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Remote Sensing (C)

Nebraska Science Olympiad
Regional Competition
Henry Doorly Zoo
Saturday, February 19th 2011
100 points total

Show all mathematical operations and answer all questions with complete sentences unless noted.

1) Synthetic-aperture radar (SAR), LIght Detection And Ranging (LIDAR), and multi-spectral Radiometers (e.g. LandSat) are all different types of remote sensing platforms used in monitoring earth processes. Please compare and contrast these platform types. Provide situations where one platform may be more advantageous over another. (6pts)

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2) Many remote sensing studies create land use maps (as in Figure 1). How might a researcher/scientist create such a map without physically visiting all the locations on the map? (4pts)

Figure 1: Land Cover map of Nebraska. (Source: UNL School of Natural Resources).

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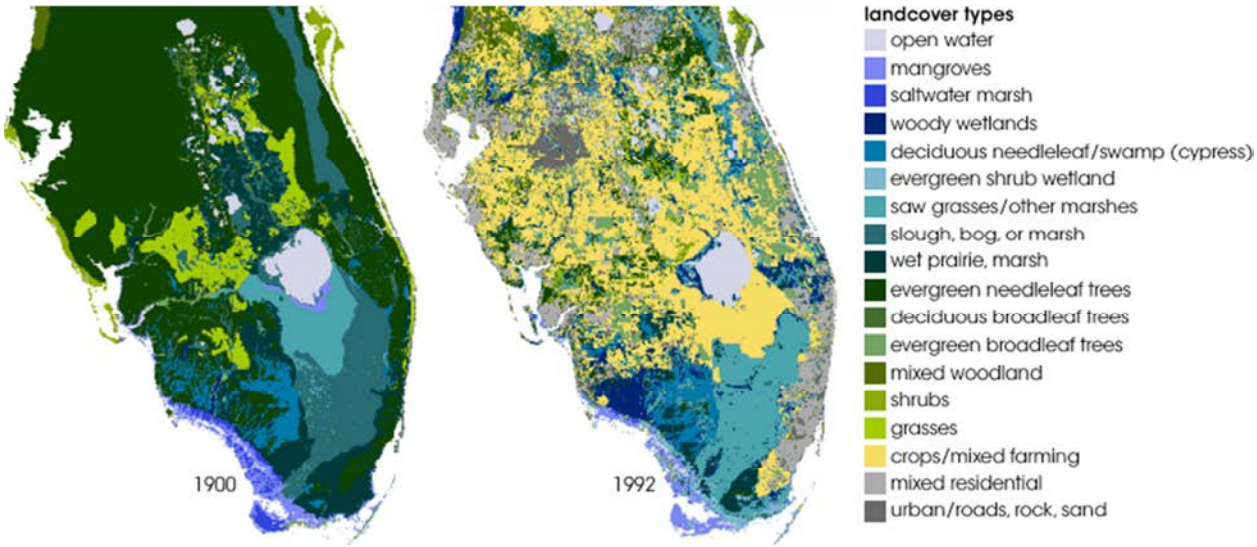
3) In Figure 2, what is the predominant land cover in 1900? 1992? What are the likely cause(s) of this change? (6pts)

Figure 2: Land cover change in southern Florida (Source: "Deep Freeze and Sea Breeze: Changing Land and Weather in Florida by Rebecca Lindsey, data from Lou Steyaert)



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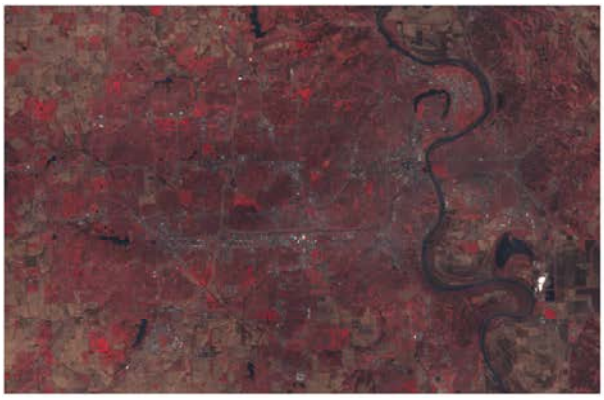
4) What is the difference(s) between the two images in Figure 3 (Use Remote Sensing terminology)? How might a remote sensing scientist produce these images? (4pts)

Figure 3: LandSat 7 imagery of Omaha, NE taken on 11/18/2010 (Source: USGS Global Visualization Viewer)

a)



b)

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5) Quantitative remote sensing is used to provide estimates of a biophysical characteristic of interest. Since the frequency of algae blooms in freshwater lakes and reservoirs have increased due to excessive fertilization, there is great interest in developing remote sensing techniques to monitor algae. Chlorophyll *a* (CHL) is used as a proxy of algae. One spectral index is equation 1 (Mittenzwey *et al.* 1991). Researchers at Indiana University-Purdue University Indianapolis (IUPUI) found the following relationship (eq. 2) for CHL with this index on two eutrophic reservoirs located near Indianapolis:

$$(R_{705} - R_{670})/R_{670} \text{ (eq. 1)}$$

where R_n represents the reflectance at n waveband

$$y = 275.39x + 21.43 \text{ (eq. 2)}$$

where y=CHL concentration (μg/L)
x=spectral index (unitless)

Find the CHL concentration using this relationship for the reflectance spectral in Table 1. You do not have to use complete sentences, but be sure to show all steps, and use significant figures. (6pts Note: Part of this question will be used as a tiebreaker)

Table 1: Example water reflectance collected

Waveband	Reflectance (%)
600	6.7
635	1.5
670	1.1
705	1.2
740	2.4

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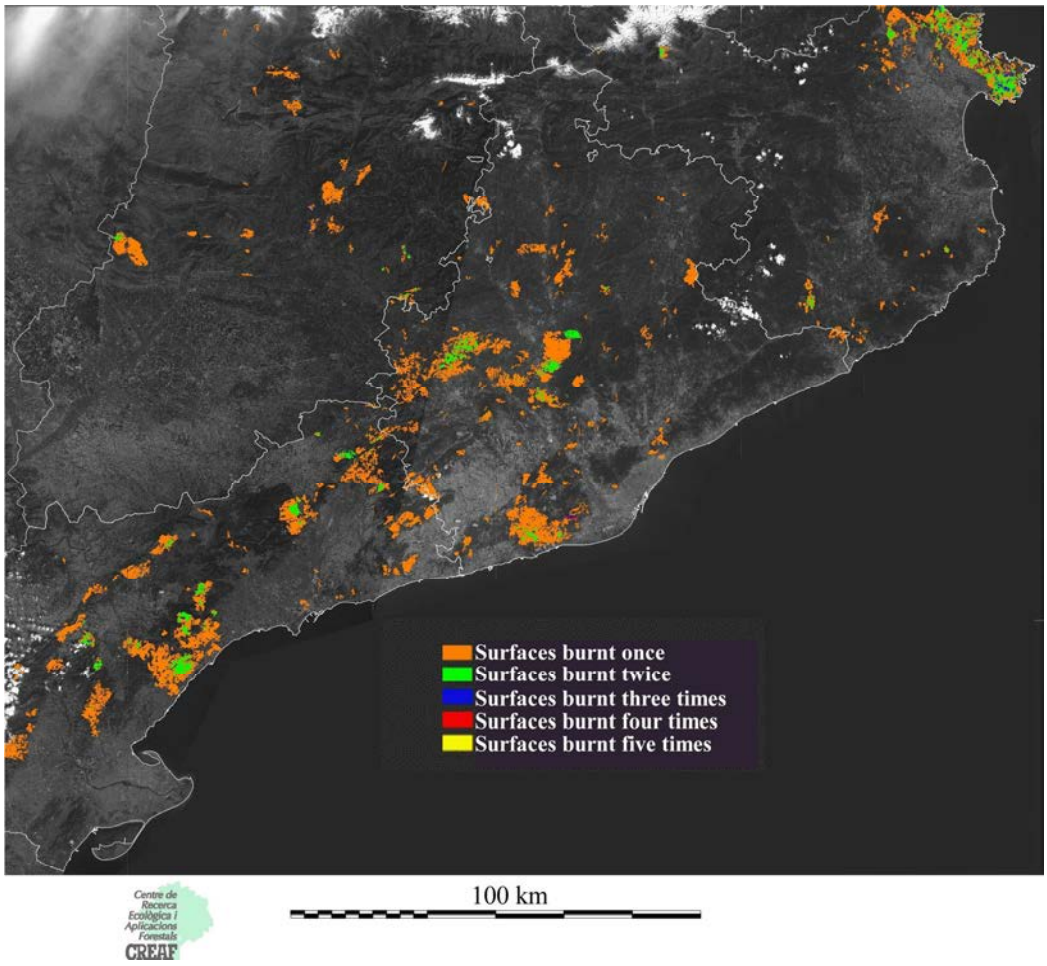
6) Using GIS methods, scientists/researchers can create maps that can assist in determining areas of interest for management decision. Using Figure 4, determine areas where forestry management teams may wish to focus their energy to prevent future fires (You may indicate on the map by circling). Why did you choose these areas? (4pts)

Figure 4: Map of burnt forested areas and frequency of wildfires in Catalonia (located in NE Spain) during the period of 1975-1993. (Source: Remote Sensing of Forest Fires: Remote sensing as a tool to map forest fires, to study the fire regime and their effects on plant communities and the integration into a GIS by R. Salvador *et al.*)



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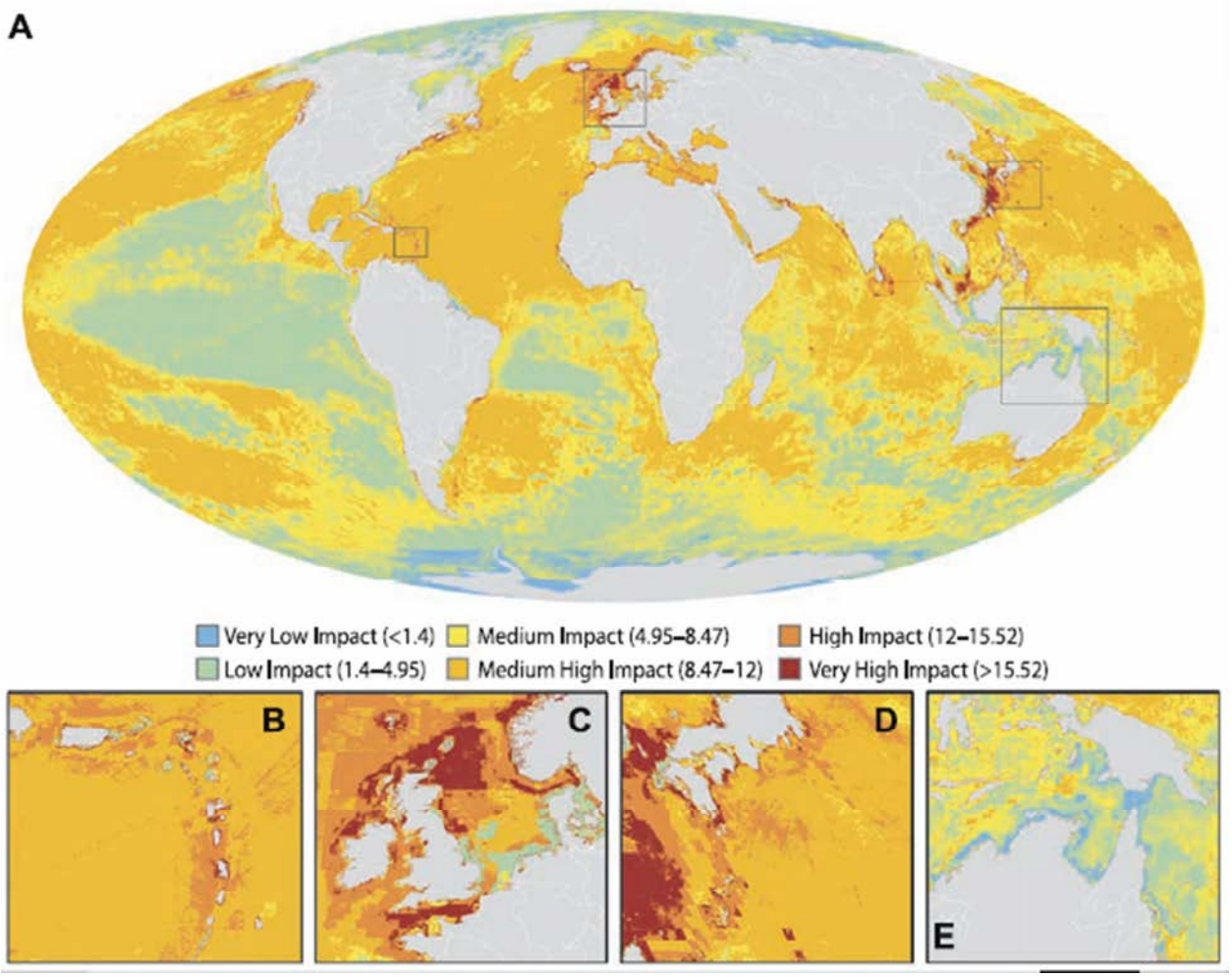
7) Scientists use remote sensing data to indicate areas heavily impacted by anthropogenic disturbances (Figure 5). On the global map, what areas are the most and least impacted, why? Using the regional panels, which area is the least impacted. (6pts)

Figure 5: A) Global map of cumulative human impact across 20 ocean ecosystem types. Regional panels inclue B)Eastern Caribbean, C) North Sea, D) Japanese waters, D) Torres Strait. (Source: A Global Map of Human Impact on Marine Ecosystems by B.S. Halpern *et al.* 2008 *Science* **319**, 948)



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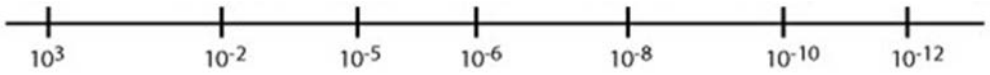
8) Indicated where in Figure 6 following are located (You do not have to write in complete sentences for the first part of the question): Gamma Ray, Infrared, Microwave, Radio, Ultraviolet, Visible, X-ray. What visible color has the longest waveband, shortest? (6pts)

Figure 6: Electromagnetic Spectrum: Wavelength (meters)



9) Referencing the electromagnetic spectrum, why are plants green? (4pts)

10) Compare/contrast the LandSat TM and MODIS satellite platforms. What are the advantages/disadvantages for each platform? (6pts)

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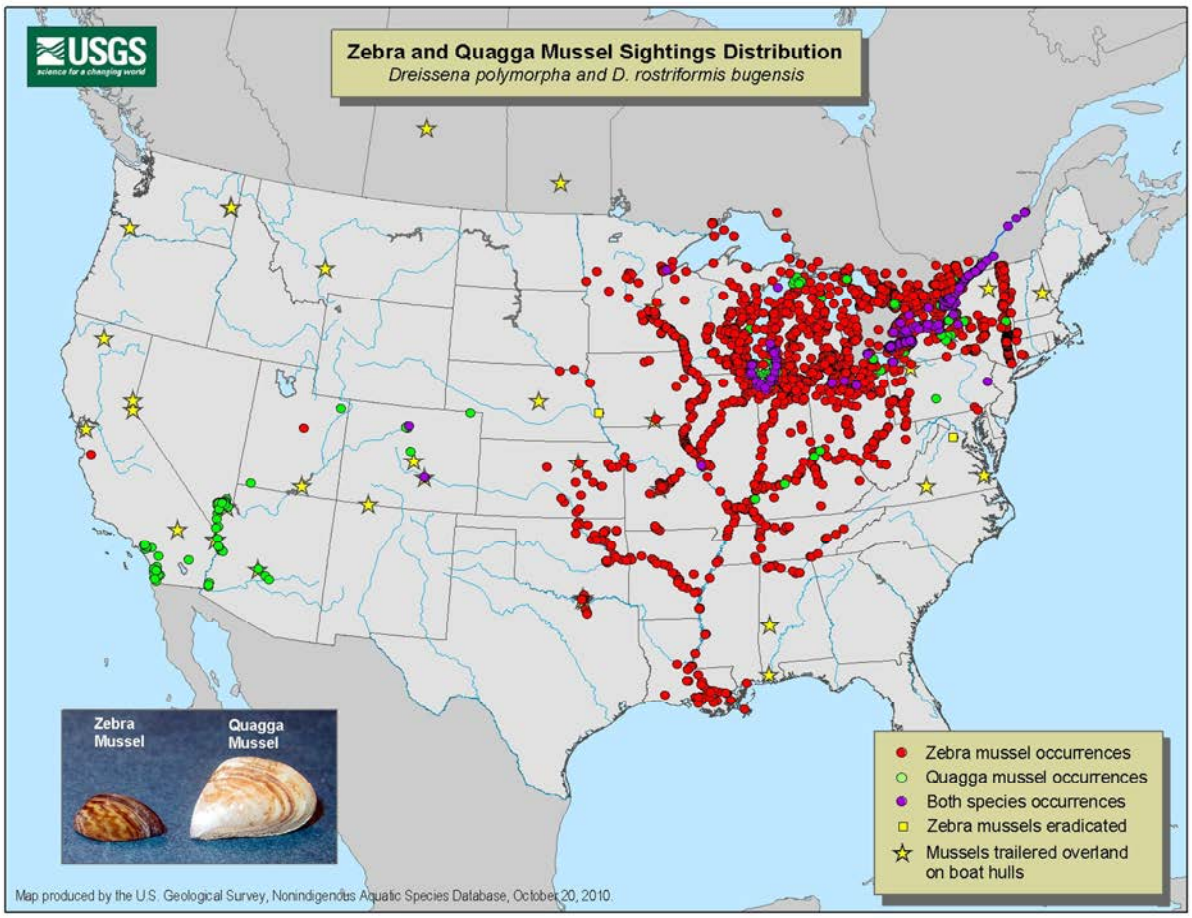
11) Using Figure 7, where did the Zebra mussel outbreak most likely occur? Zebra mussel DNA was recently confirmed in Electric Lake in Utah. What is the most likely method for the invasion of Electric Lake? (4pts)

Figure 7: Zebra and Quagga Mussel Sightings (Source: USGS Nonindigenous Aquatic Species division)



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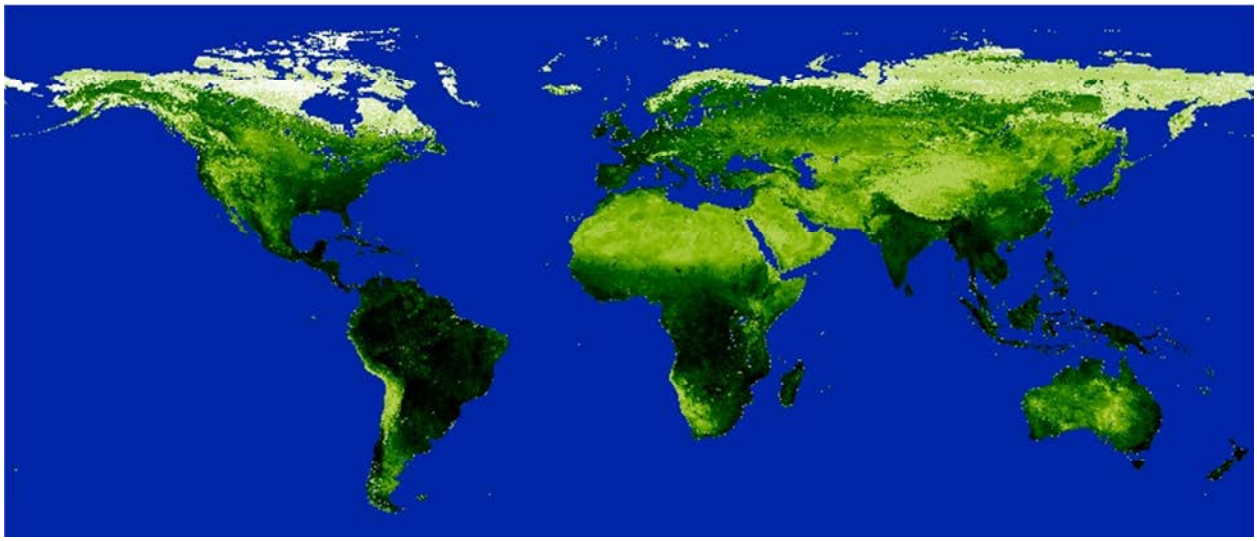
12) Explain the differences between the two maps. Why do scientists use NDVI? Pick a region on both maps and explain in detail from an ecological standpoint why an area might have a low or high NDVI (e.g. Why is Northern Africa nearly white in Figure 8b). (6pts: Part of this question will be used as a tiebreaker)

Figure 8: NDVI maps from a) January 15th 2006, b) September 15th 2006 where blue is water, and the darker green means a higher NDVI value. (Source: Global Land Cover Facility)

a)



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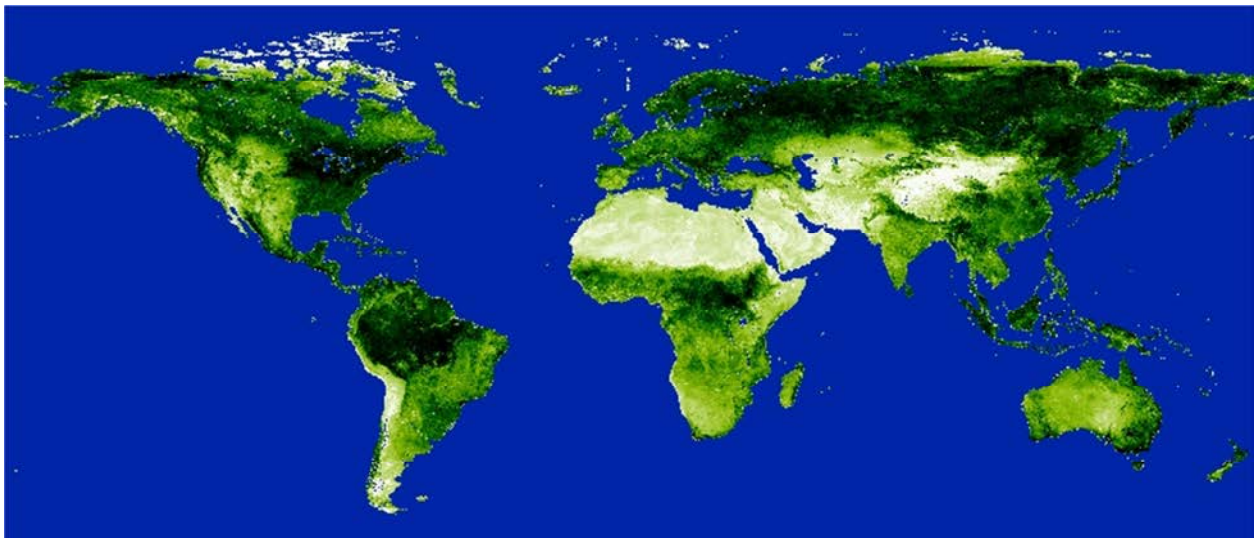

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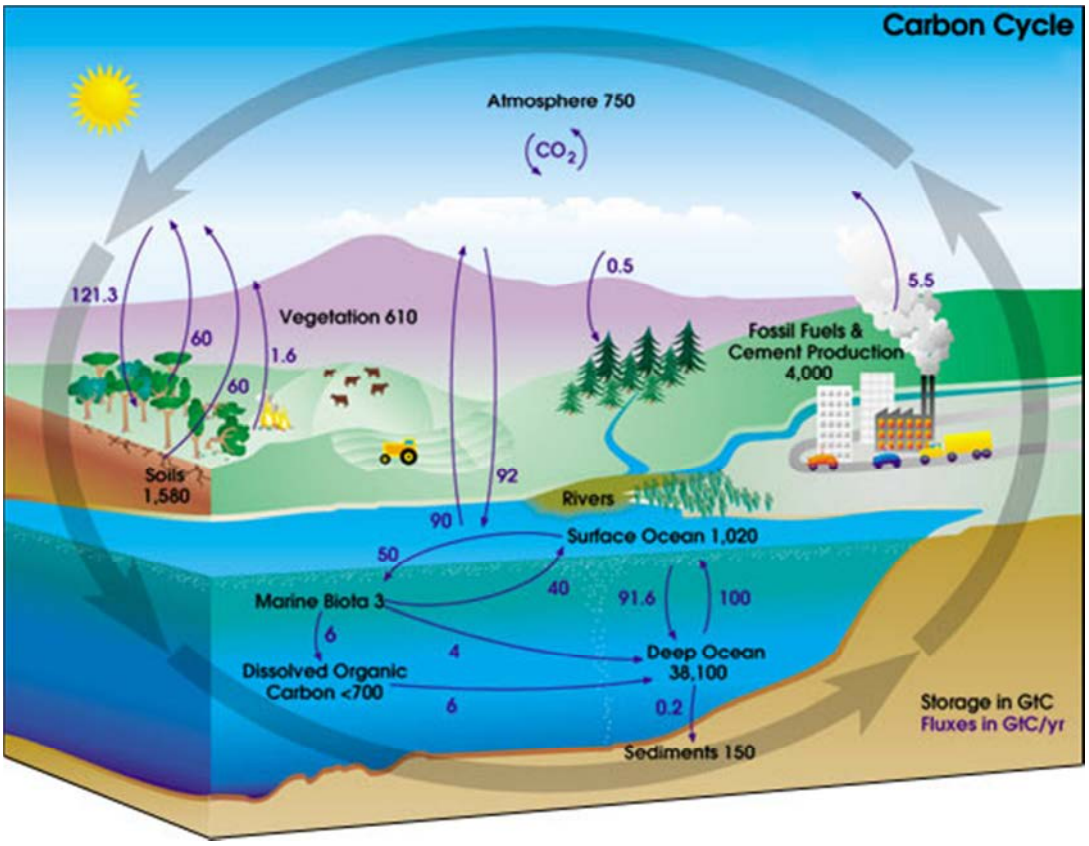
13) Use Figure 9 to answer the following questions. You do not have to write complete sentences; however show all work and create a legible figure. If anthropogenic activity disturbs the carbon stored in the soils and 500 GtC is released into the atmosphere, calculate the final values for atmosphere, vegetation and ocean sediments if 30% is absorbed by the atmosphere, 27% by vegetation, and the remainder by ocean sediments. Draw the pathway that includes all steps for the carbon released from the soils to reach the ocean sediments (6pts).

Figure 9: Carbon Cycle (Source: NASA Earth Observatory)



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14) Explain how remote sensing data can be used to monitor human activity. Provide at least three examples. (6pts)

15) Ignoring multipath and other errors in remote sensing data, what kind of information is gathered by passive remote sensing platforms? How is this information manipulated to provide a value comparable to data collected at a different date or by a different sensor? (6pts)

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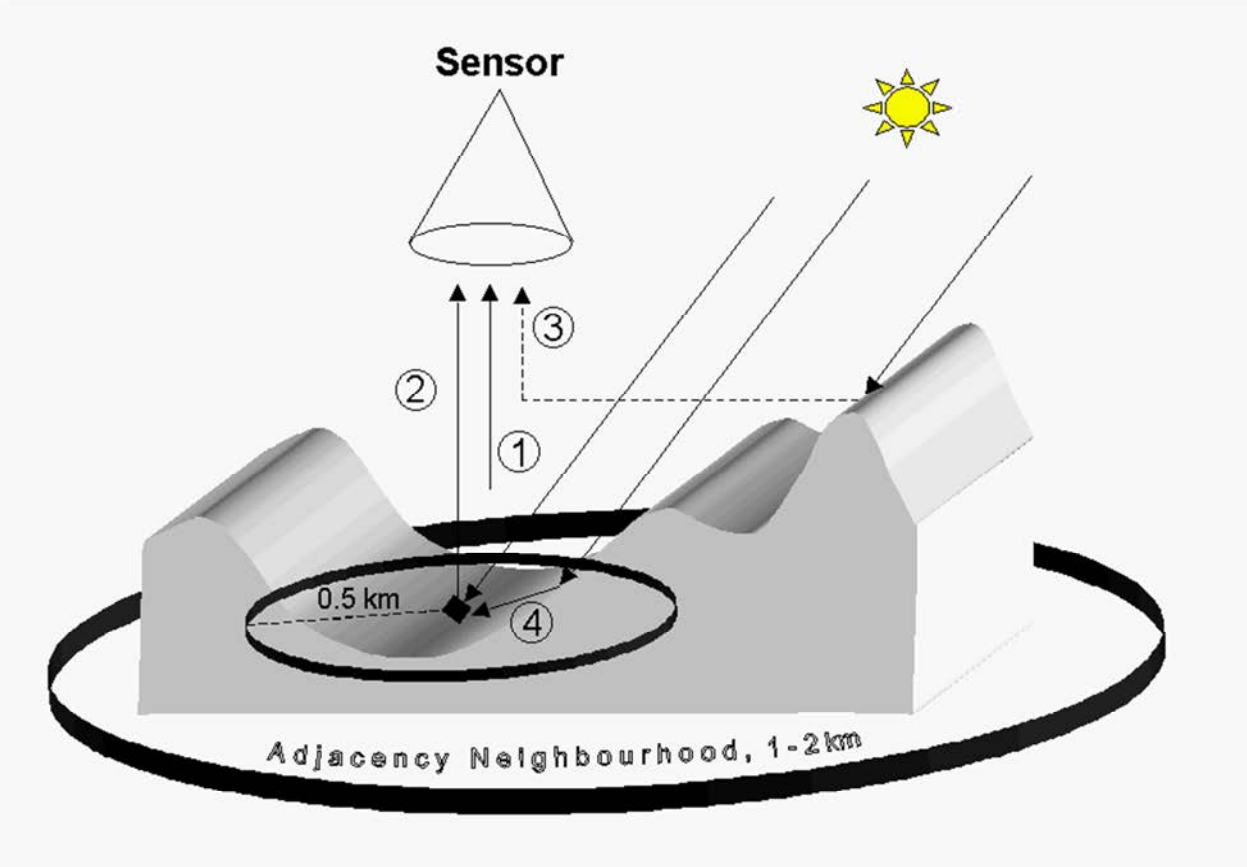
16) Using Figure 10 indicate which of the components contains unaltered data from the location of interest (black square below sensor). What are the effects of each of the other components on the raw radiance value collected by the sensor? (6pts)

Figure 10 Radiation components in rugged terrain



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17) Calculate the total area where reflectance is greater than 80% from Table 2. You do not need to use complete sentences for this question. (4 pts)

Table 2: Reflectance values (%) of a LandSat TM image band 3.

79	92	93	78	72
82	87	62	67	63
80	53	63	55	43
13	16	37	69	38

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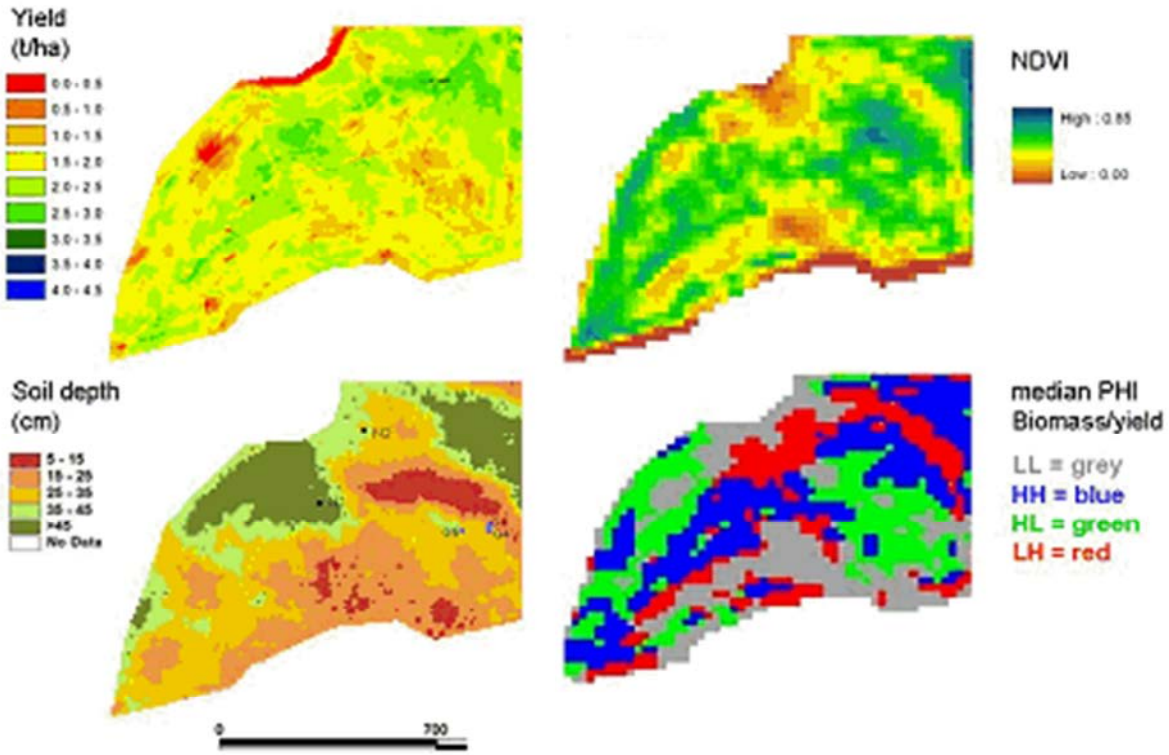
18) Using Figure 11: High yield tends to correspond to what values for NDVI, Soil Depth? (4pts).

Figure 11: Yield, NDVI, soil depth, and NDVI (biomass)/yield classification on a single field at Buntine, WA. (Source: Managing spatial and seasonal variability within field can improve the profitability of WA grain production by Robertson *et al.* 2006. Proceedings of the 13th ASA Conference).



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19) During the two events indicated in Figure 12, what is roughly the ocean temperature to the north of Australia? Is this temperature a departure for both graphs? If so, roughly how much? Does this correspond to the temperature along the equator in the central Pacific Ocean? (6pts)

Figure 12: Average ocean temperature and temperature departures during an El Niño and a La Niña event. (Source: NOAA/National Weather Service Climate Prediction Center).