SHIMANE
University

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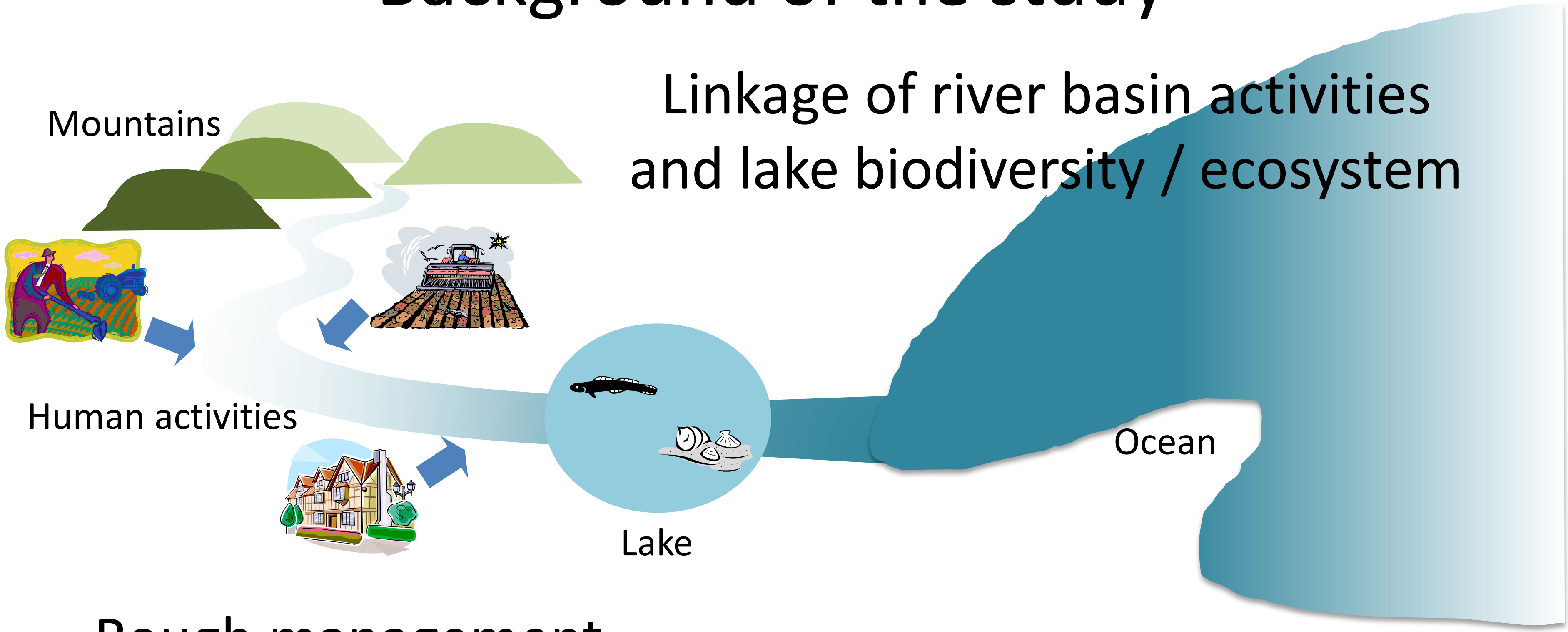
SWAT 2013
Toulouse France

Evaluation of small watersheds inflowing Lake Shinji against the water environment

Shimane University
Hiroaki SOMURA

Background of the study

Linkage of river basin activities and lake biodiversity / ecosystem



Rough management in agriculture and forestry

Watershed degradation

Rapid aging of the population resulting from the decline in the birthrate

Impact / damage to economic activities, water environment and biodiversity

About Lake Shinji: Why important?

1. Brackish lake: Delicate balance of saline and fresh water
2. Salinity level: 1/10 of sea water
3. Average water depth: 4.5m
4. The third largest brackish lake in Japan (79.1km^2)
5. 80 species of brackish water fish and shellfish
6. Annual catch of the clam is about ~~7,000t~~ (40% of National total)
7. Sales amount of the clam is about ~~40 million~~ dollars in the lake

3,700t (2010)
2,200t (2011)
23% of NT

Less than half?

Size: 2cm

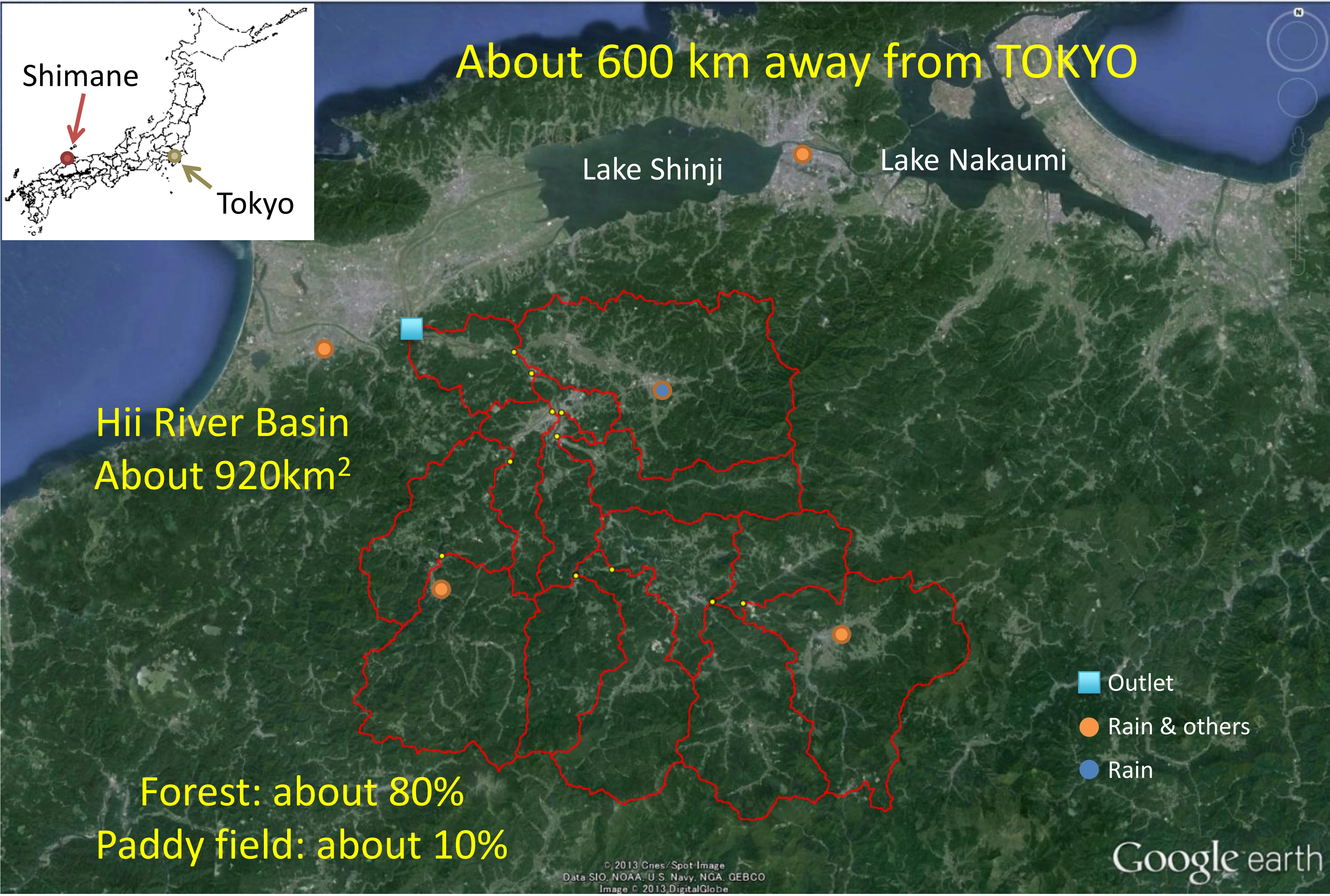
http://www2.odn.ne.jp/shokuzai/Shijimi.htm

Corbicula japonica Prime,1864

Size: 5cm

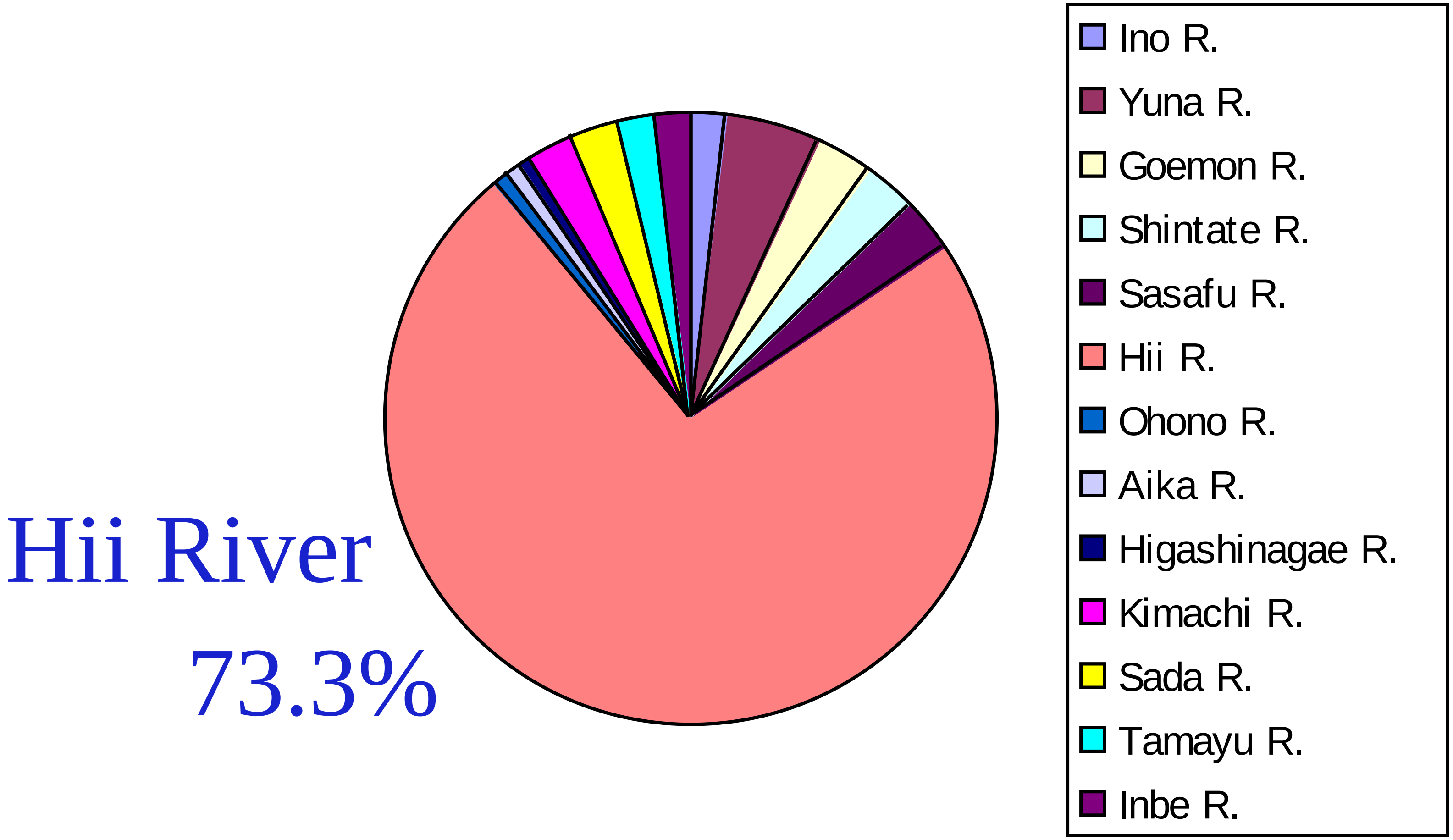
http://fishing-forum.org/zukan/mashtml/M000712_1.htm

Gymnogobius taranetzi,1878

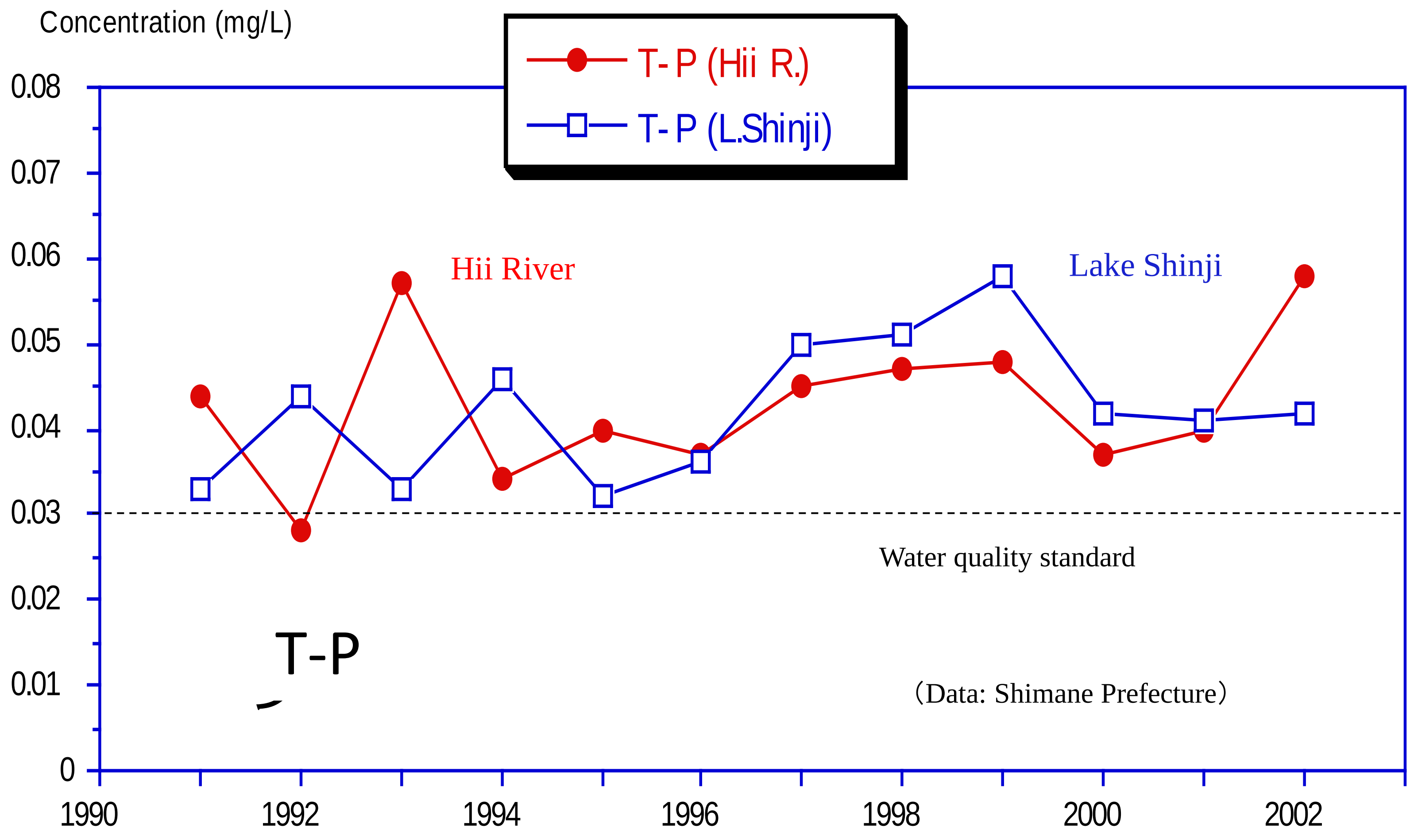


Location of Hii River basin

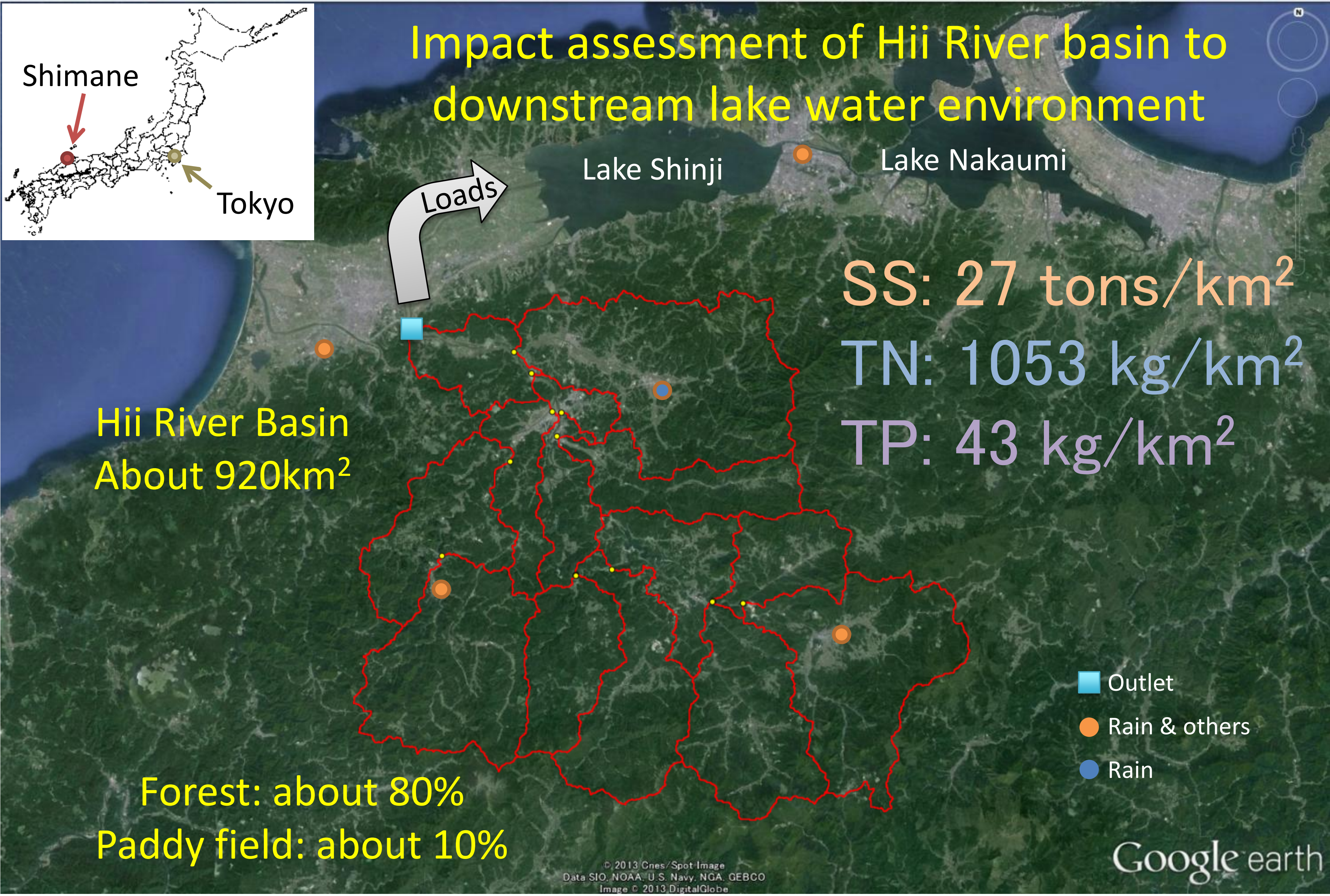
Percentage of catchment area of rivers flowing into Lake Shinji



Average Water Quality
- Hii River and Lake Shinji -



Made by Dr. Ikuo TAKEDA



Results of Previous Study -Hii River basin-

Published in Journal of Hydrology

Results of Previous Study

Unit loads from each land use under both fine and rainy days conditions

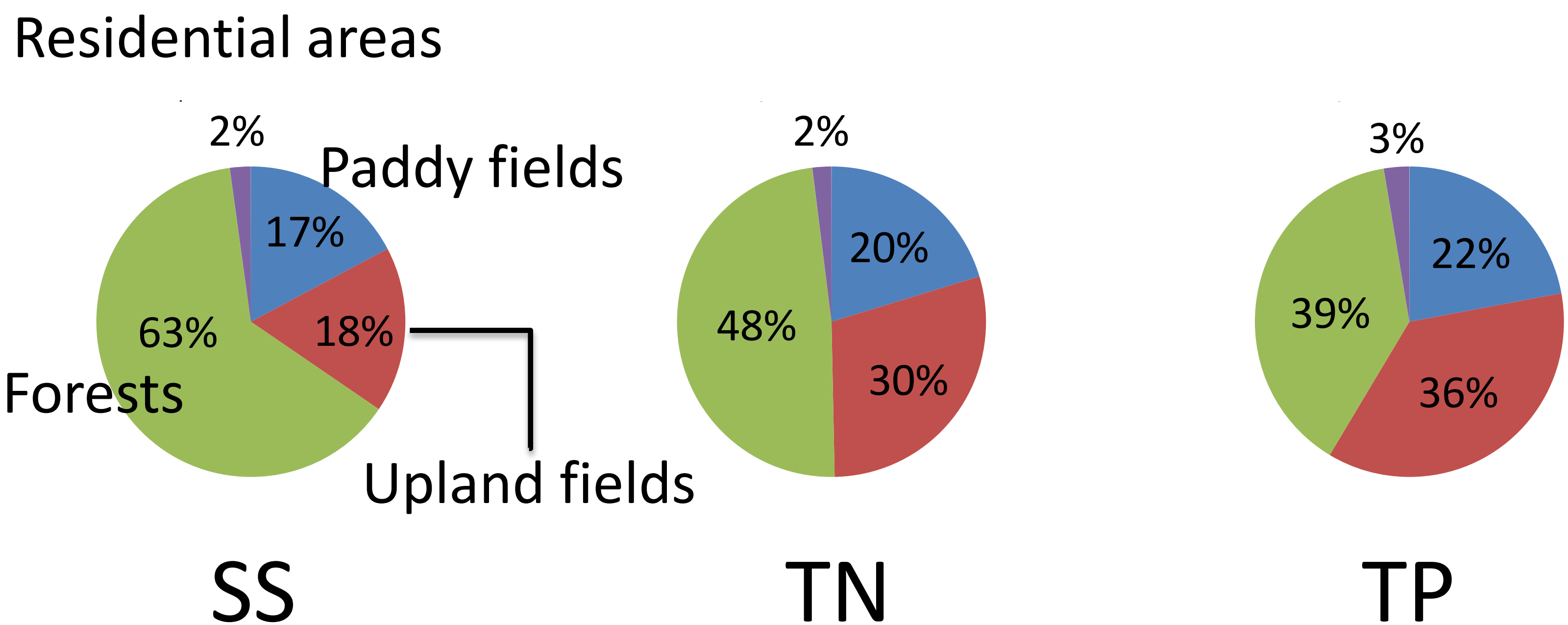
		Paddy fields	Upland fields (include Japanese tea and persimmon)	Forests	Residen. areas
SS (ton km^{-2})	Fine day	1.9	3.1	0.5	0.6
	Rainy day	25.4	119.6	11.6	23.6
TN (ton km^{-2})	Fine day	828.7	5261.4	180.5	330.2
	Rainy day	1277.9	8363.0	425.2	1107.8
TP (kg km^{-2})	Fine day	5.3	15.3	0.7	2.3
	Rainy day	77.6	595.7	16.9	67.5

Forests < Residen. areas < Paddy fields < Uplands

Published in Journal of Hydrology

Results of Previous Study

Ratios of SS, TN, and TP loads from each land use against total loads



- SS, TN, TP loads, there are the biggest impact from the forests
- TP load, agricultural lands has big influence against total loads

Published in Journal of Hydrology

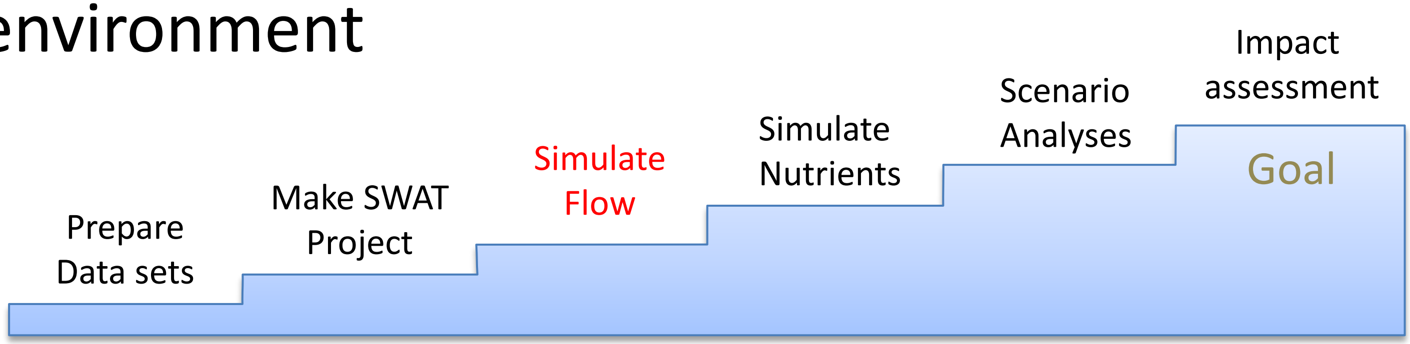
Objectives

We didn't consider small river basins around the Lake Shinji

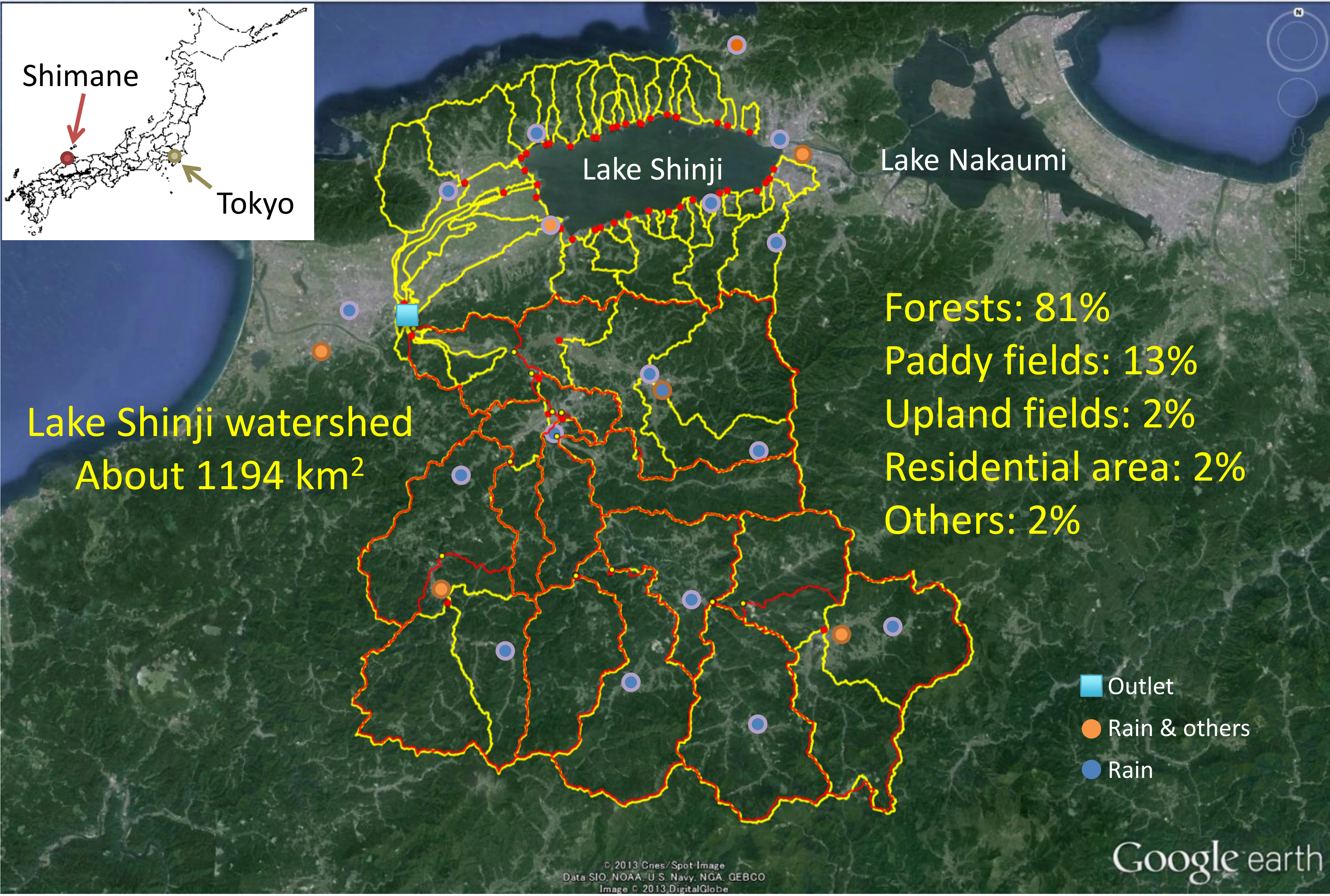
For more accurate analysis, we have paid attention to small river basins around the lake along with Hii River basin

The aim of this study

- Estimate the amount of flow and nutrient discharges from small river basins to the downstream lake
- Evaluate influences of the basins to the lake water environment



Toulouse



Location of Study Area

Simulation periods and input data

Watershed

Divided into 64 subbasins

Input data period: 1985-2011

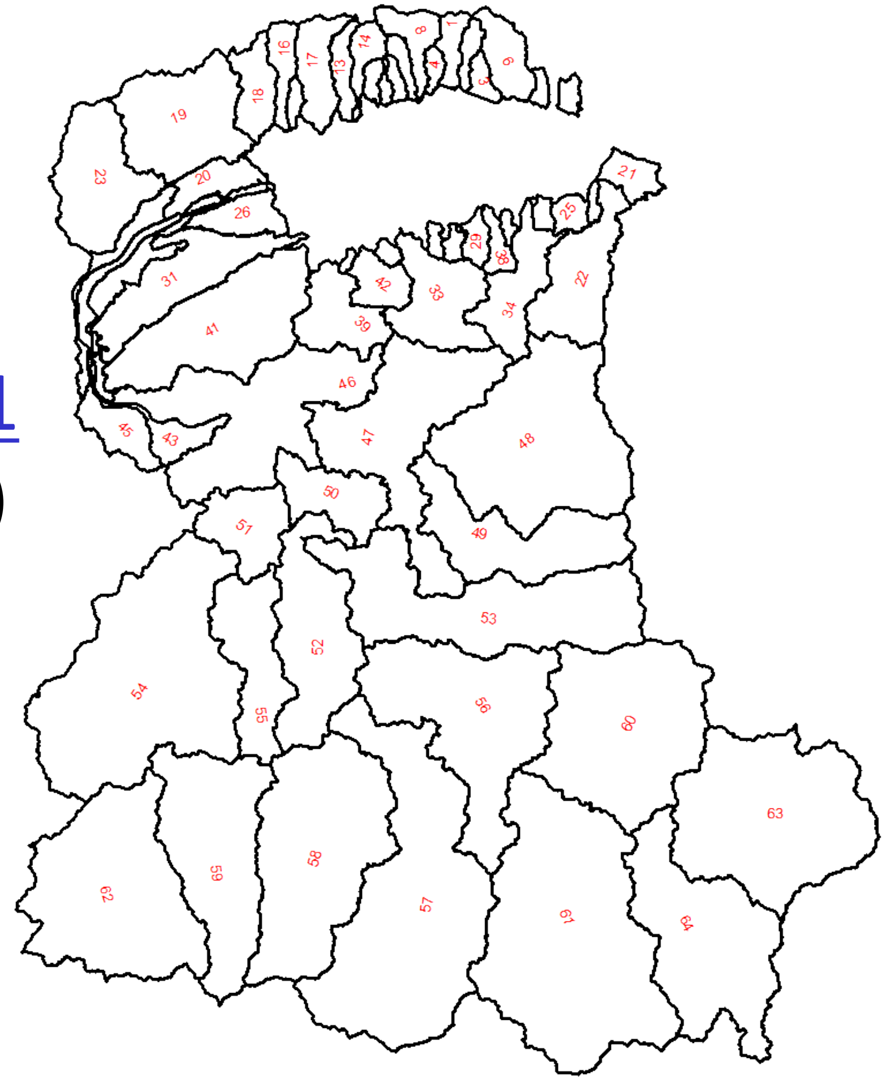
Calibration: 1988-1997 (10 years)

Validation: 1998-2011 (14 years)

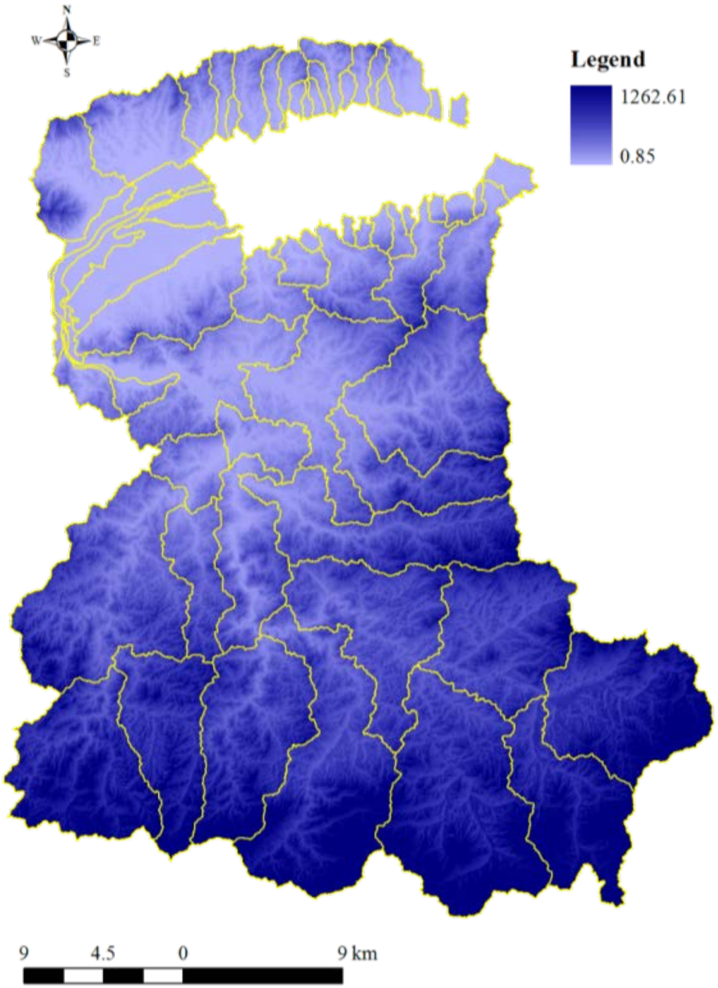
Warm-up: 1985-1987 (3 years)

Target of simulation

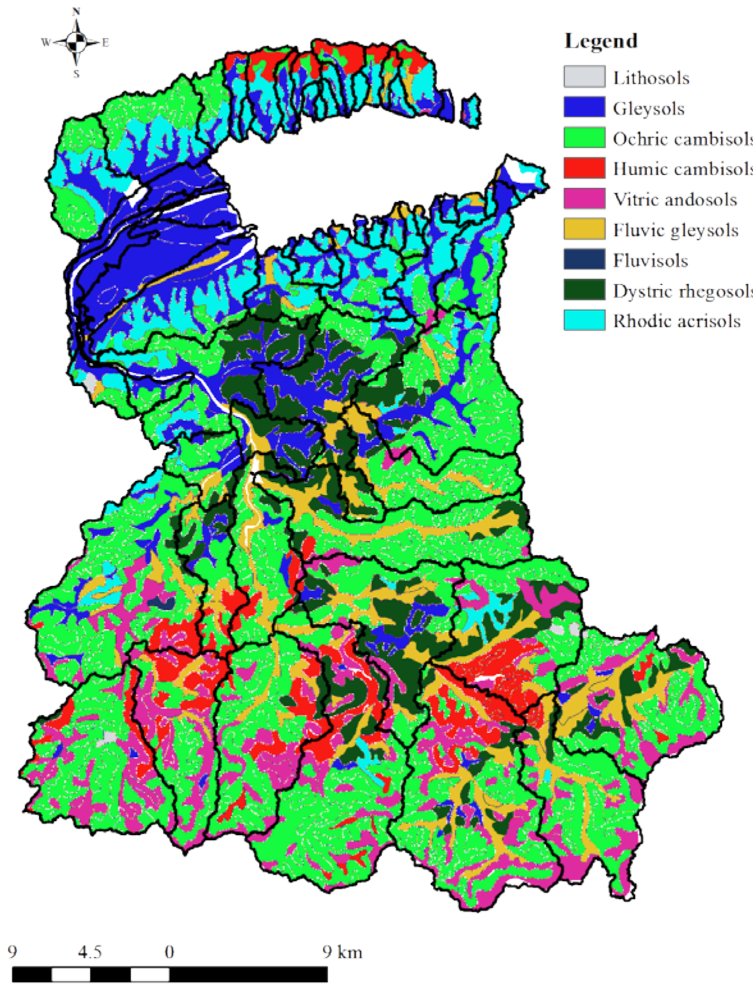
Flow: Monthly basis



DEM and Soil GIS data

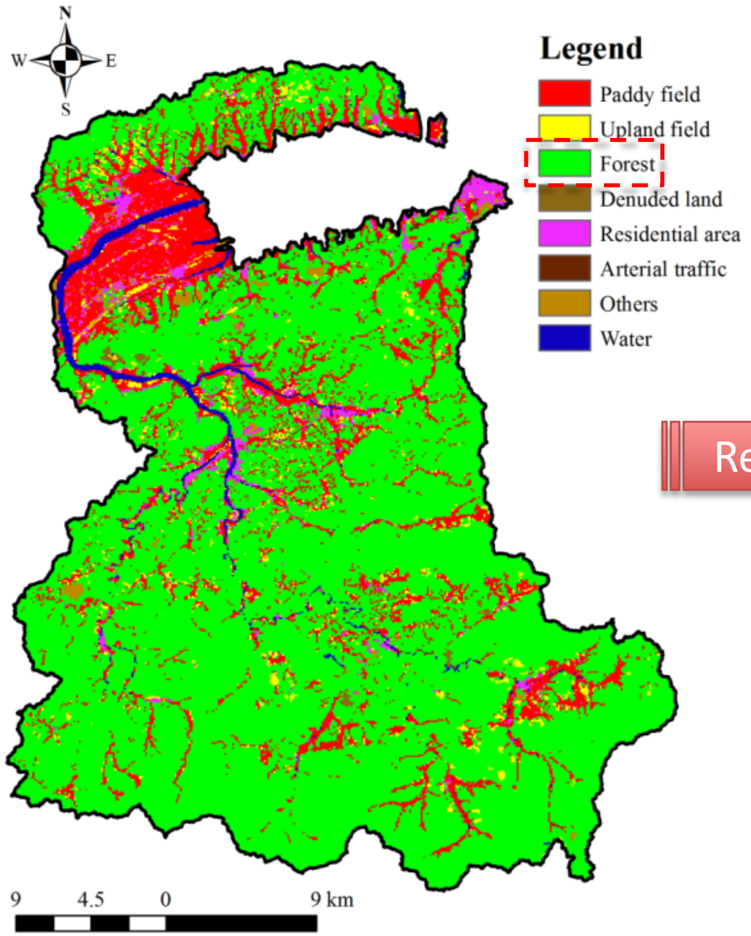


10m DEM

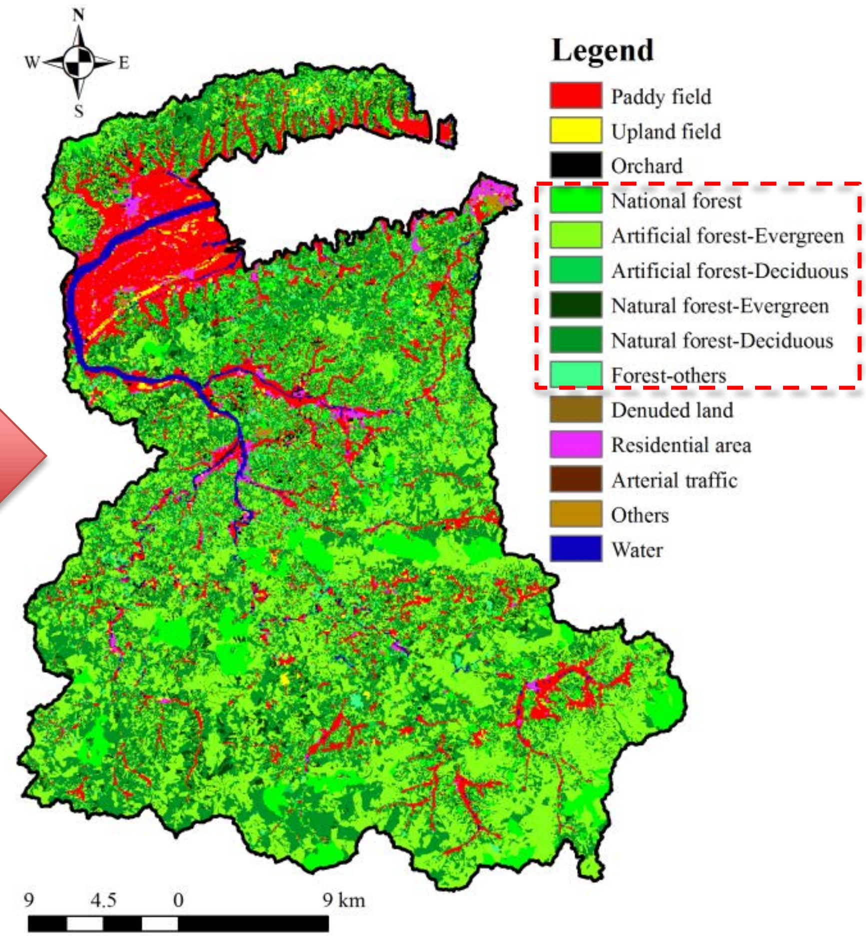


1:200,000 Soil Data

Land use GIS data



Refinement



Previous study

Current study

Parameter values calibration

Parameter values were calibrated "Manually" basically

Alpha-baseflow: Baseflow Filter Program (J.G. Arnold and P.M Allen, 1999)

Sensitive parameters

Ranking	Parameter	Definition
1	ESCO	Soil evaporation compensation coefficient
2	CANMX	Maximum canopy storage
3	CN2	Moisture condition II curve number
4	Sol_AWC	Available water Capacity
5	BLAI	Potential maximum leaf area index for the plant
6	Sol_Z	Depth from soil surface to bottom layer
7	GWQMN	Threshold water level in shallow aquifer for base flow
8	Ch_K2	Effective hydraulic conductivity of channel

Model Performance Evaluation

1. Nash-Sutcliffe efficiency (*NSE*)
2. Coefficient of determination (R^2)
3. RMSE -observations standard deviation ratio (*RAR*)
4. Percent bias (*PBIAS*)

Model performance criteria

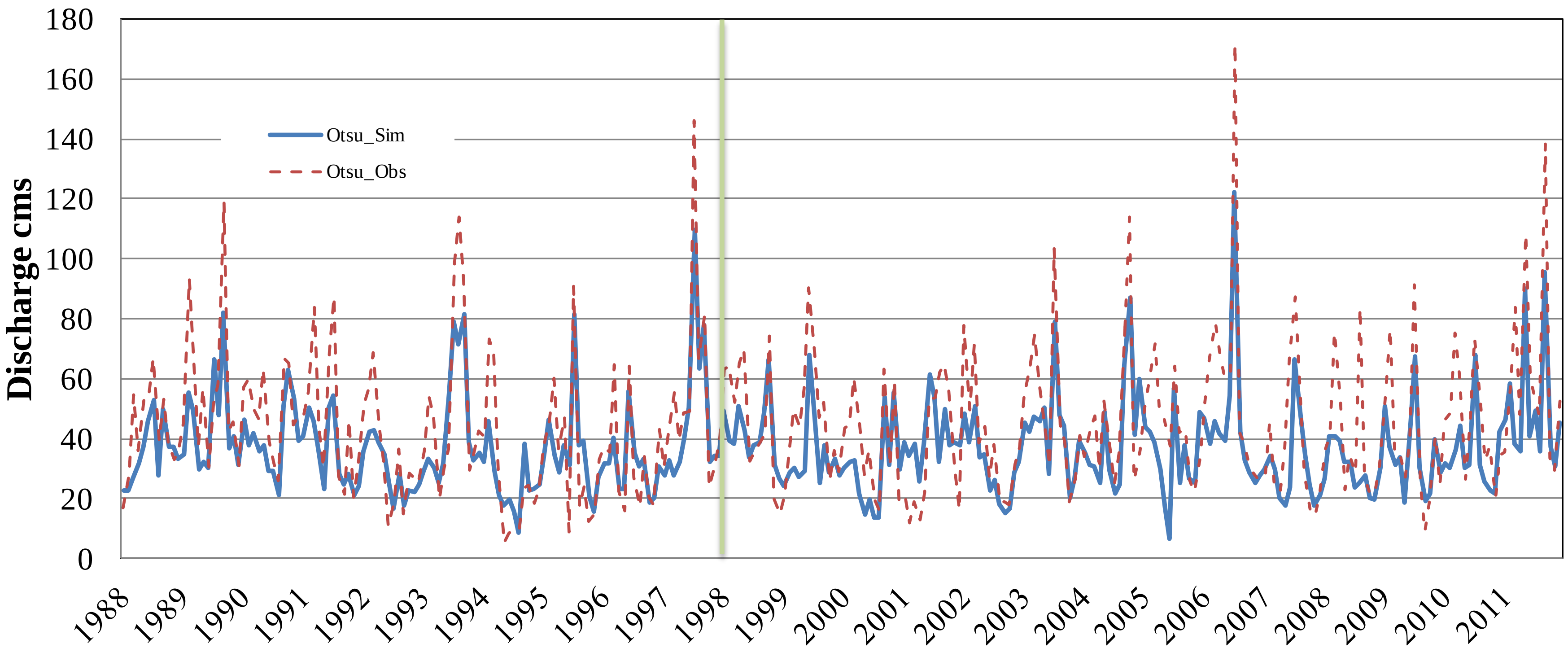
Satisfactory

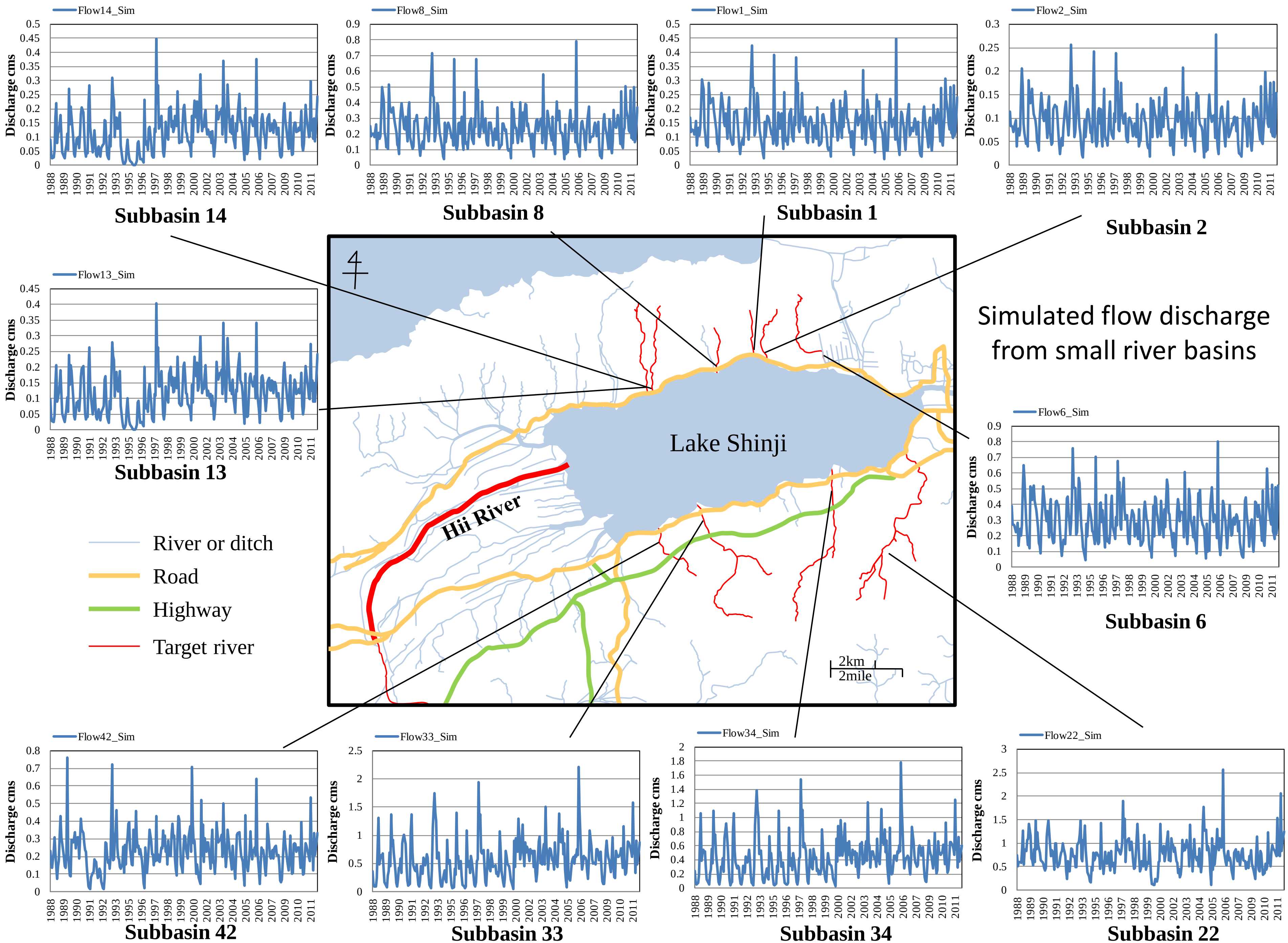
Flow: NSE > 0.5; RSR ≤ 0.7; PBIAS ±25%

(Moriasi et al., 2007)

Reproducibility of steam flow

	Calibration 1988-1997	Validation 1998-2011
NSE	0.64	0.51
R^2	0.75	0.65
RSR	0.60	0.70
PBIAS	15	18




Simulated flow discharge from small river basins
Lake Shinji
Hii River
River or ditch
Road
Highway
Target river
2km
2mile
Subbasin 14
Subbasin 8
Subbasin 1
Subbasin 2
Subbasin 13
Subbasin 6
Subbasin 42
Subbasin 33
Subbasin 34
Subbasin 22
Flow14_Sim
Flow8_Sim
Flow1_Sim
Flow2_Sim
Flow13_Sim
Flow6_Sim
Flow42_Sim
Flow33_Sim
Flow34_Sim
Flow22_Sim
Discharge cms

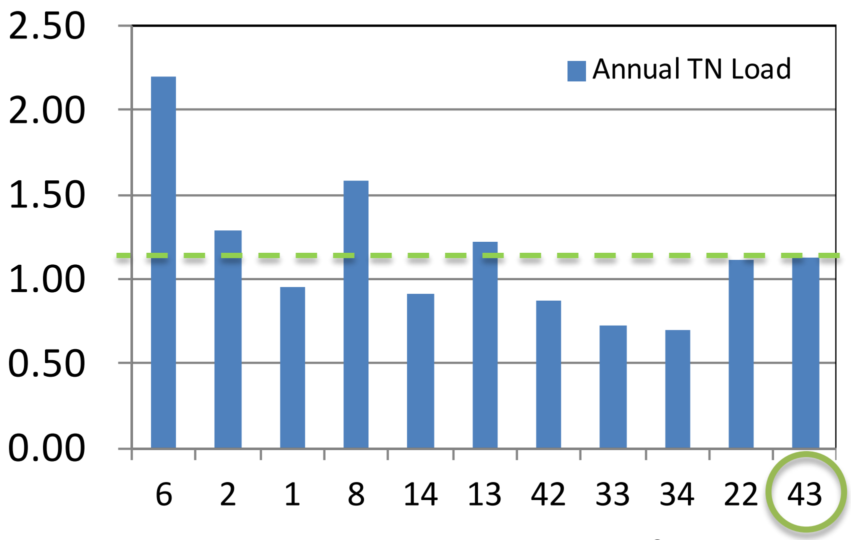
Field investigation

To calibrate model parameter values,
we've started measuring flow

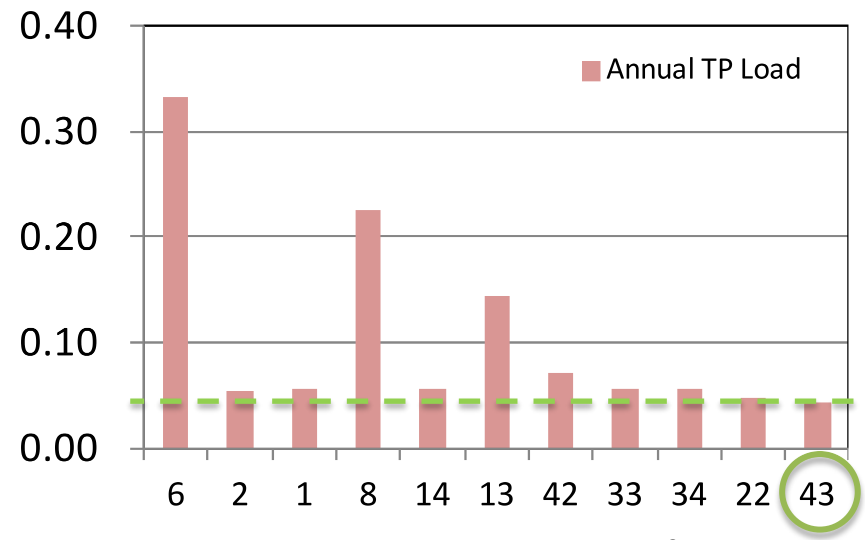
and collecting water samples

Preliminary calculation of nutrient load discharges from small river basins

Hii River (No.43)



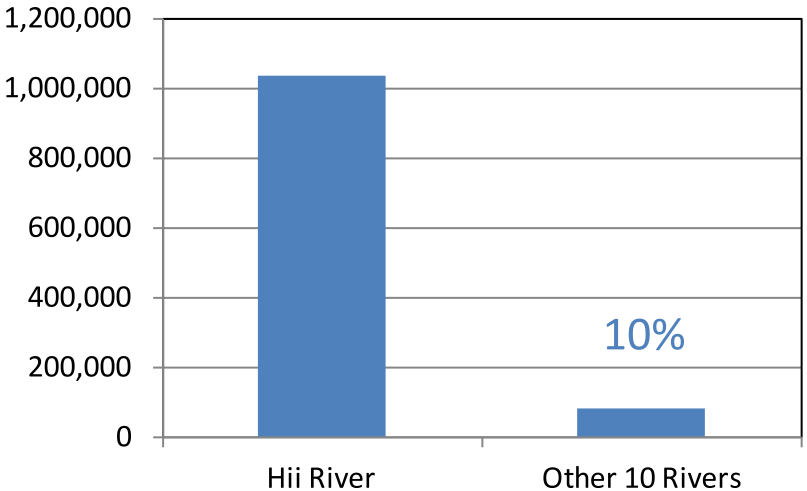
Annual TN load (tons/km²/year)



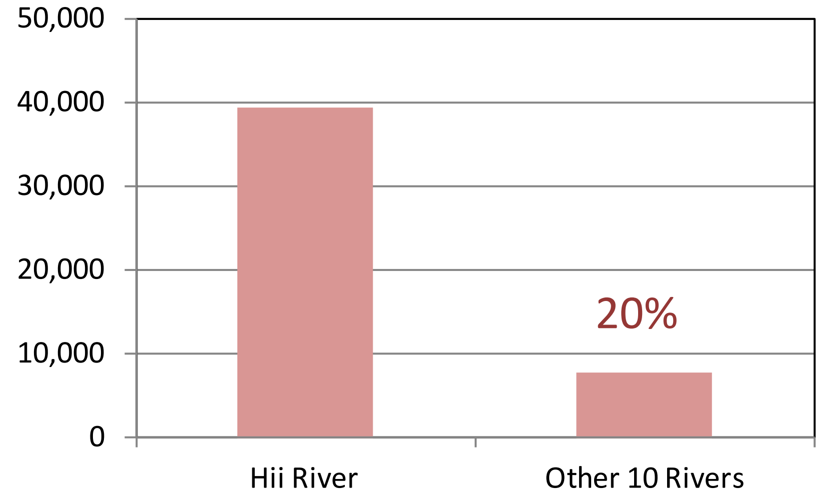
Annual TP load (tons/km²/year)

- In unit load discharges, Subbasin Nos. 6, 8, 13 (Northern part of Lake Shinji) showed higher values in the watershed
- Annual loads per area vary from 0.70 (34) to 2.2 (6) tons/km² in TN, and from 0.043 (43) to 0.33 (6) tons/km² in TP.

Preliminary calculation of nutrient load discharges from small river basins



Annual Total TN load (tons/year)



Annual Total TP load (tons/year)

- Annual total loads occupy about 10 % of TN and 20% of TP of annual total loads from Hii River basin.

10 river basins were considered in this preliminary calculations, and it was revealed that total load discharges from small river basins are relatively large though each load discharge from a small river basin is small

Conclusion

We are trying to evaluate discharges of flow and nutrient loads from small river basins around the Lake Shinji for considering conservation ways of water environment

- SWAT could represent flow discharges “Satisfactory” from 1988 to 2011 in Monthly basis (in the future, daily basis)
- SWAT could make flow discharges of small river basins around the lake (they need to be calibrated later, though)
- From the preliminary calculation of averaged annual TN and TP loads from small rivers, it is considered that total loads from small river basins may have large influences in total, though Hii River basin still has a larger impact to the lake water environment

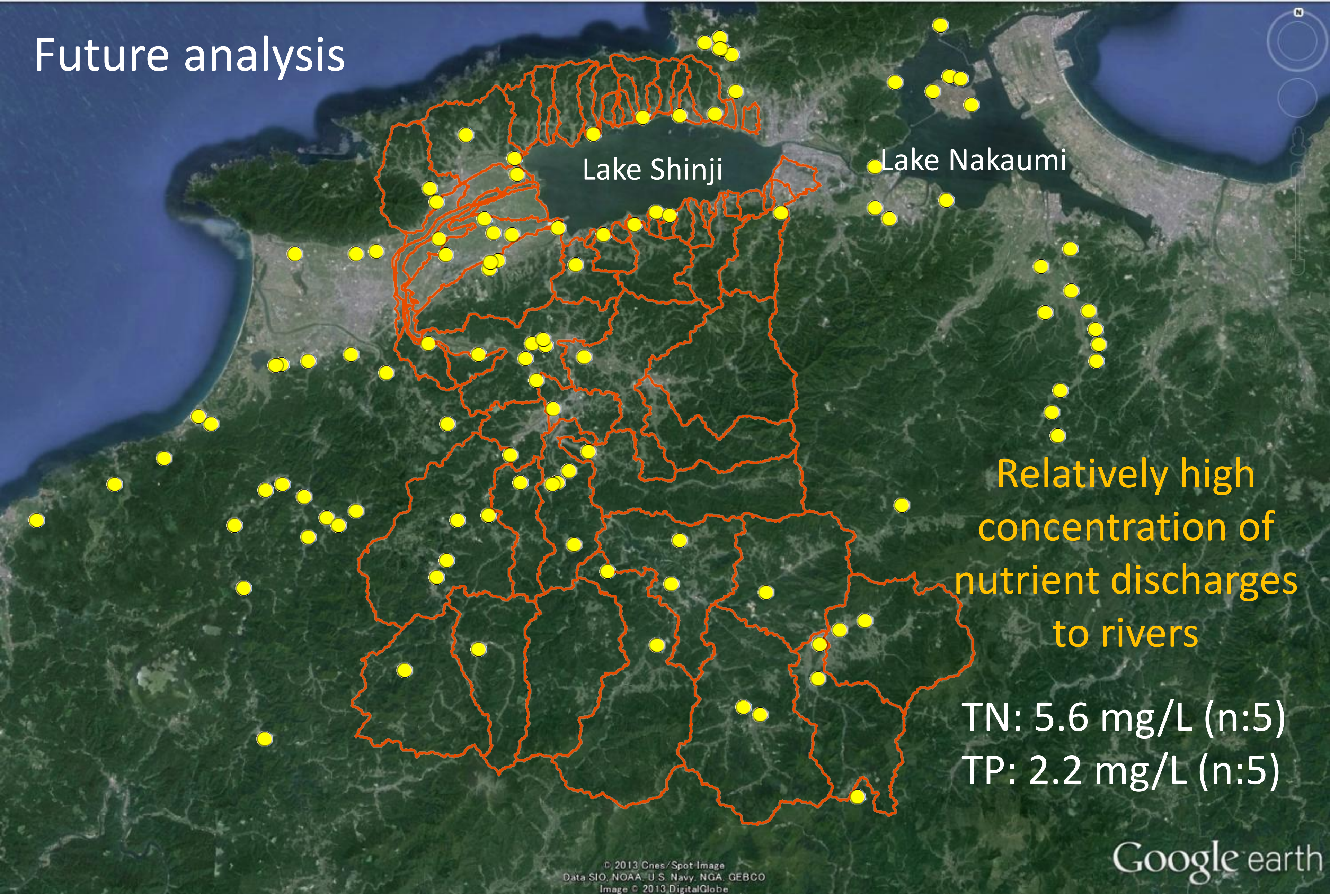
Future Plan

- Calibrate parameter values of small river basins
- Input monthly load discharges from the rural community sewerage
- Scenario analysis, especially pay attention to forestry of artificial coniferous forest

⬇

Impact assessment of river basins against the Lake Shinji water environment

Future analysis



Location of rural community sewerage in / around the study area

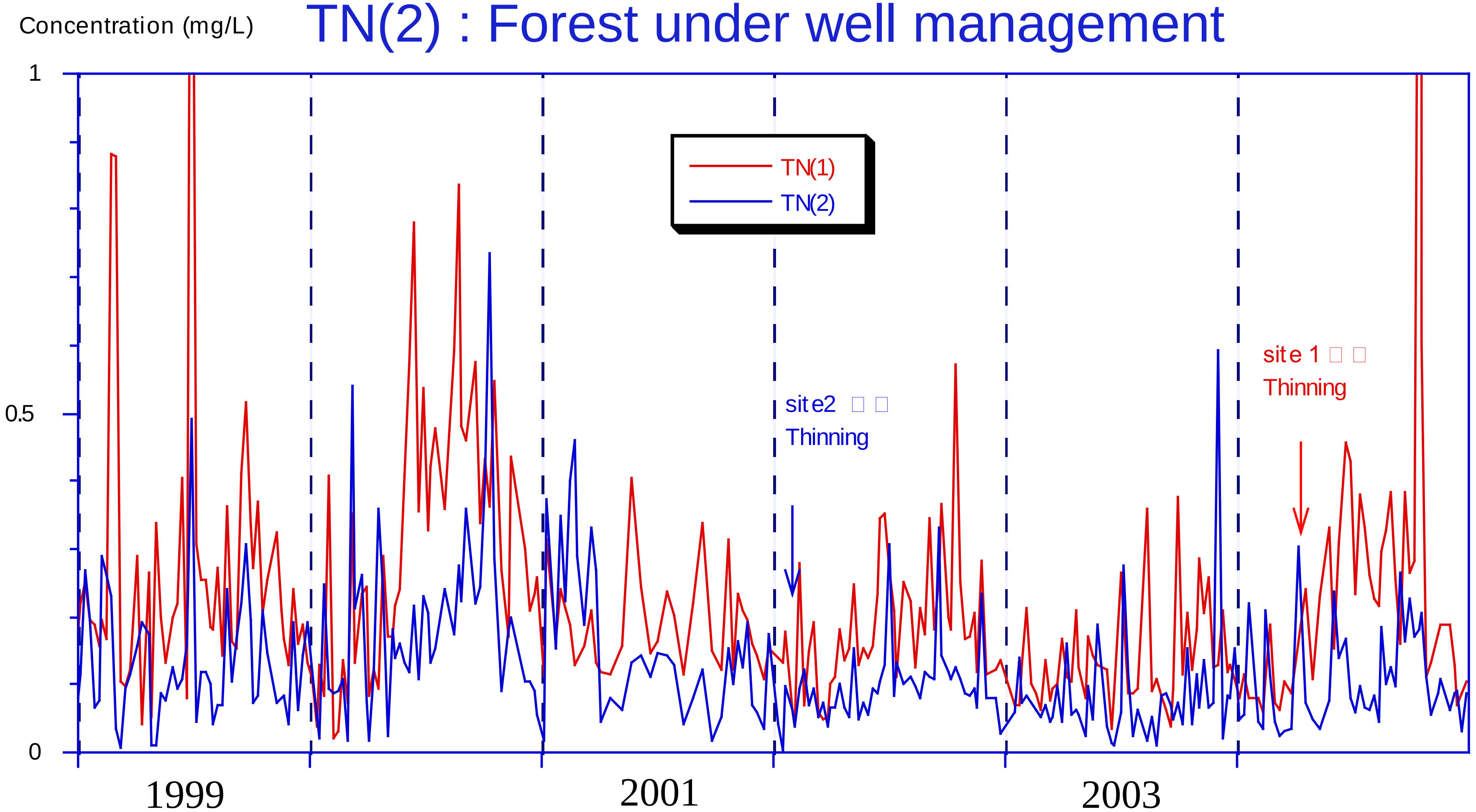
Inside of a forest (for example)

Rough management

Higher concentration of water discharged from a rough management forest

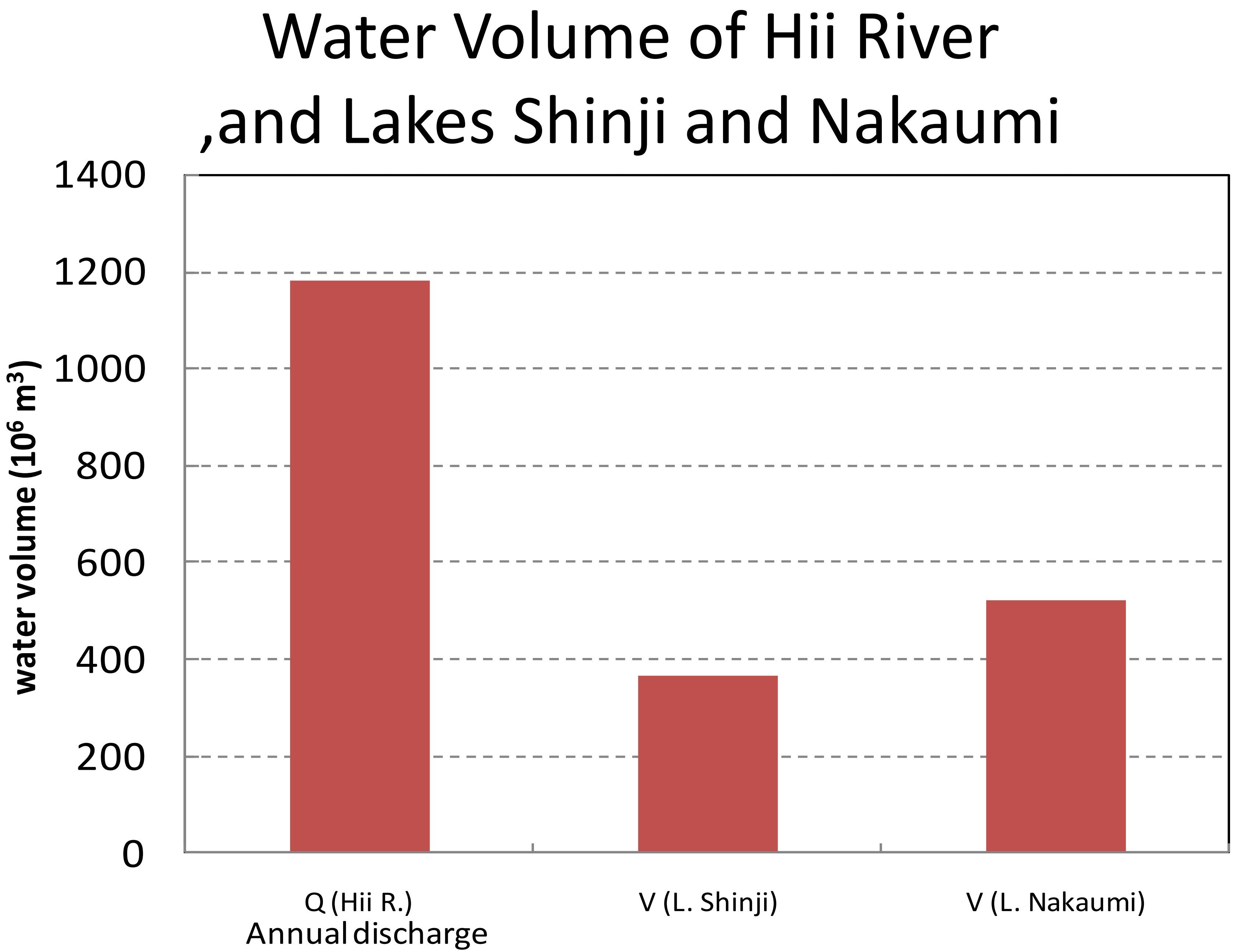
TN(1) : Forest under delay thinning

TN(2) : Forest under well management

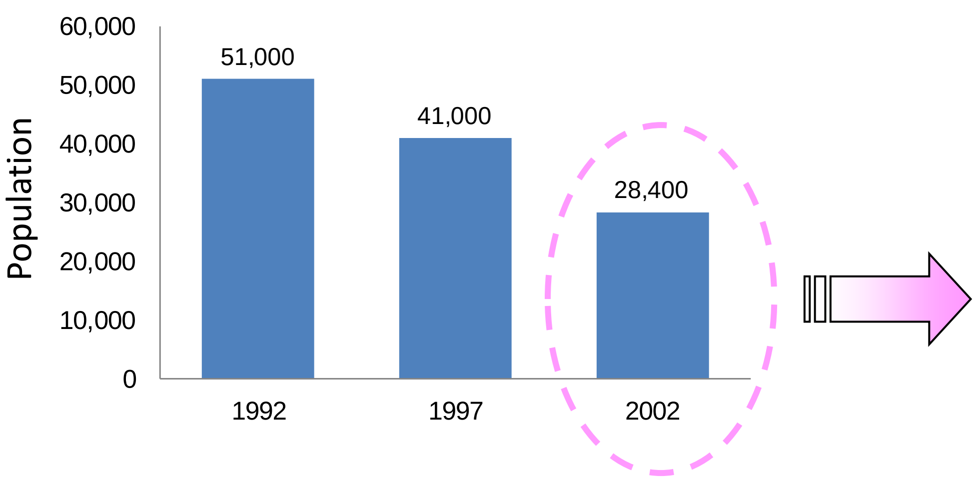


（Analyzed by Prof. Takeda）

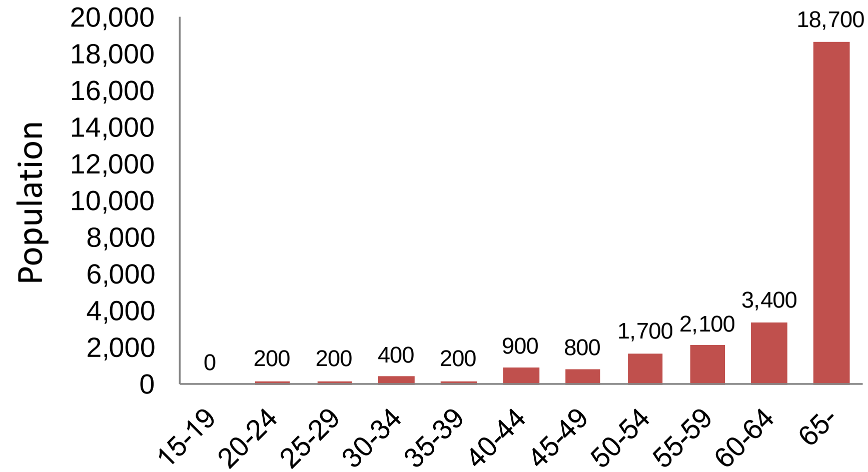
Thank you very much for your attention


Water Volume of Hii River
,and Lakes Shinji and Nakaumi
1400
1200
1000
800
600
400
200
0
water volume (10^6 m^3)
Q (Hii R.)
Annual discharge
V (L. Shinji)
V (L. Nakaumi)

Number of employed persons by age and population changes in agriculture and forestry employment (Shimane Prefecture)



population changes in agriculture and forestry employment



Number of employed persons by age

- Working population in agriculture and forestry has declined
- Most of the workers are 65 years old or older

According to the Census of Agriculture and Forestry,

Agriculture：54,651 households（1995）→49,480 households（2000） -9.5%

Forestry：38,335 households（1990）→36,379 households（2000） -5.1%

しまね統計情報データベースより
http://www.toukeika.pref.shimane.jp/toukei/st0/st0100.asp

Hii River basin : Major contributor for the downstream lake water environment because it occupies about 75 % of watershed area of Lake Shinji

For more accurate impact assessment of river basins against lake water environment, it is nece

土地利用更新・・・森林の影響をみるため
DEM更新・・・河道網を正確に引くため