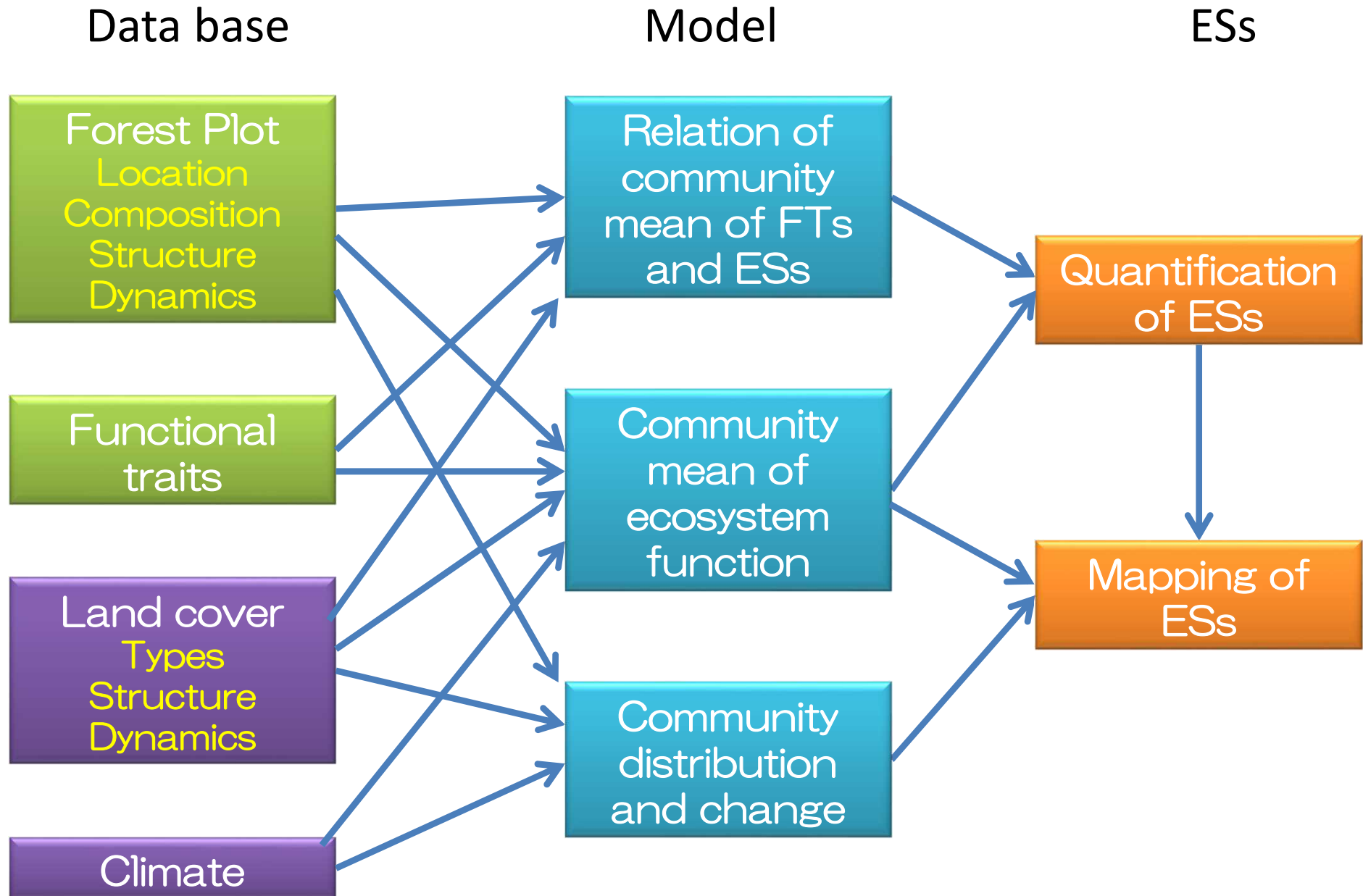# Trait-based mapping of forest function

Tohru Nakashizuka
Research Institute for Humanity and Nature

- Spatio-temporal resolution and accuracy of ES /NCP assessment including scenario analyses are required for decision making

- Combination of various databases on functional traits and abundance of key species which relate to ES are the expected to contribute greatly to quantification of ES

ESs estimated from biomass and structure of forests

Data base

Model

ESs

Forest Plot
Location
Composition
Structure
Dynamics

Functional traits

Land cover
Types
Structure
Dynamics

Climate

Relation of community mean of FTs and ESs

Community mean of ecosystem function

Community distribution and change

Quantification of ESs

Mapping of ESs

Functional traits measured

Target species

Japanese trees 300 spp., about 140 FTs

E and SE Asian trees 900 spp. 16 FTS
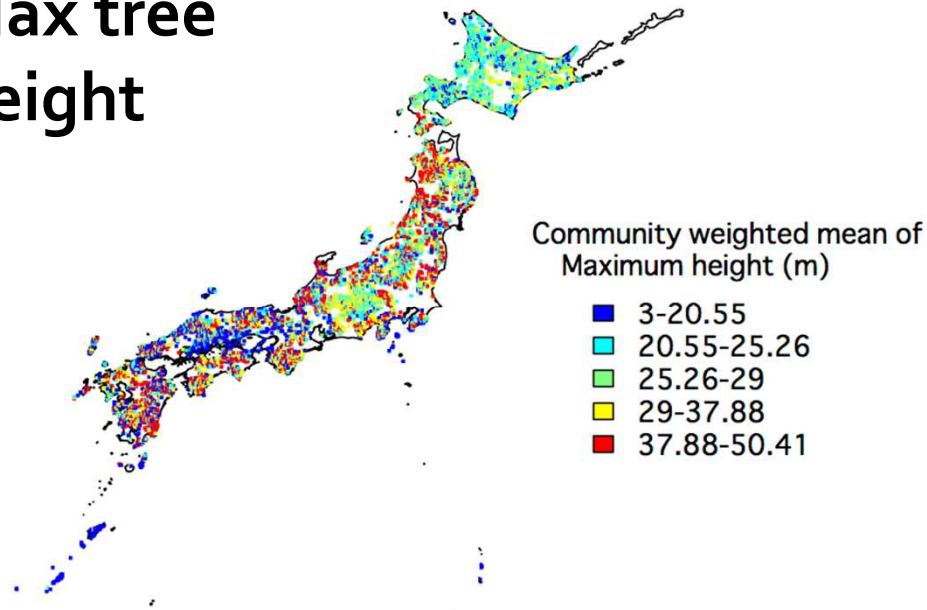
FTs measured（16 FTs）

- Leaf size, LMA, toughness, thickness, water contents
- Leaf nitrogen and carbon (contents/stable isotope）
- Leaf total phenol, condensed tannin, lignin, NDF
- Leaf vein density
- Photosynthetic rate
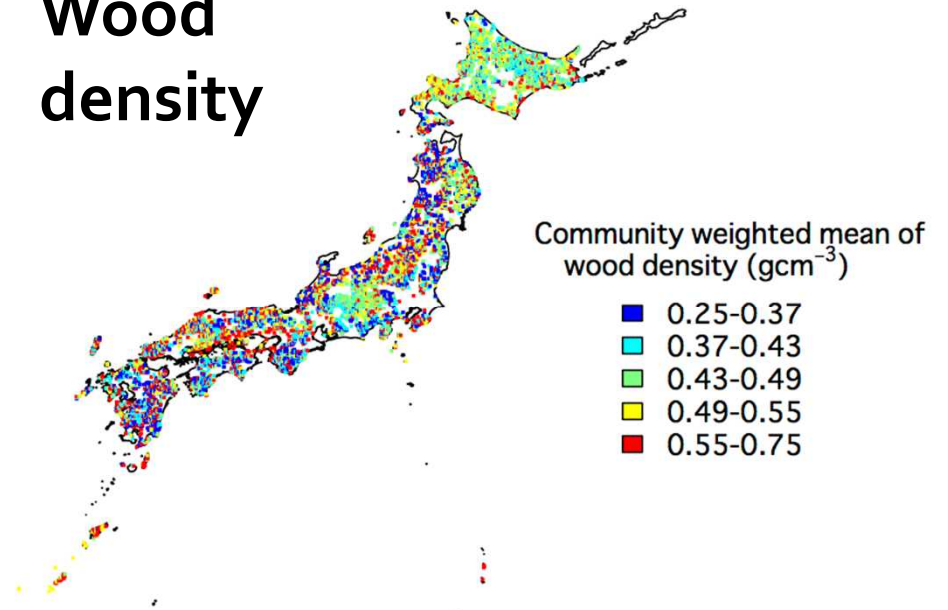- Wood density

Literature source（about 120 FTs）

- Defensive Traits（trichomes, chemicals, etc.）
- Reproductive Traits（pollen, nectar, flower color, etc.)
- Root system（root diameter, mycorrhiza, etc.)
- Utilization（timbers, foods, medicines, etc.）

Map of FTs
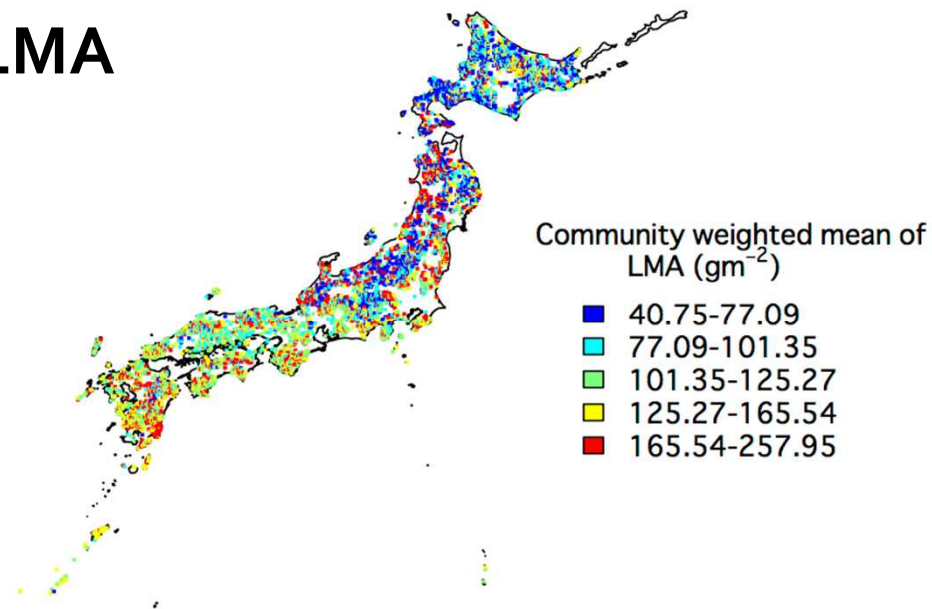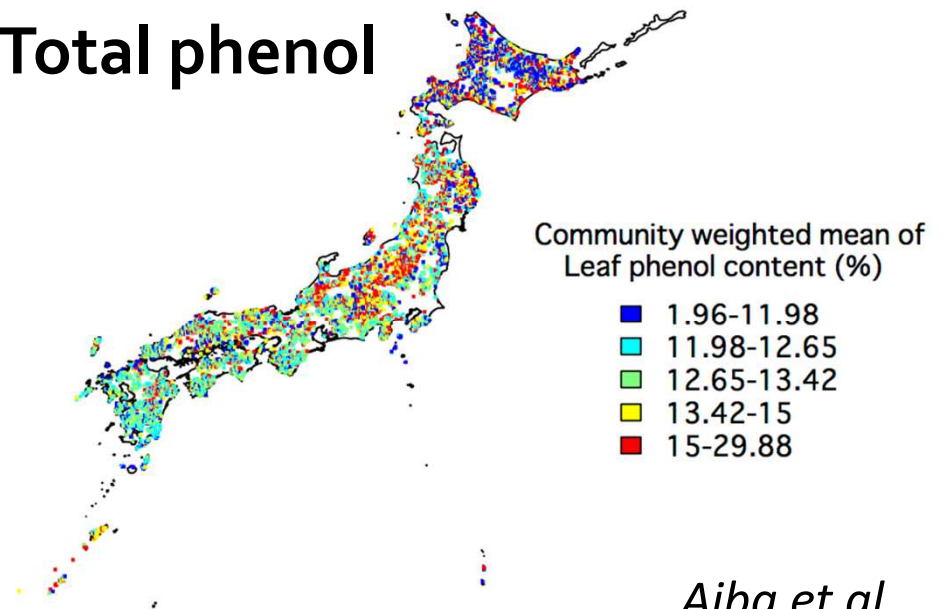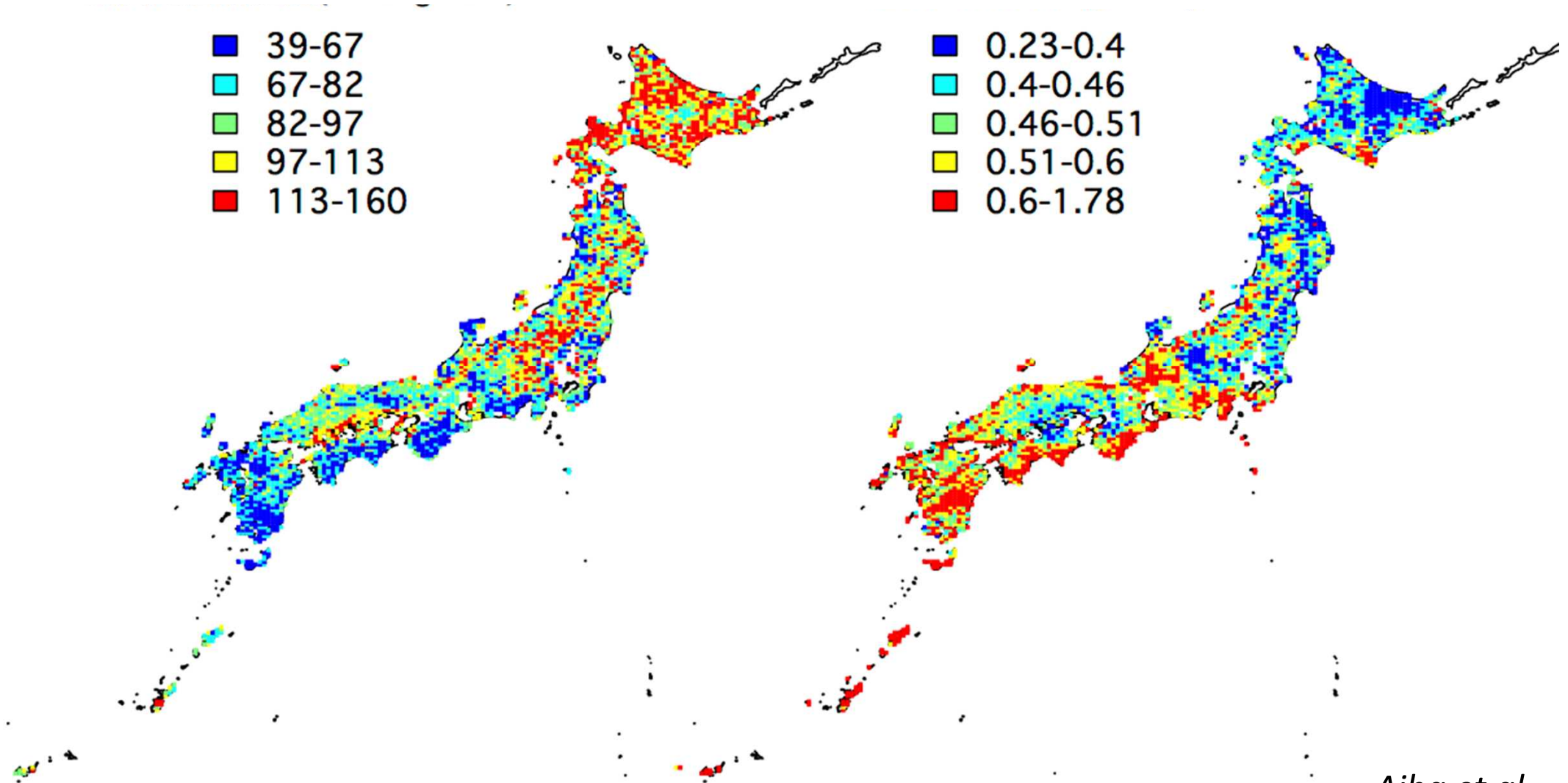
Max tree height

Community weighted mean of
Maximum height (m)

- 3-20.55
- 20.55-25.26
- 25.26-29
- 29-37.88
- 37.88-50.41

Wood density

Community weighted mean of
wood density (gcm^{-3})

- 0.25-0.37
- 0.37-0.43
- 0.43-0.49
- 0.49-0.55
- 0.55-0.75

LMA

Community weighted mean of
LMA (gm^{-2})

- 40.75-77.09
- 77.09-101.35
- 101.35-125.27
- 125.27-165.54
- 165.54-257.95

Total phenol

Community weighted mean of
Leaf phenol content (%)

- 1.96-11.98
- 11.98-12.65
- 12.65-13.42
- 13.42-15
- 15-29.88

Aiba et al.

Ecosystem functions estimated by the data bases on forest plots and functional traits

Maximum photosynthesis rate
(nmol $g^{-1}s^{-1}$)

Decomposition coefficient,
K (year^{-1})

- 39-67
- 67-82
- 82-97
- 97-113
- 113-160

- 0.23-0.4
- 0.4-0.46
- 0.46-0.51
- 0.51-0.6
- 0.6-1.78

Aiba et al.

Probability of soil erosion

- Data base on forest resource by Forest Agency（7200 sites）
    - Tree composition, Basal area, grass cover, shrub cover)
    - Inclination, Soil erosion (Y/N)
- Functional trait data base
    - Horizontal distribution, root hair density, root thickness
- Climate data base
    - Annual precipitation, Max snow depth, water deficit
- Models to cause soil erosion
- Verifying if functional trait is included in the model or not

Probability of soil erosion (%)

- 0.03-0.87
- 0.87-1.48
- 1.48-2.24
- 2.24-3.45
- 3.45-5.07
- 5.07-7.28
- 7.28-10.59
- 10.59-14.53
- 14.53-21.02
- 21.02-52.15

Aiba et al.
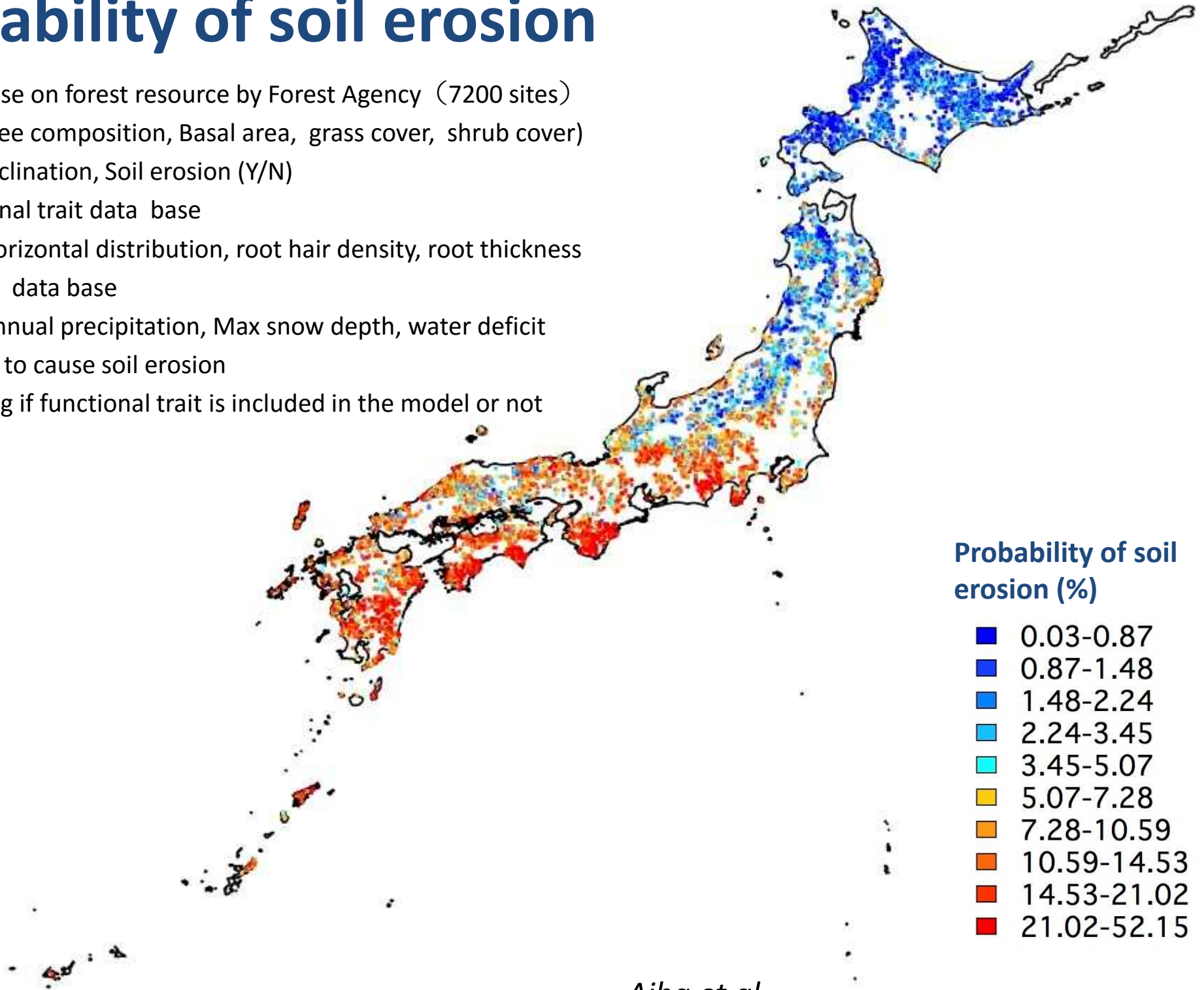
Many tourists enjoy autumn color of forests in Japan

Popular spots for the beauty of autumn color

- Data was collected from a special site for autumn foliage.
- Records for 457 spots are available.

紅葉名所の分布
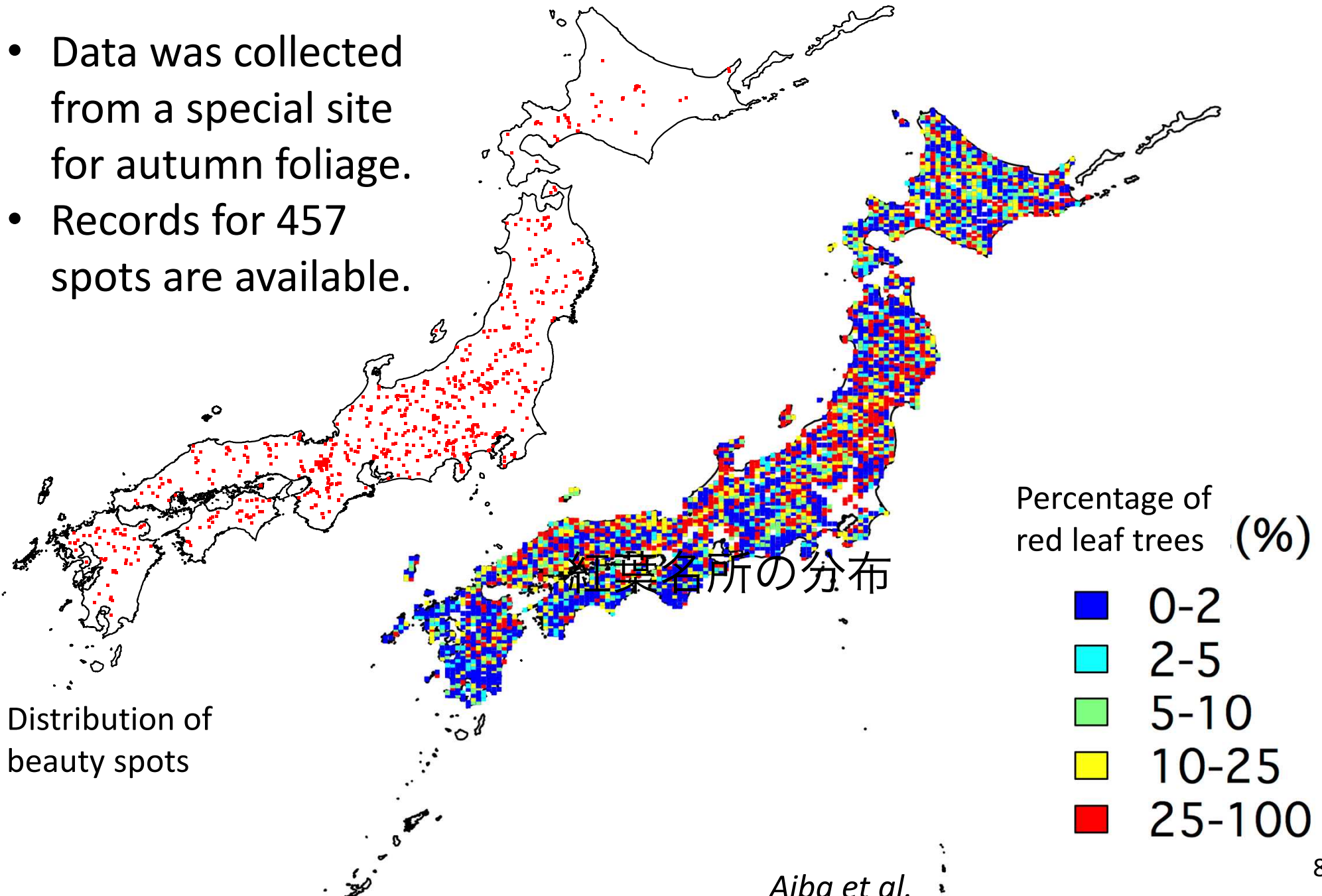
Distribution of beauty spots

Percentage of red leaf trees (%)

- ■ 0-2
- ■ 2-5
- ■ 5-10
- ■ 10-25
- ■ 25-100

Aiba et al.

ESs estimated from the abundance of key spp.

Data base

Model

ESs

- Distribution
  - Location
  - Abundance
  - Dynamics

- Land cover
  - Types
  - Structure
  - Dynamics

- Climate

- Relation of key species abundance and ESs

- Habitat and change of key species abundance

- Quantification of ESs

- Mapping of ESs
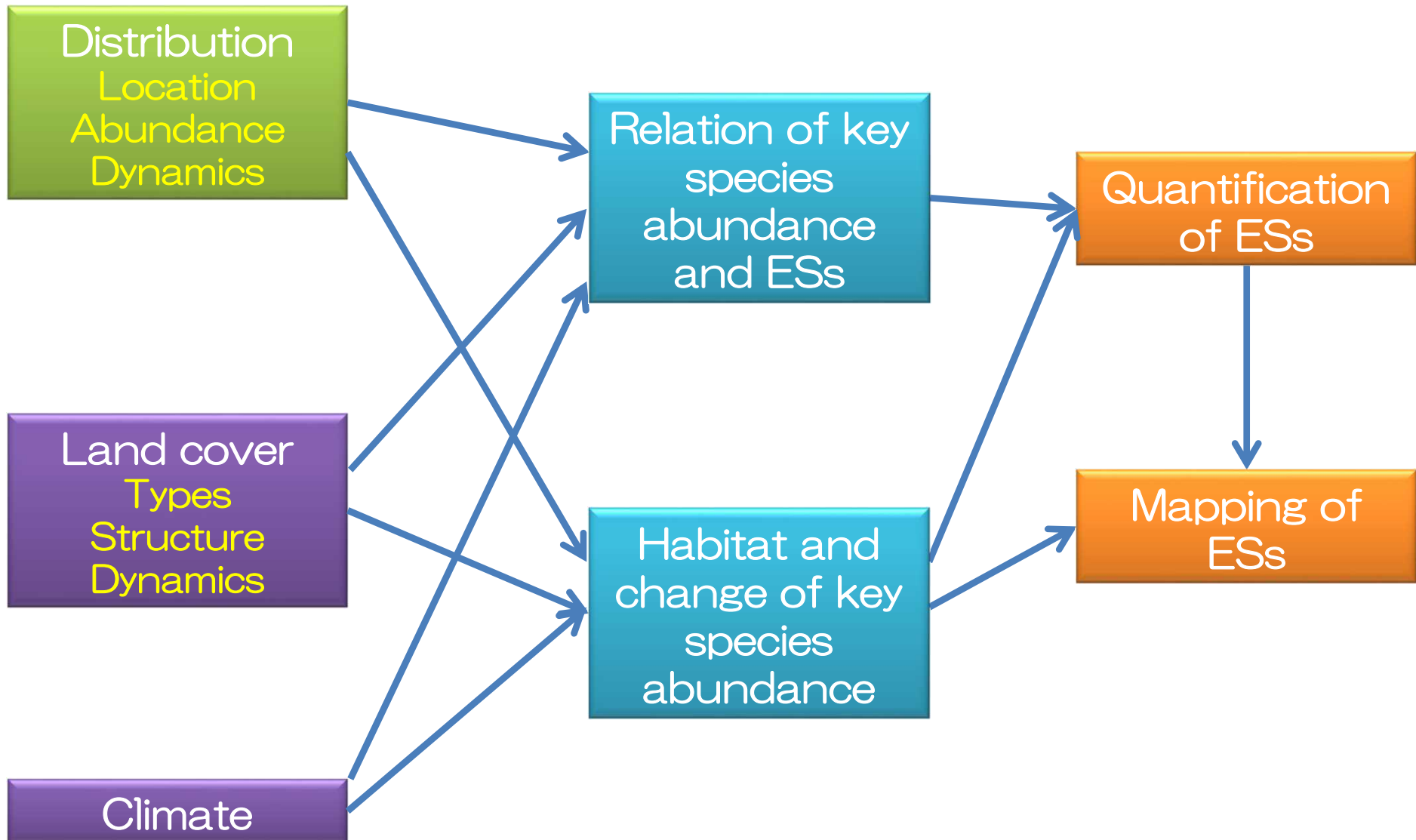
Landscape and seed set of buckwheat

Seedset of buckwheat

Forests within 3 km

Grassland or shr' within 100m
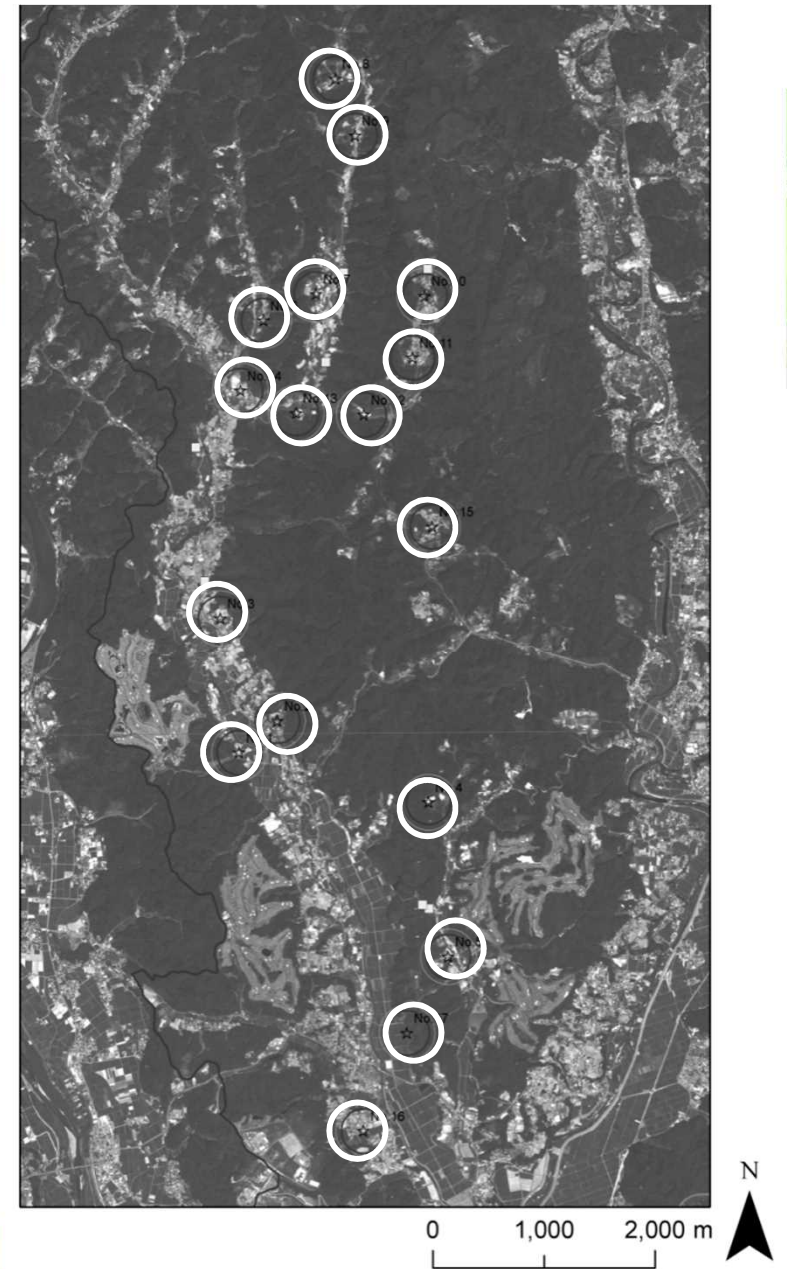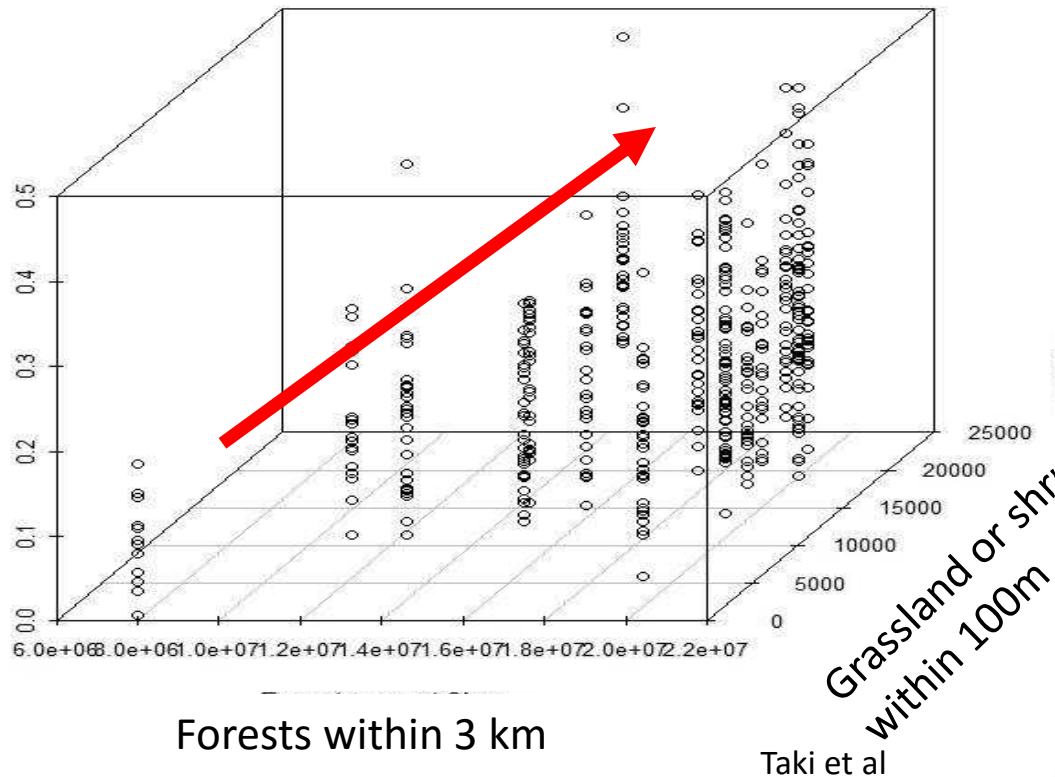
Taki et al

Taki et al.

森林生物による送粉サービス・ローカルマップ

Honey bee abundance
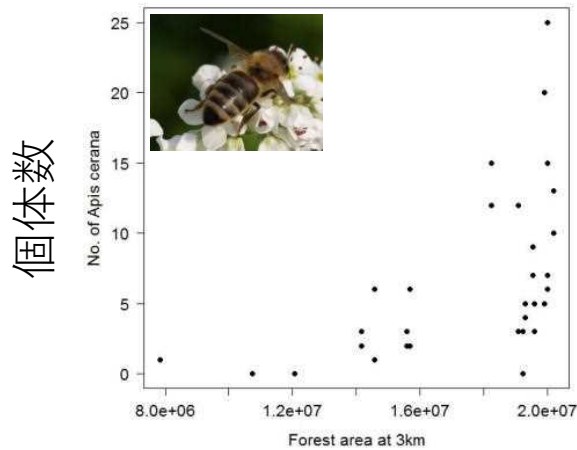
Forested area with in 3km from the filed（m²）

Abundance of other insects
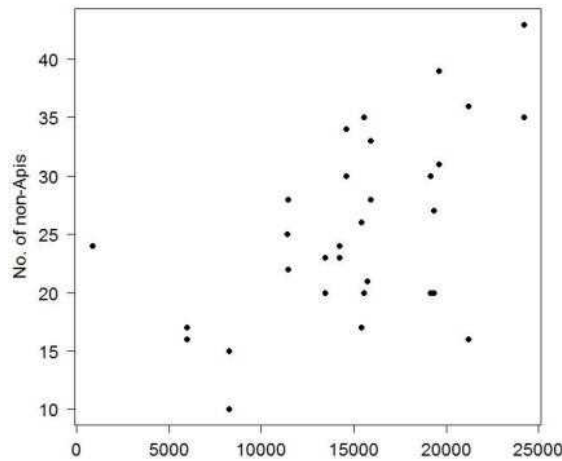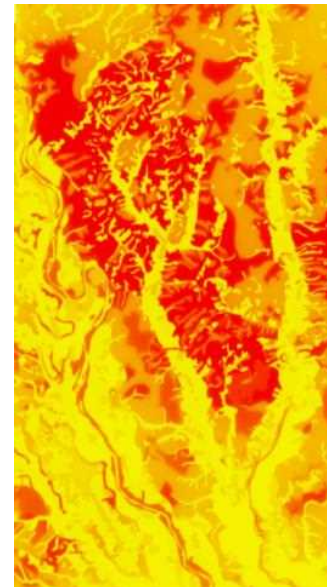

Grassland area within 100 m from the field（m²）
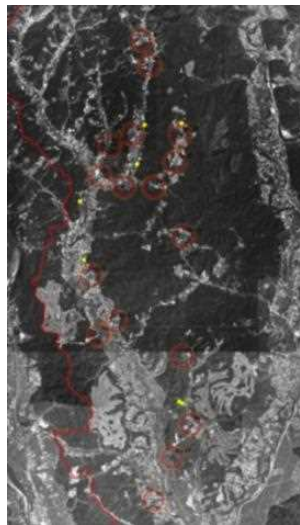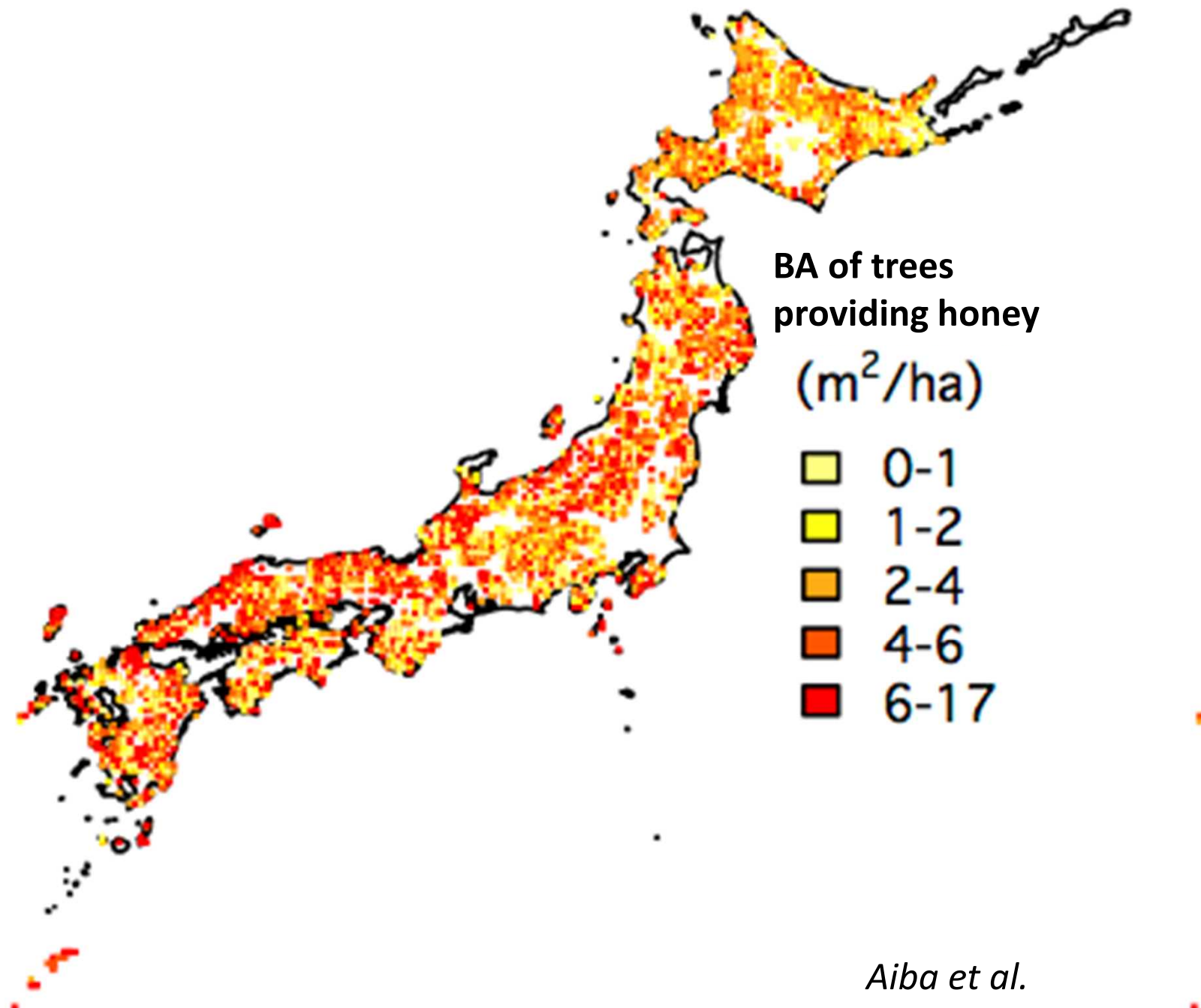

Landcover
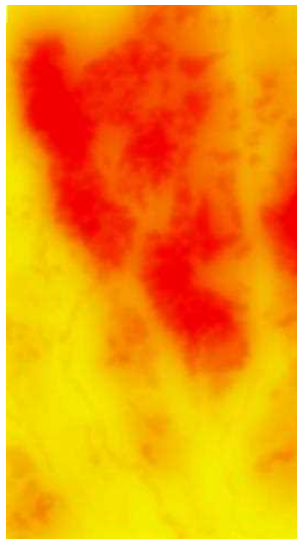
Distribution of sampled individuals

+

=

Estimated habitat of honey bee

1)Garibaldi at al. (2013) *Science*
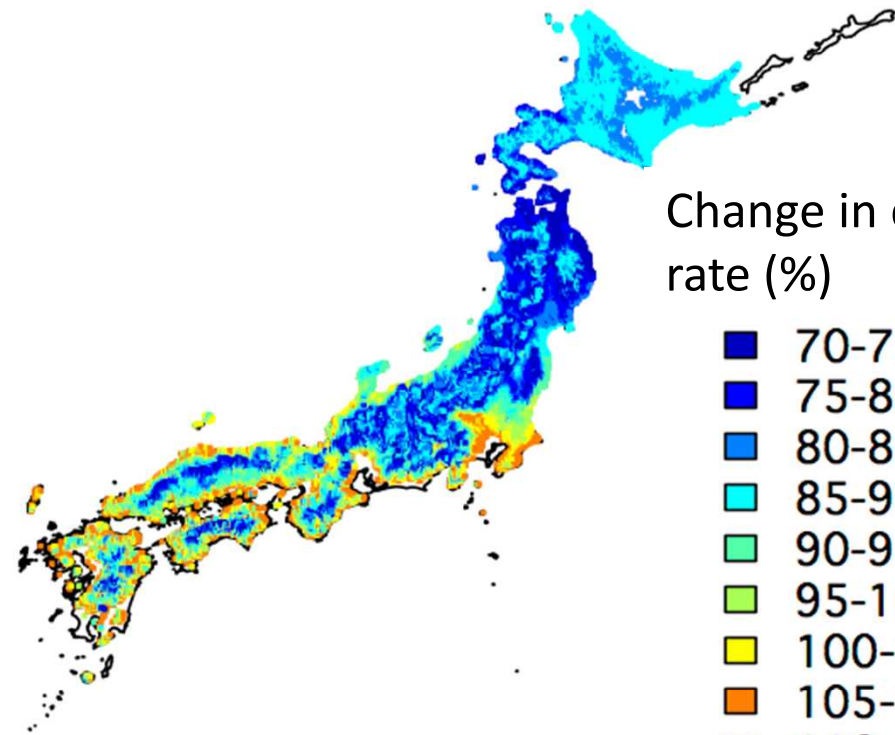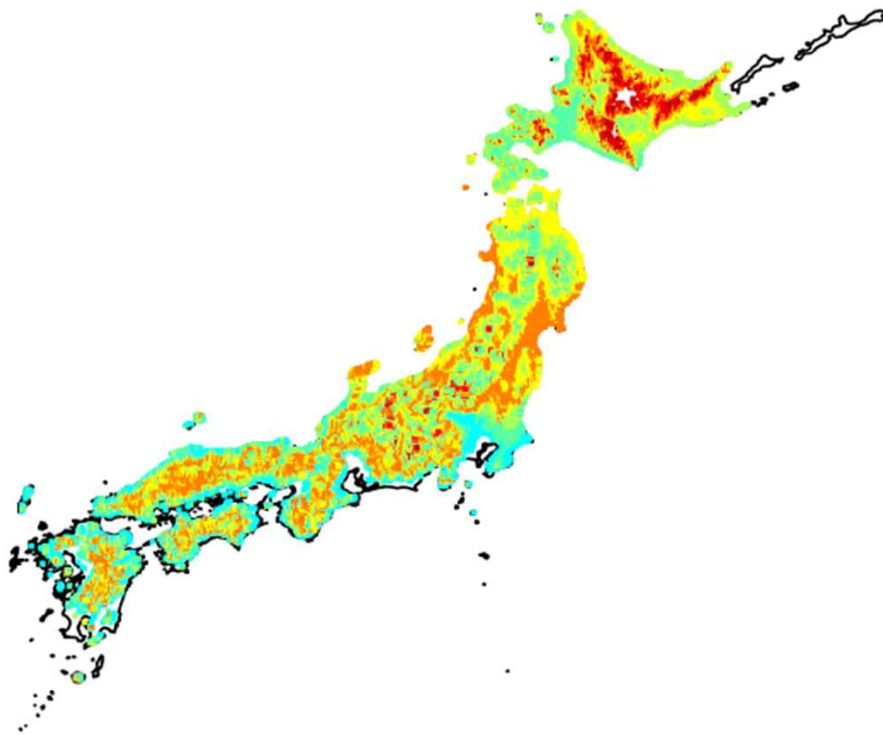2) Kennedy et al. (2013) *Ecology Letters*

Forest potential to provide honey

BA of trees
providing honey

(m^2/ha)

- ☐ 0-1
- ☐ 1-2
- ☐ 2-4
- ☐ 4-6
- ☐ 6-17

Aiba et al.
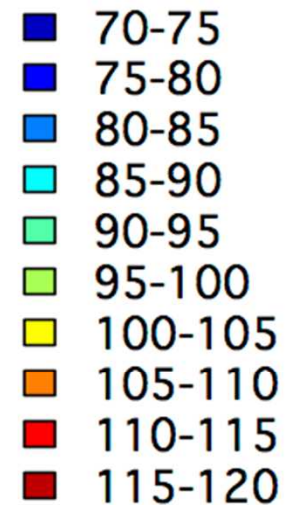
Land use change and ESs

Primary f. -> Secondary f.   Primary f. -> Plantation

Change in decay rate (%)

- 70-75
- 75-80
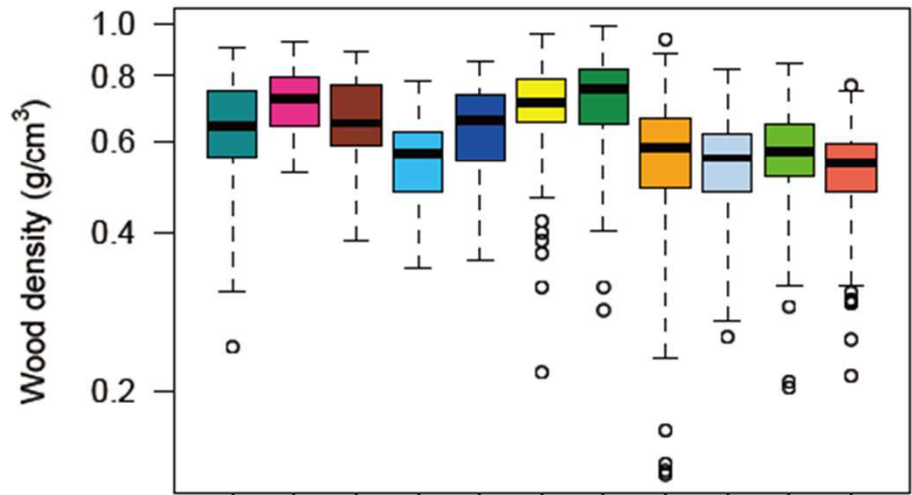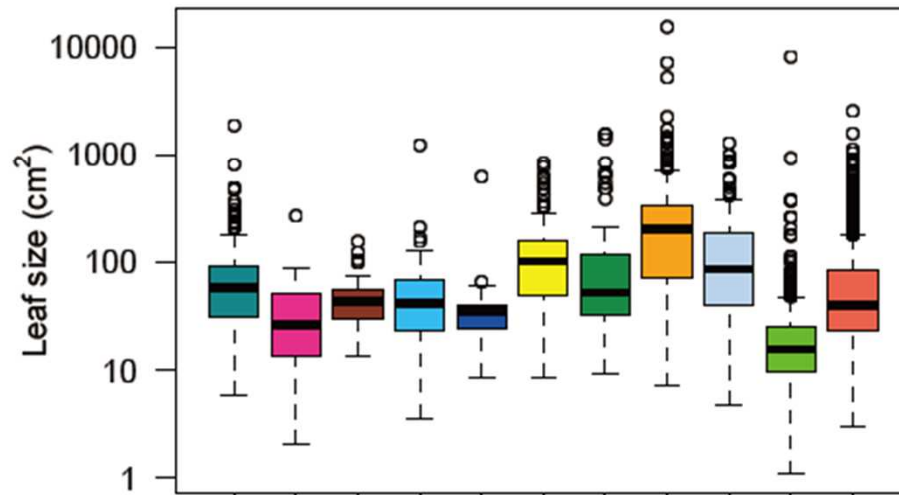- 80-85
- 85-90
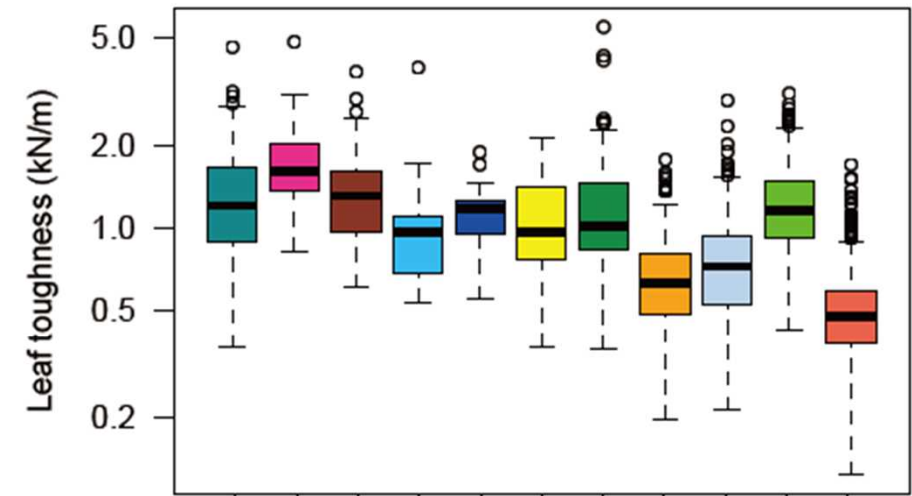- 90-95
- 95-100
- 100-105
- 105-110
- 110-115
- 115-120

Aiba et al.

Effects of climatic change on ESs

Decay rate (yr^{-1})

- ■ 0.24-0.54
- ■ 0.54-0.63
- ■ 0.63-0.67
- ■ 0.67-0.72
- ■ 0.72-1.18

Present

MIROC5-RCP2.6
(2075-2100)

MIROC5-RCP4.5
(2075-2100)

MIROC5-RCP8.5
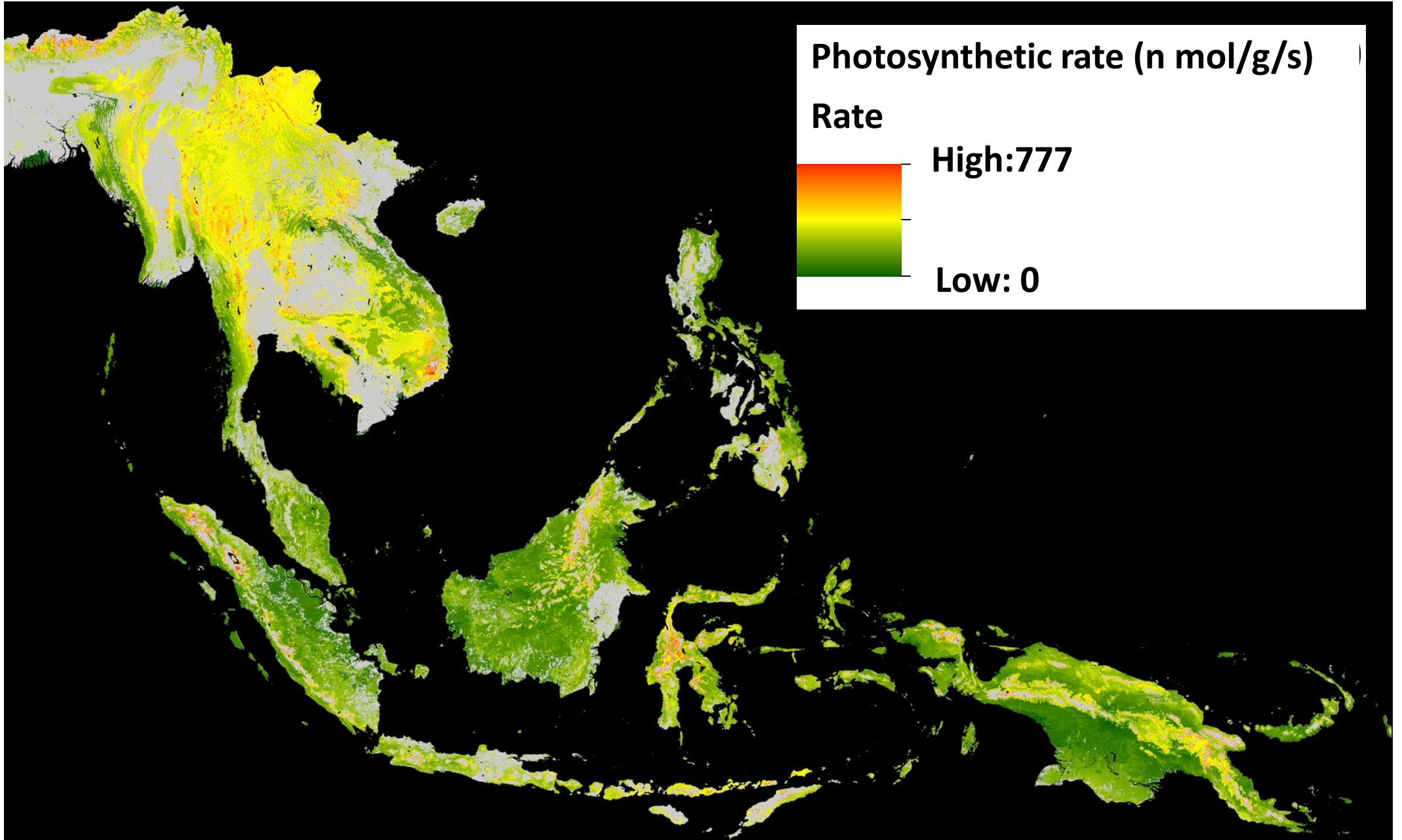(2075-2100)

Aiba et al.
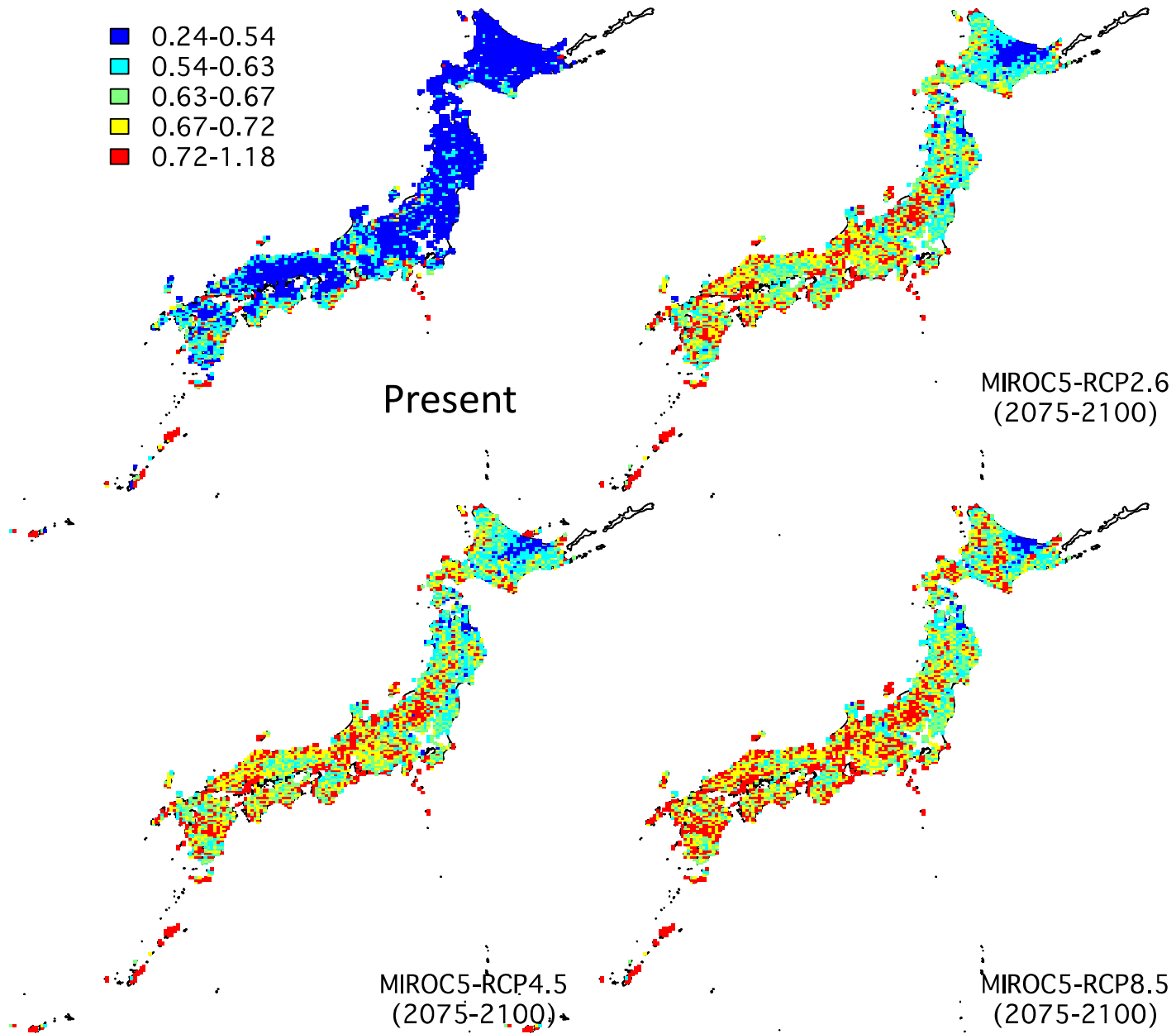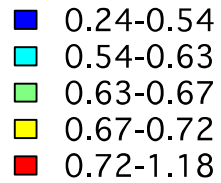
Community weighted mean of forest types in SE Asia

Aiba et al.
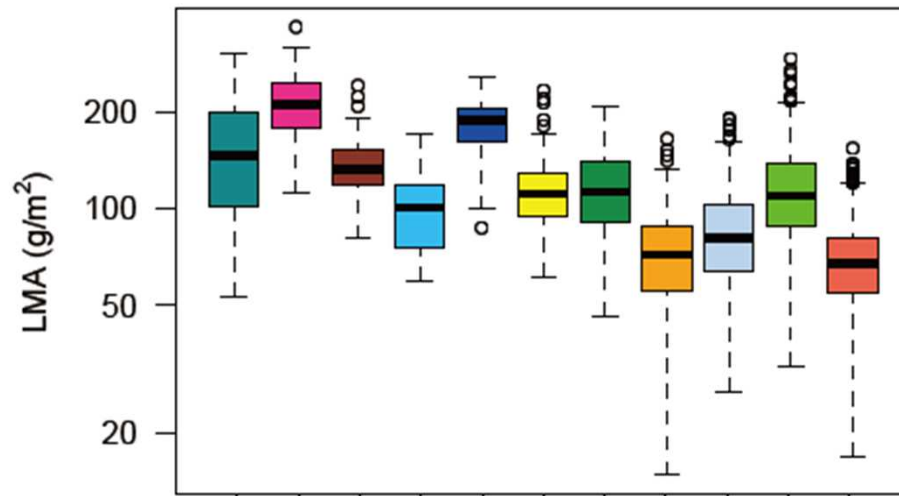
Mapping functional traits in SE Asia

0.29

0.12

−0.04

Log (N contents in leaf)
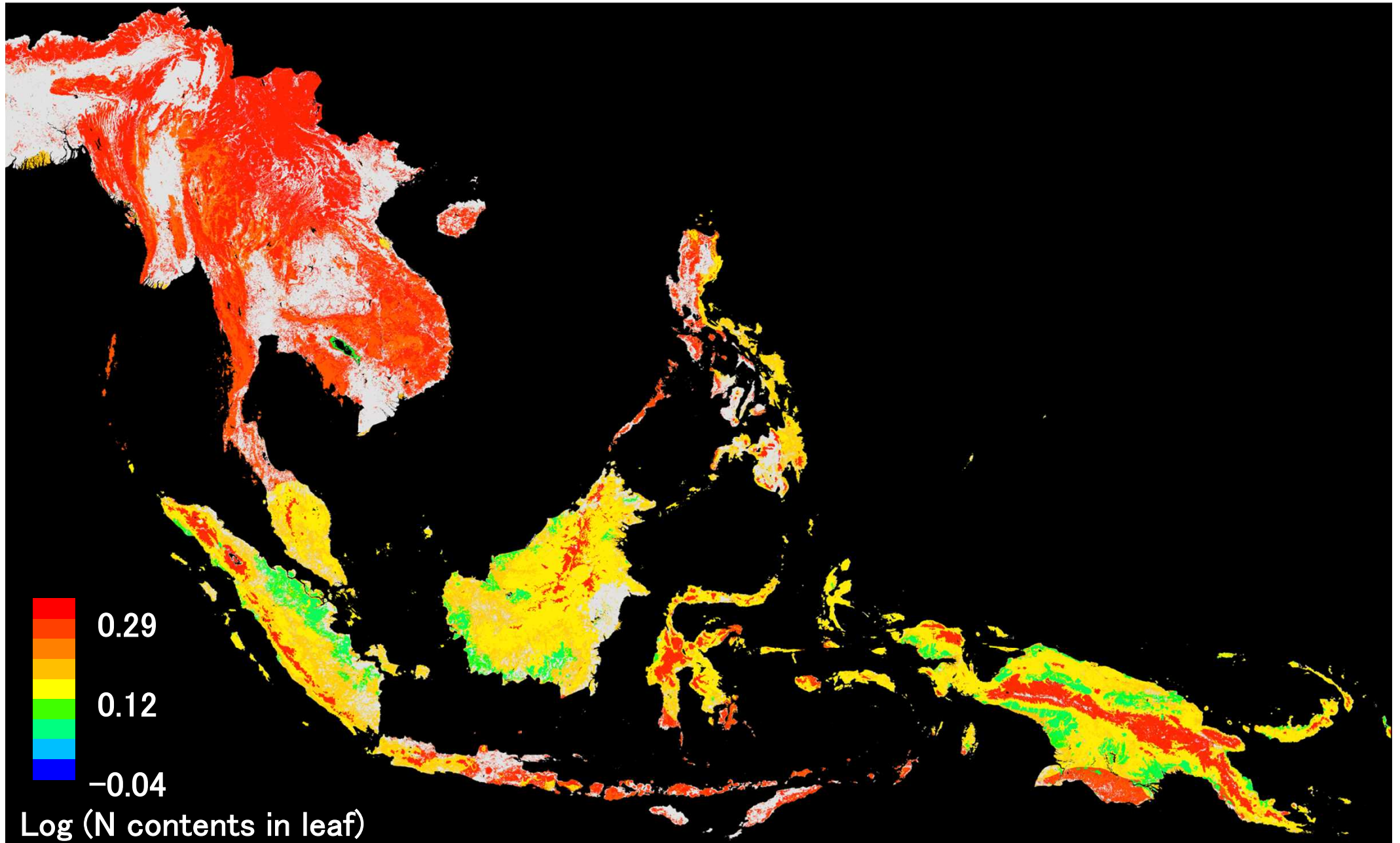
Photosynthetic rates in Asian forests

Photosynthetic rate (n mol/g/s)

Rate

High:777

Low: 0

The effect on FTs by transformation from natural to secondary forests

LMA (relative valure)

Rate

High:777

Low: 0
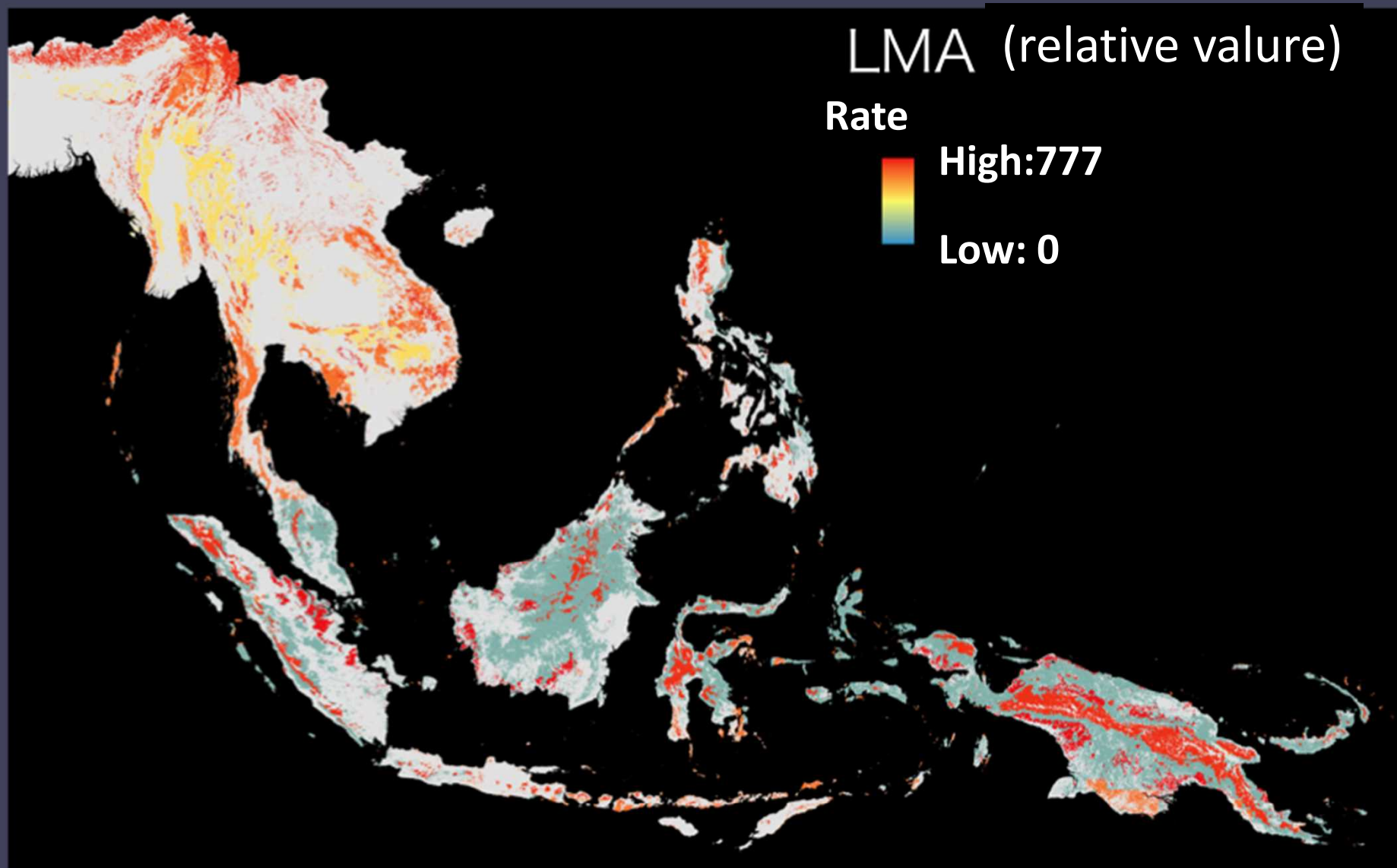
Community weighted means of natural forests were replaced by those of secondary forests of the same forest types

Biodiversity/ecosystem observation and ES assessment

- Quantitative assessment on ES/NCP including scenario analyses gives critical information on policy and decision making

- Combination of various databases gives great range of quantification and mapping of ESs

- Database on functional traits and abundance of key species which relate to ES are the expected to contribute greatly to quantification of ES

- Spatio-temporal resolution and accuracy of ES assessment are depending on information/database, and thus, observation

19

Thank you!