Accepted Manuscript

Hydrodynamics of storage release during river ice breakup

Spyros Beltaos

PII: S0165-232X(16)30416-5
DOI: doi: 10.1016/j.coldregions.2017.04.009
Reference: COLTEC 2388

To appear in: *Cold Regions Science and Technology*

Received date: 19 December 2016
Revised date: 31 March 2017
Accepted date: 29 April 2017

Please cite this article as: Spyros Beltaos , Hydrodynamics of storage release during river ice breakup, *Cold Regions Science and Technology* (2017), doi: 10.1016/j.coldregions.2017.04.009

Hydrodynamics of storage release during river ice breakup

Spyros Beltaos

Watershed Hydrology and Ecology Research Division, Canada Centre for Inland Waters, Environment and Climate Change Canada, Burlington, Ontario, Canada
spyros.beltaos@canada.ca

ABSTRACT

The breakup of the ice cover in cold-region rivers is a brief but seminal period of their hydrologic regime, with important ecological and socio-economic implications. The main driver of ice breakup processes is the flow discharge hydrograph. It is generated by runoff from snowmelt and rainfall but can be modified by rapid release of water from storage as the ice cover recedes by ablation and mechanical breaking up. Despite its potential importance, there is very limited quantitative information concerning the hydrodynamic processes that control storage release during ice breakup in rivers, while the issue of climate change underscores the need for improved understanding of the relevant mechanisms. Quantitative analysis for assumed prismatic channels shows that ablation and sustained ice dislodgment and breaking can cause significant flow enhancement via storage release. The latter process is far more dynamic than ablation and, under certain conditions, may lead to formation of a self-sustaining wave (SSW). Analytical results are applied to natural stream conditions, using the Lower Peace River as a case study. Observed rates of ice recession typically indicate ice melt as the dominant process. A rare occurrence of rapid ice breaking over hundreds of kilometres (2014) indicated partial agreement with the SSW concept and revealed that discrepancies may arise from the characteristic irregularity of rivers. Impacts on storage release by climate-driven changes to river ice regimes are examined, along with their implications to ice-jam formation and associated flooding.

KEY WORDS

Breakup, celerity, climate, flow enhancement, ice cover, melt, self-sustaining wave, storage release