MareFrame

A description of the potential impact (including the socio-economic impact and the wider societal implications of the project so far) and the main dissemination activities and the exploitation of results

The MareFrame project was initiated in order to facilitate increased implementation of ecosystem-based approach to fisheries management (EAFM) in Europe. The challenge of implementing EAFM is that it requires development and best use of innovative scientific methods, new tools and technologies as well as new statistical, modelling tools and assessment methods that go beyond the single-species approaches which have been the main sources of scientific advice in European fisheries until now. It also requires adaptation of current management objectives and practises. A key objective of the project was therefore to develop and/or make the best use of new tools, technologies and information that could be used to assist with EAFM. Innovative assessment methods also needed to be developed or expanded to address multispecies concerns, resulting from biological interactions between species and the ecosystem as a whole; including socio-economics. A new range of approaches supporting the development of new assessment tools, including ecosystems models, were considered and developed. These were then tested/validated in eight case studies; ranging from data rich marine ecosystems with a long history of fisheries exploitation, to data poor systems where biological-, ecological, social- and economic data was lacking. The models and their outputs were compared and evaluated with respect to their suitability for fisheries and environmental management purposes. All of this was then used as input when developing an innovative decision support framework (DSF) that serves to provide an evidence basis for stakeholders and policy makers about the trade-offs between various management options on a multispecies basis. Management Plans (MPs) where developed in an iterative process in co-creation with stakeholder, which integrated fisher's knowledge and considered socio-economic effects. Last, but not least, the project placed emphasis on disseminating the findings from the project and training relevant scientists, policy makers and stakeholders in using the outputs of the project. Some of the MareFrame outputs were indeed designed to be user-friendly specifically for this purpose and an interactive learning tool was in addition developed so that non-scientific stakeholders could benefit from the outputs of the project.

Following is a discussion on the potential impact of MareFrame and summary of the main dissemination activities and exploitation results.

Potential impact:

The expected impact in the topic description (KBBE.2013.1.2-08), according to which MareFrame was funded, stipulated that the project should provide new knowledge, methods, models and tools to support the integration of an ecosystem-based approach in fisheries advice and to support decision-making for ecosystem based fisheries and environmental management. It should also be of high relevance to the future management of marine living resources and support proper implementation

of the new CFP, the Marine Strategy Framework Directive (MSFD) and the Habitat Directive. It is safe to say that all of these expected impacts have been met, and more.

New knowledge that supports EAFM has been gathered and developed. This includes integration of new and sometimes novel data into ecosystem models. A specific WP was dedicated to this task (WP2) and as result there have been a wide range of new data identified, collected and integrated into the models. The data generated included for example biological data, fisheries dependent data (e.g. fishers' knowledge, VMS), environmental data (e.g. microchemist, climate, oceanography), diet-related data (e.g. isotopes and stomach), and genetic data (e.g. close-kin, connectivity). A total of fourteen different protocols were written to describe the final implementation of the novel data into models within each case study. These protocols can be useful to the scientific community to implement similar data in ecosystem models beyond the lifetime of MareFrame. WP2 did also Identify and recommend areas of future data collection for optimum implementation of the models that will have impact on future work within the field of EAFM research.

A large amount of data was collected within MareFrame. Much of this data was harmonised and imported into the MareFrame DataBase (MFDB) which was designed to be a generic tool for the future, rather than being irrevocably wedded to MareFrame. The MFDB is now available for everyone at github (https://github.com/mareframe/mfdb) and is already in an active use by MareFrame partners, as well as scientists outside the consortia. The utility of the MFDB has been validated in projects outside MareFrame and has even been added to by projects such as MINOUW. Both the data itself and the MFDB represents a major impact that expands beyond MareFrame and will potentially be widely used in the future.

MareFrame developed and advanced ten ecosystem models (Gadget; gadget-like, EwE, EwE like, Atlantis, MSPM, T-ONS, Green-, amber- and red models) and at least two were applied to each of the eight case studies. The models and the understanding that was reached regarding their use and their data requirements represents an important impact; both within the case study areas and beyond. Knowledge gaps were also identified, and steps were taken toward multispecies management strategy evaluation. The project leaves behind fully operational ecosystem models ready to implement an EAFM. These ecosystem modelling tools and the associated indicators used in all case studies were all documented in the deliverable reports. In addition, most of these are currently being prepared for peer-reviewed publication, ensuring that the results will be available and used by scientists beyond the lifetime of the project. The potential impact of the models and the associated work are therefore significant.

In regard to the case studies themselves, it is clear that the potential impact of MareFrame is substantial. The knowledge, tools and data that can support the implementation of EAFM are now available and in some cases the work has already commenced. Both ICES and GFCM working groups

are currently using some of the models developed within the case studies. It is therefore safe to say that specific case study models have already had impact beyond the project.

The DSF developed within MareFrame is designed to support the presentation, comparison, and structured evaluation of a set of scenarios developed to represent candidate strategies to address identified management problems and concerns. The approach allows users to evaluate trade-offs between the scenarios across a range of relevant dimensions, while taking their preferences and priorities explicitly into account. It therefore allows for exploring "what-if?" scenarios were likely effects of management decisions are presented. Most of the tools (DSTs) that are in the DSF are generic and can be readily applied to new cases, and this is supported by available guidelines. A number of planned publications will help to facilitate awareness and foster critical discussion about the development and use of the DST as instruments to advance EAFM. The potential impact of the DSF and the DSTs beyond MareFrame are therefore significant. MATIS has committed to hosting the DSF beyond the lifetime of MareFrame and there are at least two on-going H2020 projects that will be utilising the DSTs i.e. REEEM and FarFish.

A specific WP was dedicated to synthesising the outcomes from the rest of the WPs and to compare and evaluate the developed ecosystem based models and the decision support system with respect to their suitability to predict ecosystem changes in the regional case studies investigated in the project, their capability to improve marine policies and their ability to assess socio-economic impacts. This WP also aimed to propose how a new integrated EAFM could be implemented in Europe, and develop an interactive learning tool to facilitate the implementation of EAFM. In order to achieve this, MareFrame developed a methodology for comparing models and assessing DSF for the implementation of EAFM, a methodology for Socio-Economic Impact Assessment (SEIA) for EAFM was also developed. A Road-map for integration of DSF for EAFM was constructed, which was in the format of a policy brief that included identification of barriers for wider implementation of the DSF and provided recommendations on how to overcome these barriers for EU decision- and policy makers. And finally, an interactive learning tool was developed for training purposes for key users of the DSF. This learning tool is called "SeafoodSim" and is available at https://tokni.com/dev/main.html.

All of these outputs could potentially make an impact well beyond the MareFrame project. The methodologies for comparing models, assessing DSF and the SEIA will undoubtedly be used by scientists in future work on EAFM. The road map has already provided policy makers with recommendation on future integration of EAFM in Europe, and SeafoodSim has the potential to increase understanding on the DSF and EAFM among stakeholders. SeafoodSim has as well contributed to work in the H2020 project SAF21 and could potentially be expanded on in the future.

The co-creation approach was embedded in the research design and implementation of MareFrame. The co-creation approach combines analytical and participatory tools to generate knowledge that has scientific acceptability (credibility), policy relevance (salience) and social robustness (legitimacy). In practice, this has meant a total of 30 stakeholders meetings, 10 remote meetings, 4 EU level meetings

and 166 participants involved in an iterative process. The main conclusion from this co-creation approach with stakeholders is that the approach leads to benefits beyond what could be achieved through traditional research. If successfully implemented, the approach ensures an enhanced and meaningful participatory process, which is particularly relevant due to the complexities of the EAFM and of the EU institutional setting. The pathways to integrate EAFM in the advisory system – considering the ecological, biological, economic and social dimensions- have been jointly identified with the main players (ICES, STECF, DG-MARE, ADVISORY COUNCILS). The results have been widely disseminated to the scientific, policy, industry, NGOs, and other social communities. Furthermore, a recommendation regarding participatory approaches in research and policy processes linked to EAFM has been presented. The researcher-stakeholders' teams involved in MareFrame have experienced an in-depth collaborative process with impacts that go beyond the project lifetime, contributing to the transformation of the culture of science in the EU.

MareFrame has placed emphasis on disseminating the results of the project to a wider audience and as results there have already been reported 246 dissemination activities within the project, 23 peer-reviewed publications in scientific journals, and 4 PhD and 2 MSc theses have been submitted. Many additional scientific publications are being worked on, most of which will be published in a special issue of Fisheries Research. There are as well 8 PhD students that have been working on MareFrame that have yet to submit their final theses. All this dissemination of project results has the potential to have impact beyond the lifetime of the project, as scientific outputs will be used and expanded on; and all of the students educated within MareFrame will undoubtedly have impact on the future of science.

MareFrame has developed educational materials relevant for EAFM and held advanced training schools, workshops and webinars where these materials have been used. These have now been made available as downloadable educational lessons for teachers on EAFM and made available on Tutor-Web https://tutor-web.net where they will have impact into the future.

MareFrame organised a number of events where stakeholders and policy makers were invited to participate and contribute to the co-creational approach. Their participation ensured the appropriate uptake of the project's results by the target audience. A Policy Day was organised in Brussels in June of 2017 and again in December that same year, where EU policy makers and other high-profile stakeholders were familiarised with the DSF and presented with other outcomes of the project. A concluding symposium was also organised in Brussels in December of 2017 where the main outcomes of MareFrame were presented to the scientific community.

An important product of MareFrame is the H2020 Marie Skłodowska-Curie MSCA-ETN project SAF21 (Grant Agreement no. 642080). SAF21 (www.saf21.eu) is in essence a "daughter project" to MareFrame where 10 PhD students are being educated in topics related to social-science and fisheries management. Early on in MareFrame, some key partners decided to apply for ITN to fill in gaps that MareFrame was not addressing, related to social-science and fisheries. These two projects have

consequently supplemented each other and SAF21 can therefore be considered as a product of MareFrame that will have impact beyond MareFrame.

Socio-economic impact:

During the MareFrame project the socio-economic impact for the various scenarios in the seven European case studies was calculated and reported on in a report titled “Socio-economic impacts of a EAFM” (D7.6). The impact assessment was considered as part of one of the steps in the decision support processes, by highlighting the socio-economic consequences of the various scenarios, informing the stakeholders of the implications of their decisions. A multi-criteria analysis (MCA) was employed to measure the socio-economic impacts, which allowed for an analysis of how the different priorities or weights influenced the analysis. A key conclusion from this process was that the ecosystem models have taken a large step forward in including economic and - to a lesser extent - social variables, within the models. This is a very positive development towards the EAFM and provides a better foundation for exploring management alternatives. The need to work towards incorporating a wider range of economic variables and social indicators as part of the modelling effort is evident, in view of the limited social indicators included in the ecosystem models thus far. Addressing such a challenge would require collaboration across disciplines and the inclusion of economists and social scientists within the modelling work. A successful collaboration would present a huge step in the right direction in advancing EAFM. These results have the potential to have impact beyond MareFrame. Future research and innovation may build on these outputs to further improve the tools available for implementing EAFM and evaluate the associated socio-economic consequences.

The socio-economic impact assessment was applied to all of the European case studies, where MCA analysis was performed on the management alternatives. Due to the MareFrame co-creation approach, the case studies vary greatly in terms of the identified challenges, objectives and management alternatives to be explored. As a result, there is no single conclusion from the analysis that is valid across all case studies.

Since the weightings for the MCAs were not assigned directly with stakeholders, additional sensitivity analyses were performed assigning different weights to the various criteria, to illustrate the variations across management alternatives according to the criteria prioritised. These sensitivity analyses were largely based on the objectives set by the stakeholders of each case study. Keeping this sensitivity analysis in mind, the optimal scenarios were quite clear in some cases, like for the South-Western Waters and for the Black Sea, whilst the level of complexity was higher for cases such as the Baltic Sea and the Strait of Sicily, where the best performing scenario was dependent on what weights were assigned. However, there were clearly a few select scenarios which performed the best despite the weightings, and in those cases, the MCA narrowed the range of options, but the most desirable scenario depending on the priorities assigned by the decision-makers.

The socio-economic impact assessment highlighted that a larger integration of economics into the ecosystem models would be desirable. Either directly by treating economic data as any other data

component or by linking different ecosystem, economic and social modelling approaches together to a greater extent than is done today. Also, there is a need to extend the analysis to a larger range of economic variables, as well as to ensure that these variables are modelled as realistically as possible. Additionally, the need to work towards incorporating a wider range of social indicators as part of the modelling effort is evident, in view of the limited social indicators included in the ecosystem models.

Socio-economic impacts of implementing EAFM could be extreme and would depend largely on how decision makers prioritise trade-offs. It is clear that MSY cannot be reached for all species in the same time when considering EAFM, which essentially means that some stocks, fleets and regions will have to be prioritised. A good example of this is the trade-off between the cod and the pelagic stocks in the Baltic Sea, where it is clearly in the benefit of the demersal fleet to protect the pelagic stocks, but in the benefit of the pelagic fleet to overfish the cod stock. When also considering social and economic prioritising these trade-offs become even more complex. The core of the MareFrame project is to allow policy makers and other stakeholders to understand these trade-offs; which have severe socio-economic impacts.

The main dissemination activities and exploitation of results

The aim of the dissemination in the MareFrame project was to make the project results well-known in Europe and to disseminate the results to all potential stakeholders; including other relevant on-going projects and initiatives, aiming to create synergies and to increase the visibility of the project worldwide.

The dissemination strategy was focused on awareness (activities and outcomes), understanding and action (change of practice resulting in the adoption of the MareFrame approaches). Dissemination and training actions were the primary building blocks for complete and effective communication, dissemination and exploitation of the MareFrame foreground (i.e. results, including information, materials and knowledge generated).

The co-creation approach proved to be an effective way to increase utilisation and improve the quality and relevance of research, by involving potential users in the planning and implementation of the research design; ensuring the continued coherence of the research questions and the answers needed. Co-creation through participation enhances dissemination, as stakeholders feel greater ownership and responsibility for the goals, activities and successes of the project.

The main dissemination activities

Peer-reviewed publications are important to ensure uptake and dissemination of project results. To date, there are 23 peer-reviewed scientific papers that have been published within the project. In addition, there are a large number of MareFrame manuscripts that have been submitted for publication in a special issue of Fisheries Research journal, titled: “Advancing Ecosystem Based

Fisheries Management" that will be published in 2018. Many of the papers were presented during the MareFrame Scientific Conference in Brussels.

There were 246 dissemination activities recorded during the course of the project, and four of them had to do with organising conferences. The last conference - the scientific conference in Brussels, December 2017 - was preceded by a Policy Day and the Final Meeting of the MareFrame consortium. The External Advisory Group (EAG) evaluated the final meeting, finding that the project has been highly successful in meeting its overall objectives and increasing the skills of participants across Europe in the use of multispecies and ecosystem models. They stated that the participation in the final project conference in Brussels was impressive, notably from external stakeholders, with more than 140 registering an interest in the conference. They reported that overall, dissemination of information from MareFrame has been impressive throughout, both with regards to the level and the variety of stakeholders included. The EAG wrote that stakeholders consulted at the conference vouched for this, and that there was also evidence of MareFrame's scientific penetration in various other projects. The EAG professed to being pleased to record the progress made in disseminating the information and approaches of MareFrame to a broader scientific and stakeholder audience, in many cases beyond Europe. They plaudit the website content, and the publications achieved and planned, as testament to the will of all participants to make this project work and deliver, but still to generate excellent (mainly peer-reviewed) output.

However, they also found that to achieve the aims of the Decision Support Framework (DSF) more broadly in the future, there needs to be a "champion" identified to advance its use. Furthermore, they emphasise that the roadmap produced by the MareFrame project is a critical outcome. They do say that the level at which it is presented seems rather too high to encourage its implementation in as meaningful a manner as it could be. The fact that EAFM is not currently being implemented by as many practitioners as the partners would wish is however not a failing the MareFrame project, or associated projects, in terms of a scientific knowledge gap, but rather a policy or administrative issue.

Exploitation of MareFrame Foreground

Each work package generated a series of exploitable results, which are outlined in part B2 of the Final Report, along with potential users, use manner and the way in which they can reach these users.

The development of innovative knowledge frameworks on EAF is an example of an exploitable foreground from WP1 of the MareFrame project. Its purpose is to explore current practices in participatory approaches and to define new frameworks for science-stakeholders' cooperation, which will encourage more effective collaboration between scientist and stakeholders. The Fact Sheets produced by WP1, summarising the events and outputs of each case study, are another example of an exploitable foreground. These Fact Sheets may be used to raise awareness of EAF at stakeholder and public regional sea levels.

A protocol for the correct implementation of novel data types into assessment models is an example of an exploitable foreground from WP2, allowing assessment scientists to put the tools developed by MareFrame to their intended use.

The main exploitable foreground of WP3 is the finalised version of the MareFrame database (MFB), used for upload and extraction routines available for all data sources and methods.

WP4 of the MareFrame project produced many exploitable foregrounds, the most important of which was the parameterisation of two or more ecosystem models for each case study, used to develop the EAFM models.

The main exploitable foreground of WP5 were the developed case studies that allowed scientists and regional stakeholders to investigate the effects of fishing and climate change scenarios on key ecosystem processes.

The "MareFrame platform for EAFM decision support" was the main exploitable foreground of WP6. It can be used by stakeholders, policy makers and researchers as an interface and a source of data to explore "what-if?" scenarios to support EAFM planning. Additionally, the platform contains the toolbox, applications, installation procedures, databases, documentation and reports needed to install, configure and run the DSF in another context.

The main exploitable foreground of WP7 was the road map that was created for the implementation of DSF. It is a comprehensive guideline for the implementation of EAFM based on the project findings, and may be used by researchers, policy makers and stakeholders alike to ensure that ecosystem issues (including socio-economic once) are considered robustly in future resource management decisions.

The final evaluation of the EAFM is the main exploitable foreground of WP8. It has been published as a scientific paper, allowing policy makers, researchers and stakeholders to learn of the Risk Based Management Strategies (RBMS) involved in EAFM.

MareFrame successfully disseminated the project outputs and the project main dissemination material was assembled in a MareFrame Portfolio that has been published at the project website. A special issue of the Fisheries Research journal will be dedicated to peer-reviewed publications on MareFrame results, titled: "Advancing Ecosystem Based Fisheries Management".

To determine which of the expected results had the best exploitation potential, two surveys were designed and circulated within MareFrame, one focusing on the scientific results and the other on the commercial outcomes (See Annex 3 of D8.7). Out of the project deliverables, it resulted that D5.3. "Report on model outputs in each CS and DSF tools" have the highest capitalisation potential, as well as the teaching material resulting from training activities.

Concerning the commercial outputs, the potential customers were represented by the fishing industry, NGOs, decision makers, and the commercialisation channels by consultancy services.

As a continuation of the project, the MareFrame homepage will be hosted at MATIS and active at least for the next five years (domain and hosting covered by MATIS). Furthermore, after the five years period, the content of the MareFrame website will be included under MATIS' website web tree and MareFrame address will be forwarded to this new site location. The resulting Database and Decision Support Framework will be subsequently taken over by MATIS.

The MFDB will continue to be available at https://github.com/mareframe/mfdb

Finally, the MareFrame consortium echoes the hope stated by the External Advisory Group in their final meeting evaluation: “Hopefully, the momentum and enthusiasm this project created will be maintained into the future, to the benefit of mankind in general, not just science.”