

Team Number: 86

School: New Futures High School

Area of Science: Environmental science

Language: Netlogo

Team member's Grade: 12th

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Shadow Balls

Beginning in 2015 our team set out to find an effective and efficient way to conserve water here in the drought prone climate of New Mexico. We decided to investigate into shadow balls. These are small spheres made of plastic that float on the surface of water, made to block UV rays from hitting the water thus preventing evaporation.

Our team had multiple perspectives on taking this problem and modeling. There for a long while has been conflict on what to do for modeling and where could we model this problem. We contemplated multiple places such as, Rio Grande River, Acquires, and even Elephant butte. Each teammate went off and researched individual perspectives pertaining to our problem. We came into contact with the makers of the shade balls and Greg Gates, PE principal technologist CH2M. We also found many online sources that helped the team decide on how to model our problem.

New Mexico is a desert, and has had a drastic increase in drought and lowering weather conditions over the past few years. With the use of shadow balls, we plan to reduce the amount of evaporation, and conserve New Mexico water supply. The cost for one shadow ball is \$0.36, their size is 4 inches in diameter, they weight 8.9 oz., and the material they are made out of is Polyethylene, which is a way safer plastic, leaving no BPA's or leaching material into the water. The balls are mechanical and there are no special features, other than depending on the size of the location they are put in, they will fit and arrange themselves to accommodate the body of water they are in.

Using this information we have created a program using Netlogo to illustrate and calculate evaporation rates. Our model is based in Cochiti lake of New Mexico. We have made improvements on last year's model using the advice from the judges. Now our program allows us

to vary ball count along with prevailing winds to display the amount of open water on the lake with different coverage of balls and demonstrate the effect of coverage with wind changes. This matters because the primary camping areas at Cochiti are on the west shore. We have created several different barriers (ball coverage) to demonstrate this.

Our team will have the conclusions and results of our model by the time we make it to the award ceremony at the Expo.

The software we used was Netlogo, <http://ccl.northwestern.edu/netlogo/models/Heatbugs>. For our references we reached out to Greg Gates, PE Principal Technologist CH2M, and Joe Vertrees our sponsor coordinator.

Our most significant achievement on our project this year is that we have improved from last year's model according to the judges' advice. Since last year we have been able to make a successful program that actually gives the results that we want.

CODE

This is last year's code. We have had technical difficulties, as the PC we contained the model on has crashed.

```

globals [ color-by-unhappiness? ]

turtles-own

[ ;; Original variables from borrowed code... might be removed

ideal-temp ;; The temperature I want to be at

output-heat ;; How much heat I emit per time step

unhappiness ;; The magnitude of the difference between my ideal

;; temperature and the actual current temperature here

]

patches-own

[

temp ;; short for "temperature"

]

to setup

clear-all

import-pcolors "Cochiti_Lake.jpg" ;imports image of Cochiti Lake as patch color

;; creating the balls the following way ensures that we won't

;; wind up with more than one ball on a patch

ask n-of ball-count patches [

sprout 1 [

set output-heat min-output-heat + random (max-output-heat - min-output-heat)

set unhappiness abs (ideal-temp - temp)

set heading Wind

set color green

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```

set size 1

]

]

ask turtles [ if pcolor != black [ die ]]

ask turtles [ if ycor > 10 [ die]]

ask turtles [ if xcor < -70 [ die ]]

ask turtles [ if xcor > 70 [ die ]]

;; plot the initial state of the system

reset-ticks

end

to go

if not any? turtles [ stop ]

;; diffuse heat through world

diffuse temp diffusion-rate

;; The world retains a percentage of its heat each cycle.

;; (The Swarm and Repast versions have 1.0 meaning no

;; evaporation and 0.0 meaning complete evaporation;

;; we reverse the scale to better match the name.)

ask patches [ set temp temp * (1 - evaporation-rate) ]

;; agentsets in NetLogo are always in random order, so

;; "ask turtles" automatically shuffles the order of execution

;; each time.

```

```

ask turtles [ step ]

Tick

end

to step ;; turtle procedure

;; my unhappiness is the magnitude or absolute value of the difference

;; between by ideal temperature and the temperature of this patch

set unhappiness abs (ideal-temp - temp)

;; if unhappy and not at the hottest neighbor,

;; then move to an open neighbor

;if unhappiness > 0

ifelse random-float 300 < random-move-chance

[ bug-move one-of neighbors ]

[ bug-move best-patch ]

set temp temp + output-heat

end

;; find an empty patch ahead while being pushed by the wind; also

;; take my current patch into consideration

to-report best-patch ;; turtle procedure

set heading Wind

let winner patch-ahead 1

ifelse [temp] of winner > temp

[ report winner ]

[ report patch-here ]

```

```
end

to bug-move [target] ;; turtle procedure

;; move to the target patch (if it is not already occupied)

if not any? turtles-on target [

face target

if [pcolor] of patch-ahead 3 != black [ stop ]

move-to target

stop

]

set target one-of neighbors with [not any? turtles-here]

if [pcolor] of patch-ahead 2 != black [ stop ]

if target != nobody [ move-to target ]

end

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```