ENVIRONMENTAL MANAGEMENT EDUCATION IN FISHERIES

(FOCUSING ON AQUACULTURE)

Edited by Thomas Potempa, Lynn Besenyei, Nguyen Hoang Nam Kha, Rakpong Petkam

DOI: 10.26271/opus-1252

Co-funded by the Erasmus+ Programme of the European Union

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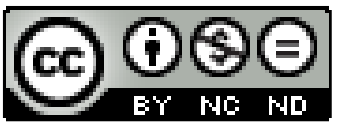

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ACKNOWLEDGMENTS

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PREFACE

This teaching unit is intended to introduce environmental management and to provide the prerequisites for organising operational environmental protection and for implementing and maintaining environmental management systems.

The purpose of the teaching unit is to provide the basic tools and knowledge in order to develop a procedure for the self-assessment of the status of an environmental management system and to actively support the introduction of an environmental management system in accordance with ISO 14001 (ISO - International Standard Organisation, 2009).

Consequently, this teaching unit deals with the essential elements of this international standard, explains the basic steps in the implementation of an environmental management system and proposes the techniques and tools to facilitate this.

The topics that are dealt with in varying depths are:

Environmental policy,

Environmental management systems

Environmental auditing,

Life cycle assessments

By far the largest part of this course will cover Management and Audit Systems. In this respect, the teaching unit gives an idea of the work to be done by an organisation.

Since each company is different, this teaching unit remains general enough to maintain the flexibility for transfer to different companies, but also specific enough to develop the necessary systematics for setting up and implementing an environmental management system.

This teaching unit does not aim to cover every aspect of environmental management in great breadth but it is more of a guide than a rigid textbook. Although all the elements of ISO 14001 are addressed, you will notice when you read it that not every word has to be implemented letter by letter, but there is plenty of scope for flexibility and creativity and yet you can still meet the requirements of the standard.

Accordingly, a few exercises as well as preparatory tasks for the classroom are integrated into this teaching unit. You will find the solutions for these exercises at the end of each lesson. The preparatory tasks should be worked out in preparation for the face-to-face meeting, as these are discussed within the framework of class contact sessions.

01 INTRODUCTION

Thomas Potempa*, Nguyen Van Trai** and Nguyen Hoang Nam Kha**

** Ostfalia University (OU)*

***Nong Lam University - Ho Chi Minh City*

Learning Outcomes

Identify and explain the reasons for introducing environmental management systems

01.1 WHY ENVIRONMENTAL MANAGEMENT?

Dealing with the environment is a challenge that almost all actors in our economies have to face. Manufacturers, suppliers as well as governments and communities, but also public interest groups, have recognised that the shaping of the future should be oriented towards sustainable economies and must be oriented towards these in the long term. Achieving sustainability, however, presupposes that companies and the public sector take responsibility for the environment in a structured and organised manner.

A system that enabled companies and institutions to achieve this would certainly be helpful. An international standard could remedy the situation, but how can we map the most diverse sectors of the economy without drowning in a flood of standards?

Of course, there are standards such as ISO 14001 (ISO - International Standard Organisation, 2009), but these only provide a basic outline of the environmental management system (EMS). The design of the content remains the task of the organisation. This way, the organisation itself decides what it wants to do for the environment and which improvement targets it wants to pursue. It organises its environmental management system and the necessary tasks in such a way as to achieve its self-imposed objectives. Only if the organization aligns its environmental management system with specific operational processes will it be able to operate sustainably and thus reduce operating costs and minimize ecological risks.

The development of an environmental management system that meets the requirements of ISO 14001 is a very ambitious undertaking. Certification of the EMS entails additional effort and costs - especially if an external auditor is appointed to audit the environmental management system and to ensure that it meets the requirements of the standard (Figure 1).

Many companies are subject to environmental legislation without knowing it. Any company, whether large or small, commercial or industrial, can emit vapours or dust into the air, discharge process effluents into sewers or generate waste that needs to be disposed of. These companies are therefore subject to environmental regulations. The same applies if facilities are located in ecologically sensitive areas, such as floodplains or zones of groundwater recharge. In addition, there

are also a number of facts to be reported, or approved, that the companies have to take into account.

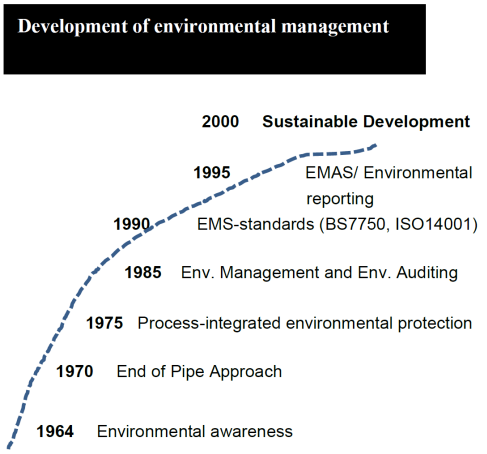


Figure 1 Development of the idea of environmental management according to (UNEP / ICC / FIDIC, 1996))

Environmental management is not an invention of recent years, but a development triggered by negative side effects in economic life and driven by recent scientific findings. Figure 1 shows the development of environmental management since the early 1960s. Starting from the emergence of environmental awareness, we have come a long way towards sustainable development. It can be taken for granted that environmental management will continue to evolve over the next decades.

There are a large number of companies that do not appear at first glance to be subject to environmental legislation. These include, for example, car workshops, car body construction companies, bakeries, car washes, cleaners, paint shops, laundries, printers and dentists. This list does not claim to be complete and of course there are many special regulations and exceptions, so that many companies and establishments do not have to apply the environmental requirements. If this is the case, disregarding the environmental regulations can lead to substantial fines or even to the closure of the company. There is no denying that environmental legislation can be very complex, sometimes even confusing and ambiguous, but once regulatory compliance has been achieved and a system implemented to maintain this state of affairs, the company is on the right side of the law.

For many people and companies, compliance with environmental regulations entails additional costs, which have a negative impact on a company's profits. However, this effect can be minimized. The reduction of waste, water or energy consumption can lead to considerable savings. Companies working with environmental management systems are convinced of the advantages of such an approach. In addition, there are so-called "soft facts" that affect the image of such a "green" company (e.g. through active external communication) and thus indirectly have a positive influence on the company balance sheet.

Of course, there are unfounded fears that prevent many companies from determining their legal status and, if necessary, from asking the competent supervisory authority for assistance. The Environmental Inspectorate will usually work with the company to try to achieve compliance and provide the company

with the best possible support. If the company does not approach the authorities and then becomes conspicuous, it is usually already too late to follow the path outlined above. The authority will have no choice but to initiate and implement the coercive measures imposed on it by law.

An environmental management system is a systematic approach to achieving environmental and other organisation-specific goals. This can range from complying with environmental requirements to improving environmental performance to meeting customer expectations or the expectations of other stakeholders. In addition, an environmental management system offers the possibility of systematically identifying risks and thus contributing to the avoidance of environmental damage and financial losses in equal measure.

Irrespective of the nature of the environmental management system, the key objectives to be achieved should include prevention of environmental impacts and compliance with environmental legislation. But an EMS is only one of several ways to achieve such goals. Many organisations have managed to reduce waste and prevent pollution even without an environmental management system.

After all these abstract explanations, the question still remains: "Why should an organisation need an environmental management system?

To answer this question you should think of a company of your choice and try to answer the following questions for that company (Stapleton, et al., 2001):

- Does the company have to meet environmental requirements and if so what are these?
- Is there interest in finding ways to improve the company's environmental performance?
- How much time does the company have available to sort out its "environmental matters"?
- Does a lack of time and/or resources prevent the company from effectively managing its environmental obligations?

An exercise for audiences in particular countries such as Vietnam, Thailand, and Indonesia, is for them to search for their country's legislation in relation to the environmental requirements of the aquaculture industry. The outputs of their search together with the objectives of their fish farming activities should prompt them to answer these questions.

01.2 WHAT EXACTLY IS AN ENVIRONMENTAL MANAGEMENT SYSTEM?

Behind an environmental management system there is a continuous cycle, which is to lead from planning to implementation and from review to an improvement of processes and measures. In short, it is a constant target-performance comparison with which an organisation checks whether, and to what extent, its environmental goals and requirements have been met and counteracts any deviations accordingly. To comply with the requirements of ISO 14001: It is the part of the overall man-

agement system that includes organisational structures, responsebilities, behaviours, processes and resources for the development, implementation, review and continuation of the environmental policy. The expected result of this approach is an improvement process in environmental management that indirectly optimises the environmental impact of the organisation.

Due to the fact that an environmental management system standard is very general, it is possible for any type of company to organise environmental management processes from a specific perspective. A furniture store without its own production facilities could limit its environmental management system to the environmental behaviour of its suppliers as far as possible. Another company that produces hazardous chemicals may orient its environmental management system towards the design of environmentally friendly products, including the recycling and reuse of the product and its residues.

Each environmental management system is unique and difficult to compare in detail with any other. The link that links the environmental management systems of different companies is the fulfilment of the structural requirements of the relevant standard (ISO 14001, EMAS) as well as the verification by an external auditor that the policy, objectives and targets of the environmental management system are indeed fulfilled.

To answer a question such as "Does a company act in an environmentally conscious manner in various areas?", the observer would first need to know exactly what the company is trying to achieve with the help of its environmental management system. Is an EMS certified? It can only be deduced that the company has developed a system to achieve continuous improvements along ecological vectors. If compliance with environmental requirements is the sole objective of the management system, the above requirement appears to have been met.

ISO 14001, which is an international standard, is committed to compliance with applicable laws and regulations. However, these environmental regulations can vary greatly from country to country. Accordingly, in countries with very few environmental laws, compliance can be relatively straightforward, while in other countries it is exorbitantly more complex.

01.3 ADVANTAGES AND COSTS OF AN ENVIRONMENTAL MANAGEMENT SYSTEM

Is the introduction of an environmental management system according to ISO 14001 a "money sink" or an investment in the future? The answer depends on the approach of the organisations that want to implement and maintain an environmental management system. If the management system is aimed at improving production processes and product design, it can make a significant contribution to preventing environmental pollution, reducing operating costs and, in part, increasing

customer satisfaction and market share. However, a more complex EMS that covers more of the company's activities and processes requires or includes more time and financial resources.

There are numerous advantages associated with the introduction of an environ-mental management system. These include:

- Improved environmental performance,
- Improved compliance with legal requirements,
- Prevention of environmental pollution,
- Conservation of resources,
- Development of new customers / markets,
- Efficiency increase / reduction of costs,
- Improved workplace morale,
- Improved image with the public, local authorities, lenders, and investors
- Improved environmental awareness among employees
- Competitive advantages
- Fewer accidents.

The experience that companies have had with environmental management systems to date is evidence of this. If an environmental management system is well implemented, the profits and resource efficiencies of companies usually improve. The amount of waste to be disposed of decreases and the level of pollution caused by the company also decreases. As a rule, other organisation-specific aspects such as teamwork also improve. Almost all companies that have introduced an environ-mental management system consider such a system to be sensible and economical-ly profitable, although it involves a lot of work.

In general, the cost of implementing an environmental management system will depend on the nature and extent of the company's environmental impact. In addition, factors such as the speed of implementation, the existence of previous systems and their effectiveness also play a role.

Other sources distinguish between internal and external costs incurred in implementing an EMS. A large part of the necessary resources that a company must provide for an environmental management system will be human resources. This means that most organisations will have to incur personnel costs and these include:

- Working hours of managers and
- Working hours of other employees

The reason for these internal personnel costs results from the time staff have to spend collecting information, reading and understanding the requirements of an environmental management system, preparing worksheets, attending EMS meetings and (further) developing the environmental management system. Additional costs are incurred for the internal training/education of staff in the new processes and for technical facilities for the analysis of environmental impacts and possible investments to improve these impacts. External costs arise from external consulting and

training for the environmental team, which occurs in particular during the pro-cess of implementing an environmental management system.

As a rule, the introduction of an environmental management system is associated with more benefits than costs. In order to avoid unpleasant surprises, however, the possible costs should be estimated before implementing environmental management measures.

It is advantageous and cost-saving if environmental management systems are based on existing and well-functioning production or quality management systems. If such systems are weak, ineffective or simply non-existent, there is a need to change the management framework before starting to set up an environmental management system.

02. ENVIRONMENTAL MANAGEMENT OF AQUACULTURE

Nguyen Van Trai, Vu Cam Luong, Nguyen Hoang Nam Kha

Nong Lam University (NLU) - Ho Chi Minh City

Learning Outcomes
Apply tools and standards for environmental management
Set objectives, targets and programs for environmental management
Plan actions for environmental management;
Identify and implement the roles and responsibilities of stakeholders in environmental management of aquaculture systems.

Sustainable production of any discipline requires not only the efficiency of operational cost of a company but also satisfactory environmental management and protection. Specifically, a company of any size, either at large or small scale, generating waste from its production cycle is subject to environmental regulations and legislation. Therefore, the company has to have a comprehensive management system for environmental protection. Aquaculture enterprises do not step aside these regulations, however, at the present many fish farming companies in Vietnam are not paying enough attention to environmental protection. This is because they have not established an effective environmental management system or may not know how to set up and operate such a system. Or perhaps they have not realised the tremendous benefits of running a successful management system for environmental protection.

This chapter will provide a practical guide for establishing an environmental management system which can be applied by aquaculture enterprises in order for them to protect the surrounding environment during their operations. Its focus is on relevant audiences, including aquaculture students, technicians, enterprise managers, government officials, and other interested audiences. The main contents of this chapter include:

- Tools and standards to be used for aquaculture enterprises in Vietnam
- Setting objectives, targets and programs for environmental management
- Implementation of environmental management into aquaculture enterprises
- Roles and responsibilities of stakeholders in environmental management implementation for aquaculture

02.1 TOOLS AND STANDARDS FOR ENVIRONMENTAL MANAGEMENT

02.1.1 Reviewing the enterprise activities

In order to plan an environmental management program for an

aquaculture company, first the planner has to master its production activities, from inputs, production processes, outputs, by-products, discharge, marketing and selling products, and so on. Then an appropriate plan for environmental management would be developed accordingly. This is a very important step in the management system. The aim of this management system is to support the company on their production process without threatening the surrounding environment, as well as to improve its performances in terms of both product quality and operation cost efficiency. By implementing a good environmental management system, the company should seek the certification/registration of its system by an external organization. Currently, a company who holds such a certificate will have many advantages in terms of market competition.

Commonly, activities of an aquaculture farm company would include farm design and construction, feed selection and feeding strategies, water quality management, disease control, harvesting, waste treatment after harvesting, management of waste derived from human living activities, trading products to end consumers, and so on.

02.1.2 Setting environmental policy for company activities:

Environmental policy is the commitment of a company's managers to comply with legal and other requirements, to prevent pollution and to continually improve its performance. This policy forms the basis on which the company will set its objectives and targets for environmental management. It should be clear for both internally and externally interested parties to understand. It should also be reviewed and revised according to changing conditions and information. It should identify the scope of environmental management based on the nature of the company's activities, products and services.

The environmental policy should be communicated to all workers/staff working for the company and may be in alternative forms such as a statement, list of rules, list of procedures, etc.

02.1.3 Identifying environmental aspects

Based on the specific activities of an aquaculture company, which have been reviewed, all environmental aspects would need to be identified. Environmental aspects are elements of the company's activities, or products, or services, that can impact the surrounding environment. For instance, a fish farm designed with an availability of waste treatment ponds should significantly minimize water pollution to the natural waters, otherwise wastewater discharged from such a farm could harm the surrounding biodiversity.

02.1.4 Assessing environmental aspects

From the identified environmental aspects, an efficient environmental management system must be able to comprehensively assess the possible impacts, including positive and negative ones. Environmental assessors should address all environmental impacts, or likely changes, from any activities, even though it is not easy to recognize in some circumstances. Within an aquaculture farm, setting up a waste treatment pond is usually considered to be a positive practice, however, its negative impact would be to reduce the fish raising area, and to increase the operating costs for the company. Therefore, it is always a good idea to carefully balance benefits and costs but also to prioritize environmental protection for long-term production.

02.1.5 Environmental performance indicators and eco-balances

Environmental performance is the result of conducting an management system of the company, by dealing with its environmental aspects. These results will be measured and reported as indicators, which can be used for the evaluation of such an environmental management system. This measurement will based on the company environmental policy, objectives and other requirements. One specific example of an environmental performance indicator at an aquaculture farm is the measurement of water quality parameters of its discharged flow, to check the extent to which it meets the legal quality standards for wastewater. Indicators are usually set dependent on the nature of its activities and its environmental impacts. To some extent, people may apply the ecosystem approach to aquaculture (EAA) as a strategy to manage their farming sector by taking into account all interactions between their production activities with the local ecology and by acknowledging its multi-ple ecosystem services (Soto et al., 2012). This EAA will focus on aquaculture-fishery interactions in relation to biological, technological, social, economic, environmental, policy, legal and other aspects of aquaculture activities.

02.1.6 Legal obligations and other requirements of aquaculture activities

For the sustainability of the aquaculture industry, Asian countries including Vietnam, have launched a legal regulation which is applied to all aquaculture sectors. At International level, as a member of the Food and Agriculture Organization (FAO), Asian countries, including Vietnam, have to subscribe to the Code of Conduct for Responsible Fisheries (1995) and its underlying guidelines and plans of action. Being a member of ASEAN, Vietnam embraces the codes of conduct adopted by the SEAFDEC. One such example is the “Manual of ASEAN Good Shrimp Farm Management Practices” (Association

of Southeast Asian Nations – https://asean.org) which was adopted in 1998 at the 20th Meeting of the ASEAN Ministers of Agriculture and Forestry (AMAF) held in Hanoi, Vietnam. In addition, ASEAN has also published two other guidelines on fisheries, including the "Manual of Practical Guidelines for the Development of High Health Penaeus monodon Broodstock and the Harmonization of Hatchery Production of Penaeus monodon in ASEAN Countries" (Association of Southeast Asian Nations – https://asean.org). Another important inter-governmental organization working to improve the sustainability of aquaculture development is the Network of Aquaculture Centres in Asia-Pacific (NACA). A part of NACA's work includes the devel-opment, dissemination, and support of policy guidelines such as the "Guidelines for Environmental Management of Aquaculture Investments in Vietnam" (Net-work of Aquaculture Centres in Asia-Pacific - https://enaca.org). Vietnam is currently contributing to improving the standards of ASEAN shrimp Good Aquaculture Practice (GAP) and ASEAN GAP. Vietnam is improving the implementation of Viet GAP in its aquaculture practice which is also based on FAP guidelines which will be recognized by other organizations.

02.2 SETTING OBJECTIVES, TARGETS AND PROGRAMS FOR ENVIRONMENTAL MANAGEMENT

Aquaculture companies have to establish environmental objectives and targets that are relevant to their functions and activities at the company level. It is very important that these objectives and targets should be measurable, and consistent with environmental policy, including the commitments to pollution control. They also need to be compliant with legal and other requirements.

The establishment of objectives and targets should consider using available techniques where these are appropriate and economically viable, and cost effective to apply them. Then a program needs to be established, implemented and maintained, to achieve these objectives and targets. The program should describe how to achieve these objectives and targets and include a timeframe, the necessary re-sources and itemise the personnel responsible to action them. Each program should address specific elements of the company's operations.

For example, an aquaculture company which aims to raise fish that meet the market requirement for "clean products" should include relevant objectives that include producing "safe fish" without chemical residues, and no pollution to the surrounding environment. In order to achieve these objectives, they will need to: develop a program which strictly monitors pond water to maintain good water for

farmed fish; limits chemical use and if necessary uses only legally permitted ones following strict instructions. Additionally, the farm design should consist of a treatment pond to treat wastewater before discharging it to the environment as re-quired by law. The company will always implement and maintain this program in order to achieve its environmental management objectives.

02.3 TAKING ACTION

02.3.1 Allocating resources and tasks

The company needs to ensure the availability of its resources, to establish, implement, then improve the environmental management system. Its resources include the work force with specialized skills, organizational infrastructure, drainage and waste treatment facilities, technical equipment and funds. Firstly, the company should define clear roles, responsibilities and authorities for the individuals involved. This process needs to be documented and communicated within its organization and this is very important in order to facilitate an effective environmental management system. Secondly, the company needs to appoint a specific management representative who will manage all these processes. This appointed person will play a key role in ensuring the smooth operation of the environmental management system. He/she must report to the company's board of directors on the performance of the environmental management system and to provide recommendations for improvement. In a large company, however, there may be more than one appointed representative, and each one will be responsible for a specific aspect of the environmental management system.

02.3.2 Competences, training and awareness:

The company must appoint skilled person(s) with strong competences to be able to successfully perform environmental management tasks. He/she should be qualified with appropriate education and experience. In many cases, the company would identify what need to be trained for the appointed person(s) for their comprehensive qualification, in order to meet its environmental management requirement. Then the training will be provided. The appointed person(s) has to be aware of the importance of conformity with the environmental policy, following accurate procedures to meet the environmental management system. Awareness of significant environmental aspects and potential impacts related to their works is also important. He/she has to understand his/her roles and responsibilities in achieving conformity of environmental management requirements. In general, awareness, knowledge, understanding and competence may be obtained or improve through training, education or work experience.

02.3.3 Communication:

It is essential to make its environmental management program well understood by all personnel in the company, to ensure the effective implementation of the envi-ronmental management systems. Thus, the company has to internally communicate these aspects at various levels and departments, by regular meetings, newsletters, bulletin boards and websites.

The company should decide whether to communicate with external interested par-ties, for the purpose of receiving feedback from outside its organization. This communication should include a dialogue with interested parties and consideration of their relevant concerns. The feedback should help to improve its environmental management program. External communication can be in the form of annual re-ports, newsletters, websites and community meetings.

02.3.4 Documentation:

The level of detail of the documentation should sufficiently describe the company's environmen-tal management system and how its elements link together. It should also provide the detail of where to obtain more detailed information on the operation of specific elements of the environmental management sys-tem. The required documents may vary from one company to another, depending on:

- the size and typical type of aquaculture, its products and services,
- the complexity of its operation and interactions, and
- the competence of its appointed person(s)

For example, the document includes: its environmental policy, objectives and tar-gets; a description of the scope of the environmental management system; a check-list of the main elements of the environmental management system and their inter-action, including related documents; all related documents and records required by law; documents and records that are necessary for the company to ensure the effective planning and operation of the environmental management system; internal and external standards; the company organi-zational charts.

02.3.5 Control of documents:

All required documents, including records, will be controlled under the environ-mental management system. The controlling program will cover the following:

- Approval of documents for adequacy prior to issue,
- Carefully review and update, if needed, then re-approve documents,
- Identify any changes from previous versions of the documents,
- Make relevant versions of applicable documents available whenever needed,
- Make documents readable,
- Ensure that all documents of

external origin are identified, and

- Avoid using out-of-date documents.

02.3.6 Operational control:

The company should evaluate its operations, which identified significant environ-mental aspects and ensure that these operations are performed in an environmental-ly responsible manner to mitigate their adverse impacts, in order to meet its objectives and targets.

The company will identify and plan the operational process, in order to maintain it under specified conditions. It includes implementing and maintaining the documented procedure to control the process as accurately as intended; stipulating the operating criteria in the procedure; implementing and maintaining procedures to control all environmental issues of goods and services used by the company, and communicating applicable procedures and requirements to suppliers or contractors.

02.3.7 Preparation for Emergency cases and responses:

The company has to predict any potential emergency situations or accidents which can lead to impacts on the environment; and should plan how to respond to these cases. It should ensure that it can prevent or mitigate adverse impacts to the envi-ronment. It also needs to periodically test the procedures for responses, and review and/or revise, after the occurrence of any accidents or emergencies.

When developing the procedure(s), the company should consider the following aspects:

- The nature of on-site hazards, e.g. electrical shock, chemical contact, water-exhausted accidents, and how to respond to these cases,
- The most likely type and scale of emergency situations or accidents at aqua-culture farms, and the most appropriate methods to deal with them,
- Guidance for internal and external communication in emergency cases, for example providing a list of key person(s) and aid agencies (e.g. fire department, first-aid service) with contact details,
- Action(s) required to minimize environmental damage,
- Post-accident evaluation, corrective and preventive actions,
- Training for emergency response,
- Evacuation routes and assembly points, etc.

02.4 ROLES AND RESPONSI-BILITIES OF STAKEHOLDERS IN ENVIRONMENTAL IMPLEMEN-TATION FOR AQUACULTURE

Roles and responsibilities of stakeholders in environmental implementation for aquaculture can be considered at three levels (AU-IBAR, 2019) as follows:

02.4.1 Regional level

Regional organizations have a requirement to perform the following tasks:

- Spatial assessments and zonation for aquaculture within the context of other ecosystem uses.
- Build and maintain a database of aquatic species biodiversity.
- Revise and strengthen regional policies, strategies and plans based on available data
- Strengthen regional institutions to support sustainable aquaculture development.
- Establish mechanisms for conflict resolution in shared water bodies.
- Data analysis to monitor utilisation and management of trans-boundary aquatic resources in line with regional policies.
- Develop, coordinate and supervise the implementation of regional strategies, programs and projects to harness, maintain supply and manage sustainably transboundary aquatic and other natural resources for aquaculture.
- Regional ecosystem environmental monitoring and mitigation programs.
- Zonation for aquatic animal disease surveillance and control.

02.4.2 National level

Agencies at a national level have a requirement to perform the following tasks:

- Identifying and demarcating high potential areas and zones for aquaculture.
- Selection and development of species for commercial aquaculture.
- Undertake technical and infra-structural designs, designate aquaculture development zones.
- Develop guidelines (Best Practices) for producers and other sector players at enterprise level.
- Build national and stakeholder capacity to implement recommendations and best practices.
- Establish a harmonised mecha-nism for conflict resolution between aquatic resource stakeholders.
- Register farms and maintain a national inventory of aquaculture establishments.
- Assess status and trends to prioritise, streamline and improve national policies and development actions
- Develop and implement national aquaculture sectoral strategies, programs, plans and projects that are in harmony with regional stakeholders to ensure ac-cess and sustainable management of aquatic and other natural resources for aquaculture development.
- Create associations that support effective participation and contribution of the private sector as one-voice at national level.
- Secure financial resources to implement programs and plans to safeguard and ensure the sustainable utilisation and management of aquatic resources for aquaculture.
- Harmonise regional guidelines and standards with national sector guide-lines.
- Implement environmental impact

assessment guidelines and protocols for aquaculture.

- Develop and implement an environmental monitoring plan in line with regional guidelines.
- Develop appropriate climate change risk reduction strategies and measures for the aquaculture sector.
- Develop and support national R&D aquaculture programs and projects.

02.4.3 Private sectors and practitioners

Private sectors and practitioners have a role to perform the following tasks:

- Evaluation and selection of production system developments.
- Application of GAPs in the private sectors.
- Apply and implement the Sector Standard Operating Procedures (SOPs)
- Register establishment and record keeping to set-up and maintain a producer association database.
- Develop, invest and operate various projects and/or enterprises in line with GAPs and sector SOPs and enterprise objectives.
- Effectively use financial packages for environmentally friendly aquaculture systems.
- Mobilise resources for environmental management in aquaculture.
- Implement good aquaculture practices within the application of Standard Operating Procedures
- Implement an environmental impact assessment based upon guidelines recommended by government.
- Create platforms, or associations, to share information.

In general, aquaculture interacts with the environment as it utilizes resources and causes environmental changes. Most interactions have beneficial effects (Barg, 1992). There have been substantial socio-economic benefits arising from the expansion of aquaculture. However, environmental management systems are being implemented in many sectors of aquaculture in order to assist organizations to (a) comply with legal requirements minimizing impacts on the environment, (b) reduce waste, and (c) gain an advantage in the market place. Much effort has been made to focus on environmental and developmental circumstances and requirements of aquaculture practices in developing countries. It is believed that appropriate environmental management of aquaculture can be achieved by strengthening efforts towards increased success and efficiency in the development and management of aquaculture operations.

03. BASIC MODULES OF AN ENVIRONMENTAL MANAGEMENT SYSTEM

Thomas Potempa*, Alena Mychkova* and Rakpong Petkam**

* *Ostfalia University (OU)*

** *Khon Kaen University (KKU)*

Learning Outcomes
Present the DEMING cycle and describe its significance for environmental management
Apply the process concept to environmental management and define process types and
Present and compare key performance indicator areas in environmental management.

In the previous chapter we set the stage for work to be done when implementing an environmental management system. However, at this point it is not clear, what consequences are to be expected for practical work. Therefore we will go back and ask some questions.

What is Management? How does this relate to an environmental management system? Is it all just a bunch of baloney?

These questions are frequently asked in the ever-changing world of environmental management systems.

03.1 THE DEMING CYCLE AS THE MAIN PRINCIPLE OF ALL MANAGEMENT SYSTEMS

Around 1930 Walter Shewart formulated the PDCA cycle as the basic consideration for any systematic improvement of processes and/or systems. This approach was subsequently adopted by W. Edwards Deming and is often referred to in literature as the Deming Circle. The PDCA cycle, or DEMING cycle, starts from the following chain of thoughts (Figure 2):

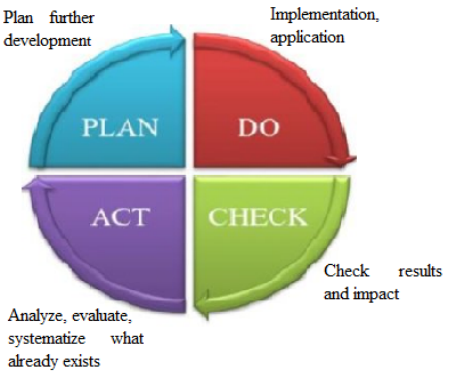


Figure 2: The DEMING cycle (after Commercial Industrial Vocational School Thun, 2013)

Plan: All activities, processes, etc., within a functioning organization,

should be performed and planned and should not be implemented ad hoc.

Do: After planning, the implementation should also take place systematically and be planned (e.g. in the form of pilots).

Check: The activities, processes, etc. are to be checked and monitored at suitable locations.

Act: Based on the controlling results and findings, activities for improvement must be implemented.

In order to achieve an improvement in

environmental protection in accordance with this management approach, an organization needs to focus not only on the obvious (e.g. smoke from the chimney), but to answer the question of why it happens. With time the systematic identification and elimination of deficiencies in the system will yield an improvement in environmental quality (and thus an overall increase in organisational performance).

Environmental management is part of the strategic planning in an organisation or company. In order to achieve a continuous improvement of this strategic planning, this cycle should be run through frequently. The following sub-steps result in the necessary detail:

Commitment and policy:

- Top management is committed to protecting the environment
- Introduction of an environmental policy as a guideline for entrepreneurial action

Planning:

- The company conducts a review of its activities,
- identifies legal requirements and environmental aspects,
- sets goals and draws up a plan to achieve them.

Implementation and operation:

- In order to achieve the environmental objectives/targets set, the company defines responsibilities,
- trains employees in environmental issues,
- communication,
- documents and prepares work instructions and
- creates plans for emergency situations

Measurement

- the company monitors its activities in order to assess whether the objectives set have been achieved
- initiates a corrective or precautionary manner if the targets have not been achieved.

Management review

- Top management moderates the EMS to optimize its effectiveness,
- reviews at this high corporate level, closes the current cycle and opens the next cycle

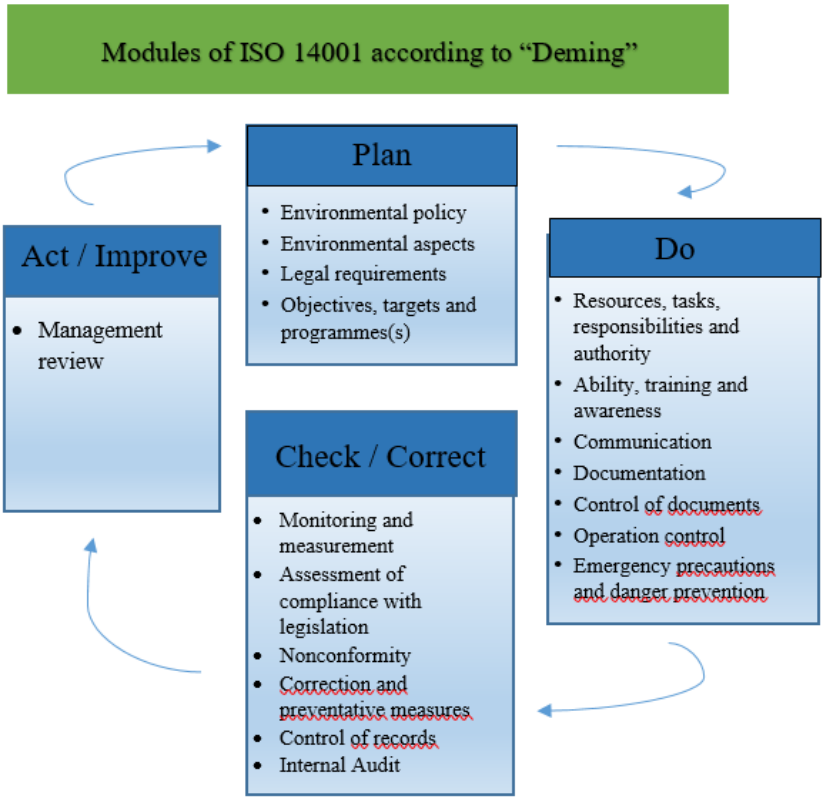


Figure 3: Modules of ISO 14001 "Deming" (UNEP / ICC / FIDIC, 1996)

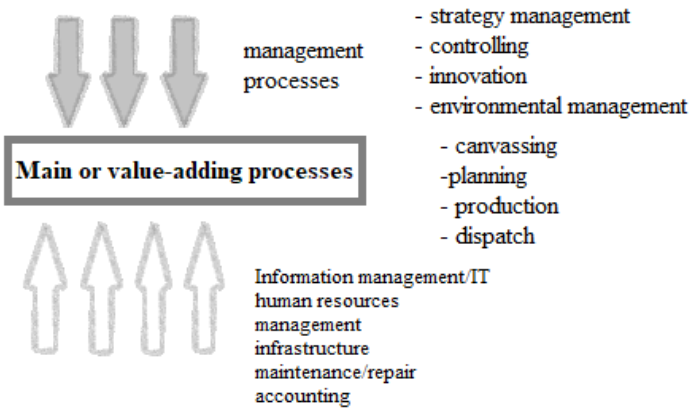


Figure 4: Processes and Process types - the basis for environmental management.

If ISO14001 is chosen as the basis for an environmental management system, Figure 3 shows the modules which were assigned to the individual stages of the DEMING cycle. The individual modules will be dealt with in more detail in the following chapters.

03.2 FROM COMPANY ACTIVITIES TO PROCESSES AND INDICATORS

In order to facilitate the development of an environmental management system, or even to make its structure appear a little clearer, it is now time to deal with processes. Processes form the basis for most management systems. By definition, a process is:

- A sequence of logically related activities for creating a service or changing an object (transformation).
- It has a defined beginning (trigger or input)
- It has a defined end (result, value, output)
- Maintains an objective: value growth or added value

The most important processes in a company can be divided into three different types: Planning and strategy processes (management processes), core or value-added processes and supporting processes (secondary processes). A possible assignment of individual processes to the three process types is shown in Figure 4. The assignment, especially in the area of management and auxiliary processes, is partly arbitrary by the author. Depending on the corporate philosophy in individual companies, the assignment may be different.

Irrespective of the classification, Figure 4 shows that environmental management manifests itself in all three process types. The management process "environmental management" is already conceptually linked. However, environmental concerns are also affected in the areas of production and shipping as value-adding processes, but also in the areas of maintenance and personnel management as supporting processes. This must be taken into account when implementing environmental management.

Processes and process performance are usually monitored using key indicators that can be assigned to different key indicator areas. In environmental management you usually find the following distinctions:

Input Indicators	Raw materials Auxiliary material Supplies Water Energy
Output Indicators	Products Waste Sewage Exhaust
Environmental Status Indicators	Soil Water Air
Infrastructure Indicators	Regulations and permits Health and Safety

	Incidents Law and complaints
System Evaluation Indicators	Environmental policy Environmental objectives Environmental audit

03.3 IMPORTANT INTERNATIONAL STANDARTS AND GUIDELINES

In the early 1990s, various countries developed their own standards for an environmental management system, of which the BS7750 from Great Britain is probably the best known. However, following the introduction of ISO 14001 in 1996, all of these standards were withdrawn in favour of the new global standard. ISO 14001 is the main document in a series of standards developed in recent years, covering various aspects of environmental management and the environmental performance of companies and organisations. A brief description of the various individual standards in this family can be obtained from the Internet at http://www.iso.org/iso/theiso14000family_2009.pdf. By the beginning of 2016, about 350,000 organizations worldwide had been certified to ISO 14001 (see Figure 5).

In 1995, EMAS (Eco Management and Audit Scheme), a European Union regulation on an environmental management system, which until recently was only valid in the EU member states, was also established. However, EMAS can also be applied worldwide since the last amendment (2009). (Article 1: "inside and outside the Community"). Member States may, but are not obliged to, introduce appropriate arrangements (e.g. modalities for registration, or for carrying out and monitoring evaluations).

Originally, the scope of EMAS was limited to industrial sites. It was only in the context of revisions that the scope was opened up to all private and public organisations in all sectors. EMAS is a voluntary scheme designed to improve the environmental performance of companies and to provide environmental information to the public. Private and public organisations established in the European Union and the European Economic Area - Iceland, Liechtenstein and Norway - may participate in EMAS.

The current version, EMAS 3, is now fully compatible with ISO 14001. All ISO 14001 environmental management requirements are integrated in EMAS 3. In addition, however, a number of special features have been introduced so that EMAS's claim is significantly higher than that of ISO 14001. A summary of the main differences is shown in Figure 5 and Table 1.

In general, the main difference between EMAS and ISO 14001 is the strong focus on providing information to the public, external communication and the company's responsibility for

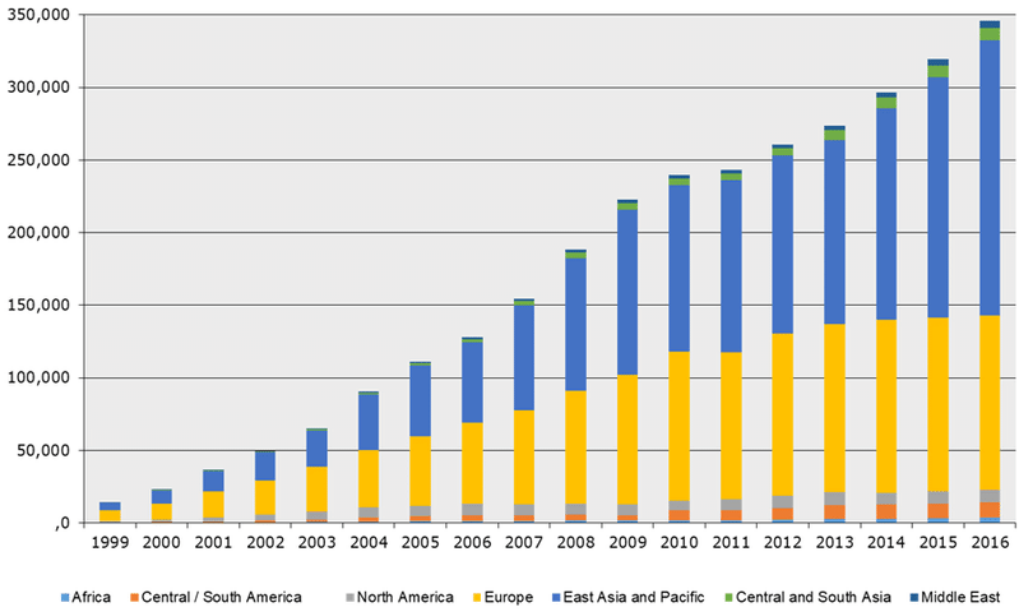


Figure 5: The number of ISO 14001/EMAS registration of the world. (Erceg, 2017).

its environmental performance.

In order to meet the objective of continuously improving environmental performance, EMAS requires an initial environmental audit to be carried out. The determination of the environmental aspects also includes the indirect environmental aspects of the organisation. While only the management system was assessed in ISO 14001, EMAS also validates the environmental statement, i.e. the disclosure of environmental impacts by the auditor (reliable, credible and correct). Environmental statements must be updated and validated annually. In addition, the assessment ensures that the organisation complies with relevant environmental legislation.

If it bases itself on these two standards, an organization can:

- create a management system that meets the requirements of ISO 14001 without being certified
- establish a management system that meets the requirements of ISO 14001 and has been certified by an external auditor
- additionally comply to the stronger regulations of EMAS

Which choice an organization makes in the end is ultimately its decision, which depends on economic, social and other factors.

Table 1 - Main differences between ISO 14001 and EMAS (UGA - Umweltgerachter-Ausschuss, 2013)

	EMAS	ISO 14001
Scope	European Union	worldwide
Character	governed by regulation	agreed privately
Small and medium enterprises	facilitation of requirements / process	no special provisions
First Environmental Assessment	mandatory	only recommended
Environmental aspects	consideration of all direct and indirect environmental impacts	only direct environmental aspects are considered
Public relations	obligation with substantive requirement to the environmental statement	there is no need to publish an environmental statement
Participation of workers	mandatory	only indication
Content of the assessment	management system and environmental statement	only management system
Registration and publication of the participants	public register	none

EXERCISE 1 / DISCUSSION

DEFINE A DEMING-CYCLE FOR THE FOLLOWING PROCESS: "LEARNING FOR AN EXAMINATION". LIST THAT NEEDS TO BE CONSIDERED IN EVERY PHASE OF THE CYCLE.

04. RESPONSIBILITIES OF TOP MANAGEMENT

Thomas Potempa* and Alena Mychkova*

** Ostfalia University (OU)*

Learning Outcomes
Understand the tasks and responsibilities of top management in environmental management,
Identify the main elements of an environmental policy and formulate environmental policies,
Develop environmental objectives and define indicators for the achievement of these objectives; and
Be familiar with the necessary information for a management review.

While Section 4.1 of ISO 14001:2009-11 describes the basic content and formal requirements for an environmental management system,

> *"The organization shall establish, document, implement, maintain and continuously improve an environmental management system in accordance with the requirements of this International Standard and determine how it will meet those requirements."*

Section 4.2 "Environmental Policy" in conjunction with section 4.5 "Management Review" reflect the value and importance of organisational management.

The management of an environmentally conscious organisation must both provide framework conditions and - here there is still a great potential in practice - serve as a role model for the entire management team in order to make it clear to all parties involved (customers, employees, society, donors, etc.) on a daily basis what is really understood by environmental protection in the organisation itself and what should be understood in the future. Without the continuous and stringent role model function of the entire management team, the essential potential of an environmental management system remains untapped. The tasks of organizational management within the framework of an environmental management system do not end with the appointment of a project manager for this topic. Rather, it must also be actively involved in this project and help to shape it.

The concrete tasks of the management include:

- Communicating the importance of a truly consistent environmental orientation within the entire organisation
- Communicating the need to consistently reduce environmental impacts throughout the organization
- Understand the importance of regulatory compliance throughout the organization.
- Definition of environmental policy
- Setting environmental targets
- Performance of the management evaluation
- Provision of resources

With these remarks it becomes clear that the continuous improvement

process also includes the activities of the organizational management and that the management itself is integrated in a quasi "own" DEMING cycle. PLAN activities in this cycle include in particular the definition of environmental policy and objectives for the organisation as a whole. DO and CHECK activities are generally delegated to those responsible for the environmental management system, but ACT activities, i.e. the management evaluation, are once again a matter for the boss.

04.1 ENVIRONMENTAL POLICY

In the environmental policy (also: guidelines, mission statement, etc.), the organisational management formulates the overriding intentions and orientations of its own company with regard to the comprehensive topic of "environmental protection".

It forms the thematic framework for the subsequent definition of concrete environmental goals, etc.. In other words, the overarching issues mentioned in the environmental policy must be reflected in some way in the concrete objectives for the company and all the organisational areas involved.

Environmental policy provides the framework for managing and directing an organization. It is important for all those involved in an organisation to critically question their own activities with regard to the implementation of environmental policy and, if necessary, to improve and/or adapt them.

The environmental policy must be appropriate in content, scope and form of the own organisation in order to really serve as a framework and to be understood at all levels as well as in all areas (and by all employees).

In order to meet the requirements of ISO 14001, it is appropriate for the environmental policy to address, or reflect, the nature, scope and environmental impact of its activities, products and services, since the environmental policy provides the framework for the definition and assessment of environmental objectives and targets.

PREPARATION 1

INVESTIGATE THE ENVIRONMENTAL POLICIES OF AT LEAST 5 DIFFERENT COMPANIES AND DERIVE FROM THEM THE OBLIGATIONS REQUIRED BY THE STANDARD.

EXERCISE 2/ DISSCUSSION

BELOW YOU WILL FIND THE DRAFT ENVIRONMENTAL POLICY. CORRECT THE POLICY SO THAT IT MEETS THE REQUIREMENTS OF ISO14001:

ENVIRONMENTAL POLICY
OF
AQUACULTURE INC.:

THE PROTECTION OF THE ENVIRONMENT IS OF PARTICULAR CONCERN TO US. WE STRIVE TO PROTECT OUR ENVIRONMENT AND AVOID HARMFUL EFFECTS.

WHEREVER POSSIBLE, WE REDUCE WASTE, WASTE WATER AND EXHAUST AIR BY CHANGING TECHNICAL PROCESSES.

WE FEEL BOUND TO LEGAL REQUIREMENTS.

REACTION INSTEAD OF PREVENTION IS OUR IMPERATIVE.

ALL EMPLOYEES OF A-INC. WORK TOWARDS THIS GOAL.

SIGNED F. ISHING 2019
CEO

The environmental policy must be documented, implemented and maintained (i.e. it is also subject to a continuous improvement process). It must also be communicated to all persons working for, or on behalf of, the organisation and must remain available to the public. Accordingly, the environmental policies of many organisations can be accessed and viewed on the World Wide Web.

In addition to the points mentioned above, the organisation must commit itself to a number of things within the framework of environmental policy.

04.2 ENVIRONMENTAL ODJECTIVES

Since an environmental management system deals with the systematic design and implementation of processes, it goes without saying that the implementation and realisation of the environmental management

system itself must be equally systematic and planned.

In order to turn the (theoretically) high demands of environmental policy into reality, these statements must be concretized. This concretization and/or cascading takes place in the environmental goals. This inevitably results in the following characteristics for environmental objectives:

- Environmental goals are concrete and measurable
- Environmental goals represent the following level(s) of environmental policy concretization
- Environmental goals are defined for all relevant areas (including product and service).
- Environmental goals must be realistic, since unrealistic environmental goals are not accepted as an incentive and will therefore never be achieved.

This will be explained using a small example:

The environmental objectives of a company state:

"ECO-Net VSC has set itself the following environmental goals in order to safeguard its claim to continuously improve environmental protection:

- Reduce energy and water consumption
- Reduction of the number of operating materials and hazardous materials
- Reduction of waste quantities
- Improvement of environmental protection in procurement
- Continuous improvement of environmental protection in production
- Reduction of VOC emissions".

From these objectives it is relatively easy to derive key indicators to check the achievement of objectives. These are for example:

- Total energy consumption per year
- Total water consumption per year
- Number of operating materials and hazardous materials used in the company
- Quantity of waste disposed of per year
- Quantity of hazardous waste disposed of
- Number of suppliers with a certified environmental management system
- Number of environmental improvement suggestions implemented in production
- Issued quantities of VOCs per year

The above list is of course not exhaustive. On closer examination, a large number of other indicators could also be found. But the much more important question that the "inventor" of indicators must ask himself is the following:

"Do I really get the testimony I'm hoping for?"

PREPARATION 2

FOR EACH INDICATOR MENTIONED IN THE PREVIOUS LIST, GIVE AN EXAMPLE OF WHICH INDICATOR GIVES A COMPLETELY WRONG RESULT (POSITIVE OR NEGATIVE).

WHAT'S YOUR CONCLUSION?

After consideration of the hard facts, which were treated in the previous example, now a rather soft environmental goal is to be considered.

"We want satisfied, competent and excellently trained employees, who identify themselves with the company's environmental protection goals and act accordingly inwards and outwards."

In order to achieve its goals, the company can reward its own initiative, define binding training courses, make connections within the company known and provide employees with up-to-date information about the company's goals. Also the pointing out of advancement and/or development chances would be a possibility to reach this goal.

Indicators for the achievement of objectives could then be used:

- Number of positive employee appraisals
- Number of improvement suggestions submitted
- Number of employees working voluntarily in environmental protection working groups
- Number of trainings held
- Number of employees who successfully participated in training courses

But here, too, the organisation must make sure that misinterpretation of the result is either impossible or difficult.

04.3 MANAGEMENT REVIEW

With the help of a practical environmental management system, all processes within the organization will be more structured than before and thus contribute to improved environmental performance. It is therefore the responsibility of top management to assess the environmental management system itself at regular, planned intervals to determine whether it is still appropriate and effective and on what issues management expects further improvements.

In order to achieve this, management must rely on the following information:

- Results of internal audits and assessment of compliance with legal obligations and other requirements to which the organisation is committed,
- comments from external interested parties, including complaints,
- the environmental performance of the organisation,
- the degree to which the objectives and individual targets have been met,

- status of corrective and preventive actions,
- follow-up of previous assessments by management,
- changing circumstances, including developments in legal obligations and other requirements related to the environmental aspects of the organisation; and
- Suggestions for improvement.

The assessments made by the organisation's top management shall include an assessment of the potential for improvement and the need to adapt the environmental management system, ensuring that the planned adaptations are consistent with the continuous improvement process to which the organisation is committed. Records of management assessments shall be retained.

It makes sense to carry out this management evaluation (also: management review) in advance of the strategy definition for the coming fiscal year, since findings from the management evaluation may have a not negligible influence on the future strategy and/or the use of funds and resources.

The aim of the management evaluation is to obtain an overview of the current status quo on the basis of the cumulative evaluation bases and, building on this, to initiate new goals and concrete improvement activities from the top. The improvement activities may include, where appropriate, the environmental policy, the environmental objectives and

EXERCISE 3/ DISSCUSSION

DEFINE A WORKFLOW FOR THE TOP MANAGEMENT THAT ENSURES THAT THE TOP MANAGEMENT MEETS THE REQUIREMENTS OF ISO14001.

05. PLANNING

Thomas Potempa*, Chanagun Chitmanat**

* *Ostfalia University (OU)*

** *Maejo University, Chiangmai*

Learning Outcomes
Identify ways and means of identifying environmental aspects and evaluating environmental aspects,
Identify and determine environmental performance indicators,
Name the most important environmental laws and present their contents,
Identify ways to investigate an organization with regard to legal compliance, and
Develop environmental programmes from the results of an environmental audit.

In most environmental management manuals, the topics "Determination of environmental aspects" and "Legal obligations and other requirements" are dealt with after the topic "Environmental policy planning".

Practical experience shows that the order should be changed in favour of "environmental aspects". An organisation that knows its environmental aspects and also its legal obligations can formulate the individual policy areas of environmental policy more clearly and precisely.

05.1 ENVIRONMENTAL ASPECTS

However, before determining environmental aspects, an initial review must be carried out to identify the environmental aspects associated with the organisation's activities and their impacts.

05.1.1 Carrying out an initial review

An initial review is a snapshot of a company's environmental performance at a given point in time. A thorough and comprehensive review provides a solid basis for the development of a list of environmental aspects and impacts and for an environmental management programme. The first check is sometimes called a preliminary check. The process includes the collection of information on a company's environmental performance, environmental aspects and impacts, and the management structures that govern how the above issues are dealt with.

In order to create a clear understanding of the terms used, both terms are first defined and illustrated in Figure 6:

Environmental aspects:

Elements of an activity, product or service of a company that can interact with the environment.

Environmental impact:

Actual interaction with, or impact on, the environment.

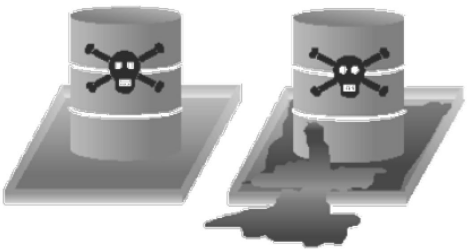


Figure 6: The relationship between environmental aspects and environmental impacts. EPA (US Environmental Protection Agency), 1999)

05.1.2 Identifying Environmental Aspects

In order to plan environmental aspects and manage their impact on the environment, an organisation needs to know what these impacts are and where they are generated. The impacts (through resource savings) and are likely to improve the environmental performance of the organisation. Therefore, an organisation must establish and maintain procedures to identify the environmental aspects it can control or influence.

There are two types of environmental aspects that need to be distinguished:

- direct aspects (controlled) and
- indirect aspects (influenceable)

Direct aspects arise directly from the operation of plants, such as raw materials in production or emissions from combustion processes. Indirect aspects can only be associated indirectly with the operation of the plant. These are e.g. aspects related to the production of raw materials purchased from a supplier (e.g. emissions from the transport of the purchased raw materials). Although the organisation/company is not obliged to manage things outside its immediate sphere of influence, measures should be considered to improve the situation.

The term "environmental aspect" is neutral and therefore environmental aspects can be either positive (e.g. manufacturing a product from recycled materials) or negative (e.g. discharging toxic substances into water).

It is almost impossible to optimize all identified environmental aspects at the same time. But "continuous improvement" implies that this is an ongoing process in which some problems are dealt with now and others in the future. The operation of a company may have many environmental aspects, but not all need to be significant, at least in a short-term perspective. Other aspects only become significant in the long term, especially if they are not adequately monitored and managed.

Only a ranking in which the aspects are evaluated according to ecological criteria (e.g. toxicity, material consumption, etc.) can determine which are the most important environmental aspects. The next step is to decide which environmental aspects are to be addressed. This is based on practical criteria such as technical feasibility or economic feasibility. But also benefit criteria (e.g. improved health) should be considered. For those aspects that were selected, environmental targets for improvement must then be defined (EPA (US Environmental Protection Agency), 2000).

So far, much has been said about environmental aspects without going into different categories. Environmental aspects can be classified into different categories. These are:

- emissions to air
- noise

- odours
- concussions
- water consumption
- energy consumption
- installations for water protection (storage tanks, substances hazardous to water)
- solid and liquid waste
- sewage/wastewater
- rainwater drainage
- soil/soil protection contamination
- raw material consumption
- natural habitats

For an initial overview, one should first follow the main processes (cf. Chapter 3) and check whether these categories occur in a sub-process and whether it is a direct or indirect environmental aspect. In case of uncertainties, it should be assumed that the aspect occurs. Then the supporting processes are examined. Even a site plan (see Figure 7) containing information about the value-adding process can serve as a starting point for this.

In the following table (Table 2) such an analysis has been carried out as an example for the goods receiving area. What has arisen here solely on the basis of the view of the site plan is a first prejudice, which facilitates the detailed search in the individual departments.

More precise results are achieved with an input-output analysis that looks at each individual process and conceals a material and energy balance of the process. The most important inputs and outputs of an organization, that should be considered, are given in Table 3. A more detailed description of IO-Analysis's (Eco-balances) will be given in Section 05.1.4

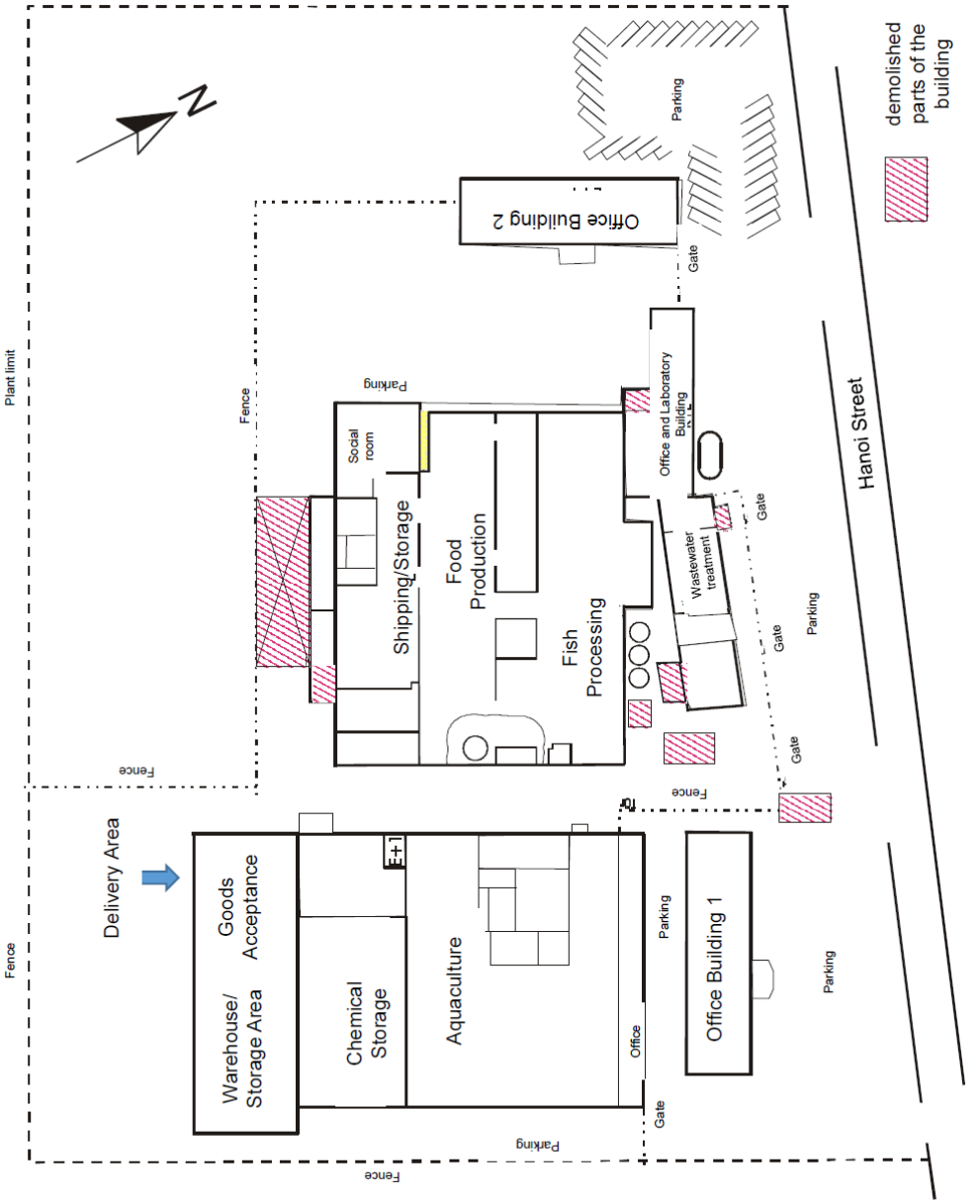


Figure 7: Site plan of a fishery enterprise

Table 2 - Environmental aspect analysis of the receiving department

environmental aspect	receiving department	
	direct aspect	indirect aspect
Emissions to air	x	x
Energy consumption	x	
Noise	x	x
Odours	(x)	
Concussions		
Solid and liquid waste	x	
Water consumption	(x)	
Installations for water protection (storage tanks, substances hazardous to water)	x	
Sewage/wastewater	(x)	
Rainwater drainage	x	
Raw material consumption		
Soil/soil protection contamination		
Natural habitats / nature conservation		x

x : occurance of Environmental Aspect expected; blank: no occurance

Table 3 – Basic outline of an Input-Output-Analysis

Input	Output
Raw materials, consumables and supplies (including dangerous substances)	Products
Energy	Waste (including hazardous waste)
Water	Sewage
Air	Exhaust air/exhaust gas
	Noise and odours

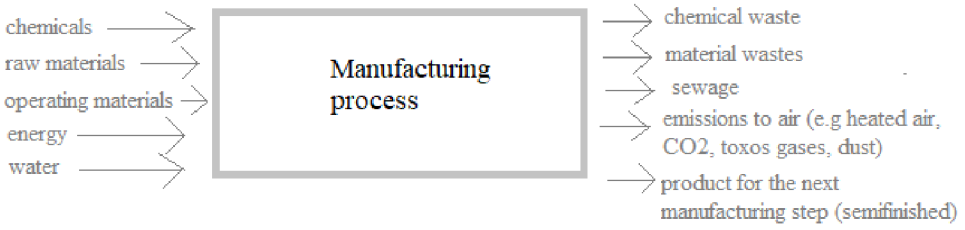


Figure 8: First draft of an input-output diagram based on EPA (US Environmental Protection Agency), 1999)

Figure 8 shows a draft input-output diagram as it might look after the first inventory. Starting with this first view, the draft will step by step become more detailed until all relevant aspects have been identified.

05.1.3 Assessment of environmental aspects

Once the environmental aspects have been identified, the company must determine which of them are significant and which of them may have significant effects on the environment. The simple postscript "can have an impact on the environment" refers to aspects that do not occur in the normal operation of the company and only come to bear in emergencies (fire, leakages, operational disturbances, breakdowns). This should therefore be taken into account when the environmental aspects are included and evaluated. Figure 9 shows the procedure for determining and evaluating environmental aspects.

In establishing the criteria for assessing the materiality of an organisation's environmental aspects, account may be taken, *inter alia*, of the following:

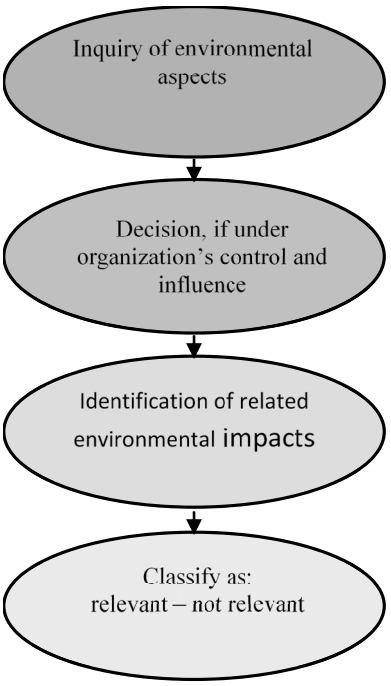


Figure 9: Identification and evaluation of environmental aspects (Stapleton, et al., 2001)

- Information on the state of the environment to determine what activities, products and services of the organisation may have an environmental impact,
- The organisation's existing data on material and energy use, discharges, wastes and emissions with regard to the associated environmental hazards,
- The views of interested parties,
- Legally regulated environmental activities of the organisation,
- Procurement activities,
- Design, development, manufacture, distribution, after-sales service, use, reuse, recycling and disposal of the organisation's products,
- Activities of the organisation with the most significant environmental costs and positive results for the environment.

In assessing the significance of the environmental impacts of its activities, the organisation should consider not only normal operating conditions, but also conditions at commencement or completion of activities and emergency situations that must be realistically anticipated. Past, present and planned activities should be taken into account.

Determining which aspects are significant is a partially subjective decision of the organization. For this reason, the definition should not be made by an individual, but by a team composed of different professional groups and representing a cross-section of the different areas/departments.

This is necessary because every manufacturing process involves the extraction of raw materials from the environment and the processing of these raw materials into a saleable product (Starkey et al., 1998).

As a result of the production processes, in addition to the product, various forms of waste (solid, liquid and gaseous) are released into the environment. Service companies also generate environmental impacts (e.g. in transport processes and marketing activities). But also the activities around the manufacturing process are connected with environmental aspects. The maintenance of facilities and the maintenance of infrastructure as well as the packaging and transport of goods - all these activities have an impact on the environment. Accordingly, expertise from all areas of the company is required.

The environmental team formed should/must define the criteria that will be used to determine the significance of the environmental aspects. Such criteria often include the types of effects, the nature of the effects, their size, frequency and duration. Also the legal status of the impact (subject to regulatory control or not) naturally plays a role. The evaluation procedure shall be transparent overall and the criteria established shall be chosen in such a way as to be comprehensive, independently verifiable and

reproducible.

The following questions (EPA (US Environmental Protection Agency), 2000) should be taken into account in the assessment of environmental aspects and their impacts.

- Which aspects could influence the ability of the company to meet legal and other requirements?
- Are there ways to prevent pollution?
- Are cost savings possible? Can new business relationships develop? (e.g. potential customer requires an environmental management system)
- Are there concerns shared by customers or suppliers?
- Is there a "quick fix" that can be used to achieve quick results in order to build trust in the environmental management system?
- Is it possible to integrate environmental management with other management systems?
- Are there any complaints from residents about the company's activities?
- Are there hazardous chemicals that can be substituted for safer ones (substitution)?
- Can resources be used more efficiently (energy, water, raw materials and supplies)?

Typical assessment procedures used in organisations are:

- the Failure Action Influence Analysis (FAIA)
- the verbal-argumentative method
- the "traffic light valuation" or ABC valuation
- the scoring/point evaluation
- the expert survey

In the following we want to take a closer look at the traffic light evaluation, which is the simplest possible procedure, and the point evaluation. These procedures make it possible to organise the available information in such a way that completely different aspects can now be compared. It should be noted that the aspects are very far-reaching. In practice, the aspects would be much more strongly differentiated according to processes (see chapter 05.1.2).

The traffic light valuation differentiates between three states that are used for an evaluation:

- State A, to which a low/no relevance of the environmental aspect is assigned,
- State B with a medium relevance and
- State C with a significant relevance

The significance (importance) of the aspect is then determined according to its classification A, B or C. (Table 4 and 5)

Table 5 - Example of an assessment of environmental aspects according to the points system

Aspect	Occurrence /Amount	Hazard to environment (B)	Influenceable (E)	Total (A*B*E)
Production				
Water	8	9	2	144
Emissions to air	7	9	2	126
Waste	4	7	6	168
Transport				
Noise	9	5	2	90
Emissions to air	8	5	2	80
Water	3	8	3	72
Soil	5	6	4	120

Table 4 - Example of an evaluation of environment-tal aspects according to the traffic light procedure

Environmental aspect	**A**	**B**	**C**
exhaust air	X		Y
noise		XY	
odour	X		Y
sewage	X		Y
waste		XY	
consumption of resources		XY	
energy		XY	
X: Normal operation Y: Faulty operation			

05.1.4 Environmental performance indicators and eco-balances

ISO 14001 has some weaknesses as it does not distinguish between prevention and reduction of environmental impact. It is therefore unclear whether the assessment of environmental aspects will reveal prevention strategies as part of an environmental management plan. This is the reason why we take a look at some additional methodological concepts. One of these is the eco-balance, another is the formation of environmental performance indicators, which are now part of EMAS III.

A corporate eco-balance is actually nothing more than a material and energy balance or input/output analysis, which is formed via the "company" balance area. This means that the company records all incoming materials and energies as input and everything that leaves the company as output, just like in bookkeeping. Such a procedure is already indicated in Figure10 for a process. Product or process eco-balances are created by reducing the balance area. An extension of the balance area leads to formation in the most extreme case of a life cycle analysis, which examines a product "from cradle to grave". Here, accounting begins with the extraction of the raw materials and ends with the completion of the disposal process at the end of its useful life. In this section, however, only the corporate

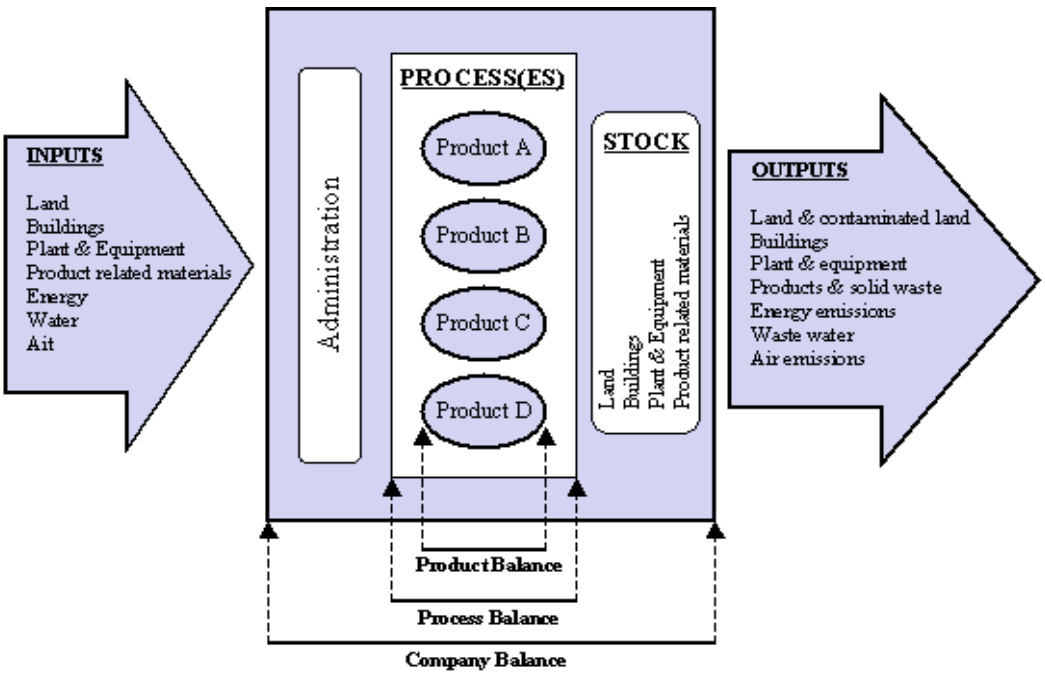


Figure 10: Types of life cycle assessment and their (balance) limits (Starkey, et al., 1998)

eco-balance will be considered.

Figure 10 shows three types of life cycle assessment and their (balance) limits. Table 6 shows the framework for the preparation of balance sheet accounts.

A life cycle assessment is a useful business tool that provides a clear picture of the flow of raw materials and energy within a company and thus makes it possible to identify increases in efficiency after measures have been taken (Starkey, et al., 1998). The

Table 6 - Accounts framework for the LCA.

Creation of balance sheet accounts		
Input		**Output**
		0 Products 0.1 Semi-finished products 0.2 Finished products
1 Properties 1.1 Soil 1.2 Buildings		1 Properties 1.1 Soil 1.2 Buildings
2 Fixed assets 2.1 Operational Investments 2.2 Facilities 2.3 Vehicle fleet		2 Fixed assets 2.1 Operational investments 2.2 Facilities 2.3 Vehicle fleet
3 Circulating goods 3.1 Raw materials 3.2 Auxiliary materials 3.3 Operating materials		3 Waste / Emissions 3.1 Waste for recycling - material 3.2 Waste for recycling - energetic 3.3 Waste to be disposed 3.4 Emissions 3.4.1 Sulphur dioxide 3.4.2 Dust
4 Water 4.1 Drinking water 4.2 Domestic water 4.3 Rainwater		4 Sewage 4.1 Amount 4.2 Content and freight
5 Energy 5.1 Electricity 5.2 Heating oil 5.3 Natural gas 5.4 Steam		5 Energy 5.1 Electricity

balance sheet will show this immediately. The prerequisite for this is, that a consistent system of units is used that enables a comparison. In the case of real estate and fixed assets, this is always the number. The circulating goods are stated in kilograms [kg] or tons [t], depending on the size of the company. The balance account "Water" contains data in cubic meters [m³]. Energy is usually expressed in kilowatt hours [kWh]. This naturally means that some conversions must be carried out.

Environmental performance indicators are specific expressions that provide information about an organisation's environmental performance. Indicators provide a very good overview of the environmental impacts caused by the organisation, of successes and of the potential for improvement that still exists. When environmental performance indicators are identified and compared over time, they provide a good basis for setting concrete and measurable environmental objectives.

In EMAS III, as already mentioned, this has been integrated by defining core indicators and their benchmarks for certain key areas. These core indicators shall be mandatory when the environmental aspects concerned are identified by the organisation as direct and significant.

As environmental performance indicators are an important planning, control and monitoring tool, EMAS sets the following general requirements for indicators (Annex IV, C. point 1):

- authenticity, i.e. an unadulterated representation of the environmental performance
- comprehensibility and unambiguity
- comparability from year to year to assess how environmental performance has developed, i.e. the same indicators and benchmarks

The uniform definition of the indicators allows, on the one hand, a comparison between different sectoral, national or regional benchmarks. On the other hand, this makes it possible to carry out a comparison with legally defined limit values or with state of the art values (BAT documents).

EMAS has defined indicators for 5 key areas that apply to all types of organisations. These are:

- Energy efficiency,
- Material efficiency,
- Water,
- Waste,
- Biodiversity and
- Emissions

Table 7 - Key areas, inputs and impacts for environmental performance indicators according to EMAS (UGA - Environmental Advisory Committee, 2013)

Key area	Input or effects
Energy efficiency	**Total annual energy consumption** in MWh or GJ **Total consumption of renewable energies:** Share of energy from renewable energy sources in total annual consumption (electricity and heat)
Material efficiency	**Annual mass flow of the various input materials** (without energy source and water) in tons
Water	**Annual water consumption** in m^3
Waste	**Annual waste generation** by type of waste in tonnes **Total annual generation of hazardous waste** in kilograms or tonnes
Biodiversity	**Land use** in m^2 built-up area
Emissions	**Total annual emissions of greenhouse gases** at least emissions of CO2, CH4, N2O, hydrofluorocarbonate, perfluorocarbonate and SF6 in tonne CO2 equivalent **Total annual emissions to air** at least the emissions of SO2, NOX and PM, in kilograms or tonnes

Input and effects were defined for each key area (see Table 7).

05.2 LEGAL OBLIGATIONS AND OTHER REQUIREMENTS

In addition to environmental aspects, compliance with legal obligations and other requirements to which the organisation is committed is the second building block of planning activities. A company fulfils the legal requirements if it complies with all environmental requirements arising

for the organisation from environmental laws, ordinances and operating permits. In exceptional cases, non-compliance with the legislation will be accepted by the competent authorities if a documented or written consent of the authority is available. Such exceptional situations exist, for example, when costly remediation measures have to be carried out on installations which push the organisation to the limits of its financial capacity or even exceed it, and the organisation submits a corresponding application to the authority in advance. The action plan resulting from this request will then in any case be subject to the strict control of the competent authority.

Environmental protection and legal compliance are of course nothing new. Even without an environmental management system, all relevant legal requirements must be complied with. Compliance with legal requirements is just one element of an environmental management system as described in ISO 14001 or EMAS. What is new for an organization is that it documents this legal compliance comprehendsively and independently within the framework of environmental management. This of course means that these documents are systematically checked on a regular basis and always kept up to date (Roos-Rohrer, et al., 1998).

As already mentioned, compliance with legal requirements is one of the "three pillars" on which environmental policy should be based (Stapleton, et al., 2001). In order to comply with laws and regulations that apply to an organization, it is necessary to know what they are and how they affect a company's activities. The potential costs of non-compliance (e.g. possible damage to the environment, loss of revenue and impact on the public image of the organisation) can be very high. In the case of extreme violations, even environmental criminal law could apply and/or the authority could order the suspension of operations.

Therefore, effective environmental management must include processes by which the organisation can identify and communicate the legal and other requirements that apply to it and ensure that these are taken into account by management in its decisions.

05.2.1 Development of environmental law

The task of environmental protection is to protect the environment from adverse effects caused by human intervention, to eliminate ecological damage that has occurred and to preserve a humane environment for human beings. Environmental law is an instrument for putting these objectives into practice. In recent years, it has continued to develop due to the increasing importance that environmental protection has gained in securing the foundations of life. This is illustrated, among other things, by the flood of new legislation in this area.

Initially, environmental law focused

mainly on the prevention of hazards and the repair of damage. It was a right aimed at subsequent "repair". Today, environmental legislation is increasingly characterised by precautionary environmental protection. In this respect, environmental law has kept pace with developments in environmental policy. In environmental policy, too, there is a transition from end-of-pipe technologies to integrated, i.e. precautionary, environmental protection. The aim is to prevent adverse environmental impacts at source instead of reducing their cost-intensively in the second step, e.g. through filter technologies. The starting points for integrated environmental protection are environmentally friendly product development and design as well as the introduction of resource-saving production processes.

The actual cause of environmental degradation is seen in the fact that, despite their scarcity, the environmental goods air, water and soil are largely used free of charge, i.e. polluted or consumed, without the damage occurring having a cost effect on the producer or consumer. They are borne by the general public from tax revenue. Under competitive conditions, this results in excessive use of "free" environmental goods. There are therefore increasing considerations of charging prices for the use of environmental goods.

In environmental law, efforts are being made to replace the previously predominant regulatory instruments, i.e. prohibitions, with market-based and economic instruments. They are intended to make environmental law more enforceable in practice. It is assumed that entrepreneurial decisions are primarily determined by economic calculation and therefore economic incentive systems exert a stronger influence on them than legal prohibitions. The wastewater levy, the amount of which depends on the amount of wastewater and the harmfulness of the wastewater, is an example of how environmental law intends to influence the environmental behaviour of companies by means of cost pressure. The environmental audit based on an EC regulation, in which companies can participate on a voluntary basis, is another example of how market-based instruments can be used to influence the implementation of ecologically oriented management.

05.2.2 Basic legal requirements for aquaculture

As the wild fish stocks have been abused by overfishing, destructive fishing practices, and environmental deterioration, they are now not able to support expanded demand for seafood, so aquaculture has rapidly extended in recent decades. Although aquaculture has advantages compared to other protein sources, it raises environmental concerns, such as habitat loss, water pollution, and use of overfished stocks for feed. As a result, the legal and management frameworks are needed for sustainable management of wild and farmed fish

and shellfish resources. Whether focused on fisheries enforcement, offshore aquaculture policy, marine protected area management, or other topics, our work helps rebuild depleted stocks, ensures that fishing and aquaculture do not harm habitats or ecosystems, and preserves livelihoods over the long term around the world.

The primary legislation governing fisheries and aquaculture in Thailand is the Thai Fisheries Act, B.E. 2490 (1947). The newly enacted Royal Ordinance on Fisheries of 2015 (the Royal Ordinance) establishes "National Fisheries Committee" (the Committee) with the power and duty to develop fisheries policies. One of the policies the Committee authorized to investigate is on the country's aquaculture development.

National Aquaculture Development Policies (NAqDP) is a policy document outlining the contributions of the aquaculture sector in carrying out the National Economic and Social Development Plan (NESDP) and National Agricultural Development Plan (NADP). Specific strategies for lucrative species such as shrimp and tilapia may also be developed.

NESDP and NADP 2017 – 2021 were adopted in late 2016. Since then, the Committee has established an ad hoc committee to devise NAqDP which remains under the consultation and drafting process.

At the provincial level, fisheries policies and plans are developed by Provincial Fisheries Committees (PFC). PFC are authorized to designate aquatic species sanctuary, prescribe requirements for fishing gears, fishing methods, by catch as well as other conditions for fishing operations in their respective provinces.

The Royal Ordinance on Fisheries of 2015 provides for the overarching legislative framework governing management of aquatic resources in Thailand. It also aims to ensure legal working conditions and welfare of workers in all areas of the fisheries sector. Ministry of Agriculture and Cooperatives (MAC) is charged with the responsibility to determine matters for the execution of this Royal Ordinance in subsequent Ministerial Regulations.

Department of Fisheries (DOF) has the principal mission of implementing laws and regulations regarding fisheries, exploitation rights, fishing port, wildlife conservation and protection, as well as feed, veterinary drug, disease control of commercial aquatic animals and other regulations relating to fisheries and aquaculture operations.

The Royal Ordinance is further implemented by Provincial and District Fisheries Officers. Among others, they are tasked with ensuring that aquaculture operation in their localities is in compliance with relevant regulations and guidelines. This is done in collaboration with local authorities and municipalities.

05.2.3 The Royal Ordinance on Fisheries B.E. 2558 (2015)

Key principles and objectives are:

- To establish good governance in the management of the fisheries sector and the conservation of aquatic resources, based on the best available scientific evidence, precautionary principle, internationally accepted standards and Thailand's international obligations.
- To combat illegal, unreported and unregulated (IUU) fishing, as well as prevent overfishing and overcapacity of the fishing fleet, in order to achieve sustainability of fisheries resources.
- To ensure effective monitoring, control and surveillance of fishing activities.
- To bolster the traceability system of fisheries products along the whole value chain, from fishing vessels to end consumers.
- To eliminate all forms of forced labour and improve welfare and working conditions of workers in the fisheries sector, both in fishing vessels and in seafood processing factories.
- To introduce proportional and deterrent administrative and criminal sanctions.

05.2.4 Farm registration

No one shall engage in aquaculture in areas within public domain of the State unless a license is granted by District Fishery Offices. Public domain is broadly defined to include land and water area not owned privately. Public waterways and near-shore sea fall under this definition.

Criteria for granting license include total capacity, proximity from aquatic sanctuary and raw water capture point for utility, as well as impacts on navigation, irrigation, nearby communities and the environment.

Furthermore, licensees must abide by the following conditions:

- lighting and clear marking
- non-construction of permanent shelter
- non-use of banned drug, chemical or other material
- sanitary and on-land disposal of the diseased carcasses
- others as specified in the license

Certain species of aquatic animals and certain features of aquatic enterprises (size, form, type, objective etc.) may fall under aquaculture control as promulgated by ministerial regulation.

Such control is aimed to prevent harmful environmental consequences, hazards to consumers and negative impact on other enterprises. This control applies regardless of whether the operation is within the public domain or not.

Thus far, there are six (6) categories of controlled aquaculture including designated species such as marine shrimp, crayfish, crocodile and sea shells. Only one aquaculture method (cage and pen culture) is controlled. For each category, Provincial Fisheries Committee must prescribe designated zone for its operation within the province.

For crayfish (Procambarus clarkii) farmers, there are additional obligations to:

- provide prior notification to local fisheries office in accordance with prescribed format
- adopt heightened escapement prevention measures for pond/enclosure/container

05.2.5 Code of Conduct for responsible fisheries, Good Aquaculture Practices, and biosecurity

The Agricultural Standard Act of 2008 empowers MAC to establish standards for agricultural products upon the submission of Agricultural Standards Committee. National Bureau of Agricultural Commodity and Food Standards (the Bureau) is the main implementing agency for this Act.

Standards can be either voluntary or mandatory. They can also focus on any aspect ranging from characteristics of agricultural commodity (quality, safety, sanitary or phytosanitary issues etc.), production methods and procedures, packaging and labelling, to inspection, assessment, and analysis. Certificate for both type of standards can be granted by the Bureau or licensed conformity assessment service providers (certification bodies) upon compliance inspection.

Once MAC issued a mandatory standard in Ministerial Regulation for any agricultural commodity, all producers, exporter or importer of the commodity must obtain a license from the Bureau. This license is 3-year renewable and non-transferable. As of early 2017, there is only one mandatory standard in relation to the aquaculture sector, namely the standard on hatchery of disease free pacific white shrimp: tas 7432-5015.

Since its enactment, Good Aquaculture Standards (GAqP) are promulgated as standards under this Act. The Fisheries Commodity Standard System and Traceability Division of DOF is the primary entity for certification of GAqP and other fisheries-related standards.

There are numerous voluntary aquaculture standards for species such as abalone, blue swimming crab and mud crab, crocodile, soft-shell turtle, marine shrimp, tilapia, striped snakehead fish, and ornamental freshwater animals. There are also generic guidelines on Hazard Analysis and Critical Control Point (HACCP), veterinary drugs, marine finfish/shrimp farm, as well as freshwater aquatic animal farm and hatchery/nursery.

Code of Conduct for marine shrimp farm and hatcher/nursery promulgated by DOF in 2003 still remains in force having been afforded legality and enforceability by the Royal Ordinance.

05.2.6 Water management and treatment

Promotion and Preservation of Environmental Quality Act of 1992 empowers Ministry of Natural

Resources and Environment (MoNRE) to prescribe quality for sea, ground and underground waters.

MoNRE is also granted authority to regulate wastewater discharge from point sources in the form of effluent standards. Owners and operators of regulated point sources must invest in on-site treatment facility to monitor, control and treat wastewater ensuring constant compliance with the discharge standards.

Furthermore, an effective by-law of the Royal Ordinance on Fisheries imposes further conditions on particular quality of discharge from all registered and approved shrimp farms. It also demands that water treatment facilities must be installed with at least 10% of the operation areas dedicated to it.

To date, specific effluent standards for coastal, brackish, and in-land aquaculture have been adopted and enforced by the collaboration between DOF, Department of Pollution Control of MoNRE and Marine Department under Ministry of Transport.

05.2.7 Disease control and health management

In reducing risks in aquaculture farmers, policy-makers and other stakeholders are increasingly aware of the risks of food production and are working together to manage them efficiently. Adoption of national aquatic animal health strategies (FAO/NACA, 2000, 2001; FAO, 2007) is helping to address biosecurity and ensure the health and welfare of aquatic animals.

The following resources provide guidance on specific aspects of effective aquaculture biosecurity governance.

- diagnostics: Bondad-Reantaso et al. (2001), Bondad-Reantaso, McGladdery and Berthe (2007)
- quarantine: Arthur, Bondad-Reantaso and Subasinghe (2008)
- risk analysis: Arthur and Bondad-Reantaso (2012)
- surveillance and zoning: Subasinghe, McGladdery and Hill (2004)
- emergency preparedness and contingency plans: Arthur et al. (2005)
- emergency disease investigations: FAO (2017q)
- early warning/forecasting: the quarterly Food Chain Crisis Early Warning Bulletin

Animal Epidemics Act of 2015 imparts DOF with the power to issue orders for the confinement, isolation, movement of diseased aquatic animals if there are reasonable grounds for outbreaks.

Under Section 65 of the Royal Ordinance, MAC can require permits for importation, exportation, transiting as well as culturing and possession of any kind of aquatic animal in order to curtail foreseeable harm potentially caused by epidemic diseases.

Thus far, MAC has announced the following 5 species for this permit requirement:

- Litopenaeus vannamei
- Penaeus monodon
- Penaeus stylirostris
- Cyprinus carpio
- Procambarus clarkii / Cherax quadricarinatus

05.2.8 Trade laws and Limitations

National aquaculture legislation should seek to implement international standards on trade and quality control as they relate to the development and conduct of aquaculture activities. If a country is considering exporting fish products from aquaculture production to markets in the European Union (EU), a regulatory framework should be adopted that meets EU market standards. If international trade is being considered, World Trade Organization (WTO) rules, including requirements under the Sanitary and Phyto-Sanitary Agreements of WTO, have to be met (Takoukam and Erikstein, 2013).

Whether a regulatory approach is effective or not, producers remain responsible for the daily management of aquaculture operations and play a key and direct role in formulating and implementing the best available practices (Van Houtte, 2001).

05.2.9 Possibilities for ensuring legal compliance

As can be seen from the above, there are quite a number of rules that the organisation may need to follow. One first good idea, is to have a look at the website of the Ministry for the Environment and Nature Conservation. For many countries you can find a list there of all relevant laws.

Compliance with legal requirements is a critical situation in the development and implementation of an environmental management system. Therefore, the implementation of the organization requires among other things:

- Develop and communicate an environmental policy that includes a commitment to legal compliance,
- Establish, implement and maintain a procedure to identify and have available applicable legal obligations and other requirements to which the organisation is committed with respect to its environmental aspects.
- Ensure that objectives and targets set are consistent with its environmental policy
- Establish management programs to achieve their goals,
- Train employees and communicate the relevant environmental management requirements to them
- Define and implement procedures for operational control of operational processes,
- Develop a procedure for regularly assessing and verifying compliance with legal requirements, and
- Develop and implement a procedure for the implementation of corrective and preventive actions (Stapleton, et al., 2001).

New or changed legal requirements

may require changes to the environmental objectives or other elements of the environmental management system. By anticipating the new requirements and changes in business processes, it is possible to prevent future violations of legal compliance.

There are many ways to obtain information about applicable laws or regulations. These options include: (EPA (US Environmental Protection Agency), 2001)

- commercial services (with updates offered online, on paper),
- supervisory authorities (federal, state and local level),
- Employers' associations, interest groups/associations,
- Internet,
- Public libraries,
- Seminars and courses,
- Newsletter / Magazines,
- Consultants and lawyers as well as
- Customers, suppliers and other companies.

Once the applicable requirements have been identified and analysed and the potential impact is known, the resulting requirements for the organisation (and, of course, the compliance plans) must be communicated within the organisation. External communication (e.g. contractual partners) is possible as required.

But before turning to this task, the existing operating permits should be studied and evaluated. They list the laws and regulations on which the authorisation is based. This already tells the organization in which legal areas it must at least search. Of course, the resulting list will not be complete, because if the organisation has at some point in the past forgotten to obtain the necessary approval, the approval authority cannot name any related legal sources.

Table 8 - Example of a list of relevant legal environmental obligations in environmental management

Aspect	Law/Regulation (Title)	Source/location in the company	Affected areas or plants	Compliance status
Waste water discharge	Waste Water Ordinance - AbwV, Notes 50	http://www.gesetze-im-internet.de/abwv/index.html	Amalgam separator Dentist's chair	
Mercury disposal	Closed Substance Cycle Waste Management Act - KrWG	http://www.gesetze-im-internet.de/krwg/index.html	Waste management	

Identifying and interpreting applicable regulations and determining their impact on a company's operations can be a time-consuming task. As a rule, small businesses will not have a legal advisor or in-house lawyer. Nevertheless, it is possible to achieve legal compliance at a reasonable cost. Initially, it is often sufficient to draw on the knowledge of internal experts who are familiar with operational procedures and seek contact with the authorities.

This approach avoids high costs, because existing resources are used, which will have the necessary knowledge in the future, because legal requirements often change in the course of time and information about the legal status must be updated accordingly regularly (Table 8).

Therefore, it is imperative to keep a list of relevant environmental legislation which, in addition to the name of the law/regulation, the source and information where in the company

INFORMATION IN SECTION 05.2 IS BASED ON THE FURTHER READING SECTION HERE	
FAO. National Aquaculture Legislation Overview Thailand http://www.fao.org/fishery/legalframework/nalo_thailand/en	Patrice Talla Takoukam and Karine Erikstein. Aquaculture regulatory frameworks. FAO LEGAL PAPERS ONLINE No. 91 July 2013
Van Houtte, A. 2001. Establishing legal, institutional and regulatory framework for aquaculture development and management. In R.P. Subasinghe, P. Bueno, M.J. Phillips, C. Hough, S.E. McGladdery & J.R. Arthur, eds. Aquaculture in the Third Millennium. Technical Proceedings of the Conference on Aquaculture in the Third Millennium, Bangkok, Thailand, 20-25 February 2000. pp. 103-120. NACA, Bangkok and FAO,	

this document is available (a URL is sufficient), will also indicate which environmental aspect of the company is affected. In addition, a status indicator should be added that reflects the current status of legal compliance. It is of course advantageous for later work if the installations affected by this regulation are also listed. Should the relevant law be amended /strengthened, it is immediately apparent which systems are to be reviewed with regard to legal compliance. The list can also be used to identify which laws/regulations already exist in the company and which do not.

In addition to the list of environmental aspects, this list of relevant environmental requirements is another core document of environmental management. Both lists must be kept up to date at all times. It is therefore imperative to appoint a person responsible for this activity.

Once the list of relevant environmental requirements has been drawn up, it will subsequently be necessary to determine the state of compliance with each environmental requirement. The results of this compliance review should identify those areas that are legally compliant and where there is a need for improvement. If a need for remedial action has been identified, immediate action must be taken. Not only to make the environmental management in the company happy, but also because in the case of official controls, one has to reckon with sensitive administrative offence penalties or fines. It is therefore highly recommended that an action plan be first drawn up to (re-)establish compliance as quickly as possible and then discussed with the competent authority.

05.3 OBJECTIVES, TARGETS AND PROGRAM (S)

As already mentioned in Chapter 2, the environmental policy contains an obligation for continuous improvement. In order to control this process, the organization needs a system of goals and objectives. (Objectives were also discussed in

Chapter 2). This section will therefore focus on converting the objectives into individual goals and then merging the individual goals in an environmental management program.

Of course, the same applies to individual goals as to the goals set by kept in mind when setting objectives. In addition, the essential environmental aspects, the relevant legal requirements and the views of interested parties must be observed. Technological options, financial, operational and other organizational

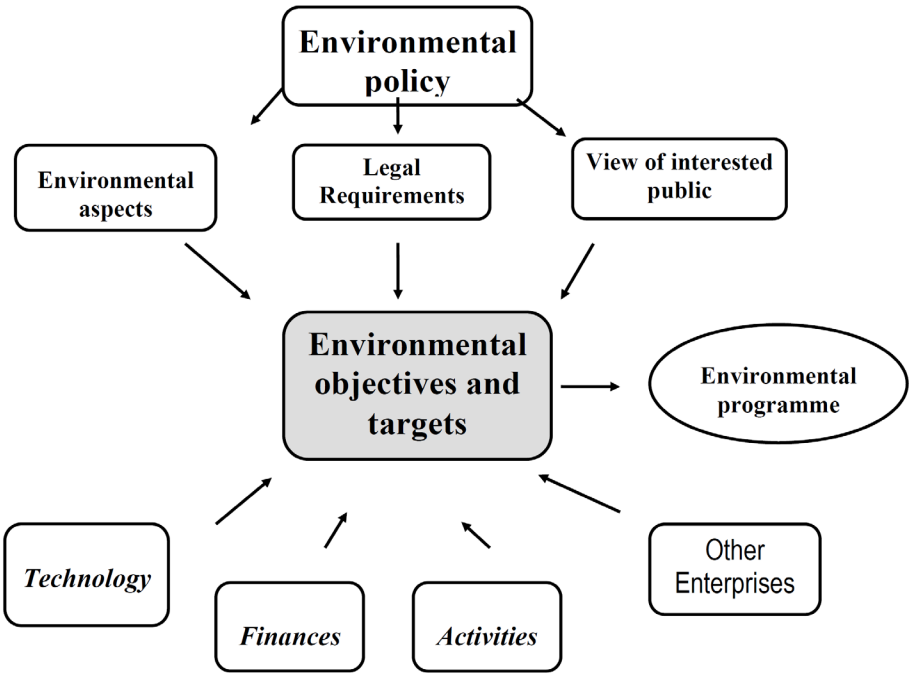


Figure 11 : Factors influencing environmental objectives and targets (Stapleton, et al., 2001)

the organizational management. To be effective, the objectives and targets should be specific, quantifiable and measurable. After the targets have been set by management, a decision has to be made as to how they can be applied or structured: company-wide or only in individual areas or departments (Figure 11). This design leads to the individual targets.

The Environmental policy should be considerations must also be taken into account.

Environmental objectives are in most cases unique, i.e. Not the same for every company / organization, because the goals reflect, who the organization is and what it wants to achieve and how. Environmental goals can be general, or specific, as Figure 12 shows.

7.1 Environmental goals Roth Werke, Buchenau

Table 12: Environmental goals and environmental program from 2010 - Roth Werke Buchenau

	Objective	Activities	Events	Responsible
1.	**Saving of heating energy** Heating energy saving Reduction of CO2 emissions Additional use of existing process heat Reduction of fosslier fuels Energy report "steam generation" (efficient use, utilization)	**Implementation of the energy and environmental management project E*** · Overall energy study of the buildings on site, analysis and evaluation of the energy efficiency "Energy management" suggest, plan, implement and evaluate measures and projects · Individual measures Reduction of the use of fossil fuels in Hall 1 through energy recovery from the cooling water circuit using heat pumps Heat recovery from existing systems Savings of approx. 100,000 liters of heating oil (for 2011)	06/2012 12/2010 12/2011	Mr Kind Mr Hedderich Mr Hedderich Mr Kind Mr Hedderich

Figure 12 : Extract from the Environmental Statement (Roth Werke GmbH, 2010)

The environmental program of an organization arises from the individual goals, which are now provided with a time frame for implementation and a person responsible, as well as the necessary financial and human resources. Once this has been done, the environmental program is approved by the organizational management. By choosing target-specific indicators, progress and success can be measured so that the effectiveness of this measure for target achievement is increased.

EXERCISE 4/ DISSCUSSION

WHICH ACTIVITIES//EVENTS ARE HIDDEN BEHIND THE CROSSES IN TABLE 2? MAKE A LIST OF POSSIBLE ACTIVITIES FOR EACH ENVIRONMENTAL ASPECT.

EXERCISE 5/ DISSCUSSION

THE FOLLOWING TEXT SHOWS THE ENERGY CONSUMPTION OF A COMPANY. FROM THIS DATA CREATE THE BALANCE SHEET ACCOUNT "5 ENERGY" FOR THE YEARS 2011 AND 2012. COMPARE THE RESULTS. WHAT DO YOU SEE?

THE CONSUMPTION OF NATURAL GAS, HEATING OIL AND ELECTRICITY AND THE RESULTING ENVIRONMENTAL IMPACTS OVER THE YEARS 2011 TO 2012 ARE AS FOLLOWS.

OF THE TOTAL CONSUMPTION OF HEATING OIL, 46.55% WAS ACCOUNTED FOR BY LIGHT HEATING OIL IN 2011 AND 47.14% IN 2012.

NO SIGNIFICANT EMISSIONS ARE GENERATED BY COMPANY VEHICLES. THERE ARE 6 CARS, WHICH TOGETHER DRIVE APPROX. 290,000 KM/YEAR. 2 VEHICLES HAVE BEEN EQUIPPED WITH DIESEL ENGINES SINCE 2012 (PREVIOUSLY ONLY 1 CAR); THEY COVER AN AVERAGE DISTANCE OF 45,000 KM/YEAR. THE AVERAGE DIESEL CONSUMPTION IS 9L PER 100 KM, THE FUEL CONSUMPTION 8L PER 100 KM.

ONE OF THE SITE'S FORKLIFTS IS POWERED BY DIESEL, TWO OTHERS BY ELECTRICITY; 8 HAND PALLET TRUCKS ARE ALSO POWERED BY ELECTRICITY.

CONVERSION FACTORS:

1 M^3 OF NATURAL GAS IS EQUIVALENT TO 8.816 KWH

1 T HEATING OIL CORRESPONDS TO APPROX. 1200 L; 1 KG LIGHT HEATING OIL CORRESPONDS TO 1.458 HARD COAL UNITS (HCU); 1 KG HEAVY HEATING OIL CORRESPONDS TO 1.384 HCU; 1 KWH CORRESPONDS TO 0.123 HCU

1 T DIESEL FUEL CORRESPONDS TO APPROX. 1200 L; 1 KG DIESEL FUEL CORRESPONDS TO 1.466 HARD COAL UNITS (HCU); 1 T SUPER GASOLINE CORRESPONDS TO 1300 L, 1 KG MOTOR GASOLINE CORRESPONDS TO 1.486 HCU; 1 KWH CORRESPONDS TO 0.123 HCU

CONSUMPTION:

YEAR	CONSUMPTION	LOADS IN KG/YEAR			
	NATURAL GAS IN M^3	CO	CO2	NOX	SO2
2011	450,888	153.30	847,669.26	1,351.70	12.14
2012	483,312	164.32	908,626.37	1,448.91	13.02

YEAR	CONSUMPTION	LOADS IN KG/YEAR			
	HEATING OIL IN M^3	CO	CO2	NOX	SO2
2011	87.432	101.55	250,476.58	176.00	287.71
2012	76.860	98.27	220,189.75	154.72	252.92

YEAR	ELECTRICITY CONSUMPTION IN KWH
2011	5,338,284
2012	5,039,988

06. IMPLEMENTATION AND OPERATION

Thomas Potempa*, Alena Mychkova*, and Nguyen Van Quynh Boi**, Nguyen Phuc Cam Tu***

* *Ostfalia University (OU)*

** *Nha Trang University*

*** *Nong Lam University-Ho Chi Minh City*

Learning Outcomes
Present the essential elements in the implementation and operation of environmental management,
Specify the requirements for control of documents and processes and
Know the importance of employee orientation in order to develop measures for implementation,

After the environmental aspects, the legal and other requirements of the organization are known and evaluated and the environmental program has been approved by the top management, the stage is now set for the DO step of the DEMING cycle. The "DO" is about putting the visions of the program into practice, but also mastering the subtleties of daily on-and-off management. And of course the organization must also be prepared for the unprepared.

06.1 RESOUURCES, DUTIES, RESPONSIBILITIES AND AUTHORITY

It is of course the task of the top management to ensure that all responsibilities and authorities are clearly and unambiguously regulated within their own company. In addition, one of the most important tasks of top management is to make resources available (Starkey, et al., 1998). In order to do this for environmental management, the organization management appoints an environmental management tepresentative (EMR), whose task it is to systematically implement, maintain and further develop the environmental management system and to set innovation impulses.

The EMR is a member of the management team and in this function is independent of other responsibilities. In small and medium-sized enterprises (SMEs) it cannot be avoided that the EMR fulfils a double function, i.e. in his/her function as EMR s/he has a staff function, but in his/her function as department head or division manager fulfils a line function.

But naming a EMR is actually only the first step. The EMR ensures that the environmental management system is implemented and implemented as planned. In his/her role, s/he reports regularly to the management of the organization, but of course also has to work with others in order to modify and continuously improve the environmental management system - where necessary.

Different functions within the organization / company can support an environmental management system in different ways (see Table 9).

Table 9 - Functions within an organization and their support function for an environmental management system according to (EPA (US Environmental Protection Agency), 2000)

Functions	Support from (possible roles):
Purchasing	• Development and implementation of controls in the procurement process (chemicals, raw materials, etc.)
Human relations dept.	• Define competencies and job descriptions for different roles within environmental management • Training of employees and contractors • Keeping a record of training • Integration of environmental management in wage and evaluation systems
Service & Maintenance	• Implementing preventive maintenance programs for important plants and plant components • Support in identifying environmental aspects
Finance dept.	• Tracking of data on environmental costs (such as resource, material and energy costs, waste disposal costs, etc.) • Prepare the budget for environmental management programs • Assess the economic feasibility of environmental projects
Process technology	• Tracking of data on environmental costs (such as resource, material and energy costs, waste disposal costs, etc.) • Prepare the budget for environmental management programs • Assess the economic feasibility of environmental projects
Quality management	• Support with the control of documents and records, with the training of employees • Support with the integration of environmental and quality management systems
Worker (line)	• Providing immediate knowledge of the environmental aspects of their work • Support with training for new employees

Table 9 shows how complex environmental management is in an organization. This interweaving of relationships, but also competencies, has to be used on the one hand for environmental management, on the other hand it has to be regulated precisely so that no one is curtailed in their competencies or doing things twice. Particularly when developing an environmental management system, the process landscape in the organization should therefore be determined in advance in order to identify interactions (resources, information, material flow) between individual processes, as well as partial or sub-processes (see Figure 13). Every interaction indicates that competencies and thus responsibilities and authorities are to be assigned.

Especially in the introductory phase it

can be helpful to ask employees to describe their personal responsibility for environmental protection and to develop tasks from this. The comparison between the views of employees and superiors (at all hierarchical levels of the organization) will bring valuable insights to light that will enable the organization to recognize differences in the perception of its own tasks and responsibilities and thus to correct weaknesses.

If this has happened at the organizational level, an organizational chart for environmental protection should have been created in the organization. The definition of responsibilities and authorities can be included in the form of job, function or job descriptions.

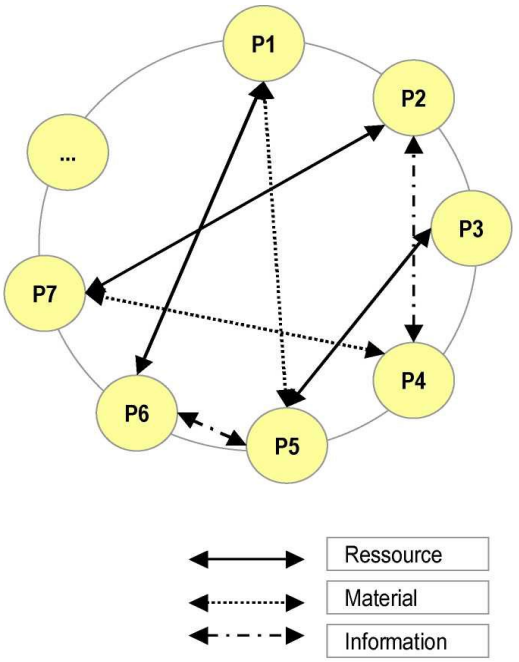


Figure 13: Interactions between processes

In order to give everyone inside and outside the organization the opportunity to contact the responsible person directly, these regulations must also be made known, e.g. in that the resulting organization chart becomes part of the environmental management manual or a notice or similar. is published.

06.2 SKILL, TRAINING AND AWARENESS

The basic intention of the training is to explain to the employees the importance of environmental protection in the organization and to explain to each individual what responsibility s/he has in the context of his / her work for compliance with and implementation of environmental policy and thus also for environmental protection.

In order to be able to implement this effectively in the organization, three terms must first be clarified, which are of essential importance:

What is behaviour?

Interaction with social or natural environment observable from outside. The causes of the interaction cannot be observed.

What is action?

Scheduled behaviour based on knowledge, attitudes, motives, emotions. Actions are perceived as behaviour.

What is learning?

Process that leads to relatively stable changes in behaviour.

Learning is perceived as changed behaviour.

This means that environmentally friendly behaviour can only be achieved through a sustainable learning process within the organization, which leads to the desired behaviour. Environmental awareness and thus environmentally friendly behaviour are influenced by several factors (Figure 14). Environmental knowledge naturally plays an essential role. But knowledge alone is not enough. Of course, all motorists know what the maximum speed is in built-up areas. Does this knowledge prevent many drivers from driving "a little faster"? Of course not.

Changes in behaviour can only be observed when there are tangible consequences. For environmental protection, this means that a certain degree of environmental impact must be added in order to heighten environmental awareness and thus initiate stable environmental behaviour. Only when this interplay is understood in the organization will training measures - supported by behavioural offers and incentives for action - be successful in the organization.

The basic intention of the training is to explain the importance of the environmental management system and environmental protection to the staff and to make them aware of personal responsibility for environmental protection. Many employees are particularly unaware of their personal responsibility.

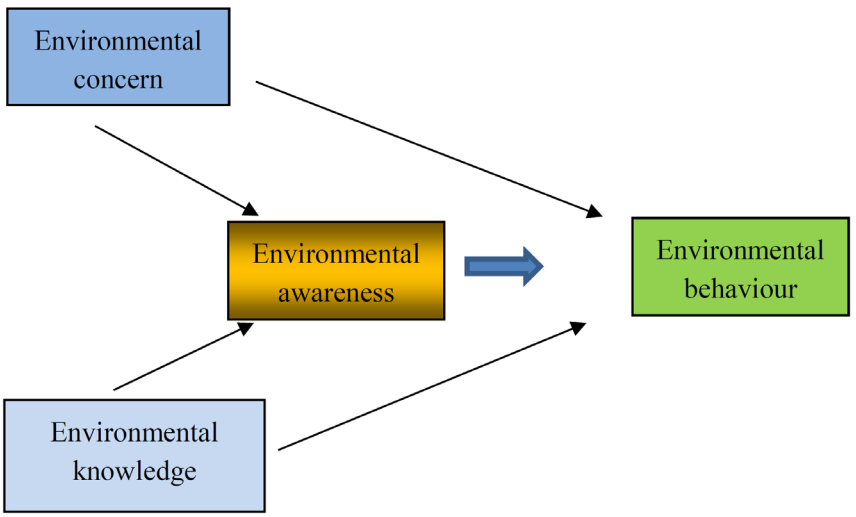


Figure 14: Constitution of environmentally friendly behaviour (Diekmann, et al., 1992)

Environmental protection is very often associated with production processes, as the following (fictitious) example with a warehouse manager of a company shows.

> *Auditor: What are the environmental impacts associated with your work?*
>
> *Warehouse manager: Well, if everything goes well in my work, there is no environmental impact. I'm just a warehouse manager, so I'm not really involved in production. Auditor: What do you do when you receive chemicals for storage?*
>
> *Warehouse manager: First, I enter the incoming materials in the inventory book. Then I check my list to see if the chemicals fall under the Hazardous or Safe Substances category. If they are classified as dangerous, I make sure that all labels are correct, store them and inform the department concerned. If the incoming materials are classified as harmless, I just store them and inform the department concerned about the incoming goods.*
>
> *Auditor: How do you store the dangerous chemicals?*
>
> *Warehouse manager: To make things a little easier, I first ask the department concerned about when they will need the chemicals. If they are needed within the next few days, I just put the chemicals somewhere in the warehouse. If they are not needed for a week or even later, I will store them in the hazardous materials area.*

The more remote the area of activity is from production, the more likely a minimization behaviour (not me, but the others) will be observed.

In order to understand responsibility in environmental protection, an appropriate (further) qualification is essential and this is not only for ordinary employees but of course for management staff.

The qualifications of the staff are extremely important because:

- Almost every activity in the company has potential effects on the environment,
- This is an excellent resource for developing ideas for improving operational processes, avoiding environmental impacts and determining structural responsibilities.

All staff should be trained according to their specific environmental responsibilities, too much training can confuse staff and will not be cost effective. Qualification measures should always be directly related to the essential environmental aspects, the objectives in environmental protection and the objectives in environmental management and should take into account the personal work environment. It must be ensured that all employees are aware of the possible consequences of non-compliance and understand the positive effects of environmentally friendly behaviour.

Training must take place if:

- new employees are hired,
- changes to job descriptions take place,
- corrective actions take place because audits have determined that instructions are not followed,
- new procedures are introduced or existing procedures are changed,

Environmental aspects, objectives or individual objectives have changed.

The most important steps in connection with a qualification measure are:

- Step 1: Assess training needs and requirements
- Step 2: Define learning objectives
- Step 3: Selection of suitable methods and materials
- Step 4: Prepare the Training Plan
- Step 5: Carry out the training
- Step 6: Accompany the training (and keeping records)
- Step 7: Determine the effectiveness of the measure
- Step 8: Improving training (if necessary)

Qualification measures should be planned as part of existing meetings in order to keep the financial costs for the measure as low as possible. Participation in training measures must always be documented and should also be included in the personnel files.

06.3 COMMUNICATION

The exchange and dissemination of information are essential in many processes (see Figure 20). This also applies to communication in environmental protection. Normally, different groups of people have a keen interest in the environmental impact of organizations and the efforts of organizational leaders in this area. Effective environmental management requires communicating information both internally and externally (Starkey, et al., 1998).

Internal communication is communication within a facility or organization that is directly related to environmental protection and environmental management. This requires the establishment of communication channels and types on and between all relevant functional levels within the organization. External communication is communication between the organization and interested parties outside the organization.

There are numerous benefits to having effective internal communication (Stapleton, et al., 2001). Internally s/he helps to:

- motivate the workforce,
- gain acceptance for the plans and efforts,
- convey the environmental policy, the environmental management system and their connection with the visions of the organization,
- ensure roles and expectations,
- show management's commitment
- monitor and evaluate system performance and potential improvements.

Effective external communication

will:

- demonstrate the commitment of the management to protect the environment,
- make others aware of the environmental policy and responsible behaviour of the organization for environmental protection.
- mitigate external concerns about the organisation's environmental performance.
- establish communication channels that regulate responsibilities in emergencies,
- help to avoid problems with supervisory and licensing authorities as well as citizens' initiatives.

Well-known methods for successful communication in environmental protection are given in Table 10.

A good communication system requires that information flow both top-down (top-down approach) and bottom-up (bottom-up approach). A smooth and fast flow of information is particularly necessary in emergency situations or when information about environmental risks has to be exchanged urgently. Regardless of the type of communication, communication should always be kept as simple, clear, concise and precise as possible.

Table 10 - Known methods for successful environmental communication

Internal methods	External methods
• Newsletter • Intranet • Staff meetings • "Notice boards" • Training • Voluntary working groups	• Open days Round table discussions • Web sites or email list • Press releases • Annual reports • Advertising • Informal conversations

06.4 DOCUMENTATION

For some requirements, ISO 14001 explicitly stipulates the creation of a documented procedure (also: process instructions, procedural instructions, standard etc.) In the sense of the standard, the term “documented procedure” includes the definition, documentation, implementation and maintenance of the necessary internal regulations.

In order to plan, carry out and control

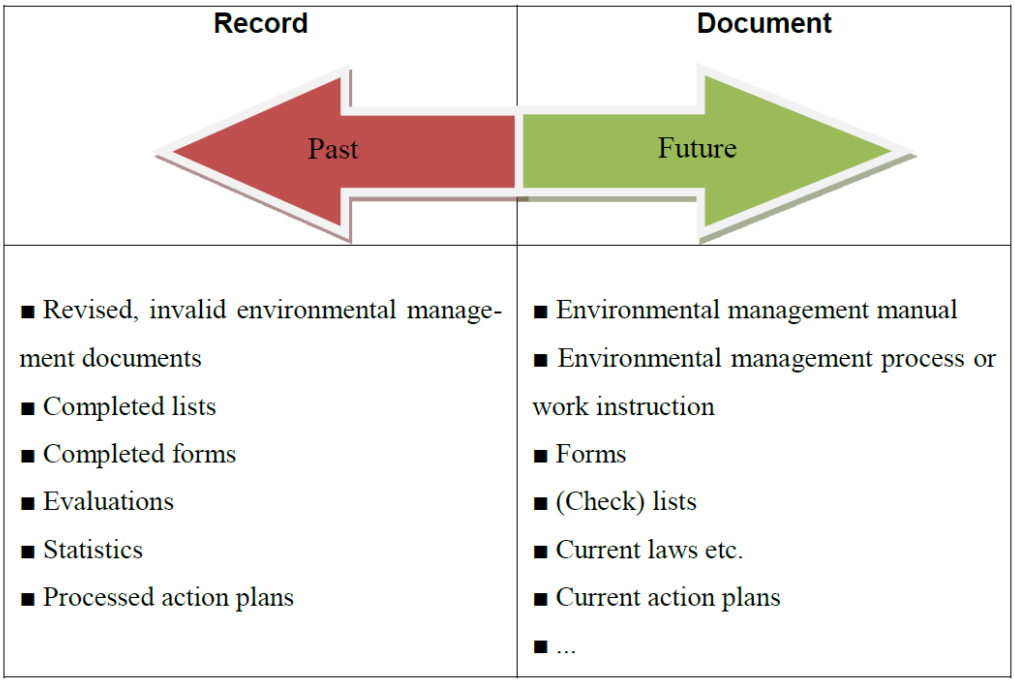


Figure 15: The opposite: records and documents

a process in a regulated manner, further documents are necessary depending on the organizational sector, size and the wider environment, such as Production plan, staffing plan or forms.

At a large number of process sub-steps, records of what has been achieved are created within the organization; these must e.g. are kept for a specified period for legal reasons or questions of liability.

"Documentation" is NOT to be equated with "production of paper"! The documentation of the documents relevant to the environmental management system can be in written or in electronic form. In the latter case, however, the regulations regarding accessibility, data backup, etc. must be observed, regulated and monitored accordingly.

Records and documents (see Figure 15) are both part of an environmental management system. In the sense of the standard definition, documents are all types of specifications that can be created both internally and externally (e.g. laws). The records can be used to provide evidence of what has been achieved (e.g. process key figures). In this sense, documents represent a target state and are therefore future-oriented, while records depict an actual state that is in the past (past-oriented).

The previous chapters should have made it clear that a practical and

efficient environmental management system is used to ensure that all processes within an organization run smoothly while taking environmental protection into account and to permanently improve the processes and interfaces involved.

The documentation, which is often perceived as disruptive or even obstructive in connection with management systems, is not an end in itself, but rather represents a collection of the necessary internal regulations: It can therefore be understood as the internal lexicon or the internal "operating instructions". It is not the aim of an environmental management system to create and / or leave behind a “paper pile” (Figure 16). Not a single piece of paper, not a single file is created “for environmental management”.

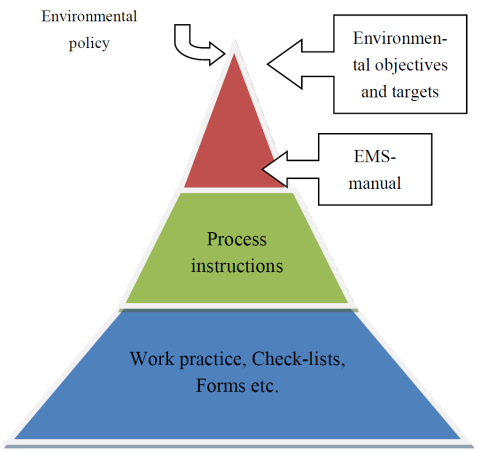


Figure 16: The pyramid-like structure of the environmental management documentation (ISO 14001)

However, the use of language in organizations often must change in this regard. In many cases it is said: “We are doing this for environmental management”. It would be desirable if it were to say: "Environmental management helps us to achieve our goals". The above statement ultimately leads to the following consequences:

Like all organizational areas, the environmental management system is also integrated into the dynamics of the company and, like all other areas, is subject to the necessary changes within the organization.

Typically, the entire environmental management documentation has the pyramid-like structure shown in Figure 16, with the level of detail increasing from top to bottom, i.e. forms, checklists, etc. form the most detailed part of this documentation. The more detailed the documents are, the easier it is for external third parties to understand what the day-to-day practice of an organization looks like; It is therefore understandable that, as a rule, only the environmental management manual is passed on to interested external persons.

Neither the structure shown above nor the distribution of specific documents are in ISO 14001 or EMAS or the like, explicitly regulated and thus remain solely at the discretion of the organization itself. However, the above structure and distribution regulation has proven itself in practice.

According to ISO 14001, the documentation of the environmental management system must contain:

- the environmental policy, objectives and targets;
- a description of the scope of the environmental management system;
- a description of the main elements of the environmental management system and their interaction, as well as references to related documents;
- documents, including records, required by this International Standard, and
- documents, including records, that the organization considers necessary to ensure the effective planning, implementation and control of processes related to its significant environmental aspects.

In order to meet this requirement of the standard, an environmental management manual (EMSM) is created. It contains an overview of the organization's management system and contains a summary of the implementation of the individual standard requirements. It is usually created by the environmental management officer, but before it can be distributed in the company, the distribution and distribution process must be regulated.

Typically, the EMSM also provides the reader with the following content:

- company history,
- company management,
- organizational structure (organizational chart).

According to the rough presentation in the EMSM, the following level is referred to as "procedural instructions (PI)". In practice, the term "process description (PD)" or "process instruction (PI)" is often used in order to illustrate the process-oriented approach of the QM system. But since these terms are not explicitly prescribed either, there is only one limit to the imagination: The designation must be clearly understood and accepted within the organization. In ISO 14001 the term “documented procedure” is used for this. For some processes, the creation of a documented procedure is explicitly required (Figure 17).

The procedural instructions regulate and document all internal processes (including responsibilities) in the manner and scope that are required to ensure implementation at the level formulated in the environmental policy. In order to create greater comfort for the user (better orientation) and thus automatically greater acceptance, it is often advisable to choose an identical structure for both procedural and work instructions.

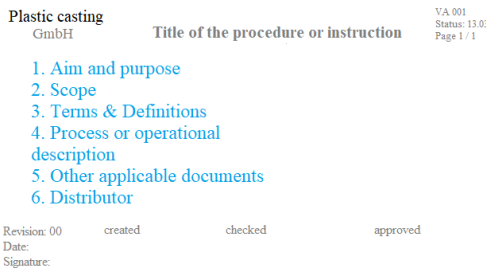


Figure 17: Example of an outline for procedures and work instructions

Procedural instructions are created in cooperation between the management representative and the respective

process owner (see Figure 18). The environmental management officer ensures compliance with the requirements of the standard and the formal regulations, while the person responsible for the process contributes his specialist and process knowledge.

If the agreements and regulations of a procedural instruction are insufficient, work instructions, checklists, forms etc. are created. There is no fixed form of representation for the entire environmental management documenttation; rather, it is left to the wealth of ideas of the environmental management representative. However, since people are generally very visually inclined and the environmental management documents are intended to offer rapid support, it is advisable to clarify and document the processes in the form of flow charts instead of a purely textual description. Such flowcharts can then also contain additional information, such as including responsibilities for individual process steps, interfaces to other processes and which documents are required for process execution.

Also with photos etc. work can be carried out if the essential environmentally relevant regulations can be made understandable and documented. If necessary, documents must also be translated into the respective mother tongue of the employees in order to ensure that the agreements can really be understood by everyone involved.

06.5 CONTROL OF DOCUMENTS

Without a mechanism to properly manage the environmental management system documents, an organization / company cannot be sure that its employees are working with the correct aids or tools (up-to-date procedures and instructions as well as other documents).

To ensure that everyone is working with the correct environmental management documents, this organization must have a procedure in place for how such documents are managed. The purpose of this procedure is to ensure that:

- environmental management documents can be localized,
- are checked and updated periodically,
- current versions are available where they are needed, and
- obsolete documents are withdrawn from circulation.

It must be determined who is responsible for the creation and approval of these documents. The same applies to changing documents and the update process. Accordingly, the document control includes

- the creation,
- the issue and distribution,
- the revision,
- the regular review and
- the withdrawal of outdated documents.

The procedure for doing this should be kept simple. While larger companies often have complex processes for

document control, smaller organizations can implement simpler processes.

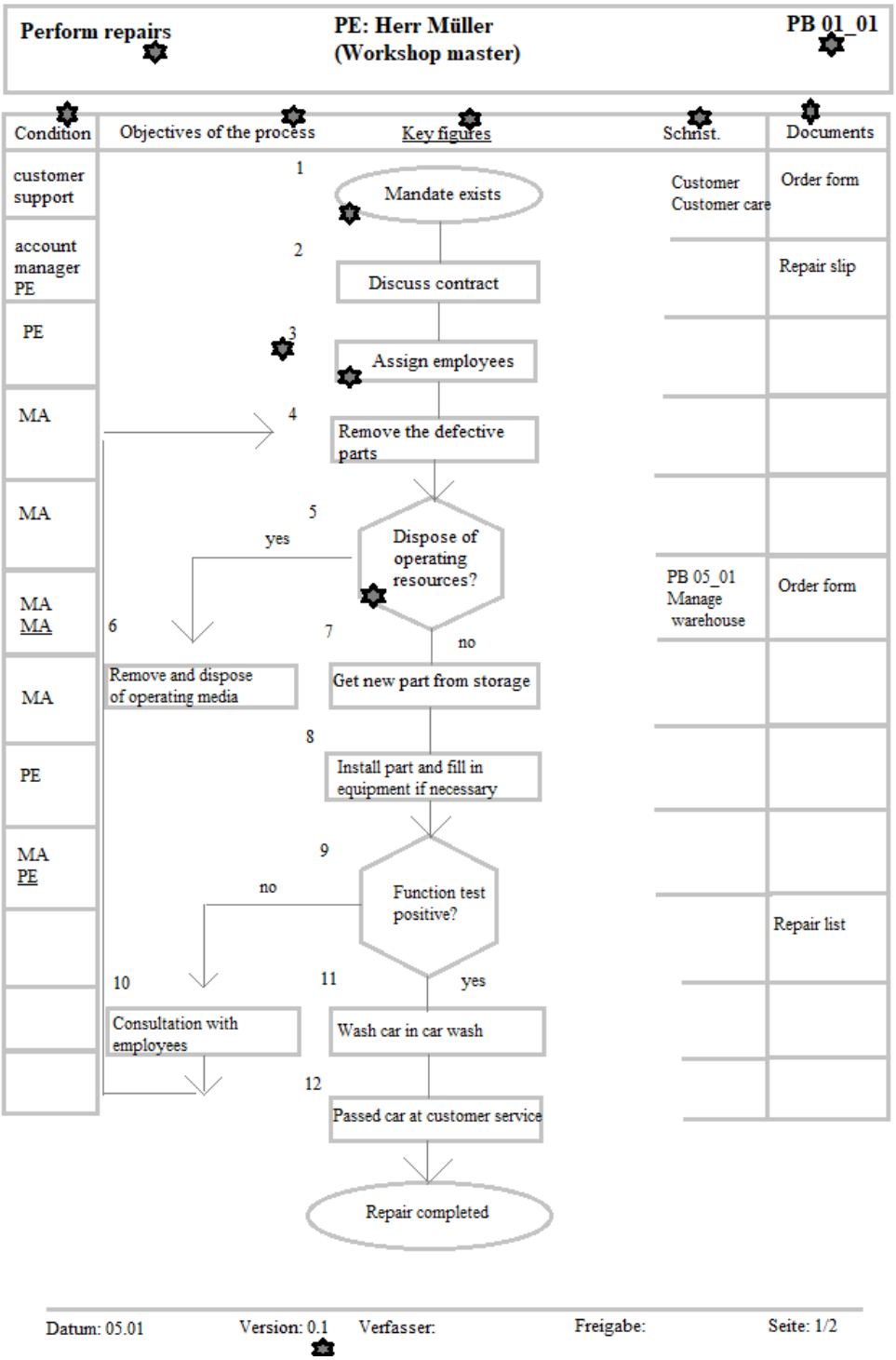


Figure 18: Example of a process instruction that has been worked out as a flow chart.

Limiting the distribution of documents is always an effective means. Therefore, it should be determined how many copies are really needed and where they should be available for easy access. The introduction of a paperless system should be considered if a group of people who need access to the documents has access to a local area network (LAN) or intranet. Such a system makes it much easier to control and revise documents. An index that lists the environmental management documents and their revision history is also often useful (Starkey et al., 1998).

If it is essential that several versions of individual documents must be available in paper form (e.g. no intranet access in the production area), a distribution list must be drawn up that shows the location of the document in question. This distribution list is then also the basis for recalling documents that are no longer up-to-date and replacing them with the new version of the document. In the case of particularly essential documents, it is advisable to have the receipt of the new documents confirmed.

06.6 PROCESS CONTROL

A process control (and thus a documented procedure) will generally exist for some activities or processes that are associated with significant environmental aspects. These will often be production processes. Nevertheless, the task remains to identify the environmental aspects for which processes have to be defined and, in the absence of which, deviations from environmental policy or violations of legal requirements would occur.

Determining which processes should be covered by documented procedures and how they are controlled is a crucial step in the design of effective environmental management. It must be borne in mind that a process control must also be specified for those aspects or legal requirements for which there are no environmental objectives or individual objectives.

In particular, it is necessary to look beyond the pure production or service process. Many supporting processes such as maintenance and servicing, warehouse management or the activities of contractors and service providers on company premises can influence the environmental performance of an organization. The starting point for the process control should be the business processes that are related to the essential environmental aspects of the organization or have been identified for the legal requirements. The processes linked to these processes (see Figure 19) are then to be examined more closely and, if necessary, also controlled.

Flow diagrams that are available, or that can easily be generated, simplify the identification of process steps for which flow control could be useful. Developing a blueprint for such a process will in most cases ensure that the process is appropriate, realistic,

and workable.

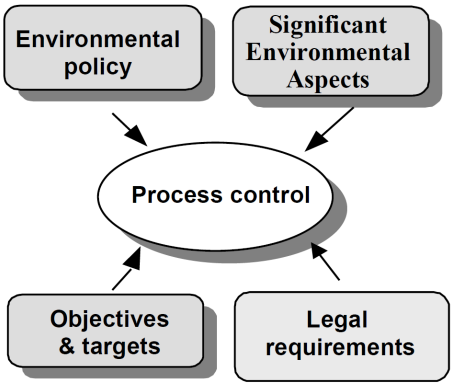


Figure 19: The importance of process control according to (Stapleton, et al., 2001)

When developing processes, it is important to involve those employees who will implement the processes later. This can be achieved through a meeting with the employees in the relevant area, at which the current processes are described and put down on paper. In a subsequent discussion, options should then be sought as to how the requirements for the process could be met. Then a draft version (or revision) has to be created, which has to be checked for correctness and revised by both the employees and the management.

The written procedures should be kept as simple as possible and be concise. They should contain the appropriate measures, precautions and reporting requirements.

06.7 EMERGENCY PREPAREDNESS AND DEFENCE

When assessing the significance of environmental aspects in Chapter 3.1.3, it was already mentioned that the organization should not only consider normal operating conditions, but also emergency situations that can realistically be expected.

In order to prevent the effects of these uncontrolled events or at least to minimize their effects, an emergency preparedness and hazard prevention program should be established. Of course, this also has financial implications, because a major incident can be much more expensive than implementing a well-run emergency program.

To be effective, the program must take into account:

- assessing the potential for accidents and emergencies;
- early detection of faults and the associated environmental impact;
- plans and procedures for responding to emergencies and accidents;
- regular review of contingency plans and procedures and
- measures to reduce the environmental impacts associated with these incidents.

In order to ensure continuous improvement, it is important that the organization, in cooperation with authorities and / or the fire brigade, evaluates the effectiveness of the emergency measures after an incident and adjusts the processes and communication channels if necessary.

In addition, it must be ensured that every employee in the organization knows what to do in the event of an emergency. This should be taught in training courses and practiced in emergency exercises.

EXERCISE 6/ DISSCUSSION

OUTLINE STRATEGIES FOR (EXTERNAL) COMMUNICATION WITH:

- RESIDENTS,
- LOCAL CITIZENS' INITIATIVES,
- OTHER INTERESTED PARTIES,
- REGULATORY AND LICENSING AUTHORITIES.

WHICH OTHER GROUPS DO YOU HAVE TO COMMUNICATE WITH?

EXERCISE 7/ DISSCUSSION

FIGURE 19 SHOWS A PROCESS INSTRUCTION THAT DOES NOT YET CONTAIN ANY PROCESSES FOR ENVIRONMENTAL PROTECTION. FIND 3 WAYS IN WHICH THIS PROCESS INSTRUCTION CAN BE EXPANDED TO ALSO TAKE THE ENVIRONMENTAL ASPECTS OF THIS PROCESS INTO ACCOUNT..

WHICH OTHER GROUPS DO YOU HAVE TO COMMUNICATE WITH?

07. REVIEW ACTIVITIES

Thomas Potempa* and Alena Mychkova*

** Ostfalia University (OU)*

Learning Outcomes
Name the most important elements of the review activities,
Define their characteristics
Develop procedures for controlling records and legal compliance
Know the tasks of the internal audit.

A management system without effective process monitoring and measurement is like driving an automobile at night without lighting. You know that you are moving, but it is difficult to make statements about the direction and it is almost impossible to tell whether a tree is in the way. To avoid this, the DEMING cycle contains a review phase, which extends over various areas in environmental management, the aims of which are:

- improve environmental performance,
- analyze the cause of problems,
- to assess compliance with legal requirements and
- identify areas where corrective action is necessary.

07.1 MONITORING AND MEASUREMENT

In order to be able to achieve continuous improvement of the environmental management system, the monitoring of processes or the measurement of the most important process parameters is of crucial importance. Many strategic options, such as increasing resource efficiency or avoiding environmental impacts cannot be done without adequate monitoring and measurement. However, this process control requires current and reliable data, but this directly means that all devices for monitoring and measurement work precisely and must be calibrated regularly. The data gathered from the measurements must be documented in such a way that they can be verified by an internal or external tester.

The monitoring and measurement of the key indicators and environmental performance linked to the environmental aspects will usually be specified in the organisation's environmental program. The review of whether the organization is acting in conformity with the specified environmental objectives is usually achieved as part of an internal audit process. If deviations are found, this can also be the definition of a corrective measure. The process control is almost always monitored using environmental management programs, processes and procedural instructions as well as work instructions and visual aids. In any case, the measurement methods, the frequency and the responsible persons, or groups of persons, must be specified.

The process "calibrations and maintenance of measuring devices for environmental monitoring" should serve as an example of this. A procedural instruction could read:

> *"Affected areas and departments must ensure that the measuring devices for environmental monitoring are calibrated and are maintained in accordance with the manufacturer's recommendations. If the manufacturer's recommendations are not known, maintenance should be carried out at least every 12 months. The affected areas and departments should create records of the calibrations and maintenance carried out in order to prove compliance with these procedural instructions.*
>
> *The calibration and maintenance of measuring devices for environmental monitoring is, where applicable, included in preventive maintenance programmes of areas and departments. Each affected area, or department, keeps a list of items of equipment that need to be calibrated and serviced, as well as their corresponding maintenance cycle. "*

07.2 LEGAL COMPLIANCE ASSESSMENT

ISO 14001 and EMAS require proof that all applicable legal obligations in the environmental area have been determined, their effects are known and that compliance with them is ensured. This also includes the official approvals including the limit values and monitoring and measurement obligations specified therein.

The organization must introduce, implement and maintain a procedure for the regular assessment of compliance with the relevant environmental obligations as well as other requirements to which it has committed itself (see Section 3.2) The flow of information with regard to changes in legal provisions must be ensured and documented. Records must be retained to evaluate the results (Zell, et al., 2012).

Compliance with the legal provisions can be assumed, for example, in the following cases: (UGA Environmental Verification Committee, 2004):

- if legal requirements (if necessary, specified by official notification) are met in a timely manner (timely fulfilment of exploration, security or remediation measures according to law),
- if limit values (precautionary values) are exceeded, if legal or officially regulated transition periods exist for the organization after they have been specified in administrative regulations, until the transition period has expired,
- in the case of an exception provided by the competent authority,
- in the case of a statutory exemption from certain requirements issued by the competent authority,
- if there is an administrative act issued by the responsible environmental authority or another record from which it emerges that the legal status has been checked by

the administration, and this has come to the result, taking into account further legal considerations (e.g. the principle of proportionality), that there is no legal violation in the specific individual case; this record must be signed by the authority,

- in the case of a subsequent order by the responsible environmental authority with a deadline for implementation,
- in the case of a binding redevelopment plan agreed with the responsible environmental authority,
- in the event of a change to an ancillary provision agreed with the responsible environmental authority and this is documented in the documents of the organization in order to enable the verification by the environmental verifier.

The organizations can take appropriate measures to ensure compliance with the law. Examples of this are (UGA Environmental Verification Committee, 2004):

- in the event of non-compliance with limit values, completed emission reduction measures that guarantee permanent legal compliance;
- the creation of a proper floor sealing of a hazardous material store if this was not carried out, or not carried out properly;
- in the absence of a permit, catching up with a permit application including the submission of an already issued permit. Insofar as legal requirements still need to be met in the future (e.g. following a reorganization plan or as a result of a subsequent order), the EMAS participant will present the facts and, if applicable, the relevant agreement with the authorities in the environmental statement (transparency).

07.3 DEVIATIONS, CORRECTION AND PREVENTIVE MEASURES

If deviations from the specified target state are found during the monitoring of processes, improvement activities must be initiated by the organization. A distinction is made between two types:

• Corrective actions:

The error or problem has already occurred and will be eliminated.

• Preventive measures:

Prevention of the recurrence of the error or problem.

Corrective action includes:

- the error assessment,
- the determination of the cause(s) of errors / deviations,
- the assessment of the need for action to prevent the error from occurring again,
- the determination and implementation of the necessary measures,
- a record of the results of the action taken and
- the assessment of the corrective action taken.

Preventive measures are those used to counter potential errors, or problems,

in advance and thus to avoid them. The measures to be taken must be appropriate to the potential error or problem.

A preventive measure includes:

- the determination of potential errors / deviations and their causes,
- the assessment of the need for action in order to prevent the occurrence of the error / deviation,
- the determination and implementation of the necessary measures,
- the record of the results of the actions taken and
- the evaluation of the preventive measures taken.

Responsibility for the initiation and processing of corrective and / or improvement measures is usually the corresponding area, or department, head in whose area of responsibility the deviation occurred. The implementation of the measures is supported by the EMR. Measures can include the revision of old, or the creation of new, work or process instructions, because the occurrence of a deviation does not always mean something negative. The term "deviation" shows first of all that there is a discrepancy between the existing documentation (target state) and the actual processes (actual state). The first thing to do is to find out why this discrepancy exists.

As the two previous lists show, an evaluation step is provided for both types of improvement measures. This is absolutely necessary in order to assess the effectiveness of the measure taken. The underlying objective of the management system is known to be continuous improvement. If a measure is ineffective, i.e. not effective, then one cannot speak of improvement. As a result, it follows that another solution for eliminating the discrepancy must be sought.

07.4 CONTROL OF RECORDS

As part of environmental management, a large number of records are created, such as the results from environmentally relevant measurements, the test reports from recurring system inspections, but also evidence of disposal of waste, or energy, consumption data.

For all records related to environmental management, the following applies:

- they must be legible, findable and assignable to the activities, products and services,
- they are to be protected against damage, destruction and loss and
- they must be kept for a certain period of time, whereby the retention periods are based on legal or other requirements.

It is therefore advisable to keep a list of environmental records which, in addition to the type of record, the storage location and the storage period, also includes the assignment to the processes in which they are created. In addition, it must be ensured that only the responsible personnel have access to this list and can only edit the entries for which they are

responsible, or which arise in their area of responsibility.

The control of records is usually documented in a procedure or process instruction. The procedure is to be reviewed regularly with regard to its appropriateness and effectiveness. If deviations are found, corrective or preventive measures must be initiated.

07.5 INTERNAL AUDIT

In order to ensure that the requirements of the standard are fully met and that the environmental management system is fully functional, it is necessary that effective internal audit procedures are in place. This is particularly important if the environmental management system is to be certified.

Regardless of whether certification is now planned, it is important to clarify the procedures and processes required for an audit, because the audit is intended to determine whether the environmental management system is in conformity with the standard as well as with environmental policy, environmental objectives and environmental aspects and the environmental management programs as well as the procedural and work instructions outlined ideas or target states are given.

Since the audit is a central topic in environmental management, reference is made at this point to the following chapter, in which the audit is dealt with in more detail.

08. AUDITS IN ENVIRONMENTAL MANAGEMENT

Thomas Potempa* and Nguyen Hoang Nam Kha**

** Ostfalia University (OU)*

*** Nong Lam University-Ho Chi Minh City*

Learning Outcomes
Name the different types of audit and explain them in more detail,,
Know the tasks and responsibilities of those involved in an audit and
Present the process of an audit with its individual steps.

Both EMAS and ISO 14001 prescribe an environmental management system audit. The audit is intended to check compliance with ISO 14001 - or EMAS - and can be combined with other audits, such as Quality audits, energy audits, legal compliance audits or the audit of other management systems can be combined.

A combined environmental compliance audit and environmental management system audit makes the most sense. Whatever is checked (e.g. the environmental management system, compliance with legal regulations or waste management processes) is referred to as the "subject of the check". The instructions, guidelines, procedures, standards or other regulations, on the other hand, are the "test criteria".

Accordingly, the examination criteria in a legal compliance audit are the environmental laws that an organization must comply with. The audit covers the organization's environmental activities and the conditions under which compliance with this legislation is ensured. When the environmental management system is audited, the subject of the audit will be the organization's environmental management system and the audit criteria result from EMAS or ISO 14001. The audit itself is carried out in accordance with ISO 19011, the "Guide to auditing management systems" (ISO (International Standard Organization), 2011).

08.1 TYPES OF AUDITS

The purpose of the audit is to obtain crucial indications for continuous improvement. Since it is not easy for internal staff to ensure the necessary critical view and thus to provide objective information for a system modification, EMAS and ISO 14001 provide for a certification of the management system in addition to the internal audit and an assessment by external parties. By the way, one of the best ways to train internal employees on site in the application of the environmental management system is to have them accompany the audit in another area, or department. In connection with external auditors, these employees can then experience and learn an external perspective in addition to the “internal” view.

Depending on who undertakes the audit, a distinction is made between:

- first party audits,

- second party audits and
- third party audits.

In a first-party audit, only one organization is involved in the audit, i.e. internal staff carry out the audit and provide the audit evidence. This is the internal audit, as discussed in the previous chapter. Two organizations are involved in a second-party audit. Depending on the position in the bilateral relationship, there is also talk of supplier or customer audits. An "external" audit, or certification audit, occurs when an "uninvolved" third party carries out the audit. In the case of certification according to ISO 14001, the auditors come from approved certification bodies, such as the German TÜV. If the environmental management system is to be registered according to EMAS, the assessment is carried out by approved environmental verifiers.

In addition to differentiating the audits according to the organizations involved, a second typification is possible, which is based on the scope of the audit. A distinction is made here between:

- process audits,
- product audits or
- system audits.

The process audit has the smallest scope. Only a single process - regardless of whether it is a management, main or secondary process - is checked. The product audit as an extension considers all processes connected with the creation of a product. The most comprehensive audit is the system audit. All processes in the management system are checked here.

08.2 THE AUDIT-PROCESS

Regardless of the type of audit and the subject of the audit, it should be noted that these are all proceed according to the same scheme. The following terms are used to describe the parties involved in an audit:

- Audited - members of the organization being audited. It is the task of the auditee, during the audit, to answer questions, provide the documentation, provide evidence and take part in the inspection of the premises.
- Audit team - a group of auditors, or a single auditor, who conducts the audit. The head of the auditing team is designated to conduct a specific test. The head of the auditor team is referred to as the lead auditor. The task of the auditors is to conduct interviews, inspect the premises, collect audit evidence and view the documentation.

An audit is roughly divided into three phases: preparation, implementation and follow-up (see Figure 20).

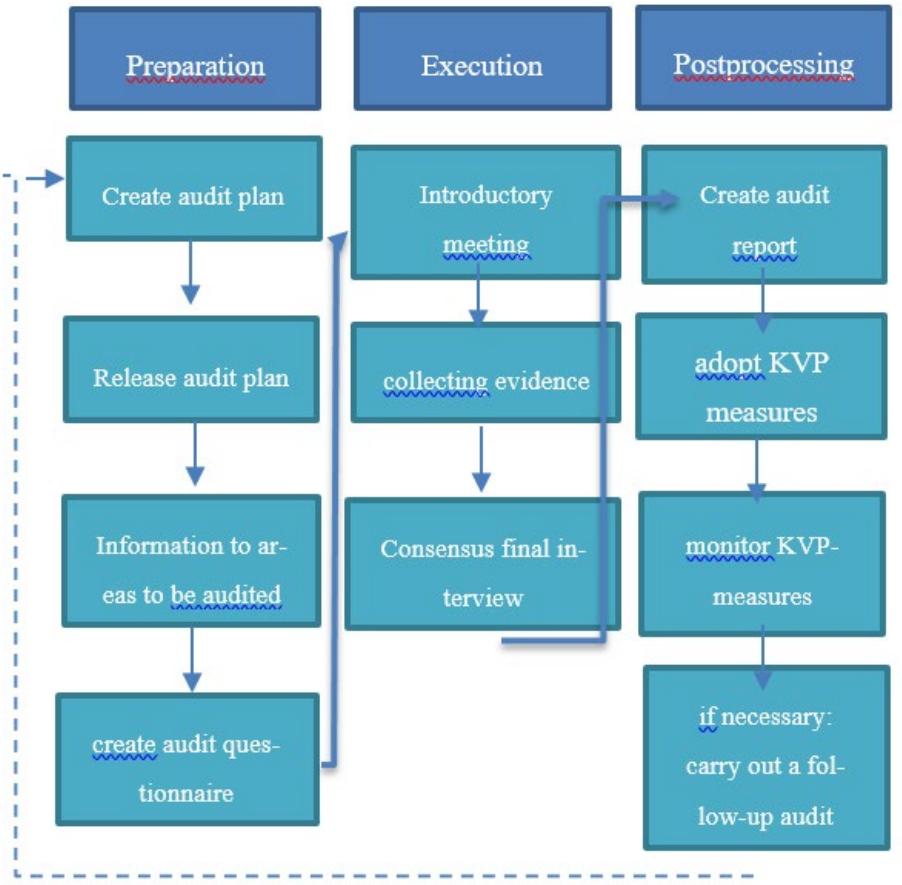


Figure 20: Phases of an audit

According to ISO 19011, an audit is divided into 10 steps. The first step (1) is to define the audit goals, scope and program. Then (2) the audit team and the lead auditor are determined. After the audit team has been established, (3) the first contact is established between the body to be audited and the audit team and the area to be audited is informed about the audit.

Then (4) the audit team begins to sift through the documentation and to prepare work equipment (e.g. checklists as shown in Figure 18) and (5) to plan the activities during the audit. This completes the preparation phase.

As part of the audit, the auditors first (6) conduct an introductory meeting followed by interviews with those responsible and employees of the area and collect relevant data (so-called audit evidence). All audit results should be verifiable, demonstrable and explainable.

Checklist

Audit questions DIN EN ISO 14001

		J N	Comments (documentation, audit observation, evidence)
28.	Have responsibilities for the monitoring of the storage of hazardous substances and the creation of instructions been regulated?		
29.	Are the employees sufficiently instructed in handling hazardous substances and do they have the latest information?		
4.4.7 Emergency preparedness and security			
1.	Are there procedures in place to identify possible accidents and emergency situations that may have an impact on the environment?		

Figure 21: Extract from a checklist on audit questions (ZDH-Zert GmbH, 2010)

After sufficient audit evidence has been compiled, the auditors withdraw, (7) analyze data, prioitize and (8) establish solutions for the identified deviations and opportunities for improvement. This is followed by (9) the final discussion with the audited unit, in which the participants are informed about the results of the audit.

Following the on-site inspection (10) the audit report is drawn up and sent to the audited area. From the auditors' point of view, this completes the audit. For the audited area, it is then necessary to initiate and monitor the measures proposed by the auditors for continuous improvement. If serious deviations are found during the audit, a follow-up audit is usually carried out.

Audits should be carried out at least once a year, the frequency depending on the type of processes and activities. Areas with significant environmental aspects and impacts should be audited significantly more frequently than other areas. The results of previous audits and the results of the monitoring processes must also be taken into account.

08.3 AUDIT PARTICIPANTS – TASKS AND RESPONSIBILITIES

In order for an audit to be truly

successful and to contribute to the continuous improvement process, all those involved in the audit must be aware of their role and responsibilities. Due to the auditing character that an audit has, those audited run the risk of not wanting to attract attention due to misunderstood ambition. On the other hand, the auditors have to avoid an occurrence under all circumstances which the auditee could interpret as "environmental POLICE". Both behaviors miss the actual purpose of an audit. The aim is not to find errors / deviations but to avoid errors / deviations. This means that every deviation found and the associated improvement measures are a step towards continuous improvement of the overall system.

Therefore the audited should:

- not prepare and conduct a show for the auditors, but rather
- show typical examples, not the "exception to the rule",
- answer questions without evaluations and not make any lengthy explanations,
- admit mistakes and not look for excuses (the child has already fallen into the well, so the future, in which everything will be better, should be looked at. “Ifs” and “hates” don't help anymore), and
- ensure that all participants in the audit have the same level of knowledge and access to the same information.

The lead auditor is responsible for defining the purpose and objectives of the audit. He defines the requirements in the audit, plans it and prepares the work equipment. He evaluates the management system documents regarding their appropriateness and informs the area to be audited immediately if critical deviations threaten. His final report on all audit results must be written in an understandable manner and should include all obstacles and challenges that have arisen during an audit.

The auditors are obliged to work with the lead auditor in order to achieve the set audit goals. This includes compliance with the scope of the audit in order to obtain sufficient audit evidence to evaluate the environmental management system. Auditors have to be objective and impartial. You have to be attentive to the smallest details and also be sensitive to circumstances that could influence or falsify the audit result or require a new audit. It goes without saying that the auditor is well informed and prepared and does not allow himself to be guided, but instead chooses the areas he would like to see.

There are no differences with regard to the qualification of an auditor, regardless of whether he is employed as an internal or external auditor. A prerequisite is always a broad knowledge in the field of environmental sciences and technologies, knowledge of the

technical and environmentally relevant aspects of the operation of plants and knowledge of the relevant environmental protection laws and regulations. He should also have experience in dealing with environmental management systems and the necessary audit techniques.

EXERCISE 8/ DISSCUSSION

In Exercise 6 you expanded the process instructions from Figure 19 to include environmental protection topics.

Refer to Figure 21 for a checklist for auditors.

a) Develop questions that will provide the auditor with the necessary audit evidence on the items listed.

b) What evidence would the person responsible for the process have to provide so that the auditor does not certify any deviations from the points listed in Figure 15?

09. SUSTAINABLE DEVELOPMENT IN AQUACULTURE – A CASE STUDY OF THAILAND

Rakpong Petkam* and Lynn Besenyei**

* *Khon Kaen University*

** *Unversity of Wolverhampton*

Learning Outcomes
Name and Explain the definition of sustainable development as it is applied to aquaculture
Understand current concerns and factors affecting development toward sustainability in aquaculture
Identify discrepancies between local practices and international awareness of the sustainable development of aquaculture

9.1 INTRODUCTION

In the past, fishery products were mainly based on capture fishery production which gradually increased and reached its plateau in the early 1990s)FAO, 2020(. The decline in catch was due to the fact that fish populations were over-exploited to serve a drastic increase in the world's population. Since the early 1990s, the world catch of capture fisheries was somewhat steady at around 90 million tons per year until the present. While capture fisheries have reached a plateau, the development of aquaculture has contributed to its production to become almost level with that of capture fisheries at 82 million tons in 2018)FAO, 2020(. This indicates the immense contribution of aquaculture products, as a protein source, for the world population which has been supported by a gradual increase in per capita consumption. In addition, aquaculture industries have shown a rapid growth with a 527 percent increase from 1990 to 2018)FAO 2020(. This suggests that fishery products have become a more important factor in food security for human consumption. Aquaculture is now recognized as being among the fastest growing businesses in current times.

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs")Bruntland Commission, 1987). Sustainable development is of great concern worldwide. The sustainable development goals)SDGs(set by FAO cover a broad area and include economics, social sciences/aspects and the environment. SDG14 was set to conserve and to sustainably use the oceans, seas and marine resources for sustainable development)FAO, 2018(. SDG14 is directly related to the objective of this chapter. However, the chapter is not aimed at providing a review of the information concerning

the sustainable development of aquaculture, but it is a broad view of the possible constraints to the sustainable development of aquaculture in Thailand in particular.

9.2 CURRENT STATUS OF AQUACULTURE IN THAILAND

Thailand is among the top aquaculture producers in the world. In the case of aquaculture in Thailand, tilapia)Oreochromis niloicus(and white shrimp (Penaeus vannamei) were the two main exported aquatic species in 2016. Thailand is in the top five of the world exporters of fish and fish products)FAO, 2018(and aquaculture products are part of that total since captured fisheries remain steady. Aquaculture not only serves as an important food supply, but the industry also provides revenue and employment. Aquaculture systems in Thailand are very diverse and include the use of a wide range of culture systems including earthen ponds, concrete ponds, polyethylene lined ponds and cages. In terms of farm size within the aquaculture industry, there is a wide range in both size and productivity. In general, they range from small holder farms to intensive farms. Although the closed, or recirculating system, has been developed and used elsewhere, in the case of Thailand, natural water bodies such as dams, reservoirs and rivers are more commonly used water sources for cage culture in addition to different types of ponds. Geographically Thailand is located within the tropical zone with relatively high water temperatures and a long photoperiod throughout the year which renders advantages for aquaculture in terms of an abundance of primary producers which is particularly beneficial for subsistence aquaculture. However, in intensive aquaculture, such as in cage culture, fish and prawns are commonly reared at a high stocking density in order to benefit from the optimum primary production and from good water quality. An intensive culture system generally utilizes a genetically improved seedling at a high stocking density. Thus, this requires high quality feed which is given at a high feeding rate. In most cases, the system is equipped with equipment to elevate dissolved oxygen if needed. The use of high quality feed and at a high feeding rate are aimed at producing a fast growth rate, high biomass and a short production cycle, with a resulting high level of excretion into the water environment as a bi-product.

9.3 IMPACT OF AQUCULTURE ON THE ENVIRONMENT

In general, for those businesses who

use natural water bodies, aquaculture could be affected by pollutants released into these water resources. Various sources of pollution include industrial, agricultural and household discharges. These lead to the deterioration of water quality which eventually affects aquatic animal health. In addition, various pollutants have been reported to have many mechanisms of toxic action on aquatic animals. The fast growing aquaculture systems, in particular the intensive systems which utilize a high stocking density, feed their seedlings on high quality feed at a high feeding rate to ensure high production. As a result, waste released from the culturing system includes both faeces and uneaten feed which is a major environmental concern)Cao et al., 2007(. Under tropical conditions, the waste from aquaculture is utilized by primary producers and leads to water with a high dissolved oxygen content due to photosynthesis. Conversely, oxygen is required for their respiration. Under conditions of less sunlight, an abrupt shortage of dissolved oxygen might lead to massive mortality. Once sedimentation occurs, fermentation in the absence of oxygen normally leads to toxic products that affect living organisms. The long term accumulation of organic matter, could affect the physico-chemical properties of water and ultimately the deterioration of the ecosystem could lead to habitat destruction and/or modification, and loss of native species resulting in a lowering of species diversity and species richness)Serpa and Duarte, 2008(. Generally, the rapid growth of the aquaculture industry is high to meet the need of growing global consumption. Particularly the world consumption trend of aquaculture products is constantly increasing. It is of primary importance to manage this fast growing industry and to mitigate the afore mentioned adverse effects in order to avoid the long-term effects on ecosystems and biodiversity.

Globally, it has already been foreseen to set the SDGs in particular SDG14 as mentioned earlier. Clearly sustainable development within the aquaculture industry is an ultimate goal worldwide. In the case of aquaculture in Thailand these aquaculture industries will certainly continue to grow in order to supplement its depleted capture fishery and to provide an increase in the availability of aquatic products to provide for increased global consumption (FAO, 2020). Thus, achieving sustainable development within the aquaculture of Thailand is a

challenging task for Thailand as it is elsewhere.

9.4 WHAT IS INVOLVED IN THE SUSTAINABLE DEVELOPMENT OF AQUCULTURE?

Global concern for the sustainability of fishery resources has been addressed and has planned for activities that will lead to an increase in the economic benefits from the sustainable use of fishery resources between 2016 -2030)FAO, 2018(. These intend to raise awareness of sustainability within the fishery and aquaculture industries. Although activities were mainly based on captured marine resources in the past, aquaculture is now equally as important due to its impacts on world fishery products in 2018)FAO, 2020(. Similarly, the environmental sustainability of aquaculture in Thailand must continue to be assessed to avoid the environmental and ecological impacts mentioned in the previous paragraph. Boyd et al. (2020) highlight the history of the industry, the current perspectives along with the future needs and challenges. Good pond management is crucial to reduce the use of freshwater resources and to reduce waste exchange by increasing waste removal capabilities eg. Use of a partitioned pond and biofloc pond technologies (Tucker 2020). In addition this is also important to avoid contamination of nearby water resources. Accumulation of organic matter is usually a result of over feeding and faeces accumulation. This can be improved by using feed technologies to increase feed efficiency e.g. the use of probiotics, enzyme additives or other additives (Huyben and Glencross, 2020).

It is generally accepted that the sustainability of aquaculture is not based on an ecological or a biological view point. Sustainable development in aquaculture must consider ecological, social and economic aspects (Kutty, 1995; White, O'Neill

Suggested reading	
Boyd, C. E., D'Abramo, L. R., Glencross, B. D., Huyben, D. C., Juarez, L. M. Lockwood, G. S., McNevin, A. A., Tacon, A. G. J., Teletchea, F., Tomasso Jr., J. R., Tucker, C S & Valenti, W. C. (2020). Achieving sustainable aquaculture: historical and current perspectives and future needs and challenges, Journal of the World Aquaculture Society, 51:578–633	White, K., O'Niell, B. and Tzankova, Z. (2004). At a crossroads: will aquaculture fulfill the promise of the blue revolution? SeaWeb 17p.

and Tzankova, 2004). It is also necessary to bear in mind that ecological, social and economic aspects are identified and/or recognized unequally among society and among high, middle and low income countries)Salin and Ataguba, 2018(. This suggests that policy and management planning should be suitable for every country and society including Thailand. In addition, knowledge, technology and financial assistance should be modified to suit the needs of all fish farmers from small holder farms to intensive culture systems and it is unlikely that one approach will fit all systems. Most importantly knowledge of the environmental impacts of each culturing system must be addressed for both short-term and long-term development. An awareness of the likely environmental impacts, in particular from waste released from the culturing system itself, should be considered first. Furthermore, it is necessary to update the carrying capacity of the water resources as principle form of information needed for planning and policy to ensure sustainable development.

10. TECHNOLOGICAL ASPECTS OF ENVIRONMENTAL MANAGEMENT

Nguyen Van Quynh Boi*

** Nha Trang University*

Learning Outcomes

Name and explain the core elements of environmental management systems

Nowadays, the development of aquaculture should be approached by basing it on an ecological viewpoint. One of the major challenges for the sustainable development of aquaculture is the sharing of water, land and other resources with alternative uses (Aguilar-Manjarrez et al., 2017). With regard to the environmental impacts of aquaculture they are seen in a variety of ways including user conflicts, alteration of hydrological regimes, introduction of exotic species (including genetically modified organisms - GMOs) to the wild, and pollution of water resources (Midden and Redding, 1998). According to Crawford and MacLeod (2009), pollutants from aquaculture discharge water could lead to organic enrichment around the farm, increased dissolved nutrients or chemicals in the growing area, loss of habitat and loss of amenity.

However, regarding the environmental impact extent of aquaculture, it is difficult to determine the impact of aquaculture on the environment in isolation, as the observed consequences are in many cases the cumulative effect of several factors that disturb its natural state (Pillay, 2004). Therefore, to some extent, concern over the environmental impacts of aquaculture is a relatively recent phenomenon. According to Tucker et al. (2008), environmental impacts of aquaculture can be divided into near-field and far-field effects. Near-field effects are the localized effects of aquaculture production, which are, in most cases, reversible. Examples of near-field effects are benthic disturbances beneath net-pen facilities and habitat conversion when ponds are constructed. Near-field effects have been the best-studied, primarily because they are more amenable to evaluation. In contrast, far-field effects of aquaculture are less well understood, primarily because they are often one of many sources of impact and estimating the relative contribution of aquaculture to environmental change is difficult. Examples of far-field effects are the introduction of non-native species, pathogen exchange between captive and wild populations, and effects of predator control at aquaculture facilities on wildlife populations and biodiversity.

The uncertainties associated with far-field environmental effects of aquaculture are large. Therefore, improving aquaculture's environmental performance requires solutions implemented at spatial

scales ranging from individual culture units to the entire biosphere. In other words, solutions also range from farm-level implementation of improved practices to fundamental changes in social and economic values (Tucker et al., 2008). Relating to aquaculture practices, the concentration of this section is on farm-level implementation. In general, the development of aquaculture is restricted due to the pressure it causes on the environment by the discharge of waste products into water bodies. The nature and extent of the environmental consequences of aquaculture depend largely on the location and type of farms, as well as the production technologies employed (Pillay, 2004). As described by Crawford and MacLeod (2009), the effects of aquaculture on the environment will vary according to a number of factors, amongst which the most important are:

- size and intensity of farming;
- location of the farm (e.g. ecological sensitivity and assimilative capacity of the area, hydrology, presence of other industries/polluters);
- type of organism cultured (e.g. plants or animals, filter feeders or carnivores, endemic or introduced);
- the farming method and management practices (e.g. open water cage or shore-based culture, subsistence or technologically advanced).

By the time, there has been increased concern about the environmental effects of aquaculture. This concern due to dissolved nutrients from aquaculture wastes, that are released into the surrounding environment and dispersed into the wider ecosystem (Crawford and MacLeod, 2009). For that reason, environmental management for aquaculture is absolutely necessary.

10.1 WASTEWATER/WATER QUALITY INDICATORS (RELATED TO AQUACULTURE PRODUCTION)

Water, the stuff of life, covers three-fourths of the earth's surface and represents a major component of the bodies of plants and animals. According to Parker (2012), water is the universal solvent, dissolving almost everything. As a solvent, it acts as a medium for biochemical reactions and carries waste products and nutrients. Therefore, as indicated by Alley (2007), water as a reservoir, can provide minimal treatment to certain organic pollutants because of the oxygen and the biota in the water. However, water also acts as a disperser of pollutants. Thus, water pollution can be of regional interest because of this dispersion. According to the author, there are several ways of classifying pollutants in order to predict their effect on water quality and the means of their removal.

First they can be classified as a solid, a liquid or a gas, or as one of these mixed with, dissolved in, or absorbed onto, another. Further each of these

can be organic or inorganic. An organic waste can additionally be classified as volatile or non-volatile, biodegradable or refractory, and of animal, mineral or vegetable origin. Inorganic wastes should be classified as dissolved, suspended or settleable and by pH. Further information needed on a waste includes temperature, volume or quantity. In fact, the life and activities of plants and animals, including humans, contribute to the pollution of the earth, especially water bodies and even underground water. Sources to cause pollution for water bodies can be classified by different approaches. In general, the common sources of water pollution include industrial, municipal, agricultural and natural ones.

These sources make a change in the characteristics of water. In order to

Table 11 -Common environmental condition indicators, method of use and reporting time (Source: Adapted from Crawford and MacLeod, 2009; page 688)

Indicator	Method	Reporting time
Nutrient level (NOx, NH_3, PO_4)	Lab analysis	Medium - Slow
Dissolved oxygen	Field probe	Rapid
Redox	Field probe	Rapid
Sulphide	Field probe	Rapid
Turbidity	Field probe	Rapid
Sediment particle size	Lab analysis	Medium
Organic matter	Lab analysis	Medium
Chlorophyll a	Field probe/ lab analysis	Rapid - Medium
pH	Field probe	Rapid
Bacteria/pathogens	Lab analysis	Medium
Specific chemicals	Lab analysis	Slow
Benthic community (spp. abundance & diversity)	Lab analysis	Slow
Microalgal community (spp. abundance & diversity)	Lab analysis	Slow
Macroalgal community (spp. abundance & diversity)	Field & lab analysis	Medium
Seagrass (extent & condition)	Field & lab analysis	Medium
Epibenthic community	Video	Rapid

assess water quality, especially in aquaculture practice, three aspects that should be considered include physical, chemical and biological characteristics (See Table 11).

According to Crawford and MacLeod (2009), indicators of the status of the system ('system indicators') in aquaculture, are commonly used in monitoring programs, e.g. water quality indicators such as nutrient levels or dissolved oxygen concentrations (Table 11). These indicators demonstrate the current condition of the aquaculture growing area; however, they are generally from temporally and spatially isolated samples (e.g. water samples taken once a month from a few sites). Although this provides a valuable quick assessment ('snap shot') of the physicochemical condition, it does not necessarily represent the biological response. Ecological indicators, which are similar to and sometimes referred to as value or impact indicators, can provide a more integrative assessment of overall condition spanning longer time periods. The distribution, abundance and community composition of specific flora and/or fauna are commonly employed as ecological indicators.

10.2 TECHNOLOGIES FOR AQUACULTURE ENVIRONMENTAL MANAGEMENT

10.2.1 Waste from aquaculture

As mentioned above, waste loading into natural water bodies from aquaculture production depends on many factors such as culture species, stock density, farming technology and management activity, etc.. However, the most significant effect of aquaculture waste is increasing the nutrient concentrations in natural water (hypernutrification) and so causing an increase in plankton and microbial populations (eutrophication) (Midden and Redding, 1998). The source of these nutrients is mainly wasted feed. Thus, the waste water from an intensive aquaculture system will contain (1) particulate solids (faeces and waste feed), (2) dissolved metabolic wastes, (3) dissolved nutrients from feed and wastes, and (4) biocide and pharmaceutical residues. Or, as indicated by Pillay (2004), the main types of waste from aquaculture can be described as (1) residual feed and faecal matter, (2) metabolic by-products, (3) residues of biocides, drugs and chemicals. However, the aim of this section is to focus on solids and dissolved nutrients as wastes of frequent forms in aquaculture production (Midden and Redding,1998).

(1) Solids

Solids are generally classified into three categories: settleable, suspended, and fine or dissolved solids (Tidwell, 2012). According to Midden and Redding (1998), there are two forms of solids from aquaculture facilities discharged into water bodies including inorganic and organic ones. However, as mentioned above, its important to pay attention to organic solids especially with regard to the

environmental impacts of aquaculture because it is easy for these wastes to flow outside within water as sediment. In the case of flow-through farms, according to Cripps and Bergheim (2000), concentrations of solids in the untreated effluent are low at around 5–50 mg l−1. These solids can commonly carry 7–32% of the total nitrogen and 30–84% of the total phosphorus in the wastewater. In addition to these organic wastes, residues of any chemical and drugs used in the farming process will enter the water column or sediment.

(2) Dissolved nutrients

According to Midden and Redding (1998), the dissolved nutrients of most concern with regard to the environment impact of aquaculture are nitrogen and phosphorus in their various chemical forms. These are important nutrients for plants in the aquatic environment, and their increased availability in natural waters can significantly affect the balance of natural ecosystems. While not generally regarded as an ecologically important nutrient in the same way as nitrogen and phosphorus, sulphur also can be important with regard to the environmental impact of aquaculture.

a) Nitrogen:
   Nitrogen occurs in aquaculture ecosystems in either inorganic or organic form. Inorganic inputs of nitrogen include chemical fertilizers, nitric acid in rainfall and exiting inorganic nitrogen in the water supply. Whilst organic inputs are manures and feed.
b) Phosphorus:
   Generally, phosphorus tends to be absorbed by bottom sediments. However, exiting forms of phosphorus in the aquatic environment depend on specific conditions such as redox potential, amount of organic matter and inorganic ions (Fe3+, Al3+ and Ca2+) in the sediment, etc..
c) Sulphur:
   Sulphur is of some interest in aquaculture because of its importance in anoxic sediments. In aerobic conditions, organic sulphur decomposes to sulphide, which in turn oxidizes to sulphate. Sulphate is highly soluble in water, and so gradually disperses from sediments. Sulphide oxidation is mediated by micro-organisms in the sediment, though it can occur by purely chemical processes. Under anaerobic conditions, sulphate may be used in place of oxygen in microbial metabolism. This process leads to the production of hydrogen sulphide gas.

An example of waste from aquaculture production is illustrated in Figure 22.

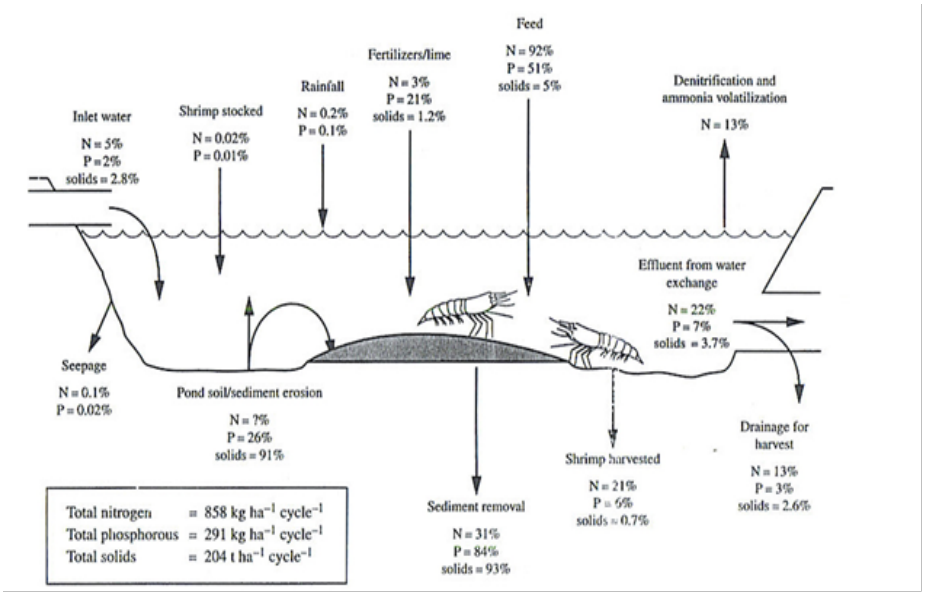


Figure 22: The sources and sinks of nitrogen (N), phosphorus (P) and solids in intensive shrimp ponds. Numbers refer to the total introduced or exported percentages from the pond, as indicated by the direction of the arrow. (Source: Briggs and Funge-Smith, 1994; cited in Midden and Redding, 1998; page 37).

10.3 ENVIRONMENTAL MANAGEMENT FOR AQUACULTURE

For aquaculture, it is possible to consider environmental management by the application of administrative and technical measures/tools.

10.3.1 Administrative measures/tools

An ecosystem approach to aquaculture (EAA) and aquaculture planning

It is now widely recognized that further aquaculture development should be a planned activity that is designed in a more responsible manner so as to minimize negative social and environmental impacts as much as possible. As indicated by José et al. (2017), one essential step is appropriate spatial planning at the local, regional and national levels, and accounting for transboundary issues where these are relevant. Although many of the social and environmental concerns surrounding the impacts derived from aquaculture may be addressed at the individual farm level, most impacts are cumulative. Impacts may be insignificant when an individual farm is considered, but potentially highly significant when multiple farms are located in the same area, or when the entire sector is taken as a whole. The process and steps through which aquaculture is spatially planned and managed, and integrated into the local economy and ecological

context is termed the ecosystem approach to aquaculture (EAA).

Three principles govern the implementation of the EAA: (i) Aquaculture should be developed in the context of ecosystem functions and services (including biodiversity conservation) with no degradation of these beyond their resilience. (ii) Aquaculture should improve human well-being with equity for all relevant stakeholders (e.g. access rights and fair share of incomes). (iii) Aquaculture should be developed in the context of other sectors, policies and goals, as appropriate.

The EAA provides a planning and management framework to effectively integrate aquaculture into local planning, and give clear mechanisms for engaging with producers and the government for the effective sustainable management of aquaculture operations by taking into account local and national, social, economic, environmental and governance objectives.

The process of spatial planning usually consists of the following three steps:

i. Aquaculture zoning: which brings together the criteria for locating aquaculture and other activities in order to define broad zones suitable for different activities or mixes of activities.

ii. Site selection: which identifies the most appropriate locations for individual farm development within zones.

iii. Aquaculture management areas (AMAs): within zones, AMAs contain a number of individual farms that share a common water supply and/or are in such proximity that disease and water quality are best managed collectively rather than by individual farms.

According to José et al. (2017), the process and recommended steps for implementation of aquaculture spatial planning and management require further works that are summarised in the Figure 23 below.

Environmental Impact Assessment (EIA) and monitoring in aquaculture

Nowadays, EIA and monitoring are applied in many countries in Africa, Asia-Pacific, Europe, North and Latin America, as a legal requirement for any new aquaculture development (FAO, 2009). However, the full EIA is not applied to the bulk of global aquaculture production. This is because most aquaculture production is small-scale, and in many cases is a traditional activity. Therefore, EIA is considered as just one tool for the environmental management of aquaculture, which needs to be adapted according to circumstances.

Characteristics	*Scoping*	*Zoning*	*Site selection*	*Area management*
Main purpose	Plan strategically for development and management	Regulate development; minimise conflicts; reduce risks; maximise complementary uses of land and water	Reduce risk; optimize production	Protect environment; reduce disease risk; reduce conflict
Spatial scale	***Global to national***	***Subnational***	***Farm or farm clusters***	***Farm clusters***
Executing entity	Organizations operating globally; national aquaculture department	National and local goven-ments with aquaculture responsibilities	Commercial entities	Farmer associations; regulating agencies
Data needs	***Basic, relating to technical and economic feasibility; growth and other uses***	***Basic environment, social and economic sets***	***All available data***	***Data for carrying capacity and disease risk models***
Required resolution	Low	Moderate	High	High
Result obtained	***Broad indicative***	***Directed, moderately detailed***	***Specific, fully detailed***	***Mderately to fully detailed***

Figure 23: Main characteristics of the process for scoping, zoning, site selection and area management for aquaculture.

According to FAO (2009), EIA practice varies significantly, although it usually follows standard national and international guidelines. The first stage is usually screening to determine if EIA, or what level of EIA, is required. Most countries apply thresholds which may include area, production volume, intensity, technology or species. In some cases, EIA is triggered by specific characteristics, such as the introduction of alien species.

In reality, an EIA will have a major influence on the feasibility study, where different operational procedures will be evaluated for their environmental impacts (Midden and Redding, 1998). As a first step in the procedure, to define the scope of the EIA, a list should be compiled of all possible impacts from the proposed development, using past experience of similar aquaculture operations. The contents of the list should be assessed, using a scoring method where appropriate, so as to identify those impacts that are likely to be of significant environment concern. The EIA should be focused on these factors. Table 12 illustrates that adverse environmental impact is not confined to the aquatic environment, but in the case of aquaculture the most severe impacts are likely to be related to the release of pollutants into the aquatic environment as a result of the farming operation.

Table 12 - Defining the scope of an EIA for a new intensive fish farm (Source: Midden and Redding, 1998; page 71).

Category of impact	Source of impact	Severity (score)
Eutrophication of river	Nutrient discharge	
Oxygen depletion in river	Fish respiration/effluent BOD	
Reduced flow in river	Abstraction	
Alteration of benthic substrate	Sediment of solids	
Prevention of migration movements	Abstraction weir	
Destruction of wetland/mangrove (high wildlife value, users conflicts)	Pond/site construction	
Disturbance of wildlife	Construction activities	
Visual pollution (scenic area)	Predator nets/buildings	
Alteration of wild fish populations	Competition between escapees and wild fish, genetic interaction, pathogen transfer	
Hydrocarbon contamination of soil and water	Diesel oil spillage	
Alteration of microbial and invertebrate populations	Use of antibiotics and other chemicals	
Noise pollution	Blowers/pumps/vehicles	

Once the scope has been defined, baseline studies can be conducted to gather the range of information needed to make the assessment.

Together with the EIA, as indicated by FAO (2009), monitoring may apply to:

- the practical implementation of conditions or plans arising from an EIA;
- the state of the environment in the vicinity of a farm, which has been subject to EIA (by the farmer or the authorities); and
- the state of the environment more widely, which may be influenced by one or many farms and other activities.

The above mentioned items mean that monitoring is the priority for effective environmental management of aquaculture. Without monitoring we have little understanding of the key environmental issues relevant for a given location, or knowledge of the effectiveness of any management interventions, including EIA (FAO, 2009).

In fact, the specific monitoring and assessment approach employed in any given situation will be determined by a variety of factors including, but not limited to, culture species, biomass, location, type of feed and chemicals used and available technology. In establishing any environmental monitoring /assessment program, it is an essential prerequisite that the objectives are clearly defined and that these specify (i) why the assessment is being conducted, (ii) the boundaries (spatial/temporal/ecological) of the assessment, (iii) the level of accuracy required and (iv) the expected outputs/outcomes from the assessment. Unfortunately these requirements are often overlooked with assessments being undertaken for a particular purpose that is not representative of all environmental issues, or monitoring programs are designed that are manifestly insufficient for their purpose (Crawford and MacLeod, 2009).

According to Crawford and MacLeod (2009), the monitoring program including baseline assessment will generally include several indicators of water quality and ecological condition. Invariably, no one environmental variable will provide sufficient information on the health of the environment around the aquaculture operation and a combination of variables is required; the selection of which will be dependent upon economic, social and ecological imperatives. The environmental variables to be measured should be SMART (specific, measurable, achievable, relevant and time-bound).

The adoption of the EIA and monitoring legislation in many countries and their application to some forms of aquaculture has undoubtedly raised awareness of the environmental issues associated with aquaculture, and this in itself is likely to lead to better environmental management. However, many weaknesses were identified by FAO (2009) such as difficulty of addressing the cumulative impacts of many small-scale developments through conventional EIA; lack of environmental objectives and standards, especially suited to the local context, against which to assess impacts and design mitigation; limited participation or engagement of key stakeholders, or where this does take place, poor management and inadequate conflict resolution; or lack of effective monitoring, analysis and feedback into sector management, as well as into management of individual farms, or groups/clusters of farms; etc.. According to FAO (2009), these are all indicative of a tendency for governments and regulatory

authorities to focus on particular techniques (such as EIA) rather than on an adaptive management system for the sector. It is important that such a system be "nested" with elements at national level, at water catchment level, and at farm level.

Furthermore, it is noted that other tools could be applied for the environmental management of aquaculture, such as regulation and codes of practice.

10.4 TECHNOLOGIES

According to Crawford and MacLeod (2009), impacts of aquaculture on the environment can be reduced by careful site selection, to provide the appropriate conditions for the species being cultured, and good farm management. In addition, some measures that could be applied to minimise wastes in order to reduce the pollution loading from aquaculture operation include farm design, cage site rotation, operation management (including feed storage and handling), or sedimentation pond use, application of biological treatment systems (such as biofilter and wetland treatment systems), etc (Midden and Redding, 1998). Furthermore, new technologies are assisting in minimising these environmental impacts.

In general, at the farm level, the most important issue is to treat outlet waste at any form produced from aquaculture production. This section focuses on two technologies that could apply for farm production. These are Recirculation (Recirculating) Aquaculture System (RAS) and Biofloc technology.

Recirculating Aquaculture Systems (RAS) are operated as outdoor or indoor systems (Rijn, 2013). Due to the intensive mode of aquaculture production in many of these systems, waste treatment within the recirculating loop as well as in the effluents of these systems is of primary concern. According to Bregnballe (2015), although primarily used in fish farming, nowadays, recirculation aquaculture becomes essentially a technology for the culture of aquatic organisms by reusing the water in the production. This technology is based on the use of mechanical and biological filters, and the method can in principle be used for any species grown in aquaculture such as fish, shrimps, clams, etc.. According to Rijn (2013), in outdoor RAS, waste treatment is often achieved within the recirculating loop. In these systems, extractive organisms, such as phototrophic organisms and detritivores, are cultured in relatively large treatment compartments whereby a considerable part of the waste produced by the primary organisms is converted into biomass. In indoor systems, capture of solid waste and conversion of ammonia to nitrate by nitrification are usually the main treatment steps within the recirculating loop. Waste reduction (as opposed to capture and conversion) is accomplished in some freshwater and marine indoor RAS by incorporation of denitrification and

sludge digestion. In many RAS, whether operated as indoor or outdoor systems, effluent is treated before final discharge.

According to Browdy et al. (2009), in aquaculture practice, reduction or elimination of water exchange was shown to have many advantages. It improves stability of pond microbial communities reducing problems with algal blooms and crashes which have complicated management strategies based on pumping and flushing. It reduces problems with self-pollution resulting from eutrophication of receiving waters.

In reality, recirculation can be carried out at different intensities depending on how much water is recirculated or re-used. As indicated by Bregnballe (2015), from the environmental point of view, the limited amount of water used in recirculation is of course beneficial as water has become a limited resource in many regions. Also, the limited use of water makes it much easier and cheaper to remove the nutrients excreted from culture organisms as the volume of discharged water is much lower than that discharged from a traditional farm. Recirculation aquaculture can therefore be considered a most environmentally friendly way of aquaculture performance at a commercially viable level. Besides, the limited use of water gives a huge benefit to aquaculture production. Instead of traditional farming systems that totally depend on external conditions such as the temperature of supply water, cleanliness of the water, oxygen levels, etc.; the application of a recirculated system will eliminate either completely or partly, depending on the degree of recirculation and the construction of the farm. Therefore, recirculation enables aquaculture farmers to completely control all the parameters in the production. For that reason, the skills of the farmers to operate the recirculation system itself becomes just as important as their ability to take care of cultured organisms.

Most RAS will have an overflow of process water for balancing the water going in and out of the system. This water is the same water as the culture organisms are swimming in, and is as such not a pollutant unless the discharged amount of water from the overflow is excessive and the yearly discharge through this point escalates (Bregnballe, 2015). The more intensive the rate of recirculation, the less water will be discharged through the overflow.

As mentioned above, it is noted that aquaculture production in a recirculation system, where the water is constantly reused, does not make the waste from aquaculture production disappear. According to Bregnballe (2015), the biological processes within the RAS , at a smaller scale, reduce the amount of organic compounds, because of simple biological degradation or mineralisation within the system. But, a significant load of organic sludge from the RAS will still

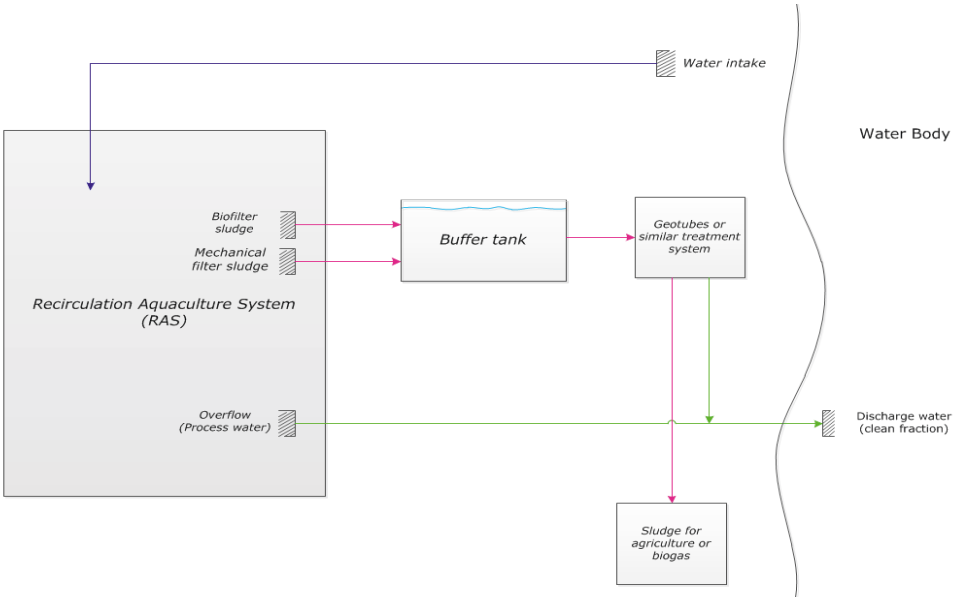


Figure 24: Sketch of flows to and from a recirculation aquaculture system (Source: Bregnballe, 2015; page 71)

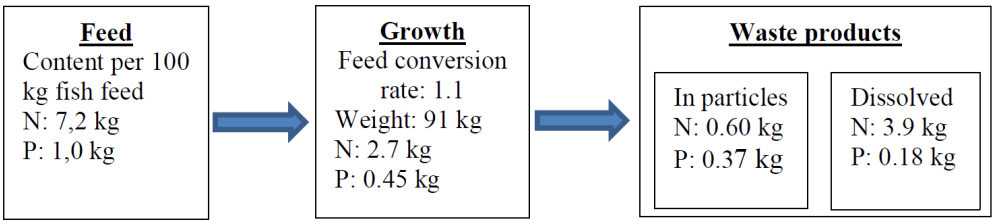


Figure 25: Excretion of nitrogen (N) and phosphorus (P) from farmed fish. (Source: Biomas and the Environmental Protection Agency, Denmark; cited from Bregnballe, 2015; page 71)

have to be dealt with (Figure 24).

The wastewater leaving the recirculation process typically comes from the mechanical filter, where faeces and other organic matter is separated into the sludge outlet of the filter. Cleaning and flushing biofilters also adds to the total waste water volume from the recirculation cycle (Figure 25).

Treating the waste water leaving the RAS can be accomplished in different ways. Quite often a buffer tank is installed prior to the sludge treatment system where sludge is separated from the discharge water. Sludge will go to an accumulation facility for sedimentation, or further mechanical dewatering, before it is spread on land, typically as fertilizer and soil

improvement on agricultural farms, or it can be used in biogas production for generating heat or electricity. Mechanical dewatering also makes the sludge easier to handle and minimises the volume whereby disposal or possible fees becomes cheaper.

The cleaned waste water from the sludge treatment will usually have a high concentration of nitrogen, whereas the phosphorus can be almost removed completely in the sludge treatment process. This discharge water is called reject water, and is most often discharged to the surroundings, river, sea, etc.; together with the overflow water from the RAS. The content of nutrients in the reject water and in the overflow water can be removed by directing it to a plant lagoon, root zone or seepage system, where remaining phosphorus and nitrogenous compounds can be further reduced (Rijn, 2013; Bregnballe, 2015).

Biofloc technology offers a solution to the challenge of outlet waste treatment that includes avoiding the environmental impact of high nutrient discharges and reducing the use of artificial feed (Ekasari et al., 2010). According to Schryver et al. (2008), in BFT systems, a co-culture of heterotrophic bacteria and algae is grown in flocs under controlled conditions within the culture systems. The system is based on the knowledge of conventional domestic wastewater treatment systems and is applied in aquaculture environments. Microbial biomass is grown on excreta of culture organisms resulting in removal of these unwanted components from the water.

Nowadays, this technology is commonly applied in many countries such as Australia, Indonesia, Vietnam, Thailand, United States of America, etc.. In regard to the environmental aspect, one of the key components of BFT is development and management of biofloc communities to support the system water quality (Browdy et al., 2009). According to Schryver et al. (2008), BFT combines the removal of nutrients from the water with the production of microbial biomass, which can be used by the culture species in situ as an additional food source. Taw (2010) supposed that this microbial protein has a higher availability than feed protein. Biofloc technology could be applied for both indoor aquaculture systems (Azim and Little, 2008) and outdoor ones (Taw, 2010). In fact, biofloc technology has become a popular technology in the farming of Pacific white shrimp, Litopenaeus vannamei. According to Taw (2010), biofloc technology provides high productivity, low feed-conversion ratios and a stable culture environment. Also, with viral problems and rising costs for energy, biofloc technology can help deliver sustainable production at lower cost (Figure 26). The basic requirements for the biofloc system operation include high stocking density, high aeration and lined ponds. Pelleted grain and molasses are added to the culture water.

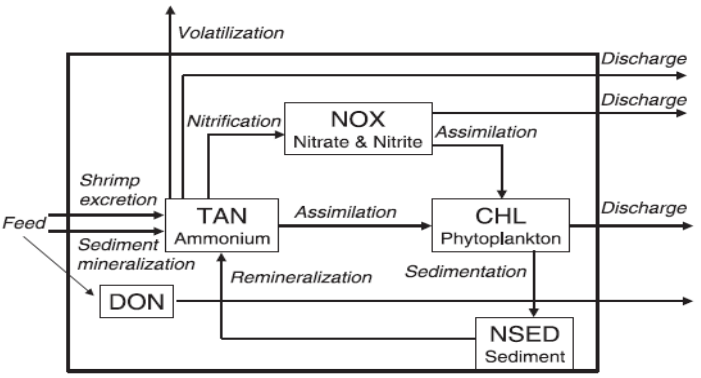


Figure 26: Conceptual model of N input, transformation and removal in intensive shrimp ponds. Arrows represent pathways and boxes indicate the key N components represented as state variables in the model: TAN=total ammonia N; NOX=nitrate plus nitrite; CHL=chlorophyll a as a measure of phytoplankton, and hence particulate N biomass; DON=dissolved organic N; and NSED=N buried in the sludge. (Source: Burforda and Lorenzen, 2004)

According to Ekasari et al. (2010), in BFT, excess of nutrients in aquaculture systems are converted into microbial biomass, which can be consumed by the cultured animals as a food source. Therefore, understanding the basics of bioflocculation is essential for optimal practice (Schryver et al., 2008). According to Taw (2010), biofloc is defined as macroaggregates composed of diatoms, macroalgae, faecal pellets, exoskeleton, remains of dead organisms, bacteria and invertebrates. Generally biofloc includes an active heterotrophic community and varying levels of photoautotrophic activity (Browdy et al., 2009). According to the authors, the relative mix of bacteria and algae with very high feed inputs into the system is dependent upon intensity of cropping of biofloc particles, resulting light levels and nutrient balances within the system.

Chemoautotrophic nitrifiers colonizing the biofloc particles, and other surfaces, make up a third important component of the community in biofloc systems (Table 13). Nitrification is a significant part of the overall microbial activity serving to control ammonia and nitrite levels in the system once the community becomes established. High levels of nitrification necessitate supplementation or regeneration of system alkalinity. The relative balance between these community components may vary depending upon different philosophies regarding inputs, solids removal and management protocols. The major driving force is the intensive growth of

Table 13 - Overview of the main operational parameters for bio-flocs technology based aquaculture, the floc parameters they influence and how these can be manipulated (Source: Schryver et al., 2008.)

Parameter	Floc parameters influenced	Manipulation possibilities	Related to
Mixing intensity/shear rate	– Floc structure and final floc size	– Choice of power input (W m^{-3})	– Dissolved oxygen
		– Aeration device	
Organic carbon source (e.g. glucose, acetate, starch, glycerol)	– Chemical floc composition (fatty acids, lipids, protein, polyhydroxyalkanoates)	– Type of organic carbon source	– Organic loading rate – Dissolved oxygen
Organic loading rate	– Microbial floc composition (filamentous vs. floc forming bacteria)	– Feeding strategy (continuous feeding or regular interval feeding)	– Dissolved oxygen
	– Chemical floc composition (cellular reserves like polyhydroxyalkanoates)		
Dissolved oxygen (DO)	– Microbial floc composition (filamentous vs. floc forming bacteria)	– Choice of power input (W m^{-3})	– Mixing intensity
	– Floc structure and floc volume index	– Aeration device	– Organic carbon source
		– Floc production in the pond vs. floc production in external unit	– Organic loading rate
Temperature	– Floc structure and activity	– Addition of heat	– Dissolved oxygen
pH/Ionics	– Stability of the flocs	– Addition of acid/base; mono- or polyvalent ion	– Alkalinity – Conductivity

heterotrophic bacteria (Avnimelech, 1999) which consume organic carbon; and depending on the bacterial C/N-ratio, thereby immobilize mineral nitrogen.

Schryver et al. (2008) reveal that cells in the flocs can profit from advective flow and as a result, exhibit faster substrate uptake than the planktonic cells. Other factors such as dissolved oxygen concentration, choice of organic carbon source and organic loading rate also influence the floc growth. These are all strongly interrelated.

ASSESSMENT QUESTIONS / DISSCUSSION

WHAT FACTORS DO THE ENVIRONMENTAL EFFECTS OF AQUACULTURE DEPEND ON?
HOW CAN THE IMPACT AND EXTENT OF AQUACULTURE ON THE ENVIRONMENT BE DETERMINED?
WHAT IS THE ROLE OF WATER BODIES RELATING TO O WATER POLLUTION IN GENERAL?
HOW CAN (WE) CLASSIFY POLLUTANTS IN ORDER TO PREDICT THEIR EFFECT ON WATER QUALITY AND THE MEANS OF THEIR REMOVAL?
HOW CAN (WE) ASSESS THE WATER QUALITY? OR, WHAT CAN IT BE BASED ON AS A PROXY FOR WATER QUALITY?
WHAT IS THE MOST SIGNIFICANT EFFECT OF AQUACULTURE WASTE?
WHAT FORMS OF WASTE ARE OFTEN CONTAINED IN THE DISCHARGE WATER FROM AN INTENSIVE AQUACULTURE SYSTEM?
WHY IS IT IMPORTANT TO PAY ATTENTION TO DISSOLVED NUTRIENTS IN THE ENVIRONMENTAL IMPACT OF AQUACULTURE?
WHAT STEPS ARE INCLUDED IN THE PROCESS OF SPATIAL PLANNING FOR AQUACULTURE?
WHY ARE AQUACULTURE ENVIRONMENTAL IMPACTS POTENTIALLY HIGHLY SIGNIFICANT WHEN MULTIPLE FARMS ARE LOCATED IN THE SAME AREA OR THE ENTIRE SECTOR IS TAKEN AS A WHOLE?
WHY SHOULD WE CONSIDER AQUACULTURE DEVELOPMENT BASED ON THE ECOSYSTEM APPROACH?
WHAT FURTHER WORKS ARE REQUIRED FOR AQUACULTURE SPATIAL PLANNING AND MANAGEMENT?
WHY SHOULD A MONITORING PROGRAMME FOR AQUACULTURE BE UNDERTAKEN?

ASSESSMENT QUESTIONS / DISSCUSSION

WHICH THRESHOLDS (SUCH AS AREA, PRODUCTION VOLUME, INTENSITY, TECHNOLOGY OR SPECIES) USUALLY APPLY FOR AN EIA OF AQUACULTURE?
WHAT SHOULD BE COMPLETED AS THE FIRST STEP OF AN EIA FOR AQUACULTURE?
WHY IS APPROPRIATE SPATIAL PLANNING CONSIDERED AS ONE ESSENTIAL STEP FOR AQUACULTURE DEVELOPMENT?
WHY IS AN EIA CONSIDERED AS JUST ONE TOOL FOR THE ENVIRONMENTAL MANAGEMENT ADAPTED ACCORDING TO CIRCUMSTANCES FOR AQUACULTURE?
WHAT SHOULD BE INCLUDED IN THE AQUACULTURE MONITORING PROGRAM?
WHAT ARE THE BENEFITS OF RAS FOR AQUACULTURE?
WHAT ARE THE MAIN COMPONENTS OF RAS?
HOW CAN RAS REDUCE THE WASTE COMPOSITION OF AQUACULTURE PRODUCTION?
WHAT SHOULD BE PAID ATTENTION TO FOR RAS FOR EFFECTIVE ENVIRONMENTAL MANAGEMENT?
WHAT ARE THE GENERAL BENEFITS OF BFT FOR AQUACULTURE?
WHAT ARE THE MAIN COMPONENTS OF THE BFT AQUACULTURE SYSTEM?
WHAT ARE THE MAIN PROCESSES OF BFT?
WHAT SHOULD BE PAID ATTENTION TO IN ORDER TO MAINTAIN BFT OPERATION?
HOW CAN BFT REDUCE THE WASTE COMPOSITION OF AQUACULTURE PRODUCTION IN GENERAL?
WHAT SHOULD BE PAID ATTENTION TO IN ORDER TO MAINTAIN BFT OPERATION?

11. REFERENCES AND ADDITIONAL READING

Alley Robert E.; 2007. Water quality control Handbook (Second Edition). Mc Graw Hill

AU-IBAR; 2019. Guidelines to support the implementation of Africa's regional frameworks on environmental management for sustainable aquaculture development. AU-IBAR, Kenya, 32 p.

Avnimelech Yoram; 1999. Carbon nitrogen ratio as a control element in aquaculture systems. Aquaculture 176, Pages 227–235.

Azim M.E., Little D.C.; 2008. The bio-floc technology (BFT) in indoor tanks: Water quality, bio-floc composition, and growth and welfare of Nile tilapia (Oreochromis niloticus). Aquaculture 283, Pages 29–35.

Barg, U.C.; 1992. Guidelines for the promotion of environmental management of coastal aquaculture development (based on a review of selected experiences and concepts). FAO Fisheries Technical Paper. No. 328. Rome, FAO. 122 p.

BMU.; 2013. Alle Gesetze und Verordnungen aus dem Geschäftsbereich des Bundesumweltministeriums. BMU.de. [Online] 20. 08 2013. [Zitat vom: 15. 09 2013.] - http://www.bmu.de/themen/strategien-bilanzen-gesetze/gesetze-verordnungen/alle-gesetze-und-verordnungen-aus-dem-bmu-geschaeftsbereich/.

Boyd, C. E., D'Abramo, L. R., Glencross, B. D., Huyben, D. C., Juarez, L. M., Lockwood, G. S., McNevin, A. A., Tacon, A. G. J., Teletchea, F., Tomasso Jr., J. R., Tucker, C S Valenti, W. C.; 2020. Achieving sustainable aquaculture: Historical and current perspectives and future needs and challenges. *Journal of the World Aquaculture Society*, 51:578–633.

Bregnballe Jacob; 2015. A Guide to Recirculation Aquaculture - An introduction to the new environmentally friendly and highly productive closed fish farming systems. FAO and EUROFISH.

Browdy J. A., Venero A. D., Stokes and Leffler J.; 2009. Super intensive bio-floc production technologies for marine shrimp Litopenaeus

vannamei: technical challenges and opportunities. In Gavin Burnell and Geoff Allan (Eds), new technologies in aquaculture – Improving production efficiency, quality and environmental management. CRC press.

Bruntland Commission; 1987. *Our Common Future* Ed: Hauf, V. Oxford University Press

Burforda M.A., Lorenzen K.; 2004. Modelling nitrogen dynamics in intensive shrimp ponds: the role of sediment remineralisation. Aquaculture 229, Pages 129–145

Crawford C. and MacLeod C.; 2009; Predicting and assessing the environmental impact of aquaculture. In: Gavin Burnell and Geoff Allan (Eds), new technologies in aquaculture – Improving production efficiency, quality and environmental management. CRC press.

Cripps Simon J. and Bergheim Asbjørn; 2000. Solids management and removal for intensive land-based aquaculture production systems. Aquacultural Engineering, Volume 22, Issues 1–2, Pages 33-56.

Diekmann, Andreas und Preisendörfer Peter; 1992. Persönliches Umweltverhalten. Diskrepanzen zwischen Anspruch und Wirklichkeit. Kölner Zeitschrift für Soziologie und Sozialpsychologie. Bd. 44, Pages 226-251.

Ekasari Julie, Crab Roselien, Verstraete Willy; 2010. Primary Nutritional Content of Bio-Flocs Cultured with Different Organic Carbon Sources and Salinity. HAYATI Journal of Biosciences, Vol. 17 No. 3, Pages 125-130.

EPA (US Environmental Protection Agency); 2001. Environmental Management System (EMS) - Template for the Metal Casting Industry. Washington: US Environmental Protection Agency.

—. 1999. Environmental Management Systems - Process Mapping Approach. *US Environmental Protection Agency.* [Online] 1999. [Zitat vom: 10. 09 2013.] http://www.epa.gov/dfe/pubs/ie ms/tools/process.pdf.

—. 1999. *Environmental Management Systems: A Design for the Environment Approach.* Washington : US

Environmental Protection Agency, 1999.

EPA (US Environmental Protection Agency). 2000. *Integrated Environmental Management Systems, An Implementation Guide.* Washington : US Environmental Protection Agency, 2000.

Erceg Aleksandar; 2017. Why are Companies Implementing ISO 14001 – Example from Croatia, Proceedings of the 7th International symposium on environmental management and material flow management, Technical Faculty in Bor, University of Belgrade, 2017, Pages 22-32. (ISSN 978-86-6305-071-6)

EU - DAS EUROPÄISCHE PARLAMENT UND DER RAT DER EUROPÄISCHEN UNION; 2009. Verordnung (EG) Nr. 1221/2009 des Europäischen Parlaments und des Rates vom 25. November 2009 über die freiwillige Teilnahme von Organisationen an einem Gemeinschaftssystem für Umweltmanagement und Umweltbetriebsprüfung und zur Aufhebung der Verordnung (E. Amtsblatt Nr. L 342 vom 22/12/2009 S. 0001 - 0045. Brüssel: s.n.

FAO; 2009. Environmental impact assessment and monitoring in aquaculture - Requirements, practices, effectiveness and improvements. Fisheries and Aquaculture Techical Papers 527.

—; 2018. The state of world fisheries and aquaculture: Meeting the sustainable development goals. Food and Agriculture Organization of the United Nations, Rome, 210p.

—; 2020. The state of world fisheries and aquaculture: Sustainability in action, Food and Agriculture Organization of the United Nations, Rome, 206p. https://doi.org/10.4060/ca9229en

—; 2020a. Vietnam National Aquaculture Legislation Overview. FAO Vietnam country profile.

Firma Roth Werke GmbH; 2010. Umwelterklärung der Firma Roth Werke GmbH. EMAS = Eco-Management and Audit Scheme / EMAS.de. [Online] 2010. [Zitat vom: 15. 10 2013.] - http://www.emas.de/fileadmin/u

ser_upload/umwelterklaerungen/2010/DE-117-000026_Roth-Werke-GmbH_2010.pdf.

Gewerblich Industrielle Berufsfachschule Thun; 2013. Gewerblich Industrielle Berufsfachschule Thun. Q2E. [Online] 2013. [Zitat vom: 30. 11 2013.] - http://www.gibthun.ch/index.php?page=298, Stand 01.12.2013.

ISO, Technical Committee; 2004. Environmental management systems- Requirements with guidance for use. Second Edition.

ISO - International Standard Organisation; 2009. Norm DIN EN ISO 14001:2009-11 (D/E). Umweltmanagementsysteme - Anforderungen mit Anleitung zur Anwendung. s.l.: Beuth.

ISO (International Standard Organisation); 2011. Norm DIN EN ISO 19011:2011-12. Leitfaden zur Auditierung von Managementsystemen. s.l.: Beuth.

José Aguilar-Manjarrez, Soto Doris and Brummett Randall (Eds.); 2017. Aquaculture zoning, site selection and area management under the ecosystem approach to aquaculture - A handbook. FAO/The World bank.

Kutty, M N; 1995. Aquaculture development and sustainability in

Southeast Asia. In: T.U. Bagarinao & E.E.C. Flores (eds.) Towards

Sustainable Aquaculture in Southeast Asia and Japan. (pp. 91-108). Iloilo,

Philippines: SEAFDEC Aquaculture Department.

Midden Alex and Redding Theresa A.; 1998. Environmental management for Aquaculture. Kluwer Academic Publishers.

Parker Rick; 2012. Aquaculture Science (Third edition). Delmar Cengage Learning.

Peglau, Reinhard; 2007. Worldwide number of ISO14001. Corporate Risk Management (former ISO World). [Online] 2007. [Zitat vom: 30. 11 2013.] - http://www.ecology.or.jp/isoworld/english/analy14k.htm.

Pillay T.V.R; 2004. Aquaculture and the Environment (Second Edition). Blackwell Publishing.

Rijn Jaap Van; 2013. Waste treatment in recirculating aquaculture systems. Aquacultural

Engineering, Volume 53, Pages 49-56.

Roos-Rohrer Erika, Cathomas Norbert und Fletcher Siomon; 1998. Guide to Environmental Legal Compliance as an element of ISO 14001 & EMAS. 3rd Ed. Hamburg: Internatonal Network for Environmental Management.

Salin, K.R. and Ataguba, G.A.; 2018. Aquaculture and environment: toward sustainability. In Sustainable Aquaculture Edited by Hai, F.I., Visvanathan, C. and Boopathy, R.. Springer International Publisher, p 1-62.

Schryver P. De, Crab R., Defoirdt T., Boon N., Verstraete W.; 2008. The basics of bio-flocs technology: The added value for aquaculture. Aquaculture 277, Pages 125 – 137.

Serpa, D. and Duarte, P.; 2008. Impacts of aquaculture and mitigation measures in Aquculture I: Dynamic Biochemistry, Process Biotechnology and Molecular Biology edited by Russo, R., Global Science Books

Soto D., White P., Dempster T., De Silva S., Flores A., Karakassis Y., Knapp G., Martinez J., Miao W., Sadovy Y., Thorstad E. and Wiefels R.;2012. Addressing aquacul-ture-fisheries interactions through the implementation of the ecosystem approach to aquaculture (EAA). In R.P. Subasinghe, J.R. Arthur, D.M. Bartley, S.S. De Silva, M. Halwart, N. Hishamunda, C.V. Mohan & P. Sorgeloos, eds. Farming the Waters for People and Food. Proceedings of the Global Conference on Aquaculture 2010, Phuket, Thailand. 22–25 September 2010. Pages 385–436. FAO, Rome and NACA, Bangkok.

Stapleton Philip J., Glover Margaret A. and Davis S. Petie; 2001. Environmental Management Systems: An Implementation Guide for Small and Medium-Sized Organizations. 2. Edition. Ann Arbor : NSF International, p. 9.

Starkey, Richard und Andersson, Ingvar; 1998. Environmental Management Tools for SMEs: A Handbook. Kopenhagen : European Environment Agency, 1998. Bd. Environmental Issues Series.

Taw Nyan; 2010. Bio-floc Technology Expanding at White Shrimp

Farms. Global aquaculture advocate, Pages 20 -22.

Tidwell James H. (Eds); 2018. Aquaculture Production Systems. World Aquaculture Society. Wiley – Blackwell.

Tucker Craig S. and Hargreaves John A (Eds.); 2008. Environmental Best Management Practices for Aquaculture. Blackwell Publishing.

Tucker Craig S., J Hargreaves John A., and Boyd Claude E.; 2008. Aquaculture and the Environment in the United States. In: Craig S. Tucker and John A. Hargreaves (Eds), Environmental Best Management Practices for Aquaculture. Blackwell Publishing.

UGA –Umweltgutachterausschuss; 2004. Stellungnahme des Umweltgutachterausschusses zur Prüfung der Einhaltung umweltrechtlicher Vorschriften bei EMAS-Teilnehmern unter aufsichtsrechtlichen Aspekten. Berlin: s.n.

UGA – Umweltgutachterausschuss; 2013. Broschüren der Geschäftsstelle und des Umweltgutachterausschusses. Mit EMAS Mehrwert schaffen - Die Unterschiede zwischen EMAS und ISO 14001. [Online] 05 2013. [Zitat vom: 10. 09 2013.] - http://www.emas.de/fileadmin/user_upload/06_service/PDF-Dateien/Mit-EMAS-Mehrwert-schaffen_Vergleich-ISO14001.pdf.

UNEP / ICC / FIDIC; 1996. Environmental Management System-Training Resource Kit. s.l. : UNEP, S. 7.

White, K., O'Niell, B. and Tzankova, Z.; 2004. At a crossroads: will aquaculture fulfill the promise of the blue revolution? SeaWeb 17p.

ZDH-Zert GmbH; 2010. Informationsmaterial. Startseite ZDH-Zert. [Online] 2010. [Zitat vom: 02. 12 2013.] http://www.zdh-zert.de/fileadmin/user_upload/pdf/Checkliste_ISO_14001_E_W_Audit_Rev_5.pdf.

Zell Carina, et al.; 2012. IN 10 SCHRITTEN ZU EMAS - Ein Leitfaden für Umweltmanagementbeauftragte. Berlin: Geschäftsstelle des Umweltgutachterausschusses.

Cao L Wang, W Yang, Y Yang, C Yuan, Z Xiong S and Diana, J; 2007.

Environmental impact of aquaculture and counter measures to aquaculture pollution in China. Environ Sci Pollut Res Int 14(7): 452-62.

12. SOLUTIONS TO SELECTED EXERCISES

EXERCISE 1 / DISCUSSION

DEFINE A DEMING-CYCLE FOR THE FOLLOWING PROCESS: "LEARNING FOR AN EXAMINATION". LIST THAT NEEDS TO BE CONSIDERED IN EVERY PHASE OF THE CYCLE.

PLAN: YOU HAVE TO THINK ABOUT THE FOLLOWING QUESTIONS:

A) WHAT DO I WANT TO ACHIEVE? (JUST PASS OR MAYBE EXCELLENT)
B) WHAT DOES MY TEACHER WANT TO ACHIEVE, HOW WILL HE PREPARE THE EXAM?
C) WHAT DOES MY FAMILY WANT FOR ME AND DO I CARE ABOUT IT?
D) ORAL OR WRITTEN EXAM?

DO: A) READING, SELF-STUDY
B) DOING CALCULATIONS
C) LEARNING AND REHEARSAL WITH FRIENDS
D) ASKING QUESTIONS (TEACHER, FELLOW STUDENTS)

CHECK: FOR CHECKING IT SEEMS EASIER DO DEFINE INDICATORS OF SUCCESS:
A) NUMBER OF ERROR-FREE CALCULATIONS
B) NUMBER OF REHEARSALS WITHOUT STOPS OR ERRORS
C) …….

ACT: REVIEW - DEPENDS ON RESULTS FROM CHECKING

THIS LIST ISN'T COMPLETE, THERE ARE A LOT OF OTHER POINTS, THAT WILL FIT INTO THIS LIST

EXERCISE 2/ DISSCUSSION

BELOW YOU WILL FIND THE DRAFT ENVIRONMENTAL POLICY. CORRECT THE POLICY SO THAT IT MEETS THE REQUIREMENTS OF ISO14001:

ISO 14001 SPEAKS OF THE FOLLOWING THREE OBLIGATIONS THAT MUST BE INCLUDED IN ENVIRONMENTAL POLICY.

- A COMMITMENT TO CONTINUOUS IMPROVEMENT,
- AN OBLIGATION TO AVOID POLLUTION AND
- AN OBLIGATION TO COMPLY WITH APPLICABLE LEGAL OBLIGATIONS AND OTHER REQUIREMENTS TO WHICH THE ORGANIZATION IS COMMITTED AND WHICH RELATE TO ITS ENVIRONMENTAL ASPECTS;

WITH THAT IN MIND, THE ANALYSIS OF THE ENVIRONMENTAL POLICY YIELDS THE YELLOW

HIGHLIGHTED SHORTCOMMINGS.

THE PROTECTION OF THE ENVIRONMENT IS OF PARTICULAR CONCERN TO US. WE STRIVE TO PROTECT OUR ENVIRONMENT AND AVOID HARMFUL EFFECTS.

WHEREVER POSSIBLE, WE REDUCE WASTE, WASTE WATER AND EXHAUST AIR BY CHANGING TECHNICAL PROCESSES.

WE FEEL BOUND TO LEGAL REQUIREMENTS.

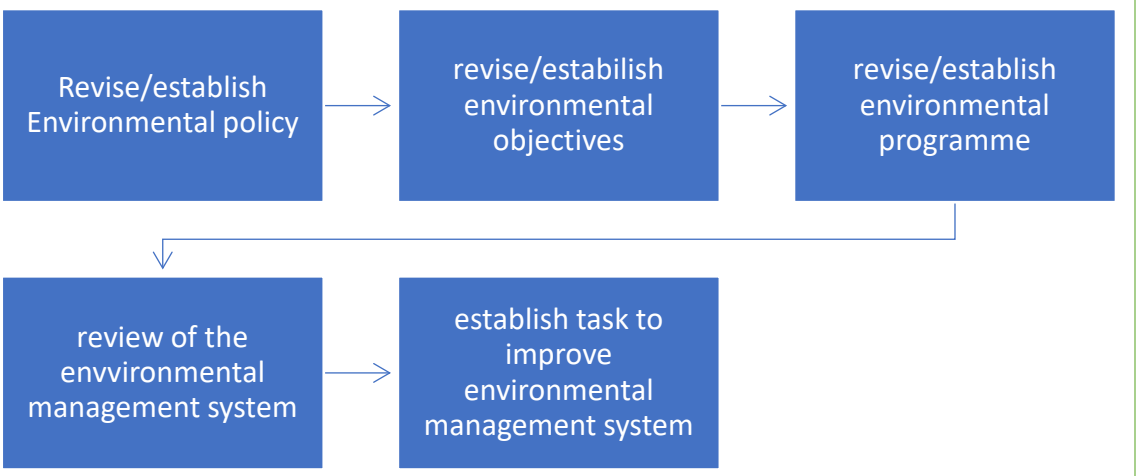
REACTION INSTEAD OF PREVENTION IS OUR IMPERATIVE.

ALL EMPLOYEES OF A-INC. WORK TOWARDS THIS GOAL.

EXERCISE 3/ DISSCUSSION

DEFINE A WORKFLOW FOR THE TOP MANAGEMENT THAT ENSURES THAT THE TOP MANAGEMENT MEETS THE REQUIREMENTS OF ISO14001.

THE FIRST THING WE HAVE TO CONSIDER IS, THAT THE TOP MANAGEMENT WILL MAKE DECISIONS FOR THE ENTERPRISE/COMPANY. THEREFOR THE WORKFLOW WILL CONSIST OF DECISION MAKING SU-PROCESSES. THE SECOND THING TO REMEMBER IS THAT THE WORKFLOW WILL DEFINE A PROCESS THAT WILL BE PERFORMED REGULARLY (I.E. ANNUALLY). THIRDLY WE HAVE TO REMEMBER THE TASKS OF THE TOP MANAGEMENT. THIS COULD LEAD LEADS US TO THE FOLLOWING WORKFLOW. BUT IT IS ONLY ONE OF MANY POSSIBLE SOLUTIONS TO ORGANIZE TH WORK TO BE DONE.



EXERCISE 4/ DISSCUSSION

WHICH ACTIVITIES//EVENTS ARE HIDDEN BEHIND THE CROSSES IN TABLE 2? MAKE A LIST OF POSSIBLE ACTIVITIES FOR EACH ENVIRONMENTAL ASPECT.

Environmental aspect	Receiving Department	
	direct aspect	indirect aspect
Emissions to air	Forklift trucks for unloading and storage	Emissions from delivery vehicles
Energy consumption	lighting, heating, fuel forklifts	
Noise	Forklift trucks	Ddelivery vehicles
Odours	(possible - chemicals)	
Concussions		
Solid and liquid waste	packaging	
Water consumption	washing hands?	
Installations for water protection (storage tanks, substances hazardous to water)	handling of chemicals	
Sewage/wastewater	sanitary sewage?	
Rainwater drainage	At the terminal, possibly contaminated	
Raw material consumption		
Soil/soil protection contamination	Possible if the unloading area is not sealed	
Natural habitats / nature conservation		Influence through noise and light possible (delivery traffic)

EXERCISE 5/ DISSCUSSION

THE FOLLOWING TEXT SHOWS THE ENERGY CONSUMPTION OF A COMPANY. FROM THIS DATA CREATE THE BALANCE SHEET ACCOUNT "5 ENERGY" FOR THE YEARS 2011 AND 2012. COMPARE THE RESULTS. WHAT DO YOU SEE?

Energy consumption [MWh]	2011	2012	Change compared to previous year
Electric current	*5.338,28*	*5.039,99*	*-298,29*
Light heating oil	*438,20*	*380,96*	*-57,24*
Heavy fuel oil	*402,03*	*357,90*	*-44,13*
Natural gas	*3.975,03*	*4.260,88*	*285,85*
Diesel fuel	*40,23*	*80,45*	*40,22*
Petrol	*182,15*	*148,69*	*-33,46*

TO ANALYSE THE DATA MORE CORRECTLY, WE WILL NEED INFORMATION ON THE PRODUCTION OF THE COMPANY. SINCE NO PRODUCTION DATA ARE GIVEN, WE WILL ASSUME THAT THE PRODUCTION MAINTAINED AT A CONSTANT LEVEL.

WITH THIS PREREQUISITE, WE FIND

A) FROM AN ENERGETIC POINT OF VIEW, THE REPLACEMENT OF THE VEHICLES (PETROL-> DIESEL) DID NOT BRING ANY IMPROVEMENT.

B) THE SAME APPLIES TO THE MEASURE (HEATING OIL-> NATURAL GAS)

C) THE MEASURES TO REDUCE ELECTRICITY CONSUMPTION WERE SUCCESSFUL

EXERCISE 6/ DISSCUSSION

OUTLINE STRATEGIES FOR (EXTERNAL) COMMUNICATION WITH:

- RESIDENTS,
- LOCAL CITIZENS' INITIATIVES,
- OTHER INTERESTED PARTIES,
- REGULATORY AND LICENSING AUTHORITIES.

WHICH OTHER GROUPS DO YOU HAVE TO COMMUNICATE WITH?

A) MEASURES GIVEN IN TABLE 10 WILL APPLY

B) CUSTOMERS, SUPPLIERS, SHAREHOLDER, BANKS, ……

EXERCISE 7/ DISSCUSSION

FIGURE 19 SHOWS A PROCESS INSTRUCTION THAT DOES NOT YET CONTAIN ANY PROCESSES FOR ENVIRONMENTAL PROTECTION. FIND 3 WAYS IN WHICH THIS PROCESS INSTRUCTION CAN BE EXPANDED TO ALSO TAKE THE ENVIRONMENTAL ASPECTS OF THIS PROCESS INTO ACCOUNT.

AT FIRST WE HAVE TO LOOK AT THE ENVIRONMENTAL ASPECTS OF THIS PROCESS:

PROCESS STEP 4: WASTE HANDLING (DEFECTIVE PARTS)

PROCEESS STEP 6 AND 8: HANDLING OF OPERATING MEDIA (OIL, HYDRAULIC LIQUIDS, ETC)

PROCESS STEP 11: CAR WASH -> WASTE WATER

AND

PROCESS STEP 3: SELECTION OF QUALIFIED STAFF (DEPENDING ON TASKS)

ADDITIONALLY

PROCESS STEP 9: TEST RUN, IF ENGINE IS RUNNING -> EMISSIONS INTO AIR

FOR THESE ASPECTS WE NEED A SOLUTION. WE CAN REWRITE THE PROCESS COMPLETELY, BUT THAT WON'T MAKE MUCH SENSE, BECAUSE MANY REPAIRS WON'T HAVE ANY OR VERY LOW IMPACT ON THE ENVIRONMENT. THEREFOR IT MAKES MORE SENSE TO USE REFERENCES OR DOCUMENTS INSTEAD.

FOR PROCESS STEP 6 AND 8 A "NEW" PROCESS DESCRIPTION PD 09: "HANDLING OPERATING MEDIA" COULD BE INTRODUCED.

FOR PROCESS STEP 3 WE COULD INTRODUCE A NEW SUPPORTING DOCUMENT "LIST OF WORKERS QUALIFIED TO ENVIRONMENTALLY HANDLE OPERATING MEDIA", WHICH WILL HELP TO AVOID ENVIRONMENTAL IMPACT.

ABOUT THE MAIN AUTHORS

THOMAS POTEMPA

Dr. rer. nat. Dr. h.c. (TU Kaliningrad) Thomas Potempa studied Chemistry at Braunschweig and Albany, NY, USA. Since 1994 he is senior lecturer at the *Institute for Recycling* at Ostfalia (Hochschule Braunschweig/Wolfenbüttel), teaching „Environmental Protection “, „Environmental and Quality Management“ and „Project Management“. From 1998 to 2001 he temporarily worked for a big German steel company as head of the „Environmental Management “sub-department

NGUYEN VAN TRAI

Dr. Nguyen Van Trai completed his BSc. in Fisheries at Nong Lam University-HCMC, Vietnam in 1992, then graduated at AIT Thailand with an MSc. in Aquaculture in 1997. He studied his PhD. in Sustainable Resources Management at the University of Newcastle, Australia and achieved this degree in 2008. He currently works as a senior lecturer at the Faculty of Fisheries, Nong Lam University-HCMC, Vietnam, and teaches Environmental Impact Assessment and Aquatic Ecology.

VU CAM LUONG

Assoc. Prof. Dr. Vu Cam Luong studied Aquaculture and Aquatic Resources Management at the Asian Institute of Technology, Thailand for his MSc (1999) and PhD (2004). Since 1997 he has been a lecturer at Nong Lam University, Ho Chi Minh City, Vietnam, and teaches Fisheries management, Aquatic Resources Management, Fishing technology and Ornamental Fish.

NGUYEN HOANG NAM KHA

Dr. Nguyen Hoang Nam Kha studied Food Science and Technology at Ecole Nationale Superieure des Industries Agricoles et Alimentaires – Section Industries Agro-Alimentaires Regions Chaudes (ENSIA SIARC), Montpellier, France, and achieved his MSc in 2004. He graduated with a PhD. in Applied Biology and Biotechnology from the Royal Melbourne Institute of Technology (RMIT) University, Australia in 2012. He currently works as a lecturer in the Faculty of Fisheries, Nong Lam University-HCMC, Vietnam, and teaches Applied Microbiology and Biotechnology, Quality Assurance and Testing of Aquatic Products and Human Nutrition.

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Education, Audiovisual and Culture Executive Agency

Tuning environmental competencies in Asian fishery education for sustainable development (TUNASIA - EPP 586144-2017)

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