The Movement of Sediment in the Old Woman Creek Watershed

A study by Case Western Reserve University

Research at Old Woman Creek has furthered the understanding of the critical role coastal wetlands play in the Great Lakes region. The ability of these wetlands to effectively trap and retain sediment is dependent on two factors:

1. the amount of sediment delivered to the wetland from the watershed and
2. the water level of the lake relative to that of the wetland.

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To develop better remedies to address sediment problems, researchers at Case Western Reserve University in Cleveland, Ohio, have been studying sediment movement within the Old Woman Creek watershed.

Developed by Christopher Wilson, Dr. Gerry Matisoff and Dr. Peter Whiting, this Case Western Reserve University study was funded by the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET). For more information on the study, please contact Case Western Reserve University at (216) 368-3690.

Soil loss is a problem, not only for farmers, but also for those who rely on the streams below the fields for food, water and recreation. Erosion removes nutrient-rich soil from fields, resulting in lower crop yields. This sediment, with attached nutrients and contaminants, enters the streams and travels to wetlands and coastal zones, degrading the water quality and productivity of these areas.

Wetlands, like the one at Old Woman Creek State Nature Preserve, act as "sinks" for sediment, nutrients and contaminants. The wetland areas at the mouth of Old Woman Creek have been preserved and protected as both a state nature preserve and national estuarine research reserve.

Old Woman Creek drains a 27 square mile (69km^2) region in north central Ohio. Agriculture has been the major land use activity in the basin since the mid-1800s. Today, about two-thirds of the watershed is in row crop agriculture–corn, soybeans and winter wheat.

The Old Woman Creek watershed lies in two counties; agricultural practices differ between the counties. One county mainly practices conventional tillage–fields are either plowed or disked annually. The other county practices conservation or no-till farming–plant debris is left on the soil after harvest. Conservation farming enables the root structure to stay intact, holding the soil in place.

Case Western Reserve University (CWRU) studies show that conventional tillage results in six to 10 times more sediment runoff than no-till areas. That agricultural sediment is washed from fields, travels downstream and is deposited along the way on the creek bed and banks, in vegetative stands, in the wetland or in Lake Erie.

Wetlands progressively lose their ability to filter as they fill with sediment. Cultivation and urbanization can increase erosion in the watershed, causing the wetland to fill more rapidly. The rate at which sediment is delivered to the Old Woman Creek wetland has increased tenfold due to human activities, during the last 150 years which included clearing the lands for farming and urbanization.

Lake Erie also influences the Old Woman Creek wetland. Water levels in Lake Erie change on both short-term (hours to days) and long-term frames (months to years). Winds during individual storms can cause water to build up on one side of the lake. As the winds slacken, the water will oscillate back and forth over a period of days. These oscillations are called seiches.

Water level changes on an annual basis are largely dependent upon the amounts of water entering Lake Erie from the upper Great Lakes. If snow and rain events are depressed in the upper Great Lakes, the amout of water flowing into Lake Erie will be decreased, and Lake Erie water levels will be lower.

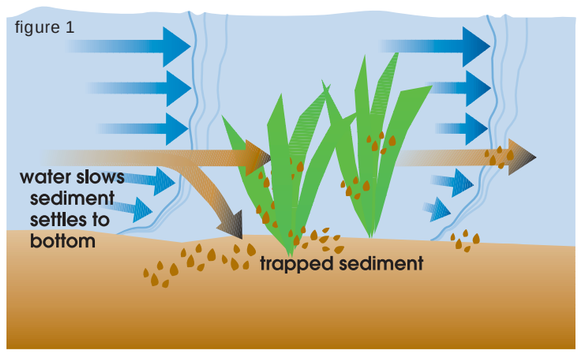
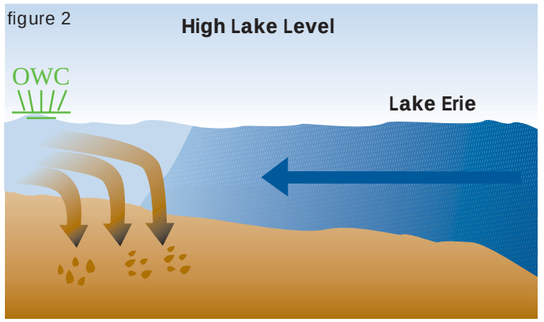
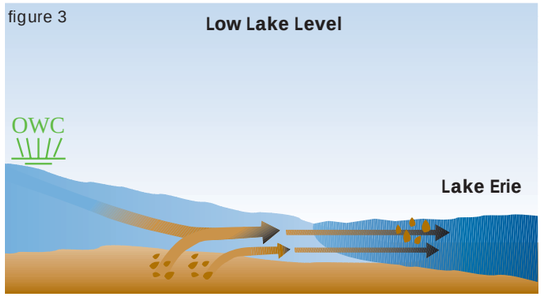
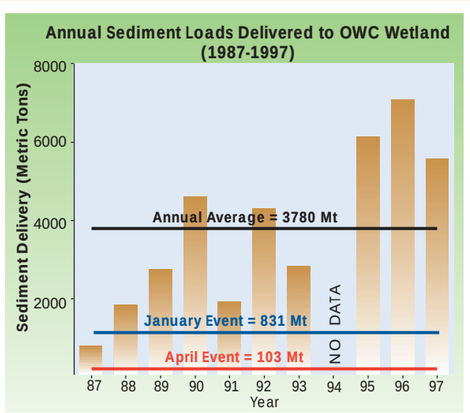


Figure 1 represents a wetland. Water slows as it spreads out into the wider wetland. The length of the blue arrows symbolize the speed of the water. As the water slows, sediment, which is carried with the water, settles to the bottom. Aquatic plants in a wetland also trap sediment (brown arrows) by preventing it from passing through to larger bodies of water, such as Lake Erie. The water passes through at a much slower rate, but the sediment settles out from the water and becomes trapped.

Figures 2 and 3 illustrate the effect of changing lake levels on wetlands like Old Woman Creek. River water slows when it meets the rising lake water as it floods the wetland, and sediment deposits. As the lake's level drops, lake water drains from the wetland. The entering stream water flows through the wetland into the lake, still carrying its sediment load. The river water may also erode sediment from the bed of the wetland. The elevation of the wetland and its ability to adequately filter sediment and pollutants from the water is controlled by factors inside and outside the watershed.







Between 1987 and 1997, an average 3,780 metric tons of sediment was delivered annually to the wetland. If all the sediment that entered the wetland over the years was retained in the wetland, the result would be a sediment layer, 17.5 millimeters thick. Eventually, the wetland would fill with sediment and lose its ability to filter the incoming sediment and contaminants from the water.

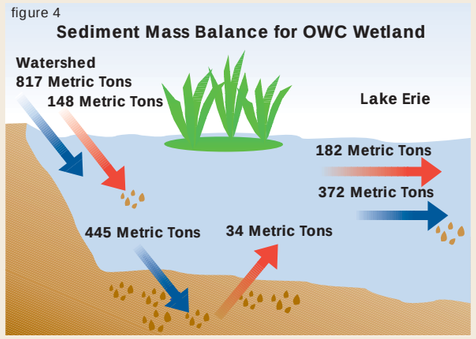
Wetlands, though, are not usually 100 percent efficient. CWRU studies have shown that the actual amount of sediment deposited over the past 50 years is about 5 millimeters per year.

Researchers at CWRU are tracking sediment movement through the watershed to identify sediment sources and understand the transport of sediment. Naturally-occurring radioactive particles delivered to the landscape with rain and snow tag the soil with a recognizable signature. This signature can be tracked as the sediment moves off the fields and downstream to the wetland. When combined with theoretical models, these natural tracers are used to determine the rate of soil erosion, the source of the sediment, the quantity and velocity of material in transit, the travel distances of the sediment, and the final areas and accumulation rates of sediment deposit.

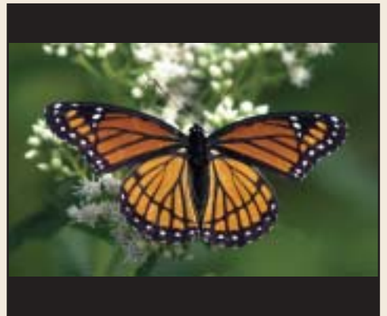
In the Old Woman Creek watershed, the movement of sediment is triggered mainly by large storms. The timing and intensity of a storm, coupled with the specific land use of the area, determines the amount of sediment which will erode. At Old Woman Creek, the majority of sediment appears to be transported into the wetland within a few hours of a rainstorm.

Nearly two-thirds of the watershed is agricultural–when these fields are bare, erosion occurs. During storms, researchers collect water and suspended sediment samples along the stream, including at the inflow and outflow to the wetland, to evaluate the transport of sediment.

The runoff from two storms were studied in detail to determine how sediment moves through the watershed and the wetland. The two storms removed about 148 and 817 metric tons of sediment from the watershed. The amount of sediment associated with each storm corresponds to 4 and 22 percent of the 1987-1997 average annual delivery to the wetland (3,780 metric tons).



The blue and red arrows in Figure 4 represent the January and April events, respectively. The wetland trapped 57 percent of the sediment delivered during the January storm. However, during the April storm, there was a net export of material to Lake Erie. A drop in lake level, due to the changes in the wind direction, may have caused erosion of sediment from the bed similar to the scenario presented. Over the long-term, though, the wetland traps 29 percent of the sediment delivered from the watershed. However, during individual storms, it is possible that the wetland can be a source of sediment to Lake Erie, especially when lake levels are low.

Sediment budgets were also developed for the two events. These budgets were used to determine the effectiveness of the Old Woman Creek wetland at trapping sediment. The budgets incorporate inputs from the watershed, as well as inputs from and exports to Lake Erie. The difference between the delivered and exported sediment was attributed to either erosion from, or deposition in, the wetland.

The studies show the variability in sediment discharge from individual storms. Using only long-term averages to develop Best Management Practices (BMPs) may obscure important details, like variability between storms. Therefore, both long-term and single event studies should be used to develop effective BMPs.