MESSIN' IN THE MUD

Grade Level: 4 - 12

Subjects: Math, Social Studies, Science

Duration: 30 minutes

Group Size: Individual

Setting: Classroom

Key Vocabulary: sedimentation, Cesium 137, radio-isotope

Materials:
- *graph paper*
- *sedimentation rate handout*

OBJECTIVES

Students will acquire a basic understanding of:

1. how sediment samples are gathered
2. how sedimentation rate values are calculated.

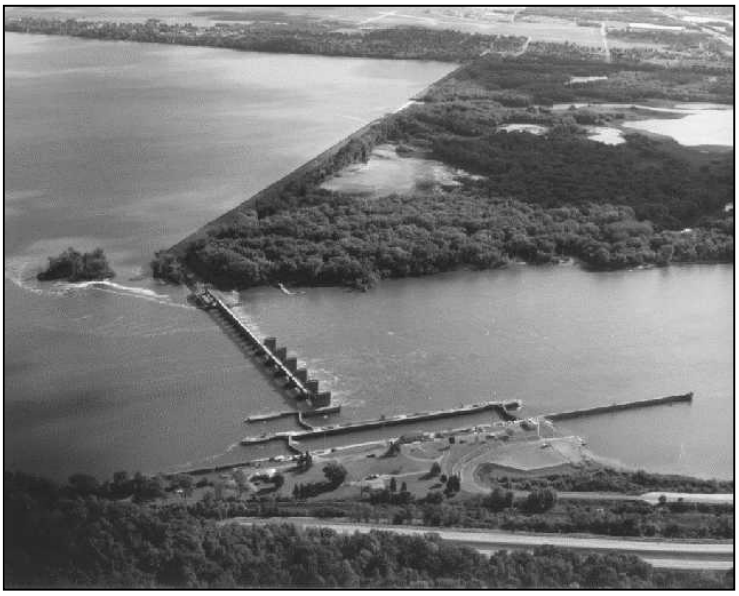
METHODS

Students graph and interpret actual Mississippi River data of sediment accumulations.

BACKGROUND

Commercial navigation on the Upper Mississippi was enhanced in the 1930's with the construction of a lock and dam system. This lock and dam system provided a 9-foot deep navigation channel and transformed the free-flowing Upper Mississippi River into a series of 27 shallow pools.

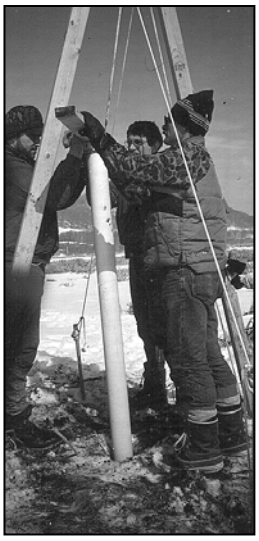
The purpose of the locks and dams was to create a series of pools, or impoundments, that would provide adequate depth for navigation. These pools form a stair step of water between Minneapolis, Minnesota, and St. Louis, Missouri to assure a navigation channel of at least nine-feet deep for commercial navigation. The construction caused lowland flood plains upstream from the dams to become permanently flooded and transformed from seasonal wetlands (marshes and swamps) to large pools of water.



Unfortunately, stabilization of water levels also disturbed the natural balance of the river by reducing its current velocity and thereby its ability to transport sediment. The resultant decrease in water velocity has accelerated the rates of sedimentation along the river.

The effects of man's physical alteration on the once free-flowing,

unchanneled river have become increasingly evident in recent years. Sediment is now considered one of the river's most damaging pollutants. The constant erosion of upland sediments threatens to fill in major backwaters of the Mississippi within the next 50 to 100 years. The rate of sedimentation and erosion in the river corridor is therefore an important factor to monitor.



Sediment core sampling during the winter on the Mississippi River.

One way in which sedimentation rates can be determined is by obtaining bottom samples of the river and analyzing the contents for the depth at which the radio-isotope cesium-137 appears (Figure 1). ^{137}Cs is a radioactive product of the explosions from nuclear bomb tests carried out in the 1950's and early 1960's.

Nuclear fallout first entered our environment in 1954 with the running of nuclear tests. Peak nuclear testing by Americans occurred during the years of 1957-58; heavy Russian nuclear testing occurred during the years of 1962-64; and in 1971, the French and Chinese engaged in some limited nuclear testing. The deposition of radioactive material was greatest during the Russian testing phase, followed by that of the Americans, and lastly, by the French and Chinese.

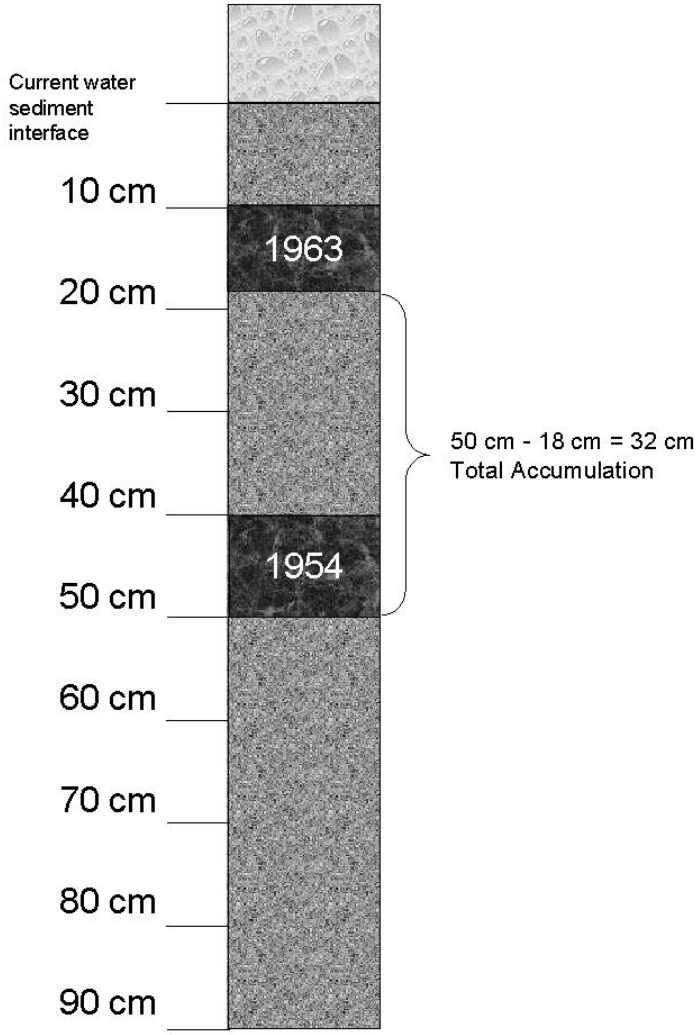
Sediment core sample.

Assuming the fallout from these nuclear tests is uniformly distributed; ^{137}Cs and other radioisotopes would expectedly be found in fields, watersheds, and existing surface soils and sediments in similar quantities. ^{137}Cs binds strongly to small particles such as clay and organic matter, and consequently tends to retain it's positioning in the soil column rather than absorbing further downward. When erosion of surface soils occurs, some of the soil particles that have ^{137}Cs bonded to them will be deposited downstream as sediment. Provided that an accumulating sediment profile is left undisturbed, and that regular erosion of the sediment occurs, the sediment deposited downstream will reflect the following fallout pattern: ^{137}Cs absent prior to 1954; 1954-58, increase in the level of ^{137}Cs; then, following a slight decrease, a large peak corresponding to 1963-64. From 1964 onward, concentrations or ^{137}Cs show a fairly rapid decline to currently low values, with exception of a small jump in 1970-71.

Sedimentation rates have lowered in recent years but are, unfortunately, still a threat to the Upper Mississippi River valley. The present rates of accumulation are significant enough to convert some backwater lakes into marshes within the next century. Since much of the upland drainage basin is being utilized in

cultivation, maximum conservation of upland soils is crucial to the maintenance of the Upper Mississippi River. (See WQ 4-5 for more information on sedimentation.)

Figure 1. Example of a sediment core using Cesium 137 to deteremine sedimentation rates



The diagram shows the bottom of the first peak (1954) at approximately 50 cm. Cesium 137 was absent from the environment prior to 1954, therefore, in this area of the Mississippi River the maximum depth of the bottom of the first peak would be 50 cm.

The bottom of the second peak (1963) is at 18 cm. This represents the second of two main peaks which occurred in 1954-58 and in 1963-64. This information suggests that the bottom line of the first peak occurred in 1954, and the bottom line of the second peak occurred in 1963. If we consider these to be inclusive years, we can say that 32 cm of sediment accumulated over this 10 year time period.

MATERIALS

- graph paper
- Table 1

PROCEDURES

1. Share and discuss the background information regarding how the construction of the locks and dams and other factors have contributed to accelerated sedimentation in the Mississippi River. Point out the positive and negative impacts of sedimentation on Mississippi River fish and wildlife.

2. Describe to students how ^{137}Cs is used as one means of determining sedimentation rates in the Mississippi River. (Fig 1 may be helpful).

3. Provide students with the sedimentation rates data from Table 1. Have them graph pool number (x-axis) versus sedimentation rate (y-axis) for the 1954-64 and 1965-75 time blocks. Students should include a legend with their graph.

4. Have students generate possible explanations for differences in the amounts of deposited sediment for the different pools as well as the different time blocks (i.e. quantities of suspended sediments increase as you go downstream, farmlands in tributary watersheds contribute to greater degrees of erosion where the tributary enters the Mississippi River).

5. Have students speculate on the reasons behind the decreased sedimentation rates in more recent years (i.e. soil loss reduction techniques such as contouring, conservation tillage, contour strip-cropping).

ASSESSMENT

1. Where does ^{137}Cs in the environment come from? (It came from nuclear fall out.)

2. How is ^{137}Cs used to determine sedimentation rates? (Instruments can detect the layers of radiation in the soil. The layer of radiation provides a "marker" within a window of time when it was released into the atmosphere.)

3. List three things (human induced or natural) which contribute sediments to the Mississippi River. (Agriculture, construction, stream bank erosion, island erosion, urban runoff from streets and parking lots.)

4. How does sediment impact the Mississippi River habitats and critters? (Sediment transport is necessary in the river to provide sand bar habitat for

shorebirds and nesting turtles. Sedimentation also degrades river habitat by filling in wetlands, covering up fish eggs and freshwater mussels, shading out light that plants need to grow.)

5. What are some ways of reducing the amount of sediments that reach the Mississippi River? (Strip cropping, stormwater retention basins, stream bank erosion protection, buffer strips along streams.)

EXTENSIONS

1. Remove the top and bottom of a smooth, clear plastic water bottle or container to form a "tube." At a river, lake, or marsh with a soft bottom (not rocky), push the tube gently into the bottom with a slight twisting motion. When the tube has been pushed as far in as possible, dig down with your hand to the bottom of the tube and lift out of the water. After wiping any mud off the outside of the tube, you should be able to see layers of sediment which have been deposited over time. This is similar to how core samples for calculation of sedimentation rates are done.

Table 1. Comparison of selected sedimentation rates for Pools 4 through 10, Upper Mississippi River.

POOL	PRINCIPAL TRIBUTARY STREAM	NUMBER OF PROFILES SAMPLED	MAXIMUM DEPTH ^{137}Cs(cm)	ESTIMATED RATE OF SEDIMENTATION (cm/yr) 1954-64 (AVERAGE VALUES)	1965-75 (AVERAGE VALUES)
4	Chippewa	5	60	3.4	1.2
5	Zumbro	5	60	3.1	1.1
5A	(none)	4	70	4.1	2.0
6	Trempealeau	6	90	3.0	3.3
7	Black	7	60	3.2	0.9
8	Root	6	80	2.8	2.0
9	Upper Iowa	8	70	4.3	1.2
10	Wisconsin	6	90	3.6	2.5
MEAN				3.4	1.8

Source: Wiener, James G., Richard V. Anderson, and David R. McConville. (ed.) Contaminants in the Upper Mississippi River. Boston: Butterworth Publisher, 1984.