

Response to Reviewer #1.

We thank the reviewer for reading and commenting on our manuscript while also suggesting how to improve it. We can and will revise the manuscript following the reviewer's comments and suggestions, or at least to the extent that is possible. We would like to conduct some of the proposed analyses, but it is unfortunately not possible due to the lack of data for all three rivers. There is some updated data for Torne River because it is monitored by the Finnish Environment Institute (SYKE) and there is some historical data for the other rivers that we will add this to article. We have answered each question in more detail below.

RC1

The manuscript presents a new ice breakup dataset for the Kokemäki river and compare it with dates of ice breakup at two other rivers - Aura and Torne, as well as with air temperature values. The long time series (220-320 years) constructed from archives are very helpful to get an assessment of long-term variability of ice breakup.

General remarks.

The manuscript often gets very descriptive, especially starting from section 4 (Results), and one may easily feel overwhelmed by various details and lose track of what is important and what is just a side observation. I strongly suggest to streamline the manuscript by a) shortening some parts and focusing only on important issues, b) clarifying importance of some facts (and not just enumerating them) and c) providing intermediate conclusions.

We will try to streamline the paper and make it less wordy. This was also addressed by other reviewers. It will take some time to get the focus in this type of interdisciplinary manuscript. There is quite a lot of information in the discussion, some of this can be omitted or moved.

Dates of ice breakup are dependent on various factors, including earlier or late ice formation, severity of winter (reflected in ice thickness). Influence of air temperature on ice growth and decay may further be modulated by snow depth (as you mention in the "Discussion"). I understand that the authors do not have the data on ice formation dates and other parameters to take all these factors into account. However it would be very helpful to indicate - even roughly - the duration of presence of ice cover on rivers (or average dates of ice formation), as well as maximal ice thickness, typical range of depth of snow on ice. Otherwise ice breakup dates are somewhat taken out of context.

The reviewer is correct, we do not have this type of information for all rivers or for a common period. Data has not been systematically collected except for Torne River. There is some information dispersed across centuries and we added this in a new section 2.4. This addition will give a better idea of the ice conditions. It might seem out of place to only include data from before 1900s, but we will connect it to current conditions to create historical context. We want to remind the reviewer that the purpose of this paper is not to discuss all factors that directly or indirectly determine, for each year and event, the breakup date.

I suggest to provide an overview map with location of the three rivers, otherwise it is not easy to imagine their location. Provide at some point in the introduction some rough average values of river discharge, river length and size of the watershed for each of the three rivers.

We will add a map and we can add averages on discharge and watershed. The length was mentioned in the original manuscript.

Also - if you have those data - provide in sub-sections 2.1-2.2-2.3 some estimates of river depth at place of measurement/observations.

We will add the data we have and can find. There is no exact information on river depth or how it has changed since last measured. For instance, we have information from Kokemäki River from when it last was dredged, but it is very general. We have not found any data for Torne River.

Climatic correlations - why use air temperature for fixed months for correlation and not do some dynamic approach (if ice breakup this winter happens in month X, then we will look at air temperatures in months X and X-1)? Or - better still - do some integration/aggregation of air temperatures, such as sums of negative/positive degree-months or similar, to account the severity of each winter and estimate influence of spring air temperatures on ice breakup.

This is a good idea and we have also considered the dynamic approach. It is an analysis we would like to do. However, it would require that we create a new temperature data series (a series that is adapted to the specific breakup dates) and the problem is that daily temperature data is not available. Even if we would go down to actual raw data, the used dataset only provides daily data for the last five years. We therefore use the more common approach of comparing with fixed months.

Another reviewer suggested to include precipitation and this we can do. This data is again on a fixed monthly level.

RC 1: Specific comments.

Line 9 - please specify that Pori it is a name of settlement and not a person's name. [Done](#).

Abstract - provide at least rough location of the three rivers, distance between them. [Done](#).

Line 47-48 please clarify the difference between "ice breakup series" and "observations". [Done](#).

Line 53 - please clarify. Ok, it did not escape the boom, but then what - the time series are not homogeneous? Or else?

The sentence was unclear. The section was rewritten to provide clarity. We wanted to highlight that the Kokemäki River series needs to be compared to other series because of the possible impact of the power plants.

Line 68 - "because of their length" - rephrase so that it is clear that it is length of time series and not length of rivers. [Changed to improve clarity](#).

Line 101 - put comma after "by temperature". This section was rewritten to answer some of the other question that were raised concerning discharge, watershed, river depth etc. This information is now found in section 2.4.

Line 120 - here and for other sub-sections I would suggest to put river name first and then city name (and also specify that it is a city/settlement). [Did when considered necessary.](#)

Line 141 - specify that it is 80 km upstream. Any significant tributaries between power plant and Torne? [No.](#)

Line 141 - observation site - Torne or Tornio? [Changed to Tornio.](#)

Line 160-161. Rephrase this sentence ("For example...") or split in two sentences. [Deleted the sentence and rewrote this section.](#)

Lines 169 and 170 - so this river has a delta or estuary? [Delta.](#)

Line 283 - please remind the reader on which river the power plant is located. [Added Kokemäki River to improve clarity.](#)

Line 316 - "16 respectively" => "16 and respectively"? [Changed.](#)

Line 318 - please remind what are these distances. [Distances were added.](#)

Lines 360-370 (and also in general). Please use expressions such as "worth noting", "noticeable", "remarkable", "noteworthy", "notable" etc sparingly. See also my general remark on the descriptive style of the manuscript.

[Rewrote, these were all in the same part of the paper and the only time, so it was definitely repetitive. The descriptive style is difficult to give up because the data is descriptive.](#)

Lines 419 and 420. Temperature and breakup dates are presented in Fig 4 but they are not discussed in the text. Is figure 4 really necessary then? [The figure was referred to on line 433.](#)

Figure 1 - upper panel, and also Figure 5: Tornio or Torne river?

[Changed to Torne River. The idea was to refer the river as Torne and the city as Tornio.](#)