

# World Bank's case in China

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Water

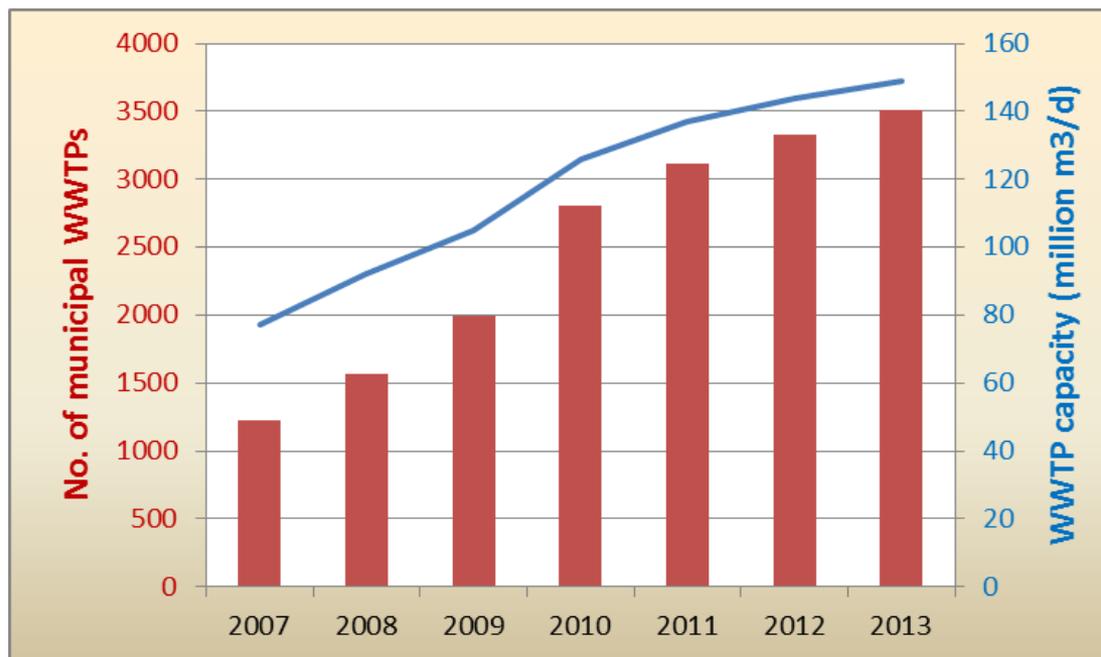
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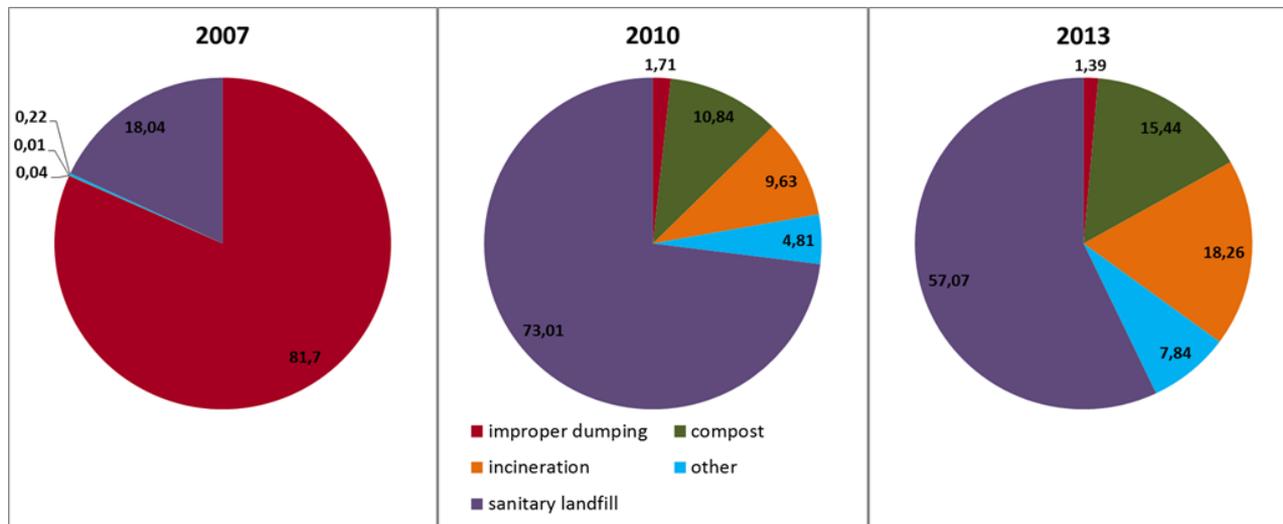
# 1. Background of urban sewage sludge mgmt in China

- Urban population:
  - > 50% of China's population (> 700 million).
- Urban sewer connection rates:
  - 87% (WHO+UNICEF, 2015).
- Wastewater Treatment Plants (WWTPs)  $\approx$  3,500 nr.



# Background of urban sewage sludge mgmt in China

- Sludge treatment:
  - $\approx 90\%$  of WWTPs have only sludge thickening + dewatering.
  - Very few WWTPs utilize other sludge treatment technologies (digesters, etc)
- Sludge disposal/ reuse:
  - Dramatic change over the last couple of years (see below).
  - Total quantity > 30 million tons / year.
  - Possible data gap of up to about 20-25% additional sludge.



Source:  
WRI (2016), using  
data from MOHURD  
and its own estimate

# Background of urban sewage sludge mgmt in China

- Legal background:
  - **Overlapping responsibilities for sludge mgmt of 5 institutions.**
- 3 main objectives of sludge mgmt:
  - **Volume reduction** mostly done in China, but somewhat inefficient due to high organics content (lack of stabiliz.)
  - **Sludge stabilization** mostly NOT done in China
    - => odor,
    - => high DS/cap
    - => poor dewatering results
  - **Safe disposal / reuse** mostly done in China

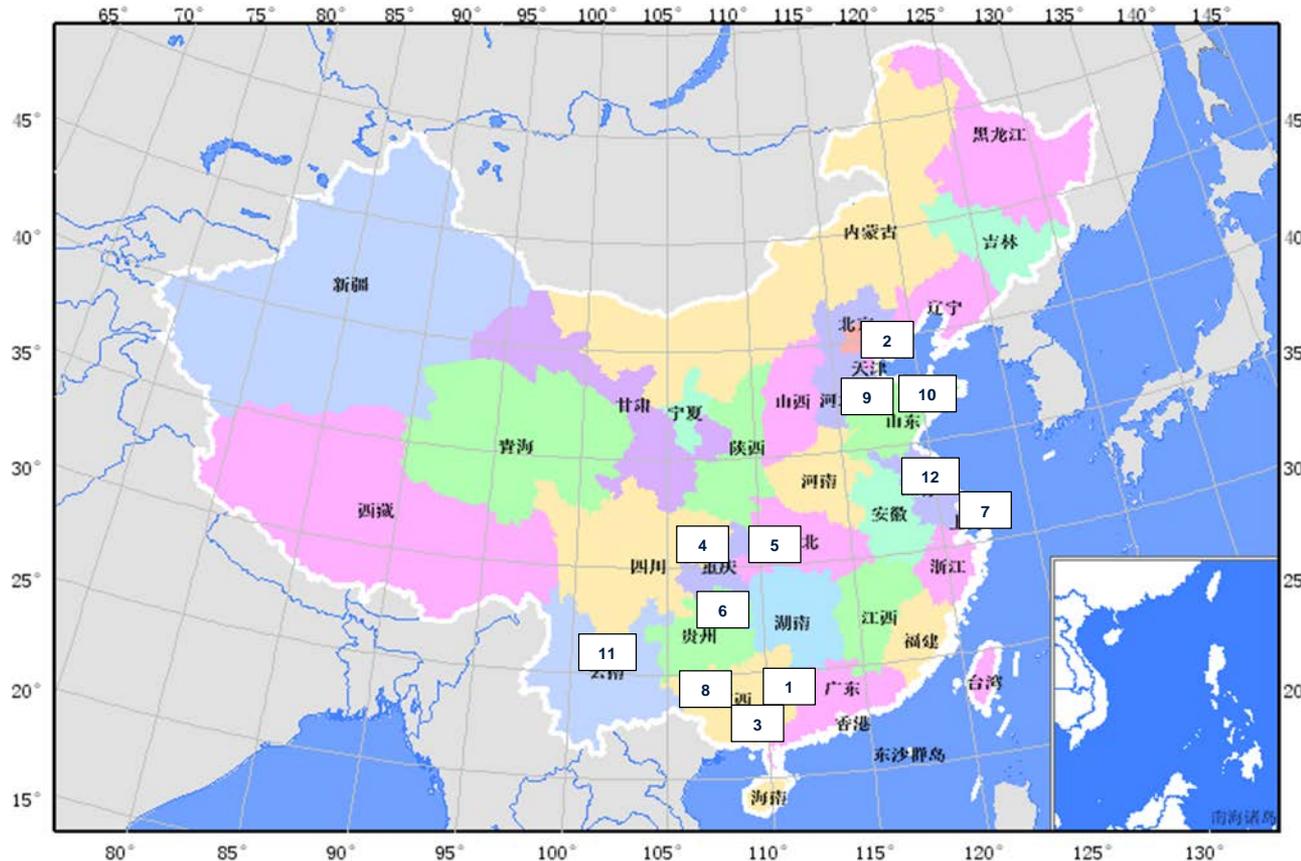
## 2. Survey of Bank/Non-Bank Projects in China

### Visited / analyzed facilities

Location	Sources of Sludge	Treatment Technology	Capacity tons/day	Sludge Final Disposal / Reuse
Guilin, Guangxi	M	composting	130	fertilizer for forestation
Tianjin	M & I	thermal hydrolysis	150	fertilizer, bricks
Liuzhou, Guangxi	M	co-processing	140	cement
Chongqing	M	co-processing	100	cement
Chongqing	M	co-processing	100	cement
Zunyi, Guizhou	M	co-processing	100	cement
Shanghai	M	incineration	600	bottom ash landfilled
Nanning, Guangxi	M	composting	300	fertilizer for forestation
Yucheng, Shandong	M&I	solar drying	100	fertilizer
Linyi, Shandong	M	solar drying	40	fertilizer
Kunming, Yunnan	M	natural drying	20	supplementary fuel
Zhangjiagang, Jiangsu	M	natural drying	100	supplementary fuel

- Notes:
1. "M" denotes sludge from municipal WWTPs and "I" denotes sludge from industrial WWTPs or industries
  2. Bottom ash from incinerator combustion process normally at 30% of the sludge feed

# Survey of Bank/Non-Bank projects in China

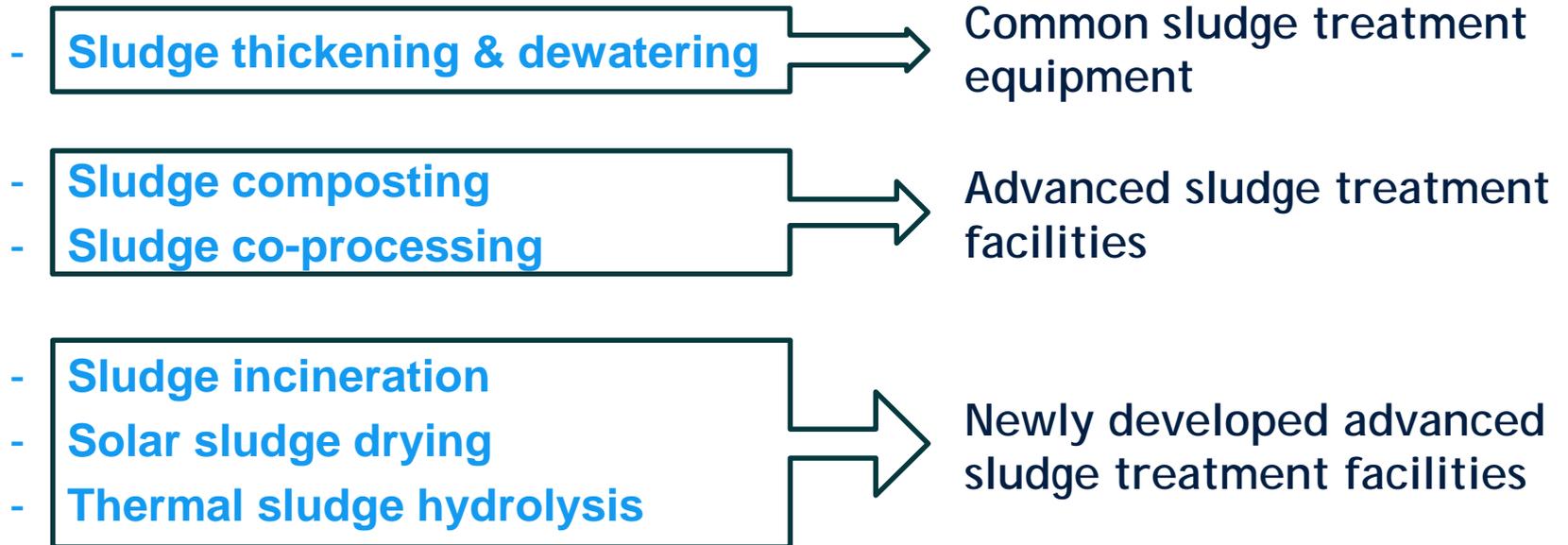


Location of visited sludge treatment facilities

<b>Number</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
City	Guilin	Tinjian	Liuzhou	Chongqing	Chongqing	Zunyi
<b>Number</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>
City	Shanghai	Nanning	Yucheng	Linyi	Kunming	Zhangjiagang

# Survey of Bank/Non-Bank projects in China

## - Categories of sludge management in China:



# Survey of Bank/Non-Bank projects in China



Composting



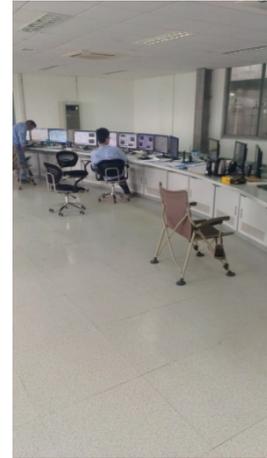
In-vessel composting



Co-processing in cement industry



# Survey of Bank/Non-Bank projects in China



Sludge incineration



Solar sludge drying

# Survey of Bank/Non-Bank projects in China

## Thermal sludge hydrolysis



... with protein manufacturing



# Survey of Bank/Non-Bank projects in China

- Findings:
  - Sludge thickening normally operating inadequately, or not at all.
  - Typical dewatering results: DS = 20% (80% water content).
  - Certain trend to Frame Filter Presses with lime addition => 40%DS for landfill disposal.
  - Frequent and strong odor problems.
  - None of the facilities visited had an anaerobic digester.
  - Sludge production in the order of 70 gDS/cap/d <= poor stabilization.
  - Land requirement: highest for composting, lowest for co-processing.
  - Privately-owned facilities with reduced CAPEX and OPEX, as compared to publicly-owned facilities.
  - Private sector plays important role in sludge mgmt; mostly BOT and JV contracts.
  - Engineering cost curves (see report).

### 3. International Trends and Best Practice in Sludge Mgmt

- International trends include additional technologies not found in China during site visits, such as:
  - New types of mechanical thickening (screw thickener, disc thickener).
  - New types of mechanical dewatering to  $\approx 20\text{-}30\%$ DS (screw press).
  - New types of mechanical dewatering to  $\approx 35\text{-}50\%$ DS (membrane press, high-pressure hydraulic (Bucher) press).
  - Different technical variations of solar sludge drying.
  - Low-temperature thermal sludge drying ( $\approx 50\text{-}150$  °C).
  - Ultrasound sludge hydrolysis.
  - Many variations for biogas utilization (co-generation, microturbine, supply to natural biogas pipelines, direct drive engines, utilization as vehicle fuel, etc)
- Based on what is already operating successfully in China, none of the above described technologies appears (operationally) out of reach for Chinese WWTPs.

# International Trends and Best Practice in Sludge Mgmt

- The case for anaerobic digestion (AD):
    - **Obstacles:** Dilute nature of many Chinese wastewaters lead to widespread perception that AD is not applicable in China. Further, operation is considered difficult.
    - However, frequent unfavorable conditions do not exclude AD per se. Instead it requires case-specific analysis, and adjusted design.
    - Digesters can be constructed in simple cylinder shape; no need for sophisticated egg-shaped digesters.
    - **Benefits are not yet fully recognized in China:**
      - sludge volume reduction of  $\approx 50\%$  (less DS + improved dewatering);
      - elimination of bad odor issues;
      - increased WWTP operation safety; less dependence on public power grid.
      - financially viable;
      - reduced GHG emissions (total saving potential in China  $\approx 15$  million tons CO<sub>2</sub>e/year).
- => Studies based on specific Chinese conditions usually include AD.**

# International Trends and Best Practice in Sludge Mgmt

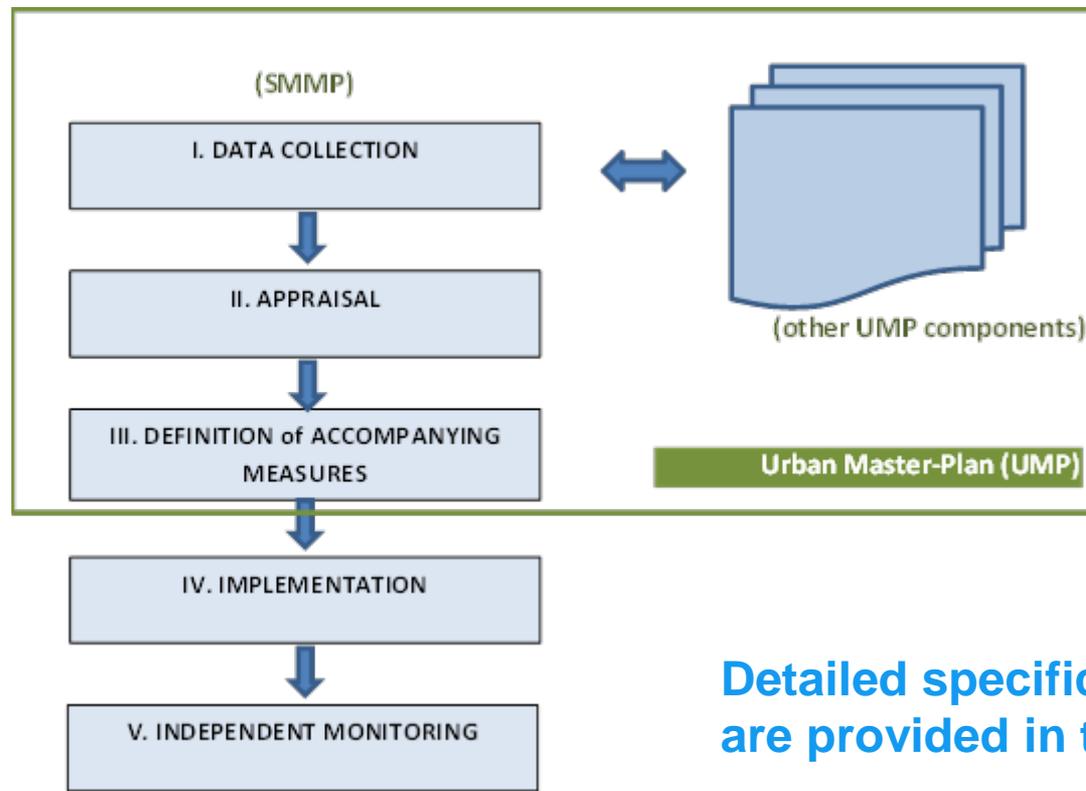
- Pilot projects in China:
    - International experiences have so far only led to pilot projects in China, but did not lead to general trends.
    - Pilots demonstrate that much scope for future improvements exists.
  - Institutional setup in China:
    - Optimization required, by installing clear “command structure”.
    - Wastewater treatment and sludge mgmt have to be considered as one.
  - Future of legal development in China:
    - Expect more changes of legal requirements for sludge disposal/ reuse.
    - Consider that direction of changes is not clear. International trends are quite diverse.
    - Public opinion and market forces will get increased relevance.
- ⇒ Expect the unexpected, and develop flexible solutions, permitting different options for sludge disposal / reuse.
- ⇒ The “one-fits-all-solution” for technical sludge routes does not exist.

## 4. Recommended Guideline for SMMP in Chinese City

- Principles for any SMMP (Sludge Management Master Plan):
  - A SMMP is an important aspect of city development.
  - City specific conditions must be taken into account, and the SMMP must be developed hand in hand with the Urban Master Plan (UMP).
  - Urban sewage sludge quality is a consequence of wastewater quality (strong impact of monitoring of industrial discharges!); sludge quality is thus influenced by quality mgmt of sewerage catchment.
  - Treatment technologies have only limited influence on sludge quality. Thus a SMMP cannot be reduced to a mere treatment technology issue, but has to be seen in a wider context.
  - SMMP has to be safe, flexible, cost-effective and sustainable.
  - SMMP should always be done as early as possible.

# Recommended Guideline for SMMP in Chinese City

Main steps of the recommended approach to the development of a SMMP for a city in China:



Detailed specifications for each step are provided in the Bank report.

# Thank you!



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