Realizing China's Dream: Gross Ecosystem Product Accounting

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Gross ecosystem product

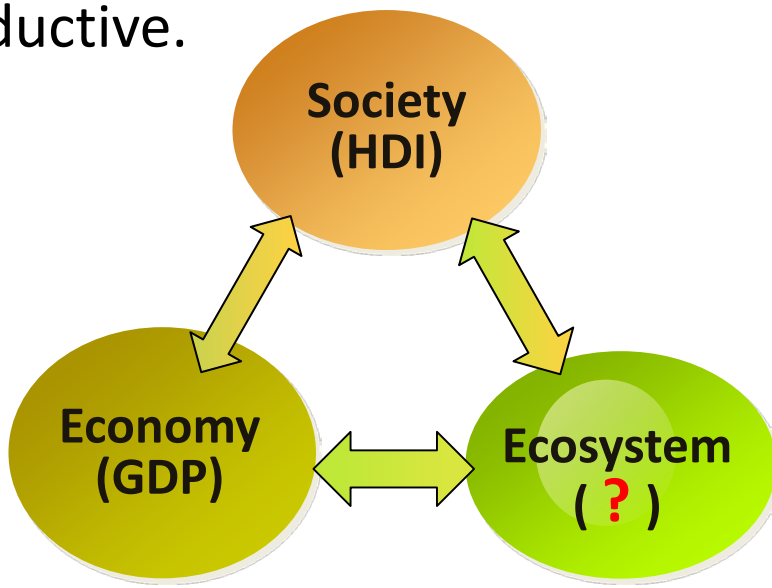
1. Background of GEP
2. Concept of GEP
3. Accounting framework of GEP
4. Case study: GEP accounting of Guizhou Province

Background of GEP

Background

Region is the coupled nature-economic-social system

- Region sustainability: the integration of highly economic efficiency, social equity, ecosystem productive.
- Economy: GDP is widely used economic indicator for measuring the value of total final goods and services produced by human economic activities at a given period in a country or region.



- Society: HDI(Human development index) is used to measure social development based on health, education and living-standard since 1991.
- Ecosystem: currently we do not have widely used index.

Background

- **Ecosystem is the essentials 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

Ecosystem service evaluation is the hot topic globally

- ✓ 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 resource consumption, environmental damage and **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

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.
- Ecosystems:
  - Natural ecosystem: forests grasslands, wetland, desert, marine, …
  - Managed ecosystem: cropland, orchards, aquaculture farms, urban ecosystem, …

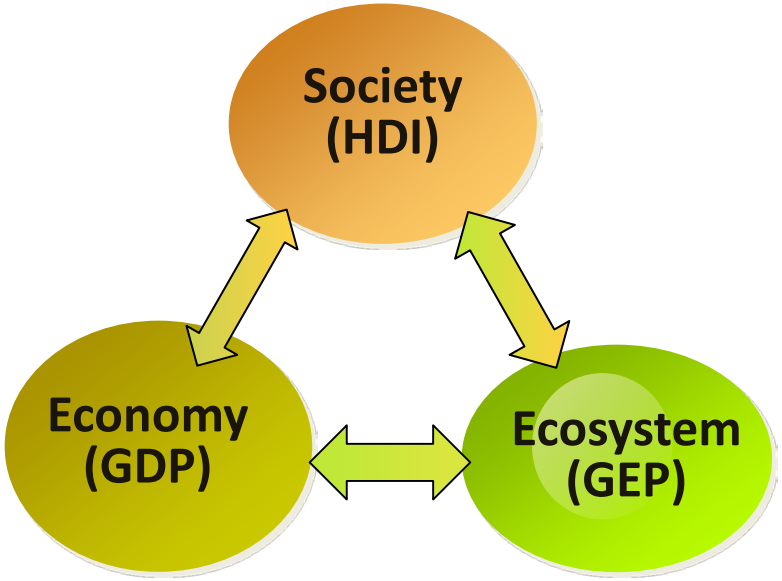
Concept of GEP

Ecosystem goods and services

Categories	Goods and services (examples)
Ecosystem goods	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

Concept of GEP

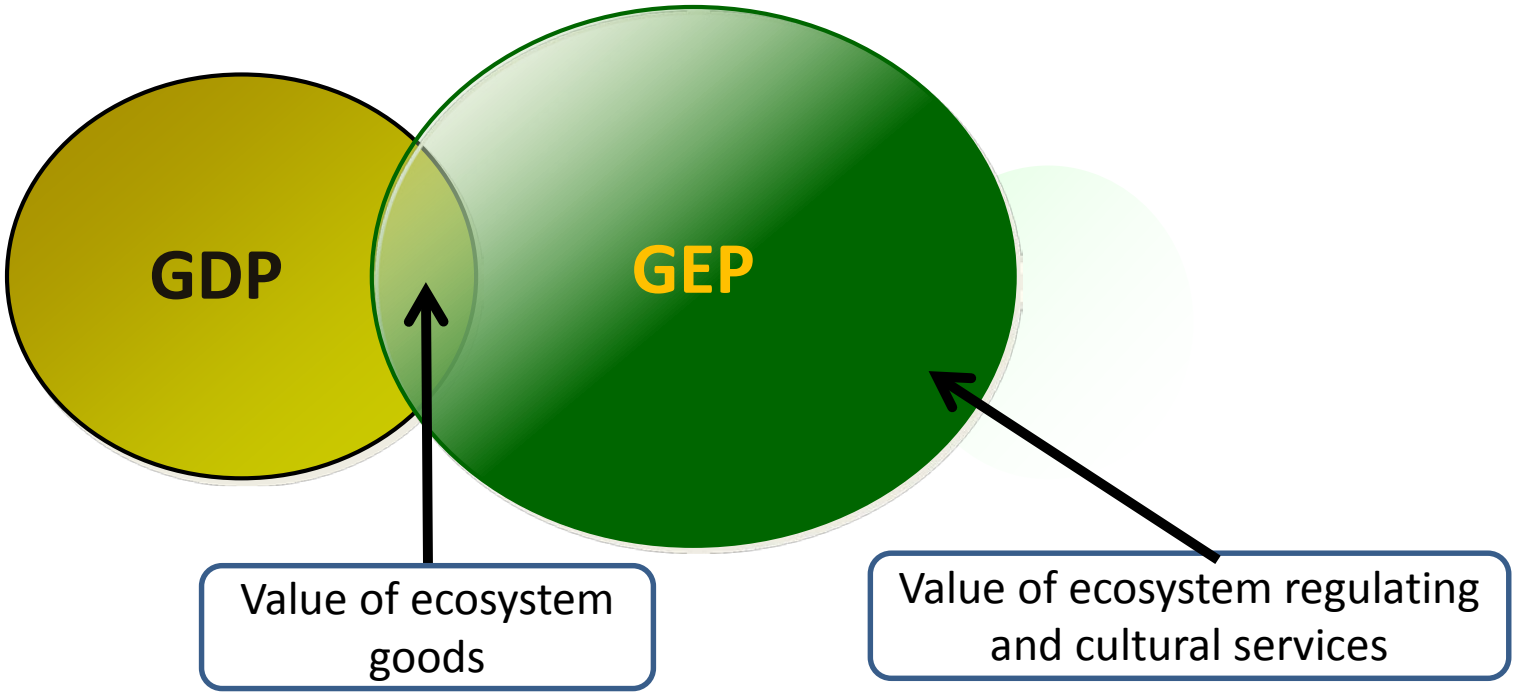
- GDP, HDI, and GEP



- 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

- GDP and GEP
  - ✓ overlapped in value of ecosystem goods.



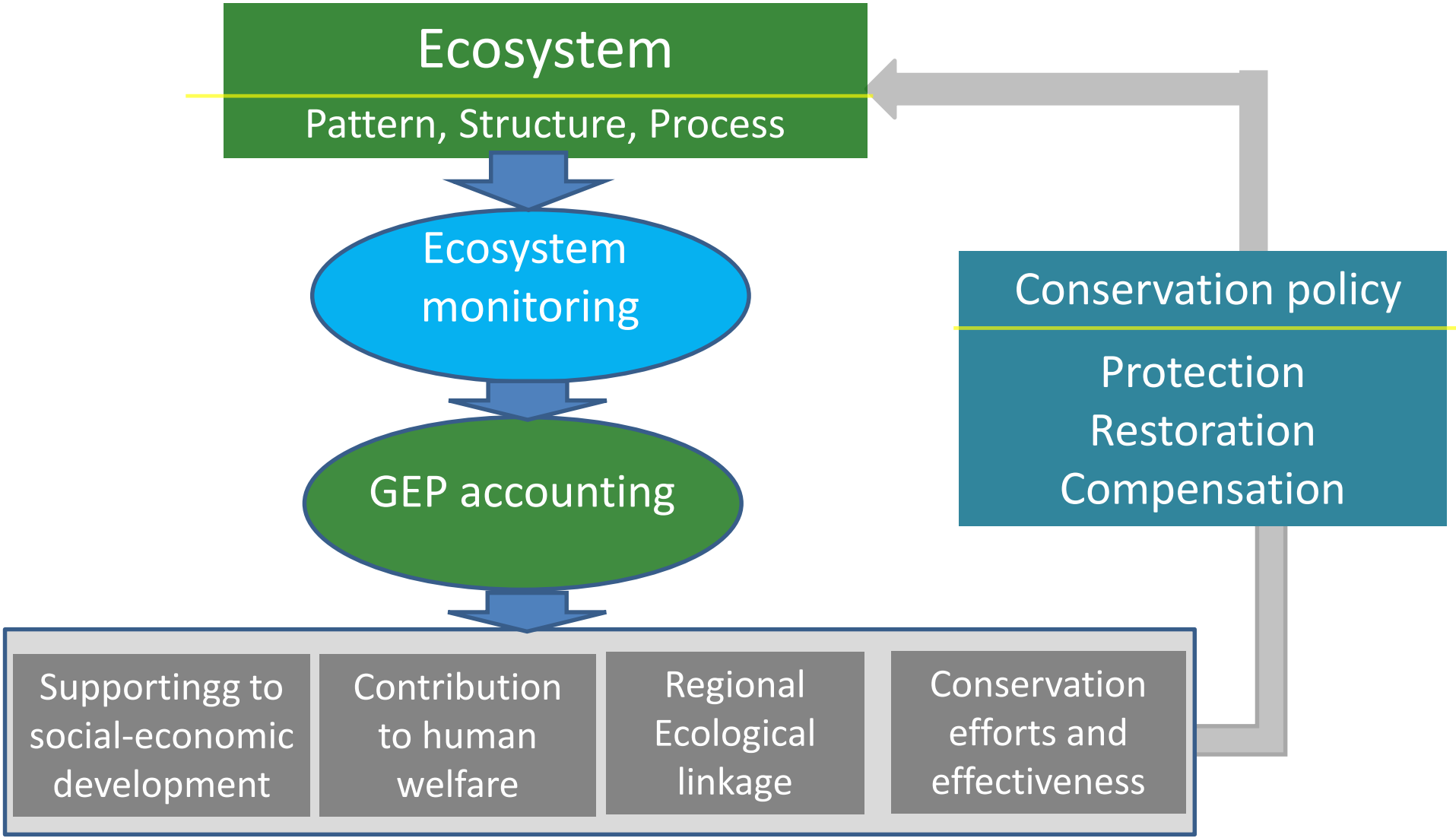
Concept of GEP

Purposes of GEP accounting

- Assessment/description of ecosystem status
- 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

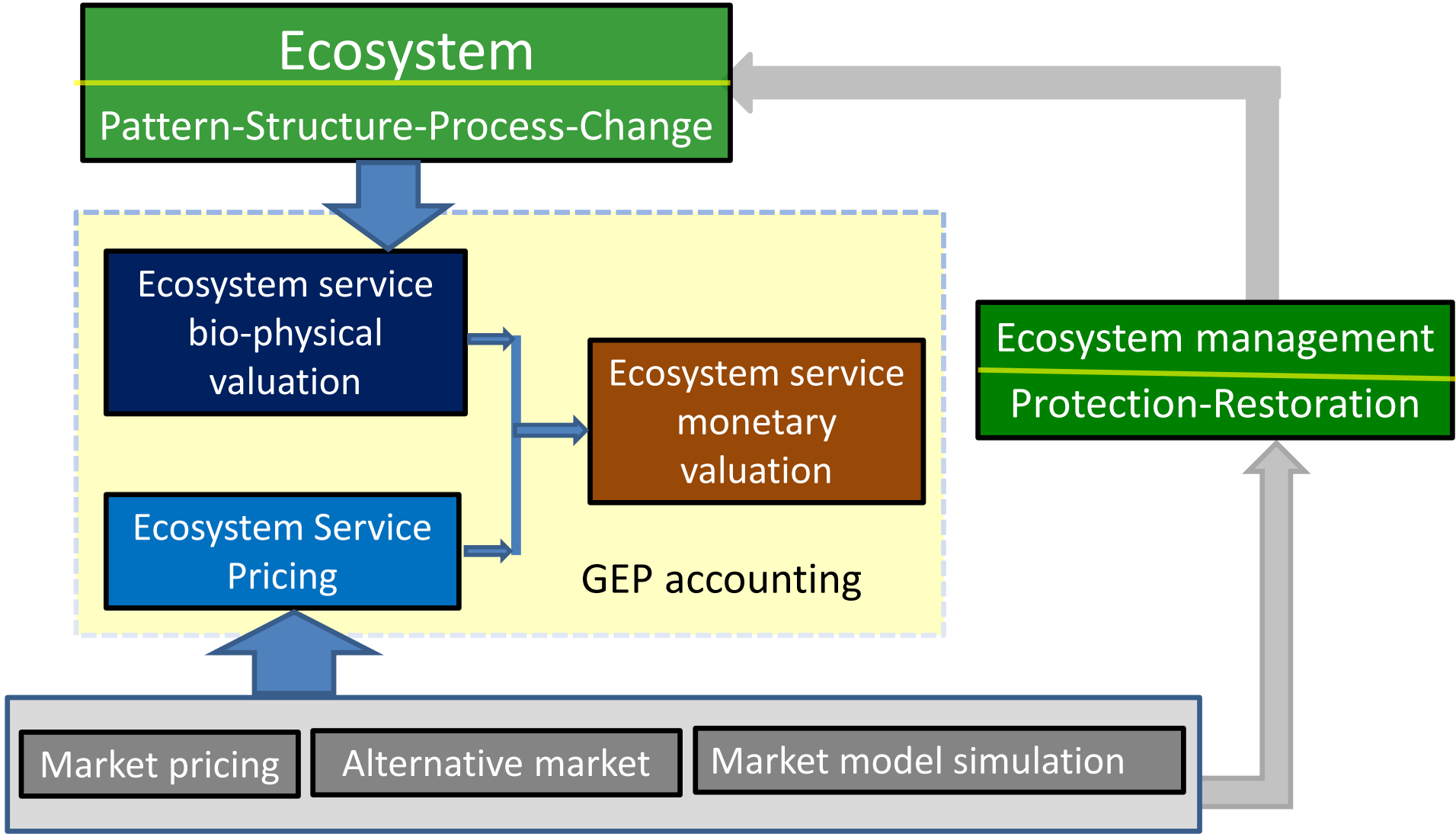
Concept of GEP

GEP accounting and policy implementation



Accounting framework of GEP

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.

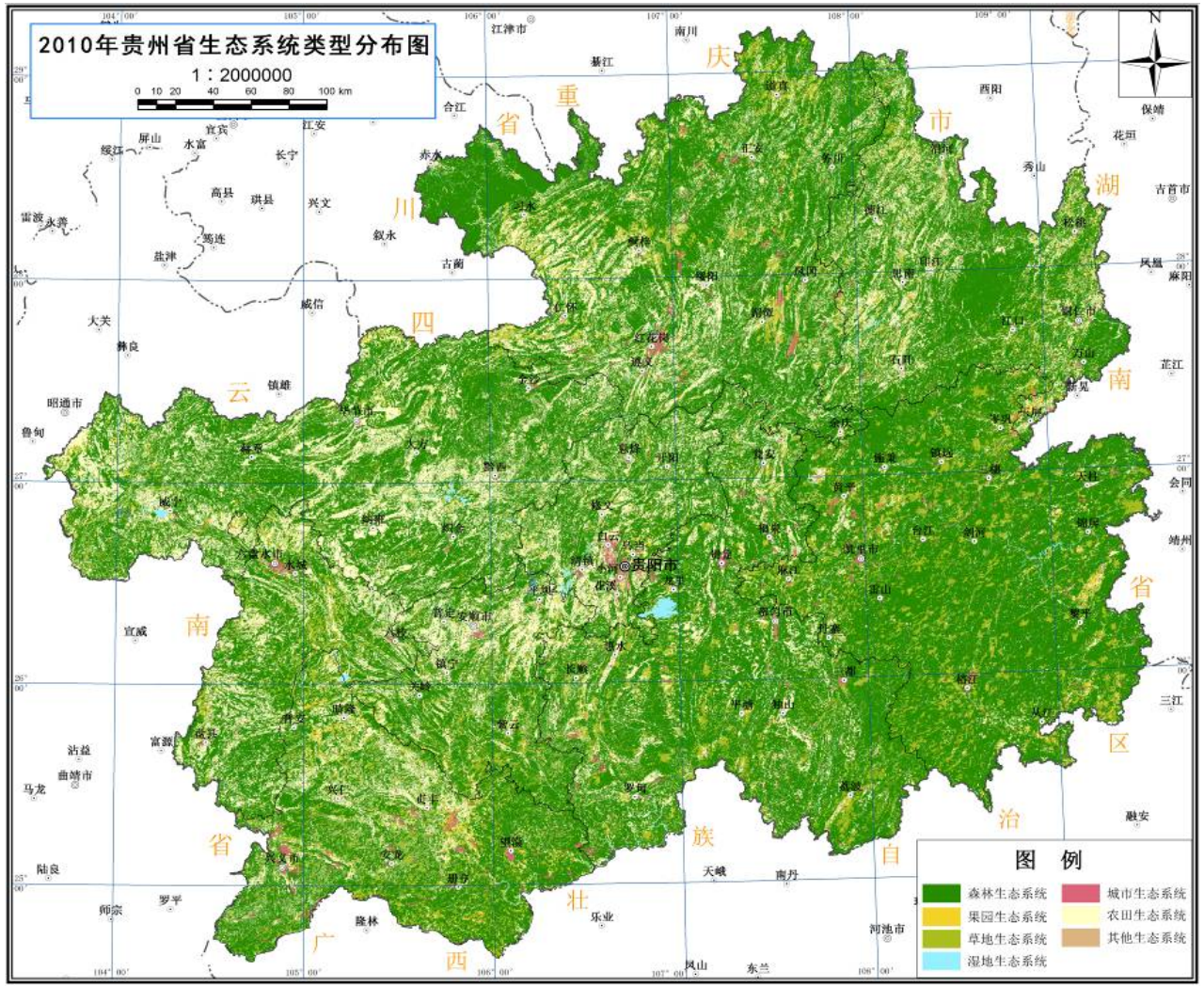
$$\mathrm{GEP} = EPV + ERV + ECV$$

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

Case study: GEP accounting of Guizhou Province

GEP accounting of Guizhou

Guizhou ecosystem distribution



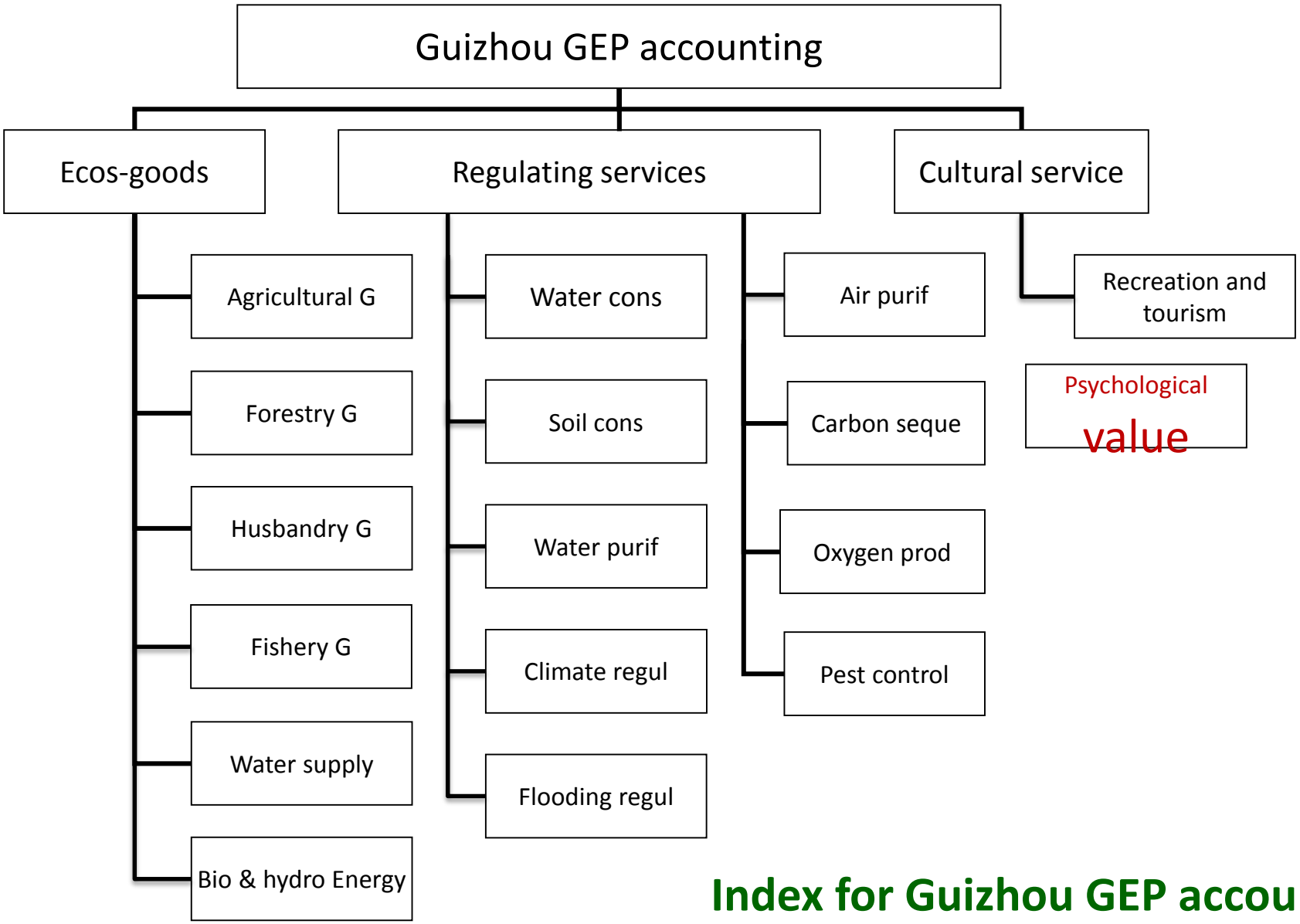
Population:35.02 M

Area: 176,167 km^2

Ecosystem

- Forests
- Grassland
- Wetland
- Cropland
- Urban

GEP accounting of Guizhou



Index for Guizhou GEP accounting

GEP accounting of Guizhou

- Soil conservation

$$A_c = R \cdot K \cdot LS(1-C \cdot P)$$

$$E_f = \sum_i A_c \cdot C_i \cdot P_i \cdot 10000^{-1} (i = N、P、K)$$

$$E_n = 24\% \cdot A_c \cdot C/\rho$$

- Water regulating

$$W_f = R + I_w - E_r - O_w$$

$$E_w = W_f \cdot P$$

- Flooding mitigation

$$L_p = 134.83 \cdot \mathrm{EXP}（0.927 \cdot Ln(L_a)）$$

$$E_a = （L_p + R_p） \cdot P_v$$

- Climate regulation

$$E_c = E_v + E_w \qquad （8）$$
$$E_v = （F_a + G_a） \cdot H_a \cdot \rho \cdot P_e$$
$$E_w = W_a \cdot E_p \cdot \beta \cdot P_e$$

- Pest control

$$E_b = NF_a \cdot (MF_r - NF_r) \cdot P_b$$

GEP accounting of Guizhou

Ecosystem goods in Guizhou in 2010

Category	Goods	Output	Value(x10^8)yuan
Agricultural goods	Rice (x10^{4}t)	445.65	118.59
	Wheat (x10^{4}t)	24.83	4.42
	Corn (x10^{4}t)	415.43	81.34

Category	Goods	Output	Value(x10^8)yuan
Forest goods	Wood (x10^3 m^3)	2391	11.47
	Herb medicine (x10^3 ha)	28.12	16.42
	Seedlings (x10^{3}mu)	10.5	5.27

Category	Goods	Output	Value(x10^8)yuan
Husbandry goods	beef meat (x10^{4}t)	11.99	40.77
	lamb meat (x10^{4}t)	3.40	15.37

Category		Goods	Output	Value(x10^8)yuan
Water resource	Inner GZ	Irrigation water(m^3)	51.17×10^8	1.88
		public water use(m^3)	0.73×10^8	1.31
		Industrial water use(m^3)	33.75×10^8	77.63
		Living water use(m^3)	12.32×10^8	19.71
		sum	97.97×10^8	100.53
	Outflow water resource to other province (m^3)		911.93×10^8	935.76
	Total		1009.90×10^8	1036.29
Hydro-power	Hydro-power(kwh)		416.58×10^8	3.03
Fishery goods				

GEP accounting of Guizhou

Ecosystem goods in Guizhou in 2010

Category	Output	Value($x10^8$)yuan
Agricultural goods($x10^4$t)	2445.46	565.23
Forest goods	——	64.59
Husbandry goods($x10^4$t)	194.99	332.86
Fishery goods($x10^4$t)	8.79	13.82
Water resource（m^3)	1009.90×10^8	1036.29
Hydro-power（kwh）	416.58×10^8	3.03
Fuel woods（$x10^4$t）	1207.67	67.63
Total		2083.45

GEP accounting of Guizhou

Ecosystem regulating services in Guizhou in 2010

Services	Indicators	Bio-physical values	Prices	Economic value (billion yuan)
Soil conservation	Fertilizer conservation (million t)	0.65	2600yuan/t	1.697
	Silt decreasing (billion m^3)	0.10	6.11yuan/m^3	0.593
	Sub-total			2.290
Water supply	water conservation (billion m^3)	86.40	6.11yuan/m^3	527.898
Flooding mitigation	Lakes conditioning (billion m^3)	0.08	6.11yuan/m^3	0.507
	Reservoir conditioning (10billion m^3)	11.76	6.11yuan/m^3	71.847
	Sub-total	118.42		72.354
C fixation	C fixation (million t)	368	1200yuan/t	441.600
Oxygen production	Oxygen production (million t	276	1000yuan/t	276.000

GEP accounting of Guizhou

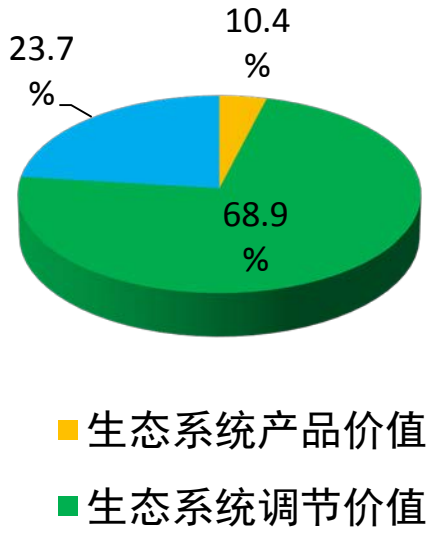
Ecosystem regulating services in Guizhou in 2010

Services	Indicators	Bio-physical values	Prices	Economic value (billion yuan)
Air purification	Sulfur dioxide purification(million t)	1.15	1200yuan/t	1.379
	Industrial fumes(million t)	0.25	150yuan/t	0.038
	Dusts(million t)	0.09	150yuan/t	0.013
	Sub-total			1.43
Water purification	Industrial wastewater(million t)	32	2.09yuan/t	0.067
	Domestic wastewater(million t)	159	2.09yuan/t	0.332
	total(million t)	191		0.399
Climate regiulation	Plant heat absorption(MJ)	1.03×10^{9}	0.128yuan/MJ	0.131
	Surface water heat absorption(MJ)	4.18×10^{12}	0.128yuan/MJ	533.6
	Sub-total	4.18×10^{12}		533.731
Pest control	Area of natural forest(km^2)	52151.86	1500yuan/hm^2	0.091

GEP accounting of Guizhou

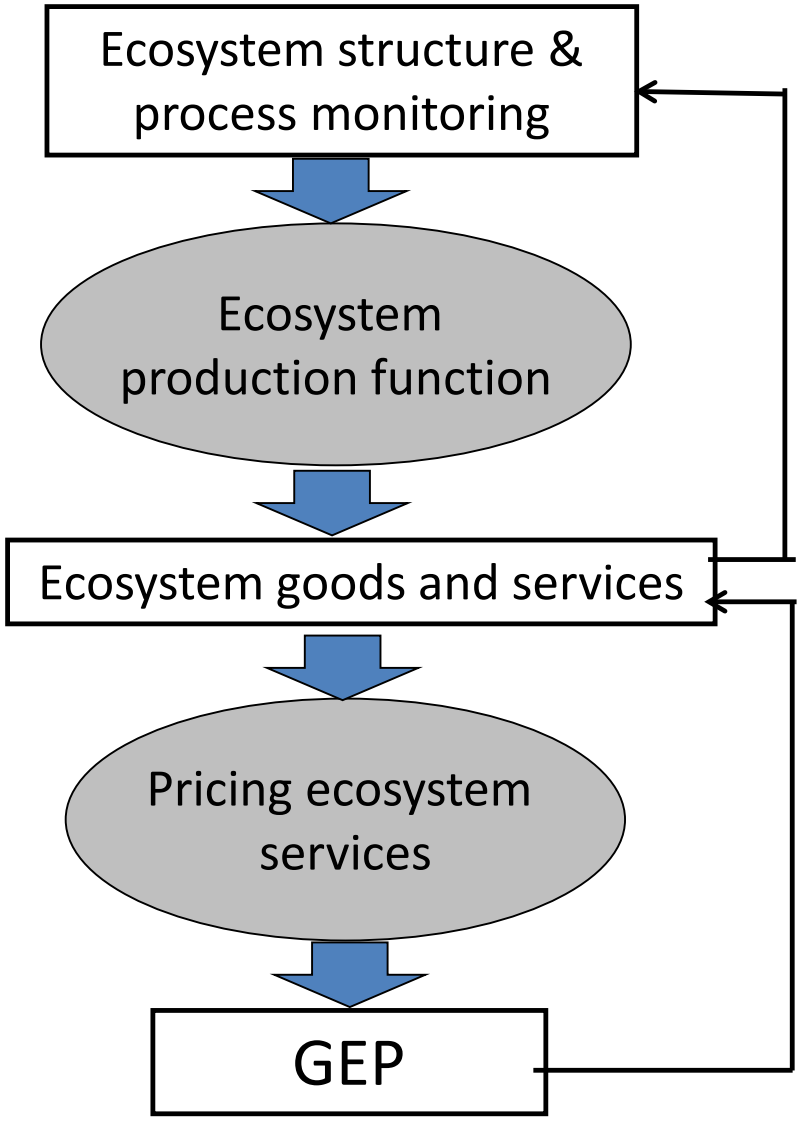
Guizhou GEP in 2010: 2,001.35 billion yuan

Categories	Economic values (billion yuan)	Ratio
Ecosystem goods	208.3.4	10.4%
Regulating services	1379.3.1	68.9%
Cultural services	413.6.9	21.7%
Total	2001.3.5	100%



Next

- ✓ More case studies at different administrative regions: provinces cities, and counties.
- ✓ Prepare national guideline for GEP accounting.
- ✓ Pricing methods for ecosystem goods and services, particularly, the pricing methods for regulating services and cultural services
- ✓ GEP in policy applications, such as PES, evaluation system of government in conservation efforts.



Thanks

Natural Capital Project
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