

Strategies for Using the Stormwater-Floodplain Model Based on Field Days with 6th Graders

Objective: Although they may learn and remember other things, the important take home message is that **rain water needs to be able to soak into the ground and if for some reason it can't, it can cause flooding and flooding can cause mayhem.** Key vocabulary words are:

- **Runoff** – Rain water that doesn't soak into the ground, but instead flows over land into streams and rivers.
- **Floodplain** – Low area near a river or stream that floods when water overflows the banks.

25-30 Minute Sessions:

Summary: Run the model with the wetland and then with the parking lot, collecting hydrograph data for each (an abridged version of Activity 3 in the Teachers Guide). Then experiment with ideas for reducing flood damage – brainstorm solutions, implement them in the model, and test with one or more model runs as time permits (anchor houses, elevate on fill, detention pond, levee, dams, etc.). There's not enough time to do the hydrograph for these experiments, so just watch and talk about what happens.

Set up: Before the students arrive, set up the model, insert the Wetland Headwater Tray (with damp sponges), use either Rainmaker tray, and use any slope position. The downstream bucket should be empty and the other bucket relatively full (so the pitcher can be filled by dipping it in rather than pouring).

Introduction: Start off by asking what happens to rain after it falls? Some soaks into the ground, some is consumed by thirsty plants, some evaporates, and the rest runs off into streams, rivers, lakes, and eventually the ocean. What causes floods? More rain or more of the rain runs off. Other possible discussion questions include: What is a model? Why do we use a model? Etc.

Jobs: The ideal class size is 10-15 students. With larger groups, it is hard to get everybody involved and also hard to make sure they can all see the action. Job assignments can include:

- Landscapers – “Plant” trees and bushes (trees can be stuck down with clay)
- Rain Maker - Measure and pour rain.
- Time Keeper - Call out every 5 seconds. (Difficult because the model is more fun to look at than the clock.)
- Gauge Reader - Read stage (water level) every 5 second using the scale on the side of the tank. (This is difficult to read; try to get the teacher to help choose someone to do this.) (It might be possible to reduce data gaps by having a second student monitor the other gauge on the downstream bank. I haven't tried this because I thought it would be too confusing for the Recorder.)
- Recorder - Write down gauge heights and other info on the Wetlands and Parking Lot data sheets (from the Teachers Guide).
- Bankfull Observer (optional) - Note what time the river begins to overflow the banks. (There is a tendency to forget the time this occurred.)
- Flood Stage Observer for 2nd run (optional) - Note what time the river reached houses. Flood stage is when the flooding begins to pose a risk to lives or property.
- Runoff Checker - Measure amount of runoff that drained into the bucket.

Switch assignments for the 2nd run to get more students involved.

Experiment 1, Well-drained Wetland: Have the Landscapers plant trees in the undeveloped watershed. Ask what a wetland is and talk about it being a place that's good at soaking up water. Assign and explain jobs. Rain Maker and/or instructor fills the pitcher to about 3 liters. Rain Maker reports how much water is in the pitcher.

Recorder writes this down. Gauge Reader reports the initial (low flow) water level. Recorder writes this down for time 00:00. When the Time Keeper is ready to start he/she calls out “zero seconds” and the Rain Maker starts pouring the water. Time Keeper calls out the time every 5 seconds; Gauge Reader reports the water level; and Recorder writes it down. Keep going until the water level drops. Runoff Checker uses pitcher to measure the amount of water that drained into the bucket. Recorder writes this down.

Discussion: What happened? Was there any flooding? What time did the river start flowing out of its banks? Recorder writes this down. What was the highest gauge reading? Recorder writes this down. How much runoff was there? (Teachers Guide calls for calculating the percent of water added that was runoff and calls this the Runoff Footprint. Nice idea, but for this age the calculation diverts time and attention from the model.) Hold up the pitcher. Less than half of the water ran out of the model. Where is the rest? (No wonder it’s called a wetland; nice place for frogs to live.)

Experiment 2, Parking Lot: People move into the valley and they need a place to shop. Give each student a house to place in the model (just the green ones as larger ones get caught in the drain and require more time to dislodge). Instructor replaces Wetland Tray with Parking Lot Tray (cars are stuck in place with clay). When their houses are all in, instructor puts one on stilts anchored with clay right on the river bank. Assign new jobs. This time there can also be a Flood Stage Observer. Flood stage is when high water begins to cause flooding problems. Make sure the downstream bucket is empty (more water may have drained into it when removing wetlands). Ask what they expect to happen this time. Repeat the experiment. If houses are lodged in the drain, the small ones can be pushed through with a pencil.

Discussion: What happened? Was there any flooding? Why? Where is the floodplain? Why is it called a floodplain? Flooding is a natural process. It wouldn’t be a problem if there were no houses in the floodplain. What time did the river start flowing out of its banks? Recorder writes this down. Was this sooner or later than before? Why? What was the highest gauge reading? Recorder writes this down. Was this higher than before? Was it a lot higher? Why? Did the river become a lake? Why? Because houses often get stuck in the drain blocking flow. Are there more houses in the bucket? What could have been done to keep the houses from floating downstream? Anchor them. What happened to the people living in those houses? I sure hope they had time to evacuate. In real life there usually aren’t houses floating downstream, but there are trees and they often get stuck at bridges and make the flooding worse. Did the water rise faster than before? How much runoff was there? Hold up the pitcher. Why so much? Do parking lots always cause flooding? Is there a way to have shopping centers without flooding? Need to consider runoff and include a strategy for storing the extra water. Slow it down; spread it out; soak it in. Did the house on stilts get wet?

Experiment 3, Testing Solutions: Let owners of houses that washed away re-build in the same or different location. What can we do about this flooding problem? When a student has an idea, ask them to implement it. Possible suggestions include:

- Move houses out of the floodplain.
- Anchor houses in the floodplain. Give them small pieces of clay to do this.
- Elevate houses in the floodplain. On fill or on stilts? Give them chunks of clay to build hills with. Or toothpicks for stilts with small amount of clay to stick things together.
- Build a levee or flood wall. They usually need to be prompted for this and don’t really understand the concept even if they live in a levee protected community. Give them a big chunk of clay and see what they do with it. Refrain from advising them about how to do it right. Just explain that it’s designed to hold water in the river and out of the houses.
- Build a dam. Where? Give them clay and see what happens.
- Manage runoff at the parking lot or restore the wetland. They don’t usually think of this without prompting. Can demonstrate by putting the Detention Pond or Wetland Tray under the Parking Lot Tray, positioned to catch the runoff.
- Emergency operations to keep houses from blocking the drain. Hire a public works crew.

- Flood warnings and evacuation.

When they are happy with what they've done (or when time is running low) have someone make it rain again and watch what happens.

Discussion: What strategies worked? Move to higher ground. Elevate houses. Anchor houses. Why didn't the levee work? Rarely is it tied in. Even adults don't usually make it high enough. If it was as high as the last flood, would that be high enough? Why not? Lost the ability for water to spread out on the floodplain. If levee worked, did it make flooding worse downstream? Why didn't the dam work? Try to get them to think about location and storage capacity. Show them the pitcher as a visual clue to the volume of water that needs to be managed.

Continue experimenting and discussing until the time runs out.

Follow up: Keep the data sheets. Make sure to indicate the group on each sheet so the results can be forwarded to the proper class. Enter the data into the Excel file to make plots. Fill in the crest information and Runoff Footprint. Print the spreadsheet for each class to use for follow-up discussion.

Adapting to 15 Minute Sessions:

Summary: Run the model with the wetland and then the parking lot, but without taking the time to collect hydrograph data. The focus will be on how high the water gets and comparing the amount of water draining from the model with what was poured in to show how much was stored in the landscape. Do these two experiments as quickly as possible to allow time for experimenting with ideas for reducing flood damage.

Set up: Before the students arrive, set up the model with the Wetland Headwater Tray (with damp sponges), either Rainmaker Tray, any slope, and no water in the downstream bucket. Place trees in the landscape (stuck in place with clay) to represent an undeveloped landscape. Fill the pitcher with roughly 3 liters of water.

Introduction: Start off by asking what happens to rain after it falls and discuss the water cycle. Keep it short.

Jobs: Job assignments can include:

- Rain Maker - Measure and pour rain.
- Gauge Reader - Read the crest height, which is the maximum depth of water on the gauge on the side of the tank.
- Recorder - Write down rainfall amount, crest height, and runoff amount on the attached data sheet.

Switch assignments for the 2nd run to get more students involved.

Experiment 1, Well-drained Wetland: Ask what a wetland is and talk about it being a place that's good at soaking up water. Give clipboard to the Recorder. Give pitcher of water to the Rain Maker and have him/her say how much is in it. Recorder writes this down. Show someone the staff gauge and ask him/her to follow the water level with his/her finger, stop at the maximum height, and tell us how high the water got. This is called the crest height. Let it rain. There should be a little bit of out-of-bank flow, but not much. Have the Gauge Reader report the maximum depth (may need help, since it's hard to read). Recorder writes this down. Second instructor (or a student) pours water from bucket to pitcher and reports how much came out. Recorder writes this down.

Discussion: What happened? Was there any flooding? Hold up the pitcher to show the amount of runoff from the model. What happened to the rest of the water?

Experiment 2, Parking Lot: People move into the valley and they need a place to shop. Give each student a house to place in the model (just the green ones). Instructor replaces Wetland Tray with Parking Lot Tray. When their houses are all in, instructor puts one on stilts anchored with clay right on the river bank. Ask what they expect to happen this time. Repeat the experiment with different students doing the various jobs.

Discussion: What happened? Was there any flooding? Where is the floodplain? Why is it called a floodplain? Flooding is a natural process. It wouldn't be a problem if there were no houses in the floodplain. Why was the flooding so much worse? Why did more water drain out of the model? Can discuss other issues (backwater flooding, need to evacuate, etc.) as time permits.

Experiment 3, Testing Solutions: Let the owners of houses that washed away re-build in the same or different locations. What can we do about this flooding problem? When a student has an idea, ask them to implement it. Do as much experimenting and discussing as time permits. I left space on the data sheet for ideas and observations, but most students lose interest in writing things down at this point and would rather interact with the model. If there is time, I add a few notes about their ideas and observations.

Follow up: Give the data sheet to the teacher as they leave.

Adapting to a Fair Setting:

No data collection, just run a series of scenarios and watch what happens. The following sequence can be done in 10-15 minutes:

- Wetland Headwater Tray to demonstrate pre-developed condition.
- Wetland Tray again without ringing out sponges to show that pre-existing conditions matter.
- Ring out sponges into the pitcher to show how much of the rainfall volume was stored in the wetlands.
- While you're doing that, give each child a house to put where he or she wants to live.
- Put in the Detention Pond and Parking Lot Tray. The shopping center for all those people who just moved in was built by a "good developer" who managed the increased runoff from all that pavement.
- Let it rain again without allowing the pond to empty. The pond wasn't maintained and got filled with sediment, so it no longer worked as designed.
- Give kids clay to protect their houses. Let it rain again to see what happens.

These ideas and those in the Teachers' Guide can be adapted to the time constraints, age of the children, and other circumstances.

BE CREATIVE! And HAVE FUN!

Field Day Data Sheet

Date: _____

Group _____

Experiment #1: Well-drained wetland

Rainfall (amount of water added): _____

Crest height (maximum depth of water on the gauge): _____

Runoff (amount of water that came out of the model): _____

Experiment #2: Parking lot

Rainfall (amount of water added): _____

Crest height (maximum depth of water on the gauge): _____

Runoff (amount of water that came out of the model): _____

Experiment #3: Testing Solutions

Ideas for reducing or preventing flood damage: _____

Rainfall (amount of water added): _____

Crest height (maximum depth of water on the gauge): _____

Runoff (amount of water that came out of the model): _____

What worked? _____

What did not work? Why not? _____
