Pharmaceutical Mayhem

**New Mexico
Supercomputing Challenge
Final Report
April 5, 2006**

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INTRODUCTION

Estrogen. Zoloft. Amoxicillan. Does the Rio Grande contain these drugs? Will we be drinking them soon? We don't know as almost no research has been done to find these in our water. A limited number of pharmaceuticals have been found in the Rio Grande with levels in the billionths of a gram. Although the pharmaceutical levels are very low, no research has been done to determine the long-term health effects of exposure to these substances.

Anti-depressants, antibiotics, and various hormones (including estrogen) have been detected. Although there is not only one source of all of these drugs, many of them have been found to be coming out of nursing homes and hospitals, which makes sense considering they can't re-use medications. Excretion and direct flushing of these compounds is also contributing to the problem.

Starting in spring of 2008, the city of Albuquerque will begin pumping drinking water straight out of the Rio Grande. Obviously this raises some concern considering the fact that we have no idea what exposure to these drugs is doing. CH2MHILL is over-seeing the project, but they have not been doing any research as to what pharmaceuticals have been detected in the water.

Many of these metabolically significant organic compounds have been known to degrade naturally (with dilution or exposure to sunlight) but others aren't degrading at all. Since nobody has really been looking at pharmaceuticals in our surface water, there are, at present, no techniques as to how to filter these compounds.

STATEMENT OF THE PROBLEM

"Today we are already "borrowing" about 60,000 acre-feet/year from the river in the stretch that runs past Albuquerque. We do this by pumping 110,000 acre-feet of water from the aquifer, half of which is being replenished by river water. We don't notice the reduction in flow because it is not happening at a single point, but occurs gradually over several miles. We return about 55,000 acre-feet of water to the river in the form of reclaimed (cleaned) wastewater. For now, the 5,000 acre-foot deficit is made up for by the 23,000 acre-feet of Rio Grande water rights the City owns. When we add our San Juan-Chama water AND reduce pumping to a sustainable amount less water will leave the river to recharge the aquifer. Thus, the net change is minor.

Even without the compensating reduction in river-to-aquifer water, the additional 47,000 acre-feet of water that the Water Utility "borrows" in this stretch of the river, is less than 5 percent of the river's flow of 1.1 million acre-feet past Albuquerque. For example, in October, when flow is traditionally lowest, this would amount to about ONE TO TWO INCHES of river depth. When flows are very low, the Utility will reduce or eliminate withdrawals altogether and rely on ground water supplies alone until flow is higher." (cabq.gov)

Whereas our Mentor Joe Sterling says that according to the U.S.G.S. we are essentially mining the water from the aquifer. The reason is that river water takes a long

time to get into the aquifer, due to clay and ground layering, causing water drop rate to be

slower then models shown by the city.

This shows the politics of water in an arid climate.

METHODS

We have developed a basic linear model of the mid Rio Grande River using

USGS gage station data. We will align flow of velocity and volume with historical data

using the data that we have already found on the USGS site. The model will show how

pharmaceutical pollutants degrade over distance and time, based on a scaled down, linear

model of the Rio Grande.

RESULTS

At this point in time, we have not been able to achieve the results we were

hoping for. We were hoping to show how these pharmaceuticals degrade over distance

and time, but that is something that we will be able to add to our already existing, simple

linear model in the near future. We will also be able to show the increase and decrease of

the velocity and volume of the water as it flows down the Rio Grande, keeping in mind

such factors as evaporation and absorption.

CONCLUSIONS

At this point we can conclude that this model is "do-able". At this point we are not able to draw any conclusions from the current state of our model, but we should be developing preliminary results in the near future.

SIGNIFICANT ACHEIVMENTS

We have been able to examine and understand the complexities of ground water and the geological effects of pulling water out of aquifers. We understand the dangers and positive affects of using surface water. During our studies we were able to take an in-depth tour of our new water treatment plant, which is in the process of construction and being overseen by CH2Mhill. We have learned about the complexities of surface water (i.e., flow rates, evaporation, etc.) and understand the methods used to purify this water for public consumption.

THE MODEL

As of now our model is a linear representation of a quantity of water flowing

down the Rio Grande. At the top right hand corner we have a water volume graphic that

represents the increase in water at given points in our model. Things such as evaporation

and absorption are factors that will be added later. We have different points that

represent different drainage stations, based on information from the USGS data.

The model is a scaled down view of the Rio Grande
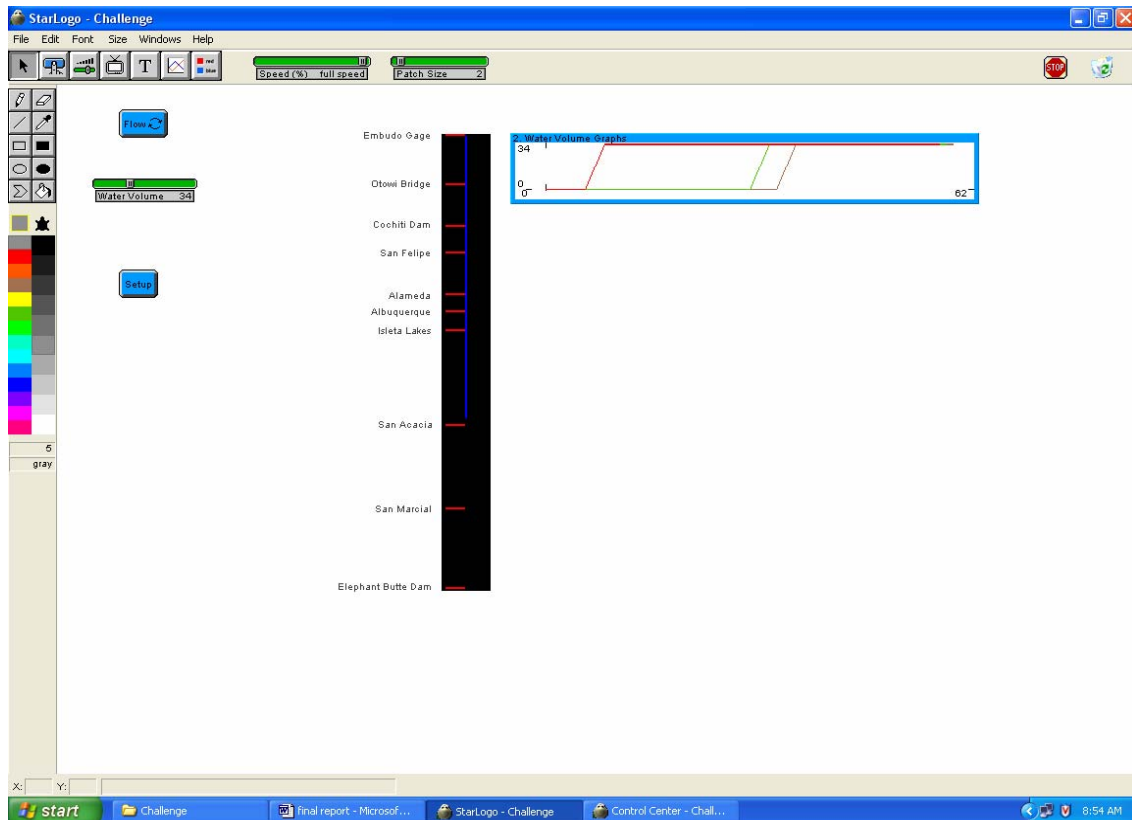
HOW IT WORKS

As of now we only have two buttons, which is really all we need to test the model. The first, the setup button, calls the setup parameters and kills the already existing "turtles" and resets the graphics. The locations of the USGS gages were determined from their latitude and longitude using GPS software. This allowed us to find the river miles between the stations and create the framework for the model. Then we have the "flow" button, which tells the turtles to go forward from their creation point. We have a slider that allows us to manipulate the volume of water coming down the Rio Grande. The volume of water each "turtle" represents is yet undetermined. This slider will eventually be replaced by a function that allows us to add certain quantities of water at input points along the Rio Grande, thus modeling the natural flow of the river. The input quantities will be based on historical values from USGS data. We will also need to add exit points based upon water usage, evaporation, etc. Upon reaching a rough flow model for the Rio Grande we will then be ready to introduce various pollutants. We will begin with more traditional pollutants that are regularly measured to test the accuracy of our model. At this point we will be ready to introduce pharmaceuticals into our system. We understand this is the point we wished to be at in our interim report, but this is a project that we plan on extending into next years challenge.

THE CODE

First shown are the observer commands, which is most definitely the bulk of our coding. This is where the setup and flow buttons call all of their procedures.

```
globals [count otowi albuquerque isleta]


to setup
 ca ;clears the graphic model window
 set count -10
 repeat 10 [ask-patch-at count 120 [setpc red] set count (count + 1)] set count -10 ; Embudo
 repeat 10 [ask-patch-at count 94 [setpc red] set count (count + 1)] set count -10  ; Otowi
 repeat 10 [ask-patch-at count 72 [setpc red] set count (count + 1)] set count -10  ; Cochiti
 repeat 10 [ask-patch-at count 58 [setpc red] set count (count + 1)] set count -10  ; San Felipe
 repeat 10 [ask-patch-at count 36 [setpc red] set count (count + 1)] set count -10  ; Alameda
 repeat 10 [ask-patch-at count 27 [setpc red] set count (count + 1)] set count -10  ; Albuquerque
 repeat 10 [ask-patch-at count 17 [setpc red] set count (count + 1)] set count -10  ; Isleta Lakes
 repeat 10 [ask-patch-at count -33 [setpc red] set count (count + 1)] set count -10 ; San Acacia
 repeat 10 [ask-patch-at count -77 [setpc red] set count (count + 1)] set count -10 ; San Marcial
 repeat 10 [ask-patch-at count -119 [setpc red] set count (count + 1)] set count -10; Elephant Butte
end

to flow
 repeat number [make_water]; generates water at points in the model
 ask-turtles [fd 1]
 set otowi (count-turtles-at 0 94)
 set albuquerque (count-turtles-at 0 27)
 set isleta (count-turtles-at 0 17)
 ask-turtles [if ycor = (-120) [die]]
end

to make_water
 ask-patch-at 0 120 [sprout [seth 180 setc blue]]; makes water at the Embudo Gage on the Rio Grande
end
```

We don't have coding in the turtle command center of the procedures page, but we will eventually need to add more to it.

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