**Homework 1 Solution**

**GIS in Water Resources**

**Fall 2012**

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1. *Map Projection Parameters*
2. *What earth datum is used in this coordinate system?*

North American 1983

1. *What map projection is used in this coordinate system?*

Lambert Conformal Conic

1. *Sketch on the map the standard parallels, the central meridian and the latitude of origin of this projection.*



1. *For this projection, what are the coordinates of the origin (φo, λo) (in units of degrees minutes and seconds) and the corresponding (Xo, Yo) (in units of feet?*

$$\left(ϕ\_{0},λ\_{0}\right)=\left(29°40'0"N;100°20'0"W\right)$$

 $\left(x\_{0},y\_{0}\right)=\left(2,296,583.33;9,842,500.00\right)ft$

1. *Locations on the Earth*

Austin $ϕ=30°17'10"N=30+17/60+10/3600=30.2861°$

 $λ=97°44^{'}22"W=97+44/60+22/3600=-97.7394°$

 $Lat,Long=\left(30.2861°,-97.7394°\right)$

Logan $ϕ=41°44'54"N=41+44/60+54/3600=41.7483°$

 $λ=111°48^{'}30"W=111+48/60+30/3600=-111.8083°$

 $Lat,Long=\left(41.7483°,-111.8083°\right)$

Lincoln $ϕ=40°49'09"N=40+49/60+9/3600=40.8192°$

 $λ=96°41^{'}55"W=96+41/60+55/3600=-96.6986°$

 $Lat,Long=\left(40.8492°,-96.6986°\right)$

Distances on the Earth

1. Logan to Austin

Logan $ϕ\_{A}=41.7483°\left({π}/{180°}\right)=0.728646$

 $λ\_{A}=-111.8083°\left({π}/{180°}\right)=-1.951424$

Austin $ϕ\_{B}=30.2861°\left({π}/{180°}\right)=0.528592$

 $λ\_{B}=-97.7394°\left({π}/{180°}\right)=-1.705875$

$$R=6.371km$$

$$Dist=Rcos^{-1}\left[\sin(ϕ\_{A})\sin(ϕ\_{B})+\cos(ϕ\_{A})\cos(ϕ\_{B})\cos(\left(λ\_{A}-λ\_{B}\right))\right]$$

$$Dist=1,791km$$

1. Austin to Lincoln

Austin $ϕ\_{B}=30.2861°\left({π}/{180°}\right)=0.528592$

 $λ\_{B}=-97.7394°\left({π}/{180°}\right)=-1.705875$

Lincoln $ϕ\_{B}=40.8192°\left({π}/{180°}\right)=0.712429$

 $λ\_{B}=-96.6986°\left({π}/{180°}\right)=-1.687709$

$$R=6.371km$$

$$Dist=Rcos^{-1}\left[\sin(ϕ\_{A})\sin(ϕ\_{B})+\cos(ϕ\_{A})\cos(ϕ\_{B})\cos(\left(λ\_{A}-λ\_{B}\right))\right]$$

$$Dist=1,175km$$

1. Lincoln to Logan

Lincoln $ϕ\_{B}=40.8192°\left({π}/{180°}\right)=0.712429$

 $λ\_{B}=-96.6986°\left({π}/{180°}\right)=-1.687709$

Logan $ϕ\_{A}=41.7483°\left({π}/{180°}\right)=0.728646$

 $λ\_{A}=-111.8083°\left({π}/{180°}\right)=-1.951424$

$$R=6,371.0km$$

$$Dist=Rcos^{-1}\left[\sin(ϕ\_{A})\sin(ϕ\_{B})+\cos(ϕ\_{A})\cos(ϕ\_{B})\cos(\left(λ\_{A}-λ\_{B}\right))\right]$$

$$Dist=1,265km$$

Slopes

1. Logan to Austin

$$S=\frac{4,789-693}{1,791}\left(\frac{0.3048}{1,000}\right)=0.0007$$

The water would flow from Logan to Austin

1. Austin to Lincoln

$$S=\frac{693-1,174}{1,175}\left(\frac{0.3048}{1,000}\right)=0.0001$$

The water would flow from Lincoln to Austin

1. Lincoln to Logan

$$S=\frac{1,174-4,789}{1,265}\left(\frac{0.3048}{1,000}\right)=0.0009$$

The water would flow from Logan to Lincoln

1. *Web Mercator Coordinates*

$$LatDD,LongDD=29.9942,-98.0886$$

The relationships between the Geographic Coordinates and the Web Mercator Coordinates are the following:

$$WebMercatorX=Semimajor Axis×LongDD$$

$$WebMercatorX=6,378,137m\left(-98.0886\right)\left({π}/{180}\right)$$

$$WebMercatorX=-10,919,173m≈-10,919,174m$$

$$WebMercatorY=Semiminor Axis×LongDD$$

$$WebMercatorY=6,356,752.31m\left(29.9942\right)\left({π}/{180}\right)$$

$WebMercatorY=3,327,744m\ne 3,502,800m$

The pair of coordinates in the X direction (Longitude) follows a simple relationship. In contrast, the pair of coordinates in the Y direction does not follow the simple relationship: $Wm=R\_{e}×Angle$. This means that for the projection, the X direction is conserved and the error is carried by the Y direction (with a correction). This is because the Mercator is a cylindrical map projection and in the cylinder is oriented from South to North.



1. *Sizes of DEM cells*

$$R\_{e}=6,371.0km$$

$$∆λ=∆ϕ={1}/{8}°=\left(0.125°\right)\left({π}/{180°}\right)=2.1817×10^{-3}$$

1. Austin

$$ϕ=30.2861°=0.528592$$

$$\overbar{AB}=R\_{e}∆λ\cos(ϕ)$$

$$\overbar{AB}=\left(6,371.0km\right)\left(2.1817×10^{-3}\right)\cos(\left(0.528592\right))$$

$$\overbar{AB}=12.00km$$

$$\overbar{AC}=R\_{e}∆ϕ$$

$$\overbar{AC}=\left(6,371.0km\right)\left(2.1817×10^{-3}\right)$$

$$\overbar{AC}=13.90km$$

$$\overbar{ABCD}=12.00×13.90=166.8km^{2}$$

1. Logan

$$ϕ=41.7483°=0.728646$$

$$\overbar{AB}=R\_{e}∆λ\cos(ϕ)$$

$$\overbar{AB}=\left(6,371.0km\right)\left(2.1817×10^{-3}\right)\cos(\left(0.728646\right))$$

$$\overbar{AB}=10.37km$$

$$\overbar{AC}=R\_{e}∆ϕ$$

$$\overbar{AC}=\left(6,371.0km\right)\left(2.1817×10^{-3}\right)$$

$$\overbar{AC}=13.90km$$

$$\overbar{ABCD}=10.37×13.90=144.1km^{2}$$

1. Lincoln

$$ϕ=40.8192°=0.712429$$

$$\overbar{AB}=R\_{e}∆λ\cos(ϕ)$$

$$\overbar{AB}=\left(6,371.0km\right)\left(2.1817×10^{-3}\right)\cos(\left(0.728646\right))$$

$$\overbar{AB}=10.52km$$

$$\overbar{AC}=R\_{e}∆ϕ$$

$$\overbar{AC}=\left(6,371.0km\right)\left(2.1817×10^{-3}\right)$$

$$\overbar{AC}=13.90km$$

$$\overbar{ABCD}=10.52×13.90=146.2km^{2}$$