Simulation of Global Warming in the Continental United States Using Agent-Based Modeling

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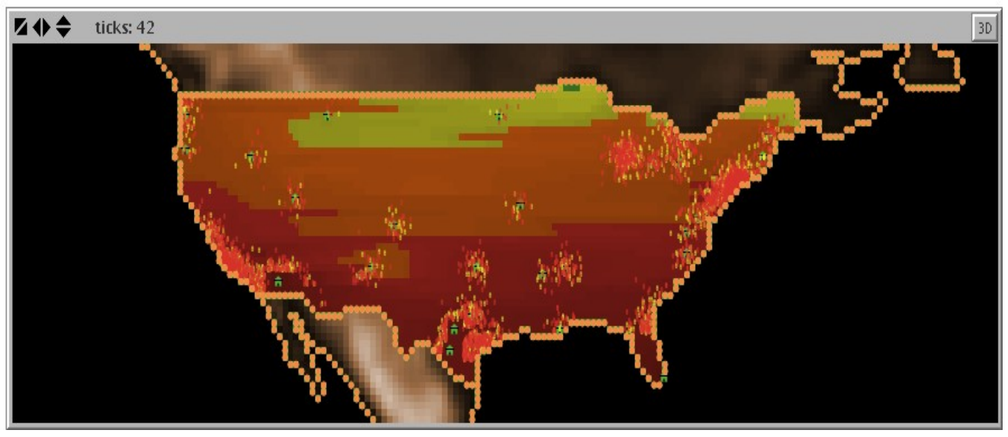
Abstract

It is a commonly accepted fact that as the population increases, the carbon footprint of the United States increases, further accelerating the effects of global warming. However, not many studies have been constructed correlating the effects that global warming will have on population. The purpose of this experiment is to combine the effects that population will have on greenhouse gas output and then the effect that the resulting temperature and sea-level changes will have on the population. The goal of the experiment is to show the detrimental effects that global warming will have in the United States if nothing is done to limit the greenhouse gas output.

Background

Most of the common formulas used in this project come from an online University of Michigan class. The basic elevation map was taken from a previous project by Josh Unterman on the Continental Divide, and a temperature map was based off of it using average annual temperatures and linear interpolation.
Agent-based modeling is a popular way to represent human behaviors through simple heuristics and basic societal rules. Each agent needs to have a set of values, which in this case is the temperature and elevation of the patch that they are currently inhibiting, their salaries and money and those of the agents and patches around them. The only previous research on this topic has been mainly done by the International Panel on Climate Change (IPCC) which creates simple and complex models of possible climate situations. However, none of them actually have real people agents to simulate what would happen to them.

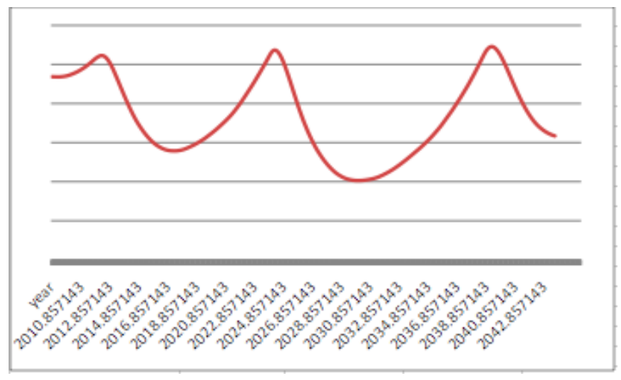


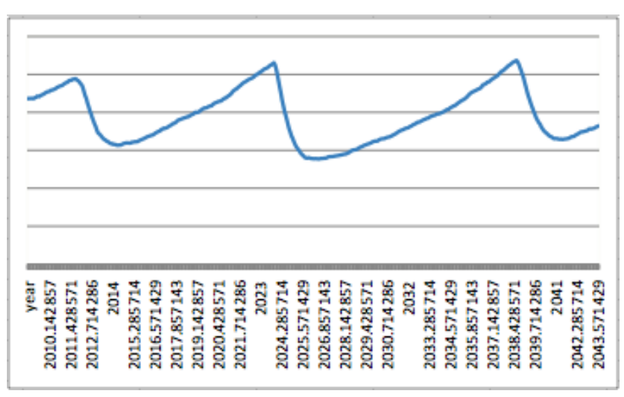
Variables

Patches (Land): Each patch has an elevation, average temperature, birth rate and a changing death rate.
Agents (Population): According to demographic information, each agent has a salary.
Cities: Each city has a name, average salary and a percent of people living under the poverty line.
Constant Variables: Temperature limits and birth rate.
Changing Variables: Death rate changes according to temperature and sea-level.

Progress

As ticks progress, the population of the agents increases according to the birth and death rate racio, determined by a random number generator. If the population increases, then so will the greenhouse gas output and thus the temperature. When the temperature peaks, there is a sudden drop in the population size to offset the change.





Results

The main purpose of this experiment is to show a possible bleak future scenario of what will happen when nothing is done about global warming. The expected results are unknown, but will most likely show that over time, the population will first increase due to favorable conditions. However, as the population increases, more greenhouse gases are produced and thus the climate changes and heats up. As infectious diseases start to spread and sea-levels start to rise, the population will decrease, now decreasing the amount of greenhouse gases in the atmosphere. The climate will now cool down, and the death rate will once again decrease, enabling the birth of more agents. There is a slow oscillating relationship between the population and greenhouse gases in the atmosphere already shown by the simulation.