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Environmental Risk Assessment for a Fish Farm. Note II: Fuel Leaks and Waste Generation Risks

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Abstract

The Environmental Risk Assessment for a fisheries development is an essential process for identifying and managing potential negative effects on the environment. It is carried out in several directions, each with its own specific aspects and methodologies. The aim of the study is to develop risk matrices for water quality and chemicals manipulation risks in a fish farm. Effective oversight of operational and maintenance expenses, along with the ability to adapt to evolving approaches in aquatic resource management, are essential in maintaining the sustainability and profitability of fisheries management initiatives. Employing sound management strategies and adopting a proactive stance toward risk mitigation can ensure that investments in fisheries management yield long-term economic gains while fostering the growth of the fisheries sector in a socially and environmentally conscious way.

Keywords: facility, hazard, monitoring, spill.

1. Introduction

There has been increasing discussion recently about the growth of the global population. The world population is expected to increase by 2 billion people, reaching 9.6 billion people by 2050[3].

This poses a serious challenge when it comes to securing food supplies while preserving natural resources for future generations. Fisheries and aquaculture play an important role in eradicating hunger, promoting healthy diets and reducing poverty. Fish are a natural source of protein and essential nutrients, making them an important part of a healthy diet. Aquaculture is the fastest growing food production sector in the world and currently the main source of fish supply. However, environmental sustainability is one of the main challenges facing this sector [1, 7].

The establishment of a fish farm can have various effects on the environment, both positive and negative. If we refer to the positive ones, first of all we are talking about increasing biodiversity. In some cases, fish farms can contribute to increasing biodiversity by introducing and supporting populations of fish and other aquatic organisms. Reducing pressure on natural resources is achieved by the fact that fishing in natural waters can be reduced if there are viable alternatives of fish produced in fish farming [2].

Another positive effect is due to the fact that some fish farms are designed to purify the water by filtering nutrients and sediments. In addition to these effects, there are also negative ones with impact, due to the alteration of habitats by building fishponds affecting local flora and fauna.

Organic and chemical waste from fish farms can pollute surrounding waters, affecting water quality and aquatic life. The spread of diseases and parasites from fish in fish farms to wild populations can be a significant risk. Environmental risk assessment in general is a systematic process by which potential risks that may arise as a result of action on the environment are identified, analyzed and quantified.

This process involves several steps, namely: hazard identification, exposure assessment, risk characterization, risk management [1, 4, 6].Hazard identification is possible by determining factors or activities that could cause environmental damage, such as air, water or soil pollution, destruction of natural habitats, etc.

Exposure assessment is carried out by analyzing the way and extent to which the environment and living organisms are exposed to these risk factors [3, 6].

This may include measuring the concentrations of chemicals in the environment or assessing the frequency and duration of exposure. Risk characterization can result from combining information about hazard and exposure to estimate the probability and severity of adverse effects on the environment. This may involve mathematical and statistical models to predict potential impacts. Risk management is achieved by developing and implementing strategies to minimize or eliminate identified risks. These strategies may include regulations, pollution control technologies, sustainable management practices and other preventive measures. Environmental risk assessment is essential for protecting ecosystems and human health, ensuring that economic development and human activities are carried out in a sustainable and responsible manner [1, 3, 5].

The aim of the study is to develop risk matrices for fuel leaks and waste generation risks in a fish farm.

2. Material and Method

In order to assess the environmental risk for a fish farm, in the present study we proposed to draw up a risk matrix for the aforementioned purpose, using for this purpose the 3 x 3 matrix type. Low risk is characterized by low probability and low impact on the environment. Effective management measures are sufficient to minimize the risk. Moderate risk is characterized by moderate probability and moderate impact on the environment. Additional management measures are required to reduce the risk. High risk is characterized by high probability and significant impact on the environment. Urgent and effective actions are required to manage the risk to reduce the risk [8].

3. Results and Discusions

Fuel leaks from machinery used as a source of risk in a fish farm. Fuel leaks from machinery used in fish farms or from other sources pose a significant threat to the aquatic environment, with the potential to pollute waters and negatively affect aquatic life in several ways. Fuel leaks can originate from vehicles and machinery used in fish farms, including cars, trucks, construction machinery or material handling equipment.

They can occur during refueling, during filling or unloading operations, or because of accidents and technical failures. Spilled fuel can reach surface waters through direct leakage onto the ground, into storm sewers or through infiltration into the soil, subsequently reaching water bodies.

These leaks can be even more problematic in the case of inadequate drainage or sewage systems. Fuels contain toxic chemicals, such as hydrocarbons, that can affect aquatic organisms in various ways. These substances can interfere with the metabolic processes of aquatic organisms, affecting the functioning of internal organs and the nervous system.

They can contaminate water and aquatic sediments, alter water chemistry and directly affect organisms that depend on these environments for feeding and reproduction.

If not managed properly, fuel spills can have long-term effects on the aquatic ecosystem, leading to reduced biodiversity, diminished populations of fish and other aquatic organisms, and damage to natural habitats. The proposed risk matrix is presented in Table 1.

In order to reduce the risk of contamination or pollution of water with residues from fish feeding and their excretions within a fish farm, the following measures are proposed:

- adequate training of personnel and subcontractors on safe practices for handling fuel and associated equipment;
- implementation of a monitoring program to quickly identify and manage any fuel leaks or spills;

- ensuring the use of appropriate personal protective equipment and safe equipment for fuel supply and handling;
- implementation of effective drainage and wastewater management systems to prevent fuel contamination;
- development and implementation of an accident response plan to promptly manage fuel leaks and minimize environmental impact.

Table 1. Risk matrix prepared for potential fuel leaks within a fishing facility

Probability/Impact	Low impact	Moderate impact	High impact
Low probability	Vehicles are well maintained, there are strict protocols for fueling and handling./ Spills are minor and localized; impact on water and fauna/aquatic life is negligible.	Vehicles are well maintained, there are strict protocols for fueling and handling./ Spills that may affect a small area of water and cause temporary disturbances to the aquatic habitat.	Vehicles are well maintained, there are strict protocols for fueling and handling./ Massive spills that can extensively affect aquatic habitat and have serious consequences for fauna and flora.
Moderate probability	There is an increased risk of accidental spills, but vehicles are regularly monitored and maintained./ Spills are minor and localized; impact on water and fauna/aquatic life is negligible.	There is an increased risk of accidental spills, but vehicles are monitored and maintained regularly./ Spills that may affect a small area of water and cause temporary disturbance to aquatic habitat.	There is an increased risk of accidental spills, but vehicles are monitored and maintained periodically./ Massive spills that can extensively affect the aquatic habitat and have serious consequences for fauna and flora.
High probability	Improper fuel management is a common problem; vehicles are old or not properly maintained./ Leaks are minor and localized; impact on water and wildlife/aquatic life is negligible.	Improper fuel management is a common problem; vehicles are old or not properly maintained./ Spills that can affect a small area of water and cause temporary disturbances to aquatic habitat.	Improper fuel management is a common problem; vehicles are old or not properly maintained./ Massive spills that can extensively affect aquatic habitat and have serious consequences for fauna and flora.

Inorganic waste as a source of risk within a fish farm. Improper disposal of waste from activities such as pond cleaning, water treatment and fish feeding in fish farms can generate significant soil and water pollution.

This can have various negative effects on the environment, namely soil pollution, groundwater and surface water pollution.

Waste from activities such as materials used in pond cleaning (such as silt and algae) can be improperly disposed of on the ground near work areas or near water.

These materials may contain excess nutrients (such as nitrates and phosphates) or chemicals that, in contact with the soil, can lead to soil contamination.

Waste disposal can affect soil fertility by changing its chemical and biological balance. Excess nutrients can promote the growth of invasive plants, altering the composition of native vegetation and affecting local biodiversity.

Improperly stored waste can allow chemicals and nutrients to leach into groundwater or surface water during rainfall or through direct infiltration into the soil.

This can lead to eutrophication of water, algae growth and alteration of the ecological balance of the aquatic ecosystem.

Chemicals in waste, such as those used in water treatment or other biocides, can affect water quality, reducing the oxygen available to aquatic organisms and creating favourable conditions for the growth of toxic algae or for the development of water quality degradation conditions.

The above aspects should be taken into account when developing the matrix for inorganic waste as a source of risk in a fish farm (Table 2).

In order to reduce the risk of contamination, respectively of water pollution with residues from fish feeding and their excretions within a fish farm, the following measures are proposed:

- develop and implement a detailed inorganic waste management plan that includes the specific storage area, the types of waste and the specific procedures for their handling and disposal;
- promote waste separation practices to allow the recycling of valuable materials and to reduce the amount of waste that ends up in landfills;
- ensure the use of appropriate personal protective equipment (PPE) and waste handling equipment to prevent accidental spills and minimize the risk of contamination;
- implement a soil and water quality monitoring system to promptly detect and report any pollution incidents and take immediate corrective measures.

Table 2. Risk matrix prepared for inorganic waste within a fish farm

Probability/Impact	Low impact	Moderate impact	High impact
Low probability	There are strict protocols for waste management, trained personnel and adequate equipment for collection and storage./ Waste is managed correctly, with negligible impact on soil and water quality.	There are strict protocols for waste management, trained personnel and appropriate equipment for collection and storage./ There are some waste spills that may locally affect aquatic habitat or soil quality.	There are strict protocols for waste management, trained personnel and adequate equipment for collection and storage./ Improper waste disposal causes significant soil and water pollution, having a severe impact on biodiversity and the aquatic ecosystem.
Moderate probability	There is an increased risk of improper disposal due to human error or non-compliance with protocols./ Waste is managed correctly, with negligible impact on soil and water quality.	There is an increased risk of improper disposal due to human error or non-compliance with protocols./ There are some waste spills that may locally affect aquatic habitat or soil quality.	There is an increased risk of improper disposal due to human error or non-compliance with protocols./ Improper waste disposal causes significant soil and water pollution, having a severe impact on biodiversity and the aquatic ecosystem.
High probability	Waste management is often inadequate, lacking clear protocols or necessary equipment./ Waste is managed correctly, with negligible impact on soil and water quality.	Waste management is often inadequate, lacking clear protocols or necessary equipment./ There are some waste spills that can locally affect aquatic habitat or soil quality.	Waste management is often inadequate, lacking clear protocols or the necessary equipment./ Improper waste disposal causes significant soil and water pollution, having a severe impact on biodiversity and the aquatic ecosystem.

Organic waste as a source of risk in a fish farm. Fish deaths and organic waste from fishing or aquaculture activities can have a significant impact on water quality in fish farms. These aspects can contribute to environmental degradation by increasing nutrient levels, oxygen consumption, increasing disease risk, impacting biodiversity, etc.

Fish deaths and organic waste (such as uneaten food scraps, excrement, dead biological material) are sources of nutrients such as nitrogen and phosphorus in water. These nutrients can trigger the eutrophication process, especially in closed aquatic systems or in waters with a small volume of water, such as fishponds or ponds.

The degradation process of organic waste can lead to the rapid consumption of dissolved oxygen in the water. In the case of a large amount of decomposing organic material, there is a risk of hypoxia or anoxia in the aquatic environment, which can negatively affect the life of fish and other sensitive aquatic organisms.

Decomposing organic material can create a favorable environment for the development of bacteria, viruses and other pathogens. This can increase the risk of disease in fish in the facility,

which may require additional treatments with chemicals or drugs, with potential side effects on water quality.

Pollution with organic waste can change the composition and structure of aquatic communities. In addition to the impact on fish, other aquatic organisms, such as macroinvertebrates and algae, can be negatively affected by increased nutrients and changes in water quality.

In order to draw up a matrix for organic waste as a source of risk in a fish facility (Table 3), the above aspects should be taken into account.

In order to reduce the risk of contamination, respectively of water pollution with residues from fish feeding and their excretions within a fish farm, the following measures are proposed:

- implementation of an adequate organic waste management system, including its regular collection and disposal to prevent excessive accumulation in the aquatic environment

Table 3. Risk matrix prepared for organic waste within a fish farm

Probability/Impact	Low impact	Moderate impact	High impact
Low probability	Effective water quality management and monitoring systems, trained personnel and well-established protocols./ Fish deaths are rare and effectively managed; organic waste is biodegradable and does not significantly affect water quality.	Effective water quality management and monitoring systems, trained personnel and well-established protocols./ There are some fish deaths and impacts on water quality, with possible temporal variations in water parameters.	Effective water quality management and monitoring systems, trained personnel and well-established protocols./ Fish deaths and accumulation of organic waste led to significant deterioration of water quality, affecting biodiversity and the ecosystem.
Moderate probability	There is an increased risk of fish kills and organic waste disposal due to management errors or uncontrolled conditions./ Fish kills are rare and managed effectively; organic waste is biodegradable and does not significantly affect water quality.	There is an increased risk of fish deaths and organic waste disposal due to management errors or uncontrolled conditions./ There are some fish deaths and impacts on water quality, with possible temporal variations in water parameters.	There is an increased risk of fish kills and organic waste disposal due to management errors or uncontrolled conditions./ Fish kills and organic waste accumulation lead to significant deterioration of water quality, affecting biodiversity and the ecosystem.
High probability	High frequency of fish deaths and improper management of organic waste, lack of monitoring and adequate preventive measures./ Fish deaths are rare and effectively managed; organic waste is biodegradable and does not significantly affect water quality.	High frequency of fish deaths and improper management of organic waste, lack of monitoring and adequate preventive measures./ There are some fish deaths and impact on water quality, with possible temporal variations in water parameters.	High frequency of fish deaths and improper management of organic waste, lack of monitoring and adequate preventive measures./ Fish deaths and accumulation of organic waste lead to significant deterioration of water quality, affecting biodiversity and the ecosystem.

- regulating the amount of food offered to fish to minimize uneaten waste and reduce the impact on water quality;
- applying ecological practices in the management of fish ponds and ponds,
- such as the use of aquatic plants to absorb nutrients and reduce eutrophication;
- informing staff and managers of fish facilities about the impact of organic waste and promoting responsible practices to reduce it.

4. Conclusions

Proper management of operational and maintenance costs, as well as adaptation to changes in aquatic resource management, are particularly important for ensuring the sustainability and financial success of fisheries management projects. By applying good management practices and a proactive approach to risk management, investments in fisheries management can provide sustainable economic benefits and contribute to the development of the fisheries sector in a socially and environmentally responsible manner. It is considered that by applying the aforementioned strategies, fisheries management can minimize environmental impacts and contribute to a more sustainable use of aquatic resources, while ensuring efficient and sustainable fisheries production.

References

[1] Soto, S.D., J. Aguilar-Manjarrez, C. Brugère, D. Angel, C. Bailey, K. Black, P. Edwards, B. Costa-Pierce, T. Chopin, S. Deudero, 2008, Applying an ecosystem-based approach to aquaculture: principles, scales and some management measures Build. Ecosyst. Approach Aquacult, 14, 18-25.

[2] Ghid general aplicabil etapelor procedurii de evaluare a impactului asupra mediului, 2020, https://legislatie.just.ro/Public/DetaliiDocumentAfis/224 614

[3] FAO. 2024. Sustainable Development Goals – Indica tor 14.6.1., https://www.fao.org/.

[4] FAO. 2022. Blue Transformation – Roadmap 2022–2030: Avision for FAO's work on aquatic food systems. Rome. https://doi.org/10.4060/cc0459en.

[5] Odagiu A., 2021, Evaluarea riscurilor şi managementul dezastrelor, Editura Bioflux Cluj-Napoca.

[6] https://www.fao.org/publications/home/fao-flagship-publications/the-state-of-world-fisheries-and-aquaculture.

[7] https://openknowledge.fao.org.

[8] https://udnapps.com/ro-ron/resource/ what-is-a-risk-matrix.