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A SURVEY ON MONITORING SYSTEM REQUIREMENTS OF TURKISH AND GREEK MARICULTURE INDUSTRY WITH ASSESSMENT OF PRODUCTION COMPLICATIONS

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ABSTRACT

The use of monitoring systems in Mariculture industry in Turkey is limited. Main monitoring effort is directed towards physical and chemical properties of aquatic environment such as O2 / CO2 content, pH, temperature and ammonia (NH3). This survey is aimed to understand current problems faced by Turkish and Greek Mariculture industry to identify threats that can be monitored by the means of monitoring technologies. Sea bass, sea bream and Blacksea trout farms were targeted as these were the major fish species cultured in Turkey and Greece. A total of 30 Mariculture companies took part in face-to-face survey representing 75 % and 90 % of all production in Turkey and Greece respectively. The survey was conducted during months September till November, 2014.

Keywords: Mariculture, Egean Sea, Monitoring System, Turkey, Greece

Introduction

Seafood is a desired protein source and growing world population puts pressure on the existing resources. Aquaculture, the husbandry and farming of aquatic animals and plants is a fast growing food production industry which has expanded more than any other livestock sector in the recent decades with an annual 7-5 % growth rate between 1990 and 2009 (Buck et al. 2018, FAO 2016, Little et al. 2015). As the global demand increases, more intensified production is needed and is seen as a solution to high demands for fish (Simbeye et al. 2014). The growth of the aquaculture industry is foreseen to continue its growth in the near future (Pauly & Zeller 2017, Eguiraun et al. 2015). According to FAO (2016), world wild fishery stocks are overexploited with 31.4 % overfished, 58.1 % fully fished and 10.5 % with remaining capacity. As of today, one out of two fish consumed is farmed (Little et al. 2015).

Turkey is third in the world in terms of aquaculture production growth and has a 25 % market share in Europe in seabass and seabream. The share of Turkey in global aquaculture production has increased from 0.03 % to 0.3 % in 10 years. Turkey is the leading country in Trout (fresh water) production in Europe. Turkey also has marine trout farms along the shore line of Blacksea. During 2006 to 2010, aquaculture production has increased 30 %, production capacity increased 128 % and value of the production increased 39 %. Many producers established processing plants for value adding. There are challenges that should be noted; instability of prices, prejudiced approach to aquaculture products by the domestic consumer, bureaucracy which consumes time, conflict with tourism. There are approximately 2200 farms (167 marine) in Turkey with a total of 405.000 tonnes capacity. More than half of this production comes from fresh water production (56 %). Marine production is supported by 20 hatcheries with 330 million fry production annually. There are 160 licensed fish processing establishments nationwide and 101 of these are approved for EU. There are 23 feed plants of which 7 produce only fish feed (FAO 2005-2018)

The intensification of production results in different complications throughout the production (Granada 2018). Cage culture struggles with eutrophication of the water body where mooring system is installed. Eutrophication may be the result of self-pollution or environmental factors and is a threat for aquaculture establishments (Edwards 2015). Farms near shores are under the influence of coastal waters where dramatic changes and rapid changes may occur due to winds and tidal currents. Especially shellfish farms which are potential supply of high quality proteins are under the pressure of pollution in coastal waters (Schmidt et al. 2017). Fish are more susceptible to pollutants in comparison to crops and terrestrial animals because they ingest water for respiration directly therefore aquaculture is directly affected by the adverse effects of environmental conditions (Simbeye et. al. 2014). Ferreia et al. (2011) mentions that monitoring environmental conditions in shrimp farms results in better control and good management of water quality in the ponds by avoiding the occurrence of unfavorable conditions. According to Harun et al. (2012) some species are more sensitive to low oxygen, temperature, salinity and pH requiring better monitoring practices.

Both in developing countries and developed countries there is a big problem of contamination of water resources with bacteria (Florentin et al. 2016, Hancock et al. 1998, Lemarchand and Lebaron, 2003)

Industrialization and increasing chemical products use in daily life led to the permeation of chemicals and toxic compounds into the aquatic systems threatening the safety of aquatic life and food safety (Lagarde et al. 2011). Safe evaluation for water toxicity has limited methods. Detection of chemical oxygen demand (COD) and biological oxygen demand (BOD) and laboratory analysis of samples are the main water safety assessment techniques which are mostly not adequate for real time protection in aquaculture establishments (Hsieh et al. 2004, Ma et al. 1999). It is difficult to measure all possible toxicants contained in the water although there are methods that can detect the toxicants qualitatively and quantitatively they are time consuming, sophisticated detection procedures and needs well trained personnel (Rodriguez-Mozaz, 2005) Bioassay tests can be an alternative technique to obtain real time results for water quality assessment. They can be used to evaluate bio toxicity levels of environmental and industrial water. They can be electrochemical methods or optical methods.

In this study our aim was to evaluate monitoring system requirements of Turkish and Greek fish farmers to identify their needs based on the problems they are facing through production periods. We hope our results will provide a database for monitoring technology developers to steer their efforts to the needs of aquaculture producers that would benefit for both parties.

Materials and Methods

Questionnaire

A questionnaire was produced with AquaBioTech Group to collect data on various problems from fish farmers. This questionnaire was designed after the meeting held at the AquaBioTech Group premises in Mosta, Malta, March

2014. The questionnaire was carefully designed so as to serve the purpose of the study. The team of people worked together to develop that questionnaire consisted experts in aquaculture, project management and market research. The survey was designed, worded and formatted in such way to be acceptable to respondents and to be a clear and interpretable. The questionnaire was developed with multiple-choice answers, easy to be answered in less than fifteen minutes. The questionnaire was developed in such way that pre-coded responses were proposed but an option for open answers was also provided so as to give the participant the chance to elaborate on the answer or propose another answer.

Layout

The survey is composed by forty (40) questions. The questions are grouped in eight (8) sections based on the subject of the question. These sections include general information of the participant and background questions, diseases, chemical pollutants, reducing risks, dealing with diseases, algal blooms and chemical pollutants, further communication and participants' information.

Online Survey

The survey was disseminated online in various websites both with the use of social networks and use of the media so as to reach as much stakeholders possible. The participants were invited to visit the webpage of the EnviGuard project and fill in the on-line questionnaire. As feedback received from different participants we are in a position to say that due to the confidentiality of the data requested in this survey the participants are reluctant to hand over sensitive information online without having some sort of personal relationship or face to face contact.

Face-to-Face Survey

The survey was conducted face-to-face to support online survey system with the fish farmers on site. Both Aegean and Blacksea fish farmers were visited to conduct the survey in Turkey. Face-to-face survey had given the opportunity to get more details from the fish farmers. The response rate to online system was not as appreciated as anticipated.

Results and Discussion

Site visits in the Aegean region and Black Sea where the biggest Turkish production is allocated covered seventy-five (75%) percent of the total marine aquaculture production of 110.520 tons in Turkey, collecting surveys from cage farmers and hatcheries. At the end of the survey, data collected were processed and conclusions reached both on national level and as a total from all surveyed countries so as to provide a better understanding of the similarities and the differences of all surveyed markets.

Turkish producers showed their interest in problems like birds and theft during surveys. Black sea farmers reported instantaneous oxygen and current changes to be harmful against the farms. Aegean farmers had important parasite issues during production cycles. Most important questions about the monitoring sensor modules were about the possible price range. Some farmers were concerned about the usefulness of the monitoring module in terms of possible actions to be taken after the modules threat assessments. Another concern about the modules was about the implementation of the modules to the farms. Farmers requested the modules to be mountable or similar to buoys used in cage farms.

Farm characteristics that took part in the survey for both countries are composed of grow-out farms with marine cages, hatcheries, nurseries and broodstock nurseries. In addition to seabass, sea bream and Blacksea trout, mussel, red porgy, dentex, sharp snout sea bream, meagre were also reported as species produced by the participants. Sea bass and sea bream were the major species with approximately %60 of the production.

Survey results showed that Turkey had more medium sized farms with 250-500 metric tons production compared to Greece with small sized farms with 150-300 metric tons production capacity.

In both countries, most important problems encountered were reported as diseases (bacterial, viral, fungal and parasites), predators (birds, fish, mammals etc.), sudden temperature changes, heavy bio fouling and theft. These problems concern all farmers with more than fifty per cent to identify them as regular and severe in many cases. The importance level for the mentioned problems changed from farm to farm with changing geographical location.

A more detailed analysis on the diseases and pathogens challenges derived from the survey indicates that viral diseases, bacterial pathogens and hazardous parasites are all of high importance with the most severe to be the hazardous parasites (Figure 1 & 2).

Farmer's opinions about several disease outbreaks were identified as transfer from hatcheries, wildlife, ballast waters, high stocking, low water quality, and stress from handling and natural occurrence (Figure 3).

The farmers' opinions about reducing environmental hazards were as follows; development of new technologies and products, hatcheries with health certification, state compensation, low stocking densities, regulation of other activities close proximity to the farm (Figure 4).

Farmers listed their current methods for avoiding harmful environmental effects as monitoring of fish mortality, visual changes in fish and their behavior, water quality monitoring, regular laboratory analysis of fish/mussel, information sharing with other farms in proximity, information by government entities (Figure 5).

At this point of the survey, farmers expressed their need for better monitoring technologies which would allow the farmer to act much faster before the problem even starts. Preventive action is desired instead of corrective actions. Although they are confident that their experience lets them to identify the problems, they would like to take action beforehand, 83 % of the farmers answered that all disease, algal or pollutant caused problems has to be identified in very early stage, only 22 % of them think that they are able to recognize these problems on time (Figure 6).

Participants of the survey expressed relatively high interest on monitoring technologies with concern regarding high capital investment and operational costs. Farmers were interested in monitoring technologies but there was doubt on the efficiency of the applications and lack of field experience (Figure 7).

As mentioned before, each farm has different needs according to their production systems, choice of species, geographical characteristics and etc. This brings out different monitoring needs as we can see from the answers of the participants in the survey. Farmer's demands monitoring systems for environmental pollution, weather conditions, natural events, predators, pathogens, parasites, diseases and algal blooms (Figure 8).

Figure 1. Importance of parasites as a problem for fish farmers

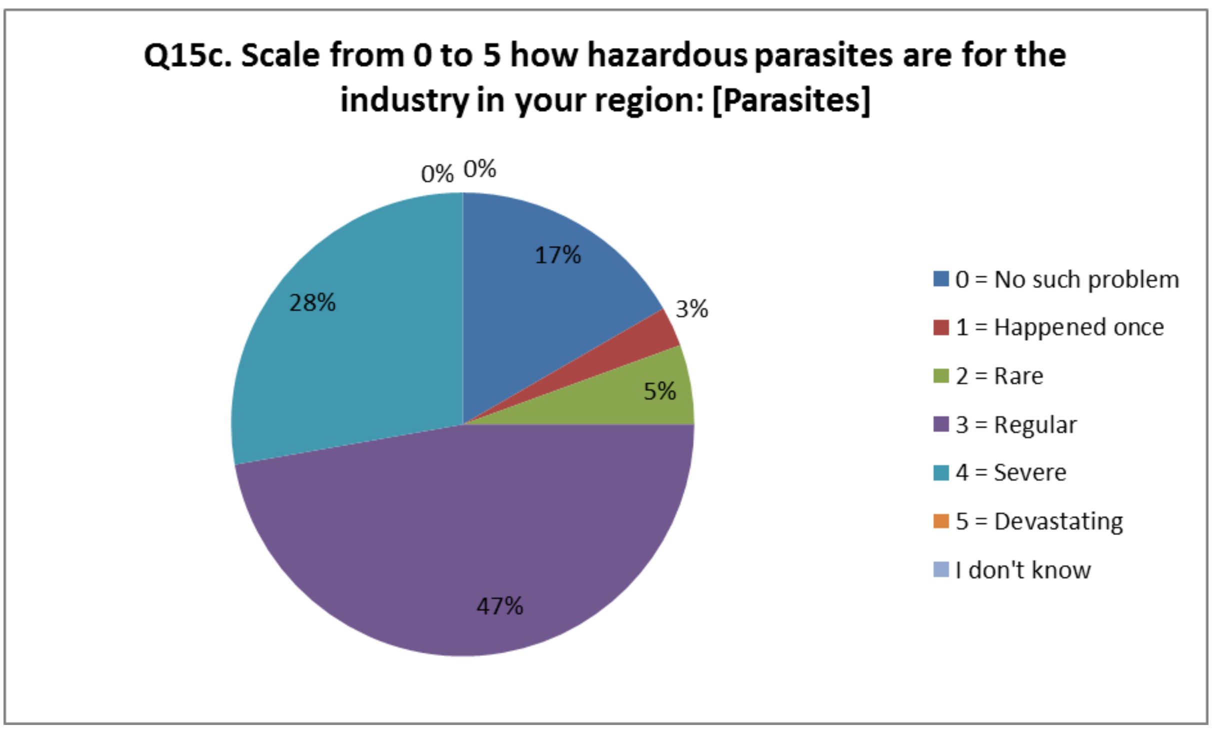


Figure 2. Importance of viral diseases as a problem for fish farmers

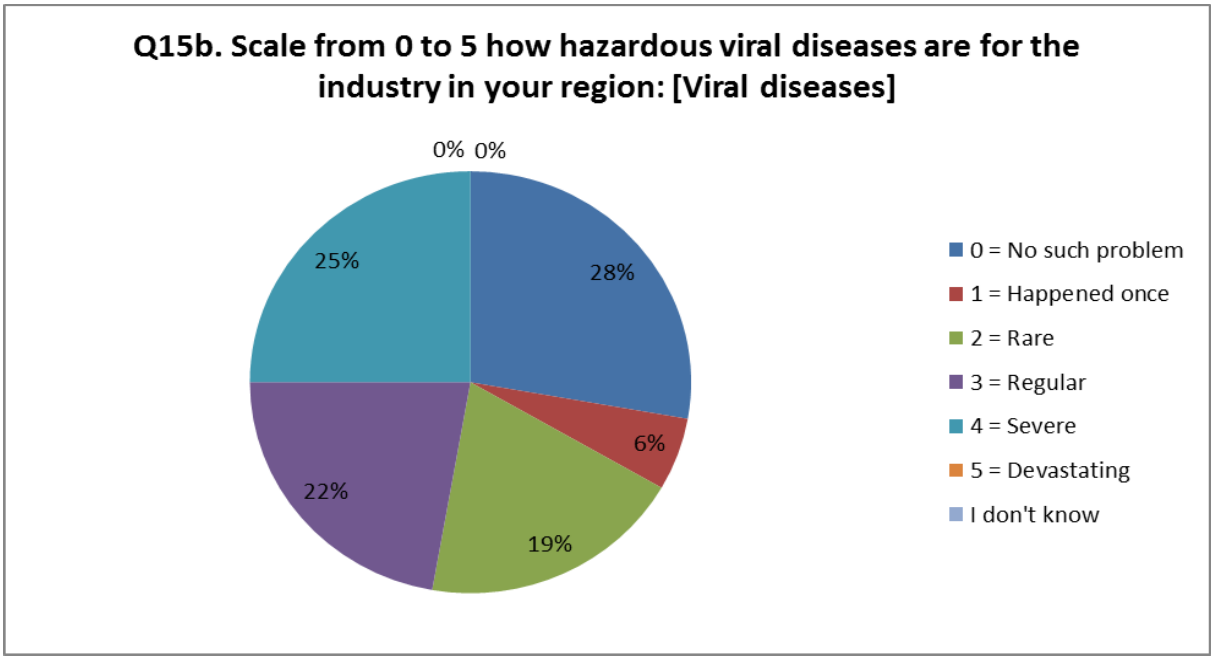


Figure 3. Farmer's opinion about the main reasons of disease outbreaks

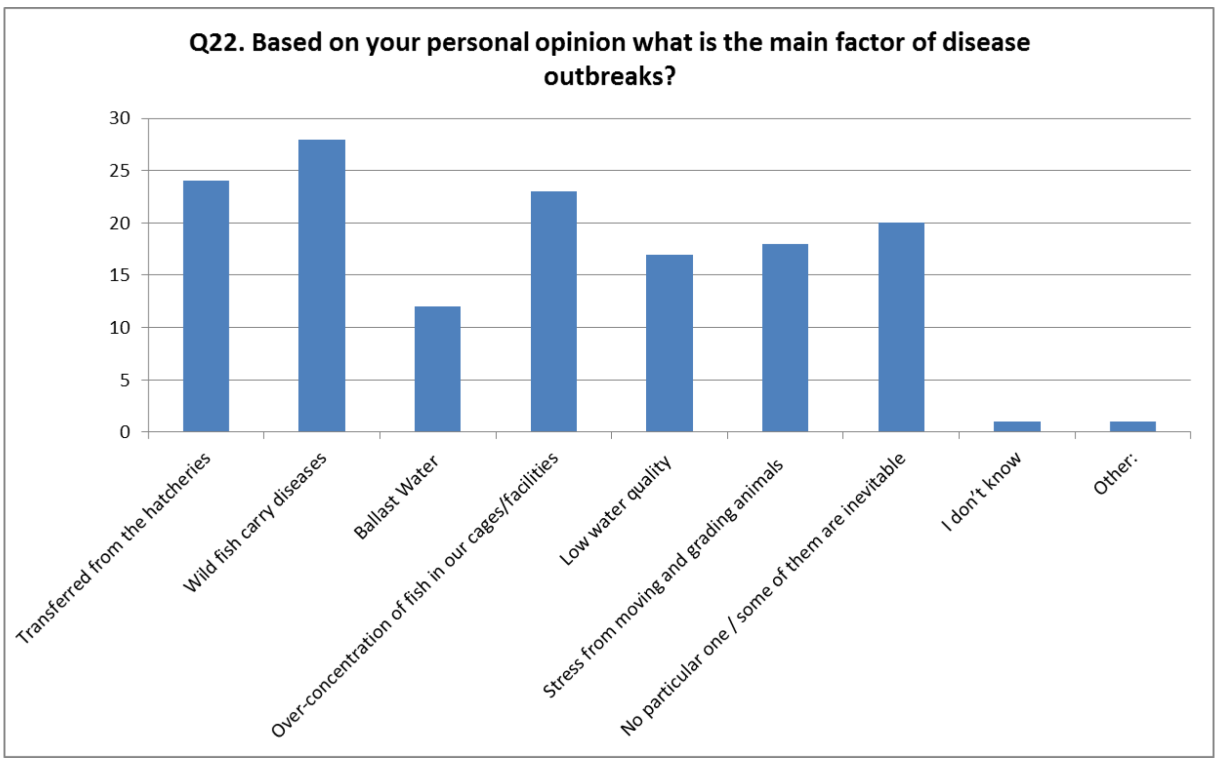


Figure 4. Farmer's opinion about the reducing environmental hazards of aquaculture

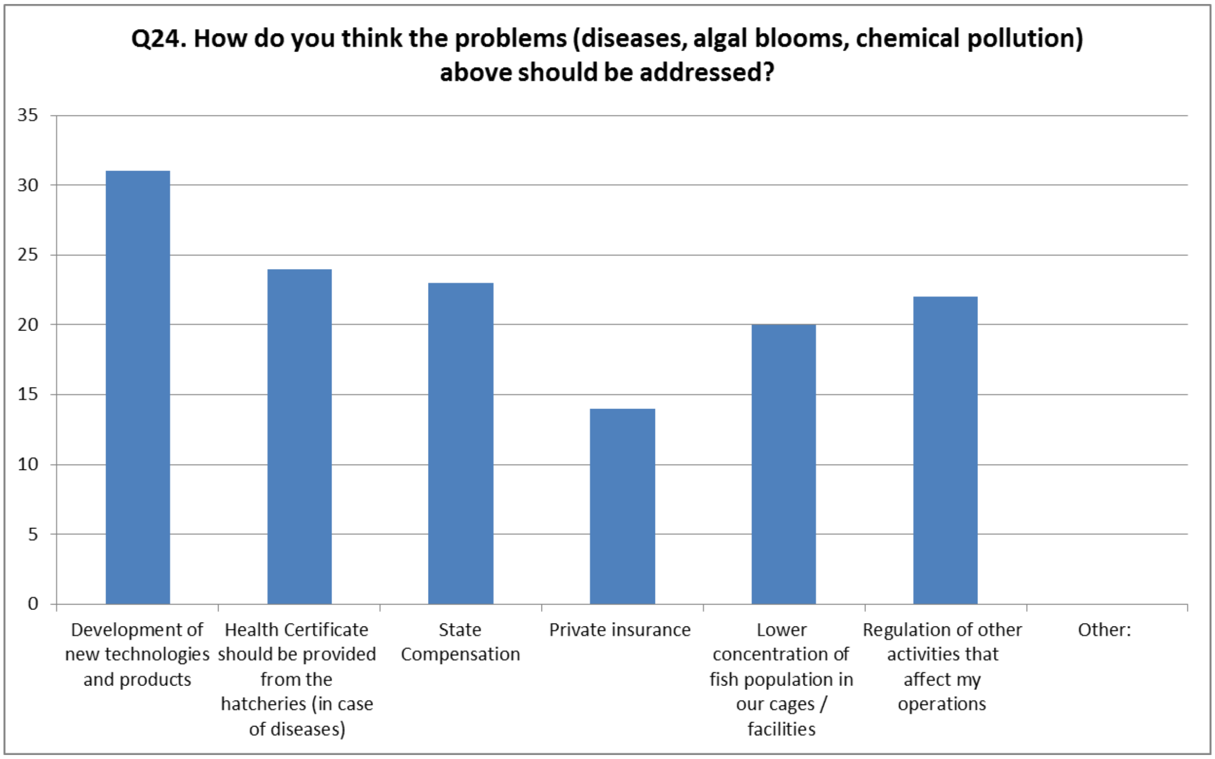


Figure 5. Distribution of answers regarding the existing methods used to avoid harmful environmental effects

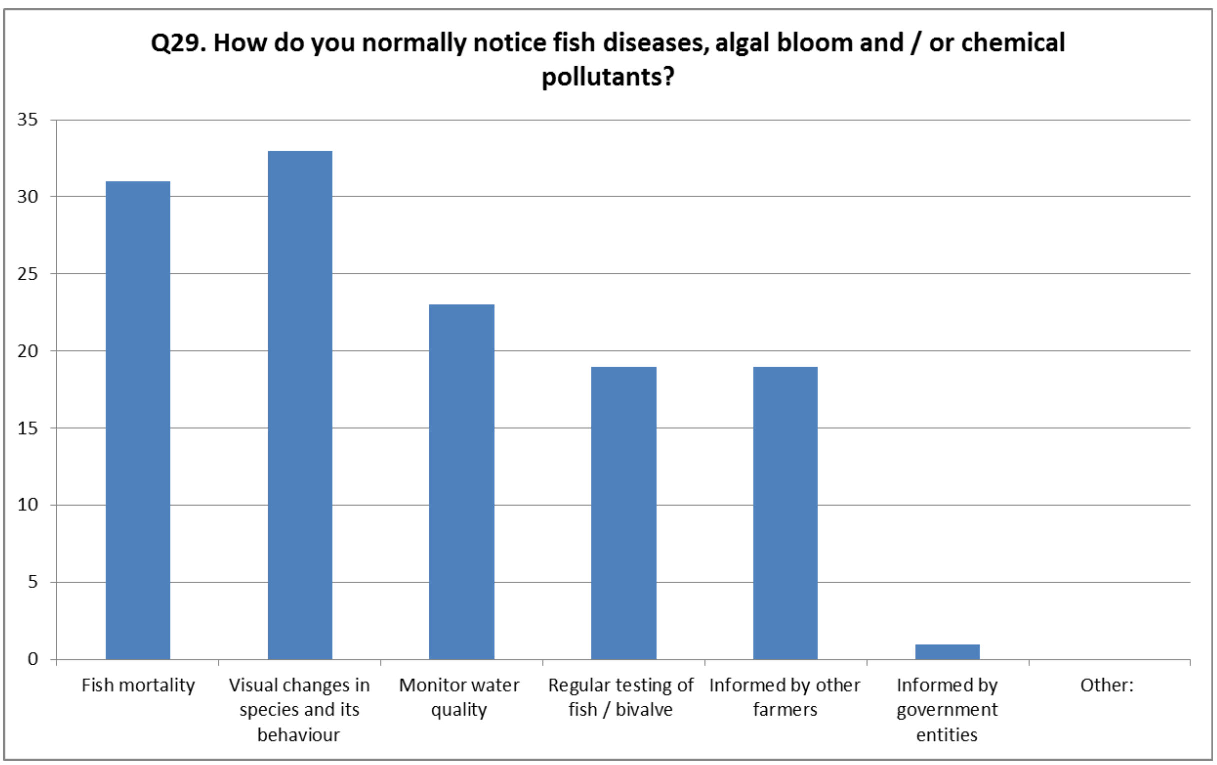


Figure 6. Farmer's opinion about their capability to identify any environmental problem in time

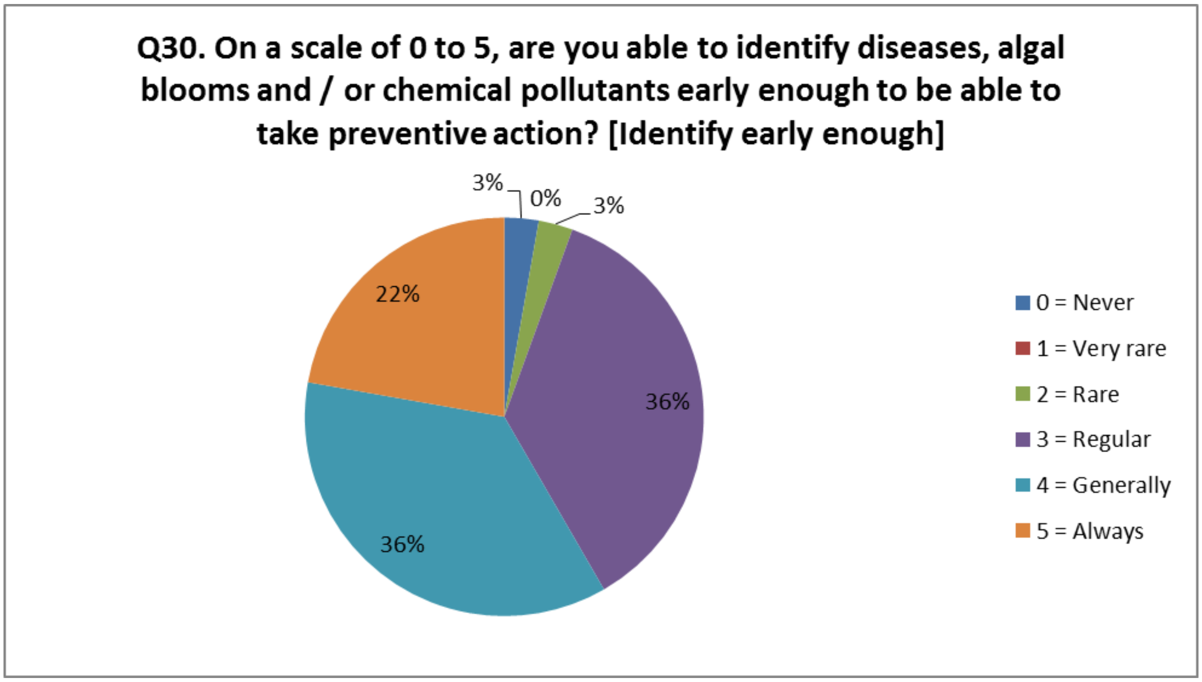


Figure 7. Farmer's interests in early-warning monitoingsystems

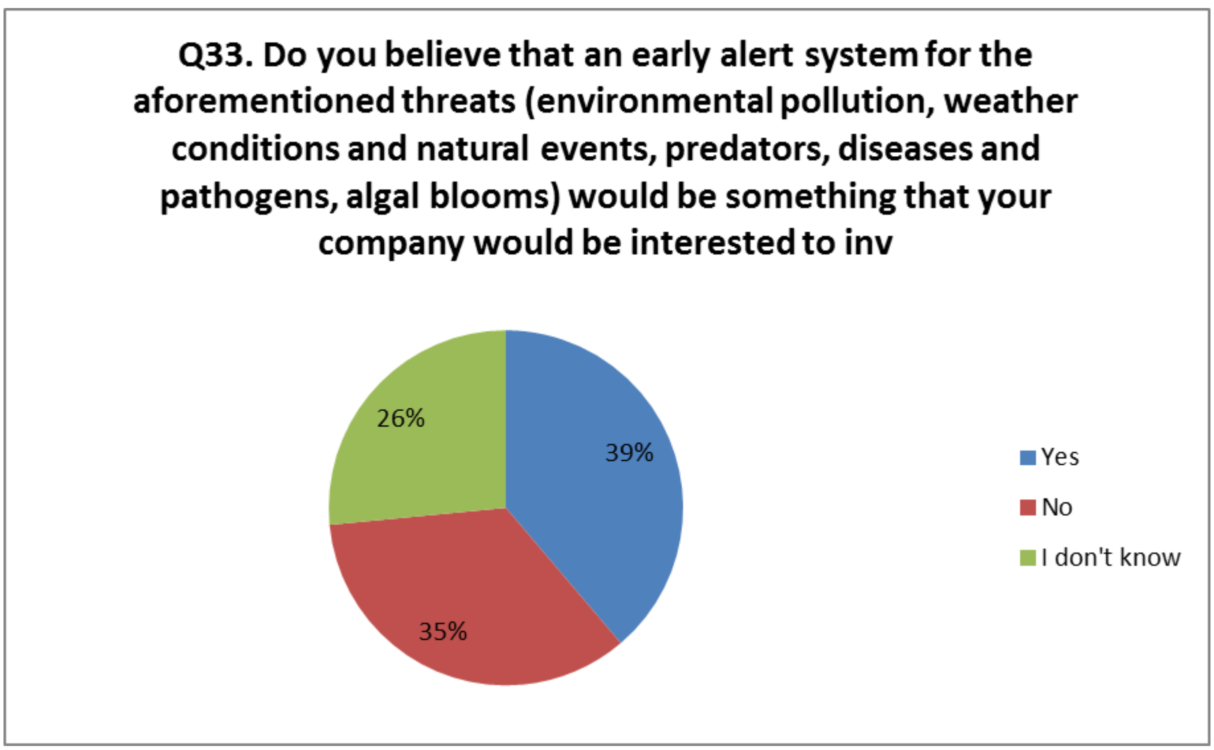
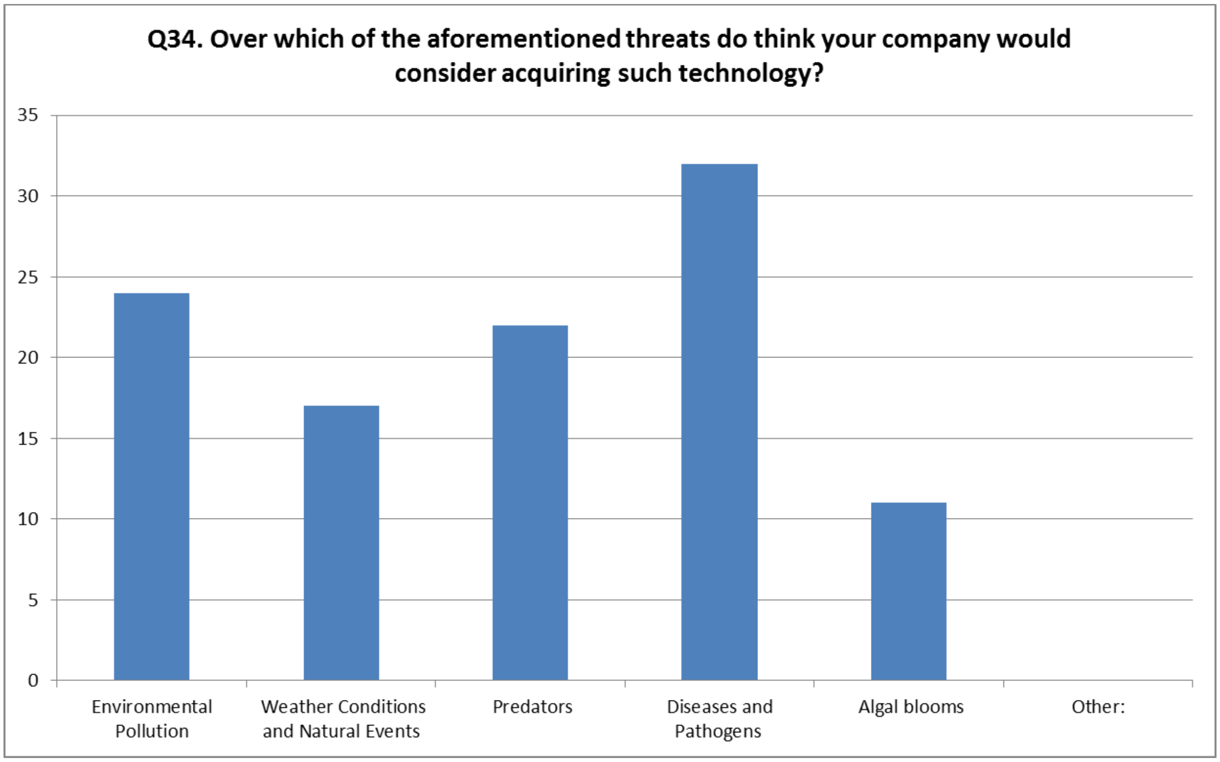


Figure 8. Farmer's interests in different types of early-warning monitoring systems



Conclusions

Early warning is a very important concept for livestock production. Early warning systems provide relevant and timely information in a systematic way during production that lets the producer make informed decisions and take preventive actions before upcoming problems. A farmer must know the risks of their establishment to choose best monitoring practices and parameters that would result in efficient responses to brewing problems. Monitoring technologies are needed for increased control in aquaculture industry. Presently, the occurrence of microalgae, pathogens, toxins and chemicals in the aquatic environment may lead to contaminated end products which may be rejected by the market for not being fit for human consumption resulting in economic losses. A better marketable product is possible with early knowledge of any problem that can be prevented by early precautions. Modular systems using different types of sensors depending on the choice of the farmers for microalgae, pathogens, predators, toxins and chemicals as well as temperature, salinity, dissolved oxygen, turbidity and weather patterns would benefit aquaculture industry. These monitoring systems use geographical information systems (GIS) to capture, store, manipulate, manage, analyze and display spatial and geographic data. Information is gathered and shared in real time, using mobile data transmission through the internet to a dedicated server. Processed data can be used to make decisions related with both production and upcoming problems that can be foreseen within the data received. Although farmers are concerned with capital investments, it would be advisable for any aquaculture establishment that monitoring systems would benefit in the long term for a much profitable business.

Acknowledgement

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References

Buck, B.H., Chopin, T. (2018). State of the Art and Challenges for Offshore Integrated Multi-Trophic Aquaculture (IMTA) Sustainable Aquaculture Systems View project INTERNAS (Wissenschaftliche Übertragung der Ergebnisse von INTERnationalen ASsessments im Bereich Erde und Umwelt in den deutschen Politikkontext) View project. doi:10.3389/fmars.2018.00165

Hsieh, C.Y., Tsai, M.H., Ryan, D.K., Pancorbo O.C. (2004). Toxicity of the 13 priority pollutant metals to Vibrio fisheri in the Microtox® chronic toxicity test. Science of the Total Environment 320, 37-50.

Edwards, P. (2015). Aquaculture environment interactions: Past, present and likely future trends. *Aquaculture*, 447, 2-14.

Eguiraun, H., Izagirre, U., Martinez, I. (2015). A paradigm shift in safe seafood production: From contaminant detection to fish monitoring - Application of biological warning systems to aquaculture. *Trends in Food Science and Technology*, 43(1), 104-113.

Lagarde, F., Jaffrezic-Renault, N. (2011). Cell-based electrochemical biosensors for water quality assessment. *Analytical and Bioanalytical Chemistry*, 400, 947-964.

FAO, (2016). The State of World Fisheries and Aquaculture. doi:10.5860/CHOICE.50-5350

Ferreira, N.C., Bonetti, C., Seiffert, W.Q. (2011). Hydrological and Water Quality Indices as management tools in marine shrimp culture. *Aquaculture*, 318, 425-433.

Florentin, A., Lizon, J., Asensio, E., Forin, J., Rivier, A. (2016). Water and surface microbiologic quality of point-of-use water filters: A comparative study. American Journal of Infection Control, 44(9), 1061-1062.

Granada, L., Lopes, S., Novais, S.C., Lemos, M.F.L. (2018). Modelling integrated multi-trophic aquaculture: Optimizing a three trophic level system. Aquaculture, 495, 90-97.

Gao, G., Fang, D., Yu, Y., Wu, L., Wang, Y., Zhi, J. (2017). A double-mediator based whole cell electrochemical biosensor for acutebiotoxicity assessment of wastewater, Talanta, 167, 208-216.

Hancock, C.M., Rose, J.B., Callahan, M. (1998). Crypto and Giardia in US groundwater: Groundwater systems need to be carefully monitored until contamination levels and acceptable risk factors are determined. Journal - American Water Works Association, 90(3), 58-61.

Harun, A., Ndzi, D.L., Ramli, M.F., Shakaff, A.Y.M., Ahmad, M.N., Kamarudin, L.M., Zakaria, A., Yang, Y. (2012). Signal propagation in aquaculture environment for wireless sensor network applications. *Progress in Electromagnetics Research*, 131, 477-494.

Lemarchand, K., Lebaron, P. (2003). Occurrence of *Salmonella* spp. and *Cryptosporidium*spp. in a French coastal watershed: relationship with fecal indicators. *FEMS Microbiology Letters*, 218(1), 203-209.

Little, D.C., Newton, R.W., Beveridge, M.C.M. (2016). Aquaculture: A rapidly growing and significant source of sustainable food? Status, transitions and potential, in: Proceedings of the Nutrition Society. Cambridge University Press, pp. 274-286. doi:10.1017/S0029665116000665

Ma, M., Tong, Z., Wang, Z., Zhu, W. (1999). Acute toxicity bioassay using the freshwater Luminescent Bacterium Vibrio-qinghaiensis sp. Bulletin of Environmental Contamination and Toxicology, 62, 247-253.

Pauly, D., Zeller, D. (2017). Comments on FAOs State of World Fisheries and Aquaculture (SOFIA 2016). *Marine Policy*, 77, 176-181.

Schmidt, W., Raymond, D., Parish, D., Ashton, I.G.C., Miller, P.I., Campos, C.J.A., Shutler, J.D. (2018). Design and operation of a low-cost and compact autonomous buoy system for use in coastal aquaculture and water quality monitoring. *Aquacultural Engineering*, 80, 28-36.

Simbeye, D.S., Zhao, J., Yang, S. (2014). Design and deployment of wireless sensor networks for aquaculture monitoring and control based on virtual instruments. *Computers and Electronics in Agriculture*, 102, 31-42.

Rodriguez-Mozaz, S., Alda, M.J., Marco, M.P., Barcelo, D. (2005). Biosensors for environmental monitoring: a global perspective. Talanta, 65, 291-297.