

World Bank's case in China

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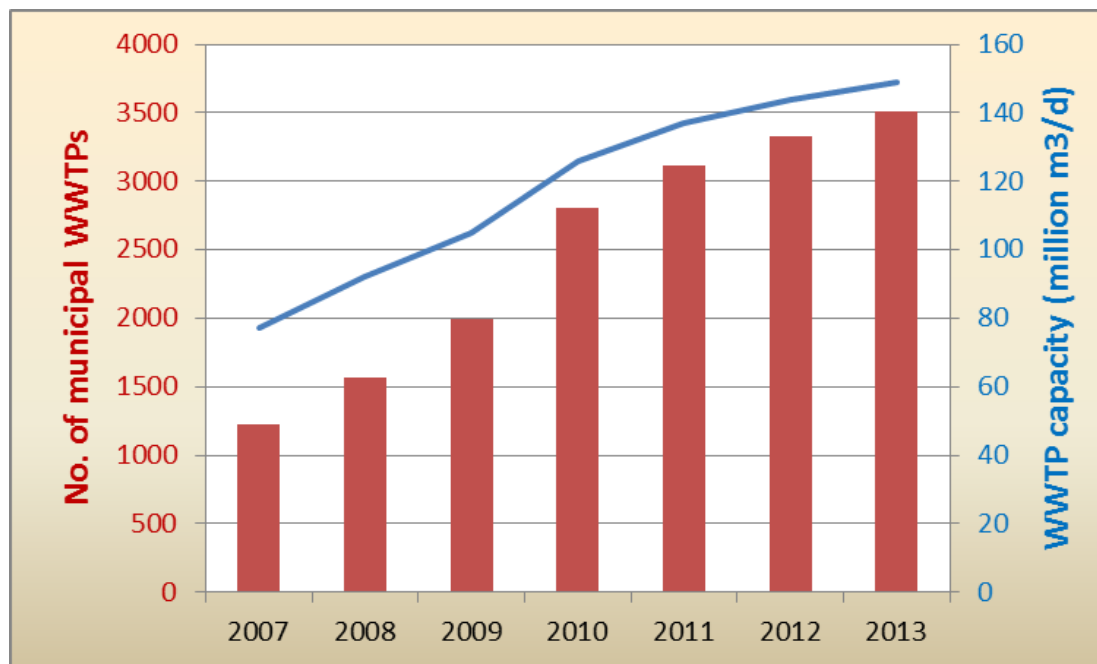
Water

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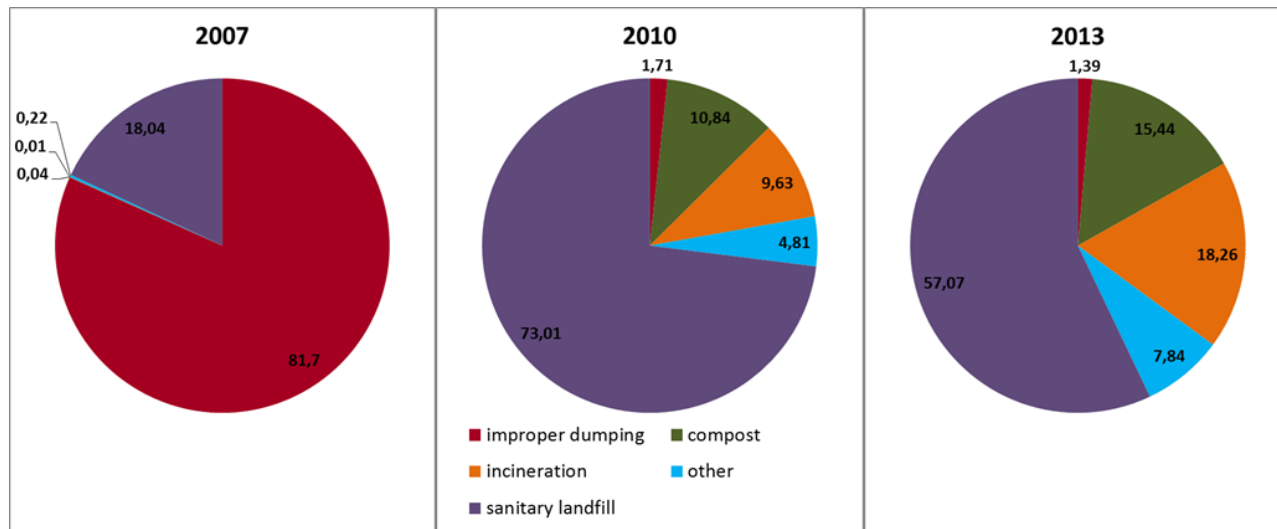
1. Background of urban sewage sludge mgmt in China

- 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**

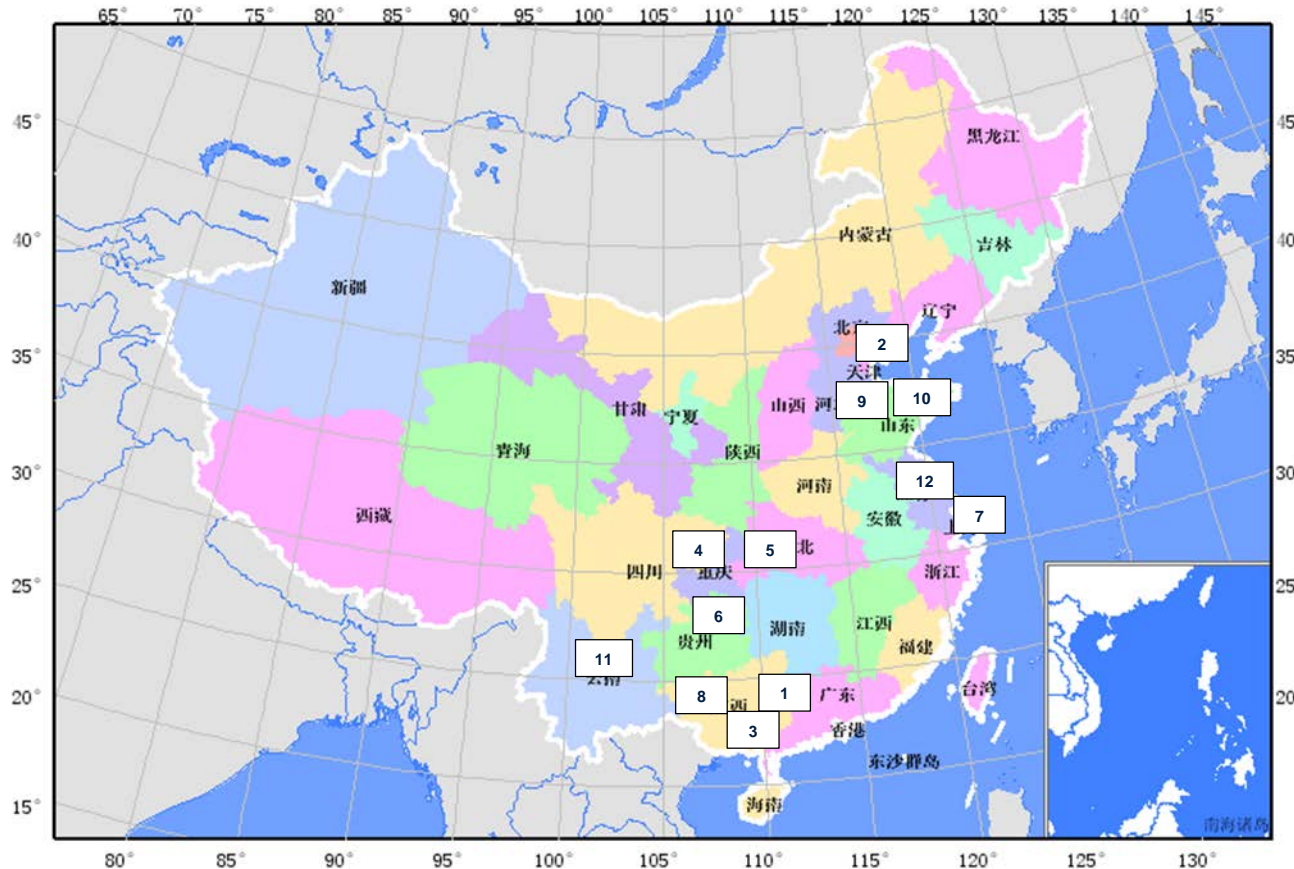
2. Survey of Bank/Non-Bank Projects in China

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

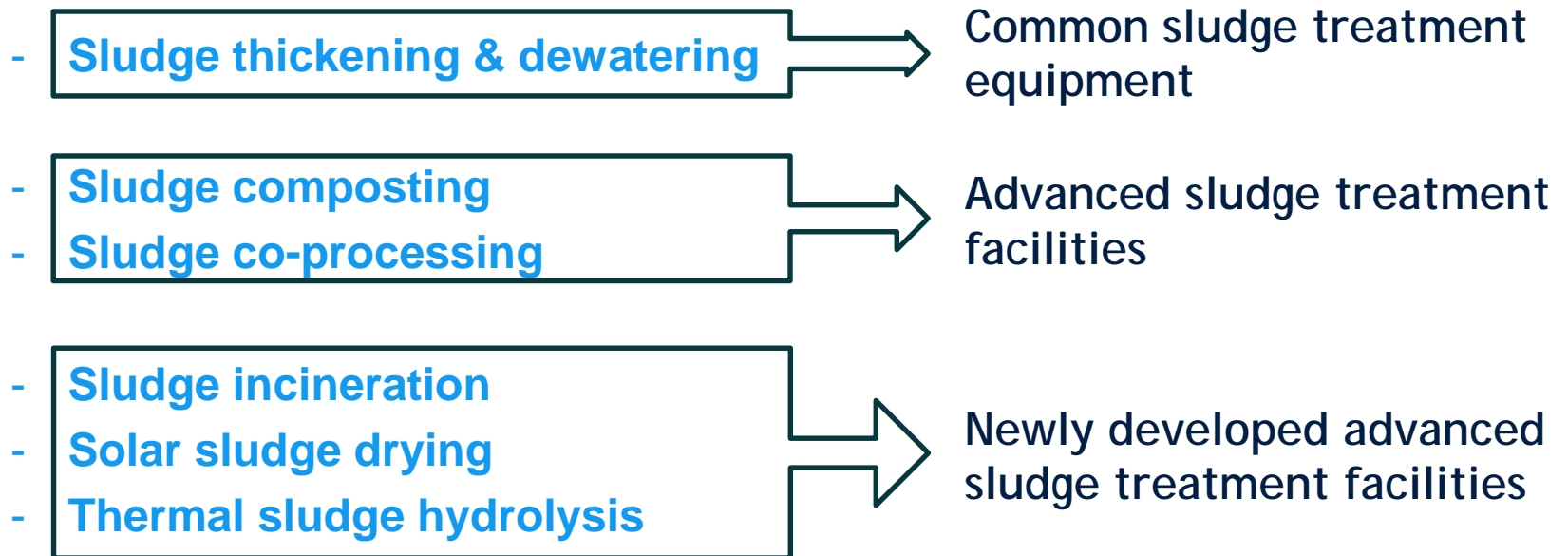


Location of visited sludge treatment facilities

Number	1	2	3	4	5	6
City	Guilin	Tinjian	Liuzhou	Chongqing	Chongqing	Zunyi
Number	7	8	9	10	11	12
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



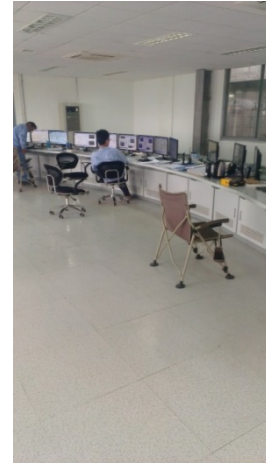
In-vessel composting



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 ≈ 15 million tons CO₂e/year).
- => Studies based on specific Chinese conditions usually include AD.**

International Trends and Best Practice in Sludge Mgmt

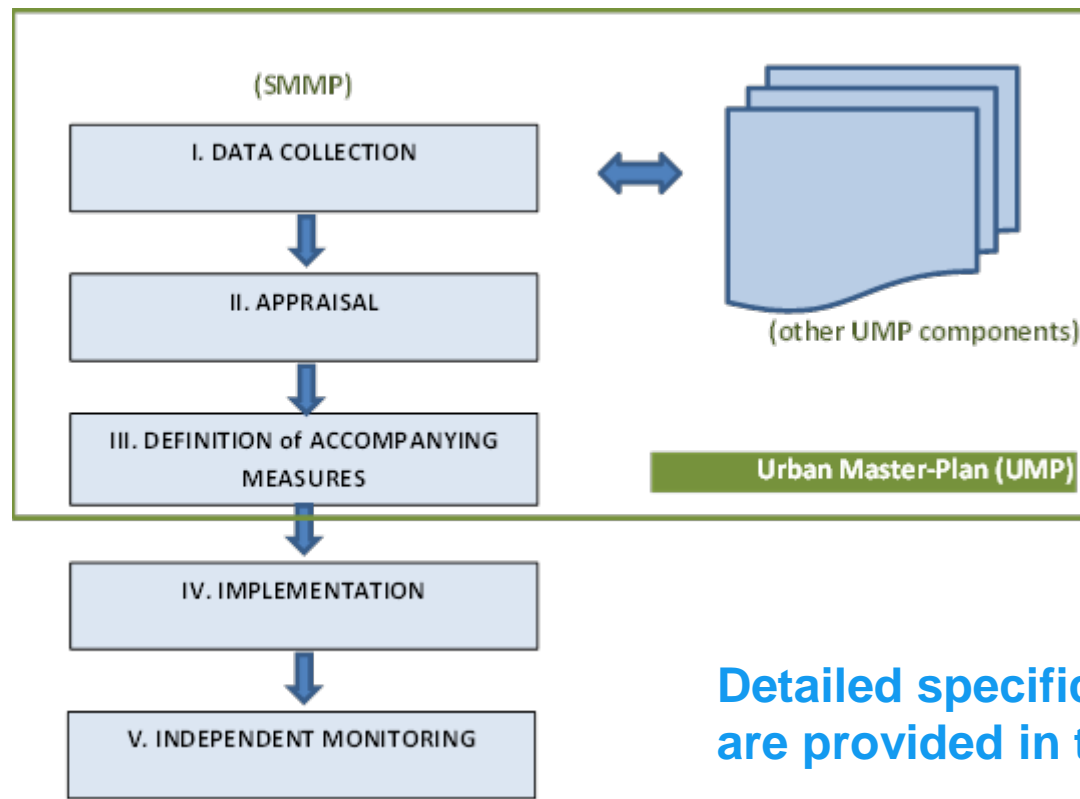
- Pilot projects in China:
 - International experiences have so far only led to pilot projects in China, but did not lead to general trends.
 - Pilots demonstrate that much scope for future improvements exists.
 - Institutional setup in China:
 - Optimization required, by installing clear “command structure”.
 - 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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