

第59回 日本生態学会大津大会 自由集会W24 IPBES と生態系サービス評価の国際動向  
ESJ59 Annual Meeting, Workshop W24, IPBES and Trends of Ecosystem Service Study  
2012年3月19日 龍谷大学  
19 Mar. 2012, Ryukoku University, Otsu, Japan

# 生態系と人間社会のシステムリンケージ

Linkage between ecological and social systems

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# Sustainable ecosystem service use

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## Ecological system

- ▶ Service supply
- ▶ Service potential = stock  
biomass  
bio-diversity
- ▶ Natural capital maintenance
  - ▶ Exploited
  - ▶ Abandoned
  - ▶ Maintained

## Social system

- ▶ Service demand
- ▶ Service use = flow  
harvest  
land use change
- ▶ Investment to human system
  - ▶ Overuse → ill-managed
  - ▶ Underuse → dis-managed
  - ▶ Sustainable use  
→ well-managed

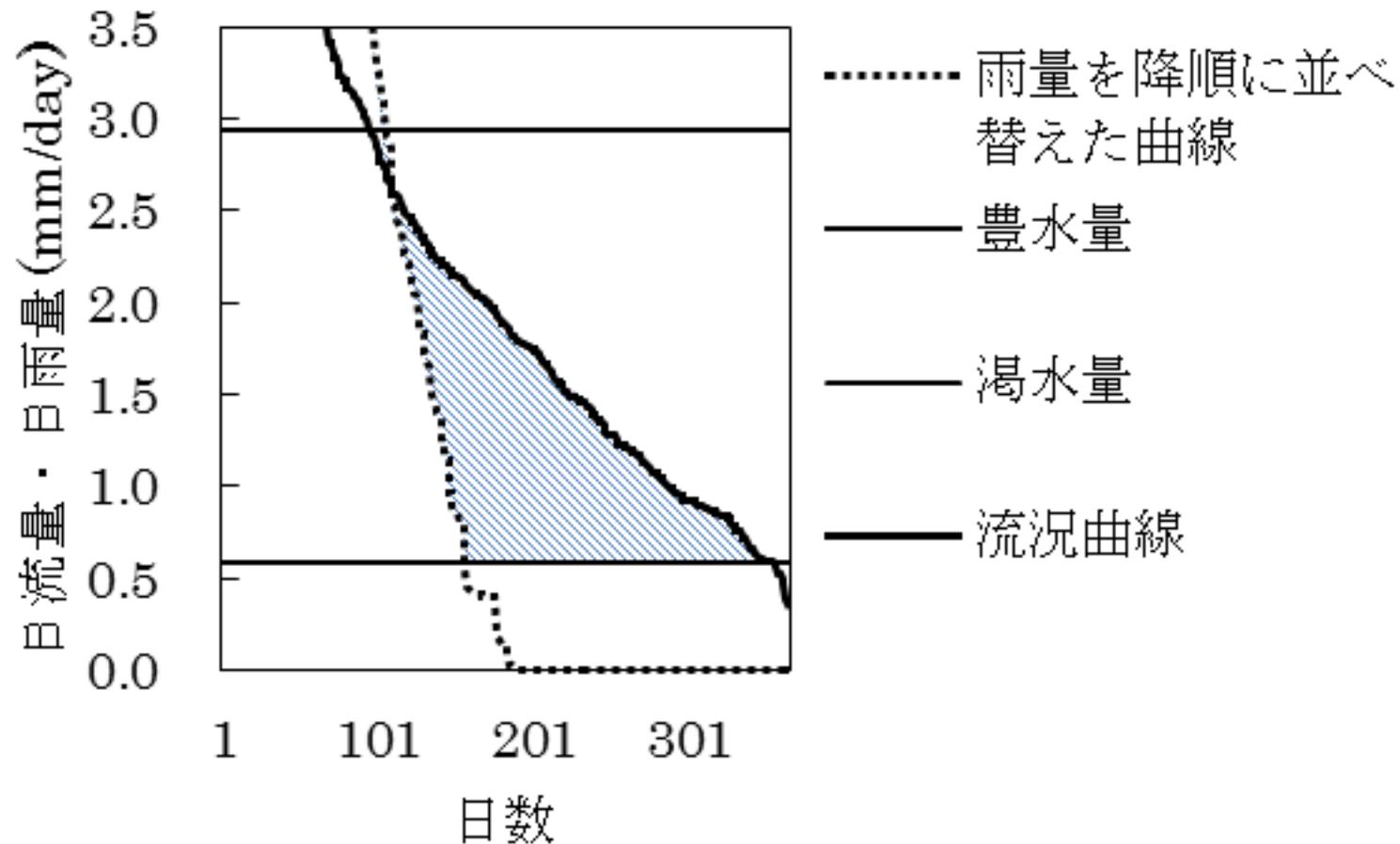
# Examples of eco- and socio-system linkage studies

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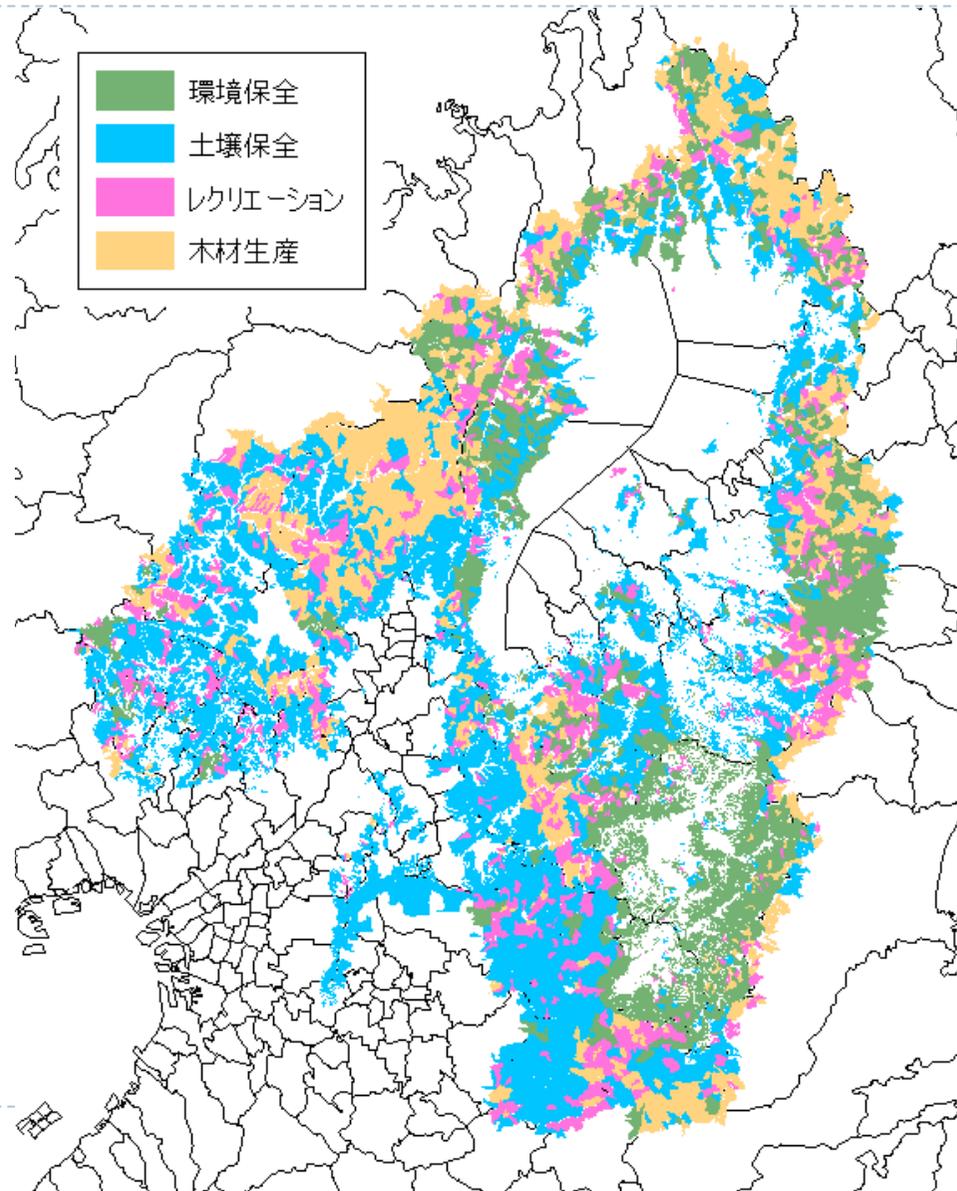
- ▶ Water resource provisioning service
- ▶ Future projection of multiple forest services under demographic scenarios
- ▶ Organic material circulation analysis in coupled eco- and socio-systems
- ▶ Ecosystem service use (ESU) by industrial sectors

# Evaluating water resource service of forest by means of discharge duration curves

(Hayata *et al.* @ Ann. Meeting Jpn. Soc. For. Sci. 2012)



# Future projection of multiple forest services under demographic scenarios (Iizuka *et al.* P3-271J)

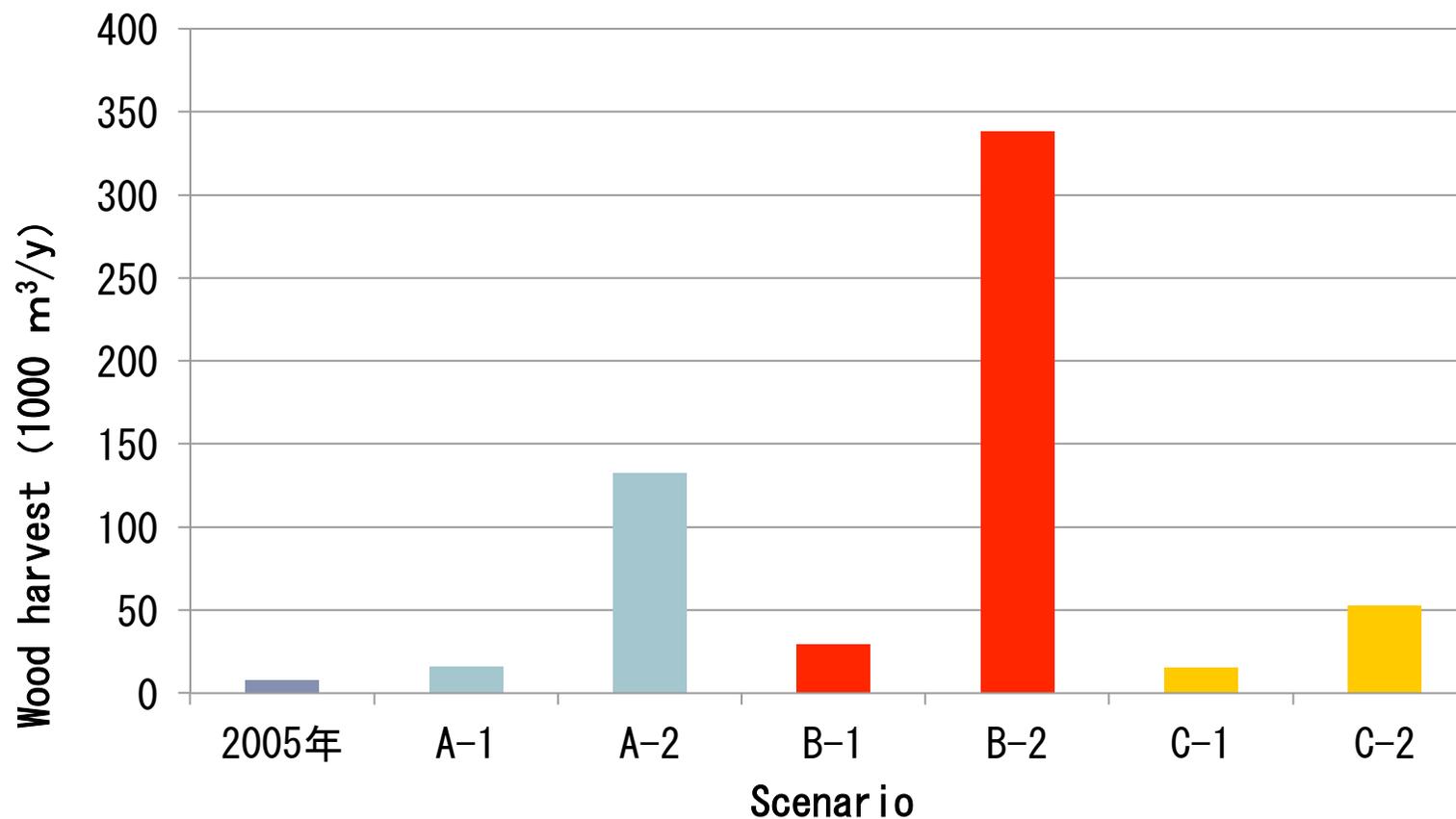


## Functional forest zones in Yodo River Basin

Nature preserve	110,500ha
Land protection	209,300ha
Recreation	90,200ha
Wood production	105,400ha

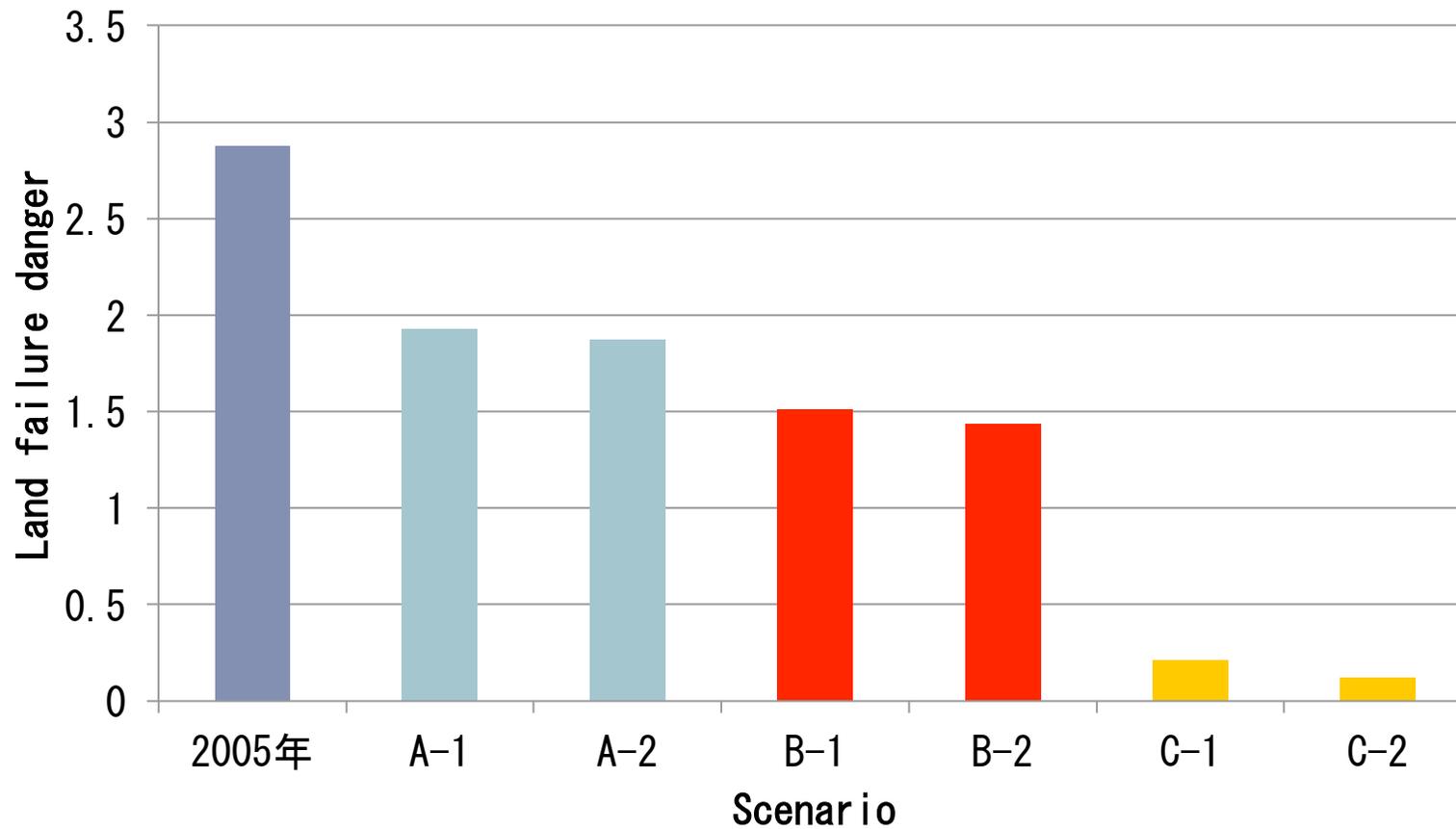
# Projected wood production in 2100

Scenarios		Forestry	
		inactive	active
Rural population	BAU	A-1	A-2
	Promoting	B-1	B-2
	Evacuating	C-1	C-2



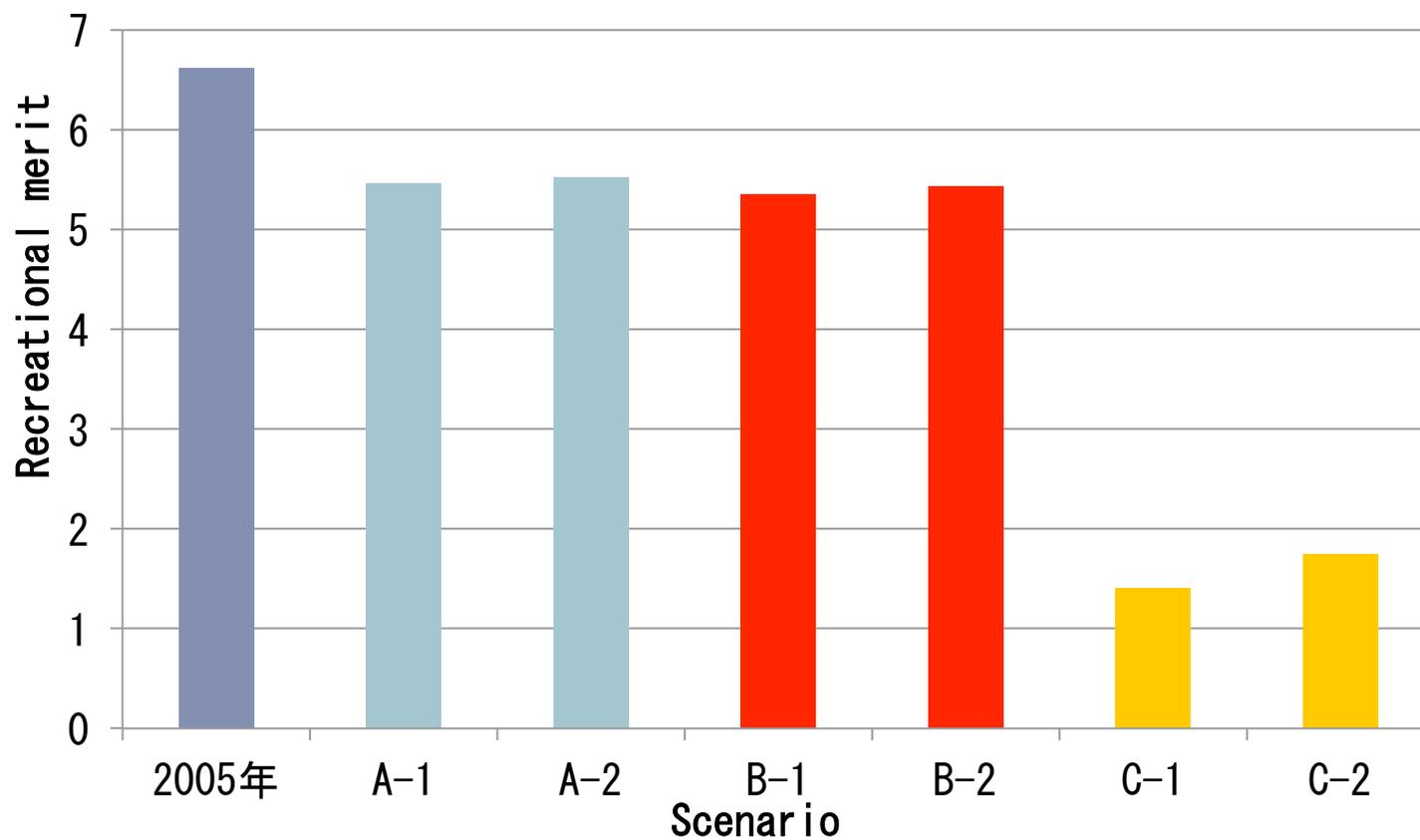
# Projected land failure danger in 2100

Scenarios		Forestry	
		inactive	active
Rural population	BAU	A-1	A-2
	Promoting	B-1	B-2
	Evacuating	C-1	C-2



# Projected recreational merit in 2100

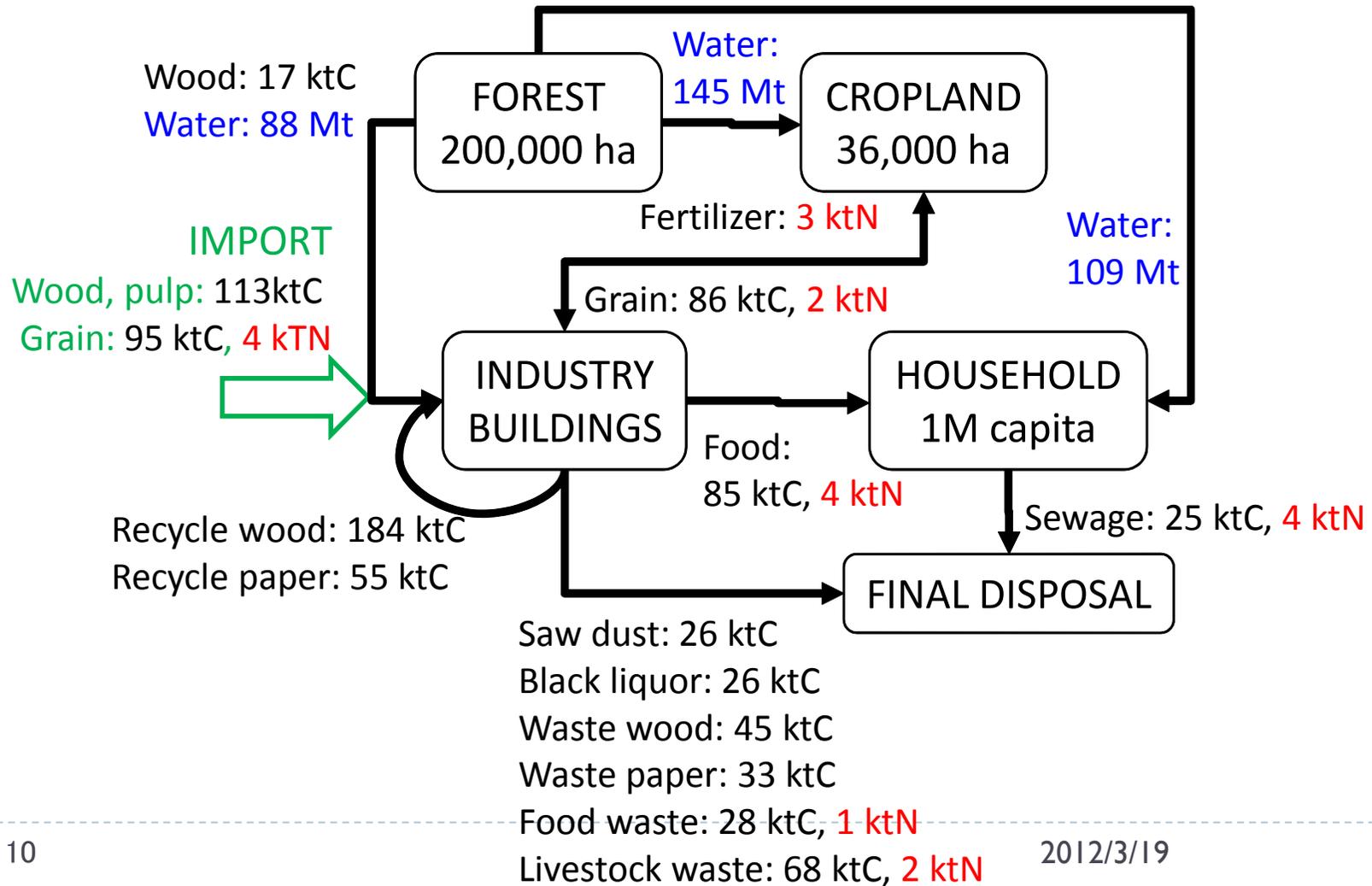
Scenarios		Forestry	
		inactive	active
Rural population	BAU	A-1	A-2
	Promoting	B-1	B-2
	Evacuating	C-1	C-2



# Case study of a virtual million-city and surrounding farms and forest in Japan (Machimura *et al.*, 2011 @ AsiaFLUX Workshop)

- ▶ Demonstrate availability of the linkage model
- ▶ A virtual million-city
  - ▶ Household: consume food and water, and generate sewage
  - ▶ Industry + building: consume paper, wood and water, and generate waste paper, wood and food
  - ▶ A part of waste paper and wood is recycled
  - ▶ Evaluate based on statistics
- ▶ Cropland of 36,000 ha: Agro-C, climate at Hachioji, produces rice
- ▶ Forest of 200,000 ha: BGC-ES, climate at Hachioji, plantation of Japanese cedar
- ▶ Difference between demand and supply is compensated by importing or exporting crops and wood including pulp

# Annual circulation flow of carbon, nitrogen and water in a virtual million-city and its suburbs in Japan



# Evaluating internal resource circulation

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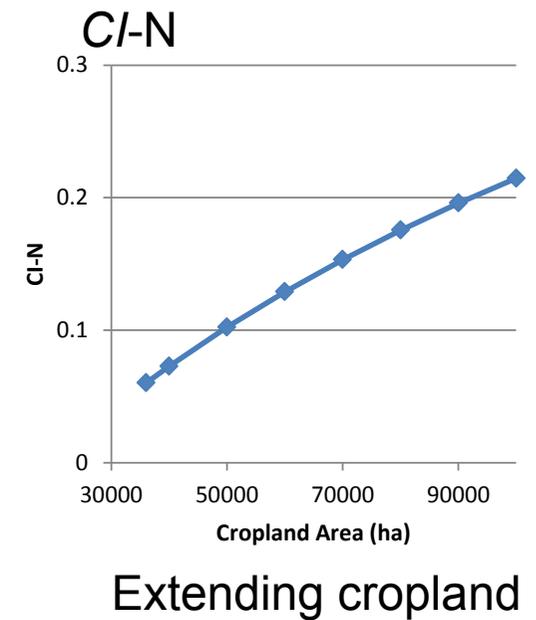
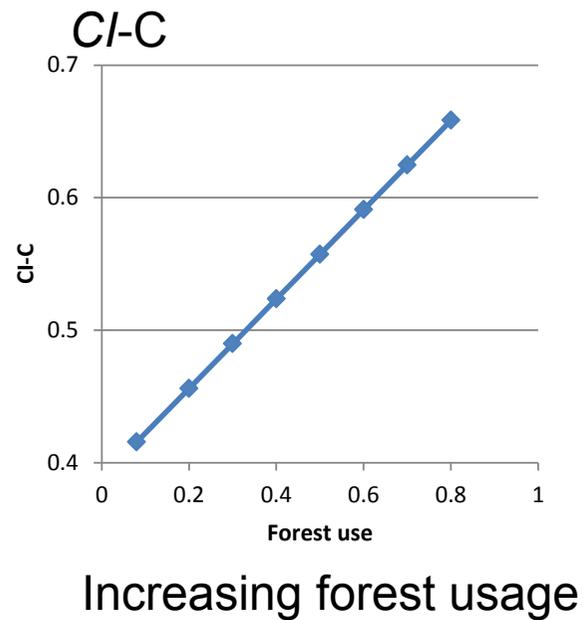
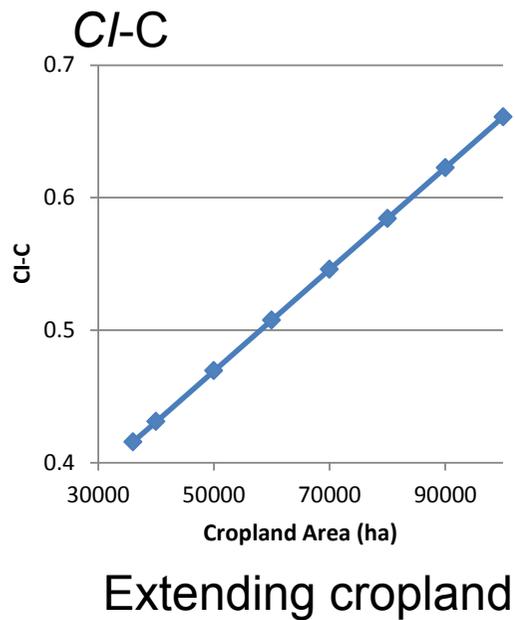
- ▶ Circulation index  $CI$

$$CI = 1 - \frac{\text{import} + \text{final disposal (+fertilizer for N)}}{2 \times \text{total demand (+fertilizer for N)}}$$

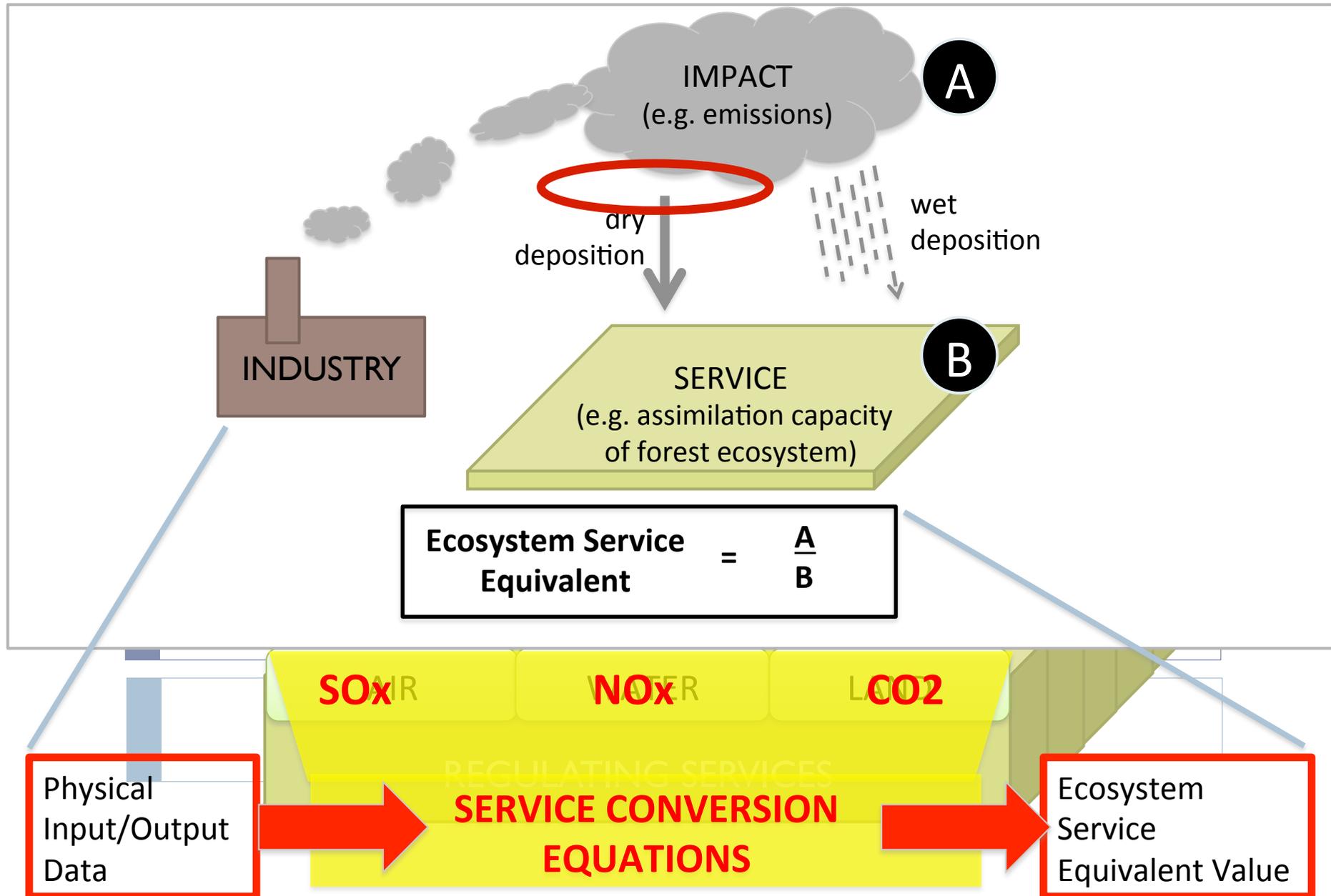
- ▶  $CI\text{-H}_2\text{O}=1 \rightarrow$  perfect self support
- ▶  $CI\text{-C}=0.42$
- ▶  $CI\text{-N}=0.06$

# Analysis of resource circulation policies by *CI*

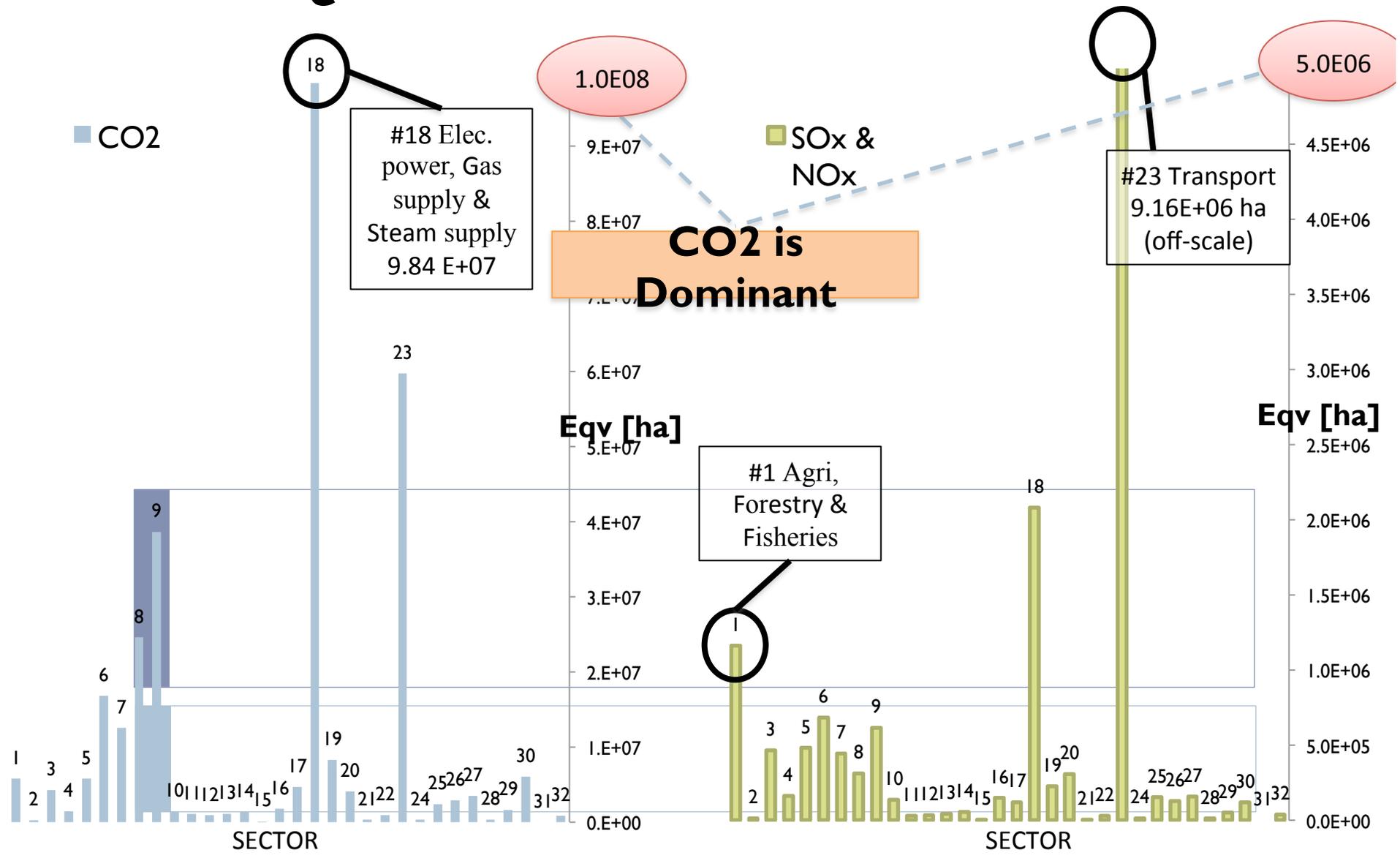
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# Framework (Shaw *et al.*, 2010 @ EcoDesign Intl. Symposium)

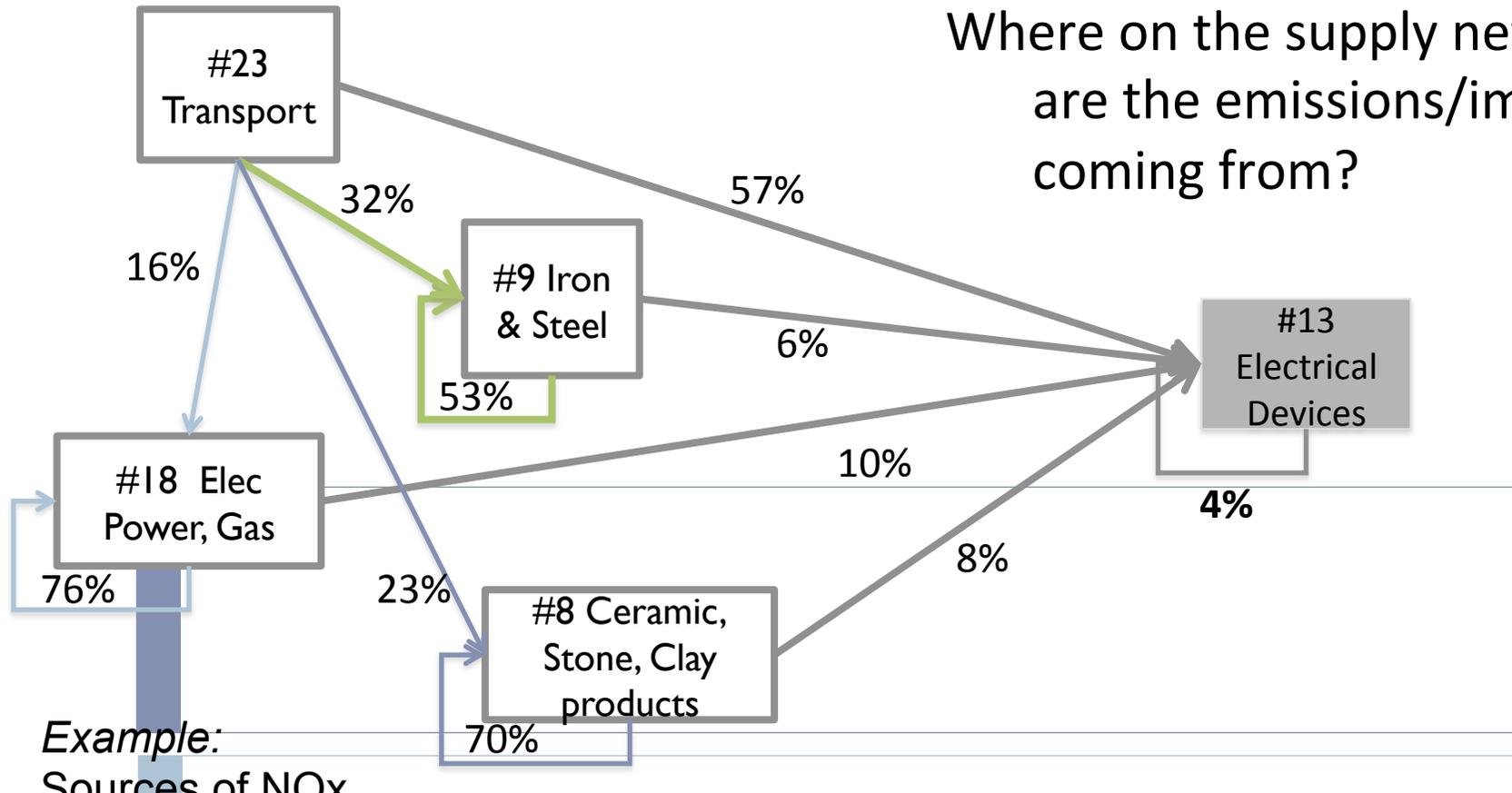


# IMPACT EQUIVALENTS for 32 sectors



# supply chain network

Where on the supply network are the emissions/impacts coming from?

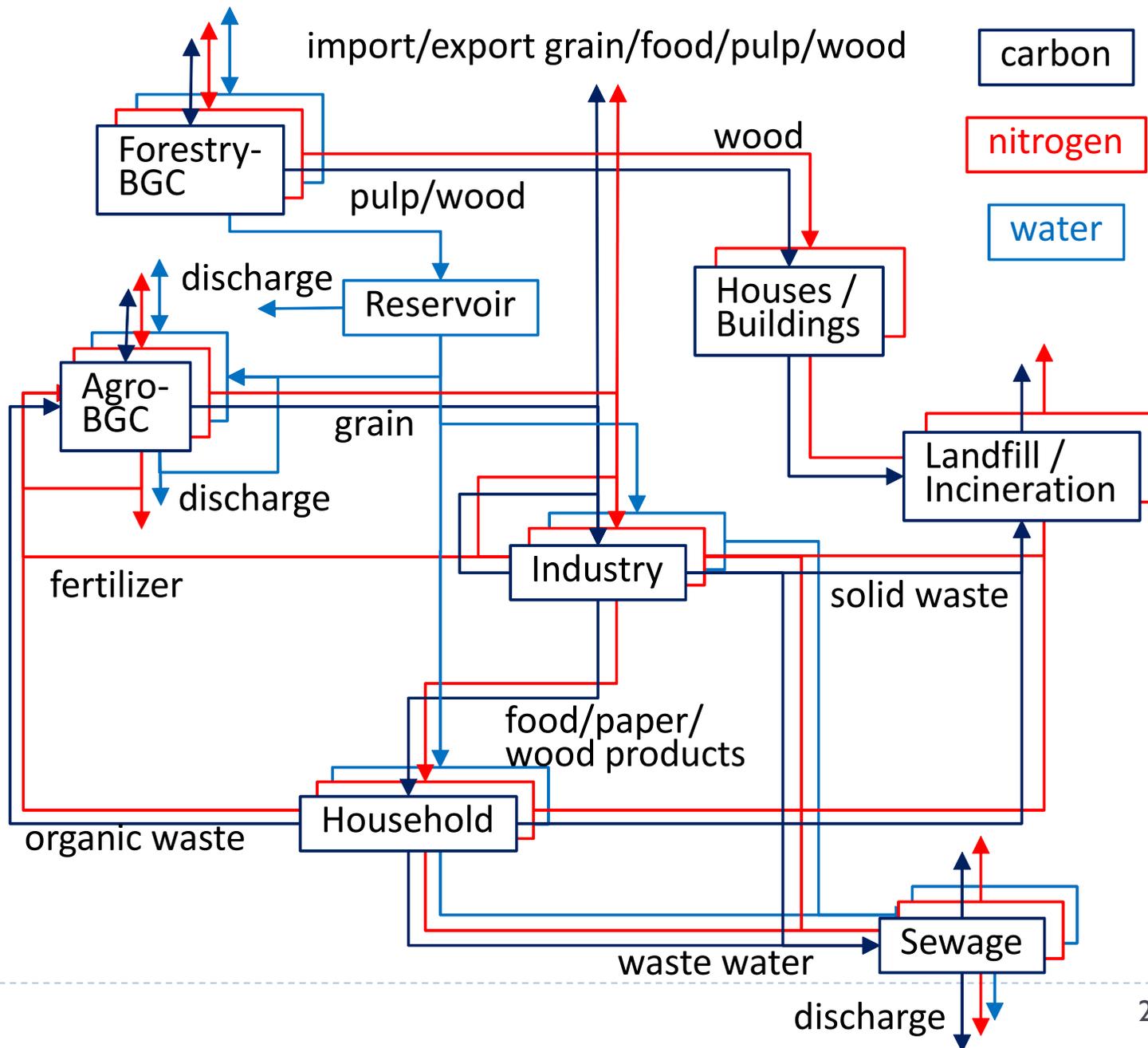


- DIRECT Impact only 4% of total
- Over 80% of emissions from 4 upstream sectors
- Transport Sector accounts for 57% for 1<sup>st</sup> link, and 62% for 1<sup>st</sup> and 2<sup>nd</sup> links

# Concept of a natural- and social-system linkage model

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- ▶ Ecosystem model (biomass production) + social model (biomass conversion, use and disposal)
- ▶ Carbon, nitrogen and water flow with biomass materials
- ▶ Dynamic models
  - ▶ Temporal scale of day – annum - century  
Rainfall discharge – crop production – afforestation and logging  
Water demand/supply – food and paper demand/supply – building replacement
- ▶ Process based models
  - ▶ Drivers → responses
- ▶ Spatially dimensionless



# Conclusion

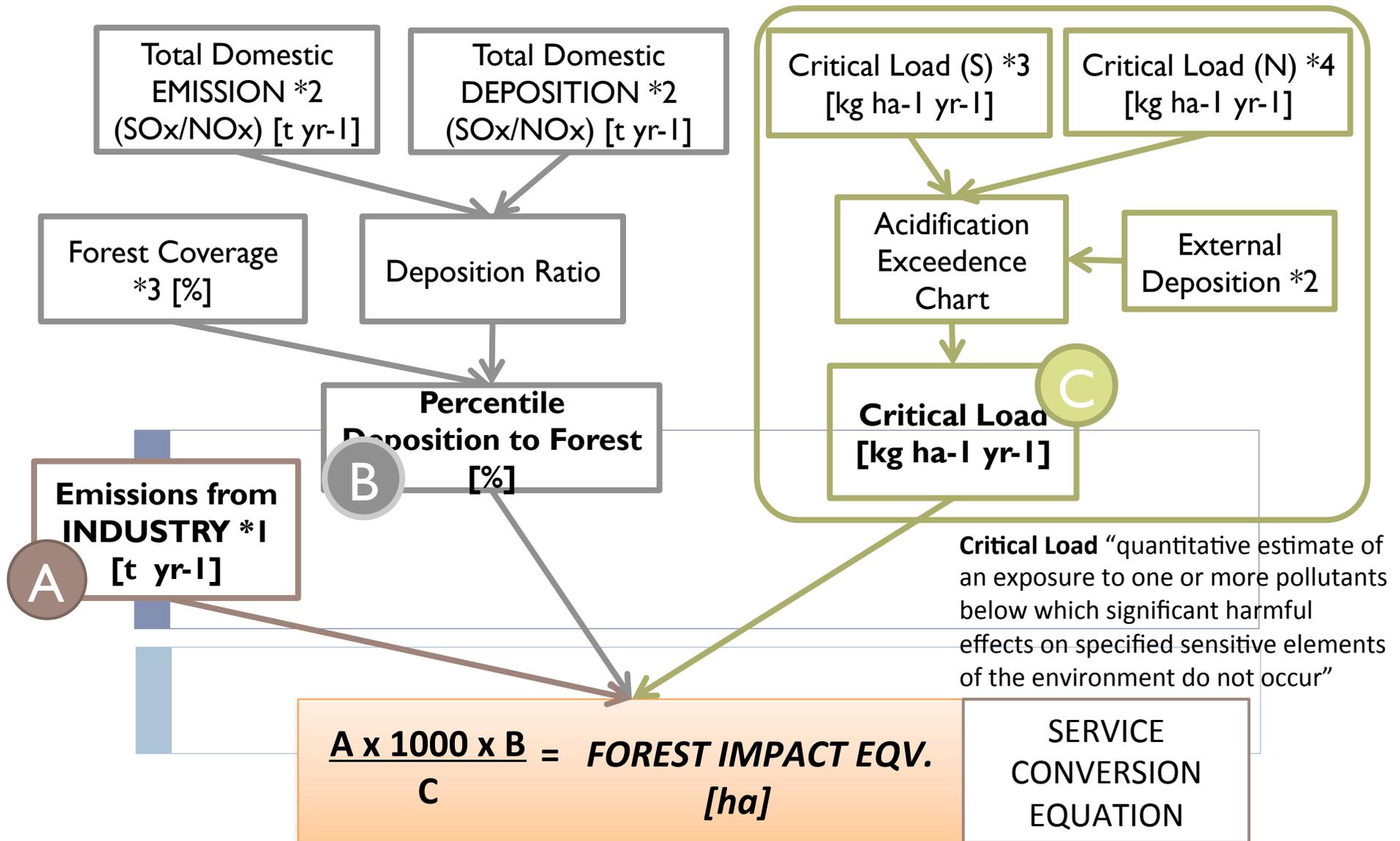
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For sustainable ecosystem service use and bio-diversity conservation ...

- ▶ To quantify service stock by analyzing service potential
- ▶ To quantify service flow by analyzing service demand
- ▶ To know consequence of service use and stock change
- ▶ To know multiple service trade off
- ▶ To visualize human dependence on and impact to ecosystems
- ▶ To pay attention on responsibility of human social sectors to BES

# FOREST IMPACT EQUIVALENT SO<sub>x</sub> & NO<sub>x</sub>

methodology



# FOREST IMPACT EQUIVALENT – CO<sub>2</sub>

