ECOLOGICAL PROBLEMS IN CHINA COAL MINING AREA AND CONSTRUCTION OF ENVIRONMENTAL INFORMATION SYSTEM

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ABSTRACT

Our society developed along the route of traditional industrializing civilization, and accompanying with many coal mines being constructed, a great deal of ecological problems emerged, especially in coal mining area: its atmosphere, soil, water and geological condition were all destroyed more or less. All these directed in over-exploitation, ecological environmental pollution which affected the development of mines and human. This paper first expounded the content of environmental problems in coal mining area, and then investigated these problems as follows: during exploitation, plenty of mine tailings, CH_4 and collapse of ground were brought, soil and water resource became shortage and were greatly destroyed; during processing, a great deal of wastewater were discharged unorganized; many coal dust produced from transportation and a great deal of SO_2 and CO_2 from burning had an serious impact on atmosphere. Then some thoughts and methods to resolve environmental problems were suggested to realize the sustainable development of coal mining area, and finally, based on GIS, an environmental information system of coal mining area was constructed, which could support resources exploitation and environmental protection.

Key words: coal mining area, ecological environmental problems, sustainable development, environmental information system, math model.

ENVIRONMENTAL PROBLEMS IN COAL MINING AREA

The exploitation of mine brings human material and energy, but also directs in a series of environmental and ecological problems because of prolonged unconscionable exploitation. These problems can become multipolar, including the pollution of water, soil, atmosphere, noise and ecological environment, and also can induce some illness such as pulmonary and stomach disease which strictly injured mineworkers' health. Altogether, the exploitation, processing and using of coal resources were negative for environment.

Geological disaster

The exploitation of mines brings a series of geological disasters, which were induced by exploitation and also can induce other environmental problems.

Soil resource

Opencast working results in the abruption of surface soil and the rock undersurface, at the same time a large of area must be used to deposit this garbage which can pollute soil and groundwater, finally endangers biology around; underground exploitation induces collapse, which can destroy road, building, farmland and pipeline; The solid wastes, such as gangue and cinder, is not only occupy a great many of ground and also pollute the environment more or less.

Water pollution

The decline of groundwater table can be induced by non-processed drainage of wastewater, and then water resource in this area becomes short, and the aquifer will be destroyed, and water circulation will be destroyed; A large number of pollution in mine wastewater endangers water environment around; a great deal of washing coal water was discharged unorganized and it can make coal-swamp; Furthermore, the exploitation can also brings some hydro-chemic problems, for example, groundwater type will transform from CO_3^- to SO_4^{2-} in coal-mining area.

Atmosphere pollution

The large number of gangue and coal pile in coal-mining area not only can float and diffuse in the air, and also be easy to self-ignite. Researches indicate that many harmful substances such as SO_2, CO, H_2S, CH_4 and polycyclic aromatic hydrocarbons (PAHs) etc. are emitted to the air during gangue spontaneous combustion, at the same time a great deal of soot is diffused. All these can bring us atmosphere pollution, greenhouse effect, acid rain and so on.

Noise pollution

Noise pollution occurs during producing process. Researches indicate that 70% of equipments used in coal mines in China has exceeded the standard 90dB(A), especially the equipments under the well, which produce noises with large intensity, high pitch, more fountains and very long time. Serious noise can disperse mineworkers' attention, and make them slow in thought or action, hard of hearing, even bring mineworkers cordis and neural diseases.

To sum up, the producing process in coal mining area is catastrophic and dissolving, and has endangered human health and living. Therefore, actualizing sustainable development is significant to protect and improve our living environment. The relation between resources exploitation and environment protection is the central problem of sustainable development

in coal mining area. Based on GIS, it's necessary to preview, analyze and assess the actuality and direction of environmental condition in coal mining area, and then adopting countermeasures which can effectively resolve the geological disasters and environmental problems in coal mining area, and also can mitigate the conjuncture that resources are lacking in China.

ENVIRONMENTAL INFORMATION SYSTEM (EIS) IN COAL MINING AREA

During the process of founding sustainable development system in mining area, many relevant analyze models and assess index systems are necessary to be built based on the modern spatial information technology to ensure the harmony within the society, economy, population, resources and environment in mining area.

Geographic information system (GIS) is an important part in modern spatial information technology, which is used on management and research of spatial data. Supported by computer software and hardware, geographic spatial data can be processed according to the geographic coordinate or spatial position, and data can be managed effectively and diverse spatial entities and its relation can be studied. By comprehensive analyzing multi-factors information, some of information which satisfies the needs of the application can be acquired rapidly. The results of the processing will be shown in the form of maps, graphs, data etc.

Therefore, GIS become more and more useful in application, such as hazard monitoring, environmental protection and so on. GIS can analyze environmental monitoring information to sustain environmental simulation, evolvement preview and analyzed assessment, and provide external evidence for environmental treatment. Accordingly, GIS is a powerful instrument for storage, disposal, combination, analysis and assessment of the dynamic space-time information including multidimensional spatial data and environment information.

Assignment and structure of EIS in mining area

Object and assignment

(1) Environmental Management: manage all environmental resources in coal mining area, including atmospheric quality, water resource, soil resource, geological change etc, and effectively organize the information upwards.

(2) Environmental Programming: Based on GIS, carry out some programming of mining area, for example, preview and treatment programming of collapse brought by exploitation, to collocate environmental elements and compare or assess each project.

(3) Environmental Impact Assessment: collect and manage data concerned with coal mining area as instruments for environmental impact assess, such as water quality of

groundwater and surface water, quality of atmosphere, using situation of soil, geological change etc.

(4) Environmental Treatment: based on the conclusion above, an environmental treatment model can be constructed, and the treatment effect can be previewed by adding, buffer, digital terrain model and some other analysis methods.

Structure

Environmental Information System in mining area consists of four parts: environmental database, environmental analysis, ecological remote sensing and environmental charting. Figure 1. presents functions of each part.
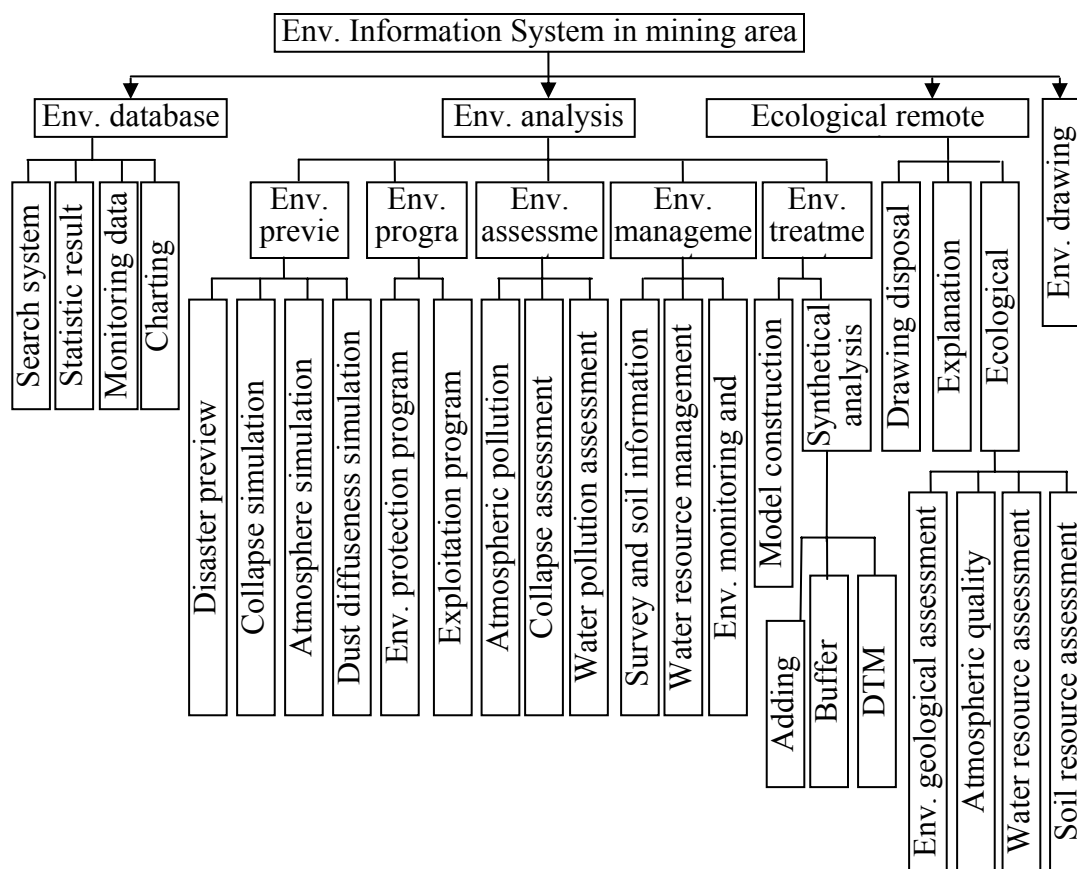

Figure 1.: Structure of Environmental Information System in mining area.

Realization of EIS in mining area

Construction theory

Systematic dynamic model is ought to be used when designing or constructing EIS to imitate the relationship between exploitation and natural resources, and to simulate the

action and course of processing in coal mining area, consequently the management, programming, impact assessment, development direction preview and control measures will be achieved.

Data collection

The precondition of achieving objective is provided with integrated, exact and timely data. But the object disposed by EIS is uncertain, so some estimate indexes are needed: source, precision, logic-consistency, integrality, dependability, realism and safety grade. The EIS in coal mining area has a error control function to help users confirm the error limit of data.

Data model

Three-dimension spatial data model and structure and comprehensive analysis ability of dynamic spatial data are requisite for effective search and updating.

Furthermore, the standardization of categorizing, coding and format of data must be disposed well in order to exchange them.

DATA MODEL OF ENVIRONMENTAL IMPACT CAUSED BY MINING ACTIVITIES

Mathematical and space-time simulation

The numeric answer of math model of environmental impact caused by mining activities has been educed to preview and analyze the impact:

$$\frac{\partial u_i}{\partial t} + u_j \frac{\partial u_i}{\partial x_j} = -\frac{1}{\rho}\frac{\partial p}{\partial x_i} + \frac{\partial\left(-u'_i\,u'_j\right)}{\partial x_j} - \beta_T q\delta_{i3} + lu_2\delta_{i1} - lu_1\delta_{i2} + J_i$$

$$\frac{\partial T}{\partial t} + u_j \frac{\partial T}{\partial X_j} = \frac{L}{C_p}\Phi + \frac{\partial V_{Tj}}{\partial X_j}\cdot\frac{\partial T}{\partial X_j} + Q_T + J_T$$

$$\frac{\partial q}{\partial t} + u_j \frac{\partial q}{\partial X_j} = \frac{\partial V_{qj}}{\partial X_j}\cdot\frac{\partial q}{\partial X_j} - \Phi + J_q$$

where
    u_i=change rate of every mass liquid in reference frame
    t=time
    ρ=density
    p=pressure
    β_T=caloric coefficient of volume extension
    q= temperature
    l=mutual mend coefficient
    J_i J_T J_q=overfall fountain of pulse, heat and temperature

T=different value from background temperature
L=latent heat produced from pervasion
Φ=rate of cohesion
V_i V_T T_q=overfall speed of pulse, heat and temperature
Q_T=heat fountain produced by mining activities.

Moreover, $\partial u_i / \partial X_i = 0$, $-\overline{u'_i u'_j}$ is a two rank tensor, and $-\overline{\rho u'_i u'_j}$ is called Renault stress, expressing the transmitted rate of momentum of unit area caused by overfall pulse:

$$-\overline{u'_i u'_j} = V\left(\frac{\partial u_i}{\partial X_j} + \frac{\partial u_j}{\partial X_i}\right) - \frac{1}{3}\overline{u'_k u'_k} \cdot \delta_{ij}, (i,j,k = 1,2,3)$$

The equation of heat exchange between soil and terrane:

$$\frac{\partial T_Z}{\partial t} = \frac{\partial k(X)}{\partial X_j} \cdot \frac{\partial T_Z}{\partial X_j} + Q_T$$

where
T_Z=temperature of terrane
k=heat exchange constant of different terranes.

The follow math model showed the rule of radiation and transfer of hazardous elements in environment:

$$\frac{\partial C_k}{\partial t} + u_j\frac{\partial C_k}{\partial X_j} - W_q\frac{\partial C_k}{\partial X_j} = \frac{\partial D_{kj}}{\partial X_j} \cdot \frac{\partial C_k}{\partial X_j} + W_k + J_k$$

where
C_k=concentration of element k, k=1,2,…n
D_{kj}=rate of pervasion or exudation
W_q=leak coefficient of pollution
W_k=other components produced from chemical reaction
J_k=pollution fountain caused by mining activities.

These diverse models can be used to analyze: ventilation and tiny climate of mining work below well and on ground; interaction between rock temperature (or radiant element) and environment; preview the environmental condition while exploiting; how to optimize mine according to environmental protection.
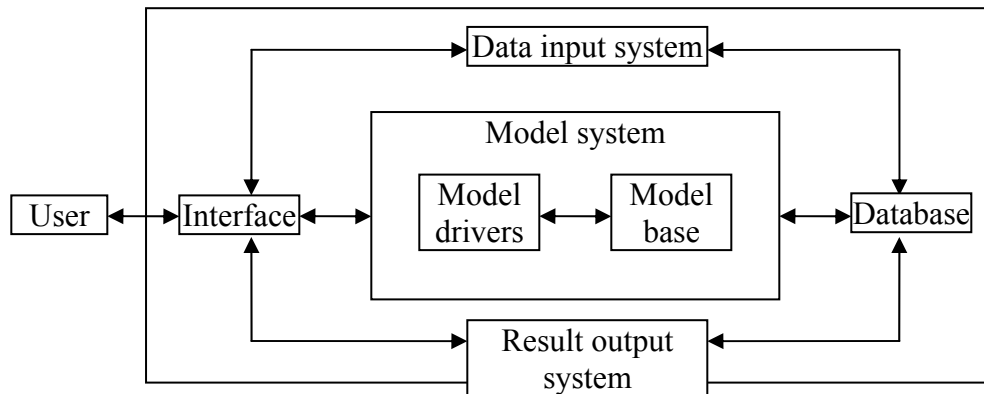
Collapse analysis system

Figure 2.: Elements of Exploitation Collapse Analysis System (ECAS).

The exploitation collapse analysis system showed in Figure 2., supplies effective methods to research the structure and process of ecological environment, and to preview the future of mining environmental system. The function of ECAS is managing information about collapse and model analysis, including input and output of spatial data and attribute, and results are exported by document, printout and standby. Moreover the system sustains professional search and model analysis. Users connect with each subsystem through the interface and operate database restricted in purview.

CONCLUSION

Coal mining area is a complex ecological system of nature, society and economy, and now the environmental problems caused by mining activities is one of the focus of sustainable development. Environmental information system supplies theory and method to optimize the usage of resources and to protect environment. Its theory and technology is a powerful instrument for storage, disposal, combination, analysis and assessment of the dynamic space-time information including multidimensional spatial data and environment information. Based on this, several of environmental information systems of mine resources fit different mines should be exploited, and some qualitative and quantitative simulation supported by math, physics and mechanics theory should be done. Then it's capable to realize optimizing exploitation of mine resources, dynamic comprehensive analysis of environmental impact and also the feedback and control function, and sequentially EIS can supply service and assistance to sustainable development of coal mining area.

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