

ICE EFFECTS ON SEDIMENT TRANSPORT IN RIVERS AND STREAMS

Robert Ettema

Professor, Dept. of Civil & Environmental Engineering, Colorado State University, Fort
Collin, Colorado, USA

ABSTRACT

Fluvial ice forms seasonally, and may exert long-term effects on stream morphology and sediment transport in cold regions. The effects are a matter of considerable debate. This presentation describes ice formation and its effects in terms of time, length, and dynamic scales associated with thermal and fluvial processes in streams. The effects encompass altered dynamics and thermodynamics of flow, the direct entrainment and transport of bed sediment by ice, adjustments in the transport capacity of ice-covered flow, localized increase in bed-material transport when and where ice accumulations increase local flow velocities, and ice gouging of channel bed and banks. The effects also have consequences for channel bank strength and loading, floodplain erosion, riparian vegetation and the winter ecology of fish.

A particular focus of this presentation is frazil and anchor ice formation, which can form large masses covering 100's of m² of a streambed, and stick tenaciously to the bed for as long as the water remains supercooled. Although frazil and anchor ice usually form at night when conditions typically are more frigid, incoming solar radiation during daylight hours usually warms the water to the freezing point in the morning. When this occurs, anchor ice releases from the bottom and floats to the surface carrying entrained sediment that can potentially be ice rafted long distances downstream. The processes involved really are rather fascinating – they can be very delicate yet surprisingly robust – and require considerable further research. Their consequences for stream biota also require more research.