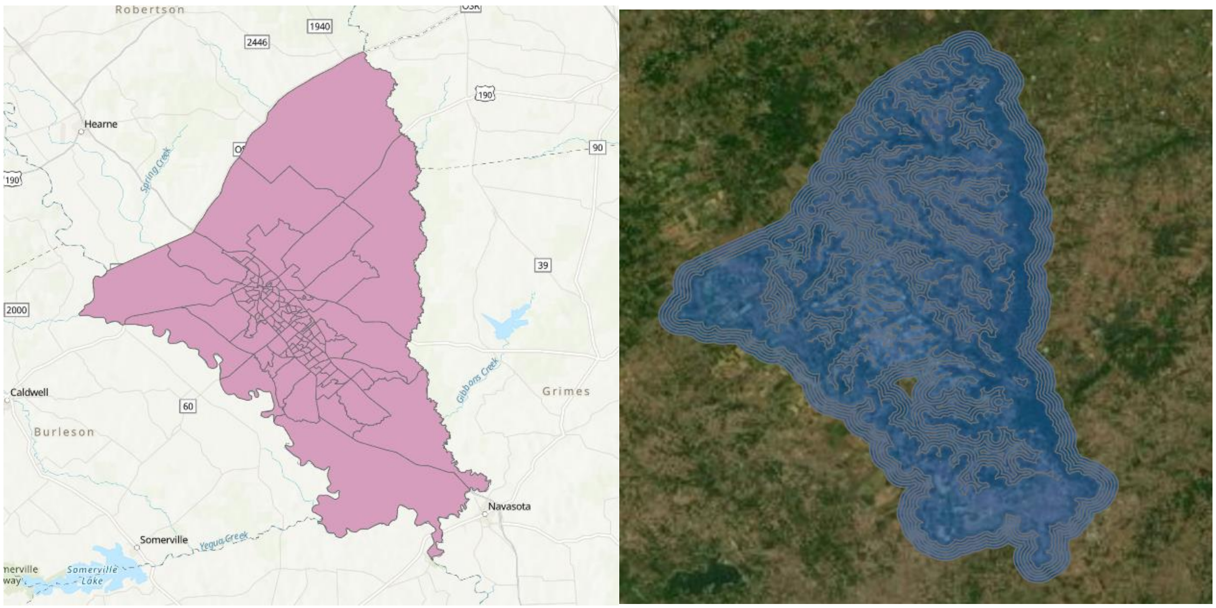
Madyson Bradford

GEOG 475 Section 504

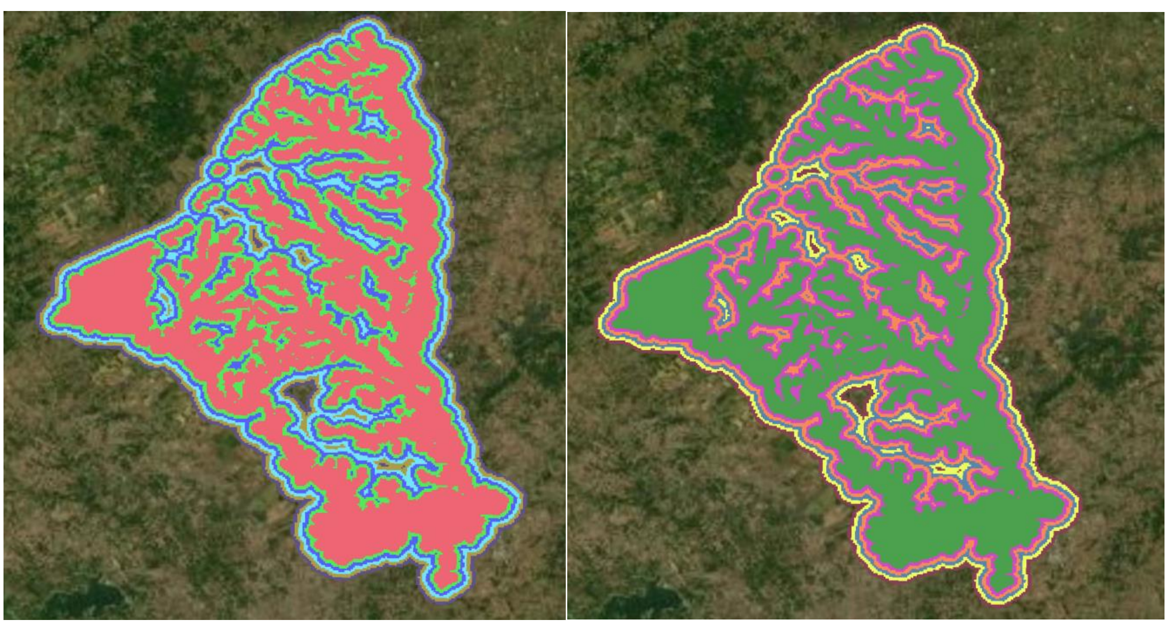
April 18 2021

Spatial Modeling

Criteria-Based Modeling

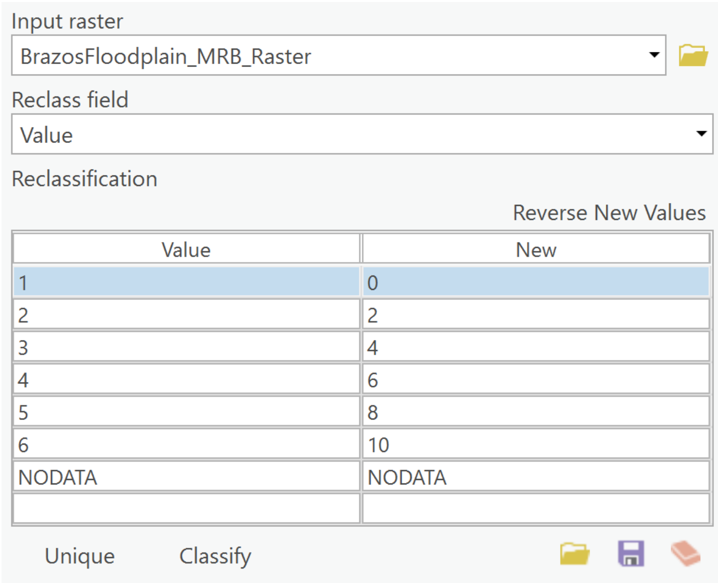


*Brazos County Clip from ACS Layer (**left**) & Floodplain Multiple Ring Buffer (**right**)*



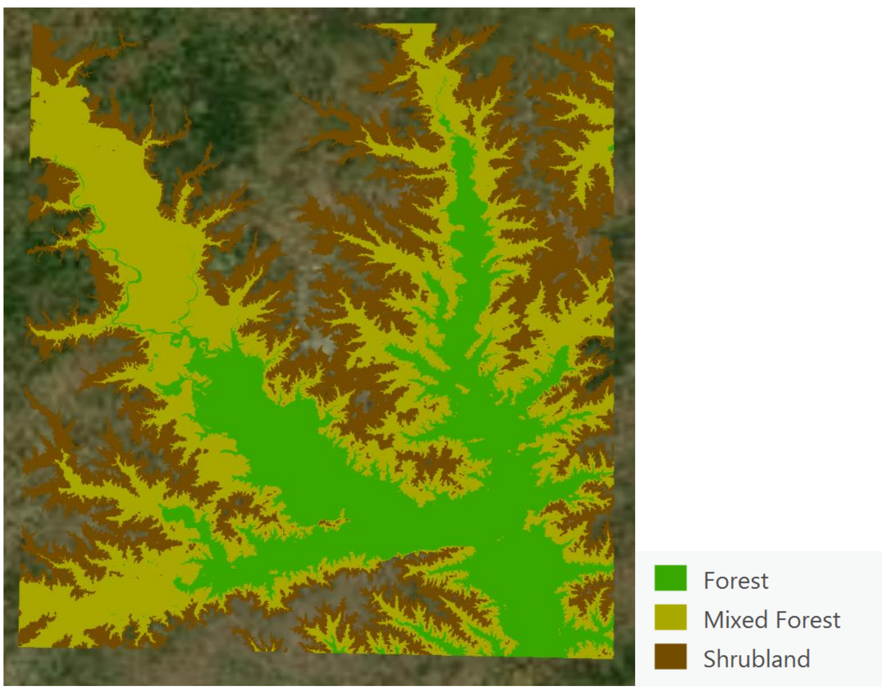
*Floodplain Multiple Ring Buffer after Polygon to Raster Tool (**left**) & Reclassed Floodplain Raster (**right**)*

Floodplain Multiple Ring Buffer: 0.25 mi, 0.5 mi, 0.75 mi, 1 mi, 1.25 mi, and 1.5 mi.

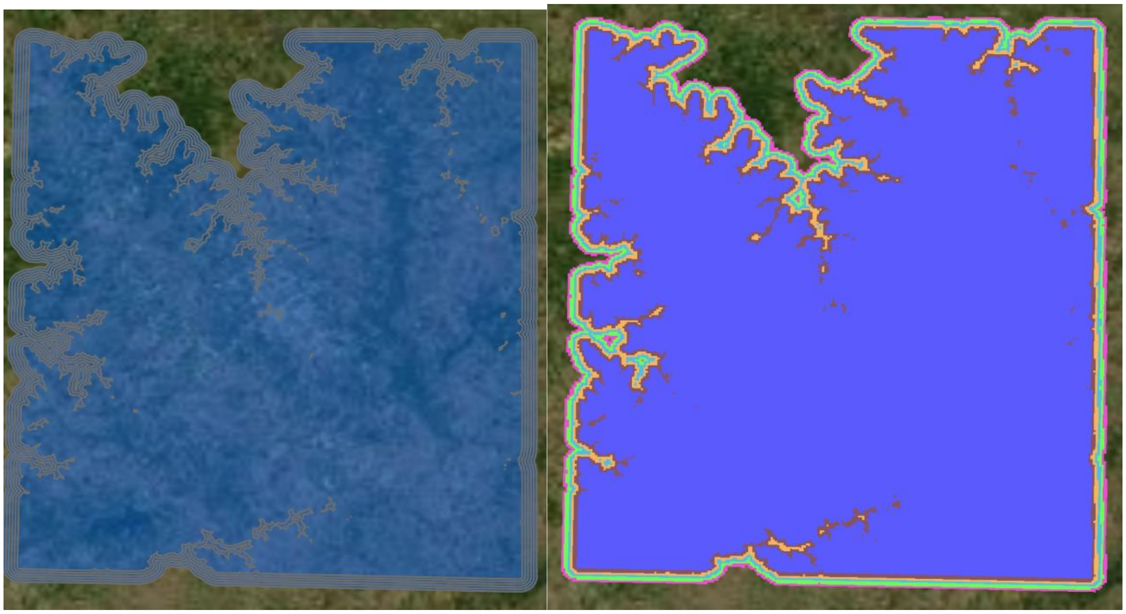


Value	New
1	0
2	2
3	4
4	6
5	8
6	10
NODATA	NODATA

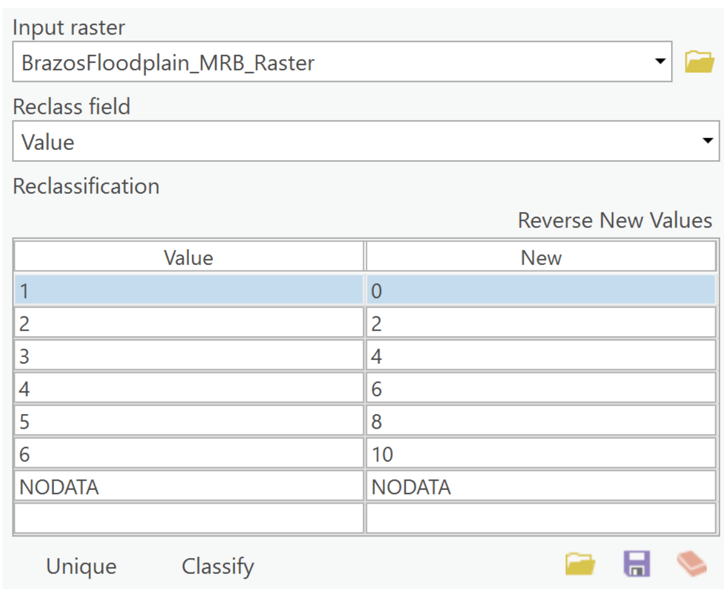
Reclassification scheme for the Floodplain Reclassification. Farther from flood zones was ranked higher (better).



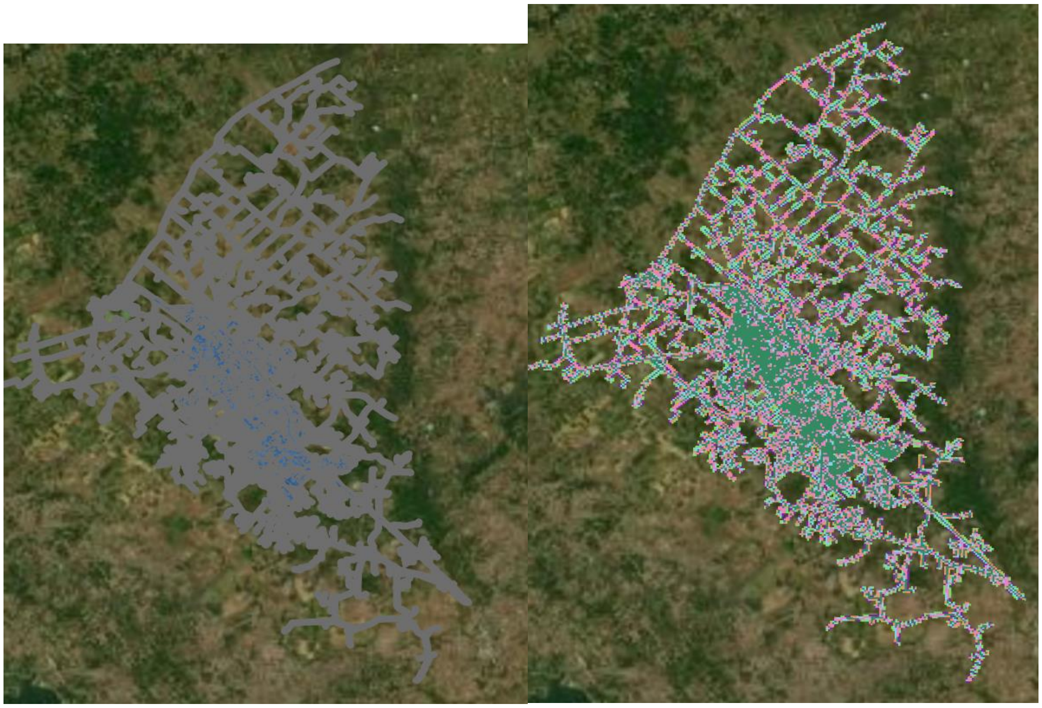
Unsupervised Classification of Forest Land Cover with post-processing to narrow down 3 main classes: Forest, Mixed Forest, and Shrubland.



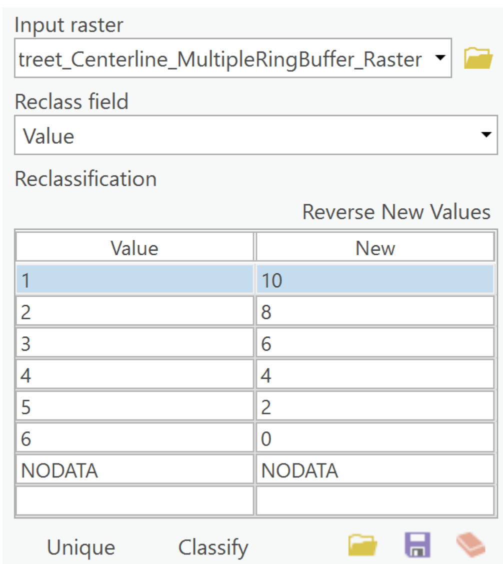
*Forest Cover Polygon Multiple Ring Buffer: 0.25 mi, 0.5 mi, 0.75 mi, 1 mi, 1.25 mi, and 1.5 mi. (**left**) and Forest Reclassification (**right**).*



Reclassification scheme for the Forest Landcover classes Reclassification. Closer to Forest was ranked higher (better) than farther away.



Street Centerlines Multiple Ring Buffer: 50 m, 100m, 150m, 200, 250m, and 300m, & Street Reclassification.

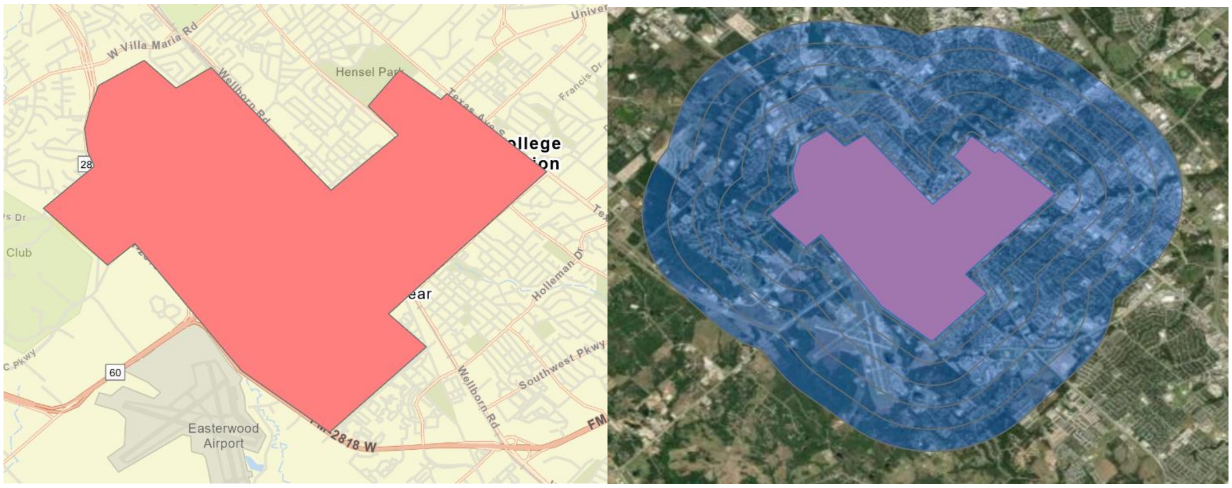


Input raster
treet_Centerline_MultipleRingBuffer_Raster
Reclass field
Value
Reclassification
Reverse New Values

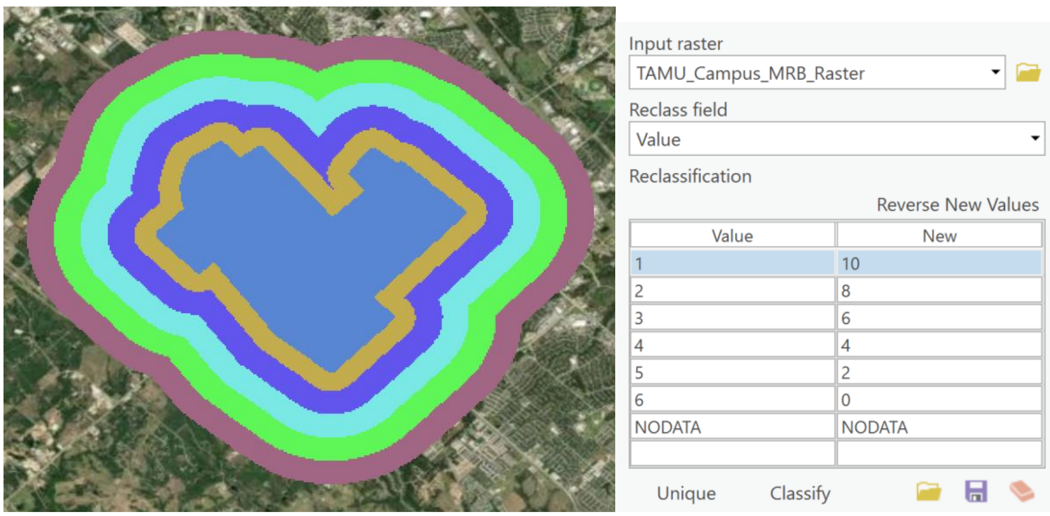
Value	New
1	10
2	8
3	6
4	4
5	2
6	0
NODATA	NODATA

Unique Classify

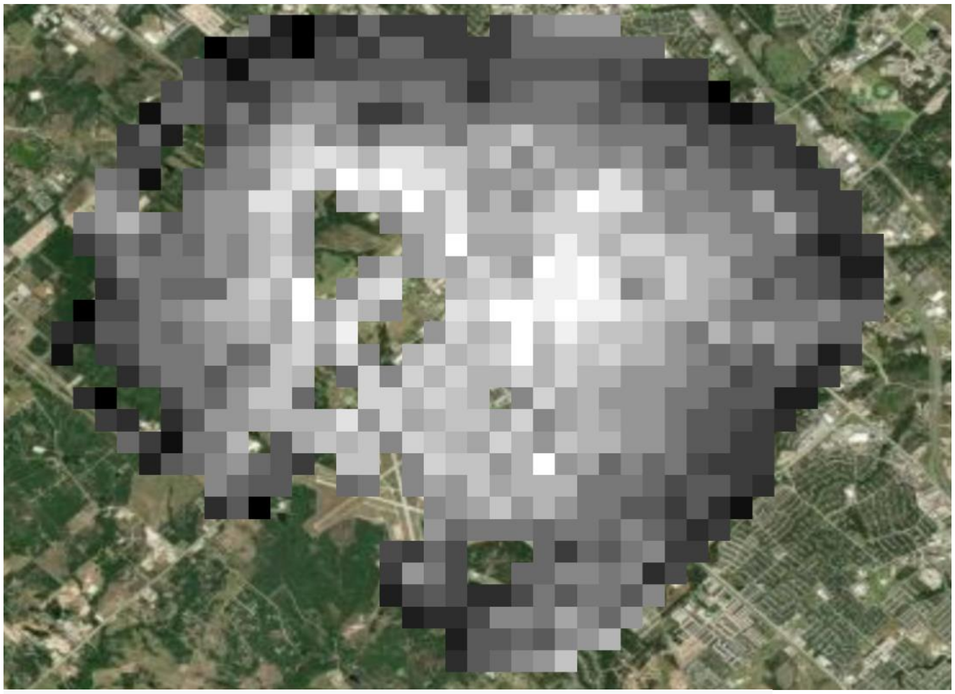
Streets reclassification scheme: closer is better and ranked higher (10).



*Digitization of TAMU Campus (**left**), & TAMU Multiple Ring Buffer (**right**): 100m, 500m, 1000m, 1500m, 2000m 2500m.*



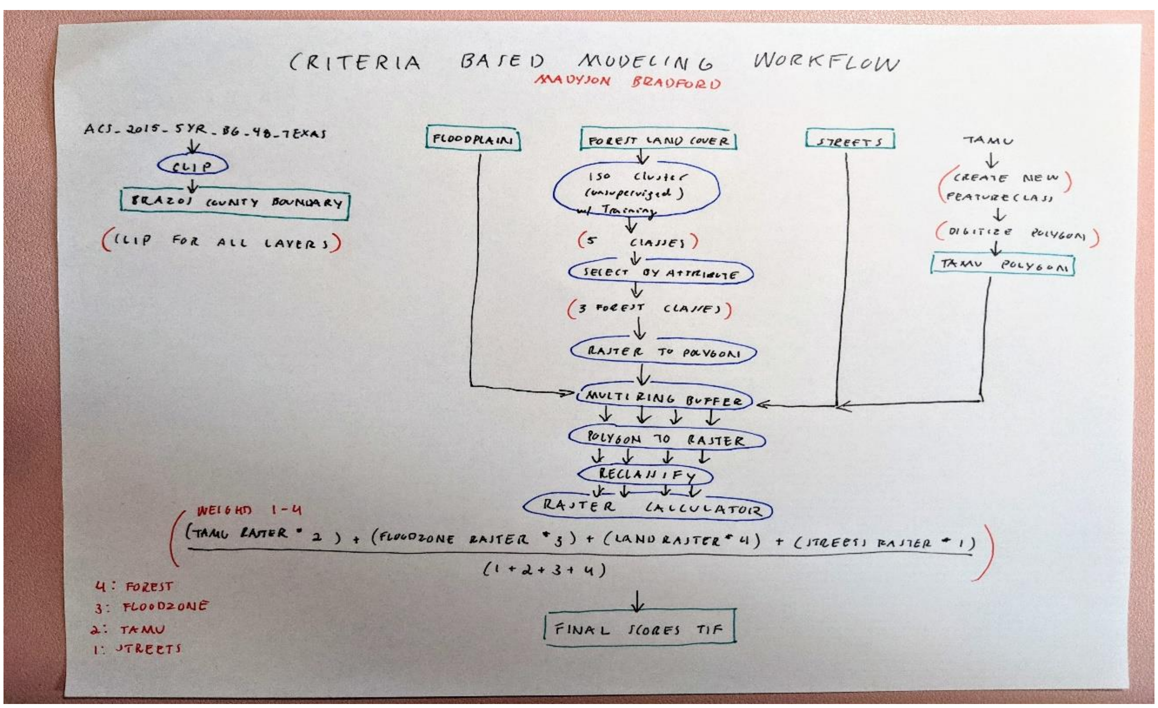
*TAMU Reclassification (**left**) & Reclassification scheme (**right**): closer is ranked highest (better).*



```
(("TAMU_reclass"*2)+("Streets_Reclass"*1)
+("Forest_Reclassification"*4)
+("Floodplain_Reclass"*3))/(1+2+3+4)
```

Final Overlay Analysis and Associated Merging Equation.

Develop your conceptual workflow that highlights data, processing, suitability ranking and suitability-site modeling. Describe the overall workflow.



Here is the overall workflow I used for the Criteria based modeling. After making sure all the layers were clipped to the Brazos County Boundary, the analysis could begin. The Floodplains and Streets classes required the least amount of processing, since they could immediately be put in Buffers and reclassified. The next simplest process was digitizing the TAMU campus area (I used the entire campus as delineated by streets base map) which was then put in buffers and reclassified. The Forest land cover took the longest, with an unsupervised ISO Cluster done in ArcGIS Pro that created 5 classes based off the North American land cover datasets. I picked 3 kinds of vegetation: Forest, Mixed Forest, and Shrubland. Once that was converted to a polygon, buffered, and converted back to raster format it was treated the same way as the other data with a reclassification.

Justify your choice of data and processing for producing each criteria map.

For the floodplain criteria map, I justified the farthest distance (1.5 miles) as the best choice with a rank of 10 because it is not ideal to live near flood zones. Living near a flood zone is extremely hazardous, since risk of flooding is so much higher in those areas.

For the Forest Land Cover criteria, I chose closest to forested areas as more ideal, and therefore ranked higher than farther away. Forested land helps mitigate urban noise, as well as provides an aesthetic elements with natural greenery.

For the Street Centerline criteria, I ranked closer as better. Access to streets makes travel a lot easier in the area, and also shortens drive time significantly. Access to roads is vital to reducing overall travel time, whether it be work or school. This also allows greater access to amenities like grocery stores and restaurants, or medical attention if needed.

For the TAMU criteria I ranked closer to campus as more ideal. Especially for students, travel time to campus is very important because it dictates your entire schedule. Whether you can go home between classes is heavily dictated by distance to campus, since those who lived in Bryan may not be close enough to justify leaving campus between classes. This adds to convenience.

How did you rank your criteria maps?

Each criteria map was ranked from 0 – 10 at intervals of 2, depending on suitability. The only criteria map where the closer the buffer the lower the ranking was the Flood Plain map, since that was the only criteria that proximity to is actually detrimental. Each map had 6 different buffer distances, so the rankings were consistently 0, 2, 4, 6, 8, and 10: ranging from Not suitable to Excellent.

How can you justify the weights that you used in your model?

I ranked Forest Land Cover as the most important criteria (Weight = 4), then Flood Zone (Weight = 3), then TAMU proximity (Weight = 2), and lastly Street Centerlines (Weight = 1). I can justify the weights by explaining how Forested Land cover is most important to me, since greenery is key to happiness and relaxation. Happiness and relaxation are my highest priority, despite the important of Flood Zone. Flood zone proximity had to be second since, being the only negative criteria, was important especially since damage can be very expensive. TAMU proximity ended up more heavily weighted than street centerlines, mainly because proximity to campus may allow walking rather than having to use roads.

Do different weights produce different index results?

I did try different a different set of weights, where each criteria map was rated from 1 to 125, each one going up a scale of 5. This did change the index results, so the final index ended up more homogenous and less detailed than my original ranking. This is the main reason I ended up returning to my original weights of 1-4.

Do you think that the suitability-site model accurately represents the best location to build your home in Brazos County? Explain the reasons behind your answer.

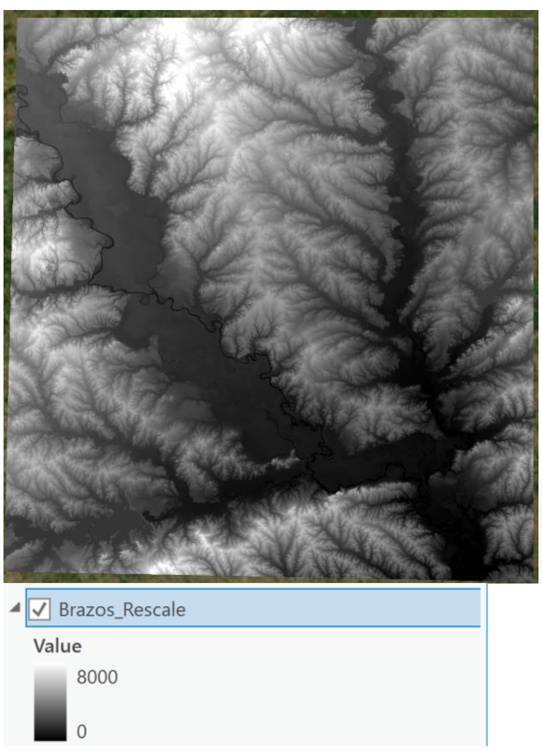
I do believe the suitability-site model accurately represents the best location to build my home in Brazos County. Areas closer to campus with more forest and less proximity for flood plains were ranked with the highest index values, with areas near the fringes of the raster having the lowest values. This directly corresponds with the way I defined the reclassifications, ranked, and subsequently weighted the importance of the criteria. It appears slightly right of the center of the raster is where the home will be built.

If you had to do it all over again (please don't do this), what would you do differently?

If I were to do this all over again, I would probably try a supervised approach of the Forest Land Cover just to see how much more accurate the locations would be. If unsupervised was this well trained, then supervised would likely create an even more accurate depiction of forested areas. I would also want to try out more classification tools, since that was the most fun part of Part 1.

Numerical Modeling

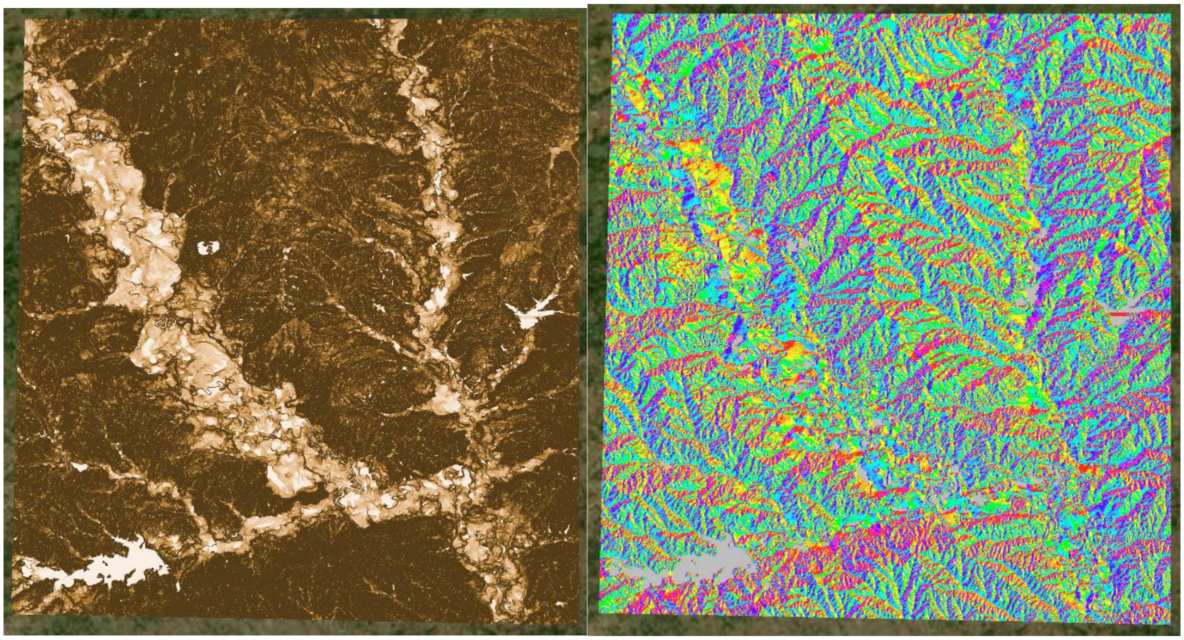
July 4th 2020 9am, 12pm, and 4pm used.



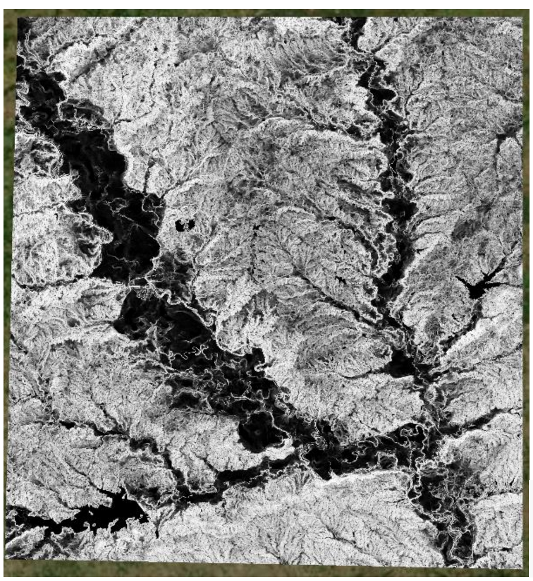

```
[("Brazos_Numerical_Raster" - "Brazos_Numerical_Raster".minimum) /
("Brazos_Numerical_Raster".maximum -
"Brazos_Numerical_Raster".minimum)]*8000
```

*Brazos DEM Rescale by 8000 (**left**), with Rescaling of the DEM by 8000 equation (**right**)*

CALCULATING COSi FOR EACH TIME

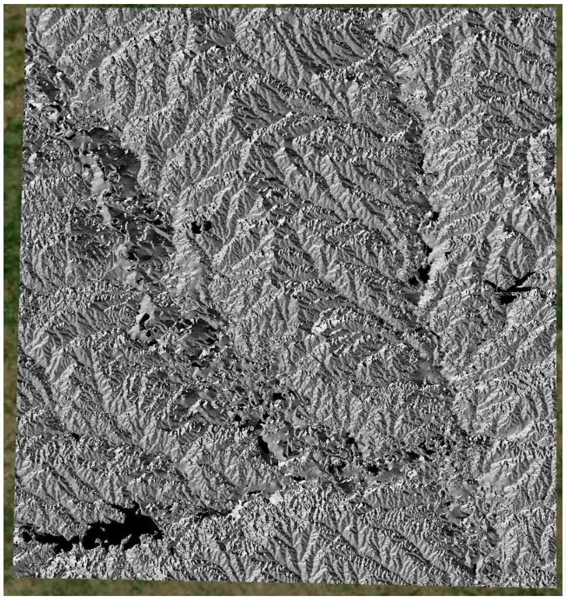


*Rescaled DEM Slope Raster (**left**), and Aspect Raster (**right**).*



```
("Brazos_Slope_Degree" * 3.1415)/180
```

Rescaled DEM Slope Raster converted to radians with equation.



```
("Brazos_Aspect_Rad" > 0) * "Brazos_Aspect_Rad"
```

```
("Brazos_Aspect_Rad" > 0) * "Brazos_Aspect_Rad"
```

Rescaled DEM Aspect Raster converted to Radians and made positive with associated equations.

```
Cos(0.593412) * Cos("Brazos_Slope_Rad") + Sin(0.593412) * Sin("Brazos_Slope_Rad") * Cos
(1.6427039 - "Brazos_Aspect_Rad_Positive")
```

9am: Cosi Raster with equation: Solar azimuth = 94.12 degrees → 1.6427039 radians, Solar zenith = 34 degrees → 0.593412 radians (calculated from solar elevation, where solar elevation = 90 – zenith).

```
Cos(0.18238691) * Cos("Brazos_Slope_Rad") + Sin(0.18238691) * Sin
("Brazos_Slope_Rad") * Cos(3.89819288 - "Brazos_Aspect_Rad_Positive")
```

12pm: Cosi Raster with equation: Solar azimuth = 223.35 degrees → 3.89819288 radians, Solar zenith = 10.45 degrees → 0.18238691 radians (calculated from solar elevation, where solar elevation = 90 – zenith).

```
Cos(1.049641) * Cos("Brazos_Slope_Rad") + Sin(1.049641) * Sin
("Brazos_Slope_Rad") * Cos(4.89233243 - "Brazos_Aspect_Rad_Positive")
```

4pm: Cosi Raster with equation: Solar azimuth = 280.31 degrees → 4.89233243 radians, Solar zenith = 60.14 degrees → 1.049641 radians (calculated from solar elevation, where solar elevation = 90 – zenith).

CALCULATING M_R0 FOR EACH TIME

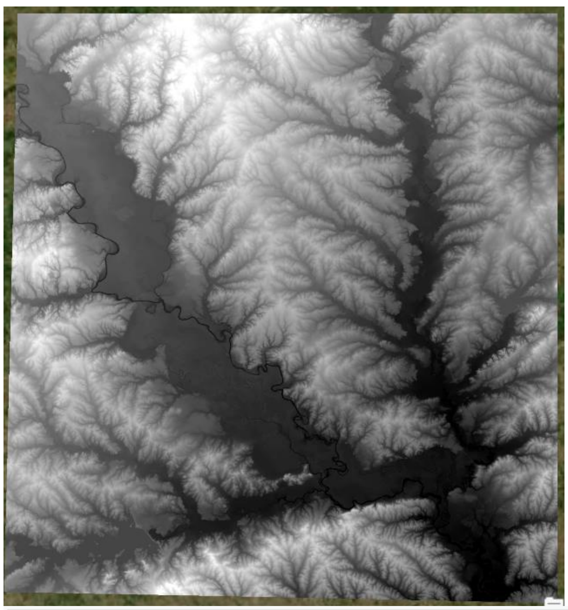
$$((\cos(1.6427039) + 0.15(93.885 - 1.6427039)^{-1.253}))^{-1} = -14.0197450367$$

$$(\cos(3.89819288) + 0.15(93.885 - 3.89819288)^{-1.253})^{-1} = -1.37619721864$$

$$(\cos(4.89233243) + 0.15(93.885 - 4.89233243)^{-1.253})^{-1} = 5.57055345069$$

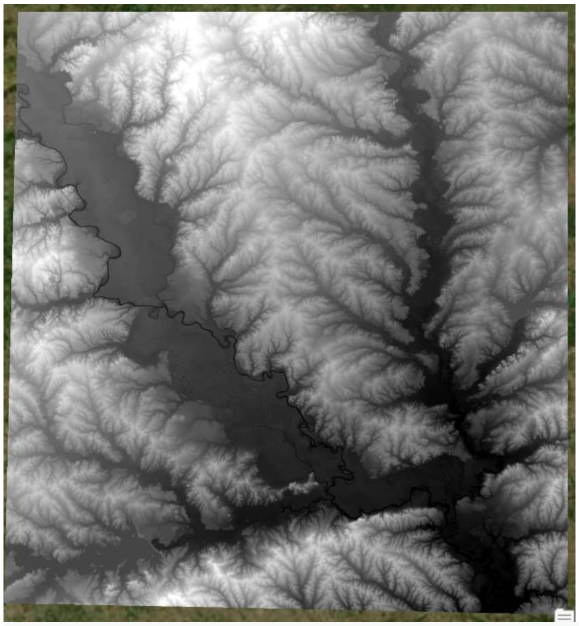
*9am m_r0 (**top left**), 12pm m_r0 (**top right**), and 4pm m_r0 (**bottom left**)*

CALCULATING M_R FOR EACH TIME



```
(-14.0197450367)*Exp(-0.0001184*"Brazos_Rescale")
```

9am m_r with associated equation (m_r0 = -14.09…).



```
(-1.37619721864)*Exp(-0.0001184*"Brazos_Rescale")
```

12pm m_r with associated equation (m_r0 = -1.37…).

```
(5.57055345069)*Exp(-0.0001184*"Brazos_Rescale")
```

4pm m_r with associated equation (m_r0 = 5.57…).

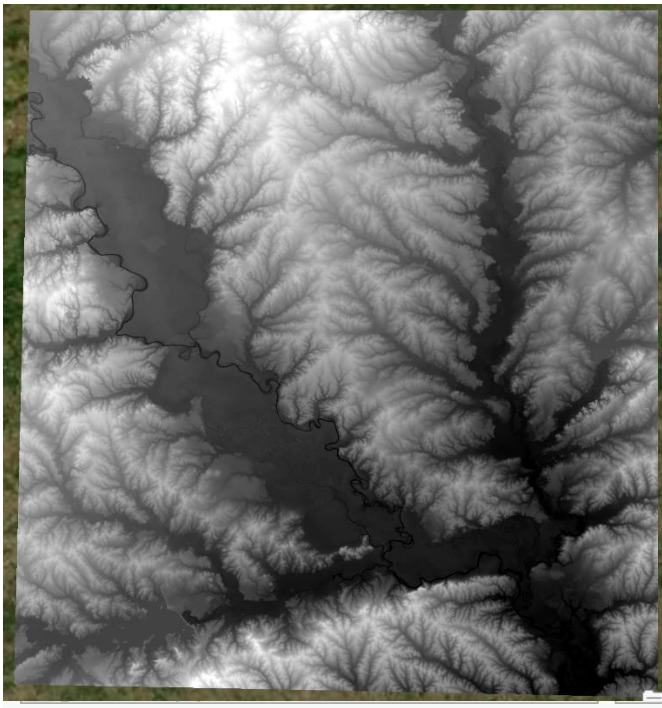
CALCULATING TRANSMITTANCE FOR EACH TIME

```
Exp(-0.008735 * (0.651 ** -4.08) * "Brazos_mr_9am")
```

9am Transmittance with associated calculation.

```
Exp(-0.008735 * (0.651 ** -4.08) * "Brazos_mr_12pm")
```

12pm Transmittance with associated calculation.



```
Exp(-0.008735 * (0.651 ** -4.08) * "Brazos_mr_4pm")
```

4pm Transmittance with associated equation.

CALCULATING DIRECT IRRADIANCE FOR EACH TIME

```
1608 * ("Brazos_T_9am") * ("Brazos_cosi_9am")
```

9am Direct Irradiance with associated equation.

```
1608 * ("Brazos_T_12pm") * ("Brazos_cosi_12pm")
```

12pm Direct Irradiance with Associated Equation.

```
1608 * ("Brazos_T_4pm") * ("Brazos_cosi_4pm")
```

4pm Direct Irradiance with associated equation.

Describe the spatial and temporal patterns associated with cosi.

The spatial patterns associated with cosi are dependent on the solar angles, so they cast different shadows depending on the time. The 12pm cosi raster has the most intricate details of cosi, considering how the sun is highest the sky at that point. Cosi is very dependent on the orientation of the topography, which explains the spatial differences as they're affected by the solar angles. This ties into the temporal aspect, because depending on the time the same area has a completely different range of cosi values. The range is largest at 12pm, next largest at 9am, and smallest at 4pm. This could have to do with the amount of sun reaching the Earth's surface at those times, since cosi values are dependent on the angle of the sun.

Describe the spatial and temporal patterns associated with $\tau\downarrow\tau\downarrow$. What are they associated with?

The spatial and temporal patterns associated with transmittance may appear similar, but the largest difference occurs between the morning times (9am and 12pm) and the late afternoon time (4pm). You can see the pattern in the 4pm transmittance raster is an inverted version of the earlier rasters. This spatial distribution associated with the time is associated with the increased Raleigh scattering that occurs during the afternoon, since the ephemeris is much increased during that time of day. The farther light travels through the ephemeris, the more scattering occurs and this causes decreased transmittance values. That is also why the transmittance values are much lower at the 4pm time. You can also see this in the m_r calculations, where the 4pm calculation of the optical air mass is the only positive value calculated between the three times.

Describe the spatial and temporal patterns associated with Eb given your simulations? Do the spatial patterns of irradiance change with time? Are there magnitude differences? What causes this?

Given the simulations, you can see a clear difference in Direct Irradiance depending on the time of day. The highest values in Direct Irradiance are seen in the 9am time, with the lowest value seen in the later afternoon at 4pm. You can see the slightly longer shadows in the 9am raster, with much shorter shadows at 12pm, and the longest shadows at 4pm. This shading emulates the amount of Direct Irradiance, since the values reach their highest at 9am, with the shortest range at 12pm when the sun is highest in the sky and almost all of the topography is fully illuminated. There is an obvious shift with time. The magnitude is most similar between the 9am and 4pm times when the sun is at an angle, with a clear magnitude difference seen at 12pm. This because the 12pm time has the most areas illuminated, and therefore much fewer low values. All of these values are affected by the time of year, so these summer values (July 4rth, 2020) will be more extreme than other times of year.

ALL THE MATH I DID WRITTEN OUT (PROOF OF CALCULATIONS)

(next page)

July 4th 2020 9am, 12pm, and 4pm used.

475 lab 4 CALCULATIONS.

minimum = 42.76283 78418

maximum = 168.2189941406

$E_b(\lambda) = E^{o}(\lambda)\, \tau^{v}(\lambda) \cos$

$E^{o} = 1608$

$m_r^{o} = \{\cos\theta_s + 0.15\,(93.885 - \theta_s)^{-1.253}\}^{-1}$

July 4rth 2020

9am $\theta_s = 94.12°$ } azimuth — zenith cos = 0.829

12pm $\theta_s = 223.35°$ — zenith cos = 0.9834

4pm θ_s = 280.31° — zenith cos = 0.4979

9am radian : 1.6427039

12pm radian : 3.89814288 } azimuth

4pm radian : 4.89233243

elevation = 90 − zenith, so...

9am = 56 = 90 − zenith = 34° = 0.593412

12pm = 79.55 = ~~9am~~ 90 − zenith = 10.45° = 0.18238691

4pm = 29.86 = 90 − zenith = 60.14° = 1.049641

9am $m_r^{o} = [\cos\text{ine } 9am + 0.15\,(93.885 - \overset{1.6427}{\cancel{94.12}})^{-1.253}]^{-1} = -14.0197450367$

12pm $m_r^{o} = [\cos\text{ine } 12pm + 0.15\,(93.885 - \overset{3.8981}{\cancel{223.35}})^{-1.253}]^{-1} = -1.376197 21864$

4pm $m_r^{o} = [\cos\text{ine } 4pm + 0.15\,(93.885 - \overset{4.8923}{\cancel{280.31}})^{-1.253}]^{-1} = 5.57055345069$

9am m_r = 9am m_r^{o} exp(−0.000118 4 * DEM) =

12pm m_r = ~~12am~~ m_r^{o} exp(−0.0001184 * DEM) =

4pm m_r = 4pm m_r^{o} exp(−0.0001184 * DEM) =

9am $\exp(-0.008735\,(0.651)^{-4.08}\ 9am\,m_r)$

12pm $\exp(-0.008735\,(0.651)^{-4.08}\ 12pm\,m_r)$

4pm $\exp(-0.008735\,(0.651)^{-4.08}\ 4pm\,m_r)$

9am $E_b(\lambda) = 1608\,(T\text{-}9am)(\cos i\ 9am)$

12pm $E_b(\lambda) = 1608\,(T\text{-}12pm)(\cos i\ 12pm)$

4pm $E_b(\lambda) = 1608\,(T\text{-}4pm)(\cos i\ 4pm)$