COMPLETE PLUS

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IMPLEMENTATION OF THE MULTI-CRITERIA DECISION SUPPORT TOOL FOR BIOFOULING MANAGEMENT

Memorandum

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CONTENT

SUMMARY

The aim of the COMPLETE PLUS project is to explore how the results and outputs of the earlier COMPLETE project can be implemented and operationalized to ensure their sustainable use by all relevant actors and stakeholders. Therefore, during the COMPLETE PLUS project, a series of on-line meetings were held for potential end-users representing different backgrounds and countries to demonstrate and use the multi-criteria decision support tool for biofouling management developed within the earlier COMPLETE project. In these meetings, the main results of the tool were presented and the feedback from the end-users considering the benefits and drawbacks of the tool and possible future development was collected. This memorandum presents the results of these on-line meetings. Based on the results, the tool is useful for increasing the comprehensive understanding about the complex biofouling issue and to study the general trends of the issue. However, a user-friendlier software is needed where the modifications are easy to make by the end-users.

INTRODUCTION

Biofouling is a natural process caused by the accumulation of micro-organisms, algae, or plants on immersed surfaces such as ship hulls (Amara et al., 2018). Biofouling has a significant impact on the ecosystems as it is considered one of the main pathways of introduction of harmful non-indigenous species (NIS) (Molnar et al., 2008). The International Maritime Organization (IMO) has recognized biofouling as one of the most significant ecological and economic challenges of shipping (IMO, 2011). Currently, IMO has set optional guidelines for action with biofouling but binding biofouling management regulations for the shipping industry are needed to control and manage ships' biofouling and reduce the risk of introduction of NIS.

The accumulation of biofouling causes a major economic impact on the shipping industry as it increases drag and fuel consumption as well as reduces the overall hydrodynamic performance and maneuverability of the ship. To control the negative impacts of biofouling, the shipping industry uses the coating and in-water cleaning (IWC) as methods to keep the hull clean. The benefits of biofouling management for the shipping industry are reflected in reduced fuel cost and maintenance as well as the improved maneuverability of the ships. However, environmental risks related to biocidal coatings and IWC without collecting devices occur. Thus, decisions related to the biofouling management have various effects on both shipping and the environment, requiring balancing between different aspects to make optimal decisions. When the biofouling is managed properly, the risk of transferring NIS is reduced and less greenhouse gasses and air pollutants are emitted from ships.

Biofouling management is a complex socio-eco-technical system that needs to consider different environmental, economic and societal factors in order to find the most optimal management approach. The former Complete ("Completing management options in the Baltic Sea to reduce risk of invasive species introduction by shipping") project was designed to tackle this complex socio-eco-technical problem (See https://balticcomplete.com/). The overall aim of the Complete project was to find ways to minimize the introduction of harmful NIS via ballast water and biofouling of the ships by developing management strategies and tools for the Baltic Sea region.

All the main results and deliverables of the Complete project related to the regional biofouling management are provided in the roadmap to regional biofouling management in the Baltic Sea (BMEPC, 2019). As one of the outcomes of the project, a causal, graphical, multi-criteria decision

support tool was developed to support transparent decision-making and communication and increase user's comprehensive understanding about the biofouling management issue. The tool allows case-specific analysis (different ship types and sizes, and operational profiles) and considers both costs related to fuel consumption and biofouling methods (coating type and IWC) and environmental risks related to NIS introduction risk, eco-toxicological risk due to the biocidal coatings and CO_2 emissions (Luoma et al., 2021). Based on the tool, the optimal biofouling management often consists of a biocidal-free coating with regular IWC and filtering devices collecting the released material. Consequently, eco-toxicological risk and the NIS introduction risk is low and savings in the fuel costs due to the lower biofouling level occur. Therefore, the tool demonstrates that biofouling management can be both environmentally conscious and cost-effective. The increased understanding about environmental risks can increase the acceptance for the future legislation regarding biofouling management.

This memorandum is written as a part of the COMPLETE PLUS ("Practical implementation of the Complete project outputs and tools") project funded by the Interreg Baltic Sea Region Program, which is an extension of the initial Complete project. The aim of the Complete Plus is to ensure that the tools and outputs developed in the Complete will be operationalized by the end-users. In order to achieve this objective, online meetings and training were provided for the main target groups - such as shipping companies, environmental and maritime authorities and ports. In these meetings, the tool and its results were presented to the potential end-users, and feedback on this tool and its development was collected. Next, the content of the meetings, the main findings and the future development will be presented in more detail.

ON-LINE MEETINGS

We organized five on-line meetings for ten end-users with various backgrounds (authorities, shipping and IWC companies) and from different countries (Finland, Denmark, Estonia and Latvia). It was important that the meetings were as interactive as possible and therefore we only had a couple of end-users per session. At the beginning, the idea was to have face-to-face meetings but due to the COVID-19 pandemic situation, we could only have on-line meetings.

Each meeting was a two-hour long consisting of a presentation considering the COMPLETE project, the development of the tool and its main findings and a facilitated pilot use of the tool. The sessions were recorded and notes were written. The aim was to 1) present the main findings of the tool 2) demonstrate and pilot-use the tool and finally 3) gather information and opinions from the end-users considering the tool. The goal was to have open discussions and bilateral knowledge sharing to increase both the end-users and researchers' understanding considering the topic.

RESULTS OF THE MEETINGS

Feedback on the benefits of the tool

The end-users involved were generally of the opinion that there is a need for a more holistic understanding about the consequences of the biofouling management actions. They all thought that the tool increases this understanding. They appreciated the logical and graphical presentation of the overall biofouling management issue. Further, the end-users appreciated the causal effects reflected in the tool. The tool was seen as being the most optimal when analyzing the general level of the biofouling management issue. As the "big picture" on the biofouling management is transparently visible in the tool, the authorities believe that it could even increase support for certain restrictions while increasing the awareness. Holistic understanding about the issue can help to avoid undesirable situations, where small economic savings are achieved with the cost of large environmental damages.

Ship-owners and other operators are particularly interested in the economic impact of biofouling management such as fuel costs. However, it is often hard for the ship-owners to estimate the actual fuel savings due to the biofouling management, and thus many of the end-users valued the tool's ability to present the expected savings e.g. due to the IWC. On the other hand, it was acknowledged that the tool is the most optimal for analyzing fixed routes in the Baltic Sea. Many ships in the Baltic Sea sail in fixed routes between the ports and in those cases, the tool can be used for studying the expected consequences of different biofouling management methods. Some of the end-users even acknowledged that the tool has the potential to support the planning of a vessel-specific biofouling management plan recommended by the IMO (IMO, 2011).

All the ship-owners collaborating with the COMPLETE project perform regular IWC. However, the cleaning interval is often based on the experiential knowledge and thus several end-users confirmed that a decision-making tool supporting the optimal biofouling management and IWC interval could be a useful and welcome tool. In addition, IWC companies are also often asked about the effects of hull cleaning on a ship's resistances and fuel costs. This tool provides answers to these questions since it can be used to create different scenarios to study the impact of different coating types and IWC

methods and intervals on fuel costs. In particular, the end-user group representing an IWC company considered this an excellent advantage.

Positive feedback was also received on the illustration of the NIS introduction risk. The tool demonstrates the NIS introduction risk related with certain routes and with different management methods; coating types and IWC methods. The tool's ability to present the importance of collecting the released cleaning material after IWC to decrease the NIS introduction risk was valued by several stakeholders. The end-users noted that this information could encourage the voluntary collection of cleaning material, but also demonstrate the importance of regulations related to IWC. The biggest problem with voluntary collection is related to the cleaning costs that increases significantly when collecting the released material. The marine traffic entering the Baltic Sea region from other regions is intensive and, as IWC prices in the Baltic Sea are currently relatively low, they attract performing IWC in the Baltic Sea. The end-users believe that this is why regulations related to the IWC are needed.

Summary:

- The tool was welcomed for supporting the decision-making of biofouling management
- It supports holistic understanding
- The tool is useful as a general level analysis revealing the multiscale consequences of the issue
- The tool could be utilized when making the biofouling management plan for the ship: allows comparing various methods (coating types and IWC methods) multi-perspectively
- The tool is suitable for fixed routes
- It reveals the NIS introduction risk and the importance of collecting the released cleaning material after IWC

Feedback on the drawbacks of the tool

The tool was seen to offer promising potential but still needing further development to make it more usable. All the participants commented on the software interface. The Hugin Researcher-software (See https://www.hugin.com/hugin-developerhugin-researcher/) that was used as a platform for the tool is mainly intended for researchers and requires some knowledge of the theoretical framework of Bayesian networks and logic structures of the program. Hugin Researcher-software was not originally intended as a tool for casual users. As a result, many stakeholders found its interface difficult to understand. Thus, it was suggested that a more user-friendly and understandable interface would be useful for stakeholders.

Some end-users representing shipping companies raised the need to study the whole fleet at the same time to make the most optimal management decisions. Therefore, they believe that adding this feature to the tool could improve its usability. It was also stated that there should be more routes and even outside the Baltic Sea to make the tool more useful to different stakeholders. “In our case, where traffic is going everywhere, things are much more complex and thus this tool cannot really support our decision making”, one stakeholder said. On the other hand, it was argued that when used only for a specific ship, the model could be even more simplified and focus only on some of the most interesting aspects.

Some end-users wanted more possibilities to modify and update the tool settings such as the fuel, coating and IWC prices. As all the prices may differ annually and between companies, that could be a useful development idea for the tool. Further, it was argued whether the environmental risks could also have comparable units such as monetary values, or whether it would be possible to model the environmental utilities gained due to economic losses (i.e. the tool could show that it costs this much to decrease the NIS introduction risk to this level).

Some of the end-users, especially in a position to make the decisions for the timing of the IWC, wanted a tool for supporting them in solving such practical problems. However, a tool of this kind would need automatically delivered data from the specific ships to be able to model this, which is impossible in this case. In addition, many end-users discussed the usefulness of the tool in winter. It is important to take winter conditions into account in the Baltic Sea region, but this was intentionally

omitted from the first version of the tool. Winter conditions with varying ice coverage are challenging to model and thus left out from the first version of the tool.

Summary:

- A user-friendlier interface is needed
- Options to study the whole fleet at once and more routes could be added
- The simplified version of the model for the single ship-level modellings could be developed
- Possibility to modify and update the tool easily by the end-user is required
- Comparable units for costs and risks is desired
- A tool for defining the most optimal ship-specific cleaning time is needed
- Winter time modelling (including ice-free and icy conditions) is missing

FUTURE DEVELOPMENT AND CONCLUSION

The general feedback from the meetings was that the decision support tool was seen as a useful addition to increase the understanding considering the complex biofouling management issue. However, the first version of the tool is a prototype, and thus further improvements are needed to enhance the practical usability. As models are always simplified versions of reality, not everything can be considered. The selected software imposes boundaries and the quantity and quality of the data is often limited which result in that trade-offs need to be made regarding the structure of the model. However, one of the advantages of the tool is that it is easy to update when more data occurs.

The decision support tool can increase the understanding considering the biofouling management issue and could actually be utilized when the biofouling management plan is made. However, the tool could be more user-friendly to make it easier to use, especially among non-researchers (the current software is made for research purposes). In addition, if the tool had more routes and the costs could be easily modified by the users themselves, the tool could be even more case-specific. For wider use, it is essential that the tool is free and easy to access.

The tool demonstrates that if the devices collecting the released material are not utilized when the hull cleanings occur, the NIS introduction risk is multiple in comparison with the situation when the devices are utilized. However, the hull cleaning devices collecting the material are always an additional cost and, therefore rarely used if not compulsory. This is very essential to recognize when planning the guidance considering the biofouling management in the Baltic Sea. Since some biofouling management methods cause more expenses for the private sector, only mandatory legislation can secure the use of environmentally conscious methods. In addition, due to the high competition between hull cleaning companies and the lack of regulations in the Baltic Sea, the hull cleaning costs are lower there than in many other regions. This attracts the ships sailing in the Baltic Sea to perform the cleaning rather in the Baltic Sea than somewhere else. Therefore, legislation requiring collecting devices is even more urgent. Finally, there is still a need for better hull cleaning methods and effective but environmentally conscious coatings to achieve improved biofouling management in the Baltic Sea.

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