Interactive discussion: Response to comments from Anonymous Referee #1
November 12th, 2024

General comment
This manuscript presents an interesting and valuable contribution to our understanding of sediment transport processes, specifically focusing on the propagation of aggradation waves under supercritical flow conditions. The work addresses an important topic in geomorphology with potential implications for flood risk assessment and channel management. The experimental approach, featuring detailed spatial and temporal measurements of bed elevation changes, provides a strong foundation for investigating the relationship between theoretical predictions of perturbation celerity and observed aggradation patterns.
The study's primary strength lies in its methodical comparison between experimentally observed celerities and theoretical eigenvalues derived from governing equations, offering insights into how different mathematical formulations correlate with physical observations. The laboratory dataset appears robust and well-suited to the investigation's objectives, although only one case was considered.

Many thanks for the general appreciation of the work.

However, the manuscript would benefit from several improvements to enhance its impact and accessibility. The presentation of the material requires restructuring to improve flow and clarity, particularly in separating results from their interpretation. The discussion section could be expanded to better explore the broader implications of the findings and their potential applications. Additionally, some technical aspects need attention, including more precise definitions of key concepts and a more rigorous approach to statistical analysis.
The discussion section needs to be improved significantly as it appears to repeat the results section without substantially expanding on implications and broader applications, or considering cases beyond the single experiment conducted.
With appropriate revisions, this work has the potential to make a significant contribution to our understanding of sediment transport processes in supercritical flows and provide valuable guidance for practical applications.

Should the Editor ask us to prepare a revised manuscript, we will follow the Reviewer's suggestions, for which we deeply thank her/him. We just notice here that the experiment presented in this manuscript was actually one among several performed in a campaign that took many months. The key trends found in this study apply also to the other runs of the campaign, even though in this manuscript we preferred to show one as a proof of concept. This will be made explicit in the discussion.

Introduction to the attached formal review
Based on my review, I recommend that this manuscript be declined in its current form, with an encouragement to resubmit after substantial revision. This recommendation is not based on the scientific merit of the work, which addresses an important topic and presents valuable experimental data, but rather on the need for significant restructuring of the presentation.
The manuscript would benefit from improved organization and flow, as the current structure sometimes creates disconnections between related ideas across paragraphs. Additionally, the separation between results and their interpretation could be clearer, and the discussion section needs substantial development.

Honestly, while we do not intend to excuse ourselves from revising the manuscript, we were a bit surprised by a recommendation that the paper be declined, considering the general appreciation of the scientific merit of the work, and that none of the detailed comments below sounds insuperable.

The detailed comments below highlight specific instances where improvements are needed, though they should not be considered exhaustive. I encourage the authors to use these comments as guidance for a comprehensive revision. A resubmission that addresses these structural issues would make a valuable contribution to the field.

Detailed comments (that we have grouped by topic)

Scatter plots and correlation metrics

Line 22: Consider revising the term "correlation trends." The figures present scatter plots showing relationships between dimensionless or dimensional variables. To strengthen the analysis, statistical measures (such as correlation coefficients) would be valuable additions to quantify these relationships.

Figure 8: Consider revising the terminology from "correlation" to "scatter plot" to better reflect the analysis presented. To strengthen the relationship analysis, statistical measures (such as Pearson's r or Spearman's rho) could be added. This would allow for quantification of the observed relationships.

In our view, a scatter plot shows the mutual relationship between two quantities, thus how they are correlated. However, we can change from "correlation" to "scatter plot" even if we think that the previous term was also appropriate.

The following table presents the Pearson correlation coefficient to illustrate the strength of the relationship between C/u and Fr, as well as C/u and $\lambda i/u$ (Figures 8 and 10). The values of the correlation coefficient for all plots range between 0.5 and 0.6, indicating a moderate correlation between the variables.

		Goutière et al. (2008)			***Morris and Williams (1996)***		
	$\boldsymbol{Fr}$ (Fig. 8)	$\boldsymbol{\lambda_1/u}$ (Fig. 10)	$\boldsymbol{\lambda_2/u}$ (Fig. 10)	$\boldsymbol{\lambda_3/u}$ (Fig. 10)	$\boldsymbol{\lambda_1/u}$ (Fig. 10)	$\boldsymbol{\lambda_2/u}$ (Fig. 10)	$\boldsymbol{\lambda_3/u}$ (Fig. 10)
$\mathbf{C/u}$	-0.53	0.54	-0.60	-0.54	0.55	-0.59	-0.55

Discussion

Line 340: Consider expanding the Discussion section to move beyond restating results, perhaps including broader implications and connections to other studies.

The present discussion goes beyond a repetition of the results as it introduces interpretation, in line with the general comment above that the latter should be separated from the results. Furthermore, it provides the key practical information that C/u is less than 0.04. We will strengthen this as the Reviewer's comments demonstrated that our intent was not easily perceivable by a reader.

Richer referencing

Line 31: The discussion of hazards would be more impactful with specific examples, helping readers better understand the practical implications of this research.

In a revised manuscript, we may add a few lines with examples instead of just referencing papers as in the mentioned line. It is actually now generally agreed that sediment transport is a key factor in flood hazard, and we can indeed support our statements with various examples.

Line 32: Consider expanding the statement "Sediment aggradation has been studied in the past for both the effects of pulsed sediment supply and the formation of depositional fronts" by including key findings from these studies, similar to the effective approach used in Line 39 regarding translational front and dispersive processes.

We can surely include relevant findings from related studies.

For example, on the topic of pulsed sediment supply, Cui et al. (2003) and Cui and Parker (2005) discussed that in mountain streams sediment enters rivers in pulses, typically from landslides or debris flows. These pulses cause topographic disturbances on the riverbed, which are gradually eliminated through two mechanisms: translation where the topographic high moves downstream, and dispersion where it gradually fades away. By conducting experiments on sediment pulses with varying pulse material and feed sediment sizes, they discovered that in all cases, the pulse deformation was primarily dispersive. Nevertheless, when the pulse was finer than the surrounding sediment, both translation and dispersion were observed. Sklar et al. (2009) conducted a laboratory study to examine the effects of gravel pulses of different volumes and grain sizes on an immobile, armored bed. The results showed that the sediment pulses evolved through a combination of translation and

dispersion, with translation being more pronounced for smaller volumes of added sediment. Finer-grained pulses moved through the flume faster, causing a larger but shorter-lasting bed fining effect.

Furthermore, for the case of more persistent sediment overloading, Soni (1981), Yen et al. (1992), Alves and Cardoso (1999) and Zanchi and Radice (2021) provided quick predictors of a bulk celerity for an aggradation front. These formulae may be used to provide expeditious estimates of the time an aggradation wave would need to move from a sediment source to a key spot.

We will find a suitable equilibrium between adding some details and avoiding excessive length of the added material.

Line 49: The statement "as most (if not all) prior investigations" would be strengthened by citing specific references to support this claim.

We will more sharply mention that the present manuscript indeed considers sediment aggradation in supercritical flow with the purpose of investigating its propagations scales, as, to the best of our knowledge, all prior investigations have been conducted for subcritical conditions.

Line 208: The validation statement would be strengthened by providing references and additional details about the validation process.

Basically what we did was, for some experiments, taking manual readings of bed and water elevation, paying attention to avoiding interference with the field of view of the cameras. The difference between the manual readings and the automatic measurements was satisfactorily small. We will be happy to provide some more information in a revised manuscript.

Line 324: The reference to "typical curves shown in mathematical studies" would be more helpful with specific examples or references provided.

Not sure if citing a specific figure of a referenced paper is appropriate; however, in this statement we referred, for example, to Figure 1 of Lyn and Altinakar (2002) and Figure 2 of Garegnani et al. (2013). Figure 1 of Goutière et al. (2008) could be equally mentioned.

Contextualization

Line 28: Consider strengthening the connection between "This paper is focused..." and the previous discussion of time-scales to improve the logical flow of ideas.

This should be also made possible by accounting for a previous comment on line 32.

Line 36: Since celerity is a central concept in this work, consider providing its definition early in the text to establish a clear foundation for readers.

We will strengthen the concept and relevance of celerity, even if we would not take mathematics to the Introduction.

Line 59: Consider introducing the role of sediment concentration with more context, as this is a key parameter that would benefit from a clearer introduction.

This is extensively accounted for in section 2, where approaches for negligible and non-negligible concentration are presented separately. We can spend more words here and, however, mention that more details will be provided in a following section with mathematical models.

Line 73: The three research questions presented provide a valuable framework. Consider strengthening how questions 1 and 2 are addressed in the text, as question 3 is well explained but the others would benefit from more explicit answers.

While we are not answering these questions in the Introduction, answer 1 comes from the mathematical models of section 2 for the small perturbations and from eq. (19) for the aggradation wave. Answer 2 comes from figure 10, and answer 3 from comparing the left and right plots in figures 6 and 10, as well as from figure 9. In a revised manuscript, we would probably rephrase question 1 that needs more specification, and sharpen the answers at the end.

Line 217: Consider enhancing the experimental description by including key parameters (flow velocity, Froude number, Reynolds number) early in the text. While these are discussed later, providing initial values would help readers better understand the flow regime.

We will include the key parameters of the experiment in Table 1 as follows:

$T\,(s)$	$S_0\,(\%)$	$Q\,(l/s)$	$Q_{s-in}\,(m^3/s)$	$Q_{s0}\,(m^3/s)$	Lr	$H\,(m)$	$U\,(m/s)$	Fr	Re
316	1.37	7.0	4.28×10^{-4}	1.33×10^{-4}	3.2	0.033	0.705	1.236	19113.2

where H and U show water depth and velocity, respectively, calculated using the Gauckler-Strickler formula under the assumption of uniform flow.

Sharpness

Line 60: The use of "However" suggests a contrast - consider clarifying what is being contrasted to strengthen the logical flow.

Line 69: The phrase "something different" could be more specific - consider indicating whether this refers to a different equation, method, or approach.

Line 71: Consider rephrasing "determined as just mentioned" to provide clearer reference to the specific method being discussed.

Line 219: Consider focusing figure descriptions on the interpretation of results rather than describing the axes. This would help readers better understand the significance of the findings.

Line 224: The term "relatively high flow velocity" would be more informative with specific values provided.

Line 223: Consider replacing subjective terms like “evident” with more specific descriptions of the observations.

Line 283: Consider replacing subjective phrases like "obviously provides a nicer plot" with more objective descriptions of how the smoothing operation benefits the analysis.

Line 284: The Results section would be strengthened by focusing on specific observations rather than using terms like "evidently." Consider guiding readers through the interpretation with clear, objective descriptions.

Lines 344 and 353: Consider replacing terms like "obviously" and "evidently" with specific explanations of the observations and their significance.

All these are phrasing modifications that will be implemented to increase rigour and clarity of the manuscript.

Style issues

Line 30: Consider reviewing sentence structure throughout the manuscript. The current use of commas occasionally interrupts the natural flow of ideas.

Line 51: Consider using consistent terminology throughout the manuscript (e.g., replacing "for example" with "e.g." for consistency).

Line 57: Consider integrating the important explanation "that is the ratio of sediment discharge to the water-sediment mixture discharge" into the main text rather than using parentheses. This would improve readability and emphasize this significant information.

Line 90: Consider integrating parenthetical information into the main text throughout the manuscript. For example, the statement about volumetric concentration could be restructured to maintain better flow while preserving the important reference to Armanini et al. (2009).

Line 283 and 318: Consider incorporating the parenthetical information into the main text, as these details are important for understanding the analysis.

Line 355: Consider integrating the parenthetical phrase "(positive and thus)" into the main text to improve readability and clarity.

These are also slight modifications that may improve the flow of ideas.

Other

Line 104, eq2: A minor technical correction: consider removing the "x" for clarity.

Will be done.

Figures 9 and 10: Consider revising these figures to:

- Use consistent terminology (scatter plot rather than correlation)
- Maintain consistent axis scales where appropriate for comparison
- Clarify that the data points, rather than graphs, are obtained from the analysis

We will improve these plots.