This document reports the answers to the Editor's and Reviewers' comments. The Editor's and Reviewers' comments are indicated in black front, corresponding answers in blue font and copy/paste from the revised manuscript (as a support) in red font.

We would like first to thank the Editor and two reviewers for their careful reading of the paper, their pertinent remarks and comments. In addition to the answer to the reviewers and the Editor, we enclosed the revised version of our manuscript according to reviewers' recommendations. In the revised version of the manuscript, red characters indicate the changes that have been made.

General comments:

This paper presents a hydromorphodynamic modeling study in a small river system, the Orne catchment in France. The objective of the study was to assess the importance of sediment characteristics (i.e. grain size distribution and distributed sediment densities) using the existing fully coupled hydromorphodynamic models TELEMAC 3D and SISYPHE. The latter allows for consideration of cohesive and non-cohesive sediment regimes and was further developed for the use of 10 grain size classes with varying densities for each class. In the framework of the modeling study, the sensitivity of SISYPHE to grain size distribution, sediment density and suspended sediment concentration at the upstream boundary was evaluated.

The modelling study in combination with the flood event data monitored at the Orne river and presented in this manuscript is well placed in HESS and worth publishing. In particular, with regard to the prediction of the resuspension and transport of particulate pollutants, it is necessary to consider several particle classes.

We thank reviewer 3 for these positive comments.

However, I have some general comments regarding the configurations of the modelling study:

The standard configuration of the SISYPHE model allows for 2 grain size classes. This is clearly not enough for modelling suspended sediment concentrations. It is thus not surprising, that the model configuration with 10 size classes performs better than the configuration with only 2 classes. However, the 4 configurations (Page 12, Table 1) are a bit arbitrary chosen and too few tested possibilities for a sensitivity study.

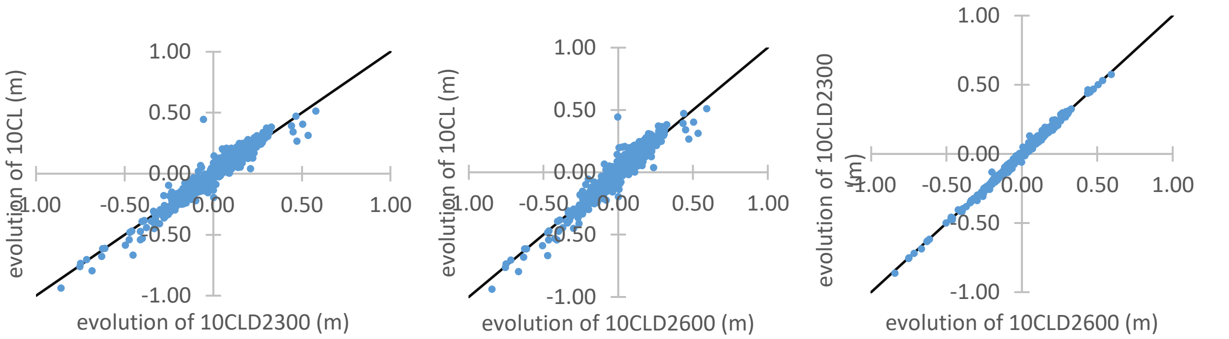
In my opinion, it would be interesting, to find out, how many size classes are needed to receive a good prediction of the suspended sediment concentration and evolution of bathymetry. Are 10 classes necessary or can it be less? Therefore, the authors should consider testing also model configurations with other numbers of grain size classes.

We thank Reviewer 3 for these comments and for raising these interesting points. We understand that choosing ten classes could be seen as slightly arbitrary. The number of classes was mainly chosen based on the vibratory sieve shaker at our disposal and on standard filters. As a matter of fact, for technical reasons, it is not straightforward to set up a model with a higher number of sediment classes. Moreover, as can be seen in the Figure 7 of the manuscript, the suspended load is limited to fine sediment (3 classes of diameter < 100µm). This figure shows that only the three finer classes are transported as suspended matter. Using fewer classes would then result in representing suspended load through two or one class only, which is closer to the scenario we set up with only two classes. Moreover, it is also important to highlighted that searching for an "optimal" number of class as suggested by Reviewer 3 would be really site and event specific. The "optimal" number of class therefore obtained would not be easily generalizable or scalable. It was also originally our intention to test the proposed approach on various flood events. Unfortunately, during three years of monitoring, we were able to collect a complete validation dataset only for the proposed flood event. We argue that the objective of this paper is rather to provide some evidence of the benefit of increasing the number of sediment classes than identifying how many classes are best suited - as this number would be site and event specific.

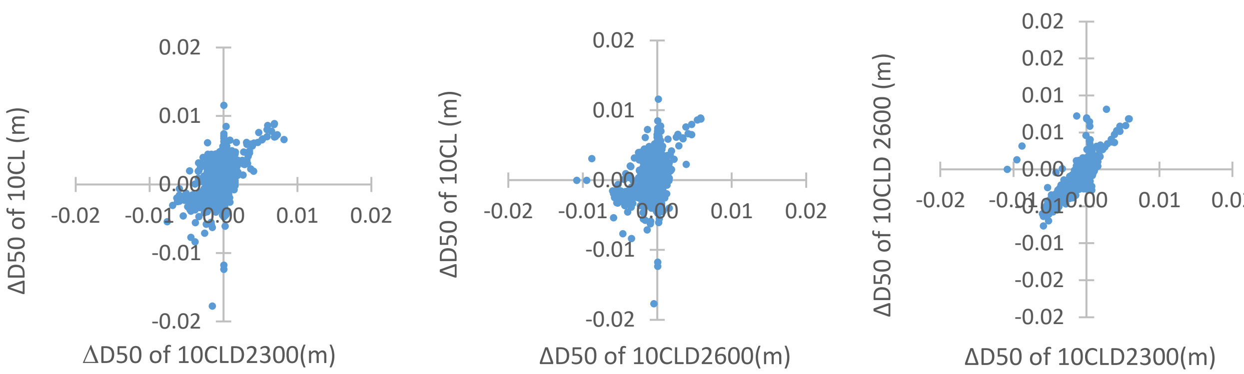
Furthermore, the modelling study shows that the configuration with size specific sediment densities outperforms the configuration that uses the standard density of 2600 kg.m^{-3}for each class. This is also not surprising, since the average measured density for the sediments in the Orne river is 2300 kg.m^{-3} (Page 11, line 11). Therefore, a further model configuration with the measured average density of the sediments in the Orne should be modelled in order to see, if the distributed densities per size class are really needed or if an average measured value would also be adequate. The latter would also be less effort to measure than distributed densities for each class.

We thank Reviewer 3for these comments.

We choose to consider an average value of 2600 kg.m^{-3} in the homogenous density scenario as this is the value commonly used in sediment transport modelling studies.
To follow reviewer 3 suggestion, we carried out a new simulation with a set up identical to the 10CLD configuration (referred below as 10CLD2600) using this time a sediment density of 2300 kg.m^{-3} (average value in the Orne sediment; 10CLD2300).
The scatter plots of the evolution and the D50 variation of this new simulation are shown below.



Cross-comparison of simulated bed elevation evolutions (elevation final-initial) for configurations 10CLD2300, 10CLD2600 and 10CL.



Cross-comparison of simulated bed D50 evolutions (final-initial) for configurations 10CLD2300, and 10CLD2600 and 10CL.

The left hand side panels show the scatter plots allowing the comparison of the 10CL and the 10CLD (ρ=2300 kg.m^{-3}) configurations.
The centre panels show the scatter plots allowing the comparison of the 10CL and the 10CLD (ρ=2600 kg.m^{-3}) configurations.
The right hand side panels show the scatter plots allowing the comparison of the 10CLD(ρ=2600 kg.m^{-3}) and the 10CLD(ρ=2300 kg.m^{-3}) configurations.
As can be seen in this figures the two simulations with a constant sediment density yield similar results. Moreover, the differences between the 10CLDs and the 10CL simulations are more significant that the difference between the two 10CLD simulations. This thus indicates that imposing a nominal density for each class has an influence on the model results and is therefore worth. Defining per-class sediment densities is especially relevant when simulating flood events with a wide range of magnitudes: as the flow intensity increases, larger sediment classes are transported. As a matter of fact, using class-based sediment densities helps in improving model results. In our experiment, the 100µm and the 65µm classes have respectively a density of 2850 and 1750 kg.m^{-3}. Using the mean density (2300 kg/m^3) for both classes necessarily introduces a source of error in the model that can subsequently induce errors in the assessment of locations where fine sand and silt are deposited. We added the following sentences in the article to clarify this:
"In this sediment transport modelling study, we chose to consider an average density value of 2600 kg.m^{-3} in the 10CLD scenario as this is the most commonly used value. One could argue that the average measured sediment density could also perform satisfactorily. To evaluate this option, we carried out an additional simulation identical to 10CLD but using a sediment density of 2300 kg.m^{-3} (results not shown). The results obtained were similar to those obtained with the 10CLD configuration and different from the 10CL simulations, showing the added value of using nominal measured densities. This is arguably mainly due to the fact that only fine sediment classes are transported during this flood event and fine sediment classes have different nominal densities than the tested average values, namely 2300 and 2600 kg.m^{-3} (see Fig. 5)."

Some process representations of the SISYPHE model are simplified and pragmatic. This is adequate, since many sub-processes of erosion and deposition as well as the interaction of particles (in particular when cohesive sediments are involved) are too complex for a precise physical description. Nevertheless, it is important to think about improvements of the model, as the authors have done in section 6, Future Scope. But, in my opinion, too many improvements are mentioned, which are unlikely to be achievable in the near future. I thus suggest, to mention only a few and feasible model adaptations.

We thank Reviewer 3 for these comments. We modified the future scope to take this into account. Especially, we clearly separate the improvements that can be envisaged in a near future from the others:
"The proposed sediment transport modelling framework is found to improve the accuracy of the results. However, additional developments could be considered in order to integrate bio-physico-chemical processes. Indeed, the temporal variability of the bio-physico-chemical conditions in rivers plays a key role in shaping the sediment dynamics during flood events. In this context, we envisage implementing two important developments:

1. A new generation of high-frequency measurement sensors could be used to record the model input data. A LISST sensor (Fugate, D. C. and Friedrichs, 2002), which measures the size and concentration of particles suspended in water, or a combination of two acoustic doppler current profilers (Jourdin et al., 2014) could for example be used to monitor the SSC for each individual sediment class. This would provide more realistic model inputs and more accurate validation data at the same time.

2. Flocculation processes could be integrated as they play a key role in sediment transport due to the fact that the density and the shape of flocs differ from those of individual sediment particles. As a result, their displacement in the water column is different from that of isolated sediment particles (Parker, 1972; Van der Lee, 2009). The integration of flocculation process could be implemented by coupling a morphodynamic model with a floc population model such as FLOCMOD (Verney et al., 2009, Lepesqueur et al., 2018).

In terms of longer-term developments, the erosion and deposition laws used in the morphodynamic model should also take into account interactions between sediment classes, as argued for example by Starck (2014). Indeed, many existing studies highlight the importance of the compaction of non-cohesive sediment (Swidersky, 1976), armouring (Egiazaroff, 1965), hiding/exposure (Ashida, 1973), filtration of fine particles by coarser sediment (Karim, 1982; Brunke, 1999; Herzig et al., 1970) and lubrication (Barry, 2006), together with biological processes (e.g. Arthur et al., 1980; Widdows et al., 2000; Le Hir et al., 2007). "

In general, the Figures, in particular the cross comparisons in Figures 8 and 9, are informative and catchy.
We thank Reviewer 3 for this positive comment.

However, the overall presentation quality of the text could be improved. In the Results and Discussion section, many assumptions are made, which are not supported by observations or references in the literature. The discussion should be more precise. Furthermore, the present manuscript version contains many grammatical and typing errors. It should thus be thoroughly proofread.

We thank Reviewer 3 for these remarks. We carefully proofread the manuscript with the help of a native English speaker. Moreover, we put some efforts on being more precise in the result and discussion part.

Specific comments and technical corrections:

Page 1, line 13: This study has a main objective to... The main objective of this study is to…
This has been corrected in the new version of the manuscript

Page 1, line 16: allow allows
We corrected the sentence.

Page 1, line 21 and 24: insert 'configuration' behind 'model'
We corrected the sentence.

Page 2, line 1: inputs emissions
We corrected the sentence

Page 2, line 7: ...of mineral particles of amorphous or poorly crystalline.... a word is missing
We corrected the sentence as follows:
"River sediments are heterogeneous aggregates, composite structures composed of amorphous or poorly crystalline mineral particles, organic matter, and biological matter (biofilms, bacteria, virus and bio-macromolecules)."

Page 2, line 16: 'transport formula' better 'transport equation'
This has been changed.

Page 2, line 20 and 22 and also later in the manuscript: ‘fall velocity’ better ‘settling’ or ‘sink’ velocity’

To our knowledge, both expressions are widely used in the literature. We did not really see the benefit of using systematically “settling” instead of “fall”. As a consequence, we use both term in the manuscript.

Page 2, line 34: insert ‘distributed’ before ‘sediment density’

We corrected this.

Page 3, line 2 and also very often later in the manuscript: SYSIPHE SISYPHE.

We corrected the typos.

Page 3, line 5: mad made

We corrected the typo.

Page 3, line 12: ‘This modeling framework has the following interests’ rephrase

We rephrased this sentence:

“We adopted this modelling framework for two main reasons:”

Page 4, line 12: deposit deposition

Corrected

Page 6, line 10-21: I do not understand if the representation of deposition is the same for the cohesive and non-cohesive regime. Please clarify.

For the non-cohesive sediment, deposition is always represented via eq 8:

“the deposition rate of the non-cohesive sediment is invariably computed using:

$$D=W_s*C_{ref} \quad (8)$$

In Eq. 8, D is the deposition rate and C_ref the reference sediment concentration at the bottom of the water column.”

For the cohesive sediment, deposition is always represented via eq 5.

To clarify this point we removed the word deposition in the following sentence:

“Depending on the mud fraction (i.e., ratio between mud and total sediment mass) in the top layer of the river bed sediment, SISYPHE treats non-cohesive sediment erosion according to the so-called non-cohesive and cohesive regimes.”

Page 8, Figure 1: Pleas add a scale bar in the sub-figure on the right.

We added a scalebar in Fig. 1

Page 9, Figure 2: Please add the monitoring period and number of SSC measurements in the Figure caption.

We added this information.

Page 10, Figure 4: Please add number of samples in the Figure caption.

We added this information

Page 11, line 8-11 and Figure 5: In Figure 5 the distributed densities for 10 grain size classes of the Orne river are displayed. How many samples were measured? Please consider to add error bars to show the variation of the sediment densities per grain size class.
Unfortunately, we did not repeat the density measurements many times and we are consequently not able to add error bars to show the variance of the density distributions between particle sizes. Moreover, we do not have the sample anymore. As a matter of fact, it is at that time impossible for us to answer the reviewer request. We apologize for this.

In addition, the high density of the 100 µm size class is interesting. Is there an explanation for that?
We thank Reviewer 3 for these comments. Depending on the mineralogical aspect the density can be spread from 1400 $kg.m^{-3}$ (Morraine for example) up to 7600 $kg.m^{-3}$ (the exception of the Galena). The Schist or the Gneiss for example can have such density values (i.e. 2850 $kg.m^{-3}$). In the Orne River, sediment is not only composed of quartztite (2600 $kg.m^{-3}$) and can be attributed to soil microagregates and residues of anthropogenic past and actual activities, which can explain the rather large density variability.

Page 11, line 16-21: add dates of field campaigns.
We add the dates of the field campaigns.

Page 12, Table 1: I suggest testing of additional model configurations (see general comments).
Please see the answers to the general reviewers comments

Page 12, line 19: insert ‘class’ behind ‘100 µm’
We did so in the new version of the manuscript.

Page 12, line 23: delete ‘obtained’
We did so in the new version of the manuscript.

Page 12, line 24: insert ‘upstream’ before ‘boundary condition’
We did so in the new version of the manuscript.

Page 13, line 9: delete ‘for the discussion’
We did so in the new version of the manuscript.

Page 13, line 16: underestimate underestimates
We did so in the new version of the manuscript.

Page 13, line 12: increase increased
We did so in the new version of the manuscript.

Page 13, line 21: move ‘’in the 10 CLD (2600 kg m -3)’ to line 20, between ‘whereas’ and ‘we’
We did so in the new version of the manuscript.

Page 14, Figure 6: explain abbreviations in the Figure caption or refer to Table 1
We will refer to Table 1 and explain abbreviations.

Page 15, line 10-11. This statement is not clear: What other kind of processes should influence the transport of suspended particles than advection and diffusion? Please clarify.
To clarify this statement, we edited the text as follow:
“Fig. 3 shows that the SSC time series have similar shapes and magnitudes at the upstream and downstream boundaries of the model. This indicates that erosion plays a limited role in the overall

sediment transport budget when compared to advection and dispersion, during this rather low magnitude flood event."

Page 15, line 15: insert 'the' before '63 and ...'
We did so in the new version of the manuscript.

Page 15, line 19-23: Please try to verify the assumptions in this paragraph.
We thank Reviewer 3 for this comments. This is actually more than an assumption.
When simulating high magnitude flood events, the flow velocities increase resulting in a larger number of sediment classes potentially eroded, transported and deposited. The studied flood event was of moderate magnitude and not all the 10 classes of sediment where transported in suspension. Only the five smallest classes were imposed as suspended sediments at the upstream boundary and only the four smallest classes were simulated in suspension at the dowstream boundrary. Indeed, the size of particles transported in suspension, especially through advection-dispersion processes, would be larger during events with higher flood magnitude. Moreover, it would increase the deposition and erosion of coarser particles along the river section.
The related sentences have been modified in the revised version of the manuscript:
"It is also worth mentioning that larger differences between the two configurations are expected in terms of simulated SSC for higher-magnitude flood events. Indeed, for such flood events, larger sediment particles are transported as a result of higher flow velocities. Distributing the upstream SSC over various sediment classes would then allow the transport of larger sediment particles via advection-dispersion in configuration 10CL."

Page 16, Figure 7: it is very difficult to identify the grain size classes in the graph from the colors in the legend. Please use colors which are clearly differentiated
We changed the color scale as suggested by the reviewer.

Page 17, line 4: delete 'the' before 'erosion and...'
We did so in the new version of the manuscript.

Page 17, line 15: delete 'the' before 'deposition'
We did so in the new version of the manuscript.

Page 17, line 15-17: This statement is unclear. In addition, is there a reference in the literature?
The related sentences have been modified in the revised version of the manuscript to clarify this statement:
"Moreover, we argue that the influence of sediment density on model simulations would be larger when simulating higher-magnitude flood events as the range of transported sediment sizes would be broader. Indeed, during larger flood events, we might expect that coarser sediments are transported, eroded and deposited. Moreover, a change in sediment density is associated with a change in fall velocity, which implies changes in the transport processes: a higher density reduces transport and, on the contrary, a lower density increases it. Changes in density would therefore also result in the displacement of erosion and deposition areas for coarser sediment, making bathymetry evolutions more markedly different in 10CL and 10CLD configurations during higher-magnitude flood events."

Page 19, line 18-19: This statement is imprecise. Please clarify.
The cross comparison of the final riverbed elevation evolution is a proxy of changes in location and amplitude of deposition and erosion.
The related sentence has been modified in the revised version of the manuscript to clarify this statement:
"Our analysis, based on a correlation of riverbed evolutions, also shows that using measured sediment densities instead of standard ones slightly changes the areas of erosion/deposition."

Page 20, line 11: ';;;;' missing reference?
Sorry for this error. This has been corrected in the new version of the manuscript

Page 20, line 5-21: In my opinion the list of improvements of the modeling framework is too comprehensive in the context of the manuscript. I thus recommend to focus on feasible improvements in the existing model framework.
We thank Reviewer 3 for this suggestion. We now separate improvements that can be done in a near future and longer-term perspectives in sediment transport modelling:
"The proposed sediment transport modelling framework is found to improve the accuracy of the results. However, additional developments could be considered in order to integrate bio-physico-chemical processes. Indeed, the temporal variability of the bio-physico-chemical conditions in rivers plays a key role in shaping the sediment dynamics during flood events. In this context, we envisage implementing two important developments:

1. A new generation of high-frequency measurement sensors could be used to record the model input data. A LISST sensor (Fugate, D. C. and Friedrichs, 2002), which measures the size and concentration of particles suspended in water, or a combination of two acoustic doppler current profilers (Jourdin et al., 2014) could for example be used to monitor the SSC for each individual sediment class. This would provide more realistic model inputs and more accurate validation data at the same time.

2. Flocculation processes could be integrated as they play a key role in sediment transport due to the fact that the density and the shape of flocs differ from those of individual sediment particles. As a result, their displacement in the water column is different from that of isolated sediment particles (Parker, 1972; Van der Lee, 2009). The integration of flocculation process could be implemented by coupling a morphodynamic model with a floc population model such as FLOCMOD (Verney et al., 2009, Lepesqueur et al., 2018).

In terms of longer-term developments, the erosion and deposition laws used in the morphodynamic model should also take into account interactions between sediment classes, as argued for example by Starck (2014). Indeed, many existing studies highlight the importance of the compaction of non-cohesive sediment (Swidersky, 1976), armouring (Egiazaroff, 1965), hiding/exposure (Ashida, 1973), filtration of fine particles by coarser sediment (Karim, 1982; Brunke, 1999; Herzig et al., 1970) and lubrication (Barry, 2006), together with biological processes (e.g. Arthur et al., 1980; Widdows et al., 2000; Le Hir et al., 2007)."