DEVELOPING THE REFORESTRATION SIMULATION SYSTEM USING 3D GIS

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ABSTRACT:

In this study the spatial distribution characters of forest in forest damaged area were first considered by analyzing spatial data and monitoring forest landscape. Then suitable tree species on each site were selected through the weighted score analysis of GIS analysis methods. Finally, the best forest stand arrangement method could be presented on the 3D based simulation system for the advanced reforestation technology in Korea.

For this purpose, the virtual reforestation system was implemented by using the concept of virtual GIS and CBD (Component Based Development) method. By use of this system the change of forest landscape of burnt forest area some years after reforestation practice could be detected and monitored by applying the site index and 3D modeling method.

KEY WORDS: 3D GIS, forestation simulation system, forest, virtual, landscape

1. INTORDUCTION

Until recently the studies related to forest fire cases have focused on not developing restoration technologies but simulating forest danger forecasting or forest fire spreading mode.

However, nowadays constructing firebreak, which is considering forest allocation environment, local meteorology, the best forests stand allocation method, and the scientific management for the density of forest, is very demanded.

In Korea there are studies about the reforestation especially the forest fire damaged area such as classification of forest fire occurrence hazard region using GIS in Uiseong-gun by Si-young Lee (2004) and the development of landscape analysis method for forest fire damaged area Restoration using virtual GIS by Myung-hee Jo (2004).

In this study for the best forest stand arrangement and the reforestation simulation, the spatial database using GIS and remote sensing such as satellite images and aerial photos constructed especially various thematic maps.

Also, the spatial analysis and the reforestation for the suitable tree on a site was developed and simulated.

Furthermore, the tree growth modeling based on 3D tree model was simulated on passing years and then virtual environment was constructed on 3D topological data by using Virtual GIS and 3D GIS. In addition, reforestation simulation system was deigned and constructed to manage all related data and integrate all information.

Finally, this system will become the foundation technology for the forest restoration especially in forest fire damaged area. Moreover, this system is expected to perform an important role as the DSS (Decision Supporting System) for our reforestation policies. Also, this system deliveries the high performance in the view of coast and time and manpower to restore forest fire damaged area.

2. MATERIALS AND METHOD

In order to construct spatial database and analyze the forest fire topography environment, 21 satellite images such as Landsat TM, ETM and 23 aerial photos before forest fire and 25 aerial photos after forest fire and topography map scaled on 1:5,000 and 1:25,000 were used through Arcview 3.2 and IMAGINE 8.5. In addition, to process the aerial photos and present three in 3D Adobe 7.0 was used.

This system was implemented based on Windows 2000 by using object-oriented language such as Visual Basic 6.0 and GIS component such as Map Object 2.1 and XDWORD and DBMS

(Data Base Management System) such as Access2000 and VRML language for landscape analysis as shown in Fig. 1.

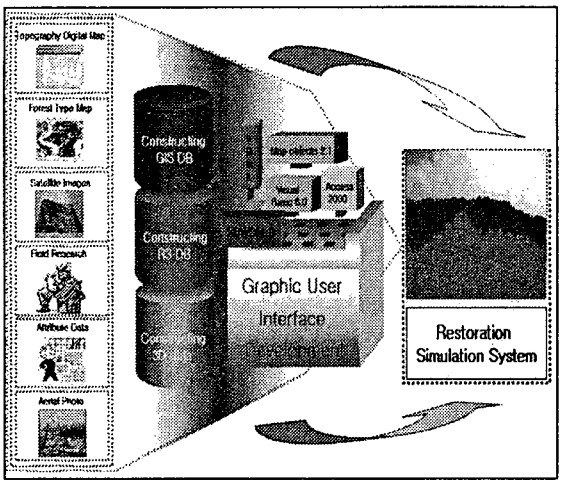


Fig. 1 System development diagram

3. 3D BASED REFORESTRATION SIMULATION SYSTEM

The main function of this reforestation simulation system is to analyze the spatial charter in a forest fire damaged area and to select the suitable tree species against forest fires and simulate on computer.

Through this system interface to possibly implement best forest stand arrangement function; the weight score analysis was first performed. For this, the main factors, which are considered importantly, such as soil depth, topography, soil moisture contents, slope, deposition type, eroded soil, soil hardness and soil texture has each weight score as below in table 1.

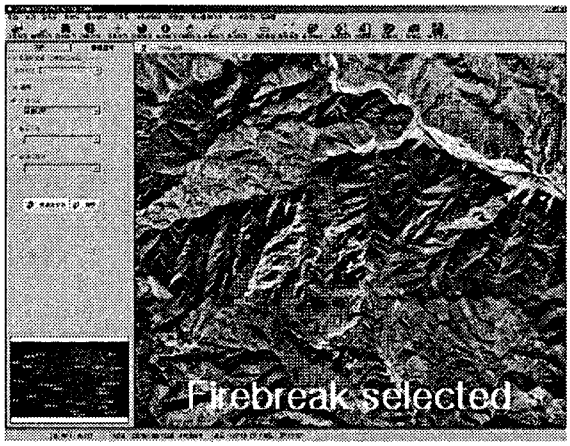
Table 1. Weight score of each factor

Factor	Class					Correlation
Soil depth	More than (12)90 ㎝	(9)90~60 ㎝	(5)60~30 ㎝	less than (1)30 ㎝		0.62
Topography	(11)Flat	(8)Foothill	(6)Hilly	(4)Hillside	(1)mountainto p	0.55
Soil moisture contents	(11)Moist	(8)Slightly wet	(6)Slightly dry	(3)Wet	(1)Dry	0.55
Slope	less than (9)15°	(8)15~20°	(7)20~25°	(5.5)25~30°	More than (3.5)30°	0.45
Deposition type	(9)Colluvia l soil	(5)Creeping soil	(1)Residual soil			0.40
Eroded	None	some	Full			0.40
Soil hardness	(9)very soft	(8)soft	(7)Smooth	(4)hard	(1) very hard	0.40
Soil texture	(6)Sandy loam, loam	(4)Silty loam, Silty clay loam, Sandy clay loam	(3)Silty clay	(2)Clay loam	(1) Clay, Loamy sand, Sand	0.30

Table 2 shows the selection of suitable tree species on total weight score.

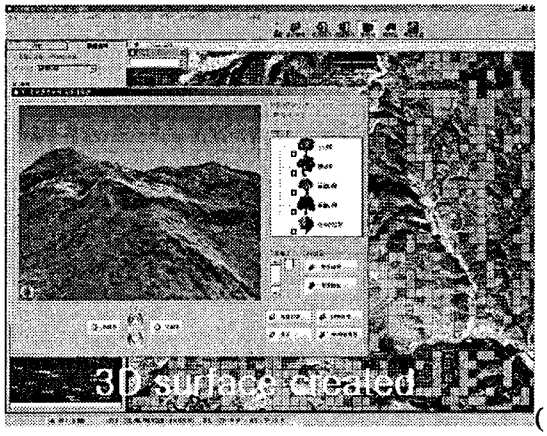
Table 2. Selection of suitable tree species

Total weight score	Suitable tree species
75~55	Quercus acutissima, Kalopanax pictus,
54~45	Pinus densiflora, Quercus acutissima, Kalopanax pictus, Quercus variabilis,
44~35	Pinus densiflora,Quercus variabilis
34~25	Pinus densiflora,Quercus variabilis
24~8	Pinus densiflora

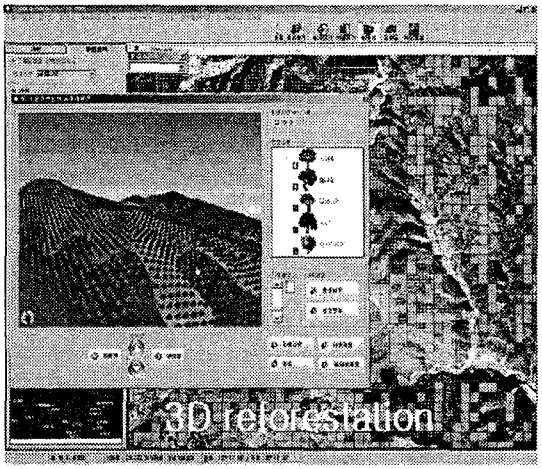


(a) Firebreak selected in forest fire damaged area

(b) Suitable tree species selected



c) 3D surface created



(d) 3D forestation simulated

Fig. 2 3D based reforestation simulation

Finally, this system could regard the suitable tree on a site and make a great role as DSS for the domestic Reforestation policy as shown in Fig. 2(a), (b), (c) and (d).

In order to monitor a forest landscape and predict the future advanced forestation, this system presents the tree growth simulation on 3D geography using reference site index of KFRI(Korea Forest Research Institute) as shown in Fig. 3.

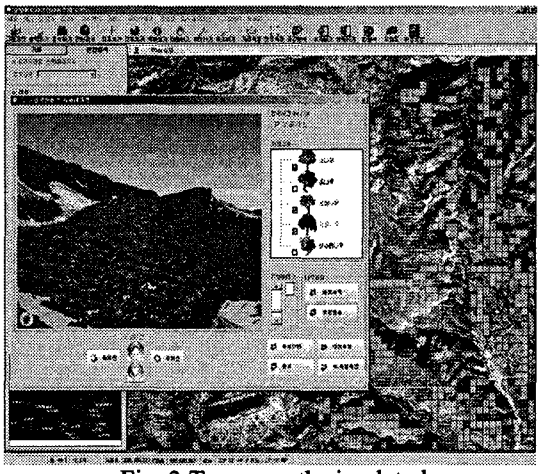


Fig. 3 Tree growth simulated

In order to measure 3D topography based distance, the highest and lowest of topography and coordination this system provides the topography cross section as shown in Fig. 4.

3D tracking simulation could be performed after constructing virtual environment by overlaying firebreak on 3D topography. Also, the reforestation statue, which is before and after a forest fire, could be monitored and compared by using aerial photos as shown in Fig. 5.

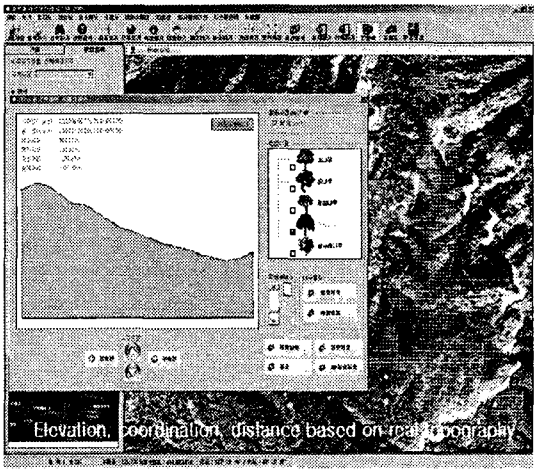


Fig. 4 Topography information

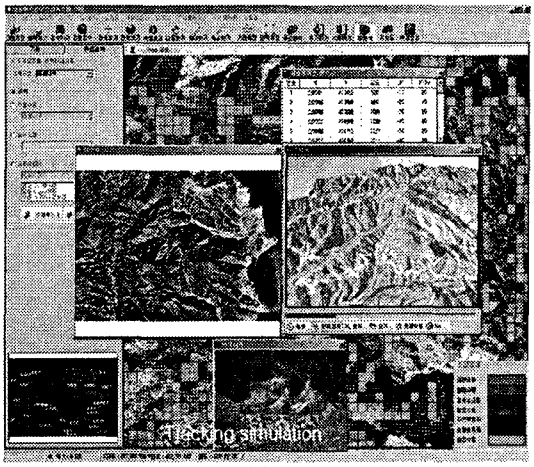


Fig. 5 Tracking simulation

In order to construct the firebreak in mountain, there are several conditions such as between 30~40° elevations, pine tree area and between 70%~80% of total ridgeline.

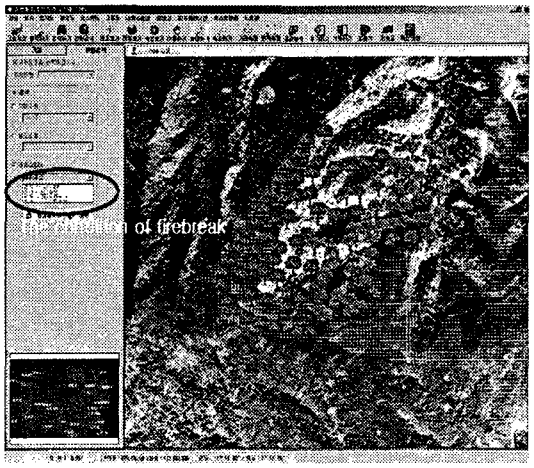


Fig. 6 Firebreak retrieval

As shown in Fig. 7, the result of system operation could be stored with word process program so that system users could make a report data easily.

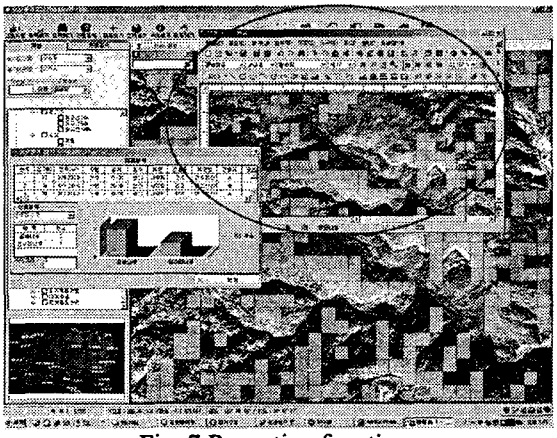


Fig. 7 Reporting function

4. CONCLUSION

In this study, the spatial information technique for landscape ecological analysis performed by constructing GIS data based on satellite images and aerial photos and analyzing topography and selecting the suitable tree species on desired site and implementing these on the system based on virtual GIS.

Through this system forest landscape could be monitored and predicted more scientifically and visually by passing years and then possibly helps the related forest officials to establish the best reforestation policy.

This system is expected to provide the reality of field status so that perform an important role as the DSS (Decision Supporting System) for the domestic reforestation technology.

This study shows the possibility that GIS and remote sensing technology could help to increase the high quality of domestic reforestation technology.

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