Jour. Korean For. Soc. Vol. 95, No. 5, pp. 605~613 (2006)

JOURNAL OF KOREAN FOREST SOCIETY

# The Building Strategies of Natural Park Integration Monitoring System Based on Geographic Information Analysis System

Min-Ki Bae[1] and Ju-Hee Lee[2]*

[1]Post Doc., Daegu University,
[2]Professor, Daegu University 15 Naeri, Jinryang, Gyeongsan 712-714, Korea

**Abstract :** The goal of this study was to propose building strategies of web-based national park monitoring system (WNPMS) using geographic information analysis system. To accomplish this study, at first, this study selected and made integrated management indicators considering physical, ecological, and socio-psychological carrying capacity in national park. Secondly, this study built up an integrated management indicator database and loaded this database in geographic information system. Thirdly, this study connected this system with statistical analysis program for execution of various multivariate analysis and spatial analysis. Finally, WNPMS could identify the relationship among visitors, natural resources, and recreation facilities in national park, and forecast the future management status of each national park in Korea. The results of this study will contribute to prevent the damage of natural resources and facilities, improve visitor's satisfaction, prevent an excess of carrying capacity at national park, and established tailored management strategies of each national park.

***Key words*** : *web-based national park monitoring system, integrated management indicator, carrying capacity, national park, geographic information analysis system, tailored management*

## Introduction

The 68% of animals and plants that inhabit Korea is in national park, national park occupies more than 90% of the 9-10 green nature level area, and national park occupies 53.5% of the natural environment conservation area in Korea. Therefore national parks should be considered preferentially for natural environment conservation in Korea. However, the 42.8% of the Korean tourist visited national parks in year 2005. With increase in leisure time due to the growing of income and the spread of the 5 days work week, the national park became major tourist attraction in Korea. Therefore, the establishment of management policy to respond to these trends is most important thing for sustainable use and the conversation of natural resources.

On the other hand, in order to lead an knowledge society the Korean government has established the National Information Infrastructure and digitized various data such as, population, housing, land, traffic, and environment etc. into a database to institute a Digital Korea. But the theoretical and practical research towards the usage of information technology for the management of environmental protection region including national parks is still in the early stages. There is almost no research towards development of management indicator considering carrying capacity, database construction, and analysis method for national park monitoring.

Also environmental thematic maps such as, eco-map, land cover map, and satellite images that are being constructed only serve the function of showing the current status through a digital map and there are no guidelines made. in terms of how to use various data for national park management. As a matter of fact, the Geographic Information System serviced by Korea National Park Service (www.npa.go.kr) does not differ greatly with pictures that indicate mountain paths and facilities and has limitations to use for establishing policies on national park management.

Problems that arise in national parks are not from one simple cause, because the problems are mutually related to visitors, natural resources, and facilities. So in order to grasp the fundamental problem and establish efficient management policy, all relationships such as, between visitors and recreation natural, visitors and facilities, natural resources and facilities, visitors and visitors must be considered comprehensively.

*Corresponding author
E-mail: jhlee3@daegu.ac.kr
This work was supported by the Korea Research Foundation Grant funded by the Korean Government (MOEHRD)(KRF-2005-037-F00006)

Therefore, it is necessary to select and develop management indicators and build a database accordingly. And load the database on geographic information system with analysis programs. And then, identify relationships existed among management indicators. However, up until now, there have been a lack of research on how to link the geographic information system and analysis program, how to analyze the data, and how to utilize the analytic results in the decision making process.

Hence, the purpose of this research is to propose building strategies of web-based national park monitoring system (WNPMS) using geographic information analysis system. The integrated management indicators (IMIs), integrated management indicator database (IMIDB), satellite images, geographic information system linking analysis program, those are provided by this research will be applicable to not only national parks but other environmental sensitive areas. At the same time, this system can be used to efficient tool to solve various types of environmental problem. Fundamentally, the goal of this research will contribute to establish online national environment management system by creating a process that loads the data from geographic information to an analysis program and then input the analysis results on the geographic information system again in internet.

## Review of Related Literature and Information Sytems

### 1. Review of Existing Literatures

First, even though national parks retain the most representative environmental, cultural and recreational values, management indicators have never been developed for the management of national park. Especially, the factors that affect the carrying capacity (Schneider, *et al.*, 1978; Stankey and McCool. 1984; Shelby and Heberlein, 1986; OECD, 1998; Kang, *et al.*, 2002) need to be included in management indicators for the accomplishment of original objective for national park, i.e. environmental resources conservation and sustainable use. Therefore, management indicators considered national park carrying capacity has never been developed.

Second, most of the existing research has focused on visitors, resources and facilities separately and lacked research in understanding the reciprocal relationships among management sectors, i.e. visitors, natural resources, and facilities (Lime and Stankey, 1971; Chang, 1997; Kim, 1997; Lee, 1997; Manning, 1999). As a results, the knowledge that is actually required in establishing a national park management policy has not been provided, such as what relationship exist between the increase of visitors number and the degree of resource and facility damage in the activity space.

Third, up to now, accumulated data about visitor's behavior, facility, and natural resource in national parks have not been loaded in to geographic information and are left in books and excel files lowering the efficient usage of the data (Kim and Han 2000; Lee, 2002; Cho and Bae, 2005). But there is close to no research done in how to load the data on geographic information for national park management. Therefore it was extremely hard to grasp important factors in national park management such as, the exact location the facility or resource damage occurred, the periodic and radical change of visitor's behavior, the visitor's movement characteristic classified by space and time, and so on.

Fourth, the existing research (Park *et al.*, 2001; Lee and Shim, 2002) did not consider the temporal changes of the management indicators and limited the specific time periods, which made it difficult to grasp the aggravation or improvement process of management problems. Therefore, this research hopes to understand the transformation process and causes of management problems through building time series database and establish an appropriate management policy.

Finally, national park management issues, such as, national park facility and resource damage, lower visitor satisfaction, carrying capacity calculation etc., are related to various factors, so there needs to be a multilateral analysis between management indicators to find causes of these problems and prepare a prevention countermeasure. In addition, in order to establish a tailored management policy that reflects the problems of each national park, linking the databases with analysis program to find the origin of the problems and submitting management policy solving problem are necessary. However, currently there is a lack of research on how to construct a geographic information database, link the database with an analytical program, and what method is needed for analysis.

### 2. Review of Related Information Systems

Address and facility searching are major function of Internet map services. However, these figures conceptually differ from statistical geographic map. At present, National Geographic Information System (NGIS), Korea Statistical Information System (KOSIS)(Choi, 1997), National Atlas in USA (http://www.nationalatlas.gov), Statistical Bureau in Berlin (http://www.stadtentwicklung.berlin.de), and United States Census Bureau (Marx, 1993) are the representative information systems. The goal of the NGIS is to provide the geographic information for the environmentally sound and sustainable land development. The KOSIS is built for efficient management the statistical data such as economy, population, land,

and housing and so on. One of the major functions of the KOSIS is to provide statistical information for a variety of users. The Ministry of Environment only supplies physical environmental statistical data such as, air, water, solid waste, and so on. But it does not provide the social environmental data such as, environment education, budget, and environmental technology which are important factors in building the environmental policy (http://ngis.me.go.kr/egis/). The Korea Forest Research Institute, Wu *et al.* (2001), and Alippi *et al.* (2004) also service a nationwide forest map that shows the location of national forest resources such as, botanical species and rare plant habitats. And the Korea National Park Service and Valeriano and Santos (2003) provide satellite pictures such as, climbing routines, facilities, and culture resources of each natural park on the web (http:/www.npa.or.kr/). The National Geographic Information Institute is servicing a National Atlas that collects a representative statistical data such as, population, industry, economy, and environment on its website (http://www.ngi.go.kr). However, this database only aggregated statistical data at the nation and city level. Therefore, there are some limitations to use these data for analyzing the environmental status in national park area. The Land Suitability Assessment System is newly introduced to provide criteria for land use classification in order to prevent unplanned development. It classifies land-use types into five grades: priority preservation, preservation, agriculture, development, and the developed area grade. The land suitability assessment should be executed before processing the land development in order to select the suitable land for the development.

After reviewing the related geographic information systems, this research figured out that most of map focused on the visualization of information but they do not provide the analytical procedure for getting the secondary information. In addition, there is no environmental geographic information system which provides realistic solutions on what relationship is existed among IMIs?, which IMIs cause management problem?, How will management problems change in the future? What is the most suitable solution to prevent the deterioration of management problems? Therefore, this research proposed how to link IMIDB with geographical data, to analyze the relationship among IMIs through time series analysis, spatial analysis, causal analysis, and so on, and to suggest tailored management policy through forecasting and monitoring.

## Material and Methods

### 1. Temporal Range

The time range of this research is from 1968, when the research subject Kyeryongsan was authorized as a national park, to the present. However, various thematic maps such as, stock maps, land cover maps, and satellite images, and attribute data such as, visitor's behavior data, natural resource data and other data needed to build a geographic information analysis system, were gathered starting different years and have different cumulative periods. Therefore there maybe some discrepancies in the time range.

### 2. Spatial Range

The spatial range of this research is the Kyeryongsan national park considering the number of visitors, the types of natural resources, the quantity of facilities, management problems that are currently occurring, ease of data collection, park dimensions, time to build a system, etc. Approximately one million persons visit Kyeryongsan national park per year. And due to its high density, many problems such as, resource and facility damage, Disorder, and social conflicts, etc occurred. On the other hand, Kyeryongsan national park possesses more accumulated data than other national parks, which eases research (Figure 1).

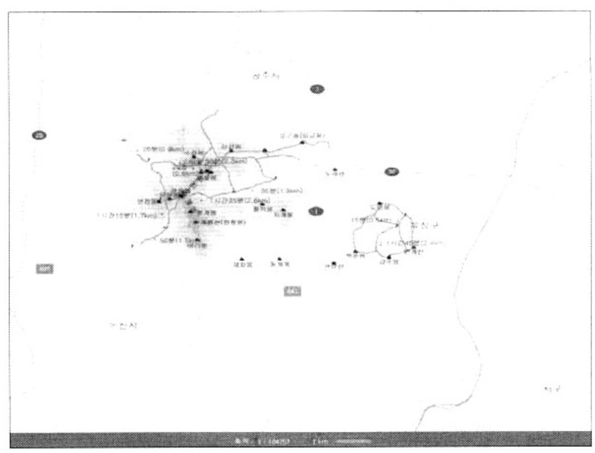

**Figure 1. Kyeryongsan national park (www.nap.go.kr).**

### 3. Research process and conceptual figure

First, this research selects and develops integrated management indicators considering the carrying capacity of national park. Second, this research collects time series data and satellite images that correspond to the integrated management indicators based on relational database model. Third, this research loads the database to the geographical information gearing an analysis program and executes various analyses such as, time series analysis, multiple regression analysis, and correlation analysis to identify the relationships among management indicators. Fourth, this research establishes the tailored management policy, forecasts the future status of man-

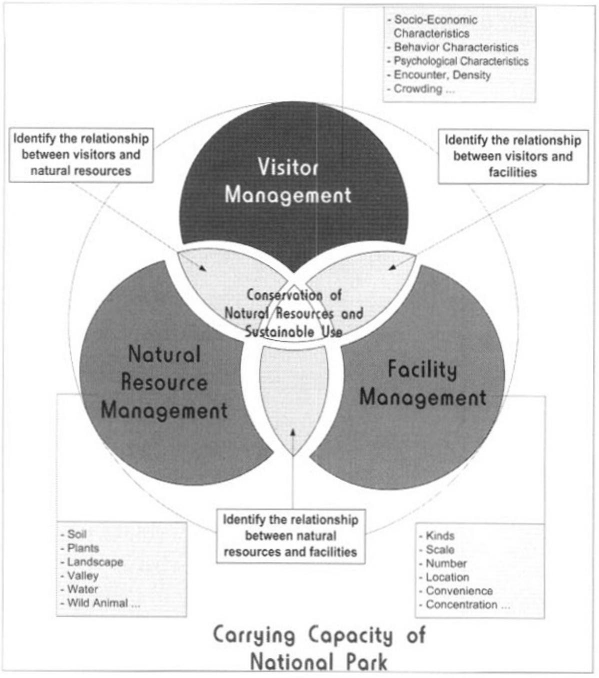


**Figure 2. The conceptual figure of the national park monitoring system.**

agement indicators, and monitors based on the results of analyses such as, which factors affect the damage of resource and facility and the decline of visitor's satisfaction?, where and when the problems occur?, how the situation might worsen in the future?, at which point there needs be a countermeasure? (Figure 2).

**4. Development of integrated management Indicators**

Because national parks have two different objectives at the same time, the conservation of natural resource and the sustainable use, carrying capacity should be considered certainly for the management of national park. Therefore this research aims to develop IMIs that include not only physical indicators such as, the number of natural resources and facilities, but also IMIs considering the national park's physical, ecological, social-psychological carrying capacity such as, crowding, encounter, expectation, etc.

In order to develop integrated management indicators, this research reviews domestic and international research papers and reports on carrying capacity (Godschalk and Parker, 1975; Jubenville, 1976; Frissell *et al.*, 1980; Graefe *et al.*, 1984; Heberlein *et al.*, 1986; Gunn, 1994; Hammitt and Rutlin, 1995; Jo, 1995; Park *et al.*, 2001; Chung, 2002; Jang and Bae, 2002; Shin *et al.*, 2002; Park, 2005). Especially, sustainable tourism indicators developed from the WTO (World Tourism Organization) and the related indicators submitted by IUCN (International Union for Conservation of Nature) and UNEP (United Nations Environment Program) are carefully examined to select indicators those are applicable to the Korean national parks. Also, related literatures and park management methods such as ROS (Recreational Opportunity Spectrum) (Driver *et al.*, 1987), LAC (The Limits of Acceptable Change) (Stankey *et al.*, 1985), VIM (Visitor Impact Management), VERP (Visitor Experience and Resource Protection) etc., are carefully examined. The selected indicators considered and sorted according to the current domestic environmental laws to maximize the effectiveness of the research. Finally, the research aims to apply sectoral frame work (Maclaren, 1996) and develop indicators that have not yet been considered.

**5. Analysis software**

This research builds up environmental database using Excel and Access (XLS file Format) and link environmental database with geographic information using ArcView 9.0 (SHP file format) with extensions such as, Spatial Analyst, 3D Analyst, and Geo-statistical Analyst, because XLS and SHP file formats are compatible with most GIS software and easy to link to environmental database and geographic information. It also uses the SAS® Bridge for ESRI to link geographic environmental data with an analysis program such as, SAS, SPSS. Also the analysis programs are used to identify what kind of relationships exist among IMIs through various analyses such as, logistic analysis, correlation analysis, time series analysis and so on.

## The Building Strategies of Web-based National Park Monitoring System

**1. The building of integrated management indicator database**

1) Using the already developed integrated management indicators, this research collects time series data as soon as possible to grasp the change process of integrated management indicators. That is, Increase in visitors → Induce natural resource and facility damage → Compose a response policy that examines a series of cause and effect.

2) For satellite images, use LANDSAT, SPOT, IKONOS, and KOMSAT constructed form the Ministry of Environment, Satellite Technology Research Center (http://satrec.kaist.ac.kr/).

3) This research builds up integrated management indicators database by using a relative data model because this data model can implement the spatial analysis and arithmetic analysis.

4) This research links collected data with spatial units such as, point, line, and polygon using Extension Entity Relationship Data Model. It designs a spatial database schema per spatial units using tabular type data structure

**Table 1. Examples of integrated management indicators that consider carrying capacity.**

| Carrying capacity | Management sectors | Management indicators | |
|---|---|---|---|
| Social carrying capacity | Visitors | Visitor Behavior | Visit Season<br>Company Type<br>Lodging Type… |
| | | Social – economic Characteristic | Occupation<br>Income Level<br>Education Level<br>Residence… |
| | | Individual Characteristic | Gender<br>Age… |
| | | Psychological Characteristic | Expectation<br>Density<br>Satisfaction … |
| | | Use Level… | A Number of Visitors<br>Duration of visit… |
| Ecological carrying capacity | Natural Resources | Soil<br>Plants<br>Wild Animal … | …<br>…<br>… |
| Physical carrying capacity | Facilities | Scale<br>Location<br>Convenience … | …<br>…<br>… |

because tabular type data structure is easy to insert and delete environmental data, and to transfer its data to other analysis programs.

**2. Loading database to the geographic information system**

By loading the built database with the actual geographical position of the national park space, it eases approaching geographic information in the space and related information. Also it will present the position information and characteristic information visually, increasing the actuality or reality of the information.

In order to load the database on to geographic information, according the characteristic of the indicator decide which data form between point, line, and polygon should be synced. Also, another thing that must be taken in to account is assigning each indicator UFID (Unique Feature IDentifier). This type of code assignment will become a standard for expansion and manipulation of future data (Figure 4).

A problem that arises when database is loaded on geographic information system is the renewal of data. Because the cycle and scale differs for each data, the period of data renewal needs to be considered. Therefore, instead of loading various data on to one layer, this research uses one layer per attribute data.

1) Getting a grasp on the characteristics of data corresponding to indicators loaded with geographic information.

a. Identify the research method and period of data.
b. Confirm if the existing maps such as, facility allocation map, hiking map, natural resource inventory map, are digitized and draw thematic map for any missing information.

2) Identify the geographic topology relationship of IMIDB.

a. Confirm spatial range, data structure, and scale should be included in each indicator.
b. Develop a topology relationship according to the spatial boundary of each indicator.
c. Assign a geographical position depending on the spatial characteristic of each indicator.

Enable the query of geo referenced data depending on the data user's objective, and ease the integration and division of data to increase the application possibility in the future.

**3. The building of geographic information analysis system**

1) This research applies the OLAP (On-line Analytical Processing) method enabling each indicator to become function as a variable in analysis programs such as, SPSS or SAS etc. This research builds the geographic information analysis system (GIAS) by gearing GIS with analysis programs like SPSS or SAS and executes various analyses to solve management problems such as, time series analysis, causal relation analysis and corre-

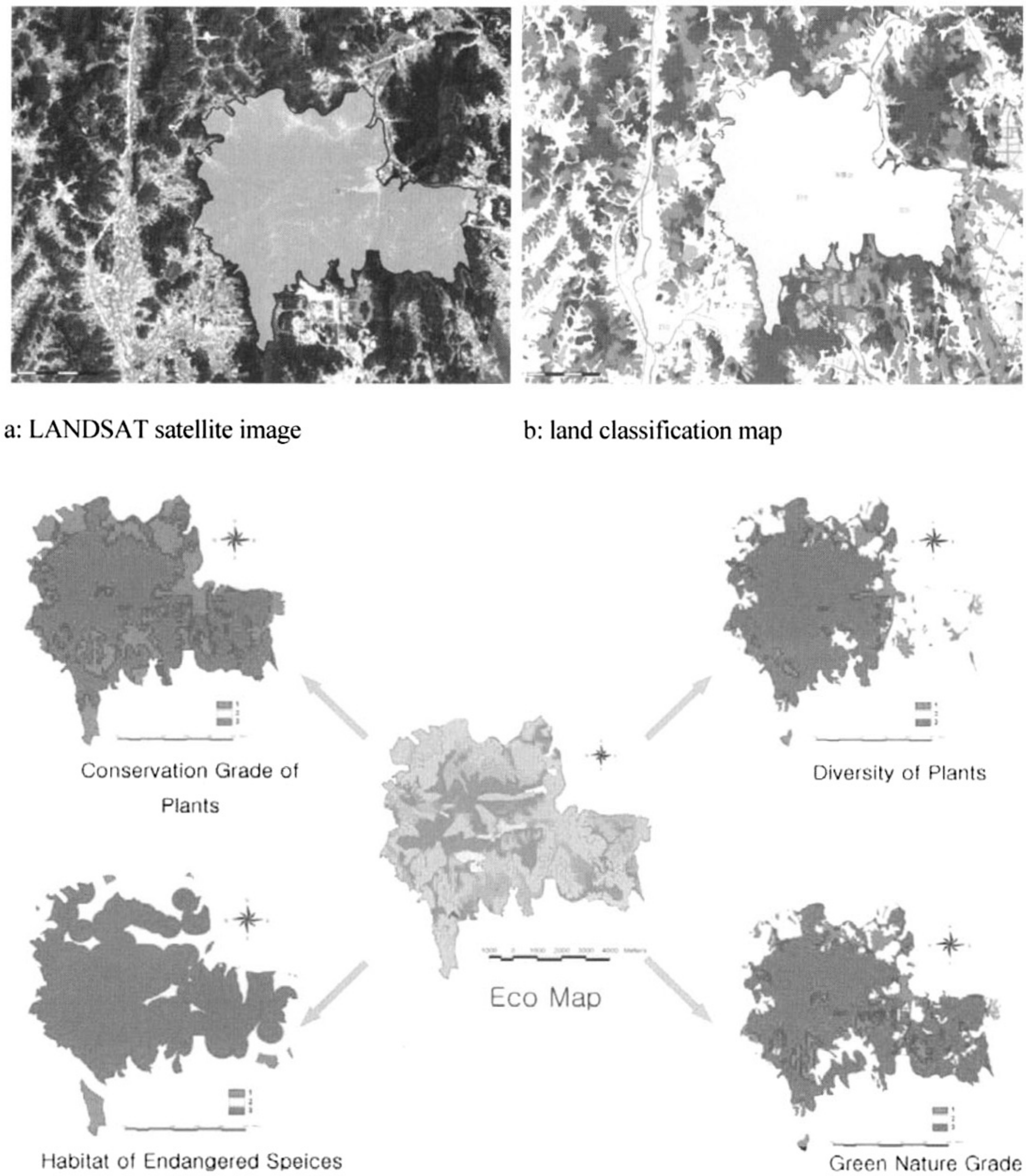


**Figure 3. Examples of thematic map in Kyeryongsan National Park (Korea National Park Service, 2005).**

lation analysis. More specifically, GIS gears with a SAS or SPSS programs using the SAS bridge® for ESRI and executes various analysis for building a tailored management policy.

2) Each data corresponding to indicators is imported into analysis programs and various analysis methods are executed such as, correlation analysis, regression analysis, logistic regression analysis, and multidimensional scaling analysis to identify the relationships among management indicators. Therefore the results of various analyses are available for establishment of fundamental management policy to solve specific management problems and provide scientific proof to establish a preventive management countermeasure.

3) Using the deduced analysis results, prediction models for the future status of the research area's visitors, resources and facilities can be developed. Also, in order to verify the model's validity main indicators can be manipulated to confirm the consistency between actual and predicted values. For example, if visitor number at specific national parks increase the same amount as it does currently for the next 5 years, how much hiking road damage will occur can be predicted and observing the current policy results, the most beneficial policy can be selected to be executed at the most appropriate time. When a model's validity is confirmed through this process, utilizing the current planning factors, problems that can occur in the future and the extent of its scope can be predicted to submit a management policy accordingly.

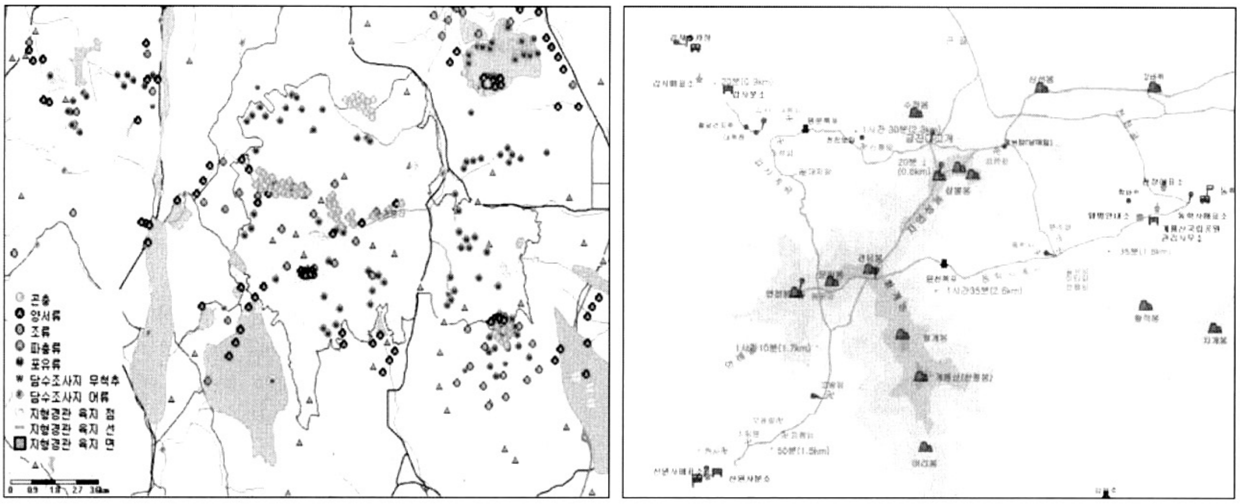

**Figure 4. Examples of GIS loaded IMID (http://egis.me.go.kr/egis/intro.asp).**

## Conclusions

First, this research is based on international organizations, such as, WTO, UNEP, and IUCN, to contribute by providing a guide for selecting and developing IMIs for visitor, resource and facility management that take in to account the national park's carrying capacity.

Second, this research may execute the time series analysis, cause and effect relationship and correlation relationship among IMIs to find out the cause of many problems in a specific activity space or area, to predict how the indicators will change in the future, and to visually present when, where and what kind of environmental problems will arise. These steps the research is taking will be able to contribute to provide a theoretical basis for solving the predicted problems.

Third, this research can be applied in the development of various theoretical models on the relationship among management sectors. In other words, the IMIDB loaded in the geographic information is used in an analysis program to construct a theoretical model that identifies IMIs affecting number of visitors, resource and facility damage, visitor's satisfaction, etc.

Fourth, this research overcomes fragmented angles, which is one of the main problems in managing national parks, and provides a framework with a multidimensional angle interpreting indicators that affect national park management and national park planning.

Fifth, this research will be able to identify the fundamental causes of why and where a certain issue or problem arises. The results of this research will be able to contribute in realizing the problems that occur in nature or environment as a whole and the organic relationships of the larger environment, such as, the relationship between the sociological environment and natural environment.

Sixth, the synthesizing methods of the data, constructing and manipulating the data, methods of constructing a database that facilitates renewal, geographic information loading scheme, satellite images handing scheme, and using the collected data in analysis programs to enable various analysis scheme that use identifiers submitted through the research process can contribute to research methodology and encouragement of related research.

Seventh, by developing IMIs affecting national park carrying capacity, this research can be utilized as a standard in managing leisure area centered natural resources, such as, provincial parks, natural recreation forests, etc.

Eighth, because this research visually shows the status of IMIs linked with geographic information, not only is it easy to recognize the factuality of the data but the current condition and analysis results. Also with the basis of the aforementioned advantages, the research can contribute to speediness of execution, efficiency, and the finding of a fundamental solution for the mistakes and problems in execution, because not only is the analysis and assessment of a policy is possible, but policy results can be predicted and visually presented.

Finally, if a GPS and 3D geographic information system is applied in the future, real-time data renewal and the approach and analysis of information on the web, without any temporal or spatial limitations and simulation of the management plans execution, will be possible. These processes will be applicable in fostering a foundation for an information technology society.

## Literature Cited

1. Alippi Cesare, Giussani Alberto, Micheletti Carlo, Roncoroni Fabio, Stefini Giuseppe, and Giogio Vassena. 2004. Global positioning and geographical information

system. IEEE Instrumentation & Measurement Magazine. December 2004: 36-43.
2. Chang, Chun-Yen. 1997. Using computer simulation to manage the crowding problem in parks. Landscape and Urban Planning 37: 147-161.
3. Cho, D.H. and Bae, M.K. 2005. The building of the environmental and geographic information system based upon the administrative boundary. The Korean Association of Geographic Information System Studies 8(1): 32-49.
4. Choi, J.W. 1997. Survey results of the usage of KOSIS and its improvement. Applied Statistics Studies 10(1): 37-46.
5. Chung, Y.K. 2002. Sustainable development indicators for Korea environmental policy 10(3): 115-128.
6. Driver, B.L., Brown, P.J., Stankey, George H., and T.G. Gregoire. 1987. The ROS planning system: evolution, basic concepts, and research needed. Leisure Sciences 9: 201-212.
7. Frissell, Sidney S., Lee, Robert G., Stankey, George H. and Ervin H. Zube. 1980. A framework for estimating the consequences of alternative carrying capacity levels in Yosemite Valley. Landscaping Planning 7: 151-170.
8. Godschalk, David R., and Francis H. Parker. 1975. Carrying capacity: a key to environmental planning?. Journal of Soil and Water Conservation 30(4): 160-165.
9. Graefe, A.R., Vaske, Jerry J., and F.R. Kuss. 1984. Social carrying capacity: an integration and synthesis of twenty years of research. Leisure Sciences 6(4): 396-431.
10. Gunn, Clare, A. 1994. Tourism Planning, 3rd ed., Washington: Taylor and Francis.
11. Hammitt, William E., and William M. Rutlin. 1995. Use encounter standards and curves for achieved privacy in wilderness. Leisure Science 17: 245-262.
12. Heberlein, Thomas A., Alfano, G.E., and L.H. Ervin. 1986. Using a social carrying capacity model to estimate the effects of marina development at the Apostle Islands National Lakeshore. Leisure Sciences 8: 257-274.
13. Jang, B.M., and Bae, M.K. 2002. A causal model on the relationship between resources of natural parks and user's satisfaction. Journal of the Korean Institute of Landscape Architecture 30(3): 12-24.
14. Jo, H.G. 1995. Ecological sensitivity assessment using GIS techniques for Oracle State Park in Arizona. Journal of Korean Gardening 13(1): 83-93.
15. Jubenville, Alan. 1976. Outdoor Recreation Planning, Philadelphia: W.B. Saunders Company.
16. Kang, M.H., Kim, N.J., and Choi, S.D. 2002. Monitoring the management of Mt. Sorak National Park utilizing WTO's sustainable tourism indicators. Journal of Korean Forest Society 91(6): 799-811.
17. Kim, N.J. 1997. Structural Approach of Social Carrying Capacity and GIS Application, The Pennsylvania State University. Ph. D. Dissertation.
18. Kim, Y.P. and Han, S.H. 2000. Methodology on statistical map production for utilization improvement of statistical information. Korea Research Institute for Human Settlement 29: 81-96.
19. Korea National Park Service. 2005. Park Management Based on Characteristics by National Park III.
20. Lee, H. 1997. Social Carrying Capacity of Tourism Planning at an Alternative Tourism Destination: Crowding, Satisfaction, and Behavior. The Pennsylvania State University Pennsylvania Ph. D. Dissertation.
21. Lee, J.H. and Shim, K.W. 2002. Development of the facility monitoring system for the Korean national parks. Journal of the Korean Forest Recreation 6(4): 75-80.
22. Lee, K.W. 2002. A Study on the development of environmental information system using GIS. The Korea Spatial Planning Review 35: 97-111.
23. Lime, David W., and George H. Stankey. 1971. Carrying Capacity: Maintaining Outdoor Recreation Quality in Northeastern Forest Experiment Station. Recreation Symposium Proceedings. pp. 174-184.
24. Maclaren, Virginia W. 1996. Urban sustainability reporting. Journal of the American Planning Association 62(2): 184-202.
25. Manning, Robert E. 1999. Studies in Outdoor Recreation, 2nd ed. Oregon State University Press.
26. Marx, R.W. 1993. The TIGER System: Automating the Geographic Structure the United States Census : Introductory Readings in Geographic Information Systems. Ed. By Donna J. Peuquet and Duane F. Marble. Taylor & Francis, New York, NY, USA. pp.120-141.
27. OECD. 1998. Indicators for the integration of environmental concerns into transport policies. Environment Monographs 79(93): 133.
28. Park, C.I. 2005. A study on social carrying capacity by normative approach of perceived crowding. Journal of the Korean Institute of Landscape Architecture 33(1): 10-19.
29. Park, K. Jang, E.M., and Shin, S.H. 2001. A study of application of remotely sensed data for the management of national parks. Journal of Environmental Impact Assessment 10(3): 167-174.
30. Schneider, Devon M., Godschalk, David R., and Norman Axler. 1978. The Carrying Capacity Concept as a Planning Tool. Planning Advisory Service. Report No. 338.
31. Shelby, Bo, and T.A. Heberlein. 1986. Carrying Capacity in Recreation Setting, Corvallis, OR: Oregon State University.
32. Shin, J.M., Kang, B.S., and Lee, G.S. 2002. Land use change detection at kyeryongsan national park by using remote sensing and geographical information systems.

Journal of the Korean Institute of Landscape Architecture 30(3): 94-101.
33. Stankey, George H., and S.F. McCool. 1984. Carrying capacity in recreational settings: evolution appraisal, and application. Leisure Sciences 6: 454-473.
34. Stankey, George H., Cole, D.N., Lucas, R.C., Petersen, M. E., and S. S. Frissell. 1985. The Limits of Acceptable Change(LAC) System for Wilderness Planning. USDA Forest Service General Technical Report INT-176.
35. Tarrant, Michael A. 1999. Variability of the perceived crowding scale: a research note. Leisure Sciences 21: 159-164.
36. Valeriano, D.M. and J.S.M. Santos. 2003. Effectiveness of land cover regulations for biodiversity conservation: a remote sensing and landscape simulation study in a mountain range in southeastern Brazil. Geoscience and Remote Sensing Symposium, IGARSS '03. Proceedings 7: 4564-4566.
37. Wu, Mu-Lin, Lin, Young-Fa, Yang, Jin-Jen, and Ching-An, Chung. 2001. National park management using self-developed and web-based geographic information systems. Geoscience and Remote Sensing Symposium, 2001. IGARSS '01. Proceedings 5: 2483-2485.
38. http://factfinder.census.gov
39. http://www.ngi.go.kr
40. http://www.npa.or.kr/
41. http://gis.nso.go.kr/
42. http://kosis.nso.go.kr/
43. http://www.epa.gov/enviro/html/em/em_openlink.html#wizard
44. http://www.me.go.kr
45. http://www.nationalatlas.gov
46. http://www.stadtentwicklung.berlin.de
47. http://www.stat.go.kr/statcms/main.jsp
48. http://www.census.gov/geo/www/tiger/

(Received August 30, 2006; Accepted October 9, 2006)