Final Scientific Report

concerning the implementation of the project

Renewable Energy extraction in MARine environment and its Coastal impact

REMARC

in the period July 2017 – December 2019

This is the third report that completes the two previous reports. In the third (and last) stage of the project implementation (stage 3 - E3) carried out in the period above mentioned, the specific objectives of the project were pursued, as follows:

1. Performing joint analysis of the wind and wave data and design long term seasonal scatter diagrams for the sea states. At each location, an evaluation of the electric power provided by various technologies for wave and wind energy extraction has been carried out (A3.1).
2. Studies concerning the influence of the energy farms operating in the nearshore on the down wave climate and on the shoreline dynamics, targeting especially the coastal protection that can be offered by the future marine energy farms. Updating the webpage for the project dissemination (A3.2).
3. Dissemination of the results.
4. Conclusions

1. Performing joint analysis of the wind and wave data and design long term seasonal scatter diagrams for the sea states. At each location, an evaluation of the electric power provided by various technologies for wave and wind energy extraction has been carried out (A3.1).

A first analysis was performed at a global level and the areas targeted are island environments. Thus, twenty–two sites were selected, all of them being located at approximately 50 km from the shoreline, in deep–water areas (>100 m). This aspect is relevant for the waves, which loose energy as they enter into shallow water areas. Furthermore, where it was possible, they were defined on the western side of the islands which are usually associated with more significant wind and wave resources. In this way, it was possible to estimate the best performances of the wave energy converters, performances that are expected to decay as we move closer to the coast. On the other hand, such approach will also reduce the errors that may occur in the interpolation process of the wave dataset, caused by the interference between water and land.

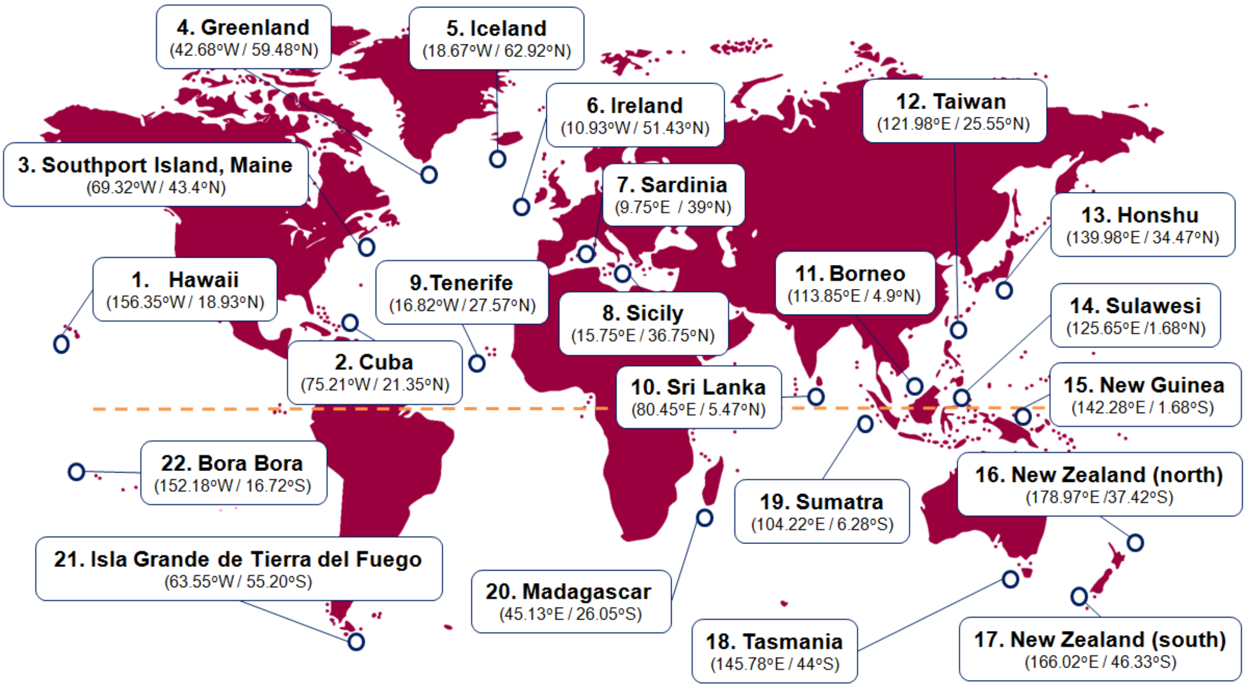

Figure 1.1. World map and the reference sites (including their coordinates) considered for assessment

In order to assess the performances of a WEC system, it is important to define first the joint distribution of the parameters *Hs* and *Te*. This is a bivariate diagram constructed from 0.5 m×0.5 s cells (Δ*Hs* ×Δ*Te*), the results indicating the percentage from the total occurrences. Examples of such diagrams are illustrated in Figure 1.2 for the reference sites P1–P11, including the wave power isolines. By looking at this data, we can notice that the sites P4, P5 and P6 are defined by values which cover a larger range of the *Hs*–*Te* bins, compared for example with the sites P8, P9 and P11, which are defined by an uniform distribution. Usually a site defined by a sea state distributed over a larger number of *Hs*–*Te* bins is suitable for a wave project, since there will be more opportunities to extract the wave power. We can notice that the values corresponding to the site P2 are distributed around the line of 5 kW/m, compared to the sites P8 and P11, where these values are located below this isoline. On the other hand, the values corresponding to the sites P4–P6 may reach the isolines 500 kW/m – 800 kW/m, but in general, they are located below the 50 kW/m isoline, where the maximum distribution does not exceed 4% per cell. As regards the cell distribution, the highest percentage is noticed for P2 (14%), being followed by P1 (12%), P8 (10%), P7 and P11 (9%), respectively. Such an analysis is very useful for the WEC developers since the most effective approach would be to adjust the converters for each particular site in order to provide the maximum energy corresponding to the bins where the highest percentages are encountered.

A trivariate diagram represents another way to visualize the wave energy resources by combining the scatter and wave energy diagrams. Such diagrams are illustrated in Figure 1.3, where the sites P12–P22 were considered. The number in each cell reflects the occurrence of a particular sea state indicated in hours for the average year (defined as the average of the 20–year dataset considered), while the colour bar presents the contribution of different sea states to the annual wave energy. By looking at these values, we can notice that the sites P17 and P18 look more promising for a wave project.

The performance of a WEC system can be determined by combining the bivariate distributions (*Hs* × *Te*) corresponding to the sea site considered with the power matrix of each WEC. Thus, the expected electric power can be estimated as:

$$P_E = \frac{1}{100} \cdot \sum_{i=1}^{n_T} \sum_{j=1}^{n_H} p_{ij} \cdot P_{ij}, \qquad (1.1)$$

where p_{ij} is related to the energy percentage associated to the bin defined by the line *i* and column *j*, where P_{ij} is the expected electric power output defined in the power matrix of each WEC for the same bin (defined by line *i* and column *j*). The AEP (MWh) values related to wave generators are obtained by multiplying the P_E results with the average hours per year (8760).

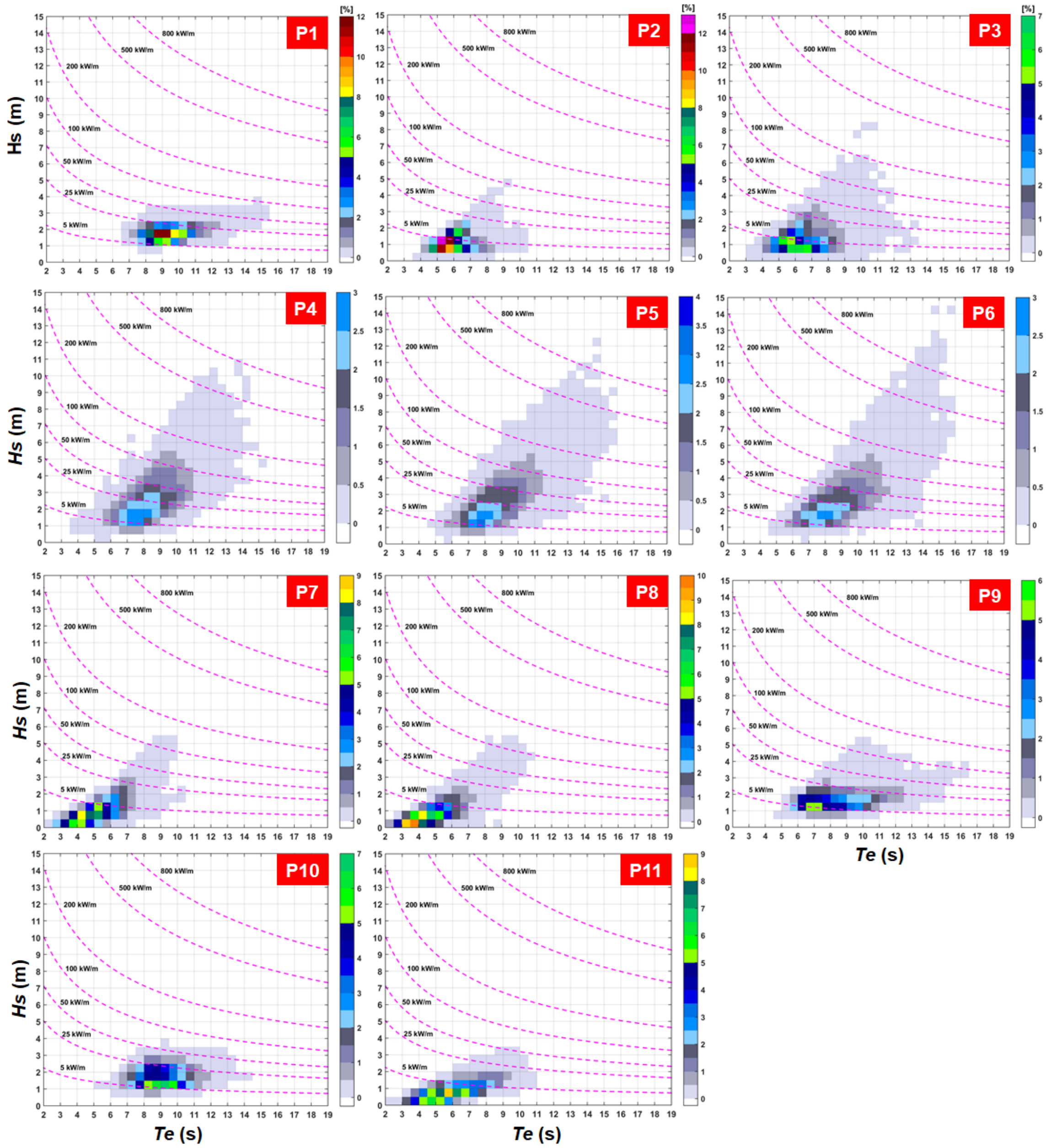

Figure 1.2 Bivariate distributions of the sea states corresponding to the bins defined by the parameters *Hs*–*Te* for the reference points P1–P11 (from Figure 1.1). The wave power isolines were designed for seven energetic levels (5, 25, 50, 100, 200, 500 and 800 kW/m, respectively).

An analysis is performed in Figure 1.4 for the most relevant wave generators. As expected, the performances of the WECs are directly related to the energy potential corresponding to each site and also to the rated capacity of the generators. Wave Dragon stands out with more impressive values, reaching a maximum of 3390 MWh in the vicinity of the reference points P17 and P18 (located in Australia region). In this case, the European sites P4–P6 present lower performances reporting values in the range 2400 – 25000 MWh. Nevertheless, there are also some sites, such as P2, P8 or P14, where this device does not exceed 3000 MWh.

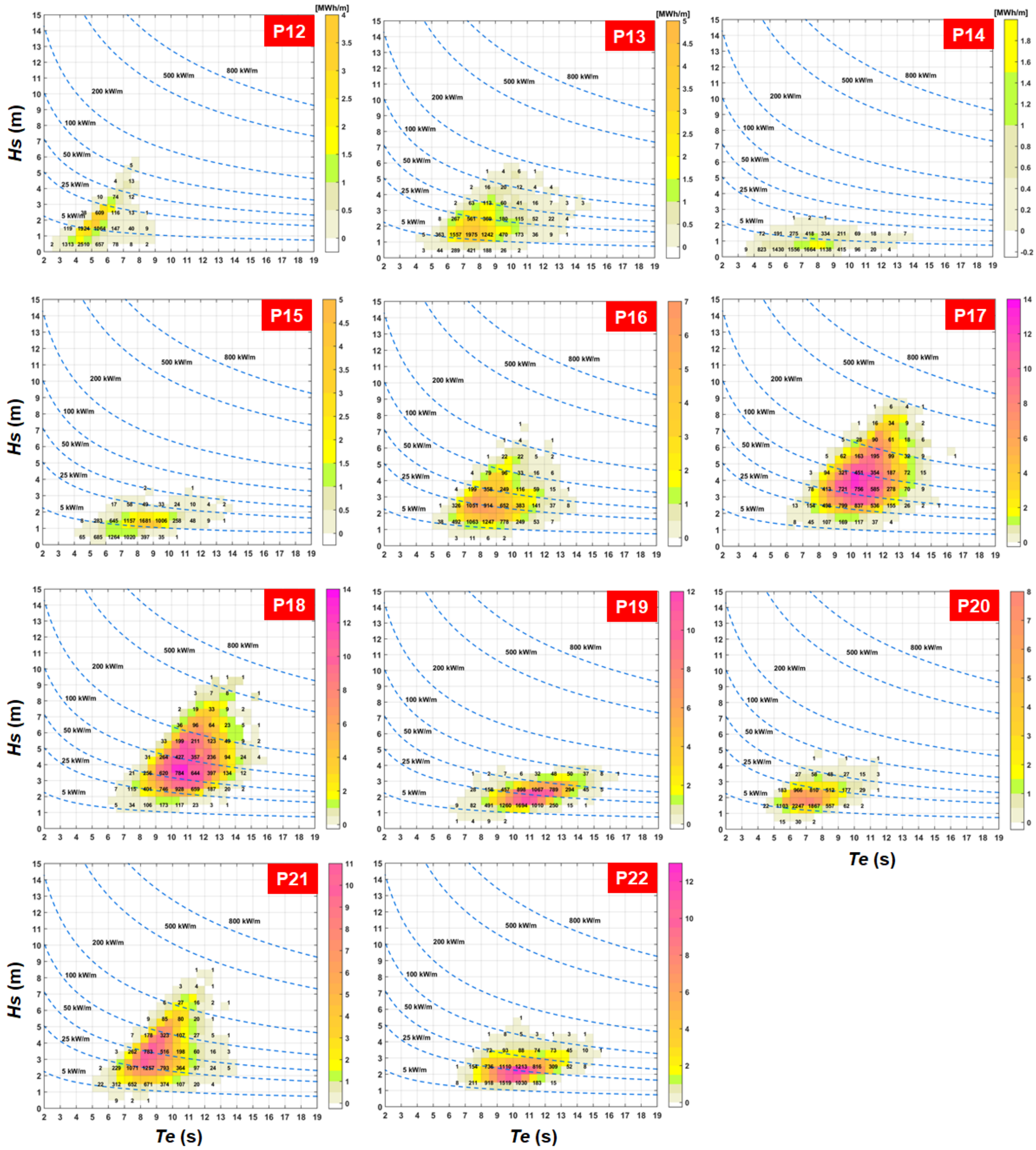

Figure 1.3 Trivariate diagrams illustrating the wave energy resources at the sites P12–P22 (defined in Figure 1.1), where for each combination of significant wave height (*Hs*) and energy period (*Te*), the color indicates its contribution to the annual energy, whereas the numbers represent the occurrence (in number of hours corresponding to an average year).

More results, including also wind analyses are presented in the paper ”An assessment of the wind and wave power potential in the island environment”, published in Energy journal, which is one of the most prestigious journals in the field (Q1).

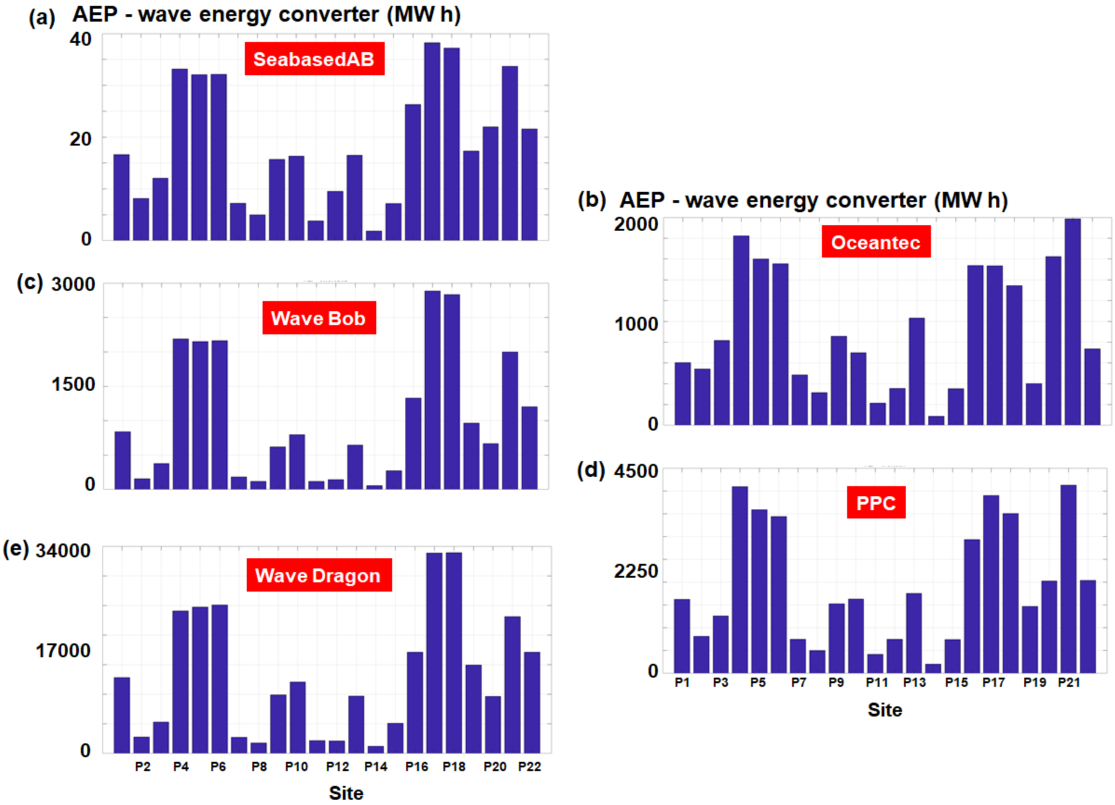

Figure 1.4 Annual Energy Production (in MWh) of one WEC device of each type considered near the 22 sites selected, where: (a) SeabasedAB; (b) Oceantec; (c) Wave Bob; (d) PPC; (e) Wave Dragon.

In this activity (A3.1) it was passed from the global to the regional level. The reference points considered next for evaluation are illustrated in Figure 1.5, with the mention that they were defined at a distance of about 100 km from the shore. Therefore, these points are located in deep water areas and the results reported for these sites will present the best energy potential, which is expected to decrease as we approach to the shoreline. The European sites are indicated as EU1 to EU10, while for the Latin America five points are considered on the western coast (W1–W5) and other five on the eastern coast (E1–E5).

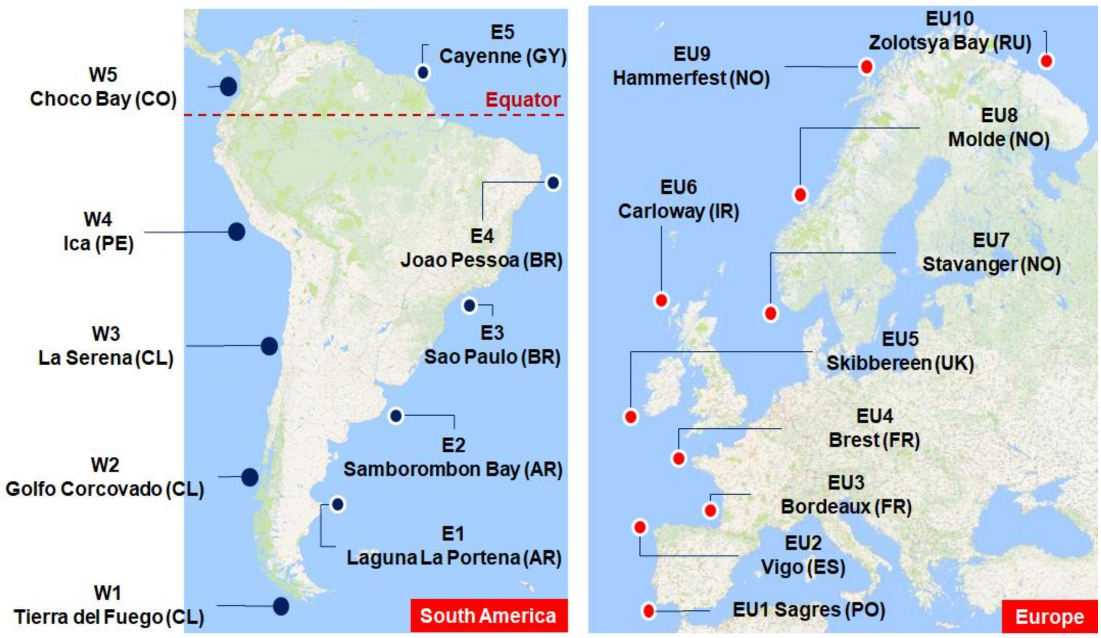

Figure 1.5 Map of the two target areas (Latin America, left side and Europe, right side) including the positions the reference points considered and the country to which they are closer.

Figure 1.6 presents the distribution of the sea states for several reference sites (W1, W5, E1, E4, EU5 and EU8) by using the joint distribution of the significant wave height and wave energy period. These diagrams are designed for the total time, including also the wave power isolines which may be associated with the wave classes. The purpose of such a diagram is to illustrate the probability of occurrences of different sea states, these events being expressed in percentages from the total number of occurrences. The colour of each bin indicates the percentage share according to a colour-map illustrated in the colour-bar of the figures.

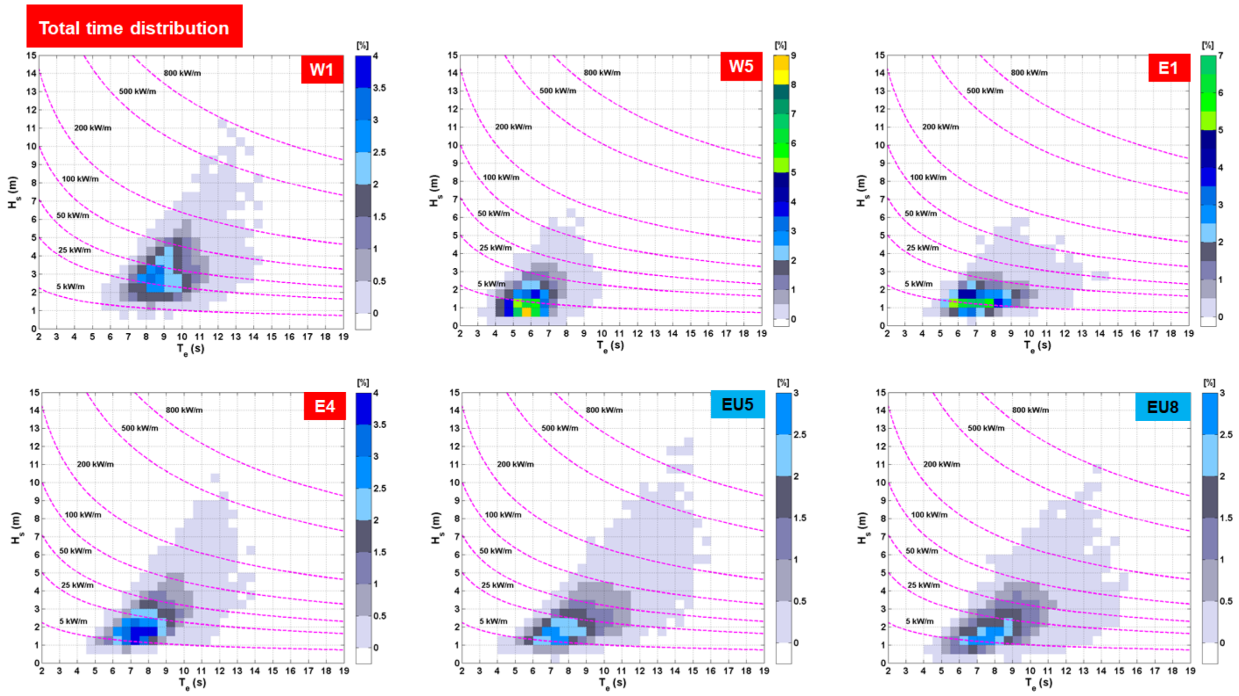

Figure 1.6 Sea state characteristics corresponding to the total time distribution, defined for the 17–year time interval 2000–2016 (ERA–Interim data). The bivariate distributions of the *Hs* and *Te* parameters are indicated for some reference points. Each color indicates the percentage from the total associated with the respective bin.

Figure 1.7 illustrates the performances of the selected WECs. Since there are significant differences between the rated powers of each device, the results were highlighted through a colour variation reported to each system individually. Thus, it seems that the sites defined by important wind energy resources are also identified as suitable for a wave project. Nevertheless, if we compare the expected power output of the Wave Dragon system (rated at 7 MW) with the output of the Senvion 6.2M 126 (rated at 6.15 MW), we notice that the selected wave convertor indicates lower performances. Also, it is important to mention that the WECs do not indicate higher capacity factors, which means that a significant percentage of the energy will be lost over the whole wave-to-wire power conversion chain. Reported to the full time values, the Wave Dragon system indicates a power output of 0.79 MW (EU3) and 1.78MW (EU6), while a maximum of 2.1 MW is expected in W1. The rest of the WECs are defined by power output that does not exceed 0.5 MW, with the exception of the PPC generator which seems to perform much better close to the sites EU6 and W1.

(a) Electric power (MW) — Full time distribution

	W1	W2	W3	W4	W5
EU1	0.86	0.26	0.10	0.04	0.003
EU2	1.26	0.34	0.14	0.05	0.003
EU3	0.79	0.24	0.09	0.03	0.002
EU4	1.34	0.39	0.16	0.05	0.003
EU5	1.66	0.47	0.20	0.06	0.004
EU6	1.78	0.54	0.23	0.07	0.004
EU7	0.87	0.36	0.15	0.04	0.003
EU8	1.42	0.46	0.19	0.06	0.004
EU9	0.86	0.33	0.13	0.04	0.003
EU10	0.44	0.21	0.08	0.02	0.002
W1	2.10	0.69	0.28	0.10	0.005
W2	1.69	0.46	0.19	0.08	0.004
W3	0.95	0.29	0.11	0.04	0.003
W4	0.03	0.05	0.00	0.000	0.000
W5	0.11	0.04	0.01	0.003	0.000
E1	0.54	0.24	0.10	0.02	0.003
E2	0.40	0.18	0.07	0.02	0.002
E3	0.46	0.19	0.07	0.02	0.002
E4	0.52	0.23	0.10	0.03	0.002
E5	0.42	0.19	0.07	0.02	0.002

(b) Electric power (MW) — Winter time distribution

	W1	W2	W3	W4	W5
EU1	1.26	0.32	0.12	0.05	0.003
EU2	1.88	0.44	0.18	0.07	0.004
EU3	1.21	0.32	0.13	0.05	0.003
EU4	2.04	0.52	0.22	0.08	0.004
EU5	2.48	0.62	0.27	0.09	0.005
EU6	2.64	0.72	0.30	0.10	0.005
EU7	1.35	0.53	0.22	0.06	0.004
EU8	2.17	0.64	0.26	0.09	0.005
EU9	1.31	0.47	0.19	0.06	0.004
EU10	0.65	0.28	0.12	0.03	0.003
W1	2.25	0.70	0.28	0.10	0.005
W2	1.95	0.50	0.21	0.09	0.004
W3	1.02	0.29	0.11	0.05	0.003
W4	0.04	0.07	0.00	0.000	0.001
W5	0.08	0.03	0.01	0.002	0.000
E1	0.62	0.27	0.12	0.03	0.003
E2	0.45	0.20	0.08	0.02	0.002
E3	0.53	0.21	0.08	0.02	0.002
E4	0.58	0.24	0.11	0.03	0.003
E5	0.53	0.23	0.10	0.03	0.002

(c) Capacity factor (%) — Full time distribution

	W1	W2	W3	W4	W5
EU1	12.28	7.06	13.15	14.54	16.93
EU2	17.95	9.35	18.48	20.72	21.01
EU3	11.28	6.51	12.08	13.29	14.27
EU4	19.20	10.71	21.43	21.48	21.87
EU5	23.75	13.06	26.59	25.80	25.39
EU6	25.48	14.93	30.05	28.78	27.28
EU7	12.49	9.87	19.82	15.34	20.19
EU8	20.31	12.61	24.89	23.69	23.68
EU9	12.26	9.11	17.70	15.51	18.71
EU10	6.34	5.68	11.05	7.17	14.07
W1	29.93	19.10	36.95	38.52	32.29
W2	24.16	12.71	25.16	30.80	26.09
W3	13.51	7.96	15.23	17.80	19.03
W4	0.45	1.26	0.38	0.02	2.30
W5	1.59	1.24	1.50	1.04	2.53
E1	7.79	6.68	13.66	8.96	17.25
E2	5.69	5.09	9.16	6.20	12.62
E3	6.56	5.12	8.81	7.95	11.79
E4	7.44	6.33	13.07	10.52	16.54
E5	6.03	5.30	9.28	6.72	12.48

(d) Capacity factor (%) — Winter time distribution

	W1	W2	W3	W4	W5
EU1	17.99	8.71	16.61	21.45	20.62
EU2	26.84	12.03	24.06	29.97	25.97
EU3	17.33	8.89	17.16	20.31	19.31
EU4	29.18	14.41	29.55	31.26	28.01
EU5	35.45	17.10	35.35	35.71	31.29
EU6	37.75	19.98	40.56	40.32	33.96
EU7	19.30	14.54	29.91	24.40	27.55
EU8	31.03	17.59	35.03	34.99	30.75
EU9	18.65	12.98	25.92	24.15	25.31
EU10	9.29	7.78	16.34	10.92	19.39
W1	32.14	19.43	37.38	39.07	32.24
W2	27.89	13.92	27.68	34.40	27.76
W3	14.62	7.98	15.16	18.82	19.32
W4	0.57	1.84	0.46	0.03	3.37
W5	1.18	0.89	1.07	0.78	1.84
E1	8.86	7.36	15.49	10.57	18.63
E2	6.46	5.55	10.41	7.44	13.67
E3	7.57	5.68	10.24	9.72	13.35
E4	8.30	6.70	14.88	11.27	18.29
E5	7.52	6.36	12.80	10.03	16.17

W1 – Wave Dragon; W2 – PPC; W3 – Pelamis; W4 – Aqua Buoy; W5 – Seabased AB

Figure 1.7 Performances of the WECs in Europe and Latin America based on the 17-year ECMWF data (2000-2016). The parameters considered for evaluation are: (a), (b) Electric power – full time and winter time distribution; (c), (d) Capacity factor – full time and winter time distribution, respectively.

More results including also wind analyses are presented in the paper number [11] from the list with journal publications, “*A parallel evaluation of the wind and wave energy resources along the Latin American and European coastal environments”*, published in *Renewable Energy* a very prestigious journal (Q1).

Further on, it was passed from the regional level to the local level. The study was focused on the western side of the Black Sea where simulations with the SWAN spectral phase averaged model have been performed for a 40-year period (1987-2016). Figure 1.8 presents two such examples of bivariate distributions of the sea states (*Hs*–*Te)* in the Black Sea. The left side relates the Turkish nearshore in location close to Bosporus while the right side in the Romanian nearshore close to the arm Sfântul Gheorghe of the Danube.

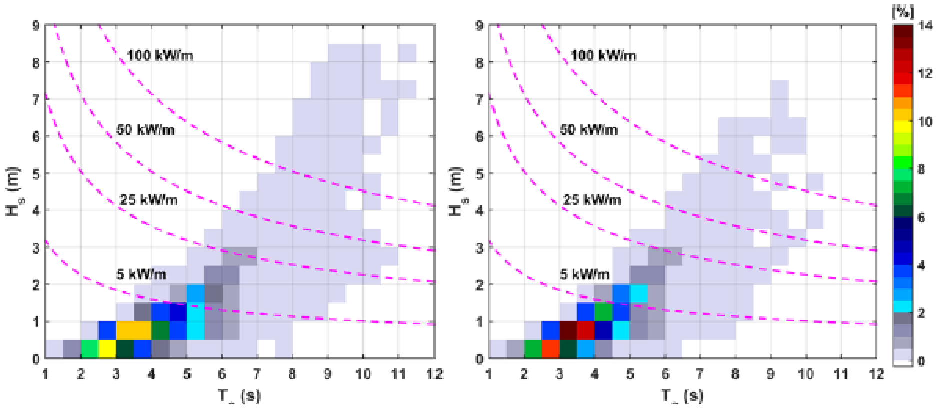

Figure 1.8 Bivariate distributions of the sea states (*Hs–Te)* in the Black Sea.

More results including also wind analyses are presented in the paper number [10] from the list with journal publications, *"The wave and wind power potential in the western Black Sea Renewable Energy"* published in *Renewable Energy* a very prestigious journal (Q1).

2. Studies concerning the influence of the energy farms operating in the nearshore on the down wave climate and on the shoreline dynamics, targeting especially the coastal protection that can be offered by the future marine energy farms. Updating the webpage for the project dissemination (A3.2).

In this activity studies concerning the coastal impact of the marine energy farms have been performed. For these the project benefits from the existence of an original computational environment associated with waves and nearshore currents modelling. This is called ISSM (the Interface for SWAN and Surf models). This computational environment was designed for NATO by the project director (Rusu, E., Conley, D.C. and Coelho, E.F., 2008: A Hybrid Framework for Predicting Waves and Longshore Currents. *Journal of Marine Systems*, Volume 69, Issues 1-2, pp 59–73. http://dx.doi.org/10.1016/j.jmarsys.2007.02.009) and afterwards further developed. Figure 2.1 illustrates 3 geographical locations where such complex studies have been performed.

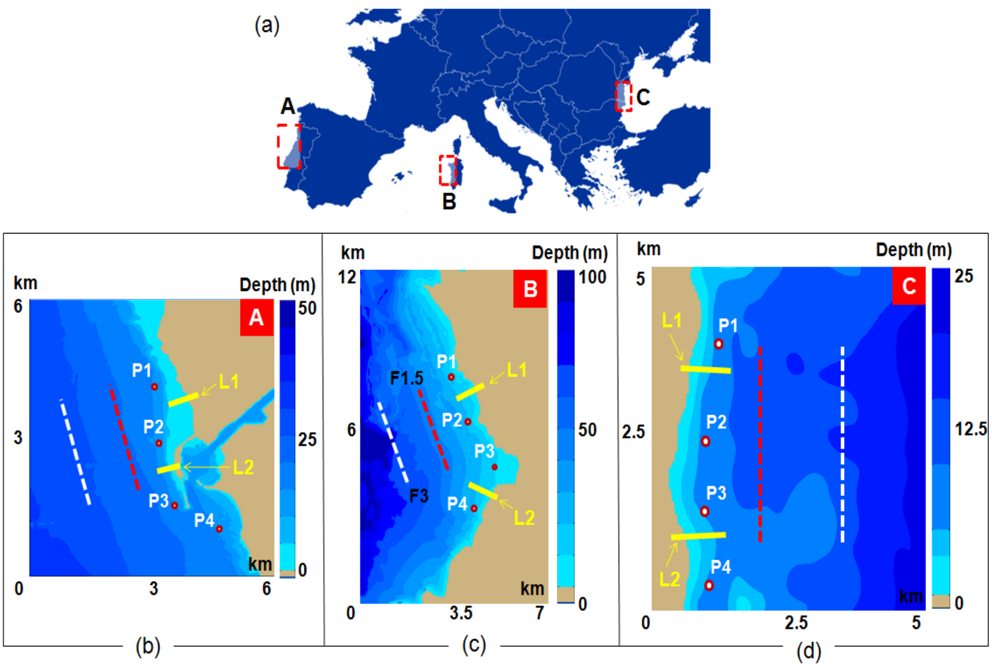

Figure 2.1 (a) Location of the three target areas and the computational domains considered for the SWAN simulations (b) Leixoes in the Portuguese nearshore, (c) Porto Ferro in the coastal environment of Sardinia Island and (c) Mangalia in the Romanian nearshore). In the background the bathymetry is presented while in the foreground the set-up of the wave farm scenario and the reference lines and points selected for the analysis.

A first evaluation of the WEC influence is presented in Figure 2.2, considering also the scenario when both WEC lines (F1.5+F3) will operate, as in the case of a wave farm configuration. For the no farm situation, it can be observed the distribution of the wave fields and the tendency of the waves to rotate as they enter in the surf area.

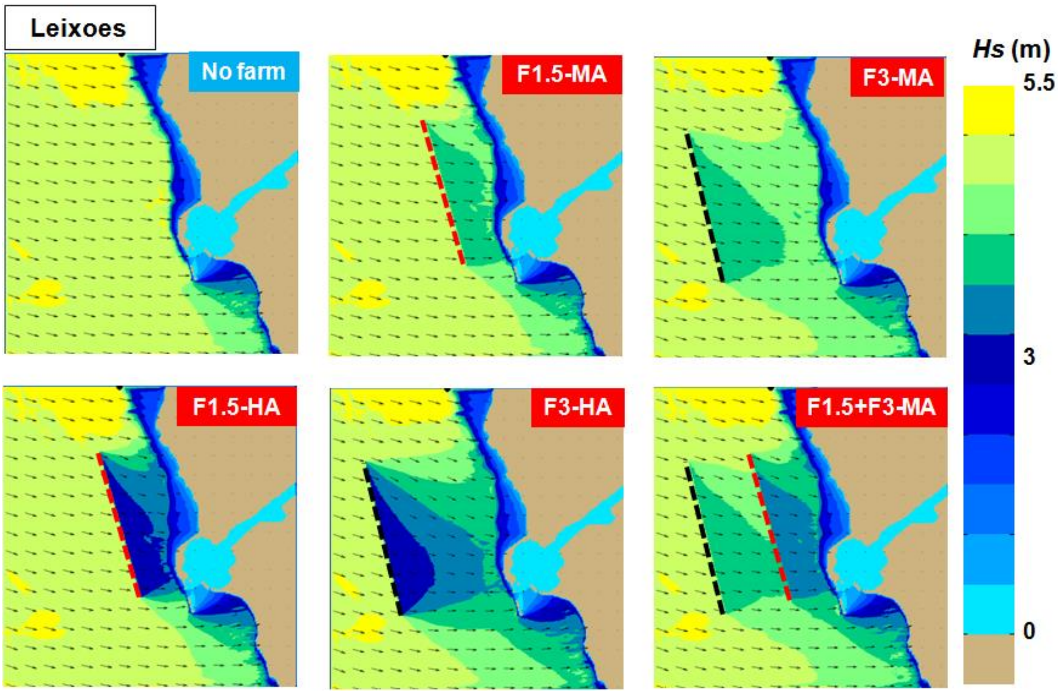

Figure 2.2 Evaluation in the geographical space (significant wave height scalar fields and wave vectors) based on the influence of the generic farm operating in the Leixoes region (Portugal) under extreme conditions.

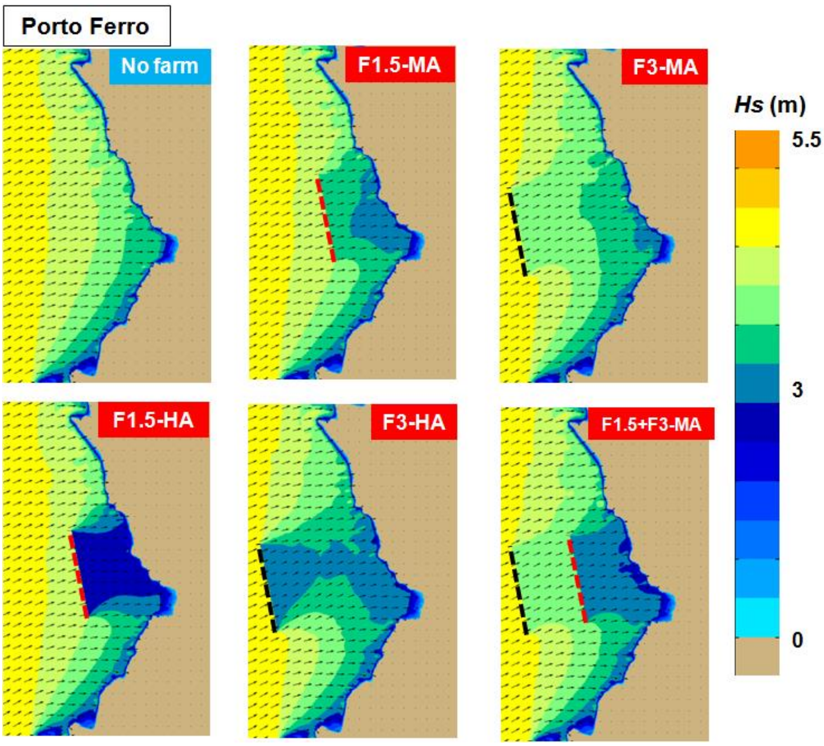

Figure 2.3. Evaluation in the geographical space (significant wave height scalar fields and wave vectors) based on the influence of the generic farm operating in the Porto Ferro region (Sardinia Island) under extreme conditions.

The shielding effect induced by the farm is influenced by the line position according to the incident waves and shoreline orientation, being also influenced by the distance to the shore. In the case of the F3 scenario, the values from the interval 4-4.5 m seems to occur mainly in the southern part of the Leixoes harbour compared to F1.5 scenario. The absorption property of the farm also plays a key role, which is revealed by the multiple wave fields that occur between the farm and the shoreline. The presence of the two WEC lines (MA set-up) seems to replicate the effects observed for the study F3-HA, with the mention that the shielding effect is noticed closer to the shoreline.

In a similar way, Figures 2.3 and 2.4 present the results of the SWAN simulations as a component of the ISSM modeling system in the coastal zones Porto Ferro, Sardinia and Mangalia, Romania. From these figures result in an obvious way the fact that the marine energy farms can play an important role in coastal protection.

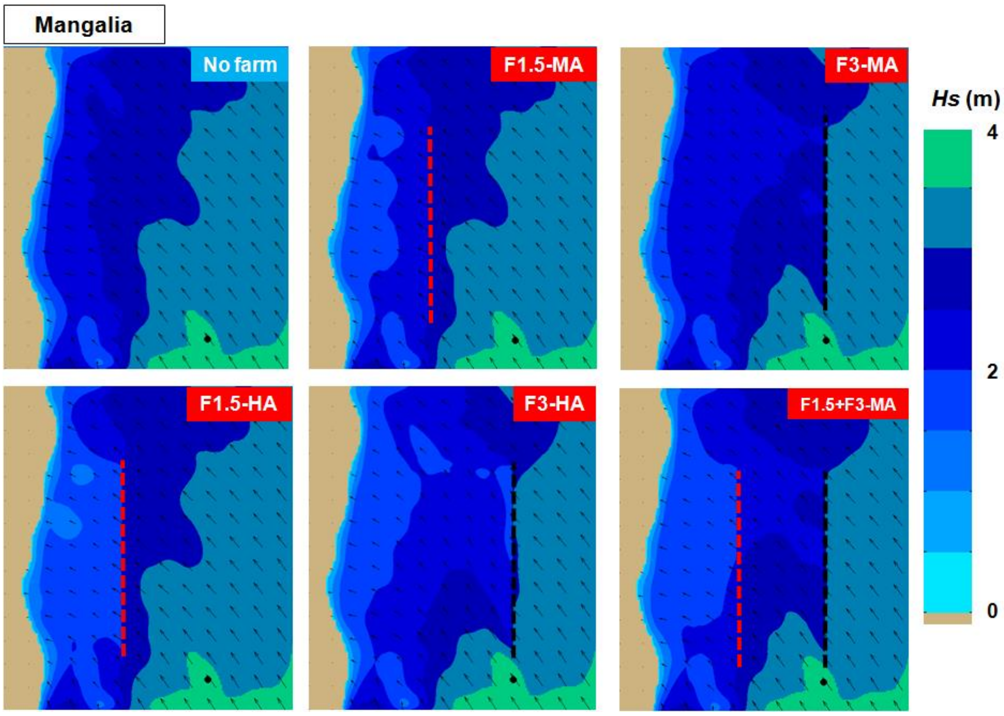

Figure 2.4 Evaluation in the geographical space (significant wave height scalar fields and wave vectors) based on the influence of the generic farm operating in the Mangalia region (Romanian nearshore) under extreme conditions.

In the vicinity of the coastline, the longshore currents may change the balance between the accretion and erosion processes by influencing the flux of the sediment transport. In this respect, Figure 5 illustrates the profile of the longshore currents along the reference lines L1 and L2, from which it can be observed that in some cases (L1-Porto Ferro and L1-Mangalia) the presence of the WEC lines reduces the distance to the shore. For example, in the case of Mangalia (no farm situation) the profile reveals a total length of 400 m, which may decrease until 250 m in the F1.5-HA. For the Leixoes region, we can notice that the WEC influence increases the current velocity from 0.5 m/s (no farm situation) to a value located close to 2 m/s (F3-HA).

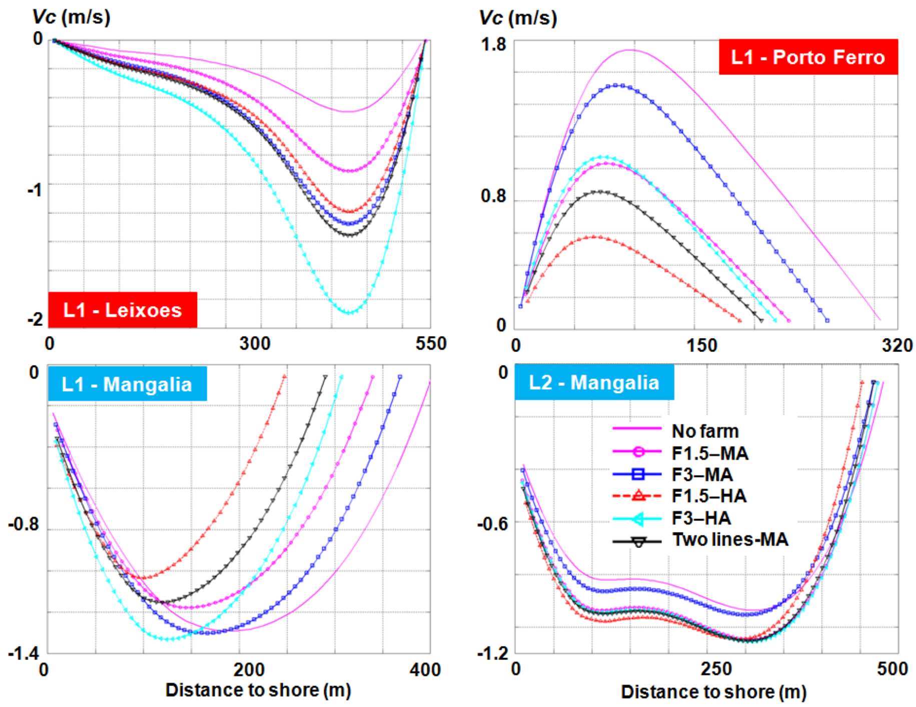

Figure 2.5. Nearshore current profiles indicating the impact of the generic wave farm in the vicinity of: line L1-Leixoes; line L2-Porto Ferro; lines L1 and L2 - Mangalia.

3. Dissemination of the results

3.1 Dissemination through scientific publications

3.1.1 Publications in journals with WoS quotations (15, 3Q1 & 7Q2)

1. Rusu, E., Onea, F., 2017, Joint Evaluation of the Wave and Offshore Wind Energy Resources in the Developing Countries, *Energies* 2017, *10*(11), 1866; **WoS Q2, IF=2.262,** http://www.mdpi.com/1996-1073/10/11/1866

2. Onea, F., Ciortan, S., Rusu, E., 2017, Assessment of the potential for developing combined wind-wave projects in the European nearshore, SAGE Journals, Energy & Environment, 2017, **IF=0.302** http://journals.sagepub.com/doi/abs/10.1177/0958305X17716947

3. Ganea, D., Amorțilă, V., Mereuță, E., Rusu, E., 2017, A Joint Evaluation of the Wind and Wave Energy Resources Close to the Greek Islands, Sustainability Journal, Special Issue Wind Energy, Load and Price Forecasting towards Sustainability, 2017, 9(6), 1025; doi:10.3390/su9061025, **WoS Q2, IF=1.789**, http://www.mdpi.com/2071-1050/9/6/1025

4. Rusu, E., 2018, *"Numerical Modeling of the Wave Energy Propagation in the Iberian Nearshore"*, Energies 11(4), 980, (**WoS Q2, IF=2.676**), https://doi.org/10.3390/en11040980

5. Rusu, E., 2018, *"Study of the Wave Energy Propagation Patterns in the Western Black Sea"*, Applied Sciences 8(6), 993, (**WoS Q2, IF=1.689**), https://doi.org/10.3390/app8060993

6. Belibassakis, K., Bonovas, M., Rusu, E., 2018, "A novel method for estimating wave energy converter performance in variable bathymetry regions and applications "Energies 11(8), 2092, (**WoS Q2, IF=2.676**), https://www.mdpi.com/1996-1073/11/8/2092

7. Onea, F., Rusu, E., 2018, *"Sustainability of the Reanalysis Databases in Predicting the Wind and Wave Power along the European Coasts"*, Sustainability 2018, 10(1), 193, (**WoS Q2, IF=2.075**), http://www.mdpi.com/2071-1050/10/1/193

8. Niculescu, D., Rusu, E., 2018, *"Evaluation of the new coastal protection scheme at Mamaia Bay in the nearshore of the Black Sea"*, Ocean Systems Engineering, Vol.8, No. 1 (2018), pp. 1-20, **(WoS)**, http://www.techno-press.org/?page=container&journal=ose&volume=8&num=1

9. Rusu, E., Onea, F., An assessment of the wind and wave power potential in the island environment, Energy, Volume 175, 15 May 2019, Pages 830-846, https://doi.org/10.1016/j.energy.2019.03.130 **WoS Q1, IF=5.537**
10. Rusu, L., The wave and wind power potential in the western Black Sea Renewable Energy, Volume 139, August 2019, Pages 1146-1158, https://doi.org/10.1016/j.renene.2019.03.017 **WoS Q1, IF=5.439**,
11. Rusu, E., Onea, F., A parallel evaluation of the wind and wave energy resources along the Latin American and European coastal environments, Renewable Energy, Volume 143, December 2019, Pages 1594-1607, https://doi.org/10.1016/j.renene.2019.05.117 **WoS Q1, IF=5.439**,
12. Adem Akpınar,Halid Jafali and Eugen Rusu, Temporal Variation of the Wave Energy Flux in Hotspot Areas of the Black Sea, Sustainability 2019, 11(3), 562; https://doi.org/10.3390/su11030562 **WoS Q2, IF=2.592**
13. Markos Bonovas,Kostas Belibassakis and Eugen Rusu, Multi-DOF WEC Performance in Variable Bathymetry Regions Using a Hybrid 3D BEM and Optimization, Energies 2019, 12(11), 2108; https://doi.org/10.3390/en12112108 **WoS, IF=2.707**
14. Onea, F., Rusu, E., An assessment of the wind energy potential in the Caspian Sea, *Energies 2019*, 12(13) 2525 https://www.mdpi.com/1996-1073/12/13/2525 **WoS, IF=2.707**
15. Picu, L., Picu, M., Rusu, E., 2019, An Investigation into the Health Risks Associated with the Noise and Vibrations on Board of a Boat—A Case Study on the Danube River, *JMSE2019,* 7(8), 258 https://doi.org/10.3390/jmse7080258 **WoS, IF=1.732**

3.1.2 Publications in other international journals (4)

1. Rusu, E., Onea, F., 2018, *"A review of the technologies for wave energy extraction"*, Clean Energy, 2018, 1–10, https://academic.oup.com/ce/advance-article/doi/10.1093/ce/zky003/4924611
2. Onea, F., Rusu, E., 2019, *Sensitivity analysis of the wave energy converters operating in the French coastal waters*, International Journal of Smart Grid and Clean Energy, 8(2), pp. 239-244, **SCOPUS**, http://www.ijsgce.com/index.php?m=content&c=index&a=show&catid=78&id=438
3. Catalin Anton, Carmen Gasparotti, and Eugen Rusu, Multi-criterial Analysis by Determining the Supportability Factor in the Western of the Black Sea, Journal of Clean Energy Technologies, Vol. 7, No. 4, July 2019 http://www.jocet.org/vol7/509-ER0007.pdf
4. Catalin Anton, Carmen Gasparotti, Iulia Anton and Eugen Rusu, Analysis of the Mamaia Bay shoreline Retreat with Hard and Soft Protection Works, Journal of Marine Science, Volume 01, Issue 01, April 2019, https://ojs.bilpublishing.com/index.php/jms/article/view/490

3.1.3 Publications in Romanian national journals (12)

1. Pintilie, V., Rusu, E., 2017 A brief overview of the renewable energy potential in Romania, Mechanical Testing and Diagnosis ISSN 2247 – 9635, 2017 (VII), Volume 2, pp. 24-29, http://www.im.ugal.ro/mtd/issue2017-2.htm
2. Covalenco, V., Ciortan, S., Rusu, E., 2017, Analysis of the extreme environmental conditions In the Black Sea considering different data sources , Mechanical Testing and Diagnosis ISSN 2247 – 9635, 2017 (VII), Volume 2, pp. 16-23 , http://www.im.ugal.ro/mtd/issue2017-2.htm
3. Picu, L., Rusu, E., 2017, *"Whole Body Vibration of A Pushtow Boat Crew Operating on the Danube River"*, Journal of Mechanical Testing and Diagnosis,ISSN 2247 – 9635, 2017 (VII), Volume 1, pp. 28-35, http://www.im.ugal.ro/mtd/issue2017-1.htm
4. Novac, V., Rusu, E., 2018, *Black Sea littoral military operations - environment impact*, Scientific Bulletin of Naval Academy, Vol. XXI 2018, pp. 607-616. doi:10.21279/1454-864X-18-I1-091, https://www.anmb.ro/buletinstiintific/buletine/2018_Issue1/04_FAR/novac.pdf

5. Gasparotti, C. and Rusu, E., 2018, Assessment of the energy potential of the waves in the Black Sea, Mechanical Testing and Diagnosis, ISSN 2247 –9635, 2018 (VIII), Volume 3, pp. 5 -10, http://www.im.ugal.ro/mtd/download/2018-3/1_MTD_Volume%203_2018_Gaparotti%20xx.pdf
6. Stingheru, C., Gasparotti, C., Raileanu, A., Rusu, E., 2018, *A SWOT Analysis of the Marine Energy Sector at the European Level*, Acta Universitatis Danubius. Œconomica, Vol 14, No 3 (2018), pp. 213-237, http://www.journals.univ-danubius.ro/index.php/oeconomica/article/view/4551
7. Caranfil, V., Rusu, E., Onea, F., 2018, An evaluation of the solar and wind energy in the south - east of Romania Mechanical Testing and Diagnosis, ISSN 2247 –9635, 2018 (VIII), Volume 2, pp. 15 -20, http://www.im.ugal.ro/mtd/download/2018-2/3_MTD_Volume%202_2018_Caranfil%20xx.pdf
8. Carmen Gasparotti, Eugen Rusu, An Overview on the Shipbuilding Market in Current Period and Forecast, EuroEconomica, Vol 37, No 3 (2018), http://journals.univ-danubius.ro/index.php/euroeconomica/article/view/5134
9. Alexandra DIACONITA, Florin ONEA, Eugen RUSU, AN EVALUATION OF THE WIND ENERGY IN THE NORTH SEA COAST, Mechanical Testing and Diagnosis ISSN 2247 –9635, 2019 (IX), Volume 1, pp. 17-22, http://www.im.ugal.ro/mtd/download/2019-1/2_MTD_Volume%201_2019_Diaconita%20xx.pdf
10. BĂNESCU Alexandru, GEORGESCU Lucian – Puiu, ITICESCU Cătălina, RUSU Eugen, Analysis of the Industrial Metallic Halls under Lateral Force Action Generated by an Earthquake in the Danube Delta Area, Scientific Annals of the Danube Delta Institute, Tulcea, Romania, vol. 24, 2019, https://doi.org/10.7427/DDI.24.14
11. Cristina CALIN, Eugen RUSU, Stefan DRAGOMIR, 2019, RISK ANALYSIS ON THE HEAT PUMP SYSTEM TO USE FOR BUILDING HEATING, IN URBAN AREA, Mechanical Testing and Diagnosis ISSN 2247 –9635, 2019 (IX), Volume 2, pp. 5-10, http://www.im.ugal.ro/mtd/download/2019-2/1_MTD%20Volume%202%202019%20Lucrare%20Calin.pdf
12. Laurentiu PICU, Eugen RUSU, 2019, EFFECTS OF LOW-FREQUENCY NOISE ON CREWS OF RIVER VESSELS ON THE DANUBE, Mechanical Testing and Diagnosis ISSN 2247 –9635, 2019 (IX), Volume 3, pp. 11-17, http://www.im.ugal.ro/mtd/download/2019-3/2_MTD%20Volume%203%202019%20Picu%20%20Rusu%20v3_DL.pdf

3.1.4 Papers presented in international scientific conferences (33)

1. Rusu, E., 2017, *"The synergy between wind and wave power along the coasts of the Black Sea"*, the 17th International Congress of the International Maritime Association of the Mediterranean on "Maritime Transportation and Harvesting of Sea Resources", IMAM 2017, Lisbon, Portugal, 9 - 11 October 2017, http://www.imamhomepage.org/imam2017/ **WoS.**
2. Niculescu, D., Rusu, E., 2017, *"Water flow and bathymetry - sensors integration for precise measurements"*, The International Symposium Protection of the Black Sea Ecosystem and Sustainable Management of Maritime Activities - PROMARE 2017, 8th Edition, 7-9 September 2017, Constanta, ROMANIA**)**
3. Picu, L., Rusu, E., 2017, Studies of vibrations induced and their effect on the river ship crew fatigue, poster presented at the International Conference TEME2017 http://www.teme.ugal.ro/, paper published in the proceedings.
4. Rusu, E., Onea, F., 2018, *The Synergy Between Wave and Wind Energy along the Latin American and the European Continental Coasts*, Conference: 1st Latin American SDEWES conference, Rio de Janeiro, Brazil, http://www.rio2018.sdewes.org/programme.php
5. Rusu, L., 2018, *The Wave and Wind Power Potential in the Western Black Sea*, Conference: 1st Latin American SDEWES conference, Rio de Janeiro, Brazil, **BEST PAPER AWARD!** http://www.rio2018.sdewes.org/programme.php
6. Rusu, E., Onea, F., 2018, *Evaluation of the shoreline effect of the marine energy farms in different coastal environments*, Conference: ICACER 2018 - 3rd International Conference on Advances on Clean Energy Research, 4-6 April, 2018, Barcelona, SPAIN, http://icacer.com/ **WoS**

Ciortan, S., Rusu, E., 2018, *Prediction of the wave power in the Black Sea based on wind speed using artificial neural networks*, Conference: ICACER 2018 - 3rd International Conference on Advances on Clean Energy Research, 4-6 April, 2018, Barcelona, SPAIN, http://icacer.com/ **WoS**

7. Niculescu, D., Rusu, E., 2018, *An overview of the wind power potential in the Romanian coastal environment-moving from onshore to offshore*, Conference: ICACER 2018 - 3rd International Conference on Advances on Clean Energy Research, 4-6 April, 2018, Barcelona, SPAIN, http://icacer.com/ **WoS**

8. Rusu, L., 2018, *Evaluation of the synergy between wind and wave power for combined exploitation in the Black Sea*, Conference: ICACER 2018 - 3rd International Conference on Advances on Clean Energy Research, 4-6 April, 2018, Barcelona, SPAIN, http://icacer.com/ **WoS**

9. Banescu, A., Georgescu, L., Iticescu, C., Rusu, E., 2018, *Analysis of the wind action on the turbines operating in the Dobrogea region from Romania*, Conference: 18th International Multidisciplinary Scientific GeoConference SGEM 2018, Albena, Bulgaria, https://www.sgem.org/ **SCOPUS**

10. Anton, C., Gasparotti, C., Rusu, E., Anton, I., 2018, *Approach to the analysis and evaluation of strategic intervention options in the romanian coastal zone taking into account economic, social and environmental factors*, Conference: 18th International Multidisciplinary Scientific GeoConference SGEM 2018, Albena, Bulgaria, https://www.sgem.org/ **SCOPUS**

11. Anton, C., Gasparotti, C., Rusu, E., 2018, *Identification of the economic pressure on environmental factors in the Romanian coastal zone-case study Eforie*, Conference: 18th International Multidisciplinary Scientific GeoConference SGEM 2018, Albena, Bulgaria, https://www.sgem.org/ **SCOPUS**

12. Picu, L, Rusu, E., Picu, M., 2018, *Evaluation of human exposure to whole-body vibration-verification method of stevens's power law*, Conference: 18th International Multidisciplinary Scientific GeoConference SGEM 2018, Albena, Bulgaria, **SCOPUS**, https://www.sgem.org/

13. Caranfil, V., Rusu, E., Onea, F., 2018, *An analysis of the renewable energy resources in the Republic of Moldova*, Conference: 18th International Multidisciplinary Scientific GeoConference SGEM 2018, Albena, Bulgaria, https://www.sgem.org/ **SCOPUS**

14. Stingheru, C., Rusu, E., and Gasparotti, C., 2018, The cause-effect method used in highlighting the main causes and implications of maritime accidents in the Black Sea, ICTTE Belgrade 2018. International Conference on Traffic and Transport Engineering, 27th – 28th September 2018, Belgrade (Serbia), pp 283-289, http://ijtte.com/uploads/news_files/ICTTE%20Belgrade%202018_Proceedings.pdf

15. Picu, L., Rusu, E., 2018, Quantifying the effect of the ship vibration on crew for the inland navigation-case study a cargo navigating in the lower Danube sector, ICTTE Belgrade 2018. International Conference on Traffic and Transport Engineering, 27th – 28th September 2018, Belgrade (Serbia), pp. 169-174, http://ijtte.com/uploads/news_files/ICTTE%20Belgrade%202018_Proceedings.pdf

16. Anton, C., Gasparotti, C. and Rusu, E., 2018, A challenge for the inland navigation-a connection between the Baltic and the Black Seas, , ICTTE Belgrade 2018. International Conference on Traffic and Transport Engineering, 27th – 28th September 2018, Belgrade (Serbia), pp. 175-186, http://ijtte.com/uploads/news_files/ICTTE%20Belgrade%202018_Proceedings.pdf

17. Rusu, E., Rusu, L., Evaluation of the wind power potential in the European nearshore of the Mediterranean Sea, 4th International Conference on Advances on Clean Energy Research (ICACER 2019), Coimbra, Portugal, April 5-7, 2019, **WoS** https://doi.org/10.1051/e3sconf/201910301003

18. Rusu, L., A Projection of the Wind Energy in the Black Sea along the 21st Century, 4th International Conference on Advances on Clean Energy Research (ICACER 2019), Coimbra, Portugal, April 5-7, 2019, **WoS** https://doi.org/10.1051/e3sconf/201910301005

19. Ciortan, S., Rusu, E., Analysis of Wave Energy Conversion with Dynamic Systems Theory, , 4th International Conference on Advances on Clean Energy Research (ICACER 2019), Coimbra, Portugal, April 5-7, 2019, **WoS** https://doi.org/10.1051/e3sconf/201910302003

20. Rusu, E., Onea, F., Wind and wave energy resource of Germany reported by ERA-Interim reanalysis data, The 2nd International Conference on Renewable Energy and Environment Engineering, August 19-22, 2019 Munich, Germany, **WoS** http://www.reee.net/

21. Rusu, E., Wind energy assessments in the Baltic Sea, past and future projections, The 14th Conference on Sustainable Development of Energy, Water and Environment Systems (*SDEWES*), October 1-6, Dubrovnik, Croatia, https://www.dubrovnik2019.sdewes.org/
22. Rusu, L., A projection of the expected wave power in the Black Sea until the end of the 21st century, The 14th Conference on Sustainable Development of Energy, Water and Environment Systems (*SDEWES*), October 1-6, Dubrovnik, Croatia, https://www.dubrovnik2019.sdewes.org/
23. BĂNESCU Alexandru, GEORGESCU Lucian – Puiu, ITICESCU Cătălina, RUSU Eugen, 2019, Analysis of the Earthquake Force for a Frame Structure Located in Seismic Risk Areas, XIX International Multidisciplinary Scientific GeoConference SGEM 2019, Section Applied and Environmental Geophysics pp. 739-747, **SCOPUS** https://doi.org/10.5593/sgem2019/1.1
24. Turcanu (Marcu) Andra, Carmen Gasparotti, Eugen Rusu, 2019, Management platform for the port communities, XIX International Multidisciplinary Scientific GeoConference SGEM 2019, Section Informatics pp. 399-405, **SCOPUS** https://doi.org/10.5593/sgem2019/2.1
25. Valerian Novac, Eugen Rusu, 2019, Black Sea Oil Spils – Preventive and Remedial Actions, XIX International Multidisciplinary Scientific GeoConference SGEM 2019, Section Marine and Ocean Ecosystems, pp. 683-690, **SCOPUS** https://doi.org/10.5593/sgem2019/3.1
26. Gheorghe Stavarache, Sorin Ciortan, Eugen Rusu, 2019, Analysis of Environmental Characteristics Influence on Wind Power with Artificial Neural Networks, XIX International Multidisciplinary Scientific GeoConference SGEM 2019, Section Renewable Energy Sources and Clean Technologies, pp. 43-50, **SCOPUS** https://doi.org/10.5593/sgem2019/4.1
27. Valerian Novac, Eugen Rusu, 2019, Air Emissions from Ships – Western Black Case Study, XIX International Multidisciplinary Scientific GeoConference SGEM 2019, Section Air Pollution and Climate Change, pp. 813-819, **SCOPUS** https://doi.org/10.5593/sgem2019/4.1
28. Laurentiu Picu, Eugen Rusu, Mihaela Picu, 2019, An Analysis of the Noise in the Engine Room – Case Study a Merchant Ship Navigating on Danube, XIX International Multidisciplinary Scientific GeoConference SGEM 2019, Section Ecology and Environmental Protection, pp. 69-75, **SCOPUS** https://doi.org/10.5593/sgem2019/5.2
29. Laurentiu Picu, Mihaela Picu, Eugen Rusu, 2019, Noise Analysis on the Navigation Bridge for a Boat Traveling on the Danube River, XIX International Multidisciplinary Scientific GeoConference SGEM 2019, Section Ecology and Environmental Protection, pp. 571-578, **SCOPUS** https://doi.org/10.5593/sgem2019/5.2
30. Laurentiu Picu, Eugen Rusu, Mihaela Picu, 2019, Study of the Vibration Transmited to the Crew by the Equipment of a River Boat before Repairs, XIX International Multidisciplinary Scientific GeoConference SGEM 2019, Section Ecology and Environmental Protection, pp. 695-700, **SCOPUS** https://doi.org/10.5593/sgem2019/5.2
31. Liliana Rusu, 2020, An assessment of the wave energy in the European seas based on ERA 5 reanalysis dataset, paper accepted at MARTECH 2020 - 5th International Conference on Maritime Technology and Engineering, Lisbon Portugal, 10-13 May, 2020, **WoS** http://www.centec.tecnico.ulisboa.pt/martech2020/structure.aspx
32. Liliana Rusu, 2020, Evaluation of the climate change impact on future wave energy resources with a focus on the Black Sea basin, WECANet Assembly Porto, 28-29 November 2019 https://docs.wixstatic.com/ugd/493ce7_4023a11327f2442e9a000d5964cbb3be.pdf?index=true

3.1.5 Papers presented in Romanian national conferences (11)

1. Rusu, E., 2018, *An Assessment of the Wind Energy Potential in the Romanian Nearshore*, **INVITED PRESENTATION**, Conference: CSSD2018 -Scientific Conference of the Doctoral Schools - Perspectives and Challenges in Doctoral Research, June 2018, Galati, Romania, https://www.researchgate.net/publication/325662815_An_Assessment_of_the_Wind_Energy_Potential_in_the_Romanian_Nearshore

2. Anton, C., Gasparotti, C., Rusu, E., 2018, *Analysis of the Mamaia Bay Shoreline Retreat Using Hard and Soft Protection Works*, Conference: CSSD2018 -Scientific Conference of the Doctoral Schools - Perspectives and Challenges in Doctoral Research, June 2018, Galati, Romania, http://www.cssd-udjg.ugal.ro/index.php/abstracts-2018
3. Anton, C., Gasparotti, C., Rusu, E., 2018, *Introducing the Blue Economy Concept in the Romanian Nearshore*, Conference: CSSD2018 -Scientific Conference of the Doctoral Schools - Perspectives and Challenges in Doctoral Research, June 2018, Galati, Romania, http://www.cssd-udjg.ugal.ro/index.php/abstracts-2018
4. Picu, L., Rusu, E., 2018, *Multiple Physical Stress Exposures of Sailors on Several Ships. A Longitudinal Study*, Conference: CSSD2018 -Scientific Conference of the Doctoral Schools - Perspectives and Challenges in Doctoral Research, June 2018, Galati, Romania, http://www.cssd-udjg.ugal.ro/index.php/abstracts-2018
5. Caranfil, V., Rusu, E., Onea, F., 2018, *Partial Energy Consumption Supplied by Renewable Energy Sources for a Production Hall*, Conference: CSSD2018 -Scientific Conference of the Doctoral Schools - Perspectives and Challenges in Doctoral Research, June 2018, Galati, Romania,
6. Picu, L., Rusu, E., 2018, *Single Degree of Freedom Vibrating System and the Prediction of Human Discomfort Due to its Transient Vibrations*, Conference: CSSD2018 -Scientific Conference of the Doctoral Schools - Perspectives and Challenges in Doctoral Research, June 2018, Galati, Romania, http://www.cssd-udjg.ugal.ro/index.php/abstracts-2018
7. Rusu, E., 2018, Mediul marin o parte importantă a viitorului nostrum, **INVITED PRESENTATION** la Filiala Iași a Academiei Române, 1 Noiembrie 2018. http://acadiasi.org/mediul-marin-o-parte-importanta-a-viitorului-nostru/
8. Anton, C., Gasparotti, C., Rusu, E., Alexandru Bănescu, Lucian Puiu Georgescu, Cătălina Iticescua, Eugen Rusu, Use of GIS Technology in Flood Risk Analysis. Case Study Mila 23 Locality from the Danube Delta, OP2.13, Conference: CSSD2019 -Scientific Conference of the Doctoral Schools - Perspectives and Challenges in Doctoral Research, June 2019, Galati, Romania, http://www.cssd-udjg.ugal.ro/index.php/abstracts-2019
9. Laurențiu Picu, Eugen Rusu, Non-Linear Characteristics of Transmissibility in the Dynamic Responses of Standing Subjects Exposed to Vertical Whole-Body Vibration, PP1.7, Conference: CSSD2019 -Scientific Conference of the Doctoral Schools - Perspectives and Challenges in Doctoral Research, June 2019, Galati, Romania, http://www.cssd-udjg.ugal.ro/index.php/abstracts-2019
10. Valerian Novac, Eugen Rusu, Black Sea Naval Accidents – Intervention Management, PP1.11, Conference: CSSD2019 -Scientific Conference of the Doctoral Schools - Perspectives and Challenges in Doctoral Research, June 2019, Galati, Romania, http://www.cssd-udjg.ugal.ro/index.php/abstracts-2019
11. Gheorghe Stăvărache, The Wind Energy Potential in Republic of Moldavia, PP2.16, Conference: CSSD2019 -Scientific Conference of the Doctoral Schools - Perspectives and Challenges in Doctoral Research, June 2019, Galati, Romania, http://www.cssd-udjg.ugal.ro/index.php/abstracts-2019

The synthesis of the dissemination through scientific publications for each stage and publication category is presented bellow in Table 3.1. It has to be highlighted that in this table are indicated only the works which have been already published and that there are still works under preparation or submitted for publications being currently under review.

Table 3.1 Synthesis of the publication results

Stage / Publications	Stage I	Stage II	Stage III	Total
WoS journals	3	5	7	15
Other international journals	-	1	3	4
Romanian national journals	3	5	4	12
International conferences	3	14	16	33
Romanian national conferences	-	7	4	11
Total	9	32	34	75

We can notice that in the framework of the REMARC project have been published up to now 75 scientific publications. These can be structured as follows: **15 papers published in journals with WoS quotation, among them 3 are in Q1 and 7 in Q2,** 4 in other international journals and 12 in national journals. Furthermore, 33 papers have been presented in international conferences (10 WoS and 13 SCOPUS) and 11 papers have been presented in Romanian national conferences. The value of the cumulative impact factor is **IF cumulat = 39.623.** It has to be mentioned that this value has been computed considering the impact factors from the year of publication and whether the actual impact factors would be used the value of this index would exceed the value of **45.**

3.2 Providing support for the young researchers

In the project team are included two PhD students, Dragoş Niculescu (who finished his PhD) and Cătalin ANTON (who is now in the third year) and a master student Gheorghe Stavarache (who finished the master and started a PhD under the supervision of the project director). Also, in the framework of the REMARC project have been made and published an important number of scientific works (more than 50) in which young researchers are included (PhD or master students). They are both team members, but also other researchers supervised by the senior team members. Besides these, there have been finalised in the period reported under the supervision of the team members of the REMARC project 1 PhD thesis, 9 Master degree theses and 1 Bachelor degree thesis all of them having the REMARC project mentioned in Acknowledgement. They are listed below.

3.2.1 PhD thesis finalised

a. Dragoş NICULESCU, Studii privind evaluarea resurselor de energie regenerabilă în zona litoralului românesc al Mării Negre, (Studies concerning evaluation of the renewable energy resources in the Romanian nearshore) supervisor Professor Eugen RUSU, Mai 2019, Universitatea Dunărea de Jos din Galaţi, (2019)

3.2.2 Master theses finalised

b. Cristea Adriana (Master MSIM), tema: *"Studii privind dezvoltarea extragerii energiei valurilor, prezent și perspective pentru viitor"(Studies concerning the development of wave energy extraction, present and perspectives)* , supervisor Prof. Dr. Ing. Eugen Rusu (2017);

c. Pintilie Viorel (Master: Modelare şi Simulare în Inginerie Mecanică), tema: *"Instalație de extragere a energiei nepoluante din curenții fluviilor și ai râurilor în vederea folosirii în zonele neracordate la sistemul energetic național"(Instalation of extraction renewable energy from river currents)*, supervisor Prof. Dr. Ing. Eugen RUSU, (2018);

d. Migireanu Bogdan (Master: Arhitectura Navala - limba engleza), tema: *"Studies on the main economic indicators (LCOE, CAPEX, OPEX) in extracting renewable energy from the marine environment"*, supervisor Conf. Dr. Habil. Ing. Carmen GASPAROTTI, (2018);

e. Niță Lucian (Master: Arhitectura Navala - limba engleza), tema: *"Floating devices for wave energy extraction"*, supervisor Conf. Dr. Habil. Ing. Carmen GASPAROTTI, (2018);

f. Florea Viorica (Master: Ingineria Materialelor Avansate), tema: *"Analiza comportării la oboseală a unei turbine de val"*, supervisor Conf. Dr. Ing. Sorin CIORTAN , (2018);

g. Stăvarache Gheorghe (Master: Ingineria Materialelor Avansate), tema: *"Analiza potentialului energetic marin cu ajutorul retelelor neurale"*, supervisor Conf. Dr. Ing. Sorin CIORTAN, (2018);

h. Păun George Robert (Master Arhitectură Navală în limba Engleză) *"Joint evaluation of the wind energy resources in the Black Sea nearshore and comparison with other European coastal environments",* supervisor Conf. Dr. Habil. Ing. Carmen GASPAROTTI, (2018);

i. ZABUNOV (MIHAI) Cristina, ANALIZA VARIAȚIEI VITEZEI VÎNTULUI CU SCOPUL OPTIMIZĂRII SISTEMELOR EOLIENE, (Analysis of wind speed variation for optimizing of the eolian systems), Coordinator Assoc Prof. Sorin Ciortan, Iulie 2019, Universitatea Dunărea de Jos din Galaţi, FACULTATEA TRANSFRONTALIERĂ , SPECIALIZAREA INGINERIA MATERIALELOR AVANSATE (2019)

j. Usturoi Vera, Analiza FMEA pentru o instalatie de energie solara, (FMEA analysis for a PV instalation), Coordinator Assoc Prof. Sorin Ciortan, Iulie 2019, Universitatea Dunărea de Jos din Galaţi, FACULTATEA TRANSFRONTALIERĂ , SPECIALIZAREA INGINERIA MATERIALELOR AVANSATE (2019)

3.2.3 Bachelor degree thesis

k. Codreanu Andrei Gabriel (Licență IM), tema: *"Studiu privind potențialul energetic eolian in zonele costiere și marine"*, (Study of the wind energy potential in the marine and coastal zones), supervisor Prof. Dr. Ing. Eugen Rusu (2017)

3.3 Dissemination through participation in scientific boards

The international recognition and the dissimination of the results of the REMARC project are also reflected by the following participations:

Prof Eugen RUSU Program chair – 3rd International Conference on Advances on Clean Energy Research – ICACER2018 – Barcelona Spain, and 4th International Conference on Advances on Clean Energy Research – ICACER2019 – Coimbra, Portugal, http://icacer.com/com.html

Prof Eugen RUSU: Program chair – 2nd International Conference on Energy Economics and Energy Policy , ICEEEP2018, 3rd International Conference on Energy Economics and Energy Policy , ICEEEP2019, http://www.iceeep.com/com.html

Prof Eugen RUSU: organizing committee member, 2018 International Conference on Clean Energy and Smart Grid (also CCESG2019 and CCESG2020), http://www.ccesg.org/

Prof Eugen RUSU: 1st and 2nd International Conference on Power and Energy Technology 2018, 2019.http://www.icpet.org/

Prof Eugen RUSU: Member in the international evaluation panel for MAREI (Center for Marine and Renewable Energy http://www.marei.ie/), Ireland (2017), appointed by the Science Foundation Ireland, http://www.sfi.ie/

Prof Eugen RUSU: technical committee member, International Maritime Association of the Mediterranean, IMAM2017 http://www.imamhomepage.org/imam2017/structure.aspx

Prof Eugen RUSU: scientific committee member - 2nd International Symposium on Natural Hazards and Disaster Management (ISHAD2018), http://ishad.info/Content/Pages/Committees.aspx

Prof Liliana RUSU: organizing committee member, 2018 International Conference on Clean Energy and Smart Grid (also CCESG2019 and CCESG2020), http://www.ccesg.org/**,**

Prof Liliana RUSU, scientific advisory board member, 1st Latin American Conference on Sustainable Development of Energy Water and Environment Systems, SDEWES2018, http://www.rio2018.sdewes.org/sab.php

Prof Liliana RUSU, scientific advisory board member, 13th SDEWES Palermo, Italy http://www.palermo2018.sdewes.org/sab.php

The international recognition of the project director in the area targeted by the REMARC project is reflected by the fact that he had five collaborations as an expert with the European Commission in the field of Marine Energy (CT-EX2006C098949-108-112). Also he was Editor in Chief for two Special Issues both in Marine Energy "Offshore Renewable Energy: Ocean Waves, Tides and Offshore Wind" www.mdpi.com/journal/energies/special_issues/offshore and "Renewable Energy in Marine Environment", https://www.mdpi.com/journal/energies/special_issues/marine. He has also revised in the period of the project unfolding more than 100 revisions in journal with high impact factors, as resulting from his PUBLONS profile https://publons.com/researcher/1170248/eugen-rusu/. The project director was appointed also Editor in Chief, for Journal of Marine Science, http://ojs.bilpublishing.com/index.php/jms.

An important aspect related to the high international recognition in the field targeted by the project that has to be mentioned is that the project director was appointed by UN as reviewer for a chapter (Chapter 22) related to the ocean energy for the “Second World Ocean Assessment”. The letter of appointment is given bellow:

United Nations Nations Unies

HEADQUARTERS • SIEGE NEW YORK, NY 10017

TEL.: 1 (212) 963.1234 • FAX: 1 (212) 963.4879

REFERENCE: LOS/RP/2019

23 September 2019

Dear Mr. Eugen Rusu,

By this letter, I would like to thank you for agreeing to serve as a peer-reviewer for the second world ocean assessment, the major outcome of the second cycle of the Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socioeconomic Aspects (Regular Process).

You have already received from a member of the Group of Experts a communication describing your role as a peer-reviewer and the expectations for peer-reviewers with regards to the peer-review process.

Once you receive a chapter, you will have four weeks to review it and send it back to the secretariat. The secretariat will then share your comments with the writing team for its consideration.

My sincere appreciation once again for the important work that you have agreed to undertake.

Yours sincerely,

Gabriele Goettsche-Wanli

Gabriele Goettsche-Wanli
Director
Division for Ocean Affairs and the
Law of the Sea
Office of Legal Affairs

Mr. Eugen Rusu
Peer-reviewer
Second world ocean assessment

Also in relationship with the international recognition of the project director there can be mentioned participations in PhD boards abroad for theses with topics directly related to the targets of the REMARC project, as follows:

- Control of the generated power in OWC-based wave energy generation systems – Implementation to the Mutriku Wave Power Plant, Jon Lekube Garagarza, **Bilbao UNIVERSITY OF THE BASQUE COUNTRY, Spain;**
- Numerical Study of the Far Field Effects of Wave Energy Converters in Short and Long-Crested Waves Utilizing a Coupled Model Suite*,* Gael VERAO FERNANDEZ, Department of Civil Engineering, University of Ghent;

Furthermore, he has been included in top 1% world reviewer in the field of Engineering https://publons.com/awards/2018/esi/?name=Eugen%20Rusu&esi=3.

Finally, it is also relevant to mention that the national and international recognition of the project director is reflected also by the fact that he was elected in 2018 **corresponding member of the Romanian Academy** http://www.acad.ro/sectii/sectia08_tehnica/teh_membri.htm This is the highest scientific and culture forum in Romania.

The team members of the REMARC project organised also a workshop with the topic *„Marine Renewable Energy in the European Coastal Environment, Present & Perspectives".* The flyer is presented below.

The above mentioned workshop was held in 13 June 2019, it had 24 participants and it was associated with a major scientific event in Galati University, which was the 7th Scientific Conference of the Doctoral Schools, http://www.cssd-udjg.ugal.ro/index.php/news having more than 300 participants.

4. Conclusions

At the end of the project, it can be appreciated that all the parameters which were initially targeted in the project have been accomplished. Furthermore, some related research directions have been also explored, as for example the use of artificial neural networks in assessing the wave energy resources or studies concerning the vibrations impact on the ships crews. With more than 70 papers published and with collaborations with the European Commission and the United Nations the project outcomes and visibility can be considered as being outstanding.

Total project buget: 787 500 Lei (aprox 170.000 Euro)

December 2019

Director proiect

Prof. dr. ing. Eugen Rusu