Environmental Geology Lab 11 – South Texas Sustainability

Substainability Definition

What is a term that means many things depending on context. In terms of environmental issues a functional definition is the consideation the needs of future generations as well as the present. Our current activities ideally should not degrade the environment inperiling the ability of future generations to live with a smiilar quality of life as people today. Therefore, substainability lies at the nexus of economic development and environmental stewardship. Substainability is a long-term concept that considers what the earth might be like decades and even centuries from now.

This course has addressed resource extraction and environmental pollution. Our generation ideally should not deplete nonrenwable resources like soil, water, mineral, and energy. In addition, their are consequences to resource extraction that should be managed wisely. Pollution generated in the present should not be the inherence we leave our children.

An issue of consideration in the popular media is that we need to save the Earth. Our planet is 4.6 b.y. old. The blunt truth is that humans are really not that important when considered against the entire history of the planet. The Earth and life on the planet flourished before humanity arose and likely witll survive fine after our extinction. It's not the planet that needs saved but its us as a species.

South Texas Population

Humanity has grown over the last forty thousand years from bands of hunter-gatherers that numbered a few million to billions that occupy nearly every corner of the globe. In recent decades, one place that has seen expansive grow is South Texas as illustrated below. Most of these people will live in the regions urban centers that will expand greatly. Laredo is projected to have population 600,000 by 2070 over double what it is now.

Table 1. Projected population of the countries along the Rio Grande (in blue on Figure 1) in South Texas (in millions of people)

Year	2020	2030	2040	2050	2060	2070
Population	1.96 M	2.38 M	2.79 M	3.21 M	3.67 M	4.03 M

Many of the environmental problems we face are generated by the human footprint produced by a large population, especially those who live in urban centers. Greater numbers of people require more resources that can generate more environmental issues.

This lab will explore the two greatest issues, water and energy, that threaten the substainability of the South Texas region.

QUESTIONS

1. In your own words, write a definition for substainability.

2. By examinning Table 1, determine approximately, how many years will it take for the population in South Texas to double.

3. Discuss how the expanding urban footprint of South Texas in the future might affect the environment based on previous topics discussed in this course. Give three examples. Hint think about issues like flooding and soil degradation amongst others we have dicussed in this class.

Recently CEES has developed its own YouTube channel for a dozen videos that we produced related to substainability focusing specifically on the South Texas region. To access this page in google type (Center for Earth and Environmental Studies-TAMIU YouTube). In today's lab we will watch four videos. The first one focusing on Population. To access this video click on the Videos menu item. After you have watched the Population video answer the following questions.

4. During which year does Webb County's population pass 400,000 _____

5. What is the population of Webb County in the year 2050 _____

South Texas Water

Remember that water in South Texas is a non-renewable resource. In the immediate Rio Grande valley, the regions relies mostly on surface water as the region's ground water resources lie in the relatively sparsely populated area between the Rio Grande and San Antonio (Figures 1 to 3). The four major aquifers in the region provide groundwater that is used primarily for crop irrigation. In 2004, South Texas used almost four times more surface than groundwater. South Texas accounts for nearly half of Texas' coastline along the Gulf of Mexico. Fresh water flowing into coastal bays and estuaries is essential to the ecosystems that support the fishing, shrimp and oyster industries, in addition to tourism.

Suth Texas water management has some unique features. The region contains the only two reservoirs Texas shares with Mexico, Falcon Lake and Lake Amistad, and the only channel dams on the Rio Grande that provide water for crop irrigation, These facilities, in addition to miles

of levees and a weir (a low dam) in Brownsville, are owned and controlled by the International Boundary and Water Commission

Amistad is one of Texas' largest reservoirs, with more than four trillion of capacity. The National Park Service maintains the Amistad National Recreation Area (NRA) near Del Rio in Val Verde County. Amistad NRA is the U.S. portion of the reservoir and is known for excellent water-based recreation, prehistoric rock pictographs and a wide variety of plant and animal life.

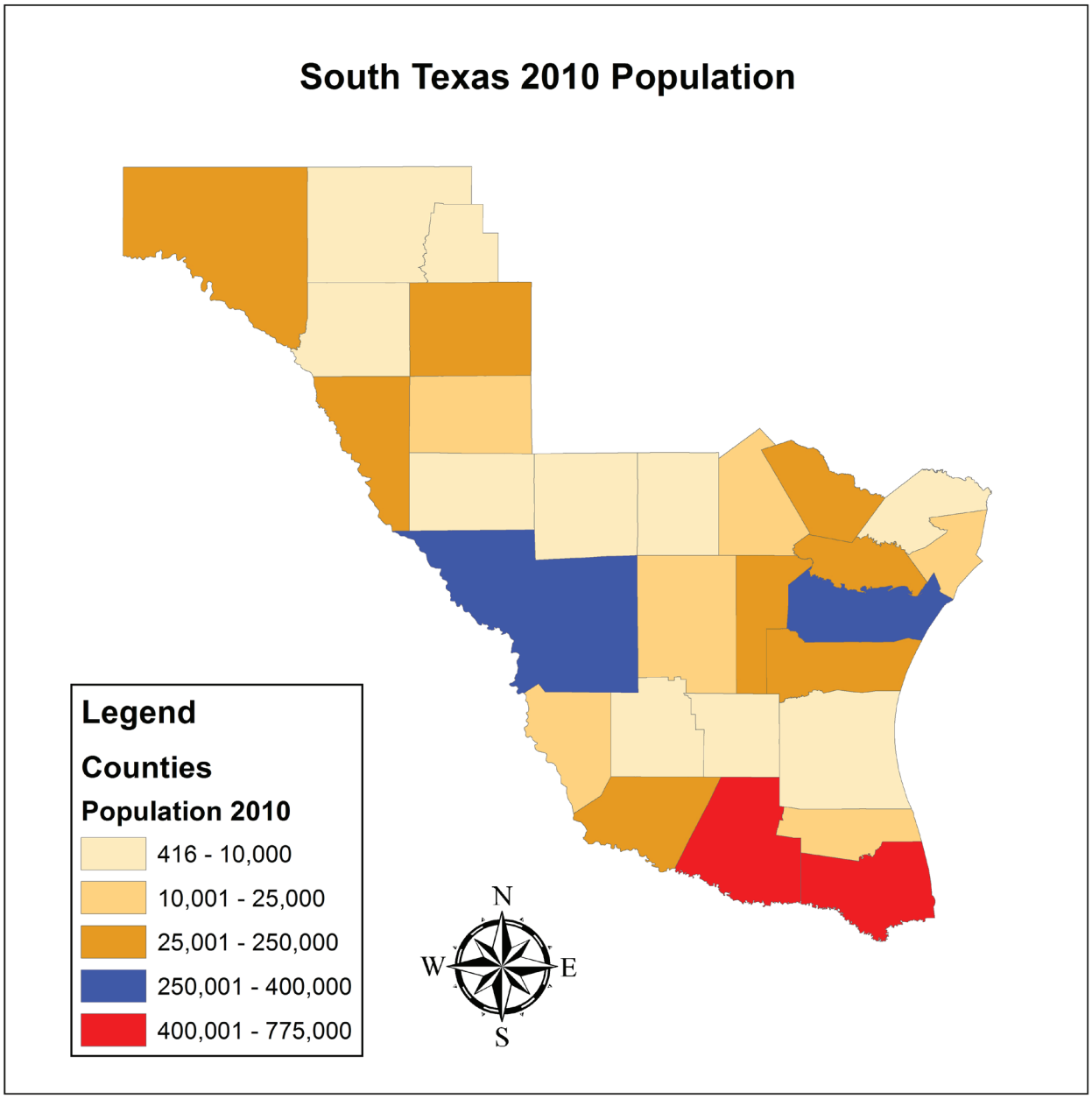

Figure 1. South Texas region. The Rio Grande planning district includes the counties along the border from Cameron to Maverick counties. See Figure 2 for country names.

Water use in the future is projected to grow with population. Table 2 outlines how water use is projected to change from 2000 to 2060. Note the general upward increase in water consumption.

Additionally notice that while there is in general growth in all sectors the magnitude of the upward trend differs between sectors.

Given the upward trend in consumption, political leaders have begun to examine more costly alternatives for supplying the region with water. Desalination ("desal") or the desalting of water is, as water treatments go, a fairly straightforward but energy-intensive enterprise. Two methods are employed – reverse osmosis or RO, which involves high-pressure membrane filtration, and distillation, which is a steam recovery system. RO is more useful for low-salinity waters; distillation is better for high-salinity seawater. The Texas Water Development Board (TWDB) estimates that the average annual cost of desalinating brackish or semi-saline water was about half of the cost of desalinating seawater costs. These costs are roughly two to 10 times higher than the average costs of preparing non-saline water for human consumption. The cities of Brownsville and Corpus Christi have considered this as an option for supplying the needs of their growing populace in the future.

Figure 2. Surface water resources present in South Texas.

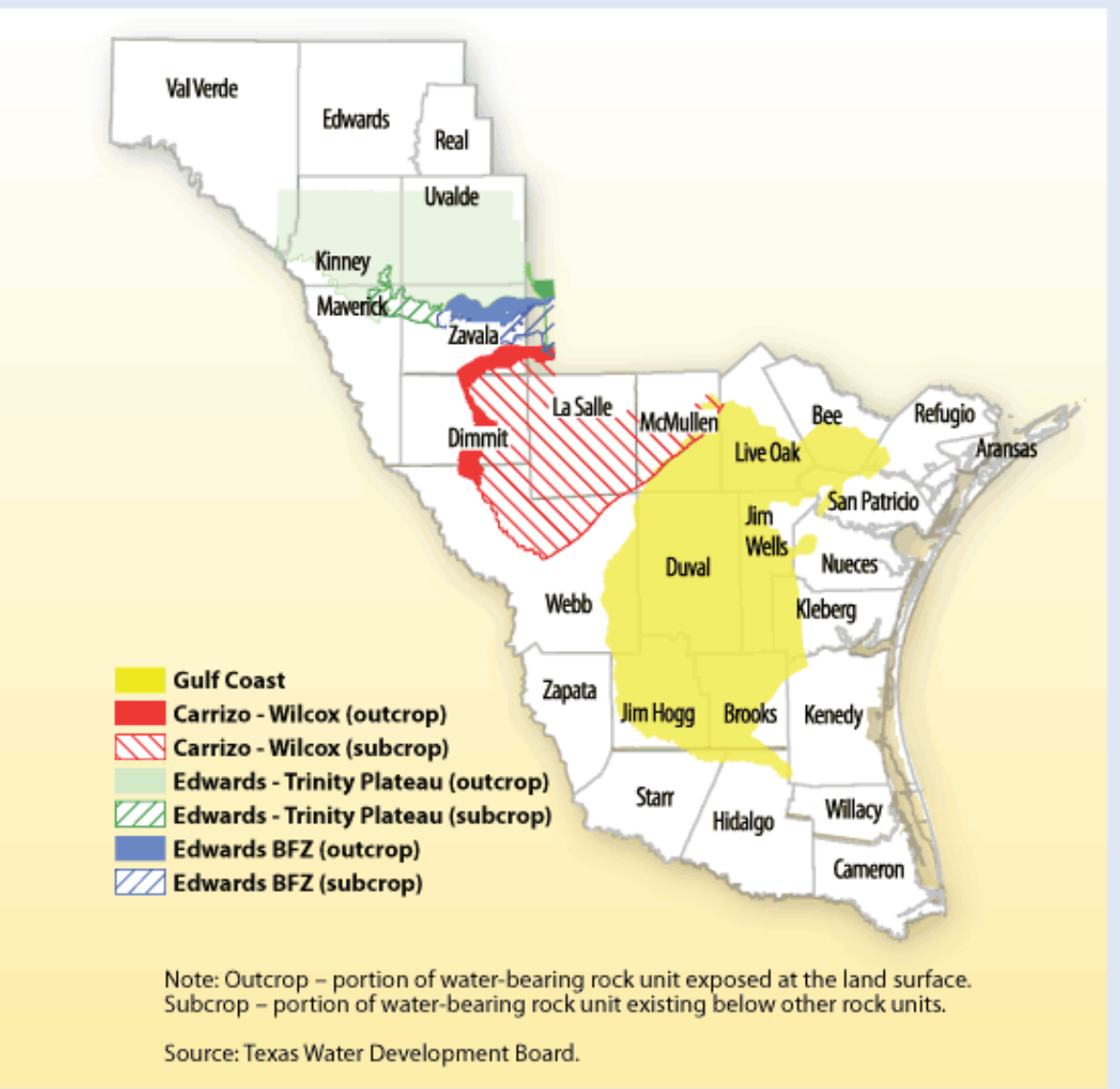

Figure 3. Groundwater resources present in South Texas.

Sector	2000 Actual	2020 Projected	2040 Projected	2060 Projected
Irrigation	1.000	1.548	1.406	1.389
Municipal	0.441	0.617	0.807	1.013
Manufacturing	0.076	0.098	0.111	0.125
Livestock	0.024	0.027	0.027	0.027
Mining	0.022	0.028	0.029	0.032
Steam Electric	0.017	0.038	0.053	0.074
Total	1.581	2.355	2.432	2.659

Table 2 (on previous page). Water Consumption for the Rio Grande Region in Trillions of Liters / year

QUESTIONS

6. Is there a dismatch between the location of urban areas and groundwater aquifers in the region? Comment in detail.

7. Besides human consumption, what other functions does the region's surface water support?

8. Calculate the municipal water use per person in liters per day the Rio Grande region for the year 2020. Hint: Take the value from Table 2 and divide by the population from Table 1. Then, mutiply this number by 2.74 billion.

9. Do the same calcuation for the year 2060.

Watch the South Texas Projections 2020-2070 - Individual Water Demand video from YouTube.

10. Does the projected water demand per person change at all in Webb County over the next 50 years?

11. Come up with an explaination for the difference in your answers for questions 9 and 10. Hint: think about how technology and people's life styles might change over the next fifty years.

12. The year is 2070. 11. The population of Laredo is now 600,000. Detemine the total amount of water used by the city based on your answer to question 8. Hint: multiply 600,000 times your answer to question 8.

13. Imagine that South Texas is facing its third straight decade of severe drought. The flow in the Rio Grande is only 5,000 liters per second. Multiplying by 86,400 to determine the flow of water pass Laredo during a day.

14. Let assume that the answer to question #13 reflects the worst-case scenario for drought in Laredo in the future. How much of the river would be used by the city on a percentage basis? **Hints: Take water consumption value from question 12 and divide by the total amount of water available from question #13. Multiply by 100%.**

15. Given this dire situation the region's leaders long ago opted to build a desalination plant. Comment on some issues, both envirnomental and fiscal, associated with adopting this technology.

South Texas Energy and Climate

Energy resources, which do or are capable of supplying our energy needs, may be classified, based on their current stage of development and market status, into three categories (a) conventional, non-renewable sources (fossil fuels, fission nuclear energy, hydroelectric power), (b) alternate renewable sources (solar energy, wind energy, tidal energy, geothermal energy), and (c) sources of the future (fusion nuclear energy, hydrogen). Fossil fuels constitute the most important energy resource at present totaling more than 90% of the world's energy consumption (as well as that of Texas) is obtained from *fossil fuels* -- crude oil, natural gas, and coal. Figure 4 illustrates the energy sources used to produce electricity in Texas.

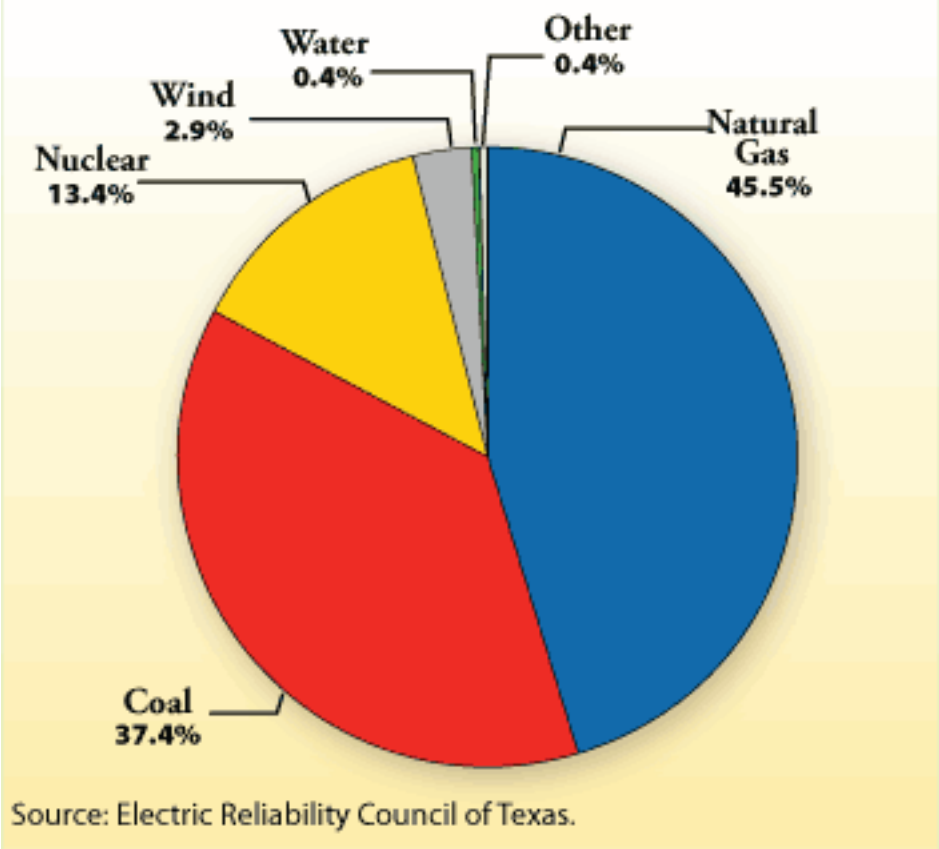

Figure 4. Proportion of energy sources used for electricity production in Texas.

As fossil fuels are nonrenewable resources, there has been a legitimate concern about the longevity of this irreplaceable resource on which our civilization and economy are so dependent. In this lab you will learn some basic facts about the overall energy picture and the impact of fossil fuel utilization on the global environment. Additionally we will examine how human development has impacted the ecology of the planet as a whole.

An important consequence of the combustion of fossil fuels is the production of CO_2 gas by the combination of carbon and oxygen ($C + O_2 = CO_2$). Coal yields about 11% more CO_2 than oil and 67% more than natural gas for the same energy value. About half of this released CO_2 gets dissolved in the ocean waters and some of it is used up by plant photosynthesis. Quantitative estimates of the "sinks" of CO_2 are rather uncertain at the present time, but measurements and estimations of atmospheric CO_2 strongly suggests a steady increase in the concentration of CO_2 in the atmosphere since about 1880 (Figure 5).

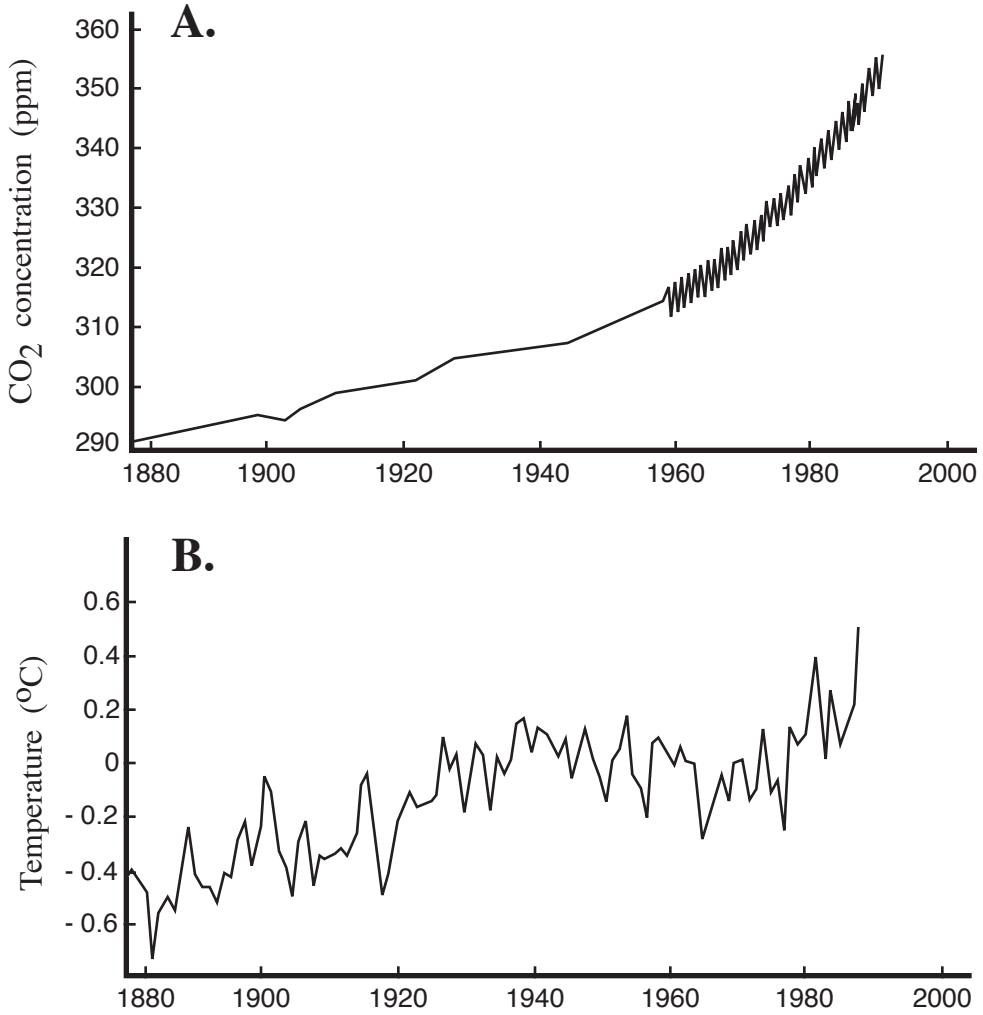

Figure 5. Atmospheric CO_2 and temperature changes since 1880. (**a**) Changes in CO_2 concentration synthesized from measurements at Mauna Loa, Hawaii, observatory (1858-1992) and from data on ice cores (prior to 1958). The zigzag pattern probably reflects seasonal variation in CO_2 uptake by plants. (**b**) Average annual surface air temperature plotted as deviation from the average.

The continuation of the present rate of increase in the concentration of CO_2 gas in the atmosphere is leading to *global warming* because of its *greenhouse effect*. CO_2 gas is a *greenhouse gas* in the sense that CO_2 molecules in the earth's atmosphere act similarly to the glass (or plastic) cover in a greenhouse; that is, they obstruct the escape of heat from the earth's surface (Figure 2). CO_2 is relatively transparent to sunlight (short-wave radiation), so that it does not obstruct the heating of the earth's surface by sunlight, but it absorbs a portion of the heat radiated back from the earth's surface in the form of infrared (long-wave) radiation and reradiates a part of it back to the earth. Thus, too much atmospheric CO_2 will have the effect of "trapping" some of the heat in the atmosphere and increasing the earth's surface temperature. We should also take note of the contributions of other greenhouse gases such as, water vapor, methane (CH_4), nitrous oxide (N_2O), and chloroflurocarbons (CFCs), but CO_2 is the biggest culprit.

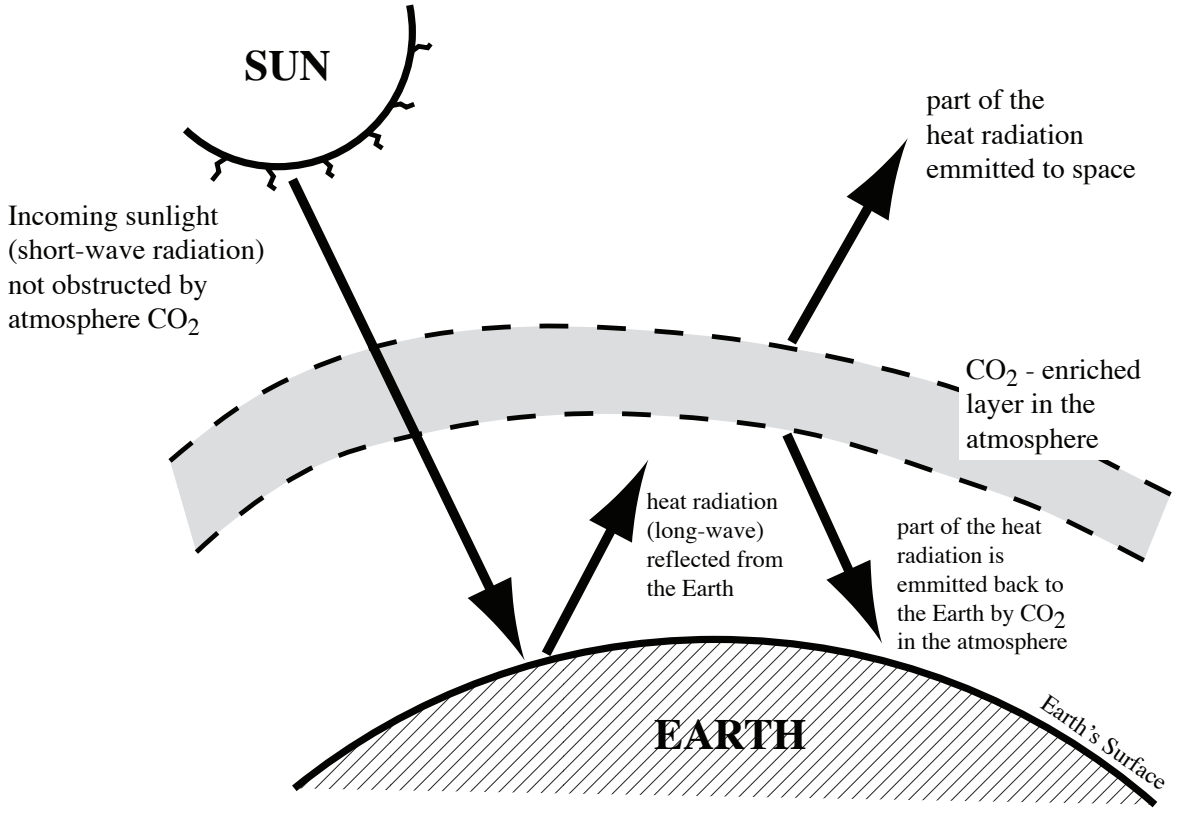

Figure 6. Schematic illustration of the greenhous effect caused by atmospheric CO_2.

QUESTIONS:

16. How much of current electrical production in Texas is tied to fossil fuels? _____

17. How much of current electrical production in Texas is tied to renewable energy resource? _____

Watch the Night Lights video from the CEES YouTube channel

18. Can you explain the cause of the increase in nightlights between Laredo and San Antonio starting about 2010.

19. What are the greenhouse gasses that affect earth's climate and how are they linked to the burning of fossil fuels.

Watch the Climate Change Scenarios - Annual Average Temperature video from YouTube.

20. Determine the average annual temperature for the Laredo areas during following years?

2020 _____ 2090 _____

21. How many degrees of global warming are predicted for Laredo by the Climate Change Scenario you just watched _____

22. To foster greater substainability, which type of energy resources would you advise the region's leaders move towards. Also comment on the feasiblity of your proposed guidance.