Internal Mechanism and Interpretation of Coordinated Index of Sustainable Development System

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Abstract: The material environment for people's subsistence is widely researched on as a sustainable development system, this paper mainly explores the connotation and characteristic of coordination of sustainable development system by developing a framework, and sets up a vibration and dissipative entropy structure. At the same time the paper formulates an index from the structure which indicates the levels of sustainable development ability and finally concludes that the level of coordination directly affects the ability of sustainable development system and impartiality between generations.
Key words: Sustainable development; Coordination level; Entropy law; Interpretation

1 Introduction

Survival and development is eternal theme of human society, since the concept of sustainable development is put forward. Although different disciplines understand it from different angles, However systems analysis is used on specific issues in the study. That is to study living dependence environment of human survival and development as a large-scale system. And SPERE system is put forward, namely, social, population, environment, resources, economic factors of the five subsystems.[1] Once coordination among the five subsystems, we can conclude that the system of human existence is harmonious and sustainable. So, test whether an economical society is sustainable is turned into the quantitative analysis on degree of coordination among the various subsystems. People are so concerned about the sustainable development coordination which reflects the ideas that people attempt to measure the degree of sustainable development from the measurement of coordination.

2 Features and Content of Sustainable Development Coordination

The introduction of the system theory laid the theoretical foundation of sustainable development for the study of human society, but also for the establishment of various mathematical models to determine the level of coordination among the various subsystems established the theoretical foundation. Degrees of coordination research are on very different levels, and the research on sustainable development is usually combined with the study of practical problems, for example, some scholars defined coordination between the subsystems as W（i,j）=min{W（i/j）,w（j/i）}/ max{W（i/j）,w（j/i）}[2], Where W（i,j）is the degree of coordination between the two subsystems, W（i/j）is degree of coordination of i system based on j system, w（j/i）is degree of coordination of j system based on i system, Another scholars defined coordination as $C=X+Y/\sqrt{x^2+y^2}$,Where X, Y are respectively the rates of change of the two subsystems. Of course, there are other different calculation methods from documents. But no matter what calculation methods are adopted, the calculated coefficients of coordination have two main characteristics: first, the coefficient values are of real numbers which fluctuate back and forth in a fixed closed interval, second, the greater value in the closed interval, indicating the higher level of coordination system, when the coordination coefficient reaches the maximum the systems are fully coordinated, when the coefficient reaches the minimum the system is completely incompatible.

When the physical environment of human existence is studied as a big system, coordination degree formula $C=X+Y/\sqrt{x^2+y^2}$ (Formula 1) is a typical representation. Although the formula is simple in form, but its content is very rich. We can read it by constructing a map. For X, Y are relative numbers, therefore, secondary line and the unit circle are used to construct the map (as Figure 1 shows)

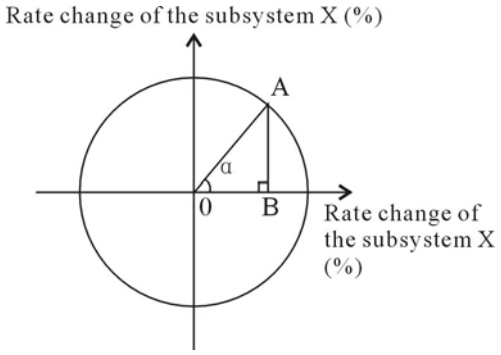

Figure 1 Coordinated Development Map Between Subsystems

Take a point A in the unit circle, then its coordinate in the coordinate system is A(X, Y), a perpendicular line AB is cited to the X-axis from A point, this will form a right triangle OAB(as Figure 1), Let α be the angle between line OA and X-axis, formula $C=X+Y/\sqrt{x^2+y^2}$ can be deformed: $C=X+Y/\sqrt{x^2+y^2}=X/\sqrt{x^2+y^2}+Y/\sqrt{x^2+y^2}=W1+W2=\cos\alpha+\sin\alpha=\sqrt{2}\sin(\alpha+\pi/4)$ [3] (Formula 2), and its value range is closed interval [-1.414 , 1.414]. Where W1 = cosα is the coordinated factor contribution of one subsystem, where W2=sinα is also the coordinated factor contribution of another subsystem with their value ranges closed interval [-1,1], the W1, W2, and C are drawn in the same map coordinate system to constitute the second map.

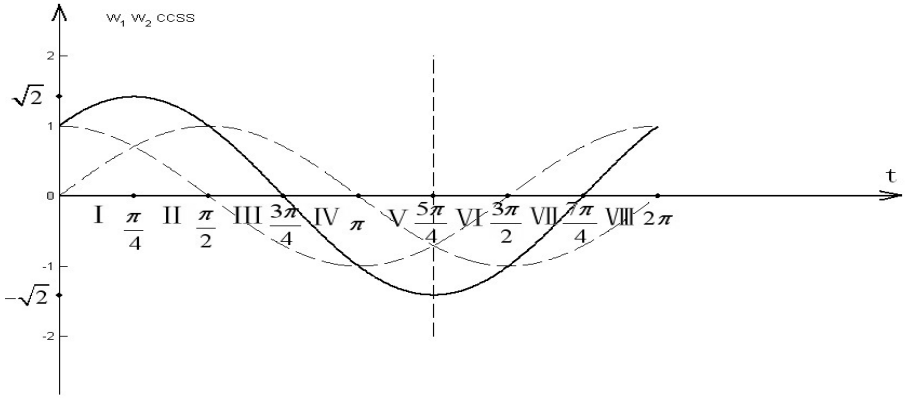

Figure 2 Coordination Resonance Map Between Subsystems

Figure 2 directly reflects the formula 2, solid curve is synthesis of superposition of two curves W1 = cosα, W2 = sinα. From equation (2) we also easily calculate coordinate contribution coefficient of the two subsystems. The Figure 2 described the development of mutual superposition of all possible patterns and conditions between two subsystems.

From the view point of W1=cosα, W2=sinα and $C=\sqrt{2}\sin(\alpha+\pi/4)$, they are consistent with flexible standard equation of the form of vibration system. When two mechanical waves encounter, we can get a higher peak crest. Instead, we can get a lower trough. Accordingly, we can study large-scale systems of mankind survival as an elastic vibration system. Of course, the simple harmonic motion is idealized model, in the actual process of Vibration, the first obtained energy will reduce due to constantly do work to overcome the diminishing, thus Vibration strength will gradually decay, vibration amplitude also gets smaller and smaller, so that the final vibration stops. Environment of human existence is in fact an extremely complex “vibration damping” system. This “damping” comes from incompatibility among subsystems between the various elements. Therefore, “damping” and “coordination” opposite each other. Assume resources assigned to the contemporary people are limited. In the process of development and utilization, the greater of this “damping”, the faster dissipation of resources. Energy failure point will come sooner. It can be said large-scale system coordination vibration of human existence and energy failure process are fully “consistent with ”energy failure process of damping vibration.

3 Vibration Spectrum and Construction of the Entropy Dissipation Map

Based on the fact that the environment of human existence is studied as an integrated "elastic vibration".[4] At the same time combined with the law of entropy a vibration pattern and entropy dissipation map is built. In order to further understand the profound meaning of sustainable development and judgments on sustainable development. A map is built as following:

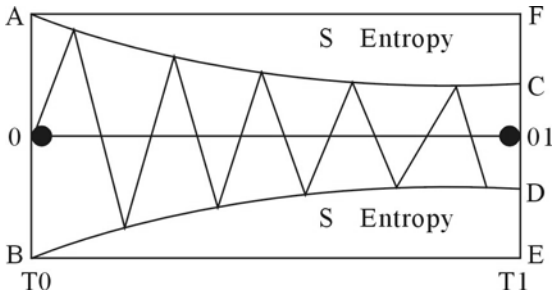

Figure 3 Figure Vibration Patterns and Entropy Dissipation

The explanation of the Figure 3: (1) t0 is the starting point of contemporary people, t1 is starting point for the next generation, (2) OO1 is the axis, there is a "energy burst point" with the same amount at each end. "O point" belongs to contemporary for the development and utilization of the contemporary. "O1 point" belong to the next generation for development and utilization for the next generation, (3) OA=OB= $\sqrt{2}$ indicates the maximum degree of coordination of the integrated two subsystems, (4) Curves of AC, BD show the decay curve of two subsystems. The second law of thermodynamics shows that, in a given macro-state, the system entropy is proportional to the logarithm of thermodynamic probability, that $S=K \ln \Omega$(S is system entropy, K is Boltzmann constant, Ω is the number of microscopic quantum states namely the thermodynamic probability of macro state). Macroscopic spontaneous process tends macro-state transition from the small probability to the large probability. A small macro probability means low-entropy, that means neat and orderly, the system has a large degree of coordination value. While a large macro-probability means high entropy, that implies chaos and disorder, the system has a small degree of coordination value. That is to say a greater system coordination value means a smaller system macro-state probability, the system entropy is small, conversely a smaller system coordination value means a larger system macro-state probability. The system entropy is large. It can be seen Macro-state probability of the system has an inverse correlation with the degree of system coordination. Which uses $\Omega \infty (m/C)$ to represent (Where C is the degree of coordination between subsystems), this can create a function relationship between system entropy and system coordination: $S \infty K \ln (m/C)$, that is that system entropy is inversely proportional to the logarithm of the system coordination degree. Thus the two curves of AC, BD also has the trend of convergence to the axis, and if the degree of coordination between the two subsystems is higher

The two entropy curves inward, the less the degree of convergence. The inward degree of convergence of the two entropy curves is lower. That means a higher degree of development and utilization of resources; otherwise the two curves will enhance the trend of convergence, that indicates a lower degree coordination between the two subsystems, it shows a lower utilization of resources. (5) The size of quadrilateral ABEF area indicates the sum of all energy released from "burst point", including two parts: entropy of two subsystems by the curve of the area enclosed between the energy region called the effective; the enclosed area between two entropy curves and two subsystems is called effective area, we name it S(energy).

The two remaining areas between two entropy lines and the boundary is called ineffective area, we name it S (entropy). We construct a sustainable development index reflecting the strength within generation, we call it R, its expression is R= S (energy) / S (energy)+ S(entropy). Because S(energy)+ S(entropy) is a constant value, its size is equal to the area of quadrilateral ABEF. Therefore, there lies in a shift of relationship between S(energy) and S(entropy). It is easy to see the value of R is within the scope of closed interval [0,1], by the relationship $S \infty K \ln (m / C)$ We know that the greater the degree of coordination, the smaller value of the entropy S. At this point the two curves expand up and down respectively, while able to increase the S (energy). Thus we can get a greater index value by the formula R= S(energy) / S(energy)+ S(entropy). It indicates a higher level of resource utilization within the

generation and the ability of sustainable development is the stronger. Therefore, we can measure the sustainable development status with the value of S.

4 Conclusion

As can be seen from the above that during development process of the contemporary a higher value of coordination among SPERE subsystems means a lower degree of inward convergence of the two entropy curves, the space of S(energy) will increase, Because S(energy)+ S(entropy) is a constant value, the R-value will increase by the formula R= S(energy) / S(energy)+ S(entropy),which shows a stronger capacity for sustainable development, at the same time the two points C and D will not coincide, which means that a certain number of wealth will be left as legacy from contemporary people to the next generation, its value can be expressed with the height of line CD. In this case, we can say that the development of inter-generations is sustainable. If this situation continues from generation to generation, there is a wealth accumulation trend to future generation. Thus the ability of sustainable development will be correspondingly stronger than former generation.

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