VIC routing model pre-processing in ArcGIS

<u>Generating a watershed boundary and fraction file for a specific pour point (gage</u> station location)

This uses as input four files:

- the flow direction and flow accumulation rasters (from hydrosheds.cr.usgs.gov)
- a shapefile with the one outlet point
- a polygon file with the outlines of the VIC grid cells for the domain of interest.

The hydrosheds files are available globally at 15s resolution (approximately 500 m). For reference, I also downloaded the 'rivers' layer from the hydrosheds, as it will be useful for checking locations. Here I have downloaded them, and clipped them to the general region of interest in central Chile, which are my first two input files. How to generate the polygon file of the VIC grid is described in Appendix A. For the outlet point, this begins with a shapefile of river flow stations, which will be candidate routing points, and one is extracted as shown below. These are all in WGS84 geographical coordinates (or have been projected into that). The one highlighted below is used to demonstrate the following steps.



Zoom into the point of interest, and identify the latitude/longitude coordinates of it. Hover the curser over the point where the true outlet is, based on the defined rivers.



By selecting the one point and using the editing tool, you can move the point to the exact location noted above:



After saving edits and stopping the editor, the point will be where you specified. Now select the point again, and export this point as its own shapefile, in this case as **mataquito_outlet.shp**.

Now open the ArcGIS model VICrouteprep. This shows the workflow to produce the fraction file.



Specify your four input files by right-clicking on each, selecting 'open' and pointing to the appropriate file. Rename the output file to what you would like. Run the model. This will produce a fraction file. Alternatively, you can load the python code generated by ArcGIS from this model and edit it directly. After successfully running the script, model, or the individual steps, you can check the VIC-scale fraction file by adding it to the ArcGIS display:



If you want to walk through the steps one at a time, the following describes each step.

1) Use the snap pour point function to make sure the outlet point is on a line of high flow accumulation.

Input raster or feature pour point data				. 😐	Snap distance
mataquito_outlet			- 🖻		
Pour point field (optional)			 		Maximum distance, in map
ID			-		units, to search for a cell of
Input accumulation raster				1	higher accumulated flow.
4basin_acc			- 1 🖻		
Output raster				.	
C:\Documents and Settings\Ed\Desktop	o\chile\gis\ChileVICbasi	ns\mataq_out01			
Snap distance					
]			.005		

This produces a raster of the outlet point.

2) Use the spatial analyst watershed function to delineate the contributing are to this point:

A Watershed		
Watershed Input flow direction raster [4basin_fdir Input raster or feature pour point data [mataq_out01 Pour point field (optional) [Value Output raster [C:\Documents and Settings\Ed\Desktop\chile\gis\ChileVICbasins\mataq_bas01		Watershed Determines the contributing area above a set of cells in a raster.
OK Cancel Apply Show Help >	>	Tool Help

The result of this can be checked against the other layers to see if it is reasonable.



If it looks satisfactory, continue to the next steps.

2) Convert the watershed raster to a polygon

Aster to Polygon	
Input raster	Raster to Polygon 🦳
mataq_bas01 🗾 🖻	
Field (optional)	Converts a raster dataset
VALUE	to polygon features.
Output polygon features	
C:\Documents and Settings\Ed\Desktop\chile\gis\ChileVICbasins\mataq_bas01_poly.shp	
☐ Simplify polygons (optional)	9
OK Cancel Apply Show Help >>	Tool Help

3) Now add the vic grid to the map. This is a polygon file (created from raster to polygon conversion) at the larger VIC grid resolution. This is used to develop the fraction file for the basin.



Use the intersect tool to combine them.

➢ Intersect	X
Input Features	ntersect
C in G vic_grid G vic_grid C mataq_bas01_poly.shp ↓ ■ ↓ ■ ↓	omputes a geometric tersection of the Input eatures. Features or ortions of features which verlap in all layers and/or iature classes will be ritten to the Output eature Class.
	INPUT
Output Feature Class	
C:\Documents and Settings\Ed\Desktop\chile\gis\ChileVICbasins\basin_grid_intersect.shp	
JoinAttributes (optional)	
XY Tolerance (optional)	
Decimal degrees 🔽 👽	·
OK Cancel Apply Show Help >>	Tool Help

4) Add a field to the output of the intersection called "int_area" to contain the area internal to the delineated basin:

input Table			Fiel	d Type	
basin_grid_intersect.shp		- 🖻			
Field Name			The	field type used in the	
int_area			crea	tion of the new field.	
Field Type					
FLOAT		_		 TEXT—Names or 	
ield Precision (optional)				other textual	
Tield Context and the state				qualities.	
-leid Scale (optional)					
Field Length (optional)				 FLOAT—Numeric 	
Tota congen (optionaly	 	 		values with fraction	ıa
Field Alias (optional)				snecific range	
				opeenie range.	
Eight latitudable (actional)				DOUBLE_Numeri	~
rieu isinuilable (optional)				values with fraction	ia
Field [sRequired (optional)				values within a	
Field Domain (optional)				specific range.	
-leid Domain (optional)	 	 	*		

Then populate it:

Acalculate Field		×
Input Table	Calculate Field	^
basin_grid_intersect.shp (2)		
Field Name	Calculates the values of a	
int_area	field for a feature class,	
Expression	feature layer, or raster	
1000 * float (!SHAPE.AREA!)	catalog.	
Expression Type (optional)	The investment is the solution	
PYTHON 💌	The input table will be modified: a conv should be	
Code Block (optional)	made to preserve the original information.	<
OK Cancel Apply Show Help >>	Tool Help	

Add another field to contain the fraction of the VIC grid cell within the delineated basin:

Input Table			📋	Input Table
basin_grid_intersect.shp (4)		•	E	
Field Name				The input table to which the
frac				specified field will be
Field Type				added. The field will be
FLOAT			_	table and will not practe a
Field Precision (optional)				new output table
 Field Scale (optional)				non oupur tablo.
[Fields can be added to
, Field Length (optional)				feature classes of ArcSDE,
				file or personal
Field Alias (optional)				geodatabases, coverages,
ļ				shapetiles, raster catalogs,
Field IsNullable (optional)				standaione tables, and/or lavers.
_				,
Field IsRequired (optional)				
Field Domain (optional)				

And populate it:

Calculate Field (2)				
Input Table			<u> </u>	Calculate Field (2)
basin_grid_intersect.shp (5)			💽 🚅 👘	.,
Field Name				Calculates the values of a
frac			-	field for a feature class,
Expression				feature layer, or raster
(!int_area!)/(!base_area!)				catalog.
Expression Type (optional)				The input table will be
PYTHON			-	modified: a conv should be
Code Block (optional)			~	made to preserve the original information.
2			<u>~</u>	
			~	
	OK Cancel	Apply	Show Help >>	Tool Help

5) Now the "frac" field can be joined to the large-scale VIC grid polygon, since they share an attribute called "GRIDCODE" which is the VIC ID number assigned originally.

🎢 Add Join		×
Layer Name or Table View	Add Join	^
vic_grid 🗾 🖼		
	Joins a table view to a layer	
	(or a table view to a table	
	field	
Dasin_grid_intersect.snp (3)		
Output Join Field	The records in the input	
	layer or table view are	
I κeep All (optional)	matched to the record in the join table view based on the join field and the Input Field when the values are equal. The join is temporary as is the layer and will not persist from one session to the next unless the document is saved.	
OK Cancel Apply Show Help >>	Tool Help	

Then dump out the rasters for fraction and flow accumulation (see Appendix B) as ascii grids. These need to have the same extent. Make sure the fraction file has the same number of rows and columns, and the same cellsize as the original VIC grid from which the polygon was created.

6) A secondary calculation produces an output file with the VIC grid cell ID for the basin outlet.

nput Features				• 🖻	Output Feature Class
Features			Ranks	+	The feature class to which
🔉 mataquito_outlet					the results will be written.
🖧 vic_grid				X	
				- I	
<u><</u>				>	
Output Feature Class			and a set of a	_ []	
C:\Documents and Settings\Ed\	Desktop\chile\gis\ChileVIC	basins\mataquito_ou	utlet_vicgridi,shp		
loinAttributes (optional)					
ALL				_	
(Y Tolerance (optional)					
			Decimal degree:	5 🔳	

After the model runs, add this layer to the map and look at its properties. The GRIDCODE should correspond to the VIC cell ID where the outlet is located. This will be useful to note later.

Attributes of mataquito_outlet_vicgrid										
VIGENCIA	AÑO_INICIO	AÑO_SUSP	SEDIMENTOM	OBS_30años	SATELITAL	N_en_Mapa	FID_vic_gr	ID_1	GRIDCODE	base_area
VIGENTE	Jan 1 1972 12:00AM	NO SUSPENDIDA	NO	SI	SI	9	35	36	5068	62.5

Appendix A: To create the VIC grid polygon that is an input to the above:

- 1) Get a list of <lat> <lon> <ID> values for the grid cell centers of the VIC domain. Each grid cell must have a unique ID number. These should be placed in a 3-column text file.
- 2) Use grid_latlon.c to convert the 3-column format to a grid ascii format. The output may need to be modified to convert values to integers.

To do this, first compile the grid_latlon.c program (*cc -lm grid_latlon.c -o grid_ll*). Then run the program (*grid_ll <infile_from_step_1> <resolution in degrees> -9999*).

3) Use the arcgis function to convert the ascii file from step 2 to raster format

ASCII to Raster	
ASCII to Kaster Input ASCII raster file C:\cygwin\home Ediprojects\thile\gisdata\VIC_GRID_0.25.asc Output sater C:\Documents and Settings\Edipositop\thile\gis\ChileVICbasins\vic_grid_rast Output data type (optional) INTEGER	Cutput raster dataset to be created. When not saving to a geodatabase, specify. tif for an ERDAS IMAGINE file format, or no extension for a GRID file format.
OK Cancel Environments << Hide Help	Tool Help

 Then convert the raster to a polygon (uncheck the "simplify polygons" option).



5) Similar to the above, use the Add Field data management tool in ArcGIS to add a base_area attribute to the polygon shapefile. Populate it with calculated values using the same formula as above.

Appendix B: Creating an auxiliary grid to define the domain for output files (for having multiple stations use the same flow direction file)

Create a regular raster grid at the same resolution as the fine fdir and facc files, and covering the desired domain equal to the domain of the VIC grid created in Appendix A. All of the generated frac, fdir output files will use this grid, aggregated to the final VIC resolution, and station files will identify the drainage points relative to it as well.

A Create Constant Raster	
Output raster C:Donoments and Settions/Erd/Deskton/chile/nic/ChileVIChasins/and rast. 15s	Output extent
Constant value	(optional)
-9999	Extent for the output raster
Output data type (optional)	dataset.
INTEGER	This is the contraction the
	environment if specifically
Output extent (optional)	set. If not specifically set, it
🔹 🔽	IS 0, 0, 250, 250.
-33.750000	
Left Right -73.000000 -70.00000	
Bottom -37.500000 Clear	
OK Cancel Environments << Hide Hel	lp Tool Help

Turn it into a true no_data raster with the spatial analyst *con* command (not exactly as typed in the window below; use > instead of = in the expression):

P Con	
Con Input conditional raster Ind_rast_15s Expression (optional) "V4.UE" = -9999 Input true raster or constant value 0 Input false raster or constant value 0 Input false raster or constant value (optional) Cutput raster C:\Documents and Settings\Ed\Desktop\chile\gis\ChileVICbasins\Wull_15s	An SQL expression used to select a subset of raster cells. For information on SQL syntax, see SQL Reference.
OK Cancel Environments << Hide Help	Tool Help

Merge it with the flow accumulation and flow direction rasters so everything has the same extent, and the outer boundaries coincide with the large-scale VIC cells.

Use the spatial analyst toolbar to set this up to union the extents:

Options	?×
General Extent Cell Size	
Analysis extent: Union of Inputs	2
Тор:	
	_
Left: Bight:	
Bottom:	
Span extent to:	8 2
	ncel
OK Ca	ncel

From the dropdown menu go to raster calculator and type in the expression to merge:

# Raster Calculator						(?×		
Layers:									
4basin_acc 4basin_fdir	×	7	8	9	=	\diamond	And		
null_15s vic_grid_rast		4	5	6	>	>=	Or		
	·	1	2	3	<	<=	Xor		
	+		0	•	()	Not		
MERGE ([4basin_acc] , [null_15s])									
							~		
About Building Expressions Evaluate Cancel >>									

Te output is labeled "calculation" and will look the same as the acc grid, but have the complete extent needed.

Use the raster to ascii conversion to dump this file out as an ascii grid, which will be used by later programs (outside of arcgis) to determine the flow directions at the VIC scale.