

AOS/IES 171  
Quantitative Assignment #3  
Human Impact on the Earth  
10 points  
Due Thursday, April 14

1. (5 points) The average adult consumes about 2000 kcal (food calories) per day.
  - a) How much heat energy does the average adult give off per second, expressed in Watts? (1 W = 1 J/s; 4136 J = 1 kcal)
  - b) Given that 1 kg of food contains about  $16 \times 10^6$  J, how many kg of food does the average adult consume each year?
  - c) Given that 0.06 kg of edible plant food is typically produced on each square meter of crop land each year, how much crop land is needed to grow food for each adult each year?
  - d) The total land area is about  $1.5 \times 10^{14}$  m<sup>2</sup>. If we assume that about 10% of the land surface can be used for agriculture, about how much land can be allotted equally to each person alive today for growing food?
  - e) It takes about 7 kg of plant food to make 1 kg of animal food. Most of the food consumed worldwide is plant food. Based on your answers to c) and d) above, do you think it is possible for everyone to eat mostly meat?
2. (2 points) In the USA people use about 5 m<sup>3</sup> of water per person per day. Madison has about 200,000 people. If all of the water used by Madisonians came from Lake Mendota, what percent of the water in the lake would be used each year? (Lake Mendota has the approximate dimensions of 5 miles by 3 miles by 40 feet deep.)
3. (2 points) On Daisy World there are only two kinds of plants, white daisies and black daisies. The white daisies reflect sunlight back to space, while the black daisies absorb sunlight well, keeping energy in the earth system. Using concepts of feedback and stability, describe what would happen on Daisy World if black daisies outcompeted white daisies when it is hot, while white daisies outcompeted black daisies when it is cold.
4. (1 point) Net primary productivity (NPP) is defined as the energy fixed by plants minus what plants use for themselves. Terrestrial NPP has been estimated to be  $132 \times 10^{12}$  kg organic matter per year. It is estimated that humans currently use directly or divert about  $42 \times 10^{12}$  kg organic matter per year for their own use. Estimate the holding capacity of planet earth for humans if we a) keep the current average standard of living, and b) increase the average consumption by a factor of five (everyone at USA consumption rates).