Plant Diversity in the Dynamic Mosaic Landscape of an Agricultural Heritage System: The Minabe-Tanabe Ume System

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land

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Article

Plant Diversity in the Dynamic Mosaic Landscape of an Agricultural Heritage System: The Minabe-Tanabe Ume System

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Abstract: The Minabe-Tanabe Ume System in central Japan is defined as a Globally Important Agricultural Heritage System (GIAHS) by the United Nations Food and Agriculture Organization. This study examined relationships between parcel-level plant diversity and land use, management, and development in traditional sloped Ume (Japanese apricot; *Prunus mume*) orchards and adjoining level orchards recently developed through large-scale cut-fill land development. We constructed and overlaid past (1974) and present (2015) digital land-use maps to assess land use and topography. We conducted field vegetation surveys in land parcels with different development and management histories. Although 249 ha (4.6% of the total 2015 area) were developed using cut-fill methods, 5148 ha remain a traditional orchard surrounded by coppice forests. Vegetation surveys and a two-way indicator species analysis revealed that traditional orchards had more native species and a higher plant diversity index. Cut-fill orchards contained a higher proportion of alien species; however, the degree depended on parcel history and management. Overall, this area remains a dynamic mosaic landscape containing a core of long-standing Ume orchards. We suggest that biodiversity conservation in this area should focus on conservation measures such as indirect land-use regulations, including some acceptable landform transformations, to promote continued farming of this ecologically important area.

Keywords: GIAHS; parcel dynamics; agroecosystems; satoyama; dynamic landscape conservation; anthropogenic landform transformation; energy use; Anthropocene

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Minabe-Tanabe ***Ume*** System: Location

Climate Type: Temperate and rainy climate
Annual average temperature: 16.6℃
Annual precipitation: 2000mm or more

What is ***UME***?

Processing

Ume
(Prunus mume,Japanese apricot)

Umeboshi
(Ume pickled)

Ume :Daily basis as Japanese side dish

Ume

Pickling

Sun drying

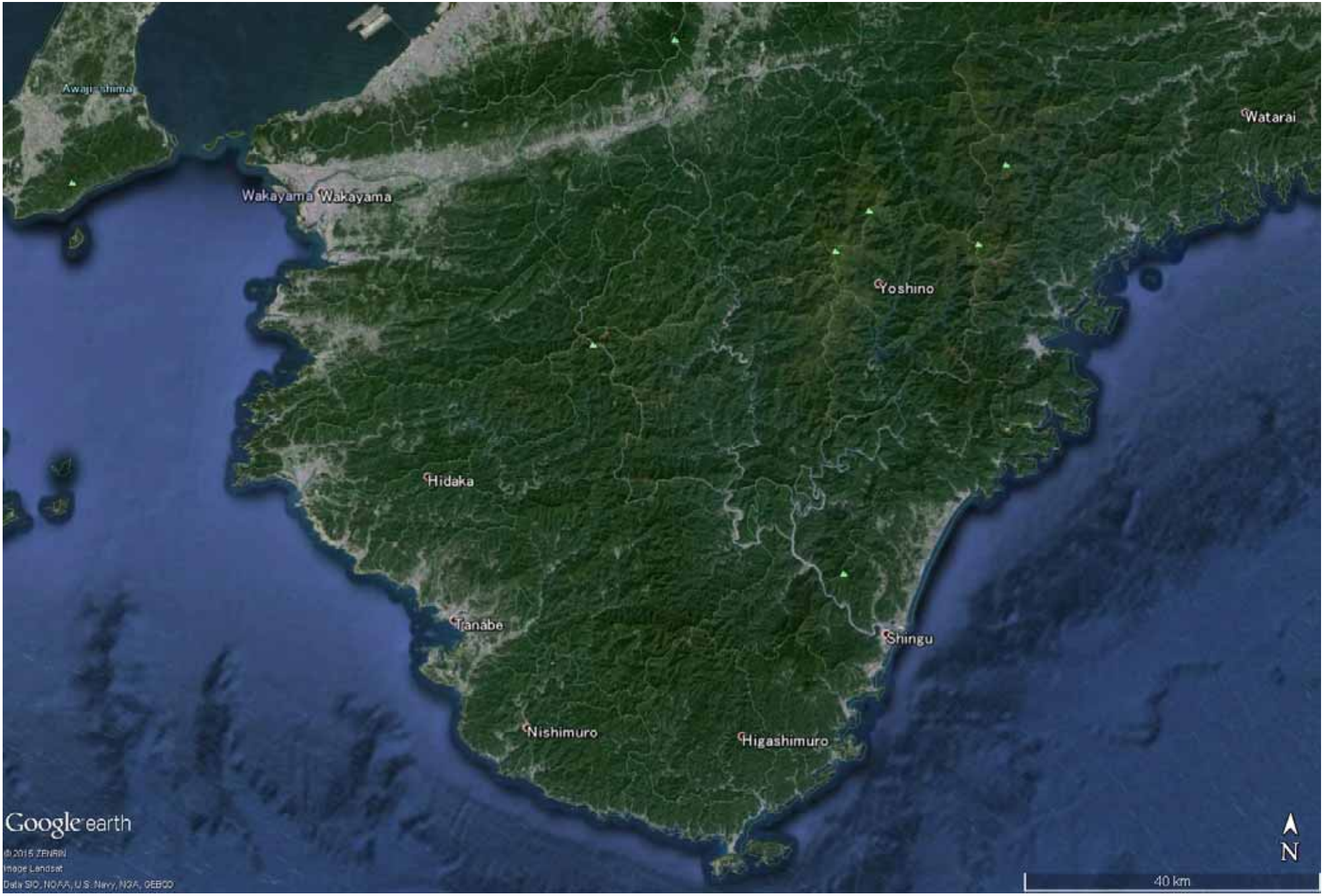
Desalting

Flavoring

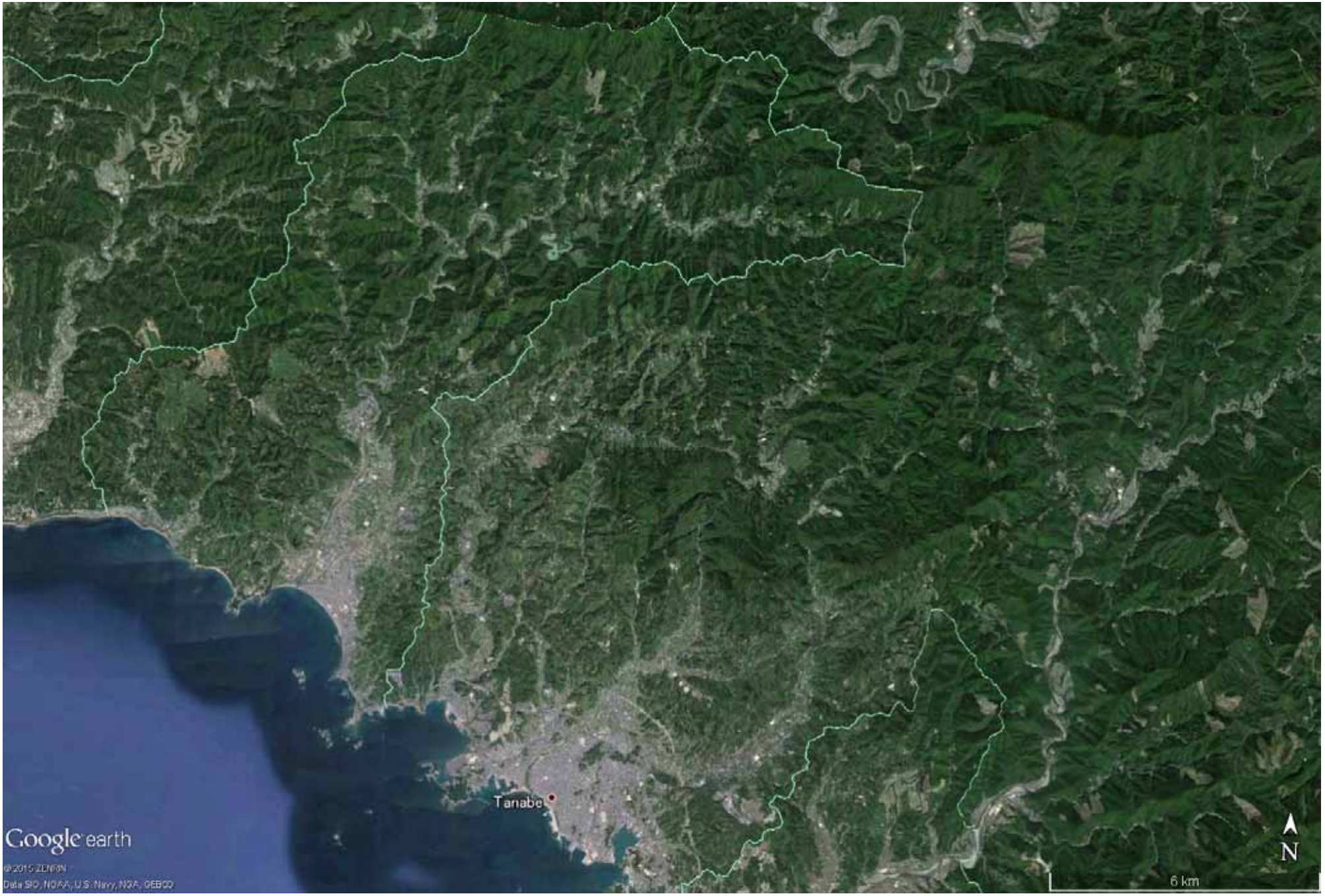
Umeboshi

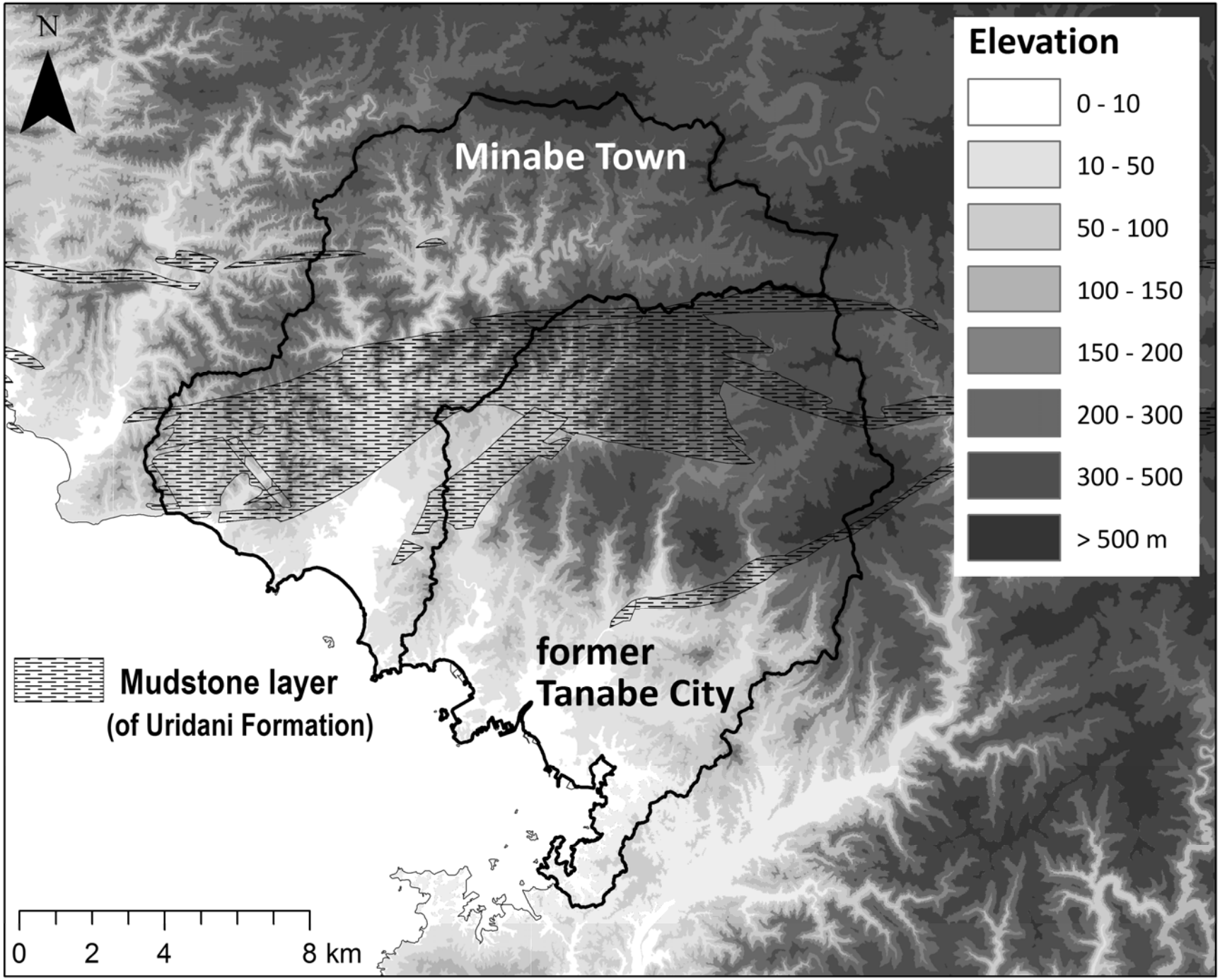
A uniquely Japanese processed food,Umeboshi

Kii peninsula



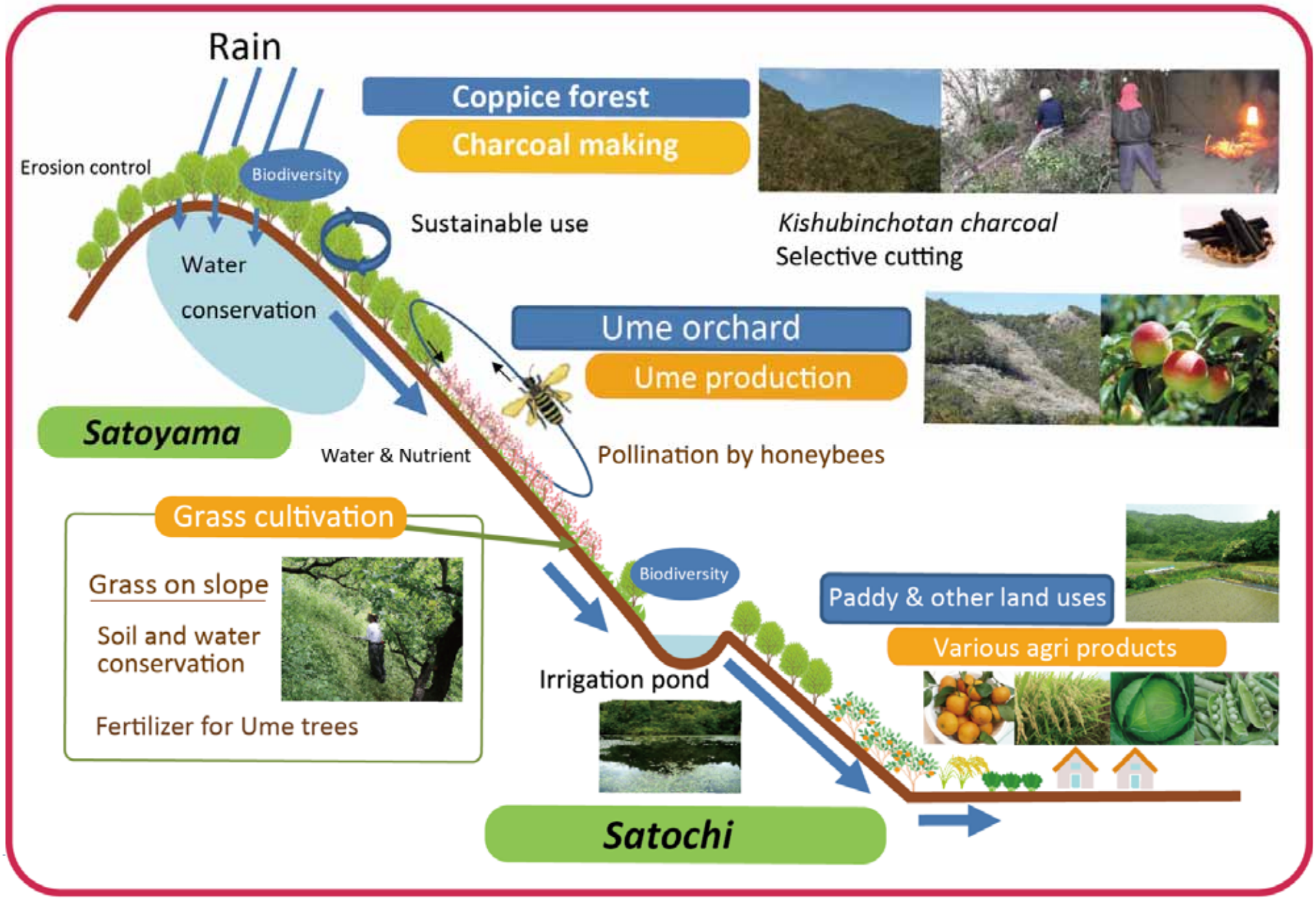
Minabe-Tanabe area





- Steep coastal terrace landform with fragile mudstone geology

Schematic transect image model in GIAHS application



- Traditional model Ume system

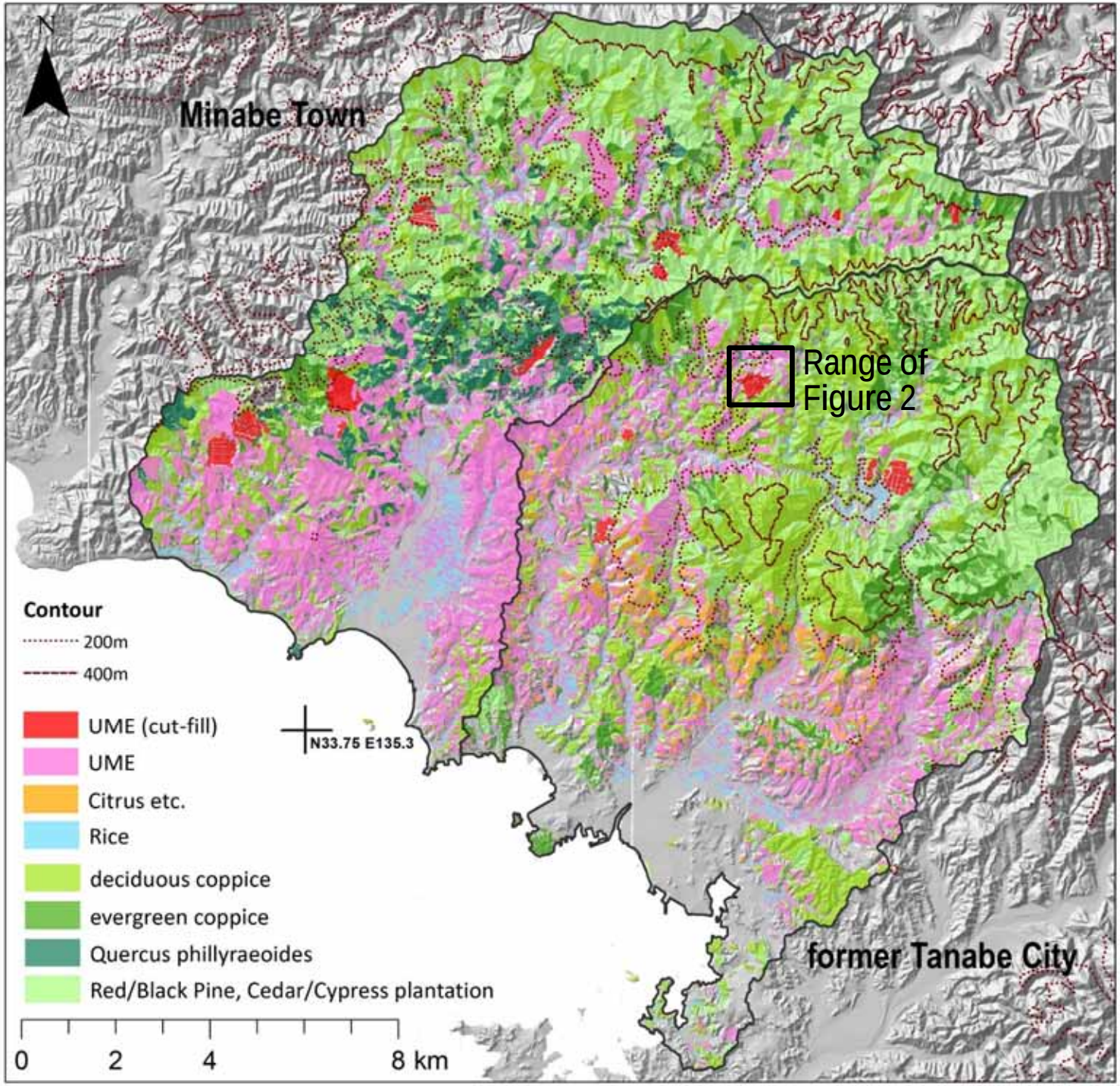
- Also parcel based vegetation subject to succession management and abandonment

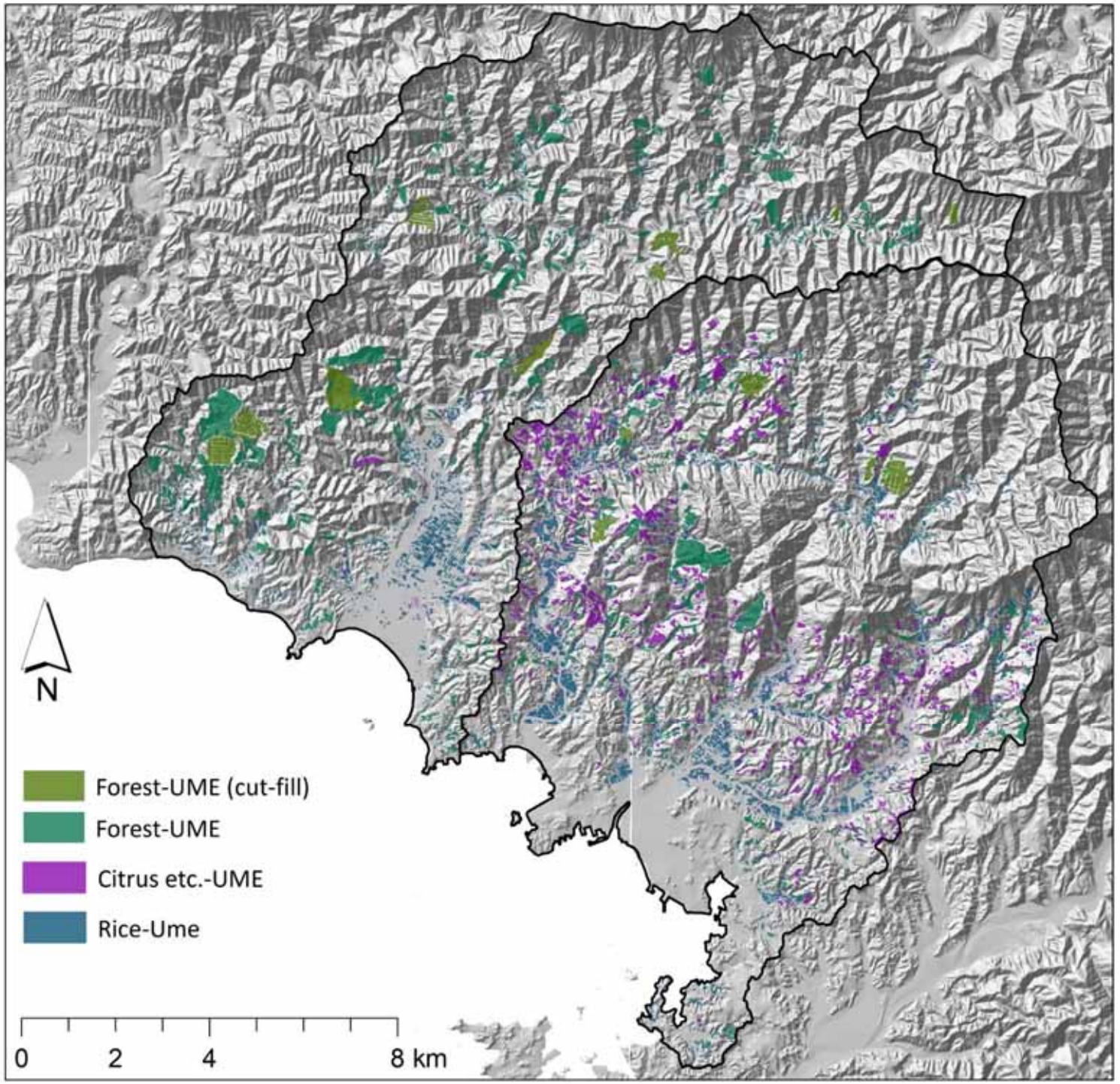
Forest-Ume ecotone providing various nectar sources

- Ume flowering season (Feb.)


後世に残そう！
「みなべ・田辺の梅システム」

- Cut-Fill: Parcel based vegetation with windbreak hedges


N
Minabe Town
Range of Figure 2
Contour
200m
400m
UME (cut-fill)
UME
Citrus etc.
Rice
deciduous coppice
evergreen coppice
Quercus phillyraeoides
Red/Black Pine, Cedar/Cypress plantation
N33.75 E135.3
0
2
4
8 km
former Tanabe City

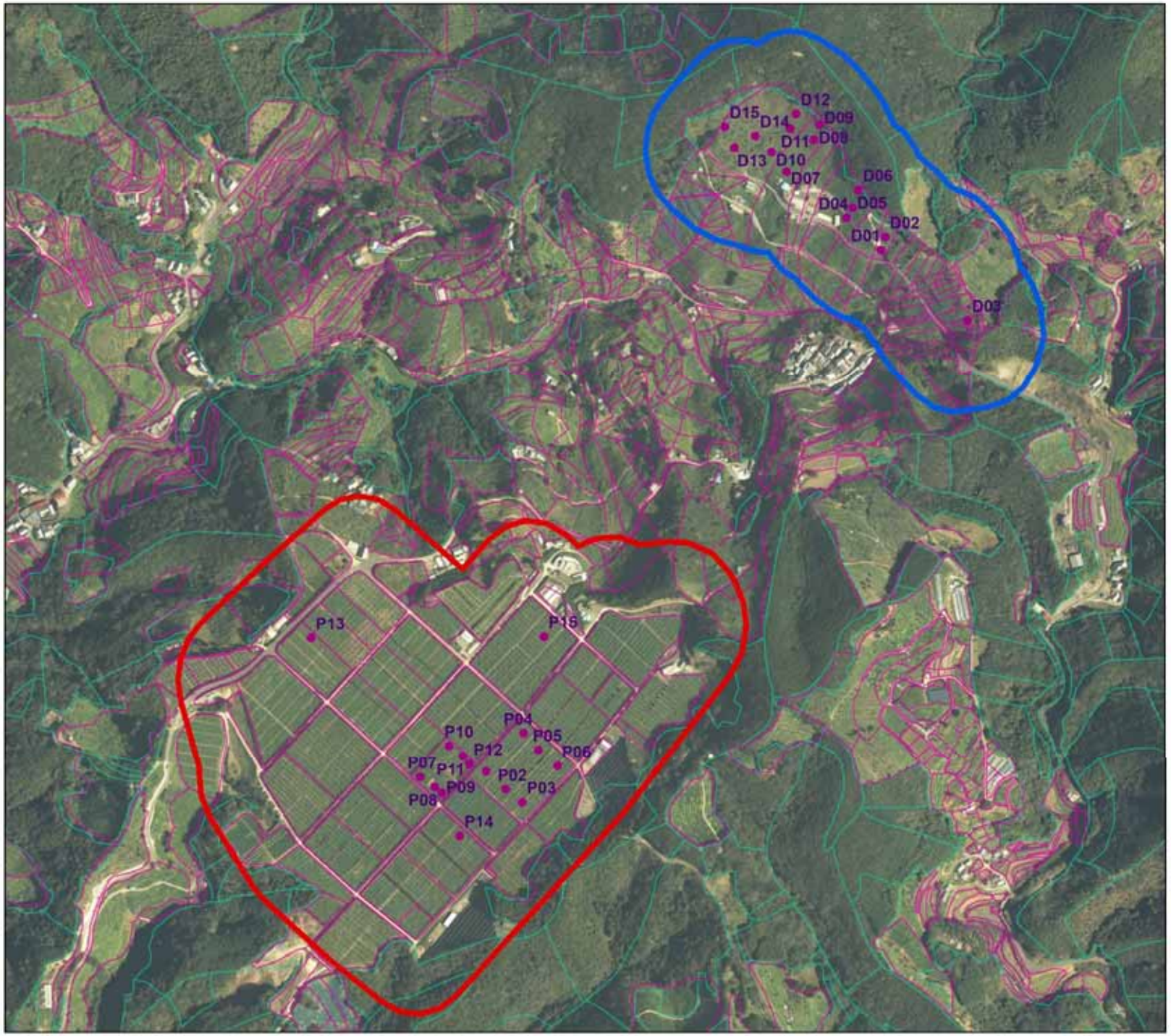


- Parcel based land-use change map between 1974 and 2015

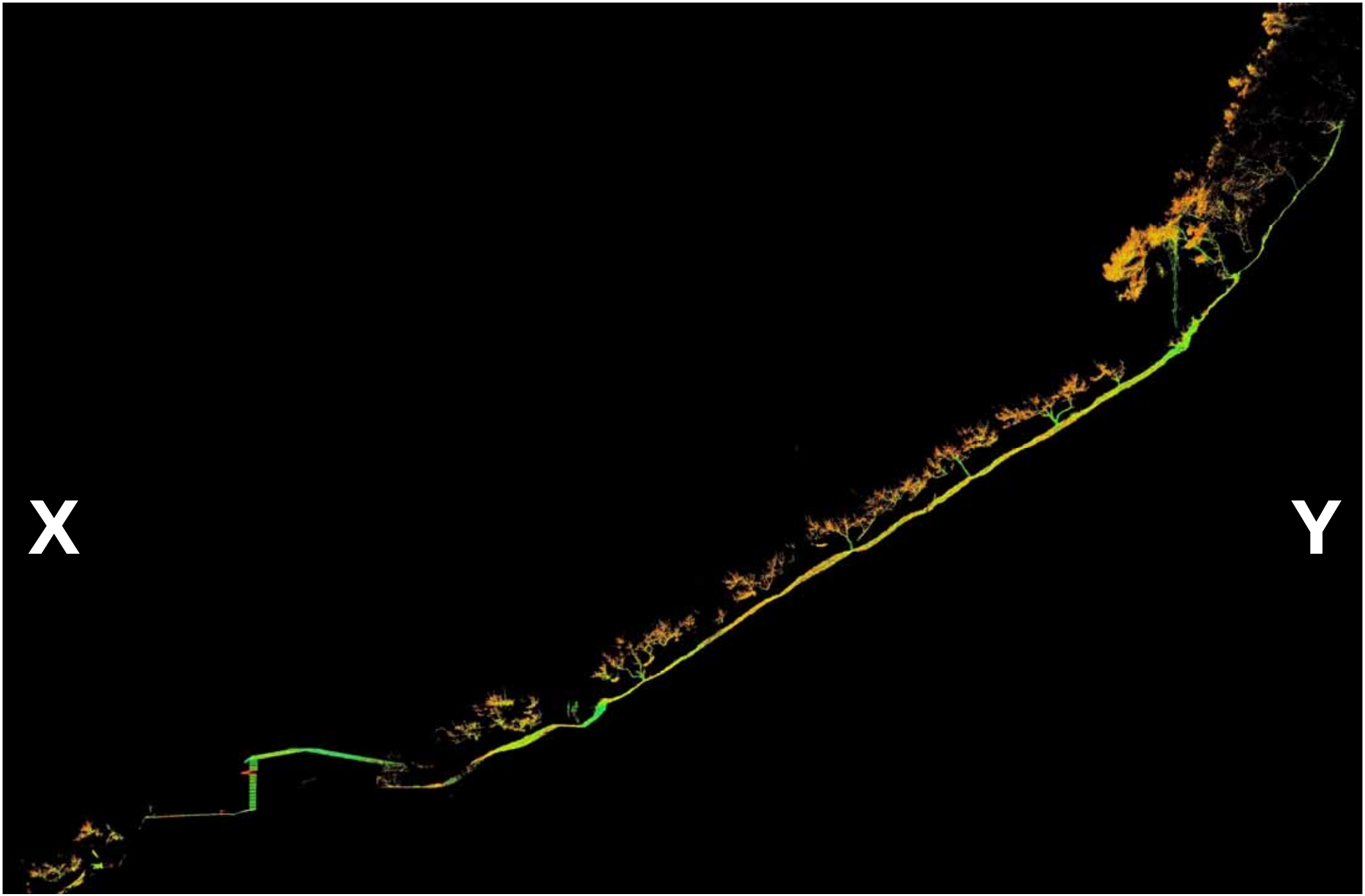
	2015						
1974	UME (cut-fill)	UME	Citrus etc.	Rice	Forest	uninterpretable	Total
UME (cut-fill)	0	0	0	0	0	0	0
UME	5.8	3027.6	27.0	0	0	29.2	3089.7
	(1461)	(1765)	(975)			(1727)	(1482)
Citrus etc.	0	598.7	421.9	0	0	18.7	1039.4
		(1833)	(1739)			(1102)	(1786)
Rice	0.1	579.5	9.0	453.8	0	4.3	1046.7
	(1187)	(785)	(636)	(639)		(1102)	(870)
Forest	242.9	905.6	15.9	0	0	41.2	1205.5
	(4291)	(2951)	(1786)			(5570)	(3649)
uninterpretable	0	36.6	5.7	5.4	0	1.3	49.0
		(890)	(1415)	(556)		(956)	(954)
Total	248.8	5148.1	479.4	459.2	0	94.8	6430.3
	(2313)	(1645)	(1310)	(597)		(2228)	(1619)

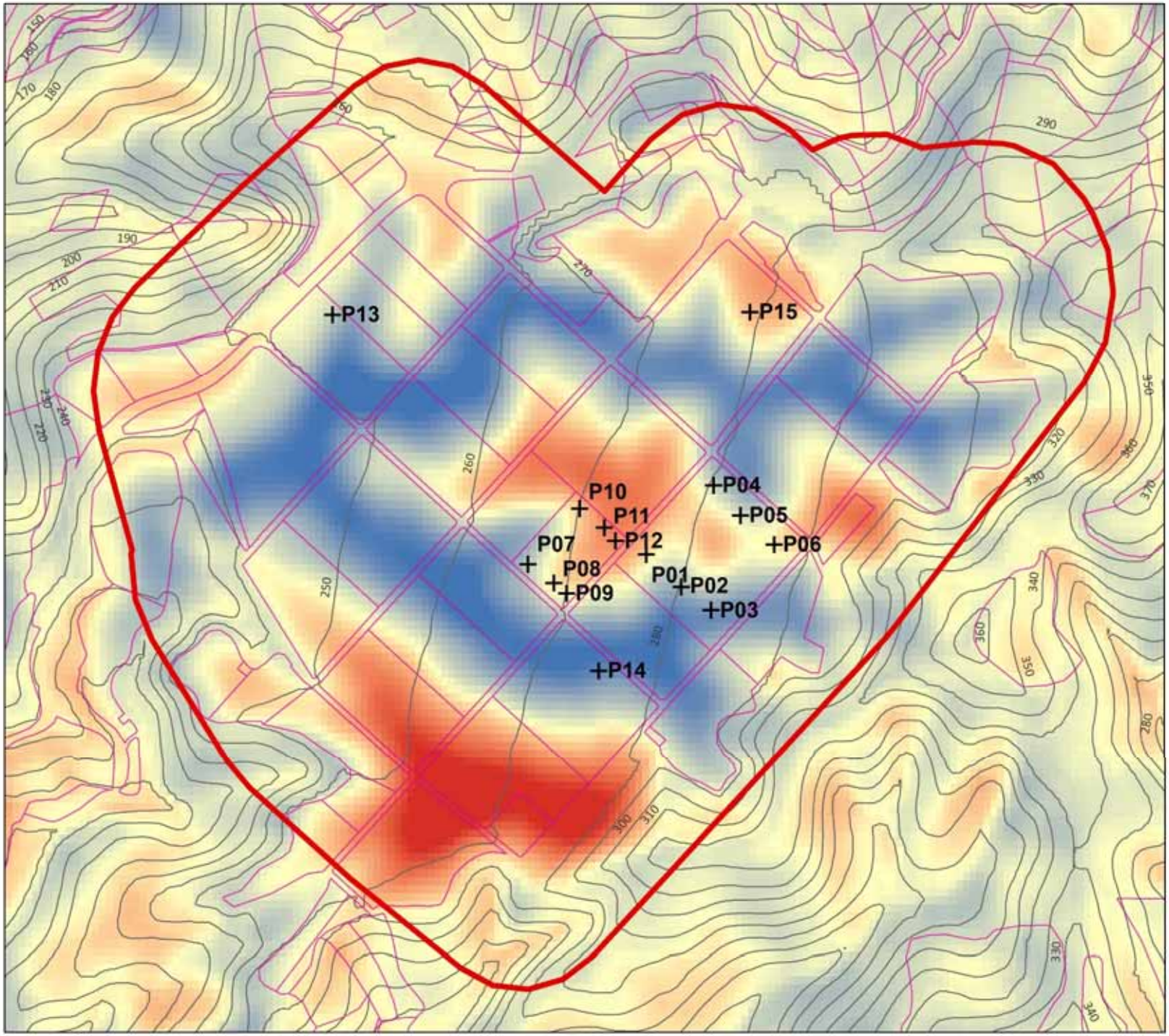
Cross table of area (in hector) altered between 1974 and 2015.

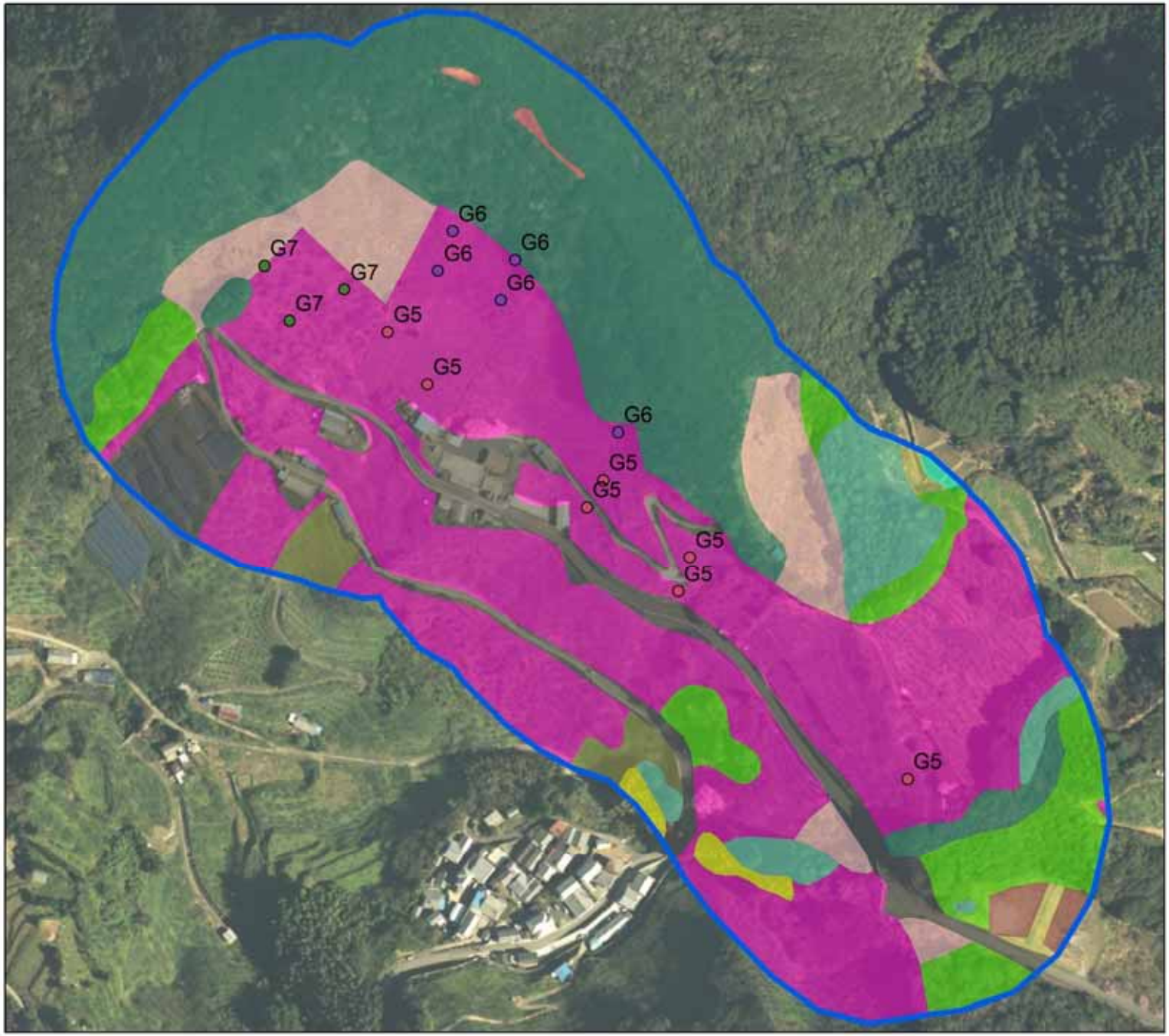
- Number in parenthesis is an average parcel size in square meter.

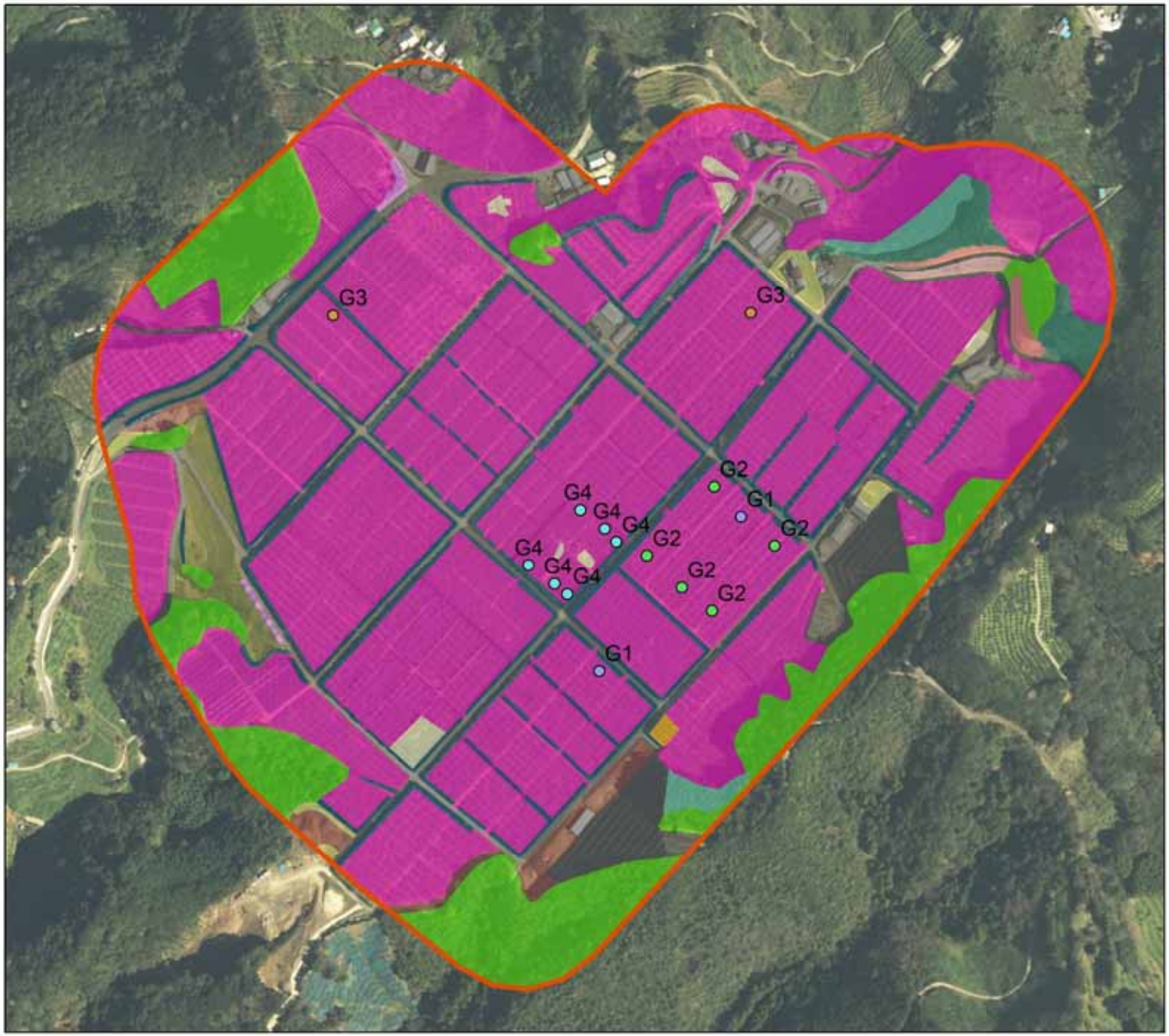

D12
D15
D14
D09
D11
D08
D13
D10
D07
D06
D04
D05
D02
D01
D03
P13
P15
P04
P10
P05
P12
P06
P07
P11
P02
P09
P03
P08
P14
N
0
100
200
400 m
Vegetation survey area
Traditional UME orchard
Cut-fill UME orchard
Grass species survey plot (1m×1m)
Agricultural land parcel
Forest land parcel


350m
Y
D12
D15
D11
D14
D13
D10
300m
D07
286m
X'
N
0
20
40
80 m
1m-interval contour line


X
Y


P13
P15
P10
P11
P12
P07
P08
P09
P01
P02
P03
P04
P05
P06
P14
N
0 50 100 200 m
Grass species survey plot (1m×1m)
Contour (10m-interval)
Agricultural land parcel
Elevation change
Fill : 34.4626
Cut : -57.5823


G6
G7
G6
G6
G7
G6
G7
G5
G5
G6
G5
G5
G5
G5
G5
coppice (Quercus glauca/Castanopsis cuspidata etc.)
Quercus phillyraeoides
pioneer shrub (Clerodendrum trichotomum/Mallotus japonicus etc.)
Cedar/Cypress plantation
bamboo grove
tall grass (Miscanthus sinensis/Fallopia japonica etc.)
short grass (Artemisia princeps etc.)
Ume orchard
rice field
artificial land cover
artificial bareland
natural bareland
TWINSPAN Grouping
G1
G2
G3
G4
G5
G6
G7
N
0
100
200
400 m



coppice (Quercus glauca/Castanopsis cuspidata etc.)

Quercus phillyraeoides

pioneer shrub (Clerodendrum trichotomum/Mallotus japonicus etc.)

Cedar/Cypress plantation

planted ornamental trees (Japanese cherry etc.)

tall grass (Miscanthus sinensis/Fallopia japonica etc.)

short grass (Artemisia princeps etc.)

Ume orchard

other orchards (citrus etc.)

hedge (Photinia glabra/Podocarpus macrophyllus etc.)

dry field

artificial land cover

artificial bareland

natural bareland

TWINSPAN Grouping

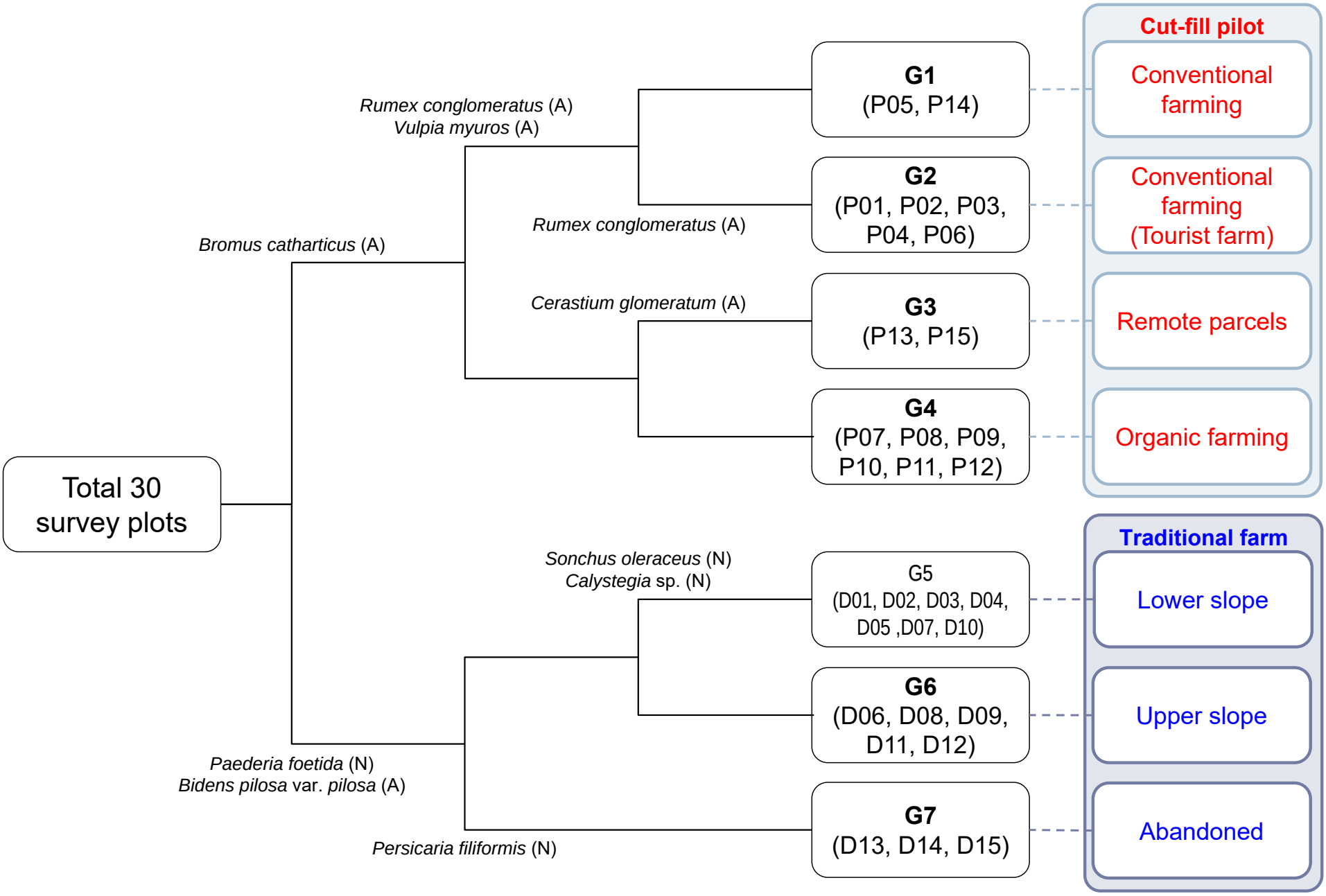
- G1
- G2
- G3
- G4
- G5
- G6
- G7

N

0 100 200 400 m

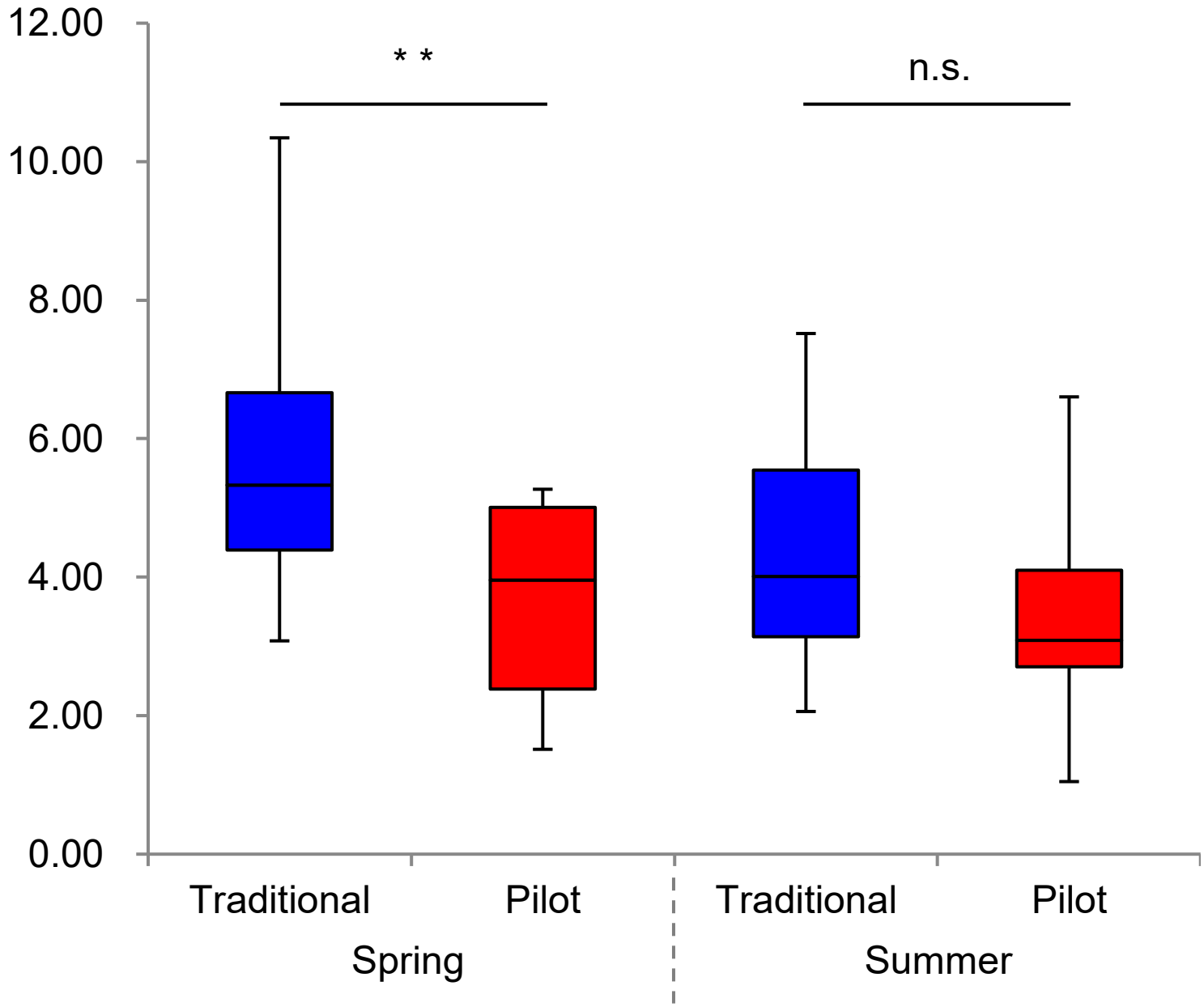
分類順※1	科名	種名	学名	パイロットファーム															伝統的梅林													備考※2
				P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14	P15	D01	D02	D03	D04	D05	D06	D07	D08	D09	D10	D11	D12	D13	D14	D15	
1	フサシダ	カニクサ	*Lygodium japonicum*																●														
2	コバノイシカグマ	ワラビ	*Pteridium aquilinum* var. *latiusculum*																		●						●					●	●	
3	チャセンシダ	トラノオシダ	*Asplenium incisum*																●			●	●											
4	イラクサ	カラムシ	*Boehmeria nivea* var. *concolor*																●					●								●		
5	タデ	ミズヒキ	*Antenoron filiforme*																												●	●	●	
6		イシミカワ	*Persicaria perfoliata*																														●	
7		イタドリ	*Reynoutria japonica*												●				●		●	●	●							●			●	
8		スイバ	*Rumex acetosa*	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●		●				●			●	●		
9		ナガバギシギシ	*Rumex crispus*	●	●	●	●		●									●																外来種
10		ギシギシ	*Rumex japonicus*				●		●									●																
11	ナデシコ	オランダミミナグサ	*Cerastium glomeratum*	●	●	●	●									●	●	●													●			外来種
12		コハコベ	*Stellaria media*		●	●		●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●			●		●	外来種
13	ヒユ	ヒナタイノコズチ	*Achyranthes bidentata* var. *tomentosa*			●			●		●	●	●	●	●	●			●	●				●		●			●				●	
14	キンポウゲ	ボタンヅル	*Clematis apiifolia*												●			●	●	●		●	●	●	●						●	●		
15		センニンソウ	*Clematis terniflora*																●													●		
16	アケビ	アケビ	*Akebia quinata*																				●									●		
17		ミツバアケビ	*Akebia trifoliata*																													●		
18	ツヅラフジ	アオツヅラフジ	*Cocculus orbiculatus*																			●										●		
19	ケシ	ムラサキケマン	*Corydalis incisa*												●																			
20	ベンケイソウ	コモチマンネングサ	*Sedum bulbiferum*																●			●										●		
21	バラ	キンミズヒキ	*Agrimonia japonica*																													●		
22		ヘビイチゴ	*Duchesnea chrysantha*							●			●					●																
23		ヤブヘビイチゴ	*Duchesnea indica*													●		●																
24		ノイバラ	*Rosa multiflora*																														●	
25		ナワシロイチゴ	*Rubus parvifolius*																														●	
26	マメ	クズ	*Pueraria lobata*																			●												
27		コメツブツメクサ	*Trifolium dubium*														●	●																外来種
28		ヤハズエンドウ	*Vicia angustifolia*	●				●						●		●	●		●		●		●											
29		ナヨクサフジ	*Vicia dasycarpa* var. *glabrescens*														●																	外来種
30		スズメノエンドウ	*Vicia hirsuta*	●		●			●	●	●		●	●	●		●	●	●	●	●	●	●		●				●					
31		カスマグサ	*Vicia tetrasperma*			●														●		●												
32	カタバミ	カタバミ	*Oxalis corniculata*	●	●	●	●		●	●	●	●			●	●		●	●	●	●	●		●			●		●		●			
33		ムラサキカタバミ	*Oxalis corymbosa*																●	●		●		●		●							●	外来種
34		オッタチカタバミ	*Oxalis stricta*								●			●			●																	外来種
35	フウロソウ	アメリカフウロ	*Geranium carolinianum*		●		●	●						●	●		●	●	●									●						外来種
36	ブドウ	ヤブガラシ	*Cayratia japonica*																		●													
37	スミレ	ヒメスミレ	*Viola minor*													●																		
38	セリ	オヤブジラミ	*Torilis scabra*													●				●	●	●		●		●			●		●			
39	サクラソウ	コナスビ	*Lysimachia japonica* f. *subsessilis*																												●			
40	アカネ	ヤエムグラ	*Galium spurium* var. *echinospermon*		●					●			●	●	●	●				●	●	●	●	●	●	●	●	●	●	●			●	
41		ヘクソカズラ	*Paederia scandens*								●	●							●	●	●	●	●	●		●			●	●	●	●	●	
42	クマツヅラ	クサギ	*Clerodendrum trichotomum*																				●			●	●					●		
43	シソ	トウバナ	*Clinopodium gracile*																●	●														
44		ホトケノザ	*Lamium amplexicaule*							●							●				●	●	●	●		●	●		●					
45		ヤブチョロギ	*Stachys arvensis*																●	●	●													外来種
46	ゴマノハグサ	タチイヌノフグリ	*Veronica arvensis*	●				●		●			●	●			●		●	●		●									●			外来種
47		フラサバソウ	*Veronica hederifolia*																●	●														外来種
48		オオイヌノフグリ	*Veronica persica*		●	●			●	●	●	●	●			●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	外来種
49	オオバコ	オオバコ	*Plantago asiatica*													●																		
50	キク	ヨモギ	*Artemisia indica* var. *maximowiczii*	●	●	●	●	●	●					●				●		●	●	●												
51		コセンダングサ	*Bidens pilosa*																							●	●		●	●		●	●	外来種
52		ヒメムカシヨモギ	*Erigeron canadensis*	●															●	●		●	●	●		●			●					外来種
53		チチコグサモドキ	*Gnaphalium pensylvanicum*																			●												外来種
54		ブタナ	*Hypochoeris radicata*					●																										外来種
55		オオヂシバリ	*Ixeris debilis*																●	●				●										
56		ヨメナ属の一種	*Kalimeris* sp.																●		●										●		●	
57		アキノノゲシ	*Lactuca indica*																	●														
58		フキ	*Petasites japonicus*																		●													
59		ノゲシ	*Sonchus oleraceus*		●				●	●	●	●		●					●	●		●			●									
60		ヒメジョオン	*Stenactis annuus*							●	●	●		●		●		●		●						●				●				外来種
61		シロバナタンポポ	*Taraxacum albidum*		●																													
-		タンポポ属の一種	*Taraxacum* sp.				●																											
62		オニタビラコ（広義）	*Youngia japonica*										●			●		●	●			●	●											
63	ユリ	ノビル	*Allium grayi*						●										●		●	●			●			●			●	●		
64		ジャノヒゲ	*Ophiopogon japonicus*																			●	●											
65	イグサ	スズメノヤリ	*Luzula capitata*	●																											●			
66	ツユクサ	ツユクサ	*Commelina communis*			●										●			●	●	●	●	●	●		●	●		●		●	●	●	
67	イネ	アオカモジグサ	*Agropyron racemiferum*					●																										
68		カモジグサ	*Agropyron tsukushiense* var. *transiens*	●			●		●												●													
69		ヌカボ	*Agrostis clavata* ssp. *matsumurae*	●																														
70		ヒメコバンソウ	*Briza minor*				●																											外来種
71		イヌムギ	*Bromus catharticus*	●	●	●			●	●	●	●	●	●	●	●				●														外来種
72		トボシガラ	*Festuca parvigluma*																●												●	●	●	
73		ススキ	*Miscanthus sinensis*																												●	●		
74		ミゾイチゴツナギ	*Poa acroleuca*																●	●		●	●										●	
75		スズメノカタビラ	*Poa annua*	●		●			●	●	●		●		●	●	●	●		●		●			●						●			
76		カニツリグサ	*Trisetum bifidum*											●	●																			
77		ナギナタガヤ	*Vulpia myuros*	●	●	●	●	●									●	●											●					外来種
78	カヤツリグサ	メアオスゲ	*Carex candolleana*													●																		
79		マスクサ	*Carex gibba*																												●			
-		スゲ属の一種	*Carex* sp.																			●												
種類数合計			31科79種類	15	13	14	11	9	14	13	12	9	11	14	13	18	13	17	30	26	20	29	16	16	7	12	8	8	10	6	27	14	17	外来種：20種類

※1 種名および学名、種の配列は原則として「河川水辺の国勢調査のための生物リスト-平成29年度版-(水情報国土データ管理センター、2017年10月12日)」に従った。
※2 外来種：江戸時代末期以降に外国から侵入し、日本に定着した種類（新帰化植物）のうち、以下の文献により証拠が比較的明確な種類。
・清水建美編（2003）日本の帰化植物．平凡社．
・清水矩宏・森田弘彦・廣田伸七（2001）日本帰化植物写真図鑑．全国農村教育協会．
・植村修二・勝山輝男・清水矩宏・水田光雄・森田弘彦・廣田伸七・池原直樹（2010）日本帰化植物写真図鑑第2巻．全国農村教育協会．



N: native species; A: alien species

Tree diagram structure of TWINSPAN results



**: p<0.01; *: p<0.05; n.s.: Not significant

Summary of our vegetation survey

- Tree species
  - Cut-fill has windbreak hedge trees functioning nectar sources
  - Traditional has upper forest with various coppice trees especially along the ecotone border with Ume
- Grass species
  - Both cut-fill and traditional have grass species compositions basically according to parcel managements
  - Considerable alien species were investigated especially in cut-fill that were introduced by local governmental guideline for soil erosion prevention and fertilization when cut-fill development was carried out (1995-2005)
  - Parcels (using former forest topsoil) managed by farmers with strong wills toward organic farming tended to have higher species varieties
  - Parcels becoming abandoned had higher native potential species compositions

Balancing traditional and modern cut-fill

- There is an increasing trend toward large-scale anthropogenic cut-fill land developments, which promote efficient Ume cultivation and are becoming core sites of production
- Nevertheless, large areas continue to function as traditional slope-type Ume orchards with surrounding coppice forest, providing major landscape components
- Our vegetation survey in sample traditional and cut-fill Ume orchards revealed that traditional orchards have more native species and higher plant diversity indexes, owing to their varied topography and parcel management history
- Cut-fill orchards had a considerable amount of alien species, but the degree depended on land parcel history and individual land management practices

Balancing traditional and modern cut-fill

- Overall, this area has not experienced any one-way land-use change toward extensive and abandonment until now; instead, it remains a dynamic mosaic landscape with a core of long-standing Ume orchards, which provide ecosystem services in the form of plant species diversity across the area
- Based on these results, we suggest that biodiversity conservation in this area should focus not on direct protection of specific species and/or places, with probably higher socioeconomic costs, but on dynamic landscape conservation measures such as indirect land-use regulations and incentives
- Such measures, in consideration of balancing traditional and modern agricultures, can be applicable to other existing and candidate GIAHS sites in the world

Ongoing challenges

- Drone image (acquired on 26 November 2020) showing unexpected sudden landslide in the traditional site occurred on 23 April 2020 as well as recent emerging solar panel on abandoned parcel

Thank you for your attention!