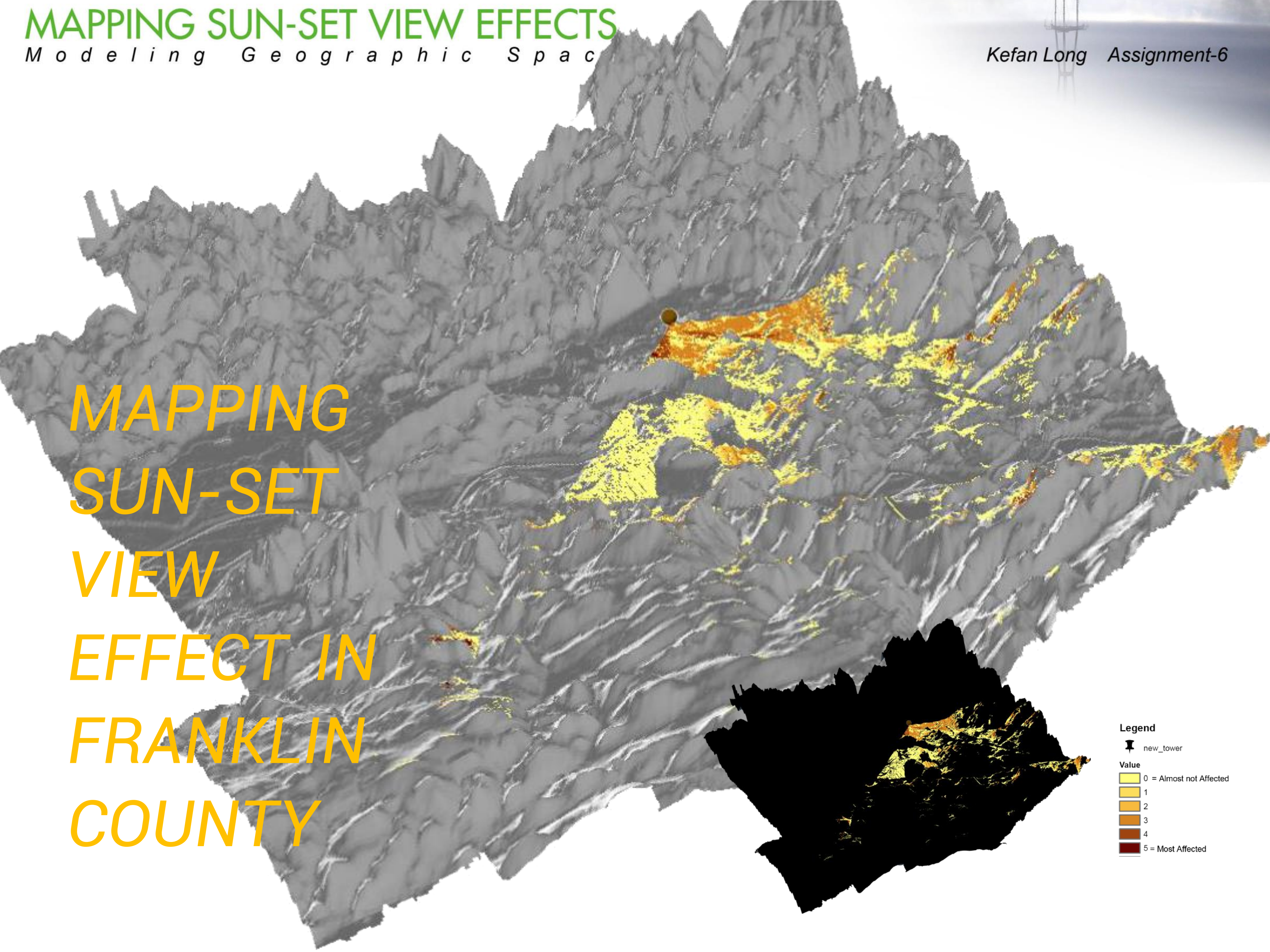
MAPPING SUN-SET VIEW EFFECTS

Modeling Geographic Spac

Kefan Long Assignment-6



MAPPING SUN-SET VIEW EFFECT IN FRANKLIN COUNTY

Goals

Generate a new grid on which values ranging from 0 to 5 indicate the likelihood that any given pixel will have its future sunset views be affected by a soon-to-be-sited cell phone tower.

Understanding of the Goal

Basically, this task consists of two main parts.

Part A: Siting the cell phone tower

1. Finding a suitable place for this "soon-to-be-sited" cell phone tower
2. Finding the sunset direction for this place

Part B: Grading & mapping the sun-set view effect

3. Define what is "sun-set view effect"
4. Setting different levels of "Sun-set view effect" and giving corresponding values when creating the new raster.

3. Definition of Sun-set View Effect

Since the height of new tower is not sure, I would define the effect as:

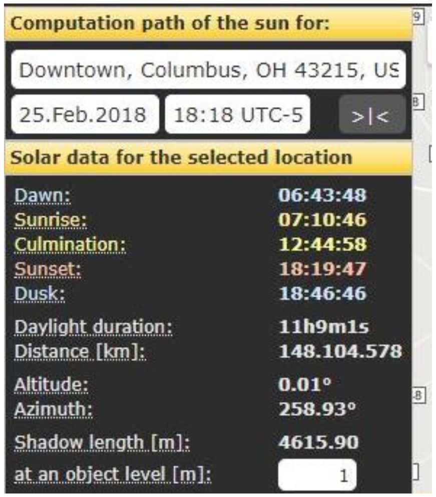
If you can see any part of the tower when its height is 5 meters from your place, you will see more of it when its height exceeds 5 meters. The sooner you see any part of a cell phone tower when its height increases, the more likely your position is to be affected by this cell phone tower when you view the sun-set.

2.Sun-set time, azimuth of the sun, and view scope.

We use the Feb-25, 2018 data from:

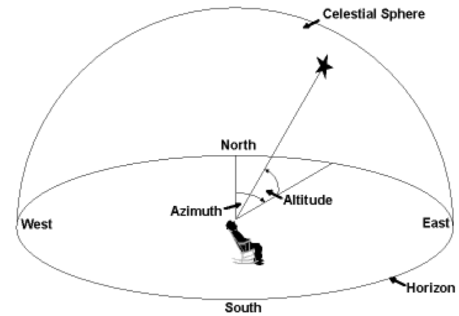
https://www.suncalc.org/#/39.9588,-82.9947,12/2018.02.25/18:18/1/0

From the sun-set time, we can set it as 18:18pm since the altitude of sun is still positive, and the corresponding azimuth is 258.93°.


Computation path of the sun for:
Downtown, Columbus, OH 43215, US
25.Feb.2018 | 18:18 UTC-5

Solar data for the selected location

Dawn:	06:43:48
Sunrise:	07:10:46
Culmination:	12:44:58
Sunset:	18:19:47
Dusk:	18:46:46
Daylight duration:	11h9m1s
Distance [km]:	148.104.578
Altitude:	0.01°
Azimuth:	258.93°
Shadow length [m]:	4615.90
at an object level [m]:	1

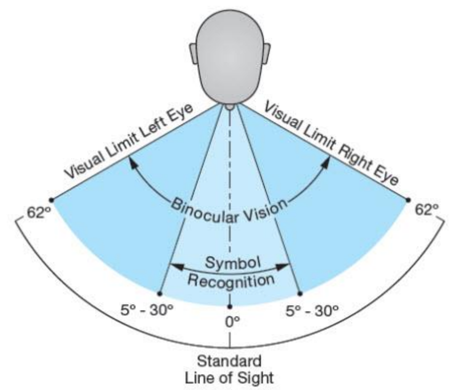


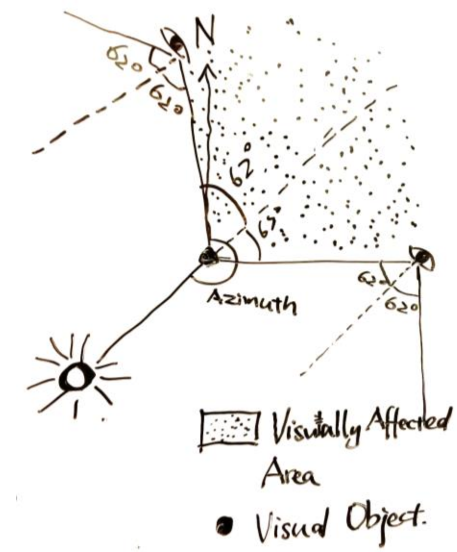
If a cell phone tower clearly appears in your visual view, then it partly influences the sun-set view from your eye. Current research has shown human's visual limit of two eyes is 124°. So we set the scope of residents visual view as 124°.

Based on the sun-set azimuth and human's visual limit, the visual scope of affected area should be:

(Azimuth-180-62, Azimuth-180+62)

The angle scope is (16.93°,140.93°)





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Part A: Siting a cell phone tower.

What's important for a new cell phone tower is: its users, its convenience of maintenance, its counter-positional relationship with built towers.

For the users' factor, we believe the denser road a pixel has in its neighborhood, the more likely it is to have more users. The higher grade the road is, the more likely it is to gather large user groups. So we choose the road raster and apply several "smoothing" steps to find those pixels with highest road value using focal statistics.

For the convenience of maintenance, we use Euclidean distance to select pixels whose distance to roads are less than 100 meters.

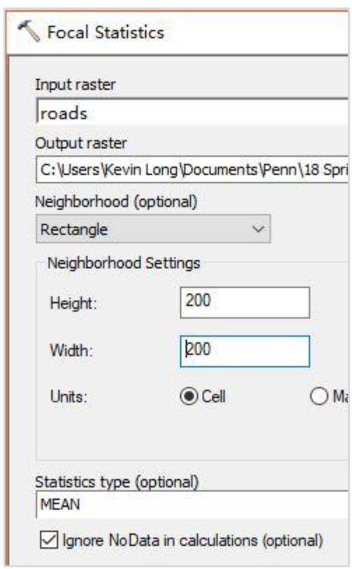
For the position, we use Euclidean distance to find pixels whose distance to current towers are less than 5000 meters. New tower should avoid these pixels so that the services wouldn't be largely overlapped.

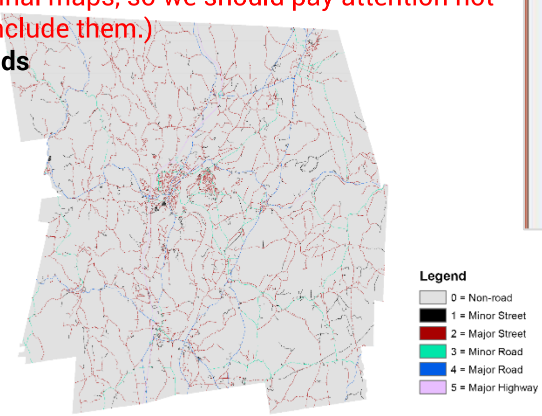
Step1: Finding pixels with high road value through "smoothing".

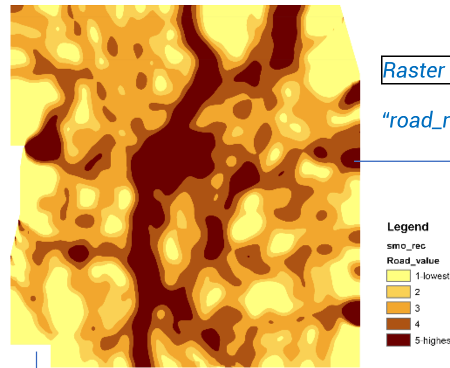
We directly use road raster and do 4 focal statistics-MEANs. Considering the cell size is 5m*5m, we set the method as: **triangle with 200 * 200 cells**. So each time we do a "smoothing" step, we consider the average road within 1000m * 1000m neighborhood.

Since we check "ignore NoData in calculation", every time we do a "smoothing", the edge of the raster will expand by 100 cells, which is 1000m.

(The edge of smoothing layers has some strange peaks because neighborhood calculation has expanded the raster size. Most high picks on edges are not located in original maps, so we should pay attention not to include them.)

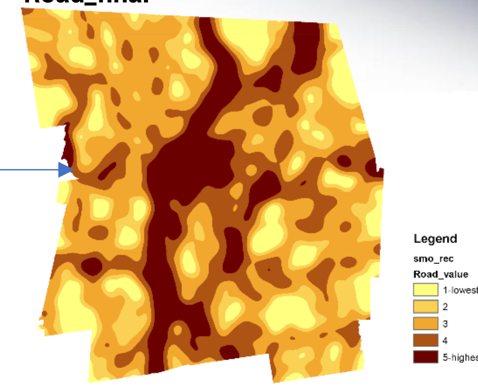


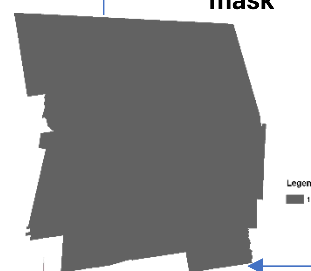




Raster calculator:

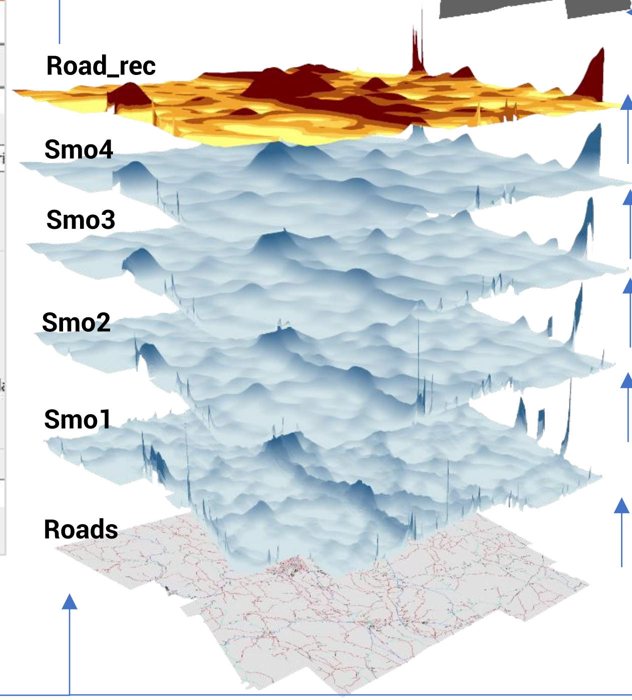
"road_rec" * "mask"





Reclassify:

All road values set equal to 1



Reclassify: quantile-5 classes

"smoothing"

"smoothing"

"smoothing"

"smoothing"

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M o d e l i n g   G e o g r a p h i c   S p a c e

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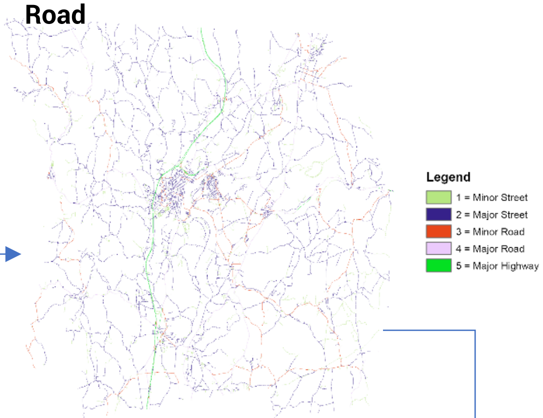
Step 2: Maintenance Factor

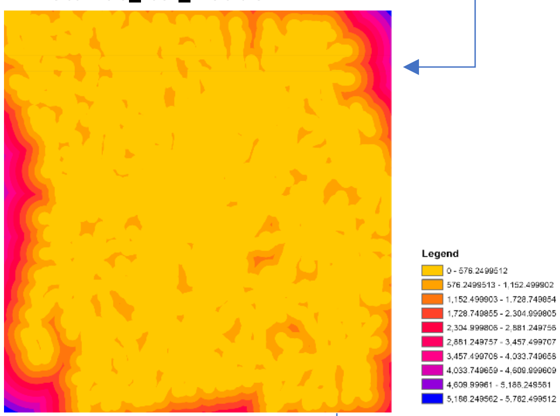
SetNull("Roads" == 0, "Roads")

Road



Distance_ to _Roads

Euclidean Distance

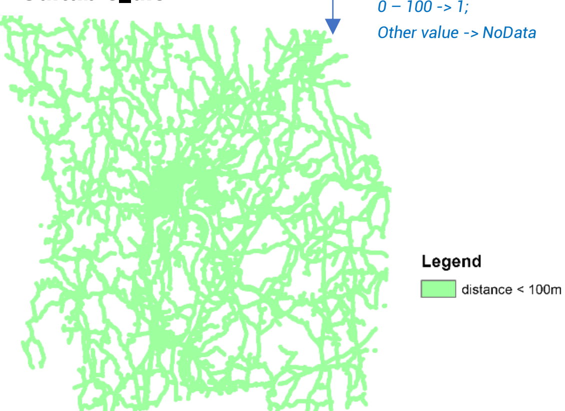


Reclassify:

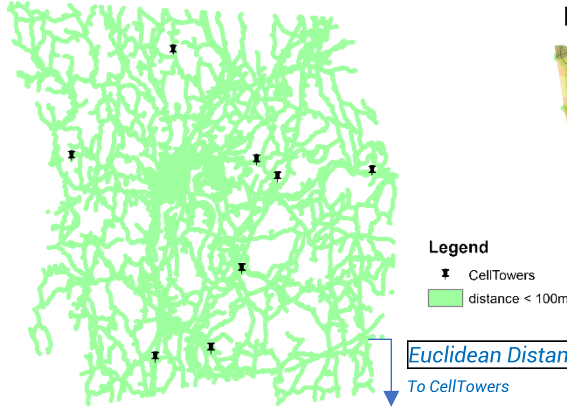
0 – 100 -> 1;

Other value -> NoData

Suitable_dis



Step 3: Avoiding Current Towers



Euclidean Distance

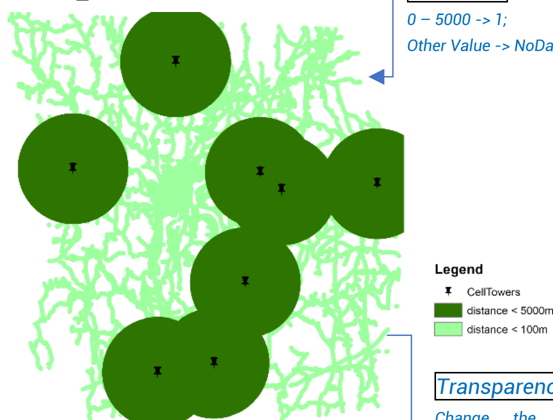
To CellTowers

Reclassify

0 – 5000 -> 1;

Other Value -> NoData.

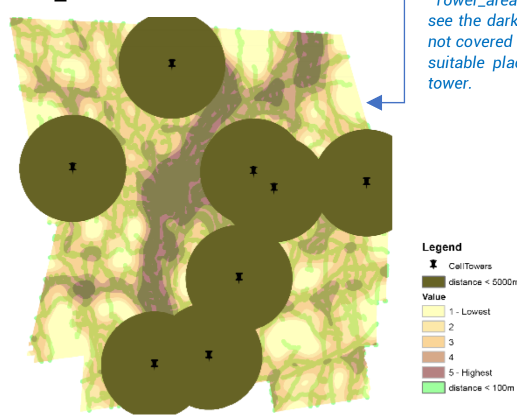
Tower_area



Transparency

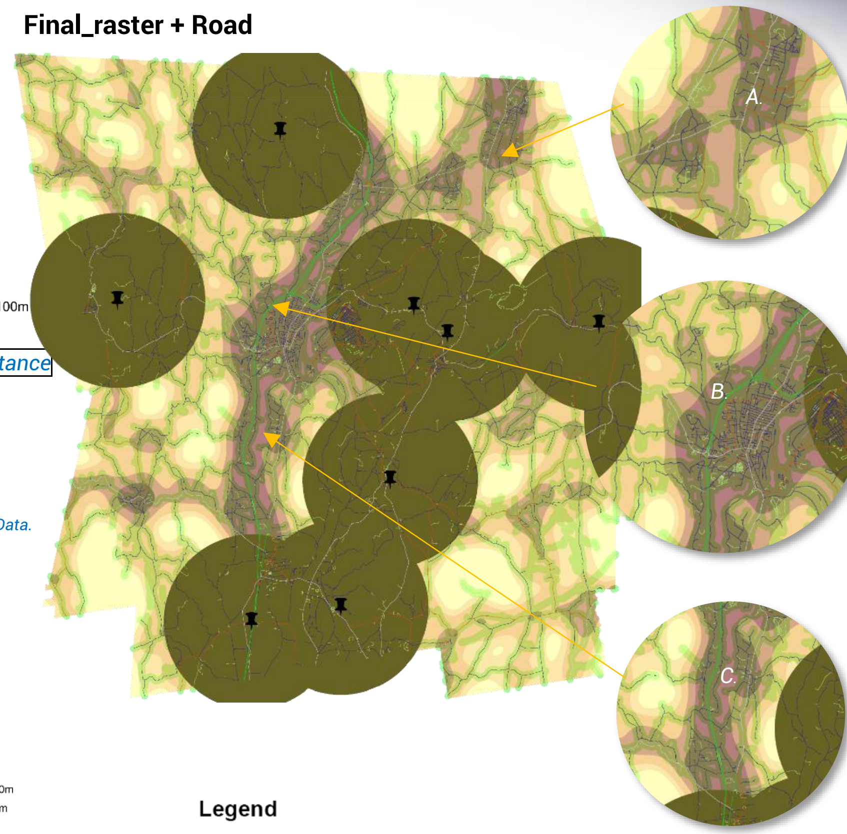
Change the "Road_final" transparency to 50% and put it between "Suitable_dis" and "Tower_area". Then we can see the darkest area that are not covered by circles are the suitable places for this new tower.

Final_raster



Step 4: Site Selection

Final_raster + Road



Legend

CellTowers
1 = Minor Street
2 = Major Street
3 = Minor Road
4 = Major Road
5 = Major Highway
distance < 5000m

Value

1 - Lowest
2
3
4
5 - Highest
distance < 100m

Check possible options and select

We overlap the "Road" raster on the "Final_raster" to see the three options.

Based on the current roads, option B has clearly larger road density than option A and C. So I would select site B as the place for this new cell phone tower.

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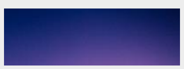
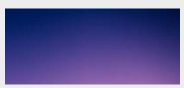
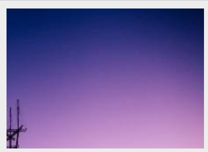
Part B: Grading & mapping the sun-set view effect

Step1: Explaining the sun-view effect.

Place\Tower Height	10m	20m	40m
A			
B			
C			

Can you tell which pictures are more “affected” by the tower between (A,10m), (B,20m), (C,40m)? Probably there isn’t a fixed answer, because the view is subjective, and we can judge the affect by the tower's visual proportion or its position on the view. But we can tell that place A is more “affected” by the reason that 10-meter tower appears on its view. For the same reason, B is more “affected” than C.

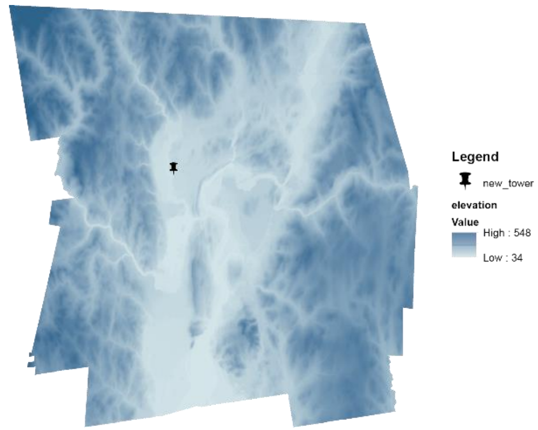
So we can define this “sun-set effect” by setting a list of tower heights and calculating viewsheds. Below is the affect chart we select.

Height	10m	20m	30m	40m	60m	250m
Class	5	4	3	2	1	0

We set the 60m line because any tower that is over than 200ft will require exrtra approval. And the 250m line is the height of Sutro Tower, one of the highest cell phone tower around the world.

Step2: Calculating Viewshed for 10m,20m,30m,40m,60m,250m.

Elevation + New_tower



Add 6 new shapefiles + each add a point

For each shapefile, edit it and add a point on the same place of B, which we find most suitable for the new tower.

Add Field called “OFFSETA”

1.For each point layer, right click to open its attribute table.

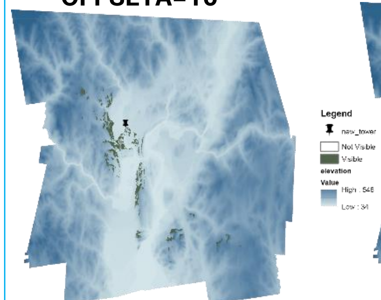
2.Add a field called “OFFSETA”(no wrong spell!)

3.Edit each point layer to add height to the OFFSETA field.

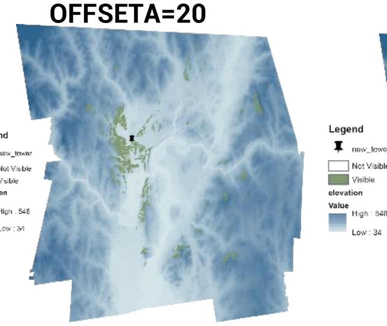
Viewshed Calculation

For each point layer, calculate its viewshed on the elevation raster, we will get 6 rasters of 1-0. 1 means visible. while 0 means not visible.

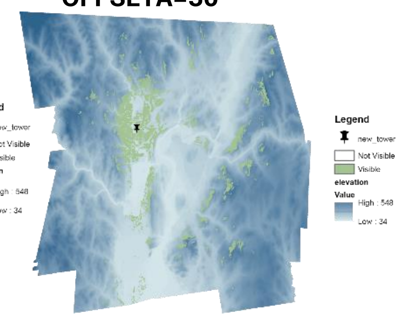
OFFSETA=10



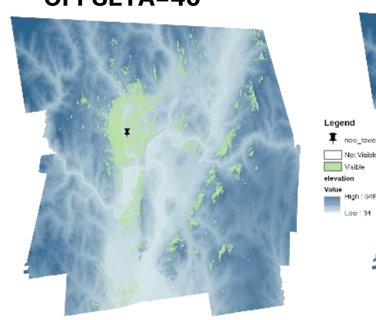
OFFSETA=20



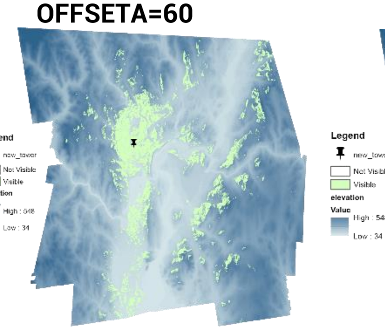
OFFSETA=30



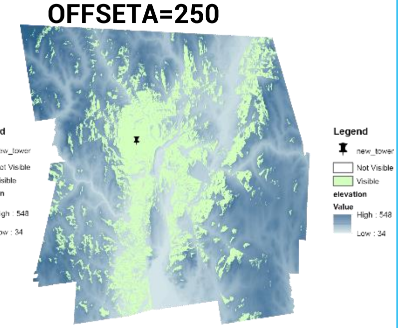
OFFSETA=40



OFFSETA=60



OFFSETA=250



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Step3 : *Viewsheds calculation and reclassify.*

If you can see any part of the tower when its height is 5 meters from your place, you will see more of it when its height exceeds 5 meters.

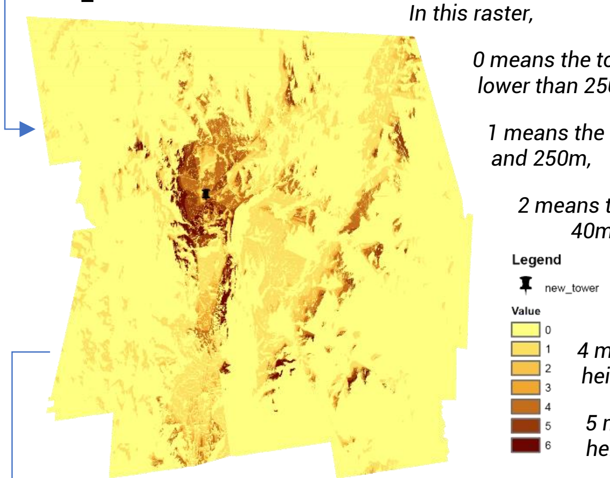
Since all viewshed rasters are "1-0" rasters, which 1 means visible and 0 means not visible, we can simply use raster calculator to add all these viewsheds. The higher value a pixel has in resulting raster, the more likely it is to be "affected" visually by this tower. (Due to our definition.)

Raster Calculator

The formula is:

"OFFSETA_10" + "OFFSTEA_20" + "OFFSETA_30" + "OFFSETA_40" + "OFFSETA_60" + "OFFSETA_250"

Sum_viewsheds



In this raster,

0 means the tower is not visible when its height is lower than 250m,

1 means the tower is visible between height 60m and 250m,

2 means the tower is visible between height 40m and 60m,

3 means the tower is visible between height 30m to 40m,

4 means the tower is visible between height 20m to 30m,

5 means the tower is visible between height 10m to 20m (10m not included),

6 means the tower is visible between height 0 to 10m.

To let it have the same value as affect chart, we use reclassify.

Reclassify

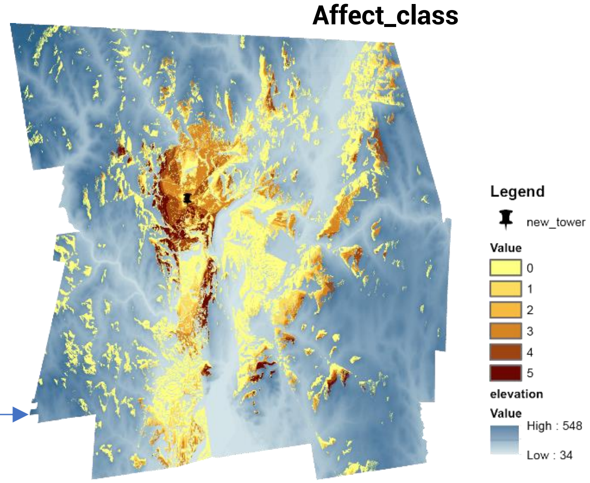
Input raster: sum_viewshed

Reclass field: Value

Reclassification

Old values	New values
0	NoData
1	0
2	1
3	2
4	3
5	4
6	5
NoData	NoData

Affect_class

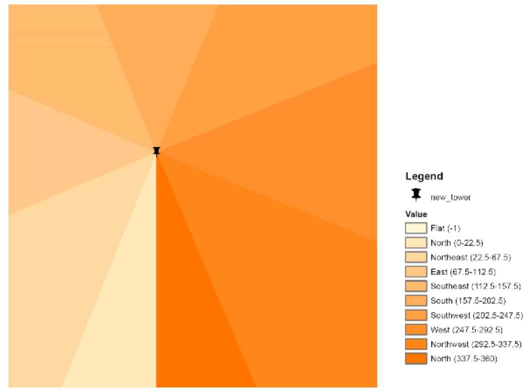


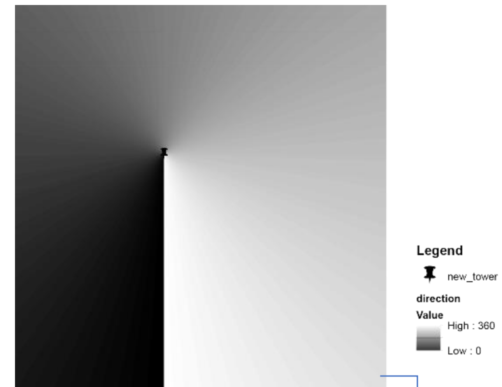
Step4 : *Finding the affected direction.*

From previous part, we calculated the angle scope that a visual object can affect in the Franklin County during its sun-set, and the scope is ***(16.93°,140.93°).***

To find this visual scope, we apply Euclidean direction to the new tower.

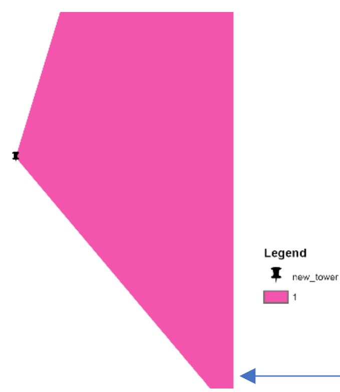
Dir_newtower → *Property* – *Symbology* – *Stretched Color* → **Dir_newtower**





Seeing from the stretch symbology, the Euclidean direction layer is calculated counter-clockwise, which is the same as azimuth, but starts from south. We should add 180 to the original angle scope, which turns out to be (196.93°, 320.93°). This is the angle scope that the object might influence, and we can use reclassify to keep it.

Dir_mask



Reclassify

Input raster: direction

Reclass field: Value

Reclassification

Old values	New values
0 - 196.93	NoData
196.93 - 320.93	1
320.93 - 360	NoData
NoData	NoData

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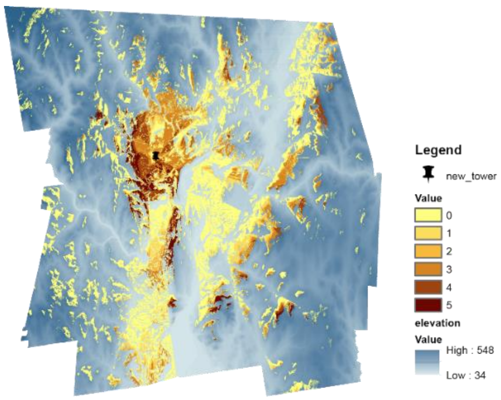
Step5 : *Keeps the viewshed pixels within the scope.*

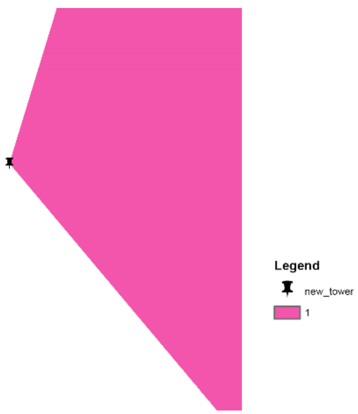
Although we have graded the affect level in step 3, we need to know that step 3 didn't involve any directions. This means you may see this tower in a direction that is not the sun-set direction.

To keep those pixels that fall into the sun-set view direction, we use raster calculator.

Affect_class



Dir_mask

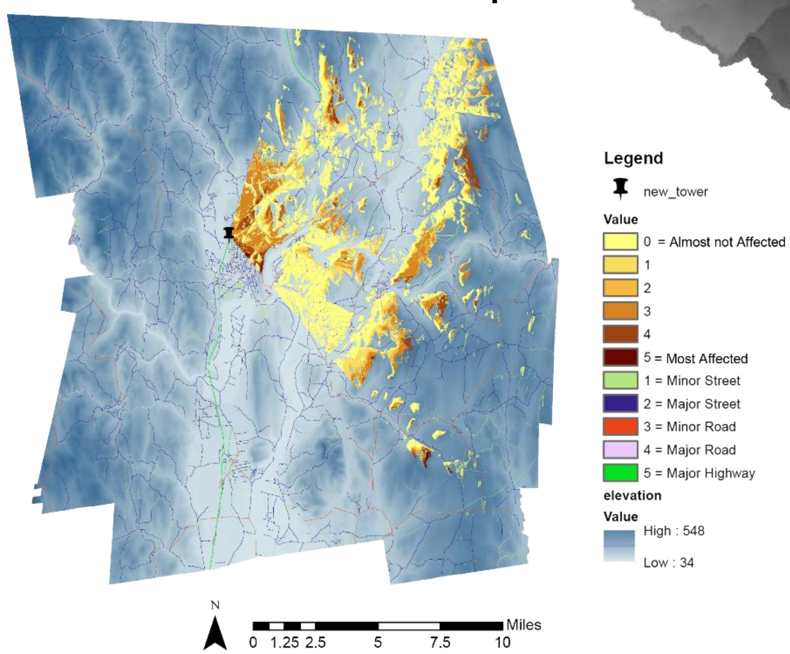


Raster Calculator

The formula is:

*"Affect_class" * "Dir_mask"*

Sun-set View Affect Map



Attention:

Here I did not give value zero to all other pixels. Because I want to use zero to represent a very small possibility that the pixels might be influenced by new tower on the sun-set view. There are three conditions:

a.The pixels that fall out of the sun-set angle scope is hardly influenced on its sun-set view.

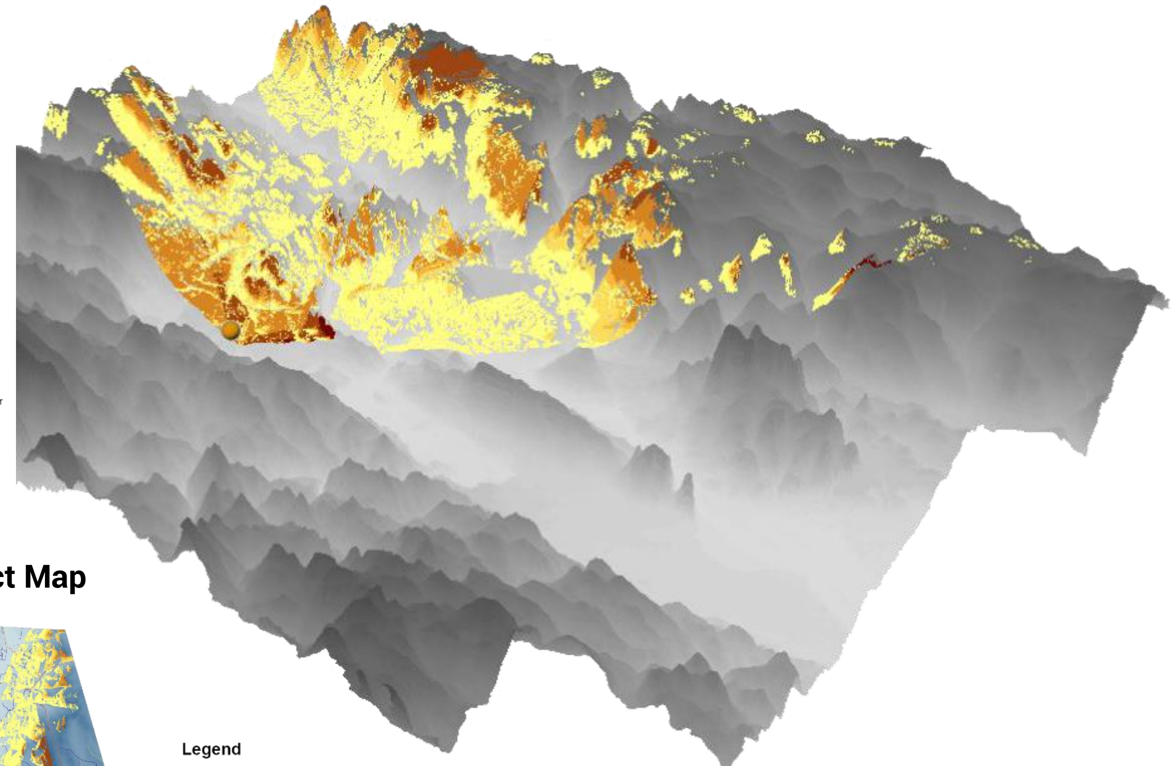
b. The possibility of the new tower to have a height that is higher than 250 is impossible.

c.Besides, the possibility of the new tower to have a height that is higher than 60m is very small.

I finally choose to only keep condition c as zero. For condition a and b, it is impossible to happen in such a small town. So pixels that fall in condition a and b are all set to null, and only condition c pixels are kept as zero.

View in ArcScene

Copy and paste the final class layer and the elevation layer to ArcScene. From the 3-D view, it is easy to distinguish these pixels that are affected by this new tower when it is sun-set time.



ArcScene Layer Properties Setting