Faecal Sludge Dewatering: New Research Facilities for a Multi-Directional Approach

Dr. Linda Strande

Sandec: Sanitation, Water and Solid Waste for Development

B.J. Ward, Nienke Andriessen, Moritz Gold, Eberhard Morgenroth, Richard Kimwaga

Eawag: Das Wasserforschungsinstitut des ETH-Bereichs

February 2017, Chennai, India

Motivation: Faecal sludge dewatering

- Onsite sanitation serves 40% of global population
- Faecal sludge is > 90% water
- Dewatering required for resource recovery

High transport costs

Large treatment footprint

FSM4

eawag aquatic research

UDSM, Tanzania

EMPIRICAL RESEARCH
WHAT?

eawag aquatic research

FUNDAMENTAL RESEARCH
WHY?

Sandec
Water and Sanitation in Developing Countries

MEWS
RESEARCH STRATEGY

APPLIED RESEARCH
HOW?

HEKIMA NI UHURU

RESEARCH INTO ACTION

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Sandec/Eawag, Switzerland

Building on Previous Research

Applied and empirical studies justify deep-dive into fundamentals

- Fresh, unstabilized faecal sludge does not dewater as well
- Onsite sanitation technology influences dewaterability
- Mechanical and mobile dewatering require conditioners, dose changes with every batch of sludge

We have questions that only **controlled, fundamental** studies can answer.
Dewatering can only be **optimized** after **understanding mechanisms**.

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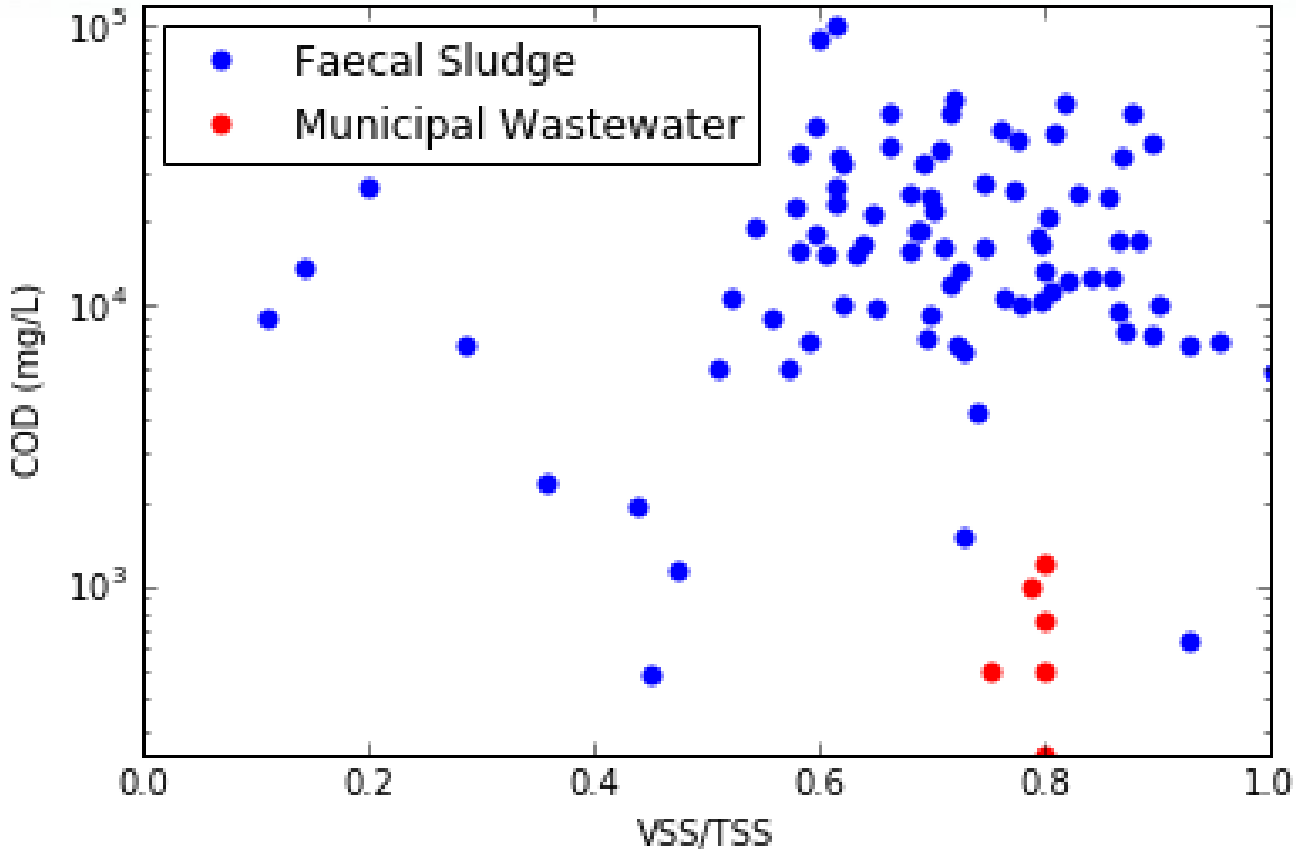
Faecal Sludge vs. Wastewater



Faecal sludge is **extremely variable** in concentration and stabilization.
Wastewater knowledge is **not directly transferable.**

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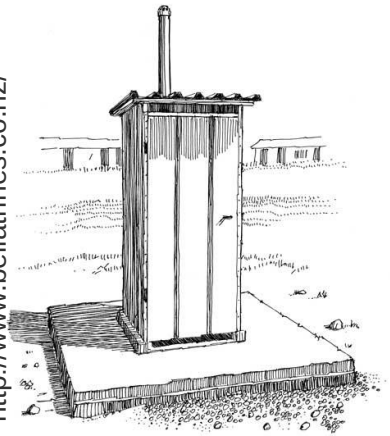
Macroscopic Observations

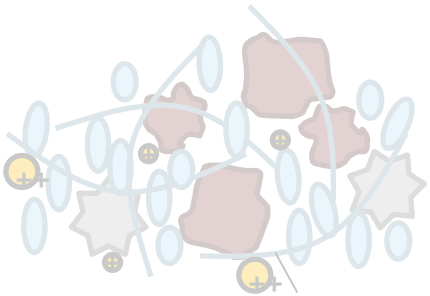


http://www.bellatrines.co.nz/

Faecal Sludge Characteristics

Janicki Bioenergy

Microscopic, Mechanistic Behaviors



Settling and Dewatering Performance

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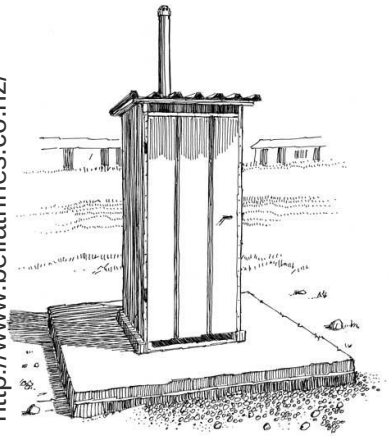
Macroscopic Observations

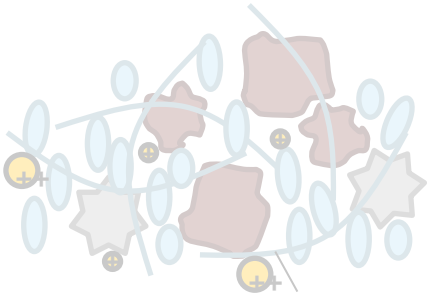


- Onsite technology
- Climate
- Water table
- Sanitary practices/usage
- Emptying frequency

Faecal Sludge Characteristics

- Sand content
- Water content
- Ionic strength / pH
- Stability
- Microbial community (EPS)

Microscopic, Mechanistic Behaviors



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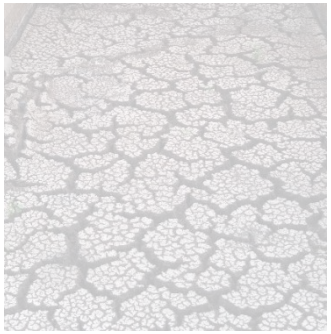

Ongoing MEWS research

- Schoebitz, L., et al. (in process)
- Bassan, M., et al. (in process)

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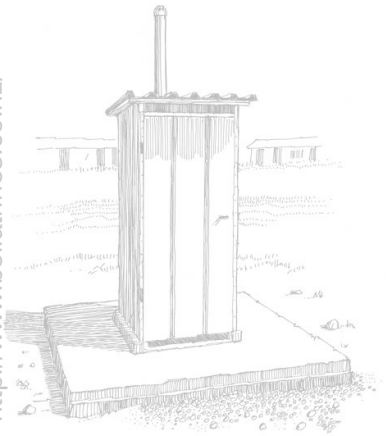
Macroscopic Observations



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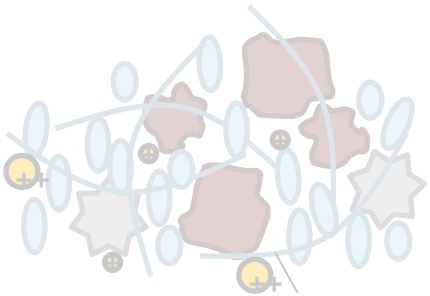

Settling and Dewatering Performance

- Dewatering rate
- Final cake solids
- Conditioner demand

Ongoing MEWS research

- Gold et al. (in process) Cross-country analysis of faecal sludge dewatering.

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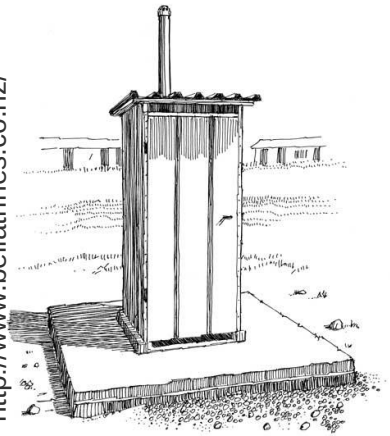
Macroscopic Observations



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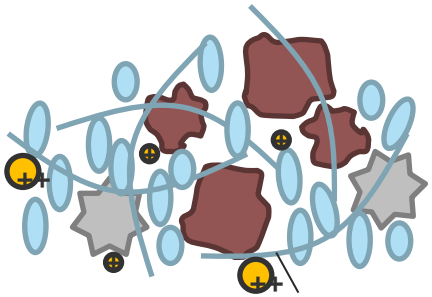

- Degree and strength of flocculation
- Particle size distribution
- Water-binding affinity
- Compressibility

Settling and dewatering performance

- Dewatering rate
- Final cake solids
- Conditioner demand

Fundamental research must be conducted to understand link between faecal sludge characteristics and dewatering performance

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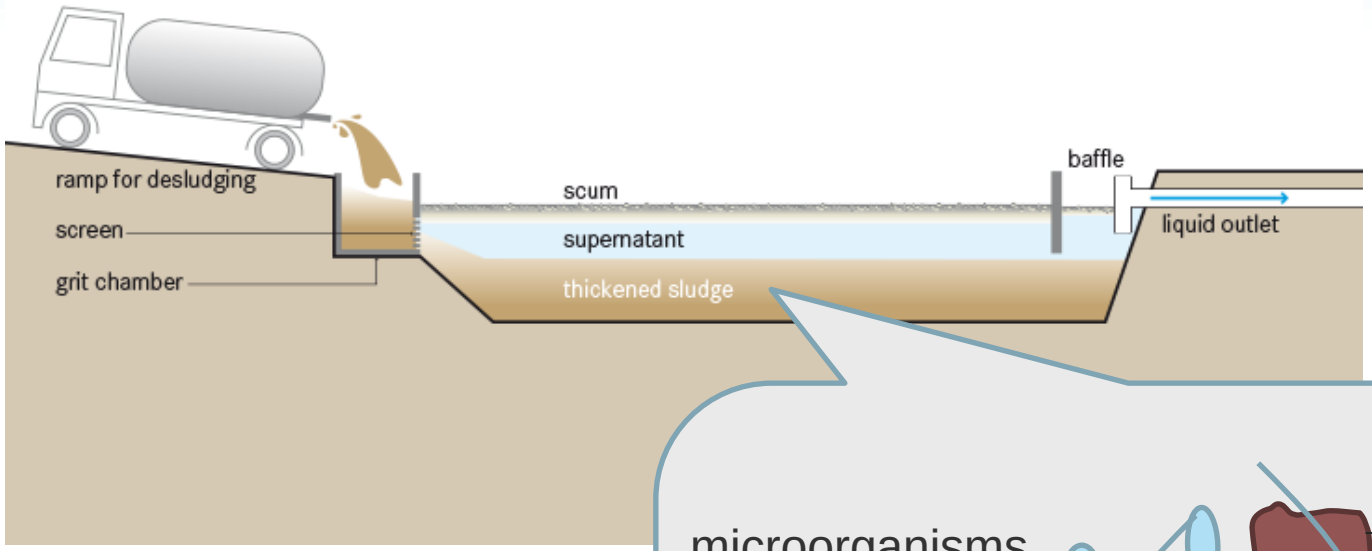
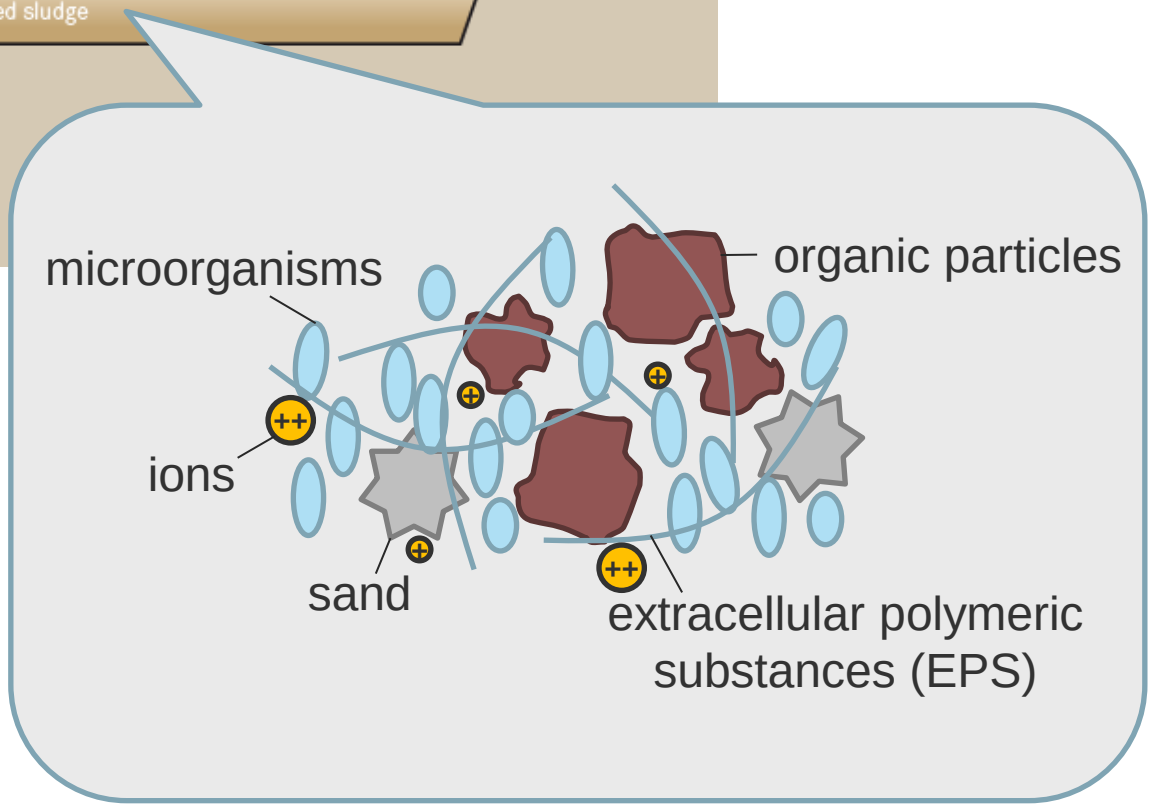
Research Questions

- Which physical, chemical, and biological characteristics govern solid-liquid separation in faecal sludge?
- Can settling and dewatering performance be predicted by physical/chemical indicators?
- How can faecal sludge settling and dewatering be optimized?

Fundamentals of Solid-Liquid Separation





Dewatering performance?

- EPS
- Ionic strength/pH
- Concentration
- Sand content

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Research Facilities

WaterHub at NEST, Eawag

- Fully source-separated wastewater
  - urine, blackwater, heavy greywater, light greywater, and rainwater
- Blackwater for faecal sludge research
- Expected 1000 L/day of blackwater by 2020

NEST building at Eawag

Separated wastewater streams entering NEST Water Hub laboratory

Research Facilities

WaterHub at NEST, Eawag

- Aquatron technology for initial solid-liquid separation
- Dewatering in collaboration with Bucher
- Base for fundamental dewatering research

Aquatron solid-liquid separator

Bucher Unipektin laboratory-scale filter press

Research Facilities

FS dewatering facility at University of Dar es Salaam

- UDSM facility video

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Research Facilities

FS dewatering facility at University of Dar es Salaam

- Chitosan and moringa conditioners with drying beds and geotextiles
- Quantification and characterization

Conditioner mixing tank

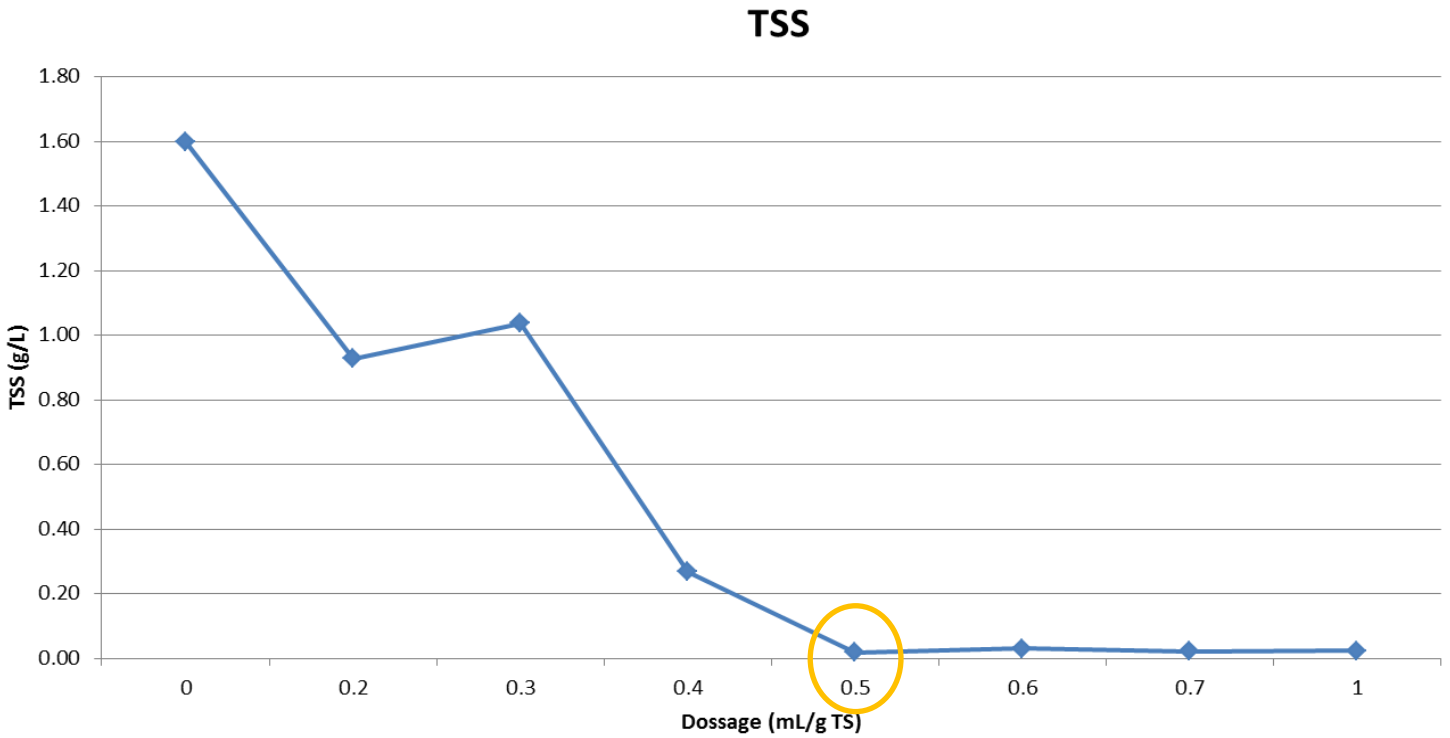
Sludge on drying bed

Vacuum trucks at Vingunguti stabilization ponds

Preliminary Results

Dewatering with local conditioners

- Chitosan and Moringa
- Jar tests for dosage and pilot scale testing for scaling up



Preliminary results dosage:
0.5 mL Chitosan solution / g TS

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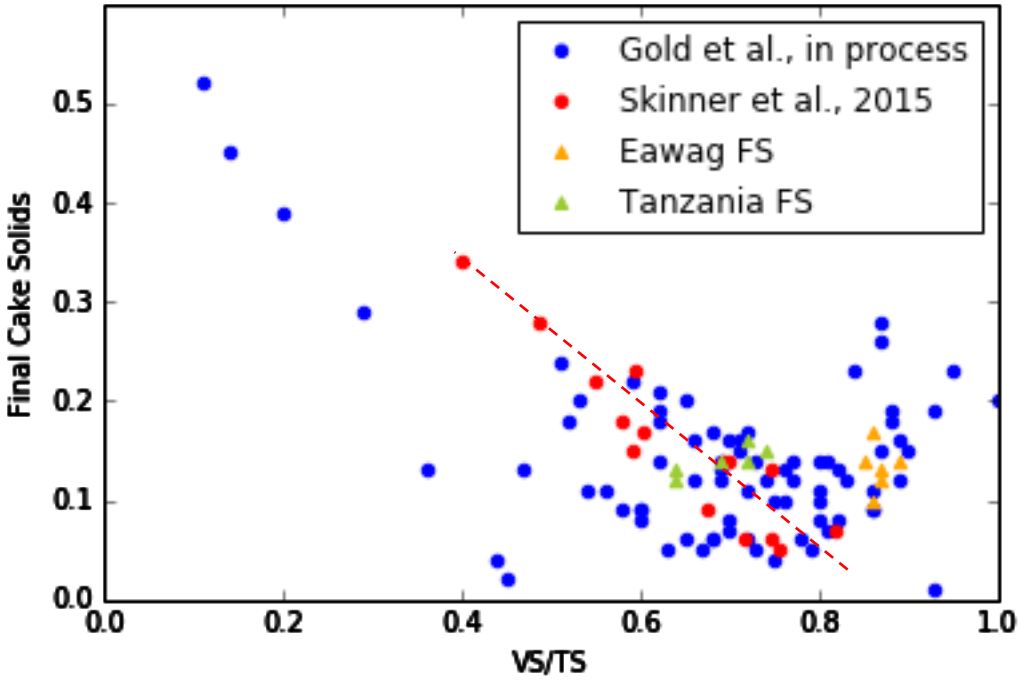
Preliminary Results

Factors influencing dewatering performance



- Faecal sludge dewatering does not follow same dewatering models as WW
- Further investigation is needed to explain faecal sludge dewatering behavior

Skinner, S. J., et al. (2015). Quantification of wastewater sludge dewatering. *Water research*, *82*, 2-13.
Gold, M., et al. (in process), Cross-country analysis of faecal sludge dewatering.

Future Plans: Holistic predictive model

FS characteristics

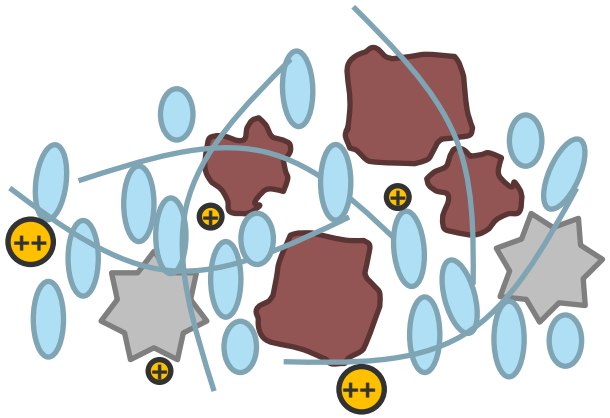
- Age/stability
- Microbial community
- EPS
- Ionic strength/pH
- Concentration
- Sand content

Predictive Model

based on fundamental principles and observed trends

Recommended dewatering technology

Appropriate conditioner dose



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Research Team
MEWS and UDSM

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www.sandec.ch/fsm_tools

FSM4

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Massive Open Online Course "Introduction to Faecal Sludge Management"

Language: English
Subtitles: French, Spanish and English
Costs: FREE

www.coursera.org/learn/faecalsludge

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coursera

Start: 1st of May 2017