Visionmaker Education
Wildlife Conservation Society 2016

Module 2, Lesson 2: Water, Water Everywhere: Challenges of Water Management in an Urban Environment

Grades: 6-12
Duration: 3 class periods (each 4 5-5 0 minutes)
Objective: Students learn how water flow is affected by urban landscapes by recording differences in inputs, storage, and outputs in 1609 vs. 2014 for a given area. On Visionmaker NYC, they are introduced to strategies for managing stormwater runoff (i.e. cisterns, planting street trees, bioswales) in the urban environment. They will look at the proportion of impervious surfaces for different ecosystem types and be challenged to reduce stormwater runoff by 25% with different teams given different parameters to accomplish their challenges.
Materials:
Activity 1: Smartboard or projector; Activity 2: Per student group: 1 data sheet, 1 clipboard, 1 coffee can with top and bottom removed, 1 container with 1L of water, 1 stopwatch; Activity 3: Smartboard or projector; laptops for students (one per student or student pair)
Standards:
NYS Content Standards:
Grade 6-8 Science Standards:
Sl.2, Sl.3, Sl.4, Tl.5, Standard 1- 1.2a, 1.2b, 3.1a, Standard 2- 1.5, Standard 4- 2.1j, 2.2r, 6.1c, 7.2b, 7.2d, Standard 6- 2.2, 2.3, Standard 7- 1.1, 1.3
Grades 9-12 Science Standards:
Standard 4- 1.2g, 6.3a, 6.3c, 7.1c, 7.2b, 7.3a

Common Core State Standards:
Grades 6-8 Standards for Literacy in History/Social Studies, Science, and Technical Subjects
Text Types and Purposes
2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
Production and Distribution of Writing
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Grades 9-12 Standards for Literacy in History/Social Studies, Science, and Technical Subjects
Text Types and Purposes
2. Write informative/explanatory texts, including the narration of historical events, scientific procedures / experiments, or technical processes.
Production and Distribution of Writing
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Activity 1:
The Effects of Urbanization on Water Flow over Time (45-50 mins)
To bridge the gap between Lesson 1 and Lesson 2, have the students do a brief reflection exercise. Ask them to either reflect individually or do a think-pair-share activity with the following prompt: Thinking back on what we've learned about water storage in the natural ecosystem, how do you think urbanization will affect how water is stored in the environment? Once students reflect, you can choose to have some students share out their responses.

Inform students that we will now be exploring the ways in which urbanization can affect water flow and storage. To do so, over the course of three lessons, we will use the Visionmaker NYC platform to explore data; collect data in the field; and then return to the platform to model how changes in the environment can affect run-off. Today's lesson will focus on exploring data through the platform.

Prior to beginning this lesson, you should choose one vision. It does not matter which vision you have selected, provided that it represents an urban environment in the vision. Group students into pairs or groups of three. Project the vision from the VISIONMAKER NYC platform onto a smartboard or projection screen. Pull up the vision and ask students to identify where in the city the vision represents. If students guess correctly, or if they need additional clues, zoom out of the vision in order offer your students the perspective of where the vision is located in the city. Demonstrate the features of the platform by showing the vision area in 2014 using the existing 2014 map and then in 1609 using the 1609 map. Elicit responses from students as to how the area has changed in 400 years.

Pull up the data summary menu. Begin by having students acclimatize to the format by asking them to look at the first two data columns and tell you: What is the lifestyle of the inhabitants of those two visions (1609 and 2014)? What is the climate? What is the precipitation event?

Students should be able to identify that the 1609 vision shows Lenape person lifestyle, a past 1609 climate, and a rainy day. The 2014 vision shows average New Yorker lifestyle, the baseline climate (1970-2010), and a rainy day.

Introduce two concepts to the students: 1.) substrates- the substances that makes up the ground cover (for example, soil, concrete, etc.); and 2.) soil absorption- referring to the rate at which water absorbs into different substrates; different substrates have different absorption rates. Give students the following task: In their groups, they should compare and contrast the water output measure by exploring the stored water and outputs parameters. Students should be looking at the differences in just the first two columns (not the primary vision data) to identify patterns in the ways in which water flows differently in the urban ecosystem when compared to the 1609 natural ecosystem. Some patterns that you want them to notice:

- There is much more "open water" in the 1609 vision. They should think about what implications this has on the water cycle. Specifically, where does run-off go if there is less open water? (Hint, some of it goes into "standing water", but not all of it)
- There is a tremendous amount of runoff in 2014 and no runoff in 1609. Why is this? How has the environment been changed to affect run-off? They should recognize that the hard-top substrates (such sidewalks and roads) have affected the absorption rates, which increases runoff.

After students have made these observations, explain to them that the next activity will be an exploration of how soil absorption can affect run-off and how human activities can affect soil absorption rates. Explain to students that you will be going out to a nearby location (you should choose a park, garden, or soil pathway near the school) and, as a reflection, ask them to make predictions about how humans have affected that area with regard to the substrate and then to predict what this means for soil absorption rates.

ACTIVITY 2:
Managing Stormwater Runoff in Urban Environments (45-50 mins)
Prior to this lesson, you should have identified a location where you will be taking your students. This location should be a field, park, or pathway that has a soil substrate. Additionally, there needs to be areas in which the soil has been compacted from human foot traffic. You will be able to identify these areas by the sparse grass growth (they are often foot paths through grassy areas, but can also be found near benches and at the base of trees). It is important for the success of the lesson that there are both compacted and non-compacted areas of soil for students to explore.

To introduce the lesson, have students revisit their reflection from Activity 1. If time allows, have select students share out their reflections from Activity 1 as a way to re-engage students in the concepts of water absorption and runoff. Inform students that different soil types have different absorption rates, which can affect runoff rates. In an urban environment, runoff can lead to flooding very quickly. We are interested in exploring the relationship between soil absorption and flooding.

To explore this question, take students out to the pre-determined location. Prior to leaving, make sure that students are aware of their groups and are familiar with the lab materials. When arriving at the outdoor location, describe to students how they will explore this research question. Students will conduct a two-phase experiment in which they explore this question. In the first trial, they will conduct their experiment in an area of soil that is grassy and has not been walked on; in the second trial, students will conduct their experiment in an area of soil that is compacted (such as a path or walkway). In both trials, students will place the coffee can on the ground so that one of the open ends is facing up and the other is on the ground. They should press the can gently to make sure that lip of the can is slightly indented into the soil. They will pour the water from the water bottle into the open can and time how long it takes the water to absorb into the soil. Note: If the can is not firmly pressed on the ground, there will be significant leakage out of the gaps at the bottom, which will affect their data.

Student roles for this activity are:

1. Materials Manager- responsible for collecting materials from the teacher; ensuring that materials do not get misplaced or broken; setting up the materials for the trials; collecting and returning materials to the teacher at the end of the lesson
2. Timekeeper- responsible for using the stopwatch to record the time it takes for the water to absorb into the substrate
3. Data Recorder- responsible for recording accurate data for each trial; reporting out results to the group at the conclusion of data collection

When data has been collected for both trials from each group, take the class back to the classroom for a discussion on data results. Upon arriving in the classroom, draw a data table on the board/smartboard that looks like this:

	Trial One: Loose Soil (in seconds)	Trial Two: Compacted Soil (in seconds)
Group 1		
Group 2		
Through all groups		

Students should be invited to identify trends in the data. In general, the times should be shorter in the loose soil trials. Students should be encouraged to discuss why they think this trend occurs and then

connect this trend back to the discussion on water cycle from Lesson 1. If students are struggling with making this connection, they should be reminded that water absorption into soil can affect run-off and flooding. They should be encouraged to make a connection between urbanization and substrate absorption rates.

If time allows, students should look for outliers within the data. In some cases, groups might have much shorter absorption time, which is often due to a failure to press their coffee can into the soil. If they make this mistake, the water will flow directly out of the can through gaps in the bottom. This is a good entry point· for discussions about how human error can conflate data.

ACTIVITY 3:
Effecting Change in Stormwater Runoff using Visionmaker NYC (45-50 mins)
Prior to this lesson, you must have identified or created a vision that you will introduce to students and allow them to modify for this activity. Since the activity will be exploring the ways in which storm water runoff can be affected, the vision that you select should have the following criteria: (1) it should be a vision that represents a "rainy day" precipitation event (or wetter); (2) it should have high levels of stormwater runoff (this will happen if you use any visions that are mostly man-made ecosystems; and (3) it should have enough buildings that the addition of green roofs will affect the storm water runoff data.

In Activity 2, we explored the relationship between substrate type and water absorption rates. To remind students, begin the lesson with a reflection activity where students work with their lab partners from Activity 2 to summarize the class conclusions from the data observations and to reflect on one way in which they think that urbanization can influence this relationship.

Explain to the students that, to explore the ways in which we can effect change in an urban environment, we will be using the Visionmaker NYC platform to create "visions" that will reduce stormwater runoff in a particular area of New York. At this time, project the vision that you had previously selected onto the screen or smartboard. Show the students the vision, as well as what that area looked like in 1609. Bring up the data summary image and show them the differences in stormwater runoff in 1609 and 2014. Have students write down several ideas that they might have as to why stormwater runoff is so much higher in 2014. If time allows, ask several students to share out their thoughts.

Inform students that they will be modifying this vision in order to reduce stormwater runoff. Demonstrate the "modifiers" tool in the toolbar (fourth box down on the far right column of boxes). Explain to students that modifiers do just that: they "modify" the currently existing ecosystems. What this means for them: They will not be changing the current ecosystems in the vision (buildings will stay buildings, lawn will remain lawn, sidewalks will remain sidewalks). However, they can modify what currently exists in order to reduce runoff. For example, they could add a green roof to a building. Green roofs have soil substrates in which plants are growing. This soil has better absorption rates than blacktop and will reduce runoff. There are modifiers that modify man-made ecosystems (such as green roofs, cisterns, bioswales, and street trees) and modifiers that modify natural ecosystems (such as eel grass meadows, trails, and streams). As students work on their challenge, you should leave the data summary projected so that they can monitor how their changes compare with the "baseline data".

Note 1: Unless you have taught about green practices in previous lessons, you will most likely need to teach your students about each of the modifiers in order for them to make more informed decisions in

their visions. Conversely, you could require students to read about each of the modifiers using the Visionmaker NYC platform and accessing the descriptions for each.

Note 2: If this is the first time that your students have accessed the platform directly, you will need to ensure that they have created accounts prior to beginning this lesson.

At this point, provide your students with the following challenge: They are to reduce stormwater runoff by modifying the vision. They can modify as many aspects of the vision as they want, but they are restricted to "modifying" (i.e., they cannot tear down a building and replace with a pond). Their goal is to reduce runoff by the greatest amount that they can. There are multiple ways that they can achieve this goal, so ensure that they understand that there is not a "correct answer" to this problem.

Students should work either individually or in pairs on this task. If students are working in pairs, one student should be in charge of manipulating the platform and the other student should be responsible for recording all of the changes that they made on a separate worksheet / journal entry. If students are working individually, each student is responsible for both tasks. In either case, the student manipulating the platform should log into their account. Once they are logged in, they should bring up the vision carousel at the bottom of the screen. On the carousel, there is a search function. Provide the name of the vision to the students so that they can find the correct vision. Once they locate and load the vision, they will need to "copy and edit" the vision in order to make changes to it. They should rename the vision (Vision Name- Student Name) and save. Once they have done so, they are now "owners" of this version of the vision, can modify the environment, and save those modifications.

Students should have between 10 and 15 minutes to make modifications (not including time to load and save their vision). Throughout this time, be prepared to circulate through the classroom and help students as they make their changes. Once students have made their changes and recorded their steps, they should save their vision and recalculate the data summary.

After students have made their changes, ask each student/group to share their data results. Specifically, ask them to report out the stormwater data (in gallons/day). As students share their numbers, record them on the board / smartboard. Have students identify which vision has the least amount of stormwater runoff. The student(s) responsible for that vision should share out the steps that they took in order to get this data (What modifiers did they use? Where did they use it?)

Explain to students that urban ecosystems are challenging to drastically alter because of the high population density and high associated costs for major construction. However, modifying existing ecosystems are more cost-effective green practices that can still effect major changes. As a culminating exercise, have students write a paragraph in which they explain why they think it is important to reduce stormwater runoff in urban ecosystems. They should be prompted to make connections to content on the water cycle, ecosystems, and human impacts from the NYS Content Standards. If this activity has been done as an introduction to these concepts, then they should be prompted to "make their best guess" and then ensure that you revisit these paragraphs in a later lesson to address misconceptions should might have.