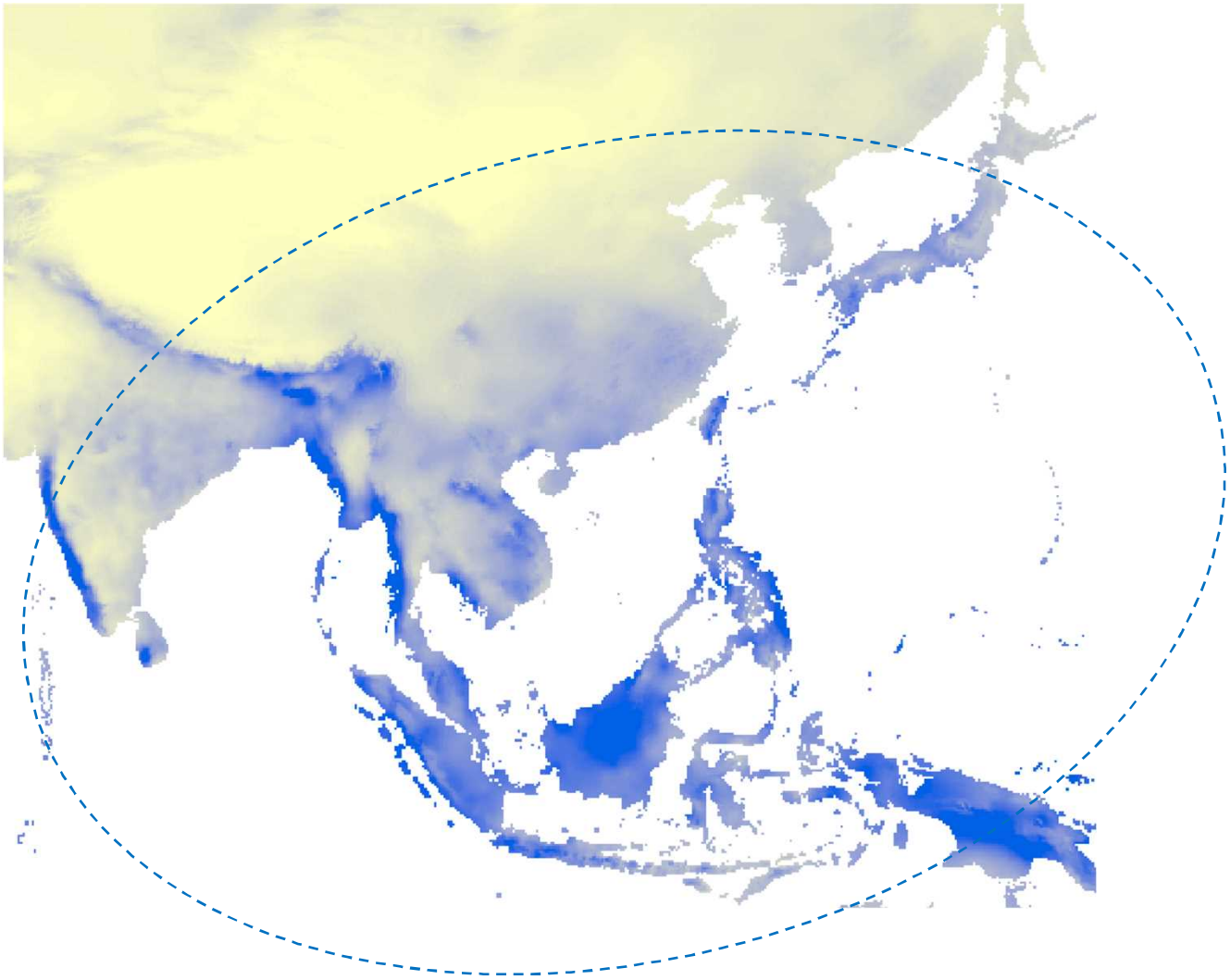
Comparing three representative lakes in Monsoon Asia

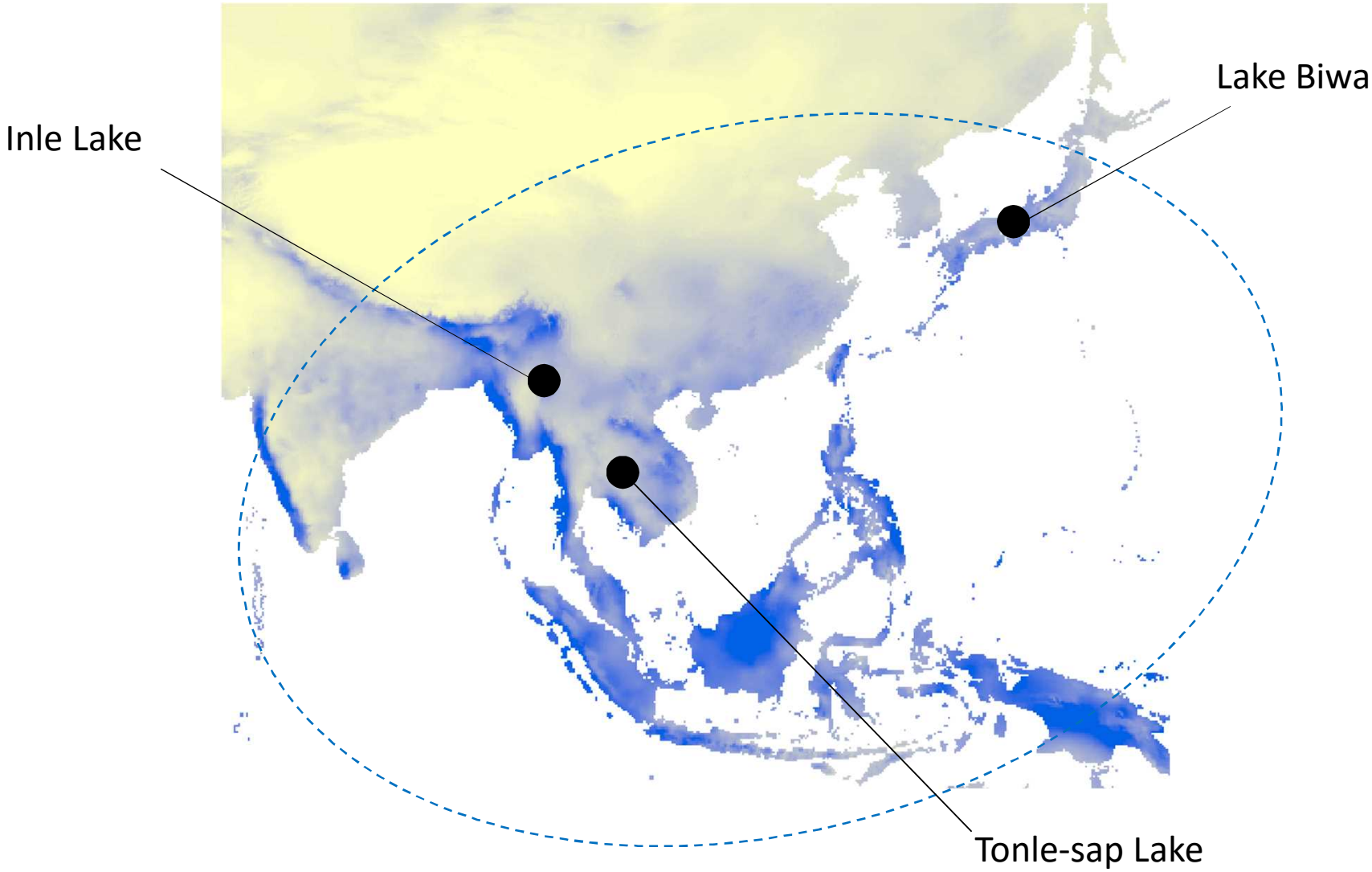
AP-BON Freshwater group

Monsoon Asia…….one of the highest rainfall in the world

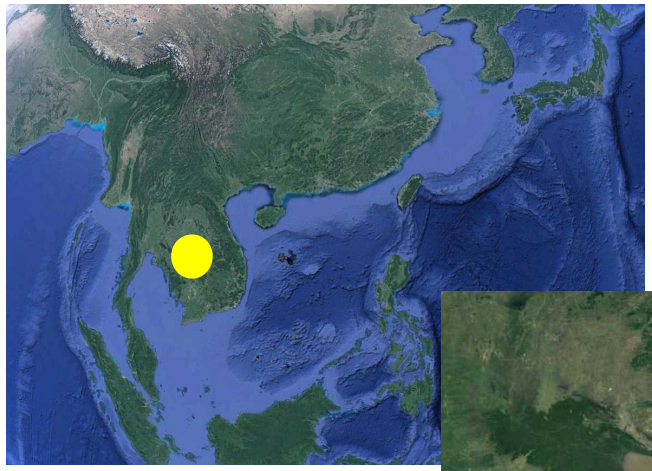
…….rich freshwater biodiversity



Not only rivers, but also natural lakes which have outstanding freshwater biodiversity……



Tonle-sap Lake and Mekong (by Dr. Bunthang Touch and Dr. Thach Phanara)

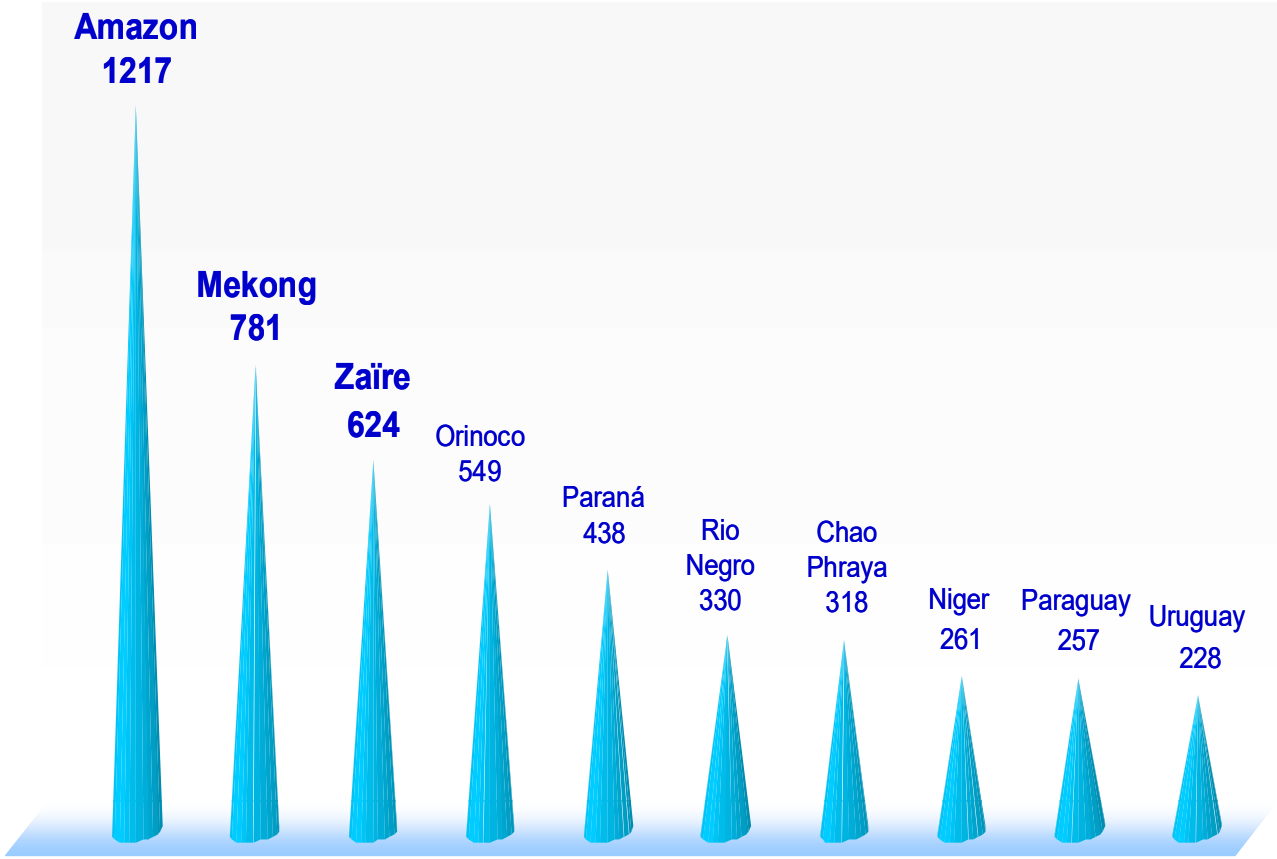


Features of Tonle-sap Lake

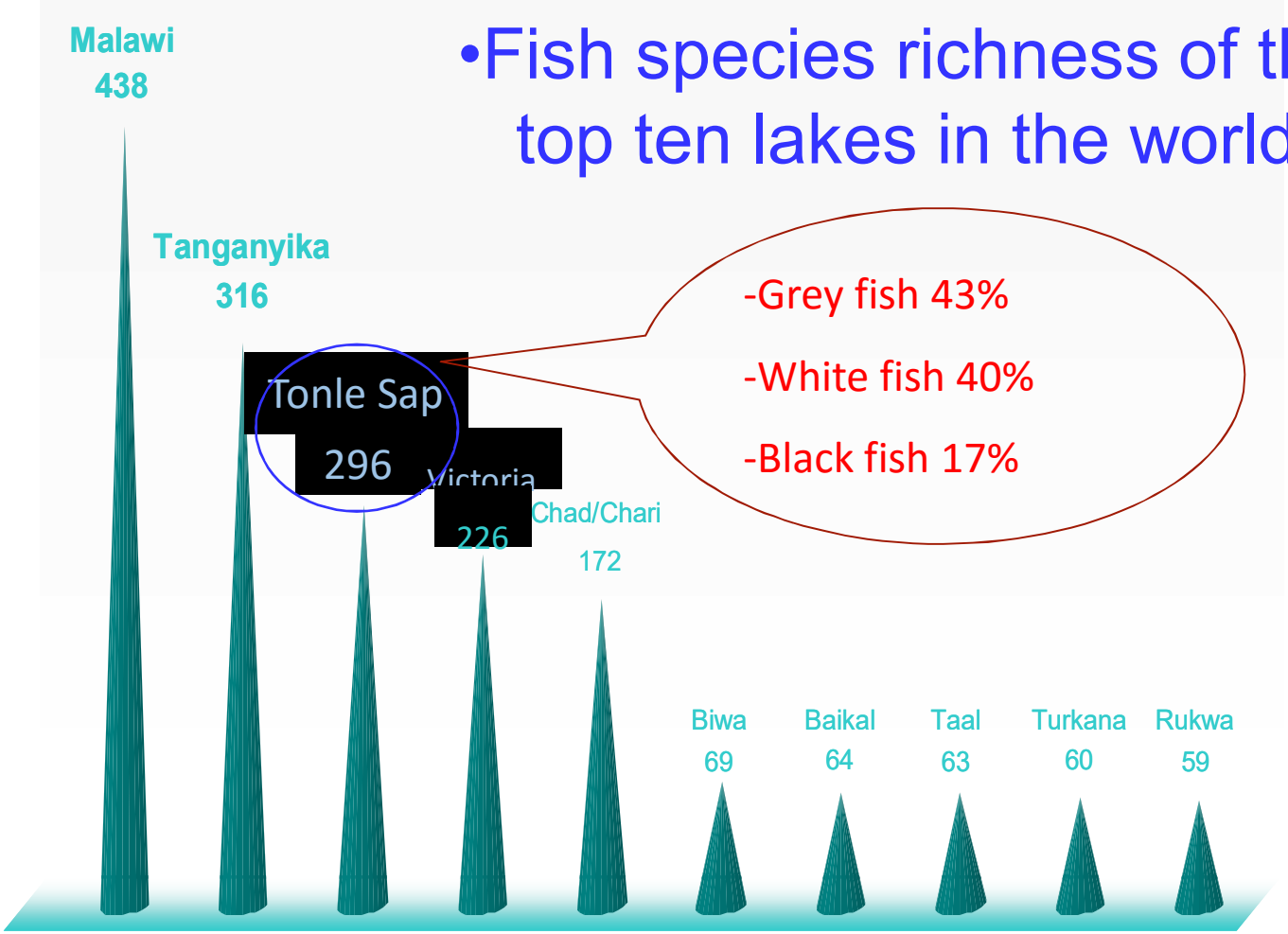
- One of the most famous sightseeing areas in Cambodia
- Largest flood-palin in SE Asia (dry season 2500 -> rainy seaon 16000 km2 [x4 larger])
- Rice paddy around
- High alpha diversity (300 fish species)
- Likely impacted by future hydropower dam development of Mekong Basin

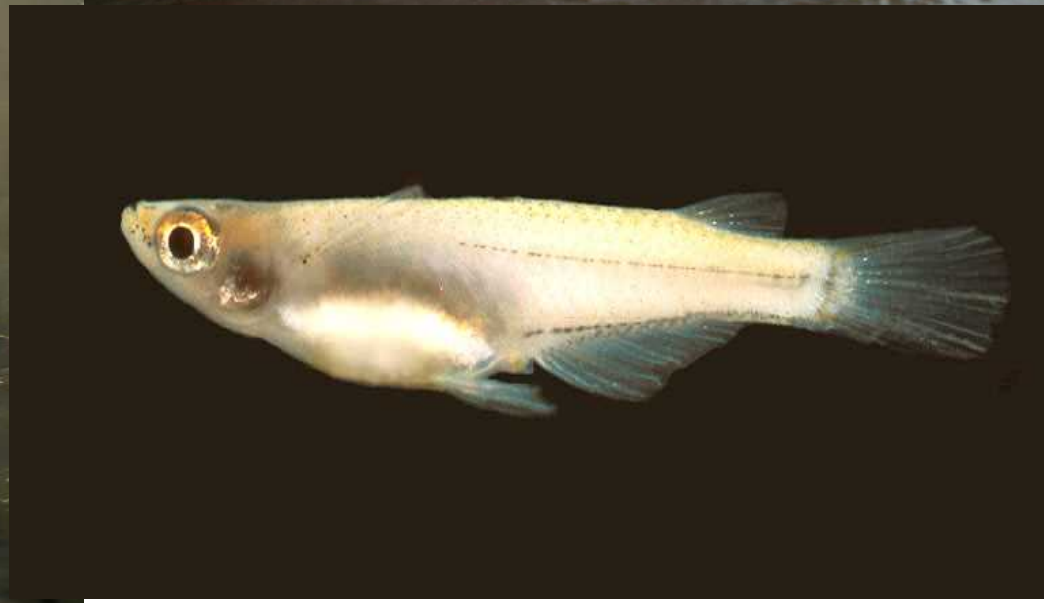
- The Mekong River has the highest fish biodiversity in the world after the Amazon River.
- 850 freshwater fish species recorded from the Mekong River Basin
- With a total estimate of about 1,100 fish species if the possible coastal or marine visitors are included.

> 60% (448 species) in Cambodian inland waters; ranked 18th



The fish species diversity of the Tonle Sap lake in Cambodia is ranked third (i.e. 296 species) in the world after the East-African lakes Malawi and Tanganyika. It the largest lake in the SE Asia and the most productive lake in the world.





Social Access

…….via political, communal, familial "non-market" mechanisms

- Subsistence fisheries
- Cambodia: 70% of rural households depend on fisheries
- Mostly small-scale and partly large scale nature
- Women and children play important role (ensuring food and nutrition security and livelihood)
- Community fisheries
- Large participation throughout value chains

Economic Access

…….via market mechanisms, purchasing power

- **Over 6 million Cambodians = part-time fishing and related fishing activities = 45.5% of the total population**

- More than 1.5 million full-time fishers

- **87%** = small-scale fishers
- **9%** = medium-scale fishers
- **4%** = large-scale fishers

- **High employment factor throughout value chains**
- High income generating factor throughout value chains
- **<u>Affordable</u>**, especially for poor people

Economic Value of Cambodia fisheries

- An estimated Value of fisheries US$ 1.2 – 1.6 billion

- Value of inland fisheries = US$ 0.8 – 1.0 billion

- This estimated value accounts for about 8.0-12% of Cambodia's GDP.

- The fisheries accounted for 25% of the Agriculture GDP, ahead of animal production (15.5%), forestry (6.9%) and nearly half of rice and crop production (52.6%).

- Export: approx. 50,000 tons to many Asian countries and Australia and USA = US$250 million/year

Food Security Value

- Fish consumption estimated based on:
  - Official statistical data (Average): 52.4 kg/person/year
  - Household survey (Average): 60 - 66 kg/person/year
  - Household (Tonle Sap and plain region): 67 – 80 kg/person/year

- This rate is in the mid-upper level of world ranges of 15 – 90 kg/person/year.

- **Fish provide 81.5% of total animal protein intake for the population.**

Characteristics of main fish groups

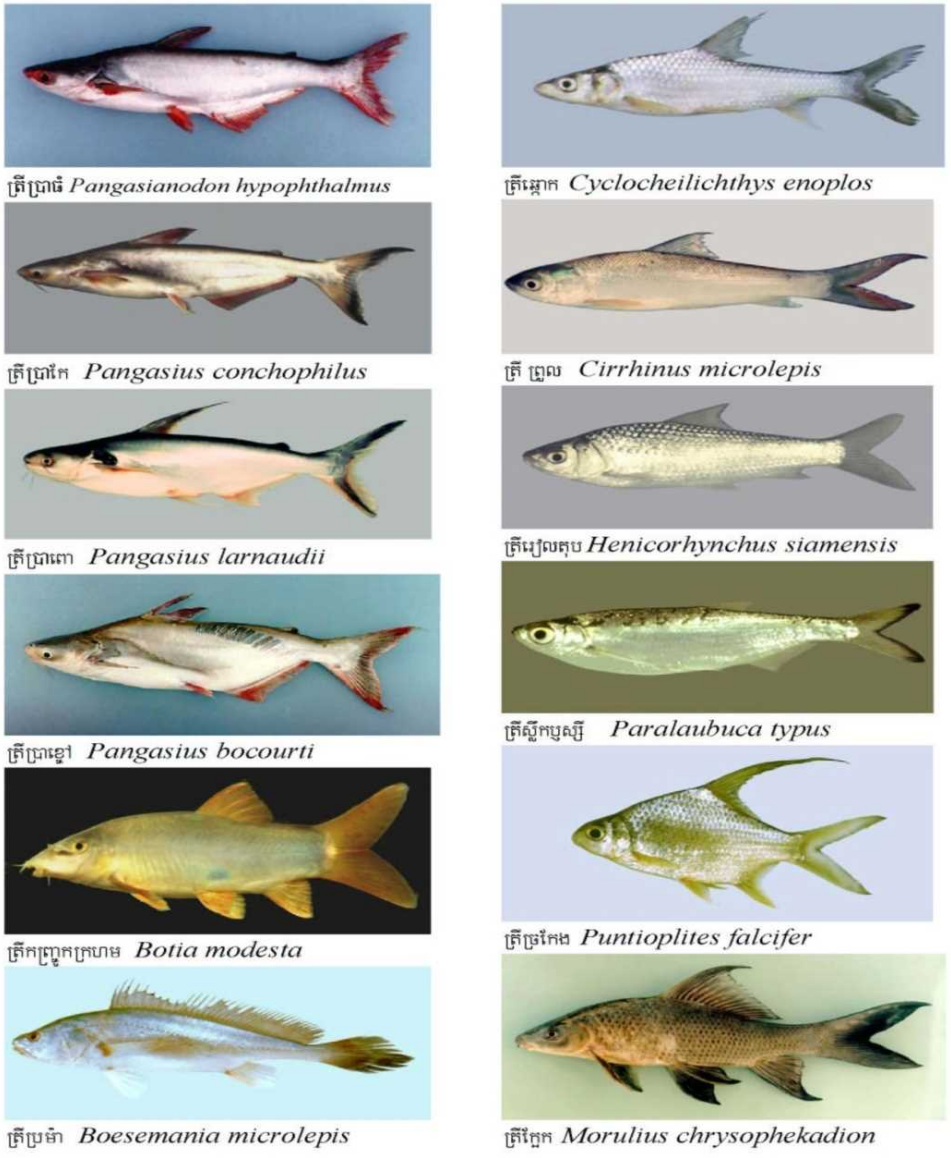
White fishes

- Long distance migrators - undertaking migrations between upper and lower Mekong mainstream and its major tributaries.

- Short distance migrators – undertaking migrations between lower floodplains and Mekong mainstream and its major tributaries

37% of species richness

36% of capture



Source: MRC

Characteristics of main fish groups

Black fish- Floodplain resident fish, with limited lateral migrations from the river onto floodplains and no longitudinal migrations upstream and downstream.

13% of species richness

50% of capture


ត្រីអណ្តែងវែង *Clarias batrachus*


ត្រីអណ្តែងទន់ *Clarias macrocephalus*


ត្រីរស់ *Channa striata*


ត្រីឆ្ពា *Channa micropeltes*


ត្រីក្រាញ់ *Anabas testudineus*


ត្រីកន្ត្រៃ *Pristolepis fasciata*


រ៉ូត្រីកម្ពុ *Trichogaster pectoralis*


ត្រីកាំភ្លាញសង្រៃ *Trichogaster trichopterus*


ត្រីជួរ *Mastacembelus favus*


ត្រីអង្ករ *Macrognathus siamensis*


ត្រីមន្ទក់ *Monopterus albus*


ត្រីក្រឹម *Trichopsis vittata*

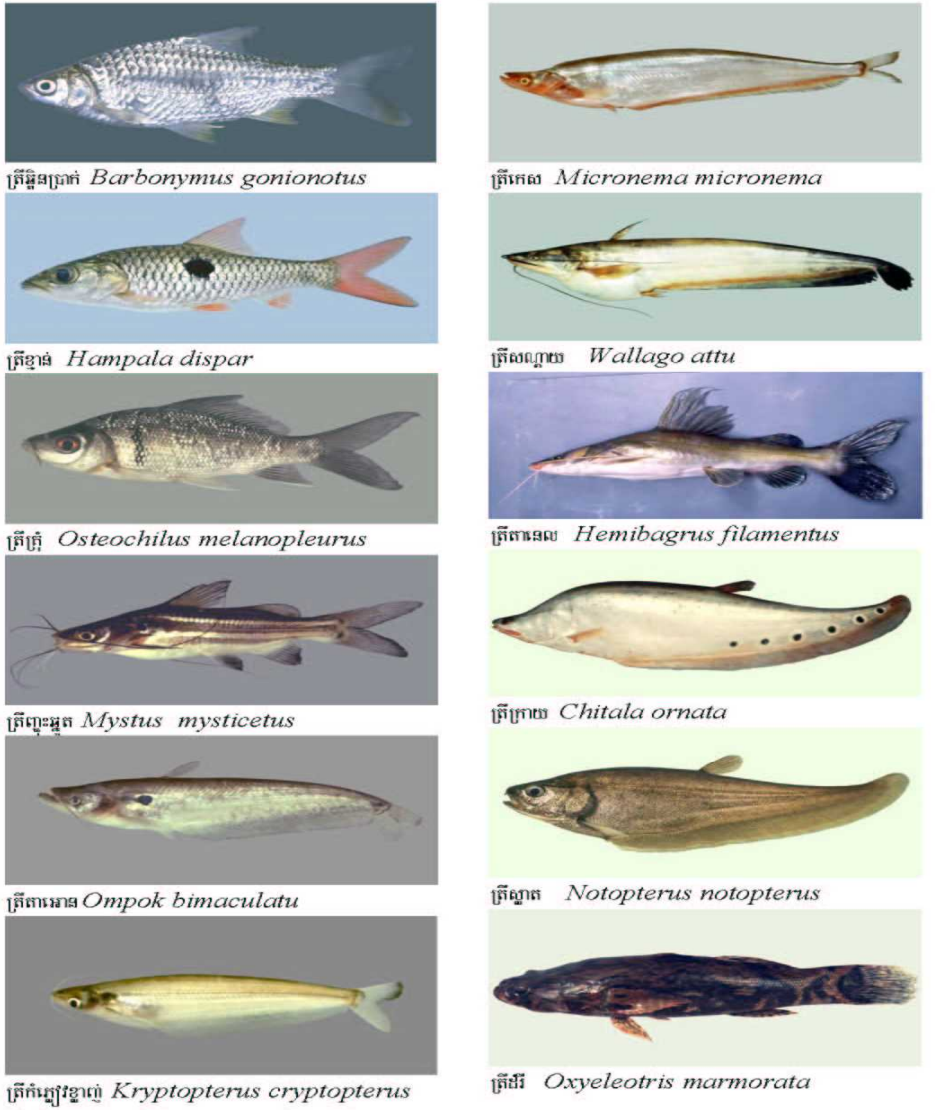
Source: MRC

Characteristics of main fish groups

Grey fish:
ecologically intermediate between two previous groups, corresponds to fishes that do not spend the dry season in floodplain ponds, but do not undertake long distance migrations either.

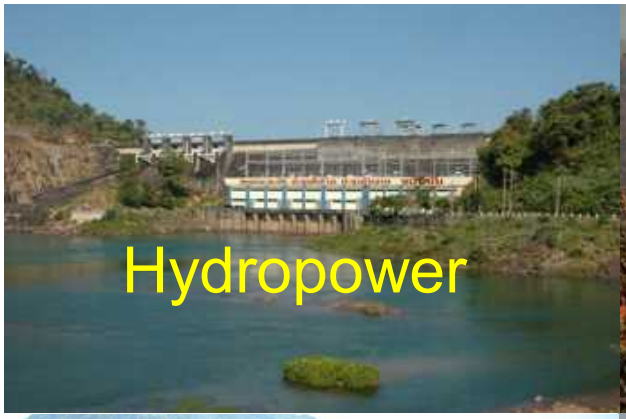
50% of species richness

14% capture



Source: MRC

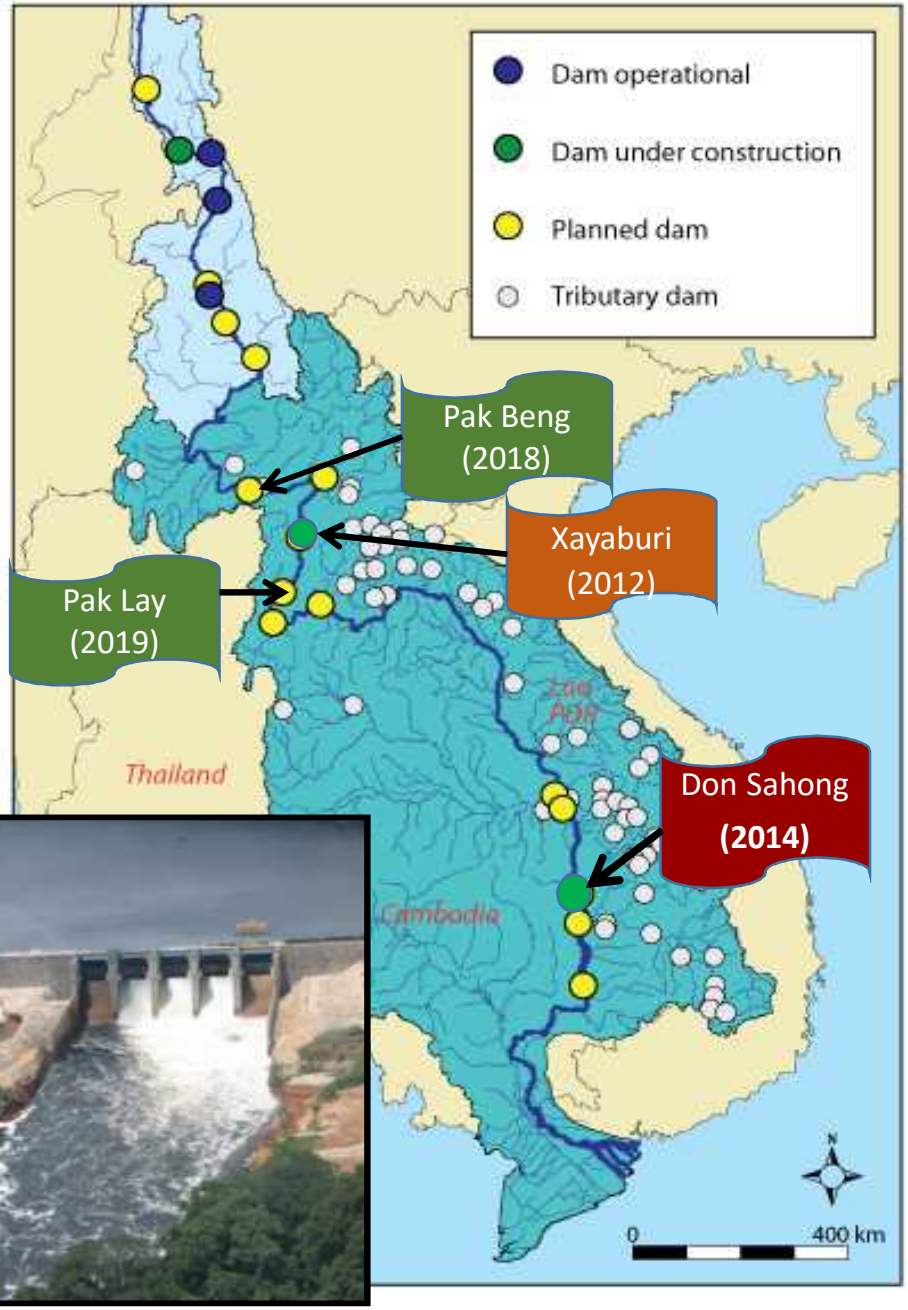
Pressures on Mekong fisheries



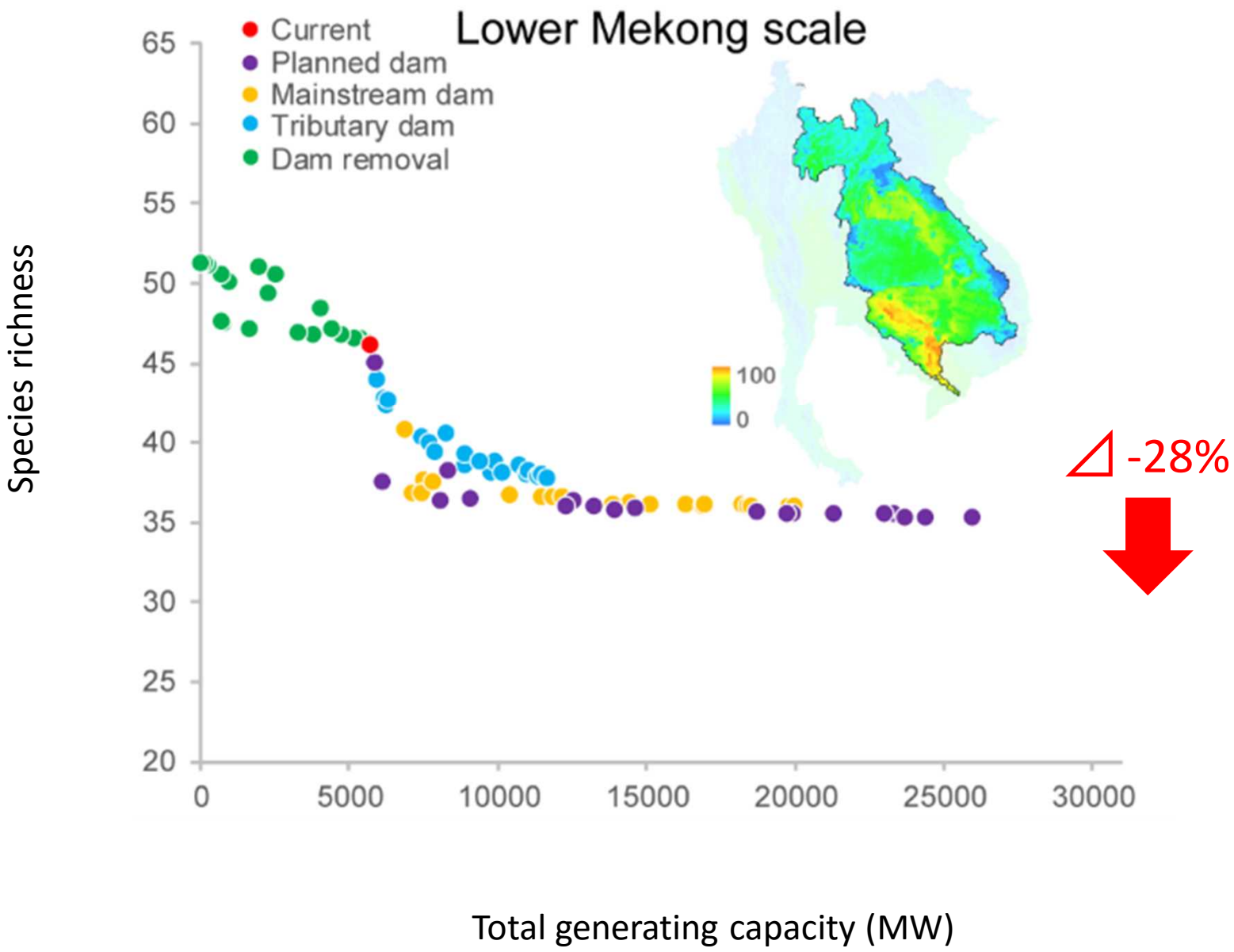
CLIMATE CHANGE

Hydropower dams

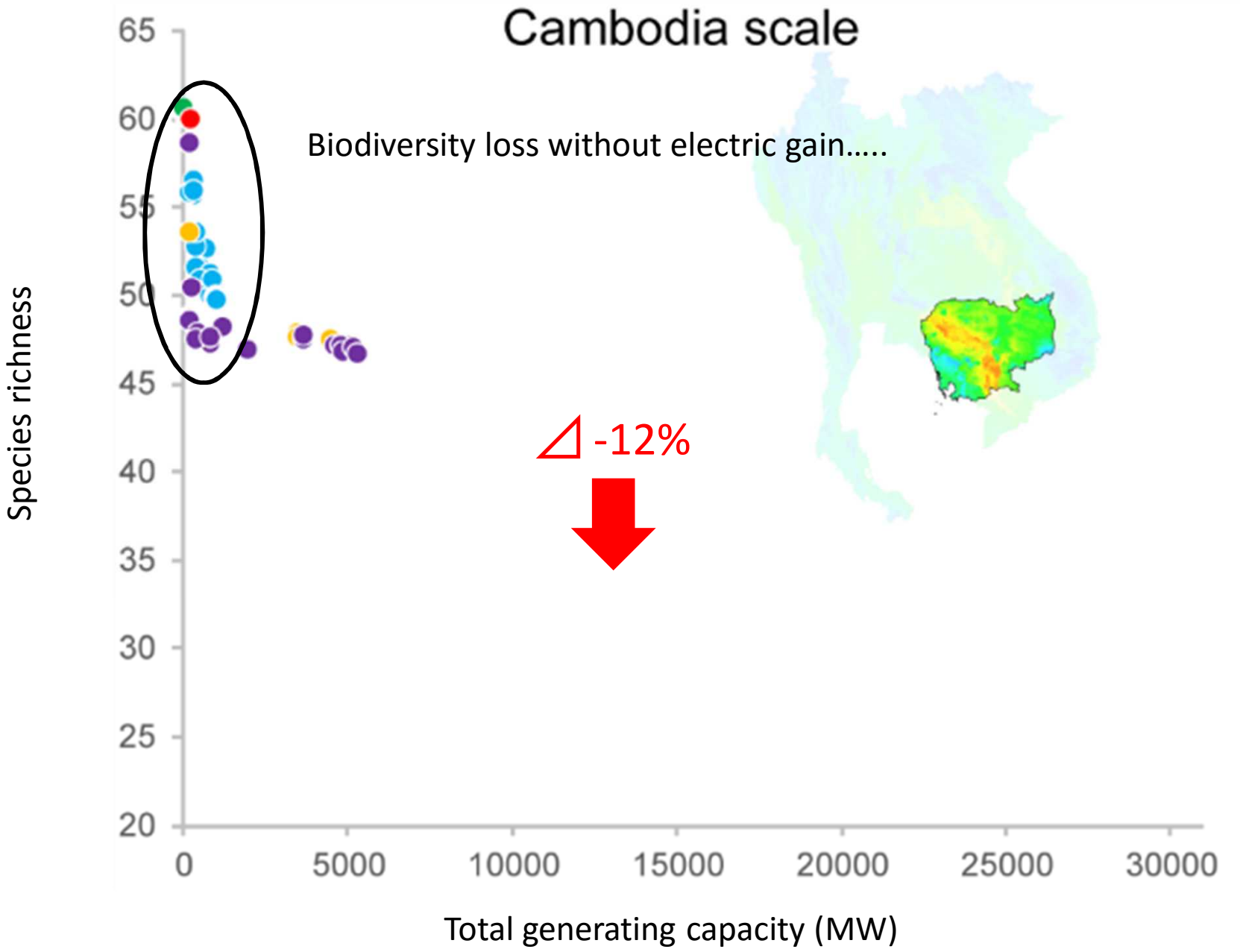
- 9 planned dams on LMB (mainstream) – two under construction.
- 23 existed dams (> 20 MW) on tributaries
- Many more tributary dams are projected or under construction



Future hydropower dam impact in Lower Mekong



Future hydropower dam impact in Cambodia



The Contribution of IFReDI

Agricultural Strategic Development Plan 2019-2023 (ASDP 2019-2023)

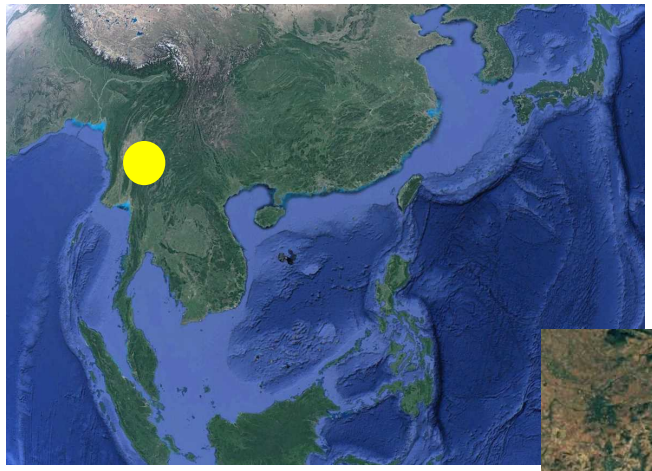
Objective of ASDP 2019-2023 "….to maintain wild catches at around 600,000 tons per year,……."

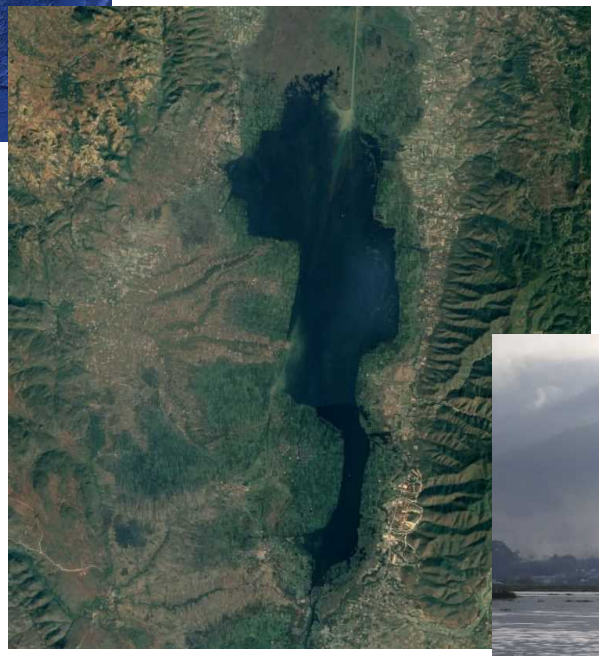
IFReDI Activities:

- Scientific research and technology on inland fisheries resources on issues such as stock status, catch per unit of effort, gear selectivity, eco-systems impacts, critical habitats, socio-economics, costs and earnings studies, etc,
- Encourage and strengthen research collaboration on inland fisheries resources, with national, regional and international research institutes, universities and other relevant institutions,
- Disseminate results of research

After spending more than 10 years of research and development, IFReDI of the Fisheries Administration of Cambodia has last week published a Field Guide Book on Fishes of the Cambodia Freshwater Bodies, the first book in the Mekong region.
Funded by Nagao National Foundation Environment, Japan and MRC

Inle Lake (by Dr. May Thet Su Kyaw Tint and Yuichi Kano)

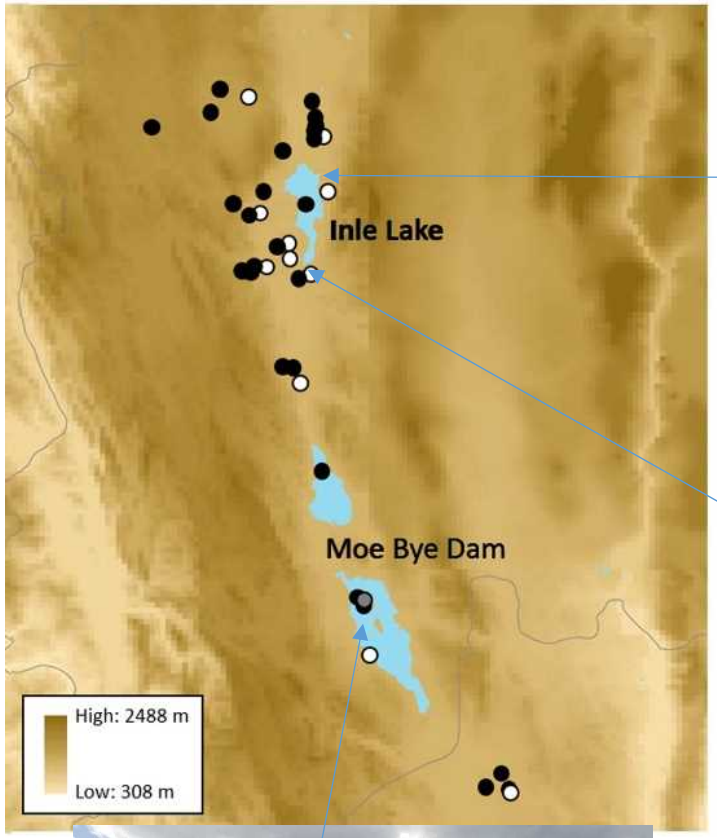




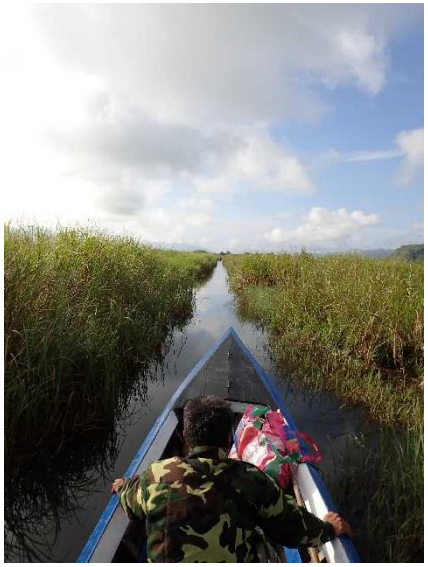
Features of Inle Lake

- One of the most famous sightseeing areas in Myanmar
- Ancient Lake (3~4 million years ago?)
- Rice paddy around
- Endemic cultures
- Many endemic species (fish: 13) including an ancient carp Cyprinus intha
- Alien fishes, but local people do not think it a problem: local people like to eat Nile Tilapia
- Water pollution from Nyaungshe City and floating garden agriculture

Current environment condition of Inle Lake Basin



Around Nyaungshwe City, polluted

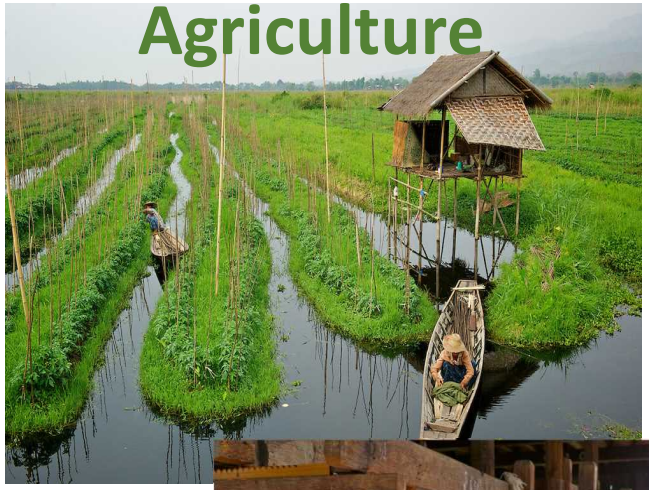


Southern part of Inle Lake, looks good condition

Moe Bye Dam, looks good condition

Main Livelihoods of the local people

Floating Agriculture



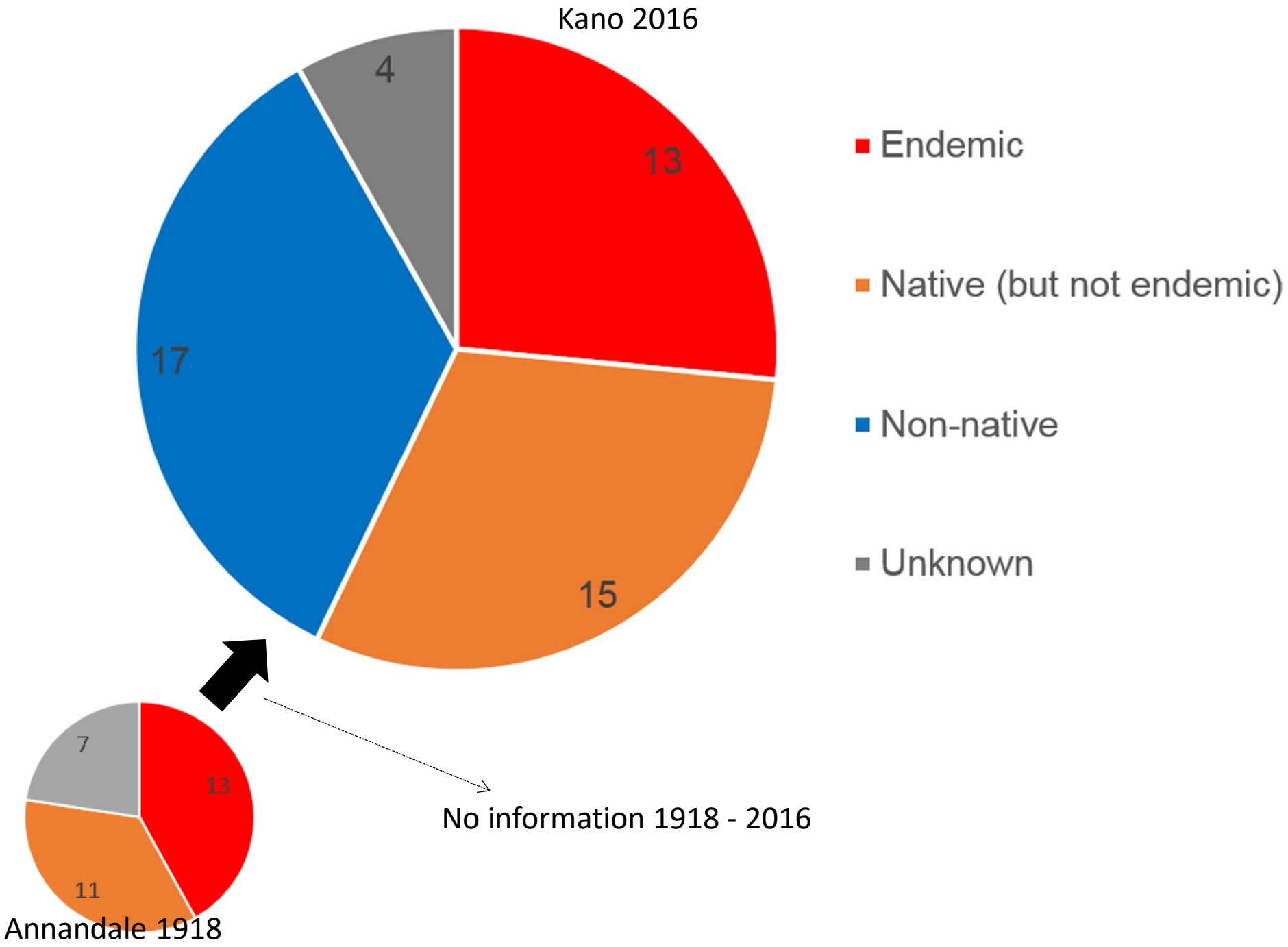
Fishing

Weaving

Tourism-related Activities

Local fish markets of Inle Lake Basin

Imported from Yangon


Kano 2016
4
13
17
15
Endemic
Native (but not endemic)
Non-native
Unknown
7
13
11
Annandale 1918
No information 1918 - 2016

Hybrid between *Cyprinus intha* (endemic) and *C. rubrofuscus* (introduced)

Cyprinus intha

Cyprinus rubrofuscus

Hybrid

Systomus compressiformis (endemic) has been likely extinguished

The last specimen in 1990s

Silurus burmanensis (endemic) might been extinguished

The last observation in 2010

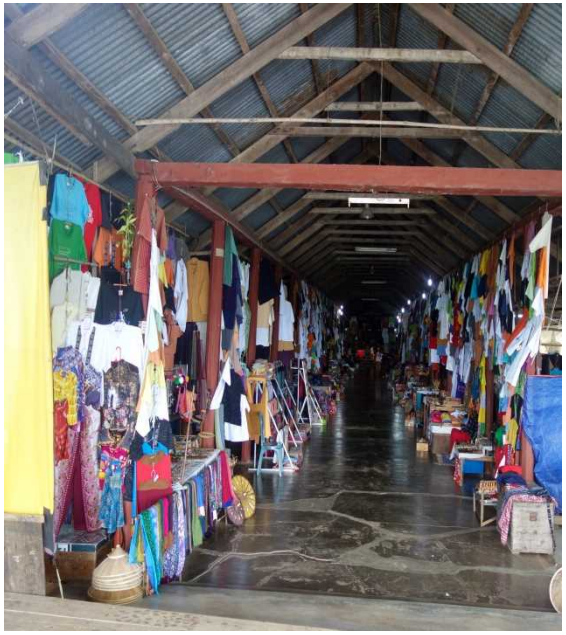
Floating Agriculture

Used weeds and silt from the lake bottom, put them onto floating beds

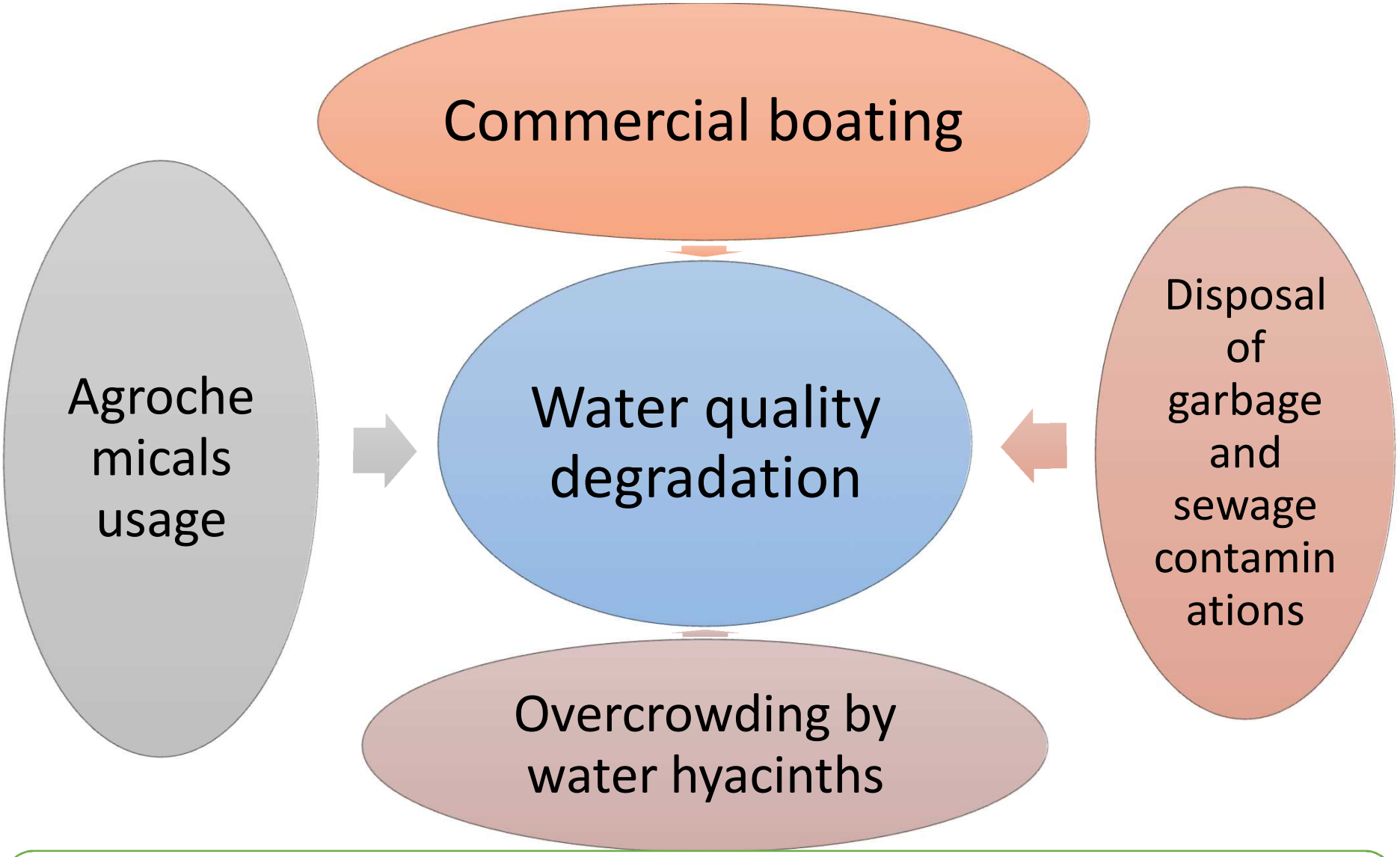
Bamboo poles are used to anchor the floating bed in position

About 2 m wide and 180 m long

Commercial tomato production



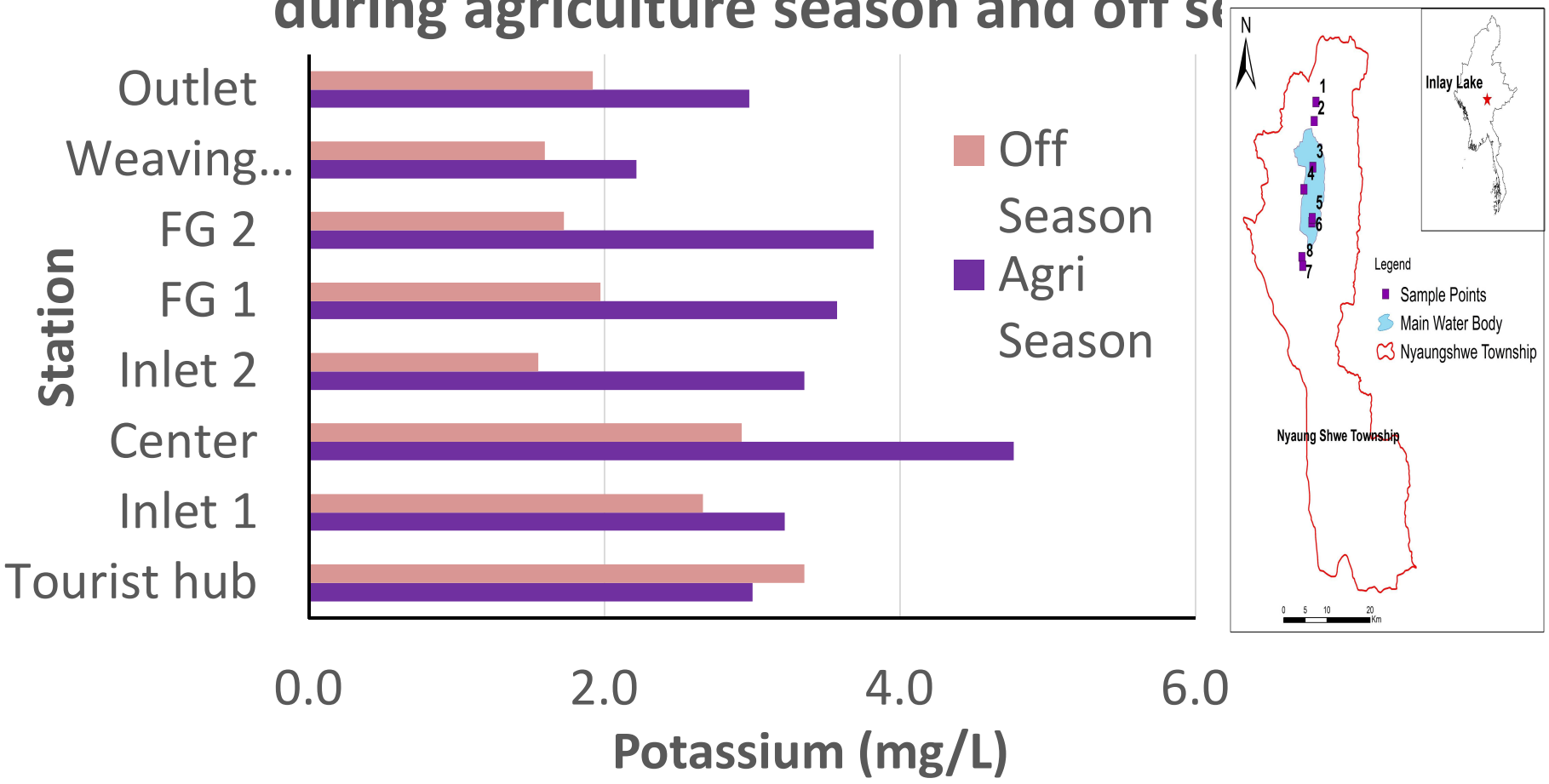
Tourism in Inle lake



Water quality has declined at an increasing rate.
(Butkus and Myint, 2001)

Commercial tomato production : Hybrid variety, High input of agrochemicals of pesticides, fungicides and fertilizers

Comparison of mean values of potassium during agriculture season and off se



- Higher concentrations in agri-season except tourist hub station
- High input of agro-chemicals

Table 1 Comparison of water quality results between December 2004 and December 2017

Locations	**Cl**(mg/L)		**Alkalinity** (mg/L)		**NO3-N** (mg/L)	
	Previous study (2004)	This study (2017)	Previous study (2004)	This study (2017)	Previous study (2004)	This study (2017)
Tourist hub	3.67	110.2	140	381	ND	1.30
Inlet 1	2.51	118.4	129	370	0.008	0.70
Center	2.26	121.7	140	385	ND	1.46
Inlet 2	2.55	121.7	117	325	ND	0.70
Weaving village	2.05	128.8	117	329	0.454	1.03

ND= Not Detected

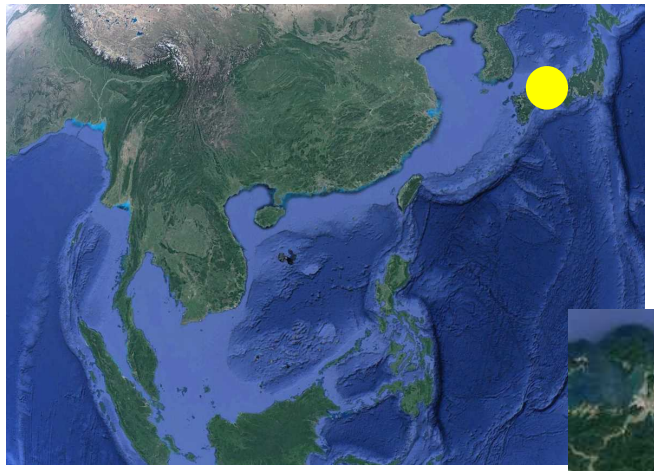
Conclusions

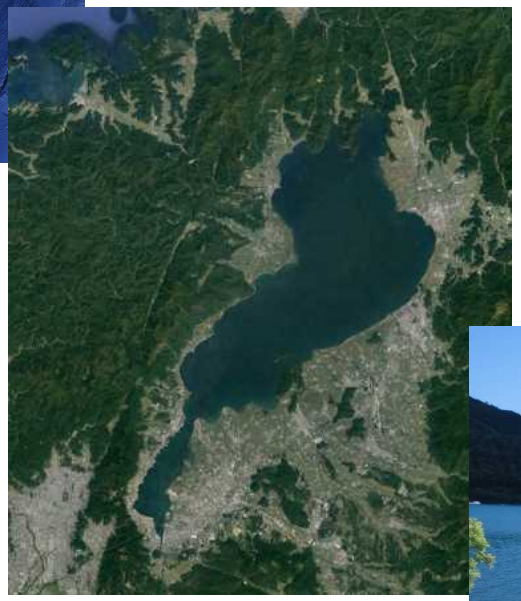
- There were significantly increased in the concentration of Cl, Alkalinity and Nitrate nitrogen between December 2004 and 2017.

- The most polluted region, tourist hub station and Inlet 1 station (Group 1) which is located near Township, because of human activities such as commercial boating ,and sewage and garbage contamination.

- The concentration of nitrate nitrogen is become increasing and it is leading to water pollution as well as eutrophication due to the usage of chemical fertilizers and pesticides.

Lake Biwa (by Dr. Koji Mabuchi)





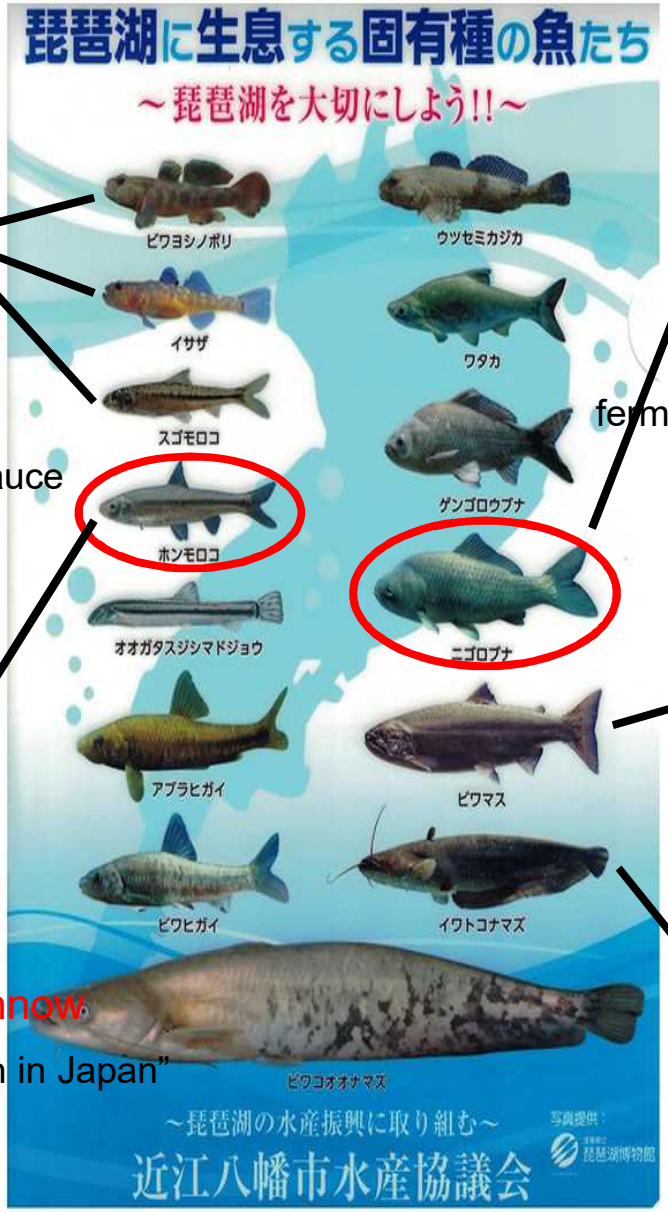
Features of Lake Biwa

- The largest lake in Japan
- Ancient Lake (4 million years ago)
- Rice paddy around
- Many endemic species (fish: 16) while most of them are endangered
- Problem of alien fish
- Water level is artificially controlled against flooding

Lake Biwa Endemic fishes as edible fishes

http://www.uoju.jp/product2/index.html

Small fishes boiled down in soy sauce



https://mainichi.jp/articles/20181006/ddl/k25/040/482000c

Grilled “*Hon-moroko*” minnow

“The most tasty cyprinid fish in Japan”

“*Funa-zushi*”,
fermented “*Nigoro-buna*” crucian carp,
a traditional dish of Shiga Pref.

https://kyodonewsprwire.jp/release/201807256317

Sliced raw “*Biwa-masu*” salmon

https://www.tokkuri-otsu.com/ippin.html

Sliced raw “*Iwatoko-namazu*” catfish

Reproduction sites of Lake Biwa endemic fishes

Hon-moroko

Nigoro-buna

https://mainichi.jp/articles/20181006/ddl/k25/040/482000c

Vegetation zo

Rocky zone

Sandy zone

River

Shallow lake shore

Two major invasive alien species in Lake Biwa

Considered to be the main cause of the native fish decrease

Largemouth bass

Micropterus salmoides

Both from North America

Bluegill

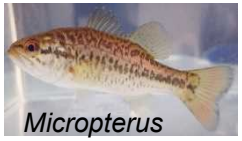
Lepomis macrochi

- Typical fish-eating fish
- One of the 100 of the world's worst invasive alien species
- Popular game fish in Japan

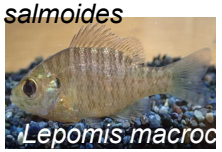
- Omnivorous fish that also eats fish eggs and fry
- One of the 100 of the Japanese worst invasive alien species

Targeted for removal in Shiga Pref.

Alien fishes' propagation and native fishes' decline

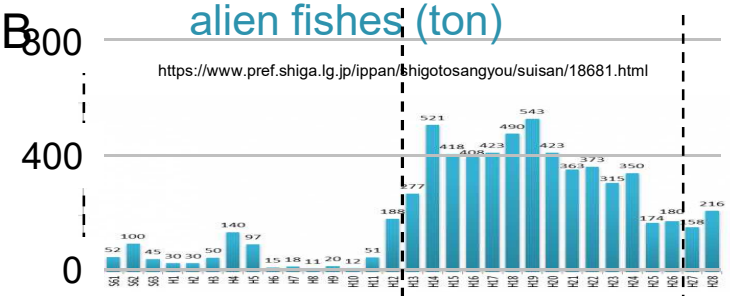


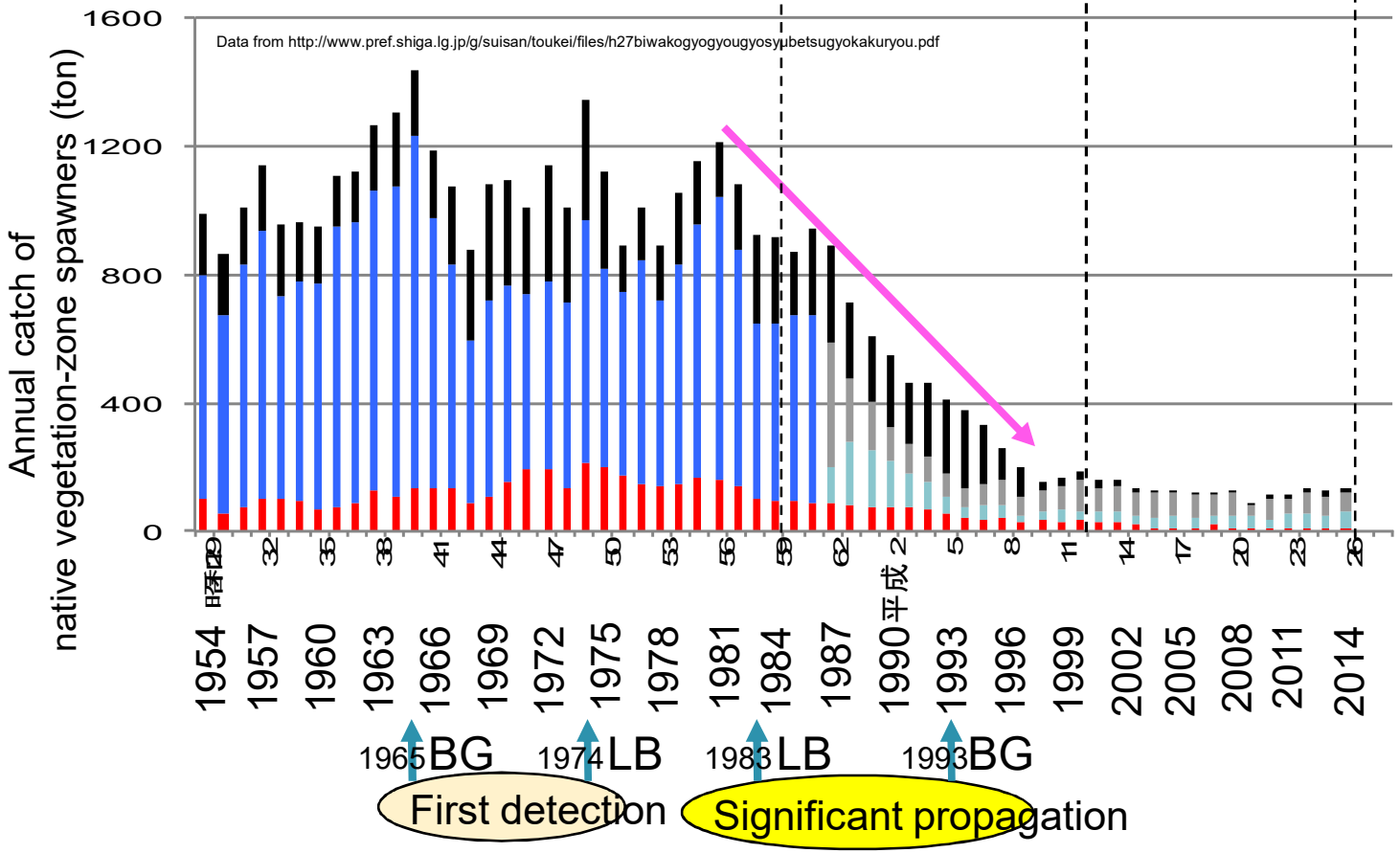
Largemouth bass: LB

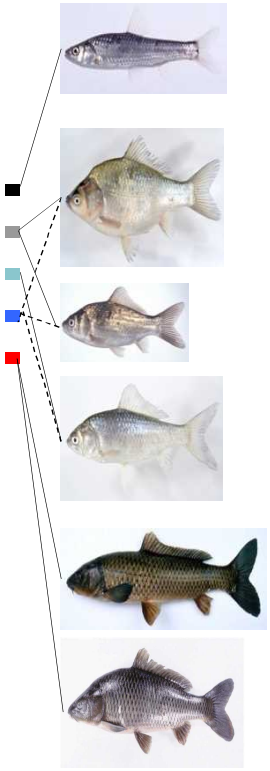


Bluegill: BG

Annual removal amount of the two alien fishes (ton)







Three factors affecting the decline of vegetation-zone spawners

- Propagation of alien fishes

- Vegetation-zone reduction caused by infrastructure projects

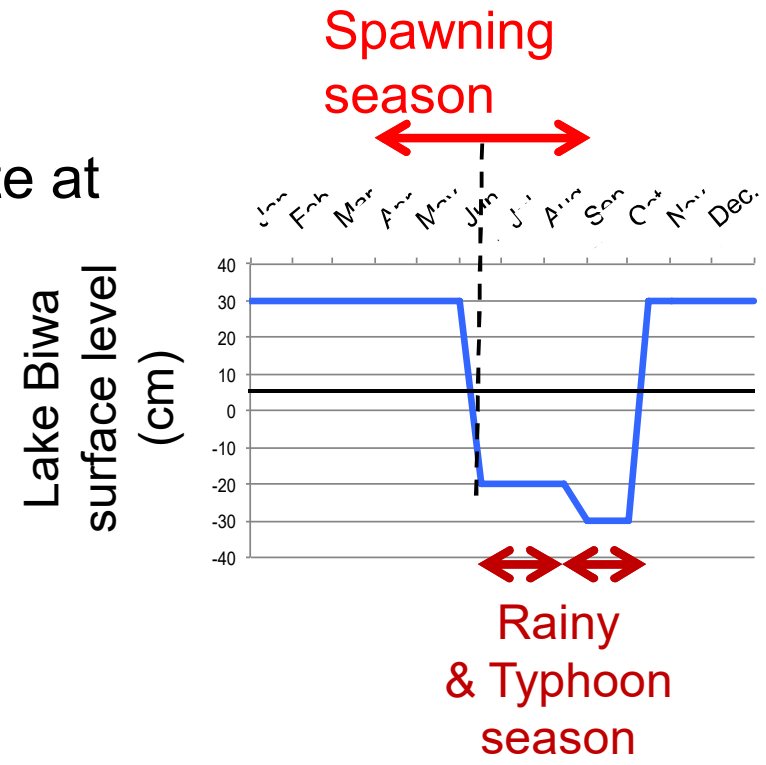
- Artificial water level control by Seta River Dam

Japanese‘s government countermeasure for improvement

Seta River Dam is operated by the Ministry of Land, Infrastructure, Transport and Tourism, not Shiga Prefecture

Slowing down the water level drop rate at high water level due to heavy rain

On the other hand, the low water level setting in the rainy and typhoon season has been maintained based on the operation rules determined by law



Major threats to 16 Lake Biwa endemic fishes

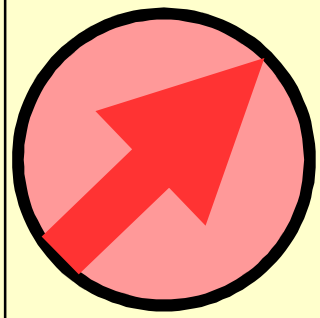
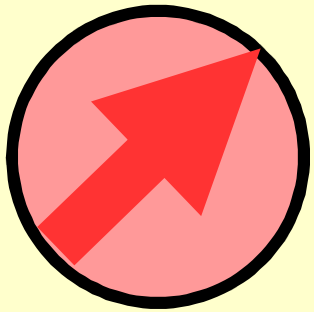
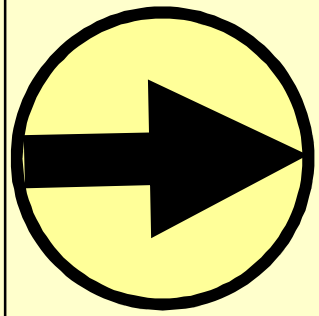
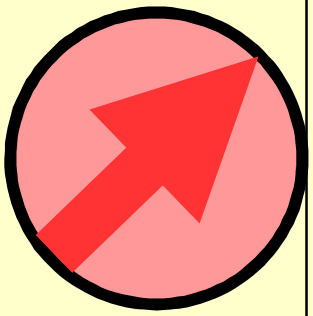
Comparing the three lakes

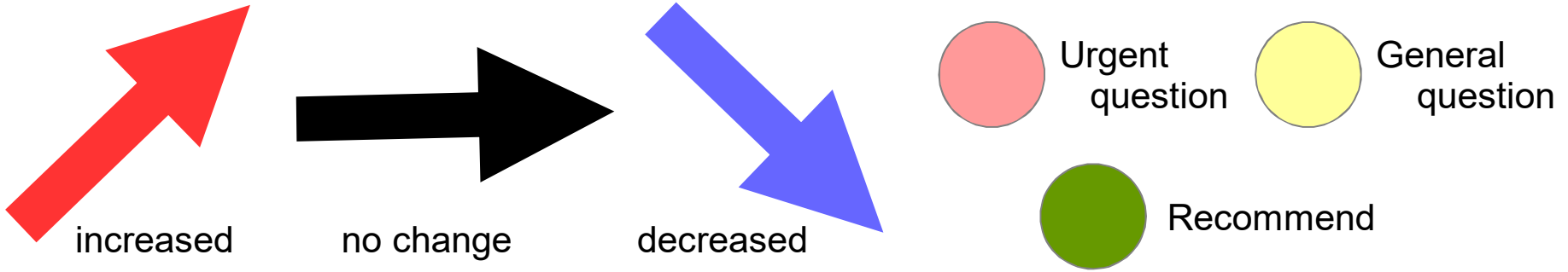
	Tonle-sap	Inle	Biwa
Area	2500-16000 km^2	43.5km^2	670km^2
Depth	Max. 9-13m	Max 3.1m	Max 104m
Ancient Lake	No	Yes	Yes
Fishery	Very High	High	Middle
Sightseeing	High	High	Middle
Flood Plain	Yes	Partially	No
Water quality			
Rice Paddy	Yes	Yes	Yes

Comparing the three lakes

	Tonle-sap	Inle	Biwa
Fish α diversity (native)	High (300)	Low (30)	Middle (65)
Fish β diversity (endemic)	Low (3-5)	High (13)	High (16)
Alien fishes	Low (5-10)	High (17)	High (14)
Conservation issues	• Overfishing (increasing population) • Illegal fishing (weak law enforcement) • Water quality (pesticide, Open toilet) • Flooded forest (convert to fields) • Water level regulation (potentially by hydropower dam) • Sedimentation loading, erosion by dam • Climate change • Waste gavages	• Alien fishes • Water degradation (floating garden, deforestation, erosion, open toilet) • Climate change • Increasing population (tourism) • overfishing	• Alien fish • Lake shore modification • Bottom degradation • Overfishing • Water level regulation • River/paddy improvement (concreted) • Climate change (poor oxi.. deep water)

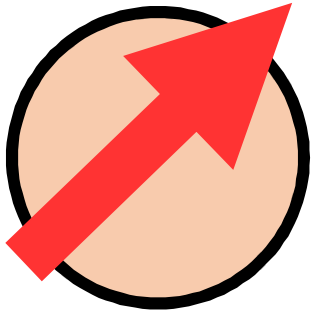
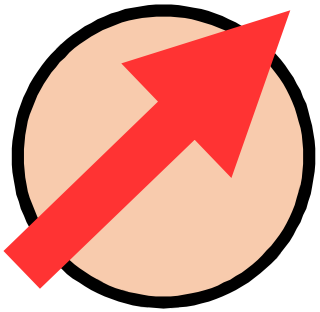
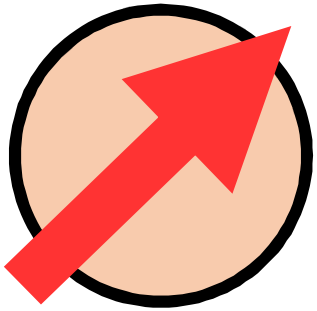
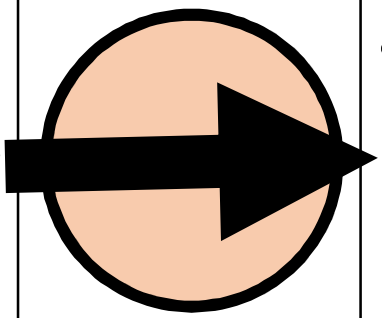
Example

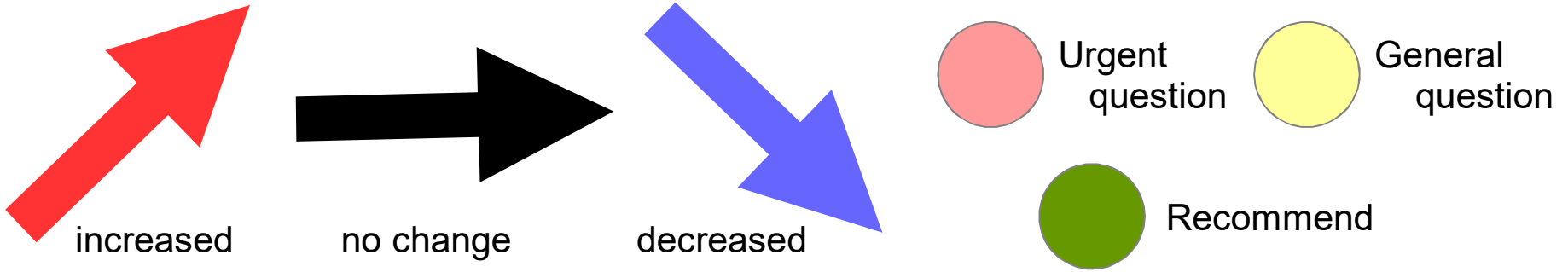
Parameter	Evaluation 2009-2019	Action plan 2019-2030	To Do (within 3-5 yrs)	SDGs Contribution
Mapping of diversity of tree species			● Encourage fieldworks in Cambodia, ...	
Collection of phenological information of tree species			● Encourage to collect phenological information in each countries	



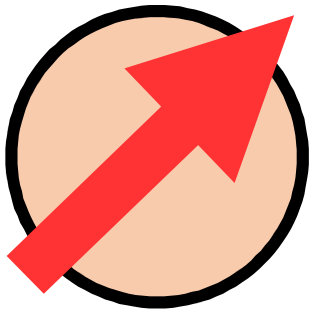
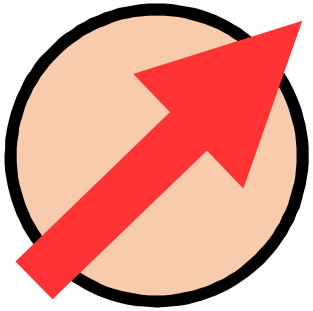
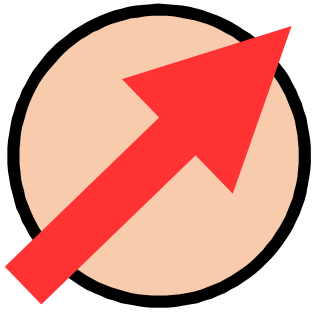
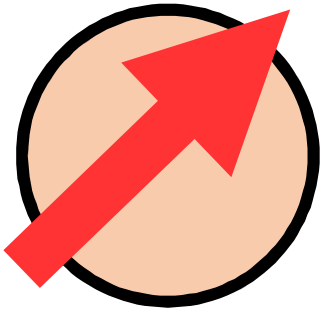
1. Biodiversity research and monitoring

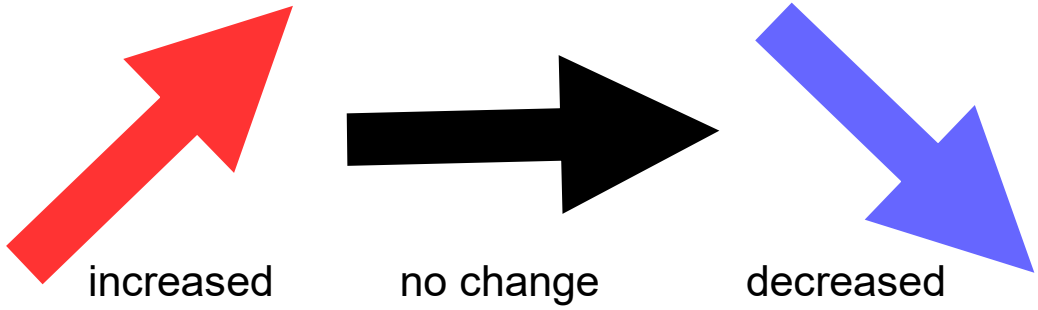
WG :

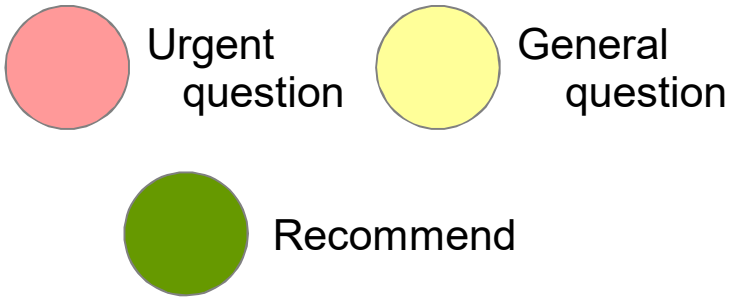
Parameter	Evaluation 2009-2019	Action plan 2019-2030	To Do	SDGs Contribution
1.Monitoring states and changes of biodiversity			• Encourage fieldworks in Whole of SE Asia • To increase collaboration (Collaboration with MRC, Larvae monitoring, dai fisheries monitoring, fish abundant diversity monitoring, Mekong 3S Rivers, Tonlesap Lake, River ecological health monitoring) • To find researchers from AP countries to fill the gap • Communicate with other field researchers/specialists • To gather information on water plants, mollusks, crustacean, other aquatic animals	
2.Filling gaps in data availability				



WG :

Parameter	Evaluation 2009-2019	Action plan 2019-2030	To Do	SDGs Contribution
3.Increasing access to data (data sharing)			• Datapaper • Online database • Keep AP-BON workshop	
4.Improving knowledge on cutting-edge technologies			• eDNA • AI for species identification • Big data • Sonar sensor	





1. Biodiversity research and monitoring

WG :

5. How can we contribute to AO-GEO pilot studies 1) Mekong 2) Pacific islands 3) Himalaya

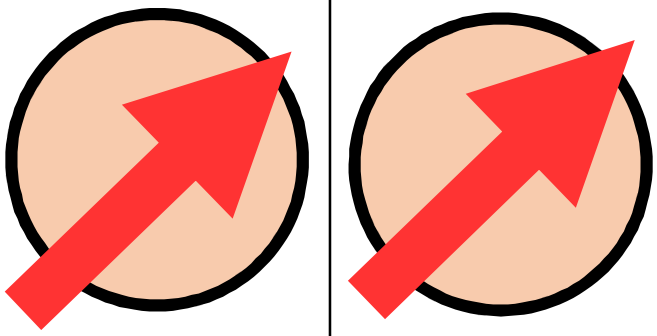
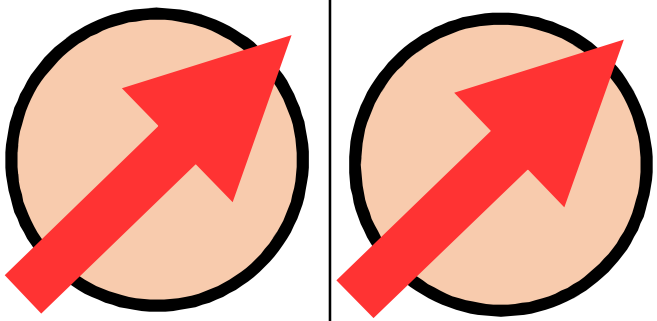
1) Research on Tonlesap Lake
2) N/A
3) Research on Inle Lake (Geographically easternmost Himalaya?)

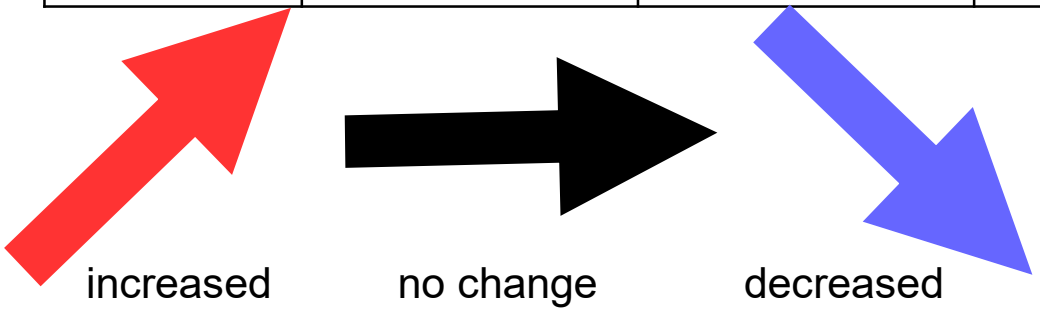
6. How can we raise funds for AP-BON activities?

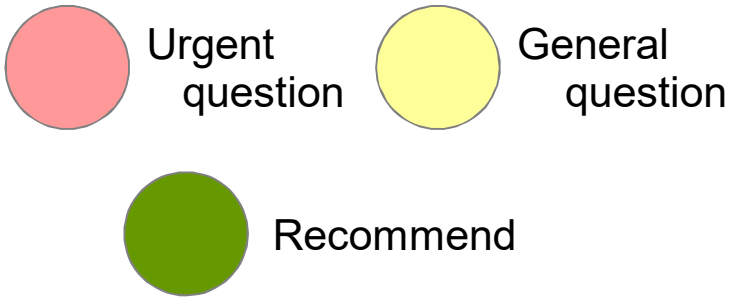
1) Now Inle Lake survey team [Watanabe (Kyoto-U) and Kano (Kyushu-U)] is raising a fund “Sumitomo Foundation”
2) Raising a fund for “Comparing Tonlesap, Inle and Biwa lakes”???

2. Networking of networks

WG :

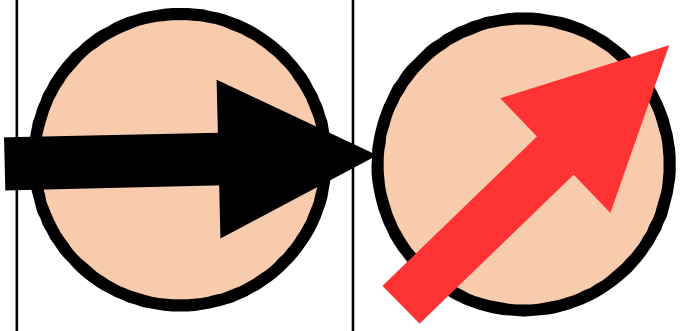
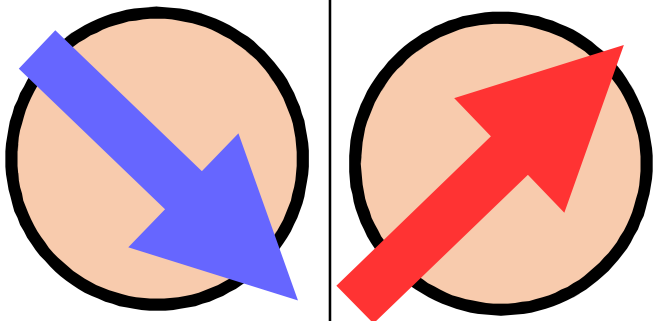
Parameter	Evaluation 2009-2019	Action plan 2019-2030	To Do	SDGs Contribution
1) Networking with observation sites and networks			● Enhance collaborative researches ● Find possible researchers in AP-BON Workshop, etc. ● Discussion and agreement about transboundary rivers ● Transfer technology ● Lessens learned	
2) Networking with global platform, policy-relevant communities				

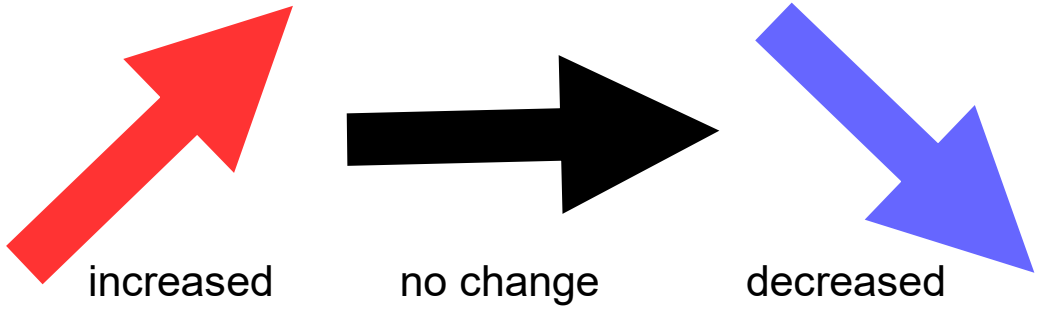


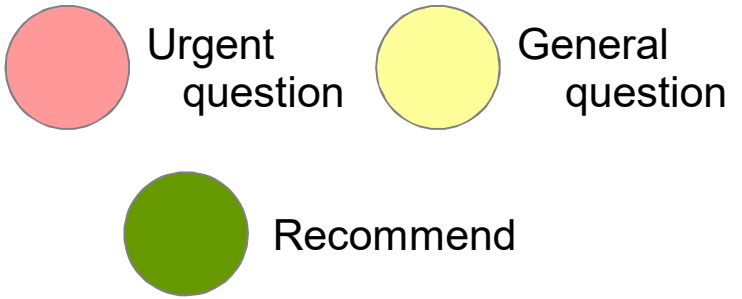


3. Outreach activities, Capacity building, Actions for biodiversity of networks

WG :

Parameter	Evaluation 2009-2019	Action plan 2019-2030	To Do	SDGs Contribution
1) Outreach activities & social communication			• Improve public awareness (meeting, books, forum, conference, Radio/TV,) • Find funding • Human resource	
2) Capacity building				






1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS

Agenda

1. Monitoring states and changes of biodiversity (networking)
2. Filling gaps in data availability
3. Increasing access to data (data sharing, capacity building)
4. Improving knowledge on cutting-edge technologies
5. Mapping achievements and working plans using the template figure format (including SDGs etc)
6. Contributions to AOGEO pilot studies 1) Mekong, 2) Pacific islands, 3) Himalaya
7. Raising funds

1. Monitoring states and changes of biodiversity (networking)

Tonle-sap	Inle	Biwa
IFReDI MRC Kagoshima University (finished)	Kyoto-Kyushu University (finished)	Many institutes of Japan

2. Filling gaps in data availability

Tonle-sap	Inle	Biwa

2. Filling gaps in data availability
3. Increasing access to data (data sharing, capacity building)

Tonle-sap	Inle	Biwa
• Several scientific papers • Mekong River Committee (many online publications) • Nagao Natural Environmental Foundation (many capacity building activities in Indo-china)	• Annandale 1918 • Kano et al. (2016) [datapaper] • No data available between 1918-2016	Many scientific publications and information

4. Improving knowledge on cutting-edge technologies

Tonle-sap	Inle	Biwa
eDNA (Eva et al. 2016 [Jiant Catfish]) eDNA (Jerde et al. 2019) eDNA (Kanno et al. unpubished data)	Unknown… Several JICA projects are now running	eDNA by many researchers

5. Mapping achievements and working plans using the template figure format (including SDGs etc)

6. Contributions to AOGEO pilot studies 1) Mekong, 2) Pacific islands, 3) Himalaya

Tonle-sap	Inle	Biwa
Yes (Mekong)	Yes?? (Geographically easternmost Himalaya?)	No

7. Raising funds

Tonle-sap	Inle	Biwa
	Watanabe, Kano and Tokuchi (Sumitomo foundation)	
Raising fund that compare the three lakes from aspects of not only biodiversity but also culture		