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Investigation of Environmental Change Pattern in Japan

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(Investigation of the Ecological Environment Index from Observation of the Regional Vegetation cover and Their Growing Conditon)

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Investigation of the Ecological Environment Index from Observation of the Regional Vegetation Cover and their Growting Condition.

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1. Introduction.

LANDSAT data is confirmed that it is very useful for the foundamental information source of the regional exploitation and conservation planning. In this report the auther described the significant test results of the operational use of the land cover and land use discrimination from LANDSAT data.

The contents of this report are as follows :

1. The discrimination leves of the land cover and land use of the remote sensing data in Japan.
2. The use of the theme extruction map of the vegetation growth and land use type for natural environment survey.
3. The effective use of the digital pattern recognition for the actual vegetation map drowing.
4. The natural conservation planning of the north Kanto area (1500 km^2) under the use of LANDSAT data.

The respective advantages of the various survey techniques as by LANDSAT, air-borne and the field survey became clear through these research results. Then the prospective and basic environmental resourses inventory and survey system was considered.
The satellite information play the leading part of the total survey techniques in future system. The research continuse to day for the operation in Japan.

II. Techniques.

II-1. Basic acknowledgement of the environmental information research.

"Plate 1" shows the total Aspect of Japan Island by 64 LANDSAT-1 and -2 image of those the least crouds and snow cover sceneries. The infrared color composition and the mosaic work was down by the photogrammetry Laboratory of Forest Experiment Station.
The color tones of each plane or the forest area are not same because of their searsonable difference.

The image ilustrate that, Japan Island are coverd by the mountenious forest up to almost 70%, also every flat area are cultivated intensively as farm field. Each flat plane have many density urban areas in blue color. The blue urban areas occupied about 2% of the whole of Japan. But more than 60% population of total in Japan are gathering in these limited part.

On the enlarged picture, the coast line of near the large cities are covered by the artificial construction complately, also many whitish dots, of bare soil where the newly construction work going are scattering in the mountain food zone. The ecological environmental qualities of the area are composed by the natural conditions and human activities and transform with the progress of these land use exploitation.

These aspects shows the rapid changing pattern of the natural environmental condition in Japan Island.

The environmental information of the earch surface including the natural resources information usable for the industry are accepted through the pattern recognition and also time change of .....

1. The physical condition of the earch surface.
2. The coverage patterns of the earth surface.
3. The human activity pattern on the earth.

The physical condition of 1. are composed by the regional structure elements such as position, topographic, geographic, and the climetical condition. These are quantitative factors. The main information source of these items in Japan are prepared by maps and other conventional data. The coverage patterns of 2. are composed by rather qualitative factors of the earth surface such as forest type, grass land type, bare soil ratio, residential cover and other natural and man made land surface types.

The LANDSAT data is the most effective information source than anything else for this item.

The human activity pattern of 3. are partly predictable from the land cover phenomena. But the main information sources are offered by the sociological information such as the national or local sensus data and the conventional survey.

The evaluation of the regional ecological environmental qualities should be down by the effective use of remote sensing data with the combination of the map and sociolosical information.

The applied techniques in these test for LANDSAT data recognition was ....

1. Photogrammetric interpretation of the mono-chrome and color-composit pictures of LANDSAT-1, -2.
2. The theme extruction map making of the vegetation types and the land use by the photographical procedure .
3. Digital pattern recognition by man-machine systems (Mdas, Image 100 and the other).

The multi-altitude air-borne data of air photos and MSS scanning, also the field survey was widly adopted for the accumulation of the traning data of LANDSAT data recognition or for the checking and adjustment of their results.

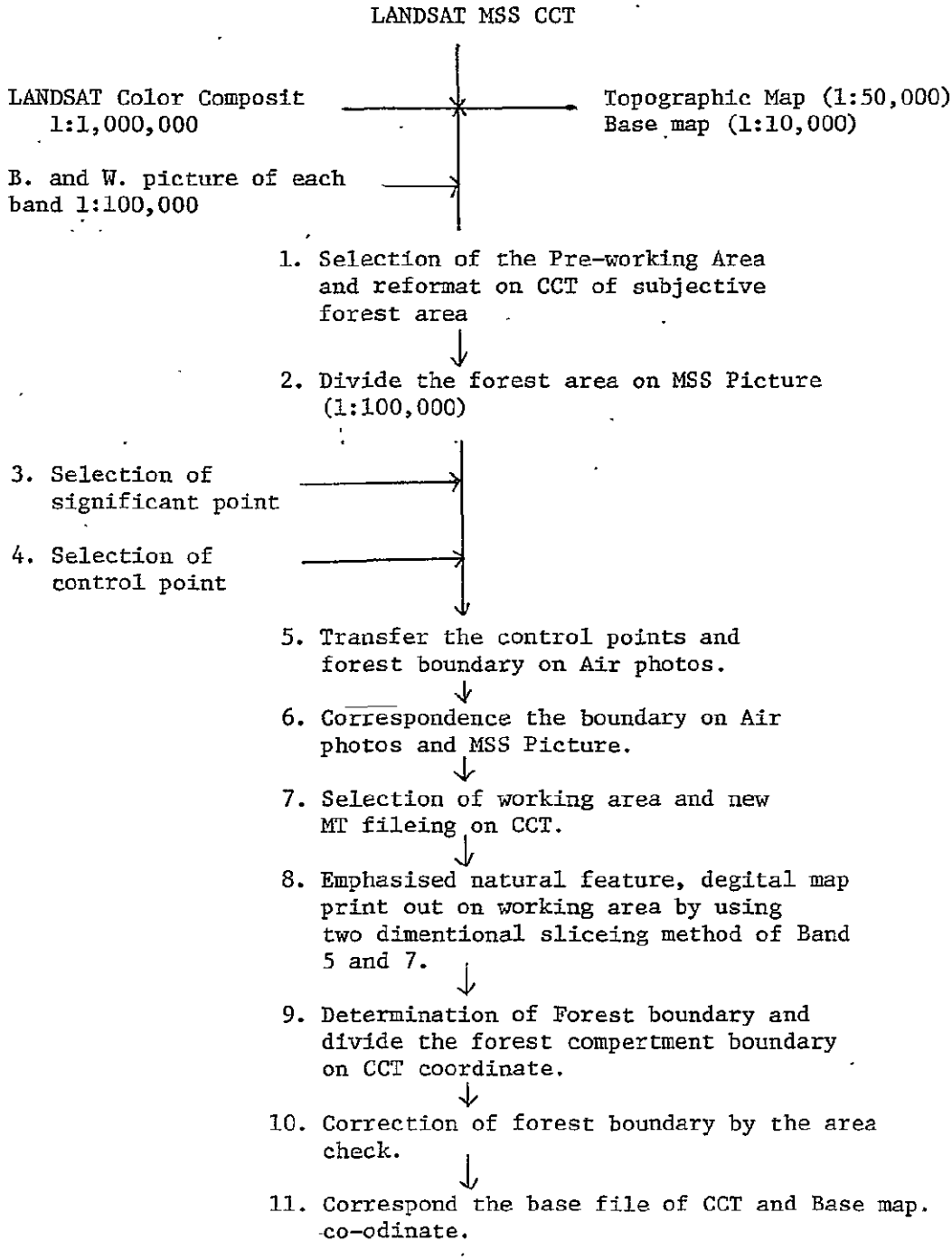
II-2. Pattern recognition techniques.

The accurcy of the LANDSAT data recognition for land cover types was investigated at 6 test areas of typical land use type regions of Japan, such as suburbs of large city area, agriculture, foresty, national park, eroded mountain and industrial area. The pattern recognition results was compared with the air photo interpretation results and the conventional vegetation type map.

In these case, each LANDSAT-CCT was transformed in map coordinated after geometric coordinate registration by three dimensional formula, with in a pixel unit accurace.

For the detail correspondence of LANDSAT-CCT with the map coordination, Fig. 1 procedure was used as the most effective method in nallow forest area of the test site.

Fig. 1


LANDSAT MSS CCT
LANDSAT Color Composit 1:1,000,000
Topographic Map (1:50,000) Base map (1:10,000)
B. and W. picture of each band 1:100,000
1. Selection of the Pre-working Area and reformat on CCT of subjective forest area
2. Divide the forest area on MSS Picture (1:100,000)
3. Selection of significant point
4. Selection of control point
5. Transfer the control points and forest boundary on Air photos.
6. Correspondence the boundary on Air photos and MSS Picture.
7. Selection of working area and new MT fileing on CCT.
8. Emphasised natural feature, degital map print out on working area by using two dimentional sliceing method of Band 5 and 7.
9. Determination of Forest boundary and divide the forest compertment boundary on CCT coordinate.
10. Correction of forest boundary by the area check.
11. Correspond the base file of CCT and Base map. co-odinate.

The control points was selected from those location points of .....

1. Sunny part of the mountain peak where clearly changed from dark shadow part to light part as the sharp edges.
2. On the boundary of the bare soil surface and vegetation coverage such as erosion, clear cutting forest stand, farm field and etc. at the mono-tone forest pattern area.
3. The artificial construction groups in the forest.
4. The clearly curved point of the river bed.

Table 1 shows a example of the map co-odinate test results in the forest area. From this results, even by the 1st. order formurae transformation has enough accuracy for practical use when adop a lot of control points in nallow area coodination. 32 control points was use in this case.

Table 1. Accuracy of Coordinate Transformation

Map(X,Y) $\longleftrightarrow$ MSS·CCT(x,y)				
$\begin{cases} X = \Sigma a_{ij} x^i y^j \\ Y = \Sigma b_{ij} x^i y^j \end{cases}$			$\begin{cases} x = \Sigma A_{ij} X^i Y^j \\ y = \Sigma B_{ij} X^i Y^j \end{cases}$	
$(i,j) = 1, 2, 3, 4$				
Order	M_x	Max_x	M_y	Max_y
1	47.2^m	123.2^m	36.6^m	73.4^m
2	42.7	95.7	37.9	80.0
3	43.7	91.9	36.0	81.1
4	46.1	84.3	38.8	73.1
Order	m_x	max_x	m_y	max_y
1	0.77	2.30	0.48	1.08
2	0.68	1.29	0.50	1.14
3	0.67	1.25	0.50	1.17
4	0.67	1.06	0.54	1.03

The linear function classification, maximum likelihood method and Maharanovis distance method was applied for the discriminating of the vegetation pattern recognition procedure.

The histogrum of the 4 bands spectro signature of the training area was used to find out the basic classification pattern groups. Then the spectro signature of each class was obtained by their average vector of their spectro groups. Also the cords of classifications by the land use survey was combined.

The spectro signature of each class is composed with the groups of the reflected light values of the individual surface structure materials of that class. The range, the spectro signature of each class is overlapped with the other similer signature classes. Then results of the pattern recognition was coincide satisfactory in wide view point but many differencies was happend in detail when compared with the surface survey result.

Table 2 shows a example of the pattern recognition accuracy of simply aplied the maximum likelihood method at the city suburb area. In this table the percentages of the total correctness of the pattern recognition when compared with surface survey was only 43.7% in average when classified in 9 itemes as soft wood forest, hard wood forest, orchard, agriculture, residential, sense-urban, park, under construction and others. Even the most good results class of soft wood forest showed 60% only.

Table 2 · A Example of the Test Results of Pattern Identifications by total 437 Systematic check points.

Conventional Survey / LANDSAT		1	2	3	4	5	6	7	8	9	10	% Coinside
Soft Wood F.	1	60	20	1	1	0	0	0	0	0	82	73.2
Hard Wood F.	2	18	29	2	2	0	0	1	0	3	55	52.7
Orchard.	3	11	3	21	8	0	1	1	1	3	49	42.9
Farm.	4	3	5	6	33	8	9	2	0	10	76	43.4
Residential.	5	5	4	4	20	22	17	3	0	6	81	27.1
Dense Urban.	6	1	3	0	6	5	25	1	2	14	57	43.9
Park.	7	2	5	0	1	1	1	4	0	3	17	23.5
Under Const.	8	0	0	1	1	0	2	1	0	1	6	0.0
Others.	9	3	2	1	1	0	5	1	0	1	14	7.1
Total.	10	103	71	36	73	36	60	14	3	41	437	
% Coinside		58.3	40.8	58.3	45.2	61.1	41.7	28.6	0.0	2.4		

It was considered that those classes of the similar with the land cover types and the land use types are belonged in the best recognized groups such as forest, farm or density urban area.
The reasons of the recognition error happening was mainly as follow ....

(1) The different pattern recognition of several to ten order pixels unit in a uniform pattern.
(2) More than 2 classes mixture and difficult to cincide in the pixel unit each other, especialy such as residensial area over 30% vegetation cover or the park area.
(3) Different classified with several tens pixel units with each other because of the different land use class even in the similer land cover condition.

(1) was reduced from the miss recognition by the shadow influence of topografic feature mostly.
(2) was reduced from the difference between a classification unit area and an identification unit size on a pixel. These errors was possible to eliminate by adopting the air bone information.
(3) was happened at the classes of which was composed by some different surface conditions such as the underconstruction area of including bare soil, grass land, swamply bush, river bed and etc. These are necessary the additional conventional survey information.

An other example of the pattern recognition accuracy in the most complicate forest area showed only 3 forest types classes in sunlit side was nicely coincide with surface survey results among the 10 classes of the spectro signature classes which was settled by cluster analysis groups of the training area. The rest signature was classified as threshold by the shadow-influences.

It means that to improve the acuracy of the pattern recognition, the research of the shadow effect and the selection of the classification category are the most important factors in the complicate topograhic and land use area.

Finaly, when we combine the topographic data on land cover data, the recognition accuracy was usprised more than 50% than land cover data only. Most convinient and effective way to combine the topographic data on land cover data was use the training area information on digital display of man-machine system.

II-3. Land cover and land use discrimination Level form Space data.

LANDSAT data basicaly inform the physical electro magnetic reflectance responce from the earch surface of the land cover formation. On the other hand, our necessary informations are the actual land use and their future estimation which are composed by the natural potensiality and human activity also the dynamic ecological bio-environmental condition of each area.
Though LANDSAT data does not catch these information directly, we can assume the major part of them from their physical and graphical characteristics, but that depending of ~~the~~ their ground resolution capacities.
To obtain the actual information for the land management, it is necessary to combine the other more detail corresponding information of the land use or bio-environmental condition on LANDSAT data according our demanderings, especialy at the intensive and complicated land use area as in Japan.
Between direct recognition level of land cover from LANDSAT data and land use, the six stages was considered according to the necessity of the corresponding work steps.
That is shown in Table 3
The basic standard of each levels are as follow.
Level I to Level 4 are the groups of those possible to automaticaly recognize from LANDSAT data only.
Level 5 groups are possible to recognize by the combination with the air borne information on LANDSAT data.
Level 6 groups are basicaly depending on the conventional information besides the air borne data, or the other seasonal information etc.
The other words "Level 1-4" are possible to recognize from the spectrum patterns recognition. "Level5" needs the additional of the graphical knowledgement."Levle 6" is necessary another information of human activities, on identification.
Land use discrimination Level of 3 stages in Japan was considered as Table 4 depending on the reasonable data sources and their ground resoulution grades.
The usefulness of the LANDSATobservation are evaluated by the economical data aquisition, analysis, stocking and easy for reference, besides the accuracy and objectivities of the final results.
The unite area of the land use and bio-ecological condition are subdivided rather than LANDSAT resolution, then are understude as the rough information in this point of view in Japan.

Table 4. Unite area Level of the information

Level	Unite area size	Use
I	1000-500 m net work (Resolusion 100_m-50_m)	Regional planning Vegetation naturality etc.
II	400-200 net work (Resolution 50_m-20_m)	Forest inventory. Basic Management plan. Land fuculty survey
III	100-50m net work (Resolution 20_m-10_m)	Agriculture productivity. Forest management, Road construction, Ecological survey. Vegetation growth and damage, etc.

But that is very effective for the rapid and correct statistical data preparation, especialy for the total aspects of wide region.
The Forestry and Agricultural land use levels in Japan are as Table 5.
In this Table 5, LANDSAT data offers effectively the "Level I" information with more than 90% accuracy and 80 to 70% in "Levle II" with combine the air borne data.
LANDSAT recognition of "Level I" offers very efficient information for the "Level II and III" classes by their timely and regulary observation abilities and enable to make the planning and design the multistage sampling survey, also for adjustment the conventional survey results.
As a principle, the regional land information must be composed by the multi-altitud observation data and the socialogical data of the conventional way. In these total survey system, LANDSAT information are consist the foundamental frame to adjust other multi informations both in grpahical and digital methods. The evaluation of the every survey method are considerd as Table 6.

II-4. Theme Extruction Mapping Techniques.

"Plate 2" shows the land cover interpretation results on LANDSAT color composit picture of 1972. Dc. 15, of Mt. Fuji area. That was classified in 9 classes such as the 4 coniferous forest types, desidious forest, field, farm and range, bare soil and water surface.
Same interpretation works was down in this area on the other LANDSAT color composit of 1972 Feb. 25. Unfortunately we could not get the nice images of LANDSAT-2 in same area by the havey croud covering. "Plate 3" in shows a example of theme extruction map of that area, which was producted using the 4 bands negative and positive films of two sceaneries those of 10 steps density sliced by the photographic procedure according the above interpretation results. Each class was extructed by the determined spectro signature constructions of 4 bands of one sceanary. The theme extruction map was printed on the seven tranceparency films as one set.
The vegetation cover information was used as the basic index for the classification of each category as follow.

Table 3. Landcover identification level by LANDSAT data.

Condition A : A.D.P. (Spectral)
" B : + Air photos (Graphical)
" C : + Other information.

Vegetation, + Water −	Dry Wet	Material Type	Land Cover Condition 4:	Land Cover and Use Condition. B:	Land use Condition C:
Level 1 (A)	2 (A)	3 (A)	4 (A)	5 (A+B)	6 (C)
Vegetation	Dry	Grass (Grass Land)	Dark Light Tall Low	Farm Crop. Vegetable. Range Lawn Wild grass	Range City park Simetory Cutting area Ground Lest farm Garden Reclamation River bed
		Tree (Forest)	Dark Coniferous Light Evergreen Decidious Mixed Bamboo	Arfifical (Tree sp.) Natural Oarch	Forest type
		Grass Tree and	Dark Light Tall Low	Farm Wilder Plantation Bush Shurub	Range Reclamation Tea Cutting area Sabanma Mulbery Lest farm Park Nursery Garden
	Wet	Grass (Wet gnass land)	Dark(Densi) Light(Poor)	Water grass Paddy farm Wet land	Peat Fish pound Law Land Lotus Hose radish Seed bed.
		tree (Forest)	Dark Light	Mangrove forest.	
		Grass, tree	Dark Light		
Non Vegetation	Dry	Construction (Artificial)	Urban area (Deni) (Open)	Bilding Dike Road Air port Rail way Pevemnet Bridge Harbor	Residensial Dike Hause Factory Parking Park Ground Dam site
		Natural	Bare Soil Gravel Dry grass	Reclamation Sand hill Dike Paddy field Rood Farm "	Reclamation Clift Ground River bed Dum
	Wet	Construction (Artificial)		Culture raft	Habor Cultur raft Mole
		Natural	Bare soil Gravel Dry grass	Sea shore Paddy field	River bed
Water		Water	Clear Impurity	Lake Flood Pound Sea River Harbor	Praimage
Othes		Snow Ice Crowd Shadow			

Table 5. Land Use Identification Level from Remote Sensing Data.

LANDSAT Resolution : 60m x 70m Net work L 500m Map scale : 1/200,000	LANDSAT High Altitute Air Craft. Resolution : 25m x 25m Net wark : 200m Map scale : 1/50,000	High Altitude to low Altitude Air craft. Resolution : 5m under New wark : 50m Map scale : 1/25,000 to 1/10,000
Level I	Level II	Level III
Town (Artifical construction)	Residential	High Density Town Low Regidential Construction Village Others (School Campus etc.)
	Factory	Factory
	Special equip	Athletic field Other (Tunk, Green house etc.)
	Road	Auto road Main road Other road
Agriculture	Paddy field	Paddy field
	Farm	Farm Others (Tee Mubel Nursery ect.)
	Grass land	Lange Loan Wild grass Shrub Wet grass
Forest	Coniferous	Artificial forest Natural coniferous
	Hard wood	Ever green forest Decidious fores
	Mixed	Miced forest
	Others	Orchard Other forest
Bare Surfact	Rock	Lava Stone factory Rock
	Gravel	Volcanic Ash Gravel Other Sandy
	Soil surface	Reclement Under construction Open space
	Others	Dry grass Wet land
Water	River Drinage	River, Drinage Lake, Pound Artificial pound, poor
	Sea	Sea
Snow Ice	Snow Ice	Snow Ice
Growd		
Shadow		

Table 6. The charactaristics of the data acquisition

Spec. / System	Wideness	Symultanity	Periodic	Urgency	Quantitive	Quaritive	Digitalization	Economicaly
Field (manual)	Need the abundant field plots ***	Hardly difficult ***	Difficult ***	Difficult ***	Hight *	Adequate *	Low efficiency **	Expensive ***
Air borne	Need the respectable flight **	Need the respectable flight **	Expensive ***	Adequate *	High *	Difficult ***	Expensive ***	Expensive ***
Satellite	Best *	Best *	Best *	Depence on the opputunity ***	Low resolution **	Difficult ***	Best *	Best for long term. *

1. Vegetation cover 70% over : ..... Forest, glassland, range.
2. 70% to 40% : ..... Agricultureal area.
3. 70% less : ..... Residencial, Urban, bare soil.

The density difference of the band 4 and 5 was used especialy as the main index of classify the artificial constructions, bare soil area.

The volcanic rocky area, the Mt. Fuji to and water surfaces was extructed by the absonption of infrared reflectance. The snow cover area had very strong reflectance in every 4 bands. The vegetation cover difference between autum and winter images read out the index of the detail classification of the coniferous and the decidious forest types, grass land and farm field also the fir (Abies) and spruce (Picea) tree secies in the coniferous forest. "Plate 4" is a same example of land use theme extruction map, used 4 seasons LANDSAT images in Toyama prifectare (Located in north side of middle part of Japan). (irustrated on Plate I).

Seasonal changes of the color images were as follow : .....

1) Decidious forest, grass and farm field changed their tone time to time by each of their seasonal vegetation growth and water contents or the covering conditions of the land surface. Especialy remarkable difference was recognized between May 10 and May 25 sceneries.
2) The farm field expressed their seasonal changes according to their cultivation works.
3) The infrared reflection values of the new reaves in the spring times was extremery high and difficult to classify each of the forest types. By the diduction of the coniferous forest area of the winter images from all vegetation cover images of the spring images the grass and decidious forest area was extructed.
4) The distribution of the paddy field was cleary extructed by the water surface cover images of the early planting seasons.
5) The Artificial construction and urban area have the larger reflection difference in the band 5 and 7 at the fall season and the winter.

The average density measurement values of band 5 and 7 of each images was as Table 7.

Theme extruction works carried out by checking the extruct effect of the test site images with the manual observation of the display images on multi-data color system 4200. This method was a very economical and practical way to compare with the digital processing way.

Table 7 Average density of the defferent seasons
(Band 5 and 7)

Date	73.5.10		73.5.25.		72.10.5.		72.12.6.	
Band	5	7	5	7	5	7	5	7
Forest	1.0	4.55	1.03	8.33	0.74	3.23	0.84	2.22
Paddy	1.67	0.52	1.49	0.57	0.81		1.00	0.73
City	1.05	0.40	0.95	0.39	0.78	0.29	0.85	0.58

The boundaries of the actual vegetation map which was drown by the conventional method and corrected lines was over laied. The pattern recognition classes and their color are irustrated in Table 9.

Table 9. Legent of the pattern recognition

4	Fir	(Dark green)
5	Hemlock	(Green)
6	Alder	(Redish)
9	Beech	(Brown)
14	Red pine	(Light green)
20	Oas (34)	(Yellow)
21	Birch	(Dark yellow)
22	High grass	(Blue)
23	Lawn	(Light blue)
40	Sugi	(Dark green)
41	Larch	(Copper green)
44	Orchard	(Light yellow)
47	Farm	
49	Paddy field	(Red)
51	City	
52	Water	(Dark blue)
53	Bare soil	(White)
	Snow cover	(Black)

"Plate 6" is a enlargement of a part of the above image and shows the classifications of the pine and fir forest (Abies firma) classes with the reference of the IR air photographs.

The LANDSAT pattern the recognition was very useful for effective adjustment and adding the accuracy in the conventional mapping results. The boundaris and the location of the vegetation classes was newly reversed complately.

Roughly esimted that the application of the LANDSAT recognition must be decrease the cost and time of vegetation mapping work under than 10% of the conventional way also far more accuracy.

III-3. The natural conservation planning from space data in north Kanto.

The principal subject of the regional information for the industrial exploitation and the environmental conservation of the wide area is the data adjustment for the planning and practical opperation for the highly display of the land resourses functions of that area.

Expecialy the forest has the common environmental values besides the timber productivites.

Then the forest management plan must be designed for must effectively both of the regional industrial also sociological point of views.

This research was carried out for find out the basic index of the forest land conservation against the rapid decreasing of natural environmental condition in the cuntries of North Kanto area where covering three prefectures and total about 1500 km^2 . (irustrated on Plate 1.)

The land cover information from LANDSAT data was combined with census data, topographic data and the regional planning data for analysis the forest function and evaluate the each faculties such as timber production, water shade, erosion or flood control and recreation use of each area.

The zoneing and classification work have down very effectively by ADP works of LANDSAT data. [illegible] the total work procedure.

(1) Basic network and analytical data sources.

The total numbers of the quadrates was determined as 1792. Each quadrate is 2.25 km x 1.85 km square and contain 4 geometric standard quadrates in its. By the digital information of LANDSAT CCT, the land use types was recognized in 14 classes as Table 10 in each of the subdivided quadrate of 1/20 x 1/20 of one standard quadrate. These result was printed out from 4 baunds spectro signature of the classified categories as Fig. 2

Fig. 2 An example of the LANDSAT data out put

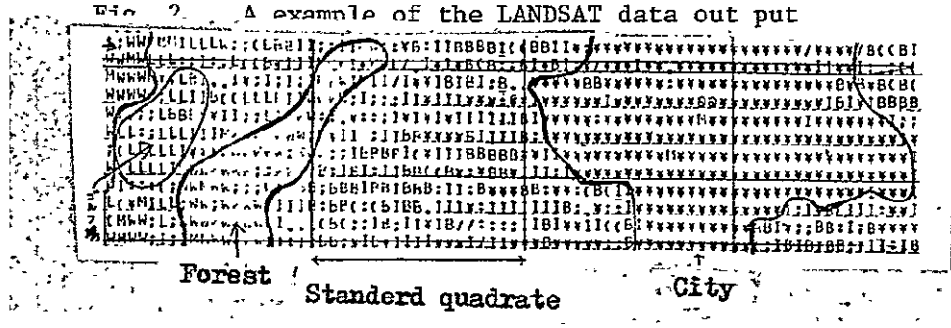


Table 10 Pattern recognition class by LANDSAT-CCT of North Kanto

1	Water(1)		Clear
2	Water(2)		Muddy
3	Forest		
4	City		
5	Bare soil		
6	Grass		Lawn
7	Farm(1)	} ———	Paddy
8	Farm(2)		
9	Farm(3)	} ———	Corn
10	Farm(4)		
11	Farm(5)		
12	Farm(6)	} ———	Vegetable
13	Farm(7)		
14	Others		

The 14 classes was adjusted in 7 items as the Table 11. Mainly the air photos was used for the confirmation and the correct of these recognition results. The other combined data are also shown in Table 11.

(2) The results of the data recognition and analysis of the area.

1) Present condition of vegetation growth in North Kanto.

North Kanto area are covered by 38% of the forest class, 50% of the other vegetation growth area.

But the distribution patterns of the forest also the populations are the partial. The land use zoneing work in the 3 categories of those forestry, agricultureal and urban area was down by the computation using the liner function method to make clear the relationships between land use and vegetation growth. The classification functions are ditermined from the selected 243 sample quadrate data of LANDSAT recognition. As the variants

of this calculation, following 12 items was used such as forest, artifical grass cover, population, dynamic population, 1st, 2nd, and 3rd. industrial emploiment population ratio, agricultural population, families, terrain feature, elevation and valley density of each sample quadrate.

The correctabilities of this zoning was 98.8% in forestry and agriculture zone and 97.6% in urban area. According to this result, the zoning map was drown and the area was measured as 42% the forestry, 45% agriculture and 13% urban area.

From this zoning results, the scanty vegetation growth area was located only in the center part of big cities. But the 65% of the urban zone was less than 5% of forest cover, even in agricultureal zone 40% was flaived the forest.

It means the forest area are remarkebly decreased in the flat plans of North Kanto.

Table 11 Quadrate information

1	x coodinate	Vegetation map	16	Population	Census
2	y coodinate		17	Dynamic Po.	
3	Artificial F.		18	1st. Indust. Po.	
4	Natural F.		19	2nd. Indust. Po.	
5	Orchard		20	3rd Indust. Po.	
6	Grass		21	Forest rabor	
7	City green		22	Agrical. rabor	
8	City		23	Agrical. Family	
9	Forest	LANDSAT	24	Terrein	Map
10	Artificial Ve.		25	Elevation	
11	Urban		26	Vally density	
12	Non Vegetation		27		
13	Lown		28	} Regional plan	
14	Water		29		
15	Others		30		

2) The evaluation of the land resouce funtions.

The erosion denger grade was classified in 4 stages by the settled 9 categories from the forest cover % and types, topographic features and the population as shown in Fig. 3 and mapped as Fig. 4.

Using the samely techniques the flood danger grade map, and the water shade potensiality map was drown.

The forest productivity map was drown after the evaluation of timber productivites of each quadrate from the combined data of the forest type, cutting and planting rabor force, topografic condition, vegetation naturaity and regional park plan as Fig. 5.

The faculties of the recreation purposes of each quadrate was evaluated by the analysis of the forest cover persentages and the distance function with the population distribution of each quadrate and mapped in 5 steps of the common recreation supply ability grades as Fig. 6.

The total procedure of above workes is shown in Fig. 7.

3) The forest conservation plan maping.

The north Kanto forest conservation plan was designed under the use of the above every evaluated forest function of each area by the procedure of the flow chart of Fig. 8. Then the final map of the forest conservation planning was drwon as Fig. 9.

Fig. 3 Erosion danger grade classification

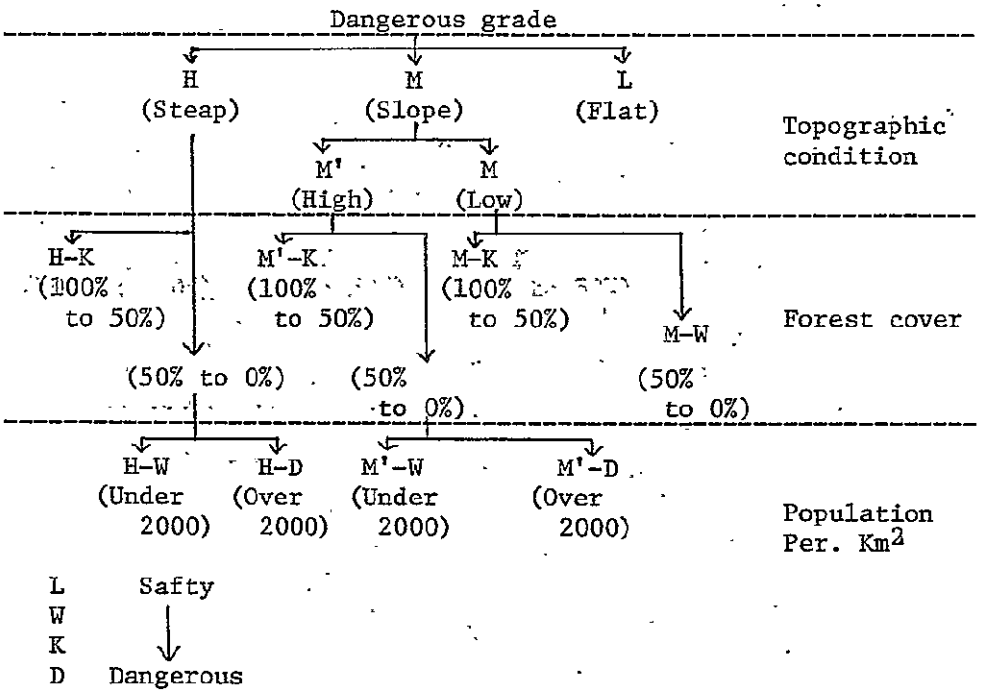


Fig. 5 Timber productivity classification

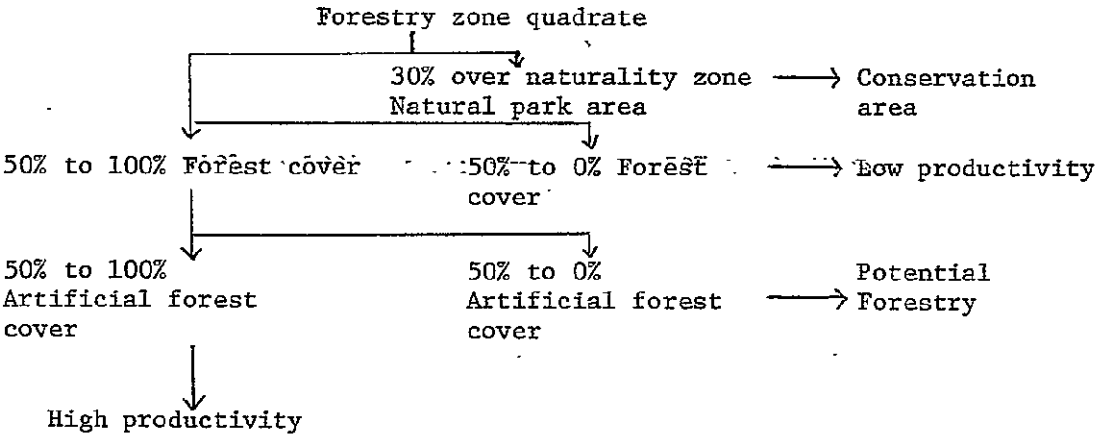


Fig. 7 LANDSAT data application diagrame for Forest conservation plan.

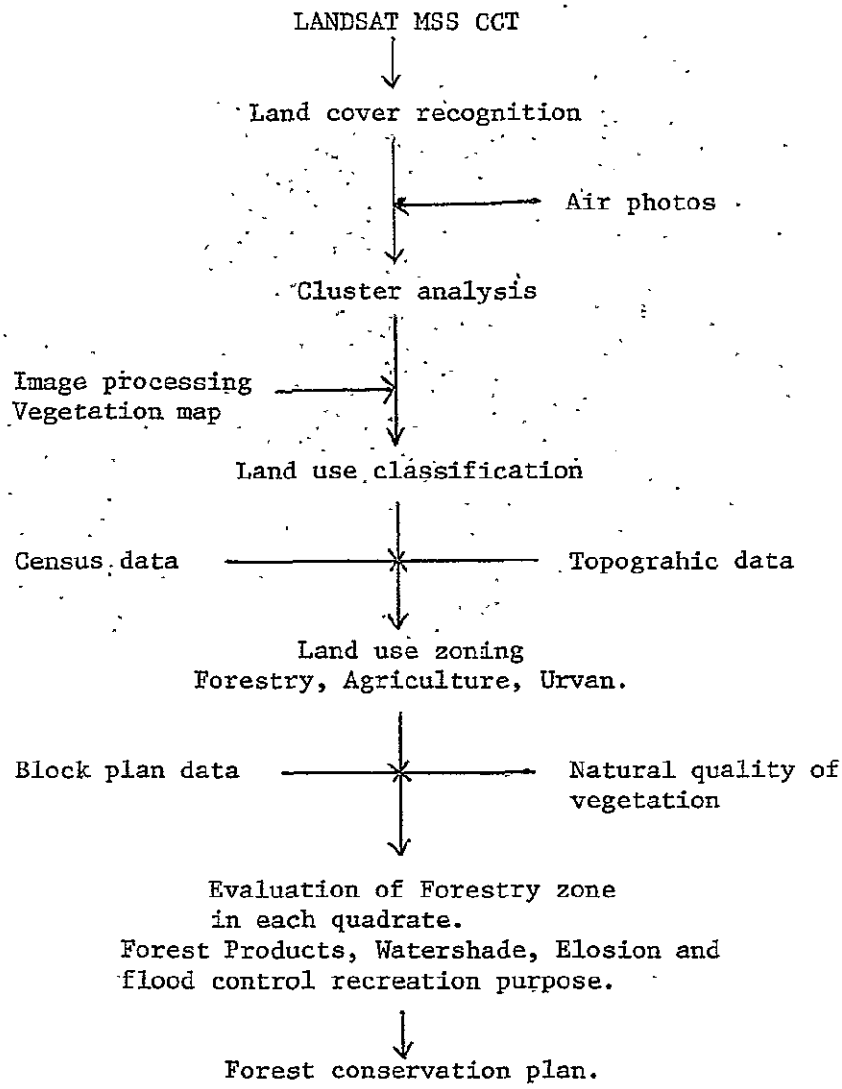
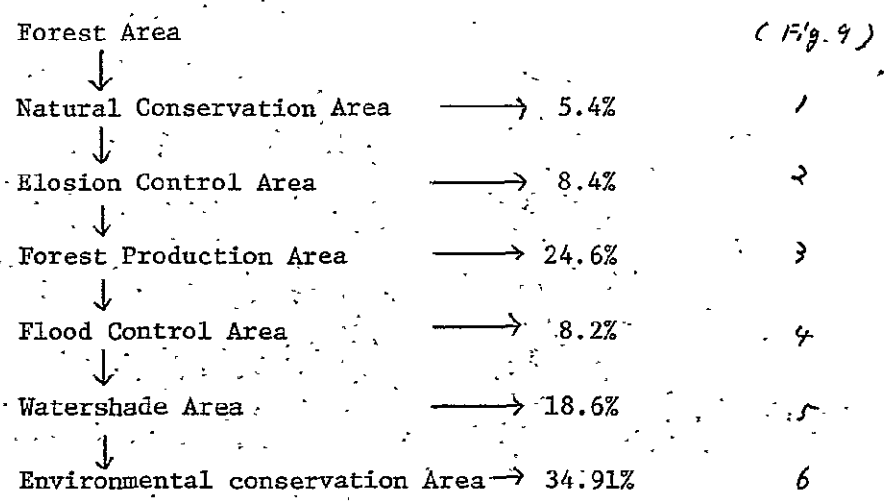


Fig. 8 Forest exploitation and conservation plan of North Kanto forest area.



As the result of this work, the 53% of the forest of this area must be treated to sustain the common forest fucultus besides the timber production management. These are shows the typical types of the natural environmental conservation condition of where the surronding of the density populated area such as in Kanto.

These results was reported to the National Land Agency from Forest Agency in 1976, 3.

IV Significant Results.

The actual land cover condition of Japan is very fractonated and changeable after the lapse of time. Although LANDSAT data is regareded as the rough information for the land use management or the ecological environment survey under this condition, but it has the remarkable abilities for the preparation of the original information of the total aspect or the correct statistical data of the wide region, that is almost difficult by the conventional survey method by the time and rabor of today.

Also LANDSAT data produce economicaly the detailed and practical report for regional planning with the combination of the other various survey informations in developed countries.

The significant results of this research are especialy as follow:

(1) The actual land cover and ecological environment are remarkably changeable at the rapid industrial developing area by the urbanization in the flat plane also in the mountanious area by the forest works and road construction. Then the adjustment or the correction of the formal vegetation or the land use map for practical use are almost difficult even in 5 years times lapse by the conventional survey.

The practical use of the recognition results of the LANDSAT data as the base map of the field survey or the retouching work of the vegetation and land use has the effective benefit to cut down the cost, rabor and time lower than 10% and more of the conventional method.

(2) The correct and detailed vegetation map are prepared by the combinated interpretation of the repetition data of LANDSAT of the different seasons at the warm and temperat forest as in Japan.
(3) The basic land use zoning map for the exploitation and conservation planning of the wide area are prepared very effectively by LANDSAT data application in the intensive countries.
(4) LANDSAT data compose the basic frame to combine the other many informations in a total analytical system of the country.
(5) LANDSAT data prepar the basic information from the wide point of view for the other nallow survey methods and make possible the most efficient use of the air borne or the surface survey fuculties.

VI Publications.

1. Iwao Nakajima : Environmental Quality pattern Mapping from Space Data. The 11th. International Symposium on Space Technology and Science. June 1975, Tokyo.
2. Iwao Nakajima : Degradation of the Vegetation Cover with Urbanization and its Infruence on the Flow of Polluted Air. The 10th International Symposium on Remote Sensing of Environment Oct. 1975, Michigan.
3. Iwao Nakajima : The Kinki district observation from LANDSAT data. Histry and Geography (66) pp.1-13. 1975. 7.
4. Iwao Nakajima : The data proccessing in Remote Sensing. Application Physics : Vol. 44. No. 11. pp.45-55. 1975, 11.
5. Iwao Nakajima : Forest Survey by Cosmic Photograph, Farming Japan, Vol. 9. 1975. 7.
6. Iwao Nakajima : Thr Research for the Interpretation and Anlaysis of the Forest, the Analysis of the Digital Despley Images. The Exploitation of the Remote Sensing Applitation : Science and Technology Agency. 1976, 3.
7. Iwao Nakajima : The Vegetation Survey by Remote Sensing. Environment Agency : 1976, 3.
8. Iwao Nakajima : The Forest and Land Surface Mensuration by Remote Sensing. The JAPAN Electic ScienceSociety. 1976, 4.
9. Iwao Nakajima : Air-Borne and LANDSAT data Processing for Environment Study. US-Japan Seminar on Image Processing in Remoto Sensing. Maryland 1976, No.V.
10. Iwao Nakajima : Remoto Sensing for Agriculture and Forestry. RESTEC Vol.I 1976, 12.
11. Iwao Nakajima : The Forest Conservation Planning of North Kanto by LANDSAT data. Report of the Japan Society of Photogrammetry 1976, 5.
12. Iwao Nakajima : Remoto Sensing : Manual of Photographic Techniques: 1977, 6.

VII Data Quality and Delivery.

The data quality is very satisfactory. But sorry the shortage of the repitition coverage by LANDSAT-2 in Japan.

VIII Recommendation

Especialy the steroscopic data would be desirable.

IX Conclusion

The investigation of LANDSAT data application have been continued now. It is certain that more effective results will be obtain in near feature.

Plate 1.

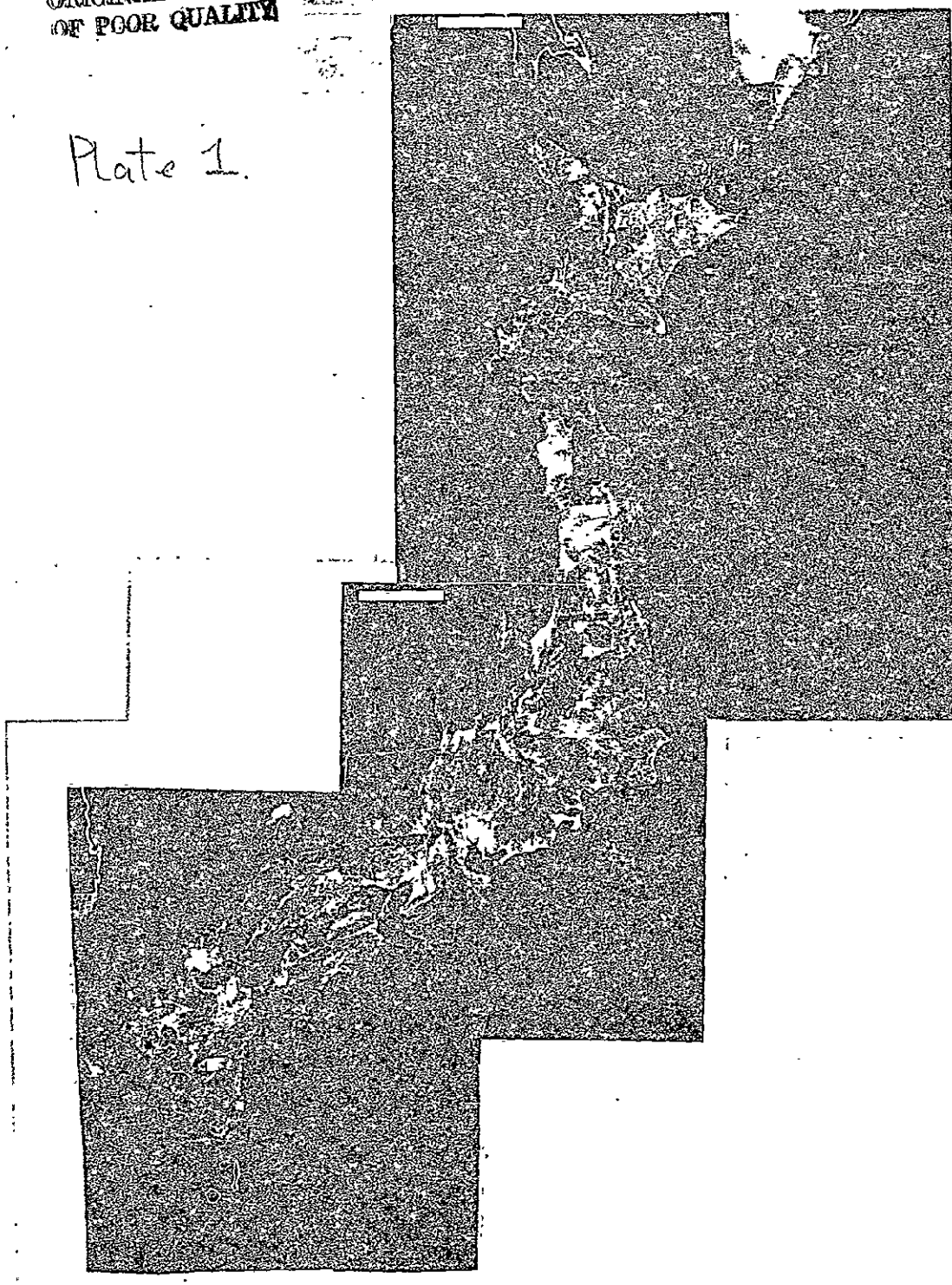
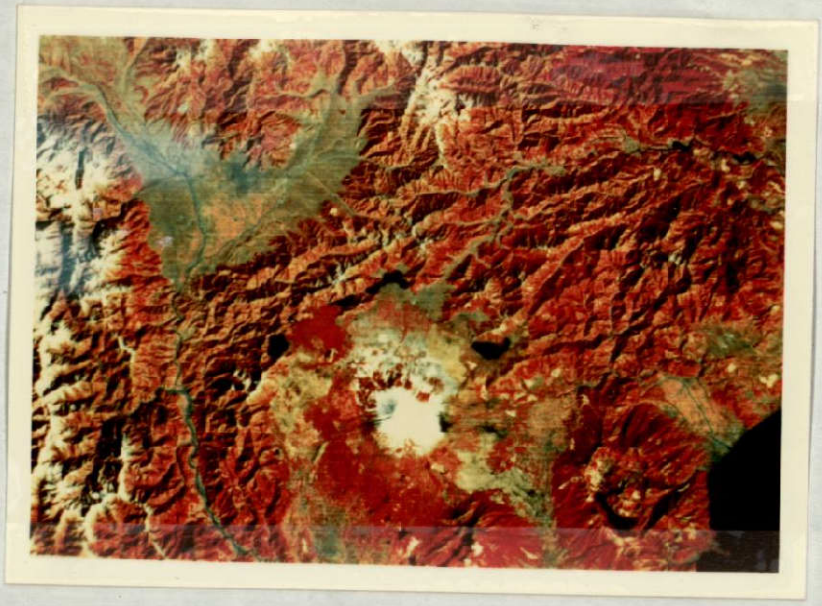


Plate 2
(P.7)

Mt. Fuji area



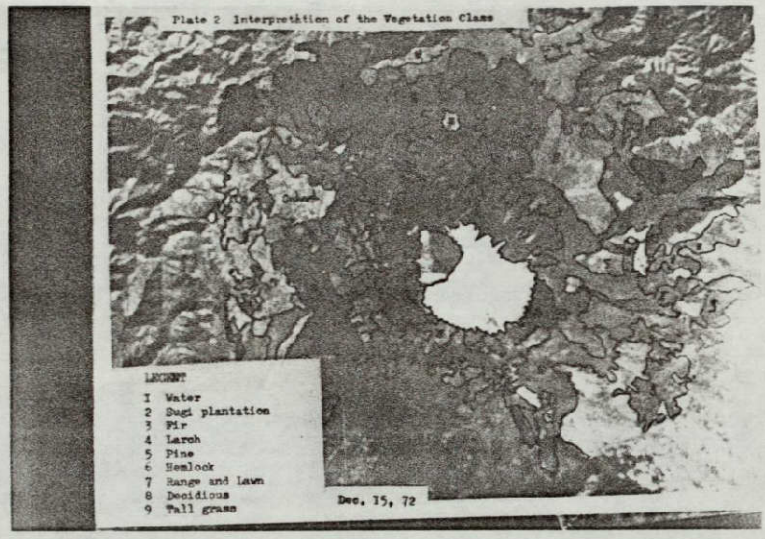
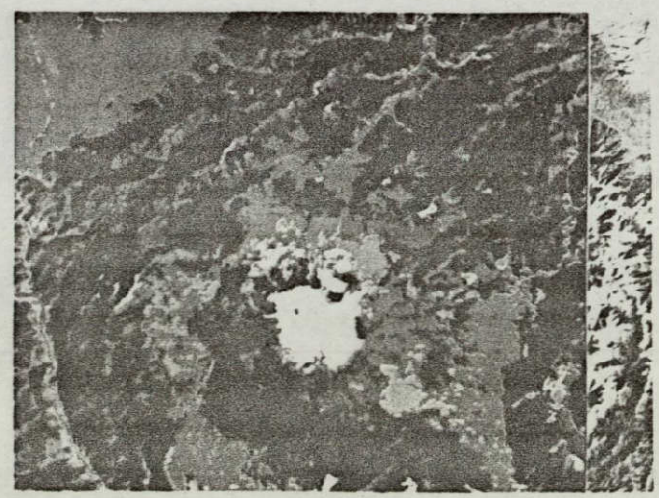
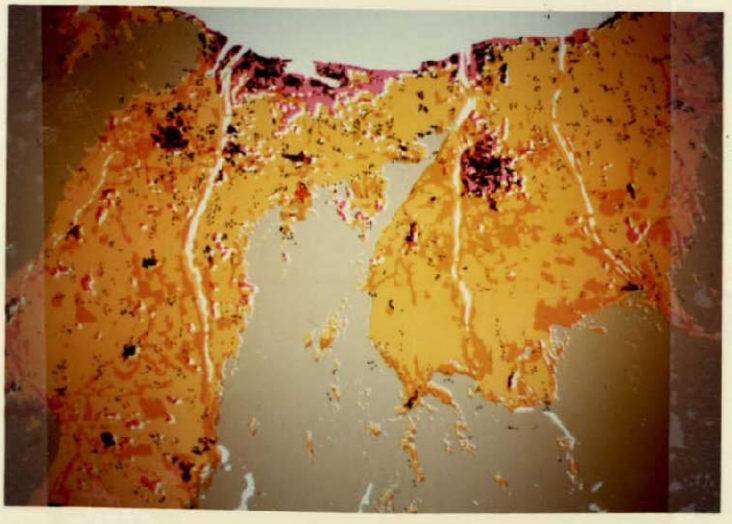


Plate 3.
(P.7)






Vegetation Cover Type classification
M-DAS North side of Mt. Fuji

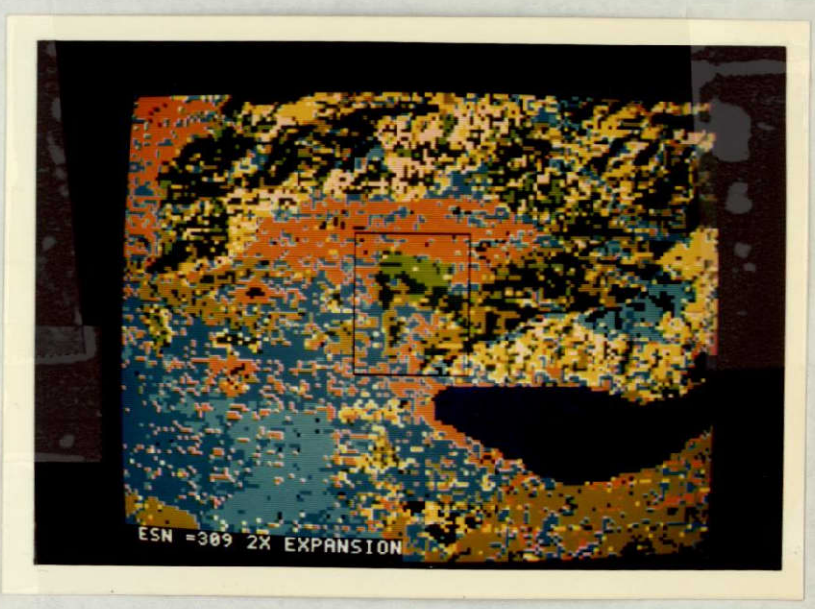
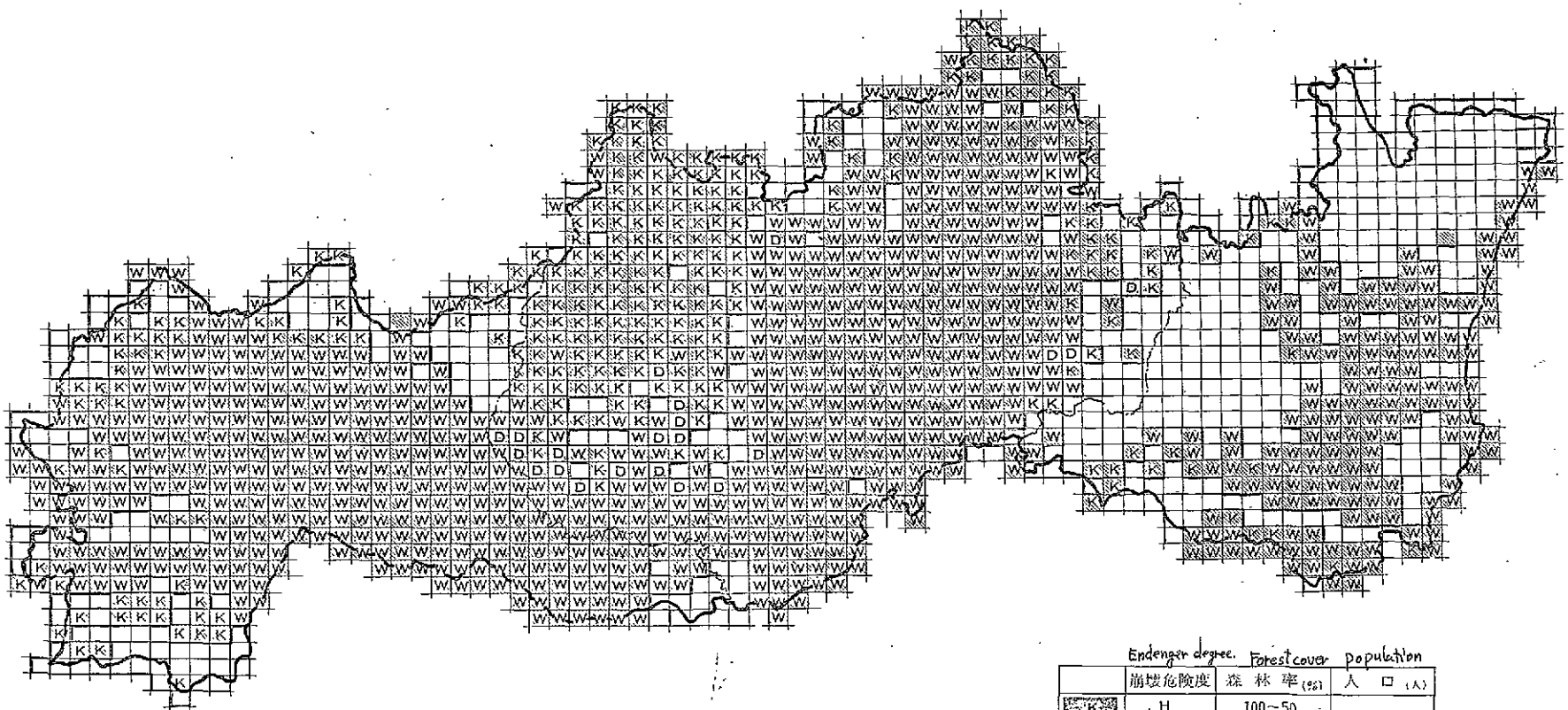

ESN =309 2X EXPANSION

Fig. 4. EROSION DENGER.

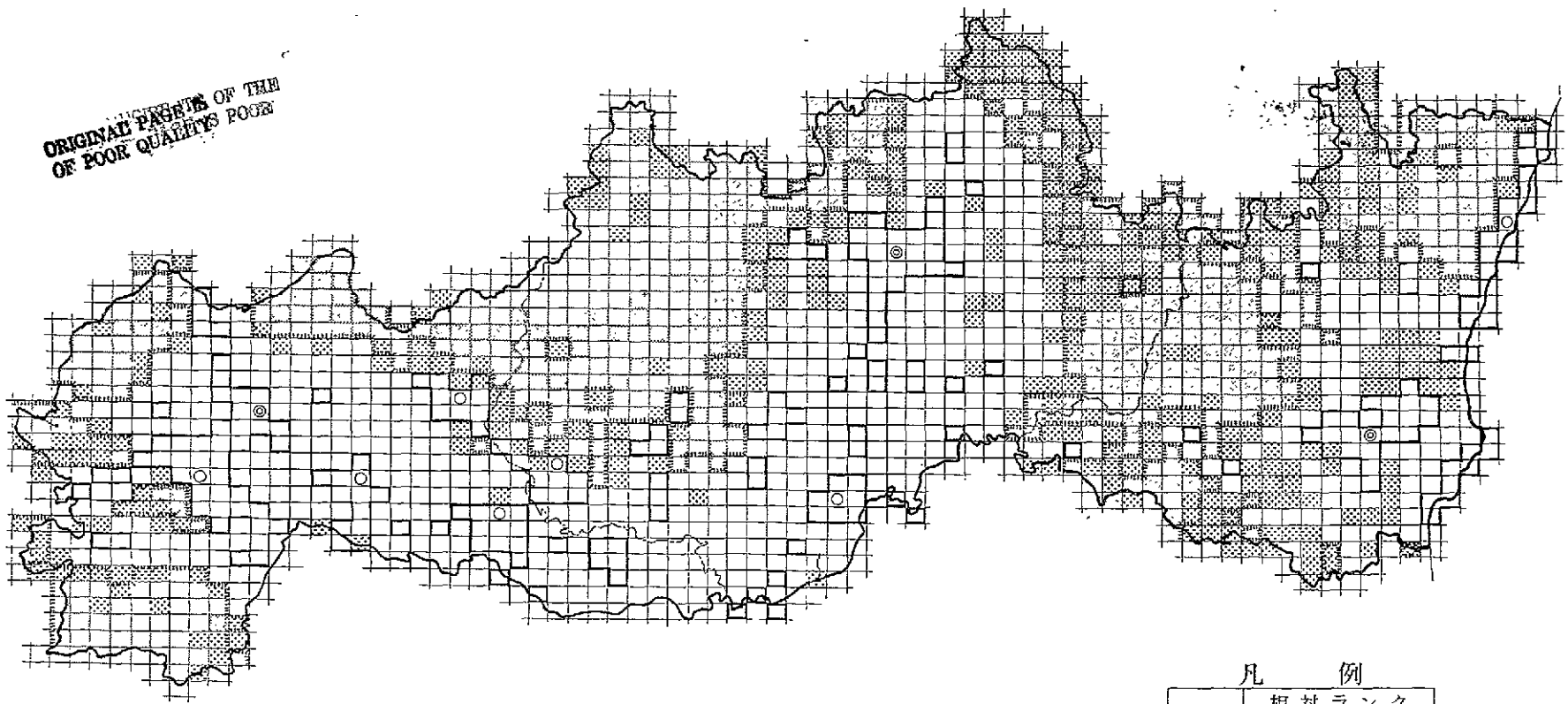
崩壊危険度図



	Endenger degree. 崩壊危険度	Forest cover 森林率 (%)	population 人口 (人)
K	H	100~50	
W	H	50~0	0~2,000
D	H	50~0	2,000以上
K	M	100~50	
W	M	50~0	0~2,000
D	M	50~0	2,000以上
K	M	100~50	
W	M	50~0	
	L		

Fig. 6 Common Recreation supply Ability

生活環境機能供給力図



凡　例

	相対ランク
	6
	5
	4
	3　2　1
	都市地域 City
	農山村地域 Agriculture

FOLDOUT FRAME 1

FOLDOUT FRAME 2

Fig. 9. Forest Conservation plan.

森林保全構想図