**Toolkit for Educators:**

**Climate Change, Rivers and Dams – A Video Exploration**

This toolkit includes a lesson plan that features a 20-minute video called “Wrong Climate for Damming Rivers,” which uses Google Earth to visualize what might happen to the world’s major rivers when climate change and the current dam-building boom collide. Students will be encouraged to think critically about the role of dam-building in a changing global environment from a systems-level prospective, at times taking on the role of different stakeholders to understand the complexity of the problem. This toolkit includes the video, extension ideas, and links to additional resources.



**Contact:**

This toolkit was produced by International Rivers ([www.internationalrivers.org](http://www.internationalrivers.org)). We welcome your feedback. We would particularly like to hear about how this lesson plan was implemented in your classroom, your evaluation of its content, and how your students went beyond this lesson to explore local and/or global issues around rivers, dams and climate change.

Please send us your feedback or share your experiences with us by contacting Katy Yan, katy@internationalrivers.org, +1 510 848 1155.

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**Target Audience:**

This lesson plan can be adapted for a range of students and adults, starting from the ages of 12 and up. This is equivalent to US/Canada: Grades 6 and up; International: Year 7 and up. Some background in basic geography, biology, the hydrologic cycle, climate change science, and chemistry is required.

# Learning Goals for this Activity:

* *Analyze the environmental, social, political, and economic impacts of dam building, the potential costs and benefits, and the different values various stakeholders attach to these costs and benefits.* This activity is aimed at practicing critical thinking and interdisciplinary skills to problem solving. Through the extensions, students learn that there is often not a right or wrong answer, and that decisions are often made depending on the different values that various stakeholders hold.
* *Clearly describe the challenges that climate change brings to dam building.* These include: (1) the increased drought and flooding, and thus the increased risks to dam safety and cost-effectiveness; (2) the increased importance that healthy rivers can play for climate adaptation; and (3) dams and reservoirs in tropical countries are significant sources of greenhouse gas emissions.
* *Use the video to understand the different impacts of climate change and dams on in three specific regions.* These include the following dam building hotspots: Sub-Saharan Africa, the Himalayas, and the Brazilian Amazon.

# Activity Materials:

* Personal familiarity with the topics and issues in order to guide students.
* The video, “Wrong Climate for Damming Rivers” either as a DVD or online: <http://www.internationalrivers.org/node/4343>. To receive a DVD copy of the video, email Katy (katy@internationalrivers.org) with your name and mailing address.
* Projector and laptop with internet and power source.
* Optional – Google Earth and the “Wrong Climate for Damming Rivers” Google Earth KML installed on classroom and/or home computers for further exploration:
	+ Install Google Earth: <http://www.google.com/intl/en/earth/download/ge/agree.html>
	+ Download the Google Earth Tour (Courtesy of the Internet Archive): <http://ia700807.us.archive.org/0/items/WrongClimateForDammingRivers/Wrong_Climate_for_Damming_Rivers_rc1.kmz>
* Optional – Climate Change, Rivers and Dams infographic and slides.
* Optional – Role-playing cards for Extension #2.

# Activity Set Up:

1. A review of the following topics prior to this lesson is recommended. The exact choice of topics should be based on students’ age and the teacher’s assessment.
	1. Sustainability (How do you define sustainable development?)
	2. Basic concepts of electricity (What is the difference between kW and kWh? What is capacity? What is a “large” dam from a capacity point of view?)
	3. Different sources of electricity (coal, natural gas, nuclear, oil, wind, solar, geothermal, wave and tidal, etc.). Students should have a basic understanding of greenhouse gas emissions from fossil fuel use.
	4. Climate science and greenhouse gases: clarify that there are many different kinds of greenhouse gases, which remain in the atmosphere for different time periods and which have different global warming capacities.
2. Give students a homework assignment to prepare them for the topic and make them curious. Possible tasks:
	1. Ask students to write down the different uses people have for rivers, what animals and plants depend on rivers, and/or a personal visit to a river.
	2. Ask students to watch the video beforehand and come to class with a list of three questions.

# Outline of Activity:

*Total recommended in-class time: 50 minutes.*

1. Before the lesson, set up laptop and projector. Load DVD or website with video.
2. Climate Change and Dams
*Time length: 15 min*
	1. Start the lesson by asking, “Who can tell me where our electricity comes from?” [For instance, in California, in 2010 PG&E got about 20% from natural gas, 24% from nuclear, 16% from hydro and 16% from other renewables.]
	2. Have students brainstorm the benefits rivers provide to people. Ask them, “What happens when you put a dam in a river?” Draw or show a slide of a dam. Collect answers for upstream impacts (changes to water quality, accumulation of sediments, flooded land, relocation) and downstream impacts (less water, fewer migratory fish, fewer nutrients reach fields and farms because sediments are held behind the dam).
	3. Describe what dams are used for and other impacts. Some facts to share (consider asking students to guess at some of the figures below):
		1. Dams can provide electricity, flood control, water supply, and navigation. But their environmental and social costs are often overlooked and not taken into account when developers conduct a cost-benefit analysis.
		2. There are over 54,000 large (i.e. >10MW) dams around the world, mostly in the U.S., China and India. Large dams have affected more than 60% of our rivers, including some of the biggest rivers in the world, such as the Mekong, the Nile, the Mississippi, etc.
		3. Dams have displaced 40-80 million people upstream (about the size of Germany’s population) and affected up to 500 million more downstream (which is more than the number of people living in the U.S.). Resettlement can lead to social disruption, conflict with new host communities, and poverty due to the loss of traditional livelihoods.
		4. A third of freshwater species are threatened or extinct due to water pollution, dams and diversions, and overfishing.
	4. Discuss the use of dams for hydropower, and how it is being used to replace coal and other fossil fuel projects because of climate change. Explain that there is currently a major dam-building boom worldwide in Africa, Southeast Asia, and Latin America.
	5. Discuss the impacts of climate change. Ask, “What is expected to happen to water availability as global temperatures warm?” [For instance, worse droughts and floods, less predictable water flows in rivers, more frequent storms and hurricanes, etc.] “How will this impact hydropower operation?” Some issues you might raise:
		1. Dams need predictable water flow and rainfall to be efficient and provide a steady flow for electricity generation. Without this, dams not only become less efficient but also less economical.
		2. Safety concerns with overflowing dams.
	6. Set up the video and tell students, “We’re going to watch a video that tells a cautionary tale about what could happen and has happened in some places when climate change and the dam building boom collide.”
	7. Put on the board the following questions for students to think about. Tell students, “These are questions that decision makers, companies, banks, and environmental and social organizations are grappling with every day.” Questions posted on the board:
		1. Would you consider large dams “sustainable development”? What makes a project truly sustainable?
		2. How should we weigh the importance of competing needs for a river?
		3. How else can we get electricity in ways that help us reduce carbon dioxide emissions and address climate change?
3. Google Earth Video and Discussion
*Time length: 12 min video, 18 min discussion*
	1. *Optional.* Pass out note cards for students to jot down any questions they might have during the video.
	2. Start the video, dim the lights, make sure sound is working.
	3. Discussion after the video:
		1. Ask students to share their questions from their cards. Encourage other students in the class to answer their classmates’ questions.
		2. Ask “What was one interesting thing that you learned from the video?” If students are not shouting out terms such as Reservoir Emissions, Glacial Lake Outburst Floods, Droughts and Electricity, Dam Safety, etc., throw out a few and ask if they remember that topic.
		3. Ask “What was confusing or unclear to you, or what did you want more information about?” Jot down topics for elaboration later.
4. Elaboration on Key Issues
*Time length: 5 min*
	1. Go through the list of questions for clarification and explain some of the issues in further detail.
	2. Time permitting, summarize the issues raised in the video:
		1. River flows are becoming harder to predict due to climate change. More frequent droughts will make many hydropower projects too expensive. More extreme rainfall will increase the risk of dam breaks, which could lead to massive floods.
		2. Big dams make it harder for people and ecosystems downstream of dams to adapt to climate change by reducing water quality and quantity, drying up forests and wetlands, flooding productive land, and destroying fisheries.
		3. Dam reservoirs can be sources of carbon emissions that make climate change worse. Dam reservoirs are a major source of one of the most powerful greenhouse gases, methane, which is a more potent global warming forcer than carbon dioxide.
		4. There are some exciting advances in water and energy solutions that offer alternatives to large hydropower dams.
	3. Students can find more information, take action, watch this video again, or download Google Earth to explore on their own at: <http://www.internationalrivers.org/campaigns/wrong-climate-for-damming-rivers>

# Possible Extensions: (With additional time, what could students accomplish? What sorts of experiential, place-based exercises or homework could you assign the students?)

1. Local Watershed/Energy Distribution
*Suggested time length: 45 min (works well as a homework assignment)*
	1. Ask each student or a small group of students to investigate online either:
		1. Where their electricity comes from and how it’s distributed; or
		2. Where their water is stored and how it’s distributed.
	2. For electricity:
		1. Draw a map of their state or province’s electricity grid and energy sources.
		2. Label the map with the main competing users of the electricity.
	3. For water:
		1. Draw a map of their state or province’s water distribution system and sources of water.
		2. Label the map with the competing water consumers.
	4. Climate Change: for both scenarios, ask students to consider how climate change might impact (or has already impacted) their energy or water supply. This could be done as a short essay assignment to accompany their maps.
2. Stakeholder Role Play
*Suggested time length: 45 min*

A number of variations can be done on this exercise, including a scenario where stakeholders must decide whether or not to proceed with a large hydropower project. For case studies on four major dams, see: <http://www.internationalrivers.org/node/2104>.

* 1. Introduce the scene: Four Klamath dams in California – Iron Gate, Copco 1, Copco 2 and J.C. Boyle – have blocked salmon migration for a century along the California-Oregon border and have been blamed for much of the historic decline of Chinook and Coho salmon and steelhead trout in the Klamath River Basin. The state is trying to decide whether to decommission the dams. Make sure that students have a basic understanding of salmons’ life-cycle, and bring a map of the basin to class so students can get a better understanding of the distribution of cities and water users.
	2. Introduce the players: A special commission has been established composed of farmers, recreational river fishermen, the hydroelectric company and dam owner (PacifiCorp), Native American tribes, and state assemblymembers. Divide the group into groups of 4-5. Print out and distribute descriptions (see page 9) for each stakeholder role that lists why this particular stakeholder would be for or against decommissioning the dams. Assign or have students pick a role and think about why they would support or oppose the dams.
	3. Give the students 15-20 minutes to discuss and negotiate whether they would decommission the dams or propose an alternative solution. Make sure to remind students that there is no right or wrong answer, but to focus on the decision-making process, and ensuring that all voices are heard and needs are considered.
		1. Some potential benefits of the dams: drinking water storage, irrigation of crops, hydroelectricity production, flood control, expensive to decommission and restore the river.
		2. Some potential drawbacks of the dams (in other words, the benefits to decommissioning): block fish passage, costly to maintain, restrict fish migrations, displaced people and cultural disruption (e.g., flooded burial grounds), sediment buildup, etc.
	4. Have each group report back on their discussions and what they finally decided to do.
	5. Give an update on the Klamath: An agreement was reached in 2009 after a decade of negotiations among 28 parties, including Native American tribes, farmers, fishermen and the company that operates the dams and distributes the water. If the dams were decommissioned, this would be the world's biggest dam-removal project. The final decision now rests with Congress, which is expected to vote on the issue in 2012. [For more info, see: <http://www.oregonbusiness.com/articles/105-november-2011/6057-klamath-dam-removal-uncertain> and <http://www.times-standard.com/localnews/ci_18951905>]

*Stakeholder Role Play cards:*

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| --- |
| *The Farmer*You own a small tract of land that is irrigated by the reservoir created by these dams. If the dams are removed, the amount of water available for your farms will decrease and be more expensive. Some of this water would go to wildlife refuges. If not enough water is available, you would receive federal aid. You would receive some money for water conservation technologies. You are in general against dam removal. |
| *The Recreational River Fisherman*If the dams are removed, you and other recreational river fishermen and recreationists would be able to enjoy more sport fishing and river sports such as rafting and kayaking in a more natural and wild setting. Recreational river fisheries are expected to increase by 9 percent. However, you face opposition from commercial lake fishermen and boaters. You are in general for dam removal. |
| *The PacifiCorp Representative*All four dams would have to be removed by 2020. Your company would have to pay for the cost of dam removal, but those costs would likely be passed on to Oregon’s taxpayers. Your company would lose revenue from not being able to generate and sell electricity. However, you would no longer bear the costs of maintaining the dams if they were removed. You are in general against dam removal. |
| *The Yurok Tribal Member*Your tribe, along with the Karuk and Klamath, has lived along the banks of the Klamath River for centuries. The river’s resources that have sustained your tribe were taken from you as new economies and communities began depending on the river, including agriculture and commercial fishing. Members of your tribe still harvest salmon from the river for cultural and subsistence purposes, family farmers and ranchers use the river for irrigation, and coastal commercial fishing families depend on Klamath salmon to earn their living. You are in general in favor of dam removal. |
| *The State Congressperson*The hydropower projects represent cheap and abundant electricity. In a time of sky-rocketing energy prices, you do not want to impose an additional burden on those who elected you into office. However, your electorate also includes the various other stakeholders that are in favor of dam removal, including commercial fishermen. According to the dam removal project’s environmental impact report, if the dams are removed, Chinook ocean commercial and sports harvest would increase by nearly 47 percent, while tribal harvest would increase by nearly 55 percent.  |
| *The River Advocate*You work for a non-profit river advocacy organization. You are concerned about the continued impact of the dams on salmon runs. Your group points to the latest environmental impact report, which states that through the removal and subsequent restoration work, water quality will improve, Chinook populations would increase, and jobs would be created, ultimately benefiting the Klamath community as a whole. You are in favor of dam removal.  |
| *The Lake Property Owner*You own a lake house and are unsure whether your property would be inundated. If not, you will at least lose your lakeside view, in which case, your property value would decrease. This also means a loss of property taxes for the county. You and other property owners would not be able to enjoy recreational activities on the lake like lake fishing and jet-skiing. You are against dam removal. |

1. Group Exercise
*Suggested time length: 45 min*
	1. Divide students into groups of 3-4 and give each of them a region to explore: the Amazon, the Himalayas, and Sub-Saharan Africa.
	2. Let each group explore one proposed or existing dam project within each region (current projects can be found by searching www.internationalrivers.org):
		1. Ask students to list the major issues that their region is dealing with when it comes to dams, water and climate change.
		2. Ask them to think about what they would do if they were a decision-maker and had to decide whether to build this dam or some other energy project for electricity generation. List the pros and cons.
		3. Ask each group to report back to the class what they learned and their final decision. Ask the class whether they would agree with the decision.

# Student Products for Assessment:

If Exercise 1 is chosen, students would turn in a map and short essay. If Exercise 2 or 3 is chosen, students could be evaluated on their class presentation and/or a short policy memo on their final recommendation and justifications.

# Other Resources

* Additional factsheets and reports on specific issues like reservoir emissions, dams in Africa, Brazil, and the Himalayas, etc. A range of publications and guides can be found here: <http://www.internationalrivers.org/en/publications>
* The Nature Conservancy, Heartbeat of a River online infographic: <http://www.nature.org/ourinitiatives/habitats/riverslakes/explore/rivers-and-lakes-the-heartbeat-of-a-river.xml>
* American Rivers, 10 Ways Dams Damage Rivers: <http://www.americanrivers.org/our-work/restoring-rivers/dams/background/10-ways.html>
* Further lesson plans on water, rivers and dams: <http://www.internationalrivers.org/en/node/3750>

# Connection to National and International Curriculum Standards:

* US/Canada: Fits within the Environmental Science AP sections on renewable energy. Fits within Grade 6: Strand 5 (Physical Science) – Concept 3 (Transfer of Energy). Fits within Grade 7: Strand 3 (Science in Personal and Social Perspectives) – Concept 1 (Changes in Environments).
	+ Meets California’s Education and the Environment Initiative (EEI) Curriculum:
		- Sixth Grade Science on benefits of dynamic rivers and renewable energy resources, and Sixth Grade History/Social Science on early river-based civilizations.
		- Eighth Grade History/Social Science on western water rights.
		- Twelfth Grade Economics on scarce resources, and Twelfth Grade History/Social Science on democracy and rights.
* Europe: In all countries of the European Union, environmental education is provided as a compulsory subject, as part of a compulsory subject area (normally science), or as an interdisciplinary theme in primary education.
	+ Lower Secondary Education, ages 10-15 (varies by country): Environmental Science is at times taught as its own subject, but is more often embedded into other subjects. This lesson fits in courses on Geography, Natural Sciences, and Technology.
	+ Upper Secondary Education, ages 15-18 (varies by country): This lesson could fit into a number of specialized subjects on environmental science, earth science, environmental politics and economics, and resource management.
* India: This lesson could fit within Science and Geography in primary and secondary school, and within a number of specialized subjects within the Natural Sciences or Social Sciences in higher education. The National Policy on Education (NPE), 1986, has provided for environment awareness in secondary school.
* Brazil: This lesson could fit within Geography in Ensino Fundamental II, the exploration of sustainable development in secondary school, and within a number of specialized subjects within the Natural Sciences or Social Sciences in higher education.

# Relation to Learning Cycle or Inquiry Process:

This is an *authentic* experience, with a current, real-world issue.

We hope to *engage* students by relating the topic to ideas and experiences that they’re familiar with. The Google Earth video is also meant to *engage* students on a visual and technological level, as a dramatic and innovative way of showing global changes and issues.

The *exploration* process happens in the initial discussion as the issue is framed and diagrammed. It is continued through the video and with the group exercise and extensions.

There are opportunities for *explanation* during the initial introduction, the discussion, and then the period of elaboration after the video. Some of the explaining should also be done elsewhere in the course (in the lectures and learning of content material).

This activity is aimed at allowing students to *apply* critical thinking skills to real-world problems.