Water & Climate Change

Key Concepts

- A variety of factors will influence water quality and quantity in the future.
- Actions we take in our everyday lives influence the sustainability of the Greater Victoria water supply.

Method

Students examine local precipitation data and other factors and discuss the impact of climate change for the Greater Victoria area.

Activity Information Box:

Time Required: 90 minutes

Grade Level: Grades 8-12

Key Words: *climate change, precipitation, rainfall, microclimate, future trends, variables, x-axis, y-axis, graphing*

Materials:

- Student worksheets
- Rainfall data sheets (CRD and school-based)
- Internet and other information resources
- Graph templates (optional)
- Water gauge (optional)
- Computer lab (optional)

Setting: indoors

Skills: gathering information, data interpretation, analysis

Subjects: Science 8-10
Earth Science 11
Geography 12

Learning Outcomes:

It is expected that the student will:

- Describe, using graphs, the relationship between rainfall in two different microclimates in Greater Victoria;
- Discuss the relationship between rainfall and water consumption trends;
- List ways that we can manage potential impact of climate change on our water supply.

Background

Water availability in response to climate change is a critical issue in Greater Victoria, throughout B.C. and the world. Most of our drinking water comes from reservoirs which are replenished in the winter and drawn down in the summer. Climate change involving rising temperature and decreasing rainfall may affect our water supply through increased water losses due to evaporation and increased water demand for drinking and irrigation, for example. Current climate change models predict longer drier summers, increased precipitation intensity (heavier rain and snow storms) during the winter months, and 1 – 4 ˚C warmer weather on average. We need to know how much water will be available and how will we manage our water resources in the years to come. Climate scientists can gather climate data and use computer programs to analyze how the climate may change. By understanding climate trends, decision-makers can plan for future reservoir needs and develop programs to manage water resources efficiently.

Weather:

Weather stations are one of the ways that scientists gather data about climate. Weather is the specific condition of the atmosphere at a particular place and time. It is measured in terms of such things as wind, temperature, humidity, atmospheric pressure, cloudiness, and precipitation. In most places, weather can change from hour to hour, day to day, and season to season.

Climate:

A region's climate is based on long-term weather conditions. Climate is the average weather pattern over longer periods of time – generally tens to thousands or even millions of years. Temperature ranges, amounts of precipitation, and wind are the atmospheric variables that most often characterize climate at the Earth's surface. Climate in Greater Victoria is based on its location on the planet, nearness to the ocean, and the circulation of planetary winds. Location mainly determines temperature and precipitation trends. Climate profoundly affects the total amount and seasonal timing of water availability in our reservoirs.

FTS RG-T Tipping Bucket

The climate in the Greater Victoria area is generally called a Northern Mediterranean type climate. This means that, in the summer months, our weather is dominated by masses of warm air moved by winds from the south, known as subtropical high pressure cells. Rainfall is generally less and we can go for weeks without any measurable precipitation. During the winter months, a series of Pacific storms reaches the shores of Southern Vancouver Island, bringing rain with snow at higher elevations. As a result, areas with this climate receive almost all of their yearly rainfall during the winter season, and may go anywhere from two to three months during the summer without having significant precipitation. The term microclimate describes the variations within a region's climate.

Old saying: "*Climate is what we expect, and weather is what we get.*"

Monitoring Rainfall and Reservoir Levels at Sooke Reservoir

The reservoir water level is recorded hourly using a float and pulley type system which is located at the intake tower in the reservoir. The precipitation (rain and snow) for Sooke Reservoir is recorded every 15 minutes using an FTS RG-T heated tipping bucket rain gauge, located at the toe of the dam. There are additional rain gauges located at the toe of the dam and on the intake tower for data verification.

CRD Water Services maintains a weekly "Water Watch" to help manage water resources and to educate local citizens. The Water Watch is available on the CRD website: **http://www.crd.bc.ca/water/**

The Water Watch provides data on:

- Usable water volume in the Sooke and Goldstream reservoirs;
- Average daily water demand (water usage);
- Average 10 year daily demand;
- Rainfall for the month (average, actual); and
- Rainfall for the week (average, actual).

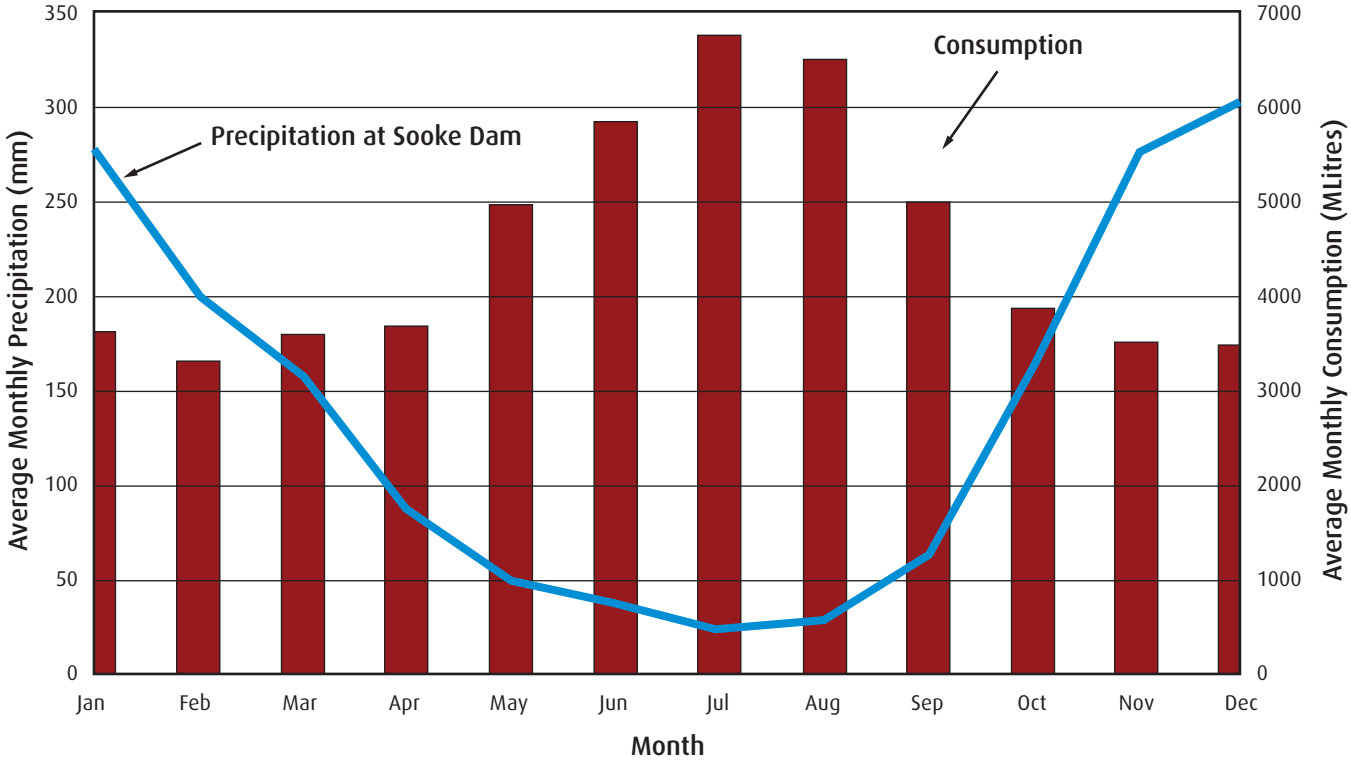
School-based weather stations are installed in many schools throughout the CRD, all part of the School-Based Weather Station Network (**www.victoriaweather.ca**). This network operates out of the University of Victoria. The measurements from the school weather station network are measured using the Davis Vantage Pro2 Plus weather station. The stations measure temperature, humidity, atmospheric pressure, wind speed, insolation (sunshine), UV index and rain.

Davis Vantage Pro2 Plus Weather Station

Water Daily Demand

Water daily demand is a measurement of the amount of water used by the people on the water system in a day. These measurements are taken to help plan how best to meet current and future water needs. The CRD Water Services monitors daily, weekly, and monthly patterns of both rainfall and water use. Daily demand is often converted to monthly demand. As the graph below indicates, seasonal patterns of weather (rainfall) and average monthly demand help tell the story of when we receive the most rainfall and when we use the most water. By understanding these seasonal patterns, water managers can make decisions about when to implement the Water Conservation Bylaw. For example, the Water Conservation Bylaw for Stage 1 is applied from the period from May 1st to September 30th each year. This bylaw defines watering schedules and other water use restrictions applicable during that time.

Greater Victoria
Average Monthly Precipitation and Consumption



PROCEDURE

Prior to class, reserve the computer lab (if needed) and decide which set of data to use: either the data tables provided or data from the CRD website and the Victoria Weather Network and then gather the data for in-class use.

To gather data from the CRD website, go to page **http://www.crd.bc.ca/water/** and extract the Water Watch data on a month-by-month basis for your selected year. Do this by taking the actual rainfall from the last week of each month to generate monthly data for the year. You can use the Water Watch data provided in the lesson plan as a template.

Teachers can find out if their school has a weather station, by going to the following website:
http://www.victoriaweather.ca/all_current_data.php

If there is no local school-based weather station, pick a weather station closest to you on the network. To gather rainfall data from the School-Based Weather Network go to: **http://www.victoriaweather.ca/** and go to " *Stations in the Network.*" Pick your school or a school close to your school and click on the link to that school's data page. Click on "*More Data*" to access Data Summary Options. Click on "*Total Rain.*"
The table that results will be for the current year. To get data to compare to the CRD watershed, click on "*Select a Year*" and click on your preferred year. This will bring up a table for that year. See the example for Mount Douglas High School included in this activity. This data can be printed out prior to this activity or, alternatively, the teacher can ask students to print the table as homework prior to the lesson.

PART A:

1. Start this activity by asking a question such as: "with all the rain we get in the Greater Victoria, why should we be concerned about how much rainfall we get?" "Why might we be worried about water and climate change?" Ask students to make a list of what they know about this topic and what questions they might have.
2. Explain to students that they will examine and graph actual rainfall data from the CRD's Sooke Reservoir watershed as well as data from their school. In this case, actual data from CRD Water Services "Water Watch" and local school data from the School-Based Weather Station Network will be used.
3. Explain that rainfall is measured in millimeters or "mm". Show students a photo of the school's weather station or an actual water gauge supplied from CRD Water Services and demonstrate how precipitation is measured.
4. Give students the CRD data from the table provided (Table 1: 2007 data/Table 2: Water Watch) or use the Water Watch data, for the year you have selected.
5. Explain to students that total rainfall will be compared month by month, using data from the school weather station (see Table 3 example) and from the CRD watershed to further understand the microclimates of the Greater Victoria area.
6. Review the data tables with students. Ask them to examine the data provided on the two tables by:
   - Finding the total rainfall per month;
   - Having them select a month from each season (e.g., spring, summer, fall, winter) in each data table and compare figures. By doing this, students should get the general idea of the trends represented by the data.
7. Review how to set up graph paper using the template provided or how to create a graph using Excel®. See Additional Resources for websites for educators wanting to learn how to use Excel for graphing. This graph will be used in Part B of this lesson with the addition of a third variable (water usage).
8. Hand out the Student Activity Worksheet Part A and have students complete the graph of School rainfall and CRD watershed rainfall.

9. Review the results with students and discuss the following questions:

   - Which area has more rainfall?
   - Is the rainfall pattern similar for each area, why or why not?
   - If you were a climate scientist or water resource manager, what other variables might you want to plot to help you manage water resources?

PART B:

1. In this second part of the lesson, students will use the graph they created in Part A to compare rainfall patterns and water demand (that is, water use by consumers) within the CRD system. The objective of this part of the lesson is to understand that, within the CRD, the greatest demand on our water resources occurs when we receive the least amount of rainfall to recharge our reservoirs. In addition, this already challenging situation may become more difficult for our water supply in the future due to the effects of climate change and population growth.
2. In this case, we make use of the Water Watch average monthly consumption data. Students can get the CRD data from the table provided (Table 4: 2007 data) or go to the Water Watch page and extract the data on a month-by-month basis (Hint: take the Average Daily Demand for the month and multiply it by the number of days in that month). This data is provided in "ML" or million litres.
3. Review the graph "Average Monthly Precipitation and Consumption" with students and tell them they will make a similar one that includes their own microclimate at their school.
4. Hand out the Student Activity Worksheet Part B and have students complete the graph of Monthly Precipitation and Monthly Consumption.
5. Go over the results with students and discuss the following questions:
   - Based on the graph, what is the relationship between rainfall and water consumption?
     (We use nearly twice as much water in the summer than in winter, with the increase due mostly to watering lawns and gardens. This can mean that we can have summer water shortages because we have limited storage in our reservoirs and get most of our annual rainfall during the winter months.)
   - Climate scientists predict that climate change may bring more winter rainfall and longer, hotter and drier summers. How will this affect the supply of water in the CRD?
     (We will receive more water that we might be able to store, yet will have to increase the storage capacity in our reservoirs to take advantage of this additional supply. Increasing storage capacity has significant financial and environmental costs that must be considered. If there is no increase in storage capacity, there will be longer time periods during which we would have to use a limited supply – this means that there will be a need for water conservation and water efficient technologies.)
   - What are some of the ways that we might be able to manage the potential impacts of climate change on our water supply?
     (Brainstorm ideas for water conservation, water efficient technologies, and other ways to manage water usage at home, schools, and businesses.)
6. Wrap up the lesson by reviewing what students knew about the topic of water and climate change and the questions students had at the beginning of the lesson. Discuss any outstanding questions.

Evaluation

Have students:

- Complete graphs of rainfall and rainfall versus water usage and discuss the relationship between the two variables;
- Predict what will happen to our water supply if climate change increases rainfall during winter and lessens rainfall during the summer months;
- Describe possible impacts of climate change on water availability and how those impacts might be managed.

Extensions

1. Students have graphed current data of rainfall and water usage. Ask students to predict what the impacts will be if the CRD population increases by 5% with the same amount of rainfall. What about if population increases by 5% and there is a 20% decrease of summer rainfall?
2. Create one or more simple computer models using Excel® by changing the data; discuss the resulting graph(s).

Community Connections

Ask students to research other ways to find out about local climate trends, such as local weather media (TV, radio, newspapers, nearby schools in the weather network, University of Victoria Climate Lab, etc.).

Invite a local TV station weather reporter into the classroom.

Additional Resources

Canadian Centre for Climate Modeling and Analysis. **http://www.cccma.bc.ec.gc.ca/eng_index.shtml**

Graphing links using Excel:

http://www.ncsu.edu/labwrite/res/gt/gt-menu.html

http://phoenix.phys.clemson.edu/tutorials/excel/graph.html

http://chemed.chem.purdue.edu/genchem/lab/datareports/excel/plotting.html

http://chemed.chem.purdue.edu/genchem/lab/datareports/excel/excel.html

References

CRD website: **www.crd.bc.ca/water**

Lemmen, D.S., Warren, F.J., and Bush, E., Editors; *From Impacts to Adoption: Canada in a Changing Climate 2007.* Government of Canada, Ottawa, ON 2008.

Table 1: CRD Water Watch

Rain Totals for Sooke Reservoir Intake for 2007

Month	mm
January	495.4
February	162.6
March	340.8
April	102.3
May	24.0
June	21.6
July	41.1
August	33.0
September	64.4
October	195.1
November	120.1
December	323.0

Table 2: CRD Water Watch Sample Page

Capital Regional District - Water Services
Water Watch for September 30th 2007

1. Useable Volume in Storage

Reservoir	September 30 10 year average		September 30/06		September 30/07		% existing full Storage
	ML	MIG	ML	MIG	M33,	MIG	
Sooke	33,915	7,461	55,588	12,229	61,931	13,625	67%
Goldstream	6,983	1,536	7,486	1,647	7,365	1,620	75%
Total	**40,898**	**8,997**	**63,074**	**13,876**	**69,296**	**15,245**	**68%**

2. Average Daily Demand

For the month of September	165.3 ML	36.37 MIG
For the week ending September 30, 2007	139.7 ML	30.73 MIG
Max. day September 2007, to date:	207.4 ML	45.64 MIG

3. Average 10 Year Daily Demand for September

Actual	175.8 MLD [1]	38.68 MIG [2]
Adjusted for Population	139.7 ML	40.48 MIG

[1] MLD = Million litres Per Day [2] MIGD = Million Imperial Gallons Per Day

4. Rainfall September

Average (1914 - 2006)	62.4 mm
Actual Rainfall to Date	64.4 (103% of average)

5. Rainfall Sept 1 - Oct 1

Average (1914 - 2006)	62.4 mm
2007	64.4 (103% of average)

6. Water Conservation Action Required:

Stage 1 of the water conservation bylaw has ended for the year, but using water wisely is a year round activity.

Check our website at www.crd.bc.ca/water for more information on the bylaw.

If you require further information, please contact:

Capital Regional District Water Services
479 Island Highway
Victoria, BC V9B 1H7

(250) 474-9600

Table 3: School Based Weather Network - Sample School Data

Rain Totals for 2007
at Ian Stewart Complex/Mt. Douglas High School

Month	mm
January	169.5
February	68.5
March	95.2
April	25.7
May	9.4
June	20.1
July	26.3
August	15.7
September	11.3
October	48.1
November	57.4
December	128.9

Table 4: CRD Water Monthly Consumption Summary

CRD Monthly Water Consumption Tables for 2007

Month	million litres
January	3,639.4
February	3,236.8
March	3,630.1
April	3,693.0
May	4,950.7
June	5,850.0
July	6,736.3
August	6,500.7
September	4,959.0
October	3,868.8
November	3,516.0
December	3,499.9

NAME: BLOCK:

WATER AND CLIMATE CHANGE – PART A

ASSIGNMENT INSTRUCTIONS:

AIM: The objective of this activity is to graph data similar to what climate scientists and water resource managers use to identify climate and rainfall trends.

You will use actual data from CRD Water Services "Water Watch" and from your own school or from the School- Based Weather Station Network. Total rainfall will be compared month by month with data from the school's weather station and from the CRD watershed to further understand the microclimates of the Greater Victoria area. Finally, you will consider what impacts climate change may have on your water supply.

MATERIALS:

- Tables of Rainfall data
- Coloured pencils (at least three colours)
- Excel Spread Sheet or Graph paper

PROCEDURE:

1. Select a colour for each line on your graph. Place the Month on the horizontal axis and Rainfall (mm) on the vertical axis (determine your scale based on your rainfall data).
2. Plot each measurement from your first table as a point on your graph. Make a line graph using Excel or connect the points with a line using one of the coloured pencils.
3. Plot the measurements from the other table as points on the graph. Make another line graph using Excel or fill connect the points each month with different coloured pencil.

DISCUSSION:

Answer the following questions:

Which area has more rainfall in July? In December?

Is the rainfall pattern similar for each area? Why or Why not?

If you were a climate scientist or water resource manager, what other variables might you want to plot to help you manage water resources?

Precipitation Template

Monthly Precipitation at Sooke Reservoir and _____ School

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	
Average Monthly Consumption (M Litres)													
Average Monthly Precipitation (mm)													

NAME:	BLOCK:

WATER AND CLIMATE CHANGE – PART B

ASSIGNMENT INSTRUCTIONS:

AIM: The objective of this activity is to graph rainfall data from the CRD Sooke Reservoir watershed and monthly water consumption from CRD Water Services to better understand the relationship between the water that is available to us at any given time and the water we use in our homes, schools, and businesses.

MATERIALS:

- Tables of Rainfall data and CRD Water Consumption Totals
- Graph from Part A
- Coloured pencils
- Excel Spreadsheet or Graph paper

PROCEDURE:

1. Make a copy of your graph from Part A.
2. Add a new right hand axis for Water Consumption (million litres).
3. Plot the measurements from the Water Consumption table as points on the graph. Make a bar graph using Excel or fill in the bars with one of the coloured pencils.

DISCUSSION:

Answer the following questions:

Based on the graph, what is the relationship between rainfall and water consumption?

Climate scientists predict that climate change may bring more winter rainfall but longer, hotter summer dry seasons. How might this affect the supply of water in Greater Victoria?

List some of the ways that we might be able to manage the potential impacts of climate change on our water supply.

Precipitation & Consumption Template

School	Average Monthly Consumption (M Litres)																
																	Dec
																	Nov
																	Oct
																	Sept
																	Aug
																	July
																	June
																	May
																	April
																	Mar
																	Feb
																	Jan
	Actual Monthly Precipitation (mm)																