JOURNAL OF COASTAL AND HYDRAULIC STRUCTURES

Review and rebuttal of the paper

Layouts of a Cluster of Heaving Point Absorbers in front of Wall-type Coastal Structures under Regular Wave Attack

Rafail Ioannou & Eva Loukogeorgaki

Editor handling the paper: Bas Hofland

The reviewers remain anonymous.

Editor decision, 2021-09-17

Dear Rafail Ioannou, Eva Loukogeorgaki:

We have reached a decision regarding your submission to Journal of Coastal and Hydraulic Structures, "Optimum Layouts of a Cluster of Heaving Point Absorbers in front of Wall-type Coastal Structures under Regular Wave Attack".

We decided that you need to resubmit your paper after major revisions.

Note that reviewer one has concerns about the novelty of the findings compared to other (recent) papers. This is an important aspect, and the novelty of the findings should be clearly stated in the introduction. If this cannot be proven, for instance in a discussion section, the paper can still be rejected after the second review round.

Please revise your paper considering the remarks and needs of modifications of the reviewers and provide a description of your revisions in an extra file. In this text the consideration of all reviewers' remarks and proposals must be addressed one-by-one, using clear numbering.

Best regards,

Bas Hofland

Editor of Journal of Coastal and Hydraulic Structures

Reviewer comments and rebuttal review round 1, 11 October 2021

Paper JCHS No. 5970
Optimum Layouts of a Cluster of Heaving Point Absorbers in front of Wall-type Coastal Structures under Regular Wave Attack

Response to the 1st Reviewer's (Reviewer A) comments

After reading carefully the reviewer's valuable suggestions and comments, we revised our manuscript properly in order to address his/her comments and, consequently, enhance the quality of the paper. Below we would like to explain our response to the reviewer's comments. We hope that this response will be helpful to him/her for the review of the revised manuscript and will clarify the points he/she indicates. It is mentioned that all modifications resulted from the 1st reviewer's comments are highlighted in cyan in the revised manuscript. If a common modification results from the comments of both reviewers, it is highlighted in green.

***Reviewer's comment 1*: "The lack of novelty considered is based on the fact that the Genetic Algorithm for optimization of layouts of wave energy converters was already proposed by the cited work of Sharp et al. (2018) and the hydrodynamic analysis of a cluster with the same configuration was done in the cited work of Loukogeorgaki et al. (2020). In addition, the approach proposed in this manuscript for regular waves, can be seen as a particular case of the similar study done by Loukogeorgaki et al. (2021) for a irregular waves, where the clustering effect was already discovered."**

Our response: As already mentioned in the Introduction section of the initially submitted manuscript, the present work aims at determining optimum layouts for a cluster of heaving PAs in front of a ***bottom-mounted wall-type structure*** under ***the action of regular waves***. This physical problem has not been investigated in the past by any other researchers, including those mentioned by the reviewer.

To be more specific, in the work of Sharp and DuPont (2018) [1], a Genetic Algorithm (GA) approach was developed in order to determine the optimum layouts of WECs arrays in ***offshore environments***, namely, ***without the presence of a wall-type coastal structure***, as we consider in the present paper. This has been already mentioned on ***page 2 of the initially submitted manuscript***, where it was written: "*Regarding the determination of optimally-arranged clusters of various WECs types, the relevant problem has been tackled extensively by many researchers for* ***isolated (i.e., without the wall presence) clusters.***".

Loukogeorgaki et al. (2020)[2] performed indeed hydrodynamic analysis of a cluster of five heaving oblate spheroidal PAs, as we consider in the present paper, in front of a wall. However, the PAs formed a ***linear array*** and they were situated at ***predefined locations within this linear configuration***. Furthermore, the ***objective*** of ***that investigation*** was to ***assess*** the ***effect*** of the ***array's distance from the wall*** and of the ***wall's length*** on the ***physical quantities describing*** the ***array's performance***. A relevant description has been

[1] *Sharp, C.; DuPont, B. (2018): Wave energy converter array optimization: A genetic algorithm approach and minimum separation distance study. In: Ocean Engineering 163, 148–156.*
[2] *Loukogeorgaki, E.; Boufidi, I.; Chatjigeorgiou, I. K. (2020): Performance of an array of oblate spheroidal heaving wave energy converters in front of a wall. In: Water 12 (1), paper No. 188.*

already provided on ***page 2 of the initially submitted manuscript***, where it was written: "*…Loukogeorgaki et al. (2020) investigated the performance of a linear array of…five oblate spheroidal, respectively, heaving PAs in front of a finite-length bottom-mounted wall and illustrated the direct effect of the devices-wall distance on the array's power absorption ability.*". Contrary to all the above, in the present paper, we focus on ***determining optimum PAs layouts in front of a wall***. In that respect, the ***hydrodynamic model*** is ***deployed*** as a ***tool to calculate the responses of the PAs*** and, thus, ***quantify the objective function*** (i.e., ***hydrodynamic analysis*** is ***not performed*** in terms of ***assessing parametrically*** the ***effect*** of ***various design parameters*** on the ***PAs' performance***). It should be also emphasized that in Loukogeorgaki et al. (2020)[2], the coupling of the hydrodynamic model with an optimization algorithm in terms of defining optimum locations of the PAs in front of the wall was mentioned as an item for future research.

Finally, the work of Loukogeorgaki et al. (2021)[3] focuses indeed on the optimization of PAs in front of a wall considering, however, the ***action of irregular waves***. Accordingly, a ***different***, compared to the present paper, ***objective function*** was deployed (annual averaged absorbed power) taking into account simultaneously the contributions of all sea states on the quantification of the objective function. Optimum clusters were determined for ***specific marine areas in Greece*** and, thus, all ***results*** and ***conclusions*** were ***related*** to the ***wave climate of the examined marine areas***. For example, for all sites, the peak periods of the most frequent sea states were larger than the heave natural period of the devices. Accordingly, optimum layouts were determined ***only*** for ***wave environments*** characterized by ***low peak frequencies***. Contrary to the above, in the present investigation, the consideration of regular waves enabled us to perform optimization ***not only for a low incident wave frequency*** ($\omega = 1.1$ rad/s), but also ***for a high frequency*** equal to the devices' heave natural frequency ($\omega = 2.4$ rad/s). This fact has led to ***results*** and ***conclusions*** that are ***different*** compared to those of Loukogeorgaki et al. (2021)[3]. For example, the ***sub-clustering effect***, mentioned by the reviewer, is realized in the present paper ***only*** when optimization is performed at $\omega = 1.1$ rad/s, but ***not*** in the case of $\omega = 2.4$ rad/s (for both symmetrical constrained or non-constrained optimum solutions). Accordingly, we do not feel that the present paper can be seen as a particular case of Loukogeorgaki et al. (2021)[3]. We believe that our work is original and makes a contribution on the subject under investigation, since it demonstrates in a clear and consistent manner critical aspects of the examined physical problem, not previously presented by other researchers.

Based on all the above and in order to illustrate more clearly the differences of the present paper compared to Loukogeorgaki et al. (2021)[3], the following changes have been made in the revised manuscript:

(a) ***On page 2***, the part "*…who developed a GA-based optimization framework to determine optimally-arranged clusters at specific near-shore locations for real sea states (i.e., under the action of irregular waves).*" has been replaced with: "*…who developed a GA-based optimization framework to determine optimally-arranged clusters for real sea states (i.e., under the action of irregular waves).*".

(b) ***On page 2***, the following has been added: "*The framework was applied at specific near-shore locations in Greece, where the peak frequencies of the most dominant sea states were smaller than the heave natural frequency of the devices (equal to 2.6 rad/s). Accordingly, optimum layouts were determined for wave environments characterized by low peak frequencies (<2.0 rad/s).*".

[3] *Loukogeorgaki, E.; Michailides, C.; Lavidas, G.; Chatjigeorgiou I. K. (2021): Optimum layouts of a cluster of heaving point absorbers in front of a wall. In: Proceedings 31st International Offshore and Polar Engineering Conference (ISOPE), Rhodes (virtual/online), 1, 736–743.*

(c) ***On page 3***, the part "*…aiming at investigating the effect of the incident wave frequency and of…*" has been replaced with: "*…aiming at investigating the effect of low and high incident wave frequencies and of…*".

We hope that all the above changes address adequately the reviewer's specific comment.

***Reviewer's comment 2*: "The authors assume that the wave elevation and motions of the PAs are small enough to be described by a linearized potential flow theory. This assumption neglects nonlinear and/or viscous phenomena that might appear when the devices are close to each other or close to the wall. This should be discussed in the manuscript since the authors do not enforce any minimum distance (other than no-contact) between devices as constraints in the optimization."**

Our response: The purpose of the present investigation is to determine optimally-arranged PAs in front of a vertical wall under regular wave conditions, which inevitably neglect nonlinear and/or viscous phenomena. We agree, however, that these phenomena could be important when the devices are placed close to each other or close to the leeward boundary. Accordingly, their inclusion in the hydrodynamic analysis could be considered as an item for future research. Based on the above and for addressing the reviewer's specific comment, the following changes have been made in the revised manuscript:

(a) ***On page 3***, the following sentence has been added: "*It is noted that in the present investigation, nonlinear and viscous effects are neglected and, thus, minimum distances between the devices (Eq. 2) as well as between the PAs and the wall (Eq. 3) are defined considering only the requirement of overlapping avoidance.*".

(b) ***On page 14***, the following sentence has been added: "*Moreover, optimization could be performed by including in the hydrodynamic analysis nonlinear and/or viscous effects.*".

(c) ***On page 14***, "The determination…" has been replaced with: "*Finally, the determination…*".

It is also noted that in the reference list of the revised manuscript, full details (volume number and number of pages) have been provided for the paper of Loukogeorgaki at al. (2021)[3], which were not known on the time of the submission of the initially manuscript.

***Reviewer's comment 3*: "The performance of Genetic Algorithms strongly depends on the initial population size. A small initial size might lead to poor optimal values, while large sets might lead to a large number of iterations. In this work, the authors do not assess the quality of the initial set, assuming that M=10 is leads to the optimal solution within a 100 iterations cycle. Moreover, the authors only rely on the number of iterations as a stopping criteria, which does not give any control on the optimality of the solution. The authors should consider a proper assessment of the effect of the initial population size, together with a stopping criteria based on the convergence of the objective function (p_tot). The current setting of the GA is prone to sub-optimal layouts.".**

Our response: For selecting the population size, M, and the number of iteration cycles, Q, appropriate relevant preliminary tests were implemented prior to the submission of the paper. Those tests were realized for C2a and C2b (optimization cases with the largest solution space) by increasing successively M up to the value of 30, as well as Q up to the value of 500. For $M = 30$ and $Q = 500$, the relevant difference of the

optimum solution, with respect to $M = 10$ and $Q = 100$, for both C2a and C2b was smaller than 2%. Accordingly and aiming at keeping the computational effort at a reasonable level, while preserving the required numerical accuracy, $M = 10$ and $Q = 100$ have been selected for all optimization cases examined in the paper. It should be noted, however, that for addressing the 1st reviewer's comment No. 4 additional runs were made for C2a and C2b with $M = 30$ and $Q = 1000$ and the corresponding results were included in the revised manuscript as explained in detail below.

Regarding the stopping criterion, the convergence of the objective function could be indeed deployed as a stopping criterion. The authors had already checked the deployment of this option prior to the submission of the initially submitted manuscript; however, this stopping criterion led to early convergence of the optimization algorithm to sub-optimum solutions. For this purpose, the maximum number of iterations corresponding to a traditional stopping criterion for GAs (see for example Safe et al. 2004[4]), has been deployed in the present investigation.

Based on the above and for addressing the reviewer's specific comment, the follow changes have been made in the revised manuscript:

(a) ***On page 8***, the sentence "*For all optimization cases of Table 1, the following options were defined at the beginning of the optimization process: (a) population size* $M = 10$*, (b) consideration of an* 0.1 *m X* 0.1 *m grid for placing the devices (i.e., the design variables* X_i *and* Y_i*,* $i = 1, \dots, 5$ *have values up to their first decimal), (c) application of Eq. (7) with* $\beta_{sel} = 2.0$*, (d) crossover and mutation rates equal to* 85% *and* 30% *respectively and (e) maximum number of iteration cycles (stopping criterion) equal to* 100*.*" has been replaced with: "*For all optimization cases of Table 1, the following options were defined at the beginning of the optimization process: (a) consideration of an* 0.1 *m X* 0.1 *m grid for placing the devices (i.e., the design variables* X_i *and* Y_i*,* $i = 1, \dots, 5$ *have values up to their first decimal), (b) application of Eq. (7) with* $\beta_{sel} = 2.0$ *and (c) crossover and mutation rates equal to* 85% *and* 30% *respectively*.".

(b) ***On page 8~9***, the following has been added: "*For optimization cases C2a and C2b, characterized by a larger solution space, optimization was performed by setting the population size* M *equal to* 30 *and the maximum number of iteration cycles (stopping criterion) equal to* 1000*. For the rest optimization cases of Table 1, the above parameters were taken respectively equal to* 10 *and* 100*, based on appropriate relevant preliminary tests, aiming at keeping the computational effort at a reasonable level, while preserving the required numerical accuracy.*". Regarding cases C2a and C2b more explanations are provided in our response to the 1st reviewer's comment No. 4 below.

(c) ***On page 5***, the following sentence has been added: "*It is noted that the convergence of the objective function to a certain value was not deployed in the present investigation as a stopping criterion, since for the characteristics of the problem examined it had led to an early convergence of the optimization algorithm to sub-optimum solutions.*".

<u>Reviewer's comment 4</u>: "The case C4a leads to a total power absorption 1.3% higher than the case C2a. This is not possible. The set of possible outcomes of the optimization process of case C4a is a subset of the possible outcomes of the optimization process of case C2a. Therefore, a maximum of C4a should, at least, be a maximum of

[4] *Safe, M.; Carballido, J.; Ponzoni, I.; Bringole, N. (2004): On stopping criteria for genetic algorithms. In: Advances in Artificial Intelligence – SBIA 2004 (Bazzan A.L.C., Labidi S. editors), Springer, 405–413.*

C2a (if there is no other non-symmetrical layout with higher power absortion). This indicates that the GA algorithm used in this work does not give the optimal solution.".

Our response: We agree with the reviewer's comment that the set of possible outcomes of the optimization process for C4a should be a subset of possible outcomes of C2a and we would like to thank the reviewer for this constructive comment. Accordingly and in order to address the reviewer's specific comment, optimization cases C2a and C2b, characterized both by a large space solution, were solved for a population size, M, equal to 30 and a number of iteration cycles, Q, equal to 1000. The relevant results are shown in Table I and Table II of the present document along with results corresponding to $M = 10$ and $Q = 100$.

Table I. C2a optimization results for different population size and number of iteration cycles

M	Q	X_1 (m)	X_2 (m)	X_3 (m)	X_4 (m)	X_5 (m)	Y_1 (m)	Y_2 (m)	Y_3 (m)	Y_4 (m)	Y_5 (m)	p_{tot} (kW/m^2)
10	100	-29.2	-14.1	-0.5	12.9	27.9	4.5	4.9	5.3	5.1	4.8	544
30	1000	-28.5	-13.6	-0.1	13.6	28.4	4.9	5.0	5.2	4.9	4.9	553

Table II. C2b optimization results for different population size and number of iteration cycles

M	Q	X_1 (m)	X_2 (m)	X_3 (m)	X_4 (m)	X_5 (m)	Y_1 (m)	Y_2 (m)	Y_3 (m)	Y_4 (m)	Y_5 (m)	p_{tot} (kW/m^2)
10	100	-26.1	-21.8	-17.7	19.9	24.2	2.8	2.1	2.3	2.3	2.1	159
30	1000	-26.1	-21.8	-17.7	19.9	24.2	2.8	2.1	2.3	2.3	2.1	159

For C2a, the results of Table I of the present document demonstrate a slightly different positioning of the PAs in the case of $M = 30$ and $Q = 1000$ compared to $M = 10$ and $Q = 100$, which, however, resembles better a symmetrical arrangement with respect to the OY axis. Furthermore, in the case of $M = 30$ and $Q = 1000$ a small increase of p_{tot} equal to 1.7% relatively to $M = 10$ and $Q = 100$ is observed. However, the new calculated maximum value of p_{tot} is larger than the corresponding one of C4a (551 kW/m^2), which is in absolute accordance with the reviewer's comment.

As for C2b, the results of Table II of the present document demonstrate no differences between the solutions obtained for $M = 30$, $Q = 1000$ and for $M = 10$, $Q = 100$. Thus, for the specific low wave frequency, where optimization has been performed, the deployment of $M = 10$ and $Q = 100$, as already considered in the initially submitted manuscript has resulted to a global optimum solution.

Based on all the above and for addressing the reviewer's comment, ***the optimization results for $M = 30$ and $Q = 1000$ in the case of C2a have been taken into account in the revised manuscript***. Although for these M and Q values the optimization results for C2b are not modified at all, ***$M = 30$ and $Q = 1000$ have been also considered to be deployed in the case of C2b in the revised manuscript for consistency reasons.*** The above have resulted to the following changes in the revised manuscript:

(a) ***On page 8~9***, the following sentence has been added: "*For optimization cases C2a and C2b, characterized by a larger solution space, optimization was performed by setting the population size M equal to 30 and the maximum number of iteration cycles (stopping criterion) equal to 1000.*".
(b) ***On page 10***, the C2a optimization results of Table 2 have been appropriately revised.
(c) ***On page 10***, the part "*…from 4.5 m up to 5.3 m…*" has been replaced with: "*…from 4.9 m up to 5.2 m…*".
(d) ***On page 10***, the part "*…(i.e., at $X = -0.5$ m)…*" has been replaced with: "*…(i.e., at $X = -0.1$ m)…*".
(e) ***On page 10***, the part "*…(≈ 13.5 m)…*" has been replaced with: "*…(≈ 13.6 m)…*".
(f) ***On page 10***, the part "*…(≈ 15.0 m)…*" has been replaced with: "*…(≈ 14.9 m)…*".
(g) The ***C2a results of Figures 4a, 5a and 6a have been appropriately revised***.
(h) The $p_{tot} - \omega$ ***curves*** for ***C2a in Figures 4b, 5b and 6b have been appropriately revised***.
(i) ***On page 10***, the part "*…the value of 544 kW/m^2 (Table 2), which represents an 39.8% increase compared to C1.*" has been replaced with: "*…the value of 553 kW/m^2 (Table 2), which represents an 42.2% increase compared to C1.*".
(j) ***On page 11***, the part "*…to an 27.9% decrease compared to C2a…*" has been replaced with: "*…to an 29.1% decrease compared to C2a…*".
(k) ***On page 12***, the part "*…a very small increase (1.3%) compared to C2a (Table 2).*" has been replaced with: "*…a very small decrease (0.4%) compared to C2a (Table 2).*".
(l) ***On page 13***, the part "*…varying between $2.2a$ and $2.8a$, while…*" has been replaced with: "*…varying between $2.4a$ and $2.9a$, while…*".
(m) ***On page 13***, the part "*More specifically, an 27.9% and…*" has been replaced with: "*More specifically, an 29.1% and…*".

<u>Reviewer's comment 5</u>: "In the conclusions, the authors state that introducing the symmetry constraint "... affect at a small degree the power absortion ability...". Again, this statement is not correct since the symmetric solution should be included in the not constrained solution. The symmetric solution can only result in less or equal power absortion than the non-constrained solution. The only gain that one can get by enforcing symmetry is a reduction of computational cost in the optimization process, as noted by the authors in line 421-422. However, this improvement on the computational cost comes at the expense of not being able to capture optimal non-symmetric layouts like the sub-clusters found for cases 2b and 3b."

Our response: For addressing the reviewer's specific comment, the following changes have been made in the revised manuscript:

(a) ***In the abstract***, the part "*…affects at a small degree…*" has been replaced with: "*…reduces at a small degree…*".
(b) ***On page 12***, the part "*…layouts has a small effect on the power absorption… irrespectively of the wave frequency considered for conducting the optimization.*" has been replaced with: "*…layouts reduces at a small degree the maximum power absorption…especially when optimization is performed at the high frequency of 2.4 rad/s.*".
(c) ***On page 14***, the part "*…affects at a small degree the power absorption ability of the optimally-arranged clusters, irrespectively of the wave frequency considered for conducting the optimization.*" has been replaced with: "*…reduces at a small degree the maximum power absorption ability of the optimally-arranged clusters, especially when optimization is performed at the high frequency of 2.4 rad/s.*".
(d) ***On page 14***, the part "*…optimum layouts can be determined with much less computational effort by exploiting symmetrical features.*" has been replaced with: "*…optimum layouts could be determined with much less computational effort by exploiting symmetrical features.*".

***Reviewer's comment 6*: "The title and abstract do not accurately reflect the setting, results and conclusions. The authors should explicitly mention that the optimization is only done for a single cluster of 5 PAs, using a unique wave direction perpendicular to the wall and considering only two frequencies."**

Our response: Regarding the abstract and for addressing the reviewer's comment, the part: "*…on the effect of the incident wave frequency…*" has been replaced with: "*…on the effect of two different incident wave frequencies…*". The number of the devices and the perpendicular wave action, were explicitly mentioned in the abstract of the initially submitted manuscript, where it was written: "*Next, various optimization cases for a cluster of five devices under the action of perpendicular to the wall waves are formed and solved.*". Thus, to our opinion any relevant modification is not required.

Regarding the title and for addressing the reviewer's comment, the number and the incident wave direction have been included in the revised manuscript, by modifying the title as follows: "*Optimum Layouts of a Cluster of Five Heaving Point Absorbers in front of Wall-type Coastal Structures under Perpendicular Regular Wave Attack*".

***Reviewer's comment 7*: "Water depth is assumed to be fixed and constant. The authors should reflect on the reasoning behind this assumption."**

Our response: There is no specific reasoning behind the assumption of a fixed and constant water depth. This assumption results straightforwardly from the deployment of the linear potential theory, where the bottom boundary is considered to be horizontal.

Based on all the above and for addressing the reviewer's specific comment, ***on pages 6~7 of the revised manuscript*** the part "*…the bottom boundary condition (Eq. 11)…*" has been replaced with: "*…the bottom boundary condition on the assumed horizontal sea bed (Eq. 11)…*".

***Reviewer's comment 8*: "In line 126 the authors write "... on the well-known...". Avoid using subjective perceptions."**

Our response: For addressing the reviewer's specific comment, on ***page 5 of the revised manuscript*** "*...based on the well-known roulette wheel technique ...*" has been replaced with: "*...based on the roulette wheel technique ...*".

***Reviewer's comment 9*: "In equation (16), Mij and Cij are introduced without being defined. For completeness of the manuscript, these matrices should be defined."**

Our response: For addressing the reviewer's specific comment ***on page 7 of the revised manuscript***, the following changes have been made:

(a) "*The coefficients M_{ij} for $i = j = 1, \dots, N$ are equal to ρV, where $V = 2/3\pi\alpha^2 c$ is the submerged volume of a PA, while $M_{ij} = 0$ for $i \neq j$. As for the hydrostatic-gravitational stiffness coefficients, given that each device is assumed to oscillate only in the vertical direction, $C_{ij} = 0$ for $i \neq j$, and C_{ij} for $i = j = 1, \dots, N$ are obtained as follows:*" has been added.

(a) Eq. 17 has been added related to the calculation of C_{ij} coefficients.

The inclusion of Eq. (17) has led to re-numbering of the equation that follows. Appropriate relevant changes have been made in the revised manuscript.

***Reviewer's comment 10*: "In line 54 the authors write "... is solved by developing and coupling a GA solver ...", when referring to the implementation of the GA solver and its coupling with the hydrodynamic model. This statement can mislead the reader who could interpret that the authors develop a new GA solver. Use another verb: implement/apply/... instead of develop."**

Our response: In the present investigation, the GA was not realized by adopting an existing relevant toolbox (e.g., using the Optimization Toolbox™ of MATLAB). On the contrary, the employed GA was developed from scratch (a relevant code was written in MATLAB). Traditional GA operators were indeed taken into account. However, these operators were combined appropriately to meet the demands of the problem under investigation. For this purpose, the authors would like to keep the term "*develop*" in the revised manuscript.

***Reviewer's comment 11*: "The authors state in different places that the results are verified against the parametric results of Loukogeorgaki et al. (2020), e.g. lines 57, 225, 261. First, since the values of the cited source are discrete and given every 1.0 meters, it cannot be said that the results of this study (with a precision of 0.1 meters) are verified. At most, it could be said that the results "go in line with" what is shown in the cited source. To verify that the optimum is the same as predicted, a parametric study with finer than 0.1m discretization should be used. On another side, in Loukogeorgaki et al. (2020) the highest computed value is at 6.0m, but this not excludes that the overall highest value should be lower than 6.0m.**

Our response: For addressing the reviewer's specific comment, the following changes have been made in the revised manuscript:

(a) ***On page 1***, the part "*…developed optimization process is verified by comparing…*" has been replaced with: "*…developed optimization process is assessed by comparing …*".

(b) ***On page 3***, the part "*…developed algorithm is, initially, verified by comparing…*" has been replaced with: "*…developed algorithm is, initially, assessed by comparing…*".

(c) ***On page 8***, the part "*…enabled us also to verify the efficiency…*" has been replaced with: "*…enabled us also to assess the efficiency…*".

(d) ***On page 9***, the part "*This outcome agrees very well with…*" has been replaced with "*This outcome is in line with…*".

(e) ***On page 9***, the part "*…wall within* $5.0\ m < Y \leq 6.0\ m$*, as it has been verified from…*" has been replaced with: "*…wall within* $5.0\ m < Y < 7.0\ m$*, as it has been illustrated from…*".

(f) ***On page 13***, the sentence "*The very good agreement of the relevant optimization solution with the parametric numerical results of Loukogeorgaki et al. (2020) verified the efficiency of the developed optimization process.*" has been replaced with: "*The relevant optimization solution was in line with the parametric numerical results of Loukogeorgaki et al. (2020), demonstrating the ability of the developed optimization process to solve efficiently the relevant problem.*".

<u>Reviewer's comment 12</u>: "Use a color scale in the plots with an equivalent linear grey scale. Otherwise, the blue and red lines are difficult to distinguish in the black and white version of the manuscript."

Our response: Appropriate changes have been made in the revised manuscript (i.e., change of red color lines as well as change of line type), so that the blue and red lines can be distinguished in the black and white version of the manuscript. Some additional changes have been also made in the figures showing the optimum layouts of the PAs cluster.

We would like to thank the reviewer for his/her comments and to express our appreciation for his/her contribution to the improvement of the paper. We also hope that our answers fully clarify the points he/she makes.

Respectfully,

The authors

Response to the 2nd Reviewer's (Reviewer B) comments

After reading carefully the reviewer's valuable suggestions and comments, we revised our manuscript properly in order to address most of his/her comments and, consequently, enhance the quality of the paper. Below we would like to explain our response to the reviewer's comments. We hope that this response will be helpful to him/her for the review of the revised manuscript and will clarify the points he/she indicates. It is mentioned that all modifications resulted from the 2nd reviewer's comments are highlighted in yellow in the revised manuscript. If a common modification results from the comments of both reviewers, it is highlighted in green.

***Reviewer's comment 1*: "Abstract: The language could be improved. Eg. "under the action of perpendicular to the wall waves"? Do the authors mean: under the action of incident waves perpendicular to the wall?; "the available for deploying"?; "affects at a small degree" perhaps "to a small.."; Line 24,35,36,46,50...: PA cluster; Line 32: significantly affects; Line 38: WEC types; line 40: have been developed; Line 47: GA-based"**

Our response: For addressing the reviewer's specific comment, the following changes have been made in the revised manuscript:

(a) ***On page 1 of the revised manuscript***, the part "*…under the action of perpendicular to the wall waves…*" has been replaced with: "…under the action of *incident waves perpendicular to the wall*…".

(b) ***On page 1 of the revised manuscript***, the part "*…the available for deploying the devices wall length…*" has been replaced with: "*…the available wall length for deploying the devices…*".

(c) ***On page 1 of the revised manuscript***, the part "*…affects at a small degree…*" has been replaced with: "*…reduces at a small degree…*". This change has been made considering also the 1st reviewer's comment No. 5.

(d) ***On page 2 of the revised manuscript***, the part "*…that the cluster-wall distance affects significantly the power absorption…*" has been replaced with: "*…that the cluster-wall distance significantly affects the power absorption…*".

(e) ***On page 2 of the revised manuscript***, the part "*…WECs types…*" has been replaced with: "*…WEC types…*".

(f) ***On page 2 of the revised manuscript***, the part "*…who developed a GAs-based optimization framework…*" has been replaced with: "*…who developed a GA-based optimization framework…*".

As for the reviewer's comment to use "*…a variety of optimization techniques **have** been developed…*" instead of "*…a variety of optimization techniques **has** been developed…*" (***page 2 of the revised manuscript***), we kept the verb "**has**", since the subject of this sentence is the word "variety". Finally, regarding the reviewer's comment to use "***PA** cluster*" instead of "***PAs** cluster*" (lines 24, 35, 36, 46, 50, …), we would like to keep the term "***PAs** cluster*". Considering that PAs is an abbreviation for Point Absorbers, while PA is an abbreviation for Point Absorber, we believe that it is better to use plural number in terms of describing/referring to the cluster.

***Reviewer's comment 2*: "Lines 66-75: Regarding the assumptions in the model: The model seems to rigidly assume only heave motion of the PAs. While this is the working principle of the device, in a realistic**

scenario, the PA has a 6DOF motion which will affect the hydrodynamic interaction and therefore the calculated/ realised efficiency. A comment to this regard should be made."

Our response: Pure heaving PAs can be physically realized by appropriately attaching each device of the cluster on the leeward wall-type structure. Within this context, each PA can be connected via a lifting rod to a truss structure fixed on the wall (see for example https://www.sinnpower.com/) or, alternatively, each device could be attached on the wall via arms, which move vertically along sliding guide-ways fixed on the wall. The latter type of connection has been proposed in Gkaraklova et al. (2021)[5] for the case of a combined offshore wind-wave system. Accordingly, the consideration of pure heaving devices is realistic and, thus, it does not affect the hydrodynamic interactions existing on the examined physical problem, as well as the power absorbed by the optimally-arranged clusters determined in the present paper.

Based on the above and for addressing the reviewer's specific comment, ***on page 6 of the revised manuscript***, the following has been added: "*The latter assumption can be physically realized by attaching the PAs on the wall via appropriate attachment configurations, which allow the devices to move only along the vertical direction (see for example Gkaraklova et al., 2021).*". Accordingly, the paper Gkaraklova et al. (2021)[5] has been added in the references list of the revised manuscript.

Reviewer's comment 3: "Section 2.2: While it is nice to see the adoption of an algorithm that is based on biology, the method should be explained in the context of a WEC. Therefore the explanation/ examples should not refer to chromosomes, but the desired physical quantity addressed in relation to a WEC. This will provide better context to the application of the GA to the current case."

Our response: For coherence reasons, the authors would like to keep the term "chromosome" in the revised manuscript. However, for the readers' convenience and for avoid any misunderstandings, the following changes have been made in the revised manuscript:

(a) ***On page 5 of the revised manuscript***, the sentence "*For the optimization problem examined in the present paper, a chromosome of a population consists of $2N$ genes, the size of the population (i.e., number of chromosomes), M, remains constant throughout the whole optimization process, while, finally, the fitness function corresponds to the total power absorbed by the cluster, p_{tot}.*" has been replaced with: "*For the optimization problem examined in the present paper, a chromosome of a population consists of $2N$ genes, corresponding to a specific set of values of the design variables X_i and Y_i, $i = 1, \dots, N$, while the size of the population (i.e., number of candidate solutions), M, remains constant throughout the whole optimization process. Finally, the fitness function corresponds to the total power absorbed by the cluster, p_{tot}.*".

(b) ***On page 5 of the revised manuscript***, the part "*Each of this population is…*" has been replaced with: "*Each chromosome (i.e., a candidate set of X_i and Y_i, $i = 1, \dots, N$, values) of this population is…*".

(c) ***On page 5 of the revised manuscript***, the sentence "*The selection operator aims at selecting the fittest chromosomes as "parents" to pass their genes to the new population.*" has been replaced with: "*The selection operator aims at selecting the fittest chromosomes (i.e., the fittest sets of X_i and Y_i, $i = 1, \dots, N$, values) as "parents" to pass their genes (i.e., the corresponding X_i and Y_i, $i = 1, \dots, N$, values) to the new population.*".

[5] *Gkaraklova, S.; Chotzoglou, P.; Loukogeorgaki, E. (2021): Frequency-based performance analysis of an array of wave energy converters around a hybrid wind–wave monopile support structure. In: Journal of Marine Science and Engineering 9 (1), paper No. 2.* ***This reference has been included in the revised manuscript.***

(d) ***On page 6 of the revised manuscript***, the part "*Having selected the "parents", new chromosomes are generated by:…*" has been replaced with: "*Having selected the "parents", new chromosomes (i.e., new sets of X_i and Y_i, $i = 1, \dots, N$, values) are generated by:…*".

(e) ***On page 6 of the revised manuscript***, the part "*The chromosomes of the new population are then used …*" has been replaced with: "*The chromosomes of the new population (i.e., new sets of X_i and Y_i, $i = 1, \dots, N$, values) are then used…*".

We hope that the above changes address adequately the reviewer's specific comment.

***Reviewer's comment 4*: "Line 217 Remove the parentheses and text within".**

Our response: In case the reviewer's refers to "*…optimization cases (problems)…*", this part has been replaced with "…*optimization cases*…" (***page 8 of the revised manuscript***); namely, the parentheses and text within have been deleted.

***Reviewer's comment 5*: "Fig 3b, 4a, 4b, 5a, 5b, 6a, 6b. x-axis missing"**

Our response: In the initially submitted manuscript, the x-axis of Figures 3b, 4a, 4b, 5a, 5b, 6a and 6b was included. The absence of the x-axis may be attributed to the word edition used by the reviewer to open the relevant word file (for example, if we use Word 2010, the x-axis of the above figures is indeed missing). In any case, we have made some changes in the revised manuscript in order to solve this issue. We hope that the reviewer will be able to see the x-axis in those figures.

***Reviewer's comment 6*: "Line 294,328,365: would be useful to add the value of omega as well eg. "At w=2.4 rad/s, where..."**

Our response: For addressing the reviewer's specific comment, the footnote "*At ω, where optimization is performed.*" has been replaced with: "*At $\omega = 2.4$ rad/s (C2a) and at $\omega = 1.1$ rad/s (C2b), where optimization is performed.*" (***page 10 of the revised manuscript***), "*At $\omega = 2.4$ rad/s (C3a) and at $\omega = 1.1$ rad/s (C3b), where optimization is performed.*" (***page 11 of the revised manuscript***) and "*At $\omega = 2.4$ rad/s (C4a) and at $\omega = 1.1$ rad/s (C4b), where optimization is performed.*" (***page 12 of the revised manuscript***).

***Reviewer's comment 7*: "Conclusions should address the major assumption of "have-only" motion and its effects on the results of the optimisation study, possible extension of the study to cover that or a requirement on the mooring to ensure heave-only motion and/or the influence on such mooring on the deployed devices."**

Our response: As mentioned in our response to the reviewer's comment No. 2 above, pure heave motion of the PAs can be physically realized by attaching the devices on the wall via appropriate attachment configurations, which allow the devices to move only along the vertical direction. Accordingly, a mooring system is not required to be deployed. Within this context, the effect of the stiffness resulting from the

configurations attaching the PAs to the wall, on the PAs hydrodynamic response and the cluster's power absorption ability, could present an item for future research.

Based on the above and for addressing the reviewer's specific comment, ***on page 14 of the revised manuscript***, the sentence "*The present work could be further deployed in order to assess the effect of the devices' geometrical characteristics on the formation of the optimum layouts and the maximized absorbed power.*" has been replaced with: "*The present work could be further deployed in order to assess the effect of the devices' geometrical characteristics and/or of the stiffness resulting from the configurations attaching the PAs on the wall on the formation of the optimum layouts and the maximized absorbed power.*".

We would like to thank the reviewer for his/her comments and to express our appreciation for his/her contribution to the improvement of the paper. We also hope that our answers fully clarify the points he/she makes.

Respectfully,

The authors

Editor decision, 9 November 2021

Rafail Ioannou, Eva Loukogeorgaki:

We have reached a decision regarding your submission to Journal of Coastal and Hydraulic Structures, "Optimum Layouts of a Cluster of Heaving Point Absorbers in front of Wall-type Coastal Structures under Regular Wave Attack".

Our decision is to: Accept the manuscript for publication.

The manuscript will now go to production. The paper can be published when the formatting is up to standards. Please prepare the document according to the latest template that is given on the website, add author information, remove line numbers, and resubmit the paper. The copyeditor will then check the format.

Thanks again for considering JCHS.

Best regards,

Bas Hofland
JCHS

Reviewer A:

The authors have addressed all the reviewer comments and I hereby propose the current version of the manuscript for publication.

The reviewer aknowledges the efford made by the authors on clarifying the novelty of the original manuscript, stating that the novelty is limited to the assessment of regular waves with high and low frequencies. The authors also addressed the discrepancy between symmetric and non-symmetric optimum layouts by increasing the population size and number of iterations in the genetic algorithm.

Recommendation: Accept Submission
