Agricultural Drought

New Mexico
Supercomputing Challenge
Final
Report
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Team#: 18

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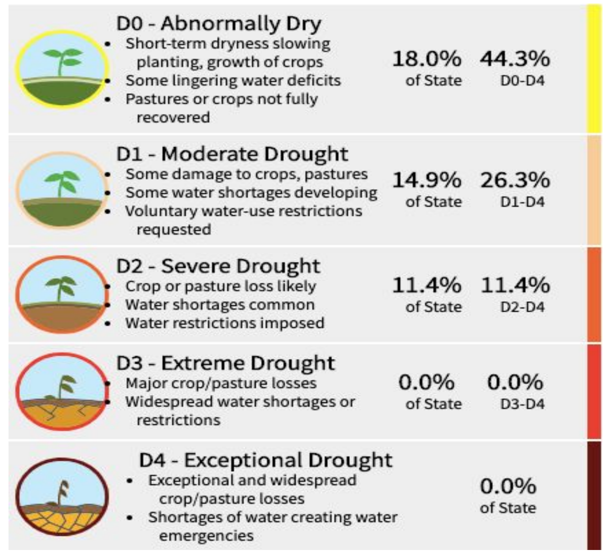
1.1 Purpose.

We made this our focus for this year for many reasons, one reason is that we believe that the higher a person is educated in this subject the more they will realize their mistakes, more exclusively farmers who use large amounts of water daily for their fields. New Mexico relies on both groundwater and surface water sources, but about 87 percent of New Mexico's (public water) supply comes from groundwater if added along with our various periods of drought and inconsistent precipitation water shortages become common, and with the daily threat of global climate change our water supply will be inconsistent with the amount we need. So, through all these variables, we came to the conclusion that the main step towards our goal of efficiency would be to influence and teach people/farmers of automation. In general, our main purpose for this project is to inform farmers/people that moving towards automation is the next big step towards water efficiency.

1.2 Significance

Day through day water is used in New Mexico without regulations, a lot of water is being used with no benefit. We believe that if this continues we will eventually have to install extreme measures to save our water. We believe that by informing our citizens of adequate water use no drastic changes will be needed. We'll better manage and store our water for the coming future. This graphic shows how the drought levels around New Mexico showing how scarce water will become in the coming future.



1.3 Research

While researching this subject we have spoken to two people who are working at the forefront of water automation in New Mexico. One of them being David Gensler at the MRGCD (Middle Rio Grande Conservancy District) who along with his team manages the water use by farmers as well as all the water held in dams, and reservoirs. We spoke to him on the water readings on their website and how much water farmers are overusing daily. We were also able to speak to him on automation which they already have all the tools in place to install yet farmers for some reason shy away from these methods. That's when we decided that part of this project would be to try and convince farmers that automation will not only help them but help the future conserve, and use their water. To do this we decided to visit the great people at the ABCWUA (Albuquerque Bernalillo County Water Utility Authority), here they have a completely eco-friendly system that even takes waste (poop) and turns into compost that is then sold to homeowners. They also manage to make over half of their own energy through their solar panels, and methane chambers. After seeing this impressive facility we were absolutely convinced it would make a great example of how automation will be better for farms around New Mexico.

Executive Summary

During our time in the SuperComputing Challenge, one of the many lessons we have learned is that no matter how simple the first problem may seem the more you try and solve it the more you'll encounter opposition. We encountered that again this year when we learned of the disliking farmers have on automation, we knew we could overcome it but that it wasn't gonna be so easy. In the end, all we could do was show the pros of auto-farming, and how its best for all.

2.1 Code

When working on our code we found it very hard to convey our idea clearly, yet we found a simple model called plant growth and can be found in the model library in NetLogo. The model can change the nutrient density, as well as the nutrient concentration. It shows how overwatering the plants doesn't mean it will increase the yield. Using the perfect amount will give you the best yield without wasting water.

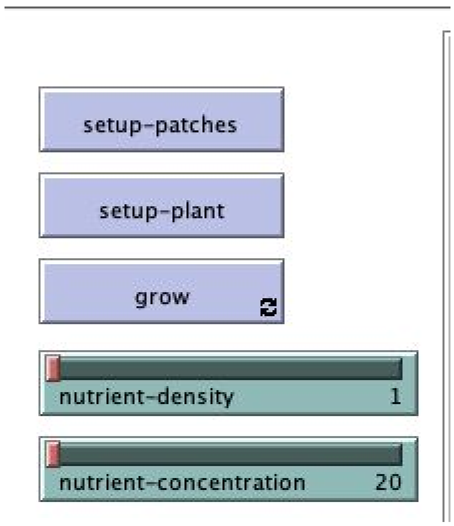


Figure 1.
These are the buttons and sliders in our code.

```
turtles-own
[
  water     ;; Amount of stored water
  sugar     ;; Amount of stored sugar
  adjacent  ;; Holds the identity of the adjacent turtles when nutrients are being shared
]

patches-own
[
  moisture  ;; Amount of water in the soil
  light     ;; Amount of light available for the leaves to turn into sugar
]
to setup-patches
  clear-all
  ask patches
  [
    ifelse pycor > 0
    [ ;; Allocate Light
```

```
      ifelse (random (world-width ^ 2)) < (nutrient-density * world-width)
      [ set light random nutrient-concentration ]
      [ set light 5 ]
    ]
    [ ;; Allocate Moisture
      ifelse (random (world-width ^ 2)) < (nutrient-density * world-width)
      [ set moisture random nutrient-concentration ]
      [ set moisture 5 ]
    ]
  ]
  diffuse-light
  diffuse-moisture
  ask patches
  [
    ifelse pycor > 0
    [
      set pcolor scale-color yellow light 14 -1
      set moisture 5  ;; No moisture in the light area
    ]
    [
      set pcolor scale-color blue moisture 14 -1
      set light 5  ;; No light in the moisture area
    ]
    ;; draw the ground
    if pycor = 0 and abs pxcor > 2
    [ set pcolor gray ]
  ]
  reset-ticks
end

to diffuse-light
  diffuse light 0.1
  if max [light] of patches > 15
  [ diffuse-light ]
end

to diffuse-moisture
  diffuse moisture 0.1
  if max [moisture] of patches > 15
  [ diffuse-moisture ]
end


to setup-plant
  set-default-shape turtles "circle"
```

```
  ;; Kill the old Plant
  ask turtles [ die ]
  ;; Create the new Plant
  create-turtles 1
  [
    set color brown
    set sugar 5000
    set water 5000
    set heading 0
    hatch 1
    [
      set color green fd 1
    ]
  ]
end

to grow
  ask turtles [
  ;; Get Nutrients from environment
  ifelse color = green
  [ set sugar sugar + light ]
  [ set water water + moisture ]
  ;; Grow Plant
  if random 100 < 1
  [
    hatch 1
    [
      move
      ;; Five Conditions under which the new growth should be aborted
      if sum [count turtles-here] of neighbors >= 3 [ die ]  ;; Overcrowding
      if any? other turtles-here [ die ]  ;; Overlapping
      if color = green and pycor < 1 [ die ]  ;; Leaves Underground
      if color = brown and pycor > 0 [ die ]  ;; Roots Aboveground
      if pcolor = gray [ die ]  ;; In the ground
      set sugar 1
      set water 1
    ]
  ]
  share-with-gs
  ;; Use Resources
  set sugar sugar - 0.1
  set water water - 0.1
  if sugar <= 0 or water <= 0 [ die ]
  ]
  tick
```

```
end

to move
  ifelse cactus?
  [ ;; Plant grows up and down only
    set heading 180 * random 2
    rt 30 - 30 * random 3
  ]
  [ ;; Plant grows in all directions
    rt random-float 360
  ]
  ;; if this is the edge of the world obviously don't grow there.
  ifelse can-move? 1
  [ fd 1 ]
  [ die ]
end

to share-with-gs
  set adjacent nobody
  if any? turtles-at 1 1
  [ set adjacent one-of turtles-at 1 1
    share-up
  ]
  if any? turtles-at 0 1
  [ set adjacent one-of turtles-at 0 1
    share-up
  ]
  if any? turtles-at -1 1
  [ set adjacent one-of turtles-at -1 1
    share-up
  ]
  if any? turtles-at 1 0
  [ set adjacent one-of turtles-at 1 0
    share-side
  ]
  if any? turtles-at 1 -1
  [ set adjacent one-of turtles-at 1 -1
    share-down
  ]
  if any? turtles-at 0 -1
  [ set adjacent one-of turtles-at 0 -1
    share-down
  ]
  if any? turtles-at -1 -1
  [ set adjacent one-of turtles-at -1 -1
```

```
    share-down
  ]
end

to share-up
  let old-water water
  set water 0.95 * water + 0.02 * [water] of adjacent
  ask adjacent [ set water 0.98 * water + 0.02 * old-water ]
End
;; Nutrients are shared equally, but the sharing is executed by the left turtle
to share-side
  let old-water water
  set water 0.95 * water + 0.05 * [water] of adjacent
  ask adjacent [ set water 0.95 * water + 0.05 * old-water ]
  let old-sugar sugar
  set sugar 0.95 * sugar + 0.05 * [sugar] of adjacent
  ask adjacent [ set sugar 0.95 * sugar + 0.05 * old-sugar ]
end
to share-down
  let old-sugar sugar
  set sugar 0.95 * sugar + 0.02 * [sugar] of adjacent
  ask adjacent [ set sugar 0.98 * sugar + 0.05 * old-sugar ]
end
```

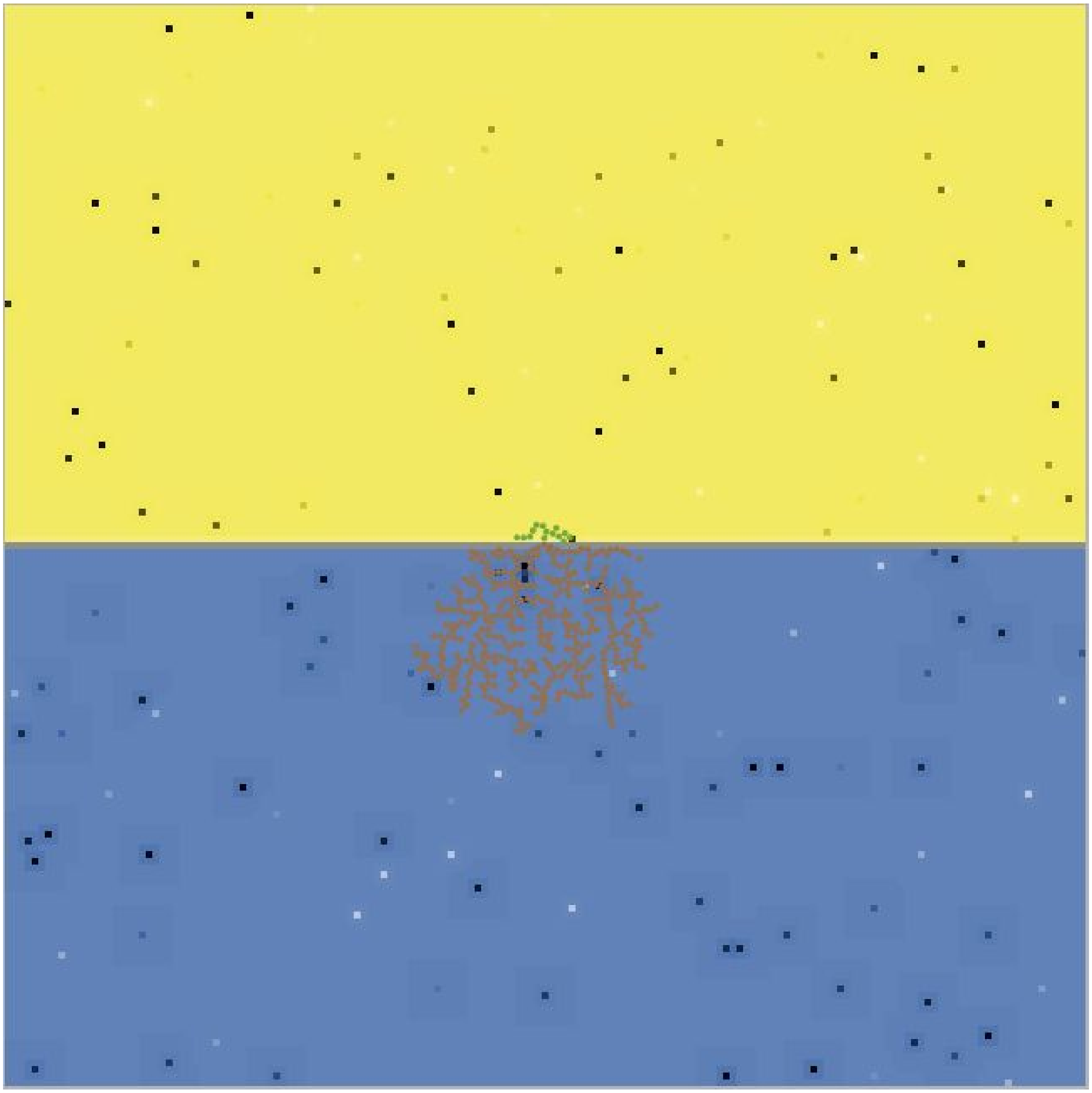


Figure 1.

This is with the lowest amount of nutrients showing there is still exponential, and maybe even more growth than when it's overwatered

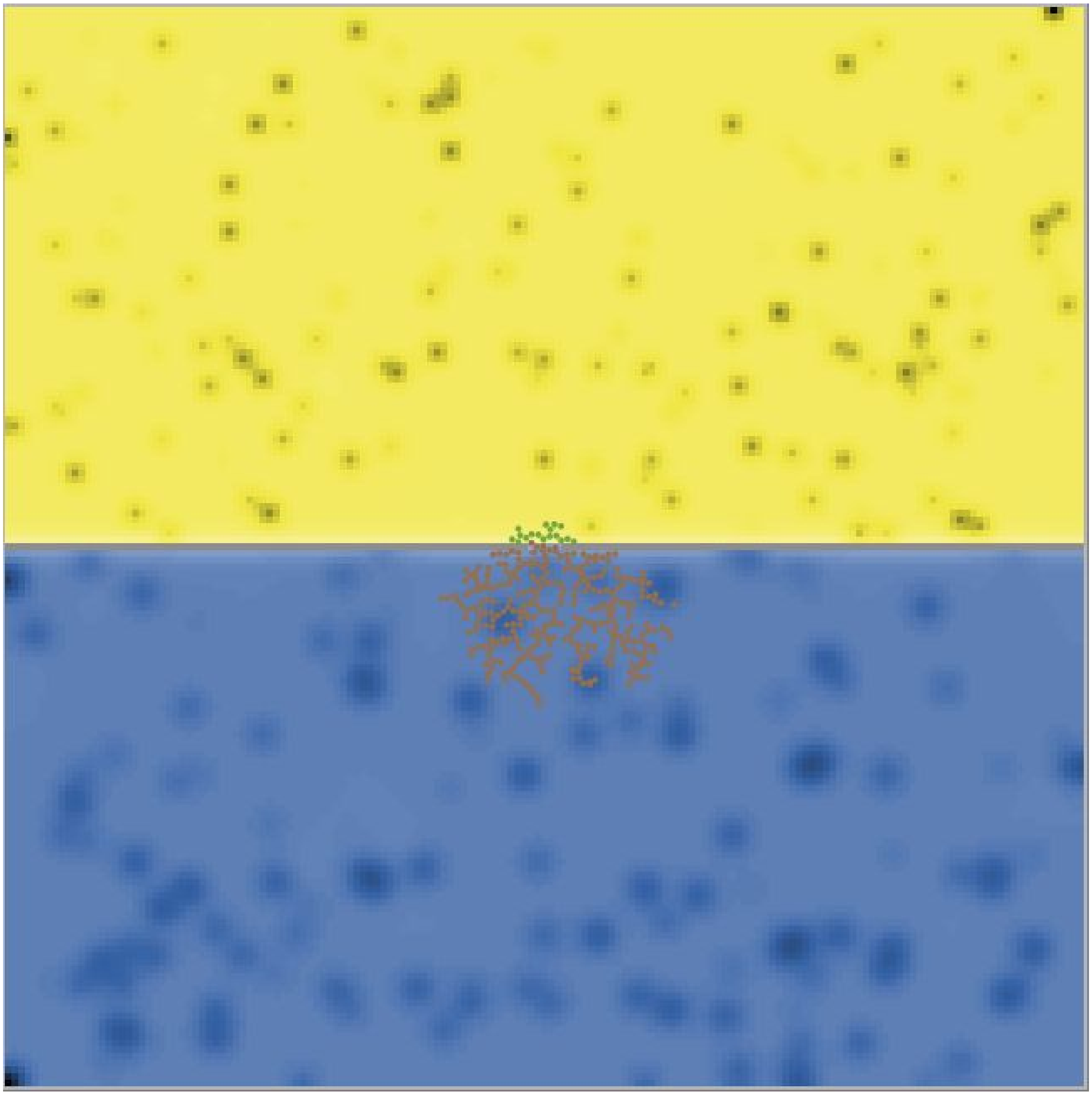


Figure 2.

This is with the perfect amount of nutrients needed to grow the plant and shows that using the perfect amount of water leads to better growth.

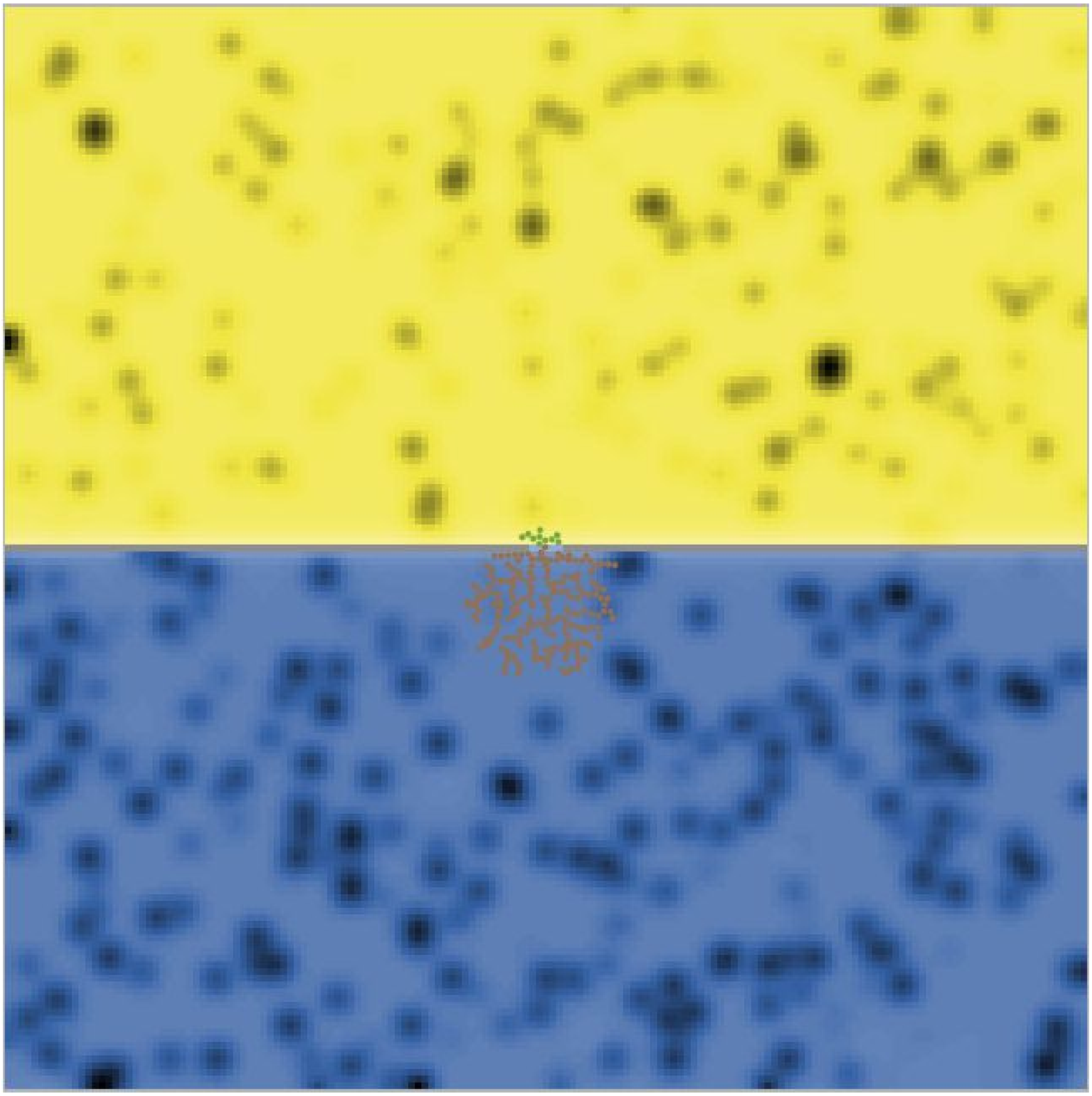


Figure 3.

By overwatering certain plants you may lower the yield and plant growth.

2.2 Numbers

Gage Information - R1GAL - REACH 1 GAINLOSS

Year 2020

Month	Day	Time (mst)	Rain (PP cfs)	Depletion (WU cfs)	DailyAvg.Inflow QR (cfs)	GainLoss QR (cfs)
Apr	6	1200	0.0	46.4	642	595.6
Apr	5	1200	0.0	43.1	644	600.9
Apr	4	1200	0.0	41.6	648	606.4
Apr	3	1200	0.0	36.2	655	618.8
Apr	2	1200	0.0	42.3	659	616.7
Apr	1	1200	0.0	40.9	672	631.1
Mar	31	1200	0.0	37.2	609	571.8
Mar	30	1200	0.0	28.5	658	629.5
Mar	29	1200	0.0	28.5	739	710.5
Mar	28	1200	0.0	21.2	739	717.8
Mar	27	1200	33.5	-13.8	743	756.8
Mar	26	1200	0.1	27.1	810	782.9
Mar	25	1200	0.0	27.2	867	839.8
Mar	24	1200	0.0	24.3	871	846.7
Mar	23	1200	0.0	24.3	864	839.7
Mar	22	1200	-0.0	20.4	845	824.6
Mar	21	1200	14.2	3.0	852	849.0
Mar	20	1200	110.4	-95.8	836	931.8
Mar	19	1200	13.1	1.5	781	779.5
Mar	18	1200	107.2	-91.6	778	869.6
Mar	17	1200	2.8	16.8	762	745.2
Mar	16	1200	0.0	19.6	765	745.4
Mar	15	1200	0.2	18.6	776	757.4
Mar	14	1200	-0.0	15.6	777	761.4
Mar	13	1200	170.3	-155.7	777	932.7
Mar	12	1200	-0.0	18.8	775	756.2
Mar	11	1200	17.3	1.5	775	773.5
Mar	10	1200	0.1	15.4	775	759.6
Mar	9	1200	0.0	5.4	720	714.6
Mar	8	1200	1.1	3.3	678	674.7
Mar	7	1200	-0.0	5.8	707	701.2
Mar	6	1200	0.0	5.4	714	708.6
Mar	5	1200	-0.0	5.8	719	713.2
Mar	4	1200	0.0	5.1	719	713.9
Mar	3	1200	0.0	5.1	713	707.9
Mar	2	1200	0.0	4.4	708	703.6
Mar	1	1200	0.2	4.9	708	703.1

Figure 4.

Shows the data collected from the beginning of March till now in the reach 1 of the Cochiti dam

3.1 Results

We have come to the ending conclusion that if farmers don't change their water rights we will experience longer, and more damaging droughts then ever before. If we look at auto-farming we see how much the pros outweigh the cons.

1. Lower Water Bill
2. Less chance of drought
3. Increased crop yield

Yet, one con of this may be job security if computerized robots water our farms, farmers may lose purpose and bigger automated farms may take their place that's why as much as the greatest solution would be automation a better one may even require more time and patience.

3.2 What we learned

During this project, we have learned many new things of how the water is moved in New Mexico, we got the opportunity to see and experience how the water we use every day is treated. We got to see all the steps it takes to ensure the water is clean enough to put back in the river. We were also fortunate to be taught by a professional face to face over the importance of water treatment, and the different bacteria in the untreated water. We also got the opportunity to sit down and talk with David Gensler over at the MRGCD over overusing our water and how that will affect our future

3.3 Future Expectations

In the next year, most of my team will be freshmen in high school, whether or not we will continue the challenge is a mystery, but if we do we will definitely continue working on this project and expanding what we know. We also expect to further our code and make it simpler to understand, yet have more complex mechanics for more simulations.

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Thank you.