The Activity of Asia Regional Task Force on Climate Change (ARTF-CC)

Managing Climate Change Effect on Groundwater through Monitoring Groundwater

Group	Science& Technology
Field	Strategy

16 October 2011
People's Republic of China
Gao Zhanyi

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Implementing Organization	**China Institute of Water Resources and Hydropower Research (IWHR) The Centre for Groundwater Monitoring, Ministry of Water Resources**
Operating Members	**Researchers from pilot areas, government officials and professors**
Active term of this case study	**From May 2008 to May 2011**
Contact person	**Dr. Gao Zhanyi (gaozhy@iwhr.com)**

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I. Background

- **The total groundwater resources in China is 760 billion m^3, accounting for 26.8% of the total water resources in China;**
- **Out of 57.8 million ha of irrigated area, 17.1 million ha are irrigated by groundwater, accounting for 29.6 % of the total irrigated area. \;**
- **Out of 700 million rural population, 460 million people depend on groundwater for drinking water supply, accounting for 65 % of the total rural population in rural area.**

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I. Background

Problem 1: Over development induced groundwater tables drop continuously in northern China.

Problem 2: Climate change induced extreme uneven distribution of precipitation in both time and space. with extreme draught events, which.

Problem 3: Extreme draught events not only reduced recharge to groundwater but also induced more groundwater pumping;

The increased scale of possible impacts of climate change and over development of groundwater creates water vulnerabilities and risks to both irrigation and drinking water supply.

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II. Purpose & Goal

To maintain the sustainable development of groundwater under climate change condition, it is essential to monitor groundwater tables and analyze the change trend of groundwater table by using the monitoring data and modeling technology.

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III. Project objectives

- **Update the existing groundwater monitoring system to carry out continuous intensive monitoring of groundwater level and quality, and build capacities to track the effects of climate changes on groundwater, using monitoring data at the selected areas;**
- **Increase capacity for comprehensive data analysis, and identify appropriate remedial measures for rational groundwater management for the selected areas, such as development pattern, safe yield and recharge;**
- **Analyze the effect to groundwater by climate change and human activities, to raise public awareness the effects of climate change on groundwater availability for sustainable development at the selected areas.**

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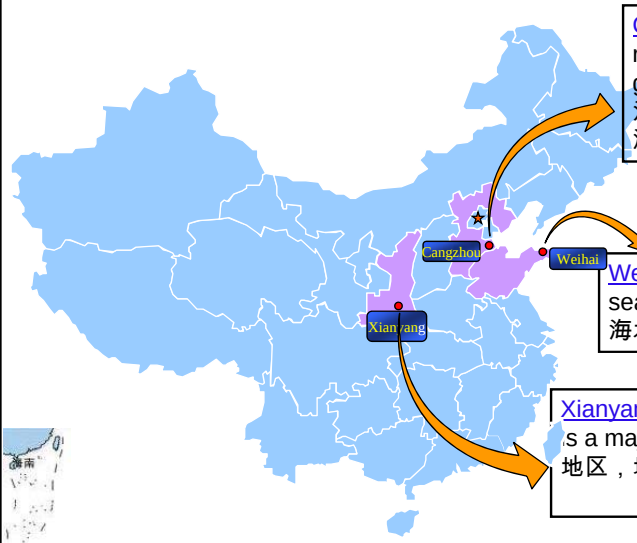
IV. Outline of the activity



Cangzhou, Hebei: Typical region in northern China, groundwater overexplored 河北沧州，华北地区典型水资源紧缺、地下水严重超采区

Weihai, Shandong：Serious seawater intrusion山东威海，海水严重入侵

Xianyang, Shaanxi Groundwater s a major water supply 陕西咸阳地区，地下水是主要的供水水源

MDGF

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CAPACITY BUILDING FOR GROUNDWATER MONITORING

A Update the existing groundwater monitoring system

New equipment provide by MDGF—
Online conductive y-meter ,
Online groundwater monitoring system and
Master Station.

MDGF

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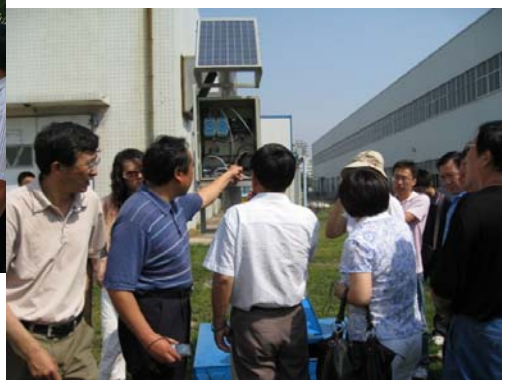
CAPACITY BUILDING FOR GROUNDWATER MONITORING

B Field technical support for groundwater monitoring

Field technical training



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Methodology

IPCC SRES Scenarios + Climate(MIROC3.2) model
气候模型模拟的气候情景输入

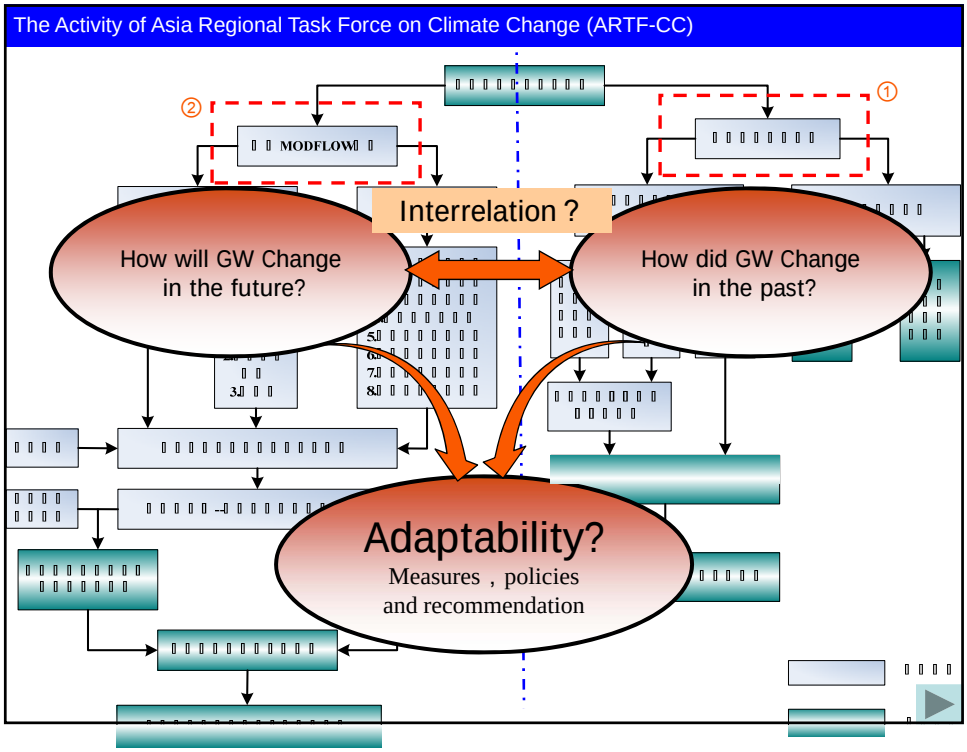
Historical data

Future Climate Change Scenarios in the pilot area
历史气候资料为基准推测未来气候

Land use, crops and groundwater pumping

Groundwater Response to Climate Change in Future
气候变化对地下水的影响

Adaptable Measures, Policies Recommendation
提出适应措施和政策建议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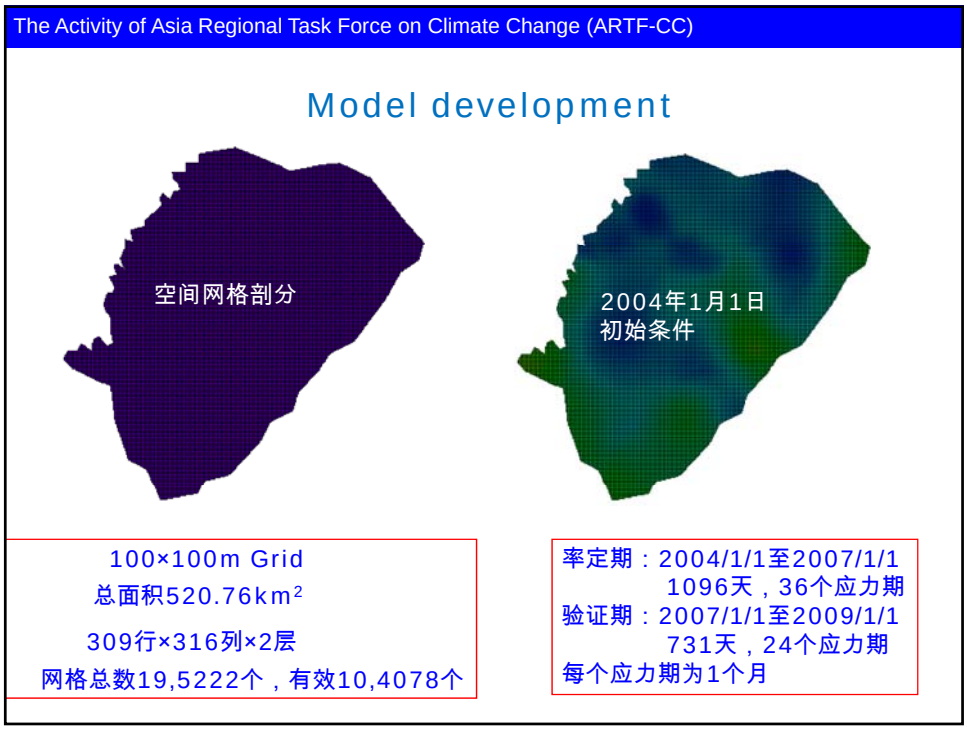
MODFLOW
Interrelation ?
How will GW Change in the future?
How did GW Change in the past?
Adaptability?
Measures，policies and recommendation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Model development
空间网格剖分
2004年1月1日
初始条件
100×100m Grid
总面积520.76km²
309行×316列×2层
网格总数19,5222个，有效10,4078个
率定期：2004/1/1至2007/1/1
1096天，36个应力期
验证期：2007/1/1至2009/1/1
731天，24个应力期
每个应力期为1个月

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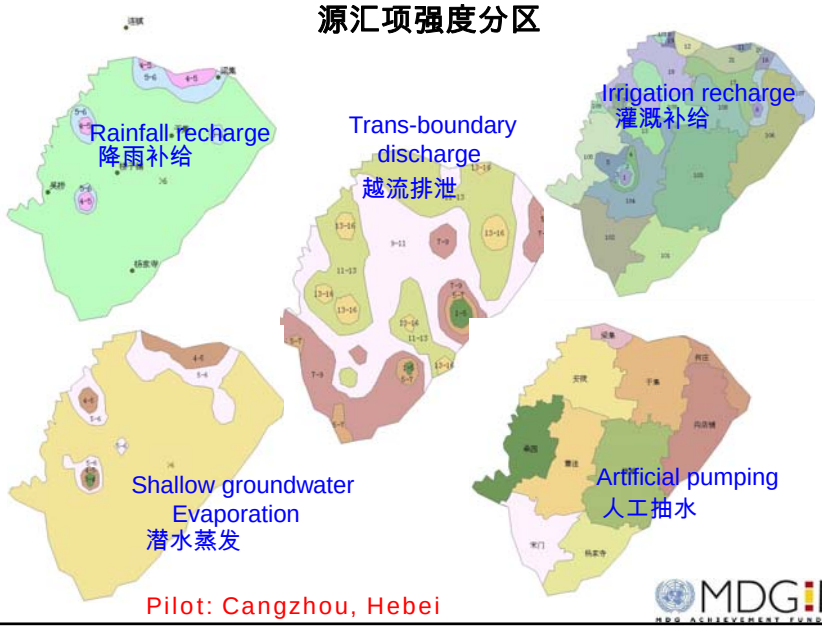
Partition of Source and Sink Terms
源汇项强度分区



Pilot: Cangzhou, Hebei

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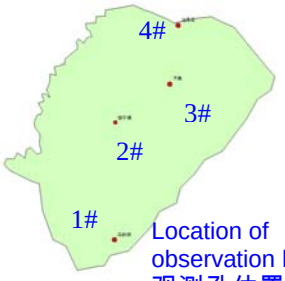
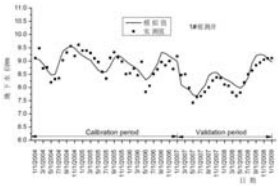
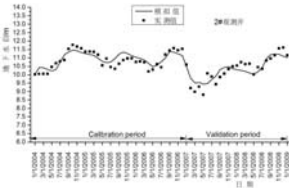
Calibration and Validation of Model
模型率定和检验



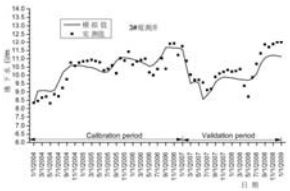
Location of observation hole
观测孔位置



No. 1



No. 2



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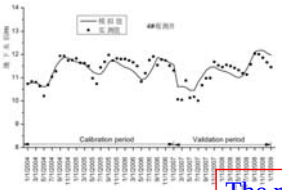

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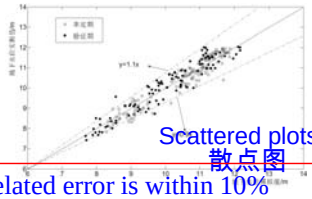

Scattered plots
散点图

The related error is within 10%
大部分相对误差10%以内

Pilot: Cangzhou, Hebei

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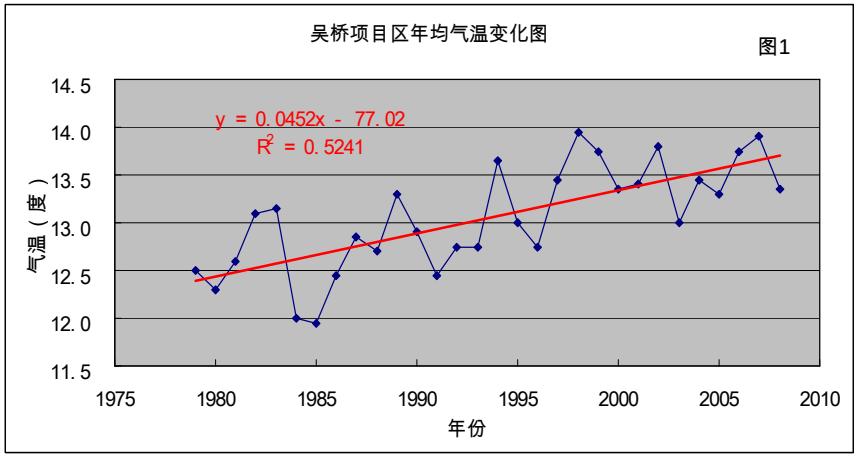
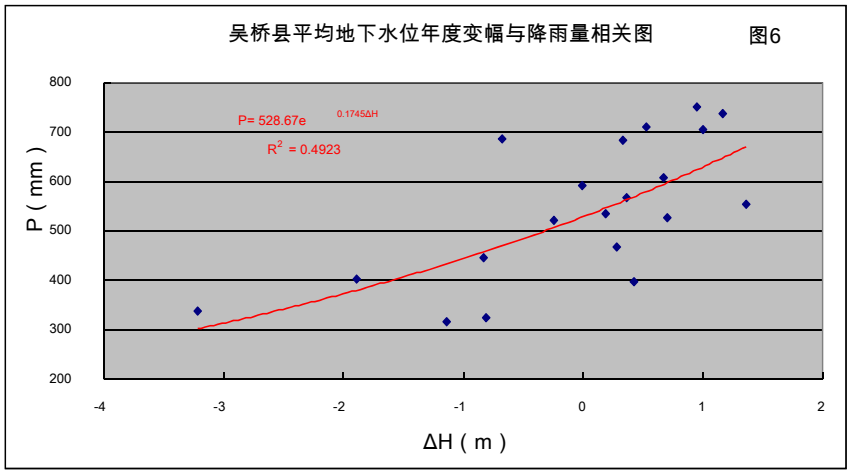
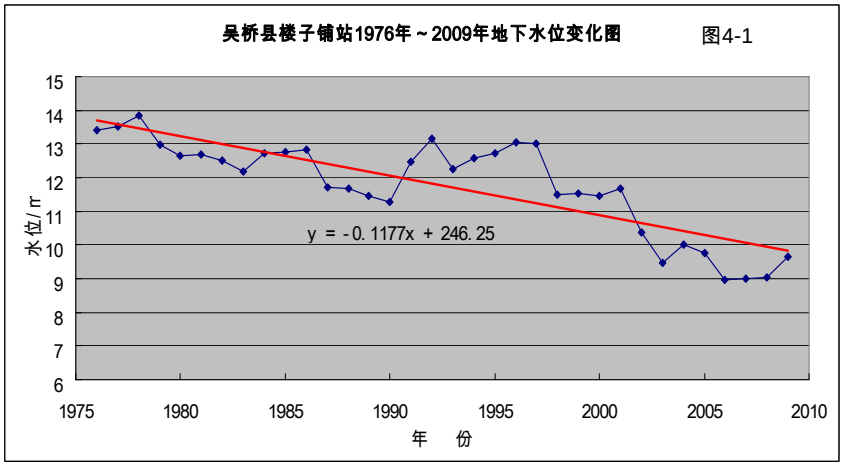
V. Effect and Result

1. Capacity building for groundwater monitoring has been strengthened through updating the existing groundwater monitoring system, field technical support of groundwater monitoring.
2. Assessment of climate change on groundwater irrigation and live hood vulnerability carried out by using historical and monitoring data from three pilot areas.
3. The groundwater management models have been developed and tested, and training for model application has been conducted.




吴桥县平均地下水位年度变幅与降雨量相关图
图6
P= 528.67e 0.1745ΔH
R2 = 0.4923
P (mm)
800
700
600
500
400
300
200
-4
-3
-2
-1
0
1
2
ΔH (m)


吴桥县楼子铺站1976年～2009年地下水位变化图
图4-1
水位/ m
15
14
13
12
11
10
9
8
7
6
y = -0.1177x + 246.25
1975
1980
1985
1990
1995
2000
2005
2010
年 份

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Preliminary results

1. **In recent 30 to 40 years groundwater table has been influenced by both precipitation and human activities.**

2. **In the pilot areas about 30% drop of groundwater is attributed to precipitation, and 70% attributed to human activities.**

3. **Human activities are affected by precipitation**

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Preliminary results

4. **Both evaporation and temperature have slight impact on groundwater table directly, but they affect water use significantly and have indirect impact the groundwater table significantly.**

5. **Climate change affected the groundwater recharge and human activities, human activities amplified the effect of climate change.**

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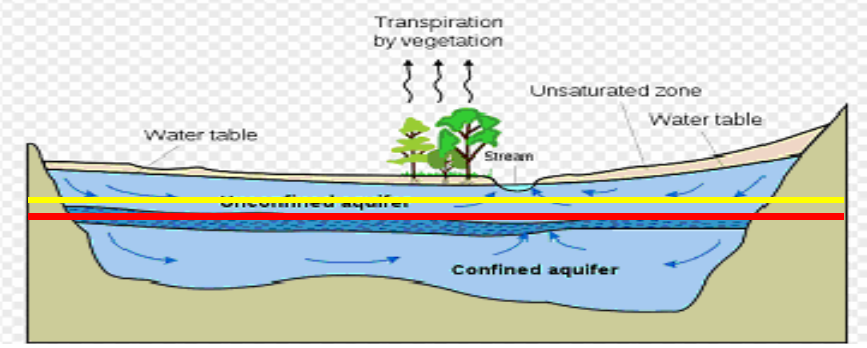
Policy for groundwater utilization and management

Groundwater is strategic resources to cope with extreme draught and should be utilized and managed properly



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VI. Key for Success

i) Experienced troubles

1. Definition of the existing problems: In the three pilot areas, the groundwater is major source of irrigation, drinking and industry. The situation of water utilization, groundwater quality and groundwater depletion is complex.

2. It is difficult to collect groundwater table, pump volume data with same standard and quality.

3. The groundwater table is affected by both climate change and human activities, and climate change and human activities are interacted.

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VI. Key for Success

How to overcome

1. Historical data, statistics methods and field visits were applied to identify the complex relationships of factors which affected groundwater recharge and application.

2. The project team closely cooperated with hydrogeological , meteorological, land use and water supply sectors to collected qualified data.

3. The groundwater models and statistics analysis were conjunctively used to identify the affect of climate change and human activities, and the interaction of climate change and human activities.

4. Groundwater table monitoring with same standard and data share are imported to conduct better research and management of groundwater.

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Thank you !