TOPIC 8. WATER — THE TRANSPORTER

Chapter 8

Purpose

To help students gain an awareness about another of water's cyclical roles — as a transporter of sediment — and to have students see that the movement of sediments in water affects the environment.

Subject areas

Science, Geography, Language Arts, Math, Environmental Studies, Art

Procedure

1. Focus students' attention on this topic by asking them if they have noticed how water in rivers and streams can change colour in spring when it is moving faster. Find out if they know why water changes colour, and if they are aware that water can carry away valuable topsoil and transport toxics.

2. Draw their attention to another of nature's cycles: that of erosion, transportation, and deposition.

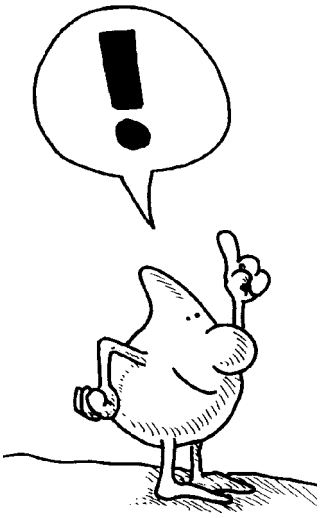
3. Lead a discussion about how human activities add sediment to the water systems through forestry, agriculture, and construction, for example. Ask how sediment might harm the environment.

Vocabulary

deposition *erosion*	*navigation* *suspended solids*	*sediment*

References

- Freshwater Series A-8: "Water — The Transporter"



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What does water transport?

If someone asked you how water carries things from one place to another, you would probably think of the ships, barges, and canoes that travel on water and carry goods and people around. You might even think of your water skis that let you skim over the lake. But these aren't the only things that water transports.

Take a good look at your favourite beach. Notice how sandbars or other deposits of sand grow larger or smaller from one year to the next. This is because water transports soil from one place to another in the form of **sediment**. First, water erodes soil from the land and then, by its river systems and currents, moves this soil to other areas, and deposits it there.

This is another of nature's cycles.

The cycle of **erosion**, transportation, and **deposition** is called the sediment cycle.

- The cycle starts with erosion, the weathering of small particles from rocks by water, wind, glaciers, plants, and animals. But this does not hap-pen overnight; it takes place slowly, over centuries or millennia (thousands of years), unless, of course, humans become involved, when erosion can take place much faster.

- When the eroded material is small enough, it is ready to be moved into streams and rivers and carried downstream by the flow of the water. This is the transportation part of the cycle.

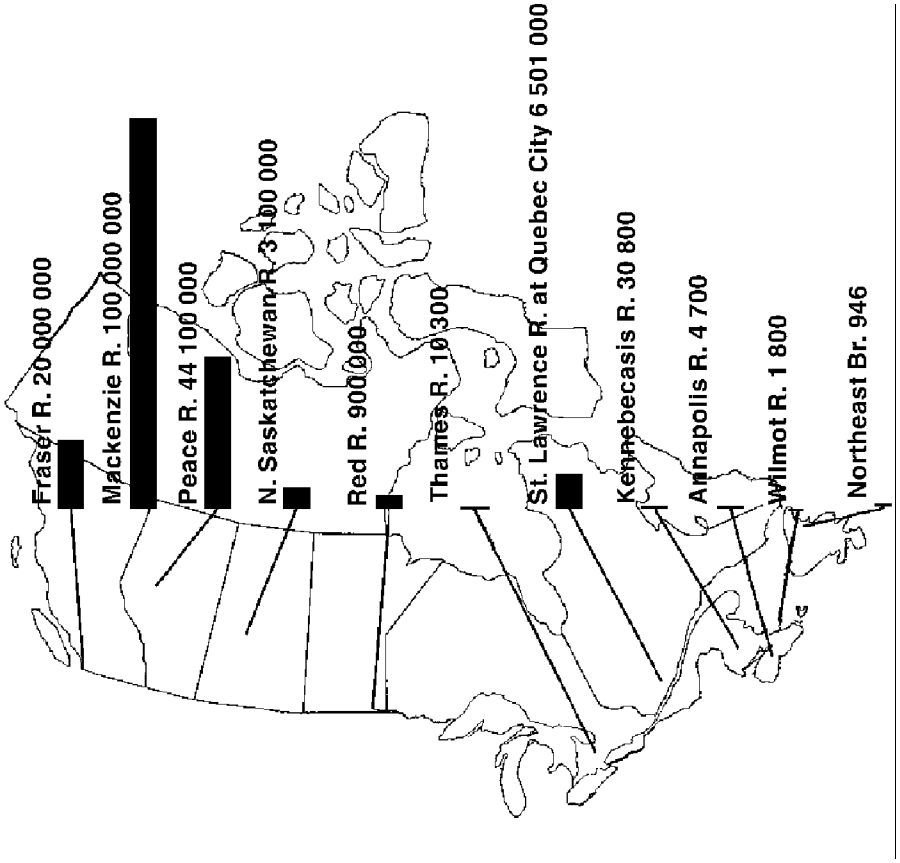
- The final process in the cycle is deposition: meaning that when there is not enough movement in the water to continue carrying the sediment, it comes to rest, or is deposited — on floodplains, on sandbars, on islands, and in deltas.

How much sediment is transported in Canada?

As you know, Canada is a huge country. The amount of sediment being transported depends on the area where you live. If you look at the map showing the average

sediment loads for rivers in Canada, you will see that western and northern Canadian waterways carry much more sediment than those in other regions. There are reasons for this.

Average annual suspended–sediment load (in tonnes)
for selected rivers in Canada



Canada's glacial history

Ten thousand years ago glaciers covered much of Canada. When the climate became warmer, the glaciers melted and left a great deal of erodible material across western Canada. In the mountains, where rivers such as the Fraser, Peace, and upper Mackenzie flow, steep slopes and plentiful water carry away large amounts of sediment.

In contrast, the flat and dry Prairies have lower sediment loads; and in eastern Canada, much of the land is bedrock and therefore provides smaller loads.

If a river or stream has a great rate of flow, it can carry many tonnes of sediment a year. One good example of this is the Fraser River, which carries an average of twenty million tonnes of sediment a year. The St. Lawrence River transports approximately 2.3 million tonnes of sediment past Montreal each year; this is equal to 230 000 truckloads of soil. Other rivers carry much less.

Why is sediment important?

You probably know that water moves particles of soil along with it because you have seen that rivers become muddy in spring when they are rushing downstream. But you may be surprised to learn:

- how much sediment water can carry
- what may be contained in the sediment
- what serious effects sediment can have on the environment

What are some of these effects?

- Pollution — Sediment sometimes carries toxic chemicals from sources such as agriculture and industries. These toxics pollute our water supplies.

- Obstruction of navigation — Sediment can also make navigation difficult or impossible. If sediment from fast-moving rivers is deposited downstream, it eventually builds up and may make the water too shallow for boats or ships to go through. Sediment in navigation channels may be a problem in your area, as it is in the Fraser River (British Columbia), the Mackenzie River (Northwest Territories), and the Great Lakes and St. Lawrence River system (Ontario and Quebec).

- Damage to fish/aquatic habitat — Sediment in streams directly affects fish in several ways:

    - Suspended sediment can irritate fish gills and lead to death. It can also destroy the protective mucous covering the eyes and scales of fish, making infection and disease more likely.
    - It cuts down on the light penetrating the water. This affects fish feeding and can reduce fish survival.
    - Settling sediments can bury and suffocate fish eggs.

- Sediment particles absorb warmth from the sun and thus increase water temperature. This can stress some species of fish.

- Damage to water supply plants — Sediment in the water can wear out pumps and turbines which in turn can increase the cost of keeping things in good repair. And this can increase the costs of water supplied to households in Canada.

- Interference with energy production — Sediment affects the size and life expectancy of reservoirs that were created for power generation. A dam traps sediment that would normally be carried downstream, and that sediment builds up and decreases the size of the reservoir.

- Erosion — Some farming practices increase soil erosion. This affects Canadians in three ways:

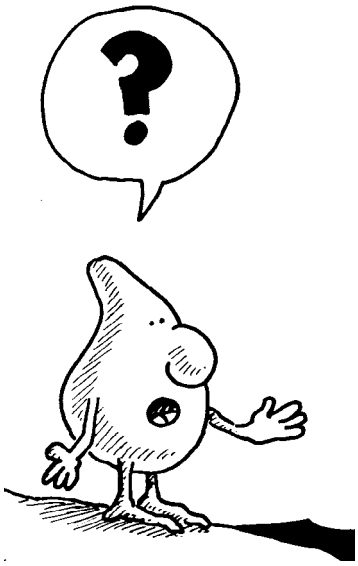
    - Productive soil is lost to farms.
    - Sediments and pollutants are added to streams.
    - Costs of maintaining irrigation systems rise.

- Negative effects from construction — Sediment from construction sites can find its way to sewers and streams and increase the cost of water treatment or affect aquatic life.

Canada's waterways move many millions of tonnes of sediment each year in this never-ending cycle. The sediment is measured and classified in three different ways:

- as suspended load (**suspended solids** in the water)
- as bed load (rolling or bouncing along the bottom)
- as bed material (stationary on the bed)

Once this sediment is measured and classified, it is analysed to determine just what is being transported in our waterways. The data from this research are then used to address environmental and engineering concerns.



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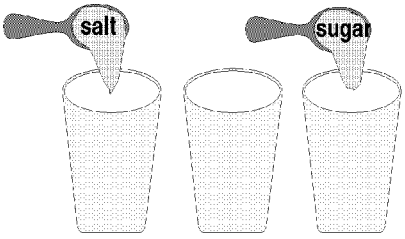
Activity 1 — Science

Conduct a simple experiment to demonstrate how water can be transporting solutions even though we cannot see them.



- Take three water glasses and fill them with water.
- Ask a classmate to put a spoonful of salt in one glass and a spoonful of sugar in another. Stir both glasses.
- When the solutions have settled, challenge other students to identify which glass of water is the "pure" one.
- What conclusions would you draw from this simple experiment?
- What message would you deliver to others?

Activity 2 — Geography, Math

Check back to the map of Canada that shows the average annual suspended- sediment load for selected rivers in Canada.

- Make up ten math questions based on the information contained in the diagram.
- Explain why there are such differences between the load of the Mackenzie River and the load of the Thames River.

- Over 750 stations across Canada collect and analyze sediment data. Find out where the stations are in your province or territory. What are the loads of rivers in your region?

- Does sediment movement cause a problem in your province or territory? Explain why or why not.

Activity 3 — Art, Environmental Studies

Prepare a diagram or model to illustrate the stages in the sediment cycle.

Activity 4 — Environmental Studies, Research

Read the following case study, then find out whether your province or territory takes measures to protect the environment during construction as was done in St. John's.

When people in St. John's, Newfoundland began to build the Institute for Marine Dynamics in 1982, they also built a desedimentation plant to keep sediment from reaching the water supply.

They used a settling pond and added alum to the water. Alum is the short name for aluminum sulphate, a compound that acts as a magnet, attracting dirt particles, which may colour the water. As the sediment particles come together, or coagulate, they become heavier and settle to the bottom of the tanks. (The water purification plant in your community may use alum in its process; if so, you might want to learn more about how it works.)

Over three years, 1250 tonnes of sediment were kept from entering the nearby water of Rennie's River. The cost of the desedimentation was less than one tenth of the con-struction costs, and a trout habitat was protected from contamination.

Activity 5 — Science, Environmental Studies

As you read in the Student Information sheets, sediment can harm fish populations.

Take one or two of the harmful effects mentioned and find out how and why these things happen. For example:

- how does sediment change the way light penetrates water?
- how does this light change affect the feeding and survival of fish?
- how does sediment irritate fish gills and how can it cause death?
- what kinds of infection and disease do fish get from sediment?
- how do sediment particles absorb warmth from the sun and increase water temperature?
- what can happen when fish are stressed?

If you can, find examples of some of these events and when they happened.

Include diagrams to explain your research.

Activity 6 — Environmental Studies, Research

Many sediment problems are caused by human activity.

Deforestation and sediment problems

Sediment problems caused by deforestation occur in several Canadian provinces for example, British Columbia, Ontario, Quebec, New Brunswick, and Newfoundland:

- Tree cutting can increase water runoff and soil erosion, thus adding to the sediment transported by river systems.
- Tree cutting can also release chemical substances that occur naturally in forest soils.

Take either of these topics and find out the relationship between forestry practices and sediment in the water system in your area.

Agriculture and sediment problems

Sediment-related problems associated with agriculture occur across Canada. For example:

- toxic chemicals are added to the environment
- soil is eroded and thus lost to farmlands
- costs of maintaining irrigation systems are increased

Take one of these topics and find out what is happening in the area of agriculture in your region or province.