Waste water management and environmental concerns in cold climate

Pernille Erland Jensen,
Department of Civil Engineering
Technical University of Denmark (DTU)
pej@byg.dtu.dk
What is waste water?

- Toilet waste
- Kitchen drain
- Bath drain
- Laundry
- Industrial wastewaters
- Rain water

Domestic waste water

- Black water
- Grey water

Combined sewers
What does wastewater contain?

- Color, Odor
- Particles
- Organic matter
- Grease
- Microorganisms

- Heavy metals
- Chemicals
- Personal care products
- Medical residues
- Micro plastics
- Nano-materials
- ...
<table>
<thead>
<tr>
<th>Treatment level</th>
<th>Method</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary</td>
<td>Screening</td>
<td>Large particles removal</td>
</tr>
<tr>
<td>Primary</td>
<td>Screening and/or sedimentation</td>
<td>Smaller particles removal, sand, fraction of OM incl. some P, fraction of HM's and other compounds bound to OM.</td>
</tr>
<tr>
<td>Secondary</td>
<td>Chemical and/or biological treatment (e.g. flocculation/biological conversion and sedimentation)</td>
<td>Smaller biodegradable organics and suspended solids. Disinfection effect.</td>
</tr>
<tr>
<td>Tertiary</td>
<td>Biological treatment and or chemical (e.g. precipitation of nutrients with Fe and Al salts, fluctuating oxygen /anaerobic)</td>
<td>High level nutrient removal. Disinfection effect.</td>
</tr>
<tr>
<td>Advanced</td>
<td>Various additions</td>
<td>Depending on need</td>
</tr>
</tbody>
</table>
Present management of waste water the North

Wastewater lagoons
Primary/secondary
(photo: Lisbeth Truelstrup Hansen)

Mechanical plants – primary/secondary
(photo: Kenneth Johnson)

Secondary treatment for towns
> 20.000 persons
Smaller places no treatment

Incomplete wwtp in Iqaluit (2004)

No treatment

Primary treatment
Wastewater in Greenland

In 2005 a report concluded that no harm to the environment was to be expected from current practise. *

BUT the report also clearly states:
Only nutrients are considered, not e.g. pathogens, heavy metals or anthropogenic compounds.
The evaluation anticipates that the outlet is in open water and not closed Fjords.

Wastewater in Greenland

New legislation requires municipalities to make environmental impact assessment of recipients and implement treatment of wastewater if impacts are observed. **

Water quality criteria set for wastewater from mineral extraction projects.***

**Selvstyrets bekendtgørelse nr. 10 af 12. juni 2015 om bortskaffelse af latrin og spildevand:
Observed environmental effects (no treatment)

- Floating items on surface
- Eutrophication and dead bottom of bay
- Ecosystem disturbance
- Heavy metal accumulation in sediments
- Antibiotic resistance
Observed environmental effects:
Visibility
Ecosystem disturbance

Fig. 6. Population cost as % affected individuals measured as mortality ± standard deviation after 7 days of exposure to unknown contaminant, dimethoate (150 µM) (A) tested in May and (B) tested in August and to salinity (C) tested in August (%). Letters above each bar refers to the statistics where different letters indicate significant differences (p < 0.05, Kruskal–Wallis test) between sites.

Elevated concentrations of heavy metals and anthropogenic compounds
Elevated concentrations of heavy metals and anthropogenic compounds
Ecosystem disturbance

Fig. 6. *Orchomenella pinguis*. Gender and intersex distribution for the Harbor, Hospital and North Bay samples.

Fig. 4. *Orchomenella pinguis*. Percentage of females within each site carrying broods with aberrations (see Fig. 3). The degree of aberrations is indexed within each brood into >2–5%, >5–20%, >20–50% and >50–100% embryo aberrations per female.

Sediment bacterial community impact
Sediment bacterial community impact

- There is a difference in resistance patterns between unexposed and exposed areas.
- Ciprofloxacin, Tetracyclin and Macrolide resistance is only found near the sewage outlet.
- β-lactam resistance is found everywhere as is one type of aminoglycoside resistance.
- Sediment bacterial community function at the sewage outlet shows signs of eutrophication impact.
- Bacterial abundance is severely reduced in guts of marine organisms living in the vicinity of the sewage outlet.
- Resistance patterns are replicated at different trophic levels along the exposure gradient.