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지형정보시스템을 활용한 생태학적인 폐광지역 재개발 계획 및 관리

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A Strategic Plan and Management for Ecological Abandoned Mine Land (AML) Reuse Using GIS

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ABSTRACT

Plan and management for Ecological Abandoned Mine Lands (AMLs) reuse using Geographic Information System (GIS) technique are an ideal method. GIS technique display, manage and analyze a spatially referenced data, which can be combined in user-defined ways to make plan and decision about AMLs reuse. Local communities are affected by AMLs. In the past, plan and management of AMLs have never been considered for ecological aspects as well as using GIS. However, the rapidly growing GIS technology have proven to be a valuable tool in the process of understanding environment and of making responsible environmental decisions. This paper suggests that making responsible decision and plan using GIS can create a various types of benefits to local communities. This also shows that GIS may play a vital role at the decision/planning process of analysis and exploration of local environmental situation. We are trying to apply to decision support system for AMLs reuse. Moreover, a lot of thematic maps are making using GIS providing a comprehensive data with images. These can be an ideal platform to deliver meaningful outcomes.

Key words : Geographic Information System (GIS), Abandoned Mine Lands (AMLs)

요 약 문

폐광지역은 경제적 측면에서 낙후된 지역이며, 무엇보다도 폐광개발로 인한 주변생태계 파괴는 우려할만한 수준에 이르고 있다. 폐광산은 지형적인 관점에서 접근성이 용이하지 않으며 그곳에서 유출되는 폐광배수는 하천과 지하수로 유입되어서 지역 주민들 건강에 위협을 주고 있는 실정이다. 특히 강원도 일부 지역에서는 이러한 현상으로 지역주민들이 고통을 겪고 있으며 무엇보다도 폐광후의 경제적 낙후현상이 심해지고 있는 실정이다. 기술적인 폐광지역 복원은 이미 많은 기술보고서와 논문을 통해 알려져 있다. 하지만 많은 기술적인 노하우가 축적되어 있어도 계획단계와 관리단계가 제대로 되지 않으면 경제적 손실 뿐만 아니라 지역주민의 불만을 오히려 유발시킬 수 있다. 따라서 본 연구의 목적은 폐광지역의 생태학적 재이용 측면을 고려하여 효율적인 계획과 관리 모델을 제시하고자 한다. 특히 지형정보시스템(Geographic Information System)의 정책결정단계에 적용함으로써 경제적 가치, 환경적 가치 그리고 공익적 가치 창출에 크게 이바지 할 수 있다.

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1. Introduction

Gangwon province has discussed possible regional cooperation for Abandoned Mine Discharge (AMD) management for over 20 years, and begun joint efforts for government legislation, local government funding, planning and management sharing. Recently, AMD has made many problems including ecological or environmental destruction and human health damage. Despite the expenditure of billion Won to prevent AMD and control flow from upstream to downstream. Recently, local people keep complaining to local government about soil and water contamination. Also, extreme climatic phenomena have frequently occurred in recent years due to a climate change as well as geological complicates with many abandoned mines. Local government leaders and officers have higher awareness about these problems as well as ecological and health risks for local communities. Therefore, the effective plan and management techniques are needed

For AMLs reuse, decision makers and engineers should understand complex environmental issues, evaluate proposed environmental plan and law, and how individual decisions affect the local to global scales (Pfirman and AC-ERE, 2003). Recently, environmental problems such as AMD have multiple causes and multiple effects. Such complex problems causes climate change, variability and geological complexity. Known as “cognitive flexibility” and the understanding complexity of AMD problem will help for solution (Spiro and Jehng, 1990). The understanding of complexity requires a variety of data collection and analysis.

The GIS technique has played an important role in understanding the environmental complexity and making decisions for environmental issues (Carrarra and Fausto, 1995; Heit et al., 1991). However, the GIS application for AMLs reuse has not been applied yet. Recently, our group and Mine Reclamation Corp. (MIRECO) actively promote a better understanding of hazardous potential of abandoned mine through the use of GIS. GIS technology has already proven to be an extremely powerful tool in decision makers and raising public awareness for environmental management.

Mitigating the effects of abandoned mine hazards, providing potential risk analysis and ecological abandoned mine reuse for local communities are a useful application area. Furthermore, GIS transcends interdisciplinary field such as environmental, ecological, and social science by integration and combination data. Then using AMD maps and natural habitats maps through GIS in inquiry-based investigation and evaluation, decision makers and environmental planners use evidence and practices in the same manner as engineers.

This paper can be served over GIS to make decision and action plan for AML reuse. Also, GIS can be used to track how ecological system and human habitats are changing in response to AML reuse. The most important thing is that this paper provide a framework for integration of environmental, ecological, and social data across a range of temporal and spatial scales. In addition, this helps decision makers and developers integrate interdisciplinary perspectives.

2. Identification of benefits and constraints

Ecological abandoned mine reuse should consider benefits and constraints at the planner's point of view such as plan and management for environmental, economic and public aspects. These can gain advocates such as government leaders, environmental policy makers, local communities and community stakeholders. The understanding benefits and constraints for redeveloping AML can allow the incorporation of ecological enhancements. Benefits should contribute to many groups such as local industries, local communities, and regulatory. Even though benefits are assigned to local communities in aspects of environmental, economic and public, there are also constraints, which have unexpectedly caused public concerns. Then, the plan should carefully set up. The AML reuse plan is the last step after an AML remedial work. At first, remedial plan is simply referred in Fig. 1.

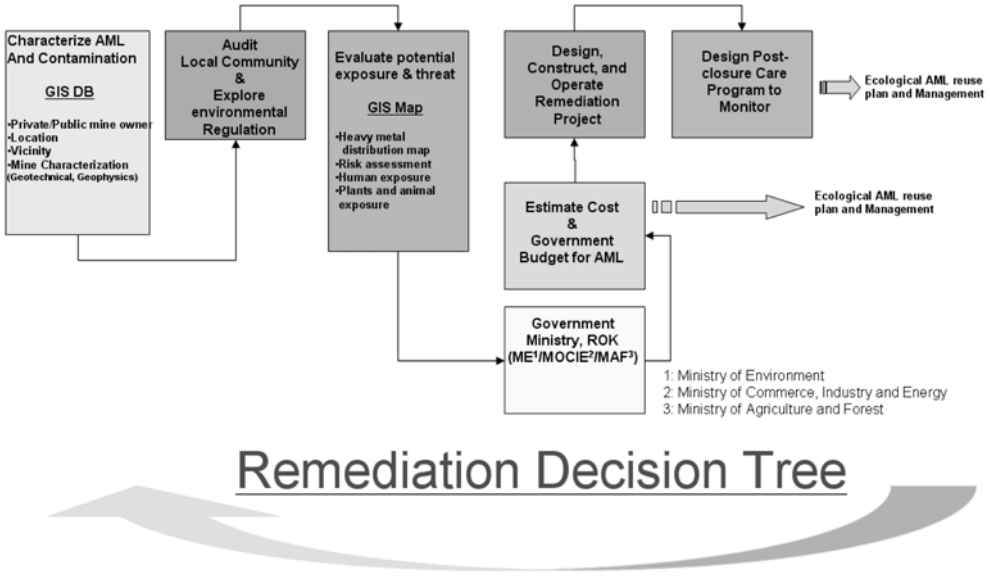

Fig. 1. Decision Tree for Remediation.

2.1. What is environmental benefits?

Recreating an ecological AML provides environmental benefits to soil, water, plant and animal as well as human health. Gangwon province has the mountain ridge. There are well preserved beautiful valleys and mountains make it a most favorite tourist attraction and only a clean area in South Korea. Unfortunately, serious environmental problems are brought about by derelict mines. Then, ecological abandoned mine reuse should be necessary and their results will give birth to many environmental benefits. These benefits are described below:

1) Preserves wildlife and improves plants diversity
2) Provides recreational areas
3) Reduces mine tailing and sediment with heavy metals
4) Improves surface water quality
5) Improves ground-water quality
6) Improves aesthetics

Specially, these benefits refer to recreational and natural conservational activities that do not require prepared facilities like wildlife viewing, camping, walking, picnicking, running/jogging, fishing and observing and photographing nature. Ecosystem service benefits can provide tourists and local communities. While local government such as Gangwon province proposes to different types of activities that require the use of special facilities, courses, fields, or equipment. They can provide local communities with opportunities to improved community health and higher quality of life.

For the GIS application, a database structure is designed to include environmental and ecological information from surveys/monitoring and site visits. The project of the AML reuse by designing GIS maps to support the process of optimal decision can be processed to the ideal way.

2.2. What is economic benefits?

Economic benefits mean that derelict mine can be better enhancement site as economic aspects. The points are whether an amount invested and compensation to local community may be recovered or not. Briefly to say, this could be a recreational use outcome with AML reuse or municipalities managements. The reuse governed by municipalities may be viewed as an economic benefit because it has the potential to return the property to productive AML reuse. These benefits are described below:

1) The break even points
2) Is cost competitive
3) Generate revenue

4) Provides municipalities managements
5) Offers tax advantages from central government
6) Reduces natural resources damage liability

Active environmental benefits also offer economic benefits that include local economic development. Active environmental facilities such as hiking trail, ski, and recreational facilities attract investment. Economically depressed areas such as AMLs can help attract home buyers and businesses and spur economic growth. Also, many visitors spend money on food, hotels and consumer goods. Then, local economy will boost.

GIS can also serve as a catalyst to revitalize AMLs. Spatial coordinates for contaminated sites and potential reuse sites are created from newly required GPS coordinates. For combining information, additional GIS layers updates automatically. These information provide a number of shared benefits such as increased investment, local economic growth, increased property values and tourism opportunities.

2.3. What is public benefits?

Local communities desire to use the ecological AML redevelopment to provide educational opportunities, aesthetic benefits, and natural resources to the Municipalities. The environmental conservation associated with AML reuse could be serve as educational opportunities. The AML reuse is an item of educational interest according to biology, ecology, plant horticulture and hydrology. These benefits are described below:

1) Provides recreational and tourism opportunities
2) Provides educational opportunities
3) Improves aesthetics to local communities
4) Improves goodwill through good neighbor
5) Improves good reputation

These benefits has been correlated with environmental benefits and economic benefits. Conveniently mental and physical health come from these benefits. The ecological AML reuse may reduce psychological stress and feeling depress. The remediated AMLs provide opportunities for together with local residents or tourists. First of all, the remediated sites can also provide educational effects to people.

In GIS system application activity, analysis for public benefits consists of indicating safe and remediated AML regions and adding/recommending healthy ecosystems such as forest, grasslands, wetlands, lakes, ponds, rivers, and estuaries. Besides providing these information to local residents and tourists as well as decision makers and planners, the ecological AMLs reuse can serve as a catalyst to educational benefits.

3. Reviewing regulation and guidance

The Mine Reclamation Corps. (MRC) have issued guidance to regional redevelopmemt project to AML including ecological enhancement. MRC's document *Guidance on prevention and reclamation of abandoned mine at AML* (http://www.mireco.or.kr/jsp/bbs_template/front/data07) describes how corrective actions can be completed, with contaminants remaining, using controls tailored to protection. Unfortunately, there are not in detail how to reuse or how to plan and manage AML for ecological purposes. The regulation and guidance of Ministry of Commerce, Industry and Energy (MCIE) has mainly documented about coal industry support, mine reclamation and clean-up and regional development. After all, MRC has been building up a mine GIS network designed to provide for the comprehensive management of such tasks as the prevention of safety-related accidents and environmental pollution in the mine area (http://www.mireco.or.kr/eng/html/MR_D310_G100.jsp). However, there are insufficient GIS data for ecological AML plan and management. For these, building-up GIS DB should be needed more than now. Especially, environmental data, ecology data, ecosystem data, administration information and information of local community and industry should be builded up through Ministry of Commerce, Industry, Energy (MCIE), Ministry of Environment (ME) and Ministry of Agriculture and Forestry (MAF) guidance, Then, decision makers will make a strategic plan for redeveloping AML and GIS information should be needed. The concept diagram

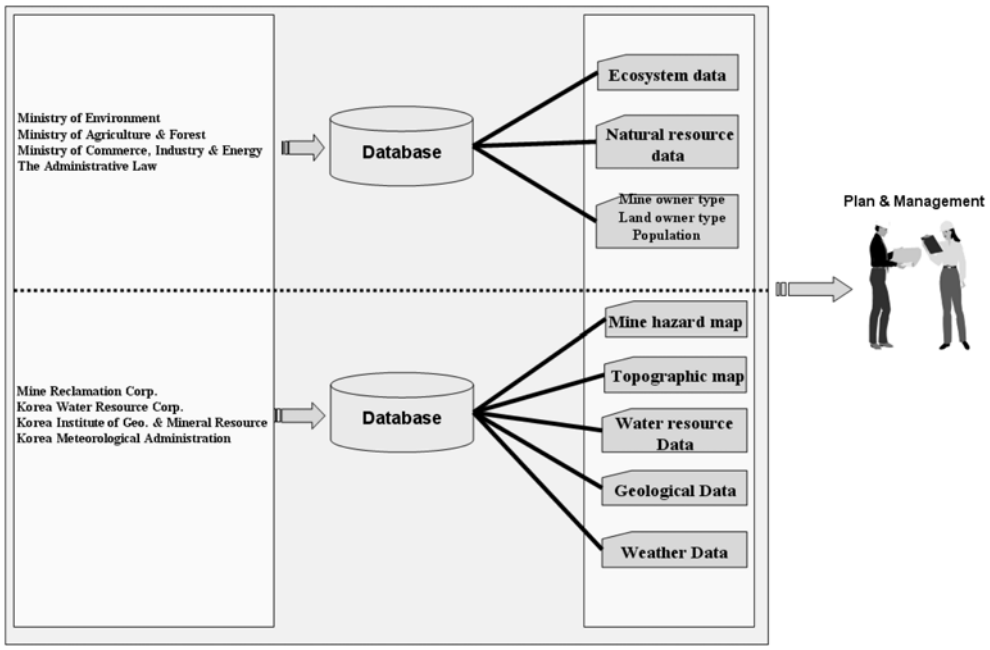

Fig. 2. GIS Concept Diagram for Planning and Management.

are described in Fig. 2. In GIS concept diagram, for ecological AML reuse and management, a GIS consists of spatially explicit information and two databases that combines them together to create a Web-based spatial analysis. Several information were already ended and is been collecting such as topographic map, water resource data and landuse data. This information can be displayed on a computer screen. However, the most important thing is that metadata and information should be included for spatial analysis and management. For example, when point source pollutant map such as abandoned mine location with no information is shown on the computer, it is useless. Then, much of the information we collected and monitored about AMLs contains a relating that information at the point as a objective site. This GIS systems can help decision makers and developers make the most appropriate decision about ecological AMLs reuse. Specially, ecological information and ecosystem information should be necessarily.

4. Estimation of ecological AMLs reuse

Every abandoned mine possesses a unique value to society that is dependent on its properties and its relationship to the surrounding region (AML). The ability of an abandoned mine to produce jobs, housing, environmental habitat, mineral sources, agricultural goods, and other several values is the service capacity (Chao, 1983; Clark, 1911; Crew and Kleindorfer, 1971, 1976, 1986). The service capacity of an abandoned mine is dependent on its regional setting. For example, the Gangwon Land within Gangwon province has a very different service capacity than other all area in Gangwon province. Actually, Gangwon Land is located on Jengseongun. There were several big coal mines such as Sabuk coal mine. Moreover contamination reduced the service capacity and rather threaten the capacity of a site before mines are closed. After all, local economic situation was depressed. Now, the active of Gangwon Land contributes to improve regional economy and maximization of benefit although Gangwon land is not ecological aspect. The outset of reuse process is critically important as redistribution of benefits to invest AMLs. Bringing together interested stakeholders to pursue making benefits opportunities through AMLs reuse offers benefits to everyone involved. Then, estimation of ecological AML's reuse is based on the ethical code of active of regional economy, manage-

ment considers the interests of the stakeholders as an important factor, fair, transparent and honest management, observes the law and fulfills its social responsibility as proper business activities. Estimation of ecological AML's reuse can be expressed as venn diagram (Fig. 3).

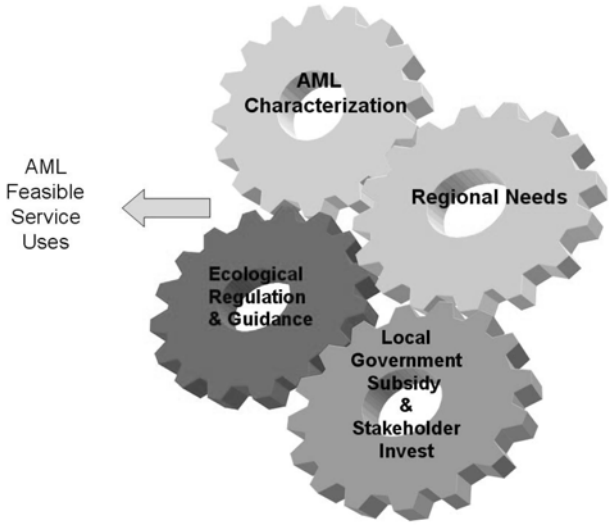

Fig. 3. Venn diagram of the general elements used to estimate a AML's feasible service uses.

5. Decision making

To accomplish strategic decision making, the concept of decision making process has been suggested through Fig. 4. The decision makers should have a future view and define a clear vision of the desired end use of AMLs. Here, GIS technique should play a vital role at the process of decision making for AMLs reuse. In general, decision making process should investigate the stage of exploration and analysis of effects of local communities and ecological/environmental resource. Specially, GIS technique may make explicit in recognition of ecological/ environmental impacts by AMLs reuse. Many thematic maps must provide a comprehensive information with picture of AMLs.

This paper suggests in concept model that decision-making process can be structured into several major steps as Fig. 4; clean-up, cost analysis, reviewing guidance, design, and action.

During the information in clean-up step is gathered to understand the situation for which a strategic decision is required. Cost analysis and review guidance

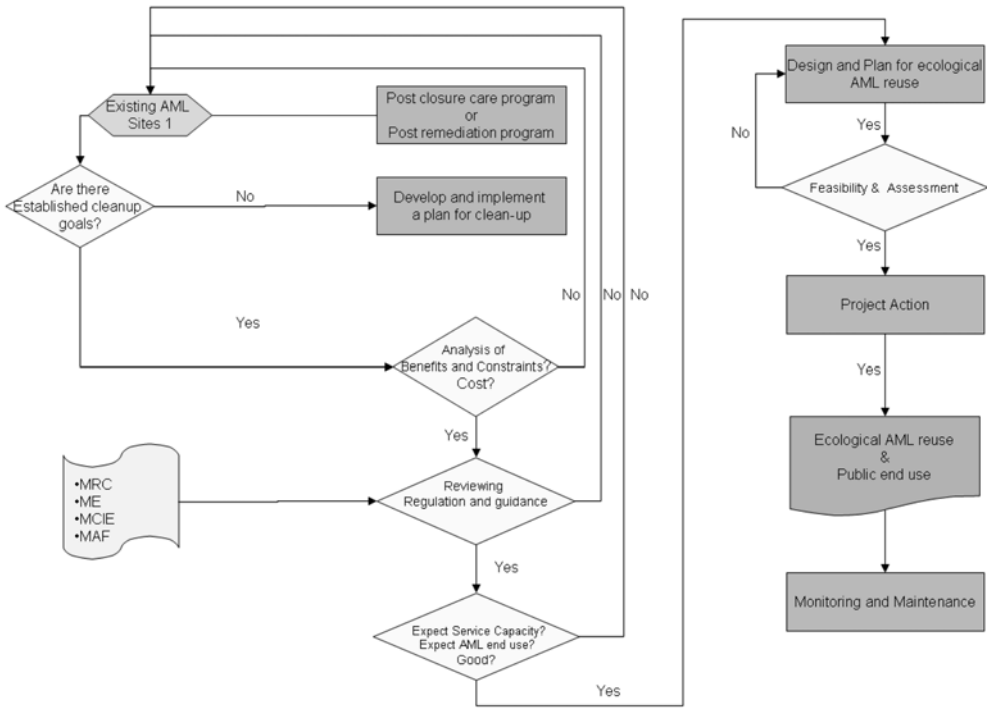

Fig. 4. Decision making for ecological AMLs reuse.

steps make explicit a possibility for AMLs reuse by the various assumptions and facts. Hence, during the various designs are explored and considered, an action and maintenance are undertaken.

6. Conclusion

Abandoned mine lands offer opportunities for ecological valuable reuses. Decision makers and developers consider that all local communities might either be affected by their plans. In other words, The plan and decision must play a key role in the decision process.

The objective of this study refer to effective role can be played by GIS for data exploration and analysis of ecological/environmental information, regional information, and so on through producing thematic maps. The statistical interpretation is suspected to play a powerful role for updated understanding of decision support.

Moreover, it should be noted that there is advantages for using GIS in the economic, environmental and public benefits. These depend on the abilities of decision makers and planners to manage AMLs. Therefore, for maximizing benefits, decision makers should fully understand a whole decision process, the cost and cost-saving potential and economic benefits of the AML designed with an ecological land reuse. Also, the decision makers and planners have to consider about a strategic maintenance and an effective management after end up.

In additional, GIS technology seems to be useless in the quantification of social satisfaction and ecological value. This might due to a restriction for using GIS. However, GIS application, especially related to quantification method such as Net Present Value (NPV) analysis (Bennet and Fulhage, 1993; Cason and McAuslan, 1973; Dhuyvetter, et. al., 1999), will be necessarily for effective AMLs reuse management.

Finally, GIS application offers unique opportunities for ecological AMLs reuse. It help ensure that AMLs reuse is compatible with ecological reuse guides and environmental laws. Therefore, this paper will play a major role in the reuse process and work with the local communities towards regional developing that protects health for ecological AMLs successful reuse.

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