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Investigation and Analysis on The Relationship between Marine Sport Ability Classifications and Marine Environmental Conditions

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ABSTRACT

In recent years, water recreation activities have flourished, and the government has promoted the policy of paying tribute to the sea, expecting to increase services in the field of water recreation activities, especially in the construction of safety information systems. The safety of water recreation activities is related to many factors, one of the most important being the marine environment. The suitable marine environmental conditions that can endure various kinds of water recreation activities and various levels of water recreation activity participants are different. The aim of this project is to establish the relation between water recreation activities of various levels and factors of the marine environment.

The project is carried out through questionnaires and analysis by experts. The questionnaires are used to obtain extensive information feedback, and the Delphi method is used to analyze the extensive information feedback obtained. Through six consultation meetings, water recreation activities participants and marine dynamics experts and scholars were arranged to meet for cross-domain discussions. It translates the ocean state that the general public actively perceives and non-academic descriptions into theoretical ocean dynamic parameters, and provides a reference for future monitoring and prediction systems for serving water recreation activities. The project selects five water recreation activities for the above study, and provides safety information by establishing the corresponding marine environmental conditions for all levels of participants in the five water recreation activities.

According to the results of the project and after collecting and analyzing relevant domestic and foreign literature, the first-stage three expert consultation meetings, expert questionnaire survey, large sample size questionnaire survey, and the second-stage three expert consultation meetings were conducted to compile two conclusions, among which the important marine environmental parameters of various sports can provide a reference for the marine environmental information that the future information platform should provide, and the results of the relationship between marine ability classifications and marine environmental conditions can provide a reference for the information platform for setting up each graded light signal, enabling a more concise and intuitive user interface for the platform.

Keywords: marine sports ability, marine environment, marine sports safety, marine recreation risk.

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1 INTRODUCTION

Among natural factors, wind, waves, tides, currents, water temperature and the rapidly changing marine meteorology belong to the category of physical factors. Taiwan is located in the contact zone between the continental air mass and oceanic airflow; during the monsoon reversal period, the cyclone is active, the wind direction is changeable, and there are many typhoons in summer. In addition, sudden gusts of wind will have a large impact force in a short period of time, which will easily cause loss of life and property. Therefore, the potential danger caused by the wind is not considered low. Waves are the fluctuations caused by the energy transfer between the atmosphere and the ocean that is caused by the wind blowing on the sea surface. Its characteristics are affected by the wind and water conditions; the higher the wind speed, the wider the water area and the longer the wind blows, the higher the wave, and vice versa. Among all physical factors, waves have the greatest energy. Huge waves can easily overturn ships, and as the size and timing of occurrence cannot be predicted, it can cause people to fall into the sea. The potential danger caused by waves cannot be ignored. Tides are the fluctuations caused by the gravitational force (tidal force) between planets such as the sun and the moon, and the influence of weather (wind and air pressure) on the surface of the oceans on Earth. The change of tide level is a slow process and should not affect the safety of water recreation activities. However, the change of tide level is not easy to detect on coasts with a gentle slopes, and tourists often get caught in the high tide, such as the central area of the west coast of Taiwan. Therefore, the change of tidal range is a more important factor that causes potential danger; when the sea water is subjected to external forces, ocean currents will be triggered. Commonly there are tidal currents caused by celestial gravity, wind-driven currents formed by monsoons or typhoons, and regional circulations and offshore rip currents caused by topographic lifting, temperature, rivers, and structures, etc. As the ocean currents have the characteristics of transferring substances, when the flow direction is the same as that of the recreation activities, it will be a good assistance. But on the contrary, it will cause resistance to the recreation activities if the flow direction is reversed. Over time, reversed flow direction will exhaust the human body and cause accidents. The water temperature has less impact on the safety of water recreation activities than on the comfort of activities, but it is not completely unaffected. If the human body is exposed to low temperature seawater for a long time, it will experience hypothermia. In milder cases, the person's body temperature may drop below 35°C and experience a hypothermic coma, and in more serious cases, the person's body temperature may drop below 26°C, which may cause death. In addition, the sudden drop in water temperature will also cause rapid consumption of body's physical strength, thereby causing harm.

Marine environmental conditions may cause harm, but among which some may also be elements contributing to recreational fun. For example, surfing requires wave height. Entry-level surfers may be afraid of large waves or even encounter danger, but professional-level surfers are eager for huge waves, which will bring them greater enjoyment. There are many such contradictions, and the factors include: the types of water recreation activities, the ability level of recreation activities participants (players), and marine environmental elements. In recent years, foreign countries have conducted studies on suitable marine environmental conditions for different player levels, such as Scarfe et al. (2003), who recommended wave conditions for different levels of surfers, including junior, intermediate, and professional. Doing so allows players to have a reference in understanding the possible hazards of the predicted ocean state, as well as more fun. Of course, the safety of marine recreation activities is not only related to marine environmental elements, as there are many other elements, but this work can also contribute to the safety of marine recreation activities. In order to make it easier for the public to understand the relationship between marine observation information and planned activities when engaging in marine sports, to understand its safety risks, and to improve the marine recreation experience, this project intends to combine marine recreation activities with near-shore hydrodynamics and other experts to carry out cross-disciplinary cooperation to classify the abilities of marine sports players (such as beginner,

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intermediate, and expert levels), and to further analyze the range of marine environment and climatic conditions suitable for users at all levels, and to provide the results to the "Dynamic Information System on Recreational Sea Area Risk" for use, thereby allowing the public to enjoy water recreation activities safely and with peace of mind.

2 MARINE ENVIRONMENTAL ELEMENTS

Marine environmental elements can be divided into physical elements, chemical elements, and biological elements. When discussing the relationship between marine sports and marine environmental elements, it usually refers to physical elements, including wind, waves, tides, currents, temperature, salt, terrain, water depth, etc. These factors may affect the levels of danger and fun of water recreation activities. Chemical factors and biological factors may also be influencing factors, but they are usually less important.

Physical elements can be further divided into highly variable elements (such as wind, waves, tides, currents, temperature, salt, etc.) and elements that are nearly constant throughout the year (such as terrain, water depth, reefs, etc.). Highly variable physical elements are the main objects of discussion in this project, especially the five items including wind, waves, tides, currents, and temperature.

The wind will have an impact on all kinds of water recreation activities, especially sudden gusts. The impact force of the physical force is the ratio of the action force to the time. The shorter the time, the more force acts on the object. The gust is an impact force that rapidly increases in a short period of time. Therefore, the impact of wind on potential hazards is mainly the sudden change of gust. In addition, wind shear is closely related to the safety of paragliding and parasailing. Wind shear refers to changes in buoyancy caused by changes in the headwind or tailwind that last for more than a few seconds. The reduction in buoyancy can cause flying objects to deviate downward, below intended flight paths. When significant wind shear occurs, immediate corrective action must be taken to ensure safety. The strength of the wind is usually expressed by the wind scale, and the wind scale can be estimated by the situation of the ground or sea surface objects being blown by the wind. British Admiral Sir Francis Beaufort (1774-1857) proposed a simple classification method for wind speed, which is mainly based on the speed of the ship at sea and how many sails can be pulled to distinguish the size of the wind. He pioneered wind classification. According to the standard, the wind scale is divided into thirteen grades. Each grade of wind has its own term to describe the wind power. No wind is included in the zero grade. The greater the wind, the higher the grade.

The energy possessed by waves is the largest among all marine meteorological factors, and huge waves can easily throw up several tons of wave-absorbing blocks. The greatest potential danger caused by waves is the size of the wave height, and almost every item of water activities is related to the size of the waves. Waves can be divided into two types: wind waves and swells. Swells, commonly known as long waves, have the characteristics of long period, large wavelength, and small wave sharpness. Since the wave propagation speed is related to the period, a swell with a longer period has a faster propagation speed, and as the sharpness of a swell is small, it is not easy to break, so it dissipates slowly, and travels long distances. The definition of swells in general textbooks only refers to "waves with a relatively long period," they are not clearly defined as waves with a period of more than a few seconds. Marine scientists generally believe that a swell period should be more than 10 seconds. The Central Weather Bureau of Taiwan defines a wave height of more than 1.5 meters, with mean wave period exceeding 8 seconds as a swell, and issues an instant message. After a swell spreads to the nearshore waters, it is affected by the shallower water depth, the wave is deformed, the wavelength decreases, and the wave height increases rapidly. It is often the favorite of professional surfers, but for beginners, it may still be too large. The size and even the distribution of wave components, the distribution of directions, the concentration of energy, etc., may have different interpretations in various water recreation activities.

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Tides are the fluctuations caused by the gravitational force (tidal force) between planets such as the sun and the moon on the surface of the oceans on Earth. Changes in tides are related to the relative positions of planets such as the Earth, the sun, and the moon, and are coupled with the effects of Earth's rotation. As the tide ebbs and flows, the tide water changes direction. The flow of water caused by the different heights of tides in different parts of the earth is called a tidal current. Tides may be semi-diurnal (two high tides and two low tides a day), or diurnal (only one cycle per day), the tides are semidiurnal on most of the coast of Taiwan. The difference between the daily high and low tide is called the tidal range. Tide level changes are a slow process and should not affect the safety of water recreation activities. However, on the coasts with gentle slopes, such as the central part of the west coast of Taiwan, due to the flat slopes, the slowly changing tide levels are not easy to detect, and tourists often get caught in the rising tide. Changes in tide level are not only affected by astronomical tidal forces, but also by the weather (wind and air pressure), such as the suction caused by the pressure gradient during a typhoon, which causes the water level to rise, resulting in a storm surge. But when a storm surge occurs during the typhoon period, according to the Disaster Prevention and Protection Act, people are prohibited from playing in the water at the beach. Therefore, the impact of storm surges on water recreation activities should be small, but the change in tidal range is a more important factor.

Tidal currents are caused in seawater by celestial gravitational, and ocean currents are also generated by wind, waves, seawater density, and other marine meteorological factors. Currents near the coast vary greatly due to the influence of topography and coastal structures. Generally, ocean currents in coastal waters mainly include tidal currents, mean currents, regional wind-driven currents formed by monsoons or typhoons, nearshore currents caused by waves, and regional circulations formed by terrain, structures, or rivers. There are spatial and temporal variations with tides and seasons. The nearshore current is bounded by the surf zone, and the inner and the outer sides of surf zone vary greatly. Generally speaking, the flow field outside the surf zone is mainly dominated by mean current, tidal current, and wind-driven current, and the mass transfer caused by waves is secondary. Whereas in the surf zone, in addition to the tidal current, the flow field is mainly dominated by the flow field caused by the breaking waves. At this time, the flow field contains the obvious three-dimensional eddy currents; the wave after the breaking wave and the newly formed transmission wave cause the movement of the water spot and the backflow brushed off the beach surface. This part of the flow field has the greatest impact on the safety of coastal water play, swimming, and snorkeling.

All marine sports have their own suitable marine environmental conditions in terms of safety, entertainment, competition. The Ocean Affairs Council (2019) has commissioned experts and scholars to discuss the main and secondary factors impacting various types of water recreation activities while conducting study on dangerous sea areas. The Ocean Affairs Council (2019) also formulated suitable marine environmental conditions for various water recreation activities based on theoretical analysis, expert opinions and foreign standards. In fact, the above-mentioned study has already achieved preliminary results similar to the research objectives of this project. On the above-mentioned basis, this project attempts to conduct a more extensive and detailed discussion.

3 RESULTS AND DISCUSSION

Figure 1 shows the project's discussion on the relationship between marine sports capacity and marine environmental conditions. In order to grasp the important environmental parameters corresponding to marine sports, three expert consultation meetings were held at the first stage. Through cross-disciplinary discussions, the five marine sports and the marine environment parameters corresponding to each level were preliminarily established, and the first-stage expert questionnaire was further conducted to initially understand the importance and quantitative data of each marine environment parameter, and to establish the prototype of "the relationship

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between marine sports ability and marine environmental conditions". The second-stage large sample size questionnaires were carried out to verify the above results through a wider questionnaire survey. The results of the questionnaires were compiled, and the second-stage of the expert consultation meetings were held to review and revise "the relationship between marine sports ability and marine environmental conditions."

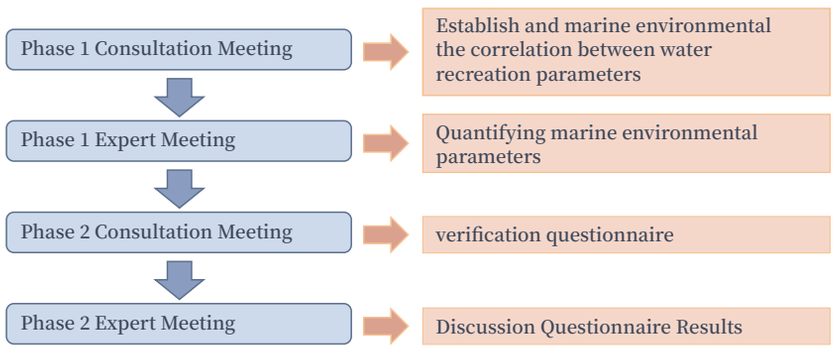

Figure 1. The main research work and aim of this project.

3.1 Defining various marine sports environmental parameters

In order to explore the relationship between marine sports ability classification and marine environmental conditions, it is necessary to define the relevant marine environmental parameters for various marine sports. Through the expert meeting method, this project invited relevant associations, organizations, players and practitioners of surfing, diving, swimming, canoeing, windsurfing, and other activities, to hold first-stage 3 consultation meetings with experts and scholars of nearshore hydrodynamics. Each meeting invited at least 10 experts and scholars to participate. Attendees of the marine sports put forward the needs of marine sports players for marine environmental conditions, the analysis methods and terminology of various parameters were explained by marine dynamic experts and scholars, the non-academic descriptive marine conditions raised by marine sports attendees were translated into physical parameters or indicators used in ocean dynamics, and then master the important marine environmental impact parameters corresponding to the five marine sports in this project. This project summarizes the discussion results of the three consultation meetings in Table 1, which is used as a reference for the subsequent questionnaire design structure.

Table 1. Summary of important marine environmental parameters for various sports.

Sport type	Important marine environmental condition parameters
Surfing	Offshore wave height, nearshore wave height, breaking wave height, wave period, sea direction, wind speed, wind direction, gust, tide, sea temperature, air temperature, surf zone location, breaking wave angle, breaker type, ocean floor type
Diving	Wave height, water velocity, flow direction, tide, sea temperature, air temperature, surf zone location, organisms, water visibility
Windsurfing	Wave height, wave period, wind speed, wind direction, gust, water velocity, tide, surf zone location, wave steepness
Swimming	Wave height, water velocity, flow direction, tide, sea temperature, air temperature, surf zone location, organisms
Canoeing	Wave height, wave period, wind speed, water velocity, sea temperature, daylight, ocean floor type

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3.2 Design and analysis of the questionnaire on the relevance between sports ability classification and marine environment

After obtaining the marine environmental parameters corresponding to the five water recreation activities through the expert consultation meetings, the project further determined the main and secondary factors affecting the player's experience and safety in water recreation activities through expert questionnaires, and further quantified them, to set out the marine environmental conditions corresponding to all levels (primary, intermediate, and expert) of sports ability, and establish a prototype of "the relationship between marine sports ability classification and marine environmental conditions". Regarding the classification of sports ability, the primary level is athletes who are new to marine sports, the intermediate level is for athletes who can participate in marine sports alone, and the expert level is for athletes with coaching ability.

The questionnaire is divided into two stages. The first stage is an expert questionnaire, which invited mainly experts and scholars with professional experience in marine sports, marine education, and water recreation activities to complete the questionnaire. More than a dozen experts in five fields including surfing, swimming, diving, windsurfing, and canoeing participated in the questionnaire. The second stage was a large sample questionnaire. Based on the survey results of the first stage, the marine sports ability at all levels were classified and suitable parameters of marine environmental conditions were formulated, and their applicability was confirmed.

Based on the results of the questionnaire survey, parameters such as the mean, standard deviation, and quartile deviation were analyzed to present the statistical dispersion that respondents agreed with each indicator. Among them, the mean represents the measure of central tendency, and the larger the score, the higher the degree of importance; the standard deviation (SD) is the statistical dispersion from the mean, and the larger the value, the greater the statistical dispersion ($SD \geqq 1$), the lower the degree of consensus on the representative opinion; the smaller the value, the smaller the statistical dispersion ($SD \leqq 1$), the higher the degree of consensus on the representative opinion.

The results of the questionnaire analysis of this research show that in the survey of the influence degree of marine environmental conditions parameters, the average of the 12 items in surfing is between 4.15 and 4.59, and the quartile deviation shows that the overall scores are highly consistent; the mean is between 4.18 and 4.57, and the quartile deviation shows that the overall scores are highly consistent; the mean of the 10 items in diving is between 3.97 and 4.56, and the quartile deviation shows that the overall scores are generally highly consistent, except for temperature, which is moderately consistent, and the initial judgment is the temperature items can reduce their impact on sports through the athlete's equipment; the mean of the 10 items in windsurfing is between 4.38 and 4.80, and the quartile deviation shows that the overall scores are highly consistent; the mean of the 7 items of canoeing is between 3.98 and 4.63, and the quartile deviation shows that the overall scores are generally highly consistent, but the temperature and seabed type items are moderately consistent. The initial judgment is the temperature items can reduce impact on sports through the athlete's equipment; the seabed type is less likely to directly contact the seabed in canoeing, so the degree of impact is lower than other sports.

Each sport ability classification is suitable for the analysis of marine environmental conditions. Among the 4 items classified by different abilities in surfing, the turnover rate of the opinion in the professional level wave height 16.67% is the highest; among the 4 items classified by different abilities in swimming, the turnover rate of the opinion in the professional level wave height 14.84% is the highest; among the 4 items classified by different abilities in diving, the turnover rate of the opinion in professional level water visibility 13.48% is the highest; among the 4 items classified by different abilities in windsurfing, the turnover rate of the opinion in intermediate level water velocity 10% is the highest; among the 4 items classified by different abilities in

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canoeing, the turnover rate of the opinion in professional level wave height 12.31% is the highest. The overall turnover rate is less than 15%, the evaluation results of each project are stable.

In summary, the questionnaire survey results of the second stage in this research show that the importance of various marine environmental parameters is generally highly consistent. Each sports ability classification is suitable for the marine environmental conditions, the overall turnover rate of which is lower than the modification standard 25%, with no correction required. It shows that the results of the large-scale questionnaire survey of this project are representative. The surfing score table is extracted from Table 2 and Table 3.

Figure 2. Photos of the large-scale questionnaire survey in recreational areas.

Table 2. The score table of the importance of the influence of marine environmental parameters - surfing (example).

Marine sports	The importance of the influence of the parameters of marine environmental conditions		Questionnaire statistical analysis results			
	Structure	Item	Mean	Standard deviation	Quartile deviation	Consistency level
Surfing	1. Waves	1-1 Wave height	4.59	0.54	0.5	High
		1-2 Wave period	4.43	0.65	0.5	High
		1-3 Sea direction	4.37	0.80	0.5	High
	2. Wind	2-1 Wind speed	4.29	0.86	0.5	High
		2-2 Wind direction	4.33	0.86	0.5	High
		2-3 Gust	4.15	0.90	0.5	High
	3. Tide	3-1 Tide	4.33	0.82	0.5	High
	4. Water flow	4-1 Water velocity	4.25	0.85	0.5	High
	5. Breaking wave	5-1 Surf zone location	4.21	0.87	0.5	High
		5-2 Breaking wave angle	4.18	0.82	0.5	High
		5-3 Breaker type	4.37	0.71	0.5	High
	6. Other	6-1 Ocean floor type	4.44	0.74	0.5	High

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Table 3. Summary table of quantization parameters corresponding to marine sports ability classification - surfing (example).

Ability level	Large sample size questionnaire items	Number of comments (126)			Correction suggestion	Turnover rate	Correction results
		Agree	Suggested corrections	Disagree			
Primary level	**Wave height**/< 1.2 m	108	10	8	(1) < 0.3 m (2) < 0.7 m (3) < 0.8 m (4) < 1.0 m (5) < 1.5 m (6) < 0.6 ft	16.67%	Not up to the correction standard
	Breaker type/Spilling breakers	125	0	1		0.8%	Not up to the correction standard
	Wave period/<7 seconds	114	7	5	(1) <8 seconds (2) 8–10 seconds (3) > 9 seconds (4) < 10 seconds (5) >10 seconds	9.52%	Not up to the correction standard
	Breaking wave angle/90 degrees	115	2	9	(1) 45–90 degrees (2) 80 degrees	8.73%	Not up to the correction standard
	Water velocity/< 0.5 m/s	121	2	3	(1) Close to no flow	3.97%	Not up to the correction standard
Intermediate level	**Wave height**/< 2.5 m	108	9	9	(1) < 1.0 m (2) < 1.5 m (3) < 1.8 m (4) < 2 m (5) < 4 m (6) < 0.6–2.0 m (7) < 1.2–2.5 m	14.28%	Not up to the correction standard

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Ability level	Large sample size questionnaire items	Number of comments (126)			Correction suggestion	Turnover rate	Correction results
		Agree	Suggested corrections	Disagree			
	Breaker type/Spilling breakers Plunging breakers	122	1	3	(1) Depends on the board	3.17%	Not up to the correction standard
	Wave period/<7 seconds	115	8	3	(1) 8–10 seconds (2) > 9 seconds (3) < 10 seconds (1) 10–15 seconds	8.73%	Not up to the correction standard
	Breaking wave angle/45–90 degrees	120	1	5	(1) 45–80 degrees	4.76%	Not up to the correction standard
	Water velocity/< 0.5 m/s	122	1	3	(1) < 0.7 m/s	3.17%	Not up to the correction standard
Professional level	**Wave height**/< 8.0 m	105	13	8	(1) < 1.5–3.5 m (2) < 1.8–5.4 m (3) < 2.0 m (4) < 2.5 m (5) < 3.0 m (6) < 4–5 m (7) < 5.0 m (8) < 10.0 m (9) Unrestricted	16.67%	Not up to the correction standard
	Breaker type/ Spilling breakers Plunging breakers	123	2	1	(1) Depends on the board (2) All kinds of breaker types	2.34%	Not up to the correction standard

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Ability level	Large sample size questionnaire items	Number of comments (126)			Correction suggestion	Turnover rate	Correction results
		Agree	Suggested corrections	Disagree			
	Wave period/<12 seconds	120	3	3	(1) <5 seconds (2) >10 seconds	4.76%	Not up to the correction standard
	Breaking wave angle/<45 degrees	116	2	8	(1) Long and short boards should be separated (1) Full angle	7.94%	Not up to the correction standard
	Water velocity/< 1.0m/s	121	0	5	(1) Sometimes the water velocity is greater than 1.0m/s. It may also be suitable for advanced level. It is recommended to correct it to an interval such as "__m/s–__m/s"	3.97%	Not up to the correction standard

3.3 Correction of the relationship between marine sports ability classification and marine environmental conditions

In order to make the results of the project more representative and provide subsequent application to related platforms in the future, the project held three expert consultation meetings, including two physical meetings and one online meeting, and invited more than 30 experts to discuss this project. It was planned to discuss in detail the results of the questionnaire with a large sample size and to compile and correct the relationship between the classification of marine sports ability and marine environmental conditions.

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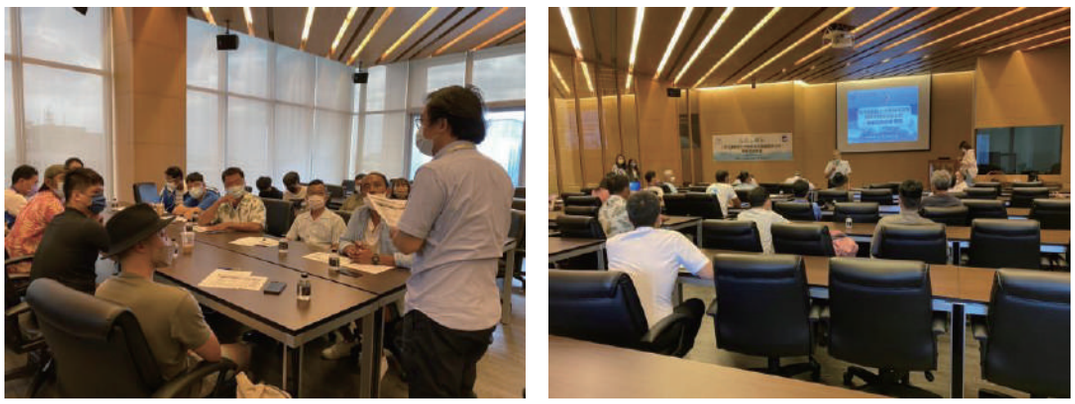

Figure 3. Photos of the expert consultation meeting.

Based on the results of 3.2 of this study, the expert consultation meeting was guided by the moderators of each group, and the participating experts spoke freely. The conclusions of the meeting are as follows:

1. Conclusions of the first consultation session

In the part of influence in marine environmental conditions, it is recommended to add nearshore current information for surfing, and provide sea state images of surfing spots, so that surfers can fully understand the marine environmental information; for windsurfing, in addition to the original influencing factors, information such as water temperature, air temperature and location of wave-absorbing structures, as well as environmental conditions which are followed by windsurfing athletes. On the issues related to sports ability classification and marine environmental parameters, there should be a clearer system for surfer ability classification, including government training, graded education (license), or a list of excellent stores and coaches listed by the government, which will be presented on the future information platform and simplify the difference between different levels with light signals. For windsurfing, the wind speed unit should be changed from series to knots, which can reflect the on-site environmental conditions more clearly. The wind speed of the primary level ability in windsurfing should be revised to 2–6 knots, the intermediate level ability should be revised to 6–16 knots, and the professional level ability should be revised to 16–27 knots.

The gust of the primary level ability should be revised to less than 8 knots; the intermediate level ability should be revised to less than 20 knots, and the professional level ability should be revised to less than 28 knots. The wave height of the primary level ability was suggested to be revised to less than 0.2 meters; the intermediate level ability should be revised to less than 1 meter, and the professional level ability should be revised to less than 2 meters. The flow velocity of the primary level ability should be revised to be less than 0.5 m/s; the intermediate level ability should be revised to be less than 1 m/s, and the professional level ability should be revised to be less than 2 m/s.

2. Conclusions of the second consultation session

The degree of influence in marine environmental conditions and the environmental safety conditions of diving sports are mainly determined by the flow rate and wave height; visibility in water can be listed as the second important parameter. The data such as water velocity and flow direction can be collected by radar and patrol boats of the Coast Guard; water visibility can be real-time monitored by buoys set for turbidity; and it is recommended to provide additional surface and underwater image information.

The sports ability classification is related to the marine environment parameters. For the diving ability classification, it is recommended that the water velocity of primary level should be revised to 0.25 knots, and

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the intermediate level should be revised to 0.7 knots; The water visibility of professional level does not have to be limited, because expert athletes who have a current diving license should have the ability to dive at night. Experts from the swimming sports team suggest that considering recreational experience, the marine conditions above the intermediate level specified in this plan are not comfortable environmental conditions, and it should not be relaxed in the future. In addition, at this stage, there is no perfect system for swimming ability classification and sports risk management in the country. It is mainly to determine the suitable swimming range and set up lifeguards for the venue. Therefore, the planning and arrangement of the lifeguard system and lifesaving measures should be considered. In the section of the canoe sports group, the participating members said that due to the variety of canoes, the ability classification and environmental parameters set at this stage are reasonable. It is suggested that the reference boat type should be indicated on the display platform in the future, and various data should be adjusted according to the situation. For example, in the wind speed part, if a platform boat is used for the primary level and professional level, it will be high. In the future, the information platform should be able to include real-time images, including the Central Meteorological Administration and real-time information provided by other non-governmental organization to simplify the presentation of data, so that the public can access relevant information more easily.

3. Conclusions of the third consultation session

In the section on the degree of influence of marine environmental conditions, experts in the surfing conference suggested that the interaction between terrain type and marine environment should be emphasized, and the marine environmental data can be included in the information of offshore weather towers off the coast of Zhunan, Miaoli, to complement the sea condition information in the western seas. In addition, on-site players or operators can also provide real-time information feedback on the platform in the future, so that the actual sea conditions can be understood more intuitively. For canoeing, it is recommended to add wind direction information, and sunshine can be presented by the UV index level, and the remaining environmental conditions parameters are agreed by the participating experts in principle. For windsurfing, swimming, and diving, the participating experts agreed and representative of the results mentioned in this project.

On the issue of the relationship between sports ability classification and marine environmental parameters, the participating experts generally agreed with the environmental parameters corresponding to each sports ability classification proposed in this project. Among them, some experts in surfing believed that the condition data for the speed improvement item was low, it was mainly due to the discrepancy between offshore data and inshore data, it was recommended to consider the reliable range of the provided data on the platform in the future. Some windsurfing experts suggest that the sports ability classification system should be improved in the future, education and training can be carried out through local associations, sports organizations, government agencies; and professional sports coaches, industry or clubs can jointly control and bear sports risks. For canoeing sports, it was recommended to indicate the boat type (ocean boat) referenced in the classification of the data lights, and other boat types such as platform boats can be included in the evaluation in the future.

The above results are summarized in Tables 4 and 5.

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Table 4. Ranking list of important marine parameters for various sports.

Order of importance	Surfing	Diving	Windsurfing	Swimming	Canoeing
1	Wave height	Water velocity	Wind speed	Flow direction	Wave height
2	Ocean floor type	Water visibility	Wind direction	Wave height	Wind speed
3	Wave period	Wave height	Wave height	Water velocity	Water velocity
4	Breaker type	Flow direction	Water velocity	Tide	Wave period
5	Sea direction	Tide	Gust	Organisms	Daylight
6	Wind direction	Organisms	Wave period	Sea temperature	Ocean floor type
7	Tide	Surf zone location	Surf zone location	Ocean floor type	Sea temperature
8	Wind speed	Sea temperature	Tide	Surf zone location	/
9	Water velocity	topographic form	Ocean floor type	Air temperature	/
10	Surf zone location	Air temperature	Wave steepness	/	/
11	Breaking wave angle	/	/	/	/
12	Gust	/	/	/	/

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Table 5. Summary table of the relationship between sports ability classification and marine environmental parameters.

Sport type	Environmental parameters/ability level	Primary level	Intermediate level	Professional level
Surfing	Wave height	< 1.2 meters	< 2.5 meters	< 8.0 meters
	Wave period	< 7 seconds	< 7 seconds	< 12 seconds
	Breaking wave angle	90 degrees	45–90 degrees	< 45 degrees
	Water velocity	< 1 knot	< 1 knot	< 2 knots
Windsurfing	Wind speed	2–6 knots	6–16 knots	16–27 knots
	Wave height	< 0.2 meter	< 1.0 meter	< 2.0 meters
	Gust	Can withstand ≤ 8 knots	Can withstand ≤ 20 knots	Can withstand ≤ 28 knots
	Water velocity	< 1 knot	< 2 knots	< 4 knots
Swimming	Wave height	< 0.4 meter	< 0.8 meter	< 1.2 meters
	Water velocity	< 0.5 knot	< 1.0 knot	< 2.0 knots
	Sea temperature	25°C–30°C	22°C–30°C	17°C–30°C
	Air temperature	25°C–33°C	18°C–36°C	18°C–36°C
Diving	Wave height	< 0.5 meter	< 1.0 meter	< 1.2 meters
	Water velocity	< 0.2 knot	< 0.7 knot	< 1.0 knot
	Sea temperature	25°C–30°C	25°C–30°C	17°C–30°C
	Air temperature	25°C–33°C	25°C–33°C	25°C–33°C
	Water visibility	Minimum visibility > 5.0 meters	Minimum visibility > 3.0 meters	Minimum visibility > 3.0 meters
Canoeing	Wind speed	< 10 knots	< 16 knots	< 21 knots
	Wave height	< 0.4 meter	< 1.0 meter	< 1.8 meters
	Water velocity	< 1.0 knot	< 3.0 knots	< 4.0 knots
	Wave period	< 8.0 seconds	< 10.0 seconds	< 12.0 seconds

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4 CONCLUSIONS

According to the results of this project, surfing, swimming, diving, windsurfing, and canoeing were selected as the non-powered marine sports ability research objects, and after collecting and analyzing relevant domestic and foreign literature, the first-stage three expert consultation meetings, expert questionnaire survey, large sample size questionnaire survey and the second-stage three expert consultation meetings were conducted and our conclusions were compiled, as follows. The important marine environmental parameters of various sports can provide a reference for marine environmental information that the future information platform should provide, and the results of the relationship between marine ability classification and marine environmental conditions can provide a reference for the information platform for setting up various graded lights, enabling a more concise and intuitive user interface for the platform.

Based on the results of the preliminary research work, this project initially formulated relevant marine parameters for the five marine sports, and conducted three expert consultation meetings at the first stage. Through discussions between hydrodynamic experts and experts in various fields, the marine environmental parameters for various marine sports were defined. The conclusions of the three consultation meetings were further consolidated, the structure of the expert questionnaire was drawn up, and two rounds of questionnaire surveys with more than 50 experts participating were conducted to draw up the prototype of the relationship between various marine sports ability and the marine environment. Continuing the above, the content of the questionnaire with a large sample size was further designed based on the relationship prototype and the conclusions of the mid-term review meeting, and extensive questionnaire surveys and opinion collection through on-site questionnaires (Fulong Beach, Waiao Beach). Online questionnaires were conducted to understand the comprehensibility and applicability of the relationship prototype. After 500 valid questionnaires were eventually selected for statistical analysis, this project held the second-stage three expert consultation meetings, including two physical meetings and one online meeting. More than 30 experts were invited to discuss in detail the results of the large sample questionnaire of this project, and to compile and revise the relationship between the classification of marine sports ability and marine environmental conditions. The above results are summarized in Tables 4 and 5 as follows.

(I) Degree of influence of important marine environmental parameters for each sport (conditional parameters under each sport are ranked according to the degree of influence)

1. Surfing: wave height, ocean floor type, wave period, breaker type, sea direction, wind direction, tide, wind speed, water velocity, surf zone location, breaking wave angle, gust
2. Swimming: flow direction, wave height, water velocity, tide, organisms, sea temperature, ocean floor type, surf zone location, air temperature
3. Diving: water velocity, water visibility, wave height, flow direction, tide, organisms, surf zone location, sea temperature, ocean floor type, air temperature
4. Windsurfing: wind speed, wind direction, wave height, water velocity, gust, wave period, surf zone location, tide, ocean floor type, wave steepness
5. Canoeing: wave height, wind speed, wind direction, water velocity, wave period, daylight, ocean floor type, sea temperature

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(II) The relationship between marine ability classification and marine environmental conditions (this project defines a list of quantitative parameters corresponding to the sports classification)

1. Surfing: wave height, wave period, water velocity, breaking wave angle
2. Swimming: wave height, water velocity, sea temperature, air temperature
3. Diving: water velocity, water visibility, wave height, sea temperature, air temperature
4. Windsurfing: wind speed, wave height, water velocity, gust
5. Canoeing: wave height, wind speed, water velocity, wave period

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