

## Challenges of Ecosystem-Science & -Engineering toward Conservation of Biodiversity

International Workshop on  
Ecosystem-Science & -Engineering Approach  
Toward Conservation of Biodiversity

May 13, 2010  
Shirotori Hall, Nagoya Congress Center

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## What is “Ecosystem-Science & Engineering”?

National land management to support human activities

**Safety** flood  
**Resources** water resources ..... city water, food, hydropower  
**Environment** quantity and quality of water

Human activities

(Reclamation of river and river basin, water channel regulation,  
dam construction, etc.)

on

**River basin**

Runoff process (hydrology)  
River flow, sediment transport, fluvial process (fluvial hydraulics)  
River eco-system (biology, ecology, limnology)

have resulted in

“Degradation of River Ecosystem” along a river

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### Revised River Law (1997)

Flood Mitigation,  
Water Resources Management,

River Environment Management including **Ecosystem Conservation**

### Environmental Impact Assessment (EIA) (1997)

Public nuisance management (pollution control)

**Ecosystem Assessment**

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## Execution of Revised River Law and EIA



### Scientific and Technical Support

Cooperation of **Ecology** and **Civil Engineering**

*Ecology & Applied Ecology, Environmental Management  
Hydrology-Hydraulics & River Engineering, River Management*

*Interdisciplinary Academy*

*Policy making and execution on scientific basis*

Cooperation among **scientists**, **engineers**, **government officers**



“**Ecology and Civil Engineering Society**” 1997

- × Applied Ecology
- × Ecological Engineering

**Ecosystem-Science & -Engineering**

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## Target field

National land management  
River and River basin  
Urban and rural planning

## Projects

Road and traffic facilities construction, etc.  
Road, Urban planning

*gardening, landscaping*

River and river basin management

River improvement Regulation of rivers  
for *flood mitigation*

Regulation of water discharge  
for *flood control, water resources*

*Runoff process*

dam & reservoir

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Results in ECES activity have been applied to:

### Public Works:

Road and traffic facilities construction, etc.  
Road, Urban planning,...

“Close to Nature Public Works”

*Revegetation, planting, gardening, landscaping*

River and river basin *Revised River Law*

River improvement Regulation of rivers

“Close to Nature River Improvement”

*Revegetation, planting, gardening, landscaping +  $\alpha$*

Regulation of water discharge

environmental discharge *River ecosystem*

EIA for projects located inside river basin

*Ecosystem Assessment*

*Habitat, Target species*

*Evasion, Reduction, Compensation*

Survey, Prediction, Evaluation

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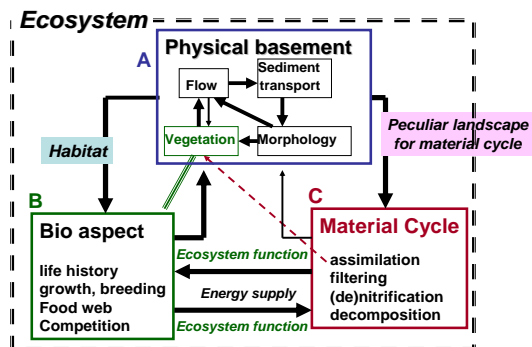
How to Access “Biodiversity”?

*certification*

“Sound Ecosystem”

How to Understand Ecosystem?

*Structure and functions of Ecosystem*



Interaction among three subsystems

Ecosystem function=Interactions among subsystems

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Understanding of Ecosystem

Habitat Management

Success in

Restoration and Follow-up for Conservation of *Local Landscape*

Methodologies:

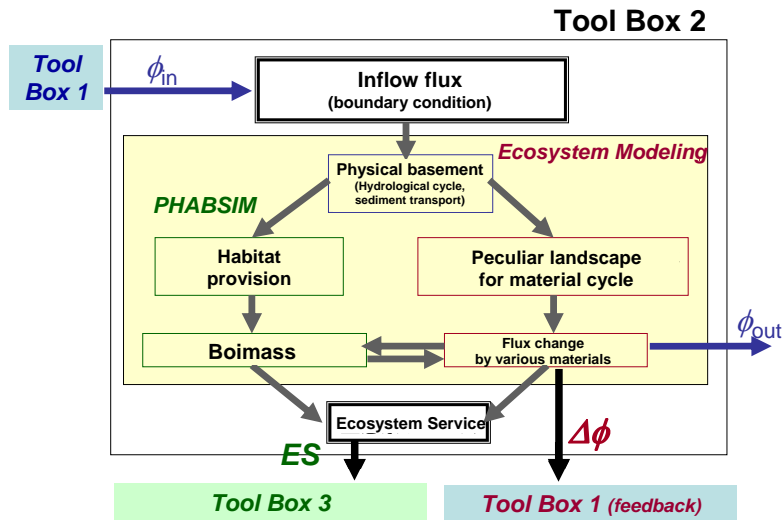
Habitat evaluation

PHABSIM (Physical Habitat Simulation)

HEP (Habitat Evaluation Procedures)

IFIM (Instream Flow Incremental Methodology)

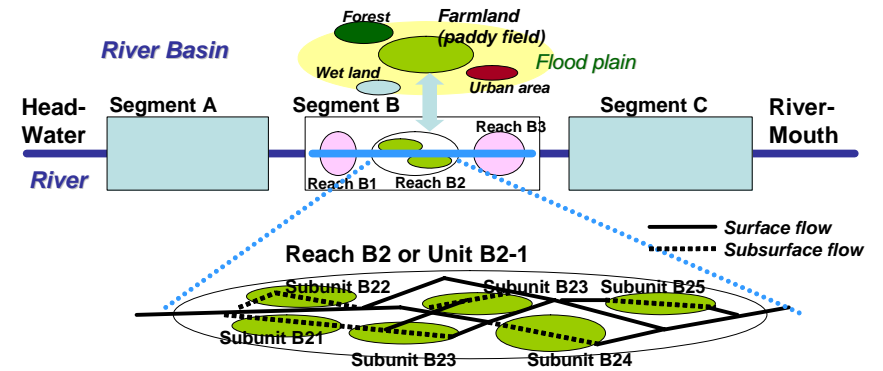
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## River Ecosystem Conservation along a River

Local Landscapes (Habitat mosaics) are connected by river flow with water/sediment/materials flux



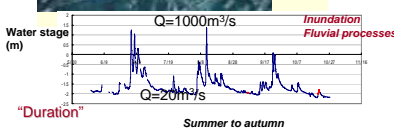
Recognition of Hierarchy in scales

One of the characteristics of Structure of River Ecosystem 10

### River Dynamics

River landscape in various scales  
 segment (mountain, fluvial fan, alluvial plain,...)  
 gravel-bed river, sandy river,  
 reach scale landscape  
 sub-bar scale landscapes

Reach scale  
 sub-bar scale landscapes to characterize the segment



"Duration" Summer to autumn



Sandy river with alternate bars (Kizu river 5-12km, Kyoto pref.)

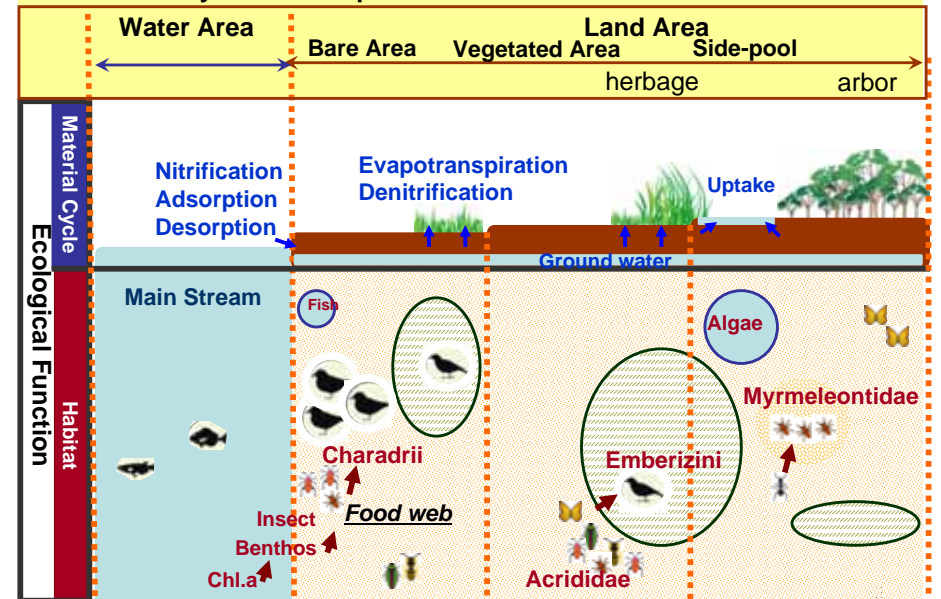
Understanding of the mechanism

Structure subjects to the surface flow and subsurface flow behaviors. (inundation, fluvial process) (seepage in and out to bar area)

Textures are sub-bar scale landscapes, which supports "habitat" and "elementary processes" in material cycle (biophilic materials).

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### The hierarchy of Landscape



(Kizu River Ecological Research Group, 2008)

1974: Sand bar without vegetation



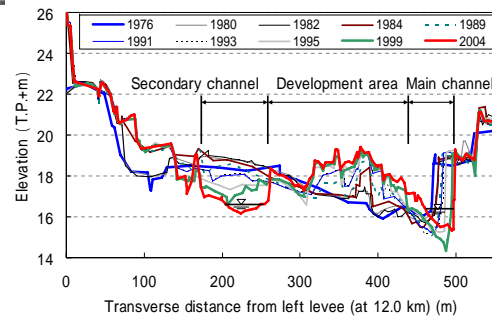
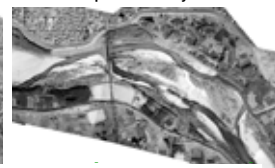
1979: Vegetation appearing at shoreline



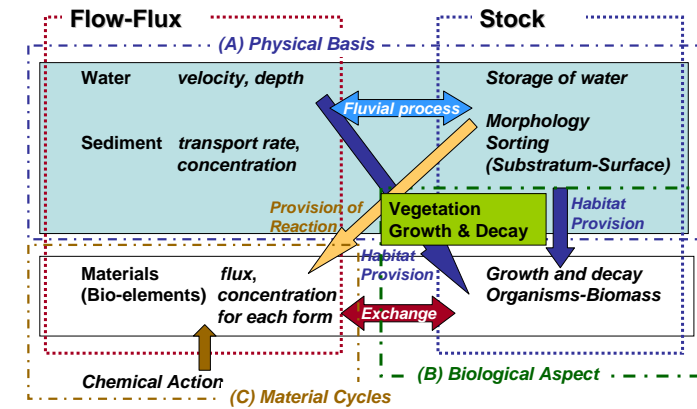
1998: Developed vegetation



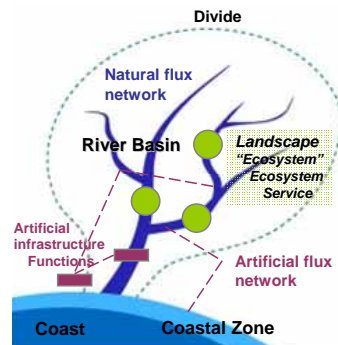
2005: Developed secondary channel



### One more characteristic in Structure of River Ecosystem



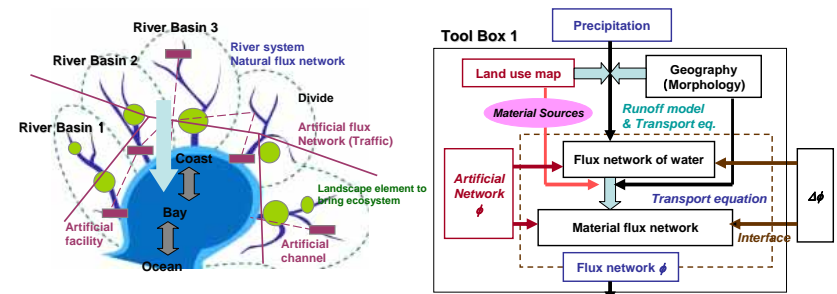
### Basin-wide Ecosystem Conservation



*River basin is an assembly of water/sediment/material flux network driven by runoff.*

*Local landscapes (Habitat mosaics) are connected by water/sediment/material flux network.*

### River Basin Complex



Multiple river basins are connected by artificial flux networks and facilities to support human activities with drastically increasing population and economic efficiency

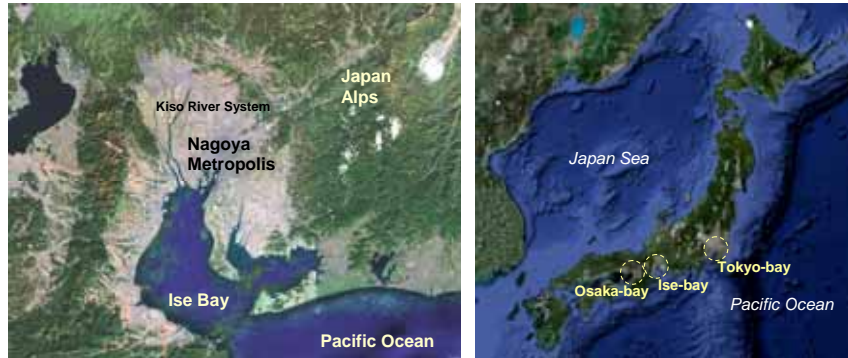
Natural landscapes (mosaics) with natural flux networks

ecosystem service

artificial facilities and flux networks

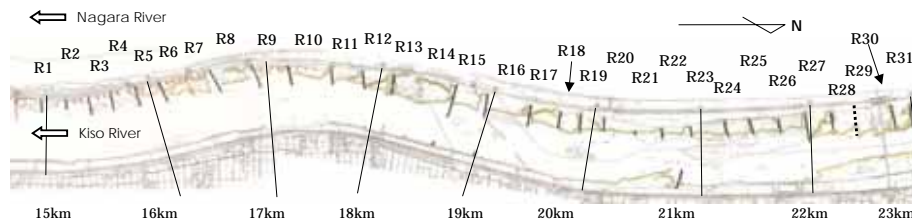
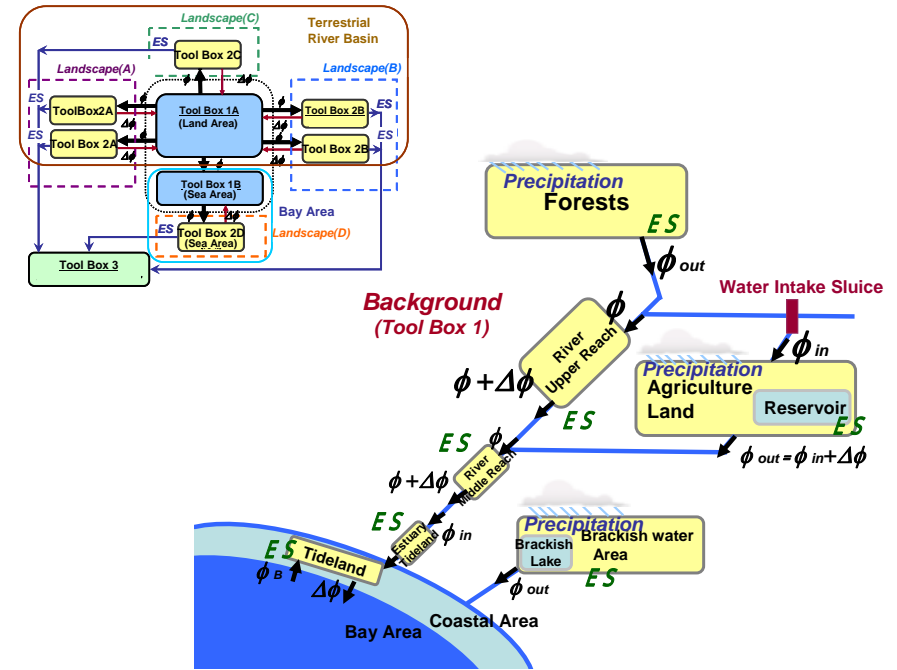
high energy requirement

**Mosaic degradation and flux-network changes**

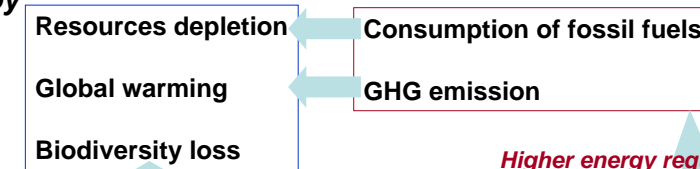


Ise-bay River Basin Complex with Nagoya Metropolis  
 Tokyo-bay River Basin Complex with Tokyo Metropolis  
 Osaka-bay River Basin Complex with Osaka Metropolis

Multiple rivers pour into a bay  
 with water quality, ecosystem, fishery  
 Bay, Metropolis, and River-basins are in the same destiny



Sustainability is threatened by



Ecosystem Degradation leads to Ecosystem Service to Artificial facilities

Degradation of River Basin Complex

degradation of habitat mosaic  
 change in water/material flux network

In order to overcome the threats to sustainability, we have to mitigate degradation of river basin complex

Challenge to overcome the threats to sustainability

**“Eco-compatible” management** of river basin complex  
*River basin complex in harmony with nature*

**Blessing of “Ecosystem Service”**

to suppress

**consumption of resources and GHG emission**

*(to overcome the global warming and resources depletion)*

**Conservation of Biodiversity**    *CBD target !*

Habitat conservation (Restoration)

Habitat (Life cycle) of

target species representative to the local landscape

Significance of local representative

Contribution of local habitat restoration to basin-wide biodiversity

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## Who is responsible to this challenge, and how?

Metropolitan with

**fair consciousness,**

**rich knowledge,**

**wealth,**

**and high technology**

**Role of Academy in “Ecosystem-Science and -Engineering”**  
cooperating with “challenging governance”

**Interdisciplinary Science on Ecosystem**

**biology, ecology, limnology, .....**

**hydology, hydraulics, morphology,...**

**coupled with technology and engineering**

**river engineering,**

**civil, rural, fishery engineering,**

**planning, management, ....**

**cooperated with**

**government, citizens,....**

*Scientists*

*Researchers*

*Engineers*

*Technicians*

*Government officers*

*Administrators*

*Governors*

*Citizens*

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**More efforts in “Ecosystem-Science and -Engineering”**

**Understanding and Description to lead “forecasting”**  
**of Ecosystem in scale of River Basin Complex**

**Scattered habitat mosaics connected by flux networks**  
**(natural and manmade)**

**Propagation of local actions in river basin complex**

**Quantitative Ecosystem Service**

**(ex. How equivalent are various ES quantitatively?)**

**How effective is complex of habitat mosaics connected by FNW**  
**to “Bio-diversity”?**

**How does the local peculiarity contribute to**  
**basin-side bio-diversity?**

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