

DHSVM SET-UP DOCUMENT FOR REFERENCE

I am using ArcGIS 9 on a PC which includes ArcMap and ArcInfo. I also use my Sun workstation to compile java and C codes (and run C codes).

PURPOSE: EXPLAIN AND DETAIL SET-UP OF DHSVM INPUT GRIDS

The purpose of this document is to briefly explain the procedure for generating the input Grids to DHSVM. This procedure is specific to the Lake Whatcom Watershed, in Whatcom County, Washington. If this document is used for a different watershed it would need to be altered accordingly, i.e. names of DEMs, etc. It is very helpful to use ArcDoc for information about Arc commands.

Most of these steps were coached by Matt Wiley at UW.

From: <matthew@wiley.net>
To: "Robert Mitchell" <robert.mitchell@geol.wvu.edu>
Subject: creating dhsvm models...
Date: Wed, 10 Nov 2004 14:21:07 -0800

Bob,

Hi, this is Matt Wiley, I'm a research engineer in the CE department at UW. It is not well documented, actually not documented at all I'm afraid, but if you are looking for dhsvm input maps for Washington, I have a set of ESRI grid files at 150m, including a filled DEM, GAP1991 landcover, STATSGO soils, and the Monthly PRISM precipitation maps from OSU. All can be found at http://www.tag.washington.edu/data/dhsvm_data/WA_DHSVM_grids.zip

I am in the process of updating the landcover using a NOAA product from 2000/2001. <http://www.csc.noaa.gov/crs/lca/westcoast.html>

Good luck with the stream network. I assume you have the createstreamnetwork aml script? My only tip is to notice that there is a java executable that is invoked in the middle of the script (AddAat2) that must run properly or else you get a bunch of zeros in your output files.

Matt

1. CREATE A WATERSHED MASK AND DEM GRID

1. Using "My Computer" setup a "workspace" for the Arc and Grid work. For example, I created one in my C Drive (C:/DHSVM/Whatcom/DEM).
2. Download the required 10m-DEMs from UW's web site to the DEM workspace folder

<http://duff.geology.washington.edu/data/raster/tenmeter/>

The projection of the DEMs are UTM, Zone 10, datum NAD 27, and units in meters. All the final Grids will be in this projection.

3. From Start button go to ArcGIS then Arc Workstation and open up Arc and ArcDoc (ArcDOC is the Help window).

4. At the Arc: prompt type *&workspace C:/DHSV/Whatcom/DEM* to get to the workspace. At the Arc prompt type *workspace*, Arc will list the workspace you are in.

Then assign workspace, i.e. *:workspace setup*), and watch file. The watch file is converted to an AML after the process is done and the AML is named and cleaned up for smooth running.

- a) Create a watch file: *'&watch may10.watch'*. (&watch = command, space, then name)
- b) I typically name a watch file the date I create it or the specific action I am working on, such as *dem.watch* or *soils.watch*.

5. In Arc, load the **Grid** by typing GRID at the Arc prompt

Arc: Grid

6. Convert all the DEMs to Grid files using the DEMGRID command, for example

Grid: alger_grd = DEMGRID(alger.dem)

7. Merge all the Grids necessary to cover the watershed into one Grid using the MERGE command.

Grid: merge_grd = MERGE(acme_grd, ..., sedro_grd)

8. Aggregate the 10 meter Grid to 30 meter Grid. This is done to reduce run time of model and lack of detailed vegetation and soil data. If better coverages can be created to detail vegetation and soil coverages, the 10 meter DEMs maybe a better choice in the model.

GRID: 30m_grd = AGGREGATE(clip_grd, 3, MIN)

The '3' indicated the level of aggregation and 'MIN' takes the minimum elevation of the 3 Grids. When the mean was used, a number of Grids were assigned as 'No Data' and when the maximum was used, the watershed became extremely rugged.

9. Describe the new Grid to verify that 'aggregate' worked correctly

Grid: DESCRIBE 30m_grd

10. Fill any sinks in the Grid using the 'Fill' command.

Grid: FILL 30m_grd fill30_grd sink 1000.0

11. Perform flow direction on the filled Grid. This Grid will be used to determine the watershed boundary.

Grid: flowdir = FLOWDIRECTION(fill30_grd)

12. Create watershed area Grid by first opening the DISPLAY window.

Grid: DISPLAY 9999

Establish the spatial extent of the view of the image in DISPLAY

Grid: mapextent fill30_grd

Display the Grid file in the display

Grid: Gridshade fill30_grd

You are going to establish the lowest elevation of the watershed interactively after you initiate the WATERHSED command, so create a blow-up of the outlet area of the watershed by using the Create View command on the Display window. After you box in the blow-up area a new display

window will pop up. Expand the size of the window, then change the mapextent for that window by typing

Grid: mapextent fill30_grd

Display the blown-up area by typing

Grid: Gridshade fill30_grd

13. Now try to create the watershed area by using

Grid: lw_grd = WATERSHED(flowdir,selectpoint(fill30_grd,))*

The Selectpoint* command puts you in manual mode. With the mouse cursor select the outlet elevation point of the watershed on the blown-up map—after clicking with the cursor on the low elevation point of the outlet, type “9” on the keyboard to exit the manual mode.

Display the newly created watershed to ensure it worked—you may have to go through this process a number of times to make sure that it creates the watershed Grid.

Grid: Gridshade lw_grd

14. Use lakews_grd for a “mask” to clip the DEM, Vegetation, and soils coverages. First clip the filled elevation Grid to polygon coverage using the mask (a two-step process). **This will be the DEM input Grid to DHSVM.**

Grid: SETMASK lw_grd

Grid: lwdem = fill30_grd

15. *Optional:* Create a hillshade (shaded relief) coverage map for maps in document.

Grid: hillshd_grd = HILLSHADE(lwdem)

16. Quit the Grid function and convert the watch file to an AML file using the &CWTA command.

Grid: q

Arc: &CWTA may10.watch finaldem.aml

17. Clean up the workspace by deleting unneeded Grids (see AML for complete list).

2. CREATE A LAND COVER GRID

Katie used the USGS National Land Cover Data (1991) and I used C-CAP 2001 data from NOAA (go to step to step 9 for the NOAA data). The raster data file is called wa_wa2000.img

1. USGS National Land Cover Data image was used for the vegetation Grid for DHSVM. Pascal Storck recommended GAP Analysis but too many misclassifications were found in that vegetation coverage.
2. This coverage is downloaded from the site at <http://landcover.usgs.gov/ftpdownload.asp> This is a classified image based on the 30-meter Landsat thematic mapper data for Washington State.
3. Download the following files

washington_nclد_bin.gz

washington_readme.txt

flat2Grid.txt

4. Unzip the *.gz file. It will expand to a *.bin. Rename the .bin extension to *.bil. Arc will recognize the bil extension, not the bin.
5. The flat2Grid.txt is a text file that explains how to convert the *.bil file to a Grid.
6. The flat2Grid.txt file will tell you to create a *.hdr file. The constructed .hdr file looks like this for Washington state and has the exact name as the .bil file (Washington_NCLD_flat_032200.hdr)

```

BYTEORDER M
LAYOUT BIL
NROWS 14795
NCOLS 19975
NBANDS 1
NBITS 8
SKIPBYTES 0
ULXMAP -2144460
ULYMAP 3177720
XDIM 30
YDIM 30

```

7. Next use Arc/Info used to create a Grid from the image

Arc: IMAGEGRID washington_NLCD_flat_032200.bil wa_lc

8. The next step is to define the projection as noted in the text file. This is an Arc command. The list of inputs for the projection is in the aml file.

Arc: projectdefine grid wa_lc

- a) 'Project: projection albers equal area'
- b) 'Project: datum NAD 83'
- c) 'Project: Spheroid GRS80'
- d) 'Project: units meters'
- e) 'Project: parameters'
- f) 'First parallel: 29 30 0.00'
- g) 'Second parallel 45 30 0.00'
- h) 'Central Meridian -96 0 0.00'
- i) 'Latitude of origin 23 0 0.00'
- j) 'False Easting 0'
- k) 'False Northing 0'

9. There is a 2001 coverage I downloaded from a NOAA site.
<http://www.csc.noaa.gov/crs/lca/westcoast.html>

Download the Washington 2001 Coverage. It is already a grid file, so you don't have to go through Steps 4-9. It has the same PCS and GCS as the USGS landcover, which is different than the lw_grd, so you have to transform the projection (of either one) using steps 10 and 11 below.

10. Open Arc Map in bring in the wa_lc grid. Clip the grid into a smaller grid encompassing the watershed using the Spatial Analyst tool. First, zoom in on the watershed area in the ArcMap display window.

Click on the View Icon
Toolbar

Spatial Analyst

Use the pull-down menu on the Spatial Analyst window and click on Options then Extent and then “Same as Display” then OK.

Use the pull-down menu on the Spatial Analyst window and click on Raster Calculator. In the window type `newfilename = [oldfilename]` then OK. For example `wa_clip = [wa_lc]`.

11. Now you must transform the coordinate system of the clipped landcover grid to that of the lake whatcom grid (`lw_grd`).

Open up a new Arc Map and drag the `lw_grd` into it. Now drag the clipped landcover map into the window (`wa_clip`). It is important that you bring the `lw_grd` in first. Right click on the Layers icon in the Table of Contents. Click on Properties, Coordinate System, then Transformations (follow the steps). Hit OK. Then open up the Tool Box and step through

- Data Management
- Projections and Transformation
- Raster
 - Project Raster
- Input Raster is `wa_clip`
- Output Raster is `wa_noaa_trans`
- Choose the coordinate system of the `lw_grd`
- Choose Neighbor
- Output Cell size is 30

Before you hit OK, click on Environments and General Settings. Scroll down and put in `lw_grd` for the Output Extent. In Environments, now click on Raster Analysis Settings and put in `lw_grd` as the cell size. Hit OK and OK. The coordinate system should be transformed. I called it `wa_noaa_trans`.

12. Finally, the land cover Grid needs to be clipped to the study area using the `lw_grd` rid. This was done in the Grid module in Arc.

- Grid: SETMASK lw_grd*
- Grid: lw_lc = wa_noaa_trans*

13. The Grid was verified in ArcMap, to make sure the grids overlaid perfectly.

14. Change the classification table using the Reclass tool in the Spatial Analyst dropdown in Arc Map.

NOAA	NOAA	DHSVM	DHSVM
2	High Intensity Developed	13	Urban
3	Low Intensity Developed	13	Urban
5	Grassland	10	Grassland
6	Deciduous Forest	4	Deciduous Broadleaf
7	Evergreen Forest	15	Coastal Conifer
8	Mixed Forest	5	Mixed Forest
9	Scrub/Shrub	8	Closed Shrub
10	Palustrine Forested Wetland	4	Deciduous Broadleaf
11	Palustrine Scrub/Shrub Wetland	8	Closed Shrub
12	Palustrine Emergent Wetland	10	Grassland
16	Unconsolidated Shore	12	Bare
17	Bare land	12	Bare
18	Water	14	Water

3. CREATE A SOIL TEXTURE GRID

Katie used the CONUS soil data base developed from STATSGO

http://www.essc.psu.edu/soil_info/index.cgi?soil_data&conus&data_cov&texture

It is under the heading "Datasets" and then you select the projection, the first one is fine, then it can be reprojected into UTM or whatever projection you are using. The documentation under 'data files' is a good thing to read over too. You have to download multiple files.

1. Downloaded the CONUS dominant texture Grid at
2. Used IMPORT in Arc to import the grid
3. Changed the projection to UTM (see previous two sections)
4. Clipped Grid to area (see previous two sections) called dom_grd

I used soil data given to me by the DHSVM group (Matt Wiley) called **wasoil_150**. The values in the grid are related to the soil class library that is a part of the dhsvm configuration files. The attribute values are based on the average soil texture for the multiple layers in the statsgo database. Sections of the file I sent have been replaced using higher resolution data from the WA DNR soil surveys. These areas were classified in the dhsvm soil types based on the Soils-main fine-frac field.

<http://www3.wadnr.gov/dhnapp5/website/dmmatrix.html#Soils>

Where the higher resolution DNR data exists it is used, and the rest of the state is filled in with the stasgo derived data.

The values in the grid correspond to:

Soil Description	1 = SAND
Soil Description	2 = LOAMY SAND
Soil Description	3 = SANDY LOAM
Soil Description	4 = SILTY LOAM
Soil Description	5 = SILT
Soil Description	6 = LOAM
Soil Description	7 = SANDY CLAY LOAM
Soil Description	8 = SILTY CLAY LOAM
Soil Description	9 = CLAY LOAM
Soil Description	10 = SANDY CLAY
Soil Description	11 = SILTY CLAY
Soil Description	12 = CLAY
Soil Description	13 = ORGANIC (as loam)
Soil Description	14 = WATER (as clay)
Soil Description	15 = BEDROCK
Soil Description	16 = OTHER (as SCL)
Soil Description	17 = MUCK
Soil Description	18 = TALUS

1. I opened up wasoil_150 in ArcMap and clipped it to an area surrounding the Lake Whatcom watershed (see number 10 in the landcover section). It is already in the same projection as the other Lake Whatcom grids.

2. The 150 m grid must be Resampled to a 30 m grid to match the other lw grids. Open up a new Arc Map and drag the lw_grd into it. Now drag the clipped soils map into the window. It is important that you bring the lw_grd in first. Now open up the Tool Box and step through

Data Management
Projections and Transformation
Resample

Input Raster is wa_clip
Output Raster is wa_clip_30
Choose the coordinate system of the lw_grd
Choose Neighbor
Output Cell size is 30

Before you hit OK, click on Environments and General Settings. Scroll down and put in lw_grd for the Output Extent. In Environments, now click on Raster Analysis Settings and put in lw_grd as the cell size. Hit OK and OK. The grid system should be resampled. I called it *wa_clip_30*.

15. Finally, the soils grid needs to be clipped to the study area using the lw_grd rid. This was done in the Grid module in Arc.

Grid: SETMASK lw_grd
Grid: lw_soils = wa_clip_30

16. The Grid was verified in ArcMap, to make sure the grids overlaid perfectly.

4. CREATE A SOIL DEPTH AND STREAM NETWORK GRID

1. I created a new folder called "Streams". In this folder I put the lw_grd and lwdem30 grids and the "Info" folder. I also copied the amlscripts folder from the DHSVM Tutorial and put them in the Streams folder.
2. In Arc you will be running an AML called createstreamnetwork.aml. It requires a Java script. Therefore you will have to compile a code called AddAat2.java. It requires two other Java codes (Aat.java and Aaterror.java). You can find these codes in the Programs folder in the DHSVM Tutorial folder. Transfer AddAat2.java, Aat.java and Aaterror.java to the Sun workstation. At the Sun cursor type

```
darcy>javac AddAat2.java
```

The result will be three *.class files. Transfer these back to the PC (use binary or BI). Put them into the amlscripts folder.

3. You will also need software on the PC that allows you to run the Java script. Go to www.sun.com and download and install the Java Runtime Environment (JRE). The JRE enables your computer to run applications and applets that use Java technology. It is currently called Java-VM. After you download and install, open up Arc and type

```
Arc: &sys java -version      (you should get)
java version "1.4.2_04"
Java(TM) 2 Runtime Environment, Standard Edition (build 1.4.2_04-b04)
Java HotSpot(TM) Client VM (build 1.4.2_04-b04, mixed mode)
```

Make sure your mask is defined as inbasin=1 outside basin=NoData, rather than 1 and 0. Otherwise you will get a stream network for the whole raster. Open the lw_grd and lwdem30 grids in ArcMap and make sure the regions outside the watershed are defined as NODATA.

4. Open the createstreamnetwork.aml in the amlscripts folder (use Notepad). Look for the call to the AddAat2 java program. Make sure that the path to the class file is correct. I have the AddAat2.class file in the same folder as my amls (amlscripts) which is in my "streams" folder which is my workspace, therefore I modified the line in the createstreamnetwork.aml to look like

```
&sys java -classpath ../streams/amlscripts/ AddAat2 %streamnet%
```

The dem grid (lwdem30) has to be in floating point. To convert from integer to floating point use FLOAT

Also, Create a watch file called *aml.watch*

In arc type:

```
ARC: &workspace C:/DHSVM/Whatcom/Streams
```

```
ARC: &watch aml.watch
```

```
ARC: Grid
```

```
Grid: lwdem30f = FLOAT(lwdem30)
```

```
Grid: q
```

```
ARC: &amlpath ../Streams/amlscripts
```

```
ARC: &run createstreamnetwork lwdem30f lw_grd lw_soild lw_streams MASK 220000
0.76 1.5
```


The last three values are free to be changed to whatever you think is appropriate. They represent the minimum contributing area before a channel begins (225000 m² is what Matt usually uses), the minimum soil depth (0.76m is what Matt uses, if you go smaller you will probably have problems later with the channel depth being deeper than the soil thickness). And 1.5m maximum soil depth. The thicker this is the slower the peak response to rain events tends to be. That is a thin layer will have a sharp hydrograph peak, and a thick layer will be more drawn out. This aml will create the soil depth raster, a stream.map.dat and a stream.network.dat files (as well as some other intermediate files, including an arc coverage of the stream network).

5. The last stream file stream.class.dat needs to be created based on your knowledge of the basin. I have attached a sample from. Use the program assign.class the c-code written by Pascal Storck for the Snoqualmie basin This program will post process the stream-map and stream-class files based on his observational data from the Snoqualmie basin. The classes are a reasonable approximation for most of the Cascades.

Transfer assign.class.c, stream.network.dat and stream.map.dat to the Sun workstation. Compile the c code.

```
darcy> cc -o assign.class assign.class.c
```

Run the c code which will create two new *.dat files that you name (e.g., lw.stream-net.dat lw.stream-map.dat)

```
darcy> assign.class stream.network.dat stream.map.dat lw.stream-net.dat lw.stream-map.dat
```

Where the lw. Files are the final map and network files.

6. After that there is a process_solar aml than will create the Shadow maps and the Skyview map.

```
ARC: &r process_solar <basin_name> <elevationgrid> <model timestep> <GMT offset>
```

For example

```
ARC: &r process_solar whatcom lwdem30 3 0.0
```

I usually use 0 as the GMT offset, it's a little confusing, in that the time stamp on the model runs is then off by 8 hours, for example the warmest part of the day is at 8:00 pm, but that works better when using daily data with the met record creation programs, and avoids the confusion of daylight savings time, times zones etc.