Fraccident Effects

New Mexico
Supercomputing Challenge
Final Report
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Team 15
Centennial High School

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Table of Contents:

Executive Summary:

Fracking, or hydraulic fracturing, is the process of injecting the ground with a chemical solution, which breaks up the shale and limestone rock. Breaking up the rock releases the natural gas trapped in it. The gas is collected, along with the chemical solution. However, only anywhere from 30 to 70 percent of the cheon is solution remains in the ground. The chemical solution contains acids, detergents, biocides, and other harmful chemicals that erode rock. When the harmful chemicals seep into the ground, several things can occur. One effect of the harmful chemicals is the development of sinkholes. Another effect is the possibility of groundwater and aquifer contamination.

During evaluations, we were told that our project was to extensive, so we decided to focus on hydrochloric acid, a common acid used in most fracking fluid. We programed our code to represent a fracking site that is in a wooded area and near a river. We wanted to show what would happen if the acid contaminated the water, and originally we wanted to see how the implementation of a water treatment plant would reduce the risk of contamination, but due to limited research, we were unable to program that aspect. Despite these limitations, we were able to show how vegetation dies when it comes in contact with hydrochloric acid.

INTRODUCTION:

Problem:

Fracking is the process of injecting the ground with chemical solutions to break up the shale rock in the earth so that natural gas can be released. Only 30-70 percent of the chemical fluid is recovered in the process, however. This means that anywhere from 30 to 70 percent of the fluid remains left in the earth. That chemical solution can then seep into the ground and contaminate the groundwater and aquifers. In New Mexico, there have been 400 instances where fracking fluid contaminated the groundwater (Environment New Mexico). Due to flimsy regulations regarding fracking, the possibility of water contamination rises higher the more fracking takes place. Our project focused primarily on the effects that hydrochloric acid, a common acid which is a component of fracking fluid, has of the environment surrounding the site of the spill (NIP).

Purpose:

The purpose of our project was to determine the exact effects a fracking spill would on the environment and the drinking water in the surrounding area. Rather than show the effects of the fracking fluid in its entirety, the focus of our project is on hydrochloric acid, the most common acid found in most fracking fluid. The initial purpose of the code was to show the effects of hydrochloric acid on the soil, the vegetation, and the organisms that inhabit the environment surrounding a fracking spill.

Background:

In the state of New Mexico, there have been 400 instances of groundwater contamination linked to waste pits that are used to store waste produced by fracking as of 2008. As of 2012, New

Mexico produces 6 percent of the total gas production in the United States (Sourcewatch). In 2013, a well in the San Juan Basin spilled out due to the high pressure of a nearby well. In fact, scientists have linked the high pressure resulting from fracking to earthquakes. Fracking has become such a major issue that is has been used on some crime television shows as an incentive for murder. These negative aspects involved in fracking caught our attention, not only for their magnitude but also for their location. Fracking is an issue that is highly relevant in our community today.

DESCRIPTION:

Scope:

Initially, the scope of our project was too broad. We wanted to show the effects of the entire "chemical cocktail", as so termed by the New York Times (Brantley), on the environment surrounding a fracking spill. While gathering research, it was almost impossible for our team to find specific recipes for the chemical fluid. The most that we could find was a list made by the FracFocus Chemical Disclosure Registry which listed the most common ingredients used in fracking fluid, which all fell under the following categories: acid, biocide, breaker, clay stabilizer, corrosion inhibitor, crosslinker, friction reducer, gelling agent, iron control, non-emulsifier, pH adjusting agent, scale inhibitor, and surfactant. Because there was such a wide range of ingredients, determining which chemical to focus on proved to be a challenge. Taking the advice of our project evaluators, we were able to narrow down our project to the most common acid, hydrochloric acid. Using this guidance, we decided to depict the effects of hydrochloric acid specifically on the vegetation that would typically surround the fracking site.

Materials and Methods:

Since the focus of the project was shifted to the effects of hydrochloric acid, research was gathered to see just what the effects are on such vegetation. While doing research, it was discovered that acute exposure in humans can cause dental erosion as well as corrosion of mucus membranes, esophagus, and stomach. When plants are exposed to the acid, it can be toxic (NPI); however, no research has been done on the long term effects of exposure to the acid.

Incorporating the research we had gathered, we programed our model in Netlogo to represent a forested area with a river nearby and a fracking site near the river. We created two breeds: one breed to represent the trees and one breed to represent the hydrochloric acid. We programed sliders to change the amount of acid which is released and to change the number of trees that are near the fracking site. When the program runs, the “acid” turtles move outward from the fracking site at a slow rate. Each tree is given an “energy” value, and when an “acid” turtle comes into contact with a “tree” turtle, the energy value of the tree decreases. If the “tree” turtle doesn’t come into contact with an acid turtle, the energy value of that tree increases slightly, to represent the tree growing.

RESULTS:

In the code, sliders determine how many trees and what percentage of the chemical is spilt. The code and results are based on limited available research and data. Using what research we had, we ran several experiments by changing the initial percentage amount of chemicals spilled. The first was experiment was run with the percentage set at the lowest for New Mexico (30 percent) whereafter roughly 50 percent of the trees were killed or damaged after repeated exposure (we

assumed twenty-thirty repeats of the go procedure to be “repeated exposure”). As the percentage of chemicals released increased, so did the deterioration of the surrounding forest. Experiments are still under way, and eventually experiments will be conducted regarding the chemicals washed away in the stream, with realistic motion and interaction with other agents.

CONCLUSIONS:

Based on the code and data we have collected, it can be concluded that hydrolic acid effectively kills the surrounding organisms, though it is a slow process. With repeated spills, however, the trees and other organisms are left exposed to the damaging chemical. Currently, the model shows a linear relationship between the amount of chemical spilled and the death rate of plants. This relationship is obvious, but we seek to validate our model within the next few weeks and obtain further results that accurately represent the complexity of a fracking spill. Our most original accomplishment was programing the acid turtles to flow with the river without the use of an extensive if then statement.

RECOMMENDATIONS:

Had there been more time or more research available, the project would have been more in-depth in regards to what the combination of chemicals does to the earth when left there for an extended period of time. In addition, the code would have been a better representation of the way the chemicals spread when a spilling occurs. Our goals over the next few weeks are to validate the model and get it running more realistically, program the chemical agents to wash down the river, and run further experiments to obtain meaningful data. Should we choose to prolong the project

further, we would like to better understand and model the actual chemical interactions that take place between hydrochloric acid and plants species. Without relevant data available, we believe we could run our own tests to determine the impact of the acid.

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REFERENCES:

"Benefits of Fracking." *EnergyFromShale*. N.p.. Web. 2 Apr 2014. <http://www.energyfromshale.org/fracking-benefits>.

Brantley, Susan L., and Anna Meyendorff. "The Facts on Fracking." *New York Times* 13 Mar 2013, The Opinion Pages. Print. <http://www.nytimes.com/2013/03/14/opinion/global/the-facts-on-fracking.html?_r=1&>.

"Hydrochloric acid." *National Pollutant Inventory*. Australian Government: Department of the Environment, 09 Jul 2013. Web. 2 Apr 2014. <http://www.npi.gov.au/resource/hydrochloric-acid>.

"Hydrochloric Acid (Hydrogen Chloride)." *United States Environmental Protection Agency*. N.p., 18 Oct 2013. Web. 2 Apr 2014. <http://www.epa.gov/ttn/atw/hlthef/hydrochl.html>.

" Hydraulic Fracturing 101." *EARTHWORKS*. N.p.. Web. 2 Apr 2014. <http://www.earthworksaction.org/issues/detail/hydraulic_fracturing_101

"Fracking by the Numbers." *Environment New Mexico*. N.p.. Web. 2 Apr 2014. <http://www.environmentnewmexicocenter.org/reports/nmc/fracking-numbers>.

"New Mexico and fracking." *SourceWatch*. N.p., 02 Oct 2013. Web. 2 Apr 2014. <http://www.sourcewatch.org/index.php/New_Mexico_and_fracking

Paskus, Laura. "New Mexico's "Fracking" Legacy." *KUNM*. N.p.. Web. 31 Mar 2014. <http://kunm.org/post/new-mexico-s-fracking-legacy>.

"What Chemicals Are Used." *FracFocus Chemical Disclosure Registry*. N.p.. Web. 2 Apr 2014. <http://fracfocus.org/chemical-use/what-chemicals-are-used>.

"What goes in and out of Hydraulic Fracturing." *Dangers of Fracking*. N.p.. Web. 2 Apr 2014. <http://www.dangersoffracking.com/>.

APPENDIX:

```
breed [forests forest]
breed [frackings fracking]
breed [chemicals chemical]
forests-own [lifejuice]
to setup
  clear-all
  grass
  trees
  river
  Fraccident
  create-chemicals chemicalsslider [set size size  * 0.5 ]
  set-default-shape chemicals "circle 2"
  ask chemicals
  [
```

```
        setxy -13 -2
  ]
end

to grass
  ask patches
  [
        set pcolor green
        ]
end

to trees
  create-forests forrestsslider
  [
        set size size * 5
        set shape  "tree"
        setxy random-xcor random-ycor
        repeat 4
  [
        if pcolor = blue
        [
        forward 10
        ]
  ]
]
end

to river
  ask patch -16 7
  [
        set pcolor blue
  ]
  ask patch -15 7
  [
        set pcolor blue
  ]
  ask patch -14 6
  [
        set pcolor blue
  ]
  ask patch -13 6
  [
        set pcolor blue
  ]
  ask patch -13 5
  [
        set pcolor blue
  ]
  ask patch -12 5
  [
        set pcolor blue
```

```
]
ask patch -11 4
[
        set pcolor blue
]
ask patch -10 4
[
        set pcolor blue
]
ask patch -11 3
[
        set pcolor blue
]
ask patch -10 3
[
        set pcolor blue
]
ask patch -9 3
[
        set pcolor blue
]
ask patch -8 2
[
        set pcolor blue
]
ask patch -7 2
[
        set pcolor blue
]
ask patch -6 1
[
        set pcolor blue
]
ask patch -5 0
[
        set pcolor blue
]
ask patch -4 -1
[
        set pcolor blue
]
ask patch -3 -2
[
        set pcolor blue
]
ask patch -2 -3
[
        set pcolor blue
]
ask patch -1 -4
[
```

```
        set pcolor blue
]
ask patch 0 -5
[
        set pcolor blue
]
ask patch 1 -6
[
        set pcolor blue
]
ask patch 1 -7
[
        set pcolor blue
]
ask patch 1 -8
[
        set pcolor blue
]
ask patch 1 -9
[
        set pcolor blue
]
ask patch 2 -7
[
        set pcolor blue
]
ask patch 2 -8
[
        set pcolor blue
]
ask patch 2 -9
[
        set pcolor blue
]
ask patch 2 -10
[
        set pcolor blue
]
ask patch 1 -10
[
        set pcolor blue
]
ask patch 1 -11
[
        set pcolor blue
]
ask patch 1 -12
[
        set pcolor blue
]
ask patch  0 -12
```

```
[
        set pcolor blue
]
ask patch  0 -13
[
        set pcolor blue
]
ask patch  -1 -13
[
        set pcolor blue
]
ask patch  -1 -14
[
        set pcolor blue
]
ask patch  -1 -15
[
        set pcolor blue
]
ask patch  -1 -16
[
        set pcolor blue
]
ask patch  0 -16
[
        set pcolor blue
]
ask patch  1 -16
[
        set pcolor blue
]
ask patch  -2 -16
[
        set pcolor blue
]
ask patch  -3 -16
[
        set pcolor blue
]
ask patch  -3 -15
[
        set pcolor blue
]
ask patch  -2 -15
[
        set pcolor blue
]
ask patch  -2 -14
[
        set pcolor blue
]
```

```
ask patch  -2 -13
[
        set pcolor blue
]
ask patch  -2 -12
[
        set pcolor blue
]
ask patch  -1 -12
[
        set pcolor blue
]
ask patch  -2 -11
[
        set pcolor blue
]
ask patch  -1 -11
[
        set pcolor blue
]
ask patch  0 -11
[
        set pcolor blue
]
ask patch  0 -10
[
        set pcolor blue
]
ask patch  -1 -10
[
        set pcolor blue
]
ask patch  -1 -9
[
        set pcolor blue
]
ask patch  0 -9
[
        set pcolor blue
]
ask patch  0 -8
[
        set pcolor blue
]
ask patch  0 -7
[
        set pcolor blue
]
ask patch  0 -6
[
        set pcolor blue
```

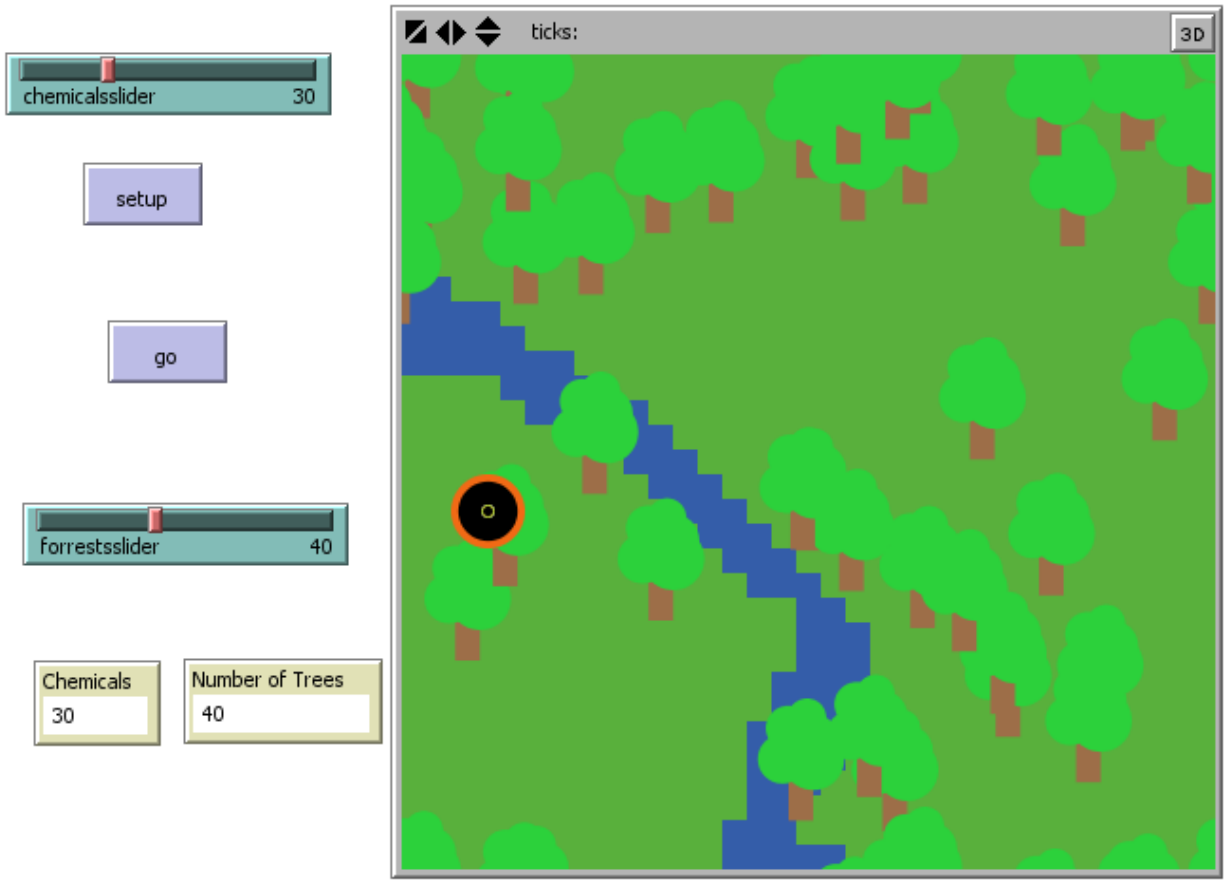
```
]
ask patch  -1 -5
[
        set pcolor blue
]
ask patch  -2 -5
[
        set pcolor blue
]
ask patch  -2 -4
[
        set pcolor blue
]
ask patch  -3 -4
[
        set pcolor blue
]
ask patch  -3 -3
[
        set pcolor blue
]
ask patch  -4 -3
[
        set pcolor blue
]
ask patch  -4 -2
[
        set pcolor blue
]
ask patch  -5 -2
[
        set pcolor blue
]
ask patch  -5 -1
[
        set pcolor blue
]
ask patch  -6 -1
[
        set pcolor blue
]
ask patch  -6 0
[
        set pcolor blue
]
ask patch  -7 0
[
        set pcolor blue
]
ask patch  -7 1
[
```

```
        set pcolor blue
]
ask patch  -8 1
[
        set pcolor blue
]
ask patch  -8 2
[
        set pcolor blue
]
ask patch  -9 2
[
        set pcolor blue
]
ask patch  -10 2
[
        set pcolor blue
]
ask patch  -11 2
[
        set pcolor blue
]
ask patch  -12 3
[
        set pcolor blue
]
ask patch  -12 4
[
        set pcolor blue
]
ask patch  -13 4
[
        set pcolor blue
]
ask patch  -14 4
[
        set pcolor blue
]
ask patch  -14 5
[
        set pcolor blue
]
ask patch  -15 5
[
        set pcolor blue
]
ask patch  -15 6
[
        set pcolor blue
]
ask patch  -16 6
```

```
  [
        set pcolor blue
  ]
  ask patch  -16 5
  [
        set pcolor blue
  ]
  ask patch  -16 4
  [
        set pcolor blue
  ]
  ask patch  -15 4
  [
        set pcolor blue
  ]
end

to Fraccident
  create-frackings 1 [set size size * 3 ]
  set-default-shape frackings "circle 2"
  ask frackings [setxy -13 -2]
end

to go
   ask chemicals
  [
        ifelse count forests-here > 0
        [
        forward 0.0
        die
        ]
        [left random 1
        right random 1
        forward 1
        ]
        if pcolor = blue
        [
        right random 40
        forward 0.05
        ]
  ]
  ask forests
  [
  ifelse count chemicals-here > 0
  [
        set lifejuice lifejuice - 5
        set size size - .5
  ]
  [
        set lifejuice lifejuice + 0.1
        set size size + 0.0001
```

```
  ]
  if lifejuice <= 0
  [
        die
  ]

  ]
end
```

Initial Interface



Interface - Mid Experiment