CZO | SOUTHERN SIERRA CRITICAL ZONE OBSERVATORY

SimWater *a resource management simulation*

Overview

Water managers are faced with complex systems of water storage, delivery, and use. This simulation encourages students to consider some of the decisions facing water managers. It also challenges students to think about the where and when water falls compared to where it is needed.

Objectives

By the end of this activity, students will be able to:

- Balance water inputs and water outputs
- Name water uses and describe the timing, amount and benefit of water needs for each of the uses
- Apply value to water uses
- Propose solutions that balance environmental regulations with other water needs

Subjects

Science

Grade Level

9-12, University

Length of Activity

60-80 min

Activity Location

Inside classroom

Materials

Print WaterSim exercises, maps and play pieces online.

Introduction

Water managers must weigh water supplies and demands and distribute water to supply water rights and the public good. SimWater demonstrates some of the main issues that challenge water managers. Students are asked to judge the benefits of agriculture, residential and other water uses, while meeting environmental regulations, and to justify their decisions for water distribution. Students will need to calculate incoming and outgoing water supplies.

California has a Mediterranean climate, which means that most precipitation falls during the cool, wet winters. Almost no precipitation falls during hot and dry summers. Water storage in the snowpack helps to supply California water needs through the dry summer. The large Central Valley lies between the Coast Ranges and the high Sierra Nevada peaks. Hot and sunny weather in the valley favors productive agriculture if it can be supplied with water.

A series of reservoirs, dams and canals supplies both hydroelectric power and water needs. State and local agencies make decisions on when and where to distribute water. Decisions must respect lawful water rights and environmental flows. In the west, laws grant water rights to users based on seniority and riparian (river or stream-adjacent) rights. Environmental flows refer to water that must remain in rivers for wildlife and ecosystem services. Students will not face the full complexity of the California water system in this activity, but can discuss it after.

Materials

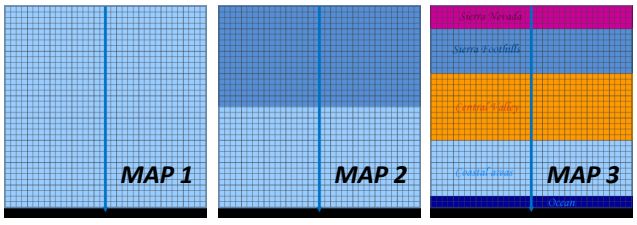
Printed copies of the SimWater Maps and Pieces file. Students may work individually, or in groups of 3-4. Play pieces representing different land types can be cut up or augmented by construction paper. The full exercise instructions and the maps and pieces, are available online at CriticalZone.org/Sierra/Education-Outreach/K-12-education-sierra.

Activity Description

Students use a series of three maps, which have different color blocks representing incoming precipitation. The maps get progressively more complicated, with more water falling in the “mountains” which are less useful for agriculture. Numbers for precipitation and water uses are included on the map boards and in the activity sheet.

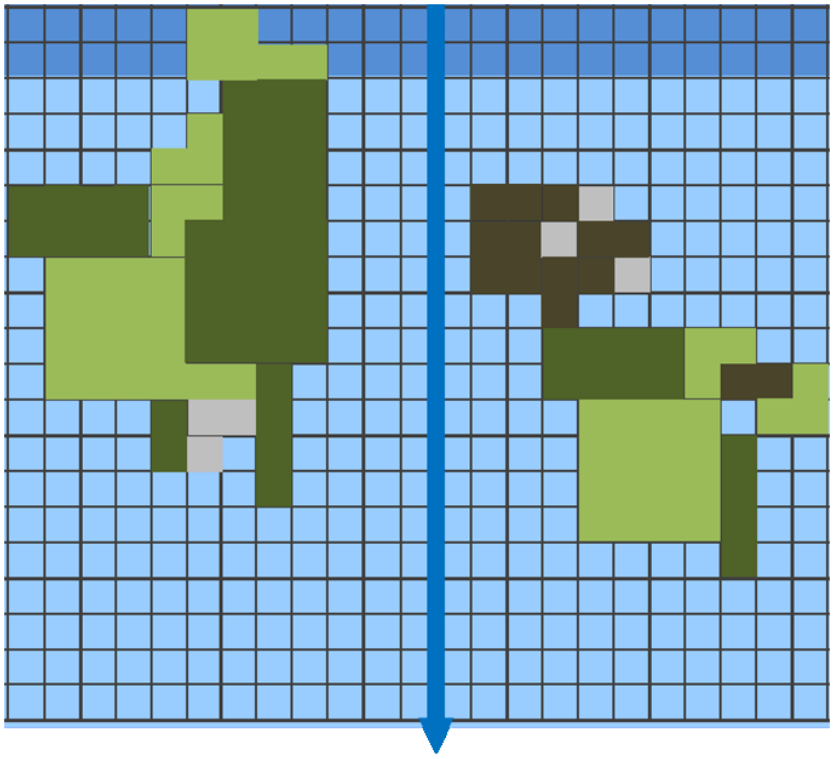
Students should cut out the pieces representing land uses. The pieces can be rearranged on the maps until all conditions are met for each exercise. Two types of agriculture have different water needs and productivity levels to add complexity. Regulations can be implemented to prevent development near streams or the ocean.

The three maps (right) act as boards for the exercises. Colors mark precipitation regimes, and water flows across the board to the river and then to the ocean.



Example

In this example, pieces representing different agriculture types (dark and light green), residential areas (brown) and commercial/industrial areas (gray) have been laid out on the board. The water use by this land allocation is laid out in the table below.



Type	Water use per m^2	Total blocks (1 block = 10,000 m^2)	Total water use (m^3)
Incoming	1 to 2 m yr^{-1}	506	5,060,000
Ag 1	0.5 m $year^{-1}$	52	260,000
Ag 2	1 m $year^{-1}$	54	540,000
Res	0.5 m $year^{-1}$	12	60,000
Com	1 m $year^{-1}$	8	80,000
Total			940,000
Net outflow (incoming - use)			4,120,000

Ag 1 feeds 6 people per block, for a total of 312 people. Though **Ag 2** uses more water, it feeds 10 people per block, for a total of 540 people. These **residential blocks** indicate 80 people each—a total of 960 people. This land allocation could not feed all of the people locally, but there is plenty of space to grow right now. It is not indicated how many people each commercial block employs, but it likely depends on what type of industry or commerce is in place there.

Assessment

- Have students write a short essay on what choices they made and why, including numbers for how many residential, agricultural and commercial blocks are supported.
- Have students tabulate their final numbers on the board. What were the trade-offs between different uses? Are there common patterns across all maps?
- Is it possible to produce surplus food? What is the maximum number of people?

Extensions

- Ask the students about what makes water "useful" (quality, quantity, production) - ultimately a judgment call linked to strong societal values and historical decisions
- What technologies would make the water more productive? Use the internet to explore technologies for water use efficiency or water movement.
- Explore the website of the California Department of Water Resources, and information on water use efficiency. How would drought affect the exercise? (Think about less incoming precipitation, and lower production, increased efficiency.)

Resources

- California Water Plan from the Department of Water Resources: waterplan.water.ca.gov
- Water use efficiency, incl. agriculture and urban water uses: water.ca.gov/wateruseefficiency
- Current drought updates: U.S. Drought Monitor;
- Water quality, especially for policies and laws: water.epa.gov
- Water rights process FAQ: waterboards.ca.gov/waterrights/board_info/faq.shtml

Next Generation Science Standards

HS-ESS2-2
HS-ESS3-1, HS-ESS3-4
ESS3-A, ESS3-C, ETS1-B