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

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Marika Lohmus

Abstract

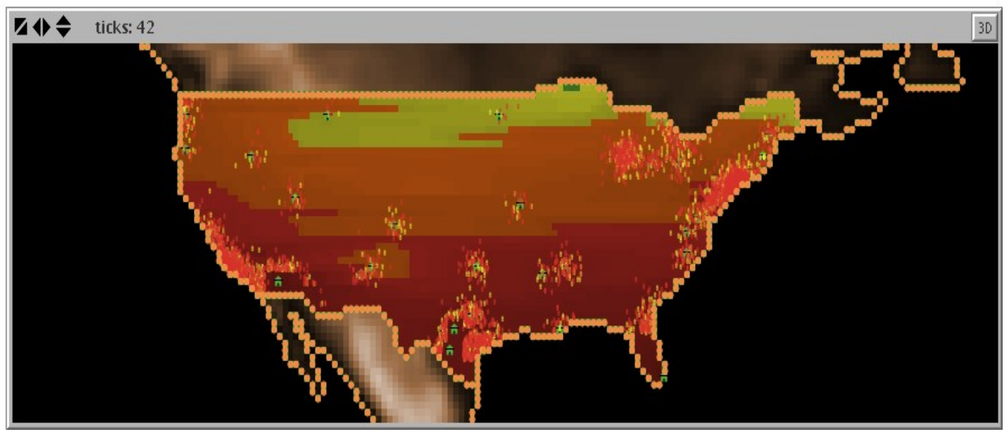
It is a commonly accepted fact that as the population increases, the carbon footprint of the United States increases, further accelerating the effects of global warming. However, not many studies have been constructed correlating the effects that global warming will have on population. The purpose of 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. The results of this experiment would be useful to environmental scientists all over the world, not just in the United States, since similar population changes should be happening globally.

Background

Most of the common formulas used in this project come from several Stella models and from an online University of Michigan class based on global change. There are various versions of global warming models available on the internet, but none of them concentrate on the effects of people on global warming and climate change on the population. 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.
Agent-based modeling is a popular way to represent human behaviors through simple heuristics and basic societal rules. David Batten, in his paper "Are some human ecosystems self-defeating?" discusses the potential downfalls and problems of such modeling and proposes that the agents should be able to communicate with one another in addition to their environment. 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 and of the ones around them. Romulus-Catalin Damaceanu performed his research on studying wealth distribution using NetLogo, which used similar parameters and private variables as will be used in my simulation of the global warming and population effects.

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

Currently, the people move around the country according to a random number generator, but they are also trying to escape unfavorable situations. The temperature changes and population changes are evident and clearly linked to each other. The elevation changes are not very reliable yet, but they will soon be determined according to previous models.

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.