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Map Analysis: *Understanding Spatial Patterns and Relationships*

by Joseph K. Berry

Topic 5. Calculating Visual Exposure — *Visual analysis is an extension of effective distance measurement that considers line-of-sight connectivity among map locations. This section discusses the procedures, considerations and applications of derived viewshed and visual exposure maps.*

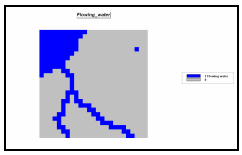
18 Line-of-Sight Buffers Add Intelligence to Maps — *describes procedures for creating line-of-sight buffers that track relative visual exposure and noise levels.*

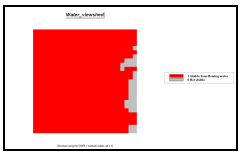
19 Identify and Use Visual Exposure to Create Viewshed Maps — *discusses basic considerations and procedures for establishing viewsheds and visual exposure from point, line and polygonal features.*

20 Visual Exposure Is in the Eye of the Beholder —*investigates procedures for assessing simple and weighted visual exposure.*

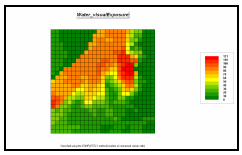
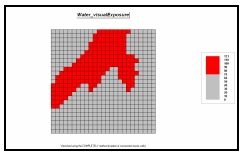
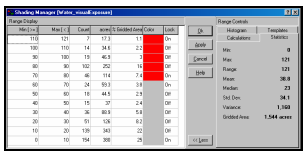
21 Use Exposure Maps and Fat Buttons to Assess Visual Impact — *describes procedures for creating a simple model that determines the relative visual impact of alternative power line routes on local residences.*

Hands-on Experience

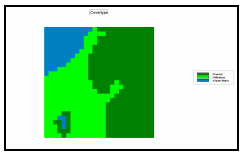
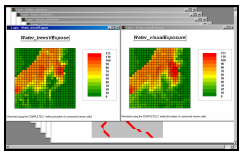




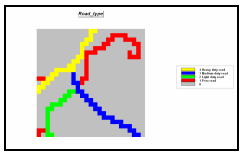
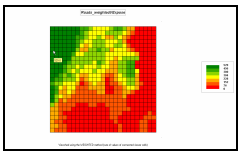
Exercise 5.1 Calculating Viewsheds — *in this exercise you will first create a map of all the water locations (viewer map) in the Tutor25 database and then generate a simple viewshed map that indicates the visual connectivity to water— all locations are identified as either 0= not seen or 1= seen from at least one water location.*

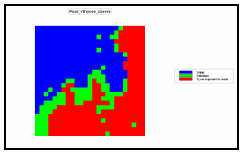
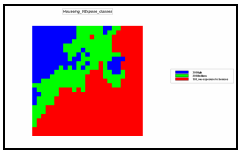
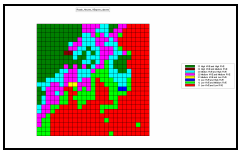
Exercise 5.2 Calculating Visual Exposure — *this exercise demonstrates generating a visual exposure map to water indicating the number water locations visually connected to each grid location in a project area— 0= not seen with increasing values indicating higher visual exposure to water.*

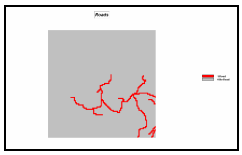
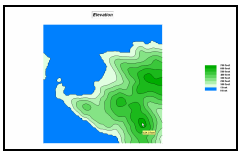
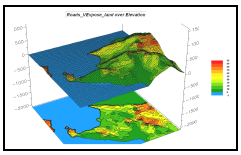
Exercise 5.3 Accounting for Screens — *this exercise extends the previous exercise to create another visual exposure map to water that accounts for a screening forest canopy of 75 feet and then compares the result to the "non-screened" solution to determine the differences in the two approaches.*

Exercise 5.4 Calculating Weighted Visual Exposure *— this exercise first calibrates Roads in terms of traffic flow and then creates a weighted visual exposure map accounting for the relative amount of traffic on different road types— 0= not seen from any road location with increasing values indicating higher weighted visual exposure to traffic flows.*

Exercise 5.5 Modeling Visual Exposure Impacts *— this exercise creates and classifies visual exposure maps for relative connectivity to roads and houses (Low, Medium, High) and then combines the two classified maps into a single map that characterizes the joint visual exposure for each map location using a 2-digit code— a location with a value of 11 indicates 1= Low housing exposure and 1= Low roads exposure; a value of 12= Low/Medium, … to a value of 33= High/High.*

Exercise 5.6 Extending Visual Analysis to Other Areas *— this exercise creates a visual exposure map to roads and graphically overlays it on the Elevation surface for the Island database.*

Cross-Reference for Grid-based Map Analysis Operations

used in Topic 5 exercises (a complete cross-reference is on Companion CD)

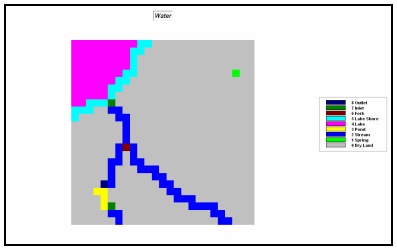
Class	Description	MapCalc Command	ESRI GRID/SA Command	ERDAS Imagine Command
Reclassify	Assigns new values to the categories on an existing map	**RENUMBER**	RECLASS	RECODE
Distance	Creates a map indicating areas that are visible from specified locations (visual exposure)	**RADIATE** (simply)	VISENCODE, VISIBILITY	VIEWSHED ANALYSIS
Distance	Creates a map of the number of visual connections from a set of viewing locations (visual exposure)	**RADIATE** (completely)	VISENCODE, VISIBILITY (limited visual exposure)	*<None, only simple viewshed>*
Distance	Creates a map of the viewshed or visual exposure considering screening features (i.e., tree height) on top of the elevation surface	**RADIATE** (thru)	VISENCODE, VISIBILITY (limited screening capability)	*<None, only simple viewshed>*
Distance	Creates a map of the sum of the weights of the visual connections from a set of viewing locations (weighted visual exposure)	**RADIATE** (weighted)	*<None, only non-weighted visual exposure>*	*<None, only simple viewshed>*
Overlay	Creates a map as the mathematical or statistical function of two or more maps	**CALCULATE** (plus)	GRIDMATH	ADD

Topic 5 Exercises

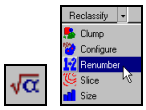
Access *MapCalc* using the *Tutor25.rgs* by selecting **Start** à **Programs** à **MapCalc Learner** à **MapCalc Learner** à **Open existing map set** à **MapCalc Data** à **Tutor25.rgs**. The following set of exercises utilizes this database.

5.1 Calculating Viewsheds

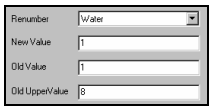
 Use the *View* button (binocular icon) to select and display the **Water** map.



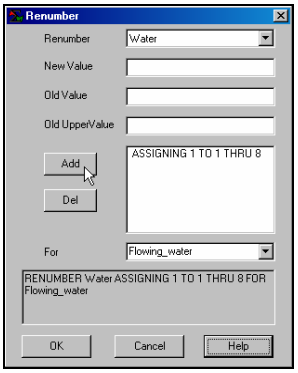
Note that there are eight different types of water depending on its flow.



Press the *Map Analysis* button and choose **Reclassify** à **Renumber** to access the dialog box for reclassifying map values. Complete the input specifications as shown below to derive a binary map of *Flowing Water*

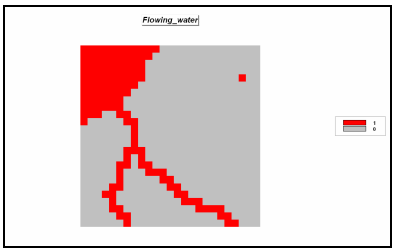


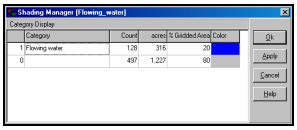
Select the **Water** map from the drop-down list, then specify **1** as the *NewValue*, **1** as the *OldValue* and **8** as the *OldUpperValue*. Press the **Add** button to submit the reassignment phrase. Specify F**lowing_water** as the new map name and press **OK** to create a binary map where 1= any water type and 0 = not water.



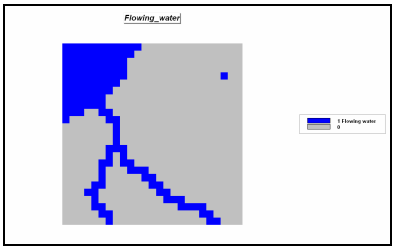
RENUMBER Water ASSIGNING 1 TO 1 THRU 8 FOR Flowing_water

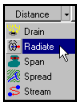
 Press the **Use Cells** button to set the display type to *Grid*.



Press the **Shading Manager** button then enter "**Flowing water**" as the category description. Double-click on the red *Color* and choose **blue** from the color pallet. Click **OK** to submit the display changes.

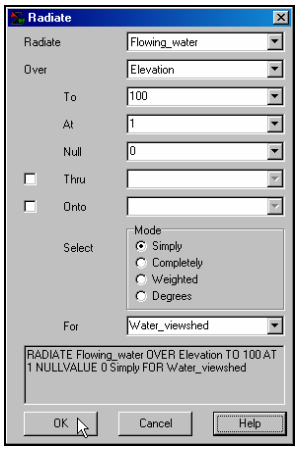


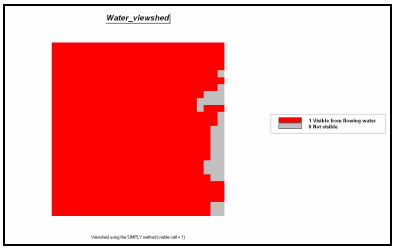
Press the **Map Analysis** button and choose **Distance** à **Radiate** to access the dialog box for visual analysis. Complete the input specifications as described below to derive a binary map of *Water_viewshed*.

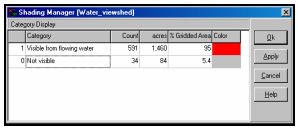
Press the **Help** button to get a description of the *Radiate* command's function and input fields. Specify…

Flowing_water as the *viewersMap*
Elevation as the *surfaceMap*
100 as the *# of grid spaces* away
1 as the *viewer_heightValue*
Simply as the calculation *mode (binary viewshed)*
Water_viewshed as the *newMap*



RADIATE Flowing_water OVER Elevation TO 100 AT 1 NULLVALUE 0 Simply FOR Water_viewshed

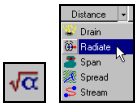




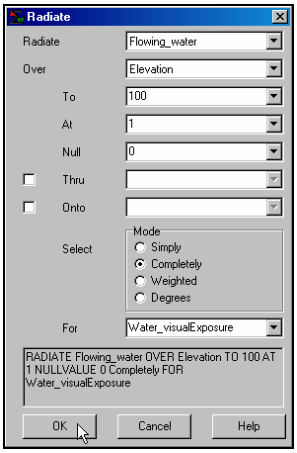
Double-click on the map legend to pop-up the *Shading Manager* dialog box. Enter a description for the map *Categories* as 1= "Visible from flowing water" and 0= "Not visible." Note that approximately 95% of the project area is visually connected to flowing water and that the few "Not visible" areas are concentrated along the eastern edge.

On your own, follow a similar visual analysis procedure to generate a *viewshed* map (**Roads_viewshed**) of any road location (based on the **Roads_type** map). What percent of the project area is visually connected to roads?

5.2 Calculating Visual Exposure

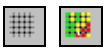


Press the **Map Analysis** button and choose **Distance** à **Radiate** to access the dialog box for visual analysis. Complete the input specifications as shown below to derive a visual exposure map showing "how many" water grid cells are visually connected to every location within in the project area.

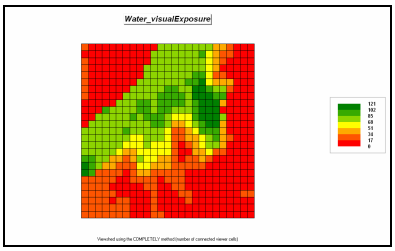


RADIATE Flowing_water OVER Elevation TO 100 AT 1 NULLVALUE 0 Completely FOR Water_visualExposure

Selecting the "*Completely*" calculation mode identifies the number of connected viewer cells. Larger values indicate higher visual exposure to water—locations that "seen" from a lot of water locations (and by direct line-of-sight, "see" a lot from water locations).

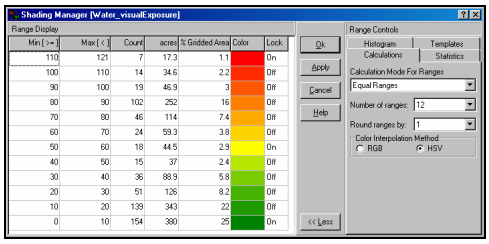


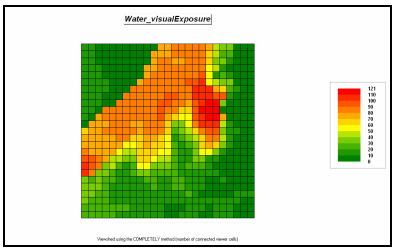
Press the **Layer Mesh** button to superimpose the analysis grid. Press the **Use Cells** button to set the display type to *Grid*.



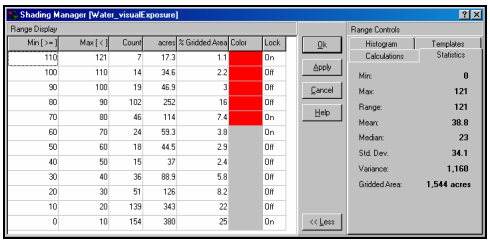
Double-click on the legend to pop-up the *Shading Manager*. Change the *Number of ranges* to **12**. Note that the data intervals are expressed as increasing steps of 10 additional viewer cells (water locations).

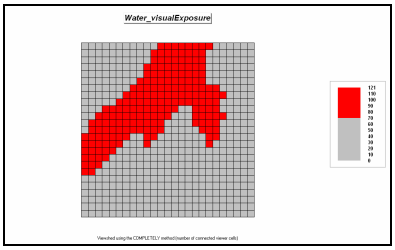
Under the *Lock* column, click **Off** the automatically assigned *yellow* inflection point for the range 30 to 40. Click the *Color* block for range for 50 to 60 and select **yellow** from the pallet to reset the color inflection point on the color ramp. Switch the colors for the minimum and maximum ranges by clicking on the respective color blocks and choose **green** for the lowest range and **red** for the highest range. Press **OK** to generate the new display.





Use the *Shading Manager* to create a display that isolates the areas of very high visual exposure (70 or more water locations visible) as red with a background of grey—set **grey** as the *Color* from 0-10 through the 60-70 intervals and *Lock* on **red** for the 70-80 and 110-121ranges.

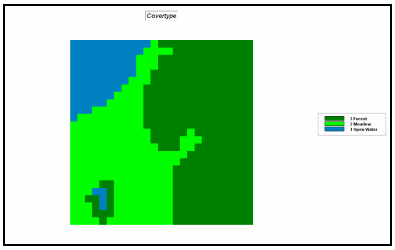


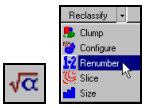


On your own, follow a similar visual analysis procedure to generate a *visual exposure* map (**Roads_visualExposure**) of any road location (based on the **Roads_type** map). What is the highest visual exposure to roads in the project area?

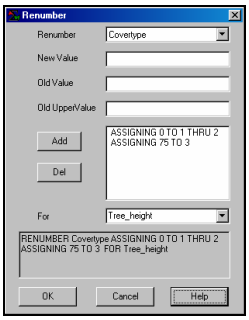
5.3 Accounting for Screens

Use the **View** button (binocular icon) to select and display the **Covertype** map.





Use the **Map Analysis** button and choose **Reclassify** à **Renumber** to access its dialog box and complete as shown.

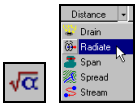


RENUMBER Covertype ASSIGNING 0 TO 1 THRU 2 ASSIGNING 75 TO 3 FOR Tree_height

Do not forget to press the Add button to enter each *Renumber* phrase…

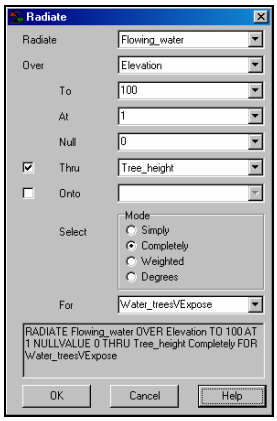
ASSIGNING 0 TO 1 THRU 2 (*Water & Meadow*)
ASSIGING 75 TO 3 (*Forest*)

…to indicate the height of the vegetation canopy (same units as the Elevation map). This assigns 0 feet (*NewValue*) for Water (*Oldvalue*= 1) and Meadow (*OldValue*= 2) locations and 75 feet (*NewValue*) for Forest locations (*OldValue*= 3).



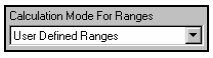
Press the **Map Analysis** button and choose **Distance** à **Radiate** to access the dialog box for visual analysis. Complete the input

specifications as described below to derive a visual exposure map accounting for the height of the tree canopy.



RADIATE Flowing_water OVER Elevation TO 100 AT 1 NULLVALUE 0 THRU Tree_height Completely FOR Water_treesVExpose

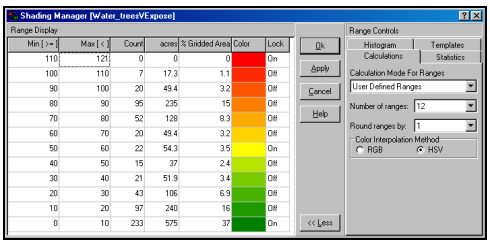
Double-click on the legend to pop-up the *Shading Manager*. Change the *Number of ranges* to **12**.

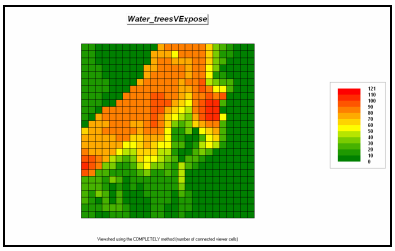


Change the *Calculation Mode* to **User Defined Ranges**.

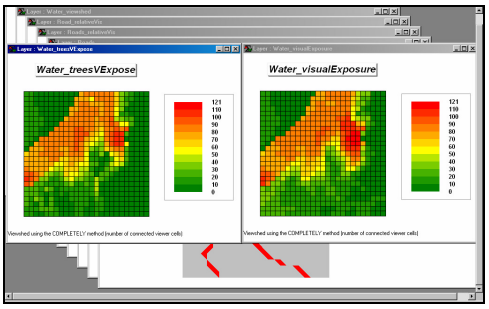
Min [>=]	Max [<]
110	121
100	110
90	100
80	90
70	80
60	70
50	60
40	50
30	40
20	30
10	20
0	10

Starting at the bottom of the *Min [>=]* column enter values increasing by **10** as shown above, then ending with **121** at the top of the *Max [<]* column. Set the Color settings the same as before— **green** for the lowest range, **red** for the highest range and **yellow** for the 50 to 60 range. Press **OK** to display the map using the custom legend that is the same as used for displaying the *Water_visualExposure* map generated in the previous section.





Click on the **Restore Down** button in the upper-right corner of the display. Use standard Windows "click-and-drag/size" techniques to position the *Water_visualExposure* and *Water_treesVExpose* side by side as shown below.

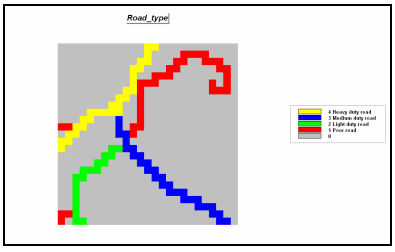


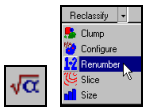
Note the visual differences between the two maps—visual exposure with and without accounting for the height of the tree canopy. The area of high visual exposure (red tones) that accounts for the tree canopy barriers has a similar shape but is smaller than the corresponding area without trees.

Note: Each map display is contained in a separate window. Standard Windows techniques such as cascading, horizontal and vertical "tiling" are available.

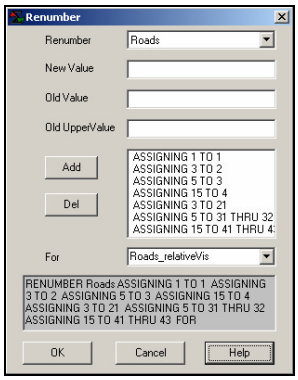
5.4 Calculating Weighted Visual Exposure

Use the **View** button (binocular icon) to display the **Roads_type** map.





Press the **Map Analysis** button and choose **Reclassify** à **Renumber** to access its dialog box and complete as shown.

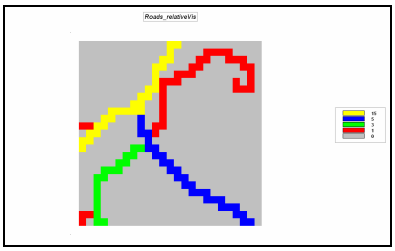


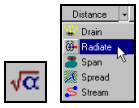
RENUMBER Roads ASSIGNING 1 TO 1 ASSIGNING 3 TO 2 ASSIGNING 5 TO 3 ASSIGNING 15 TO 4 ASSIGNING 3 TO 21 ASSIGNING 5 TO 31 THRU 32 ASSIGNING 15 TO 41 THRU 43 FOR Roads_relativeVis

Do not forget to press the *Add* button to enter each *Renumber* phrase…

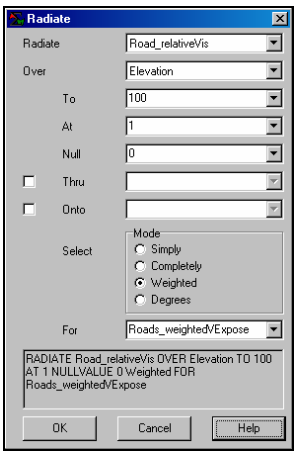
ASSIGNING 1 TO 1 (*one car*)
ASSIGING 3 TO 2 (*three cars*)
ASSIGNING 5 TO 3 (*five cars*)
ASSIGNING 15 TO 4 (*fifteen cars*)

…to indicate the relative number of cars in a given period of time.

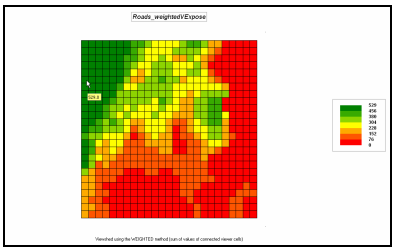




Press the **Map Analysis** button and choose **Distance** à **Radiate** to access the dialog box for visual analysis. Complete the input specifications as shown below to derive a weighted visual exposure map showing the relative visual exposure to roads for every location within in the project area.

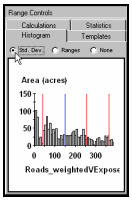


RADIATE Road_relativeVis OVER Elevation TO 100 AT 1 NULLVALUE 0 Weighted FOR Roads_weightedVExpose



Note that the weighted visual exposure ranges from 0 to 529. The most visually exposed location is in the west border at column 1, row 20 as reported in the lower-left corner of the display window as the mouse is positioned over the location on the map.

5.5 Modeling Visual Exposure Impacts

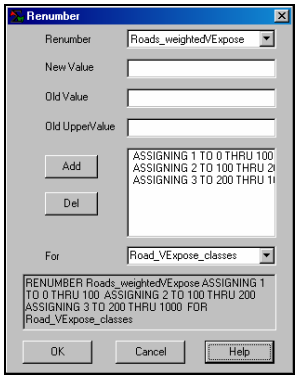


Double-click on the *Roads_weightedVExpose* map's legend to pop-up the *Shading Manager*. Select the **Histogram** tab and click **Std. Dev.** button to get a plot of the data distribution. Note that the average is about 150.

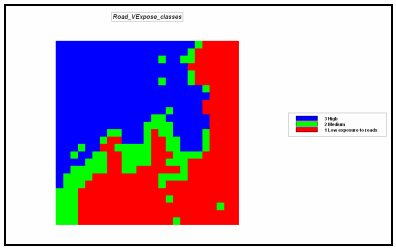
Based on the *Roads_weightedVExpose* data distribution, create a map that identifies areas of…

Low= 1 (0-100 seen)
Medium= 2 (100-200 seen)
High= 3 (>200 seen)

…visual exposure by choosing **Reclassify** à **Renumber** and completing the dialog box as shown below.

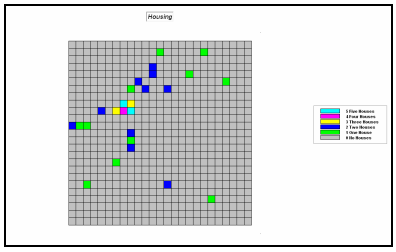


RENUMBER Roads_weightedVExpose ASSIGNING 1 TO 0 THRU 100 ASSIGNING 2 TO 100 THRU 200 ASSIGNING 3 TO 200 THRU 1000 FOR Road_VExpose_classes

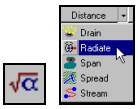


Notice that the area of High visual exposure to roads is concentrated in the northwestern portion of the project area while the areas of Low visual exposure are generally in the southeast.

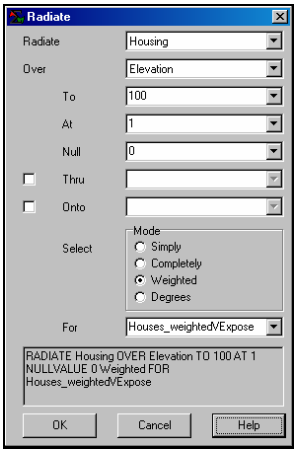
Use the **View** button (binocular icon) to select and display the **Housing** map.



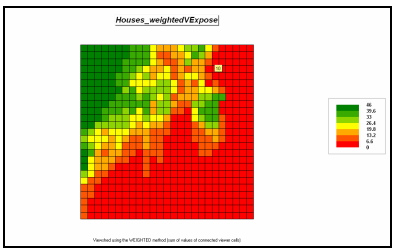
The values stored for grid cell indicates how many houses occur at that location (1 hectare grid cell).

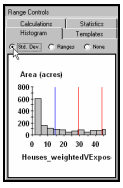


Press the **Map Analysis** button and choose **Distance** à **Radiate** to access the dialog box for visual analysis. Complete the input specifications as shown below to derive a weighted visual exposure map showing the relative visual exposure to houses for every location within in the project area.



RADIATE Housing OVER Elevation TO 100 AT 1 NULLVALUE 0 Weighted FOR Houses_weightedVExpose

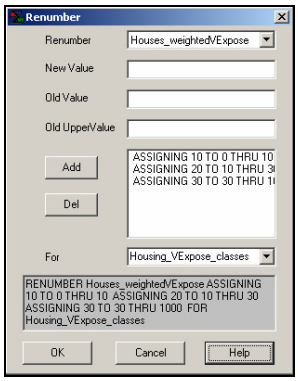




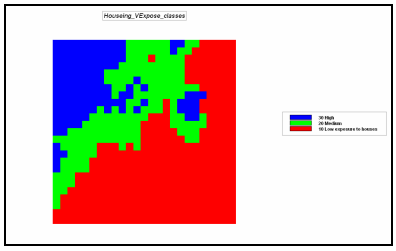
Use the *Shading Manager* **Histogram** tab to get an idea of the data distribution for the *Housing_weightedVExpose* surface.

Create a map that identifies areas of Low, Medium and High visual exposure by 1) pressing the **Map Analysis** button 2) choosing **Reclassify** à **Renumber** and 3) completing the dialog box as shown below so…

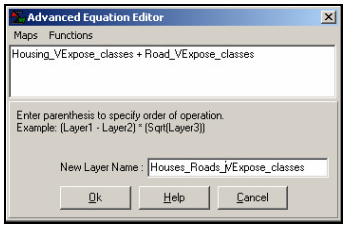
Low= 1 (0-10 houses seen)
Medium= 2 (10-30 houses seen)
High= 3 (>30 houses seen)



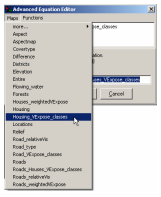
RENUMBER Houses_weightedVExpose ASSIGNING 10 TO 0 THRU 10 ASSIGNING 20 TO 10 THRU 30 ASSIGNING 30 TO 30 THRU 1000 FOR Housing_VExpose_classes



Combine the two maps indicating the classes of visual exposure to roads and houses by **Map Analysis** à **Overlay** à **Calculate** and completing the following dialog box as shown below.

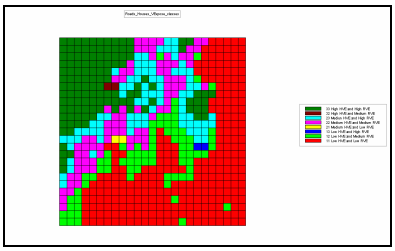


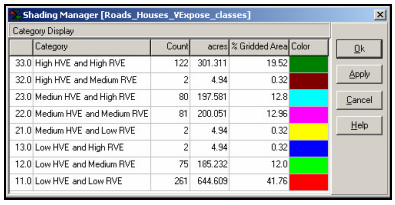
CALCULATE Housing_VExpose_classes + Road_VExpose_classes FOR Houses_Roads_VExpose_classes



To select a map, select **Maps** and choose the map from the drop-down list. You can select the math operation from the **Functions** list or simply enter the "+" symbol to indicate addition.

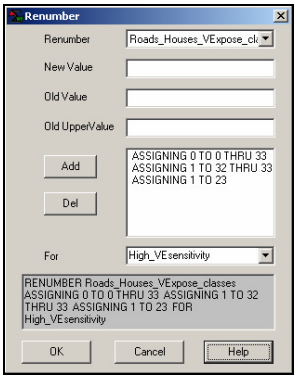
Press the **Use Cells** button to switch the default display to discrete data type.



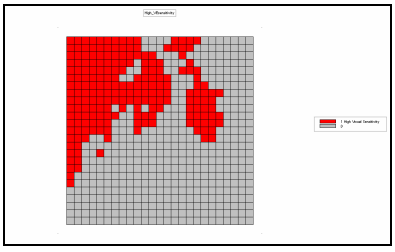


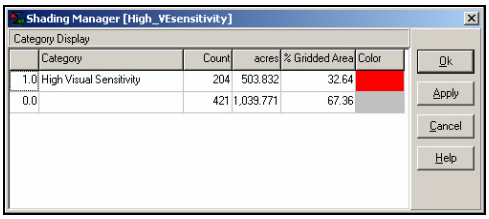
Use the *Shading Manager* to label each of visual exposure combinations. For example, the 11 value is interpreted as condition class "one-one" (Low, Low) derived by adding a 10= Low *Housing_VExpose_class* plus 1= Low *Roads_VExpose_class*.

Isolate the visually sensitive areas by selecting **Map Analysis** à **Reclassify** à **Renumber** and completing the dialog box as shown.



RENUMBER Roads_Houses_VExpose_classes ASSIGNING 0 TO 0 THRU 33 ASSIGNING 1 TO 32 THRU 33 ASSIGNING 1 TO 23 FOR High_VEsensitivity





Note that about a third of the project area is visually vulnerable and is concentrated in the northwestern portion of the area. "Ugly" development or activities ought to avoid these areas.

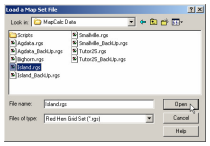
On your own, follow a similar visual analysis procedure to generate a map that identifies visual exposure classes to water (**Water** map) and forest cover (**Covertype** map). What percent of the project area has high visual exposure to water and forest combined? "Pretty" areas like these might be potential areas for hiking trails or that new cabin you have wanted to build.

5.6 Extending Visual Analysis to Other Areas

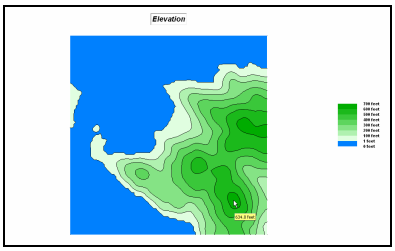
Click on the **Map Analysis** button and select **Script** à **Save As…** and specify a file name for the command script such as **Tutor25_exercises_5.scr**. This will save all of your work so you can re-access the command file at a later date by selecting **Map Analysis** à **Script** à **Open** à **Tutor25_exercises_5.scr**.

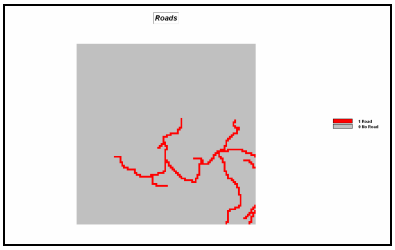
To save the database, from the main menu select **File** à **Save As…** and save the file under a different name than the basic *Tutor25.rgs* name, such as **Tutor25_exercises_5.rgs**.

Click on the **Open existing file** button and respond **No** to whether you want to save changes to the existing database.

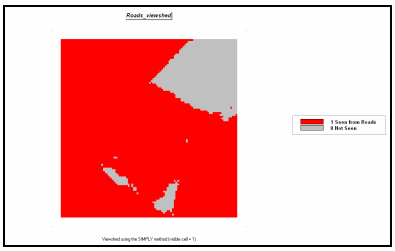


Select the **Island.rgs** database from the list and click **Open**.

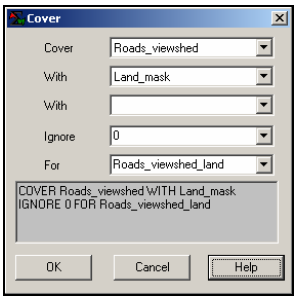




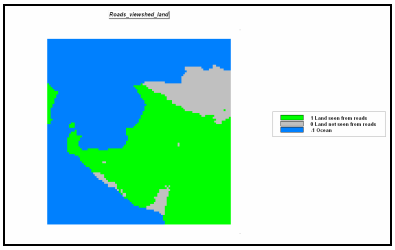
Using the **Elevation** surface and **Roads** map create a *Viewshed* map identifying all locations that can be seen (at least once) from the road network.



Use the **Land_mask** map and the **Map Analysis** à **Reclassify** à **Cover** operation to enter the command…



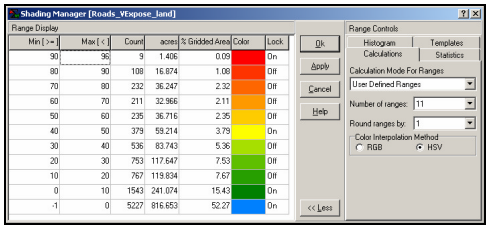
COVER Roads_viewshed WITH Land_mask IGNORE 0 FOR Roads_viewshed_land

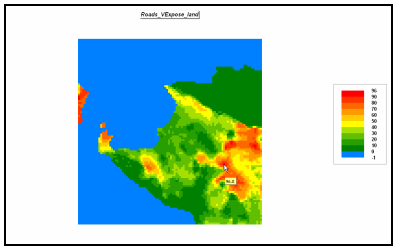


What percent of the project area is classified as "land seen from roads."

Repeat the procedure calculating a *Visual Exposure* map from roads. Display the map using User Defined calculation mode for ranges from **-1 to 0**, **0 to 10**, 10 to 20,…,**90 to 96**.

Assign **blue** to -1 to 0, **green** to 0 to 10, **yellow** to 40 to 50 and **red** to 90 to 96.

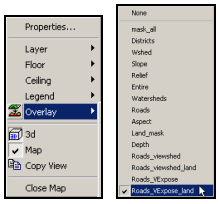




Create a more interesting display by draping the visual exposure map over a 3-dimension plot of the terrain by—

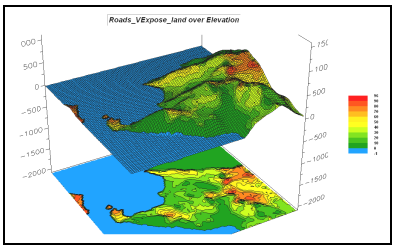
Use the **View** button (binocular icon) to display the **Elevation** map.

Use the **Toggle 3D view** button to switch the display to a 3-dimensional plot.



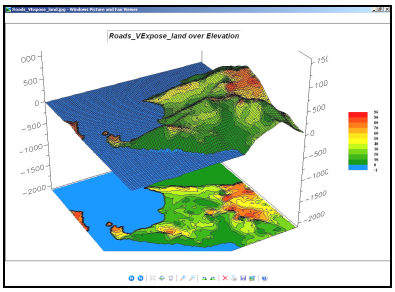
From the main menu select **Map** à **Overlay** à **Roads_VExpose_land** to superimpose the visual exposure map on the *Elevation* surface.

Select the **Zoom Out** tool (magnifying glass with minus sign), click/drag up/down anywhere on the display to size the plot. Use the **Move** tool (hand) and click/drag to center the plot.

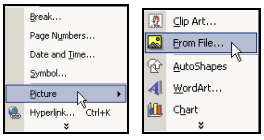


Use the **Save picture of map** button to capture a "screen grab" of the display as a file named **FancyMap_graphic.jpg**.

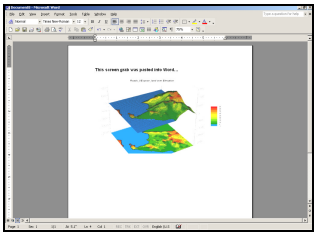
Use *Windows Explorer* to browse to the saved file and double click on it to display in your default viewer.



Open a blank *Word* document and insert the saved file into it by—



From the main Word menu select **Insert** à **Picture** à **From File…** and browsing to the saved file.



*Note: The MapCalc "**Save picture of map**" button provides basic screen grab capability of just the map window. Microsoft Windows "**Ctrl/Print Screen**" capability grabs the entire computer screen. The inexpensive yet versatile SnagIt program provides advanced screen capture capabilities and was used to capture/insert all of the graphics used in this book. To order, see…www.techsmith.com/*