Where has all the water gone?

LESSON

GRADE LEVEL 10-12

CATEGORY Energy, Atmosphere & Climate

TOPIC Climate Change

LENGTH
Three 60 minute class periods

MATERIALS
- Student Handouts #1-11
- Teacher Resources #1-5

SUBJECT AREAS
Science, Social Studies, Science and Technology, Civic Studies, Geography

Overview

Finding solutions to water management in the context of climate change

Students simulate a water management meeting based on one that actually occurred in the Okanagan. They assume the roles of real stakeholders, and assess the actual water management options reviewed by the community. The role play highlights the environmental, social and economic challenges associated with climate change and freshwater management and encourages students to analyse factors that make proposed resource management solutions challenging to implement.

Objectives

Students will be able to:

- Evaluate possible impacts of climate change on natural systems.
- Analyse factors that make proposed resource management solutions challenging to implement.
- Assess environmental challenges including global warming and fresh water supply.
- Apply the themes of place, human and physical interactions to the subject of climate change and freshwater supply.
- Evaluate how climate affects human activity and human activity affects climate.

Teacher's Notes

One consequence of climate change in many regions of British Columbia and the world will be reduced fresh water availability. In this lesson, students assume the roles of various local stakeholders to create a water management strategy for the Okanagan. There are seven roles provided in the lesson. To reduce time, select only the roles of most interest to your class and ask students to read the backgrounder about their role and the water management options as homework. To add some fun to this activity, ask your students to dress up for their role. You could even consider holding the activity in a town hall or a special meeting room. The way that students dress can open up an interesting discussion around how we stereotype particular groups, and how this can limit or influence negotiations.

As an alternate introduction to the lesson use the Okanagan Basin Waterscape Poster: http://geoscape.nrcan.gc.ca/h2o/okanagan/poster_e.php

HCTF Education

Procedure

1. Introduce concepts and activity (Class 1)

- Ask students if they have been to the Okanagan. Can they describe the region
- Use ***Teacher Resource 4: Climate Change in the Okanagan*** to briefly explain anticipated changes to water supply in the Okanagan due to climate change.
- Tell students that they are going to participate in a role play water management meeting in the Okanagan where they must decide what water management options to implement now to avoid potential water shortages in the future.

2. Prepare for role play (1st class)

- Divide students into groups. There should be one group assigned to each role.
- Provide each group with the backgrounder that describes their role.
- Assign groups a specific amount of time to prepare forthe role play, by working through exercises 1, 2 and 3 on ***Student Handout 1: Group Tasks.***
- Tell students that you will play the role of chairperson in the water management meeting.

3. Start role-play (2nd class)

- Begin the role play by explaining that from this point forward what students say and all decisions that they make on management strategies should be done from the perspective of their assigned role, unless you tell them otherwise.
- Ask a reporter from each group to state to the rest of the class:
- the stakeholder their group represents
  - why water is important to them
  - how they could be affected by climate change and water shortages
  - what their "bottom line" is – or their most important need coming out of the negotiations.

4. Present water management options

- Hand out ***Student Handout 2: Water Management***
- Options and place a copy on the overhead. Ask students to read through the hand-out.
- Tell stakeholders to develop a proposal for a water management strategy by selecting and ranking their top three water management options, based on which options most effectively meet their needs while addressing the "bottom-line" of the other stakeholders. ***(Question 3 on Student Handout 1: Group Tasks).***
- Ask Negotiator 1 from each stakeholder group to present their groups proposal to the rest of the class.
- Ask stakeholders to consider what options they would be willing to adopt that are not within their top three, and which options they would refuse to consider.
- Use an overhead version of ***Teacher Resource 2: Water Management Priorities*** to record stakeholder priorities. Alternatively, put up the choices on the board or a flip chart and ask groups to put a star or a number beside their top three choices.

5. Analyze the options

- Ask stakeholders to analyze the proposals put forward by each of the groups and consider the similarities and differences.
- Identify the water management options that received the most votes and note them on the board or a piece of flipchart paper, from most to least votes.
- Ask stakeholders if they would be satisfied with a plan that incorporated only the three strategies that received the most votes.
- If stakeholders are not satisfied with this option, ask them to suggest how the proposal could be modified to include their concerns. Continue this discussion until you run out of time or agree upon a proposal that is satisfactory to all.

6. Prepare for action and debrief the role play (3rd class)

- As a class, outside of the role, ask students to consider the steps that would need to be taken to implement the proposal that they developed.
- Ask students to consider the following questions:
  - How did playing another role change how you felt about this issue?
  - How will the role play change the way you approach this issue?
  - Discuss the questions in ***Teacher Resource 1: Role Play Debriefing.***

Assessment

- Use the ***Teacher Resource 3: Role Play Rubric*** to evaluate the role play.
  - Use the questions on T***eacher Resource 1: Role Play Debriefing Questions*** to assess knowledge attainment related to:
  - Knowledge of fresh water management options
  - Challenges of implementing resource management options
  - Ask students to hand in their responses to ***Student Handouts 11 & 12: Self Assessment and Group Assessment*** to evaluate their group's participation.

Extensions

- Contact your local/regional water utility to find out where your water comes from. Are there any changes in supply from one season or one year to another? What kind of storage system is used for the water? Is water supply currently an issue in the community? What water conservation programs are in place?
- Invite a water manager from your community to talk to your class about water management. Is your community thinking about climate change impacts?
- Okanagan Basin Waterscape Poster: http://geoscape.nrcan. gc.ca/h2o/okanagan/poster_e.php . Use this poster to continue to explore water management issues in the Okanagan with students or as an alternate introduction to this lesson.
- Begin a school wide campaign to reduce water use. See Destination Conservation www.dcplanet.org and Pembina Institutes Greenlearning Online. www.greenlearning.ca

Additional Resources

Water Bucket: www.waterbucket.ca provides timely information about sustainable water management in B.C.

Handouts

Student Handouts

1. Group Tasks
2. Water Management Options
3. Environmental NGO Role
4. Fisheries Role
5. First Nations Role
6. Municipal Government Role
7. Tourist Operator Role
8. Farmers' Role
9. Water Utility Role
10. Group Assessment
11. Self-Assessment

Teacher Resources

1. Role Play Debriefing
2. Water Management Priorities
3. Role Play Rubric
4. Climate Change in the Okanagan

Student Handout 1

Group Tasks

Follow the directions below to prepare for and participate in the Water Management Meeting.

Before the meeting

1. Decide on roles for students in your group. The possible roles are:

   For Stakeholder meeting/preparation for water management meeting

   - **Facilitator** Ensures that each group member contributes.
   - **Note Taker** Records important points for the presentation at the water management meeting.
   - **Analyst** Ensures that your group selects water management options that are representative of your stakeholders´ interests, not your personal interests.

   For the water management meeting

   - **Reporter 1** Explains why water is important to your group and how climate change may affect your interests.
   - **Reporter 2** Explains your groups "bottom line" or what your group feels you must have coming out of the negotiation.
   - **Lead Negotiator** Explains your group's top three water management options.
   - **Negotiators** Lead negotiations for water management options during the water management meeting in consultation with other group members.

2. Read through the backgrounder describing the perspective of the stakeholder your group represents. Discuss the following questions, record your answers, and be prepared to present your case to the group during the first part of the water management meeting:

   - Why is water important to this stakeholder group? (Reporter 1)
   - How will climate change and the potential shortage of water affect this stakeholder group? (Reporter 1)
   - What is the bottom line for your stakeholder? What is the minimum that you need to be satisfied when leaving the negotiations? (Reporter 2)
   - What can your stakeholder group do to decrease the amount of water they require?
   - What can your stakeholder group do to increase the amount of water available?

To prepare for the second part of the meeting (the negotiating session)

3. Read through the list of water management options on Student Handout 2, and decide which three most effectively meet the needs of all stakeholders, while ensuring that the interests of your stakeholder group are met. Prioritize these options from strongest to weakest fit.
4. Decide what other water management options your stakeholder group would be willing to consider, what options they would refuse completely and why. Negotiator 1 presents your proposal in the second round of the water management meeting.
5. During the second round of the water management meeting, compare stakeholder group's proposals and identify the similarities and differences.
6. Select and modify the proposal if necessary by creating further options that effectively meet the needs and interests of the stakeholder you represent and all other stakeholders.

Student Handout 2

Water Management Options

Although the water in British Columbia is owned by the public, anybody who wants to use water needs to have a license from a public or private water utility. Once people have such a license, they maintain it, and pass it on to new owners of their land or business when it's sold. B.C.'s policy is "first come, first served", and when water is in short supply, people with older licenses have priority. License holders also tend to want to use all the water their license allows, because B.C.'s policy is also "use it or lose it.. If a licence-holder conserves water now, they might not be able to get more water if they need it in future. Given this context it is difficult to implement water conservation measures.

Outlined below are options presented to stakeholders in the Okanagan for reducing water demand and increasing water supply. At the conclusion of the meeting the group must choose the three options that will meet the needs of the stakeholders you represent and the bottom line of all other stakeholders.

The costs of the options below are expressed in Ml which signifies megalitres or one million litres. The amount signifies how much it costs to save a million litres of water. For instance, a measurement such as $400/Ml, means that it costs $400 for every million litres of water that are saved or conserved using this option.

Option 1

Public Education for Residential Water Conservation

DESCRIPTION

This option can achieve a 10% reduction in water use if a consistent effort is made to reach the public, stressing the importance of reducing residential consumption and showing how water can be used efficiently for washing, bathing and gardening.

COST

$700/Ml saved

WHO PAYS?

The water utility pays for the education. Individual households pay the cost of installing water saving devices, such as low flow showerheads, but can recuperate the costs through savings in water bills.

Option 2

Irrigation Scheduling

DESCRIPTION

Irrigation scheduling can achieve a 10% reduction in water use. It involves calculating exactly how much water is required to irrigate a particular parcel of land. Farmers are given information about how much water they use compared to the amount they need according to soil and weather conditions. Particular days and times for irrigation may also be established. Often this option is combined with water metering.

COST

$400 – $700/Ml saved

WHO PAYS?

The water utility pays for implementing this strategy.

Option 3

Irrigation Metering and Pricing

DESCRIPTION

Irrigation metering involves monitoring the amount of water individual farmers use for watering their crops. It can include charging for water use or fines if a farmer uses more than his/her allocation of water. Some systems may also be used to ensure that farmers comply with the designated hours of irrigation.

COST

$450 – $600/Ml

WHO PAYS?

The water utility pays the cost of installing the water meter and monitoring. If farmers have their own water source they pay for installing the meter.

Option 4

Trickle Irrigation

DESCRIPTION

Trickle irrigation releases small drips of water directly into the soil beside a plant. It is an option that farmers can use to reduce the amount of water they use. The quality of grapes and wine depends on having specific amounts of water, so some farmers can actually improve the quality of their product by implementing trickle irrigation. Drip irrigation uses 30% less water than conventional sprinkler systems, which are less direct and spray water into the air to reach the soil.

COST

$1200 – $1400/Ml

WHO PAYS?

Farmers pay for the installation of the system, but save a portion of the cost through reduced water bills, and increased quality and productivity in the case of grapes.

Option 5

Leak Detection

DESCRIPTION

Leak detection entails finding and repairing leaks in municipal water pipes. It can save 10 to 15% in older water systems.

COST

$1200 – $1400/ Ml

WHO PAYS?

Water utility incurs the cost.

Option 6

Domestic Water Metering

DESCRIPTION

Metering requires the installation of an instrument in houses and businesses to measure how much water they use. It also involves charging those who use more a higher price for water.

COST

$1500 – $2200/Ml

WHO PAYS?

The water utility pays for installing meters. Households with higher consumption pay a higher amount per litre for water.

Option 7

Landscape change

DESCRIPTION

Landscape change involves modifying an urban or residential landscape that requires a high amount of water to one that requires very little water. This is often accomplished by switching from grass, which requires a lot of water, to native plants and shrubs that use less, a technique known as xeriscaping.

COST

No costs available.

WHO PAYS?

Households, business (including the municipality) pay, and may recuperate costs through reduced water bills.

Option 8

Water recycling

DESCRIPTION

Water recycling cleans municipal wastewater so that it can be used again for irrigation. In some cases the water comes from our sinks, and at times directly from the sewer system. There is some concern about whether this option is safe for food crops; however, it has been used in Europe for several years and is presently being used in some golf courses and for some forage crops in the Okanagan.

COST

No costs available.

WHO PAYS?

On a large scale the water utility covers the costs. On small scale, individual households would pay to install a water filter.

Option 9

Pumping Water from the Lake

DESCRIPTION

In this option communities would pump water uphill from the Okanagan Lake and into communities. The amount of water taken from the lake can't exceed the amount that flows into it each year. If this amount is exceeded it could negatively impact marine life in the lake and downstream. It would also take years for the lake to refill to its original level. There is uncertainty about how climate change will impact the amount of water available in the lake, although we do know that rising temperatures will cause more evaporation and reduce the amount of water that can be used.

COST

$800 – 3200/Ml

WHO PAYS?

The Water Utility pays for infrastructure and passes down the costs to customers through higher fees.

Option 10

Increase upstream storage capacity through dams & reservoirs

DESCRIPTION

Increasing upstream storage requires raising the height of current dams or building new dams and reservoirs to catch more water from the spring run off. Because upstream storage from streams has been the historically preferred way of supplying water since the early 1900's, most of the low cost sites have already been developed. A very limited amount of low cost storage may be available through raising the height of current dams or developing small sites.

COST

$1000 – $5000/Ml

WHO PAYS?

Water utility pays the cost of infrastructure and passes the costs down to customers through higher fees.

Option 11

Groundwater

DESCRIPTION

Groundwater is like a natural tank of water located below ground. Its use is not currently regulated in B.C., so anybody who digs a well – sometimes a very deep well – can use groundwater free of charge. However, using groundwater may not be a perfect solution. Groundwater flows depend on above-ground precipitation and the amount of water that percolates deep into ground, so climate change may affect future groundwater supplies.

COST

$200/ M1

WHO PAYS?

The water utility or the rural landowner pays for the well.

Student Handout 3

Environmental Non-Governmental NGO Role

You represent the Nature Conservancy of Canada (NCC), an environmental organization that works in the Okanagan. NCC helps to protect biodiversity and the environment by conserving natural landscapes. They do this by either purchasing land, having it donated to the organization, or asking businesses or individuals to transfer their rights to the land to the Nature Conservancy.

The Okanagan has ecological significance because nearly half the bird species in the country are found here, along with many plants and animals that exist nowhere else in North America and in some cases the world. The area is a corridor for species migrating between the dry grasslands of the B.C. interior and the desert areas of the western United States.

You believe that one of the most important ways of managing future water crisis and reducing the impact of climate change is altering the way land is used and protecting natural landscapes. You want to protect riparian zones, which are shorelines and places where water and land intersect. Riparian zones are important for numerous reasons including their ability to filter water entering streams and lakes and their capacity to keep water temperatures down. These qualities are vital for fish, since they can't survive in excessively warm or contaminated waters. Riparian zones tend to support dense vegetation because water is available, and animals use them as habitat and travel corridors. There are laws to protect riparian zones on public land, but not on privately owned land. If water levels are drawn down too low in the lake, this could put riparian zones at risk.

Another threat to the land in the Okanagan is All Terrain Vehicles. You think the areas where ATVs are used should be regulated, because they contribute to the problem of water scarcity. Tourists and locals regularly ride over fragile landscapes chewing up the vegetation. When there is no vegetation, rain water drains directly down-hill rather than being absorbed. This process prevents groundwater sources from refilling.

You are concerned about the impact that increasing the number of dams will have on the natural landscape. However, you are willing to consider the possibility of raising the height of the present dams. Using groundwater to make up for a lack of surface water is not a wise idea in your mind. Groundwater recharges streams and rivers. If we draw too heavily on groundwater we could decrease the amount of water in local streams and rivers, damaging riparian zones and fish, and reducing the water available to terrestrial plants and animals.

You think public education is essential to reducing water demand and conserving our present supply.

Student Handout 4

Fisheries Manager Role

As representatives from the Department of Fisheries and Oceans Canada (DFO), a federal government organization, you are responsible for the conservation and sustainable use of Canada's fisheries resources. According to Canada's constitution, the Government of Canada is responsible for managing "sea coast and inland fisheries", including salmon fisheries. The federal Department of Fisheries and Oceans is responsible for First Nation fisheries, commercial and recreational fisheries in tidal waters, and salmon fisheries in non-tidal waters and has primary responsibility for fish habitat protection. The federal Fisheries Act, however, delegates the responsibility for managing provincial non-salmon freshwater fisheries to the B.C. Ministry of Environment.

Sockeye salmon and Kokanee are of principal concern in the Okanagan. Kokanee inhabit the upper end of the Okanagan Basin and spawn on the shores of Okanagan Lake. Sockeye occupy lower levels of the basin and spawn in the river. These fish are sensitive to climate change because their survival depends on water temperature. Sockeye function best in water that is 15 C or cooler. Between 17 C and 24 C their systems are stressed, and at 25 C they will die.

As a result of climate change, there will likely be less water in Okanagan streams, rivers and lakes during the summer and early fall. The water will be warmer because air temperatures will be warmer, and because less water will come directly from melting snow. Added to this, the human population in the Okanagan is growing, and so is the demand for water. If water levels in streams, rivers, smaller lakes, and the Okanagan Lake go down, and water temperatures go up, there could be serious problems for the salmon population.

In the Okanagan, the amount of water in lakes and streams varies depending on the season, with peak flows during spring runoff and low flows in late summer and early fall.

On some streams and rivers, and on Okanagan Lake, people have built dams and reservoirs to capture and store some of this water for later use. People can control the amount of water and in part the temperature by how much water they release from the dams at any given time. DFO recently developed a computer model that allows water managers to determine the potential impact on fish of releasing different levels of water from the Okanagan Lake dam at different times of year. The model allows them to release the appropriate amount of water at the correct time in response to the seasonal cycles in streamflow, the flow variations from year to year, and the timing of lifecycle stages of fish. As DFO representatives, you want to ensure that there is a sufficient amount of water available to maintain appropriate stream flows.

Your main concern when ranking the water management options is how they will affect sockeye and Kokanee. Consider how the options will influence the quantity and therefore the temperature of water in the lakes and rivers, and if the options will damage the riverbanks and lakeshores where the salmon spawn. Remember that groundwater also feeds rivers and streams. If the amount of groundwater is reduced, the water available in streams and rivers will also be decreased which could jeopardize salmon.

Kokanee lay their eggs on the shores of Okanagan Lake around October 15th and the eggs hatch in April. If the water in the lake drops by more than 20cm at any time between October 15th and April, significant numbers of shore-spawned Kokanee eggs will be destroyed. If an excessive amount of water is pumped from the lake, this could occur.

Student Handout 5

First Nations Role

Our view of water often differs from other groups. For us, water is alive. Water is not just something that flows down rivers and sits in a lake as some people see it. Our elders speak of the power of water by saying that where it comes from is never empty and where it arrives is never full.

If you stand by the water and watch it go past, you will notice that at no time does the same water go by you; it constantly changes, just as life constantly changes. Even though water is the most powerful thing on earth and nothing can survive without it, water doesn't stand up and boast; it flows through the lowest places finding its strength in this humble attitude. Water is powerful, whether it flows through a pristine river or an inner city gutter. It originated in the sacred places in the mountains.

Water is home to one of the main sources of food for our people: Kokanee and sockeye salmon. As the climate changes, so does our access to this vital food source. In recent years we have seen fish dying in the streams because of the warm temperatures and lack of water. The fish depend on a fine balance of water and temperature, without this they will not survive.

An adequate supply of water in the creeks and rivers is essential to our livelihood. A few years ago in Summerland during a terrible drought, the people held back water meant for the creek to irrigate their orchards. Their justification was that they needed to save the apples and grapes, their source of livelihood, and that this was more important than the fish. What they perhaps didn't recognize was that the livelihoods of many or our people are based on the fish. When you put the fish at risk, you put our people at risk.

The Okanagan people have always lived here, and we will continue to live here. We know that we have to use water responsibly, because if we don't we must live with the consequences. The non-native population is transitory; they aren't tied to this place in the same way we are. If they create a mess they can leave it; if they use up all the water they don't have to face the consequences. The legacy they are leaving is sad. People are forgetting to take care of what takes care of them.

This is not to say that we aren't in favour of economic growth. We need a strong economy. We also need a sustainable economy that brings jobs to our people without destroying the resources on which we depend.

Water is a finite resource. Regardless of how much of it we store, if we don't learn to use it responsibly it won't be there for us or for the fish, plants and animals that need it to survive. When we look at increasing supply – we aren't solving the real problem, which is the way that we use the water. To change the way we use water, we need to start by changing people's attitudes toward water.

Student Handout 6

Municipal Government Role

The municipal government, supplies most of the immediate services people depend on within a community, like roads maintenance, street lighting, waste management, sewage treatment and domestic water supply. They decide what areas should be used for industry, where stores and other commercials buildings should be, where people should live, and what codes must be followed in the building of new homes. They hire municipal staff, set policies (within provincial requirements) for delivering the services and decide how much the people in the community should pay for those services.

As municipal councillors, you have the challenge of trying to meet the needs of a diverse population that requires a range of different services within a limited budget. As an elected official, you must also ensure that you listen and respond to all of the people in your community. The challenge comes when the community is divided and different interest groups want different things.

Water shortages cause some of the greatest tensions in your community. Water in the Okanagan Valley comes from three sources: lakes, small rivers, and ground water (on a limited scale). In 2003, during an extended drought, a fierce debate arose between the federal government represented by the Department of Fisheries and Oceans and local farmers. Fisheries managers believed that the water in the reservoir should be used to ensure fish survival by maintaining critical flows in streams and rivers. Farmers thought that the water from the reservoir should be used for irrigation, to save the plants that were dying of thirst. Luckily, just as things were getting extremely tense, it rained. However, the experience showed councillors the importance of having a strong water management plan, and a way of resolving conflicts related to water.

As a municipal councillor, your job is to ensure that there is enough water for all users. This isn't always easy, since it involves convincing people to spend money to manage the resource and to change the way they use water.

Each spring, water from the melting snow is held back in a reservoir. Once the soil begins to dry out, water from the reservoir is used to irrigate crops and provide water to homes and businesses. As more people move into the community they need more water. Building a big reservoir costs a lot of money. It is possible to take a slightly bigger share of the water flowing in the creek, but this could harm fish during particularly dry years. Pumping water out of the Okanagan Lake is another possibility, but it is extremely expensive. A significant drop in water levels in the Okanagan Lake, as a result of pumping, could also lead to negative impacts for recreational users and Kokanee. Lower make certain boating activities more difficult and render certain docks unusable. If the water in the lake drops by more than 20cm at any time between October 15th and April, significant numbers of shore-spawned Kokanee eggs could also be destroyed.

The cheapest option for municipal council is for people to use less water or to ensure that the population doesn't grow. However, these options have their challenges; it's difficult to convince people to change their habits, and limiting residential growth can limit economic growth and the municipal revenue from property taxes – something that not everyone supports.

With climate change, warmer climates are anticipated. Warmer temperatures will lead to a greater demand for water. As municipal councillors you need to select water management options that ensure that there will be sufficient water for future populations and work to achieve the support of the greatest number of community members in this decision.

Student Handout 7

Tourist Operator Role

Tourism is one of the driving forces of the economy in the Okanagan Valley. In 2004, tourist accommodation alone brought over $200 million in revenue to the region. As tourist operators, you want to keep tourists happy and boost the numbers of people visiting the Okanagan each year. This means ensuring that the Okanagan continues to provide the things that attract tourists: moderate climate, beautiful landscapes, parks and gardens, and all season recreation. Opportunities for tourists include: bird-watching, hang-gliding/para-sailing, hiking/backpacking, horseback riding, llama trekking, rockclimbing, day sailing, wildlife observation, wine tours, ATV riding, boating, fishing, snowmobiling, snowboarding, skiing and golfing.

In such a dry region, water is an important tourism resource. Imagine the profits that could be lost, for example, if the 58 golf courses in the region have to shut down because they can't keep the turf green! Water restrictions for lawns and golf courses, may reduce the aesthetic appeal of the region for some people and lead to economic losses. Lakes in the Okanagan are also a huge draw for tourists, who enjoy fishing, water skiing, boating, sailing, and jet skiing. If water levels on the lakes are low, tourists won't be able to do these activities, since boats will become difficult to navigate. Docks may also need to be rebuilt, since the water around many of them may dry up. Climate change and lower water levels in streams, rivers and lakes could also jeopardize the salmon populations, which would be a disaster for sport fisherman.

Another potential consequence of climate change may be less snow in the future and snow melting earlier in the year. This could mean that the ski industry may incur economic losses while other types of tourism become more important in bringing tourists and their money to the Okanagan. Skiing is a very important tourist draw, as the Okanagan contains almost 30% of the ski runs in B.C

Some groups argue that because of potential water shortages the use of all-terrain vehicles (ATVs) should be prohibited, since they can destroy vegetation that absorbs water. You support restricting ATV use, since this also protects pristine areas for hikers and backpackers, but you don't want to see the activity shut down entirely.

As a tourist operator your principal concern is how water shortages could affect the industry. You want to do something about it, and are willing to support any measure as long as it doesn't jeopardize tourism.

Student Handout 8

Farmers' Role

As a farmer, your livelihood is closely linked to the weather. In an ideal world there is just the right amount of sun and rain in the spring and summer when the crops are growing, a dry period at harvest time, and irrigation to supplement water during the growing season. As in any business, in farming you need to make a profit to pay for land, water, labour, equipment and all the other costs associated with farming. Having the right amount of water at the right time is essential to producing a high quality crop that can be sold for a good price.

The Okanagan has been a farming region for a long time, and like you, many farmers have older water licenses that give them priority in the use of water over applications for new water licenses. One of your biggest concerns is that if farmers reduce the amount of water they use, the water saved will go directly to residents to fill the increasing demand of the growing urban population instead of being designated to agriculture. With rising temperatures, the amount of water that crops need will likely increase, by an estimated 10%. Farmers think it would be a foolish mistake to give up water to residents, when agriculture, which we all need to survive, could require even more water in the future.

You recognize that effective water management is essential now, and will become more so as a result of climate change. You are in favour of new techniques, such as mulching, drip irrigation and irrigation timers that ensure a more efficient use of water in agriculture. Nevertheless, water saving strategies such as drip irrigation, don't work for everyone. Drip irrigation is ineffective when soils are extremely dry, because the water goes straight down and doesn't branch sideways to the roots. In regions like the South Okanagan where there is a high mineral content in the water, the minerals clog the irrigation systems and in orchards where drip irrigation is used instead of sprinklers, leaves get curled up and the apples get sunburnt because of the lack of humidity in the air.

Options to increase the overall supply of water are appealing, but extremely expensive and you can't afford a lot of added costs. In some communities they have implemented irrigation scheduling, and irrigation metering. You don´t mind the irrigation scheduling but you don´t agree with metering since it penalizes those who don´t have money. Another option is to have water limits, and fine those that exceed the limits. This option could work, but some farmers may disagree with the idea of fines. Groundwater is a potentially valuable resource of unknown quantity. You could dig a deeper well to obtain groundwater for your own farm, but you are uncertain if you can afford the cost. A well would ensure that no one could regulate the amount of water you use, but it could affect the amount of water available in rivers and streams that are fed from groundwater.

The bottom line for agriculture is that you need an affordable, reliable and adequate supply of water, and you are willing to adopt measures that will help achieve these criteria.

Student Handout 9

Water Utility Role

A water utility provides water for residents, farmers and businesses. Municipalities assume the role of water utilities in many instances, although a private company can also be a water purveyor (supplier). In the Okanagan, utilities obtain water from three sources: major lakes; small rivers; and groundwater (to a lesser extent).

Water utilities generally pay the upfront cost of implementing water management options, and pass on the costs to customers through increased fees. Most of the water management options must be implemented by water utilities. Public education and residential conservation are your top choices in terms of water management options because of the low cost incurred by you the utility. However, conservation efforts by residents may not be sufficient to meet the joint challenges of population growth and climate change in the long term. Larger gains in water conservation can come through investment in agricultural metering, but this is unpopular in the region.

In order to increase supply, utilities (who have not implemented these option) will need to consider three principal options:

1. 1 Increasing capture and storage through new dams and reservoirs. However costs are high are there are few locations left where dams and reservoirs can be built.
2. Tapping into groundwater sources to meet water demand. The cost of this option is reasonable however groundwater is an unregulated resource, and drawing too heavily upon it could cause problems in streams and rivers, since they depend on groundwater to recharge.
3. Pumping water from major lakes. This option will be able to meet the demands of population growth and climate change, but comes at an extremely high cost to water utilities and eventually to their customers.

Water utilities are concerned about the cost and effectiveness of different water management options. If they select a water management option that is extremely costly to customers, the customers will complain. However, the bottom line for the water utilities is meeting the growing demand for water in the region, even if the option for accomplishing this goal is expensive.

Student Handout 10

Group Assessment

Please work together to evaluate your group on the following:

1. Teamwork

◯ **1** *Unacceptable* ◯ **2** ◯ **3** ◯ **4** *Excellent*

Comments: _____

_____

2. Participation

◯ **1** *Unacceptable* ◯ **2** ◯ **3** ◯ **4** *Excellent*

Comments: _____

_____

3. What are two important things members of your group learned from this activity?

_____

_____

4. State three ways in which your group was successful in working together.

_____

_____

5. Name two challenges of working with each other. How did you group overcome these challenges?

_____

_____

6. What would you do next time to work together more effectively?

_____

_____

Student Handout 11

Self Assessment

1. Rate your individual participation in the group.

◯ **1** *Unacceptable* ◯ **2** ◯ **3** ◯ **4** *Excellent*

Comments: _____

_____

2. How did you contribute to your group?

◯ **1** *Unacceptable* ◯ **2** ◯ **3** ◯ **4** *Excellent*

Comments: _____

_____

3. Rate your level of participation in the group

◯ **1** *Unacceptable* ◯ **2** ◯ **3** ◯ **4** *Excellent*

Comments: _____

_____

4. Describe how you worked with others in your group. Did you listen to the ideas of other group members? Did you contribute your ideas? Did you ensure that everyone had an opportunity to participate in the discussion?

_____

_____

5. What did you do well in your group?

_____

_____

6. What can you do in the future to work more effectively in a group?

_____

_____

Teacher Resource 1

Role Playing Debrieng Questions

After the role play ask students to discuss these questions as a whole class or in small groups:

1. If an agreement on the water management options was not reached:
   - What concerns stopped the groups from reaching an agreement?
   - What would you do differently in the next negotiation in order to reach an agreement?
2. If a full or partial agreement on the water management options was reached:
   - What strategies helped the teams reach an agreement?
   - Are you happy with the agreement you reached? Why or why not?
   - Is the solution that you reached realistic? Do you think stakeholders in the Okanagan would actually have chosen these options? Why or Why not?
3. What did you learn in this exercise about the different stakeholder groups? What stakeholders were not represented in the role play that you think should have been included?
4. What will make the selected water management options challenging to implement?
5. Do you think that people in your community would have similar or different perspectives on water from those in the Okanagan role play?
6. What similarities exist between the Okanagan situation and that of your own community/region? Consider geography and climate, agriculture or urban development and population growth?
7. Would you select the same priorities for your community? Why or why not?
8. Which of the proposals suggested would work in your region? What other options would you recommend?
9. List three things that you can do every day to reduce the amount of water that you use at home.

Teacher Resource 2

Water Management Priorities

Create an overhead of the table below. During the negotiation round of the role play note the water management options prioritized by each stakeholder group.

Stakeholder Groups								
OPTIONS	Example Group X	NGO	Fisheries	First Nations	Municipal Government	Tourism	Farmers	Water Utility
1 PUBLIC EDUCATION	2							
2 IRRIGATION SCHEDULING								
3 IRRIGATION METERING AND PRICING								
4 TRICKLE IRRIGATION								
5 LEAK DETECTION								
6 DOMESTIC WATER METERING	3							
7 LANDSCAPE CHANGE								
8 WATER RECYCLING	1							
9 PUMPING WATER FROM THE LAKE								
10 INCREASE UPSTREAM WATER STORAGE								
11 GROUNDWATER								

Teacher Resource 3

Role Play Rubric

Use the rubric below to assign a mark for student groups in the role play.

CRITERIA	1 Unacceptable	2 Acceptable	3 Very Good	4 Excellent
ROLE	Group did not assume role.	Group assumed role in an unenthusiastic and unconvincing fashion.	Group enthusiastically assumed the role, and used anecdotes to make their role more convincing.	Group went beyond expectations using props, physical gestures, anecdotes, and compelling arguments.
UNDERSTANDING OF PROBLEM	Group unable to state their position.	Group stated their position but was unable to substantiate their opinion.	Group provided a complete explanation of their position.	Group provided a complete explanation and drew conclusions not mentioned in their description, based on logical connections.
PARTICIPATION	Only one or two group members appeared to be doing the work.	All members participated, but some appeared to have token roles. Some tension between group members.	All members participated equally.	Based on their evaluations, it appears that group members collaborated to arrive at higher levels of understanding, and were supportive of those in the group who were struggling,
AGREEMENT	Group made no effort to reach agreement	Group gave up values important to the stakeholder they represented to reach an agreement and made minimal effort to arrive at an innovative resolution.	Group worked enthusiastically to reach a decision that worked for all stakeholders without compromising on strong values.	Group worked to develop innovative solutions and facilitated other groups in arriving at an agreement.

Teacher Resource 4

Climate Change in the Okanagan

Imagine a mountain covered from the base to the peak in deep white snow. Spring arrives and the temperature gradually warms, melting the snow and filling the lakes, rivers and reservoir with water. There is so much snow on the mountain that the melting continues right into the summer. By the end of summer, however, almost all the snow is gone and the lake and river levels drop. That's when farmers and communities start using the water supply from the reservoir for irrigation, drinking water and domestic use. There is enough water in the reservoir to last until the fall rain and snow arrive.

Now imagine that spring arrives early and the snow starts to melt sooner. The snow disappears, and the lakes and rivers run dry earlier in the summer. There may be the same amount of water in the reservoir, but it needs to last for a much longer time. Imagine further that summer temperatures are hotter than usual, summer precipitation is less than usual, and crops need more water earlier. People are worried that there won't be enough water to meet the demand.

Sound familiar? This situation is occurring in the Okanagan. If you've eaten B.C. apples, peaches, nectarines or cherries, chances are that they came from the Okanagan. You may also have spent your summer vacation swimming in Skaha, Okanagan or Osoyoos Lake or visiting Vernon, Kelowna and Penticton, the largest communities in the valley. Or perhaps you are one of the approximately 300 000 people that live in the Okanagan. Regardless of where you come from, it's important to understand what is happening in the Okanagan, since it will have an impact on food, fish, places and people that are significant to us.

Scientists predict that in coming years there will be less snow in the Okanagan because winters will be warmer. At low elevations, winter precipitation will fall as rain rather than snow, and disappear into rivers, lakes and reservoirs. In some places there may even be too much water in the winter. At higher elevations, winter precipitation will continue to fall as snow and remain on the mountain until spring, but the total area covered by snow will shrink, so there will be less water stored in the snowpack and available later in the summer. Scientists suggest that by 2100 temperatures in the Okanagan may increase by 1.5 C to 4 C. Overall, the Okanagan will have warmer and wetter winters and warmer and drier summers, with an increased probability of droughts. Changes in temperature, rain, snow and other abiotic factors will have considerable impacts on fish, crops, and residents in the Okanagan.

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