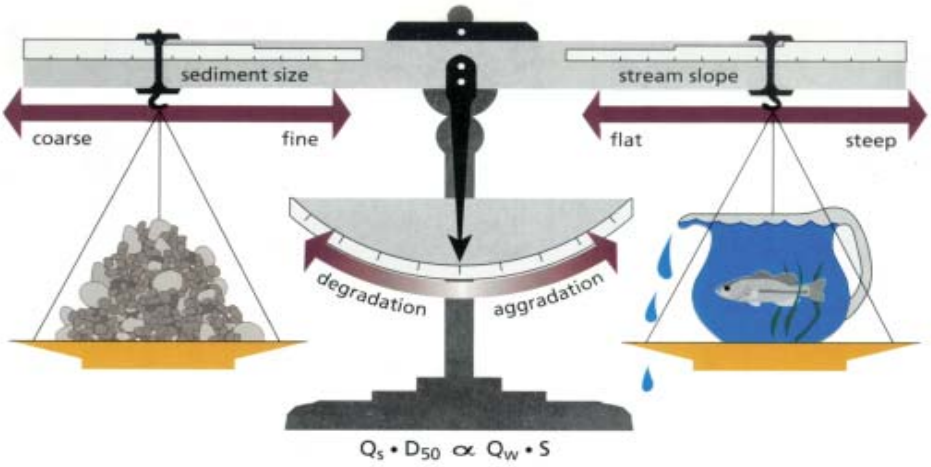
Stream Dynamics

Streambank erosion is a common resource concern seen in waterways throughout the state. The results—degraded water quality, unstable structures, and increased flood risks—impact communities environmentally and economically. Understanding stream dynamics is crucial in order to stabilize and maintain Illinois' streambanks.

Understanding Streambank Erosion

Natural streams change and adjust their shape and pattern in response to the speed, volume and duration of flow over long time periods. The way that natural forces interact to shift and alter stream patterns and characteristics is described as stream dynamics. A good understanding of stream dynamics in Illinois first requires recognition of how these natural forces (e.g. stream flow, sediment load) have been altered.

A Balancing Act



Stream balance equation (Lane, 1955), where Qs is sediment discharge, D50 is median grainsize of bottom sediment, Qw is water discharge, and S is slope of stream.

Over many years, streams develop their patterns and characteristics of transporting water and sediment from upland areas, through floodplains, and on to larger streams and rivers, and eventually, oceans. For hundreds of years, only minor changes were made to the landscape, and stream systems developed a balance of size and shape capable of carrying the water and sediment generated within each watershed. This balance is known as a state of equilibrium in which stream channels continue to shift and change slowly while maintaining their overall shape and size.

The Effects of Human Activity on Stream Dynamics

The Illinois landscape has been altered dramatically by human activity since the beginning of European settlement over 200 years ago. We have cleared the timber and plowed the prairie, drained the wetlands and straightened the creeks, to develop some of the most productive farmland in the world. In the process, we also have covered large areas of our cities with concrete, asphalt and rooftops—impermeable surfaces that cannot absorb rainfall as the forests and prairies once did. The development of both farmland and urban land has resulted in a landscape that produces more runoff that moves at a faster rate. "Straightened" creeks then quickly transport the runoff at increased velocities. Finally, we have built levees along the streambanks to confine all the water in the smallest area possible. It is easy to recognize that the natural forces which cause streams to adjust and change their shapes and patterns have themselves been altered. These alterations have caused our stream systems to change dramatically in an attempt to restore equilibrium.

The response of a stream to watershed changes has been expressed by hydraulic engineer E.W. Lane as a stream balance equation (Lane, 1955). Lane concluded that a stream's energy, a function of speed and volume of water, must be in balance with the size and volume of sediment carried by the stream. In practical terms, this means that if either the volume of water (increased runoff) or velocity of water (steeper slope usually caused by channelization) increases, then the stream will need to carry more sediment to balance the increased energy. The usual source for the additional sediment is either from the stream bottom or the stream banks—resulting in severe erosion. Conversely, if sediment load exceeds the available energy to transport it, then the stream aggrades, or fills in, causing loss of capacity and increased flooding. Both conditions are constantly observed in Illinois streams.

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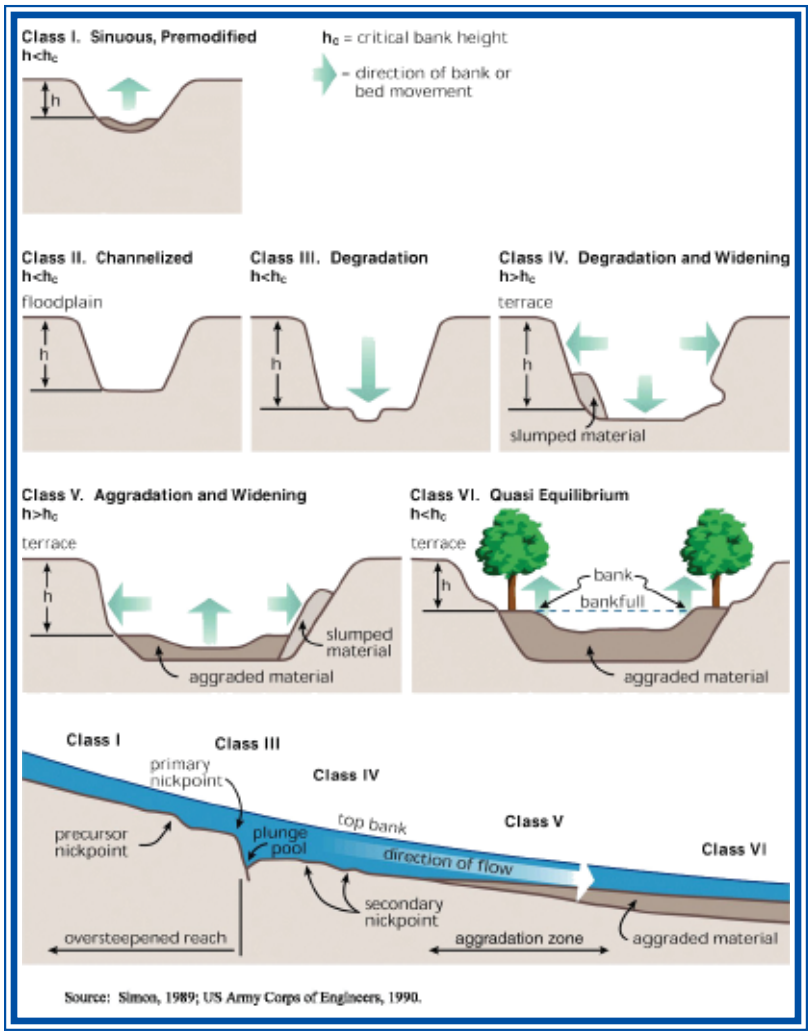
From Disruption to Equilibrium

Once the stream equilibrium has been disrupted, the stream bottom typically erodes, deepening the channel. This process is referred to as downcutting. This in turn sets off a series of events that is described by a Channel Evolution Model (CEM) (Simon, 1989). Simply put, the CEM describes that as a channel cuts deeper, more water will remain inside the deeper channel before the stream floods, further increasing velocity and setting off a series of events that will result in failing banks, widening of the top stream width and development of a floodplain within the new channel. After this series of events, the channel will have again established equilibrium, but at a lower elevation and a newly formed floodplain. It is important to understand that once a channel downcuts at one location, it will downcut upstream and in all tributaries throughout the watershed unless a grade control is encountered (i.e. bedrock or an artificial structure, such as a culvert). Therefore, if a lower reach undergoes downcutting as the result of a channelization project, the effects will be felt throughout the watershed, although it may take many years or decades for the effects of the downcutting to be seen throughout the entire watershed.



Stabilizing streams is a matter of balancing the force of the flowing water against the resistance of the channel sides and bottom. This task may sound simple but can be very complex and costly. Left alone, nature will find this balance; however, it may take decades, and may cause tremendous damage to cropland, roads, homes and other structures built near the stream. Also, large deposits of sediment may result in streams, lakes, and oceans that may degrade aquatic habitat and require expensive maintenance.

Maintaining Equilibrium

Is there a solution? Yes! Newer, less costly, and more environmentally friendly methods of stream stabilization known as "Soil Bioengineering," a blend of natural processes and traditional engineering solutions, have been developed and tested. The key to successful stabilization is an understanding of the natural processes that are causing destabilization at each location. Once the cause of the problem is determined, then a low-cost, innovative solution may be found. Individuals interested in receiving technical assistance in the assessment and treatment of streambank erosion problems should contact their local NRCS or SWCD office.

Certain types of stream work require permits. For more information, contact your U.S. Army Corps of Engineers, District Regulatory Office; and the Illinois Department of Natural Resources, Office of Water Resources.

For more information on stream dynamics and streambank stabilization, visit the NRCS website at: www.il.nrcs.usda.gov. Click on Technical Resources, then select Stream Corridor Restoration.

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