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

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- 2. GEP and EA concept and purposes
- 3. Accounting framework
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Background



Region or city 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.
- Nature: currently we do not have widely used index to measure nature contribution to people and sustainability.





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.





 In both 18th and 19th National Congress of the Communist Party declared China's Dream
♦ Harmonizing people and nature
♦ Building the ecological civilization of the 21st century

Key issues: how to coordinate conservation and development ?

- ✓ Where we must protect to ensure sustainable supply of ecosystem services?
- ✓ How to achieve natural capital conservation & poverty alleviation?

✓ How to evaluate the development achievements, not only GDP?



Iucid waters and lush mountains are invaluable assets
(Clear water and green mountain are golden and silver mountain)
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 people with high quality ecosystem products (and services).



GEP Concept



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.
- Ecosystem 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,



Purposes of GEP accounting

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



✤ 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,







GEP accounting and policy implementation





Accounting method of GEP

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



- 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

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

$$GEP = EPV + ERV + ECV$$

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



Ecosystem goods and services

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

Services	Indicators	Quantity indicators	Quantitative valuation methods	Value indicators	Value valuation methods	
	Agricultural products	Production of agricultural products		Value of agricultural products		
	Forestry products	Production of forestry products		Value of forestry products	Markat price	
Material	Animal products	Production of animal products		Value of animal products		
	Fishery products	Production of fishery products	Statistical data	Value of fishery products	mothod	
services	Water resources	Water consumption		Value of water resources	methou	
	Ecological energy	Amount of ecological energy		Value of ecological energy		
	Others	e.g., production of ornamental resources		Value of ornamental resources		
	Water retention	Amount of water retention	Water Balance Equation	Value of water retention		
	Sail rotantian	Amount of soil rotantian		Value of sediment reduction		
	Soli retention	Amount of soil retention	RUSLE	Value of diffused pollution reduction		
		Lake: adjustable storage capacity	Hydrologic data			
	Flood mitigation	Reservoir: flood control storage	Monitoring data	Value of flood mitigation		
		Swamp: stagnant water	Wollitoning data			
	Sandstorm prevention	Amount of sand-fixation REWQ		Value of desertification reduction		
	Carbon sequestration	Amount of carbon sequestration	Mass balance	Value of carbon dioxide	Surrogate market	
Regulating		Amount of carbon sequestration	method	sequestration		
services	Air quality	Amount of SO ₂ absorption	Model of plants	Value of SO ₂ treatment	method	
	maintenance	Amount of NO _x absorption	nurification	Value of NO _X treatment	1	
	maintenance	Amount of dust reduction	parmeation	Value of dust treatment		
		Amount of COD reduction	Model of water	Value of COD treatment		
	Water purification	Amount of total nitrogen reduction	nurification	Value of total nitrogen treatment		
		Amount of total phosphorus reduction	parmeation	Value of total phosphorus treatment		
		Energy consumption of plant transpiration	Model of	Value of plant transpiration		
	Climate regulation	Energy consumption of water surface	transpiration and	Value of water surface evaporation		
		evaporation	evaporation			
	Biological control	Area of pest and disease occurrence	Analogy method	Value of biological control		
Cultural	Natural landscape	Number of tourists	Travel cost method	Value of landscape recreation	Travel cost	
services	i i atararianascape		naver cost method	value of landscape recreation	method	

EA Accounting Methods

Ecosystem asset index

Index of ecosystem assets was calculated based on ecosystem areas and quality.

$$\mathsf{E}A_{i} = \frac{\sum_{j=1}^{5} \left(\mathsf{E}CO_{ij} \times j \right)}{\left(\mathsf{E}A_{i} \times 5 \right)} \times 100$$

EA_i: the comprehensive index of *i*th ecosystem asset; *i*: the ecosystem type; *j*: the ecosystem quality level (1-5); *ECO_{ij}*: the area of the *j*th level of the *i* type of ecosystem;

EA Accounting Methods

Evaluation indicators of ecological assets

Ecological acceta	Evaluation	Quality grade					
Ecological assets	indicators	I	II	III	IV	V	
	Forest	Relative	N 9E%	70 95%	50 70%	25 50%	~ 25%
	Shrub	density	≥ 0J /0	70-0370	50-70%	23-30%	× 2570
Natural ecosystem	Grassland	Fractional vegetation coverage	≥ 85%	70-85%	50-70%	25-50%	< 25%
	Lake		Class I	Class II	Class III	Class IV	Class V and
	River	Water quality					Inferior
	Swamp						Class V
	Desert	-	-	-	-	-	-
Artificial ecosystem based on natural ecological processes	Urban green	-	-	-	-	-	-
Wildlifo	Wild plants	-	-	-	-	-	-
wiidine	Wild animals	-	-	-	-	-	-

EA Accounting Methods

Physical quantity accounting tables of ecological assets (2xxx)

Ecological assets					Qualit	y level	(km ²)				
		Excellent		Good		Medium		Poor		Very Poor	
Categories	Total	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											

		GEP	SEEA-EEA				
Category	Division	Indicators	Category	Division	Indicators		
	Food	Grain		Water	Water		
		Meat, eggs, milk, honey			Uncultivated terrestrial plants and animals for food		
		Fishery food					
		Mushroom			Uncultivated freshwater plants		
		Vegetable			and animals for food		
		Fruit					
		Tea, coffee					
	Water	Irrigation water	Provisioning	Materials	Uncultivated marine plants, algae and animals for food		
		Industrial water			Nutrients and natural feed for		
		Residential water			cultivated biological resources		
Production of	Energy	Bio-energy			cultivated biological resources		
goods		Hydropower			Plant and animal fibres and structures		
	Material s	Timber			Chemicals from plants and animals		
		Fiber			Genetic materials		
		Rubber					
		Medicinal resource		Eporgy	Riomass based energy		
		Oilseed plant		Energy	Biomass-based energy		
		Sugar plant					
	Other	Genetic resource					
	goods	Nursery products		Other	Other provisioning services		
		Non-timber products		Other	other provisioning services		
		(decoration)					

	GEP		SEEA-EEA				
Category	Division	Indicators	Category	Division	Indicators		
	Hazard mitigation	Inland flood mitigation Coastal flood mitigation Coastal erosion mitigation		Remediation and	Bioremediation		
	Water quality improvement	Non-point pollution prevention Water purification (river, lakes)		biophysical environment	Dilution, filtration and sequestration of pollutants		
	Air quality improvement	Air purifications			Air flow regulation		
	Soil conservation Sandstorm prevention	Sedimentation mitigation Sandstorm prevention		Flow regulation	Mass flow regulation		
services	Climate regulation Carbon sequestration	Albedo	Regulating		Atmospheric regulation		
Services		Local climate moderation (temperature, humidity)			Water cycle regulation		
		Carbon sequestration		Regulation of	Pedogenesis and soil cycle regulation		
		Other GHG reduction		physicochemical	Noise regulation		
		For crop		environment			
	Pest and disease	Livestock disease risk regulation			Pest and disease control (including invasive alien		
	control	For forestry			species))		
	Pollination	Pollination					

		GEP	SEEA-EEA			
Category	Division	Indicators	Category	Division	Indicators	
	Health	Human disease risk mitigation		Physical or	Non- extractive	
		Mental health Physical activity and health		of ecosystems [environmental setting]	recreation	
Non-	Recreation, and tourism	Recreation			Information	
		Tourism	Culture	561118]	and knowledge	
services	Aesthetics	Ecological aesthetic premium		Intellectual representations		
(Cultural services)	Spiritual and symbolic	Spiritual and symbolic			Spiritual and symbolic	
	Information and knowledge	Ecological/environmental education		of ecosystems [of environmental	Non-use (for	
	Option	Genetic diversity		settings]	future)	
	value of Biodiversity	Species diversity				

		GEP	SEEA-EEA				
Similarity	Basic ideas	Valuing the contribution of nature to human we	/aluing the contribution of nature to human wellbeing				
	Accounting principles	aluing the products and services provided by ecosystems					
	Main contents	lows of value (ecosystem material products, regulating services, and cultural services) nd stocks (ecosystem asset)					
	Methods	imilar methods for regulating and cultural services					
	Definition	The aggregated value of ecosystem products and services in given region.	Comprehensive framework for valuing ecosystem services				
	Attributes	A comprehensive indicator to measure the contribution of nature to human wellbeing	Technical guideline for valuing ecosystem products and services				
Difference	Index	Ecosystem products including the materials from both natural and managed ecosystems	Ecosystem products including the materials only from natural ecosystems				
	Policy implementation	An indicator to evaluate performance of conservation policies and efforts	A technical guideline to evaluate performance of conservation policies and efforts				
	Calculation methods	There are some different calculation methods for individual services, eg, ecosystem material products, water retention, ecosystem asset.					

GEP accounting in China



GEP and EA accounting Applications

- ✓ In Lishui city, GEP accounting was used to develop new policy and financial mechanism to promote sustainable supply of ecosystem services and rural development.
- ✓ In Shenzhen, Pu'er city, GEP was applied to coordinate urban development and nature conservation, and to evaluate the performance of government agency in natural conservation
- ✓ In Qinghai province, GEP accounting was applied to evaluate effectiveness of eco-compensation policies.

Conclusions

There are more and more provinces, cites and counties apply GEP and EA accounting as an indicator to evaluate the contribution of nature to human, effectiveness of ecosystem conservation, and performance of protection efforts in China.

- Standardization administration of China supports to draft GEP and EA accounting guideline
- Existing ecological and environmental monitoring and statistics can largely support GEP and EA accounting in provincial, city and county. Some cities and counties, such as Shenzhen, Lishui, Deqing, planed to build ecosystem monitoring system for GEP and EA accounting.
 We are happy to collaborate with SEEA-EEA and others to improve methods, data and applications in GEP and EA accounting.