TEEB & Freshwater Ecosystem Services in China

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Chinese Research Academy of Environmental Sciences (CRAES)
CONTENTS

1. The Economics of Ecosystems and Biodiversity (TEEB)

2. Case Study of Ecological Assets Assessment of the Three Rivers Source

3. Assessment of Water Environmental Carrying Capacity of Fuxian Lake
1. TEEB
In 2012, Ecological Civilization was set as national development goal by the 18th CPC National Congress.

- Improve and optimize spatial development pattern
- Promote natural resource conservation
- Intensify ecosystem & environmental protection
- Enhance environmental administration system building

In 2013, The Third Plenary Session of the 18th CPC Central Committee detailed plan to construct Ecological Civilization

- Improve natural resource capital administration system
- Implement ecological compensation and payment
- Reform ecological protection management system
- Delimit Ecological Red Line
**International Research on Ecological Assets Accounting and Evaluation Assessment**

- **Millennium Ecosystem Assessment (MA)**
- **Checked Global Ecosystem Service Value by Costanza etc.**
- **InVEST Model Jointly Developed by the Stanford University, World Wide Fund For Nature and the Nature Conservancy, Realizing Quantitative Assessment of Ecosystem Service**

**Joint TEEB forum in Beijing by UNEP & BFN & CRAES**
TEEB

**TEEB-China**

**Urgent Demand of Ecological Civilization and Biodiversity Conservation in China**

**Action Plan for Biodiversity and Ecosystem Service Evaluation Assessment in China, issued by MEP**

Aiming at

- **TEEB Method and System suitable for China**
- **Evaluation of national biodiversity value**
- **Finding how to include biodiversity into the performance evaluation system**
- **Propose the methods for management and compensation of the use biodiversity resources**
- **Promote the biodiversity conservation and sustainable use**
- **Serving for Ecological Civilization Building**

**Beautiful China**
TEEB

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**TEEB-China**

- **Main Tasks**

1. Assessment of **TEEB progress**
2. Establishment of **China’s TEEB methods and system**
3. TEEB **demonstration and case study**
4. TEEB **dissemination and training**
5. Enhancement of **cooperation and communication** home and abroad
6. Advance the **implementation** of TEEB in policies
### Research & Assessment on Ecological Assets Accounting in China

#### Research Results of TEEB by Chinese Researchers

<table>
<thead>
<tr>
<th>Ecosystem Type</th>
<th>Value (¥)</th>
<th>Researcher</th>
<th>Year</th>
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<td>$7.78 \times 10^8$</td>
<td>ZHANG Xinshi, etc.</td>
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#### Equivalent Factor Table of China’s Ecosystem Service Value (XIE Gaodi, 2007)

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<th>River</th>
<th>Lake</th>
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<td>0.06</td>
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<td></td>
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Research & Assessment on Ecological Assets Accounting in China

Preliminary assessment of the ecological assets status in key national ecological function zones for Year 2010 by CRAES in 2014

The value is about 72,300 billion RMB, which is 48.8 times of 2010 local GDP
2. Case Study of Ecological Assets Assessment of the Three Rivers Source
Case Study of Ecological Assets Assessment of the Three Rivers Source

Location of the Three Rivers Source

It is located in the Qinghai Tibet Plateau. It is the origin of the Yangtze River, Yellow River and Lancang River (the upper stream of Mekong River), known as the “Water Tower of China”, and administratively located in Qinghai province.

- Including 16 counties and 1 village
- Total area 363,700 km²
- Average elevation over 4,000m
- Annual average precipitation 500mm

- Account for 2% of the Yangtze River total water amount (TWA), 49% of the Yellow River TWA and 15% of the Lancang River TWA;
- The Three Rivers Source provides the down stream with drinking water value of 3,200 billion RMB, hydro power value of 1,300 billion RMB and aquatic product value of 100 billion RMB.
Case Study of Ecological Assets Assessment of the Three Rivers Source

**Importance of the Three Rivers Source**

- Great ecological strategic importance
- Important ecological function regulating area, sensitive area to climate change, and biodiversity concentrated area
- With extremely sensitive and fragile ecosystem, which is hard to recover once damaged

*Administrative Map of the Three Rivers Source*
Problems in the Three Rivers Source

Comparatively large area of grassland degradation, with incomplete improvement of ecosystem service, needing long-term efforts for ecological conservation.

- Grassland degradation in the Three Rivers Source was formed before 1980s
- Total area of degraded grassland is 196,000km², taking for 56.7% of that in the Three Rivers Source.

Stream flow regulation improved to some extent

- The stream flow regulation above Jimai Station is improved
- In 2010, the amount of water conservation was 3.341 billion m³

No improvement in the soil conservation

- During spring flood season and summer flood season, the sand concentration showed a slowly increasing trend
- In 2010, the amount of soil conservation is 1.232 billion tons

Variation of Grassland Degradation in 2001-2006
Variation of Water Source Conservation in 2000-2010
Variation of Soil Conservation in 2000-2010
Case Study of Ecological Assets Assessment of the Three Rivers Source

Identification of Ecological Assets

- Natural Resources Assets
  - Non Ecological Assets
    - Mineral, Fossil Energy
  - Ecological Assets
    - Ecological Resources
    - Ecological Service
      - Forest
      - Grassland
      - Farmland
      - Water Body
      - Water Conservation
      - Soil Conservation
      - Climate Regulation
      - Biodiversity
      - Ecological Carbon Sequestration
      - Clean Water Source
      - Clean Air

Ecological Assets: the ecological resources and its ecosystem services and ecological products
Case Study of Ecological Assets Assessment of the Three Rivers Source

Ecological Assets Management Platform

Stock Assets Investigation

Ecological Status
- Ground Monitor, Dynamic Change, Remote Sensing Retrieval, Grassland Degradation

Natural Resources
- Animals, Plants
- Minerals, Hydro Power

Ecological Engineering
- Ecological Engineering, Compensation, Migration, Conservation

Analysis on Ecological Service and Products
- Water Conservation
- Soil Conservation
- Ecological Carbon Sequestration
- Climate Regulation
- Biodiversity Conservation

Accounting of Ecological Assets
- Stock Assets
- Ecological Service
- Ecological Products

Value Accounting
- Evaluation of Ecological Assets
- Cost of Ecological Conservation and Recovery
- Opportunity Cost of Giving up Development
  - Development of Animal Husbandry, Mineral Resources, Industry & Hydropower

Assets List Parameter Set Model Base Optimized Monitor Technical Guidance Management Countermeasures Profession System
**Case Study of Ecological Assets Assessment of the Three Rivers Source**

- **Survey on the Status of Ecological Resources**
  - Collecting basic data, integrate ground monitoring data, retrieval of land surface parameters by remote sensing

**6 Ecosystems**
- Forest
- Shrub
- Grassland
- Wetland
- Farmland
- Desert

**4 Key Monitoring Factors**
- Water Status
- Soil Physical and Chemical Properties
- Climate Condition
- Biological Characteristic

**Monitoring Index of Sample Fields**
- Plant Samples: 87
- Soil Slopes: 78
- Soil Samples: 234

**Ecosystem Service**
- Ecological components
- Landscape pattern
- Ecological energy
- Beneficial regulations
- Soil conservation
- Air regulation
- Bodily regulation
- Evapotranspiration
- Runoff interception
- Water storage
- Soil conservation
- Soils
- Soil slopes
- Vegetation
- Root distribution

**Integration of Ground Monitoring Data**

2011.10 Workshop in Xining

2012.03 Field Survey in Zeku County

87 Plant Samples, 78 Soil Slopes, 234 Soil Samples
Water Conservation Function

Water Conservation = Supply of Water Resource (SWR) + Flood Storage (FS) + Runoff Regulation (RR)

- SWR = W_{surface} + W_{ground}
- FS = P_{max} - P_{a}
- RR = R_{time1} - R_{time2}

In which:
- $W_{surface}$ — surface water resources amount (runoff)
- $W_{ground}$ — amount of groundwater resources (Ji Liu)
- $P_{max}$ — potential maximum storage capacity of ecological system
- $P_{a}$ — actual storage capacity
- $R_{time1}$ — time 1 river runoff
- $R_{time2}$ — time 2 river runoff

Assessment of the value of water conservation services

- CGE "Input-occupancy-output" model;
- Alternative market value method namely unit reservoir capacity cost;
- Replacement cost method
Biodiversity Maintenance Function

Biodiversity Maintenance Function refers to the function and value of the maintained biological diversity (species level) in the region.

Assessment Methods
The evaluation of the importance of biodiversity maintenance adopted the Biodiversity Model of the InVest Model. The overall evaluation on the habitat’s quality, status of deterioration, and diversity was conducted adopting the information of land use/cover and integrating ecological threatening factors of biodiversity.

Value Evaluation Methods
The opportunity cost method, contingent valuation method (CVM) is adapted to estimate the value of biodiversity protection.
Soil Conservation Function

**Soil Conservation** = Maintained Soil Fertility + Mitigated Soil Erosion

- **Maintained Soil Fertility**  \( G_{PC} = A_c \times C \)

  - \( G \) refers to the amount of reduced organic matter loss in soil (t/a)
  - \( A \) refers to the amount of soil conservation (t/a)
  - \( C \) refers to the percentage content of organic matter in soil

- **Soil Conservation (SC):**

  \[ SC = R \cdot K \cdot LS \cdot (1 - C \cdot P) \]

- **Value Assessment Method:** calculated by InVest Model

  **Fertility Value** = Actual Soil Erosion × Fertility Percentage/Soil Amount × Price of Fertilizer;
Ecological Carbon Sequestration Function (ECSF)

ECSF = Soil Carbon Reserve + Vegetation Carbon Reserve + Carbon Sinks in Ecosystem

- “Soil Type Method” and “biomass carbon density transformation” is used to evaluate the soil and vegetation carbon reserve in the ecosystem of the Three Rivers Source, integrating ground field monitoring data.
- Taking TEPM Model to inverse GPP, and evaluate the economic value of ecological carbon sequestration function, integrating the estimated carbon sequestration amount by soil respiration modelling.

Assessment of the ECSF value

- Different afforestation cost method is used to estimate the economic value of carbon reserve
- Assessment of carbon sinks value is conducted from carbon sequestration and oxygen release
- The international general Swedish carbon tax rate method is used to calculate value of carbon sequestration
- Industrial oxygen generation method is used to calculate the value of oxygen release
Climate Regulation Function (CRF)

Definition:
Climate regulation function refers to the influence by underlying surface change of regional ecosystem on Radiation, sensible heat and sensible heat flux, water vapor flux, temperature, wind, boundary layer structure, and even the ground and larger-scale circulation changes, which will in turn regulate air humidity, slow down temperature amplitude and achieve the regulation of regional climate.

Assessment Model

- Weather Research and Forecasting (WRF) Model
  Multi-scale meteorological model is used, to assess wind, pressure, temperature, humidity, and radiation flux, water vapor flux and heat flux status change caused by underlying surface change of current and of future ecosystem types under different scenarios in the Three Rivers Source
- Replacement cost method is used to calculate the value of CRF
Results of Ecological Assets Assessment in the Three Rivers Source

Preliminary Results: the Ecological Assets in the Three Rivers Source is 6,520 billion RMB, among which the assets of ecological service takes up 98.5%.

<table>
<thead>
<tr>
<th>Results of Ecological Assets Assessment in the Three Rivers Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ecological Assets</strong> (Trillion RMB)</td>
</tr>
<tr>
<td>Service Value</td>
</tr>
<tr>
<td>Stock Value</td>
</tr>
<tr>
<td>Product Value</td>
</tr>
<tr>
<td><strong>Total Value of Ecological Assets</strong></td>
</tr>
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</table>

Spatial Distribution of Reserves in the Three Rivers Source

Water Carrying Capacity of Soil in Degraded Grassland
3. Assessment of Water Environmental Carrying Capacity of Fuxian Lake
In Yuxi, Yunnan, the lake covers a total area of 216.6 km² with a maximum depth of 158.9 m and an average depth of 95.2 m. Overall, the lake water totals 20.62 billion m³, taking up nearly 10% of China’s total fresh water resources, being mostly the Class I water.

<table>
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<tr>
<th></th>
<th>Agricultural Runoff</th>
<th>Livestock</th>
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<td></td>
<td>Output</td>
<td>Input</td>
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<td>COD</td>
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<td>1804.86</td>
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<tr>
<td>N</td>
<td>618.81</td>
<td>433.16</td>
</tr>
<tr>
<td>P</td>
<td>51.57</td>
<td>36.1</td>
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</tbody>
</table>
Assessment of Water Environmental Carrying Capacity of Fuxian Lake

Relation between Economic Development of Lake and Lake Carrying Capacity

- Socioeconomic Development
- Industrial Structure
- Urban and Rural Structure
- Air Pollutant Emissions
- Hydrological & meteorological conditions
- Land use Structure

Typical Lake regional socio-economic development model

Staged & Zoned Lake Environmental Carrying Capacity

Optimization & Adjustment

Rational Determination of Development Model

Carrying Capacity of Lake Environment
Assessment of Water Environmental Carrying Capacity of Fuxian Lake

Water Environment Carrying Capacity (WECC) Distribution Table of Fuxian Lake

<table>
<thead>
<tr>
<th>Water Pollution Prevention &amp; Control</th>
<th>Objective Planning</th>
<th>WECC of Main Pollutants (t/a)</th>
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<tbody>
<tr>
<td></td>
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<td>COD</td>
</tr>
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<td>Northern Pollution Control Area</td>
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<td>Southern Pollution Control Area</td>
<td>Class I</td>
<td>939.9</td>
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<td>Northeastern Phosphate Control Area</td>
<td>Class I</td>
<td>2187.2</td>
</tr>
<tr>
<td>Western Tourism Control Area</td>
<td>Class I</td>
<td>2362.9</td>
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<tr>
<td>Eastern Soil &amp; Water Loss Control Area</td>
<td>Class I</td>
<td>2523.7</td>
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<tr>
<td>Independent Control Area</td>
<td>Class I</td>
<td>4760.1</td>
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</table>

Water Environment Carrying Capacity (WECC) Distribution Table of Fuxian Lake

- **Northern Pollution Control Area**: Class I, COD 7291.9, TN 309.7, TP 40.8
- **Southern Pollution Control Area**: Class I, COD 939.9, TN 41.3, TP 4.8
- **Northeastern Phosphate Control Area**: Class I, COD 2187.2, TN 90.4, TP 11.3
- **Western Tourism Control Area**: Class I, COD 2362.9, TN 113.4, TP 13.5
- **Eastern Soil & Water Loss Control Area**: Class I, COD 2523.7, TN 80.1, TP 15.2
- **Independent Control Area**: Class I, COD 4760.1, TN 187.1, TP 30.2

![Map of Fuxian Lake showing different pollution control areas and their WECC values](image-url)
### Assessment of Water Environmental Carrying Capacity of Fuxian Lake

**Prediction of Lake Pollution Input in Different Planning Period**

#### Scenario I

<table>
<thead>
<tr>
<th>Year</th>
<th>COD$_{Cr}$ (t/a)</th>
<th>TN (t/a)</th>
<th>TP (t/a)</th>
<th>COD$_{Cr}$ (t/a)</th>
<th>TN (t/a)</th>
<th>TP (t/a)</th>
<th>COD$_{Cr}$ (t/a)</th>
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#### Scenario II

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#### Scenario III

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</table>
Assessment of Water Environmental Carrying Capacity of Fuxian Lake

The goal will be difficult to achieve, even all the main pollution sources of the watershed is treated.

**Scenario I**
- Gross National Product and Gross Industrial Product growth rates will need to reach 12% & 15%, respectively.

**Scenario II**
- Watershed National Product and Industrial Product growth rates will need to reach 7% & 10%, respectively.

**Scenario III**
- Gross National Product and Gross Industrial Product growth rates will need to reach 3% & 5%, respectively.

**TN Forecasts for Each Scenario**

- Carrying Capacity 1232t/a

**TP Forecasts for Each Scenario**

- Carrying Capacity 180t/a
Assessment of Water Environmental Carrying Capacity of Fuxian Lake

Overall Layout of Basin Industrial Structure Adjustment
New Concept of Water Governance

Co-governance of water in Zhejiang province:
- Water-saving
- Safeguarding of irrigation water
- Flood prevention
- Waste water treatment
- Drainage of storm water

Co-governance of water from the perspective of aquatic ecosystem:
- Safeguard water resource supply
- Ensure water environment safety
- Maintain aquatic ecosystem health
- Protect aquatic biodiversity
- Improve water environment services and function
The natural property of water environment should be respected. The prerequisite for the utilization of water is that the natural property of watersheds shouldn’t be damaged. Socio-economic development shouldn’t be obtained at the costs of environmental quality degradation, the loss of watershed integrity and ecosystem health deterioration.

*Keep the harmony of human, nature and water environment!*
Thank you for your attention!

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