1. Why do we express human pressure on the environment as ecological footprint, rather than talking about carrying capacity?

Carrying capacity and ecological footprint serve a similar analytical goal, but the difference is the unit of expression: carrying capacity is expressed in individuals per hectare, which provides a limit to the maximum number of individuals per hectare.

However, carrying capacity (number of individuals/unit area) does not work in the same way for humans as it does for other animals, mainly because humans can use technology, and trade goods to bypass the overuse of resources.

In contrast, the ecological footprint is expressed in hectares per individual, and is not limited to the land area of a specific country. Using the ecological footprint, we can calculate how much a certain subpopulation of humans (a city, a province/state, a country, a continent) needs (ecological footprint), and how many resources they have available in the specific area (biocapacity). Furthermore, we can also determine the total amount of productive land available per person.

1. Why has a Malthusian catastrophe not occurred?

There are three key reasons. First, this is because we are using more land for producing our food. In the period between 1961 and 2007, arable land use has increased by 1.3 million km2, and the total area of pastures increased by 2.9 million km2 (FAO, 2009). Secondly, scientific innovations have led to a Green Revolution within our food system. Unlike other animals, humans have been able to innovate, inventing new technologies to avoid the Malthusian trap, and expand their carrying capacity. Thirdly, all these innovations have been fuelled by large quantities of cheap energy in the form of fossil fuels.

1. Give two further examples of resource stocks, and two further examples of resource flows.

Next to fossil fuels (natural gas, coal oil), other examples of resource stocks are minerals, metal ores and phosphate (see Chapter 3). In addition, soil (see Chapter 5) and some forms of groundwater (see Chapter 4) are stocks.

Next to sunlight, other examples of resource flows include timber, biomass, air, water (not in all cases: see example aquifers in Chapter 4), and fish. If managed properly, these do not run out.

1. Define sustainability, and explain why, based on the concept of ecological footprints, humanity is currently not using resources sustainably.

Sustainability refers to a situation in which both human and natural systems are able to survive and flourish in the very long-term future. The total amount of productive land on Earth in 2010 was ~11.9 billion hectares, which was available for a total global population of ~6.7 billion. Therefore, the average amount of productive land available per person was around 1.8ha/person. The average global usage in 2010 was 2.7 ha/person, clearly exceeding the amount of productive land available. This means we would need approximately 1.5 planets (2.7/1.8) to support our current lifestyles in the long-run.

1. What is the difference between reductionism and holism in scientific research?

Reductionism explains systems in terms of their individual, constituent parts, and their interactions. In contrast, holism focusses on studying systems and their properties as a whole, and assumes that the whole is greater than the sum of its parts. In practise, you often need both: you need to have a solid understanding of the different components of complex systems before you can understand the added complexity of these systems.

1. Briefly describe the process of climate change in a paragraph (this may seem difficult, but the best way to learn is to try and explain this yourself).
   1. This answer should read similarly but differently to the overview in the chapter. It should include concepts such as albedo, reflectance, absorption, and insolation.
2. How are life cycle assessments used to calculate the environmental impacts from food systems, and why are they important?
   1. This answer should an understanding that the environmental impacts are summed up through the supply chain of a food product in order to compare one product to another product (students are not expected to know that the same boundaries must be used in the approach, or to have a deep insight into LCA).
3. In this chapter, we outlined the story of a steak, from production to consumption. Create your own story for a food product you eat often. Can you discover where the ingredients were made and how they were produced? Consider if knowing the whole process would impact your purchasing decisions.
   1. This answer will depend a lot on the product investigated.
4. What choices would you make when looking at Table 6.3? What difference would they make to your lifestyle?
   1. This answer will depend on the student
5. What kinds of impacts can we expect from climate change across the food system?
   1. This answer should include concepts such as how climate change is creating new and different climates and impacting how crops grow. It should highlight that some areas will benefit but most will see a negative impact due to higher temperatures, extreme weather events, water availability, and expansion of new weeds, diseases, and pests.