Review of "Estimating velocity distribution and flood discharges at river bridges using the entropy theory. Insights from Computational Fluid Dynamics flow fields" by Bahmanpouri, F. et al.

REVIEWER 1

Thanks to the authors of this manuscript for accounting for the comments I provided. I think that improving the explanation of how the method is applied is particularly beneficial for the manuscript. I have just two remaining comments (the second of which is a bit more challenging than the first) and several suggestions for change of wording at specific places. Please note, line numbers refer to the track-change version of the submission.

RE: We thank the reviewer for appreciating the revision work.

58: this line sounds like horseshoe and wake vortices are created by secondary currents; rather, they form due to the flow-bridge interaction. I suggest rephrasing.

RE: Thank you for pointing out. We reworded the sentence to

> "~~This creates s~~ Systems of vortices with horizontal (horseshoe vortex) or vertical axes (wake vortex) ~~that in turn~~ modify the velocity distribution"

301: these lines introduce a concept that, if I remember correctly, was not mentioned in the previous version. Attributing to an increased Manning coefficient the energy dissipation that is instead due to Reynolds stresses may work, but then the "turbulence-enhanced" Manning coefficient is a new parameter. So, two questions: (1) was the increased value of 0.055 the result of a calibration? (2) What should one do to apply (4) in a wake region, are there guidelines?

RE: We agree with the reviewer in that the "turbulence enhanced" Manning coefficient is indeed a new parameter. We observe that, while it is quite common to use a higher Manning coefficient to account for additional head losses due to the presence of in-stream structures, the purpose of using here a larger value is not determinant for the application of the (iterative) procedure. It was only meant to show that the entropic function may assume similar values to those computed from the 3D-CFD flow field by accounting for additional head losses at the cross-section just downstream of the bridge. This is expressed in the comment added to respond to the next point.

305: after presenting tab 2, a comment is probably needed about the similarity of the M and phi(M) values obtained with the two approaches. The intent declared at line 311 does not result in a statement (using, for example, the two panels of fig. 3).

RE: Thank you for noting. We added a comment on the similarity of the M and phi(M) values obtained with the two approaches. In the same comment, we also frame the additional calibration effort needed to obtain the Manning values in the case of disturbed flows (see the previous comment):

> "The first-guess estimates of $\phi(M)$ in Figure 3b, although having a marginal role in the entropy-based computations, show a similar trend to the 3D-CFD estimates (Figure 3b),

provided that increased Manning parameter is used at the section just downstream of the bridge. The need to calibrate such an increased Manning parameter complicates efforts in case of disturbed flows."

Minor Comments
19: downstream of
23: suggests
33: applicable
38: no new line here
47 to making
124: is used
261: denotes
500: severe
504: no new line here

RE: All the above requests for changes have been applied. Thank you.

REVIEWER 2

I found this paper interesting. The topic of Information Entropy is very actual and I think that the entropy-based method can be applicable to many issues of risk assessment and environmental research.

RE: We thank the reviewer for appreciating the work.

The main criticism I found in the paper is the calculation of the entropy-parameter M. The authors state that that Um in the equation (2) is the average flow velocity within entire cross-section.
Such statement is correct only when 1D distribution is considered in the form of wide channel, according to Chiu's initial work (1987, 1988). In general, Um in equation (2) represents the expected value of velocity. Marini and Fontana (2020) have clarified this aspect.
This issue affects the model's outcome because using the mean velocity value instead of the expected value of velocity in equation (2) leads to an incorrect calculation of M. Consequently, the resulting velocity distribution will have an average flow velocity different from the desired one.

For example, consider the calculations performed for the "2019 +50" configuration. Referring to the data in Table 2 the average flow velocity is 1.93 m/s. Now setting in eq. (2) the expected value of velocity Um=1.93 m/s results in F(M)=0.515 and therefore M=0.18. With M=0.18, applying equation (1) coupled with equation (5) will yield an average flow velocity 1.93 m/s. If the channel were wide, as demonstrated by Marini and Fontana (2020), the mean sectional velocity would be greater than 1.93m/s. This inconsistency should be apparent in the authors' results; in fact, I would have expected an average flow velocity reported in Table 3 different from 1.93. However, the authors report in Table 3 that the result of the average flow velocity calculated by integrating the velocity distribution values is 1.90, practically the same as the expected one. Therefore, the inconsistency does not appear.

The reason this inconsistency does not appear, in my opinion, is that the authors use an iterative procedure to find the velocity distribution based on controlling the error in calculating F(M) between successive iterations. This iterative procedure is necessary because the authors impose that the M value for different verticals of the same river cross-section must be the same. However, I believe that the main reason this procedure must be used is to obtain a mean flow velocity value equal to the desired one.

I would like to clarify that I am not saying the authors' procedure is incorrect (Moramarco is an undisputed authority in the entropy-hydrology field), but I believe the authors should emphasize:

- The difference between the expected value of velocity (which appears in equation (2) - the Chiu original one) and the average flow velocity, which is considered given in the problem.
- Due to the discrepancy between the expected value of velocity and the average flow velocity, an iterative process is necessary. This process seeks the value of Um (expected value) which, when inserted into equation (2), provides an M value from which a velocity distribution can be obtained that has the desired average flow velocity.

At this point, a column for the expected velocity values Um for each configuration, obtained as a result of the iterative procedure, should be added to the results tables (Table 2). This would make it clear that Um is not a known a priori value (the known a priori value is the average flow velocity) but a value calculated through a procedure.
Gustavo Marini

RE: We thank Prof. Marini for his interesting point. In accordance with his suggestion, we added a comment in the text recalling the difference between the expected value of velocity and the average velocity and quoting Marini & Fontana (2020). In our case, however, considering the aspect ratio of the river channel greater than 5 (as mentioned in Table 2), these two values are quite similar.
As described at the end of Sect. 2, in applying the Entropy model we used as input value only the cross-section geometry and the surface velocity (either river-wide or a single value), then we computed the expected velocity and, hence, the discharge using the bathymetry-based flow area. Importantly, it has to be considered that we forced the Entropy model with a variable spanwise distribution of both the bathymetry and the surface velocity. This is true in particular for the +50 cross-section, just downstream of the bridge, where the velocity field is strongly perturbed by the bridge piers, thus markedly irregular in the spanwise direction. As we used a single M value for all the verticals in a single cross section, the iterative procedure is used to make the spanwise entropic distribution coherent with the definition of $\phi(M) = U_m/U_{MAX}$ given in Eq. (2). As regards the hypothesis to fit M through an iterative approach, which minimizes the error between expected U_m and the average velocity, this is beyond the paper's purpose but will be the object of future work definitely.
Finally, as per the request of adding a column with the velocity values Um for each configuration, obtained as a result of the iterative procedure, we note that these values of Um are already reported in Table 3.
In the revised version of the manuscript, we added a sentence just after Eq. (2) to warn about the possible difference between the average and the expected value of the velocity. The added sentence reads:

"It is worth mentioning that, Um represents the expected value of velocity that can be different from the observed mean velocity (Marini and Fontana, 2020). These two values are quite similar in the case of wide rivers (aspect ratio larger than 5). In the present research, considering the large aspect ratio for all cross-sections (Table 2), this hypothesis is valid."

Added reference

Marini, G. and Fontana, N.: Mean Velocity and Entropy in Wide Channel Flows, Journal of Hydrologic Engineering, 25, 06019009, https://doi.org/10.1061/(ASCE)HE.1943-5584.0001870, 2020.