

River Basin Management and Climate Change

---Design of Management System and Integrated Simulation Model

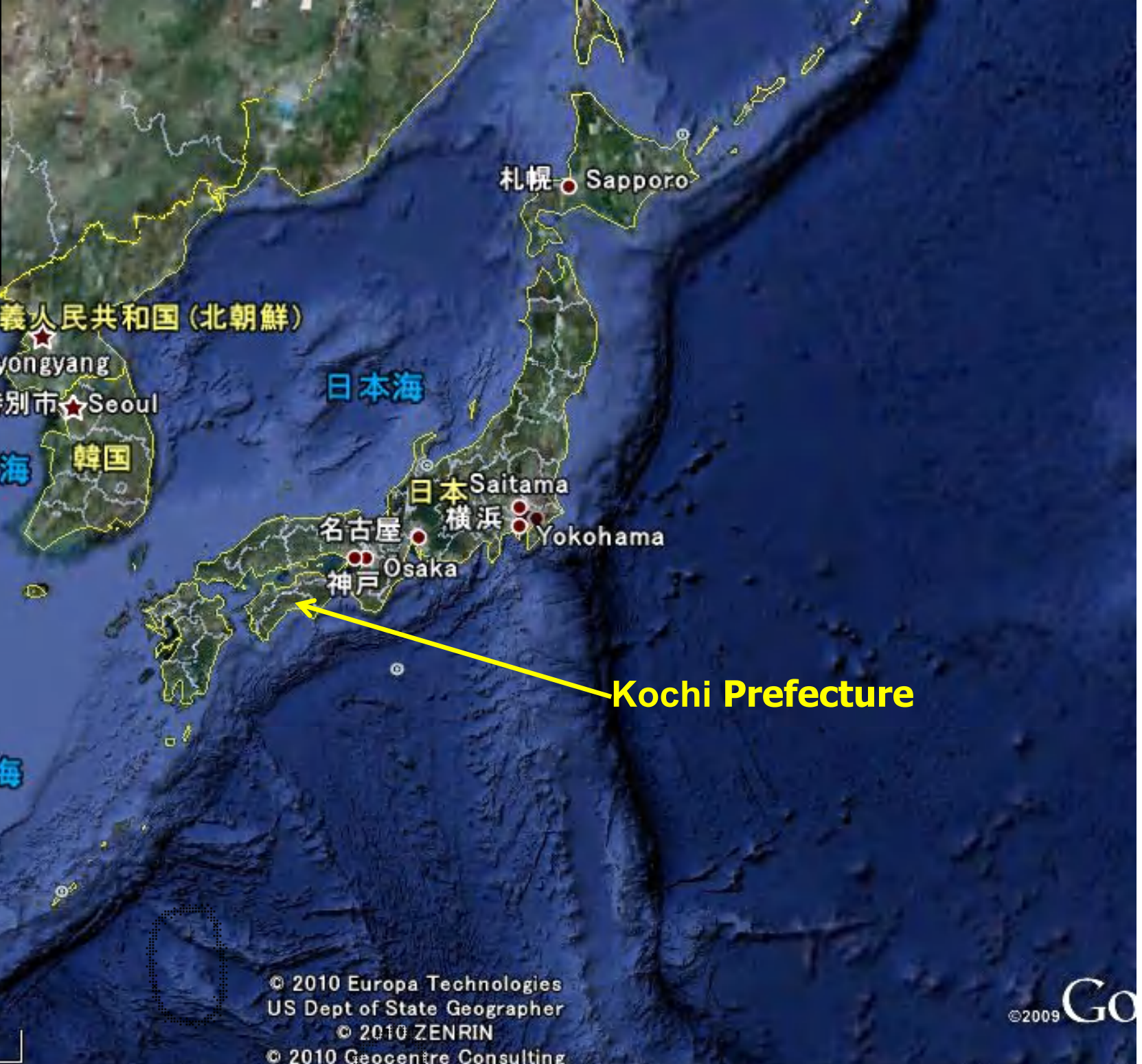
At Nan river basin, Thailand

& At Yoshino river basin, Japan

October 6th 2010

Seigo NASU

Kochi University of technology



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34° 56'52.28" N 136° 49'54.21" E 標高 79 メートル

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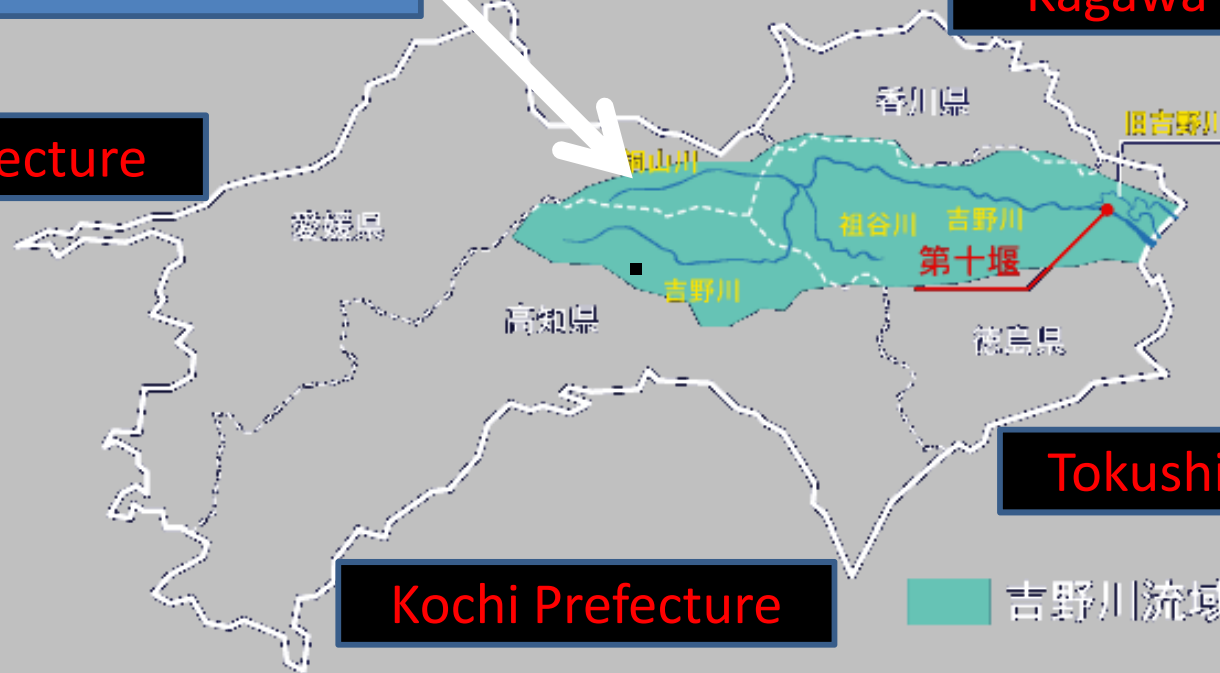
Shikoku Island and Yoshino River

吉野川のデータ

Yoshino River Basin

Kagawa Prefecture

Ehime Prefecture



Tokushima Prefecture

Kochi Prefecture

吉野川流域

河川流路延長・・・194km

流域面積・・・ 3,750km²

流域内人口・・・約64万人

基本高水流量・・・24,000m³/s

計画高水流量・・・18,000m³/s

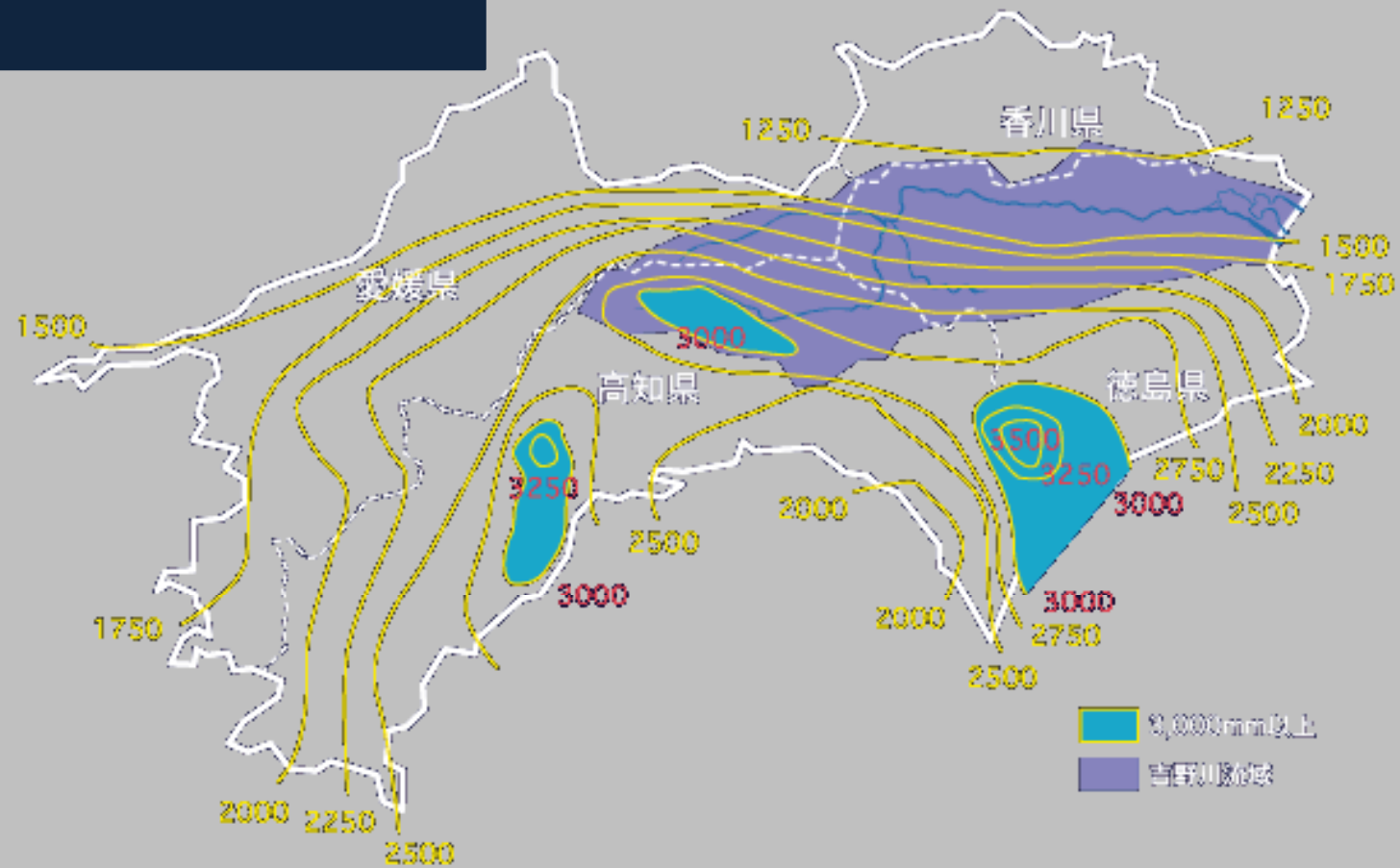
(基準地点: 岩津)

Shikoku Island

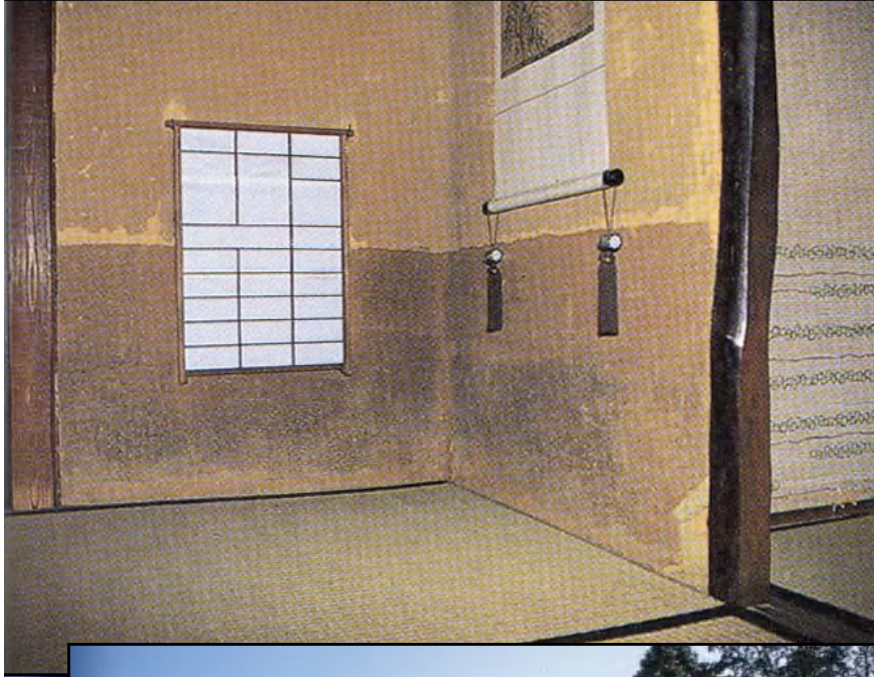
四国のランドサット写真



Total Rainfall per year at Shikoku Island



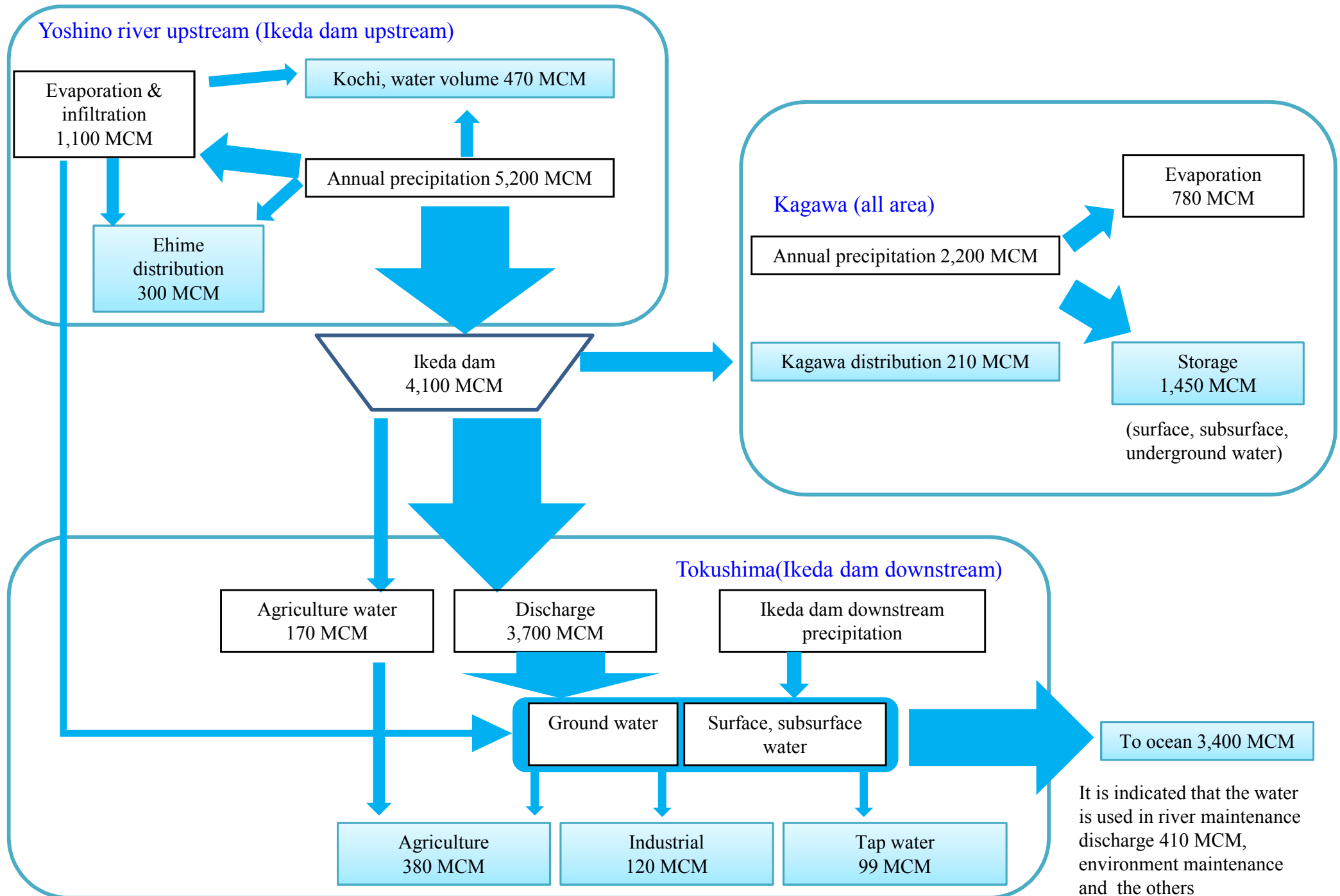
Long History of Flood Damage



Flood of Yoshino River



Water resource statistics in Yoshino river region



Research target: Yoshino river basin in Shikoku area and Shikoku water issue committee

1. Shikoku water issue committee

The committee is established on the proposal of the rector (at that time) of Kochi university of technology having **a purpose to solve the water issue in Shikoku and Yoshino river**. The members are **representatives from 4 prefectures, from private stakeholders, mass communication, and experts**.



2. Awareness of the problem in the Yoshino river area

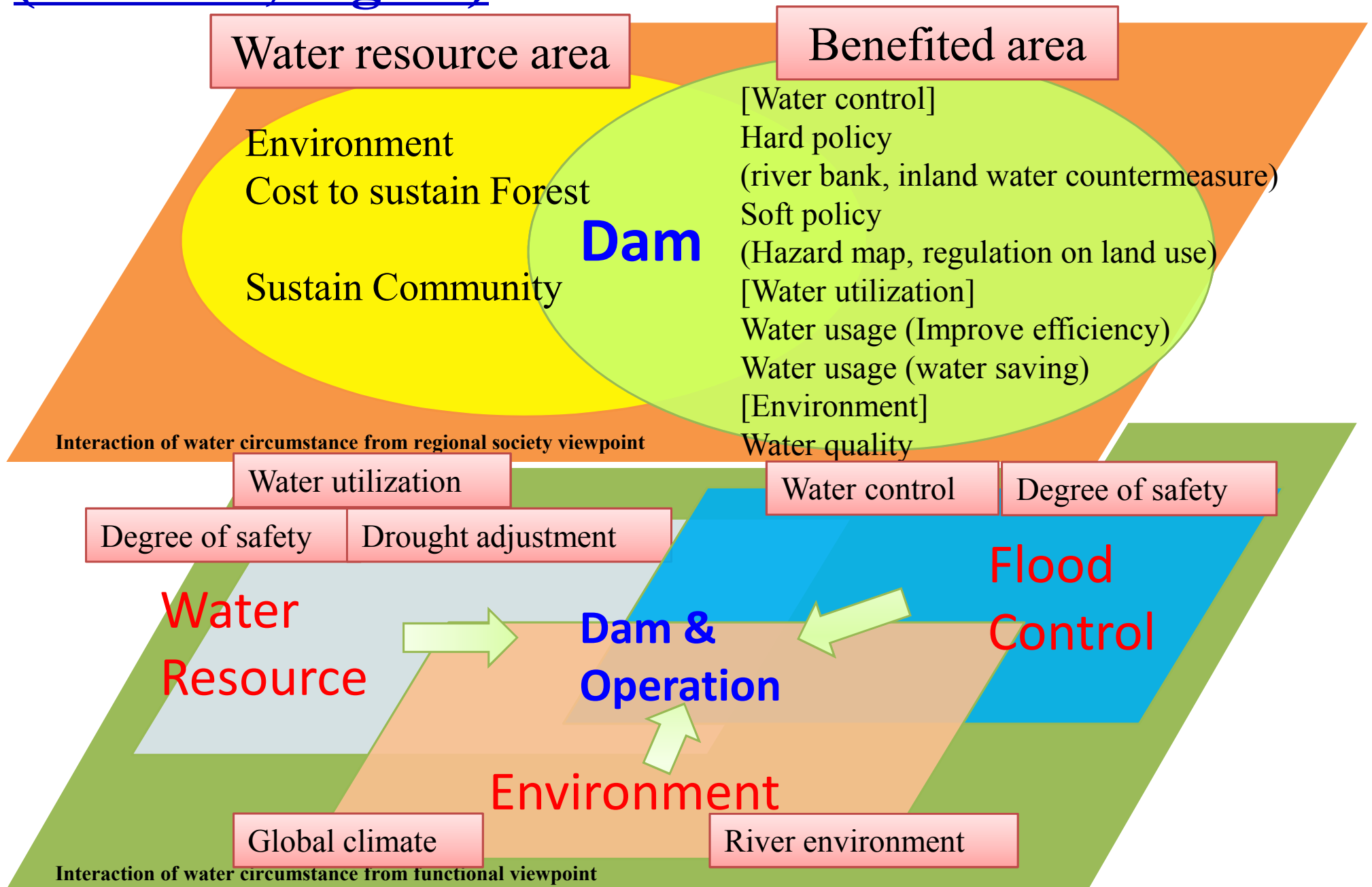
1. No basic regulation to confirm on flood safety, safety on water utilization, environment, and their benefit interaction
2. Relations on benefit from using water between the burdened area and benefited area are unclear. It is difficult for the burden & benefit area to share the understanding of each others for proper water resources sharing.
3. There are **no existing models or tools to (a.) consider interaction among water control, water utilization, and environment from the functional view point of river engineering, (b.) consider relation of burden and benefit on the understanding of each others, (c.) consider relation between water resource and social benefit.**
4. There are **difficulties to make some compromise for whole basin because of uncertainty of long-term fluctuation of flood, drought and water resource due to climate change.**

3. The picture of Yoshino river, Shikoku in future

It is **necessary to form an agreement on adaption policy as a result from the information sharing and understanding**. Awareness on necessity of the integrated regional management system including “Science of prediction”, “Impact evaluation”, “Development” and “Enforcement” the adaption policy.

Interaction on water problem in river basin

(function, region)



Impact evaluation and regional policy

○Simulate impact of policy by evaluating the effect of changes in water resource fluctuation, amount of water, and water disaster due to climate change

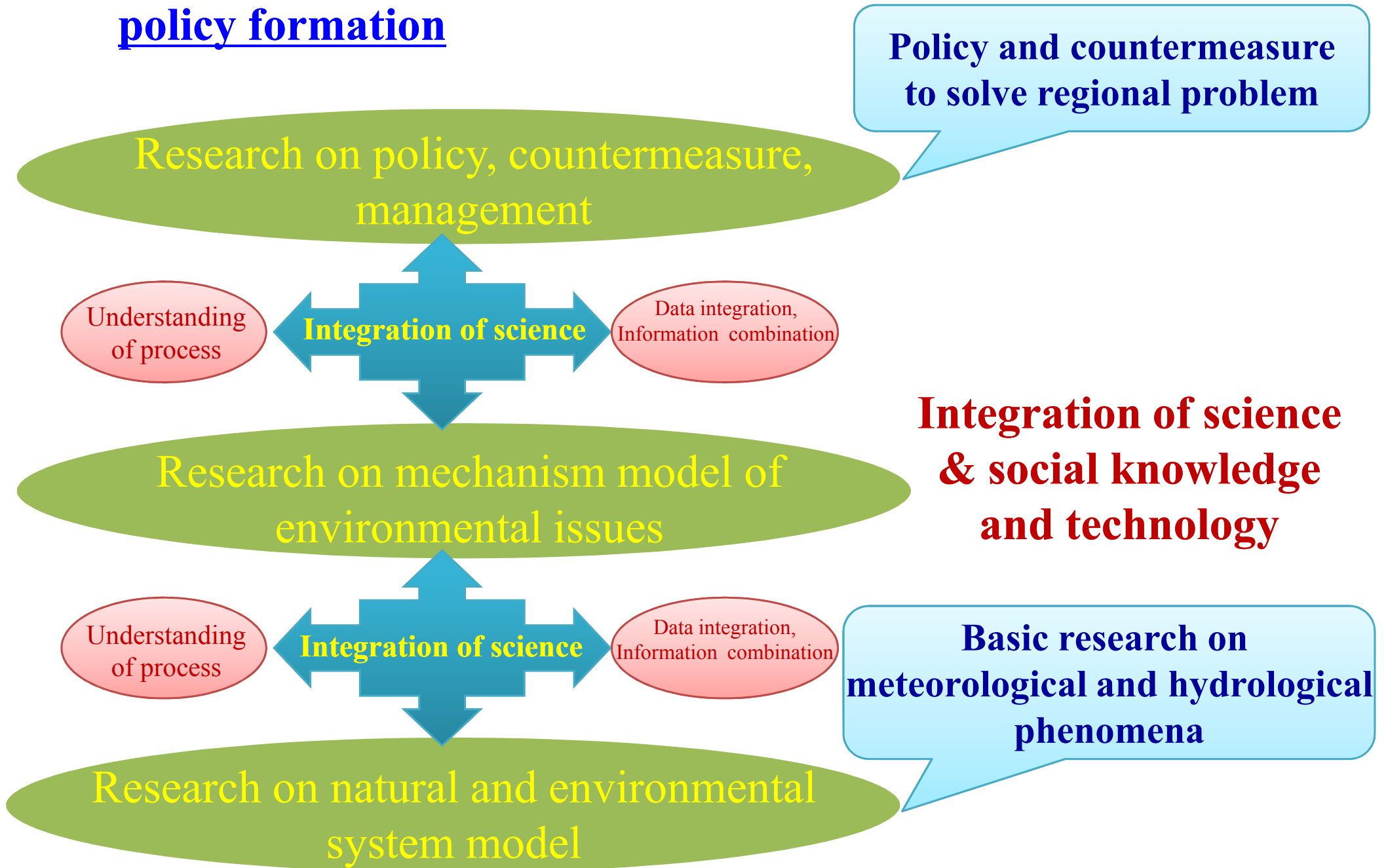
According to the 4th IPCC evaluation report, the degrees of drought and heavy rain are dramatically increasing due to the climate change. In Japan, Yoshino river basin in Shikoku Island is facing severe problems on drought and flood disaster also. It is necessary to understand quantitatively the impacts to the socio economics part and lifestyle as a result of developing the integrated model named “End to end model” that consists of “scientific climate change model, hydrological model to predict water resource and its fluctuation, and social impact evaluation model”, in the Yoshino river basin area.

○Adaptation of policy agreement formation and regional management based on information sharing and mutual understanding

Nowadays, the should-be-shared information is not properly shared, only existing information is emphasized. By this reason, effect of policy among the related persons in river basin is still unclear.

In order to form an agreement on regional policy, it is necessary to establish a regional management system based on information creation and sharing of the policy impact.

○ Necessity of the integrated model for water resource policy formation



The basic issues needed to be solved

1. “Science of prediction” of the climate change

Reflect the quantitative evaluation of the uncertainty when downscaling from global level.

→ Quantitative evaluation and improvement of uncertainty from climate change prediction on water circulation in regional and water basin scale

2. “Impact evaluation” of the climate change

Quantification of the impacts on agricultural, industrial, lifestyle and environment from converting precipitation patterns calculated by climate change to river discharge, volume and quality of the water resource.

→ Evaluation of the impacts on drought, water disaster and water contamination in regional and river basin scale due to climate change.

3. “Establishment” of a policy decision making to the climate change

Development a policy decision making system by considering the uncertainty of climate change and cost expectation in the future. Evaluation of benefit of economic activities and satisfaction of people in this area.

→ Development of option selection system in order to maximize the social profit while considering the uncertainty in the future.

4. Policy implementation

From the above problem solving procedures , it is necessary to form the management system that can monitor, verify, evaluate and correct the processes in the “Regional management system” by combining the functions of agreement formation and benefit sharing in the region.

→ Propose the regional management system for the adaptation policy implementation on the climate change.

How to cope with citizens, specialist, and stakeholders?

(Based on the experience of River Basin Committee at Japan)

In case of Decision Making Committee at the region

① Have to recognize all stakeholders, citizen at the area, those who paying tax and other expense in order to construct the committee.

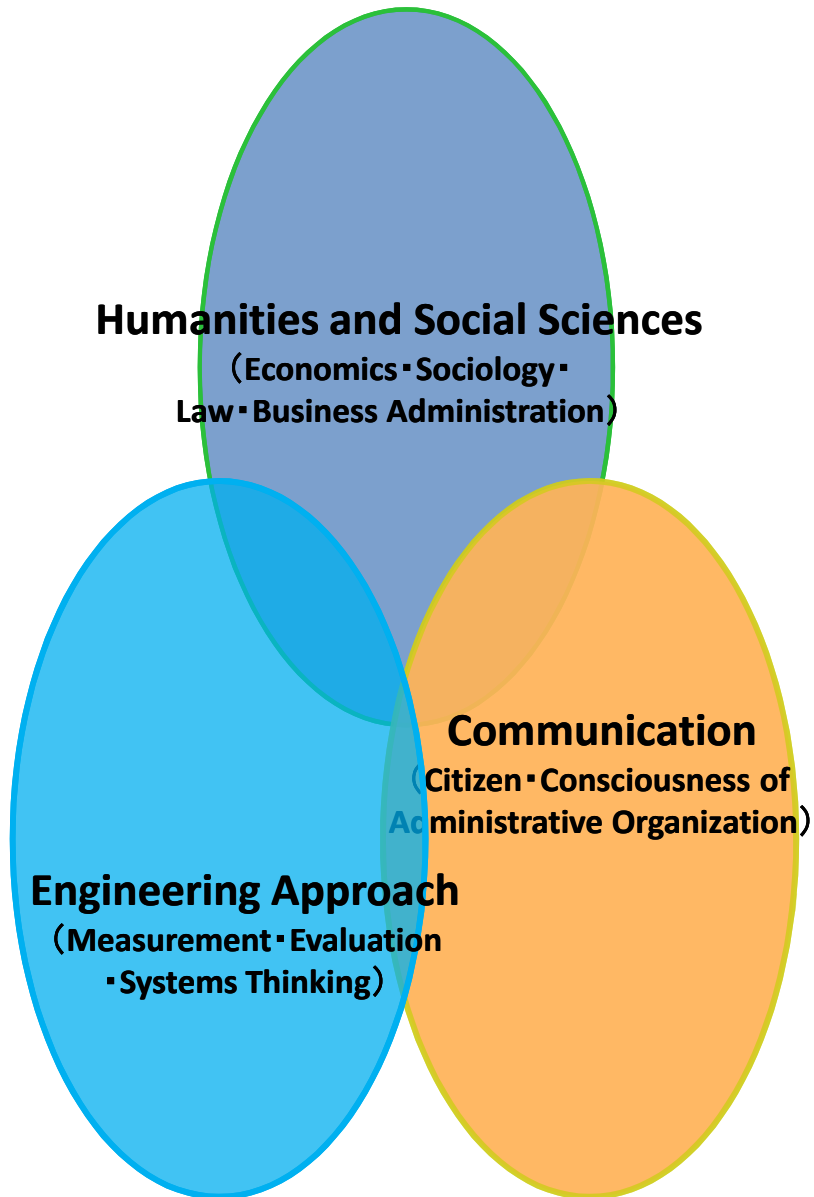
② Enough specialist, citizens to determine purpose and management target. Here, citizens are also specialist of regional issues. **Participation of those who have specific purpose has to be questioned.**

③ **What is the rules for decision making at the committee, and who has what kind of authority.**

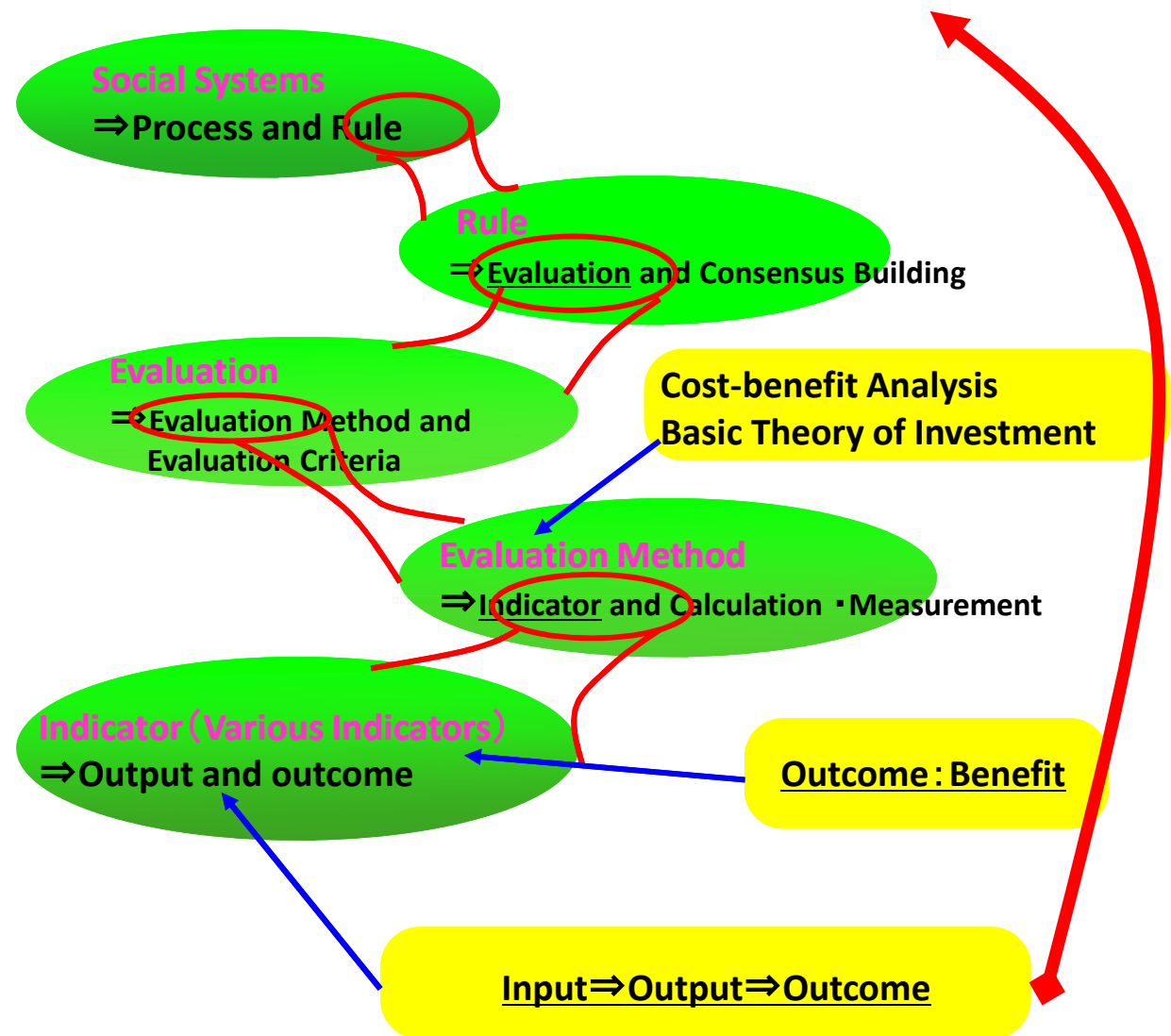
④ **Transparency, information to reveal to citizens,** personal information to protect, Sometime some restriction of information to reveal is possible.

⑤ **You need some model to explain whole issues,** which is good enough to let people understand. So it is also the **responsibility of all participants to have a skill to explain their opinion good enough so that every other participant can understand.**

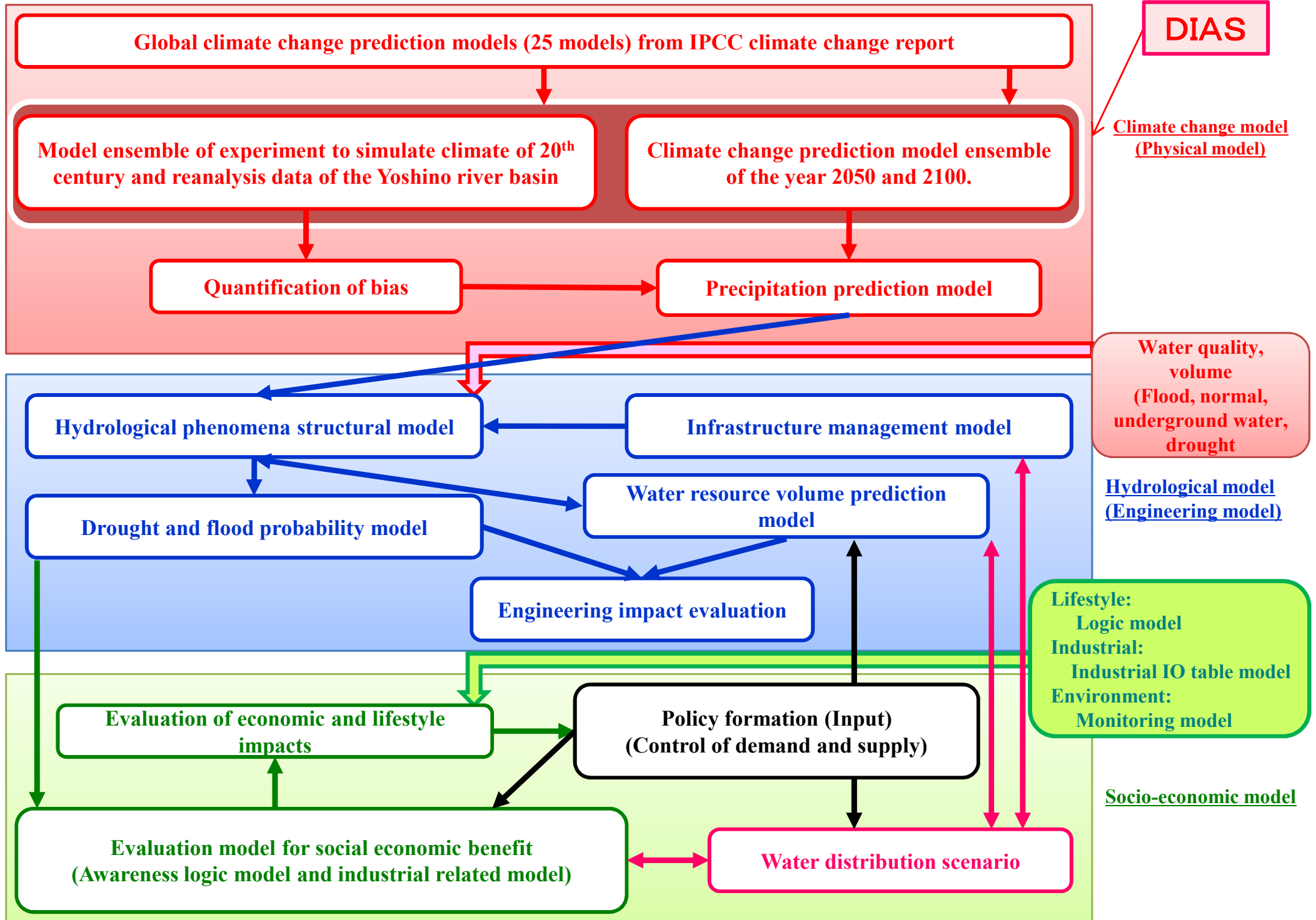
Functional Design for Management System



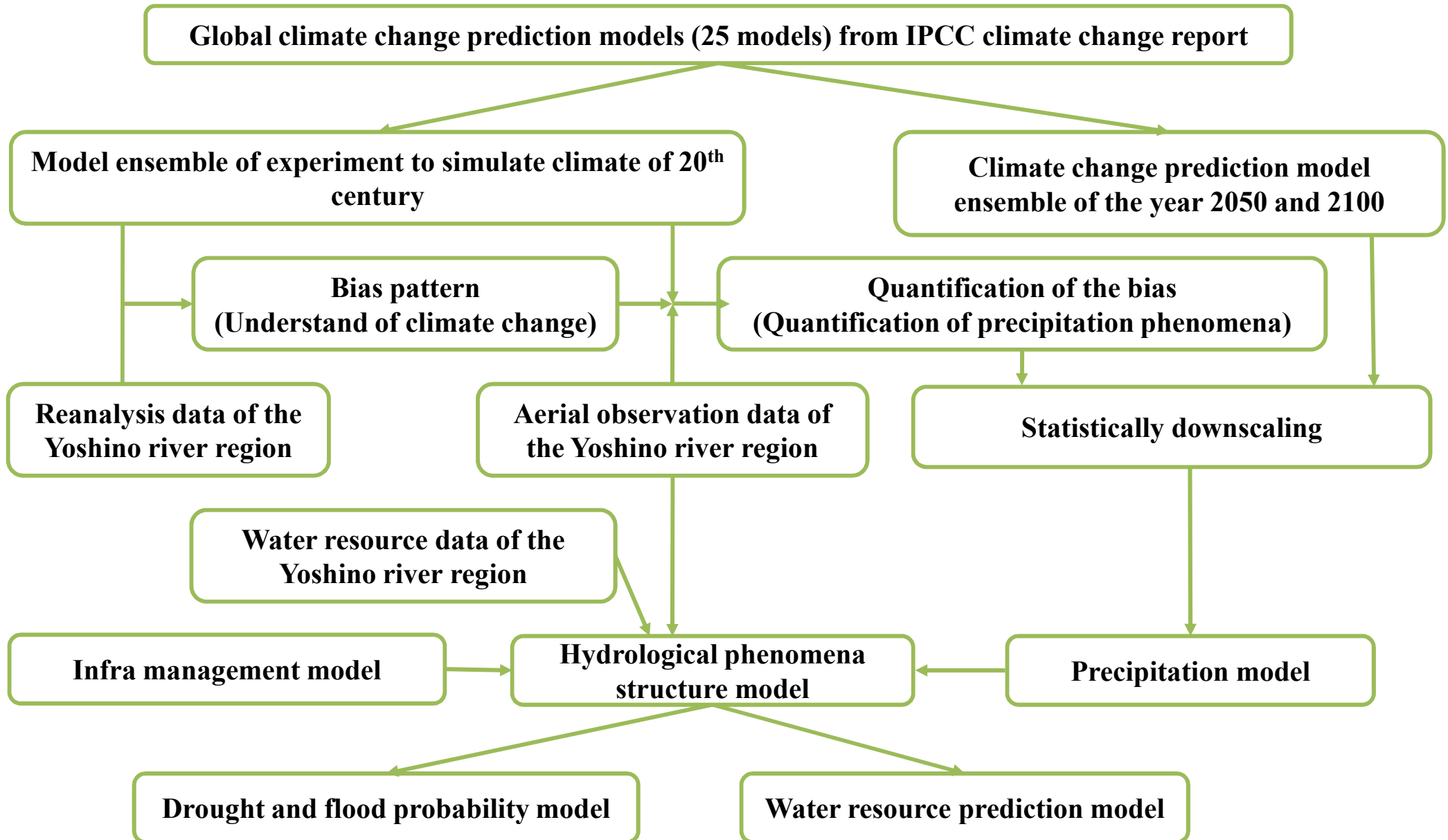
Hierarchy of Social Systems



(1),(2) Integrated model for prediction (End to End Model)



● Development of climate change model in Yoshino river region and hydrological structural model



Water demand prediction model: industrial sector

$$\text{Water demand} = U * [(I-A)^{-1} * FD]$$

Water use unit: U

Industrial linkage model in each prefecture:
 $(I-A)^{-1}FD$

Analysis step

- Water resources statistic
 Price elasticity

$(I-A)^{-1} FD$
(IT,GDP)

Cobb-Douglas production function
 $(I-A)^{-1} FD = x (\text{capital})^a (\text{labor})^b$
Variables : (K,L)

Prediction step with policy effect

-Prediction step of the policy effect by using each governmental policy scenario

Input-output in each prefecture

	AGRI	IND	SER	TOTAL						
IO code	001-029	030-134	135-180	190	201-209	210	401-409	501-509	600	700
AGRI	001-029	Intermediate demand			Total final demand (309)	Total demand (309)	Total imports (409)	Total margin and transportation (509)	Control Total (500-509)	Total supply (600-609+700)
IND	030-134	This matrix tells the amount of sector's output used in the production of sector j			Sum (301-306)	Sum (190-199)	Sum (401-404)	Sum (501-503)	Sum (500-509)	
SER	135-180									
TOTAL	190	Total intermediate Transaction Sum (001 to 180)								
	201-209	Total value added Sum (201 to 204)								
	210	Control total (190-209)								

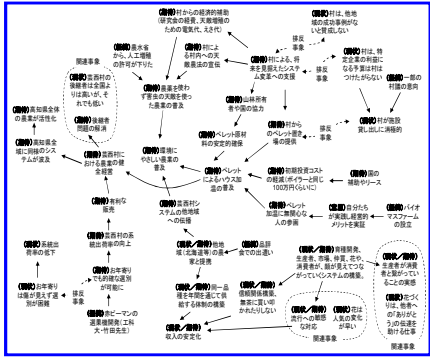
RAS method

To generate new IO table in each area with local condition and change in the future

	AGRI	IND	SER	TOTAL						
IO code	001-029	030-134	135-180	190	201-209	210	401-409	501-509	600	700
AGRI	001-029	Intermediate demand			Total final demand (309)	Total demand (309)	Total imports (409)	Total margin and transportation (509)	Control Total (500-509)	Total supply (600-609+700)
IND	030-134	This matrix tells the amount of sector's output used in the production of sector j			Sum (301-306)	Sum (190-199)	Sum (401-404)	Sum (501-503)	Sum (500-509)	
SER	135-180									
TOTAL	190	Total intermediate Transaction Sum (001 to 180)								
	201-209	Total value added Sum (201 to 204)								
	210	Control total (190-209)								

Development of Logic Model of Citizens' Mind Set regarding Water Issues

Structuring of policy issues

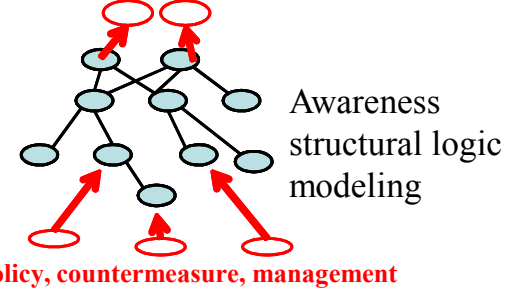


Evaluation model for a set of adaptation policy

$$A_i = f(N_i, O_i)$$

Establish an benefit (outcome) evaluation model of the adaptation policy for citizen and entrepreneur by utilizing awareness structural logic model

Target: outcome



Structural logic model of citizen and entrepreneur awareness

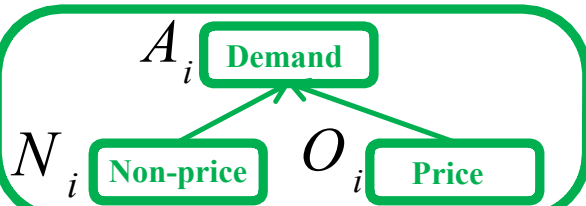
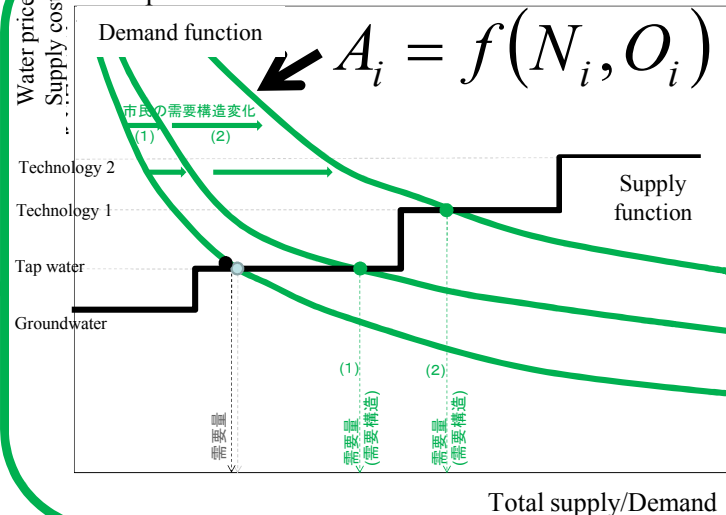
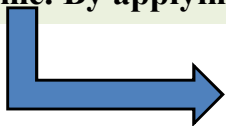


Figure of water volume and water quality equilibrium analysis from changes in economic viewpoints



Predict the shifting of "demand function" from the changes of regional and citizen characteristics by modeling the element other than price

* Water demand can be expressed by function(price elasticity) of price. But it depends on living standard and income. By applying the logic model to those, we can model the shifting of the demand curve.



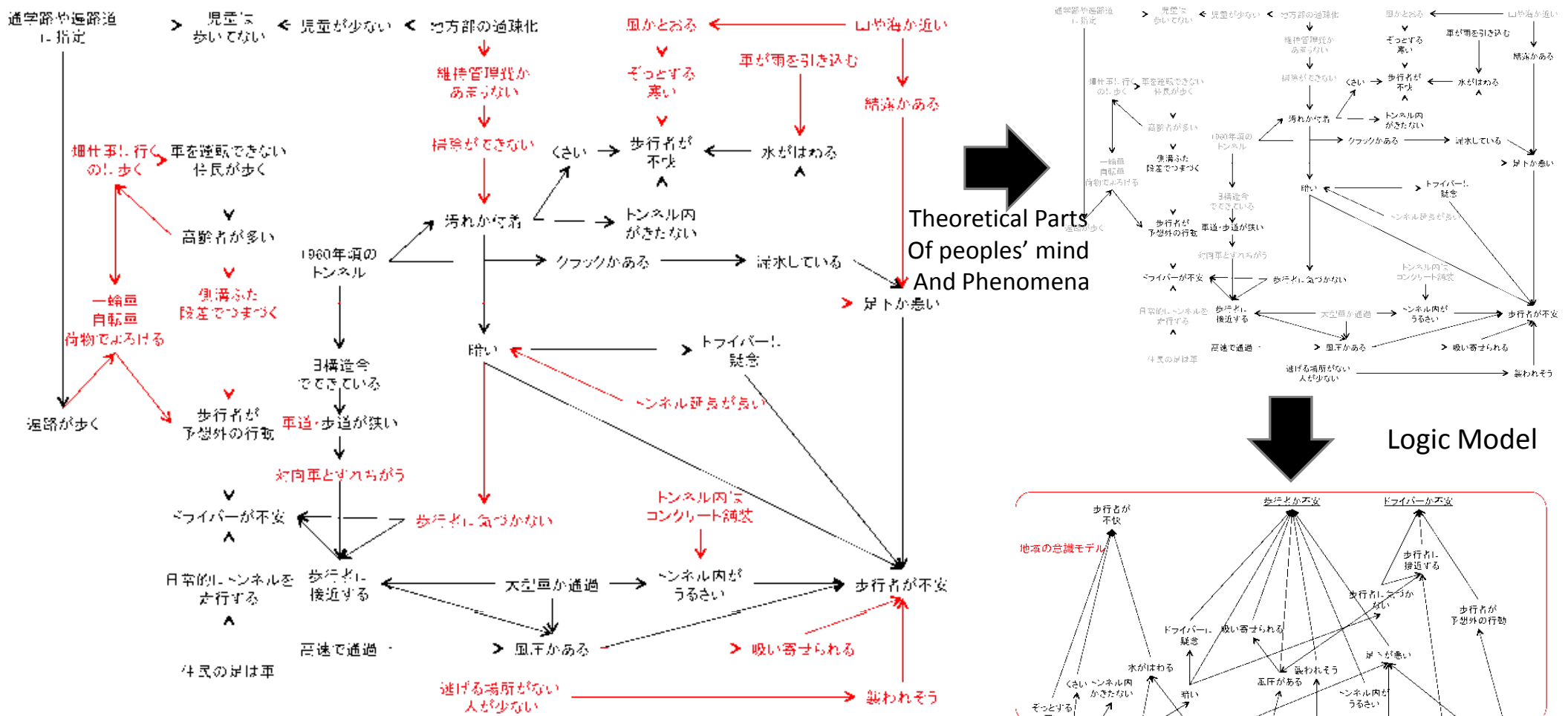
Structuring the problems in the region by hearing observation



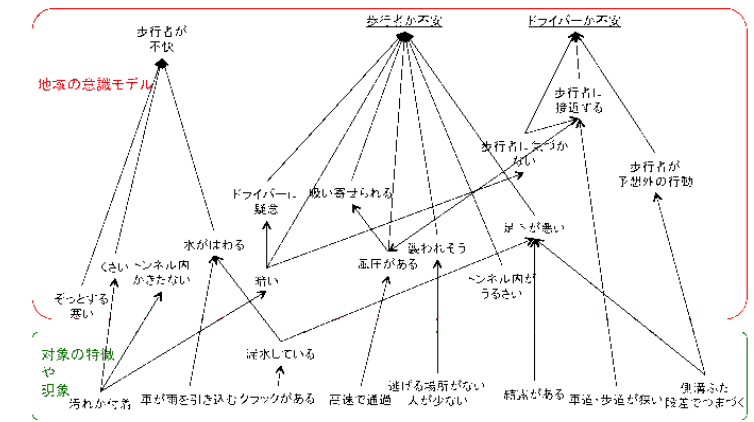
Make function from water demand awareness structures

Example

Safety feel of pedestrian and driver at tunnel



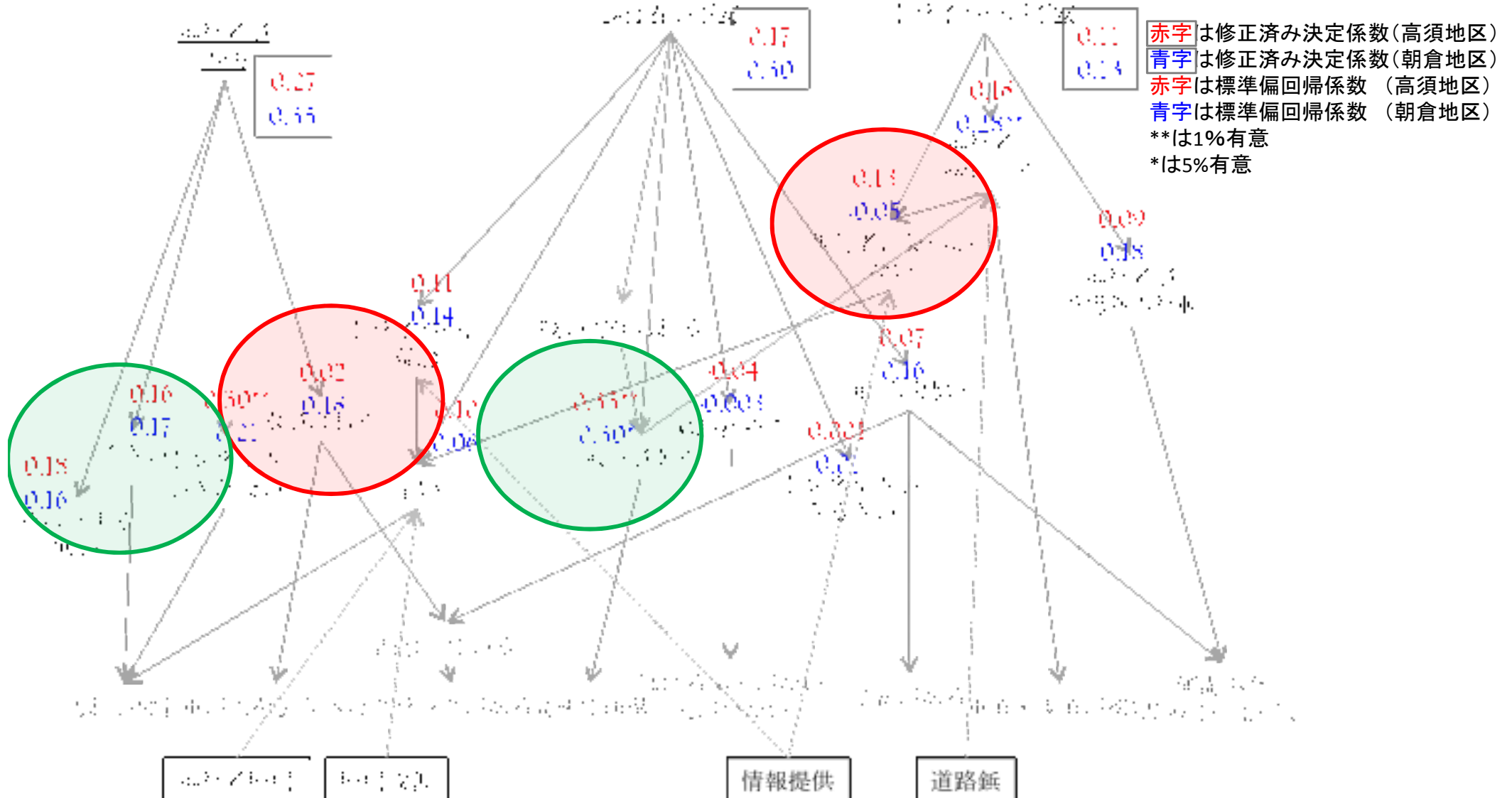
● Red parts of structured problems was a missing partion at the real implementation



Conduct countermeasures

	Charatersictics
Inomisaki Tunnel (n=111)	Length 315m、
Ida Tunnel (n=125)	Length 172m、

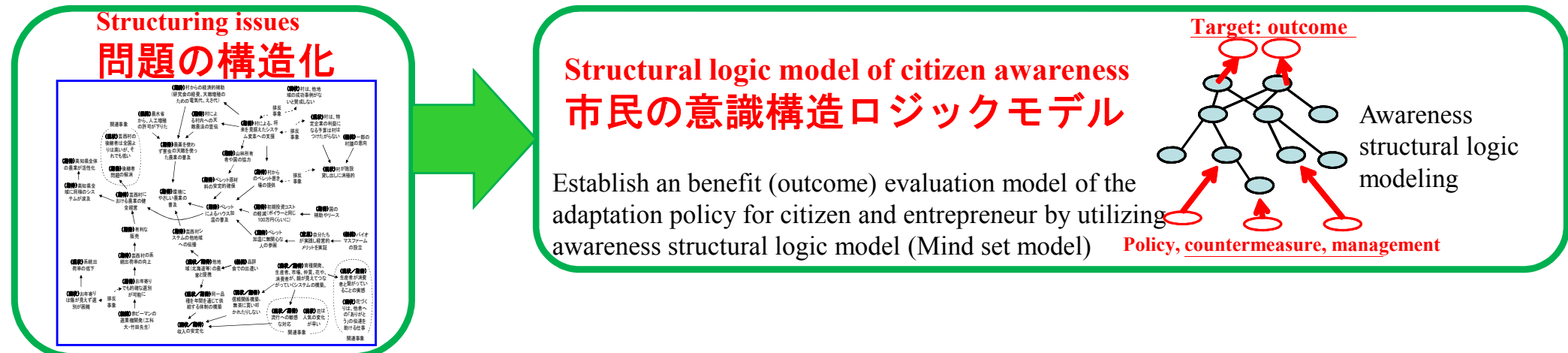
Example



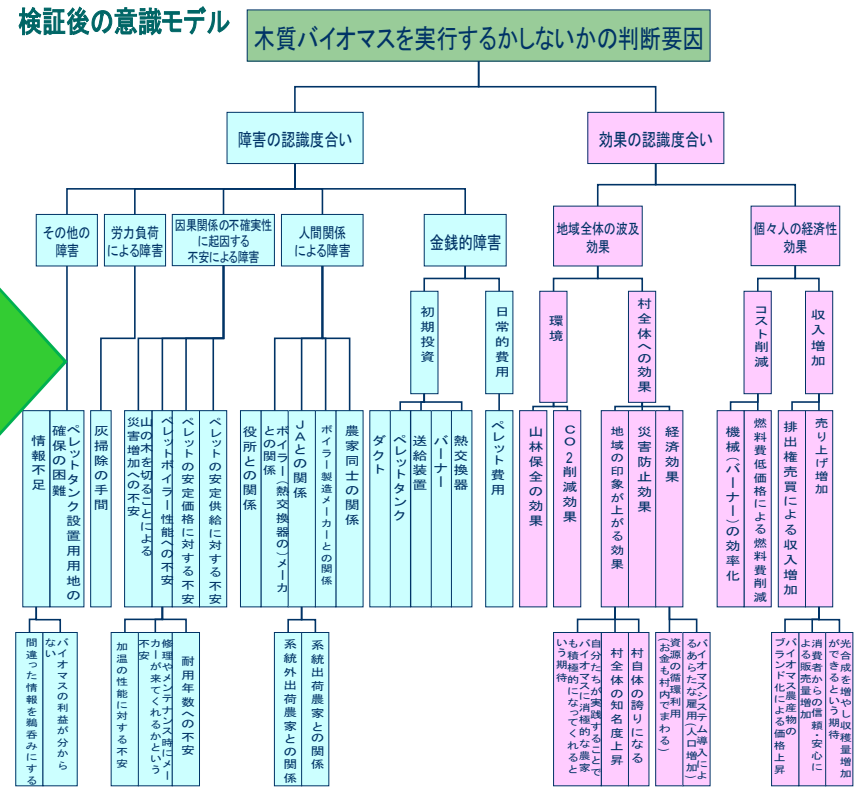
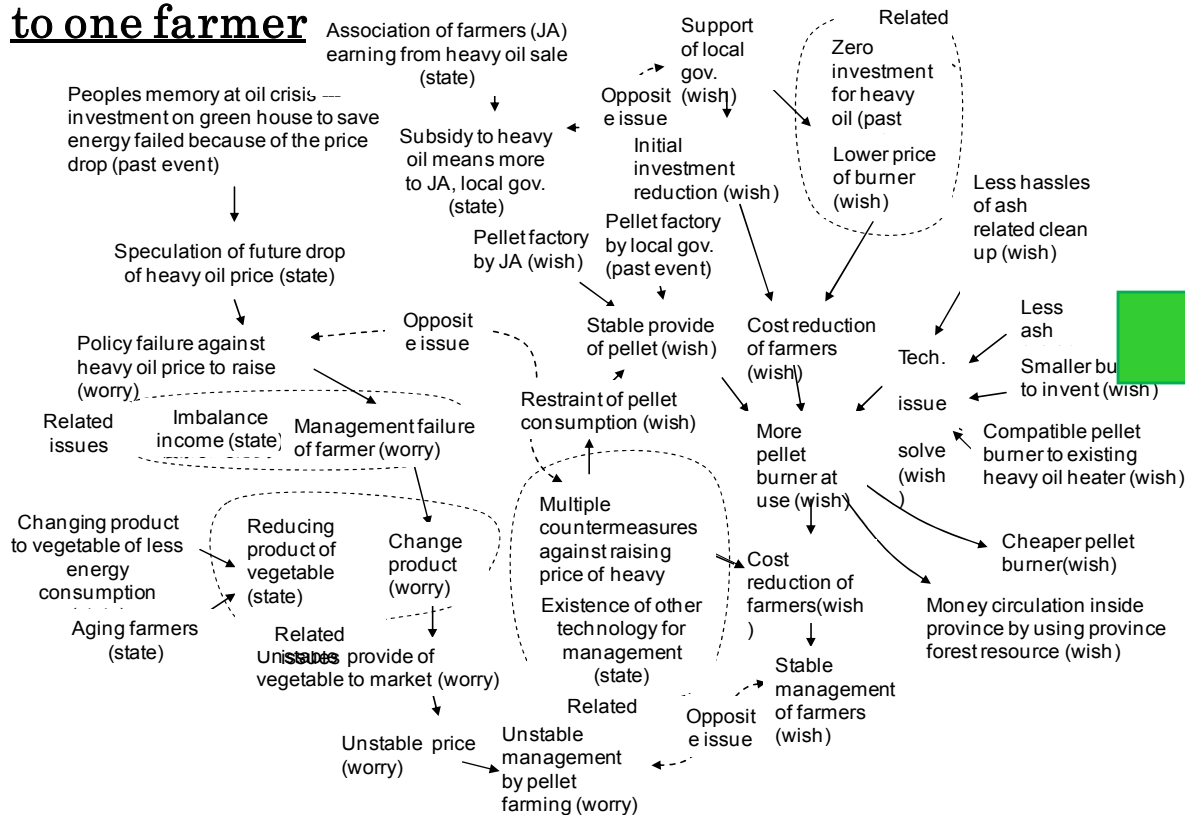
*figure of Dr. Kenji OKAMURA, Kochi University of Technology

Procedure to conduct policy and management systems from structured problems of natural and social phenomena (JST Project Example)

問題の構造化から政策や経営システムを構築するプロセス



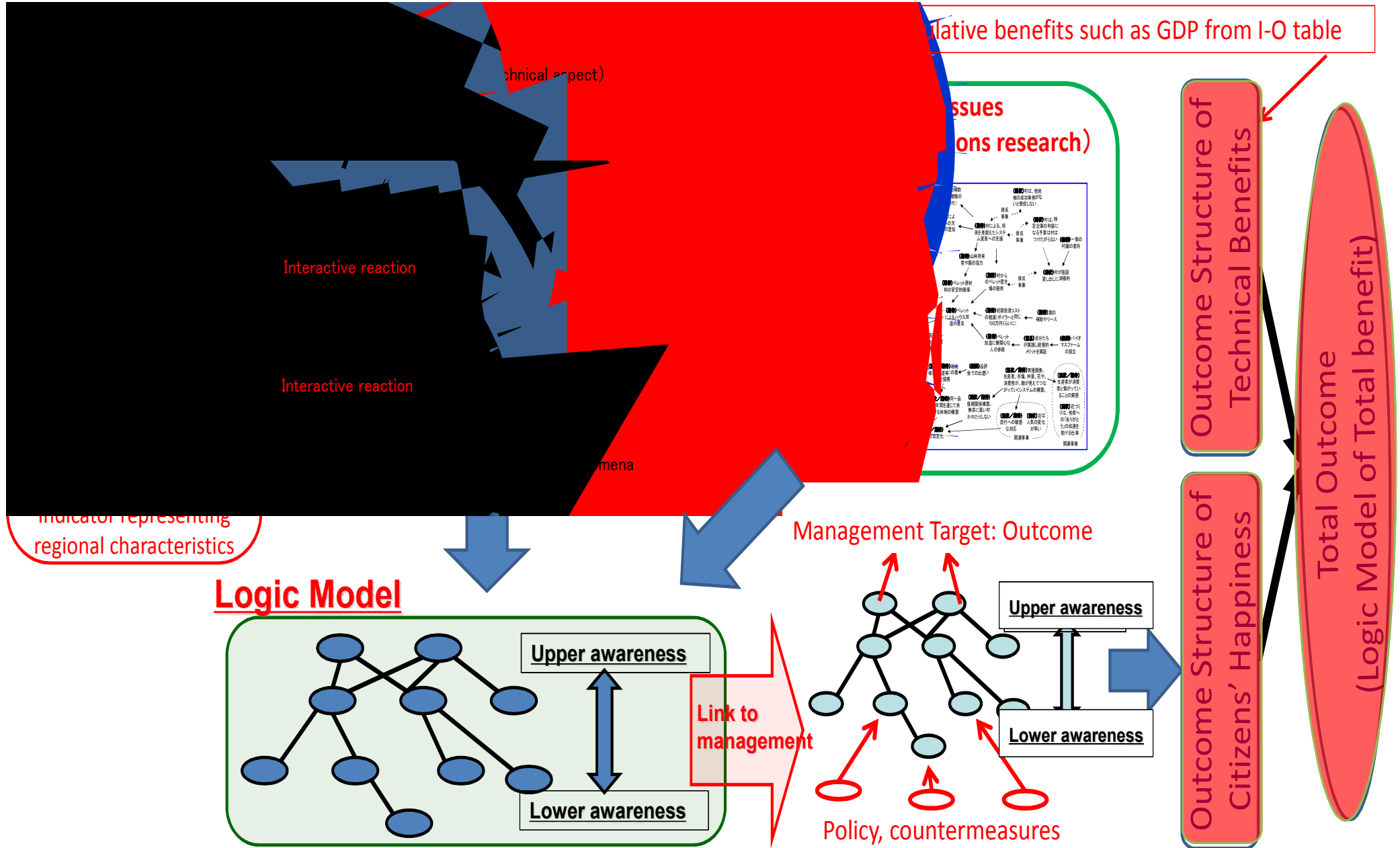
Example of structured issue by the interview to one farmer





- Benefit evaluation model in each prefecture

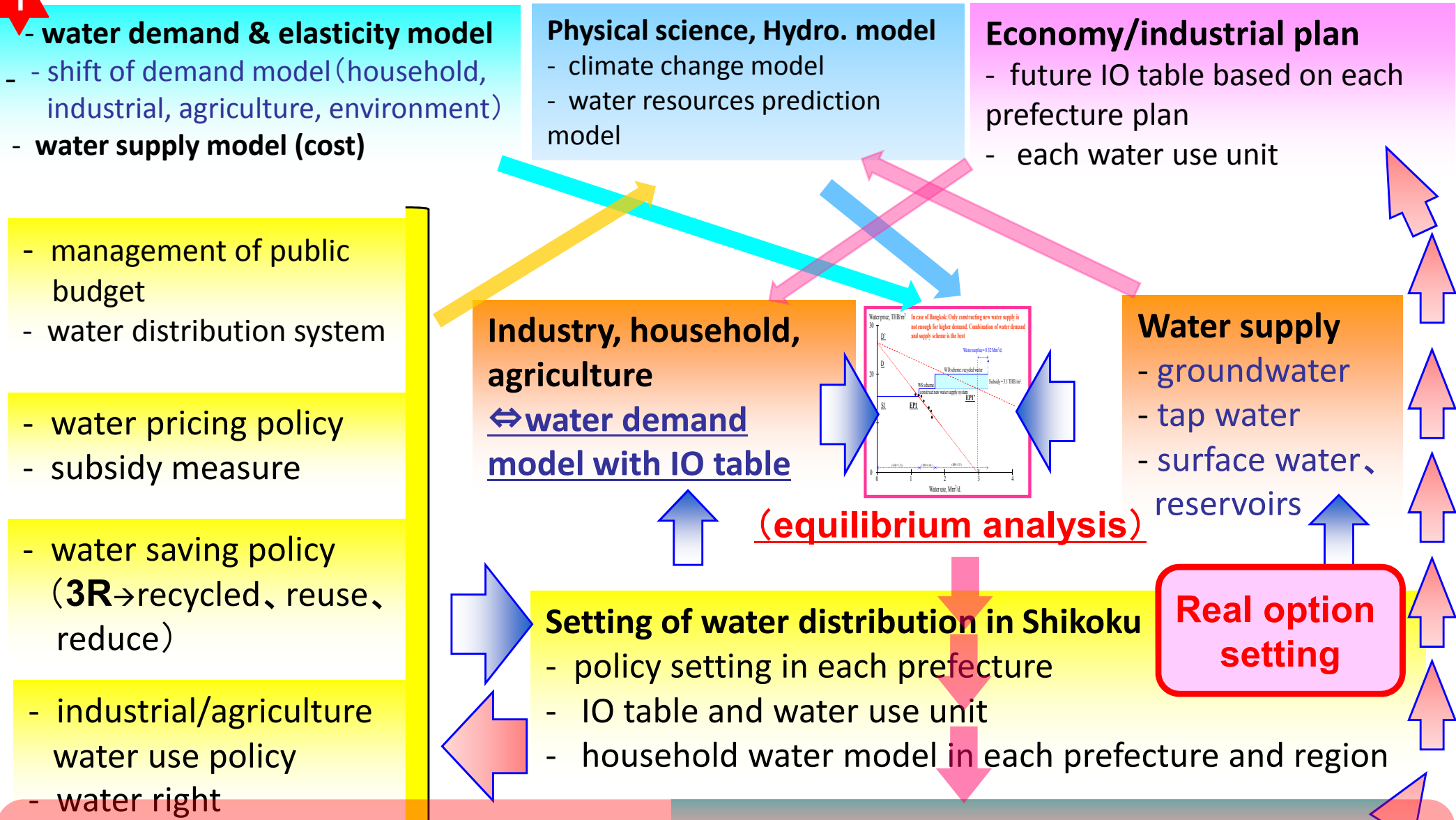
⇔ A policy evaluation model based on total benefit evaluation



(3) Development of adaptation plan to climate change

policy evaluation system based on water demand-supply analysis

1

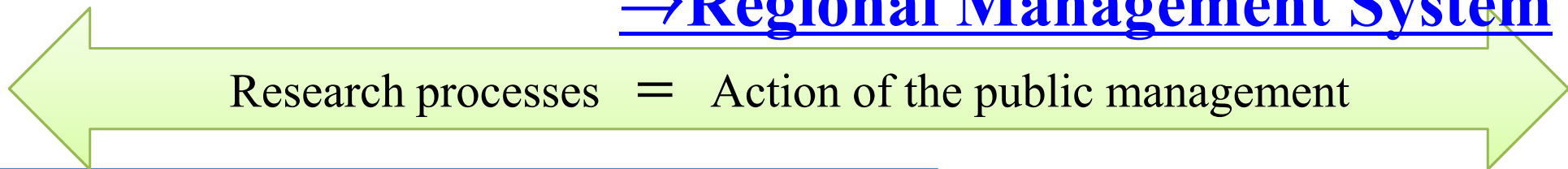


- 2
- management of public budget
 - water distribution system
 - water pricing policy
 - subsidy measure
 - water saving policy (3R→recycled, reuse, reduce)
 - industrial/agriculture water use policy
 - water right
 - benefit evaluation by logic model
 - benefit evaluation by industrial IO table

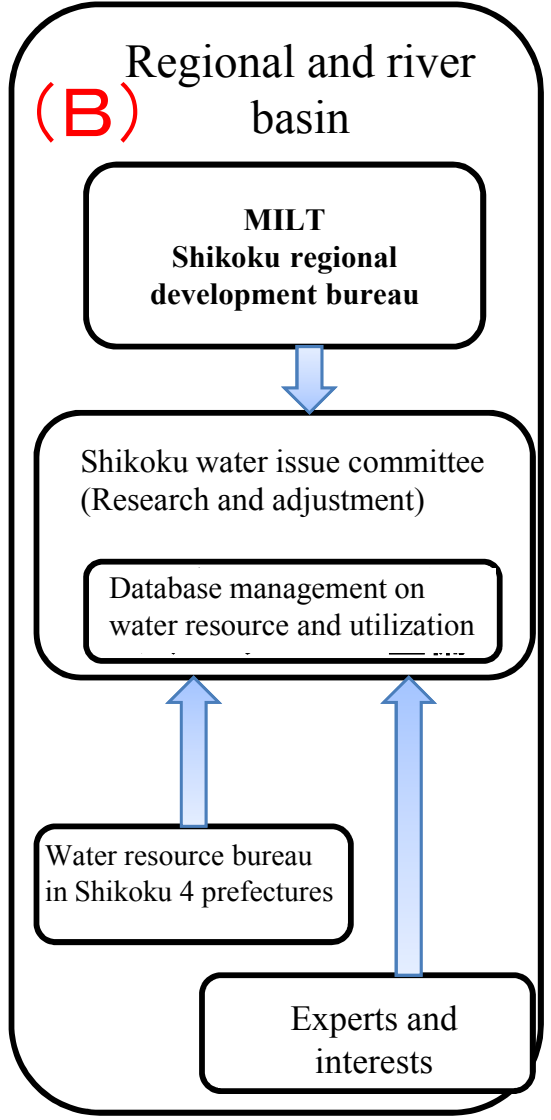
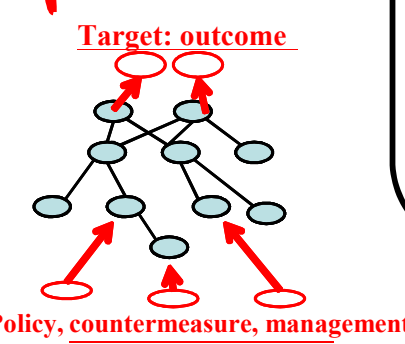
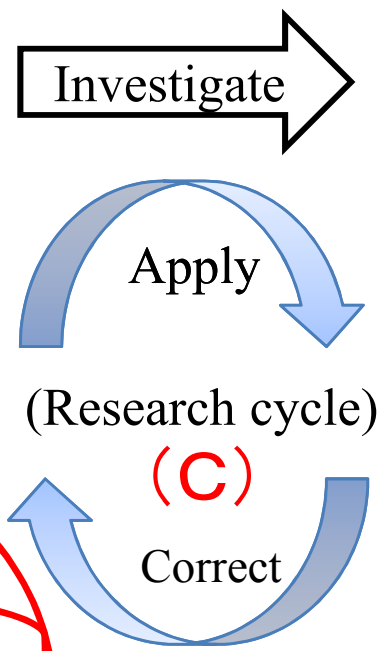
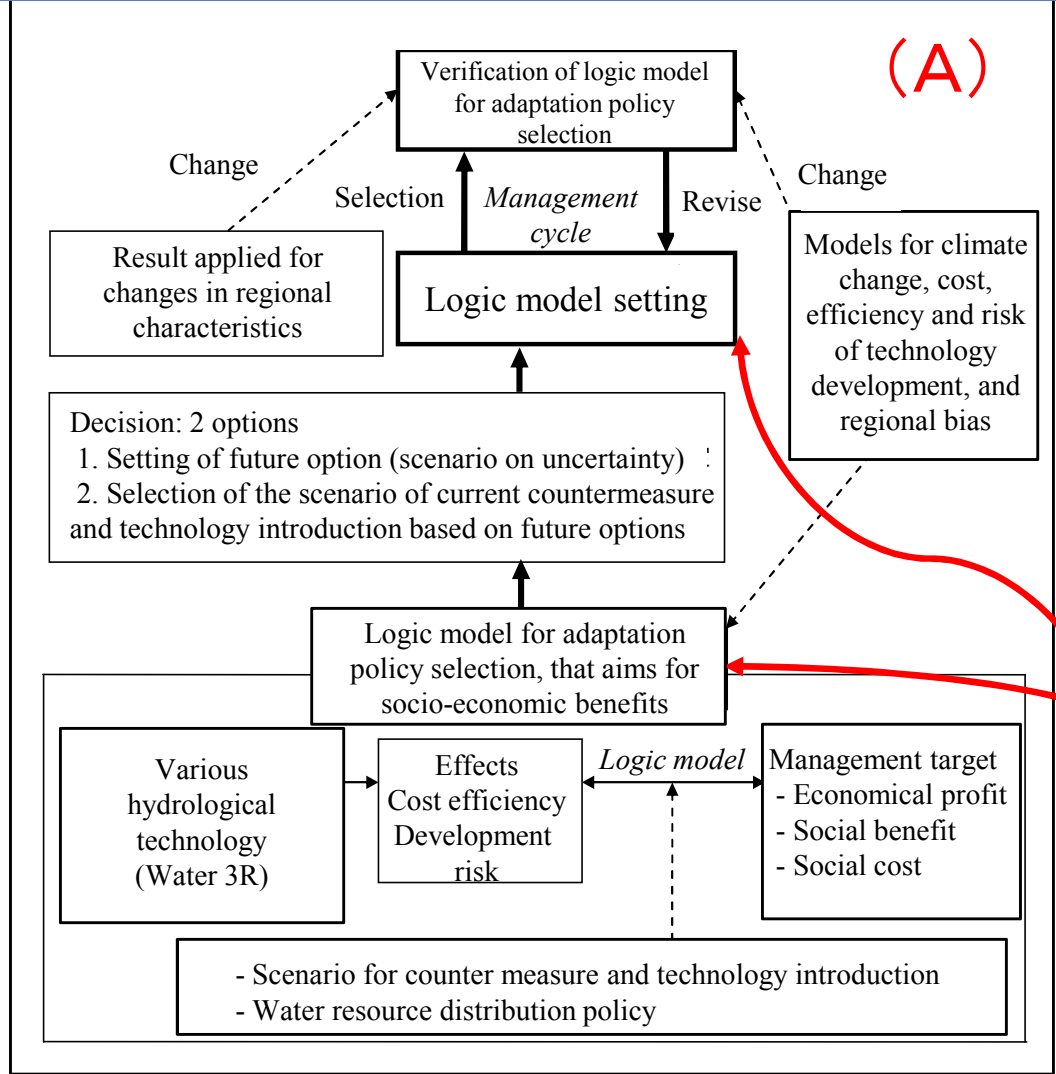
- Benefit evaluation model in each prefecture
- ↔ A policy evaluation model based on total benefit evaluation

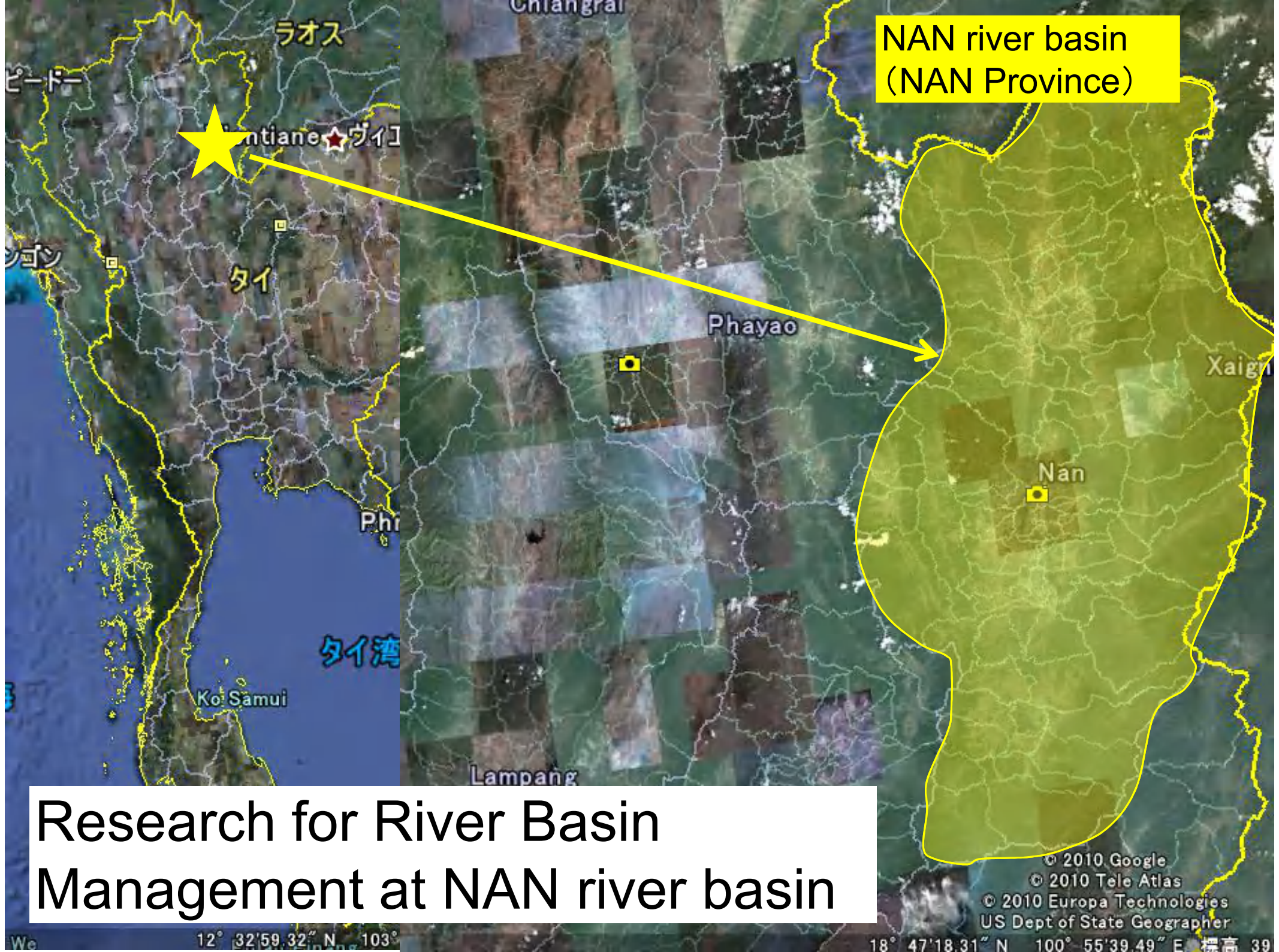
(4) Implementation of the policy

⇒ Regional Management System



Process model for adaptation policy
(Regional and river basin management model)





NAN river basin
(NAN Province)

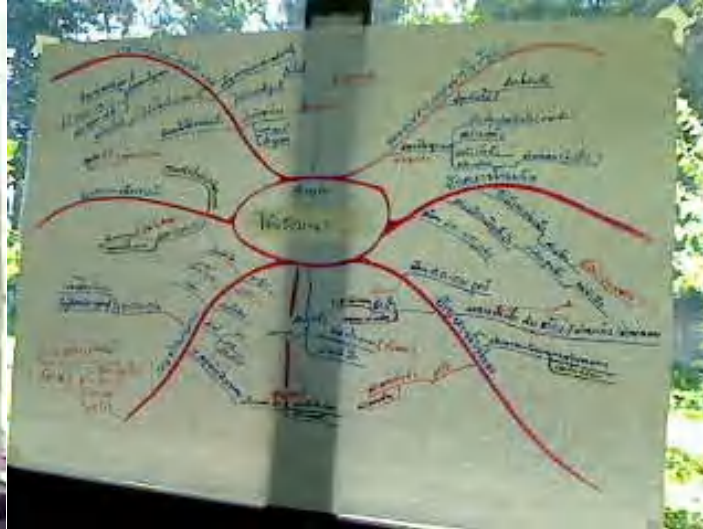
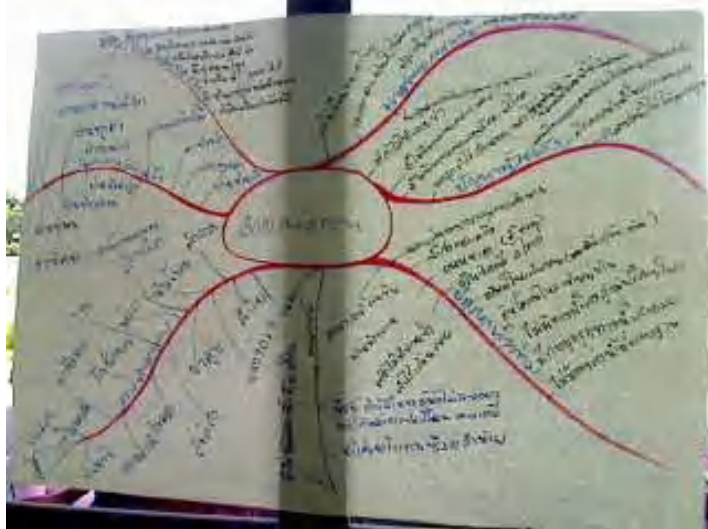
Research for River Basin
Management at NAN river basin

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US Dept of State Geographer

12° 32' 59.32" N 103° 18' 47.18.31" N 100° 55' 39.49" E 標高 39

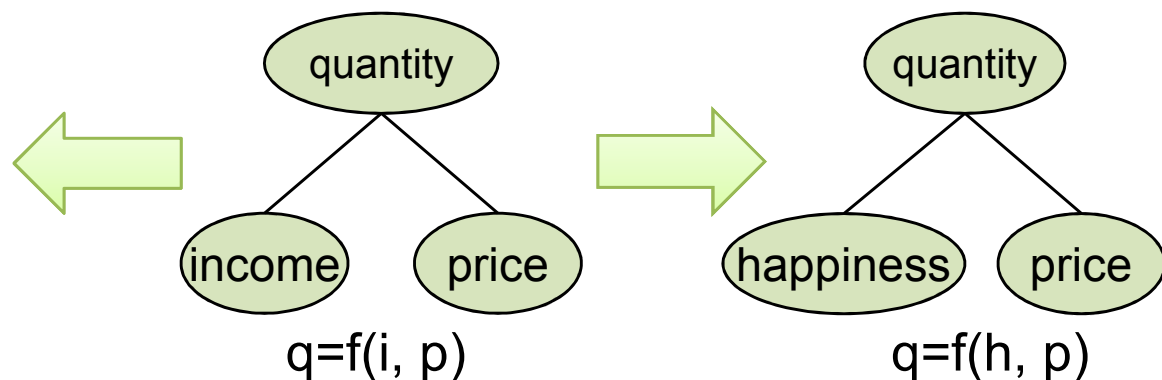
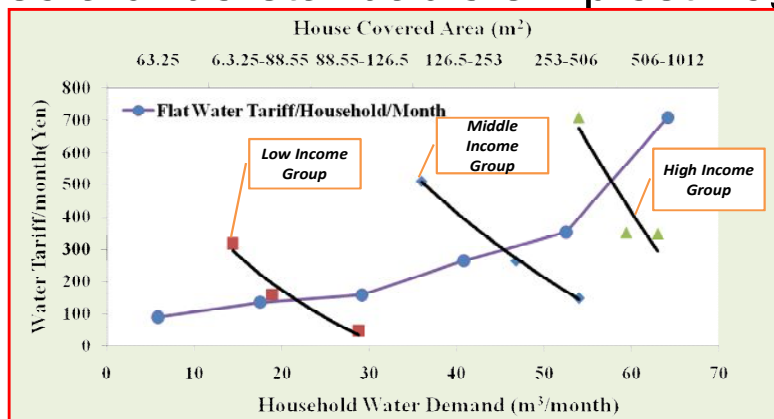
○ An Important first step for river basin management Attempt to create studying committee with citizens at sub-district

- Importance to start with sub-district work shops in order to obtain information regarding peoples mind and problems unrecognized.
 - 1) We do not know wholly about the real issues at the residential area.
 - 2) We do not know how residences are feeling the impact of issues including policy implemented.
- We have to question ourselves at each level of water issues, whether the policies or decisions made is linked to the lower level in an integrated manner.
- In order to check these problems, and to build a hierarchy integrated system for proper decision making, we must start researches from sub-district and up to the central governmental level.

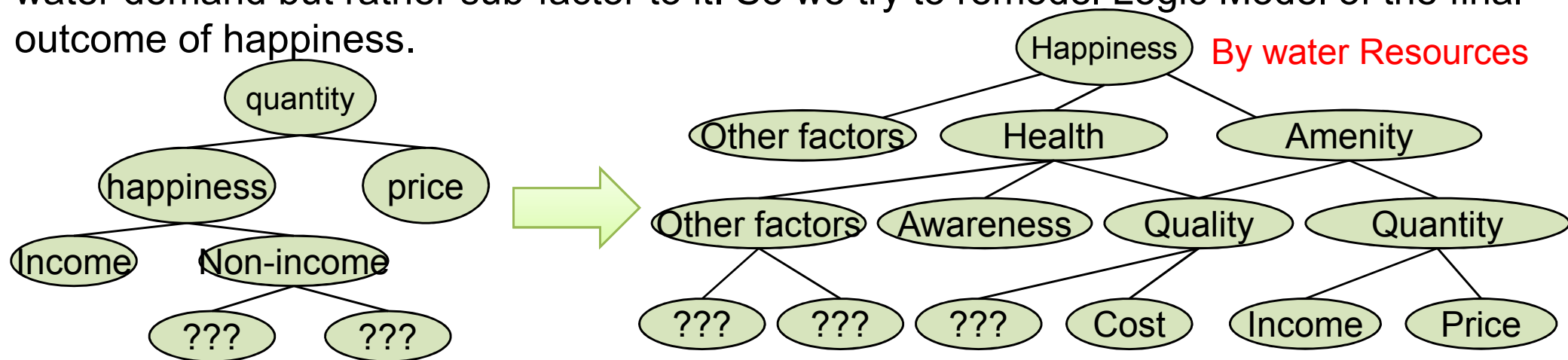


Discussion at Thailand over Logic Model of mind set

1) Water Demand regarding Income and Price can be described as $q=f(i, p)$. But if we substitute Income with Satisfaction (Happiness) based on the water consumption, it is also a understandable simplest Logic Model of mind set.

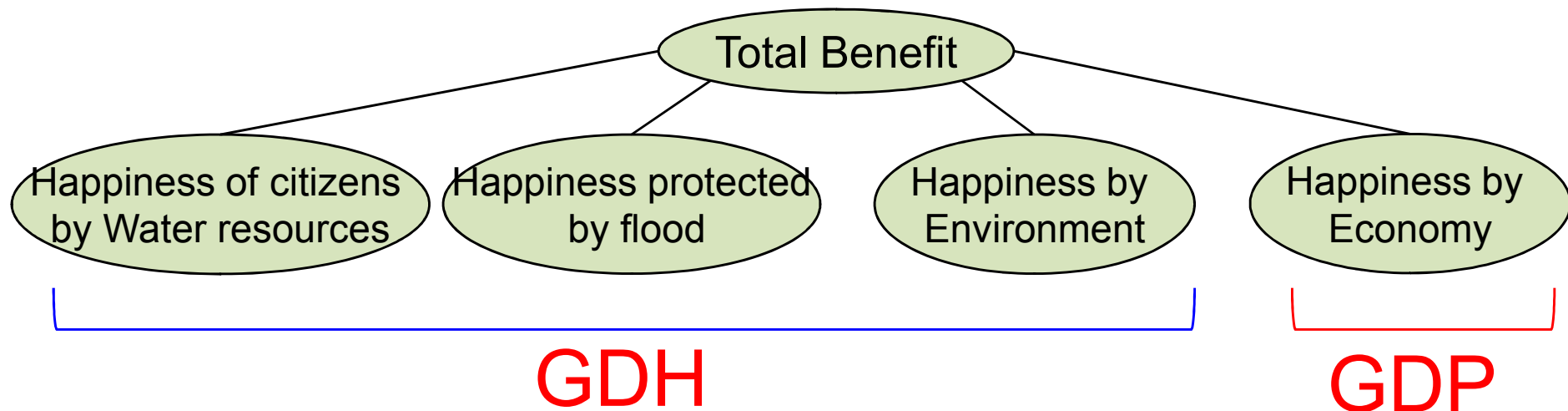


2) Then we have to obtain the structure of Satisfaction (Happiness), which we can easily imagine that it consists of many factors. But here if we look carefully at the structure of the Logic Model derived from the minimum modification from the previous Logic model which consists of just happiness and price shown below, Income and Price are included in the model, which are relative and not fundamental factors to the water demand but rather sub-factor to it. So we try to remodel Logic Model of the final outcome of happiness.



Discussion at Thailand over Logic Model of mind set

- 3) Of course Logic Model has to be evaluated through the process from structuring the issue to picking up the logical part of the mind set, and then we have to make it to a numerical model by questionnaire survey.
- 4) The purpose of numerical Logic Model of mind set is to obtain numerical outcome for river basin management associated with numerical numbers of economical benefit from water resources, and here comes the question how to make happiness outcome to monetary number.
- 5) If we ask river basin citizens how much do they want to pay for water to get happiness, we may be able to obtain monetary model. However, there was a question that they may say no-money to pay for better quality and quantity, and it is not like Japan that people would answer to these kind of questions. In that case we have to utilize the research results of relationship among quantity, price, and happiness.
- 6) If we will successfully go through these procedure to obtain monetary Logic Model of mind set, the next issue is to integrate a total benefit of the citizens at river basin.



○ Importance of integrated system from sub-district to district, province, central government.

●Problems have to be categorized for proper solutions at proper administrative level. Then we may be able to select proper issues for each level of the policy making and decision making.

1)Some issues can be solved at community with their resources.

2)Some issues need local regulations at local government level.

3)Some issues need central governmental law making.

●In order to categorize issues, local study from community level to integrated study at central government is necessary.

●Issues studied at lower level is useful for upper level study.

●For all these studies, regardless of the level, integrated simulation systems from meteorology, hydrology, to socio-economical activities is necessary.

●Future study have to be extended from sub-district to upper level.

○Significance of the Integrated simulation model for policy making and regional management at Thailand

- (1) If the simulation from the meteorological science to engineering and social science are integrated, it is possible to promptly evaluate the impacts of the policy.
- (2) Integrated Model for Policy Evaluation will become a frontier example to utilize knowledge of natural science for the society.
- (3) One of the most difficult issues regarding water can be solved by evaluating the policy impact by this integrated model.
- (4) Integrated Model for Policy Evaluation may contribute at each stage of decision making such as sub-district, district, province, river basin, and central government.
- (5) Especially, science of Public Management will have a important development with the practical study at river basin and local area like sub-districts.

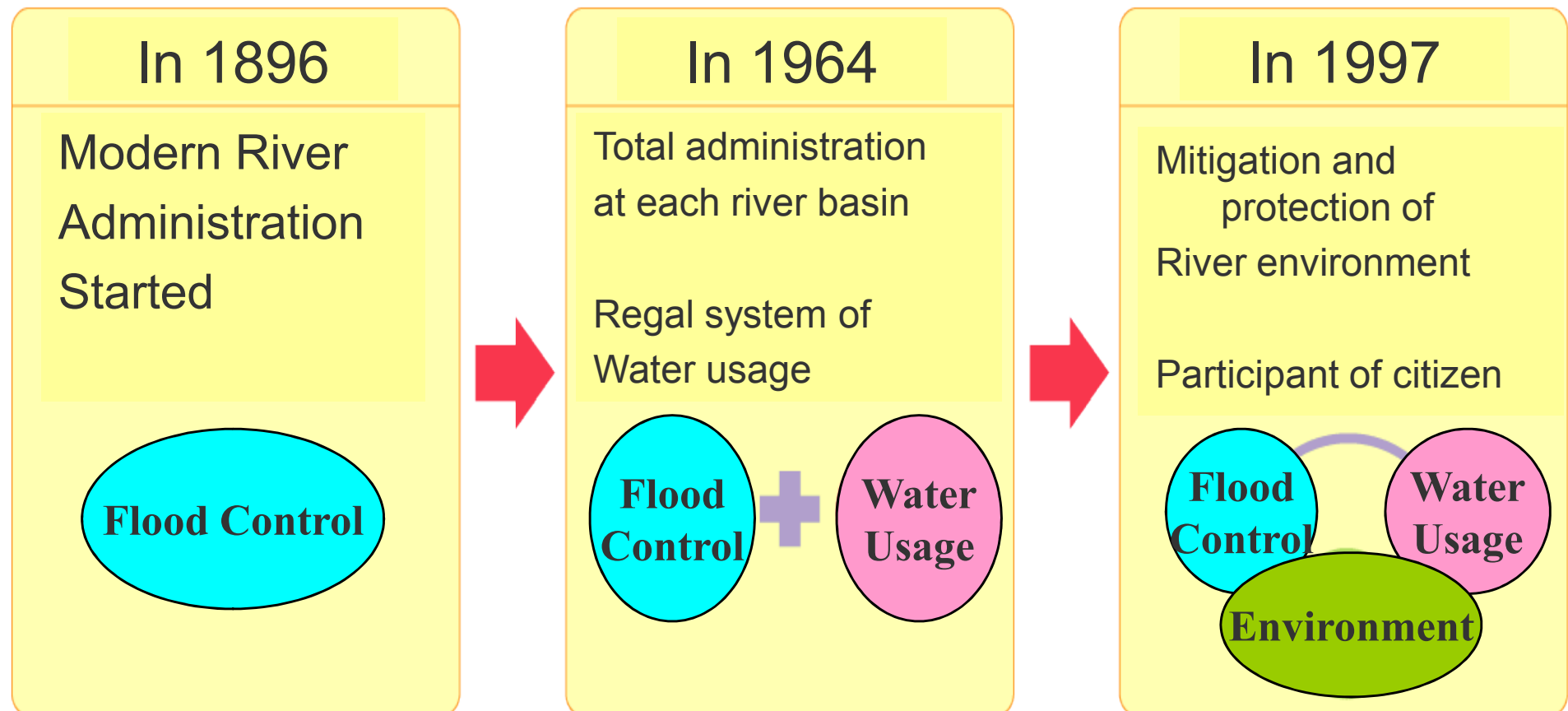
Thank you

■ Changing the Way of Thinking

- We did not well communicate with people for Infrastructure Planning.
- We did not inform them with enough information that they want.
- We did not let them involved in the planning process.
- A New Way of Planning system started in River development.
- New Public Management is a new issue expected to answer for financial crisis.

■ River administration of Japan

- History of River Administration & Law



■ River Basin Committee for planning

● Planning River Development for the next 20-30 years(1)

Old system

- Every development was planned by administration

New system

- New Law requires administration to listen to the opinion of residences, mayors, specialists
 - development policy Administration determine what level of safety should be kept. But actual development plan is not included.
 - development plan Initial Plan is planned by river administration, but opinions of residences, mayors, specialist has to be taken.

(Reference)

In Japan, annually, or any other short term basis, special committees for water resources, water quality, disaster management, environmental issues are already conducted.

■ River Basin Committee for planning

● Planning River Development

for the next 20-30 years(2)

- Planning
 - ▪ ▪ ▪ flood control, water utilization, environment
- River Basin committee
 - ▪ ▪ ▪ mainly consists of regional residence
 - ▪ ▪ ▪ and specialists of each field
(hydrology, agriculture, culture, history, mass media, biology, environment, city planning, industry etc.)
 - ▪ ▪ ▪ planning Official of administration can participate ,but cannot talk at the committee unless committee allows.
- For the committee a preparatory committee is set
 - ▪ ▪ ▪ how to manage the main committee
 - ▪ ▪ ▪ who to consists of
and volunteer member of the committee is allowed.
(For main committee)

■ River Basin Committee for planning

● Planning River Development

for the next 20-30 years(3)

- What they determined at the preparatory committee?
 - ▪ ▪ The number of committee members
 - ▪ ▪ How to obtain additional volunteer member
- The rules determined at the preparatory committee were checked and authorized at the main committee.
- The main committee discussed about
 - ▪ ▪ the aim of the river development over 20 to 30 years
 - ▪ ▪ actual development plan for the next 20 to 30 years
 - ▪ ▪ how to inform residences of the planning process

Ibo River

兵庫県

Kakogawa River

Yodo River

太島

神戸

Osaka

大阪

大阪府

27 キロメートル

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Image © 2010 DigitalGlobe

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34° 50'19.50" N 135° 12'00.01" E 標高 271 メートル

Google

高度 92.78 キロメートル

Example: Yodo River Basin Committee

- **Function of the Basin Committee**

1. To express opinions by checking the procedure of planning the river basin development plan.

2. To express opinions to reform the river basin development plan.

3. To discuss for reevaluation of existing development plan and evaluation after completion of development plan and to express opinions by the authority of Act of Evaluation on Governmental Activities and related regulations, until the river basin development plan is planned by River Law.

4. To discuss for reevaluation of existing development plan and evaluation after completion of development plan and to express opinions by the authority of Act of Evaluation on Governmental Activities and related regulations after the planning of the river basin development plan completed.

● Process of River Basin Committee

- Committee made opinion paper for the river development planning.



- River Development plan have to take the committee opinion ; administration dose not have to follow the whole opinion exactly ,but most of them should be.



- Initial Plan made by administration “again” have to be explained to residences, mayors



- Based on their opinion initial plan is going to be reviewed, and administration determine the final development plan.

● “Ibo River”

River Basin Committee



- Environmental conflict
 - Budget conflict
 - Culture and History conflict
-
- What's good?
 - What's bad?
 - What to control?

■ What happened at two river basin committees

◆ Results of the committees

- Both river basin committee made recommendation not to plan dams.
- Environmental issues obtained higher priority at both committee.

◆ Different Aspects among committees

- Ibo river basin committee did not have shiver conflict among government and committee, since dam was not recognized as an urgent issue, but rather a matter of the interest of the residences how deeply they think dam was needed.
- At Ibo river basin committee, recommendation report from committee was an acceptable contents for central government, which is going to be taken into account with the available budget for the next 20 to 30 years.
- Yodo river basin committee which just made a final recommendation report in this April is still under the conflict, whether central government should take the recommendation not to construct or stop constructing dams.

This happened after that central government did not take the part of the recommendation not to construct dams.

Ibo River

兵庫県

Kakogawa River

Yodo River

太島

神戸

Osaka

大阪

大阪府

27 キロメートル

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Image © 2010 DigitalGlobe

© 2010 Cnes/Spot Image

34° 50'19.50" N 135° 12'00.01" E 標高 271 メートル

©2009 Google

高度 92.78 キロメートル

Shikoku Water Issues Research committee(1)

***Purpose**

Integrated discussion of Water issues in Shikoku Island to find solution of flood control, Water resource utilization, environmental protection.

***Committee**

Committee consists of industrial sector, university researchers, and government officials, including central government, prefecture.

***Proposal**

Logical and sustainable solution and its implementation methodology is going to be summarized.

Shikoku Water Issues Research committee(2)

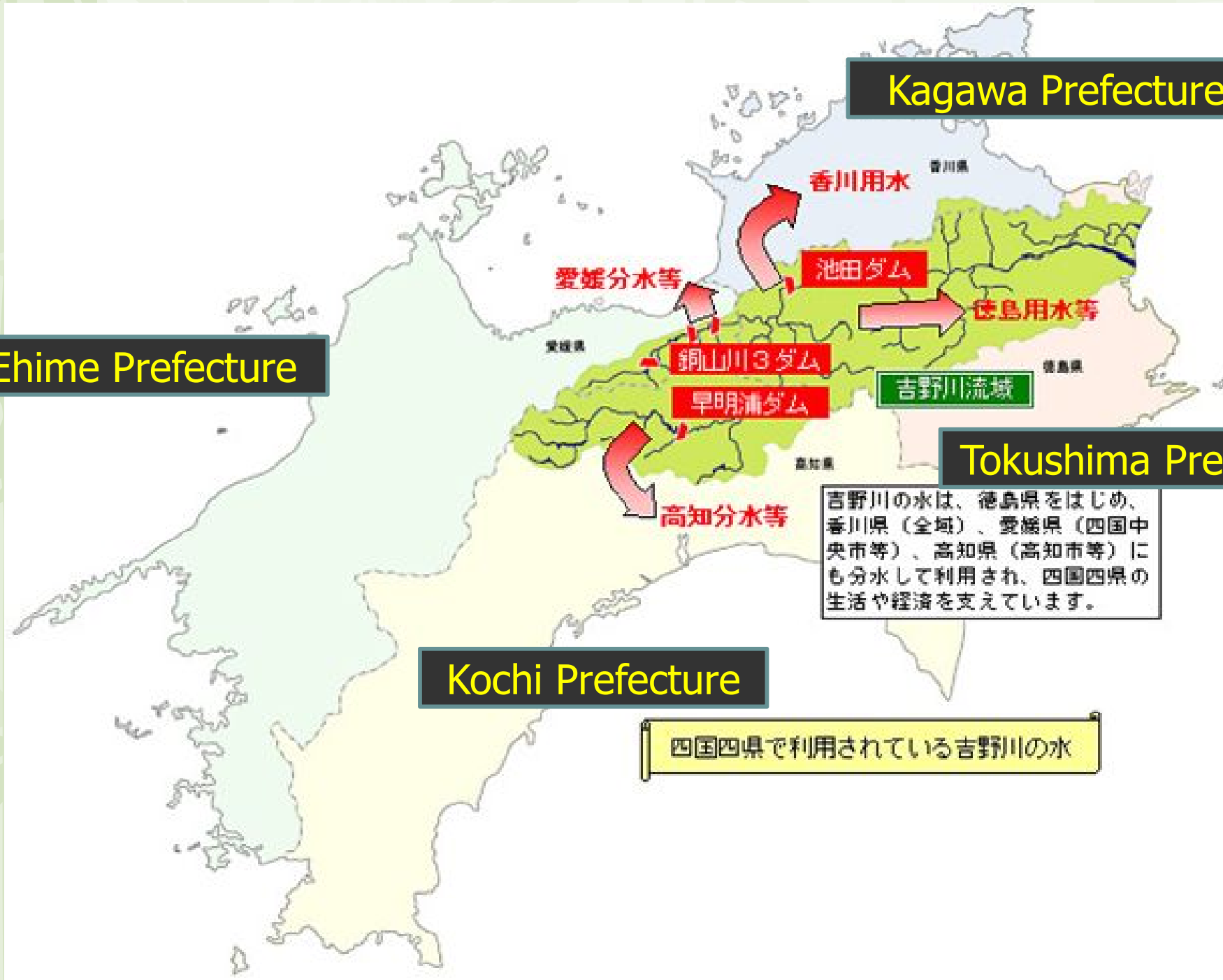
Kagawa Prefecture

Ehime Prefecture

Tokushima Prefecture

Kochi Prefecture

四国四県で利用されている吉野川の水



吉野川の水は、徳島県をはじめ、香川県（全域）、愛媛県（四国中央市等）、高知県（高知市等）にも分水して利用され、四国四県の生活や経済を支えています。

Shikoku Water Issues Research committee(3)

Intermediate Report

●Water resource are seems to be not fairly shared, but we have lack of accurate information, regarding

- 1)Amount of available water resource of each prefecture
- 2)Total social welfare of each prefecture

●Current Water Right is too much protected so that even at drought, some water are not effectively used.
including water which do not have specific utilization.

●According to Law of River, at drought stakeholders have to share water resources with spirit of compromise, yet Authority of river manager is too weak to realize the spirit.

Shikoku Water Issues Research committee(4)

Intermediate Report

● Assert of one prefecture who has more than enough water resource.

1) Water which do not have specific utilization is now diverted to pipe water.

2) Water which do not have specific utilization protect environment or river.

3) Water which do not have specific utilization is a property of the prefecture to hand over to a descendant.

○ Research processes for the regional management system

In this project, we can obtain general knowledge from the following 3 methodologies

(A) Regional management system (1. Logic model for structure of social problem and management target, 2. Management hypothesis from policy evaluation logic model)

(B) Verification and hypothesis correction by confirming the interaction between actual regional management system development and scientific approaches.

Step 1: Verify the accuracy of the logic model

Step 2: Modify the element function coefficients in the logic model by analyzing the effects of adaption policy

Step 3: Reconstruct the logic model from the social environmental changes to confirm the validity of the integrated management cycle model and regional management system

(C) From the state of the regional management system from interaction of feedback(management cycle) from (A) and (B), we can verify the applicability of the regional management system that integrated the natural and social sciences affected by the problems of climate change.