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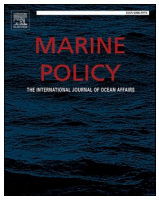

Management of spatial data integrity including stakeholder feedback in Maritime Spatial Planning

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ABSTRACT

The Maritime Spatial Planning process is data intensive, having to draw upon the best available data coming from many different sources. There are, therefore, multiple challenges in managing spatial data for inclusion in Marine Plans. These challenges include the need for data integrity to drive reproducibility; as well as providing contextual information to enable end users to increase understanding as well as the potential for the data to be reused independently. This paper examines the challenges associated with managing spatial data for inclusion in Ireland's marine plan. It demonstrates how repeatability can be achieved for such data products and the underlying processes necessary to drive data integrity to ensure the best data is available for decision-making. During the marine plan consultation period, the spatial data used in the baseline and subsequent draft plan became outdated, with newer and better-fitting data identified. In total, 124 map products matured throughout the process; consequently, processes were developed to integrate stakeholder feedback as well as a method to provide a uniform way to deliver, manage and update datasets. Ireland held an array of stakeholder engagement efforts. The entire stakeholder engagement process spanned several years and involved numerous organisations. Informed by the process of engagement-data interaction the paper explores the innovative potential of using Maritime Spatial Planning as a driving force for Data Quality. This paper aims to describe the interwoven process of updating datasets in a marine plan and the benefits of simultaneously integrating stakeholder consultation feedback and developing repeatable data management processes.

1. Introduction

1.1. Introduction to Maritime Spatial Planning

Maritime Spatial Planning (MSP), a strategic and dynamic process, aims to balance the different demands for using the sea. MSP is defined in the European Union 2014/89/EU Directive [1] as '*a process by which the relevant Member State's authorities analyse and organise human activities in marine areas to achieve ecological, economic and social objectives*', and has resulted in member states developing their own marine plans and processes. Furthermore, the 2014/89/EU Directive stipulates that Member States shall organise the use of the best available data.

Ireland's Maritime Spatial Plan is the National Marine Planning Framework (NMPF) [2] and was adopted by the Irish Government in March and subsequently adopted in May 2021. The NMPF outlines the government's vision, objectives and marine planning policies for each marine activity, ensuring the sustainable use of the country's marine resources to 2040. The preparation of Ireland's NMPF was underpinned by three key parallel processes; development of a statutory framework, stakeholder participation and the establishment of an evidence base. An important function of the NMPF is to provide a sound basis to balance the development of Ireland's offshore wind potential with other marine activities, international climate change targets and the protection of the marine environment.

The NMPF was developed under the Planning and Development (Amendment) Act 2018 [3]. Since adoption of the NMPF, new legislation in the form of the Maritime Area Planning Act (2021) (MAP Act) has been signed into law. In addition to underpinning marine planning at the national level, the MAP Act adds the ability for public bodies to develop Designated Maritime Area Plans (DMAPs). DMAPs can be area or sector based and once finalised, become statutory parts of the overall NMPF. Beyond plan making the MAP Act introduces a substantially reformed,

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plan-led system of marine management in Ireland. This includes new consenting processes, changes in the roles and responsibilities of Government both national and local, and the creation of a new regulator with decision making and enforcement responsibilities. Unchanged from the Planning and Development (Amendment) Act 2018, bodies regulating Ireland's maritime area are obliged to consider the objectives of the NMPF when making policies, plans or granting consents.

1.2. Coordination of MSP in Ireland

In Ireland, the Department of Housing, Local Government and Heritage (DHLGH) retains overall responsibility for the implementation of marine planning policy. The Marine Institute, Ireland's national agency responsible for provision of marine scientific and technical services to Government, provides government with MSP-related data management support. A principle of good practice for Maritime Spatial Planning is that it should be informed by a public and participatory process; the best outcomes are reached when marine plans involve stakeholders and are coordinated with sectoral policies and decision-making [4]. As part of Ireland's MSP process, an NMPF Stakeholder Advisory Group [5] was established to facilitate stakeholder participation in the MSP process. The Stakeholder Advisory Group consisted of participants from non-governmental organisations; industry; government agencies; academia; local authorities and the public. The Advisory Group ensured involvement from the public sector, business, environmental interests, social and knowledge-based sectors. An Inter Departmental An existing cross-departmental Marine Legislation Steering Group was engaged to ensure coordination across government departments [6].

Robust marine planning requires extensive and thorough stakeholder engagement. Stakeholder engagement in marine planning is a mechanism where MSP implementing bodies seek feedback from relevant organisations and the public on prospective marine plans. The aim is to integrate input and responses to ensure the MSP process incorporates relevant expertise and views of key audiences invested in the maritime area. Stakeholder engagement requires different methods at different MSP stages [7,8] to enable active engagement from the beginning and throughout the decision-making process. The Irish MSP Stakeholder engagement process offered a unique opportunity to provide valuable context towards how data should be used, and what for; including how it should it be combined. This can be referenced as Data Appropriateness – "*also known as fitness for purpose, meaning the degree to which the chosen data source aligns with the ability to accurately and reliably address the research question being posed*" [9]. By integrating feedback from stakeholders (e.g. data generators) upstream into MSP data products on an ongoing basis, data may be utilised and interpreted appropriately by downstream stakeholders and decision makers. Throughout the MSP process in Ireland, the assimilation of the stakeholder participation and availability of data and information was key to the successful delivery of the NMPF.

When applying a marine plan in decision making, numerous anthropogenic pressures by human activities such as fishing [10], shipping [11], aquaculture [12], and tourism [13] must be accounted for, as well as indirect stressors including climate change [14], species loss, and changes in habitat and biodiversity [15]. Thus, sectoral, environmental and socio-economic data make up the backbone of the evidence base required for effective decision making when using a marine plan. This wide array of data must be well cared for and managed, which is discussed in detail below.

1.3. Data governance, reuse & provenance

At an early stage in the MSP process, the need for information was identified as vital to success. Businesses and individuals rely on information for strategic planning and growth; for decision-making and understanding. Data can be described as facts; information as captured data; and knowledge as understanding. All information is driven by knowledge, and for knowledge to be of value; it must be accessible, complete, and accurate. Furthermore, providing contextual metadata as in Nathen Shedroff's Data-Knowledge information "ecosystems" model [16] demonstrates that using metadata to provide context for data, coupled with presenting the data in a homogenised and comprehensible manner, facilitates how the full potential of information may be realised. This information can then be used as the basis for evidence based marine planning. In the case of Stakeholder feedback, both as data owners and data consumers, having contextual metadata and information, combined with a user's specific experience of their specialist subject area, knowledge may be gained and information entropy [17] can be avoided.

Data Governance can be described as the process of classifying and securing information [18] making it accessible and shared for reuse for all Marine stakeholders and decision makers. Governance is a discipline that requires people, processes, and classifications to ensure that the available information delivers a whole and precise set of facts. A Data Governance Policy is a live dynamic document containing a set of best practice guidelines to ensure digital information is managed correctly over time. Furthermore, it establishes proper standards to assure the quality and integrity of data and defines the roles in relation to data access, retrieval, storage, and backup, ensuring proper management and protection of data. Critical components of marine spatial planning a the data application stage are (1) spatial data collection, (2) data management, (3) data analysis, and (4) decision support systems [19].

The Data Management Association (DAMA) Dictionary of Data Management [20] lists 10 components of data management in the DAMA-DMBOK (Data Management Body of Knowledge). Data Governance is identified as the core component of Data Management, tying together other disciplines such as Metadata Management; and Document & Content Management. This work is therefore a key component in the context of marine planning. The Data Governance Policy must have at its core the need to document the origin of data and facilitate the reuse of data, which is discussed below.

Data reuse saves time and can accelerate the pace of scientific discovery [21]. By making data open and available to others, it is possible to answer questions that haven't yet been asked. There are many reasons for sharing and enabling the reuse of data, including encouraging scientific enquiry, promoting innovation, and reducing the cost of duplicating data collection; however good data management is key for data reuse. In line with the FAIR Data Principles [22], good data management is not a goal in itself, but when curated well can lead to better knowledge discovery and innovation, and enhanced reuse post publication.

The FAIR Data Principles are widely accepted guidelines that, when applied, enhance the reusability of data. These FAIR Principles place an emphasis on enhancing the ability of machines to automatically find data, supporting its reuse. "*One of the grand challenges of data-intensive science…is to improve knowledge discovery through assisting both humans, and their computational agents, in the discovery of, access to, and integration and analysis of,* ***task-appropriate scientific data*** *…*" Mark D. Wilkinson (2016). The European Commission, in the H2020 programme, is promoting these FAIR principles for data [23]. One key item of the FAIR principles is understanding the provenance of a dataset, or its lineage.

The provenance of data, a metadata entity, refers to the origin and the processes undertaken to obtain a specific geographic digital feature or product and is deemed "*…critical to evaluate the quality of spatial information….in reproducing and replicating geospatial processes*" [24]. It should be possible to ascertain the quality of the data based on its ancestral data and derivations, track sources of errors, allow automated re-enactment of derivations to update a data, as well as provide attribution of data sources. Provenance data can be used to drill down to the source of data in a data warehouse, track the creation of intellectual property, and provide an audit trail for regulatory purposes.

Data lineage [25] is used to define the provenance of derived products within geographical information systems (GIS) by providing transparency and simplifying the ability to trace errors back to the root cause in a data analytics process. Lineage is more recently considered as

'metadata recording the process of workflows' [26]. It can be summarised that data 'Provenance' is metadata regarding the origin and the processes undertaken; which can subsequently be used to evaluate the quality of geospatial datasets.

1.4. MSP data management

To support efforts concerning the governance, reuse and provenance of data, a quality management framework for data was developed for Ireland's Marine Planning data processes [27,28]. It served to improve data and knowledge generation; manage and share data, and develop new products and services where appropriate. Underpinned by this quality management framework, the collection, collation, validation, and analysis of new and existing spatial datasets enabled the creation of a variety of maps (containing temporal and spatial information), made publicly available for use in policy, including for marine planning. This spatial evidence was and is being used to support policy at both a local and national level. It is therefore vital that these datasets are managed in a coordinated manner to maximise the integrity of the data available, complying with relevant legislations (INSPIRE) [29], best practice guidelines and licensing conditions; putting in place the framework for Maritime Spatial Planning to enable decisions that are consistent, transparent, sustainable and evidence based.

By their very nature spatial datasets and map products evolve over the course of time, it is documented that maps do not always accurately represent changeable marine environments and situations [30]; whilst the issue of ontological security is acknowledged, this is beyond the scope of this paper. Recognising this, a disclaimer was added to each map product included in the NMPF to encourage users to refer to the maps as a reference only. Evidence based marine planning means that the 'best available data' and information are used to make decisions. The approach helps to ensure that decisions will address identified priorities using appropriate data. This in turn ensures that the implementation of the plan objectives is well coordinated and resources are not wasted, providing a mechanism whereby the needs are reviewed and assessed [31]. The quality of data from the many contributing data providers can be variable, given the vast array of people, processes, technologies and methodologies employed in collecting marine data. Similarly, the 'best available data' is a fluid concept with newer, more suitable and appropriate data being identified, gathered and interpreted continuously. Marine spatial data, managed appropriately, can be used to highlight opportunities and validate data lineages such that users of any documented data process flow will be able to determine the appropriateness of the data product for its intended application to MSP decision-making needs.

The terms 'Suitability' and 'Readiness' in an MSP context have been offered as both formal and considered assessments of data [28]. 'Suitability', is used to consider what datasets are potentially most relevant to marine planning; examples include datasets of national importance around ecosystem services and climate change. Suitability can also be subjective and is open to interpretation, often depending on how data will be utilised. Data may be suitable to provide context on a certain area of the marine environment but may be inappropriate for decision making. For example, a dataset resulting from a citizen science project may be useful for a preliminary understanding of a specific component of the ecosystem, but a government-funded authoritative dataset may be required for legality robustness during decision making. 'Readiness' is more objective and relates more to the FAIR Principles: Findable – are the metadata around the data present and of a standard; Accessible – where is the data stored and in what format; Interoperable – is the metadata standardised formal, accessible, shared and in an applicable language to describe the data; finally, Reusable – are there clear usage licences in place to provide accurate information on Provenance.

Strict, coherent and repeatable data governance processes are necessary to ensure the robustness of data over time. A dataset can be deemed suitable but far from ready to be ingested into a marine plan or a marine planning decision-making tool. Efforts are necessary to identify suitable datasets but similarly, preparation for readiness is something that must be appreciated, resourced and governed.

1.5. Spectrum of approaches

The MSP Directive stipulates that member States are 'responsible and competent' in their approach to developing national plans. This is positive as it means plans produced work and are appropriate in the context of the individual country in question. This has resulted in the development of new approaches, organisations, legislation, and requirements for new multi-disciplinary resources at the national level that are not necessarily consistent across member states [19,31–36]. However, in terms of data management this has resulted in a wide diversity of approaches being used and therefore convergence towards common best practice has been limited. Despite regional data harmonisation efforts, some online guidance documentation [37] and proposed solutions for the sharing of maritime spatial plans in common formats for the development of a harmonised pan-European MSP map [38] there is a lack of published and clear data management protocols for ensuring the integrity of spatial data over time. While previous work has been done on technical data management in MSP [28], this paper offers a scientific interpretation of MSP implementation in an EU member state. Publishing detailed processes on national approaches to MSP implementation can allow for countries to learn from each other as they develop robust data management strategies for MSP.

This paper examines the detail involved in managing the evolutionary nature of data used in maritime spatial planning, along with the considerations necessary when responding to and integrating stakeholders' valuable feedback. Stakeholders are data owners as well as data consumers.

2. Methodology

2.1. Overview of Ireland's MSP stakeholder consultation efforts

Ireland's marine plan was developed in 4 stages (outlined below). Each of the 4 stages involved stakeholder consultations and data management activities simultaneously. In total there were 26 maps in the Baseline Report (2018), and 62 maps in the NMPF Consultation Draft Report (2019). The Final NMPF report (2021) contained 36 maps.

1. **Stage 1 - Roadmap:** This stage included a detailed assessment of MSP data requirements, identification of data sources, collation and collection of data and a detailed gap analysis. The output from this stage was the, 'Towards a Marine Spatial Plan for Ireland' Report published in 2017.
2. **Stage 2 – Baseline Report:** This stage included a collation of baseline information and an understanding of primary human activities and environmental data in the maritime area. The output from this stage resulted in the, 'National Marine Planning Framework Baseline Report' published in 2018. This report was used to launch a series of public consultation efforts.
3. **Stage 3 – NMPF Consultation Draft**: This stage built on the Baseline Report, responding to stakeholder feedback, and resulted in the publication of Ireland's National Marine Planning Framework Consultation Draft in 2019. This report was used to launch a series of public consultation efforts.
4. **Stage 4 - Final NMPF:** This stage integrated the stakeholder feedback received on the National Marine Planning Framework Consultation Draft and resulted in the Ireland's final marine plan, the 'National Marine Planning Framework', published in 2021.

2.2. Overview of the data management process

The cycle of MSP Stakeholder and related data processes are

represented in Fig. 1. The cycle was repeated a total of 3 times as part of Stages 2 and 3 Development & Draft.

Initial map products were developed for the Baseline Report (2018), and 2 revisions were undertaken for the NMPF Consultation Draft (2019), and the Final NMPF (2021). At the start of the MSP process in Ireland the following series of steps were implemented to create the Baseline Report (2018):

- Step 1 Identify Requirements – what is expected from the map product?
- Step 2 Expert Input – what data and where might it be obtained?
- Step 3 Acquisition of raw data – lots of data sources, with varying quality levels
- Step 4 Processing – preparing the products using several new and existing Standard Operating Procedures (SOPs)
- Step 5 Presentation – map preparation
- Step 6 Expert Consultation

The review process paused here for a period to facilitate stakeholder feedback. When stakeholder feedback on the Baseline Report was received, the process began again for another iteration to incorporate integration of the feedback for the NMPF Consultation Draft (2019).

- Step 1 Extract new requirements and turn into actions / tasks
- Step 2 Using expert feedback to obtain new sources for potentially more suitable data
- Step 3 Contacting new sources or updating existing dataset
- Step 4 Processing
- Step 5 Presentation
- Step 6 Expert Consultation

The process was repeated for the preparation and completion of the NMPF, the published version of Ireland's Marine Spatial Plan (2021).

Eight SOPs were drafted as part of this work: from Publishing a 'New Map' to managing Licence conditions. For each map generated (n = 124) several checks were necessary and grouped into tasks. Each task was deemed necessary to ensure accuracy in relation to Map generation (n = 11 Tasks), Metadata management (n = 8 Tasks) and Licence adherence (n = 5 Tasks). Once all the above checks were cleared, a draft for each map was available and placed into the first draft of the document for stakeholder review NMPF Baseline Report (2018). As further comments were received the cycle repeated to rework the final map product.

3. Results

3.1. Stakeholder engagement

Throughout the Irish MSP development process, stakeholder engagement and evidence gathering activities overlapped and informed one another. Stakeholders provided data and were consulted on draft outputs. Over 3000 comments on the Draft NMPF [Stage 3] were received, with 39 of these (approximately 1.3%) pertaining to the spatial data products (maps). This paper focuses on the 1.3% relating to spatial data only.

In addressing the 39 spatial data comments received, there were 330 individual ticket items raised; this involved tasks such as contacting data providers for updated information, sourcing new data and representing data in the right context; 295 required consideration and/or prompted revisions. From these 295 required revisions, 1273 communication events were logged between the governmental MSP team and data providers regarding expert guidance and stakeholder feedback.

The 1273 communication events contained tracked documentation of communications with data generators and providers. Communications were held on platforms such as emails and phone calls and required meticulous documentation to ensure stakeholder feedback was implemented accurately. Ultimately, all communications resulted in the final set of data products within the Final NMPF [Stage 4].

3.2. Data management

Upon receipt of stakeholder feedback throughout the MSP process, the map products evolved. The map represented in Fig. 2 was referred to internally as 'Map 5 #293 Designated Sites', and illustrates the evolution of a map product.

All communications with the dataset source owners and expert advisors with the Marine Institute were captured to ensure each communication was logged. Each instruction was implemented and a full lineage representing the evolution of the map over time is preserved. This method allows for complete reproducibility of the process for future

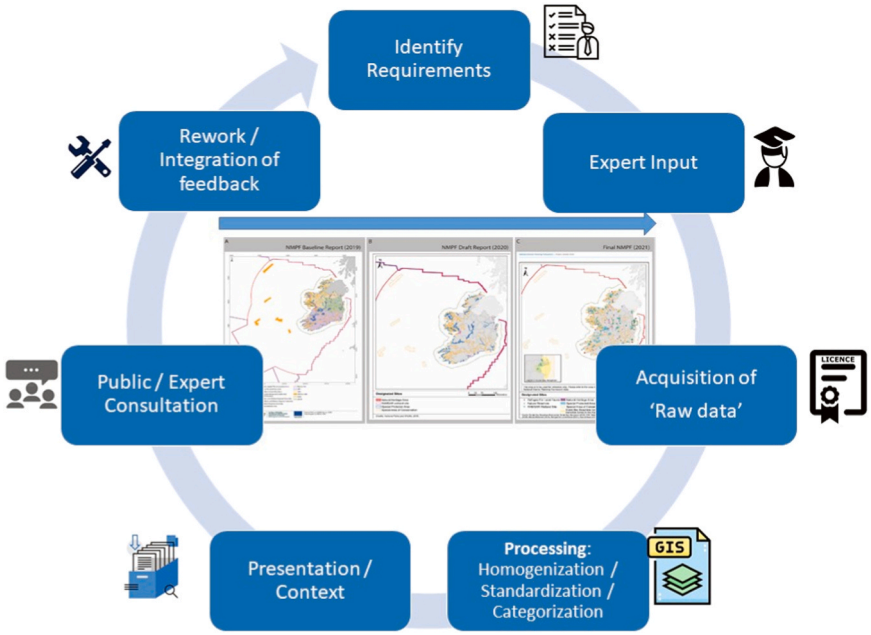

Fig. 1. The Quality Process employed to integrate stakeholder feedback and generate and update the maps throughout Ireland's MSP process.

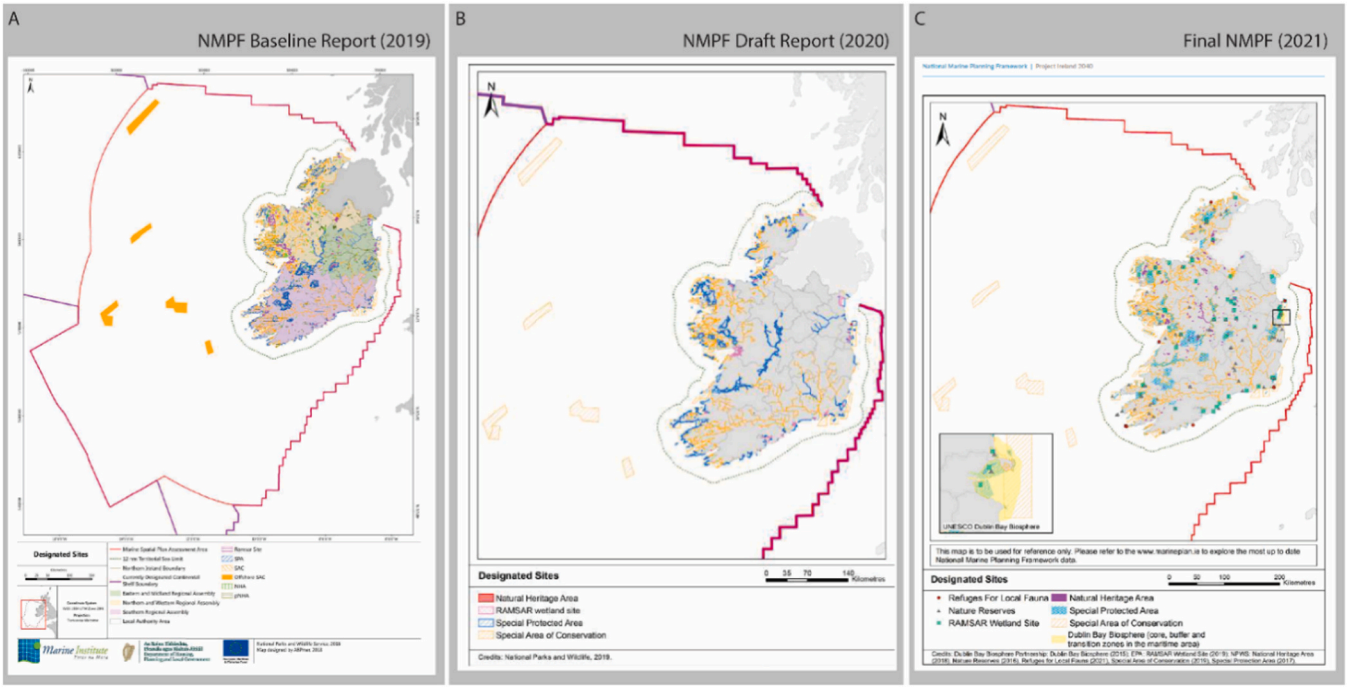

Fig. 2. An example evolution of one of Ireland's MSP maps, called 'Designated Sites'. The three panels demonstrate how the map changed over time with updated data and stakeholder feedback; **A**- the map exhibited on page 75 of the NMPF Baseline Report, **B**- the map exhibited on page 44 of the NMPF Consultation Draft, **C**- the map exhibited on page 45 of the Final NMPF.

NMPF planning updates. The comments facilitated appropriate context in relation to each map product.

Changes included, but is not exhaustive:

- Cosmetic colour changes to ensure the map highlighted each dataset appropriately
- Symbols pertaining to the geographical location and scale were enlarged and reoriented as advised
- The map extent was set and adjusted depending on the data being displayed
- Meetings to ensure the best available data was being utilised – this included obtaining further papers from the literature
- An Inset was added to highlight a particular area
- Credits were updated to ensure all underlying datasets were acknowledged accordingly
- A Disclaimer was added to each map reading "*This map is to be used for reference only. Please refer to the www.marineplan.ie to explore the most up-to-date NMPF data*"

In addition, new maps were created as a result of this process. For example, the ports jurisdictions mapping process was a result of interplay between iterative data management, consultation and engagement [see Maps on pages 158–160 Final NMPF Report].

An approach taken in relation to data in marine planning is to recognise that a fixed policy set is needed to provide certainty for marine users, investment and marine management, but that these need to be applied in the context of best available information. In this context, Ireland's government created a website (marineplan.ie) to provide a centralised resource for MSP data that could be continually updated for use by decision makers applying the plan. This means that the context of plan application is always up to date even though the paper /.pdf maps provided at first publication become out of date.

4. Discussion

The effort involved to ensure data is appropriately used and accurately represented cannot be underestimated. The FAIR Data Principles [22] not only apply to 'data' in the conventional sense, but to the algorithms, tools, and workflows that led to that data being created. The individual elements of the FAIR Principles whilst related, are independent and separable. The Principles define characteristics that contemporary data resources, tools, vocabularies and infrastructures should exhibit to assist discovery and reuse by third-parties. The Principles may be adhered to in any combination and incrementally, as data providers' publishing environments evolve to increasing degrees of 'FAIRness'.

Data sharing and reuse for environmental management is a topic of importance in the context of global marine conservation particularly in the physical [39], biogeochemical [40] and ecological [41] domains. However, when data is discovered by a user, how can the reusable nature within an MSP context be ascertained? Having data and understanding the potential locked within, or how to combine said data with other datasets, is what is demanded to ensure Ireland's marine waters are protected; by providing evidence based, comprehensive and comprehendible data to facilitate informed decision- making.

Data quality is defined as the state of completeness, accuracy, validity, uniqueness, consistency, timeliness, clarity, and availability, integrity, reasonability [42,43]; collectively these all make data suitable for a specific use. However, traceability is not mentioned – it is possible to obtain traceability from data; not only to get to the origin of the data, along with any transformations it may have gone through; its lineage, but no one understands the potential and limitations of a dataset better that its creator. These findings emphasise the positive outcome when stakeholders are consulted in relation to what the data may be used for, and or how it could be combined. This is exactly what this innovative MSP stakeholder engagement process has offered to the quality of the data being utilised for marine planning in Ireland.

Enabling data generators to add context to the datasets via metadata management and presentation optimises the reuse potential and overall value of a given resource [44]. This can be achieved using matrices: *"Data stewardship is the management and oversight of an organisation's data assets to help provide business users with high-quality data that is easily accessible in a consistent manner"* [45]. Adding context associated with a

dataset can really help the end users ascertain the reusable nature and help to establish the 'best available data' within an MSP context.

Different management approaches can be observed within 'quality, accessibility, and usability' including varying levels of accuracy and completeness within the metadata, despite coming from the same organisation or agency [46]. The Stewardship Maturity Matrix [34] measures how well data are managed, taking 5 Preservation Principles into consideration: 1) Discoverability, 2) Accessibility, 3) Usability, 4) Preservation and 5) Curation; by assessing these components against a scale, data can be compared objectively and improved over time ([27]).

When developing appropriate internationally agreed data flagging systems for use on individual data points in data files, Peng et al., mapped **Usability** to 4 components of a Maturity Matrix:

1. **Data Encoding** - Data structured using best practice methods; with preference given to non-proprietary international standards.
2. **Data Documentation** - Data documented to optimise access, use of, comprehension, well defined processes implementing international or community approved standards.
3. **Data Traceability** - Data to include provenance metadata clearly illustrating the origin, full processing information around data lineage for all raw data and final products.
4. **Data Quality-Control** - Data integrity maximised using optimised quality control measures clearly indicated in the metadata.

This study demonstrates a combination of similar tactics such as homogenisation, standardisation and categorisation to address Data Encoding. A set of fully documented processes were developed under the Data Management Quality Management Framework to manage Data Documentation and well as provide the context in relation to Data Quality-Control. The Marine Institute's Data Catalogue [47] handled Traceability by holding all the relevant information regarding the underlying datasets, where the data was owned or managed by the MI staff. However, data owned and supplied by external organisations requires a different approach. Without appropriate measures, one cannot be sure that the metadata supplied is of the required standard that will not require significant rework to extract all the pertinent information in the future [48]. Whilst steps are being made in relation to the management of data within organisations [27], there is little research on the data quality issues of the metadata used to describe and annotate external datasets [49].

Dekker's [50] states that data is of high quality "*if they are fit for their intended uses in operations, decision making and planning*". MSP looks for the 'best available data' but what are the approaches to communicating data quality? For instance, the map disclaimer discussed in the Methodology Section starts to move into the "appropriateness" space - what should the data be used for, and how should it be combined? The NMPF is a document with a wide audience, intended for use by the public, stakeholders, applicants and decision makers. As such, the approach to data and mapping aimed to balance accessibility with accuracy and certainty required for use in decision making. That concept is vital, not only useful in terms of upstream stakeholders wanting to add that message, but in guiding downstream stakeholders in how best to utilise the data.

5. Conclusion

Stakeholder engagement and robust data management are two fundamental elements for successful maritime spatial planning. They must co-occur and evolve in tandem throughout the MSP development, finalisation and implementation stages. Without them the adoption and implementation of plans may be delayed or halted altogether. Examples within the literature of systematic integration of stakeholder engagement responses into maps in a marine plan while concurrently updating spatial datasets plan are scarce. This paper highlights an innovative approach to managing the integrity of marine spatial data over time, while also incorporating the concept of usability and data quality and stakeholder feedback under the guise of 'best available data' in the establishment of an evidence base.

Getting the processes around the management of marine spatial data documented to a high standard, whilst balancing the needs to simultaneously engage and interpret stakeholders' inputs and requirements, has taken a team of numerous disciplines and professional specialisations years to achieve. However, without this investment, how can Ireland be confident they are utilising the best available data in decision-making with respect to our marine environment for future generations?

Having achieved the above, there is the potential to consider application of a similar approach in Member State delivery of other international commitments (for example the Sustainable Development Goals) and objectives by enhancing Data Readiness for other data-hungry initiatives and by utilising the FAIR Principles along with the concept of Data Maturity Matrices.

Declaration of Competing Interest

The author declares that they have no known competing financial interests or personal relationships that would have influenced the literature and work reported in this paper.

Data availability

Data will be made available on request.

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