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An aerial photograph of a landscape. On the left, a dark blue river flows. The middle ground is dominated by a large, dark, irregularly shaped area, possibly a forest or a large pond. Surrounding this central area are numerous small, rectangular plots of land in various shades of green and brown, suggesting agricultural fields. In the background, a dense urban area with many small buildings is visible. The overall scene is a mix of natural and human-made environments.

Theoretical basis for considering biodiversity towards sustainable ecosystem services

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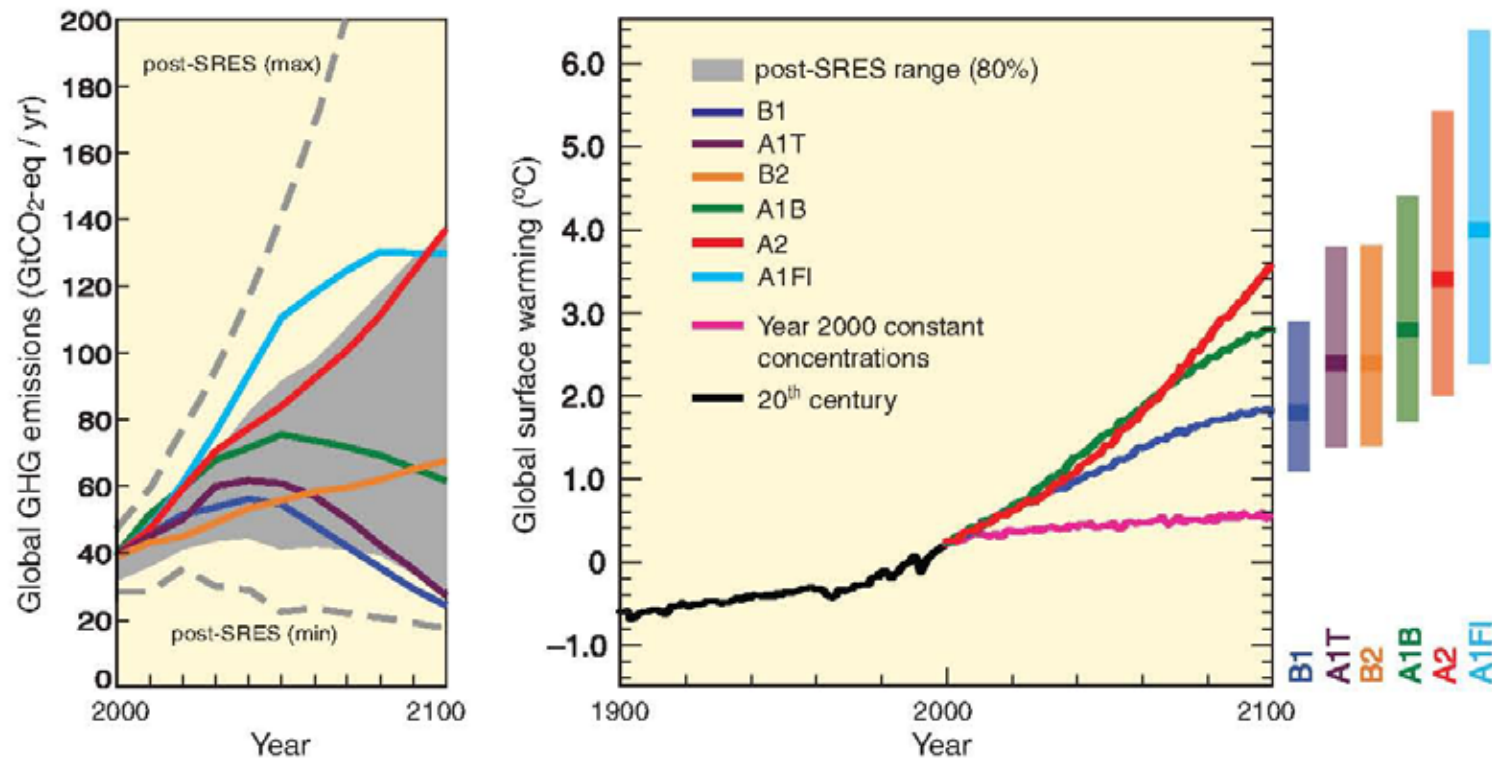
3 July, 2008

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-Linking Ecology and Sustainability Science-
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-Watershed Governance Project-
- 3. Conclusions**

IPCC 4th Synthesis Report (2007)

Scenarios for GHG emissions from 2000 to 2100 (in the absence of additional climate policies)
and projections of surface temperatures



Climate Change

MA Synthesis Report (2005)

Drivers		Habitat change	Climate change	Invasive species	Over-exploitation	Pollution (nitrogen, phosphorus)
Forest	Boreal	↗	↑	↗	→	↑
	Temperate	↘	↑	↑	→	↑
	Tropical	↑	↑	↑	↗	↑
Dryland	Temperate grassland	↗	↑	→	→	↑
	Mediterranean	↗	↑	↑	→	↑
	Tropical grassland and savanna	↗	↑	↑	→	↑
	Desert	→	↑	→	→	↑
Inland water		↑	↑	↑	→	↑
Coastal		↗	↑	↗	↗	↑
Marine		↑	↑	→	↗	↑
Island		→	↑	→	→	↑
Mountain		→	↑	→	→	↑
Polar		↗	↑	→	↗	↑

Driver's impact on biodiversity over the last century

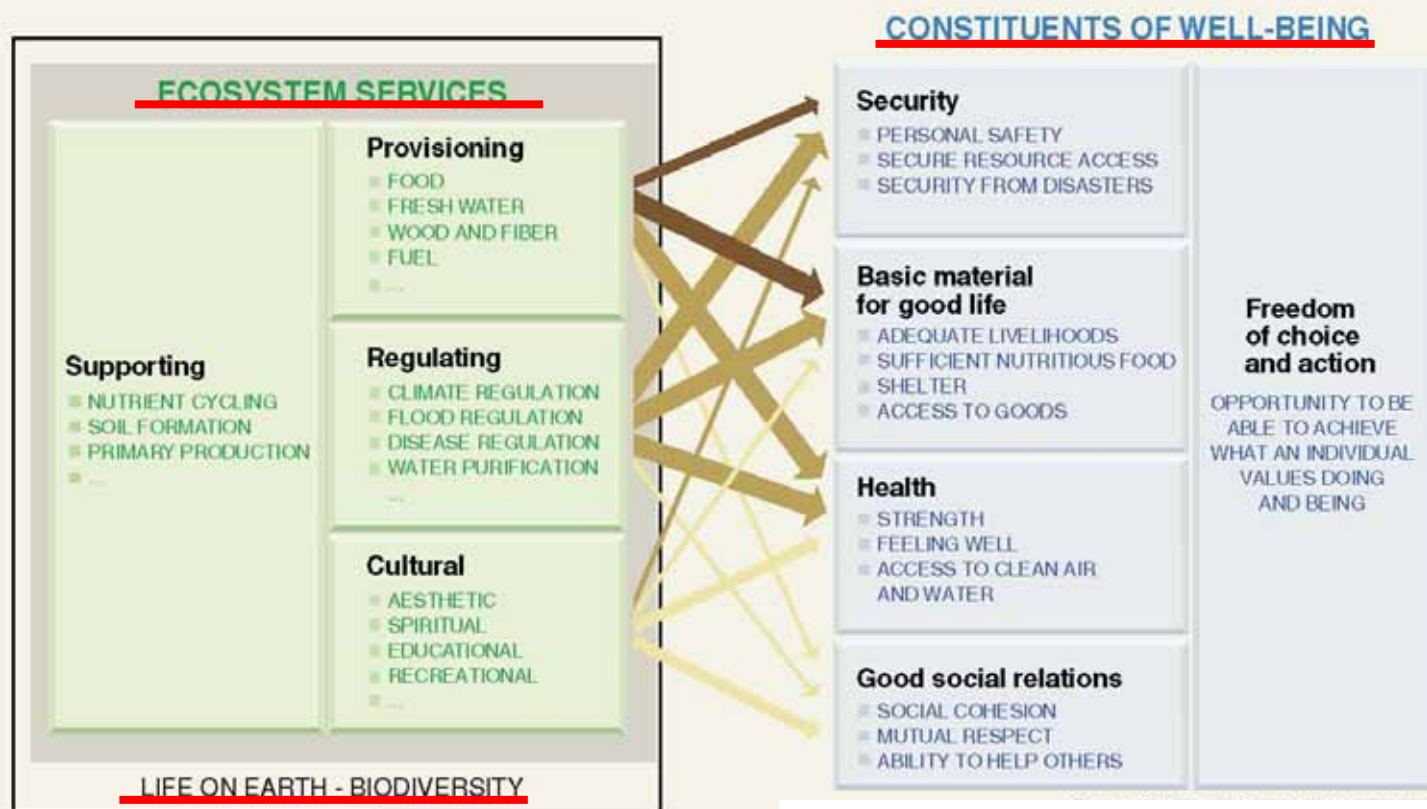
Low
Moderate
High
Very high

Driver's current trends

Decreasing impact
Continuing impact
Increasing impact
Very rapid increase of the impact

Source: Millennium Ecosystem Assessment

Human Well-Being depends on various Ecosystem Services



ARROW'S COLOR
Potential for mediation by socioeconomic factors

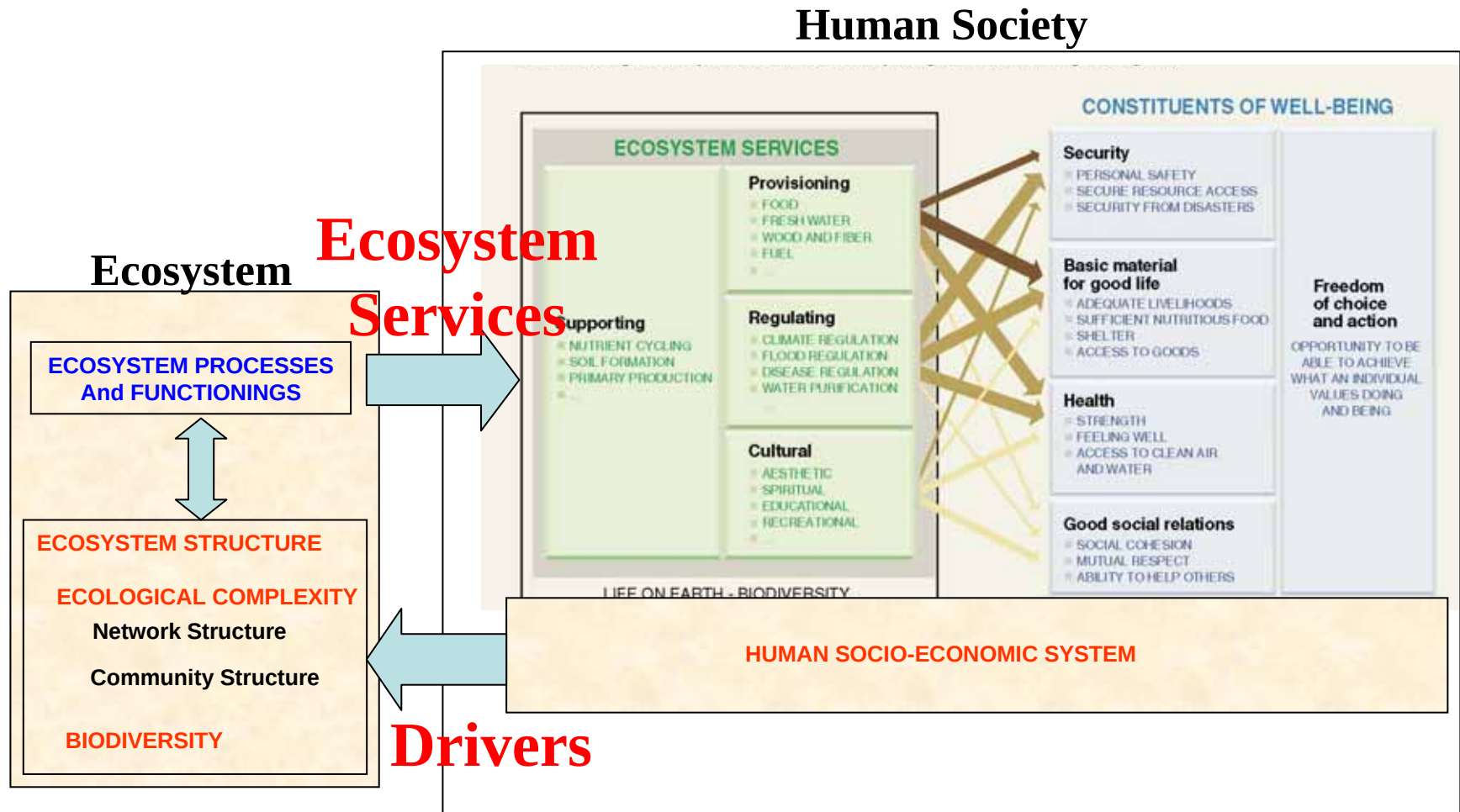
Low
Medium
High

ARROW'S WIDTH
Intensity of linkages between ecosystem services and human well-being

Weak
Medium
Strong

Source: Millennium Ecosystem Assessment

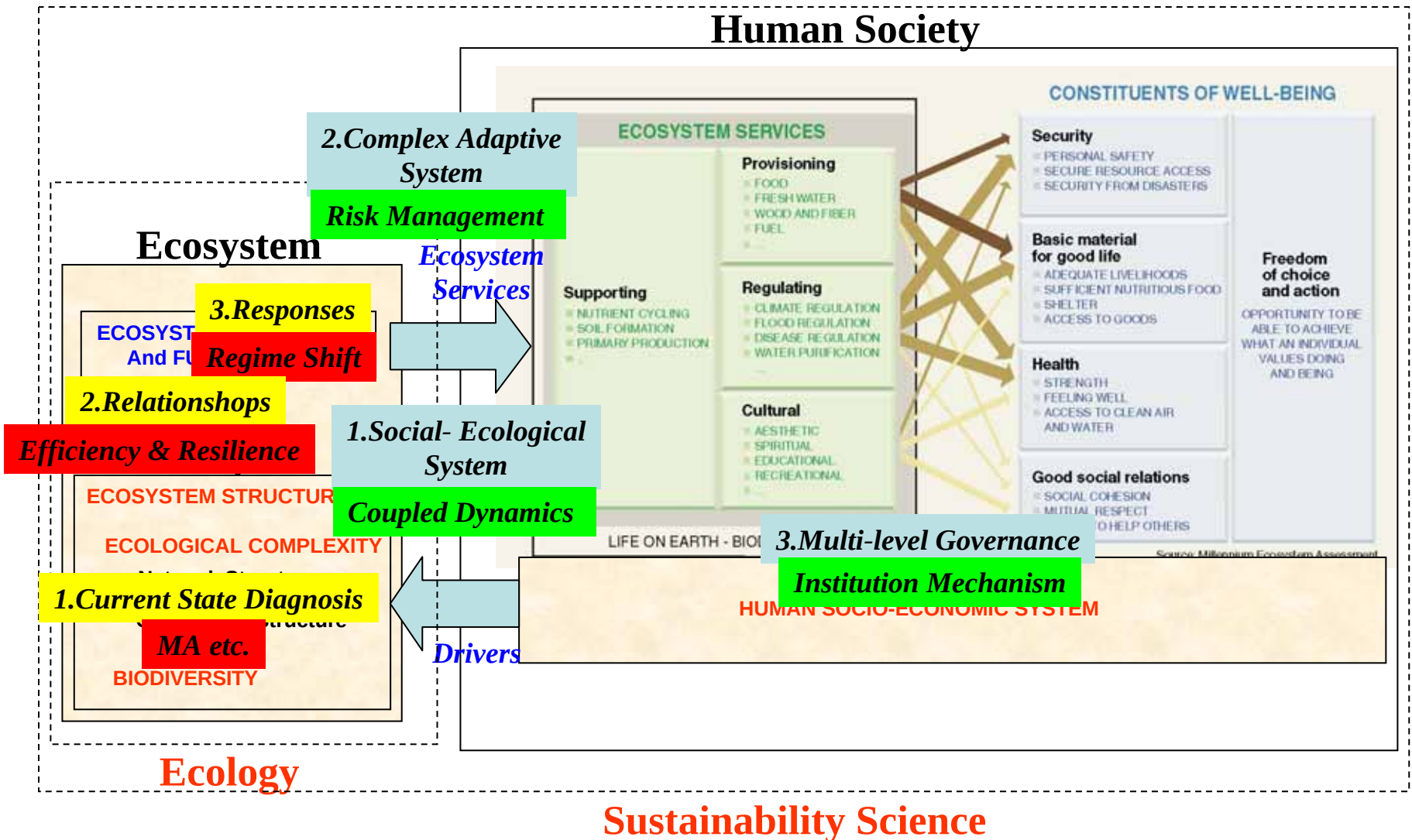
Ecosystem Services rely on Ecosystem Functionings



Drivers determined by Human Socio-Economic System

Linking Ecology and Sustainability Science

-Recent Theoretical Principles and Advances-



RIHN Watershed Governance Project

E-01 (CR2)

(2002-2006)

Ecology

Project Homepage • <http://www.chikyu.ac.jp/biwayodo/index.html>

1. Current State Diagnosis Stable Isotopes

2. Research for Understanding Humans and Nature over Watershed

3. Ecosystem Resonse Regime Shift Model

4. Social-Ecological System

Social Science-Natural Science Collaboration

5. Complex Adaptive System Adaptive Management

6. Multi-level Governance

Hierarchical Watershed Management System

The differences in problem consciousness among various stakeholders occurring from "hierarchy" of a watershed could be a major hindrance to awareness, leading to conflicts between top-down and bottom-up Management. To overcome the restrictions derived from these idea, we conducted research on the agricultural turbidity problem for environmental diagnosis and consensus building with an aim in 1) developing a new methodology to promote governance 2) approach to natural science and social science 3) practical prefecture as macroscale, Inae district as mesoscale, local communities in Inae district as microscale, 4) moving towards practical watershed and global environmental studies.

The results of newly developed watershed diagnosis methods including stable isotope ratio and

Bottom-up approach is both effective and necessary for the environmental management of Lake Biwa.

ment and its local work- provision of information related to the current status of the water environment or measures for water environmental preservation would affect the farmers' awareness of environmental considerations or their actions. These results indicate the need to develop a communication method based on the assumption of the individuality of the community and the importance of conditions such as social capital that allow such a method to work effectively.

and Studies must be environmental important in only solves

in global environmental problems and also constitutes a test bed for specific solutions to global environmental problems; and (2) It is essential to appropriately coordinate various stakeholders with various patterns of involvement in the environment that are deeply rooted in the area, although this project has the methodology for watershed management as its main theme, we believe the project provided a prototype methodology which can contribute to the way we consider and solve global environmental problems.

Communication of Research Findings

The project final report (in Japanese, ISBN 978-4-902928-11-9) is now available at university libraries in Japan and at the libraries of cities and towns in the Shiga prefecture. In it, 5-year transdisciplinary research on watershed management is compiled as a first step to "watershed environmental studies" with close connection to global environmental problems. Readers will find not only the new research findings but also the message and dynamism of the project emphasizing the importance of practice in regional societies, the social meaning of transdisciplinary collaboration, academic and social issues to be challenged.



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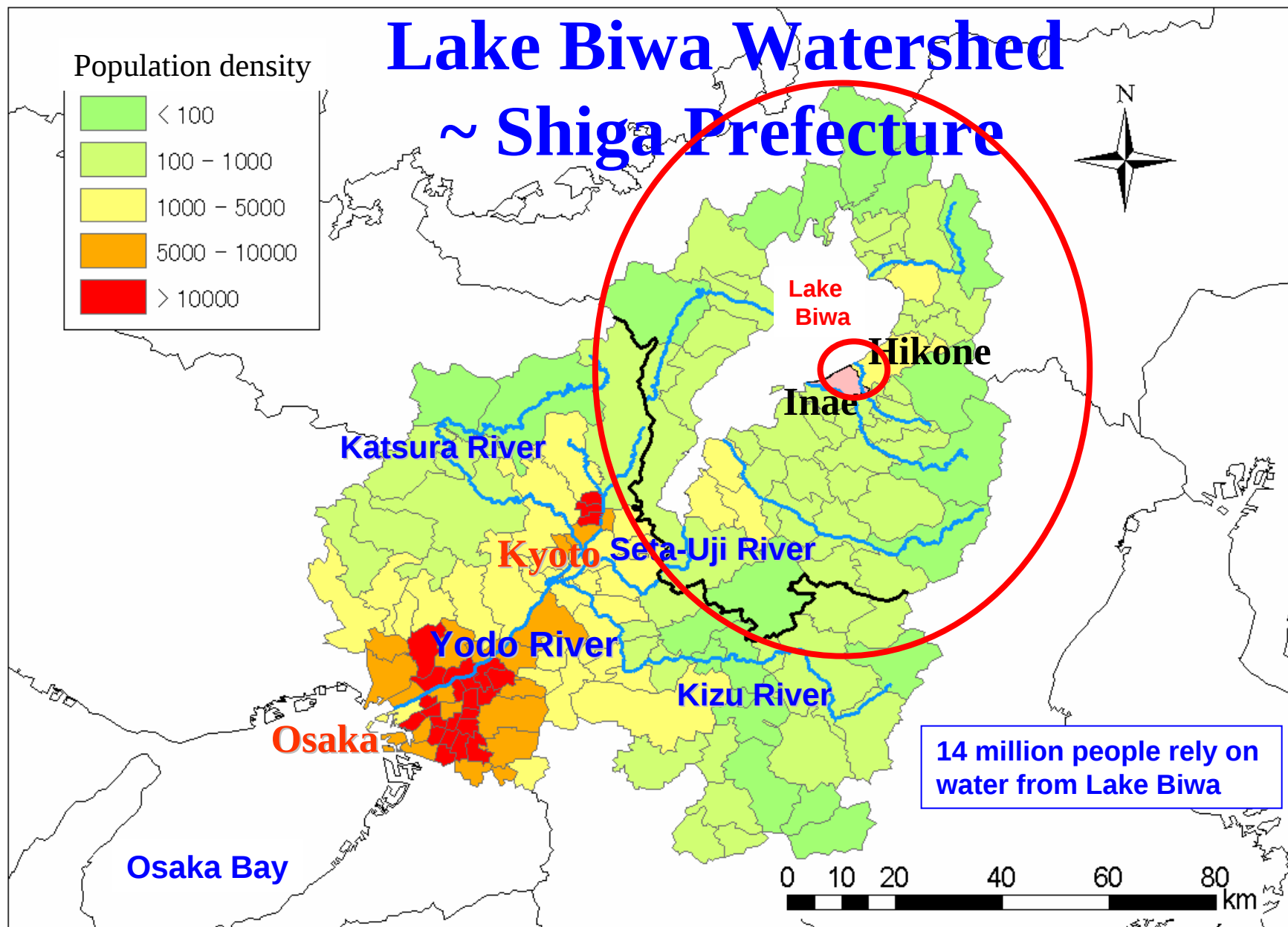
Figure Hierarchical Watershed Management System Applied to Lake Biwa Watershed in the Case of Agricultural Turbidity Problem



Lake Biwa watershed
Shiga prefecture, Inae district (region colored red) and local communities in Inae district (indicated by red circles) (left) and regional stakeholders concerning the agricultural turbid water problem, however, their consciousness of the problem is not the same. The hierarchical watershed management system is a mechanism to promote watershed management by governance of the various stakeholders in the region by building 1) feedback mechanism (PDCA cycle) consisting of monitoring with diagnosis, reflection at each scale, and 2) mechanism to promote communication between hierarchies (indicated by red arrows).

Lake Biwa Watershed ~ Shiga Prefecture

Population density



Agricultural Turbid Water Problem

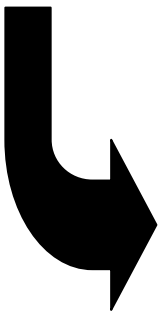
- A Non-Point Source: Watershed Management Issue -



Soil paddling before rice planting



Lake Biwa



Enforced draining



Small rivers in local communities

Turbid Water Problems as *Combined Problems*

Level	 Macro	 Meso	 Micro
Major Problem	Water Quality Regime Shift	Fishery Damage	Deterioration of waterside
Area	Lake BIWA	Lake shore	Canal
Causing	Load from land	Farming household	Farming household
Suffering	Lake water user	Fishery household	Farming household
Material	Cognitive Conflict between Stakeholders!		
Distance	Long	Middle	Short
Time scale	Long	Middle	Short
Type	Global Warming	Causing/Suffering Separation	Self-Feedback

How can we resolve the Conflict?

Watershed Scale

Human Society

Lake Biwa

Shiga Prefecture

Macro

Meso

Micro

Lake Biwa

Inae

Tributary

Echi River

Kyoto

Hikone City

Local Settlements

P→D
↑ ↓
A←C

P→D
↑ ↓
A←C

P→D
↑ ↓
A←C

P→D
↑ ↓
A←C

P→D
↑ ↓
A←C

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A←C

P→D
↑ ↓
A←C

P→D
↑ ↓
A←C

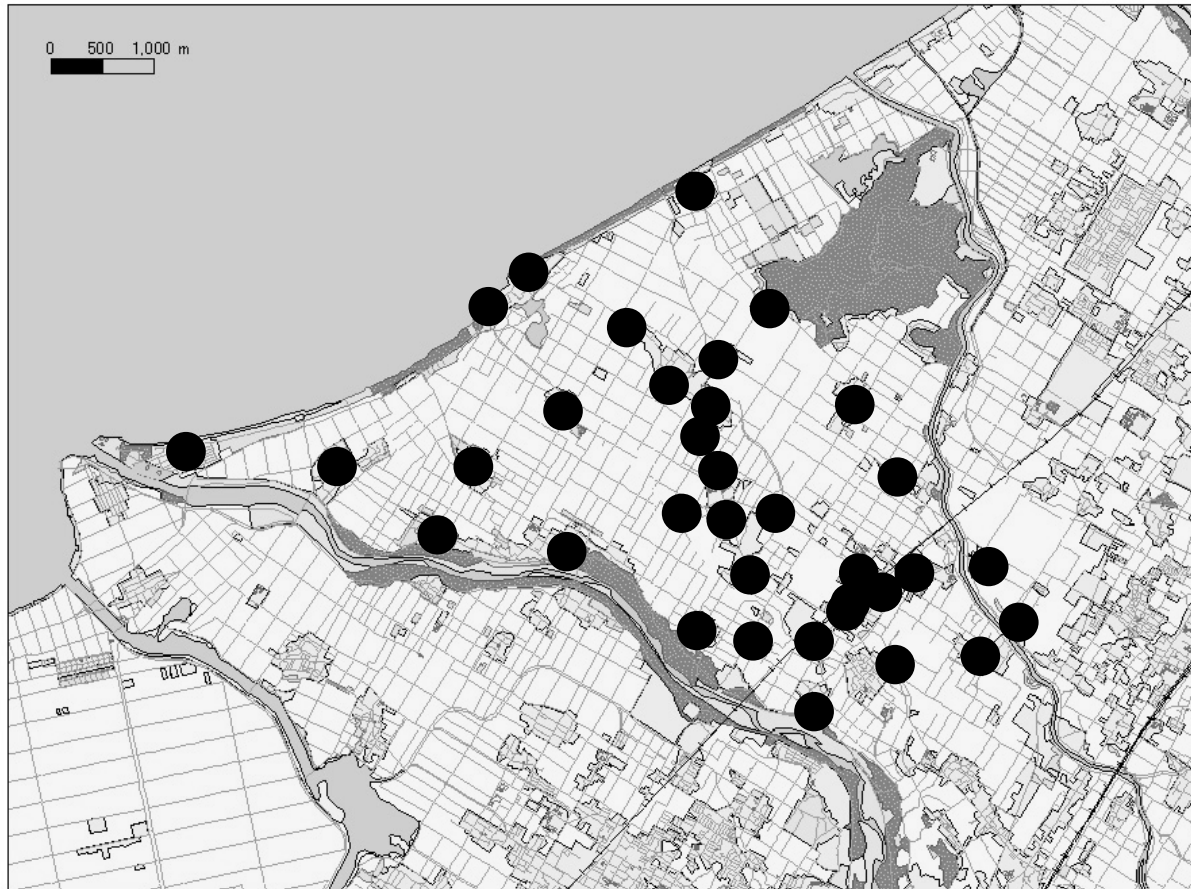
P→D
↑ ↓
A←C

P→D
↑ ↓
A←C

Hierarchical Watershed Management

1. Adaptive management
2. Inter-hierarchy communication

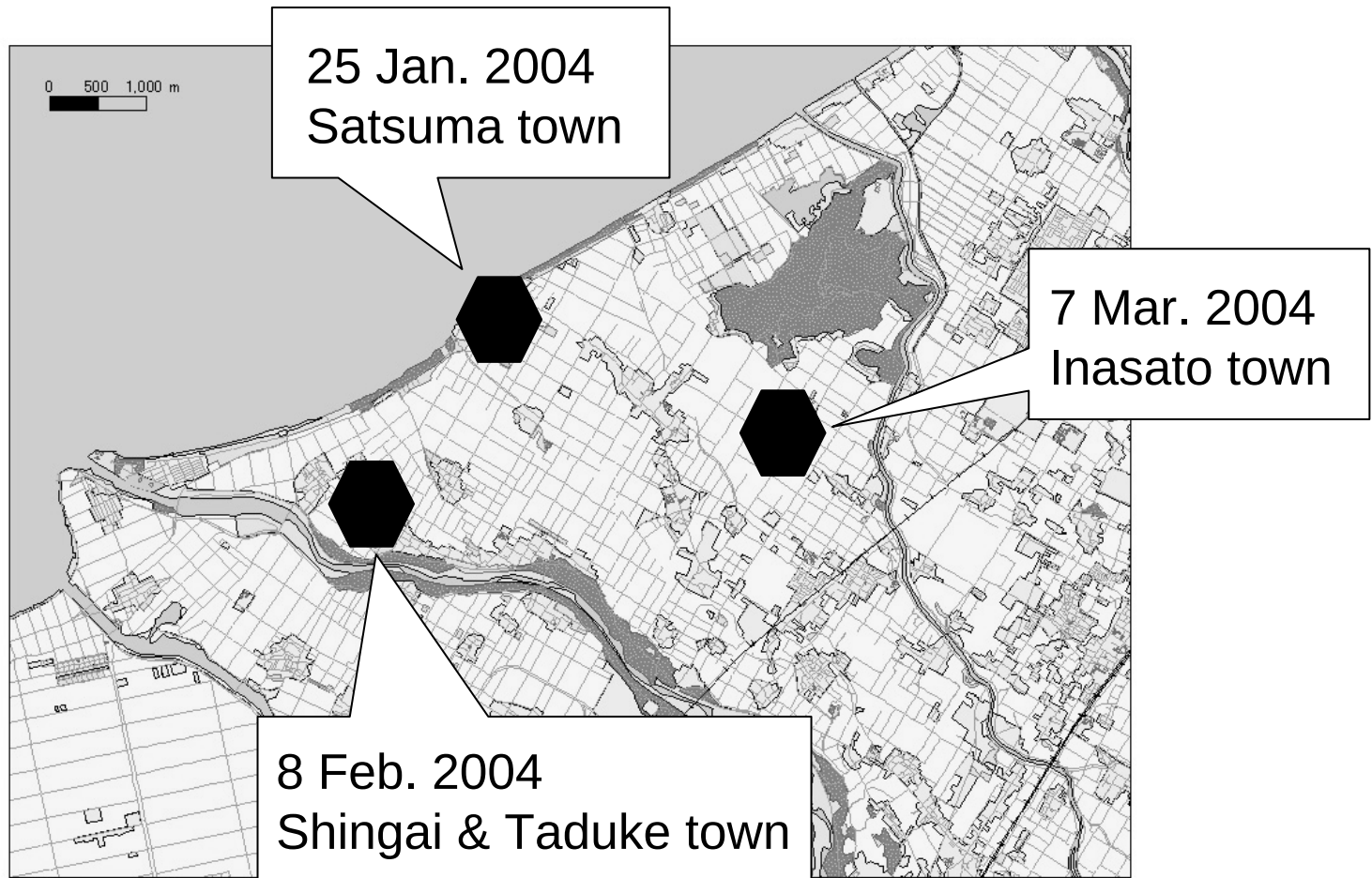
Face to Face Interviews in 35 communities (June - August, 2003)



**Interview of community-based water management system
-Sharing information using GIS-**

Workshops in 3 towns

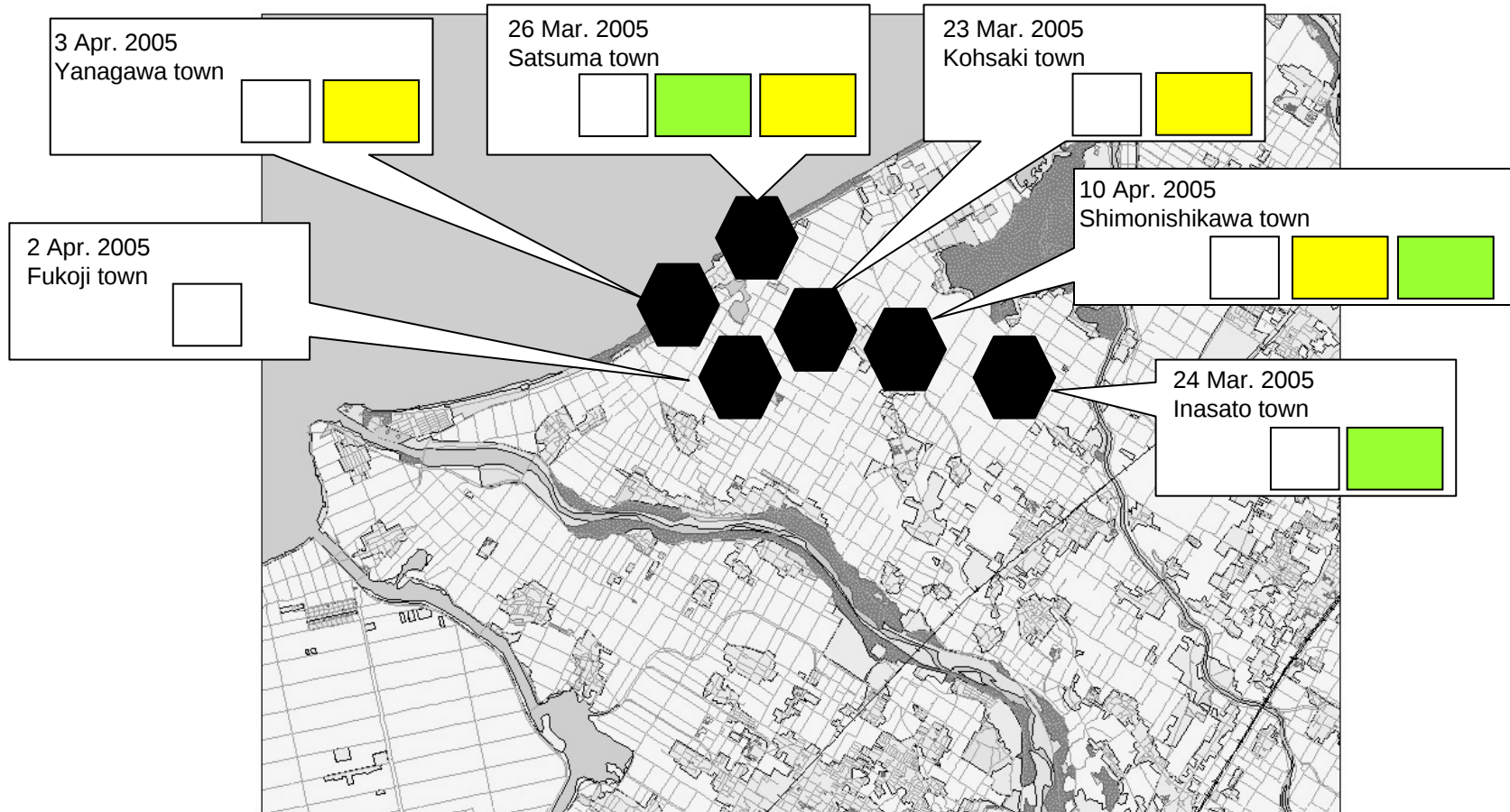
Water Environment in the Future



Empower local residents with discussion opportunities
Develop methods for making regional scenarios for and by residents themselves

Workshops in 6 towns

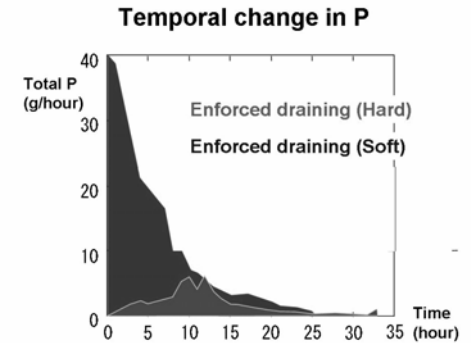
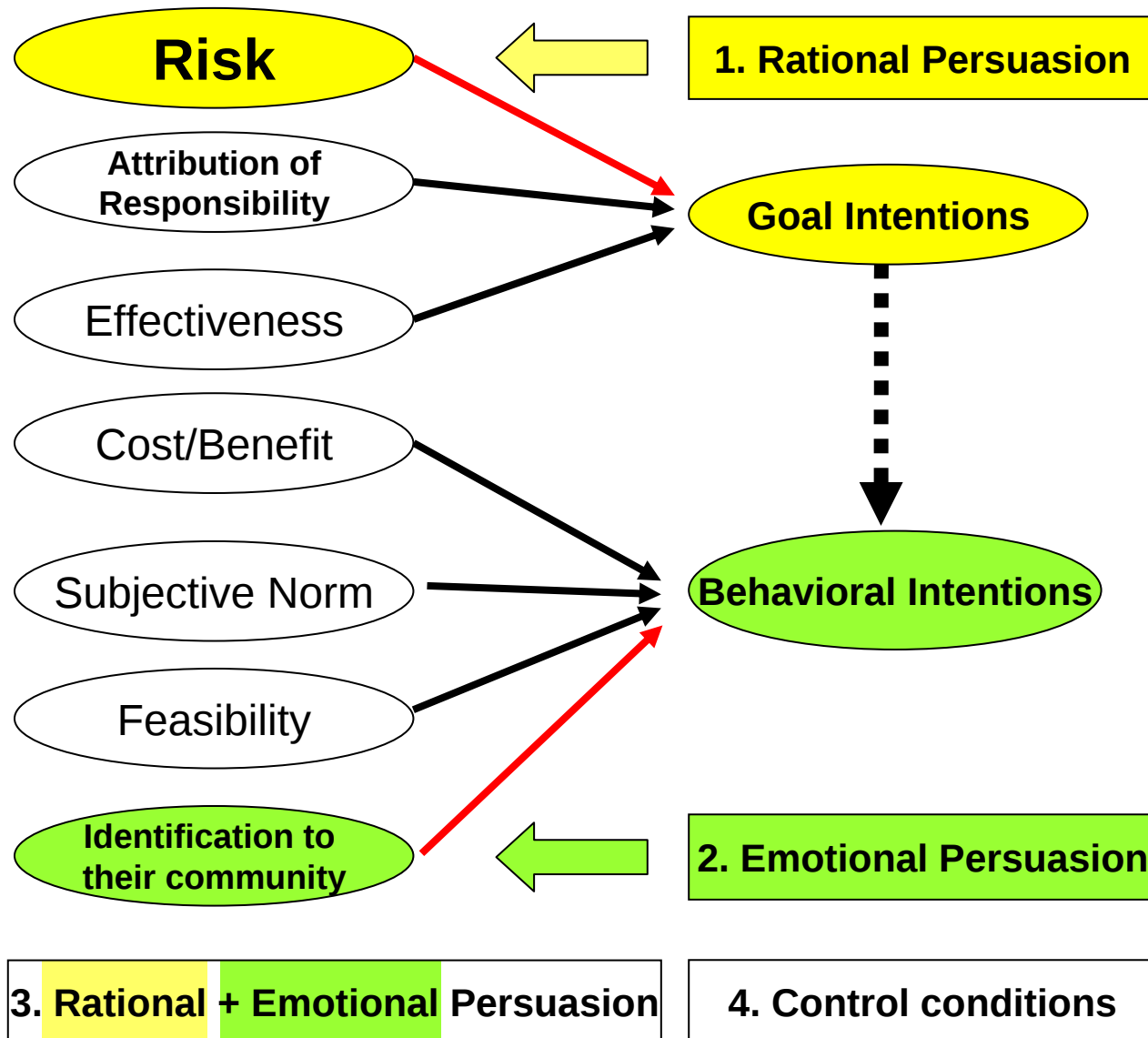
Social psychological Factors



**Seek conditions to resolve cognitive conflict to
empower environmental consciousness behaviors**

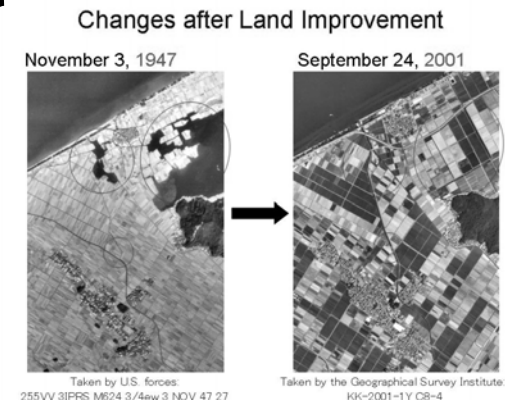
Environmental Consciousness Behavior Model

(Hirose 1995, Nonami & Kato 2006)



Scientific information

Information such as the farmer's attachment to their local areas and living things



Conclusions

- (1) Theoretical Framework and Recent Advances
-Linking Ecology and Sustainability Science-**
- (2) Case study to link Ecology and Sustainability Science**
- (3) Future Challenges: Linkages between Theory and Practices**