Comparative Analysis of Development Patterns of Mining Areas from the Point of View of Environmental Economics

Wan linwei

Business School, Henan University of Urban Construction,
Pingdingshan, Henan, 467036, China

Corresponding author is Wan linwei

Abstract
This study adopted entropy model to deduce the calculation formulas of increasing entropy for three different development patterns of mining areas from the perspective of environmental economics and then a simulation calculation was conducted by use of a computer to forecast the increasing entropy of three development patterns within the next twenty years. The simulation results showed that ecological mining pattern was absolutely necessary because its entropy increasing curve was the flattest. Traditional mining pattern as well as end-of-pipe treatment pattern inevitably had some negative impact on the ecological environment. With this research, the author's endeavor is to provide a reliable base in theory for choices of the development of mining areas.
Keywords: MINING AREAS, DEVELOPMENT PATTERNS, ENTROPY MODEL, SIMULATION CALCULATION

1. Introduction

Coal resources play the fundamental role of social and economic development; however, mining activities can also cause lots of environmental damages all over the world [1-2]. In general, development patterns of mining areas have experienced three periods, including the traditional mining pattern, the end-of-pipe treatment pattern and the ecological mining pattern. Mining enterprises which adopt the traditional development pattern actually only take the economic efficiency of enterprises into account, yet unawareness of the ecological and social benefits [3]. The end-of-pipe treatment pattern originated in the European countries after World War II, and it was generally accepted and popularized in the 1960s and early 1970s. As an important stage in the development of environmental management, the end-of-pipe treatment was helpful to eliminate pollution incidents, which could also relieve trends of environmental pollution by production activities to some extent at that time [4-5]. Based on the concept of cleaner production, ecological mining leads to increases in resource efficiency and deceases in waste generation and it can reduce the environmental burdens of industrial production to a certain extent. In terms of mining enterprises, ecological mining pattern demand they take the green mining technology in the initial stage of coal mining [6]. Additionally, comprehensive prevention of environmental strategy is applied throughout the whole course of coal processing so as to realize the utilization of high efficiency of coal resource and reduce the risk of ecological environment in the process of coal resources exploitation and processing [7]. The practice has proved that different development patterns of mining areas inevitable make a big difference to the way the industrial production have impact on the environment. However, there is limited literature that focuses on the comparative analysis of development patterns of mining areas from the perspective of environmental economics.

A primary definition of entropy is stated in classical thermodynamics and statistical mechanics. The second law of thermodynamics states that, in any physical or chemical process, the quality of the energy in a system degrades, thus proving the existence of irreversibility in nature [8-9]. From the second law descends the existence of the extensive state function, namely 'entropy', which measures the disorder degree of a system, and it is also an evidence of the unidirectional flow of time. It is nowadays possible to use the concept of entropy as a powerful instrument to deal with ecology, management, economics and even some humanities and social science problems. Entropy runs through the natural environment and human activity, accompanied by the destruction and downgrading of the ecological environment in the process of exploitation and utilization of mineral resources [10]. Meanwhile, to accurately predict the increasing entropy of three development patterns of mining areas, this paper can use sophisticated computer simulation technology to apply theory to this research [11-12]. A scientific computer simulation is the imitation of a behavior of a system, entity, phenomenon or process in the physical universe using limited mathematical concepts, symbols, and relations through the exercise or use of a scientific computer model. The objective of every scientific computer simulation is the same: to accurately predict some behavior of the physical universe. The objective of every scientific computer simulation is the same: to accurately predict some behavior of the physical universe. The traditional simulation method is an iterative process, which provides an abstract model to experimenters, and then the test results are interpreted and the model is tested by experimenters under the related parameters. [13-16]. Computer simulation technology all over the world is widely used in many high-tech fields, such as aerospace, nuclear industry and the military, meanwhile, it has greatly extended from the natural sciences to the social sciences in the past years.

2. Methodology

2.1. Analysis of entropy change in coal production process

It is theoretically possible that all the exploitation and utilization of resources is the process of making use of its dispersal ability, which is also a typical entropy increasing process, so as to realize the potential entropy transfer ability reserved in recourses. So the entropy change caused by resource exploitation can be considered to be the ability for entropy increasing of resources in the whole economic system and the capacity of entropy change is proportional to the resources diffusion capacity. Therefore, entropy is irreversible transferred to the ecological environment in the course of mineral resources development and utilization. It can break the original state of nature, thereby forming a state of chaos. There's a risk of the entire environmental system crash in case of the entropy accumulated to a certain extent and the mining ecosystem will be degraded or completely destructed in that case.

According to the thermodynamic entropy theory, the whole process including coal mining and coal washing is actually a process of entropy increasing (PEI) [17]. First, we may consider the process of coal mining as a system with spontaneous thermodynamic processes. Assume the entropy change of the whole system is ΔS, and entropy change produced by the internal system irreversible process is ΔS_i, entropy change produced by energy and material exchange between external environment and the coal mining areas production system is ΔS_o.The formula can be expressed as:

$$\Delta S = \Delta S_i + \Delta S_o \qquad (1)$$

Given that the whole system is completely open, the principle of entropy of coal mining system can be deduced from the second law of thermodynamics:

$$\Delta S \ge 0 \qquad (2)$$

With $\Delta S > 0$, the system is in an unstable state; only if $\Delta S = 0$, the state of thermodynamic system will be in dynamic equilibrium. As shown in formula (1), when the system is in dynamic equilibrium, the formula is expressed as:

$$-\Delta S_i = \Delta S_o \qquad (3)$$

Therefore, when the open thermodynamics system is in dynamic equilibrium, the increasing entropy internal is equal to the external entropy change in number, but contrary to the sign each other. Meanwhile, under no circumstances will exist $\Delta S_i \ge 0$, so the open thermodynamic system in a static state can be described as:

$$\Delta S_o \le 0 \qquad (4)$$

Systems theory is the interdisciplinary study of systems in general, with the goal of elucidating principles that can be applied to all types of systems at all nesting levels in all fields of research. In this respect, a system must exchange entropy with the outside so as to maintain a dynamic equilibrium state. It's necessary to absorb or emit the negative or positive entropy which is equal to the increasing entropy produced by internal system [18]. As for a coal mining system, original state of dynamic equilibrium system is broke due to the coal mining and initial processing. It is possible to restore stable and orderly internal organizational structure of the original system, only if the system emits positive entropy to the outside. It mainly reflects in emitting various forms of industrial wastes including coal gangue, gas and mine waste water to the outside. So the total entropy change is $dS = 0$. As shown in Figure 1, entropy flow of production process of coal mining can be briefly described as follows.

2.2. Construction of the entropy model for coal mining areas

Assume the total entropy change of the coal mining system is $\Delta S_I(t)$; the internal entropy change produced by coal production activities is $\Delta S_i\ (t)$. The equation is expressed as:

$$\Delta S_i\ (t) = \Delta Q(t) / T(t) \quad (5)$$

Where $\Delta Q(t)$ is the heat value of coal production activities; and $T(t)$ is thermodynamic temperature of the process of coal mining; we also assume $\Delta S_o(t)$ is the amount of the entropy change caused by material and energy flow in and out of the system. Because total entropy change of coal production process for coal mining areas is the sum of exchange entropy change between internal and the external entropy changes, the total entropy change of coal production activities can be expressed as:

$$\Delta S_I(t) = S(t+1) - S(t) = \Delta S_i + \Delta S_o = \int_t^{t+1} \frac{Q_p(\lambda) + Q_u(\lambda)}{T} d\lambda + \int_t^{t+1} \frac{\Delta S_o}{d\lambda} d\lambda = \frac{1}{T}\left[\int_t^{t+1} Q_p(\lambda) d\lambda + \int_t^{t+1} Q_u(\lambda) d\lambda\right] + \int_t^{t+1} \frac{\Delta S_o}{d\lambda} d\lambda \quad (6)$$

Where $Q_p(\lambda)$ is the total value of heat released by coal production; $Q_u(\lambda)$ is the value of heat released by industrial wastes (coal gangue, gas, etc.) Based on the integral mean value theorem, it can be computed as:

$$\int_t^{t+1} Q_p(\lambda) d\lambda = \sum_\alpha \varphi_\alpha \cdot I_\alpha(t) - \sum_\beta \varphi_\beta \cdot R_\beta(t) \quad (7)$$

$$\int_t^{t+1} Q_u(\lambda) d\lambda = \sum_\gamma \varphi_\gamma \cdot G_\gamma(t) \quad (8)$$

Where $I(t)$ is annual total input of resources for coal production; $R(t)$ is annual net output of the coal industry; $G(t)$ is the amount of total annual waste; φ_α is the equivalent energy coefficient of the kind of α resource(kj/t); φ_β is the equivalent energy coefficient of the β kind of clean coal(kj/t); φ_γ is the equivalent energy coefficient of the γ kind of industrial waste(kj/t); t is the time interval, usually one year.

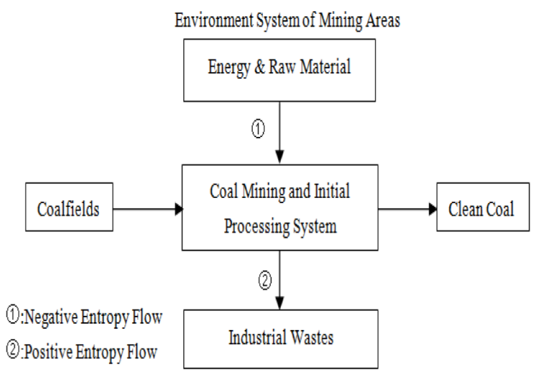

Figure 1. Entropy flow of the coal mining

The formula of annual total entropy change of coal mining can be written as below:

$$\Delta S_I(t) = \frac{\sum_\alpha \varphi_\alpha \cdot I_\alpha(t) - \sum_\beta \varphi_\beta \cdot R_\beta(t) + \varphi_\gamma \cdot G_\gamma(t)}{T} + \Delta S_{oI}(t) \quad (9)$$

When the production system of mining areas is in stable state, therefore $\Delta S_{oI}(t) = -\Delta S_{iI}(t)$.When $\Delta S_I(t) = 0$, we can use Formula (6) to build the formula of annual total entropy change in the coal mining system as follows:

$$\Delta S_{oI}(t) = -\frac{\sum_\alpha \varphi_\alpha \cdot I_\alpha(t) - \sum_\beta \varphi_\beta(t) \cdot R_\beta(t) + \varphi_\gamma \cdot G_\gamma(t)}{T} \quad (10)$$

Generally speaking, modern industrial production process includes product produce process and waste treatment process, and there is no exception for coal mining. Moreover, what needs to be explained is that this study assumed that the coal enterprise only produces one kind of coal product, and so only discharges one kind of waste in order to simplify the calculation. Under this assumption, annual total input of resources for coal production and annual net output of the coal industry together with annual waste all can be determined, and then the total entropy of coal mining can be calculated by using the entropy model.

2.3. Application of the entropy model for coal mining areas

Based on the theory of Environmental Economics, production process can use financial and labor inputs to translate renewable resources and non-renewable resources into the final goods or services [19-20]. We assume that the state of labor is in unlimited supply in this paper. The outputs measured by physical units I are in direct proportion to investment K ; and the capital-output coefficient is δ ; so the formula of outputs measured by physical units can be expressed as:

$$I(t)=\delta K_p(t) \quad (11)$$

The formula of amount of total annual waste, as given in the following:

$$G(t)=\tau_1 \cdot I(t)+\tau_2 \cdot \eta K(t-1) \quad (12)$$

Where τ_1 is generation coefficient of waste for coal mining; τ_2 is generation coefficient of waste in waste disposal process (secondary wastes generation coefficient); η is waste conversion ratio.

Since a part of the production funds can convert into new wastes, the formula of net output in the production process can be expressed as:

$$R(t)=I(1-\tau_1-\tau_2) \quad (13)$$

Using Formulas (10)-(13), we can express the formula of annual total entropy change in the coal mining system as:

$$\Delta S_o(t)=-\frac{\delta K_p(t)(1+r)[\varphi_\alpha-\varphi_\beta(1-\tau_1)+\varphi_\gamma\tau_1]+\varphi_\gamma\tau_2\eta K_p(t-1)}{T} \quad (14)$$

In formula (14) r is annual growth rate of funds, and its formula is written as below:

$$r=rr(1-\tau_1)\delta-{I_g}/{K_p(t)} \quad (15)$$

rr is rate, I_g is investment in pollution treatment.

3. Results and Discussion

3.1. Results

Firstly, there is no investment in end-of-pipe treatment and ecological mining construction if the mining areas adopt traditional mining pattern, and so $I_g=0$, $\eta=0$. Secondly, If the mining areas adopt end-of-pipe treatment pattern, there's no need for the mining enterprises to improve the original coal mining technology and processing, but specialized environmental treatment funds is required to increase waste treatment processes based on the original traditional mining pattern. In this paper we assume the funds of waste treatment accounts for 5 percent of the production funds, and thus seventy percent of the waste can be treated and recycled. so $I_g=0.05K_P$, $\eta=0.7$. Thirdly, As for the mining areas adopting ecological mining pattern, they take full consideration of environmental impacts and made a concerted effort to improve environmental performance, and The discharge of waste must decrease year by year in theory. In this paper we assume $I_g=0.06K_p$, $\eta=0.8$ and we also assume that the waste produced by mining activities has a decrease in the ratio of ρ, generation coefficient of waste for coal mining τ_1 will become $\tau_1(1-\rho)^t$ and we assume $\rho=0.03$.

Base on the formulas (14) and related parameters above, we used matlab9.0 to make simulation calculation to forecast the increasing entropy of three development patterns for mining areas. In order to carry out the simulation of the simulation, we needed to assign the initial value of the variables. Therefore, referring to other available literatures about simulation calculation, this paper made the necessary assumptions as follows: $K_{p1}=10$, $rr=0.05$, $\tau_1=\tau_2=0.15$, $\delta=0.6$ and the simulation time span was set to twenty years. The result of simulation calculation is shown in Figure 2.

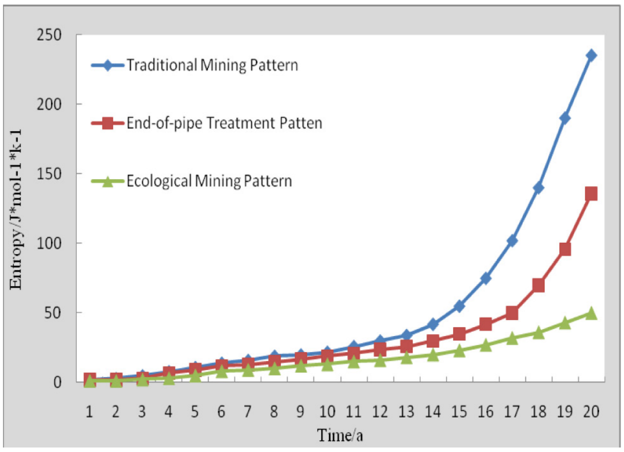

Figure 2. Growth trends of entropy in different development patterns of mining areas

3.2. Discussion

Figure 2 shows that the growth trend of entropy for different development patterns of mining areas was not uniform, especially from the beginning of the fifth year, growth trends began to have obvious difference. Specifically, the entropy increasing curve of traditional mining pattern was the steepest, and it indicated that the rate of entropy growth was the fastest; therefore it could easily threaten to the ecological environment. The curve of entropy increasing for end-of-pipe treatment was flatter, and it demonstrated that the situation of environmental damage improved to some extent, but the total value of entropy was still relatively large. So the development of end-of-pipe treatment for mining areas was not accord with the concept of mining sustainable development. As for the development of ecological mining pattern, its curve of entropy increasing was the flattest. Therefore it proved that the speed of entropy increasing was relatively slow, and the impact on the ecological environment was quite slight.

Conclusions

In this study, the environmental effects of three development patterns of mining areas were investigated. Based on the results of simulation calculation, we can conclude that traditional mining pattern prompt the mining enterprises to seek economic interests, regardless of environmental responsibility, and it can create negative externalities from the point of view of environmental economics, and so it should be abandoned according to the concept of sustainable development; As for the end-of-pipe treatment pattern ,although it takes measures to prevent and control industrial pollution, it also consumes resources and produces wastes and its treatment of pollution itself is a thermodynamic process according to Thermodynamics Theory, so it perhaps produces secondary pollution problems; under the concept of clean production and green mining, the ecological mining pattern takes necessary measures to reduce or even eliminate the waste generation , depending on the full implementation of pollution control in the production process. Therefore, the empirical results of this paper demonstrate that ecological mining pattern is undoubtedly the best of development pattern of mining areas at present.

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Interactive Transmission Mechanism of Eco-environmental and Social Benefits in Sustainable Urban Regeneration

Zhi ZHOU[1], Ying HUANG[2], Guijun ZHANG[1]

1College of Land Resources, Agricultural University of Hebei, Baoding, 071001, China
2 Economics and Management, Wuhan University of Engineering Science, Wuhan, 430200, China

Corresponding author is Zhi ZHOU

Abstract
The lack of eco-environmental and social benefits in old city reconstruction has always been a problem restricting sustainable urban regeneration. In order to obtain interactive transmission mechanism of ecological and social benefits in old city reconstruction, the work analyzed Tanhualin reconstruction by Amos path analysis with questionnaires. The results showed that: firstly, there was significant positive correlation between eco-environmental evaluation and social evaluation, with path coefficient of 0.98; secondly, the most important factor influencing eco-environmental benefits evaluation was history culture, followed by tourism development and environment greening; thirdly, public service facility was the most important factor influencing social benefits evaluation, followed by traffic and living conditions. Therefore, traditional evaluation system of reconstruction effect should be changed to focus on the dominance of eco-environmental environment and detailed sustainable development, thus promoting sustainable urban regeneration.
Keywords: SUSTAINABLE URBAN REGENERATION, OLD CITY RECONSTRUCTION, ECO-ENVIRONMENTAL BENEFITS, SOCIAL BENEFITS, INTERACTIVE TRANSMISSION MECHANISM

1. Introduction

At present, there are many new social and ecological problems in cities, along with rapid development of economy and promotion of urbanization. However, the intervention effect of traditional urban planning is not significant, sustainable urban development is a