

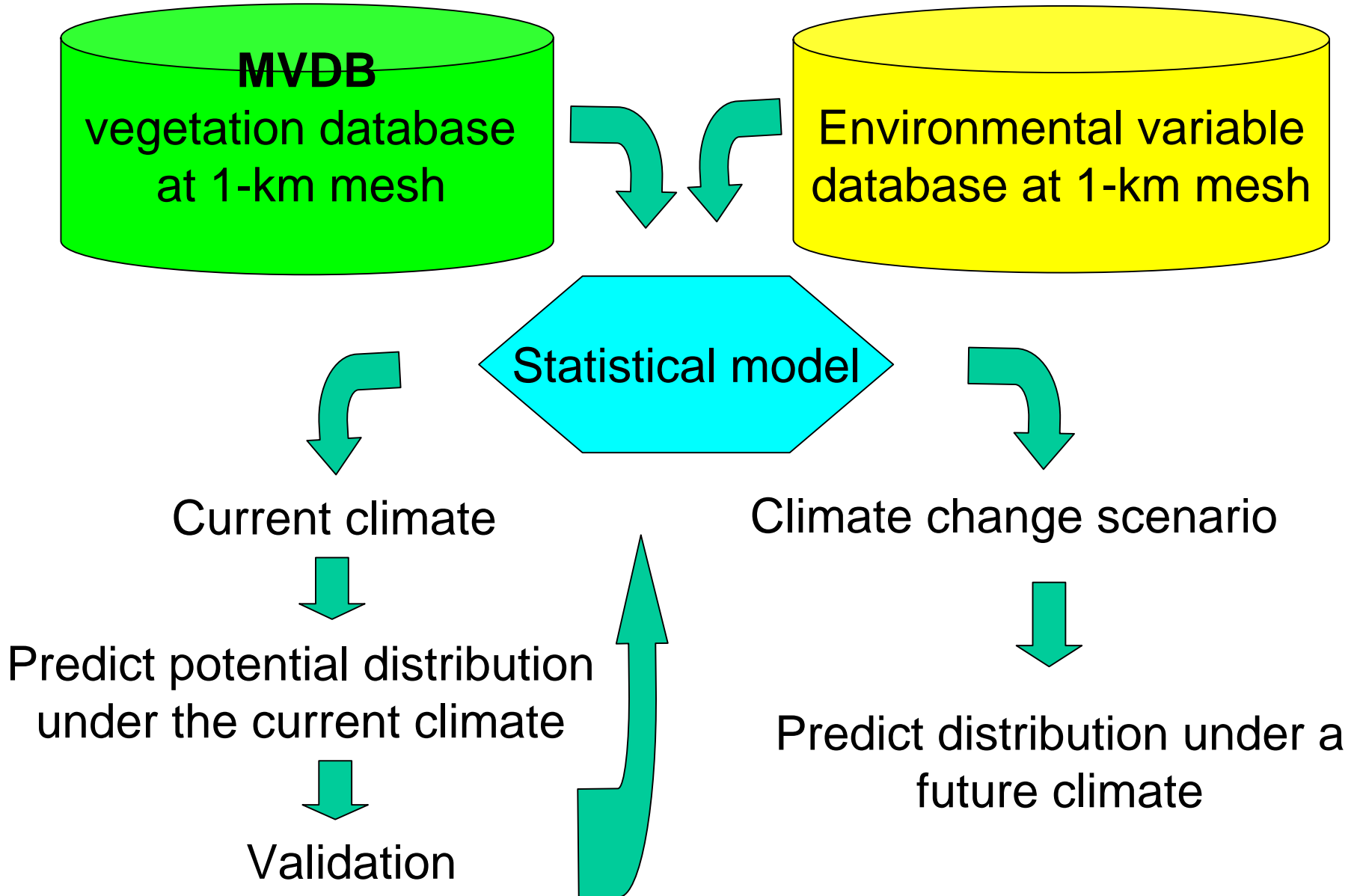
Predicting potential habitats for plants
under climate change and assessing
vulnerability in Japan: especially referring
to buna (*Fagus crenata*) forests

Tanaka, N., Matsui, T., Yagihashi, T., Taoda, H.
Forestry and Forest Products Research Institute
(FFPRI), Tsukuba, Japan

Topics

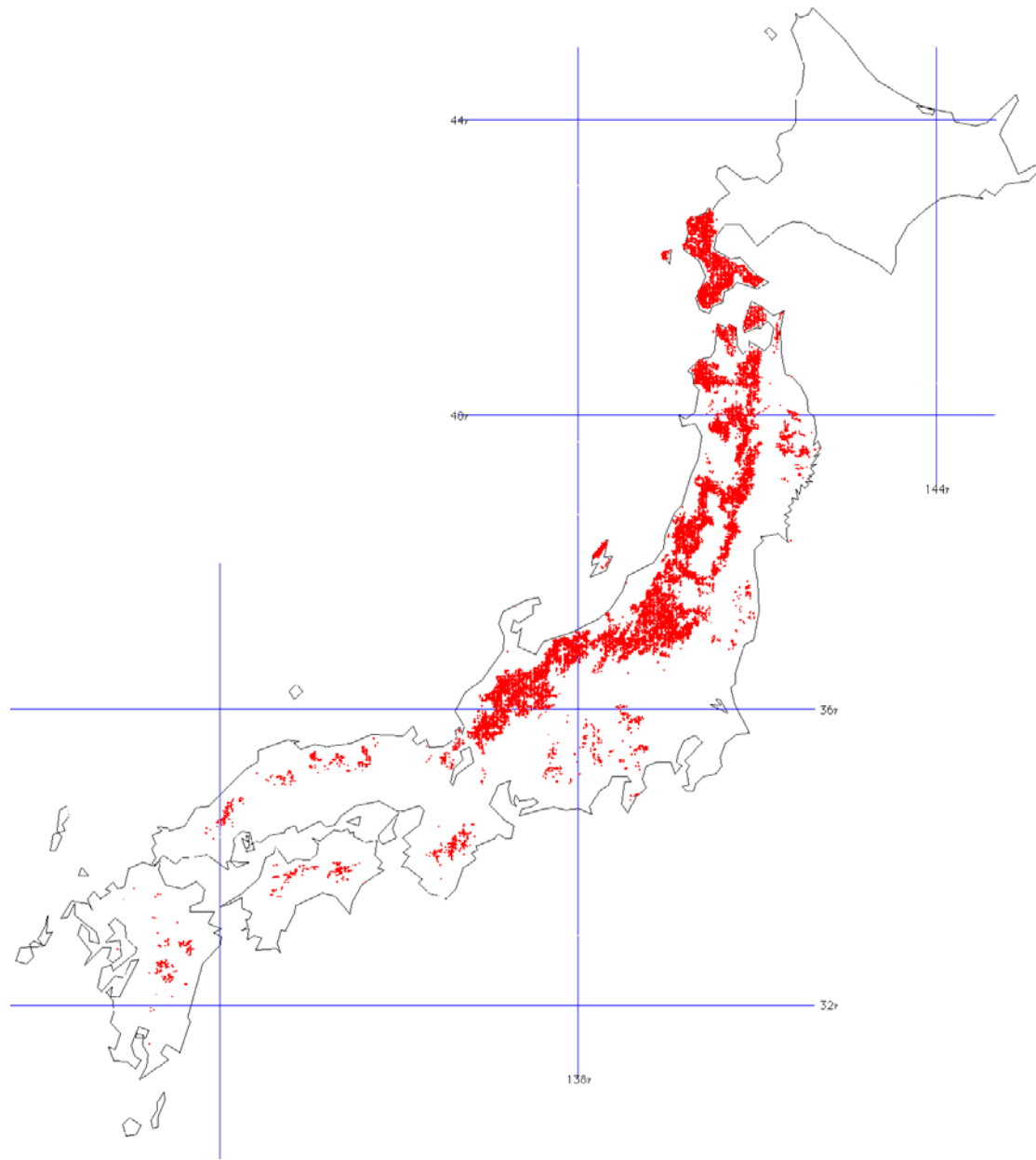
1. Predicting potential habitats for buna forests
2. Predicting potential habitats for a dwarf-bamboo species
3. Monitoring to detect effects of climate change

Studies using the NSNE 3rd (1-km) mesh vegetation database (MVDB)



Buna (*Fagus crenata*)





Actual distribution of buna forests

Data

Vegetation data

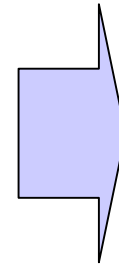
3rd (1-km) mesh vegetation data (MVDB)

Anthropogenic vegetation and lands: 188,363 cells ----- Excluded

Natural vegetation: 156,804 cells

Buna forests: 23,432 cells

Other vegetation types: 133,372 cells



Analysis

Environmental data

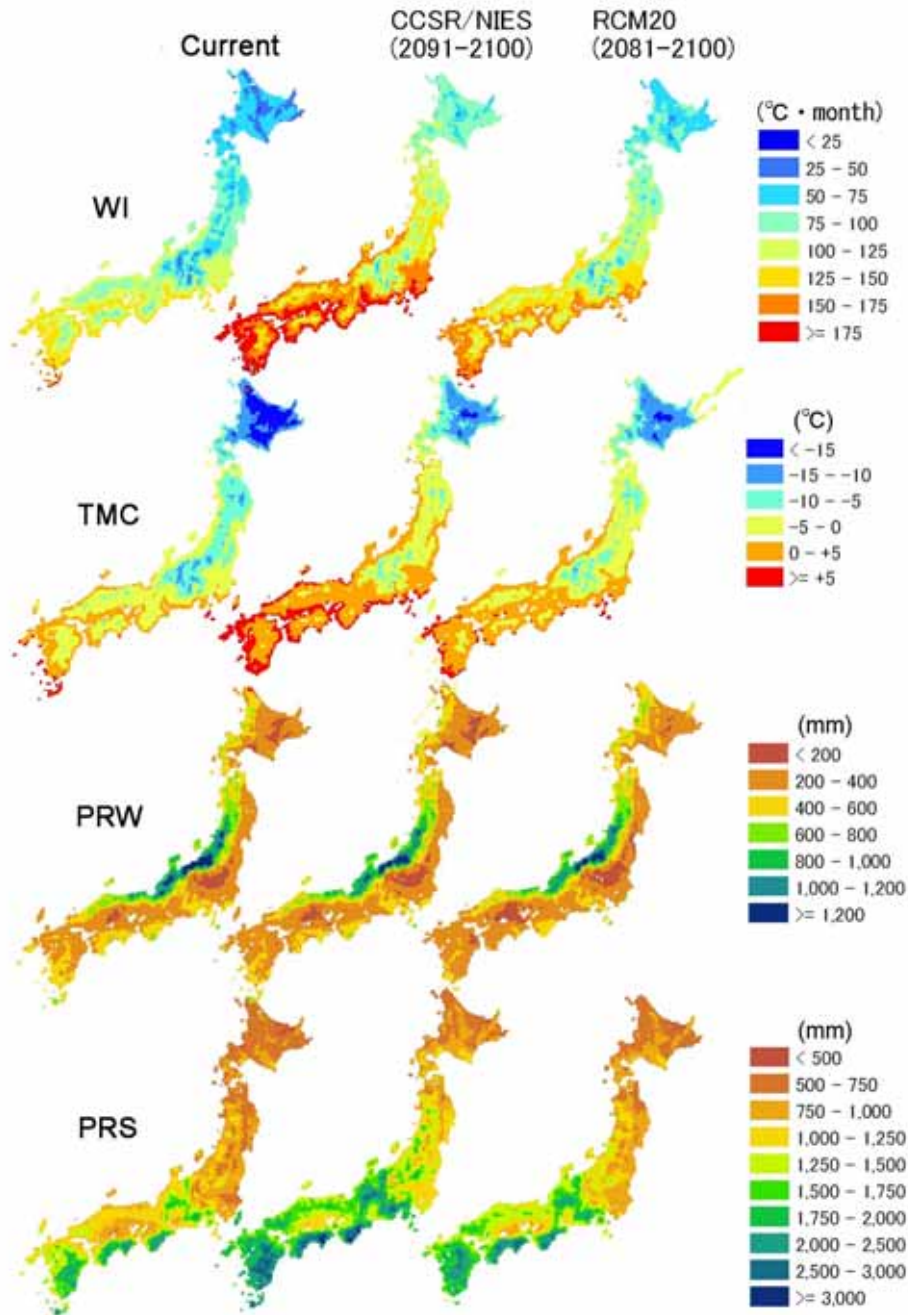
3rd (1-km) mesh climate data (Average for 30 years, Japan Meteorological Agency)

WI: warmth index (° C·month)

TMC: mean minimum daily temperature of coldest month (° C·month)

PRW: winter precipitation (Dec. to March; mm)

PRS: summer precipitation (May to September; mm)



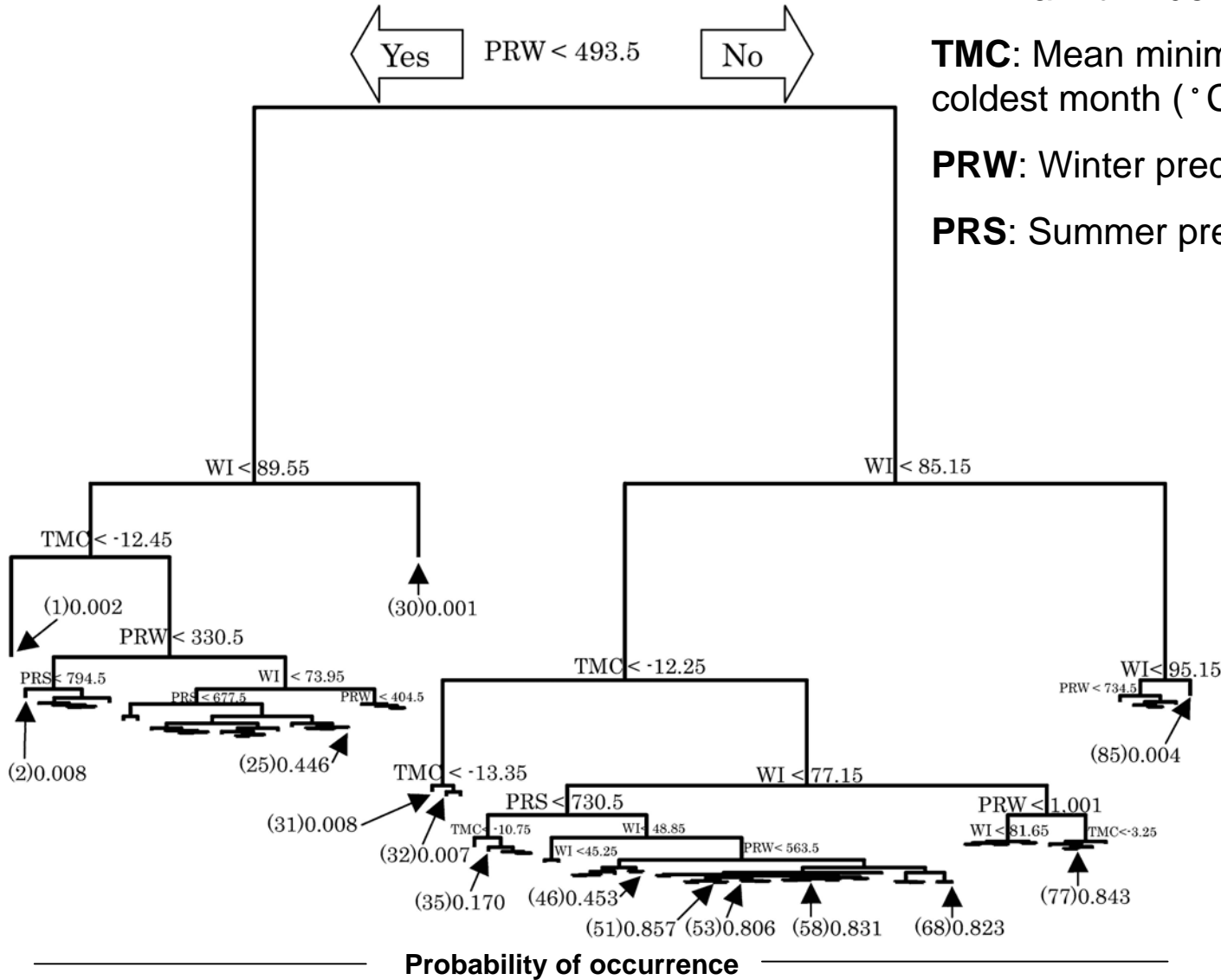
Maps of four climatic variables under the current climate and future climates, i.e. the CCSR/NIES scenario in 2091-2100 and the RCM20 scenario in 2081-2100.

WI: Warmth index ($^{\circ}\text{C}\cdot\text{month}$)

TMC: Mean minimum temperature of coldest month ($^{\circ}\text{C}\cdot\text{month}$)

PRW: Winter precipitation (mm)

PRS: Summer precipitation (mm)



Classification tree model for buna forests

Suitable habitat conditions for buna forests

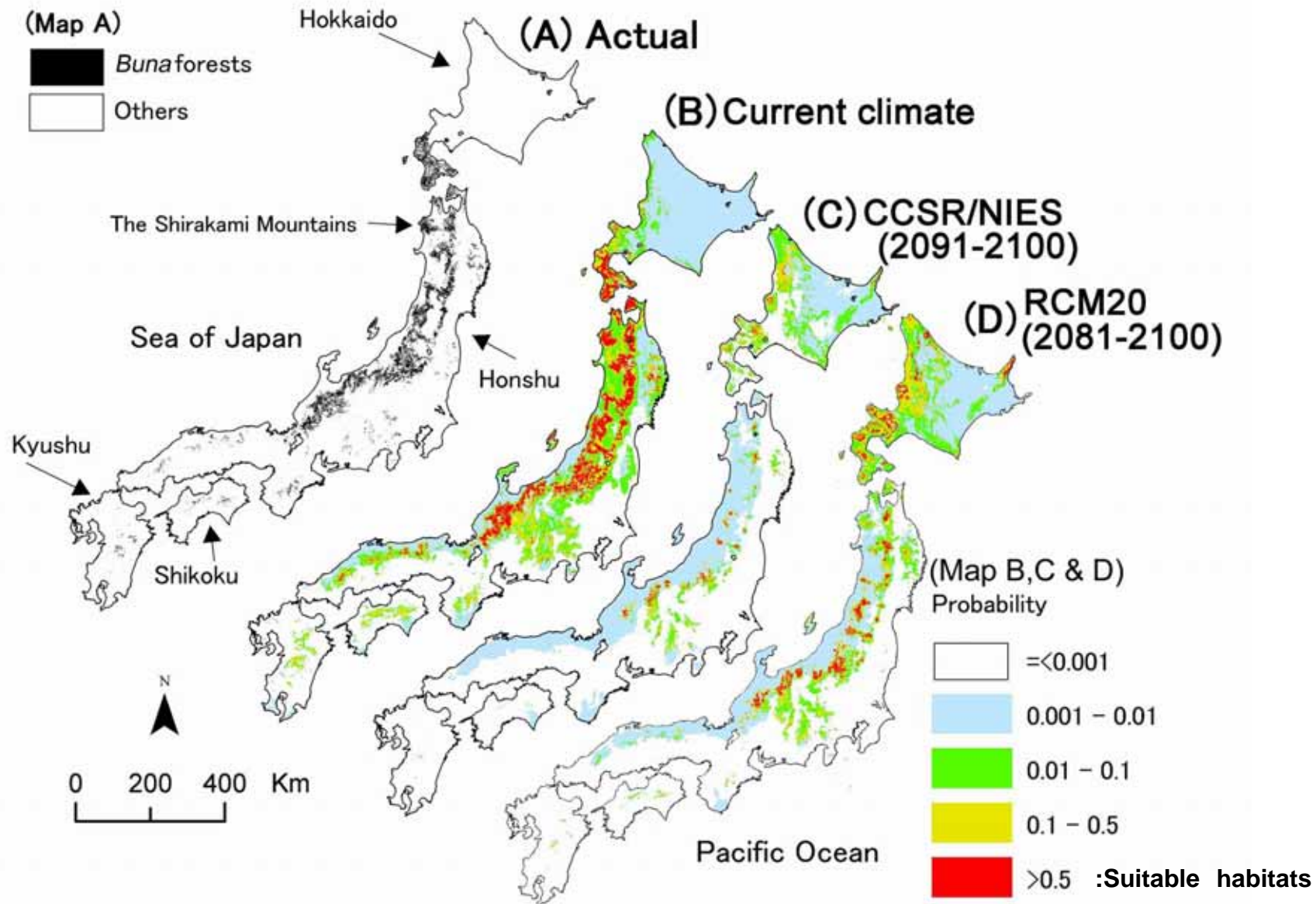
Where probability of occurrence is more than 0.5

The Sea of Japan side of northern Honshu and the southern Hokkaido

High precipitation both in winter and summer ($564 < PRW$, $731 < PRS$)

Moderate WI ($48.9 < WI < 77.2$)

Moderate coldness in winter ($-12.3 < TMC$)



Buna forest distribution maps:

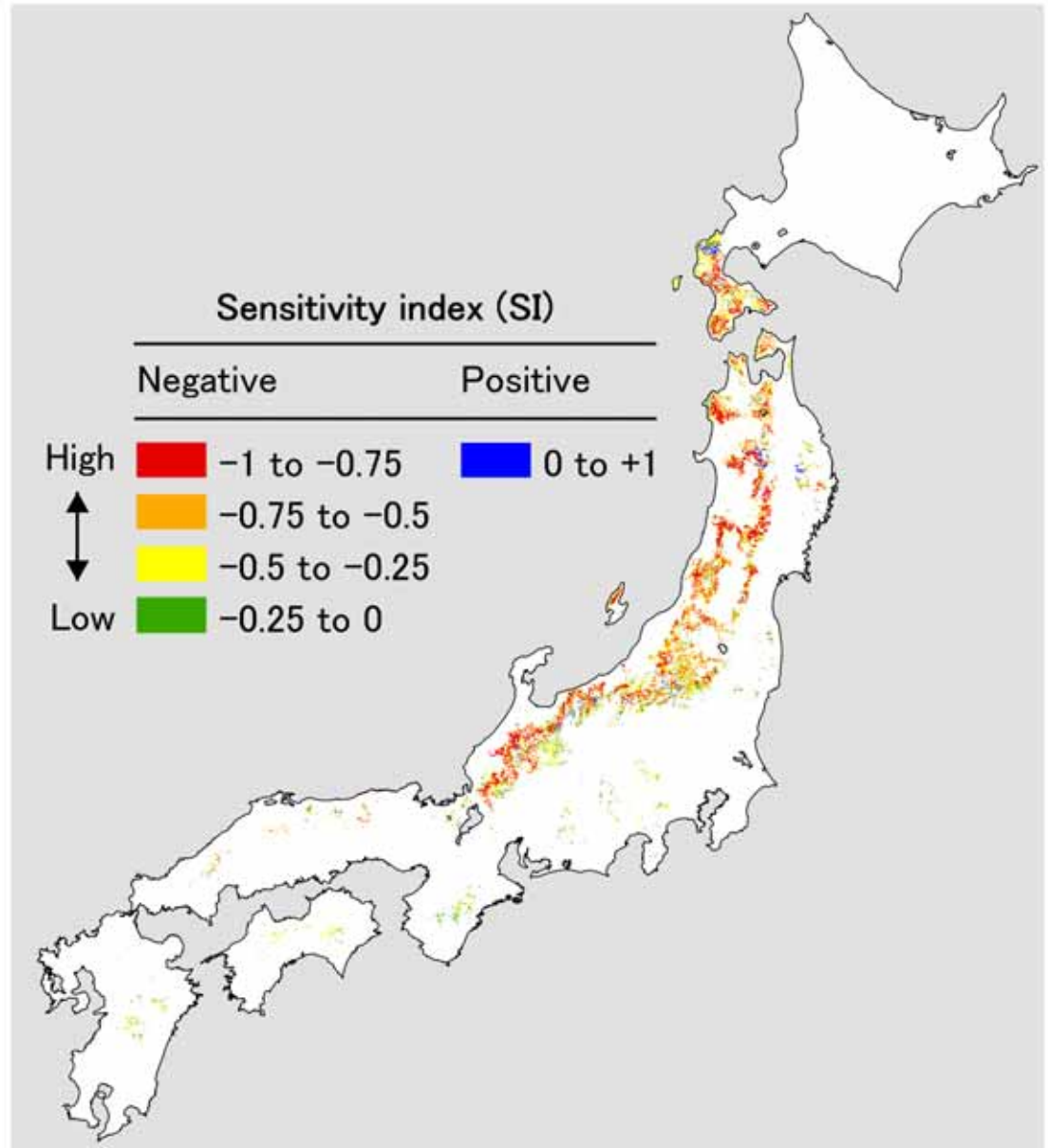
(A) Actual distribution and predicted probability distributions of buna (*Fagus crenata*) under (B) the current climate and (C) the CCSR/NIES climate change scenario in 2091-2100 (D) that under the RCM20 scenario in 2081-2100.

Distribution of sensitivity index (SI) of buna forests

$$SI = PS - PC$$

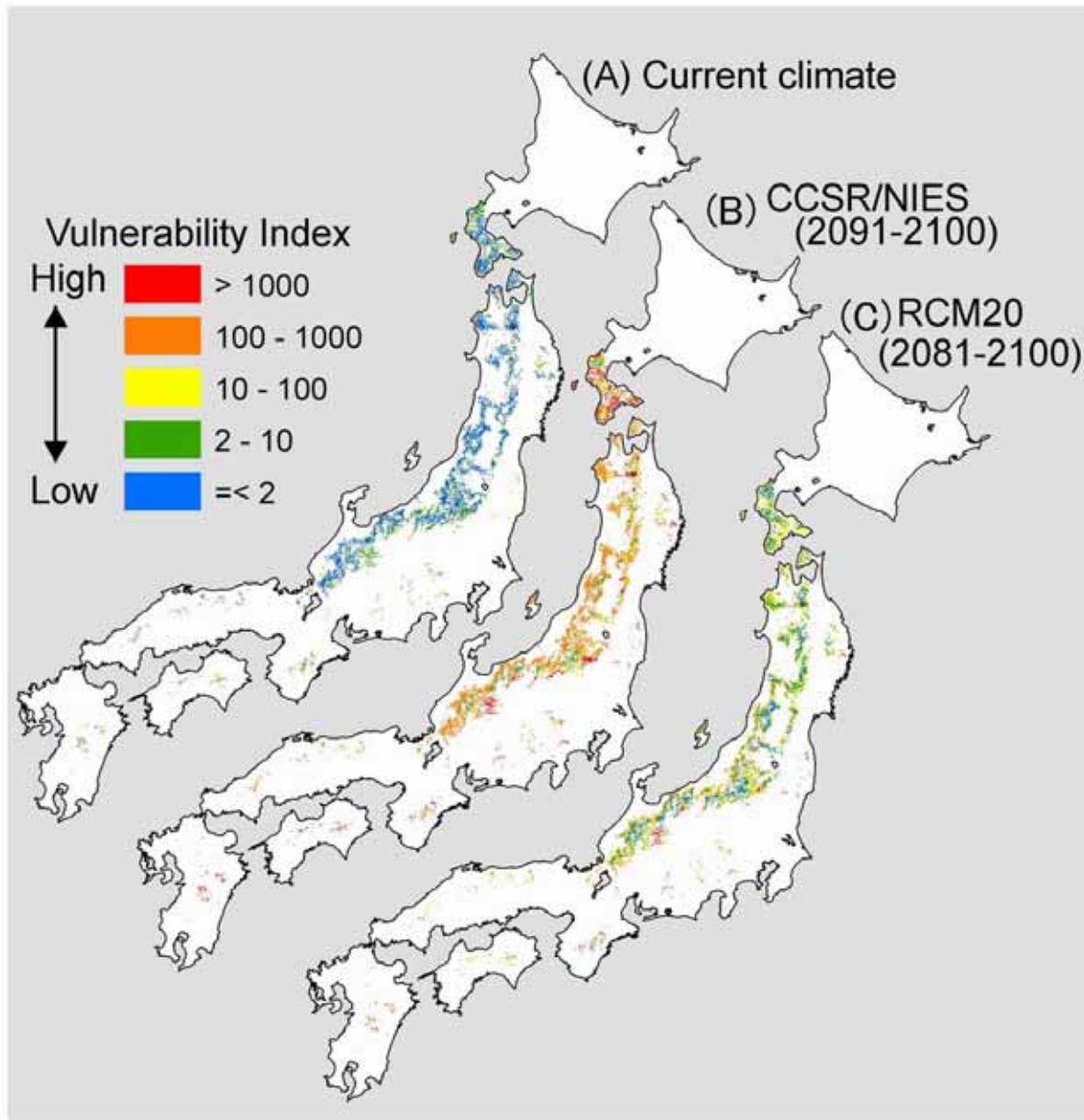
PS = probability of the
CCSR/NIES scenario

PC = probability of the
current climate



Vulnerability Index for buna forests (VI)

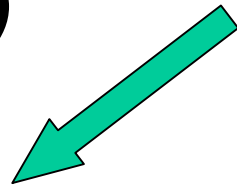
$$VI = 1 / \text{Occurrence probability}$$



The MVDB (NSNE 3rd mesh vegetation database) provides the distribution data on vegetation types, **but lacks the species distribution data.**

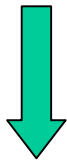
In order to predict habitats of a variety of species, it is necessary to construct databases on plant species distribution.

A relevé data sheet of Phytosociological Relevé Database (PRDB)



Survey date

Mesh code



Key data for temporal
and spatial analysis

植生調査データベース作成 Version 4.15

ファイル(F) ツール(T) 編集(E) 検索(S) 設定変更(O) ヘルプ(H)

ファイル Sample千葉.fvi 収録数 182 スタジイ 閲覧・編集

収録番号 9 Elevation(m) 45 番号 1 スダジイ T1 44 T2 13 S 23
ID no. TN10713 Aspect N20E 2 ヒサカキ 22 22 11
Place name 猿田 Incrination 25 3 ヤブニッケイ 22 + 11
Survey date 19780825 Topography 斜中 4 ヤブツバキ 12 +
Tok Latitude 0354442 Microtopogr 凸地 5 ヤマボウシ +
yo Longitude 14043574 Geology 6 ネズミモチ 12
Mesh code 53404598 Soil 褐森 7 ムラサキシキブ + +
Story no. 5 Area (m2) 100 8 ヤマグラ +
Dominance 2 Sp. no. 43 43 9 テイカカズラ 33
Surveyers 若林裕 白紙化 10 アズマネザサ 12
T1 height (m) 10 T1 cover (%) 70 11 ヤブコウジ 23
T2 height(m) 7 T2 cover (%) 30 12 ツルグミ 11
S1 height (m) 3 S1 cover (%) 20 13 ナキリスゲ 23
S2 height (m) S2 cover (%) 14 クワ 11
H1 height (m) 1.3 H1 cover (%) 65 15 ジャノヒゲ 13
H2 height (m) H2 cover (%) 16 キズタ 12
M height (m) M cover (%) 17 モチノキ 11
18 ノダフジ +
19 コバノガマズミ 11
20 アカガシ 11
21 ヤブラン 12
22 ミツバアケビ +
23 ツタウルシ 12
24 ヤマノイモ +
25 ガマズミ 11
26 サルトリイバラ +
27 サワラ +
28 イボタノキ +
29 ビナンカズラ +
30 ヘクソカズラ +
31 カクレミノ +
32 シロダモ +
33 タブノキ +
34 シュンラン +
35 チヂミザサ +
36 マンリョウ +
37 ホウチャクソウ +
38 アオキ +
39 カミエビ +
40 モッコク +
41 ゴンズイ +
42 コナラ +
43 キヨスミイボタ +

Remark 重要な植物群落千葉県5

Creation 20060426 Revision 20060427 追加 前へ 任意位置 次へ 書込次

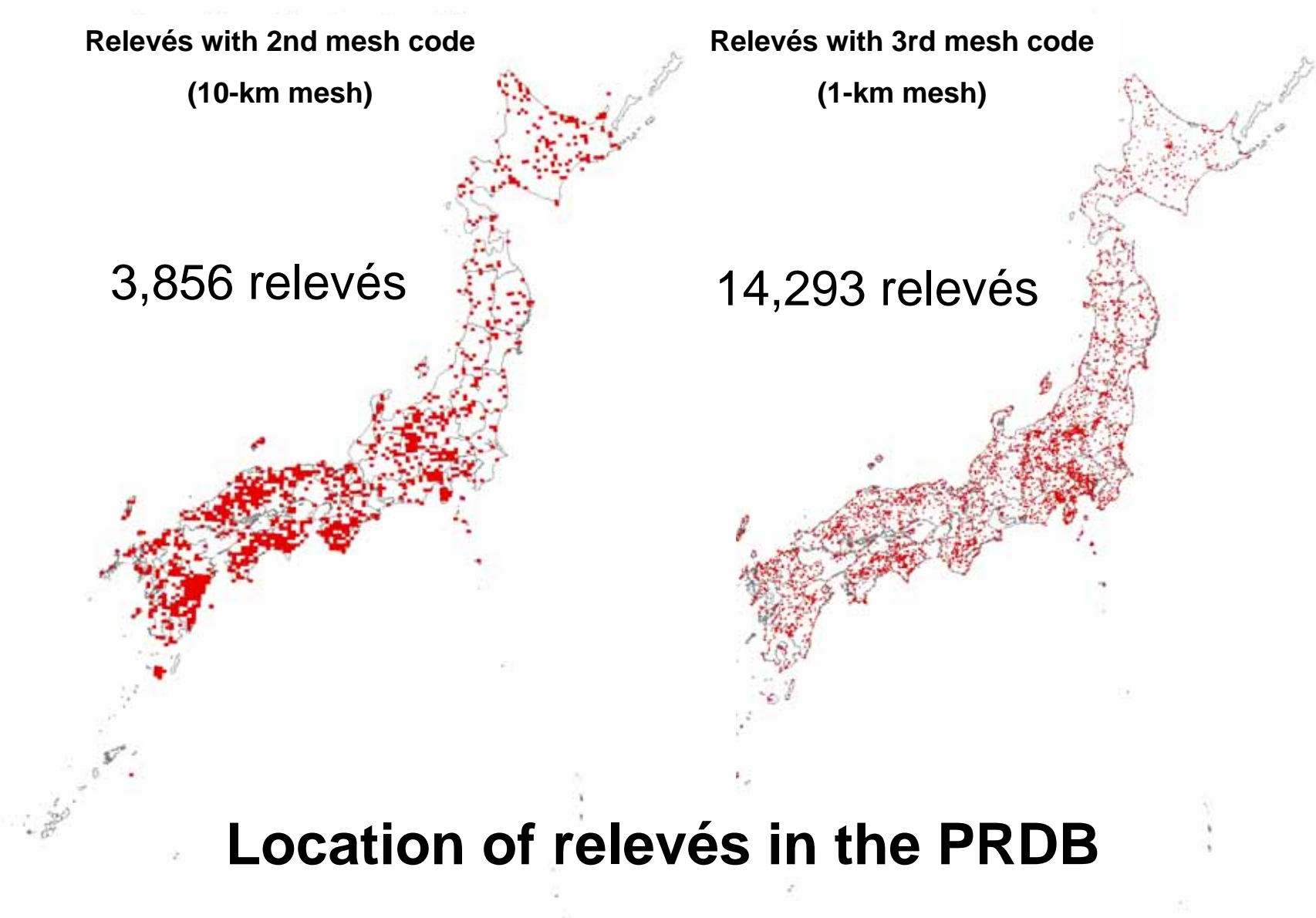
**Relevés with 2nd mesh code
(10-km mesh)**

3,856 relevés

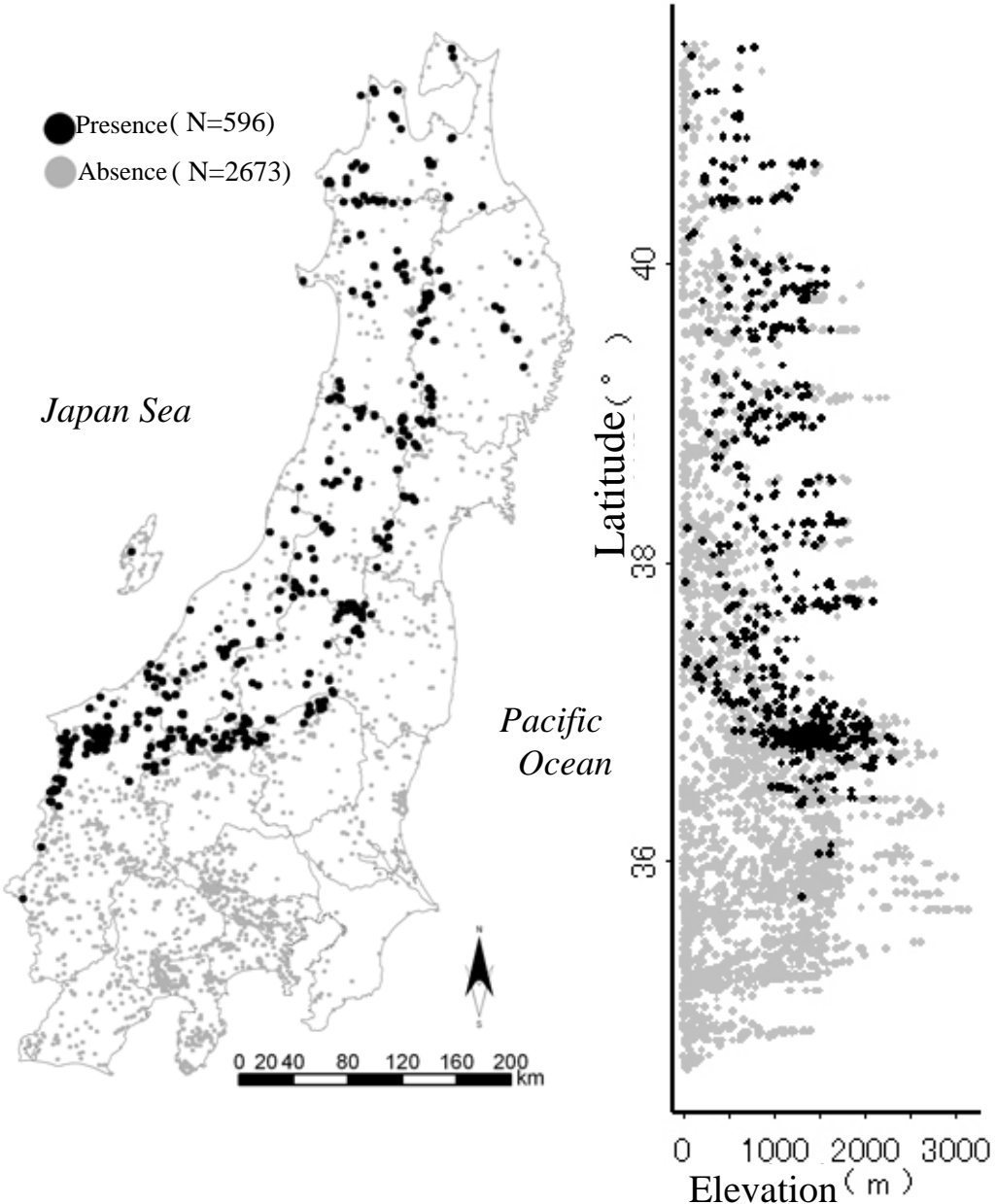
**Relevés with 3rd mesh code
(1-km mesh)**

14,293 relevés

Location of relevés in the PRDB

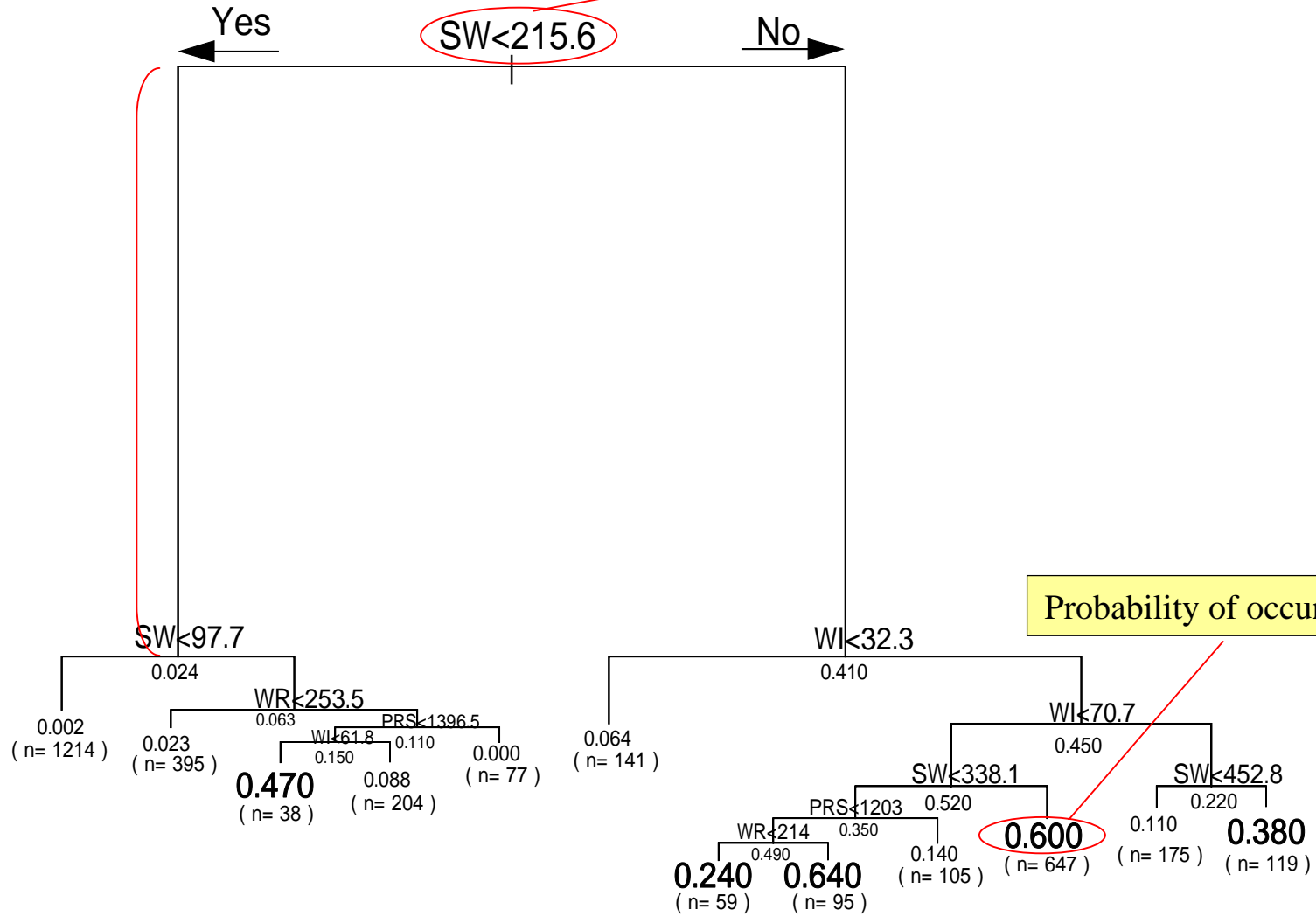


Sasa kurilensis ▢ Dominant undergrowth plant species in snowy areas



Classification tree model

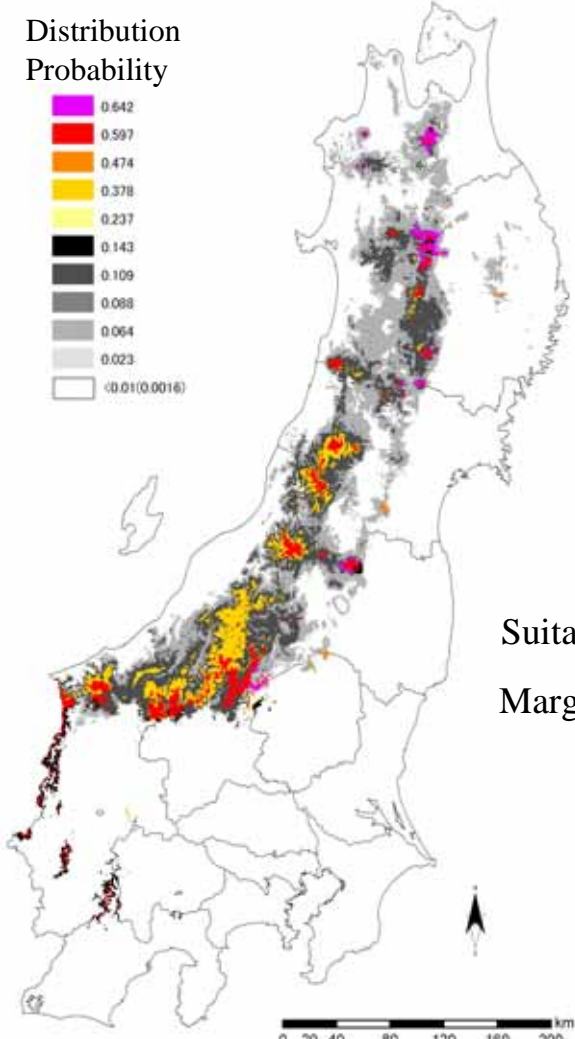
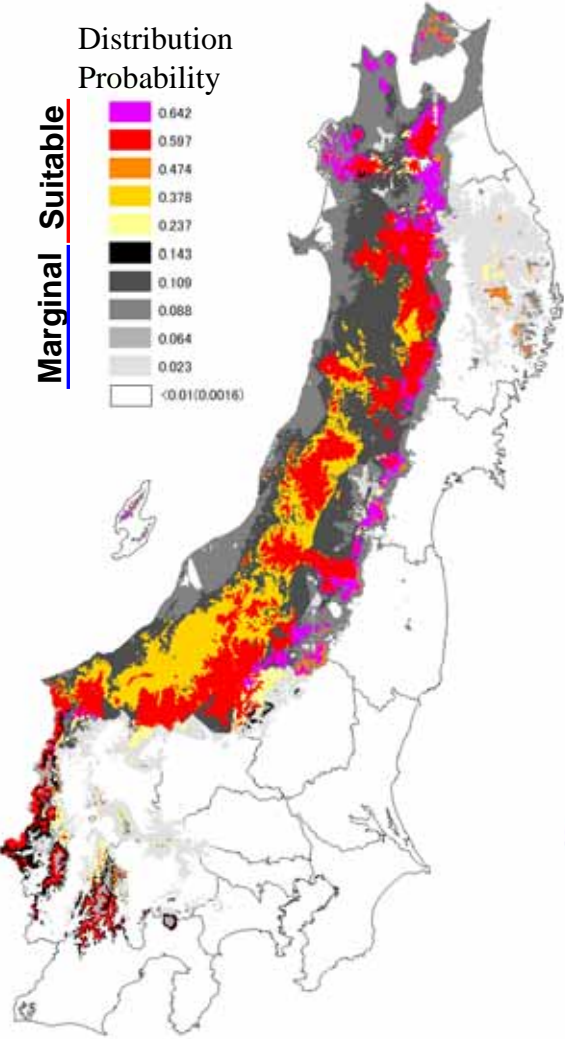
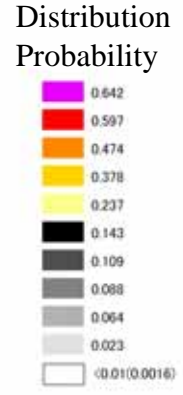
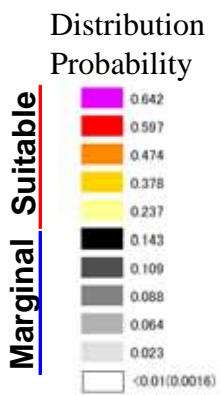
Splitting condition



Predicted probability distributions of *Sasa kurilensis* under the climate change scenario, RCM20 (2081-2100)

Current

2081-2100



	Current	2081-2100	
Suitable habitat	26,067	5,657	(21.7%)
Marginal habitat	46,217	31,010	(66.3%)



Monitoring to detect effects of climate change

- Suitable places for monitoring:

Vulnerable and/or sensitive areas

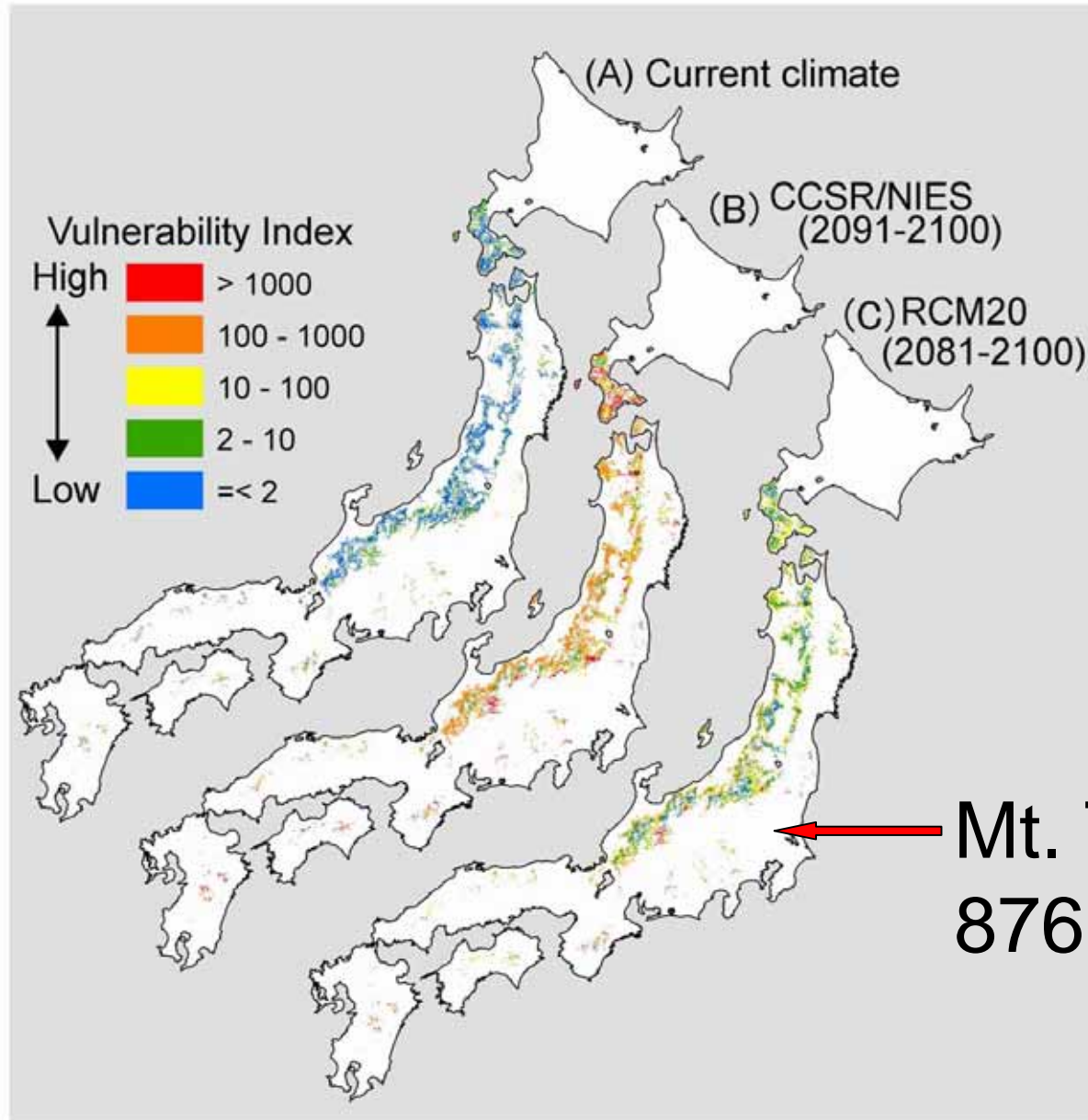
- Methods of monitoring:

Permanent plots: less than 10 ha

Remote sensing techniques: more than 10 ha

Vulnerability Index for buna forests (VI)

$$VI = 1 / \text{Occurrence probability}$$





A declining buna forest in Mt. Tsukuba, located in a marginal habitat with low precipitation in winter and high temperature.

Monitoring of buna trees by ortho air photos in Mt. Tsukuba

Ortho air photo

Date: April 30, 2004

Area: 820 ha

Spatial resolution: 12.5cm

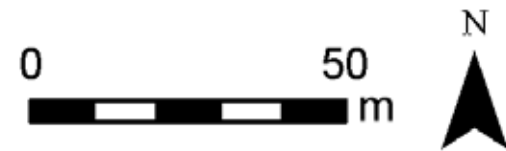


Mt. Tsukuba in autumn

Identifying buna canopies



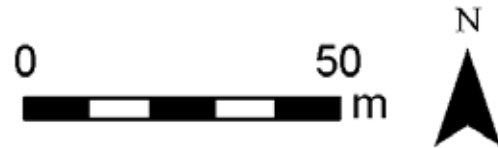
Buna trees have new leaves on April 30, 2004



Identifying buna canopies



Buna: polygons of red lines
Estimated no. of buna trees: 1,915



Monitoring of a buna forest by 1-ha permanent plot



Census of all trees with DBH>5cm

Conclusion

- The tree model using the MVDB and four climatic variables could predict the distribution of buna forests.
- The area of suitable habitats for buna forests decreases into 9 % under the CCSR/NIES scenario (2091-2100) and 37 % under the RCM20 scenario (2081-2100). Buna forests in Pacific side of Honshu, Shikoku, Kyusyu will be most vulnerable.
- The MVDB lacks the information on plant species distribution. In order to predict habitats of a variety of species, it is necessary to construct databases on plant species distribution such as the PRDB.
- In order to Monitor effects of climate change on plant species, it is necessary to place monitoring sites in areas vulnerable and/or sensitive to climate change.

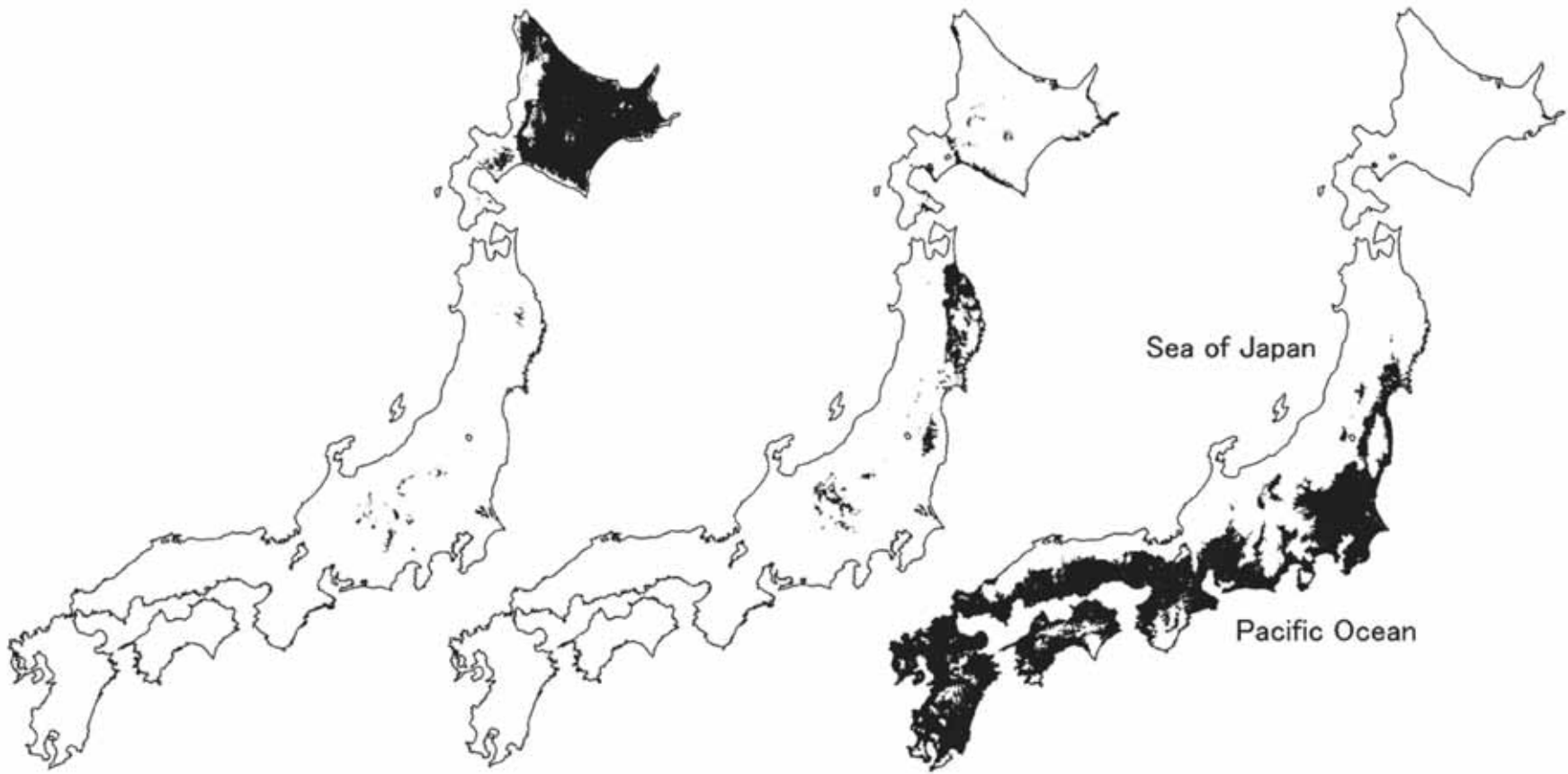
Thank you

This studies have been supported by the grants:
the Global Environmental Research of Japan (B-11 and S-4)
program, the Ministry of the Environment

Influential variables of climate

Deviance weighted score (DWS) in the
model shows

PRW > WI > TMC > PRS



(A) Terminal node no. 1

Predicted score = 0.002
 Number of squares = 56,014

- $PRW < 493.5$
- $WI < 89.55$
- $TMC < -12.45$

(B) Terminal node no. 2

Predicted score = 0.008
 Number of squares = 15,593

- $PRW < 330.5$
- $WI < 89.55$
- $TMC \geq -12.45$
- $PRS < 794.5$

(C) Terminal node no. 30

Predicted score = 0.001
 Number of squares = 124,043

- $PRW < 493.5$
- $WI \geq 89.55$

Unsuitable habitats

Distribution of cells with low probability of occurrence (<0.01)



(D) Terminal node no. 31

Predicted score = 0.008
 Number of squares = 5,492
 $PRW \geq 493.5$
 $WI < 85.15$

● $TMC < -13.35$

(E) Terminal node no. 32

Predicted score = 0.007
 Number of squares = 1,377
 $PRW \geq 493.5$
 $WI < 85.15$

● $TMC \geq -13.35$ and < -12.25

● $PRS < 758.5$

(F) Terminal node no. 85

Predicted score = 0.004
 Number of squares = 28,809
 $PRW \geq 493.5$

● $WI \geq 95.15$

Unsuitable habitats

Distribution of cells with low probability of occurrence (<0.01)



Atlas of Current and Potential Future Distributions of Common Trees of the Eastern United States

Louis R. Iverson
Anantha M. Prasad
Betsy J. Hale
Elaine Kennedy Sutherland



Index of Scientific Names

Page number in **bold** is for map information; number in *italics* is for life history information.

<i>Abies balsamea</i>	12	176	<i>Pinus echinata</i>	92	193
<i>Acer negundo</i>	14	176	<i>Pinus elliotii</i>	94	193
<i>Acer pensylvanicum</i>	16	176	<i>Pinus palustris</i>	96	194
<i>Acer rubrum</i>	18	177	<i>Pinus resinosa</i>	98	194
<i>Acer saccharinum</i>	20	177	<i>Pinus strobus</i>	100	195
<i>Acer saccharum</i>	22	178	<i>Pinus taeda</i>	102	195
<i>Betula alleghaniensis</i>	24	178	<i>Pinus virginiana</i>	104	196
<i>Betula lenta</i>	26	179	<i>Platanus occidentalis</i>	106	196
<i>Betula papyrifera</i>	28	179	<i>Populus deltoides</i>	108	197
<i>Carpinus caroliniana</i>	30	180	<i>Populus grandidentata</i>	110	197
<i>Carya cordiformis</i>	32	180	<i>Populus tremuloides</i>	112	198
<i>Carya glabra</i>	34	180	<i>Prunus serotina</i>	114	198
<i>Carya ovata</i>	36	181	<i>Quercus alba</i>	116	199
<i>Carya spp.</i>	38	181	<i>Quercus coccinea</i>	118	199
<i>Carya tomentosa</i>	40	182	<i>Quercus falcata</i> var. <i>falcata</i>	120	200
<i>Celtis laevigata</i>	42	182	<i>Quercus falcata</i> var. <i>pagodifolia</i>	122	201
<i>Celtis occidentalis</i>	44	183	<i>Quercus laurifolia</i>	124	201
<i>Cercis canadensis</i>	46	183	<i>Quercus macrocarpa</i>	126	202
<i>Cornus florida</i>	48	183	<i>Quercus marilandica</i>	128	202
<i>Crataegus spp.</i>	50	184	<i>Quercus muehlenbergii</i>	130	203
<i>Diospyros virginiana</i>	52	184	<i>Quercus nigra</i>	132	203
<i>Fagus grandifolia</i>	54	185	<i>Quercus palustris</i>	134	204
<i>Fraxinus americana</i>	56	185	<i>Quercus phellos</i>	136	204
<i>Fraxinus nigra</i>	58	186	<i>Quercus prinus</i>	138	205
<i>Fraxinus pennsylvanica</i>	60	186	<i>Quercus rubra</i>	140	205
<i>Fraxinus spp.</i>	62	187	<i>Quercus stellata</i>	142	206
<i>Gleditsia triacanthos</i>	64	187	<i>Quercus velutina</i>	144	207
<i>Ilex opaca</i>	66	187	<i>Robinia pseudoacacia</i>	146	207
<i>Juglans nigra</i>	68	188	<i>Salix nigra</i>	148	208
<i>Juniperus virginiana</i>	70	188	<i>Salix spp.</i>	150	208
<i>Liquidambar styraciflua</i>	72	189	<i>Sassafras albidum</i>	152	209
<i>Liriodendron tulipifera</i>	74	189	<i>Taxodium distichum</i> var. <i>distichum</i>	154	209
<i>Maclura pomifera</i>	76	190	<i>Taxodium distichum</i> var. <i>nutans</i>	156	209
<i>Magnolia virginiana</i>	78	190	<i>Thuja occidentalis</i>	158	210
<i>Morus rubra</i>	80	190	<i>Tilia americana</i>	160	210
<i>Nyssa aquatica</i>	82	191	<i>Tsuga canadensis</i>	162	211
<i>Nyssa sylvatica</i> var. <i>biflora</i>	84	191	<i>Ulmus alata</i>	164	211
<i>Nyssa sylvatica</i> var. <i>sylvatica</i>	86	192	<i>Ulmus americana</i>	166	212
<i>Ostrya virginiana</i>	88	192	<i>Ulmus rubra</i>	168	212
<i>Oxydendrum arboreum</i>	90	192	<i>Ulmus spp.</i>	170	213

Fagus grandifolia American Beech Fagaceae

Life History Section, Page 185

CURRENT STATUS AND RANK AMONG 80 SPECIES

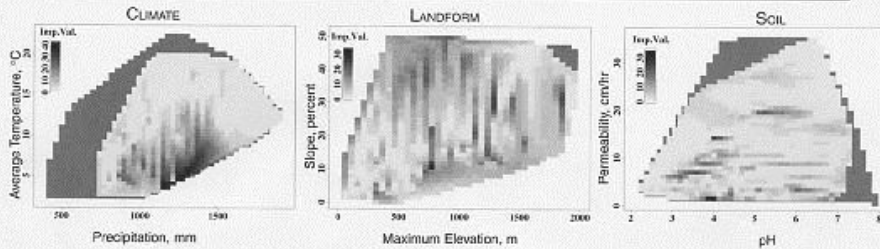
	AMOUNT	RANK	AMOUNT	RANK
Area (FIA), km ² x 10 ⁶	1.64	16	Σ Area x IV x 10 ⁶	0.91
Area (Little), km ² x 10 ⁶	1.92	29	IV, Average (FIA)	5.01

POTENTIAL CHANGE FROM CLIMATE CHANGE

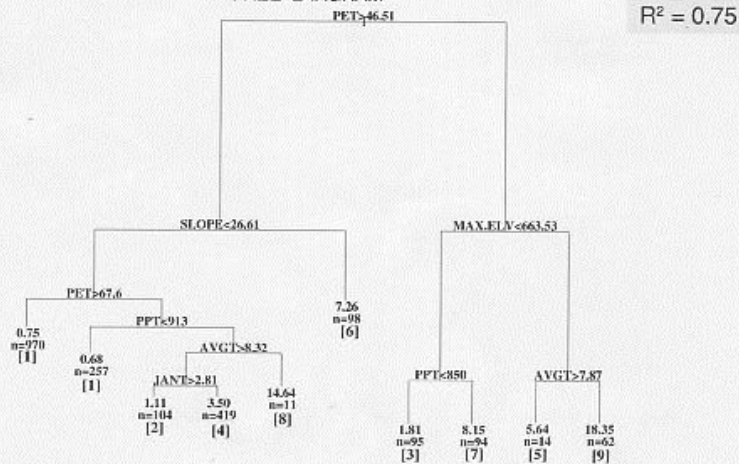
	GISS	GFDL
Weighted IV, %	-75	-88
Area, %	-83	-90
Optimal latitude, km	210S	280S

FIA DISTRIBUTIONS (1101 COUNTIES)_QUARTILES:

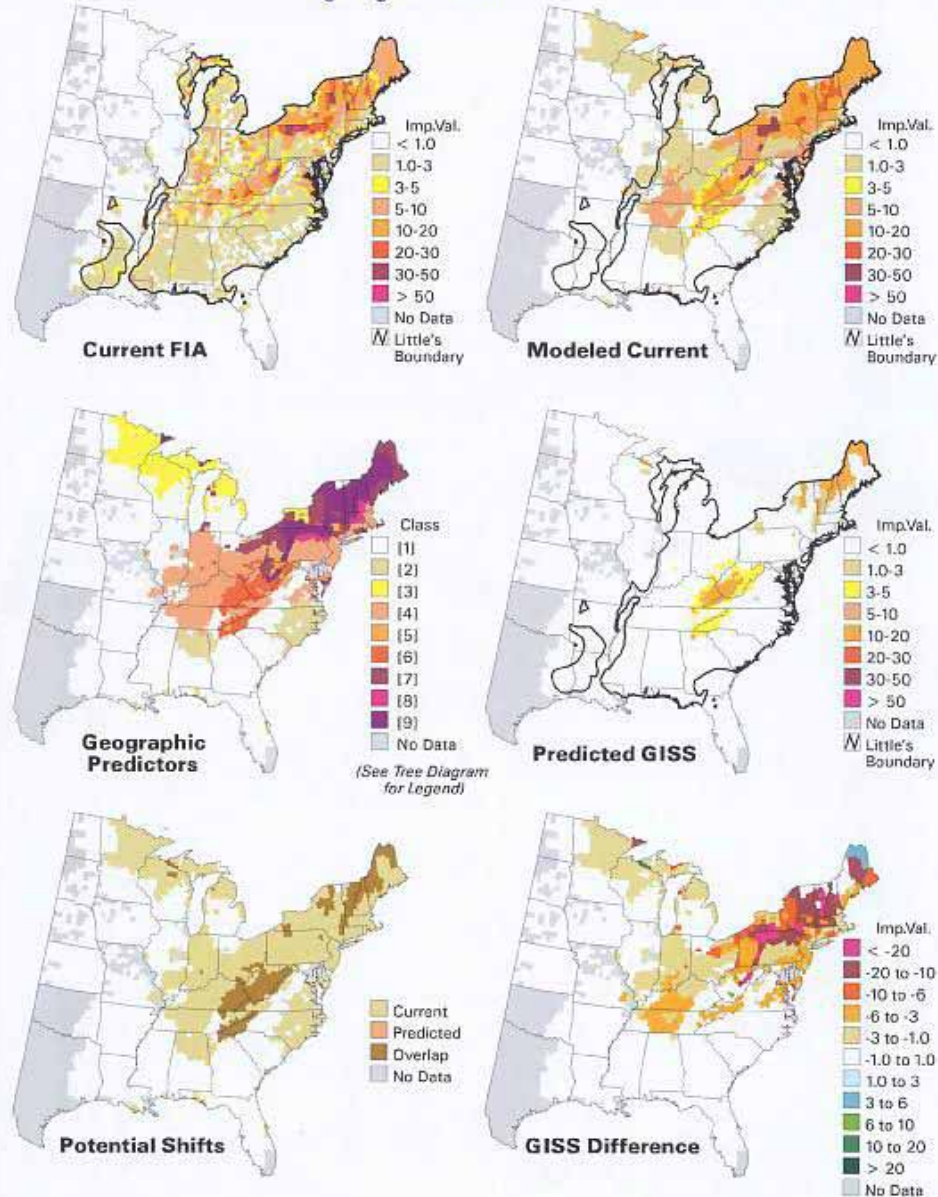
	MIN	1ST	MEAN	MEDIAN	3RD	MAX	RANK
Diameter, cm (8909 plots)	0.3	7.6	24.2	21.0	36.4	142.7	38
Growth Rate, cm ² /yr (3728 plots)	0.2	13.2	25.1	20.7	32.5	231.8	20
Annual Temperature, °C	2.2	9.3	12.2	12.2	15.3	20.4	44
January Temperature, °C	-12.5	-4.1	0.1	0.0	4.4	12.5	38
Precipitation, mm	710	1020	1160	1160	1310	1930	33
Potential Evapotranspiration, mm/month	12.6	49.6	60.6	61.4	71.3	104.0	58
Maximum Elevation, m	5	188	432	320	548	2000	38
Slope, percent	0.0	4.8	12.2	9.7	16.1	51.0	20
pH	2.1	3.9	4.6	4.5	5.0	7.4	63
Permeability, cm/hr	0.3	1.2	2.5	1.7	2.8	14.2	30
Organic Matter, percent	0.8	1.6	3.3	2.2	3.5	34.5	37
Clay, percent	2.5	16.6	21.4	22.0	27.0	46.7	60
Water-Holding Capacity, cm/152 cm	3.1	6.0	7.1	6.9	8.3	11.5	53



TREE DIAGRAM



Fagus grandifolia



Phytosociological Relevé Database (PRDB) operated by FVD

