The Role and Perspective of Hydropower in Water-Energy-Food Nexus in China

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1, Water-energy-food nexus

- **Water** is the most basic factor of energy and food processing
  - **Production, Life, and Ecology** need abundant and good quality water
  - Water is needed for electricity generation including thermal and nuclear power generation
  - Hydropower is a integrated product of water and energy

- **Energy** is the basic guarantee factor for water use, food processing.
  - Water purification, transportation, pumping , supply and consumption
- Water, energy and food are independence, and interaction
  - **No water no life**
  - **No water no development**
  - **No food no life and no development…..**

* As basic factors, water, energy and food shortages are existing in some countries and regions, especially in Least Developed Countries (LCDs)

* **For human being and development,** water is basic, energy is key, and food is fundamental demand.

2, Water Resources Status and Challenges in China

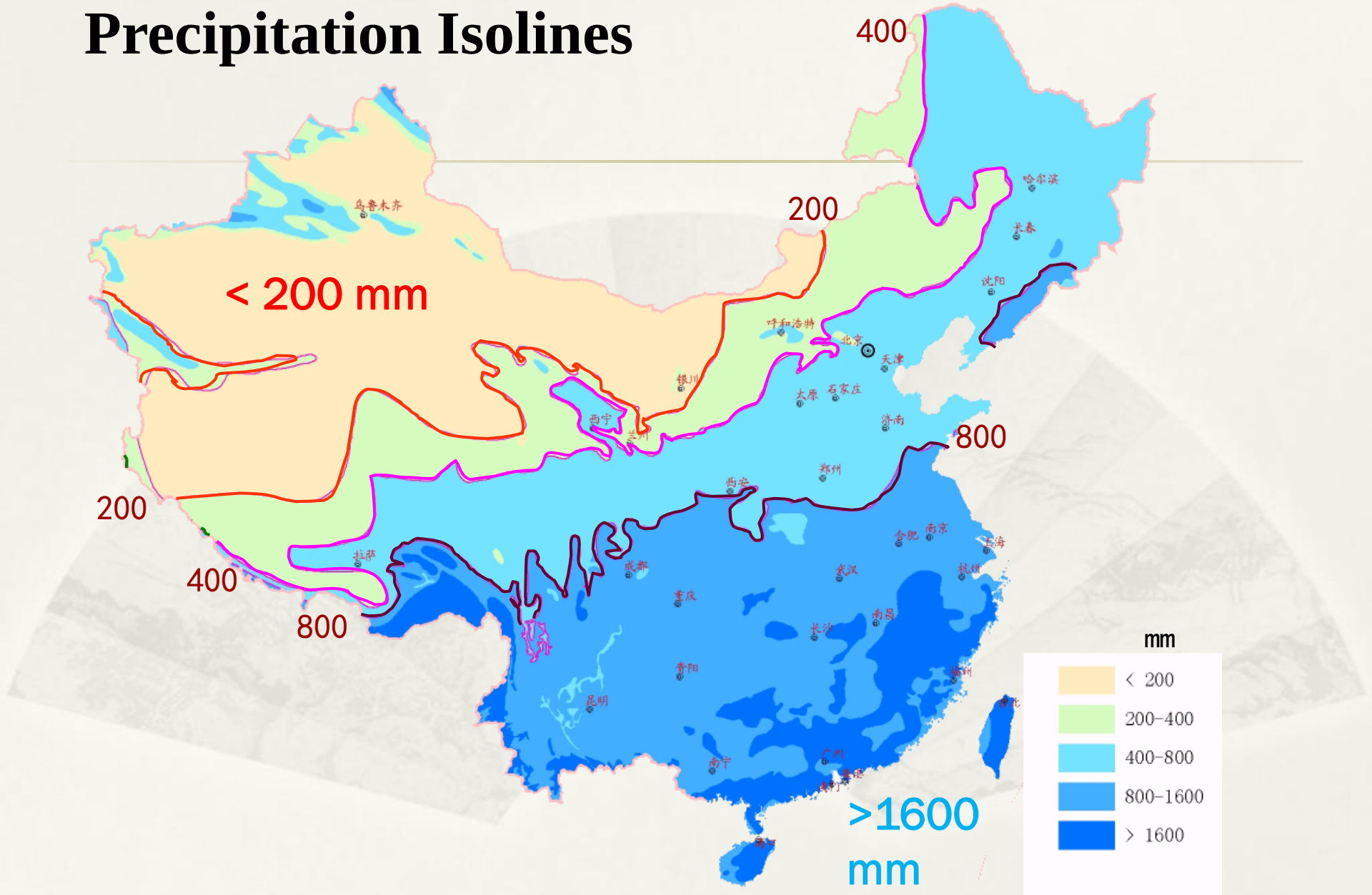
- **Population**： China is the most populous country in the world, with about 1.3 billion people, about 22 percent of the world's total.
- **Land Area**: 9.60 million km^2， in which,
  Mountains, Hills and Plateaus: 2/3;
  Cultivated land: 136 million hm^2 : 14%

Precipitation

* Precipitation: Mean: 608 mm
  Varying: 50mm — 1500/1600mm

In June-September: Precipitation is about
60-80%, Causing floods (2/3 of them flooding runoff)

Precipitation Isolines



Water Resources Availability

- Total water resources: 2,800 billion m^3
  - in which, 730 billion m^3 are underground
  - WR per capita is about 2,100 m^3

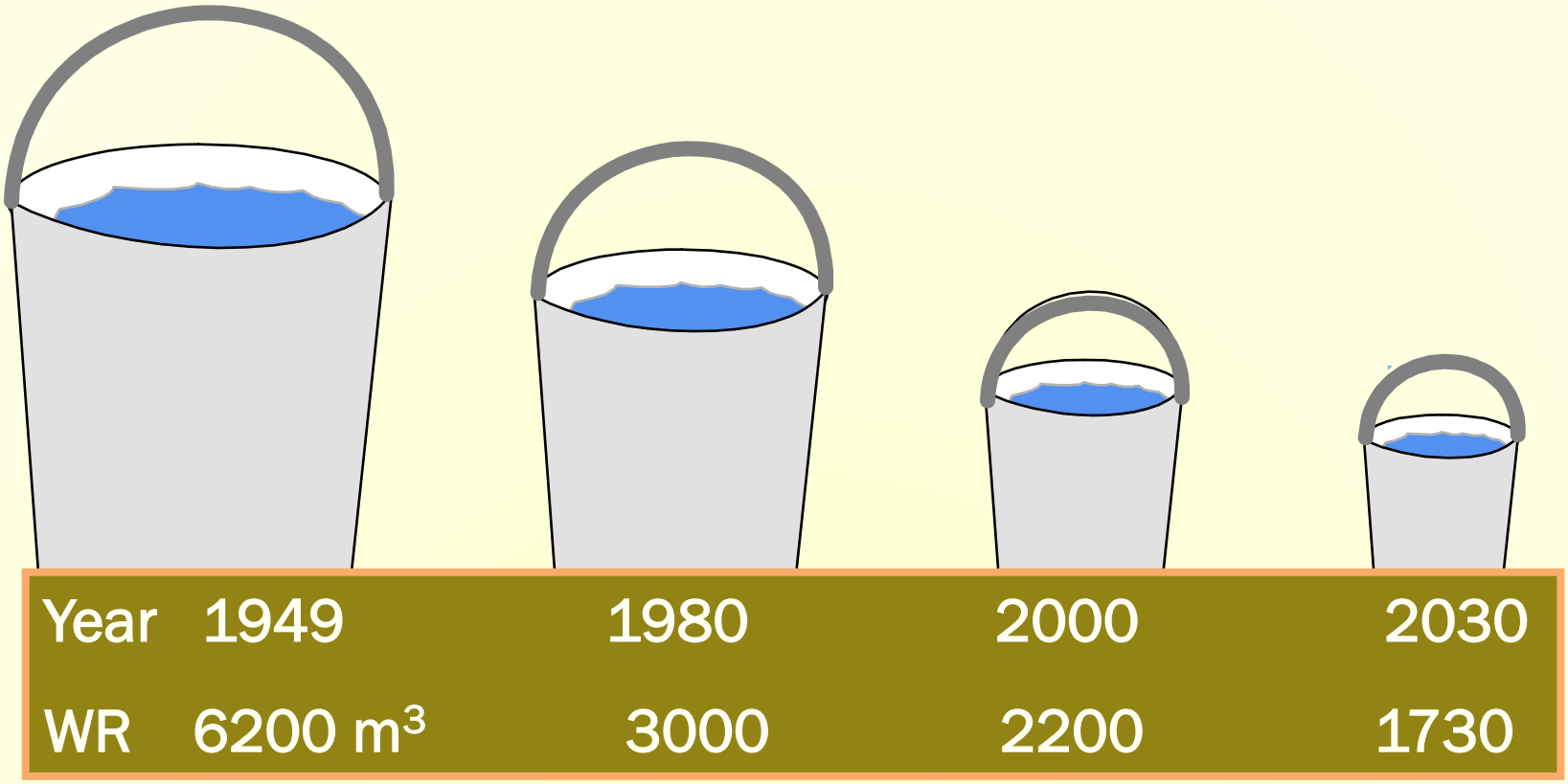
Uneven Distribution of Water, People & Land

	Water,	*Population,*	*Land*
South:	81%,	54%,	36%
North:	19%,	46%,	64%

Water Shortage

- From 1970s, there are more than 400 cities facing water shortage in 660 cities, and in which 100 cities are seriously lack of water , annual water shortage is 5.8 billion m^3.
- **Three reasons:**
  - Natural sources scarcity
  - Shortage of water infrastructure
  - Pollution and waste (low efficiency)

Freshwater availability per capita from 1950- 2030 in China



Year	1949	1980	2000	2030
WR	6200 m^3	3000	2200	1730

Agricultural water use (Effective Irrigation plays key role for grain yield)

YEAR	2000	2013	
Irrigation Land:	53.3	63.5	million hm^2
Irrigation water:	63%	55%	of total water use

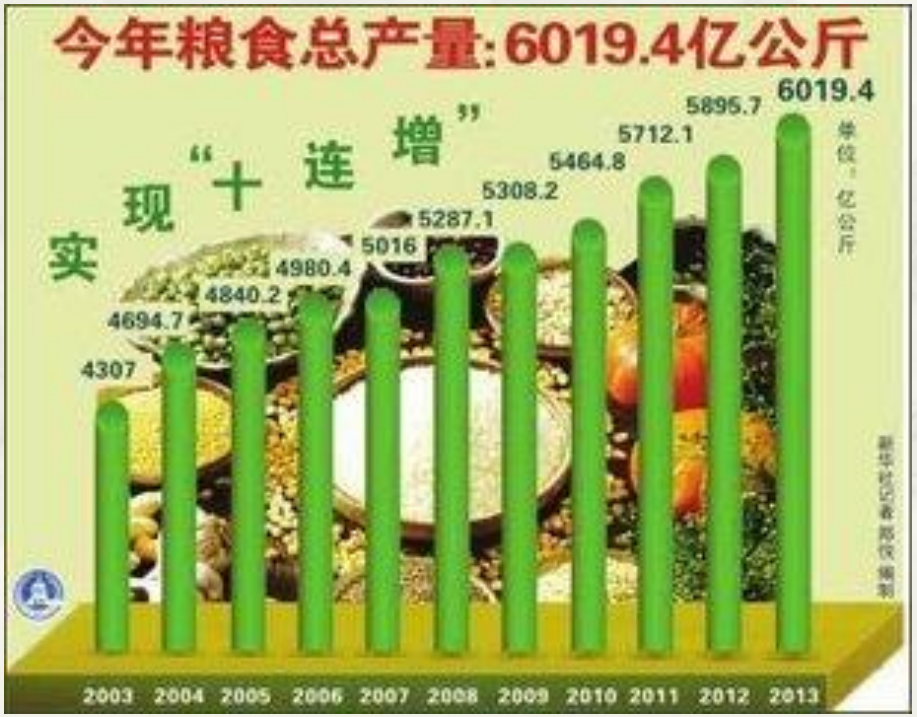
- Irrigation efficiency: from 0.45 to 0.5

Agricultural Water Demand

* Due to irrigation land and water efficient use, and many other measures, grain yield increased 10 years stably

- Cultivated land expanded yearly

- Water saving



- In conclusion, **total water** availability is large in the country, but water per capita is much less, and uneven distributed, especially not matched with land and cultivation activities.

- Agricultural water use is dominant, but low efficiency. For **food security**, (1) increasing irrigation area (2) increasing water efficiency

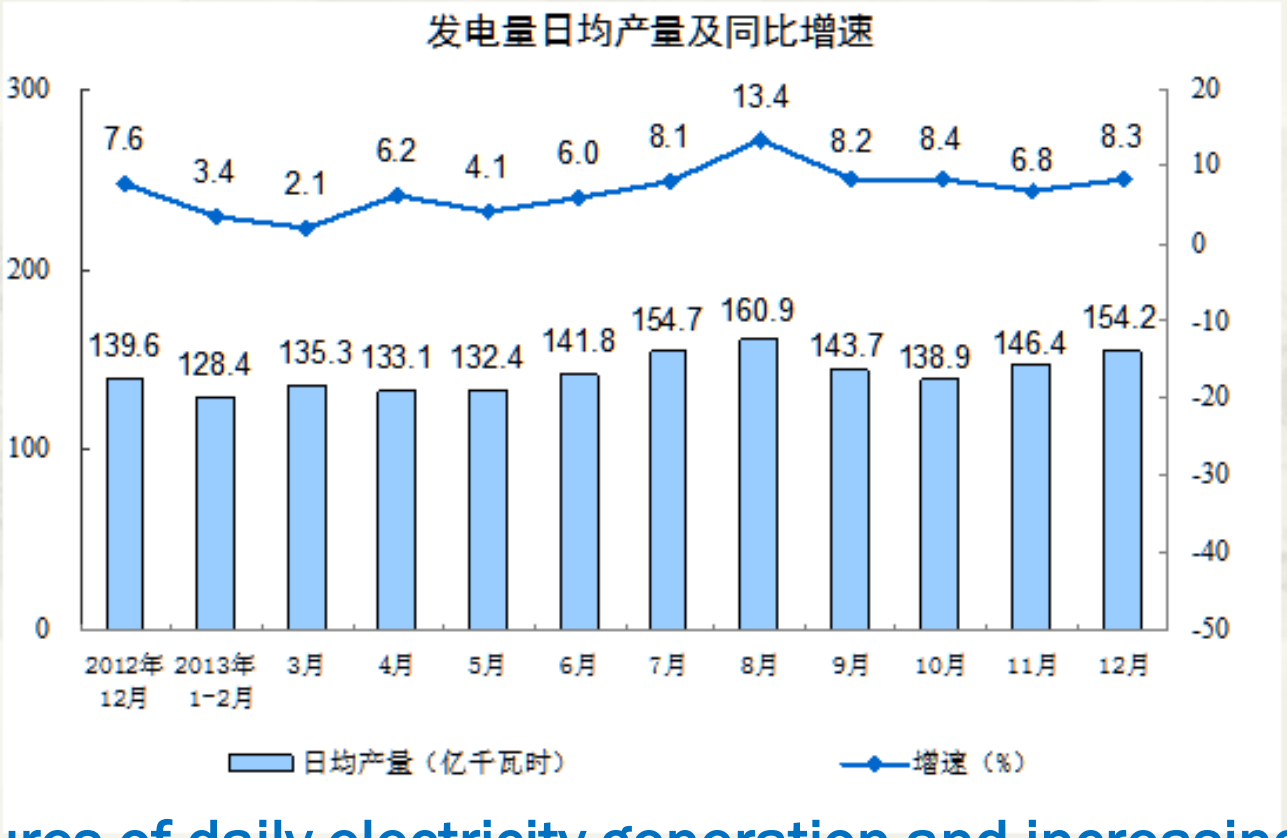
3, Role and perspective of Hydropower in China

* Hydropower is the dominant renewable energy in the world. The first hydropower in China has been operated over 100 years. (Yunnan Province)

  Renewable energy, including hydropower, instead of fossil energy is a trend/strategy in the world.

  Hydropower is a succeeded technology. After Fukushima nuclear power station disaster, hydropower were recalled attention.

* Total Electricity Generation (2013： 5245.5 TWh)



Figures of daily electricity generation and increasing rate

Power Installation

* Total Installation 1247 GW (2013)

* Thermal	862	69.1%
* Hydropower	280	22.5%
* Wind power	75	6%
* Nuclear power	15	1.2%
* Solar power	15	1.2%

In renewable energy, hydropower is dominant

Hydropower

- Total Potentials 680 GW
  - 70% is distributed in southwest region

- Total developed 280 GW (Year 2013)
- 420 GW (Year 2020)

  - in which **SHP** 128 GW (potential)
  - 71 GW (2013)

- **In total electricity production:**
  - Thermal 78.3%
  - Hydropower 16.8%
  - Wind 2.6%
  - Nuclear 2.1%
  - Solar 0.2%

At present, the electricity production mainly depends on coal, oil, gas, but hydro has big potential. **More hydropower development is requested, for clean production and renewable energy**

* Hydropower development rate:
  * USA 82.1%
  * Japan 83.6%
  * Norway 90%
  * China 41.2% (less than developed countries)

  * Per capita hydropower installation:
  * **USA: 3kw, Japan/Europe: 1.5Kw, China: 0.75**

- Currently, China hydropower installation is **280 GW** (about 22% of total power installation, 16% of total electrification. It has already exceeded the goal of 12th National Five Year Planning(till 2015) for RE, which is 260 GW.
- So Hydropower has been encouraged and supported in last years.

Perspective

- In the near future, based on **Chinese National Renewable Development Planning**, especially for adaptation of climate change, hydropower will be increased continually.

- Large hydropower basis. To develop abundant hydropower potential rivers with priorities, 10 basis with over 10GW each, including upstream of Yangtze river, Yellow river . Hydropower development feasibility study for Southwest river will be started.

About Small Hydropower

SHP is an abundant resource in China, widely distributed in more than 1700 counties in over 30 provinces, regions and municipalities, mainly in western area.

With a total potential capacity of 128 GW according to the latest survey.

* The largest scale small hydropower development: 46,000 stations with 71 GW installation

- Small hydropower is one of key roles in water-energy-food nexus
  - Basic electricity supply and rural industries demand
  - Pumping and irrigation can guarantee agricultural production, and food security
  - Environmental protection

4, Coping strategies to the challenges

- Strategies and measures for three challenges: water-energy-food
  - **Innovation**
  - **Cooperation**
  - **Integrated measures**

- 13th National Five Years Development Planning

- **Water** reform and development (No.1 Document of Central Government, 2011)
  - By the 2020, water resources problems should be solved basically.
- Recent strategies (by President Xi)
  - **Water saving**
  - Space Balance (water and land, economy)
  - System Governance (integrated measure)
  - Governmental and Market functions

- **Energy strategy**: National Middle and long term Renewable Energy Development Planning (2007)
  - Non fossil energy consumption is 11.5% and 15% of primary energy consumption, in 2015 and 2020
  - Therefore, develop renewable energy, including hydropower (small hydropower), will be prior to fossil energy.
    - Compulsory percentages of RE
    - Infrastructure Investment
    - RE electricity price
    - Marketing orientation
    - Institution reform
    - ……..

- **Food security** is always top issue in China
  (2014, No.1 Central Governmental Document)
  - National agriculture security strategy
  - Guarantee cultivation land
  - Increasing irrigation efficiency, irrigated land
  - Investment and integrated measure
  - Modern agricultural system (include water saving)
  - ……

5, Summary

- **Water-energy-food nexus**, one problem may lead to other problems.
  - **Water security** is key issue in , water saving is national strategy.
  - **Energy security** is important issue. Hydropower will be focused as one of key renewable energy.
  - **Food security** is top issue in China, in which, irrigation agriculture will be emphasized.
- **Integrated policies and measures** for W-E-F nexus