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DEWATS System with Upgrading Components for High Quality Community Wastewater Treatment

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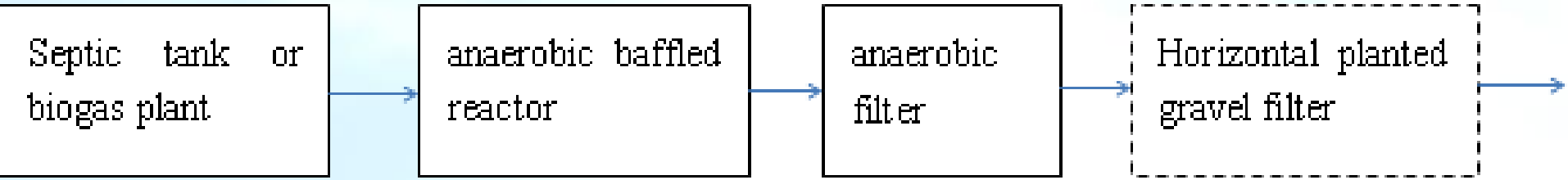
- Case study in Sichuan Province, China
- Opportunities and challenges for DEWATS in rural China
- Conclusions

Introduction

- Centralized wastewater treatment systems (CTS) have become a mainstream technology to treat urban wastewater. However, disadvantages:
  - A large-scale sewage treatment plant depends on an extended pipeline network (sewer).
  - These drainage network systems encounter economic, environmental, social and spatial difficulties for construction in rural and suburban areas.
  - The treatment process produces a lot of unstable and contaminated sludge, which is unsuitable for agricultural reuse, but requires a pollution-free disposal.

Introduction

- DEWATS is a combination of anaerobic and aerobic process units which is suitable for decentralized wastewater treatment and limited land space with its unpowered/low-powered character and low investment.

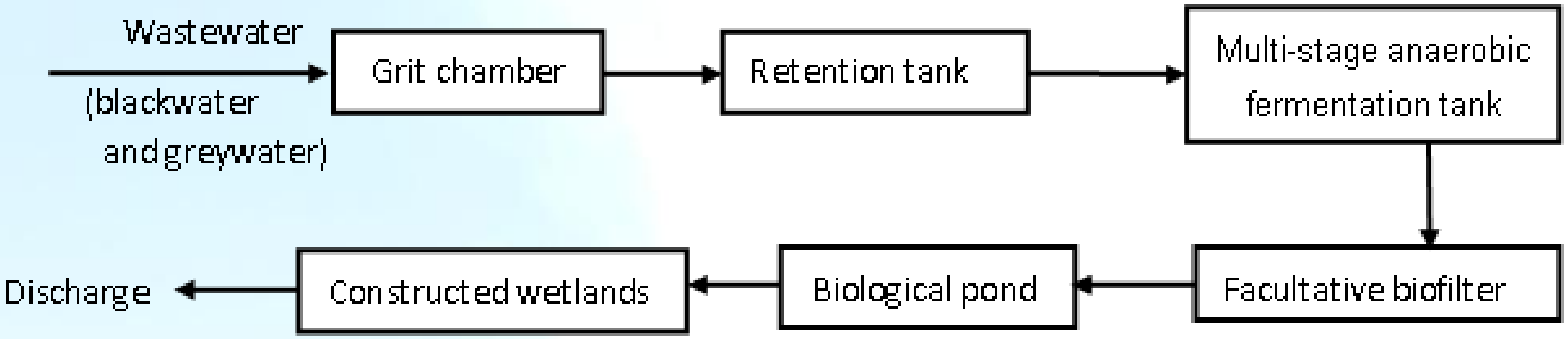


- With increasing discharge quality requirements, such system must be modified and improved in order that DEWATS system can be promoted reasonably in China.
- A case study was carried out in Sichuan Province, China.

Locations of 7 selected DEWATS

- ✓Sichuan Province already took the lead in the implementation of DEWATS.
- ✓7 typical DEWATS were chosen randomly.
- ✓A questionnaire was prepared for the field study.
- ✓Some effluent samples were taken, and later analysed in the laboratories.

Case 1


Wastewater
(blackwater
and greywater)
Grit chamber
Retention tank
Multi-stage anaerobic
fermentation tank
Facultative biofilter
Biological pond
Constructed wetlands
Discharge

Case 1

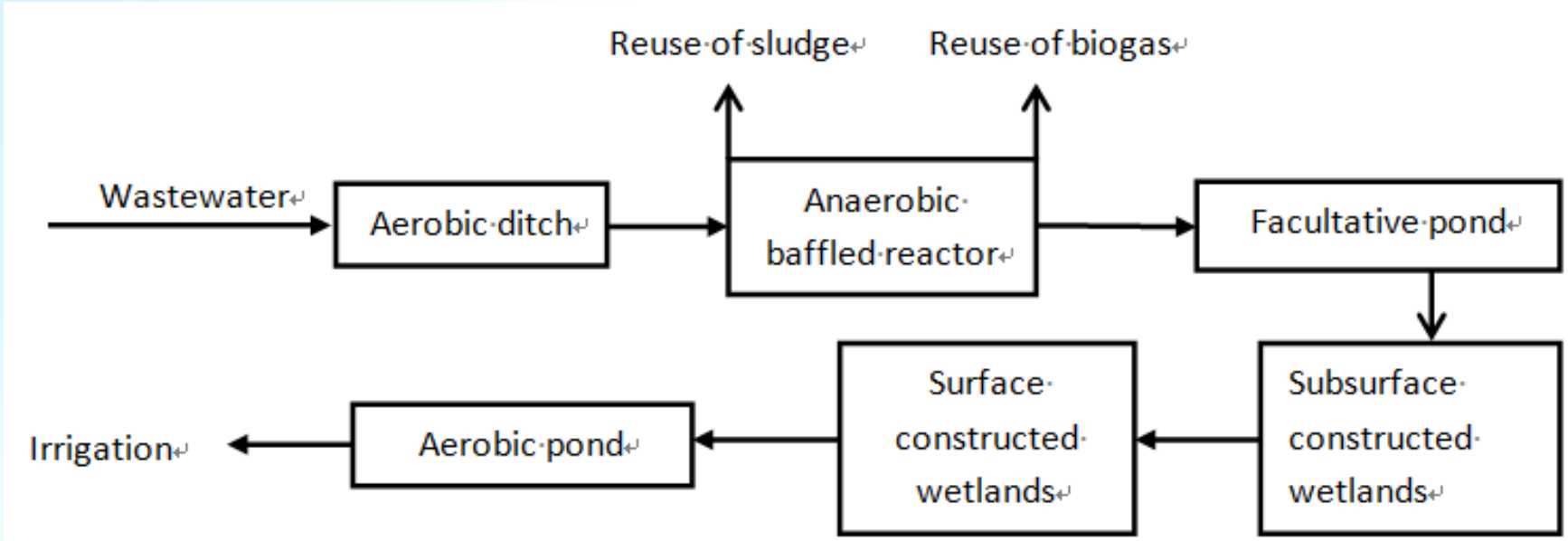
- Service type: domestic sewage
- Service population: 2000
- Discharge of effluent: river
- Problems & recommendations:
  - Absent of reuse of biogas, sludge and effluent
  - Total Phosphor (TP) concentration of effluent was a little higher compared to the level 1A of Discharge Standard of Pollutants for Municipal Wastewater Treatment Plant (GB 18918-2002)
  - As this DEWATS is located in a geological hazard-prone area, emergency situations such as flood and debris flow should be paid more attention to.

Case 2

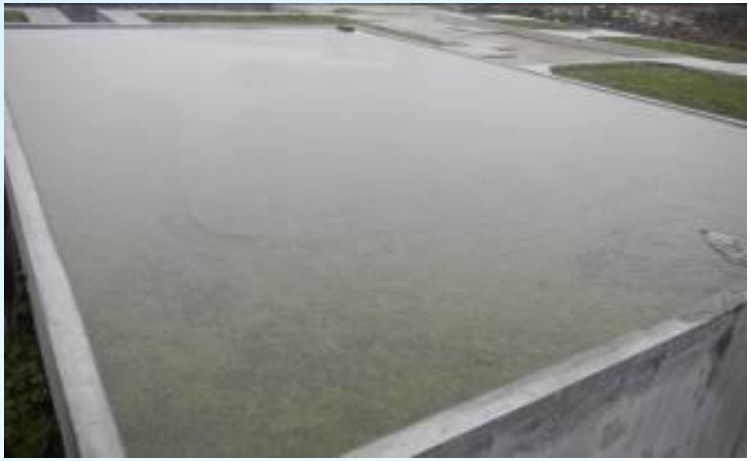
State: under construction

Service population: 3000-5000

Feature: The CW system includes 2 surface CW and 4 subsurface CW. This DEWATS will be finally landscaped like a park.



Case 2

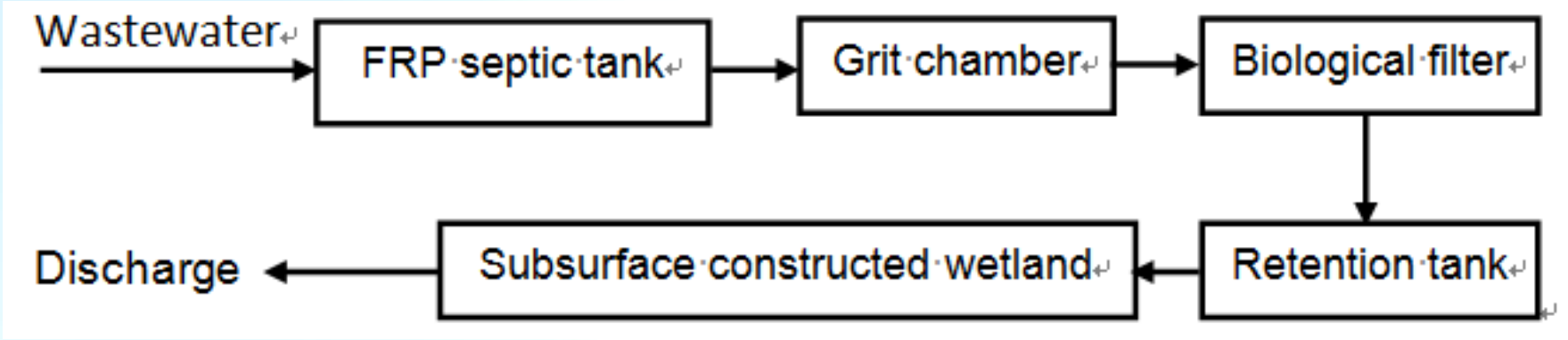


Case 3

Service type: school sewage

Service population: 1800

Feature: Key elements of this DEWATS are a biological filter and a constructed wetland with subsurface flow.



Case 3

Case 3

- Problems & recommendations:
  - No maintenance had obviously been carried out since it started when observing
  - Not yet any reuse of sludge and treated wastewater.
  - Odour took place
  - Reuse of effluent is strongly suggested

Case 4

Case 5

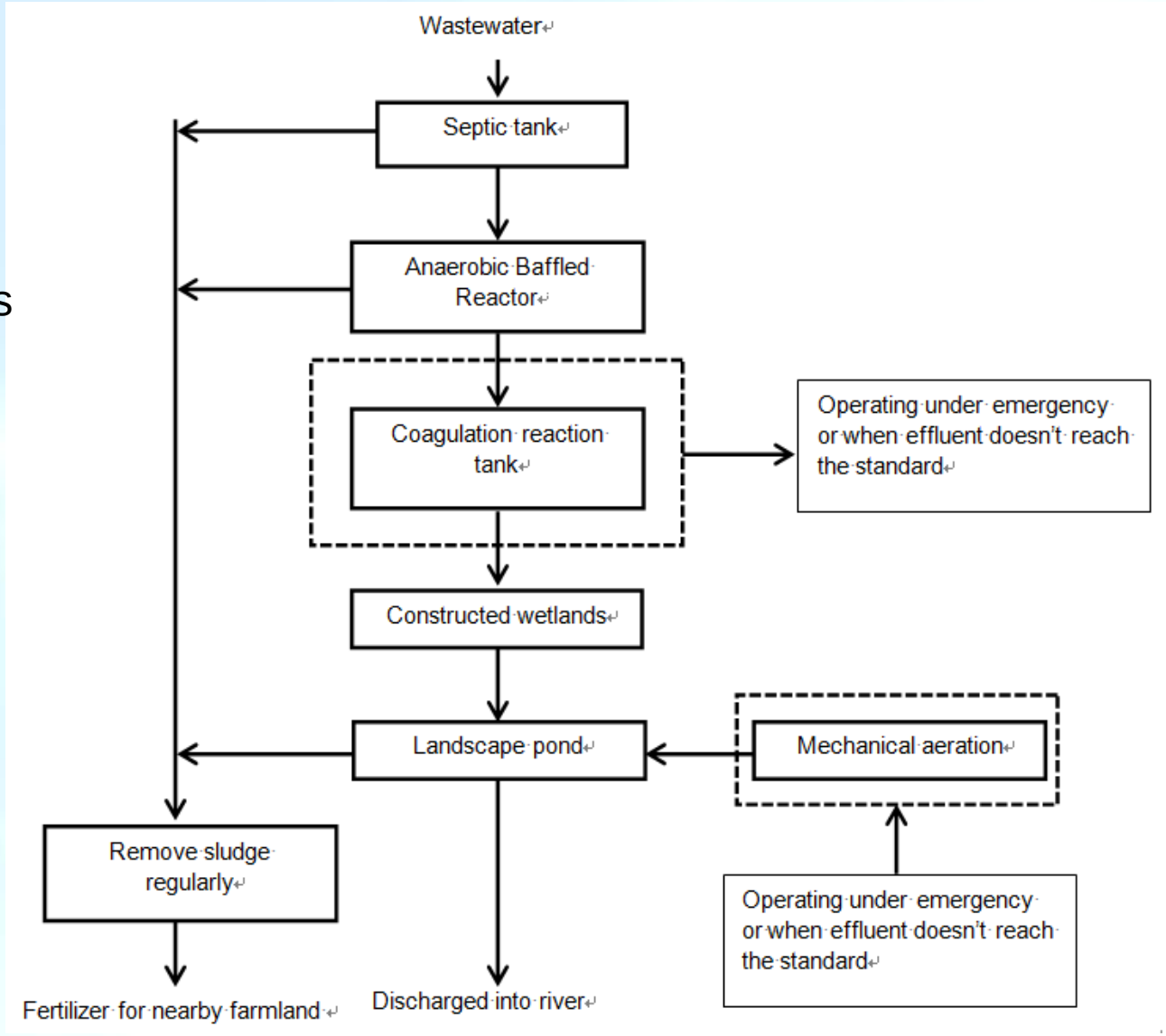
Case 4 & Case 5

- Problems & recommendations
  - For case 4, there was no surface effluent at all. For case 5, we could intuitively see that water quality was poor.
  - The effluent was beyond the discharge standard.
  - Treatment configuration was insufficient.
  - Most of local farmers have no awareness of water saving. They have no idea of DEWATS.
  - Local government and related departments should fulfil their responsibility of popularizing know-how about environment and sanitation.

Case 6

Service population: 147 households

Feature: The community was reconstructed after the earthquake. The DEWATS process applied in this case is a more sophisticated than in other DEWATS. The CW combines mini CW and mini pond, placing several mini CWs close to several mini ponds. Each mini CW is about 10m length*1m width*0.5m depth.



Case 6

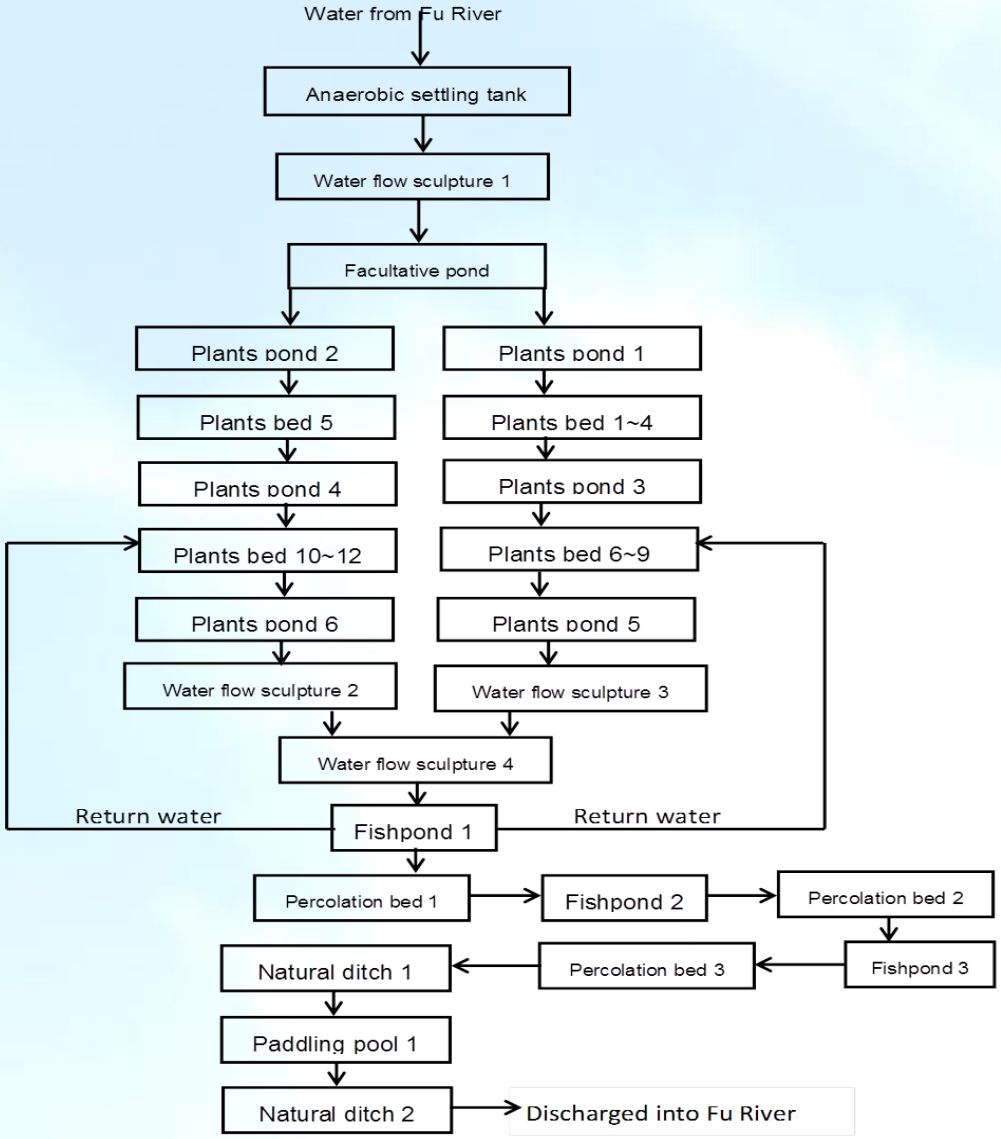
Case 6

- Problems & recommendations
  - The system emitted odour, mainly from the effluent of the anaerobic baffled tank. The plants on the surface testify a short operation period.
  - The quality was obviously not as good as could have been expected
  - Farmers want to be paid because in their opinion, they are treated as test-person and their farmland will “suffer” a lot from organic fertilizer use.
  - Know-how about organic fertilizer needs to be disseminated strongly.

Case 7

The system is located in a park. The park received the UN Habitat Scroll of Honour Award in 1998; it has been selected and exhibited in Shanghai Expo as “Urban Best Practices”. It is the first urban environmental park of the world which is based on water. The theme of the park is “natural ecology”. So the designer implemented water elements into each zone. From bird’s eye view the park looks like a fish: the fish’s eye is the anaerobic settling pond. The core of this DEWATS is a CW, which consists of 6 deep plant ponds and 12 shallow plant beds. The incoming water is taken from the river nearby. The park only displays the process of wastewater treatment to the public instead of reusing any effluent. Therefore demonstration purpose is far more important than its practical function.

Case 7


Water from Fu River
Anaerobic settling tank
Water flow sculpture 1
Facultative pond
Plants pond 2
Plants pond 1
Plants bed 5
Plants bed 1~4
Plants pond 4
Plants pond 3
Plants bed 10~12
Plants bed 6~9
Plants pond 6
Plants pond 5
Water flow sculpture 2
Water flow sculpture 3
Water flow sculpture 4
Return water
Fishpond 1
Return water
Percolation bed 1
Fishpond 2
Percolation bed 2
Natural ditch 1
Percolation bed 3
Fishpond 3
Paddling pool 1
Natural ditch 2
Discharged into Fu River

Case 7

Samples analysis

Effluent sample (from left to right: Case 1, Case 3, Case 6, Case 5, Case 7)

	Temperature (°C)	pH	CODcr (mg/L)	BOD_5 (mg/L)	TP (mg/L)	NH_3-N (mg/L)
Case 1	17.8	8.77	34.8	12	1.5	2.9
Case 3	20.9	8.36	20.5	9	2.9	11.9
Case 5	22.4	8.67	96	38	15.1	105.2
Case 6	20.0	8.12	48.3	19	4.8	104.4
Case 7	21.1	8.21	10.4	5	0.4	1.5

Opportunities for DEWATS

MDGs

- Approx. 9 billion tons domestic wastewater discharged annually in rural China
- 90.84 million people suffer from contaminated water sources in rural China

Merits of DEWATS

- -Low investment
- -Low operating costs
- -Energy savings
- -Land saving
- -Energy recovery
- -Limited sludge
- -Removal of parasitic ovum and pathogens

Opportunities for DEWATS

Water Pollution and Infrastructure Deficiency

- Ca.96% of villages are absent of drainage and wastewater treatment system
- Coverage of wastewater treatment at township level only reaches 19.4%
- Only septic tank or biogas digester is built

Government Support and Policy Drive

- 2000, Technical Policy on Municipal Wastewater Treatment and Pollution Prevention
- 2007, Opinions on Strengthening Rural Environmental Protection Work
- 2010, Guideline on Rural Domestic Wastewater Treatment

Reuse Demand

- 80 million rural people face the deficit of drinking water
- Annual agricultural water-shortage gap reaches up to more than 30 billion m^3
- 60% of cultivated land is lack of irrigation water

Challenges for DEWATS

Conceptual Transformation

- Public acceptance of DEWATS is an important issue
- Local farmers prefer chemical fertilizer instead of organic fertilizer.
- Famers hope to be paid if they use the “waste sludge” from DEWATS

Fund Shortage

- The urban and rural dual structure renders the unbalanced investment
- There is a general helplessness when it comes to individual implementation
- It is not easy to take in social funds for rural areas and financing channel is single

Challenges for DEWATS

Reuse Issues

- The nitrogen and phosphorus resources and biogas are not always recovered and well utilized
- Landscape or irrigation utilization for qualified effluent
- Sludge for organic fertilizer production

Uncertain effluent quality

- Big fluctuation of inflow
- Neglect denitrification and dephosphorization
- Short of approved regulations and standards

Follow-up Service and Management

- There is no specification for project completion acceptance
- Short of follow-up service
- Implementation of DEWATS must experience a series of examinations and approvals

Conclusions 1/4

- Economic aspects
  - Operation cost of conventional WWTP is about 0.8-1.0 CNY/ton, thus far above the DEWATS operation cost.
  - The cost of DEWATS normally comes from labour cost.
  - There is no doubt that DEWATS are economically feasible.

	Case 1	Case 2	Case 3	Case6
Water volume (ton)	400	500	250	70
Investment (CNY)	600,000	800,000	500,000	1,090,000
Operation cost (CNY/ton)	Less than 0.2	Less than 0.2	Less than 0.2	0.38

Conclusions 2/4

- **Technical aspects**
  - In many cases, a standard septic tank (prefabricated FRP septic tank) is used as primary treatment unit for collecting wastewater and a subsurface CW is used as final treatment unit.
  - Familiarity with the design principles apart, a mastery of structural details will be crucial to the proper functioning of the plant.
  - The core of DEWATS should be a CW. Technical issues about CW should be paid more attention.
  - Reuse of biogas is neglected by contractors. Biogas collection and storage structure need to be improved; gas tight would be a key technical issue at present (climate protection!).

Conclusions 3/4

- Social aspects
  - Public acceptance of DEWATS: farmers prefer chemical fertilizer instead of organic fertilizer. They hope to be paid if they use the “waste sludge” from DEWATS.
  - DEWATS could be an ideal material to educate students.
  - Money is often not the biggest problem, at least for pilot or demonstration projects. However, there is a general helplessness when it comes to individual implementation, and more so when it comes to active and well organized dissemination of DEWATS.

Conclusions 4/4

- **Opportunities for DEWATS**
  - Millennium Development Goals (MDGs)
  - Intrinsic Merit of DEWATS
  - Water Pollution and Infrastructure Deficiency
  - Government Support and Policy Drive
  - Reuse Demand
- **Challenges for DEWATS**
  - Conceptual Transformation
  - Fund Shortage
  - Reuse Issues
  - Uncertain effluent quality
  - Follow-up Service and Management

Thank You Very Much for Your Attention!

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