

Research on the Valued Method of Natural Resources -- for the Compilation of Natural Resources Balance Sheet

自然资源价值化方法研究——服务于自然资源资产负债表编制

The Research Team of Professor Feng

Institute of Geographic Sciences and
Natural Resources Research, CAS

2019-11-13

Team Introduction

承德市8个县级单元、西藏自治区、宁波市.....

类 别 委托研究与专项咨询服务
项目编号 KJ-EW-TS-001

中国科学院科技服务网络计划（STS 计划）
项目任务书

项目名称：自然资源资产负债表原型研究与应用
项目类别：委托研究与专项咨询服务
承担单位：中国科学院地理科学与资源研究所
参加单位：中国科学院东北地理与农业生态研究所
中国科学院寒区旱区环境与工程研究所
环境保护部环境规划院
起止年限：2014年5月—2016年4月
项目负责人：封志明
负责人电话：010-64889393
负责人 E-mail：fengzm@igsnrr.ac.cn
申请时间：2014年3月
批准时间：2014年4月
中国科学院科技促进发展局制



课题编号：2016YFC0503507
密 级：公开

国家重点研发计划
课题任务书

自然资源资产负债表编制与资源环境承载力评价系统集成与应用

课题名称：自然资源资产负债表编制与资源环境承载力评价技术集成与应用
所属项目：典型脆弱生态修复与保护研究
所属专项：自然资源资产负债表编制与资源环境承载力评价技术集成与应用
项目牵头承担单位：中国科学院地理科学与资源研究所
课题承担单位：中国科学院地理科学与资源研究所
课题负责人：封志明
执行期限：2016年07月至2020年12月

中华人民共和国科学技术部制
2016年07月23日
000207201607230902 2016-07-23 11:41:20



概念提出

承担“自然资源资产负债表原型研究与应用”项目。

编制完成国内首张地市级自然资源资产负债表——“湖州模式”

首次公开发布自然资源资产负债表编制成果——“承德模式”

承担“自然资源资产负债表编制与资源环境承载力评价系统集成与应用”项目。

Team Introduction

Publication of Articles 发表论文

自然资源资产负债表编制中的负债核算方法与案例
作者: 封志明, 刘玉洁
来源: 土资源科技管理
发表时间: 2016-05-20
数据库: 程序
被引: 1
阅读: 1
收藏: 1

湖州/安吉:全国首张市/县自然资源资产负债表编制
作者: 封志明, 杨艳霞
来源: 资源科学
发表时间: 2016-05-20
数据库: 程序
被引: 1
阅读: 1
收藏: 1

自然资源资产负债表编制的“承德模式”
作者: 封志明, 杨艳霞
来源: 资源科学
发表时间: 2016-05-20
数据库: 程序
被引: 1
阅读: 1
收藏: 1

自然资源资产负债表编制的若干基本问题
作者: 封志明, 杨艳霞
来源: 资源科学
发表时间: 2016-05-20
数据库: 程序
被引: 1
阅读: 1
收藏: 1

自然资源资产负债表编制系统研究
作者: 封志明, 杨艳霞
来源: 资源科学
发表时间: 2016-05-20
数据库: 程序
被引: 1
阅读: 1
收藏: 1

自然资源资产负债表编制与资源环境承载力评价
作者: 封志明, 杨艳霞
来源: 生态学报
发表时间: 2016-05-20
数据库: 程序
被引: 1
阅读: 1
收藏: 1

自然资源资产负债表编制准在哪儿?
作者: 封志明, 杨艳霞
来源: 中国环境报
发表时间: 2016-05-20
数据库: 程序
被引: 1
阅读: 1
收藏: 1

国家资产负债表研究及其对自然资源资产负债表编制的启示
作者: 封志明, 杨艳霞
来源: 资源科学
发表时间: 2016-05-20
数据库: 程序
被引: 1
阅读: 1
收藏: 1

自然资源核算进展及其对自然资源资产负债表编制的启示
作者: 封志明, 杨艳霞
来源: 资源科学
发表时间: 2016-05-20
数据库: 程序
被引: 1
阅读: 1
收藏: 1

自然资源资产负债表编制中土地资源核算体系设计与实践
作者: 封志明, 杨艳霞
来源: 资源科学
发表时间: 2016-05-20
数据库: 程序
被引: 1
阅读: 1
收藏: 1

自然资源资产产权制度与自然资源资产负债表编制
作者: 封志明, 杨艳霞
来源: 资源科学
发表时间: 2016-05-20
数据库: 程序
被引: 1
阅读: 1
收藏: 1

从自然资源核算到自然资源资产负债表编制
作者: 封志明, 杨艳霞, 刘玉洁
来源: 中国科学院院刊
发表时间: 2016-05-20
数据库: 程序
被引: 1
阅读: 1
收藏: 1

Publication of Books 出版专著



Media Report 媒体报道

CHINA ENVIRONMENT NEWS
中国环境报
2016年5月26日
承徳公布自然资源资产家底
2010年至2013年自然资源资产增加3.9%

101北京日报
2010年至2013年自然资源负债总量为218.4亿元
承德首次公布负债倒逼绿色发展

中国科学报
2015年7月8日
首张市县自然资源资产负债表编制完成
编辑国内首张
地市级自然资源资产负债表

中国改革报
首张市县自然资源资产负债表编制完成

Application for Patent 申请专利



Institute of Geographic Sciences and Natural Resources Research, CAS



Contents

□ 研究背景 (Background)

□ 基本原则 (Principle)

□ 价值方法 (Method)



Background

- “Explore the compilation of natural resources balance sheet and carry out the departure audit of leading cadres by natural resources assets” published in The Third Plenary Session of the 18th CPC Central Committee.

“探索编制自然资源资产负债表，对领导干部实行自然资源资产离任审计”是十八届三中全会做出的重大决定。

- Natural resources balance sheet is inherited the natural resources accounting and national balance sheet.

自然资源资产负债表虽然是一个全新称谓，但与自然资源核算研究、国家负债表编制一脉相承。

- The valued methods of natural resources has always been a difficult problem in natural resources accounting research.

There is no agreement on the selection of valued methods in the world.

自然资源价值化一直是自然资源核算研究的难点问题，各国在自然资源价值化方法选取上尚未达成一致。





Principle for Select Valued Methods

● Scientific principle (科学性原则)

Using recognized standards and practices on asset valuation, which are based on value and price theories and formed by long-term evaluation practice, are generally accepted internationally.

Such as replacement cost standards, current market price standards, capital present value standards.

科学性原则就是要选用在一定价值化理论基础上发展起来的、经过长期实践形成的、国际上普遍认可的价值化方法（如，重置成本标准，现行市价标准，资本现值标准）



Principle for Select Valued Methods

● Practical principle (实用性原则)

The purpose of compiling natural resources balance sheet is to serve the departure audit of leading cadres. Therefore, the parameters used in the process of natural resources valuation should be connected with the data published by the government.

编制自然资源资产负债表目的在服务于领导干部离任审计，因此，自然资源价值化过程中所采用的参数，尽可能与政府公布的数据相衔接。

● Data availability (数据可获得性)

There are many parameters involved in natural resources valuation, and the availability of parameters affects the rationality of the results of valuation. Therefore, data availability is also a factor that must be considered in the selection of valuation methods.

自然资源价值化涉及众多参数，参数的可获得性直接影响到价值化结果的合理性，因此，数据可获得性也是自然资源价值化方法选择要考虑的因素。

The Value of Natural Resources

- **Direct use value (直接使用价值)**

Natural resources provide a useful material basis for human production and consumption. 自然资源作为人类生产和消费提供有用物质基础所表现出来的价值

- **Indirect use value (间接使用价值)**

The service functional value of natural resources to social and environmental systems (自然资源对于社会和环境系统的服务功能价值)

- **Future value (未来价值)**

The value of willingness paid by human beings for direct or indirect use in the future. (人类为将来能够直接或间接利用自然资源而支付的意愿价值)

- **Existence value (存在价值)**

A natural resource cannot be utilized by the current level of science and technology. The value embodied in guaranteeing its continued existence is the willingness of human beings to pay. (指某种自然资源在当前科学技术水平下无法利用，为保证其继续存在人类愿意支付的价值)

The Value of Natural Resources

- Direct use value (直接使用价值)

Major Consideration

and

- Indirect use value (间接使用价值)

Embodied in the Eco-environmental Accounting Section

Env

- Future value (未来价值)

Temporarily ignore

the

- Existence value (存在价值)

Temporarily ignore

and

the

will

用,

on

d

in

nd

he

利

The Value Methods of Natural Resources

- **The market price method (市场价法)**

The market price method determines the price of natural resources in the region by comparing the transaction prices of natural resources in similar circumstances.

市场价法通过比较相近情况下自然资源的交易价格来确定本地区的自然资源价格

- **Income Method (收益法)**

Based on the theory of marginal utility value, the income method uses mathematical linear programming to determine the optimal allocation price of natural capital.

收益法以边际效用价值论为基础，运用数学线性规划来确定自然资源的最优配置价格

- **Cost Method (成本法)**

The cost method determines the price of natural resources according to their price components and manifestations.

成本法根据自然资源价格构成因素和表现形式来确定其价格

The Value Methods of Natural Resources

Resource Type	Value Methods
Land Resource	The market price method (current market price、 alternative market method、 land datum value method) ; Income Method (Income Capitalization Method、 Earnings multiple method)
Water Resource	The market price method (current market price) 、 Income Method (income present value method) 、 Cost method (Fuzzy Mathematics 、 AHP、 Neural Network)
Forest Resource	The market price method (Market transaction price comparison method、 Market price inversion algorithm) 、 Income Method (income present value method) 、 Cost method (replacement cost method)
Mineral Resource	The market price method (Comparable sales method) 、 Cost method (replacement cost method、 Geological element evaluation method) 、 Income Method (limited income method、 unlimited income method)

Selecting Valued Method by Referring to SEEA

Value accounting adopts the method of classification:

- Natural resources, which can be invested in economic activities and market transactions, are subject to market and cost methods, such as minerals, forests, land.

第一类：可投入经济活动和市场交易的自然资源，如矿产、森林、土地等资源用市场法、成本法。

- Natural resources, which have not yet been involved in economic activities, continue to study their valued methods or willingness to pay methods.

第二类：尚未投入经济活动的自然资源，暂不进行价值核算，继续研究其定价方法或采用支付意愿法。

- The capital formed by human intelligence is not included in accounting.

第三类：人类智力形成的资本，不进行价值核算。

The Value Methods of Natural Resources

Resource Type	Value Methods
Land Resource	The market price method (current market price、alternative market method、 land datum value method) ; Income Method (Income Capitalization Method、Earnings multiple method)
Water Resource	The market price method (current market price) 、Income Method (income present value method) 、Cost method (Fuzzy Mathematics 、AHP、Neural Network)
Forest Resource	The market price method (Market transaction price comparison method 、Market price inversion algorithm) 、Income Method (income present value method) 、Cost method (replacement cost method)
Mineral Resource	The market price method (Comparable sales method) 、Cost method (replacement cost method、Geological element evaluation method) 、Income Method (limited income method、unlimited income method)

The Valued Methods of Land Resources

The market price method——In SEEA

Many countries have active markets to deal all kinds of land (residential, industrial and agricultural land). The market price method can be used to value land resources.

许多国家都存在活跃的市场进行各类土地（包括住宅用地、工业用地和农业用地）的购买和销售，可采用市场价法对土地资源进行价值化。

Disadvantage:

- Difficult to distinguish between the value of land itself and its appendages.
不能明确区分土地本身与土地附属物的价值。
- The turnover of land resources is relatively small, and the market price may not be representative.
土地资源成交量相对较少，市场价格可能不具有代表性。
- Some land has never been exchanged in the market, such as public land, land under traditional ownership, and remote and desolate land.
有些土地未在市场上交换，如公共用地、共有制土地，以及偏远荒凉的土地。

The Valued Methods of Land Resources

Land datum value method (基准地价修正法)

- The urban land benchmark land price have formulated at all levels administrative units in China, which provides a good data reference for the value of natural land resources.

我国各级行政单位都制定了城镇土地基准地价并且定期进行更新，为土地资源价值化提供了良好的数据参照。

- Land datum value method is a special state of the market price method. It can overcome some drawbacks of unstable land market price by using the benchmark land price formulated by the local government as a reference and modifying the coefficient to obtain the land resources valuation.

基准地价修正法是市场法的一种特殊状态，利用当地政府制定颁布的基准地价作为参照，并进行系数修正，来计算土地资源价值，可以克服土地交易市场价格不稳定的弊端。

The Valued Methods of Land Resources

The value of natural land resources is closely related to its own quality and location. Therefore, revision of the benchmark land price **by Quality and Location Factor**.

土地资源价值与其本身的质量和所处的区位息息相关，因此，基准地价修正法采用质量与区位因子对基准地价进行修正。

□ Case Study Area1——HUZHOU(湖州市) :

Land datum value method——Based on Quality and Location

基于质量与区位的基准地价修正法

□ Case Study Area2——CHENGDE (承德市) :

Land datum value method——Based on Net Primary Production

基于植被净初级生产力的基准地价修正法

The Valued Methods of Land Resources

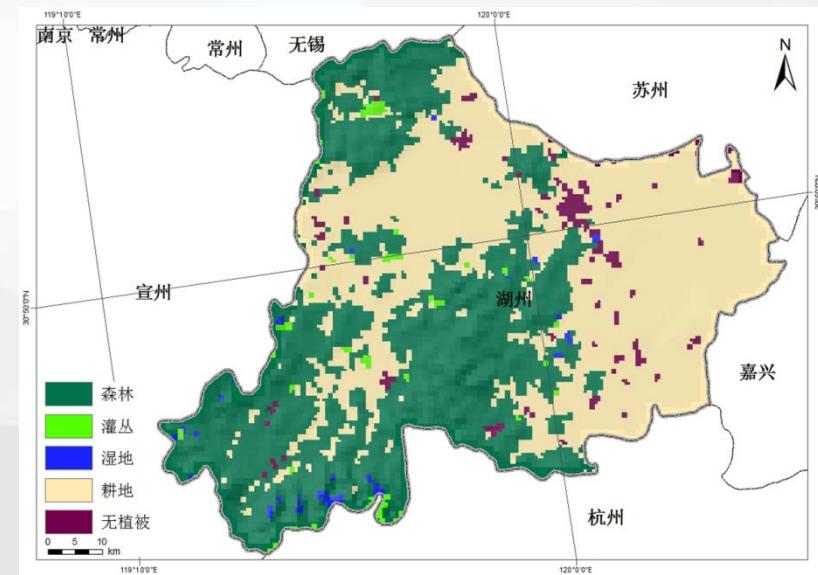
Case Study Area1——HUZHOU(湖州市):

Land resource price (P) = Benchmark Land Price (P_b) × Land Quality

Weight Coefficient (q) × Land Location Weight Coefficient (l)

Explanation: The value of land resource is mainly considered the natural land , which includes cultivated land, garden land, woodland, grassland, water area and water facilities land.

说明：主要考虑自然地类的价值；自然地类包括耕地、园地、林地、草地、水域和水利设施用地



The Valued Methods of Land Resources

Case Study Area1——HUZHOU(湖州市):

First step: Determining the Benchmark Land Price (确定基准地价)

According to the 2011 Huzhou benchmark land price table, the lowest benchmark industrial land price is regarded as the benchmark land price of land resources.

根据2011年湖州基准地价表，将最低一级工业用地基准地价作为土地资源的基准地价。

湖州市区基准地价更新研究【2011年】.....成果表格.....			
成果表 2 · 湖州市区级别基准地价表			
级别	商业用地基准地价	住宅用地基准地价	工业用地基准地价
I 级	7690	4430	700
II 级	4840	3780	500
III 级	3300	2480	400
IV 级	2370	1520	298
V 级	1530	1020	
VI 级	970	710	
VII 级	600	500	
VIII 级	410	360	

单位: 元/平方米

备注

1、基准地价基准日: 2011年1月1日; +
2、基准地价内涵: 各土地级别范围内达到大市政基础设施配套要求的土地开发程度下, 法定最高土地使用年限的完整土地使用权单位土地面积平均价格, 地价内涵构成包括国家土地所有者收益、土地取得费用和土地前期开发费用; +
3、基准条件界定: I~IV级地商业用地的容积率、建筑密度为2.5、45%; 宗地进深为50米, 住宅用地的容积率、建筑密度为1.5、30%; 工业用地的容积率、建筑密度为1.0、40%; V~VIII级地商业用地的容积率、建筑密度为2.0、45%; 宗地进深均为50米, 住宅用地的容积率、建筑密度为1.2、30%; 工业用地的容积率、建筑密度为1.0、40%; +
4、土地使用年限: 商业用地40年、住宅用地70年、工业用地50年; +
5、土地级别范围: 参见湖州市区土地级别及区片范围一览表及土地级别基准地价图。+

The Valued Methods of Land Resources

Case Study Area1——HUZHOU(湖州市):

Second step: Determining the Land Quality Weight Coefficient (确定土地质量权值系数)

The yield or output value of per unit area of various natural land resource is used as an index to measure land quality.

采用各种自然地类的单位面积产量或者产值作为衡量土地质量的指标。

- Yield: cultivated land, garden land, water area

- Output Value: Woodland

Data source: Statistical Yearbook

LUCC Area	Wuxing	Nanxun	Deqing	Changxing	Anji
cultivated land	18962	29601	24127	46813	32178
Woodland	25173	168	29216	47421	115091
garden land	1496	6016	4506	5640	6291
water area	13905	15293	11825	11923	8830



q	Wuxing	Nanxun	Deqing	Changxing	Anji
cultivated land	1.00	1.00	0.50	0.86	0.62
Woodland	0.73	1.27	1.66	0.82	0.59
garden land	1.00	1.00	1.00	1.05	1.02
water area	0.80	1.20	1.52	0.67	0.28

Taking Wuxing District and Nanxun District as the benchmark

The Valued Methods of Land Resources

Case Study Area1——HUZHOU(湖州市):

Third step: Determining the Land Location Weight Coefficient

(确定土地区位权值系数)

According to the price of commercial land, residential land, industrial land and the distribution area of all kinds of land in Huzhou City, the difference of the proportion of the distribution area of all kinds of land in different districts and counties is used to reflect the difference of the location characteristics of each district and county.

The area proportion of each kind is estimated according to the LUCC, and the average value of Wuxing District and Nanxun District is taken as the benchmark.

依据湖州市各区县商业用地、住宅用地和工业用地的地价以及各类用地的面积，应用各类用地在各区县分布的面积比例差异反映各区县土地资源区位特征差异。

各地类的面积比例根据土地利用现状图进行估算，同样以吴兴区和南浔区两区的平均值作为基准。

The Valued Methods of Land Resources

Case Study Area1——HUZHOU(湖州市):

Third step: Determining the Land Location Weight Coefficient

(确定土地区位权值系数)

Land grade scale	Wuxing	Nanxun	Deqing	Changxing	Anji	Land Price
III	4%	5%		4%		3300
IV	8%	5%		6%		2370
V	13%	10%	4%	12%	3%	1530
VI	10%	20%	6%	15%	7%	970
VII	20%	25%	10%	30%	10%	600
VIII	45%	35%	80%	33%	80%	410
Land Area	86272	70224	93792	143134	188603	
III	11387942	11587021	0	18893718	0	
IV	16357226	8321588	0	20353688	0	
V	17159558	10744329	5740066	26279445	8656874	
VI	8368412	13623528	5458690	20826030	12806139	
VII	10352675	10533656	5627515	25764161	11316176	
VIII	15917238	10077197	30763750	19366061	61861761	
	79543051	64887318	47590020	131483104	94640950	
	922	924	507.4	918.6	501.8	
Land Location Weight Coefficient	1.00	1.00	0.55	1.00	0.54	

The Valued Methods of Land Resources

Case Study Area1——HUZHOU(湖州市):

Last step: Determining the Land resource price (确定土地资源价格)

Land resource price (P) = Benchmark Land Price (P_b) × Land Quality

Weight Coefficient (q) × Land Location Weight Coefficient (l)

Land resource price	Wuxing	Nanxun	Deqing	Changxing	Anji	Huzhou
Cultivated land	287.18	288.83	79.52	248.93	97.65	202.46
Woodland	211.02	365.14	263.18	235.75	91.75	160.32
Garden land	288.49	287.51	158.99	301.77	160.43	227.70
Water area	229.61	346.52	240.73	193.98	43.94	227.26
Grassland	287.18	288.83	79.52	248.93	97.65	202.46
Others	260.70	315.36	164.39	245.87	98.28	204.04

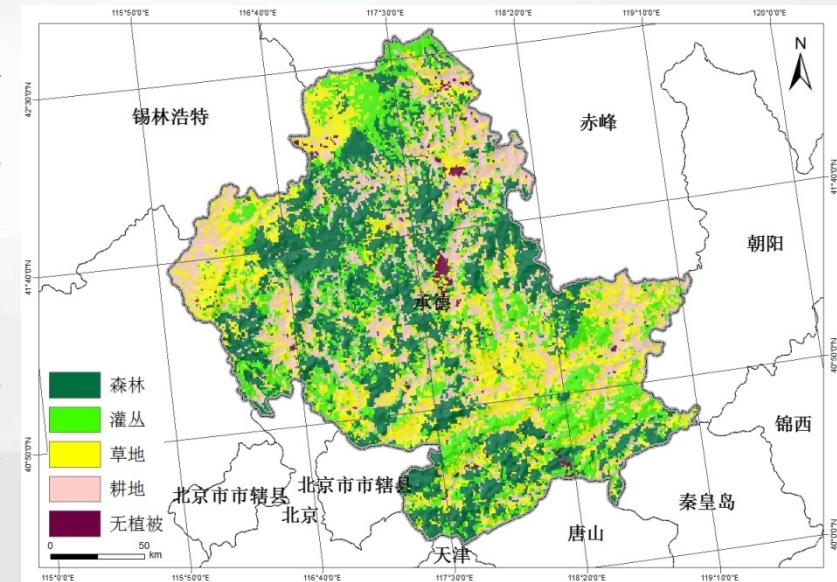
The Valued Methods of Land Resources

Case Study Area2——CHENGDE(承德市):

Land resource price (P) = Benchmark Land Price (P_b) × Land Quality Weight Coefficient (q)

Explanation: The value of land resource is mainly considered the natural land , which includes cultivated land, garden land, woodland, grassland, water area and water facilities land

说明：主要考虑自然地类的价值；自然地类包括耕地、园地、林地、草地、水域和水利设施用地



The Valued Methods of Land Resources

Case Study Area2——CHENGDE(承德市):

First step: Determining the Benchmark Land Price (确定基准地价)

The lowest benchmark industrial land price is regarded as the benchmark land price of land resources.

基于2013年承德市基准地价表，将最低一级工业用地基准地价作为土地资源的基准地价。

The image shows five pages from the 2013 Chengde Land Price Table. The first page contains a table for commercial land with five rows. The second page is a title page with a note about the table being approved by the Ministry of Land Resources. The third page lists land types: commercial, residential, and industrial. The fourth page provides detailed tables for each land type, including industrial land which shows a range of 279.25 RMB/m². The fifth page is a summary table for industrial land.

工业用地	基准地价	元/平方米	446	361
		万元/亩	29.73	24.67
	地价幅带	元/平方米	541~372	425~269
		万元/亩	36.07~24.80	28.60~17.93
		元/平方米		31.8
	承德	万元/亩	35.87	29.67
	土地级别	元/平方米	475~31.3	358~228
	2012 年定级面积	万元/亩	31.67~28.87	23.87~15.20
	基准地价	元/平方米	337	285
	上下限	万元/亩	22.47	19.00
		元/平方米	405~287	325~208
		万元/亩	27.00~19.13	21.67~13.87

279.25RMB/m²

The Valued Methods of Land Resources

Case Study Area1——CHENGDE(承德市):

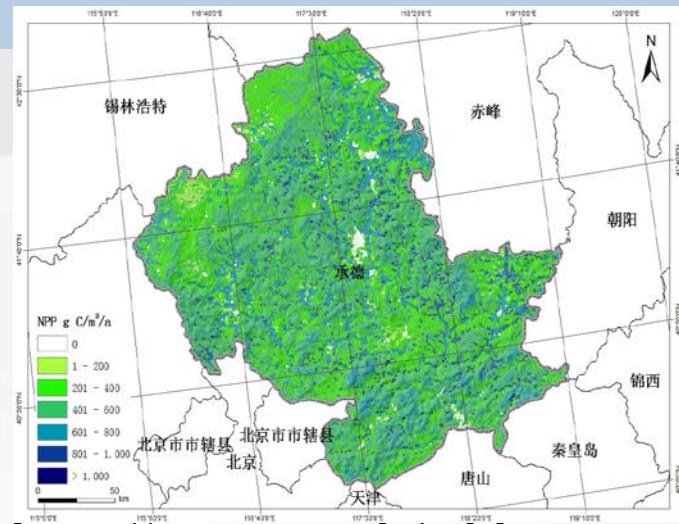
Second step: Determining the Land Quality

Weight Coefficient (确定土地质量权值系数)

Based on Net Primary Production

Net primary productivity refers to the amount of organic matter accumulated by green plants in unit time and area. Its value is related to life activities such as plant growth and reproduction. It can reflect the efficiency of fixing and transforming light energy compounds of growing vegetation on land, and essentially reflects the quality of land.

植被净初级生产力是指绿色植物在单位时间、单位面积所积累的有机物数量，其数值与植物生长繁殖等生命活动息息相关，能够反映土地上生长植被固定和转化光能为化合物的效率，从本质上反映了土地的质量。



Vegetation Types	Forest	Grassland	Farmland	Shrubland	Average
NPP	479.9	376.7	610.96	454.7	469.36
Weight Coefficient	1.27	1.00	1.62	1.21	1.25

The Valued Methods of Land Resources

Case Study Area2——CHENGDE(湖州市):

279.25RMB/m²

Last step: Determining the Land resource price (确定土地资源价格)

Based on grassland NPP, the revised benchmark land prices of other land types are calculated separately.

以草地NPP为基准，分别计算其他地类NPP修正后的基准地价

LUCC		Weight Coefficient	revised benchmark land prices (RMB/m ²)
Farmland	Paddy field (水田)	1.62(Farmland)	452.91
	Dry farm (旱地)	1.62(Farmland)	452.91
	Irrigable farm (水浇地)	1.62(Farmland)	452.91
Forest	Woodland (有林地)	1.27(Forest)	355.75
	Shrubland (灌木林地)	1.21(Shrubland)	337.07
	Other woodland (其他林地)	1.00(grassland)	279.25
Grassland	Natural grassland (天然牧草地)	1.00(grassland)	279.25
	Artificial grassland (人工牧草地)	1.00(grassland)	279.25
	Other grassland (其他草地)	1.00(grassland)	279.25
Garden land	Orchard (果园)	1.27(Forest)	355.75
	Tea garden (茶园)	1.27(Forest)	355.75
	Other garden (其他园地)	1.27(Forest)	355.75

The Valued Methods of Water Resources

The most commonly used method:

- The market price method (Current market price) 现行市价法
- Cost method (Fuzzy Mathematics) 模糊数学法

Comparison:

	Fuzzy Mathematics	Current Market Price
Unit Price	High	Low
Data Demand	Much	Little
Factors	Much	Little
Complexity	Complicated	Simple
Authority	Weak	Strong

较模糊数学法相比：现行市价法有数据需求少、操作简单、权威性强的特点

The Valued Methods of Water Resources

Cost method——In SEEA

- Water resources, as public goods provided below the cost of production, are often used free of charge or at a fixed cost to support production and life.

水资源作为以低于生产成本提供的公共物品，往往是免费使用的或以一个固定费用提供，以支持生产与生活。

- Considering this situation, it is impossible to evaluate water resources scientifically and reasonably by using the methods of net present value and market price.

考虑到这种情形，采用净现值法、市场价法等价值化方法无法对水资源进行科学合理的估价。

- Therefore, a trend of water pricing is to reflect the total cost of water resources management, extraction and distribution.

因此，给水定价的一种趋势是体现水资源管理、提取和配送的全部成本。

The Valued Methods of Water Resources

□ Case Study Area1——HUZHOU(湖州市) :

- **The market price method (current market price)** 现行市价法
- **Cost method (Fuzzy Mathematics)** 模糊数学法

□ Case Study Area2——CHENGDE (承德市) :

- **Cost method (Fuzzy Mathematics)** 模糊数学法

Taking Huzhou City as an example, two methods of water resources valuation are introduced:

下面以湖州市为例介绍两种水资源价值化方法：

The Valued Methods of Water Resources

Current Market Price(现行市价法):

Water resource Value (V) = Water resource price (P) × Water resources quantity (Q)

Water resources of different quality have different.

- Using the current local value standards, which began to implement on 2014. The criteria for the valuation of regional water resources are as follows:
- 采用地方现行的价值标准，浙江省2014年10月1日开始执行的新的全省水资源费收取标准。区域水资源价值化标准为：
 - Class I, Class II and Class III water: 1.4 yuan/m³;
 - Category IV and V water: 0.2 yuan/m³; ➤ I类、Ⅱ类、Ⅲ类水:1.4元/m³;
 - Class V inferior water: 0. ➤ Ⅳ类、Ⅴ类水:0.2元/m³;
 - 劣Ⅴ类水:0。

The Valued Methods of Water Resources

Fuzzy Mathematics (模糊数学法):

- Fuzzy mathematics divides the factors affecting the value of water resources into three categories: natural factors, social factors and economic factors. Choosing the evaluation index of secondary factors in each category and expressing it with function.

模糊数学法将影响水资源价值的因素分成自然因素、社会因素和经济因素三大类，分别选择影响三大因素的二级评价指标，构建模糊函数，得到水资源综合评价值。

- The comprehensive evaluation value of water resources obtained by the method of fuzzy mathematics is dimensionless vector. In order to get water resource' price, it needs to be transformed. The price vector of water resources is introduced, and the specific price value of water resources can be obtained through the maximum bearing capacity of society to water price.

模糊数学法得到的水资源综合评价值是无量纲的向量，为求出水资源价格，还需引入水资源价格向量进行转换，通过社会对水价的最大承受能力来求出具体的水资源价格数值。

The Valued Methods of Water Resources

Fuzzy Mathematics (模糊数学法):

First Step: Establishment of Fuzzy Comprehensive Evaluation Model of Water Resources Value——建立水资源价值模糊综合评价模型

Establishing Index Set of Evaluation Objects (V)
建立评价对象指标集 V

$V=\{\text{Quantity, Quality, Population, Social economy, Eco-environment}\}$
水量 水质 人口 社会经济 生态环境



Establishment of Evaluation Set (U) and Evaluation Vector (W)
建立评价集 U 与评价向量 W

$W=\{\text{High, Secondary high, Middle, Secondary low, Low}\}$
高 次高 中等 较低 低



Establishment of single factor evaluation matrix (R)
建立单因素评价矩阵 R

$$R = \mu^\circ \omega$$

μ is a membership matrix, which is determined by membership function.

μ 是通过隶属函数确定的隶属矩阵。

\circ is the Conformity Operator of Fuzzy Matrix.

\circ 表示模糊矩阵符合运算符。

Fuzzy Comprehensive Evaluation
进行模糊综合评价

$$V = A^\circ R$$

A is Indicator Weight of Water Resources Value.

A 表示水资源价值指标权重。

The Valued Methods of Water Resources

Fuzzy Mathematics (模糊数学法):

Second Step: Establishment a membership matrix by membership function

通过隶属函数确定隶属矩阵

- A linear membership function of one variable is established by using reduced half trapezoidal distribution.

选用降半梯形分布，建立一元线性隶属函数，确定隶属矩阵

$$\text{当 } j = 1 \text{ 时, } \mu_{i1}(x) = \begin{cases} 1, & x \leq x_{i1} \\ \left| \frac{x - x_{i1}}{x_{i1} - x_{i2}} \right|, & x_{i1} < x < x_{i2} \\ 0, & x \geq x_{i2} \end{cases}$$

$$\text{当 } j = 2, 3, 4 \text{ 时, } \mu_{ij} = \begin{cases} \left| \frac{x - x_{i,j-1}}{x_{ij} - x_{i,j-1}} \right|, & x_{i,j-1} \leq x \leq x_{ij} \\ \left| \frac{x - x_{i,j+1}}{x_{i,j+1} - x_{i,j}} \right|, & x_{ij} < x < x_{i,j+1} \\ 0, & x \leq x_{i,j-1}; x \geq x_{i,j+1} \end{cases}$$

$$\text{当 } j = 5 \text{ 时, } \mu_{in}(x) = \begin{cases} 1, & x \geq x_{i,n} \\ \left| \frac{x - x_{i,n-1}}{x_{in} - x_{i,n-1}} \right|, & x_{i,n-1} < x < x_{i,n} \\ 0, & x \leq x_{i,n-1} \end{cases}$$

The Valued Methods of Water Resources

Fuzzy Mathematics (模糊数学法):

Third Step: Establishment of evaluation index system and determination of index weight——建立评价指标体系并确定指标权重

- The method of linear weighted average of subjective and objective weights is used to determine the comprehensive weights of indicators, which avoids the deviation caused by the supervisor's empowerment and the absolutization of objective empowerment method.
- 对主客观权重进行线性加权求平均值的方法确定指标的综合权重，避免了主管赋权导致的偏差以及客观赋权法的绝对化。

表 2 湖州市水资源价值评价指标权重

Table2 The assessment indexes weight of water resources in Huzhou

准则层	权重A	指标层	熵权法 ω_1	AHP 权重	权重 ω
水量	0.1145	人均水资源量	0.109	0.317	0.213
		单位面积水资源量	0.190	0.275	0.233
		供水总量	0.376	0.199	0.287
		径流系数	0.223	0.108	0.166
		干旱指数	0.102	0.102	0.102
水质	0.2958	高锰酸盐	0.488	0.6	0.544
		氨氮	0.512	0.4	0.456
源 价 值	0.2461	人口密度	0.307	0.144	0.226
		人均GDP	0.218	0.462	0.340
		人均综合用水量	0.278	0.205	0.241
		人均灌溉面积	0.197	0.188	0.193
社会经济	0.1812	城镇需水比例	0.319	0.198	0.258
		万元工业增加值用水	0.045	0.303	0.174
		水资源开发利用率	0.636	0.499	0.568
生态环境	0.1624	农业灌溉水利用系数	0.376	0.282	0.329
		工业用水重复利用率	0.624	0.718	0.671

The Valued Methods of Water Resources

Fuzzy Mathematics (模糊数学法):

Last Step: Calculating water resources prices —— 计算水资源价格

Converting Fuzzy Evaluation Results
into Price Vectors (WLJ)

将模糊评价结果转化为价格向量WLJ



Calculating the maximum price of water
resources (P)

计算水资源价格上限P

$$WLJ = V^{\circ}S$$

S is value vector, which is determined by the method of water toll index.

S是价值向量，用水费承受指数的方法确定。

$$P = E * A / C - D$$

A: Maximum Water Cost Bearing Index(最大水费承受指数)

E: Per capita disposable income (居民人均可支配收入)

C:Per capita water consumption (人均用水量)

D:Water Supply Cost and Normal Profit (供水成本与正常利润)

Year	2009	2010	2011	2012	2013
E: Per capita disposable income	23280	25729	29367	32987	36220
C:Per capita water consumption	168	180	150	130	148
A: Maximum Water Cost Bearing Index	2	2.5	2.8	3	3
D:Water Supply Cost and Normal Profit	2.5	3.5	4	5	5
P:the maximum price of water resources	2.62	3.75	4.49	5.28	6.96

The Valued Methods of Water Resources

Water Resources Price of Huzhou:

- ◆ Current Market Price: 1.4Yuan/m³
- ◆ Fuzzy Mathematics : 6.96Yuan/m³

Compared with the fuzzy mathematics method, the current water price method is easy to get data and strong operability; however, it has two drawbacks. 较模糊数学法相比，现行水价法虽然数据易获取，可操作性强；但是存在以下两点弊端：

➤ At present, China implements the mechanism of differentiated water resources pricing in different regions and industries. Most of the current water resources prices are far below their actual value.

目前我国实行分区域分行业的差异化水资源价格确定机制，现行水资源价格远低于其实际价值

➤ In the evaluation of natural resources assets value, if the actual water resources price of the study area is directly used for accounting, it can not reflect the real value of regional water resources.

在水资源价值化过程中，若直接使用研究区实际水资源价格进行核算，则无法反应区域水资源的真实价值。

Therefore, the method of fuzzy mathematics is used to calculate the value of water resources.

The Valued Methods of Forest Resources

Net Present Value——In SEEA (净现值法)

The total operating surplus (special taxes and subsidies are also included) obtained from harvesting timber resources minus the user cost of the production assets used in the harvesting process.

林木资源价值用采伐木材资源得到的总营业盈余（专项税与补贴也计入）减去采伐过程中生产者生产成本而得。

The production cost mainly includes:

- Land Rent (土地租金)
- Cutting cost (采伐成本)
- Thinning cost (疏伐成本)
- Administration cost (管理费用)

The Valued Methods of Forest Resources

The market price method (市场价法)

- The basic methods of forest assets evaluation include market method, income method and cost method. Because different types of forest assets have different characteristics, there are also differences in evaluation methods.

林木资源价值化的基本方法包括市场法、收益法、成本法；由于不同类型的林木资产具有不同的特征，因此，价值化方法也存在差异。

- The formulas used in income method and cost method involve too many parameters and are difficult to obtain. Therefore, market price method is chosen to calculate the value of forest assets.

收益法和成本法采用的计算公式涉及的参数太多，并且获取困难；因此，选择用市场价法来计算林木资源的价值。

The Valued Methods of Forest Resources

The market price method (市场价法)

- The market price method: The value of forest resources is estimated according to the observed value of each unit of forest resources traded in the actual market.

市场价法：根据实际市场交易的每单位林木资源的观察值即单位价格来估算所有林木资源的价值。计算公式为：

Forest resource price (P) = market price (G) × Stand quality adjustment coefficient (K) × Market price adjustment factor (Kb)

- Explanation: In the market price method, the data of forest quality adjustment coefficient and market price adjustment coefficient are not complete in county and municipal level; therefore, it is necessary to collect relevant data to calculate the standard parameters of forest resources valuation in the national or provincial level.

说明：市场价法中，县市级林分质量调整系数、市场价格调整系数等数据并不完备；因此，需要在国家级或省级尺度上收集相关数据，计算林木资源价值化标准参量。

The Valued Methods of Forest Resources

The market price method (市场价法)

- The research team of "China Forest Resources Accounting Research" has made a full analysis of the transaction price of forest resources during forest resources accounting research. This study is based on the price data provided by it.
- 中国森林资源核算研究团队，在中国森林资源核算研究过程中对中国林木资源市场价格做了充分的分析，本研究以其提供的价格数据为依据。



	forest stock volume (1,0000m ³)	Value (Billion RMB)	Prices (Billion RMB/1,0000m ³)
1 Forest	1488478.85	130076.94	0.0874
(1) Natural forest	1238534.94	74596.52	0.0602
1) Woods	1229583.97	74140.78	0.0603
Timber stand	305001.50	16622.66	0.0545
Fuelwood forest	710778.49	436.21	0.0006
Protection forest	208259.07	40545.29	0.1947
Special-purpose forest		10095.61	NULL
Economic forest		1291.46	NULL
Bamboo fore		5149.56	NULL
2) Sparse forest	8950.97	455.75	0.0509
(2) Artificial forest	249943.91	55480.42	0.2220
1) Woods	248324.85	55384.14	0.2230
Timber stand	155193.83	8200.69	0.0528
Fuelwood forest	364.67	82.87	0.2272
Protection forest	84037.53	5600.03	0.0666
Special-purpose forest	8728.82	484.04	0.0555
Economic forest		38353.84	NULL
Bamboo fore		2662.67	NULL
2) Sparse forest	1619.06	92.38	0.0571
2 Other woods	118927.37	6439.84	0.0541
(1) Scattered trees	78859.03	4164.96	0.0528
(2) Four-side tree	40068.34	2274.88	0.0568
Total	1607406.26	136516.79	0.0849

The Valued Methods of Mineral Resources

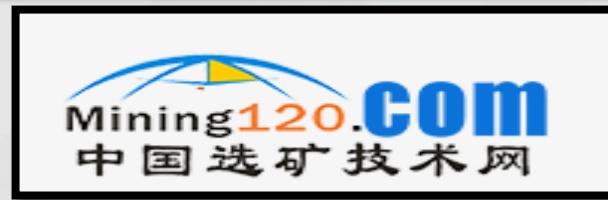
The market price method (市场价格法)

- Among land resources, water resources, forest resources and mineral resources, mineral resources trading market is the most perfect, and trading data is easy to obtain. Therefore, the market price method is used to value mineral resources.

在土地资源、水资源、林木资源和矿产资源中，矿产资源交易市场最为完善，且交易数据容易获取；因此，采用市场价法进行矿产资源价值化。

- Data Sources: Official Network Trading Platform

The screenshot shows the homepage of InfoMine, a global mining resource platform. The top navigation bar includes links for Sign In, Join, Subscribe, and More. Below the navigation is a search bar with a magnifying glass icon. The main menu features categories such as Front Page, People, Careers & Education, News & Intelligence, Suppliers & Equipment, Technology & Practice, Services & Events, Solutions, and Start. A prominent banner at the top left promotes "Grease Transfer Coupling" with the tagline "Easy, safe and fast". Another banner on the right side promotes "MEET THE BANLAW GTX ▶". The background of the page is white with blue and yellow accents.



The Valued Methods of Mineral Resources

The market price method (市场价格法)

Commodity Closing Prices			
		chgl%	
Precious Metals			
Gold	USD/ozt	1,302.80	-3.39
Silver	USD/ozt	15.30	-0.07
Platinum	USD/ozt	855.13	4.48
Palladium	USD/ozt	1,602.34	8.33
Iridium	USD/ozt	1,460.00	0.00
Rhodium	USD/ozt	3,190.00	20.00
Ruthenium	USD/ozt	266.00	0.00
Base Metals			
Aluminum	USD/lb	0.85	0.00
Copper	USD/lb	2.90	0.00
Lead	USD/lb	0.92	-0.01
Nickel	USD/lb	5.81	-0.02
Tin	USD/lb	9.60	-0.08
Zinc	USD/lb	1.29	0.00
Steel Raw Materials			
Cobalt	USD/lb	13.15	0.00
Molybdenum Oxide	USD/lb	12.55	-0.05
Nickel	USD/lb	5.81	-0.02
Tin	USD/lb	9.60	-0.08
Zinc	USD/lb	1.29	0.00
Minor Metals			
Cobalt	USD/lb	13.15	0.00
Molybdenum Oxide	USD/lb	12.55	-0.05
Tantalite Ore	USD/kg	186.50	0.00
Energy Minerals			
Crude Oil	USD/bbl	66.64	0.54
Natural Gas	USD/mmBTU	2.85	0.05
Industrial Minerals			
Phosphate Rock	USD/t	86.00	0.00
Potash	USD/t	226.00	0.00

产品价格							
贵金属	有色金属	黑色金属	非金属矿	稀有金属	稀土	能源矿产	水气矿产
铜	品名	属性参数		最新报价	单位	涨跌	报价时间
铅	1#铅锭	1#铅锭		¥17100.00	元/吨	↓	2019-03-20
锌	铅矿石	品位:Pb>10%		¥55.00	元/吨度	→	2019-03-20
铝	铅矿石	品位:Pb>30%		¥70.00	元/吨度	→	2019-03-20
镍	铅精矿	品位:Pb>60% 地区:广东		¥14750.00	元/金属吨	→	2019-03-20
黑钨	铅精矿	品位:Pb>60% 地区:湖南		¥14850.00	元/金属吨	→	2019-03-20
白钨							
钴							
锡							
铋							
钼							
汞							
锑							

- Explanation: Because the market value of mineral resources changes frequently, the price of various mineral resources at a certain time point is selected as the benchmark price of mineral resources valuation.

说明：由于矿产资源市场价值变化频繁，在矿产资源核算时，选取核算期内某一时间节点各类矿产资源价格，作为矿产资源价值化的基准价格。



Thank you for your listening !



Institute of Geographic Sciences and
Natural Resources Research, CAS

2019-11-13