SAFE WAVE

STREAMLIING THE ASSESSMENT OF ENVIRONMENTAL EFFECTS OF WAVE ENERGY

DELIVERABLE 5.2
RISK-BASED APPROACHES AND ADAPTIVE MANAGEMENT

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1. SAFE WAVE project synopsis

The Atlantic seaboard offers a vast marine renewable energy (MRE) resource which is still far from being exploited. These resources include offshore wind, wave and tidal. This industrial activity holds considerable potential for enhancing the diversity of energy sources, reducing greenhouse gas emissions and stimulating and diversifying the economies of coastal communities. As stated by the European Commissioner for Energy, Kadri Simson, during the Energy Day in the framework of the climate conference (COP25) held in Madrid (2-13 December 2019), "the European experience shows that the benefits of clean energy go beyond reduced greenhouse gas emissions and a healthier environment. Clean energy transition boosts the economy and creates jobs. The European Green Deal is also a growth strategy". In the same framework of COP25 and during the Oceans Day, the European Commissioner for Environment, Oceans and Fisheries, Virginijus Sinkevičius explained that "fighting climate change and protecting marine life biodiversity is a centrepiece of the EU's Ocean policy. Due to climate change, our oceans are facing serious challenges, which require an urgent and comprehensive response. But oceans are also a part of the solution". Therefore, ocean energy is one of the pillars of the EU's Blue Growth strategy. Ocean energy could provide clean, predictable, indigenous and reliable energy and contribute to the EU's objective of reaching a share of renewables of at least 32% of the EU's gross final consumption by 2030. As underlined by Virginijus Sinkevičius, "Marine renewable energy has an incredible potential. The offshore wind sector is growing strongly enough to compete with traditional energy sources. The emerging technologies such as wave and tidal energy will take the same pathway".

The nascent status of the Marine Renewable Energy (MRE) sector and Wave Energy (WE) in particular, yields many unknowns about its potential environmental pressures and impacts, some of them still far from being completely understood. Wave Energy Converters' (WECs) operation in the marine environment is still perceived by regulators and stakeholders as a risky activity, particularly for some groups of species and habitats.

The complexity of MRE licensing processes is also indicated as one of the main barriers to the sector's development. The lack of clarity of procedures (arising from the lack of specific laws for this type of projects), the varied number of authorities to be consulted and the early stage of Maritime Spatial Planning (MSP) implementation are examples of the issues identified as resulting in a delay to the permitting of projects.

Finally, there is also a need to provide more information on the sector not only to regulators, developers and other stakeholders but also to the general public. Information should be provided focusing on the technical aspects of ocean energy, its effects on the marine environment, the role in local and regional socio-economics and effects on a global scale as a sector producing clean energy and thus having a role in contributing to decarbonise human activities. Only with an informed society will it be possible to carry out fruitful public debates on MRE implementation at the local level.

These non-technological barriers that could hinder the future development of wave energy (WE) in EU, are being addressed by the WESE project funded by EMFF in 2018. The present project builds on the results of the WESE project and aims to move forward through the following specific objectives:

1. Development of an **Environmental Research Demonstration Strategy** based on the collection, processing, modelling, analysis and sharing of environmental data collected in WE sites in different European countries where wave energy converters (WECs) are currently operating (Mutriku power plant and BIMEP in Spain, Aguçadoura in Portugal and SEMREV in France). The SafeWAVE project aims to enhance the understanding of the negative, positive and negligible environmental effects of WE projects. The SafeWAVE project will build on previous work, carried out under the WESE project, to increase the knowledge on priority research areas, enlarging the analysis to other types of sites, technologies and countries. This will increase information robustness to better inform decision makers and managers about real environmental risks, broaden the engagement with relevant stakeholders, related sectors and the public at large and reduce environmental uncertainties in consenting of WE deployments across Europe;
2. Development of a **Consenting and Planning Strategy** through providing guidance to ocean energy developers and to public authorities tasked with consenting and licensing of WE projects in France and Ireland; this strategy will build on country-specific licensing guidance and on the application of the MSP decision support tools (i.e. WEC-ERA[1] (Galparsoro *et al.*, 2021) and VAPEM[2] tools) developed for

[1] https://aztidata.es/wec-era/
[2] https://aztidata.es/vapem/

Spain and Portugal in the framework of the WESE project; the results will complete guidance to ocean energy developers and public authorities for most of the EU countries in the Atlantic Arch.

3. Development of a **Public Education and Engagement Strategy** to work collaboratively with coastal communities in France, Ireland, Portugal and Spain, to co-develop and demonstrate a framework for education and public engagement (EPE) of MRE enhancing ocean literacy and improving the quality of public debates.

2. List of acronyms

AM	Adaptive Management
EC	European Commission
EIA	Environmental Impact Assessment
ERA	Ecological Risk Assessment
EU	European Union
ERES	Environmental Risk Evaluation System
MRE	Marine Renewable Energy
RBA	Risk Based Approaches
SDM	Survey Deploy Monitor
MSFD	Marine Strategy Framework Directive
WEC	Wave Energy Converters

3. Executive summary

The development of a Marine Renewable Energy (MRE) sector is increasingly becoming one of the key low-carbon energy solutions for coastal nations in their drive both to tackle the impacts of a changing climate and to provide energy security in the face of this global challenge. While MRE development has led to significant growth in the design, testing and deployment of novel technologies, the challenge of gaining permissions to test and deploy these installations and the lack of detailed quantitative data as to their impact on the environment has represented a block to progress. While certainty about the impacts of the devices is some way off, there is an opportunity in the meantime to revisit consenting processes in order to determine whether changes to these could help to release this bottleneck.

One potential solution is the use of Adaptive Management (AM), a now widely-used learning-based process, whereby management approaches can be adapted as lessons are learned throughout a project. Using AM, the collection of regular monitoring data both informs any adaptations made and reduces scientific uncertainty in future management decisions. One aspect of AM is the incorporation of a Risk-Based Approaches (RBA), whereby an assessment of risk is used in the decision-making process when managing a project. Risk-based procedures already play an explicit and important role in a number of environmental regulations and associated guidance documents in various countries. It is clear that RBA may also clear the way for more streamlined and timely development of MRE projects, but the practical possibilities around this have not yet been explored. The purpose of this report is to explore the use of RBA further in the MRE space and to review the current state of knowledge around the use of RBA, analyse the different approaches, examine the practical application of RBA and make recommendations as to what work might be required to progress this area.

The report identifies five RBAs that have been developed for practical use in the implementation of different policies globally: The ISO Standards, The Survey Deploy Monitor approach, the Environmental Risk Evaluation System, the Risk Retirement approach and the Ecological Risk Assessment approach. These five approaches are summarised and the relationships between the approaches are explored. An overview of the legal considerations around the use of RBAs within the EU is also provided. Finally, the practical application of RBAs in Ireland, France, Spain and Portugal are

investigated, and some conclusions and recommendations are made to help advance this area of work to allow a fuller understanding of the potential role of RBAs to emerge.

4. Introduction

4.1 Background

The development of a Marine Renewable Energy (MRE) sector is increasingly becoming one of the key low-carbon energy solutions for coastal nations in their drive both to tackle the impacts of a changing climate and to provide energy security in the face of this global challenge (Martinez et al., 2021). While harnessing the vast energy resources of the oceans has led to significant growth in the design, testing and deployment of novel technologies, progress in this area has often been slowed by - amongst other things - the challenge of gaining permissions to test and deploy these installations and the lack of detailed quantitative data as to their impact on the environment (Copping et al., 2018; Simas et al., 2015 and see Galparsoro et al., 2021 for a comprehensive summary of challenges). In fact, the impact of individual novel devices on marine species, habitats and hydrological systems remains largely unknown and this represents a block to the speed of development and a financial challenge due to the requirements of consenting processes (Peplinski et al., 2021). While certainty about the impacts of the devices is some way off, there is an opportunity in the meantime to revisit consenting processes in order to determine whether changes to these could help to release this bottleneck. In addition, the aim of the European Green Deal (European Commission, 2019) is for the EU to be climate-neutral by 2050, and part of that vision is for marine renewable energy to play a key role in sustaining the blue economy (European Commission, 2021).

While consenting processes for novel technologies should be stream-lined and scientifically robust, the challenge lies in balancing this requirement with the urgent need to make progress as climate change accelerates. In many jurisdictions, it has been necessary to adopt the ‘precautionary principle’ (UN, 1992) in the consenting process because of the *potential* risk associated with MRE devices and/or of the uncertainty associated with their impacts and interactions with the environment (Galparsoro et al., 2021). This has led to a situation where consenting processes have become very onerous on developers, requiring the collection of detailed data for both pre- and post-installation phases, sometimes to an extent that is considered dis-proportionate with the proposed development (Boehlert and Gill, 2010; Copping et al., 2018). The precautionary principle has therefore been blamed for stalling or halting the development of MRE technologies, whilst not helping either to increase scientific certainty or to improve decision-making within a reasonable timescale.

4.2 Adaptive Management

One solution to this is the use of Adaptive Management (AM), a term first used by Holling (1978) referring to a now widely-used learning-based process, whereby management approaches can be adapted as lessons are learned throughout a project. Using AM, the collection of regular monitoring data both informs any adaptations made and reduces scientific uncertainty in future management decisions. For example, if AM is used to manage a newly-installed MRE device, data gathered during this process can then be used to improve the scientific understanding of its interaction with the environment to inform similar future projects. Essentially, AM can be summarised in several (from Williams et al., 2009). There are five initial steps:

1. Stakeholder involvement
2. Objectives – Identify clear, measurable and agreed upon management objectives to guide decision-making and assess the effect of management actions
3. Identify a set of management alternatives for decision-making
4. Monitoring protocols and models that will detect changes in natural resource status
5. Implementation of monitoring plans

An iterative phase then involves three additional steps which should be applied in a cyclical manner:

1. Decision-making – Selection of management action based on management objectives
2. Implementation of monitoring to track resources dynamics and response to management actions
3. Assessment of management actions – Comparison of predicted and observed changes

Hanna et al. (2016) identified some unique features of AM that make it stand out from other decision-making processes. Firstly, it addresses a scientific uncertainty by using a question-driven approach which can facilitate input from multiple stakeholders. Secondly, it is adaptable and flexible according to the new information generated by the process and finally, the process is iterative such that a feedback loop of information and data improves understanding over time. These three attributes mean that AM lends itself well to projects involving novel hypotheses or technologies.

4.3 Risk-based Approaches within Adaptive Management

One aspect of AM is the incorporation of a Risk-Based Approaches (RBA), whereby an assessment of risk is used in the decision-making process when managing a project. Risk-based procedures already play an explicit and important role in a number of environmental regulations and associated guidance documents in various countries (Norris et al., 2014). Examples include the REACH - Registration, Evaluation, Authorisation and Restriction of Chemicals Regulation (European Commission, 2006), the Environmental Liability Directive (European Commission, 2004), the Regulation on the prevention and management of the introduction and spread of invasive alien species (European Commission, 2014), the Water Framework Directive (European Commission, 2000) and the Floods Directive (European Commission, 2007), amongst others. In recognition of the challenge posed by the implementation of the EC Marine Strategy Framework Directive (MSFD; European Commission, 2008) over large spatial scales, the provision for a Risk-Based Approach was incorporated in recent years (European Commission, 2017) to "enable Member States to focus their efforts on the main anthropogenic pressures affecting their waters". Although RBAs have not been adopted extensively of yet, and a universally agreed method for their use in the MRE space requires more research (Galparsoro et al., 2021) there is some evidence from other contexts that they could help to improve both coherence and regional cooperation (e.g. Verling et al., 2021; Hollatz et al., 2021; RAGES, 2021). Previous studies have highlighted the role that RBAs could have in consenting processes (Koppel et al., 2014; Le Lievre and O'Hagan, 2015; Le Lievre et al., 2016) and in particular, Le Lievre et al. (2016) highlighted the complexity of the interplay between Adaptive Management (AM) and the precautionary principle in the use of an RBA to consenting for Offshore Renewable Energy. It is clear, however that RBA could assist in reducing the perceived paralysing effect of the precautionary principle and could clear the way for more streamlined and timely development of MRE projects. The purpose of this report is to explore the use of RBA further in the MRE space and to:

- **Review** the current state of knowledge on the use of RBA in MRE consenting processes and to identify the most relevant approaches.
- **Analyse** the similarities and differences between the different RBA used to date.
- **Examine** the extent to which RBA are used in Ireland, France, Spain and Portugal (SAFEWave countries) at present.
- **Make recommendations** as to what further work is needed to advance this area.

5. Summary of risk-based approaches relevant to MRE

A number of key RBAs have been developed for practical use in implementation of different policies globally. The most relevant of these have been summarised below, along with a description of their application.

5.1 ISO Risk Standards

The International Standards Organisation (ISO) has published both a series of guidelines for risk management (ISO, 2009) and a standard for risk management which may be applied to risk in any context (ISO, 2018). ISO 31000 sets out the principles (clause 4), framework (clause 5) and process (clause 6) for risk management. ISO 31010 sets out a detailed methodology for the risk management process including a non-exhaustive suite of potential tools and techniques which can be applied to risk management (Figure 1).

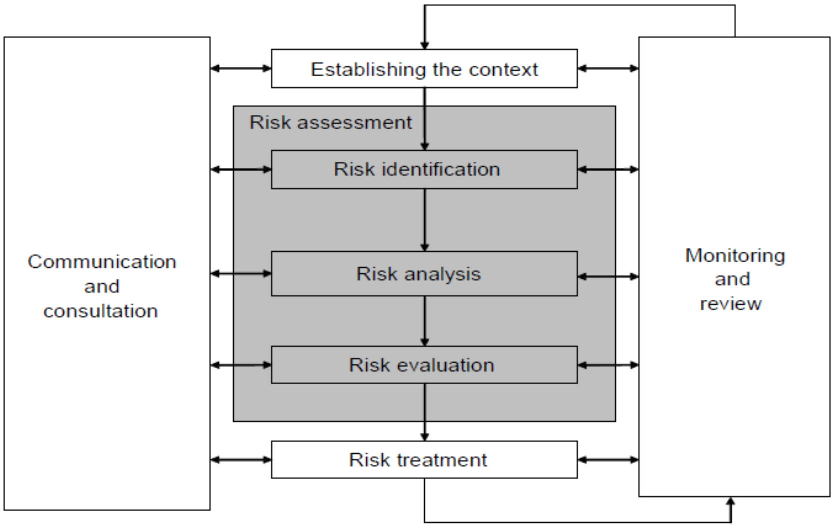

Figure 1. The Risk Assessment approach from ISO Standard 31010 (from ISO, 2009).

This risk assessment approach has already been tested at different spatial scales for Ecosystem Based Management systems (e.g. Sardá et al., 2015; 2017), and has been found to be useful for interpretation of data from experts, indicators and ecosystem models (Bland et al., 2018). The RAGES project (http://www.msfd.eu/rages/rages.html) developed and tested a robust risk-based methodology which brought together the legal articles of the MSFD, a standard methodology based on ISO risk assessment standards and harmonised this with the conceptual frame of the DAPSI(W)R(M)[3](Elliott et al., 2017). The process was then tested on two descriptors of the MSFD, Descriptor 2 (Non-Indigenous Species) and Descriptor 11 (Underwater Noise). While some of the components of these applications may well be relevant, the ISO Risk system has not yet been directly tested for use in the ocean energy arena. However, these risk standards have formed the basis of a number of other RBAs and they also represent the only current international standard around Risk Assessment and therefore it is important to include them in any consideration of risk assessment.

5.2 The Survey-Deploy-Monitor-Approach (SDM)

The Survey-Deploy-Monitor guidance (Marine Scotland, 2016) was developed by the Scottish Government specifically to provide regulators and developers with an efficient risk-based approach for taking forward wave and tidal energy proposals. The approach focusses on the gathering of baseline data and then on the identification of post-installation impacts through the collection of monitoring data post-deployment. Figure 2 was created to summarise the process graphically.

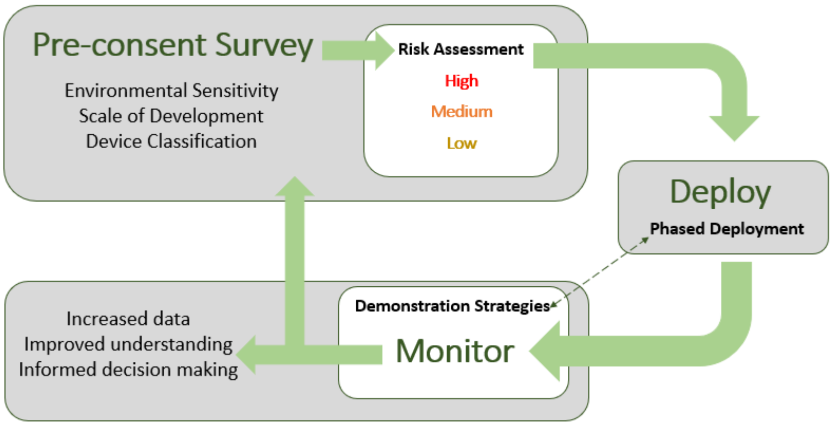

Figure 2. A graphical representation of the Survey-Deploy-Monitor process.

The process is designed *"to enable novel technologies whose potential effects are poorly understood to be deployed in a manner that will simultaneously reduce scientific*

[3] DAPSI(W)R(M) (pronounced *dap-see-worm*) in which Drivers of basic human needs require Activities which lead to Pressures. The Pressures are the mechanisms of State change on the natural system which then leads to Impacts (on human Welfare). Those then require Responses (as Measures) (see Elliott et al., 2017).

uncertainty over time whilst enabling a level of activity that is proportionate to the risks". The guidance makes a distinction between:

- those proposed developments for which there are sufficient grounds to seek determination on a consent application based on a lesser amount of wildlife survey effort and analysis to develop site characterisation pre-application, and
- those proposed developments where the combined site sensitivities, technology risk and project scale make a greater level of site characterisation appropriate. It then highlights how those developments will be deployed and monitored.

Importantly, the SDM process includes 'Demonstration Strategies', which use a case-study approach to tackle areas of uncertainty. By pooling resources, the results from these strategies may inform a number of projects, therefore allowing increased efficiency and sufficient effort to help deliver robust conclusions. Deployments can be made in a phased manner if deemed necessary, and again the Demonstration Strategies can be used to inform decisions to move to subsequent phases.

5.3 The Environmental Risk Evaluation System (ERES)

An Environmental Risk Evaluation System (ERES) was developed by Copping et al. (2015) specifically to allow preliminary assessments of risks associated with MRE devices but also to provide a framework for the incorporation of any data collected in the future on the impacts of MRE devices with the environment. The ERES system was tested on seven different case studies in marine waters and this is described in detail in Copping et al., 2011 and Copping & Hanna, 2011. The process takes account of the fact that the risk level is very much dependent on the nature of the Stressor-Receptor interaction itself and therefore makes a distinction between episodic (e.g. rare but potentially catastrophic oil spillage from a vessel caused by the device), intermittent (e.g. fish and turbine interactions only occurring when fish are present) and chronic (e.g. toxicity from antifouling paint) risk scenarios. The steps in an ERES analysis include screening for a consequence and probability analysis, and there are also further steps which define, manage, and communicate risk (Figure 3).

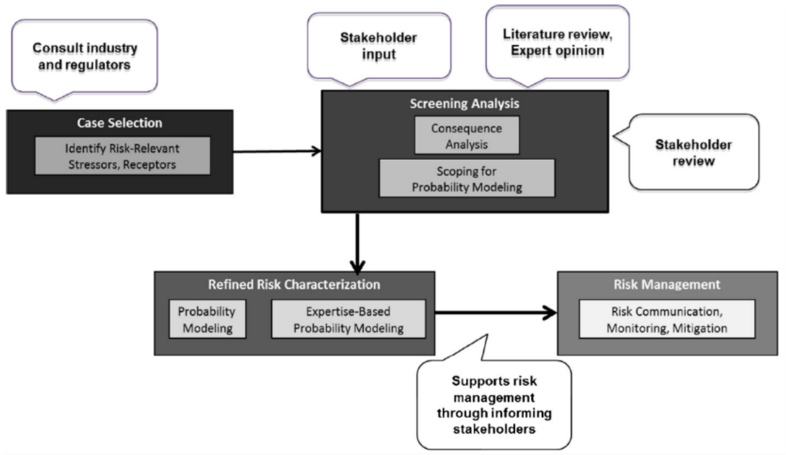

Figure 3. The ERES approach as outlined (from Copping et al., 2015).

The selection of suitable case studies for which the Stressor-Receptor relationship can be defined sufficiently forms a very important aspect of the ERES process and this is inherently limited by the number of specific devices and receptors that has been examined and by the lack of field data to determine the likelihood of each interaction.

5.4 The Risk Retirement Approach

The Risk Retirement process developed by Copping et al., 2020 is based on the principle that once the risk associated with a stressor-receptor interaction is considered sufficiently low, then that risk can be 'retired'. The term is used in the MRE and other (e.g. National Academy of Sciences, Engineering and Medicine, 2018) industries to refer to circumstances where key stressor–receptor interactions are sufficiently understood to remove the need for a detailed investigation for each proposed MRE project. The steps of the process (shown in Figure 4) involve defining the risk (stressor-receptor combination), examining existing data and collecting new data where needed and applying and finally testing mitigation strategies before making a decision to 'retire' a risk. The aim of the process therefore is not simply to identify a risk; it is in fact to collate information about stressor-receptor relationships for consenting purposes and to provide a structure whereby experts can evaluate whether a risk can be 'retired' or ruled out. This information can then be collated to be used to inform future consenting applications. The Risk Retirement process described in Copping et al., (2020) was developed specifically for the MRE industry (although it has a wider application) and allows for a strategic and long-term approach to consenting.

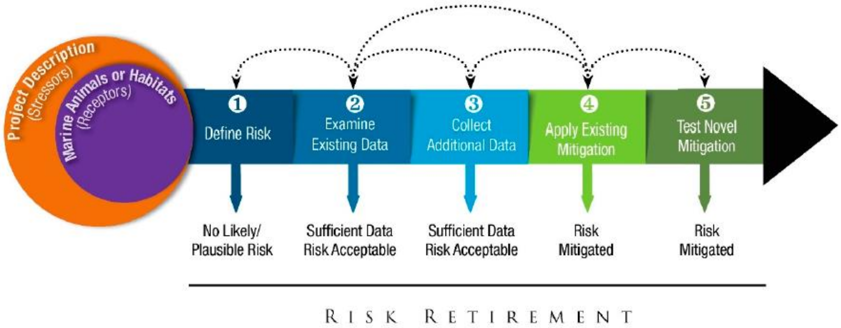

Figure 4. The steps of the Risk Retirement approach (from Copping et al., 2020).

5.5 Ecological Risk Assessment (ERA) Framework

The Ecological Risk Assessment Framework outlined in the work of Galparsoro et al., 2021 uses expert judgement, literature review and a web tool[4] to capture the interactions between a wave farm and the marine environment. It is adapted from Cormier et al. (2018) which was ultimately based on the ISO 31000 standard (ISO, 2018) and has already been put into practical use in the context of Marine Spatial Planning (MSP) by Stelzenmüller et al., 2010. For its use in WEC (Wave Energy Converters) consenting, a four-stage process was developed (illustrated in Figure 5) whereby firstly a **Risk Identification** step specifies the intensity and likelihood of the pressure as well as the sensitivity of the ecosystem component. Next, a **Characterisation** step specifies the likely impact on the ecosystem element, followed by an **Assessment** step which identifies the most relevant pressures and most likely ecosystem elements to be affected and examines overall risk. Finally, the **Management** step identifies the management measures to reduce or mitigate for hazards.

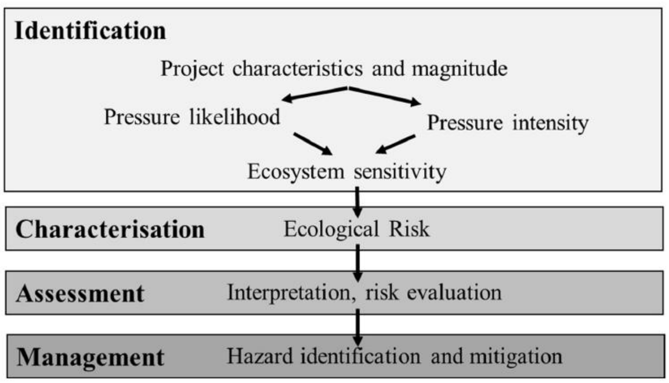

Figure 5. The steps of the Ecological Risk Assessment approach (from Galparsoro et al., 2021).

[4] https://aztidata.es/wec-era/

6. Understanding the relationships between RBAs

6.1 Language and definitions

There are many links and similarities between the five RBAs outlined in Section 2 above. Importantly, most of the frameworks explicitly define risk in a similar way (see Table 1) and all provide a systematic approach to considering risk.

Table 1. The definitions of risk used in the five RBAs, and an indication of whether they were developed in the context of Marine Renewable Energy consenting.

Risk Approach	Risk Definition	Developed for MRE?
ISO Risk Standards	Defined as "the effect of uncertainty on management objectives"	No
Survey-Deploy-Monitor	Not explicitly defined but it is stated that Survey-Deploy-Monitor "....is designed to enable novel technologies whose potential effects are poorly understood to be deployed in a manner that will simultaneously reduce scientific uncertainty over time whilst enabling a level of activity that is proportionate to the risks"	Yes
Ecological Risk Evaluation System	Defined as "the probability of occurrence of an action and the severity of the effect"	Yes
Risk Retirement Process	The work cites the following definition of risk: "....the intersection of the likelihood or probability of an event occurring, and the consequences of the event if it were to occur"	Yes
Ecological Risk Assessment Framework	Ecological Risk Assessment is defined as "a flexible process for organising and analysing data, assumptions, and uncertainties to evaluate the likelihood (probability) of adverse ecological effects that may have occurred or may occur as a result of exposure to one or more stressors related to human activities" based on Hope (2006)	Yes

A number of important points emerge from an examination of the five frameworks together:

- All of these risk approaches explicitly tackle the **receptor-stressor** relationships.
- All of them perform some sort of **risk evaluation** process in order to identify the most critical risks.

- Some of them (e.g., Copping et al., 2020) focus on **removing risks**, but ultimately have the same goal – to identify the most pertinent risks and to address these.
- An assessment of the likelihood and consequence of a receptor-stressor interaction is a common theme in the majority of these approaches.

There are several examples where steps within the different approaches are equivalent or almost equivalent, but have been given different titles:

- **Risk Identification** of the ERA approach is approximately equivalent to the **Risk Analysis** step in the ISO standards.
- **Risk Assessment** step of the ERA Approach is approximately equivalent to the **Risk Evaluation** step of the ISO.
- **Risk Management** of ERA is approximately equivalent to the **Risk Treatment** step of the ISO.
- The Risk Retirement process appears approximate to the concept of **Preliminary Analysis** within the ISO standard (see ISO 31010 (ISO, 2009), pg. 15); both of these have as their aim the need to **remove low or non-existent risks.**
- The value of incorporating **expert judgement** is acknowledged (in Galparsoro et al., 2021), particularly at the early screening stage.

The evolution of several different approaches globally to the same problem (in this case for consenting for Marine Renewable Energy Projects) is in fact an indication of the pervasive and urgent requirement for this issue to be addressed. Although the development of these different frameworks might be viewed as an impediment to progress, each of the RBAs reviewed here focusses on the issue from a slightly different perspective, and in so doing provides a greater understanding and allows a more in-depth interpretation of the requirement for risk-based consenting processes. Leaving space for this increased understanding to develop means that any harmonized approach emerging in the future will incorporate the crucial elements and should therefore be more effective.

Many of the points above concern the use of language and the use of varied terms to refer to equivalent or quasi-equivalent steps. This varied use of language adds to the complexity of using such frameworks for regulators and developers alike and may be a deterrent in many cases. The language of Risk-based approaches has become more complex as new and slightly different methods are developed for various purposes. The increased research interest and subsequent refinement of risk frameworks has greatly assisted with the understanding of risk assessment, and indeed in some cases has succeeded in unpicking the complexity of it (e.g., the work of Galparsoro et al., 2021 claims to move towards the capture of additional complexity compared with earlier approaches).

6.2 Finding the key crosswalks between RBAs

Figure 6 shows a diagrammatic representation of the relationships between the five approaches and illustrates that there are many categories that apply to several of the frameworks, although the terms used vary from approach to approach. Four clear patterns emerge from this visualisation:

1. The ERES, ERA and ISO frameworks have much in common in that all contain a number of steps moving from identification of the receptors and stressors, to a description of risk via assessment of consequence and likelihood and then an evaluation of relative risk. In this sense, these frameworks provide a detailed approach to assessing the risk itself.

2. The Risk Retirement and Survey-Deploy-Monitor Approach contain some elements for which there aren't direct equivalents in the other three frameworks. This is due to the '**deploy**' and '**monitor**' aspects of the SDM and the **collection of additional data** and **testing of novel mitigation** aspects of Risk Retirement, which are rooted in the practical application of an RBA and are more focussed on the mechanistic feedback of information required for Adaptive Management.

3. The Pre-consent Survey step of the Survey-Deploy-Monitor process is not prescriptive, and it is likely that it is sufficiently all-encompassing to allow many of the steps from the ERA, ERES and ISO frameworks to be nested into it.

4. The Risk Retirement framework contains a bridge between the more prescriptive approach of the ERES, ERA and ISO frameworks and the less detailed Survey-Deploy-Monitor process.

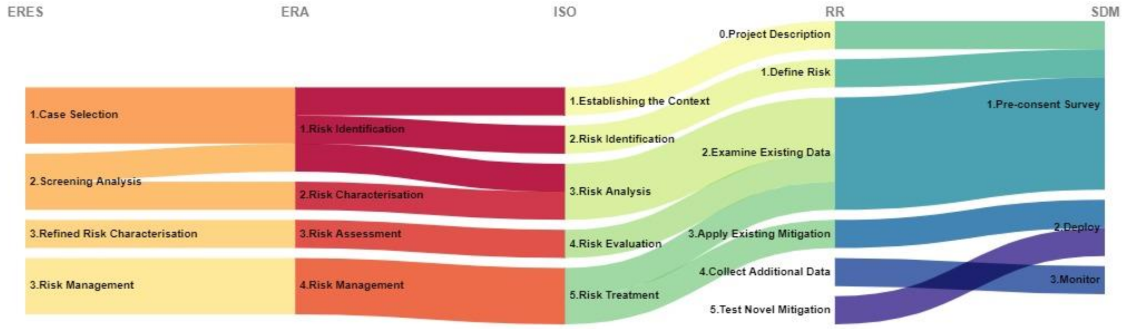

Figure 6. An illustration of the crosswalks and links between the different RBAs described.

7. Legal Considerations of RBA

Although Risk-based approaches have not historically formed part of European marine policies, in recent years there have been increasing efforts to incorporate an element of risk assessment into management of the marine environment. For example, while Risk-based approaches are not explicitly described in the Renewable Energy Directive (European Commission, 2018), the principle of 'low-ecological-risk' deployment of renewable energy is cited in Article 15(7) of the Directive. In addition, *The EU Strategy to Harness the Potential of Offshore Renewable Energy* (EC, 2020a) emphasises the need to minimise the impact of offshore energy on biodiversity and using appropriate risk-based consenting processes would be compatible with this aim. The *European Commission Guidance document on wind energy developments and EU nature legislation* (European Commission 2020b) draws on the wider principles underpinning EU policy on the environment and wind energy development to provide guidance on the framework for permitting and planning under Articles 15-17 of the revised Renewable Energy Directive. This guidance document also emphasises the importance of accurate monitoring data in the implementation of an Adaptive Management approach.

Perhaps the area in which risk-based approaches have been most promoted is within the Marine Strategy Framework Directive (MSFD), article 1(1) of which establishes the overall aim of the Directive to be achieving GES (Good Environmental Status) of the marine environment, and as part of that to:

> *"prevent and reduce inputs in the marine environment, with a view to phasing out pollution as defined in Article 3(8), so as to ensure that there are no significant impacts on or* ***risks to marine biodiversity, marine ecosystems, human health or legitimate uses of the sea****."*

Therefore, the concept of risk is already embedded in the objectives of the MSFD, and although the Directive does not explicitly mandate Member States to carry out a risk assessment, article 14 (4) states that MS may not take further steps beyond article 8 (Assessment) if there are no significant risks to the marine environment. This promotion of risk-based approach was further cemented in the Commission Decision (EU) 2017/848 (European Commission, 2017), which creates an explicit link to risk, particularly in **recital 6:**

> *"the number of criteria that Member States need to monitor and assess should be reduced,* ***applying a risk-based approach*** *to those which are retained in order to allow Member States to focus their efforts on the main anthropogenic pressures affecting their waters"*

The use of a risk-based approach within MSFD was explored in detail by the RAGES project and has been particularly drawn out in RAGES (2021), Hollatz et al. (2021) and Verling et al. (2021). However, more work needs to be done to move the risk-based concepts from a policy level to an operational level. For example, although there are several guidance documents and studies have been produced in relation to the EIA directive, none of these have directly addressed or formalised the use of risk-based approaches. Using a risk-based approach is often seen as part of a pragmatic or common-sense approach, but without a more formal mechanism by which to apply the principles and risk assessment, there is a danger of inconsistencies and omissions of key steps. Although there may be different pieces of national guidance within individual countries which reference the risk-based approach, (for example the *Guidance Documents for Offshore Renewable Energy Developers* produced by the Department of Energy Climate Change in Ireland (DECC, 2020)) it is important that this be brought together in a more holistic way to facilitate regional harmonisation avoid duplication of work. The following section explores the manner in which risk-based approaches may be in use - either formally or informally - amongst SafeWAVE partners.

8. Exploring RBA in Practice: Key Findings

To gain an increased understanding of the use of RBAs in practice in the different Member States represented by the SafeWAVE project, partners were asked a series of questions about their own experiences of the consenting process in their country (see Annex I). The information received was practitioner-based, in that the respondents were involved either in development or testing of WECs (and not in their regulation). Although this meant that the process did not explore the situation at a national level, it did provide an insight into the extent to which RBAs are considered in the planning process on the ground and explored whether there is an appetite at present for guidance or a clearer understanding of RBAs in consenting processes. The following points highlight the most significant findings:

- Overall, RBAs to consenting have not been used historically for MREs in Ireland, Portugal, France or Spain.
- There is an awareness that the interest in RBAs has increased in the last decade and that they are being employed in other aspects of environmental management.
- There does not appear to be a strong allegiance to one RBA over another.
- In some cases, RBAs were not knowingly used in consenting processes but there was a feeling that risk forms part of the decision-making process in an informal way.
- There is a feeling that guidance around the use of RBAs would be useful into the future.
- Due to the wide range of device type and the diversity of environmental conditions in which they will be deployed, any risk-based approach needs to be flexible and adaptable.
- Some consenting processes were completed for test sites over a decade ago and were based on learnings from MRE projects overseas at that time. These authorisations continue to apply now (providing the characteristics of devices are included in the "envelope" described in the Environmental Impact Assessment issued at that time).

- To date, provision has not been made for cumulative effects at the time of consenting, but the importance of considering this is seen as being important into the future.
- Detailed information about the consenting processes in Spain and Portugal can be found in WESE Project Deliverable 4.2 (Bald et al., 2020)

The list below contains some key findings and messages in order to continue to make progress in this area:

1. A number of risk-based frameworks have been developed that could be adapted for MRE consenting processes.
2. Some frameworks are more prescriptive and others more general.
3. There are many similarities between the frameworks and once the relationships between them are understood there should be flexibility within a project to choose the most useful one.
4. Allowing scope for this flexibility to choose a particular risk framework is important because attempting to use a standard approach in a dynamic and variable situation is that something will be omitted.
5. The development of one standardised risk-based framework for MRE consenting processes is not appropriate due to the varying nature of the devices themselves, differing environmental conditions and potential impacts where devices are deployed.
6. Consideration of regional and temporal variability in the receiving environments is required in order to fully understand impacts.
7. In the longer term, there is a need to consider how cumulative impacts can be taken into account in the consenting process (see ICES, 2019, Korpinen and Anderson, 2016; Stellzenmüller et al., 2018).
8. The link between risk-based approaches and the Adaptive Management system is complex and work should continue to better understand this link in order to make best use of risk-based approaches.

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10. Annex I. SafeWAVE Deliverable on Risk-based, adaptive management – request for further information

Background and purpose

As part of the SAFEWave project, University College Cork are tasked with carrying out an *"Evaluation of potential risks and determination of operational feasibility of risk-based adaptive management"* (Deliverable 5.2). For the purposes of this work, we would appreciate it if you could respond to the questions below so that we can better understand risk-based approaches in your country/region.

Risk-based Approaches (RBAs) are widely used in a number of different disciplines and involve using an assessment of risk to guide decision-making processes when managing a project. RBAs already play an explicit and important role in a number of EU environmental instruments in Europe (e.g. EU Water Framework Directive and EU Floods Directive) and a number of detailed interpretations of RBAs have been developed (e.g. ISO 2009; ISO, 2018). Importantly, RBAs can form part of a broader Adaptive Management (AM) process. AM is a widely used learning-based process, whereby management approaches can be adapted as lessons are learned throughout a project. Using AM, the collection of regular monitoring data informs any adaptations made and reduces scientific uncertainty in future management decisions. For example, if AM is used to consider the interaction between a Marine Renewable Energy (MRE) device and the environment, data gathered during this process can then be used to improve the scientific understanding for similar future projects. An RBA can be a flexible component incorporated into any part of this AM process, depending on the context.

This questionnaire focusses on the use of RBA in consenting processes for MRE devices and aims to gather information about these processes in Spain, France, Portugal and Ireland.

Should you have any questions on this please contact Dr. Emma Verling (emma.verling@ucc.ie)or Dr. Anne Marie O'Hagan (a.ohagan@ucc.ie)

Please use as much space as you need to answer Questions 1-4 below.

Q1. Do you use a Risk-based Approach in your consenting processes for Marine Renewable Energy devices?

Q2. Which Risk-based Approaches do you use and how do you use that approach (please check the box as appropriate and provide further detail if possible)?

☐ Survey-Deploy-Monitor (Marine Scotland 2016)
☐ ISO Standards (ISO 2009; 2018)
☐ Risk Retirement approach (Copping et al., 2020)
☐ ERES approach (Copping et al., 2015)
☐ Other (please state what it is below)

Comments:

Q3. If you are not currently using a Risk-based approach, are you planning to use one in the future, and if so which one?

☐ Survey-Deploy-Monitor (Marine Scotland 2016)
☐ ISO Standards (ISO 2009; 2018)
☐ Risk Retirement approach (Copping et al., 2020)
☐ ERES approach (Copping et al., 2015)
☐ Other (please state what it is)

Comments:

Q4. Would guidance on the use of Risk-based approaches to MRE consenting be useful to you? If so, please provide information on any particular issues you would like to see addressed in this guidance or any further comments you may have.