CIVE 230 Assignment 1

1. Each definition does not define environmental impact as the absolute driving factor, but rather that there is as a trade-off between biological and socio-economic systems. They all discuss sustainability as a timeless, continuous process from the past to the future. They all mention that sustainability changes as society changes. Lastly, they are all grounded in cosmopolitan equity. The Environmental Protection Agency (EPA) defines sustainability as, "based on a simple principle: Everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment. To pursue sustainability is to create and maintain the conditions under which humans and nature can exist in productive harmony to support present and future generations." (2017, January 19)
2. The triple bottom line is environment, economic, and equity. In simpler terms, it is planet, people, and profit. Conflicts between the environment and equity arise from growth control. Conflicts between economics and equity arise from class and property conflicts. Conflicts between the environment and economics arise from resource and pollution conflicts.
3. Traditionally, engineers have been the source of technological development, and thus have had and continue to have a major impact on economic and human activity. This includes resource consumption and pollutant transportation and transformation, which consequently create environmental changes and impact the valuation of environmental changes. The contemporary domain also includes public policy, as engineering expertise is quintessential for changes in regulations and standards, and economics, as engineers design transportation systems and others which fuel the economy.
4. SDG 11 is about making cities and human settlements safe and sustainable. The motivation behind this goal is clear: 9/10 city dwellers breathe polluted air, 2 billion people don't have waste collection, and 1/4 urban residents like in slum conditions. Targets 11.a and 11.b aim to strength national and regional development planning. This would be accomplished large amounts of settlements adopting inclusive and resilient plans for risk management and resource efficiency by 2020. This has progressed to the point where 150 countries have

developed national urban plans. However, most of the targets are set to 2030. Target 11.1 requires access for all to safe affordable housing, including basic services and upgrading from slums. Progress is indicated by the proportion of urban population living in inadequate housing. This has progressed significantly between 1990 (46% of the globe) and 2016 (23% of the globe). Target 11.2 requires access to sustainable transport systems for all peoples through the expansion of public transport and road safety. This is measured by the proportion of the population with convenient access to public transport, with emphasis on disadvantaged community members. Low progress has been made towards this goal thus far. Many other targets, like reduced city pollution, improved access to construction materials, and improved heritage protection, are also being implemented and monitored under the umbrella of this goal.

5. The Kaya identity is an equality that states that total CO_2 emission levels (F) can be expressed as product of human population (P), GDP per capita (G/P), energy intensity per GDP unit (E/G), and carbon footprint of energy (F/E). It was developed by Japanese energy economist Yoichi Kaya in 1993, and provides a formidable understanding of the factors that promote greenhouse gas emissions. After all, population and GDP are really the two defining forces behind demand, while energy intensity and carbon footprint are really the impact of demand. Without demand or negative impact, there would be no problem.

$$F = P \cdot \frac{G}{P} \cdot \frac{E}{G} \cdot \frac{F}{E}$$

6. The IPAT equation suggests that impact (I) is a product of population (P), affluence (A), and technology (T). It demonstrates theoretically that developed countries are enabled to cause catastrophic impacts. If increased affluence means more people are polluting with energy-consuming technology, and many people have some affluence, that means there will be lots of subconscious pollution.

$$I = P \times A \times T$$

7. Carrying capacity is defined as the maximum capacity of people the world can support according to demands of natural resources, energy, and other essentials. Concepts of

sustainability are important in this definition as the carrying capacity is dependent on the need of resources. As such, the rate at which renewable resources are consumed cannot be greater than the rate at which they are created. The rate at which non-renewable resources are used cannot be greater than that of the development of renewables. As well, the rate of waste production cannot exceed the rate at which the environment breaks them down.

References

Environmental Protection Agency. (2017, January 19). *Learn About Sustainability*. EPA. https://www.epa.gov/sustainability/learn-about-sustainability#what

CivE 230 Assignment 1 $nM=m$ Jan 19, 2017 May 21 2020

⑧ a) $E = 3E17 \frac{kJ}{yr}$

$C_2H_3 = 43E3\ kJ/kg$

$kg\ CO_2/year$?

$2\,C_2H_3 + \frac{11}{2}O_2 \rightarrow 4\,CO_2 + 3\,H_2O$

, 1 mol C_2H_3 = 2 mol CO_2

$M\,C_2H_3 = (12.011)2 + (1.008)3$
$= 27.046\ g/mol$

$MCO_2 = 12.011 + 2(15.999)$
$= 44.009\ g/mol$

$3E17\ kJ/yr \div 43E3\ kJ/kg =$

$= 6.976E12\ kg/yr$ of C_2H_3

$= \frac{6.976E15\ g/yr}{27.046\ g/mol}$

$= 2.5793E14$ mol/year C_2H_3, 1:2 mol ratio

$\therefore 5.15861865E14\ mol\ CO_2/yr$

$5.15861865E14 * 44.009 = 2.270256482E16\ g/year$

$\therefore$ The annual emissions of CO_2 is $2.27026E13\ kg/year$

b) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

$\frac{12.011}{44.009} = 27.29\%$, mass fraction of C

$\therefore m_c = \frac{6.19619086 5E12\ kg/year}{3E17}$

$= 20.65396955E{-6}\ kg/kJ$ of C in C_2H_3

moles of CH_4

$= \frac{10.9E16\ kJ/yr}{39 \times 10^3\ kJ/m^3} \times \frac{1}{22.4E{-3}\ m^3/mol}$

$= 12.5E13$ mol/yr

$MCH_4 = 16.036\ g/mol$

$MCO_2 = 44.009\ g/mol$

Since 1:1 ratio, $\frac{12.5E13\ mol\ CO_2}{year}$

$12.5E13 * 44.009 = 5.501125E15\ g/yr * \frac{1\ yrs}{10.9E16\ kJ}$

$= 0.050469036\ g/kJ$

, since 27.29% C

$0.2729 * 0.050469036$

$= 0.013773\ g/kJ = 0.000013773\ kg/kJ$

$\text{ratio} = \frac{20.65396955E{-6}}{13.773E{-6}}$

$= 1.5$

9) a) $\frac{CO_2}{year}$?

1mg/L

ppm

$kWh = 12773 / 0.93$

$= 13734.4086 \cdot \frac{1293\ lb}{\cancel{MWh}\ Mwh}$

$= 17758590.32\ lb$

b) $166000000 \times 17758590.32\ lb$

$= 2.947925994\ E12\ lb$

10) 10 mg/L pollutant

5 million gallons/day = 18925000 L

3.785 L/gal

2.2 lb/kg

10 mg = 37850000

3 mg/L pollutant

$C_m = \frac{18925000\ /day * 10 + 37850000 * 3}{(18925000 + 37850000)}$

$= 5.\bar{3}\ mg/L$

$= 5.\bar{3}\ ppm$

$lb = 5.\bar{3}E\text{-}6\ \frac{kg}{L} \cdot [18925000 + 37850000] \cdot 2.2\ \frac{lb}{kg}$

$= 666.16\ lb$ of pollutant

11)

pop	
2012	7B
2000	6B
0	0.3B
1500	0.5B

a) $\frac{7}{6} = e^{r12}$

$\ln\frac{7}{6} = 12r$

$r = 1.285\%$

b) $\frac{0.5}{0.3} = e^{r1500}$

$\frac{\ln\left(\frac{0.5}{0.3}\right)}{1500} = r$

$r = 0.00034055 = 0.0341\%$

c) The rate between 2000-2012 was 37.68 x greater than the rate between 0-1500

(12) $P_2 = 0.8e^{43*0.0175}$

$= 1.698$ billion

(13) $\frac{\text{impact}}{\text{GDP}}$

Assuming that the E carbon footprint remains constant...

$P_1 = 72M$

$F_1 = 72000000 \cdot [1] \cdot [1]$

$\frac{GDP}{capita} = (1.05)^{40}$

$F_2 = [72000000(1.0063)^{40}] \cdot (1.05)^{40}(1-r)^{40}$

$r = 0.0063$

$F_2 = F_1$, $1 = (1.0063)^{40}(1.05)^{40}(1-r)^{40}$

$0.946418515 = 1-r$

$r = 0.053581484$

$(1-0.053581484)^{40} = 0.110491567$, $\therefore$ 0.8895 % reduction

(14) a) (20g CO)/mile, $\therefore$ in 5 miles, 100g CO produced

$T = 25°C = 298K$

$P = 1$ atm

$n = \frac{100g}{(12.011+15.999)}$

$= 3.570153517$

$pV = nRT$, $V = 3.570153517(0.08205)(298)$

$= 87.3L$

b)

meter = mile * 1609.34

$20g/mile * \frac{1 \text{ mile}}{1609.34m}$

$= 0.012427454g$

$n = \frac{m}{M}$, $\frac{0.012427454}{28.01}$

$n = 0.000443679$ moles

$pV = nRT$

$V = 0.000443679(0.08206)(298)$

$V = 0.010849678$ L

$0.010849678 = \frac{9}{1000000}V$

$V = 1205.52L$