CHINA

Innovations In Integrated Water Resources Management

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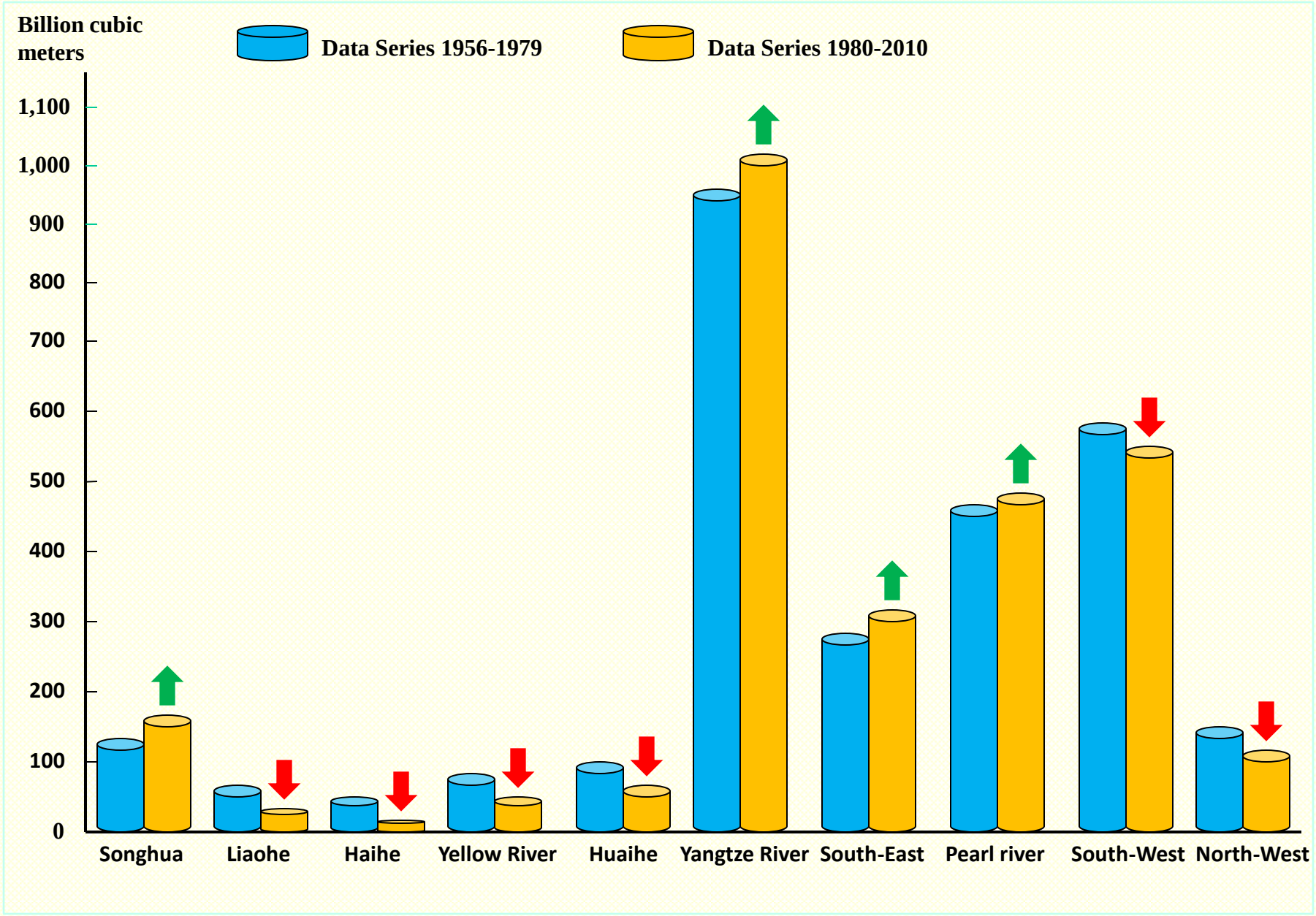
Outlines

1. **Impact of climate change on water scarcity in China;**
2. **Climate change adaptation strategy in irrigated agricultural water savings;**
3. **Increase of water productivity in the water scarcity areas in China;**
4. **Integrated water resources management for climate change adaptation.**

1. Impact of climate change on water scarcity in China

- There has been a serious water scarcity and ecosystem degradation, particularly in the northern and north-western part of China;
- The social and economic development in these water scarcity areas partly depends on over-exploitation of surface and groundwater sources;
- Climate change makes the situation even more serious.

Climate Change Makes Water Scarcity More Serious



Types of Water Scarcity Areas in China

- ***Economic water scarcity area*** - where there are relatively abundant water sources and water scarcity occurs when there is a lack of investment in water infrastructure or a lack of human, institutional or financial capacity to satisfy demand;
- ***Physical water scarcity area*** - where surface and groundwater resources have already been overused and water scarcity occurs when there are insufficient water resources available to meet all water demands; and
- ***Mixed types of water scarcity areas*** – where it's not possible to build infrastructure in the near future.

2. Climate Change Adaptation Strategy in Irrigated Agricultural Water Savings

Conventional Approach for Water Conservation

- Increase water use efficiency with improved technologies to “save” water and then use “saved” water to expand irrigated area or other uses, e.g. urban water supply;
- Believe that it would save 30% of extra water resources if water use efficiency is raised by 30%.
- Two key indicators are used to evaluate effectiveness of water savings: (a) the improved irrigation efficiency and (b) the increased areas where improved irrigation technologies are applied.


CHENGAN COUNTY (HEBEI) – CHINA
Using Sprinklers


CHENGAN COUNTY (HEBEI) CHINA
lining of canals and ditches

Problems on conventional approach

- Case 1 from Turpan of Xinjiang: Improved water use efficiency makes 30% of reduction in water delivery from a reservoir. The reservoir supplied all "saved" water to other water users !
- Case 2 from Guantao of Hebei: Improved water use efficiency makes a village of farmers be able to irrigate more land. The village irrigated more land with "saved" water!
- Field observation showed that the above two cases consumed much more water than before, which contributed to serious overdraft of groundwater and degradation of ecosystems !

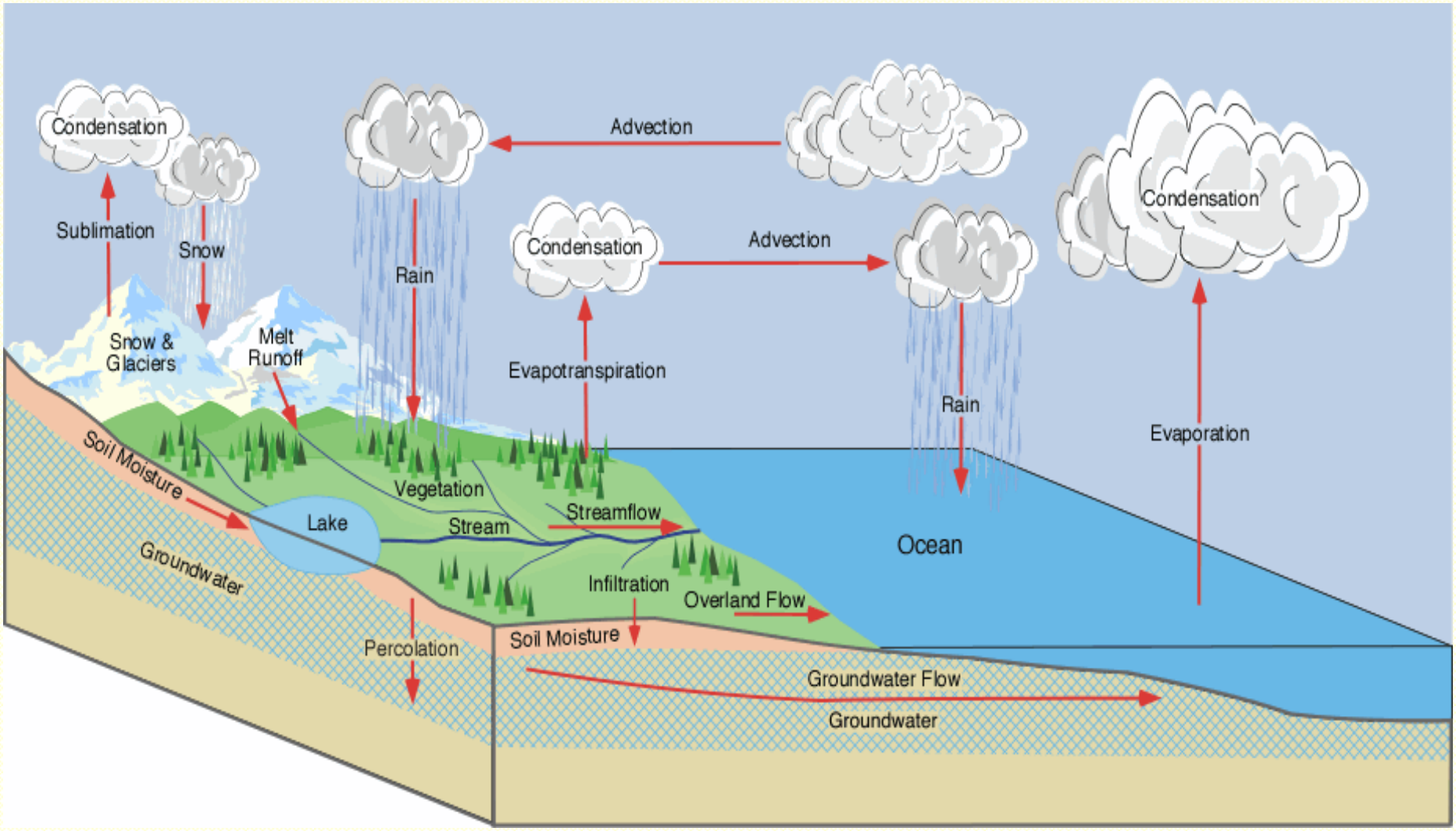
Why does conventional approach contribute to more consumptive use of water and degradation of ecosystems?

- Water "saved" with conventional approach is not all lost: much of it returns to the aquifers below and keeps dynamic balance of groundwater storage;
- If "saved" water is used to irrigate more land or supplied to other water users, the consumptive use of water will greatly increase, which would result in more serious groundwater overdraft and ecosystem degradation;
- The field investigation showed wherever the conventional approach was used to save water in physical water scarcity areas, there must have been a serious over-exploitation of water resources and a serious degradation of ecosystems.

Concept of Real water savings

- The only water truly lost in a hydrologic system is through Evapotranspiration or ET, which is water evaporated from water surface or transpired from plant leaves into the atmosphere;
- Growing more crops over a wider irrigated area or increasing of cropping intensity in the same irrigation area would raise the level of ET !
- ET is the real consumptive use of water or real water savings since no one can make further use of it once it is in the atmosphere.

ET is the only water truly lost in a hydrologic system !



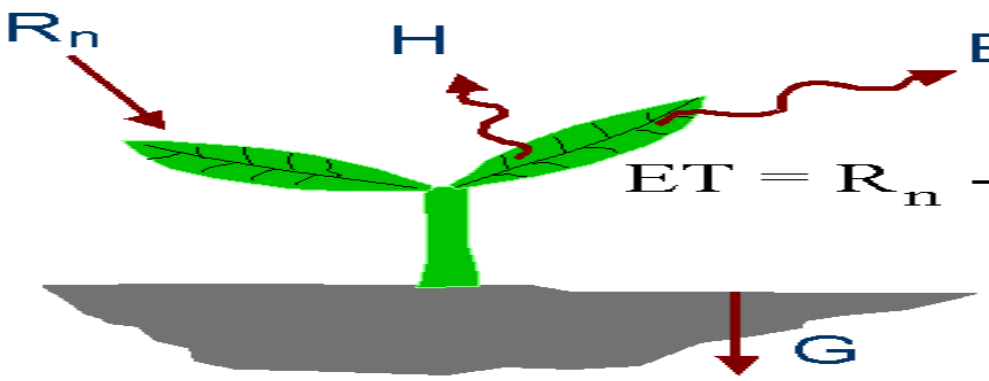
How to design and implement a project which really saves water and doesn't result in an increased consumptive use of water ?

- The project should be designed to reduce ET or reduce consumptive use of water, and to ensure that ET with project is less than ET without project;
- Non-beneficial ET or ET should be cut down with integration of engineering measures, agricultural measures and irrigation management measures;
- While reducing ET, farmer incomes can be increased with a higher water productivity or cropping pattern adjustment from growing low-value crops to higher value crops.

How can we measure ET ?

- By the Latest Remote Sensing (RS) Technology, which is being developed very fast in China !
- Remote sensing by satellites can now provide ET readings for pixels of 30 by 30 meters with a good accuracy. This tells farmers how much water they can consume without adversely affecting the ecosystems around them.

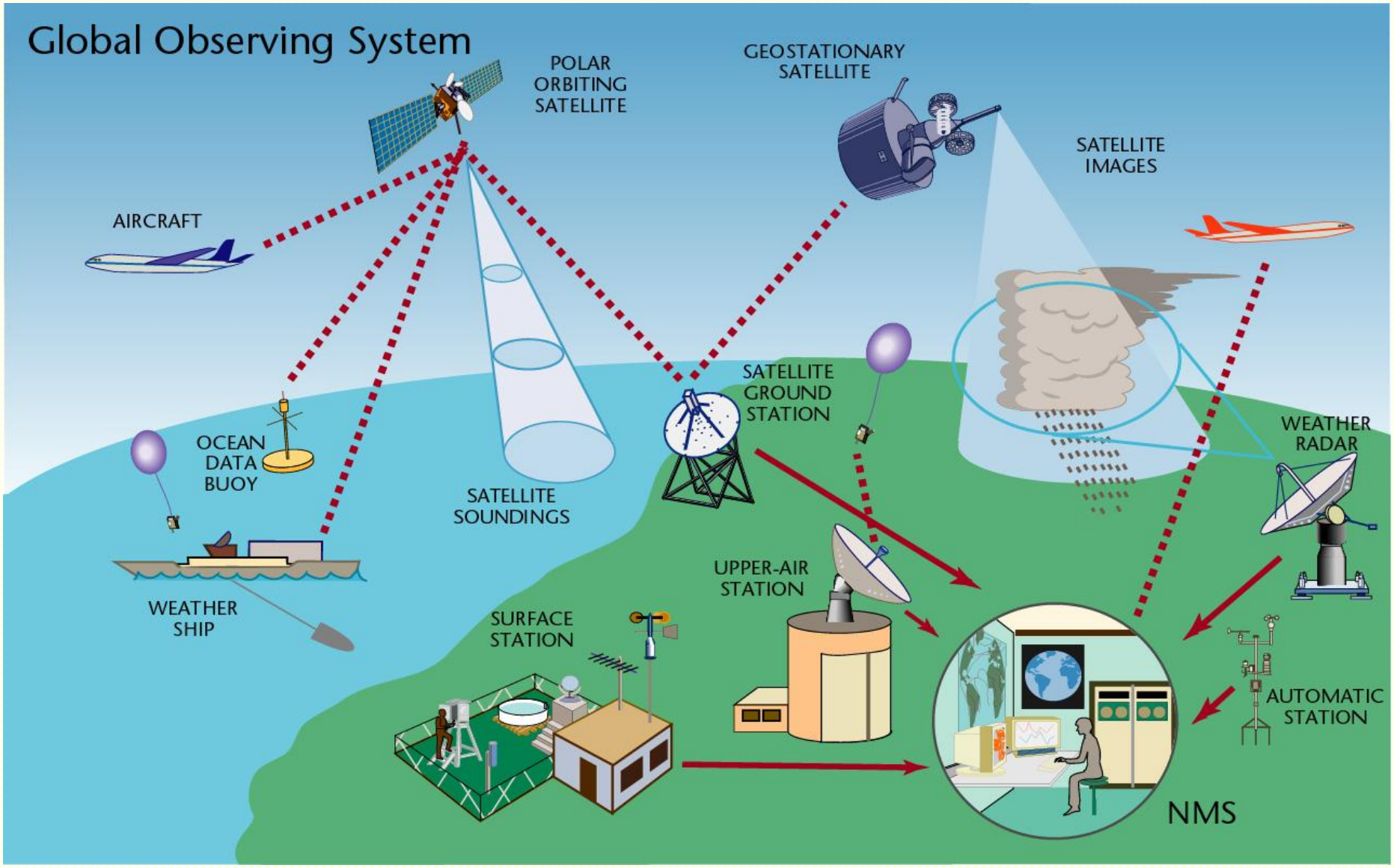
ET is calculated as a "residual" of the energy balance



$$ET = R_n - G - H$$

The energy balance includes all major sources (R_n) and consumers (ET, G, H) of energy

The Latest RS-based ET Measuring Technology



What are the climate change adaptation strategies in irrigated agricultural water savings?

- *Economic water scarcity areas*

The main stream of the strategy is to increase water use efficiency with conventional approach to increase agricultural production or value, together with other measures

Substance: consuming more water for higher yield

- *Physical water scarcity areas*

The main stream of the strategy is to increase water productivity with real water saving approach to increase agricultural production or value per unit of consumptive use of water or ET, together with other measures

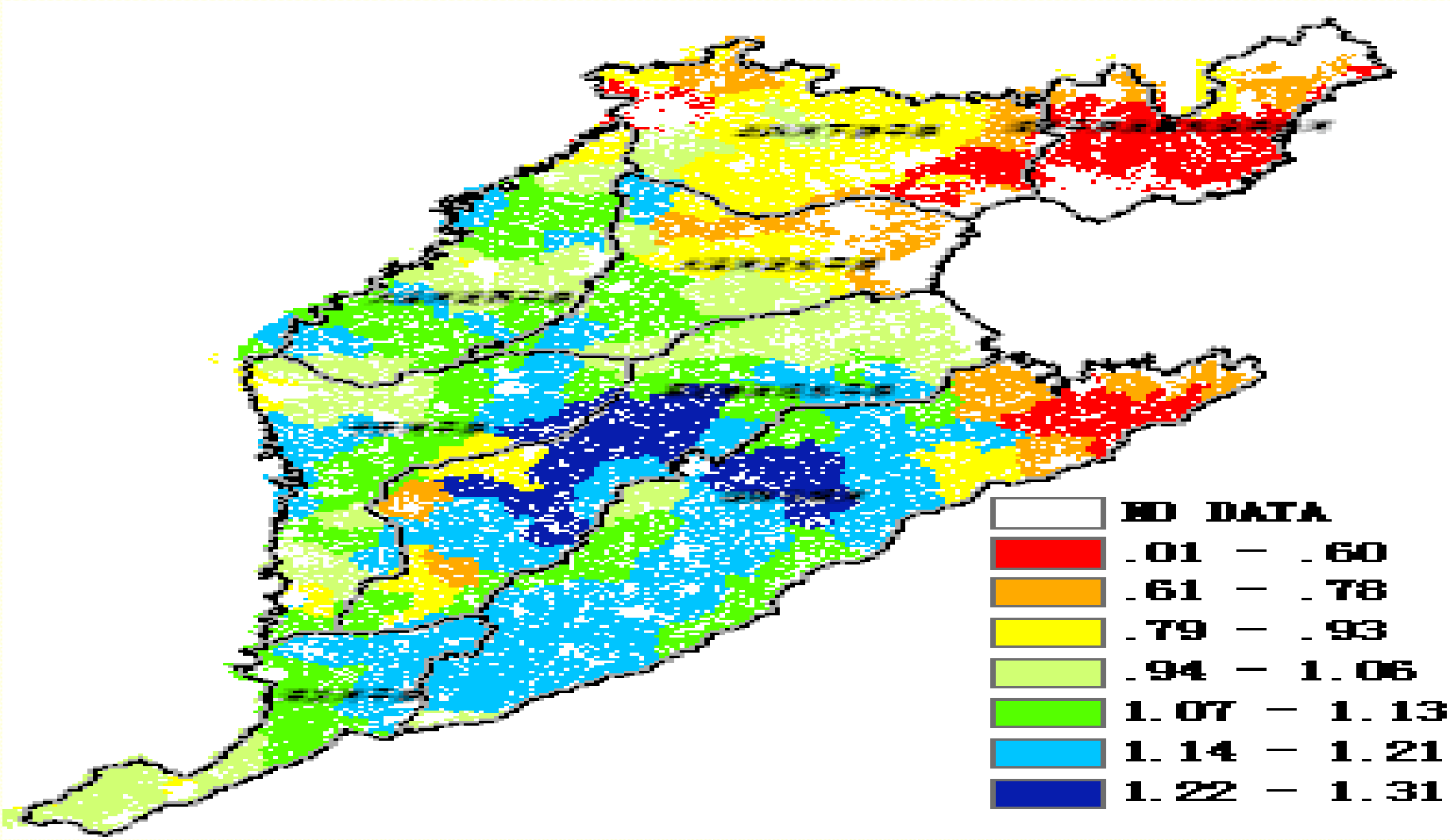
Substance: consuming less water for higher yield

3. Can water productivity increase in China?

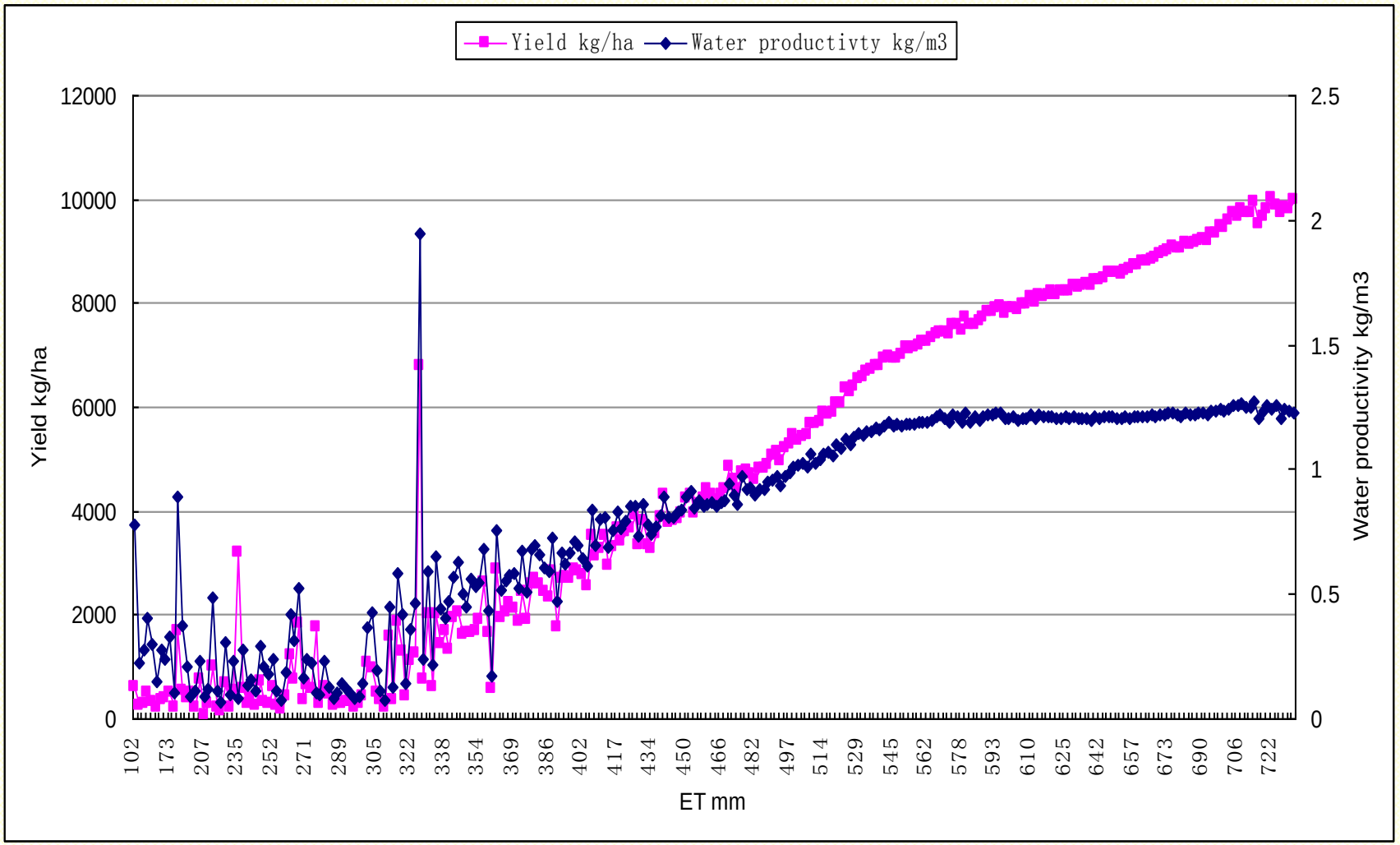
- China's average water productivity of grain is only 0.7-0.8 kg/m^3, while some other countries can reach 2.0-2.5 kg/m^3;
- Experiment in China's irrigated areas showed that the water productivity still has potential to increase with enhanced agricultural measures;
- The agricultural measures include all measures in proposed in the conservation agriculture.

Note: Agricultural measures include cropping pattern adjustment; plant breeding or drought resistance seeds; integrated pest management; improved soil fertility and fertilization; improved soil salinity; and plastic-culture (mulch, tunnels, green houses); and tillage and weed control and other effective measures.

There has been potential to increase water productivity in the Hai Basin



Water productivity in Hai Basin – one of key grain production areas in China



4. Integrated water resources management for climate change adaptation

Keeping in mind three internationally recognized principles to see how we should do to adapt the impact of climate change?

- Ecological principle - water should be managed in the context of the river basin as the development and management unit with special attention paid to environmental protection;
- Institutional principle – water resources management is best done when all stakeholders participate, including government, private sector and civil society and involving participation by women;
- Instrument principle – water is a scarce resource and economic good whose management requires greater use of incentives and economic principles in improving its allocation and enhancing equity.

4. What have we been doing ?

- Ecological principle – established a close linkage which links the target ET for economic activities at the river basin level and that at the water user level, taking into consideration the needs for ecosystem restoration at the river basin level;
- Institutional principle – established farmer user associations to do ET management in the field while increasing their incomes, with the strong support from government and other stakeholders; and
- Instrument principle – established and implemented a ET-based water rights system and carry out cropping pattern adjustment from growing low-value crops to higher-value crops to increase water productivity.

Water Consumption Balance Analysis

Water Consumption Balance in Turpan Basin

Items in Water Balance Equation	Water Items	Baseline Year			Project Completion Year 2015						Target Year 2025					
		Area	mm	Amount	Area	mm	Amount	Change to Baseline			Area	mm	Amount	Change to Baseline		
		Hectare		million m^3	Hectare		million m^3	mm	million m^3	%	Hectare		million m^3	mm	million m^3	%
Available Water Resources	1. Precipitation	1,916,744	14.95	286.59	1,916,744	14.95	286.59				1,916,663	14.95	286.59			
	2. Water inflow			874.00			874.00						874.00			
	3. Groundwater base flow			41.00			41.00						41.00			
	Total Available			1201.59			1201.59						1201.59			
Water Consumption	1. Ecological ET	484,188	85.10	412.04	484,188		412.04			0	498,119		412.04			0
	1.1 Man-made ET	2,950	208.52	6.15												
	1.2 Natural ET	481,238	84.34	405.88												
	2. Water Surface ET	14,013	240.45	33.69	14,197		29.48		-4.21	-13	14,197		29.48		-4.21	-13
	2.1 Man-made ET	963	293.68	2.83	1,147		5.20		2.38	84	1,147		5.21		2.38	84
	2.2 Natural ET	13,050	236.52	30.87	13,050		24.28		-6.59	-21	13,050		24.28		-6.59	-21
	3. Agricultural ET	114,206	542.49	619.56	114,206	484.95	553.84	-57.54	-65.72	-11	114,206	318.62	363.89	-223.87	-255.67	-41
	3.1 Crop ET	94,271	630.62	594.50	85,942	603.76	518.89	-27.27	-76.02		54,275	533.87	289.76	-97.16	-305.15	
	3.2 Non crop ET	19,935	125.72	25.06	28,264	123.68	34.96	0.00	10.31		59,931	123.69	74.13	0.00	49.47	
	4. Unused Land ET	1,304,338	25.80	336.57	1,304,338		336.57		0.00	0	1,304,338		336.57	0.00	0.00	0
	5. Industries			15.42			43.61		28.19	183			100.00		84.58	549
	6. Domestic Use			7.03			11.35		4.32	62			20.00		12.97	185
	Total Consumption			1,424.30			1,386.89		-37.41	-3			1261.97		-162.33	-11
Outflow				7.86			7.86		0.00	0			7.86		0.00	0
Change in Groundwater Storage				-230.57			-193.16		37.41	-16			-68.24		162.33	-70

Case study No. 1 on Water Conservation Project (2000-2006)

- The farmers' per capita income increased by 193 percent, while consumptive use of water or ET over the irrigated areas fell by 27 percent;
- Water productivity was increased from 0.85 kg/m3 to 1.20 kg/m3 for wheat and from 1.30 kg/m3 to 2.2 kg/m3 for maize with integration of engineering, agronomic and irrigation management measures;
- The project focuses on the enhanced inputs to agricultural measures and irrigation management measures incorporation with agricultural departments;
- Government's pilot in Shandong/Huantai (2005): the case study showed that water productivity for wheat increased for wheat from 1.0 kg/m3 to 2.0 kg/m3.

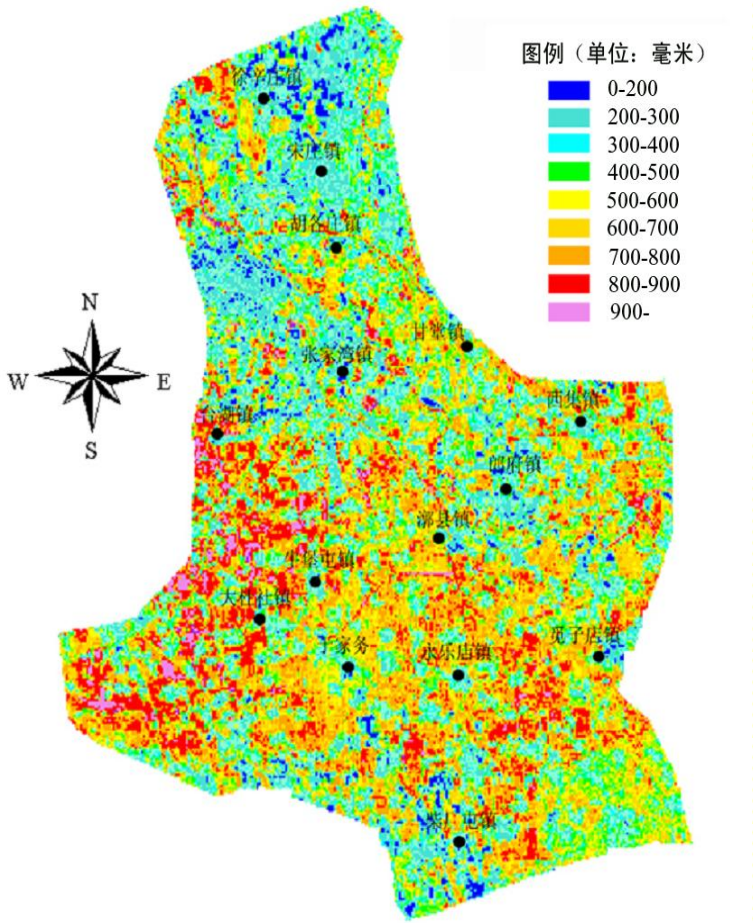
Case study No. 2 on GEF Hai Basin Project

- The project helped 360,000 farm households to save water and to leapfrog technology;
- The target ET for irrigated agriculture was derived based on the water balance at the river basin level, which took into consideration the annual reduction of groundwater overdraft and restoration of ecosystems;
- Then the target ET derived at the basin level was distributed to each of the counties, and further to each of WUAs in the county;
- A water withdrawal quota was assigned to each WUA, which was derived based on the target ET for that WUA. The WUA then distributed the quota to each farmer household; and
- Each farmer household got a pre-paid card for water. Once it was used up, the pump shut down. Farmers used less water, they used it better, and their incomes increased five-fold.

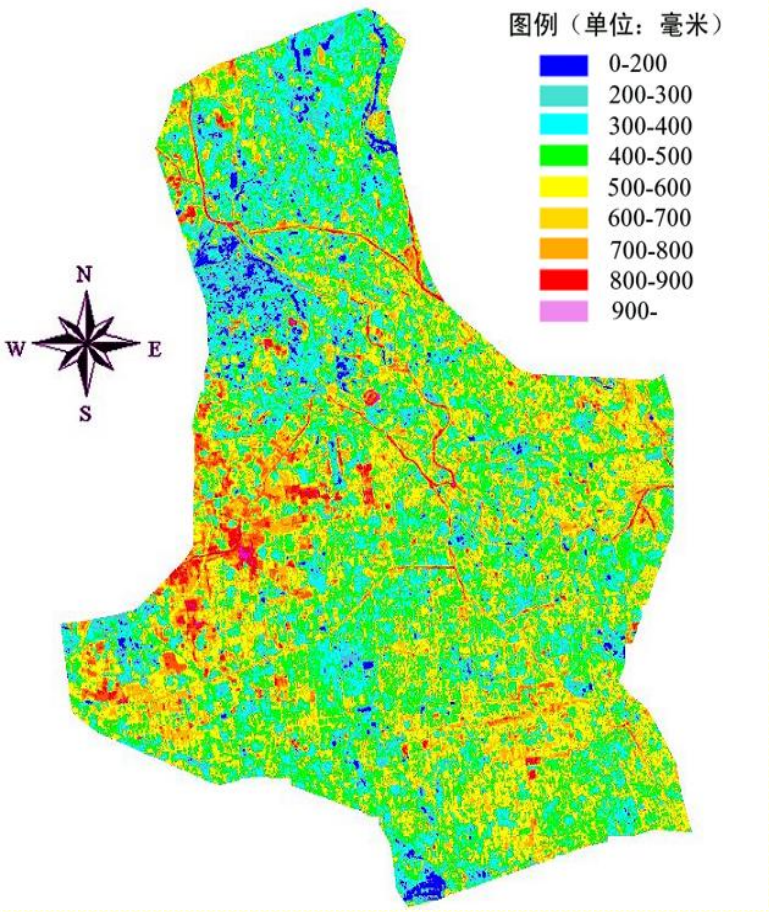
Farmers Learn How to Operate ET Management !

ET in TongZhou District of Beijing, China

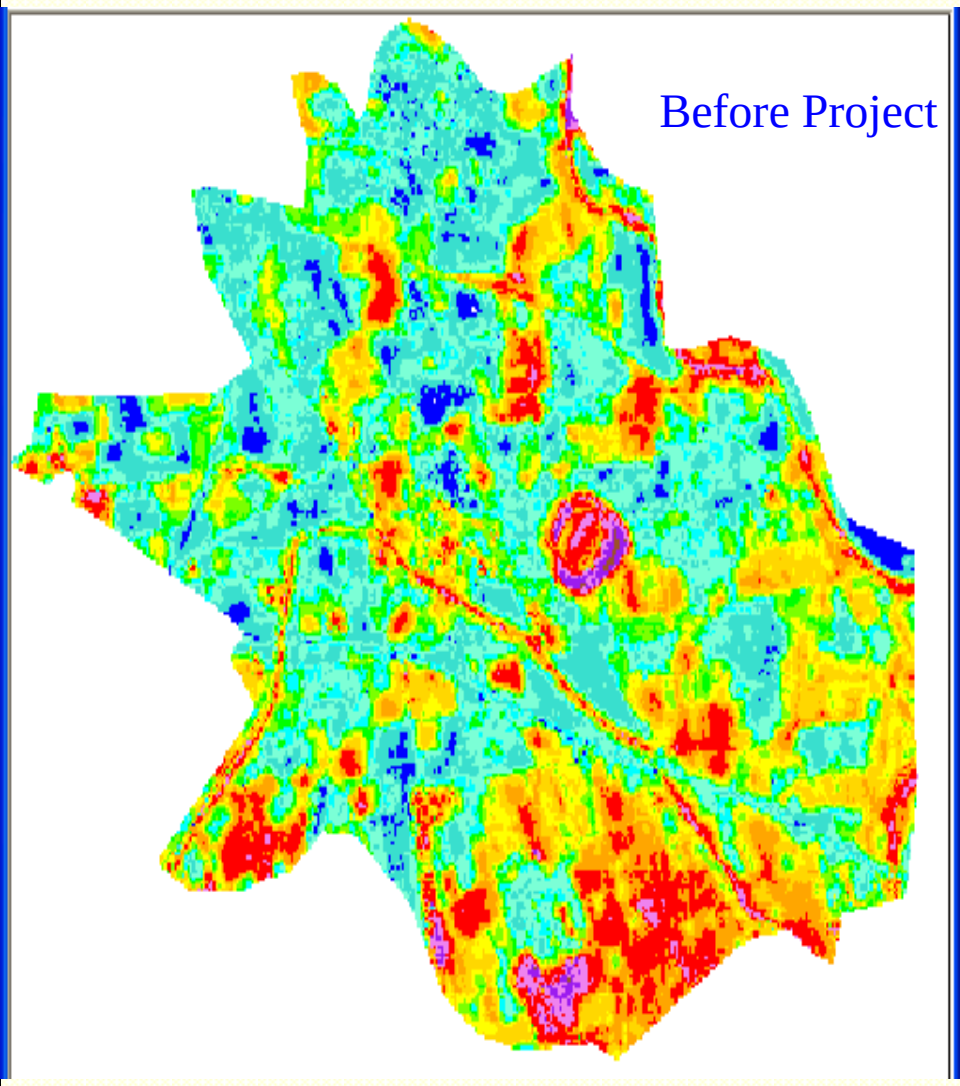
Before Project

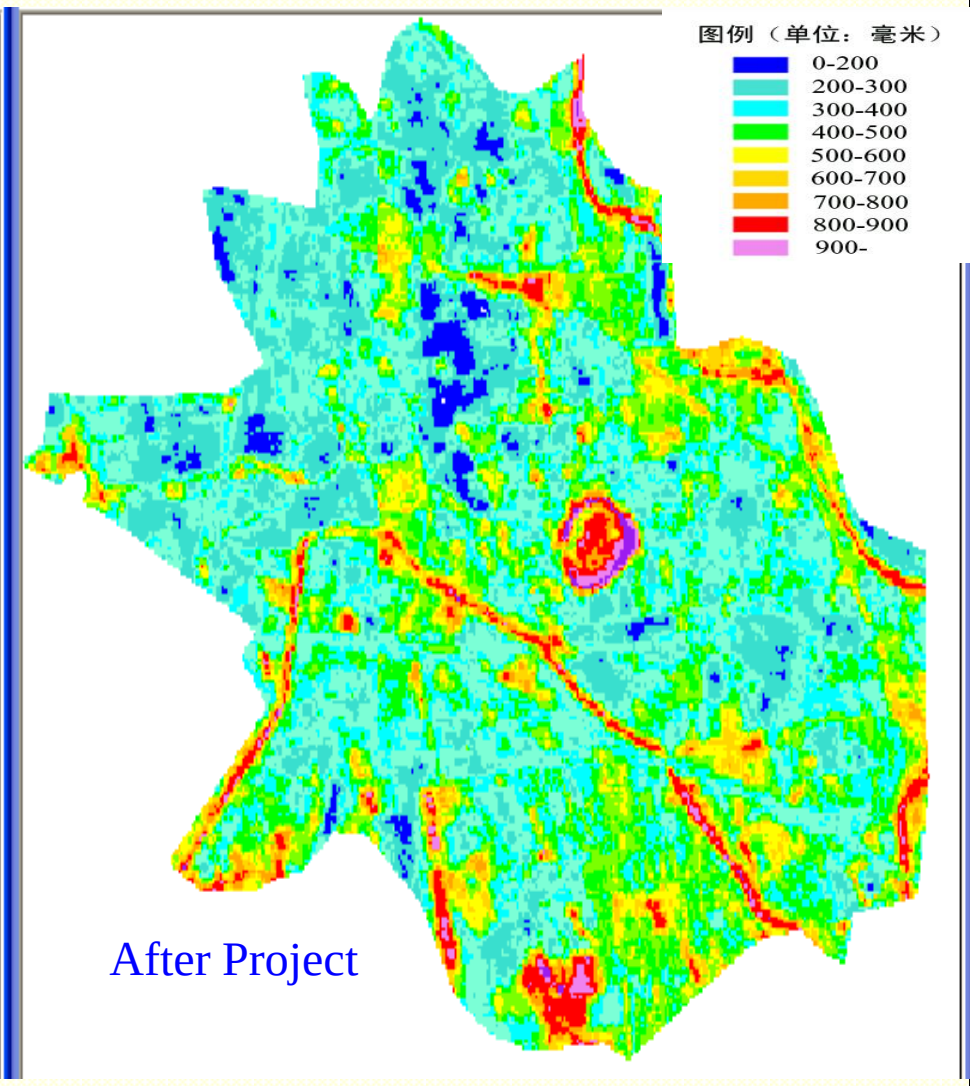


After Project



Zhang-Jia-Wan Township Tongzhou District of Being, China





The innovation was welcomed by farmers - a placard in the field says “let’s do real water savings” in Hebei

Concluding Remarks

- Impact of climate change made water scarcity more serious, especially in China's northern and north-western regions;
- Climate change adaptation strategy is different in economic and physical water scarcity regions in China;
- There has been a potential to increase water productivity in China's main grain production areas;
- Integrated water resources management should be carried out to adapt the climate change impact with three principles, and a linkage on ET should be established between river basin level and water user level;
- Remote Sensing ET measurement technology can be used to understand the status of water productivity in a wider areas to identify the areas for improvements;
- Case studies showed that there has been a urgent need to scare the experience up to China's 14 main grain production areas and similar regions in the other countries

Thanks
Welcome Questions