STADIUM GENERAL *for Agribusiness Dept.,*
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Green Infrastructure and Sustainable Resource Management in Southeast Asia

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4 Types & Main Issues of Ecosystem Services in SE Asia

4 Types of Ecosystem Services (ES)	Ecological risks due to reduced level of ES	Responsible human activities	Countries in Asia where ecological risks are highly likely
Supporting •Nutrient cycling •Soil Formation •Primary Production	Poor soil quality Destruction of genetic resources such as fish & frog in paddy field	Use of chemical fertilizers and insecticides Introduction of aquaculture	Bangladesh, India, Indonesia, Nepal
Provisioning •Food •Fresh Water •Wood and Fiber •Fuel	Food insecurity Water pollution Soil erosion	Conversion of agricultural land for human settlements Deforestation	Bangladesh, India, Nepal, Indonesia, Philippines, Sri Lanka
Regulating •Climate Regulation •Flood Regulation •Disease Regulation •Water Purification	GHGs emission Water pollution Flood Public health	Extension of oil palm and sugar cane plantation	Indonesia, Malaysia, Philippines
Cultural •Aesthetic •Spiritual •Educational •Recreational	Aesthetic Recreational Communication among people	Use of chemical fertilizers Use of chemical insecticides	Bangladesh, India Indonesia,

Expanding Ecological Risks in Asian Agriculture

Factors for Expanding Ecological Risks:

1) Deforestation ;

2) Expansion of Agricultural Land (Conversion);

3) Intensification & Heavy Chemical Use

- **①Soil Erosion/Soil Degradation**
- **②Water Pollution**
- **③Salinity Problem**
- **④Desertification / forest fire, etc**

→ **Natural Disaster Increased;**

More Frequent Flooding／Higher Health Risk(?) → Biodiversity Losses;

Need to Examine Environmental Impacts on Food & Health Security

—More Frequent Flooding & other Natural Disasters (caused by Climate change);

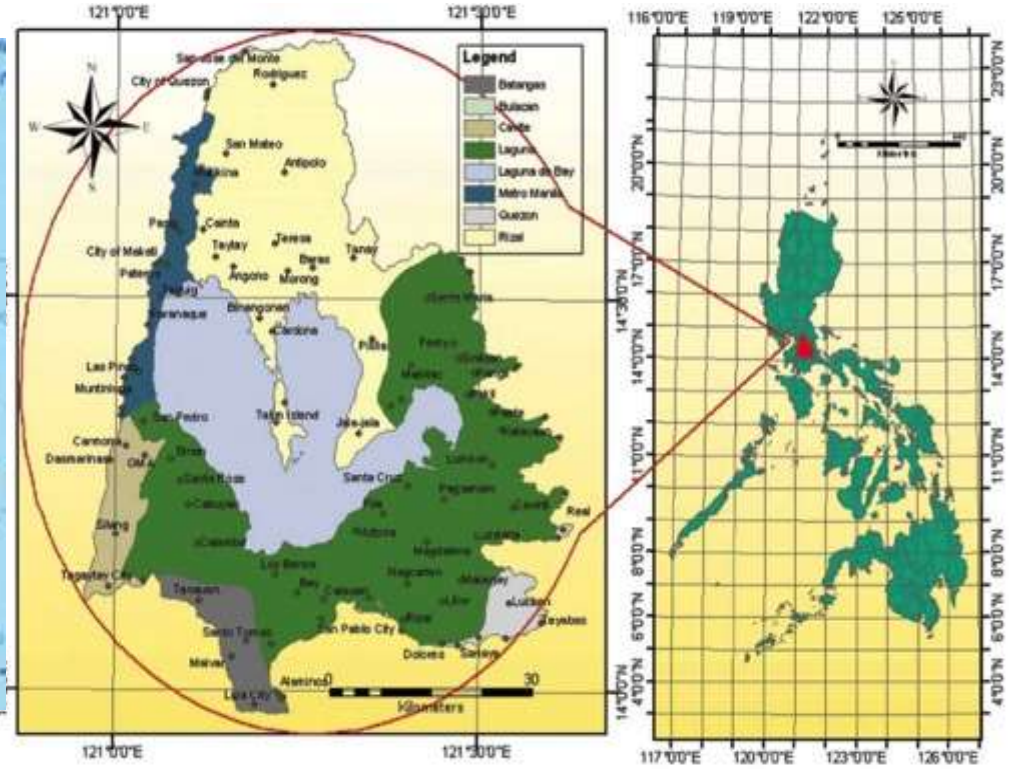
—Pollution & Resource Degradation Environmental Issues vs. Economic Development ;

⇒ Endangering Food and Health Security;

⇒ Higher Risks and Vulnerability;

⇒ Huge Social Cost in the Long Run

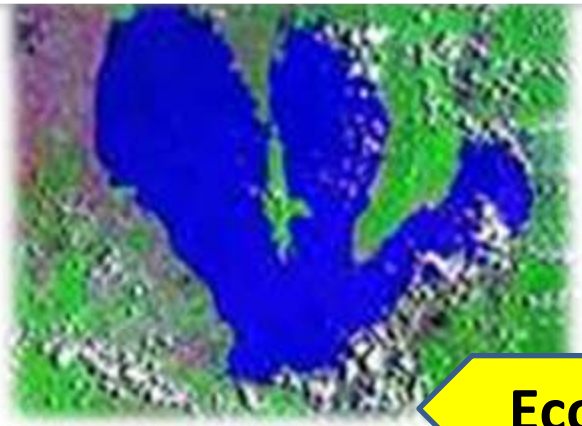
Research Sites



Philippines, Indonesia & Malaysia (left) have been chozen; Location of the Laguna Lake watershed (right)

Watershed-based Analysis on Food and Health Risks

Ecological Changes in Upstream Area



Ecological Degradation

Impacts to Downstream

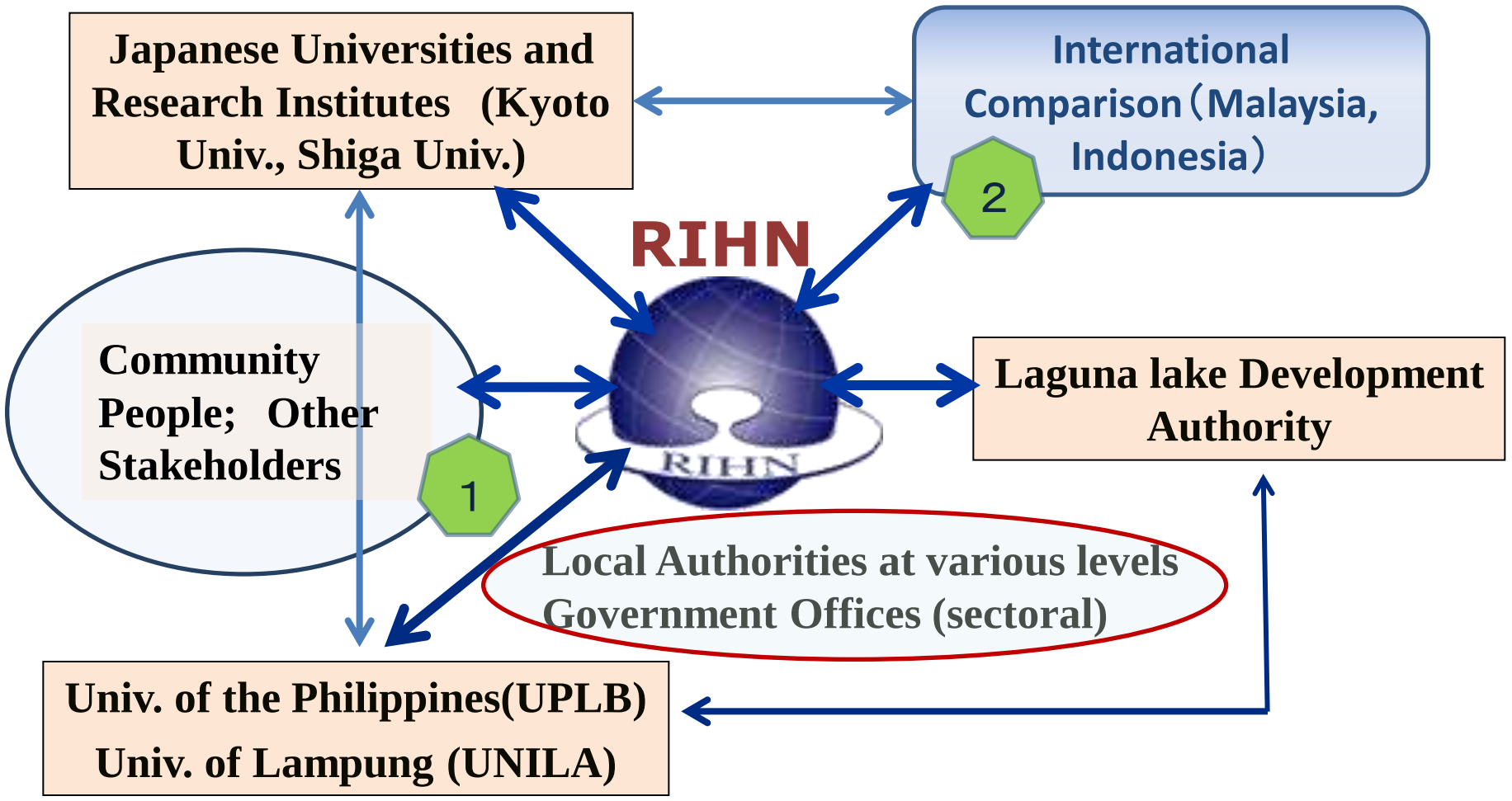
Climate Change

Food Insecurity

Health Insecurity

Poverty, Institutions

International Research Collaboration



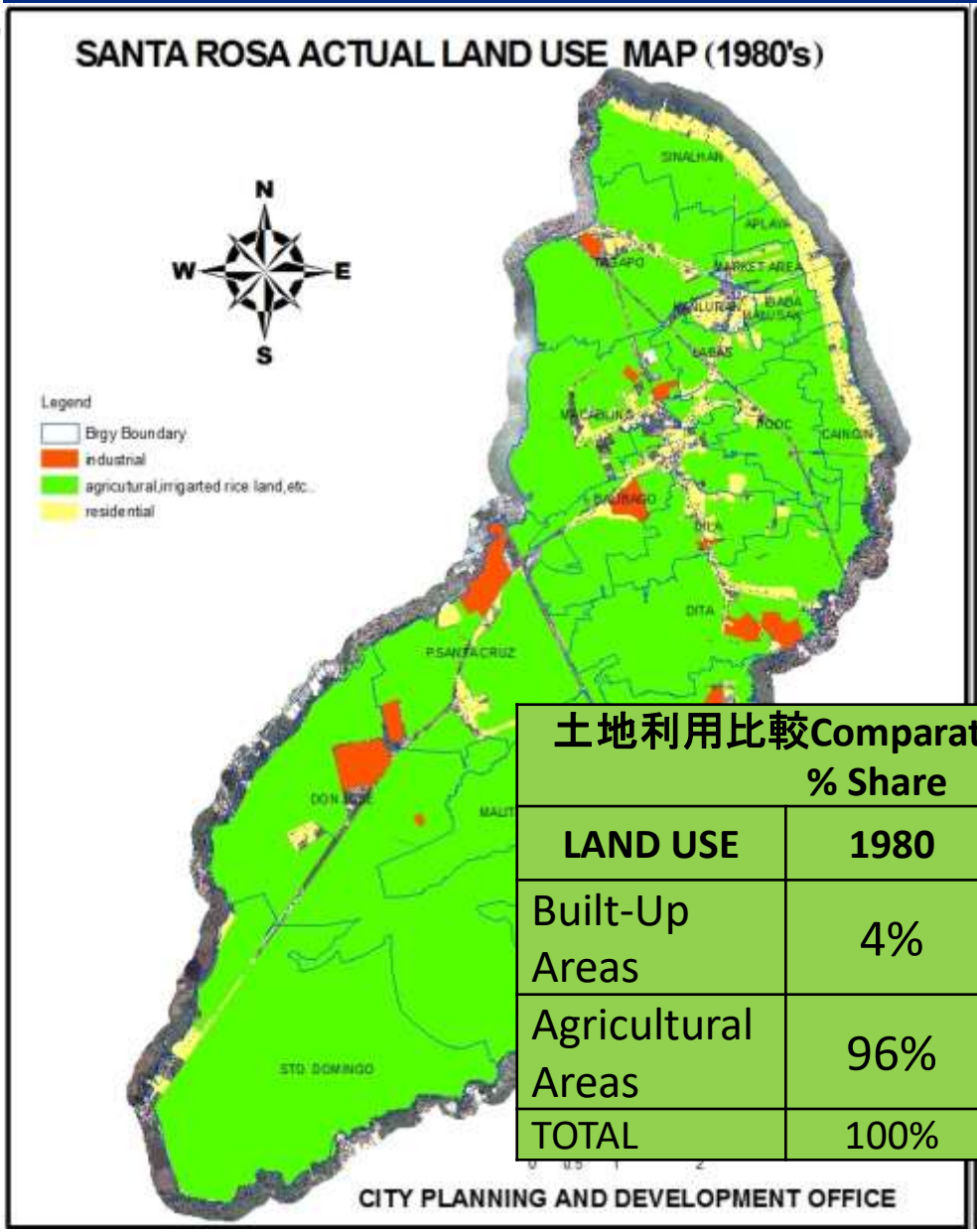
From Upstream to Downstream: Watershed-based Analysis

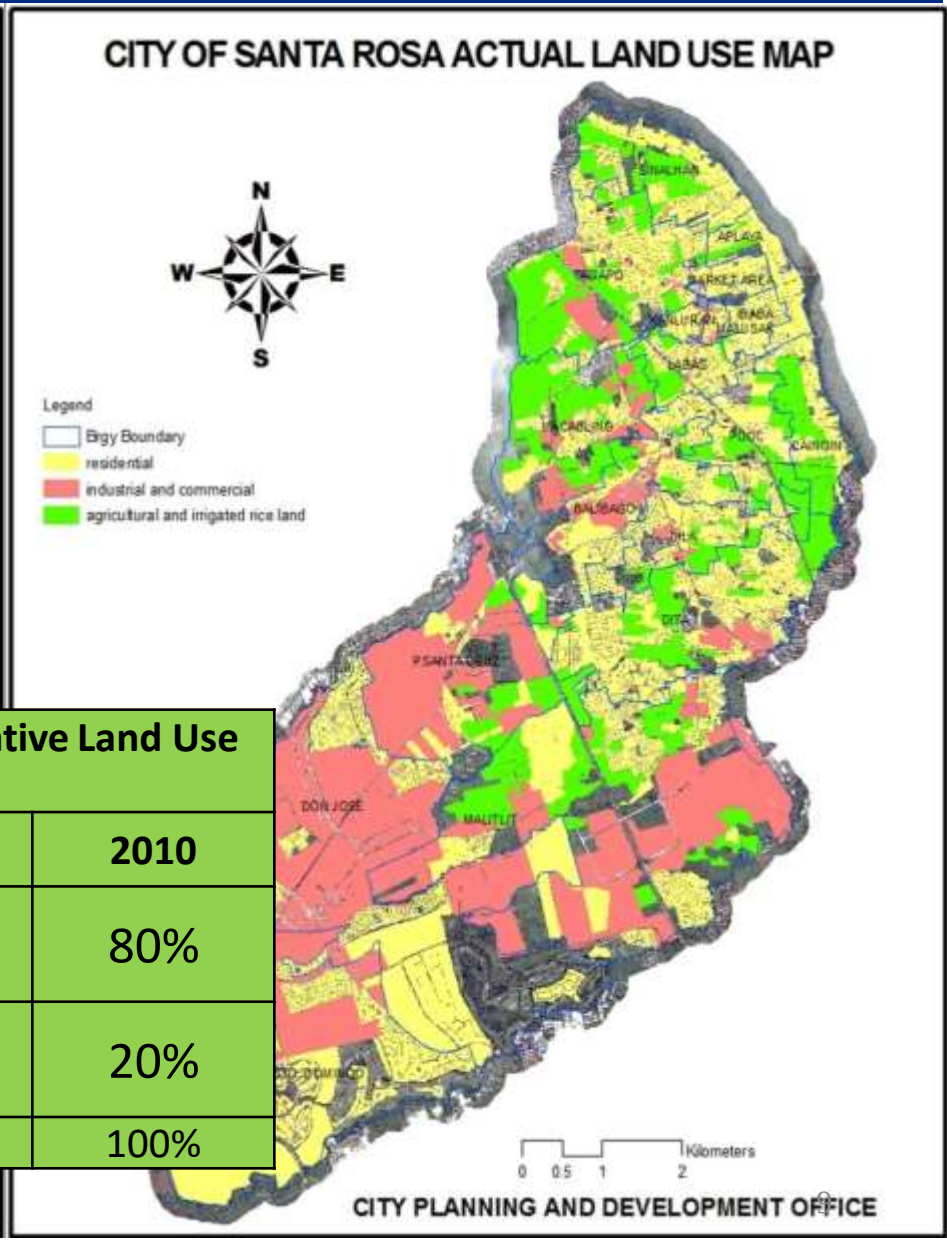
Upstream: Soil erosion easily occurs due to land use changes

Midstream: Less Water than before; more flooding

Downstream : Urban sprawl and housing development; river turned to be a drainage.

Land Use Changes : 1980 → 2010





土地利用比較Comparative Land Use % Share		
LAND USE	**1980**	**2010**
Built-Up Areas	4%	80%
Agricultural Areas	96%	20%
TOTAL	100%	100%

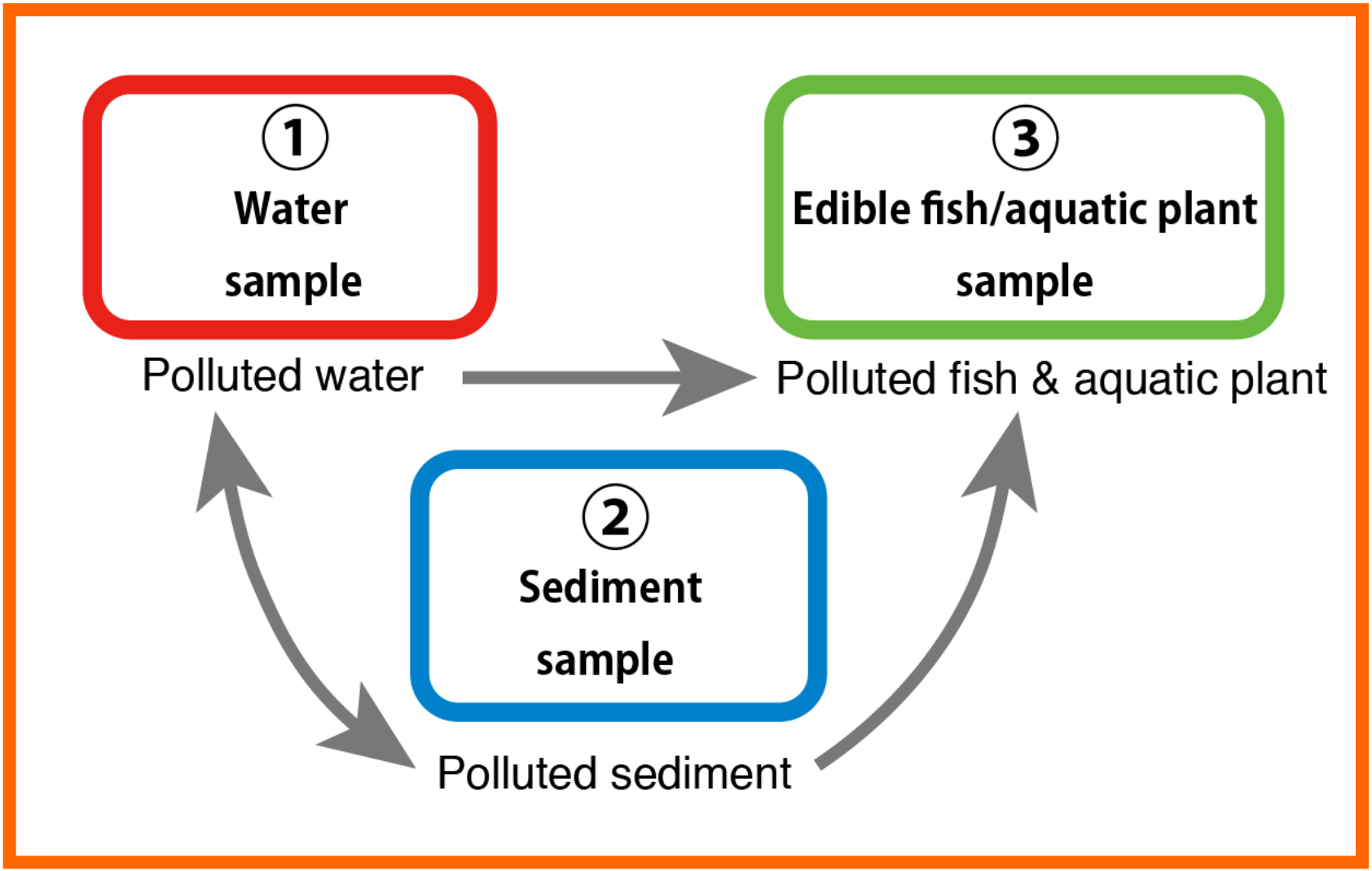
Locally produced fish and plants are mostly consumed by local people

Hito

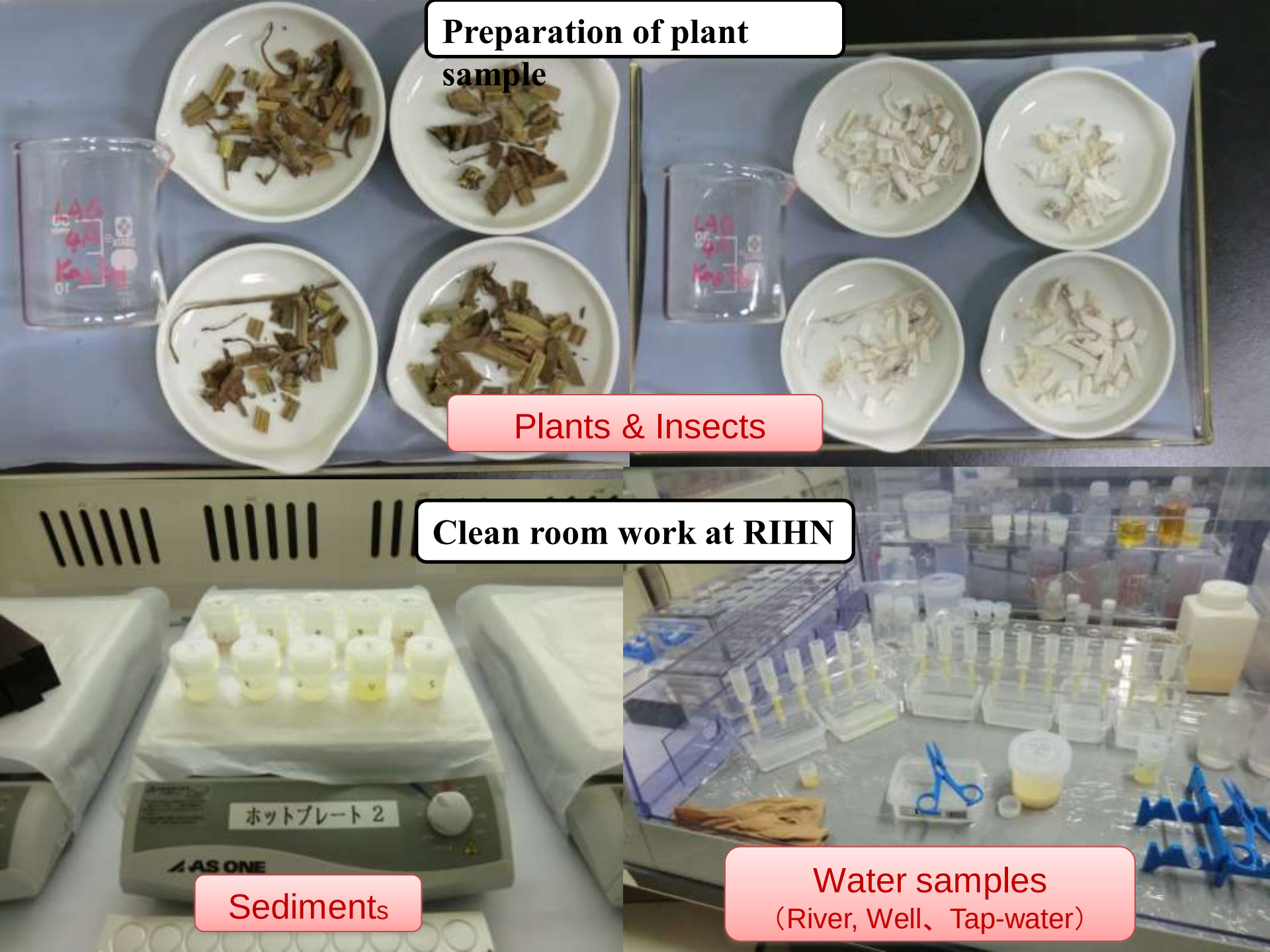
Tilapia

Kang kong

Unique Sampling (3 in one) in this Research



Lake water sampling (March and May, 2011)


Preparation of plant sample
Plants & Insects
Clean room work at RIHN
ホットプレート 2
AS ONE
Sediments
Water samples
（River, Well、Tap-water）

Water quality analysis at RIHN


Dionex ICS-3000

Ion Chromatography System (Dionex ICS-3000)

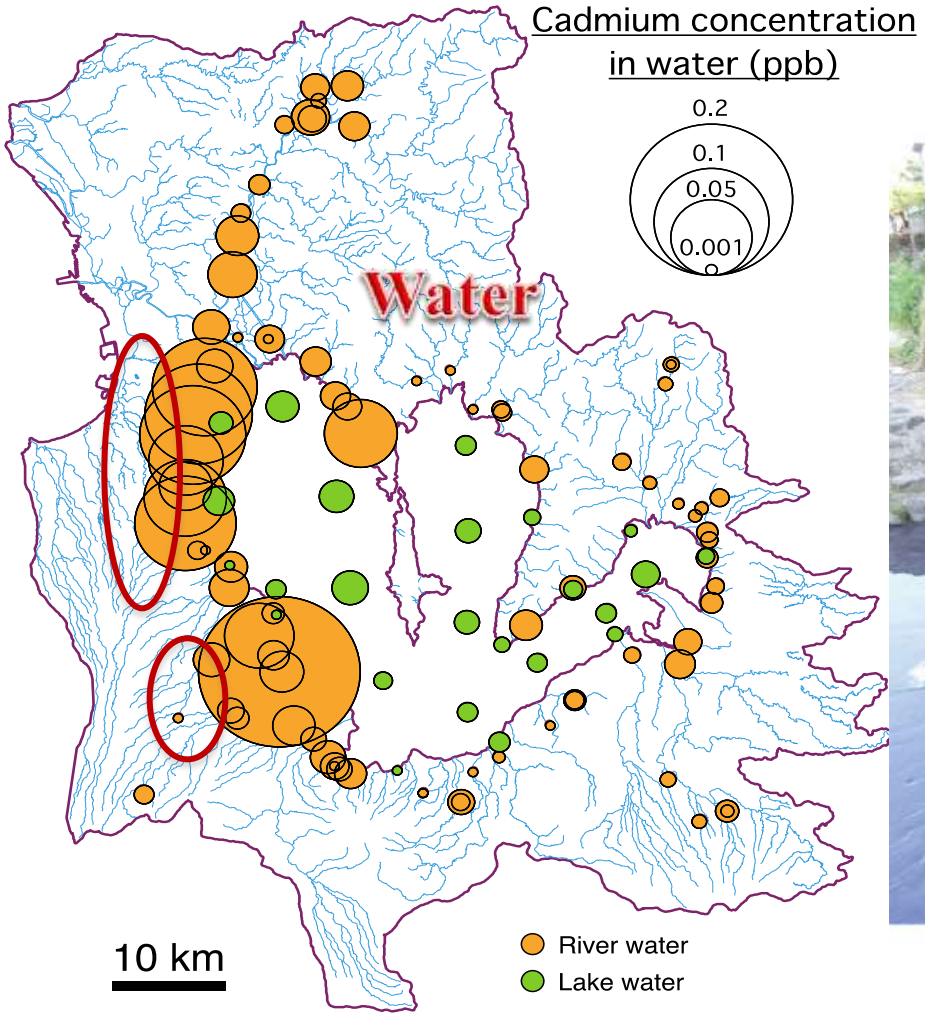
Major component analysis
(Cl^-, NO_3^-, SO_4^{2-}, Ca^{2+}, Mg^{2+}, Na^+, K^+)

Inductively Coupled Plasma Mass Spectrometer (ICP-MS) (Agilent Technologies 7500cx

Trace element analysis
(Cu, Zn Ga, Ge, As, Se, Rb, Sr, Y, Zr, Mo, Ag, Cd, Sn, Sb, Cs, Ba, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, W, Pb, U)

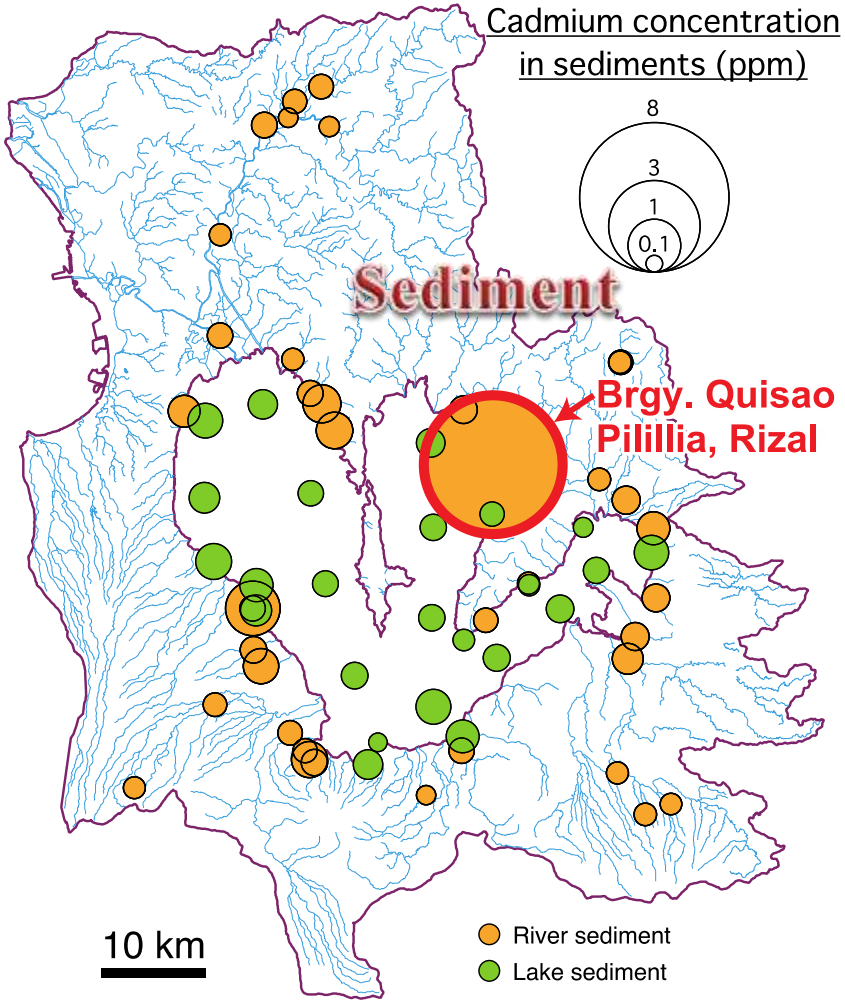

Agilent Technologies 7500cx

Cadmium concentration in water is high in western region (urbanized area).



Sediment samples are collected during March & May in 2011.

‘Hot Spot’ of cadmium in sediment occurs in rural area (Brgy. Quisao Pilillia, Rizal).



Sediment samples are collected during March, May & August in 2011.

Emerging Ecological Risk: *Massive Fishkill*

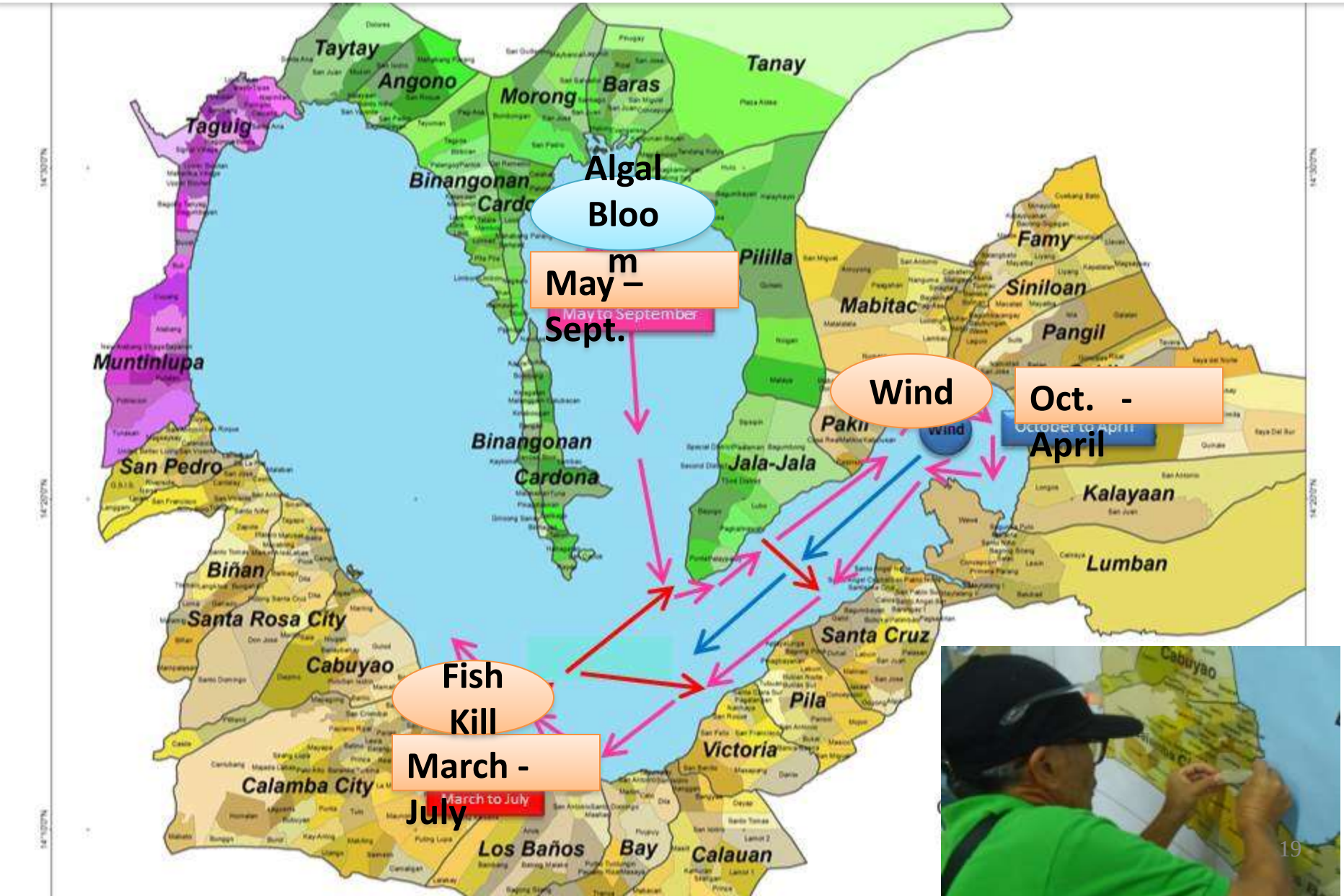
Los Banos, Laguna (May, 28 2012)

Calamba, Laguna (May, 26 2012)

In Laguna Lake aquaculture, a number of Fishkill incidences are occurring, often in massive scale, in recent years.

Workshops and Occasional Meetings with the Community people; Local Knowledge as the Key

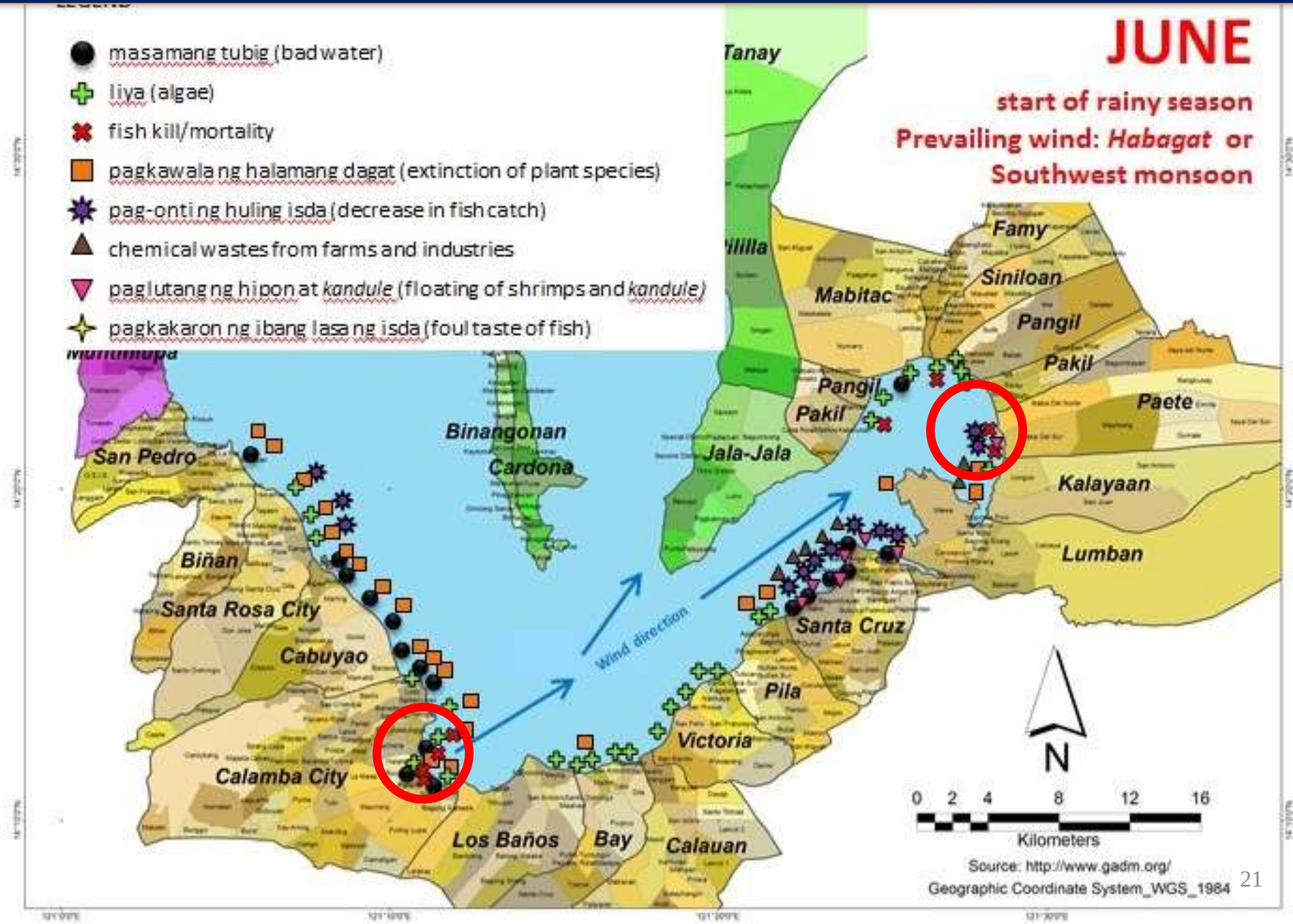
Bio-Signal Mapping by Fisherfolks ~Algal Bloom, Fishkill & Wind~



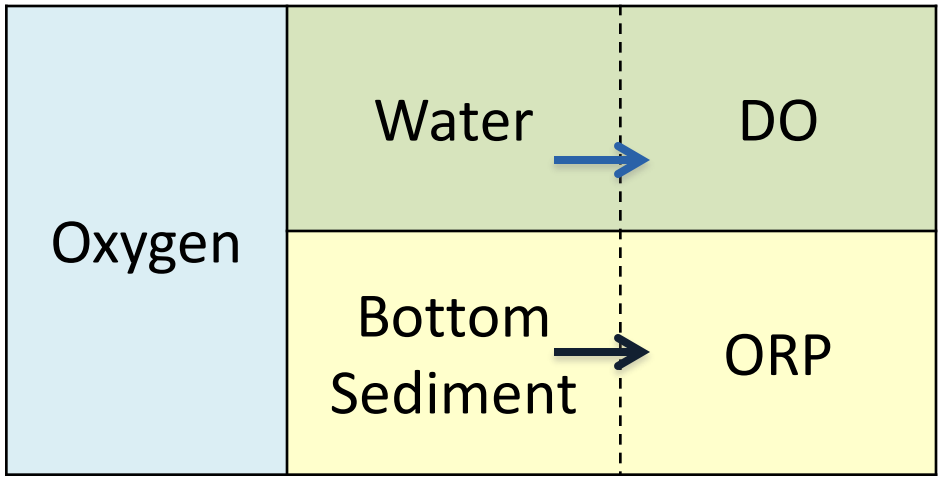
Bio-signals of Ecological Risk and Map Symbols

Bio-signals	Messages being conveyed
• Bad water smell (Blackened polluted waters) 	Water pollution, poor fish catch
• Algal Bloom(Green waters) 	Hot weather, signs of forthcoming fish kill
• Loss of Lake Water Plants 	Poor fish reproduction
• Floating shrimps and Catfish and White Cranes 	Benthic organisms/ sediment feeders affected by toxins
• Scum tastes in fishes 	Dry months fish feeding on decaying algae
• High temperature/massive algae 	Fish Kill
• Presence of chemicals in water 	
• Reduction in Fish Catch 	

Ecological Risk Mapping: Monthly data, by bio-signals



Risk Assessment for Precaution against Mass Death of Aqua-cultured Fish



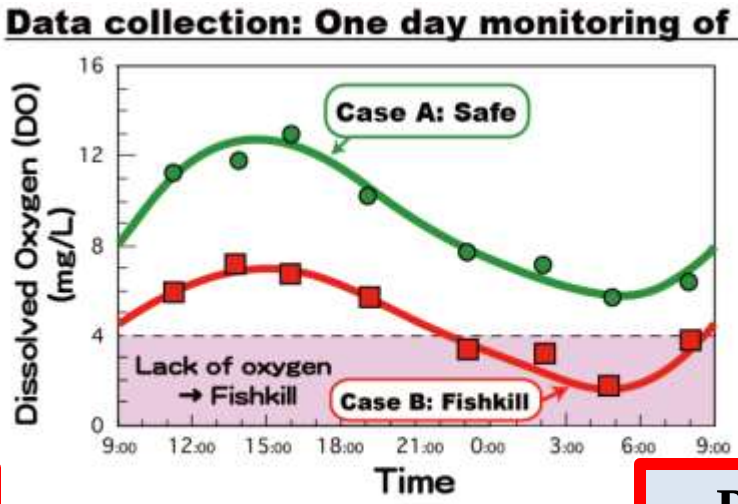
Requirements

- Easy to measure for a short time
- Measurable *in situ* by an instrument
- A lot of data should be obtained temporally and spatially in a short time

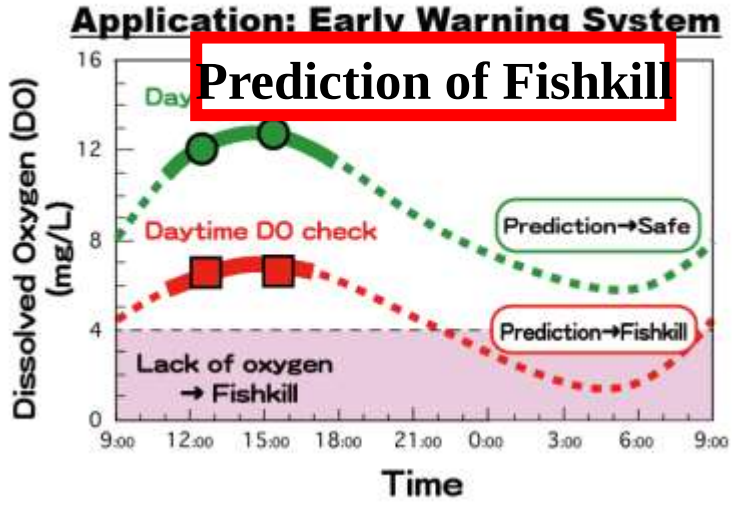
Source: Prof. Zen Kawabata (2012)

Community Participation for Fishkill Protection and Early Warning System

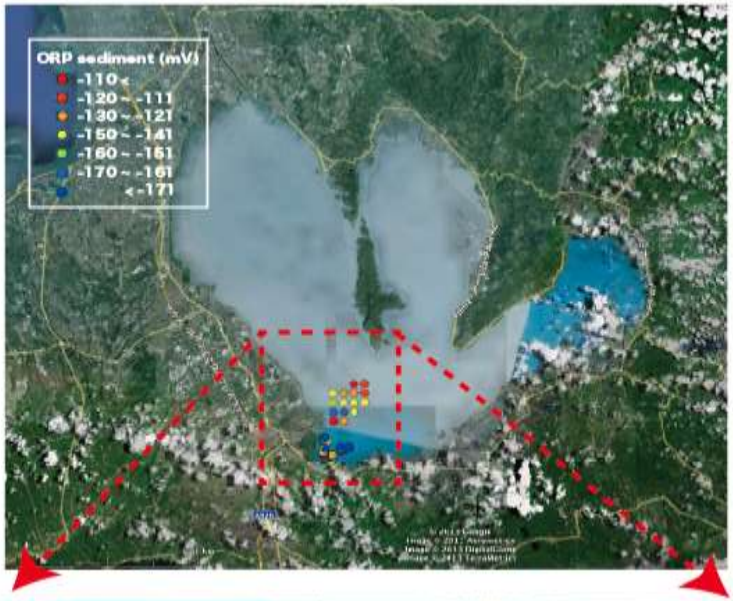
Data collection by fishermen



Preventive Measures



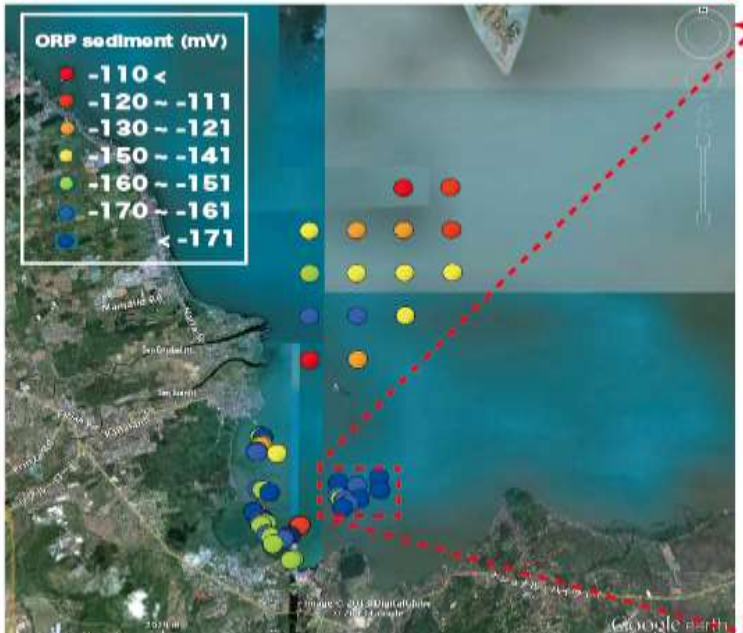
DO Measurement and Sediment Data are Collection by Fishermen → *Fishkill Risk Mapping*

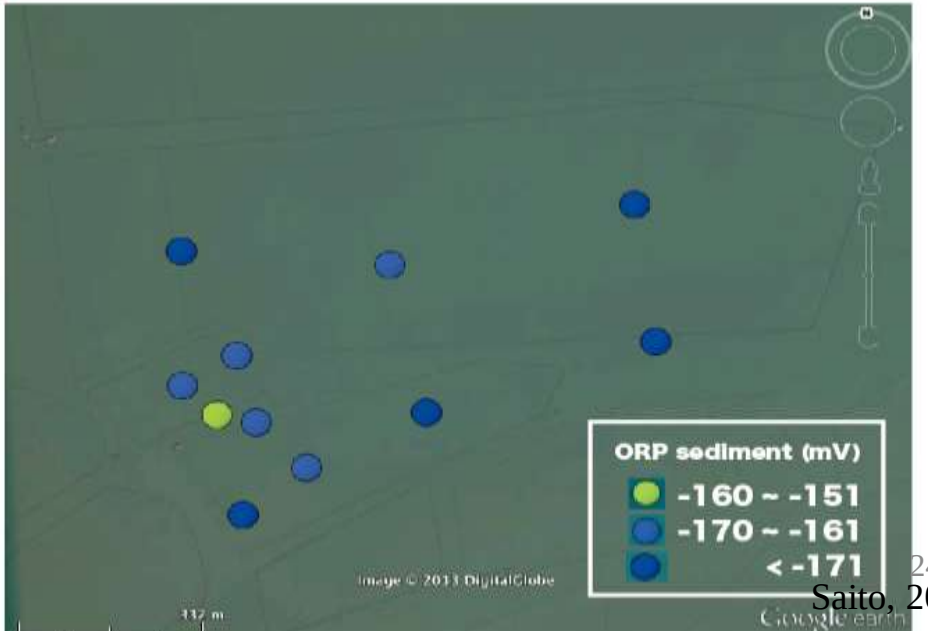


Measuring ORP of bottom sediment

Bottom sediment sampling

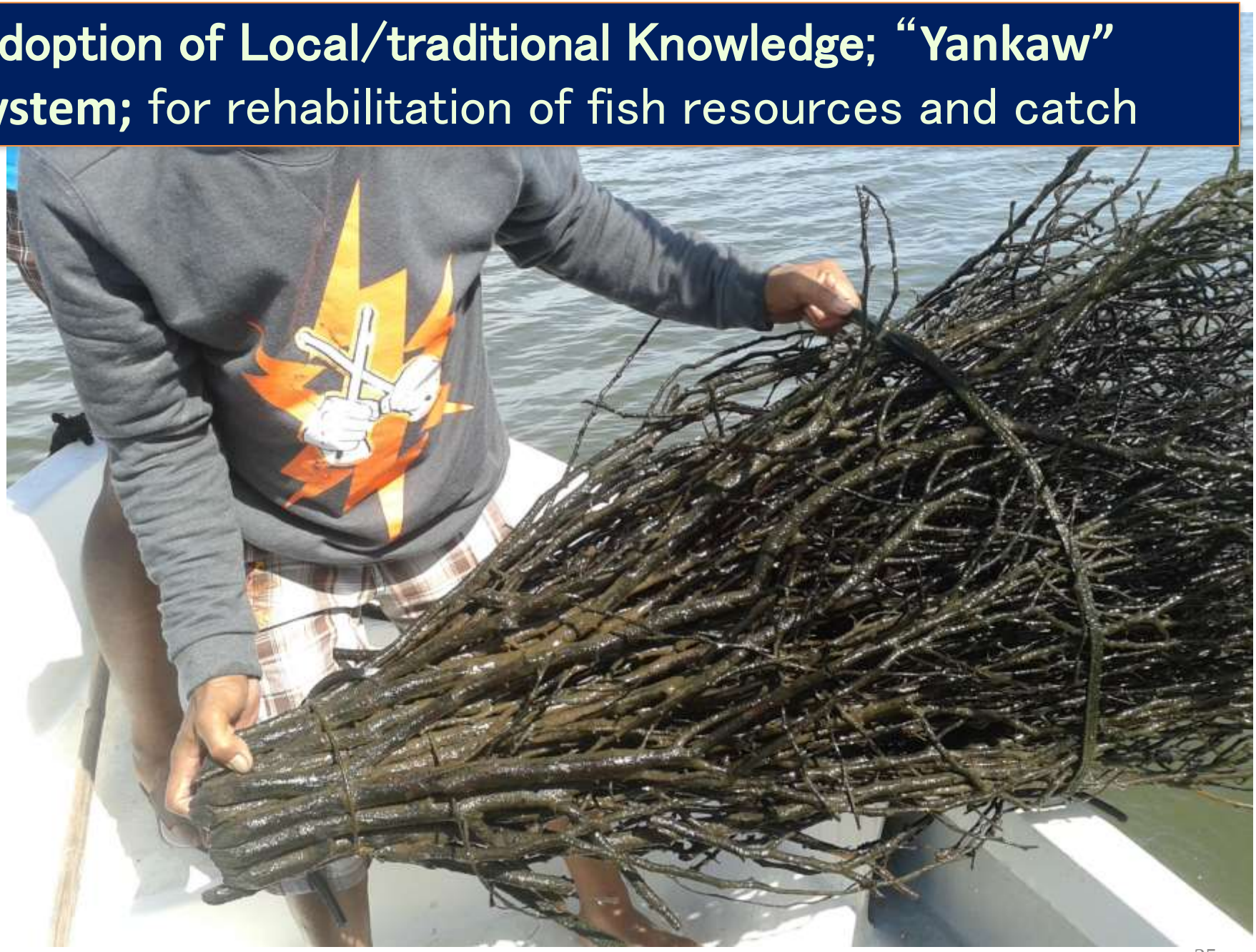
Data recording





Saito, 2013

Adoption of Local/traditional Knowledge; "Yankaw" system; for rehabilitation of fish resources and catch



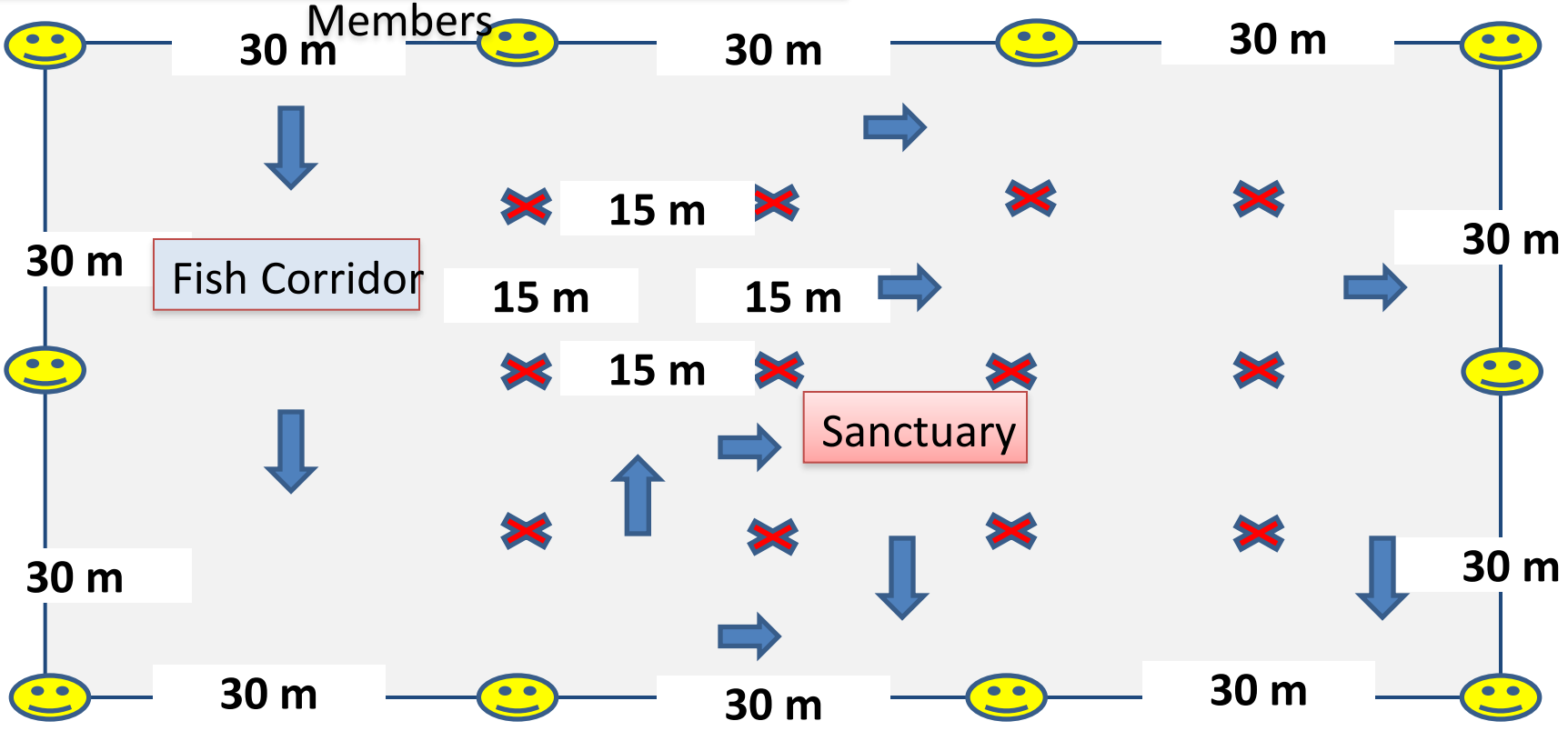
カマチリ枝の伐採･収集･結束 -- Self-Help by Fisheries and Agriculture Management Councils (FARMC) in 10 barangays (villages)

伝統的共助システムの活用（Traditional Bayanihan

--- Helping each Other ; Voluntary Pool of Resources

Designing the Yankaw Fish Sanctuary Zone by Collective Action (Setting a sanctuary Zone and Voluntary Fishing Rules)

Co-management of Fish Resources by Members



LEGEND:

Livelihood , 10 “harvestable” yankaws, sustainability & expansion of Yankaws

Conservation 12 “restricted” yankaws, for fish breeding and multiplication

Fish/Shrimps have returned after 3 to 6 months

Bayanihan **(Gotong Royong), revived !!**

= Self Help, Voluntary Community Assistance

Need to adopt

Alternative Resource Management System

①

PES ***(Payment for Ecosystem Services)***

②

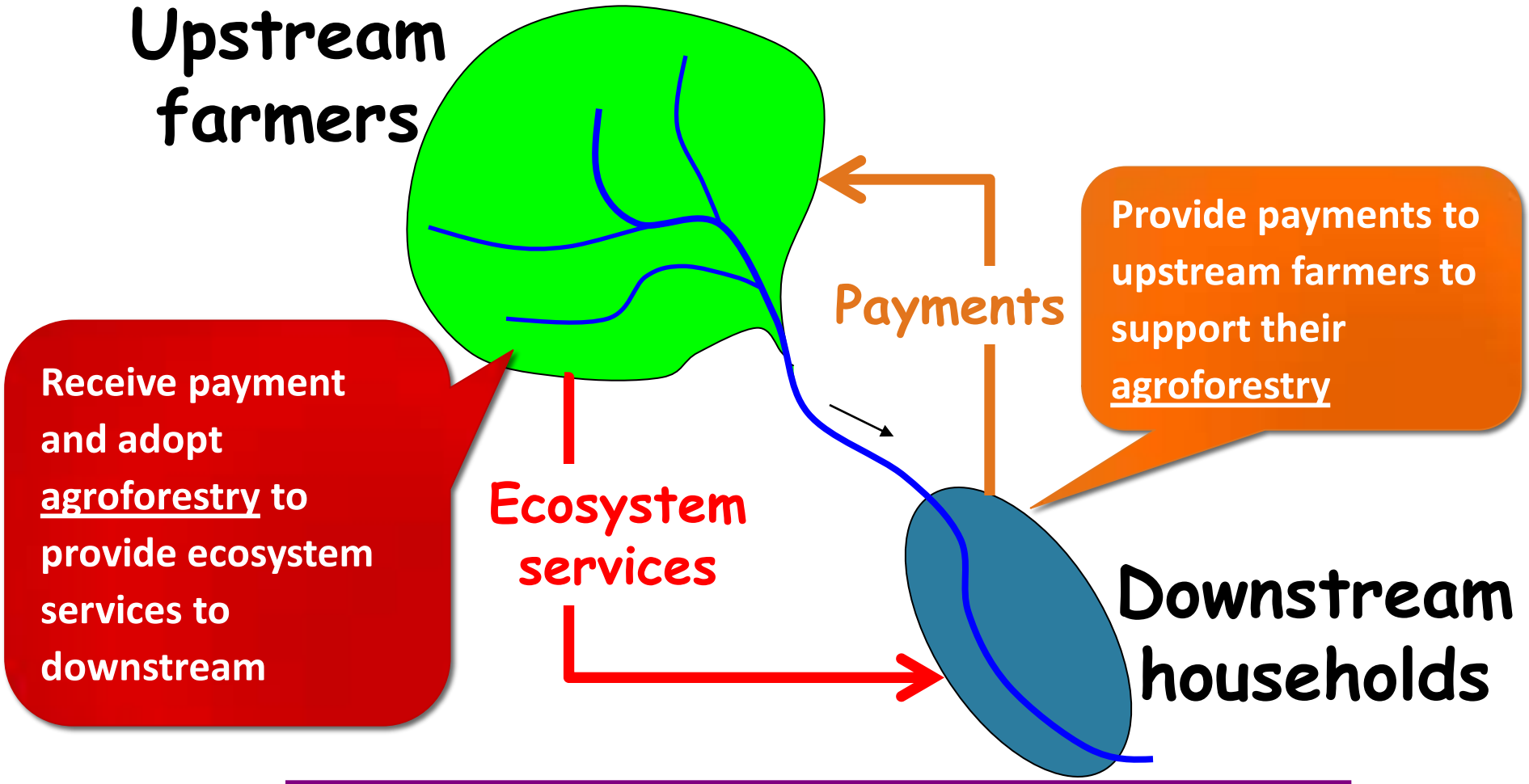
Eco-Certification ***(Agroforestry-based Land use system)***

- **Voluntary and mutually beneficial contracts for sustainable resource use** ***(Gotong Royong);***
- **Community-based, participatory system.**

Eco-certification Research in Lampung, INDONESIA（2014 ～19 ）

Agroforestry-based Eco-certification and PES Study in Lampung, South-Sumatra, Indonesia

PES in the case of agroforestry



Voluntary and mutually beneficial (win-win) transactions for sustainable watershed

Research Questions:

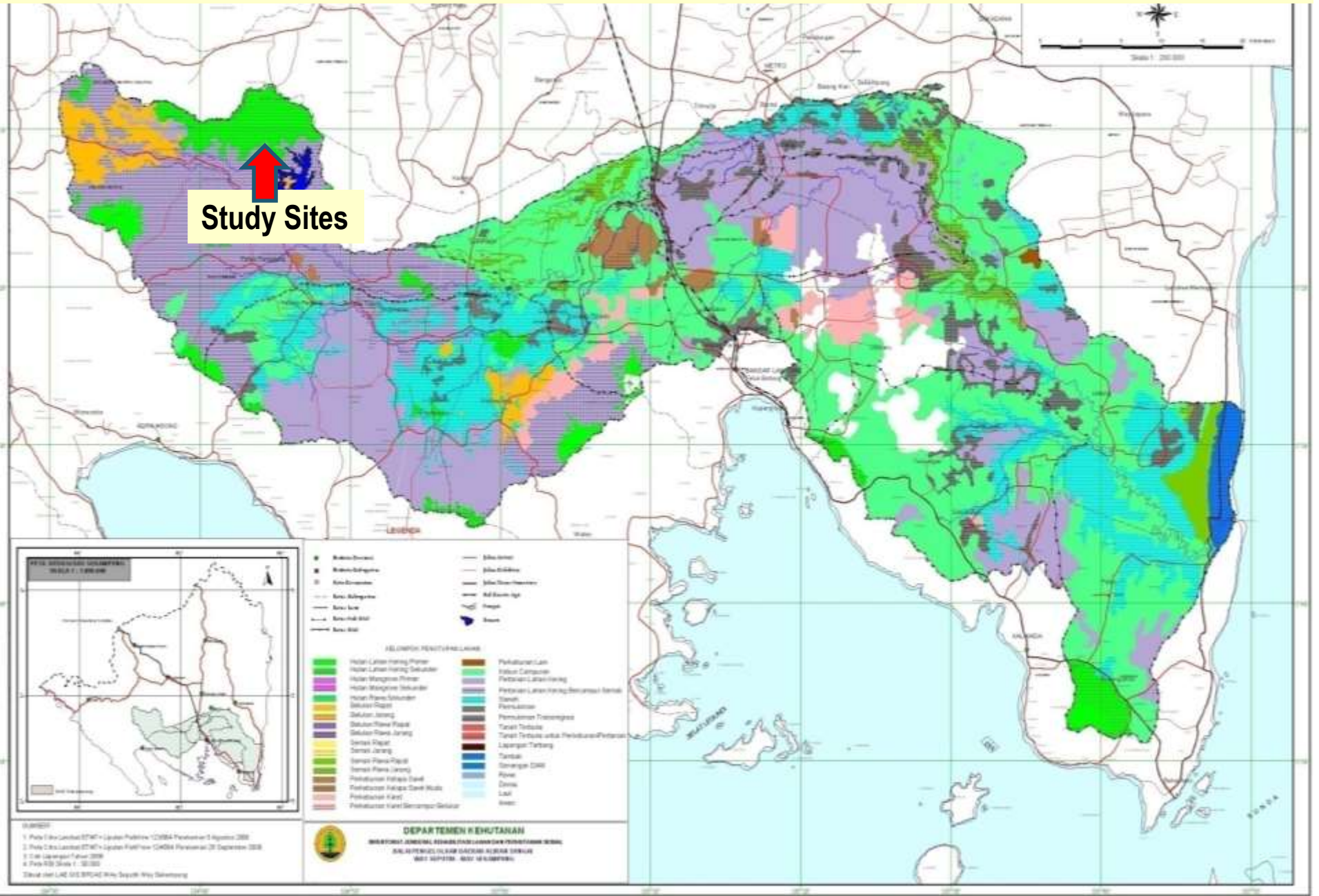
- **Does eco-certifications (or PES) support farmers' livelihood?**
  - Measured in terms of per-hectare incomes
- **Does eco-certifications reduce negative environmental impacts?**
  - Measured in terms of per-hectare fertilizer applications

Why is eco-certification effective?

- Coffee farmers can voluntarily choose to comply with eco-friendly practices defined by the certification service;
- Most certifications are originally from US and European countries;
- Becoming popular in Indonesia because of its significance in coffee production;

Economic Incentives, provided

Map of Land Use at Sekampung Watershed



Why focus on agroforestry?

- **Forest protection and food production could be compatible – How?**
- **Agroforestry = Agriculture + Forestry**
  - Planting crops and trees in the same land – enhance forest while maintaining agricultural production

Multistrata coffee with shade trees

Coffee-Agroforestry System in Upper Sekampung Watersheds, Lampung, Indonesia

- About 60% forest land at upstream Sekampung watersheds converted to farm land and settlements;
- Upstream watershed is threatened by land degradation and deforestation: Land Degradation → erosion → river sedimentation → Hydrological destruction
- Coffee production faced disruption by global climate change → rainfall changing→ Ecological risks (flood and drought)
- A trade-off occurs between coffee production and ecosystem services in the catchment area.

Environmental Impacts of Coffee Eco-certification

Comprison	Mean difference	t-value
Control - RA	0.645 ***	4.667
Control - 4C	-0.348	-1.661
RA - 4C	-0.992 ***	-6.295

- Coffee farmers joining Rainforest Alliance (RFA) certification have significantly **higher environmental benefits** (less fertilizer) than their control groups (those not joining certification)
- Coffee farmers joining 4C certification have **no difference** in environmental benefits with their control groups (those not joining certification)
- RFA certification has significantly **higher** environmental benefits than 4C

Economic Impacts of Coffee Eco-Certifications

Comprison	Mean difference		t-value
Control - RA	-6,318,305	***	-6.747
Control - 4C	1,514,419		1.904
RA - 4C	7,832,723	***	8.715

- Coffee farmers joining Rainforest Alliance (**RFA**) certification have significantly **higher economic benefits** (higher income) than their control groups (those not joining certification)
- Coffee farmers joining 4C certification have **no difference** in economic benefits with their control groups (not joining certification)
- RFA certification has significantly **higher** economic benefits than 4C

Multifunctional Roles Played by *Green Infrastructure*

- *Green Infrastructure (GI)* can provide Sustainable Ecosystem Services to local people and regional economy.
- *GI* can provide invaluable functions to protect and/or reduce natural disaster risks (of flooding, tsunami, soil erosion or even drought).
- *GI* can provide good nutrient cycles, biodiversity with healthy ecological balance; providing sustainable fishery, aquaculture, forestry and agricultural resources (and biomass energy outputs).
- *GI*, in contrast to "gray infrastructure," can provide beautiful landscape and scenery, which will be the basis for eco-tourism; platform of communication network among local people and communities.

Main Objective of Collaborative Research on GI

Next research project on GI (JSPS 2020-22) will be conducted in Sekampung Watershed, by the participation of the local people and communities; intends to examine the following 3 points:

(1) Major roles and significance of Green Infrastructure, especially with respect to disaster risk (reduction) management;

(2) Whether environmental conservation and productivity enhancement (sustainable rural development) be compatible?;

(3)How community-oriented and watershed-based approaches (Trans-disciplinary Approach) are effective in this case?.

Overall Summary and Policy Implications

- ***Environmental conservation and productivity enhancement are compatible and more sustainable;***
- ***Community-oriented and watershed-based approaches are viable and effective, with the following conditions:***

⇒ **① strong political will; involvement of local government & university (science) plus local people/institutions;**

② awareness & use of local resources ;

③ adoption of new technology and institutions, while adopting economic incentives;