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ICE JAM MONOGRAPH
CHAPTER 8 - FIELD OBSERVATIONS AND MEASUREMENTS
SECTION 4: SEASONAL CONSIDERATIONS

by

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4. SEASONAL CONSIDERATIONS

It is instructive here to recapitulate the characteristics of and differences between freeze up and breakup ice jams. With reference to Chapter 3 (Ice Jam Processes), we may note some important differences which essentially arise from three factors, weather conditions, flow magnitude and amenability to release.

During freeze up, the flow discharge is relatively low and steady. Freeze up jams thus tend to be thinner and cause lower water levels than do breakup jams, while exhibiting a more orderly evolution. Air temperature is low during freeze up so that extra "strength" is provided to the jam by the solid ice layer forming on the water surface. This contributes to thinner jams and much more frequent occurrence of "narrow" jams. Though not impossible, release of freeze up jams is highly unlikely due to the steady flow and freezing temperatures, so that surge-like transients that are typical of breakup, are not expected to occur during freeze up.

In some regions (e.g., S.W. Ontario), "winter thaws" are frequent. These are warming trends that bring air temperatures close to or above 0°C, usually accompanied by rain. The resulting runoff is sometimes sufficient to cause ice breakup and jams in some river sections. Such jams are of the breakup type but, from the observational point of view, deserve special attention as will be discussed later.

With this background we now proceed to discuss seasonal aspects of ice jam observations. In the following sections it will be assumed that meteorologic data are being recorded as a matter of course. Usually, this is done at a nearby meteorological station operated by the Atmospheric Environment Service and observers can obtain pertinent information upon request. Where no representative stations exist, it is necessary to install appropriate instruments to measure basic meteorological parameters.

4.1 Freeze Up Jams

During the freeze up period, ice and water conditions change relatively rapidly, so that observations within the study reach should be carried out at least twice a day, starting when ice first appears on the river. Ground-based observations are the most common but aerial observation, where feasible, provides a more complete coverage of the study reach.

Early in the freeze up process, the formation and evolution of border ice and the amounts of frazil ice should be documented. Areas of anchor ice, if any, should be identified. Good water level records at frequent locations along the study reach are also needed. Flow velocities can be estimated by timing floating objects. Depending on the intended use of the observational data, water temperature could be an important parameter and would require high-accuracy measurements, particularly when the temperature approaches 0°C.

Increasing amounts of frazil in transport will eventually lead to "bridging" at certain locations, and these sites have to be identified. This is the start of the period of freeze up jamming which usually ends with the formation of complete ice cover in the study reach. Once bridging has occurred and incoming ice accumulates into a jam, it is important to document the rate of upstream progression of the leading edge (head) of the jam; the surface appearance of the jam; and the water level profile along the jam. Record and describe any "telescoping" events as they signify a collapse of the jam which provides useful information regarding internal strength characteristics. Describe conditions at the head, at least qualitatively, by noting flow velocity, amounts of incoming slush and whether arriving floes are arrested or submerged.

Once a strong solid layer of ice has formed near the water level, the thickness of the various jams can be measured.

4.2 Breakup Jams

Ice and flow conditions change very rapidly during the breakup period so that observations should be carried out continuously or as often as possible.

During the pre-breakup period, that is, start of runoff to start of breakup, it is important to document the competence of the winter ice cover and determine how it may decrease with time. Look for such features as thickness, strength, longitudinal and transverse cracks.

Monitor water levels and temperature and, if feasible, carry out one discharge measurement.

Once sizeable sections of the ice cover have moved and broken up, ice jams will form, release, join together, and release again until the study reach is cleared of ice. During this period, it is important to obtain a good record of the locations of various jams and of the water level profiles along the jams. A particularly quick, though not very accurate, method is to photograph the water level against identifiable features of the river banks and use the photos for later survey. Speed of observation is essential because ice jams can change configuration or even release soon after they have formed. When attempting to define the water level profile along the jams, or the thickness profile as will be discussed later, it should be kept in mind that water surface slope and jam thickness gradients are largest near the toe. Typically, measurements should be obtained not further apart than 10-20 m in the toe region. This limit can be increased to several river widths well upstream of the toe. Ice conditions downstream and upstream of each jam should be noted. The surface appearance of a jam should be described, at least near the head, mid-section and toe (downstream end). Conditions at the toe, where the jam is thickest and partly or fully grounded, are particularly important because they provide clues as to how the jam is held in place and when it might release.

The time and manner of the release of a jam are also important but observations may be hampered by lack of visibility or access. It should be kept in mind that major jam releases result in surge-like waves which may lead to further breakup of the downstream ice cover or even to flooding. The speed of propagation of the surge (celerity) can be determined by comparing stage hydrographs at different gauges downstream while water velocity, always less than surge celerity, can be estimated by timing various ice floes. The interaction of the surge, or of the moving ice rubble from the released jam, with the downstream ice cover is not well understood and few relevant observations have been made. Such observations are thus very valuable and could best be performed from the air.

Usually, the release of a jam is accompanied by a large drop in local water levels, exposing vertical cliffs of grounded ice rubble near the river banks, known as shear walls. The height of the shear wall is a crude indication of the local thickness of the jam, and should be measured or estimated because it is normally the only quantitative measure of thickness that can be obtained.

Flow discharge is a very important factor during breakup but a difficult one to measure. Conventional discharge measurements require safe access to the river for periods of at least an hour which is usually problematic during breakup. A less accurate but more practical alternative is to estimate surface flow velocities and convert to average velocity, using an appropriate factor ($\simeq$0.87). If the water level and cross-sectional geometry are known, the flow area and thence discharge can be calculated.

4.3 Winter Breakup

As mentioned earlier, winter jamming is the result of breakup events occurring during winter thaws. Such events typically last for only a few days and any jams still present when cold weather resumes, freeze in place. This provides a good opportunity to measure the thickness variation across and along the jam, as soon as an adequate layer of solid ice has formed near the water surface. The work is laborious (e.g., Beltaos and Moody, 1986), but worthwhile because it provides data that are not otherwise obtainable.

The evolution of winter jams should be monitored for the rest of the winter, particularly with respect to water levels; melting at the bottom of the porous ice accumulation; and growth of the thermal ice layer. The latter could be augmented by the presence of ice floes underneath, with possible adverse consequences during the next breakup.

4.4 Post-season Measurements

After the ice has gone, the study reach can be accessed by boat and complementary measurements performed. These include such items as high water marks at sites that were inaccessible during the ice season; cross-sectional and water surface slope surveys, as needed to interpret the ice observations; and survey of the elevations of photographically documented ice-jam levels, if any.

Scars on trees near the river banks are frequently caused by ice floes and their elevation provides a crude indication of high water levels during past breakups. Usually, it is possible to date such scars by examining thin tree sections which helps in assessing the frequency of breakup water levels. It should be kept in mind, however, that scar elevations could sometimes be too high (ice floe ride up) or too low (scarring before peak level is attained), so that validation with data from other sources would be advisable.

REFERENCE

Beltaos, S. and Moody, W.J. 1986. Measurements of the Configuration of a Breakup Jam. NWRI Contribution 83-123, Burlington, Ontario.