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Review and rebuttal of the paper

Loads and effects of ship-generated, drawdown waves in confined waterways - A review of current knowledge and methods

León-Carlos Dempwolff, Gregor Melling, Christian Windt, Oliver Lojek, Tobias Martin, Ingrid Holzwarth, Hans Bihs, and Nils Goseberg

Editor handling the paper: Sebastien Erpicum

The reviewers remain anonymous.

Second round of review

Response to the reviewers

Dear Editor,

we would like to express our appreciation for the time and effort you and the respected reviewers took to help to improve the presented manuscript. We think that addressing the raised comments increased the overall quality of the revised manuscript.

Please find attached a marked version of the manuscript, indicating the amendments performed and a cleaned-up manuscript. Detailed answers to the reviewers' comments are provided in this letter.

Answers to the individual comments can be found below. The convention is as follows:

- Refers to the reviewer's comments
- *Refers to our responses to the comments*
- Refers to new text added to the manuscript
- ~~Refers to text deleted from the manuscript~~

In addition to incorporating the reviewers' comments, literature published during the review or shortly before the initial submission was also included, making sure that the present manuscript is still up-to date with the latest advancements. Details on these amendments are given in Section 4 of this letter.

1 Reviewer E

1.1 Major Comments

Comment 1.1.1 : The abstract is unnecessarily lengthy, and reads more like an introduction. Please condense it, particularly the second and third paragraphs.

Response: *Thank you for this advice. We reformulated the abstract as outlined in the following:*

Actions taken: ~~So far, the effect of ship-generated waves on waterway embankments has yet only routinely been considered for inland waterways with a constant cross-section. Less attention has been payed to the ship-induced wave and current loading in more complex bathymetries like coastal waterways and estuaries, as naturally occurring loads had been thought to dominate. However, the hydrodynamic loads induced by ships grow and become increasingly relevant in coastal waterways, due to continuously growing dimensions of sea-going ships. At the same time, requirements rise to allow for restoring the ecological value of of inland and coastal waterways, leading to spatially more diverse bathymetries and embankment structures. Hence, the prediction of ship-generated primary wave magnitudes at banks becomes increasingly complex, due to deformation processes of the propagating waves in shallow water. Knowledge on ship-generated waves characteristics and methods to predict induced loads are thus essential for the assessment~~

~~of bank stability and the dimensioning of engineering structures to resist present-day and prospective ship-induced loads.~~

The ship-induced loading has recently become more relevant, since ship sizes increase and traffic intensifies, leading to higher and more frequent loads. Especially in non-homogeneous waterways, like estuaries and natural or re-naturalized rivers, shallow-water wave deformation processes affect the far-field loading induced by ships. Thus, methods to predict these loads need to account for the site-specific effects regarding wave generation and propagation.

Comment 1.1.2 : While the English in the article is generally understandable and of an acceptable clarity, there are numerous grammatical errors and instances where the sentences are poor from a style point of view. This reviewer has provided a non-exhaustive list of these below, which the authors should go through when preparing their next draft of the manuscript. Due to these alone, this reviewer concludes that a “major revision” is needed of this paper.

Response: *Thank you for your time and effort in compiling this detailed list. We included your comments as detailed in the Section 1.2 of this letter.*

Comment 1.1.3 : The authors also at times repeat themselves. Review papers are long, though still effort needs to be made to present information in a succinct manner. Again, a non-exhaustive list of instances where some sentences can be cut is given below.

Response: *Thank you for bringing this to our attention: We rephrased several sentences. We think, that this greatly contributed to the overall quality of the manuscript. For the sake of brevity, not all changes are listed in this document; however, all changes can be traced in the attached manuscript with tracked changes.*

1.2 Minor comments

Comment 1.2.1 : L68. Unclear what the authors mean by “Initially, the development of sea-ship size and associated reports on intensifying ship-induced loads were sparking this literature review.”

Response: *Thank you: we adapted our choice of words.*

Actions taken: Initially, the ~~development of sea-ship size~~ **increasing size of sea-going ships** and associated reports on intensifying ship-induced loads were ~~sparking the motivation for~~ this literature review.

Comment 1.2.2 : L88 why the use of the word “developing” (developing ship wave systems)?

Response: *We agree that this word was misplaced and removed it.*

Actions taken: The relative magnitude of different ~~developing~~ ship wave systems are dependent on the ship size and speed, as well as the dimensions of the surrounding waterway.

Comment 1.2.3 : Figure 1. “The dashed line indicates the still water level”. There is no dashed line in this figure.

Response: *Thank you for this correction. The caption was still associated with a previous version of the figure. We corrected this mistake, indicating that the line is blue.*

Comment 1.2.4 : L159 “is getting less steep”... is getting less steep according to what? (is this due to the passage of time, as the morphology of the lagoon changes? Or with distance to the ship?). This phrase is unclear...

Response: *Thank you for this comment. We complemented the sentence with the missing information:*

Actions taken: Field measurements in the lagoon revealed that ship-generated drawdown waves are symmetric on the boundaries of the navigation channel, but progressively deform during their propagation over the adjacent wetlands (Parnell et al., 2015). The authors report that the front slope of the drawdown wave is getting less steep **during its propagation away from the ship**, while the rear slope is rapidly gaining in steepness, eventually even exhibiting shock like features or breaking and formation of bore-type waves (e.g. see also (von Häfen et al., 2019)).

Comment 1.2.5 : L480 The gates are arguably not sensitive to “variations” of ship parameters, but to “some of these factors”, or something like this.

Response: *Thank you. We adapted the sentence.*

Actions taken: The authors report the gates to be highly sensitive to **variations of** ship parameters, speed among the most relevant factors.

Comment 1.2.6 : L501 do the authors mean “around the foot of the groin”?

Response: *Thank you for your question: We actually intended to use the term root. We included a short explanation in the text, as the term might not be very common.*

Actions taken: The interaction of the drawdown and stern wave with the rock groins typically results in a very characteristic damage pattern, where the groin root - **the transition region between the groin and the adjacent bank** - and the lee-side of the groin body are severely damaged.

Comment 1.2.7 : L579 what is “parameter space”?

Response: *We replaced the term by the probably more common term ‘range of’ parameters.*

Actions taken: The **large wide range of** parameters **space** and the number of variables affecting the propagating drawdown waves in coastal waterways and near-natural rivers results in inaccurate prediction of loads in complex bathymetries.

Comment 1.2.8 : L649, what is the “fairway”?

Response: *We used fairway and waterway synonymously. To avoid any confusion we now use the term waterway throughout the entire manuscript.*

Comment 1.2.9 : L664 why do the authors state “balance the displaced sediment volumes”? Why the word “balance”

Response: *Thank you: The choice of words was somewhat odd. We therefore replaced it.*

Actions taken: Particularly for morphodynamic studies and effects on embankments, the effective duration, which is closely coupled to the wave period, is an important parameter ~~to controlling balance~~ the displaced sediment volumes.

Comment 1.2.10 : L722 it is unclear what the difference is between “symmetry planes or as impermeable surfaces.”. Please explain. Also, it is unclear what the authors mean by “Mirror images of the same strength as the original sources can represent symmetry planes when positioned in symmetry to the original sources.” It is possible that this confusion is due to this reviewer being unfamiliar with the BEM, but please explain.

Response: *There are two ways of accounting for a channel side wall. It can either be enforced as a boundary condition, such that no velocity component orthogonal to its surface exist. The second option is to extend the domain and include a second set of sources. This set of sources acts like a second ship leading to the same velocity field around it. Consequently, at the channel boundary (the symmetry plane), the velocity components cancel each other out as they are directly opposing.*

We see that our short explanation on BEM can not really be read as an introduction to this family of methods, since this topic is too big to cover in a short paragraph. However, we think that pointing at references that cover these methods in detail is sufficient, considering that our review paper is focusing on waterway-related problems.

Comment 1.2.11 : L997 maybe delete “very” (deviations of less than 20% are good (L1004), but probably not “very good”)

Response: *We agree that this wording is a bit too euphemistic and adapted the text according to your suggestion.*

Comment 1.2.12 : L1010 what is the meaning of the acronym SGH?

Response: *SGH stands for ship-generated hydrodynamics, as now included in the updated version of our manuscript.*

Comment 1.2.13 : L1016 what is the value of 0.55 m/s? a velocity? Of what?

Response: *There was a mistake in the units of this value. This is now corrected. The value describes the drawdown amplitude. Thank you for pointing us at this error.*

Comment 1.2.14 : L1190 Unclear what the authors mean by “Therefore, advances are given regardless of the question if an implementation of ship wave generation has yet been performed.” Please clarify and rephrase.

Response: *Thank you for raising this point. Some of the codes mentioned are not yet able to represent the process of ship wave-generation. However, we think that advances are interesting to the reader, as recent developments contribute to accuracy and speed of far-field wave prediction and, hence, could be applied to ship waves in the future. The sentence was rephrased and now reads:*

Actions taken: ~~Therefore, advances are given regardless of the question if an implementation of ship wave generation has yet been performed.~~ Therefore, recent improvements of this type of numerical models are summarized

in the following, irrespective of whether the generation of ship waves is already included in the respective code.

Comment 1.2.15 : L1253 “outlined the relevance”... the relevance of what?

Response: *Thank you for your comment. We adapted the sentence.*

Actions taken: On the basis of the comprehensive literature review of the loads and effects of these long waves, our work has outlined the relevance of **primary-waves** compared to other ship-generated wave systems.

Comment 1.2.16 : L1255 Unsure as to whether the waves can really be called “remarkable”.

Response: *Thank you: We replaced remarkable by significant.*

Actions taken: Large ships progressing through confined waterways generate long-period drawdown waves of **significant remarkable**, often design-relevant magnitude.

Comment 1.2.17 : L1266 why the word “times” (maybe delete?)

Response: *We agree that, this way the sentence sounds more elegant and therefore deleted the word ‘times’*

Comment 1.2.18 : L1271 again the use of the word remarkable. What is remarkable about them?

Response: *We replaced the word remarkably by substantially.*

Actions taken: Given these more complex bathymetric features, ship-generated drawdown waves deform **remarkably substantially** during their propagation analogous to the effects observed in coastal waterways.

Comment 1.2.19 : L1273 what do the authors mean by “locally varying dependent”?

Response: *We adapted the sentence.*

Actions taken: The loads induced by a propagating drawdown wave can hence be expected **to vary largely at different locations of the waterway to be locally varying**, dependent on the stage of wave transformation within the bathymetry surrounding a ship.

Comment 1.2.20 : L1286 “In addition, structural elements of waterways such as groins subject to overtopping are not covered sufficiently by present day guidelines. Recent achievements to overcome the limitations of the existing guidelines resulted in adapted groin design.” These two sentences appear to slightly contradict each other.

Response: *We agree, that the formulation was slightly imprecise and adapted the text accordingly:*

Actions taken: ~~Recent achievements to overcome the limitations of the existing guidelines resulted in adapted groin design.~~ Experimental tests allowed for the adaption of groin design for one specific site. The adapted geometry ~~relies on extensive experimental data, and~~ is found to withstand the new loads induced by the present-day navigation fleet.

Comment 1.2.21 : L1296 “with computationally-costly efforts to provide the necessary level of detail”. The grammar here is strange, compared to the beginning of the

sentence. Please rephrase. The beginning of the next sentence “Therefore they are limited to modified waterways,” thus also becomes unclear

Response: *The sentence was really confusing indeed, therefore we decided to simplify it accordingly.*

Actions taken: Empirical and analytical approaches are not fully suitable to include the multivariate input data arising from complex bathymetries in sufficient detail. ~~with computationally-costly efforts to provide the necessary level of detail.~~ Therefore they are limited to modified waterways, or require site-specific input data from experimental data or field measurements.

1.2.1 Style, grammar, punctuation

Comment 1.2.22 : -Abstract “This review work is specifically concerned with the long-period, primary wave system, large- volume ships travelling through conned waterways, generate,” please rephrase, grammar is somewhat unelegant

Response: *We agree that the sentence was of poor style and adapted it accordingly.*

Actions Taken: This review work is specifically concerned with the long-period, primary wave system, ~~large-volume ships travelling through confined waterways, generate~~ generated by large-volume ships travelling through confined waterways. ~~as it~~ This wave system may exert intensive wave and current loading on the banks, affecting local morphology, engineering structures and ecology.

Comment 1.2.23 : L12 “ships are of increasing size with corresponding transport capacity, as well as their outer dimensions.” Not clear what the authors mean by “increasing size with corresponding transport capacity”. Please re-write this sentence.

Response: *We thank the reviewer for the advice*

Actions taken: As a result of cost optimization, ~~larger ships are employed, increasing the transport capacity per ship. ships increasing in size and corresponding transport capacity, as well as their outer dimensions.~~

Comment 1.2.24 : L71 generally speaking the use of the word “believe” is frowned upon in academia (though this reviewer also from time to time forgets to use a better word... but please do change it).

Response: *Thank you. The revised sentence now reads:*

Actions taken: At the same time, the authors ~~believe are of the opinion~~ that the derived conclusions can ~~to a large extent~~ be applied to inland waterways alike, as established within the framework of river restoration measures.

Comment 1.2.25 : L146 this sentence is strange “Since design relevant primary ship waves are generated by large carriers, they are particularly long.”. Why the word “carriers”. Also, it is unclear what the authors mean by “They are particularly long”. Please clarify and rephrase

Response: *Thank you for this comment. The manuscript was revised.*

Actions taken: Since design relevant primary ship waves are generated by large ~~carriers vessels~~, ~~they are their wave-length is~~ particularly long.

Comment 1.2.26 : L194 is “to his credit” the correct expression? Maybe “In his honor” or “To credit him”

Response: *Thank you for this comment. The sentence now reads:*

Actions taken: ~~To his credit~~ **In his honor**, the alternative name Havelock angle -for the cusp locus angle in shallow or intermediate water-depth- has been introduced in the research community.

Comment 1.2.27 : L209 “in a threshold” . . . what threshold? This is not clear.

Response: *Thank you: We specified the missing information.*

Actions taken: Considering characteristic lengths for both transverse and divergent waves, this results in a threshold **for the transition from deep to shallow water conditions** of about 0.55 to 0.7 for the depth Froude-number (Soomere, 2007)

Comment 1.2.28 : L207 What is the point being made in this part of the sentence: “where the wave is experiencing the bottom over which it propagates”? Delete?

Response: *Thank you for bringing this point to our attention. It was deleted as suggested.*

Comment 1.2.29 : L360 unclear what the authors mean by “on embankments performed by the authors’ institutions are displayed”

Response: *Thank you. We revised the manuscript as follows:*

Actions taken: As an additional novel contribution in this work, some findings of previous research on damaging influence of primary ship waves on embankments ~~performed by the authors’ institutions~~ are displayed; these are often only available as technical reports to date and shall supplement the summary knowledge collected in here.

Comment 1.2.30 : L449 change to “Navigated waterways can be protected from erosion by constructing . . .” (much of the sentence in L449-450 is superfluous.

Response: *Thank you for this suggestion. We adapted the manuscript accordingly.*

Actions taken: Navigated waterways ~~can be protected from erosion are subject to adaptation strategies, required to fulfill site-specific demands. They are supposed to protect shorelines from erosion~~ by constructing riprap along the banks, prevent damage of the surroundings resulting from flooding events using dykes, or ensuring safe operation conditions installing groins and training walls along the waterway.

Comment 1.2.31 : L506 change to “the new designs were also” . . . but, what do the authors mean “to trail”? (to test?)

Response: *Indeed, the choice of word was odd. The text now reads:*

Actions taken: In addition, the new designs ~~were was~~ also ~~put to trail examined~~ in a prototype study, testing two different groin designs in the Elbe estuary where the incident primary wave loads and damage development of the groins were monitored over several years (Melling et al., 2020).

Comment 1.2.32 : L581 again the word “believed”...

Response: *Thank you for the comment. The word was replaced:*

Actions taken: Numerical methods ~~can be believed to~~ overcome the issues mentioned.

Comment 1.2.33 : L799 unclear what the authors mean by “Confined waterways are emphasized in the following, regarding the scope of the paper.” Delete sentence?

Response: *Thank you for this suggestion. The sentence was deleted in the revised manuscript.*

Comment 1.2.34 : L1132 “its intensity”. This is the intensity of what? This phrase is slightly confusing...

Response: *Thank you for bringing this to our attention. The sentence was rephrased:*

Actions taken: Floods are found to erode upper banks, ~~while erosion its~~ intensity ~~is~~ mainly controlled by protective plant growth. ~~This relation~~ highlights the complex cascading effects ship waves can have.

Comment 1.2.35 : L272 the following sentence is superfluous, probably better to delete “The ship hydrodynamic phenomena introduced in the following are of great concern regarding safe and efficient navigation, for which they have been studied extensively”.

Response: *Thank you for this comment. The sentence was removed from the updated version of the manuscript.*

Comment 1.2.36 : L545 avoid use of passive tense in academic writing. Please rephrase this sentence.

Response: *Thank you for raising this point. We rephrased the sentence.*

Actions taken: ~~Summarizing the findings of the literature concerned with the impact of ship-generated primary waves, the variability of primary wave impact is highlighted.~~

~~A primary conclusion of the existing literature on ship-generated waves is the large variety of the effects of shipping activities on the built and living environment depending on each specific site and the local traffic structure.~~

Comment 1.2.37 : L893 to 908. This is possibly too long an explanation for this one model? Can this be summarised further?

Response: *Thank you for bringing this to our attention. We agree, that details of the measurement campaign are not required and make this paragraph unnecessary long. However, the publications mentioned are of special interest in the framework of our paper, as these are -to the best of our knowledge- the only ones focusing on detailed CFD simulations of ship-wave bank interaction. Therefore the paragraph was only slightly condensed.*

Actions taken: Finally, regarding the modelling of the interaction between ship-induced waves and river banks, Fleit et al. (2016, 2019) employ the finite difference based RANSE tool REEF3D::CFD (Wang et al., 2020). The authors focus on the determination of hydrodynamic loads

acting on river banks, necessary for the quantification of the environmental impact of ship traffic on species living or breeding on the banks. The studies rely on experimental input of the water elevation caused by passing ships to provide adequate boundary conditions for a reliable analysis. ~~Pressure and velocity during a ship passage are measured at several locations perpendicular to the riverbank at varying water depths. Obtained time series were filtered and decomposed into a spectral information using the Fast-Fourier-Transformation. Primary wave components are neglected in the filtered data.~~ The littoral zone is reproduced in a numerical wave tank, representing a 2D-slice model of the sloped bank. The measured wave spectra are used as boundary condition for the generation of irregular wave trains in the CFD model. With this input given, shoaling and wave-breaking along the river bank are modelled. The spectral information at the stations on the slope shows a qualitative good agreement between CFD and measured data, even though the maximal amount of total kinetic energy is overestimated by the numerical model. The authors conclude that CFD computations prove to be a reliable tool in reproducing the ship-induced wave run-up on the embankments.

Comment 1.2.38 : L1065 “The prediction of container ship size on this qualitative relation remains difficult, as to the number of input variables affecting the result” This sentence is confusing. Please rephrase.

Response: *Thank you for this comment. We reformulated the sentence.*

Actions taken: ~~The prediction of container ship size on this qualitative relation remains difficult, as to the number of input variables affecting the result.~~ Still, the number of input variables affecting the optimal ship size render a prediction of future ship sizes difficult.

Comment 1.2.39 : L1074 “and an expected increase in waiting times”. Revise grammar around this part of the sentence. It is not grammatically correct

Response: *Thank you for your suggestion. We revised the sentence.*

Actions taken: Park and Suh (2019) stress the need for adapting port infrastructure ~~if the past growth of container ships is extrapolated into the future.~~ The main reasons are that present-day cranes reach their capacity limit and ~~an expected increase in~~ waiting times for adequate berthing areas increase with increasing vessel dimensions. ~~,if the past growth of container ships is extrapolated into the future.~~

Comment 1.2.40 : L1160 “is largely governing local loads” incorrect grammar. Rephrase.

Response: *Thank you for bringing this to our attention. The sentence was adapted.*

Actions taken: The shipping fleet travelling a waterway is ~~decisive for the intensity of largely governing~~ local loads, ~~rendering the inclusion of ship-induced effects necessary necessitating its inclusion~~ in the design of nature-based solutions.

Comment 1.2.41 : L 1162 Unclear what the authors mean by “as to the ecological stress induced by primary waves on gentle slopes of unprotected banks” Delete?

Response: *Thank you for this comment. We modified the sentence.*

Actions taken: Introducing nature-based solutions might be beneficial from a perspective of the waterway’s maintenance for navigation and its ecological value alike, ~~as to considering the damaging effects of ecological stress induced by~~ primary waves on ~~gentle slopes of~~ unprotected banks and habitats as highlighted in Sections 3.1 and 3.3.

1.2.2 Corrections included without further details

- Comment 1.2.42 :** Abstract “So far, the effect of ship-generated waves on waterway embankments has yet only routinely”, delete “yet”
- Comment 1.2.43 :** L16, “largest ship the HMM Algeciras is”, add a comma after “ship” and after “Algeciras”
- Comment 1.2.44 :** L19 “in bilateral inuence of the ship and waterway” change to “in a bilateral influence between the ship and the waterway”
- Comment 1.2.45 :** L20 “Research has been dedicated to various aspects of the interaction of ships with the surrounding waterway.” Does not add anything, and repeats the sentence after it. Delete.
- Comment 1.2.46 :** L33 “These waves characterized” place a comma after “waves”
- Comment 1.2.47 :** L36 change to “has been known for a long time”
- Comment 1.2.48 :** L36 delete “sailing in confined waters”
- Comment 1.2.49 :** L44 maybe the word “reflecting” is not the best here...
- Comment 1.2.50 :** L46 maybe “have been published in the past”
- Comment 1.2.51 :** L55 delete comma after “navigation”
- Comment 1.2.52 :** L59 delete comma after “elaborated on”
- Comment 1.2.53 :** L62 should be “The authors focus...” (if talking about Stern et al)
- Comment 1.2.54 :** L64, probably better “This reviewer paper differs from existing literature in that it”
- Comment 1.2.55 :** L67 add comma after “parallel”
- Comment 1.2.56 :** L71 change to “to a large extent”
- Comment 1.2.57 :** L119 change to “is called the primary wave system”
- Comment 1.2.58 :** L161 should probably be “ship-induced wave” (hyphenated)
- Comment 1.2.59 :** L180 add comma after “waves”
- Comment 1.2.60 :** L181, probably a comma before “(2)”
- Comment 1.2.61 :** L190 delete all commas after “systems”
- Comment 1.2.62 :** L232 change to “In addition to the drawdown and secondary waves described...”

- Comment 1.2.63** : L233 change to “can also become relevant”
- Comment 1.2.64** : L235 delete comma after components
- Comment 1.2.65** : L238 comma after “environments”
- Comment 1.2.66** : L267 delete comma after wake
- Comment 1.2.67** : L307 delete comma after “resistance”
- Comment 1.2.68** : L333 change to “comprises the components of primary”
- Comment 1.2.69** : L334 delete “individual components are generated by the modification of the flow field surrounding the ship.” This probably adds nothing to the text
- Comment 1.2.70** : L337 change to “in the form of”
- Comment 1.2.71** : L341 Change to “by a load climate that is not affected by high-energy wind waves”
- Comment 1.2.72** : L341 change to “at transcritical conditions, and are design-relevant in coastal waterways travelled by fast ferries”
- Comment 1.2.73** : L350 change to “ship-induced”
- Comment 1.2.74** : L352 change to “design-relevant”
- Comment 1.2.75** : L362 delete “to date”
- Comment 1.2.76** : L365 change to “but as the implications also concern other questions”...
- Comment 1.2.77** : L383 maybe “to the mass shifted by wind-generated waves”?
- Comment 1.2.78** : L397 change to “of the processes involved”
- Comment 1.2.79** : L403 change to “ships” (pluaral). Also in subsequent sentences change to plural
- Comment 1.2.80** : Table 1 “drawdown wave” in the Schoelhamer row should be in capitals
- Comment 1.2.81** : L415 delete comma after velocities
- Comment 1.2.82** : L417 change to “milimitres after the passage of a single ship”.
- Comment 1.2.83** : L419 change to “locations 30 m and 230 m away from the navigational channel”
- Comment 1.2.84** : L421 change to “the gauge density is not as high there”
- Comment 1.2.85** : L422 change to “at the gauge further inshore”
- Comment 1.2.86** : L431 change to “an increase in the”
- Comment 1.2.87** : L437 change to “an increase in the offshore”
- Comment 1.2.88** : L467 change to “are difficult to untangle”
- Comment 1.2.89** : L475 change to “at either side”

- Comment 1.2.90** : L478 Elbe and Weser rivers?
- Comment 1.2.91** : L505 change to “loads, though further scientific...”
- Comment 1.2.92** : L515 change to “has become”
- Comment 1.2.93** : L518 change to “following the passage of the ship”
- Comment 1.2.94** : L520 change to “for one species left 66% of individuals on the dry slope”?
- Comment 1.2.95** : Table 3, capitalize “unspecific” in the row by Ali et al.
- Comment 1.2.96** : L527 change to “the wave induced loads resulting”
- Comment 1.2.97** : L533 change to “for inducing stress on the”
- Comment 1.2.98** : L535 change to “retreat (of up to 35 m), on...”
- Comment 1.2.99** : L537 comma after “sites”
- Comment 1.2.100** : L542 change to “contributed to the steepening of the surge component of the wave, which could be regarded as critical in this case”.
- Comment 1.2.101** : L547 “even drawdown waves of smaller height may become severe”. Not the best of expressions... maybe “may cause severe problems”
- Comment 1.2.102** : L554 change to “in the case of”
- Comment 1.2.103** : L563 change to “and the conclusions drawn”
- Comment 1.2.104** : L567 change to “primary waves can be considerable, as highlighted in Section 3”.
- Comment 1.2.105** : 571 change to “the understand of processes within existing waterways, though they are insufficient when it comes...”
- Comment 1.2.106** : L573 change to “methods can be useful to predict such loads”
- Comment 1.2.107** : L576 change to “as the replication of the bathymetry of the waterway...”
- Comment 1.2.108** : L578 probably should change change to “Such methods all have in common that reliable results can only be...”?
- Comment 1.2.109** : L589 typo, “Therefore”
- Comment 1.2.110** : L593 change to “ship-induced”
- Comment 1.2.111** : L595 change to “estuaries”
- Comment 1.2.112** : L597 change to “detailed insights”
- Comment 1.2.113** : L604 change to “was included”
- Comment 1.2.114** : L607 change to “only partly account for the hydrodynamic processes that take place during the passage of a real ship”.
- Comment 1.2.115** : L621 (maybe “were originally developed”?)

- Comment 1.2.116** : L646 maybe “A list of these equations, specifically designed to address drawdown, is compiled. . .”
- Comment 1.2.117** : L658 change to “reveals”
- Comment 1.2.118** : L661 add comma after “period”, remove comma after “loads”
- Comment 1.2.119** : L663 remove comma after embankments, add comma after duration and period.
- Comment 1.2.120** : L671 maybe “yielding maximum coefficients of determination of 0.48”
- Comment 1.2.121** : L683 delete the “(“ before CIRIA. . . add the brackets before and after the years.
- Comment 1.2.122** : L687, same as previous comment
- Comment 1.2.123** : L690 change to “have been”
- Comment 1.2.124** : L692 delete “more”
- Comment 1.2.125** : L721 change to “in its nonlinear”
- Comment 1.2.126** : L727 remove “(“ before Shahjada, and then place all the years in brackets.
- Comment 1.2.127** : L735 “cannot” is recommended in scientific writing
- Comment 1.2.128** : L738 delete comma before “Results”
- Comment 1.2.129** : L753 change to “For cases. . .”
- Comment 1.2.130** : L769 and 779 all acronyms (in this case RANSE) must be defined the first time they are introduced.
- Comment 1.2.131** : L781 maybe “Other parameters than. . .”
- Comment 1.2.132** : L789 change to “questions requiring larger domains”
- Comment 1.2.133** : L789 again, delete “(“ and place brackets outside of the years for each author.
- Comment 1.2.134** : L805 is the “textit” before ANSYS-Fluent supposed to be there?
- Comment 1.2.135** : L806 change to “at a distance of”
- Comment 1.2.136** : L883 change to “and therefore”
- Comment 1.2.137** : L889 change to “by high-fidelity”
- Comment 1.2.138** : L915. Full stop after equations.
- Comment 1.2.139** : L970 change to “primary waves were not the focus of the assessment”
- Comment 1.2.140** : L983 change to “since the length”
- Comment 1.2.141** : L985 change to “Shallow-water-equations (SWE).”
- Comment 1.2.142** : L1011 comma after “components”

- Comment 1.2.143** : L1020 change to “of up to”
- Comment 1.2.144** : L1032 change “well” to “good”
- Comment 1.2.145** : L1034 change to “that can be used to study”
- Comment 1.2.146** : L1040 ad comma after “value”
- Comment 1.2.147** : L1043 comma after “site”
- Comment 1.2.148** : L1049 change to “is coupled to a SWE tool, further predicting the wave deformation”
- Comment 1.2.149** : L1060 maybe change to “per contained bases decreased in the past few decades with enlarged ships”
- Comment 1.2.150** : L1071 delete comma after “suggests”
- Comment 1.2.151** : L1081 comma after “infrastructure”
- Comment 1.2.152** : L1097 change to “wakes”
- Comment 1.2.153** : L1110 delete comma after “concluded”, add comma after “that”
- Comment 1.2.154** : L1125 comma after “waterways”
- Comment 1.2.155** : 1140 change to “in an estuarine”
- Comment 1.2.156** : L1154 change to “at the site”
- Comment 1.2.157** : L1158 generally speaking, in academic writing, the word “However” should be placed at the beginning of a sentence, followed by a comma.
- Comment 1.2.158** : L1166 change to “ship-induced primary waves, such as in the severe...”
- Comment 1.2.159** : L1169 change to “ship-induced” (please do a Control-F and find all instances where you are not hyphenating this word, there may be more than those in this list). More are present after this point in the text, but this reviewer will no longer continue to list them.
- Comment 1.2.160** : L1186 change to “Based on either the Boussinesq...”
- Comment 1.2.161** : L1195 change to “are being improved”
- Comment 1.2.162** : L1207 change to “Further advanced include the modelling...”
- Comment 1.2.163** : L1211 change to “shows that the results of a solitary wave run-up on a slope are almost identical, if no wave breaking is expected”
- Comment 1.2.164** : L1215 change to “has proved to”
- Comment 1.2.165** : L1216 change to “in the form”
- Comment 1.2.166** : L1219 again, delete (“ Before Biausser, and place all years in brackets.
- Comment 1.2.167** : L1227 change to “accuracy, such coupling schemes appear to be promising methods to address future challenges”

Comment 1.2.168 : L1234 delete hyphen between “velocity-components”

Comment 1.2.169 : L1250 delete “as” after “waves”

Comment 1.2.170 : L1251 change to “in confined water, highlighting the need to conduct further research into this neglect aspect of river and estuary engineering”

Comment 1.2.171 : L1270 change to “key to a successful”

Comment 1.2.172 : L1275, maybe change to “characteristics, spatially-resolved to be able to. . .”

Comment 1.2.173 : L1278 delete comma after “both”

Comment 1.2.174 : L1280 not sure what the authors mean by “at first order”. Delete?

Comment 1.2.175 : L1285 add comma after “necessary”

Comment 1.2.176 : L1294 change to “into the focus of”

Comment 1.2.177 : L1299 delete comma after methods

Comment 1.2.178 : L1300 change to “in the last decade”

Comment 1.2.179 : L1305 change to “by implementing”

Comment 1.2.180 : L1307 delete comma after “way”

Response: *Thank you for these corrections: they have all been incorporated in the revised manuscript.*

2 Reviewer F

The authors presented a manuscript summarizing the current knowledge on primary waves in confined waterways. The relevance of the topic is beyond question, which is very well supported by the brief literature review at the beginning of the paper. The manuscript is well-structured and thorough regarding most of the relevant issues discussed. The text well written with very good English. Despite the scientific jargon and the high professional level, it is an easy read. Considering their obvious relevance from many aspects of river engineering, the reviewer was glad to see that the often-neglected primary waves are in the focus of this review paper.

2.1 Major comments

Comment 2.1.1 : Please discuss the effect/relevance of the different hydrological flow regimes, that is, how the low/high flow conditions affect navigation and primary waves in particular. Is there a notable relevance between free flowing and controlled (dams, HPPs, etc.) sections of rivers from this aspect?

Response: *This is clearly a very interesting point worth mentioning. However, the available literature on these influences is sparse. Therefore we included these very interesting points in our future challenges section as an additional Subsection (5.1.3) .*

Actions taken: It is known that the ambient environmental conditions during the navigation influence the impact of ship waves. In tidal waterways, the water level varies with the tides or possible storm surges. While a determining effect of tidal water level was already found for the hydrodynamic loading on groynes (Melling et al., 2019) and tidal gates (Uliczka et al., 2009), it is reasoned that it can be similarly relevant for loading on other structures. Thus, this interrelation of water level and ship-induced loads requires further research.

Comment 2.1.2 : Connecting to the previous point (and Section 5.1.1) – please briefly discuss the potential effects of changing flow regimes in the light of climate change, as one of the major challenges of engineering sciences. What tools do we have to predict these changes?

Response: *This point is very interesting but only partly covered by the available literature. Literature elaborating on the influence of climate change on estuary dynamics is widely available, yet the interdependence of ship loads and sea level rise is not indicated in the literature. An intensive review on methods on how to predict sea-level rise is beyond the scope of the paper. Concerning the prediction of ship waves, this is an additional parameter to be included in the examination, making analytical methods even less applicable and further challenging the time required for experimental test. The following is added in subsection 5.1.3:*

Actions taken: In addition, sea level rise will further modify estuary hydrodynamics and thus change the ambient conditions during navigation. The resulting effect - regarding the location of the still water-level or the altered waterway cross-sections for instance - could further challenge the existing methods for ship-induced wave prediction. Prognostic methods for the future sea level exist (e.g. Rahmstorf (2007)), yet methods need to be found that are able to include different scenarios into prediction methods for ship-induced loads routinely.

Comment 2.1.3 : In case of most of the large rivers used for navigation (e.g., the Danube) there are many dams, HPPs, which create a bottleneck for riverine traffic (queuing at ship locks). Considering the rapid increase of demand for inland navigation, could this be a relevant issue or a limiting factor in the future?

Response: *Thank you for this comment. The future development on traffic intensities on inland waterways goes far into the fields of economics, logistics and policy making and is not necessarily an engineering topic. Thus, we think that elaborating on this topic goes beyond the scope of our paper. The hydrodynamic loading occurring during maneuvering due to the propeller jet of accelerating ships is another type of loading. The review paper does not intend to cover the research within this field. Nonetheless we think that it is important to indicate the problem. Therefore, references pointing at review works on propeller jet induced scour are included in Section 1 of the updated manuscript:*

Actions taken: For the effect of propeller or thruster jets determining scour due to ship maneuvering in harbours, the reader is referred to the respective review works (Lam et al., 2011; Wei et al., 2020).

Comment 2.1.4 : Connecting to the previous point – Dams have very serious impacts on the natural sediment balance on rivers, leading to various issues in river management. From the aspect of navigation, a notable issue is the decrease of river bed levels on the downstream side of dams, as the natural bedload resupply is trapped in the reservoirs. While this is a problem specific to riverine navigation, the reviewer believes that a paragraph discussing this problem area and its contemporary research would improve the otherwise thorough manuscript.

Response: *To address the reviewer’s comment, the following is added in Subsection 5.1.3:*

Actions taken: For inland waterways, changing flow regimes may similarly cause interdependencies between the current water level and the ship-induced loading. The water level not only depends on the hydrological discharge regime but is further influenced by anthropogenic river control structures, such as dams and hydropower plants. In addition to their influence on the water level, these measures influence the sediment balance of rivers, ultimately affecting river cross-sections. It was already intensively discussed that bathymetric attributes influence the propagation of ship-generated waves. Hence, the determination of ship-induced loads with respect to the position of the study site relative to river control structures requires further research, also with respect to temporal evolution of the sediment balance.

2.2 Minor comments

Comment 2.2.1 : Abstract, paragraph 3, line 2: “value of of inland”

Response: *Thank you for your attentive reading. The additional word was removed.*

Comment 2.2.2 : Table 4: input parameter T is not mentioned in the list after the table

Response: *A description of the parameter was added, so that the list is complete now.*

3 Reviewer G

This review is very thorough and well-written. The topic has a significant novelty that differs from existing reviews.

Overall, it's a pleasure to review the manuscript, while I have some suggestions for the authors to improve:

Comment 3.1 : The manuscript lacks visual aids. It can be demanding for readers to comprehend such a long paper that does not have many figures (seems only has three sketches so far). It is a primary suggestion for authors to add some physical, CFD, and summative figures to assist the reading.

Response: *Thank you for bringing this point to our attention. The authors agree with the reviewer. To support the readability of the manuscript, 6 additional fotos of ship-induced impact are now added throughout the revised manuscript.*

Comment 3.2 : It is also suggested for the authors to add some comparison of wave patterns between open waters and confined waters. Following the same line, the authors could then summarise: how much percentage should the resistance and squat approximately change (with respect to open-water values).

Response: *Thank you for this suggestion. We discussed this point carefully among the authors, yet we believe that concerning primary waves, the relevance of confinement compared to open waters is already discussed extensively in Section 2.1. Details on the reflections of the secondary wave field within confined channels are outside the scope of the paper. However, this is mentioned and further literature elaborating on this effect is given in Section 2.3. The change of resistance when entering a confined channel is already given in Section 2.5.*

Comment 3.3 : A very relevant scenario is overlooked: ice channels. The authors should have a discussion on this, e.g. Huang, L., Li, M., Romu, T., Dolatshah, A. and Thomas, G., 2021. Simulation of a ship operating in an open-water ice channel. *Ships and Offshore Structures*, 16(4), pp.353-362.

Response: *We agree that, this is a very important scenario and an interesting publication clearly worth mentioning within the review-paper. We therefore included paragraph discussing these new findings in Section 4.2.1 as given below:*

Actions taken: A special form of channel is studied by Huang et al. (2021). The authors examine an ice channel, generated after deploying an ice-breaker that additionally cleans the channel from the remaining floes. Different from built channels, the open-water ice channel is only restricted at its surface while no confinement occurs underneath the ice surface. The results of CFD simulations with *Star-CCM+* indicate secondary wave reflections within the channel and an increase in resistance depending on channel width and ice-thickness. To date, the literature on ice-channels, especially concerning primary waves, is limited. However, the emerging intensification of navigation activities in the arctic oceans indicate a rising interest in studying this type of ship-waterway interaction.

Comment 3.4 : It is of safety importance for this review to summarise the potential conditions to occur “bank effects” (where a ship tends to be sucked towards the canal), perhaps also include the risk of being sucked by passing-by vessels.

Response: *This a clearly an important point worth mentioning. Thank you for bringing this to our attention. We included a paragraph in Section 2.5 elaborating on this point and giving further literature to continue the reading:*

Actions taken: An additional force acting upon the ship can similarly arise when a ship passes nearby a lateral obstacle or navigates close to the waterway banks. The cause for this effect is analogous to the squat. The pressure in the area between the ship and the obstacle is decreased, due to an acceleration of the flow velocity. This pressure drop leads to a force sucking the ship’s stern towards the bank (so-called bank effect), which can cause a moment turning the bow towards the waterway centerline (Lataire et al., 2009; Zou and Larsson, 2013).

Comment 3.5 : In the current version, the influence of hull forms is not well explained. A discussion on the present topic could be made between container ships, tankers, general cargos etc...

Response: *Thank you for this advice. We carefully discussed this suggestion among the authors. We concluded the hull forms are of major relevance in questions of naval engineering. Yet, the available literature does not suggest the same priority for predicting far-field wave information. We therefore decided not to elaborate on this vast topic. However, a remark explaining this decision, and giving further literature, is included in Section 2.5 of the revised version of the manuscript:*

Actions taken: The hull form of ships is of major importance to quantify the ship-related information on the combined resistance (Liu et al., 2011; Chi and Huang, 2016). In contrast, the available literature indicates that far-field properties of the ship-generated waves can be predicted by simple approximations of the hull-shape (Macdonald, 2003; Almström et al., 2021).

Comment 3.6 : The approach to scale the waves should have been mentioned, because some of the references were done in model-scale.

Response: *Thank you for this comment. The updated version now points out that Froude and Reynolds similarity are required. Furthermore, a short paragraph mentioning the need for extrapolation procedures is added in Section 4.1, including further references. The text now reads:*

Actions taken: Scaling theory ~~,using Froude or Reynolds similitude,~~ is governed by relevant force similarity, while other forces are intentionally neglected. For ship towing test, meaningful experimental campaigns commonly require the similitude of both, Reynolds and Froude number (Bertram, 2002). A review on the different scaling approaches for depicting ship-hydrodynamics has been recently conducted by Terziev et al. (2022). Despite a careful design of the experimental test, scale effects, resulting from additional forces not covered by the scaling approach eventually exacerbated by a small test scale, affect the results. The induced errors can be partly mitigated by empirically-based extrapolation procedures. Yet, the remaining inaccuracies along with tedious experimental procedures are often a reason

to employ other methods or to combine different methodological approaches (e.g. towing tests with CFD simulations).

~~with very small length scales of experiments, these may nevertheless play a role leading to scale effects. These are typically discussed in scientific literature and concerns are often dismissed after carefully weighing the overall forces involved in a process. However, small scale along with tedious experimental procedures are often a reason to employ other methods.~~

~~with very small length scales of experiments, these may nevertheless play a role leading to scale effects. These are typically discussed in scientific literature and concerns are often dismissed after carefully weighing the overall forces involved in a process. However, small scale along with tedious experimental procedures are often a reason to employ other methods.~~

Comment 3.7 : The authors should give more knowledge into the nonlinearities, viscous and turbulent effects of the ship-generated, drawdown waves. This will help justify your recommendation of using CFD instead of simplified methods such as potential flow.

Response: *Thank you: The authors wish to clarify that the recommendation for CFD only accounts for studying the land-water interface. Far-field wave propagation can efficiently be modelled by depth-averaged methods. The processes affecting the nonlinear deformation of primary waves is already intensively elaborated on in Section 2.2. The presence of viscous effects, giving rise to CFD methods is accounted for in line 896 to 908. A detailed discussion on viscous effects around the hull of a ship is outside the scope of the paper, as this affects ship-related attributes rather than water-way related questions on far-field wave propagation. We would like to raise the development of stratified flow components as an additional point that has recently been documented within the literature. The stratified flow components can develop when waves approach beaches and may be transferred to waterway banks. We included this aspect in Section 5.2 of the revised manuscript:*

Actions taken: Furthermore, waves approaching banks are known to cause complex current conditions, including opposing currents at different vertical layers of the water-column (Elsayed et al., 2022). Due to the model limitations, such vertically in-homogeneous or turbulent processes can not be replicated by an depth-averaged model. ~~These are phenomena that can not be predicted on basis of a depth-averaged numerical model.~~

4 Additional literature that has come up during the review

A mistake in table 4 was corrected. Unfortunately the authors mistook the ship block coefficient with the channel blockage factor. This was corrected in the updated version of the manuscript.

A paragraph adressing the publication of Braga et al. (2020) was added in Section 3.1

Recently, the unusually clear water in the Venice Lagoon during the start of the SARS-CoV-2 pandemic, and the associated lockdown, found its way into public media (e.g. CNN (2020)). The analysis of satellite imagery reveals the determining impact of the reduced shipping traffic and on the turbidity of within the lagoon, alongside with low precipitation and positive seasonal effects (Braga et al., 2020)

A new study by Luo et al. (2022) making use of a machine learning technique is included in section 4.1

A different approach for processing field data is presented by Luo et al. (2022). The authors present a machine learning technique, to identify ship waves from a data set of a navigation channel in a shallow estuary region and distinguish it from wind waves. The high recognition rate of ship wakes of 93.55% indicates a good performance of the approach. More research based on a wider set of field data might lead to future prediction methods employing artificial intelligence.

A study by Forlini et al. (2021), examining the parameter space covered by FUNWAVE, was added to Section 4.2.3.2. In addition the conclusion of this paragraph was modified to account for the new finding.

Forlini et al. (2021) address the problem of different time scales included in the determination of the impact of ship waves on a waterway. The authors suggest to combine numerical simulation with statistical approaches, allowing to identify long-term effects of the wave climate. Numerical simulations are used to determine characteristic wave patterns of various ship-types, yielding the input to subsequent multivariate stochastic analysis. In the study it is verified that *FUNWAVE* covers a sufficiently large range of parameters. Results indicate that limitations occur for small and slow ships, due to the limitations of Boussinesq-models to replicate the dispersion characteristics. However, the ship wakes, determining the morphological activity including the drawdown, are accurately depicted by the numerical model.

Recent data (Forlini et al., 2021) indicates a good performance of Boussinesq models for the parameter space of large-sea-going ships. Yet, further validation with data from field and towing tanks experiments is required to examine if the shallow-water deformation processes are also replicated. ~~Therefore, the evaluation of how the models perform in predicting waves of large subcritical ships with focus on the primary wave system is difficult. The limitation regarding the water depth is not problematic, since the length of the drawdown wave is large compared to water depth.~~

Furthermore, a Boussinesq model proposed by Samaras and Karambas (2021) is now included in Section 4.2.3.2 of the revised version of the manuscript.

A post-Boussinesq model presented by Samaras and Karambas (2021), making use of the slender-body pressure approximation by Ersan and Beji (2013), shows to predict both the analytical Havelock angle correctly and experimental data with good quality. Results of a ship entering a harbor basin show qualitatively good results of the reflections from harbour breakwaters; however, no quantification was performed.

The validation of the model Xbeach (Almström et al., 2021) with field data was added to Section 4.2.3.2

~~Comparison with field measurement data from a groin field at the Nieuwe Waterway, Rotterdam also indicates a qualitatively well computation of the primary wave, even though the low frequency measurements in the field do not allow a detailed evaluation. A more detailed validation was performed by Almström et al. (2021) on basis of field data from the Stockholm Archipelago. Within this waterway with a complex bathymetry, a good agreement of the measured and numerically determined primary-wave height and period could be obtained, characterized by a mean absolute error of 3 cm, respectively 6 s~~

In addition, the previously overlooked study of Pearson and Skalski (2011) was included in Table 3

First round of review

Response to the reviewers

Dear Editor,

thank you and the respected reviewers for the time and effort put into revising our manuscript. Analogous to the first round of review, we attached a marked version of the manuscript, indicating the amendments performed and a cleaned-up manuscript. Detailed answers to the reviewers' comments are provided in this letter.

Answers to the individual comments can be found below. The convention is as follows:

- Refers to the reviewer's comments
- *Refers to our responses to the comments*
- Refers to new text added to the manuscript
- ~~Refers to text deleted from the manuscript~~

1 Reviewer C

1.1 Minor comments

Comment 1.1.1 : The abstract is more streamlined, which is good. However, is there a point to the sentences below? If they were deleted, would the abstract suffer? “The ship-induced loading has recently become more relevant, since ship sizes increase and traffic intensifies, leading to higher and more frequent loads. Especially in non-homogeneous waterways, like estuaries and natural or re-naturalized rivers, shallow-water wave deformation processes affect the far-field loading induced by ships.”

Response: *Thank you for this comment. We think that it is important to point out the motivation for the reader to read this paper and for us to publish it. The most important points of this motivation are larger ships in confined channels and wave deformation in complex bathymetries. Therefore we decided not to remove the sentences from the manuscript, in order to describe the content of the paper as precisely as possible.*

Comment 1.1.2 : L323 Why is the word “information” used in this sentence. What are the authors trying to say?

Response: *Thank you for bringing this to our attention. We revised the sentence:*

Actions taken: The hull form of ships is of major importance to quantify ~~the~~ ship-related ~~parameters information on such~~ as the combined resistance (Liu et al., 2011; Chi and Huang, 2016).

Comment 1.1.3 : L719 Is there a point to the sentence “More search based on a wider set of...”. It feels both redundant and confusing.

Response: *We agree that the sentence was poor. The adapted text now reads:*

Actions taken: Machine learning techniques such as the presented one contribute to an efficient analysis of large data sets and can therefore help to ultimately develop future prediction methods. ~~More research based on a wider set of field data might lead to future prediction methods employing artificial intelligence.~~

Comment 1.1.4 : L1039 unclear what the authors mean by “however, no quantification was performed”. Delete?

Response: *We agree that the sentence was redundant, as the manuscript already states that the simulations are only evaluated qualitatively. We therefore deleted this part according to your suggestion.*

Actions taken: Results of a ship entering a harbor basin show qualitatively good results of the reflections from harbour breakwaters. ~~however, no quantification was performed.~~

Comment 1.1.5 : L1043. Unclear what the authors mean by “parameter space”

Response: *The sentence was rephrased as follows:*

Actions taken: Recent data (Forlini et al., 2021) indicates a good performance of Boussinesq models for the ~~parameter space range of parameters~~ of large sea-going ships.

Comment 1.1.6 : L1265. More recent IPCC reports will highlight other references that are newer than Rahmstorf. Also, note that the grammar in this sentence is poor, please revise.

Response: *Thank you for this comment. We included the latest IPCC report in the manuscript, and revised the structure of the sentence as follows:*

Actions taken: Prognostic methods for the future sea level exist (e.g. Fox-Kemper et al. (2021)). Yet, methods need to be found that ~~combine different scenarios for future sea-level rise with prediction methods for ship-induced loads. are able to include different scenarios into prediction methods for ship-induced loads routinely.~~

1.2 English and punctuation

Response: *Thank you for these corrections: they have all been incorporated in the revised manuscript.*

Comment 1.2.1 : Abstract. Change to “to account for site-specific...”

Comment 1.2.2 : L65. Change to “jets causing scour”

Comment 1.2.3 : Figure 1 caption. Delete the word “schematically” (you already indicated it is a sketch)

Comment 1.2.4 : L158. Delete comma after mudflats

Comment 1.2.5 : L153. Change to “wave becomes less steep”

Comment 1.2.6 : L153, change to “rear slope rapidly gains in steepness”

Comment 1.2.7 : L324, change to “In contrast, available literature...”

- Comment 1.2.8 :** L379 delete “and shall”
- Comment 1.2.9 :** L433 change to “layer a couple of millimetres thick after”
- Comment 1.2.10 :** L436 delete “determining”
- Comment 1.2.11 :** L437 change to “traffic on the turbidity within...”
- Comment 1.2.12 :** L458 change to “increase in the offshore”
- Comment 1.2.13 :** L543 delete one of the two “for one species”
- Comment 1.2.14 :** L566 add comma after “wave”
- Comment 1.2.15 :** L571 add comma after environment
- Comment 1.2.16 :** L572 change the word “structure” to “patterns”?
- Comment 1.2.17 :** L643 change to “tests”
- Comment 1.2.18 :** L644 delete comma after “both”
- Comment 1.2.19 :** L644 change to “numbers”
- Comment 1.2.20 :** L644 change to “A review of the”
- Comment 1.2.21 :** L647 change to “approach, affected the results” (i.e. delete “exacerbated by the small test scale”)
- Comment 1.2.22 :** L717 delete comma after “techniques”
- Comment 1.2.23 :** L718 change to “wakes (93.55) indicates the good...”
- Comment 1.2.24 :** L863 probably better to change “generated” to “opened”
- Comment 1.2.25 :** L1021 change to “simulations”
- Comment 1.2.26 :** L1022 change to “identify the long-term”
- Comment 1.2.27 :** L1025 change to “that there are limitation for small...” (note that the word limitations appears twice in the same sentence... consider rephrasing)
- Comment 1.2.28 :** L1036 Change to “can predict both the Analytical Havelock angle correctly” (delete “and experimental data with good quality”, which is confusing.
- Actions taken:** A post-Boussinesq model presented by Samaras and Karambas (2021), making use of the slender-body pressure approximation by Ersan and Beji (2013), ~~shows to can~~ predict ~~both~~ the analytical Havelock angle correctly. ~~Further, the numerical results agree with an additional experimental data set from a towing tank. and experimental data with good quality.~~
- Comment 1.2.29 :** L1098 Change to “Within the complex bathymetry of this waterway a good agreement between the...”
- Comment 1.2.30 :** L1100 Change to “of 3 cm and 6 s, respectively”

- Comment 1.2.31** : L1104 change to “is well captured, regarding...”
- Comment 1.2.32** : L1143 change to “cranes could reach”
- Comment 1.2.33** : L1230 change to “higher than rock structures”
- Comment 1.2.34** : L1231 change to “a waterway determines the”
- Comment 1.2.35** : L1235 add comma after “habitats”
- Comment 1.2.36** : L1257 delete the word “ambient” (redundant given you then say “environmental”)
- Comment 1.2.37** : L1261 change to “interrelation between water...”
- Comment 1.2.38** : L1271 the word “influence” appears twice in the same sentence.
- Comment 1.2.39** : L1274 change to “to the position of a given study site”
- Comment 1.2.40** : L1275 maybe change “research, that should also consider the temporal...”
- Comment 1.2.41** : L1283 change to “contributing to help to solve the future”
- Comment 1.2.42** : L1289 change to “in the following paragraphs”
- Comment 1.2.43** : L1306 why is there a line under 2020b?