**EES 22 Lab 12 – Humans significantly alter the Earth.**

Over the course of this semester we have explored the evolution of the Earth and environment and interactions between Earth systems: the geosphere, hydrosphere, atmosphere, and biosphere. We’ve seen how these systems operate on a variety of time and spatial scales, and how changes in one system can cause changes in another. We’ve also seen how feedbacks can develop, increasing or decreasing changes in ways that can be surprising and in some cases irreversible. In this lab we will explore how human (anthropogenic) activities alter the Earth. Human activities have become a measurable force of change on Earth impacting all four components of Earth systems. In this lab we will look at human impacts on the hydrologic cycle and water resources using the Aral Sea, the Colorado River Basin, and Great Salt Lake. We will also explore how population, affluence, and technology combine to impact the Earth and environment in ways that are measurable using sustainability metrics.

**Part 1. Anthropogenic impact on the water resources.**

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**Part 2. Sustainability Metrics.**

In part 2 you will explore the relationships between impact, population, affluence, and technology (IPAT) using quantitative data metrics from Gapminder Tools. Gapminder tools provide a way to assess impact using real-world data and metrics under the IPAT analytical framework.

Impact = Population x Affluence x Technology

Within the Gapminder tools, impact can be described using metrics such as greenhouse gas emissions, air pollutant emissions, or freshwater extraction rates. Affluence is typically measured by per-capita Gross Domestic Product (GDP) measured in purchasing power parity (PPP). Metrics for assessing technology could include fossil energy production, energy production, extent of communication infrastructure, among others.

2.1 Become familiar with the Gapminder interface and how it can be used to display environmental impact metrics on a country level. Launch the Gapminder Tools <https://www.gapminder.org/tools/>

2.1.1 On the y-axis, click on the axis label and enter “CO2 emissions, per person” into the search box. Click on that metric and wait for graph to load. Note the source of the data and the units used to describe this metric by clicking the question mark icon.

2.1.2 On the x-axis, click on the axis label and enter “Energy use, per person” into the search box. Click on that metric and wait for the graph to load. Note the source of the data and the units used to describe this metric.

2.1.3 In the upper right-hand corner, go to the Color section. Click on the box and enter “Income groups” into the search box. Select this option and wait for the graph to load. List the Income groups classifications. Hover your cursor over a specific country and note which classification it falls under (e.g. highlight United States, a high-income country and note that on the map all the other classification colors are greyed out).

2.1.4 In the lower right-hand corner, go to the Size section. Click on the box and enter “Population” into the search box. Select this option and wait for the graph to load. Run your cursor over any circle within the graph and note the country and its population, which will be noted in the Size box.

2.1.5 At the bottom of the graph, look at the Time Period slide bar, with a dark grey button that you can move from side to side. Slide the button to both extremes and note the time period for which all four Income Groups are visible.

2.2 Slide the time bar to 2007 and answer the following questions:

2.2.1 Using the IPAT framework: I (Impact) = P (Population) x A (Affluence) x T (Technology) framework, describe which metrics on your plot represent the different components of the framework?

2.2.2 Describe the overall pattern of the bubbles (i.e. countries) in your graph**.** Do the patterns follow the IPAT framework? Why or why not? Describe one country that meets the criteria and note its supporting characteristics.

2.2.3Are there any countries that do not fall neatly under the IPAT framework? Why or why not? If so, describe this country and its supporting characteristics. What can you theorize about this country?

2.3 In this section you’ll use the Gapminder tool to frame your own sustainability question, build a graph, interpret the results, and share your evidence-supported conclusions with the class. Launch the Gapminder Tools <https://www.gapminder.org/tools/>

2.3.1 In the upper right-hand corner, go to the Color section. Click on the box and enter “Income groups” into the search box. Select this option and wait for the graph to load. In the lower right-hand corner, go to the Size section. Click on the box and enter “Population” into the search box. Select this option and wait for the graph to load. Identify the potential drivers of environmental impact under the IPAT framework.Explore the Gapminder tool and write down which available Impact and Technology metrics could fit within the IPAT framework. Use the table in the lab answer template to do this (sample below)

Table 1. Selected Gapminder metrics

|  |  |  |  |
| --- | --- | --- | --- |
| **Impact** | **Population** | **Affluence** | **Technology** |
| Example: *CO2 emissions (tonnes/person*) | N/A\* | N/A\* | Example: *Energy production, per person* |
|  |  |  |  |

*\*It is not necessary to explore population or affluence measures, as they are reflected in the bubble size and bubble colors, respectively.*

2.3.2 Review the list of Impact and Technology metrics in your table. Consider which metrics could be integrated into a meaningful sustainability question and brainstorm a few possible sustainability questions. Select one that is most interesting to you. Make sure your sustainability question involves an Impact that could be explained by a Technology metric. For example, “*Does the number of cars, trucks, and buses explain the variation in CO2 emissions across countries?*”.

2.3.3 Plot the Impact metric incorporated into your sustainability question. On the y-axis, click on the axis label and enter the name of the Impact into the search box. Click on that metric and wait for graph to load. What are the units used to describe this metric?

2.3.4 Plot the Technology metric incorporated into your sustainability question. On the x-axis, click on the axis label and enter the name of the Technology metric into the search box. Click on that metric and wait for the graph to load. What are the units used to describe this metric in the line below?

2.3.5 At the bottom of the graph, look at the Time Period slide bar. Slide the grey button to both extremes and note the time period for which the datasets are available. Slide the bar to the most recent and most complete year. What single year you will be analyzing?

2.3.6 From the available countries, select one High Income country (dark green bubbles) and one Low Income country (dark blue). Write which countries you selected, and document that country’s population, Impact value (including units), and Technology value (including units).

2.3.7 For the countries you selected, describe the findings of your sustainability question as shown by the data. Does the IPAT framework hold?

2.3.8 For all the countries shown on the figure, what pattern(s) do you see across population, affluence, level of technology, and environmental impact? Across all the countries shown in your plot, which countries support the IPAT framework? Across all the countries shown in your plot, give an example of a country that does not support the IPAT framework. Describe why it does not fit.

2.3.9Consider and describe potential drivers of environmental impact that are not captured in the Gapminder tool metrics you selected. Qualitatively explain some of the relationships among these.

2.3.10 What are some strengths to using the Gapminder tool? Some limitations?

2.3.11 What is a sustainability claim you could make that is supported by evidence shown in your graph?

2.3.12 Take a screen grab of your figure and include it in your submitted answer template.