Twenty-Fourth Annual ESRI International User Conference

Development of Software Tools for Making Environment Map Using ArcGIS

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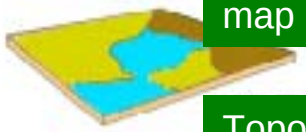
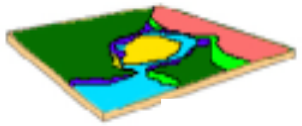
Work flow for creating ecotope maps

Environmental base maps

Vegetation map



Topographical map



Vegetation map + Topographical map

The vegetation map and the topographical map are overlaid with each other in the GIS to produce an ecotope map, which shows the relationship between them.

Describing the habitats in ecotopes, and showing the relationships between vegetation maps and topographical maps.

Landscape	Vegetation	Plants	Animals
Hills	quercus serrata	quercus serrata, viburnum s sawtooth oaks	great tits, beetles, stag beetles
	Japanese cedars	Japanese cedars, tucum	flycatchers, cicadas
	.	.	.
	.	.	.
Tablelands	pampas grasses	pampas grasses, squawroots	locusts, larks
	kudzu vines	kudzu vines, catchweeds	locusts, harlequin bugs
	.	.	.
	.	.	.
Haugh	phragmites	phragmites, Indian rice, bur reeds	flycatchers, leaf beetles
.	.	.	.
.	.	.	.

Extracting typical ecosystems in local areas.

Available in GIS

Uses of ecotope maps

- Examining ecosystems for environmental impact assessments (Reported by a working group in the Japanese Environment Agency)
- Maintaining green space in large “infrastructure sites” such as factories or power plants, and focusing on protecting the variety of habitats
- Environmental revitalization projects
- Assessing or evaluating local landscapes/ Environmental protection education
- Ecological networking projects / Creating green belts
- Other environmental issues

Problems in using GIS for ecological impact assessments

1 . Data Preparation

- Limited data for GIS (topographical maps or vegetation maps, etc.)
- Need to prepare base maps or aerial photos on your own
- Large workload and time needed to overlay data

2 . Creating ecotope layers

- Produce many unnecessary polygons when overlaying maps.
- Large effort needed to remove errors and improve overlay

3 . Estimation / Evaluation

- Estimate and input locations (point data) of local plants or animals
- Estimate potential impacts on ecotopes by construction areas / also calculating the areas of the ecotopes
- Require much time and effort to input the locations, estimate the impacts, or calculate the areas

EcoGIS is an extension program for ArcGIS.

- EcoGIS overview -

★Creation of ecological data sets

- Supports geo-referencing of scanned paper maps (topographical / vegetation) and scanned aerial photos for overlay
- Supports the input of lines, polygons, and attributes
- Users can create ecological data sets much more easily than before.

★Creation of ecotope maps

- Create ecotope maps by overlaying data sets (such as topographical or vegetation) with each other
- Apply original algorithms developed by CRIEPI for operations integrating polygons, and other processing
- Requires only a short time to create the ecotope maps

★Ecology impact assessments and evaluations

- Supports the input of existing location data (point data) of local habitats
- Estimating local habitats/ Creating potential ecotope areas affected by construction
- Easily compare planned construction areas with local habitats and ecotopes.

Example of using EcoGIS for environmental impact assessment

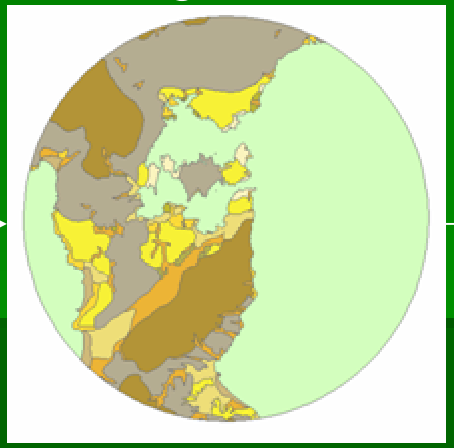
- Siting a thermal power plant.
- In a conventional method, we create thematic maps for landscapes, soils, and vegetation for a radius of 30 kilometers (km) around the location of the power plant.
- Creating GIS data through conversion of the (paper based) landscape, soil and vegetation maps described above.
- Creating an ecotope data set using our original software, EcoGIS.
- Extract typical ecosystems within the 30km radius of the proposed power plant site.
- Enable quantitative assessments to be made.

Scanning paper maps

Creating GIS data

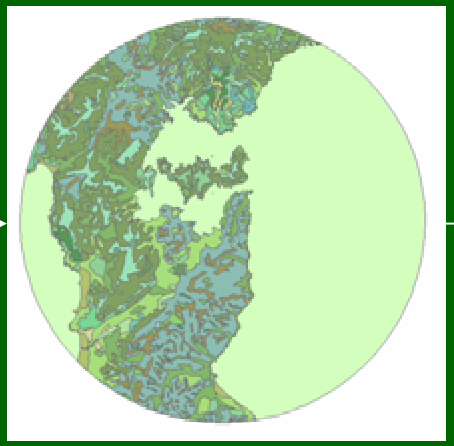
topographical maps

digitized

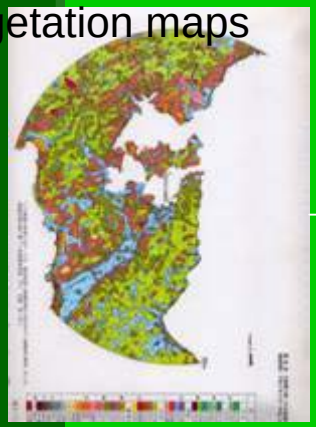


soil maps

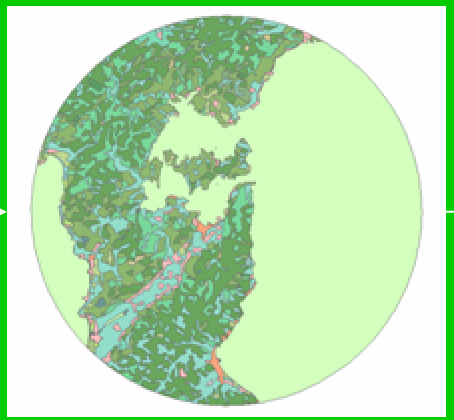
digitized



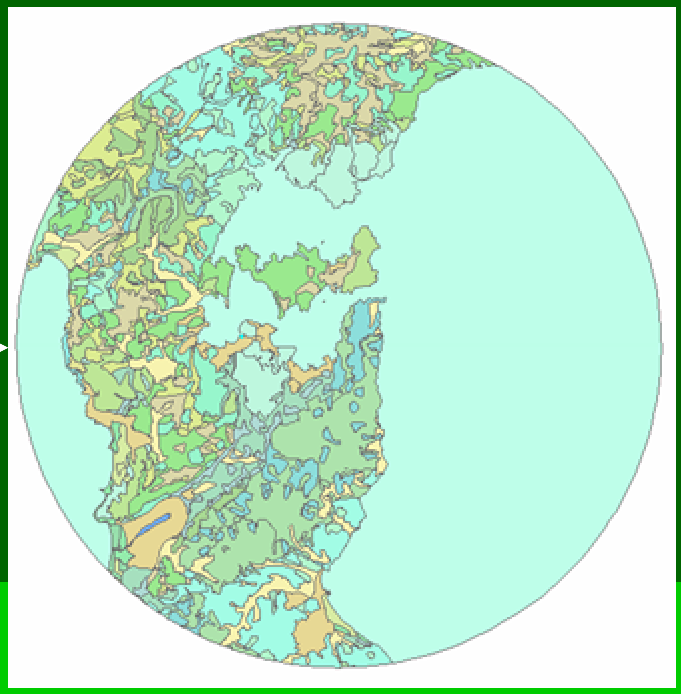
vegetation maps



digitized



overlay these thematic data sets on top of each other



Ecotope map

Example of using EcoGIS for maintaining green spaces

- Target: Green spaces or parks within the facilities of power plants or factories
- Green spaces for landscaping is the mainstream. Most green spaces are maintained in a similar fashion.
- Producing ecotope maps for the green spaces to discuss better methods for maintaining them focusing on protecting the variety of habitats.
- Using the CRIEPI Abiko office as an example.
- Creating thematic maps such as topographical maps and vegetation maps, and then producing GIS data sets.
- Creating ecotope data sets using our original software, EcoGIS.
- EcoGIS is available for a variety of environments, enables to discuss relevant methods for maintaining them and providing more varieties with them.
- Overlaying not only vegetation data but also animal distribution data; facilitates better discussion for protection and management.

Objectives of EcoGIS

EcoGIS is an extension program of ArcGIS.

- Reduces workloads for creating soil and vegetation data.
  - Specialized for producing polygon data.
- Automated overlay
  - Removal or correction of “tiny” unnecessary polygons.
- Allows for step by step operations, significantly helping GIS beginners with Ecotope data production.
  - Can be used as introductory, educational GIS software.
- Facilitates a brief evaluation of ecotope data.
  - Assessing potential impacts on ecotope maps due to construction and urban development.
  - Creation of estimated habitat maps.

Creation of environmental base maps (1/2)

Geo-referencing of raster data (scanned maps or images)

Specifying coordinates for those raster data sets

Giving coordinates for polygon shape files/ map projection

Editing polygon data files.

(Creating polygons, modifying attributes)

Quality control check for polygon data files

Creation of environmental base maps (2/2)

- Using ArcView only
  - Geo-referencing raster data
  - Specifying coordinates for data files
  - Creating polygons

  These operations above are being done separately.

  Users require a fair amount of knowledge about ArcView to perform all of these steps.

- Using EcoGIS…

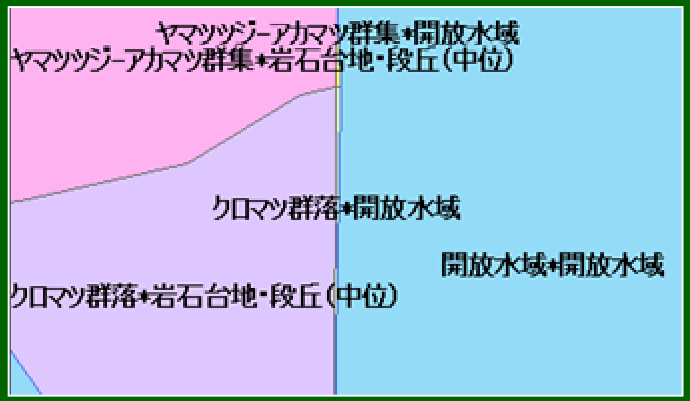
  Each operation can be done in a step by step process.

  Suitable for GIS beginners.

Creating ecotope maps (1/3)

"Ecotope maps" are created by overlaying more than one environmental thematic base map on top of another. "Ecotope maps" retain the characteristics of each of those original thematic base maps.

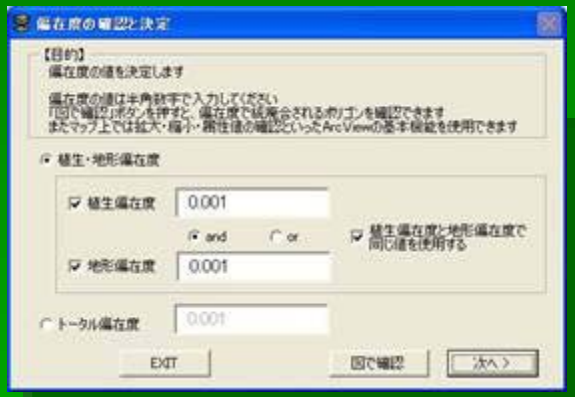
However, when overlaying those environmental thematic base maps directly on top of each other, various boundaries may not match. Matching depends on the accuracy of those original base maps.



- Deviation・・・ A quantification of the difference between the area of an ecotope map and the one of an environmental base map overlaid on top of each other.
- Discriminant analysis・・・ Correct or remove tiny unnecessary polygons.

Creating ecotope maps (2/3)

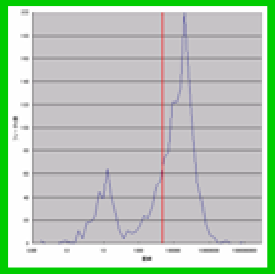
Deviation



Specifying the deviation for vegetation maps, or for topographical maps separately, or specifying the deviation for both (total deviation).

The user can choose to keep the desired features (legends) separate from other features being removed or corrected.

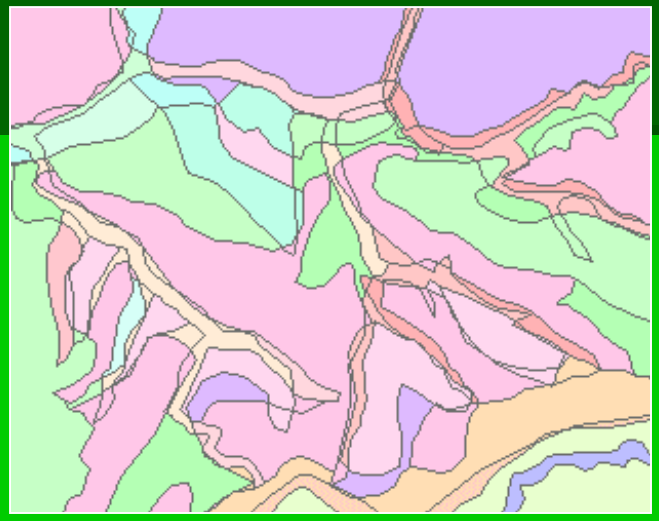
Discriminant analysis



Creating a histogram for the areas of polygons to correct or remove polygons marked less than the border line.

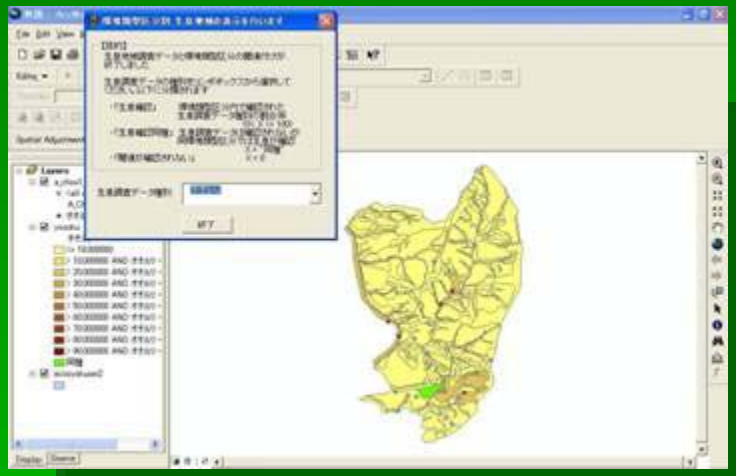
Creating ecotope maps (3/3)

- Using ArcView only
  - A lot of irrelevant ecotopes or tiny unnecessary polygons
  - Fair amount of knowledge about GIS tools is mandatory.



- With EcoGIS…
  - User can create custom ecotope maps by changing parameters according to one's objectives.
  - Facilitates rapid examination of the resulting data

Use of ecotope maps based on user objectives



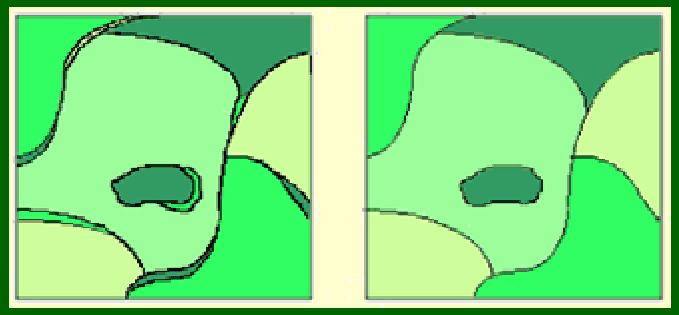
Showing the ratio of one kind of habitat with respect to other habitats.

Areas and ratios of ecotopes being lost due to construction and urban development.

植生区分	地形区分	全調査対象エコトープ	全エコトープ事業地内		一部エコトープ事業地内			全エコトープ事業地外	消失割合
		全エコトープ合計面積	エコトープ数	合計面積	エコトープ数	事業地内面積	事業地外面積	エコトープ数	合計面積	(%)
常緑広葉樹	常緑広葉樹	44	4061.805		2	3539.187	4276.052	42	400365.2	0.867064
スギ・ヒノキ人	スギ・ヒノキ人	14	386.326		1	9950.582	225740.5	13	150634.9	2.575696
モミジ・ケヤキ	モミジ・ケヤキ	49	87002.36		2	1536.895	1768.241	47	83697.22	1.766498
常緑針葉樹	常緑針葉樹	1	56760.01					1	56760.01	0
新植地	新植地	1	49007.04					1	49007.04	0
見本林	見本林	1	33389.9					1	33389.9	0
渓谷林	渓谷林	1	20984.63					1	20984.63	0
苗畑	苗畑	1	10831.48					1	10831.48	0
道路	道路	6	5531.603					6	5531.603	0
マツ林	マツ林	1	292.001					1	292.001	0

How to eliminate unwanted polygon?

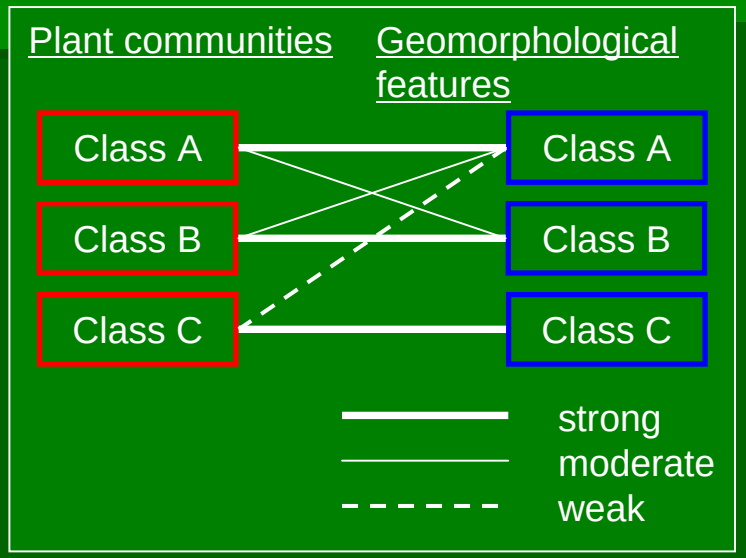
- What is eliminate?
  - Merges unwanted (sliver) polygons with neighboring polygons, by dropping *the longest shared border* between them.
  - Eliminate can be done by ARC/INFO eliminate command



Is this method adequate method for eco-tope mappings?

What is unwanted polygons in ecology?

- Ecological theories???
  - There are relations between environmental factors
  - There are differences in the relational intensity



Relational intensities between environmental factors

- ✓ Quantify the relational intensities for each combination of the environmental factors
- ✓ Define a certain polygon which are recognized as the candidate for elimination

→ **Unwanted polygons**

Eco-tope mapping procedure

Creating vegetation and geomorphological maps

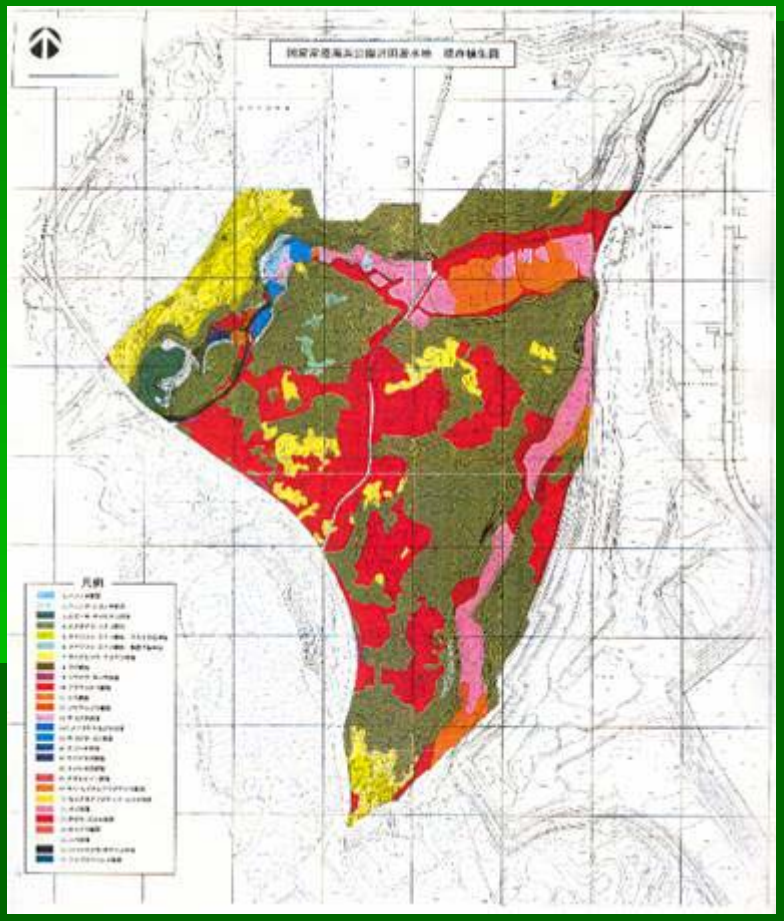
Intersecting vegetation and geomorphological maps

Determination of the overlapping-patterns for each combinations

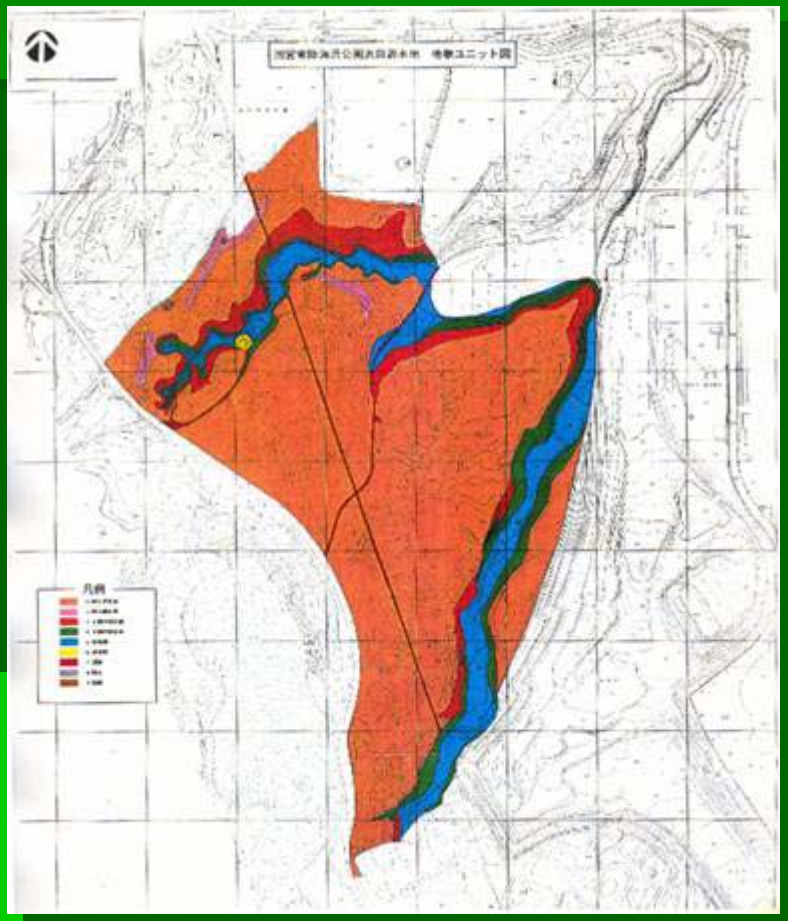
Determination of the unwanted polygons

Determination of polygons (features) which the unwanted polygons will be merged to

Vegetation and Geomorphological mapping



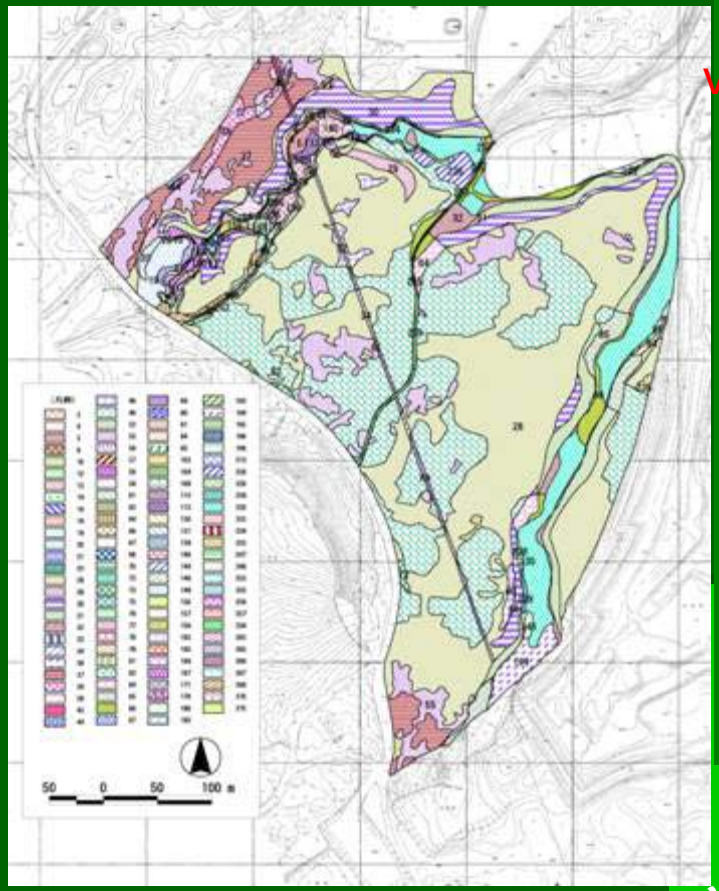
Vegetation map



Topological map

Intersecting vegetation / geomorphological maps

geomorphologic



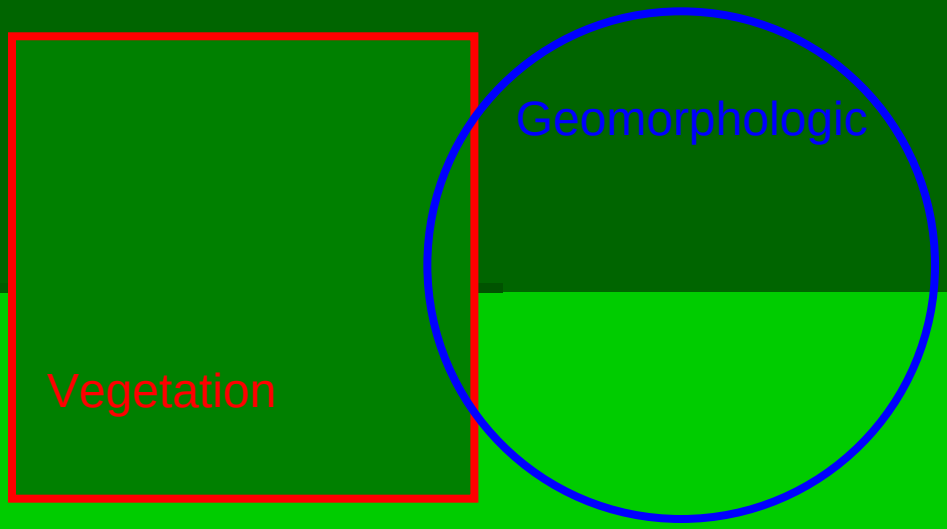
vegetation

		台地面		斜面		谷底面		人工地形		
		砂丘平坦面	砂丘緩斜面	上部谷壁斜面	下部谷壁斜面	谷底流路面		造成地	道路	凹地
落葉広葉樹二次林	イヌザクラ-コナラ群落	1	2	3	4	5	6	7	8	
	エゴノキ-ヤマザクラ群落	9	10	11	12					
	ヤマツツジ-コナラ群落典型下位単位	13		14					15	
	ヤマツツジ-コナラ群落ススキ下位単位	16	17	18					19	20
	ベニシダ-エゴノキ群落	21		22	23	24	25		26	
二次草原	アズマネザサ群落	27		28	29	30	31	32	33	
	チガヤ-ススキ群落	34								
	ヨシ-セイタカアワダチソウ群落	35		36	37	38	39	40	41	
	オギ群落	42		43	44	45	46		47	
	セイタカアワダチソウ-ススキ群落							48		
先駆性低木林	ヤマグワ-ヌルデ群落	49		50	51	52	53	54	55	
林縁性ツル植物群落	フジ群落	56		57	58	59	60		61	
	クズ群落	62			63	64				
路上植物群落	シバ群落	65		66	67	68			69	
	シロツメクサ-オオバコ群落	70			71	72	73	74	75	
常緑針葉樹二次林	ウメガサソウ-アカマツ群落	76	77	78	79	80			81	82
林縁性湿性植物群落	トボシガラ群落			83	84	85	86			
	ツリフネソウ群落				87	88	89			
湿性林	ハンノキ群落			90	91	92	93			
海岸砂丘植物群落	ヤマアワ群落				94	95				
湿性植物群落	チゴザサ群落				96	97				
	エゾノサヤヌカグサ群落				98	99				
	ミズオオバコ群落他					100				
	コツブヌマハリイ群落					101				
	ミソハギ群落				102	103		104		
	チゴザサ-ヨシ群落				105	106	107			
	ウキヤガラ群落				108	109	110			

✓A total of 110 combination was occurred

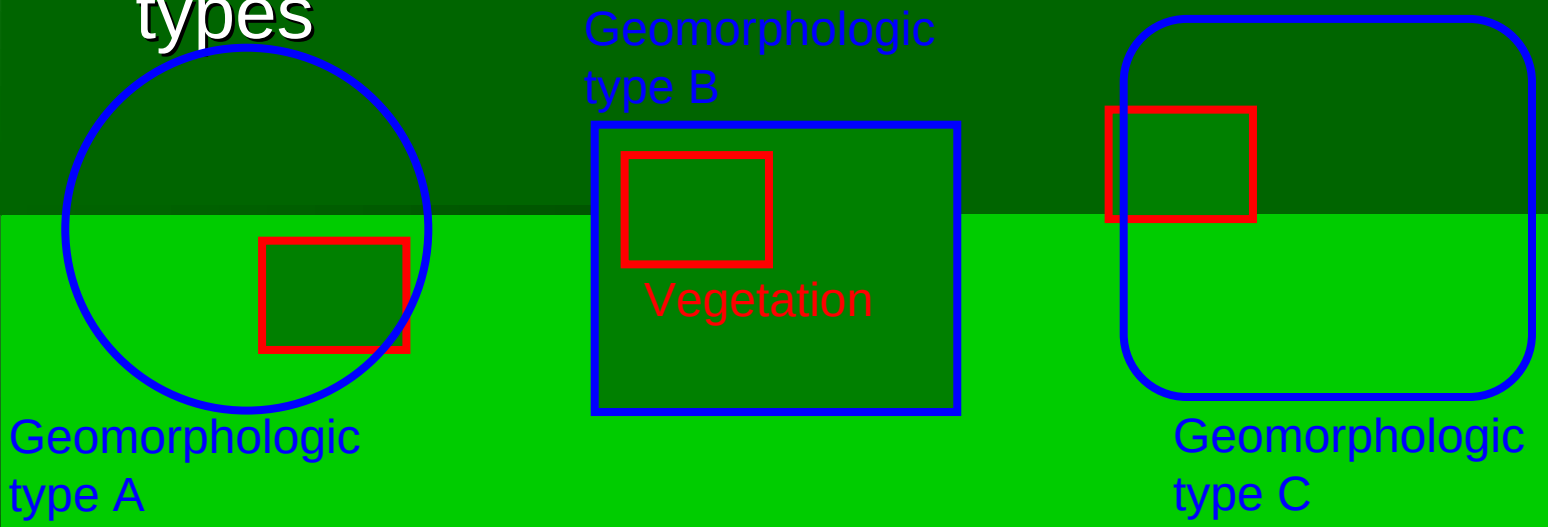
Determination of the overlapping-patterns for each combinations

- Pattern 1
  - Only very small areas are overlaps



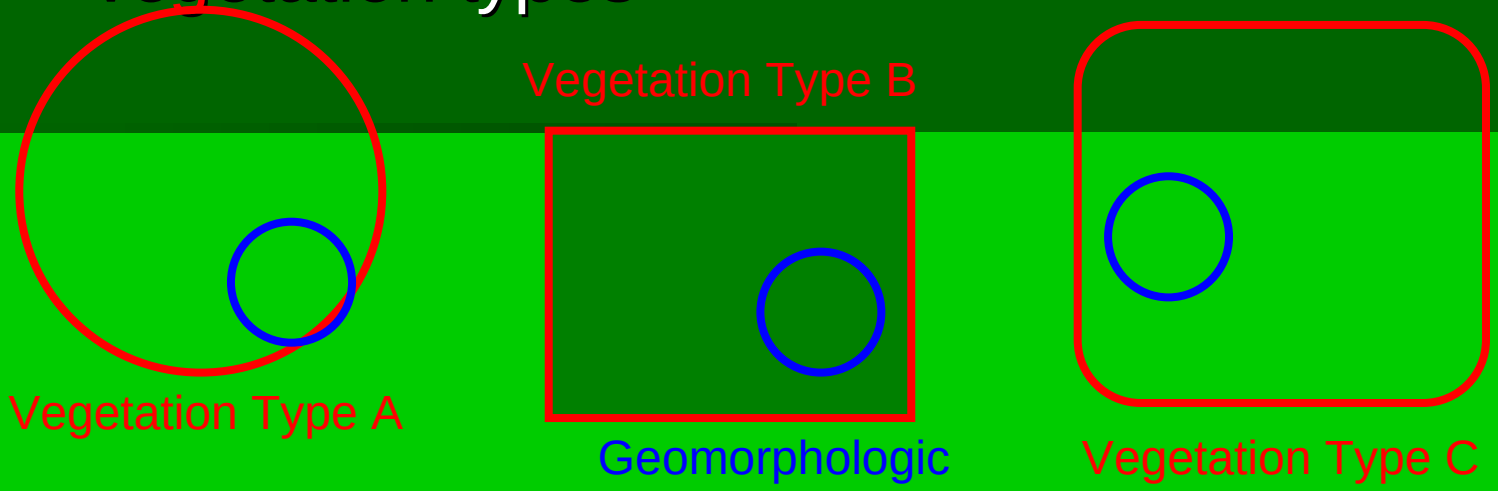
Determination of the overlapping-patterns for each combinations

- Pattern 2
  - One vegetation areas are well overlaps but overlapping in various geomorphological types



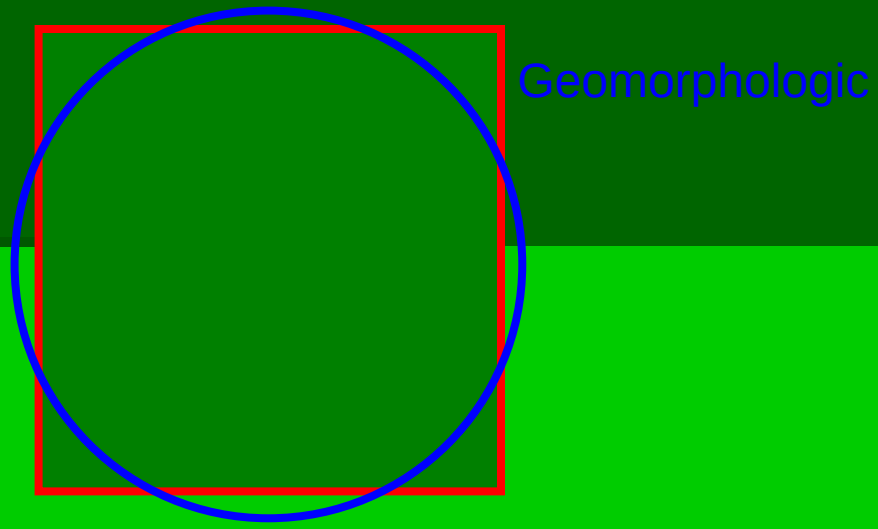
Determination of the overlapping-patterns for each combinations

- Pattern 3
  - One geomorphologic type areas are well overlaps but overlapping in various vegetation types



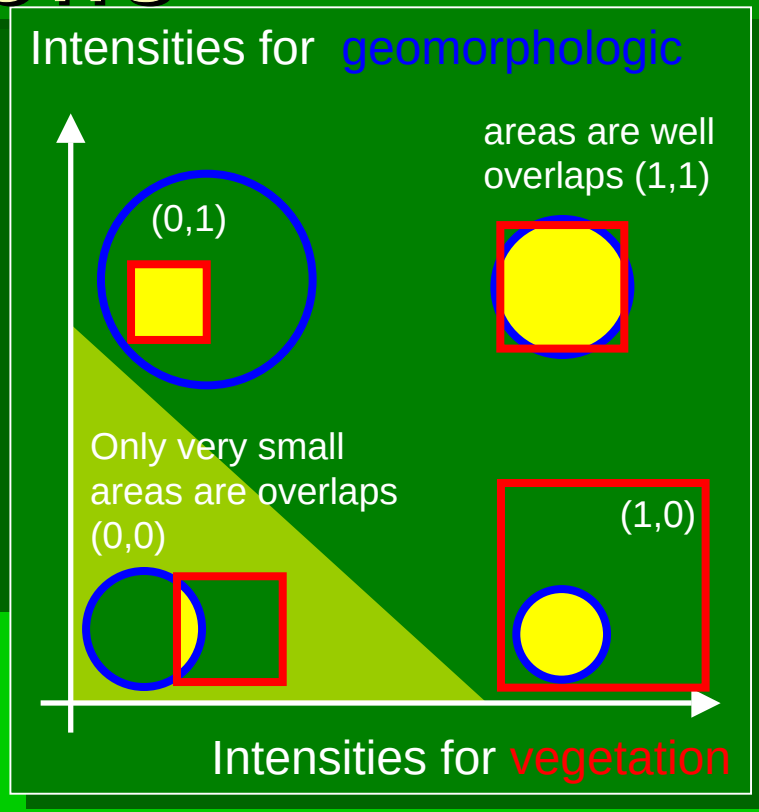
Determination of the overlapping-patterns for each combinations

- Pattern 4
  - areas are well overlaps each other



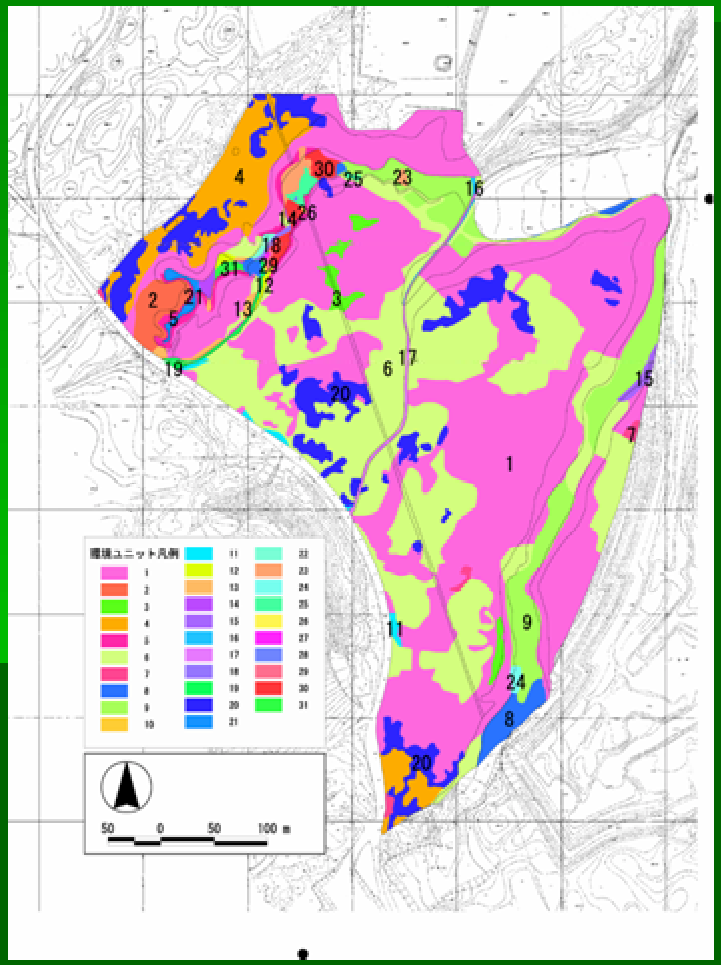
Determination of the overlapping-patterns for each combinations

- There were four main overlapping-patterns for each combinations areas are well overlap
  - Only very small areas are overlaps
  - areas are well overlaps but overlapping in various geomorphological types
  - areas are well overlaps but overlapping in various vegetation types
  - areas are well overlaps



= unwanted combination and will be eliminated

The result of elimination



エコトープ単位

		台地面		斜面		谷底面		人工地形	
		砂丘平坦面	砂丘緩斜面	上部谷壁斜面	下部谷壁斜面	谷底流路面		造成地	道路	凹地
落葉広葉樹二次林	イヌザクラ-コナラ群落	1	2	3	4				5	
	エゴノキ-ヤマザクラ群落	6								
	ヤマツツジ-コナラ群落典型下位単位	7								
	ヤマツツジ-コナラ群落ススキ下位単位	8	9							10
	ベニシダ-エゴノキ群落			11	12					
二次草原	アズマネザサ群落	13			14				15	
	チガヤ-ススキ群落	16								
	ヨシ-セイタカアワダチソウ群落					17		18		
	オギ群落					19				
	セイタカアワダチソウ-ススキ群落							20		
先駆性低木林	ヤマグワ-ヌルデ群落	21			22					
林縁性ツル植物群落	フジ群落	23				24				
	クズ群落				25	26				
路上植物群落	シバ群落					27			28	
	シロツメクサ-オオバコ群落					29			30	
常緑針葉樹二次林	ウメガサソウ-アカマツ群落	31								
林縁性湿性植物群落	トボシガラ群落					32				
	ツリフネソウ群落					33	34			
湿性林	ハンノキ群落					35				
海岸砂丘植物群落	ヤマアワ群落				36	37				
湿性植物群落	チゴザサ群落					38				
	エゾノサヤヌカグサ群落					39				
	ミズオオバコ群落他					40				
	コツブヌマハリイ群落					41				
	ミソハギ群落					42				
	チゴザサ-ヨシ群落					43				
	ウキヤガラ群落					44				

数字 エコトープ単位（数字はエコトープ凡例番号）

環境因子間の連関が認められず削除したユニット凡例

面積微細パッチの削除を行った結果、消滅したユニット凡例

✓A total of 110 combination was reduced to 44 combinations