Name: KEY

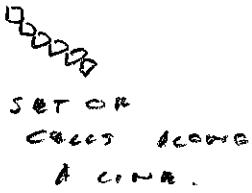
GIS in Water Resources **Midterm Quiz** **Fall 2005**

There are 5 questions on this exam. Please do all 5.

1. [25 points] **Data representation**
(a) Consider the following geographic features relevant to water resources. Briefly explain, illustrating your explanation with sketches, how each could be represented using either **a vector and a raster data** representation, or as a **vector and time series graph** representation. For each attribute indicate which representation (raster or vector) is preferable?

(i) River

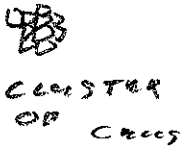
2



The vector representation is a line. The raster representation is a line of cells. Vector is preferable.

(ii) Lake

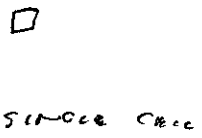
3



The vector representation is a polygon. The raster representation is a cluster of contiguous cells. Vector is preferable

(iii) Stream gage

2



The vector representation is a point. The raster representation is a single grid cell. Vector is preferable.

(iv) Topographic elevation

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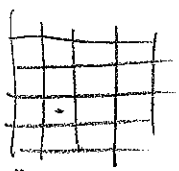


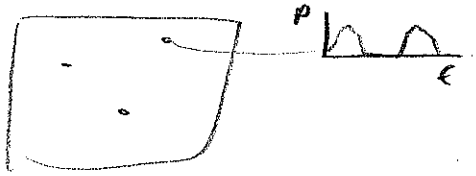
The vector representation could be contours or points of grid centers. The raster representation is a grid of elevation values. Raster is simpler.

(v) Streamflow

3 STREAMFLOW is a time series of a point on a stream

(vi) Rainfall.

3 Rainfall is a time series of points that are raingauge locations.



(b). The National Elevation Dataset (NED) provides nationwide digital elevation model coverage in geographic coordinates at 1 arc second resolution. You are working at a location with latitude 41 degrees north and longitude 111 degrees west. You need to perform some calculations from a NED digital elevation model and need to know the cell size on the earth's surface. Calculate the size of each NED grid cell assuming a spherical earth with radius 6370 km. To completely quantify size you need to report the following:

(i) N-S grid cell length (in meters)

3 DISTANCE = $r\,\Delta\theta$

$\Delta\theta = \frac{1}{60\times60}\ \text{deg} = \frac{\pi}{180\times60\times60}\ \text{rad}$

$\therefore$ DISTANCE = $6370\times10^3 \times \frac{\pi}{180\times60\times60} = \underline{30.88\ m}$

(ii) E-W grid cell width (in meters)

3 DISTANCE = $r\,\Delta\theta\,\cos\theta$ where θ = Latitude

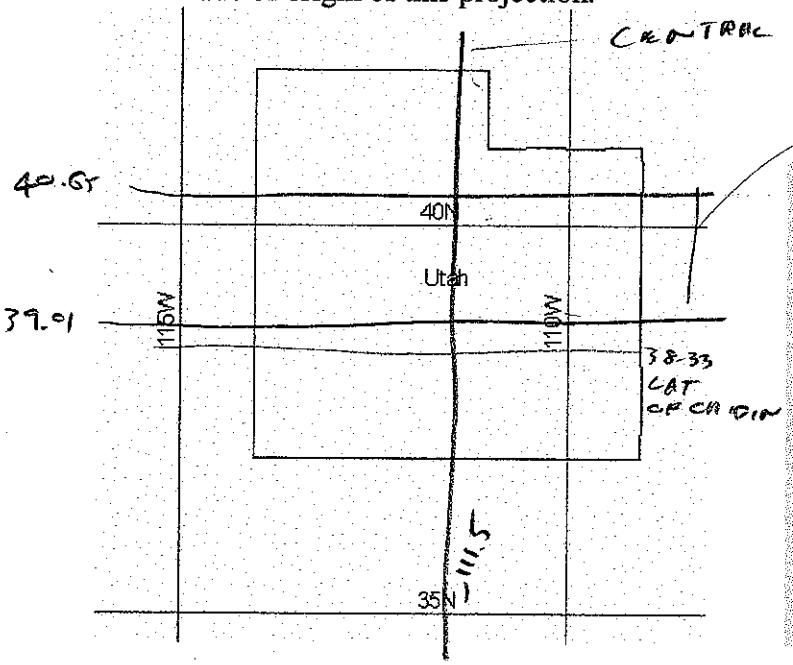
$= 30.88\ \cos 41^\circ = \underline{23.31\ m}$

(iii) Grid cell area (in square meters)

3 AREA = $\Delta x.\Delta y = 30.88 \times 23.31 = \underline{719.8\ m^2}$

2. [20 points] **Geodesy**

(a) The map below shows Utah and the display parameters of the State Plane coordinate system for the Utah Central Zone. Sketch on the map the standard parallels, the central meridian and the latitude of origin of this projection.



Name: NAD_1983_StatePlane_Utah_Central_I

Details:

Remarks:
Projection: Lambert_Conformal_Conic
Parameters:
False_Easting: 1640416.666667
False_Northing: 6561666.666667
Central_Meridian: -111.500000
Standard_Parallel_1: 39.016667
Standard_Parallel_2: 40.650000
Latitude_Of_Origin: 38.333333
Linear Unit: Foot_US (0.304801)
Geographic Coordinate System:
Name: GCS_North_American_1983

6

(b) For this projection, the coordinates of the origin $(\phi_o, \lambda_o) = (38.33, -111.5)$

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and the corresponding $(X_o, Y_o) = (1640417, 6561666.7)$

(c) What earth datum is used in this coordinate system? NAD 1983

2

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

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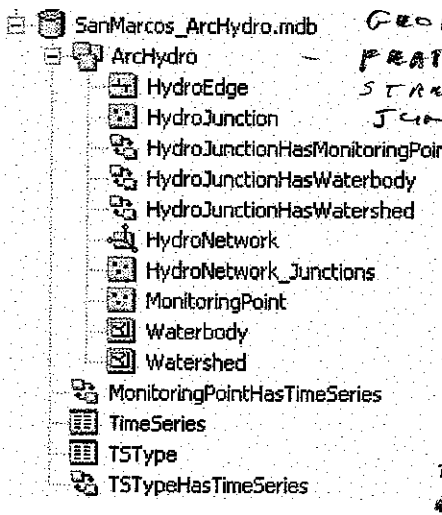
LAMBERT CONFORMAL CONIC

(e) The image below shows the Arc Hydro geodatabase that you created for the San Marcos basin. In the space to the right, briefly describe each row in this geodatabase description



GEODATABASE

FEATURE DATASET - COLLECTION OF FEATURE CLASSES IN COMMON SPATIAL REFERENCE

STREAM LINE FEATURE CLASS

JUNCTION FEATURE CLASS

RELATIONSHIP ASSOCIATING JUNCTION WITH MONITORING PT

RELATIONSHIP ASSOCIATING JUNCTION WITH WATER BODY

" " " WITH WATERSHED

8

NETWORK COMPRISING EDGES & JUNCTIONS

JUNCTIONS ON NETWORK

MONITORING PT FEATURE CLASS

WATER BODY FEATURE CLASS

WATERSHED FEATURE CLASS

RELATIONSHIP ASSOCIATING TIME SERIES WITH MONITORING POINTS

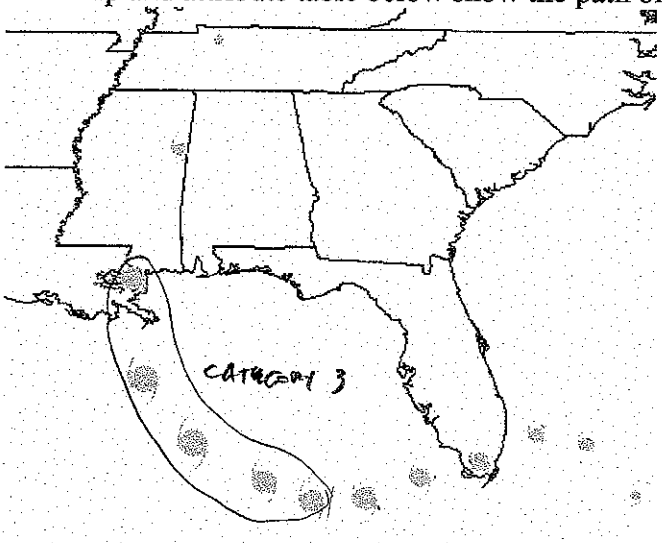
TIME SERIES TABLE

TABLE GIVING DATA TYPE FOR TIME SERIES

RELATIONSHIP LINKING TIME SERIES DATA TO ITS TYPE

3. [15 points] **Hurricane Katrina**

The map and attribute table below show the path of hurricane Katrina.



Day	Latitude	Longitude	WindMPH	CenterMB	Direction	SpeedMPH
Wed Aug 24 10AM	24.7	-76.7	40	1006	NNW	8
Wed Aug 24 10PM	26	-78	50	1001	W	8
Thur Aug 25 10AM	26.2	-79.3	60	997	W	6
Thur Aug 25 10PM	25.5	-80.7	75	984	SW	8
Fri Aug 26 10AM	25.1	-82.2	80	981	W	7
Fri Aug 26 10PM	24.6	-83.6	105	965	WSW	8
Sat Aug 27 10AM	24.5	-85	115	940	W	7
Sat Aug 27 10PM	25	-86.2	115	939	WNW	7
Sun Aug 28 10AM	26	-88.1	175	907	WNW	12
Sun Aug 28 10PM	27.6	-89.4	160	904	NNW	10
Mon Aug 29 10AM	30.2	-89.6	125	927	N	16
Mon Aug 29 10PM	33.5	-88.5	60	973	NNE	22
Tues Aug 30 10AM	36.3	-87.5	35	985	NNE	21

CATEGORY 3 WIND > 110 mph

(1) Mark on the map and in the attribute table the period for which Katrina was a Category 3 hurricane or higher (Wind > 110 mph).

(2) For what period of time (in hours) was Katrina a category 3 hurricane or higher?

$5 \times 12 = 60$ hours $= 2.5$ days

OR ASSUMING IT STARTED CAT 3 STATUS AT 10 AM ON 8/27 & ENDED 10 AM ON 8/29 - 48 hours = 2 days

(3) Approximately how far (in miles) did hurricane Katrina travel in this condition?

USE DISTANCE = SPEED × TIME

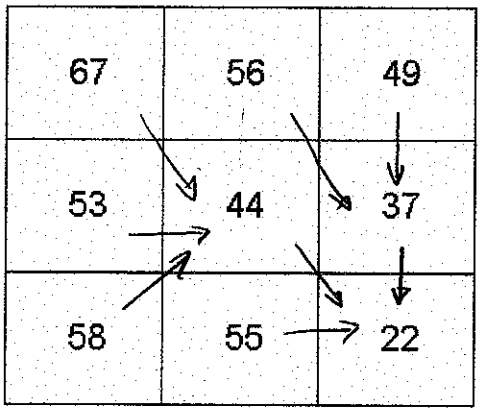
$= 7 \times 12 + 7 \times 12 + 12 \times 12 + 10 \times 12 + 16 \times 12$

$= 624$ mi

OR IF 48 hours. $\frac{7+7+12+10+16}{5} \times 48 = 499.4$ mi

4. [20 points] **Terrain Analysis**

The grid below shows a mesh of terrain elevations



32 64 128
16 1
8 4 2

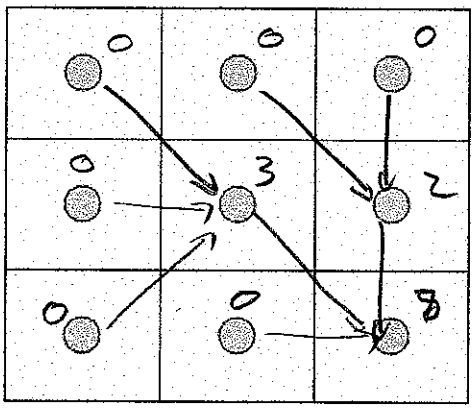
(1) Determine the flow direction in each cell and label it using the ESRI 8-direction pour point method (1, 2, 4, 8, 16, 32, 64, 128)

7

2	2	4
1	2	4
128	1	

(2) Draw the flow network showing lines from the center of each cell to the center of the cell to which it flows.

6



(3) Label each cell in the grid above with its flow accumulation (number of upstream cells).

7

5. [20 points] **Spatial Analysis of Inundation**
The grid below is a rough approximation of the ground elevations in an area exposed to flooding from failure of a dyke separating a lake from a city, such as occurred recently in New Orleans. Elevations are given in meters above sea level. The grid size is 100 m. The lake is mapped as being at sea level (elevation 0 m). Suppose the enclosed area is flooded due to the lake level increasing to an elevation of 3 m and overtopping the protective dyke.

0	0	0	0	0	0	0
4	3	3	3	0	0	0
3	3	2	3	3	0	0
3	2	2	2	3	3	3
3	2	1	1	2	3	4
3	3	1	0	3	3	4
4	4	3	3	3	4	4
5	4	5	4	5	5	5

LAKE (i)

DYKE (ii)

DEPRESSED REGION (iii)

2
3
3

(a) Based on the elevations and information given, **identify on the grid above** (i) the lake, (ii) the dyke at 3m elevation, and (iii) the outline of the depressed region protected by the dyke.

(b) Assume that the 3 m dyke is overtopped and that water at 3 m above sea level floods the depressed region. Answer the following questions:
(i) What is the **maximum depth** of flooding in the depressed region (meters)

3 4 m

(ii) What is the **average depth** of flooding in the depressed region (meters)

3

6 cells 1 m
2 cells 2 m
1 cell 3 m
1 cell 4 m

} AVERAGE $\frac{17}{10} = 1.7$ m

(iii) What is the **area** of the depressed region that is flooded (m^2)

3 $10 \text{ cells} \times (100 \text{ m})^2 = 10^5 \text{ m}^2$

(iv) What is the **volume** of floodwater within the depressed region. (m^3)

3 VOL = AREA × AVE DEPTH
$= 1.7 \times 10^5 \text{ m}^3$