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B

Monster Rain – Monitoring the Climate

INTRODUCTION

Key concepts

Ecology: plant growth; water absorption; flow; plant structure and function, nutrients, C- and N- cycle; photosynthesis, respiration, fermentation, biotopes, succession; evolution.

Physics: modelling; making a simulation; flow measurements.

Monitoring the climate is recommended for students aged 14–18 (or younger) studying applied sciences while working interdisciplinarily in physics and biology. It triggers students' critical thinking abilities while allowing them to suggest and develop methods and experiments that involve local problems. Additionally, by increasing communication, it offers a regional and global understanding and perception of education on sustainable development.

RESOURCES

Modelling is fun! However, making a simulation that really works is a challenge. Remember that graphs are useful to present your results – far better than written explanations. Photos are also useful when communicating your work to others. When asked to simulate an experiment, you can use Scratch (see annex). When asked to draw graphs, you can find many programs on the Internet free of charge.

You find a monster rain simulation at www.scratch.mit.edu/projects/agsmj/2352259. Instructions how to construct a "monster rain" prototype can be found at www.science-on-stage.de.

CORE

This unit deals with the real world. The classroom can preferably be exchanged with outdoor monitoring opportunities: In recent years, climate change and global warming have led to increased local problems, e.g. droughts in some areas and very heavy rain in others. "Monster rain" is defined as large amounts of rain pouring down in very little time. Monster rain flows unexpectedly, and can cause floods that have a great impact on houses, railroad tracks and roads, which can be flooded or even washed away.

You can help monitor the effect of monster rain on a green roof by constructing a local miniature prototype. For the best results, you should continue measurements over a long period of time – months, or even years – if possible. You can register the flow and temperature online. Using information and communications technology (ICT) you can share your knowledge and ideas with others.

Use the Internet to find out and share:

- How much precipitation does your area get per year? Has the amount changed over the last, e.g. 50 years?
- Do you get severe storms and "monster rain" at certain times of the year? If so, when and how often in recent years?
- What happens to the rain that falls on the roof of your school or your home – where does it go?
- Are any measures taken in your local area to prevent damage from climate change such as floods? If so – what measures are taken?
- Are Sedum plants growing in your local area? In what kind of biotopes?

Student experiment: Absorption and flow

It is ideal if your school has a separate, rather flat roof with a single gutter and a single drainpipe that can be used for a large-scale, long term monitoring project. A flow meter can be used to measure the flow whenever it rains. Online registration of the data is possible. However, for the following measurements a small-scale model can be constructed and used for monitoring projects short-term and to compare with an "ordinary" roof.

To make your "green roof" model have a look at the additional material at www.science-on-stage.de.

Measure length and width of your wooden pallets ("roofs") and calculate the total area in m^2 of "roofs" 1 and 2. Note the results.

Weigh each of the "roof" pallets 1 and 2 in dry condition. Note the results. Use a litre measure and slowly add water (tap water) to "roof 1" until it cannot absorb any more water and starts dripping a little. Note how much water you added to roof 1.

Pour the same volume of water onto "roof 2" and collect the run-off water from each roof. How much water ran down the drain from "roof 1"?

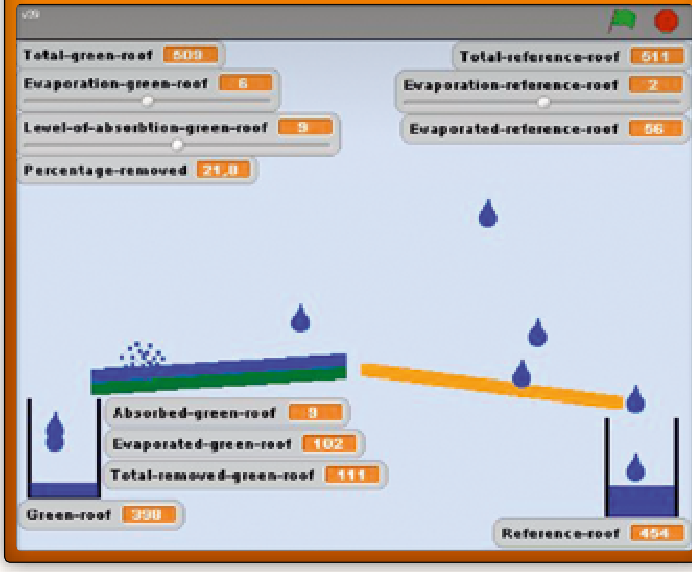
Note the volume of water that ran from both roofs. Repeat the monitoring daily, once a week, and if possible for a number of weeks.

Programming

A fun and easy way to predict the outcome of an experiment is to create your own simulation by using the simple and free drag-and-drop programming software called Scratch (see annex). A teacher's guide for this monster-rain project can be found at www.science-on-stage.de. The monster-rain project will teach students to make a small animation of their own, allowing them to see how programming can be used to describe and make calculations in a simple physical system. The source code is available at www.science-on-stage.de.

The model can then be improved and extended for advanced students permitting them to take into consideration more complex parameters. A model where you can change the absorption and evaporation has been developed at scratch.mit.edu/projects/agsmj/2352259.

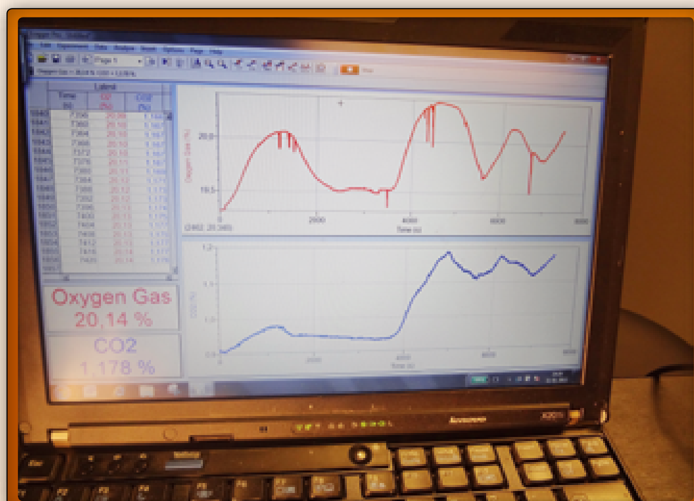
Simulation of monster rain with Scratch



On evaporation

Useful data can be obtained by studying the Sedum plants in a growth chamber connected to an oxygen electrode and a carbon-dioxide electrode. Other data such as temperature and humidity can be measured simultaneously in order to observe how the effect of a green roof will vary with seasonal and local climate.

Make sure the plants adapt to conditions in the growth chamber by placing them there 24 hours before running the measurements. Data and graphs of O_2 and CO_2 collected and created over a period of, e.g. 24 hours or longer, with and without additional light, provide excellent parameters for analysis and discussion. The students may discuss the effect of evaporation with Sedum plants as a



means for reducing the water from monster rain or delaying the water from running down the drain. Thus, they will find rather simple solutions to diminish problems caused by climate change and global warming.

Students of advanced biology may use the collected data and graphs to study the photosynthesis of Sedum plants: the CAM photosynthesis.

Discussion questions to summarise the key concepts

The students can use their observed data to discuss how much water can be absorbed or retained by a green roof and by a roof without vegetation. They might discuss what the differences measured between the covered and uncovered roofs show in terms of the Sedum plants' ability to retain or delay water. They can compare their data on evaporation and water absorption, taken from the real plant measurements, to the programmed simulation. Then they can discuss whether their programming models are realistic, or whether adjustments should be made. In accordance with their level of education, they might add other factors that influence the plants and the simulated model.

CONCLUSION

After carrying out both steps of programming and monitoring on live plants, the students will understand the effect of a green roof and the plants' ability to absorb water and delay run-off. They will find the animation fun and it will be inspiring for them to learn the programming code needed for explaining a physical model.

Share your work with others

To share achievements, the students can present their results in many ways: in articles, oral presentations, films, podcasts or posters. Constructing a scientific poster requires a layout that is pleasing to look at, easy to grasp without further introduction, and factual. It is not an easy job to tell others what was achieved and learnt with this method. Photos are useful in order to visualise your efforts. All of the methods mentioned can also serve as background material for a QR – quick response code. It's just a click and an app away on your Smartphone.

You can easily generate a QR code from the Internet – e.g. at qrcode.kaywa.com.

If you want to generate the code for a text you simply click "text" and "generate" – the bar code appears immediately. Remember to store the code. You can also click URL and thus get easy access to a Webpage containing the information you want to share with others.

Additional suggestions: www.science-on-stage.de