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Developing Forest Fire Status Information Management System using Web GIS Technology

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웹 지리정보시스템 기술을 이용한 산불 현황정보 관리시스템 개발

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ABSTRACT

In this paper forest fire status information management system was developed under web environment using web GIS(geographic information system) technology. Though this system, general users can easily retrieval domestic forest fire status information and obtain that in visual way such as maps, graphs, and texts if they have only certain web browsers. Moreover, officials, who have system access authority, can easily control and manage all domestic forest fire status information through input interface, retrieval interface, and out interface of the system. This system can be considered as the first domestic system to manage forest fire status data and service them in visual through user friendly interfaces on web. In order to implement this system, IIS 5.0 of Microsoft is used as web server and Oracle 8i and ASP(active server page) are used for database construction and dynamic web page operation, respectively. Also, ArcGIS IMS(internet map server) of ESRI is used to serve maps by using Java and HTML as system development languages. Not only the domestic tendency of forest fire but also the forest fire status information of certain area and time such as the frequency and the loss can be presented through distribution maps, graphs and tables. Therefore, this system is supposed to play as a important role when the policy relate to domestic forest fire is established. In addition, the self consciousness of people against forest fire can be inspired and the foundation of scientific and systemic forest fire services can be obtained through this system in the future.

KEYWORDS: Web GIS(Geographic Information System), Forest Fire Status Information Management System, ArcGIS IMS(Internet Map Server)

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요 약

본 연구는 시·공간적 유동성을 갖고 있는 우리나라 산불 현황정보를 인터넷상에 시각적으로 표출함으로써 일반 사용자 누구나 쉽게 산불정보에 접근 가능하도록 한다. 아울러 산불관련 공무원들이 이들 정보를 실시간에 효율적으로 관리 감독을 할 수 있도록 웹상에서 정보의 입력 및 검색, 출력이 가능한 실무자 중심의 인터페이스를 개발하였다. 본 시스템에서의 웹 서버는 MS사의 IIS 5.0을 이용하였으며 데이터베이스 구축과 웹상에서 동적인 웹 페이지를 동작시키기 위해서는 Oracle 8i와 ASP(active server page)를 각각 사용하였다. 또한, 웹상에서 처리된 정보를 사용자들에게 지도데이터로 서비스하기 위한 맵 서버로는 ESRI사의 ArcGIS IMS(internet map server)와 이들을 제어하고 개발하기 위한 시스템 개발 언어로는 Java, VB 6.0, HTML을 이용하였다. 본 시스템을 통해 운영되는 12년 간의 다양한 산불관련 현황데이터를 바탕으로 우리나라 산불 경향과 현황을 쉽게 파악할 뿐만 아니라 이들 정보의 시각화는 국내 산불관련 정책결정 시 의사결정지원시스템으로서도 그 활용성이 클 것이라 사료된다. 나아가 일반국민들에게는 산불예방에 대한 경각심을 고취하고 관련 공무원들에게는 과학적이고 체계적인 산불 행정업무를 수행할 수 있도록 하는 기반을 마련하리라 기대된다.

주요어: 웹 지리정보시스템, 산불 현황정보 관리시스템, ArcGIS 인터넷 맵 서버

INTRODUCTION

Recently in order to manage and retrieval the overall forest fire status information such as its frequency and its loss efficiently and promptly, implementing forest fire status information management system and constructing its infrastructure have been deadly needed especially since a large scale of forest fire was occurred along the east coast of Kangwon province in 2000.

Since then, the long term forest fire status information infrastructure in a national point of view has been constructed in database. However, there exist still a lot of problems such as the absence of efficient web based system to query various conditions, analyze certain data in spatiotemporal and serve for both domestic people and forest fire officers in real time.

In this paper to solve these above problems efficiently in distributed network environment and to satisfy the requests from users in real time, web GIS(geographic information system) is considered as up-to-date spatial information technology.

Especially, the efficient and easy useable GUI(graphic user interface) of this system can be main merit considering all task of forest fire officials be performed visually in a few seconds.

Therefore, the practical affair related to forest fires can be performed by supporting its policy and the foundation of infrastructure for scientific and systemic forest fire data management can be established through rapid input, various retrieval and visual output. Finally, in case of formulating domestic policies against forest fire and protecting forest, this system can play its role as main decision making supporting system.

The forest fire status information management system in this paper has mainly focused on 4 sections; 1) The construction of database, 2) The network configuration for

internet services, 3) The implementation of forest fire status information management system and its GUI.

Developing Forest Fire Status Information Management System

Figure 1 shows the main concept of forest fire status information management system. General users can have their service in format of text, graph and map corresponding on their retrieval while officials related to forest fire have four kinds of user interfaces. They first have the access authority to database then input certain data into database. Also, they retrieval not only published information but also unpublished information toward general users and output the results in various visual contents format such as text, graph and map and file format such as .xls and .txt.

1. Constructing database for forest fire status information management system

Before taking up the main subject, to manage the whole data for the system efficiently and synthetically the structure of entire tables existing in database should be defined. Then the relation and restriction among them have to be also identified.

To operate this system and serve sufficient information toward users, there exist 26 tables and basic spatial data such as administrative thematic map in database. Among the 26 tables, some tables include the fundamental data to operate database itself such as forest fire, meteorology, and system access authority while others include the additional data such as helicopters sates for extinguish, incendiary and topography. Table 1~4 classify data into 4 classes such as the attribute data related forest fire, the data for user authentication, the meteorology data to affect to forest fire, the additional data related to forest fire, respectively.

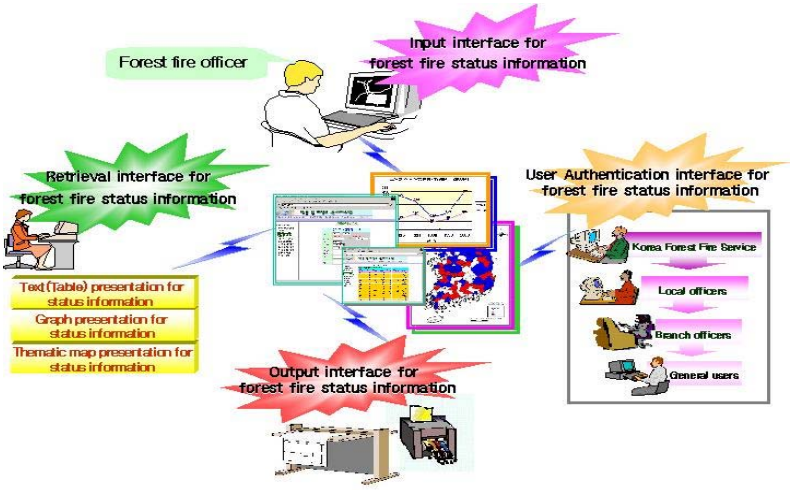


FIGURE 1. The main concept of system

TABLE 1. The attribute data related forest fire

	Large category	Detail category	Remarks
1	Ordering year		Automatic ordering
2	Ordering month		Automatic ordering
3	Occurrence time	Year/Month/Date/Time/Day	(1999-2001)
4	Extinguish time	Year/Month/Date/Time	
5	Required time		Automatic calculating
6	Government office	Government office(city name)	
7	Location	Si,Do/Gun,Gu/Up,Myeon/Li,Dong/Zipcode	
8	Owner ship	Public, Private	
9	Cause	Large categories and detail categories	
10	Damage	Area, Tree type, Money amount Additional damage	Considering forest fire overlapping two polygons
11	Assaulter	Name, Sex, Age Address, Cause	
12	Casualty list	Casualty category, Name, Sex, Age, Cause, Address	
13	Helicopters	Total number, Categories	Automatic calculating
14	Manpower	Total Number, Categories	

TABLE 2. The data for user authentication

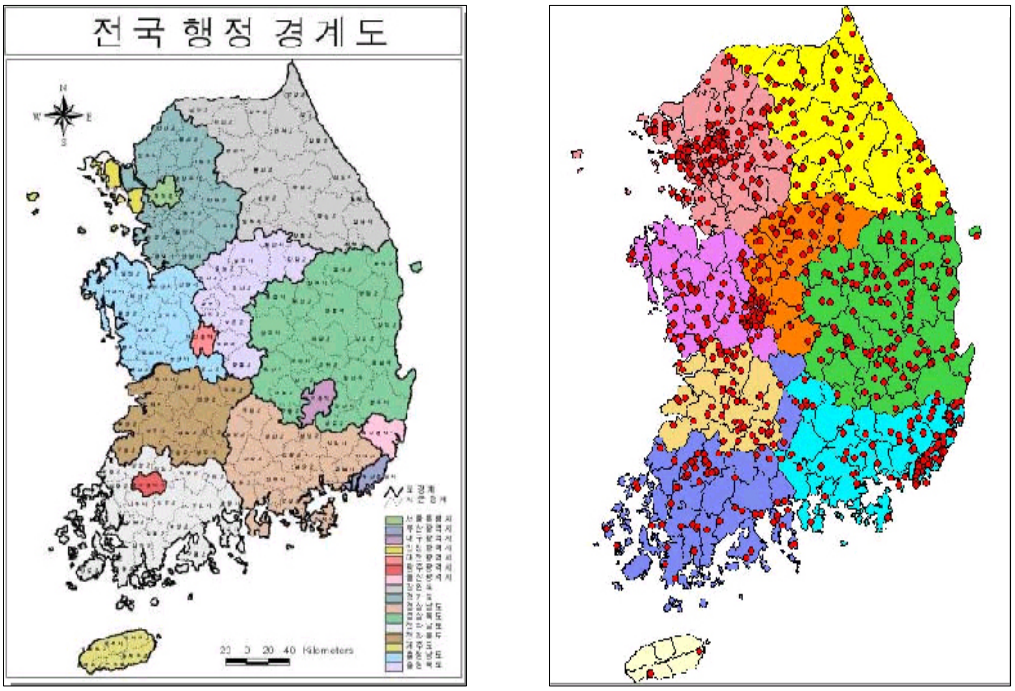
	Category	Example		Category	Example
1	Ordering	1	7	Security number	******-*******
2	Name	Kildong	8	Data retrieval	○
3	Date of authentication	***-**-**	9	Data input	○
4	ID	HKD1234	10	Data delete	○
5	Password	****	11	Data modify	○
6	Use group (Korea Forest Service, local officers, branch officers, general users)	Korea Fire Service,	12	Access mode to DB	DBA

TABLE 3. The meteorology data to affect to forest fire

	Large category	Detail category	Remarks
16	Rainfall	Year/Month/Date/Location/Amount	Automatic calculation of rainfall day
17	Dry weather alert	Year/Month/Date/Location	Automatic calculation of dry day

TABLE 4. The additional data related to forest fire

	Large category	Detail category	Remarks
18	Purchase and maintenance of aircraft	Year/Aircraft classification/purchase, disuse	Automatic numbering of forest fire
19	Organization of fire brigade	Administrative office/Total number/Ground fire brigade/Air fire brigade/Assistance fire brigade/ Officers/forest fire guardian/Volunteer fire brigade	〃
20	Status of fire facility	Administrative office/Total number/Helicopters/ Fire engine/Pump	〃
21	Forest fire observation facility	Administrative office/Total number/Observation guard post/Observation tower/Unmanned observation system/Firearms depository/ Smoking area	〃
22	Observation guardian	Administrative office/Total number/laborer/Army	〃
23	Status of restriction	Administrative office/Restriction of firearms/Control of restriction area/Status of path up a mountain/ Restriction of path up a mountain	〃
24	Status of censure	Year/Administrative office/Cause of sure/Contents of censure	〃
25	Status of assaulter	Year/Administrative office/Number of first fire/ Status of arresting assaulter/Status of inspection/ Arrest	〃
26	Compensation payment	Year/Administrative office/Number/Area/Amount/ Labor mobilization	
20	Incineration paddy field	Year/Administrative office/Area/Labor mobilization/ Amount	〃
21	Assessment of fine for default	Year/Administrative office/Total number/Control of restriction area/Restriction of cooking/Restriction of bonfire/Incinerating paddy field/Damage of forest fire signal	〃
22	Mass media advertisement	Year/Administrative office/TV broadcasting/Radio Broadcasting/Newspaper/Magazine/Cable broadcasting	〃
23	Extinguishing campaign	Year/ Administrative office/Extinguishers training/ Number of campaign/Number of participator/Mobile Regulation	〃
24	Publicity booklet	Year/ Administrative office/Total number/Standing Signboard/Placard/Flag/Handbill/Sticker/Poster/ Additional Publicity booklet	〃



(a) Administrative map (b) Forest fire location map in 2001

FIGURE 2. The basic thematic maps

Figure 2 presents the example of basic thematic maps to draw status distribution map and forest fire location map in 2001.

2. The Network Configuration for Internet Services

Figure 3 shows the network configuration diagram of forest fire statistical information management system for internet services. As you see here, this system is operated in distribution network environment. All operations corresponding on user requests are performed in server side. Thus, each GIS data processing, data retrieval and analysis are performed on server side then return the result of them in image format (.jpg), text format, file format toward users by minimizing data traffic on internet.

In order to access to this system each local official has to be granted his ID and password and database access authentication from the system DBA(Data Base Administrative) in central government officials of Korea Forest Service before operating this system while general users can access to the system without ID and password. Finally, the system DBA has the hierarchical database access authentication information.

General users can only retrieval general forest fire information such as tendency of domestic forest fire in text format or map while forest fire officers can input, retrieval, update and delete all data as shown in above Table 1~ 4.

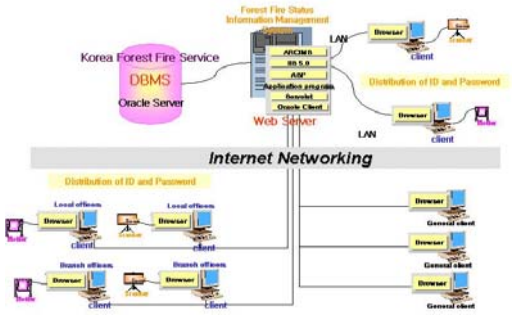


FIGURE 3. The network configuration for internet service

3. The Implementation of forest fire status information management system

As you see in Figure 4, the system operation structure is consisted of client side, middle ware and server that is corresponding on users, map server, web server, respectively(3-tier). System users request their desired results through web server using certain browser to map application server, which is located in map server.

In this paper the system interface development is focused on API(application programming interface) methodology. To implement this system, IIS 5.0 of Microsoft is used as web server and Oracle 8i and ASP (active server page) are used for database construction and dynamic web page operation, respectively. Also, ArcGIS IMS of ESRI is used to serve map data using Java and HTML as system development language.

This system has three interface sections, which works as input, retrieval and system DBA mode. The below Figure 5~12 show the example of forest fire officials system operation interfaces. Figure 5 shows the main interface of forest fire status information management system and Figure 6 presents the retrieval items for general users and forest fire officials in outline.

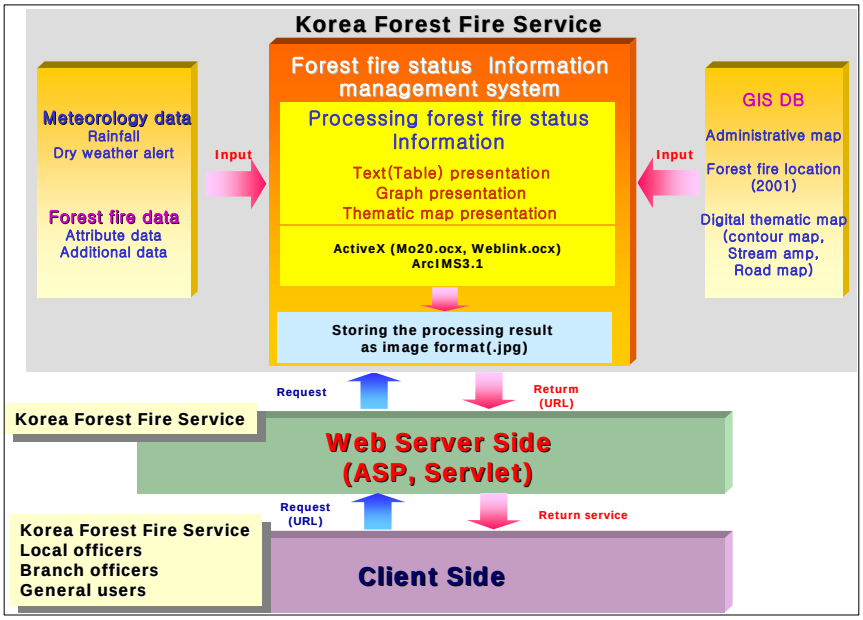


FIGURE 4. The message flow between map server and web server

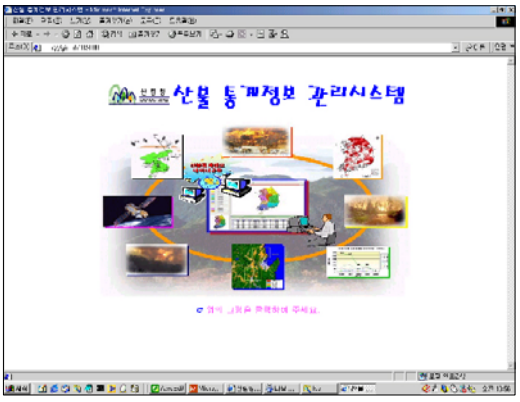


FIGURE 5. The main system interface

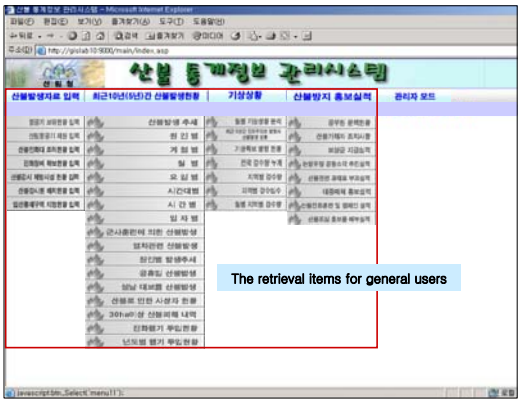
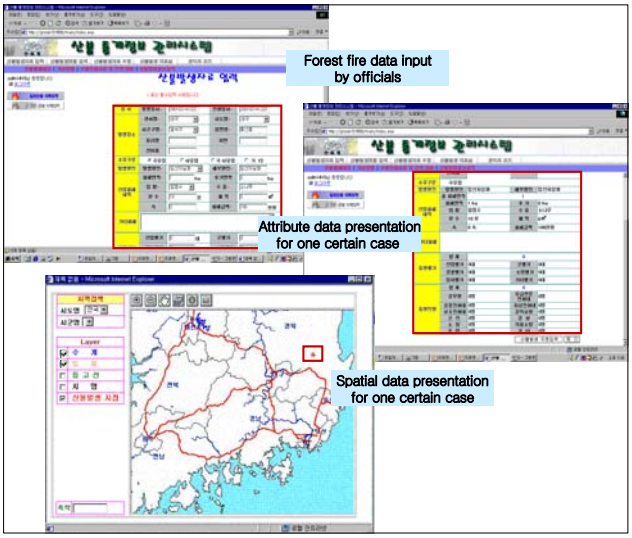
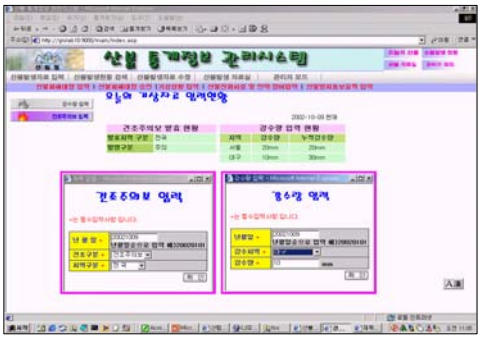


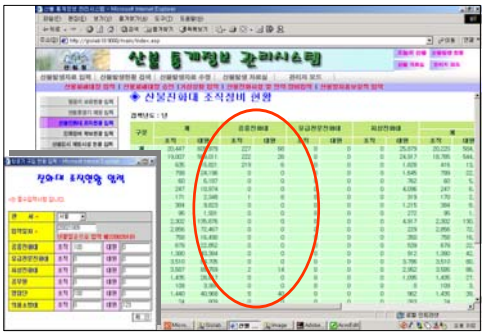
FIGURE 6. The retrieval items



(a) Forest fire attribute data and spatial data input



(b) Meteorological data input



(c) Forest fire additional data input

FIGURE 7. The forest fire data input

1) The data input

Most existing forest fire data was stored in .xls format or written in document so that the complicated various retrieval and spatial analysis cannot be performed in any cases. Therefore, it is almost impossible to perform statistical operations, integrate data and share them in network environment. Also, forest fire officials are not able to convert to any other file formats for their efficient practical affairs. Finally, these results bring out serious problems to manage those data for long term. This is real domestic situation for forest fire information management.

This system supports the data consistency through its identical input interface and records them into DBMS in real time. Figure 7 shows the input operation of one certain forest fire case. As shown in Figure 7(a), when a certain forest fire case is recorded into database, the attribute data and its desired spatial data, which means its location, and are generated and managed at the same time. Especially, the overlay function of thematic maps such as the stream network map, the road map, the elevation map and main feature map helps to recognize the location of forest fire. Also, these thematic maps are viewed its spatial information depending on its view scale in detail. Figure 7(b) and (c) show the input of the meterological data and the additional data such as used extinguish equipments, fire brigade status, reservoir water information and so on at the point of the forest fire.

Especially, Figure 8 shows this system keeps the data integration when its input. Consider that a forest fire has a movement in spatial and can be spreaded across two cities within short time. At this time, the forest fire officials in each city assumes that it is different cases and input the identical data twice in DBMS. However, this forest fire case has to be considered as same case and processed keeping its integration in database. Thus, this system lets the system DBA investigate the case and admit a final decision.

2) The data retrieval

In this system any forest fire officials, who does not have any knowledge on SQL, can retrieval their desired information through user-friendly interface. Also, the result present text, graph and map format. It helps that not only users understand the tendency of

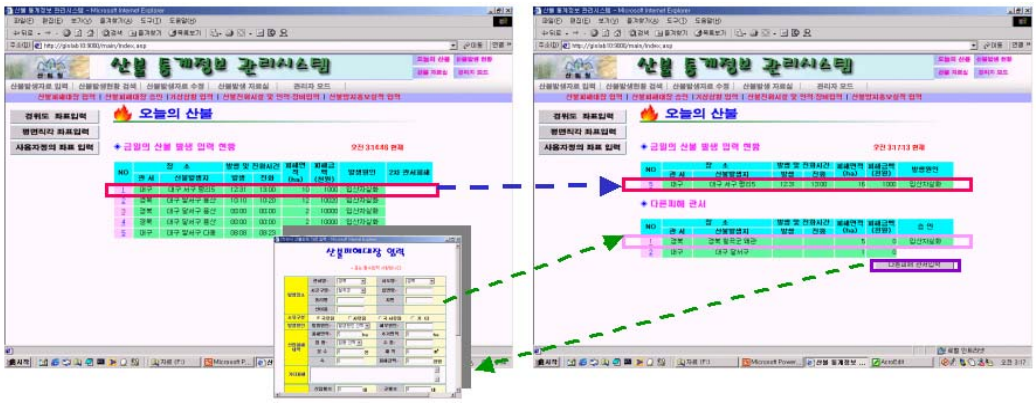
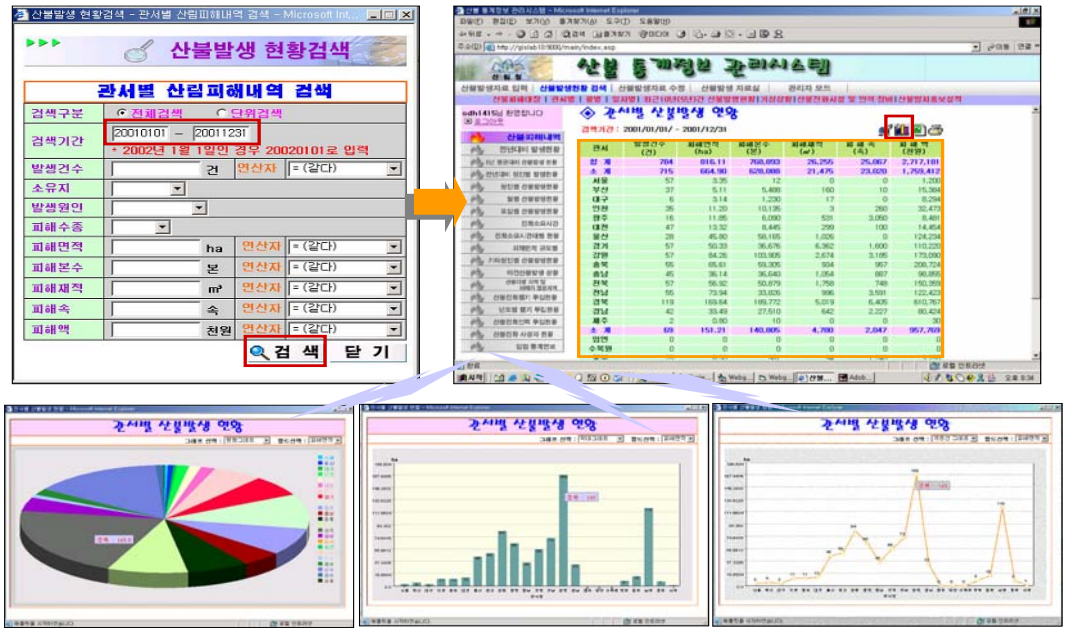


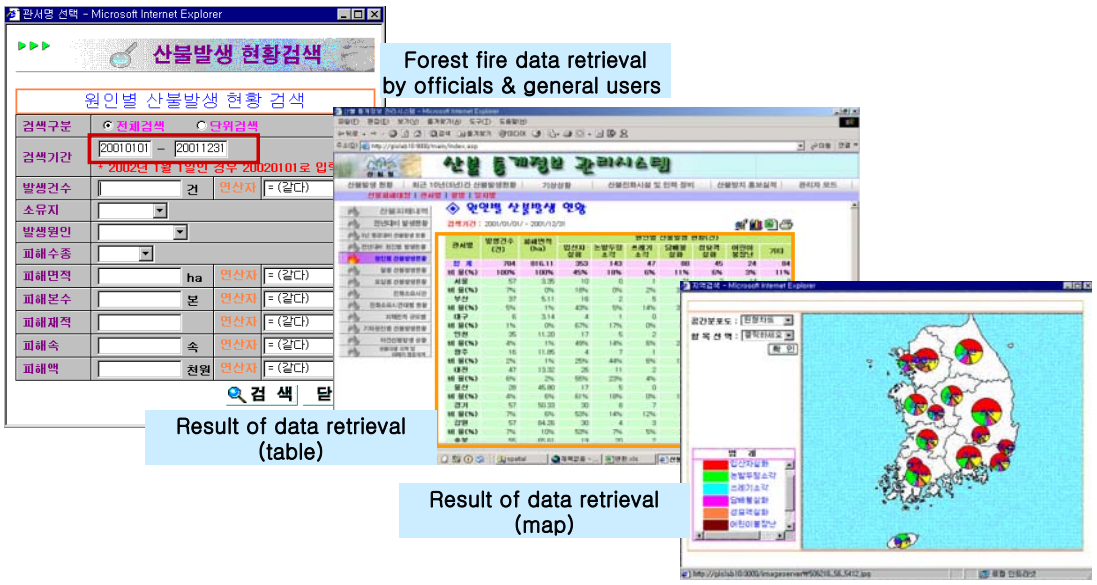
FIGURE 8. The data input considering one forest fire case spreaded across two cities

domestic forest fire more easily but also officials have useful reporting information for decision supporting system.

Figure 9 shows the example result of retrieval in table, graph(pie, bar, line) and distribution map, respectively. In this system all



(a) The retrieval result in text and graph format



(b) The retrieval result in text and distribution map format

FIGURE 9. The forest fire data retrieval(1)

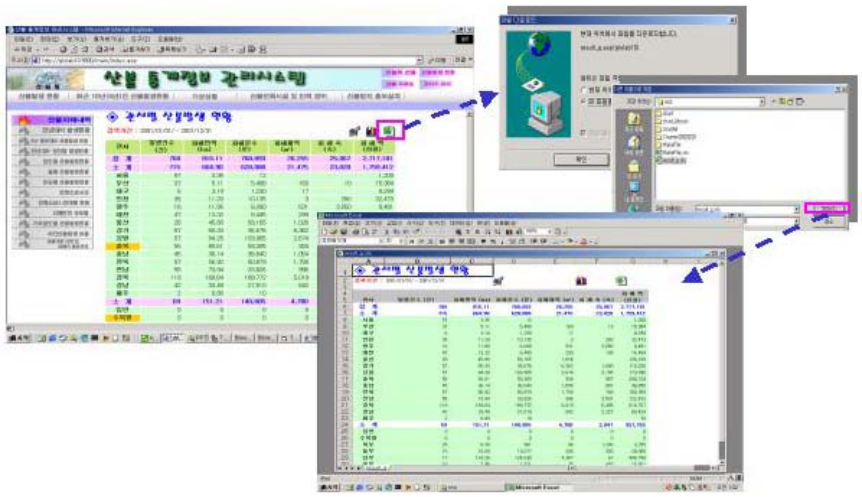


FIGURE 10. The forest fire data retrieval(2)

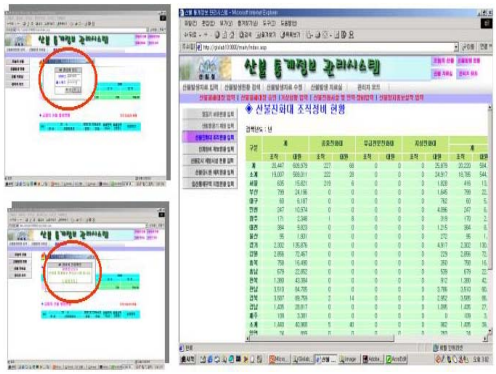
information stored in database can be presented in visual way as shown below.

As shown in Fig. 10, this system supports that the retrieval results convert two useful output file format(.xls and .txt). This is helpful to refer the retrieval result to other report document formats.

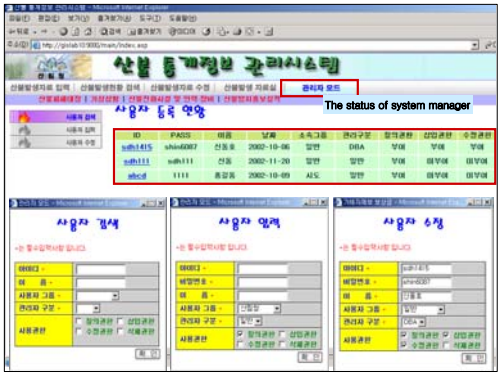
3) The system DBA mode

The system DBA should classify and manage desired user's authorities such as government officials, country officials, local officials and general users. Also, it should control various user's access to main database and keeps the data integration and security.

For this, the system DBA not only have all authorities to database but also manage all system users by modifying, limiting and granting their database access authorities as show in Fig. 11. In addition, general users have only read authority for some certain data in DBMS and local officials and branch officials



(a) System DBA's access to system



(b) Managing user's authority mode

FIGURE 11. The user authority management

have read and write authorities for their practical affairs.

CONCLUSION

It is true that most domestic forest fire data have been still written in document. Moreover, there is no the certain system to perform complicated various retrieval and spatial analysis in internet networking. Thus, it is difficult to imagine that long term domestic forest fire data would be integrated and managed in DBMS and used for practical domestic forest fire policy. This is real situation of domestic forest fire affairs.

In this paper forest fire status information management system is constructed to present domestic forest fire status and tendency by using web GIS technology and spatial information technology.

Especially, forest fire status information management system has its services for several client classes such as government official, country officials, local officials, and general users. Each clients group has been identified by its own user authority modes to database so that system DBA can control all clients, who request services to the system.

Moreover, the database of this system includes and manages all data related domestic forest fires for 12 years. And this all data is presented in certain meaningful information such as the tendency of domestic forest fire, all status of domestic extinguishing facility, the status of forest fire organizations etc. through text, graph, distribution map and file formats. Thus, the vast scope of domestic forest fire data can be controlled and managed in central database and this will be the infrastructure to plan and establish domestic forest fire policy.

▶ Following description indicates the effect of our study briefly.

1. This system plays a role as decision-making supporting system for domestic forest fire policy through not only accessing the whole existing forest fire status data constructed by GIS but also retrieving and analyzing the main reasons or places, which has high score of forest fire.
2. Forest officials can manage the domestic forest resource and inspect forest fire dangerous area by periods by analyzing and retrieving huge forest data through this system on the center of Korea Forest Service. Thus, they can find out and analyze the correlation between forest fire and its main reasons, its loss, best tree arrangement after forest fire and so on. Finally, this system help to save manpower, time and cost to manage domestic forest resource and forest fire.
3. Most domestic practical forest fire officials rotate their serve by periods. Thus, it is difficult to have enough time to understand their practical affairs and reflect their scientific and effective opinions for domestic forest fire policy. This system supports almost information retainal related to forest fire and present the results in visual way through user friendly interfaces.
4. General user can share their opinions about domestic forest fire policy through internet services and reflect them to the service contents of the system. Also,

these all motivation will construct the foundation of domestic infrastructure for forest fire policy. KAGIS

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