Quantitative analysis of Identification system of country's sustainable development degree

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Abstract. To consider all the possible parameters connected to the sustainability of a country, divide them into four aspects: Society, Humanity, Resource and Economy. Coordination coefficient is defined by analyzing the mutual influence and restriction between aspects and parameters. The point when coordination coefficient is zero can be roughly recognized as the dividing point of sustainability and unsustainability. For more accuracy, cluster is used to determine the dividing point.

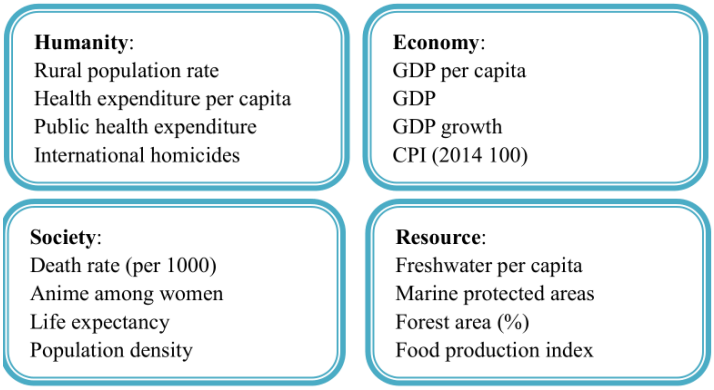
1. Introduction

Sustainable development has drawn everyone's attention for a long time. Due to the deterioration of the global environment, it satisfies our desire to protect the ecological system, and an increasing number of countries have realized it important to keep sustainable. The concept was defined by The United Nations World Commission on Environment and Development (WCED) in its 1987 report Our Common Future as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." However, how to conduct quantitative analysis has been a controversial problem. Different nations have different standards for it, no unified measures have been taken.

So in this paper, an effective model is constructed to discuss the sustainability of a country to create a more sustainable world.

2. Parameters and Aspects of sustainable development system

To measure the sustainability of a country, we should consider all the possible influence factors. Too many parameters need to be considered to obtain sustainable development. Divide them into four aspects to simplify the problem: humanity, economic, society and resource. For each aspect, four representative parameters are chosen to describe it:



3. Model to quantitative Measure the Sustainability of a Country

To measure the sustainability of a country, coordination coefficient is introduced by describing the relationship between and in different aspects. We regard every aspect as a sub system, each sub system has a goal value. For each sub system, the score decided by Entropy Method can be considered as the development index of the sub system. For different sub systems, we can study the influence of different parameters. After thoughtful derivation, the coordination coefficient can be calculated.

3.1 Coordination Coefficient of a Sub System

Considering the mutual influence between sub systems, we define coordination coefficient of sub systems as follow:

$$U_i = \begin{cases} U_{1i} = \dfrac{1-e^{k_1(O_i-S_i)}}{1+e^{k_1(O_i-S_i)}} & \text{When } S_i \text{ is positive index} \\ U_{2i} = \dfrac{1-e^{k_2(S_i-O_i)}}{1+e^{k_2(S_i-O_i)}} & \text{When } S_i \text{ is inverse index} \\ U_{3i} = \dfrac{3-e^{k_3(S_i-O_i)^2}}{1+e^{k_3(S_i-O_i)^2}} & \text{When } S_i \text{ is moderate index} \end{cases} \quad (1)$$

Where O_i is the target goal of the i_{th} aspect U_i is the coefficient of coordination of the i_{th} sub system. k_1 k_2 And k_3 are coefficient, Can be assigned as the constant greater than zero, the higher the value, the better the sensitivity.

3.2 Coordination Coefficient Between Sub Systems

For this part, we take the influence of parameters from different sub systems as consideration. The influence can be calculated as below:

$$T_i^p = \sum_{q=1}^{n} T_i^{pq} S_i \quad (2)$$

Where T_i^p means the influence of the p_{th} parameter from the i_{th} sub system, T_i^{pq} means the influence between the p_{th} parameter and q_{th} parameter.

$$T_i = \sum_{p=1}^{n}\sum_{q=1}^{n} T_i^{pq} S_i \quad (3)$$

Where T_i means the influence that the i_{th} sub system has.

$$C_i = \frac{T_i}{\sum_{p=1}^{m}\sum_{q=1}^{n} T^{pq}} S_i \quad (4)$$

Where C_i means the coordination coefficient between sub systems.

3.3 The Total Coordination Coefficient

After working out the coordination coefficient in and between sub systems, we can calculate the total coordination coefficient as below:

$$C = \sum_{i=1}^{n} k_i(\alpha U_i + \beta C_i) \quad (5)$$

Where $\sum_{i=1}^{n} k_i = 1, \alpha + \beta = 1$

Now the sustainability can be measured by coordination coefficient. We can all rank all the countries according to their coordination coefficient.

4. Calculated Conclusion of the Total Coordination Coefficient

Based on the model we have built above, we calculate the coordination coefficient between system and the coordination coefficient of a system. The result as follow:

5. How to Judge a Country's Being Sustainable

The value of the coordination coefficient is between -1 and 1. We can judge a country to be sustainable if its coordination coefficient is greater than zero, conversely, if a country's coordination

coefficient is below zero, it should be regarded as unsustainable. To be more authentic, the model of cluster is built to distinguish sustainable countries from unsustainable countries. It can also be used as a test of coordination coefficient

Table 1: Top 8 sustainable countries

Country Name	Economy	Society	Resource	Humanity	C
Norway	0.160945	0.364999	0.119265	0.413015	0.858224
Iceland	0.082751	0.307107	0.466751	0.192405	0.849013
Switzerland	0.141962	0.403166	0.09124	0.401085	0.837453
Japan	0.205054	0.470295	0.10817	0.229964	0.813483
Vietnam	0.580517	0.300319	0.070704	0.060354	0.811893
Sierra Leone	0.026805	0.798543	0.082245	0.072052	0.779645
Guinea	0.049324	0.701909	0.114959	0.093776	0.759968
Luxembourg	0.172168	0.330111	0.114509	0.326453	0.743241

Table 2: Top 10 unsustainable countries

Country Name	Economy	Society	Resource	Humanity	C
United Arab	0.07306	0.11972	0.03607	0.06762	-0.7035
Jordan	0.02385	0.25695	0.00456	0.06531	-0.6493
Oman	0.03942	0.26875	0.01703	0.05553	-0.6193
Iraq	0.04144	0.31314	0.00691	0.03468	-0.6038
Tunisia	0.03016	0.33424	0.01862	0.05095	-0.566
Qatar	0.13285	0.20666	0.01227	0.08384	-0.5644
Kuwait	0.09186	0.25471	0.0315	0.06231	-0.5596
Timor-Leste	0.02882	0.28944	0.06993	0.06079	-0.551
Algeria	0.02718	0.36457	0.01446	0.05422	-0.5396
Albania	0.02925	0.32783	0.05777	0.07643	-0.5087

6. Summary

The defined concept coordination coefficient considers the mutual interdependence, constraints and promotion of all the aspects of a country, can measure the sustainability in a more accurate way.

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