Name:______________________

GIS in Water Resources Midterm Exam **Fall 2008**

There are 4 questions on this exam. Please do all 4.

1. Basic Concepts [20 points]

Find the letter with the best answer for each term:

1._____	Datum	A.	Area(s) where a projection's scale is 100%–not enlarged or shrunken.
2._____	Parallels	B.	Model(s) that approximates the earth's shape as a flattened sphere
3._____	Standard parallels	C.	Any potential model of the earth–the basis for a coordinate system.
4._____	Meridians	D.	Line(s) of longitude
5._____	Secant, tangent	E.	Variation(s) on geometric projections in which the applied shape either rests on top of the earth's surface or cuts through the earth's surface
6._____	Ellipsoid	F.	Geometric type(s) of projections
7._____	Cylindrical, conic	G.	Line(s) of latitude

(b) Consider the following information types relevant to GIS in water resources. Indicate the *data type* for each of the data layers below which best represents the spatial entity and/or variable in GIS from (A) Vector, (B) Raster, (C) Triangulated Irregular Network, and (D) vector and time series graph (E) NetCDF file. Indicate the *data source* (i.e. organization) that provides datasets for each of these information types. For each information type, indicate whether or not the data can be obtained through *web services*.

Catchment:

River reaches:

National Elevation Dataset:

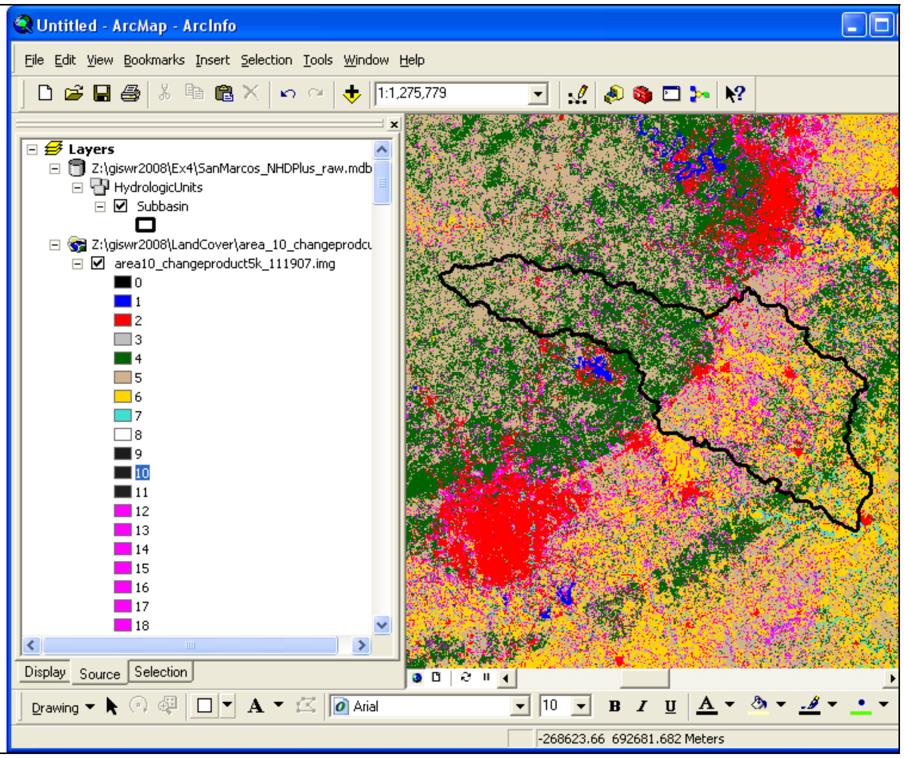
Rainfall:

Streamflow:

2. [25 points] **Land Cover Change in the San Marcos Basin**

The image below shows land cover change in the San Marcos basin from 1992 to 2001 obtained from http://www.mrlc.gov/multizone_map2.php in a file for Region 10. The numbers 1 through 7 define the principal land use categories in the San Marcos basin and the two-digit categories refer to land cover change from one of the basic categories to another.

VALUE	CATEGORY
1	Open Water
2	Urban
3	Barren
4	Forest
5	Grassland/Shrub
6	Agriculture
7	Wetlands



(a) The coordinate system for **Land Cover Change** raster image is shown below. To the right of each entry in this table, please describe what this entry specifies.

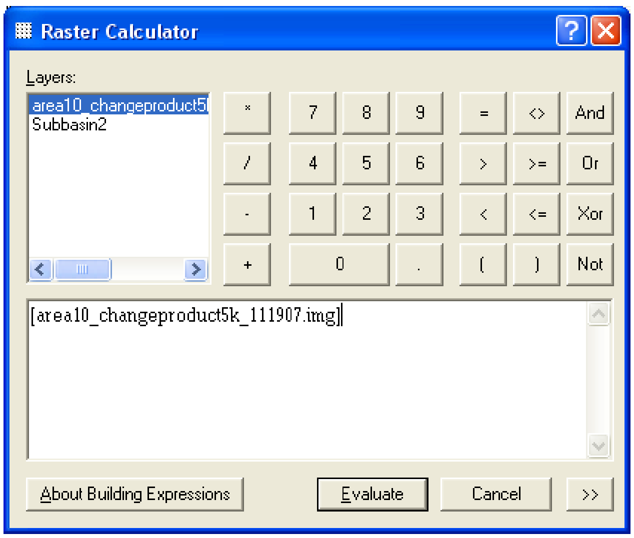
Description

USA_Contiguous_Albers_Equal_Area_Conic
Projection: Albers
False_Easting: 0.000000
False_Northing: 0.000000
Central_Meridian: -96.000000
Standard_Parallel_1: 29.500000
Standard_Parallel_2: 45.500000
Latitude_Of_Origin: 23.000000
Linear Unit: Meter

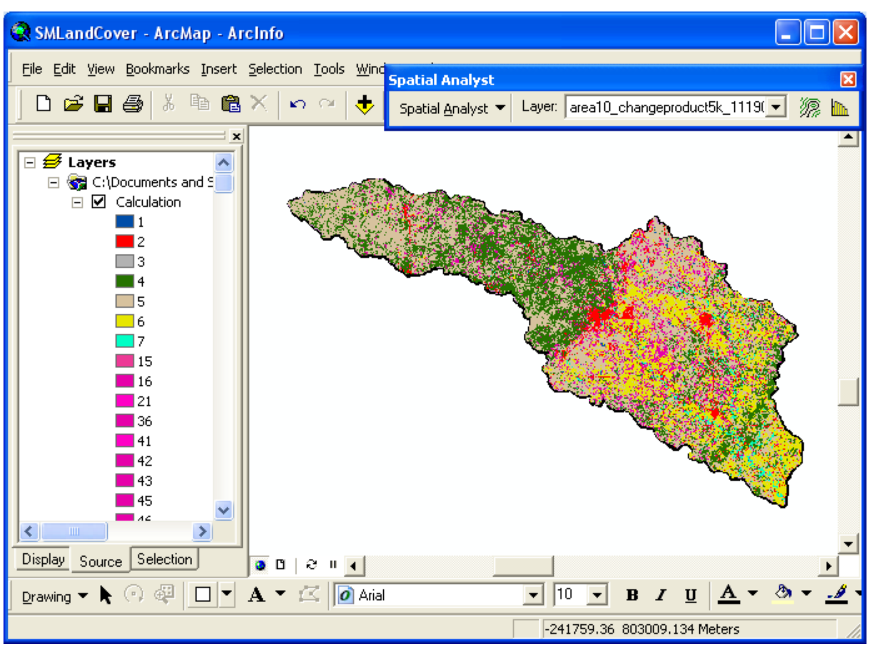
GCS_North_American_1983
Datum: D_North_American_1983

(b) The **SubBasin** feature class is in geographic coordinates using the NAD 83 datum. Describe how you would use ArcGIS to project this feature class to the above coordinate system.

(c) To select the land cover change data only for the San Marcos basin, the Subbasin feature class is converted to a raster **SubBasin2** whose values are 1 inside the San Marcos Basin and NODATA elsewhere. Complete the expression in the Raster Calculator window below that will produce a Calculation result that is just the land cover change values within the San Marcos Basin



(d) The **Calculation** result is shown below



If the Attribute Table of the Calculation is exported and edited, the result below is produced. Count refers to the number of cells in each category. Cells with Values 1-7 had the same land cover in 1992 and 2001. Cells with values 15 to 67 had changed land cover, where the first digit refers to their land cover in 1992 and the second digit to their land cover in 2001.

CATEGORY	VALUE	COUNT	TOTAL
Open Water	1	150	
Urban	2	2112	
Barren	3	17	
Forest	4	11321	
Grassland/Shrub	5	17299	
Agriculture	6	7312	
Wetlands	7	774	
Land Cover Unchanged			38985

CATEGORY	VALUE	COUNT	TOTAL
Open Water to Grassland/Shrub	15	1	
Open Water to Agriculture	16	1	
Urban to Open Water	21	3	
Barren to Agriculture	36	1	6
Forest to Open Water	41	4	
Forest to Urban	42	259	
Forest to Barren	43	12	
Forest to Grassland/Shrub	45	2394	
Forest to Agriculture	46	806	
Forest to Wetlands	47	128	3603
Grassland/Shrub to Open Water	51	25	
Grassland/Shrub to Urban	52	47	
Grassland/Shrub to Barren	53	4	
Grassland/Shrub to Forest	54	160	
Grassland/Shrub to Agriculture	56	182	
Grassland/Shrub to Wetlands	57	11	429
Agriculture to Open Water	61	4	
Agriculture to Urban	62	18	
Agriculture to Forest	64	2	
Agriculture to Grassland/Shrub	65	183	
Agriculture to Wetlands	67	18	225
Land Cover Changed			4263

What percent of the land cover changed between 1992 and 2001 in the San Marcos Basin?

What was the distribution of land cover in 1992 and 2001 measured in number of cells? Enter your answers in the table below.

VALUE	CATEGORY	1992	2001
1	Open Water	150+ =	150+ =
2	Urban	2112+ =	2112+ =
3	Barren	17+ =	17+ =
4	Forest	11321+ =	11321+ =
5	Grassland/Shrub	17299+ =	17299+ =
6	Agriculture	7312+ =	7312+ =
7	Wetlands	774+ =	774+ =

3. [25 points] **Distances on a Curved Earth**

Salt Lake City, Utah is located at 40°45'39"N, 111°53'28"W.
San Francisco, California is located at 37°46'30"N, 122°25'10"W.

a) Convert these coordinates to decimal degrees and indicate which of these numbers represents longitude and which represents latitude by filling the corresponding decimal degree longitude and latitude into the following table

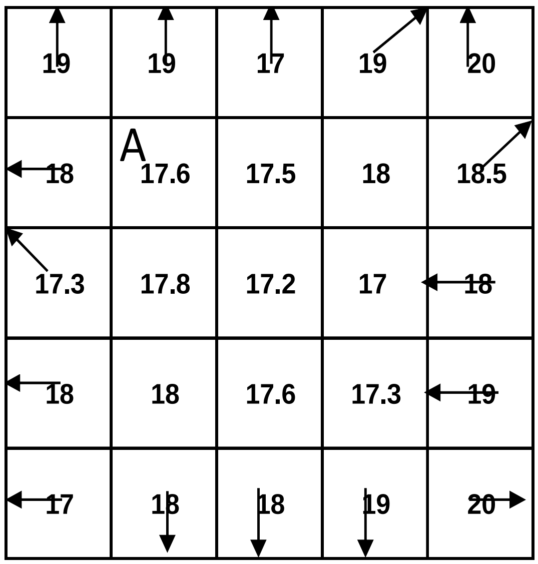
Cities	**Longitude**	**Latitude**
Salt Lake City		
San Francisco		

b) Assume a spherical earth with radius of 6370 km. Calculate the distance from Salt Lake City (Utah) to San Francisco (California).

c) Discuss some other ways that you have learned for calculating the distance between locations that are not limited to assuming a spherical earth and describe how you would go about calculating this distance more precisely. (What we are looking for here is a description of how you would do this, using the GIS knowledge and tools you have learned. You are not expected to do it in this question.)

4. [30 points] **Hydrologic Variables derived from DEM's**

Following is a grid of elevations. Because in general it is not possible to unambiguously determine flow directions around the edges, these have been specified for you as indicated.

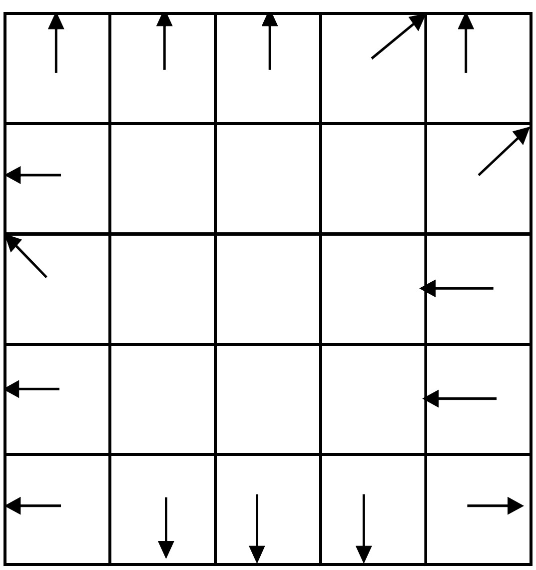


a) On the above grid, determine **which grid cells are pits** and indicate the elevation to which they need to be raised to **fill** them.

b) For the grid cell labeled A determine the slope and flow direction using the 8 direction pour point model

c) For the grid cell labeled A determine the slope and flow direction using the D∞ method.

d) Determine the **flow direction grid** using the 8-direction pour point method (D8) for the 9 internal grid cells. Indicate the flow direction by using an arrow in each cell on the grid below.



e) Determine the **flow accumulation grid** corresponding to the D8 flow directions. Label each cell on the grid below with the number of upstream cells draining **into it** (ESRI convention).