A path towards sustainable use of an overpumped aquifer – Example: The North China Plain

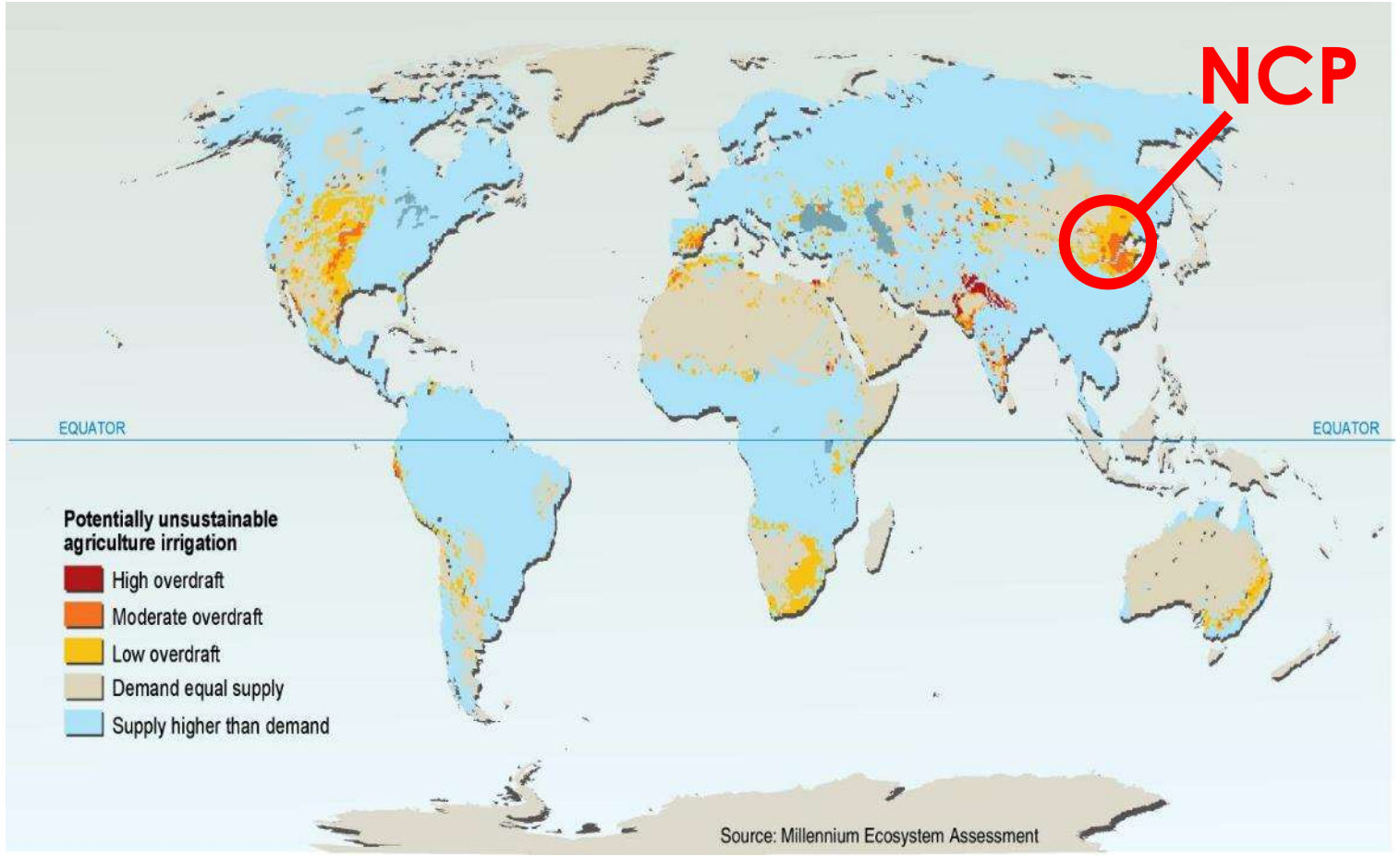
W. Kinzelbach, Yu Li, Lu Wang, Ning Li, P. Burlando
IfU, ETH Zurich

Haijing Wang, Beatrice Marti, Silvan Ragettli
hydrosolutions, Zurich

Overpumping in North China Plain (NCP)

Overpumping of aquifers due to agricultural irrigation is a worldwide phenomenon

About one quarter of annual abstractions is not sustainable

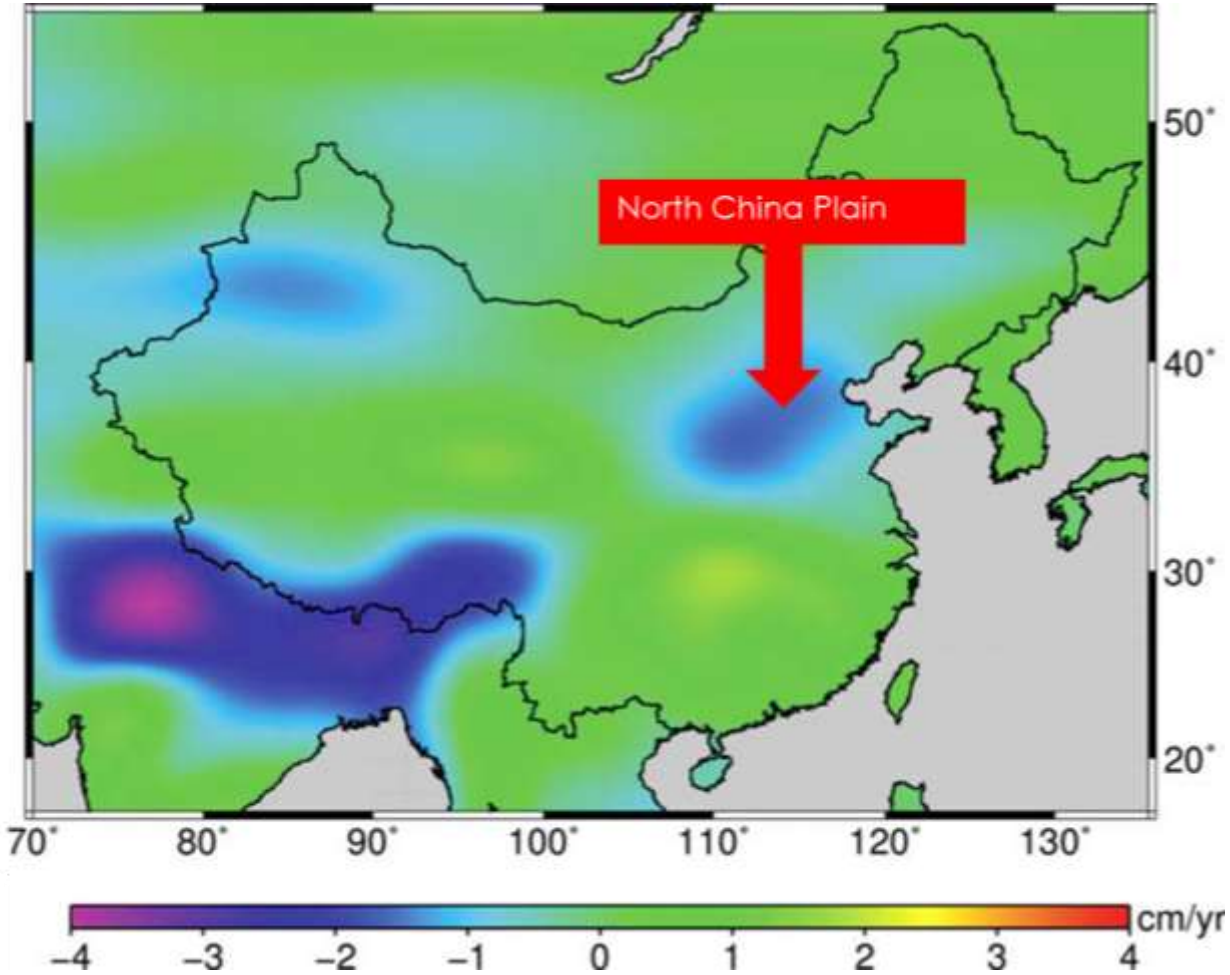


Undesirable consequences

- Streamflow reduction
- Soil subsidence
- Increase of pumping cost
- Seawater intrusion
- Storage depletion ➡ less resilience against droughts
- …

Overpumping in North China Plain (NCP)

An image from the GRACE mission



Feng Wei et al., 2013

from 2003 - 2012
depletion ≈ **80** Bio. m^3

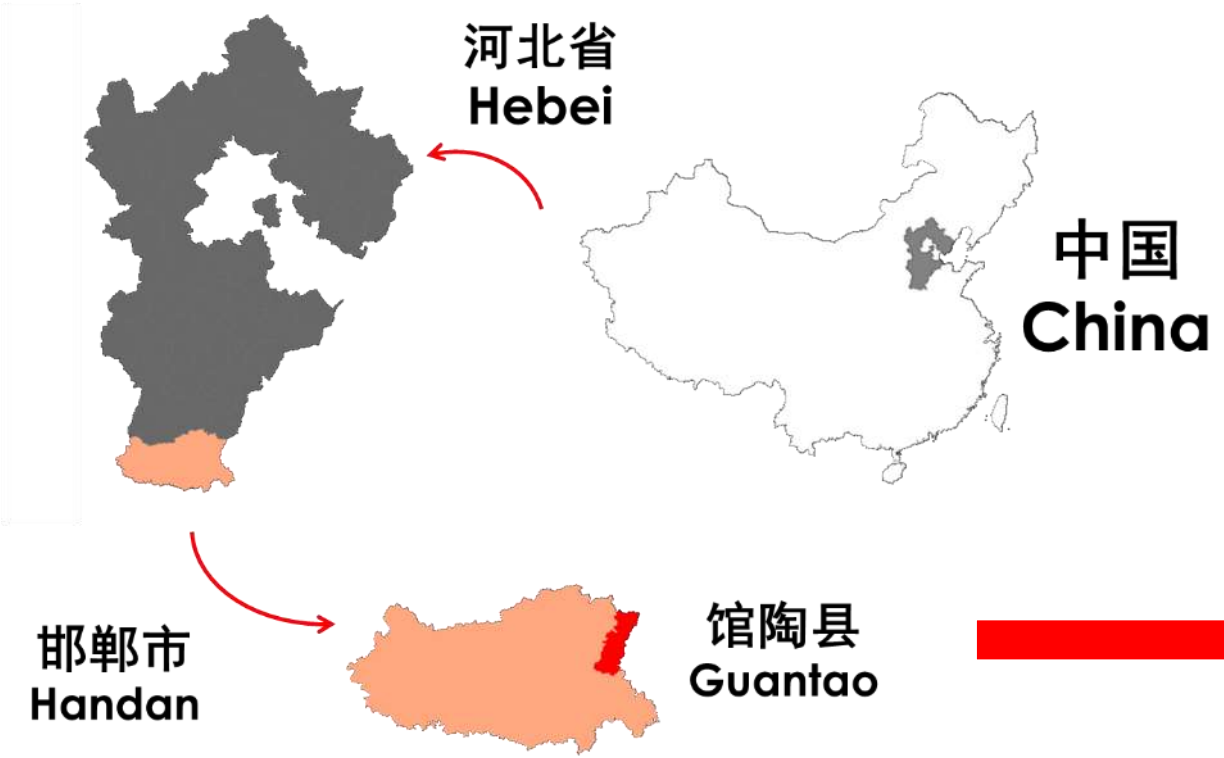
=

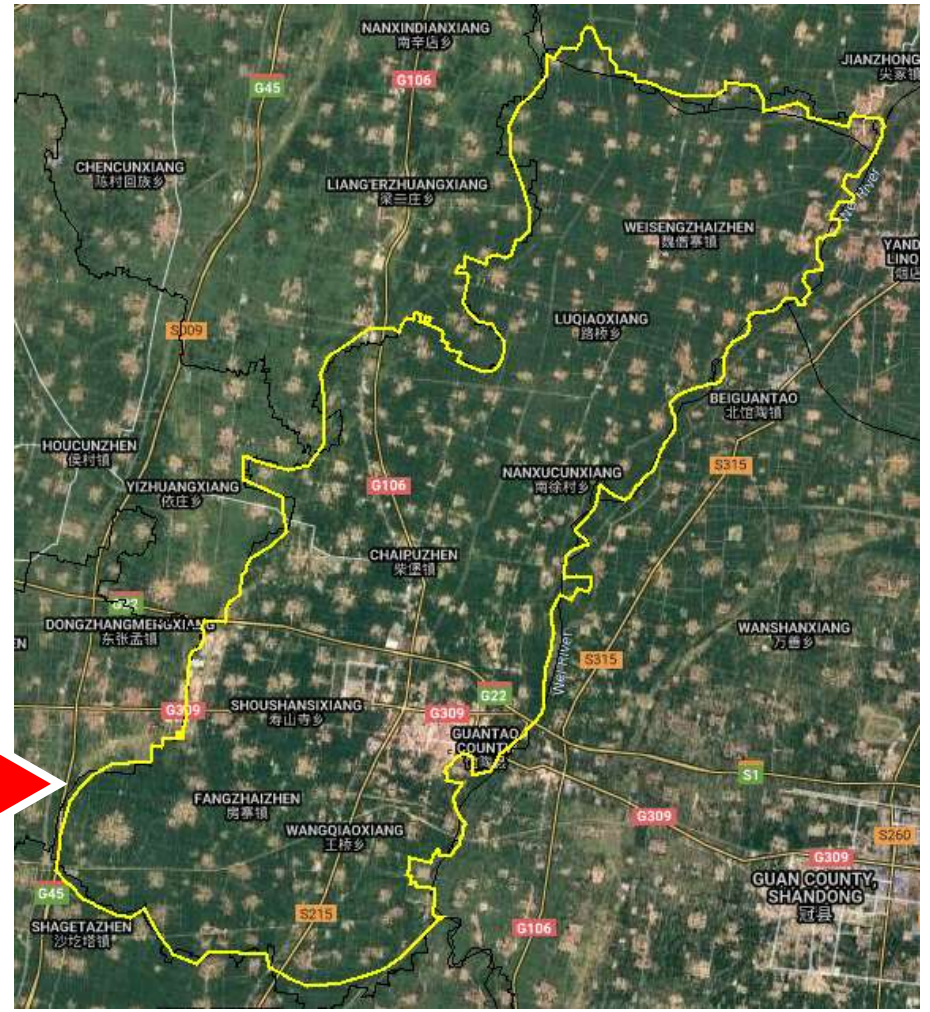
× **2**

Three Gorges Reservoir

Abstraction is about **15-20%** above sustainable level

Guantao Site in NCP





- Semi-arid climate
- supplementary irrigation mainly GW
- irrigated area 300 km^2
- total area 456 km^2

Guantao Site in NCP

Water Consumption:

400 – 450 mm

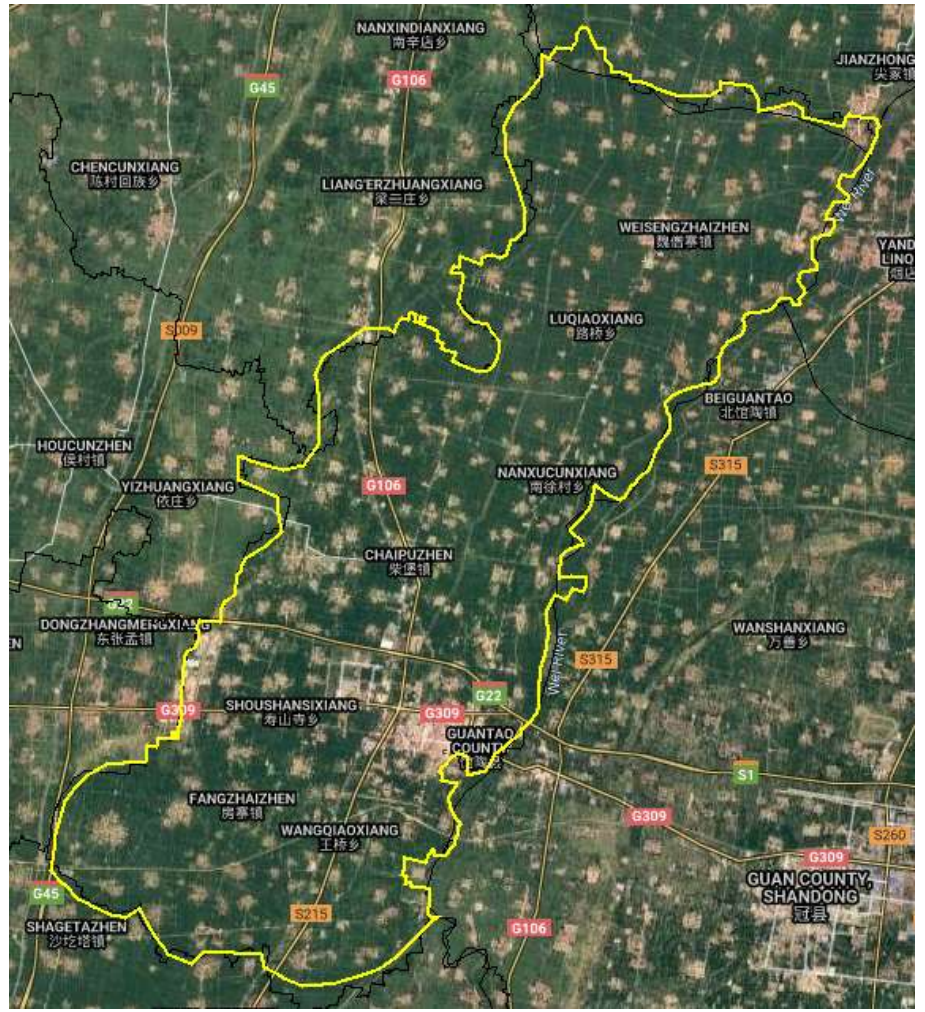
300 – 400 mm

Average annual rainfall:

450 – 550 mm (mainly in summer)

Average irrigation required:

200 – 400 mm (mainly for winter wheat)



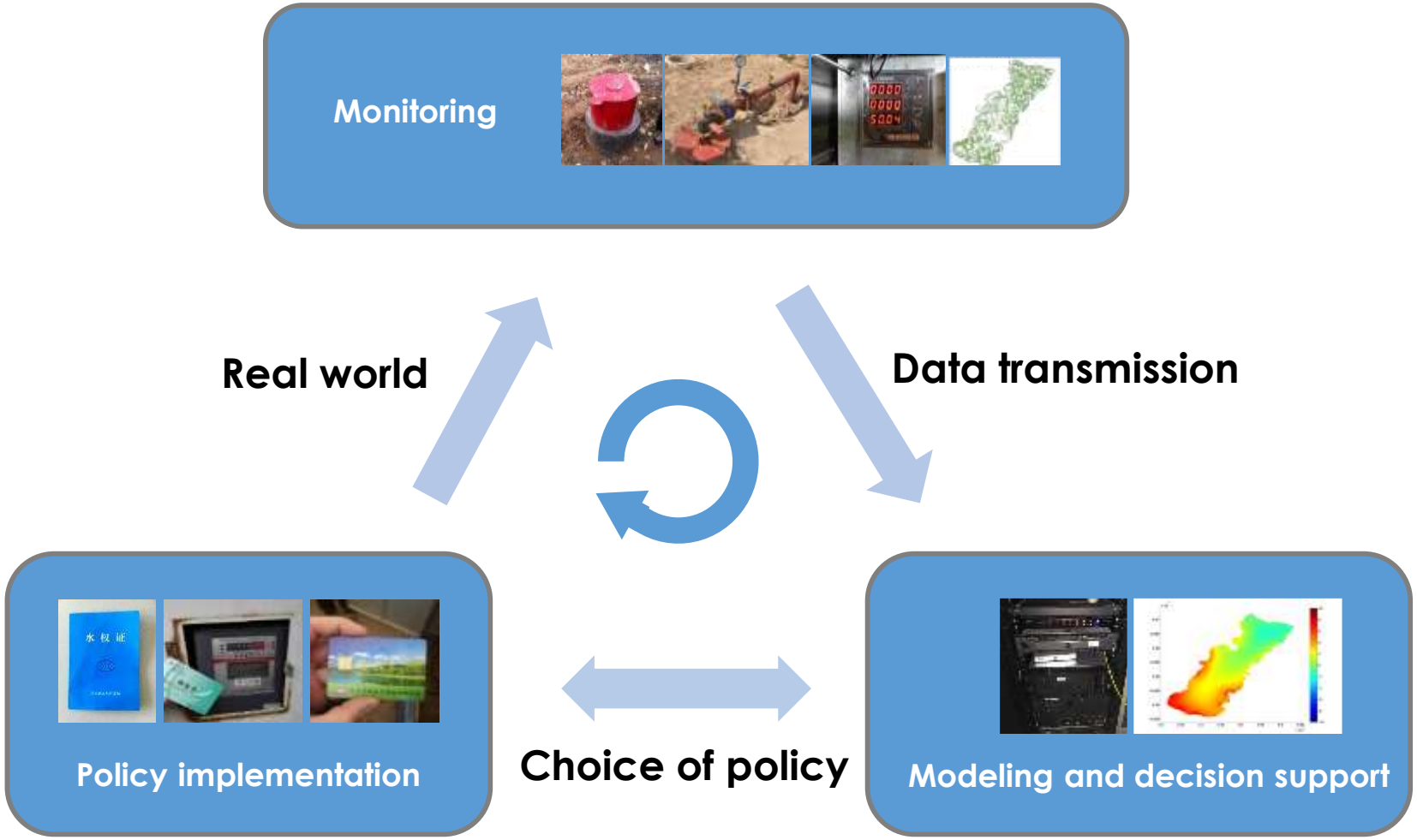
Task:

Reduce average groundwater abstraction by about 20%

- Semi-arid climate
- supplementary irrigation mainly GW
- irrigated area 300 km^2
- total area 456 km^2

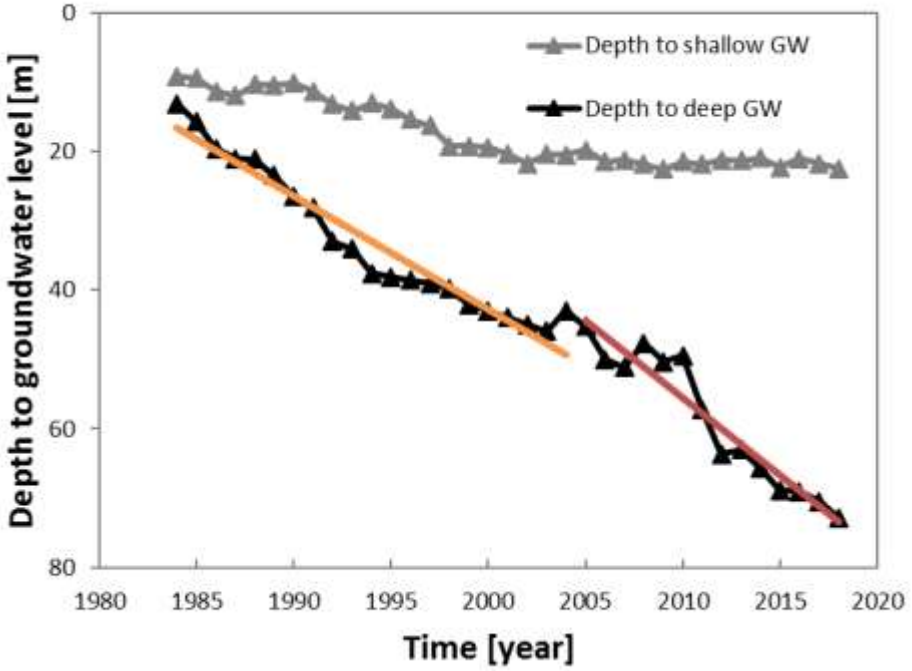
Management System

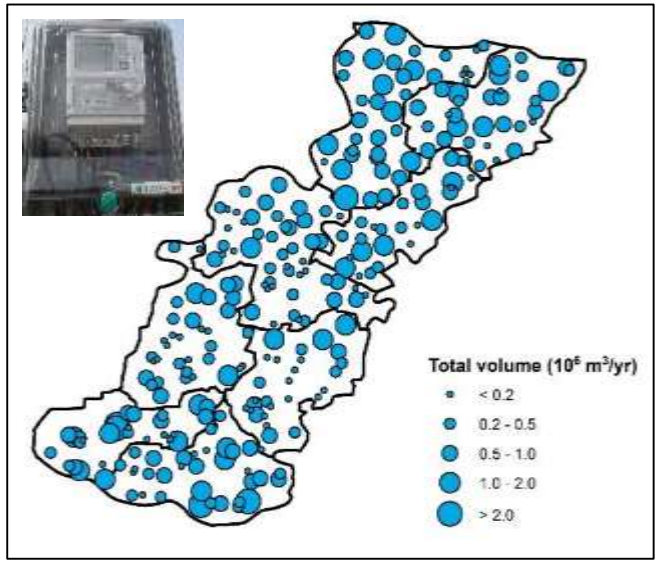
— based on monitoring, modelling and control



Data Monitoring

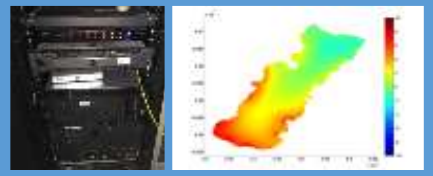
- Automatic measurement of **GW-levels** ;
- Measurement of **pumped volumes** by electricity used ;
- **Landuse** montoring by Remote Sensing ;





Water use of villages converted from electricity use

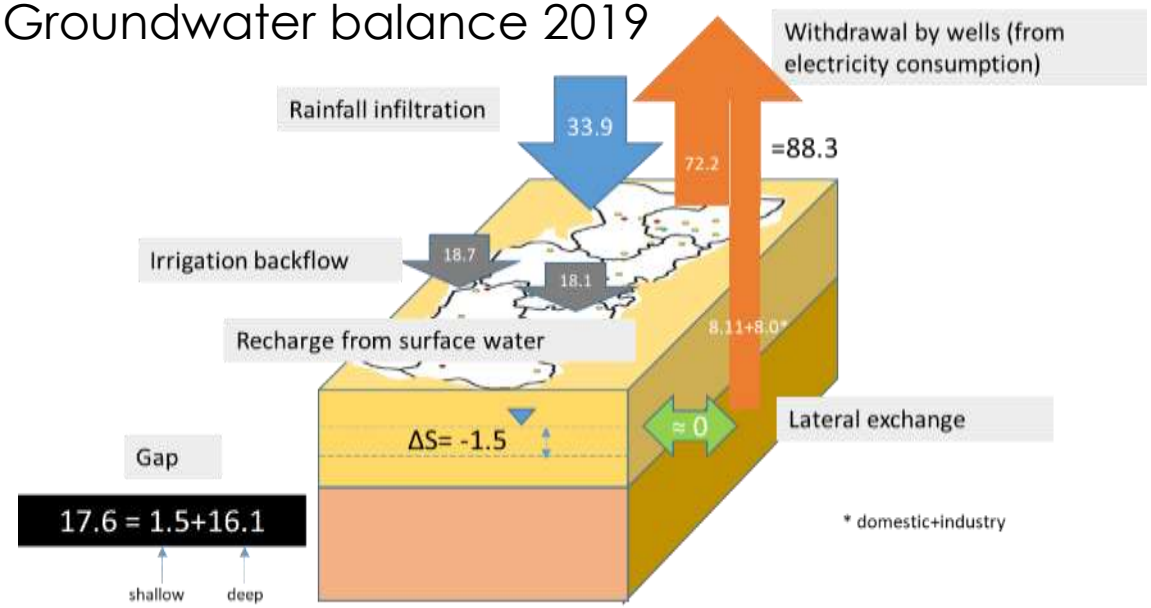
High resolution remote sensing of winter wheat



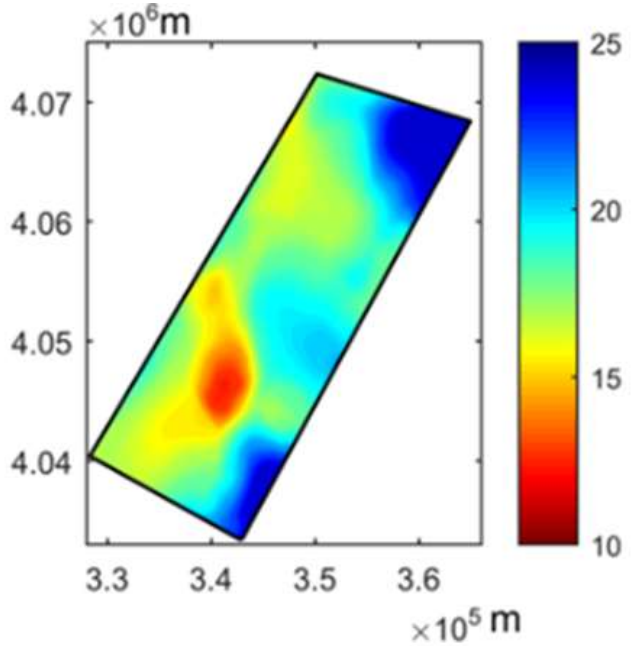
Modeling and Decision Support

- Calculation of **water balance** and **prediction of GW-levels** over next season by models ;
- **Decision** on fallowing, water import, and water saving irrigation to reach GW-level goal ;

Groundwater balance 2019



Gap: 17.6 Mio. m^3/a or about 20% of total groundwater use



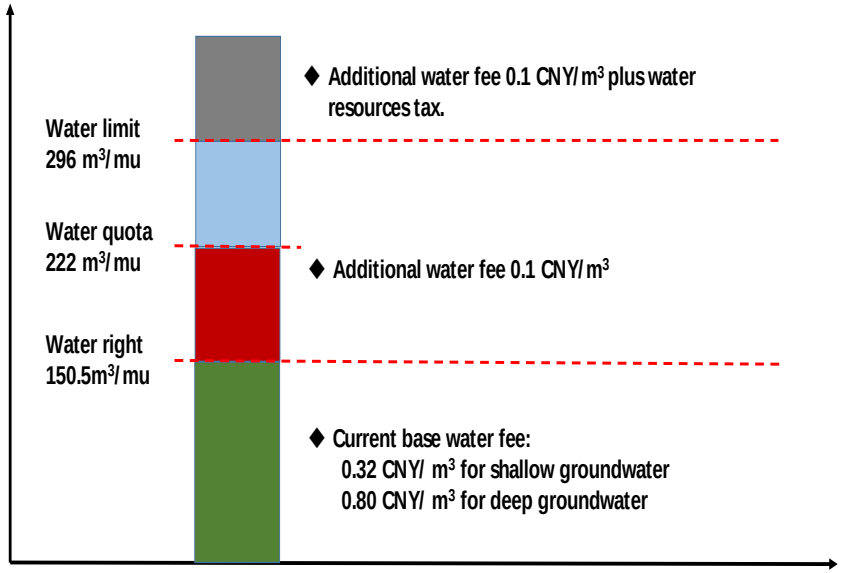
Depression cone in district with high proportion of greenhouses

Policy Implementation

- Allocation of **subsidies** for fallowing and water saving irrigation ;
- Collection of **water fees** according to tiered scheme ;

Winter wheat fallowing
(Subsidy of 500 CNY/mu)

Subsidy for water saving:
Only effective for big farms



Tiered quota scheme

Conclusions

- Most effective overpumping control measure so far is subsidised fallowing of winter wheat. The amount of fallowing cannot be increased substantially as it would contradict the food security policy of China.
- Electricity to pumping volume monitoring has shown to be an effective and feasible method for metering of many small irrigation wells in North China Plain.
- Water fees for overstepping quota have been calculated but are not yet implemented due to resistance by the farmers.
- Water saving potential is low as farmers already save water by practising deficit irrigation. It will increase somewhat as small family farms are merged to large farms, which can practise precision agriculture.
- The final solution to overpumping will come with the prolongation of the central route of the South North Water Transfer scheme into Hebei province.

Shallow aquifer

Deep aquifer

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Chinese Ministry of Water Resources

China Geological Survey