

# How Do Our Landuse Decisions Affect the Biogeochemical Cycles?

## Overview:

Alberta today is facing some tough decisions. How do we balance our need to protect our ecosystems, yet maintain economic viability? Oil and gas extraction, agriculture, forestry, mining, and water extraction have many unintended consequences on our ecosystems through disruption of the biogeochemical cycles. Since all matter is cycled through the ecosystem, disruption of one part of a cycle can have drastic effects on the ecosystem.

In this activity, you will examine the four biogeochemical cycles, carbon, oxygen, nitrogen and phosphorus. Since land use affects these cycles, you will use a computer simulation ([www.albertatomorrow.ca](http://www.albertatomorrow.ca)) to see what changes have taken place in the past in your local area, and make decisions about natural resource management and resource development and try to come up with a sustainable plan for Alberta's future, one that balances the environment and the economy.

## Objectives:

Students will:

- examine the biogeochemical cycles of water, carbon, nitrogen and phosphorus in relation to the cycling of all matter in the biosphere.
- investigate the consequences of resource production, urbanization, and economic growth on environmental, societal and economic indicators.
- examine the negative environmental impact of disruption of the biogeochemical cycles as a result of resource production, urbanization and economic growth.
- analyze water samples for DO, BOD, turbidity, fecal coliform, nitrate, phosphates and pH, macroinvertebrates.

## Biology Curriculum links:

### Attitude Outcomes:

Stewardship: Students will be encouraged to: demonstrate sensitivity and responsibility in pursuing a balance between the needs of humans and sustainable environment e.g.

- Assume part of the collective responsibility for the impact of humans on their environment
- Encourage their peers or members of their community to participate in a project related to sustainability
- Consider all perspectives when addressing issues, weighing scientific, technological and ecological factors
- Discuss both positive and negative effects on human beings and society of environmental changes caused by nature and by humans
- Promote actions that are not injurious to the environment

### Nature of Science Outcomes:

NS6a – Concepts, models and theories are often used in interpreting and explaining observations and in predicting future observations.

### Developing a Social and Environmental Contexts

SEC3 – science and technology have both intended and unintended consequences for humans and the environment

### Unit A: Energy and Matter Exchange in the Biosphere:

20 – A2.1k Students will: explain and summarize the biogeochemical cycling of carbon, oxygen, nitrogen and phosphorus and relate this to general reuse of all matter in the biosphere

20 – A-2.1sts Students will: explain that science and technology have both intended and unintended consequences for humans and the environment

- Discuss the influence of human activities on the biogeochemical cycling of phosphorus, sulphur, iron and nitrogen:
  - Feedlot operations
  - Fertilizer application

- *Waste and sewage disposal*
- *Discuss the use of water by society, the impact such use has on water quality and quantity in ecosystems, and the need for water purification and conservation*
  - *Petrochemical industry*
  - *Agricultural systems*
  - *Mining industry*
  - *Vehicle and Refinery emissions*
  - *Domestic daily water consumption*
  - *Acid Deposition*

20 – A2.2s Students will conduct investigations into relationships between and among observable variable and use of a broad range of tools and techniques to gather and record data and information

-Measure and record the pH and the amount of nitrates, phosphates, iron or sulphites in water samples

20-A2.4s Students will work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results

-*Work collaboratively in a group to investigate the influence of human activities on the biogeochemical cycles and use appropriate multimedia to present the information to a group*

20 – A3.2k Students will: explain how the equilibrium between gas exchanges influence atmospheric composition

20 – A3.2sts explain that science and technology have both intended and unintended consequences for humans and the environment

- *Describe how human activities can have a disrupting influence on the balance in the biosphere of photosynthetic and cellular respiratory activities:*
  - *Fossil fuel consumption*
  - *Forest destruction*
  - *Agricultural Systems*
  - *Domestic Water consumption*

*ICT Curriculum links:*

C6 – Students will use technology to investigate and/or solve problems:

- 4.4 generate new understandings of problematic situations by using some form of technology to facilitate the process

F1 – Students will demonstrate an understanding of the nature of technology

- 4.1 assess the strengths and weaknesses of computer simulations in relation to real-world problems

F3 4.1 demonstrate an understanding of how changes in technology can benefit or harm society

**Duration:** Approximately 3-60 minute class periods  
(Field Trip would be an additional day)

**Required Materials:** Internet Connection/Computer Lab: [www.albertatomorrow.ca](http://www.albertatomorrow.ca)

**Teacher Background:** Land use has both intended and unintended consequences on the environment and our quality of life. With Alberta Tomorrow, teachers can create an account under which their students will register. Students will watch a series of short videos talking about land use and environmental quality in Alberta. The videos can be used to graphically explain the biogeochemical cycles and what happens when humans interfere with these cycles.

After locating their school on a map of Alberta, the students will investigate historical changes on the landscape. If participating in the supplemental Alberta Tomorrow Field Trip, students will observe changes taking place on the landscape, and the effects of land use on water quality. After analyzing the water quality data, students will be challenged to create a sustainable land-use plan that aligns with the goals they have set for environmental, and socio-economic goals.

**Procedure:**

**Intro:**

Prior to class, you will create a teacher account at [www.albertatomorrow.ca](http://www.albertatomorrow.ca). Be sure to create a class for your students to register under. Your class may be something like Bio20 Fall 2018 for example. Your students will create students accounts and join your class. For privacy issues, please instruct your students not to use their real names as usernames.

*Show a picture of a healthy lake and a eutrophic lake. What is the difference?*

*Show a picture of an ecosystem with plants and animals. What processes are going on here?*

*Show a picture of a factory with smoke being released, or exhaust from a vehicle. What processes are going on there?*

Which processes are natural?

Explain the following Statement? “Energy Flows and Matter Cycles”

Energy follows the laws of thermodynamics which state that Energy is neither lost nor gained but transferred from one form to another. The second law of thermodynamics states that at every energy conversion, some energy is lost as heat. Therefore, there will become a point where there will be no useable energy left and energy must be added to the system. This energy comes from the sun. The living world is a closed system, it depends on the cycling of matter throughout the ecosystem. For example, if a tree falls in a forest and doesn't decompose, all the carbon that is incorporated into the tree's tissues would remain in that tree rather than going back into the soil. The amount of carbon dioxide would therefore become less and less as more trees die. This however, doesn't happen. When a tree dies, it decomposes, returning nutrients to the soil and releasing carbon dioxide back into the atmosphere. Plants can again use this carbon dioxide for photosynthesis.

Biogeochemical cycles move matter through the abiotic and biotic world. Matter such as carbon, water, nitrogen and phosphorus is cycled throughout the ecosystem. The pictures you saw show the cycling of matter. Biogeochemical cycles are taking place in these pictures.

When humans interfere with this cycling, it can have drastic effects on the rest of the ecosystem.

We will first examine the carbon and water cycles, and then investigate the nitrogen and phosphorus cycles .

**Part A: Biogeochemical Cycles and Video Questions:** Have students view the videos and complete the biogeochemical cycles work sheets.

**Part B: Landuse Assessment:** Go to [www.albertatomorrow.ca](http://www.albertatomorrow.ca)  
What has happened to your local area in the past 30 years?  
Complete the Student Worksheets

**Part C: Optional Field Trip**  
See Alberta Tomorrow Field Trip

**Part D: Future Land-Use Plan:**  
You have now seen how land-use affects the biogeochemical cycles. Now you will use the land-use simulator to develop a sustainable development strategy that balances economic (forestry, oil and gas and agriculture) and the environment.

Complete the Sustainable Development Worksheet as you work through the simulator.

### Conclusion:

Have students work collaboratively to:

- compare their land use plans to their classmate's plans
- create multimedia “State of the Landscape” video reports that can be uploaded to [www.albertatomorrow.ca](http://www.albertatomorrow.ca)

Projects should include:

1. Description of their local area: landscape type, land-uses present.
2. Land Use Assessment.
3. The impact of land-use on the environment (specific mention of the biogeochemical cycles).
4. Analysis of data from field trip.
5. Different scenarios for future land-use plans.
6. Explanation of how technology can have both intended and unintended consequences on humans and the environment.

**Evaluation:**

Students will print and hand in or submit their reports electronically through the website.

Marking Rubric. (Rubric can be found with the worksheet answers)

**Extensions/Variations:**

- Investigate how the Oil Sands are affecting the ecosystem.
- Have students create a poster board of their land use plan to be presented to the class.
- Research solutions to land use problems used around the world
- Land Use Debate (See Social Studies 9 Lesson Plan)
- Design a “bio bottle” closed ecosystem. The students must identify what must be included to have the biogeochemical cycles functioning and explain the nutrient cycling taking place within the bottle.
- Research regulations in Alberta on disposal of manure, water quality and use
- Interview community members working in forestry, agriculture, the oil and gas industry, non-profit environmental or conservation organizations
- List changes the students can make in their own lives to lessen their impact on the environment