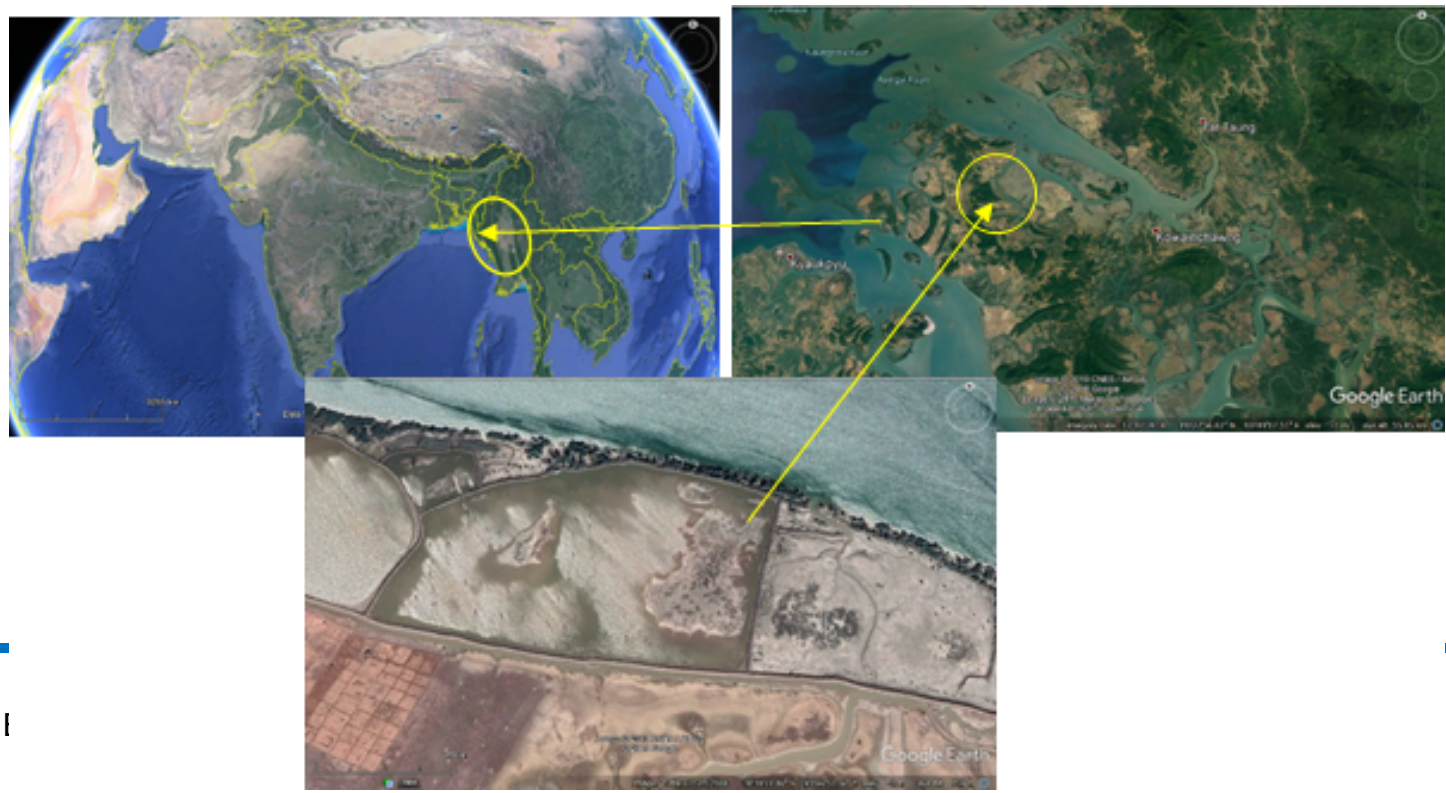
# Developing capacity in the Ecosystem Approach to Aquaculture Management (EAAM)

***CAPACITY PLUS***

***Coastal aquaculture***

# Spatial scales in aquaculture

- There are three physical scales:
- Farm/Aquaculture management area scale
- Watershed/Aquaculture zone
- Global



# Farm scale

Attention to **levels of production, carrying capacity**

EAA planning and implementation implies **ecological**, **economic** and **social** assessments

**impact from large farms**

Attention to:
- better management practices
- use of **restoration**, **remediation**, and **mitigation** methods

**exotic vs. native** species

Proper **site selection**

**Social impacts**

appropriate **farming systems** and **technologies**

**Economic impacts**

# Watersheds/aquaculture zone

**Common ecosystem issues**: diseases, seed and feeds trade, climatic and landscape conditions

Competition/Conflicts for **land and water use**

Beneficial **multiplier effects** of aquaculture on **jobs**, **communities**

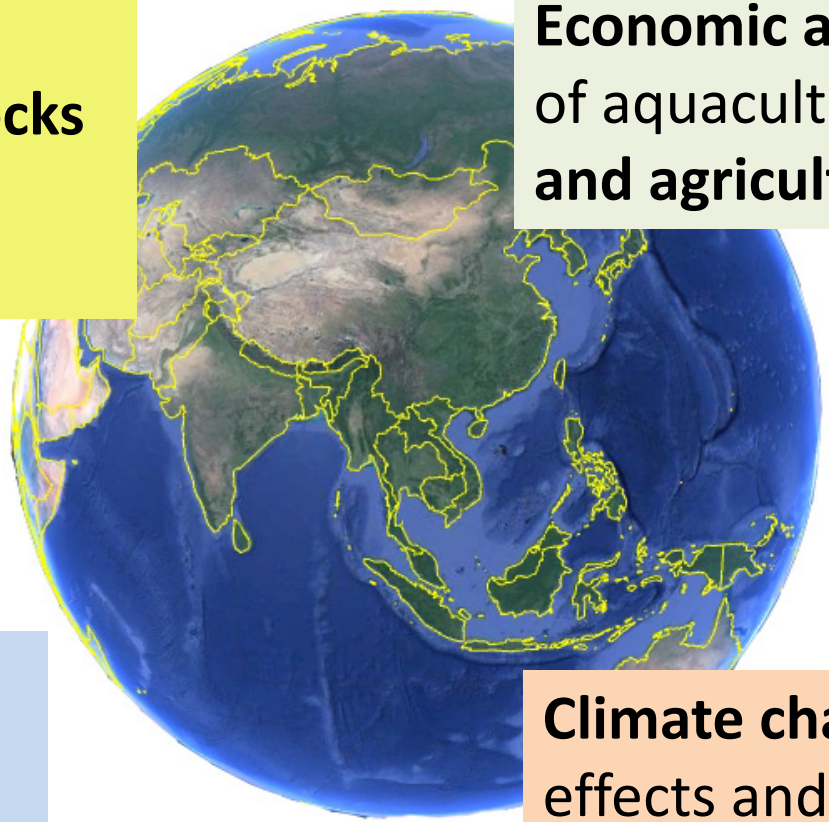
Consider **existing scenarios and alternatives**

Planning on **social**, **economic** and **political issues**

**Regional issues** such as **escapees**, **disease** transmission, **pollution** to/from aquaculture.

# Global scale

Availability of **agriculture and fisheries feedstocks** for aquaculture **feeds**



**Economic and social impacts** of aquaculture **on fisheries and agriculture** resources

Impacts of aquaculture on **food supply**

**Impacts** on the broader **marine ecosystem**

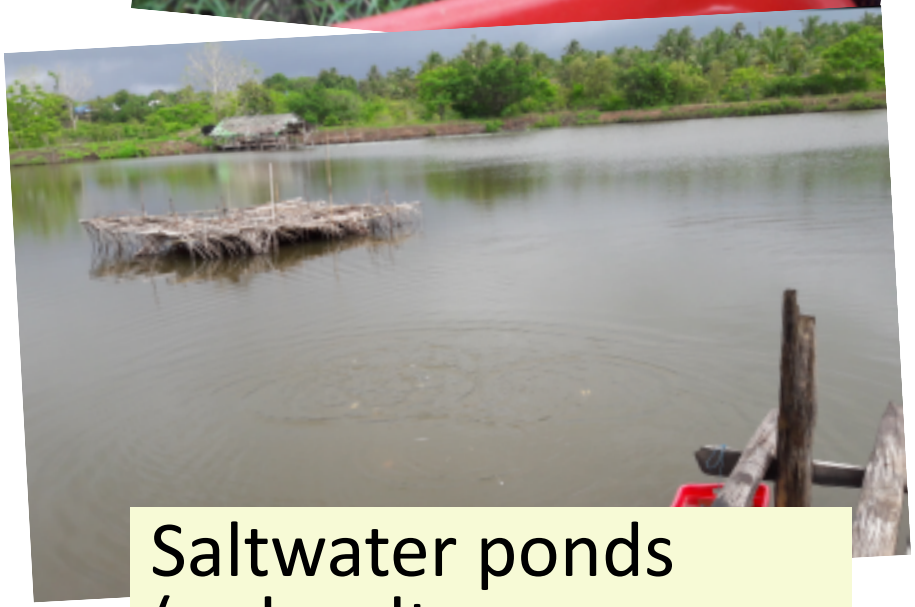
**Climate change** effects and mitigation strategies

# Types of marine aquaculture

# Finfish aquaculture

# Finfish aquaculture

## Inshore cages



Saltwater ponds (polyculture or monoculture)

Offshore cages

# Finfish cage aquaculture

**Environmental factors determining farming**

Location (open water, creeks/lagoons)
- it affects water exchange


Water Temperatures

Water stream

Depth

Sea Tides

Salinity (rivers, rain)

algal tides

Oxygen in water

Source of pollution

# Finfish cage aquaculture

**Environmental issues**

Source of feed

Fishery/agriculture

Trash fish

antibiotics

Wild seeds

No sustainable

diseases

Carrying capacity

No!

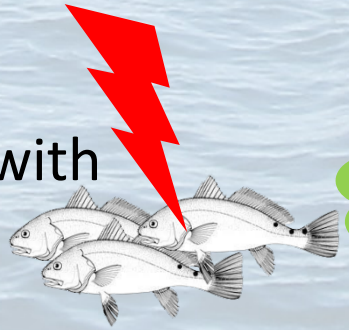
area conflicts

Water pollution

Genetic contamination

Benthic pollution

Cross infections with wild populations



hazardous algal blooms

# Finfish aquaculture

Socio-economic and governance issues

Economic aspects (credit, return)

Skills

Fair labour

Access (lease, licensing)

Inter sectorial management

Access to farming, only for rich or also poor?

Careful planning


regulatory framework

Poor compliance and enforcement

Conflict of resource use
Tourism, fishery, transport

Social security

Integrated aquaculture-fishery

# Towards EAA for Fish

## Principle 1: Ecosystems

**Farm**:

- Reduce pollution
- Respect carrying capacity
- Favor IMTA
- Address users conflicts
- Avoid trash fish
- Alternative feeds
- Biosecurity
- Proper stocking densities
- Reduce antibiotics

**Region**:

- Environmental monitoring systems
- Regional hatcheries
- Protected areas for wild species

**Global**:

- fish meal replacement
- protect stocks that are at risk
- carrying capacity
- Code of conducts and Certification

# Towards EAA for Fish

## Principle 2 : Society

Farm:

- health standard
- fair labour

**Global**:

- Population and economic growth
- labour markets

Region:

- ameliorating user conflicts
- economic/social equity
- labour standards
- Worker justice
- planning beneficial multiplier effects

# Towards EAA for Fish

## Principle 3 : Sectoral Integration

Farm:

- regulations on cage sitting
- integration
- participation

Global:

- impact on ecologically sensitive areas
- legal framework, compliance and enforcement
- research capacity
- environmental remediation

Region:

- legal and regulatory framework
- Compliance and enforcement
- Mandatory disease monitoring and control
- environmental remediation
- monitoring and regulation
- Improve site selection and zoning
- Development of coastal hatcheries

# Finfish aquaculture

**Marine finfish perspectives in Myanmar**

- Aquaculture mainly done in extensive way
  - For rich vs poor?
- Shift from overexploited fishery to aquaculture possible?
  - Incentives?
  - Some advantages: Price seasonality (high during closed season)
- Access to inputs
  - Feed/seed
- Social wellbeing
- Governance
- Favourable environment for investments, good legal framework

# Shrimp aquaculture

# Shrimp aquaculture

Different levels of pond intensification:

Extensive – Trap and hold

Semi intensive

Intensive, biofloc

Integrated systems (fish/shrimp)

# Tilapia cages in shrimp ponds

Adoption of tilapia polyculture due to severe disease outbreaks in shrimp industry in 1990's

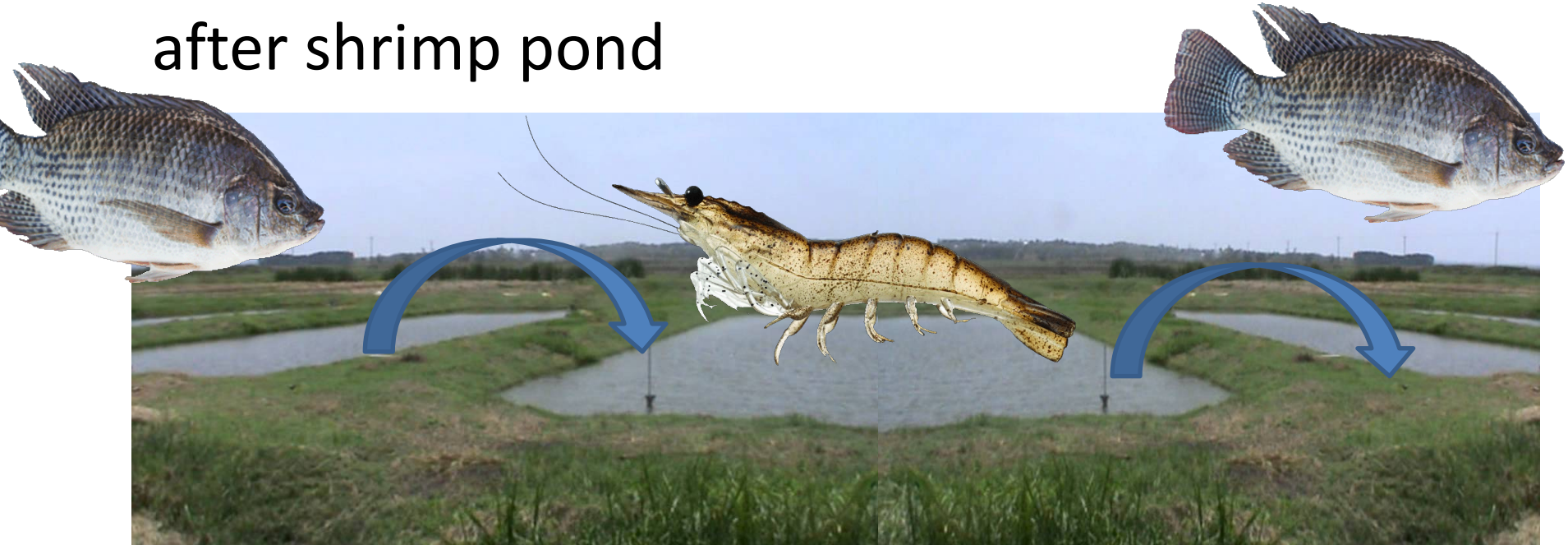
***Tilapia tolerant to 10-15 ppt salinity***

Use of feed and microalgae naturally growing in pond wastes from tilapia eaten by shrimps

# Shrimp/fish intercropping Thailand - 2004

- Tilapia in cages in shrimp ponds

- Tilapia in sequential polyculture before and after shrimp pond



# Polyculture systems – 2011 Thailand

**Tilapia cages in shrimp pond, Thailand**

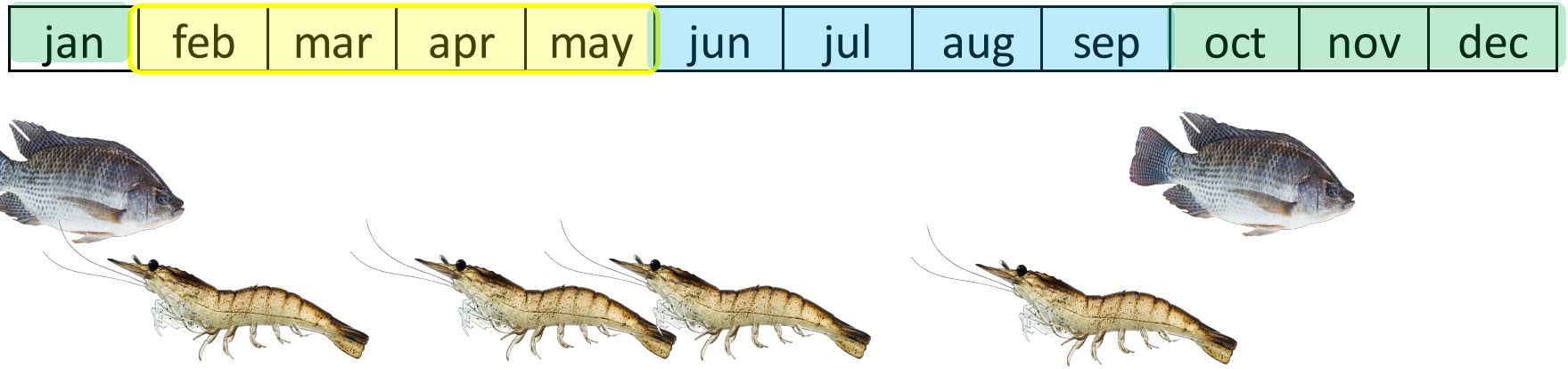
**Red tilapia from cages in shrimp pond, Thailand**

**Tilapia cages in shrimp pond, Surat Thani, Thailand**

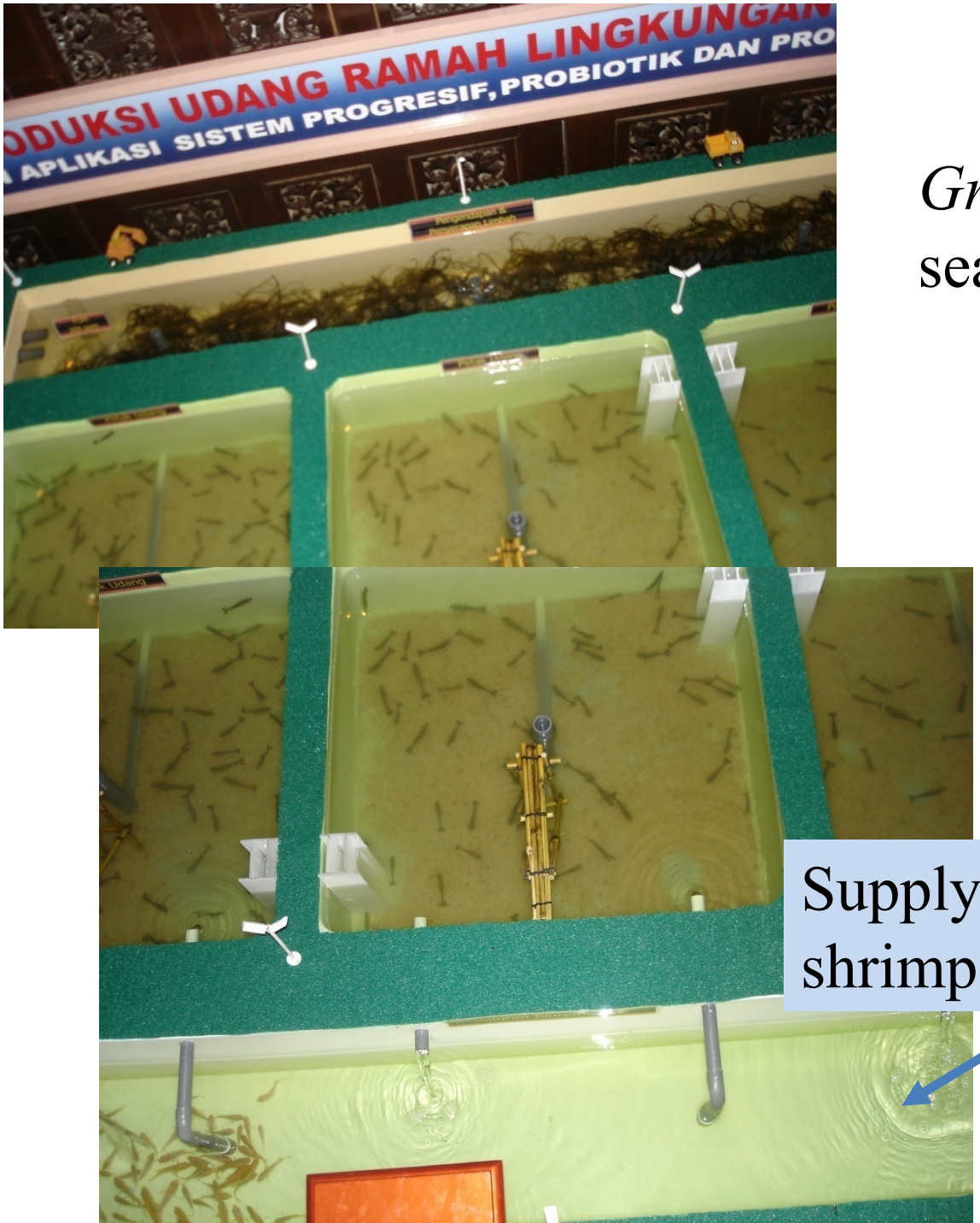
# Polyculture in Indonesia

Tilapia and shrimp in crop rotation:

- Shrimp crop 1 (4 months)
- Shrimp crop 2 (4 months)
- Tilapia crop (4 months)



EurekaFarming




*Gracilaria* seaweed

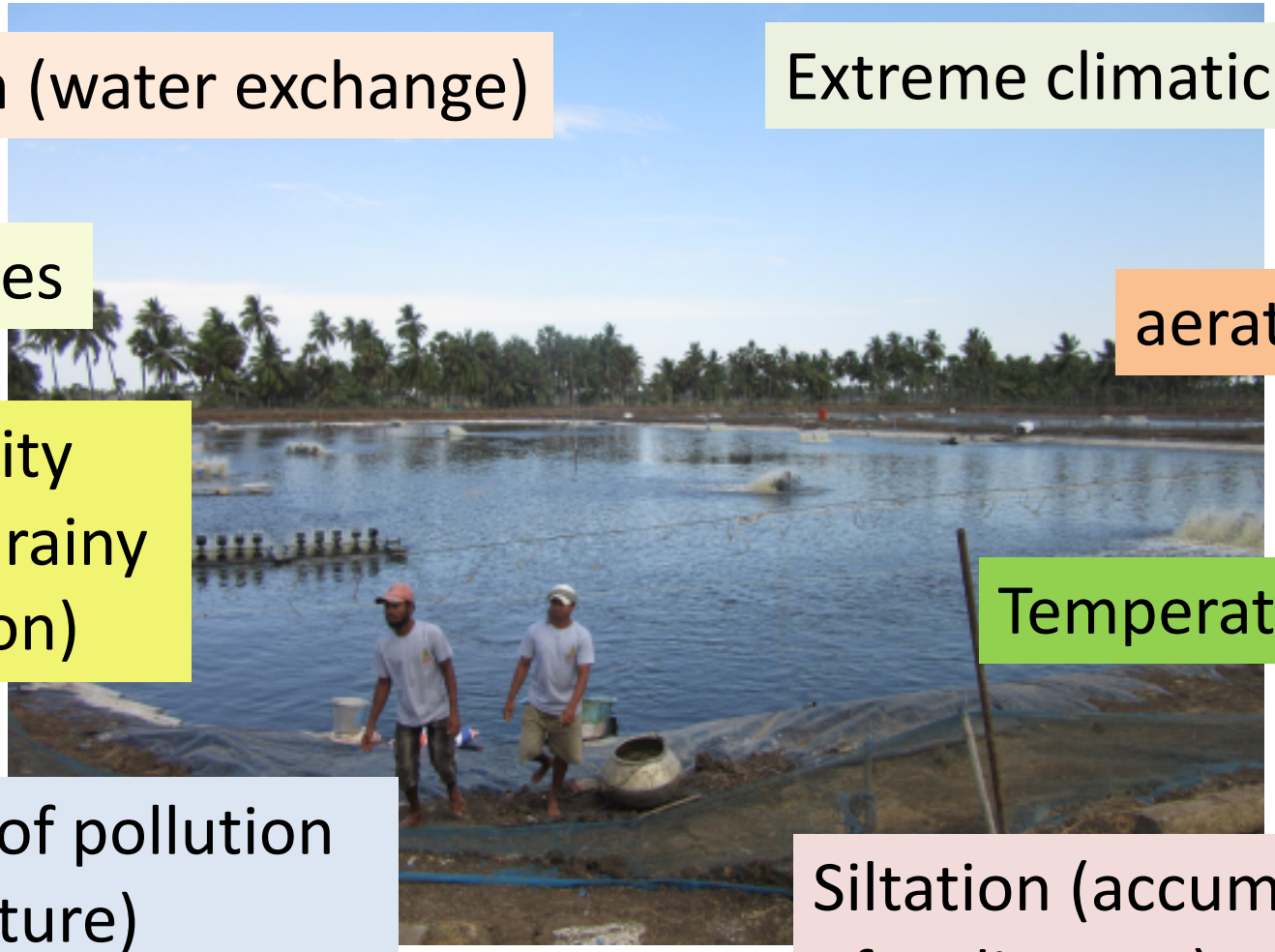
Shrimp

Supply reservoirs or shrimp pond outlets

Tilapia

# Shrimp aquaculture

**Environmental factors deterring farming**



Location (water exchange)

Extreme climatic events

High tides

aeration

Salinity (rivers, rainy season)

Temperatures

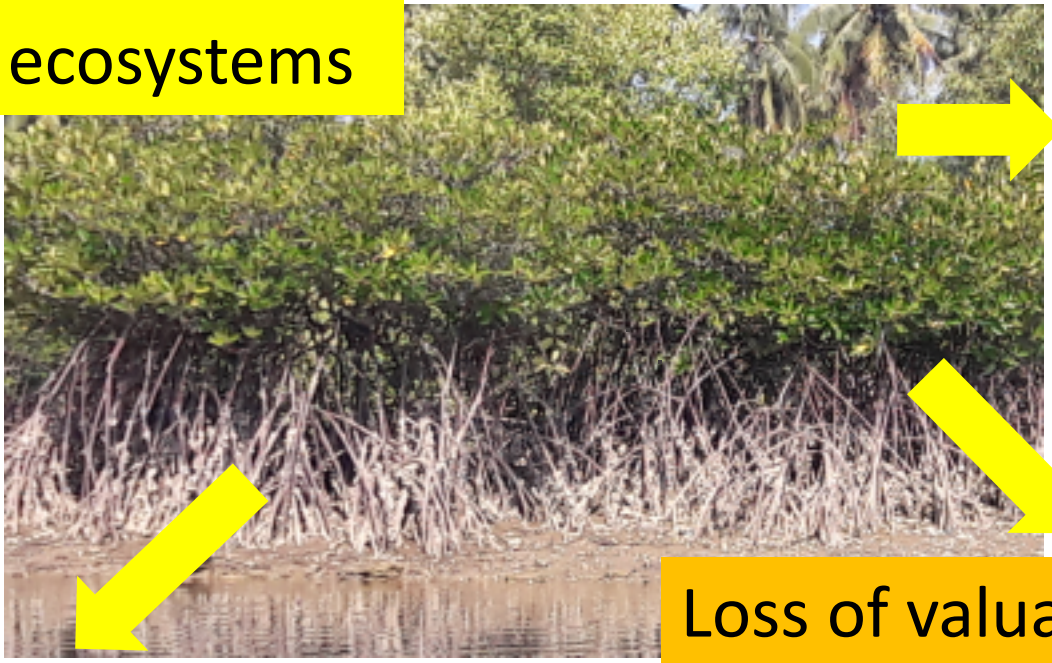
Source of pollution (agriculture)

Siltation (accumulation of sediments)

# Shrimp aquaculture

**Environmental issues**

Destruction of mangrove ecosystems



Loss of coastal biodiversity and nursery areas

Loss of valuable coastal buffer strips for storm protection

displacement of traditional livelihoods

# Shrimp aquaculture

**Environmental issues**

Introduction of exotic species

Disease risks

Sources of feed (fishmeal)

Pollution

Salinization of aquifers (ban in Thailand in rice areas)

Source of seeds: unsustainable wild captures, fish fry bycatch

# Towards EAA for Shrimps

## Principle 1: Ecosystems

**Farm**:

- Limit **stocking densities** (intensive systems);
- use **native species**;
- **zero discharge**/recycling pond
- **regional hatcheries**;
- **pathogen free broodstock**
- **disease/stock management**

**Region**:

Regional **hatcheries**

**Global**:

**innovative pond management** to reduce feed costs;

Development of **alternative low fishmeal feeds**

# Towards EAA for Shrimps

## Principle 2 : Society

Farm: in Thailand and Vietnam **small owned farms** with **low-costs loans** and credit programs have **larger societal benefits** than multinational, corporate farms

Region: Better planning for **hatchery**, **feed and infrastructure** needs that maximize societal benefits

# Towards EAA for Shrimps

## Principle 3 : Sectoral Integration

Farm: Regulatory controls and **better management practices** to **limit diseases** and introductions of **non-native species**

Region: regulations to **control clearing of mangroves** and to **limit diseases** and **non-native species**

Global: **International conventions** on better practices on farm siting, mangrove preservation/ restoration, farm design, water use, broodstock, PLs, feed, health management, food safety and social responsibility adopted in global partnership

# Shrimp aquaculture

## Shrimp farming perspectives in Myanmar

Aquaculture mainly done in extensive way

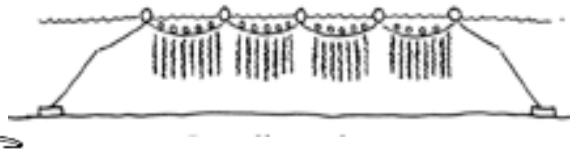
- Intensification compatible with no credit access, for poor?

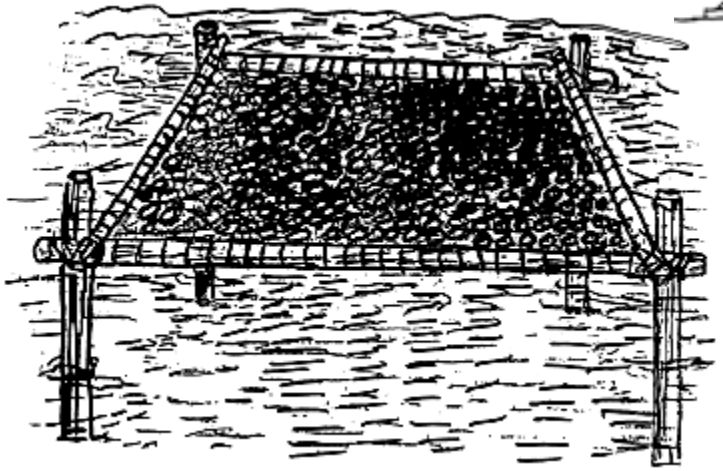
- Access to inputs
  - Feed/seed available-unavailable, what sources?
- Social wellbeing
  - How to improve incomes
  - Access to credit
  - Skill development
- Governance
  - Also framework with other sectors
- Favourable environment for investments, good legal framework

# Shellfish aquaculture

# Shellfish aquaculture

- Shellfish, coastal aquaculture, inshore
  - Longlines floating in the water, hanging systems
  - production at the bottom (intertidal)



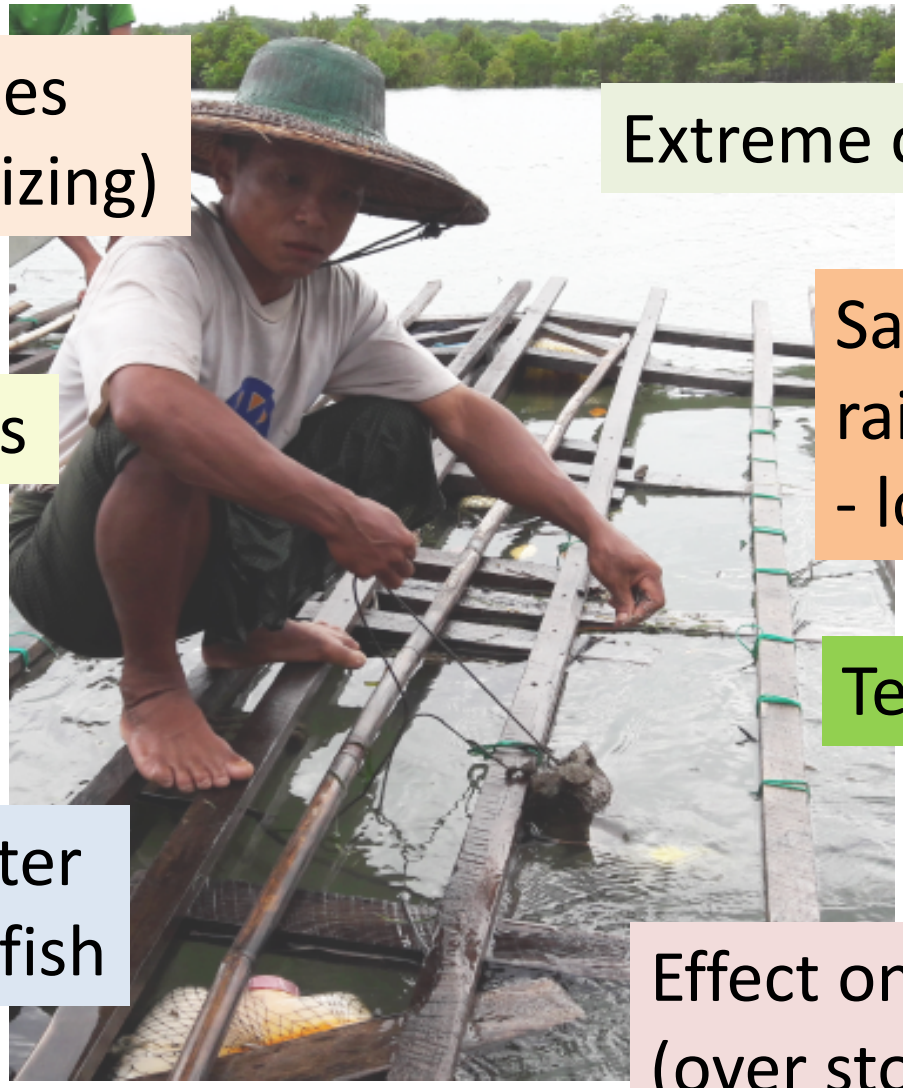


# Shellfish aquaculture

**Environmental factors determining farming**

Suitable places (naturally colonizing)

Extreme climatic events



Salinity (river, rain season) - low not good

Streams/waves

Moorings

Temperatures

Eutrophic water to feed shellsfish

Effect on benthos (over stocking)

# Shellfish aquaculture

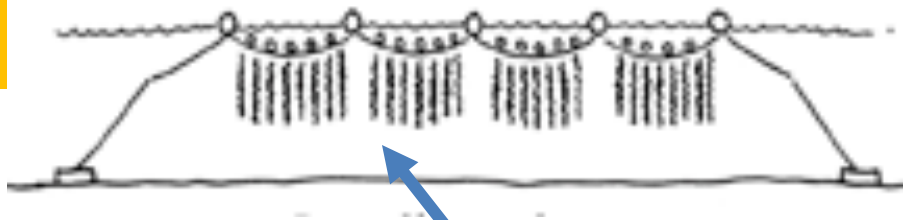
## Environmental issues

Seeds availability from nature

Competition for areas

Disease risks

Massive, floating and vertical structures



Toxic algal blooms

Localized depletion of food (phytoplankton)

Effect on benthos (over stocking)

Pollution effect on shellfish

# Towards EAA for shellfish

**Principle 1: Ecosystems**

- **Farm:** Limit biomass/ha to below pelagic-benthic carrying capacities; precautionary approach
- **Region:** Shellfish aquaculture **restore vital ecosystem** functions from pollution

**Principle 2: Society**

- **Farm:** Most **farms are small, large societal benefits**
- **Global**: shellfish **benefit water quality and marine restoration**, establish new habitats

# Towards EAA for shellfish

**Principle 3: Sectoral Integration**

- **Farm:** regulatory controls to limit diseases and non-native species
- **Region:** regulations to control diseases and limit non-native species
- New conflict resolution and decision-support systems
- Shellfish aquaculture in support of finfish in a nutrient trading scheme (remediation)

# Shellfish aquaculture

**Perspectives for production in Myanmar**

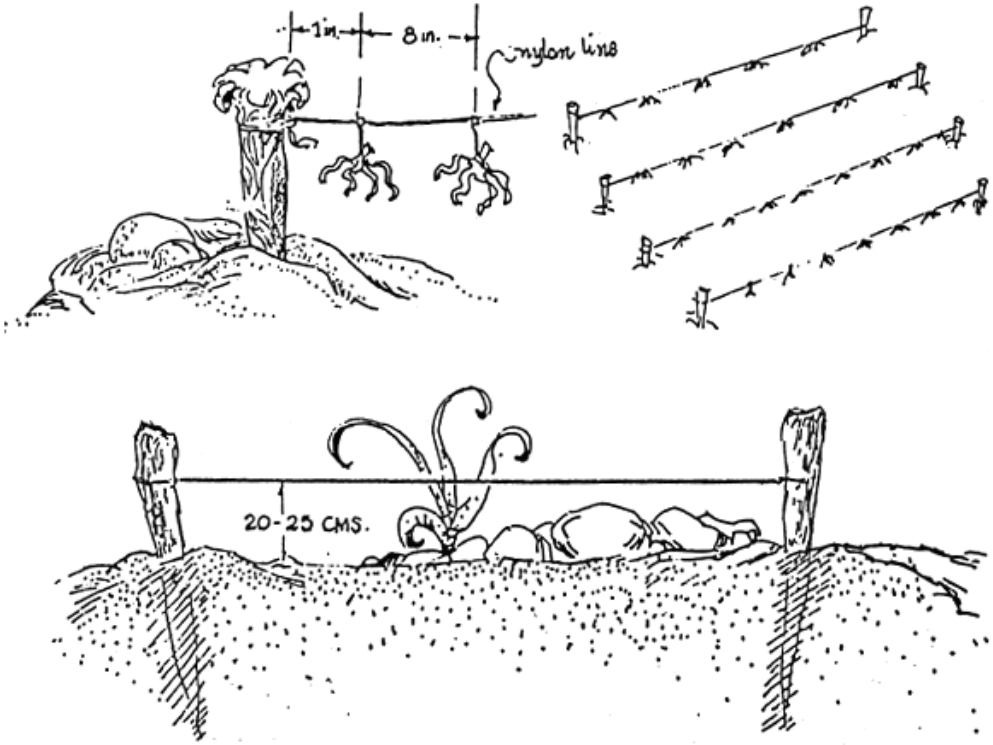
- Extractive aquaculture → good for environment
- No feed inputs (= no operating costs, no credit burden)
- Accessible for poor people/fishery communities
- Access to inputs
  - Seed (hatcheries? Starting by importing young healthy juveniles to see productivity?)
- Social wellbeing
  - Income diversification
  - Moderate use of cash
  - Work demand
- Governance
  - Licensing for SMEs, poor-focusing licenses, facilitation of integrated policies for fishery-aquaculture to reduce the impact on capture fish, integrated environmental management to remediate organic pollution, or to develop no-impacting aquaculture in protected areas banned to fishery (recruitment of wild fish)
  - Integration with planning department as integrated way to keep good water quality in tourist areas, development of local produces.
- Favourable environment for investments, good legal framework

# Seaweed aquaculture

# Seaweed aquaculture

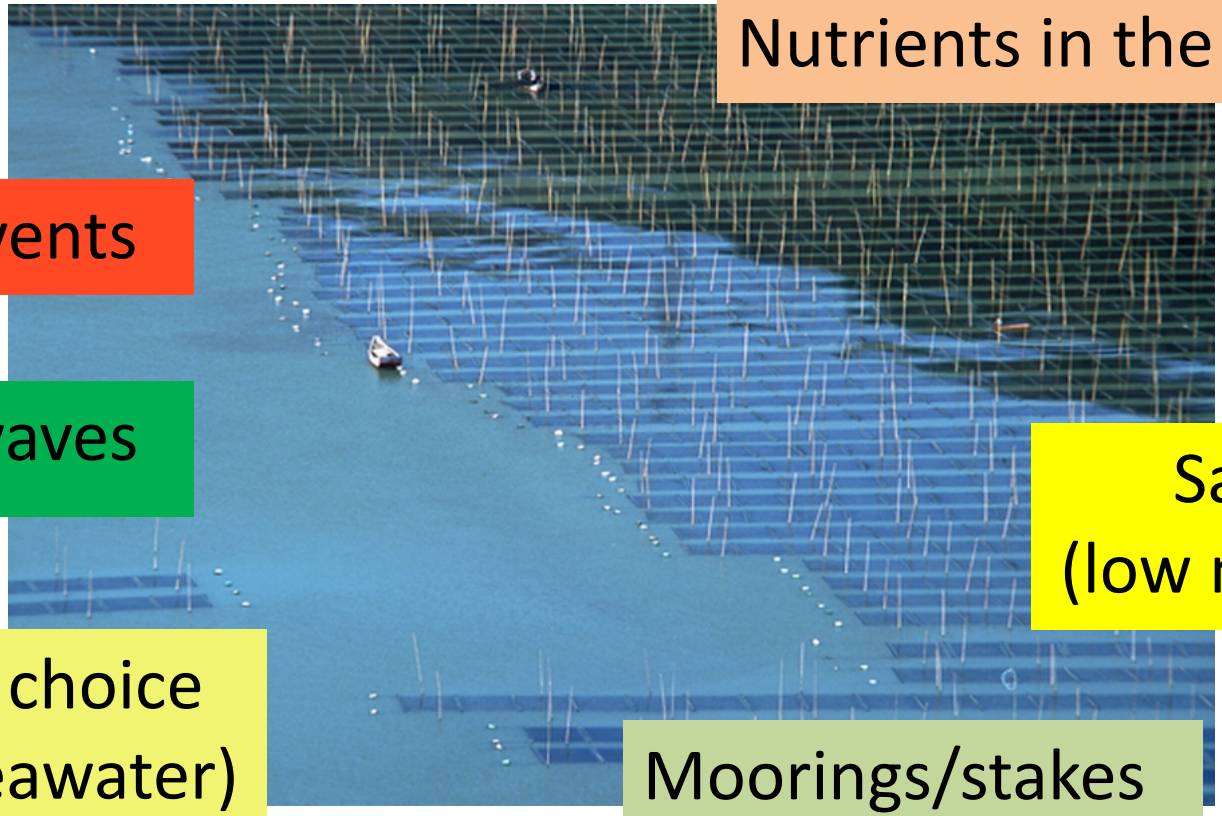
Coastal aquaculture, inshore

- Longlines suspended in the water




# Seaweed aquaculture

**Environmental factors determining farming**



Nutrients in the water

Extreme events

Streams/waves

Salinity
(low not good)

Location choice
(mainly seawater)

Moorings/stakes

# Seaweed aquaculture

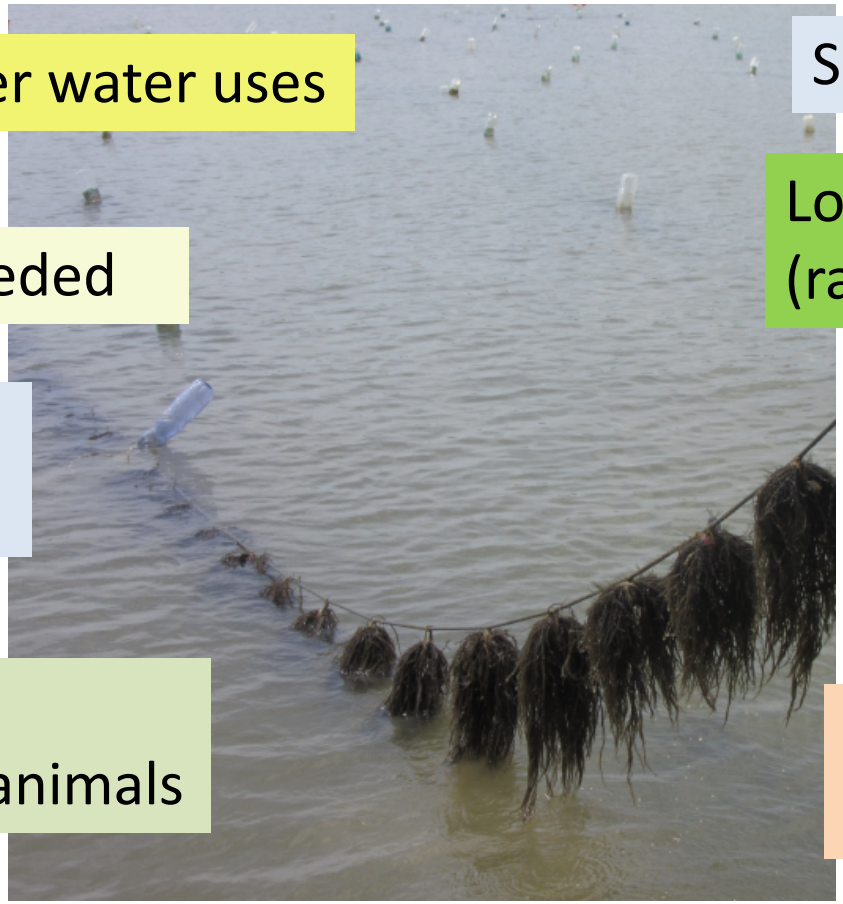
## Environmental issues

Conflict with other water uses

Seeds availability

Area of water needed

Low salinity (rainy season)



Land needed (drying)

Drying difficult in rainy season

Predation by herbivorous animals

Disease risks due to low salinity

# Towards EAA for seaweeds

**Principle 1: Ecosystems**

- **Farm:** access to **suitable areas** not prone to rough sea, saline seasonality
- **Region:** seaweed **restore vital ecosystem** functions from pollution

**Principle 2: Society**

**Farm: large societal benefits** in small farmers

**Global**: Seaweed promote water quality restoration, marine wild fish recruitment

# Towards EAA for seaweeds

## Principle 3: Sectoral Integration

**Farm:** regulatory controls to limit diseases

**Region**:

- regulations to control **diseases**
- **conflict resolution** and decision-support systems
- Seaweed aquaculture in support of finfish in a **nutrient trading scheme** (remediation)

# Seaweed aquaculture

**Perspectives for production in Myanmar**

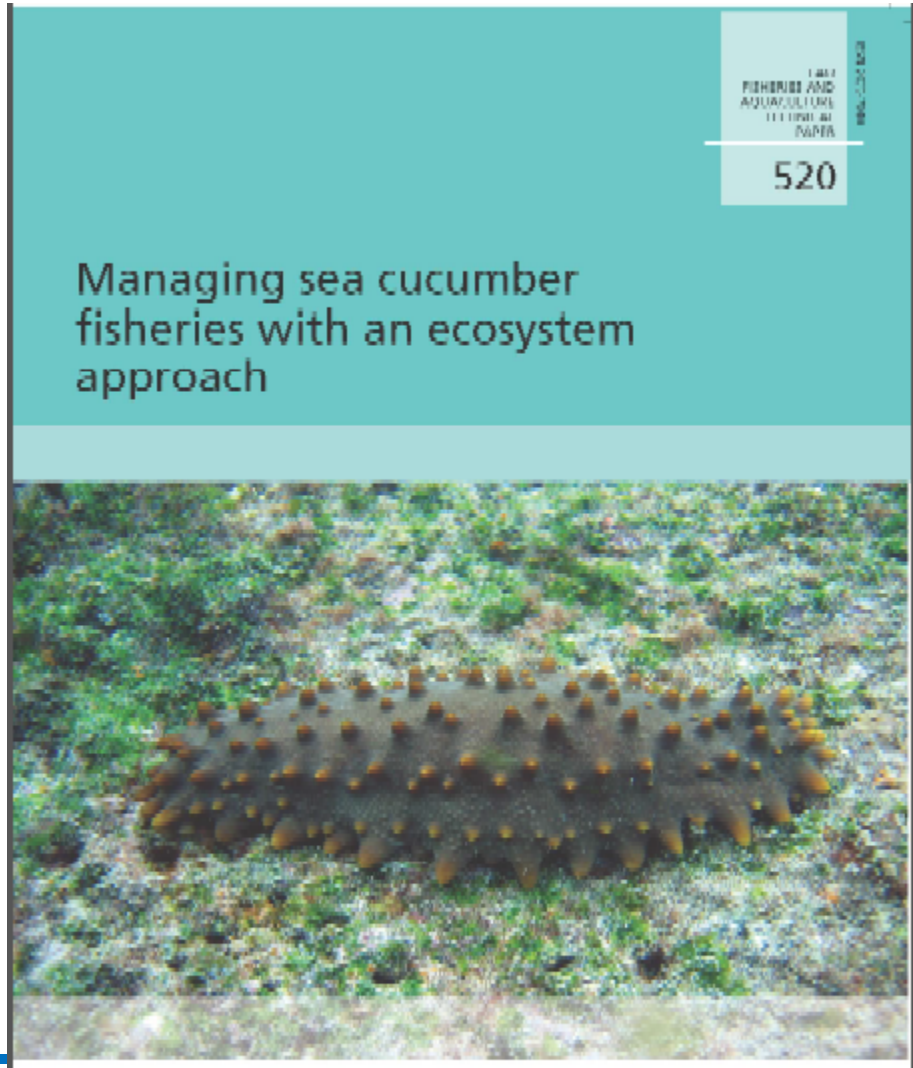
- Extractive aquaculture
- not feed inputs (no costs, no credit burden)
- Accessible for poor
- Inputs
  - Seed/nursery
- Social wellbeing
  - Income diversification
  - Very limited use of cash
  - Work demand
- Governance
  - Licensing for SMEs, poor-focusing licenses, facilitation of integrated policies for fishery-aquaculture to reduce the impact on capture fish, integrated environmental management to remediate organic pollution, or to develop no-impacting aquaculture in to favour wild fish recruitment (protected areas banned to fishery), use as fodder.
  - Integration with planning department to integrate urbanization and aquaculture (tourist areas), development of local produces and new products.

Favourable environment for investments, good legal framework

# Aquaculture with echinoderms

Sea cucumber

Farmed in: stocking ponds, for pen and cage culture and for sea ranching

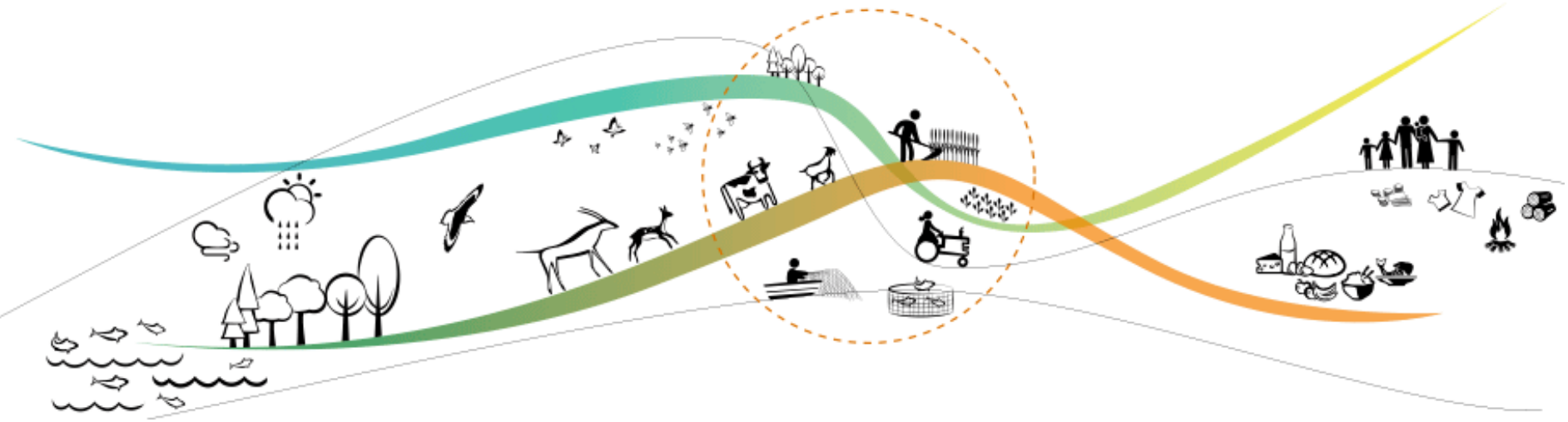


# Aquaculture with echinoderms

Sea urchins

Farmed in: Tanks, sea ranching, cages

# Approaches to sustainability

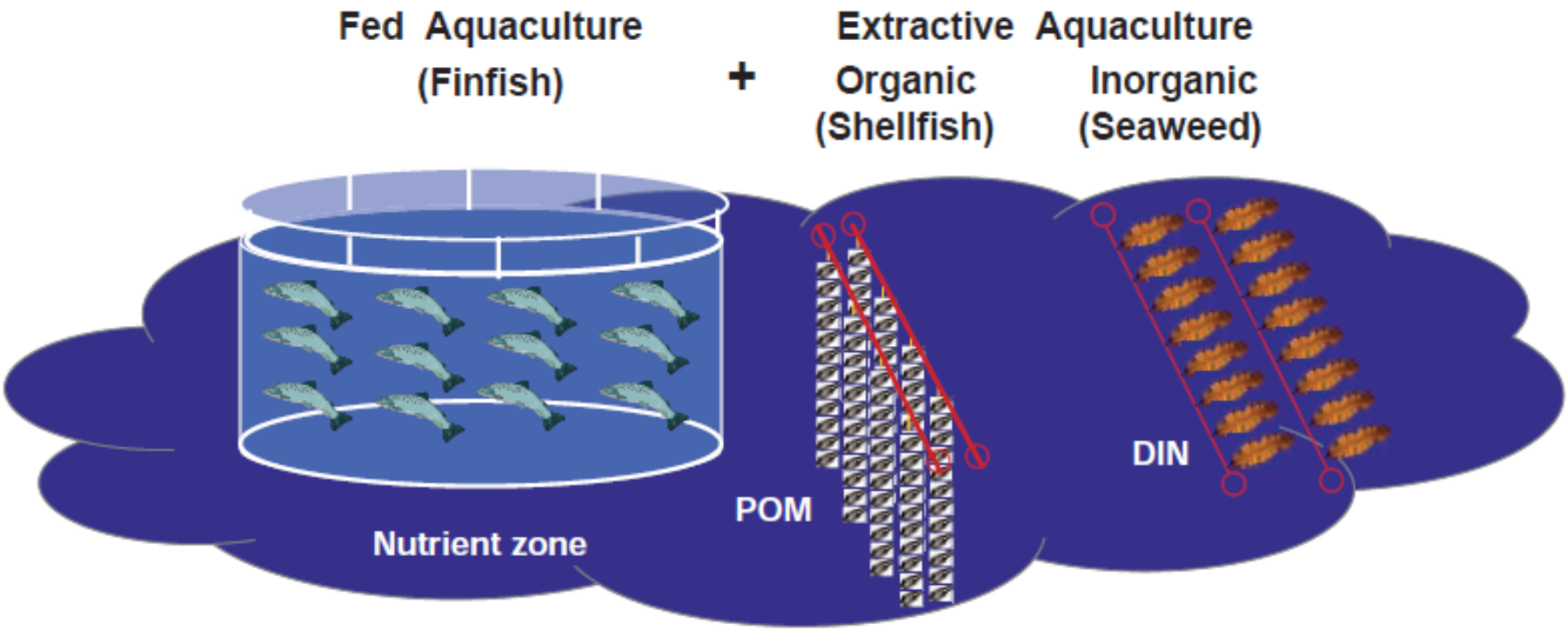


# Integrated Multi-Trophic Aquaculture (IMTA)

Integration of fish, shellfish and seaweed

- Shellfish feed on suspended organic matter from fish
- Seaweed uptake dissolved nutrients from fish

# Integrated Multi-Trophic Aquaculture (IMTA)




*Source*: Chopin (2006).

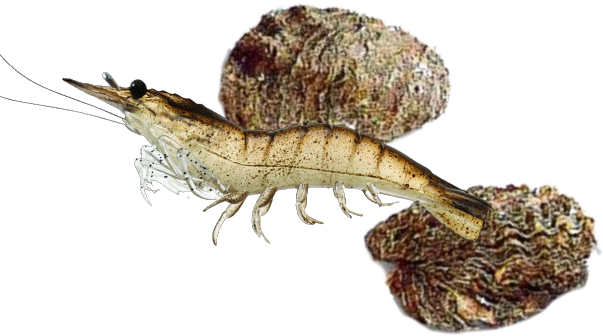
# IMTA examples

improved water quality of shrimp farm effluents

**shrimp, oysters and Gracilaria**

Bay scallops grow quickly in shrimp pond waters at intermediate densities

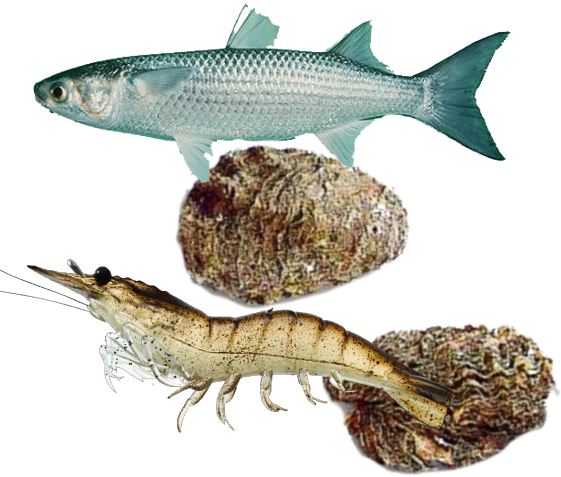
**shrimp and bay scallops**



**shrimp and oysters**

Oysters increased total economic yields and increased ecological efficiencies

# IMTA examples



4-ha shrimp system produces 40 t shrimp, 7 t mullet, 0.5 mil oysters/year

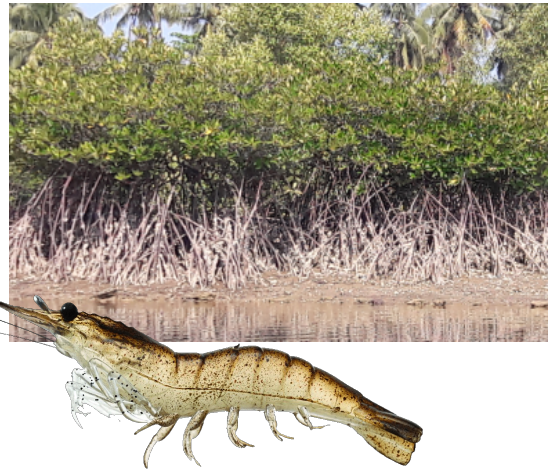
**Shrimp, mullet and oysters**

Improvements in systems economics

**Shrimp and Gracilaria**

Water quality improved

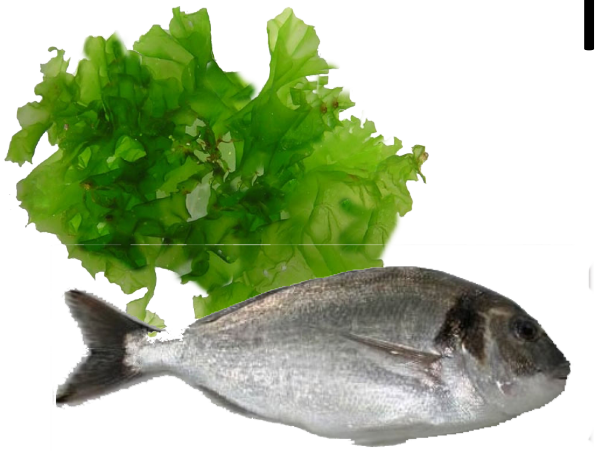
**Shrimp and Ulva pertusa**



**Shrimp and mangroves**

Devoting 30-50% of shrimp pond area to mangroves gave highest annual economic returns

# IMTA examples



**Seabream with Ulva**

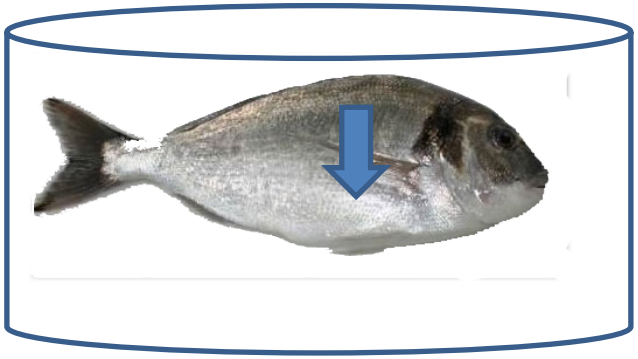
**Improved water conservation** and **water quality** of discharged water, **and improved economic** yields

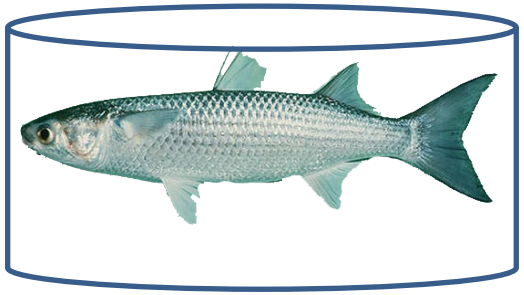
**Salmon and Gracilaria**

Integration **improved water quality** in the systems and the **effluents**, with **increased economic** yields

# IMTA examples

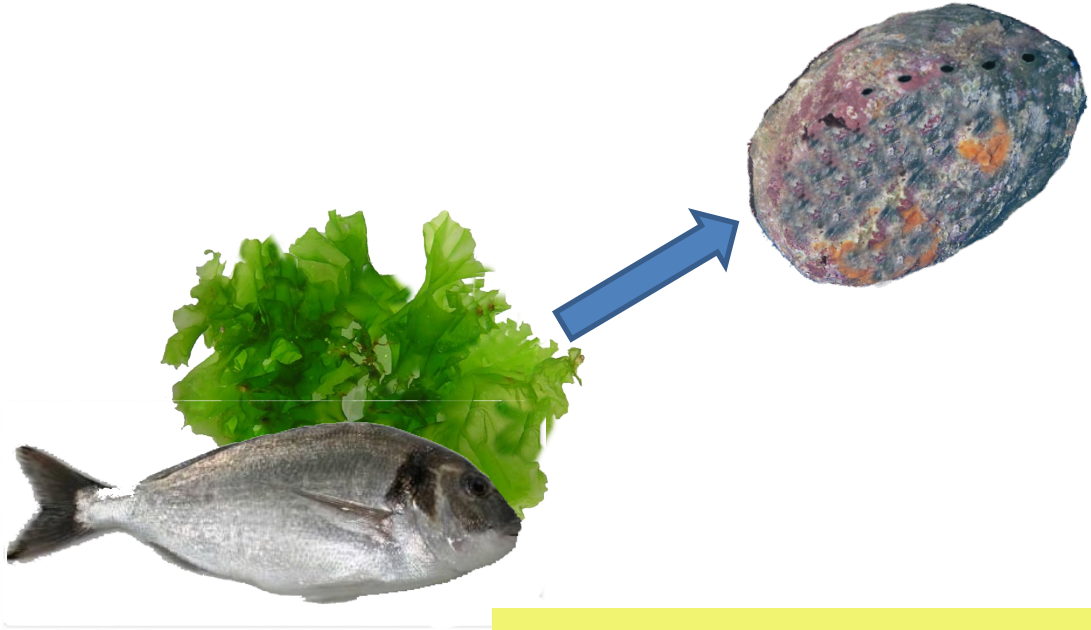
mullet reduces organic matter accumulations and oxidized bottom sediments





**Mullet in bottom cages underneath seabream cages**

Production of 22 kg of seabream, 64 kg of Ulva & 10 kg of abalone per m2 per year



**Integration of seabream and Ulva fed to abalone**

# IMTA – main issues

- Legal framework to support
- Legal advantages (less stringent regulations with IMTA in fish farming)
- Economy of complex systems
- Address users' conflicts (e.g. areas)
- Impact: dilution of nutrients depending on the distance from cages
- Acceptability by consumers

# Feed sources

**Alternatives to fish meal/fish oil**

- **Soybean** (brings gut problems, anti-nutritional factors, environmental sustainability, freshwater)
- **Microalgae** (complexity of production systems, spirulina)
- **Seaweed** (can improve the CP of product depending on the fertilization)
- **Insect meal**
- **Home made feed** (needs formulation, pellettization, some expertise and machineries)


# *Essential* EAAM

To download all materials please see

norgesvel.com