Gross Ecosystem Product (GEP) and Ecological Assets (EA)

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Outlines

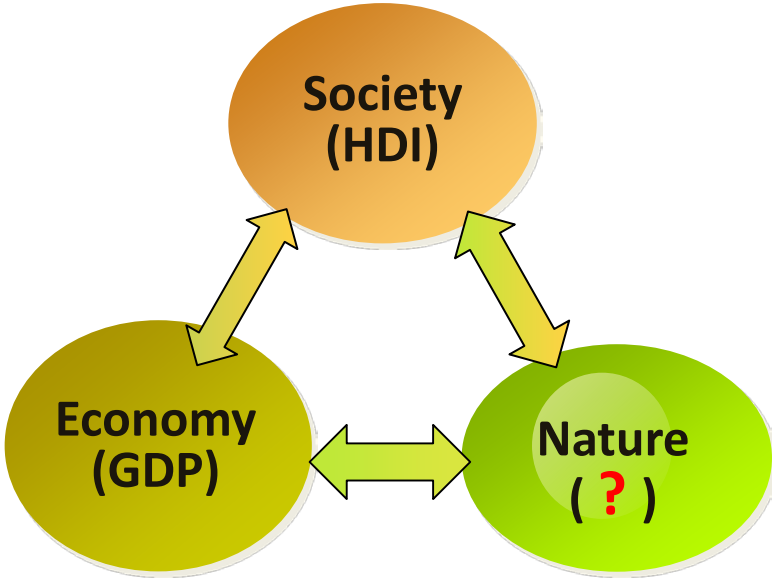
1. Background
2. GEP and EA concept and purposes
3. Accounting framework
4. GEP and EA experimental accounting
5. Main findings

Background

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

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.**

Background

- lucid waters and lush mountains are invaluable assets.
  - ✓ Ecosystem and nature have huge value
  - ✓ Ecological value can be transfer to economic benefits

- In 19th Congress of CCP, our modernization, characterized with harmony of human and nature, … and provides more high quality ecological products (and services)

GEP Concept

Concept of GEP

Gross Ecosystem Product, GEP

- Gross Ecosystem Product (GEP) is the total value of final ecosystem goods and services supplied to human well-being in given region annually, like a county, or a province, a county.
- Ecological asset (EA) is the natural asset that provides ecosystem goods and services.
- Ecosystems:
  - Natural ecosystem: forests grasslands, wetland, desert, marine, …
  - Managed ecosystem: cropland, orchards, aquaculture farms, urban green-space, …
  - Wildlife,

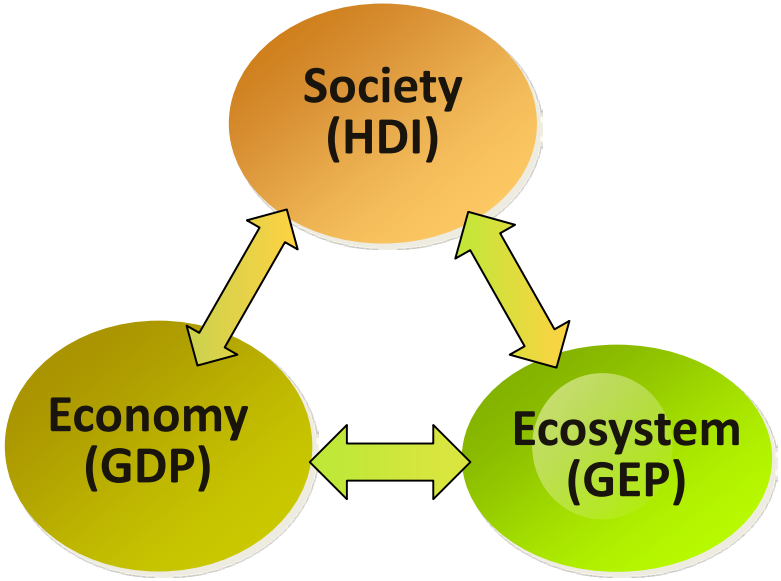
Concept of GEP

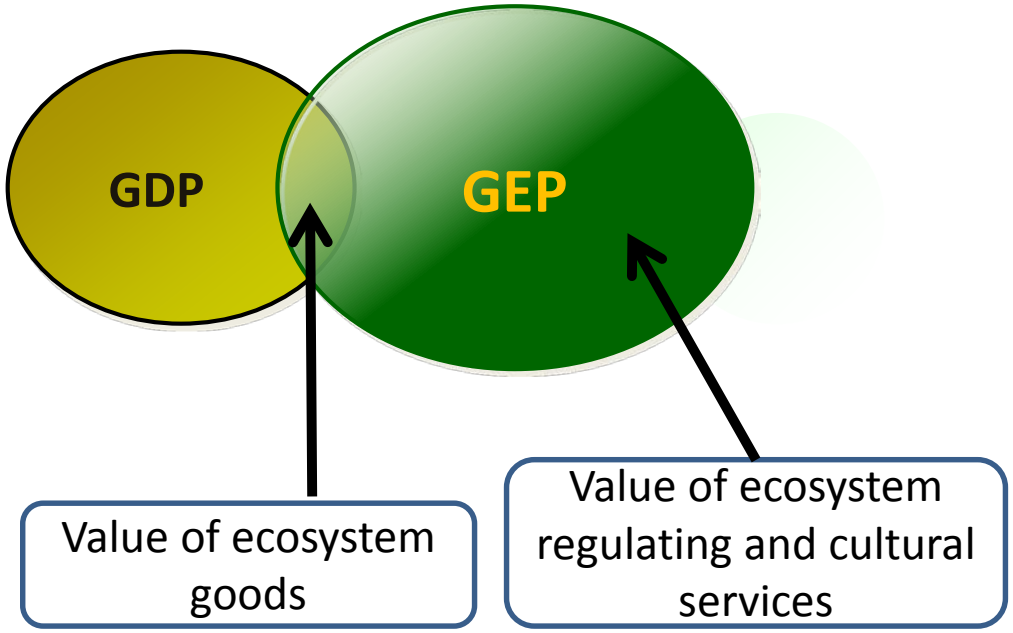
Purposes of GEP accounting

- 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

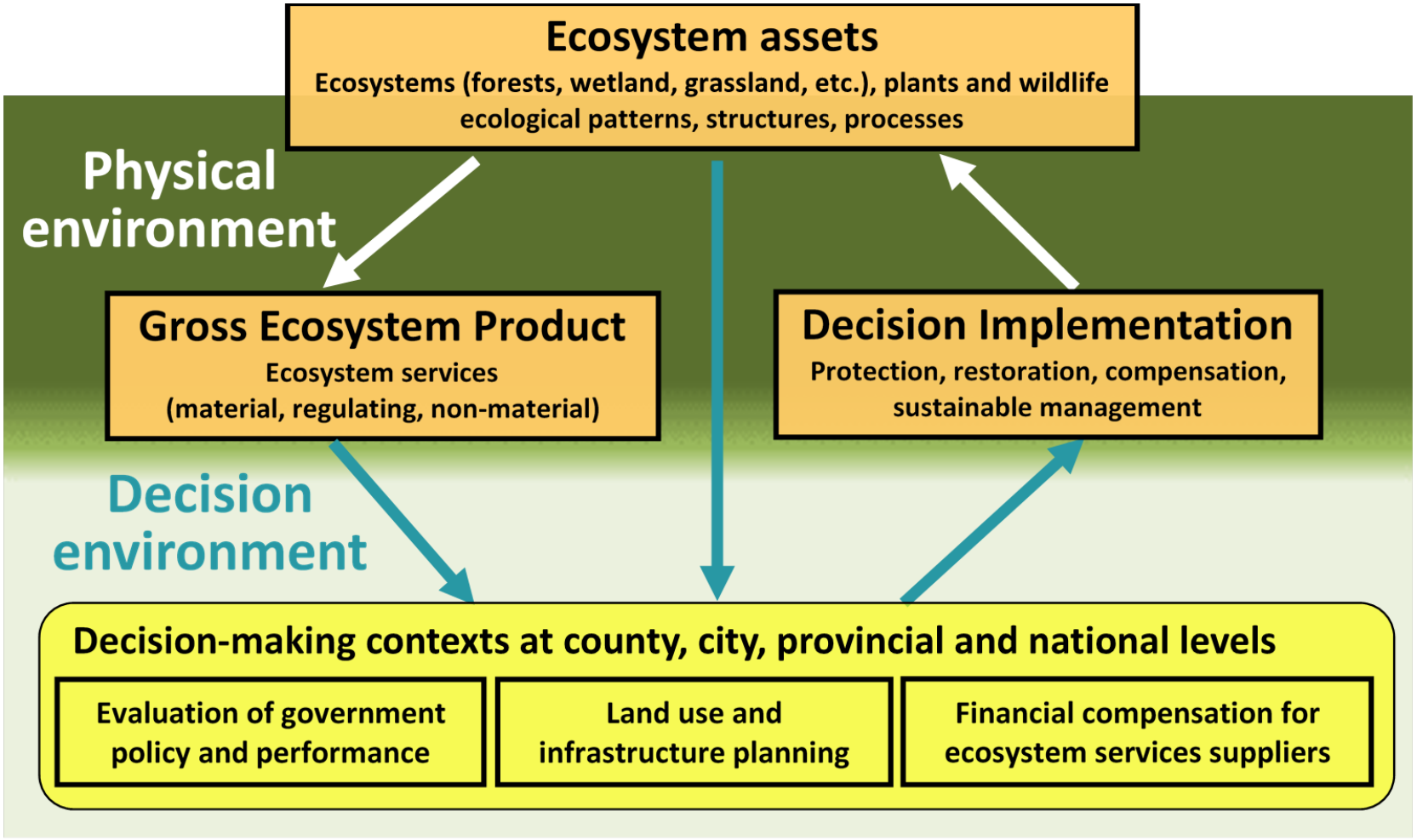




- GEP, GDP and Green GDP
  - ✓ GEP, The goods and services provided by ecosystems.
  - ✓ GDP, the goods and services provided by economic systems.
  - ✓ Green GDP, the GDP minus natural and environmental costs,

Concept of GEP

GEP accounting and policy implementation



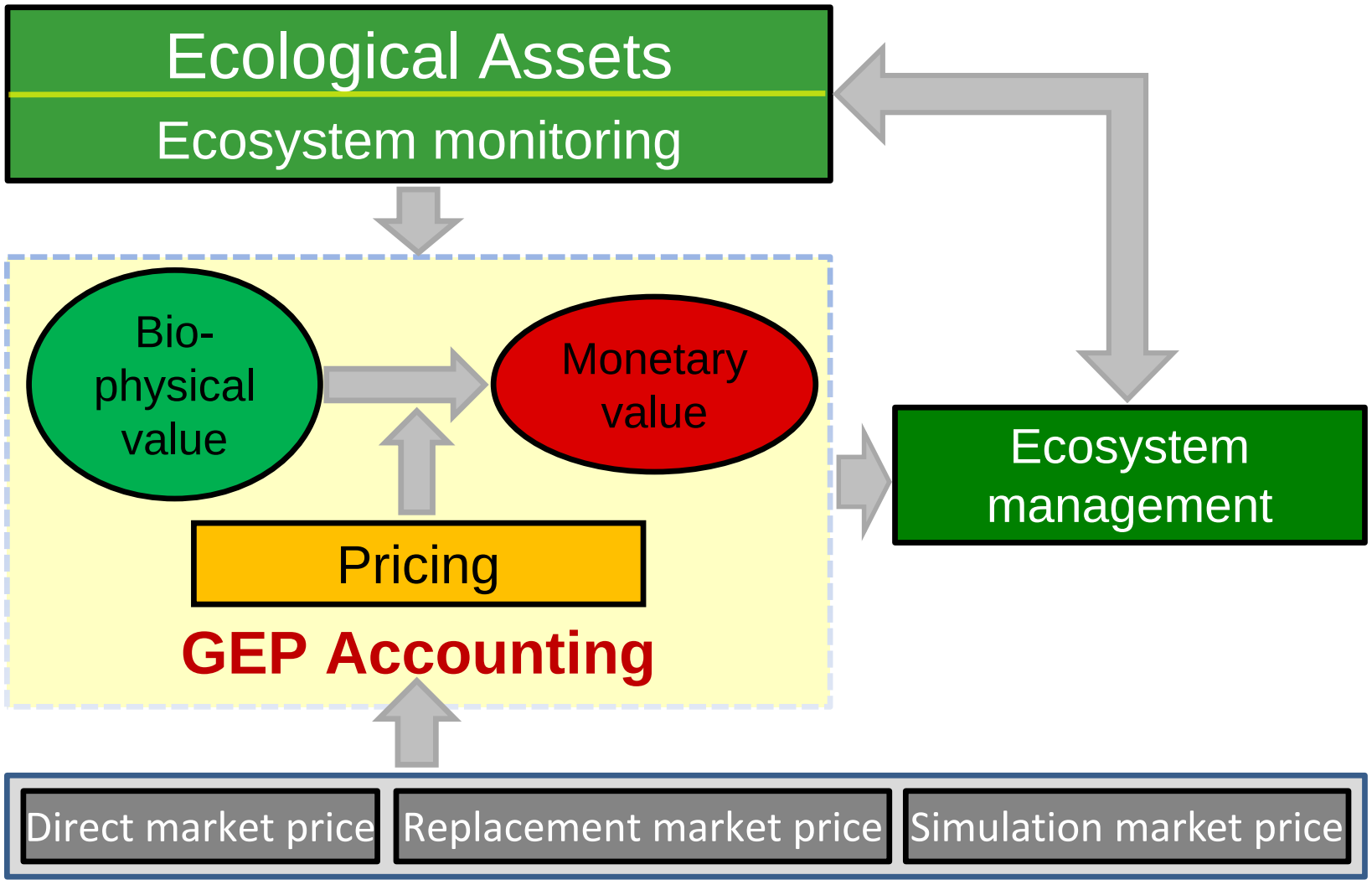
Accounting method of GEP

GEP accounting methods

The principle of GEP accounting

- ✧ Use value of ecosystem services
  - ✓ Direct use value: food, bio-energy, water resource,
  - ✓ Indirect use value: water retention, soil retention, pollutant purification, climate regulation
- ✧ The value of final eco-services
  - ✓ Ecosystem goods, regulating services, cultural services
- ✧ The bio-physical value accounting
  - ✓ Amount of food production, amount of water retention, amount of soil retention,
- ✧ The monetary value accounting
  - ✓ The economic value of ecosystem services

GEP accounting methods



GEP accounting methods

- **Accounting of bio-physical values of ecosystem goods and services**
  - ✓ Material services: 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,…
  - ✓ Replacement market, simulation market

GEP accounting methods

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

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

$$\mathbf{GEP} = \sum_{i=1}^{n} EP_i \times P_i + \sum_{j=1}^{m} ER_j \times P_j + \sum_{k=1}^{l} EC_k \times P_k$$

GEP accounting methods

Ecosystem goods and services

Categories	Goods and services (examples)
Material services	Food: grain, vegetable, fruits, 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

GEP accounting methods

Services	Indicators	Quantity indicators	Quantitative valuation methods	Value indicators	Value valuation methods
Material services	Agricultural products	Production of agricultural products	Statistical data	Value of agricultural products	Market price method
	Forestry products	Production of forestry products		Value of forestry products	
	Animal products	Production of animal products		Value of animal products	
	Fishery products	Production of fishery products		Value of fishery products	
	Water resources	Water consumption		Value of water resources	
	Ecological energy	Amount of ecological energy		Value of ecological energy	
	Others	e.g., production of ornamental resources		Value of ornamental resources	
Regulating services	Water retention	Amount of water retention	Water Balance Equation	Value of water retention	Surrogate market method
	Soil retention	Amount of soil retention	RUSLE	Value of sediment reduction	
				Value of diffused pollution reduction	
	Flood mitigation	Lake: adjustable storage capacity	Hydrologic data	Value of flood mitigation	
		Reservoir: flood control storage	Monitoring data		
		Swamp: stagnant water			
	Sandstorm prevention	Amount of sand-fixation	REWQ	Value of desertification reduction	
	Carbon sequestration -oxygen release	Amount of carbon sequestration	Mass balance method	Value of carbon dioxide sequestration	
		Amount of oxygen release		Value of oxygen release	
	Air quality maintenance	Amount of SO_2 absorption	Model of plants purification	Value of SO_2 treatment	
		Amount of NO_X absorption		Value of NO_X treatment	
		Amount of dust reduction		Value of dust treatment	
	Water purification	Amount of COD reduction	Model of water purification	Value of COD treatment	
		Amount of total nitrogen reduction		Value of total nitrogen treatment	
		Amount of total phosphorus reduction		Value of total phosphorus treatment	
	Climate regulation	Energy consumption of plant transpiration	Model of transpiration and evaporation	Value of plant transpiration	
		Energy consumption of water surface evaporation		Value of water surface evaporation	
	Biological control	Area of pest and disease occurrence	Analogy method	Value of biological control	
Cultural services	Natural landscape	Number of tourists	Travel cost method	Value of landscape recreation	Travel cost method

EA Accounting Methods

EA accounting for mainly includes **ecological asset index accounting**, **ecological assets physical quantity accounting**, **ecological assets balance sheet** and **profit and loss statement of the physical quantity of ecological assets**.

Ecological assets index

- Composite index of ecological assets: accounting forests, shrubland, grasslands, lakes, rivers, and swamps natural ecosystem assets such as converting and quality comprehensive index.

$$EQ=\frac{\sum_{i=1}^{6}\sum_{j=1}^{5}\left(EA_{ij}\times j\right)}{\left(\sum_{i=1}^{6}EA_i\times 5\right)}\times\frac{\sum_{i=1}^{6}EA_i}{9600000}\times 10^4$$

$$EQ_i=\frac{\sum_{j=1}^{5}\left(EA_{ij}\times j\right)}{\left(EA_i\times 5\right)}\times\frac{EA_i}{9600000}\times 10^4$$

EQ: the comprehensive index of ecological assets; EQ_i*:* the *i*th class ecological assets index; *i:* the ecological asset class; *j:* the ecological assets quality index (1-5); EA_{ij}*:* the area of the *j*th level of the *i*th class ecological asset; EA_i*:* the area of class i ecological assets

EA Accounting Methods

Evaluation indicators of ecological assets quality

Ecological assets item		Evaluation indicators	Quality grade				
			I	II	III	IV	V
Natural ecosystem	Forest	Relative biomass density	≥ 85%	70-85%	50-70%	25-50%	< 25%
	Shrub						
	Grassland	Fractional vegetation coverage	≥ 85%	70-85%	50-70%	25-50%	< 25%
	Lake	Water quality	Class I	Class II	Class III	Class IV	Class V and Inferior Class V
	River						
	Swamp						
	Desert	-	-	-	-	-	-
Artificial ecosystem based on natural ecological processes	Urban green	-	-	-	-	-	-
Wildlife	Wild plants	-	-	-	-	-	-
	Wild animals	-	-	-	-	-	-

EA Accounting Methods

Physical quantity accounting tables of ecological assets (2xxx)

Ecological assets	Quality level（km^2）										
Categories	Total	Excellent		Good		Medium		Poor		Very Poor	
		Area	Ratio（%）	Area	Ratio（%）	Area	Ratio（%）	Area	Ratio（%）	Area	Ratio（%）
Forest											
Shrub											
Grassland											
Lake											
River											
Swamp											
Urban green											
Wild plants											
Wild animals											
Important protected animals											
Important protected plants											

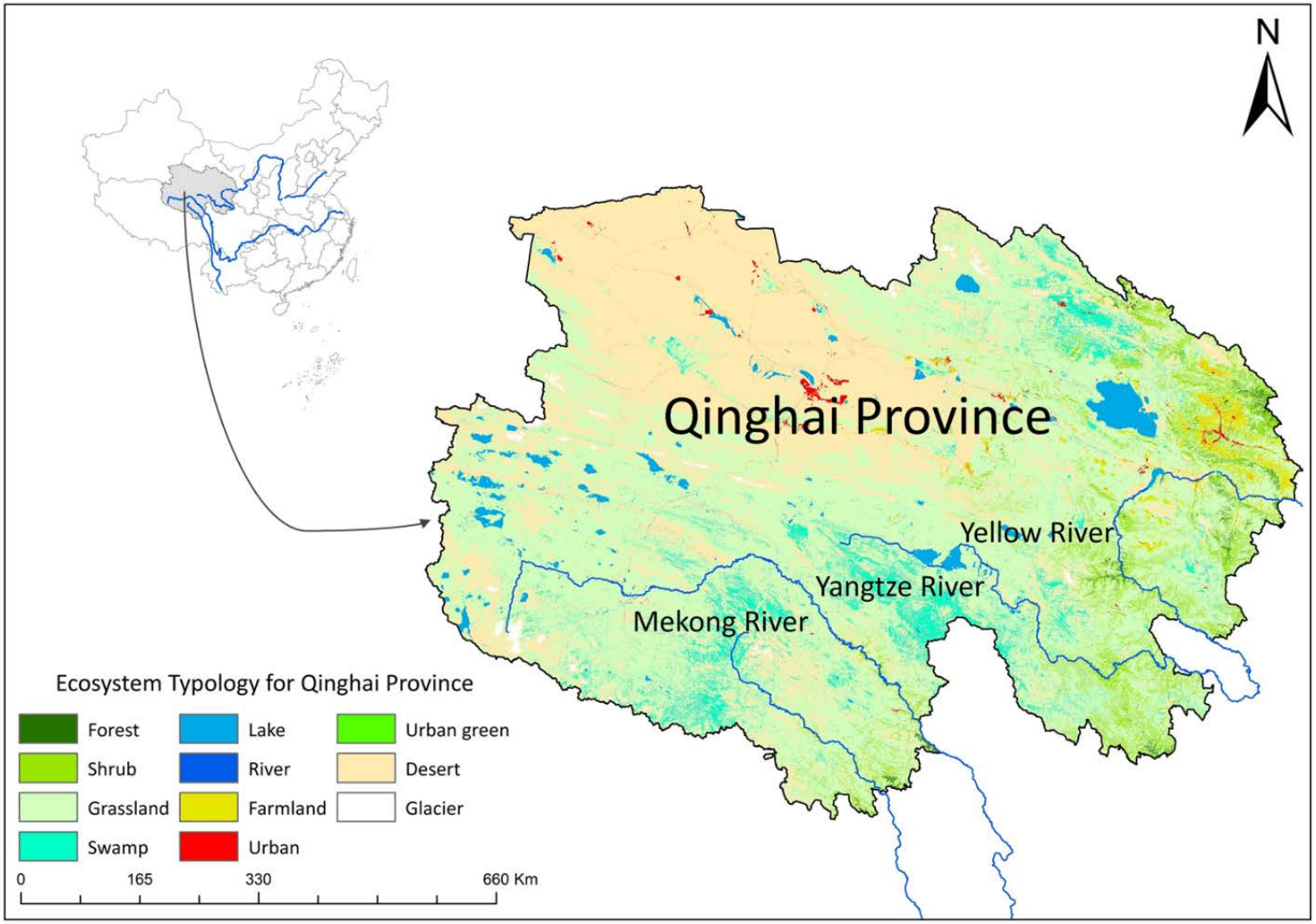
Case study

GEP accounting in

Qinghai Province and Lishui City

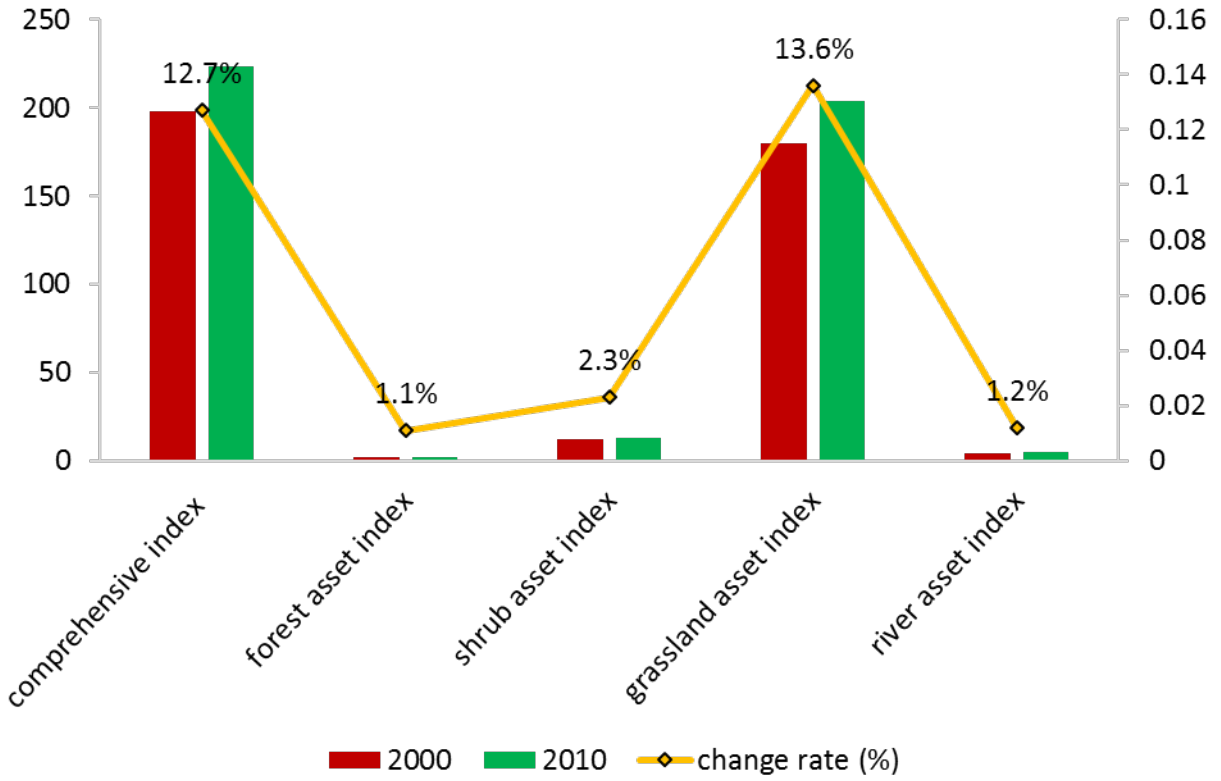
GEP and EA accounting of pilot areas

Location and ecosystem patterns of Qinghai Province



GEP and EA accounting of pilot areas

Ecological Assets Index and Its Change of Qinghai Province



- ✧ The grassland assets index is the highest, indicating that **grassland is main kind of ecological assets** in Qinghai Province.
- ✧ Grassland assets index increased the most with 13.6%, because of **grassland quality promotion**;
- ✧ Increase rate of river assets index is 12.1%, because of **river quality promotion**.

GEP and EA accounting of pilot areas

The bio-physical value and monetary value of GEP in Qinghai Province

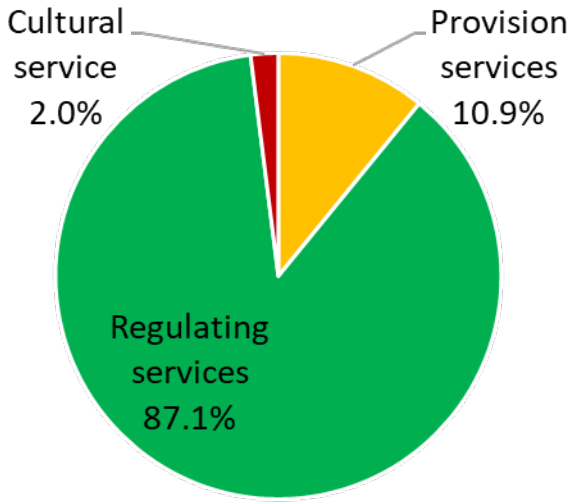
Types of service	Category of ecosystem services	Accounting items	2015		
			Bio-physical quantity	Monetary value (Billion Yuan)	% of total value
Material services	Production of ecosystem goods	Agricultural crop production ($x10^3$t)	3091.2	5.6	0.5
		Animal husbandry production ($x10^3$t)	724	5.8	0.5
		Fishery production ($x10^3$t)	10.6	0.3	0.0
		Forestry production ($x10^3m^3$)	825	0.7	0.1
		Plant nursery production ($x10^9$)	11	0.7	0.1
		Total		13.1	1.2
	Water supply	Water use in downstream agricultural irrigation ($x10^9$ m^3)		15	1.4
		Water use in households ($x10^9m^3$)		13.8	1.3
		Water use in industry ($x10^9m^3$)		29.2	2.6
		Hydropower production ($x10^9$ kwh)	92	48.8	4.4
		Total		106.7	9.7
Regulating services	Flood mitigation	Flood mitigation ($x10^9m^3$)	0.07	0.03	0.0
	Soil retention and	Retained soil ($x10^9$ t)	0.4	7	0.6
	non-point pollution prevention	Retained N ($x10^3$ t)	10	0.02	0.0
		Retained P ($x10^3$t)	0.7	0.002	0.0
	Water purification (wetland)	COD purification ($x10^3$ t)	104.3	0.1	0.0
		NH-N purification ($x10^3$ t)	10	0.02	0.0
		TP purification ($x10^3$ t)	0.9	0.003	0.0
	Air purification	SO_2 purification ($x10^3$ t)	150.8	0.2	0.0
		NO_x purification ($x10^3$ t)	117.9	0.1	0.0
		Dust purification ($x10^3$ t)	246	0.04	0.0
	Sandstorm prevention	Sand retention ($x10^9$t)	0.5	31.7	2.9
	Carbon sequestration	Carbon sequestration ($x10^9$ t)	0.02	4.7	0.4
	Climate regulation	By vegetation (x109 kwh)	653.5	346.3	31.4
		By water surface (x109 kwh)	1078.3	571.5	51.8
		Total		961.715	87.2
Cultural services	Eco-tourism	Tourists ($x10^6$ persons)	23.2	21.6	2.0
		Grand Total		1103.115	100.0

GEP and EA accounting of pilot areas

GEP of Qinghai in 2015：1103.1 Billion

GEP of Qinghai Province in 2015

Items	Value (billion yuan)	Ratio (%)
Material services	119.8	10.9
Regulating services	961.7	87.1
Cultural service	21.6	2
Total	1103.1	100.0

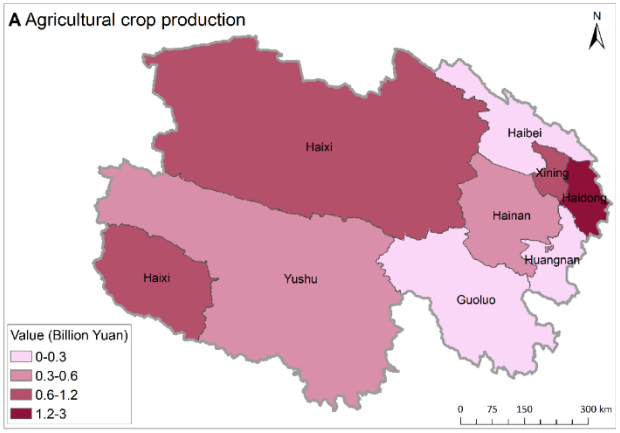


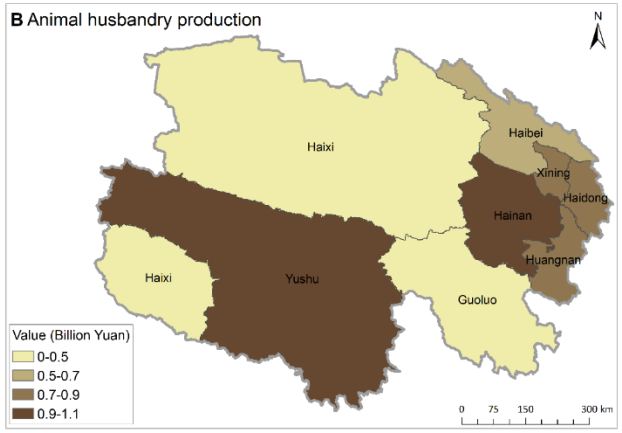
GEP constitute of Qinghai Province in 2015

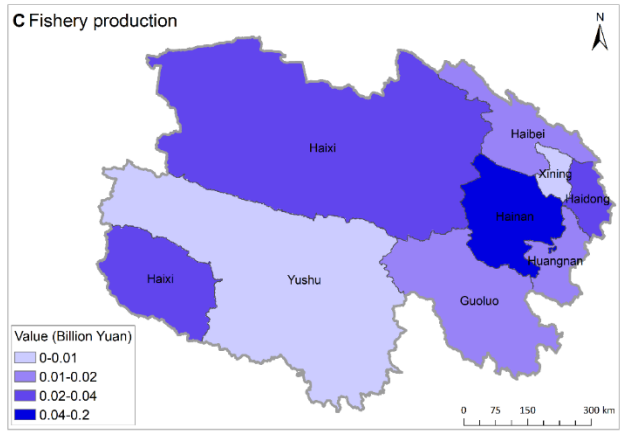
GEP and EA accounting of pilot areas

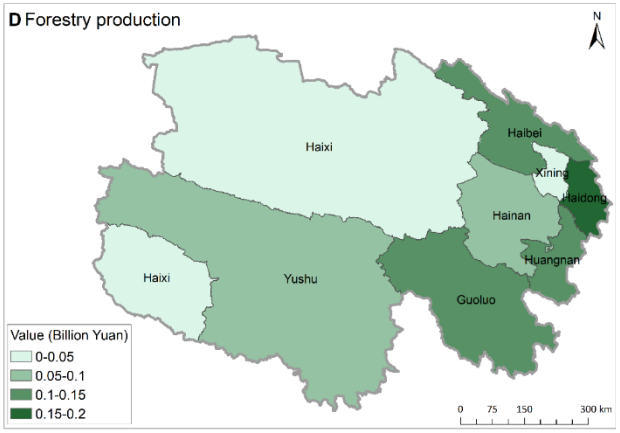
Ecosystem services produced within Qinghai Province

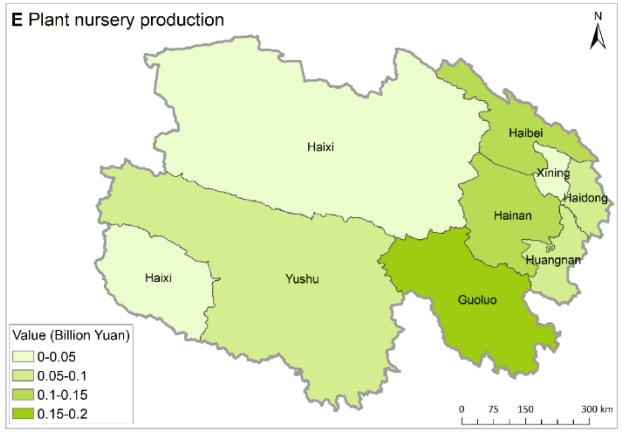
Material services

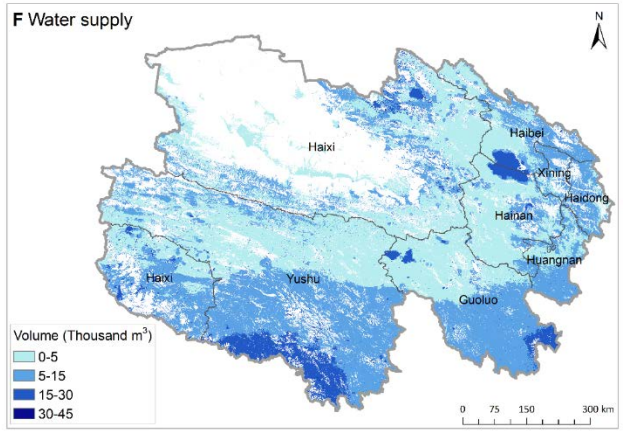








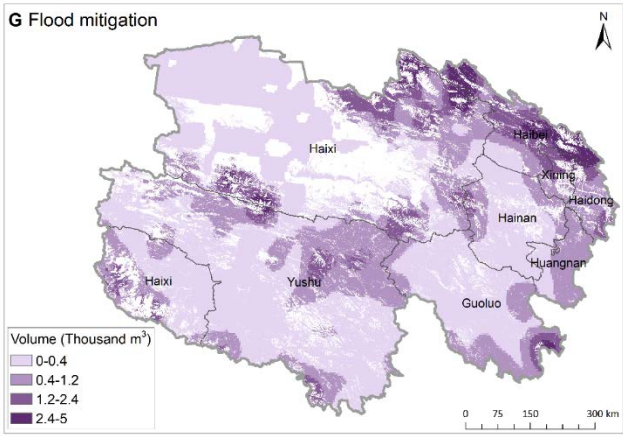


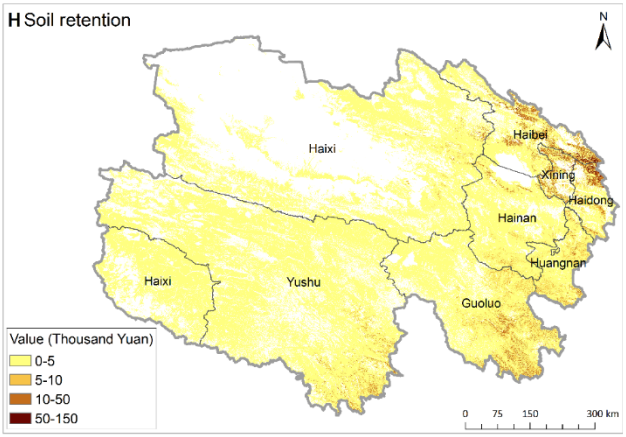


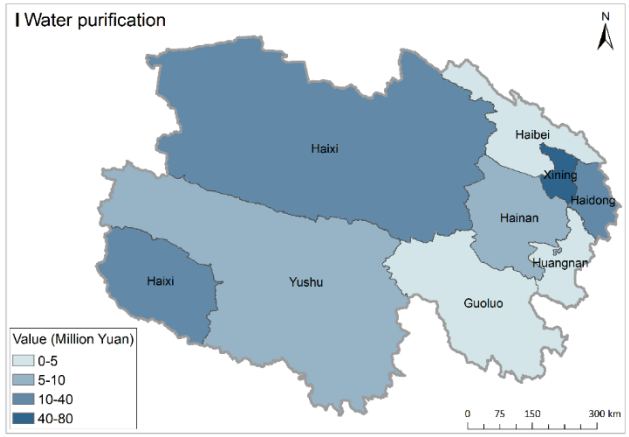
GEP and EA accounting of pilot areas

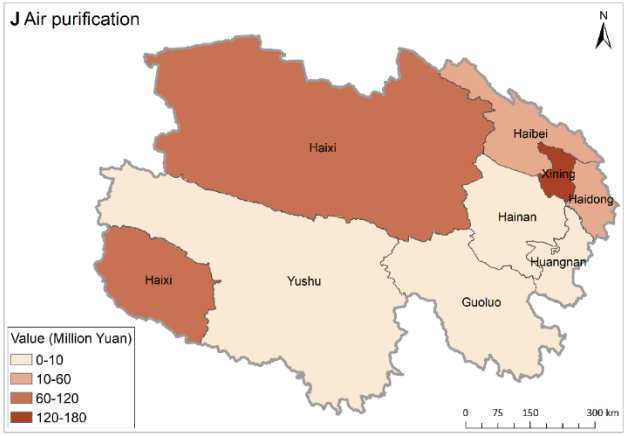
Ecosystem services produced within Qinghai Province

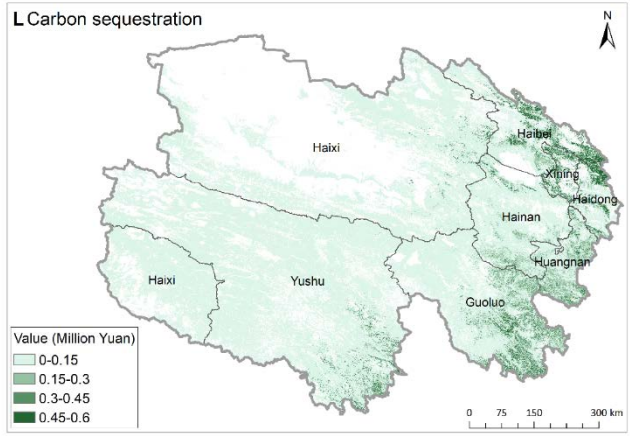
Regulating services





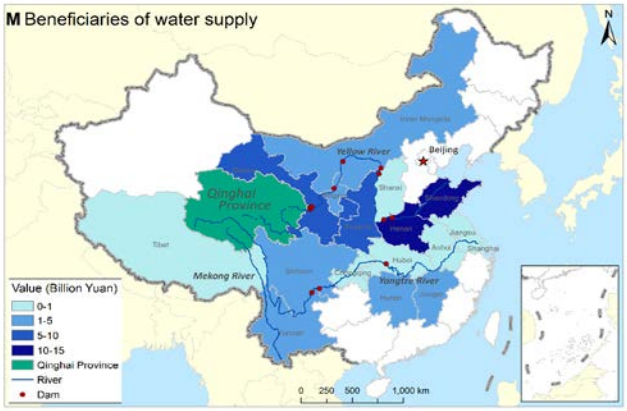


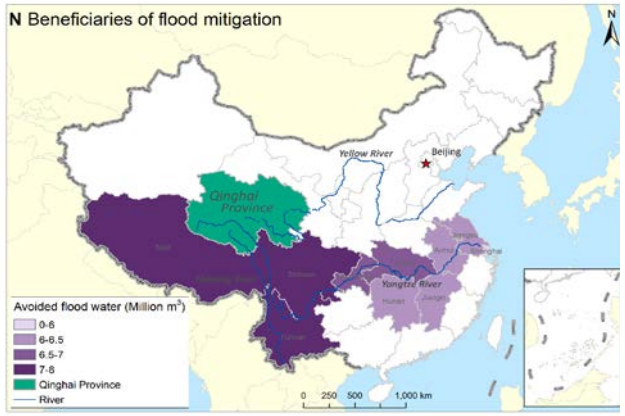




GEP and EA accounting of pilot areas

The location of beneficiaries in recipient provinces





GEP and EA accounting of pilot areas

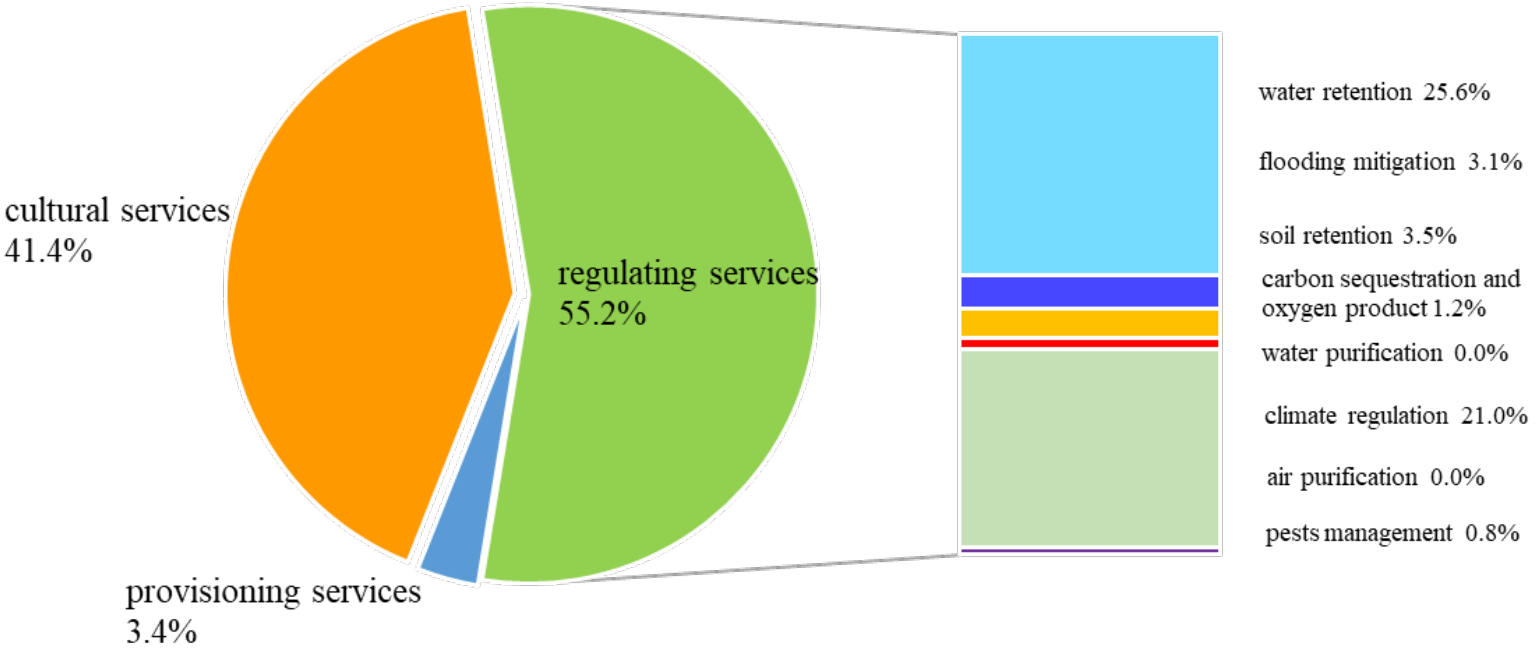
Changes of the GEP in Qinghai Province (2000–2015)

Services	2015 (Billion Yuan)	2000 (Billion Yuan)	2000–2015 (constant price) Rate of change (%)
Provisioning services	119.8	50.3	138.2
Regulating services	961.72	945.09	1.8
Culture services	21.6	3	620.0
GEP	1,103.12	998.39	10.5

GEP and EA accounting of pilot areas

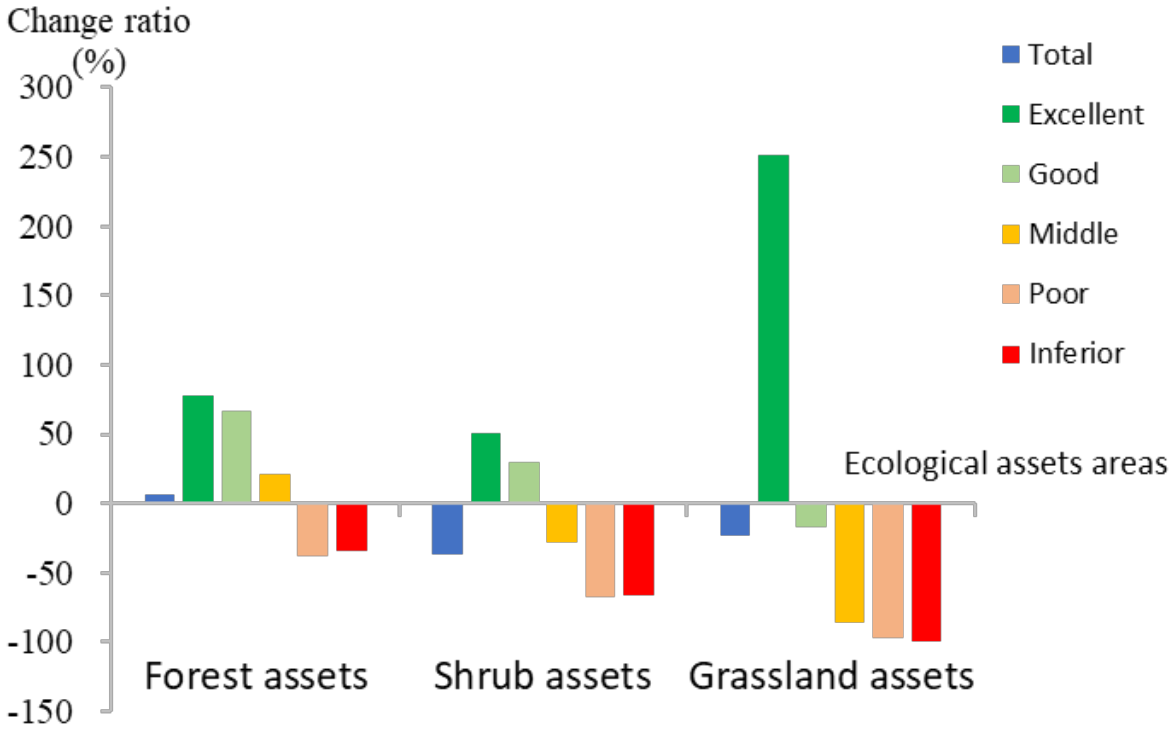
GEP of Lishui in 2017：467.3 Billion

- ✧ Regulating services：257.9 billion, 55.2%
- ✧ Cultural services：193.3billion, 41.4%
- ✧ Provisioning services：16.0billion, 3.4%



GEP and EA accounting of pilot areas

Changes of Ecological assets areas in Lishui City



- Quality of ecological assets in Lishui City has increased.
  - Areas of excellent and good grade forest assets increased 77.9%, 66.1%;
  - Areas of excellent and good grade shrubs assets increased 50.6%, 29.2%;
  - Areas of excellent grade grasslands assets increased 250.8%.

GEP and EA accounting of pilot areas

Changes of the GEP in Lishui City (2006–2017)

Billion RMB

Items	2017	2006	2006-2017	
			Change amount	Change ratio
Material services	16.0	8.1	5.7	55.6%
Regulating services	257.9	190.9	32.3	14.3%
Cultural services	193.3	10.6	179.0	1246.4%
GEP	467.3	209.6	217.0	86.7%

Main Findings

Main findings

- Indicators system of GEP and EA accounting can reflect types of ecosystem products and services in different area.
- GEP and EA accounting indicated the effects of ecological protection efforts on ecosystem products and services of the four areas.
- Existing ecological and environmental monitoring and statistics can basically support GEP and EA accounting in provincial, municipal and county scales.

Main findings

Recommendations

- Ecological benefit assessment method based on GEP and EA accounting can used to performance evaluation of eco-compensation.
- To improve GEP index system and methods, to standardize valuation methods of ecological goods and services, to program GEP and EA accounting technical guideline.
- Strengthen the sharing from environmental, hydrological, forest, meteorological and statistical data, improving the eco-environmental monitoring system, providing a data base for establish performance evaluation mechanism for eco-compensation with GEP and EA assessment.

Thanks

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