Volcanoes

New Mexico

Supercomputing Challenge

Final Report

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Team Number 36

Melrose High School

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Executive Summary:

This year our group is doing a project on volcanoes. To show how dangerous they are and can be in the area surrounding them. We want to find and show a way to help people, property, and animals stay safe if they are living in an area with a volcano. No one knows when a volcano will erupt or not, so everyone always needs to be cautious them. When something can be done to keep a set of surroundings safe then no one would have to worry about their life or their children's lives. Our project is about how diversions can be made on the volcano slope to direct the flow of lava in a direction that will cause less harm.

Our program model keeps track of how expensive it is to change lava flows. The higher up a slope and the farther the construction is from a city, the more expensive it will be. After a construction is made, additional lava flows will show how effective the measure was.

We want to help people feel protected and safe. The volcano that we are going to base our project off is going to be the volcano in Pompeii. It was one of the biggest tragic eruptions that has happened in history. This volcano is most likely one that everyone around the world has heard of, we wanted to have an example of one that is well known.

Statement of the Problem

Our problem statement we will ask ourselves is "How can we prevent volcanic lava flows from disrupting a city?" Research shows how landscape changing will affect the different direction the lava will flow downhill. The different elevation also will show the different speeds

lava can flow, as an actual volcano would do in real life. We wanted our model to be as close to a realistic image with the same features of an actual volcano would have on earth today.

Method

We made a computer model that shows:

1) A map of an area with:
    a) Volcano = the large mountain located in the middle of the screen that the lava flows out of, it has different elevations so the lava flows in different directions.

    b) Plains = large fields around the volcano that the lava flows towards.

    c) City =buildings in an area that can be destroyed by the lava flow.

    d) Waterfront = most cities are built by the oceans and rivers; it stops the lava flow.

2) Agents of lava that:
    a) Flows = go down the volcano in different directions and in different places because of the elevation changes in the volcano hillside.

    b) Build-ups = when lava flowed before and has caused an elevation increase.

c) Destroys = the building and any grass lands or anything located around the area.

Variables: (sliders)

- Magnitude =how strong the volcano is.

- volcano height = Determines how long the lava flow will take before it would hit the city, the higher up, the longer it will take, lower down the quicker it would hit the city.

- Irregular = the mountain can be smooth or have lots of little jagged and ravines.

Verified and validated

There are no volcanoes in New Mexico but there are farmers that have to fill in ravines to prevent soil erosion. This is not exactly the topic we had chosen but it is the closest thing that we can identify that is here in our area that works on the same principles. Our model affects lava flow in the same way that water flows are affected in designing drainage projects.

Conclusion

Our group's question was 'Can we stop lava from touching a city to keep it protected?' Lava flow actually can be prevented form causing any damage to any cities by building dams. It would cost money to have them built, but in the process it's also saving millions dollars of property and many lives.

As to where to place the dams, it would be best to make them up higher on the volcano but that would cost more money. Building them towards the bottom can still help block the cities though to help keep more people and property safe and this can cost less because not all the equipment would need to be moved so much, so far, or up so high.

Software

Our program used the NetLogo language. We used this program to make it have a clear image of what we want to show and to make sure when anyone looks at it that it is easy to tell what the image is and what the program is doing to the project.

Attached to the back of this report is a listing of our computer code as it works in our project. See Attachment A.

Significant achievement

Our most significant achievement is that we were able to come up with an idea to prevent a real problem. Just to have an idea that can save so many people and so much in an area can

be breath taking because of the fact that something can be done to help others, which is amazing. It is horrible that something like a volcano can do some much damage to anything in just seconds. Making dams to help preserve cities, and have families feel safer is a valuable goal.

Acknowledgements

We would like to thank Mr. Daugherty for taking us to the volcano in Albuquerque and putting this idea in our minds. Having something to do that can be interesting and still help others and the environment in the process. We would also like to thank the judges we met at Eastern for noticing the mistakes that were made by our group and helping us fix and improve our project.

Citations

https://www.britannica.com/science/volcano

Volcanoes by Robert Decker and Barbara Decker

https://www.livescience.com/topics/volcanoes

https://www.nationalgeographic.com/environment/natural-disasters/volcanoes/

https://www.zmescience.com/other/science-abc/types-of-volcano/

Attachment A Computer Code:

```
breed [lavas lava]
  patches-own [elevation original-elevation total-cost original-color]
 lavas-own [basin?]
 globals [eruption-number]


to setup
   set eruption-number 0
   volcano
   city
   ask patches [set original-elevation elevation set original-color pcolor]
end



to city
     ask patches [ if pxcor > -110 and pxcor < -70  and pycor > -106 and pycor < -71 [Set pcolor
113]]
     ask patches [ if pxcor > 90 and pxcor < 110  and pycor > 50 and pycor < 70 [Set pcolor
113]]
```

```
    ask patches [set original-color pcolor]
end


to volcano
     ask patches [set total-cost 0  set elevation 1 + ((random 9 + 1) / 10) set pcolor scale-color
57 elevation 0 2 ]
     ask patches [if pycor < -108 [set pcolor 94 set elevation  0]]
     ask patches [if pxcor * pxcor + pycor * pycor < (volcanoheight * volcanoheight)  [sloped]
          set original-elevation elevation]
      create-turtles magnitude [ setxy 0 0 set color 25 set size 4 set breed lavas  stamp set basin?
           false ]
end


to sloped
    set elevation (volcanoheight -  (sqrt (abs ( pxcor - 0) * abs (pxcor - 0) + abs (pycor - 0) *
abs (pycor - 0) )) - (((random volcanoheight) + 1) / 100))
    set elevation elevation + 2                ;;  to be sure the volcano is higher than the
countryside!
```

```
    if random 100 > (100 - irregularity * 2.5 ) [set elevation elevation + random 5]
    if random 100 < irregularity * 2.5 [set elevation elevation - random 5]
    set pcolor scale-color brown elevation 0 (volcanoheight )
end

to lava-flow
  ask lavas [
    let old-patch patch-here
    downhill elevation
    set pcolor 25
    set elevation elevation + .1
    if old-patch = patch-here [ set basin? true  set elevation elevation + .5  ]
    ask lavas [if basin? = true [die]
    if pycor < -109 [die]]
   if count lavas < 5 [ask lavas [die] ]
  if not any? lavas [ set eruption-number eruption-number + 1 ]
  show eruption-number]
end
```

```
to erupt-again
      ask patches [
         if pcolor = 25 [set pcolor 12 ]]
      ask lavas [if basin? = true [set pcolor 12] die]
      create-turtles magnitude [ setxy 0 0 set color 25 set size 4 set breed lavas]
      lava-flow
end
to ravine-dams
  if mouse-down? [
      ask patch mouse-xcor mouse-ycor [
         set pcolor red
         set elevation elevation + 10]]
end
to restore-original
   ask patches [if pcolor != red [set elevation original-elevation set pcolor original-color]]
end
```

```
to cost
  ask patches [ if pcolor = 15 [set total-cost 100 - (volcanoheight - distancexy 0 0) * 1000]]
end

to remove-dams
  ask patches [ if pcolor = 15 [set elevation original-elevation set pcolor original-color]]
end

to multiple-eruptions
   lava-flow wait 100 erupt-again
   lava-flow wait 100 erupt-again
   lava-flow wait 100 erupt-again
end
```