An Analysis on Characteristics of Evolution of Wuyishan Destination Based on the Tourist Flow

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1. Research Foundation
Stress the characteristics and laws of the destination at different development phase

Key Theory 1: Butler’s destination life cycle theory

The scale of tourists

The key capacity stage

Development

Consolidation

Involvement

Rejuvenation

Stagnation

Decline

Time
Key theory 2: theory of dissipative structure

Basis of the theory of dissipative structure: entropy and energy

First law of thermodynamics: energy conservation

Second law of thermodynamics: the ability of energy transformation
- strong
- weak

When an open system is far from the equilibrium state, exchanging energy and matter with outside: **stable orderly dissipative structure might exist**

**Open system**: \[ dS = d_e S + d_i S \]

- \( d_i S \): Entropy production inside (positive only)
- \( d_e S \): Entropy flow (positive, negative or zero)
If $d_e s < 0$ then negative entropy flow exists

**Growth stage**  
$|d_e S| > d_i S$  
$dS < 0$  
order degree increasing, from one to a superior one

**Maturity stage**  
$|d_e S| = d_i S$  
$dS = 0$  
maintaining an order state

**Decline stage**  
$|d_e S| < d_i S$  
$dS > 0$  
Order degree decreasing  
System collecting too much entropy within short time might face a failure

Negative entropy flow can reduce the amount of entropy inside an open system
Key theory 3: emergy analysis and dissipative structure

Emergy analysis: solar emergy as measurement standards, comparing different types of energy and matters against an universal unit of energy.

- Formula: \( U = N + R + \text{IMP} \)
  - \( U \): Total emergy,
  - \( N \): non-renewable resource,
  - \( R \): Renewable resources,
  - \( \text{IMP} \): Total import.

Negative flow carried by matter and energy, emergy analysis method can calculate the solar emergy of the energy existing within nature and human society, which can help us understand the relation between the loss of a dissipative structure and the increase and decrease of entropy in a destination system.
Firstly the background trend line equation is established based on Butler’s destination life cycle theory. This clarifies the evolution phases of Wuyishan. Secondly, with the help of dissipative structure theory, the nature of different phases are confirmed. Finally, calculating the emergy of the destination can help us understand the energy dissipation and to optimise the system.
The characteristics of the energy dissipation of the destination system in Wuyishan

- Renewable energy
- Basic productive materials
- Input from outside
- Feedback input from inside
- Output of nature and society
- Economic output
2. Introduction to the studied area
Wuyishan is situated at the northern part of Fujian province, occupying 999.75 square kilometers, including a National Nature Reserve, and a the National Park of China. It was listed as a world natural and cultural heritage site in 1999. Tourism is its biggest industry.
The location of destination
3. An analysis on the evolitional characteristics of the destination in Wuyishan
3.1 The evolution of tourist flow at Wuyishan

- **Background trend line** refers to the development law and trend without being impacted seriously by outside factors.

- Fitting by the cubic curve, we reach the following background line formula which can indicate the dynamic change of the number of tourist flow:
  - \( Q = 0.0433t^3 - 31.2705t^2 + 12.105t - 34.342 \)
  - Among which \( Q \) refers to the tourist numbers to Wuyishan from 1979—2014, and \( t \) from 1, 2, 3..., and the correlation coefficient \( R^2 = 0.9831 \)
Figure 3-1  The tourist background tendency in Wuyishan from 1979 to 2014

- **Initial growth period**
- **Growth period**
- **Stable growth period**
The characteristics of different phases

**Initial stage:**
The tourism industry starts and develops slowly with small scale.

**Fast growth stage:**
The integration appears, but the industrial structure is still not complete, the destination dissipation system is on the transit to a superior stage, the efficiency began to appear.

**Stable development stage:**
The higher level order situation exists in the dissipation system, whole efficiency becomes stronger, sub systems obtain an harmonized relation, which enables the system to move in an optimizing direction.
3.2 Self-organization development nature

- Destination system is open, in which the exchange of matter, energy and information with the outside around the movement of tourist flow which can be regarded as the most important entropy flow. The diffusion coefficient of tourist number can describe the harmonious degree of tourism development, the bigger its absolute value, the weaker the harmoniousness.

Dissipation index of tourism development at different times in Wuyishan

DATA Resource: 《Statistical Yearbook of Wuyishan》, 《The Tourism Statistical Communique of Wuyishan》
3.3 The emergy analysis of the destination system

Wuyishan destination system is an output—based system

The monetary flow is major entropy flow generated by tourist flow

The consumption of tourists is the main contributor to make the dissipation system work

☞ See the following Table 3-3
### Table 3-3: The emergy analysis of the destination system

<table>
<thead>
<tr>
<th>Item</th>
<th>Raw units/J ($)</th>
<th>Solar Emergy /sej</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000Year</td>
<td>2009Year</td>
</tr>
<tr>
<td><strong>Emergy Input</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunlight</td>
<td>4.704×10¹⁵</td>
<td>5.127×10¹⁵</td>
</tr>
<tr>
<td>Rain Chemical Energy</td>
<td>5.472×10¹⁹</td>
<td>4.019×10¹⁹</td>
</tr>
<tr>
<td>Wind Energy</td>
<td>9.56×10¹¹</td>
<td>8.04×10¹¹</td>
</tr>
<tr>
<td>Earth Cycle Emergy</td>
<td>2.802×10¹⁵</td>
<td>2.802×10¹⁵</td>
</tr>
<tr>
<td>Subtotal</td>
<td>8.45×10¹⁹</td>
<td>6.21×10¹⁹</td>
</tr>
<tr>
<td><strong>Emergy from tourism income</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tourism Investment</td>
<td>1.502×10⁷</td>
<td>1.03×10⁸</td>
</tr>
<tr>
<td>Tourism Infrastructure Input</td>
<td>3.373×10⁵</td>
<td>3.531×10⁶</td>
</tr>
<tr>
<td>Tourism Labor Input</td>
<td>5.874×10⁶</td>
<td>4.813×10⁷</td>
</tr>
<tr>
<td>Tourism Promotion</td>
<td>9.64×10⁵</td>
<td>2.928×10⁶</td>
</tr>
<tr>
<td>Government Tourism Budget</td>
<td>1.205×10⁷</td>
<td>3.872×10⁸</td>
</tr>
<tr>
<td>Subtotal</td>
<td>3.239×10¹⁹</td>
<td>2.869×10²¹</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1.169×10²⁰</td>
<td>2.931×10²¹</td>
</tr>
<tr>
<td>Emergy from tourist exports</td>
<td>1.095×10⁹</td>
<td>1.393×10⁹</td>
</tr>
<tr>
<td>Tourism Catering</td>
<td>1.118×10⁷</td>
<td>1.853×10⁸</td>
</tr>
<tr>
<td>Tourism Accommodation</td>
<td>1.452×10⁷</td>
<td>1.797×10⁸</td>
</tr>
<tr>
<td>Tourism Traffic</td>
<td>1.579×10⁷</td>
<td>2.828×10⁹</td>
</tr>
<tr>
<td>Tourism Shopping</td>
<td>1.436×10⁷</td>
<td>2.424×10⁹</td>
</tr>
<tr>
<td>Tourism Sightseeing</td>
<td>5.221×10⁷</td>
<td>2.954×10⁹</td>
</tr>
<tr>
<td>Tourism Recreation</td>
<td>8.458×10⁷</td>
<td>8.36×10⁸</td>
</tr>
</tbody>
</table>

**DATA Resource:** 《Statistical Yearbook of Wuyishan》、《The Tourism Statistical Communique of Wuyishan》
4. The conclusion
1. The output of the system is higher than the input, the system is output-based.

The inside potential energy must be released, so that the output and the input can be matched:

- The total solar emergy input: $1.169 \times 10^{20}$ sej (2000/a), $2.931 \times 10^{21}$ sej (2009/a);
2. **The evolution of Wuyishan tourist destination contains three stages:**

- Initial growth period,
- Growth period,
- Stable growth period.

If we want to avoid the system declining a negative entropy flow is needed.

The results of different types of man’s actions are the cause of the destination’s formation, development and decline.
3. **The destination system is an open system which provides feedback**

- The diffusion coefficient is 0.402 during the initial stage, and the difference between the highest and the lowest is 0.299. During **Growth period and Stable growth period** it appears stable between 0.12—0.16. The entropy value curve matches the evolution course of the destination. That indicates that the Wuyishan destination has progressed from simplicity to complexity.

- The only way to maintain the system stability is through the feedback mechanism, withdrawing negative entropy flow, which can help the system realize the maximized dissipative process and the best efficiency.
Further thinking

The essence of sustainable development for Wuyishan destination

Usually people think that adding different types of ecological economic flow to a destination to help it’s development but too much energy input may cause indigestion. If the system is stable, structure is harmonized and entropy flow change will not affect it due to self adjustment ability. When a system itself is not healthy - with only negative entropy flow input and without healthy metabolism - this will cause more problems. Therefore, the optimization of the destination dissipation can be realized by adding into negative entropy flow or strengthening energy utility efficiency. In this way, the system can move from a low-level order to a high-level order until the system realizes it’s final order condition covering all the aspects including time, space and function.
Thank you