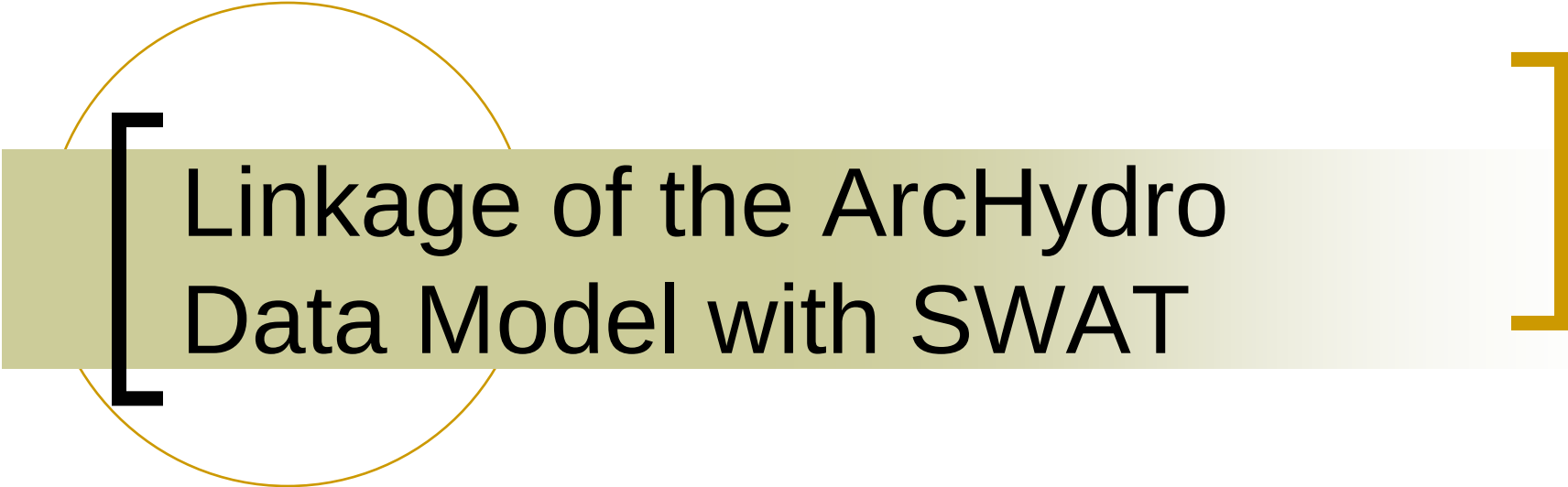




Linkage of the ArcHydro Data Model with SWAT

Francisco Olivera, Ph.D., P.E.

Milver Valenzuela

Texas A&M University - Department of Civil Engineering

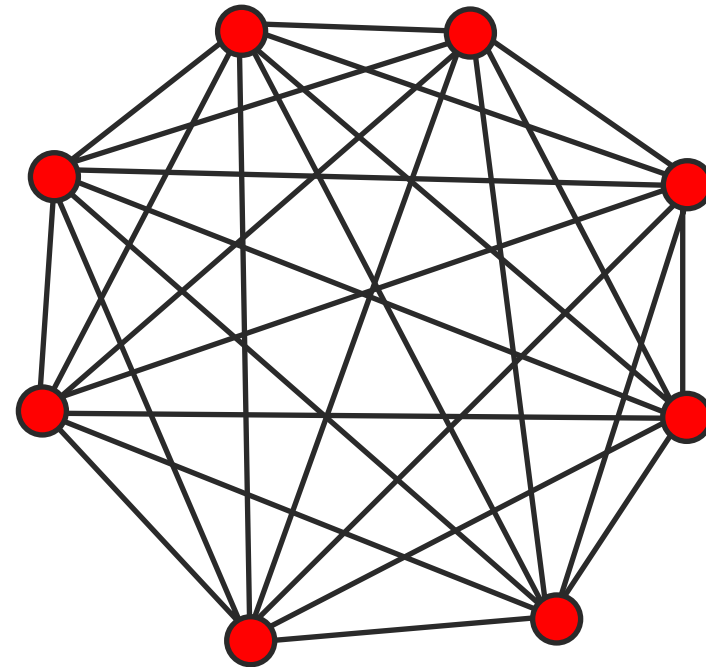
Raghavan Srinivasan, Ph.D.

Texas A&M University – Department of Forest Sciences

[Model Integration]

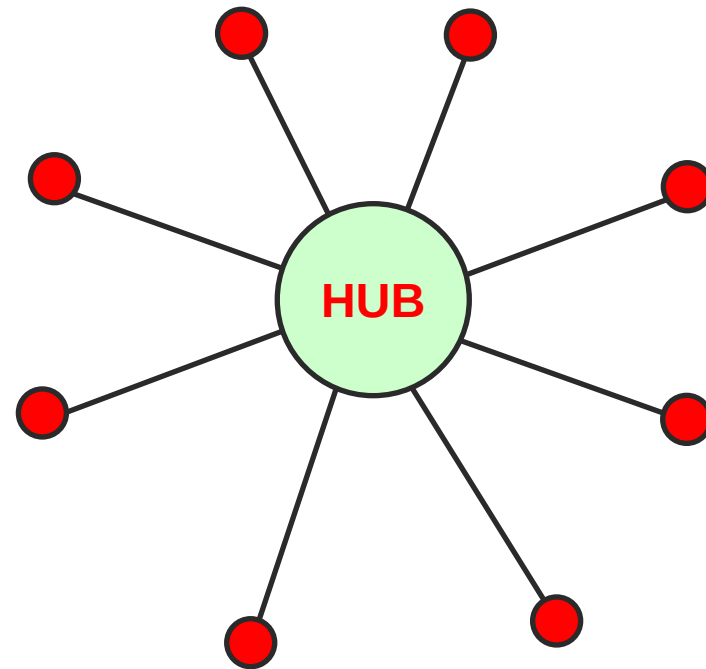
- *Sharing of information* between models is necessary to capture the complexity of natural hydrologic processes.
- This sharing of information between models in a systematic fashion is called here *model integration*.

[Model Integration]



Connection on a two-model basis.
Depends on the already connected
models.

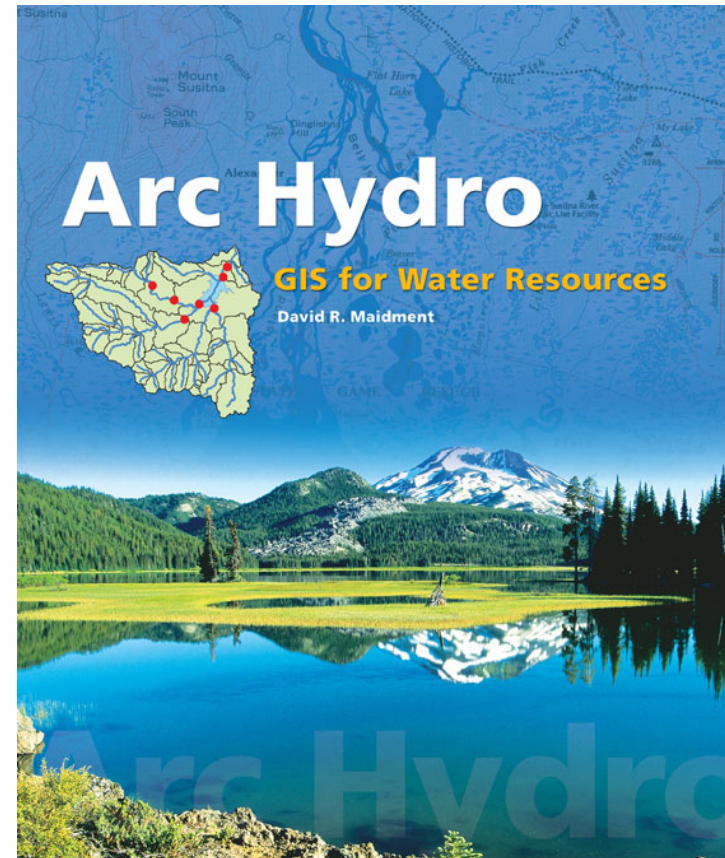
[Model Integration]



Connection on a *hub* basis.
Independent of the already
connected models

[Arc Hydro]

- Arc Hydro can be used as the **hub** for connecting hydrologic models.



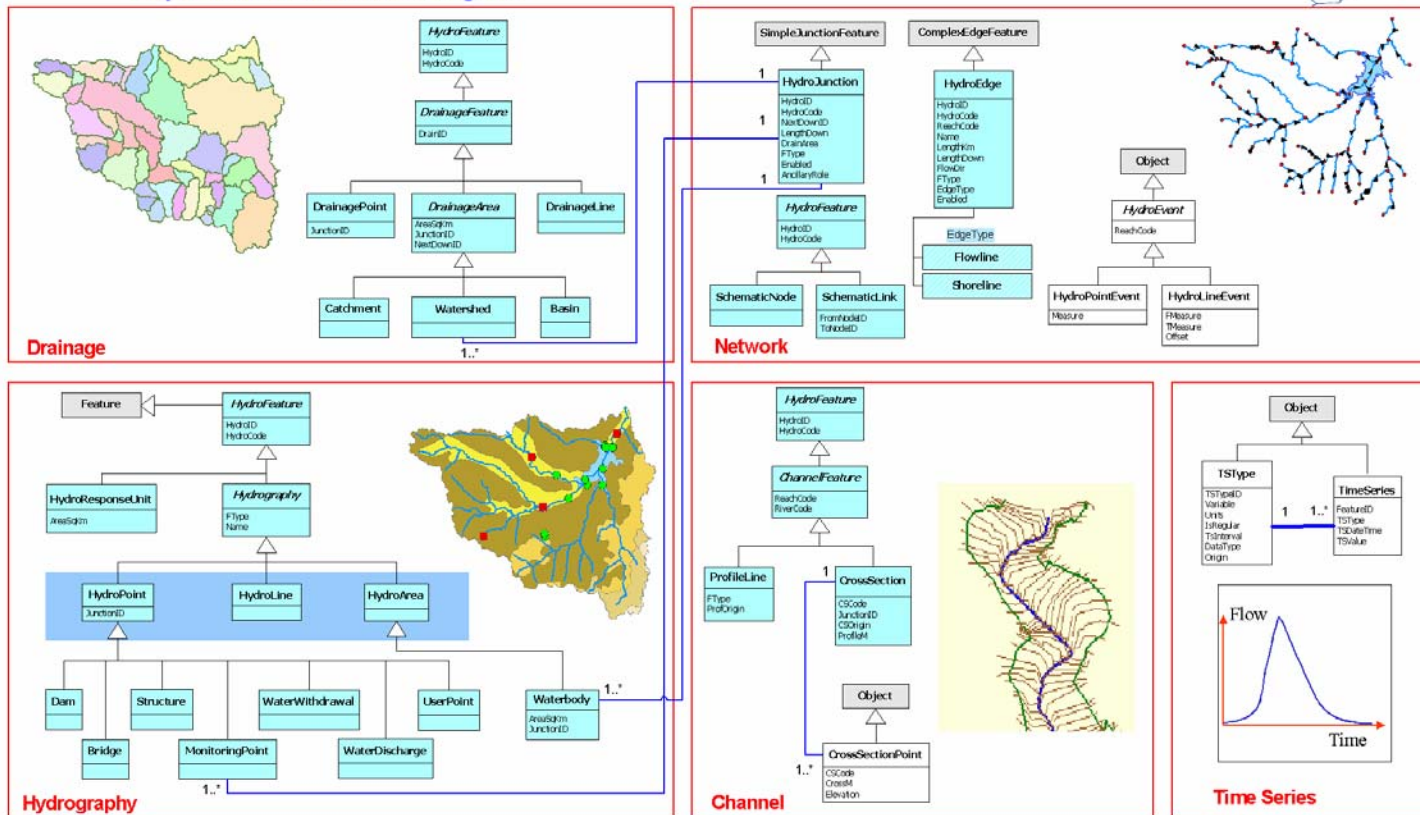
Arc Hydro

ArcGIS Hydro Data Model

<http://arconline.esri.com/arconline/datamodels/water.cfm>

<http://www.crrw.utexas.edu/giswr>

*GIS in Water Resources
Consortium*



What it is and what it is not ...

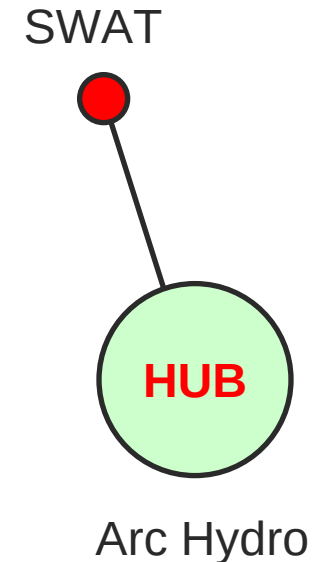
- Arc Hydro is a **geodatabase**, that is, a relational database that contains geographic information.
- Arc Hydro is a **standard data model** for spatial and temporal hydrologic data.
- A **data model** is a template for organizing data, so that it can be found and retrieved easily.



Entertainment center

[ArcGIS-SWAT]

- ArcGIS-SWAT is an **ArcView 8.x** preprocessor for the Soil Water Assessment Tool (SWAT) compatible with the **Arc Hydro** data model developed by Texas A&M University – Civil Engineering and Forest Sciences with support of the U.S. Army Corps of Engineers.
- Improvement with respect to AVSWAT developed by Di Luzio et al.



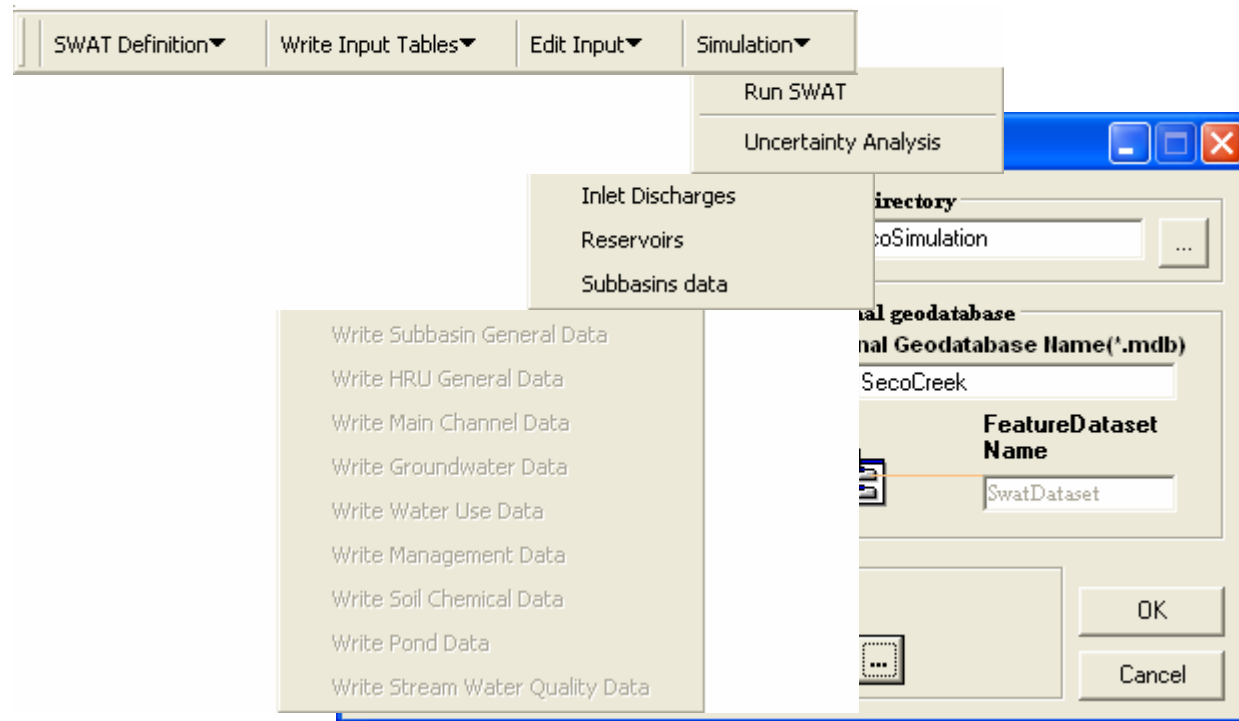
[SWAT/GIS Interfaces]

- **Srinivasan and Arnold (1994):** SWAT 1990 / GRASS – C programming language.
- **Bian et al. (1998):** SWAT 1990 / ArcInfo – Arc Macro Language (AML)
- **Di Luzio et al. (1998):** SWAT 1996 / ArcView – Avenue programming language.
- **Di Luzio et al. (2002):** Improved 1998 interface and was incorporated in BASINS.
- **Olivera et al. (2003):** Improved 2002 interface for ArcView 8.x – Visual Basic

[What's new?

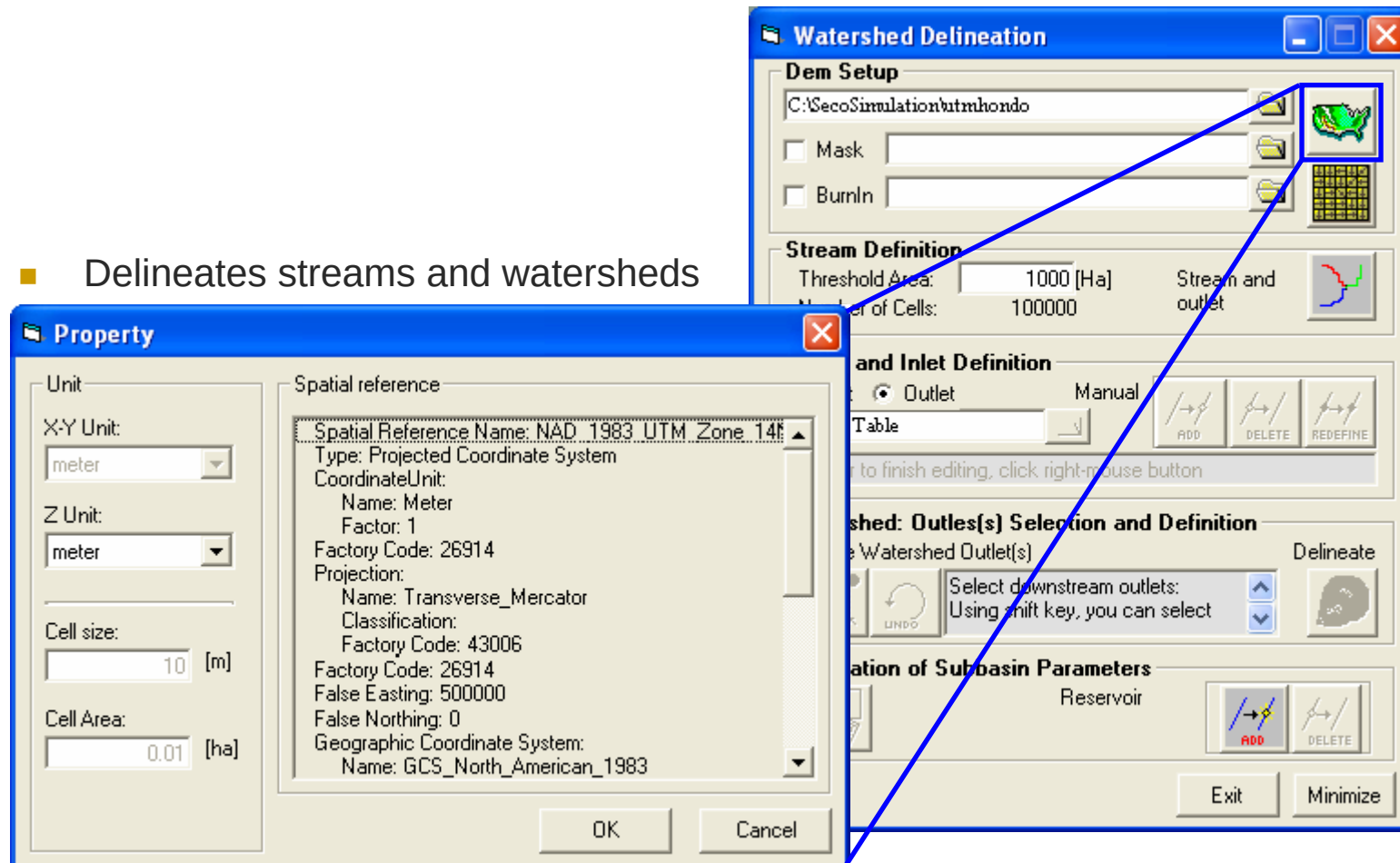
- Compatible with the latest ESRI GIS software package ArcView 8.x and programming standards.
- Uses a geodatabase data structure to store (and relate) spatial features, parameter tables and time series tables.
- Stores the location of the hydrologic response units (HRU).
- Includes a Monte Carlo parameter simulation utility.

[ArcGIS-SWAT Toolbar]

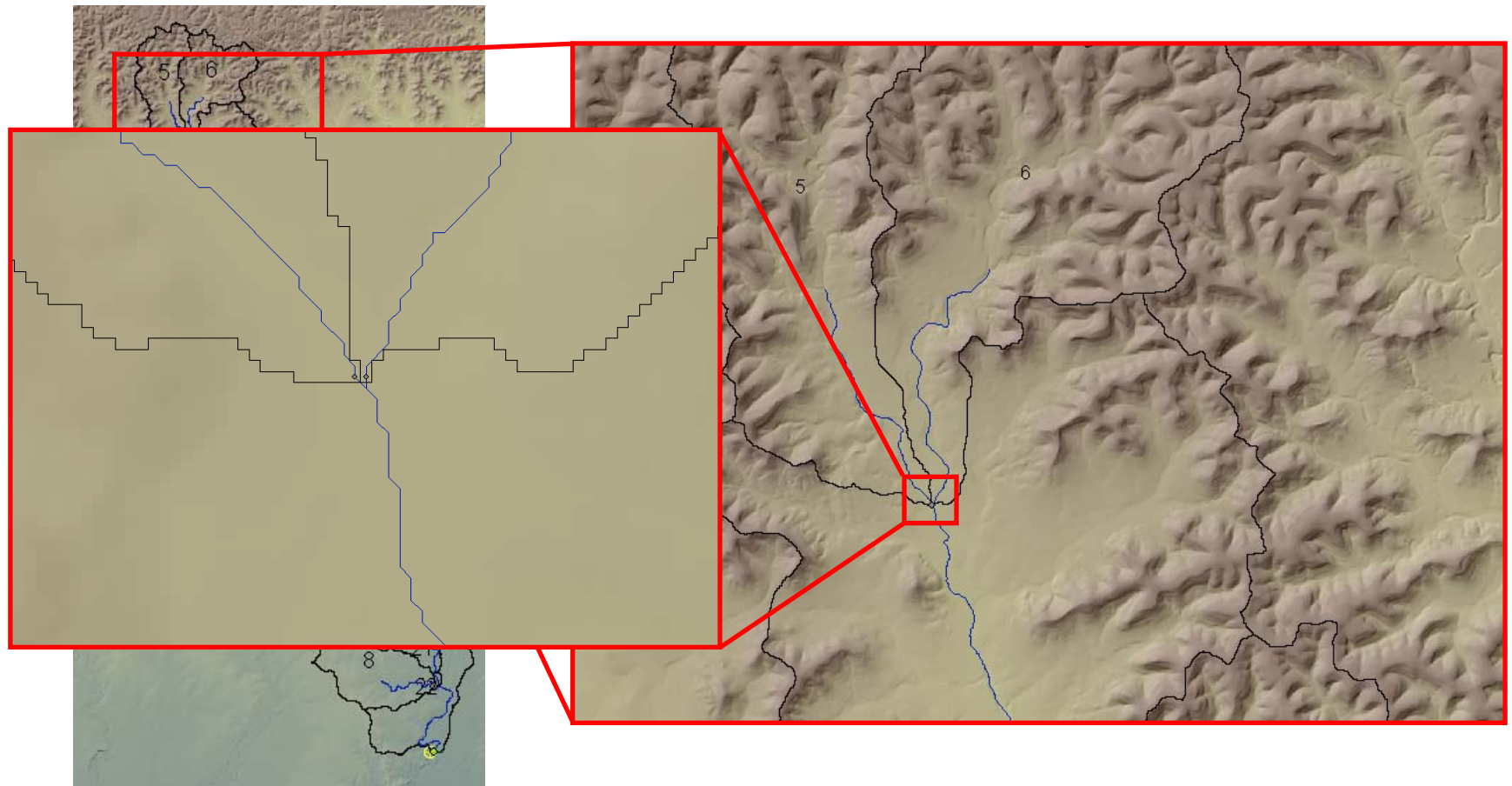


Watershed Delineator

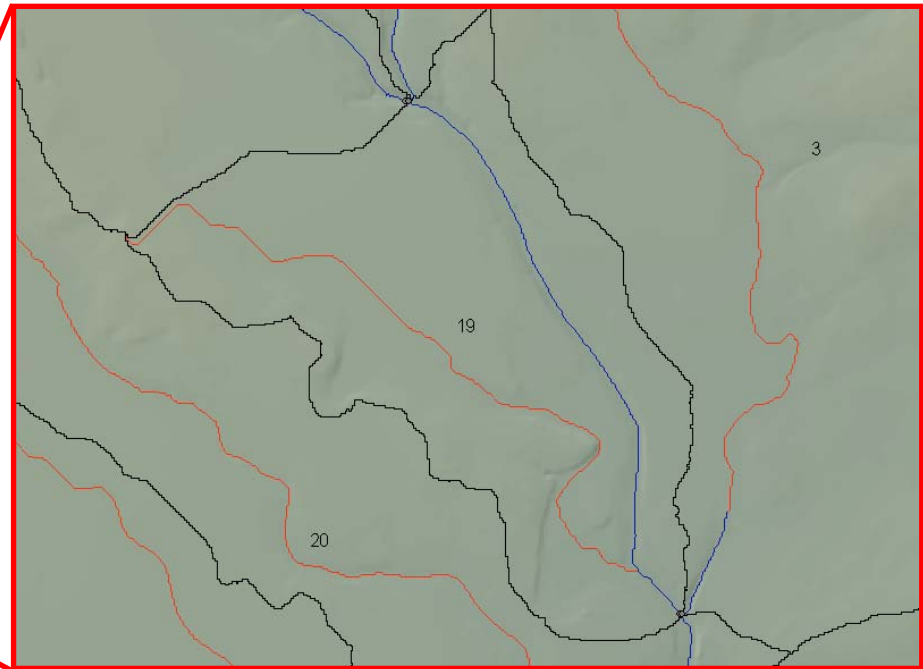
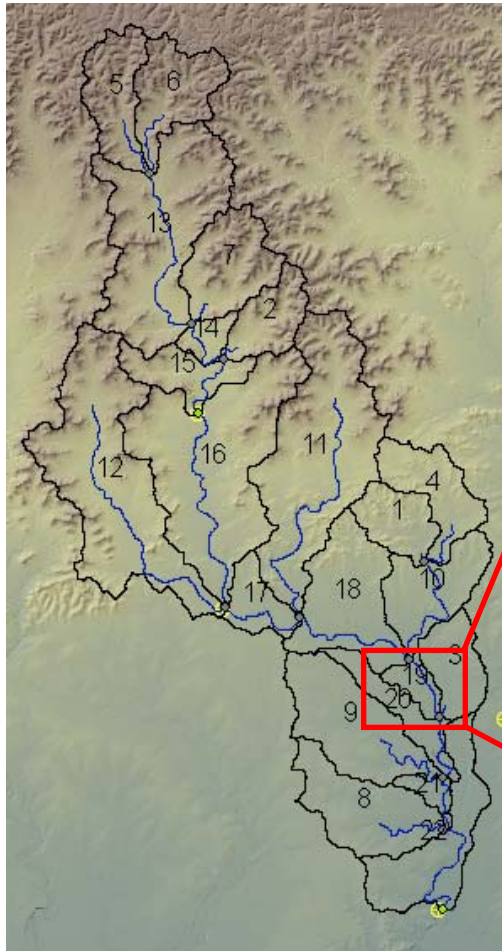
- Delineates streams and watersheds



[Watershed Delineator]



Watershed Delineator



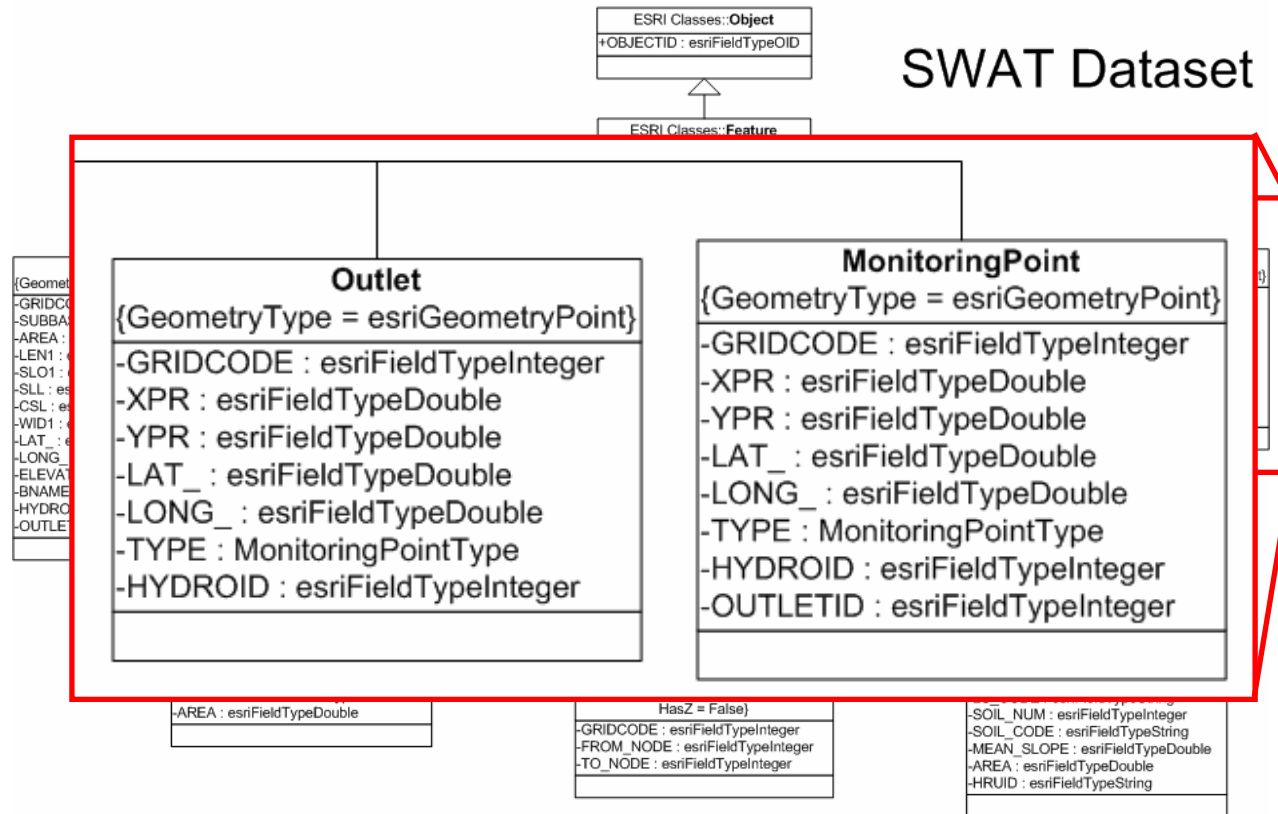
Features Classes



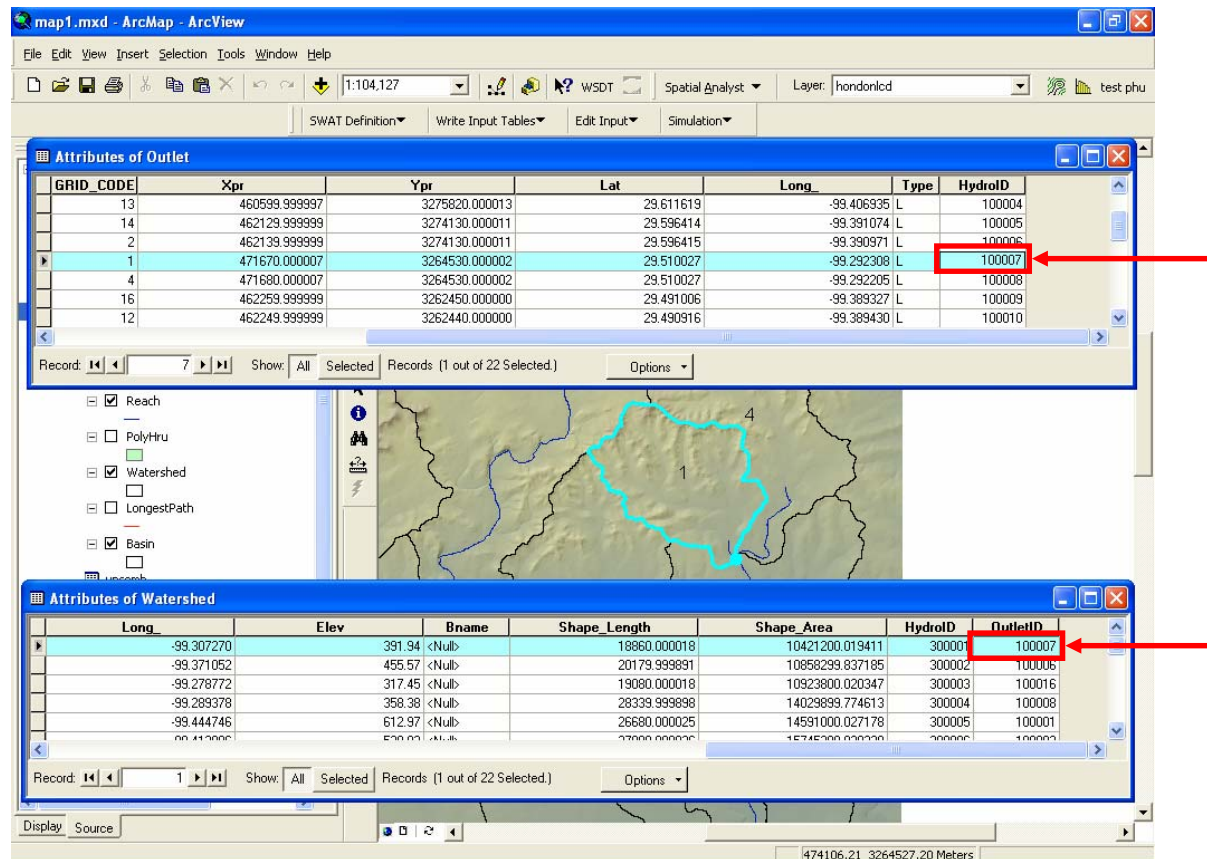
Texas A&M University

ArcGIS SWAT Data Model (Dynamic Geodatabase)

SWAT Dataset



Relationship Classes



The screenshot displays the ArcMap interface with the 'map1.mxd' file open. The 'Attributes of Outlet' table is selected, showing a record with HydrolID 100007. A red arrow points from this record to the 'Attributes of Watershed' table, which shows a record with OutletID 100007. The map in the background shows a watershed boundary.

Attributes of Outlet

GRID_CODE	Xpr	Ypr	Lat	Long	Type	HydrolID
13	460599.999999	3275820.000013	29.611619	-99.406935	L	100004
14	462129.999999	3274130.000011	29.596414	-99.391074	L	100005
2	462139.999999	3274130.000011	29.596415	-99.390971	L	100006
1	471670.000007	3264530.000002	29.510027	-99.292308	L	100007
4	471680.000007	3264530.000002	29.510027	-99.292205	L	100008
16	462259.999999	3262450.000000	29.491006	-99.389327	L	100009
12	462249.999999	3262440.000000	29.490916	-99.389430	L	100010

Attributes of Watershed

Long	Elev	Bname	Shape_Length	Shape_Area	HydrolID	OutletID
-99.307270	391.94	<Null>	19860.000018	10421200.019411	300001	100007
-99.371052	455.57	<Null>	20179.999891	10858299.837185	300002	100006
-99.278772	317.45	<Null>	19080.000018	10923800.020347	300003	100016
-99.289378	358.38	<Null>	28339.999898	14028899.774613	300004	100008
-99.444746	612.97	<Null>	26680.000025	14591000.027178	300005	100001
-99.410006	530.03	<Null>	27000.000000	15745000.000000	300006	100003

- Watershed – Outlet: One-to-one relationship class.

Relationship Classes

map1.mxd - ArcMap - ArcView

File Edit View Insert Selection Tools Window Help

1:104,127 WSDT Spatial Analyst Layer: hondonlrcd test phu

SWAT Definition Write Input Tables Edit Input Simulation

Attributes of Outlet

GRID_CODE	Xpr	Ypr	Lat	Long	Type	HydroID
13	460599.999997	3275820.000013	29.611619	-99.406935	L	100004
14	462129.999999	3274130.000011	29.596414	-99.391074	L	100005
2	462139.999999	3274130.000011	29.596415	-99.390971	L	100006
1	471670.000007	3264530.000002	29.510027	-99.292308	L	100007
4	471680.000007	3264530.000002	29.510027	-99.292205	L	100008
16	462259.999999	3262450.000000	29.491006	-99.389327	L	100009
12	462249.999999	3262440.000000	29.490916	-99.389430	L	100010

Record: 1 7 Show: All Selected Records (1 out of 22 Selected.) Options

☒ Reach
☐ PolyHru
☒ Watershed
☐ LongestPath
☒ Basin

Attributes of Reach

Dep2	MinEI	MaxEI	Shape_Length	HydroID	OutletID
0.872237	389.12	402.57	4030.609669	200007	100021
0.331979	348.74	353.68	553.700641	200008	100007
0.373908	348.74	367.97	3288.624884	200009	100008
1.010164	348.36	389.12	11936.265516	200010	100009
0.627026	348.36	443.52	15584.474095	200011	100010

Record: 1 1 Show: All Selected Records (1 out of 22 Selected.) Options

Display Source

Number of features selected: 2 471268.53 3264664.95 Meters

- Reach – Outlet: One-to-one relationship class.

Soils

- STATSGO soils d

Land Use and Soil Definition

Land Use **Soil Data**

Soils Grid

 c:\SecoSimulation\watershed\Grid\LandSoils1

Choose Grid Field

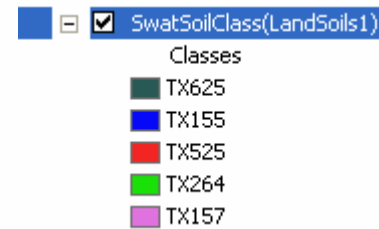
Value

Options

☐ Name ☐ Stmuid+Name ☐ S5id
☒ Stmuid ☐ Stmuid+Seqn

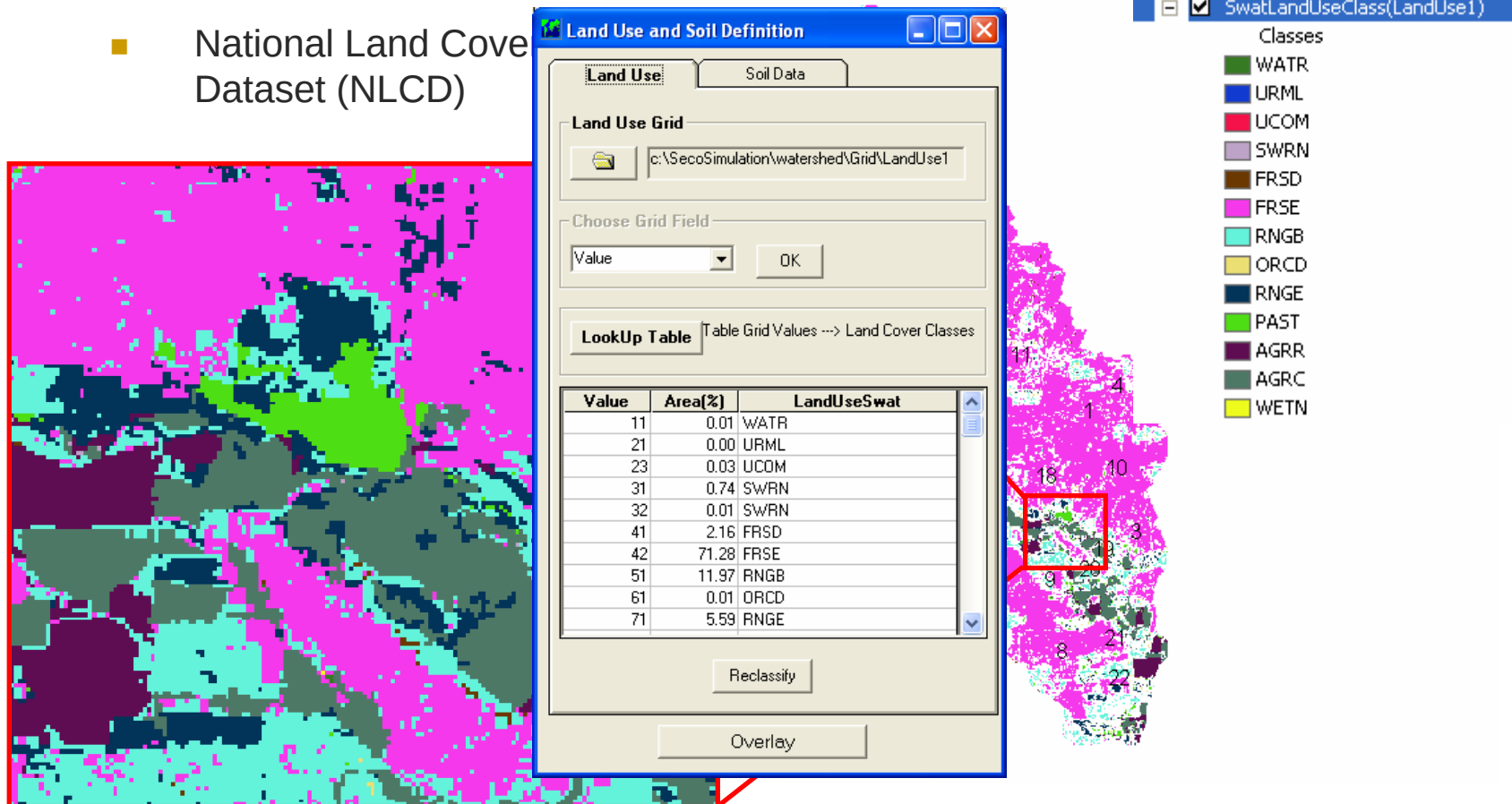
LookUp Table Table Grid Values --> Soils Attributes

Value	Area(%)	Stmuid
1	1.86	48625
2	49.80	48155
3	32.51	48525
4	15.52	48264
5	0.31	48157

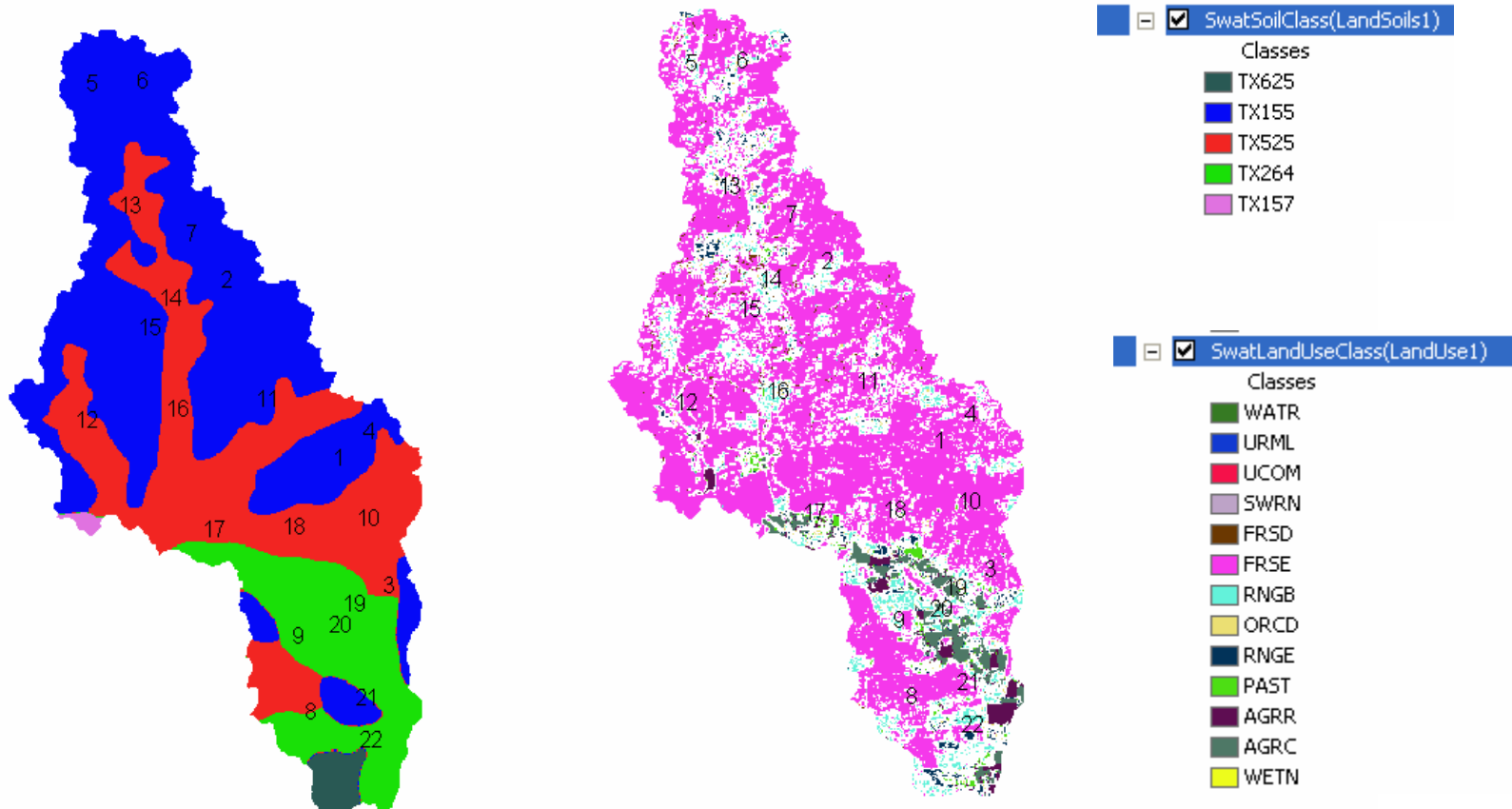


[Land use / land cover]

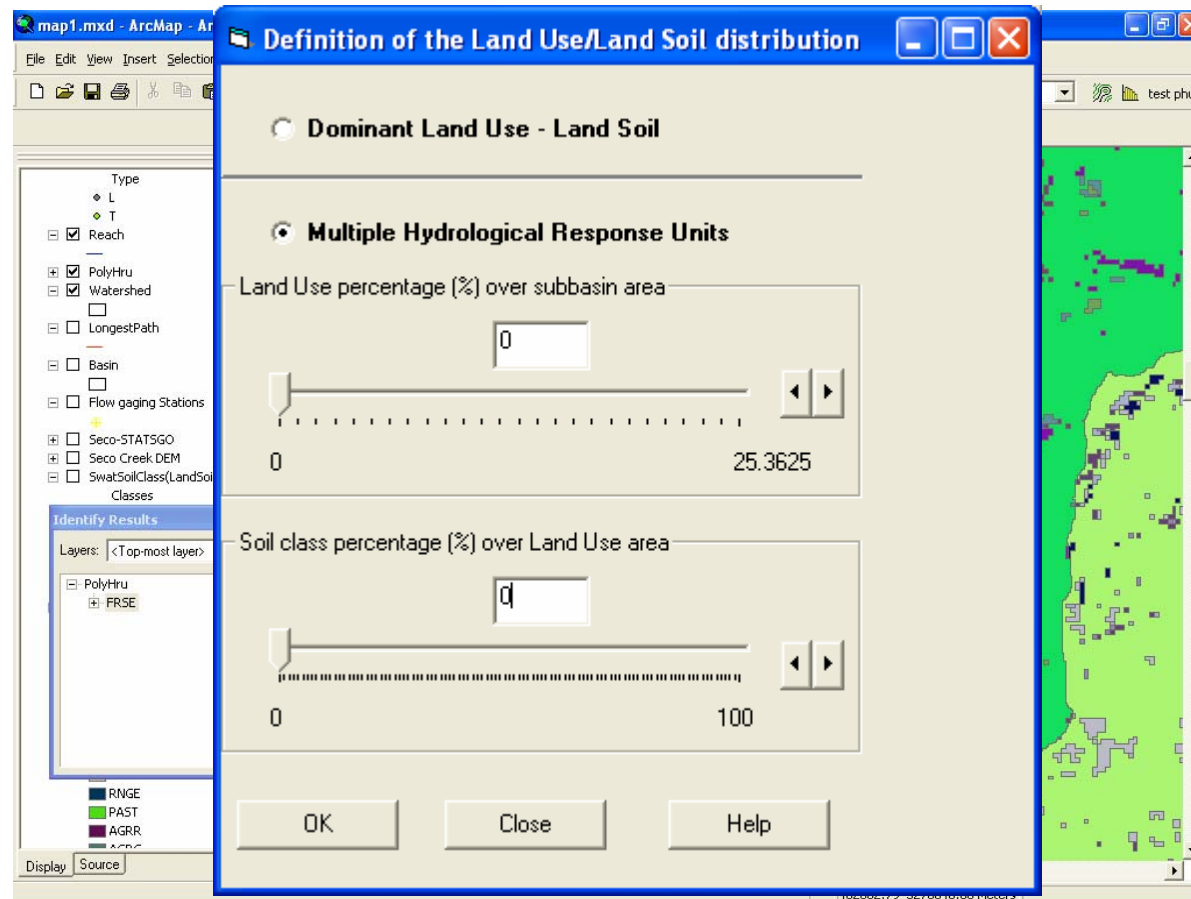
- National Land Cover Dataset (NLCD)



[Soils and Land Use Data]

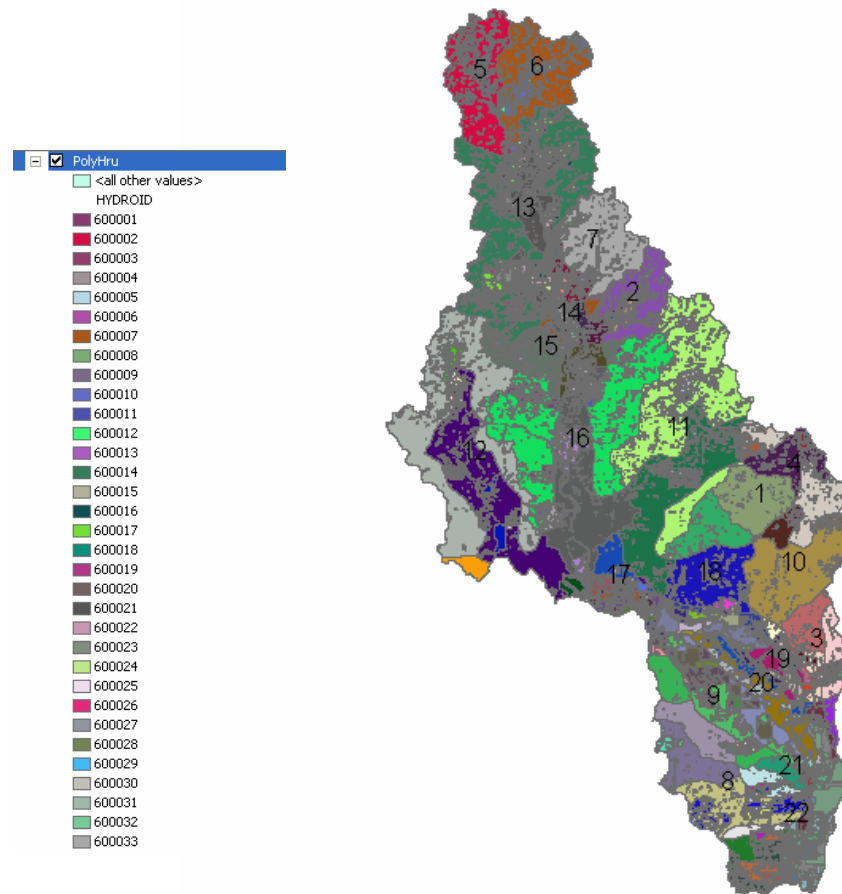


Hydrologic Response Units



- HRU are generated by intersecting watershed, soil and land-use polygons.

[Hydrologic Response Units]



- HRU are generated by intersecting watershed, soil and land-use polygons.

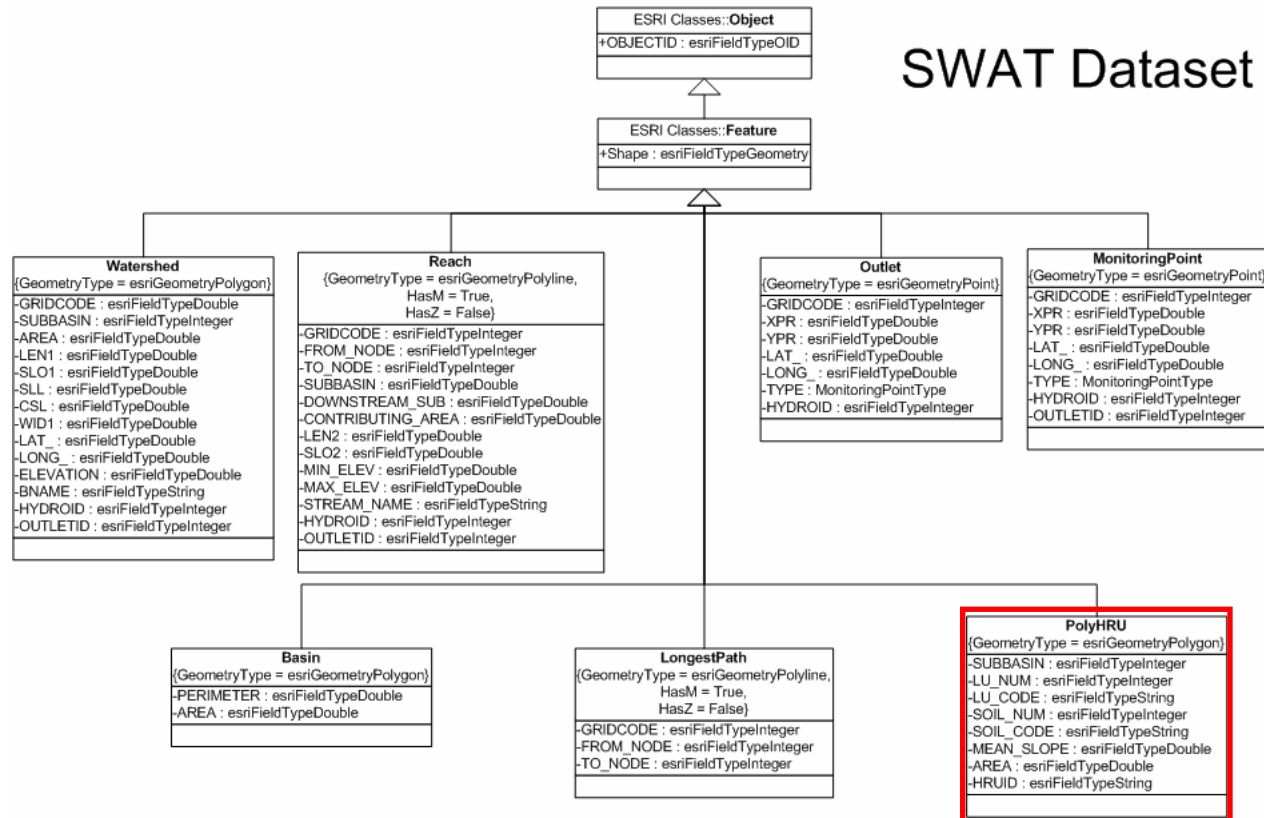
Features Classes



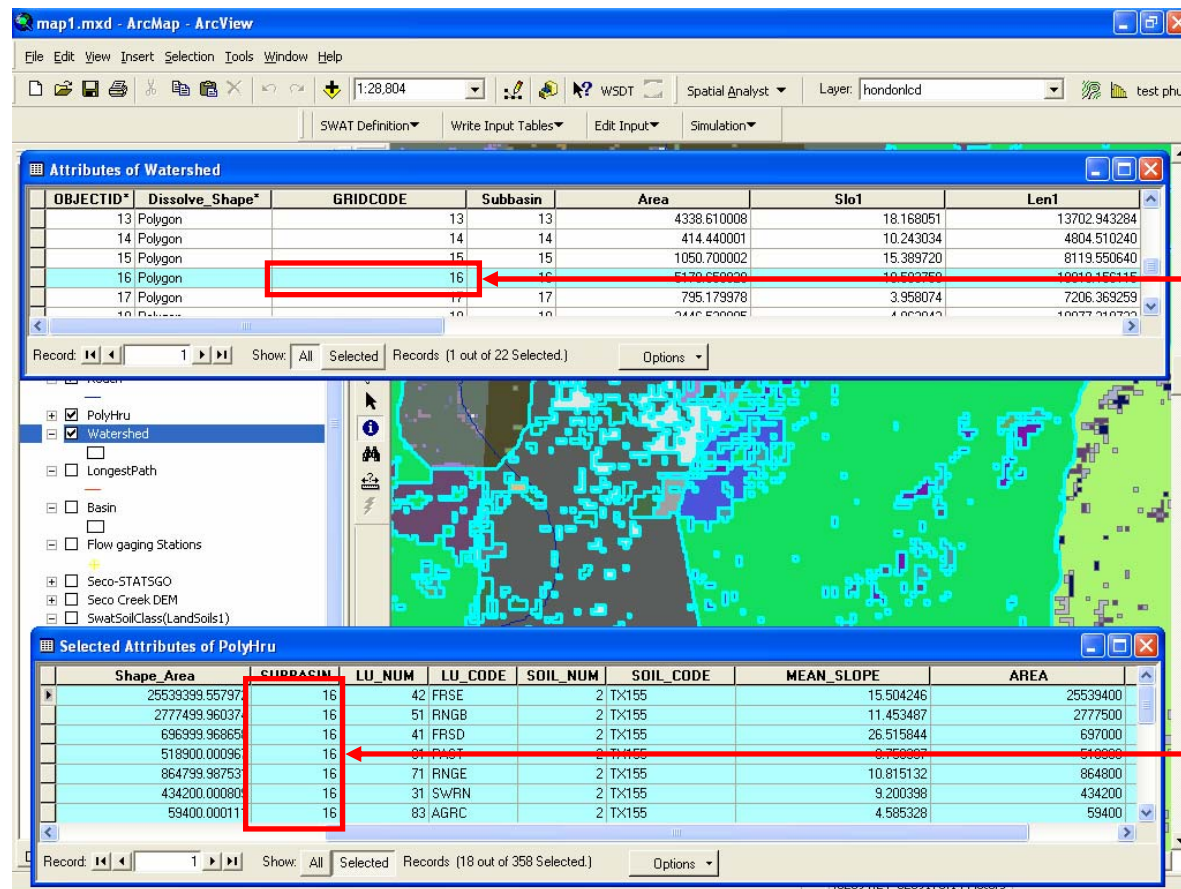
Texas A&M University

ArcGIS SWAT Data Model (Dynamic Geodatabase)

SWAT Dataset

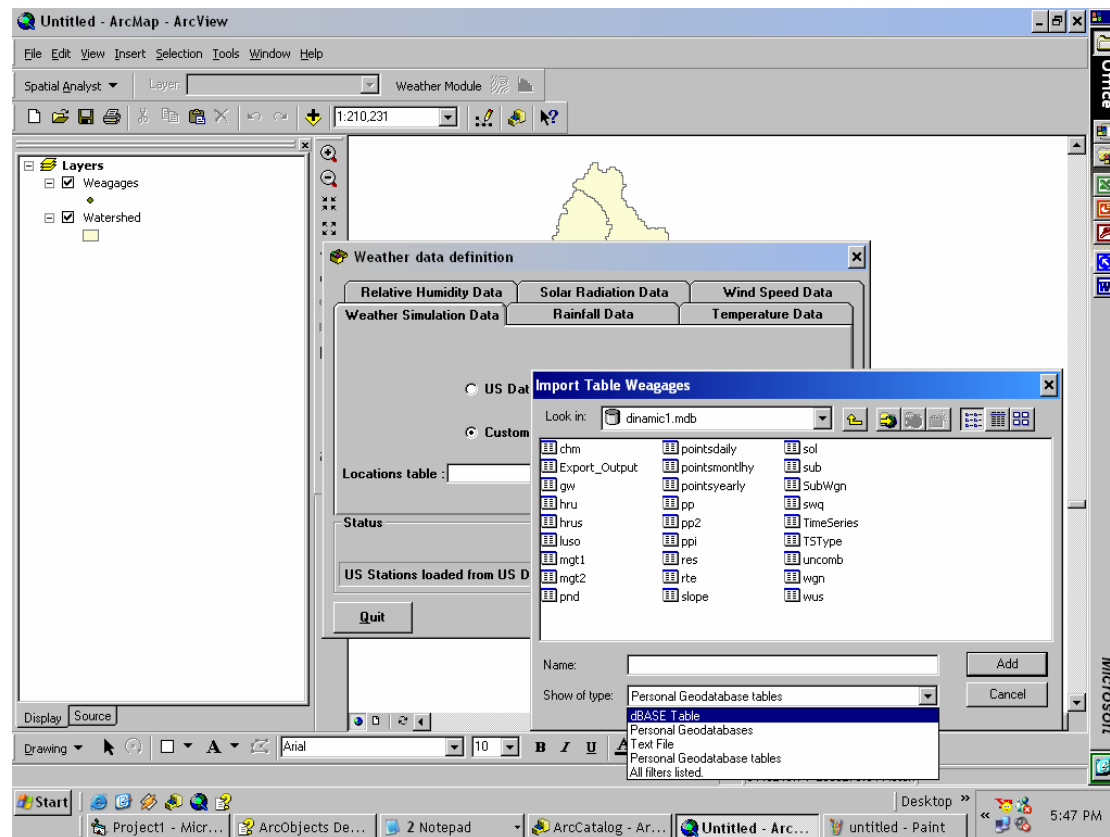


Relationship Classes

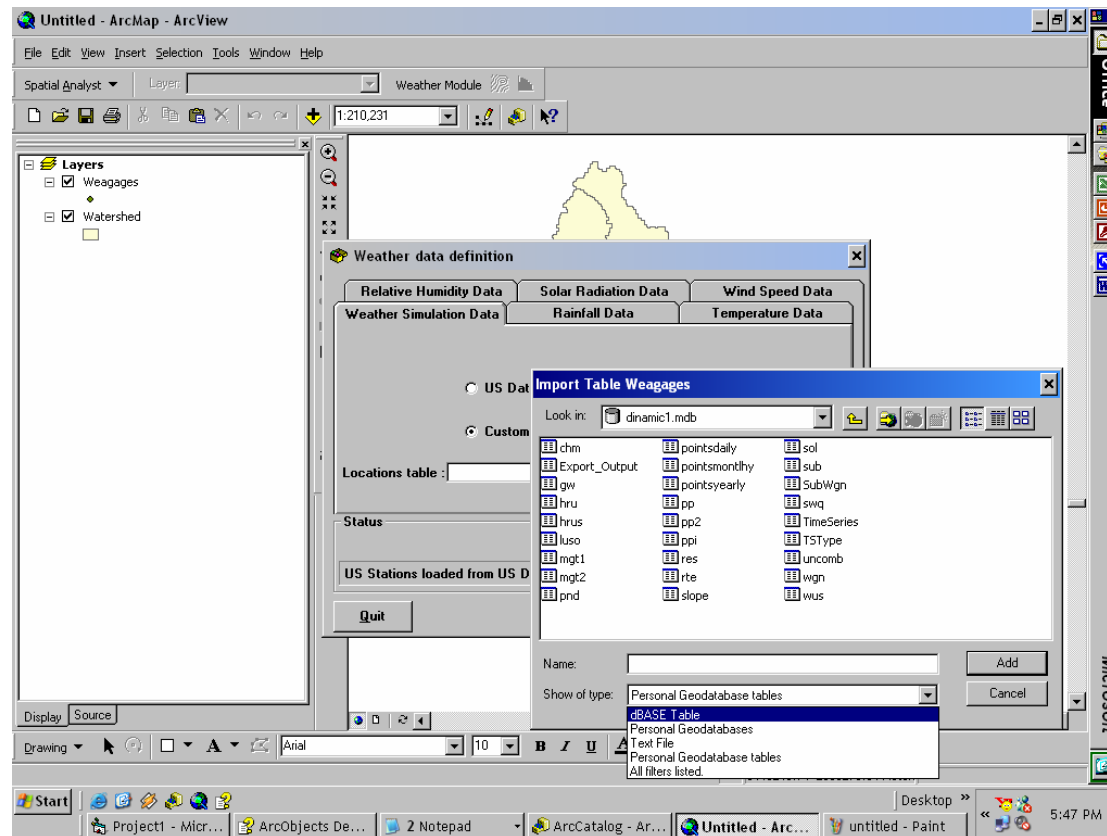


- HRU – Watershed: Many-to-one relationship class.

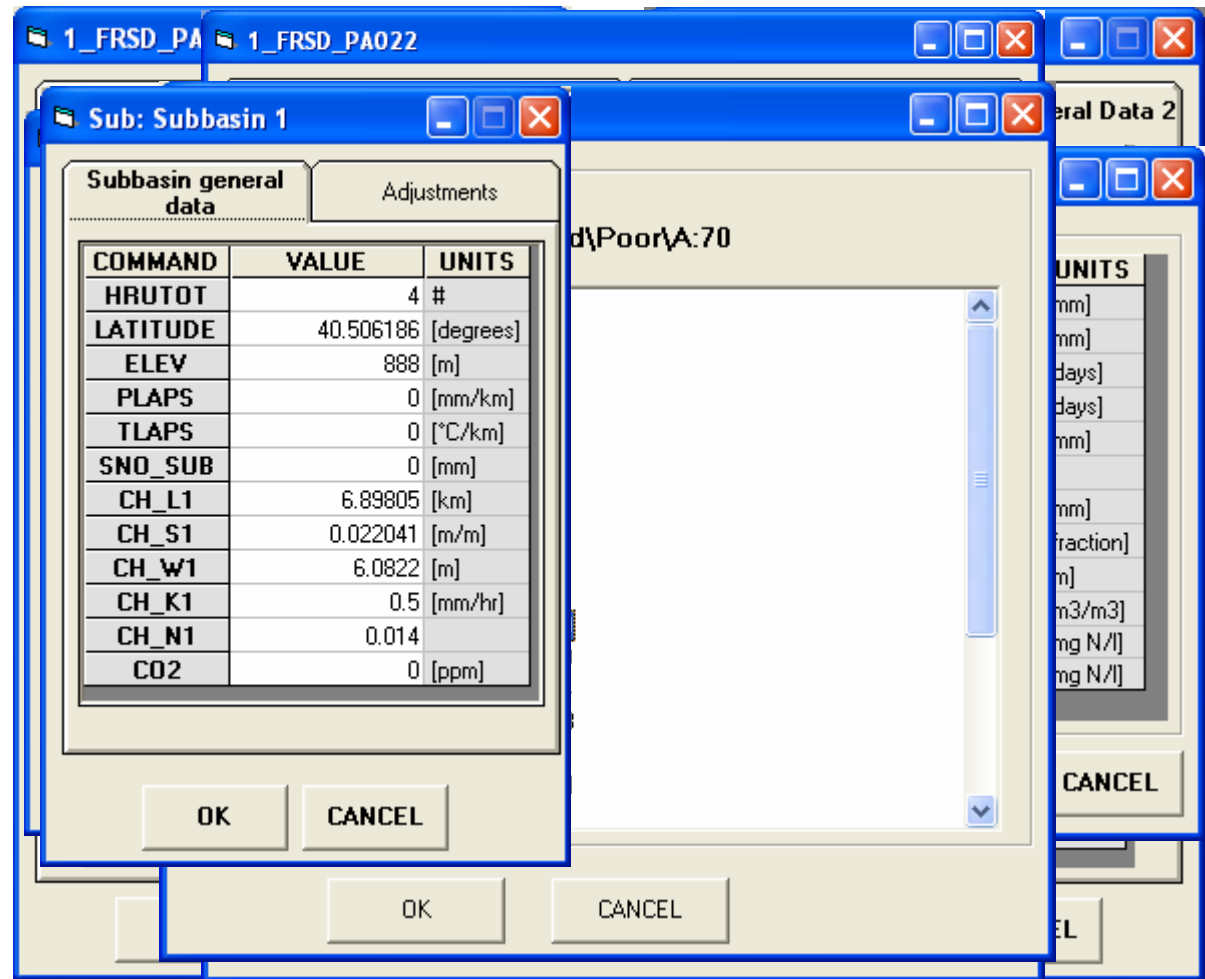
[Weather



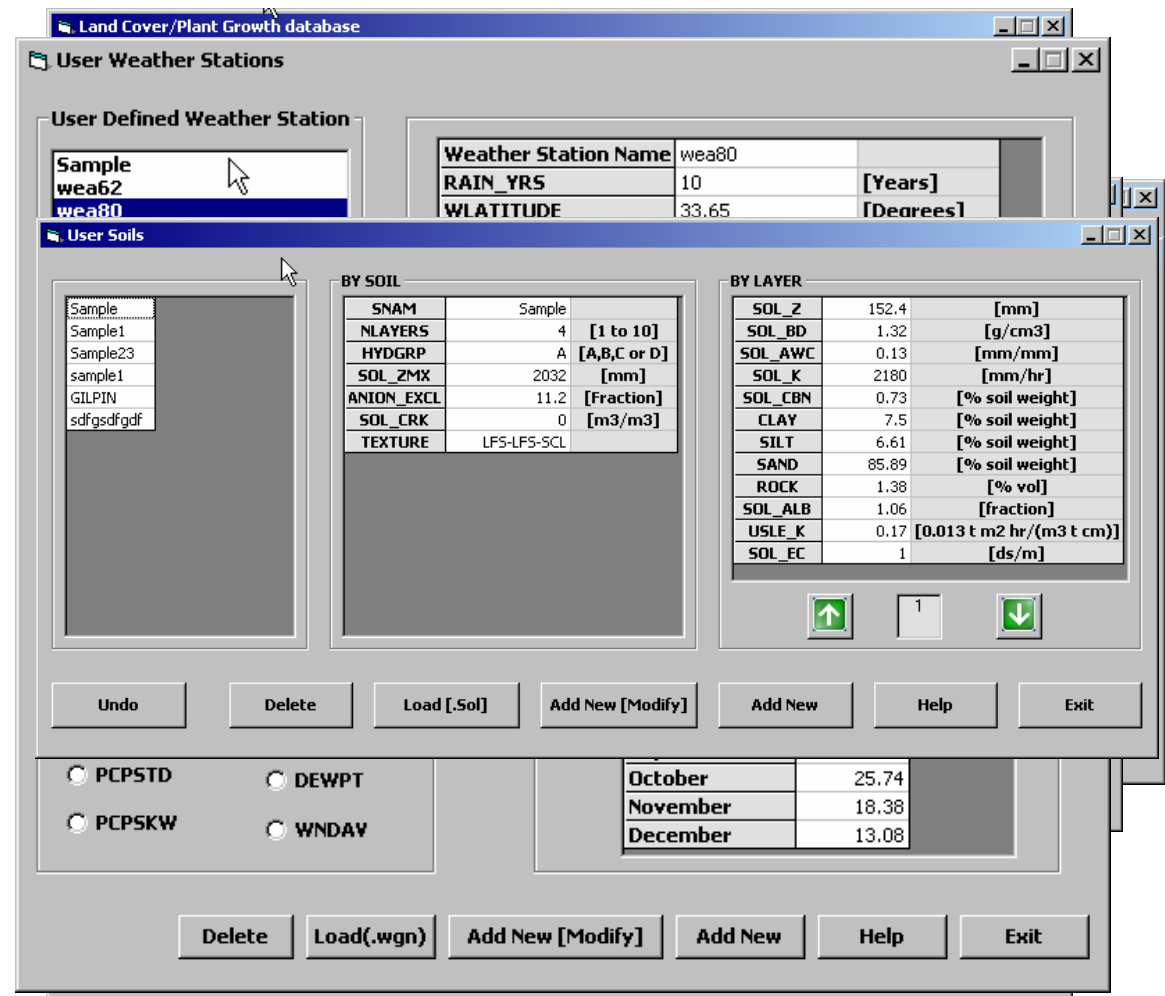
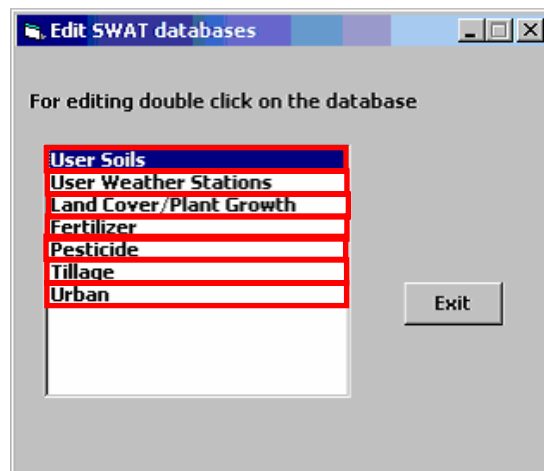
[Weather



[Editing Input Data]

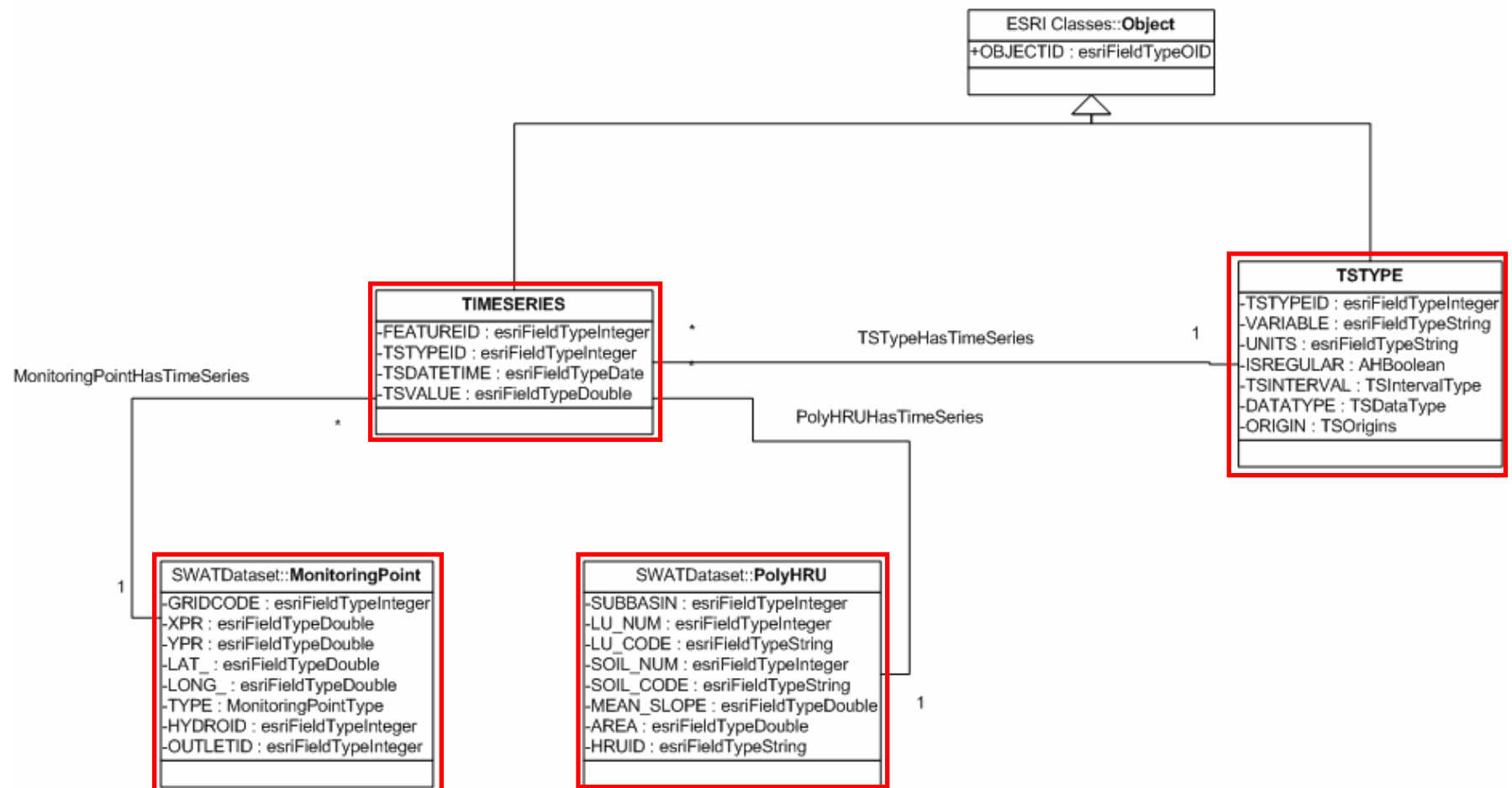


Editing Static Geodatabase





Time Series



Input Files

Parameter Tables (Input Files)

MG

```
-SUBBASIN : esriFieldTypeDouble
-HRU : esriFieldTypeDouble
-LANDUSE : esriFieldTypeString
-SOIL : esriFieldTypeString
-IGRO : esriFieldTypeSmallInteger
-NROT : esriFieldTypeSmallInteger
-NMGT : esriFieldTypeSmallInteger
-NCRP : esriFieldTypeSmallInteger
-ALAI : esriFieldTypeSingle
-BIO_MS : esriFieldTypeSingle
-PHU : esriFieldTypeSingle
-BIO_MIN : esriFieldTypeSingle
-BIOMIX : esriFieldTypeSingle
-CN2 : esriFieldTypeSingle
-USLE_P : esriFieldTypeSingle
-HUSC : esriFieldTypeSmallInteger
-ISCROP : esriFieldTypeSmallInteger
-STREC2 : esriFieldTypeSingle
-ENDREC2 : esriFieldTypeSingle
-HRUID : esriFieldTypeString
```




ArcGIS SW

Output files

BSS
-SUBBASIN : esriFieldTypeInteger
-DATE : esriFieldTypeDate
-PRECIP : esriFieldTypeDouble
-SNOMELT : esriFieldTypeDouble
-PET : esriFieldTypeDouble
-ET : esriFieldTypeDouble
-SW : esriFieldTypeDouble
-PERC : esriFieldTypeDouble
-SURQ : esriFieldTypeDouble
-GW_Q : esriFieldTypeDouble
-WYLD : esriFieldTypeDouble
-SYLD : esriFieldTypeDouble
-ORGN : esriFieldTypeDouble
-NSURQ : esriFieldTypeDouble
-SOLP : esriFieldTypeDouble
-SEDP : esriFieldTypeDouble

RCH
-SUBBASIN : esriFieldTypeInteger
-DATE : esriFieldTypeDate
-FLOW_IN : esriFieldTypeDouble
-FLOW_OUT : esriFieldTypeDouble
-EVAP : esriFieldTypeDouble
-TLOSS : esriFieldTypeDouble
-SED_IN : esriFieldTypeDouble
-SED_OUT : esriFieldTypeDouble
-SEDCONC : esriFieldTypeDouble
-ORGN_IN : esriFieldTypeDouble
-ORGN_OUT : esriFieldTypeDouble
-ORGP_IN : esriFieldTypeDouble
-ORGP_OUT : esriFieldTypeDouble
-NO3_IN : esriFieldTypeDouble
-NO3_OUT : esriFieldTypeDouble
-NH4_IN : esriFieldTypeDouble
-NH4_OUT : esriFieldTypeDouble
-NO2_IN : esriFieldTypeDouble
-NO2_OUT : esriFieldTypeDouble
-MINP_IN : esriFieldTypeDouble
-MINP_OUT : esriFieldTypeDouble
-CHLA_IN : esriFieldTypeDouble
-CHLA_OUT : esriFieldTypeDouble
-CBOD_IN : esriFieldTypeDouble
-CBOD_OUT : esriFieldTypeDouble
-DISOX_IN : esriFieldTypeDouble
-DISOX_OUT : esriFieldTypeDouble
-SOLPST_IN : esriFieldTypeDouble
-SOLPST_OUT : esriFieldTypeDouble
-SORPST_IN : esriFieldTypeDouble
-SORPST_OUT : esriFieldTypeDouble
-REACTPST : esriFieldTypeDouble
-VOLPST : esriFieldTypeDouble
-SETTLPST : esriFieldTypeDouble
-RESUSP_PST : esriFieldTypeDouble
-DIFFUSEPST : esriFieldTypeDouble
-REACBEDPST : esriFieldTypeDouble
-BURYPST : esriFieldTypeDouble
-BED_PST : esriFieldTypeDouble
-BACTP_OUT : esriFieldTypeDouble
-BACTLP_OUT : esriFieldTypeDouble
-XTR : esriFieldTypeDouble
-Y : esriFieldTypeDouble
-Z : esriFieldTypeDouble

RCH
-SUBBASIN : esriFieldTypeInteger
-DATE : esriFieldTypeDate
-FLOW_IN : esriFieldTypeDouble
-FLOW_OUT : esriFieldTypeDouble
-EVAP : esriFieldTypeDouble
-TLOSS : esriFieldTypeDouble
-SED_IN : esriFieldTypeDouble
-SED_OUT : esriFieldTypeDouble
-SEDCONC : esriFieldTypeDouble
-ORGN_IN : esriFieldTypeDouble
-ORGN_OUT : esriFieldTypeDouble
-ORGP_IN : esriFieldTypeDouble
-ORGP_OUT : esriFieldTypeDouble
-NO3_IN : esriFieldTypeDouble
-NO3_OUT : esriFieldTypeDouble
-NH4_IN : esriFieldTypeDouble
-NH4_OUT : esriFieldTypeDouble
-NO2_IN : esriFieldTypeDouble
-NO2_OUT : esriFieldTypeDouble
-MINP_IN : esriFieldTypeDouble
-MINP_OUT : esriFieldTypeDouble
-CHLA_IN : esriFieldTypeDouble
-CHLA_OUT : esriFieldTypeDouble
-CBOD_IN : esriFieldTypeDouble
-CBOD_OUT : esriFieldTypeDouble
-DISOX_IN : esriFieldTypeDouble
-DISOX_OUT : esriFieldTypeDouble
-SOLPST_IN : esriFieldTypeDouble
-SOLPST_OUT : esriFieldTypeDouble
-SORPST_IN : esriFieldTypeDouble
-SORPST_OUT : esriFieldTypeDouble
-REACTPST : esriFieldTypeDouble
-VOLPST : esriFieldTypeDouble
-SETTLPST : esriFieldTypeDouble
-RESUSP_PST : esriFieldTypeDouble
-DIFFUSEPST : esriFieldTypeDouble
-REACBEDPST : esriFieldTypeDouble
-BURYPST : esriFieldTypeDouble
-BED_PST : esriFieldTypeDouble
-BACTP_OUT : esriFieldTypeDouble
-BACTLP_OUT : esriFieldTypeDouble
-XTR : esriFieldTypeDouble
-Y : esriFieldTypeDouble
-Z : esriFieldTypeDouble

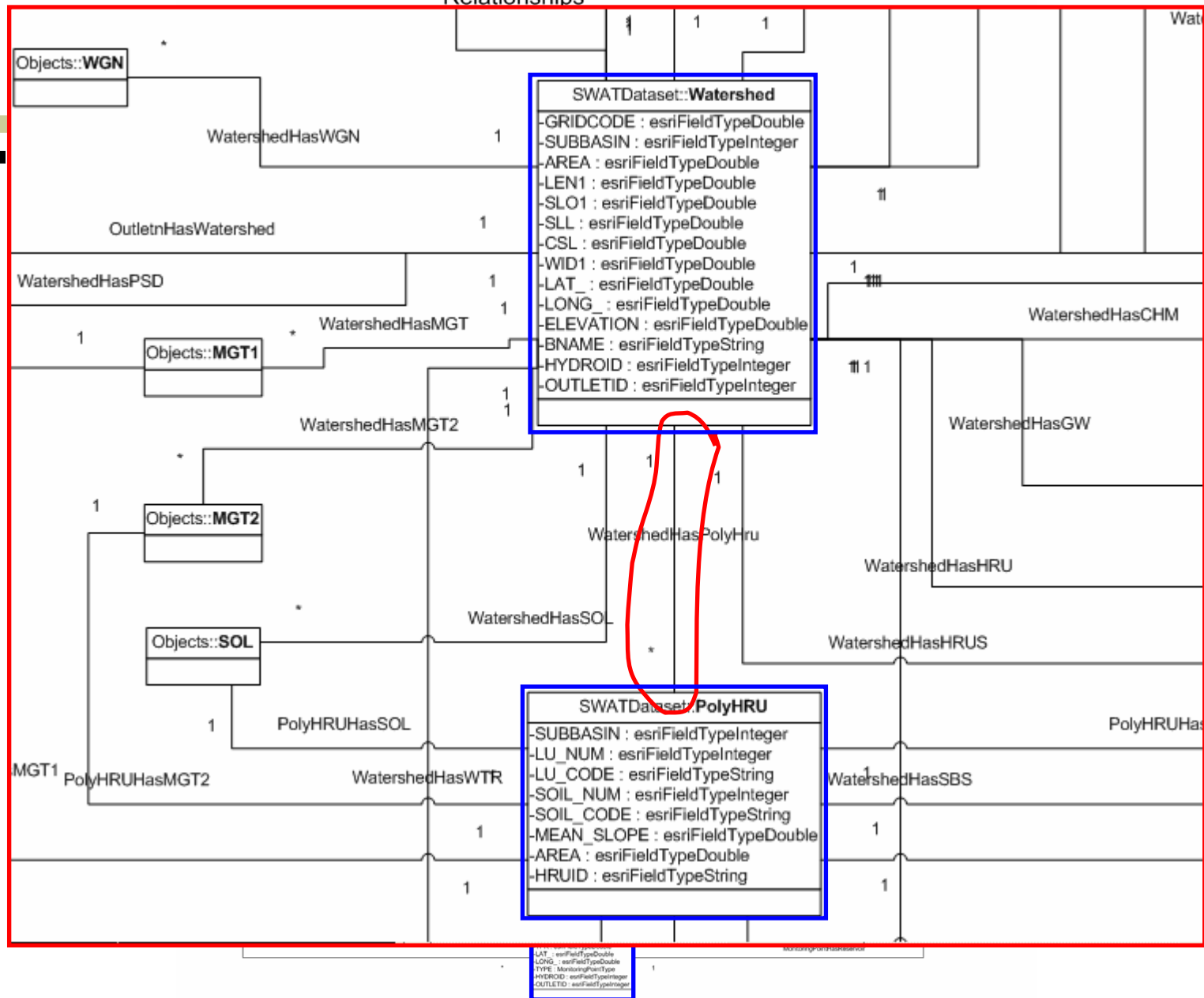
ty
c Geodatabase)

S
-SUBBASIN : esriFieldTypeInteger
-DATE : esriFieldTypeDate
-PRECIP : esriFieldTypeDouble
-SNOMELT : esriFieldTypeDouble
-PET : esriFieldTypeDouble
-ET : esriFieldTypeDouble
-SW : esriFieldTypeDouble
-PERC : esriFieldTypeDouble
-SURQ : esriFieldTypeDouble
-GW_Q : esriFieldTypeDouble
-WYLD : esriFieldTypeDouble
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-ORGN : esriFieldTypeDouble
-NSURQ : esriFieldTypeDouble
-SOLP : esriFieldTypeDouble
-SEDP : esriFieldTypeDouble

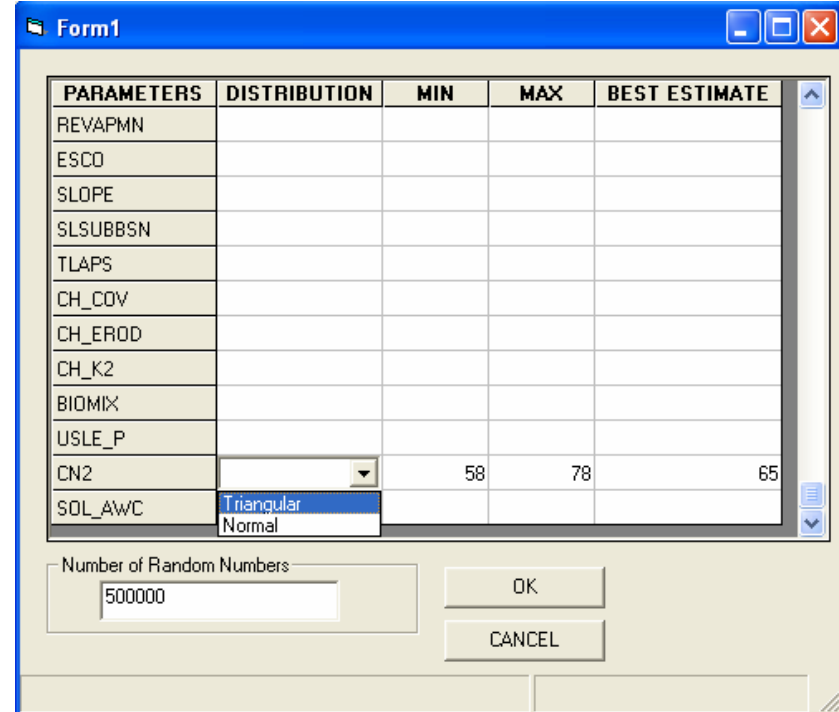
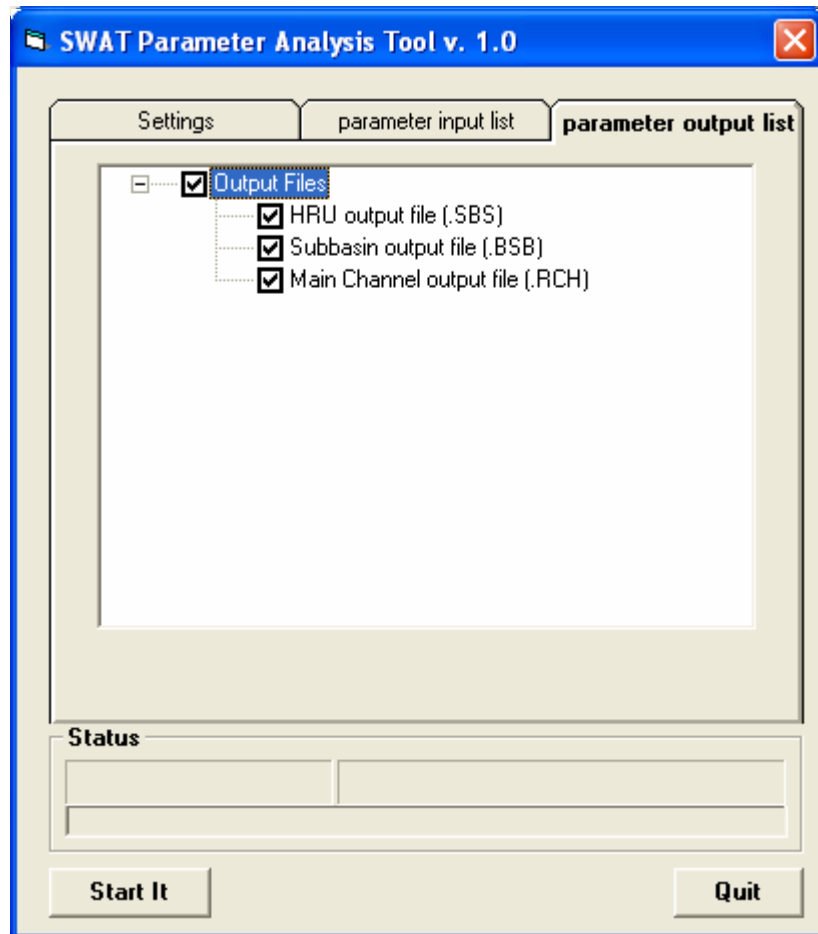
WTR
-LULC : esriFieldTypeString
-HRU : esriFieldTypeInteger
-SUBBASIN : esriFieldTypeInteger
-MGT : esriFieldTypeInteger
-DATE : esriFieldTypeDate
-AREA : esriFieldTypeDouble
-PNDPCP : esriFieldTypeDouble
-PND_IN : esriFieldTypeDouble
-PSED_I : esriFieldTypeDouble
-PNDVDP : esriFieldTypeDouble
-PNDSEP : esriFieldTypeDouble
-PND_OUT : esriFieldTypeDouble
-PSED_O : esriFieldTypeDouble
-PNDVOL : esriFieldTypeDouble
-PNDORGN : esriFieldTypeDouble
-PNDNO3 : esriFieldTypeDouble
-PNDORGP : esriFieldTypeDouble
-PNDMINP : esriFieldTypeDouble
-PNDCHLA : esriFieldTypeDouble
-PNDSECI : esriFieldTypeDouble
-WETPCP : esriFieldTypeDouble
-WET_IN : esriFieldTypeDouble
-WSED_I : esriFieldTypeDouble
-WETVDP : esriFieldTypeDouble
-WETSEP : esriFieldTypeDouble
-WET_OUT : esriFieldTypeDouble
-WSED_O : esriFieldTypeDouble
-WET_VOL : esriFieldTypeDouble
-WET_ORGN : esriFieldTypeDouble
-WET_NO3 : esriFieldTypeDouble
-WETORGP : esriFieldTypeDouble
-WETMINP : esriFieldTypeDouble
-WETCHLA : esriFieldTypeDouble
-WETSECI : esriFieldTypeDouble
-POTPCP : esriFieldTypeDouble
-POT_IN : esriFieldTypeDouble
-OSED_I : esriFieldTypeDouble
-POTVDP : esriFieldTypeDouble
-POTSEP : esriFieldTypeDouble
-POT_OUT : esriFieldTypeDouble
-OSED_O : esriFieldTypeDouble
-POTVOL : esriFieldTypeDouble
-POT_SA : esriFieldTypeDouble
-HRU_SURQ : esriFieldTypeDouble
-PLANT_ET : esriFieldTypeDouble
-SOIL_ET : esriFieldTypeDouble
-HRUID : esriFieldTypeString



Relationships



Monte Carlo Simulator



[Conclusions]

- A new **SWAT** interface for **ArcView 8.x** has been developed.
- Development of an ArcView 8.x interface for SWAT requires to develop an **application-specific geodatabase** not to build **geometric networks** or create/edit **relationship classes**.
- The **hub** for data-sharing should be time series at points and not the entire spatial representation of the hydrologic features.
- **XML** applicability to read geodatabases and write XML files will be studied.