CEE 3609
Homework 6
(Due April 1 – Submit via Gradescope)

Problem One

If a study sponsor cared about the following list of impacts, suggest impact categories and LCIA methods to be used in a study in the US. Discuss the types of inventory flows you would include in the scope of the study to be able to address them, and how those inventory flows lead to the impacts.

- Impacts on fish
  - Fate and Concentration of toxic compound in the system
  - Number of fish
  - Level of species diversity (ecology)
  - Human health
- Holes in the ozone layer
  - Concentration of ozone
  - Temperature change in the worldwide
- Hypoxia in coastal areas
  - Concentration of oxygen in coastal areas
  - Level of species diversity
- Peak oil
  - Mining rate
  - Emission of greenhouse gas
  - Emission of particles
  - Annual Electricity generated
- Pediatric cancer
  - Annual cases in the national wide
  - Prevalence
  - Lethality
  - Annual Medical expenses

First at first, ISO states impact assessment should encompass "a comprehensive set of environmental issues " so that the study should not be narrowly focus. In other words, these inventory chosen should depends strongly on our scope. For example, if we want to do some research about ozone depletion, then some impact categories should be involved such as holes in the ozone layer. On the other hand, impacts on fish may not be very necessary.

Secondly, if a study has selected Peak oil as an impact category, then the carbon dioxide fossil inventory flow would be classified in to that pile since it is a greenhouse gas, which can be generated during this LCA process. If I chose an impact category for holes in the ozone layer, then concentration of ozone would be classified there.

Problem Two

List and describe the various mandatory and optional elements of life cycle impact assessment.

Mandatory elements:

• Selection of impact categories, category indicators and characterization models

The LCIA methods deleted should be relevant to the geographical area the study. And this step should also document and reference the studies on impacts used.

• Assignment LCI result (classification)

This step is the first quantitative element of LCIA, where the various inventory results are organized such that they map in the frameworks of the relevant impact category frameworks chosen for the study.

• Calculation of category indicator retunes (characterization)

The characterization element of LCIA quantitatively transforms each set of classified inventory flows via characterization factors to create impact category indicators relevant to resources, ecosystems and human health.

Optional elements

• Calculation of the magnitude of category indicator results relative to reference information (Normalization)

This involves transforming by a selected reference value of information. A separate reference value is chosen for each impact. The rational of normalization is to provide temporal and spatial perspective or context to LICA results and also to help to validate results.

• Grouping

This results in achieved by reorganizing LCIA results to meet objectives stated in the goal and scope. Grouping is accomplished by sorting and/or ranking the characterized or normalized LCIA results. Because normalization is an optional step, it may or may not have been done.

• Weighting

The results is potentially the most subjective of the optional elements. In weighting, a set of factors are developed, one for each of the chosen impact categories, such that the result are multiplied by the weighting factors to create a set if weighted impacts.

Problem Three

Given LCI results in Figure 10-21, use the CED and IPCC (2013, 100-year) methods to characterize the LCI results and compare the two options. Which would you recommend as having better performance? Does your answer change if you use IPCC (20-year) instead?

Flow	Compartment	Units	Option A	Option B
Carbon dioxide, fossil	air	kg	5	2
Energy, geothermal		MJ	100	80

Figure 10-21: Hypothetical Study LCI Results

According to the Cumulative Energy Demand Values Used IN Ecoinvent Model (Figure 10-11) and IPCC AR5 2013 100 year Characterization Factors (Figure 10-10) to characterize the LCI results and compare the two options.

Characterization (IPCC2013, 100years)			
Indicator	Units	Option A	Option B
Equivalent releases CO2	Kg Co2 equiv	5	2
Characterization Energy (CED)			
Non-renewable total	MJ-eq	100	80

Given that only energy and green house gas related impacts were chosen for the study, and that these impacts tend to be be highly correlated. It is not a surprise to see that the characterized LCIA results suggest that option B has lower impacts than Option A. The interpretation of course should still highlight the fact that this result occurs because of the chosen impact assessment method, If other impact categories were selected, different answers could result, including tradeoffs between impacts.

According to the figure 10-10, IPCC (20-years) can impact the result of characterized LCIA. Because the flow(inventory unit) has been changed, in terms of the equation 10-1, characterized flow = flow * char.factor, then the result should change, based on the different time chosen.

Problem Four

In this question you will characterize…the set of inventory values shown below.

Flow	Compartment	Units	Option A	Option B
Carbon dioxide, fossil	air	kg	5	2
Energy, geothermal		MJ	100	80
Coal, hard		kg	4	2
Crude oil		kg	10	8

Use Cumulative Energy Demand Values, Then

Characterization (IPCC2013, 100years)			
Indicator	Units	Option A	Option B
Equivalent releases CO2	Kg Co2 equiv	5	2
Characterization Energy (CED)			
Non-renewable forest	MJ-eq	49	39.2
Non-renewable fossil	MJ-eq	612	489.6
Energy, geothermal	MJ-eq	100	80
Non-renewable total	MJ-eq	761	608.8

*Essential equation from text book

Characterized flow = flow (inventory init) * char.factor ($\frac{characterized\ units}{inventory\ unit}$). 10-1

Characterize the flows in the table above using the BEES impact assessment method, which uses IPCC for global warming, and the natural resource depletion (in units of MJ surplus) method with values excerpted in the table below.

Flow	Factor	Unit
Coal, hard	0.49	MJ surplus/kg
Crude oil	6.12	MJ surplus/kg
Gas, natural	7.8	MJ surplus/kg
