A STUDY ON THE SYSTEM DEVELOPMENT FOR MANAGEMENT OF MINING-RELATED DAMAGES USING GIS

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ABSTRACT … The mining-related damages due to the mining operations such as ground subsidence, tailing, Acid Mine Drainage, and soil contamination have a significant effect on our social and economical environment. So, for the effective prevention and reclamation works of the hazards in the mining area, the systematic management of mine information and mining-related damages is urgently needed. In this study, we estimated the possibilities of GIS-based system development for the mining area and related database. We classified the steps of building GIS as mine itself, mining-related damages, rehabilitation works and additional functions for estimating damages and analyzed the essential database and functions for each step. GIS will be helpful to estimate the mining-related damages and to carry out the reclamation works effectively.

KEY WORDS: mine, mining-related damages, GIS, database, reclamation works

1. INTRODUCTION

Recently, mining-related damages caused by mining operations, especially Acid Mine Drainage(AMD) and soil contaminations at metallic mines became serious social problems. The mineral resources are inevitable for economic promotion of the nation and wealth of the people, but the resultant environmental disruptions, if neglected, lead to the serious economical loss and casualties. So the mining-related damages should be prevented or rehabilitated appropriately, and for this aim Mine Reclamation Corporation(MIRECO) is carrying out long-term and systematic projects for the mine reclamation.

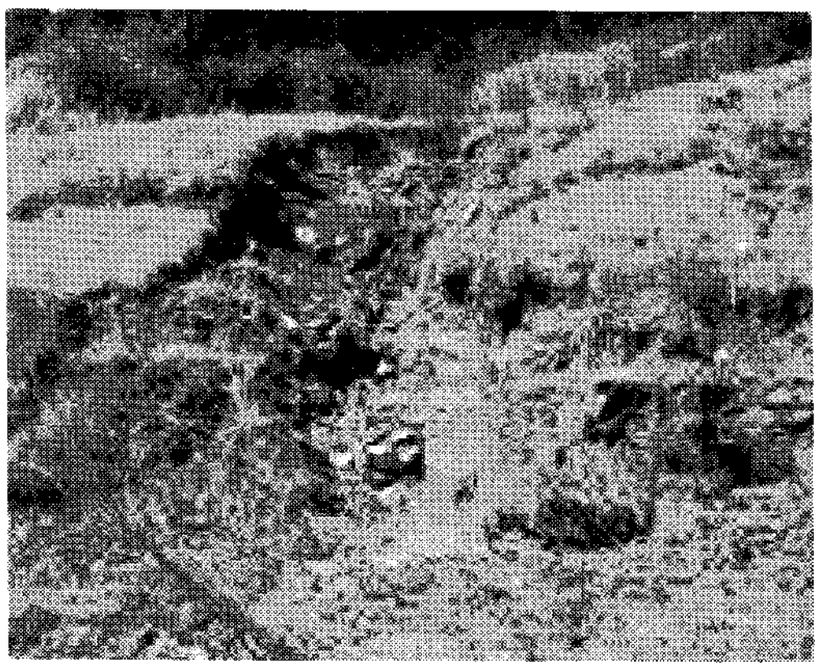

Figure 1. Contaminated soil by tailing.

In Republic of Korea, most of metallic mining and smelting works were ceased in 1980's and huge amounts of mine tailings were left behind without proper environmental treatments(Kim et al, 2007). These tailings can cause the serious problems such as AMD and soil contaminations, but it is hard to track the status of these mining-related damages. So, for the effective prevention and reclamation works of the hazards in the mining area, the systematic management of mine information and mining-related damages is urgently needed.

In this study, we estimated the possibilities of GIS-based system development for the systematic mining-related database management. For this, we classified the steps of building GIS as mine itself, mining-related damages, rehabilitation works and additional functions for estimating damages and analyzed the essential database and functions for each step.

2. BUILDING MINE INFORMATION

2.1 Mine Database

To track the status of mining-related damages we must know the mine as based information. Indispensable information for mine database are the name of mine, mined mineral at that time of working, operating or abandoned, the address of mine location, and the coordinate value surveyed by GPS (longitude, latitude) of mine position(Kim et al, 2006).

Information about mining tunnel is also inevitable because the damages are closely related to the location of minehead, the direction or slope of mining and the depth of the mined cavities. These data can be built by using the GIS method.

For the proper reclamation works it is important to know the location of mine and minehead, so the topographical map is also needed as a framework database. So all required spatial database about the location of mine and mining-related damages must be built based on the GIS.

2.2 Utilizing Mine Information

Mine database built in the previous step would be of great value when we can use that information properly and easily. Program functions needed for displaying the mine are retrieving a mine, showing its basic information, detailed information and image data around the mine. The location map of mine is very important information for finding and visiting the mine for investigation(Mireco, 2006).

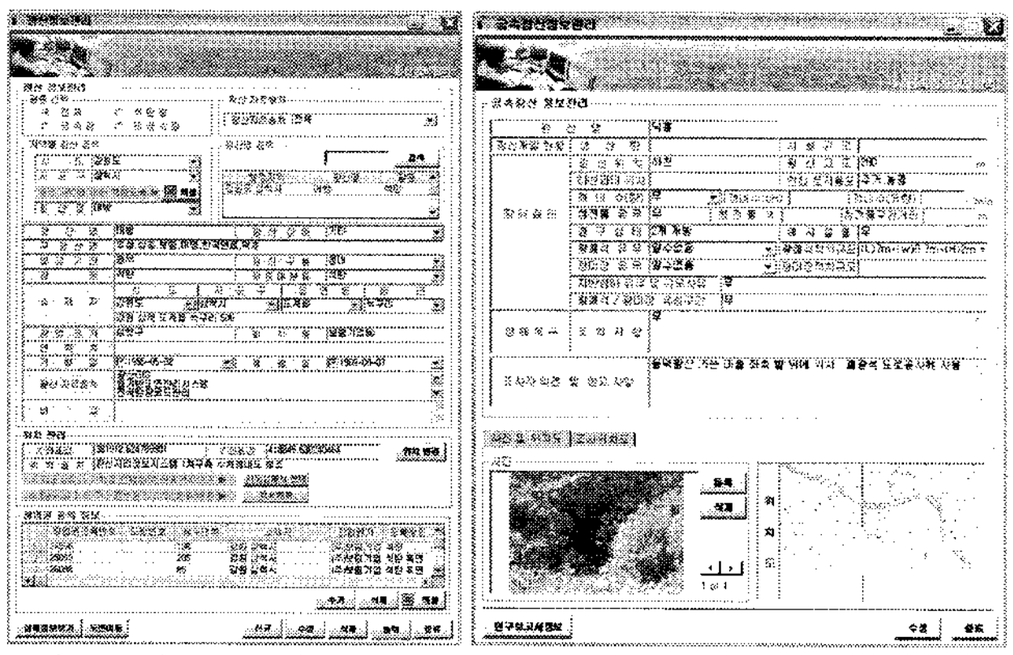

Figure 2. Function for displaying the mine information.

For the staff conducting a field survey in a mine area, map around the mine showing topological information with the mine information such as minehead, drift, etc. would helpful for finding the location of mine. So the function for map printing is very useful.

Figure 3. Function for map printing.

3. MINING-RELATED DAMAGES

3.1 Building Database

Damages due to the mining operation or not properly closed mines are ground subsidence, forest ruins, acid mine drainage(AMD), soil contaminations and mine tailings.

Areas of Ground subsidence occurrences, areas of ruined forest and area of tailings should be built as polygon shape of spatial database as those can express real boundary of damages. AMD is related to a minehead that outflows the contaminated water. So, measurement location of water qualities should be built as point shape of spatial database with relating minehead and drain information. The pollution values are also to be recorded. Soil contaminations are managed on a lot unit. So, lots database should be built as polygon and contaminations of each lot should be recorded with the pollutants and values.

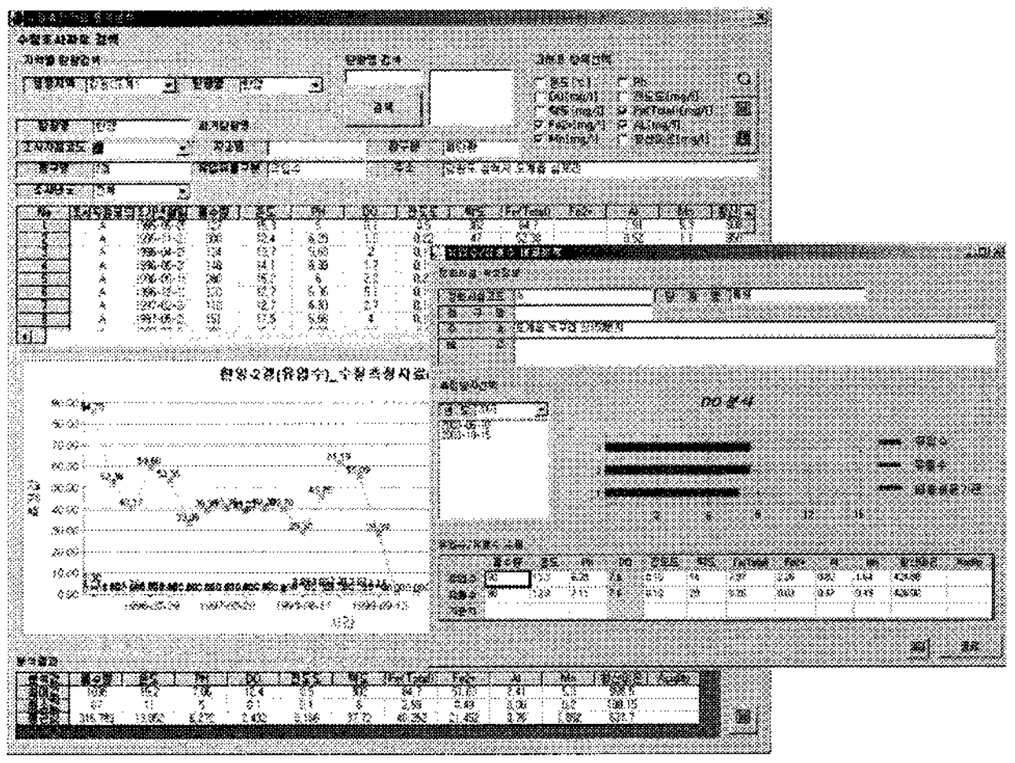

Figure 4. Windows showing the water quality values.

3.2 Database relating to Reclamation Works

Mireco has been conducting reclamation projects actively such as reinforcement works in areas of ground subsidence occurrence, establishing water purification facilities at areas water polluted by AMD, reforestation works and restoration of contaminated soils.

The former reclamation works can be guides to the next projects and it would be convenient if the reclamation works are stored as database.

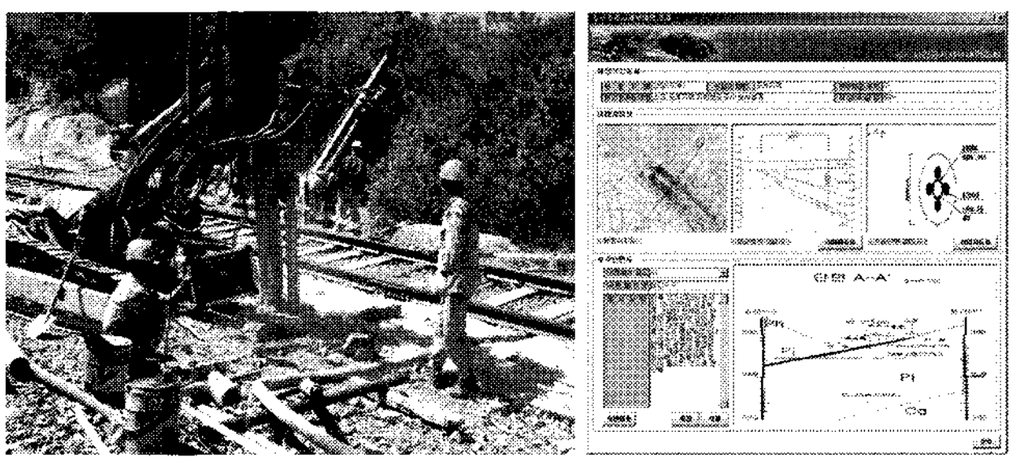

Figure 5. Reinforcement work

4. ANALYSIS AND ESTIMATION

The main purpose of building up GIS database is expressing the real world and utilizing it appropriately. Using the mine and mining-related database we can analyze and estimate the damages in the mining region by the functions of GIS, and support making decision of reclamation priority for preventing the mining-related damages.

It is necessary to catch the distribution of underground drifts to understand the occurrences of mining-related

damages. Drifts and mineheads indicates the cause of ground subsidence occurrences and flow of contaminated mine water. It is also possible to estimate the ground subsidence in the future using the distribution of drifts. We can catch the underground structure by the functions for cross section and 3-dimensional visualization(Fig. 6).

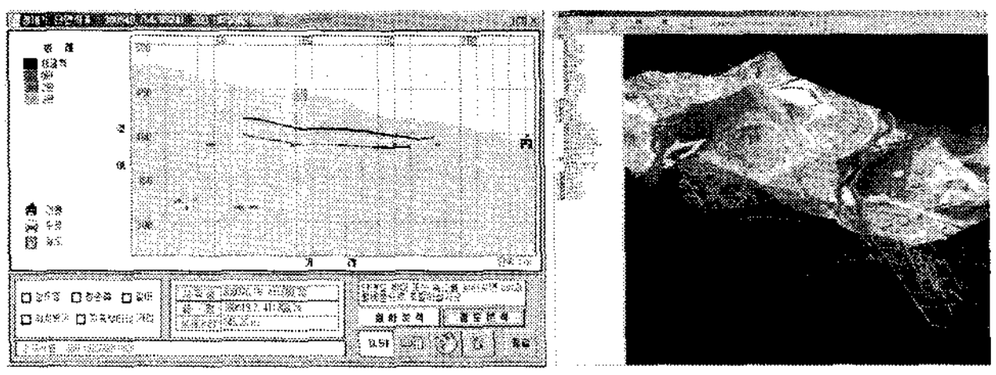

Figure 6. Cross section and 3-dimensional visualization

The pollution levels of AMD and contaminated soil by heavy metals of each mine can be the indicator of mining-related damages needed to be rehabilitated or not.

It is possible to display the pollution values of each mine joining with the mine point layer as one database. All the measurement items have its standard pollution value fixed according to the law, and we can calculate the number of items exceeding the standard pollution level for each mine. GIS can express each mine as a colored point symbol by that number(Fig. 7). Each color of mine shows the seriousness of damage status of each mine, then it will be helpful for staffs of Mireco to make a policy decision whether conducting a reclamation work or not.

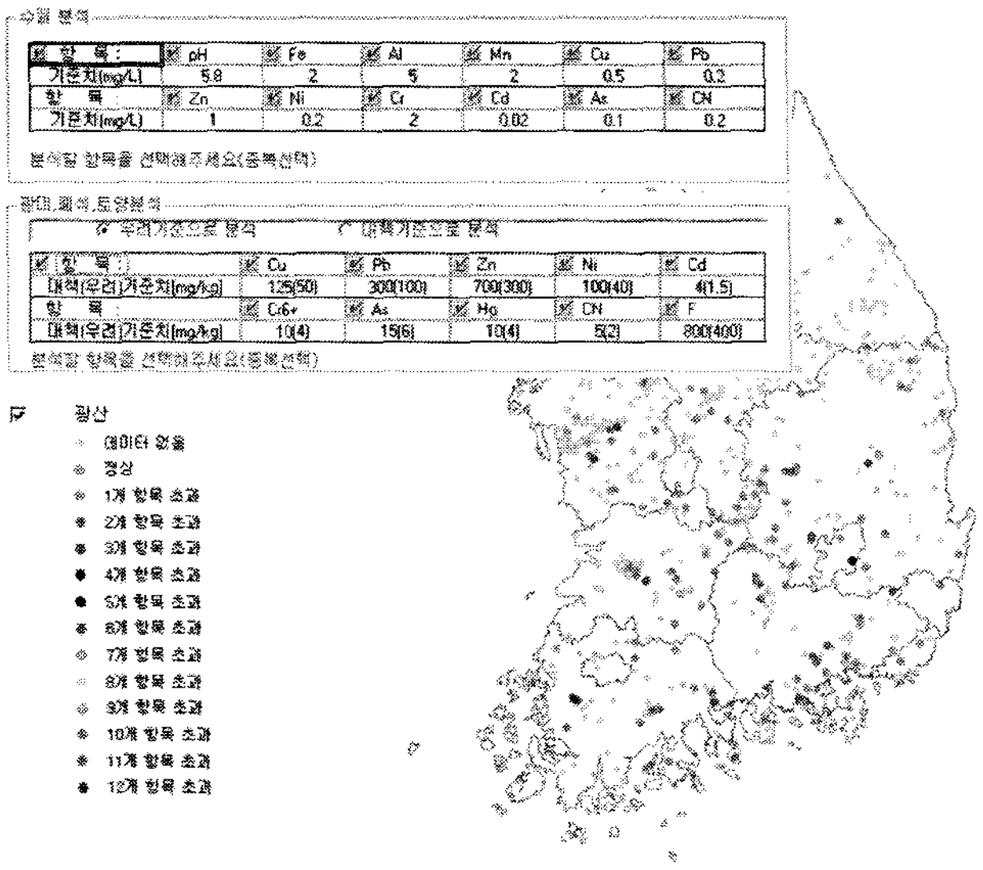

Figure 7. pollution values presentation

5. DISCUSSION

In this study, we suggested GIS-based system development for the systematic mining- related database management. Mireco has been already running a GIS for mainly abandoned underground coal mine, but mining-related damages by the metal mine are more serious than that of coal mine.

For the efficient management of damages at mine area and reclamation works using GIS, building basic database effectively, spatial or non-spatial, is the most important. Then, GIS-based system functions would support surveying the damages of each mine and functions for experts such as analyzing damages and estimating the possibilities of polluted area in the future would be helpful to decide the priority of reclamation works.

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