AQUA-USERS: AQUAculture USEr driven operational Remote Sensing information services

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Summary

The FP7 project AQUA-USERS will provide the aquaculture industry with user-relevant and timely information based on the most up-to-date satellite data and innovative optical in-situ measurements. The key purpose is to develop an application that brings together satellite information on water quality and temperature with in-situ observations as well as relevant weather prediction and met-ocean data. The application and underlying database will be linked to a decision support system that includes a set of (user-determined) management options. Specific focus will be put on the development of indicators based on Earth Observation (EO) data for aquaculture management including indicators for harmful algae bloom (HAB) events. The methods and services developed within AQUA-USERS will be tested by the members of the user board, eight aquaculture companies and organizations, which represent different geographic areas and aquaculture production systems.

Introduction

With global population expansion, the demand for high-quality protein is rising dramatically, and fish farming is gaining importance to ensure food security. Aquaculture is the fastest growing food production sector worldwide. Environmental conditions determine the growth and health of the produced species, while the production often releases large amounts of nutrients to the surrounding environment. Therefore, monitoring is needed on several levels. However, up to now, the available data is often disparate, inconsistent in coverage and of unknown quality.

To support the growth of efficient and sustainable aquaculture production, AQUA-USERS aims at providing the aquaculture industry with user-relevant and timely information based on the most up-to-date satellite data and innovative optical in-situ measurements. The key purpose is to develop a web portal and mobile application that bring together satellite information on water quality and temperature with in-situ observations as well as relevant weather prediction and met-ocean data. A decision support system underlying the applications will link this information to a set of user-determined management decisions. Specific focus during the project will be put on the development of indicators based on Earth Observation data for aquaculture management including indicators for HAB events.

Materials and methods

Satellite and in-situ data

Satellite data forms the core information of AQUA-USERS. Within the project, an archive of 10 years of water quality products derived from ENVISAT MERIS Full resolution data is set up based on algorithms specifically developed for the regions that host the aquaculture sites. Initial results are

based on data provided by the ESA Ocean Colour - Climate Change Initiative. Also, Sea Surface Temperature (SST) data are collected and validated.
In close collaboration with the users, in-situ data will be collected at the users' production sites. These data include radiometric measurements, Secchi depth, cell counts, concentrations of pigments, suspended particulate matter and coloured dissolved organic matter, data on phytoplankton composition, environmental conditions as well as the actual response of the aquaculture.

Detection of harmful algal blooms (HAB) and aquaculture indicators
The detection of HABs by satellite remote sensing is usually based on analysis of chlorophyll-a (Chl-a) as a proxy. However, this approach does not provide information about the potential harm of bloom, nor can it identify the dominant species. Within AQUA-USERS, a number of techniques are used to improve methods for HAB detection. An empirical classifier for satellite images developed by Kurekin et al. (2014) is trained with additional concurrent species count data provided by the project partners and users. In addition, algae species are cultured in the laboratory and their optical characteristics measured. From these measurements, reflectance spectra are modelled, which are subsequently used to develop hyperspectral detection algorithms.
Awareness of anomalies of phytoplankton biomass to the typical seasonal cycle is crucial for aquaculture prospects. As a first step, an analysis of algal bloom phenology was performed based on historical satellite data. The next step is to identify threshold alert levels for Chl-a and triggers such as SST and nutrient concentrations for each region, taking into account the characteristic regional values.

Decision support tool
Based on user requirements and user experience, a Multi-Criteria Analysis (MCA) method will be developed that is capable of automatically translating measured data into a subset of management options. Users will provide a series of management options (that will vary per site/ type of aquaculture). These will be collected into a database and be linked to the parameters available from EO and in-situ measurements.

Technical implementation
A web portal and a mobile app will allow the users to interactively explore both the satellite and in-situ measurements as well as all derived products. In addition, a module is set up for decision support, which will allow the users to store and evaluate management options under given environmental conditions.

Results and Discussion
AQUA-USERS is still in the method development phase. First results on bloom phenology have been attained for the aquaculture indicator development: for all regions a typical bloom lasts 60-90 days, except for the Netherlands, where blooms may occur for longer periods. Typically, the blooms peak during April/May in the Netherlands, June/July in Portugal, and regionally dependent in Norway and the UK. The developed methods will be implemented into operational tools and thoroughly tested in three case studies covering site selection and daily management based on in-situ and satellite images in close collaboration with the user board.

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References
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