TAMARIX & EROSION

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Executive Summary

The Salt cedar (*Tamarix Chinensis*) is a major problem in the United States because it causes high impact changes to the environment and the plants around it. Since this plant is not a native species this problem will get out of hand very quickly. The hypothesis is being demonstrated through this project. The model shows a rough idea of what the salt that this plant deposits does when it is deposited into the ground. It dries out soil which as the hypothesis states, leads to more erosion.

Introduction

The problem that this project is trying to demonstrate that salt cedar increases the rate of erosion more than other native species. Through experiments and research it has been found that, the Salt cedar (*Tamarix)* produces more salt than other native species. Salt dries the soil making the soil hard and crumbly leading to more erosion. More salt in the ground leads to a higher rate of erosion which means that the Salt cedar increases soil erosion because of the higher salt production. The Salt cedar inhabits the Southwestern United States near places with high amounts of water and places that are extremely hot. It is not a native species because it was brought in from parts of Asia, Africa, and Europe. It has a deep root system and this greatly reduces water availability in surrounding plants. The deposits of salt are left on the top layer of soil. This plant also increases flooding along zones known as riparian zones. The negative results of the salt cedar's presence is significant and if it is ignored more and more trees and plants could die out.

Demonstration Method

In the first version of the NetLogo model the soil was created. (Light brown color in model, see Appendix A for initial model interface) Salt cedar was then added (small brown tree) and raindrops in an attempt to saturate[1] the ground to make it darker, showing moisture. This was successful, but was an issue because the ground became saturated at an unrealistically fast speed, not to mention the fact that the soil did not go to the very bottom of the model. The final thing that needed to be changed in this model was the size of the tree because it was not even close to being a realistic representation.

In the next version of the model, (see appendix B for the next version of the model interface) the attempt that was made to fully saturate the ground did not work and didn't change anything. Another thing that was changed was the way the precipitation works and is created when it hits the ground. The final issue that was changed was that the soil reached the bottom of the torus[2], thus fixing one of the major problems with the initial model.

This next version of the model (see appendix C) was the major breakthrough because most of the major problems were solved. But there were also other issues including the simulation area being too small and the ground saturated too quickly. So, the first thing that happened was the removal of the tree to ensure that the central focus would be on the problems that needed to be solved. The ordering of the code was also changed to a more logical, chronological order. The next thing changed was the y-coordinate where the soil starts was relocated so that when the trees were replaced the soil would be a layer below the tree. Thus it would be more realistic. The biggest problem solved was the saturation problem, so that now the soil would become a little darker (more saturated) with the more rain that hit that specific area until the soil became the darkest possible color of brown. This was fixed by removing a procedure that did not work, “impact”. The final change made was that the rain was made more realistic in terms of dropping speed and movement so that it appeals to the laws of gravity, instead of just falling straight down.

In the next version of the model (see appendix D) the first thing changed was that each procedure was made into its own separate control button. Next the tree that was removed in the previous version of the model was replaced and made more in proportion to reality. The next thing was the first attempt at creating and spreading salt in the soil, which completely failed. After that, a drying factor that dries the top layer of soil was added for realism. This version of the model was also the first attempt to diffuse moisture through the soil, but again, utterly failed. (The capillary effect, similar to the way a sponge soaks up water) Next, the size of the torus was increased. Finally, the speed of saturation was balanced out to work with the current state of the model.

In the next model (see appendix E) the size of the torus was increased again to represent the information as accurately as possible. A second tree was also added. The pink tree represents a Tamarix, and the green tree represents a native tree or plant. At this stage the spread procedure worked as intended. Also at this stage there was an attempt to allow the precipitation procedure to work to its intended effect with the spread procedure running at the same time. However, it did not work as intended for realistic purposes. This stage is also when the salt that is produced by the Tamarix is created and spread effectively and realistically. The last thing that was added to the model was the beginning of a wind factor.

The final version of this model (see appendix F) was just making everything work together and making the wind work as intended and realistically. The areas that were modified were the precipitation, spread, and dry procedure values. This would allow them to work in conjunction with one another, making the wind work to fulfill its intended purpose, and to work realistically. The wind’s purpose was to first pick up soil and replace it elsewhere. The next step was to replace the soil with the same color that it picked up. The final stage was to make the soil lighter in color when the wind carried it. The final thing done to this model was that it became able to collect and produce data in a NetLogo experiment.

Real-World Work

The process of the first experiment was as follows: first, the team travelled to the Rio Grande (for location, see appendix G); second, they found a native plant and vacuumed up soil from it; third, they put string around it. This experiment failed because the team also needed to find a salt cedar and do the same thing to it, but they could not identify what one looked like. The second experiment (the same location) followed the same procedure but the team's mentors came with them. This experiment still failed because this area did not have any salt cedars within it. The third experiment had the same procedure but was located elsewhere (for location see appendix H). This physical data collection did not fail but the procedure used to weigh the soil failed. The weighing of the soil failed because the soil was not correctly separated from the water. The final procedure was set up as follows: First, 16 20-fluid ounce Gatorade bottles were gathered; second, 16 plastic cups were gathered; third, the plastic cups were cut in a way that they would have three legs; fourth, the cut cups were taped to the Gatorade bottles. The experiment was conducted by first burying the bottles at specific locations, 5 on a salt cedar and 5 on a Kochia. The distance measurement used between bottles and the tree was shovel lengths. Some bottles were placed two shovel lengths away, whereas some were put only one shovel length away.

Verification of Demonstration Method

The method was verified and validated by showing a linear relationship between amount of salt placed in the ground and the amount of dryness, while excluding wind from the program. This was done through the behavior space within NetLogo and its results after running are shown on figure A. below:

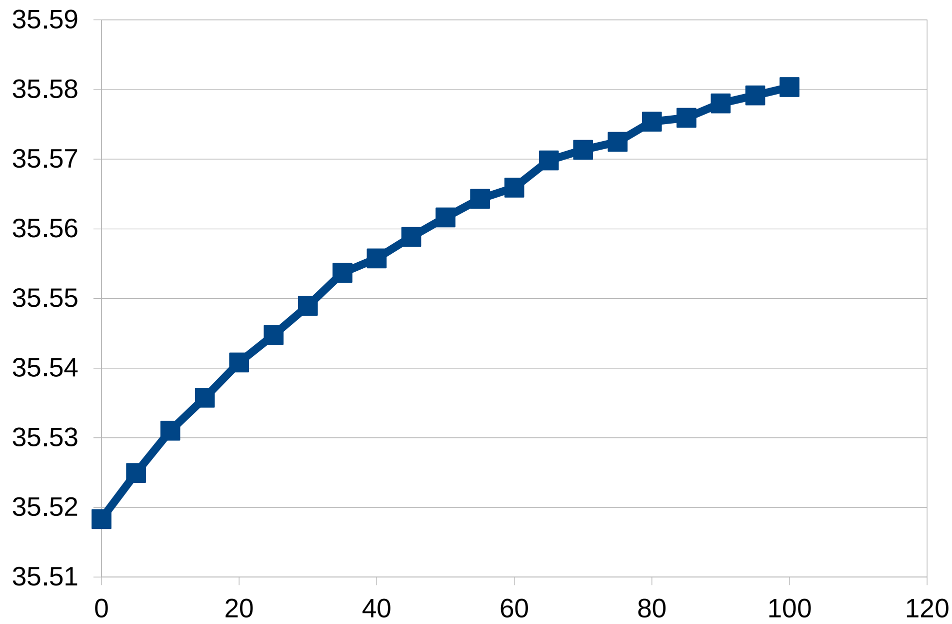


Figure A.

Figure A. shows the average dryness (y-axis) compared to the number of salt created (x-axis). This verifies and validates the model because it demonstrates that our model is valid due to it having the expected results.

Results

A second experiment was run within behavior space that, this time, included wind that would become our results. The results of the simulation are shown on figure B. below:

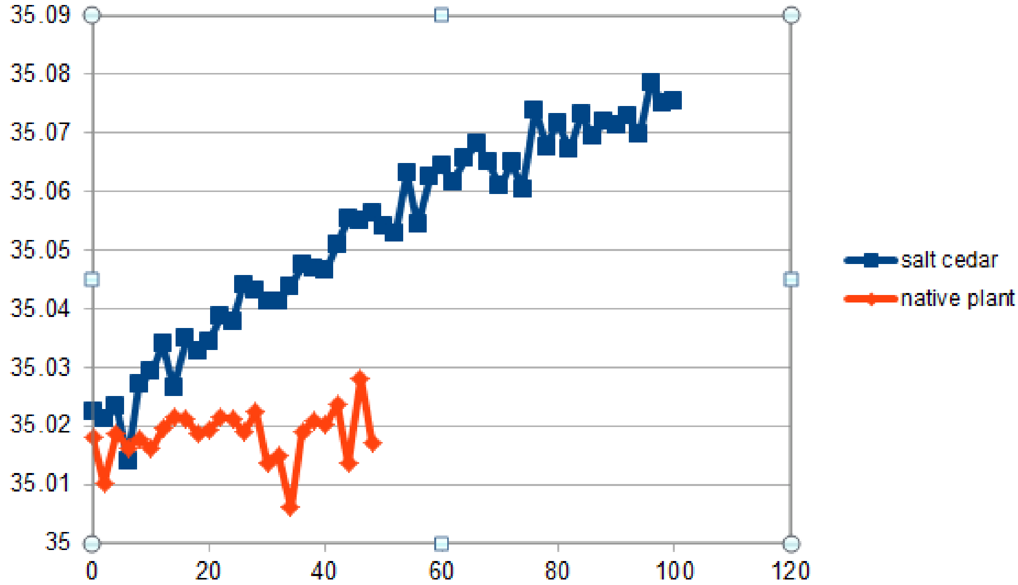
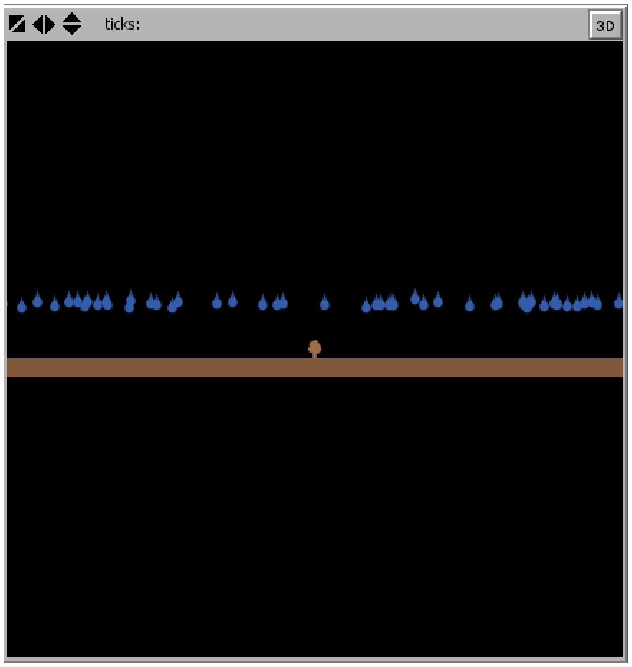


Figure B. above demonstrates that as the salt concentration (Y-axis) goes up so does dryness of the soil. The Graph has a given base salt (X-Axis) and as more salt is added, the tree dryness also increases. Since the Salt cedar produces salt it adds more salt to the base salt, which in term leads to the salt cedar having more dryness due to the higher amount of salt then the native plant. The simulation was ran a total of 50 times. Each time its run the salt amount is added by two. From the data this experiment produced it can be seen the salt cedar increases erosion if the hypothesis is not null. The native tree was cut short due to it was not changing.

Conclusion

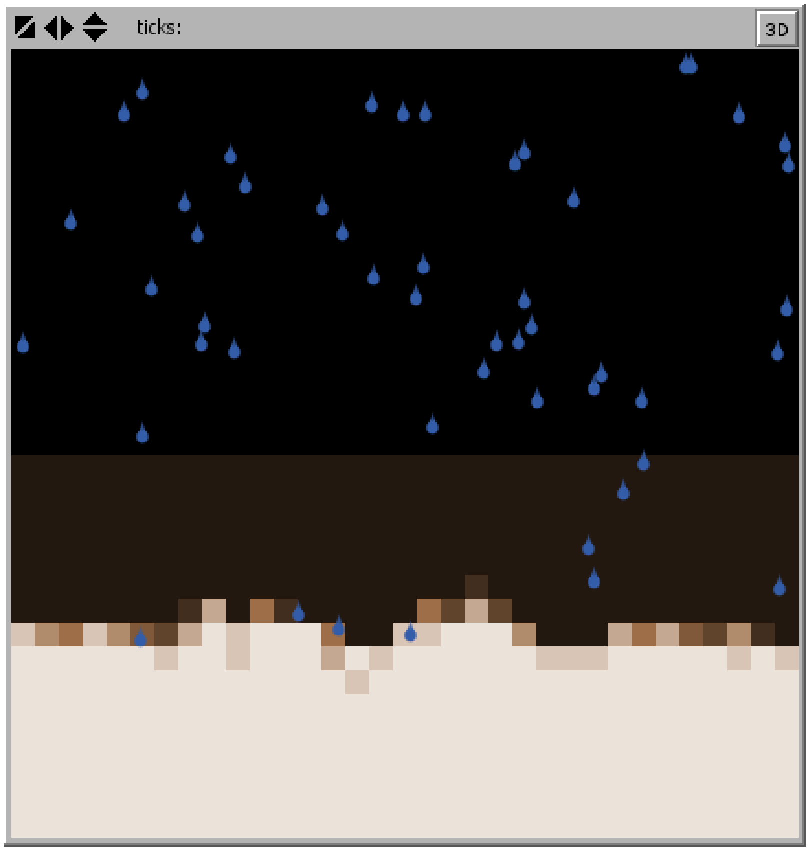
There is no conclusion for this project due to the limitation of time seeing as how in order to get data that will either nullify the hypothesis or demonstrate it to be true at least a few more months would be needed. If this project is made into a two-year project, an erosion factor will be added to the model and results will be obtained from the final field study.

Appendix A



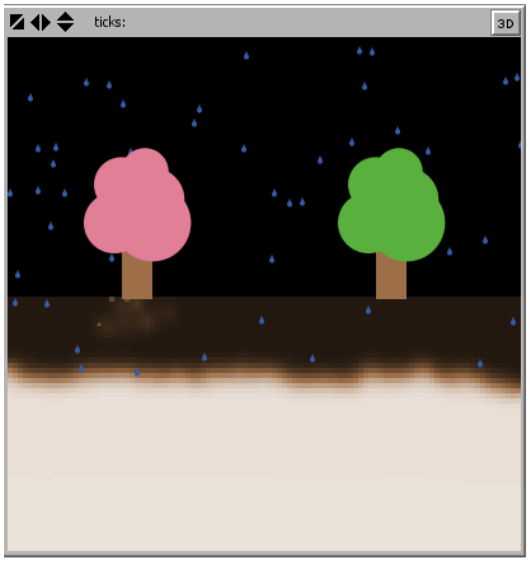
Appendix B

Appendix C



Appendix D

Appendix E



Appendix F

```
breed [waters water]           ;sets a breed of turtle to the name water
breed [cedars cedar]           ;sets a breed of turtle to the name cedar
breed [natives native]      ;sets a breed of turtle to native
breed [salts salt]
breed [winds wind]
;breed [air]

winds-own [carry]
;air-own [carry]

globals
[
  precipitate-counter
  spread-counter
  winds-counter
  air-counter
]


to setup
  clear-all              ;clears the screen
reset-ticks
  set precipitate-counter 0
  set spread-counter 0
  set winds-counter 0
  set air-counter 0

  create-waters 50       ; creates 50 rain drops
  [
    set size 2
    rain
                  ; set the rain program in motion
  ]

create-cedars 1        ; creat a tree shape figure the is represented as  the salt ceder tree
[
  set color pink       ; sets the color of the tree to green
  set shape "tree"      ; sets the shape as a tree
  set ycor 14           ; sets the position of the tree on the y axis
 set xcor 0          ; sets the position of the tree on the x axis
  set size 30
]
;create-salts 1
; [
;  setxy -25 -1
;  salt
; ]
```

```
;  create-native 1
;  [
;   set color green      ; sets the color of the tree to white
;   set shape "tree"     ; sets the shape as a tree
;   set ycor 14         ; sets the postion of the tree on the y axis
;   set xcor 25          ; sets the postiont of the tree on the x axis
;   set size 30          ; set the sixe of the object to 15
;  ]
  ask patches           ; command patches
  [
   layer                ; to perform the layer program making the ground
  ]
  create-winds winds-number
  [
     ifelse random 100 < 50
     [
     set heading 125 + random 25
     set color white
     set size 2
     set xcor -48
     set ycor random 40 + random 8
;      set shape "line"
     set carry 0

    ]

    [
     set heading 235 - random 25
     set color white
     set size 2
     set xcor 48
     set ycor random 40 + random 8
;      set shape "line"
     set carry 0
    ]
  ]
end



to go
  precipitate
  salty
  spread
;  ask air
;  [
;    blow
;  ]
;    ask wind
;  [
;    blow
;  ]

  blow


end

to rain
ask waters                   ; ask the  turtle that is (shaped and) named water
  [
    setxy random-xcor max-pycor ; set the 50 rain drops to the the to of the screen to represent
    set color blue
    set shape "drop"
    set heading 180
  ]
end


to layer                  ; the tile of the comand that set the dirt
  if pycor <= -1         ; i set patch color to brown if bellow -1 on the y axis
  [
    set pcolor brown + 4
  ]
  end

   .
```

```
to dry
  ask patches
  [
    if pycor = -1
    [
      if pcolor < brown + 4
      [
        set pcolor pcolor + .07
      ]
    ]
  ]
end



to precipitate

tick
set precipitate-counter precipitate-counter + 1



  ask waters
  [
    ifelse pcolor = black or pcolor = brown - 4
    [
      fd 2
      set heading 175 + random 10
    ]
     [
      set pcolor pcolor - 2
      if pcolor < brown - 4
      [
        set pcolor brown - 4
      ]
       setxy random-xcor max-pxcor
     ]
   forward 2
   set heading 135 + random 90 ; ask the  raind drop
   left random 25
   right random 25
  ]
;   if 10 > random 1000
;      [
;       salt
;      ]

if precipitate-counter < precipitate-amount
[
  precipitate
]
reset-ticks
end
```

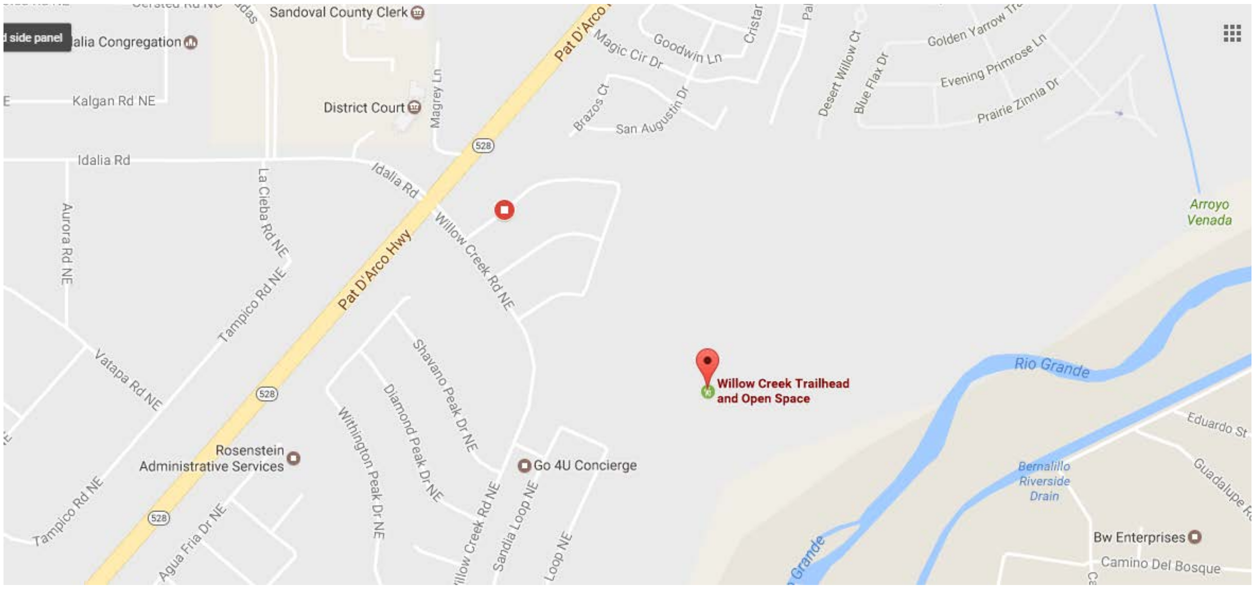
```
to spread
 set spread-counter spread-counter + 1
   ask patches
 [
  if pycor < -1 and pycor > min-pycor
  [
    ask neighbors
    [
      set pcolor (99 * pcolor + 1 * [pcolor] of myself) / 100
      if pcolor < brown - 4
       [
        set pcolor brown - 4
       ]
      if pcolor > brown + 4
       [
         set pcolor brown + 4
       ]
    ]
  ]
 ]
 if spread-counter < spread-amount
 [
   spread
 ]
   reset-ticks

end
```

```
to blow
ask winds
[
  set winds-counter winds-counter + 1
  move-to patch-here
  if count patches with [pcolor != black] in-cone 2 30 > 0  and carry = 1
  [
     set pcolor [color] of myself
     set carry 0

     ask winds-here
     [
       ifelse random 100 < 50
       [
         set heading 125 + random 25
         set xcor -48
         set ycor random 40 + random 8
       ]
       [
         set heading 235 - random 25
         set xcor 48
         set ycor random 40 + random 8
       ]
     ]
   ]
```

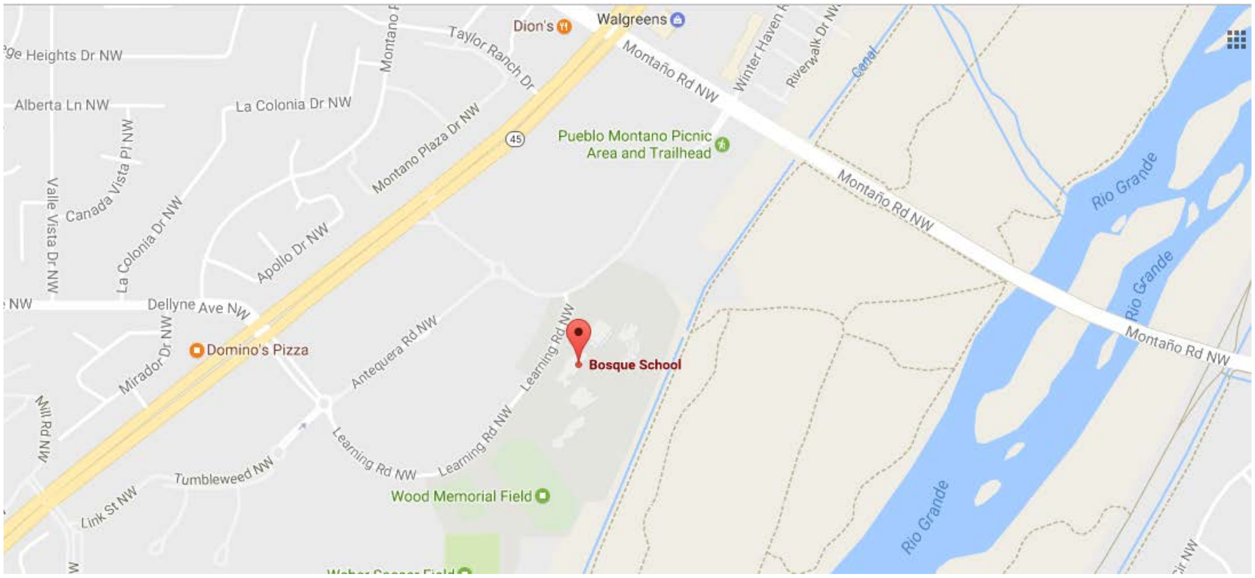
```
if count patches with [pcolor != black] in-cone 1 30 > 0 and carry = 0
 [
  ask winds-here
   [
     if [pcolor] of myself < brown + 4
     [
       set color [pcolor] of myself + 1
     ]
     set pcolor black
     set carry 1
     ask winds-here
     [
       ifelse random 100 < 50
       [
         set heading 125 + random 25
         set xcor -48
         set ycor random 40 + random 8
       ]
       [
         set heading 235 - random 25
         set xcor 48
         set ycor random 40 + random 8
       ]
     ]
   ]
 ]

fd 1
right random 10
left random 10
if ycor > 45
[
  set heading 180
]
if winds-counter < winds-amount / winds-number
[
  blow
]

]
end
```

```
to salty
  create-salts salts-number
        [
          ht
          set breed salts
          setxy 0 -1
          set heading 90 + random 180
          forward random 6
          set pcolor brown + 4
        ]
end
```

Appendix G



Appendix H



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