TOOLBOX AQUACULTURE

hcmr ΕΛΚΕΘΕ

Predicting environmental concentrations of antifoulants released from fish farms

SUGGESTED USERS	PLANNING PROCESS	TYPE OF AQUACULTURE
Aquaculture producers Regulators	EIA Environmental monitoring Prediction of environmental concentrations Risk assessment of antifoulants	Marine fish pens

SUMMARY

Use of MAMPEC to calculate the concentrations of total copper in the water column and in sediment from three fish farms in the Eastern Mediterranean Sea in summer and winter.

DESCRIPTION

Use of MAMPEC to predict the concentrations of antifoulants released from aquaculture nets for the assessment of their effects on the aquatic environment. MAMPEC is a steady-state 2D integrated hydrodynamic and chemical fate model to predict environmental concentrations (PECs) for the exposure assessment of antifoulants in marine environment. MAMPEC offers a user-friendly interface to quickly estimate the concentrations of antifoulants in the water and sediment around fish farm cages. MAMPEC take into account environmental features, antifoulant characteristics and fish farm orientation. It should be considered for use before applying antifoulants on the fish farm nets to estimate the potential effect on the aquatic environment and to evaluate the supreme coverage of nets for the least consequences on the marine aquatic life.

THE ISSUE BEING ADDRESSED

In aquaculture, the continuous biofouling of nets may increase the hydrodynamic resistance and may threaten the structural integrity of cages. It may also induce hypoxia with lethal or sub-lethal consequences to the farmed fish. Antifouling paints are used to mitigate biofouling on fish farm nets by creating a toxic boundary layer at the surface of the paint as the component biocides leach out. These paints are usually based on copper and are applied to nets typically made from synthetic fibres. The active ingredients of these paints leach into the water in their dissolved or particulate form and may provide an important source of copper to the aquatic environment. High concentrations of copper may become toxic to some algae, even if copper is essential for other organisms. Consequently, toxic effects on non-target local marine life both in the water column and the sediments below the cages, where the chemicals tend to accumulate may occur. The leaching rate of copper antifouling paints in the marine environment depends on seawater composition, temperature, and flow.

The main objective of the case study was to assess the potential impacts of the use of copper-based antifoulants on aquaculture nets on the marine environment of the Eastern Mediterranean Sea.

THE APPROACH

The approach followed was the Marine Antifoulant Model to Predict Environmental Concentrations (MAMPEC), a steady-state 2D integrated hydrodynamic and chemical fate model. The Eastern Mediterranean Sea (Greece) was selected due to its high aquaculture production and its different hydrodynamic and morphological characteristics in order to monitor the Eastern part of the oligotrophic basin. The aim was to predict the total copper loads in the water column and sediment around three fish farms with different annual fish production and different flow regimes.

The input data for MAMPEC include several parameters:

- Environmental characteristics: hydrodynamics (flow velocity etc), water characteristics (POC, DOC, SPM, Chla, salinity, temperature, pH etc), layout (site dimensions such as length, width, depth), sediment characteristics, background concentrations
- Compound description: molecular weight, solubility, Kd, etc.
- Emission of compound: coverage of product, concentration of active ingredient, fraction of released active ingredient etc

The model input data for the three fish farms were collected by the field observations, the AIM modelling based on field data, the fish industry, other case studies and literature. Antifoulant paints consists of various chemicals. Total copper was selected in order to predict the concentrations in the water column and sediment of all possible chemical forms of copper. Two

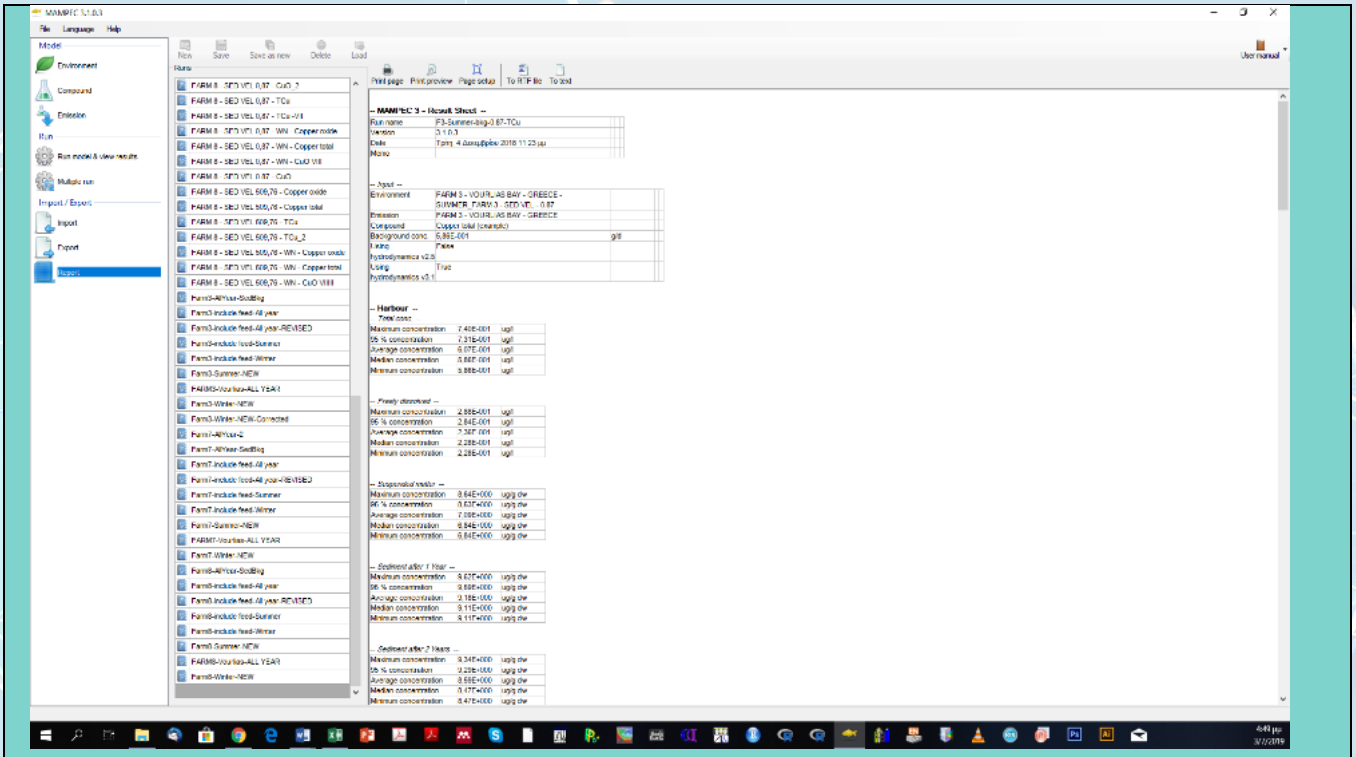
seasons were investigated so as to examine the influence of the environmental characteristics on the concentrations of copper in the marine environment.

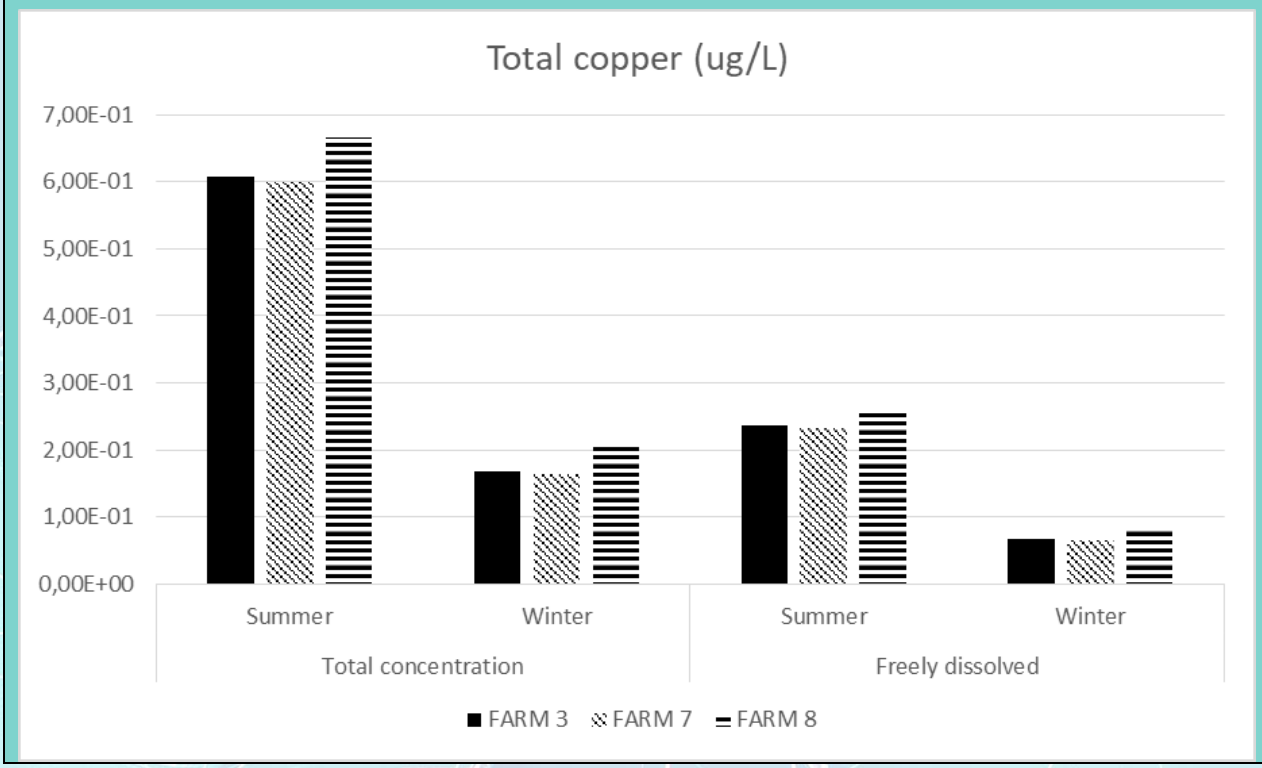
THE RESULTS

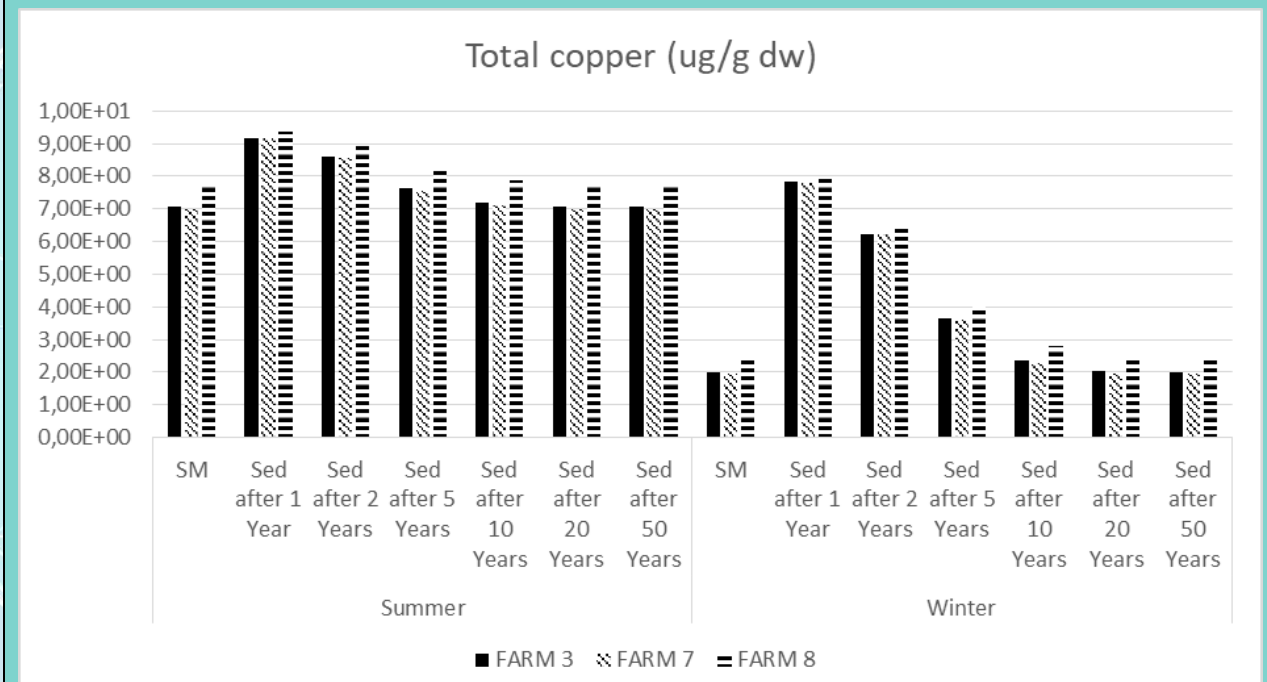
The model output suggests a seasonal differentiation of the concentrations of total copper in the water and sediment around the fish farm cages. Furthermore, the model predicts a decrease of the concentration of total copper in the sediment through years during winter. However, during summer, it seems that the total concentration increases after 1 year but after 2 years it reduces and then remains almost constant. It seems that the flow velocity is an important factor to reduce antifoulant wastes because higher velocity causes stronger dispersion of antifoulants in the environment both in the water column and sediment.

THE BROADER APPLICABILITY

The intensive aquaculture production in the Mediterranean Sea and the unavoidable use of antifoulants in cage nets impose the necessity to monitor frequently the potential effects on the marine ecosystem in terms of the possible risks for the aquatic life. The field samplings are not always possible on a monthly basis, thus other alternatives should be investigated. MAMPEC is a good choice to follow as it only needs basic field data and is easy to be performed frequently. Furthermore, for an adequate environmental management of the antifouling paints, it is necessary to apply predictive models, such as MAMPEC, to assess the concentration of the active ingredient of antifoulants in the water column and sediments, which could affect marine organisms. The model outputs including the predicted concentrations of total copper could contribute to chemical risk assessment based on established threshold limits for water and sediment. It can also contribute to the long-term chemical risk assessment based on the predictions of copper concentrations after 50 years.







SWOT ANALYSIS	
STRENGTHS	If the required data are available, the tool is quick and easy to use.
WEAKNESSES	The model does not take into account other sources of copper in the environment which may lead to an underestimation of the environmental concentrations. The additional sources of copper should be considered manually in the model.
OPPORTUNITIES	Can be used to predict environmental concentrations of antifoulants from aquaculture which may be used for further risk assessment analysis.
THREATS	Requires information and measurements from the marine fish farming which may not be available.

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LINK	Link to MAMPEC: https://www.deltares.nl/en/software/mampec/