

水文学对当代中国环境研究的贡献

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Presentation Topics:

1. Main features of hydrology
2. Major water resources problems
3. Water requirements & consumptions:
 - Present status.
 - Future projection.
4. Urbanization and water development
5. Hydrology Serves as a Science Base for China's Environmental Protection

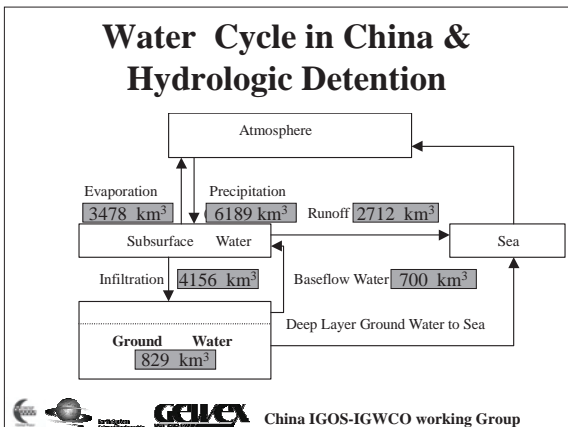
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Hydrological background

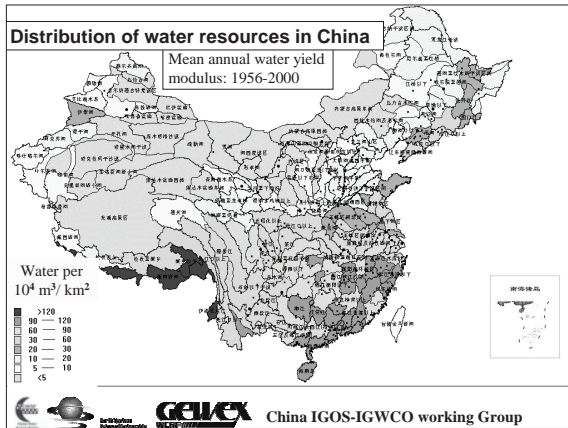
年平均降水量 (Annual Average Precipitation)

Water resource per territory (m³/ha)





Average Volume Per Capita Comparison: China / World

- Water: 25%
- Farmlands: 40%(-)
- Oil reserve: 8.3%
- Nature gas: 4.1%



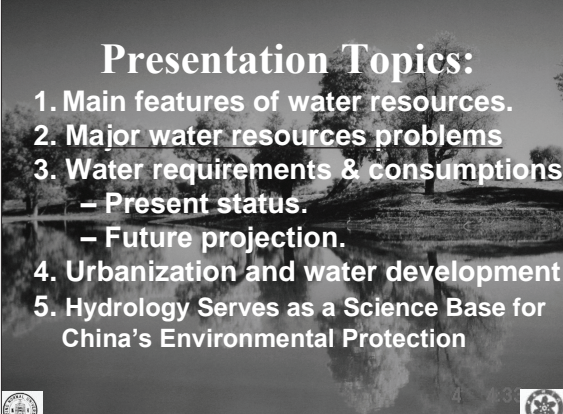
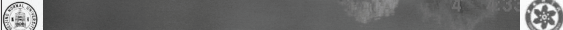
China's water resources: An unfavoured state

- Uneven distribution in time / space
- Water vulnerability
- Frequent Floods & drought
- Water/environment pollution
- Unbalance between water supply & demand
- Impact on aquatic ecology, etc.


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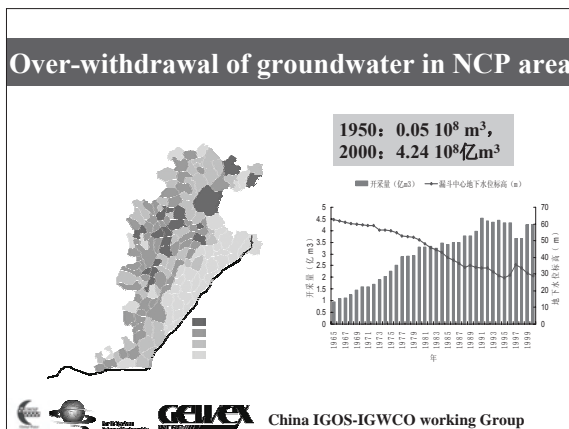
Major problems generalized as

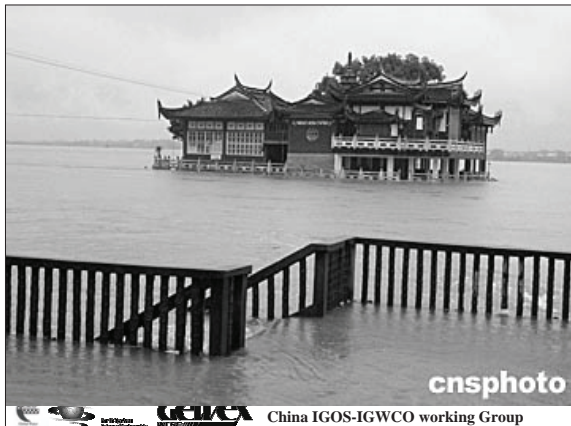
- Water is too less ;
- Water is too much ;
- Water is too dirty;



Water deficit is Severe: "too less"

- Water shortage area: 52% of China
- Spring drought frequency 90% in N.China
- 2/3 of 668 major cities lack of water or so
- Over pumping G.W.in NCP 100 billion m³
- Economic losses amount to billions RMB.

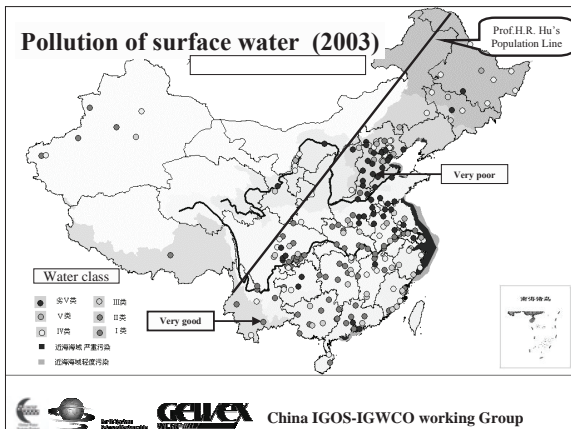
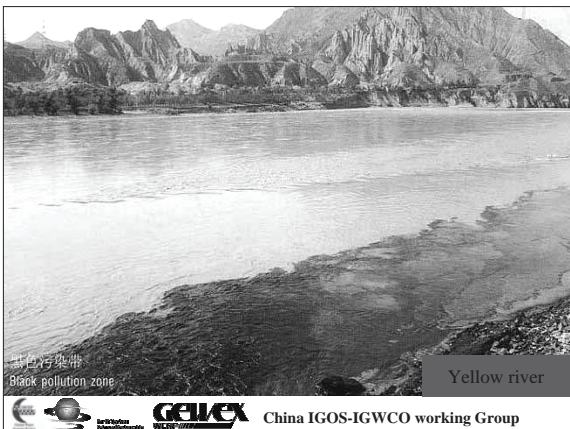





Serious Water Pollution:” too dirty”

- Such as “Three rivers & three lakes”
- Resulting in water quality shortage
- Resulting in health problems

GEIEX China IGOS-IGWCO working Group



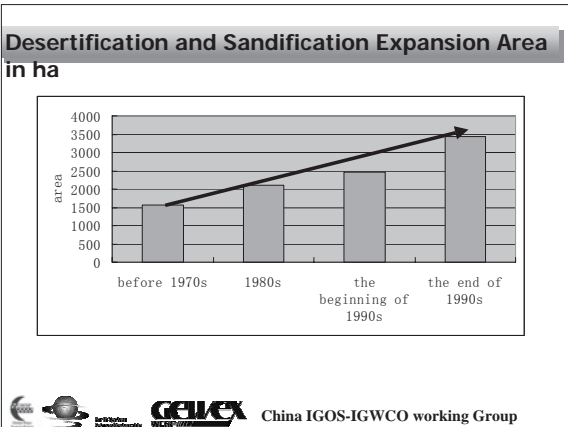
Annual economic losses is great & woeful.

It estimated that losses resulting from environment pollution would accounting for 3.5%-8% of China's GDP (both water and air pollutions)



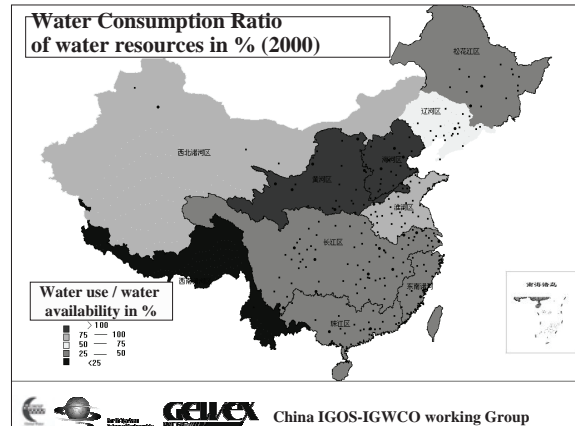
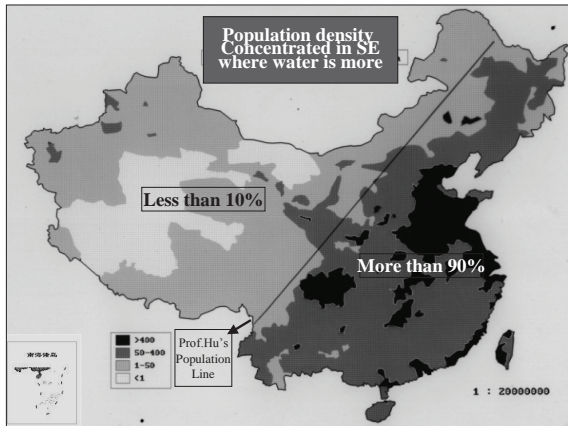
Hydrology Related: Eco-environment degradation

Desertification 	Death of forest
Water & soil losses 	Grassland degradation



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Irrigation land and irrigation quota in 2000			
Region	Arable land	Irrigation land (10 ⁴ ha)	Gross irrigation quota (m ³ /ha)
Northeast Rivers	19.9 %	448	8400
Haihe and Luanhe Basin	11.0 %	675	5250
Huaihe/Shangdong g & peninsula	15.3 %	887	7050
Yellow river Basin	12.8 %	433	7200
YangtzeRiver Basin	34.2 %	1718	9825
SouthChina Rivers	6.8 %	521	14400
Southeast Rivers	2.6 %	220	10125
Southwest Rivers	1.8 %	73	8025
Inland Rivers	5.9 %	220	9975
China	100% (123 m. hm)	5435	8925

Lowest WUE, water wasting
Very poor water management ;

WUE in China Compared with D.Cs			
Water consumption / Developed Countries in times			
\$10000 / water consumption in M ³			
Japan	208	1	
USA	514	2.47	
China	5045	24.25	

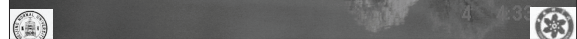
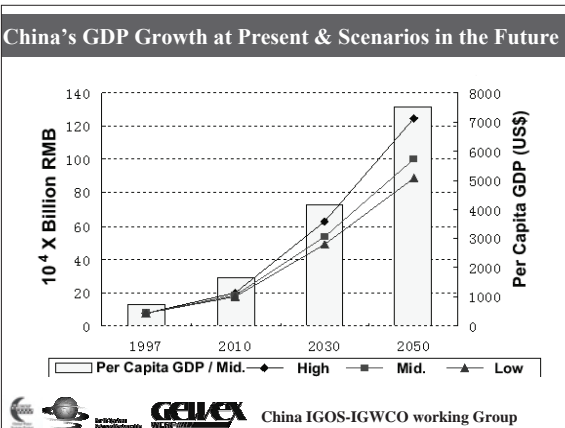
Lowest WUE in Agriculture	
About 100 % lower than developed coun	
1.0 kg grain yield consuming 1000 kg wa	
Water losses of canal conveyance :	
Isreal:	less than 10 %
USA:	22 %
Japan:	39 %
China:	50-60 %

Above-mentioned examples showed:
There is a big potential to solve water shortage by enhancing / improving water management



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5. Integrated policy & strategies

Water consumption in China (in billion cu. m)

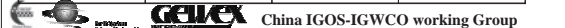
Water consumption in China (present and future) (in billion cu. m)

Year	1997	2010	2020	2030
Water consumption:	571.4	630.5	669.0	702.7 (was overestimated)
Urban Industrial	37.0	45.0	51.0	56.0 (reference 1)
Urban domestic	26.0	46.0	58.0	66.0 (reference 1)
Agriculture	406.4	421.0	426.0	420.0 (reference 2)




Urban Domestic water use in the first half of 21st century

year	water use rate (l/day-per person)	water use amount (10 ⁸ m ³)	remarks
2000	185	189	
2010	210	268	
2030	250	456	Excluding rural towns





Urban industry water use in the first half of 21st century

year	Industry production value(billion Yuan)	water use (10 ⁸ m ³)	per thousand yuan industry product water use deduct rate (%)	quota (m ³ /10 ⁴ yuan)
2000	3122.1	665	4.0	213
2010	5918.1	929	3.0	157
2030	18085.1	1899	2.0	105





Agriculture irrigation water use in the first half of 21st century

year	irrigation area(10 ⁴ ha)	gross irrigation quota (m ³ /ha)	water use (10 ⁸ m ³)
2000	5435	8925	4848
2010	5640	8250	4653
2030	6040	7500	4530

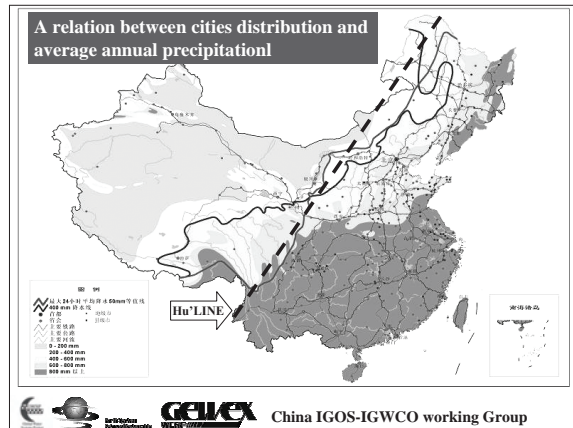


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A prediction of water demand for various sectors

year	Agriculture sector			Industrial sector			Urban Domestic sector			total (10 ⁸ m ³)
	water amount (10 ⁸ m ³)	increment rate (%)	ratio (%)	water amount (10 ⁸ m ³)	increment rate (%)	ratio (%)	water amount (10 ⁸ m ³)	increment rate (%)	ratio (%)	
2000	4848	-0.41	85.0	665	3.34	11.7	189	3.56	3.3	5702
2010	4653	-0.13	79.5	929	3.64	15.9	268	2.69	4.6	5850
2030	4530	-0.43	65.8	1899	3.00	27.6	456	2.38	6.6	6885





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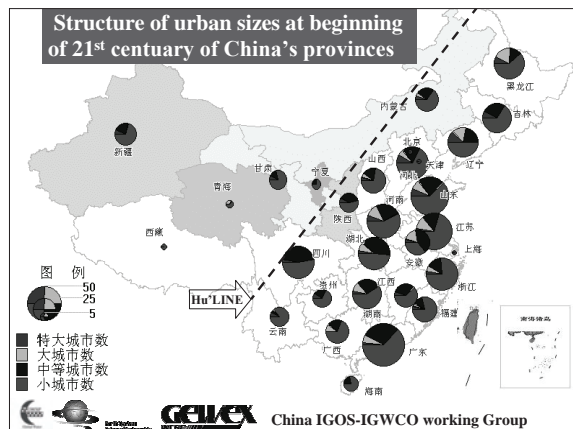
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- 


Amount of population and cities in China in 2003

population	Above 10,000,000	1,000,000 - 10,000,000	500,000 - 1,000,000	100,000 - 500,000	Below 100,000	Government established
Number of urbans	3 SUPER MEGACITIES	171	274	201	11	660
MEGACITIES			LARGE CITIES			
population	Above 4,000,000	2,000,000 - 4,000,000	1,000,000 - 2,000,000	500,000 - 1,000,000	200,000 - 500,000	Below 200,000
Number of urbans	11	22	141	274	172	40



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**A Greatest Challenge for China:
Urbanization Development too Rapid
Urban population now over 4 million
It will be reached to 9 million in 2030**



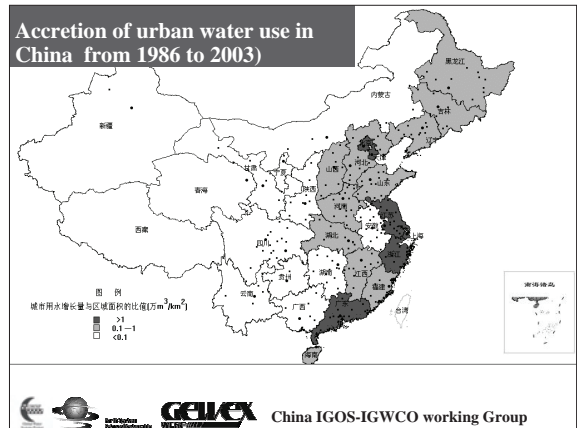

Urumqi City in Remote West Desert of China Has Expanded: As the Largest City in the Central Asia



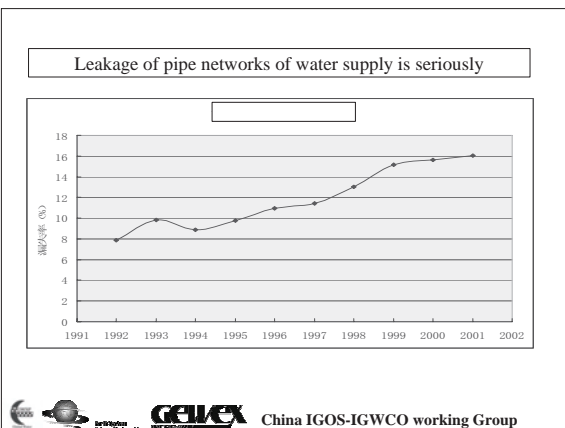


A New city of South China: Zhenzheng near Hongkong



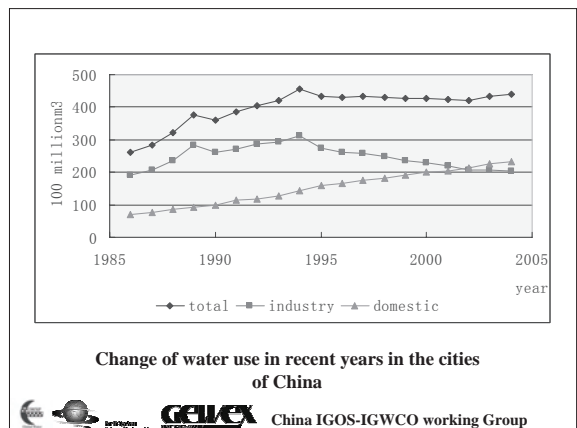


Accretion of urban water use in China from 1986 to 2003)

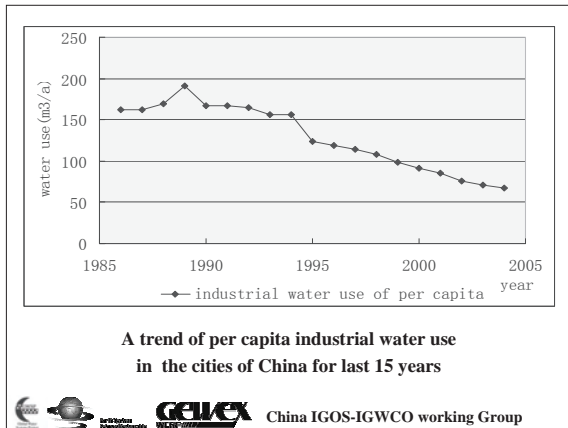
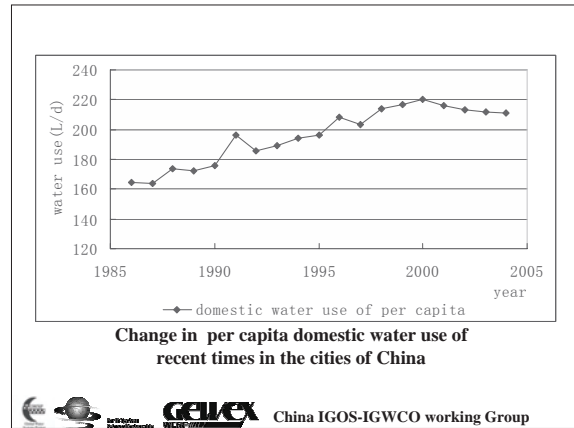
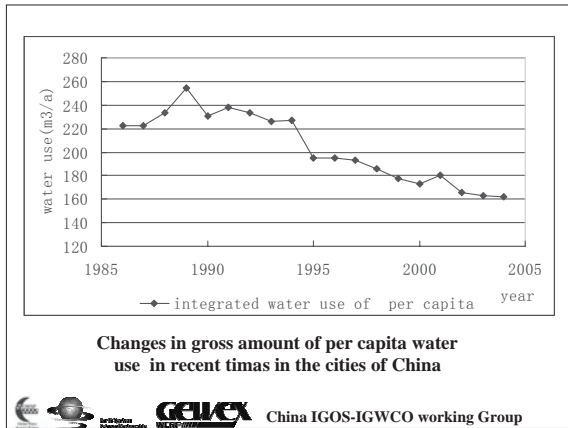



Leakage of pipe networks of water supply is seriously

Change of water use in recent years in the cities of China



Urban industry water use in the first half of 21st century

year	Industry production value(billion Yuan)	water use (10 ⁸ m ³)	per thousand yuan industry product water deduct use rate (%)	10 quota (m ³ /10 ⁴ yuan)
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2030	18085.1	1899	2.0	105

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Urban wasting water discharges in the future (in 10⁸ m)

Basins / regions	Industrial sector				Domestic sector				Sum			
	2030		2050		2030		2050		2030		2050	
	high	low	high	low	high	low	high	low	high	low	high	low
Nation	781	590	1059	711	284	266	450	414	1065	856	1509	1125
SL	75	59	104	64	34	30	40	37	109	89	144	101
HL	45	35	55	37	38	35	57	53	83	70	112	90
H	66	51	95	61	32	32	62	54	98	83	157	115
HH	47	36	62	41	18	16	26	25	65	52	88	66
CJ	364	266	492	340	89	81	136	128	453	347	628	468
PR	114	90	151	101	52	51	87	82	166	141	238	183
SE	40	31	45	30	15	16	28	25	55	47	73	55
SW	7	6	15	11	2	2	5	4	9	8	20	15
Inlands	23	16	40	26	4	3	9	6	27	19	49	32

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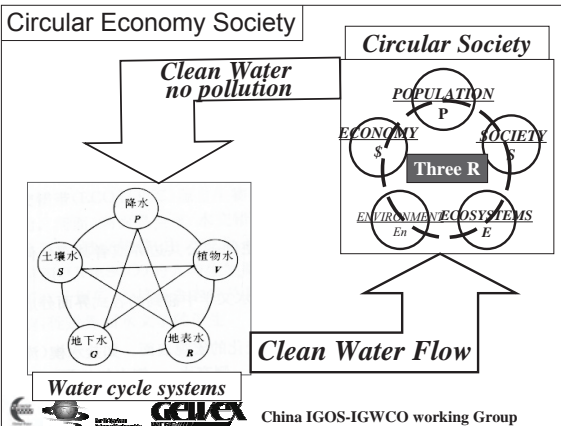
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Water cycle (水循环) theory is a fundamental connotation of hydrology, which can be referable to problems in developing resources, protecting the environment and rehabilitating ecology



Circular Economy Conforms with Water Cycle

Developing “Circular Society or Circular Economy” to control both water reserve and water pollution by using “Three Rs” i.e., Reduce, Recycle and Reuse;



Ecological Flows Need For Keeping “Four Water Balances”

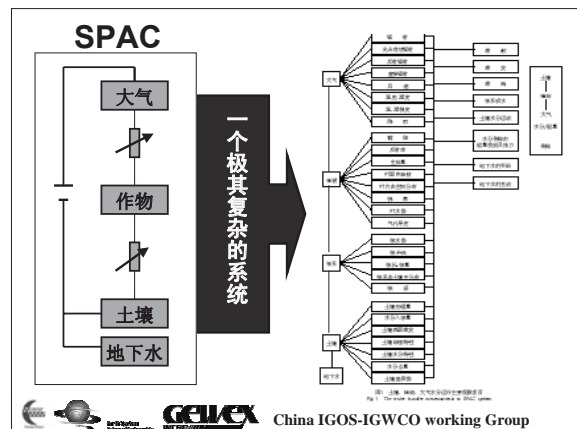
- The balance of ecosystem is a hard base for sustainable development as water is one of the most key factors for the eco-environment and the socio-economy at basin and regional levels.
- The “Four Balance” must be concerned:
 - water-energy balance (物理平衡)
 - water-sediment balance (地貌平衡)
 - water-salt balance (化学盐类平衡)
 - water ecological balance (生态平衡)



Field Water Cycle for Agricultural Water Management

**农田水(能)循环过程
土壤-作物-大气连续系统**

(SPAC)



SPAC系统的一般方程

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial z} [D(\frac{\partial \theta}{\partial z}) - \partial K(\theta) / \partial z - S(z, t)]$$

式中 D，K土壤水水力扩散与传导；θ 为深度 z 与时间 t 的土壤水分含量；S(z, t) 作物根系的吸水率；上边界为大气，下边界为地下潜水。

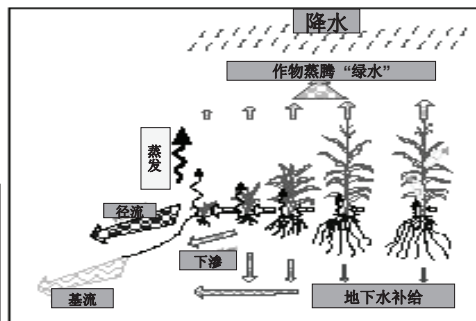
由水循环而来的水资源概念： “绿水”与“蓝水”的定义

“绿水”与“蓝水”概念的探讨

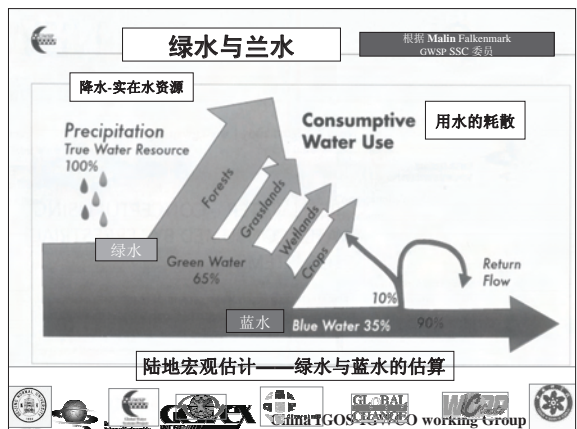
在某一区（流）域中，“绿水”（大气降水）供给陆生生态系统（自然）的耗水，“蓝水”（地表、地下水）供给社会经济（人类）和淡水生态系统的用水。“绿水”的循环反映了自然界“土壤-植物”生态系统的用水消耗。“蓝水”在地表和地下流动，从山顶到山脚，从陆地到海洋，被人类利用。

“绿水”与“蓝水”概念的探讨

- (1) 把全部降水量作可再生水资源的总量；
- (2) “绿水”的直接（人类）利用包括：经济生物量生长（Economic biomass growth），雨养旱地农业、木材、纤维、薪材、牧场等用水；
- (3) 间接（人类）利用包括：生态系统生物量（Ecosystem biomass growth），湿地植物与树木、草地、林地和其他生物群落；
- (4) “蓝水”是地表与地下水的直接（人类）取用，包括社会经济用水，即灌溉、工业与生活等用水，间接（人类）利用包括生态功能用水，淡水水生物种。



农业区的水循环主要过程示意图



蓝水、绿水计算

土壤水分（区域湿度）总通量 $W_h = P - W_s$

蓝水量 $W_B = W_s + W_G - \Delta SG$

绿水量 $W_G = P - W_B$

W_B 蓝水量； W_s 地表水资源量； W_G 地下水资源量；

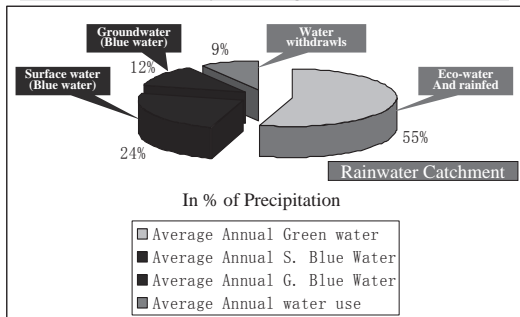
ΔSG 地表水资源量与地下水资源量的重复计算量

P 降水总量

中国的绿水量（亿立方米）

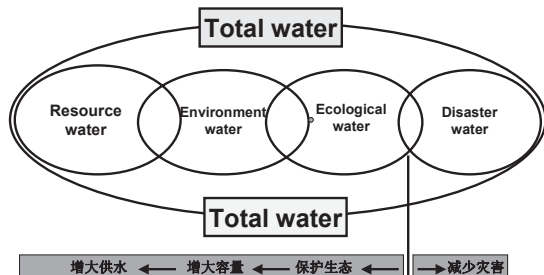
年份	全国	松花江流域	海河流域	黄河流域	淮河流域	长江流域	珠江流域	东南诸河流域	西南诸河流域	西北内陆河流域
1997	30313.7	3929.5	952.5	2149.3	1599.2	9063.9	4351.0	1603.7	3305.6	3359.0
1998	33614.0	4758.3	1398.1	3001.0	1879.9	8555.9	3875.3	1308.6	3762.7	5025.6
1999	31506.7	3838.6	1031.9	2555.4	1624.9	9149.1	4208.1	1416.6	3656.6	4025.5
2000	32391.5	4020.6	1289.8	2477.6	1829.4	9529.0	4119.5	1594.8	3394.3	4136.5
2001	31254.4	3542.9	1125.7	2704.4	1508.7	8989.6	4483.3	1417.5	3697.2	3785.2
2002	34355.0	4337.0	1115.0	2751.0	1681.0	10133.0	4626.0	1558.0	3246.0	4909.0
2003	32956.0	4478.9	1570.2	3688.1	2138.3	8703.7	3455.2	1148.6	2766.7	5006.2
2004	32747.4	3884.0	1387.1	2725.7	1821.3	9812.3	3846.4	1621.7	3435.5	4213.4
多年平均	33451.2	4321.5	1215.9	2962.3	1685.3	9834.0	4284.9	1449.2	3478.0	4220.1

How efficiently manage Green Water



Hydrological Study on Water Partition and Control

“Four Water” Regulations



Thank you
谢谢！