The Sinking Delta

Watch the segment online at http://education.savingthebay.org/the-sinking-delta
Watch the segment on DVD: Episode 3, 9:11–11:23
Video length: 2 minutes 30 seconds

SUBJECT/S

Science

History

GRADE LEVELS

6–8
9–12

CA CONTENT STANDARDS

Grade 6

Earth Sciences—Shaping Earth's Surface

2.b. Students know rivers and streams are dynamic systems that erode, transport sediment, change course, and flood their banks in natural and recurring patterns.

Grades 9–12

Chemistry—Conservation of Matter and Stoichiometry

3.g. Students know how to identify reactions that involve oxidation and reduction and how to balance oxidation-reduction reactions.

VIDEO OVERVIEW

Most of the Sacramento–San Joaquin Delta has been reclaimed for agricultural use, which has led to subsided land.

Massive flooding of the Sacramento River in the mid-1950s caused many levees in the Sacramento-San Joaquin Delta to fail. (Sacramento Archives and Museums Collections Center)

In this segment you'll learn:

- about the tidal freshwater marshes that used to exist in the Delta.
- how the construction of levees has altered the Delta.
- how reclamation of the marshes led to subsidence of the land.
- why subsided land makes levees prone to break.

TOPIC BACKGROUND

The San Francisco Bay watershed drains 40 percent of the state of California. Where the San Joaquin and Sacramento rivers meet to enter San Francisco Bay is the Sacramento–San Joaquin Delta. At one time the Delta was home to vibrant freshwater marshes with extensive tule stands, ponds, and tidal channels that were underlain by peat alluvium.

Transformation of the Sacramento–San Joaquin Delta began as early as the mid-1800s, but it was in the late 1800s that much of the Delta was reclaimed for agricultural use. By 1930, most of the 1,150 square miles of the Delta had been converted for agricultural use. To protect the 57 islands found in the Delta from flooding, more than 1,100 miles of levees had to be built.

Before agricultural development, the soil was oxygen-poor, and organic carbon accumulated faster than it could decompose. However, with drainage for agriculture, the soil was exposed to oxygen, which allows for the microbial oxidation of carbon. Most of the carbon is emitted as carbon dioxide gas into the atmosphere. The oxidation of carbon leads to subsidence, or sinking, such that much of the land ends up below sea level. This, in turn, results in the need to continually raise and reinforce the levees to withstand pressure from the tidal channels.

Subsidence threatens not only the levees, but also the quality of the Delta water, as levee failure can lead to increased saltwater intrusion. And with more than 20 million Californians relying in part on drinking water from the Delta, water quality is critical. The current state of the Delta islands and levee system is unstable.

VOCABULARY

accumulate
to collect or gather

basin
a depression in the earth's surface

delta
a usually triangular deposit of sediment at the mouth of a river or rivers

levee
an embankment to prevent flooding

microbe
a microorganism, usually associated with bacteria

oxidation
a chemical reaction in which a material gives up electrons

reclaim
to claim or demand the return of

subsidence
sinking below a normal level

tule
a marsh plant

watershed
the region drained by a river or stream

PRE-VIEWING ACTIVITIES

- Look at a map of San Francisco Bay and its watershed. Find the Delta on the map. A slideshow of the estuary can be found online at: http://www.sfestuary.org/sshow/phpslideshow.php?directory. Slide 4 is a watershed map.
- Discuss agriculture in California. Look at a map of California agricultural land use. What sort of agricultural use is found in the Delta? A map can be found online at: http://www.gic.csuchico.edu/pdf/CA_crop.pdf.

VIEWING ACTIVITY

- Watch the segment twice. Students write down at least five questions while they watch.

POST-VIEWING ACTIVITIES

- In small groups, students discuss the questions they wrote down while watching the segment. Students then research answers to the questions that were unable to be answered in small groups and present their findings to the class.
- Research restoration projects in the Delta. What can be done to address the problem of subsidence? Who is working on this issue?
- Debate the agricultural and water needs of the state versus the importance of the Delta as an ecosystem.
- Build a model of a Delta island demonstrating subsidence.
- Explore the chemistry of subsidence and draw a diagram explaining the oxidation of carbon.
- If possible, visit an agricultural area near your school. What is being grown? Who depends on the crops? How has the landscape been altered to accommodate agriculture?

ABOUT THE AUTHOR

Phaela Peck is a science teacher, environmental educator, and writer based in San Francisco. She has an M.A. in environmental education and has developed curricula for numerous science and environmental education organizations in the Bay Area.

KQED Education engages with community and educational organizations to broaden and deepen the impact of KQED media to effect positive change.

www.kqed.org/education

ADDITIONAL RESOURCES

California Foundation for Agriculture in the Classroom
http://www.cfaitc.org
Find lesson plans, contests, and other educational resources related to agriculture in California.

Delta Subsidence in California: The Sinking Heart of the State, U.S. Geological Survey
http://ca.water.usgs.gov/archive/reports/fs00500/fs00500.pdf
This article provides an in-depth explanation of subsidence in the Delta, complete with useful images and diagrams.

The Bay Institute
http://www.bay.org
The Bay Institute offers information on the Bay as well as watershed restoration and education programs.

CREDITS

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FILM ANNOUNCER: In this basin are the valleys of two rivers: in the north, the Sacramento, in the south, the valley of the San Joaquin.

NARRATOR: As the 20th century began, the watershed of San Francisco Bay—16 rivers draining into the massive Central Valley before converging at the delta formed by the Sacramento and San Joaquin rivers—was undergoing a radical transformation. It would ultimately reduce the amount of freshwater reaching San Francisco Bay by half.

JEFF MOUNT: In its historical time, when it was, when the upper parts of the estuary was all tidal freshwater marsh, it would have been this maze of channels with these spectacular, off as far you could see, these tule marshes—extraordinary tule marshes where these tules would all grow and die and be incorporated in what was then these organic soils, these phenomenal, organically rich soils.

When we reclaimed the Delta, that is, put up levees and drained all these marshes and started growing crops, we exposed those soils to oxygen. When they were low-oxygen soils, the organic breakdown was very slow. Once you expose them to oxygen, the organic breakdown is very, very fast. A new set of microbes moves in, and basically roughly half the organic material, which was accumulated over the last 5,000 years, went back into the atmosphere through oxidation.

NARRATOR: To compensate for subsidence, levees needed to grow higher as the land sank lower. Today, there are more than 1,100 miles of levees. Many fields are as much as 25 feet below sea level.

MOUNT: What you're doing in the process of subsiding these lands well below sea level is creating an unstable condition which wants to be transformed. And that transformation involves the breaking of those levees and the flooding of those islands, and the greater the subsidence, the greater the likelihood that will happen.