Travel time analysis tools for SAGA GIS

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This document describes travel time chain tools included in SAGA GIS 2.2.4 originally developed by Rohan Fisher and subsequently updated and included in SAGA releases 2.2.4 and above.

The purpose of to describe and provide application steps for using two SAGA GIS travel time tools. This document provides a step-by-step description of the processing path using example data from Indonesian West Timor. The example can be downloaded here: **rohanfisher.wordpress.com/travel-time-modelling-saga/**

The SAGA GIS travel time tools were created to join together and automate a number of processing steps in order to simplify service access modelling. The purpose of these tools is to create a simple open source way of calculating travel time to services to facilitate rapid testing of multiple travel scenarios. These tools are similar to the AccessMod plugin created by the WHO (Nicolas 2008) however this tool required proprietary software (ArcView) that is no longer supported. In addition the Tool Chains described here add a level of interactivity to modelling process through rapid analysis and display in response to variable modification. This allows scenario gaming exploring multiple. This work is building on earlier travel time research I have been involved in (Myers 2015).

Two tools have been created using SAGA GIS Tool Chains. The SAGA Tool Chains capability uses a simple xml scripting code that allows the joining of multiple SAGA processes. The two tools produced are (1) for land cover grid creation and (2) travel time calculation, the latter requiring the output of the first. Separating the two tools allows for simpler and faster execution to test multiple scenarios with the Travel Time Grid creation tool without having to recalculate the base land cover grid each analysis iteration. A flow chart of the processing steps and connection between the two tool chains is provided at the end of this document.

Land Cover grid creation

The **Land Cover grid creation tool** combines vegetation, transport infrastructure (roads) and elevation data to produce a raster grid of land cover including rivers and creeks. The land cover grid is used as the basis for the travel time calculation with each land cover type being allocated a potential travel speed value. In the example shown here the vegetation and road data were pre-processed as follows:

- Vegetation data was produced from Landsat 8 imagery and classified into 4 broad classes; Forest, Scrub, Grassland, Bare Land. This data set was produced at a 50 meter grid cell size and becomes the base grid system to which other created data are resampled to.
- Road data was obtained as vector data and attributed into three classes based on infrastructure quality; class 1 national road, class 2 provincial road and class 3 local road.

The elevation data is derived from SRTM data and used to create water channel data. The water channel data is created within the Land cover grid creation tool chain in the form of a Strahler order raster layer. The Strahler order is a measure of flow accumulation within a landscape and within the travel time calculation is used to model barriers to travel based on different seasonal scenarios. Five Strahler classes are produced in the analysis grid with the highest class most likely to be impassable throughout the year.
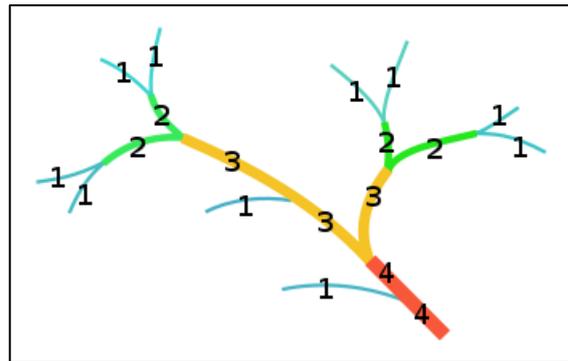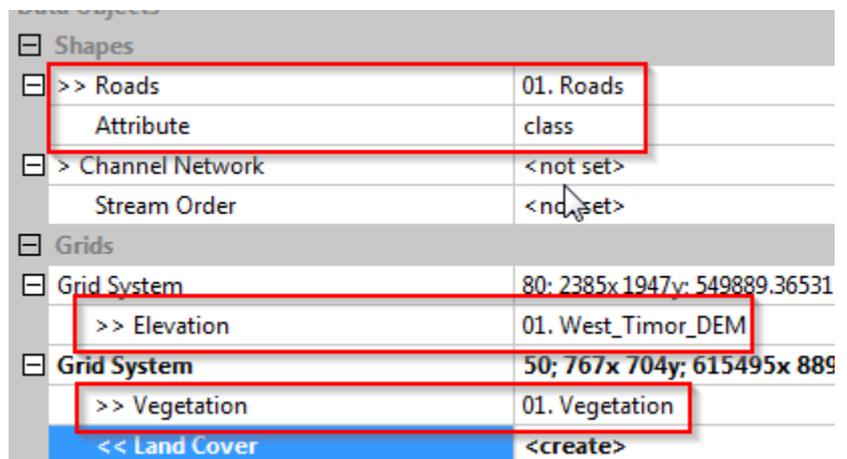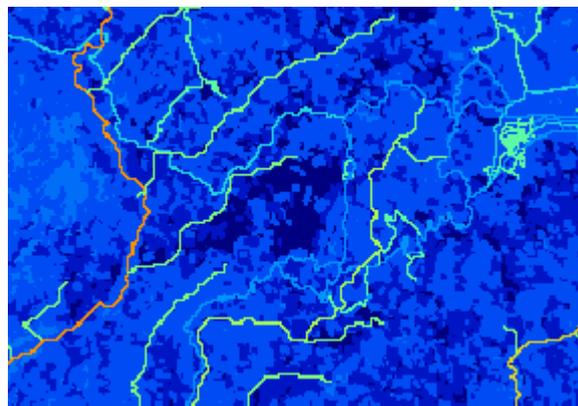

Figure 1. Strahler order.

he Land Cover grid creataion tool input window can be seen here to the left using the inputs:

1. Timor_Barat_80m (DEM)
2. Veg (Vegeatation)
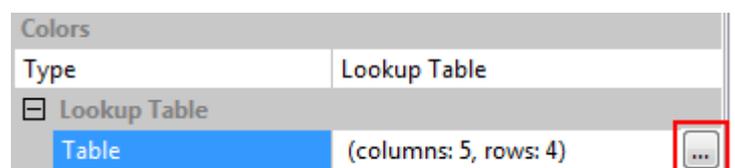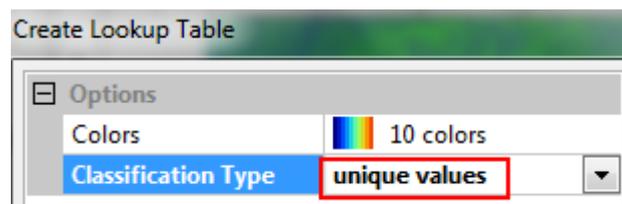3. Roads, selecting class as the attribute
4.

The output grid, shown here, is randomly coloured. It helps to interpret the output if it is re-coloured using a more intuitive colour scheme.
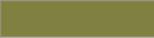

To achieve this right click on the LC grid and select Create Lookup Table.

Select **"unique values"** as the **"classification Type".**

Click **apply** in the **Object Properties Tab** then select **Lookup Table** as **the colour Type**

Finally Change the colours in the colour lookup table to produce an easily interpretable Landover grid image as shown here.

	COLOR	NAME	DESCRIPTION
1		1	Scrub
2		2	Forest
3		3	Grass
4		4	Rock
5		101	Stream 1
6		102	Stream 2
7		103	Stream 3
8		104	Stream 4
9		105	Stream 5
10		201	Road 1
11		202	Road 2
12		203	Road 3
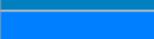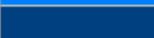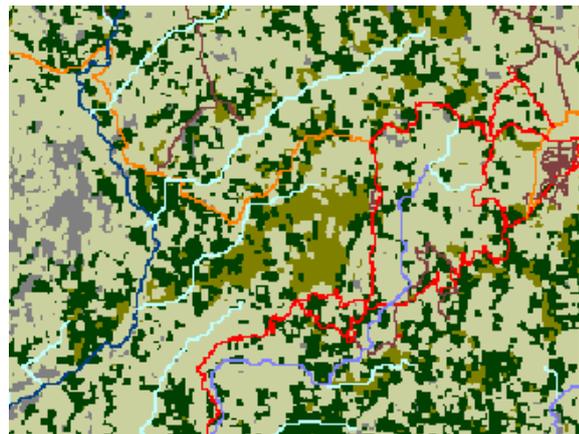
Travel Time Grid creation

The **Travel Time Grid creation tool** produces two outputs based on the input of destination point data. They are travel time to destination in minutes and this data reclassifies as travel time or remoteness zones. The Travel Time Grid creation tool requires the input of the Land Cover grid, destinations points as vector data, and two reclassification tables.

- The destination data is provided as vector points. These can be edited and moved or new point added after each run of the model to produce new output scenarios based on changing service provision.
- The first reclassification table (see table 1) gives travel speed values for each land cover class calculated as the number of seconds to travel across one grid cell using the formula [Km/h x 180] where 180 is the number of seconds to travel 50 meters at 1 km/h. For the water-way classes (8-12) a very high (>99999) is given to allocate that class as a barrier (not crossable) due to flooding. The travel time values can be altered after each run of the model to produce new output scenarios based on differing travel conditions
- The second table defines a look up table (LUT) recolouring the output grid into travel zones. (table 2). This is optional.

Table 1.

ID	Cover Class	km/h	Travel Time (Sec)
1	Forest	1	180
2	Grass	2	90
3	Bare, Rocky	3	60
4	Scrub	0.75	240
101	Stream Class 1	2	90
102	Stream Class 2	2	90
103	Stream Class 3	2	90
104	Stream Class 4	2	90
105	Stream Class 5	0	99999
201	National Road/Hi-way	50	3
202	Provincial Road	25	7
203	Local Road/Track	10	18

Table 2.

COLOR	NAME	DESCRIPTION	MINIMUM	MAXIMUM
8388608	1	0 - 15 min	0	15
8421440	2	15 - 30 min	15	30
2280084	3	30 - 60 min	30	60
65535	4	60 - 90 min	60	90
33023	5	90 - 120 min	90	120
213	6	120 + min	120	999999

Travel Time grid creation tool input window can be seen here to the left using the inputs:

1. Land Cover Grid derived from the Land Cover grid creation tool.
2. Destpoints (Sestination points)
3. LC_Speed (Table 1)
4. TT_Zones (Table 2)

| Shapes	
>> Destination Points	01. destpoints
Grids	
Grid System	50; 767x 704y; 615495
>> Land Cover	02. Land Cover
<< Travel Time	<create>
Tables	
>> Travel Times	01. LC_SPEED
Land Cover ID	ID
Travel Time	TT
> Travel Time Zones Classification	02. TT_Zones_LUT
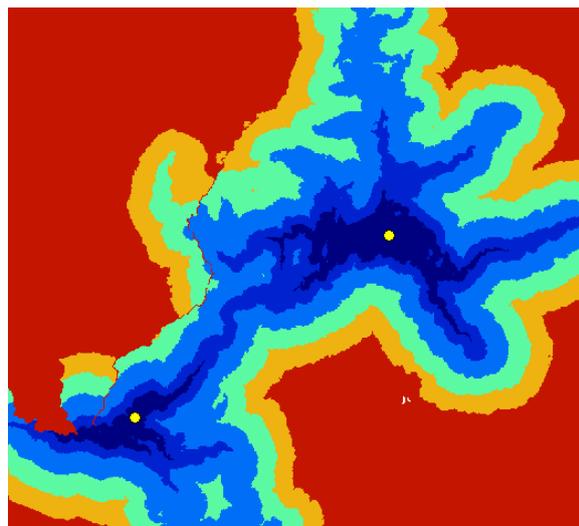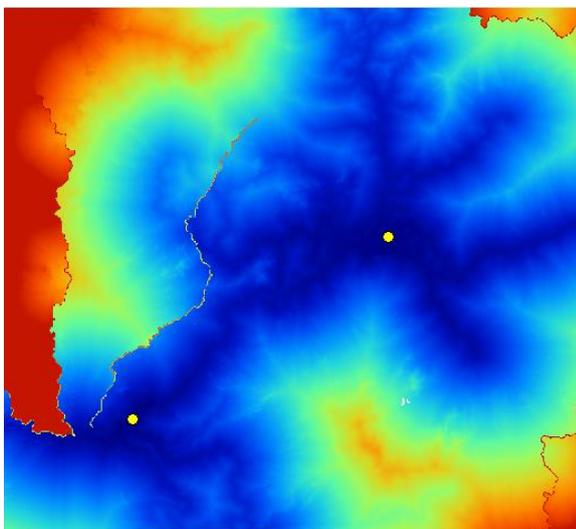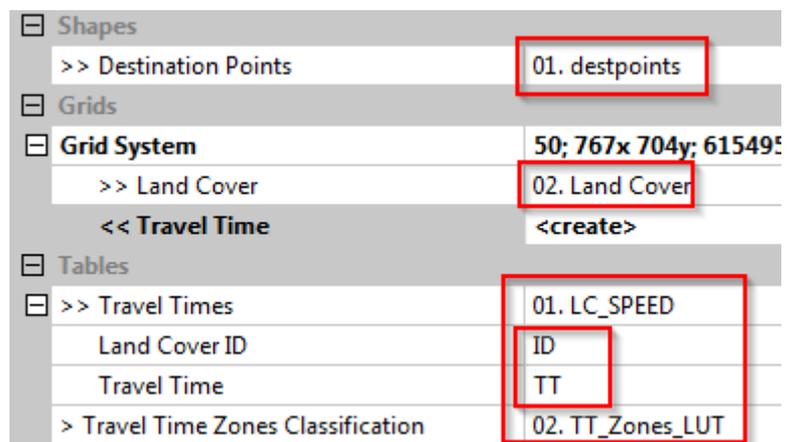
Output one is the travel time grid showing distance to destination points in minutes. Output two is the travel time grid reclassificivd into zones using table 2.

Interactive modelling

Alternative travel time scenarios can be rapidly modelled three ways through: (1) altering the location and number of destination points , (2) changing the travel speed table and (3) editing the Land Cover grid.

To edit the location and number of destination points select the point data layer on the data tab then use the pointer tool to select a point in the map window, right click and select Edit Selected Point . You can now move or delete the point. To add a point right, with the point data layer on the data tab selected, right click on the map window and select "Add Shape" then select the location on the map where you want to add a new point and hit enter.
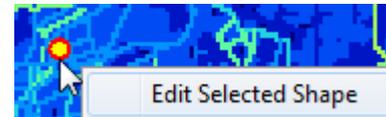
To change travel speed values right click on the travel speed table in the data tab to open the table then alter the values in the travel time column. For example you may wish to make all the travel time values for the water way classes very high to model travel after a large rainfall event making all stream channels impassable or increase all the walking (non-road) travel times to simulate someone being carried.
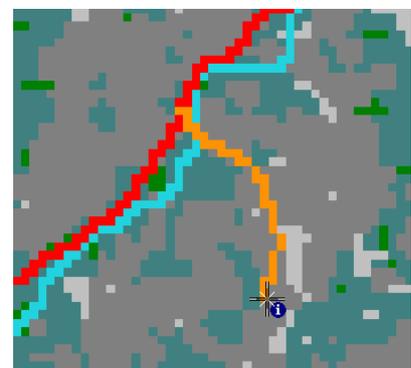
 It is also possible to directly edit the Land Cover grid to, for example, reduce travel speeds on sections of road known to be damaged or add new roads and tracks know to exists by planning participants but not otherwise captured in by the road data used in the initial analaysis. To alter the Land Cover grid use the "Change Values Interactive" found in **the Modules>Grid>Values>Change Values Interactive** menu.

In the example shown to the right the new value we wish to "draw" on the land cover grid has been set to 11 so we can draw a new local road. If adding a barrier to travel, ie a new flooded area, set the radius to 1 or more to make a solid line. Note when drawing on the travel grid move the cursor slowly to paint a contiguous line.

Now use the cursor tool to slowly draw then new cell values across the land cover grid.

After editing the destination points, travel speed table and/or land cover grid it is possible to directly run the Travel Time Tool again to see new outputs. After each iteration of the model you can save the to output as a map graphic or a GIS file to further compare scenarios.

1. Landcover grid Tool Chain flow chart

Elevation Data
(90m SRTM.
Raster data)

Fill Sinks

Sink Filled
Raster DEM

Calculate Strahler Order
Channel Network & Drainage Basins

Strahler
Order - Vector

Create Strahler Order Raster
Shapes to Grids

Strahler
Order - Grid

Add 100 to Strahler Order values
Grid Calculator

**Road Data:
3 Classes**
(Vector Data)

Create Road Raster
Shapes to Grids

Road - Grid

Add 200 Road Class values
Grid Calculator

Road Grid
Grid values:
201-203

Strahler Order
Grid values:
101-105

**Vegetation
Maping: 4 classes**
(Derived from
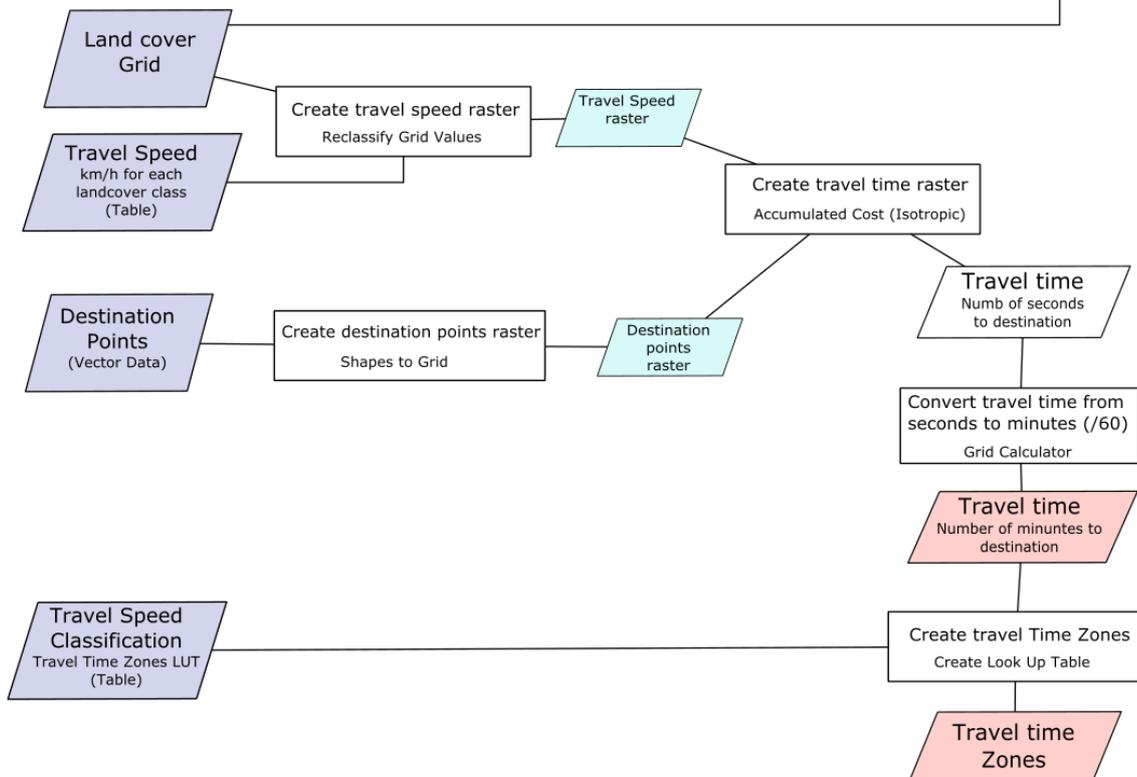Landsat imagery)

Combine all grids
Mosaic
(Highest grid value of overlapping cells)

**Landcover Grid
12 Classes**
(Raster Data)

2. Travel time grid Tool Chain flow chart

**Land cover
Grid**

Create travel speed raster
Reclassify Grid Values

Travel Speed
raster

Travel Speed
km/h for each
landcover class
(Table)

Create travel time raster
Accumulated Cost (Isotropic)

Travel time
Numb of seconds
to destination

**Destination
Points**
(Vector Data)

Create destination points raster
Shapes to Grid

Destination
points
raster

**Convert travel time from
seconds to minutes (/60)**
Grid Calculator

Travel time
Number of minuntes to
destination

**Travel Speed
Classification**
Travel Time Zones LUT
(Table)

Create travel Time Zones
Create Look Up Table

**Travel time
Zones**

References

Myers, Bronwyn A., Rohan P. Fisher, Nelson Nelson, and Suzanne Belton. "Defining Remoteness from Health Care: Integrated Research on Accessing Emergency Maternal Care in Indonesia." (2015).

Ray, Nicolas, and Steeve Ebener. "AccessMod 3.0: computing geographic coverage and accessibility to health care services using anisotropic movement of patients." *International Journal of Health Geographics* 7.1 (2008): 63.