Global Warming and Water Educator Guide

A resource for using QUEST video, audio, blogs and maps in the classroom

QUEST SUBJECTS

Life Science
Biology
Health
Environment

Earth Science
Geology
Weather
Astronomy

Physical Science
Physics
Chemistry
Engineering

CA SCIENCE STANDARDS

Grade 5
Earth Sciences
3. (b, c, d) evaporation; condensation; limited quantities of freshwater

Grade 6
Focus on Earth Science
2. (b, d) rivers and streams as dynamic systems; natural disasters and their impacts

Grades 9-12
Ecology
6. (b) analyzing changes in an ecosystem resulting from changes in climate, population, human activity or introduction of nonnative species

Earth Sciences
Energy in the Earth System
6. (c) climate change over time

California Geology
9. (b, c) prinicipal natural hazards in different regions of California; water and society in California

QUEST MEDIA FOR TEACHING ABOUT GLOBAL WARMING AND WATER

Read and comment on the blogs for any of these stories by clicking on the story link and clicking on the blog post link below the video/audio.

Watch **Tracking Raindrops** http://www.kqed.org/quest/television/tracking-raindrops

- In one of the most comprehensive hydrology studies ever done, researchers from the University of California, Berkeley, are tracking individual raindrops to learn more about the water cycle and how global climate change is affecting our freshwater supply.

Listen to **Rising Seas** http://www.kqed.org/quest/radio/rising-seas

- With sea levels on the rise, scientists are predicting that California's coastal sea levels could rise by at least three feet by the end of the 21st century. Examine the impacts such a change would have on the San Francisco Bay and other low-lying coastal areas.

Listen to **Stormwatchers Predict Flooding**
http://www.kqed.org/quest/radio/stormwatchers-predict-flooding-

- What happens when a storm hits land? A team of scientists is conducting a high-tech study on the American River to see what they can learn about storms. They hope to apply this new information to flood-prone areas in the rest of the country.

TOPIC BACKGROUND

Widely accepted climate model projections show that Earth's temperature is on the rise and is likely to continue rising. In fact, estimates project that the average temperature on Earth's surface may increase by between 2°F and nearly 12°F by the end of this century. While it may not seem like a lot, this warming trend brings climate changes that impact rainfall patterns, create rising sea levels and may lead to myriad issues for wildlife, plants and, of course, humans.

Because of these temperature changes, the Intergovernmental Panel on Climate Change (IPCC) predicts that there will be an average global increase in annual precipitation throughout the 21st century, and that rainfall intensity will also increase, particularly in tropical and high-latitude areas. Other areas, like the U.S. Southwest, are expected to experience a decrease in precipitation. Tropical storms and hurricanes are also expected to increase in intensity and produce more precipitation in some areas, thanks to warmer surface temperatures in the seas. Additionally, of particular concern in coastal zones are the rising sea levels and changes in maritime storms and flooding related to global climate change.

Additional background resources:

EPA: Climate Change Effects on Water Resources
http://www.epa.gov/climatechange/effects/water/index.html

Global Warming FAQs from NOAA
http://lwf.ncdc.noaa.gov/oa/climate/globalwarming.html

Global Warming/Climate Change on MarineBio
http://marinebio.org/Oceans/Conservation/GlobalWarming.asp

VOCABULARY

Climate
temperature, precipitation, wind and other meteorological conditions that characteristically prevail in a given region

Global warming
climate change that causes an increase in the average temperature of Earth's lower atmosphere

Levee
a natural or manmade slope or wall used for flood protection

Sediment
fragmented rock material deposited by wind, water or glaciers

Watershed
an area of land that drains into a river, river system or particular body of water

Weather
state of the atmosphere in regards to temperature, moisture and humidity and visibility conditions

INTRO QUESTIONS

- What is global warming?
- How might climate change affect our water supplies and resources?
- Describe the water cycle.
- Why is water important?
- How do floods and storms affect our lives?

FOCUS QUESTIONS

- How have global sea levels changed over time? What do these changes mean for our planet?
- What have scientists learned by studying individual raindrops?
- What factors determine whether or not a flood will occur in a storm-prone area?
- How would a rise in sea level impact the San Francisco Bay Area?

For all media see:

- Segment Summary Student Sheet
  http://www.kqed.org/quest/downloads/QUEST_SegSum_StudentSheet.pdf
- Personal Response Student Sheet
  http://www.kqed.org/quest/downloads/QUEST_PersResp_StudentSheet.pdf

LESSON PLANS and RESOURCES from PBS, TEACHERS' DOMAIN and NPR

NOTE: Resources from the Teachers' Domain collection require a fast and free registration.

With Climate Change Comes Floods NPR
http://www.npr.org/templates/story/story.php?storyId=18022014
This story examines the threat climate change poses to our relationship with water.

Climate Connections: A Global Journey NPR
http://www.npr.org/news/specials/climate/interactive/
Use this interactive map to explore the warnings and effects of climate change around the world.

Global Climate Change: Understanding the Greenhouse Effect Teachers' Domain
http://www.teachersdomain.org/resource/ess05.sci.ess.watcyc.lp_global1/
An investigation of what global climate change is and how it affects our lives. (Lesson 1 of the Global Climate Change series from Teachers' Domain)

Global Climate Change: The Effects of Global Warming Teachers' Domain
http://www.teachersdomain.org/resource/ess05.sci.ess.watcyc.lp_global2/
This lesson on Global Climate Change explores the effects of climate change on the environment, as well as human factors contributing to global warming. (Lesson 2 of the Global Climate Change series from Teachers' Domain)

Mountain of Ice: If the Ice Melts Teachers' Domain
http://www.teachersdomain.org/resource/ess05.sci.ess.watcyc.icemelt/
This interactive feature adapted from **NOVA Online** shows what might happen to the Earth's low-lying coastal areas if large segments of the Antarctic Ice Sheet were to melt.

Climate Change and California's Water KQED: The California Report
http://www.californiareport.org/climatechangewater.jsp
This Web feature on KQED's statewide radio news program includes seven radio segments examining the implications of global climate change on California and its resources.

VISIT OUR PARTNERS

The Bay Institute
www.bay.org

California Academy of Sciences
www.calacademy.org

Chabot Space and Science Center
www.chabotspace.org

East Bay Regional Park District
www.ebparks.org

Exploratorium
www.exploratorium.edu

Girl Scouts of Northern California
www.girlscoutsbayarea.org

Golden Gate National Parks Conservancy
www.parksconservancy.org

The J. David Gladstone Institutes
www.gladstone.ucsf.edu

Lawrence Berkeley National Laboratory
www.lbl.gov

Lawrence Hall of Science
www.lawrencehallofscience.org

Monterey Bay Aquarium
www.mbayaq.org

Monterey Bay Aquarium Research Institute
www.mbari.org

Oakland Zoo
www.oaklandzoo.org

The Tech Museum of Innovation
www.thetech.org

UC Berkeley Natural History Museums
http://bnhm.berkeley.edu/

U.S. Geological Survey
www.usgs.gov

MORE EDUCATIONAL RESOURCES FOR USING QUEST MULTIMEDIA TO ENHANCE 21st-CENTURY SKILLS IN TEACHING AND LEARNING

Why Use Media in Science Education?
www.kqed.org/quest/downloads/QUEST_Why_Media_08-09.pdf

- As science educators, we know how important critical thinking and new technology skills are in the scientific community…read more

Science Multimedia Analysis
www.kqed.org/quest/downloads/QUEST_Science_Multimedia_Analysis_08-09.pdf

- By increasing students' awareness of the intersections between media and science, we give them the tools to think like scientists…read more

How to Use Science Media for Teaching and Learning
http://www.kqed.org/quest/downloads/QUEST_Media_Tips_08-09.pdf

- If we consider all forms of media "texts" from which students gather information, we can use similar literacy strategies to engage them in video, audio, blogs, and Explorations. Once students have obtained information from multiple media sources, how to they share what they have learned? Through their own media creation projects, of course!

Using Google Maps to Create Explorations
http://www.kqed.org/quest/files/download/52/QUEST_ExplorationCreation.pdf

- Like the science hike Explorations on the QUEST site? Use this place-based educational guide for educators and group leaders to create similar science-based maps with youth.

OTHER WAYS TO PARTICIPATE IN QUEST

LOG ON

www.kqed.org/quest

LISTEN

KQED 88.5 FM San Francisco &
89.3 FM Sacramento
Mondays at 6:30am and 8:30am

WATCH

KQED Channel 9
Tuesdays at 7:30pm

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NOTES/QUESTIONS

To really grasp what will be happening inside the Bay, you have to go outside the Golden Gate. Just down the coast in Santa Cruz, geologist Eric Grossman is pointing out some of the hallmarks of a rising Pacific.

GROSSMAN: You can see the rocky revetment that's been placed there to try to protect this bluff. And essentially what's happening is sea level and large wave events that happen annually are carving into the base of that.

Grossman keeps an eye on the ocean for the US Geological Survey. He says the latest data from tide gauges and satellites show the global sea level rising more than an inch every six years or so. But the rate is accelerating and most scientists now concede that the rise here in California could be more like an inch every two years.

GROSSMAN: It doesn't sound like a lot but when you look around the coasts, low-lying sandy beaches, low-lying coastal plains, San Francisco Bay, a small incremental rise in sea level, vertically, can translate into tens of meters, hundreds of meters of lateral inundation.

Much of what you see around San Francisco Bay—including both major airports--is sitting on bay-fill; places that used to be under water.

Current climate models show that a sea-level rise of just one foot would mean what we now consider a "100-year" flood event would happen, on average, every 10 years.

Since the Gold Rush, a chunk of Bay about five times the size of San Francisco has been filled in for development. Scientists are in general agreement that gradually, the sea will try to reclaim this land.

…which brings us to the foot of California Street in downtown San Francisco.

TRAVIS: Where we are sitting now used to be Yerba Buena Cove. The building we're in right now is actually on top of a ship wreck.

Will Travis runs the state agency charged with managing reclaimed baylands; the Bay Conservation & Development Commission.

He says that within a few decades, the office tower in which we're sitting, at 50 California Street, would once again be awash. In fact, $100 billion of shoreline development presently sits on threatened land.

TRAVIS: The challenge that we face here is we have to build levees that are tall enough and strong enough to withstand rising seas and storm surges and they have to be able to do it during an earthquake.

Yes, he said levees--around the Bay. But we also have a kind of natural flood protection; the remaining tidal marshlands around the Bay and up the Sacramento Delta.

TRAVIS: Tidal wetlands are about as close as you can get to magic. They're huge sponges that absorb flood water—and tidal wetlands actually sequester carbon; they take it out of the atmosphere. So they both adapt to climate change and they mitigate climate change.

But the wetlands, too, are in danger.

In a tidal marsh on the Carquinez Strait, two researchers from UC Berkeley are taking core samples of sediments that lie beneath the spongy cover of sedges and pickleweed.

The hollow metal tube they're pushing into the muck will extract a cross-section of sediment layers under the marsh.

The core samples are packed with pollens, varying salt content and other clues to what happens here when the climate changes.

Climatologist Frances Malamud-Raum.

MALAMUD-RAUM: These records from the marshes tell us, one, just how variable climate can be and two, they tell us just how resilient these environments can be.

Marsh cores and other records show that the past hundred years or so have been an unusually stable time for weather and climate. Paleological studies such as this one show horrific floods and a 200-year drought, within the past few thousand years.

As sea levels rise, tidal marshes become more important as buffers.

MALAMUD-RAUM: You can imagine that water surging up along this shoreline, well if it hits that bunch of tall bulrushes you see over there and goes along the pickleweed, it's gonna slow down that water.

Though places like this can protect development from flooding, they can't do the job if they're not protected…from development.

Will Travis.

TRAVIS: As the water levels rise, the wetlands will simply rise to and they will move landward. But if they're boxed in by levees and seawalls protecting development, there's no place for them to go.

More than 150 years of development has already claimed 80% of the Bay's tidal marshes.

TRAVIS: We can no longer think about restoring the Bay to the way it was or protecting it the way it is. We have to design it for the way it will be in the future.

There are 26 cities and nine counties that front directly on the Bay. They'll have to be corralled with state and federal agencies, environmental and community groups, and somehow come up with a plan for all of this—and pay for it.

And they're going to have to start very soon.

For Quest, I'm Craig Miller, KQED Radio News.

NOTES/QUESTIONS

From KQED Radio News, I'm Andrea Kissack, and this is QUEST, a new series exploring Northern California's science and environment. We've had a dry winter in California. One group who could really use some rain is a team of scientists trying to unlock the secrets of how storms work. What they find out has critical implications for people living in flood-prone areas like Sacramento, where information is the best defense. Amy Standen reports.

Nothing gets a meteorologist fired up quite like a good storm. On this particular day, driving east out of Sacramento, it's raining. For Timothy Schneider, a scientist with the National Oceanic and Atmospheric Administration, or NOAA, that's big news.

SCHNEIDER: The weather affects humanity at its most base level every single day.

In his tweed hat and red sweater, Schneider is every bit the friendly, mild-mannered Midwesterner. These days he lives in Colorado, but he misses the dramatic weather he grew up in.

SCHNEIDER: I think every school kid in Minnesota is always looking for that great and wondrous thing called a snow day where school is cancelled because the weather is severe or hiding in the basement when tornado warnings are issued. When something affects you, your curiosity is drawn to it and maybe that's how a meteorologist is made.

Schneider's job is to try and understand one of the most complicated natural systems on earth: storms and what happens when they hit land. He and his team are using the American River as a test case, to see what they can learn, and then apply that knowledge to other parts of the country. This week, during a late winter rain, he's been called out to Sacramento to experience the weather firsthand.

SCHNEIDER: So I think this is where we want to stop…

We pull over about 35 miles east of Sacramento.

SCHNEIDER: OK, well we're standing alongside the north fork of the American River, one of three forks in the American River basin.

The water level is low here, but looks can be deceiving.

SCHNEIDER: And there's also a sign here that says warning cold water and strong currents. River level changes quickly. Stay out, stay alive.

Say the word "flooding" and it's New Orleans that often comes to mind. But Sacramento's flood risk is at least as high. The city sits at a confluence of two major rivers, the Sacramento and the American. Much of its population lives in low-lying areas, kept dry during floods by a patchwork of levees, some more than a century old. The lives and property of almost a million people could feel the effects of what happens on the river here.

SCHNEIDER: As the river flows downstream from here near Auburn, it's collected in Folsom Dam, and it's stored.

NOTES/QUESTIONS

There's not a lot of extra room in Folsom Reservoir, so when the river swells, dam operators face some tough choices. Should they retain the water to be released later in the summer to farmers and other users? Or, should they keep the dam's spillways open, to make room for more water if the storm continues? If they release too much and no more rain comes, farms and cities could go dry and fish could suffer. If they don't release enough and a deluge sets in, the dam could overflow, spelling disaster downstream. Without accurate weather forecasting, it's a high-stakes gamble. And that's where Schneider and his team, armed with increasingly high-tech gadgetry, come in.

SCHNEIDER: We're at Alta, California and this site here at Alta is a California Department of Forestry site. They've got a little space out back and they've let us set up some of our instrumentation.

It's pouring up in the Sierra foothills, about 50 miles east of Sacramento, and our little black umbrellas aren't much help. But Schneider is undeterred. From a distance, all this weather monitoring equipment looks like dilapidated household appliances at a yard sale. But every item here supplies a critical piece of information. Schneider points to what looks like a pair of camcorders perched atop a ten foot pole.

SCHNEIDER: This instrument on the pole there is the optical disdrometer. And what it's doing is it's using light and lasers to measure the size of the droplets that fall. So there's a little transmitter on one side and a little detector on the other and when the rain falls between them it can actually image the droplets, so we can count how many droplets there are and see how big they are.

Whether this area floods depends on what seems like an infinite number of factors. Not just how much rain, but how cold is it? Is it falling on bare rock? Into a creek? Onto Dirt? How saturated is the ground? Schneider says one of the most important measurements comes from a network of wires running beneath our feet, which uses electrical conductivity to detect moisture in the soil.

SCHNEIDER: You can imagine if we get a lot of rain and the ground is dry, for awhile the ground is just going to soak it up and it's not going to run down into the stream,. But like the rain that's just beginning now, it began maybe about an hour ago and the ground is already wet, and more of this water is going to run down into the streams.

All in all, a staggering amount of data is uploaded to the internet where meteorologists can monitor it around the clock. But, back in the car, Schneider says they'll never completely understand the weather.

SCHNEIDER: We'd have to accurately sample every inch of the globe to be able to do a perfectly accurate prediction. So we'll never have perfection, but we will always be able to strive and do better.

Even an imperfect model can go a long way toward protecting people in flood-prone areas. By understanding just what kind of impact storms are likely to have, dam operators and city officials can improve their odds of helping California weather even the most dangerous downpours. For Quest, this is Amy Standen, KQED Radio News.