Ecosystem service assessment in conservation policy in China

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Chinese Academy of Sciences
Ecosystem service assessment

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- Ecological challenges in China
- Ecosystem service spatial pattern of China
- Ecosystem services in conservation policy
- Land management: an eco-service approach
Ecological challenges in China’s
Highly diverse physical environment

<table>
<thead>
<tr>
<th>Topography</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plateau</td>
<td>26%</td>
</tr>
<tr>
<td>Mountain &amp; hill</td>
<td>33%</td>
</tr>
<tr>
<td>Basin</td>
<td>19%</td>
</tr>
<tr>
<td>Plain</td>
<td>12%</td>
</tr>
</tbody>
</table>

Ecological challenges in China

Average Temperature
Annual average temperature ranges from -5~26 °C

Average Rainfall
Annual average rainfall ranges from 25~4000 mm
Ecological challenges in China

China: huge population pressure & urbanization

Millions

Urbanization

- 1975: 18%
- 1980: 19%
- 1990: 26%
- 2000: 36%
- 2010: 49.7%
In 2010, China GDP 5745.1 billion $, 
USA 14624.2 B$

Ecological challenges in China

China: fast growing economy

China: fast growing economy
Poverty population and distribution

- 592 counties
- 225 million people
Main ecological problems in China

- Soil erosion
- Land rocky desertification
- Grassland degradation and desertification, sandstorm
- Wetland lost and degradation
- Wildlife habitat lost and biodiversity threatened
- Flooding
- Water resource shortage and pollution
- Natural disasters
- Vicious-circle of ecosystem degradation and poverty
Ecosystem degradation

Alpine grassland degradation in Tibet Plateau
To meet the challenges from huge population pressure, fast urbanization, and ecological crisis in China, decision makers keep asking two questions:

✓ Where we must protect, and why?
✓ Where we can use for development?
Ecosystem service spatial pattern

Purposes of ecosystem service spatial pattern of assessment

- Identify the critical ecosystems for national or regional ecological security
- Identify conservation objectives and goals
- Provide ecological dimension for regional development

What and where must be protected
Ecosystem service spatial pattern

- Population and food production distribution
- Ecosystem spatial patterns of China
- Ecological problems distribution of China

- Ecosystem service pattern assessment
- Ecological sensitivity pattern assessment

- Ecosystem function zones

- Ecosystem function conservation areas
  - National protection policy
  - Ecosystem restoration
  - Regional development policy
Food provisioning

\[ AF = \sum_{j=0}^{n} F_j \times E_j / A \]

Population density

\[ PD = N_p / A \]

Soil conservation

\[ A_c = A_p - A_r = R \times K \times LS \times (1 - C) \times P \]
\[ R = 0.207(Q \cdot I_{60}/100)^{1.205} \]
\[ LS = 0.08\lambda^{0.35}a^{0.6} \]

Hydrology regulating

\[ Q = \sum_{i=1}^{n} \sum_{j=1}^{m} \sum_{z=1}^{p} A_{ijz} \times J_{0i} \times K_j \times R_z \]

Water yield

\[ Y_{xj} = \left(1 - \frac{AET_{xj}}{P_x}\right) \times P_x \]

Wind erosion control

\[ Sc = W \times Kx \times (1 - Ci) \]

Wetland flooding mitigation

\[ Q = \sum (L_{i\text{max}} - L_{i\text{min}}) \times A_i \]
China has almost all kinds of terrestrial ecosystems types in the world.

- Tropical rain forests
- Alpine meadows
- Deserts
Ecosystem service spatial pattern

<table>
<thead>
<tr>
<th>Ecosystems</th>
<th>Million ha</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest</td>
<td>195.8</td>
<td>20.4</td>
</tr>
<tr>
<td>Grassland</td>
<td>390</td>
<td>40.6</td>
</tr>
<tr>
<td>Wetlands</td>
<td>38.5</td>
<td>4.0</td>
</tr>
<tr>
<td>Croplands</td>
<td>150</td>
<td>17.4</td>
</tr>
</tbody>
</table>
Population distribution

<table>
<thead>
<tr>
<th></th>
<th>Most Im regions</th>
<th>Im regions</th>
<th>Normal Reg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land ratio</td>
<td>20%</td>
<td>20%</td>
<td>60%</td>
</tr>
<tr>
<td>Population ratio</td>
<td>70.7%</td>
<td>20.3%</td>
<td>9%</td>
</tr>
<tr>
<td>Population density</td>
<td>506.13</td>
<td>145.51</td>
<td>21.60</td>
</tr>
<tr>
<td>No of counties</td>
<td>858</td>
<td>676</td>
<td>764</td>
</tr>
</tbody>
</table>

Population density (Ps/Km$^2$)
### Food production

#### No of counties

<table>
<thead>
<tr>
<th></th>
<th>Deficit</th>
<th>Balance 0&lt;</th>
<th>D&lt;60</th>
<th>Surplus 60&lt;</th>
<th>D&lt;250</th>
<th>Surplus+ D&gt;250</th>
</tr>
</thead>
<tbody>
<tr>
<td>DX10^{10}Kcal</td>
<td>D&lt;0</td>
<td>0&lt;</td>
<td>D&lt;60</td>
<td>60&lt;</td>
<td>D&lt;250</td>
<td>D&gt;250</td>
</tr>
<tr>
<td>level of subsistence</td>
<td>334</td>
<td>1037</td>
<td>775</td>
<td>149</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychological Requirement Food</td>
<td>423</td>
<td>1019</td>
<td>732</td>
<td>124</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Ecosystem service spatial pattern

Distribution of endangered and threaded plants

Distribution of endangered and threaded birds

Distribution of endangered and threaded mammals

Distribution of endangered and threaded reptiles
Ecosystem service spatial pattern

Important area for biodiversity conservation

Areas with high importance for biodiversity conservation, $1.76 \times 10^6$ km$^2$, 18% of total China.
Ecosystem service spatial pattern

Important area for water conservation

Areas with high importance for water conservation, $1.3 \times 10^6$ km$^2$, 11.7% of total China.

Important area for soil conservation

Areas with high importance for soil conservation, $8.9 \times 10^6$ km$^2$, 9.2% of total China.

Important area for sandstorm prevention

Areas with high importance for sandstorm prevention, $1.45 \times 10^6$ km$^2$, 15.1% of total China.

Important area for flooding mitigation

Areas with high importance for flooding mitigation, $1.8 \times 10^6$ km$^2$, 1.9% of total China.
Ecosystem service spatial pattern

Overall importance for eco-services:
Areas with high importance for eco-services, $4.36 \times 10^6$ km$^2$, 45.4% of total China.

Important area for water conservation

Important area for soil conservation

Important area for sandstorm prevention

Areas with high importance for sandstorm prevention, $1.45 \times 10^6$ km$^2$, 15.1% of total China.

Areas with high importance for flooding mitigation, $1.8 \times 10^6$ km$^2$, 1.9% of total China.
Ecosystem function zones in China

- Combining spatial pattern of ecosystem service and spatial pattern ecological sensitivity, the ecosystem function zones of China were formatted.
  - The areas with important ecosystem services
  - The areas for food and timber production
  - The areas for urbanization
Ecological function zones in China

- Ecological supporting
- Food and timber provision
- Urbanization
### Ecosystem function zones in China

#### Ecosystem function zones

<table>
<thead>
<tr>
<th>Leading eco-services</th>
<th>No of zones</th>
<th>Area (thousand km²)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological supporting and regulating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water resource conservation</td>
<td>50</td>
<td>2,379.0</td>
<td>24.78</td>
</tr>
<tr>
<td>Soil conservation</td>
<td>28</td>
<td>937.2</td>
<td>9.76</td>
</tr>
<tr>
<td>Sandstorm prevention</td>
<td>27</td>
<td>2,047.7</td>
<td>21.33</td>
</tr>
<tr>
<td>Biodiversity conservation</td>
<td>34</td>
<td>2,010.5</td>
<td>20.94</td>
</tr>
<tr>
<td>Flooding mitigation</td>
<td>9</td>
<td>70.6</td>
<td>0.73</td>
</tr>
<tr>
<td>Urbanization</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metropolitan Area</td>
<td>22</td>
<td>122.6</td>
<td>1.28</td>
</tr>
<tr>
<td>Total</td>
<td>216</td>
<td>9,562.9</td>
<td>99.61</td>
</tr>
</tbody>
</table>

**Product provisioning**

<table>
<thead>
<tr>
<th>Product provision</th>
<th>No of zones</th>
<th>Area (thousand km²)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food provision</td>
<td>36</td>
<td>1,686.3</td>
<td>17.57</td>
</tr>
<tr>
<td>Timber provision</td>
<td>10</td>
<td>309.0</td>
<td>3.22</td>
</tr>
</tbody>
</table>

The table above summarizes the leading eco-services and the areas contributed by each service in China.
Ecosystem function conservation areas

- Based on 216 ecosystem function zones in China, the areas with critical ecosystem services were identified as Ecosystem function conservation areas.
  - Biodiversity conservation
  - Water resource conservation
  - Soil conservation
  - Wind erosion control and sandstorm prevention
  - Flooding mitigation
- Many EFCAs have more than 2 important eco-services. We use its leading service to name the areas.
Ecosystem function conservation areas
Ecosystem services in conservation policy
Related Policy in China

✓ Nature forest conservation
✓ Returning slope cropland to forest/grassland program
✓ Nature reserve network
✓ Identify ecosystem function conservation areas
  – Ecosystem integrated management and restoration programs
  – Ecological financial transfer
  – National regional development strategy (constrained development areas)
✓ Urban master planning
✓ Land use planning and management (ecological red line)
From 1998, China launched nature forest conservation program

- Logging nature forests were banned
- The budgets were 96.2 billion RMB during 2000-2010
- 11 million ha forests have been protected under this program
From 1999, China launched Returning slope cropland to forest/grassland program

- Cropland with slope $>25^0/15^0$
- The budgets were 220 billion RMB during 2000-2010
- Nine million ha of slope cropland were reforested
China has set up 2640 nature reserves. Total area 149.7 million ha, about 16% land under protection of nature reserves.

90% of the endangered plants and animals protected in nature reserves.
Identify Ecosystem function conservation areas

Ecological function conservation areas

- Biodiversity conservation
- Water resource conservation
- Soil conservation
- Wind erosion control and sandstorm prevention
- Flooding mitigation
From 2008, center government launched ecological financial transfer based on ecosystem function conservation areas to guarantee the eco-service supply sustainably.

The counties located at ecosystem function conservation areas got paid.

<table>
<thead>
<tr>
<th>Year</th>
<th>Budgets (billions RMB)</th>
<th>Benefited Counties</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>6.0</td>
<td>221</td>
</tr>
<tr>
<td>2009</td>
<td>12.0</td>
<td>372</td>
</tr>
<tr>
<td>2010</td>
<td>24.92</td>
<td>451</td>
</tr>
<tr>
<td>2011</td>
<td>~30.0</td>
<td>~580</td>
</tr>
</tbody>
</table>
2011, China Council issued “Master function zone planning”

- Four types of regions
  - Optimal Development Region
  - Prioritized Development Region
  - Constrained Development Region
  - Forbidden Development Region
Constrained development regions

- water resource conservation regions
- soil conservation regions
- sandstorm prevention regions
- biodiversity conservation regions

National key ecosystem function areas

- 水源涵养功能区
- 水土保持功能区
- 防风固沙功能区
- 生物多样性维护功能区

National regional development strategy
# National regional development strategy

**Forbidden Development Region:** Natural reserve, forest parks, world natural and cultural heritage

<table>
<thead>
<tr>
<th>Types</th>
<th>Number</th>
<th>Area(Km²)</th>
<th>% of China</th>
</tr>
</thead>
<tbody>
<tr>
<td>National nature reserve</td>
<td>319</td>
<td>92.85</td>
<td>9.67</td>
</tr>
<tr>
<td>world natural and cultural heritage</td>
<td>40</td>
<td>3.72</td>
<td>0.39</td>
</tr>
<tr>
<td>National Scenic spots</td>
<td>208</td>
<td>10.17</td>
<td>1.06</td>
</tr>
<tr>
<td>National forest parks</td>
<td>738</td>
<td>10.07</td>
<td>1.05</td>
</tr>
<tr>
<td>National Geoparks</td>
<td>138</td>
<td>8056</td>
<td>0.89</td>
</tr>
<tr>
<td>Total</td>
<td>1443</td>
<td>120</td>
<td>12.5</td>
</tr>
</tbody>
</table>
Ecosystem integrated management and restoration

1. Talimu river: River and wetland restoration
2. Sanjiangyuan: Alpine grassland and wetland restoration and water resource conservation (52.3 billion m$^3$ water)
3. Heihe river: Alpine forest water resource conservation
4. Sandstorm originate area: Grassland restoration and sandstorm prevention
5. Three-northern windbreak forest engineering: Forest and grassland restoration and desertification prevention
6. Karst regions: Forest restoration and rocky desertification prevention
7. Tibetan eco-security buffer: Forest and grassland conservation and desertification prevention
Local Applications

- All provinces have finished ecosystem function zones, and identified local ecosystem function conservation areas.
- Ecosystem service spatial patterns were the basis for urban master planning and regional land use planning in many cities, as Beijing, Guangzhou.

Gansu province eco-service zoning

Anhui province eco-service zoning

Guangzhou spatial planning
Ecosystem service spatial pattern and land management in Beijing
Beijing Eco-service pattern and land management

SPOT 2007

Land use 2007
Beijing Eco-service pattern and land management

Eco-importance I land identified as ecological land: 4591.02 km$^2$, 28% of Beijing

<table>
<thead>
<tr>
<th>Eco-Importance</th>
<th>Area (km$^2$)</th>
<th>% of Beijing</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>6424.2</td>
<td>39.15</td>
</tr>
<tr>
<td>II</td>
<td>7218.7</td>
<td>43.99</td>
</tr>
<tr>
<td>III</td>
<td>2767.6</td>
<td>16.86</td>
</tr>
</tbody>
</table>
### Beijing Eco-service pattern and land management

#### Current protected areas: 10.1%

<table>
<thead>
<tr>
<th>Eco-land type</th>
<th>Area (km²)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface water conservation</td>
<td>908.1</td>
<td>19.78</td>
</tr>
<tr>
<td>Biodiversity conservation</td>
<td>2094.0</td>
<td>35.61</td>
</tr>
<tr>
<td>Soil conservation</td>
<td>1094.9</td>
<td>23.85</td>
</tr>
<tr>
<td>River green belt</td>
<td>25.7</td>
<td>0.56</td>
</tr>
<tr>
<td>Road green belt</td>
<td>69.40</td>
<td>1.51</td>
</tr>
<tr>
<td>Ground water recharge PAs</td>
<td>482.3</td>
<td>10.05</td>
</tr>
<tr>
<td>Urban green space</td>
<td>396.6</td>
<td>8.64</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4591.0</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>
Ecosystem function conservation areas

Conclusion

 Ecosystem function conservation area identification and policy application are playing an active role in environmental protection in China.

 The idea is increasingly applied in regional and urban planning, and river basin management.

 The study showed that ecosystem service assessment is not only a bridge linking nature and society, but also a powerful instrument to help us coordinating environment and development.

Thanks for your attention