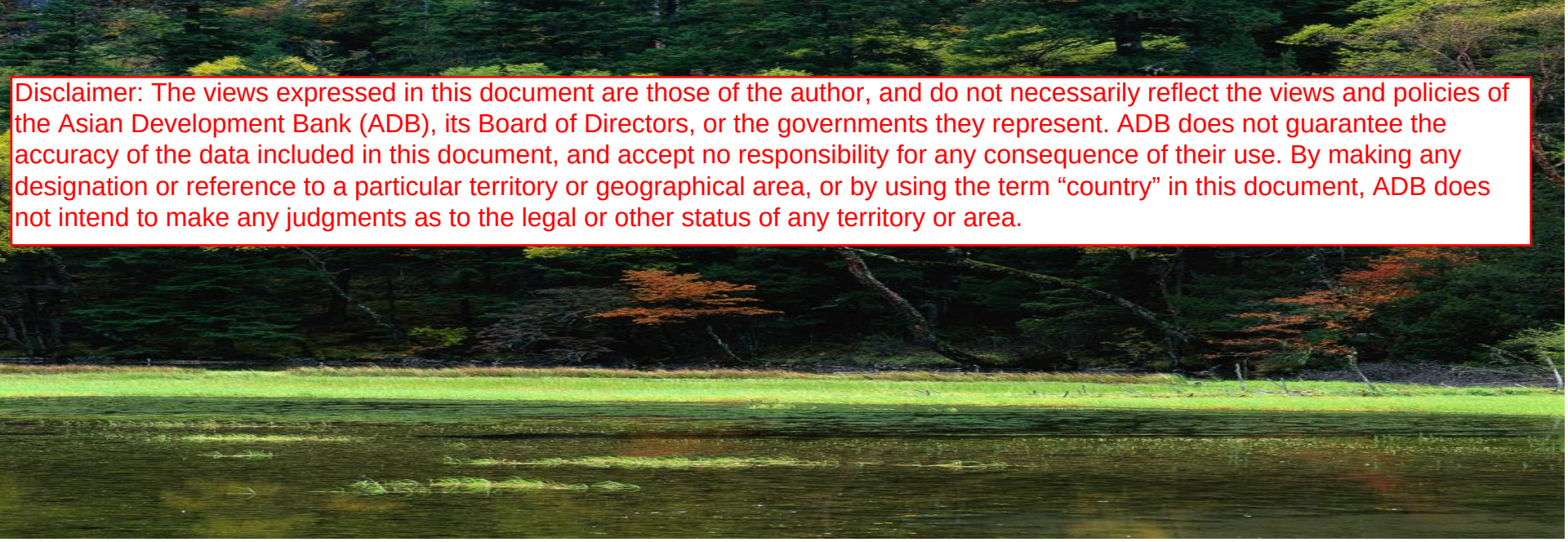



# Accounting Gross Ecosystem Product (GEP)

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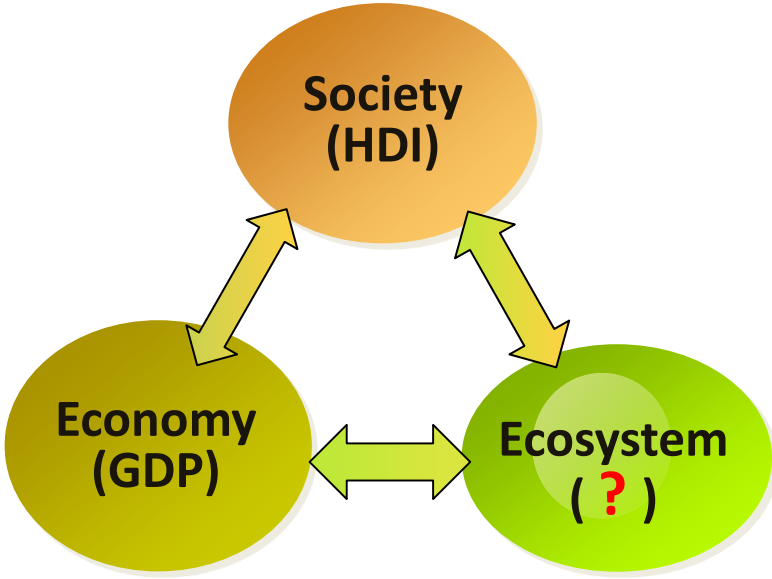
# Outlines

1. Background
2. GEP Concept and accounting framework
3. GEP accounting in China
4. On-going

# Background

## Community is a coupled nature-economic-social system

- Economy: GDP is widely used to measure economic system performance.
- Society: HDI(Human development index) is used to measure social development status based on health, education and living-standard since 1991.
- Natural environment: currently we do not have widely used index to measure its sustainability.



# Background

- Ecosystem is essential for human survival and development
  - ✓ Creating and maintaining living supporting system of the Earth: water cycling, soil formation and fertility, atmosphere chemistry stable.
  - ✓ Providing human with food fiber, water, bio-energy.
- Ecosystem services: the benefits human-being obtained from the nature/ecosystems (MA, 2003).

# Background

- Both developed and developing countries are attempting to find new accounting indicators or accounting system beyond GDP, to quantify the linkage between ecosystems and human well-being.
- The creation of a new system to account for ecosystem goods and services at national or regional scales has become a hot international topic for advancing the sustainable development agenda.

# Background

## Natural /Ecosystem service evaluation is the hot topic globally, and used as an indicator for assessing sustainability

- ✓ UN：IPBES (Inter-government platform for Biodiversity and Ecosystem Services), 2012-
- ✓ UN: Millennium Ecosystem Assessment, 2003-2008
- ✓ UNSD, SEEA (Environmental and economic accounts), 2003, 2012
- ✓ UNSD, Land and ecosystem accounts, 2012.
- ✓ World Bank, Wealth accounting and valuation of ecosystem services
- ✓ TEEB, The Economics of Ecosystems and Biodiversity， 2010
- ✓ EEA(European Enviont. Agency), Simplified ecosystem capital accounts
- ✓ Australia, Ecosystem Accounting—Policy Applications， 2012
- ✓ SC (Statistics Canada), Measuring ecosystem goods and services
- ✓ China, Ecosystem survey assessment of China

# Background

## Chinese government initiated eco-civilization and related policies

- Integrated **ecological benefits into economic and social development evaluation system**.
- Establish **eco-compensation policy, reflecting** the market demand and resource scarcity, as well as **ecological value** and inter-generational compensation.
- Improve **accountability system** of **ecological and environmental protection** and environmental damage compensation system.
- Establish **natural capital accounting system.**

# Concept of GEP

## Gross Ecosystem Product, GEP

- Gross Ecosystem Product (GEP) is the total value of final ecosystem goods and services supplied to people in given region annually, like a county, or a province, a county.
- GEP is proposed as a comprehensive index based on ecosystem service evaluation.
- Ecosystems (Ecological Assert, EA) is the natural asset providing ecosystem services,
  - Natural ecosystem: forests grasslands, wetland, desert, marine, …
  - Managed ecosystem: cropland, orchards, aquaculture farms, urban green-space, …

# Concept of GEP

## Ecosystem goods and services

| Categories | Goods and services (examples) |
|---|---|
| Ecosystem goods | Food: grain, vegetable, fruit, meat, milk, egg, fish |
| | Materials: wood, fiber, water, genes |
| | Energy: bio-energy(fuelwood), hydro-power, wind energy |
| | Others: medicine, seedling, ornament |
| Regulating services | Regulation services: water conservation, soil conservation, carbon sequestration, climate regulating, pollutant purification, pollination |
| | Protecting services: sand storm prevention, flooding mitigation, pest control |
| Cultural service | Aesthetic services: recreation and ecotourism |
| | Cultural value: knowledge, education, arts, spirit |

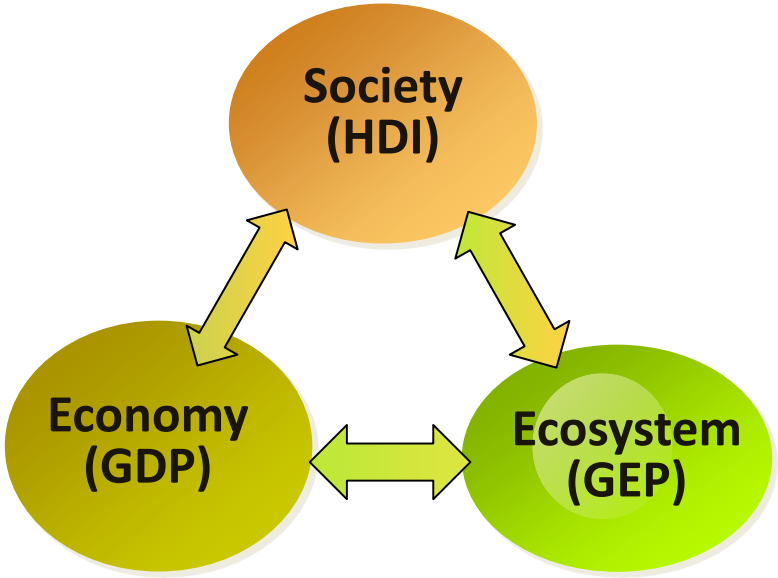
# Concept of GEP

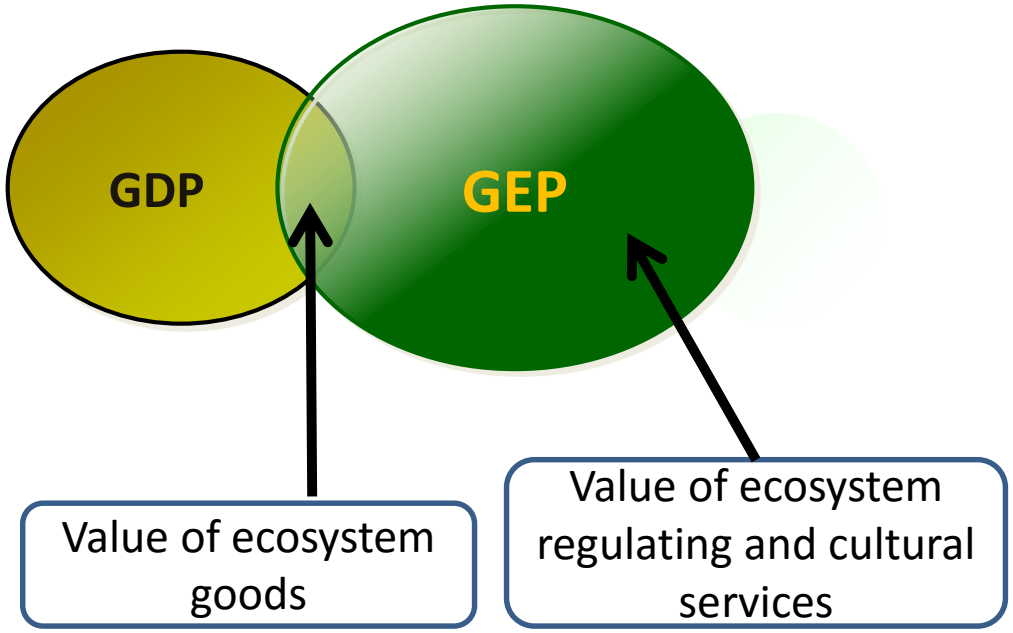
## Purposes of GEP accounting

- ✧ Assessment/description of ecosystem status
- ✧ Measurement of community sustainability
- ✧ Evaluation of the contribution of ecosystems to human welfare and socio-economic development
- ✧ Evaluation of effects of conservation efforts
- ✧ Reveal the ecological linkages among regions
  - ✓ Ecologically dependency
  - ✓ Ecological supporting

# Concept of GEP

- GDP, HDI, and GEP

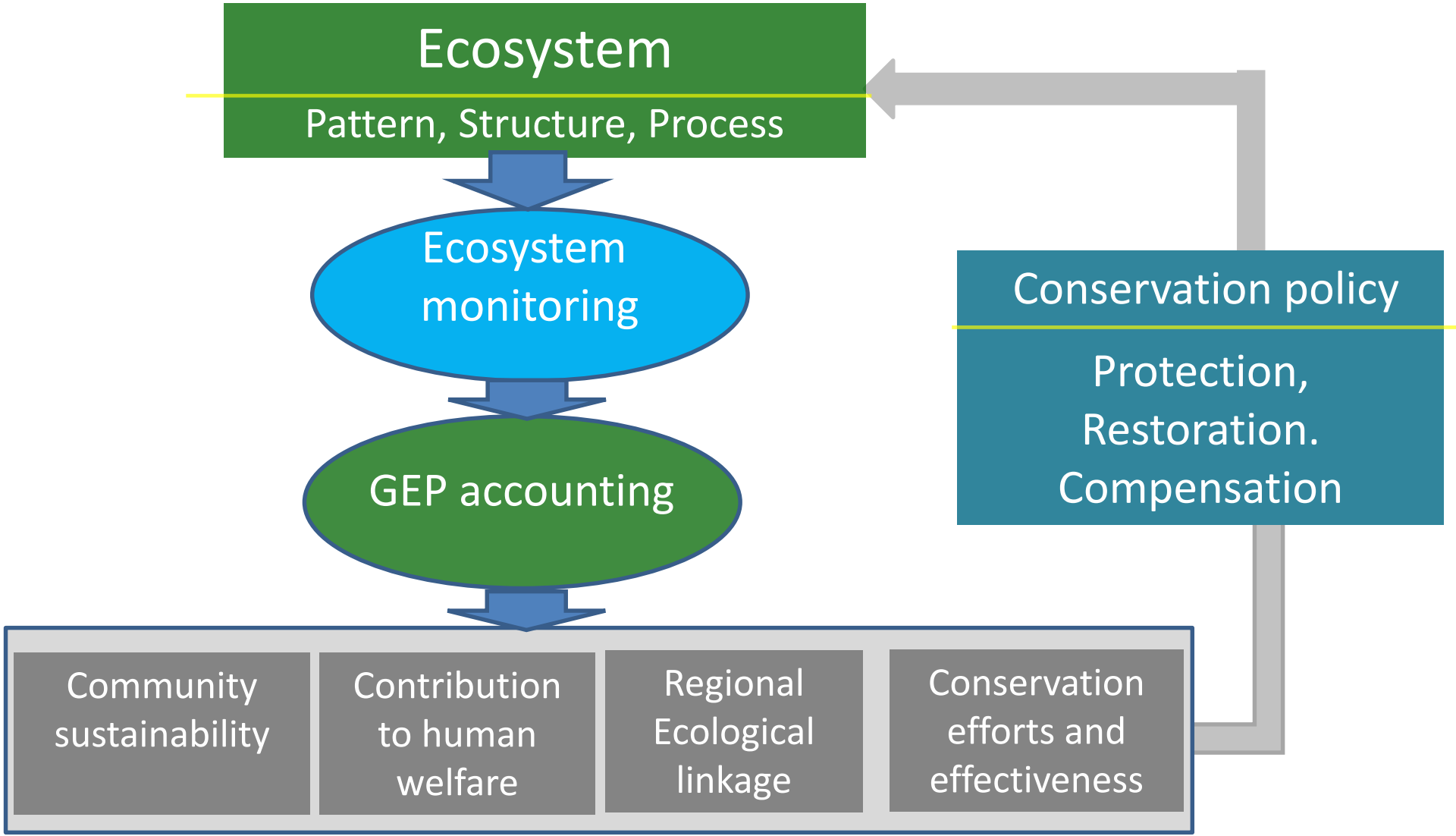


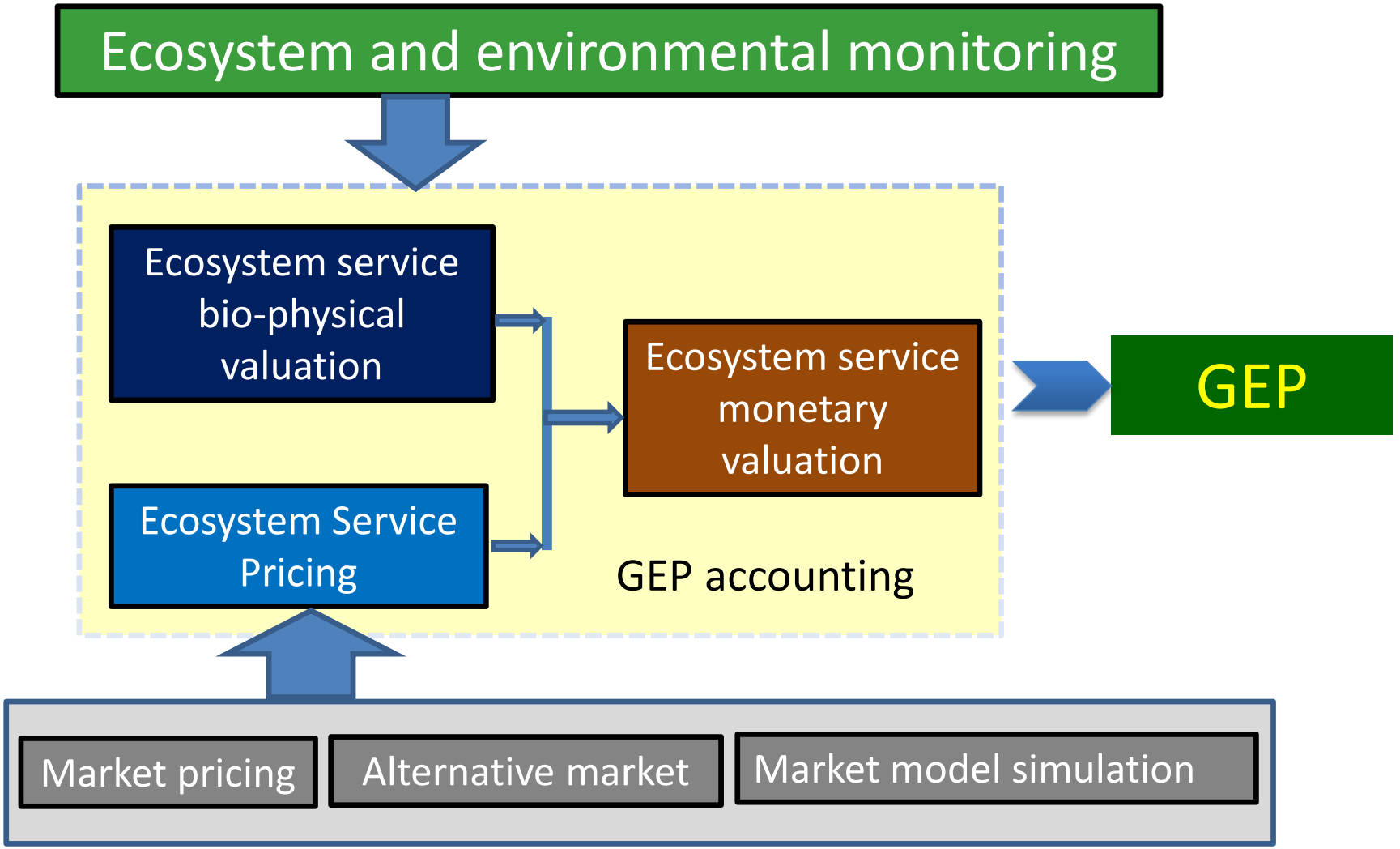

- GEP, GDP and Green GDP
  - ✓ GEP, The goods and services provided by ecosystems.
  - ✓ GDP, the goods and services provided by economic systems.
  - ✓ Green GDP, the GDP minus natural and environmental costs,

# Concept of GEP

## GEP accounting and policy implementation



# GEP Accounting framework



# GEP Accounting framework

- **Accounting of bio-physical values of ecosystem goods and services**
  - ✓ Ecosystem Goods: grain, fruit, meat, eggs, vegetables, water, medicinal materials, biological materials, fiber, biomass etc;
  - ✓ Regulation and culture services: water conservation, soil conservation, contaminants purification, carbon sequestration, oxygen production, aesthetics, recreation, culture identity, knowledge, education, inspiration for art etc..
- **Pricing of ecosystem goods or services**
  - ✓ timber price, water price, soil conservation price, pollutant purification price,…
  - ✓ alternative market, market model simulation methods

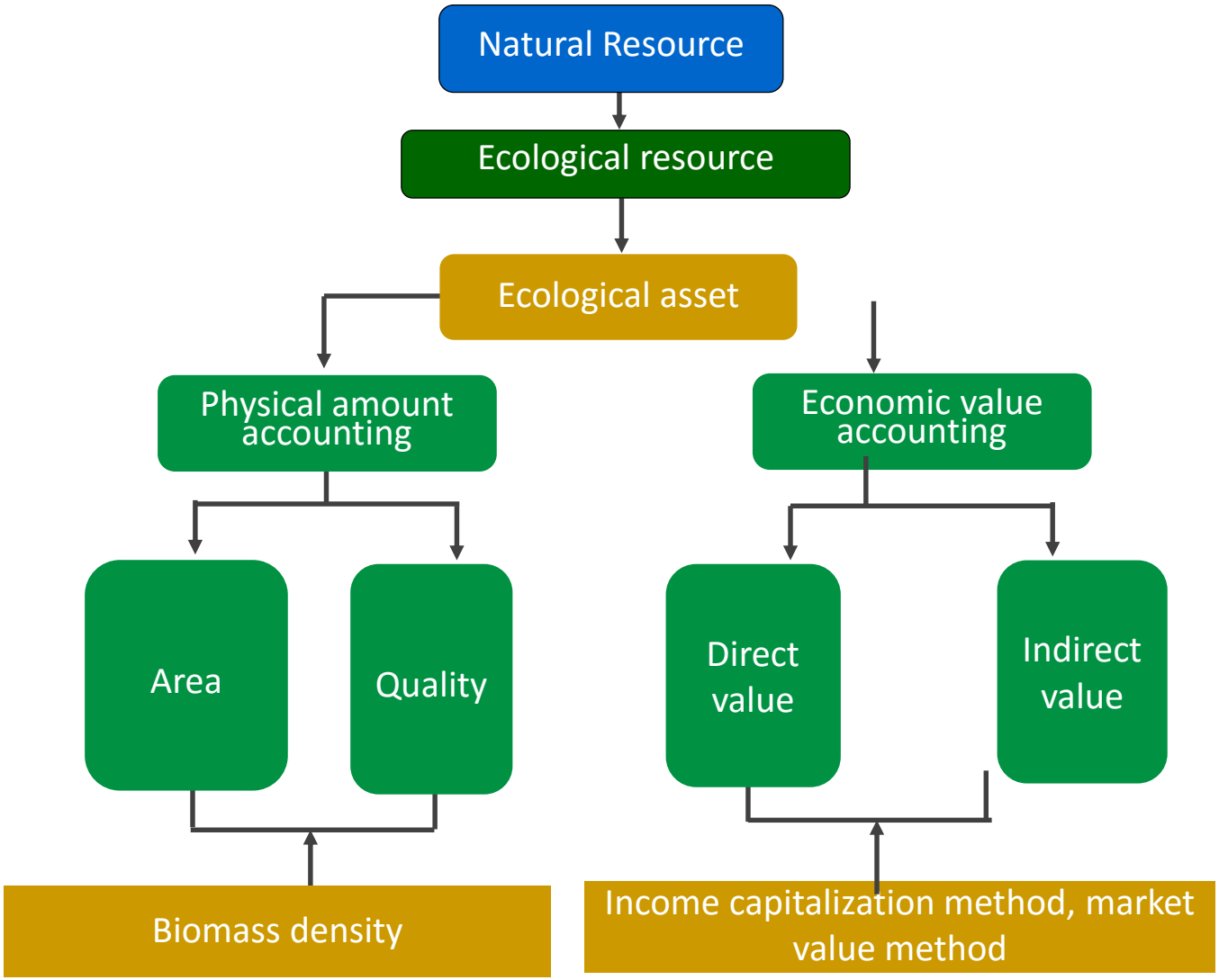
# GEP Accounting framework

- **Accounting of economic values of ecosystem goods and services**
  - ✓ GEP: the total economic value of ecosystem provision (EPV), Ecosystem regulating services (ERV) and cultural services (ECV) in the given area annually.

$$\mathrm{GEP} = EPV + ERV + ECV$$

$$\mathbf{GEP} = \sum_{i=1}^{n} \boldsymbol{EP}_i \times \boldsymbol{P}_i + \sum_{j=1}^{m} \boldsymbol{ER}_j \times \boldsymbol{P}_j + \sum_{k=1}^{l} \boldsymbol{EC}_k \times \boldsymbol{P}_k$$

# Ecological asset accounting



# Ecological asset accounting

| Types of EAs | | Items of EA | Quality level (ha) | | | | | | Physical value |
|---|---|---|---|---|---|---|---|---|---|
| | | | Sum | I | II | III | IV | V | |
| Natural ecosystem | Forest | Sub-sum | | | | | | | Area, biomass density |
| | | Coniferous F | | | | | | | |
| | | Broadleaf F | | | | | | | |
| | | Confe-Broadl F | | | | | | | |
| | Shrub | Evergreen Shrub | | | | | | | |
| | | Coniferous shrub | | | | | | | |
| | Grassland | Sub-sum | | | | | | | Area, coverage |
| | | Meadow | | | | | | | |
| | | Steppe | | | | | | | |
| | Wetland | Sub-sum | | | | | | | — |
| | | Lake | | | | | | | Area, water quality |
| | | Marsh | | | | | | | Area, water quality |
| | | River | | | | | | | Length, water quality |
| | Desert | Sub-sum | | | | | | | Area |
| | | Sand-land | | — | — | — | — | — | |
| | | Rock | | — | — | — | — | — | |
| | | Bare land | | — | — | — | — | — | |

# Ecological asset accounting

| Types of EAs | | Items of EA | Quality level (ha) | | | | | | Physical value |
|---|---|---|---|---|---|---|---|---|---|
| | | | Sum | I | II | III | IV | V | |
| Managed ecosystem | Cropland | Sub-sum | | | | | | | Area, soil fertility |
| | | Dry cropland | | | | | | | |
| | | Paddy | | | | | | | |
| | | Orchard | | | | | | | |
| | Artificial forest | Sub-sum | | | | | | | Area, biomass |
| | | Arti-Coniferous F | | | | | | | |
| | | Arti-Broadleaf F | | | | | | | |
| | Artificial grassland | Arti-grassland | | | | | | | Area, coverage |
| | Reservoir | Reservoir | | | | | | | Area, capacity, water quality |
| | Urban green space | Urban green space | | | | | | | Area |
| | | | | | | | | | |

# Ecological asset accounting

## Quality index of Ecological Asset

$$EQ = \frac{\sum_{i=1}^{5}(EA_i \times i)}{(EA \times 5)} \times 100$$

- EQ: **Quality index of Ecological Asset**;
- EAi: area of i level ecosystem;
- i: level of ecological asset, ie 1 or 2,…5;
- EA: Total area of ecosystems.

# Pilot study of GEP accounting

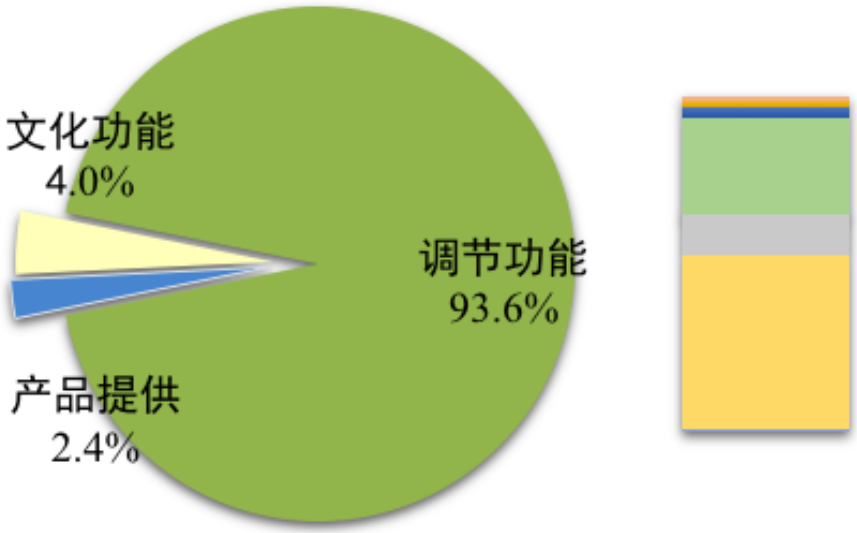
## Pilot GEP accounting in China

- China government agencies: National development and reform committee (NDRC), Environmental protection ministry (MEP), State forestry administrative (SFA), and SAC are pushing GEP accounting application in China.
- MEP supported Technical Guideline of GEP Accounting and training courses.
- Asian Development Bank(ADB): funded TA project “Developing Gross Ecosystem Product Accounting for Eco-Compensation” to pushing GEP application in China
- Local government in China: 16 pilots
  - Qinghai, Guizhou,
  - Shenzhen, Tonghua, Qiandongnan
  - Aershan, Xishui, Pingbian,Eshan

# Qinghai GEP accounting

## GEP in Qinghai：18789.69 亿元

| Items | Value(billion) | Ratio(%) |
|---|---|---|
| Provision services | 45.38 | 2.4 |
| Regulating services | 1759.18 | 93.6 |
| Cultural service | 74.41 | 4.0 |
| 合 计 | 1878.97 | 100.0 |



# Qinghai GEP accounting

## Regulating service value in Qinghai Province

| Service items | Index | Biophysical value | Unit | Economic value(billion) | Total(billion) |
|---|---|---|---|---|---|
| Water retention | 水源涵养量 | 638.72 | $10^8m^3$ | 510.34 | 510.34 |
| Soil retention | 减少泥沙淤积 | 3.91 | $10^8m^3$ | 6.89 | 20.99 |
| | 减少 N 面源污染 | 0.08 | $10^8t$ | 7.29 | |
| | 减少 P 面源污染 | 0.02 | $10^8t$ | 6.81 | |
| Sand fixation | 固沙量 | 11.74 | $10^8t$ | 33.12 | 33.12 |
| Flood mitigation | 湖泊调蓄量 | 48.04 | $10^8m^3$ | 38.39 | 59.93 |
| | 水库调蓄量 | 11.60 | $10^8m^3$ | 9.27 | |
| | 沼泽调蓄量 | 15.36 | $10^8m^3$ | 12.27 | |
| Air pollutant purification | 净化 $SO_2$ 量 | 93.63 | $10^4t$ | 0.59 | 0.62 |
| | 净化氮氧化物量 | 4.92 | $10^4t$ | 0.03 | |
| | 净化工业粉尘量 | 2.11 | $10^4t$ | 0.01 | |
| Water pollutant purification | 净化 COD 量 | 220.39 | $10^4t$ | 1.54 | 2.17 |
| | 净化总氮量 | 17.08 | $10^4t$ | 0.15 | |
| | 净化总磷量 | 17.08 | $10^4t$ | 0.48 | |
| Carbon sequestration | 固碳量 | 0.2567 | $10^8t$ | 9.75 | 205.56 |
| | 释氧量 | 2.6933 | $10^8t$ | 195.81 | |
| Climate regulating | 植被蒸腾降温增湿 | 6534.60 | $10^8kwh$ | 346.33 | 917.82 |
| | 水面蒸发降温增湿 | 10782.81 | $10^8kwh$ | 571.49 | |
| Pest control | 森林病虫害控制面积 | 0.29 | $10^8mu$ | 8.56 | 8.56 |
| Total | | | | 1759.18 | 1759.18 |

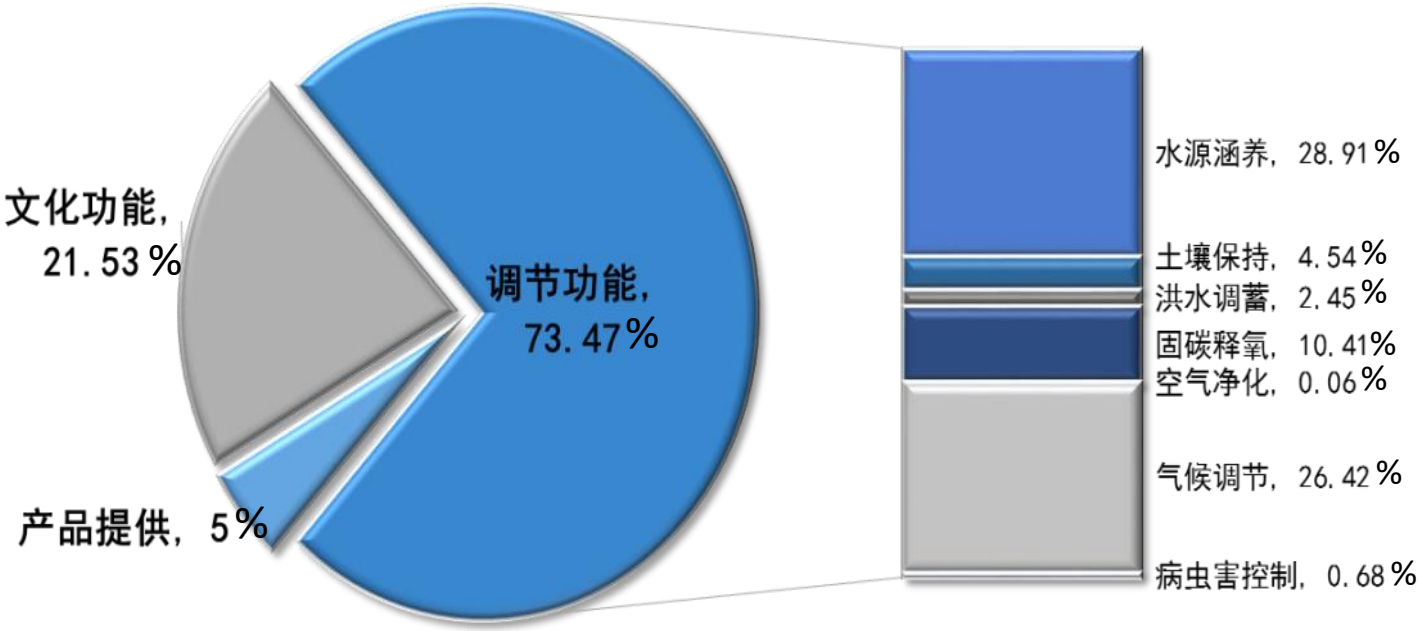
# GEP accounting of Qiandongnan,Guizhou

## Qiandongnan GEP：**539.51 billion**

Provision service：27.0 billion，5.0%

Regulating service：396.35 billion，73.5%；

Cultural service：116.16 billion，21.5%；



# GEP accounting of Qiandongnan,Guizhou

Regulating services value in Qiandongnan, Guizhou

| Service items | Index | Biophysical value | Unit | Economic value(billion) | Total(billion) |
|---|---|---|---|---|---|
| Water retention | 水源涵养量 | 195.22 | $10^8 m^3$ | 155.981 | 155.981 |
| Soil retention | 减少泥沙淤积 | 24.8443 | $10^8 m^3$ | 8.916 | 24.473 |
| | 减少 N 面源污染 | 24.8443 | $10^4 t$ | 8.043 | |
| | 减少 P 面源污染 | 24.8443 | $10^4 t$ | 7.513 | |
| Flood mitigation | 湖泊调蓄量 | 1.3125 | $10^8 t$ | 0.014 | 13.227 |
| | 水库调蓄量 | 47.2490 | $10^8 m^3$ | 13.213 | |
| Air pollutant purification | 净化 $SO_2$ 量 | 45.27 | $10^4 m^3$ | 0.285 | 0.298 |
| | 净化氮氧化物量 | 1.71 | $10^4 m^3$ | 0.011 | |
| | 净化工业粉尘量 | 1.17 | $10^4 t$ | 0.002 | |
| Water pollutant purification | 净化 COD 量 | 1.98 | $10^4 t$ | 0.014 | 0.019 |
| | 净化总氮量 | 0.15 | $10^4 t$ | 0.001 | |
| | 净化总磷量 | 0.15 | $10^4 t$ | 0.004 | |
| Carbon sequestration | 固碳量 | 0.1507 | $10^4 t$ | 5.727 | 56.151 |
| | 释氧量 | 0.6936 | $10^4 t$ | 50.425 | |
| Climate regulating | 森林蒸腾降温增湿 | 2235.2589 | $10^8 t$ | 118.469 | 142.523 |
| | 灌丛蒸腾降温增湿 | 119.6366 | $10^8 t$ | 6.341 | |
| | 草地蒸腾降温增湿 | 175.0518 | $10^8 kwh$ | 9.278 | |
| | 水面蒸发降温增湿 | 159.1704 | $10^8 kwh$ | 8.436 | |
| Pest control | 森林病虫害控制面积 | 0.1225 | $10^8 mu$ | 3.675 | 3.675 |
| Total | | | | 396.347 | 396.347 |

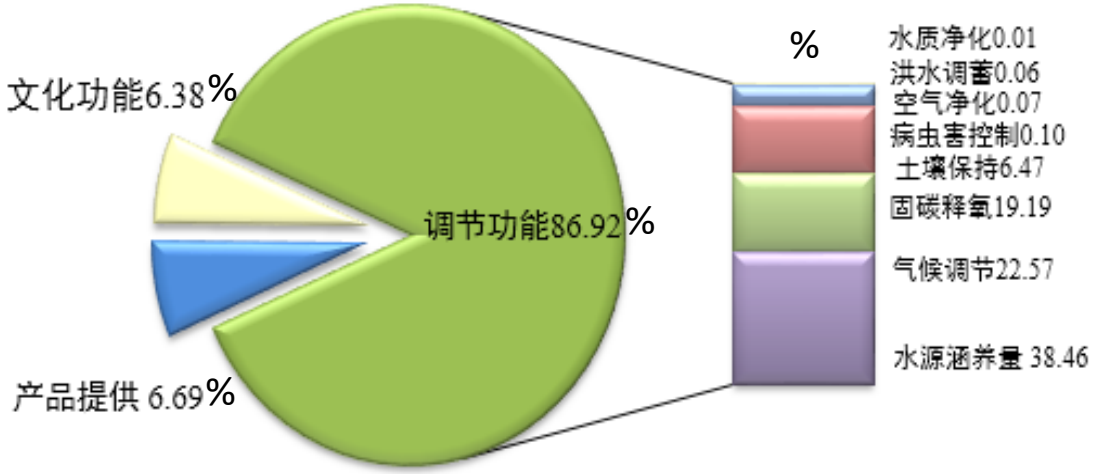
# GEP accounting of Pingbian county, Yunnan

## GEP of Pingbian county： 20.77 billion

Provision service： 1.39 billion， 6.7%

Regulating service： 18.06 billion， 86.9%；

Cultural service： 1.33 billion， 6.4%；



# GEP accounting of Pingbian county, Yunnan

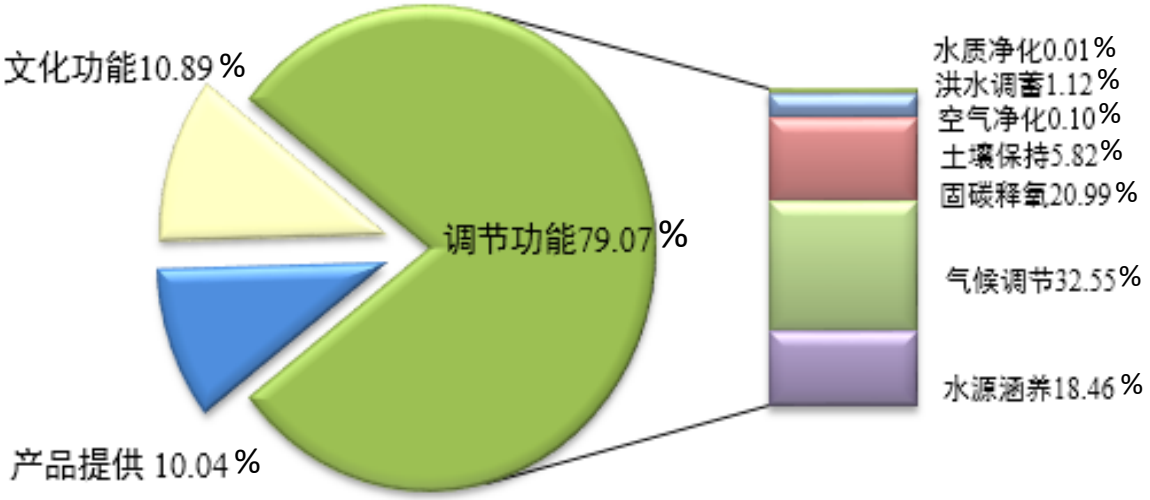
Regulating service in Pingbian county, Yunan

| Service items | Index | Biophysical value | Unit | Economic value(billion) | Total(billion) |
|---|---|---|---|---|---|
| Water retention | 水源涵养量 | 9.99` | $10^8m^3$ | 7.99 | 7.99 |
| Soil retention | 减少泥沙淤积 | 0.26 | $10^8m^3$ | 0.46 | 1.34 |
| | 减少 N 面源污染 | 52.0 | $10^4t$ | 0.46 | |
| | 减少 P 面源污染 | 15.0 | $10^4t$ | 0.43 | |
| Flood mitigation | 水库调蓄量 | 0.04 | $10^8m^3$ | 0.012 | 0.01 |
| Air pollutant purification | 净化 SO2 量 | 2.32 | $10^4t$ | 0.015 | 0.015 |
| | 净化氮氧化物量 | 0.09 | $10^4t$ | 0.00055 | |
| | 净化工业粉尘量 | 0.06 | $10^4t$ | 0.00009 | |
| Water pollutant purification | 净化 COD 量 | 0.08 | $10^4t$ | 0.00054 | 0.001 |
| | 净化总氮量 | 0.01 | $10^4t$ | 0.00005 | |
| | 净化总磷量 | 0.01 | $10^4t$ | 0.00017 | |
| Carbon sequestration | 固碳量 | 0.0069 | $10^8t$ | 0.265 | 3.99 |
| | 释氧量 | 0.0513 | $10^8t$ | 3.732 | |
| Climate regulating | 植被蒸腾降温增湿 | 84.62 | $10^8kwh$ | 4.532 | 4.69 |
| | 水面蒸发降温增湿 | 2.97 | $10^8kwh$ | 0.158 | |
| Pest control | 森林病虫害控制面积 | 0.0007 | $10^8mu$ | 0.021 | 0.02 |
| Total | | | | 18.06 | 18.06 |

# GEP accounting of Eshan county, Yunnan

## GEP of Eshan county：**8.80 billion**

- Provision service：1.89 billion，10.0%
- Regulating service：14.86 billion，79.1%；
- Cultural service：2.05 billion，10.9%；



# GEP accounting of Eshan county, Yunnan

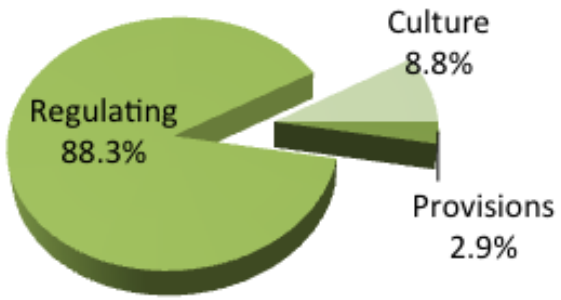
Regulating service in Eshan county, Yunan

| Service items | Index | Biophysical value | Unit | Economic value(billion) | Total(billion) |
|---|---|---|---|---|---|
| Water retention | 水源涵养量 | 4.34 | $10^8$m3 | 3.471 | 3.471 |
| Soil retention | 减少泥沙淤积 | 0.2147 | $10^8$m3 | 0.379 | 1.094 |
| | 减少 N 面源污染 | 42.0 | $10^4$t | 0.370 | |
| | 减少 P 面源污染 | 12.0 | $10^4$t | 0.345 | |
| Flood mitigation | 水库调蓄量 | 0.76 | $10^8$m3 | 0.211 | 0.211 |
| Air pollutant purification | 净化 SO2 量 | 2.94 | $10^4$t | 0.018 | 0.019 |
| | 净化氮氧化物量 | 0.11 | $10^4$t | 0.001 | |
| | 净化工业粉尘量 | 0.07 | $10^4$t | 0.0001 | |
| Water pollutant purification | 净化 COD 量 | 0.18 | $10^4$t | 0.001 | 0.002 |
| | 净化总氮量 | 0.01 | $10^4$t | 0.00008 | |
| | 净化总磷量 | 0.01 | $10^4$t | 0.00028 | |
| Carbon sequestration | 固碳量 | 0.0055 | $10^8$t | 0.209 | 3.945 |
| | 释氧量 | 0.0514 | $10^8$t | 3.736 | |
| Climate regulating | 植被蒸腾降温增湿 | 105.45 | $10^8$kwh | 5.588 | 6.119 |
| | 水面蒸发降温增湿 | 10.01 | $10^8$kwh | 0.530 | |
| Pest control | 森林病虫害控制面积 | 0.0001 | $10^8$mu | 0.003 | 0.003 |
| Total | | | | 14.864 | 14.864 |

# GEP accounting of Aershan

2014

- ✧ GDP：1.514 billion yuan
- ✧ GEP：53.494 billion yuan

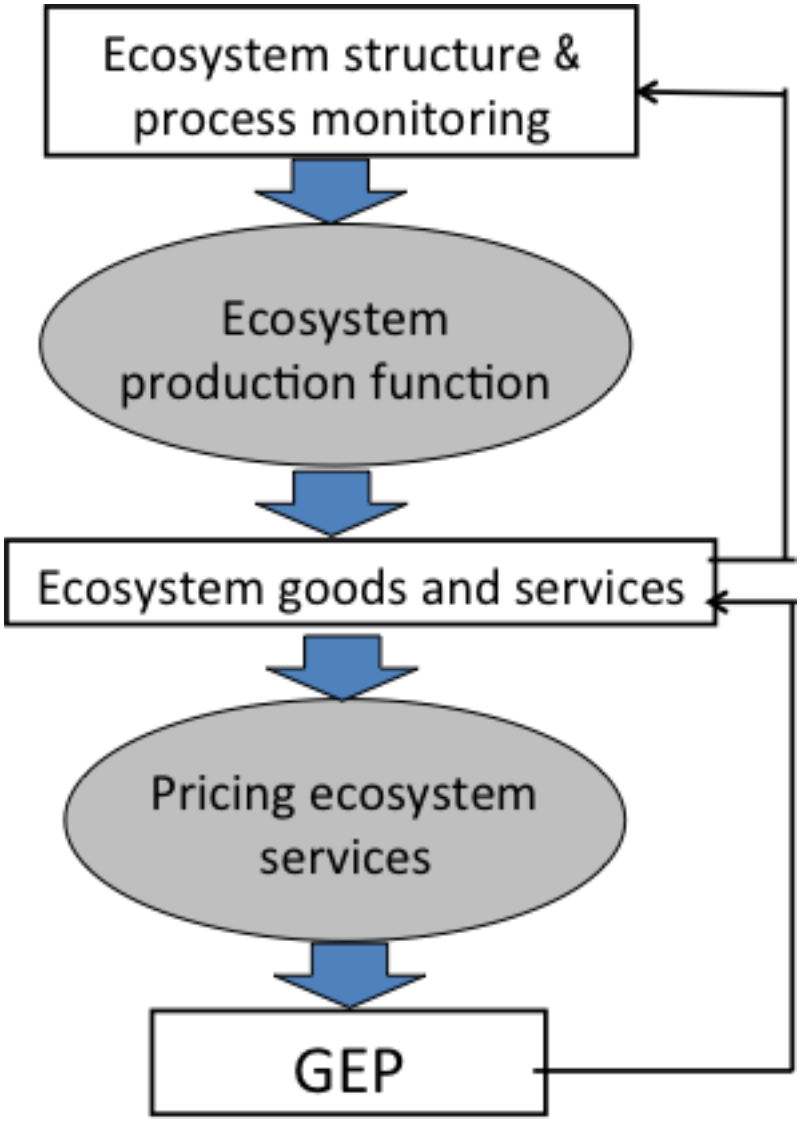



| Services | Value (billion Yuan) | Percenatage |
|---|---|---|
| Provisions | 1.529 | 2.9% |
| Regulating | 47.255 | 88.3% |
| Culture | 4.710 | 8.8% |
| Sum | **53.494** | 100% |

| Services | Items | Index | Bio-physical value | Units | Price | Monetary value | % | Sub-sum 亿元 | % |
|---|---|---|---|---|---|---|---|---|---|
| Provision | Products | Agricultural products | 8.70 | x $10^4$ tons | - | 1.59 | 0.30 | 15.29 | 2.86 |
| | | Forestry products | | | | 0.11 | 0.02 | | |
| | | Husbandry products | | | - | 1.14 | 0.21 | | |
| | | Fishery products | 3.70 | tons | - | 0.00 | 0.00 | | |
| | | Ecological energy | 11.75 | x $10^4$ tons | | 0.30 | 0.06 | | |
| | | Water resource | 1333.74 | x $10^4$ tons | | 2.15 | 0.40 | | |
| | | Other | | | - | 10.00 | 1.87 | | |
| Regulating | Water retention | Amount of Water retention | 8.19 | x $10^8$ $m^3$ | 7.63yuan/$m^3$ | 62.53 | 11.69 | 62.53 | 11.69 |
| | Soil retention | Reduce sediments | 0.2078 | x $10^8$ $m^3$ | 16.84yuan/t | 3.50 | 0.65 | 11.91 | 2.23 |
| | | Reduce N loading | 0.0038 | x $10^8$ tons | 1500yuan/t | 5.66 | 1.06 | | |
| | | Reduce P loading | 0.0011 | x $10^8$ tons | 2500yuan/t | 2.75 | 0.51 | | |
| | Sandstorm P | Amount of sand F | 0.0285 | x $10^8$ tons | 37500yuan/$km^2$ | 0.91 | 0.17 | 0.91 | 0.17 |
| | Flood M | Flood mitigated in lakes | 0.26 | x $10^8$ $m^3$ | 7.63yuan/$m^3$ | 1.97 | 0.37 | 48.90 | 9.14 |
| | | Flood mitigated in marsh | 6.15 | x $10^8$ $m^3$ | 7.63yuan/$m^3$ | 46.93 | 8.77 | | |
| | Air Purification | SO2 purification | 0.1410 | x $10^8$ $m^3$ | 1550yuan/t | 0.02 | 0.00 | 0.03 | 0.01 |
| | | NOx purification | 0.0445 | x $10^4$ tons | 810 yuan/t | 0.00 | 0.00 | | |
| | | Dust purification | 0.2298 | x $10^4$ tons | 190 yuan/t | 0.00 | 0.00 | | |
| | Water purification | COD purification | 0.1340 | x $10^4$ tons | 700 yuan/t | 0.01 | 0.00 | 0.01 | 0.00 |
| | | Total N purification | 0.0096 | x $10^4$ tons | 1500 yuan/t | 0.00 | 0.00 | | |
| | | Total P purification | 0.0010 | x $10^4$ tons | 2500 yuan/t | 0.00 | 0.00 | | |
| | Carbon sequestration | Carbon sequestration | 0.0631 | x $10^4$ tons | 312 yuan/t | 19.70 | 3.68 | 133.38 | 24.93 |
| | | Oxygen release | 0.1137 | x $10^8$ tons | 1000 yuan/t | 113.67 | 21.25 | | |
| | Climate regulating | Heat absorbed by forest | 211.80 | x $10^8$ kwh | 0.49 yuan | 103.78 | 19.40 | 212.89 | 39.80 |
| | | Heat absorbed by shrubs | 4.60 | x $10^8$ kwh | 0.49 yuan | 2.25 | 0.42 | | |
| | | Heat absorbed by grassland | 8.39 | x $10^8$ kwh | 0.49 yuan | 4.11 | 0.77 | | |
| | | Heat absorbed by wetland | 209.69 | x $10^8$ kwh | 0.49 yuan | 102.75 | 19.21 | | |
| | Pest control | Pest confront in forests | 53.33 | X $10^4$ ha | 375 yuan/ha | 2.00 | 0.37 | 2.00 | 0.37 |
| Culture | Landscape | Tourism in landscape | | | | 47.10 | 8.80 | 47.10 | 8.80 |

# On-going

- ✓ More case studies at different administrative regions: provinces cities, and counties.
- ✓ Prepare national standard for GEP accounting supported by SAC.
- ✓ GEP in policy applications, such as PES, evaluation system of local government performance beyond GDP.
- ✓ Index for monitoring progresses of ecological civilization and sustainability.



# Thanks

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International Union for Conservation of Nature