VIC routing model pre-processing for flow direction generation

Based on the original README file written by Ed Maurer ~2000, modified by Jennifer Adam 2003/2004. Adapted to work with the output from the ArcGIS preprocessing. The steps below are all done in a friendly linux environment with free programs and software.

Important note: **use the dos2unix command to get rid of embedded windows end-of-line characters in the fraction file**!

dos2unix frac_vic_0.25.asc

1) Since some shapefiles are useful for the steps below, they can be converted to an X,Y format (for plotting with GMT) using ogr2ogr, like this:

    ogr2ogr -f GMT chile_rivers.gmt sa_riv_15s_Clip.shp -lco GEOMETRY=AS_WKT

and the same can be done for river basins

    ogr2ogr -f GMT chile_basins.gmt EdBasins_wgs84.shp -lco GEOMETRY=AS_WKT

and for the outlet point (a slightly different command for a point shapefile)

    ogr2ogr -f GMT mataquito_outlet.gmt mataquito_outlet_vicgrid.shp -lco GEOMETRY=AS_XYZ

2) Compile the required programs:
gcc flowgen.c -o flowgen
gcc convert.c -o con

3) Edit the four lines of the script *make_rout.scr* to define the input flow accumulation file at the fine native resolution (produced in the earlier preprocessing programs using ArcGIS) and the output flow direction file name (at coarse VIC resolution). Also ensure the AGG_FACT and VIC_RES are correct. For example, if the input resolution is 15 sec (0.004166667 degrees), and output VIC resolution is 0.25 degrees, AGG_FACT is 0.25/0.00416666667=60.

```csh
#!/bin/csh

#TWO FILES NEEDED: INPUT FLOW ACCUMULATION AND OUTPUT FLOW DIRECTION
#30 arc-second flow accumulation grid
set ACC = ../vicroutegis/ChileVICbasins/vic_acc_15s.txt
set OUT = mataquito_flowdir.txt
set AGG_FACT = 60 #factor to aggregate from fine resolution to coarse VIC grid
set VIC_RES = 0.25
#END OF INPUT
#dump top six lines - get number of ROWS and COLS
head -6 $ACC >! temp_head.junk

set ROWS = `gawk '{if(NR==2) print $2}' temp_head.junk`
set COLS = `gawk '{if(NR==1) print $2}' temp_head.junk`

# get remaining lines to process
tail -n +7 $ACC >! temp_body.junk

#convert to long ints
con ascii longint temp_body.junk temp_li.junk $ROWS $COLS

#run program to generate 1/8 degree flow directions
flowgen temp_li.junk $ROWS $COLS temp_fd.junk $AGG_FACT $AGG_FACT

#put new header back on top
set RR = `echo $ROWS '/' $AGG_FACT | bc -l`
set CC = `echo $COLS '/' $AGG_FACT | bc -l`
gawk '{if(NR==1) $2=int('$CC') \
    if(NR==2) $2=int('$RR') \
    if(NR==5) $2= '$VIC_RES' \
    print $0 }' temp_head.junk >! temp_newh.junk

cat temp_newh.junk temp_fd.junk >! $OUT

/bin/rm -f temp*.junk
```

and then run the make_rout.scr script. This produces a first shot of a flow direction file.

4) Check the routing file (flow direction file). This involves plotting the generated VIC scale flow directions with mapped stream locations using GMT. Use the stream network generated above for a reference. Compile a necessary plotting program (depending on your computer, g77 or f77 may be used)

f77 concoord.f -o concoord

Edit the plot_rout script and use it to plot the flow directions


```
#################################################
# GMT script    set up for basins              #
#################################################
stream="../vicroutegis/gisdata/chile_rivers.gmt"
frac="../vicroutegis/ChileVICbasins/frac_vic_0.25.asc"

#scale is for mercator projection
scale=15.0
#coord has format min_lon/max_lon/min_lat/max_lat
coord="-73/-70/-37.5/-33.75"
```

By setting the "coord" to exactly the same as the extent of the VIC grid files (fraction, accumulation files), and by drawing the grid lines on the plot, locating cells is easier.

On the resulting plot, sinks (routing nodes with -9 value, which the program could not determine which way to route), are circled, and need to be manually changed to fit the flow network. There shouldn't be many of these. Outlets should be green, and sinks blue. If the network doesn't match the underlying rivers, the easiest thing to do is manually change the flow direction file with a text editor or spreadsheet program. As an alternative, there is the program revise_dir_file.c uses the file "revise" to make the requested changes to a flow direction file.

Use the plot to make sure that any cell with a fraction above zero (anything with shading) has a defined flow direction that eventually reaches the outlet, and that the directions are reasonable relative to the rivers.

As can be seen in the image below, several of the boundary cells are contributing to neighboring basins, not the Mataquito. The fractional contribution of these cells to the Mataquito is small, but they should be corrected in any case. Note that if working on a basin directly to the north or south, the directions in these boundary cells will change, since a portion of these contribute to each basin. For this reason, **flow direction files are unique to each basin (though they can be shared by all defined flow points within a basin)**.
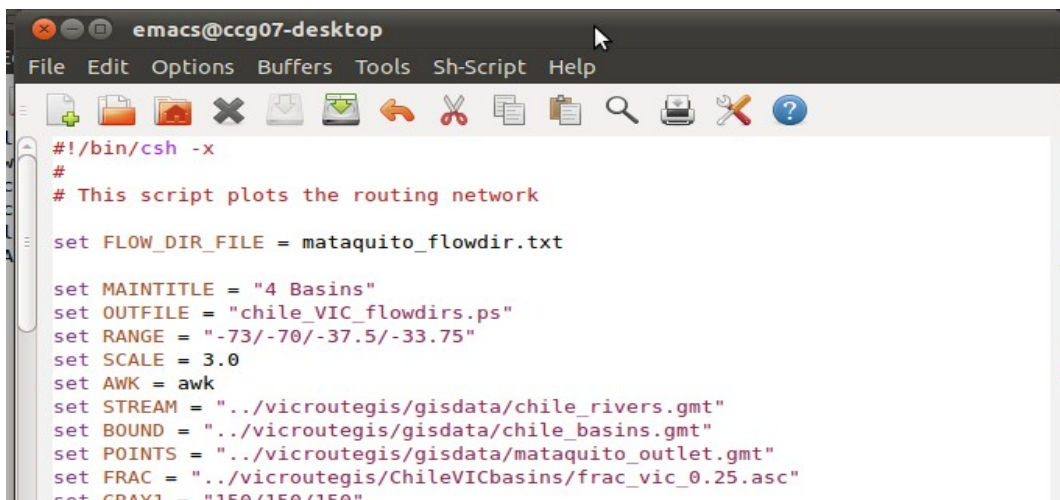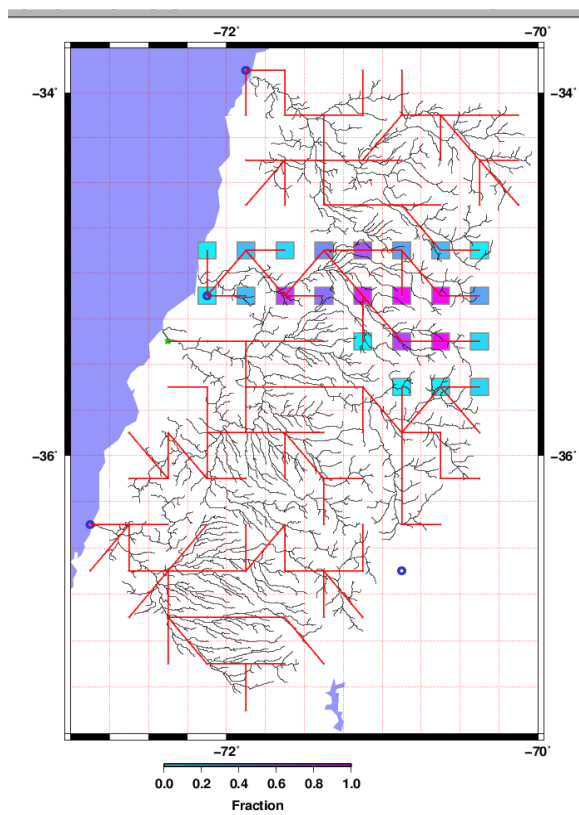

To manually edit the flow direction file, open it in an editor and change the flow direction as appropriate. It may help to also open the fraction file at the same time to help locate the correct cell(s). Note the 8-point flow directions used by VIC are non-standard:
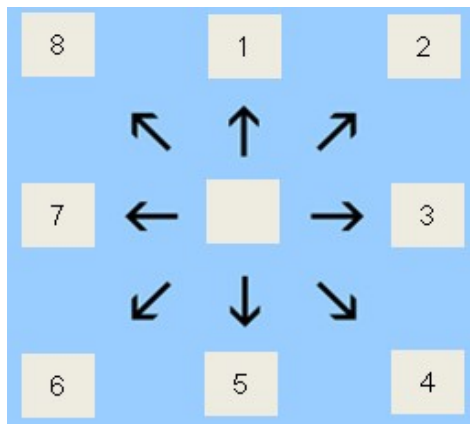
After correcting the directions manually in those cells, the flow direction network now looks like this (notice even the location of the outlet (-9 value) had to be moved in this case):
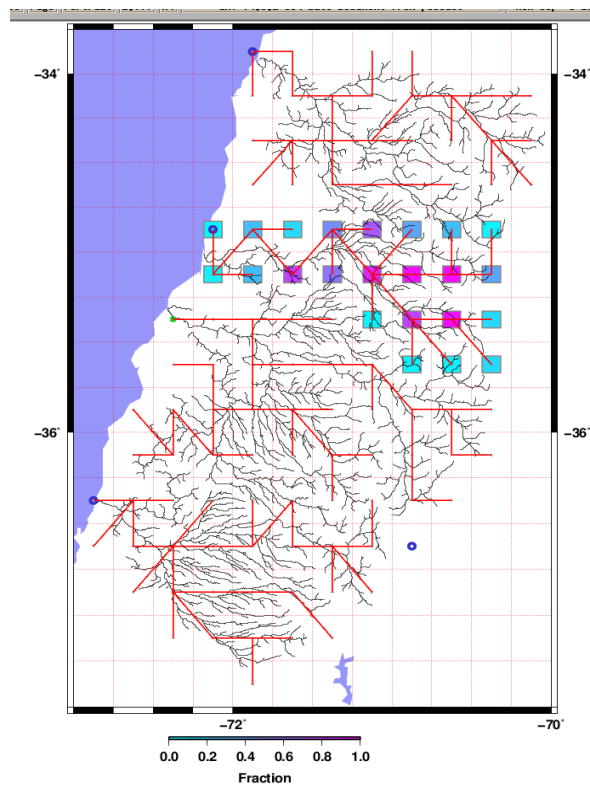
For a more flexible and nicer looking plot, edit the script plot_rout_with_bound.scr (add name of *stream and bound* files, as well as the VIC-scale fraction file, change the "range" definition to match the desired lat/long box, and modify the scale to make the plot fit properly on the page).

```csh
#!/bin/csh -x
#
# This script plots the routing network

set FLOW_DIR_FILE = mataquito_flowdir.txt

set MAINTITLE = "4 Basins"
set OUTFILE = "chile_VIC_flowdirs.ps"
set RANGE = "-73/-70/-37.5/-33.75"
set SCALE = 3.0
set AWK = awk
set STREAM = "../vicroutegis/gisdata/chile_rivers.gmt"
set BOUND = "../vicroutegis/gisdata/chile_basins.gmt"
set POINTS = "../vicroutegis/gisdata/mataquito_outlet.gmt"
set FRAC = "../vicroutegis/ChileVICbasins/frac_vic_0.25.asc"
set GRAY1 = "150/150/150"
```

Also notice where the outlet point is located, and be sure that is the specified outlet in your flow direction grid.

5) create xmask file using the supplied program (which needs to be compiled first with gcc -lm create_xmask.c -o create_xmask).

create_xmask mataquito_flowdir.txt mataquito_xmask.txt

6) make station file - this file lists the points at which hydrographs will be created. These are usually the points for which there are observed streamflow data - but be careful because often the published lat/long are slightly off. For basins with MANY outflow points, Alan's scripts can be used - they are semi-automated. These are in the following directory: create_station/. Unless there are many points, it is not recommended to use these script because it may be easier to do it by hand.

useful information when deciding what RN and CN to use in the station file:
lat = yllcorner + RN*cellres - cellsize/2
long = xllcorner + CN*cellres - cellsize/2

You can edit "**find_row_col_for_station.scr**" to use this logic to output the column and row numbers for the station file. Again, check this manually on the plot you created with the flow network to be sure it is correct.

Refer to the UW VIC website (http://www.hydro.washington.edu/Lettenmaier/Models/VIC/Documentation/Routing/RoutingInput.shtml) for further information on completing the setup and running the routing code.