GEOGRAPHIC INFORMATION DATABASE FOR LANDSCAPE EVALUATION

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Abstract. In a landscape evaluation of a large-scale facilities construction such as garbage disposal facilities, it is necessary to grasp landscape characteristics of the area that is able to observe object facilities. This landscape characteristic consists of both a geographical characteristic (landscape resources, public space, districts designated by various urban planing laws, etc.) and a visual characteristic (visibility / invisibility range, distance from the object). The facilities design with consideration for landscape requires a geographic information database for the landscape characteristic, which enable planners to share the geographic information in the area. Authors proposed Network-based Dynamic Evaluation Process for urban landscapes in CAADRIA98, and illustrated the need of the common place that shares geographic information in the process. The system has function to provide the information of the area with layered maps simply. However the system developed with HTML Layer Function, that has limited to update data and boolean operate of layers. For using the system for practical purposes, it should conduct a GIS lookup and report back, via HTML. On the other hand, at present, there are various analogue thematic maps, digital maps are not prepared enough for landscape evaluation. It causes that landscape design process is not efficient. Also, a potential (importance) of viewpoints for evaluating facilities design have been defined by qualitative analysis so far, therefore a quantitative comparison of viewpoints was not available. As a solution of those problems, authors are tackling the development of Geographic Information Database (GIDB) by using GIS. In this paper authors give an outline of GIDB composed of overlaying various digital thematic maps included visual characteristic of the facilities. As a case study, in construction of the garbage disposal facilities in Kumamoto city, the important viewpoints was extracted by GIDB.

1. Concept of Geographic Information Database for Landscape Evaluation

When large-scale facilities are constructed, it is necessary condition to evaluate the influence which the project gives to a regional landscape for making consensus decision among parties who are the planers, the administrators, and a regional resident. If the place of the information sharing and the opinion exchange is constructed on Internet, consensus decision making in landscape architecture can be expected to be promoted.

In CAADRIA98, authors proposed the dynamic landscape evaluation process where the network had been used as a technique of consensus decision making process in landscape architecture. A basic concept of this process is to aim at the decision making from the plan stage of the project. This process supports the interactive information exchange though the network among those who plan and those who evaluate the landscape of the project (Generally, it is non-expert). This process is composed of the following five steps, and the modification and the evaluation of the project is repeated.

Step 1. Sharing landscape information
Step 2. Making of landscape evaluation model
Step 3. Interactive evaluation
Step 4. Result consolidation
Step 5. Statistics and decision making

This process is achieved by the system which uses the interface on WEB and the database server. This thesis reports on the construction of the Geographic Information Database (GIDB) for " Step 1. Sharing Landscape information ". This database offers geography information for examining the landscape by GIS and the WEB server. Moreover, the role to make all parties concerned understand the circumference environment at the current state is played. GIDB offers two kinds of map information. One, is "Regional characteristic map" by which a geographic characteristic of the object area is shown. This arranges and accumulates information necessary for examining the landscape from among various maps (both analog and digital) of the object region. The second is "Visual characteristic map", by which the view to the object facilities is considered. This map shows the distance from visible region and its' aspect to the object of the object facilities in the region, based on three dimension information on the mesh data. of the contour line and the height. The weight of the selection condition is decided and based on the regional characteristic map and the visual characteristic map at the viewpoint selection for evaluating the object facilities. Moreover, the offer of sight information in which the multimedia such as photographs and videos used becomes possible on WEB. The link of these multimedia data and map information supports the grasp of a regional landscape from both sides of the geography and the sight.

2. Regional Characteristic Digital Map

This chapter describes a concrete content of a regional characteristic digital map. Map information on the following items would be needed when the landscape examined is to be input at GIS.

i) Law and ordinance which affects regional landscape
ii) Main landscape resource
iii) Regional resident's stay ground (public facilities)
iv) Road and public transportation situation

These map information is obtained from maps such as the digital map of Geographical Survey Institute, the map where image data taken from paper map with scanner was converted into vector data, and the map where statistical information in the region is assumed to be an attribute. The content of a regional characteristic digital map is the Table 1.

Table 1. regional characteristic digital map

classification	contents
Law related landscape	□Natural park law □Cultural properties protection law □The Town Planning and Zoning law □City green tract of land maintenance law □Ordinance by local institute
Natural landscape resources	□Natural parks □Geographical features □Recreation facilities
Humanities landscape resources	□Scenic spot □Shrine and temple
Public utilities	□Public office (government, city, town) □Schools □Hospitals □Parks □Recreation facilities □Public hall □Harbors
Resident areas	□Residential quarters □Apartment houses
Public transportation	□Main local road □Bus route □National roads □Highways □Railway tracks
Evaluation viewpoints	□direct input

It is possible to categorize viewpoints roughly into two types. One is main stay ground which is person's gathering place, another is movement viewpoint on the traffic line. It is necessary to consider the viewpoint selection separately for a fixed and a moving viewpoint. Moreover, a regional resident and the tourist should separately consider the estimation of the landscape. The coordinate system in a regional characteristic digital map is UTM, which enables the analysis by overlay with a visual characteristic digital map.

3. Visual Characteristic Digital Map

The influence which the object facilities exert on a regional landscape is different depending upon the position of the facilities and scales. A visual characteristic digital map is a map where the visual target characteristic of each facilities is presented. The evaluation viewpoint of the object facilities is selected by the overlay of this visual characteristic digital map and a regional characteristic digital map. A visual characteristic digital map contains the following items.

i) Visible and invisible region
ii) Area division by visual distance
iii) Azimuth

3.1. EXTRACTION OF VISIBILITY BY GIS

When the viewpoint is selected, the analysis of visibility is a physical judgment technique. Invisible region was calculated by the Triangular Irregular Network (TIN) data made based on the height data of 50m mesh. In this research, visible and invisible area were analyzed by using the VISIBILITY function of ArcInfo. When visibility is calculated, it is necessary to input the following conditions as an attribute of the viewpoint coverage in Table 2.

Table 2. Attribute of viewpoint coverage

Attribute	explanation
OFFSET	Distance from ground level to viewpoint
VERT	Vertical angle (glance is assumed to be 0 degrees)
AZIMUTH	Horizontal angle (north is assumed to be 0 degrees)
RADIUS	Range of view to assume visual distance to be radius

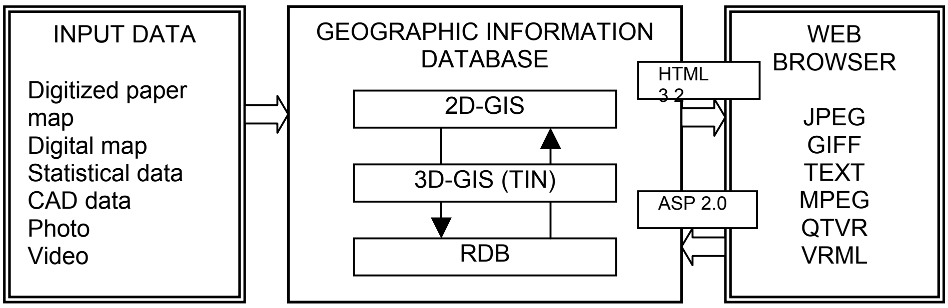
Moreover, when the viewpoint is point coverage, visibility of the object is distinguished, and for the point coverage with the line coverage two or more points, visible frequency of the object is calculated. In this research, visible frequency defines the polygon of one or more as a visible region. The calculation result output is as polygon coverage or grid coverage. The polygon of 25m*25m was assumed to be one unit in this database though the size in the polygon or the grid was able to be specified on outputting. However, even if it is a visible region, it is likely to actually become an invisible area with the adjoining building etc. Therefore, terminal decision of the viewpoint selection needs site investigation.

3.2. RANGE OF VIEWPOINT LOCATION AND VISUAL DISTANCE

In the definition of eyesight by Landolt's ring, the angle of elevation to expect the object which can be identified is made from 1 to 3 degrees to the limit. The range of the viewpoint is decided from the height to be investigated. In this research, the angle of elevation 1 degree was adopted, and the range of the viewpoint investigation was decided. On the other hand, when the structure and the building are recognized in the scenery, the distance from the viewpoint to the object is an important condition in landscape evaluation. The visual influence which the form exerts on the region differs according to the distance from the viewpoint. Therefore, the range of the viewpoint is divided into the near view, the middle view, and the distant view according to the visual distance.

4. Specification of GIDB for Landscape Evaluation

Geographic Information Database (GIDB) is composed of 2D/3D-GIS which manages geography information and RDB which manages multimedia like image and movie, etc. The map data can be inspected by setting up this GIDB in the WEB server on the home page. Neither GIS nor the WEB server cooperate dynamically though information from GIS is passed to the WEB server through RDB. Various map data made with GIS are saved to RDB as image data. Figure 1 is a system configuration chart including data entry.



Software		Program Language	Hardware
2D-GIS	Arcview 3.0	JAVA script	Pentium□ 300Mz
3D-GIS	Arcinfo 7.2	VB script	Memory 256Mb
RDB	Microsoft Access 97	ASP 2.0	HD 8G
CAD	AutoCAD R14	HTML 3. 2	
WEB Server	IIS 4.0		

Figure 1. System configuration of GIDB

5. Landscape Evaluation Viewpoint Selection Technique

When the change in the landscape is forecasted and evaluated, it is necessary to select the evaluation viewpoint ,that is, the representative viewpoint. First of all, the method of selecting this viewpoint sets an important place in the region where the object facilities can be seen as a viewpoint candidate. Finally, the viewpoint is selected by each viewpoint's situation, and the representative viewpoint is decided by the site investigation. Neither the condition nor the technique to select the viewpoint are established, and an efficient selection is not done so far. In this research, to select the viewpoint efficiently and reasonably the viewpoint was selected by GIS by using regional characteristic information and sight characteristic information on landscape information DB. The compound element is intertwined and viewpoint's importance cannot be compared simply. Here, to reflect the subjective element between parties concerned, AHP method (Analytical Hierarchy Process) was applied to the degree of importance of the viewpoint.

Three screen tests are conducted in the viewpoint selection, and all viewpoint candidate is selected with each screen. The prime screen test is a selection by the visibility. The viewpoint located in visible region is selected. Visible region is obtained by the VISIBILITY tool of GIS. The second screen test is a selection by each viewpoint's degree of importance. The AHP method is used for the importance of the degree decision of the viewpoint. The importance degree decision according to the AHP method is described in the next chapter. The third screen test is selection by the site investigation. The viewpoint from which the glance is interrupted by the building and the tree is excluded by the site investigation. In addition, a terminal viewpoint is selected by the situation around the viewpoint. The flowchart of the viewpoints selection technique is presented in Figure 2.

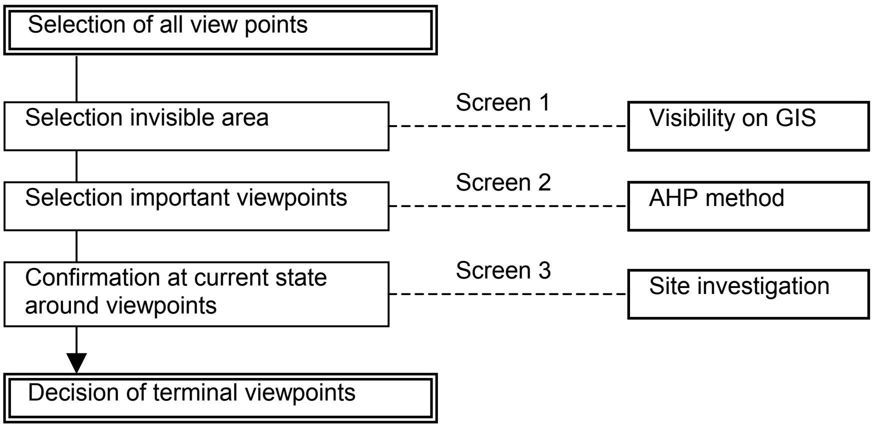


Figure 2. Flowchart of viewpoints selection

6. Case Study

The landscape design of garbage processing plant of the city outskirts is assumed to be a case study, and the case where a main viewpoint is extracted by using GIDB is to be introduced. The object facilities are an east part of

Kumamoto City environmental factories. The specification and externals of these facilities are recorded in Table 3.

Table 3. Specification of Kumamoto garbage processing plant

Site area	18,000sqm
Factory building	RC/SRC structure 5 floors above ground 2 floors underground
Building area	7,537sqm
Architectural area	24,010sqm
Chimney	RC structure Freeboard 80m

6.1. VIEWPOINTS SELECTION BY AHP METHOD

The viewpoint was applied, and the order was applied by the AHP technique and the importance degree was decided according to the following three conditions.

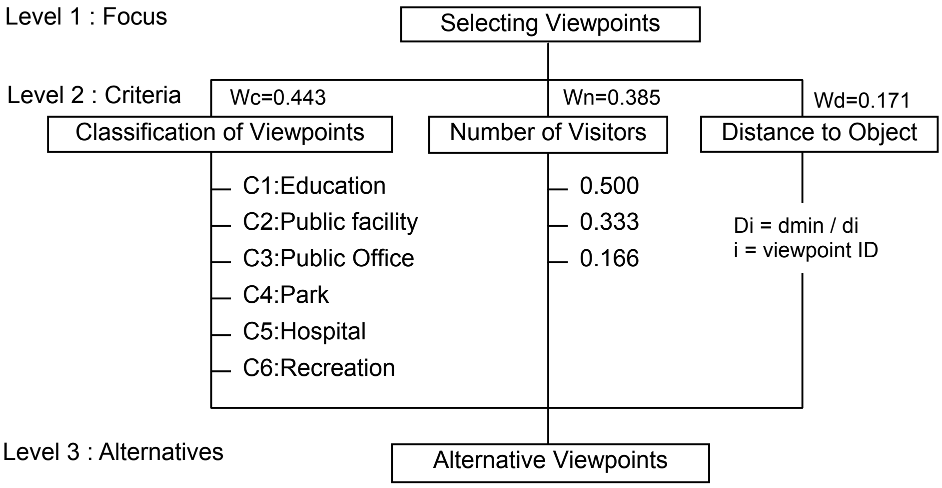


Figure 3. Hierarchy structure in selecting of the viewpoints

i) Classification of viewpoints *Wc: 0.443*
ii) Number of visitors *Wn: 0.385*
iii) Distance to object *Wd: 0.171*

Figure 3 shows the Hierarchy structure in the weighting of the viewpoints.

i) The viewpoint was classified into six categories. The matrix is made by the a couple of comparisons between the classifications of the viewpoint, and the eigenvector of the matrix, which becomes a degree of importance in the classification of the viewpoint. In the case study, geometric mean of a couple of comparison value of ten parties concerned was assumed to be representative's matrix, and the importance degree by the classification of the viewpoint was calculated.

Table 4. Matrix of classifications weight

	C1	C2	C3	C4	C5	C6	Weight
C1	1.000	0.861	2.658	0.590	0.868	0.945	0.155
C2	1.162	1.000	1.949	0.429	0.790	0.433	0.127
C3	0.376	0.513	1.000	0.256	0.410	0.230	0.061
C4	1.695	2.330	3.912	1.000	1.616	1.196	0.264
C5	1.152	1.266	2.442	0.619	1.000	0.719	0.162
C6	1.058	2.310	4.341	0.836	1.391	1.000	0.231

C.I.=0.012 C.R.=0.010

ii) The number of visitors of viewpoints was assumed to be three levels though was normally necessary the site survey.

iii)The distance to the object assumed the nearest viewpoint (450m to the object) to be 1 and used the ratio of the distance of each viewpoint.

First of all, the importance degree of three conditions is calculated by a couple of comparisons. Next, the importance degree of the viewpoint in each condition is evaluated by "Absolute evaluation method". Overall multiply, and total the importance degree of each condition to the evaluation value of the viewpoint at the end viewpoint's ranking is defined. The weight of each viewpoint: Wi is calculated by the following expressions.

$$Wi = Wc*Ci + Wn*Ni + Wd*Di$$

Wi : Weight of viewpoint *i = viewpoint ID*
Wc =0443 *Ci: Weight of Classification*
Wn =0.385 *Ni: Weight of Number*
Wd =0.171 *Di: Weight of Distance*

The ranking to the fifth high rank place of the viewpoint in the direction of the southeast is recorded in Table 5 as an example. The viewpoint of all azimuths was ranked and terminal viewpoints were selected for landscape evaluation. Figure 4 and Figure 5 show the map where the selected viewpoint was plotted.

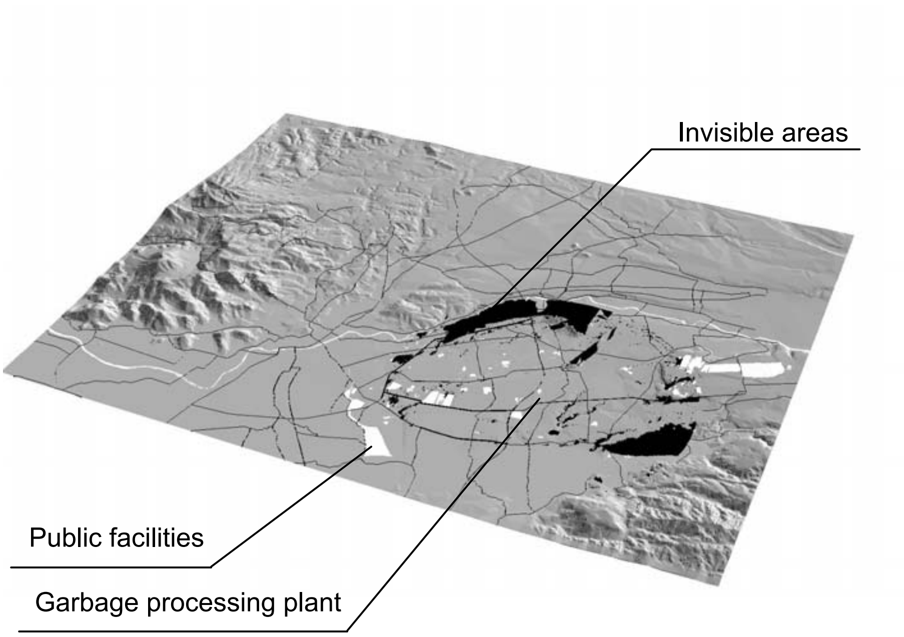


Figure 4. 3D-Map of the area

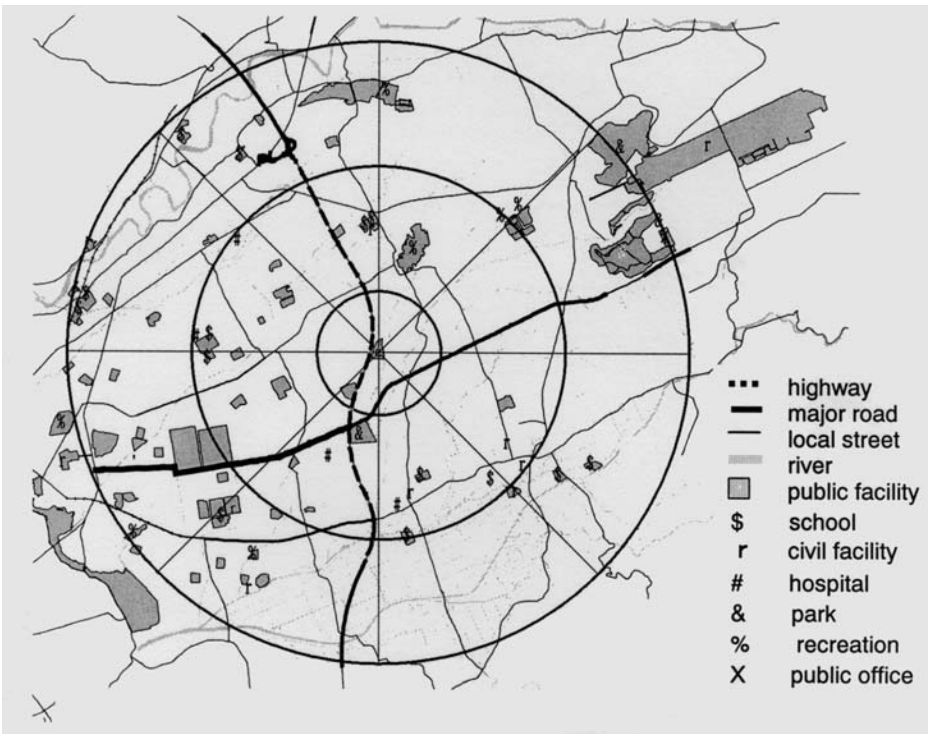


Figure 5. Map of selected viewpoints

Table 5. Rank of Viewpoints (South-East)

Name of Facilities	Classification 0.443	Visitors 0.385	Distance 0.171	Total Weight	Rank
Convention Center	0.201	0.500	0.360	0.343	1
Daini High school	0.121	0.333	0.134	0.205	2
Akitsu Park	0.217	0.167	0.243	0.202	3
Mashiki Hospital	0.128	0.167	0.106	0.139	4
Akitsu Town Center	0.107	0.167	0.118	0.132	5

7. Conclusion

The conclusions in this study are described as follows:
i) Viewpoint information and information around the site were arranged on Internet by using GIDB as a source of geographic information.
ii) The scene of the information sharing for the consensus decision making was constructed among parties in concern of the landscape examination.
iii) The viewpoint for landscape evaluation was able to be selected efficiently by using AHP method.

Future plans around the subject of discussion are described as follows:
i) An accessible system needs to be constructed directly with the WEB browser in the data of GIDB by GIDB and the WEB server by dynamic cooperation.
ii) The analysis by AHP to decide viewpoint's importance degree is not calculated dynamically in the database.
iii) It is necessary to develop the method of efficiently updating the map data and the statistical data into GIDB.

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