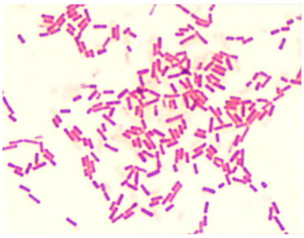
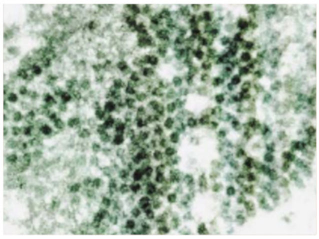
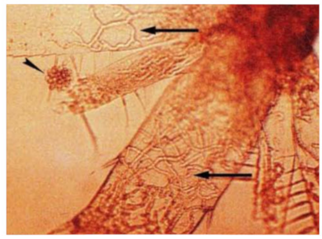


Aquatic Emergency Preparedness and Response Systems for Effective Management of Transboundary Disease Outbreaks in Southeast Asia (AEPRS)

20-22 August 2018
Bangkok, Thailand




Eleonor A. Tendencia
Leobert D. de la Peña
Joesyl Marie V. de la Cruz
Editors

asean
DEPARTMENT OF FISHERIES
ASEAN Network on Aquatic Animal Health Centres
ANAAHC
SEAFDEC
NACA
JAIF
Japan-ASEAN Cooperation

AQUATIC EMERGENCY PREPAREDNESS AND RESPONSE SYSTEMS FOR EFFECTIVE MANAGEMENT OF TRANSBOUNDARY DISEASE OUTBREAKS IN SOUTHEAST ASIA

Proceedings of
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Aquatic Emergency Preparedness and
Response Systems for Effective Management of
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FOREWORD

Aquaculture production has been one of the region's greatest economic strengths; however, this had been affected by the ever-increasing disease occurrences in the industry. Economically important and emerging diseases have affected Southeast Asian economy.

Fish health management, particularly the prevention and control of transboundary aquatic animal diseases, had been included in the region's priority areas for research and policy recommendation. Cognizant of this, SEAFDEC/AQD and the Department of Agriculture's Bureau of Fisheries and Aquatic Resources of the Philippines, with financial support from the Japan-ASEAN Integration Fund (JAIF), convened the *Regional Technical Consultation on EMS/AHPND and other Transboundary Diseases for Improved Aquatic Animal Health in Southeast Asia* last February 2016 in the Philippines. The Consultation assessed the status of EMS/AHPND and other emerging diseases in farmed shrimps in the ASEAN Member States; identified gaps, priority areas for research and development and potential collaborative arrangements; and formulated regional policy recommendations. Among the recommendations are the monitoring and early warning systems; and the development of emergency preparedness and contingency plans as strategies for disease prevention, control, and biosecurity.

This proves that there is always a pressing need for efforts in addressing diseases in aquaculture, especially in Southeast Asia. To address both the need of the region and the recommendation of the aforementioned Consultation, the *ASEAN Regional Technical Consultation on Aquatic Emergency Preparedness and Response Systems for Effective Management of Transboundary Disease Outbreaks in Southeast Asia* was conducted last August 2018 in Thailand. It was organized by the Department of Fisheries - Thailand and SEAFDEC/AQD together with the Network of Aquaculture Centres in Asia-Pacific and was funded by JAIF.

This Consultation successfully brought together representatives of ASEAN Member States (AMSs) and technical experts to assess existing laws and standard operating procedures, assess the need for a regional aquatic EPRS in the ASEAN region, and to enhance cooperation among AMSs and other important organizations. Participants managed to identify the gaps and find possibilities for cooperation as well as discuss possible recommendations on the subject which are included and summarized in this Proceedings.

We hope that this document serves its purpose of providing information and source of knowledge on aquatic animal health and its management in the region.

Dan D. Baliao
Chief, SEAFDEC Aquaculture Department

MESSAGES

While the importance of aquaculture is widely recognized considering its increasing contribution, recently to more than half of the total fisheries production globally, its sustainable development is being severely impeded by the persistent occurrence of aquatic animal diseases in the entire production cycle. During the past decades, several countries in Southeast Asia had encountered production losses from the impacts of aquatic disease outbreaks on their aquaculture endeavors, specifically from shrimps and fish culture. The SEAFDEC Council during its 48th Meeting in 2016 therefore emphasized on the need to mitigate the possible impacts of aquatic animal diseases to the aquaculture industry. Specifically, the SEAFDEC Council recommended that in addition to the technical solutions to overcome such disease problems, strengthening of the cooperation among the Southeast Asian countries is necessary and keeping each other informed when a disease outbreak has occurred in one country which could be facilitated through the establishment of a regional early warning system. Furthermore, the SEAFDEC Council also agreed to mobilize the ASEAN Network of Aquatic Animal Health Centres (ANAAHC) in addressing the aquatic animal disease concerns of the region.

In line with the recommendations of the SEAFDEC Council, the *Regional Technical Consultation on Aquatic Emergency Preparedness and Response Systems for Effective Management of Transboundary Disease Outbreaks in Southeast Asia* was organized through the efforts of the Department of Fisheries-Aquatic Animal Health Research and Development Division (DOF-AAHRDD) in Thailand together with the Network of Aquaculture Centres in Asia-Pacific (NACA), the Southeast Asian Fisheries Development Center/Aquaculture Department (SEAFDEC/AQD) and the Food and Agriculture Organization of the United Nations (FAO). Held in 20-22 August 2018, the Consultation received financial support from the Government of Japan through the Japan-ASEAN Integration Fund.

As an output of such Consultation, this Proceedings compiles the identified common issues of the ASEAN Member States (AMSs) with respect to the emergence and occurrence of aquatic animal diseases during the entire aquaculture production chain, as well as the recommendations on how such concerns could be addressed as way forward. I therefore sincerely encourage the concerned stakeholders of the AMSs to consider the results from this Consultation in the development of their respective future approaches in strengthening the region's emergency preparedness and response systems for effective management of transboundary disease outbreaks. This way, the role of the aquaculture sub-sector as a promising industry, in contributing significantly to the region's food security and economic development, is assured.

Dr. Kom Silapajarn
SEAFDEC Secretary-General

As we are all aware, disease outbreak in aquatic animals is one of the major contributing factors for economical loss in aquaculture industry, particularly the shrimp industry in Southeast Asia. Transboundary movement of aquatic animals could be considered as an important risk for disease transmission across the region and development of effective measures for the movement control is very challenging. Meanwhile, emergency preparedness and response system for the management of transboundary disease outbreaks are necessary.

The *ASEAN Regional Technical Consultation on Aquatic Emergency Preparedness and Response Systems for Effective Management of Transboundary Disease Outbreaks in Southeast Asia* project understands the impact of aquatic animal diseases on aquaculture business and appreciates the importance of planning and development of contingency plans and responses to aquatic animal disease epidemic. The project has brought together ASEAN member states to discuss the current status of aquatic animal diseases, disease preparedness and response systems as well as to provide opportunities for further cooperation in management of transboundary diseases amongst member states. In addition, this project has also gathered a number of key stakeholders in the aquaculture industry including private and government sectors such as shrimp and fish farmers, technical experts from universities and research institute, and government officials from central and regional offices. These stakeholders generally have different motivations and attitudes to risks associated with disease outbreak, preparation of contingency plans, and disease responses as a result of risk acceptance and impact of disease on the respective stakeholders. Without adequate consideration and communication, this may result in difficulty in implementation of the contingency plans and disease responses. By organizing technical consultation meeting, this project has provided useful opportunity for initiating communication throughout key stakeholders, raising awareness in emergency disease preparedness, and facilitating improvement of coordination to multi-stakeholders in aquaculture sectors in ASEAN countries. Hopingly, governmental, non-governmental and private sectors can continue effectively collaborating response to aquatic animal disease prevention and control.

On behalf of Aquatic Animal Health Research and Development Division (AAHRDD) of Thailand's Department of Fisheries, I would like to extend our gratitude to the SEAFDEC and its Aquaculture Department, Japan-ASEAN Integration Fund, representatives of the ASEAN Member States, representatives from private and university sectors for all the efforts and contributions in pushing forward aquaculture industry in Southeast Asia.

Janejit Kongkumnerd
Director of Aquatic Animal Health Research and Development Division
Department of Fisheries, Thailand

WORKSHOP PROSPECTUS

Background/Rationale

Aquaculture production in Southeast Asia has grown rapidly over the last two decades contributing approximately 10% of the annual world aquaculture production. However, unsustainable aquaculture practices including the irresponsible transfer of aquatic species, particularly farmed stocks that could potentially be carrying pathogens, has contributed to the emergence of a number of infectious diseases thereby posing serious threats to the sustainability of aquaculture in the region. One of the infectious diseases that recently impacted the shrimp industry in the region is the acute hepatopancreatic necrosis disease (AHPND) or popularly known as early mortality syndrome (EMS). AHPND outbreaks in cultured penaeids in Viet Nam, Thailand, Malaysia, and Philippines significantly led to low production and concomitant economic losses. The pressing situation on AHPND in cultured shrimp in the region at that time spurred the organization of a consultative meeting, i.e. *ASEAN Regional Technical Consultation (RTC) on EMS/AHPND and Other Transboundary Diseases for Improved Aquatic Animal Health Management in Southeast Asia*, funded by the Japan-ASEAN Integration Fund (JAIF). The RTC assessed the current status of EMS/AHPND and other emerging diseases in farmed shrimps in ASEAN Member States and identified gaps and priority areas for R&D collaboration. Another important output of the consultation is the formulation of *Regional Policy Recommendations*, which among others, focused on *Emergency Preparedness and Response Systems* (EPRS) for managing aquatic animal disease outbreaks in the region. EPRS are comprised of contingency planning arrangements that can minimize the impacts of serious aquatic animal disease outbreaks through containment (prevention of further spread) or eradication of disease outbreak whether at the regional, national, or farm level. Thus, establishing a harmonized aquatic EPRS among ASEAN member states should be a top priority and would certainly warrant a solid platform for an effective and prompt decision-making with clearly defined responsibilities and authority.

The **ASEAN Regional Technical Consultation on Aquatic Emergency Preparedness and Response Systems for Effective Management of Transboundary Disease Outbreaks in Southeast Asia** will discuss the status of and/or need for aquatic emergency preparedness and response systems for effective management of transboundary disease outbreaks in Southeast Asia. Issues will be addressed through country reports, technical presentations and a workshop. Assessment of the current status of aquatic EPRS is currently being practiced by the different countries in the Southeast Asian region from the country reports. The workshop will review the existing laws, legislations and standard operating procedures (SOPs), among others, pertinent to aquatic EPRS of each member country, identify gaps, policy recommendations and priority areas for R&D collaboration and, enhance the cooperation among member countries, regional/international organizations and other relevant stakeholders on initiatives that support aquatic EPRS for effective management of aquatic animal disease outbreaks.

ACKNOWLEDGMENTS

The fulfilment of this Consultation would not be possible without the cooperation of the agencies involved in this project. We gratefully acknowledge the Japan-ASEAN Integration Fund for providing the main financial support. We also thank the Government of Thailand through its Department of Fisheries and ASEAN Network of Aquatic Animal Health Centers (ANAAHC) for hosting the Consultation and for the logistical support. As well as, to SEAFDEC Secretariat for the assistance provided throughout the Consultation proper. Our heartfelt thanks to our partners from Food and Agriculture Organization of the United Nations and Network of Aquaculture Centres in Asia-Pacific for the wisdom and the guidance. Special thanks are also due to all participants, particularly representatives of ASEAN Member States and panel of experts for their invaluable contributions to the discussions.

The editors would like to thank the members of SEAFDEC/AQD Publications Review Committee especially, Dr. Leobert de la Peña, Dr. Jon Altamirano, Dr. Edgar Amar, Ms. Joana Joy Huervana, Dr. Roger Edward Mamauag, Dr. Nerissa Salayo, and Dr. Eleonor Tendencia for reviewing the Proceedings prior to its publication. Thanks are also due to the Development Communication Section of SEAFDEC/AQD especially to Mr. Rex Delsar Dianala and Ms. Rossea Ledesma for copy-editing and layout.

PHOTO OF PARTICIPANTS

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COUNTRY PAPERS

Current Status, Issues and Gaps of Aquatic Emergency Preparedness and Response Systems Practiced in Brunei Darussalam

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Abstract

Importation of live fish to Brunei Darussalam have incurred a major biosecurity risk to the aquaculture industry. Preventing disease incursions through quarantine, legislation and education is currently the most cost-effective management approach in Brunei. Once an incursion has occurred, national emergency response system arrangements are implemented to facilitate immediate response actions for containment and eradication. Brunei Darussalam has a list of legislation and policies to aid in the immediate response of disease outbreak. However, fisheries staff lack basic emergency response training and there are few skilled staff and resources available. Simulation exercise to review the effectiveness of the AEPR system needs to be addressed.

Keywords: aquatic emergency, surveillance, disease

Introduction

The fisheries industry in Brunei Darussalam has grown rapidly over the years with aquaculture being one of the sectors that has the potential to contribute to the country's revenue through export market. At present, aquaculture industry contributes 10% of the total fisheries output and is expected to be the main contributor by 2020, generating 60% of total estimated value of production. In 2017, the aquaculture industry produced 1,600 metric tons, growing at a rate of 18% since 2015.

However, with the increase in importation of live fish and in addition to neighboring countries being infected with diseases causing mass mortality, strengthening biosecurity measures and AEPR system have been implemented to avoid situations that could undermine the aquaculture industry in Brunei.

The Aquatic Emergency Preparedness and Response System (AEPRS) that is currently being practiced in Brunei Darussalam is composed of the following: (1) legislation and policy; (2) disease surveillance, monitoring and control systems; (3) diagnostic laboratory; and (4) national action plan to control disease outbreak.

The aquaculture industry

Aquaculture production in Brunei records modest growth over the last five years contributing to a revenue of BND5.43 million in 2013 up to BND16.7 million in 2017. The total aquaculture production in 2017 was reported 1,600 metric tons. The main aquaculture products are *Litopenaeus stylirostris*, marine fish such as *Trachinotus blochii*, *Epinephelus* spp., *Lates calcarifer* and red tilapia. Black tiger shrimp (*Penaeus monodon*) and giant freshwater prawn (*Macrobrachium rosenbergii*) were also produced from 2012 to 2015.

The development of marine fish culture in floating cages started in 1980's using timber structure with cage capacity ranged from 27 m^3 to 50 m^3. The initial stocking density is about 405 fish/cage up to 560 fish/cage giving production of 227 kg/cage. With the introduction of *Lates calcarifer*, later domesticated and produced locally, the marine finfish culture in floating cages has developed rapidly from four farmers in 1988 up to 48 farmers in 2015 with 3,285 cages. Offshore cages culture using composite iron was introduced in 2003 and the use of HDPE cages in 2009. Besides Asian sea bass, the marine finfish species cultured are *Epinephelus* spp. such as mouse grouper, tiger grouper, hybrid grouper (dragon grouper), and *Carangidae* spp. such as golden pompano *Trachinotus auratus*, red tilapia and cobia including other local marine finfish such as red snapper and trevally.

Shrimp culture is one of the fastest developing aquaculture activities in the Asian region including Brunei Darussalam. Black tiger shrimps (*Penaeus monodon*) was firstly produced locally from 1986 up to 1998 with production of 45 metric tons. Since the introduction of Mexican Blue Shrimp (*Penaeus stylirostris*) in late 1999, the shrimp industry has rapidly developed from 230 hectares in 1990 up to 300 hectares of shrimp farm areas in 2000's. At present, Mexican Blue Shrimp (*Penaeus stylirostris*) becomes the main species being cultured and constituted about 100% of the shrimp production in Brunei with production of 787 metric tons in 2015. Most shrimp farmers practices the intensive culture system with initial stocking density of 70-150/m^2 for rostris and semi-intensive culture for black tiger shrimp at stocking density of 20-40/m^2. Both shrimp has achieved a good farm productivity of 23 mt/ha/cycle for rostris culture and black tiger shrimp achieved 6.0 mt/ha/cycle at harvested weight of 40 gram using disease-free postlarvae produced locally.

To date, the aquaculture industry in Brunei Darussalam are free of diseases listed in the national disease list and the World Organization for Animal Health (OIE). Strict biosecurity measures are in place in hatchery and farms by the implementation of Brunei Good Aquaculture Practice (BGAqp).

Diagnostic Laboratory: Aquatic Animal Health Services Centre

The Aquatic Animal Health Services Centre (AAHSC) of the Department of Fisheries is responsible for providing diagnostic services to the growing aquaculture industry in Brunei Darussalam. The Centre plays a key role in aquatic animal disease prevention and control through providing diagnostic services. AAHSC uses the OIE standards to perform diagnostic testing on the aquatic animals in Brunei Darussalam.

The Centre currently provides five services; PCR, histology, microbiology, parasitology and water quality analysis for the aquaculture industry in Brunei Darussalam. The table below shows the list of diseases that are diagnosed in the laboratory and is economically important to the aquaculture industry in Brunei Darussalam.

TABLE 1. List of diseases diagnosed in the Aquatic Animal Health Services Centre

Species	Diseases
FISH	• Koi herpes virus (KHV) • Spring viraemia of carp (SVC) • Red sea bream iridovirus (RSIV) • Epizootic ulcerative syndrome (EUS) • Viral nervous necrosis (VNN) • Irido megalocytivirus (Irido-M)
CRUSTACEANS	• Infection with white spot syndrome virus (WSSV) • Infection with infectious myonecrosis virus (IMNV) • Infection with infectious hypodermal and haematopoietic necrosis virus (IHHNV) • Infection with Taura syndrome virus (TSV) • Infection with yellow head virus genotype-1 (YHV) • Infection with *Macrobrachium rosenbergii* nodavirus (MrNV) • Acute hepatopancreatic necrosis disease (AHPND) • *Enterocytozoon hepatopenaei* (EHP)

The PCR laboratory is also involved in two proficiency testing programs with the OIE reference laboratory for crustacean viruses, the University of Arizona and the Asia-Pacific Laboratory Proficiency Testing Program by Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia. These proficiency testing programs evaluates the laboratory capability to conduct diagnostic tests for infectious diseases and the quality of animals and animal products for international movement.

In 2010, Brunei declared itself free from four crustacean viruses and diagnostic testing were done using OIE standards.

AAHSC is currently practicing ISO/IEC 17025 in the laboratories and aims to obtain accreditation in 2019.

Legislation and policy in relation to aquatic animal health in Brunei Darussalam

There are a number of legislations and policies to support the implementation of aquatic animal health strategies in Brunei Darussalam. These include: (1) Fisheries Order 2009; (2) National pathogen list for aquatic animal diseases; (3) Manual of Brunei Darussalam on Good Aquaculture Practices For Shrimp Farms; (4) Manual of Brunei Darussalam on Good Aquaculture Practices For Fish; (5) Manual of Brunei Darussalam on Official Controls for Exported Fishery Products; and (6) Department of Fisheries Action Plan for Disease Occurrence.

Prior to importation, import risk analysis is carried out for any introduction of new species into Brunei's aquatic ecosystem. Health certification issued by the Competent Authority of the exporting country is analyzed and imported fish will be screened for target diseases upon arrival in the country.

For live fish movement within the country including stocking into farms, farmers are advised to request a 'Laboratory Analysis Report' from the hatchery to prevent the spread of diseases.

Farmers must also comply to the BGAqP as stated in the license conditions. BGAqP provides fundamental guides on codes of conduct and farm specification to ensure efficient and responsible aquaculture production and expansion. Among the benefits of BGAqP includes: (1) prevention or minimize risk on the food safety, environment, health, welfare of workers and the quality of products; and (2) to provide assurance to importing country on the safety and quality of local aquaculture products.

Early warning system

A national monitoring system has been implemented to demonstrate disease free status of Brunei farms in accordance with the OIE Aquatic Animal Health Code. From this monthly surveillance program, aquatic animal health information system is established and is used for national reporting as well as to international bodies including the OIE and Network of Aquaculture Centres in Asia Pacific (NACA). Annual OIE report and the Quarterly

Aquatic Animal Diseases report is submitted to the OIE through Brunei Darussalam's delegate to the OIE.

Active surveillance program is carried out in the shrimp industry screening for all shrimp diseases listed in the national disease list and OIE. On the other hand, passive surveillance program is carried out in the fish industry.

Through the surveillance program, Brunei Darussalam has declared disease free status for white spot syndrome virus, taura syndrome virus, infectious myonecrosis virus and yellow head virus in 2010. However, the country was hit with a white spot syndrome virus outbreak in 2012 and is currently gathering epidemiological data to apply to the OIE for self-declaration of recovery of disease freedom from White spot syndrome virus.

Early detection system

The Department of Fisheries has conducted training courses and on-ground awareness building for farmers and fisheries staff from the Mobile Technical Unit (MTU) and AAHSC on recognizing signs of the listed diseases, emerging disease or unexplained mortality. Pamphlets and posters on diseases related to the farmer's cultured commodities have been distributed to help recognize signs of diseases in their farms. To build national expertise on aquatic animal diseases, ongoing training courses on laboratory diagnostics are conducted annually.

Importation

When imported fish are detected positive for diseases, Competent Authority of the exporting country will be notified to initiate investigation. Disease action plan is immediately implemented to prevent disease spread in the country.

Farm

Once a suspicious report is received from the farm, immediate site visit by the MTU is done to start investigation. The ponds are quarantined, information are gathered and samples collected and sent to AAHSC for confirmation. When a positive is detected by the laboratory, disease action plan is implemented.

Early response system

When a disease is detected, farms are declared as infected zone and disease action plan is implemented. Containment, mitigation, and eradication of disease is exercised. Routine monitoring of the farm is done until the area is declared safe for a new cycle start up, with a condition of a proof that the area is free from diseases.

Issues and gaps

Brunei Darussalam already has an AEPR system in place with appropriate legislation and policies in relation to the aquatic animal health. However, the effectiveness of the EPR system needs to be reviewed through simulation exercises. Financial support plans and intensive training on individual roles and responsibilities of officers and personal involved in the disease action plan is required to strengthen the AEPR system.

Reference

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Department of Fisheries. 2016. Manual of Brunei Darussalam on Good Aquaculture Practices for Shrimp Farms. Brunei Darussalam: DOF.

Current Status, Issues, and Gaps on Aquatic Emergency Preparedness and Response Systems Practiced by Cambodia

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Abstract

A few decades ago, Cambodia was rich in both freshwater and marine fisheries resources because of its favorable geographical area. However, the fisheries resources have depleted and were unable to totally fulfill the increasing fish demands of its people. This was caused by various factors including unfavorable climate changes, increase in population, improper agricultural production practices, and other human-affecting activities. In this sense, aquaculture development in Cambodia becomes increasingly important in order to reduce the fishing pressure on its natural resources which are mainly for food security and economy of Cambodian people. Aside from this, aquatic animals in the country are vulnerable to infectious aquatic transboundary diseases as a result of insufficient and low transboundary diseases monitoring capacity. Neither the official list of aquatic transboundary diseases was created nor are the emergency preparedness and response systems for effective management of transboundary disease outbreaks in Cambodia has been well-established. Nonetheless, the government fisheries officers of both central and provincial levels have conducted fish health monitoring and undertake sample collection from fish farmers since 2016 in 10 targeted provinces as funded by the European Union's Programme. Regarding the capacity of the diagnostic laboratory, officers can perform level I and II but not for all species and diseases. Level III diagnoses cannot be effectively performed yet due to the lack of facilities, skills, and knowledge. The Marine Aquaculture Research and Development Center (MARDeC) is the only main laboratory for aquatic animal health diagnosis in the country. To minimize the spread of aquatic transboundary diseases in freshwater and seawater, the Ministry of Agriculture, Forestry and Fisheries has been moving to initiate and establish policies regarding: (1) the registrations, licensing, and law enforcement; (2) the inspection of sites; (3) and the issuance of health certificate and quality seals. However, those national regulations and legislation regarding the movement of aquatic animal stocks are not yet practical or effective. Importantly, the Royal Government of Cambodia needs both technical and financial assistance. It requires an improvement, amendment, and enforcement of the regulations, laws and the standard operating procedures (SOPs). It requires laboratory capacity building and SOPs for responsible management to establish the aquatic emergency preparedness and response systems for effective management of transboundary disease outbreaks in Cambodia as well as Southeast Asia.

Introduction

On the map of Cambodia, one can see a complex hydrological system that looks like a huge dumbbell body of water stretching across the northwest of the country, this is known as Beoung Tonle Sap or Tonle Sap Lake. This lake is the most prominent feature on the map of Cambodia with the connections to long Tonle Sap River and the Mekong River. On the southwest lies the Gulf of Thailand with a coastline of 435 km (Hav and Leap, 2005). Geographically, 30% of Cambodia is covered with seasonal and permanent wetlands. Cambodia has one of the largest and most diverse freshwater fisheries in the world with bigger fisheries were observed in geographically much larger nations like China, India and Bangladesh (SPFF, 2011). Cambodia is rich in both freshwater and marine fishery resources. More than 500 freshwater fish species (Rainboth, 1996) and over 562 marine fish species (Try, 2003) have been identified. The average fish consumption of Cambodians is 52 kg per person per year, the highest recorded level in the world (Hortle, 2007). People around the Tonle Sap Lake alone consume fish between 67-80 kg per capita (Lang, 2015).

The high fishing pressure caused by the increasing demand for fish and fisheries products in the rural areas and the fast developing urban centers (Joffre *et al.*, 2019), in addition to the unfavorable climate change, increase in population, flooded forest clearance for agricultural production, hydro-power dam constructions in upstream Mekong River, over-fishing and some illegal fishing, considerably affected Cambodia's capture fisheries. In this sense, aquaculture development in Cambodia became increasingly important as the remedy to rectify the vulnerable fisheries resources which so far have potentially contributed to the employment and livelihoods of the poor, to food security, and to the country's gross domestic product (GDP) and foreign exchange balance (SPFF, 2011). Additionally, Lang (2015) reported that 27,000 people were employed in the aquaculture sector in Cambodia.

According to the National Strategic Plan for Aquaculture Development in Cambodia (NSPAD) for 2016 to 2030, aquaculture production has grown by an average 20% per year over the past decade, increasing from less than 50,000 metric tons in 2008 to 207,443 metric tons in 2017. Aquaculture accounts for 20% of the country total fish production and in that the inland aquaculture accounts for nearly 90%. Some 50% of the total aquaculture production originates from freshwater cage culture, practiced with several main species including giant snakehead (*Channa micropeltes*, 47%), pangasius (*Pangasianodon hypophthalmus*, 27%), and hybrid catfish (*Clarias*, 27%) and other species (3%). As for seed production and trends, it increased from 20 million seed in the 2000s to approximately 180 million seed in 2015. There are 55% of seed imported from the neighboring countries, 13% sourced from the wild; and 32% from Cambodian state and private hatcheries (NSPAD, 2017). Besides the import of seed from the neighboring countries, the practices of feeding local and imported low value 'trash fish' to some carnivorous species like giant snakehead, *C. micropetes* or mixed with other ingredients to make a farm-made feed for other species without proper screening, cleaning and disinfection are still being practiced. In this manner, the chance of contracting and spreading of transboundary diseases from another country to Cambodia and vice versa is known to be high risk.

Early Warning System

Cambodia's aquatic animals are vulnerable to infectious aquatic transboundary diseases as a consequence of the insufficient and poor transboundary diseases monitoring capacity as well as early warning system. Moreover, Cambodia has not yet developed the national list of aquatic transboundary diseases at the moment. However, some major aquatic animal diseases of finfish and crustaceans that are of concern have been identified. These are listed in the tables below, including their status, level of diagnosis and the affected species.

Early Detection System

Regarding the early detection systems for effective management of transboundary disease outbreaks in Cambodia, the officers of the Fisheries Administration Cantonment of each province contacts and reports any disease occurrences to the aquatic animal health officers at the national level (Fisheries Administration) and suspected/diseased aquatic animal samples are also sent for further diagnosis. Fish samples must be collected from farmers of the suspected areas. This is the existing framework that is being followed however, there is no national standard of operation in place yet. Since Cambodia is one of ASEAN Network of Aquatic Animal Health Centres (ANAAHC), Network of Aquaculture Centres in Asia-Pacific (NACA) and World Organisation for Animal Health (OIE) member counties, it is required to report the outbreaks to the organizations, but Cambodia failed to regularly submit the reports due to some technical and financial constraints, insufficient number of personnel and diagnostic capability/capacity.

Concerning the capacity of diagnostic laboratory, the officers can perform level I and II but not for all species of aquatic animals and types of diseases. As for level III excluding histopathology, mycology and others, it is also not yet effectively performed due to the aforementioned constraints. Marine Aquaculture Research and Development Center (MARDeC) is the only main laboratory for aquatic animal health diagnosis nowadays. Some diseases such as bacillary necrosis of pangasius (BNP), red spot and motile *Aeromonas* septicemia, streptococcosis, acute hepatopancreatic necrosis disease (AHPND) or (EMS), infection with white spot syndrome virus (WSSV) are of concern in farmed aquatic animals of Cambodia. Moreover, several pathogens have been identified from farmed fish such as fish parasites: *Trichodina* sp., *Ichthyophthirius multifiliis*, *Epistylis*, *Apisoma*, *Dactylogyrus* sp., *Gyrodactylus* sp., *Lernaea* sp., *Argulus* sp., *Acanthocephalan*, *Henneguya* sp., *Cryptocaryon irritans*, *Traonchus* sp., *Hirudinea* sp., *Rocinela maculate* and *Benedinea* sp.; pathogenic bacteria: *Aeromonas hydrophila*, *Aeromonas* spp., *Edwardsiella ictaluri*, *Streptococcus* sp., *Vibrio* sp.; fungi: *Aphanomyces invadans* and *Saprolegnia* sp.; and RNA viruses (Viral encephalopathy and retinopathy). All in all, in order to be able to diagnose and report such kinds of transboundary diseases listed by NACA and OIE to the government and either local or international organizations,

Finfish Diseases	Status	Level of Diagnosis	Affected Species
1. Infection with *Aphanomyces invadans* (EUS)	+ (a)	I, II	Silver barb, Striped snakehead, Giant snakehead, Marble goby, Walking catfish
2. Koi herpesvirus disease (KHV)	*** (a)		
3. Grouper iridoviral disease (GIV)	***		
4. Viral encephalopathy and retinopathy (VNN)	+	III	Asian sea bass
5. Enteric septicaemia of catfish (ESC)	?	I, II	Striped catfish
6. Tilapia lake virus (TiLV)	0000		

Source: (a) (Racy 2004)

Crustacean Diseases	Status	Level of Diagnosis	Affected Species
1. Infection with Taura syndrome virus (TSV	(1999) (b)	I	*Penaeus vannamei*
2. Infection with white spot syndrome virus (WSSV)	(1999) (b)	I	*Penaeus vannamei*
3. Infection with yellow head virus (YHV)	(1999) (b)	I	*Penaeus vannamei*
4. Infection with infectious hypodermal and haematopoietic (IHHNV)	0000		
5. Infection with *Macrobrachium rosenbergii* nodavirus (WTD)	-	I	*Macrobrachium rosenbergii*
6. Acute hepatopancreatic necrosis disease (AHPND) or (EMS)	(2011-2013) (b)	I	*Penaeus monodon*
7. Monodon Baculovirus (MBV) Disease	(1999) (b)	I	*Penaeus monodon* *Penaeus vannamei*

Source: (b) (Lang and Sothea 2016)

Legend:

+	Disease reported or known to be present
+?	Serological evidence and/or isolation of causative agent but no clinical diseases
?	Suspected by reporting officer but presence not confirmed
+( )	Occurrence limited to certain zones
+?( )	Confirmed infection/infestation limited to one or more zones of the country, but no clinical disease
?( )	Presence of the disease suspected but not confirmed in a zone
***	No information available
0000	Never reported
-	Not reported (but disease is known to occur)
(year)	Year of last occurrence

Cambodia is seeking for the development and enhancement of its laboratory capability and capacity.

Early Response System

After the samples are submitted for diagnosis, the results and identification are recorded and reported to the Department of Aquaculture Development (FiA) and then to the provincial officers (Fisheries Administration Cantonment) for taking prompt and right actions to solve the occurring aquatic animal diseases. Up to this point, the fisheries officers of both central and provincial levels have been conducting fish health monitoring and undertake fish sample collection from fish farmers since 2016 in 10 targeted provinces under the European Union-funded programme "Promotion of Inclusive and Sustainable Growth in the Agriculture Sector: Fisheries and Livestock, DCI-ASIE/2012/023-197 Fisheries sub-sector Component, DCI-ASIE/2013/331-574 (EU-PGA-FiA)." Even though some activities on disease monitoring program have been conducted as shown in the table below, Cambodian early response system is seen as not yet functioning well. This is because, sample submission, transport, and diagnosis are not yet well conducted in a timely manner.

To minimize the spread of aquatic transboundary diseases in freshwater and seawater, the Ministry of Agriculture, Forestry and Fisheries have been moving to initiate and establish policies regarding the registrations, licensing, and law enforcement; the inspection on sites; and the issuance of the health certificate and quality seals. However, those national regulations and legislation regarding the movement of aquatic animal stocks are not yet practiced or in effect at the moment. On the other hand, not only has the government established and enforced the legal interventions but the government also has raised the awareness to its competent officers, public, and farmers regarding the aquatic animal disease and health management via several training workshops at central and provincial levels. Additionally, the aquatic animal disease and health management officers have also produced some manuals of fish health and disease management. They encourage aquatic animal farmers to adapt Good Aquaculture Practices, known as GAqP. In mid-June 2018, to facilitate and extend the work of the Aquatic Animal Health officers, the Ministry of Agriculture, Forestry and Fisheries approved the request to create the Office of Aquatic Animal Disease and Health Management under the Department of Aquaculture Development, Fisheries Administration.

Fish Sample Collection from 10 Target Provinces under National Fish Disease & Health Monitoring Program

Province	Farm	Level of Diagnosis		Affected Species	Year
		Pond	Cage		
Kampong Chhnang	17	10	7	*Channa micropeltes*	2016
Kandal	16	16	0	*Channa striata*	2016
Banteay Meachey	14	14	0	*Pangasianodon hypophthalmus*	2017-2018
Battambang	18	14	4	Oreochromis niloticus	2017-2018
Kampong Thom	18	9	9	*Anabas testudineus*	2017-2018
Kampong Cham	9	6	3	*Oxyeleotris marmorata*	2018
Pursat	14	6	8	*Cyprinus carpio*	2018
Prev Veng	9	6	3	Hybrid catfish *(Clarias batrachus* and *C. gariepinus)*	2018
Takeo	13	13	0	*Pangasius larnaudii*	2018
Preah Sihanouk	11	11	0	*Hypsibarbus pierrei*	2018
TOTAL	**139**	**105**	**34**		

Way forward

The Royal Government of Cambodia has realized the needs of both technical and financial assistance as it requires an improvement, amendment, and enforcement of the regulations, laws and the SOPs and it requires laboratory capacity building and SOPs for responsible management to establish the aquatic emergency preparedness and response systems for effective management of transboundary disease outbreaks in Cambodia as well as Southeast Asia. To mention a few, the upcoming EU-funded CaPFish Aquaculture Project (2019-2023), is currently the most important program on inland aquaculture sector in Cambodia. The expected results under sub-component 5 of the project on the leadership and management of the negative impacts of aquaculture production on the environment include the development of guidelines for managing and monitoring diseases, chemical and organic residues, and invasive species in Cambodia. In this manner, it is strongly expected that our aquatic animal health laboratory and personnel's capacity, skills and knowledge respectively will be improved, upgraded and enhanced. Ultimately, it is seen that the Royal Government of Cambodia will be able to set up its aquatic emergency preparedness and response systems by that time.

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Emergency Preparedness and Response System in Indonesia

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Abstract

The Competent Authority (CA) on aquatic animal health in Indonesia is the Directorate Aquaculture Area Development and Fish Health of the Directorate General of Aquaculture (DGA) under the Ministry of Marine Affairs. CA is supported by national reference laboratories and professional human resources that are capable of fish disease diagnosis; as well as an established network with the farmers, trading association, and relevant stakeholders which are actively involved in national meetings, conferences, socialization of emerging diseases and policy and regulation. To control transboundary fish disease at national level, the government of Indonesia has a National Strategy on Aquatic Animal Health and Environment, which was developed by FAO under project of TCP/INS/3402: 2013-2015) collaboration with DGA, Ministry of Marine Affairs and Fisheries (MMAF). To strenghten the implementation of aquaculture in the country, the Indonesian Government issued President regulation Number 28 in 2017 which includes the implementation of fish health management as well as emergency response (Section VI, Article 60). To support the implementation of EPRS, Special Task Force Teams are formed by the Director General of Aquaculture.

Stakeholders' participation is very important in the implementation of EPRS, such as a prompt report by fish farmers and extension officer to the upper level fisheries officers at district, provincial, and national level of any observed unusual mortality that indicates disease outbreaks. EPRS activities consist of emergency response on early warning (disease information, disease preventing guideline and regulation); early detection (surveillance, appointed diagnostic laboratory); and early response (collecting information, task force formation, public awareness). Standard Operational Procedures, and detection and control were done based on published scientific information available and guidelines from World Organisation for Animal Health (OIE), Network of Aquaculture Centres in Asia-Pacific (NACA) etc. Passive and active surveillance was done on major transboundary diseases in Indonesian regions including KHV, TiLV, AHPND, WSSV, and IMNV.

Introduction

Emergency Preparedness and Response System on aquatic animal disease is very important for Indonesia in order to protect aquaculture production since Indonesia is second top aquaculture producer in the world after China (FAO, 2016).

The objective of the emergency preparedness and response system is to prevent the transboundary or emerging aquatic animal disease entering and spread out within Indonesian territory.

Implementation of aquatic animal emergency preparedness and response system in Indonesia is regulated with the issuance of Government Regulation No. 28 /2017 concerning Aquaculture, Article 60 which states that "Emergency response thus involves such activities as (i) contingency planning; (ii) emergency response actions; and (iii) emergency response evaluation."

Contingency planning is recorded in an aquatic animal disease contingency plan which is a documented work plan designed to ensure that all needed actions, requirements and resources are provided in order to eradicate or bring under control outbreaks of infectious disease of significant impact to aquaculture productivity and market access. Contingency plan includes four aspects namely (i) Task force organization structure; (ii) Early warning system; (iii) Early response system; and (iv) Standard operational procedures.

Emergency response actions are activities done during emergency situation, that include (i) Creation of Task force Team; (ii) Early warning; (iii) Early detection; and (iv) Early response.

Evaluation of emergency response implementation should be done for improving the upcoming emergency response implementation.

Currently, the operational regulations are being drafted by the Minister of Marine Affairs and Fisheries Regulation as a derivative regulation from Government Regulation No. 28, year 2017 concerning Aquaculture.

Early Warning System

(1) National Competent Authority's (CA) monitoring system/mechanism on emerging/ existing transboundary diseases.

Directorate General of Aquaculture (DGA) under the Ministry of Marine Affairs and Fisheries Indonesia is the government agency who has responsibility on all activities dealing with aquatic animals, such as aquaculture production, aquaculture technology, aquaculture inputs and infrastructures (seeds, feeds, pond, net cages, canals, etc.), broodstock improvement, ornamental fishes, aquatic establishments, aquaculture business and license, health management regarding fish diseases, medicines, residue, laboratory, environment aspect, Antimicrobial Use and Antimicrobial Resistance (AMU/AMR) as well as management of aquatic animal emergency disease preparedness and response system.

The organization structure scheme of Directorate General of Aquaculture is illustrated in Figure 1.

DGA has close cooperation with the other agencies such as Fish Quarantine Inspection Agency (FQIA), Research, Development and Extension Agency (RDEA) and also supported by 15 DGA Technical Implementing Units (DGA-TIU) laboratories under Ministry of Marine Affairs of Fisheries, Province/District Government and other stakeholders such as Association of shrimp/fish farmer, hatchery and processing plan, input production companies (feed, medicines, etc.) and also supported by 15 DGA Technical Implementing Units (DGA-TIU) laboratories, FQIA Technical Implementing Units (FQIA-TIU) laboratories and RDEA Technical Implementing Units (RDEA-TIU) laboratories. Location of DGA-TIU as seen in Figure 2.

There are 47 units of aquatic animal disease laboratories under the FQIA-TIU and 3 units aquatic animal disease laboratories under RDEA-TIU. Location of FQIA-TIU laboratories and RDEA-TIU laboratories are illustrated in Figure 3.

(2) Networking mechanisms of the national competent authority with trading partners. Early warning at the national level consists of advance knowledge of transboundary, emerging and high-risk diseases which could threaten national biosecurity before pathogens enter national territory.

Early warning depends on the CA having information on current disease situation in the Indonesian region, trading partners and new emerging aquatic animal diseases occurring on a worldwide basis. Early warning thus involves such activities as:

1. Developing good communication linkages and working relationships with the responsible authorities of primary trading partners;
2. Contributing to, and frequent checking of regional and international disease reporting systems and database;
3. Communicating with key aquatic animal health researchers in primary trading – partner countries and on a worldwide basis through such as aquatic animal health newsletters and e-mail discussion groups and attendance at regional and international meetings and workshops where new disease outbreak occurrences are reported.

DGA maintains early warning system by supporting staff to attend meetings and regional/international workshops in case of occurrence of new disease, communicate with researchers in other countries, regular checking of local/regional/international disease report databases, scientific literatures and newsletters, accessing NACA, OIE or other websites, communicate with CA of trading partners in cases serious disease or pathogen is detected from imported aquatic animals, and regular reporting of disease situations to regional and international systems.

For live aquatic animal/product movement within and between country territories, the Fish Quarantine Agency is responsible. It actively exchanges information on disease incidences with aquatic animal commodity trading partner countries through Mutual Recognition Agreement (MRA).

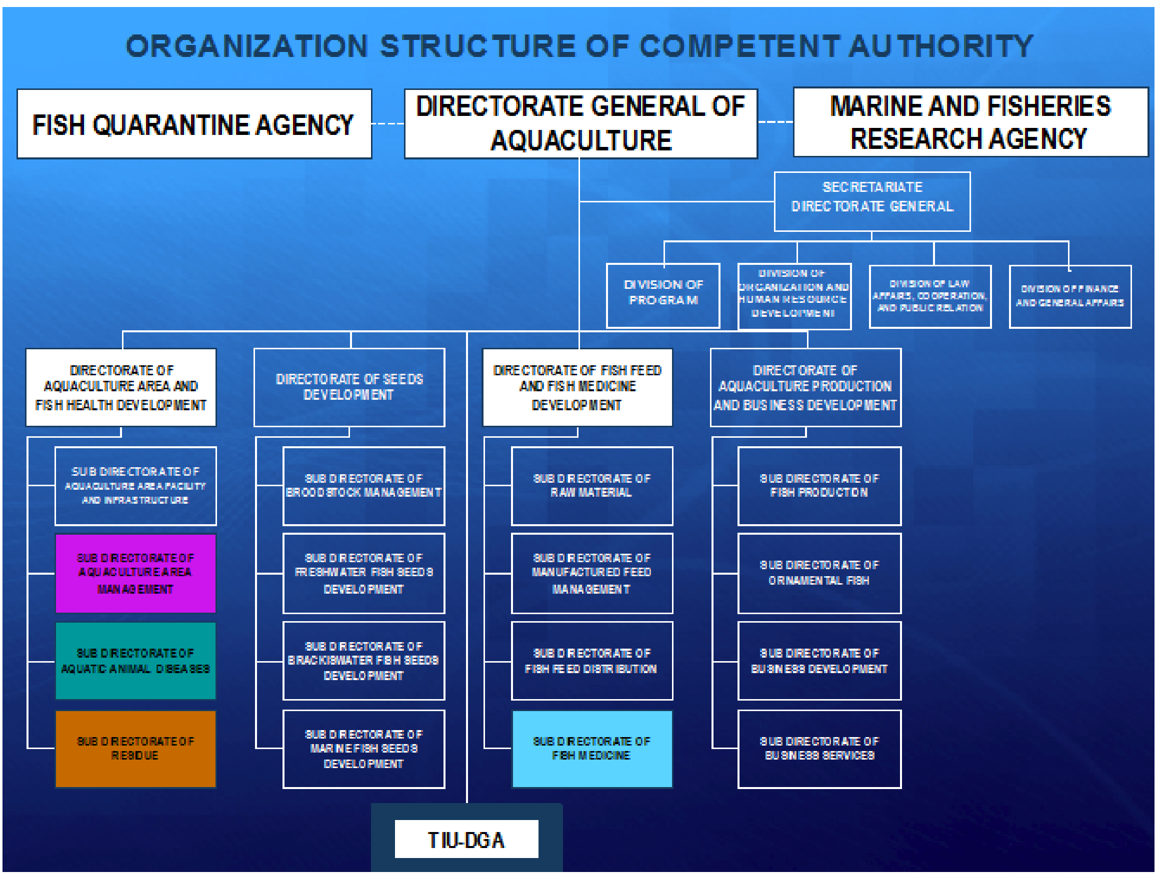

FIGURE 1. Organization Structure of Directorate General of Aquaculture as Competent Authority

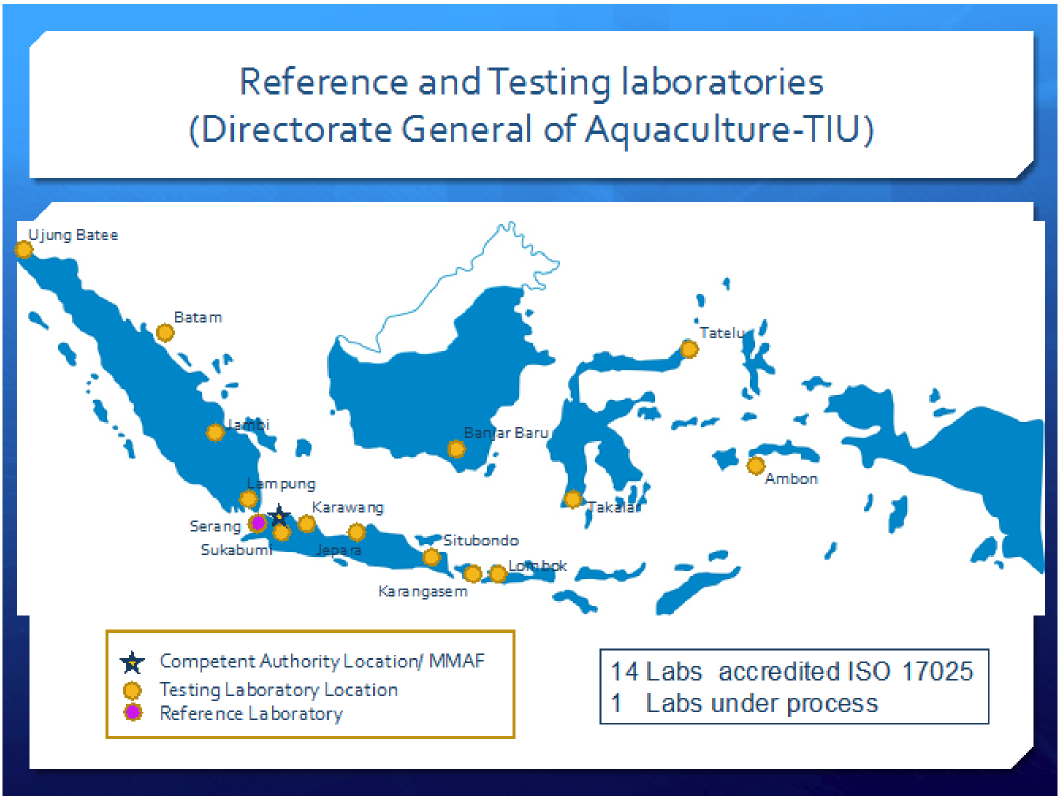

FIGURE 2. Location of DGA-TIU laboratories

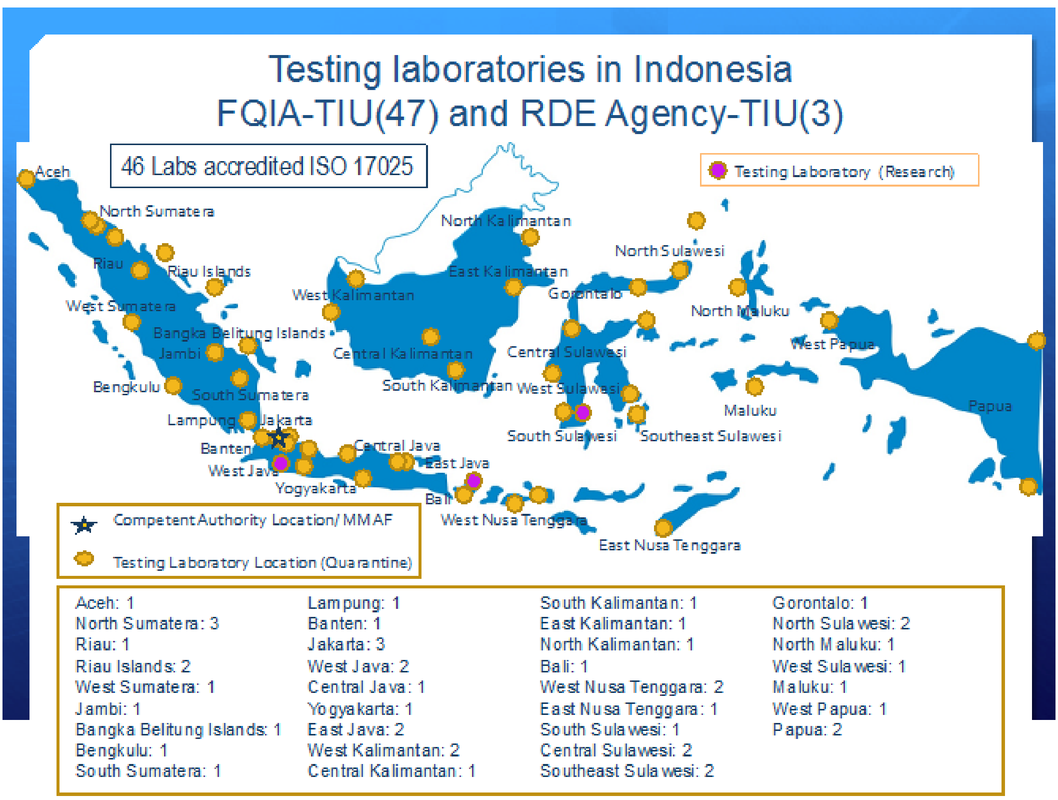

FIGURE 3. Location of FQIA-TIU and RDEA-TIU

Early Detection System

The objectives of an early detection is to ensure detection of the introduction of, or sudden increase in the incidence of, any disease of aquatic animal that has the potential of developing to epizootic proportions and/or causing socio-economic consequences.

Early detection are the activities done in order to know the status of an emerging disease rapidly in the Indonesia territory within the shortest possible time frame. Some activities relating to early detection at least include:

1. Providing information about fish diseases occurrence
2. Updating laboratory testing method
3. Conducting passive/active surveillance for fish disease detection purpose
4. Preparing diagnostic capability
5. Providing list of laboratories and experts
6. Providing reporting system

Indonesia has listed Acute hepatopancreatic necrosis disease (AHPND) and Tilapia Lake Virus (TiLV) as emerging diseases. Related to this, Director General of Aquaculture was appointed reference and testing laboratories for TiLV and AHPND based on Director General of Aquaculture Decree Number: 162/KEPDJPB/2017 (Figure 4).

Personnel competencies on recognition and reporting of a disease emergency

The front line of aquatic diseases control consisted of aquatic diseases diagnostic technician, aquaculture extension officers, researchers at various research centres and scientist at universities.


KEMENTERIAN KELAUTAN DAN PERIKANAN
DIREKTORAT JENDERAL PERIKANAN BUDIDAYA

KEPUTUSAN
DIREKTUR JENDERAL PERIKANAN BUDIDAYA
NOMOR 162/KEP-DJPB/ 2017

TENTANG

LABORATORIUM ACUAN DAN LABORATORIUM PENGUJI
UNTUK PENYAKIT *TILAPIA LAKE VIRUS (TiLV)* DAN
ACUTE HEPATOPANCREATIC NECROSIS DISEASE (AHPND)

FIGURE 4. Director General of Aquaculture Decree Number: 162/KEPDJPB/2017

DGA actively educates farmers and all stakeholders involved in aquaculture (small-scale farmers, industries, food and aquatic medicine traders, government official and extension service officers) by means of flyers, open seminars, socialization seminars and internal meetings.

Fish farmers in Indonesia have long experienced dealing with disease-related problems and are highly aware of the vulnerability of the industry to diseases. For example, shrimp farmers are well aware of the significance of early disease detection and control to mitigate the impact on the industry. Nowadays, farmers recognize many aquatic transboundary diseases and report unusual mortality or morbidity during production to competent authority by: (1) directly, through short text message and using online application and (2) indirectly, through extension service and nearest laboratory by national fish diseases information system.

Fish farmers in Indonesia exist at the lowest level (fish farmer group, in district/village level) to national level (fish farmer associations) that enables two-way communication between government and farmers. In addition, provincial and district aquaculture production ventures have their own officers and laboratories (usually Level I and II laboratories) for aquaculture disease diagnostics and control; and act as liaison between farmers and competent authority at higher level.

Fish diseases diagnostic laboratories in Indonesia work in cascading fashion according to its level. Level III laboratories are national reference laboratories and directly supervised by DGA. These laboratories are situated in Java Island where most of big aquaculture activities are situated. Laboratories at the provincial and district levels are usually categorized as Levels I and II laboratories. Export-oriented shrimp farms developed their own laboratories and trained shrimp disease specialist.

The educational background skill and knowledge of staff in each laboratory are varied and mostly have bachelors degree, with a few staff with post graduate degree in fish diseases, biotechnology and veterinary. There are 15 fish health and environment laboratories under the DGA, 47 laboratories under the Quarantine Agency, three laboratories under Research, Development and Extension Agency and 75 laboratories under the Local Government (mostly Level 1 focused on water quality monitoring). In general, the national reference and provincial laboratories have aquatic animal health professionals and veterinarians as well as competent staff to meet the accurate and rapid detection requirement.

Standard Operating Procedures

Disease awareness of farmers and officers involved in aquatic diseases control is one of the top priorities of DGA. In addition to the methods mentioned above, fish disease awareness at farmers' level is achieved by personal approach according to the local social condition. Usually, when a disease outbreak is suspected, farmers will report to extension officers and laboratory personnel at district level. However, a pilot project for diseases reporting using internet-based system was introduced recently. Through this mechanism, farmers can directly report to CA through SMS gateway, phone and website. This system gave positive results but needs improvement. The standard operating procedures for national diseases reporting and response is presented in Figure 5 below.

Surveillance System

National fish diseases surveillance and monitoring was established, supported by (i) annual planning for aquatic animal diseases surveillance and monitoring; (ii) online reporting for regular reporting through Monitoring Fish Disease System Software (SSMPI) and fast tracked through Indonesian Aquatic Animal Diseases Alert System (IAADAS); (iii) appointed diagnostic laboratory based on DGA Decree (2017). In order to support laboratory capacity, some activities are done such as (i) regular training; (ii) twinning program with OIE Reference Laboratory, (iii) proficiency test towards several types of fish disease (IMNV, WSSV, VER, EHNV) collaboration with Australian Centre for International Agricultural Research (ACIAR) and NACA.

Surveillance, monitoring and reporting of aquatic animal diseases is regularly done starting from annual aquatic animal surveillance and monitoring plan, set up of aquatic animal diseases concern, commodities and target location, appointed reference and testing laboratories and reporting. The steps in the surveillance, monitoring and reporting of aquatic animal diseases are illustrated in Figure 6.

Disease Reporting System

Results of aquatic animal disease surveillance and monitoring are reported through on line Software System Monitoring Penyakit Ikan (SSMPI). The system is illustrated in Figure 7.

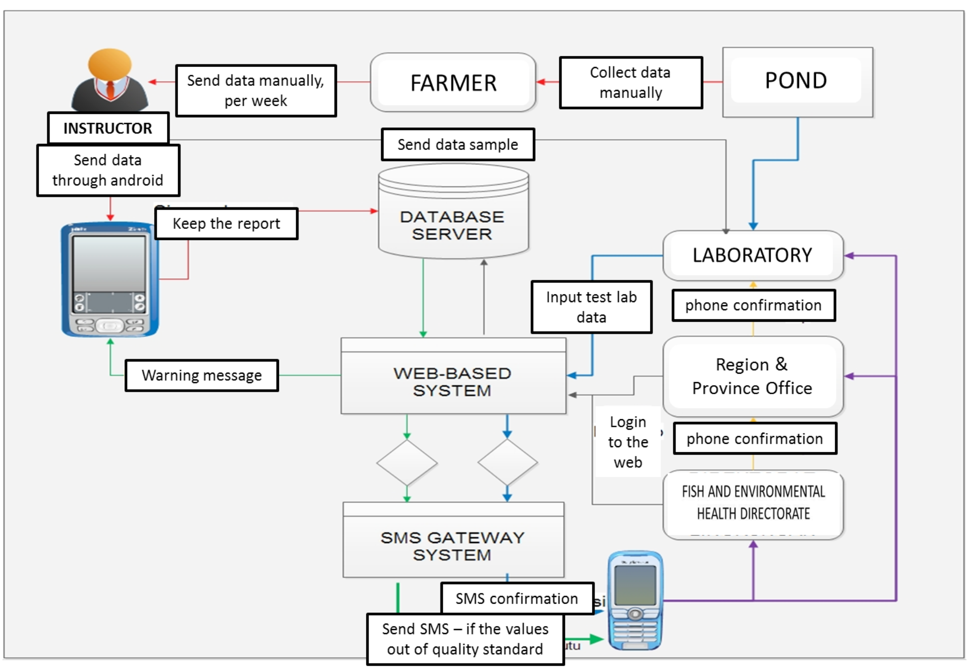

FIGURE 5. The flow of fish disease fast track report system through SMS Gateway

FIGURE 6. Surveillance, monitoring and reporting routes of aquatic diseases in Indonesia

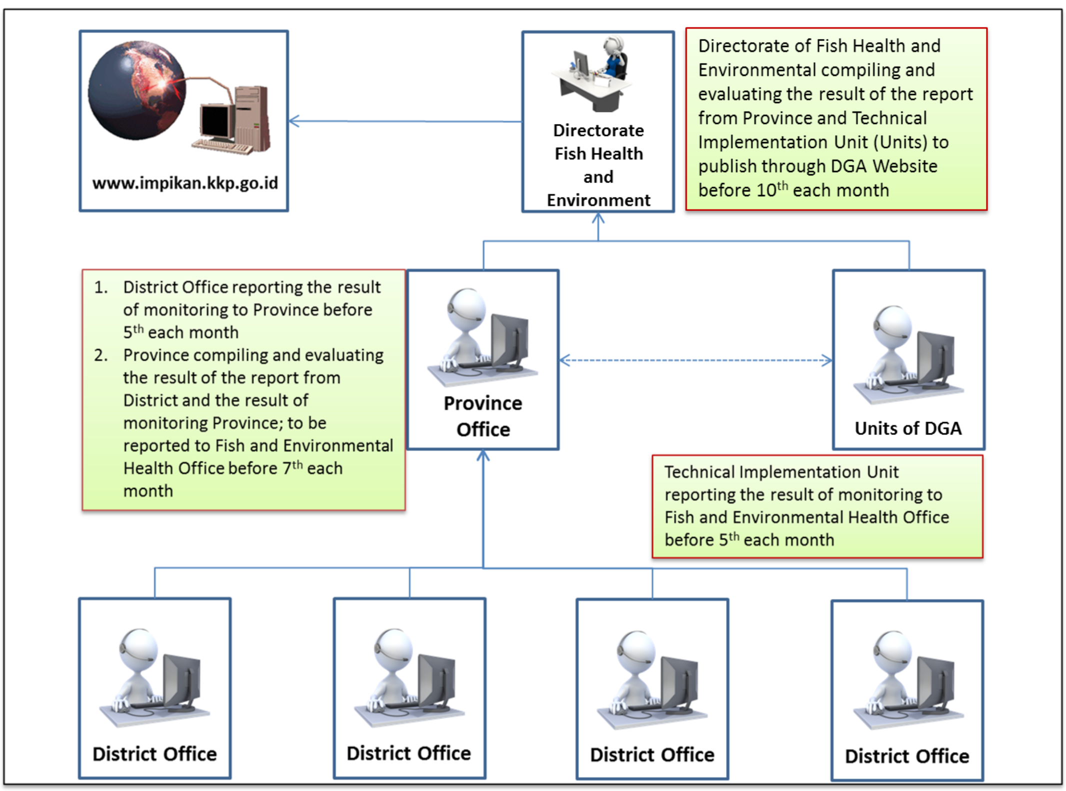

FIGURE 7. The flow of reporting the result of Surveillance and Monitoring Fish Disease through SSMPI ONLINE

Early Response System

Task Force Team

In order to support emergency response implementation, DGA establish Task Force Team following work flow as seen in Figure 8.

In case of emergency response for the emerging diseases such as KHV in 2002, EMS in 2013 and AHPND and TilV in 2017, DGA had established the Task Force. In 2017 establish Task Force on Tilapia Lake Virus (TiLV) and Acute Hepatopancreatic Necrosis Disease (AHPND) based on Director General of Aquaculture Decree No. 165/KEP-DJPB/ 2017 as seen in Figure 9.

DGA plays a central role in gathering all aquaculture stakeholders and formulating the emergency response. Member of Task Force Team consist of:

- Quarantine Agency
- Research, Development and Extension Agency
- University
- Association (shrimp farmer, hatchery, shrimp feed, processing plan, medicine and other input production)
- Expert

Public awareness

Public awareness of fish disease outbreaks is very important for farmers and stakeholders. They must be able to understand how to prevent outbreaks, treat it, and eradicate diseases so that they can by themselves minimize mortalities, economic losses and spread of disease to other ponds or farms. Improvement of public awareness has been carried out through national seminars / workshops, public counseling, and dissemination of brochures and leaflets in central aquaculture production in the Indonesian region.

A Workshop on EMS was conducted in 2013 in 12 provinces namely: West Kalimantan, Lampung, North Kalimantan, North Sumatera, West Java, Banten, Central Java, DI Yogyakarta, East Java, Bali, South Sulawesi and West Nusa Tenggara.. The workshop was conducted to update on the the status of the emerging disease EMS, understand why outbreaks occur in other countries, and how to prevent tEMS occurrencethrough the proper implementation of biosecurity measures at national, local and farm levels.

In 2014, public awareness on White Faeces Disease (WFD) was carried out in 7 provinces, namely:Central Java, North Sumatera, West

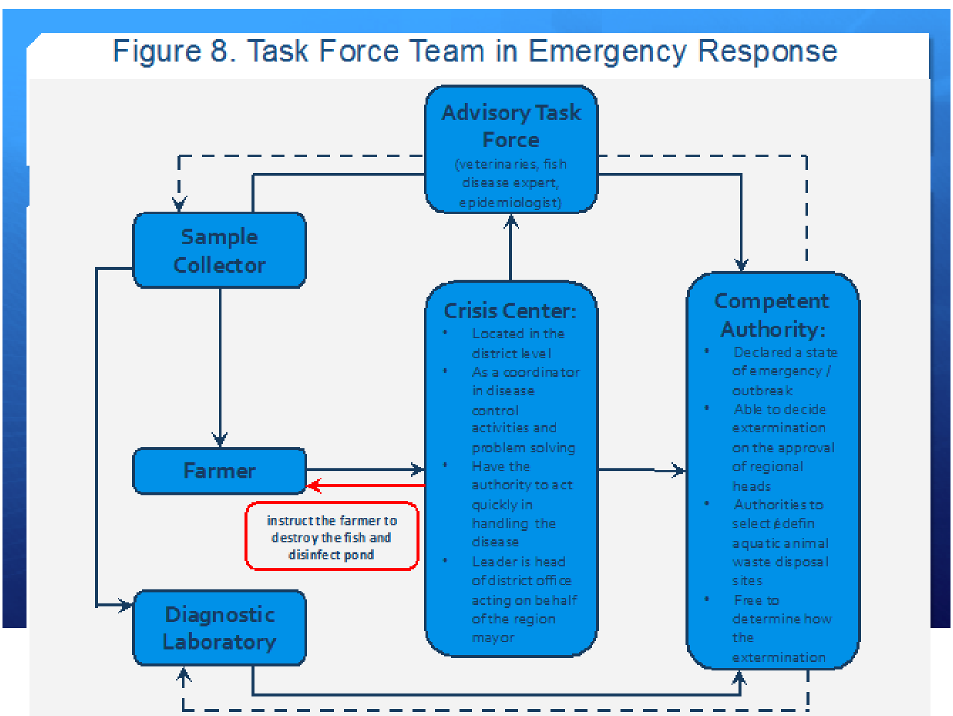

FIGURE 8. Task Force Team in emergency response

Java, DI Yogyakarta, South Sulawesi, East Java, and Lampung to update on the status of WFD in Indonesia and how to well manage WFD outbreak to reduce economic losses, eradication actions in case of outbreak in ponds as well as proper implementation of biosecurity measures.

In 2017 a public awareness seminar on Tilapia Lake Virus (TiLV) held in Jakarta was attended by 100 participants from 7 provinces: Jambi, South Kalimantan, West Java, Central Java, DI Yogyakarta, Banten and East Java. The seminar aimed to update on the status of TiLV outbreaks in different countries, to understand the hazards and risks of TiLV, and how to prevent TiLV disease from occurring in ponds and tilapia farms.

The workshop and seminar were a collaboration between the government and the private sector; the budget came from government funds with contributions from the private sectors. During the national workshops/seminars, aside from sharing information and discussions, leaflets and brochures were also distributed that provided information on diseases such as shown in one of the pictures in Figure 10.


KEMENTERIAN KELAUTAN DAN PERIKANAN

KEMENTERIAN KELAUTAN DAN PERIKANAN
DIREKTORAT JENDERAL PERIKANAN BUDIDAYA

KEPUTUSAN
DIREKTUR JENDERAL PERIKANAN BUDIDAYA
NOMOR 165/KEP-DJPB/2017

TENTANG

TIM GUGUS TUGAS PENGENDALIAN PENYAKIT *TILAPIA LAKE VIRUS (TiLV)* DAN *ACUTE HEPATOPANCREATIC NECROSIS DISEASE (AHPND)*

FIGURE 9. Director General of Aquaculture Decree No. 165/KEP-DJPB/ 2017 concerning Task Force Team on TiLV and AHPND

FIGURE 10. Workshop and seminar as public awareness on AHPND, WFS and TiLV

Standard Operating Procedures (SOP)

For the early detection and proper response to an emerging disease outbreak, an updated, accurate and simple SOP is very essential. This SOP is prepared by experts, government officers and stakeholders by adopting existing SOP's, up-to-date technology and regional/international recommendations. SOP's are prepared in a format that is easily understood and implemented by all relevant personnel.

An example of a Standard Operating Procedure provided in support of the implementation of emergency response is presented below:

- Farm investigation
- Collecting, preserving and transporting samples
- Disease diagnostic
- Disease prevention and control
- Disease treatment
- Eradication
- Rehabilitation

Reference

FAO, 2017 Guidelines for emergency preparedness and contingency plan on shrimp diseases in Indonesia, 53 p.

FAO, 2017 Aquatic Animal Health Information System on Infectious Myo Necrosis Virus (IMNV), 21 p.

Indonesian Government Regulation Number 28/2017 concerning Aquaculture.

Fish Disease Control in Japan

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Japan Fisheries Research and Education Agency

Abstract

The regulatory authority responsible for the control of aquatic animal diseases in Japan is the Animal Products Safety Division, Food Safety and Consumer Affairs Bureau, Ministry of Agriculture, Forestry, and Fisheries (MAFF). The ministry (Animal Products Safety Division) specifies certain diseases and their host species that are subjects for import quarantine on the basis of the law called "Fisheries Resources Protection Act." The MAFF also implements risk control measures for the same diseases within Japan on the basis of another law, "Fish Farming Production Maintaining Act." Currently, 24 such diseases are listed. For disease control within Japan, the MAFF issues "Guideline for the Control of Aquatic Animal Diseases," which states the roles of different stakeholders, appropriate actions that are to be taken on the occurrences of specified or other diseases, fish health guidelines for fish farmers, or diagnostic methods for specified diseases, etc. Local prefectural governments in Japan are required to place personnel who work on fish health issues at the prefectural fisheries research laboratories. These people usually inspect fish farms, observe cultured aquatic animals, supervise the use of antibiotics or vaccines, and guide fish farmers for disease control. Disease diagnosis for aquatic animals is usually conducted by these local fisheries research labs for free. The Japan Fisheries Resource Conservation Association provides a comprehensive training course on fish diseases including laws or hands-on trainings for the staff of prefectural fisheries research laboratories. The JFRCA also give local fish health personnel the qualification as the "fish health expert," if the person passes the examination conducted after the training course. Primary diagnosis for specified diseases is conducted by local fisheries laboratories. On the occurrence of the diseases that are suspected to be one of the specified diseases or OIE listed diseases that have not been reported in Japan, the samples are sent to the National Research Institute of Aquaculture (NRIA) where confirmatory diagnosis is made. When such diseases are confirmed, it is reported to the MAFF (or to the OIE through MAFF). For specified diseases, Fish Farming Production Maintaining Act enables local governments to implement necessary measures to prevent the disease from spreading, including issuing orders such as to stop the transfer of the animals to other watersheds, to destroy animals, or to disinfect the facilities. When an unknown disease is encountered by a prefectural fisheries research laboratory, the NRIA is requested to conduct diagnosis. The NRIA develops diagnostic methods for new diseases and disseminate the techniques to local fisheries research laboratories. The NRIA provide positive control materials for disease diagnosis, hands-on trainings of specific subjects concerning diagnostic techniques, or proficiency tests for the fish health personnel of the local fisheries research laboratories.

Emergency Preparedness and Response Systems for Aquatic Animal Diseases in Malaysia

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Abstract

The Department of Fisheries (DoF) Malaysia is the custodian of the Fisheries Act 1985, which serves as the main legislative source for subsidiary regulations, including aquaculture and fish health management. It has established Emergency Disease Task Force Committee for any emergency related to disease outbreak as well as standard operating procedures for massive fish kill. This committee consists of taskforce teams from federal and/or state fisheries and oversee the operations of the task force. Fisheries Biosecurity Division under DoF Malaysia holds the primary responsibility for managing the country's emergency preparedness and response system for aquatic animal diseases. As for early detection system, Fisheries Biosecurity Division has established official control and official analysis for targeted diseases listed under OIE and National Listed Diseases. Fish health monitoring programmes are conducted every six months and samples are analyzed by accredited laboratories. Quarterly and half year reports are submitted to representative offices for the health status of targeted disease. Apart from the targeted fish health monitoring program, epidemiology on common and emerging diseases are conducted by National Fish Health Research Division (NaFisH) which is the only research and development arm under DoF. Laboratories under Fisheries Biosecurity Division are responsible for organizing and coordinating surveillance programs for diseases in the OIE list while NaFisH is responsible for conducting research and development on aquatic diseases that cause high losses in industry since 2002. Currently, the DoF has four servicing laboratories under Fisheries Biosecurity Division and one NaFisH laboratory under Fisheries Research Institute for fish health diagnosis in Malaysia.

Keywords: Aquatic Health, Emergency Preparedness, Response Systems, Malaysia

Introduction

Aquaculture in the Malaysia has grown dramatically and continued to show a rapid growth. The amount of fish demand is expected to increase from 1.3 million tons in 2010 to 1.9 million tons in 2020 with growth of 3.8% per year. Per capita consumption of fish is expected to increase from 20 to 55 kilogram with growth of 1.9% annually. Aquaculture production is projected to increase to 790,000 metric tons, equivalent to 41% of total demand state fish in 2020. Export value of aquaculture, including fish products especially fillet, is expected to increase from RM1.4 billion in 2010 to RM3.2 billion in the year 2020. From 2016 to 2017, fish production from aquaculture grew 5% per year (DoF Malaysia 2016 and 2017). In terms of commodities, seaweeds contributed 47.5% from the total aquaculture production in 2017, followed by Hawaiian white shrimp (8.3%), freshwater catfish (8.2%), sea bass (7.1%), red tilapia (6.0%) and pangasius (4.7%) (Figure 1).

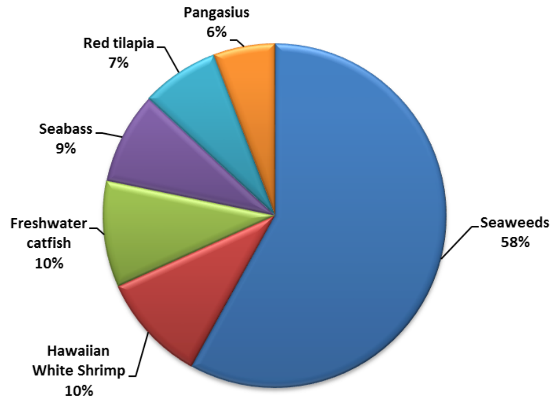


FIGURE 1. Growth of Aquaculture in 2017, Malaysia

As one of the fast growing industry in Malaysia, aquaculture sector also faced challenges related to various aquatic animal issues, managing or untimely response to disease emergencies such as disease outbreak, mass mortalities, emerging or re-emerging diseases. In order to fulfil the requirements of increased production and to secure food security for long-term sustainability, Department of Fisheries (DoF) Malaysia has been focusing on efforts to improve the quality, efficiency and effectiveness of service delivery and partnerships between the DoF and stakeholders. The DoF is the Competent Authority (CA) for fish health and biosecurity management in Malaysia (Figure 2). The CA manages fish health based on main legislative acts for subsidiary regulations, including aquaculture and fish health management. The relevant legislation implemented in Malaysia are the Fisheries Act 1985, Malaysian Quarantine And Inspection Services Act 2011, Feed Act 2009 and Animal Welfare Act 2015. As for East Malaysia, addition regulation such Inland Fisheries and Aquaculture Enactment 2003 has been implemented by DoF Sabah as well as State Fisheries Ordinance 2003 by Department of Agriculture (DoA) Sarawak (Table 1). The relevant government departments use the legislation as guidelines, and through detailed discussion with stakeholders, to formulate mechanisms that are standardised and suit the needs of industry and international trade. The implementation required rapidity and effectiveness on government to recognise and react to the first report of serious disease through early warning, first detection and responding system.

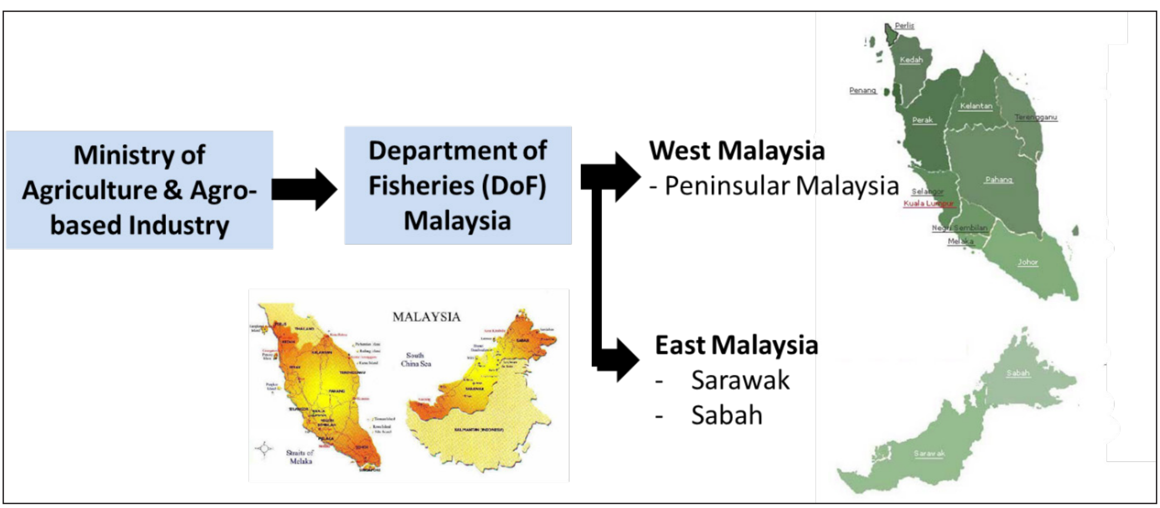


FIGURE 2. National Government Agency (CA) of fish health in Malaysia

TABLE 1. Legislative acts on fish health implemented in Malaysia

Act	Regulation
Fisheries Act 1985 (Act 317)	• Fisheries Regulation 1990 (Marine Culture System) • Fisheries Regulation 2002 (Cockle Culture and Conservation) • Fisheries Regulation 2009 (Quality of Fish for Export to the European Union) • Fisheries Regulation 2012(Fish Disease Control Compliance for Exports & Imports) • Fisheries Regulations 2010 (Prohibition of Import, etc, of Fish) (Amendment 2011) • Fisheries(Inland Fisheries Aquaculture) (Federal Territory of Kuala Lumpur and Federal Territory of Labuan) Rules 2017
Malaysia Quarantine And Inspection Services Act 2011(Act 728)	• Malaysian Quarantine and Inspection Services Regulations 2013 (Quarantine and Inspection) • Malaysian Quarantine and Inspection Services Regulations 2013 (Quarantine Procedures) • Malaysian Quarantine and Inspection Services Regulations 2013 (Issuance of Permit, License and Certificate) • Malaysian Quarantine and Inspection Services Regulations 2013 (Registration of Importers, Exporter and Agents) • Malaysian Quarantine and Inspection Services Regulations 2013 (Fees and Charges)
Feed Act 2009 (Act 968) Section 53(2) (b), (c), (e), (f), (g) and (h)	• Feed (License to Import Feed and / or Feed Additive) Regulations 2011 • Feed (Labelling of Feed and Feed Additive) Regulation 2011 • Feed (Prohibited Use of Antibiotics, Hormones or Others Chemicals) Regulation 2011 • Feed (Manufacture and Sale of Feed and Feed Additive) Regulation 2011 • Feed (Methods of Analysis of Feed and the Form of Certificate of Analysis) Regulation 2011
Inland Fisheries and Aquaculture Enactment 2003 of Sabah State	• Part IV - Aquaculture • Part VI - Control of Fish • Part VI - Control of Fish Diseases • Part X - Enforcement
Law of Sarawak, Chapter 54, State Fisheries Ordinance 2003	• Part VI - Control of Fish Diseases • Part VII - Fish Products and Fish Processing • Part VIII - Enforcement

Early Warning System

DoF Malaysia has established Emergency Disease Task Force Committee (EDTFC) which acts as national aquatic emergency preparedness and response committee toward any emergency related to disease outbreak as well as standard operating procedures for massive fish kill. This committee led by Fisheries Director General and cover Fishkill Task Force Committee and State Task Force Committee. The main tasks are to monitor, provide guidance, evaluate, oversight of progress and assist in key decisions regarding the implementation of task force.

Information from national aquatic epidemiology, alerts news from DoF Malaysia Corporate Communications Unit (CCU), National Aquatic Animal Health Focal Point (NAAHFP) for OIE and reports from DoF staff serve as early warning system for DoF Malaysia particularly to EDTFC (Table 2). The national authority monitors aquatic animal disease events in other countries through internet, literature search and attending regional consultation meetings, seminar, symposium, conference or workshop. CCU will gather news related to fisheries through social media while NAAHFP will receive latest notification of any new diseases from OIE and NACA website and subsequently will alert DoF. DoF staff participating in the regional consultation meetings, training, seminar, symposium and conference will prepare a

TABLE 2. National information sharing networks

Network	Information sharing
Corporate Communications Unit (CCU) under DoF	**Social media (Facebook, Twitter, Instagram, Whatsapp)** • Fisheries related news/issues
National aquatic animal health focal point (NAAHFP) for OIE - *E-network Malaysian Aquatic Animal Health Expert (MAAHE)*	**E-mail** • Quarterly Aquatic Animal Disease Report (QAAD) • Aquatic Animal Disease Report (OIE) • The Aquatic Animal Scientific Commission Report (OIE)
Industry Consultation	**Dialogue and meetings** • Specific issues • New regulation/requirement
Farmers Day	**Seminar and dialogue** • Annual event organized by state

detailed report and alert DoF on immediate action if required. If the alert news can cause impact to industry, Fisheries Biosecurity Division will notify the EDTFC to take appropriate action (Figure 3). Currently, DoF Malaysia is developing a specific system regarding fish health information. Under this system, information on Official Control which covers detailed profiles and activities of stakeholders, fish disease notifications, reporting and mapping will be made available. As for Official Analysis, it will include information on the disease surveillance programme and laboratory analysis. This system will be ready for use at DoF headquarter and at the state level in coming year.

DoF Malaysia also conduct risk analysis to identify high priority aquatic disease threats for introduction of alien aquatic species. Import Risk Analysis (IRA) covers list of diseases, biodiversity or genetic threat to national aquatic resources which will be carried out during the application process.

Early Detection and Response System

DoF Malaysia has developed a Fish Disease Notification Form that has been distributed to registered farms/premises (Figure 4). All registered farms/premises are obliged to notify DoF in case of the occurrence or suspicion of a listed fish disease or the occurrence of mass mortality. Farmers, state aquaculture or biosecurity fishery officers act as front line and continue to receive training and awareness on fish health management from time to time.

Apart from EDTFC, DoF Malaysia also established national aquatic epidemiology or on-ground aquatic animal disease management through Fisheries Biosecurity Division and National Fish Health Research Division (NaFisH). Fisheries Biosecurity Division is responsible for (1) preparing and drafting policies on fish and public health management, (2) providing laboratory services on fish disease diagnostics and food safety, (3) implementing the development of fish and fisheries product standards at national and international level, (4) coordinating on capacity building of staff and their training on relevant fields, and (5) managing the administration and financial aspect of the Fisheries Biosecurity Division. On their hand, NaFisH responsibilities included (1) conducting and implementing research and development of aquatic animal health specifically on fish, shrimp and mollusc health management, (2) providing laboratory services on

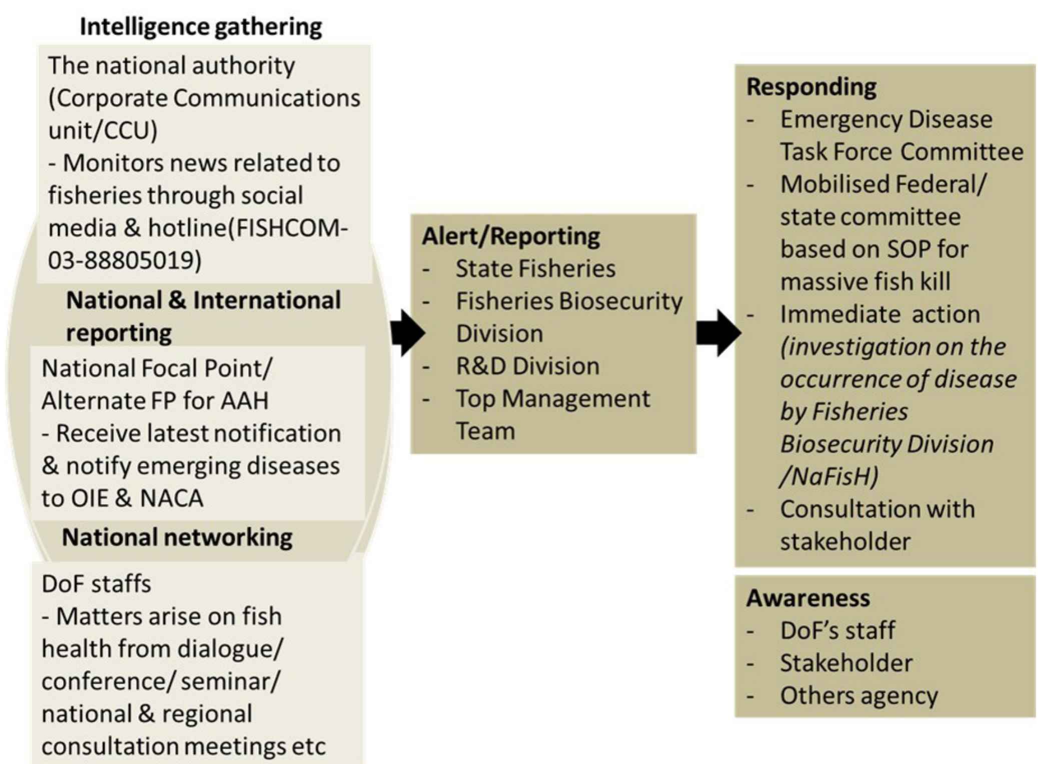
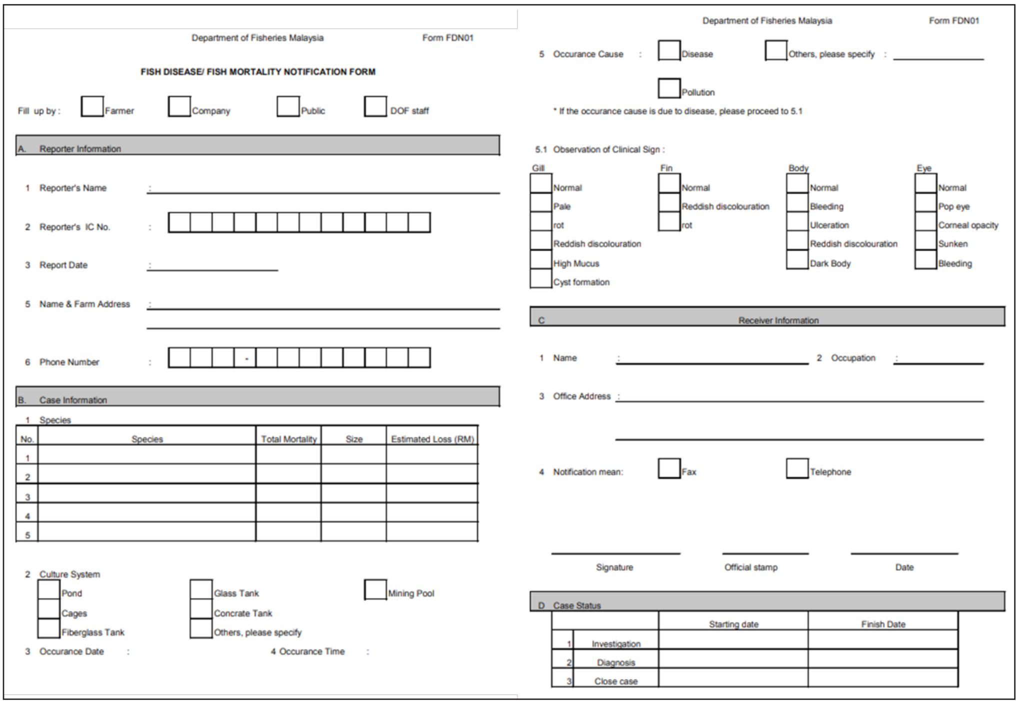


FIGURE 3. Mechanisms on early warning system by national authority on fish health management



Department of Fisheries Malaysia Form FDN01

FISH DISEASE/ FISH MORTALITY NOTIFICATION FORM

Fill up by : ☐ Farmer ☐ Company ☐ Public ☐ DOF staff

A. Reporter Information

1 Reporter's Name :

2 Reporter's IC No. :

3 Report Date :

5 Name & Farm Address :

6 Phone Number :

B. Case Information

1 Species

No.	Species	Total Mortality	Size	Estimated Loss (RM)
1				
2				
3				
4				
5				

2 Culture System

☐ Pond ☐ Cages ☐ Fiberglass Tank ☐ Glass Tank ☐ Concrete Tank ☐ Others, please specify ☐ Mining Pool

3 Occurance Date : 4 Occurance Time :

Department of Fisheries Malaysia Form FDN01

5 Occurance Cause : ☐ Disease ☐ Others, please specify : ☐ Pollution

* If the occurance cause is due to disease, please proceed to 5.1

5.1 Observation of Clinical Sign :

Gill: ☐ Normal ☐ Pale ☐ rot ☐ Reddish discolouration ☐ High Mucus ☐ Cyst formation

Fin: ☐ Normal ☐ Reddish discolouration ☐ rot

Body: ☐ Normal ☐ Bleeding ☐ Ulceration ☐ Reddish discolouration ☐ Dark Body

Eye: ☐ Normal ☐ Pop eye ☐ Corneal opacity ☐ Sunken ☐ Bleeding

C Receiver Information

1 Name : 2 Occupation :

3 Office Address :

4 Notification mean: ☐ Fax ☐ Telephone

Signature Official stamp Date

D Case Status

		Starting date	Finish Date
1	Investigation		
2	Diagnosis		
3	Close case		

FIGURE 4. Fish Disease Notification Form

fish disease diagnostics and technical assistance in fish health management to farmers, (3) providing training on fish health managements to DoF staffs and those concerned and (4) acting as adviser in main committee of National Fish Health Strategy and EDTFC. Both divisions will provide awareness and announcement through dialogs/forum to the target groups on any emerging new cases especially on the disease impact, occurrence of disease in the neighbouring countries as well as the control measures and actions to be taken by target groups (associations, breeders and other traders).

The difficulties in handling and managing the disease problems in aquaculture system are well known and worsen by the uncontrolled movement of aquatic animal species through global trading. Thus, there is a need of the industry to be aware of the current status and issues in aquatic animal health and diseases with regards to local and international requirements. In view of the increasing need of the Aquaculture industry, DoF established Fish Health Research unit under Fisheries Research Institute in 1996 with a focus on development of national personnel level with expertise on aquatic animal health. Since then, the unit grown rapidly and in 2002, the unit was upgraded into a center, carrying out R&D on fish diseases programmes, developing database of epizootics for early warning of diseases while providing and enhancing the capacity for diagnostics and disease prevention. Through five epidemiology projects focusing on diseases at national level, a database on National Pathogen Lists was established in 2010 and since then, disease surveillance on common and emerging diseases studies are based on those that cause high economic losses in the country.

Since 2010 onward, Fisheries Biosecurity Division has established official control and official analysis for targeted diseases listed under OIE-listed diseases and National Pathogen Lists (Table 3). Surveillance programme for fish, shrimp and mollusc diseases were established (Table 4). Fish health monitoring programme were conducted every six months under accredited laboratories. Currently, DoF has four servicing laboratories under Fisheries Biosecurity Division and one National Fish Health Research Division laboratory under Fisheries Research Institute for fish health control in the whole of Malaysia. These laboratories are responsible for testing of samples from the disease surveillance and investigation of fish mass mortality cases (Figure 5). From time to time, capabilities of DoF are enhanced through training conducted by national and international bodies. In the case of TiLV, two staffs of DoF were sent for TiLV course in Thailand in 2017. At the same time, development of RT

PCR detection method for TiLV was established at NaFisH. The national laboratories of Fisheries Biosecurity Division have knowledge in organising and coordinating surveillance for diseases in the OIE list while laboratories under NaFisH have been organising and coordinating surveillance for diseases that cause high losses in the country. Currently, all DoF personnel had gone through basic training course, Diagnostics Level I, II and III on aquatic animal health according to The Asia Diagnostic Guide (Melba et al., 2001).

Quarterly and half year reports were prepared by Fisheries Biosecurity Division and validation was carried by NAAHFP before submitting to representative offices for the health status of targeted disease (Figure 6). For emerging diseases, confirmation diagnosis test under national competent authority will be carried and followed by notification to OiE by NAAHFP. DoF Malaysia works hand in hand with others agencies such as (a) Department of Environment Malaysia for reporting, sampling and investigation in mass mortality of fish in open water, (b) Department of Veterinary Services (DVS) for notification/ reporting to OIE/NACA, and (c) Department of Chemistry for further laboratory analysis of unexplained mortality in open water. The positive cases were disposed under the supervision of DoF.

TABLE 3. Targeted diseases that listed under OIE-listed diseases and National Pathogen Lists

OIE-listed Diseases	National-listed Disease	Importing Country Requirements
Finfish • Koi Herpes Virus (KHV) • Spring Viraemia of Carp (SVC) • Red Sea bream Iridovirus (RSIV) • Epizootic Ulcerative Syndrome (EUS) • *Gyrodactylus salaris*	• Viral Nervous Necrosis (VNN) • Iridovirus • *Streptococcus* sp. • Enteric Septicemia of catfish • Nocardiosis • Flexibacter • Vibriosis • *Gyrodactylus* sp. • Skin monogenean • Isopod infestation	• Megalocytivirus • *Aeromonas salmonicida* (AS) • Enteric Redmouth Disease (ERD)
Shrimp • White Spot Syndrome Virus (WSSV) • Infectious Myonecrosis Virus (IMNV) • Infectious Hypodermal and Haemapoietic Necrosis Virus (IHHNV) • Taura Syndrome Virus (TSV) • Yellowhead Virus (YHV) • Macrobrachium Nodavirus (MRNV) • Acute Hepatopancreatic Necrosis Disease (AHPND)	• *Enterocytozoon hepatopenaei* (EHP) • Hepatopancreatic Parvovirus (HPV) • Spherical Baculovirus	
Mollusc • *Perkinsus olseni* • *Perkinsus marinus*	• *Perkinsus* spp.	

TABLE 4. Type of surveillance conducted in Malaysia

Active Surveillance	Passive Surveillance
Shrimp • Yellow Head Virus (YHV) • Infectious Hypodermal and Haematopoietic Necrosis Virus (IHHNV) • Infectious Myonecrosis Virus (IMNV)	**Shrimp** • *Enterocytozoon hepatopenaei* (EHP) • Hepatopancreatic Parvovirus (HPV) • Acute Hepatopancreatic Necrosis Disease (AHPND) • Spherical baculovirosis (*P. monodon*-type baculovirus)
Fish • Koi Herpesvirus (KHV) • Spring Viraemia of Carp (SVC) • Red Seabream Iridovirus • Epizootic Ulcerative Syndrome • Megalocytivirus • *Aeromonas salmonicida* • Viral Nervous Necrosis	**Fish** • Streptococcosis • Enteric Septicimia of Catfish • Vibriosis • Capsalid (Skin monogenean) infestation • *Gyrodactylus* infestation • Mycobacteriosis • Isopod infestation • Tilapia Lake Virus

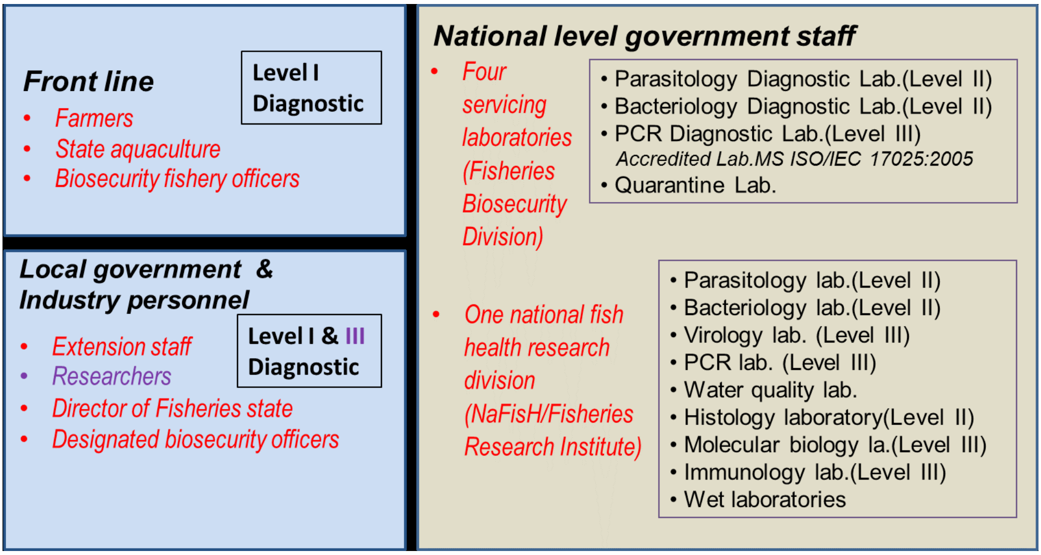


FIGURE 5. Personnel competencies of national competent authority in Malaysia

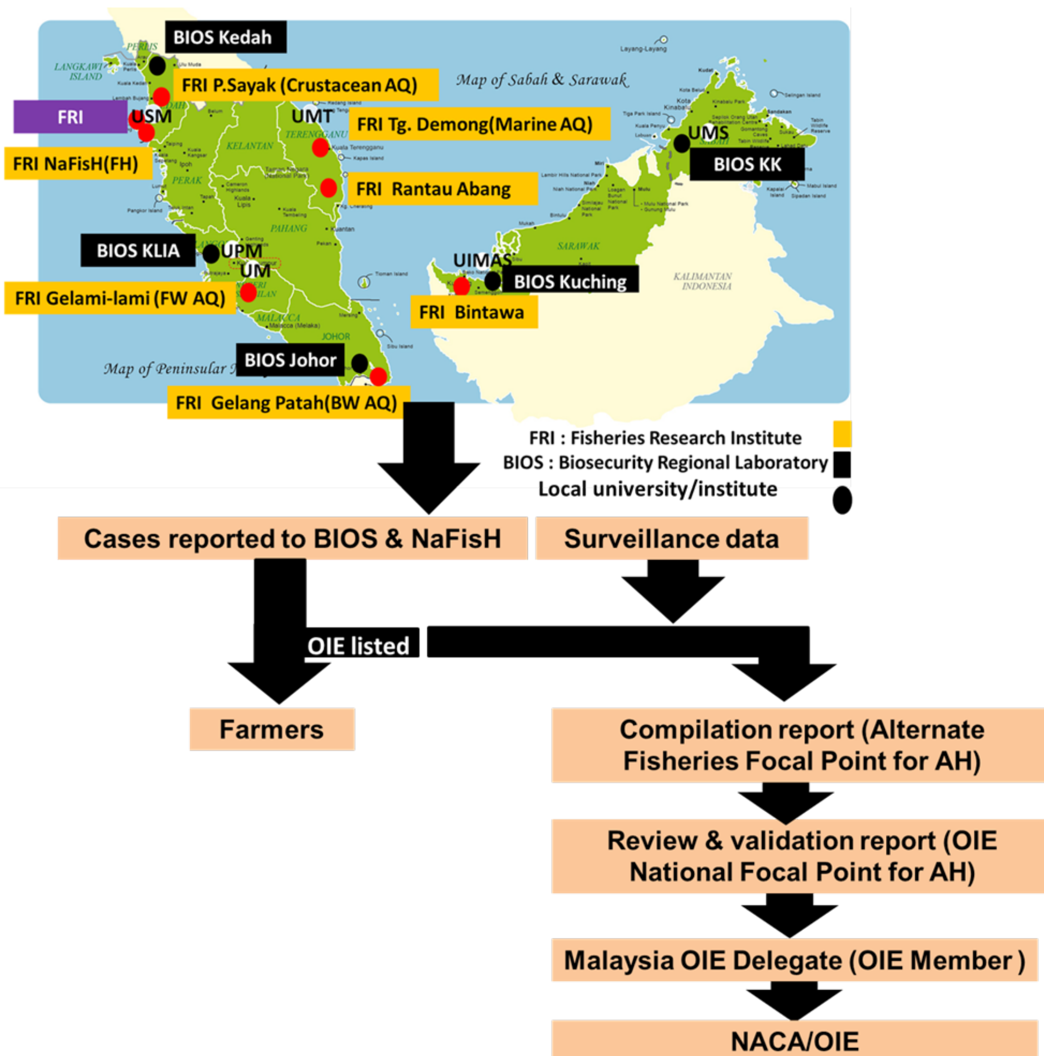


FIGURE 6. Flow chart of aquatic animal health reporting system in Malaysia

Summary

Fisheries Biosecurity Division is responsible for the implementation of official control, official guarantee and official analysis for fish and fishery products along the supply chain from farm to the exporter premises. These responsibilities cover Peninsular Malaysia, and the states of Sabah and Sarawak on the island of Borneo.

Using current procedure for early warning system, the national competent authority on fish health management was implemented on emerging disease of Acute Hepatopancreatic Necrosis Disease (AHPND) in 2011 (Figure 7) and Tilapia Lake Virus (TiLV) in 2017 (Figure 8). Imposing IRA as compulsory for country also prevent the introduction of alien aquatic species which may pose threat to national aquatic resources. Since 2010, DoF had processed and conducted 51 IRA applications for bringing in non-indigenous species to Malaysia and only 21 applications were approved (Figure 9). Through early detection and response system, an average of 15 active surveillances were performed on average of 465.4 registered farms (Figure 10). Between 2012 and 2016, the status of targeted diseases were identified (Figure 11) and the information obtained helps the competent authority to establish new guidelines for improving better fish health management.

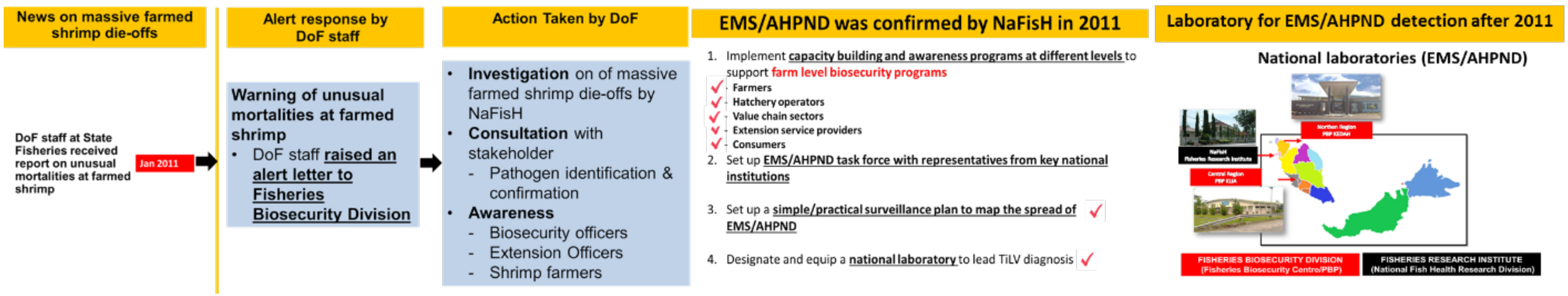


FIGURE 7. National news mechanisms for emergency preparedness and response system for emerging disease of AHPND in 2011

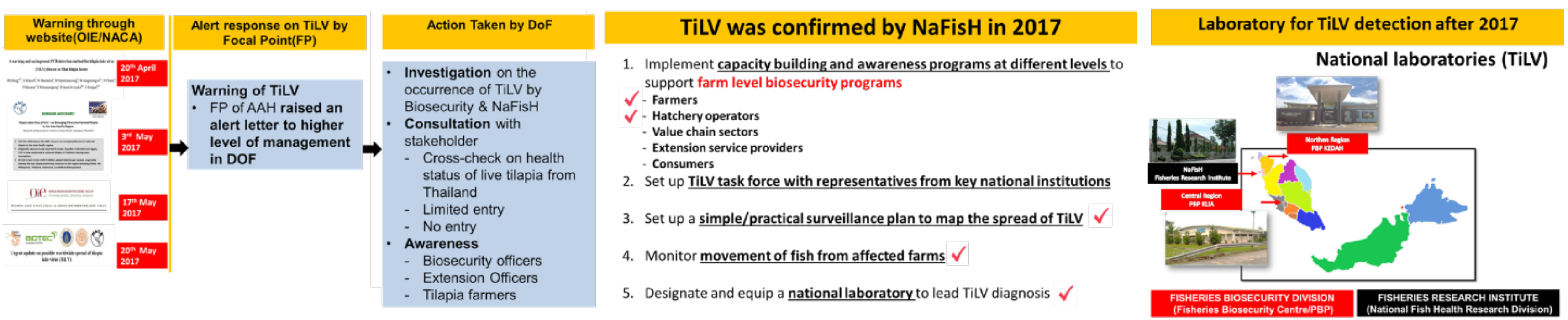


FIGURE 8. National/International reporting for emergency preparedness and response system for emerging disease of Tilapia Lake Virus (TiLV) in 2017

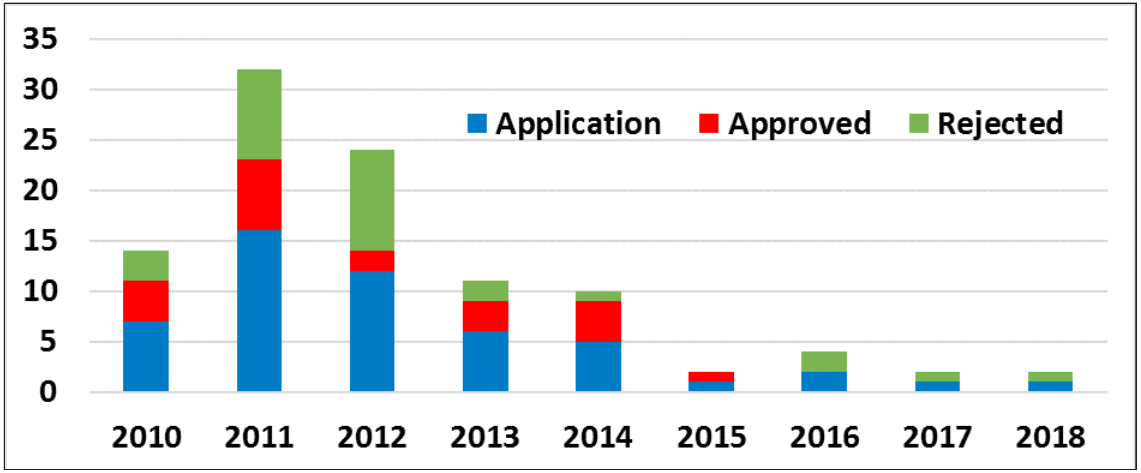
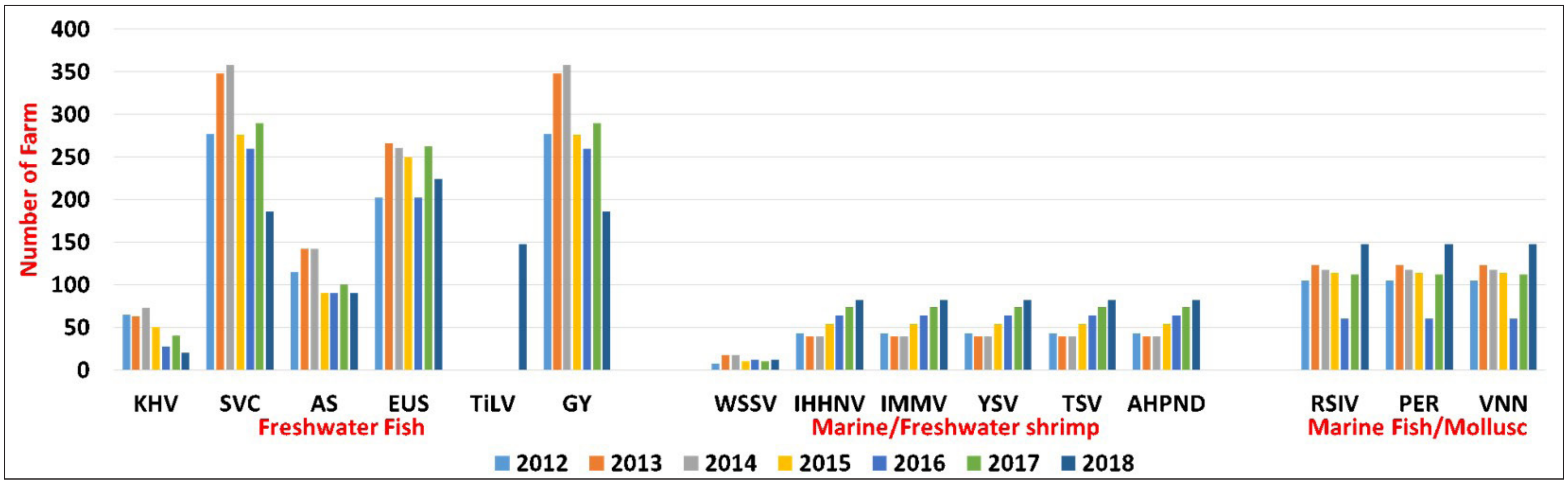


FIGURE 9. Status of application for bringing in non-indigenous species to Malaysia after IRA



Legend:
KHV - Koi Herpesvirus, SVC - Spring Viraemia of Carp, AS - *Aeromonas salmonicida*, EUS - Epizootic Ulcerative Syndrome, TiLV - Tilapia Lake Virus,
GY - *Gyrodactylus salaris*, WSSV - White Spot Syndrome Virus, IHHNV - Infectious Hypodermal & Hematopoietic Necrosis Virus, IMNV - Infectious Myonecrosis Virus,
YHV - Yellow Head Virus, TSV - Taura Syndrome Virus, AHPND - Acute Hepatopancreatic Necrosis Disease, RSIV - Red Sea Bream Iridovirus, PER - *Perkinsus olseni*, and VNN - Viral Nervous Necrosis

FIGURE 10. Fish Disease Surveillance Programmes from 2012 until 2018

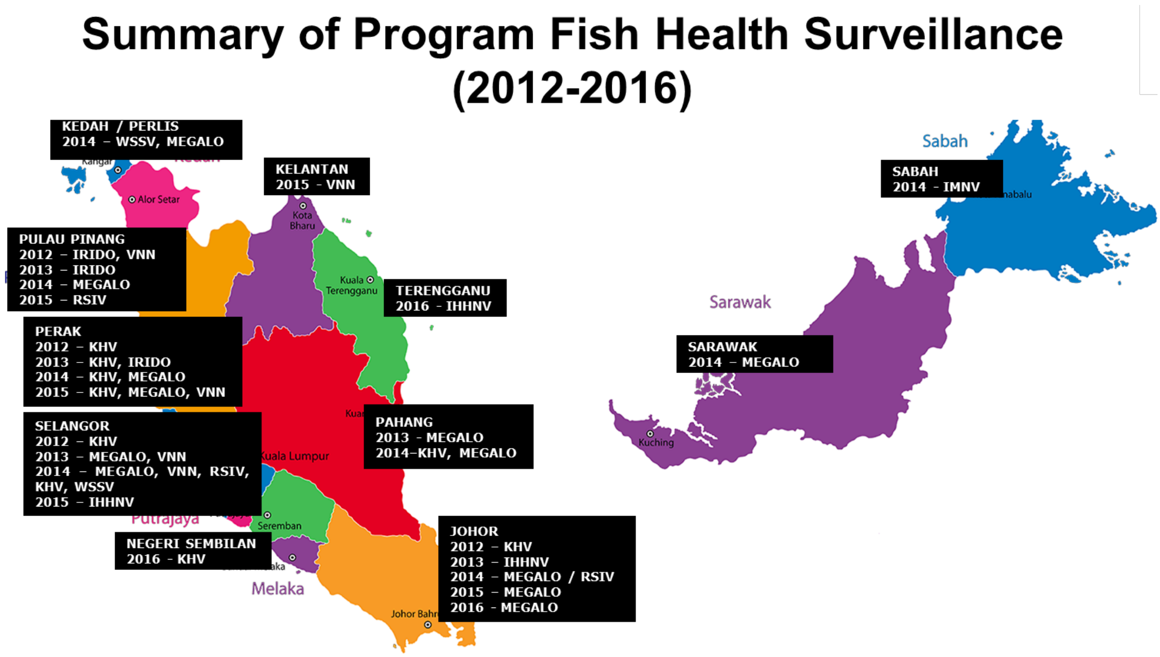


FIGURE 11. The summary of fish health programme between 2012 and 2016

Acknowledgements

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Country Status of Aquatic Emergency Preparedness and Response Systems for Effective Management of Aquatic Animal Disease Outbreaks in Myanmar

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Abstract

Myanmar is one of the OIE members and the Department of Fisheries (DoF) is highly concerned with transboundary aquatic animal pathogens. Therefore, the "Aquatic Animal Health & Disease Control Section" has already been formed not only for field diagnostic surveys but also for border control especially at international airport and border trade areas by checking and counter checking export and import of aquatic animals and products. At the moment, the DoF is stressing an issue of some transboundary diseases for finfish such as *Gyrodactylus* sp., *Dactylogyrus* sp., *Argulus* sp., *Trichodena* sp., *Streptococcus* sp., *Aeromonas* sp., and for crustacean are MrNV/XSV and WSSV. In addition, the DoF is facing challenges with parasitic disease and bacterial disease problems due to poor water quality management at culturing fish ponds. For the prevention and control of fish diseases within the country, the DoF is issuing "Health Certificates" by physical and microbiological examination of fishes and fisheries products. At the same time, "Quarterly report on fish disease" has being regularly submitted to NACA, OIE since 1998 until now. Although the DoF has no specific law and legislation on the control of quarantine pest and disease of aquatic animal, a good aquaculture practice has been implemented and code of conduct responsible for aquaculture is being followed in the country. The aquatic health management is a challenging issue in aquaculture development. Myanmar is still needing technical assistance to improve quarantine system especially for importation and exportation of live aquatic animals. Moreover, monitoring and surveillance programs with harmonized aquatic emergency preparedness and response system are required to boost up not only for Myanmar but also for effective management of transboundary disease outbreaks in Southeast Asia.

Introduction

Myanmar is one of the SEAFDEC, NACA and OIE members and the Department of Fisheries (DoF) is highly concerned with transboundary aquatic animal pathogens. Therefore, the "Aquatic Animal Health and Disease Control Section" has already been formed not only for field diagnostic surveys but also for border control especially at international airport and border trade areas by checking and counter checking export and import of aquatic animals and products. The DoF has established a total of three laboratories: central laboratory located in downtown of Yangon and the other two are in Yangon Region (located at Twante Township) and in Ayeyarwady Region (Nyaung Done Township). A competent Authority (CA) for Aquatic Animal Health Management is under the Aquatic Animal Health and Disease Control Section where "Health Certificate" (HC) is issued for Export-1 and "Registration." Applicants need to provide "Sale Contract," "Invoice & Packing Lists," "Aquaculture License," or "Collected Area's License." Mobile team does regular visits to premises for visual examination and suspected samples are collected to the nearest Disease Diagnostic Laboratory. Those are inspected by Competent Authority (CA) of DoF and finally, "Health Certificate" is issued when all necessary criteria are met. According to aquaculture law, DoF has to provide opinion comment for potential imported aquatic animals. The necessary documents for "Health Certification from CA of Oversea" are "Sale Contract," "Invoice," "Packing List," and "sample" for quarantine. Applicants need to provide "Recommendation from Imported Aquatic Animals Farm" regarding disease status. In addition, fish samples need to be submitted for Disease Detection. After that, the approval letter will be issued for the farm.

Disease Control

Myanmar DoF has not yet set quarantine unit in airport and border areas. Nonetheless, Myanmar DoF is capable of disease diagnosis: level-I on field observation of both animal and the environment including clinical and post-mortem examinations; and level-II on laboratory examination for Parasitology, Mycology, Bacteriology and Histopathology. Therefore, DoF still needs training and advanced technology; for Level-III disease Diagnostic Lab can detect the OIE Listed Disease with Real Time PCR and Conventional PCR. Some important fish disease are KHV, RSIV, VNN and SVCV and shrimp diseases are WSSV, TSV, YHV/ GAV, IHHNV, HPV, IMNV, EMS/ AHPND and MrNV / XSV)

Imported seeds including fish fry and shrimp larvae are often of low quality and affected by disease. Hatchery and farm operations are undermined by poor management due to the lack of know-how and technology, diseases prompting to increase the use of antibiotics and other chemicals increasing environmental risks, and the lack of adequate biosecurity control due to the lack of governmental capacities. The current situation highlights the need for environmental and social standards to help mitigating the adverse effects of Myanmar's aquaculture sector. As one of the intervention areas, MYSAP (Myanmar Sustainable Aquaculture Program) will increase the number of DoF services with improved quality on animal health and disease control. MYSAP organized a workshop to explore future support to improve Aquatic Animal Health and Disease Control in Myanmar and discussed with stakeholders from partner organization. So, MYSAP support the Aquatic Animal Health and Disease Control Sector Planning Workshop held on 22 May 2018.

Summaries of discussions in the workshop are as follows: (a) extension service for fish farmers is crucial to develop aquaculture sector in Myanmar, (b) capacity development for staff from DoF and universities to increase their capacities in laboratory works and aquatic animal disease control, (c) limited budget hinders for extension service in rural areas, (d) existing laboratories of DoF need to be upgraded, (e) limited staff in central laboratory in Yangon where only eight (8) staff are working and more staff needed for extension services, and (f) there is no SOP for aquatic animal movement and National Standard for GAqP in Myanmar.

Outcomes of the Workshop are as follows: (a) MYSAP will implement a 2-year plan (2019-2020) to support the Aquatic Animal Health and Disease Control Section in Myanmar, and the Diagnostic and Water Quality Management Laboratories Under Aquaculture Division of DoF will be upgraded to meet the requirements of an International Standard Laboratory; (b) there is no SOP for aquatic animal movement and National Standard for GAqP in Myanmar that MYSAP will consider technical support to develop these Standard

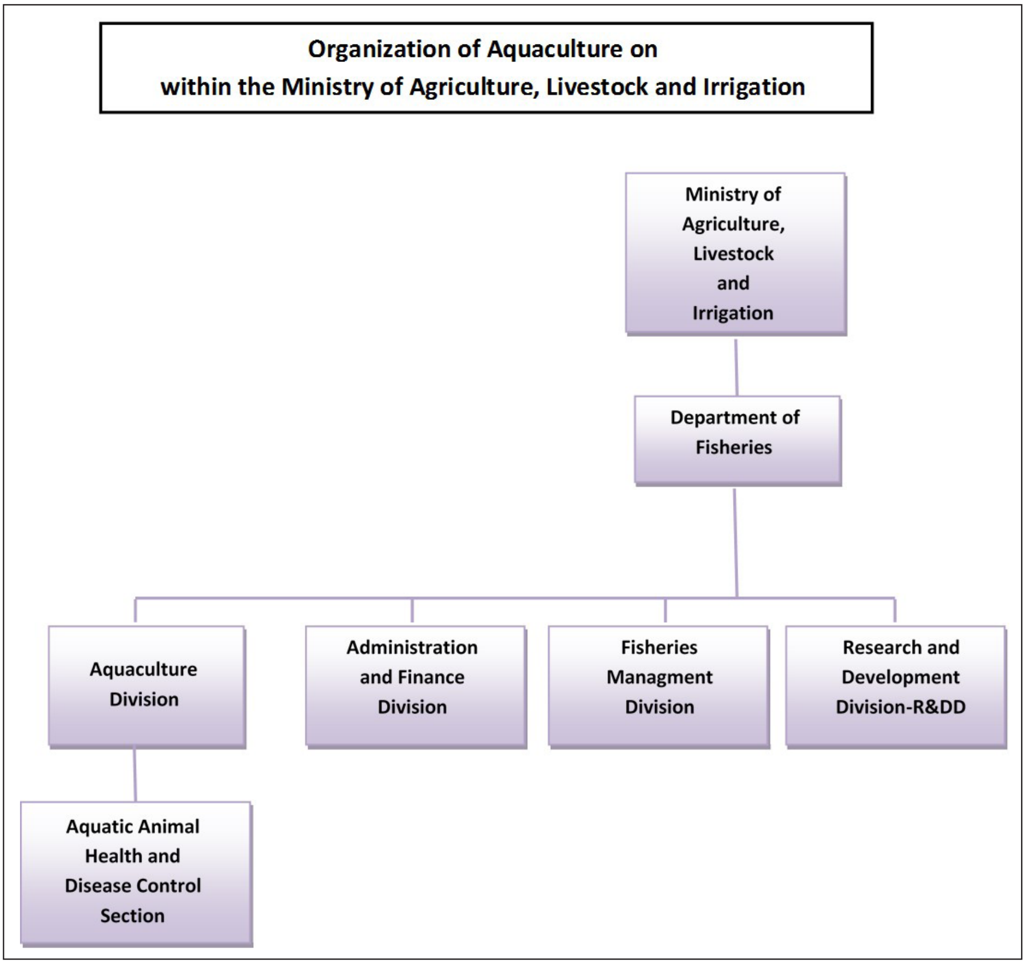
Procedures; (c) MYSAP will cooperate with DoF, Myanmar Fisheries Federation and University for capacity building programme and conduct training of trainers (ToT) for staff from partner organizations as well as the staff who attended ToT will carry out training and extension services to fish farmers; (d) DoF should set up quarantine unit to monitor live aquatic animals imported from abroad and assign the staff to work in Yangon airport and Myawaddy which is considered as main entry point from Thailand to Myanmar; and (e) MYSAP requested DoF to provide an office room for international and local consultants who will work in Thaketa, Main Laboratory during the program period and DoF agreed to it.

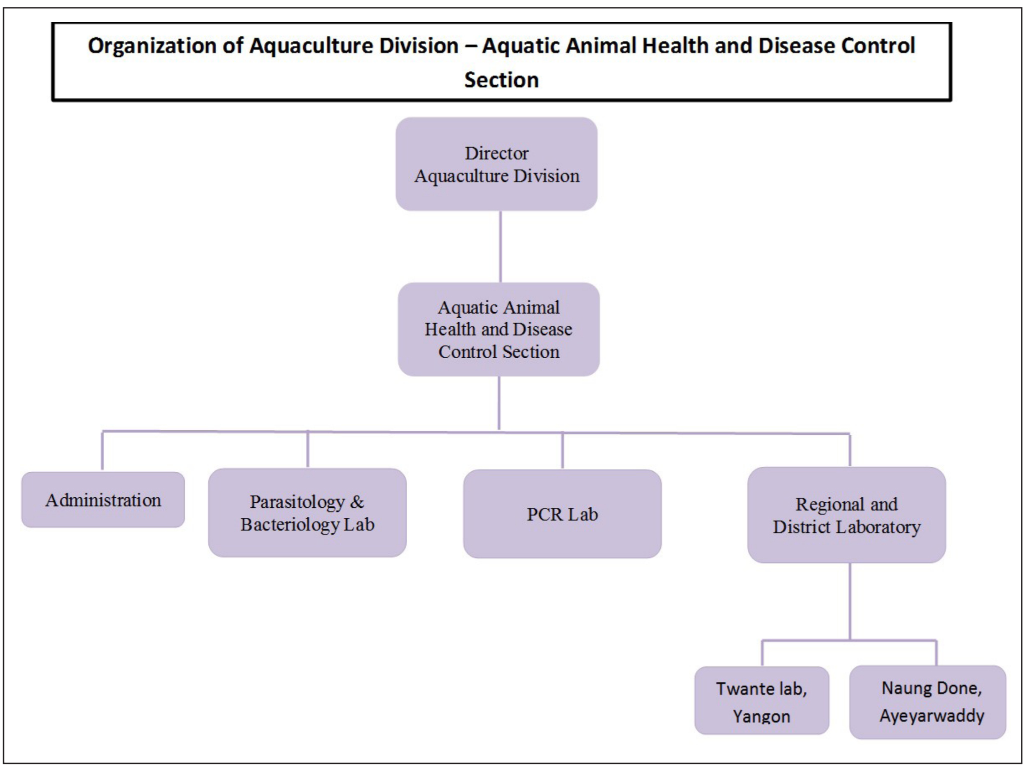
At the moment, the DoF is stressing an issue of some transboundary diseases for finfish such as *Gyrodactyous* sp., *Dactylogyrus* sp., *Argulus* sp., *Trichodena* sp., *Streptococcus* sp., *Aeromonus* sp., and for crustacean are MrNV/XSV and WSSV. In addition, the DoF is facing challenges with parasitic disease and bacteria disease problems due to poor water quality management at culturing fish ponds. At the same time, quarterly report in fish disease has being regularly submitted to NACA, OIE since 1998 until now.

Way Forward

Although the DoF has no specific law and legislation on the control of quarantine pest and disease of aquatic animal, 10th Modified Draft of the new Union Fisheries Law covered on Laboratory Sector (Amendment on Myanmar Marine Fisheries Law 1990) and DoF Directive 2/2015 (issued on July 14, 2015). The final version has not yet been completed for the import of live fish and it does not include Pest Risk Analysis chapter. A good aquaculture practice has been developed and responsible code of conduct for aquaculture is practiced within the country. DoF established a national Task Force for implementation of GAqP application in Myanmar that will adopt the ASEAN's standard for shrimp farming. Myanmar learns and tries to follow the Strategic Plan on the Development and Implementation of ASEAN Shrimp GAqP support to GAqP. DoF has established the "Directives and Regulation for prohibiting the use of chemicals in aquaculture" recently and a total of cultured areas of 4439.55 hectares for fish, shrimp and soft-shelled crab farming have applied to get national GAqP certificates. For the trade promotion of the aquaculture products, EU provided the awareness training of GAqP seven times to improve capacity building of DoF staff (n=41) and stakeholders (n=119) in 2015-2016. GAqP Extension Team was formed on 30th June 2016. They provided training in five regions and four states (19 courses) and a total of 669 trainees have attended.

The aquatic animal health management is a challenging issue in aquaculture development. Myanmar still needs technical assistance to improve quarantine system especially for import and export of live aquatic animals and monitoring and surveillance programs. It needs to harmonize with aquatic emergency preparedness and response system that can boost up not only for Myanmar but also for effective management of transboundary disease outbreaks in Southeast Asia.


Organization of Aquaculture on
within the Ministry of Agriculture, Livestock and Irrigation
Ministry of Agriculture, Livestock and Irrigation
Department of Fisheries
Aquaculture Division
Administration and Finance Division
Fisheries Managment Division
Research and Development Division-R&DD
Aquatic Animal Health and Disease Control Section


Organization of Aquaculture Division – Aquatic Animal Health and Disease Control Section
Director Aquaculture Division
Aquatic Animal Health and Disease Control Section
Administration
Parasitology & Bacteriology Lab
PCR Lab
Regional and District Laboratory
Twante lab, Yangon
Naung Done, Ayeyarwaddy

Philippines: Aquatic Emergency Preparedness and Response Systems for Transboundary Diseases

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Abstract

The Bureau of Fisheries and Aquatic Resources (BFAR) of the Department of Agriculture as the Competent Authority, develops and implements rules and regulations on aquatic animal health for the Philippines. It establishes the monitoring system for OIE/NACA listed aquatic animal diseases. The disease surveillance and reporting activities are being carried out by the BFAR Fish Health Laboratory of the National Fisheries Laboratory Division and its counterparts at the regional offices. BFAR Fish Health Laboratories have different levels of diagnostic and detection capabilities for aquatic animal diseases. Diagnostic services and technical assistance are rendered to farmers on aquatic animal health. Results of diagnostic services and surveillance by BFAR central and regional offices, and other laboratories (SEAFDEC/AQD-Fish Health, DA-Biotech, Negros Prawn Cooperative) are part of the country's aquatic animal disease reports to the OIE/NACA. BFAR has a Fish Health Network that responds to aquatic animal disease emergencies. It also coordinates and collaborates through networking with research agencies, academe, private sectors and other stakeholders on aquatic animal health.

The Fisheries Inspection and Quarantine Division implements the policies on biosecurity, quarantine and health certification for trade and transboundary movement of aquatic animals. It is also responsible for risk analysis on the importation of fish and fishery/aquatic products. Other regulatory requirements for in-country movement include local transport permit for fish and fishery/aquatic products for traceability. Importers and exporters are also registered by BFAR to ensure compliance to sanitary and food safety measures and requirements. BFAR is continuously strengthening its technical capacity, human resources, policies and regulations for a more efficient implementation of aquatic animal health services that includes response to transboundary disease emergencies of aquatic animals.

Introduction

The Bureau of Fisheries and Aquatic Resources (BFAR) is the Competent Authority for the implementation of the aquatic animal emergency preparedness and response system of the country. The implementation of programs on emergency preparedness and response system are according to the organizational set-up and network. Recent reorganization of BFAR provides for the creation of the Fisheries Inspection and Quarantine Division (FIQD) and National Fisheries Laboratory Division (NFLD), delineating regulatory functions. The FIQD implements the regulations and policies on biosecurity, quarantine and health certification for trade and transboundary movement of aquatic animals. It is also responsible for risk analysis on the importation of fish and fishery/aquatic products following the OIE Aquatic Animal Health Code guidelines.

The NFLD has central fish health and 16 counterpart fisheries laboratories in the regions with different levels of diagnostic capabilities on detection of diseases that support disease surveillance and monitoring, health certification and quarantine measures for aquaculture production, movement and trade of live aquatic animals (Figure 1).

BFAR collaborates with other agencies, institutions and industry in the implementation of aquatic animal health management programs and activities. This paper provides information on the status of aquatic emergency preparedness and response system in place.

FIGURE 1. Location map of the BFAR central and regional offices

Early Warning System

National competent authority's monitoring system/ mechanism on emerging/existing transboundary diseases (especially the OIE-listed) in the region

The Bureau of Fisheries and Aquatic Resources (BFAR) is the Competent Authority responsible for developing monitoring system on transboundary diseases. Regulations and guidelines for the implementation of programs on aquatic animal health are issued through Fisheries Administrative Orders, Office Orders, Circulars and Memoranda. The organizational structure of BFAR including administrative and technical divisions responsible for preparedness and response to emergency aquatic animal diseases is indicated in Figure 2.

The BFAR's central Fish Health Laboratory (FHL) and regional fisheries laboratories conduct surveillance and monitoring for OIE listed and other significant and emerging aquatic animal diseases in the country. It has developed the Fish Health Network composed of central and regional fish health officers that implements national programs on aquatic animal health and residue monitoring program. The central laboratory serves as the national reference laboratory of the 16 regional laboratories. It provides technical guidance to the regional laboratories and ensures harmonized implementation of programs relative to aquatic animal health management and residue monitoring including sampling, laboratory test methods and reporting system. It also provides and organizes trainings for the fish health officers. The organizational structure and coordination of central and regional offices involved in the implementation of disease surveillance and reporting system, and emergency response is illustrated in Figure 3.

Fish Health Officers at the central and regional offices conduct field investigation and laboratory analysis on the reported mortalities/outbreaks. Further, the fish health laboratories also provide laboratory analysis for (a) fry quality analysis, (b) disease screening prior to stocking of farmers, (c) disease occurence, (d) health certification and quarantine requirement for transboundary movement of aquatic animals either locally or internationally.

Information on emerging disease provided by the OIE, FAO and NACA prompt BFAR to issue Memorandum Order to regional offices about the disease for raising awareness and information dissemination. Precautionary measures are recommended such as movement restriction, health certification and quarantine to control introduction or spread of the concerned emerging transboundary disease. Consequently, the support laboratory develops detection method.

In preventing spread of significant disease from affected areas to areas where disease of concern has not been reported, domestic movement control through health certification and quarantine controls at seaports and airports are implemented.

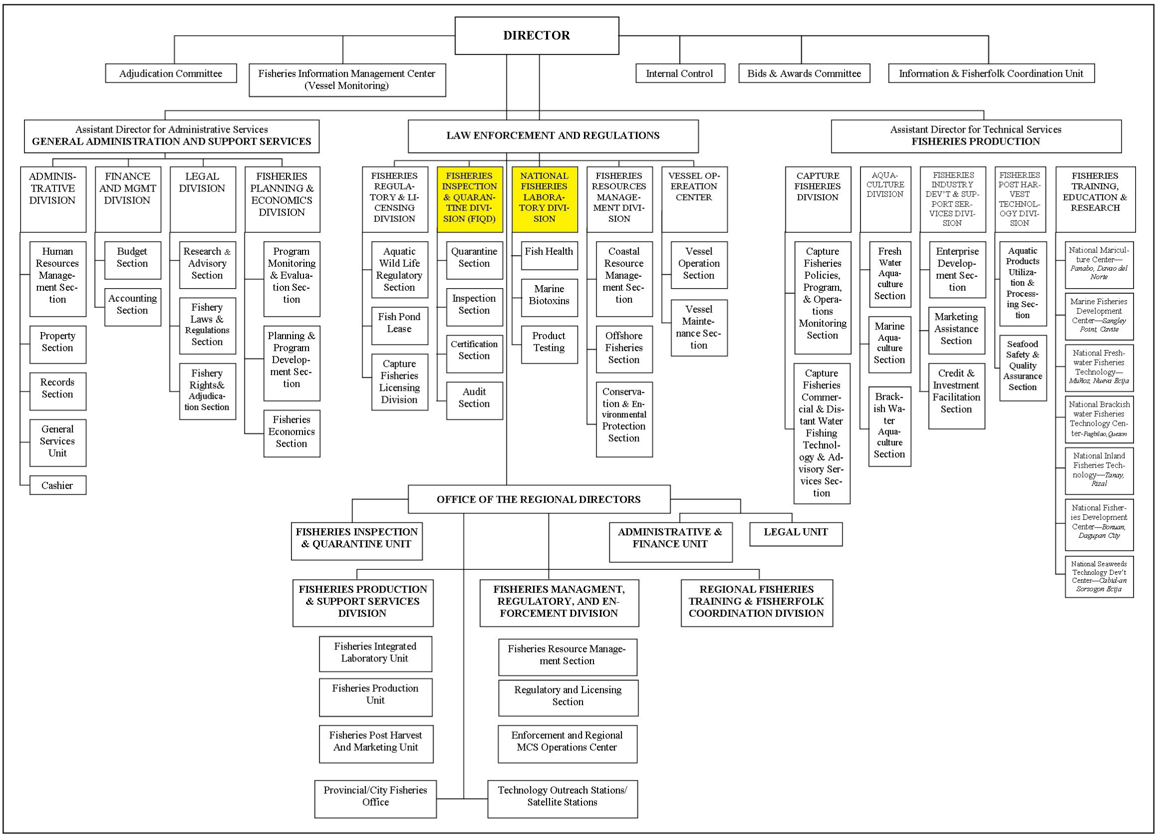
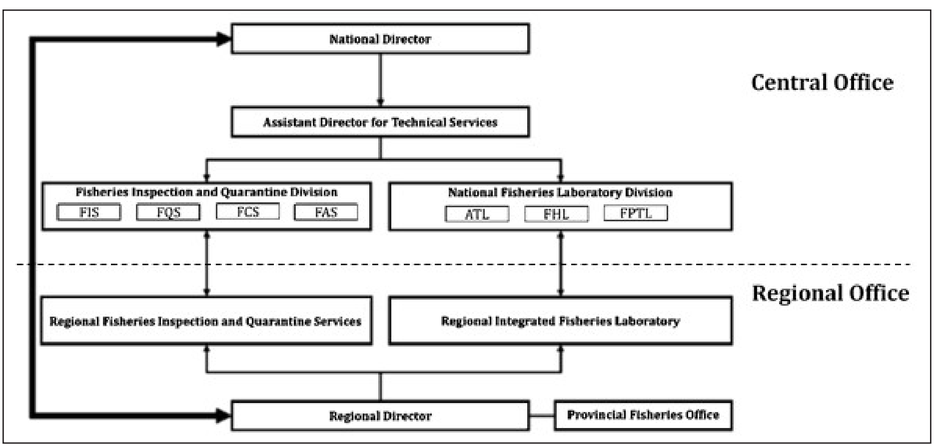


FIGURE 2. Bureau of Fisheries and Aquatic Resources (BFAR) organizational structure



Legend:
FIS – Fisheries Inspection Section
ATL – Aquatic Toxicology Laboratory
FQS – Fisheries Quarantine Section
FHL – Fish Health Laboratory
FCS – Fisheries Certification Section
FPTL – Fisheries Product Testing Laboratory
FAS – Fisheries Audit Section

FIGURE 3. Coordination of BFAR Central Office and Regional Offices in the implementation of sanitary and food safety control and supervision

Networking mechanisms of the national competent authority with trading partners

The regulations and requirements on trade (import/export) are being implemented by the Fisheries Inspection and Quarantine Division (FIQD) of BFAR. Networking with trading partners include bilateral cooperation on compliance to sanitary and food safety requirements. There are trading partners that inform BFAR through formal communication or diplomatic channel in case of detection of disease in live aquatic animal exported from the country.

The Philippines submits quarterly aquatic animal disease reports to the World Organization for Animal Health (OIE) and Network of Aquaculture Centres in Asia-Pacific (NACA) through the OIE Regional Office in Tokyo, Japan and NACA headquarter in Bangkok, Thailand, respectively. BFAR also provides disease information (six-monthly report) on the OIE listed aquatic animal diseases to the OIE World Animal Health Information System (WAHIS). The reports provided can be accessed by the trading partners for the disease situation of the country and verified when necessary during country mission inspection. Some trading partners also require detailed information on disease control measures and supervision prior to approval of importations.

Early Detection System

Recognition and reporting of a disease emergency

a. Frontline personnel (fish farmers, extension/fish health officers)

Frontline personnel are knowledgeable in recognizing disease emergency based on their experience and sharing of information among their neighboring farmers. Fish farmers also attended trainings, congress, and seminars on good aquaculture practices which include biosecurity. Compliance to requirements for registration or accreditation of aquaculture farms also improve their knowledge on aquatic animal diseases. In addition, Information, Education and Communication (IEC) materials such as disease cards are disseminated for their information.

b. Local government personnel (town/city/provincial level) and industry (extension staff, designated departmental officers, research staff officers of local disease control center, fisheries organizations)

The local government personnel participated in the trainings or seminars on aquatic animal disease recognition and reporting organized by BFAR and the private sector such as feed suppliers. They are also provided with IEC materials and exposed to field practices and monitoring and surveillance activities. Being in the local service, they have the responsibility of coordination with the farmers.

c. National government personnel (staff from national research laboratories, main authority departments, national disease control centers)

Personnel in the national government office are continuously trained to upgrade and enhance knowledge on emerging diseases and laboratory capabilities on early detection of pathogens and develop guidelines on reporting of emergency disease outbreaks. Disease card or disease bulletin provided by OIE/NACA/FAO are useful materials for disease recognition. The laboratory has continuous staff development programs and training plan so that competence is constantly improved.

Standard Operating Procedures

To provide the laboratory support, the central fish health laboratory develops capability on detection of transboundary diseases. It conducts validation of test methods and harmonization with the regional laboratories. It supervises the activities and sets direction for the operation of the RFHL and also coordinates with other laboratories that provides diagnostic/laboratory services.

It also provides the procedures for sampling, preservation and sending of samples (together with the required information) to the laboratories.

The regional laboratories have different levels of capability depending on the needs of the regions. Some regions employed screening methods for detection of diseases, and send samples for confirmatory test to the central laboratory when necessary. The central laboratory conducts annual audit of the regional laboratories on the implementation of disease surveillance and reporting program and operation of the fish health laboratories.

Awareness building and training programs

The BFAR FHOs prior to designation are required to undergo training on fish health management which is conducted by the NFLD. The trainings are handled by the core technical staff of the section who are experts on their fields of practice. The NFLD staff are also invited as resource persons to workshops/forum/trainings conducted by the regional offices and other government and non-government organizations.

Training plan for each year is programmed for continued staff development and capacity building. There are also formal non-degree training programmes and short training course on fish health management provided by regional institutions like Southeast Asian Fisheries Development Center (SEAFDEC). BFAR staff attended trainings on aquatic animal health provided by other organizations such as SEAFDEC, Network of Aquaculture Centres in Asia-Pacific (NACA), Food and Agriculture Organization (FAO), World Organization for Animal Health (OIE), European Union (EU), Japan International Cooperation Agency (JICA), Australian Centre for International Agricultural Research (ACIAR), International Development Research Centre (IDRC) and other Association of Southeast Asian Nations (ASEAN) initiatives. BFAR also participates in several regional projects of the FAO, NACA, OIE, EU-TRTA and other organizations on aquatic animal health and related activities.

Awareness programs for government and industry personnel are provided through industry conference/training/seminars (e.g. shrimp congress, milkfish congress, tilapia congress) in which topics on aquatic animal health/diseases are included.

National information sharing networks

The Fish Health Network conducts annual reporting and planning, and meeting/workshops when necessary for updates and to harmonize implementation of national program on fish health. BFAR FIQD also organizes meetings/workshops with the industry, researchers, academe, and aquatic animal health personnel for information sharing on aquatic animal health programs, activities and researches.

Surveillance systems (passive surveillance programs for targeted and non-targeted diseases and active surveillance programs for targeted diseases)

The disease surveillance program considers both targeted and non-targeted sampling, and data collection of information, in determining the status of diseases in the country. Disease surveillance is included in the farm registration scheme implemented by the bureau where history of disease/health problems encountered by the farm are declared. Samples are taken for screening of significant diseases of species being cultured and antibiotic residue analysis. The registered farms are being inspected and monitored at least once a year depending on the status of the farm based on results of analysis for diseases and residues.

Disease surveillance is focused on the OIE listed diseases and other significant and emerging diseases in the region, to determine (a) presence/absence of significant diseases that has not been reported in the country, (b) diseases already reported in the country to determine extent/spread, (c) prevalence and seasonality. Results of disease surveillance and monitoring are used in the formulation of regulation on prevention and control measures.

Disease reporting system (national and international authority; e.g. NACA/OIE)

The Fish Quarantine Section (FQS) is responsible for aquatic animal disease notification and reporting system. Results of diagnostic cases were received or taken from central and regional fish health laboratories and other laboratories. Regional Offices submit monthly reports on their disease surveillance activities to the central fish health laboratory. The collated data is submitted to the FQS for reporting to the OIE and NACA for quarterly aquatic animal disease and six-monthly aquatic animal disease reports. BFAR also coordinates with other laboratories for aquatic animal diseases such as SEAFDEC/AQD, NPPC, DA Biotech, academe. Disease reports are usually received from farmers that experience any abnormal mortalities/ morbidity. They convey the report to the local government/regional/national authority directly, whichever is most accessible to them. Fish Health Officers have forms for the reporting system. There is a direct line of communication from the regional counterparts to the national authority for reporting suspected disease agents of concern. Consequently, disease information is disseminated to the BFAR officials and to Regional laboratories.

In case of detection and confirmation of important exotic disease, BFAR notifies the stakeholders. Upon confirmation of diseases occurrence, BFAR (OIE National Focal Point for Aquatic Animals) through the OIE Delegate has the responsibility in submitting quarterly aquatic animal disease reports to the OIE Regional Office and NACA Headquarters.

Diagnostic capability/ capacity

The Fish Health Laboratory (FHL) of the National Fisheries Laboratory Division (NFLD) serves as the country's national reference laboratory for aquatic animal disease diagnosis. The Central Fish Health Laboratory and the 16 Regional Fisheries Laboratories (some with satellite laboratories) follow documented procedures on collection, packaging, transporting and sending samples to the laboratory. The regional laboratories have different levels of capability on disease detection.

Documented quality management system is implemented by the NFLD laboratory. It has undergone assessment by the Philippine Accreditation Bureau (PAB) for ISO/IEC 17025 accreditation. Detection of shrimp diseases using PCR are among the scope of proposed accredited methods. Regional fisheries laboratories (RFL) in regions III, IV-A, VI, VII, IX and XII were assisted by the EU-TRTA project to develop the quality management system according to ISO/IEC 17025.

The central fish health laboratory together with two regional fisheries laboratories, participate in proficiency testing program for aquatic animal diseases organized by the Aquatic Animal Health Laboratory-CSIRO and Australian government.

Early Response System

Personnel competencies on identification of a disease emergency, identification of risks associated with the suspected pathogen, confirmation of the aetiology/etiologic agent of the disease, reporting to competent authority, formulation of control options

a. Frontline personnel (fish farmers, health professionals, fisheries extension officers of local fish health center)

Based on the Philippine National Standard (PNS) on Code of Good Aquaculture Practice, controlling spread of aquatic animal diseases should include the training of farmers in the identification of abnormalities in fish behavior and physical appearance, evidence of awareness on disease, control and notification to BFAR of the observed abnormalities. These are achieved through participation in the various activities conducted by the BFAR central and regional offices, local government units, stakeholders' organization, academe and other concerned institutions.

Reporting of diseases by farmers is encouraged. There are fish farmers that report to their local or regional BFAR offices any unusual cases of high mortalities within their aquaculture farm. There are also farmers that consider the laboratory test results and advise of fish health officers/extension officers. Some farmers opt for emergency harvest at the early signs of problems.

b. Local government personnel (town/city/ provincial level) and industry (extension staff, designated departmental officers, research staff officers of local disease control center, fisheries organizations, processors and brokers)

Programs and activities developed by the central office on aquatic animal health, food safety and quality assurance services are coordinated with the regional offices for implementation. Each Region has an animal health, food safety and quality services linked to the Central Office. Regional Offices have Provincial Fishery Officers assigned in the Local Government Unit to implement relevant regulatory functions down to the level of the farmers.

The recognized laboratories in the industry involved in analytical testing services for aquatic animal diseases are the Negros Prawn Producers Cooperative (NPPC) and the Southeast Asian Fisheries Development Center (SEAFDEC).

c. *National government personnel (staff from national research laboratories, main authority departments, national disease control centers)*

FQS and FHL have the capacities on the identification of a disease emergency, the identification of risks associated with the suspected pathogen, confirmation of the etiology/etiologic agent of the disease and the development of control options. Staff are trained on fish health management, good aquaculture practices and biosecurity, monitoring, reporting, health certification and quarantine for the movement of live aquatic animals and national residue monitoring program for aquaculture products. Workshops on the harmonization of central and 16 regional offices are also regularly done. It also provides specialized training on fish disease diagnosis as well as good aquaculture practices to fishery biologists, extension workers, and fish farmers

Awareness building and training

BFAR Fisheries Quaratine Officers (FQO) from the central and regional offices regularly attend trainings/workshops on implementation of quarantine services and activities. Their services include pre-border, border and post-border examination of live fish, fishery/aquatic products, risk assessment, quarantine protocols in importation and exportation of live aquatic animals, compliance to disease-reporrting to the OIE, and to respond to disease outbreaks and emergencies. Continuous staff development is included in the annual plan of the division.

Standard Operating Procedures

The structure of emergency disease notification and reporting system is illustrated in Figure 4.

Upon receiving the initial report of emergency disease outbreak, assessment and verification are conducted. FQOs then coordinates with the BFAR National/Regional Director, Local Government units (LGU), other concerned agencies and the Regional Disease Outbreak Investigation team. Disease Outbreak Investigation team is composed of Quarantine officers, Law Enforcement officers, Provincial Fisheries Officers, FHOs, Fisheries Aquatic Resources Management Council (FARMC) representative, LGU and representatives from other concerned BFAR units and agencies.

Containment of affected population is recommended until on-site investigation is done and diagnosis is confirmed. Proper disposal of dead fishes and other aquatic animals suspected to be disease-carrying should be done. Other control or remedial measures that may be implement by the operator include treatment/chemical application, disinfection of affected compartment, and destruction of sick animals. FQO submit the disease outbreak report to the Director. Surveillance activity is continued to determine the extent of the disease.

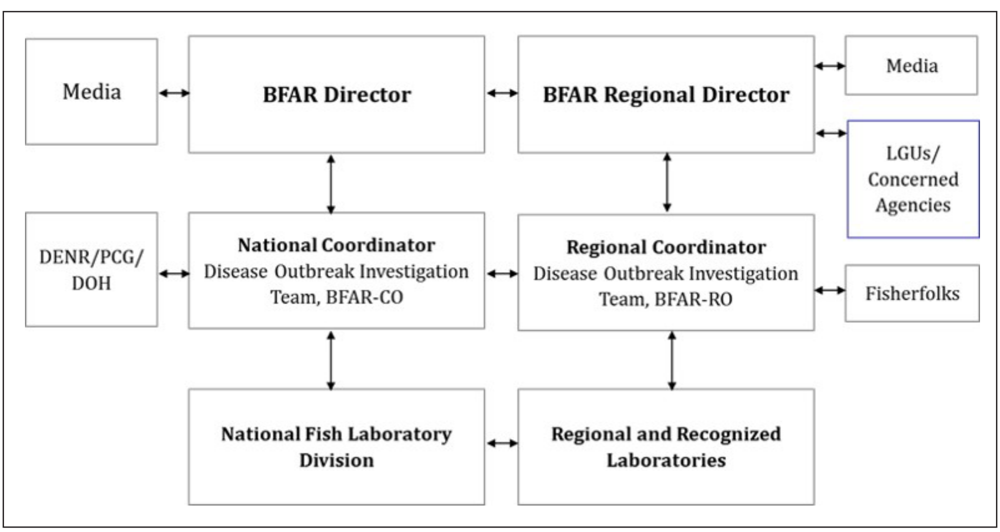


FIGURE 4. Proposed structure for the proper coordination between BFAR and other agencies in the conduct of disease emergency investigation

Conclusion and Recommendation

Currently, the implementation of aquatic animal emergency preparedness and response are carried out through coordination of the concerned sections together with the regional counterparts according to their functions and responsibilities. The EPRS has to be formalized through consultation with the industry for collective and effective management of transboundary disease outbreaks. It is also important to strengthen and maintain capacity to ensure early detection and early response.

Aquatic Emergency Preparedness and Response Systems in Singapore

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Abstract

Singapore's population-dense, urban environment presents a unique context for her increasingly important aquaculture industry. This paper provides an overview of Singapore's existing aquatic emergency preparedness and response systems, which have been constructed and refined by the Agri-Food and Veterinary Authority (AVA) in view of past experience with detections of pathogens of warmwater fish. These systems have been developed to fulfil Singapore's obligations as an OIE member country and AVA's duty to safeguard food security, animal and public health. As a trade and export hub, it is critical for Singapore to have timely detection and reporting of diseases which can have an impact on trade. Singapore also needs to balance the needs and perceptions of the multiple stakeholders using the limited space and resources in our island state. Finally, this paper outlines the current issues and gaps of Singapore's existing aquatic emergency preparedness and response systems.

Status of Aquaculture in Singapore

Singapore has a small but thriving and increasingly important food fish farming industry which accounts for about 10% of local food fish consumption. The main bulk of food fish production comes from coastal fish farming in floating netcages along the Straits of Johor and the Southern Islands. Most of these floating netcages are traditional wooden platforms but some of the farms have cages made of materials like HDPE.

There are 114 coastal and deep sea fish farms (105 food finfish and 9 bivalve farms) and 9 land-based foodfish farms that produced about 4,808 MT of food finfish in 2017. Common marine food fish species cultured include Asian seabass (*Lates calcarifer*), groupers (*Epinephelus* spp.), snappers (*Lutjanus* spp.), milkfish (*Chanos chanos*), mullet (*Mugil* spp.) and pompano (*Trachinotus* spp.). Other than finfish, a few coastal farms also produce green mussel (*Perna viridis*) and oysters (*Crassostrea gigas*) which form the bulk of shellfish production in Singapore.

Land-based foodfish farms mainly culture freshwater species like the giant snakehead (*Channa micropeltes*) and tilapia (*Oreochromis* spp.). Other species include jade perch (*Scortum barcoo*) and catfish (*Clarias batrochus*). The culture system in traditional land-based farms are mostly earthen or concrete ponds. Recently, a number of land-based farms using recirculation aquaculture systems (RAS) technology have been set-up, mainly producing groupers and shrimp.

Growing the local food fish production

Our local food production target is 15% for fish. Local production has been rising over the years. Presently, local farms are producing 10% of our fish supply. The targets that we set are reviewed from time to time as our needs evolve and as technology becomes available. New technologies such as sensors, precision farming, automation, robotics, genetic improvements, and other engineering solutions are bringing many opportunities for increasing productivity and raising local production.

Singapore is the world's leading exporter for ornamental fish

Singapore has held this position over the past 20 years and exports appoximately US $40-50 million worth[1] of ornamental fish annually to over 100 countries. Our top markets are the US, UK, Japan and Germany. The market share has been stable over the years, making up about 15-20% of the global market value. To meet international trade requirements and facilitate trade for ornamental fish, the AVA has put in place quality assurance and surveillance programs to provide an all-rounded approach to assure quality and health status of animals for export to the global market. The success of this industry is due to Singapore's strengths in the provision of health certification, quality assurance, logistic channels and aviation connectivity. Inspection and health checks, continuous education and outreach are part and parcel of the efforts to ensure that only healthy and high quality ornamental fish are exported.

Disease Control

The control of diseases in food fish

Major bacterial diseases in food fish include streptococcosis, nocardiosis, vibriosis and tenacibaculosis. Viral infections with VNNV, SDDV and Iridoviruses have also been detected [Annex 2]. All farms have access to extension and laboratory diagnosis services to ensure timely and accurate detection of the causative agent of mortalities and morbidities in fish. Farms can also voluntarily submit imported marine food fish fry and fingerlings for disease screening. Such services are provided without charge to farms and costs are borne by the authority.

TABLE 1. Farm production of food fin fish for the last 10 years

Year	Farm Production									
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Locally produced Food Fin Fish (tons) *Excluding crustaceans and mollusc*	1970	2235	3186	3476	3157	4220	4205	5272	4851	4808

[1]Aquarium accessories and ornamental plants are consolidated with OF and shipped out together.

However, disease control remains a challenge. Apart from a few large progressive food farms, the majority of food fish farms are small-holder farmers with diverse education levels. In addition, vaccines for tropical food fish are limited in availability worldwide and rarely used by smaller farms. From a voluntary survey of wholesalers of veterinary drugs done in 2015 and 2016, the aquatic food fish sector is the largest user of antimicrobials in animals in Singapore, with 77.5% of the antimicrobials sold in 2016 being used here. Sales of antimicrobials in the aquaculture sector have increased by 33% from 892 kg in 2015 to 1185 kg in 2016. From the results in the chart below, it is evident that the food fish industry is the largest user of antimicrobials[2] in animals in Singapore.

Current status of the Aquatic emergency preparedness and response systems in Singapore

Legislative powers of the Agri-Food & Veterinary Authority of Singapore (AVA)

The Agri-Food & Veterinary Authority of Singapore (AVA) is the sole national authority responsible for all matters pertaining to aquaculture health, trade and food safety in Singapore. The management of aquatic animal health and aquatic emergency preparedness and response systems, cuts across several departments in the AVA. The AVA uses the powers provided by the Agri-Food and Veterinary Authority Act[1], the Animals and Birds Act[2], and the Wholesome Meat and Fish Act[3], and their subsidiary legislation, in order to safeguard aquatic animal health and protect the health of human consumers.

In particular, the Animals and Birds Act is for preventing the introduction and spread within Singapore of diseases of animals, birds or fish; the control of the movement of animals, birds or fish into, within and from Singapore; diseases notification; the prevention of cruelty to animals, birds or fish; measures pertaining to the general welfare and improvement of animals, birds or fish in Singapore and for purposes incidental thereto.

Section 62 (1) of the A&B Act empowers the AVA to at any time, suspend or revoke the license or restrict the operation authorized by the license, where the holder or the company,

(i) Is convicted or suspected of any offense under the Animals and Birds Act
(ii) Contravenes or fails to comply with any statutory requirement relating to the license
(iii) Contravenes or fails to comply with any condition or requirement specified by the license

The Wholesome Meat and Fish Act regulates the slaughtering of animals and the processing, packing, inspection, import, distribution, sale, transshipment and export of meat products and fish products and for matters connected therewith.

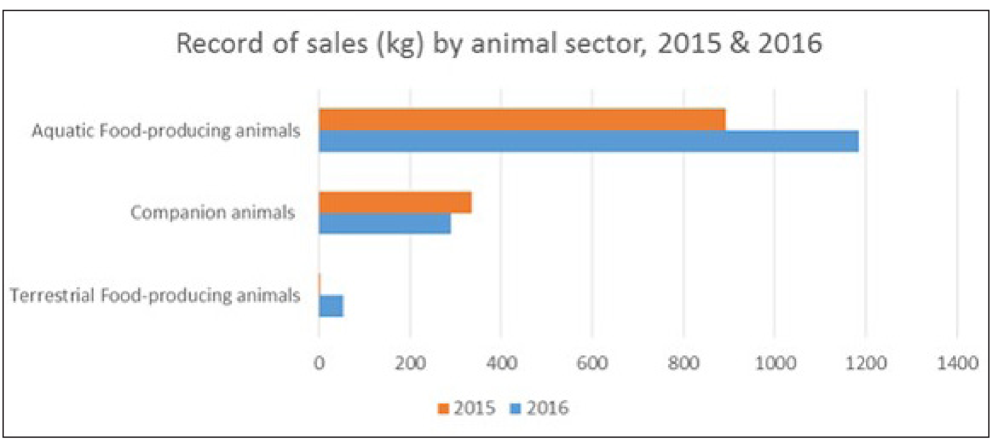

FIGURE 1. Results of survey of wholesalers of veterinary drugs

[2]Agri-Food and Veterinary Authority of Singapore is responsible for regulation and monitoring of AMU and AMR in aquaculture in Singapore. Outreach and education, accreditation schemes, good aquaculture practices, facilitation of vaccines, development of prudent use guidelines and strengthening of regulations are some areas AVA is working on in concert to reduce AMU in the aquaculture industry, especially those critically important to human health

Preparedness and response

AVA carries out national surveillance programs for significant viral and bacterial diseases of both ornamental and food fish. Based on the information derived from these surveillance programs, AVA's veterinarians, surveillance staff and extension personnel work closely with the aquaculture industry to control and manage aquatic diseases in Singapore. All farms have access to extension and laboratory diagnosis services to ensure timely and accurate detection of the causative agent of mortalities and morbidities in fish. Officers working with the farms on the ground will keep farmers informed of the results from tests. In addition to the surveillance implemented by AVA, it is a legal requirement to notify AVA if a notifiable or significant disease is suspected. It is also our obligation as an OIE member country to bear the cost of testing for notifiable diseases and report these when detected. Isolation or quarantine orders can be issued to control the spread of notifiable aquatic diseases on all premises, not limited to those licensed by AVA.

Surveillance programmes for Ornamental and Food Fish

Disease surveillance for ornamental fish involves routine sampling for the following diseases: Koi Herpesvirus (KHV), Spring Viraemia of Carp Virus (SVCV), *Aeromonas salmonicida*, Megalocytiviruses (ISKNV & RSIV), and White Spot Syndrome Virus (WSSV) for ornamental crustaceans. Samples will be taken for disease diagnosis should there be any diseased fish observed during inspection of the ornamental aquaculture premises.

A marine food fish disease surveillance programme is also in place to provide diagnostic services for local foodfish farms. The surveillance is of a passive nature with farms submitting moribund or diseased fish on a voluntary basis. Only 10 to 20% of the coastal marine food fish farms currently submit diseased fish samples for surveillance. Results and findings of the diagnostic tests are then communicated to the farms via email. Should farms need a laboratory report for the diagnostic test (e.g. for health certification and export purposes), they also have the option of paying for the diagnostic services, rather than utilising the surveillance program.

Preventive health measures are the cornerstone in all livestock production systems, including aquaculture. Without farms committing to a health management plan, they are unlikely to see improvements to fish health or farm productivity. Apart from a few top tier food fish farms in Singapore, the majority of farms have yet to establish robust fish health management plans, which would consist of a biosecurity plan, and treatment plan for when fish fall sick. With this in mind, AVA has recently reviewed the marine food fish surveillance programme to include all land-based food fish farms. Under the revised "Food Fish Surveillance Progamme", disease surveillance and sampling would be part of a fish health management plan which is developed and owned by the farm. Plans will cover both regulatory diseases and production diseases which are of economic significance to the farm, and advice provided by AVA's fish health/ aquaculture specialists when required.

Besides the OIE-notifiable diseases, there are several common but significant production pathogens (viral, bacterial and parasitic) of foodfish in Singapore. These diseases include Benedenia, Big-Belly (BB) bacteria, *Streptococcus* sp., *Tenacibaculum maritimum*, Viral Nervous Necrosis Virus (VNNV), Megalocytivirus, Grouper Iridovirus and *Nocardia* sp. Emerging pathogens such as Tilapia Lake Virus (TiLV), Scale Drop Disease Virus (SDDV) and Lates Calcarifer Herpesvirus (LCHV), though not OIE-notifiable, also pose a potential threat. In the case of these non-OIE notifiable diseases, there will not be a regulatory requirement of compulsory culling. However, in most cases, operators will chose to voluntarily cull the batch to minimise disease spread. AVA will also advise and assist the affected farms in disease management. Annex 2 summarises the key control mechanisms for several major production diseases (both notifiable and non-notifiable), in Singapore.

Aquatic Animal Contingency Plans

The Aquatic Animal Contingency Plans are activated when there are detections of notifiable aquatic animal diseases on a farm or other aquatic animal holding facilities. Key aspects of the contingency plans include:

a. Quarantine and movement restrictions of affected animals.
b. Vaccination (for certain pathogens e.g. RSIV).

c. Compliance to proper biosecurity measures.
d. On-site investigation and sampling of susceptible fish species from the affected farm and adjacent farms, to determine extent of disease spread.
e. Culling of affected and in-contact fish.
f. Disinfection and cleaning of the premises and all in-contact equipment and tanks.
g. Re-inspection of the premises to ensure compliance with disinfection and biosecurity protocols.

Formation of the Disease

In 2017, the AVA appointed a team of veterinarians and field officers involved in different operational capacities (laboratory, surveillance and regulatory) to form the Disease Investigation team (DIT). The DIT is intended to be a rapid-reaction force activated by the Director-General of AVA, capable of mounting a swift and coordinated response to local disease outbreak situations including those of OIE-listed and nationally notifiable diseases, spanning across all animal species. The DIT is a crucial facet of Singapore's response system in detecting and containing aquaculture-related disease situations in Singapore.

Current issues and gaps

Need to Build Awareness and Education of the aquaculture industry

There is a need to raise awareness of the importance of biosecurity and prevention of disease spread in the local aquaculture industry. Industry needs to take responsibility for biosecurity, starting from simple low cost improvements to their practices so as to improve performance. Biosecurity plan templates and best practice guidance documentation will be developed for farms to follow, as part good aquaculture practices. In Singapore, an existing voluntary surveillance programme for disease screening of imported fingerlings is largely under-utilised by the majority of local farms. This suggests that farmers do not see the importance of knowing the pathogen status of imported fry. Local farmers need to be educated in the areas of import quality assurance (e.g. screening of imported stock, purchasing from accredited sources) and basic disease management.

Surveys of a small proportion of local farmers also reveal non-specific use of antimicrobials and other pharmaceuticals to treat moribund stock, and correlates with data on antibiotic sales data described earlier in paragraph 7. This raises grave concerns on the development of antimicrobial resistance in the aquaculture industry. In view of the diverse educational backgrounds of farmers within the industry, AVA has organised regular Fish Farmers' Workshops and basic laboratory technique practical sessions (necropsy and wet mount parasitology examination). An annual Fish Farmer's Newsletter is also circulated to the industry to update farmers of industry and regulatory developments and provide informative content on relevant topics such as disease management, biosecurity and laboratory testing. AVA will continue to create relevant training opportunities for local farmers to address the gap in industry education.

Lack of commercial vaccines for tropical food finfish

As mentioned previously, vaccines for tropical food fish are limited in availability worldwide and rarely used by smaller farms. Combined with a lack of education in disease diagnosis and management, the lack of vaccine availability may potentiate the aforementioned non-specific use of pharmaceuticals in aquaculture. AVA is working with local farmers to increase uptake of existing vaccines, and encourage improvements in husbandry as both a preventative and reactive management tool for disease situations. As commercial vaccines have developmental periods of up to 6 to 7 years, this will be too long a wait for the management of emerging diseases in minor aquaculture species. Autogenous vaccines are customised and herd specific products. While their efficacy is unassessed experimentally, the shorter development timeframe for such products is crucial for the management of emerging diseases in minor use species such as food finfish. There is a need to develop regulations for autogenous vaccines manufacture and use in tropical food finfish. This would outline the roles and responsibilities of the farm, veterinarian and the vaccine manufacturer. AVA intends to conduct further consultation with stakeholders before these guidelines are finalised.

Inadequate public awareness

There is a need to address public education in disease outbreak situations. For example, public education efforts in harmful algal blooms (HAB)[3] episodes could involve increasing awareness of the public health impacts of HABs, such as the adverse consequences of humans or pets swimming in waters with dead decomposing fish, and elevated microbial content. With the advent of social media and increased adoption and penetration of telecommunications technology, consumers have easy access to a whole slew of information online, both true and false alike. Widespread erroneous information could adversely affect consumer perception and cause public alarm. Authorities need to step up efforts in educating and informing the public so they would know what actions can be taken to protect themselves in such an incident, and know who to report these incidents to. There is also a need to strengthen communications between countries sharing the same water resources to facilitate the timely reporting and response to HABs. The same mechanism can be applied in a disease outbreak, where the rationale for measures such as movement restriction have to be communicated and explained to ensure compliance from both local and overseas stakeholders.

Transparent Reporting of Disease Status

The OIE WAHIS system and the Quarterly Aquatic Animal Disease (QAAD) Reports to NACA serve as excellent platforms for transparent reporting of country disease status. It is believed that continued utilisation of these reporting platforms by OIE and NACA member countries, will facilitate timely notification of significant pathogen detections and implementation of mitigation measures within a region that depends heavily on commercial trade and culture of live aquatic animals for livelihood and economic growth.

Emergence of New Pathogens

The recent, rapid emergence of new pathogens, such as Scale Drop Disease Virus, Tilapia Lake Virus and *Lates calcarifer* Herpesvirus, could potentially present new disease situations and necessitate formulation of new trade requirements within the region. Hence, AVA needs to stay abreast of emerging disease situations in the region, relying on pre-emptive horizon scanning for disease threats, existing mechanisms (WAHIS and QAAD), and transparent and prompt trans-national notification of new disease situations. Moreover, pathogen emergence necessitates rapid development and advancement of the AVA's laboratory diagnostic capabilities and potentially a ramping up of disease surveillance, as well as closer partnerships with research-intensive entities (academia and pharmaceutical companies) to better understand the disease epidemiology, public health impacts and management.

[3]**Preparedness and response systems for Harmful algal blooms (HABs):** While HABs are not brought on by a pathogen but rather by plankton, their spread across nautical boundaries and zones means the effects of a bloom will be experienced by farms located in the same body of water. Early detection may allow for emergency harvest of fish stocks, which is especially vital for the farms. Following a plankton bloom episode in 2014 which resulting in massive loss of stocks for both Singaporean and Malaysian coastal netcage farms, four alert levels with trigger points were set, to provide pre-determined alert levels in a HAB event. Determination of the Alert level at any point in time depends heavily upon routine surveillance of plankton counts in local waters, as well as routine surveillance of marine biotoxin (via sampling of farmed shellfish and wild mussels), in all ten of Singapore's offshore farming sites. Any detection of elevated seawater plankton counts also acts as a stimulus for stepping up of surveillance efforts. The response protocol involved the activation of crisis investigation teams to provide technical assistance to affected farms and to collect samples for laboratory diagnostics.

Aquatic Emergency Preparedness and Response System in Thailand

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Abstract

In Thailand, Department of Fisheries (DoF) is the competent authority for various aspects of aquatic animals including aquatic animal health. There are two principal legislation giving DoF power to apply for aquatic animal disease prevention and control measures in the country as well as import-export control; namely, Royal Ordinance on Fisheries and Animal Epidemic Act.

DoF has two national reference laboratories for aquatic animal health, one is Aquatic Animal Health Research and Development Division (AAHRDD) for freshwater aquatic animal disease diagnosis and another is Songkhla Aquatic Animal Health Research Center (SAAHRC) for brackish water aquatic animal disease diagnosis. Both are ISO/IEC 17025 accredited laboratories. Besides, there are 19 regional laboratories of DoF located in different areas of the country. All of 21 laboratories are responsible for performing disease diagnosis service for fish farmers as well as for disease surveillance. There are a number of surveillance and control programs for aquatic animal diseases in Thailand. Passive surveillance: information can be collected from disease reporting and other sources such as scientific research, news, publications, social network, or rumor. Active surveillance: to provide assurance of disease status for trade purposes, DoF has setup nationally active targeted surveillance program for demonstrating a number of diseases free status of country or farm establishment in accordance with OIE Aquatic Animal Health Code.

There are several farm standards in Thailand such as Good Aquaculture Practices for Hatchery of Disease Free Pacific White Shrimp, Good Aquaculture Practices for Marine Shrimp Farm, and Aquaculture Establishment for Export of Aquatic Animals. Each standard includes necessary biosecurity practices in order to prevent the introduction of pathogenic agent into or spread within or release from the farm. To control domestic movement of live aquatic animals, in normal situation, Aquatic Animal Movement Document should be gained when purchasing as it is beneficial to traceability. However if the disease free zone or disease zone is announced according to Animal Epidemic Act, all transportation of target aquatic animals or carcasses in or out of the defined zone is prohibited, unless a written permission is obtained.

DoF had developed contingency plan for dealing with aquatic animal disease emergencies. In contingency plan, the Provincial Fisheries Officer in responsible area will act as Director of Emergency Aquatic Animal Disease Control Center while Inland Aquaculture Research and Development Center/Coastal Aquaculture Research and Development Center/AAHRDD/SAAHRC will act as disease investigator and laboratory testing. DoF maintains early warning system by supporting staff to attend the meeting and workshop where there is occurrence of new disease, regularly checking local/regional/international disease report database, communicate with competent authority of trade partner, and regularly reporting disease situation to regional and international system. For early detection system, DoF has not only supported expertise and facilities required for laboratories to diagnose different diseases but also conducted training courses for fish farmers, traders and DoF staffs to recognize signs of the listed disease and emerging disease and encouraged them for rapid reporting of the event to the nearest DoF agency for the purpose of immediate investigation. For early response system, when there is serious disease outbreak, aquatic animals in that epidemiological unit should be contained in safety area. Waste water also should not be released from that area without disinfection. Meanwhile, the DoF staffs should investigate the outbreak urgently in order to define disease zone and find out what factors associated with the outbreak so that the disease management or control measure can be applied properly.

Introduction

Department of Fisheries (DoF) is the national government agency responsible for all activities in the production of aquatic animals which also includes managing the country's aquatic emergency disease preparedness and response system in Thailand. The agencies under DoF involved in preparedness and response to emergency aquatic animal diseases include Aquatic Animal Health Research and Development Division (AAHRDD), Inland Aquaculture Research and Development Division (IARDD), Coastal Aquaculture Research and Development Division (CARDD), Fish Quarantine and Inspection Division (FQID), and Provincial Fisheries Office (PFO).

There are two principal legislations giving DoF power to apply for aquatic animal disease prevention and control measures in the country as well as import-export control; namely, Royal Ordinance on Fisheries and Animal Epidemic Act. The Royal Ordinance on Fisheries imposes on registration and various standards related to aquatic animals. The Animal Epidemic Act is operated by Department of Livestock Development (DLD). However, DOF staffs have been appointed by the Minister of Agriculture and cooperatives to be the authorized inspectors and authorized veterinarians to execute the Animal Epidemic Act for prevention and control of aquatic diseases.

Early Warning System

National competent authority's monitoring system/mechanism on emerging/existing transboundary diseases (especially the OIE-listed)

DoF gathers information about aquatic animal disease events in other countries by attending meetings and workshops related to aquatic animal diseases, communicating with researchers in other countries, checking local/ regional/ international disease report database, scientific literatures and newsletter, accessing website of Network of Aquaculture Centres in Asia-Pacific (NACA) and World Organisation for Animal Health (OIE) and communicating with the competent authority (CA) of trade partner when the serious disease or pathogen is detected from the imported aquatic animal. DoF not only checks disease status in other countries but also contributes the aquatic animal health situation within the country for others by regularly reporting to regional and international system. As Thailand is one of the NACA and OIE member countries, the national focal point, a Fisheries Biologist from AAHRDD is responsible for collaborating and communicating with NACA and OIE as well as reporting the status of aquatic animal health in Thailand to NACA/ OIE Regional Representation of Asia and Pacific through OIE delegate (DG of DLD) every three months and to OIE Headquarters through the World Animal Health Information System (WAHIS) every six months.

Networking mechanisms of the national competent authority with trading partners

DoF, by AAHRDD, and key aquatic animal commodity trading partner countries (usually competent authority) communicate mainly with email or telephone or official letter.

Early Detection System

Personnel competencies on recognition and reporting of a disease emergency

a. Frontline personnel and local government personnel

DoF staff (aquatic animal health professionals are Fisheries Biologists of AAHRDD), Songkhla Aquatic Animal Health Research Center (SAAHRC; agency under AAHRDD), Inland Aquaculture Research and Development Centers (IARDCs; agencies under IARDD), Coastal Aquaculture Research and Development Centers (CARDCs; agencies under CARDD); fisheries extension officers are Fisheries Biologists of PFOs; officers of local disease control centers or Emergency Aquatic Animal Disease Control Centers are Fisheries Biologists of PFOs) and fish farmers have been trained to recognize signs of the national-listed aquatic animal diseases, emerging disease, or unexplained mortality especially in Level I diagnosis. In addition, a number of leaflet, manuals, and other publications have been distributed to frontline individuals at the pond level from time to time.

DoF has encouraged the farmers, and farmer associations for rapid reporting of the event to the nearest DoF agency (PFO/ AAHRDD/ SAAHRC/ IARDC/ CARDC) for the purpose of immediate investigation.

b. National government personnel

Appropriate disease surveillance plan as well as rapid and accurate diagnosis are highly important. When the emerging disease or pathogen is confirmed, laboratory staff will notify to the Emergency Aquatic Animal Disease Control Center for early warning and inform the national OIE focal point and NACA coordinator to report to OIE and NACA.

Standard Operating Procedures

SOPs or instruction materials related to early detection system such as:

- Documents provided for training staffs of PFOs, AAHRDD, SAAHRC, IARDCs, CARDCs, Fish Inspection Offices (FIOs; agencies under FQID) and farmers on basic diagnosis of aquatic animal diseases
- SOP for disease diagnosis (level I, II and III) provided for AAHRDD, SAAHRC, IARDCs, and CARDCs
- Publication such as pamphlets, posters, leaflets that described signs of diseases, prevention and control
- SOP for disease surveillance provided for AAHRDD, SAAHRC, IARDCs, and CARDCs
- SOP for aquatic animal health inspection and control in quarantine facilities provided for staffs of AAHRDD, SAAHRC, IARDCs, and CARDCs
- Documents provided for training staffs of PFOs, AAHRDD, SAAHRC, IARDCs, and CARDCs on disease reporting.

Awareness building and training programs

AAHRDD and SAAHRC usually update their websites in order that DoF staffs, farmers, industry personnel and others can access the disease status/events in the country and other countries. AAHRDD and SAAHRC also revise a number of publications and produce new ones every year.

Moreover, if there is a serious disease occurring and some measures are needed to be taken, DoF staffs and farmers will be invited to attend the meeting for further collaboration. AAHRDD and SAAHRC have planned and set up a budget for training programs for DoF staffs and farmers every fiscal year.

National information sharing networks

Emergency preparedness and response related information are shared through internet website, social network, workshop and meeting.

Surveillance systems

DoF has been allocating a large amount of budget for both active and passive disease surveillance in order to gain information on the health status of aquatic animal population for assessing and managing risks associated with trade or for effective response to disease emergency.

a. Active surveillance

DoF has conducted national active targeted surveillance programs. Majority of active surveillance programs are designed for demonstrating disease free status of country or farm establishment. However, in case of the disease that has been reported in the country, though there is surveillance program for demonstrating freedom from disease at farm level, national surveillance program for assessing the prevalence of the disease is also set up. Up to now DoF can claim disease free status based on active targeted surveillance for 14 diseases at country level (10 for fish diseases and 4 for crustacean diseases) and 11 diseases at farm establishment level (4 for fish diseases, 6 for crustacean diseases, and 1 for amphibian disease).

b. Passive surveillance

As a part of a country's early detection system, when fish farmers or other organizations have experienced disease problems on their aquatic animals, consultation by calling or submitting the samples to AAHRDD/SAAHRC/IARDCs/CARDCs for disease diagnosis is available.

Disease reporting system (national and international authority; e.g. NACA/OIE)

There are 34 diseases in the national list of reportable diseases under Animal Epidemic Act. This list includes OIE listed diseases and additional diseases. Since Animal Epidemic Act imposes aquatic animal owner to notify the inspector or veterinarian (DoF staff who has appointed to be inspector or veterinarian) when (1) there is an animal which is known to be infected with national listed pathogen; (2) there is an animal which is sick or dead from an unknown cause; (3) in the same village or adjacent area, there is an animal which is sick or dead with the same symptoms during a seven-day period, therefore, when suspected disease occurs the animal owner can report to the nearest agency (PFO/AAHRDD/SAAHRC/IARDC/CARDC) by facsimile, telephone, or in person. In case of reporting to PFO, the PFO will then inform AAHRDD/SAAHRC/IARDC/CARDC to conduct disease investigation and diagnosis. If IARDC/CARDC is unable to identify the disease/pathogen, the sample will be sent to national reference laboratory, AAHRDD or SAAHRC, for identification and confirmation. If that suspicion is confirmed to be the OIE listed disease or emerging disease, it would be reported to OIE and NACA.

Diagnostic capability/capacity

DoF has two national reference laboratories for aquatic animal health, one is AAHRDD for freshwater aquatic animal disease diagnosis and another is SAAHRC for brackish water aquatic animal disease diagnosis. The National laboratories have capability/capacity of confirmation of a disease or disease agent of concern, including ability to differentiate exotic or emerging diseases from endemic diseases. There are parasitology, bacteriology, histology, mycology, immunology, molecular biology, and virology laboratories at AAHRDD and SAAHRC. Laboratory staffs are regularly trained in aquatic animal disease diagnosis for enhancing their performance. For assurance of laboratories' performance, significant internal audit is performed at least once a year. These laboratories have also participated in proficiency testing (PT) programs provided by external organizations such as the Australian National Quality Assurance Program (ANQAP) and Arizona University, one of OIE reference laboratories. AAHRDD and SAAHRC laboratories are accredited for ISO/IEC 17025. Besides, there are 19 regional laboratories of DOF located in different areas of the country. DoF has continuously supported expertise and facilities required by all laboratories to diagnose different diseases and encouraged them to achieve international accreditation for disease diagnosis laboratory. All of 21 laboratories are responsible for performing disease diagnosis service for fish farmers as well as for disease surveillance.

Early Response System

Personnel competencies on identification of a disease emergency, identification of risks associated with the suspected pathogen, confirmation of the aetiology/etiologic agent of the disease, reporting to competent authority, formulation of control options

a. Frontline personnel

Fish farmers especially those who are registered for farm standards know that the aquatic animal that will be introduced into the farm should come from a source with health status at the same level or higher level than their farm. Both moving in and out of aquatic animal, farmers should have movement document or record sheet for traceability. When the suspected disease occurs, they can coordinate and provide relevant information on disease outbreak to PFO/ AAHRDD/ SAAHRC/ IARDC/ CARDC for early response.

b. Government personnel

DoF staffs, PFOs/AAHRDD/SAAHRC/IARDCs/CARDCs, understand their role and responsibility to combat the emergency disease in accordance with contingency plan.

When staffs of PFO are informed that there is an outbreak in their responsible area, they would seek for assistance from AAHRDD/SAAHRC/IARDC/CARDC in order to communicate and assist the affected farmers. While waiting for disease diagnosis at the laboratory of AAHRDD/SAAHRC/IARDC/CARDC to identify whether it is emergency disease or endemic disease, containment of affected aquatic animal and waste water is conducted to prevent spreading the suspected pathogen. In the meantime AAHRDD/SAAHRC/IARDC/CARDC will investigate the outbreak urgently in order to define disease zone and find out what factors are associated with the outbreak so that the disease management or control measure can be applied properly.

Awareness building and training

When a serious disease occurs and some measures are needed to be taken, DoF staffs and farmers will be invited to attend the meeting for further collaboration.

Every year AAHRDD and SAAHRC have planned and set up a budget for training programs for DoF staffs and farmers to enhance their knowledge in quarantine system, sanitary and health management, disease diagnosis, disease reporting etc. At the end of training, the participants are evaluated to ensure that they understand and will be able to undertake the responsible tasks on early response.

Standard Operating Procedures

DoF has a contingency plan for dealing with general aquatic animal disease emergencies. This contingency plan manual describes steps in action to be taken such as preparedness prior to disease outbreak, action to be taken if a suspected disease occurs or in case of disease outbreak, and action to be taken after disease outbreak. This manual also includes flow charts, forms, SOP for disinfection, and SOP for collecting, packaging and transporting samples to laboratories.

At present, DoF is developing disease-specific plans for IMN and KHV. The detail of the draft of IMN contingency plan consists of:

- Introduction
- Objective
- Glossary
- Legal powers
- Chain of command
- Preparedness prior to disease outbreak
    - Preparing for registered shrimp farm data and map
    - Personal requirements and responsibilities
    - Preparing for materials, equipment and vehicle
- Operation when IMN occurred
    - IMN investigation
    - Sample collection
    - IMN diagnosis
    - Containment
    - Handling and disposal of dead shrimp
    - Eradication
    - Disinfection procedures
    - Surveillance for establishing successful eradication
    - Reporting
    - Public awareness etc.

Aquatic Emergency Preparedness and Response System in Viet Nam

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Abstract

Viet Nam is one of the top worldwide producers of aquaculture products which accounts for about 22 percent of total agricultural GDP of Viet Nam. Recently, diseases have become the biggest challenge for global aquaculture development therefore the Vietnamese government has paid close attention to develop an effective aquatic emergency preparedness and response system to timely deal with disease introduction and outbreaks. The Department of Animal Health (DAH), under the Ministry of Agriculture and Rural Development (MARD), which is the competent authority of aquatic animal health management. To monitor transboundary diseases (especially the OIE-listed diseases), the current Vietnamese regulations only allow import of aquatic animals and its products which are certified as disease-free by competent authority of exporting country, and export aquatic animals and its products complying with importing conditions of importing country. Regional Animal Health Offices (belong to DAH) shall carry out sampling for testing pathogens and isolation for imported aquatic animals and its products as regulated in Circular 26/2016/TT-BNNPTNT dated 30 June 2016 before granting permit to import or export. For domestic transportation of aquatic animals, provincial sub DAH is responsible for monitoring infectious pathogens to certify disease-free status of aquatic animals before issuing health certificate for movement. In addition, a reporting and response system to aquatic animal diseases was established in the country from farm level to central level (DAH). Early detection and warning of diseases is critical for disease prevention and control, thus since 2014, the DAH has implemented national surveillance programs focusing on dangerous diseases in the key farming species (brackish-water shrimps, pangasius catfish) according to Circular 04/2016/TT-BNNPTNT dated 10 May 2016 of MARD and support exportation of aquatic animals and its products complying with international regulations and importing countries based on OIE recommendations and Circular 14/2016/TT-BNNPTNT dated 2 June 2016.

Introduction

Viet Nam is one of the top worldwide producers of aquaculture products which accounts for about 22 percent of total agricultural GDP of the nation. The mainland of Viet Nam is divided into seven different ecological parts including the northern midland and mountain (with two sub regions of northeast and northwest), the Red River Delta, the North Central Coast, the South Central coast, the Central Highlands, the South East and the Mekong Delta (Figure 1A), of which the Highland and the northern mountainous area (except for Quang Ninh province) rearing mostly freshwater aquatic animals, the five remaining regions have freshwater, brackish and marine aquaculture areas. The provinces of the Southwest region (Mekong delta area) have aquaculture area and the farming production accounts for 70% of the total national production. Among the cultured species, brackishwater shrimp and *Pangasius* catfish are the two major cultured species in Viet Nam, mainly for export demand. Currently, Viet Nam has 30 shrimp farming provinces (Figure 1B), with black tiger shrimp (*Penaeus monodon*) and white leg shrimp (*Litopenaeus vannamei*) as the two dominant cultured species. *Pangasius* catfish are cultivated intensively in 10 provinces in Mekong River Delta in the South of Viet Nam (Figure 1C). In addition, tilapia, traditional freshwater fish, marine fish and lobsters are also important to the aquaculture industry of Viet Nam. Recently, diseases have become one of the biggest challenges for global aquaculture including Viet Nam, especially diseases in shrimps and *Pangasius* catfish, therefore Vietnamese government has paid close attention to develop an effective aquatic emergency preparedness and response system to timely deal with disease introduction and outbreaks.

Aquatic animal health system in Viet Nam

Aquatic animal health structure

The Ministry of Agriculture and Rural Development (MARD) is a governmental agency performing governance functions in the fields of nationwide agriculture, forestry, salt production, irrigation/water services and rural development; governance functions for public services of the fields under its management.

Its subordinate agencies related to aquatic animal health are the Department of Animal Health (DAH), Directorate of Fisheries (D-FISH), National Agro-Forestry and Fisheries Quality Assurance Department (NAFIQAD), National Centre for Agriculture Extension, Research Institute for Aquaculture, and aquaculture universities. Of which the DAH, D-FISH and NAFIQAD take the main responsibilities (Figure 2).

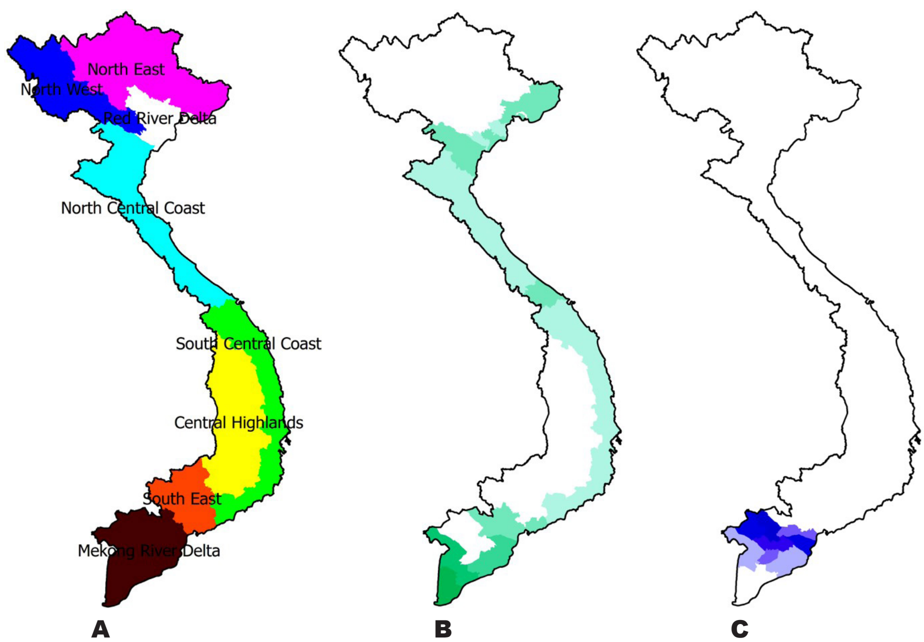

FIGURE 1. Ecological regions in Vietnam (A), 30 provinces produce brackish shrimps (B), and 10 provinces produce *Pangasius* (C)

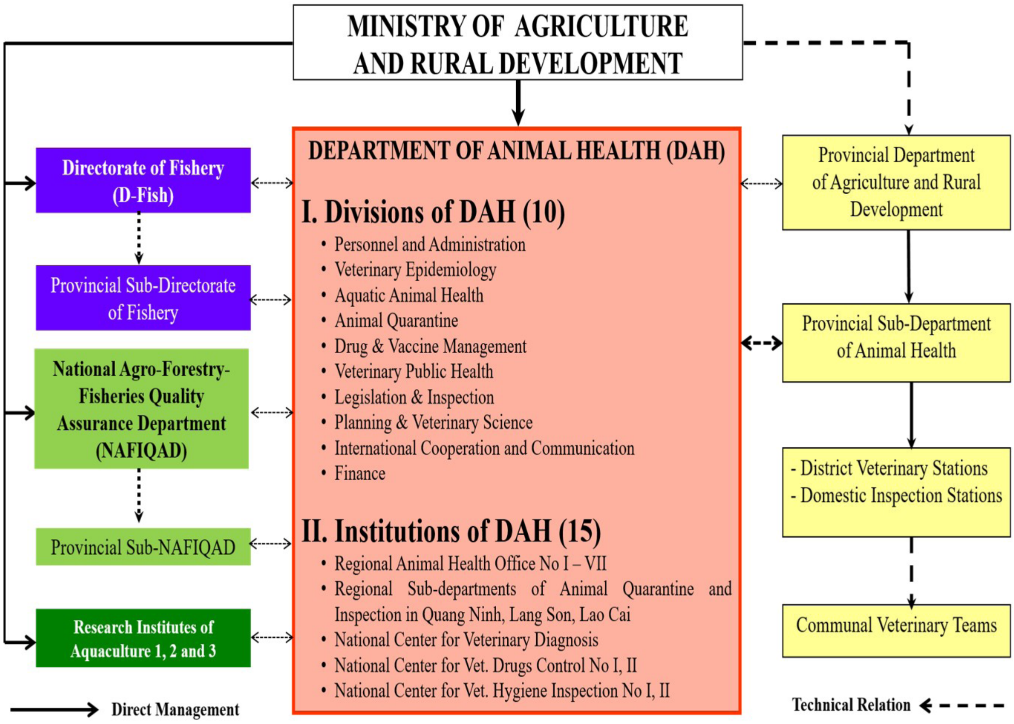

FIGURE 2. Organizational chart of aquatic animal health system in Viet Nam

The DAH is the aquatic animal health competent authority of Viet Nam. The DAH headquarters is located in Hanoi, it has 10 functional divisions. Division of Aquatic Animal Health takes the responsibilities for prevention and control of aquatic animal diseases; Division of Animal Quarantine in charge for animal quarantine and inspection (inspect and supervise quarantine for aquatic animal and aquatic animal products for export not intended for human consumption and import and domestic transportation) and Division of Veterinary Drugs and Vaccines Management is responsible for control of veterinary medicines, veterinary biologicals and vaccines for aquatic animal treatment. The agencies under DAH's management include 5 technical centres, 7 Regional Offices for Animal health (RAHOs) in charge of aquatic animal health management, diagnosis of aquatic animal diseases for the provinces of the region; 3 Animal border control stations responsible for quarantine of aquatic animals and aquatic animal products for export, import transferred through border gates. Local authorities are 60 provincial sub DAHs and 3 provincial sub D-FISH throughout the country (Figure 3).

The NAFIQAD is an agency in charge of governance in agro-forestry and fisheries quality and food safety including inspection and granting certification for aquatic animals export intended for human consumption. The D-FISH manages nationwide aquaculture including fishery feed and biological products used in farming.

Aquatic animal quarantine in Viet Nam

Legislations on import and export of aquatic animals/products

Regulations on import and export of aquatic animals/products are specified in the Animal Health Law in 2015, Decree No. 35/2015/ND-CP of the Government dated 15 June 2015 of the Government detailing for implementation of number of Articles of the Animal Health Law, Circular No. 26/2016/TT-BNNPTNT dated 30 June 2016 of the Ministry Agriculture and Rural Development regulating on quarantine of aquatic animals and aquatic animal products. Accordingly, aquatic animals and its products are only allowed to be imported to Vietnam when they are certified as disease-free by competent authority of exporting country, and exported complying with importing conditions of importing country.

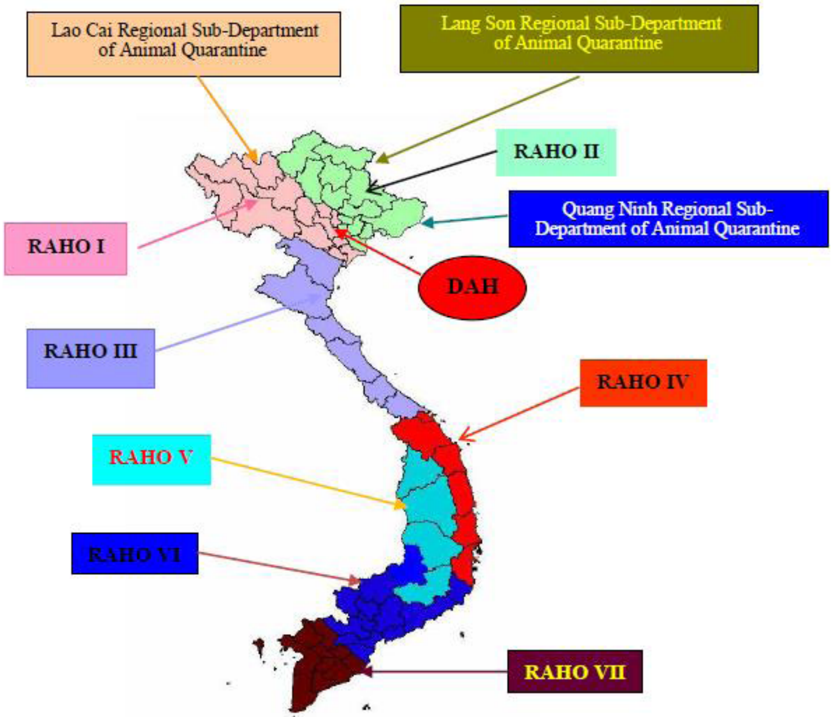

FIGURE 3. Locations of DAH headquarter and its units

Structure of aquatic animal quarantine system

The agencies belonging to Aquatic animal health system performing aquatic animal quarantine functions are Animal Quarantine section in DAH (DAH headquarter, 7 Regional Animal Health Offices I-VII, 3 Regional sub Department of Animal Quarantine in Lang Son, Lao Cai and Quang Ninh (3 provinces of border gates) and 63 provincial Sub-DAHs.

The DAH manages import and export of animals and animal products, including aquatic animals and issues Health Certificate for imported/exported aquatic animals/products (except Health Certificate for aquatic animal products exported for human consumption is granted by NAFIQAD), 63 Sub-DAHs manage local transportation of animals and animal products through animal Quarantine Checking Points along transportation roads (Figure 4).

Lists of aquatic animals, aquatic animal products; aquatic animal diseases

Subject to quarantine and inspection before import into Viet Nam. It is specified in Circular 26/2016/TT-BNNPTNT dated 30 June 2016 of MARD.1.3.

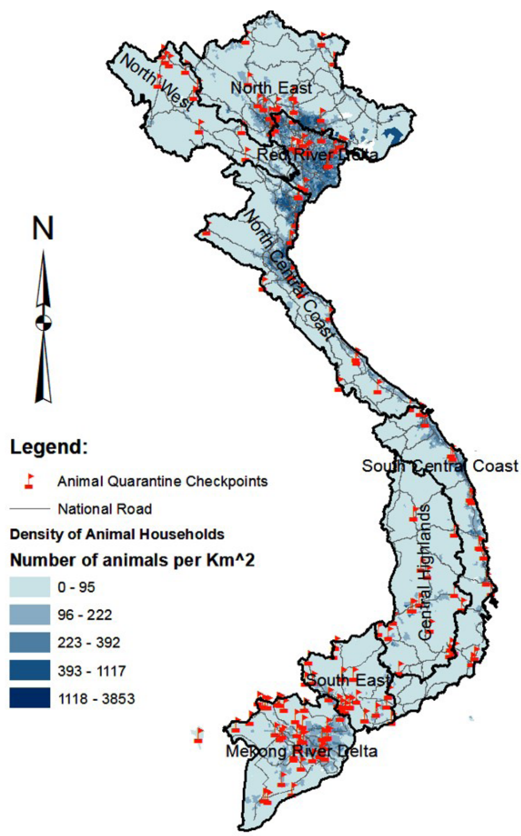

FIGURE 4. Map shows domestic animal quarantine checkpoints in Viet Nam

Prevention and control of aquatic animal diseases

Legal texts on aquatic animal disease prevention and management

Veterinary Law 2015, Circular No. 04/2016/TT-BNNPTNT dated 10 May 2016 of the Minister of Agriculture and Rural Development regulating aquatic disease prevention and control, Circular No. 14/2016/TT-BNNPTNT dated 2 June 2016 regulating disease-free zones and establishments, national technical regulations.

Structure of aquatic animal disease response system

Figure 5 describes a system for gathering disease information, responding to disease occurrence and the relations among agencies involved. A reporting, detection and response system to aquatic animal diseases is organized from farmers to local competent agencies and central level (DAH, MARD). In case of disease occurrence in one farm, the farm owner must notify competent authorities at communal or district levels, then the information will be transferred to provincial level (sub DAH), and to the DAH (headquarter and regional office). After receipt and the information clarified, the provincial Sub DAH shall conduct a field investigation to assess the situation and take samples for testing to identify the pathogens. As they detected the pathogens/causes, an updated report will be submitted to the DAH and RAHO. The DAH will supervise the implementation of provincial sub DAH, guide and support in case of new or dangerous disease outbreaks. The DAH reports aquatic disease situation to the MARD and international organizations, co-operate and request for their help in emergency disease occurrence. The collaborating agencies include D-FISH, national extension system, Research Institutes and Universities, and farmer associations.

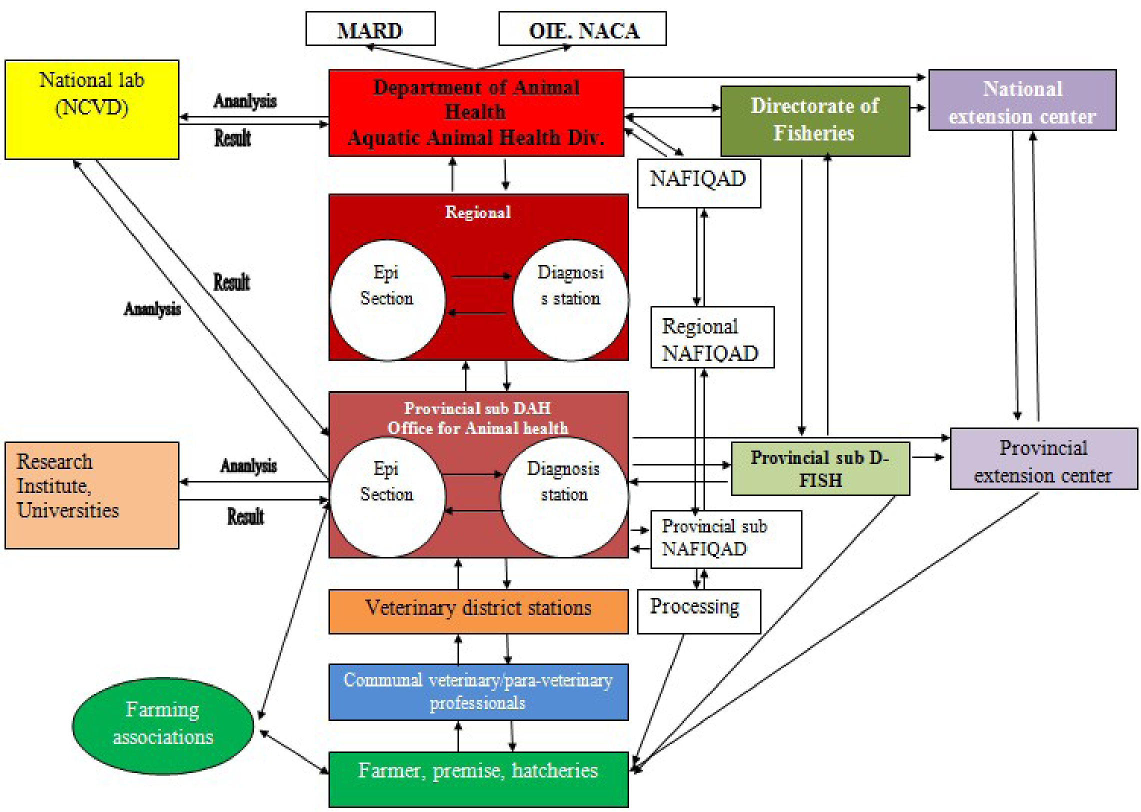

FIGURE 5. Flowchart for gathering disease information and response to disease outbreaks

List of aquatic animal diseases subject to compulsory declaration

According to Circular No 04/2016/TT-BNNPTNT, the following diseases must be reported to the competent authorities:

Shrimp diseases (8)
- White Spot Disease (WSD)
- Taura Syndrome (TS)
- Yellow Head Disease (YHD)
- Infectious Myonecrosis Disease (IMD)
- Infectious Hypodermal and Hematopoitic Necrosis Disease (IHHN)
- Acute Hepatopancreatic Necrosis Disease (AHPND)
- Lobster Milky Disease (LMD)
- *Enterocytozoon hepatopenaei* (EHP)

Fish diseases (4)
- Spring Viraemia of Carp (SVC)
- Koi Herpesvirus Disease (KHD)
- Viral Nervous Necrosis/Viral Encephalopathy and Retinopathy (VNN)
- Enteric Septicaemia of Catfish (ESC)

Mollusk (2)
- *Perkinsus marinus*
- *Perkinsus olseni*

Standard operating procedures

Circular No 04/2016/TT-BNNPTNT of MARD specifies standard operating procedures for monitoring, detection, reporting and response to disease outbreak as follows:

The farm owner, private aquatic animal health professional, or the person who identified diseased aquatic animals or observed mass mortality in aquatic animal populations or clinical signs of disease or observed the abnormal behaviors must inform veterinary staff in the communal or district level or the nearest specialized bodies of aquatic animal health.

The communal veterinary staff after receiving notification must visit the place where diseased or dead or aquatic animals exhibiting abnormal behavior were detected to clarify the information and report to the veterinary station.

Veterinary station shall carry out on-site verification of outbreak information in the farm and send report of verified results to the provincial body responsible for specialized management of animal health at provincial sub DAH. In case the epidemic disease has complicated evolution that exceeds its competence, the station must inform provincial sub DAH. Sub DAH sends staff to the suspected infected farm to recommend treatment, take samples for pathogen testing at designated laboratories, and verify origin of infection. If the sample is positive for pathogens, the farmer is guided on the proper disposal of the infected aquatic animals and taught how to disinfect the farming area then sends report to RAHO and the DAH headquarter.

Regional veterinary health office (RAHO) is responsible for summarizing and sending report to the DAH on aquatic animal disease situation of provinces in the region. The DAH shall report to the Minister of the MARD; to international organizations (NACA, OIE) in which Viet Nam is a member country or has commitment to notify disease occurrence.

In addition to early warning of disease occurrence, the provincial sub DAHs annually submits to the local competent authorities for approval, plans for the prevention and control of aquatic animal diseases including monitoring and information dissemination, training of local professionals, and supervise the implementation of the approved plan. The DAH develops national programs/strategies on prevention and control of aquatic animal diseases (national program on surveillance, epidemiological research, outbreak investigation).

During implementation of disease prevention and control, the DAH collaborates with other agencies from public and private sectors as follows:

- D-FISH system monitors the aquaculture environment, guides farmers on the prevention and control of diseases and shares environmental monitoring results in aquaculture and disease data for early warning and response to outbreaks.

- NAFIQAD collaborates with DAH to certify commodities that meet conditions for export (pathogens testing) intended for human consumption and recommend to treat infected commodities. Provincial sub NAFIQADs collaborate with provincial sub DAHs in monitoring the harvest and transportation of aquatic animals to processing plants; in monitoring diseased aquatic animals, in farms; disseminate information on the violation of food safety in farm; and carry out investigation on the origin of the disease

- National extension center system collaborate in prevention and control of aquatic animal diseases, and propaganda and promote good farming practices models to farmers.
- Aquaculture associations collaborate and propose measures in prevention and control of aquatic animal diseases.
- Research Institutes for Aquaculture and universities provide testing and diagnostic services. They also provide information on research and experiment done or needs to be done for re-emerging or new disease for the DAH and submit research proposals on measures for the prevention and control of aquatic animal diseases.

Active surveillance programs

Surveillance of shrimp diseases

From 2014-2015

DAH collected about 8,770 samples for surveillance of pathogens (WSSV, AHPND, EHP, and IHHNV), including shrimp, water, sediment, vector animals and feed from 169 commercial establishments (5,764 samples) in five provinces (Quang Ninh, Nam Dinh, Ha Tinh, Ben Tre and Soc Trang) and 60 breed establishments (3,007 samples) in two provinces (Ninh Thuan and Binh Thuan).

In 2016

DAH continued to cooperate with provincial competent authorities to conduct active surveillance for WSSV, AHPND, EHP, and IHHNV in brackishwater shrimp in Ninh Thuan, Binh Thuan, Ben Tre, Bac Lieu and Soc Trang provinces from July to December of 2016.

In 2017

Disease surveillance following the "National Plan on disease surveillance in farmed shrimp and pangasius catfish for export, in the period 2017-2020" (issued together with Decision No. 1038/QĐ-BNN-TY dated 29 of March 2017 by the Minister of MARD). Tested pathogens were those important to shrimp farming and listed by the OIE or under concern of importing countries, including WSSV, AHPND, YHV, TSV and IHHNV.

Surveillance of *Pangasius* diseases

From 2015-1016

Implementation of the "National Plan on prevention and control of diseases in *Pangasius* catfish in the period from 2015-2020" issued with Decision No. 4995/QĐ-BNN-TY dated 20 November 2014 of the Minister of MARD, DAH carried out a pilot surveillance of two infectious diseases in *Pangasius* catfish in the three key farming provinces of *Pangasius* catfish (An Giang, Ben Tre and Dong Thap). A total of 120 *Pangasius* farms (consisting of 30 hatcheries and nursing farms and 90 commercial farms) in three key farming provinces were continuously sampled every two weeks for five months, frequency two weeks/ sampling round. Fish, water and sediment samples were collected for testing to detect pathogens of enteric septicemia of catfish disease (caused by *Edwardsiella ictaluri*) and hemorrhage disease (caused by *Aeromonas hydrophila*) in order to figure out some epidemiological characteristics of these diseases.

In 2017

Implementing the "National Plan on disease surveillance in farmed shrimp and *Pangasius* catfish for export, in the period 2017-2020," two *Pangasius* establishments were selected for surveillance program from August 2017 in Dong Thap and Ben Tre provinces. Five sampling rounds were conducted with 244 samples collected to monitor pathogens of enteric septicemia of catfish disease (caused by *Edwardsiella ictaluri*) and hemorrhage disease (caused by *Aeromonas hydrophila*).

Diagnosis and testing systems for aquatic animal diseases in Viet Nam

Public laboratory for testing aquatic animal diseases

(1) Aquatic animal health system (national laboratories, under DAH's management and local laboratories under provincial sub DAH and sub NAFIQAD): 41 public laboratories at both levels, of which 20 public laboratories were granted with ISO 17025 and accredited by Competent authority as follows:

- Central level: 8 aquatic animal disease testing laboratories of the Regional Animal Health Offices (RAHO) and the National Centre for Veterinary Diagnosis (NCVD).
- Local level: provincial sub DAH 27 laboratories (testing by conventional and Real-time PCR techniques).
- Agro-Forestry and Fishery Quality Assurance Department's management (NAFIQAD): 6 labs accredited in line with ISO 17025.

and (2) Laboratories at three Research institutes for Aquaculture and fisheries universities.

Private laboratories

Some private laboratories are also accredited to provide testing service for aquatic disease.

Awareness raising and training activities

Training programs

The officially approved training and education plans is for 630 participants per year on average at national level. At provincial level, each province annually organizes training for local staff and farmers on new regulations, knowledge and skills for prevention and control of aquatic animal disease.

Training contents

Official training programs focused on the following topics:

- Enhancing aquatic animal disease management capacity for veterinary officials from central, regional and provincial levels: Post graduate education at educational institutions in Viet Nam and overseas on veterinary epidemiology (i.e. data analysis and disease warning), disease diagnosis, pathology, and biosecurity
- Strengthening capacity of local aquatic animal health system on legislation, disease surveillance, reporting and response to disease outbreaks.

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REVIEW PAPERS

Components and Implementation Strategies for Effective Hazard Monitoring and Early Warning

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Abstract

Effective monitoring of hazardous incidents for timely dissemination of notifications and warnings involves a thoughtful mixture and application of information, technology and intuitional processes. It starts with the identification of the right data – data to be used in decision making processes – from the right sources – authoritative sources that can be trusted and relied upon. Processes must then be developed to routinely and swiftly acquire, process, and ingest these data into an early warning system (EWS). Decision criteria – sometime referred to as "business rules" – must be established to transform these data into actionable information, including for the dissemination of warning messages. Finally, the warning messages must be quickly and securely transmitted to the intended recipients, often via redundant mechanisms to insure receipt. Of course, warning messages themselves, even if timely, accurate, and actionable, are not sufficient without an overall context in which to assess them as well as pre-established processes for taking actions, sometimes referred to as Standard Operating Procedures (SOPs). However, even the best SOPs will be ineffective if their users are not adequately skilled and knowledgeable. This generally means that a training and exercise program must be a key component of any successful monitoring and warning system. These elements of effective monitoring – and strategies for their implementation – are described and illustrated via the Pacific Disaster Center's DisasterAWARE™ all-hazards monitoring, early warning and decision support system.

Introduction

An effectively implemented and operated hazard monitoring and early warning system (EWS) can reduce risks and lower impacts associated with "disasters" – be the hazards natural (e.g., typhoon, earthquake, tsunami, etc.), environmental (e.g., land and water degradation, over exploitation of natural resources, etc.), or man-made (e.g., industrial accidents, terrorism, etc.) The key to successful implementation includes three key components – information content, technology, and institutional processes – that are explored in this paper. Further, they will be illustrated by examples taken from implementation and operation of natural hazards early warning systems based on DisasterAWARE™ by Pacific Disaster Center. The general processes can be extended to any monitoring and early warning system, including those related to aquatic animal health.

Components of Monitoring and Early Warning Systems

EWS include both technological and organizational. The former – including information content, and visualization, analysis and alerting technologies – are detailed below. The latter are discussed in the Institutionalization section.

Information Content

At the heart of any early warning system is the information that drives the warning issuance and decision making. Correctly identifying the hazard signals from the ordinary, day-to-day signals is the starting point for all remaining actions. Normally, those directly involved in hazard monitoring and management activities are familiar with availability and applicability of critical information and the decision rules that are associated with their use. However, this knowledge may not be well documented or shared effectively, essentially skipping the first step in the development of an EWS. As described in more detail in the institutionalization section (below), the creation of a Concept of Operations (CONOPS) helps developers and implementers of an EWS to understand what information is needed for use in the decision-making process, what data are already available, who produces these data and information, who and how they are shared with those who need them, and what rules are associated with their use.

Once key information requirements are identified, developers of the EWS must seek authoritative sources for each information element. Generally, these include regional bodies, national agencies, universities, etc. In the case of natural hazards, PDC works with such agencies as the Pacific Tsunami Warning Center (PTWC), National Weather Services, NASA, and United States Geological Survey (USGS) to obtain natural hazard data. For national-level deployments of DisasterAWARE, authoritative sources extend to national hydro/met services, seismic and volcanic agencies, mapping, and census/statistics agencies. In the case of an aquatic animal health EWS, authoritative sources may include OIE WAHID and fisheries/coastal resource/environmental health ministries, as well as regional bodies and UN agencies.

Next, processes to routinely and efficiently obtain these data must be developed, often in collaboration with the cognizant agency that produces the data. A necessary step may be the execution of a data use agreement (DUA) or data sharing agreement (DSA), outlining the intended use of the data, any restrictions or limitations associated with their use, and a general means by which they will be shared by the producer with the EWS. For dynamic data and information that change quickly or regularly, automation procedures should be considered to obtain, condition (if needed), and incorporate the source data into the EWS. For the DisasterAWARE platform, PDC has developed such an automation mechanism called "Dynamic Data Processing and Publication" (D2P2) engine. D2P2 can be configured for the required context to automate key national, regional, and international incident data sets that are pertinent to the needs of the intended users. D2P2 rules govern incident severity categorization and, when conditions are met, notifications are automatically created within DisasterAWARE for dissemination to registered users. For PDC-operated instances of DisasterAWARE, D2P2 brings in typhoon locations and forecasts from Joint Typhoon Warning Center (JTWC), tsunami bulletins from PTWC, earthquake epicenters and shaking intensity from USGS, and wildfires and floods from NASA sensors. For customized versions of DisasterAWARE deployed within national EOCs, information sources include the Indonesian Agency for Meteorology, Climatology and Geophysics (Badan Meteorologi, Klimatologi, dan Geofisika, BMKG) for the Indonesian deployment, InAWARE; Viet Nam's

National HydroMet Forecasting Centre (NHMFC) for the Vietnamese deployment, VinAWARE; and ASEAN Specialized Meteorological Centre (ASMC) for the ASEAN-regional deployment, DMRS.

Enabling technologies

EWS users need to be able to quickly and easily view hazard data within their decision-making context. Generally, this includes being able to see the location and extent of the hazard in relation to a user's area of responsibility and the resources that must be protected from harm. In the case of natural hazards, this would include a map of the hazard location and impact area along with population and infrastructure data. For animal resource management, this would include breeding/nesting areas, catch/harvest areas, specific agriculture and aquaculture infrastructure and trade routes, and ports. The PDC-hosted version of DisasterAWARE, EMOPS, in fact, contains more than 4000 map layers. PDC's DisasterAWARE incorporates GIS technology to enable users to visualize these data together, at various scales, providing context and a common operating picture. Further, the system facilitates viewing time-series data and the incorporation of user data to support incident monitoring and the specific data needs of individual users.

Another key enabling technology is the ability to share information and analyses with other system users. This can include the ability to share an annotated version of the map display or to attach a report or assessment to a hazard detected by the system. As well as providing up-to-date incident information, the DisasterAWARE platform supports interagency cooperation and information sharing through its ability to add relevant non-geographical incident "products" to a specific event. This "one-stop" repository for incident products allows for quick and easy sharing of information between users.

It is well understood the timely warnings can help limit a hazard's impact and reduce the loss of lives and livelihoods. Placing easy-to-access, real-time hazard data in the hands of the decision makers is therefore a key element of any effective EWS. Through the DisasterAWARE Alert Service (DAS), registered DisasterAWARE users can subscribe to receive e-mail and SMS notifications when new Hazards are registered by the system or when a Hazard is updated to reflect a new hazard advisory or when additional information is received. Additionally, DisasterAWARE is capable of sending similar notifications via messaging applications such as Telegram or pushing alerts to social media channels such as Twitter and Facebook. As the DisasterAWARE platform is enabled for touch-screens, notifications receivers can instantly access additional information via their mobile phone or tablet, allowing them to make response decisions while in the field or in transit.

Strategies for Effective Implementation of Early Warning Systems

Risk-based Deployment of EWS

Given the finite resources available for disaster management planning and preparedness activities, understanding high risk zones and priority areas is an important consideration in the deployment of an early warning system to maximize its impact. Risk and vulnerability assessments (RVA) can allow EWS developers and operators to make informed decisions such as where detailed data might need to be collected or where to deploy additional sensors to monitor a particular hazard. Additionally, RVA outputs can be incorporated into system, providing the wider user community – including planners and response teams – with data that can enhance their understanding of a particular incident within an overall risk and vulnerability context.

Institutionalization for Effective Use and Sustainability

When implementing an EWS, long-term use and sustainability planning must be key considerations. Users should feel confident in their abilities to leverage the system for their specific disaster management responsibilities. Additionally, such systems should be developed with the user needs and local context in mind. Understanding this, PDC places significant emphasis on the institutionalization of each DisasterAWARE application as part of the deployment process in an effort for it to achieve its full potential.

Concept of Operations

Development of an EWS should begin with a clear understanding of the current hazard monitoring, early warning, and preparedness and response decision-making and operational process of the implementing organization. This understanding must include mechanisms for sharing hazard information and providing warnings, as well the intended role that the early warning system will play in the overall disaster management framework. With PDC's deployment of its DisasterAWARE systems - both regionally and within individual nations - a Concept of Operations (CONOPS) document is developed that identifies disaster management stakeholder organizations, and includes their structures, roles, responsibilities, information flows, and decision-making processes as they relate to natural hazard monitoring and early warning. This information is obtained through a literature review, stakeholder workshops, and individual stakeholder interviews. The CONOPS is used to guide the customization, deployment, and operational utilization of the system. The drafting of this document helps developers and implementers of the system to understand what information are needed for use in the decision-making process, how data and information could be shared with those who need them, and what rules should be associated with these sharing mechanisms.

Standard Operating Procedures

EWS users also require clear direction regarding the utilization of an EWS to monitor, alert, and report on disaster events. This can be effectively achieved through the development and implementation of Standard Operating Procedures (SOPs) which provide details of required user actions as they carry out their prescribed disaster management responsibilities. Multiple SOPs may be developed to guide various categories of user interactions with the EWS. With the deployment of national or regional-level DisasterAWARE applications, for example, SOPs are typically developed for Hazard Creation (aka Manual Hazards), Response Operations, and Exercise. The input of non-automated hazard notifications into the system is guided by the Manual Hazards SOP, allowing selected administrative users to assign severity and create hazards within the system. For aquatic health monitoring, this would allow administrative users to create hazards based on incident reports received from stakeholders, in turn leading to the automatic issuance of notifications to DisasterAWARE users. The Response Operations SOP details how users can most effectively utilize the system during hazard event, such as responding to an aquatic disease outbreak, while an Exercise SOP provides guidance on how to use DisasterAWARE to conduct or support scenario-based exercises and simulations.

Staffing Plans

With a focus on the sustainability of an EWS, it is also important to consider the staffing requirements to avoid having the EWS become inoperable or obsolete. Identifying key roles and outlining responsibilities allows the agency that administers the EWS to engage the services of staff and vendors to operate and maintain the system. The development of a staffing plan achieves this, providing leadership with guidance for resourcing the system appropriately. Generally, a customized version of DisasterAWARE requires a System Administrator, Map Server System Administrator, GIS and Hazard Information Analysis, and Database Administrator. These roles could be performed by multiple staff or can be combined into fewer full-time staff positions.

Training and Exercise

While the above processes and associated documents are essential components in the development and deployment of an EWS, the use of a system can only be effective if there is sufficient user capacity to effectively operate it and carry out approved SOPs. This capacity can be successfully built through training on, and exercising of, the EWS and its various SOPs. For DisasterAWARE deployments, PDC provides training to key system users to ensure that they have a working mastery of the system's functions to allow them to use it most effectively for their activities. Additionally, PDC delivers Train-the-Trainer programs to build internal capacity for future training requirements. PDC's training activities also extend to System Administration training, again with a focus on building internal capacity, helping to ensure the sustainability of the system.

Exercises are a useful and important way to test an EWS, provide an opportunity for users to practice their skills, and to review and refine SOPs. Additionally, an EWS-supported exercise offers an opportunity to test wider disaster management operations as it can be used to simulate an evolving hazard scenario and identify operational gaps. Globally, DisasterAWARE applications have supported numerous exercises, large and small, often acting as the central information management tool during multi-country exercises. DisasterAWARE can be used to inject exercise-supporting data and map layers, providing a visual understanding of the scenario as well as supporting inter-agency information sharing throughout the exercise.

Operational Policy

While SOPs and training can provide the capacity needed to use an EWS, effective use of an early warning system ultimately requires high-level approval and direction. Such authority can be provided by agency leadership through the execution of a policy document (e.g. circular, decree, etc.) that provides users with authorization to use the system as part of the duties.

PDC's DisasterAWARE™ Platform

PDC's disaster monitoring, early warning, and decision support platform is DisasterAWARE™ (All-hazard Warning, Analysis, and Risk Evaluation). This web-accessed resource provides situational awareness, decision support, and information sharing capabilities, and is operationally used by disaster managers around the world. DisasterAWARE is available through freely-accessible public versions, a password-protected version for those with disaster management or humanitarian assistance responsibilities, and various custom versions.

DisasterAWARE is an ever-evolving solution to the everyday challenges of hazard monitoring and the related urgent needs. When the critical—possibly life-saving—disaster information exists, it is often scattered across national and subnational agencies and lacking any risk context. If the information can be found, it will be at the cost of time (and sometimes money) disaster managers can ill-afford, and often security restrictions to which they cannot conform. Specialized solutions are difficult, expensive, and narrow. DisasterAWARE overcomes these and many other obstacles by incorporating international best-practice methodologies and technologies for data acquisition, hazard modeling, risk and vulnerability assessment, mapping, visualization, and communications into one system. Additionally, the system's interoperable base platform is adaptable to support secure environments.

PDC hosts and operates two distinct web-accessible versions of DisasterAWARE at its Hawaii-based headquarters: Disaster Alert and EMOPS (Emergency Operations). EMOPS, incorporating some special holdings and features for disaster management professionals, requires a registered account and password. A mobile app version, Disaster Alert, extends monitoring and alerting capabilities to iPhone, iPad, and Android mobile devices.

Custom systems "powered by DisasterAWARE," have been developed for PDC partners around the Pacific, and more are in development or under consideration. Deployed systems include DisasterAWARE for Thailand (2006); VinAWARE for Vietnam (2011); Disaster Monitoring and Response System for ASEAN at the AHA Centre (2012); and InAWARE for Indonesia (2014). Deployment of PhilAWARE for the Philippines is planned for 2019. Generally, these custom deployments include both hazard and baseline data from relevant national agencies, and localization of the user interface to support early warning, disaster relief, and humanitarian assistance missions.

BioServ

In 2012, PDC was approached by key stakeholders in the disease monitoring and public health alerting community and asked if DisasterAWARE could be adapted to provide monitoring and warning for public health and infectious disease. The theory was tested in a small pilot project. After initial success, and in partnerships with the U.S. Navy Environmental Preventive Medicine Unit 6, Naval Medical Research Unit 2, and the Army Public Health Command, the BioSurveillance Information Service (BioServ) program was developed under funding from the US Navy's Advanced Medical Development program.

Expanding the partnership network to include authoritative U.S. and global health data sources, during subsequent years of the program, BioServ has been expanded under three major themes: disease outbreak and human security alerts, disease background information, and country/regional background information. All of these health data appear alongside PDC's global risk and vulnerability indices, infrastructure, climatic, demographic, economic, and geographic information layers.

About the Pacific Disaster Center

Pacific Disaster Center (PDC) was created following the destructive Hurricane Iniki, which passed through Hawaii, heavily impacting the island of Kauai on September 11, 1992. Seeing the destruction, Hawaii's U.S. Senator Daniel K. Inouye realized that information resources with the potential to reduce hurricane damage were, in fact, available. He knew about space-based imagery libraries, for instance, and near-real time satellite observation. He also understood that these Cold War technologies could be repurposed for the civil-military needs of disaster management. It was not easy. It took four years, working on everything from funding channels to writing new software, but 22-1/2 years ago, in February 1996, Pacific Disaster Center opened.

Since then, PDC has actively applied information, science, and technology to enable effective evidence-based decision making and to promote disaster risk reduction (DRR) concepts and strategies. The Center provides multi-hazard monitoring, warning, and decision support tools to facilitate critical information sharing, supporting effective actions throughout the disaster management cycle. PDC also conducts advanced risk assessments that integrate hazard exposure with socio-economic factors to define vulnerability and resilience, so the disproportionate impact of events on various populations can be better understood, and then mitigated through improved preparedness and planning processes.

All this, however, can only be accomplished through working partnerships: working with stakeholders to understand gaps and needs, collaborating with a broad range of data providers to facilitate access to information, and partnering with scientists and technologists to develop solutions. PDC could not possibly hope for better partners in establishing disaster management best-practices for any place than the people that call that place "home."

Transboundary Aquatic Animal Diseases: History and Impacts in ASEAN Aquaculture

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Abstract

Aquaculture is one of the important sectors in the economy of most Asia-Pacific countries. However, majority of aquaculture farms are small-scale and most often lack the necessary facilities to comply with or are not well informed of the product standards imposed by concerned authorities, especially for international trade. Most countries in the region have a high reliance on aquatic animals as the major source of protein for their populations. In the past 20 years, farming of shrimp and fish for export has become a major employer and revenue earner for many countries in the region. Aquaculture is a major employer, contributes significantly to national economies, assists in poverty reduction, and is an important element in food security and other national development priorities. Aquaculture has developed rapidly in the region and is now a significant component in the national economies of many countries. However, recent disease events in fish and shrimp farming have indicated that preparedness and response measures are lacking, contributing to spread of disease across large areas of the countries involved.

The growth of aquaculture in recent decades has been dependent on the international movement of aquatic animals and, in particular, the introduction of non-native species. The movement of live aquatic animals and their products has the potential to spread pathogens from one country or region to another, which may result to disease outbreaks. In shrimps as example, most major disease outbreaks were associated with the movement of live animals (broodstock, nauplii and postlarvae) when the patterns of disease spread were analyzed. Many aquatic animal diseases, once established, are often difficult to treat or to eliminate. Over the past 30 years, the Asia-Pacific region has been swept by a number of devastating diseases of aquatic animals which have caused massive economic and social losses. These include spread and outbreaks of infection with *Aphanomyces invadans* (EUS) in freshwater fish, viral nervous necrosis (VNN) in marine fish, viral hemorrhagic septicaemia (VHS) in marine and freshwater fish, and several viral diseases in shrimps such as white spot disease (WSD), white tail disease (WTD), yellow head disease (YHD) and infectious myonecrosis (IMN) among others. This demonstrates the vulnerability of the aquaculture industry as well as the wild populations to disease emergence in the region. The impacts of these diseases have been aggravated by the lack of effective preparedness and response whenever diseases emerge. Although some national, regional and international actions towards disease emergencies have paved way to disease spread prevention in recent years (e.g. Acute hepatopancreatic necrosis diseases; AHPND), there are still several emerging diseases that need to be considered by aquaculture-producing countries, especially in the ASEAN, through a harmonized and effective emergency preparedness and disease response.

Introduction

ASEAN member countries are among the top aquaculture producers in the world. In 2016 Indonesia, Viet Nam, Myanmar and Thailand were among the top 10 producers contributing 6.2, 4.5, 1.3 and 1.2%, respectively, of the total world aquaculture production. Table 1 summarizes the total aquaculture production of the rest of the ASEAN member states (FAO, 2018a). Aquaculture in the Asia-Pacific region in general is a significant food production sector that provides many livelihood opportunities, especially for small-scale farming communities which are common in the region. It also contributes to food security, nutrition and health of the general public, and poverty alleviation especially through the production of exportable aquaculture products. As the biggest producer of aquaculture products in the world, Asia is also the biggest consumer. It is estimated that 95% of the fish supply in the ASEAN region was used for human consumption (Chan et al., 2017). Needham and Funge-Smith (2014) reported that among the ASEAN countries, Cambodia is the highest consumer with an average of 63.5 kg per capita per year, while the lowest is Indonesia with 12.8 kg per capita per year.

TABLE 1. Aquaculture production of ASEAN member countries in 2016 (FAO, 2018a)

Rank	Country	Production (x 1,000 T)	Percentage (World Production)
1	Indonesia	4,950	6.2
2	Viet Nam	3,625	4.5
3	Myanmar	1,017	1.3
4	Thailand	963	1.2
5	Philippines	796	1.0
6	Malaysia	408	0.5
7	Cambodia	172	0.2
8	Lao PDR	110	0.1
9	Singapore	6	-
10	Brunei Darrusalam	1	-

With the rapid development of aquaculture in the region, disease outbreaks remain to be the biggest challenge in the sustainability of aquaculture production. Previous and recent disease events in shrimp and fish farming have indicated that preparedness and response measures are still lacking, which contribute significantly to the spread of diseases/pathogens across large areas of the countries involved. Several transboundary aquatic animal diseases have swept the region over the past 30 years which have caused massive economic and social losses. These include spread and outbreaks of infection with *Aphanomyces invadans* (EUS) in freshwater fish, viral nervous necrosis (VNN) in marine fish, viral hemorrhagic septicaemia (VHS) in marine and freshwater fish, and several viral diseases in shrimps (white spot disease [WSD], white tail disease [WTD], yellow head disease [YHD]) (Rogers et al., 2011). More recently, infectious myonecrosis (IMN) and acute hepatopancreatic necrosis disease (AHPND) are seriously affecting shrimp aquaculture in Indonesia (IMN; Senapin et al., 2007) and Malaysia, Philippines, Thailand and Viet Nam (AHPND; Flegel, 2012; Leaño and Mohan, 2012a; Dabu et al., 2015). For finfish, it is the Tilapia lake virus (TiLV) which was first reported in Thailand (Dong et al., 2017a; Surachetpong et al., 2017), then in Taiwan (Yang et al., 2017), Malaysia (Amal et al., 2018), the Philippines and India (NACA, OIE and FAO, 2017). The spread of these transboundary aquatic animal diseases clearly demonstrates the vulnerability of the aquaculture industry, as well as the wild fish populations, to disease emergence where impacts have been aggravated by the lack of effective preparedness and response whenever disease emergencies emerge.

Emergence and spread of serious transboundary aquatic animal diseases

The emergence and spread of transboundary aquatic animal diseases are mainly a result of two important practices in aquaculture: intensification of culture systems; and, international trade (movement) of live aquatic animals and aquatic animal products. The economic impact of these diseases is huge, around US$6 billion annually on direct production losses. Over the years, several transboundary aquatic animal diseases have affected the aquaculture industry in the region. Some of these are summarized in detail below:

Koi Herpesvirus Disease (KHV)

This viral disease can cause mass mortalities in cultured Koi and common carp (*Cyprinus carpio*). Affected culture systems will show many dead and moribund fish floating at the water surface. Affected fish also exhibit disorientation, erratic swimming behavior (sometimes hyperactivity), and gasping for air. Clinical examination of infected fish will reveal severe gill lesions (mottling with red and white patches), overproduction or underproduction of mucus on skin and gills, enlarged and haemorrhagic kidney and liver, and some fish will have bleeding gills, sunken eyes and pale patches or blisters on the skin.

KHV in the region was first reported in Hong Kong in 2001, then in Indonesia in 2002 (Lio-Po, 2010). From 2002 to 2005, it has spread in Taiwan, Japan, and Singapore. Since koi carps are highly traded ornamental fish, mass mortalities due to KHV has significantly affected production in major producing countries that were hit by the disease. Moreover, trading of healthy koi carps is also greatly affected, especially from countries reported to be positive from the disease, as the aquarium fish trade most likely played a significant role in the transboundary spread of the virus. The disease can be transmitted to common carps, an important cultured food fish in the region, and significant production losses were also reported in some countries (e.g. Indonesia). Some of the reported economic losses due to KHV include Japan with a reported loss of $2.5 million during the first year of outbreak. In Indonesia, $0.5 million loss was reported within three months since the outbreak was reported in 2002 (Sunarto et al., 2005), and as of December 2003, total losses amounted to US$15 million.

Infection with White Spot Syndrome Virus (WSD/WSSV)

WSD/WSSV is, by far, the most devastating disease of farmed shrimps. The virus can infect most of the cultured shrimps and other crustaceans, including the wild populations. It has caused heavy losses among cultured shrimps in Asia, and almost crippled the industry in countries where outbreaks were reported. The typical sign of this disease is the presence of distinct white cuticular spots mainly on the carapace (hence the name white spot disease). Some moribund shrimps also show red discoloration and loose cuticle, surface swimming and gathering at pond dikes with broken antennae. The spread of the disease happened during the peak of *Penaeus monodon* culture in Asia, mainly through trading of live postlarvae and broodstock from China, Taiwan, Indonesia and Thailand. The disease was initially reported in China, Japan and Taiwan in 1993, and from 1994 to 1999, it has rapidly spread in many shrimp-producing countries in the region including Thailand, Malaysia, Indonesia, India, Sri Lanka, Viet Nam, Brunei, Cambodia and Myanmar. The disease was also reported in the Philippines in 2000, and in Iran in 2002 (Lio-Po and Leaño, 2016). WSD is one of the reasons of the collapse of *P. monodon* culture in some major shrimp producing countries in the region (e.g. Taiwan, Indonesia, Thailand) and still considered at present as the most important disease problem in the culture of penaeids.

For economic impacts of WSD, it was reported that after the first outbreak in China in 1992, shrimp production was reduced by 70% resulting in losses of over US$2 billion (Bir et al., 2017). In the same year, Indonesia started to lose shrimp production and in the span of 10 years, production losses were roughly around US$1 billion. In Thailand, the shrimp industry incurred losses of US$1.6 billion in 1994, and by 1997, losses due to WSD was recorded at US$600 million (Flegel, 1998). Overall, total losses of shrimp production due to WSD were estimated to be at US$13 billion (Lio-Po and Leaño, 2016).

Infection with Infectious Myonecrosis Virus (IMNV)

This disease is considered as the current threat in the culture of *P. vannamei* in the region. Originally reported in Brazil, the first outbreak in Asia was reported in Indonesia (East Java) in 2006 (Senapin et al., 2007), and was contained in this area for some time until it started to spread rapidly to other shrimp producing provinces of the country. By April 2007, it reached northeast Sumatra, and by the third quarter of 2009, arrived in ponds in West Kalimantan and Sulawesi (Thong, 2013). In 2016-2017, the disease was reported in India in the shrimp-producing provinces of West Bengal and Tamil Nadu (Sahul Hameed, et al., 2017; NACA, OIE and FAO, 2017).

Shrimps affected by the disease exhibit white necrotic areas in striated muscles, especially at the distal abdominal segment, which become reddened in some affected shrimps. The disease can cause high production losses as mortalities can be instantaneously high (40-70%) and continue for several days after the onset of infection. Reported production loss due to IMNV from 2002 to 2011

(Brazil and Indonesia) was more than US$1 billion. Brazil, Indonesia and India (countries affected by the disease) produce 27% of global shrimp production (Tang, 2016).

Acute Hepatopancreatic Necrosis Disease (AHPND)

Acute Hepatopnacreatic Necrosis Disease is a recent disease problem of cultured shrimps that cause unusually heavy mortality approximately within the first 35-40 days of culture. It was first reported in China in 2009, then in Viet Nam in 2010, Malaysia in 2011, Thailand in 2012 (Flegel, 2012; Leaño and Mohan, 2012a; Joshi et al., 2014), Mexico in 2013 (Nunan et al., 2014; Gomez-Gil et al., 2014) and the Philippines in 2014 (NACA-FAO 2015; Dabu et al., 2015; dela Peña et al., 2015). The disease is caused by a highly pathogenic strain of *Vibrio parahaemolyticus* (Tran et al., 2013) that have acquired a "selfish plasmid" encoding the deadly binary toxins PirAvp/PirBvp (Li et al., 2017), and has caused significant economic losses among cultured *P. monodon* and *P. vannamei* in the affected countries.

The spread of the disease was attributed to trading of live postlarvae and non-SPF broodstock, and trading/movement of live polychaetes as natural food for shrimp broodstock (live polychaetes was found to harbor AHPND *V. parahaemolyticus*) (NACA, 2015). The further spread of the disease to other shrimp-producing countries in the region, however, was significantly prevented through early warning and efficient dissemination of information (Leaño and Mohan, 2012b). Economic losses for Thailand due to AHPND from 2011 up to the present is roughly US$7.38 billion, while in Viet Nam's Mekong Delta, AHPND in 2015 caused losses of US$8.9 million in whiteleg shrimp and US$1.8 million in tiger shrimp (Towers, 2016).

Response to major disease outbreaks in the region: A retrospect

If we look back on how the region responded to some of the major aquatic animal disease outbreaks, it can be seen that they are generally chaotic due to the lack or emergency preparedness strategies when such disease emergencies emerged. Summarized below are some of the disease events that happened in the past, and how the region responded:

Infection with *Aphanomyces invadans* (EUS)

The disease was first reported in Singapore in 1977 and rapidly spread to other countries in the region from 1981 to 1990. Most of the ASEAN member countries were not prepared enough for such emergency epizootic, especially with the rapid spread of the disease. This was coupled with the time required to single-out the main pathogen involved which was responsible for the wide and rapid spread of the disease. Overall, response of the region in dealing with this disease was a total mess.

Koi Herpes Virus Disease (KHV)

After the region's previous experiences with EUS and WSD, the first reported outbreaks in the region immediately alerted the major koi- and common carp-producing countries. Despite some concerted efforts to prevent the disease, several countries were not spared. Significant achievements, however, were made by some countries in prevention of further spread and/or eradication of the disease (e.g. Thailand). Improved preventive measures including biosecurity and quarantine also prevented the wider spread of the disease in some countries. Although some countries are prepared for such emergencies, the disease still created panic before any necessary preventive measures were implemented.

Acute Hepatopancreatic Necrosis Disease (AHPND)

Considering the experiences and improving response of the region in dealing with disease emergencies, and despite the availability of modern diagnostic tools for identification of shrimp diseases, the region was again caught off-guard by the occurrence of this disease. Efforts made to identify the main causative agent were not well-coordinated, especially in hardly-hit countries (e.g. Viet Nam), causing a lot of confusions on what preventive and control measures to be applied in affected farms. However, emergency actions of international and regional organizations (FAO, OIE, NACA), including wider dissemination of information and advisories prompted several shrimp-producing countries to apply strict biosecurity measures (e.g. Indonesia) to prevent the entry of the disease. Although a significant improvement in emergency preparedness and response by several countries in the region, AHPND still created chaos before appropriate preventive measures and strategies were put into place.

New and emerging diseases: Emergency preparedness and response

Recent outbreaks of new/emerging diseases has again tested how prepared the countries in the region are in responding to such emergencies. The emergence of Tilapia lake virus (TiLV) as an example, clearly showed the capacity of the region to respond, which can be largely due to the previous experiences in dealing with disease epizootics (as mentioned above). TiLV was first reported in the region by Thailand (early 2017) and Chinese Taipei (mid-2017); followed by Malaysia, India and the Philippines in the 3rd quarter 2017 (Dong et al., 2017a; Surachetpong et al., 2017; Yang et al, 2017; Amal et al., 2018; NACA, OIE and FAO, 2017). A local publication also confirmed the presence of TiLV in Indonesia (Koesharyani et al., 2018). The responsible pathogen, however, was already identified from the previous outbreaks in Africa and South America (Eyngor et al., 2014; Ferguson et al., 2014; Bacharach et al., 2016; Tsofack et al., 2016; Del-Pozo et al., 2017; Fathi et al., 2017) when the disease was confirmed to be present in the region, and molecular diagnostic methods were available or immediately developed/improved (Dong et al., 2017b). In response to this, many countries in the region undertook active surveillance for the presence or absence of the virus/disease. Some countries also took precautionary measures of banning importation of tilapia from TiLV-confirmed countries.

TiLV was immediately listed in the NACA-FAO-OIE Quarterly Aquatic Animal Disease (QAAD) reporting system to monitor the prevalence of the disease in the region. Moreover, an emergency regional consultation was undertaken a few months after the first report of the disease in the region (NACA, NFTEC, China-ASEAN CJRPMAT and SYU, 2018). This was organized by NACA and the Ministry of Agriculture (MOA), PR China and attended by experts from around the world and participants from major tilapia-producing countries in the region. An intensive training of TiLV diagnostics was undertaken more than a year after the first report of the disease, organized by FAO and MOA (FAO, 2018b). Overall, a much better disease preparedness and response can be seen in the region in dealing with this recent disease emergency. And while there have been no scientific studies on the socio-economic impact of TiLV, it may pose a significant threat particularly to small-scale fish farmers' livelihoods and wild tilapine populations if left uncontrolled (Jansen et al., 2018).

The question still remains, is the region really prepared enough on how to respond to new and emerging aquatic animal disease problems? In the QAAD list for 2017 to 2019 reporting, the following diseases are considered to be the new threats in crustacean aquaculture:

- Hepatopancreatic microsporidiosis caused by *Enterocytozoon hepatopeneai* (EHP)
- Viral Covert Mortality Disease of shrimps
- *Spiroplasma eriocheiris* infection in crayfish and freshwatrer prawn
- Infection with Shrimp haematocyte iridescent virus (SHIV)

These emerging diseases might spread in the region anytime, as we continue to trade live aquatic animals, as we continue to intensify culture systems, and as we continue to introduce new species for culture. It should be noted that once a disease is introduced into a country or area, it is often very hard to eradicate. However, it can be managed to prevent or at least minimize the impacts of the disease to the cultured stocks and to the industry. As we have shared water bodies and epidemiological link through trade (especially movement of live aquatic animals), a collaborative approach is necessary in dealing with such disease emergencies for effective aquatic animal health management, for improved disease monitoring, surveillance and reporting, and for effective disease preparedness and response system.

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OIE International Standards on Aquatic Animals

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Abstract

The World Organisation for Animal Health (OIE) is the intergovernmental organisation responsible for improving animal health worldwide. It is recognised as a reference organisation by the World Trade Organization (WTO) to develop international standards for animal health and zoonoses; as of May 2018, it counts a total of 182 Members.

As the global leader for animal health and welfare standards, the OIE plays an influential role in the prevention, control and information sharing of animal diseases including aquatic animal diseases. The objectives of OIE are to: (1) Ensure transparency in the global animal disease situation; (2) Collect, analyse and disseminate veterinary scientific information; (3) Encourage international solidarity in the control of animal diseases; (4) Safeguard World trade by publishing health standards for international, trade in animals and animal products; (5) Improve the legal framework and resources, national veterinary services and aquatic animal health services; and (6) to provide a better guarantee of food of animal origin and to promote animal welfare.

As an international standard setting organisation, the OIE Aquatic Animal Health Code (the Aquatic Code) provides standards for the improvement of aquatic animal health worldwide. It also includes standards for the welfare of farmed fish and use of antimicrobial agents in aquatic animals. The sanitary measures in the Aquatic Code provide international standards on importing and exporting countries for early detection, reporting and control of pathogenic agents in aquatic animals (amphibians, crustaceans, fish and molluscs) and to prevent their spread via international trade in aquatic animals and their products, while avoiding unjustified sanitary barriers to trade. In addition, to provide a standardised approach to the diagnosis of the diseases listed in the Aquatic Code and to facilitate health certification for trade in aquatic animals and aquatic animal products, the OIE also developed the OIE Manual of Diagnostic Tests for Aquatic Animals.

OIE Aquatic Animal Code chapter 2.1 Import Risk Analysis provide recommendations and principles for conducting transparent, objective and defensible risk for importing aquatic animals and aquatic animal products. The components of risk analysis are 1) hazard identification, 2) risk assessment, 3) risk management and 4) risk communication. Additionally, the OIE international standards (Code and Manual), World Animal Health Information System, and OIE Tool for the Evaluation of Performance of Aquatic Animal Health Services also provide scientific evidence to the MCs on import risk analysis.

Emergency Response to Emerging Diseases: TiLV in Tilapia

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Abstract

Tilapia lake virus (TiLV) is a novel RNA virus resembling Orthomyxovirus. It has been recently re-classified to *Tilapia tilapinevirus* species, under *Tilapinevirus* genus, *Amnoonviridae* family (ICTV, 2018). Since the first discovery in Israel in 2014, so far TiLV has been reported from 14 countries in three continents (Asia, Africa, and South America). Thailand is one of the affected countries that reported emergence of this virus in 2017. Initially, we employed nested RT-PCR primer sequences previously published for TiLV diagnosis. However, the resulting amplification of nonspecific fish genes led us to modify the nested RT-PCR protocols into a semi-nested RT-PCR by omitting a non-specific primer to avoid false positive results. Subsequently, our molecular work together with histopathology and sequence analysis confirmed the presence of TiLV infection in Thailand. Prior to the publication of our manuscript, we informed the Thai Department of Fisheries of our discovery of TiLV in Thailand. Our publication was preceded by a brief article at the website of the Network of Aquaculture Centers in Asia-Pacific in which we warned of the spread of TiLV and offered free use of a newly improved, semi-nested RT-PCR method and positive control plasmid for detection of TiLV. To date, we have provided positive controls in response to 44 requests from 24 countries who have expressed their appreciation for our attempt to help in emergent controlling the spread of this fish pathogen. Our current study focuses on genetic diversity of TiLV and development of detection method that covers all genetic variants.

What has been done

Get ready for PCR diagnosis

Tilapia Lake Virus (TiLV) was considered as an emerging tilapia virus since the publication of studies by Eyngor et al (2014) and Ferguson et al (2014) have been published. When the partial viral genome sequence and PCR primers for detection become available (Kembou Tsofack et al, 2017), Centrex Shrimp starts synthesizing and had been optimizing the PCR conditions in the laboratory without any positive control or infected fish specimens. It was observed that some false positive results occurred due to non-specific binding of one primer pair. Thus, one of the primers was omitted and PCR conditions were modified from nested to become semi-nested PCR. Until December 2016, clinically sick tilapia specimens were obtained and was reported with over mortality of 20% and 90%. These two sets of the samples were all TiLV positive and sequence analysis revealed 96.28 to 97.52% nucleotide identity with the Israel isolate (Eyngor et al, 2014; Bacharach et al, 2016). With infected samples in possession, construction of the positive plasmid for use as positive control started and was used in detection sensitivity assay. Our modified semi-nested PCR protocol had the detection sensitivity of 7.5 copies per reaction (Dong et al, 2017a).

Announcements and offering positive control

Once the presence of TiLV by histopathology and sequence analysis was confirmed, Department of Fisheries in Thailand was informed prior to publication of results (Dong et al, 2017a). Subsequently, the group wrote a brief article which served as a warning of the spread of the virus. It was published at the website of the Network of Aquaculture Centers in Asia-Pacific (https://enaca.org). It also includes the Center's offering of the newly improved, semi-nested RT-PCR method and positive control plasmid for detection of TiLV (Dong et al, 2017b). Using the newly improved detection assay, it could reveal that some of the archived samples in our laboratory kept in 2012-2016 were tested positive for TiLV. This is an indication that the virus has already circulated in the country before it became known to science (Dong et al, 2017c, d). To date, positive controls have been provided in response to 44 requests from 24 countries. All of which have expressed their appreciation for the center's attempt to help control the spread of this fish pathogen. Training courses on TiLV diagnosis based on molecular and histopathological analysis were also conducted upon request.

Way forward

There are still knowledge gaps, in many aspects, on TiLV (Jansen et al, 2018). Some massive mortalities were found to be associated with the virus while some TiLV-infected cases showed no abnormal mortality (Senapin et al, 2018). There are still problem areas that needed answer including if there are genetic variation types of this virus and whether it contributes to a difference in virulence and pathogenicity. The center's current studies focus on genetic diversity of TiLV and development of detection method that covers all genetic variants. Investigation of potential vertical transmission of TiLV is also in progress.

Acknowledgments

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Emergency Response to Emerging Disease: AHPND in Shrimp

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Abstract

Outbreaks of acute hepatopancreatic necrosis disease (AHPND) have caused great economic losses to many shrimp producing countries in Asia since its first appearance in 2009. The causative agent was first reported in 2013 as specific isolates of *Vibrio parahaemolyticus* (VP_{AHPND}) that were later found to harbor a plasmid (pVA) encoding the Pir-like binary toxin genes PirvpA and PirvpB. More recent information indicates that pVA plasmid and variants occur in many *Vibrio parahaemolyticus* serotypes and also in other *Vibrio* species such as *V. campbellii*, *V. harveyi* and *V. owensii*. Information on such genomic and proteomic studies of different VP_{AHPND} isolates from different countries are reviewed. A cohort study carried out in Thailand in 2014 indicated that AHPND outbreaks account for only a portion of the disease outbreaks reported by shrimp farmers as outbreaks of early mortality syndrome (EMS). It is urgent that the etiology of the other EMS-associated mortalities be investigated and not be overlooked. It is recommended that a regional research network and surveillance program for newly-emerging or re-emerging pathogens be established to speed up the process of diagnosis and the implementation of coordinated control measures and to avoid a repeat of the EMS/AHPND scenario.

Keywords: Early mortality syndrome (EMS), Acute hepatopancreatic necrosis disease (AHPND), *Vibrio parahaemolyticus* (VP_{AHPND}), Binary toxin A/B, Surveillance program

Risk Analysis in Aquaculture

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Abstract

The information presented in this paper were taken from several key FAO documents. The objective is to continuously raise awareness about the concept of risk analysis and its application to the aquaculture sector.

The paper provides information in response to several key risk questions, e.g.: (1) what is risk versus hazard, (2) what is risk analysis, (3) who uses risk analysis, (4) why do countries need to be able to use risk analysis? An overview of the risks in aquaculture is also provided in terms of the process and approaches; and the different risk sectors in aquaculture.

The paper concludes with some key points and challenges. Risk analysis is a decision-making tool that contributes to protecting national health and welfare. It can also contribute to sustainable aquaculture and the success of individual aquaculture businesses and operations. Risk analysis does not stand alone – it supports and is supported by other components of a National Strategy on Aquatic Animal Health. A basic strength of the risk analysis process is its flexibility - it is adaptable to almost any sector/system where risk and uncertainty occur.

Countries will often be confronted with a lack of scientific information, both quality and quantity, to support the risk analysis process. Nevertheless, governments must often act under these uncertainties as well as make decisions in the face of a great deal of complexity, significant variability, and multiple management goals.

Introduction

Aquaculture, as a food-producing sector, has surpassed both capture fisheries and the terrestrial farmed meat production systems in terms of average annual growth rate. Like other farming sectors, aquaculture is associated with environmental concerns that present a number of risks and hazards to both its development and management, and to the aquatic environment and society. The information presented in this paper were taken from several key FAO documents (e.g. Arthur and Bondad-Reantaso [2012]; and Bondad-Reantaso et al. [2008]).

The objective of this paper is to continuously raise awareness about the concept of risk analysis and its application to the aquaculture sector.

Risk versus hazard

In general terms, 'risk' is defined as 'a combination of the *likelihood* of occurrence of undesired outcomes and the *severity* of consequences; while a 'hazard' is 'the presence of a material or condition that has the potential to cause loss or harm (Johnson, 2000). No matter how well managed a system is, there will always be associated risks and hazards.

The concept of risk varies somewhat depending on the sector. Most definitions incorporate the concepts of:

- uncertainty of outcome (of an action or situation), and
- probability or likelihood (of an unwanted event occurring) and
- consequence or impact (if the unwanted event happens)

Thus, "risk" is the potential for realization of unwanted and adverse consequences to human life, health, property, and/or the environment. Its estimation involves both the likelihood, or probability, of a negative event occurring as the result of a proposed action and the consequences that will result if it does happen.

As an example, taken from pathogen risk analysis, the Aquatic Animal Health Code (OIE, 2010) defines risk as:

"...the likelihood of the occurrence and the likely magnitude of the biological and economic consequences of an adverse event or effect to animal or human health."

While some sectors incorporate consideration of potential benefits that may result from a risk being realized (e.g. financial risk analysis), others specifically exclude benefits from being taken into account (e.g. pathogen risk analysis).

Risk involves the concept of a hazard. Hazard is something with the potential to cause negative consequences. Examples of hazards include:

- ecological hazards: the aquatic animal or an accompanying organism (a "fellow traveler" or "hitchhiker");
- pathogen: infectious agent;
- genetic hazards: the aquatic animal being moved;
- human health/food safety hazards: a "contaminant" in the product; and
- financial hazard: a decision that might cause business loss or failure

The risks faced by the aquaculture sector is similar to those of the agriculture sector. Since aquaculture is very diverse (in terms of species, environments, systems and practices), the range of hazards and the perceived risks are much greater. In addition, the intensified transboundary movement of aquatic species as part of increasing trade and globalization is now recognized as a pathway for disease introduction. The sector is also vulnerable to natural disasters and on-going climate changes, and there remain many other management and operational issues.

What is risk analysis?

Governments and the private sector must often make decisions based on incomplete knowledge and a high degree of uncertainty. Such decisions may have far-reaching social, environmental, and economic consequences.

There are several definitions of 'risk analysis,' according to Society for Risk Analysis (http://www.sra.org/), as presented below:

1. A detailed examination including risk assessment, risk evaluation, and risk management alternatives, performed to understand the nature of unwanted and negative consequences to human life, health, property, or the environment.
2. An analytical process to provide information regarding undesirable events.

3. The process of quantification of the probabilities and expected consequences for identified risks.

Risk analysis is a process that provides a flexible framework within which the risks of adverse consequences resulting from a course of action can be evaluated in a systematic, science-based manner. It is a formal method of dealing with hazards and risks. In simple terms, it is science-based decision-making; but not science *per se*.

The risk analysis approach permits a defendable decision to be made on whether the risk posed by a particular action or 'hazard' is acceptable or not, and provides the means to evaluate possible ways to reduce the risk from an unacceptable level to one that is acceptable. It includes both objective and subjective components. Transparency assures that stakeholders can understand the entire process and the points where subjective decisions are made.

Who uses risk analysis?

People (individuals, private companies, non-government organizations, government agencies at various levels, policy-makers, etc.) or basically anyone who has to deal with uncertainties are users of the risk analysis process. Examples of such uncertainties are provided below.

Aquaculture risks can be viewed in several ways including:

- risks to economic well-being
- risks to human health
- risks to social well-being
- risks to the physical environment
- risks to the biological environment (biodiversity)

Examples of risks to assets (destruction or loss of infrastructure and/or stocks) due to natural and man-made disasters, such as:

- toxic algal blooms
- epizootic disease outbreaks
- chronic disease losses
- vandalism & theft
- power failure
- predation
- unusual weather events
- war

Human health risks may affect public health due to the following:

- pathogens and contaminants in live fish and their products (e.g. bioaccumulation of heavy metals, organophosphates, etc. from feeding trash fish, parasitic infections such as anisakid nematodes, and larval trematodes, algal toxins, etc.)
- post-harvest changes (spoilage bacteria, histamines)
- contamination of drinking water (by antibiotics, chemicals, feeds used in aquaculture)
- breeding of resistant strains of bacteria (via misuse of antibiotics, e.g. chloramphenicol)

Occupational risks may include the following:

- risk of physical injuries (cuts, diving accidents, boating accidents, electrical shocks, etc.)
- chemical poisoning (breathing, skin contact, consumption of caustic chemicals, poisons)
- bites and stings
- post-harvest infections (bacterial infections - e.g. from handling tilapias)

Risks to the physical environment, may be in terms of:

- risk of environmental degradation (by nets, garbage, siltation, other forms of pollution, escapees)
- risk of decreased esthetics or quality of life ("not in my backyard" syndrome - frequent in developed countries where aquaculture and residential areas are in close proximity)

Examples of risks to the biological environment (biodiversity), include:

- unintentional introduction of pests and "fellow travelers" (tilapia fry in milkfish shipments, many other examples)
- intentional introduction of species that become invasive (Invasive aquatic species, IAS) (e.g. golden apple snail)
- risk of potential genetic impacts on native stocks due to use of new species or strains

- risk of potential ecological impacts on local ecosystems
- risk of potential pathogen introductions

In terms of introductions and transfers, pathogen risks may be in the form of introduction of exotic pathogens [e.g. transboundary aquatic animal diseases (TAADs) including highly pathogenic and untreatable viruses, and species that are non-pathogenic in the normal host may be highly pathogenic in new hosts] and introduction of new strains of existing pathogens (bacteria and viruses, e.g. *Vibrio parahaemolyticus* causing Acute hepatopancreatic necrosis diseases).

Ecological risks associated with introductions and transfers includes the following: competition (food, breeding, and habitat e.g. Asian catfishes); predation (Nile perch, rainbow trout, and other carnivorous species); and habitat destruction/alternation (janitor fish in Philippines and Malaysia, and zebra mussel in the Great Lakes).

On a global scale and across all aquaculture production systems, some of the major areas of environmental concerns are as follows:

- eutrophication of water: due to accumulation of nutrients from the release of uneaten food, feces and metabolites that damage the water column and generate unwanted algae.
- biological pollution: introduction of exotic species, biodiversity loss; escape of genetically modified organisms (GMOs) from production facilities – possibility of cultured species becoming voracious predators or competitors; interbreeding causing loss of genepool; transmission of diseases to native stocks from cage and pen facilities; increased abundance of pathogens in the water due to their reproduction in farmed stocks.
- chemical pollution: release of drugs and other substances used for treatment of disease and parasitic infections into the environment.
- habitat degradation: destruction of productive coastal marshes and other physical impacts (chance or loss) on habitat.

Drivers of the risk analysis process and the benefits

Multiple objectives are driving the application of risk analysis to aquaculture. Foremost is for resource protection (human, animal and plant health; aquaculture; wild fisheries and the general environment) as embodied in international agreements and responsibilities [e.g. the World Trade Organization's (WTO) Sanitary and Phytosanitary Agreement[1], United Nations Environmental Programme's (UNEP) Convention on Biological Diversity and the supplementary agreement Cartagena Protocol on Biosafety[2], the Codex Alimentarius]. Of equal importance, the other drivers of risk analysis are food security, trade, consumer preference for high quality and safe products, production profitability, and other investment and development objectives.

The benefits of applying risk analysis in aquaculture are, thus, now slowly better understood and recently recognized as important to improve the sector's sustainability, profitability and efficiency.

The process

The risk sectors which have been afforded adequate attention and where hazards are clearly defined and risk assessment methodologies are better developed include import risk analysis (IRA) for pathogens/ infectious diseases (Bondad-Reantaso et al., 2004), hazard analysis and critical control point (HACCP) for food safety and public health hazards (Sumner et al., 2004), and geoinformatics (GIS) or risk mapping for natural disasters[3]. The levels of risk assessments used in these areas of concern are considered as qualitative (most common), semi-quantitative or quantitative. Such categories provide useful information and the choice of assessment methodology will depend on the scope of the analysis required and the availability of information that will support the analysis.

The most studied risk analysis in aquaculture include its application to avoid pathogen incursions and other ecological impacts (Bondad-Reantaso et al., 2005; Arthur et al., 2005) resulting from the movement of live aquatic animals or animal products and assessment of antimicrobial resistance (Hernandez-Serrano, 2005).

[1]WTO. 1994. Agreement on the Application of Sanitary and Phytosanitary Measures. p. 69–84. In The results of the Uruguay Round of multilateral trade negotiations: the legal texts. General Agreement on Tariffs and Trade (GATT), World Trade Organization, Geneva.
[2]CBD. 1992. Convention on Biological Diversity. 5 June 1992, 29 p. (http://www.biodiv.org/convention/articles.asp)
[3]http://mrnathan.munichre.com/

MacDiarmid (1977) considers risk analysis as a tool that provides decision-makers with an objective, repeatable and documented method for assessing the risks posed by a particular action or event; it is intended to answer the following questions:

What can go wrong?
How likely is it to go wrong?
What would be the consequence of its going wrong?
What can be done to reduce either the likelihood or the consequences of its going wrong?

Risk analysis makes use of sound scientific and technical data; the process is transparent, iterative and uses a defensible methodology upon which to base policy development and decisions.

In general terms, the principal components of the risk analysis process (World Organisation for Animal Health, 2003) are as follows: (a) hazard identification; (b) risk assessment e.g. release, exposure, consequence assessments, and risk estimation; (c) risk management e.g. risk and option evaluation, implementation, monitoring, and review; and (d) risk communication or a continuous activity that takes place throughout the entire process. This framework is commonly used for pathogen risk analysis, a similar process is used for assessing food safety and public health hazards (see Figure 1).

Regardless of the type of risk analysis, the pathway analysis approach provides a risk assessment framework that facilitates detailed and transparent examination of the key factors that contribute to the overall risk.

Risk analysis can be qualitative or quantitative. In qualitative risk analysis, risk is described in words; likelihood and consequences are described in non-numerical terms (e.g. low, medium, high). It is often the first step in the risk analysis process. In quantitative risk analysis, risk is estimated numerically; likelihood and consequences are described in numerical terms (i.e. probabilities); analyses are more in-depth and more time consuming; and it needs available reliable data. Both approaches are transparent, fully documented and valid.

Can we manage the risks?

Some risk management measures currently applied in the aquaculture sector are highlighted in **Box 1**. According to Van Anrooy et al. (2006), aquaculture stock insurance can provide protection against disease incursions and natural hazards; secure incomes, greater stability and welfare in the farming communities; improve access to investment and credit; and increase incentives for farm improvements. However, access to such insurance is still lacking for small- and medium-scale farmers. GIS is another risk management tool that will become essential in the near future.

Key points and challenges to managing risks in aquaculture

Risk analysis is a decision-making tool that contributes to protecting national health and welfare. It can also contribute to sustainable aquaculture and the success of individual aquaculture businesses and operations.

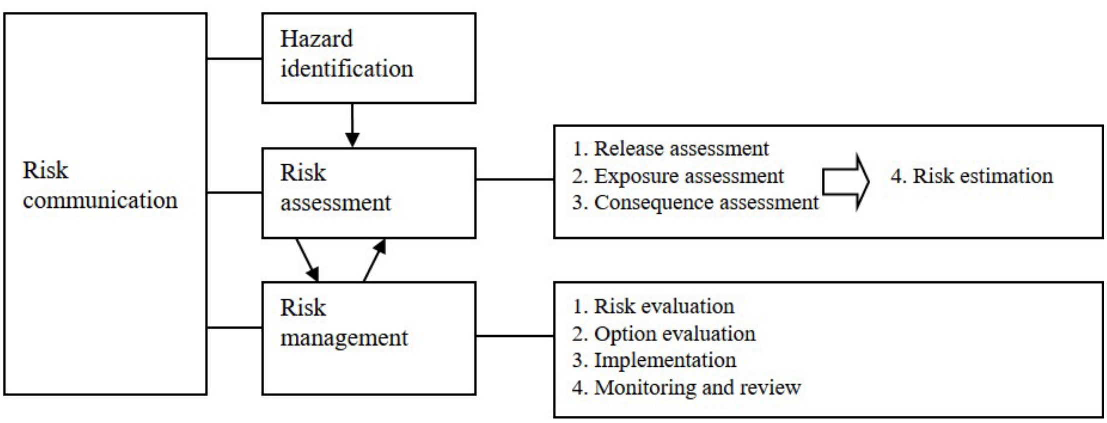

FIGURE 1. Principal components of risk analysis process

BOX 1. EXAMPLES OF RISK MANAGEMENT MEASURES APPLIED IN THE AQUACULTURE SECTOR.

Risk/Hazard	Risk Management Measures
Management and operational risks	Best Management Practices/ Standard Operating Procedures (e.g. good governance; good aquaculture practices at hatchery, nursery and farm levels; good practices for feed/drug and chemical suppliers; good practices for harvesting, marketing and processing; cluster management; other forms of risk-sharing mechanisms), aquaculture insurance
Aquatic animal pathogens/ diseases	Import risk analysis, national strategies on aquatic animal health, biosecurity, disease surveillance and reporting, early warning, emergency response and contingency planning, import risk analysis, good health management practices, vaccination, GIS risk mapping
Antimicrobial resistance	Regulatory interventions, vaccination, good husbandry practices to minimize use of antibiotics
Disease/ climate perils/natural hazards	Aquaculture insurance, GIS
Food safety and public health risks	HACCP; good management practices; good aquaculture practices (GAP), good hygienic practices (GHP), good manufacturing practices (GMP); food safety controls; consumer education; integrated approaches involving health education, vector control and selective population chemotherapy (for parasitic infections)
Occupational risks/hazards	Good orientation of employees and increasing their awareness on risks/ hazards and safety consciousness; use of protective gear; provision of first aid kits; traceability measures etc.
Environmental risks	Proactive policies and regulatory frameworks

Risk analysis does not stand alone – it supports and is supported by other components of a National Strategy for Biosecurity (National Aquatic Animal Health Strategy, Invasive Species Strategy, etc.).
Risk analysis is a framework whose structure and components vary depending on:

- the sector (e.g. technical, social, or financial);
- the user (e.g. government, company, individual);
- the scale (e.g. international, local, farm); and
- the purpose (e.g. to gain understanding of a system or to be implemented by legal measures)

A basic strength of the risk analysis process is its flexibility - it is adaptable to almost any sector/system where risk and uncertainty occur.

Countries will often be confronted with a lack of scientific information (both quality and quantity) to support the risk analysis process. Nevertheless, governments, must often act under these uncertainties, as well as make decisions in the face of a great deal of complexity, significant variability and multiple management goals. An important approach that needs to be considered when data are lacking and evidence of serious risk exists is the precautionary approach (Garcia, 1996). It must be applied responsibly and should be used as a temporary measure until such time that a more thorough risk analysis, supported by scientific information, can be undertaken. Another great challenge is deciding on the Appropriate Level of Protection (ALOP), a societal value judgement about how much a country is willing to pay in forgone trade for protection against incursions, versus the benefits of that trade. Deciding an ALOP will need to take into consideration the economic and social value of aquaculture and capture fisheries, the perceived value of natural biodiversity and the likely economic and social benefits of trade in cultured aquatic animals and their products.

It is important that the people at risk, or those who are most vulnerable, and their needs be the focus of the first mile of protection i.e. fish farmers, people in poverty. Risk communication will play an essential role and a critical step that provides over-all system integrity. Civil society dialogues and partnerships should be widely and actively promoted to enhance risk prevention. Good science, and information dissemination should form part of an integral approach to risk management (e.g. early warning systems, studies on biological pathways, public education, preventative and risk management measures, surveillance, risk mapping). National level enabling legal and policy environments for risk assessments as well as economic incentives must be provided to prevent and mitigate risks in aquaculture. Awareness raising and capacity building to: (a) better understand the risks, hazards and vulnerabilities; (b) develop methods to assess them as well as study the connections between the different risk events and patterns; and (c) identify integrated approaches to risk management, as it will be necessary and should be considered as a matter of priority, especially for developing countries.

The process can be tedious but it is important to embrace the concept first before being intimidated by the process required in some risk scenario and the lack of scientific information for other risk scenarios.

Governments may need to enhance their capacities in understanding and applying risk analysis to aquaculture to support decision-making. With good understanding, they will be able to decide whether an introduction or transfer of an aquatic organism or application for an import permit, for example, will require a risk analysis. And if required, they will be able to provide technical oversight into the process, whether the process is done in-house, by proponents or by consultants, or by expert knowledge (FAO, 2018).

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Emergency Preparedness and Contingency Plans to Aquatic Animal Disease Emergencies

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Abstract

Emergency preparedness is the ability to respond effectively and in a timely fashion to aquatic animal disease emergencies (e.g. disease outbreaks, mass mortalities). It is a key element of a National Strategy on Aquatic Animal Health and an important consideration of the Progressive Management Pathway for improving Aquaculture Biosecurity.

The important principles, requirements and elements and components of emergency prepareness and contingency plans are briefly described. The emergency preparedness response system audit is also presented as contingency planning arrangements that can provide useful insights and guidance in improving response action to disease emergencies.

The paper concludes that many important lessons and insights learned from dealing with disease epizootics in the early 2000 remains valid after more than two decades when the aquaculture sector continues to be plagued with emerging diseases. Past lessons and more recent experiences demonstrated the value of rapid response, reporting/ notification by competent authorities, continuous development of knowledge base and capacities in diagnostics, epidemiology, risk analysis, advanced financial planning and the important roles of governments and producer sectors in co-managing disease outbreak events as they both remain the critical entities responsible for launching rapid response.

Skills and knowledge need to be passed on to locals as they are in the frontline of any disease emergency. Share key lessons from experiences by state and non-state actors (producer and academic sectors and other important players in the value chain), the international players that launch emergency responses, disease investigations and field situation assessments as well as financial entities that support these actions need to be continued. However, we also need to do — a stock taking exercise to evaluate what worked, what did not work, what resources are needed and to understand what are the new drivers for aquatic animal disease emergence in order to move forward with the right and timely response actions to disease emergencies in aquaculture.

Key questions remain: Are we prepared for the next outbreak/mortality event? What are the minimum preparedness and advance preparedness actions needed?

Keywords: Contingency plans, emergency preparedness and response system audit, National Strategy on Aquatic Animal Health

Introduction

Addressing biosecurity requires significant resources, strong political will and concerted international action and cooperation. National strategic planning for aquatic animal health and biosecurity is vital; without it, a country can only react in a piecemeal fashion to new developments in international trade and serious trans-boundary aquatic animal diseases (TAADs), and its aquaculture and fisheries sectors will remain vulnerable to new and emerging diseases.

The FAO encourages Member Countries to develop and formalize national strategy on aquatic animal health (NSAAH) and health management procedures (FAO, 2007). A new initiative called the Progressive Management Pathway (PMP) for improving aquaculture biosecurity (PMP/AB) is an extension of the 'Progressive Control Pathways' (PCP) used for controlling major livestock and zoonotic diseases. The PMP/AB refers to a pathway aimed at enhancing aquaculture biosecurity capacity by building on existing frameworks, capacity and appropriate tools using risk-based approaches and public-private partnerships. This new initiative has four stages, namely:

- Stage 1: Biosecurity strategy (risk) defined;
- Stage 2: Biosecurity systems implemented;
- Stage 3: Enhanced biosecurity and preparedness; and
- Stage 4: Sustainable biosecurity and health management systems established to support national aquaculture sector.

The PMP/AB puts strong emphasis on emergency preparedness, e.g. at Stage 1 where one of the key considerations is basic capacity in emergency management. At Stage 3, it is expected that efficient and effective disease outbreak management is in place. The PMP/AB addresses the lack of effective national plans through a focus on national aquaculture biosecurity strategy development processes (mid- to long-term) and promoting a co-management approach (problems are well recognized and management solutions are identified) with the greater use of planning processes to actively engage stakeholders.

The information presented in this paper are taken from several key publications particularly Arthur *et al* (2005), Baldock (2005), FAO (2005), Bondad-Reantaso *et al* (2007), Perera *et al* (2018), and Arthur and Reantaso (2018).

Emergency preparedness and contingency plans as a component of a National Strategy on Aquatic Animal Health (NSAAH)

A NSAAH is a broad yet comprehensive strategy to build and enhance capacity for the management of national aquatic biosecurity and aquatic animal health. It contains the national action plans at the short-, medium- and long-term using phased implementation based on national needs and priorities; outlines the programs and projects that will assist in developing a national approach to overall management of aquatic animal health; and includes an Implementation Plan that identifies the activities that must be accomplished by government, academia and the private sector (Arthur and Reantaso, 2018; FAO, 2007).

The development of a NSAAH includes a gap analysis [achieved through a self-assessment survey and a SWOT (strengths, weaknesses, opportunities, threats) analysis] conducted by any existing structure [e.g. national or regional focal points, a committee or a task force, a working group on aquatic animal health (AAH)] that fits the country. Such entity will have specific terms of reference. The technical elements that may be considered in the strategic framework will vary depending on an individual country's situation, and thus may not include all the program elements listed below (alternatively, additional programs may be identified as having national and/or regional importance and thus need to be included):

i. Policy, Legislation and Enforcement,
ii. Risk Analysis,
iii. Pathogen List,
iv. Border Inspection and Quarantine,
v. Disease Diagnostics,
vi. Farm-level Biosecurity and Health Management,
vii. Use of Veterinary Drugs and Avoidance of Antimicrobial Resistance (AMR),
viii. Surveillance, Monitoring and Reporting,
ix. Communication and Information Systems,
x. Zoning and Compartmentalization,
xi. Emergency Preparedness and Contingency Planning,
xii. Research and Development,
xiii. Institutional Structure (Including Infrastructure),
xiv. Human Resources and Institutional Capacity, and
xv. Regional and International Cooperation.

An NSAAH provides a country with a comprehensive plan of action for a clearly elaborated and agreed upon programs to achieve national objectives for AAH and biosecurity. It provides clear objectives for all relevant activities, define the activities that need to be accomplished to reach these objectives, and give an indicative time-frame and priority for each activity. Its development involves an extensive process during which the current national AAH capacity and future goals are first assessed; and then, policies, priorities and needs are identified. An iterative process, the development of a NSAAH requires active engagement ideally led by the national Competent Authority in collaboration with other relevant aquaculture governance authorities, key stakeholders from other government agencies, academia and the private sector. Special attention to the needs and empowerment of small-scale producers should be accorded priority, as they represent the weak link in any biosecurity system.

Emergency preparedness and contingency planning

Emergency preparedness is the ability to respond effectively and in a timely fashion to disease emergencies (e.g. disease outbreaks, mass mortalities). The capability to deal with emergency disease situations requires a great deal of planning and coordination (including establishing operational, financial and legislative mechanisms) and making available required resources (i.e. skilled personnel and essential equipment). As long as there is importation of live aquatic animals, the possibility of serious disease outbreaks due to exotic pathogens will exist. Even under the best of circumstances, pathogens will occasionally escape detection, breach national barriers, become established, spread and cause major losses. The extent to which losses occur often depends on the quickness of detection and the rapidity and effectiveness with which governments recognize and react to the first reports of serious disease. The former depends on the effectiveness of disease surveillance, diagnostics and reporting processes. As quick and effective reaction (containment and/or eradication) is largely dependent upon contingency planning, all countries need to develop such plans for key cultured species and diseases (Arthur and Reantaso, 2018). The elements of an Emergency Response are listed in **Box 1**.

BOX 1. ELEMENTS OF EMERGENCY RESPONSE

- **National planning and coordination**
- **Operational capability**
    - Responsibility for aquatic animal disease emergencies
    - Aquatic animal disease contingency planning as a component of a National Disaster Plan
    - Legislation and enforcement
- **Early warning**
- **Early detection**
- **Risk analysis**
- **Disease surveillance**
- **Early response**
- **Contingency plans**
    - Technical plans: Control Centers Management Manual, Enterprise manual, Destruction manual, Disposal manual, Disease strategy manuals, Job descriptions
    - Surge support
    - Operational capability: Response management manuals, Diagnostic resources, Training resources, Awareness and education, Simulated response exercises
- **Recovery from an emergency disease**
    - Verification and international acceptance of disease freedom
    - Rehabilitation of farming and fishing communities
- **Staying free**

The objectives of an emergency response are to:

- prevent the incursion of exotic pathogens and pests
- put in place a rapid, well-organized and appropriate response to an emergency disease incident
- have a successful management of disease outbreaks

Early warning, early detection and early response are some of the most important elements of an effective emergency response.

Early warning

Advance knowledge of high risk diseases likely to threaten national biosecurity before pathogens enter territory is a requirement. The effectiveness of early warning depends strongly on the responsible authority having excellent awareness of the current disease situation of the country's primary trading partners and on emerging diseases at global level. It requires good communication linkages (e.g. trading partners, aquatic animal health professionals, aquaculture producers and other stakeholders) and access to disease information (disease reports both from grey and scientific literature, disease databases and from scientific meetings, workshops and other communication media). Awareness and early warning for Tilapia lake virus (TiLV), for example, came in the form of Network of Aquaculture Centres in Asia-Pacific (NACA) TiLV Disease Advisory, World Organisation of Animal Health (OIE) TiLV Disease Card, FAO GIEWs 338 Special Alert on TiLV, WorldFish FAQ on TiLV, scientific reports, OIE notification and even social media including press releases, blogs and interviews.

Early detection

This refers to an early detection of an emerging disease situation within a country's national territory within the shortest possible time frame possible. The purpose is to ensure detection of the introduction of, or sudden increase in the incidence of, any disease of aquatic animals that has the potential of developing to epizootic proportions and/or causing serious socio-economic consequences. It also refers to rapid recognition of signs of a suspicion of: (i) a listed disease, (ii) an emerging disease situation, or (iii) unexplained disease mortality in aquatic animals in an aquaculture facility or wild populations. An immediate action is the rapid communication of the event to the Competent Authority in order to activate disease investigation with minimum delay. Early detection covers all initiatives that lead to improved awareness and knowledge of the distribution and behavior of disease outbreaks (and of infection) and that allow forecasting of the source and evolution of the disease outbreaks and the monitoring of the effectiveness of disease control campaigns. The key components of early detection include: (i) broad awareness of characteristic signs of diseases (exotic, endemic, emerging); (ii) experienced veterinarians and/or aquatic animal health professionals trained in recognizing and reporting suspicious disease occurrence; (iii) ability of competent authorities (CA) to undertake rapid and effective disease investigation; and (iv) access of CA to expertise and laboratory facilities that are able to diagnose and differentiate exotic, endemic, emerging diseases.

Early response

This pertains to all actions targeted at rapid and effective containment of, and possibly elimination of, an emergency disease outbreak. The objective of early response is preventing a disease from spreading and becoming an uncontrollable epizootic. How this is done depends on many factors and the particular disease scenario. The three types of control options are eradication, containment and mitigation.

Eradication

It is the highest level of response but not always possible especially in an aquatic environment. Eradication is the elimination of pathogens from an affected population or from the country, including sub-clinical infections. Eradication is a big challenge and may not be possible if the disease is already well established prior to initial detection, if intermediate or carrier hosts are unknown and the source of infection is unknown.

Containment

It refers to containing the disease within specified compartments/zones; control measures are in place at infected compartments that will prevent the spread to uninfected populations.

Mitigation

It means reducing the impacts (occurrence and severity) of the pathogen/disease through control measures targeted to stocks in infected zone at the farm level or affected population through, for example, treatments, husbandry or vaccines, if available.

Early warning, early detection, early response and effective and timely disease outbreak investigation are crucial for working toward preventing disease outbreaks and further spread.

Contingency plan

An aquatic animal disease contingency plan is a documented work plan designed to ensure that all needed actions, requirements and resources are provided in order to bring under control outbreaks of infectious diseases of significance to aquatic animal productivity and/or market access. Efforts should concentrate on specific, high-priority emergency diseases, with a series of generic plans focused on activities or programs shared by the various specific disease contingency plans (e.g. national and local disease control centers). The components of a contingency plan are listed in **Box 2**.

Effective contingency plans need stable resources and financial support, along with legislative backing for all control actions (access to sites, animals, fishery closure enforcement, etc.). The contingency plans need to be reviewed and agreed upon in advance by all major stakeholders, including the political and

BOX 2. COMPONENTS OF A CONTINGENCY PLAN (BALDOCK, 2005)

- **Summary document**
- **Technical plans**
  - Disease strategy manuals (one for each high priority disease)
  - General procedures manuals
  - Enterprise manuals
  - Job descriptions
- **Support plans**
  - Finance
  - Resource
  - Legislation
  - Other agencies
- **Operational capability**
  - Management manuals
  - Diagnostic resources
  - Field personnel
  - Training resources
  - Awareness and education
  - Response exercises

bureaucratic arms of government and the private sector, particularly representative farmer, fishery and community organizations that have a stake in the resources falling under contingency plan protection. Contingency plans should be refined on a regular basis through simulation exercises and personnel should be trained in their individual roles and responsibilities. The frequency of such revisions should be determined by the rate of development of vulnerable resources or any changes in human activities that change vulnerability (e.g. changes to species grown on leases, regulatory responsibility or environmental changes).

Examples of technical plans, disease strategy manuals, support plans, many from Australia, are detailed in Arthur et al (2005). The Aquaculture Branch (FIAA) of FAO is currently finalizing disease strategy manuals for infectious myonecrosis virus (IMNV) and acute hepatopancreatic necrosis disease (AHPND) and planning to prepare such manuals for epizootic ulcerative syndrome (EUS) and TiLV.

Emergency preparedness and response (EPR) system audit

Emergency preparedness and response (EPR) systems audit for managing aquatic animal disease outbreaks are contingency planning arrangements that can minimize the impacts of serious aquatic animal disease outbreaks, whether at the national, subnational or farm level — such systems have the objective of containing (preventing the further spread) or eradicating emergency disease outbreaks, thereby greatly reducing the impact, scale and costs of outbreaks. An effective EPR system ensures that there are pre-agreed protocols and resources in place to act quickly in responding to suspected outbreaks of emergency diseases. Importantly, they established a clear structure for effective and rapid decision-making with clearly defined responsibilities and authority.

The EPR system audit (see Annex 3) was an initiative that was carried out as part of the FAO project TCP/INT/3501 Strengthening biosecurity governance and capacities for dealing with the serious IMNV disease.

The four sections comprising the questionnaire, are: (1) general administration, (2) operational components, (3) support systems and (4) additional information. Section 1 (General Administration) contained questions aimed at generating information on the administrative structure and the scope of responsibilities of the Competent Authority on various elements (e.g. communication, risk analysis, contingency plan, personnel skills, etc.) that are essential when dealing with an aquatic emergency response. Section 2 (Aquatic EPR System Elements) contained questions on the priority system elements identified by the OIE; namely, early warning, early response and early detection systems. Section 3 (Support Systems) contained questions about broader supporting systems in relation to legislation, information management, communications and resourcing. Section 4 (Additional Information) presented an opportunity for countries to provide any information or raise issues not adequately addressed in the questionnaire.

The EPR system audit has the ability to provide system strengths and weaknesess of a country in terms of three broad systems components: administration (e.g. resource allocation and legislation), operational components (including early warning, early detection and early response systems) and operational support systems (such as information management and communications systems).

The EPR system audit through a self-assessment survey conducted by FAO for the six countries participating in the above-mentioned project (namely: Brazil, Ecuador and Mexico representing South/Central America and China, Indonesia and Thailand representing Asia) - provided insights into each country's capabilities in terms of policies, procedures and institutional capabilities in place to detect the incursion of an emergency aquatic animal disease and to take appropriate response to that incursion. It identified six areas of need where EPR systems were not well developed. These included:

- stakeholder consultation,
- systems audit/review,
- simulation exercises,
- education/awareness building,
- documentation and dedicated resourcing.

These are important areas that may be considered in the process of improving the EPR system audit. Application of the EPR system audit to additional countries may provide further guidance on what types of advocacy and tools will be needed.

Conclusions and moving forward

Bondad-Reantaso *et al* (2005) in a review paper on disease and health management in Asian aquaculture highlighted that the most significant disease emergencies at the time included EUS, shrimp viral diseases [white spot disease (WSD), yellowhead diseases (YHD), infectious hypodermal and hematopoietic necrosis (IHHN), etc], Akoya pearl oyster mortalities, koi herpes virus (KHV) disease and abalone mortalities. It identified some of the important lessons and insights learned from dealing with those epizootics. They include the following: regional and international cooperation; increased awareness on emerging diseases in other parts of the globe and the possibility of their spread to the Asian region; improved diagnostic capabilities at both national and regional levels; pro-active reporting of serious disease outbreaks as a mechanism for early warning; contingency plans; improved compliance and implementation of policies reached at regional and international levels; emergency preparedness as a core function of government services; and advanced financial planning such that adequate funds can be immediately provided to address serious emergency disease situations at both national and regional levels.

These recommendations are still valid, after more than two decades until present when the aquaculture sector continues to be plagued with emerging diseases. These diseases could be known diseases that has spread to new geographical locations (e.g., WSD in Mozambique, KHV in Iraq) and new susceptible species (many for EUS-susceptible species since its incursion into Africa) or new diseases that has not been previously recognized or reported (unknown diseases) until its diagnosis [e.g. AHPND, TiLV, *Enterocytozoon hepatopenaei* (EHP), and shrimp hemocyte iridescent virus (SHIV)].

Above past lessons and more recent experiences demonstrated the value of rapid response, reporting/notification by competent authorities, continuous development of knowledge base and capacities in diagnostics, epidemiology, risk analysis and the important roles of governments and producer sectors in co-managing disease outbreak events as they both remain the critical entities responsible for launching rapid response. The EPR system audit may provide useful guidance and insights that can be used in improving response actions to disease emergencies in aquaculture.

Skills and knowledge need to be passed on to locals as they are in the frontline of any disease emergency. Share key lessons from experiences by state and non-state actors (producer and academic sectors and other important players in the value chain), the international players that launch emergency responses, disease investigations and field situation assessments as well as financial entities that support these actions need to be continued. However, we also need to do a stock taking exercise to evaluate what worked, what did not work, what resources are needed and to understand what are the new drivers for aquatic animal disease emergence in order to move forward with the right and timely response actions to disease emergencies in aquaculture.

Key questions remain: Are we prepared for the next outbreak/mortality event? What are the minimum preparedness and advance preparedness actions needed?

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Way Forward

Melba G. Bondad-Reantaso

The overall objective of this technical consultation is to bring together the representatives of ASEAN Member States and technical experts to examine the status of aquatic emergency preparedness and response systems currently being practiced in the region in order to identify gaps and other initiatives for regional cooperation. In the general sense, the RTC is successful in achieving the general objective.

As for the specific objectives, (a) to assess existing laws, legislations and standard operating procedures (SOPs), among others had been partially achieved. This is because the consultation didn't assess but was only informed (through the reports of country representatives) of the current situation in ASEAN member countries. The way forward of this is to complete the EPRS audit questionnaire as basis of the more systematic assessment. The second objective is (b) to assess the need for a regional aquatic EPRS in the ASEAN, the participant voted in the affirmative. The way forward of this is to create the ASEAN guidelines including the mechanics. The third objective is to (c) enhance cooperation among Member States, regional/international organizations and other relevant stakeholders on initiatives that support aquatic EPRS for effective management of aquatic animal disease outbreaks. This objective has been achieved. The way forward for this is to get the same people for a planned and proposed consultation II for continuity and for emphasis on more private sector and academe representation.

During the two full days of consultation, the following information were gathered:

1. Common issues presented are on communication, funding, stakeholder consultation, risks analysis, and lack of information, planning and system. Dr. Reantaso mentioned that these should be captured in the report of the consultation and in the proposed ASEAN guidelines on EPRS as part of the situational analysis and guiding principles.
2. Regular meetings, more funding, and trust between government and private sectors in disclosing information are the top recommendations in establishing a functional and effective engagement on EPRS between government, producers and academic sectors.

Plan of action

1. To complete the EPRS audit questionnaires as basis for a systematic assessment which will be done by SEAFDEC/AQD and member countries.
2. To develop the ASEAN EPRS guidelines including the mechanics which will be led by SEAFDEC/AQD, supported by ANAAHC and Consultation partners. The process of the developing the guidelines are the following:

    a. Use the analysis as a reference point
    b. Form a working group that will develop the scope and content. The zero draft will be circulated to participants including external experts (peer review)
    c. Information, analysis and synthesis in the working group matrix will be captured in the guidelines either in the situational analysis or guiding principle or actual guidelines.
    d. Organize a writeshop to popularize and refine the guidelines including country-level implementation and monitoring
3. To organize a part two of the consultation to present the guidelines for refinement and consensus. It is also recommended that the consultation II will not be limited to a workshop but will be an actual capacity

building on preliminary guidelines implementation. The following themes are suggested:

   a. Simulation exercise;
   b. Database registry analysis of surveillance data, experts, laboratories, preparation of contingency plans for high-profile disease, aquatic epidemiology, risk analysis pathology, etc. including private sector leads;
   c. This will be taken to ASEAN process for endorsement and approval

4. To get the same people for a planned and proposed consultation II for continuity and for emphasis on more private sector and academe representation. It was suggested to keep the AEPRS network including member countries, producers, academe and institutional partners. ANAAHC and the member countries will be responsible for this.
5. In order to accomplish the aforementioned plans, the consultation should develop a concept note or proposal to member countries, donors and explore new ways for resource generation and mobilization to support all activities. This will be the responsibility of member countries and Consultation I partners.

ANNEXES

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ANNEX 2

Regulatory/Notifiable Diseases and Common Non-Notifiable Production Diseases - Susceptible Food Fish Species and Recommended Control Measures

Disease Agent of Concern		Recommended control measures
Regulatory Notifiable Diseases	Red Seabream Iridovirus (RSIV)	Stock vaccinated fish only. In the event of detection, cull diseased fish and vaccinate clinically healthy fish.
	White Spot syndrome virus (WSSV)	Exclusion of virus Stock clean, disease free crustaceans. Production in closed systems with high biosecurity. In the event of detection, cull all diseased and potentially infected shrimp.
Non-notifiable/ production Diseases (Commonly Reported from this region)	Megalocytivirus (also includes RSIV)	Stock vaccinated fish only. Activation of heat shock proteins as part of management of viral disease. Recommended to cull diseased and potentially infected fish.
	Grouper iridoviral disease (Ranavirus, SGIV)	Exclusion of virus via screening of incoming stock. In event of detection, recommend to cull diseased and potentially infected fish.
	Tilapia Lake Virus (TiLV)	Exclusion of virus via screening of incoming stock
	Viral nervous necrosis virus (VNNV)	Stock vaccinated fish OR Exclusion of virus via screening of incoming stock. In event of detection, cull all diseased and potentially infected fish.
	Scale Drop Disease Virus	Exclusion of virus via screening of incoming stock
	Lates calcarifer herpesvirus (LCHV)	Novel virus reported with scale drop like lesions. Control via exclusion of virus via screening incoming stock.
	Big Belly Disease	Pathogen exclusion Raise early life stages of susceptible species in freshwater RAS Antibiotic treatment ineffective over several batches.
	Streptococcosis due to *Streptococcus iniae*	Stock vaccinated fish only, OR Treatment with oral, in-feed antibiotic effective against gram positive pathogen. Monitor development of antibiotic resistance.
	Streptococcosis due to *Streptococcus agalactiae*	Stock vaccinated fish only OR Treatment with oral, in-feed antibiotic effective against gram positive pathogen. Monitor development of antibiotic resistance.
	Tenacibaculum maritinum	Stock vaccinated fish only.
	Vibriosis *(V. harveyi, V. parahaemolyticus, V. alginolyticus)*	Stock vaccinated fish only, OR Treatment with oral, in-feed antibiotic effective against gram negative pathogen. Monitor development of antibiotic resistance. Environmental control for shrimp
	Infection with yellow head virus (YHV) Infectious hypodermal and haematopoietic necrosis virus (IHHNV) Infectious myonecrosis virus (IMNV) Taura syndrome virus (TSV)	Exclusion of virus Stock clean, disease free crustaceans. Production in closed systems with high biosecurity.
	Acute hepatopancreatic necrosis disease (AHPND)	Exclusion/ biosecurity

FAO TCP/INT/3501 Emergency Preparedness and Response Systems Capacity and Performance Self-Assessment Survey

Introduction

Emergency preparedness and response (EPR) systems for managing aquatic animal disease outbreaks are contingency planning arrangements that can minimize the impacts of serious aquatic animal disease outbreaks, whether at the national, subnational or farm level — such systems have the objective of containing (preventing the further spread) or eradicating emergency disease outbreaks, thereby greatly reducing the impact, scale and costs of outbreaks. An effective EPR system ensures that there are pre-agreed protocols and resources in place to act quickly in responding to suspected outbreaks of emergency diseases. Importantly, they established a clear structure for effective and rapid decision-making with clearly defined responsibilities and authority.

Purpose

The purpose of this survey is to obtain information on national capacity and the agencies mandated to implement emergency preparedness and response systems with respect to *aquatic animal diseases*. The results of this survey will help guide regional and national strategic planning with respect to improving aquatic EPR systems, thereby improving aquatic animal health more broadly and assuring adequate and rational support services to achieve sustainable aquaculture development.

This FAO questionnaire on aquatic EPR system capacity and performance is a country level self-assessment survey with four sections: (1) general administration, (2) operational components, (3) support systems and (4) additional information.

Section 1 (General Administration) contains questions that will generate information on the administrative structure and the scope of responsibilities of the Competent Authority on various elements (e.g. communication, risk analysis, contingency plan, personnel skills, etc.) that are essential when dealing with aquatic EPR.

Section 2 (Aquatic EPR System Elements) contains questions on the priority system elements identified by the OIE. These are: early warning system, early response system, and early detection system.

Section 3 (Support Systems) contains questions about broader supporting systems in relation to legislation, information management, communications and resourcing.

Section 4 (Additional information) presents an opportunity for countries to provide any other information or raise any other issues that they feel have not been adequately covered in Sections 1-3.

Process

This survey should be completed by the national Competent Authority on aquatic animal health through the designated National Project Coordinator (NPC) of TCP/INT/3501 and a second delegate of the TCP, both with primary responsibility for national aquatic animal health issues, in consultation with national, state/

provincial and local government agency officers with responsibility for responding to aquatic animal disease emergencies (or agencies that that have responsibility for managing aquatic animal health in general), and in consultation with industry, especially aquaculture representatives (including commercial, small scale and subsistence sectors, as applicable to the country).

The following **guidance** is provided in implementing the survey:

- Review the survey questionnaires to determine the relevant stakeholders that will be involved in the survey;
- Prepare a list of stakeholder respondents
- Prepare an official communication (signed by the Competent Authority of the country) to the identified respondents describing the survey, its scope, its purpose, process and target deadline
- Implement the survey through email correspondence
- For some countries, it may be necessary to translate the document into the local language; however, the returns should be sent back to FAO in English
- Ensure that responses are correct and accurate.

If the information to respond to a question cannot be found, do not respond by writing "not applicable" – please write "information not found". If there is a question that relates to an item that is not relevant to the situation in your country, please state this categorically, i.e. "not relevant to the country". For example, for the question "Describe the legislation that directly or indirectly gives the national authority the power to apply control measures during emergencies?" do not respond "not applicable" if there is no such legislation. In this situation, please write, "The country does not have any legislation giving power to the national authority".

Similarly, if there is a closed question like "Are there Standard Operating Procedures (SOPs) for diagnostic analyses at national reference laboratories?", then try to not simply write "yes" or "no", but rather to include supporting information. We are trying to gather as much information about the country's aquatic EPR system as possible within the time and resource constraints of this survey.

Some answers may need to be repeated as some questions are very similar. If there is uncertainty about the meaning of a question, you should seek clarification from FAO. Please note that completing the questionnaire will be an iterative process where you may need to contact FAO on several occasions, and you should feel free to do so. Similarly, FAO will be contacting you if clarification is required about any of the responses that you have provided.

If there is information about the country relating to its aquatic EPR system that you feel has not been adequately captured in the responses to the specific questions below, then that information should be included in the "additional information" of this document (Section 4).

The FAO International Consultant responsible for collating and preparing a summary and analysis of the survey returns is Dr. Ramesh Perera. He can be contacted by email: rameshpperera@gmail.com. Please feel free to communicate with him.

Please send back the completed survey returns on or before 26 October 2016.

A summary and analysis of the survey returns will be presented during the FAO TCP/INT/3501 Workshop on Emergency Preparedness and Response and Contingency Planning that will be held in Beijing, China from 10-12 November 2016.

Details of person completing the survey questionnaire

Country:

Contact information for person completing this survey:

Name:

Title:

Institution:

Mailing address:

Telephone:

Facsimile:

E-mail:

Signature of completing official:

Date:

SECTION 1. General administration

1.1. Provide a brief description of the national government agency (national authority) that carries primary responsibility for managing the country's aquatic emergency disease preparedness and response system.

1.2. Provide a diagram of the hierarchy of key policy, administrative and technical staff within the national agency responsible for preparedness and response to emergency aquatic animal diseases.

1.3. Provide a diagram showing the relationship between this agency and other national agencies and state/ provincial and local government agencies.

1.4. Describe the degree to which the national authority's aquatic EPR system is integrated with other emergency preparedness and response arrangements (e.g. equivalent terrestrial animal disease response arrangements or a national disaster response plan).

1.5. Describe how the country's aquatic EPR system is integrated with other elements of the country's national aquatic animal health management framework (e.g. IRA, import control, farm biosecurity plans, zoning/compartmentalization)?

1.6. Is there a nominated officer (or officers) responsible for the country's EPR system?

   a. Describe the officer's responsibilities with respect to planning and coordinating the national aquatic animal emergency disease preparedness and response system.

   b. Is the officer a high-level government officer within the agency that has primary responsibility for aquatic animal emergency disease preparedness and response, such as the national chief veterinary officer or director of fisheries?

1.7. Is there a National Aquatic Emergency Preparedness and Response Committee (or similar group) with responsibility to oversee and drive the planning and on-going maintenance of a national aquatic animal emergency disease preparedness and response system?

   a. What is the relationship between the committee and the 'responsible officer" – what is the responsible officer's role in that committee – for example, is he/she the chair of that committee?

   b. What are the committee's terms of reference?

1.8. Does the country have a National Emergency Disease Planning Officer/s (NEDPO) or equivalent with knowledge of aquatic epidemiology or on-ground aquatic animal disease management?

   a. What are his/her responsibilities? Do these responsibilities include acting as adviser to the aquatic EPR committee?

Communications

1.9. Describe the degree of consultation that the national authority has undertaken (or intends to undertake) in developing the country's aquatic EPR system (including farmers, processors, transporters, wholesalers/traders, provincial/local government jurisdictions, neighbouring countries).

1.10. Describe any rapid communication plans that are in place for accurate information dissemination during emergency disease responses?

Risk analysis

1.11. Has the national authority conducted risk analysis to identify high priority aquatic disease threats on which to focus response plans? If so, describe these analyses.

Operational capacity/capability

1.12. Describe the degree to which the national authority maintains national operational capability including establishment of early warning systems, early detection systems, national field diagnostic capability for emergency diseases, laboratory diagnostic capability, disease surveillance, reporting systems and access to disease management/epidemiology expertise.

Contingency plans

1.13. Describe any national contingency plans the national authority has developed for dealing with aquatic animal disease emergencies.

Personnel skills

1.14. Has the national authority ensured designated government and industry personnel have the necessary skills to support emergency preparedness and response activity, including through recruitment standards, succession planning, training and awareness building? If so, briefly outline these capabilities.

Resource allocation

1.15. Has the national authority assessed infrastructure and personnel requirements for an effective aquatic EPR system, and set up systems for allocating finances/resources during emergency responses?

Legislation

1.16. Describe the legislation that gives the national authority power to apply control measures during emergencies?

Systems review and improvement

1.17. Describe if and how the national authority regularly tests and improves the effectiveness of the aquatic EPR system; for example, through simulation exercises, field exercises and regularly review contingency plans to ensure effective and well-coordinated implementation?

SECTION 2. Aquatic EPR System Elements

EARLY WARNING SYSTEM

Intelligence gathering

2.1. Describe if and how the national authority monitors aquatic animal disease events in other countries (such as through the internet e.g. via the International Biosecurity Intelligence System (IBIS) [http://biointel.org/], monitoring of scientific literature and conference attendance)?

International reporting

2.2. Describe if and how the regularly national authority checks (and contributes to) Network of Aquaculture Centres in Asia-Pacific (NACA) or World Organisation for Animal Health (OIE) disease reporting systems?

Trading partner networks

2.3. Describe any formal and/or informal lines of communication that the national authority has with key aquatic animal commodity trading partner countries with respect to information exchange on disease incidents?

EARLY DETECTION SYSTEM

Personnel competencies

2.4. Describe the degree to which front line individuals at the 'pond level' (including, farmers, farmer associations, health professionals, fisheries extension officers and officers of local disease control centres have the knowledge required to:
   a. recognize a suspected disease emergency
   b. report findings to the appropriate provincial or national authority responsible for declaring a disease emergency and coordinating a response?

2.5. Describe the degree to which local government (such as at the village or county level) and industry personnel (including extension staff, designated departmental officers, farmers leaders, research staff officers of local disease control centre, fisheries organizations, processors and brokers) have the knowledge required to:
   a. recognise a disease emergency
   b. report to the appropriate authority?

2.6. Describe the degree to which national level government staff (personnel from national research laboratories, main authority departments, national disease control centres) have the knowledge required to:
   a. organise and coordinate surveillance for early warning
   b. organise and coordinate disease reporting?

Standard operating procedures (SOPs)

2.7. Describe any SOPs or similar instructional material provided to designated government and industry personnel given responsibility for the above tasks. How often are these SOPs reviewed and updated?

Awareness building / training programmes

2.8. Describe any on-going awareness building and training programs to ensure designated government and industry personnel are trained to undertake the tasks described above.
National information sharing networks

2.9. Describe any arrangements for sharing of EPR related information nationally (through either formal or informal lines of communication) with academics/researchers, industry representatives and aquatic animal health professionals; for example, through the establishment and regular meetings of advisory groups.

Surveillance systems

2.10. Describe any national, state/provincial or local passive surveillance programs for targeted and non-targeted diseases or active surveillance programs for targeted diseases.

Disease reporting

2.11. Does the national authority maintain a national list of reportable diseases, incorporating internationally reportable diseases and other diseases on concern to the country?

2.12. Is there a national aquatic animal disease reporting system that allows for rapid reporting of suspected diseases or disease agents of concern?

2.13. Does the reporting system include:
   a. legal obligations on farmers, aquatic animal health management professionals, diagnostic laboratories to report any abnormal moralities/morbidity to government authorities — for farmers, health professional and diagnostic laboratories this could for example be done as part of license or permit requirements?

b. a widely known, ready means of notifying the relevant agencies (for example through a free-call telephone number)?

2.14. Is there legislation to support the country's requirements for mandatory reporting?

2.15. Is there a formal communication system for notifying the central authority?

2.16. Is there a clear reporting mechanism for farmers, health professional etc, with information ultimately being reported to the national authority and the Responsible Officer?

Rapid diagnostic capability/capacity

2.17. Are there clear instructions to aquatic animal health personnel in the field with respect to security measures for collecting, packaging and transporting samples to designated laboratories?

2.18. Does the country have access to rapid laboratory diagnostic capability/capacity for confirmation of a disease or disease agent of concern, including ability to differentiate exotic or emerging diseases from endemic ones? This diagnostic capacity should ideally be within the country, but can also be in other countries provided that there are formal arrangements for ready access to confidential diagnostic services (e.g. through MOUs).

2.19. Are there Standard Operating Procedures for diagnostic analyses at national reference laboratories?

2.20. Are there documented procedures for confirmation of diagnosis, if necessary, at an OIE Reference Laboratory (recommended for OIE-listed disease agent detection for the first time in a country, or for a suspect detection in an "abnormal" aquatic host species)?

2.21. Is there a regularly updated national list of expertise and laboratory capacity for disease diagnosis, including identification of exotic disease agents of concern?

EARLY RESPONSE SYSTEM

Personnel competencies

2.22. Describe the degree to which front line individuals at the 'pond level' (including, farmers, farmers associations, health professionals, fisheries extension officers and officers of local disease control centres have the knowledge required to:

a. introduce precautionary movement controls if necessary, pending advice from relevant authorities'

b. facilitate implementation of the response proper, provide assistance to affected the site and assist in communication of information as it becomes available, and

c. provide local/national authorities with information as well as any movement of live animals prior to disease outbreak?

2.23. Describe the degree to which local government (such as at the village or county level) and industry personnel (including extension staff, designated departmental officers, farmers leaders, research staff officers of local disease control centre, fisheries organizations, processors and brokers) have the knowledge required to:

a. coordinate early response controls between affected farmers, fisheries interest, related stakeholders, local authorities and State/Province level authorities

b. implement recommended control options to prevent diseases spread, both prior to and following diagnosis confirmation

c. coordinate early response controls between affected farmers.

2.24. Describe the degree to which state/provincial level government staff (departmental officers, research personnel and officers of state/provincial authority disease control centres) have the knowledge required to:

a. Identify a disease emergency

b. Identify risks associated with suspected outbreak of pathogen

c. Assist with confirmation of suspected diagnosis using local/ national expertise or an OIE reference laboratory

d. Report confirmation to the national authority

e. Ensure implementation of suggested control options, both pending and following diagnostic confirmation.

2.25. Describe the degree to which national level government staff (personnel from national research laboratories, main authority departments, national disease control centres) have the knowledge required to:

    a. confirm the disease diagnosis with the reference laboratory
    b. analyse risks associated with the reported outbreak scenario
    c. define disease zones based on data from reporting laboratories.

Awareness building / training

2.26. Describe any programmes in place for on-going awareness building and training to ensure designated government and industry personnel have the skills to undertake the tasks described above.

Standard operating procedures (SOPs)

2.27. Are there regularly updated SOPs for designated government and industry personnel given responsibility for the above tasks?

2.28. Are there standard 'job cards' summarizing tasks for key personnel involved in response?

Contingency plan documents

2.29. Describe any documentation that the national authority maintains for purposes of emergency response; for example, a summary document, response management manuals, enterprise manuals, disease strategy manuals or operational procedures manuals.

SECTION 3. Operational Support Systems

Legislation

3.1. Describe the country's legislation supporting the range of potential actions that may be taken in responding to a disease emergency, such as access to farm premises, taking of samples, movement controls or mandatory stock disposal.

3.2. Is there a summary of legislative powers documented separately or incorporated into relevant response manuals?

Information management systems

3.3. Describe the country's information management systems that allow data collection, collation and analysis, including spatial mapping capability.

Communications systems

3.4. Describe any prearranged systems for communication with key stakeholders including interaction with the media.

Resources

3.5. Does the country have ready access to technical expertise in aquatic animal disease control, including epidemiology? Are these arrangements documented?

3.6. Does the country have pre-agreed access to staffing resources to handle surge activity associated with emergency responses? Are these arrangements documented?

3.7. Does the country have pre-agreed stand-by financial resources to fund preparedness and response activities? These may include for example pre-agreed funds to compensate farmers against stock losses due to mandatory destruction. Are these arrangements documented?

SECTION 4. Other information

4.1 Please provide any information about the country relating to its aquatic EPR system that you feel has not been adequately captured in the responses to the specific questions above.

ANNEX 4

Summary of Workshop Discussion

The Technical workshop was undertaken to better understand the present situation of aquatic emergency preparedness and response system (AEPRS) in the different ASEAN Member States (AMS). The workshop answered 5 questions across 10 subjects related to emergency preparedness. The summary of the workshop discussion is in the table below.

The participants also identified factors that will contribute to the success of AEPRS. In order to establish a functional and effective engagement on EPRS between government, producers and academic sectors, the participants mentioned that the AEPRS needs to be formulated with inputs from all 3 sectors; fund for emergency response development should be available and maybe taken from taxes paid on local and imported aquaculture produce; trust must be established between sectors; and create a task force that will establish a work plan and have periodic meetings.

To encourage participation in AEPRS, there should be workshops where farmers can participate, provision of recovery fund in case of losses, recognition from the government that these farms participated in AEPRS; quick response from the competent authority (CA) in case of disease outbreak; and ability to influence EPRS Policy and Conduct.

Identified limiting factors or constraints for the effective public/private sector partnership on EPRS are lack of trust on the government/CA by the farmer; lack of information from the CA; lack of commitment on farmers to follow the SOP for contingency plans and AEPRS; penalties on farmers, which they perceive as no win in being part of the partnership; no perceived advantage for the participating private sector; and conflict of interest.

SUMMARY OF ISSUES AND RECOMMENDATIONS RELATED TO AQUATIC EMERGENCY AND RESPONSE SYSTEM

	What is the problem?	Why has the problem not been solved yet?	What is possible?	What is different now?	What should we do next?
1. National planning and coordination	• Laboratories have different capabilities on disease identification • Collaboration/ coordination between the Government, the Private Sector and Research Centers are weak or lacking; which results in farmers not reporting disease occurrence to CA, existing EPRS not implemented	• Unclear policy towards disease • Change in governing body/authority leading to change in priorities and policy; blame shipping previous political party for issues • Reactive government policies • Lack of mechanism	• Have an open channel for communication of the problem • Set-up a national planning group that involves government agencies, the industry, academe/ research centers, funding agencies, and facilitators. The group will target outcomes such as agreed plan for emergency response; roles/ responsibilities of each player, source of funding and establish communication with other countries and trading partners. The group should be independent from the Governing body	• Comparing ASEAN & Norway, Norway has a clear policy and network between government and industry; the latter has a vested interest in moving aquaculture • Increased awareness of disease problem • Increasing disease problems • Increased in global trade with more requirements	• Build trust between government and private industry - Conduct consultation committee with regular dialogue sessions to government authorities and industry stakeholders opportunities to discuss issues openly and freely - A roundtable setting is better than a lecture podium so that everyone has equal opportunity to voice up

	What is the problem?	Why has the problem not been solved yet?	What is possible?	What is different now?	What should we do next?
					• Co-Funding from industry for research, i.e. Norway 3% from salmon sold to consumers will go into a fund that researchers can then tap into
		• The program of the CA on disease and EPRS is not widely disseminated or explained. This leads to the following: a) Farmers do not understand well the impact of issue as well as its effect on the economic return; b) Farmers are not transparent or do not report disease occurrence for fear of being penalised (e.g. cull and eradication as a disease control measure as opposed to emergency harvest) and lack of incentive compensation	• Develop communication/ collaboration at two levels: national and regional • Educate the farmers to understand the impact of the disease and why an ERPS is needed • Remove penalty for farmers for early reporting		• National veterinary institute in Norway is transparent in the reporting of research findings. To have transparency in reporting too • Increased collaboration between stakeholders. Empower extension officers by training • Provide funding for the effective implementation of CA activities (surveillance, capacity building and extension services)
2. Operational capability	• Lack of experts or trained personnel resulting in an imbalance in staff to farmer ratio	• Lack of funds for training/scholarships	• Offer scholarships in veterinary medicine, fisheries & aquaculture courses for students who will work with aquatic animal medicine • National registry for different expertise: epidemiology, risk analysis, diagnostics, logistics, communication • Attract mid-career and new grads people into this path by showing they have good prospects in this sector	• Use of technology takes over much of the activities that are being done by humans • Government have been listening to and involving farmers on planning GAqP, Biosecurity	• Impose tax on local aquaculture produce which will then go back towards funding research and education in the sector • Training in Information Technology for the aquaculture sector • Use of Artificial Intelligence (AI) to recognise the normal behaviour of livestock and then be able to identify what is abnormal or deviation from the normal
	• Lack of funds • Lack of technology and facility	• Lack of mutual understanding between the government and the private sector	• Agreement on criteria for funds for pre-discussed situation		• Employ officers who work directly with farmers to create trust and relationship with them

	What is the problem?	Why has the problem not been solved yet?	What is possible?	What is different now?	What should we do next?
	• Lack of coordination between government and private sectors	• Lack of confidence of the private sector to the government. The private sector does not see the benefit (not place to get solution in their disease problem)	• Open more channels for communication like schedule meetings		• Provide more resources • Practice transparency between private sectors and CA
	• Problem is now on a large scale with many different species in various properties	• Lack of roadmap and clarity for what the country needs			
3. Early warning	• Countries may not report disease status or issues in their stocks to their trading partners in time. The reporting is done through OIE, and this takes time • Farmers do not report disease occurrence due to fear of being penalised, perception of self-sufficiency, and lack of knowledge/ education in recognizing a disease and formalized reporting system • Countries either have existent EPRS that requires improvement or no EPRS at all	• Reporting of disease outbreak is not real time • Lack of informal communication channels between countries • Conflict of interest (e.g. No compensation and funding) • Inadequate human resources and funding • Existing staff are not aware of EPRS • Not a priority of the government	• Depend on informal network of information e.g. industry link, intel and other contacts • Build up surveillance network and traceability • Give incentive for reporting • Insurance to compensate for culling • Provide training to both staff and farmers • Give incentive for reporting Insurance to compensate for culling • Some countries have to develop comprehensive early warning plan	• A regional network of national aquaculture disease surveillance has been established • Technology allows traceability for movement of seafood (e.g. block chain for live aquatic animals/seafood) • Better collaboration among countries; systems from those more advance ones can be replicated	• Move the reporting to an online, real-time system to get live updates • Peg the incidence of reports to coordinates and GPS • Develop and implement comprehensive Early Warning System
4. Early Detection	• Farmers do not want to report disease • Identification of pathogen takes time • Farmer lacks awareness on unusual behavior, signs of disease and mortalities in aquacultured animals • Difficulty in getting information because farmers do not keep records of culture operation (e.g. feeding, observations of stocks behaviour, mortalities)	• The farmers are penalized for reporting e.g. cull and eradication as the country policy • There is no incentive for the farmers to report • Farmers are not aware of GAqP, biosecurity and others disease prevention and control measures • Laboratory diagnostics capabilities • Distance of laboratory to the farm • Farmers do not see the benefit of reporting disease occurrence	• A clear policy for actions that will be implemented in case of detection of a known, unknown, new emerging disease in aquaculture animals. Policy to compensate farmers for the occurrence of certain diseases (e.g. bearing cost of the disposal, disinfection,) • Extension officers build up good relationships with the local farmers also known as the human touch • Inform, educate and encourage farmers to do GAqP	• Farmers are equipped with the knowledge to detect and identify diseases in their stock • More advance technology in disease diagnosis • More meetings at all levels continue involving stakeholders are held	• Build-up capability and awareness of farmers so as to promote farm based diagnostics • Farms should have reference levels for mortality and other factors that will prompt them implement certain actions on their farm to control the spread of a known or suspected disease • For example - Normal expected mortality is 0.1% per day for tilapia at a specific life stage

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	• Time required for fish disease diagnosis (e.g. availability of services, time consumed for R&D) • Cost of diagnostic test kit		• Employ a capable person as CA • Locally assign a reference laboratory that can easily be accessed by staff working on disease diagnosis • Development of rapid test kit of important diseases for use by the farmers with Government subsidy • More fish pathologist needed for novel disease detection, not just PCR		- With mortality of 1% in a pond, hold feed, aerate, do not move stock - With mortality of 1% per day over a week, consider cull and disposal/ disinfect • Coordinate a special task force to follow up report of high mortality to take samples and make early investigation of the causative agent • Countries have to implement early detection more effectively (evaluating existing policies and procedures, and adjusting the current situation)
5. Risk Analysis	• Lack of data • Poor risk analysis of various pathogens due to lack of staff, CA and funding • Possible occurrence of new or unknown pathogen • Lack of expertise • Problem in maintaining laboratory capability and proper staff succession	• Unlike terrestrial animals, where there is one species of domestic poultry, swine, cattle, there are multiple species of aqaucultured animals (e.g. abalone, sea cucumber, tilapia, pangasius, *P. vannamei* etc) • Lack of routine for disease detection/ analysis • Lack of available scientists • Importance of risk analysis as well as an epidemiologist is not recognized • Succession and training of junior staff on RA are not planned	• Start with the most economically important species to the country (with highest contribution to GDP) • Make risk analysis based on a disease that has previously occurred in another country • Career path for technical positions should be identified and pursued • Identify expert in RA in other areas to train the fishery people	• Focus on the risk analysis of the pathogen(s) that are known to cause disease in these aquacultured species (abalone, sea cucumber, tilapia, pangasius, *P. vannamei* etc) • Start with the goal in mind, e.g. if RA is for the purpose of keeping the country's disease free status, then it will be based on the pathogen • Improved global reporting through international agencies (NACA,OIE, FAO)	• Increase the awareness of farmers on risk analysis/ ownership of risk assessment • Establish list of low, medium, and high risk

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6. Disease Surveillance	• No surveillance program due to lack of funds, manpower/ epidemiologist and laboratory capable of doing the work	• No emphasis on epidemiology - pathologist based • Lack of financial and human resources allocated for specific surveillance system • Not a priority of CA • Data are not updated, and if available are not utilized	• Conduct random disease sampling program on targeted population • Passive surveillance if unable to conduct active targeted surveillance • Prioritize surveillance on targeted groups of farms or high-risk areas. • Incorporate an epidemiologist at the Regional & National level to analyse data • Identify key diseases for active surveillance	• Advanced capability in disease analysis	• Justify the budget needed for the surveillance program based on the value that the commodity or industry brings to the country (e.g. percent of the GDP). This will ensure that the aquaculture industry will be heard and seen by the Ministry of Finance • Make disease surveillance a priority • Reduce cost of surveillance by establishing a cost sharing scheme between all stakeholders (private sectors, government and academe/ research centers)
7. Early Response	• Farmers unwilling to report to the competent authority • Difficulty in mobilizing personnel due to lack of dedication • Ineffective response or unsound decisions due to the existence of not yet validated cures • SOP's are available but not read or implemented	• No commitment/ communication for both farmer and CA • Farm are not accessible (e.g too far or CA not allowed by farmers to enter) • CA are too busy • No expertise in risk analysis • Lack of awareness • Lack of implementation • SOP is complicated with too many pages. No one has the time and patience to read	• Increase awareness to farmers • Identify responsible groups and persons (e.g task force) • Encourage public-private partnership through joint funding, clear communication and commitment to ongoing research and other activities • Present the information in an infographic or a flowchart	• Availability of SOP's and laws in some countries	• Prompt action and decision by CA • Present the SOP in a format that is easily digestible
8. Contingency Plans	• Lack of coordination between government agencies and with private sector • Legislation & regulations are unclear	• Farmer will lose money from destruction of livestock and movement as prescribed by government • Lack and/ or limited time, human resources & knowledge	• Ex-gratia payment to farmers to help them restart after the livestock has been culled • Create manual & SOPs • Prepare and review contingency plan	• Farm insurance for loss of stock due to disease incursion/ detection of notifiable diseases/natural disasters	• Draft and review contingency plans with input from all parties involved

	What is the problem?	Why has the problem not been solved yet?	What is possible?	What is different now?	What should we do next?
	• Knowledge gaps	• More focused on exported commodities			
	• Complexity due to different cultured species and different farming systems	• Several actions to be undertaken e.g. investigation, analysis, reporting			
	• Limited or no existing plan. It is deemed that preparation of Contingency Plan is time consuming and difficult			• Most countries now has contingency plans	• Consistency in reviewing SOP of contingency plan
9. Recovery	• Not enough capital to re-start	• Poor financial planning, there is no contingency fund set by the farm/company for its own needs	• Set-up an emergency/ disaster recovery fund for farms to tap into. Farms will have to contribute to fund (e.g. by paying in order to tap into them in times of need • Culture another species	• No difference seen yet	• Government set-up an emergency/ disaster recovery fund to be tapped into when farms need money to recover
	• Fear of re-occurrence of the disease due to the presence of carrier organisms	• If the same species is cultured, the disease may re-occur • Lack of evidence to prove recovery			
	• Farmers become complacent due to the lack of identified factors to measure recovery	• Absence of epidemiological data and analysis to identify factors • No compensation for farmers in exchange for cooperation	• Compensate small farmers to sustain their livelihood		• Use SPF/ SPR stocks
	• Eradication of disease is impossible in livestock cultured in the wild / irrigation system • Lack of coordination between farmers on disinfection • Break down in the culture cycle due to diseases affects the income of small farmers	• Difficult to coordinate with farmers to eradicate a pathogen • Insufficient Specific Pathogen Free or Specific Pathogen Resistant (SPF/ SPR) stock available for farmers			• Encourage farmers to practice GAqP
10. Staying free	• Poor biosecurity	• Biosecurity is deemed expensive due to the lack of understanding of what biosecurity means	• Implement Surveillance programs with sufficient budget. Use data on economic losses from the disease to justify needed budget	• Increased awareness in surveillance program, legislations, biosecurity	• Promote the advantage of disease-free compartment or zones • Live with the disease by breeding subsequent F1 generation of fish from disease survivors
	• Existing farming system no longer works in that area	• Contaminated environment	• Review of OIE Standards		

	What is the problem?	Why has the problem not been solved yet?	What is possible?	What is different now?	What should we do next?
	• Fast spread of diseases since most farms shares the same water source • Uncontrolled import at borders • Monitoring and surveillance for disease occurrence is expensive • Complacency	• Lack of experts on risk analysis • CA are too busy to implement SOPs • Biosecurity is breached and illegal importation • Lack of commitment/ communication on both CA and farmers	• Review surveillance results • Aquaculture management through zoning and compartmentalization • Better notification of emerging disease between countries and encourage unaffected countries to take precautionary measures		• Farmers should be more transparent

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