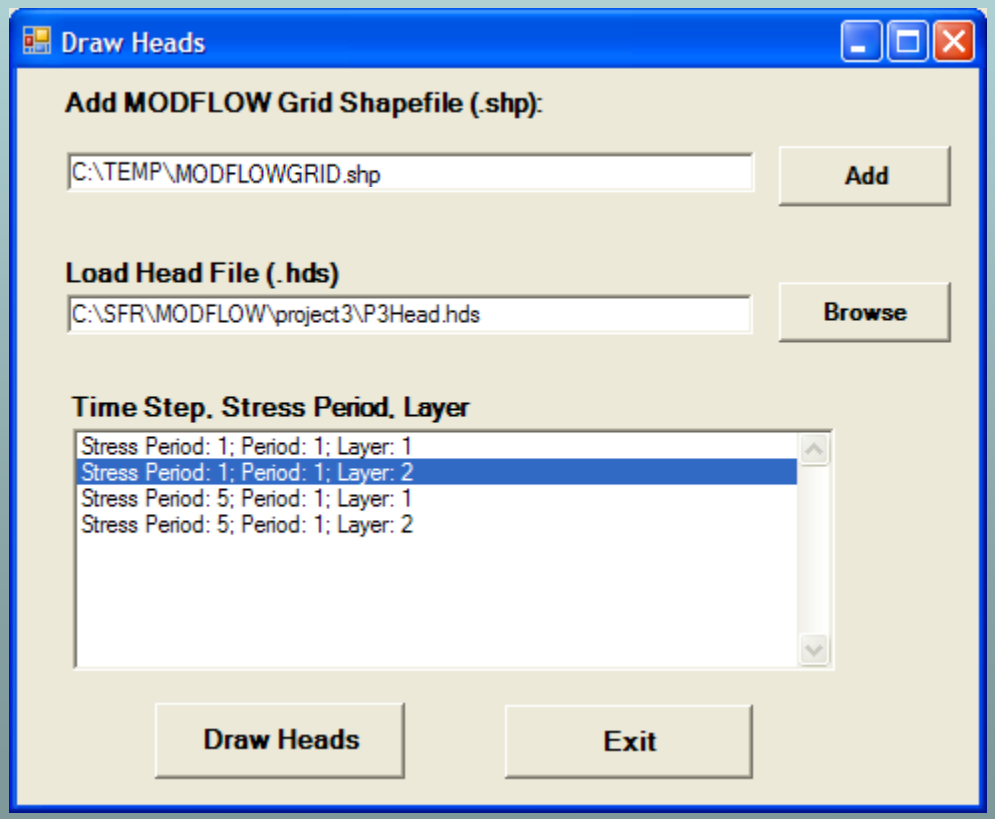
MODFLOW Grid

DEM

Postprocessor:
Visualize MODFLOW and RIP-ET Results

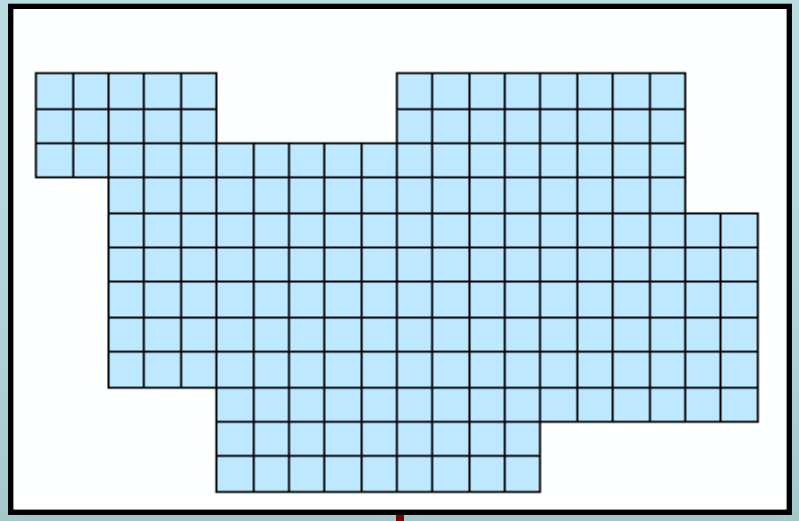
Draw Heads


RIPGIS-NET
Exit
Construct CRV Files
ETC File
Spatial Coverage
Output Control
Create Head Maps
Draw Heads
Draw Depth to Water
Plot Depth to Water for PFSG Polygons


Draw Heads
Add MODFLOW Grid Shapefile (.shp):
C:\TEMP\MODFLOWGRID.shp
Add
Load Head File (.hds)
C:\SFR\MODFLOW\project3\P3Head.hds
Browse
Time Step, Stress Period, Layer
Stress Period: 1; Period: 1; Layer: 1
Stress Period: 1; Period: 1; Layer: 2
Stress Period: 5; Period: 1; Layer: 1
Stress Period: 5; Period: 1; Layer: 2
Draw Heads
Exit


RIPGIS-NET

Draw Heads for Dry Alkaline Valley



P3Head.hds - Notepad

File Edit Format View Help

```
    1    1   6.311520E+06   6.311520E+06              HEAD     20    12     1 (20F10.3)
 3800.000  3788.691  3781.277  3776.750  3774.324  -999.990  -999.990  -999.990  -999.
 3800.000  3788.144  3780.337  3775.874  3772.768  -999.990  -999.990  -999.990  -999.
 3800.000  3786.498  3776.544  3772.987  3768.912  3764.825  3762.660  3760.605  3758.
 -999.990  -999.990  3769.658  3769.246  3767.004  3764.455  3762.762  3761.057  3759.
 -999.990  -999.990  3765.643  3765.105  3763.884  3762.881  3762.085  3761.348  3759.
 -999.990  -999.990  3764.280  3763.891  3763.205  3762.754  3762.820  3763.998  3763.
 -999.990  -999.990  3763.320  3763.051  3762.640  3762.482  3762.864  3764.473  3763.
 -999.990  -999.990  3762.697  3762.479  3762.144  3761.989  3762.165  3763.130  3762.
 -999.990  -999.990  3762.383  3762.170  3761.802  3761.479  3761.104  3759.448  3757.
 -999.990  -999.990  -999.990  -999.990  -999.990  3761.374  3761.621  3762.621  3761.
 -999.990  -999.990  -999.990  -999.990  -999.990  3761.353  3761.828  3763.351  3763.
 -999.990  -999.990  -999.990  -999.990  -999.990  3761.233  3761.492  3761.885  3761.
    1    1   6.311520E+06   6.311520E+06              HEAD     20    12     2 (20F10.3)
 3778.919  3777.221  3774.923  3772.918  3771.695  -999.990  -999.990  -999.990  -999.
 3778.673  3776.765  3774.044  3771.784  3770.228  -999.990  -999.990  -999.990  -999.
 3778.370  3776.073  3772.124  3769.569  3766.972  3763.525  3761.348  3759.353  3757.
 -999.990  -999.990  3768.404  3767.079  3765.075  3762.865  3761.086  3759.302  3757.
 -999.990  -999.990  3765.892  3765.070  3763.650  3762.117  3760.727  3759.224  3757.
 -999.990  -999.990  3764.224  3763.656  3762.623  3761.486  3760.396  3759.161  3757.
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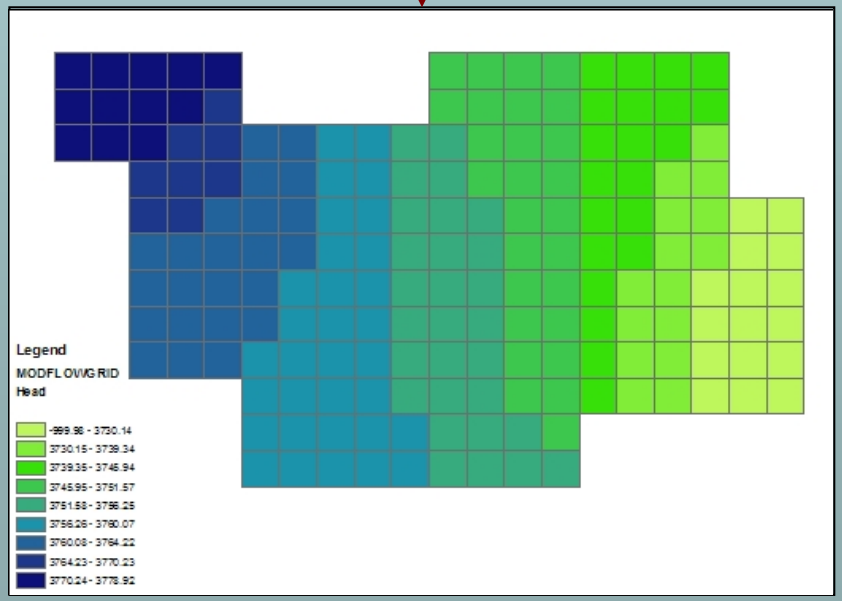
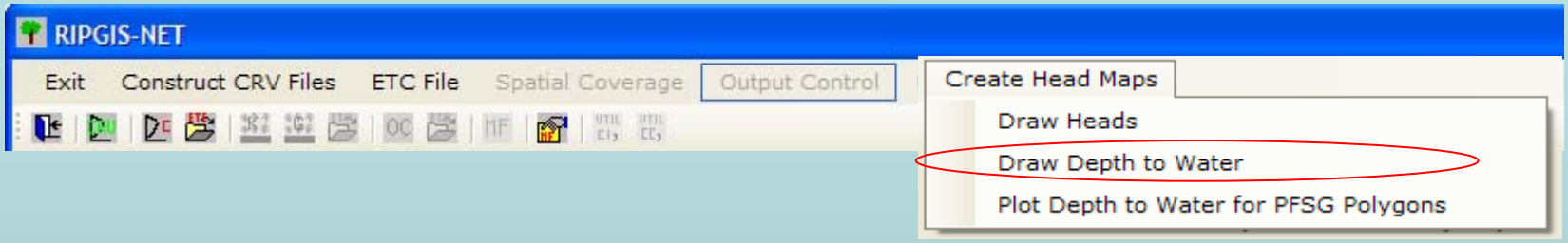
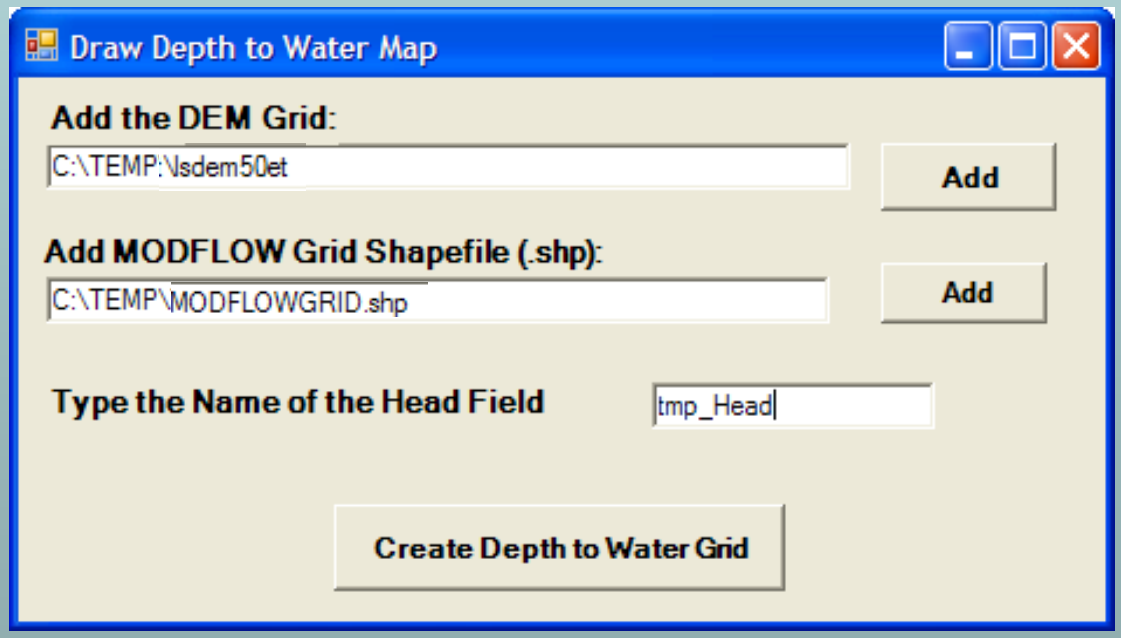
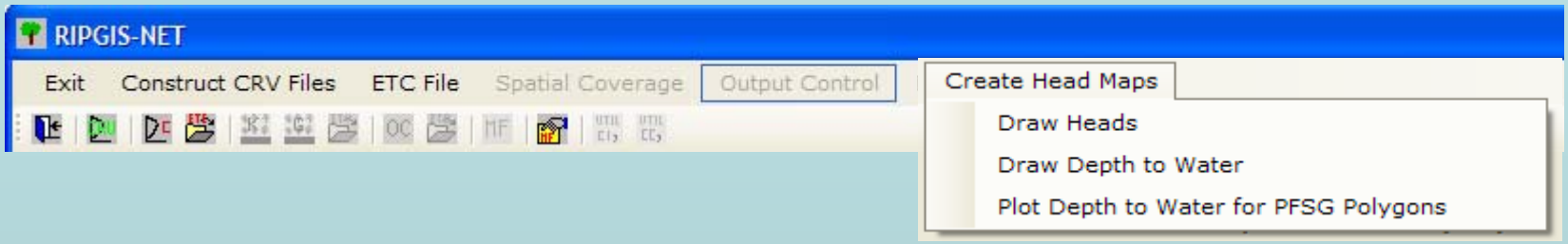


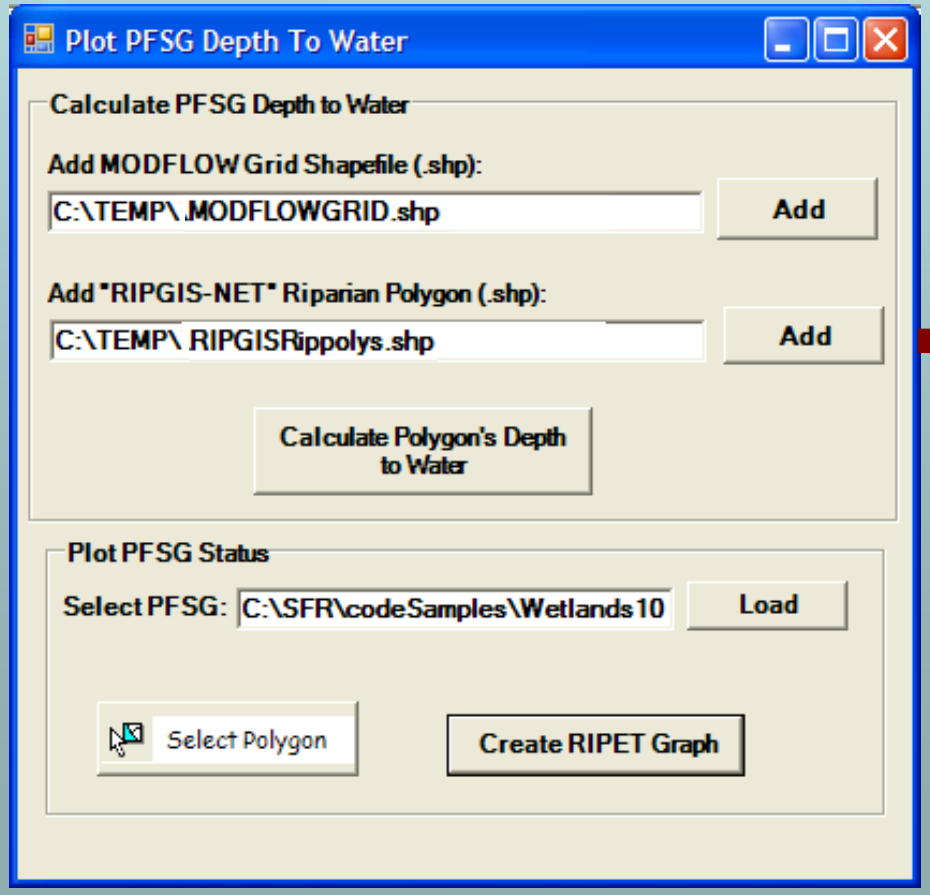
Draw Depth to Water

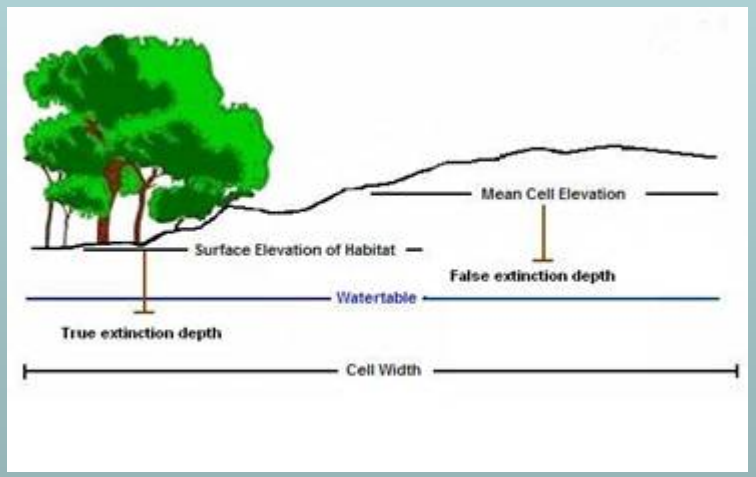




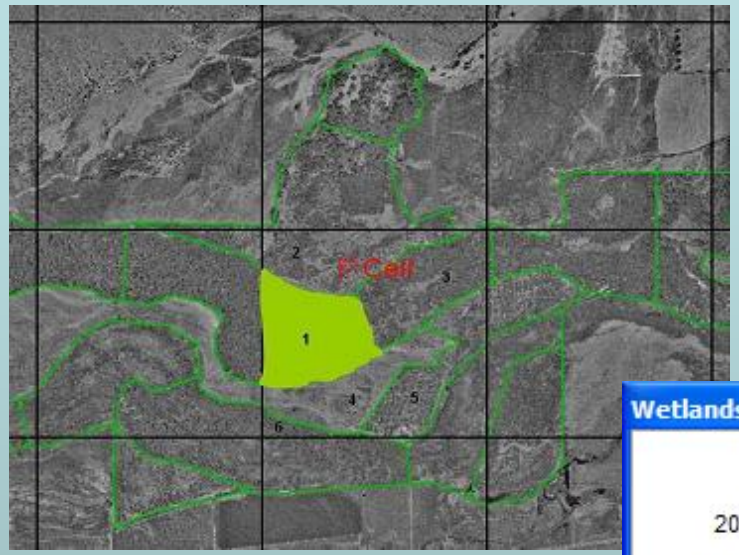
Calculate PFSG Depth to Water

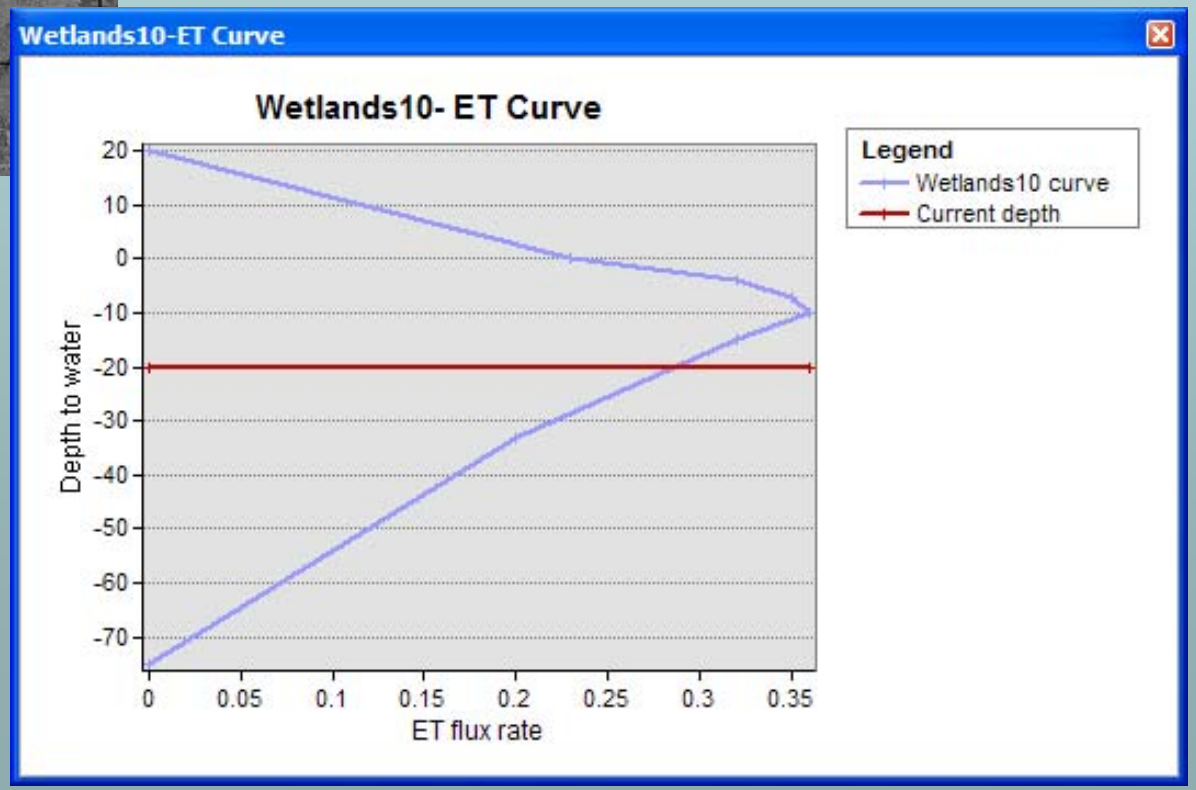






Plot Current depth to Water For PFSG





RIPGIS-NET

In Summary

- RIPGIS-NET is an application developed as a user interface for deriving the parameters for the RIP-ET module in MODFLOW.

- It provides a user interface for visualizing MODFLOW results in ArcGIS.

- It is developed in VB.NET for ArcGIS 9.2.

Conclusion

- ArcGIS is a powerful environment for GIS application development.
- Variety of platforms are available.

- User perspective

- Programmer perspective

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