Studies on Environmental Planning and Design I. An Experimental Approach to Environmental Analysis and Environmental Impact Assessment

Bull. Univ. Osaka Pref., Ser. B, Vol. 32,
大阪府立大学紀要, 農学・生物学, 1980

Studies on Environmental Planning and Design I. An Experimental Approach to Environmental Analysis and Environmental Impact Assessment

Daishu ABE, Junichi HIRAOKA, Isao NAKASE, Masami SUGIMOTO, Junji IWAMOTO, and Tadashi KUBO

Laboratory of Urban Landscape Design, College of Agriculture

(Received October 31, 1979)

Abstract

In the field of environmental planning and design, planners and designers often engage in various projects, residential planning, recreational planning, open space planning and design etc. based upon the natural landscape. But in accomplishing these projects, a series of planning, design and construction processes occur, which give rise to environmental destruction and many serious social problems. Therefore, it is very important to assess the impact which residential development, recreational development etc. with the resultant changes in the land will have on the natural environment. Microclimate, surface and underground water, geology, small animals, vegetation, landscape, cultural resources beneath the surface etc. are considered to be the items of the natural environment which such projects will generally affect. There are very few studies which discuss environmental analysis and environmental impact assessment in respect of environmental planning and design.

This study sets out to analyze the landscape changes in development sites and to assess the environmental impact on the surrounding areas from a visual aspect. As an analysis and assessment tool, a visible and an invisible concept and appearance model of landscape change were developed through topographical investigation and appraisal. As the first step, a visible and invisible potential map of the landscape changes which could occur at the development sites and which could affect to the surrounding areas was completed. As the second step, an appearance model of the landscape changes of the development sites was drawn, by considering the topographical characteristics and visual characteristics of the study area. Finally, the consequences and unpleasing effects of the impact of landscape changes were clarified based upon visible and invisible concepts and the appearance model of the landscape changes.

Introduction

Recently, residential development and recreational development in regional projects have tended to be a large scale and also their locations selected on hillsides and in mountainous districts near metropolitan areas. In general, these hillsides and mountainous districts involve various natural factors, topography, vegetation, geology, water resources etc. and these factors generally produce an attractive landscape. But once these areas have been selected as suitable sites for large scale projects, the resulting actions will cause immense changes to the land formation and will also produce many problems at the development sites and surrounding areas in the form of regional lanscape changes.

In discussing landscape changes from the point of view of environmental planning and design, it is essential to study and to analyze the landscape changes of the development sites and also to assess the visual impact on the surrounding areas. The term of "landscape" involves so many varying factors, aesthetic, physical, ecological etc. that it is very difficult to comprehensively discuss landscape changes on a regional scale. Therefore, it is necessary to set up a methodology for analyzing landscape changes and their visual impact on environmantal planning and design.

This study then sets out to develop the methodology of analysis and assessment for landscape changes from the aesthetic aspect and especially, the visual perception of the environment. The study area was selected at southern Osaka in the Kinki region and views and attitudes forwards this study are summarized below.

1. The areas which will be affected visually by landscape changes due to development are drawn as a zone of 10km radius from the highest point of development site.

2. Since environmental impact assessment naturally includes a time prediction it is defined as short term in this study.

3. Environmental impact assessment for the area surrounding a development site whose landscape will be changed, has to evaluate both the pre-excavation and post excavation situation of the hillside or mountainous district and also to evaluate their interdependence.

4. Environmental impact assessment for landscape changes should include an evaluation system to assess the consequences of visual impact and its unpleasing effects on the surrounding areas.

5. Analysis and assessment of landscape changes are mainly discussed from the viewpoint of visual characteristics and also the considered land use characteristics of the development site and its surrounding areas, to assess the consequences of the impact on the environment.

Methods and Procedure

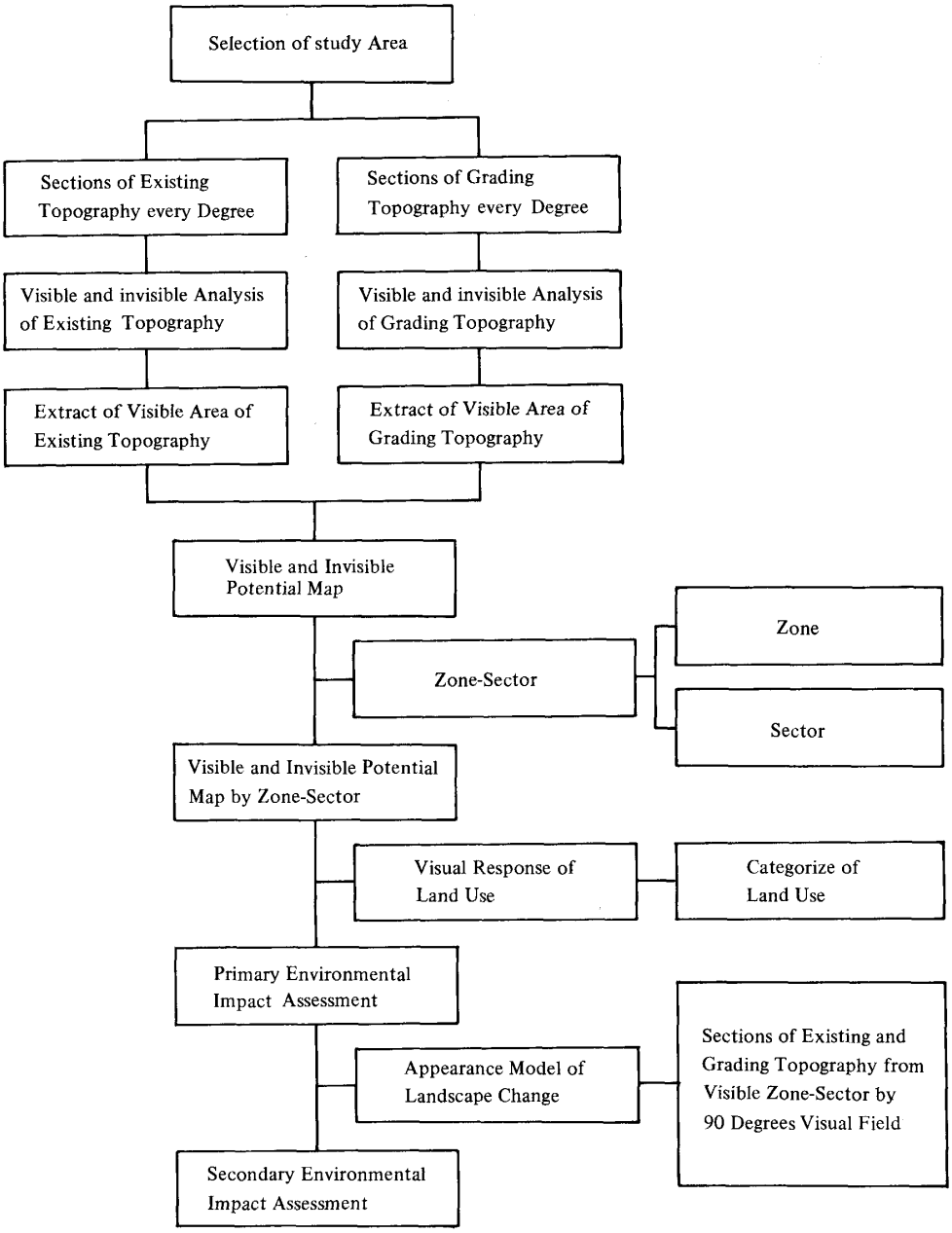
The methods and procedure used in this study are shown in Table 1 and these are described fully below. The study area selected is in a mountainous district in southern Osaka as mentioned above.

1. To study the effects of landscape changes due to the changes in the development sites, existing topography and grading topography within an area of 10km radius from the highest point of the development site, are analyzed. That is, every section of existing topography and grading topography of the study area is drawn, based upon a topographical map of 1:10,000 scale. Fig.1 and Fig.2 show the existing topography and grading topography in a model chart.

2. The visible areas are extracted by means of visible and invisible analysis which assesses the level of vision in each section from viewing point P and P′ in the development site. Fig.3 shows the visible and invisible analysis system of each section of existing topography in the model chart and also Fig.4 shows the visible and invisible analysis system of each section of grading topography in the model chart.

3. The visible and invisible maps of existing and grading toppgraphy in relation to the development site and its surrounding area where landscape changes will occur and which the visual impact of landscape changes will affect, are made by combining each section. Fig.5 shows the visible area from viewing point P of existing topography and

Table 1. Research Diagram



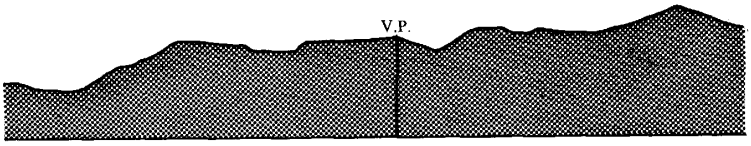


Fig. 1. Model chart of existing topography

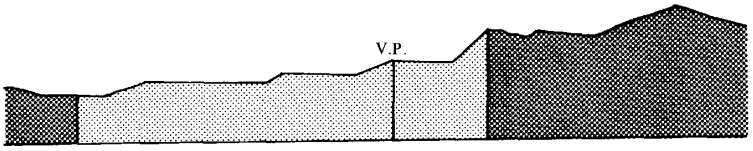


Fig. 2. Model chart of grading topography

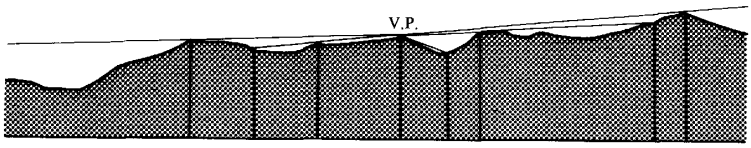


Fig. 3. Visible and invisible analysis of existing topography

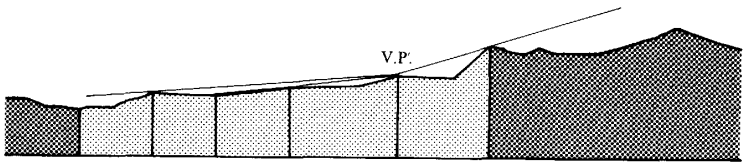


Fig. 4. Visible and invisible analysis of grading topography

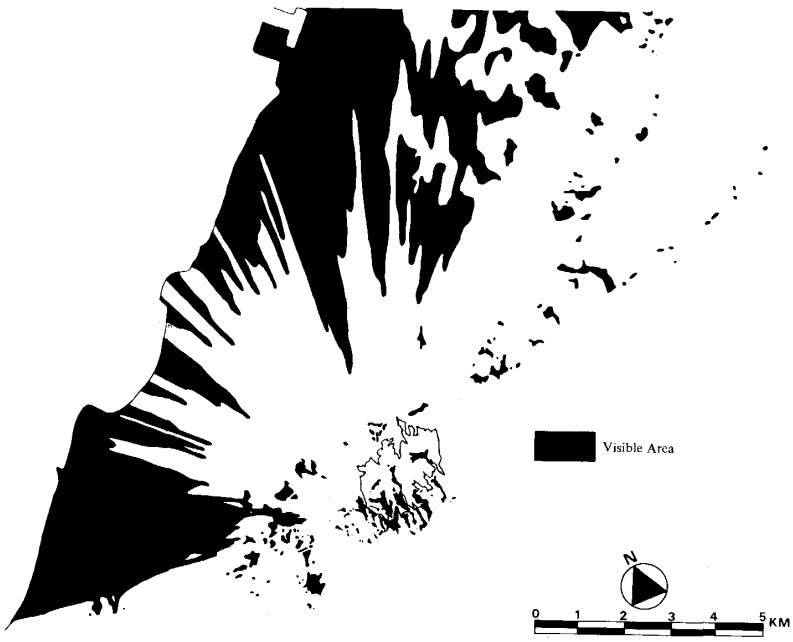


Fig. 5. Visible and invisible area of existing topography

Fig.6 also shows the visible area from viewing point P′ of grading topography.

4. The visible and invisible potential map of landscape ohange (Fig.7) is made by overlaying both the visible and invisible map of existing topography (Fig.5) and the visible and invisible map of grading topography (Fig.6). Table 2 shows the categories of visibility and invisibility relationship between existing topography and grading topography.

5. The zone-sector system as an analysis and evaluation tool for landscape changes and its visual impact on the surrounding areas of the development site is used to promote relative discussion for this study. The zone-sector system is composed of a zone which divides the study area into units 500m in radius (500, 1,000, 1,500, 2,000 -----) and a sector, which divides the study area every 10 degrees from the highest point of the deve-

lopment site. Fig.8 shows the zone-sector chart.

6. The visible and invisible potential map which is shown in Fig.7 is projected onto the zone-sector system. Fig.9 shows the visible and invisible potential map by the zone-sector system and this is very useful to study the relative likelihood of visual impact.

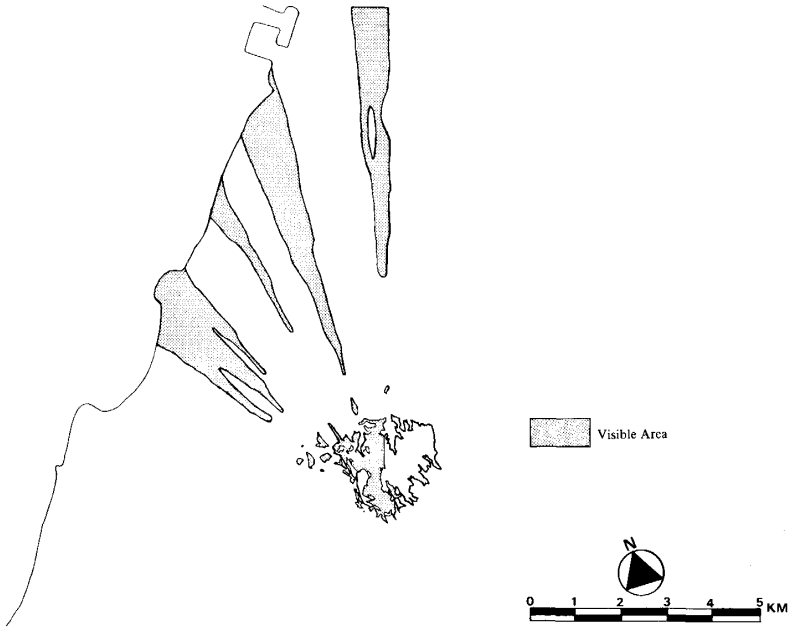


Fig. 6. Visible and invisible area of grading topography

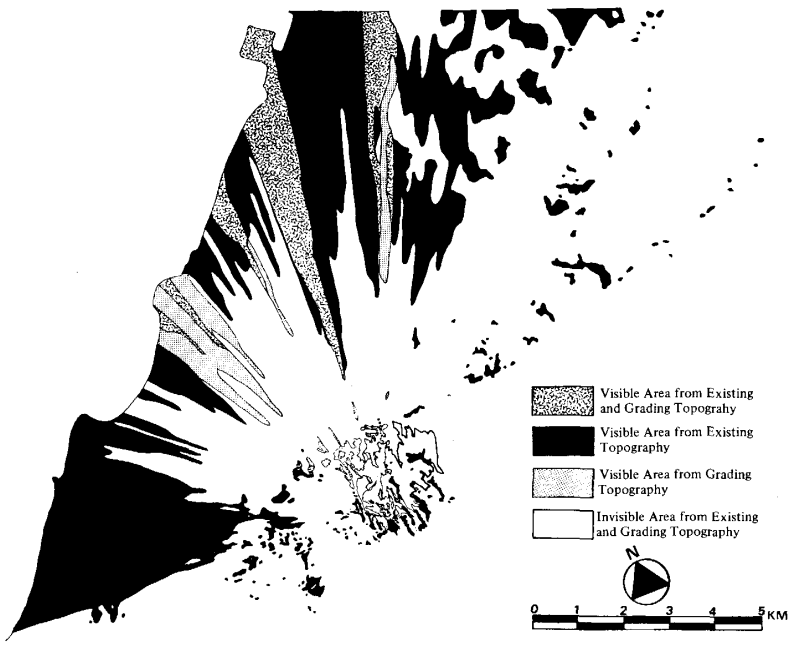


Fig. 7. Visible and invisible potential map

Table 2. Visible and invisible relationship between existing and grading topography

		Granding Topography	
		Visible	Invisible
Existing Topography	Visible	A	B
	Invisible	C	D

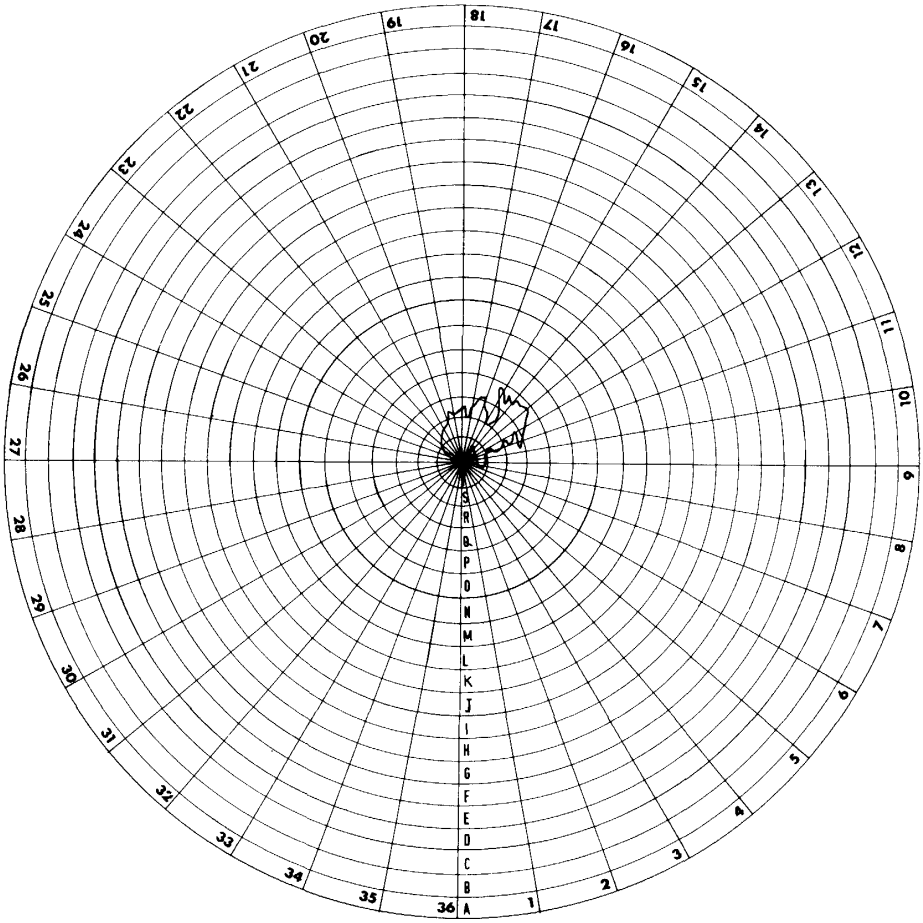


Fig. 8. Zone-sector system

7. Existing land use of development sites and their surrounding areas, where the visual impact of landscape changes will have effect analyzed to correspond with the con-

sequences of impact. Table 3 shows land use categories and the ranks of visual response. This analysis shows the visual responses which land use characteristics involve, that is the density of human settlements. In this study, the land use characteristics for each zone-sector are clarified by the priority of the occupancy, being over 50% in the land use category (Fig.10).

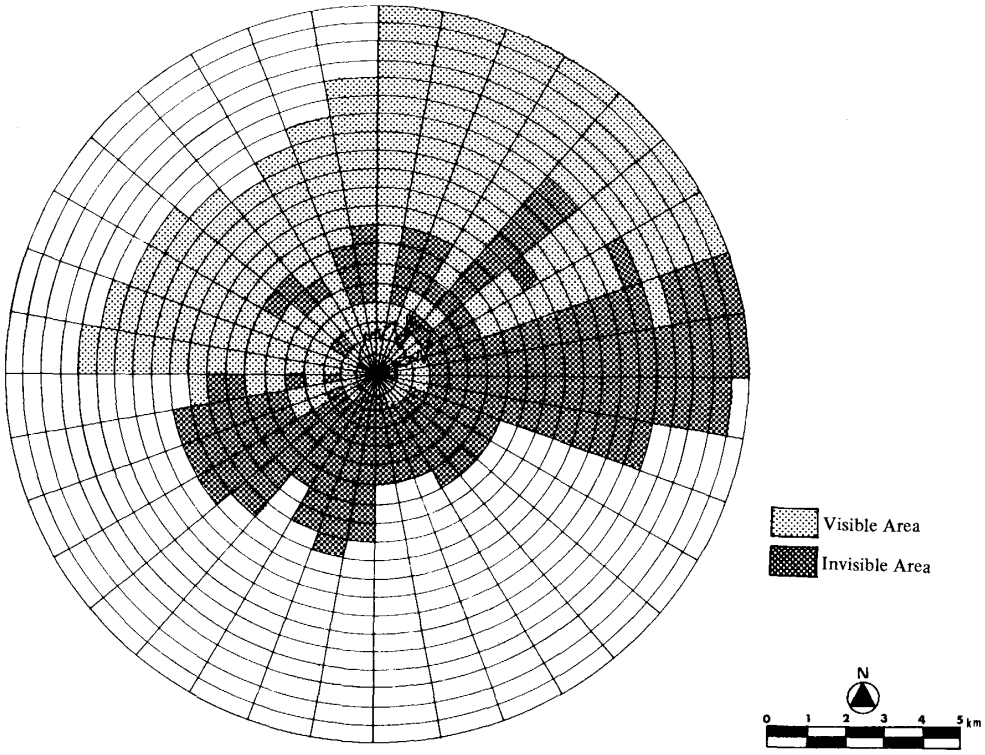


Fig. 9. Visible and invisible potential map by zone-sector

Table 3. Category of Land Use and Rank of Visual Response

Category	Rank of Visual Response
Forest Grass Land	1
Orchard Rice Field Crop Field Reservoir Vacant Lot	2
Golf Course	3
Park and Open Space Sportsground Institution Welfare Facility	4
Residential Area Commercial Area Industrial Area	5

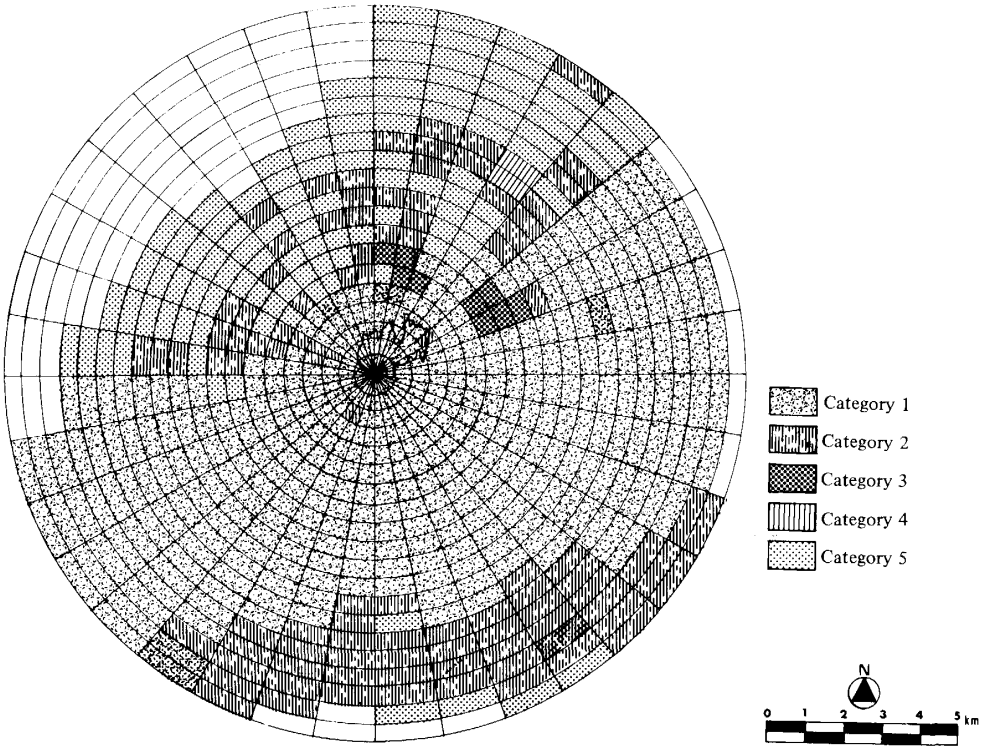
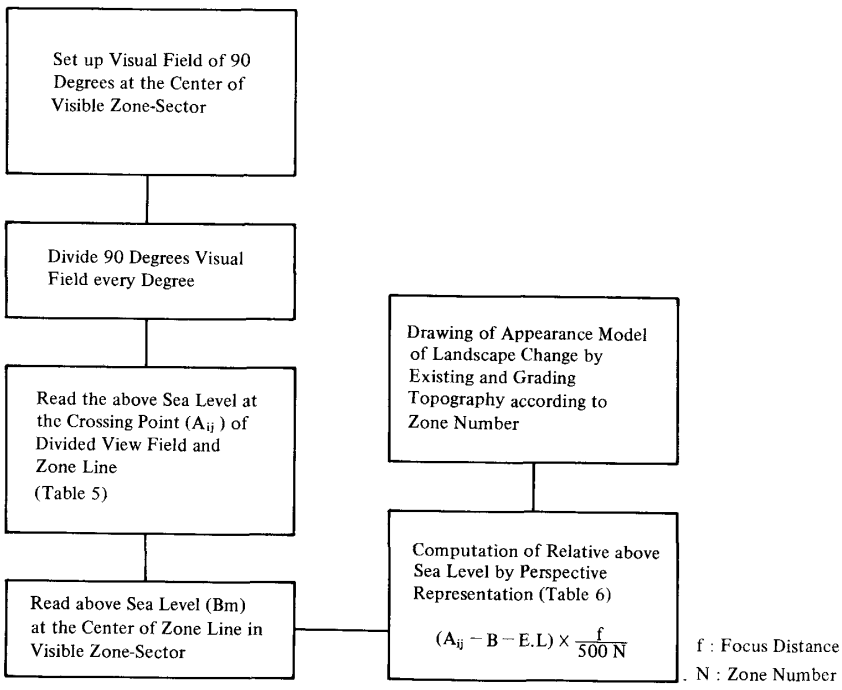


Fig. 10. Categories of land use

Table 4. Drawing process of appearance model of landscape change



8. An appearance model of landscape changes has been made in order to grasp the unpleasing effects of the visual impact of landscape changes in development sites and on

the surrounding areas. Table 4 shows a simulation for the appearance model of landscape changes. Fig.11 shows a frame for the drawing of the appearance model, the frame being defined with a 90 degree angle in the horizontal direction and a 45 degree angle in the vertical direction as the visual field for the observer. Fig.12 shows the drawing process for an appearance model of landscape changes based upon Table 4.

Table 5. Matrix of divided view field and zone line

Zone Number	Section Number of View Field									
	1	2	3	4	5	.	.	.	.	91
1	A_{11}	A_{12}	A_{13}	A_{14}	A_{15}	.	.	.	.	A_{191}
2	A_{21}	A_{22}	A_{23}	A_{24}	A_{25}	.	.	.	.	A_{291}
3	A_{31}	A_{32}	A_{33}	A_{34}	A_{35}	.	.	.	.	A_{391}
4	A_{41}	A_{42}	A_{43}	A_{44}	A_{45}	.	.	.	.	A_{491}
5	A_{51}	A_{52}	A_{53}	A_{54}	A_{55}	.	.	.	.	A_{591}
.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.
N	A_{N1}	A_{N2}	A_{N3}	A_{N4}	A_{N5}	.	.	.	.	A_{N91}

Table 6. Matrix of relative above sea level by perspective representation

Zone Number	Section Number of View Field									
	1	2	3	4	5	.	.	.	.	91
1	a_{11}	a_{12}	a_{13}	a_{14}	a_{15}	.	.	.	.	a_{191}
2	a_{21}	a_{22}	a_{23}	a_{24}	a_{25}	.	.	.	.	a_{291}
3	a_{31}	a_{32}	a_{33}	a_{34}	a_{35}	.	.	.	.	a_{391}
4	a_{41}	a_{42}	a_{43}	a_{44}	a_{45}	.	.	.	.	a_{491}
5	a_{51}	a_{52}	a_{53}	a_{54}	a_{55}	.	.	.	.	a_{591}
.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.
N	a_{N1}	a_{N2}	a_{N3}	a_{N4}	a_{N5}	.	.	.	.	a_{N91}

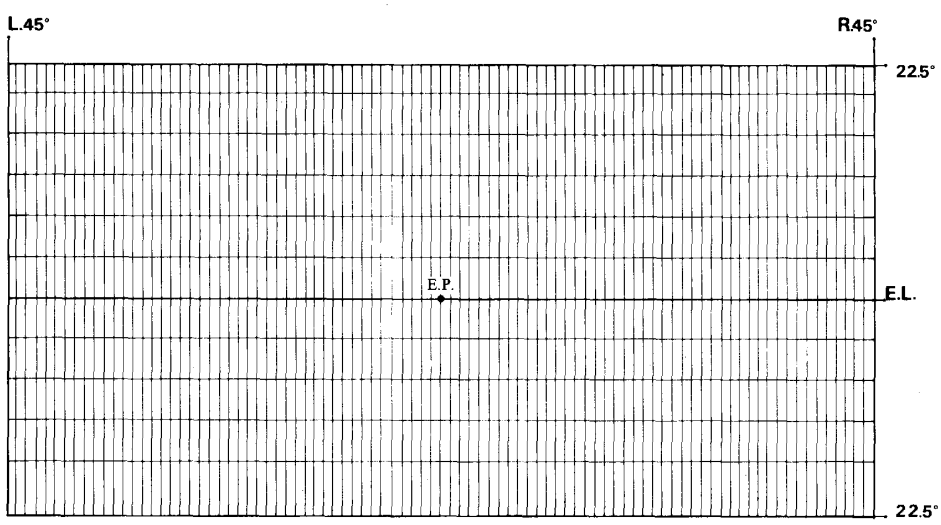


Fig. 11. Frame of drawing for appearance model

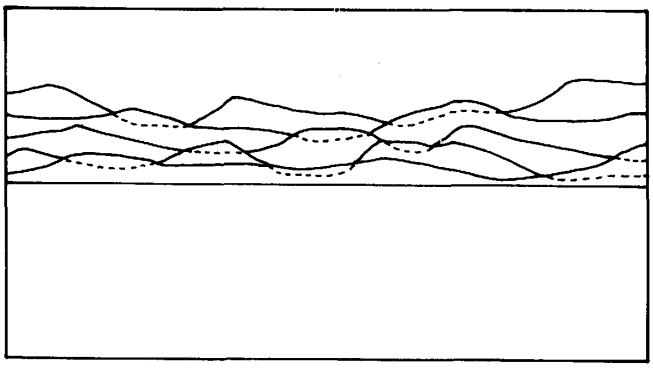


Fig. 12. Drawing process of appearance model of landscape change

Results

The results of environmental analysis and environmental impact assessment for landscape changes of development sites and surrounding areas, based upon Table 1, are described as follows. The consequences of visual impact and the unpleasing effects of visual impact were assessed through the visible and invisble concept and the appearance model of landscape changes.

1. *Visible and invisible potential of each zone-sector*

Table 2 shows the visible and invisible relationship between existing topography and the grading topography of the development site and its surrounding areas and these areas were categorized into the following four types.

Type A : Both existing topography and grading topography of the development site can be seen from this area.
Type B : Only the existing topography can be seen from this area.
Type C : Only the grading topography can be seen from this area.
Type D : Neither the existing topography nor the grading topography can be seen from this area.

Each in these four types indicates visual potential for the landscape changes in the development site. Then, by the overlaying of the visual potential of these four types (Fig.7) and the zone-sector chart (Fig.8), the visible and invisible potential for each zone-sector was classified for ten types. These are Type B, D, AB, AC, BD, CD, ACD, BCD, ABD, and ABCD. Fig.13 shows these potentials, excluding D.

2. *Response of visual impact in each zone-sector based upon land use categories*

Land use of the development site and its surrounding areas involves a visual response for landscape changes by the obserber. That is, it is possible to set up in rank the visual response for each land use category in consideration of the density of the human settlement. As a result of this consideration, the ranks of visual responses of the land use categories were evaluated as follows.

Category 1 : Forests and Grass land
Category 2 : Orchards, Rice fields, Crop fields, Reservoirs and Vacant lots

Category 3 : Golf courses
Category 4 : Parks and Open space, Sportsgrounds, Institutions and Welfare facilities
Category 5 : Residential areas, Commercial areas and Industrial areas
The ranks of visual responses of the land use categories have been indicated in Table

3. *The primary environmental impact assessment for landscape change*

Environmental impact assesment of this stage was assessed through the relationship between the visible and invisible potential of each zone-sector and the visual response of the land use category in each zone-sector. Type D in the visible and invisible potential has no response to landscape changes so Type D was omitted in this stage (Fig.13). Of the five categories of land use, categoty 5 is a very important area from the point of view of the visual response for landscape changes of the development site. Therefore, the zone-sector is appropriate to category 5 of land use is considered to be a high potential area of visual response. Fig.14 shows the zone-sector which belongs to category 5. The zone-sector shown in Fig.15 was found by overlaying Fig.13 and Fig.14. This is the area of most consequence affecting the visual impact of landscape changes in the development site. Therefore, Fig.15 shows the results of a primary environmental impact assessment for landscapepe changes.

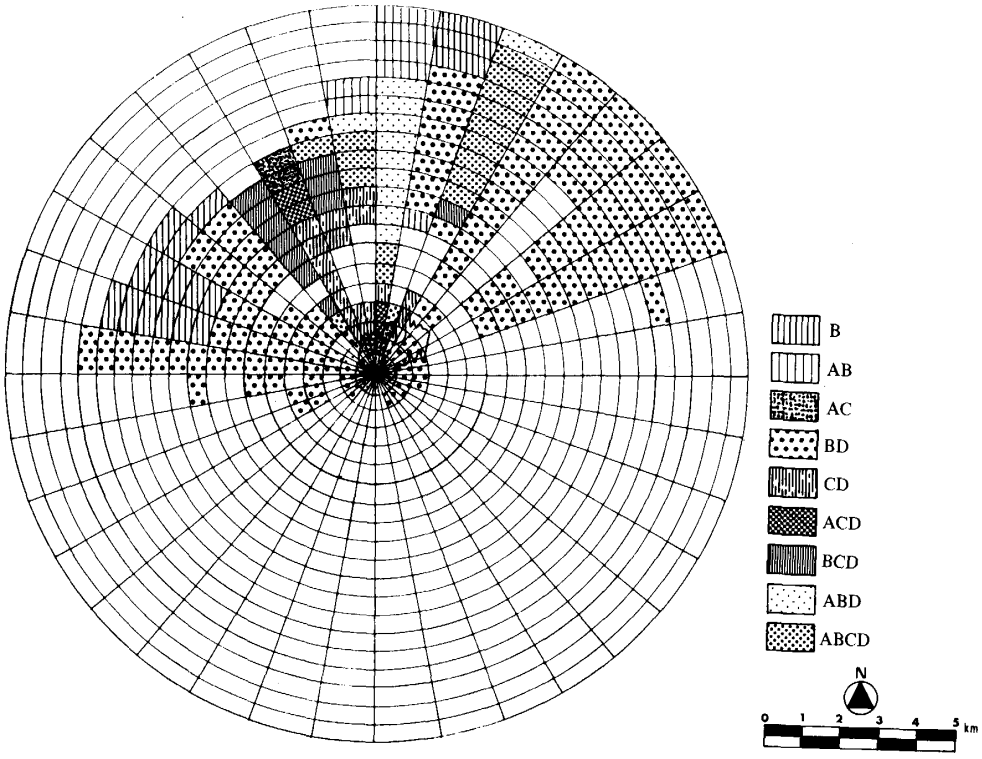


Fig. 13. Types of visible zone-sector

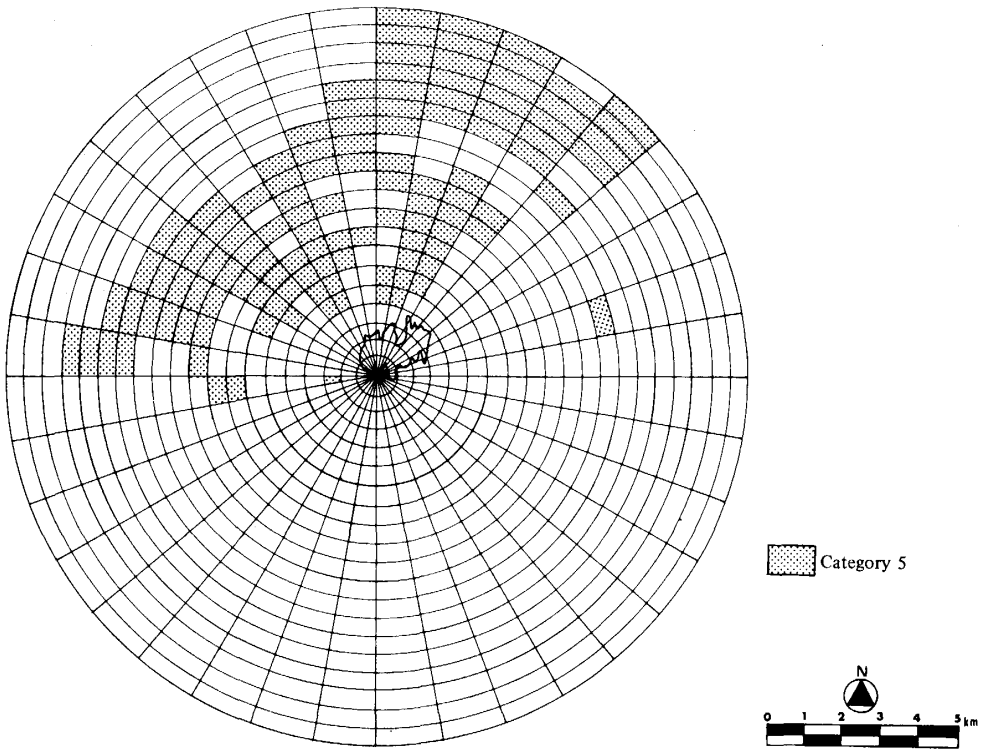


Fig. 14. Highest visual response of land use

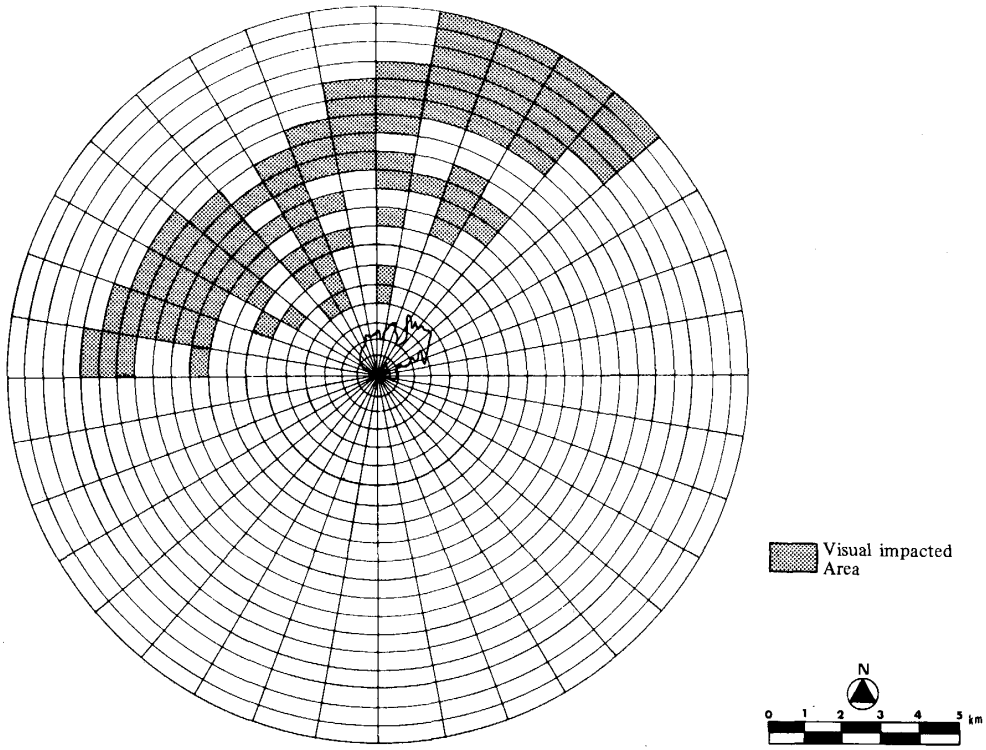


Fig. 15. Visual impacted area of landscape change

4. *The secondary environmental impact assessment for landscape changes*

The appearance model of landscape change from each zone-sector shown in Fig.15 was drawn based upon Table 4, Table 5 and Table 6. Fig.16, Fig.17 and Fig.18 show the appearance model as examples. They indicate the unpleasing effects of landscape changes in a visible area shown in Fig.15.

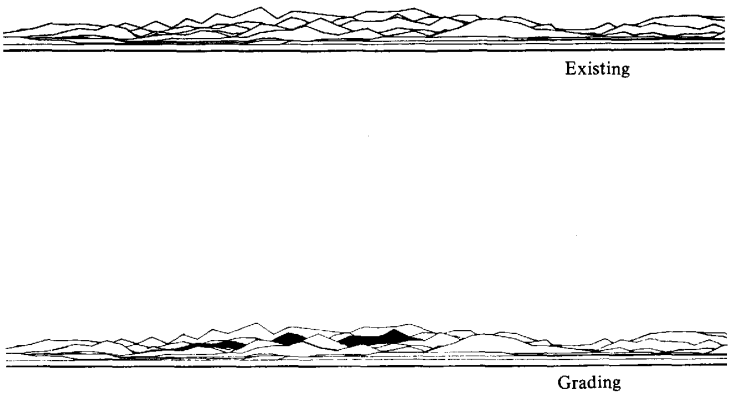


Fig. 16. Appearance model of landscape Change (1)

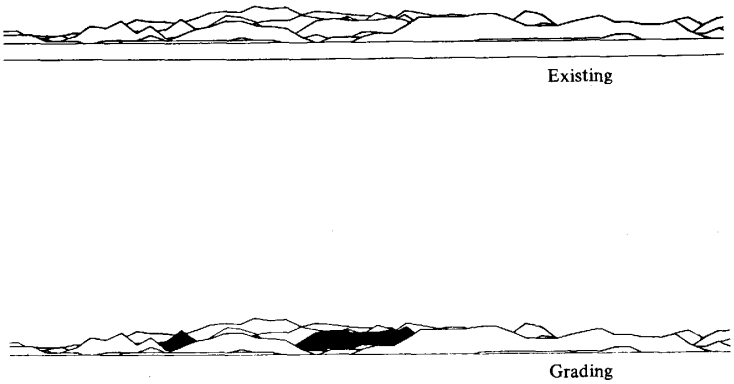


Fig. 17. Appearance model of landscape change (2)

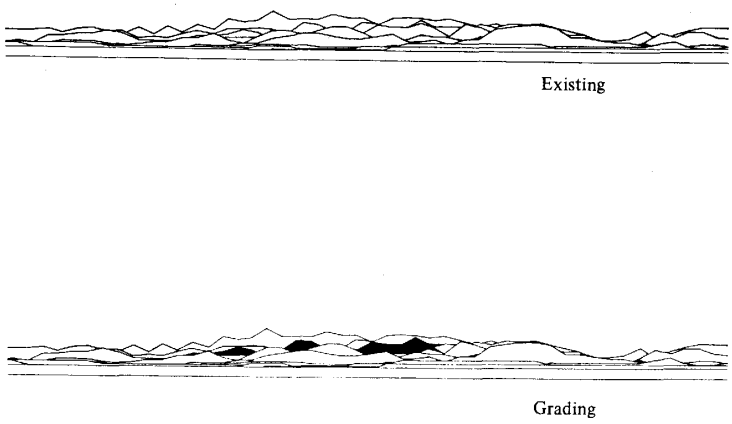


Fig. 18. Appearance model of landscape change (3)

Discussion

In this study, the landscape changes of a development site in a regional project were analyzed and their visual impact assessed on the surrounding areas. The methodology of analysis for the landscape changes and the assessment of the visual impact on the environment was developed through the consideration of the consequences and unpleasing effects of the visual impact.

References

1) LOVEJOY, D. (1973). *Land Use and Landscape Planning.* Leonard Hill Books, Great Britain.
2) HIGUCHI. T. (1975). *The Visual and the Spatial Structure of Landscape.* Gihodo, (*in Japanese*).
3) ZUBE, E.H., BRUSH, R.O. and FABOS, J.G. (1975). *Landscape Assessment.* Dowden, Hutchinson & Ross, Inc. Pennsylvania.