Nov 2, 2009

Name: _____ Pledge (sign): _____

Env Studies 201 Test #2 Key

Point Total: 100 pts possible

6 pts 1. *In your own words*, define and describe the concept of sustainable development.

Sustainable development is the marriage of two concepts in tension: *sustainability* in our use of natural resources, and continued economic *development* (growth), particularly in less-developed countries. It describes activities that increase the prosperity of a country's citizens without irreversibly depleting the country's stocks of the natural resources or raising the pollution level to levels that threaten the health of its citizens.

6 pts 2. What are Persistent Organic Pollutants (POPs) and why are they a problem?

POPs are organic pollutants that are chemically unreactive and have long lifetimes in the environment, so that they can spread widely from their point of application. They are usually not very water-soluble—they are *hydrophobic*—and so they tend to bioaccumulate to high (and potentially toxic) levels in organisms, particularly those that are higher in the food web.

6 pts 3. (a) The author of *The Story of Stuff* tells a story about a cheap radio. What is the point of her story? What's wrong with cheap 'stuff?'

The author's point is that the true cost to society of getting that product to her is not reflected in its price. In other words, there are negative *externalities* in producing and transporting that product to the store. Examples include excessive pollution and resource depletion, and poor working conditions for factory workers. So the problem with (overly) cheap goods is that their production causes excessive damage to the environment and to the health and welfare of the workers who produced the product.

6 pts (b) What is the *golden arrow* of *The Story of Stuff*, and how would Donella Meadows say it relates to the sustainable use of natural resources?

The 'golden arrow' represents the rate of consumption of produced goods. In *The Story of Stuff*, Annie Leonard contends that this rate has been artificially inflated by a number of means, such as planned and perceived obsolescence. Donella Meadows, one of the authors of *Limits to Growth*, would say that increasing the rate of consumption would necessarily increase the rate of natural resource use and pollution production; once those rates are above the rates that can be maintained indefinitely, then we are not using our resources sustainably.

6 pts 4. In “The End of Cheap Oil," Campbell and Laherrére state that there is 150 Gbo left to be discovered in the world. How could they possibly know this?

If one determines the amount of oil discovered as a function of the year in which it was discovered, it is apparent that the rate of discovery of new oil has been declining. Extrapolating this trend into the future allows one to estimate how much oil there is still to be discovered.

6 pts 5. (a) In the Hydrogen Economy, is hydrogen an energy *source* or an energy *carrier*? Briefly explain your answer, and describe two sources of hydrogen.

The Hydrogen Economy is based on the production, distribution and use of elemental hydrogen (H_2) to supply energy. Since elemental hydrogen exists only in trace amounts, it must be produced somehow. This production will require energy. Thus, hydrogen is an *energy carrier*: it essentially ‘stores’ energy used in its production until the hydrogen is used to generate energy in a fuel cell or by combustion.

The major sources of hydrogen are the fossil fuels (particularly natural gas) and water. The major fossil fuels—oil, natural gas or coal—can all be used as chemical feedstock in elemental hydrogen production. Currently the most economical method of hydrogen production is by the steam reformation of methane, the most abundant component of natural gas. High purity elemental hydrogen can be produced by the electrolysis of water; all that is needed is a source of electricity. The electricity for hydrolysis can be generated by burning fossil fuels (so this is a second way in which fossil fuels can yield hydrogen), by nuclear fission, by water or wind turbines, or from solar energy.

6 pts (b) Why is elemental hydrogen so important for modern agriculture?

Because it is used to produce ammonia through the Haber process. This production is the first step (nitrogen-fixing) in producing nitrogenous fertilizers for growing crops.

6 pts 6. (a) What is the *Green Revolution*?

The Green Revolution was the development of high-yield hybrid strains of various crops (wheat, rice, some cereals) in an attempt to increase food productivity. The seeds were developed by the Cooperative Wheat Research and Production Program in Mexico under the direction of Norman Borlaug. The new seeds grow rapidly but only with intense application of fertilizer and water; since they are usually grown in monoculture, chemical pesticides are also usually required to protect the crops.

6 pts (b) What do its detractors say about the Green Revolution? Be complete.

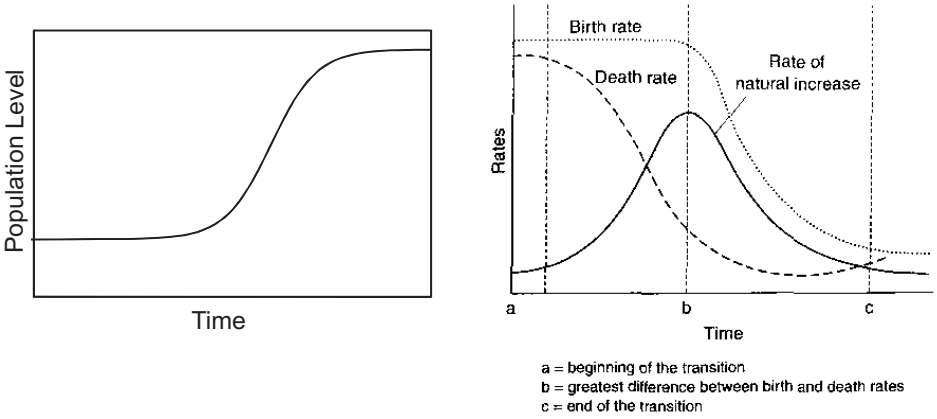
They argue that:

- (limited) food productivity is not the main factor causing world hunger. Poverty is the problem, not a limited supply of food.
- it has resulted in the industrialization of agriculture that has increased poverty (and hence hunger)
- industrialized agriculture has also harmed the environment through pollution (pesticides, nutrients) and depleted groundwater (extensive irrigation)
- food has become less diverse and less nutritious
- food production has become more energy intensive

7. Explain in some detail why Technologists like Julian Simon are reassured by the following concepts. For each concept, describe the nature of the phenomenon and explain why it occurs. Include one figure in each answer.

10 pts (a) The demographic transition

The demographic transition describes what happens to a country's population as it industrializes. Initially the population rises rapidly but it eventually stablizes, though at a higher level. A plot of population as a function of time resembles a logistic growth curve, as shown below on the left.

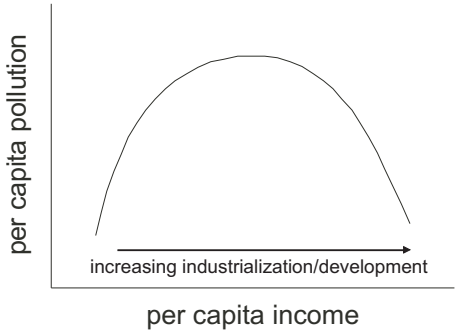


Initially—before industrialization—population growth is low because both the death and birth rates are high. As the country becomes more developed, modernized medical treatment and sanitation will lower the death rate, but the birth rate remains high. Due to this imbalance, the population growth increases greatly, straining natural and economic resources of the country. Eventually general prosperity and educational levels rise and changes in the workforce render children less of an economic asset. Birth rates fall and the population level stabilizes; the figure on the right shows the process in terms of rates of birth, death and the resulting population growth.

Technologists are reassured by the Demographic Transition—both its occurrence and the proposed theory explaining it—because it predicts that global populations can be stabilized through economic growth. Whereas biologists usually explain logistic growth in ecosystems due to containts of natural resources, human populations can stabilize due to social/economic factors rather than out of necessity through widespread hunger and disease. Furthermore, draconian methods of birth control are not needed to halt population growth.

10 pts (b) The environmental Kuznets curve

The environmental Kuznets curve (EKC) is the observation that as a country develops, initially environmental quality degrades but that at some point, continued economic growth results in a cleaner and healthier environment. The following figure illustrates the trend.



The EKC is usually explained as follows: when a country initially industrializes, most of the economic growth is focused on essentials (such as more and better food) and on highly desirable amenities of modern life (such as electricity, transportation, and communication infrastructures). Little attention is paid to the pollution or other forms of environmental degradation that might occur at this stage. However, once the quality of life improves to a certain point, a country will begin devoting more resources to environmental issues and to cleaner forms of providing goods and services. Technologists like EKCs because, again, economic growth is predicted to eventually lead to a healthier environment for humans and natural ecosystems. After all, the reasoning goes, humans value their own health and the other services that ecosystems provide them.

12 pts 8. (a) What are the two key attributes of common-pool resources (CPRs)? In your answer, distinguish between CPRs and public goods, and also give two examples of natural resources that can behave as CPRs.

The two key attributes of CPRs are:

- It is difficult to exclude people from using or deriving benefit from the CPR
- Subtractibility: one person's use means fewer or degraded resources for everyone else. The CPR can eventually be destroyed through overuse.

A public good also possesses the first attribute but not the second: it cannot be destroyed or damaged through overuse.

Examples of environmental CPRs are: fisheries, the ability to assimilate pollution (air/water/soil), and forests. Really, almost any readily-accessible natural resource that is limited can be viewed as a CPR.

14 pts (b) In some detail, describe the challenges in managing CPRs. In your answer, describe Hardin's solution(s) and also include a definition of the free-rider problem and why it can be an issue in CPR management.

In Hardin's original formulation, he described a situation of *open access* to a CPR, where a large number of people have free and easy access to the benefits to be derived from the CPR. In such a situation, if the behavior of the potential users are motivated by strict self-interest (the *rational actor* model), then destruction of the CPR is predicted. A person has two choices: use the CPR and derive benefits from it, or refrain from using it while possibly allowing others to do so. No matter what the choice of the other users, the person is better off making the choice of using the CPR and deriving some short term benefit; in this sense, the situation is similar to the Prisoner's Dilemma game. This is a famous case where self-interest results in a sub-optimal outcome.

The difficulty in managing such a resource is to control access to the resource and to control self-interest. The only people who should be allowed access are those who agree to abide by a set of rules designed to ensure the continued existence of the resource. There also needs to be a way to induce cooperation and to monitor compliance to the rules.

Another problem in managing CPRs is knowledge of their status: the science needs to be up to the task of understanding the CPR sufficiently well to predict the effects of it use and to determine rules governing its sustained use (eg, to predict the maximum sustained yield of a fishery). There must be continual monitoring of the state of the CPR while it is being used; if necessary, rules of usage need to be renegotiated based on new information. Furthermore, lack of full scientific certainty can make the task of securing cooperation difficult, since it might not be known how close the CPR is to failing or the consequences if that happens.

Hardin described two potential solutions to his 'tragedy.' The first is private ownership of the CPR. The owner would then have a financial stake in the continued health of the resource and presumably care for it accordingly. Unauthorized users would presumably be deterred by the laws protecting the owner, and by any security provisions the owner would take. The second solution is ownership by a centralized government that is empowered to make and enforce laws the restrict use of the CPR. The government presumably also has the resources and scientific expertise to monitor the condition of the CPR—a private owner would have to pay for such things as well—and the power to deter illegal usage of the CPR.

Another option is a cooperative agreement between all (or most of) the potential users of the resource. This is the situation that must exist for global resources that cannot be owned and do not below to a single state: environmental treaties between users must be signed. Examples of this situation would be emission of greenhouse gases or ozone-depleting substances into the atmosphere. The cooperating partners set up the rules of use for the CPR, the infrastructure to entice or enforce compliance to the rules, and monitoring of the health of the CPR.

All of those things cost money and other resources, as does the process of negotiation and renegotiation of the rules. The free-rider problem is when someone derives benefits from the efforts to protect a resource but does nothing to contribute to it. If too many free-ride, then the CPR will not be protected in any meaningful way and faces ruin.