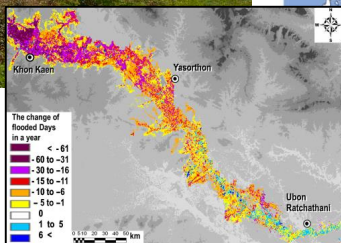
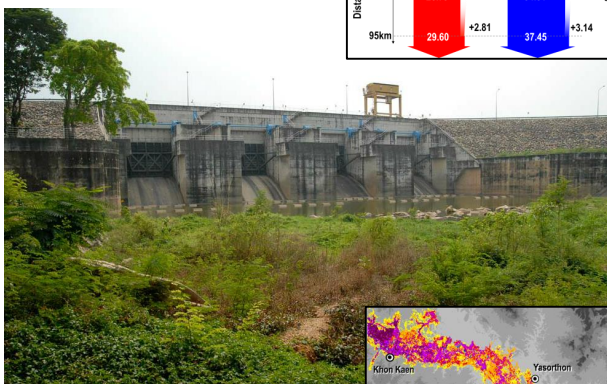
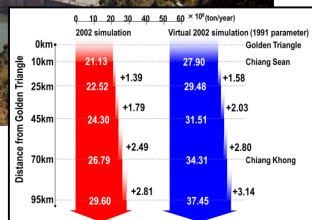
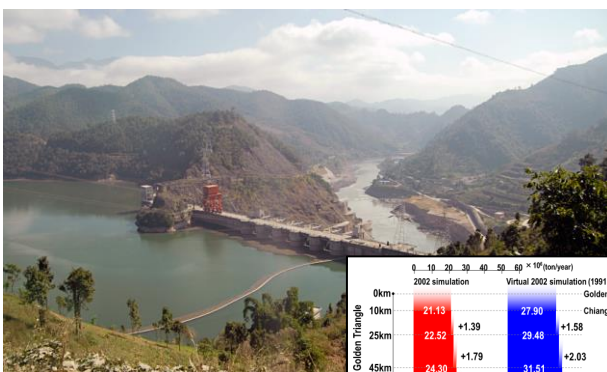
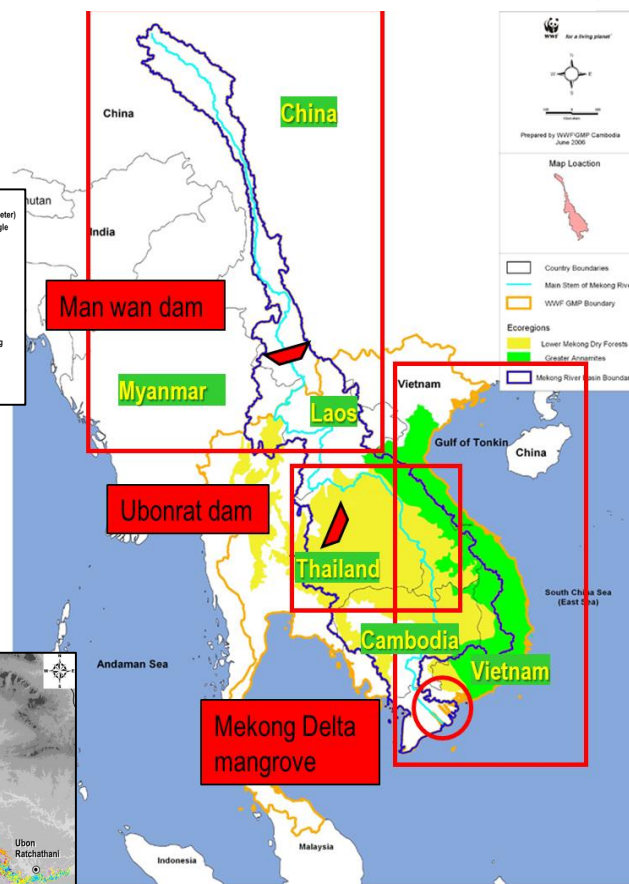


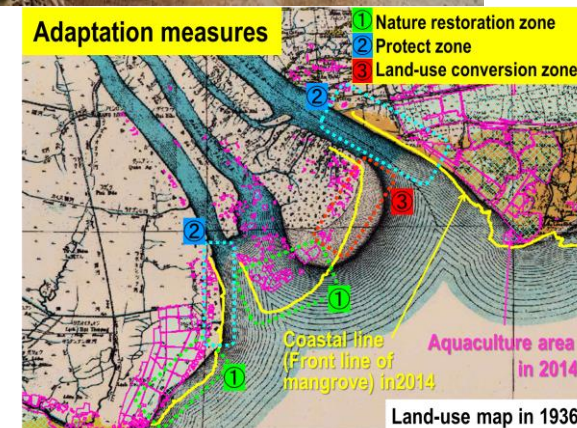
New Adaptation Strategies to Support a Sustainable Watershed Management in Asia



Three topics in Mekong River watershed



Adaptation measure to environmental change



Center for Environmental Biology and Ecosystem
National Institute for Environmental Studies
(Senior Researcher)

Kyoto University, C-PIER
(Specially-Appointed professor)
Satoshi KAMEYAMA

Self introduction



2008/11/16
Chiang Sean



**Ecosystem Function
Assessment Section
Center for Environmental
Biology and Ecosystem
(Senior Researcher)**



**Kyoto University
Center for the Promotion of
Interdisciplinary Education and Research
(Specially-Appointed Professor)**



**Vietnam-Japan University,
Vietnam National University, Hanoi
(JICA Expert)
Climate Change and Development**

Satoshi Kameyama (亀山 哲)



2012/09/18 Dong Rui,
Quang Ninh, Vietnam

Economic and population growth in Mekong River watershed

Industrial development and use of natural resources

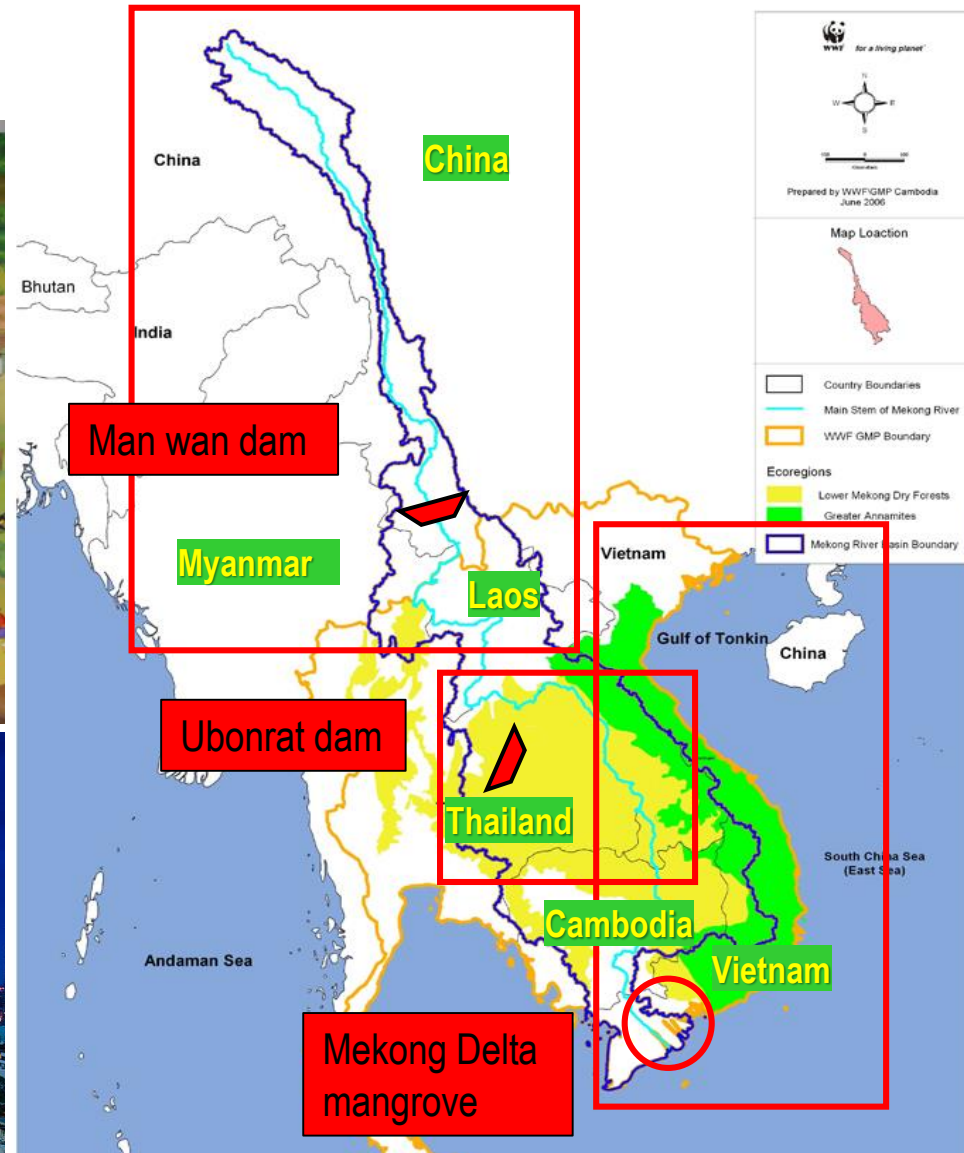
WWF Greater Mekong Programme Priority Ecoregions

Traditional life style Mekong River and human society.
(picture in local museum in Thailand)



“Ho Chi Minh City”

Creative Commons images



Basin population; Over 73 million people
Size; 795,000 km² . Length; 4,800 km

The endless **TRILEMMA** in watershed management

Nature conservation / restoration



Disaster prevention / reduction



Water resources & Energy

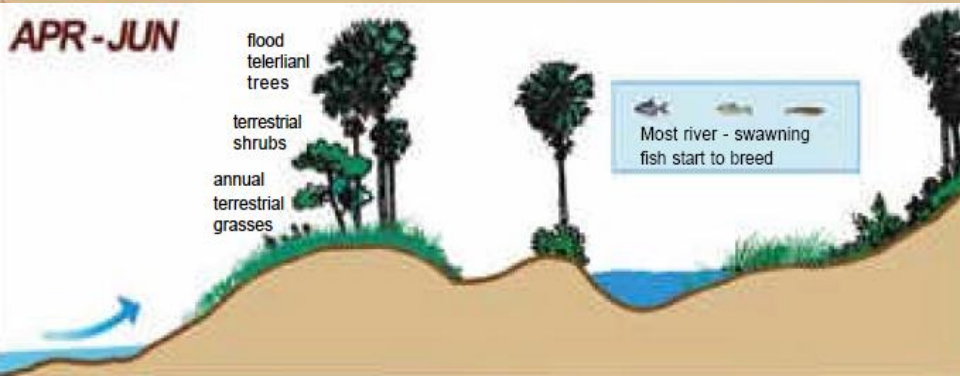
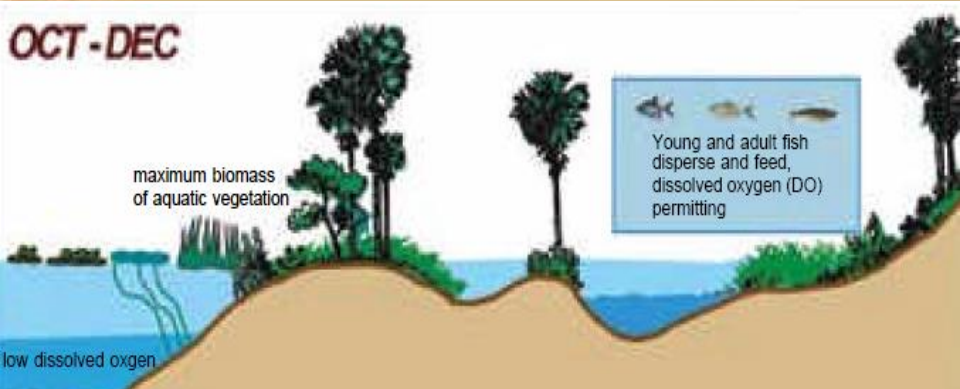
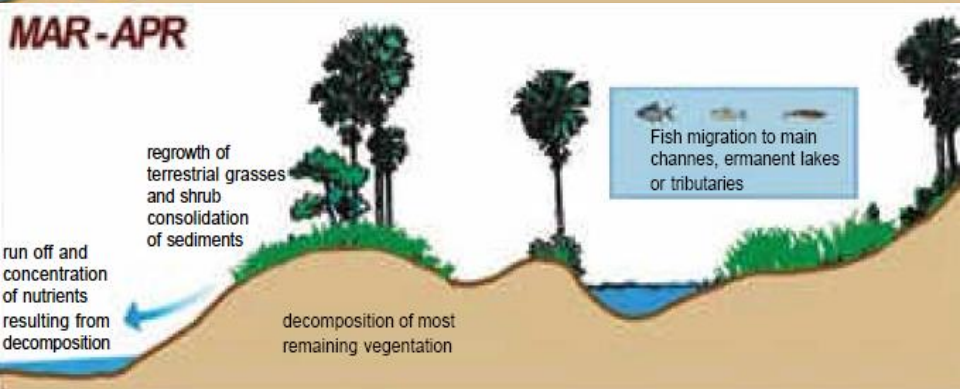
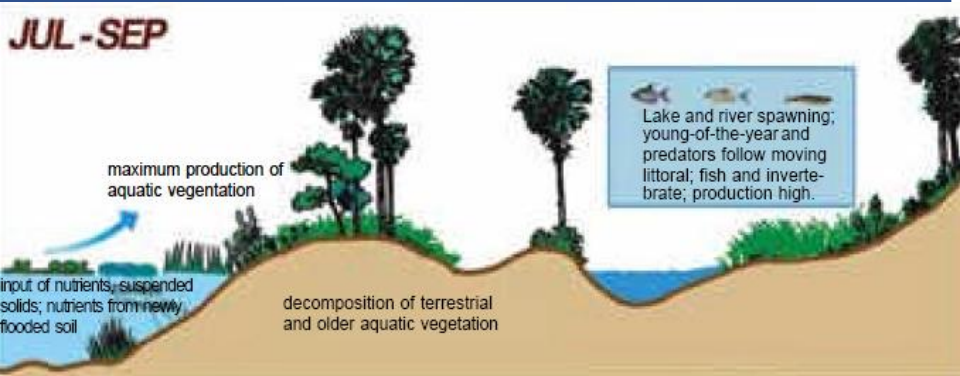
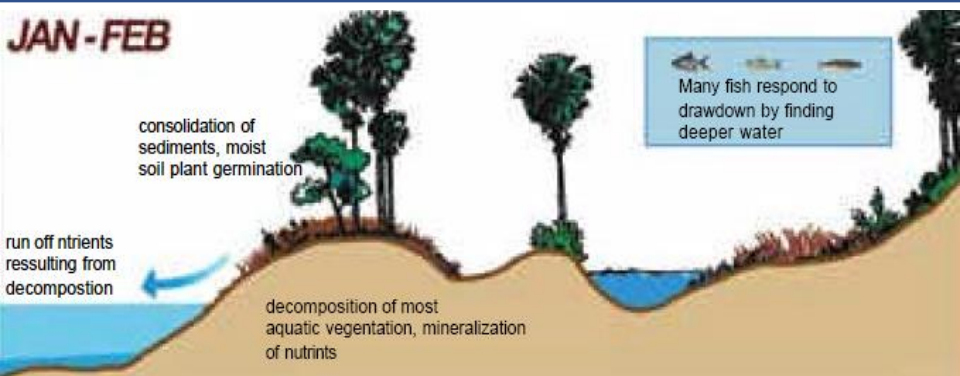
nearly

All their policy are “ **correct**” →

What should we do for their harmonization

Common background = East Asian MONSOON → Rainy season

つゆ 梅雨 မိုးရာသီ လະဂူပီၤ ရတုၤ ဝၢ်သွၢ်ၤ ကျဲၤ Mùa mùr



How seasonal changes in ecosystem greatly increase the diversity of habitats available for aquatic animals and plants over the flood-cycle.

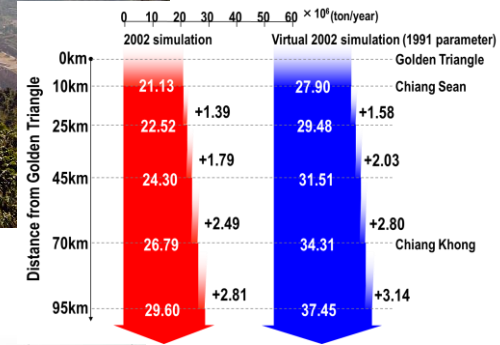
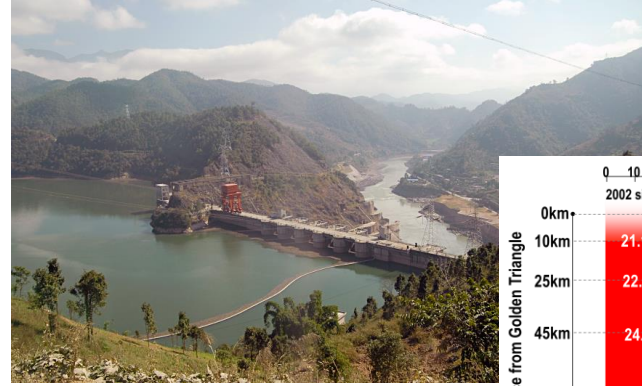
Sited from ; "Biodiversity and Fisheries in the Mekong River Basin, Mekong Development Series No.2 June 2003"

Contents

Impact of watershed development

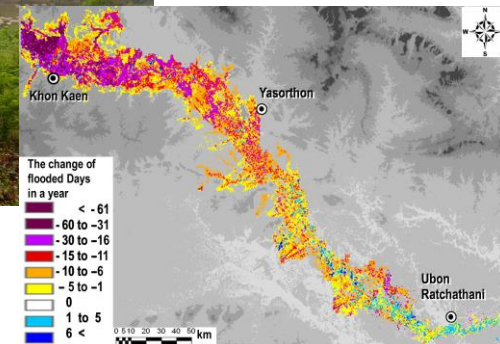
1. On seasonal hydrologic dynamics and **sediment transport**

Man wan dam



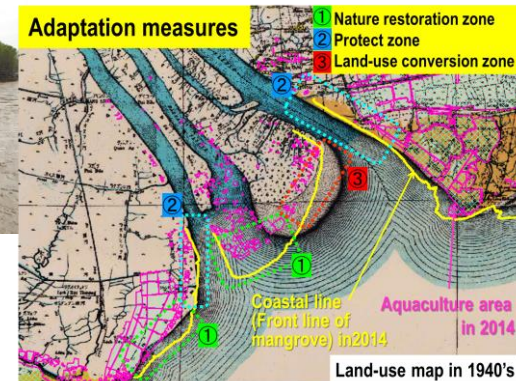
2. On seasonal discharge and **flooding**

Ubonrat dam



3. On change of **coastal zone** (Mangrove wetland)

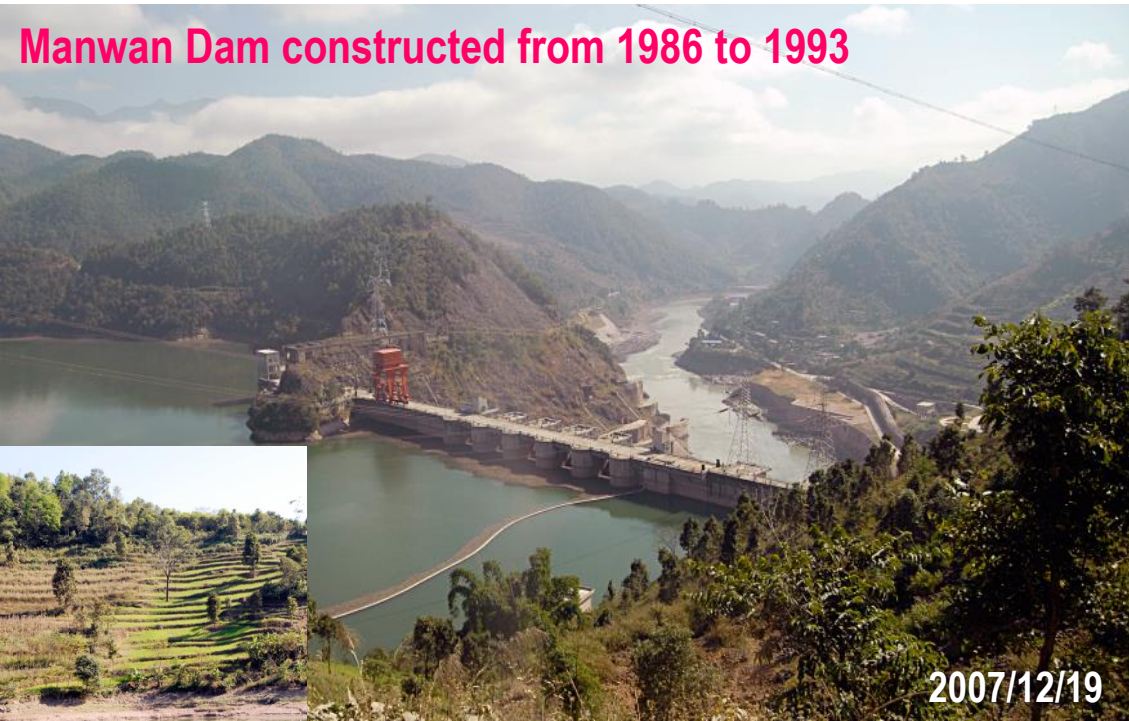
Mekong delta



New Adaptation Strategies to Support a Sustainable Watershed Management in Asia

1) Man wan dam = Upper region

FOREST AREA



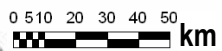
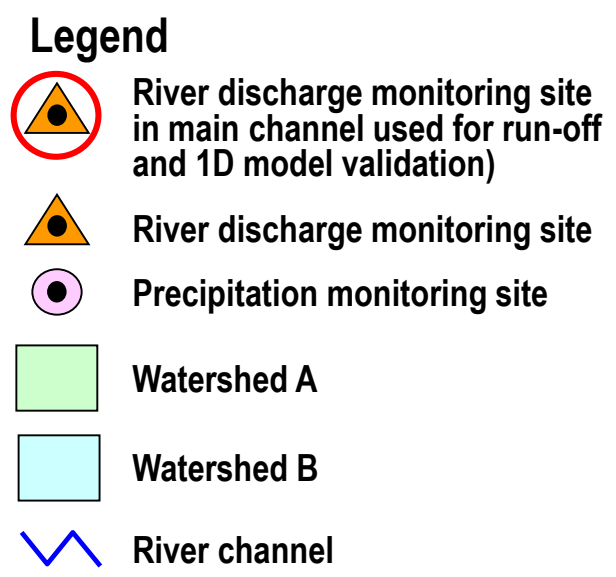
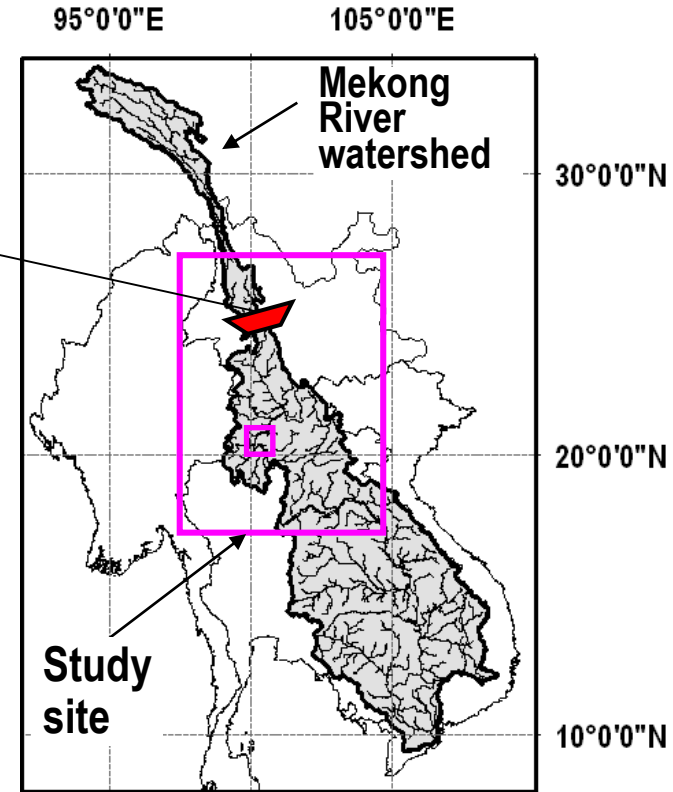
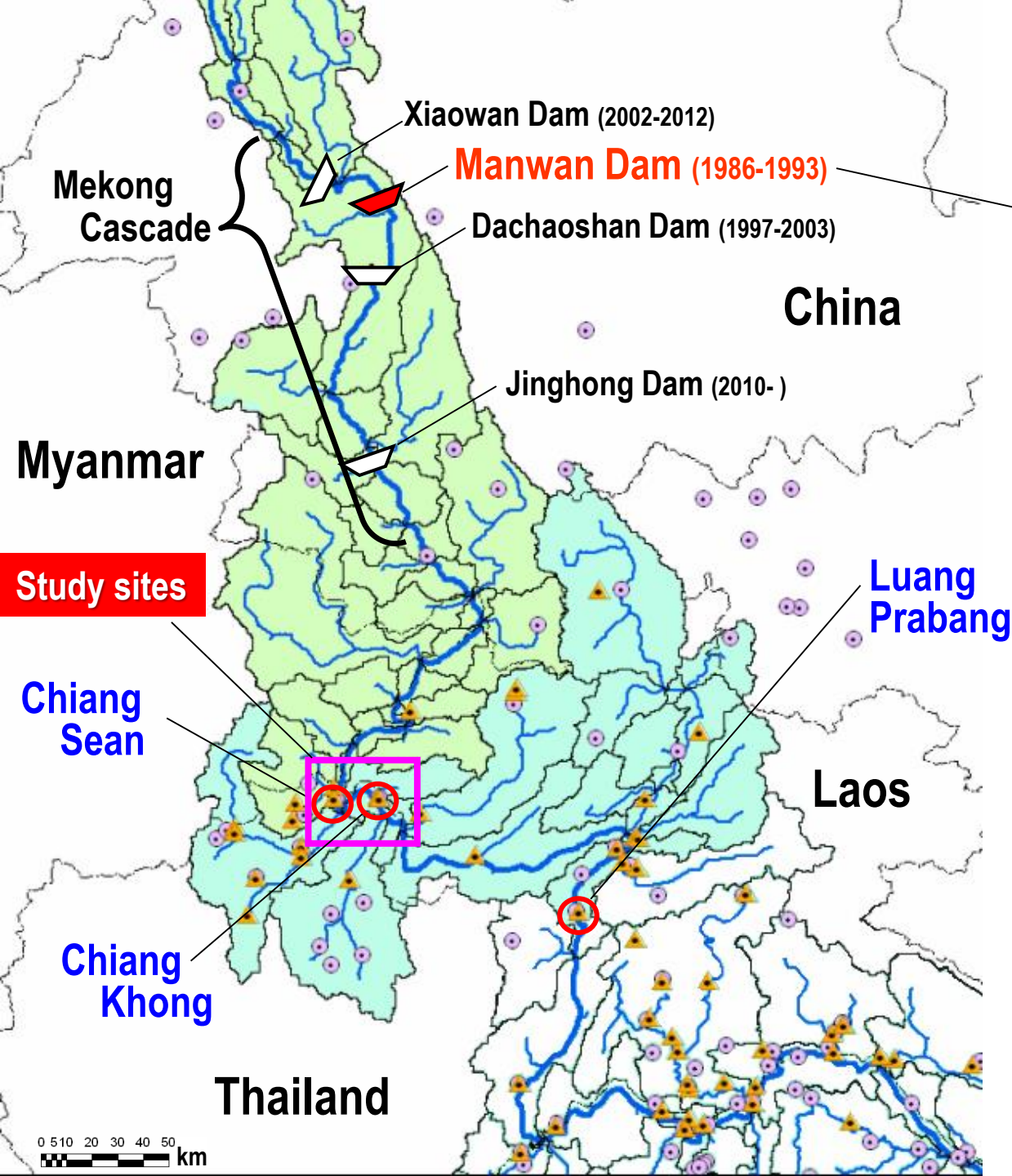
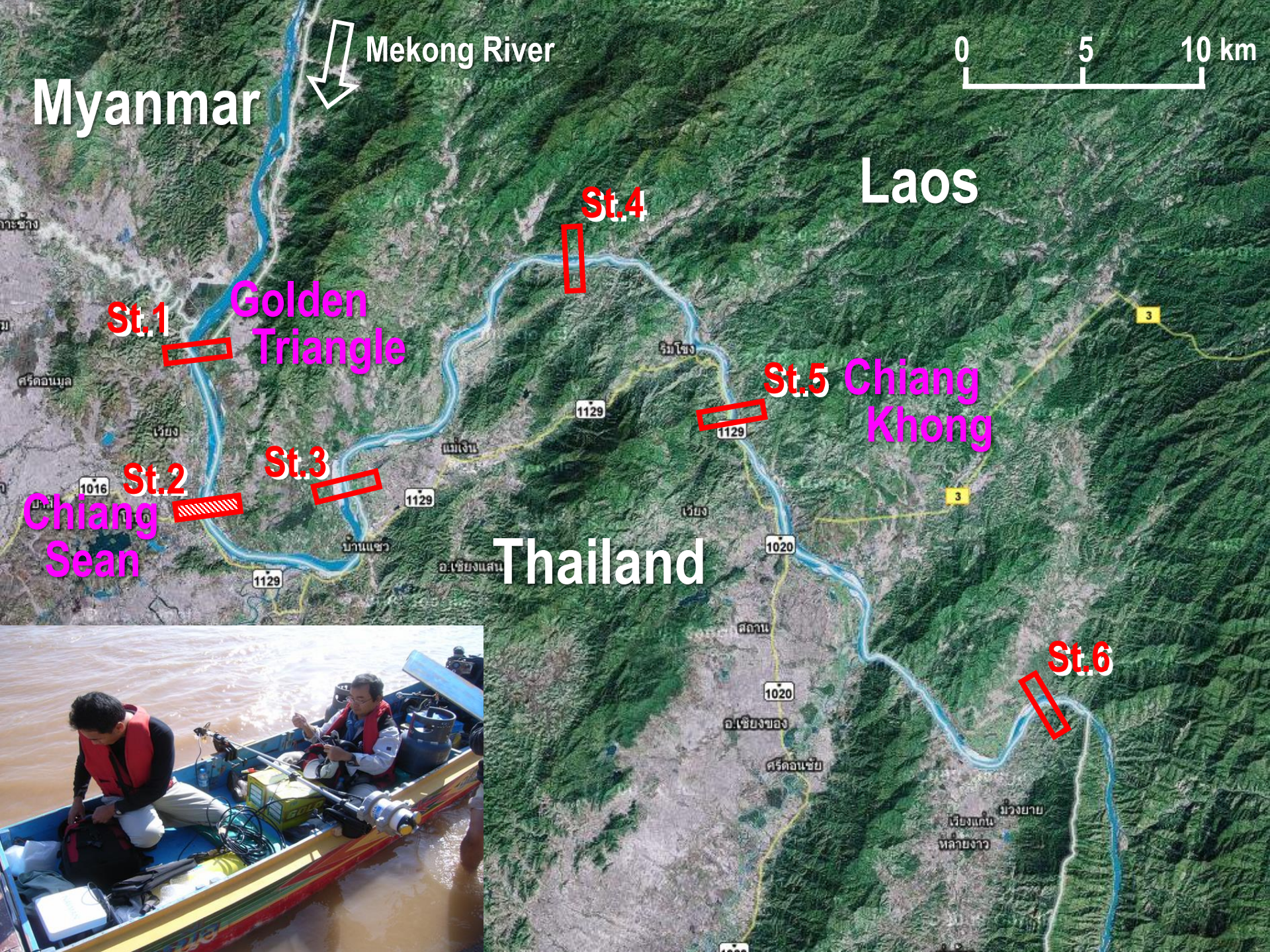


Fig.1



Anthropogenic structural changes in watershed

Target year **1991**

2002

Watershed structure

1991 & No dam

IF No dam in the upper region ?

2002 & Manwan dam

Archived observation data

1991 Daily precipitation

Daily precipitation 2002

1991 Daily
Water volume & water level
(Cheng Sean, Luan Prabang)

2002 Daily
Water volume & water level
(Cheng Sean, Luan Prabang)

Watershed Model parameters 1991 (= no dam)

Watershed Model parameters 2002

Hydro model Simulation

1991 Simulation

Virtual Simulation
1991=watershed
2002=precipitation

2002 Simulation

L-Q equation by water sampling

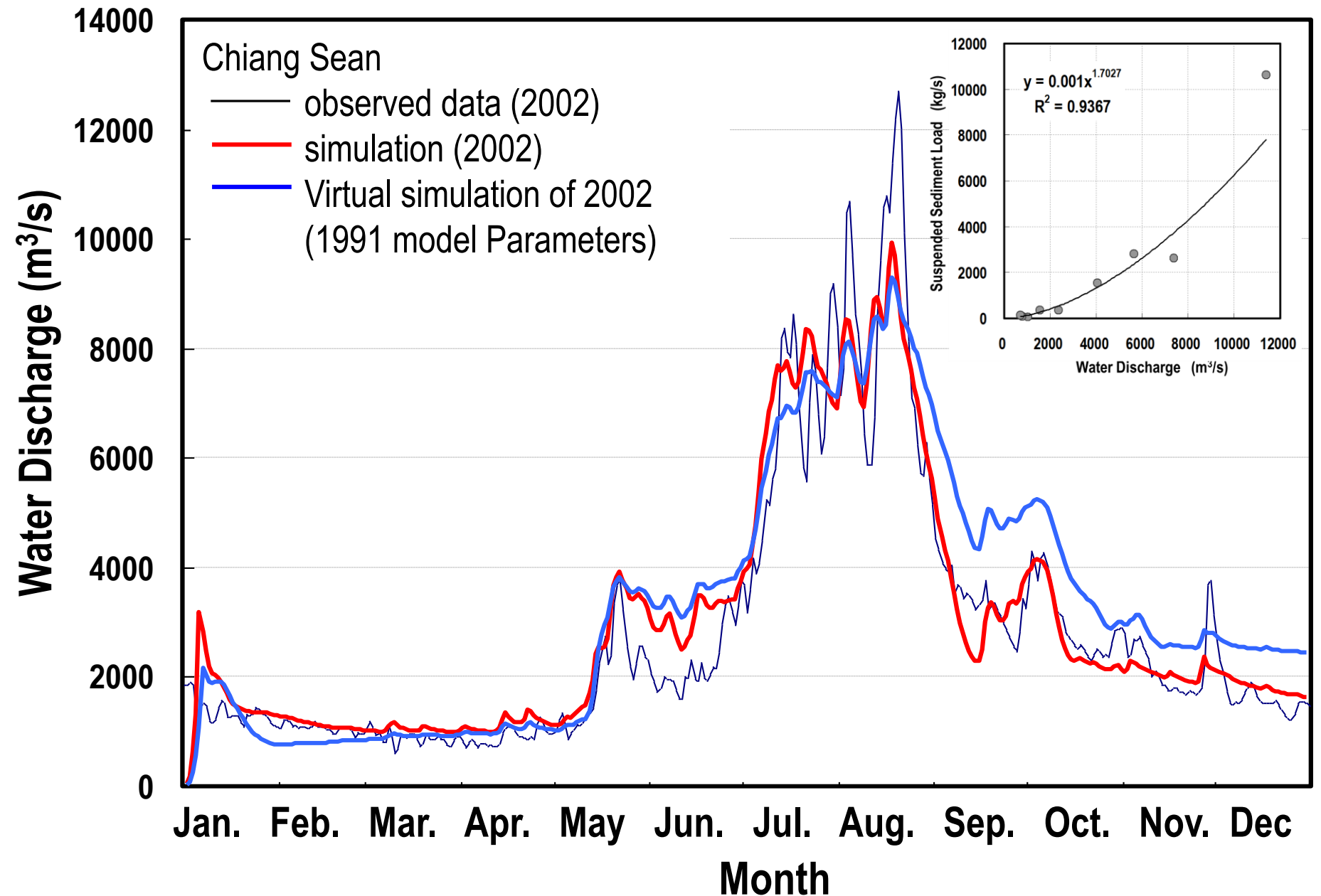
Hydrologic dynamics

River bottom tracking (ADCP)
Field survey (fish finder)

Suspended Sediment transport

Habitat evaluation of fish

Affects of anthropogenic change of watershed



The simulated annual run-off process to same watershed in two different conditions. The red data is 2002 simulation (after dam construction). The blue data is virtual simulation (no dam, 1991 parameters). In this procedure, same 2002 precipitation data was used.

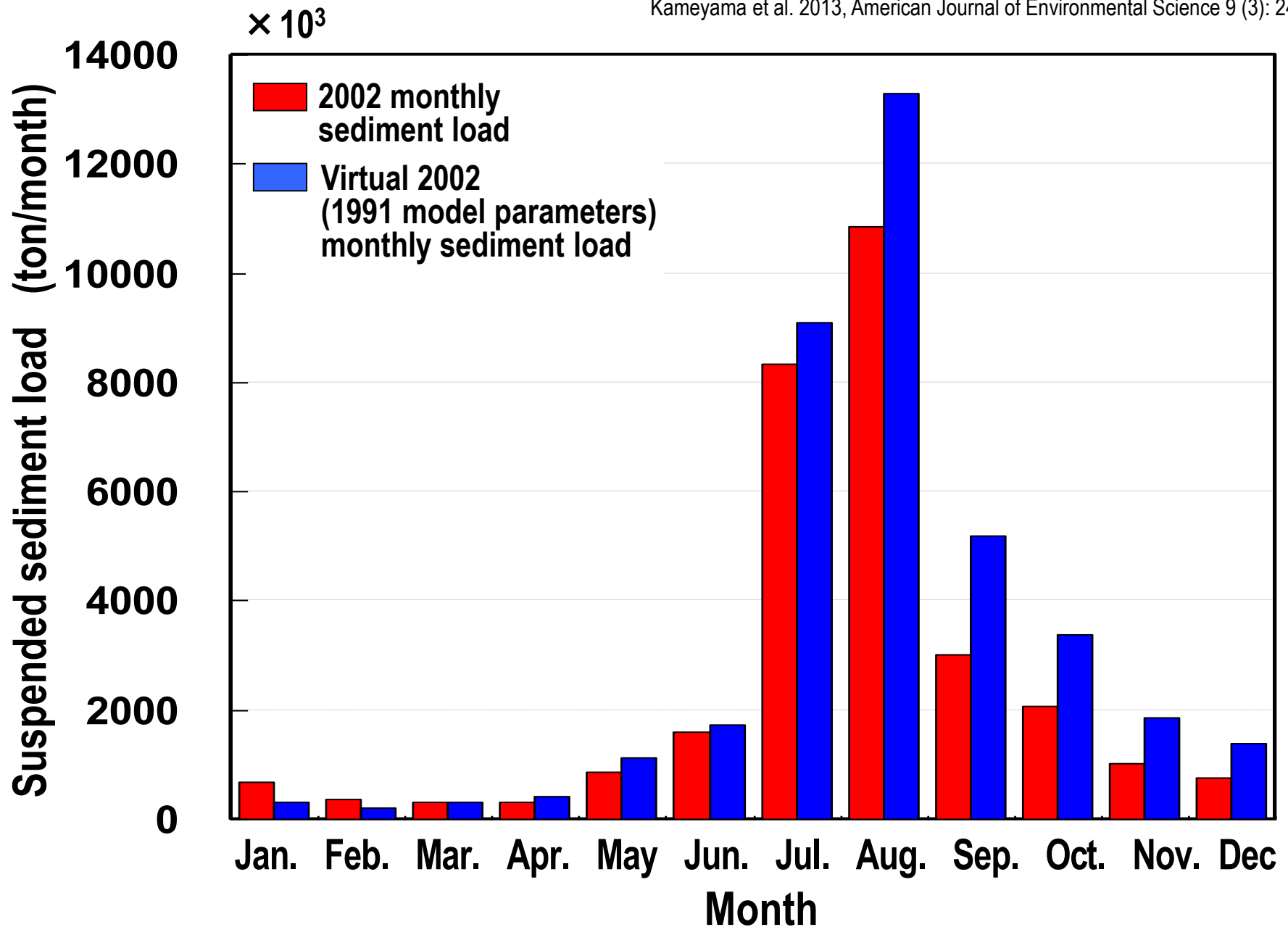
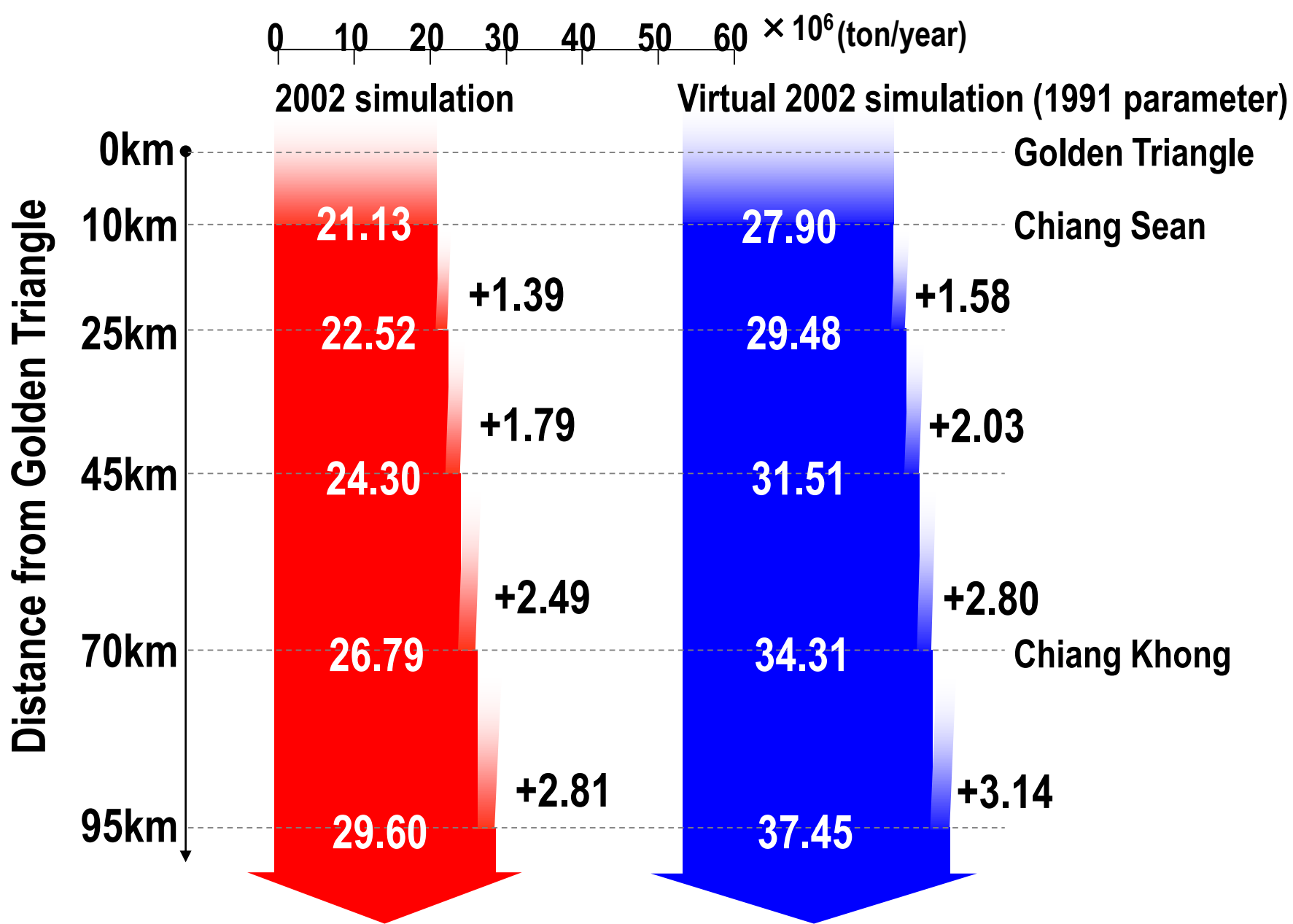


Fig. Comparison of seasonal dynamics of suspended sediment load at Chiang Sean. The red and blue bars indicate the loads calculated from the 2002 and virtual 2002 hydrographs (1991 parameter model), respectively.



Suspended sediment budget in the study site from the golden triangle to the Laos border. Red and blue arrows are results for simulations of the 2002 and virtual 2002 hydrographs (1991 parameter model)

2) Ubonrat dam = middle region

VILLAGE AREA



Ubonrat Dam constructed in 1966



2007/3/13

95°0'0"E

105°0'0"E

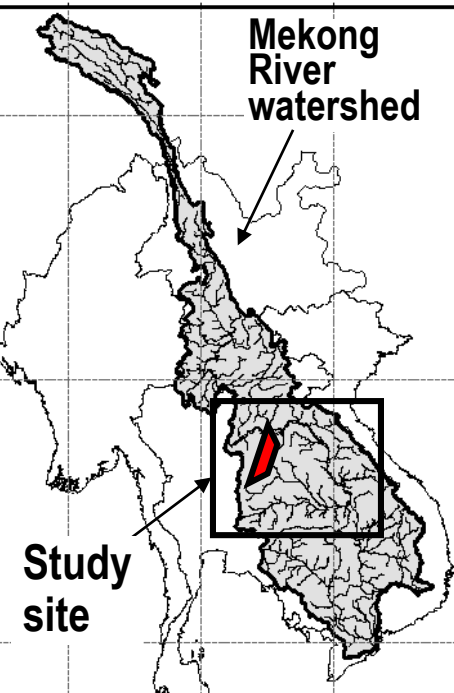
Ubonrat Dam

Pong River

Chi River

Khon
Kaen

Main Mekong
River
Mun
River



Area of
flood image analysis

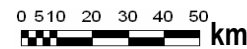
Yasorthon

Ubon

Ratchathani

Phibun

Mangsahan



Anthropogenic structural changes in watershed

Target year

1945

2002

Watershed structure

No dam & Natural river

Ubonrat dam & Channelized river

Archived observation data

Daily precipitation 2002

2002 Daily Water volume & water level
(Yasorton, Ubon Ratchani, Hhibun mangsahan)

Watershed Model parameters 2002

Virtual 2D simulation
2002=precipitation
1945=watershed

2D hydro simulation
2002=precipitation
2002=watershed

Flooded area analysis = daily
(Accumulation of flooded time on each mesh)

Landsat
ETM image

2002, Mar. 15
Sep. 23
Nov. 10

Spatial variation between simulation
and remote sensing analysis

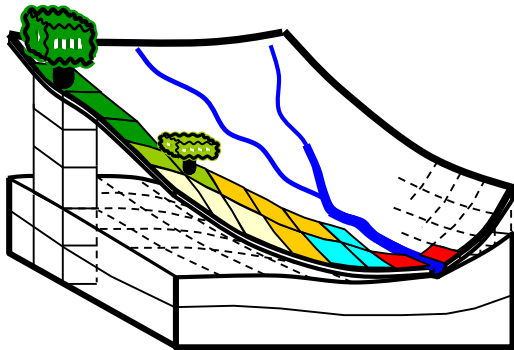
Flooded area classification map
(Spatial zoning by flooded days)

Flooded class	Flooded days in a year
A	>30
B	96-30
C	186-95
D	276-185
E	<275

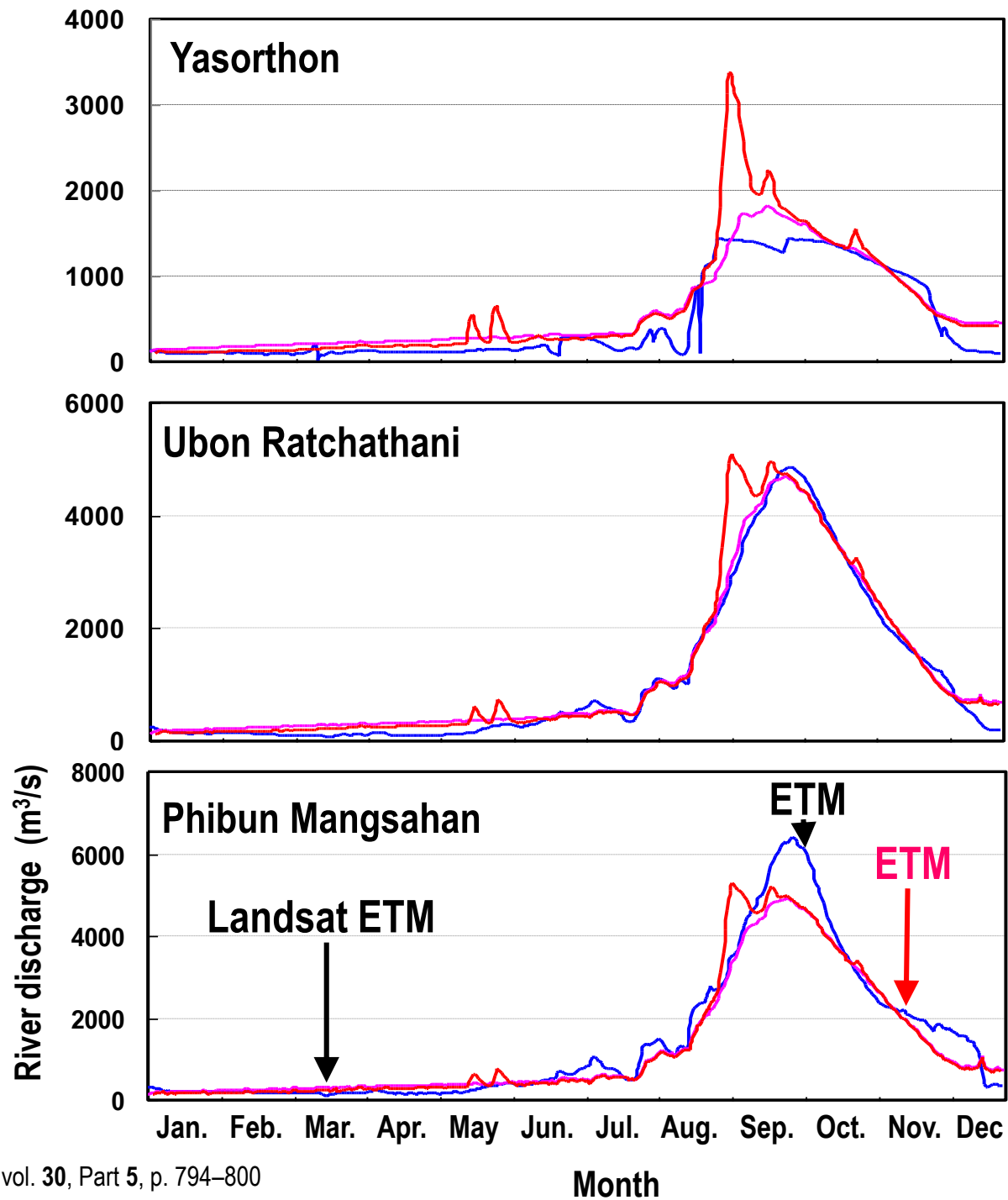
Change detection map

The hydro curve in three observation points.

Calculation based on **MIKE-SHE** and **MIKE11**

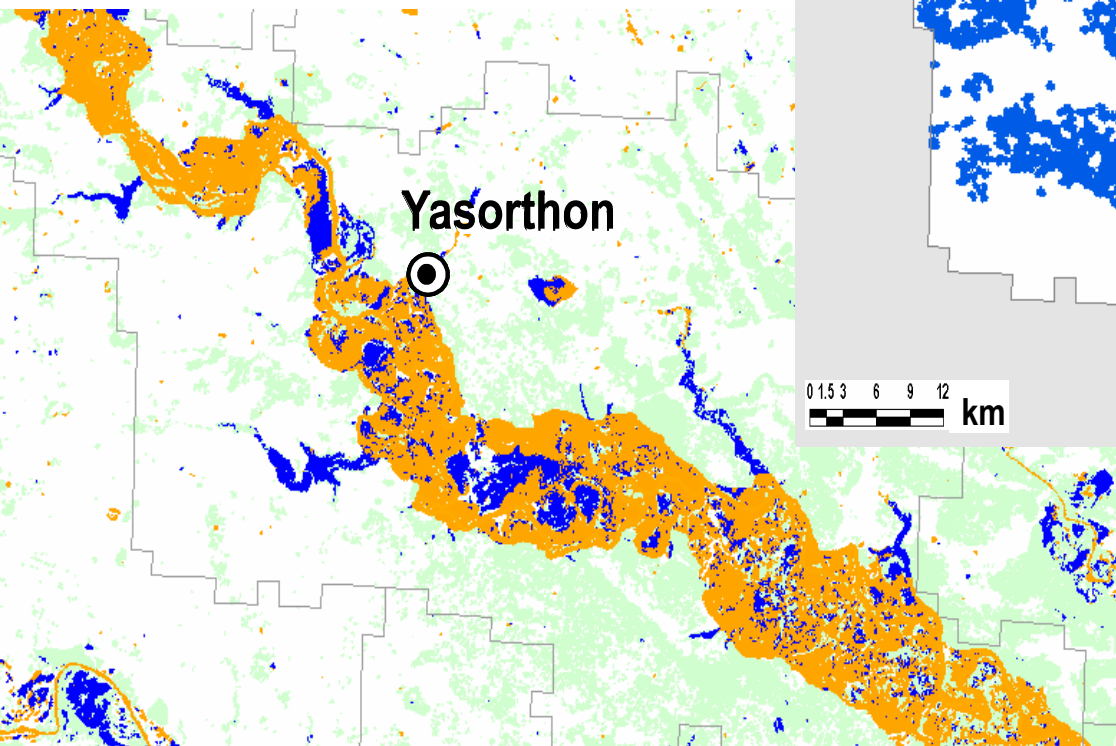


- 2002 Observation
- 1945 simulation
- 2002 simulation



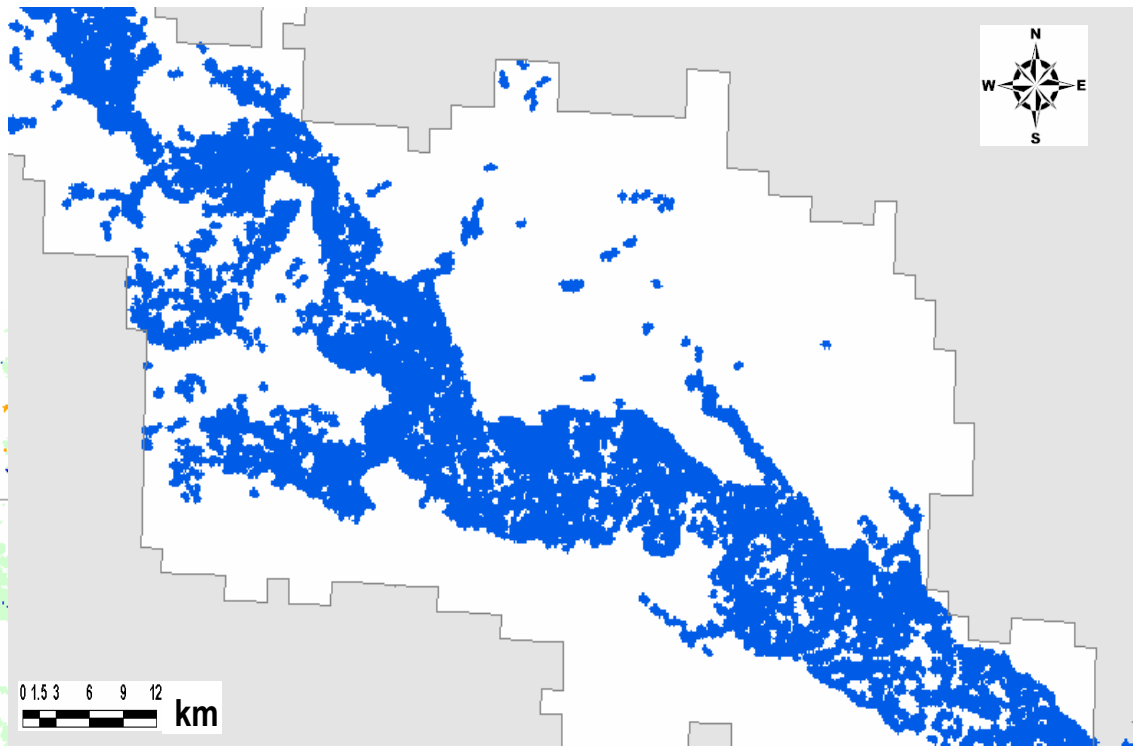
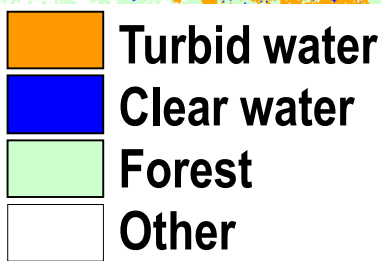
The classified satellite image and the simulated flooded area

10 November 2002



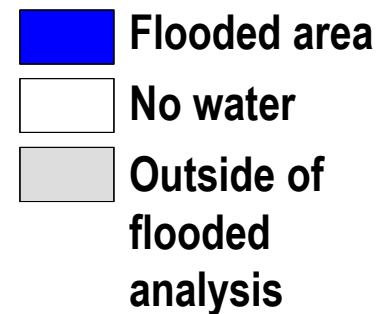
Flooded area
based on Landsat ETM image
2002/11/10, P127R049

Legend

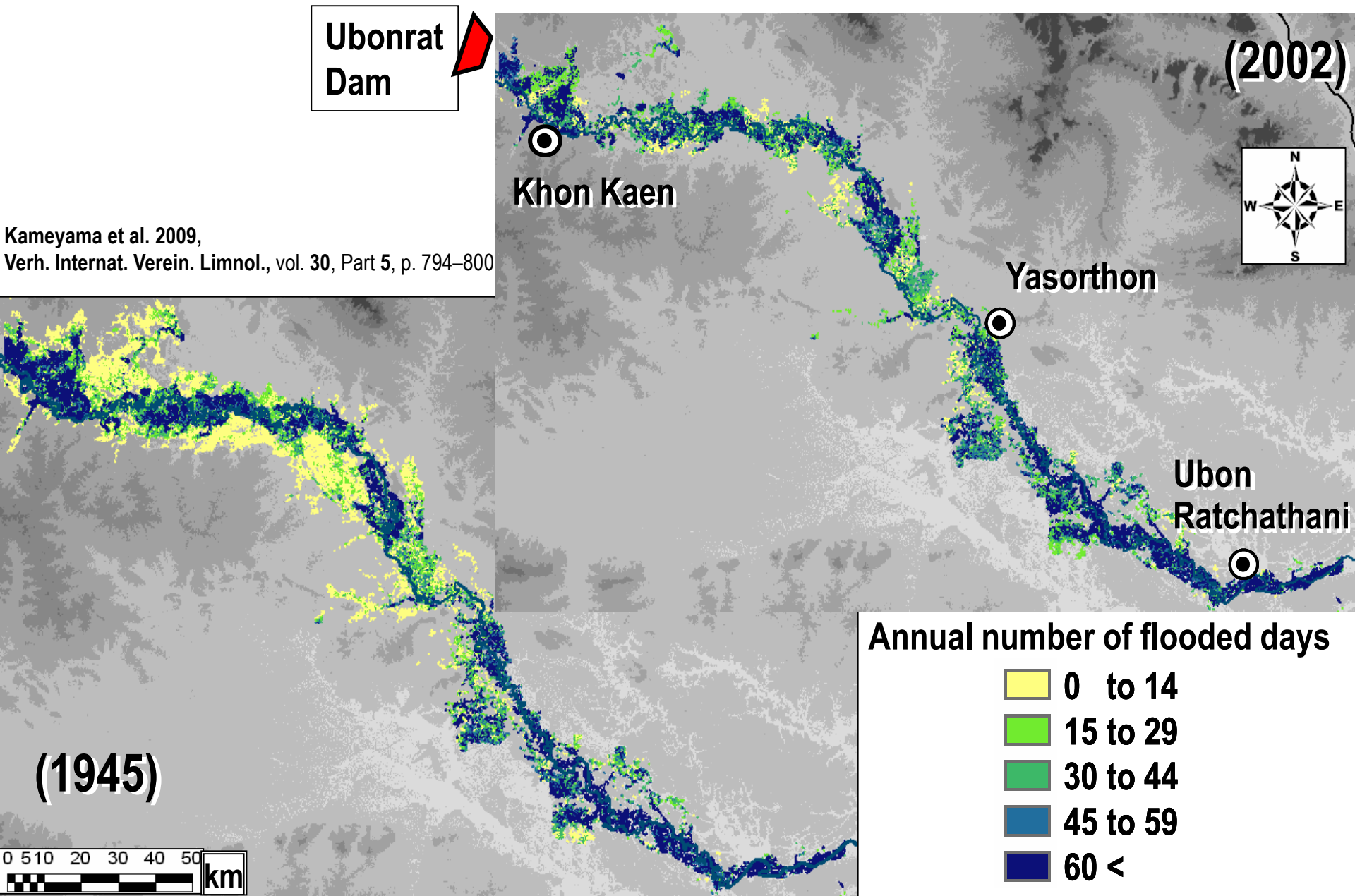


Simulated flooded area

Legend



The comparison of simulated flooded area.



The change in the number of flooded days from 1945 to 2002

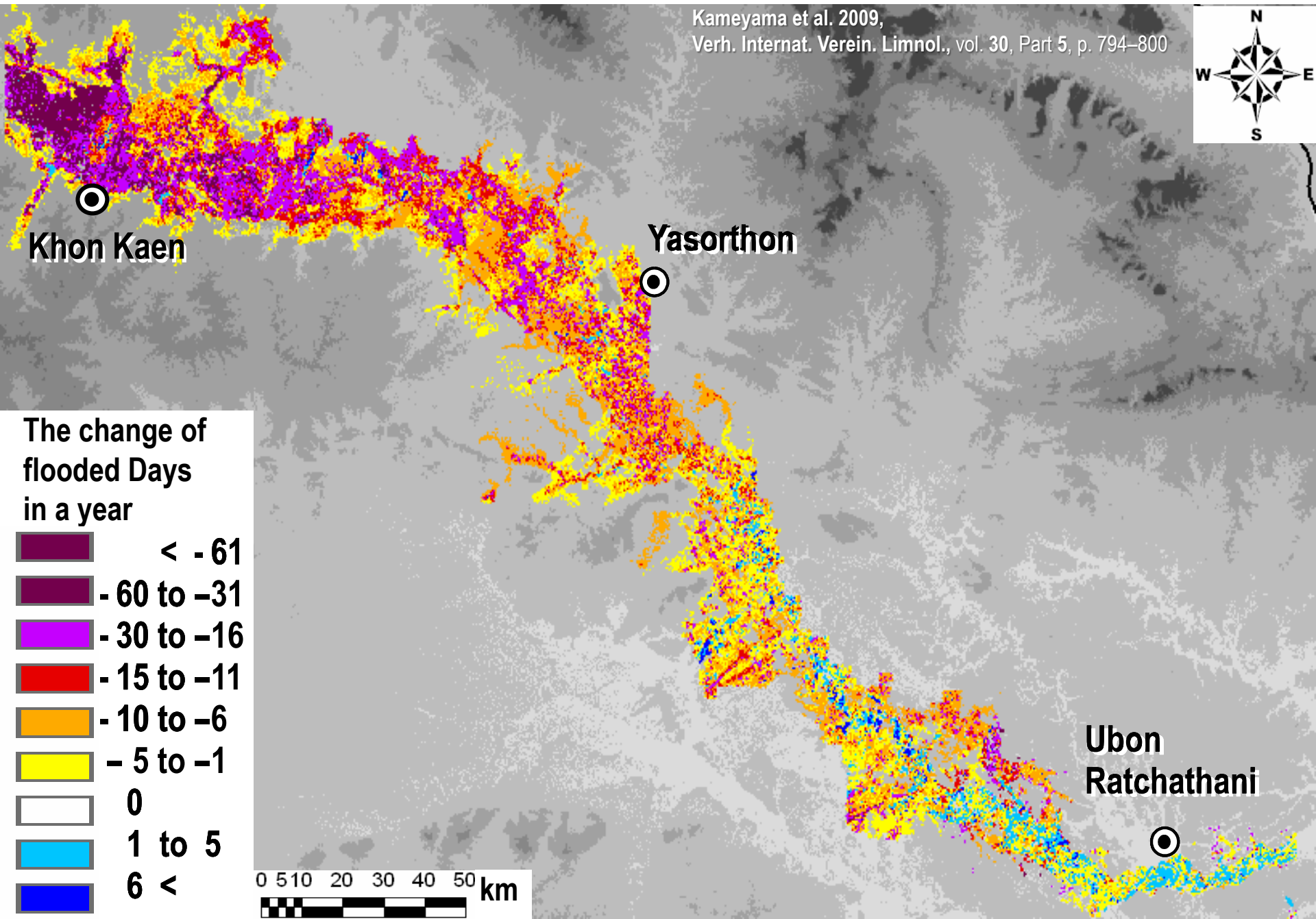
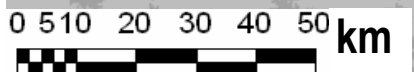
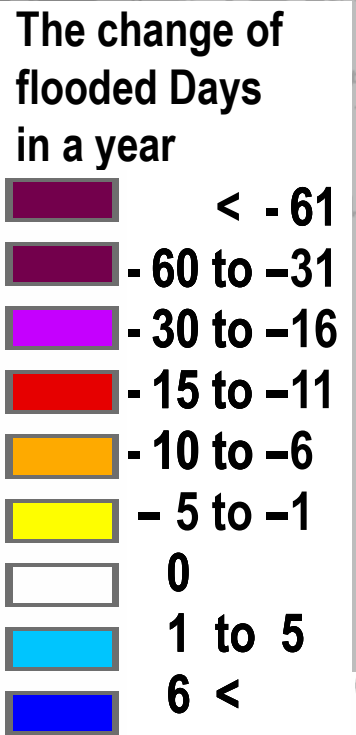
Kameyama et al. 2009,
Verh. Internat. Verein. Limnol., vol. 30, Part 5, p. 794-800



⊙
Khon Kaen

⊙
Yasorthon

⊙
Ubon Ratchathani

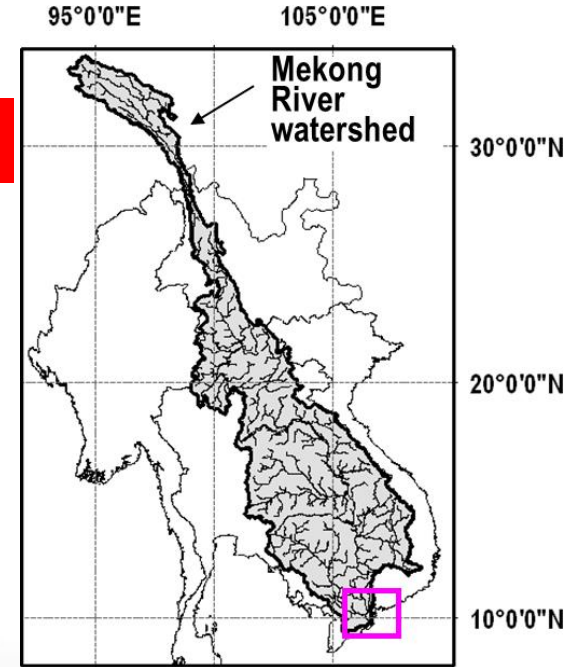


3) Mekong delta = lower region

Front line of mangrove forest in Mekong delta

The most vulnerable ecosystem to sea level rise.

CASTAL AREA



2013/04/09
N 9° 19'16.8"
E 105° 53'50.4"
Photo by S. Kameyama

Where is the original coastal line ?

← Ocean side

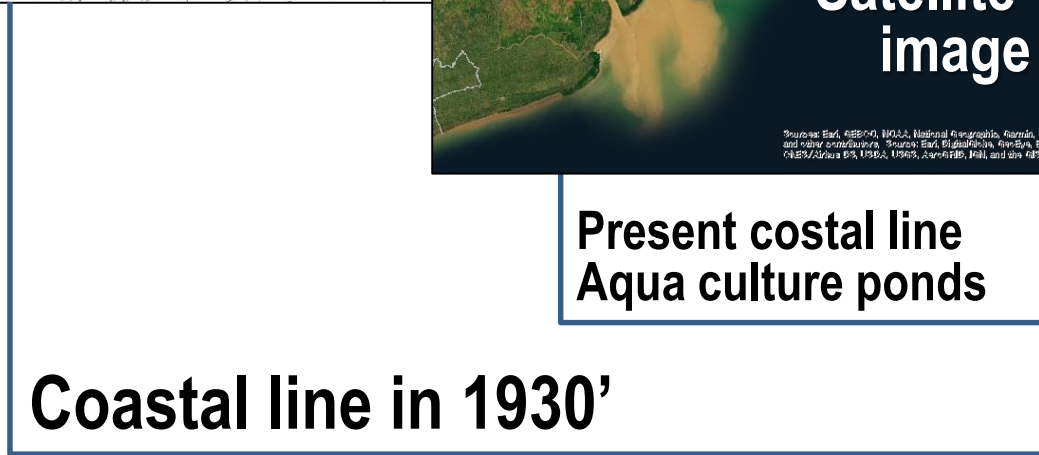
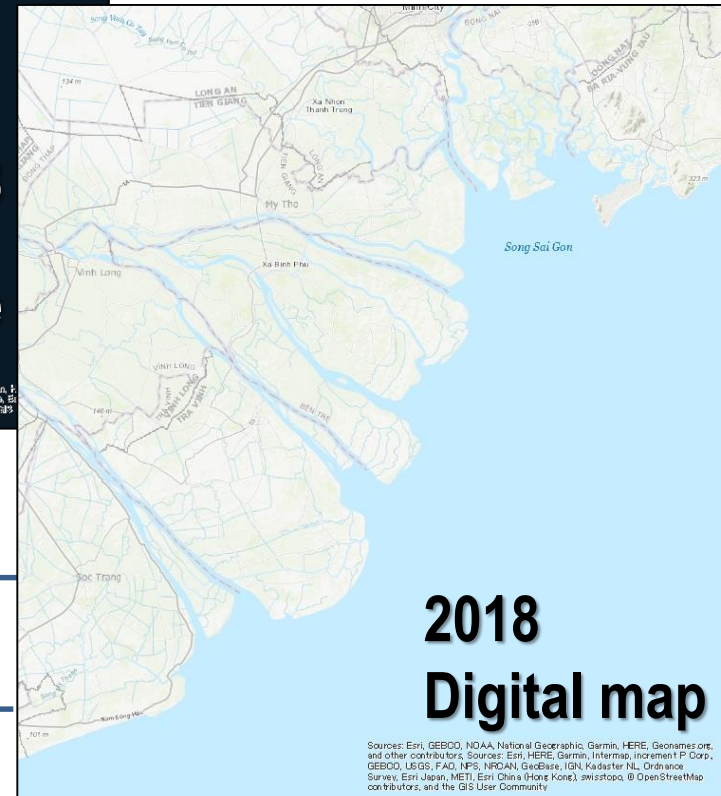
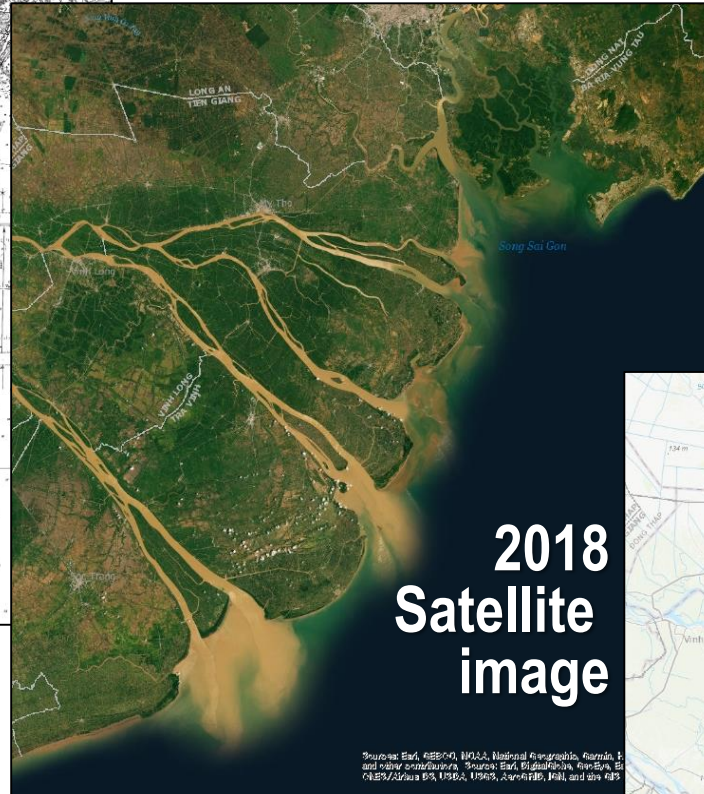
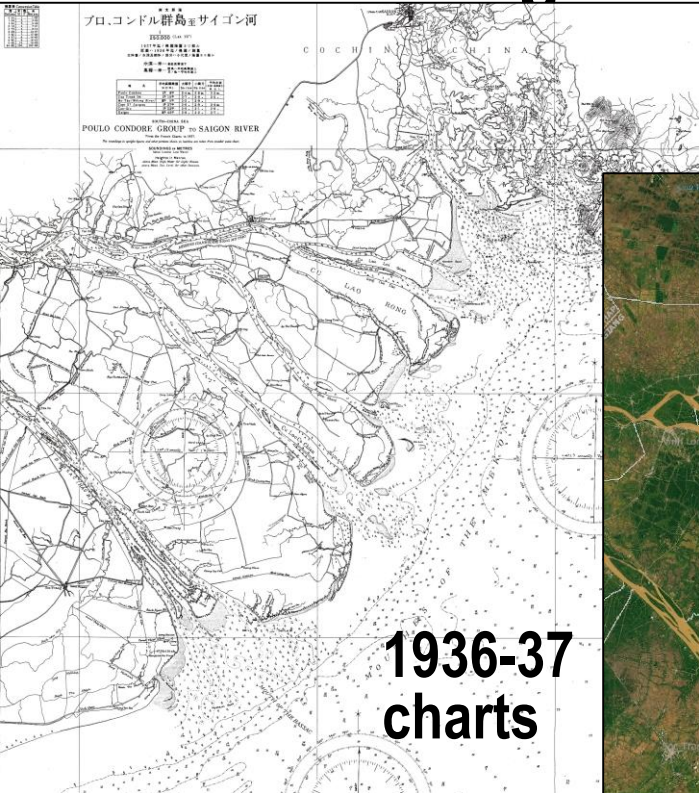
The front line of plantation ?

Terrestrial side →



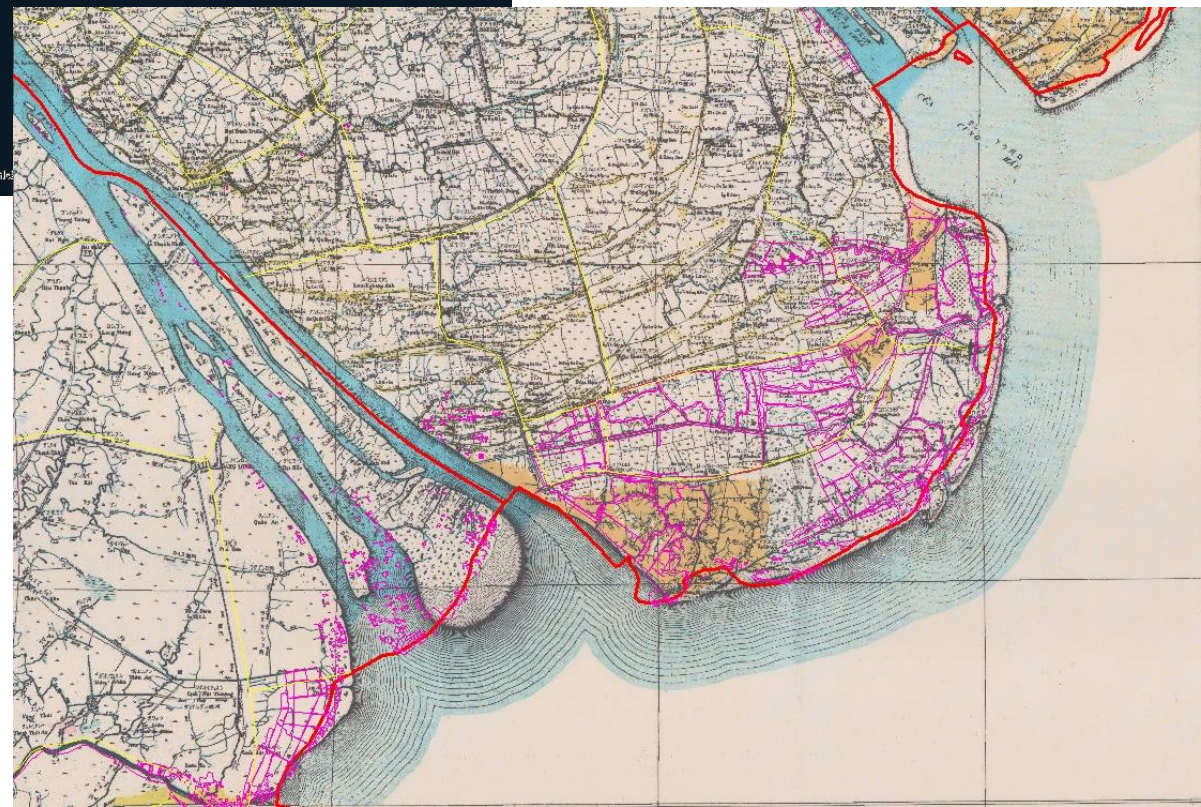
Historical change of coastal area and shore line

Data integration in GIS





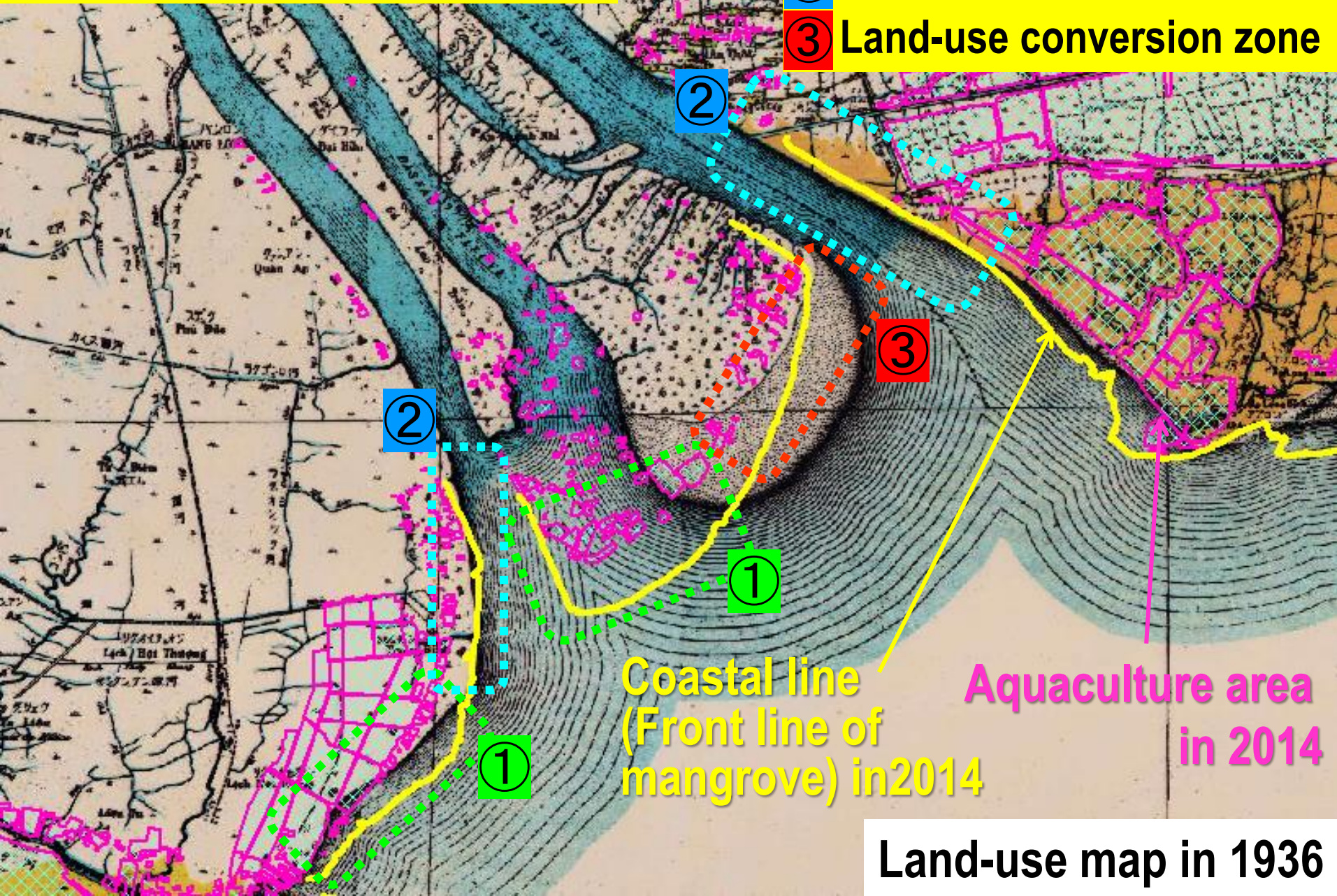
Where is the best (better) restoration sited for coastal ecosystem



Source: Esri, DigitalGlobe, GeoEye, IGN, AerGRID, AIR, and the IGN Community. Source: Esri, DigitalGlobe, GeoEye, IGN, AerGRID, AIR, and the IGN Community. Source: Esri, DigitalGlobe, GeoEye, IGN, AerGRID, AIR, and the IGN Community.

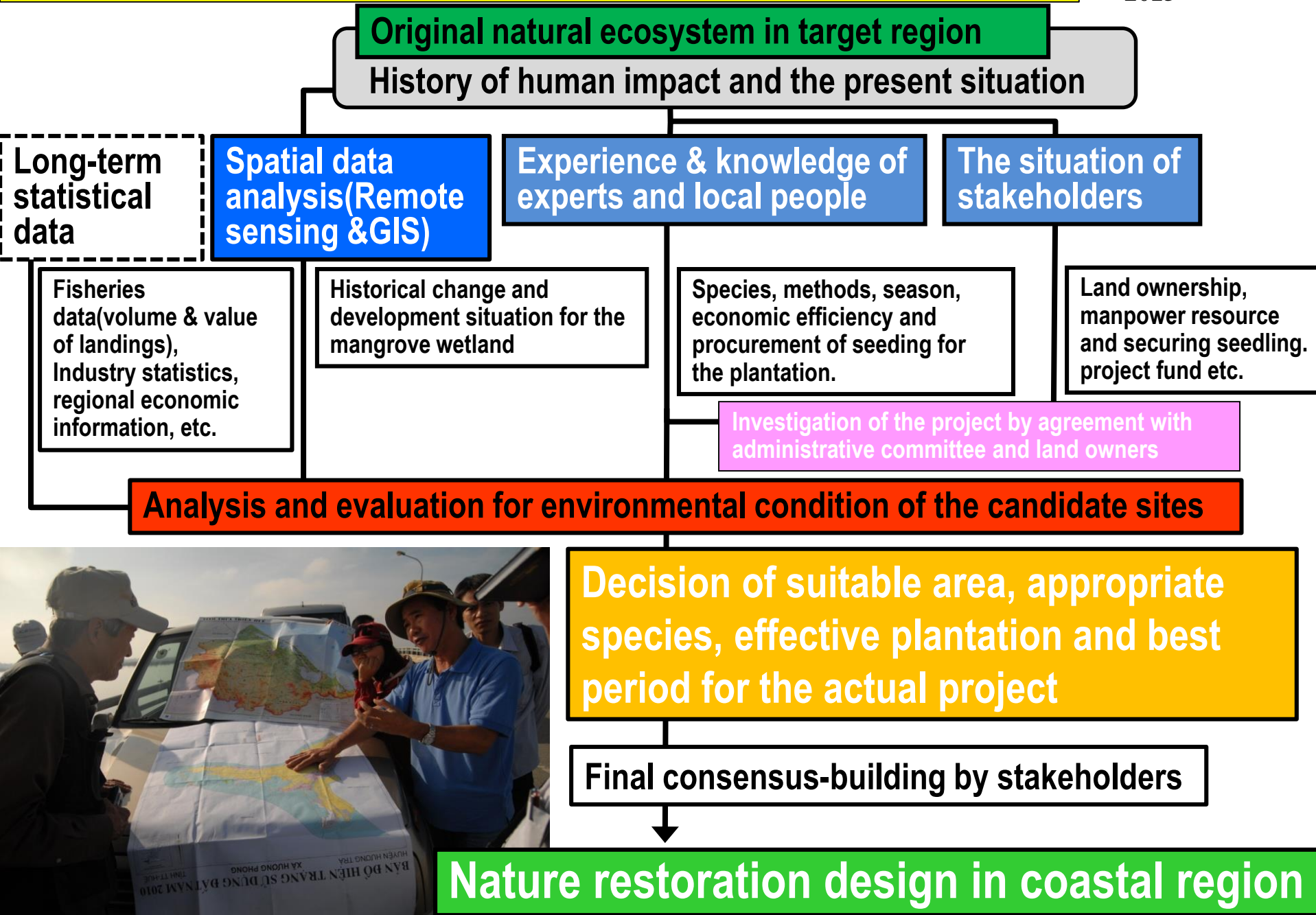
Adaptation measures

- ① Nature restoration zone
- ② Protect zone
- ③ Land-use conversion zone



A strategies for adaptation to environmental change

Modified from
Kameyama et al.
2015



Thank you for your attention!!.



Dr. Nguyen Thi Kim Cuc

Dr. Phan Nguyen Hong

Vietnam Red Cross Society & People's Committee



**Tetsumi Asano
Seiji Suda
Chiharu Miyamoto
(ACTMANG)**

**The local family living in
Ca Mau province
(2016/06/16)**



**Dr. Franz Nestmann (KIT)
Dr. Tran Duc Dung (VNU)**



Students of VJU-VNU

We are waiting friendly partners, please contact “kame@nies.go.jp”