**Dr Marc Le Groumellec**
Aquaculture Expert

# Examples of biosecurity in different production systems

Dar es Salaam, Tanzania, 4-6 December 2018

## DEFINITION

"*Biosecurity* is a set of physical and management measures which, when used together, cumulatively reduce the *risk* of *infection* in *aquatic animal* populations at an *aquaculture establishment*"

# GENERAL PRINCIPLES

## General principles

1) *Biosecurity plan*, the identified *risks* to be managed, the measures to manage the *disease risks*, required SOPs and monitoring.

2) Potential pathways for *pathogenic agents* to be transmitted into, spread within and released from the *aquaculture establishment* must be identified.

*3) Risk analysis* should be undertaken to evaluate *biosecurity* threats and ensure the plan addresses *risks* appropriately and efficiently.

## General principles

4) *Biosecurity* measures to address identified *disease risks* should be evaluated based on their potential effectiveness, initial and ongoing costs

5) Management practices should be integrated into the *aquaculture establishment*'s operating procedures and training on these procedures

6) A routine review schedule of the biosecurity plan and identified triggers for ad hoc review must be determined Third party audit may be required where recognition of the biosecurity measures.

# Biosecurity plan development

*1)* Development of a *biosecurity plan*

*a)* objectives and regulatory requirements for the *biosecurity plan*

*b)* information about the *aquaculture establishment* including the layout of buildings and production units, and maps showing major movements of *aquatic animals*, *aquatic animal products* and waste, water, *feed* and fomites (including staff, equipment and *vehicles*)

*c)* the potential pathways for entry of *pathogenic agents* into, spread within or release from the *aquaculture establishment*

*d)* a *risk analysis*, including determining the major *disease hazards* to the *aquaculture establishment*

*e)* the mitigation measures that have been determined to address identified *risks*

# Biosecurity plan development

*1) Development of a biosecurity plan*

*f)* emergency procedures in the event of a *biosecurity* failure

*g)* standard operating procedures required to support implementation of the mitigation measures, emergency procedures and the training requirements of personnel

*h)* internal and external communication procedures, and roles and responsibilities of personnel

*i)* monitoring and audit schedule

*j)* performance evaluation.

# Biosecurity plan development

2) Key components of a *biosecurity plan*

*a)* Standard operating procedures (SOPs)

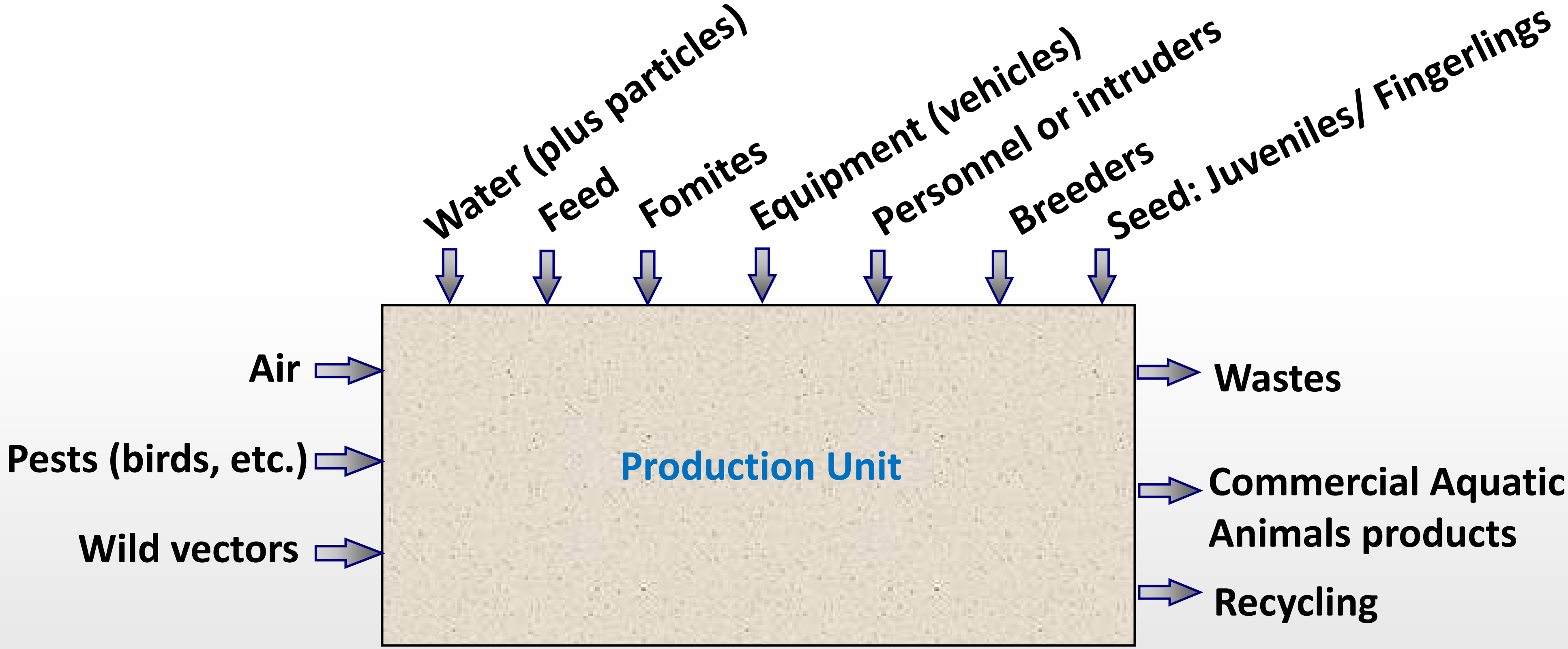
*b)* Documentation and record keeping

*c)* Emergency procedures (early detection, contingency plan, etc.)

*d)* Health monitoring (including surveillance)

*e)* Routine review and auditing

# Transmission pathways



# Overview of Steps in Risk Management

- Risk assessment
  - Requires perfect knowledge of hazard(s): perfect knowledge of the pathogen, diagnostic tools & surveillance, pathways.
  - Determine if the risk is acceptable or unacceptable
- Option evaluation
  - Identifies and evaluates possible actions to reduce the risk
- Implementation
  - applies the selected action(s)
- Monitoring & Review
  - audits to ensure intended results are achieved

# Knowledge of the hazard and risks

- Information on pathogens
  - OIE and Scientific References
  - Diagnostic Laboratories
- Specific transmission pathways
  - To be clearly determined for each pathogen
  - Depending on the Aquaculture Systems used
- Risk evaluation
  - Requires application of precise method
- Biosecurity Plan adapted to specific Aquaculture system
  - Adapted to identified risks

# Reference documents and bibliography

- Aquatic Code: http://www.oie.int/en/standard-setting/aquatic-code/access-online/
- Aquatic Manual: http://www.oie.int/en/standard-setting/aquatic-manual/access-online/
- Reference Laboratories: http://www.oie.int/en/scientific-expertise/reference-laboratories/list-of-laboratories/

# Reference documents and bibliography


**Manuals for BMPs and Biosecurity program recommendations**

**Profusion of good quality information, available for free**

# The Risk Analysis Framework

Risk Assessment is subjective by essence. A method to quantify risk is interesting to prioritize actions to be taken.

# The Risk Analysis Framework


- Keywords
  - Continuous improvement
  - Remain humble in front of nature

# Risk Management

"What can be done to reduce either the likelihood or the consequences of its going wrong?"

- What can we do to reduce the risk to an acceptable level?
- The process of deciding upon, evaluating & implementing measures to effectively manage risk

# Risk Analysis/Assessment

- Compares the estimated risk with the Appropriate Level of Protection (ALOP) to determine if the risk posed by the hazard is acceptable
- "Acceptable Level of Risk" is the inverse of ALOP.

Very high ALOP = Very low ALOR

Because risk analysis calculates the level of risk, ALOR is used in Risk Evaluation.

# RISK ANALYSIS

Consequence rating

| Likelihood rating | Insignificant | Minor | Moderate | Major | Catastrophic |
|---|---|---|---|---|---|
| Remote | 1 | 2 | 3 | 4 | 5 |
| Unlikely | 2 | 4 | 6 | 8 | 10 |
| Possible | 3 | 6 | 9 | 12 | 15 |
| Likely | 4 | 8 | 12 | 16 | 20 |
| Certain | 5 | 10 | 15 | 20 | 25 |

Schema : Risk analysis matrix

# Risk Descriptors

## Likelihood rating

| Notation | Descriptor |
| --- | --- |
| Remote (1) | Never heard of, but not impossible here (occurs less than once in 20 years) |
| Unlikely (2) | May occur here, but only in exceptional circumstances – occurs more than once in 20 years |
| Possible (3) | Clear evidence to suggest this is possible in this situation – occurs more than once in 3 years |
| Likely (4) | It is likely, but not certain, to occur here – occurs more than once in 2 years (>50%) |
| Certain (5) | It is certain to occur – occurs every year |

## Consequence rating

| Notation | Descriptor |
| --- | --- |
| Insignificant (1) | Impact not detectable or minimal |
| Minor (2) | Impact on farm productivity limited to some production units or short term only |
| Moderate (3) | Widespread impact on farm productivity due to increased mortality or decreased performance |
| Major (4) | Considerable impact on farm production resulting in serious supply constraints and financial impact |
| Catastrophic (5) | Complete depopulation of the farm and possibly barriers to resumption of production |

# Assessment of disease consequences

| Likelihood rating | Consequence rating: Insignificant | Minor | Moderate | Major | Catastrophic |
|---|---|---|---|---|---|
| Remote | 1 | 2 | 3 | 4 | 5 |
| Unlikely | 2 | 4 | 6 | 8 | 10 |
| Possible | 3 | 6 | 9 | 12 | 15 |
| Likely | 4 | 8 | 12 | 16 | 20 |
| Certain | 5 | 10 | 15 | 20 | 25 |

Schema : Risk analysis matrix

| Risk level (ALOR) | Explanation and management response |
|---|---|
| 1–2 Negligible | Acceptable level of risk. No action required. |
| 3–5 Low | Acceptable level of risk. On-going monitoring may be required. |
| 6–10 Medium | Unacceptable level of risk. Active management is required to reduce the level of risk. |
| 12–15 High | Unacceptable level of risk. Intervention is required to mitigate the level of risk. |
| 16–25 Extreme | Unacceptable level of risk. Urgent intervention is required to mitigate the level of risk. |

# Types of aquaculture production systems

# Types of aquaculture production systems

*Aquatic animals* are produced in different categories of production systems, based on the capacity to treat water entering and exiting the system, and the level of control of *aquatic animals* and *vectors*.

- Open systems
- Semi-open
- Semi-closed
- Closed

# *Aquatic animals are* produced in different categories of production systems, based on the capacity to treat water entering and exiting the system, and the level of control of *aquatic animals* and *vectors*.

- Open systems

Open *aquaculture* production systems : no control of water, environmental conditions and animals. May include stock enhancement of wild populations. Not considered further.

- Semi-open

Not possible to have control of water entering or exiting the system, or of environmental conditions. Some aquatic animals and vectors may also enter and exit the system. Examples: net pens in natural water bodies and mollusc *aquaculture*, either suspended in the water column or on the ocean floor.

- Semi-closed

Some control of water entering and exiting the system and of environmental conditions. *Aquatic animals* and *vectors* may be prevented from entering and exiting the system; Limited control to prevent the entry or exit of *pathogenic agents*. Examples: ponds, raceways, enclosed floating pens and flow through tanks.

- Closed

Control of water entering and exiting the system can exclude *aquatic animals*, *vectors* and *pathogenic agents*. Examples: recirculating *aquaculture* production systems, production systems with safe water supply free from *pathogenic agents* or *aquatic animals* (e.g. ground water), or with high levels of treatment (and redundancy) of water entering or exiting the system

# Several aquaculture production systems

## Open aquaculture production systems

No control of water, environmental conditions and animals.

May include stock enhancement of wild populations.

Not considered further.

## Semi-open aquaculture production systems

Not possible to have control of water entering or exiting the system, or of environmental conditions.

Some aquatic animals and vectors may also enter and exit the system.

Examples: net pens in natural water bodies and mollusc *aquaculture*, either suspended in the water column or on the ocean floor.

# Open and semi-open aquaculture production systems: mollusc culture

# Types of aquaculture production system: Open and semi-open






# Open and semi-open aquaculture production systems: Net Pen farms

# Open and semi-open: possible improvements in biosecurity?






Based on catchment/bay, national, regional sanitary policy and physical distance between aquaculture establishments

# Intensive farms or net pens regrouped in a same zone can easily autocontaminate

# Types of aquaculture production system

## Semi-closed aquaculture production systems

- Some control of water entering and exiting the system and of environmental conditions.
- *Aquatic animals* and *vectors* may be prevented from entering and exiting the system.
- Limited control to prevent the entry or exit of *pathogenic agents*.

Examples: ponds, raceways, enclosed floating pens and flow through tanks.

## Closed aquaculture production systems

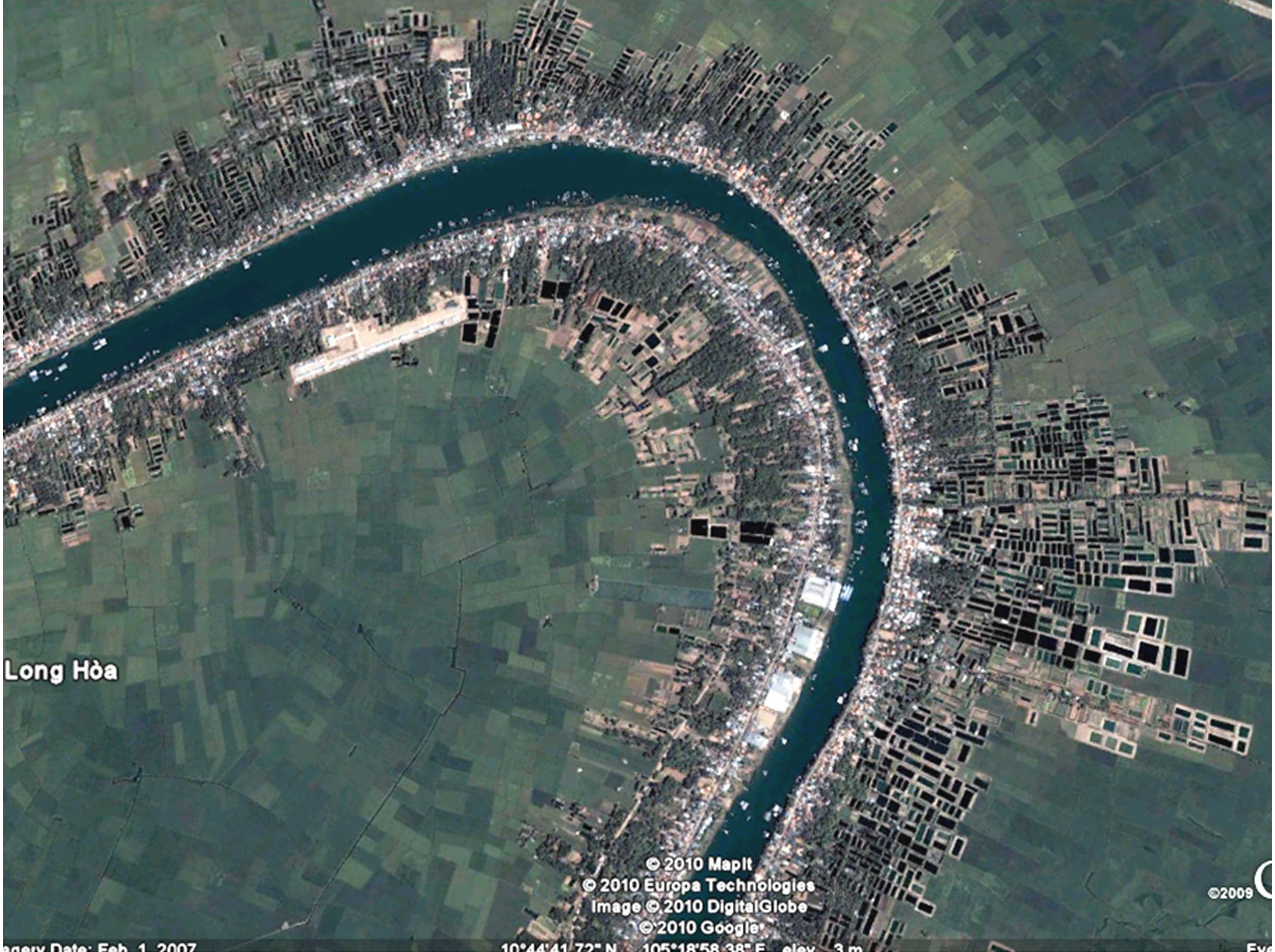
Control of water entering and exiting the system can exclude :

- *aquatic animals*,
- *vectors* and
- *pathogenic agents*.

Examples: recirculating *aquaculture* production systems, production systems with safe water supply free from *pathogenic agents* or *aquatic animals* (e.g. ground water), or with high levels of treatment (and redundancy) of water entering or exiting the system

# Semi-closed aquaculture production systems: are the infection sources excludable or not ?

But what about the other ponds and vectors around ?
All efforts could be ruined if not shared by other farmers.


Long Hòa
© 2010 MapIt
© 2010 Europa Technologies
Image © 2010 DigitalGlobe
© 2010 Google
©2009

# Semi-closed aquaculture production systems


## Importance of the facility design

# Open and semi-open: possible improvements in biosecurity?

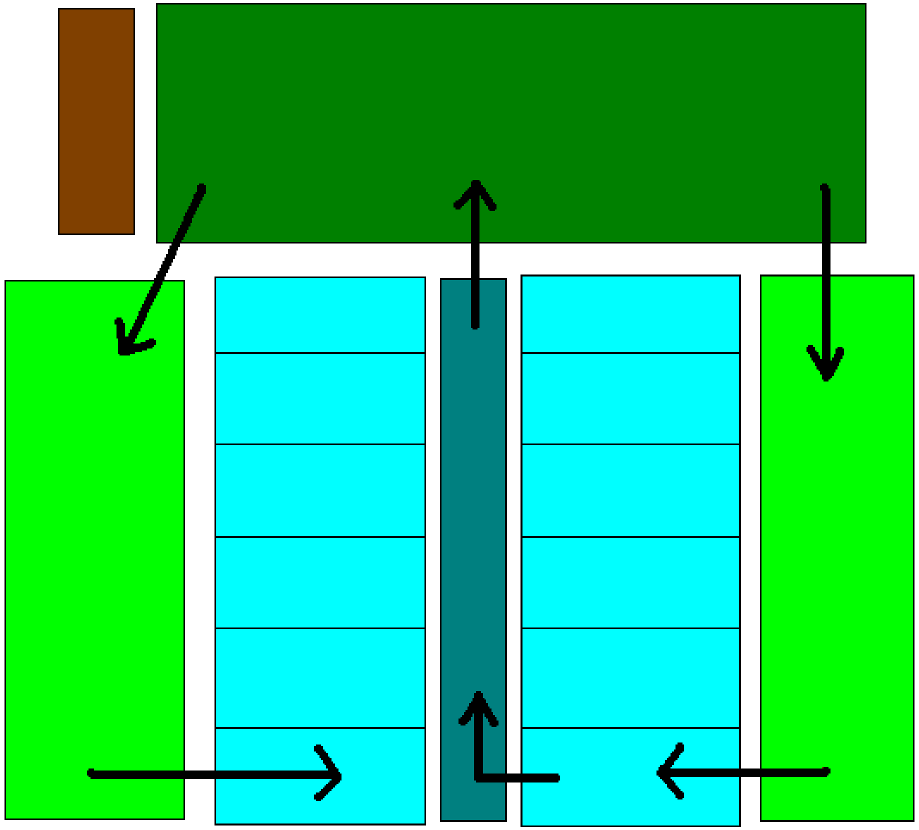
Enclosed floating pens:
switch to semi-closed aquaculture production system

# Semi-closed aquaculture establishments: possible improvements in biosecurity?

Based on better control of animals, water and vectors

# Semi-closed aquaculture establishments: possible improvements in biosecurity?

# Water recirculation or no water exchange protocols

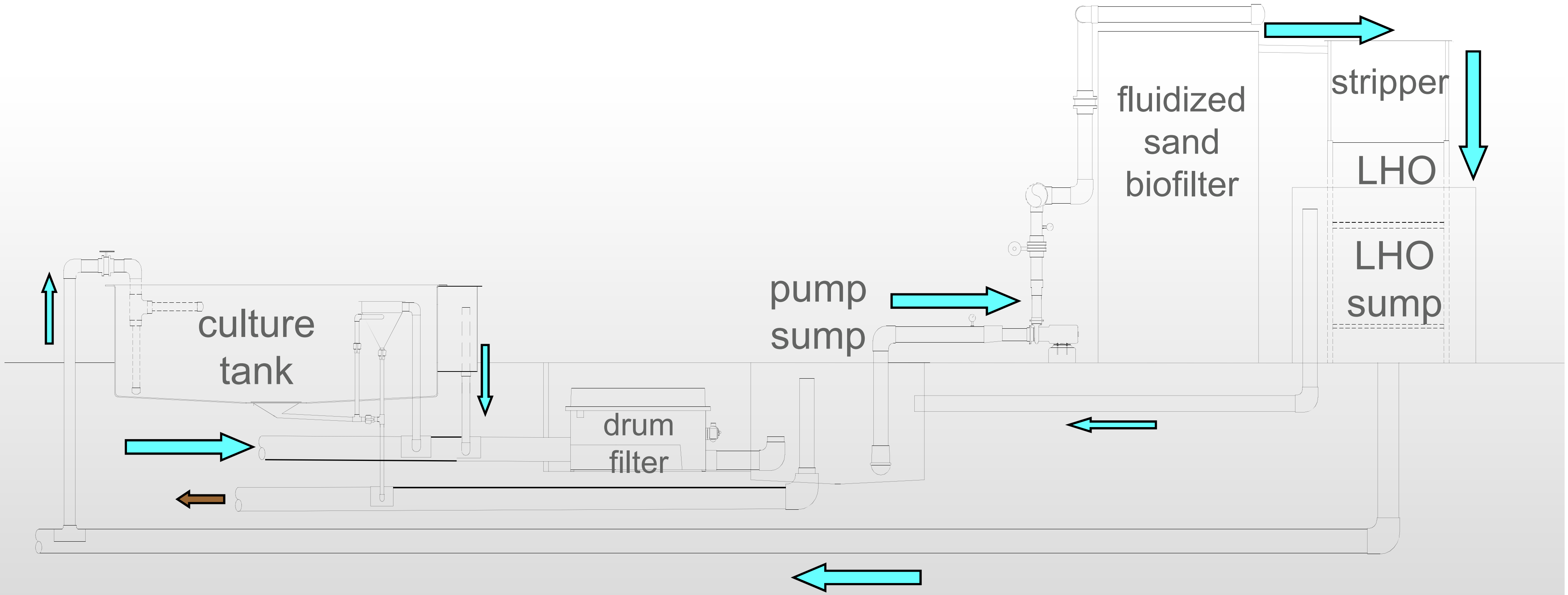


1) Shrimp pond
2) Setling pond, canel
3) Water treatment pond
4) Stocking pond
5) Sediment holding area

1) The used water from shrimp pond will be transfered to setling pond.
2) Setling pond, the water will be gradually transfered to water treatment pond giving it enough time for the solid to settle out.
3) Water treatment pond, we used many type of fish such as Tilapias, Catfish and Carp to natually clean the sediments from water.
4) Then the water will be transfer back to stocking pond for re-use.
5) After harvesting, all ponds are drained and dried. After drying, the top 3 inches of the pond's bottom will be scraped off. The scrapings are then transfer to a fully contained sediment holding area.

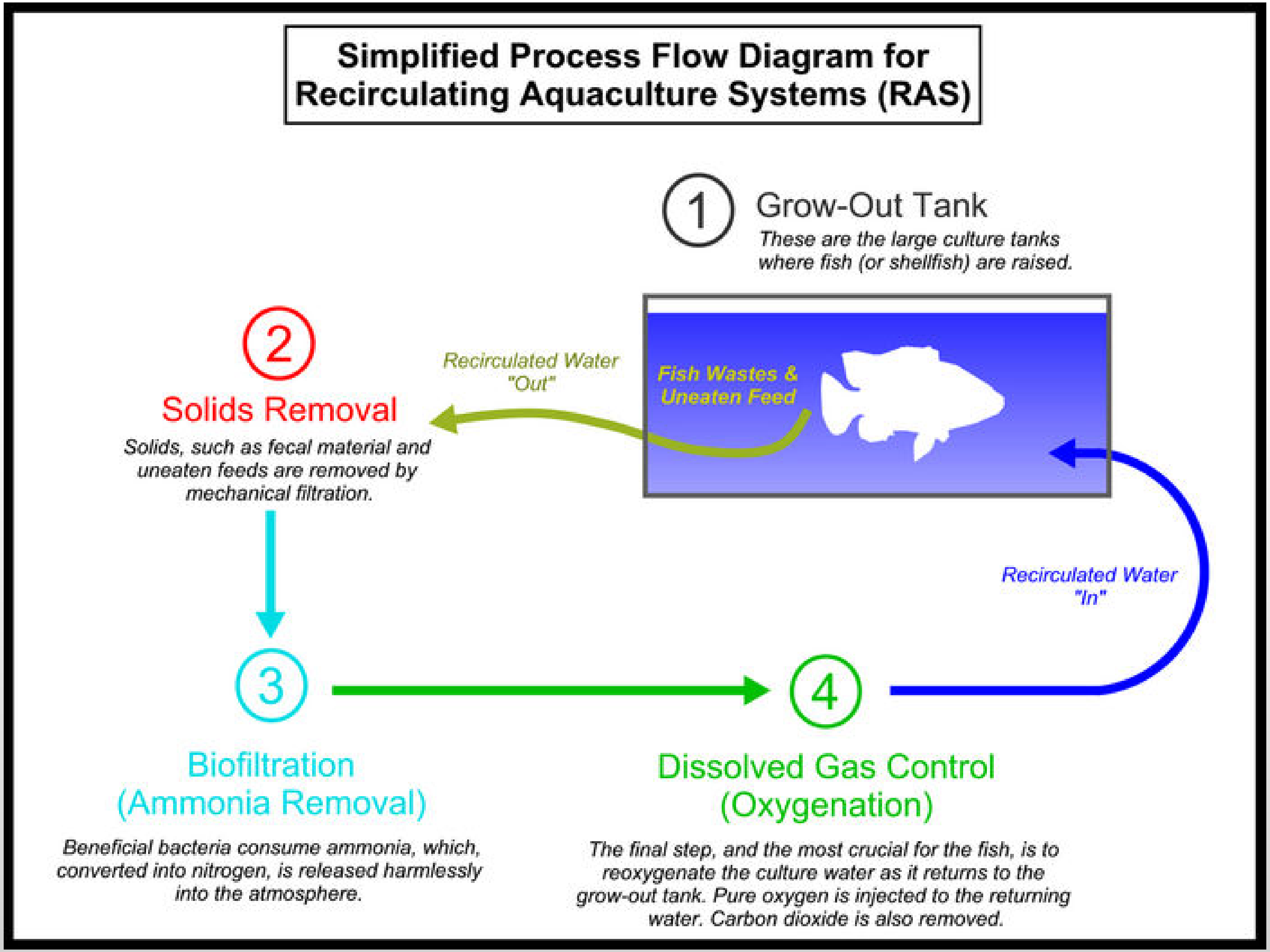
# Pathogen exclusion from water through disinfection

## Ozone Transfer, here in Recirculation Systems



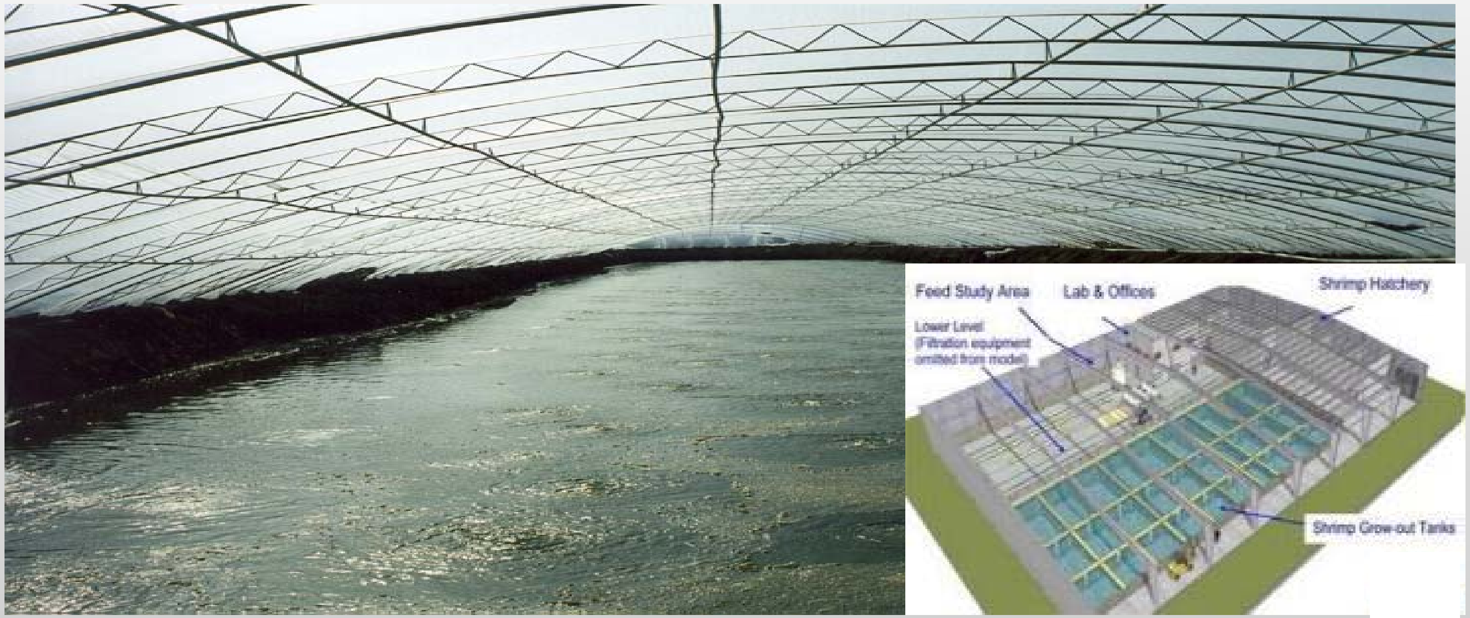

(courtesy of PRAqua Technologies)

# Pathogen exclusion from water through recirculation



# Closed facilities based on recirculation

# Alternatives ? An indoor grow out phase



# Aquaculture production systems based on recirculation

# Aquaculture production systems based on recirculation

# CONTROL OF TRANSMISSION PATHWAYS

## ANIMALS

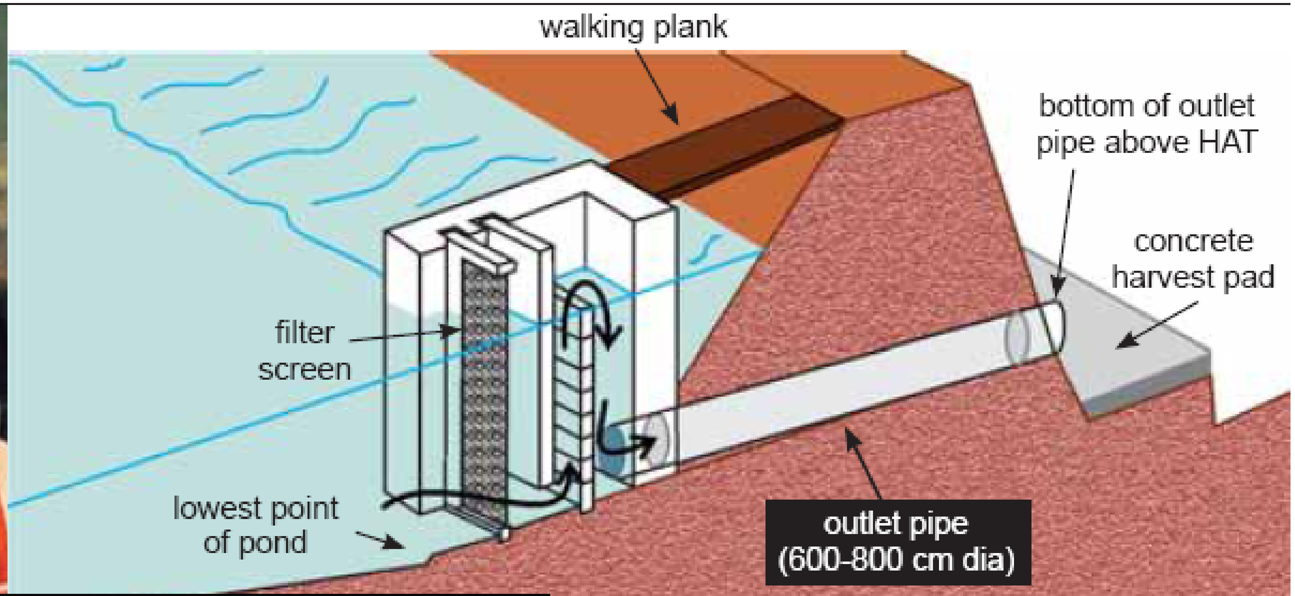
# Control of transmission Pathways

- Animals reared
  - National/Regional Policy
  - Legislations
  - Diagnostic tools
  - National surveillance
  - Zonation
  - Compartmentalization, « Specific Pathogen Free » animals

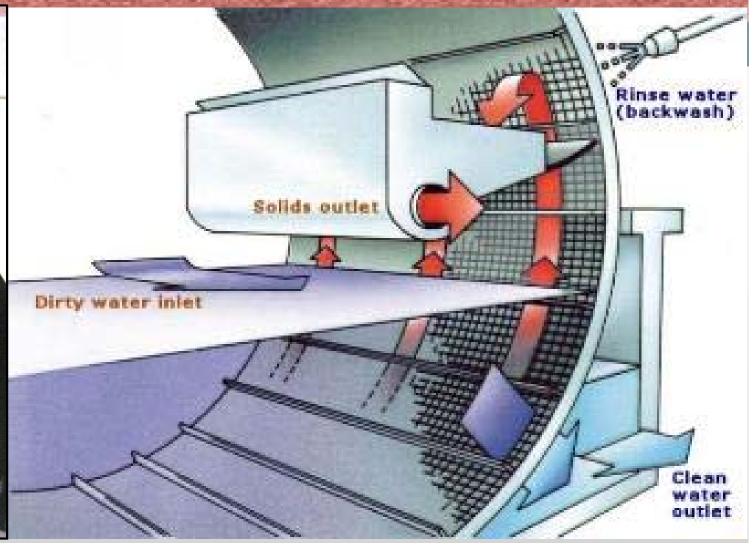
## CONTROL OF TRANSMISSION PATHWAYS

## WATER TREATMENT

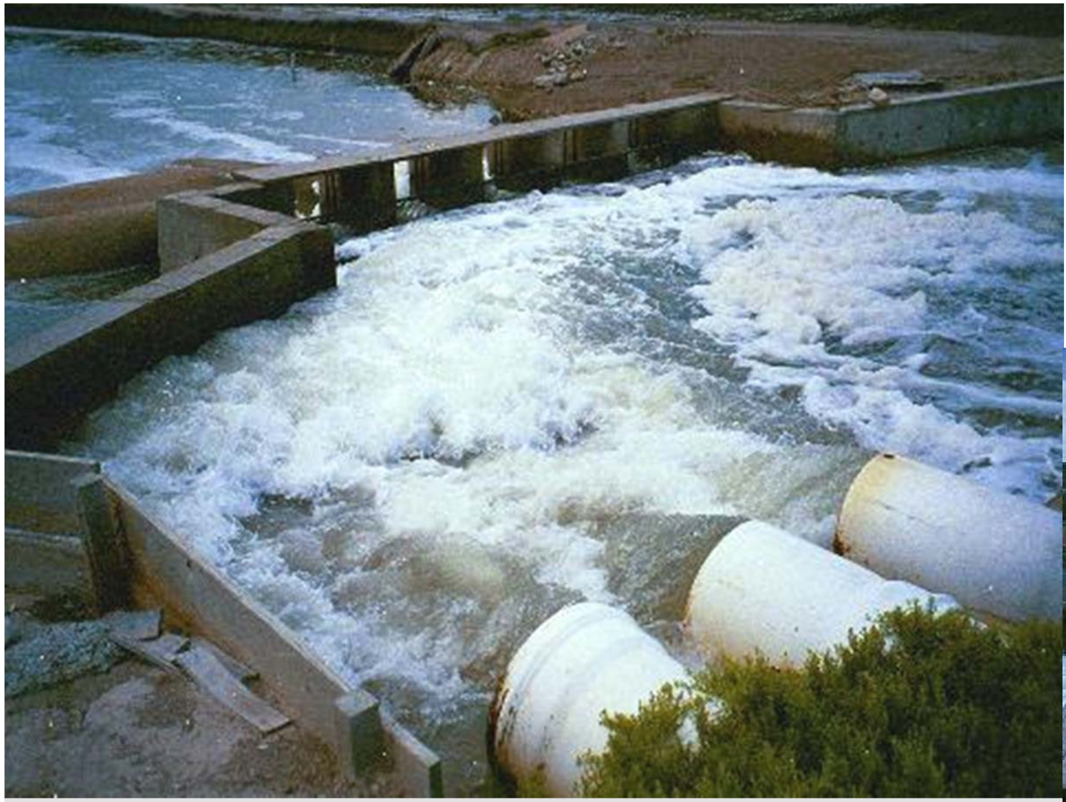
# Pathogen exclusion from water through filtration



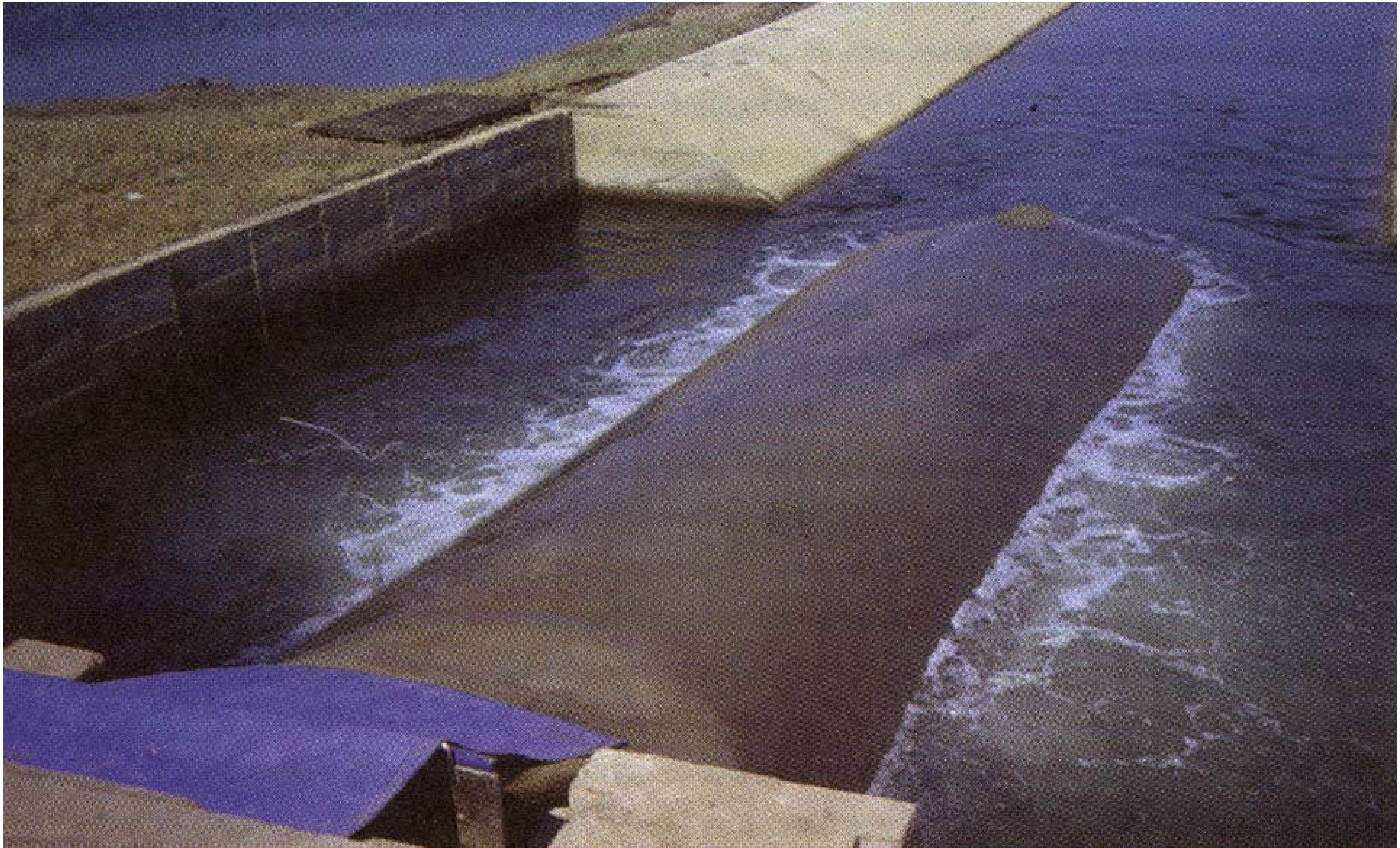




# Filter Bags Farm Supply Canal/Reservoir (Texas)



# Filter Bags Farm Supply Canal/Reservoir (Mexico)



Filter bags 150 microns - Peru

# Pathogen exclusion from water through filtration

Technologies available for low water flows (hatcheries, Nucleus Breeding Centers, in-door recirculated growout).

Seawater intake, reservoir
& chlorine gas - Malaysia

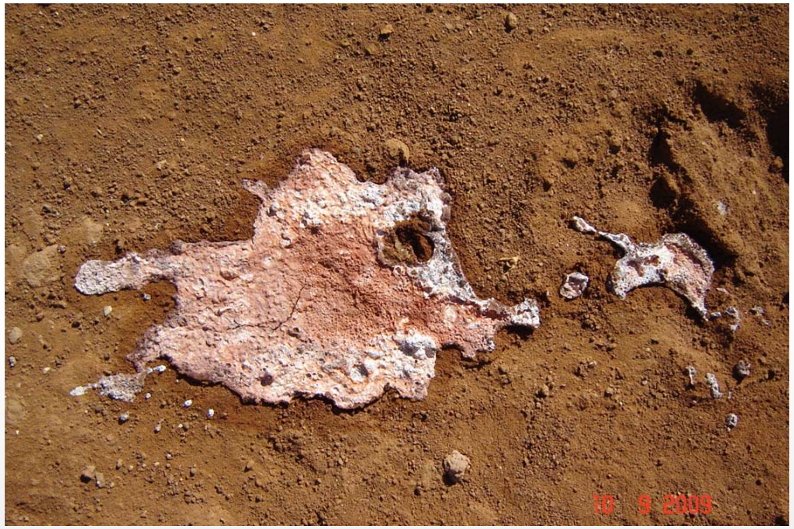
# Pathogen exclusion through water disinfection (physical or chemical )



## CONTROL OF TRANSMISSION PATHWAYS

## PROTECTION AGAINST VECTORS

# Menaces: throwings & feces





# Bird control options




# Bird exclusion devices

# Bird exclusion devices

# Vector exclusion devices



Limited possibilities to stop natural transmission (crustaceans, fish, birds, mammals, etc.)

Vector exclusion in typical intensive ponds

# CONTROL OF TRANSMISSION PATHWAYS

# PROTECTION AGAINST PATHOGEN INTRODUCTION THROUGH OTHER PATHWAYS

# Improvement of biosecurity for other potential pathways: vehicules, fomites, persons


AQU MARINA
DE LA

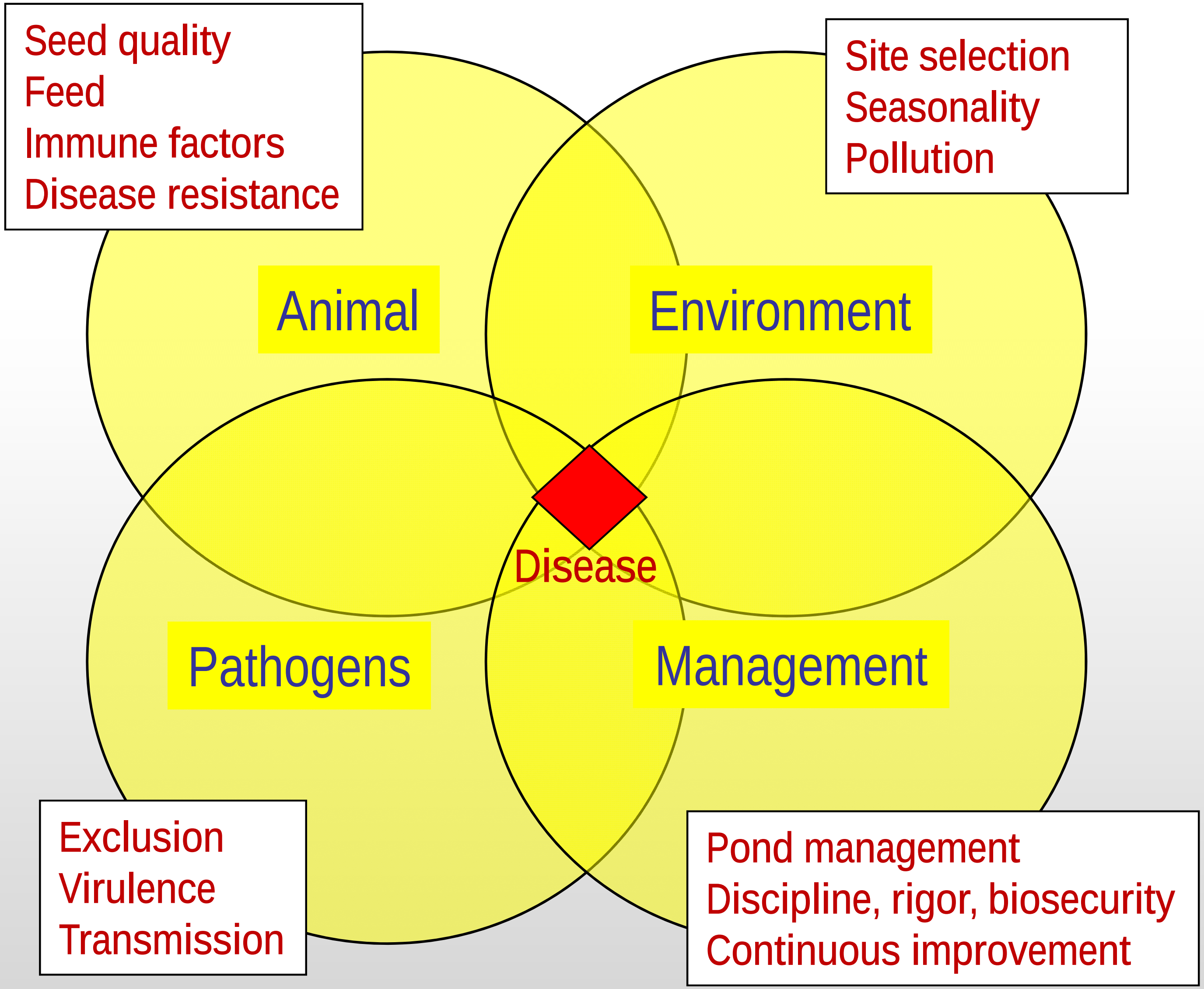
## CONTROL OF TRANSMISSION PATHWAYS

## IMPORTANCE OF MANAGEMENT IN BIOSECURITY

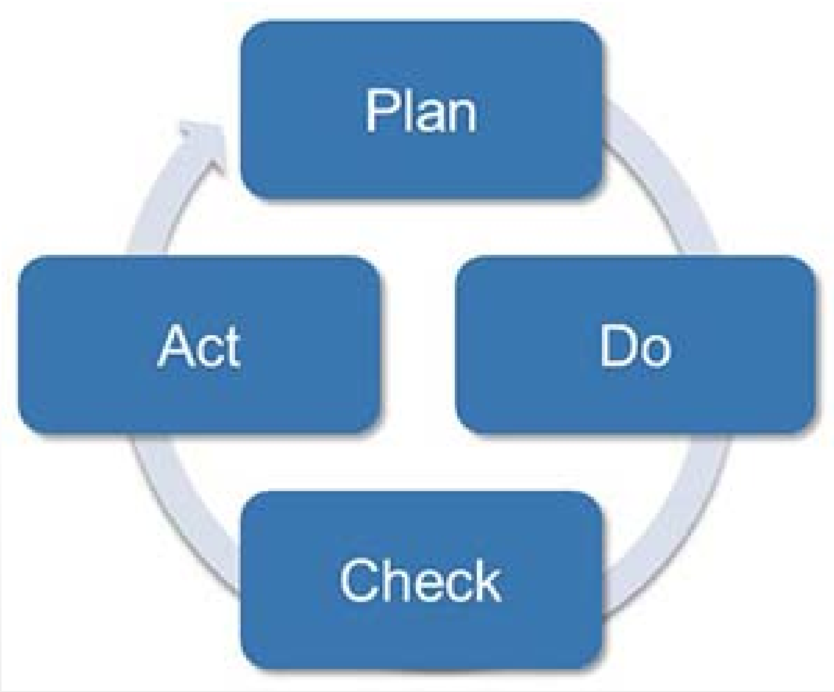
The devil is in the details !

# Management requirements

❑ Why ?
The interlink and combined effect of all these aspects is critical. Overall success of all these issues largely dependent on manpower management.



# Management requirements




- ❑ Standard Operating Procedures, records for critical points (based on HACP model).
- ❑ Specific training procedures adapted to local culture.
- ❑ Continuous monitoring
- ❑ Continuous improvement (Deming's wheel)

# Management is key for team involvement in biosecurity

- ❑ Routine biosecurity procedures: application, auditing

- ❑ Monitoring and updating biosecurity plan: surveillance, continuous monitoring and improvement

- ❑ Contingency plan (including simulation exercises)
  - ✓ Early detection
  - ✓ Quarantine
  - ✓ Emergency harvests
  - ✓ Destruction
  - ✓ Fallowing

  Objectives: no persistence of pathogen, limited to null diffusion in the environment

# Emergency harvests

# Destruction and disposal

# Fallowing Aquaculture Farms




# What could be the role of focal points for biosecurity improvement in aquaculture?

1. Can promote and contribute to biosecurity SOPs implementation.
2. Can be part of national, regional, or international biosecurity programs (NACA, FAO or OIE).
3. **Can help implement compartments (OIE definition) or zones with the stakeholders he is responsible for:**
   a) "Compartment" is applied to an animal subpopulation defined according to biosecurity practices. It contains one or more establishments where animals are under a common biosecurity management clearly defined, containing an animal subpopulation with a defined health status with respect to a disease (s) specific (s) to which you have applied measures of surveillance, control and biosecurity according to international trade rules.
   b) The compartment biosecurity must be ensured, even in cases where the threat is coming from wild fauna.
   c) Compartments are established by private companies but audited and supervised by Official Veterinary authorities
   d) It can be marketed even though the country or region are not free from disease (preserving access to foreign markets).

# Take home messages

- Common principles of all biosecurity plans (please refer to biosecurity chapter in OIE Aquatic Code)
- Needs to start with a risk assessment
- Many examples of biosecurity, depending on aquaculture production systems, diseases to be addressed and specificities of the establishment. Necessity for operators and Competent Authority to be aware of all options.
- Importance of the management and continuous improvement in the day to day routine and implementation of contingency plans

# Thank you for your attention!