Water Classroom 3-4 (version 2)

Water and Energy

Teaching plan for learning on water for middle school students

Under a project initiated by the Living Waters Museum, Centre for Water Research, IISER Pune and Research and supported by Transforming Education for Sustainable Futures, IIHS, Bangalore

3-4-1 Proposed plan

Lesson Plan number	WC-3-4
Topic	**Water and Energy**
Discipline	Physics, technology, social studies
Time	125 to 160 minutes (can be divided into multiple sessions)
Prior learning	Energy, atoms, molecules, water molecule Module 1 topic-1-1 that looks at scientific aspects of water. Module 2, topic WC-2-1 that talks about values concerning water and their implications in development and topics WC-2-2 & WC-2-3 that talk about structural inequalities in access to water
Learning objectives	● Students will *be introduced to* different ways by which water is used to generate electricity ● Students will *recognize* how different scientific models can *demonstrate* how electricity is produced ● Students will *be introduced to* the uses, and challenges/ harmful aspects of big dams

Learning outcomes	• Students are able to *describe* different ways by which water can be used to generate electricity • Students can *synthesize* an action plan based on the uses, and challenges/ harmful aspects of big dams based on what they have learned • Students are able to *justify* their action plan in relation to the Sustainable Development Goals
Resources/materials	Whiteboard, marker pens, powerpoint slides, projector, sound system, YouTube/movieplayer Prepare the scientific models prior to the session. Long rope for additional activity-II
Use of teaching time	**2-3 mins** Educator/facilitator will introduce the topic to the students and mention that we will look at how water is used to produce energy from both science and social studies perspectives. **5-7 mins** Educator/facilitator will open the discussion on how we use water in power generation through some of the following (not limited to) prompts: 1. What are some sources of electricity? 2. What is the science behind power generation? 3 What are some different places in the city where electricity is used? 4. What are some different things that electricity is used for? 5. How is water used in the generation of power?

	Optional - As students speak up, the educator/facilitator may use their answers to draw a concept map on a white/blackboard and map the existing collective knowledge of the class. OR **30 mins** Educator/facilitator may ask students to enact a role play where they explore a 'need' scenario vs a 'want' scenario for electricity consumption (conduct WC-3-4-Additional Activity-I) **15-20 min** Educator/facilitator will use scientific working models to simulate how power is generated by a moving magnet. Following this they will simulate a discussion on how this happens in a hydroelectric power plant that uses water to rotate the turbines. *Refer to – Background content for educator/facilitator – section 3-4-2a.* **5-10 min** Educator will discuss other ways of power generation that involve water - 1. Micro Hydro power plants 2. Wave energy 3. Fuel cells

	Refer to – Background content for educator/facilitator – section 3-4-2b. **5-10 mins** Educator/facilitator will conduct WC-3-4-Activity-I wherein students will recall and illustrate how water can be used in generating power. **10-20 mins** Facilitator/educator will show students the following movie by Minket Lepcha that brings forward the voices of many stakeholders and how big dams affect their lives. https://youtu.be/SoS1m-YytIQ Facilitator/educator may begin showing the movie at 8 min and show till 17.5 min or may show the entire movie if time permits. *Refer to – Background content for educator/facilitator – section 3-4-2c-d.* **7-10 mins** Facilitator/educator will discuss the uses and challenges associated with large dams for (indigenous) people and the environment. Facilitator will explain the terms downstream, upstream and stakeholder. *Refer to – Background content for educator/facilitator – section 3-4-2c.*

	3-5 mins Facilitator/educator will introduce students to United Nations' Sustainable Development Goals (SDGs). *Refer to – Background content for educator/facilitator – section 3-4-2c.* **10-15 mins** Facilitator/educator will conduct WC-3-4-Activity-II. This activity is designed to allow students to analyze building of a big dam from a multi-dimensional perspective including scientific, geographical, social and cultural. It helps them to list out the important stakeholders who should be involved before deciding to build a big dam. OR **30 mins** Facilitator/educator will conduct WC-3-4-Additional activity-II. This activity is designed to experience the push and pull of different natural and human stakeholders for water and big dams. And to evaluate that when a dam is built, needs which stakeholders get more weightage. **10-15 mins** Facilitator/educator will wrap up by focusing on the multi-disciplinary and complex nature of water systems. They will talk about how power production required one to look at

	water consumption and infrastructure building from a holistic perspective including social, cultural, geographical, environmental and scientific. The facilitator/ educator will emphasize the importance of consulting stakeholders both affected by and those making the decisions. They may open the question of what a sustainable future means to all stakeholders, before making choices for the future.
Differentiation	The level of discussion can be modulated according to the level of the students and number of students. The facilitator may choose between written activities and additional activities which are role-play based.
Additional activities	WC-3-4-Additional Activity - I **Total 30 min** **5 mins** -The classroom is then divided into 2 groups -One group is asked to enact a life with electricity and the other group is asked to enact a life without electricity. **10 mins** -They are given 10 minutes to discuss. **10 mins** Each group is given 5 minutes to enact. **5 mins** The facilitator/educator asks questions about the difference between what was actually 'needed' and what is merely a 'want.'

	WC-3-4-Additional Activity - II **Total 30 mins** **10 mins** - The participants will be asked to form a circle. - Each participant will be given a role of a resource - e.g. waterfall, fish, rainfall, electricity department, hydro dams, consumers (malls or households). Equal number of natural and individual/institutional roles are given out. - Everyone will stand in a straight line equidistant from each other. All the natural resources will stand together on one side (let's say left). All the individual/institutional resources will stand together on the other side (let's say right). - They will all hold onto a rope - open on one end and equally distributed on both sides. - Equal distance and equal lengths at the ends of the rope show equal distribution to start with **15 mins** - Then everyone will build a story and ask for how much water they require to function. As per their perceived needs, they will pull on the rope. - The pull that each one will feel on the rope will symbolize the pulls of the different stakeholders in the entire process of power production and consumption. **5 mins** - This will be followed by a group discussion to help them understand the interconnectedness of each element in the entire process, and the role each element plays in power production and consumption.

Anticipated challenges and solutions	Language, Comprehending the process, hesitation to speak up. This is a very multi-disciplinary topic and different students will likely need assistance in different aspects. Different levels of scaffolding will be required for individual students to get them engaged in the activities.
Keywords	Hydroelectricity, power, stakeholders, upstream, downstream, sustainable development, environment

3-4-2 Background content for the educator/facilitator:

3-4-2a Using scientific models to explain hydroelectric power production.

Generation of electric power used primary sources of energy. In case of hydroelectric power plants that use dams, the potential energy of water in the reservoir is converted to kinetic energy as the water falls on a turbine. As the turbine rotates, kinetic energy is converted to electric energy through an electromagnetic coil. The generation of electricity by a moving body or a rotating turbine can be illustrated effectively by using the following scientific models:

Make a syringe generator at home - https://sites.google.com/acads.iiserpune.ac.in/iiserp-scienceactivitycentre/home/syringe-generator-faradays-law?authuser=0

Make a fidget spinner generator at home - https://sites.google.com/acads.iiserpune.ac.in/iiserp-scienceactivitycentre/home/fidget-spinner-generator?authuser=0

If required one can discuss the result of increasing or decreasing the copper coils and other aspects of the physics associated with electricity generation.

3-4-2b Other ways to generate power using water

1. Microhydro or Picohydro power plants

Installed Picohydropower plant using a stream for turning the turbine and generating electricity.
Image credit: Joy Merwin Monteiro

These power plants work on a similar principle as the large dam-based hydroelectric power plants. But these are used at a smaller scale.

One can see the turbine and the generator in these images. (Image credit: Joy Merwin Monteiro)

2. Wave energy - https://oceanenergy-sweden.se/value-chain/swedish-developers/ https://www.waves4power.com/ https://noviocean.energy/concept-general-innovation-marine-blue-energy-non-resonant-buoyant/#nantes

3. Fuel cells - https://mypages.iit.edu/~smart/garrear/fuelcells.htm

3-4-2c Uses and challenges associated with large dams

Dams and reservoirs can have several uses, for example generating electricity, providing

potable (drinkable) water, water for irrigation, recreation (like swimming, boating, fishing) and flood control.

However, dams can also pose several challenges:

1. Socio-political challenges - Sometimes due to mismanagement dams can also be the reasons for floods in downstream areas. Eg. the rivers originating west of Pune like Mula and Mutha are tributaries of Bhima river as they flow east to eventually join the Krishna. Therefore, what happens to or in Mula and Mutha rivers affects Bhima and Krishna rivers and people and communities interacting with these rivers. Eventually all the water from these rivers drains into the Bay of Bengal.

This can be observed either on Google maps or using this simulation tool – https://river-runner-global.samlearner.com/

Therefore, if a dam is built upstream[$] like Khadakwasla on Mutha river and water is released in an uncontrolled or mismanaged manner, it can cause floods in downstream[$] areas in Karnataka (see the new report below). This can lead to submerging of land, community displacements, loss of livelihoods and access to potable water in downstream areas leading to cross border and other socio-political conflicts.

Karnataka: Following heavy discharge of water from reservoirs in Maharashtra, alert issued across Krishna basin

The Krishna is overflowing at many places and people on riverbanks have been alerted.

Bengaluru: Following heavy discharge of water from reservoirs in Maharashtra and continuous downpour, an alert has been issued across the Krishna basin in North Karnataka.

The Krishna is overflowing at many places and people on riverbanks have been alerted. Chief Minister Basavaraj Bommai asked Karnataka officials to be in touch with their counterparts in Maharashtra to keep tabs on water levels in reservoirs there and issue an early warning if needed.

Source: https://www.freepressjournal.in/ Dated- July 16, 2022

[$]If we select a reference point in a river, then downstream is any point in the direction of the flow of water. Upstream is any point against the flow of water as per the reference point.

2. Environmental challenges- Dams can have significant environmental effects depending on the topography - flat land vs hills and mountains – where the dam is built. Environmental impacts of large hydroelectric powerplants have been an international concern.
https://www.ucsusa.org/resources/environmental-impacts-hydroelectric-power
https://www.un.org/esa/sustdev/sdissues/energy/op/hydro_cernea_social%20impacts_backgroundpaper.pdf
https://www.nature.com/articles/s41598-019-54980-8

Hydroelectic power is a renewable source of energy but it is not climate neutral. Reservoirs cause greenhouse gas emissions due to vegetation like trees, shrubs and grasses that were growing on the land that was flooded when the dam was built, rotting without oxygen available that fungi and bacteria on land would use to decompose things (lower than other sources). Evaporation from the reservoirs can alter local weather patterns.

Reservoirs can lead to deterioration in water quality due to growth of algae and reduction in BOD. This often leads to changes in habitat conditions, loss of biodiversity, altered fish migration and spread of diseases.

3. Hydrogeological challenges - Dams can lead to changes in hydrology, such as waterlogging and altered sediment transport. This can adversely affect agriculture in the surrounding areas.

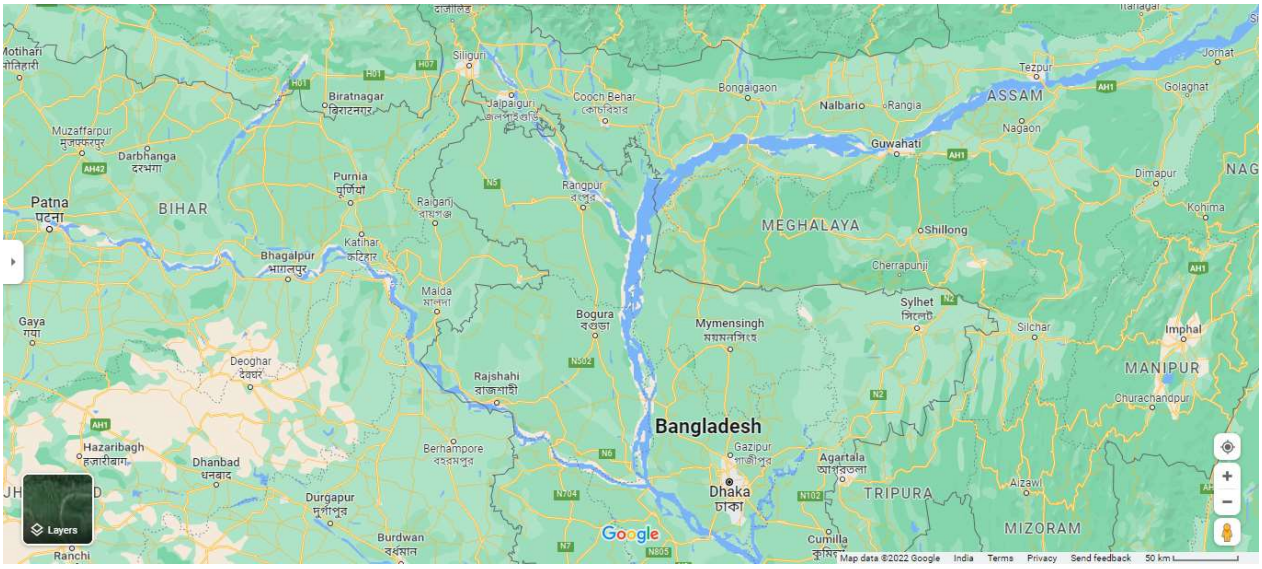
Therefore, for sustainable development it is important to be able to recognize who the various stakeholders* are, understand risks, find ways for mitigation (reducing the severity) of these risks through proper natural and human resource management. Experts believe it is important to draw upon traditional and modern knowledge in water management to pave the way for sustainable futures.

*A stakeholder is any individual, group or community living within the influence of the site or likely to be affected by a management decision or action, and any individual, group or

community likely to influence the management of the site. *(Source: https://link.springer.com/chapter/10.1007/978-1-4020-6581-1_4#:~:text=A%20stakeholder%20is%20any%20individual,the%20management%20of%20the%20site)*

3-4-2d Voices of Teesta – an award-winning movie showing the impacts of large hydroelectric power plants

An Indian filmmaker – Minket Lepcha - has looked into the impacts of hydroelectric power plants that have come up along the Teesta River in the Northeast of India and brought forward the voices of many stakeholders* that are not mentioned in any textbooks.



Movie - Voices of Teesta by Minket Lepcha - https://youtu.be/SoS1m-YytIQ

Other movies –

https://www.youtube.com/watch?v=Jlx1R4rraIM (longer version)

https://www.youtube.com/watch?v=pG3_yYOd4tk

3-4-2e Sustainable Development Goals

One may read more about United Nations' Sustainable Development Goals or SDGs at this link - https://sdgs.un.org/goals

Water Classroom WC-3-4-ACTIVITY-I

Explain in what ways water can be used for generating electricity. You may answer in words only or use drawings or sketches.

Water Classroom WC-3-4-ACTIVITY-II

Student Name: Class: Date:

Q1. Assume you are an engineer. You are a member of the committee that will decide if and how a new dam should be built in your town. Your job is to ensure that the plan allows for sustainable development in your town.

Note: For sustainable development it is important to be able to recognize stakeholders*, understand risks, find ways and methods for mitigation (reducing the severity) of these risks through proper natural and human resource management.

**A stakeholder is any individual, group or community living within the influence of the site or likely to be affected by a management decision or action, and any individual, group or community likely to influence the management of the site. (Site in this case would be the dam and the reservoir.)*

a. Which stakeholders* would you speak with in order to research into the uses, benefits and challenges of the proposed dam?

b. Write at least 5 important factors that you will research before agreeing to allow the proposed dam to be built?

Q2. Which of the following Sustainable Development Goals (SDGs) can be fulfilled by building a dam? Which of the following SDGs are contradicted by building dam?

(Only write the number associated with the SDGs in your answer.)

Note: There could be some SDGs that are neither fulfilled nor contradicted by building dams. You can choose to leave them out of the answer.

Answer:

SDGs that can be **fulfilled** by building large dams are:

SDGs that might be **contradicted** by building large dams are: