**Homework 1 Solution**

**GIS in Water Resources**

**Fall 2011**

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1. Map Projection Parameters

The map below shows Nebraska and the display parameters of the State Plane coordinate system for Nebraska.

 

(a) Sketch on the map the standard parallels, the central meridian and the latitude of origin of this projection.



(b) For this projection, what are the coordinates of the origin (o, o) and the corresponding (Xo, Yo) ?

**(o, o) = (39° 50’ N, 100° W)**

**(Xo, Yo) = (1640416.667, 0.000)**

(c) What earth datum is used in this coordinate system?

The earth datum is **GCS** (Geographic Coordinate System) **North American of 1983, or NAD83.**

(d) What map projection is used in this coordinate system?

**Lambert Conformal Conic**

2. Locations on the Earth

Using ArcGIS Explorer Online and zooming to Austin, Logan and Lincoln reveals the following designated locations for these universities. Convert these locations into decimal degrees.

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

 $λ=97°44^{'}22"W=-\left(97+44/60+22/3600\right)=-97.7394°$

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

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

 $λ=111°48^{'}30"W=-\left(111+48/60+30/3600\right)=-111.8083°$

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

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

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

 $Lat,Long=\left(40.8192°,-96.6986°\right)$

**3. Distances on the Earth**

Calculate the great circle "curved earth" distance between each combination of universities (i.e. UT to USU, UT to UNL and USU to UNL). Assume a spherical earth with radius 6378.137 km.

The great circle distance is given by the formula

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

with $R=6,378.137km$

1. Utah to Austin

Utah $ϕ\_{A}=41.7483°\left({π}/{180°}\right)=0.72865$

 $λ\_{A}=-111.8083°\left({π}/{180°}\right)=-1.95142$

Austin $ϕ\_{B}=30.2861°\left({π}/{180°}\right)=0.52859$

 $λ\_{B}=-97.7394°\left({π}/{180°}\right)=-1.70588$

$$Dist=1,793.35km$$

1. Austin to Lincoln

Austin $ϕ\_{B}=0.52859$

 $λ\_{B}=-1.70588$

Lincoln $ϕ\_{B}=40.8192°\left({π}/{180°}\right)=0.71243$

 $λ\_{B}=-96.6986°\left({π}/{180°}\right)=-1.68771$

$$Dist=1,176.29km$$

1. Lincoln to Utah

Lincoln $ϕ\_{A}=0.71243$

 $λ\_{A}=-1.68771$

Utah $ϕ\_{B}=0.72865$

 $λ\_{B}=-1.95142$

$$Dist=1,266.53km$$

**4. Sizes of DEM Cells**

Digital elevation models are stored in geographic coordinate systems with units of degrees, minutes and seconds. When applied, they are projected to a coordinate system in which the (X,Y) coordinates are in meters. Suppose you have a DEM cell that is 1” x 1” (1 arcsecond x 1 arcsecond) in latitude and longitude and that you are working on a spherical earth with radius 6378.137 km. Calculate the corresponding distances AB and AC in meters, and the area ABCD in square meters, for this cell on a spherical earth, at Austin, Logan and Lincoln.



$$R\_{e}=6,378.137km$$

$$∆λ=∆ϕ=00°00'01"=\left(0.000278°\right)\left({π}/{180°}\right)=4.8481×10^{-6}$$

The distance $\overbar{AC}$ is the same for all the cases:

$$\overbar{AC}=R\_{e}∆ϕ$$

$$\overbar{AC}=\left(6,378.137km\right)\left(4.8481×10^{-6}\right)$$

$$\overbar{AC}=30.922m$$

1. Austin

 $ϕ=30.2861°=0.52859$

$$\overbar{AB}=R\_{e}∆λ\cos(ϕ)$$

$$\overbar{AB}=\left(6,378.137km\right)\left(4.8481×10^{-6}\right)\cos(\left(0.52859\right))$$

$$\overbar{AB}=26.702m$$

$$Area=30.922×26.702$$

$$Area=825.68m^{2}$$

1. Utah

 $ϕ=41.7483°=0.72865$

$$\overbar{AB}=R\_{e}∆λ\cos(ϕ)$$

$$\overbar{AB}=\left(6,378.137km\right)\left(4.8481×10^{-6}\right)\cos(\left(0.72865\right))$$

$$\overbar{AB}=23.070m$$

$$Area=30.922×23.070$$

$$Area=713.37m^{2}$$

1. Lincoln

 $ϕ=40.8192°=0.71243$

$$\overbar{AB}=R\_{e}∆λ\cos(ϕ)$$

$$\overbar{AB}=\left(6,378.137km\right)\left(4.8481×10^{-6}\right)\cos(\left(0.71243\right))$$

$$\overbar{AB}=23.401m$$

$$Area=30.922×23.401$$

$$Area=723.61m^{2}$$