Our Carbon Footprint

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Team 026

Executive Summary

This project began around our collaborative concern about global warming and the reality that it is within human control to stop this phenomenon. Our team, originally composed of five members agreed on the proposal to compare the carbon output of various countries around the world, specifically those that produce the most carbon emissions, and those that produce the least. We wanted to further focus on countries that were able to reduce carbon emissions the most effectively, and what they were doing that was successful in reducing carbon emissions.

At our school, we are part of a community garden project. Our school's garden is called Los Jardines, and it is part of our school experience to plant, tend, harvest, and problem solve garden methods. As part of this project, we saw Jedrek Lamb, a community farmer speak about what methods could be used each month of the year. He talked at length about the benefits of

ground cover in the fall to keep your gardens and soil healthy. One of the benefits of planting ground cover was that many plants absorb carbon emissions produced locally.

This shifted our focus to looking at how much ground cover would be necessary in order to make an impact on reducing carbon emissions.

Because Netlogo was the only modeling program we knew about, we chose to model our question using this program.

Introduction

What is the plan?

We plan to use ground cover to help absorb most of the pollution. If we replace the sidewalks with a ground cover then will could absorb a percentage of the pollution cars emit. An acre of ground cover can absorb at least 1,000 kg of carbon dioxide a day. Cars emit 1.29 km per liter. Netlogo will help create a model for showing how the global temperature could go down using ground cover.

Ground cover is a type of plant that stays close to the ground. (clover, rye, grass, etc.) It often helps farmers with their gardens. It keeps the soil moist and holds important elements in to help keep the crop healthy, such as: Nitrogen, Phosphorus, Potassium, Sulfur, Magnesium, Calcium, Iron, Boron, Manganese, Zinc, Molybdenum, and Copper. If all sidewalks were replaced with a common ground cover, then we could replace over 5 billion square meters of concrete with grass. Which means we could absorb over 1 million kg of carbon dioxide from cars.

Cars emit over 6 tons of carbon dioxide a year. Cars are responsible for 15 percent of the earth's pollution. More than ⅔ of greenhouse gases are from cars. Iran has the worst pollution in the world and it has over 13 million cars.

Proposal:

Our project is based on the output of carbon dioxide that cars release. Pollution is causing global warming, which in turn causes natural disasters to be more extreme, endangers numerous living

organisms, and often leaves people with no home or basic necessities like water or food. Our plan is to use what earth has already given us, plants!

So we started thinking and tried to come up with a plant that would absorb a lot and also be good for the community, We contacted a local farmer, Jedrek Lamb, and he suggested that we use ground cover like what they use for their crops. Farmers often use ground cover to keep nitrogen for their crops. They also absorb a large amount of C02, this C02 they absorb could be all that nasty pollution that comes from cars. If we replace the sidewalks with a ground cover instead of concrete then we could have the ground cover absorbing the pollution.

We plan to show the rate at which plants absorb the C02 out of the atmosphere and turn it into oxygen. We also plan to see how much it would absorb. Ultimately trees are the best way to get rid of pollution so if we plant enough trees and ground cover plus we stop using fossil fuels then we could see a decrease in pollution.

We plan to use Netlogo in order to model the amount of carbon emissions absorbed by ground cover that is grown over a full city block. Using Netlogo will help us shoe how the atmosphere is now with all the carbon and what will change when we start to replace the concrete with grass.

The purpose of this project is to help reduce our carbon footprint on the earth. The earth's current measure of carbon dioxide is 408.05 ppm which is the highest it's ever been. We found from Jedrek Lamb's presentation at the Gathering of Gardens last fall, that various groundcovers that are planted, among other benefits, actually absorb carbon emissions. This caused us to pivot our work to studying how much ground cover would a community need to plant to make a significant reduction in carbon emissions caused by a city.

Modeling

Netlogo will help us model our data. The model that will help us the best will be the climate change model. It allows student to explore climate change. It allows you to add Co2, clouds and sunlight. This all affects the earth's temperature to rise or fall depending on what you add or subtract.

Methods and Materials

We used netlogo to study what sort of impact growing ground cover has on carbon emissions. We set out to measure how much ground cover is needed to make a significant impact in reducing carbon emissions.

Members of our team spoke to several scientists at the Supercomputing Kickoff. They gave us things to consider while looking at a countries carbon emissions, and what to look for when trying to successfully reduce carbon emissions.

At the Gathering of Gardens event in October of 2017, we heard Jedrek Lamb, a local farmer, speak about the benefits of planting ground cover in the winter. One of these benefits was absorbing carbon emissions. This caused us to significantly change the trajectory of our study. We decided to look specifically at how much ground cover was needed to make a significant absorption of carbon emissions.

One of our teachers was very helpful in teaching us Netlogo. We walked next door to consult with Joe Vertrees and he showed us how to use Netlogo, and how to adapt an existing template to show what we wanted to show: that is, how much carbon is absorbed by a city block of ground cover. Keep in mind, it is only next to sidewalks that ground cover can be planted.

Sources for our Proposal:

https://www.cartalk.com/content/global-warming-and-your-car-0
aces.nmsu.edu/pubs/_circulars/CR457/
https://www.livescience.com › Planet Earth
www.unclelukes.com/winter-garden-cover-crops-grain-rye-hairy-vetch-clovers-and-...
www.bbc.co.uk/bitesize/ks3/science/organisms_behaviour_health/food_chains/.../3/
Jedrek Lamb, Albuquerque North East Farmers' and Artisans' Market, New Mexico Farmers Market
http://www.maritimeherald.com/2017/cruiseship-air-pollution-worse-cities/
http://www.buisnessinsider.com/china-pollution-is-causing-high-ozone-in-the-us-2015-8
http://www.takepart.com/flashcards/what-is-climate-change/
https://commons.wikimedia.org/wiki/File:Golden_Gate_Bridge_Fog.JPG
https://commons.wikimedia.org/wiki/File:Golden_Gate_Bridge_Fog.JPG

Results/Climate-Change Model

Adapted from:

• Tinker, R. and Wilensky, U. (2007). NetLogo Climate Change model. http://ccl.northwestern.edu/netlogo/models/ClimateChange. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.

```
globals [
sky-top ;; y coordinate of top row of sky earth-top ;; y coordinate of top row of earth
temperature ;; overall temperature
slow ;; slow down counter

]

breed [rays ray] ;; packets of sunlight
breed [IRs IR] ;; packets of infrared radiation breed [heats heat] ;; packets of heat
energy

breed [CO2s CO2]

;; packets of carbon dioxide

breed [clouds cloud]
clouds-own [cloud-speed cloud-id]

;;
;; Setup Procedures ;;
to setup
clear-all
set-default-shape rays "ray" set-default-shape IRs "ray" set-default-shape clouds "cloud"
set-default-shape heats "dot" set-default-shape CO2s "CO2-molecule" setup-world
set temperature 12
reset-ticks

end

to setup-world
set sky-top max-pycor - 5 set earth-top 0

ask patches [ ;; set colors for the different sections of the world if pycor > sky-top [ ;;
space

set pcolor scale-color white pycor 22 15 ]

if pycor <= sky-top and pycor > earth-top [ ;; sky

set pcolor scale-color blue pycor -20 20 ]

if pycor < earth-top
```

```
[ set pcolor red + 3 ] ;; earth

if pycor = earth-top ;; earth surface [ update-albedo ]

] end

;;
;; Runtime Procedures ;;

to go
ask clouds [ fd cloud-speed ] ; move clouds along
run-sunshine ;; step sunshine
;; if the albedo slider has moved update the color of the "earth surface" patches ask
patches with [pycor = earth-top]

[ update-albedo ]
add-CO2;; New Code adds CO2 to the model based upon an input remove-CO2;; New
Code removes CO2 from the model based upon an input run-heat ;; step heat
run-IR ;; step IR
run-CO2 ;; moves CO2 molecules
tick

end

to update-albedo ;; patch procedure set pcolor scale-color green albedo 0 1

end

to add-cloud ;; erase clouds and then create new ones, plus one let sky-height sky-top -
earth-top
;; find a random altitude for the clouds but
;; make sure to keep it in the sky area

let y earth-top + (random-float (sky-height - 4)) + 2 ;; no clouds should have speed 0
let speed (random-float 0.1) + 0.01
let x random-xcor

let id 0
;; we don't care what the cloud-id is as long as ;; all the turtles in this cluster have the
same ;; id and it is unique among cloud clusters
if any? clouds
```

```
[ set id max [cloud-id] of clouds + 1 ]

create-clouds 3 + random 20

[
set cloud-speed speed
set cloud-id id
;; all the cloud turtles in each larger cloud should
;; be nearby but not directly on top of the others so ;; add a little wiggle room in the x and ycors
setxy x + random 9 - 4

;; the clouds should generally be clustered around the ;; center with occasional larger variations
y + 2.5 + random-float 2 - random-float 2

set color white
;; varying size is also purely for visualization
;; since we're only doing patch-based collisions set size 2 + random 2
set heading 90

] end

to remove-cloud ;; erase clouds and then create new ones, minus one if any? clouds [

let doomed-id one-of remove-duplicates [cloud-id] of clouds ask clouds with [cloud-id = doomed-id]

[ die ] ]

end

to run-sunshine ask rays [

if not can-move? 0.3 [ die ] ;; kill them off at the edge

fd 0.3 ;; otherwise keep moving ]

create-sunshine ;; start new sun rays from top reflect-rays-from-clouds ;; check for reflection off clouds encounter-earth ;; check for reflection off earth and absorption

end
```

```
to create-sunshine
;; don't necessarily create a ray each tick ;; as brightness gets higher make more if 10 *
sun-brightness > random 50 [

create-rays 1 [
set heading 160
set color yellow
;; rays only come from a small area
;; near the top of the world
setxy (random 10) + min-pxcor max-pycor

] ]

end

to reflect-rays-from-clouds
ask rays with [any? clouds-here] [ ;; if ray shares patch with a cloud

set heading 180 - heading ;; turn the ray around ]

end

to encounter-earth
ask rays with [ycor <= earth-top] [

;; depending on the albedo either
;; the earth absorbs the heat or reflects it ifelse 100 * albedo > random 100

[ set heading 180 - heading ] ;; reflect
[ rt random 45 - random 45 ;; absorb into the earth

set color red - 2 + random 4

set breed heats ] ]

end

to run-heat ;; advances the heat energy turtles
;; the temperature is related to the number of heat turtles
set temperature 0.99 * temperature + 0.01 * (12 + 0.1 * count heats) ask heats
[
```

```
let dist 0.5 * random-float 1 ifelse can-move? dist

[ fd dist ]

[ set heading 180 - heading ] ;; if we're hitting the edge of the world, turn around if
ycor >= earth-top [ ;; if heading back into sky

ifelse temperature > 20 + random 40
;; heats only seep out of the earth from a small area

;; this makes the model look nice but it also contributes ;; to the rate at which heat can
be lost
and xcor > 0 and xcor < max-pxcor - 8

[ set breed IRs ;; let some escape as IR set heading 20
set color magenta ]

[ set heading 100 + random 160 ] ;; return them to earth ]

] end

to run-IR ask IRs [

if not can-move? 0.3 [ die ]
fd 0.3
if ycor <= earth-top [ ;; convert to heat if we hit the earth's surface again

set breed heats
rt random 45
lt random 45
set color red - 2 + random 4

]
if any? CO2s-here ;; check for collision with CO2

[ set heading 180 - heading ] ]

end

to add-CO2 ;; randomly adds CO2 molecules to atmosphere based upon a counter let
sky-height sky-top - earth-top
```

```
set slow (slow + 1)
if slow = 50 [create-CO2s GreenHouseGas [

set color green
;; pick a random position in the sky area setxy random-xcor

earth-top + random-float sky-height ]]

if slow = 50 [set slow 0] end

to remove-CO2 ;; randomly remove 25 CO2 molecules repeat Absorption [

if any? CO2s [

ask one-of CO2s [ die ] ]

]

end

to run-CO2 ask CO2s [

rt random 51 - 25 ;; turn a bit
let dist 0.05 + random-float 0.1
if [shade-of? green pcolor] of patch-ahead dist [die] ;; keep the CO2 in the sky area
if [not shade-of? blue pcolor] of patch-ahead dist

[ set heading 180 - heading ] fd dist ;; move forward a bit

] end

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```

Discussion

Binomial Coding

With the model we plan to change it by adding vegetation to take away the carbon dioxide.

Vegetation will be added or subtracted by using a slider button. To Add more carbon there will

be a car inserted to add more pollution. This how we will see the vegetations progress into absorbing the pollution cars emit.

Where will the changes be made?

```
  ]
end

to add-CO2  ;; randomly adds 25 CO2 molecules to atmosphere
  let sky-height sky-top - earth-top
  create-CO2s 25 [
    set color green
    ;; pick a random position in the sky area
    setxy random-xcor
          earth-top + random-float sky-height
  ]
end

to remove-CO2 ;; randomly remove 25 CO2 molecules
  repeat 25 [
    if any? CO2s [
      ask one-of CO2s [ die ]
    ]
```


Conclusions:

So far we found out that plants adapt very quickly to their surroundings so the pollution shouldn't make the plants wilt. Although there is no information about clover or rye (ground cover) and how much C02 they absorb, we found out an acre of grass absorb 920 lbs per year. Cars admit more than 6 tons of C02 per year. Even though the cover will not absorb as much as we put out, it will slow down the carbon output and clean up some of our carbon footprints.