Yunus Araştırma Bülteni 2014 (3): 67-73

www.yunus.gov.tr
ISSN 1303 - 4456

Teknik Not
Technical Note

ISO 14001 Environmental Management System (EMS) and Risk Assessment Application in Aquaculture

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Receive:08.01.2014
Accepted: 07.03.2014

Abstract

This article deals with the internationally recognized ISO 14001 Environmental Management Standard, its stipulations and environmental risk assessments in aquaculture. Standard requires determination of environmental impacts and their significance in an enterprise. Risk assessment can be used as the logical and effective tool to determine the environmental effects. The outcome of an Risk Assessment is preventing or reducing the severity or likelihood of environmental failures, starting with the highest-priority ones. An organisation's proactive approach to environmental management may provide confidence in legislative compliance, easier access to investment and insurance provision, reducing operating costs, competitive advance and improved public image.

***Keywords**:* ISO 14000, Environmental Management System (EMS), Environmental Risk Assessment, Aquaculture.

Özet

ISO 14001 Çevre Yöetim Sistemi (ÇYS) ve Akuakültürde Risk Değerlendirme Uygulamaları

Bu makale; uluslararası kabul gören ISO 14001 Çevre Yönetim Standardı, standardın şartları ve su ürünleri yetiştiriciliği alanında çevresel risk değerlendirmesi hakkındadır. Bir işletmede çevresel etkilerin ve bunların önem derecelerinin belirlenmesi ISO 14001 Standardının bir gereğidir. Risk değerlendirmesi çevresel etkilerin tespiti için akılcı ve etkili bir araç olarak kullanılabilir. Risk değerlendirmesinin amacı; en yüksek öncelikli olandan başlayarak çevre başarısızlıklarının şiddeti veya olasılığını önlemek veya azaltmaktır. Bir kurumun çevre yönetimi için önleyici yaklaşımı sonucunda; işletme maliyetlerinin düşürülmesi, rekabet avantajı, kamu nezdinde firma ile ilgili imajın iyileşmesi, mevzuat uyumunu sağlama, yatırım ve sigorta hizmetlerine daha kolay erişim sağlamak gibi faydalar sağlanabilir.

***Anahtar Kelimeler**:* ISO 14000, Çevre Yönetim Sistemi (EMS), Çevresel Risk Değerlendirmesi, Su ürünleri yetiştiriciliği.

Introduction

It is obvious that there is a strong pressure on aquaculture farms for their environmental impact on aquatic environments. Consumers are also becoming more and more conscious about environmental issues and clean production. In today's world, companies have to decrease their negative impacts and show their commitment to the environment. An effective environmental management system can help a company as an administrative tool.

Global production of farmed fish and shellfish has more than doubled in the past 15 years. Many people believe that such growth relieves pressure on ocean fisheries, but the opposite is true for some types of aquaculture. Farming carnivorous species requires large inputs of wild fish for feed. Some aquaculture systems also reduce wild fish supplies through habitat modification, wild seedstock collection and other ecological impacts. On balance, global aquaculture production still adds to world fish supplies; however, if the growing aquaculture industry is to sustain its contribution to world fish supplies, it must reduce wild fish inputs in feed and adopt more ecologically sound management practices (Naylor et al. 2000).

ISO 14001 is an internationally accepted specification for an environmental management system (EMS). It specifies requirements for establishing an environ-mental policy, determining environmental aspects and impacts of products / activities / services, planning environmental objectives and measurable targets, implementation and operation of programs to meet objectives and targets, checking and corrective action, and management review (ISO, 2014; ISO, 2014a; TSE, 2005). An Environmental Management System is part of an organization's overall management system and the fisheries sector is a good case where Environmental Management System has been implemented (UNCTAD,2007).

ISO 14000 environmental management standards exist to help organizations minimize how their operations negatively affect the environment (Causing adverse changes to air, water, or land), comply with applicable laws and regulations. The major parts of ISO 14000 are ISO 14001 and ISO 14004. ISO 14001 is the standard against which organizations are assessed. ISO 14001 is generic and flexible enough to apply to any organization producing and/or manufacturing any product, or even providing a service anywhere in the world. ISO 14004 is a guidance document that explains the 14001 requirements in more detail. These present a structured approach to setting environmental objectives and targets and to establishing and monitoring operational controls (ISO, 2014; ISO, 2014a; TSE, 2005).

An EMS meeting the requirements of ISO 14001:2004 is a management tool enabling an organization of any size or type to: identify and control the environmental impact of its activities, products or services, and to improve its environmental performance continually, and to implement a systematic approach to setting environmental objectives and targets, to achieving these and to demonstrating that they have been achieved.

ISO 14001:2004 is a tool that can be used to meet internal objectives such as providing assurance to management that it is in control of the organizational processes and activities having an impact on the environment and assuring employees that they are working for an environmentally responsible organization. They can also be used to meet external objectives in order to provide assurance on environmental issues to external stakeholders – such as customers, the community and regulatory agencies to comply with environmental regulations (ISO, 2010; TSE, 2005).

The key elements of an ISO 14001 EMS are:

Environmental policy: Environmental policy and the requirements to pursue this policy via objectives, targets, and environmental programs .

Planning: The analysis of the environmental aspects of the organization (including its processes, products and services as well as the goods and services used by the organization.)

Implementation and operation: Implementation and organization of processes to control and improve operational activities those are critical from an environmental perspective (including both products and services of an organization)

Checking and corrective action: Checking and corrective action including the monitoring, measurement, and recording of the characteristics and activities that can have a significant impact on the environment

Management review: Review of the EMS by the organization's top management to ensure its continuing suitability, adequacy and effectiveness

Continual improvement: The concept of continual improvement is a key component of the environmental management system; it completes the cyclical process of plan, implement, check, review and continually improve (ISO, 2010a; TSE, 2005).

In relation to the Clause "Planning", environmental aspects of the organization's activities, products and services that it can control and influence should be identified. The next step is determination of environmental aspects which are associated with significant impacts. Organization should also identify and maintain access to legal and all other requirements that apply to the environmental aspects of the activities, products and services. Objectives and targets should be established by taking these information into consideration. The final step is establishment of EMS (Tibor and Feldman, 1996; TSE, 2005**)**.

There are several way an organisation may approach the assessment of environmental effects depending on the main ways in which they affect the environment; process-based assessment, product-based assessment and risk-based assessment (GCT, 1997).

Risk assessment is an effective tool to determine the significance of environmental impacts. Risk Assessment will be the key element on which the EMS is established. Since studies on this subject are very limited, this study may light the way for future researches. Results of this study can be benefited by aquaculture firms which aim at establishing an effective Environmental Management System and assessing their environmental impacts.

Environmental impacts of aquaculture

Environmental effects of main aspects of marine aquaculture are reported as following:

- The discharge of waste nutrients and their interaction in the marine environment
- Effects of discharges arising from aquaculture, e.g. medicines, chemicals, cleaning agents, fuels and lubricants and solid wastes
- Disease risks on wild and farmed stocks
- Escapes from fish farms and potential effects on wild populations such as diluting or altering native aquatic populations through competition and interbreeding
- Visual impact,
- Noise/vibration impact
- Impact on marine traffic
- Odourx
- Impact on underwater archaeology (Irish Sea Fisheries Board, 2010; IFOAM, 2010).

The term "Hazard" means the intrinsic property of a dangerous substance or physical situation with a potential for creating damage to human health and/or environment. The term "Risk" can be described as the likelihood of a specific effect occuring within a specified period or in specified circumstances (Hunter and Muylle, 1999; DEFRA, 2010).

Key stages in each tier of environmental risk assessment are: 1. Hazard identification, 2. Identification of consequences (The spatial scale of the consequences, the temporal scale

of the consequences, the time to onset of the consequences), 3. Estimation of the magnitude of consequences, 4. Estimation of the probability of the consequences (The probability of the hazard occuring, the probability of the receptors being exposed to the hazard, the probability of harm resulting from exposure to the hazard) and 5. Evaluating the significance of a risk (Hunter and Muylle, 1999; DEFRA, 2010).

Environmental aspect is defined as an element of an organization's activities, products and services which can interact with the environment. The purpose of identifying environmental aspects is to determine which have or can have significant impacts. This ensures that the aspects relative to these significant impacts are reflected in company's objectives and targets. Identifying environmental aspects is an on-going process and the standard requires that organizations keep the information up to date. The next step is to identify, evaluate and prioritize the significant environmental impacts associated with the environmental aspects of the activities, products or services (Tibor and Feldman, 1996).

Environmental aspects were determined by the Environment Team by taking into consideration applicable environmental legislation and regulations, experience of workers and previous incidents and non compliance with legislation and regulations. Methods such as in-situ observation of processes, conversations with employees, inspection of documents of company, working instructions, records and scientific literature were used. The study covered all facilities and all of processes which are routine and non- routine including maintenance of equipment. Activities of all employees, visitors and sub- contractors were also examined (Denkstatt, 2002).

ISO 14001 Standard requires procedures for maintaining a register of applicable legislation and regulations, for examining and assessing the effects of all activities, products and services, and for compiling and maintaining a register of those effects judged to be significant (CTA, 1994).

Risk assessment can be used as an effective tool to determine the significance of environmental impacts. In this study, possible environmental aspects have been evaluated by using the method of ABC Matrix (Denkstatt, 2002**)**.

Materials and Methods

In this study, all possible environmental impacts of aquaculture were taken into consideration and an ABC Matrix was developed.

ABC matrix (Denkstatt, 2002) uses the correlations between environmental impacts and 14 different parameters, so the environmental impacts can be classified as significant, little significant and insignificant.

Significant environmental impacts must be controlled by EMS. This can be done by application of working procedures and setting targets which are related with corresponding environmental impacts. The continual improvement of performance of EMS can be accomplished through the reached targets.

Total scoring of environmental impacts is carried out on the Environmental Impacts Table (Table 1) by evaluating each of the environmental impacts against 14 different parameters as described below:

- A: Minimum 1 A or 4 and more than 4 B per 14 parameters.

- B : No A and 2-3 B per 14 parameters.

-C: No A and maximum 1 B, rest of others C per 14 parameters.

Table 1. ABC Matrix for Environmental Impacts Assessment

		A	B	C
1	Legal requirements	- Non compliance with legal requirements - Limit values are breached	- Partially non compliance with legal requirements - Results are within 70 -100% of limit values -	- Compliance with legal requirements - Results are 70% below the limit values
2	Public	- Strong pressure from public - Number of complaints per year > 10	- Weak pressure from public - Number of complaints per year < 10	- No pressure from public - No complaints
3	Waste	- Materials harmful for disposal area	- Dangerous waste should be disposed in incinerators - Materials not harmful for disposal area - Harmless waste in huge amounts	- Recyclable harmful waste - Recyclable harmless waste
4	Emissions to air	- Emissions causing air pollution (CO_2,NO_x, greenhouse gases, ozone depleting gases, acid rain) - Emissions harmful to environment/human health	- Emissions causing air pollution (CO_2 , NO_x, greenhouse gases, ozone depleting gases, acid rain) in small amounts	- No emission
5	Discharges to water	-Discharges causing water pollution (BOD,COD, P,N, oil), other problems in rivers, lakes and sea	Discharges in small amounts causing water pollution (BOD,COD, P, N, oil) , other problems in rivers, lakes and sea	- Discharges with low pollutant burden (Waste water treatment plant exists and all legal requirements are met)
6	Discharges to soil	- Pollution of soil without an action plan - Serious pollution threat to soil and underground water	- Action plan exists to prevent soil pollution - Little pollution threat to soil and underground water	- No pollution - No pollution threat to soil and underground water
7	Noise/Vibration	- Exceeding limit values	- Results are 70 -100% of limit values	- Action Plan is prepared in line with the monitoring results which are 70 -100% of limit values - Results are 70% below the limit values
8	Odour/Visual	- Exceeding limit values effecting outside of the plant	- Little odour effect outside of the plant -Not exceeding limit values	- No odour effect outside of the plant
9	Local impacts	- Impacts effecting ecologically vulnerable areas/settlement areas/navigation/disease impacts/Escaped fish	- Impacts slightly effecting ecologically vulnerable areas /settlement areas/ navigation/ disease impacts/escaped fish	-No Impacts effecting ecologically vulnerable areas /settlement areas/ navigation/ disease impacts/escaped fish
10	Consumption of natural resources	-Resources unrenewable/ unrecyclable	- Unrenewable but recyclable resources	- Renewable and recyclable resources
11	Environmental risk (MSDS-Material Safety Data Sheet Information of materials) (Materials+Energy)	- Substances bearing the notation as following: T,T+ (Poisonous, Extremely poisonous) X_n (Harmful to health) F,F+ (Flammable, Extremely flammable) E (Explosive) C (Corrosive) N (Environmental Risk) -Too harmful to environment/human health in case of accidents and emergency situations.	- Substances bearing the notation as following: X_i (Corrosive) O (Oxidizing) -Low risk to environment/human health in case of accidents and emergency situations	-No risk to environment/human health under normal conditions and in case of accidents /emergency.
12	Cost of purchasing (Materials+Energy)	- Substance or energy resource that its cost is more than 50% of its purchasing cost	- Substance or energy resource that its cost is 20-50% of its purchasing cost	- Substance or energy resource that its cost is less than 20% of its purchasing cost
13	Cost of disposal (Wastes)	- Waste that its cost is more than 50% of its disposal cost	- Waste that its cost is 20-50% of its disposal cost	- Waste that its cost is less than 20% of its disposal cost
14	FMEA* Risk Score (R) (Activities/Operations)	FMEA Risk Score considered "Significant" (R ≥6) or TN ≥4	FMEA Risk Score considered "Little Significant" 5 ≥R ≥4	FMEA Risk Score considered "Insignificant" (R ≤3)

*Failure modes and effects analysis (FMEA) is a procedure in product development and operations management for analysis of potential failure modes within a system for classification by the severity and likelihood of the failures (ASQ 2014).

"A" (Significant environmental impacts): Effects of significant environmental impacts must be taken under control by following written procedures and instructions within the management system. Objectives and measurable targets must be set for corresponding impacts. Environmental Programmes are established on the basis of targets. In case of failure reaching the targets, necessary corrective actions must be initiated.

"B" (Impacts having little significance): The documents for this kind of impacts may be prepared and targets may be set if it is found necessary.

"C" (Insignificant impacts): No specific action is needed for this kind of impacts but they may be monitored.

FMEA Risk Score (R) in the Table 1 is calculated for each of the possible environmental effect by multiplying Time needed to neutralize the negative environmental impacts (TN) and Likelihood of Occurrence of negative environmental impacts (LO)*;* Risk (R) = LO × TN. The ranking table to determine a Risk Score is given in Table 2.

ISO 31000, a family of standards relating to risk management issued by the International Organization for Standardization can also be used. The purpose of ISO 31000:2009 is to provide principles and generic guidelines on risk management. The ISO 31000 family includes ISO 31000: Principles and Guidelines on Implementation, IEC 31010: Risk Management-Risk Assessment Techniques and ISO/IEC 73: Risk Management-Vocabulary (ISO, 2014b). Other private standards and related certification are also becoming significant features of international fish trade and marketing. "Ecolabels", or private standards and certification schemes related to the sustainability of fish stocks, designed to incentivize responsible fisheries practices and to influence the procurement policies of large retailers and brand owners, as well as the purchasing decisions of consumers (Washin-gton and Ababouch, 2013).

Results and Discussion

Taking possible impacts into account, an ABC Matrix for Environmental Impacts Assessment (Table 1) has been created for the availability of potential users of fish farming industry. The mentioned matrix can easily be developed or adopted according to local / specific requirements of business.

Taking global developments such as growing number of environmental issues, pressure on aquaculture industry and benefits of a proactive approach to the environment and costs into consideration, Environmental Management System and Risk Assessment will be an effective management tool for aquaculture. The risk assessment system described in this article may be a practical and effective tool for fish farming industry.To evaluate significance of environ-mental impacts, ISO 14004 guidance standard notes factors such as the scale of the impact, its severity, the probability of occurrence and duration of its impact (Tibor and Feldman, 1996)

Table 2. Risk Score Ranking Table

Time needed to neutralize the negative environmental impacts (TN)	Score	Likelihood of Occurence of negative environmental impacts (LO)
Can not be eliminated	6	Everyday
More than 5 years	5	Once a month
Within 5 years	4	Once a year
Within 1 year	3	Every 5 years
Within 1 month	2	Every 10 years
Within 1 day	1	Every 50 years

Environmental impacts should be systemically reviewed at the meetings of management review.

Significance is also the combination of legislation, codes of practice, scientific evidence, regulation demands, public attitudes and financial institution views (CTA, 1994). The ABC Matrix structured in this study in order to assess environmental impacts considered all possible environmental dimensions described.

Conclusions

All of environmental impacts of aquaculture such as legal requirements, public considerations, wastes, emissions to air, discharges to water and soil, noise/vibration, odour and visual impacts, consumption of natural resources, environmental risks, cost of purchasing and disposal and finally, risk score have been taken into account and the matrix can easily be adapted and used by aquaculture business as a balanced score matrix.

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