ASEAN Connected
Recirculating Aquaculture System (RAS)
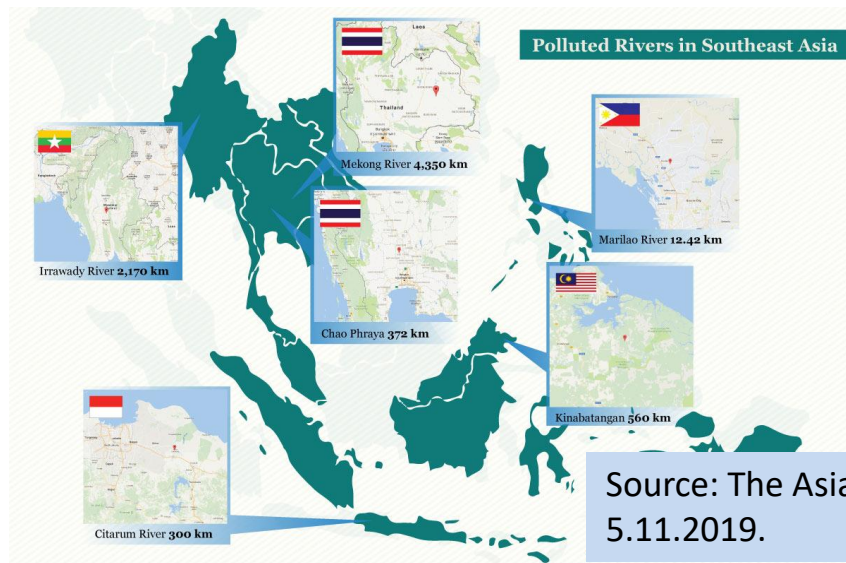
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ASEAN Connected Recirculating Aquaculture System

Background :

- Fisheries are important economic and nutritional sources to ASEAN population.
- However two big threats to current ASEAN fisheries:
  - **depletion of ASEAN marine resources**
  - **increasing pollutions in ASEAN rivers and seas**
- Aquaculture open systems, i.e. pond and cage culture systems are still highly exposed to climate and environmental conditions.
- For example, recently in August 2019, a loss of more than RM20 million was reported in Penang, Malaysia when high quality fishes bred in open system cages died over night due to changes in water quality.
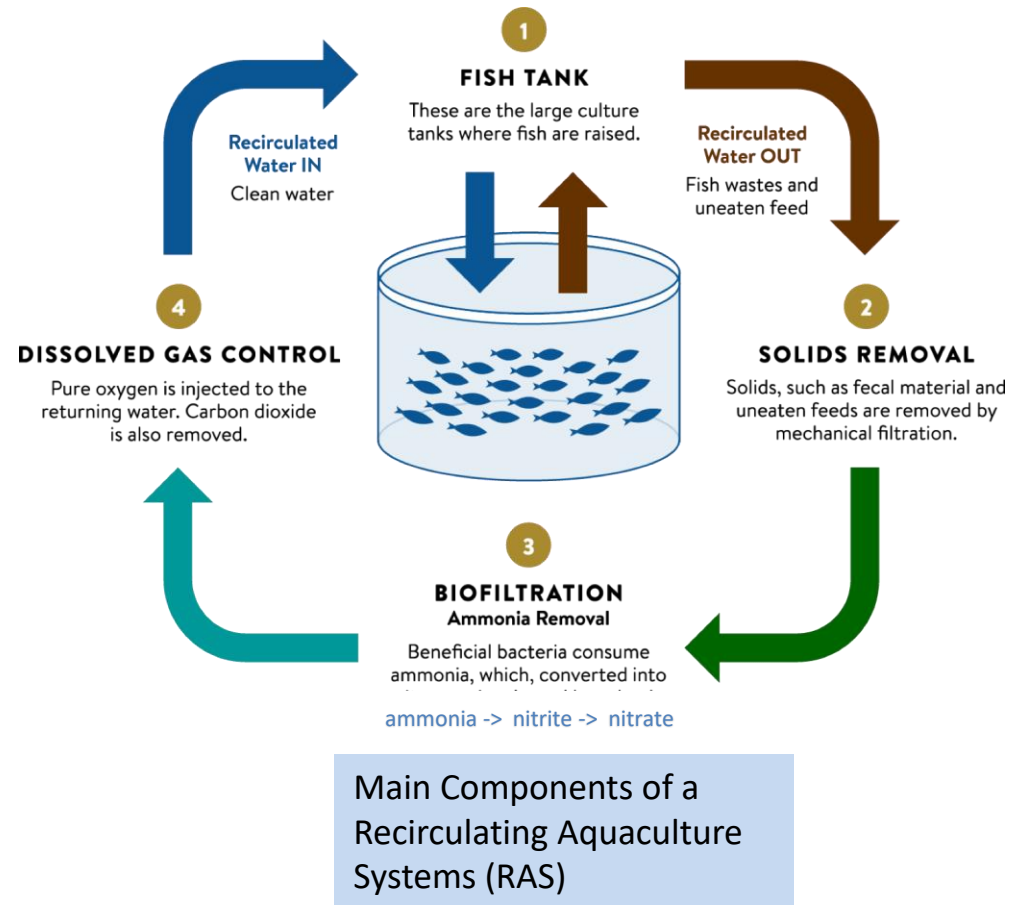

Polluted Rivers in Southeast Asia

Irrawady River **2,170 km**
Mekong River **4,350 km**
Chao Phraya **372 km**
Marilao River **12.42 km**
Kinabatangan **560 km**
Citarum River **300 km**

Source: The Asian Post, 5.11.2019.

Source: ASTRO Awani, 29.8.2019.

ASEAN Connected Recirculating Aquaculture System

Targets:

- To expand aquaculture fisheries to **closed Recirculating Aquaculture Systems (RAS)** in order to **maintain food security for ASEAN populations**.
- The RAS is often placed **indoors** to maintain **ideal** fish breeding environment where waste produce from aquaculture is treated and reused, hence reducing the need for water renewal whilst minimizing the risk of pollution from and to the environment.
- Use Intelligent IoT system to:
  - **monitor the water quality** of the RAS system
  - to provide **real time sensory readings** and analytics to stakeholders
  - to provide **meaningful advise and real time early warnings** to aquaculture farmers upon abnormal readings of the sensors.


1 FISH TANK
These are the large culture tanks where fish are raised.

Recirculated Water OUT
Fish wastes and uneaten feed

2 SOLIDS REMOVAL
Solids, such as fecal material and uneaten feeds are removed by mechanical filtration.

3 BIOFILTRATION
Ammonia Removal
Beneficial bacteria consume ammonia, which, converted into

ammonia -> nitrite -> nitrate

4 DISSOLVED GAS CONTROL
Pure oxygen is injected to the returning water. Carbon dioxide is also removed.

Recirculated Water IN
Clean water

Main Components of a Recirculating Aquaculture Systems (RAS)

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Proposed Methods:

- There are basically three main stages in a complete aquaculture system namely:
    - **brood-stock** management
    - **hatchery** management
    - **grow out** management.
- In order to provide for objective investigation of this study, it is necessary that the **mortality rate** is accurately reported.
- Of all the three stages, the **hatchery management** remains the most challenging phase since the fish larval are highly sensitive to the water quality (i.e. has the highest mortality) and it is difficult to count them accurately.

Snapshot of Fish Larval

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Proposed Methods:

Brood-stock Management

Hatchery Management

Grow-out Management

Grow-out Management
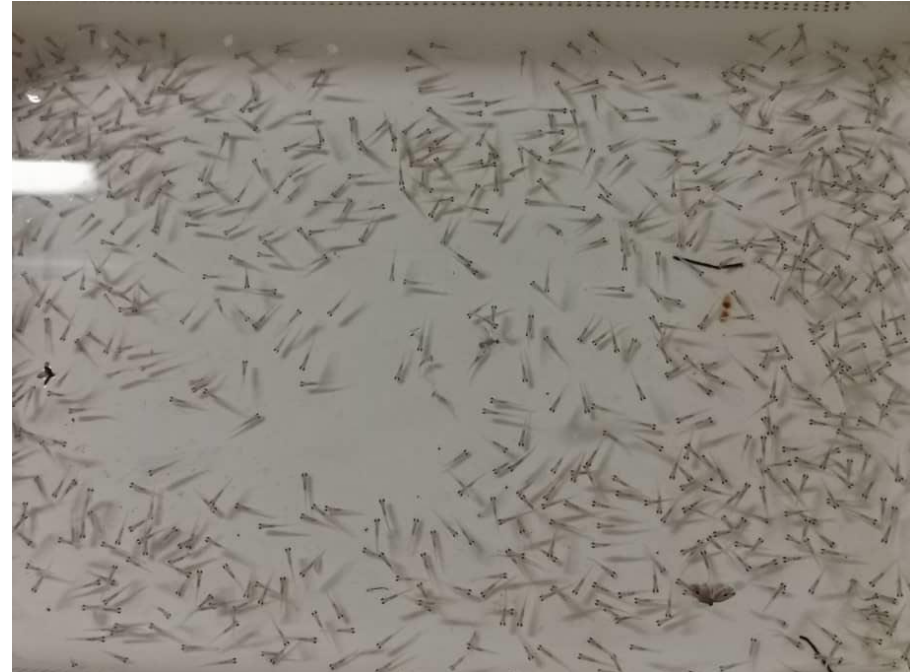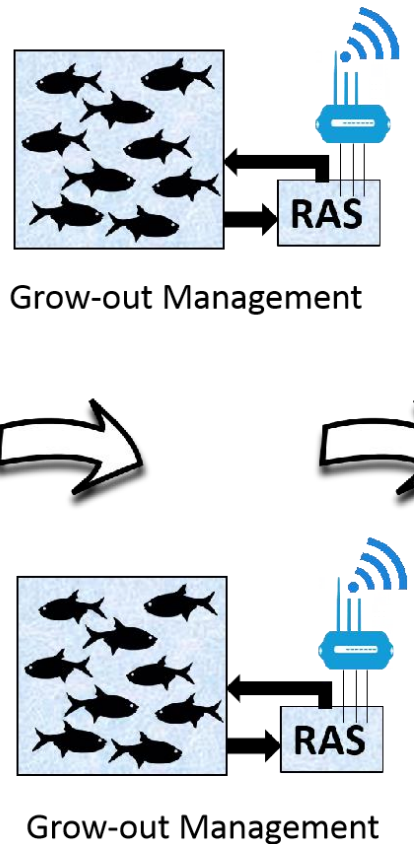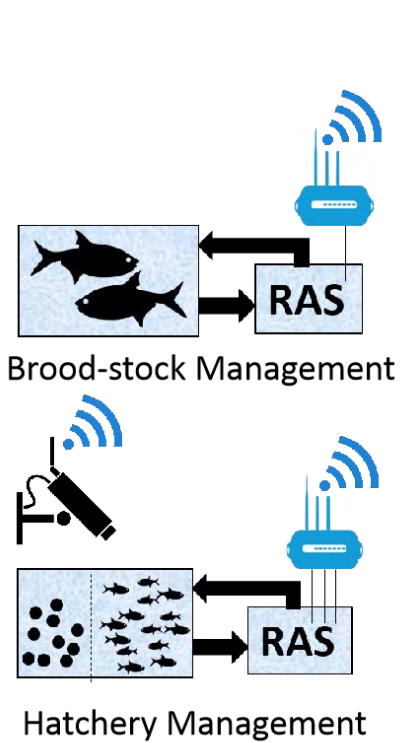
Overall Framework
Note: In this study, in addition to the environmental sensor network, we propose the use of a digital image processing at the hatchery to provide for accurate larval counting and behavioral monitoring.

Cloud and Intelligent Data Analytics

Early Warnings and Reporting

NATIONAL FISHERIES INSTITUTES / EXPERT BREEDERS

AQUACULTURE FARMS

VARIOUS STAKEHOLDERS

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Research Plans and Connectivity:

- The research members can be divided into two main groups:

    - ICT technical experts on IoT, cloud, and digital image processing (Faculty of Engineering members of UPM Malaysia, NECTEC, Thailand, ITB, Indonesia)

    - Aquaculture subject matter experts (ITB, Indonesia; Fisheries Research Institute, Malaysia; Aquaculture specialist of UPM and Tohoku University, Japan).

- The project duration is 2 years.

- Other stakeholders that will be involved in this project include:

    - National Fisheries Organization of each collaboration countries.

    - Aquaculture farmers at each collaborating countries.

- In Malaysia, we shall focus on endangered fish species – **kelah** or **mahseer** which are very sensitive to changes in environmental conditions.

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Impacts:

- **Mitigating the problems of over-fisheries** of marine resources and river and sea **pollution** by introducing a reliable aquaculture approach.
- **Ensuring fish food security** for ASEAN populations.
- Creating an **efficient communication platform** that connects remote aquaculture farms to the national fisheries organizations.
- Creating a **reliable support platform** that provides timely and real time intelligent advises and early warnings to aquaculture farmers upon abnormal readings of sensors.
- Connecting the technologist and auqaculture expert research communities across ASEAN countries.
- Providing **knowledge transfer** to the aquaculture farmers to **boost their income generations**.
- **Increasing the population of endangered fish species**.

We propose the study on the controlled species of kelah or mahseer which is expensive, elusive and facing extinction in ASEAN

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Outcome:

1. New technologies to provide real time early warning and advises on sensory input of the aquaculture system based on Machine Leaning technology at cloud.
2. A new platform to connect all relevant stakeholders.
3. Several academic publications.
4. Several Intellectual properties.
5. Societal - technologies and knowledge transfer to aquaculture farmers.
6. Guidelines documentations for national aquaculture research organizations.
7. Collaborative ASEAN research work (i.e. new partners, new colleagues) amongst academia, industry and national fisheries research organisations.

Malaysia Fisheries Research Institute, Malaysia

ASEAN Connected Recirculating Aquaculture System

Summary:

- This project is aimed at **leveraging on Internet of Things (IoT), Information and Communication Technology (ICT), cloud computing and Artificial Intelligence (AI)** to provide for **early warning, regular communications** and timely advises between relevant stakeholders in order to **ensure sufficient fish production for the country and region** via the connected Recirculating Aquaculture System (RAS)

- Method:
    - IoT and sensor network are deployed at all three stages of aquaculture system (i.e. at brood stock, hatchery and grow out managements respectively)
    - The mortality rate will be recorded and analysed.
    - At the cloud, data from sensors are analysed and intelligentlu combined via a machine learning module – and early warnings will be given in real time to farmers.

- Scientific and societal impact:
    - New technology platform to connect all stakeholders in an efficient manner.
    - Real time early warnings and meaningful advises to aquaculture farmers.
    - Food security for ASEAN populations.
    - Higher income generation for the aquaculture farmers.
    - Breeding of endangered fish species.
    - Technology and knowledge transfer to the aquaculture societies.